Appendix C
Pre-Design Investigation Work Plan

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

Pre-Design Investigation Work Plan for the Lower Duwamish Waterway – Middle Reach

Final

For submittal to

The Lower Duwamish Waterway Group
Seattle, WA

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FINAL

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ABBREVIATIONS

AOC	Administrative Order on Consent
AOC3	Third Amendment to the Administrative Order on Consent
AOC5	Fifth Amendment to the Administrative Order on Consent
BaP	benzo(a)pyrene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CQAP	construction quality assurance plan
CSCSL	Confirmed and Suspected Contaminated Sites List
DER	data evaluation report
DMMP	Dredged Material Management Program
DMMU	dredged material management unit
DQO	data quality objective
dw	dry weight
EAA	early action area
Ecology	Washington State Department of Ecology
EF	exceedance factor
ENR	enhanced natural recovery
EPA	U.S. Environmental Protection Agency
ESD	explanation of significant differences
FNC	federal navigation channel
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
ICS	Industrial Container Services
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LTMMP	Long-Term Maintenance and Monitoring Plan
MLLW	mean lower low water
MNR	monitored natural recovery
MTCA	Model Toxics Control Act
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCUL	preliminary cleanup level
PDI	Pre-Design Investigation
PDIWP	Pre-Design Investigation Work Plan

QAPP	Quality Assurance Project Plan
RAL	remedial action level
RD	remedial design
RDWP	Remedial Design Work Plan
RI/FS	Remedial Investigation/Feasibility Study
RM	river mile
ROD	Record of Decision
SCO	sediment cleanup objective
SVOC	semivolatile organic compound
TEQ	toxic equivalent
USACE	U.S. Army Corps of Engineers
VOC	volatile organic compound
WQMP	water quality monitoring plan

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1 Introduction

This work plan presents the approach for the Pre-Design Investigation (PDI) of the middle reach of the Lower Duwamish Waterway (LDW) to address the scope outlined in the Fifth Amendment to the Administrative Order on Consent (AOC5) for the LDW (EPA 2021a).[1] This investigation is being conducted as an integral part of the RD of the middle reach (RM 1.6 to RM 3.0), as described in the Remedial Design Work Plan (RDWP) to which this work plan is an appendix.

In 2000, the City of Seattle, King County, Port of Seattle, and The Boeing Company, working collectively as the Lower Duwamish Waterway Group (LDWG), agreed in an Administrative Order on Consent (AOC) to conduct a Remedial Investigation/Feasibility Study (RI/FS) for the LDW, with oversight by the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology). In September 2001, the LDW was formally listed as a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) site; in February 2002, the LDW was formally added to the National Priorities List as a Washington Model Toxics Control Act (MTCA) site. The RI was completed in 2010 (Windward 2010) and the FS was completed in 2012 (AECOM 2012a). A Record of Decision (ROD) was issued by EPA in 2014 (EPA 2014b).

1.1 Pre-Design Investigation Work Plan Objectives

The primary objective of this Pre-Design Investigation Work Plan (PDIWP) is to describe the process to be used to collect data needed to support detailed engineering designs for the selected remedy for the middle reach of the LDW, as set forth in the ROD (EPA 2014b) and AOC5 (EPA 2018). Consistent with Section 6.4 of the AOC5 statement of work, this PDIWP includes an evaluation and summary of existing data and data gaps; a strategy for timely characterization, testing, and data gathering; a conceptual design sampling plan including clearly stated rationales; and a schedule.

The objective of the PDI is to address data needs through field investigations for completion of the middle reach RD. There will be two phases of the PDI, each including a field sampling event and a data evaluation report (Figure 3-1 in the RDWP). The data obtained through field sampling in PDI Phases I and II will be used to develop the 30% RD. If, after completion of PDI

[1] The Fourth Amendment to the Administrative Order on Consent involves the remedial design (RD) for the upper reach of the LDW (river mile [RM] 3.0 to RM 5.0).

Phases I and II, data gaps[2] remain to complete the RD, these will be filled by a third PDI phase; these data would be incorporated into 90% RD.

1.2 Work Plan Organization

This PDIWP is organized into six sections, including this introduction. Section 2 presents a PDI strategy, Section 3 provides an existing data evaluation, and Section 4 presents a phased conceptual design sampling plan. The schedule and deliverables for the PDI tasks are presented in Section 5, and references are provided in Section 6.

This PDIWP has nine attachments. Attachment A contains a brief summary of monitoring data from within the Boeing Plant 2 and Slip 4 early action areas (EAAs) in the middle reach and perimeter monitoring data for Boeing Plant 2. Attachment B contains the Survey Quality Assurance Project Plan (QAPP) and results of the 2021 bathymetry survey. Attachment C provides recovery category recommendations based on the 2021 bathymetry survey. Attachment D contains data management rules. Attachment E contains supplemental data including the RI/FS surface sediment data and data from areas that have deepened significantly. Attachment F contains RM 2.2W inlet data, Attachment G contains vertical data from non-remedial action level (RAL) intervals, Attachment H contains composite sample data, and Attachment I contains pre- and post-dredging data from Terminal 115. Key tables and figures from the ROD that are referenced in this PDIWP are in Appendix A to the RDWP.

[2] The approach to addressing data gaps that are not addressed through field sampling investigations is discussed in the RDWP.

2 PDI Strategy

This section presents the overall approach to the PDI, including the phases of the field data collection efforts. To put the PDI strategy into context, an overview of monitoring is provided, key elements of the ROD are presented, and the PDI sampling strategy and reporting are summarized.

2.1 Roles of PDI Sampling, Construction Sampling, and Long-term Monitoring

The PDI design sampling in this work plan is intended to provide the information needed to complete the RD for the middle reach. The PDI will augment the existing information developed for the LDW, including RI/FS data, baseline sampling data, and other post-RI/FS data. Design sampling is part of a larger plan for data collection that will continue during and following construction.

Additional data will be collected during construction (as described in the construction quality assurance plan [CQAP] and water quality monitoring plan [WQMP]). The CQAP and WQMP sampling data will document compliance with plans, specifications, and applicable or relevant and appropriate requirements during construction, and will inform any corrective measures needed during construction.

Following construction, the LDW will be monitored as described in the Long-Term Maintenance and Monitoring Plan [LTMMP]). The purposes of the LTMMP include ascertaining attainment of cleanup levels and compliance with applicable or relevant and appropriate requirements, assessing the integrity of the remedial action, supporting five-year reviews, aiding in the evaluation of source control effectiveness, and assessing the need for and nature of additional actions following remedy construction. The LTMMP will include both LDW-wide monitoring elements and elements specific to the remedy in the middle reach, such as specific monitoring requirements for caps, enhanced natural recovery (ENR), and monitored natural recovery (MNR) areas. The LTMMP will be amended after construction of the middle reach remedy to include requirements specific to that portion of the waterway.

These various types of sampling and monitoring are discussed in general in Section 1.5.3 of the RDWP and will be discussed in detail in the CQAP, WQMP, and LTMMP outlines to be prepared as part of the 60 and 90% design deliverables.

2.2 ROD Elements

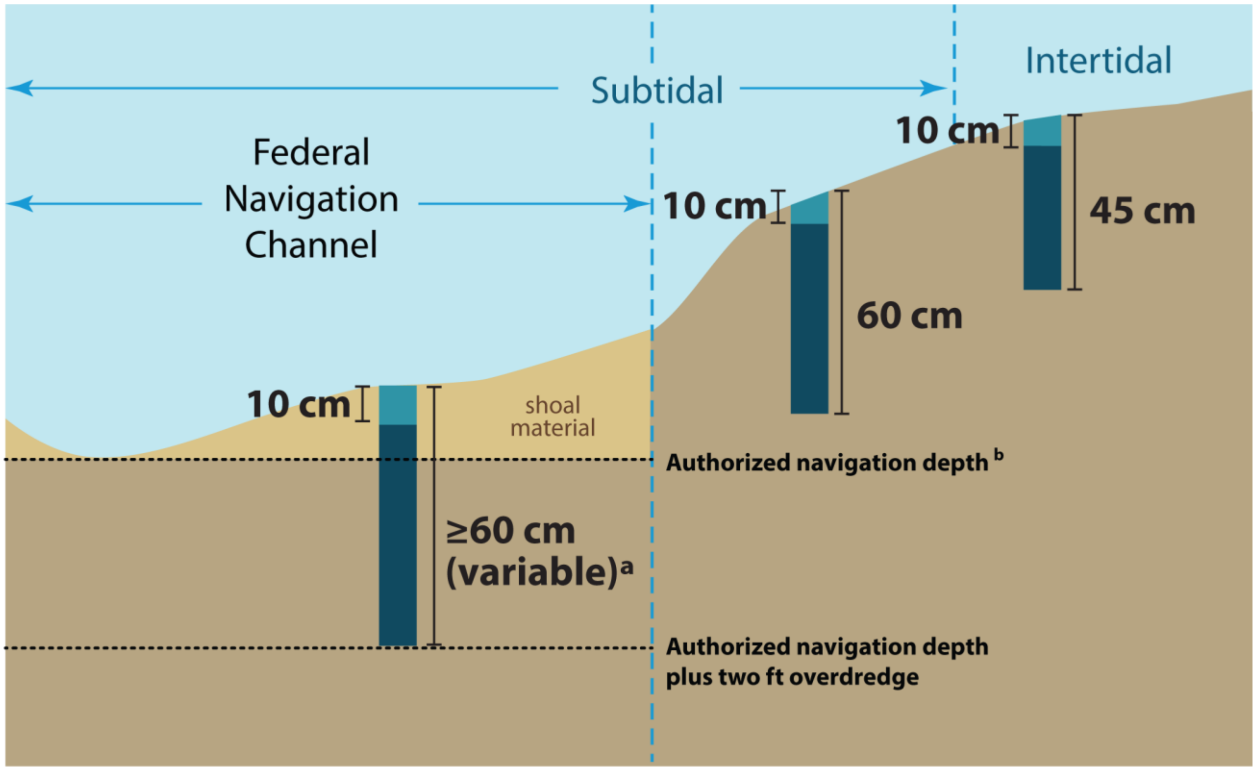
This section describes the key ROD elements that apply to the delineation of cleanup areas and the assignment of remedial technologies required to design the remedy. These elements require design sampling, as described in this PDIWP, to determine where contaminant-specific remedial action levels (RALs) (ROD Table 28[3]) are exceeded in sediment, and to collect the information needed to assign the appropriate remedial technology to a given area (based on the decision flowcharts in ROD Figures 19, 20, and 21).

2.2.1 RALs and Recovery Categories

RALs are contaminant concentrations in sediment that are used to delineate areas that require active remediation. RALs apply to sediment in specific locations and depths on a point-by-point basis (EPA 2014b). RALs have been established for contaminants of concern (COCs)[4] based on location type (intertidal vs. subtidal), recovery category, and depth interval in the sediment (e.g., 0 to 10 cm). In the intertidal areas, RALs apply to depth intervals of 0 to 10 cm and 0 to 45 cm (Figure 2-1). In the subtidal areas, RALs apply to depth intervals of 0 to 10 cm and 0 to 60 cm. Subtidal RALs applicable to 0- to 60-cm depths are dependent on recovery category designation and potential vessel scour areas. Shoal areas[5] within the federal navigation channel (FNC) have their own set of RALs. ROD Table 28 (Figure 2-2 of this PDIWP) summarizes the ROD RALs for each of the COCs. EPA has updated the carcinogenic polycyclic aromatic hydrocarbon (cPAH) RALs, target tissue levels, and cleanup levels presented in ROD Table 28 (Figure 2-2) in an explanation of significant differences (ESD) for the LDW (EPA 2021c). Figure 2-3 of this PDIWP summarizes the updated cPAH RALs. All maps in this PDIWP show comparisons of cPAH data to ESD-based RALs.

[3] ROD Table 28 is titled *Remedial Action Levels, ENR Upper Limits, and Areas and Depths of Application.*
[4] The term contaminant of concern (COC) is used herein to refer to the risk driver COCs as identified in LDW ROD and as the primary contributors to risk in the human health risk assessment and ecological risk assessment for the LDW.
[5] Shoal areas are those areas in the FNC with sediment accumulation greater than the authorized depth.

Figure 2-1
Depth Intervals where RALs Apply



[a] The variable depth intervals in shoaling cores are described in Section 4.2.2.
[b] There are three authorized navigation depths in the middle reach (Table 2-1).

Figure 2-2
Record of Decision Table 28 (EPA 2014)

Table 28. Remedial Action Levels, ENR Upper Limits, and Areas and Depths of Application

			Intertidal Sediments (+11.3 ft MLLW to -4 ft MLLW)				Subtidal Sediments (-4 ft MLLW and Deeper)				
			Recovery Category 1 RALs, ENR ULs, and Application Depths		Recovery Category 2 and 3 RALs, ENR ULs, and Application Depths		Recovery Category 1 RALs, ENR ULs, and Application Depths		Recovery Category 2 and 3 RALs, ENR ULs, and Application Depths		Shoaled Areas[b] in Federal Navigation Channel
Risk Driver COC	Units	Action Levels	Top 10 cm (4 in)	Top 45 cm (1.5 ft)	Top 10 cm (4 in)	Top 45 cm (1.5 ft)	Top 10 cm (4 in)	Top 60 cm (2 ft)	Top 10 cm (4 in)	Top 60 cm (2 ft)[c]	Top to Authorized Navigation Depth Plus 2 ft
Human Health Based RALs											
PCBs (Total)	mg/kg OC	RAL	12	12	12	65	12	12	12	195	12
		UL[a] for ENR	--	--	36	97	--	--	36	195	--
Arsenic (Total)	mg/kg dw	RAL	57	28	57	28	57	57	57	--	57
		UL[a] for ENR	--	--	171	42	--	--	171	--	--
cPAH	µg TEQ/kg dw	RAL	1000	900	1000	900	1000	1000	1000	--	1000
		UL[a] for ENR	--	--	3000	1350	--	--	3000	--	--
Dioxins/Furans	ng TEQ/kg dw	RAL	25	28	25	28	25	25	25	--	25
		UL[a] for ENR	--	--	75	42	--	--	75	--	--
Benthic Protection RALs											
39 SMS COCs [d]	Contaminant-specific	RAL	Benthic SCO	Benthic SCO	2x Benthic SCO	--	Benthic SCO	Benthic SCO	2x Benthic SCO	--	Benthic SCO
		UL[a] for ENR	--	--	3x RAL	--	--	--	3x RAL	--	--

a. The ENR Upper Limit (UL) is the highest concentration that would allow for application of ENR in the areas described. For areas with no ENR limit listed, ENR is not a currently designated technology (see Section 13.2.1.2 for further discussion).

b. Shoaled areas are those areas in federal navigation channel with sediment accumulation above the authorized depth including a 2 ft over-dredge depth that USACE uses to maintain the channel for navigation purposes. The authorized channel depths are (1) from RM 0 to 2 (from Harbor Island to the First Avenue South Bridge), 30 ft below MLLW; (2) from RM 2 to RM 2.8 (from the First Avenue South Bridge to Slip 4), 20 ft below MLLW; and (3) from RM 2.8 to 4.7 (Slip 4 to the Upper Turning Basin), 15 ft below MLLW. For shoaled areas, the compliance intervals will be determined during Remedial Design; these are typically 2-4 ft core intervals. For areas in the channel that are not shoaled, Recovery Categories 1 or 2 & 3 RALs apply as indicated in the other subtidal columns.

c. Applied only in potential vessel scour areas. These are defined as subtidal areas (i.e., below -4 ft MLLW) that are above -24 ft MLLW north of the 1st Ave South Bridge, and above -18 ft MLLW south of the 1st Ave South Bridge (see Figure 17).

d. There are 41 SMS COCs, but total PCBs and arsenic ENR ULs are based upon human health based RALs only (see Table 20).

Figure 2-3
Explanation of Significant Differences Table 3 (EPA 2021)

Table 3. Revised ROD Table 28 - Remedial Action Levels, ENR Upper Limits, and Areas and Depths of Application

			Intertidal Sediments (+11.3 ft MLLW to -4 ft MLLW)				Subtidal Sediments (-4 ft MLLW and Deeper)				
			Recovery Category 1 RALs, ENR ULs, and Application Depths		Recovery Category 2 and 3 RALs, ENR ULs, and Application Depths		Recovery Category 1 RALs, ENR ULs, and Application Depths		Recovery Category 2 and 3 RALs, ENR ULs, and Application Depths		Shoaled Areas[a] in Federal Navigation Channel
COC	**Units**	**Action Levels**	Top 10 cm (4 in)	Top 45 cm (1.5 ft)	Top 10 cm (4 in)	Top 45 cm (1.5 ft)	Top 10 cm (4 in)	Top 60 cm (2 ft)	Top 10 cm (4 in)	Top 60 cm (2 ft)[b]	Top to Authorized Navigation Depth Plus 2 ft
Human Health Based RALs											
PCBs (Total)	mg/kg OC	RAL	12	12	12	65	12	12	12	195	12
		UL[c] for ENR	--	--	36	97	--	--	36	195	--
Arsenic (Total)	mg/kg dw	RAL	57	28	57	28	57	57	57	--	57
		UL for ENR	--	--	171	42	--	--	171	--	--
cPAH BaP-eq[d]	µg/kg dw	RAL	*5,500*[e]	*5,900*[e]	*5,500*[e]	*5,900*[e]	*5,500*[e]	*5,500*[e]	*5,500*[e]	--	*5,500*
		UL[c] for ENR	--	--	*16,500*[e]	*8,850*[e]	--	--	*16,500*[e]	--	--
Dioxins/Furans	ng TEQ/kg dw	RAL	25	28	25	28	25	25	25	--	25
		UL[c] for ENR	--	--	75	42	--	--	75	--	--
Benthic Protection RALs											
39 SMS COCs[f]	Contaminant- specific	RAL	Benthic SCO	Benthic SCO	2x Benthic SCO	--	Benthic SCO	Benthic SCO	2x Benthic SCO	--	Benthic SCO
		UL[c] for ENR	--	--	3x RAL	--	--	--	3x RAL	--	--

Notes: This table reflects changes from the 2020 ESD to Table 28 in the ROD.
-- not applicable

[a] Shoaled areas are those areas in federal navigation channel with sediment accumulation above the authorized depth including a 2 ft over-dredge depth that USACE uses to maintain the channel for navigation purposes. The authorized channel depths are (1) from RM 0 to 2 (from Harbor Island to the First Avenue South Bridge), 30 ft below MLLW, (2) from RM 2 to RM 2.8 (from the First Avenue South Bridge to Slip 4), 20 ft below MLLW, and (3) from RM 2.8 to 4.7 (Slip 4 to the Upper Turning Basin), 15 ft below MLLW. For shoaled areas, the compliance intervals will be determined during Remedial Design, these are typically 2-4 ft core intervals. For areas in the channel that are not shoaled, Recovery Categories 1 or 2 & 3 RALs apply as indicated in the other subtidal columns.

[b] Applied only in potential vessel scour areas. These are defined as subtidal areas (below -4 ft MLLW) that are above -24 ft MLLW north of the 1st Ave South Bridge, and above -18 ft MLLW south of the 1st Ave South Bridge (see Figure 17 in the ROD).

[c] The ENR UL is the highest concentration that would allow for application of ENR in the areas described. For areas with no ENR limit listed, ENR is not a currently designated technology (see Section 13.2.1.2 for further discussion).

[d] Change in terminology: cPAH µg TEQ/kg dw and cPAH BaP-eq are the same

[e] Intertidal RAL modified by ESD, based on beach play RBTC at $1x10^{-5}$. The RAL of 5,500 µg/kg dw for subtidal and intertidal 0-10 cm sediments is to address hotspots. As in the ROD, the Upper Limits for ENR, where applicable, are 1.5 times the 0-45 cm RAL (in intertidal areas) and 3 times the 0-10 cm RAL (in subtidal and intertidal areas).

[f] There are 41 SMS COCs, but total PCBs and arsenic ENR ULs are based upon human health based RALs only (see Table 20 in the ROD).

Within the middle reach, there are two different potential vessel scour depths and three different authorized FNC depths (Table 2-1). From RM 1.6 to RM 2.8 within the FNC, there are no subtidal RALs for the 60-cm interval in Recovery Category 2/3 areas outside of the shoaling areas. This is because in unshoaled areas in this segment of the FNC, the potential vessel scour depth is shallower than both the actual depth and the authorized navigation depth, and there is no mechanism (e.g., vessel scour, high flow currents, or maintenance dredging) for exposing significant areas of subsurface contamination.

Table 2-1
Authorized Navigation Depths and Potential Vessel Scour Depths in the Middle Reach

FNC Segment	Authorized Navigation Depth (ft MLLW)	Potential Vessel Scour Depth (ft MLLW)
RM 1.6 to RM 2.0 (USACE Stations 113+00 -134+00)	-30	-24
RM 2.0 to RM 2.8 (USACE Stations 134+00 -176+00)	-20	-18
RM 2.8 to RM 3.0 (USACE Stations 176+00 -187+00)	-15	-18

Notes: See Map 1 for station labels.
FNC: federal navigation channel
MLLW: mean lower low water
RM: river mile

ROD Figure 12[6] outlines the spatial extent of the recovery category areas referred to in ROD Table 28 based on the FS.[7] Recovery categories are "based on information about the potential for sediment contaminant concentrations to be reduced through natural recovery or for subsurface contamination to be exposed at the surface due to erosion or scour" (EPA 2014b). Recovery Category 1 areas have less potential for natural recovery, whereas Recovery Category 2 and 3 areas have a greater likelihood for recovery and less likelihood of disturbance.

2.2.2 Technology Assignments

The flow charts in ROD Figures 19, 20, and 21[8] will be used to determine technology assignments for delineated active remedial areas (EPA 2014b). As stated in the ROD, "the use of Recovery Categories allows for more aggressive remedial technologies (such as capping and

[6] ROD Figure 12 is titled *Recovery Category Areas.*
[7] Based on the waterway users survey conducted under AOC3, a preliminary recommendation was made to change the recovery category of six berthing areas from Recovery Category 3 to Recovery Category 2 (Integral et al. 2019).
[8] Figure 19 is titled *Intertidal Areas – Remedial Technology Applications,* Figure 20 is titled *Subtidal Areas – Remedial Technology Application*, and Figure 21 is titled *Intertidal and Subtidal Areas – Natural Recovery Application*.

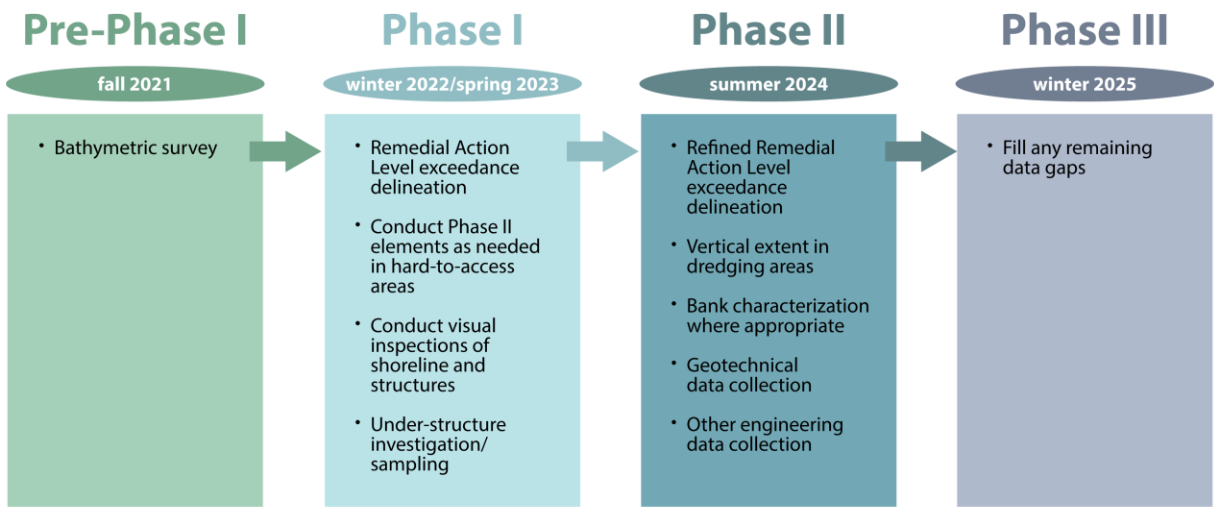
dredging) in areas with less potential for natural recovery and a higher likelihood of scour or other disturbance, and less aggressive remedial technologies (such as ENR and MNR) in areas where recovery is predicted to occur more readily and disturbance is less likely." The active remedial technologies listed in the ROD include removal through dredging/excavation, partial dredging and capping, capping, or ENR. Use of ENR includes the consideration of contaminant upper limits as specified in ROD Table 28.

Outside of active remedial action areas, more intensive long-term monitoring may be conducted in Recovery Category 2/3 areas, where contaminant concentrations are less than RALs but greater than the benthic sediment cleanup objective (SCO); these areas are referred to as MNR to benthic SCO in the ROD. If MNR does not achieve the benthic SCO or achieve sufficient progress toward achieving it 10 years post-construction, additional cleanup will be implemented as a part of the remedy. Less intensive monitoring may be conducted in areas where contaminant concentrations are below the benthic SCO but above the sediment cleanup levels (based on Puget Sound natural background) for the protection of human health for polychlorinated biphenyls (PCBs), dioxin/furans, and arsenic. PDI data and other information will be used in delineating these areas (see Section 4.1).

2.3 Design Sampling Strategy

Design sampling will be done in phases (Figure 2-4). Phase I will focus on defining the extent of RAL exceedances in order to identify initial RAL exceedance areas and make initial technology assignments. Phase II will involve the collection of additional data to further refine RAL exceedance areas (as needed), vertical contamination data, and area-specific data needed for design. Phase III will be conducted if data gaps remain after Phase II. Section 4.1 lays out the data quality objectives (DQOs) for each phase and describes the details of each design sampling phase.

Figure 2-4
Design Sampling Phases



As described in the RDWP and RI/FS (Windward 2010; AECOM 2012a), much is known about where RAL exceedances have occurred within the middle reach based on existing sediment data, sediment transport model (STM) results, and the locations of potential sources along the LDW. While additional design sampling is required to define RAL exceedance areas, the CSM and recent data suggest that in general, sediment concentrations in the middle reach are declining overall relative to RI/FS data for the following reasons:

- The baseline composite data for the middle reach show declines in spatially weighted average COC concentrations relative to those in the RI/FS, in line with modeled predictions.
- The Green River continues to deliver approximately 220,000 metric tons of upstream sediment to the LDW annually (see Section 2.1.4 in the RDWP), approximately 50% of which is deposited in the LDW (AECOM 2012a).
- Section 8.2 of the Pre-Design Studies DER (Windward 2020) summarizes concentrations of total PCBs, cPAHs, arsenic, and dioxins/furans representative of upstream sediments, which are lower than average concentrations in the LDW.[9]
- Five EAAs in the LDW have been remediated.

[9] Upstream concentrations and baseline site-wide spatially weighted average concentrations were as follows, as summarized in the Pre-Design Studies DER (Windward 2020): 20 and 172 µg/kg dry weight (dw) total PCBs, 55 and 147 µg/kg dw cPAH toxic equivalent (TEQ), 4 and 8.33 ng/kg dw dioxin/furan TEQ, and 10 and 11.6 mg/kg dw arsenic.

- Source control efforts have been on-going to reduce inputs to the LDW. If Ecology identifies new sources or source areas, or as additional source data are collected, this information will be considered in design.

Phase 1 sediment design sampling will be conducted in the middle reach using a gridded approach to determine where data should be collected. Samples in appropriate RAL intervals will generally be collected near the centroid of each grid cell, unless there are already existing data in the design dataset. In addition, samples may be collected from locations that reoccupy locations with RAL exceedance factors (EFs) ≥ 0.9, depending on the age of the data, the RAL EF, bathymetry changes since 2003, and potential source proximity. See Section 4.2, as well as Section 4.1 in the PDI QAPP, for more details of the sampling approach.

Sediment remediation has been conducted at the two EAAs in the middle reach (Slip 4 and the portion of Boeing Plant 2 located north of RM 3.0). Design sampling is not planned within the EAA boundaries because they have been remediated and these EAAs are generating data from their own monitoring programs. The Slip 4 action, completed in 2012, involved dredging contaminated sediment, capping with clean sediment, and placement of backfill (Map 1). In addition, a residuals management layer was placed to address surface sediment concentrations affected by residuals outside the EAA boundary (Integral 2013). Slip 4 monitoring has been conducted since 2012, with the Year 10 monitoring scheduled for the summer of 2022 (Attachment A). Boeing Plant 2 was dredged over three construction seasons from September 2012 to March 2015 between RM 2.85 and RM 3.6 along the eastern shoreline of the LDW and in a portion of Slip 4. Monitoring within these areas has been conducted four times since 2015; Year 7 and Year 10 monitoring will be conducted in 2022 and 2025, respectively (Attachment A).

2.4 PDI Reporting

Details regarding Phase I design sampling and analysis are described in the PDI QAPP. Phase II and Phase III (if needed) design sampling and analysis details will be presented in QAPP addenda. In addition to standard elements, the PDI QAPP and its addenda include maps and coordinates for specific design sampling locations, as well as the rationale.

Bathymetry data for the middle reach were collected in 2021 in accordance with the middle reach survey QAPP (Windward and Anchor QEA 2022). Bathymetric survey coverage was incomplete due to access challenges where vessels were moored; additional bathymetric surveying is planned for 2022 during the Phase I PDI, as discussed in Attachment B. The bathymetry data collected in 2021 and the sun-illuminated digital terrain maps[10] based on the

[10] Sun-illuminated digital terrain maps are maps with shading to enhance the appearance of bathymetric features.

2021 survey are included in Attachments B and C, respectively. This information has been used to make recommendations, where appropriate, for adjustments to recovery category designations (Attachment C). Recovery categories from RM 1.6 to RM 3.0 will be finalized in the Phase II DER after consideration of Phase I and II data for chemical trends and review of additional bathymetric survey data in areas with data gaps from the 2021 survey.

A DER will be prepared following both of the PDI sampling and analysis efforts (Phase I and Phase II).[11] Initial technology assignments will be made in the Phase I DER. These assignments will be used to determine which data are needed in Phase II (e.g., vertical information in dredging/capping areas, bank data, geotechnical data, etc.). Technology assignment modifications based on Phase II data will be documented in the Phase II DER.

[11] The Phase I DER will be submitted at the same time as the PDI QAPP Addendum for Phase II.

3 Existing Data Evaluation

AOC5 requires a summary of existing sediment data in this PDIWP to identify data gaps for design sampling. Existing sediment data include those collected for the RI/FS (1990 to 2010) (Windward 2010; AECOM 2012a) and those collected post-FS (2011 to 2021). The RI/FS dataset was submitted to EPA as part of the FS (AECOM 2012a), and post-FS data have been summarized in the *Compilation of Existing Data* (Windward and Integral 2018), the Pre-Design Studies DER (Windward 2020), and the PDI DER for the upper reach of the LDW (Anchor QEA and Windward 2022). In addition, for the PDIWP, Ecology's Environmental Information Management system was searched for additional sediment data from RM 1.6 to RM 3.0 made available between June 2018 (the Pre-Design Studies data compilation cutoff date) and October 2021. Additional data identified were compiled and combined with other middle reach data as a design dataset for the middle reach. As new data become available that are directly relevant to middle reach RD, they will be added to the dataset and considered in design.

This section presents an overview of information regarding the middle reach, including existing sediment data, upland sources, sedimentation and scour, dredging, and other in-water activities. Data management rules and a summary of data needed for RD are also presented. Observations about data gaps related to potential sources and associated COCs are preliminary pending source control sufficiency evaluations by Ecology.

3.1 Data Management Rules

The RI/FS and post-FS sediment data for the LDW have been merged into a single LDW dataset using a consistent set of data rules (Windward and Integral 2017). The LDW dataset includes all LDW data collected or made available between 1990 and October 2021. The data management rules used for this compilation are presented in Attachment D1. This section discusses LDW data included in the design dataset and other data available for the middle reach.

3.1.1 Design Dataset

A subset of the sediment data in the LDW dataset that are considered most relevant to the design work in the middle reach are referred to as the middle reach design dataset. PDI data will be added to the design dataset after they have been collected and validated. Data in the design dataset will be used to define RAL exceedance areas in the DERs. A detailed description of the data management rules used to create the design dataset is presented in Attachment D2.

The following criteria were used to define the sediment intervals included in the design dataset for comparison to RALs:

- The 0- to 10-cm samples include all samples collected from surface intervals from 0 to 5 cm to 0 to 15 cm
- The 0- to 60-cm samples include all samples collected from intervals from 0 to 45 cm (0 to 1.5 ft) to 0 to 75 cm (0 to 2.5 ft). In cases where two 1-ft intervals were collected, the 0- to 60-cm results were calculated as the mean of the results for the two intervals.
- In shoal areas within the FNC, the subsurface sediment interval is variable depending on the depth of the shoaled material (see Section 4.2.2.1). The RAL intervals include the shoaled material above and 2 ft below the authorized navigation depth.

The representativeness of the surface sediment data in the LDW dataset was evaluated to determine which data should be included in the design dataset. Surface data collected from 2011 to the present (post-FS data[12]) are included in the design dataset, as are all subsurface data (RI/FS[13] and post-FS data). In consultation with EPA, older surface sediment data from the RI/FS are not included because, consistent with the conceptual site model in the FS, surface sediment conditions have likely changed since the RI/FS data were collected. Therefore, surface sediment data from the RI/FS are not included in the design dataset. Subsurface data from the RI/FS are included in the design dataset because the deeper sampling intervals integrate sediment conditions over longer time periods. In addition, data for deeper non-RAL intervals are included in the design dataset (Attachment G); these data, with depths that will be referenced to elevations, will be useful in designing the vertical extent of contamination sampling in the Phase II PDI and may be used in RD. The non-RAL interval data will not be used in the interpolation of RAL exceedance areas.

Of the data included in the design dataset, as defined above, a small subset was removed; this subset was composed of data collected from locations identified as experiencing >1.5 ft of deepening since 2003 (see Map C-3 with the isopach analysis in Attachment C and Map E-1b with blue exceedance factor boxes in Attachment E). Samples from these locations were not included in the design dataset because the degree of deepening (>1.5 ft since 2003) indicates that the sediment horizon previously sampled may no longer exist at those locations, creating uncertainty with regard to their representativeness. Eight surface sediment locations and six subsurface locations (three 0- to 60-cm locations, one 0- to 45-cm location, and two non-RAL interval locations) were excluded. The subsurface intervals were excluded because the degree of deepening was sufficient to affect both the 0–45-cm intervals and the 0–60-cm intervals. Most

[12] The post-FS dataset includes available data from January 2011 to October 2021.

[13] The surface and subsurface RI/FS dataset includes data collected from 1990 to January 2010.

of the locations were in the area of deepening between RM 2.6 and RM 2.8 to the east of the FNC (see Map C-3 and areas with blue exceedance factors boxes in Map E-1b).

3.1.2 Supplemental Data

The sediment chemistry data in the LDW dataset that have not been incorporated into the design dataset are referred to as supplemental data. These supplemental data were used to inform the sampling design but will not be used in interpolation to define RAL exceedance areas. Attachment E summarizes RI/FS surface sediment data and the data removed from the deepened areas. Attachment H contains supplemental composite sample data,[14] and Attachment I contains supplemental data collected prior to dredging at Terminal 115 (post-dredge data were included in the design dataset).

3.1.3 Data in the Inlet at RM 2.2W

A significant amount of data has been collected in the Industrial Container Services (ICS) MTCA site, which includes an inlet of the LDW at RM 2.2W. The sediment in this area has been extensively characterized for the RI for the ICS site (DOF 2022). The sediment data for the inlet are summarized in Attachment F. The ROD addresses contaminated sediment below mean higher high water (MHHW) in the LDW; Ecology and EPA are discussing whether the inlet area of the middle reach will be remediated under MTCA site orders or under a CERCLA site cleanup order, and if so, where the administrative boundary would be. Pending this decision, only data from the eastern half of the inlet have been included in the design dataset summarized herein. The rest of the data will be added if the entire area is to be addressed under CERCLA.

3.2 Design Dataset Relative to RALs

This section presents a comparison of data in the design dataset with RALs. The delineation of areas with RAL exceedances in the middle reach is one of the primary objectives of the PDI sampling. Table 3-1 presents a summary of the design dataset by depth interval and sample type. The depth interval determines which RAL is applicable for each sample (see Figure 2-2).

[14] The baseline composite samples collected in 2018 as part of the pre-design studies included 24 composite samples, each created from 7 grab samples collected from the 0- to 10-cm sediment interval; 6 of these composites were collected from the middle reach. Splits from the discrete grab samples used to make the composite samples were later analyzed for PCB congeners, metals, butyltin, polycyclic aromatic hydrocarbons (PAHs) (including alkylated PAHs), and other semivolatile organic compounds (SVOCs) by Ecology and the National Ocean and Atmospheric Administration in 2019. The data from the split samples are included in the design dataset. In addition, there were baseline composite samples collected from beach play areas and clamming areas from the 0- to 45-cm sediment interval. Three of the beach play composites were at least partially from the middle reach. In addition, 3 site-wide composites were created from 16 potential clamming areas; 8 of these intertidal areas were within or partially within the middle reach.

Table 3-1
Summary of the Middle Reach Design Dataset

Sediment Sample Interval	Number of Locations
Surface (0–10 cm)	227
Intertidal subsurface (0–45 cm)	2[1]
Subtidal subsurface (0–60 cm)	28
Shoaling (depth varies)	8[2]
Non-RAL intervals (including deeper intervals)[3]	40

Notes:
1. One of the 0–45-cm samples was only analyzed for PCBs.
2. Two shoaling area locations characterized only the top portion of the shoal (i.e., the top 4 ft and top 2 ft).
3. Includes intertidal and subtidal core locations with sample intervals that characterize sediment deeper than 60 cm (e.g., 3- to 4-ft or 4- to 6-ft intervals). Some core locations in this category are also included in the 0–60-cm count. In addition, this category includes subsurface samples that are not RAL-defined intervals (e.g., 0–3-ft cores). Details regarding these samples are presented in Attachment G.

PCB: polychlorinated biphenyl
RAL: remedial action level

The number of samples analyzed for each of the COCs and the number of RAL exceedances in each specific depth interval are summarized in Table 3-2 for the design dataset. For each contaminant, samples were only counted for a given analyte if there was a RAL for that interval. PCBs were analyzed in the greatest number of samples (219 of the 0- to 10-cm samples); dioxins/furans were analyzed in the fewest samples (79 of the 0- to 10-cm samples). The spatial distributions of the existing design dataset sediment samples and associated RAL exceedances for specific COCs are presented on Maps 2 through 6.

Table 3-2
Summary of Middle Reach Sediment Data and RAL Exceedances by Chemical in the Design Dataset

Risk Driver COC	Sediment Interval[1]	Number of Samples	
		Total[2]	Count with RAL Exceedances[3]
Total PCBs (Map 2)	Surface (0–10 cm)[4]	219	50
	Intertidal subsurface (0–45 cm)	2	1
	Subtidal subsurface (0–60 cm)	26	5
	Shoals (depth varies)	19 (8locations)	13 (7 locations)

Risk Driver COC	Sediment Interval[1]	Number of Samples	
		Total[2]	Count with RAL Exceedances[3]
cPAH TEQ (Map 3)	Surface (0–10 cm)[4]	181	2
	Intertidal subsurface (0–45 cm)	1	0
	Subtidal subsurface (0–60 cm)	4	0
	Shoals (depth varies)	19 (8 locations)	0
Dioxin/ Furan TEQ (Map 4)	Surface (0–10 cm)[4]	79	9
	Intertidal subsurface (0–45 cm)	1	1
	Subtidal subsurface (0–60 cm)	1	0
	Shoals (depth varies)	17 (7 locations)	2 (2 locations)
Arsenic (Map 5)	Surface (0–10 cm)[4]	202	4
	Intertidal subsurface (0–45 cm)	1	1
	Subtidal subsurface (0–60 cm)	4	0
	Shoals (depth varies)	19 (8 locations)	0
Other Benthic Risk Driver COCs[6] (Map 6)	Surface (0–10 cm)[4]	184	24
	Intertidal subsurface (0–45 cm)[7]	no data[5]	-
	Subtidal subsurface (0–60 cm)[7]	3	1
	Shoals (depth varies)[7]	19 (8 locations)	0

Notes:

1. Except for data from USACE core sampling in 2012, only discrete samples are included in the design dataset. Information regarding composite samples is presented in Attachment H.
2. The total count includes only samples with a RAL for that COC in that interval. For example, there is one additional 0–60-cm sample with dioxin/furan data in a Recovery Category 3 area, which does not have a 0–60-cm RAL for dioxin/furan. Therefore, this sample is not included in the number of dioxin/furan samples for that interval.
3. RAL exceedances are defined as detected COC concentrations greater than the RALs in the 2014 ROD, or for cPAHs, in the 2021 ESD.
4. Surface samples include those in intertidal and subtidal areas.
5. Only two discrete locations exist for the 0–45-cm interval (one of which was only analyzed for PCBs). There are two beach play area composite samples from the FS, as well as nine beach play area composites in the post-FS dataset (see Attachment H).
6. These drivers include all benthic risk drivers COCs except PCBs and arsenic, which are summed separately as human health risk drivers COCs. Because benzyl alcohol is not a CERCLA hazardous substance, benzyl alcohol data will not be included in the DERs. Benzyl alcohol data obtained through routine SVOC analysis of the PDI sediment samples will be provided to EPA.
7. Benthic RALs for these sediment intervals only apply in Recovery Category 1 and shoal areas.

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act

COC: contaminant of concern

cPAH: carcinogenic polycyclic aromatic hydrocarbon

DER: data evaluation report

EPA: US Environmental Protection Agency

ESD: explanation of significant difference

FS: feasibility study

PCB: polychlorinated biphenyl
PDI: Pre-Design Investigation
PDIWP: Pre-Design Investigation Work Plan
QAPP: Quality Assurance Project Plan
RAL: remedial action level
RI: remedial investigation
ROD: Record of Decision
SVOC: semivolatile organic compound
TEQ: toxic equivalent
USACE: US Army Corps of Engineers

Map 6 presents the distribution of RAL exceedances of benthic risk drivers COCs without PCB and arsenic benthic RAL exceedances. This distinction is made because:

- PCBs and arsenic are both human health and benthic COCs, and in many instances the human health and benthic RALs are the same for both of these COCs (Figure 2-2).
- Locations with PCB and arsenic RAL exceedances are shown separately (Maps 2 and 5).
- Toxicity testing cannot be used to override RAL exceedances at locations with both human health and benthic RAL exceedances.

Of the 227 surface sediment locations in the middle reach design dataset (19 of which were analyzed only for PCBs), 70 samples (31%) had RAL exceedances for 1 or more contaminant (Maps 7a through 7d). The majority of these samples with RAL exceedances exceeded the RAL for total PCBs (50 samples). Three other human health COCs (dioxins/furans, arsenic, and cPAHs) all exceeded the RAL[15] in at least one surface sediment sample. Other benthic risk drivers COCs with RAL exceedances in surface sediment included chromium, mercury, zinc, PAHs, other SVOCs, and phthalates.

With respect to subsurface sediment, there are relatively few samples with appropriate RAL intervals (Table 3-2). COCs with RAL exceedances in subsurface sediment (intertidal subsurface, subtidal subsurface, and shoaling samples) include total PCBs, arsenic, dioxins/furans, fluoranthene, and hexachlorobenzene.

[15] All other COC concentrations (and dioxin/furan TEQs) were compared to the RALs in the 2014 ROD, except for cPAHs, which were compared to the RALs in the ESD (EPA 2021c). LDWG will voluntarily evaluate any additional RAL exceedance areas using the 2014 ROD RALs for cPAHs in the DER. One sample has been included in Phase I PDI sampling to re-occupy the only location with a cPAH TEQ greater than the 2014 ROD RAL and no other ROD RAL exceedances (see Appendix D in the QAPP).

The following bullets summarize areas with RAL exceedances by COCs for which there are RAL exceedances in the existing middle reach design dataset:

- **Total PCBs** – PCBs exceed the RAL in surface and subsurface sediment samples collected from locations throughout the middle reach. The highest PCB RAL EFs were reported in surface sediment collected from the inlet at RM 2.2W, adjacent to the ICS MTCA site (maximum EF of 53). Other areas with higher PCB concentrations include RM 1.9E (just north of the 1st Avenue S Bridge; maximum EF of 8.2), the RM 2.6E to RM 2.8E intertidal area (which includes Beach Play Area 6) (maximum EF of 5.7) and Slip 4 (maximum EF of 4.2).

- **cPAHs** – The cPAH TEQ exceeds the ESD RAL in two samples. One is a surface sediment sample collected from the intertidal area at RM 2.8E (EF of 1.3), which is part of Beach Play Area 6. The other is a surface sediment sample collected from the head of Slip 3 (EF of 1.7).

- **Dioxins/furans** – There are relatively few samples with appropriate RAL intervals for dioxins/furans. The dioxin/furan TEQ exceeds the RAL in nine surface sediment samples (EFs of 1.0 to 9.9), two shoal samples (both located between RM 1.9 and RM 2.0; EFs of 1.7 and 2.7), and an intertidal subsurface sample in Slip 3 (at RM 2.1E; EF of 1.8). The greatest RAL exceedance (EF of 9.9) was for a 2018 near-outfall surface sediment sample collected at RM 2.5W.

- **Arsenic** – Arsenic exceeds the RAL in four surface sediment samples collected just north of Beach Play Area 6 between RM 2.6E and RM 2.7E (EFs of 1.2 to 1.4). Arsenic also exceeds the RAL in one intertidal subsurface sediment sample collected in the northeast corner of Slip 3 (EF of 1.2).

- **Chromium** – Chromium exceeds the RAL in four 2011 surface sediment samples, all of which were collected at RM 2.6E (EFs of 1.6 to 6.6).

- **Mercury** – Mercury exceeds the RAL in three surface sediment samples: two from the inlet at RM 2.2W adjacent to the ICS MTCA site (EFs of 1.1 and 2.1) and one at RM 2.7W (EF of 7.9).

- **Zinc** – Zinc exceeds the RAL in four surface sediment samples: one in Slip 3 (RM 2.2E; EF of 1.4), one in the inlet at RM 2.2W adjacent to the ICS MTCA site (EF of 1.6), one from the embayment at RM 2.4E (EF of 1.4), and one in the intertidal area at RM 2.6E (EF of 2.4).

- **Phthalates** – Phthalates exceed the RAL in seven surface sediment samples. These include two samples from RM 2.0W (under the 1st Avenue S Bridge; EFs of 1.4 and 4.3), one sample from RM 1.9E (just north of the 1st Avenue S Bridge; EF of 1.2), one sample from the embayment at RM 2.4E (EFs of 5.4 and 13 for two different phthalates), one sample from Slip 3 at RM 2.2E (EF of 180), and two samples from the inlet at RM 2.2W adjacent to the ICS MTCA site (EFs of 1.0 and 1.8).
- **PAHs** – One or more PAHs exceed the RAL at six surface locations and one subsurface location in the middle reach. The surface sediment samples with the most PAH exceedances include one sample collected in Slip 3 (RM 2.2E; maximum PAH EF of 7.5) and one sample (2014) from RM 2.8E in Beach Play Area 6 (maximum PAH EF of 8.8).
- **Other SVOCs** – One or more other SVOCs exceed the RAL at five surface locations and one subsurface location. There was no clear spatial pattern in the locations of these exceedances. SVOCs with detected surface sediment concentrations greater than the RAL include 1,4-dichlorobenzene (one sample; EF of 1.1), 2,4-dimethylphenol (one sample; EF of 5.7), benzoic acid (two samples; EFs of 1.4 and 1.5), and hexachlorobenzene (one sample; EF of 1.6). The only SVOC with a detected subsurface sediment concentration greater than the RAL was hexachlorobenzene (EF of 1.6).

3.3 Upland Sources

This section presents a summary of information for the middle reach related to upland sources, including the listed sites along the middle reach, source control areas, and applicable source data (i.e., seep and bank area samples). This information will be helpful in PDI sampling design, especially in Phase II, by integrating source information into placement and analyte decisions.

3.3.1 Listed Sites and Source Control Areas

As described in Ecology's May 2021 factsheet titled *Lower Duwamish Waterway Cleanup Sites* Update (Ecology 2021a), there are a total of nine Confirmed and Suspected Contaminated Sites List (CSCSL) Ecology-led sites within the middle reach. Of these nine sites, six are immediately adjacent to the LDW, while the other three are upland within the LDW drainage basin. Another two CSCSL-listed sites are located adjacent to the LDW. In addition, a portion of Boeing Plant 2, which is an EPA-led Resource Conservation and Recovery Act site, is within the middle reach. These eight Ecology-led sites that are adjacent to the LDW and Boeing Plant 2 are summarized in Table 3-3 and shown on Map 8.

In addition, source control activities conducted in support of LDW Superfund cleanup will be considered. These activities are summarized in Ecology's LDW annual status reports (Ecology

2020, 2019). These reports describe source control action items, updates regarding site cleanups, and source control activities conducted during the reporting period for the eight source control areas in the middle reach.

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Table 3-3
Listed Sites Located within the Middle Reach

Site Name	Approx. Location	Date of AO/AOC	Status	Previous Uses	Current Uses	COCs
Ecology-led Sites[1]						
Terminal 115 Plant 1	RM 1.6 to 2.0W	2020	Pre-RI work in progress	Aircraft manufacturing (plating, assembly, engine/fuel testing, and metal working), concrete production, land filling former river channel	Retail fuel sales, cargo transfer, seafood processing, limited vehicle and cargo container maintenance	VOCs, SVOCs, petroleum, metals
Duwamish Marine Center	RM 1.9E (along Slip 2)	2011	RI complete; FS in progress	Repair and maintenance of floating vessels; junk dealer; construction services; barge shipping terminal	Tug and barge operations; metal fabrication	PCBs, PAHs, oil, metals
Douglas Management Dock	RM 2.2W	2011	RI complete; FS in progress	Sand and gravel batch plant; school bus parking and maintenance	Storage of equipment and shipping containers	PCBs, oil, metals
Industrial Container Services WA LLC	RM 2.3W	2010	RI complete; FS in progress	Cleaning and recycling of used storage drums, some used for hazardous wastes	Cleaning and recycling of used storage drums	PCBs, PAHs, VOCs, pesticides, oil, metals
Crowley Marine Services 8th Ave S	RM 2.8E (along Slip 4)	2009	RI complete; FS in progress	Manufacturing of pipe, chain, hydraulic equipment, and concrete; machinery and scrap iron storage; sawmill, lumber distribution, creosote wood treatment	Transloading/loading of contaminated soils and dredge sediments from trucks/barges onto rail cars	PAHs, metals
North Boeing Field Georgetown Steam Plant	RM 2.9E (head of Slip 4)	2008	RI in progress; interim action in 2011	Electrical power generation; aircraft manufacturing, maintenance, and research	Aircraft manufacturing, research, and delivery; jet fuel bulk storage	PCBs, PAHs, petroleum, VOCs, SVOCs, jet fuel, phthalates, metals
Independent Metals Plant 2 / Silver Bay Logging[2]	RM 2.9W	na (2009 CSCSL listing)	Awaiting characterization and/or remediation	Manufacturer of work boats; scrap metal sorting/handling facility	Scrap metal processing	PCBs and metals (other chemicals under evaluation)
Duwamish Waterway Park[3]	RM 3.0W	na (2020 CSCSL listing)	Cleanup started as part of Ecology's Voluntary Cleanup Program	Historical area use was residential and agricultural; operated as a park since 1975	Park featuring walking trail, beach access, picnic areas, and benches	PCBs, PAHs, metals, other halogenated /non-halogenated organics

Site Name	Approx. Location	Date of AO/AOC	Status	Previous Uses	Current Uses	COCs
EPA-led Site						
Boeing Plant 2[4]	RM 2.9 to 3.6E	1994	Dredging complete in 2015; site now being monitored. Cleanup in progress at upland site	Aircraft assembly and manufacturing of aluminum alloy, steel alloy, and titanium alloy parts and electronics for airplanes	Plant 2 demolished in 2011; airplane storage on tarmac lots; industrial areas are paved and/or covered by buildings	PCBs, metals, PAHs, phthalates, other SVOCs, VOCs, TPHs

Notes:

1. Information for Ecology-led sites summarized from Ecology's factsheet (Ecology 2021a), except where noted.
2. Information regarding the Independent Metals Plant 2/Silver Bay Logging Site is summarized from Ecology (2022b) and Ecology (2015).
3. Information regarding the Duwamish Waterway Park Site is summarized from Ecology (2022a).
4. Information regarding Boeing Plant 2 is summarized from EPA (2021b).

AO: Agreed Order
AOC: Administrative Order on Consent
COC: contaminant of concern
CSCSL: Confirmed and Suspected Contaminated Sites List
Ecology: Washington State Department of Ecology
EPA: U.S. Environmental Protection Agency
FS: Feasibility Study
na: not applicable
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RI: Remedial Investigation
RM: river mile
SVOC: semivolatile organic compound
VOC: volatile organic compound

3.3.2 Seep and Bank Source Data

This section summarizes source data from seep and bank samples collected from along the middle reach of the LDW, as shown on Map 9.[16]

There are 28 seep sampling locations within the middle reach for which filtered water data are available. Data for these samples were compared to Ecology's preliminary cleanup level (PCUL) screening levels calculated for groundwater to be protective of the LDW sediment remedy (Ecology 2018a, b). Of these 28 locations, 2 have detected concentrations greater than Ecology's PCULs (Table 3-4).

Table 3-4
Seep Samples in the Middle Reach with Concentrations Above PCUL

Seep Location Identification[1]	Data Source (Year)	Description of Location	Chemical(s) with Concentrations > PCUL[2]
SEEP82	post-FS (2015)	South side of Slip 2 near the over-water structure at RM 1.8E	copper
SP-54	RI/FS (2004)	Inner/western-most portion of the inlet at RM 2.2W	total PCBs

Notes:

1. This summary is as presented in the DER for the Pre-Design Studies (Windward 2020).
2. Seep data were compared with Ecology's groundwater PCULs based on the protection of sediment in the LDW (Ecology 2018a, b). This comparison was updated to use Ecology's updated PCUL for cPAHs (Ecology 2021b), which incorporates the revisions per the cPAH ESD for the LDW (EPA 2021c).

cPAH: carcinogenic polycyclic aromatic hydrocarbon
CUL: cleanup level
ESD: explanation of significant differences
FS: Feasibility Study
LDW: Lower Duwamish Waterway
PCB: polychlorinated biphenyl
PCUL: Preliminary cleanup level
RI: Remedial Investigation
RM: river mile
TEQ: toxic equivalent

There are a total of five areas in the middle reach that have been sampled as "banks," which are defined as the transition area from the LDW subtidal or intertidal bed to MHHW (Anchor QEA

[16] This summary is as presented in the DER for the Pre-Design Studies (Windward 2020), with several updates. In addition to the seep data presented in the DER for the Pre-Design Studies (Windward 2020), seep data collected after 2018 are included. These data include two samples that were collected at one location, which had been previously sampled. Further, the seep data comparison was updated to use Ecology's updated PCUL for cPAHs (Ecology 2021b), which incorporates the revisions per the cPAH ESD for the LDW (EPA 2021c).

and Windward 2019). Because the bank area samples are located below MHHW, these samples are included in the design dataset and are compared with applicable RALs. To evaluate the potential of these bank area samples to be a source of contamination to the LDW, this section presents a comparison of these samples with applicable RALs. Concentrations in one or more of the samples collected from three of these five areas were greater than the RAL for at least one contaminant (Table 3-5 and Map 9).

Table 3-5
Bank Area Sediment Samples in the Middle Reach

Bank Area[1]	Samples within Area	No. of Samples with Conc. > RAL	Chemicals with Concentrations > RAL
RM 2.1W (under 1st Avenue S Bridge)	3 samples collected as part of the Pre-Design Studies in 2018	0 (of 3 samples in area)	None
RM 2.2E (Slip 3)	3 samples collected at SeaTac Marine Services for Ecology in 2011	2 (of 3 samples in area)	total PCBs, dioxin/furan TEQ, zinc, PAHs (11 individual PAHs,[2] total HPAHs, cPAH TEQ), butyl benzyl phthalate, 2,4-dimethylphenol
RM 2.1 to 2.5W	4 samples collected at Boyer Trotsky street end for Ecology in 2011	2 (of 4 samples in area)	total PCBs, dioxin/furan TEQ
RM 2.5 to 2.7E	15 samples collected at Seattle Iron and Metals and Puget Sound Truck Lines for Ecology in 2011	6 (of 15 samples in area)	metals (arsenic, chromium, zinc)
RM 2.5 to 2.7W	3 samples collected as part of the pre-design studies in 2018	0 (of 3 samples in area)	None

Notes:

1. This summary of bank area samples is as presented in the DER for the Pre-Design Studies (Windward 2020), with the exception of cPAHs, the comparison for which has been updated to reflect the RALs in the LDW ESD (EPA 2021c).
2. Individual PAHs with concentrations exceeding the lowest RALs included anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, pyrene, and total benzofluoranthenes.

cPAH: carcinogenic polycyclic aromatic hydrocarbon
DER: data evaluation report
Ecology: Washington State Department of Ecology
ESD: Explanation of Significant Differences
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
LDW: Lower Duwamish Waterway
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level

RM: river mile
TEQ: toxic equivalent

3.4 Sedimentation and Scour

As characterized in the FS (AECOM 2012a), empirical data and results from the sediment transport model (STM) presented in the FS indicate that the middle reach is generally net depositional, with sedimentation rates ranging from ≤ 0.5 to 6.4 cm/year (Map 10). The STM predicts that there is some potential for scour during high-flow events, generally within the FNC above RM 2.85. Evidence of propeller wash scour in several areas outside of the FNC was documented in the FS, generally including the nearshore areas of RM 1.6 to RM 1.8E, RM 1.8 to RM 1.9W, RM 2.3 to RM 2.55E, RM 2.4W, RM 2.7 to RM 2.8W, RM 2.8 to RM 2.9E, and RM 2.9W, and portions of Slips 2, 3, and 4.

A review of historical and recently collected bathymetric data showed general sediment accumulation over the last 18 years (Map C-3 in Attachment C). The assessment also revealed two previously unidentified scour areas: one beneath the 1st Avenue S Bridge and one east of the FNC between RM 2.55E and RM 2.75E (referred to as Analysis Areas 4 and 8, respectively, in Attachment C). These areas of observed scour have been proposed as Recovery Category 1 areas as discussed in Attachment C. In addition, six small intertidal areas, without evidence for vessel scour and with vessel access restrictions, are recommended to be changed from Recovery Category 1 to Recovery Category 2 or 3 (Attachment C).

3.5 Dredging and Other In-water Activities

Dredge events have been conducted within the middle reach as part of the sediment remediation for the Boeing Plant 2 EAA and Slip 4 EAA (Attachment A). There has been no maintenance dredging in the FNC within the middle reach since 1976. However, maintenance dredging has been conducted by property owners to maintain navigation depths for their facilities.

The two EAAs within the middle reach are shown on Map 11 and summarized as follows:

- **Boeing Plant 2** – Sediment dredging was completed by The Boeing Company adjacent to Boeing Plant 2 along the LDW from RM 2.8E to RM 3.7E and the southern half of the mouth of Slip 4. The dredging was conducted over three construction seasons beginning in 2012 and ending in 2015; it involved dredging approximately 163,000 CY of sediment and placing approximately 160,000 CY of backfill in dredging areas (Ecology and Leidos 2018). Post-construction monitoring is ongoing; year 1, year 3 and year 5 sediment monitoring data are available and are summarized in Attachment A. Year 7 monitoring will be conducted in 2022 and year 10 monitoring will be conducted in 2025.

- **Slip 4** – Sediment remediation within Slip 4 was completed by the City of Seattle in 2012. The cleanup involved dredging approximately 10,000 CY of sediment, removal of 130 tons of creosoted timbers and piles, removal of a concrete dock structure, and construction of sediment and slope caps over 3.43 acres and engineered soil caps with habitat enhancements over 0.15 acre in the former upland area (Integral 2014). Postconstruction sampling just outside the EAA boundary showed an increase in PCB concentrations (Map 11). In response, EPA approved the placement of 9 in. of residual management layer in this area. A portion of this area was subsequently dredged as part of the Boeing Plant 2 EAA dredging within Slip 4. Postconstruction monitoring is ongoing; year 1, year 3, year 5, and year 7 sediment monitoring data are available and are summarized in Attachment A. Year 10 monitoring will be conducted in 2022.

Prior to navigation or berth maintenance dredging, sediment is characterized under Dredged Material Management Program (DMMP) criteria. Sediment to be dredged is typically characterized using composite samples made up of cores from variable sediment depths, depending on the amount of material to be dredged. Each composite represents a dredged material management unit (DMMU). In addition, Z-samples are collected that represent the 0- to 1-ft or 0- to 2-ft interval that will remain after dredging. The composite samples collected by USACE to characterize DMMUs within the FNC in the middle reach are supplemental data and not included in the design dataset. The composite data are described in Attachment H.

USACE assumed responsibility for maintaining the navigation depths in the LDW FNC in 1920 (AECOM 2012a). In the middle reach, no USACE dredging to maintain the authorized depths in the FNC has been conducted since 1976. Shoaling areas were characterized by USACE for planned maintenance dredging in 1992 and 2000. This dredging did not occur. In 2012, USACE conducted a characterization of shoaled material throughout the LDW, including the middle reach. These shoaling data are included in the design dataset.

Maintenance dredging outside of the FNC has occurred more recently. Property owners have dredged to maintain berthing depths in front of their facilities. A summary of dredging events in the middle reach conducted since 1990 is provided in Table 3-6 and Map 11.

Table 3-6
Maintenance Dredging Events Outside of the FNC within the Middle Reach Since 1990

Property	Location	Date	Area (acres)	Dredge Depth	Total Dredge Volume (CY)	DMMP Suitability[1]
James Hardie/ LoneStar	RM 1.55 to RM 1.75 East	1999	2.24	-31 ft MLLW	18,000	2 DMMUs suitable 3 DMMUs unsuitable
LoneStar	Slip 2	1990	0.66	-14 ft MLLW	1,600	1 DMMU suitable
		1991	0.66	-14 ft MLLW	1,100	Upland disposal[2]
		1994	0.66	-14 ft MLLW	3,000	Upland disposal[2]
Glacier Northwest	Slip 2	2000	0.66	-16 ft MLLW	4,900	2 DMMUs suitable
Terminal 115 (Port of Seattle)	RM 1.78 to RM 1.95W	1993	0.26	-15 ft MLLW	3,000	2 DMMUs suitable
	RM 1.76 to RM 1.86W	2009	0.29	-16.5 ft MLLW	3,000	2 DMMUs unsuitable
Boyer Towing	RM 2.39 to RM 2.49W	1998	0.59	-10 ft MLLW	8,000	2 DMMUs suitable
Hurlen	RM 2.64 to RM 2.77W	1998	1.41	-10 ft MLLW	15,000	2 DMMUs suitable 2 DMMUs unsuitable
Crowley	Slip 4	1996	1.77	-15 ft MLLW	13,000	1 DMMU suitable 3 DMMUs unsuitable
Morton	RM 2.86 to RM 2.97W	1992	1.02	-18 ft MLLW	7,980	1 DMMU suitable

Notes:
1. The DMMP program evaluates the suitability of dredged material for unconfined aquatic disposal, as described in the DMMP User Manual (DMMP 2021). All suitable and unsuitable DMMUs were dredged and the total volume was noted in the table.
2. Material not evaluated for DMMP suitability.

DMMP: Dredged Material Management Program
DMMU: dredged material management unit
FNC: federal navigation channel
RM: river mile

The maintenance dredging conducted at Terminal 115 Berth 1 in 2009 included the placement of 1 ft of sand cover material following the completion of dredging, because of PAH concentrations and dioxin/furan TEQs above the DMMP criteria in the Z-samples (DMMP 2009). In addition, four sediment cores were collected post-dredging that represented the depth intervals below the sand cover material. The pre- and post-dredge sediment data for Terminal 115 Berth 1 are described in Attachment I. The post-dredge sediment data are included in the middle reach design dataset.

3.6 Data Needed for Remedial Design

Based on the assessments presented in this section, additional sediment data are required to delineate RAL exceedances within the middle reach. The conceptual design sampling plan to collect these data in Phases I and II is discussed in detail in Section 4.

The conceptual design sampling plan in Section 4 also discusses the need for the following types of data that will be collected in PDI Phase II (and Phase III if needed) to design the engineered remedy. These data types were also summarized in Appendix B of the AOC3 design strategy report (Integral and Windward 2019).

In summary, the following PDI data will be collected:

- Bathymetric survey data to support the delineation of recovery category areas, potential vessel scour areas, and applicable RALs; this survey was conducted in 2021 and the results are shown in maps in the RDWP, PDIWP, and PDI QAPP, with details in PDI QAPP Appendix A. Bathymetric survey coverage was incomplete due to access limitations caused by moored vessels; additional surveying will be conducted during Phase I.
- Sediment chemistry data from sediment intervals with RALs (0- to 10-cm, 0- to 45-cm, and 0- to 60-cm) to delineate RAL exceedances, as previously noted
- Vertical (> 60 cm) extent data to determine depth of dredge prisms in dredge areas
- Vertical (> 60 cm) extent data below caps
- Vertical (> 60 cm) extent data outside RAL exceedance areas to inform design and monitoring of the site. Details to be determined in Phase II QAPP.
- Toxicity tests data in areas where active remediation is anticipated and only benthic RAL exceedances exist
- Focused topographic surveys data in bank areas with adjacent remedial action areas that have dredging or capping remedies
- Area-specific sediment geotechnical properties data, including geologic characterization, sediment index, and sediment strength and consolidation properties to achieve the following:
  - Determine sediment stability and stable dredge cut side-slope requirements.
  - Characterize sediment dredgeability.
  - Support sediment consolidation assessment for cap design.
  - Support selection of dredge equipment.
  - Support design of sediment handling, transport, dewatering, treatment systems, and disposal requirements.
- Specialized surveys data if needed for debris characterization, sediment thickness over armored banks, and utility locates

- Erosion/scour/disturbance process information (such as bathymetry, and engineering analyses) to support:
  - Delineation of MNR and ENR areas
  - Design of in situ treatment, if appropriate
  - Cap design
  - Outfall scour protection

4 Conceptual Design Sampling Plan

This section presents the conceptual design sampling plan to collect PDI data, including:

- DQOs
- A conceptual sampling plan for the collection of data needed to delineate boundaries of RAL exceedance areas and support remedial technology applications in designing the remedy
- A summary of bathymetric, hydrogeological, and geotechnical studies

4.1 DQOs

The purpose of the PDI is to collect data needed to delineate RAL exceedance areas and support remedial technology applications in designing a remedy consistent with the ROD (ROD Tables 27 and 28 and ROD Figures 19, 20, and 21; EPA 2014b).[17] This PDIWP lays out the general strategy and sequencing of data collection that will be used to meet PDI data needs in the middle reach. The general strategy and sequencing will be similar to those of the upper reach (Windward and Anchor QEA 2019), with some notable differences in the approach to placement of sampling locations in the Phase I PDI.

PDI data collection efforts will be conducted in two phases and a third phase if needed, as discussed in Section 2 and further described herein. DQOs have been identified: nine for Phase I design sampling and five for Phase II (Table 4-1). Eight of the nine Phase I DQOs are based on delineating exceedances of the RALs listed in ROD Tables 27 and 28 (EPA 2014b) and cPAH RALs listed in the ESD (EPA 2021c); the ninth DQO is related to a visual inspection of banks in the middle reach. DQOs for bathymetric surveying are included in the Pre-Design Survey QAPP (Attachment B). Data in certain areas may be collected in Phase I to address some of the Phase II DQOs if needed due to access issues. Details are described in the PDI QAPP.

[17] ROD Table 27 is titled *Selected Remedy RAO 3 RALs*.

Table 4-1
DQOs for Phases I and II of the PDI in the Middle Reach

Phase I	Phase II
DQO1 – Delineate 0–10-cm RAL exceedances in Recovery Category 2/3 DQO2 – Delineate 0–10-cm RAL exceedances in Recovery Category 1 DQO3 – Delineate 0–45-cm intertidal RAL exceedances in Recovery Category 2/3 DQO4 – Delineate 0–45-cm intertidal RAL exceedances in Recovery Category 1 DQO5 – Delineate 0–60-cm PCB RAL exceedances in potential vessel scour areas in Recovery Category 2/3 DQO6 – Delineate 0–60-cm RAL exceedances in Recovery Category 1 DQO7 – Delineate RAL exceedances in shoaling areas DQO8 – Conduct a visual inspection of the structures and banks in the middle reach to identify features relevant to design, such as the presence/absence of bank armoring, and to plan how to access banks and areas under structures for sampling purposes DQO9 – Sample areas under structures, if feasible, safe, and appropriate, to delineate RAL exceedances	DQO10 – Further delineate RAL exceedances, as needed for unbounded areas DQO11 – Assess chemical and physical characteristics of sediment in banks, as needed, depending on remedial technology selected and whether or not the bank is erosional DQO12 – Delineate vertical elevation of RAL exceedances in dredge (and dredge/cap) areas and collect vertical information in cap areas where deeper contamination under caps may be located. DQO13 – Collect geotechnical data as needed depending on technology proposed and/or physical characteristics of remedial action areas DQO14 – Collect other engineering applicable data as needed (e.g., structures inspection, utility location verification, thickness of sediment on top of riprap layers)

Notes:
DQO: data quality objective
PCB: polychlorinated biphenyl
PDI: Pre-Design Investigation
RAL: remedial action level

Following Phase I design sampling, a DER will be prepared to present the data, define initial RAL exceedance areas, assign preliminary technologies to these areas, and identify remaining potential data gaps for Phase II. Details regarding Phase II design sampling will be presented in a PDI QAPP addendum, including specific design sampling locations and rationale, depths, analytes, and additional types of data and information needed to design the remedy in specific areas. The Phase II DQOs reflect these needs (Table 4-1). Phase III will be conducted if data gaps remain following Phase II or are otherwise identified during preparation or EPA review of the 30% design.

4.2 Phase I Conceptual Design Sampling Plan

This section presents the general principles for Phase I that were applied in selecting specific sediment locations and intervals to sample to meet the Phase I DQOs (Table 4-1). Details are presented in the PDI QAPP. Analytes and tiering of analytical chemistry analyses are also discussed, as is the visual bank characterization.

4.2.1 General Principles for Sediment Sampling in Phase I

One of the primary goals for the PDI is to obtain sediment data to support data interpolation of RAL exceedance area boundaries. In developing the design sampling and analysis approach, a number of factors were considered. Factors that affect the location and number of samples include, but are not limited to:

- Locations of banks, slopes, structures, berthing areas, and the FNC
- Current bathymetry data and areas where RALs apply
- Dredge history
- Known current and historical sources and early actions
- Sediment chemistry data: distribution, representativeness, recency, and results
- Potential for changes in sediment quality since data were collected based on an isopach analysis that compared the results of bathymetry surveys conducted in 2003 and 2021.[18]
- Input from the Engineer of Record, particularly near structures and engineered slopes

A gridded sampling design was selected in consultation with EPA for Phase I of the middle reach PDI sampling. A systematic gridded sampling approach is appropriate because it will result in a relatively consistent spatial distribution of data to support data interpolation. Grids are rectangular (100 × 200 ft), with the long axis oriented with water flow along the main channel and in slips. Grids have been altered where necessary to adapt to the geometry of the middle reach and to result in a cross channel transect-like data distribution.

Maps showing Phase I sample locations and location-specific rationale for the sampling design are presented in the PDI QAPP. General considerations for selecting specific sampling locations include the following.

- Whether there is more than one RAL-applicable area in a grid (e.g., intertidal, potential vessel scour, recovery category, shoal)
- Whether there is an applicable RAL for each interval
- Whether the grid cell is sampleable
- Whether a portion of the grid cell is within a beach play or clamming area
- Whether a remedy is likely within a grid cell based on existing data

[18] A review of historical and recently collected bathymetric data showed general sediment accumulation over the last 18 years (Map C-3 in Attachment C).

- Presence of existing data in the design dataset within the grid cell and whether the existing data are representative
- Proximity to upland cleanup site or outfall with limited data
- Whether additional locations within a grid cell should be re-occupied because they have EFs greater than 0.9 and less than approximately 2.

Based on these criteria, Phase 1 samples will be collected in most, but not all, of the grids. In addition, most of the Phase 1 samples will be analyzed upon collection (Tier 1), although some of the reoccupation or bounding samples may be archived pending the results of Tier 1 samples (Tier 2). Tier 2 analyses of archived samples will be selected in consultation with EPA.

Sampling under structures (DQO 9) has its own study design (i.e., it does not follow the gridded sampling design). Details are presented in the PDI QAPP. Sediment under structures will be probed and potentially sampled if the structures meet the following criteria:

- The area under the structure can be accessed safely.
- Structure is sufficient in size (i.e., approximately a minimum of 50 ft in length and 50 ft wide).
- Sediment under the structure is of sufficient thickness to collect a sample.
- Structure has a contaminant source condition under it that is dissimilar to that of the adjacent open-water sediment.
- Structure does not have existing design dataset data under the structure.
- There is reason to believe contamination may be present (e.g., based on uses, drains, nearby contamination, etc.).
- There is potential for vessel scour (i.e., the area below the structure is unarmored and water depths are within the potential vessel scour limits defined in the ROD[19] and restated in Section 4.2.2.1.)

4.2.2 Depth Intervals and Analytes

This section presents guidelines for which depth intervals will be sampled to delineate RAL exceedances, as well as which analytes will be analyzed in Phase I samples. Additional details are presented in the PDI QAPP.

4.2.2.1 Intervals

Most locations will be sampled at two depth intervals to delineate RAL exceedances. Some locations will only require one interval of sampling, depending on the existing data and RAL

[19] Refer to ROD Table 28, *Remedial Action Levels, ENR Upper Limits, and Areas and Depths of Application*.

applicability in certain areas. Typical sample intervals include: 0- to 10-cm and 0- to 45-cm for intertidal areas, and 0- to 10-cm and 0- to 60-cm for subtidal areas. No subsurface samples will be collected in Phase I at Recovery Category 2/3 locations that are deeper than potential vessel scour area depths, because there are no applicable subsurface RALs. Potential vessel scour depths are defined as between -4 ft and -24 ft MLLW north of the 1st Avenue S Bridge and between -4 ft and -18 ft MLLW south of the 1st Avenue S Bridge.

In shoaling areas in the FNC, sampling intervals are dependent on the depth of the shoal and the authorized navigation depth. In the middle reach, there are three different authorized navigation depths (Table 4-2), which dictate the depths of the sample intervals to be taken for comparison to RALs. In all FNC shoaling areas, shoaling intervals and a 0- to 60-cm (2-ft) interval below the authorized depth will also be collected, per ROD Table 28. In addition, a 2-ft Z-sample will be collected below the allowable overdredge depth (DMMP 2021); the Z-samples will be archived and analyzed if needed for design. Details are presented in the PDI QAPP.

Table 4-2
Authorized Navigation and Overdredge Depths in the Middle Reach

FNC Segment	Authorized Navigation Depth (ft MLLW)	Overdredge depth (ft MLLW)
RM 1.6 to RM 2.0	-30	-32
RM 2.0 to RM 2.8	-20	-22
RM 2.8 to RM 3.0	-15	-17

Notes:
FNC: federal navigation channel
MLLW: mean lower low water
RM: river mile

Specific field methods and sampling details (e.g., core depths and sampling intervals) are detailed in the PDI QAPP.

4.2.2.2 Chemical Analyses

Detailed analyte lists for each Phase I PDI sample are presented in the PDI QAPP. The analyte lists are based on the sample type, interval, and recovery category (Table 4-3), according to the RALs presented in ROD Table 28. In general, Tier 1 samples in Phase I[20] will be analyzed for all COCs with an applicable RAL. The analyte list for Tier 2 samples, which will be archived after

[20] Tier 1 samples will be analyzed in batches as samples are collected during Phase I. Tier 2 samples will be archived pending additional discussions with EPA to determine which samples will be analyzed. See Section 4.1.2 in the PDI QAPP.

collection, will be determined in consultation with EPA based on RAL exceedances in nearby samples and other identified site-specific concerns, if any.

Table 4-3
Analytes in Various Sample Types in Phase I

Sample Type	Recovery Category 1			Recovery Category 2/3		
	0–10 cm	0–45 cm	0–60 cm and Shoaling Intervals	0–10 cm	0–45 cm	0–60 cm and Shoaling Intervals
Intertidal (Tier 1)	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	na	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	PCBs, arsenic, and cPAHs (dioxins/furans in a subset)[2]	na
Subtidal (Tier 1)	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	na	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	na	PCBs[3]
Shoaled Areas (Tier 1)	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	na	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	PCBs, arsenic, and other benthic COCs[1] (dioxins/furans in a subset)	na	PCBs, arsenic, and other benthic COCs[1] (dioxins/ furans in a subset)
Archive (Tier 2)	analyze for PCBs and COC(s) with RAL exceedance or site-specific concerns			analyze for PCBs and COC(s) with RAL exceedance or site-specific concerns		

Notes:

1. Other benthic COCs are those listed in ROD Table 27; the other benthic COCs herein exclude PCBs and arsenic because they are listed separately as human health COCs. PAHs, the basis for calculating the human health COC cPAHs, are included in the list.
2. Per ROD Table 28, there are no RALs for other benthic COCs in the 0–45-cm interval in Recovery Category 2/3 areas.
3. Per ROD Table 28, only PCBs have a RAL in the 0–60-cm interval in Recovery Category 2/3 areas in potential vessel scour areas.

COC: contaminant of concern
cPAH: carcinogenic polycyclic aromatic hydrocarbon
na: not applicable (no RAL)
PCB: polychlorinated biphenyl
RAL: remedial action level
ROD: Record of Decision

The sampling locations for dioxins/furans are presented in the PDI QAPP. Dioxins/furans will be analyzed in at least 20% of the PDI samples. Areas with existing dioxin/furan TEQs > 20 ng/kg will be targeted; remaining samples for dioxin/furan analysis will be selected for spatial coverage. Archives will be retained for all samples.

4.2.2.3 Phase I Visual Bank and Structures Characterization

Bank conditions in the entire middle reach will be assessed via visual inspection during Phase I to identify the following: where banks are armored or unarmored,[21] areas of significant bank erosion (if any), presence and type of vegetation, and bank access difficulties. The visual inspection will also be used to verify the descriptions and locations of structures and utilities identified in the Waterway Users Survey (Integral et al. 2018). Results of the visual assessment will be documented in the Phase I DER and used to plan additional bank data collection requirements during Phase II.

4.3 Phase II Conceptual Sampling Plan

This section presents a summary of the Phase II conceptual sampling plan. The results of the PDI Phase II sampling will be discussed in the Phase II DER, which will also contain a data gaps analysis conducted to determine if a third phase of design sampling is needed. The general approach for each of the Phase II DQOs is discussed in the following sections.

As needed for design, samples for vertical extent delineation, bank characterization, and geotechnical data gathering will be collected at the same time as Phase II RAL delineation refinement samples.

4.3.1 Refining RAL Delineation

The Phase I DER will support the PDI QAPP Addendum for Phase II regarding whether Phase II refinement is warranted for specific RAL exceedance areas. Phase II sampling locations and analytes will be based, at least in part, on the preliminary interpolation and areas of greater uncertainty in surface and subsurface sediment. Interpolation methods will follow the same general approaches used in the DER for the upper reach (Anchor QEA and Windward 2022). Phase I PDI chemistry data will be added to the middle reach design dataset and used in the interpolation in the Phase I DER.

Following Phase II PDI sampling, the results will be included in the design dataset and used in an updated interpolation and uncertainty analysis in the Phase II DER to define the extent of the RAL exceedance areas. These data could also affect the preliminary technology assignment. Interpolation may not be updated after Phase III sampling. The decision will be made in consultation with EPA.

[21] Definitions of armored and unarmored banks are in the RDWP, Section 2.1.7.

4.3.2 Vertical Delineation

The initial RAL exceedance area boundary and the preliminary remedial technology for each area will be established in the Phase I DER. If dredging or partial dredging/capping is the anticipated remedy for an area, additional information will be needed in Phase II to define the vertical extent of RAL exceedances and establish if partial dredging/capping is appropriate based on these depths. Vertical information will also be needed in capping only areas to design the cap, but delineating the full vertical extent of contamination (i.e., the sediment depth at which all COC concentrations are less than surface RALs) may not be necessary in cap areas, because the cap design assumes an infinite source of contaminant underlying the cap.

According to the ROD (EPA 2014b), "if greater than 1 ft of contamination would remain after dredging to sufficient depth to accommodate a cap, sediments will be partially dredged and capped." Thus, in partial dredging/capping areas, sufficiently deep vertical extent of contamination information is needed below the mudline to determine whether there remains more than 1 ft of contamination below an anticipated cap thickness. Per the ROD, if 1 ft or less of contamination is determined to remain below an anticipated cap thickness, the remedy would be to dredge only. The placement of the cores to delineate the vertical extent of contamination will be based on the interpolation of Phase I results and other information, such as local bathymetry, information about previous dredging areas and depths, variations in geology or morphology, existing COC data from cores, and proximity to nearby upland contamination or contaminant sources.

The RI (Windward 2010), FS (AECOM 2012a), and Supplement to the FS (AECOM 2012b) presented subsurface data and various subsurface analyses[22] used by EPA to determine the selected remedy provided in the ROD, including the subsurface RALs and where they apply. Subsurface data from the RI/FS and post-FS datasets will be considered along with PDI Phase I and Phase II data. Subsurface data from outside dredging and capping areas may be needed for design and remedy implementation. These data may be collected in Phases II or III, if needed.

4.3.3 Geotechnical Data

In Phase II, the appropriate geotechnical data will be collected to inform the engineering design. Geotechnical data are required to establish design criteria that inform dredge prism development; engineered capping design; work conditions around completed or pending remedial actions or habitat sites; and work conditions around existing infrastructure, utilities, and debris. Geotechnical

[22] RI/FS subsurface data are summarized in Section 4 of the RI (Map series 4-17, 4-26, 4-33, 4-41, 4-69); Section 2.3.2 (Map 2-12 series), Table 10-1, and Appendix E of the FS; and the Supplemental FS (Figure 3).

data are also required to allow the contractor to select suitable dredging equipment for use during construction.

Specifications for geotechnical data are provided in the PDI QAPP or will be presented in a QAPP addendum, and the majority of geotechnical data will be collected during the implementation of Phase II PDI activities. Potential geotechnical data needs to support RD will include the following types of data. Note that not every area will need every analysis. For example, index properties are likely to be correlated with the other properties, and thus other geotechnical properties will not likely be needed at every location.

- **Shear Strength.** Shear strength data are required to inform general sediment stability design considerations, develop stable dredge cuts (i.e., side-slopes), assess bank stability, and characterize sediment dredgeability. Subgrade sediment shear strength data are also required to inform engineered capping design and ENR materials selection and placement. Specific methods for the collection of shear strength data may include *in situ* vane shear tests, cone penetrometer tests, or calculation of shear strength based on other known geotechnical properties.
- **Compressibility/Settlement and Consolidation.** Sediment strength data are required to determine the bearing capacity of subgrade sediments, specifically how subgrade sediments will compress/settle following engineered cap placement. Additionally, consolidation of placed cap materials must be evaluated to assist with identifying the minimum required cap material thicknesses and evaluating cap thickness verification surveys. Specific methods for the collection of subgrade compressibility/settlement data include use of a Shelby tube (separate effort from collection of environmental data) to collect an undisturbed sample for laboratory analysis. Consolidation data will be obtained using samples of engineered capping materials and standard geotechnical laboratory testing methods, or by calculating predicted consolidation based on other known geotechnical properties.
- **Index Properties.** Geotechnical index properties include grain size, moisture content, bulk density, and plasticity (i.e., Atterberg Limits). These data are required to inform all facets of engineering design, including dredging, capping, and ENR, and to assess bank and in-water slope stability. Index property data are also useful in the design of sediment handling, transport, dewatering, and treatment systems.

Where appropriate, geotechnical data that pertain to the needs described above will also be collected within bank areas adjacent to active sediment remedial action areas in the middle reach, as described in Section 4.3.4.

4.3.4 Bank Areas

A variety of scenarios can be envisioned wherein a bank below MHHW is located within the interpolated RAL exceedance area. This section describes how typical scenarios will be addressed. If a bank is located within or adjacent to an interpolated RAL exceedance area, bank data up to MHHW (or up to the top of the bank, if that is higher) will be collected in Phase II (as described below).

A field visual survey of all middle reach banks (including under-structure areas) will be conducted in Phase I. In Phases II (and III, if needed), banks within interpolated RAL exceedance areas may be characterized, including the collection and analysis of surface and subsurface sediment, collection of geotechnical data, consideration of seeps, and consideration of topography as appropriate. Details of Phase II bank characterization will be presented in the PDI QAPP Addendum for Phase II.

The Pre-Design Studies compiled existing bank data and collected additional bank data where data gaps were identified by Ecology.[23] Results of the Phase I PDI may identify additional bank areas for environmental characterization during Phase II.

4.3.4.1 Bank Characterization

Bank areas located within or adjacent to RAL exceedance areas will be characterized up to MHHW (or to the top of the bank, if that is higher). The number and specific locations of samples to be collected will be developed during Phase II investigation planning, and they will be based on existing information, elevation range, armoring condition, and the type of sediment remediation proposed for the interpolated RAL exceedance area.

For unarmored banks, surface and/or subsurface sediment data will be collected where appropriate and archived for potential analysis. Subsurface sample depth limits and sediment thickness will be determined based on evaluation of available data, bank conditions, slope, and other factors that may inform the ability to collect the data or limit doing so.

[23] To supplement existing bank data, bank samples were collected in the LDW as part of the Pre-Design Studies based on the analysis presented in the surface sediment QAPP (Windward 2018). In coordination with Ecology, exposed banks were sampled if they had not already been characterized in past surveys, if they were not located adjacent to upland properties under or expected to be under an Agreed Order for site investigation, if adjacent sediment data did not exist or had concentrations greater than sediment RALs, and if the bank was sampleable. Bank samples were collected at elevations of +4 to +12 ft mean lower low water (MLLW) and were analyzed for the analytes listed in Table 20 of the ROD (EPA 2014b), with a subset analyzed for dioxins/furans. Results are presented in the draft Pre-Design Studies DER (Windward 2020).

Armored banks will require investigation using alternate methodologies. If needed, sediments accumulated on top of existing armor material or within the interstices of the armor rock will be sampled as feasible. In addition to chemical testing, sediment thickness testing will be performed using probing methods to be described in the PDI QAPP. Sediment thickness data will be used to calculate accumulated sediment thickness and to inform the selection of appropriate remediation technologies for the bank area.

4.3.4.2 Seeps

The locations of active seeps were surveyed as part of the RI and seeps were sampled during the RI and the Pre-Design Studies. Based on these two efforts, the locations of seeps are generally known, although they may vary from time to time depending on conditions. Bank areas located within initial RAL exceedance areas will be observed for active seeps, and existing seep data will be reviewed to assess seep water quality. If water quality data suggest that sediment at a location could be re-contaminated post-remedy, Ecology will be notified for upland investigation/cleanup coordination.

4.3.4.3 Topographic Surveys

Topographic survey data will be required for certain bank areas as needed for design (i.e., areas within initial and adjacent to RAL exceedance areas or with identified data needs based on Phase I and II data) to provide elevation information related to intertidal and subtidal areas, assist with cut/fill calculations during remediation design, assess slope stability, and assess habitat conditions/considerations. The EPA-approved survey QAPP (Anchor QEA and Windward 2021) will be amended as necessary to address topographic surveying requirements during Phase II investigation activities. Topographic survey data will be combined with available bathymetry survey data for use in remedial design.

4.3.5 Other Engineering-related Information

Other engineering-related efforts will be conducted in Phase II or Phase III, as needed, such as:

- Groundwater data (for use in cap design) will come from existing groundwater studies. If groundwater flow rate data are needed for cap design in bank areas, site-specific data collection may be necessary.
- Debris surveys may be performed to identify surficial debris types and specific locations, depending on the results of the bathymetric survey. Debris surveys, if needed, will employ either side-scan sonar and/or visual inspection.
- Over-water infrastructure (e.g., location, dimensions, conditions) and utility location data will be collected, as necessary to inform remediation technology selection (e.g., dredging,

engineered capping), construction offsets and no-work area locations, infrastructure support elements, etc.
- Waste characterization data may be collected to inform material handling, transport, dewatering, and disposal procedures.

Specific treatability studies (such as elutriate tests) are not anticipated to be needed at this time for remedial design; however, if such a need is identified during completion of PDI activities, an addendum to the PDIWP will be prepared and submitted for agency review and approval.

4.4 Phase III Conceptual Design Sampling

The Phase II DER will identify remaining data gaps that need to be filled as part of a Phase III sampling effort. Additional Phase III needs will be identified in the 30% design package and may be identified during EPA review and in comments on the 30% design package.

Phase III could include the collection of additional data from any of the aforementioned categories. In addition, benthic toxicity testing could be conducted in Phase II or Phase III, if benthic COC RAL exceedances exist in a given area sufficiently large to warrant further investigation[24] and lacking human health COC RAL exceedances. Benthic toxicity testing, where appropriate, will require the simultaneous collection of sediment for chemistry and toxicity testing and expedited chemical analysis. Additional details will be presented in the PDI QAPP.

In addition, Phase III could include the collection of data needed for:

- Design (e.g., waste characterization)
- Additional structure inspections/structural engineering assessments (e.g., dredge setback and under-structure construction information)
- Confirmation of MNR to benthic SCO areas, if needed (i.e., areas with chemical concentrations greater than the benthic SCO but less than the RAL for Recovery Category 2/3)

[24] Per EPA's responsiveness summary (EPA 2014a), "a single isolated exceedance of a benthic SCO will not trigger additional remedial action. Instead, it will trigger additional monitoring to determine the nature and extent of the contamination in that area. Additional remedial action may be warranted if, for example, monitoring indicates a cluster of three or more points with COC concentrations exceeding the benthic SCO."

5 Schedule

This section presents PDI deliverables and the working schedule for implementing the PDI effort per AOC5 (EPA 2018). A full working schedule for all elements in the middle reach, which may be modified as approved by EPA, is presented in Figure 7-1 in the RDWP.

- Upon approval of the PDI QAPP or QAPP addendum, PDI field work will be initiated. Phase I field work is anticipated to be completed over approximately seven months, from the end of October 2022 until the end of May 2023 (Table 5-1), in order to accommodate shoreline operations, netfishing access, and daytime low tides. All data are expected to be received and validated by approximately four months after the completion of field work (by September 2023). Phase II field, analytical, and validation work is anticipated to be completed over approximately six months (May 2024 through October 2024).
- PDI data will be submitted to EPA 10 days after receipt of validated PDI sampling data for each phase. In the Phase I pre-design sampling, two tiers of analytical rounds are planned. Following receipt of analytical results from Tier 1, a working meeting with EPA will be held to determine which archive samples should be analyzed in Tier 2. A data package will be submitted after data from both tiers have been received and validated. The data package will contain a data file, a map with numbered sampling locations, photographs, field forms, chain of custody forms, laboratory reports, and validation reports. Tiered analyses in Phase II will be discussed in the PDI QAPP Addendum for Phase II. Phase III analyses will not be tiered.
- Two PDI DERs will be submitted to EPA. The Phase I PDI DER will be submitted to EPA with the PDI QAPP Addendum for Phase II 80 days after submittal of all validated PDI data from the first phase of data collection. EPA comments on the Phase I DER will be reflected in subsequent deliverables, rather than submitted in revised versions. The Phase II PDI DER will be submitted to EPA 60 days after submittal of all validated PDI data from the second phase of data collection.
- The 30% RD deliverables will be submitted to EPA 45 days after EPA approval of the Phase II DER.
- If Phase III design sampling is conducted, it is anticipated to be in October and November 2025, with a validated data package submitted to EPA in January 2026. Results will be incorporated into (and appended to) the 90% design report in April 2026.

FINAL

Table 5-1
Anticipated Schedule for PDI Elements

Element	Submittal of Draft to EPA	Final Approved	Field Sampling and Analysis	Validated Data Package Submittal to EPA
PDI QAPP and Phase I Sampling and Analysis	5/25/22	9/29/22	10/31/22 through 9/28/23	9/28/23
PDI QAPP Addendum/Phase I DER and Phase II Sampling and Analysis	12/18/23	4/21/24	5/2/24 through 10/20/24	10/30/24
Phase II DER	12/30/24	4/29/25	NA	NA
PDI QAPP Addendum[1] and Phase III Sampling and Analysis (if needed)	8/28/25	10/1/25	10/4/25 through 1/7/26	1/17/26

Notes:
All dates are as anticipated based on assumed review, field work, and data validation periods. Any changes to the schedule will be subject to EPA approval.
DER: data evaluation report
NA: not applicable
PDI: pre-design investigation
QAPP: quality assurance project plan

6 References

AECOM. 2012a. Final feasibility study, Lower Duwamish Waterway. Prepared for Lower Duwamish Waterway Group. AECOM, Seattle, WA.

AECOM. 2012b. Technical memorandum: supplement to the feasibility study for the LDW Superfund site, approaches for addressing additional concerns in Alternative 5C and development of Alternative 5C Plus scenarios. AECOM, Seattle, WA.

Anchor QEA, Windward. 2019. Remedial design work plan for the Lower Duwamish Waterway upper reach. Final. Submitted to EPA December 16, 2019. Anchor QEA, Inc. and Windward Environmental LLC, Seattle, WA.

Anchor QEA, Windward. 2021. Quality assurance project plan: pre-design surveys of the Lower Duwamish Waterway middle reach. Final. Submitted to EPA October 19, 2021. Anchor QEA and Windward Environmental LLC, Seattle, WA.

Anchor QEA, Windward. 2022. Pre-Design Investigation data evaluation report for the Lower Duwamish Waterway upper reach. Draft. For submittal to US Envirtonmental Protection Agency, February 21, 2022. Anchor QEA and Windward Environmental LLC, Seattle, WA.

DMMP. 2009. Determination on the suitability of proposed maintentance dredged material from the Port of Seattle Terminal 115 Berth-1 maintenance dredging project (NWS-2008-01496) in Duwamish River, Seattle Washington. Dredged Material Management Program.

DMMP. 2021. Dredged material evaluation and disposal procedures. User manual. Dredged Material Management Program: US Army Corps of Engineers, Seattle District, Seattle, WA; US Environmental Protection Agency, Region 10, Seattle, WA; Washington State Department of Natural Resources; and Washington State Department of Ecology, Olympia, WA.

DOF. 2022. Personal communication (email from M. Dalton, DOF, to S. McGroddy, Windward, regarding ICS Embayment Figures). Dalton, Olmsted & Fuglevand, Inc. March 15, 2022.

Ecology. 2015. Site hazard assessment. Independent Metals Plant 2. Washington State Department of Ecology.

Ecology. 2018a. Lower Duwamish Waterway preliminary cleanup level workbook supplemental information. Washington State Department of Ecology.

Ecology. 2018b. Lower Duwamish Waterway preliminary cleanup level workbook. Excel data. Washington State Department of Ecology.

Ecology. 2019. Lower Duwamish Waterway source control status report, 2017. Washington State Department of Ecology.

Ecology. 2020. Lower Duwamish Waterway source control status report, 2018. Washington State Department of Ecology.

Ecology. 2021a. Lower Duwamish cleanup sites update. Publication 21-09-171. Washington State Department of Ecology.

Ecology. 2021b. Lower Duwamish Waterway preliminary cleanup levels. Washington State Department of Ecology.

Ecology. 2022a. Duwamish Waterway Park [online]. Washington State Department of Ecology. Available from: https://apps.ecology.wa.gov/cleanupsearch/site/15139.

Ecology. 2022b. Independent Metals Plant 2 [online]. Washington State Department of Ecology. Available from: https://apps.ecology.wa.gov/cleanupsearch/site/12300.

Ecology, Leidos. 2018. Lower Duwamish Waterway source control status report, January 2014 through December 2016. Washington State Department of Ecology and Leidos, Bellevue, WA.

EPA. 2014a. Record of Decision, Lower Duwamish Waterway Superfund Site. Part 3. Responsiveness summary. US Environmental Protection Agency, Region 10, Seattle, WA.

EPA. 2014b. Record of Decision. Lower Duwamish Waterway Superfund Site. US Environmental Protection Agency.

EPA. 2018. Remedial design statement of work, LDW Upper Reach, Lower Duwamish Waterway Superfund site. Attachment to the *Fourth Amendment of the Administrative Order on Consent for Remedial Investigation/Feasibility Study*. US Environmental Protection Agency, Region 10, Seattle, WA.

EPA. 2021a. Fifth Amendment to the Administrative Order on Consent for remedial investigation/feasibility study (AOC) for the Lower Duwamish Waterway (LDW), CERCLA-10-2001-0055. US Environmental Protection Agency, Region 10, Olympia, WA.

EPA. 2021b. Hazardous waste cleanup: Boeing Plant 2, Tukwila, Washington [online]. US Environmental Protection Agency. Updated September 3, 2021. Available from: https://www.epa.gov/hwcorrectiveactionsites/hazardous-waste-cleanup-boeing-plant-2-tukwila-washington.

EPA. 2021c. Proposed explanation of significant differences. Draft for public comment. Lower Duwamish Waterway Superfund site. US Environmental Protection Agency Region 10, Seattle, WA.

Integral. 2013. Slip 4 Early Action Area, 8th Avenue Terminals sediment sampling and analysis report. Integral Consulting, Seattle, WA.

Integral. 2014. Lower Duwamish Waterway Slip 4 Early Action Area: long-term monitoring data report year 1 (2013). Integral Consulting, Inc., Seattle, WA.

Integral, Windward. 2019. Design strategy recommendations report. Final. Integral Consulting Inc. and Windward Environmental LLC, Seattle, WA.

Integral, Anchor QEA, Windward. 2019. Recovery category recommendations report. Final. Integral Consulting Inc., Anchor QEA, and Windward Environmental LLC, Seattle, WA.

Integral, Moffat & Nichol, Windward. 2018. Waterway user survey and assessment of in-water structures - data report. Integral Consulting Inc., Moffan & Nichol, and Windward Environmental LLC, Seattle, WA.

Windward. 2010. Lower Duwamish Waterway remedial investigation. Remedial investigation report. Final. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward, Integral. 2017. Pre-design studies work plan. Appendix C. Data management plan. Lower Duwamish Waterway Superfund site. Final. Prepared for the Lower Duwamish Waterway Group for submittal to EPA Region 10. Windward Environmental LLC and Integral Consulting Inc., Seattle, WA.

Windward. 2018. Lower Duwamish Waterway baseline surface sediment collection and chemical analyses - quality assurance project plan. Final. Windward Environmental LLC, Seattle, WA.

Windward, Integral. 2018. Technical memorandum: Compilation of existing data. Final. Submitted to EPA on November 19, 2018. Windward Environmental LLC and Integral Consulting Inc., Seattle, WA.

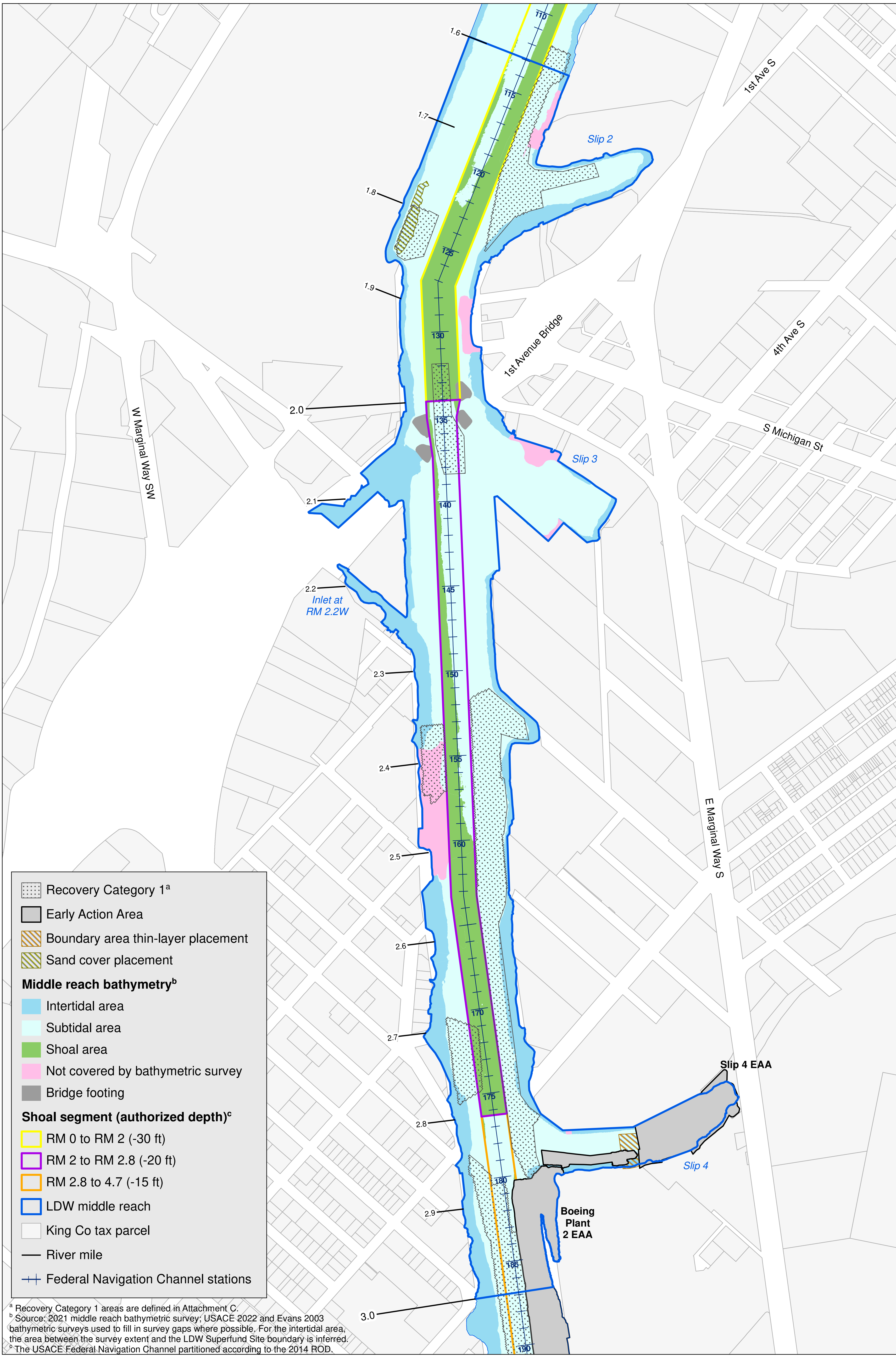
Windward. 2020. Lower Duwamish Waterway pre-design studies data evaluation report (Task 6). Final. Windward Environmental LLC, Seattle, WA.

Windward, Anchor QEA. 2022. Middle reach remedial design work plan. Draft. Appendix D. Quality assurance project plan: pre-design surveys of the Lower Duwamish Waterway middle reach. Windward Environmental LLC and Anchor QEA, Seattle, WA.

Windward, Anchor QEA. 2019. Pre-design investigation work plan for the Lower Duwamish Waterway upper reach. Final. Submitted to EPA December 16, 2019. Windward Environmental LLC and Anchor QEA, Seattle, WA.

Windward, Anchor QEA. 2020. Lower Duwamish Waterway quality assurance project plan for remedial design of Upper Reach: pre-design investigation. Final. Submitted to EPA May 19, 2020. Windward Environmental LLC and Anchor QEA, Seattle, WA.

Maps



[a] Recovery Category 1 areas are defined in Attachment C.
[b] Source: 2021 middle reach bathymetric survey; USACE 2022 and Evans 2003 bathymetric surveys used to fill in survey gaps where possible. For the intertidal area, the area between the survey extent and the LDW Superfund Site boundary is inferred.
[c] The USACE Federal Navigation Channel partitioned according to the 2014 ROD.

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N

0 500 1,000 Feet

0 100 200 Meters

Map 1. Overview of the middle reach (RM 1.6 - RM 3.0)

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

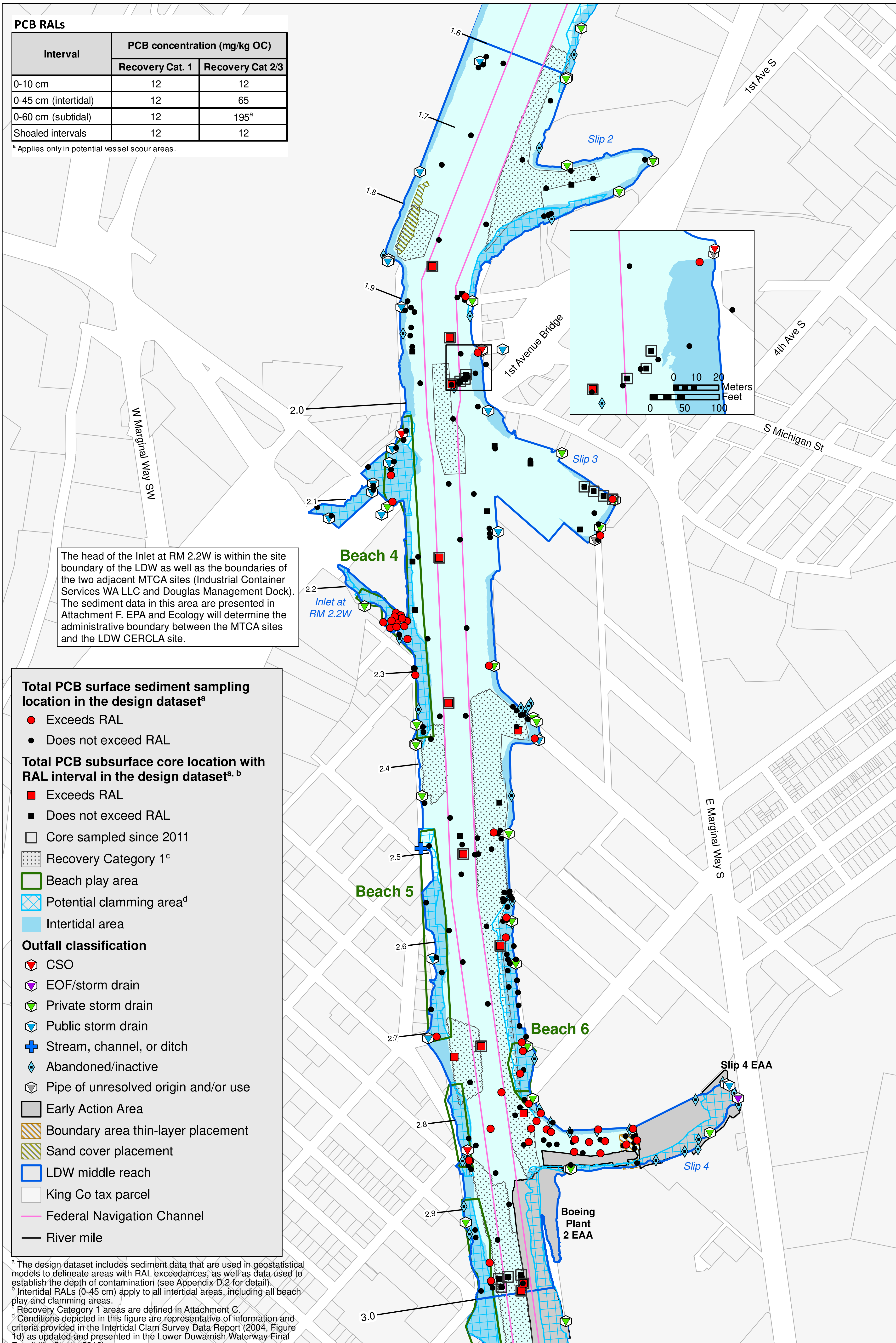
FEBRUARY 14, 2023

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map 01 7419 Middle Reach Vicinity Map.mxd

PCB RALs

Interval	PCB concentration (mg/kg OC)	
	Recovery Cat. 1	Recovery Cat 2/3
0-10 cm	12	12
0-45 cm (intertidal)	12	65
0-60 cm (subtidal)	12	195[a]
Shoaled intervals	12	12

[a] Applies only in potential vessel scour areas.



[a] The design dataset includes sediment data that are used in geostatistical models to delineate areas with RAL exceedances, as well as data used to establish the depth of contamination (see Appendix D.2 for detail).
[b] Intertidal RALs (0-45 cm) apply to all intertidal areas, including all beach play and clamming areas.
[c] Recovery Category 1 areas are defined in Attachment C.
[d] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012).

0 500 1,000 Feet
0 100 200 Meters

Map 2. Total PCB results compared to RALs in the LDW middle reach

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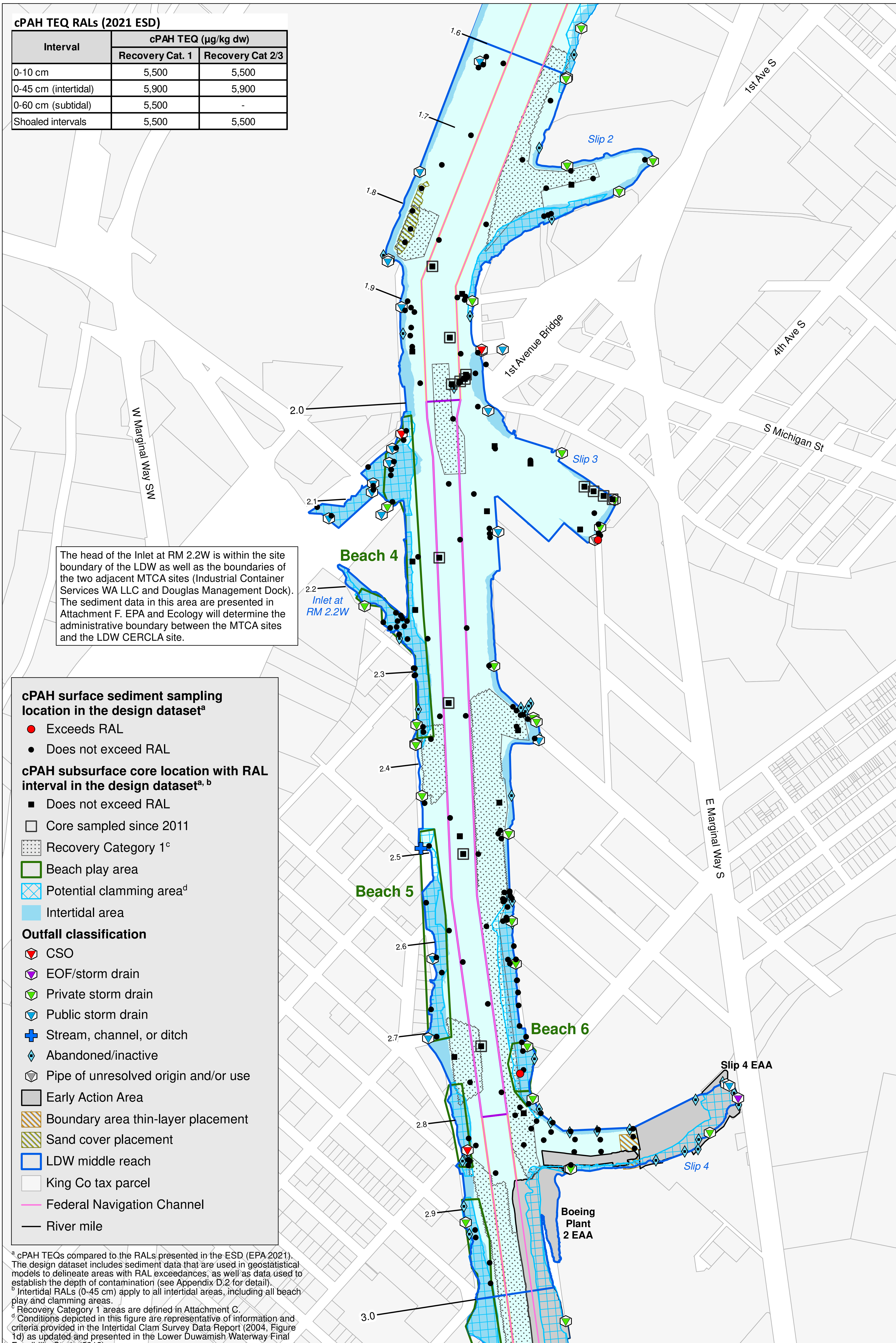

cPAH TEQ RALs (2021 ESD)

Interval	cPAH TEQ (µg/kg dw)	
	Recovery Cat. 1	Recovery Cat 2/3
0-10 cm	5,500	5,500
0-45 cm (intertidal)	5,900	5,900
0-60 cm (subtidal)	5,500	-
Shoaled intervals	5,500	5,500

[a] cPAH TEQs compared to the RALs presented in the ESD (EPA 2021). The design dataset includes sediment data that are used in geostatistical models to delineate areas with RAL exceedances, as well as data used to establish the depth of contamination (see Appendix D.2 for detail).
[b] Intertidal RALs (0-45 cm) apply to all intertidal areas, including all beach play and clamming areas.
[c] Recovery Category 1 areas are defined in Attachment C.
[d] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012).

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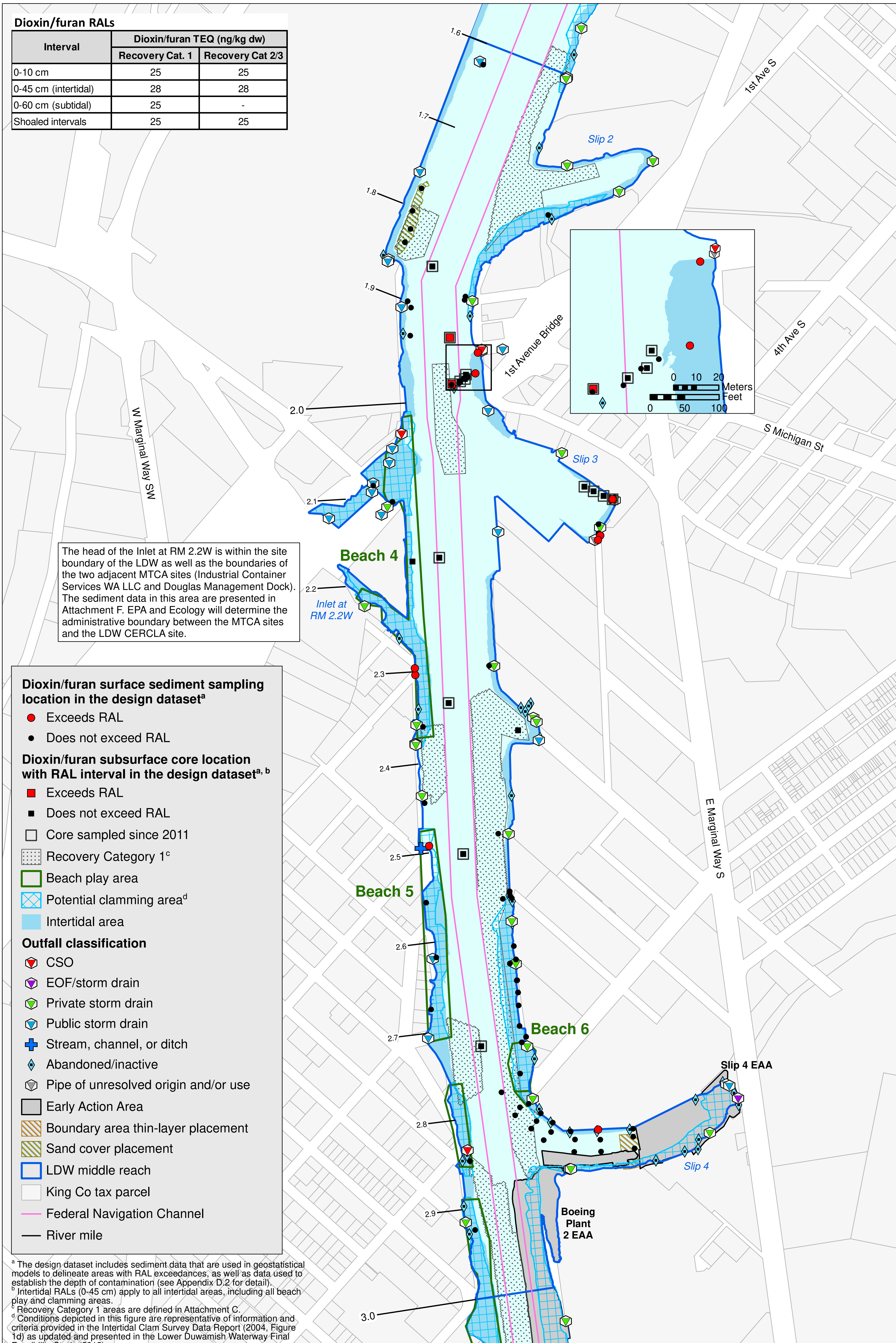
Map 3. cPAH TEQ results compared to RALs in the LDW middle reach

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

Dioxin/furan RALs

Interval	Dioxin/furan TEQ (ng/kg dw)	
	Recovery Cat. 1	Recovery Cat 2/3
0-10 cm	25	25
0-45 cm (intertidal)	28	28
0-60 cm (subtidal)	25	-
Shoaled intervals	25	25



The head of the Inlet at RM 2.2W is within the site boundary of the LDW as well as the boundaries of the two adjacent MTCA sites (Industrial Container Services WA LLC and Douglas Management Dock). The sediment data in this area are presented in Attachment F. EPA and Ecology will determine the administrative boundary between the MTCA sites and the LDW CERCLA site.

Dioxin/furan surface sediment sampling location in the design dataset[a]
- Exceeds RAL
- Does not exceed RAL

Dioxin/furan subsurface core location with RAL interval in the design dataset[a, b]
- Exceeds RAL
- Does not exceed RAL
- Core sampled since 2011
- Recovery Category 1[c]
- Beach play area
- Potential clamming area[d]
- Intertidal area

Outfall classification
- CSO
- EOF/storm drain
- Private storm drain
- Public storm drain
- Stream, channel, or ditch
- Abandoned/inactive
- Pipe of unresolved origin and/or use
- Early Action Area
- Boundary area thin-layer placement
- Sand cover placement
- LDW middle reach
- King Co tax parcel
- Federal Navigation Channel
- River mile

[a] The design dataset includes sediment data that are used in geostatistical models to delineate areas with RAL exceedances, as well as data used to establish the depth of contamination (see Appendix D.2 for detail).
[b] Intertidal RALs (0-45 cm) apply to all intertidal areas, including all beach play and clamming areas.
[c] Recovery Category 1 areas are defined in Attachment C.
[d] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012).

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0 500 1,000 Feet
0 100 200 Meters

Map 4. Dioxin/furan TEQ results compared to RALs in the LDW middle reach

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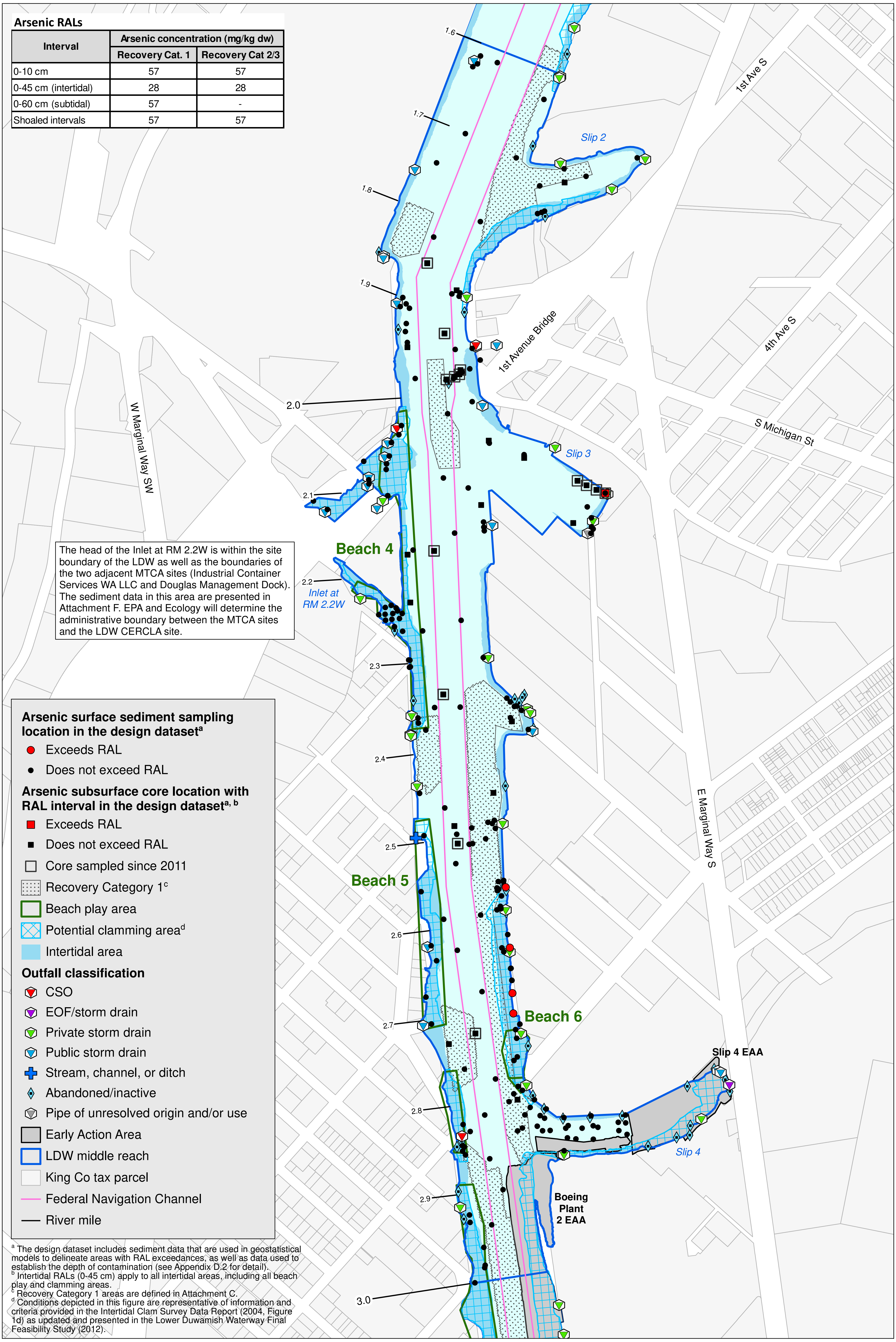

Arsenic RALs

Interval	Arsenic concentration (mg/kg dw)	
	Recovery Cat. 1	Recovery Cat 2/3
0-10 cm	57	57
0-45 cm (intertidal)	28	28
0-60 cm (subtidal)	57	-
Shoaled intervals	57	57

The head of the Inlet at RM 2.2W is within the site boundary of the LDW as well as the boundaries of the two adjacent MTCA sites (Industrial Container Services WA LLC and Douglas Management Dock). The sediment data in this area are presented in Attachment F. EPA and Ecology will determine the administrative boundary between the MTCA sites and the LDW CERCLA site.

Arsenic surface sediment sampling location in the design dataset[a]

- Exceeds RAL
- Does not exceed RAL

Arsenic subsurface core location with RAL interval in the design dataset[a, b]

- Exceeds RAL
- Does not exceed RAL
- Core sampled since 2011
- Recovery Category 1[c]
- Beach play area
- Potential clamming area[d]
- Intertidal area

Outfall classification

- CSO
- EOF/storm drain
- Private storm drain
- Public storm drain
- Stream, channel, or ditch
- Abandoned/inactive
- Pipe of unresolved origin and/or use
- Early Action Area
- LDW middle reach
- King Co tax parcel
- Federal Navigation Channel
- River mile

[a] The design dataset includes sediment data that are used in geostatistical models to delineate areas with RAL exceedances, as well as data used to establish the depth of contamination (see Appendix D.2 for detail).
[b] Intertidal RALs (0-45 cm) apply to all intertidal areas, including all beach play and clamming areas.
[c] Recovery Category 1 areas are defined in Attachment C.
[d] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012).

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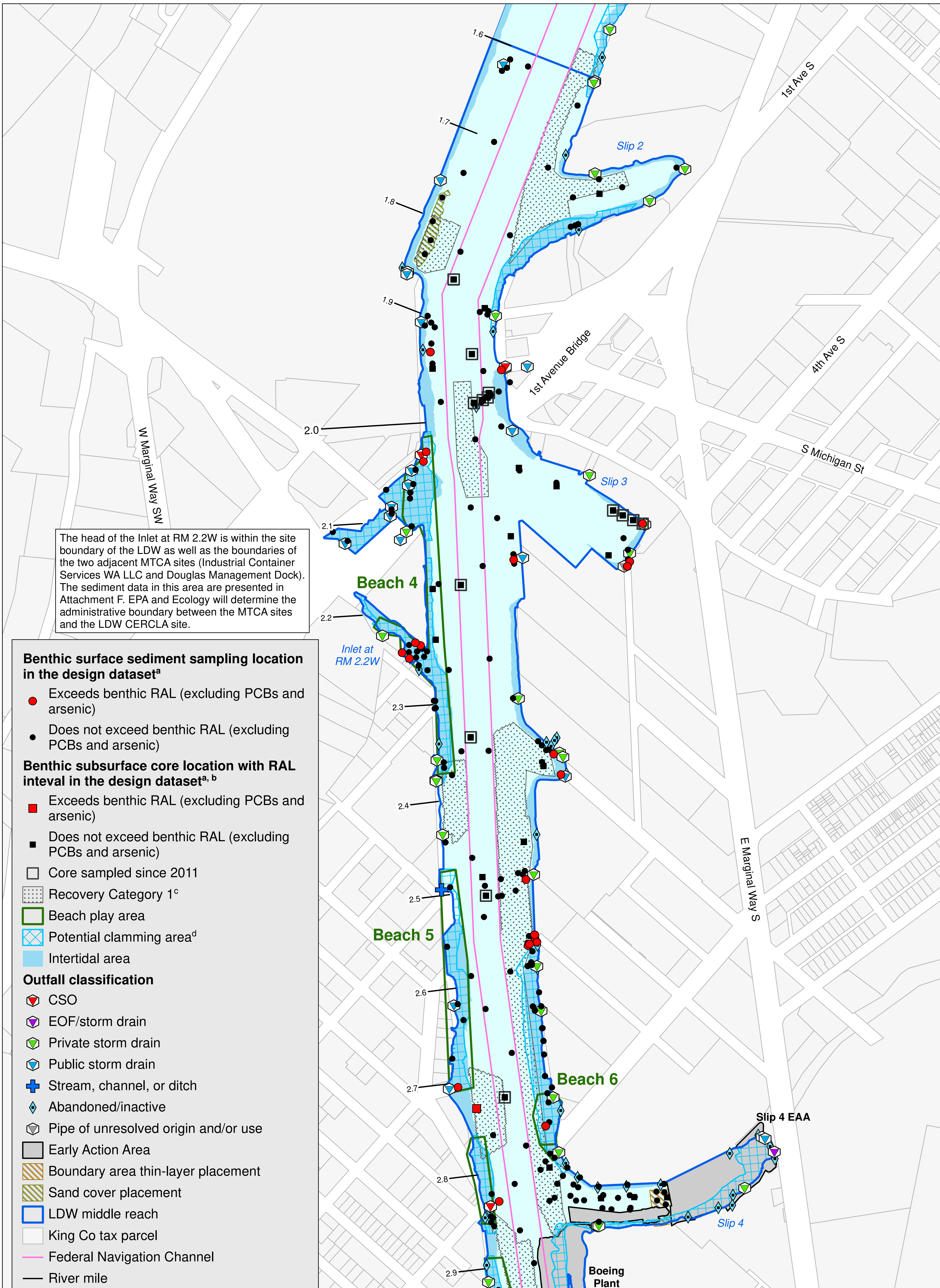
0 500 1,000 Feet
0 100 200 Meters

Map 5. Arsenic results compared to RALs in the LDW middle reach

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023



[a] The design dataset includes sediment data that are used in geostatistical models to delineate areas with RAL exceedances, as well as data used to establish the depth of contamination (see Appendix D.2 for detail). Maps 7a through 7d identify the specific chemicals with benthic RAL exceedances at each location.
[b] Intertidal RALs (0-45 cm) apply to all intertidal areas, including all beach play and clamming areas.
[c] Recovery Category 1 areas are defined in Attachment C.
[d] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012).

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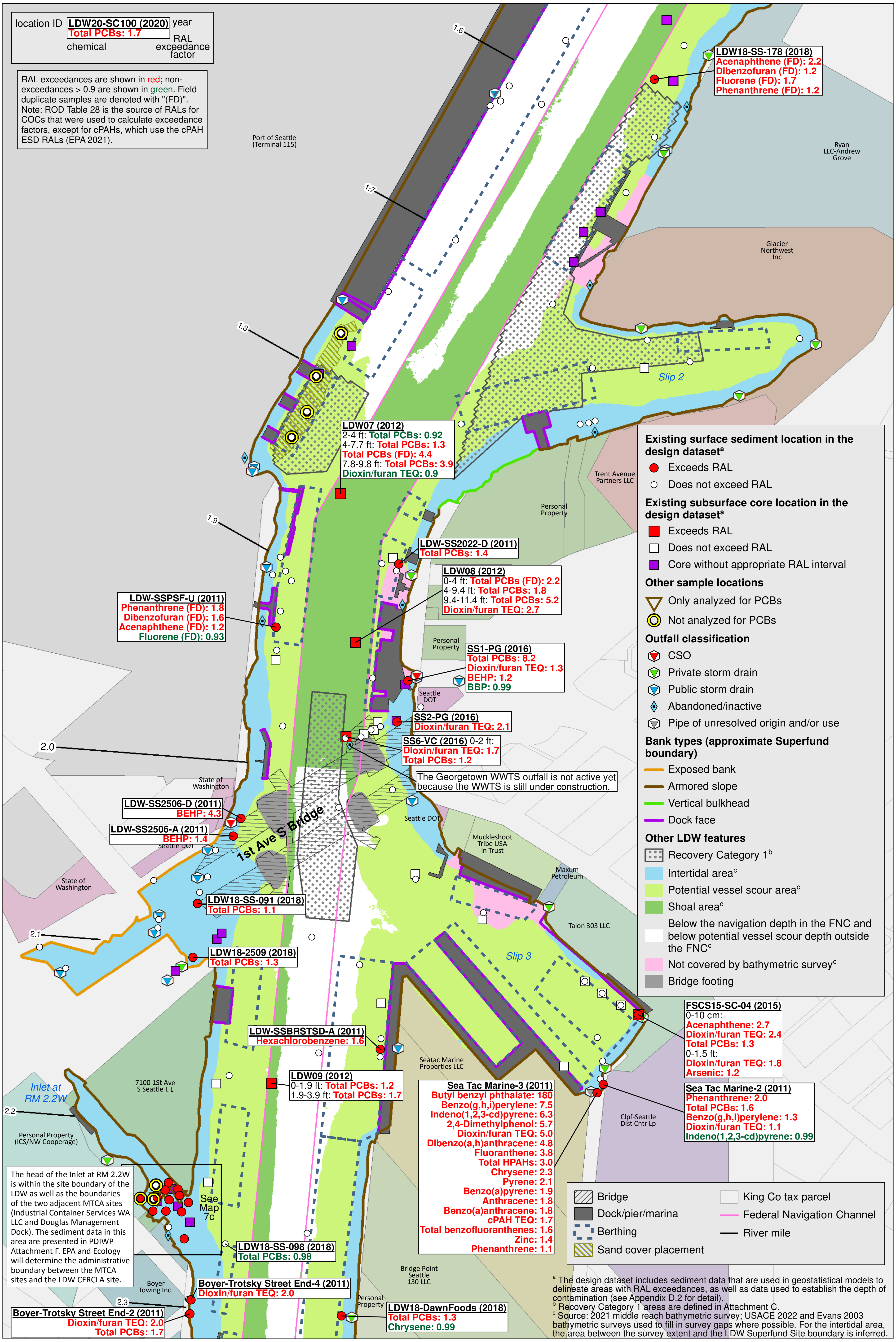
Map 6. Benthic RAL exceedances in the LDW middle reach

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023



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Map 7a. Sediment RAL exceedances from RM 1.6 to RM 2.3

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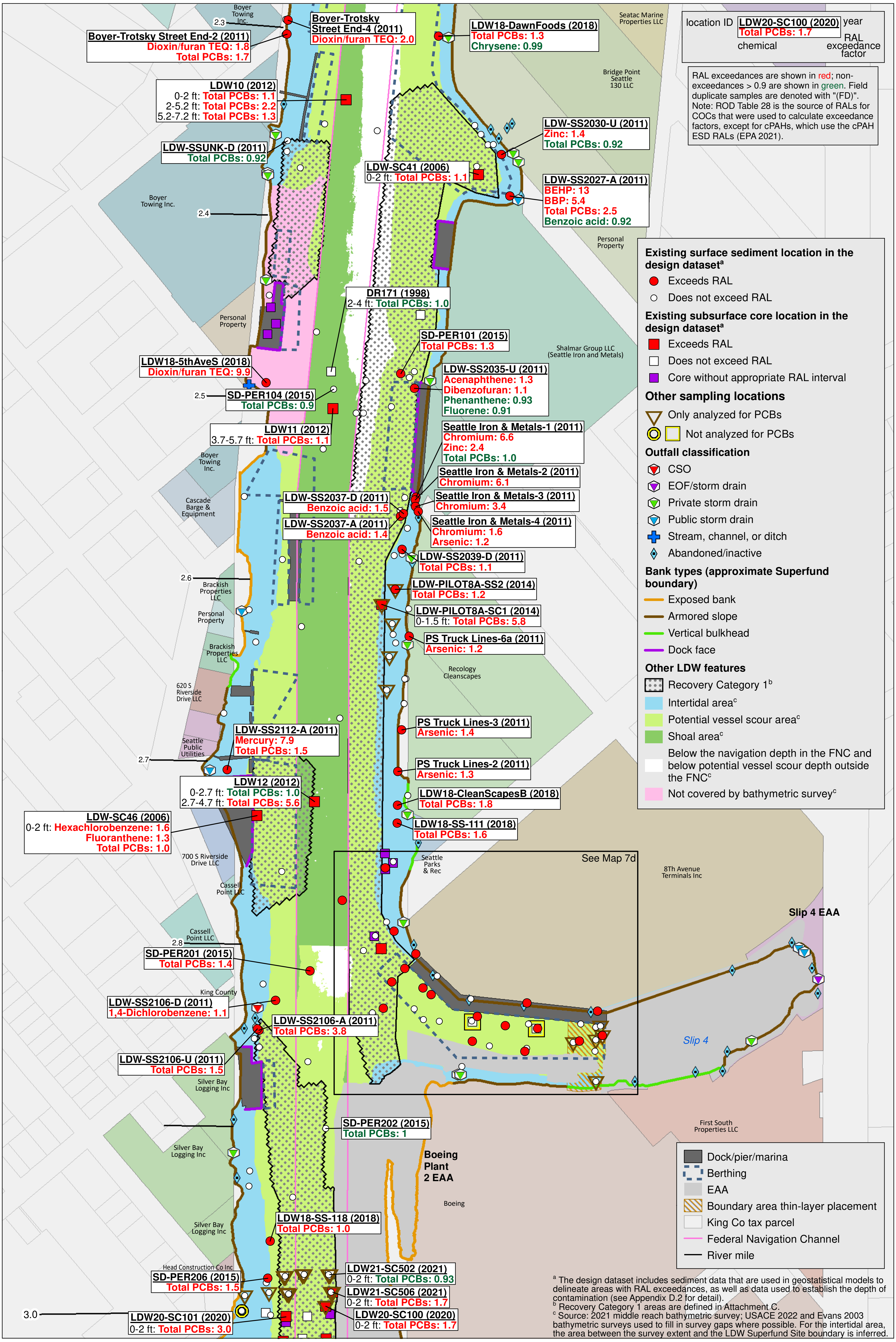

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0 200 400 Feet
0 50 100 Meters

Map 7b. Sediment RAL exceedances from RM 2.3 to RM 3.0

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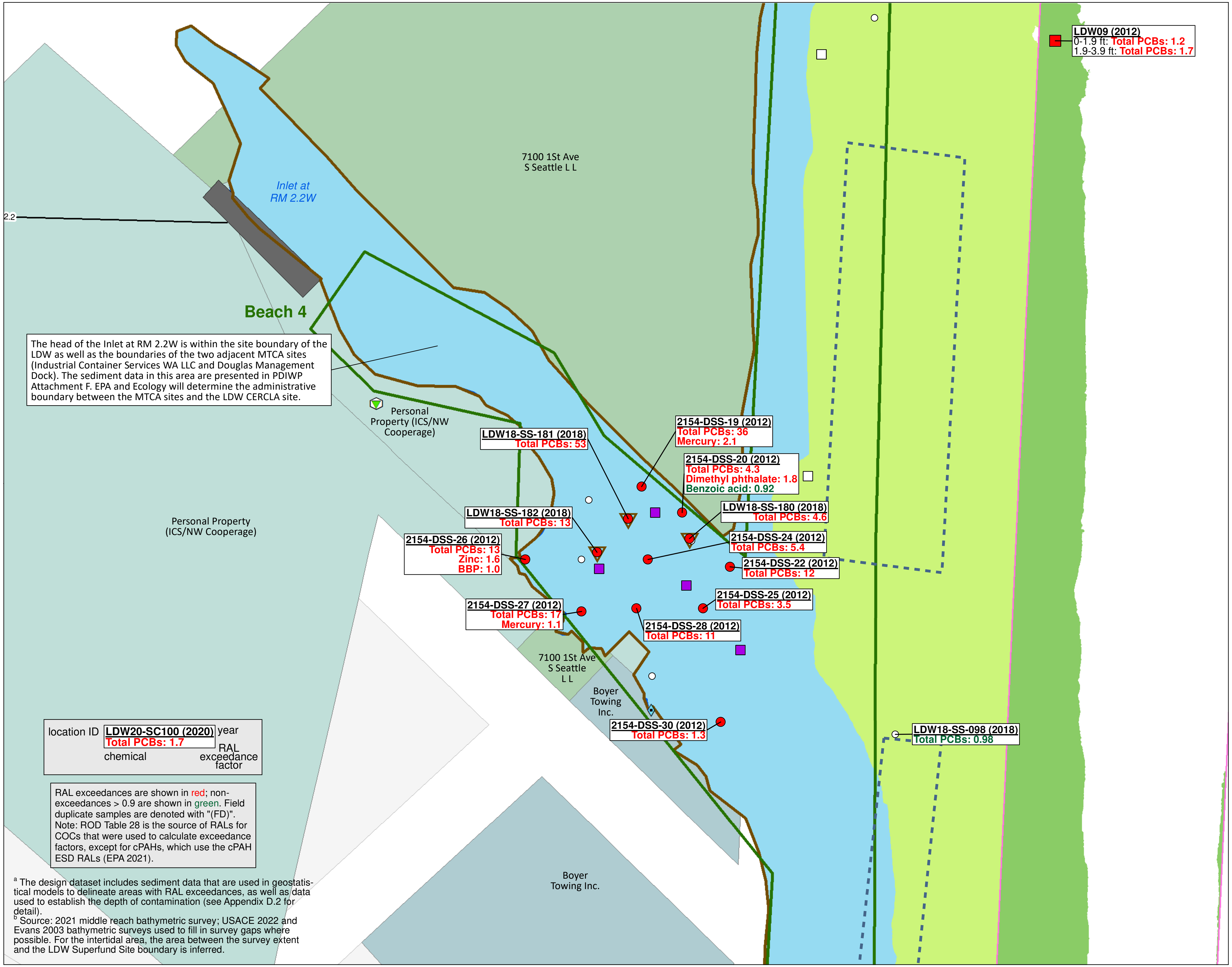

Surface sediment sampling location in the design dataset[a]

- Exceeds RAL
- Does not exceed RAL

Subsurface core locations in the design dataset[a]

- Exceeds RAL
- Does not exceed RAL
- Core without appropriate RAL interval

Other sampling locations

- Only analyzed for PCBs

Outfall classification

- Private storm drain
- Abandoned/inactive

Bank types (approximate Superfund boundary)

- Armored slope

Other LDW features

- Intertidal area[b]
- Potential scour area[b]
- Shoal area[b]
- Below the navigation depth in the FNC and below prop scour depth outside the FNC[b]
- Dock/pier/marina
- Berthing
- Beach play area
- King Co tax parcel
- Federal Navigation Channel
- River mile

Map 7c. Sediment RAL exceedances east of the preliminary administrative boundary within and adjacent to the Industrial Container Services MTCA site

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH — FEBRUARY 14, 2023

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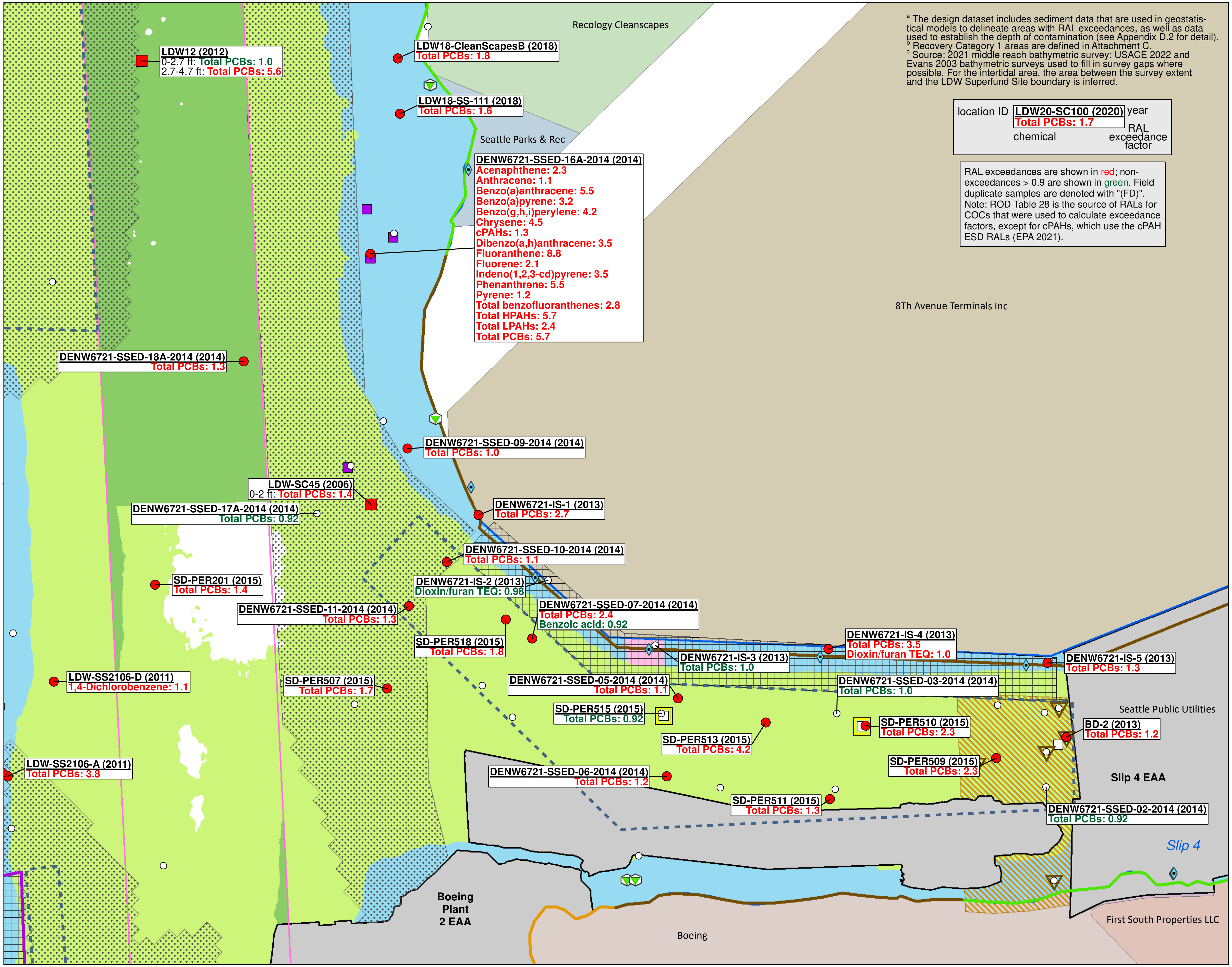

[a] The design dataset includes sediment data that are used in geostatistical models to delineate areas with RAL exceedances, as well as data used to establish the depth of contamination (see Appendix D.2 for detail).
[b] Recovery Category 1 areas are defined in Attachment C.
[c] Source: 2021 middle reach bathymetric survey; USACE 2022 and Evans 2003 bathymetric surveys used to fill in survey gaps where possible. For the intertidal area, the area between the survey extent and the LDW Superfund Site boundary is inferred.

RAL exceedances are shown in red; non-exceedances > 0.9 are shown in green. Field duplicate samples are denoted with "(FD)". 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).

Existing surface sediment location in the design dataset[a]
- Exceeds RAL
- Does not exceed RAL

Existing subsurface core location in the design dataset[a]
- Exceeds RAL
- Does not exceed RAL
- Core without appropriate RAL interval

Other sampling locations
- Only analyzed for PCBs
- Not analyzed for PCBs

Outfall classification
- CSO
- Private storm drain
- Abandoned/inactive

Bank types (approximate Superfund boundary)
- Exposed bank
- Armored slope
- Vertical bulkhead
- Dock face

Other LDW features
- Recovery Category 1[b]
- Intertidal area[c]
- Potential vessel scour area[c]
- Shoal area[c]
- Below the navigation depth in the FNC and below potential vessel scour depth outside the FNC[c]
- Not covered by bathymetric survey[c]
- Early Action Area
- Boundary area thin-layer
- Dock/pier
- Berthing
- King Co tax parcel
- Federal Navigation Channel

Map 7d. Sediment RAL exceedances in the vicinity of Slip 4

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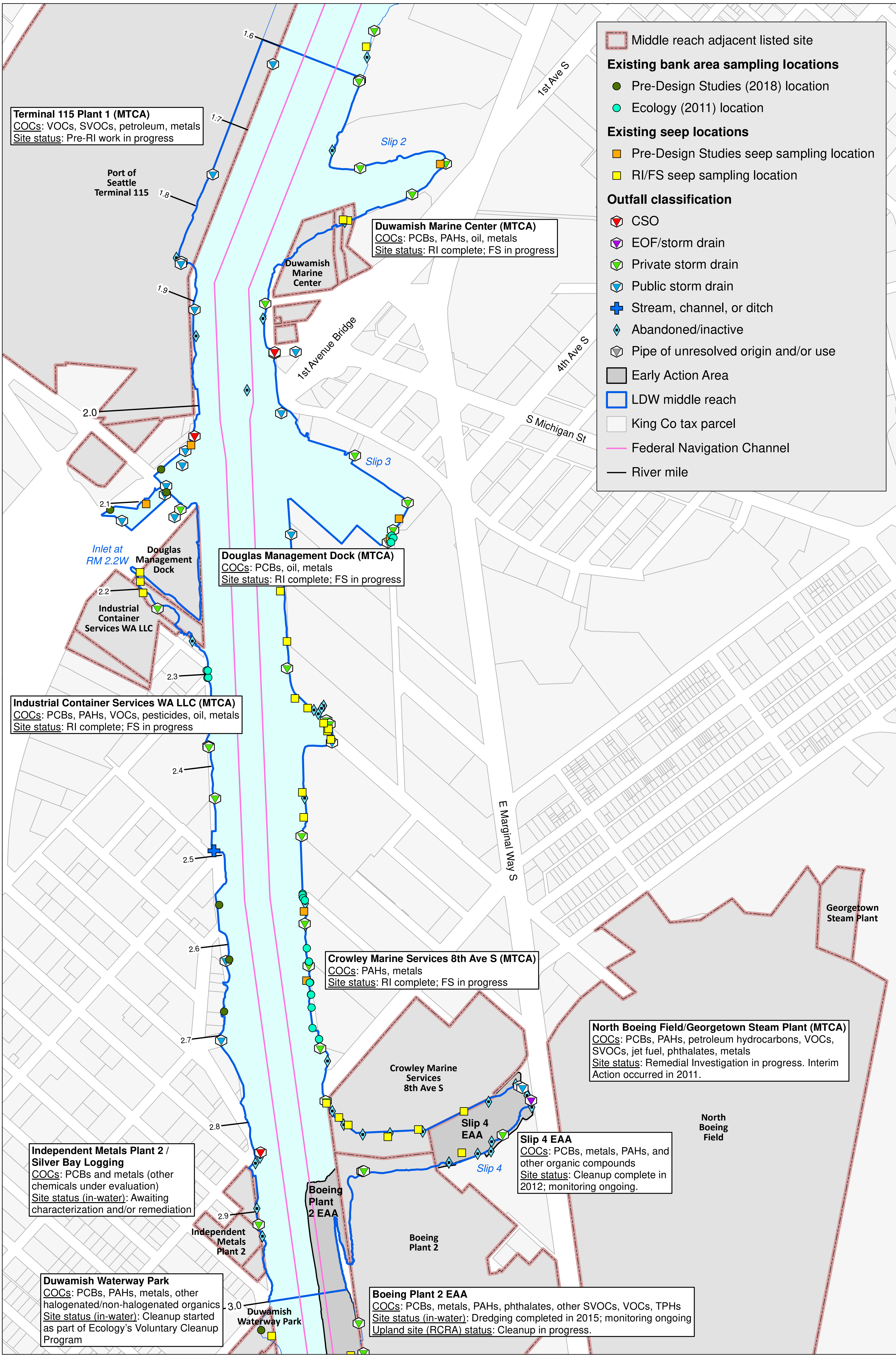
Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map 07d 7321 Middle reach Slip 4.mxd



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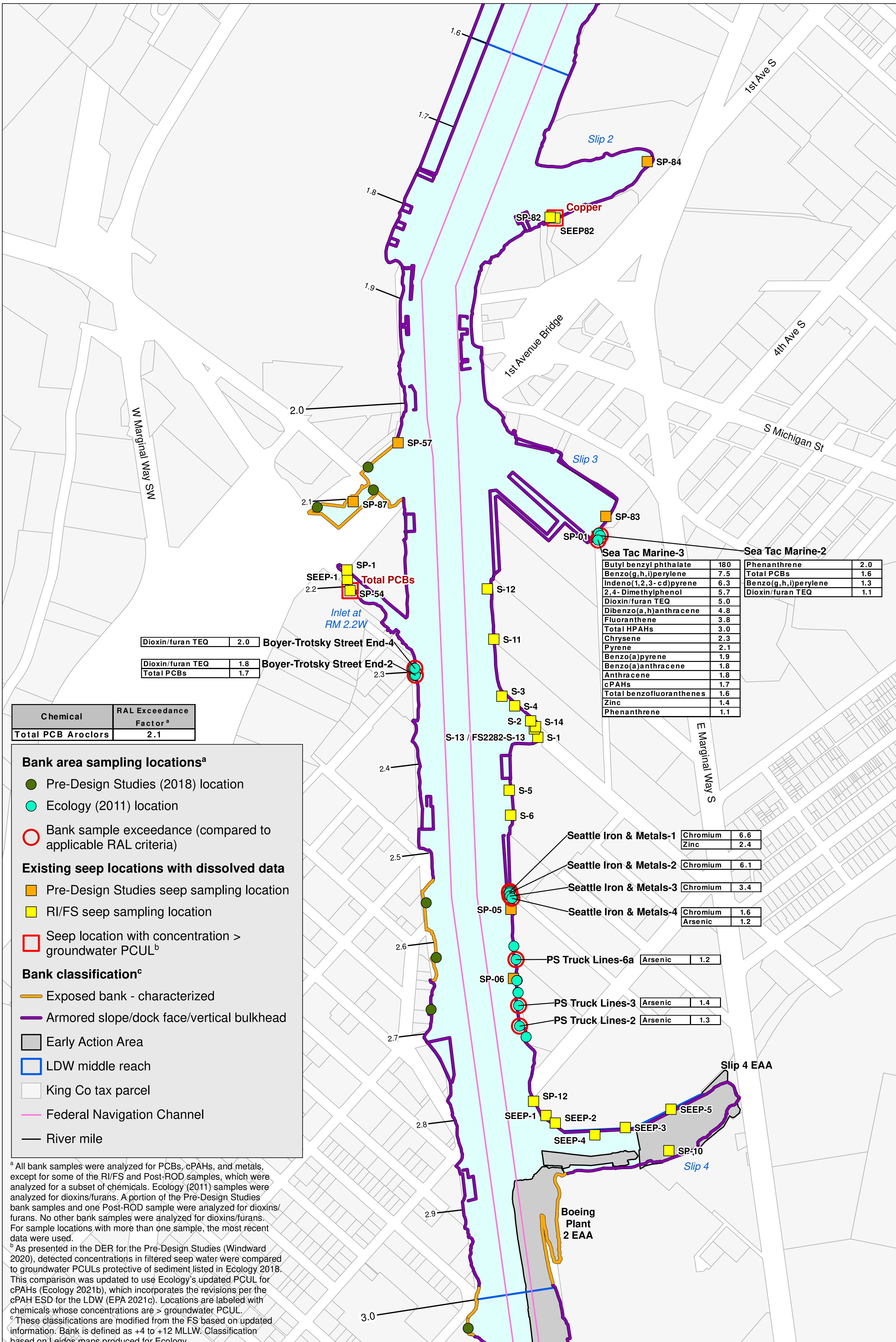
Map 8. EAAs and adjacent listed sites in the LDW middle reach

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map 08 7437 EAAs and listed sites.mxd



Sea Tac Marine-3

Butyl benzyl phthalate	180
Benzo(g,h,i)perylene	7.5
Indeno(1,2,3-cd)pyrene	6.3
2,4-Dimethylphenol	5.7
Dioxin/furan TEQ	5.0
Dibenzo(a,h)anthracene	4.8
Fluoranthene	3.8
Total HPAHs	3.0
Chrysene	2.3
Pyrene	2.1
Benzo(a)pyrene	1.9
Benzo(a)anthracene	1.8
Anthracene	1.8
cPAHs	1.7
Total benzofluoranthenes	1.6
Zinc	1.4
Phenanthrene	1.1

Sea Tac Marine-2

Phenanthrene	2.0
Total PCBs	1.6
Benzo(g,h,i)perylene	1.3
Dioxin/furan TEQ	1.1

Boyer-Trotsky Street End-4

Dioxin/furan TEQ	2.0

Boyer-Trotsky Street End-2

Dioxin/furan TEQ	1.8
Total PCBs	1.7

Seattle Iron & Metals-1

Chromium	6.6
Zinc	2.4

Seattle Iron & Metals-2

Chromium	6.1

Seattle Iron & Metals-3

Chromium	3.4

Seattle Iron & Metals-4

Chromium	1.6
Arsenic	1.2

PS Truck Lines-6a

Arsenic	1.2

PS Truck Lines-3

Arsenic	1.4

PS Truck Lines-2

Arsenic	1.3

Chemical	RAL Exceedance Factor[a]
Total PCB Aroclors	2.1

Bank area sampling locations[a]

- Pre-Design Studies (2018) location
- Ecology (2011) location
- Bank sample exceedance (compared to applicable RAL criteria)

Existing seep locations with dissolved data

- Pre-Design Studies seep sampling location
- RI/FS seep sampling location
- Seep location with concentration > groundwater PCUL[b]

Bank classification[c]

- Exposed bank - characterized
- Armored slope/dock face/vertical bulkhead
- Early Action Area
- LDW middle reach
- King Co tax parcel
- Federal Navigation Channel
- River mile

[a] All bank samples were analyzed for PCBs, cPAHs, and metals, except for some of the RI/FS and Post-ROD samples, which were analyzed for a subset of chemicals. Ecology (2011) samples were analyzed for dioxins/furans. A portion of the Pre-Design Studies bank samples and one Post-ROD sample were analyzed for dioxins/furans. No other bank samples were analyzed for dioxins/furans. For sample locations with more than one sample, the most recent data were used.
[b] As presented in the DER for the Pre-Design Studies (Windward 2020), detected concentrations in filtered seep water were compared to groundwater PCULs protective of sediment listed in Ecology 2018. This comparison was updated to use Ecology's updated PCUL for cPAHs (Ecology 2021b), which incorporates the revisions per the cPAH ESD for the LDW (EPA 2021c). Locations are labeled with chemicals whose concentrations are > groundwater PCUL.
[c] These classifications are modified from the FS based on updated information. Bank is defined as +4 to +12 MLLW. Classification based on Leidos maps produced for Ecology.

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map 09 7438 Seeps and bank samples.mxd

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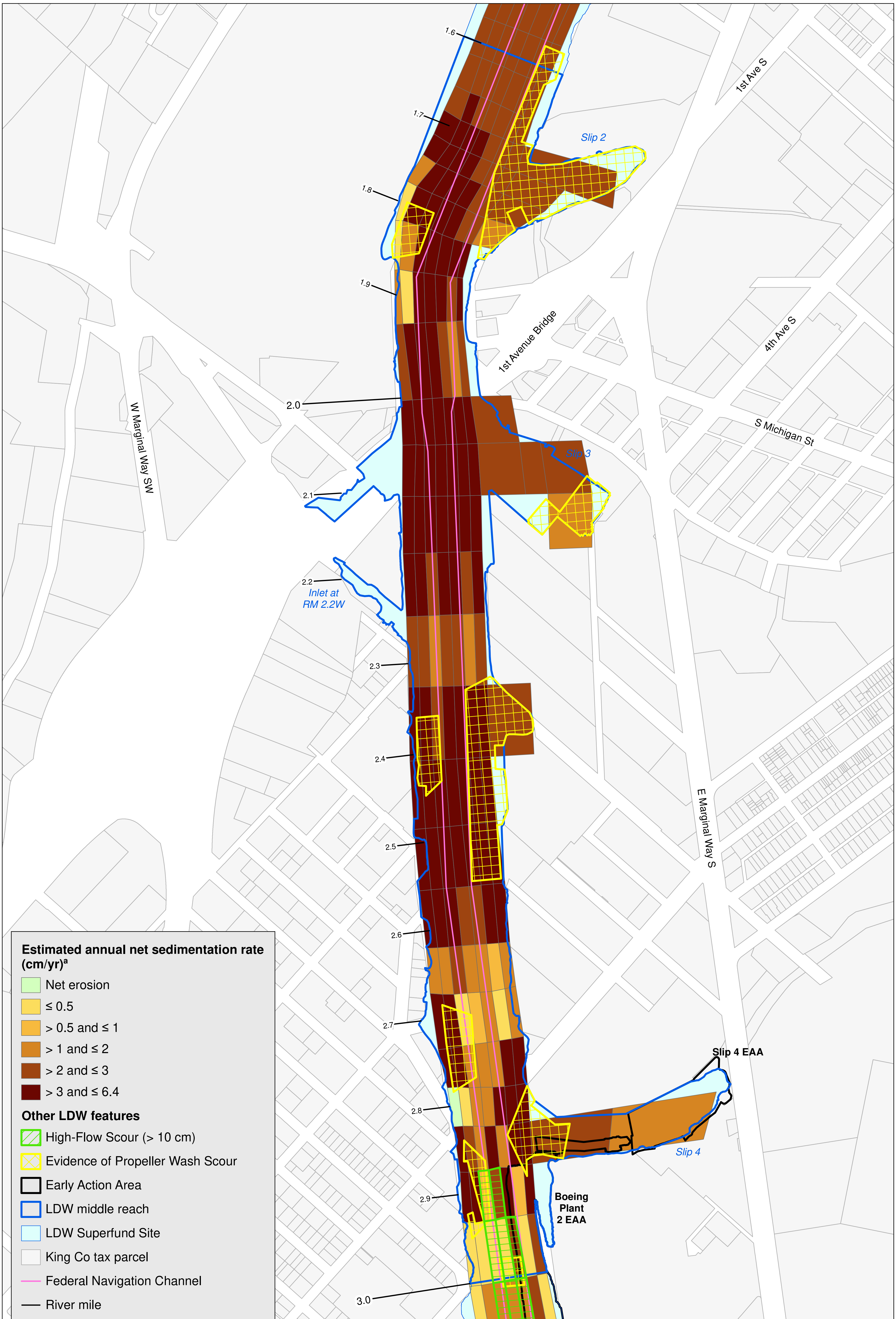
0 500 1,000 Feet
0 100 200 Meters

Map 9. Seep and bank source data in the LDW middle reach

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH
FEBRUARY 14, 2023



[a] Source: AECOM 2012.

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map 10 7439 Net sedimentation rates.mxd

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Map 10. Estimated annual net sedimentation rates and scour areas in the middle reach

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

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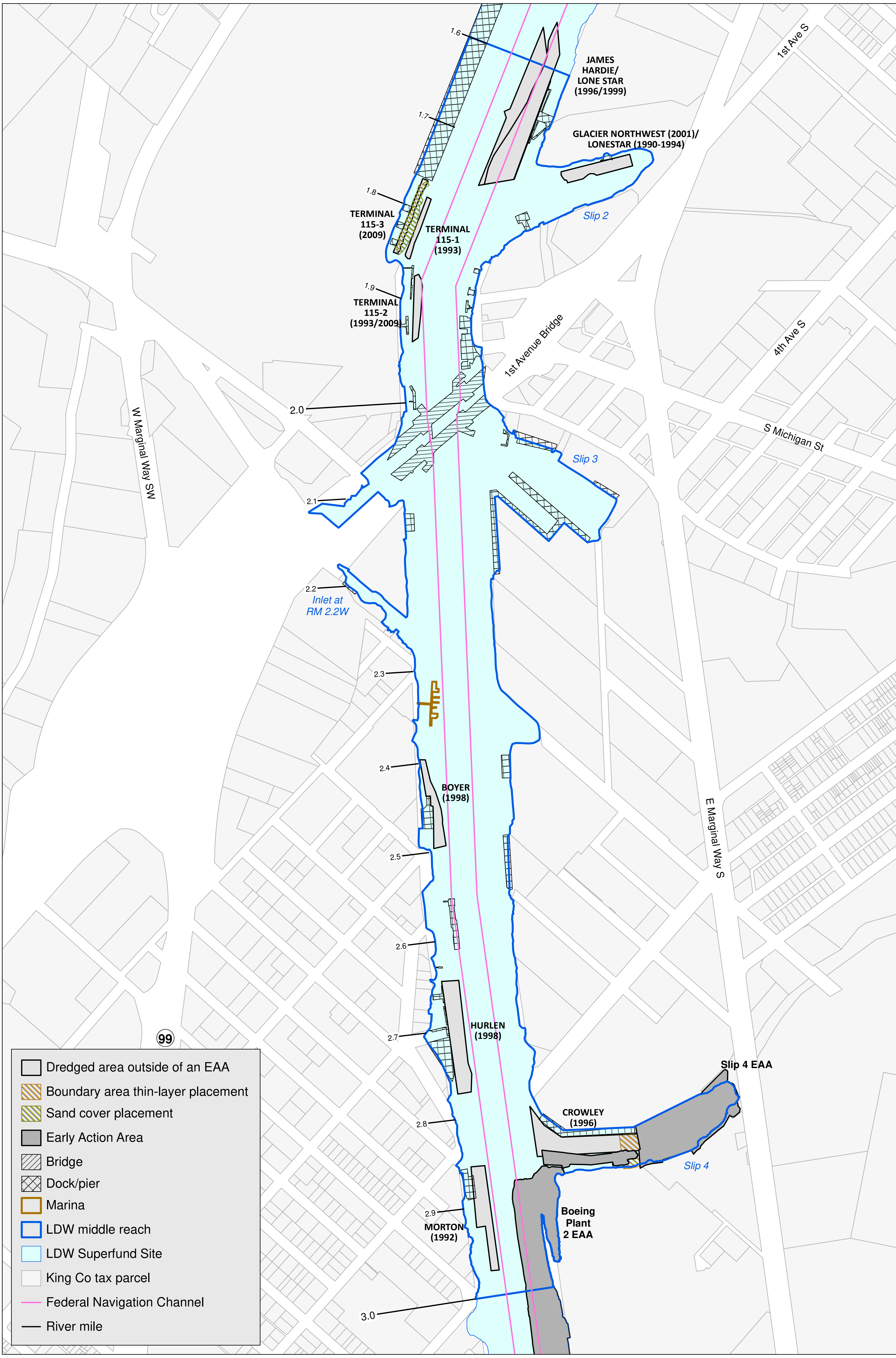

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map 11 7440 Dredged areas.mxd

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Map 11. Areas in the LDW middle reach dredged or with thin-layer or sand cover placements since 1990

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

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Attachment A
EAA Data Including Monitoring and Perimeter Data

A.1 Introduction

This attachment to the Pre-Design Investigation Work Plan (PDIWP) describes post-construction monitoring and summarizes results for the Slip 4 and Boeing Plant 2 early action areas (EAAs), which are located in the middle reach of the Lower Duwamish Waterway (LDW) (Table A-1). An understanding of the current conditions in the EAAs is helpful in Pre-Design Investigation (PDI) sampling design and data interpretation for areas adjacent to the EAAs.

In addition to summarizing data collected from within the EAAs, this attachment presents data collected along the perimeter of the Boeing Plant 2 EAA during post-construction monitoring. Data from the latest round of Boeing Plant 2 EAA perimeter monitoring are included in the middle reach design dataset, whereas data collected within the two EAA boundaries and older data from the Boeing Plant 2 EAA perimeter monitoring are considered supplemental data and are not included in the middle reach design dataset.

Table A-1
Summary of Post-construction Monitoring Activities within EAAs in the Middle Reach

RM	Location	Construction Complete	Monitoring Events	Depth Interval	No. of Locations	Analytes Monitored
2.8 to 2.9 E	City of Seattle Slip 4 EAA[1]	2012	2013 2015 2017 2019	0–10 cm	10[2]	SMS analytes (including PCBs, PAHs, and metals)[3]
2.9 to 3.6 E	Boeing Plant 2 EAA[4]	2015	2015 2016 2018 2020	0–10 cm	36 (10 within the middle reach)	SMS analytes (including PCBs, PAHs, and metals), dioxins/furans[5]

Notes:

1. The EAA includes 3.8 acres at the head of the slip.
2. Includes two samples collected for PCB analysis in 2013 to characterize the 9-in.-thick dredge residual management layer placed just outside the EAA boundary in 2012, as described in Section 3.5 of the main document.
3. There are 47 SMS analytes, as listed in WAC 173-204-562. In addition to the reported results for individual PAHs, PAH results are reported as cPAH TEQs and total PAHs.
4. The portion of Boeing Plant 2 EAA within the middle reach of the LDW is the focus of this attachment (i.e., RM 2.9 to RM 3.0, including the southern part of Slip 4 adjacent to the City of Seattle Slip 4 EAA). The rest of the Boeing Plant 2 monitoring results are discussed in the upper reach PDIWP (Windward and Anchor QEA 2019).
5. Dioxins/furans were analyzed in a subset of samples.

cPAH: carcinogenic polycyclic aromatic hydrocarbon
EAA: early action area
LDW: Lower Duwamish Waterway
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl

RM: river mile
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent
WAC: Washington Administrative Code

A.2 City of Seattle Slip 4

Remedial action construction activities for the Slip 4 EAA were completed in 2012 under US Environmental Protection Agency (EPA) oversight (Integral 2012). Post-construction monitoring has been conducted at eight locations to document surface sediment (0 to 10 cm) chemical concentrations over time (Table A-1). The first sampling event was conducted in 2013 (Year 1), with subsequent sampling conducted in 2015 (Year 3), 2017 (Year 5), and 2019 (Year 7) (Integral 2015, 2014; Windward 2018, 2020). Additional sampling will be conducted in 2022 (Year 10) and any further sampling after Year 10 will be determined in consultation with the EPA. Samples were analyzed for Washington State Sediment Management Standard (SMS) analytes, including total polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and metals. Map A-1 shows exceedances of benthic sediment cleanup objectives (SCOs) or cleanup screening levels (CSLs) (Washington Administrative Code [WAC] 173-204-562) for Years 1, 3, 5, and 7. In 2019 (Year 7), four locations had at least one detected SMS exceedance. Bis(2-ethylhexyl) phthalate (BEHP) and butyl benzyl phthalate had CSL exceedances at two locations (Map A-1). Total PCBs and BEHP had SCO exceedances at two locations each, and fluoranthene and zinc had SCO exceedances at one location each.

Slip 4 remediation included the placement of a 9-in.-thick dredge residual management layer just outside the Slip 4 EAA boundary in 2012, as described in Section 3.5 of the main document. Two samples were collected in this area for PCB analysis as part of the 2013 monitoring following placement of the layer. The total PCB concentration in one sample (4.1 mg/kg organic carbon [OC]) was less than the benthic SCO of 12 mg/kg OC. The area where this sample was collected was subsequently dredged as part of Boeing Plant 2 remediation in 2015. The total PCB concentration in the other sample was 410 µg/kg,[1] a concentration greater than the lowest apparent effects threshold (LAET) of 130 µg/kg. Samples were not collected at these two locations in subsequent years. The data for the sample that was not dredged are included in the design dataset.

A.3 Boeing Plant 2

Remedial action construction activities for the Boeing Plant 2 EAA were conducted in three dredge seasons and were completed in 2015 (Amec Foster Wheeler et al. 2016). Post-construction monitoring has been conducted both within and outside the EAA; both types of data are presented in this section.

A.3.1 Monitoring Within the EAA

Under EPA oversight, The Boeing Company (Boeing) has been conducting post-construction monitoring, including the collection of 0- to 10-cm sediment samples at 36 locations within the

[1] The total organic carbon (TOC) was outside the range for organic carbon normalization so the total PCB concentration is compared to dry weight LAET value.

EAA. Ten of these locations are within the middle reach of the LDW: two locations in Slip 4, four locations in the intertidal area along the main channel of the LDW, and four locations within the embayment of the North Shoreline habitat project area between +4 and +7 mean lower low water (Amec Foster Wheeler et al. 2016). Sediment samples for Year 0 (2015), Year 1 (2016), Year 3 (2018), and Year 5 (2020) have been analyzed for SMS analytes (including total PCBs, PAHs, and metals) and dioxins/furans (Amec Foster Wheeler 2016; Amec Foster Wheeler et al. 2016; Wood 2018, 2020). Additional sampling will be conducted in 2022 and 2025 (AMEC et al. 2014).

Detected benthic SCO exceedances at Boeing Plant 2 EAA monitoring locations in the middle reach are shown on Map A-2. Also shown on Map A-2 are the three perimeter locations within the Slip 4 dredge prism area.[2] These perimeter location results are from Year 0 post-construction monitoring conducted in March 2015 following the completion of all dredging and backfilling activities in Slip 4 (Amec Foster Wheeler et al. 2016). There were no benthic SCO exceedances at these three locations. Two locations have been analyzed for dioxins/furans in the middle reach: SD-PCM001 (Years 0 and 1) and SD-PCM010 (Years 0, 1, and 5). Dioxin/furan toxic equivalents (TEQs) ranged from 0.157 to 0.306 ng/kg at SD-PCM001 and from 0.231 to 41.1 ng/kg at SD-PCM010. Dioxins/furans will be analyzed at SD-PCM010 in 2022 monitoring.

In addition to the post-construction monitoring for EPA, Boeing conducted voluntary monitoring within the Boeing Plant 2 EAA (Wood 2019) to provide a better understanding of the deposition of fine-grained material in areas that had been backfilled as part of remediation activities completed in March 2015. Samples were collected from the depositional sediment layer[3] at 33 locations on each of 17 sampling dates between April 2015 and October 2018 (Figure A-1). Thirteen of these locations are within the middle reach: 10 along the LDW shoreline from river mile (RM) 2.9 to RM 3.0 and three locations in Slip 4 that were added to the monitoring in December 2016. All samples were analyzed for depositional thickness and a subset of the samples (six to eight each year) were analyzed for PCBs and TOC. The monitoring data report (Wood 2019) presents results as averages of all LDW locations (excluding Slip 4) as a function of time. Figures excerpted from the monitoring data report present total PCB results for the post-construction depositional material (Figure A-2), depths of depositional material (i.e., surficial silt thicknesses) at offshore locations (i.e., the deeper of the paired samples) (Figure A-3), and TOC results for the depositional material (Figure A-4). The depositional material depths for the stations within Slip 4 were similar to those along the LDW shoreline (Figure A-5). The PCB concentrations and TOC results for the Slip 4 locations are summarized in Table A-2.

[2] These three locations were established as perimeter locations for the Boeing Plant 2 dredging in Slip 4, but they were ultimately within the dredge prism.

[3] The voluntary monitoring samples are representative of material that has accumulated on top of the backfill area; therefore, sample depths vary depending on the amount of sediment deposition that occurred between the remedial action and sampling.

Table A-2
Slip 4 Depositional Material Total PCB Concentrations and TOC

Date	Location[1]	Deposition Depth (cm)	%TOC	PCB Concentration	
				µg/kg dw	mg/kg OC
December 2016	S16	14.0	2.97	133	4.5
	S18	14.3[2]	3.09	141	4.6
June 2017	S18	12.7	2.95	150	5.1
March 2018	S18	7.0	2.93	173	5.9
October 2018	S18	16.5[2]	2.87	134	4.7

Notes:

1 Only a subset of the three locations in Slip 4 were analyzed for total PCBs and TOC.

2 No backfill material was present in the bottom of the grab sampler. Thus, the depth of deposition is likely underestimated.

dw: dry weight

OC: organic carbon

PCB: polychlorinated biphenyl

TOC: total organic carbon

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Figure A-1
Boeing Plant 2 Voluntary Monitoring Sampling Locations (Wood 2019)

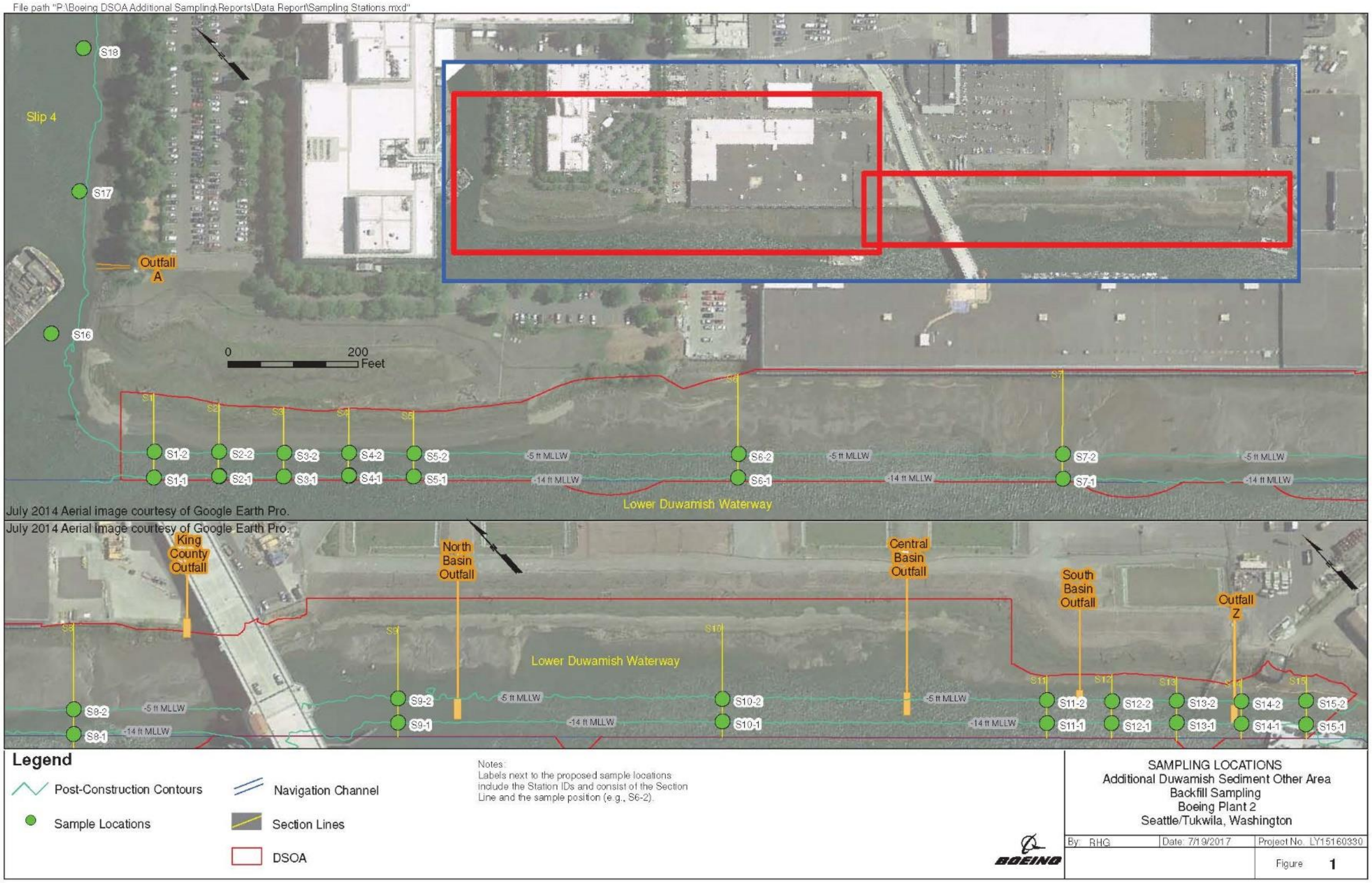

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Figure A-2
Boeing Plant 2 Voluntary Monitoring Total PCB Results (Wood 2019)

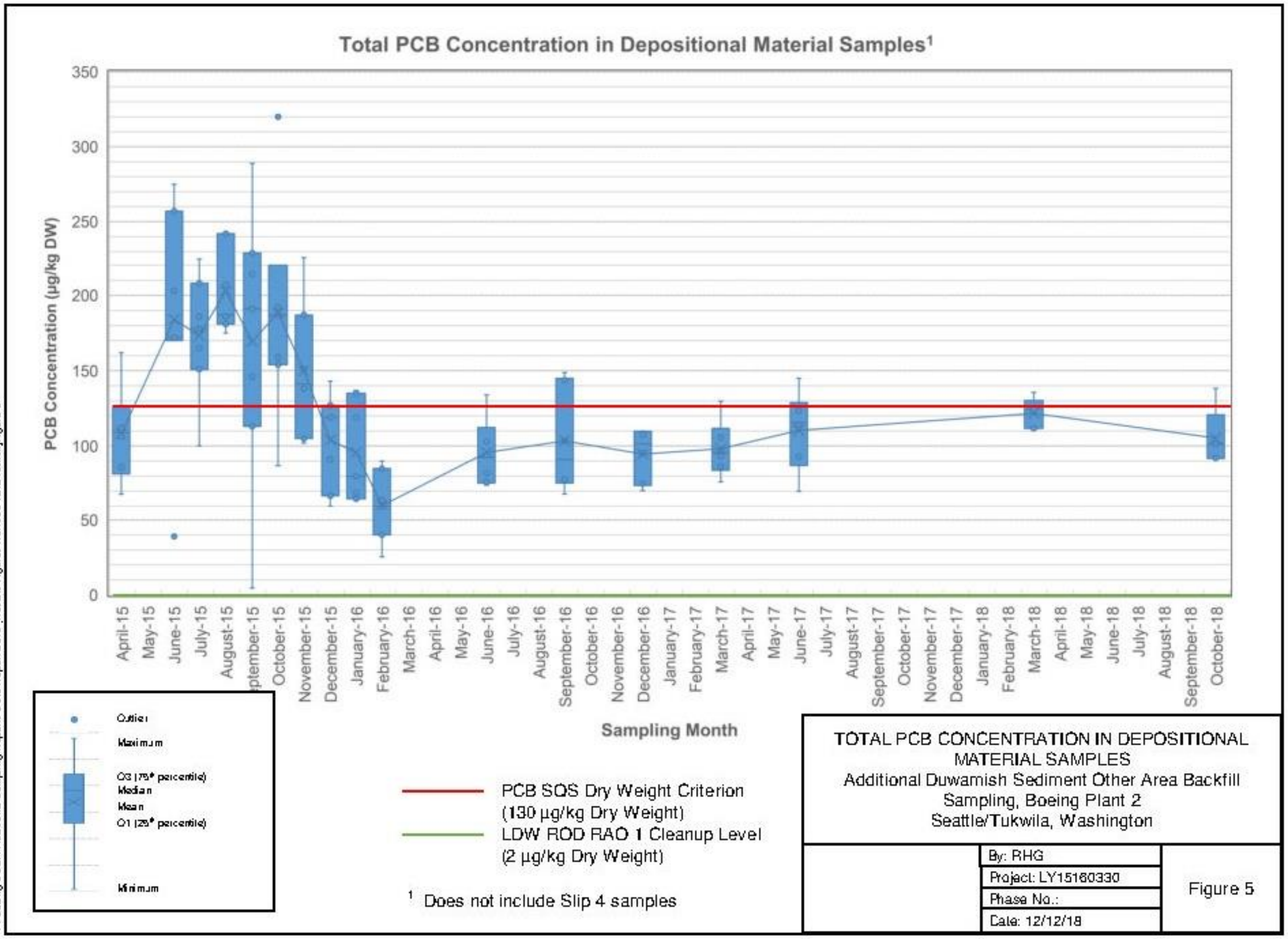


Figure A-3
Surficial Silt Thicknesses at Boeing Plant 2 Voluntary Monitoring Locations (Wood 2019)

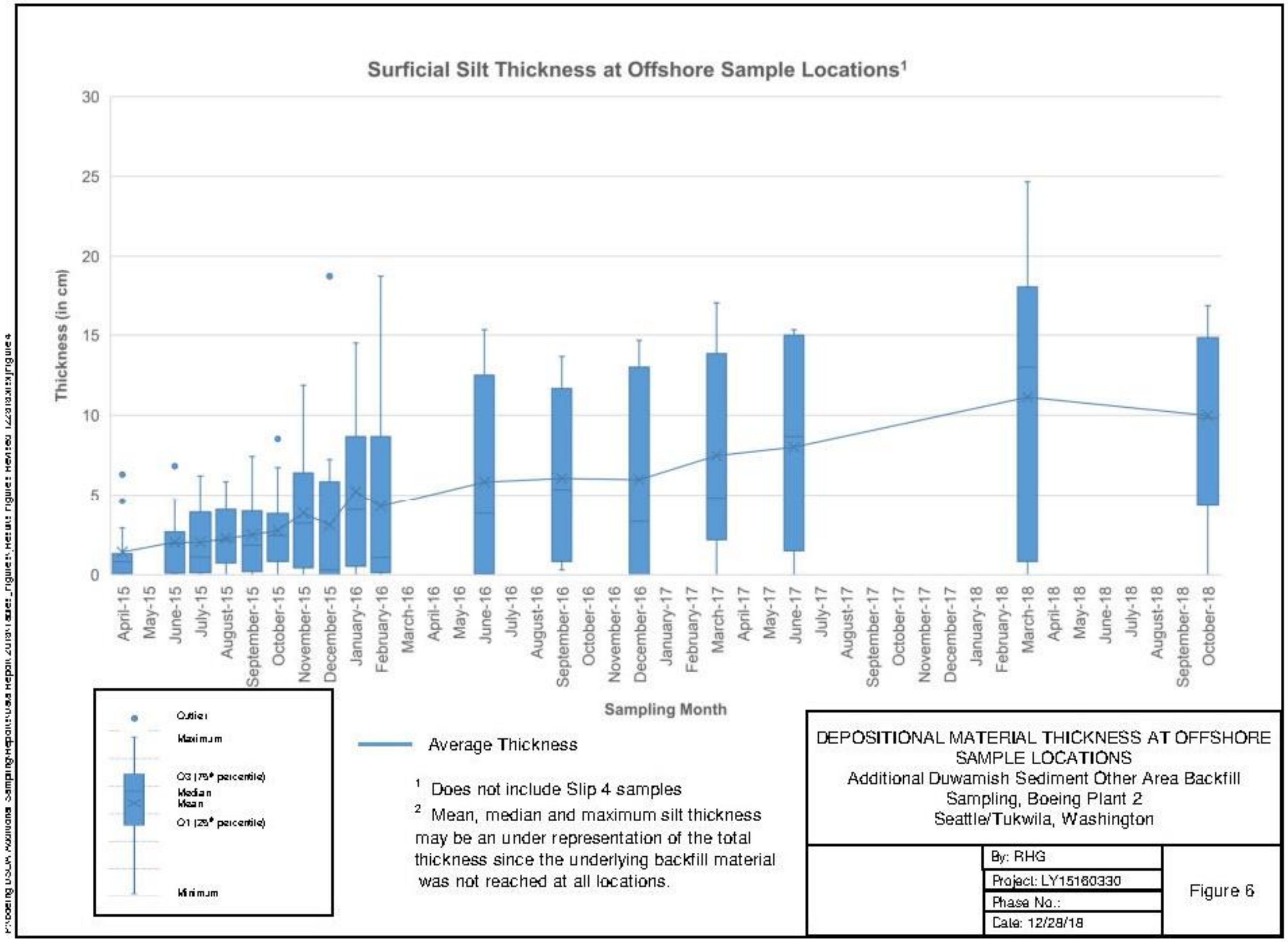


Figure A-4
Boeing Plant 2 Voluntary Monitoring Percent TOC Results (Wood 2019)

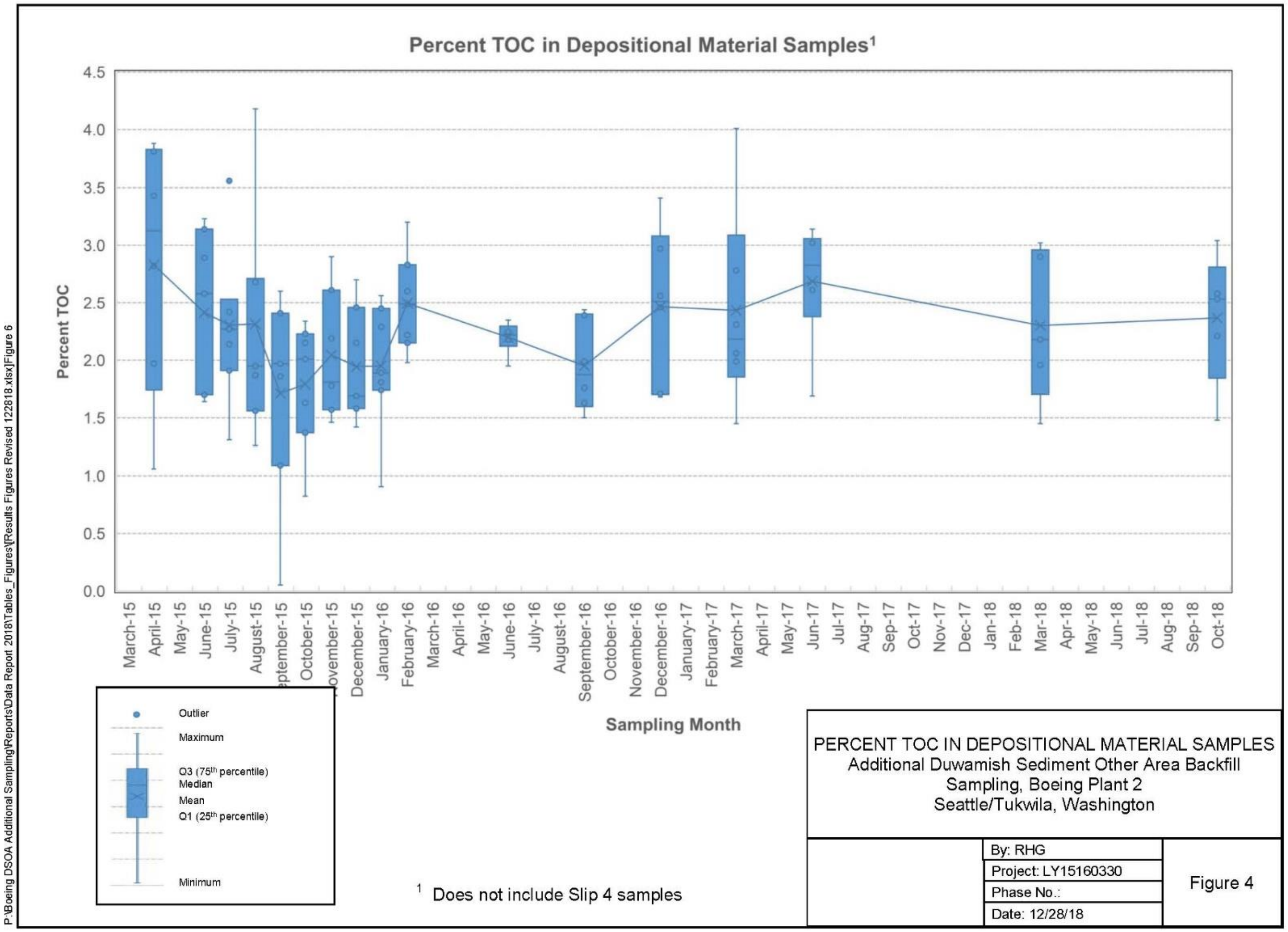
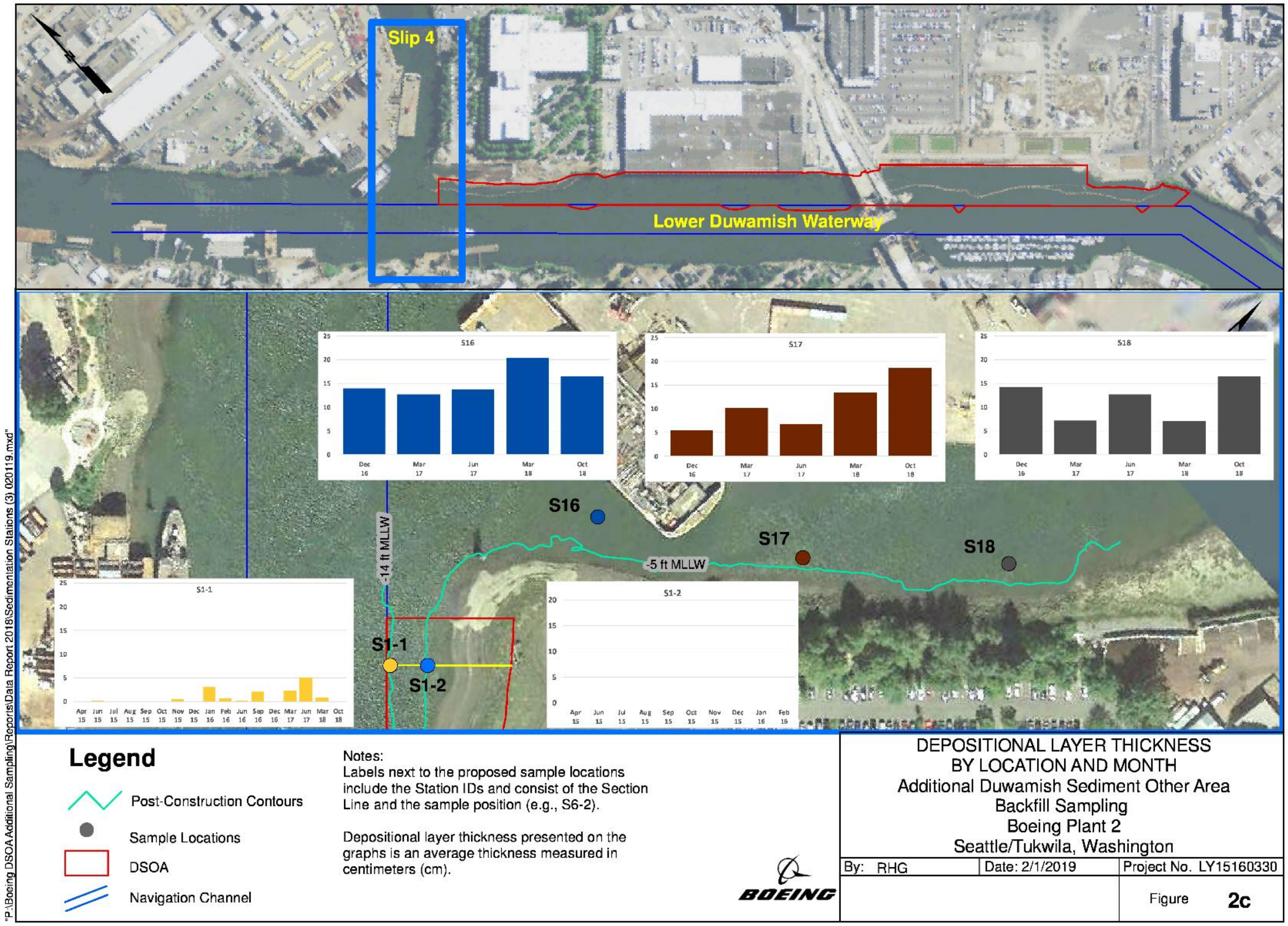


Figure A-5
Boeing Plant 2 Voluntary Monitoring Sediment Deposition in Slip 4 (Wood 2019)



A.3.2 Monitoring Outside the EAA in the Middle Reach

Perimeter monitoring at Boeing Plant 2 EAA involved both pre- and post-construction season monitoring during the multiple dredge seasons required to complete the sediment cleanup(Map A-3). The perimeter monitoring samples are 0- to 10-cm surface sediment samples. These data represent PCB concentrations in sediments near active dredging conducted in the LDW, including Slip 4 as part of the Boeing Plant 2 EAA remediation. Samples were collected just before and just after each construction season. The PCB concentrations for these locations within the middle reach are presented in Table A-3.[4] Only the most recent data for each location are represented in the design dataset.

[4] Boeing Plant 2 EAA perimeter monitoring data in the upper reach were presented in the upper reach Pre-Design Investigation work plan (Windward and Anchor QEA 2019).

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Table A-3
Boeing Plant 2 Perimeter Monitoring Data within the Middle Reach

Sample ID	Total Organic Carbon (percent)[1,2]						Total PCB Concentration (mg/kg OC, or ug/kg dw where noted)[1,3]					
	Construction Season 1		Construction Season 2		Construction Season 3		Construction Season 1		Construction Season 2		Construction Season 3	
	Pre (2012)	Post (2013)	Pre (2013)	Post (2014)	Pre (2014)	Post (2015)	Pre (2012)	Post (2013)	Pre (2013)	Post (2014)	Pre (2014)	Post (2015)
RM 2.5												
SD-PER101	2.78	2.68	3.18	1.96	2.73	1.57	4.46	6.13	3.55	7.04	3.3	15.0
SD-PER102	2.33	2.73	2.46	1.73	1.20	2.11	4.85	5.75	3.3	6.59	6.0	5.78
SD-PER103	2.43	3.30	4.26	1.67	2.53	2.66	5.06 J	6.33	170 (dw)	8.92	5.49	6.50
SD-PER104	2.85	2.98	3.10	2.22	2.19	1.83	3.2	7.0 J	6.5	6.85	6.53	10.8
SD-PER105	2.04	1.62	2.99	2.50	2.47	1.97	7.16	8.95	6.29	4.28	4.37	6.14
SD-PER106	2.50	2.35	3.11	2.08	1.88	2.35	6.55 J	4.93 J	9.88 J	7.83	6.81	5.98 J
RM 2.8–RM 3.0												
SD-PER201	2.06	1.77	2.09	2.26	2.26	0.927	4.5	8.53	7.66	7.57	8.01	16.3
SD-PER202	2.2	2.06	2.75	2.13	2.25	2.09	16	7.57	7.27	12.0	11.0	12.0
SD-PER203	2.07	1.93	2.35	2.76	2.66	1.34	3.4	5.85	4.0	5.33	4.36	10.2
SD-PER204	2.37	2.60	2.9	2.09	2.43	2.31	3.8	5.42	5.62	11.0	8.02	9.48
SD-PER206	1.83	1.21	1.36	1.39	1.20	0.53	3.4	7.9	12.2	5.8	6.9	18.0
Slip 4												
SD-PER501	2.06	0.83	na	na	3.47	2.38	5.68	1.75	na	na	11.0	26.0
SD-PER502	1.48	1.26	na	na	2.44	2.26	3.9	2.3	na	na	12.0	13.0
SD-PER503	2.73	4.14	na	na	2.82	2.3	4.25	194 (dw)	na	na	13.0	12.0
SD-PER504	3.21	3.86	na	na	3.00	0.058	7.2	201 (dw)	na	na	8.7 J	3.3 J (dw)
SD-PER505	2.85	2.87	na	na	2.10	0.053	14.5	16.5 J	na	na	13.5	3.8 U (dw)

Sample ID	Total Organic Carbon (percent)[1,2]						Total PCB Concentration (mg/kg OC, or ug/kg dw where noted)[1,3]					
	Construction Season 1		Construction Season 2		Construction Season 3		Construction Season 1		Construction Season 2		Construction Season 3	
	Pre (2012)	Post (2013)	Pre (2013)	Post (2014)	Pre (2014)	Post (2015)	Pre (2012)	Post (2013)	Pre (2013)	Post (2014)	Pre (2014)	Post (2015)
SD-PER506	2.97	3.53	na	na	2.74	0.103	4.47	220 (dw)	na	na	9.1	3.9 U (dw)
SD-PER507	3.35	3.56	na	na	3.00	3.67	4.12	220 (dw)	na	na	9.0	224 (dw)
SD-PER508	na	3.54	na	na	2.95	3.33	na	6.8 (dw)	na	na	10.0 J	10.0
SD-PER509	na	2.57	na	na	2.96	3.55	na	9.7	na	na	11.0 J	300 (dw)
SD-PER510	na	3.85	na	na	2.83	3.86	na	310 (dw)	na	na	11.0	300 (dw)
SD-PER511	na	4.55	na	na	1.79	1.65	na	270 (dw)	na	na	26.0	15.0
SD-PER512	2.20	2.21	na	na	1.62	2.01	4.2	6.15	na	na	6.98	5.82 J
SD-PER513	na	3.89	na	na	2.33	3.65	na	360 (dw)	na	na	15.0	550 (dw)
SD-PER514	na	4.73	na	na	1.99	2.74	na	310 (dw)	na	na	13.0	9.9
SD-PER515	na	4.07	na	na	2.19	2.93	na	250 (dw)	na	na	12.0	11.0
SD-PER516	na	3.41	na	na	1.14	3.33	na	6.2	na	na	20.0	7.0
SD-PER517	na	6.27	na	na	2.72	2.97	na	280 (dw)	na	na	8.5	8.8
SD-PER518	na	2.34	na	na	3.00	3.77	na	14	na	na	9.7	240 J (dw)

Notes:

[1] Data presented as reported by Amec Foster Wheeler et al. (2016).

[2] Blue font indicates TOC outside of the range for TOC normalization in Ecology's *Sediment Cleanup User's Manual II* (Ecology 2017) for applying benthic SCO for OC-normalized values (0.5 to 3.5%).

[3] **Bold** font and green shading denotes concentrations exceeding the surface sediment PCB RAL (12 mg/kg OC) or the dry weight LAET (130 µg/kg dw), depending on sample-specific TOC values. Dry weight total PCB concentrations (denoted by "dw") are provided for samples with TOC values outside the range for TOC normalization in Ecology's *Sediment Cleanup User's Manual II* (Ecology 2017) for applying benthic SCO for OC-normalized values (0.5 to 3.5%).

dw: dry weight

Ecology: Washington State Department of Ecology

J: estimated concentration

LAET: lowest apparent effects threshold

na: not applicable (no data collected)

nc: not calculated (TOC is outside TOC normalization range)
OC: organic carbon
PCB: polychlorinated biphenyl
RAL: remedial action level
SCO: sediment cleanup objective
TOC: total organic carbon
U: not detected at given concentration

A.4 References

AMEC, DOF, Floyd|Snider. 2014. Post-construction surface sediment monitoring work plan. Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project. AMEC Environment & Infrastructure, Inc., Dalton, Olmsted & Fuglevand, Inc., and Floy|Snider, Inc.

Amec Foster Wheeler. 2016. Post-construction surface sediment monitoring report - year 1. Amec Foster Wheeler Environment & Infrastructure, Inc., Seattle, WA.

Amec Foster Wheeler, DOF, Floyd|Snider. 2016. Corrective measure implementation report. AMEC Foster Wheeler Environment & Infrastructure, Inc., Dalton Olmsted & Fugelvand, Inc., and Floyd|Snider, Inc, Seattle, WA.

Ecology. 2017. Sediment cleanup user's manual II. Guidance for implementing the cleanup provisions of the sediment management standards, Chapter 173-204 WAC. Draft for review and comment through July 7, 2017. Pub. No. 12-09-057. Revised April 2017. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

Integral. 2012. Lower Duwamish Waterway Slip 4 early action area removal action completion report. Integral Consulting, Seattle, WA.

Integral. 2014. Lower Duwamish Waterway Slip 4 Early Action Area: long-term monitoring data report year 1 (2013). Integral Consulting, Inc., Seattle, WA.

Integral. 2015. Lower Duwamish Waterway Slip 4 Early Action Area: long-term monitoring data report year 3 (2015). Integral Consulting, Inc., Seattle, WA.

Windward. 2018. Lower Duwamish Waterway Slip 4 Early Action Area. Long-term monitoring data report: year 5 (2017). Windward Environmental LLC, Seattle, WA.

Windward. 2020. Lower Duwamish Waterway Slip 4 Early Action Area. Long-term monitoring data report: year 7 (2019). Windward Environmental LLC, Seattle, WA.

Windward, Anchor QEA. 2019. Pre-design investigation work plan for the Lower Duwamish Waterway upper reach. Final. Submitted to EPA December 16, 2019. Windward Environmental LLC and Anchor QEA, Seattle, WA.

Wood. 2018. Post-construction surface sediment monitoring report - year 3. Duwamish sediment other area and southwest bank corrective measure and habitat project. Wood Environment & Infrastructure Solutions, Inc., Lynnwood, WA.

Wood. 2019. Additional Duwamish sediment other area backfill sampling data report. Duwamish Sediment Other Area and Southwest Bank Corrective Measure and Habitat Project. Wood Environment & Infrastructure Solutions, Inc., Lynnwood, WA.

Wood. 2020. Post-construction surface sediment monitoring report - year 5. Duwamish sediment other area and southwest bank corrective measure and habitat project. Wood Environment & Infrastructure Solutions, Inc., Lynnwood, WA.

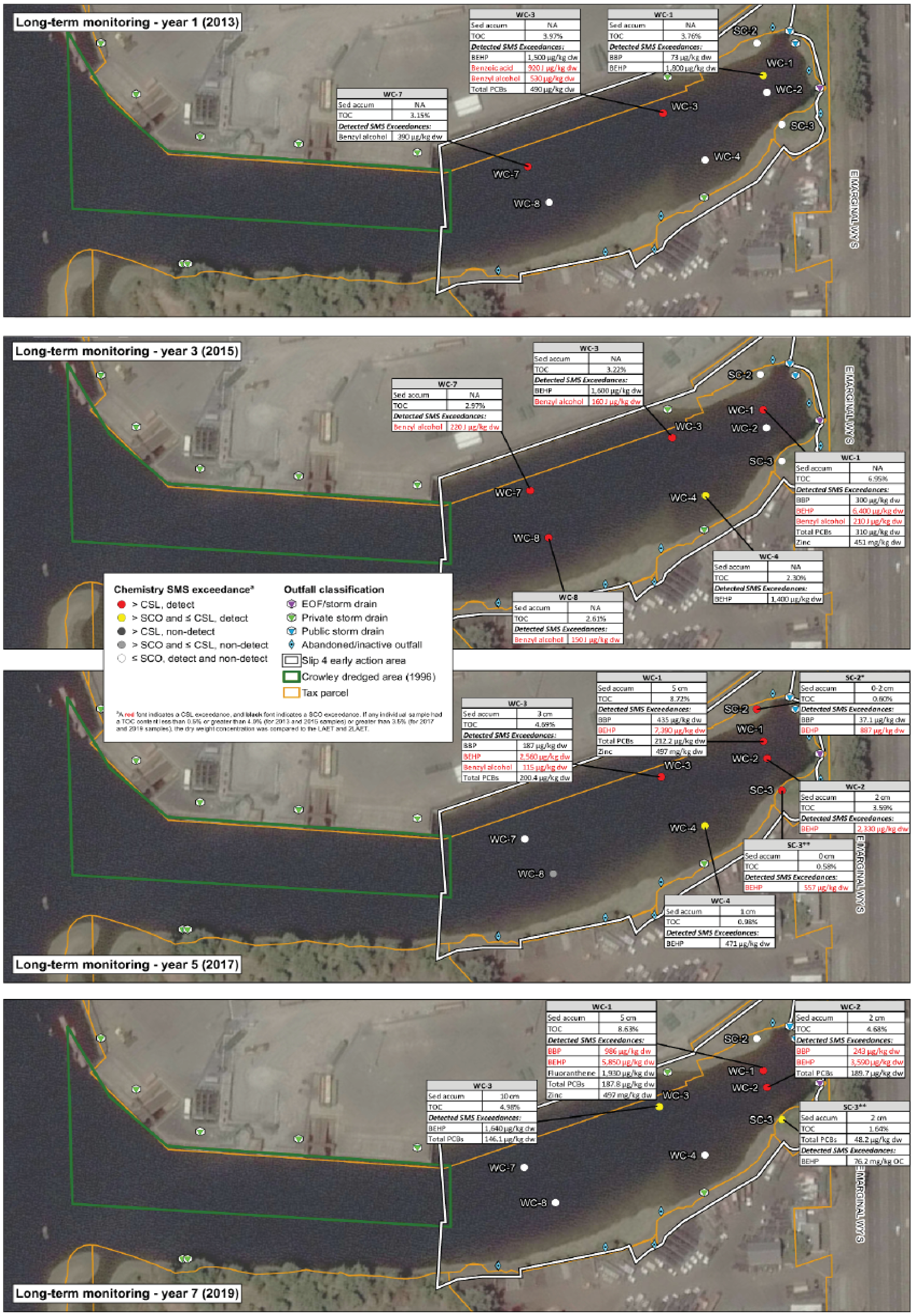

Figure 2-5. Slip 4 post-dredge surface sediment (0 - 10 cm) SMS exceedances over time

LONG-TERM MONITORING DATA REPORT FOR THE SLIP 4 EARLY ACTION AREA: YEAR 7 (2019)

Imagery (2018 0.5-meter) provided by ESRI and USDA FSA

Lower Duwamish Waterway Group
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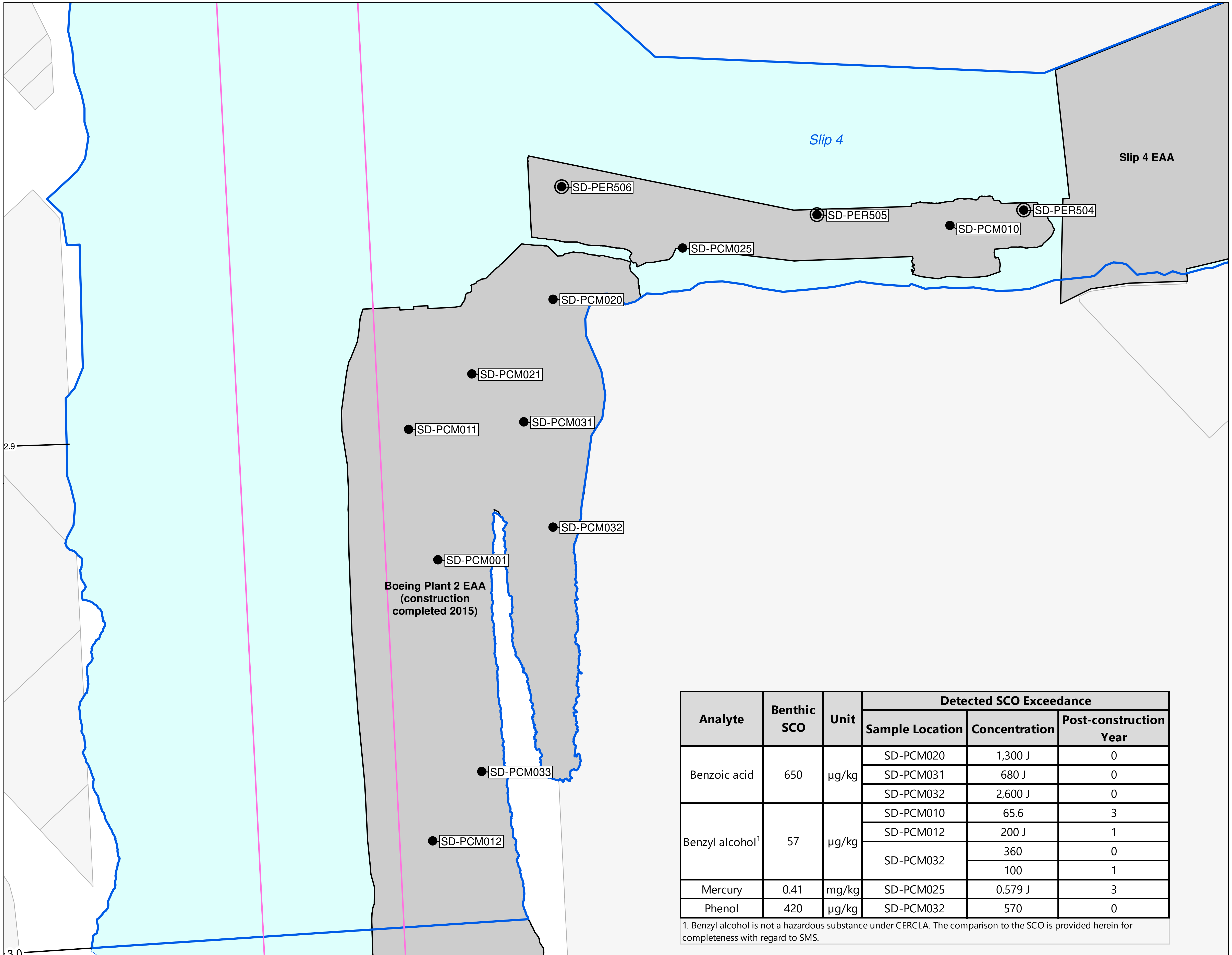
Note: Benzyl alcohol is not a hazardous substance under CERCLA. The comparison to the SCO is provided herein for completeness with regard to SMS.

Map A-1. Slip 4 post-dredge surface sediment (0 - 10 cm) SMS exceedances over time

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

Source: Long-term monitoring data report for the Slip 4 Early Action Area: Year 7 (2019)



Analyte	Benthic SCO	Unit	Detected SCO Exceedance		
			Sample Location	Concentration	Post-construction Year
Benzoic acid	650	µg/kg	SD-PCM020	1,300 J	0
			SD-PCM031	680 J	0
			SD-PCM032	2,600 J	0
Benzyl alcohol[1]	57	µg/kg	SD-PCM010	65.6	3
			SD-PCM012	200 J	1
			SD-PCM032	360	0
				100	1
Mercury	0.41	mg/kg	SD-PCM025	0.579 J	3
Phenol	420	µg/kg	SD-PCM032	570	0

1. Benzyl alcohol is not a hazardous substance under CERCLA. The comparison to the SCO is provided herein for completeness with regard to SMS.

Map A-2. Boeing Plant 2 EAA monitoring locations in the middle reach and detected SCO exceedances

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

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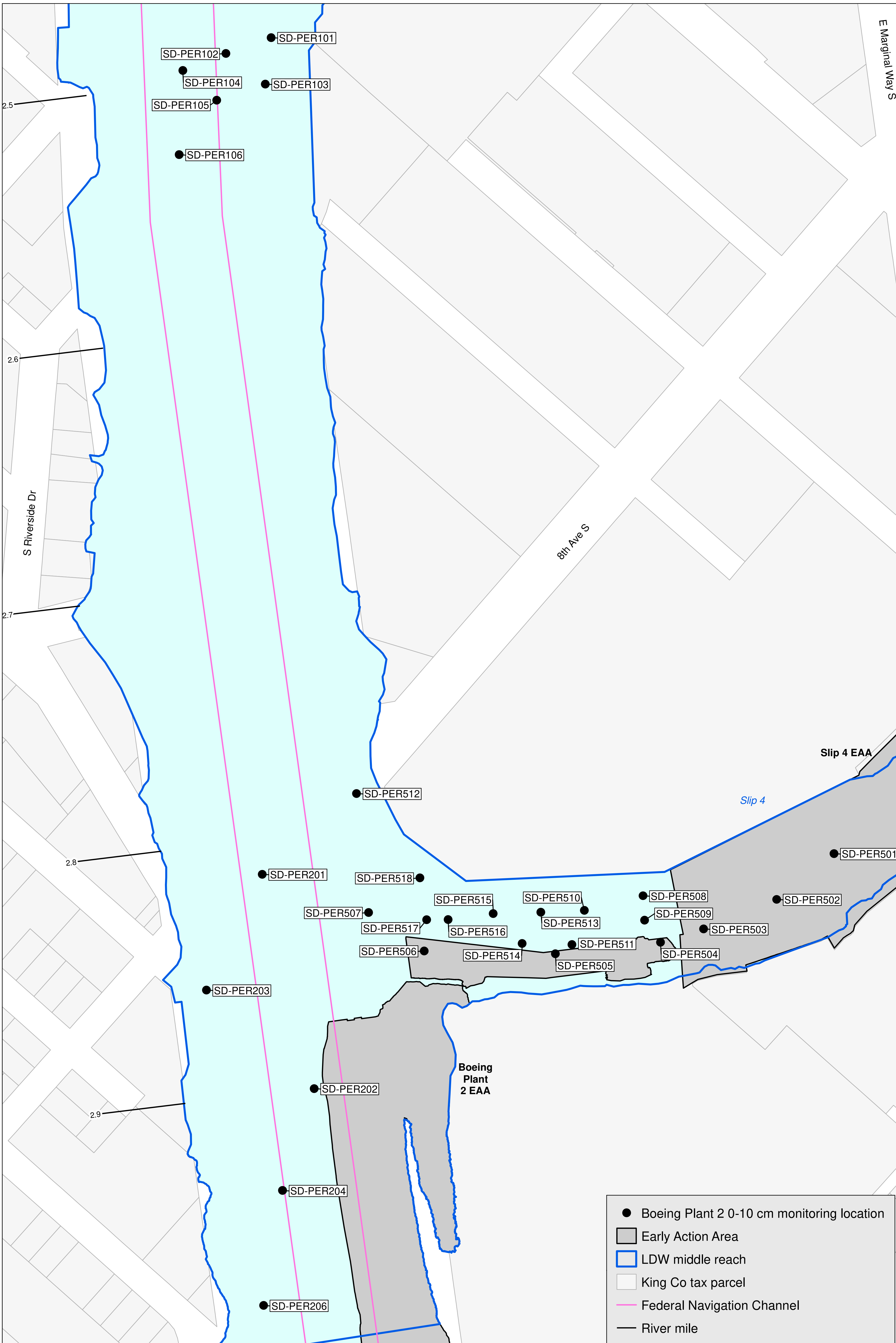
Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map A-2 7443 BP2 monitoring.mxd



Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map A-3 7443 BP2 perimeter monitoring.mxd

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Map A-3. Boeing Plant 2 perimeter monitoring locations in the middle reach

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

Attachment B
2021 Bathymetry QAPP and Results

Lower Duwamish Waterway Group

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QUALITY ASSURANCE PROJECT PLAN:

PRE-DESIGN SURVEYS OF THE LOWER DUWAMISH WATERWAY MIDDLE REACH

FINAL

Prepared for:

The U.S. Environmental Protection Agency
Region 10
Seattle, WA

October 19, 2021

Prepared by:

ANCHOR QEA

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TITLE AND APPROVAL PAGE

QUALITY ASSURANCE PROJECT PLAN:

PRE-DESIGN SURVEYS OF THE LOWER DUWAMISH WATERWAY MIDDLE REACH

Anchor QEA, LLC, Project Manager	Thomas Wang Thomas Wang, PE	October 19, 2021 Date
EPA Project Manager	DocuSigned by: Ellen Hale EDF347FD4DFB470... Elly Hale	October 19, 2021 Date
Northwest Hydro, Inc., Project Manager	James Glaeser	October 19, 2021 Date

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- Kathy Godtfredsen, Windward Environmental
- James Glaeser, Northwest Hydro
- Jo Miller, True North Land Surveying

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APPENDICES

ABBREVIATIONS

QAPP	quality assurance project plan
DGPS	differential global positioning system
DQO	data quality objective
DTM	digital terrain model
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
GIS	geographic information system
GPS	global positioning system
HASP	Health and Safety Plan
LDW	Lower Duwamish Waterway
LiDAR	light detection and ranging
LDWG	Lower Duwamish Waterway Group
MLLW	mean lower low water
NAD	North American Datum
NOAA	National Oceanic and Atmospheric Administration
NWH	Northwest Hydro, Inc.
PDI	Pre-Design Investigation
POS/MV	Position and Orientation System for Marine Vessels
QC	quality control
RD	Remedial Design
ROD	Record of Decision
RM	river mile
RTK	real-time kinematic
S/V	survey vessel
SVP	sound velocity profiles
TPU	Total Propagated Uncertainty
True North	True North Land Surveying, Inc.
USACE	U.S. Army Corps of Engineers

1 Introduction

This quality assurance project plan (QAPP) describes the methods and quality control (QC) for conducting riverbed elevation surveys for the Lower Duwamish Waterway (LDW) middle reach (river miles [RM] 1.6 to 3.0), consistent with the Lower Duwamish Waterway Fifth Amendment of the Administrative Order on Consent (EPA 2021). Bathymetric surveying (using a survey vessel) will need to be conducted over all aquatic areas between RM 1.5 to 3.0 to the extent practicable, to support the design of the remedy in the middle reach.

This Survey QAPP is focused on bathymetric surveying methods and QC, in order to expedite collecting bathymetric data to inform the Remedial Design (RD) and Pre-Design Investigation (PDI) Work Plans. Topographic surveying (or land surveying) may be needed in shoreline areas where remedial action is determined to be required, but a topographic survey will not be needed throughout the entire middle reach. Because final remedial action areas will be determined after future PDIs are completed, topographic surveying will be conducted at a future date, to be determined. Topographic survey methods and QC will be described in a QAPP addendum prior to conducting required topographic surveys.

Access restrictions and river conditions (e.g., moored vessels and tidal elevations) at the time of the initial bathymetric survey may prevent obtaining all bathymetric data required for RD in one survey event, but an initial expedited bathymetric survey is proposed to support the development of the RD Work Plan and related documents (e.g., PDI Work Plan). Additional bathymetric survey(s), if needed to obtain full coverage of the LDW middle reach, will be proposed in the PDI Work Plan. The scope of any additional bathymetric surveys would be proposed to the U.S. Environmental Protection Agency (EPA) for review; the initial and any subsequent bathymetric surveys will follow the methods and QC procedures as described in this QAPP.

EPA guidance for QAPPs was followed in the preparation of this project plan (EPA 2002). This plan is organized into the following sections:

- Section 2 – Project Management and Data Quality Objectives
- Section 3 – Data Generation and Acquisition
- Section 4 – Assessment and Oversight
- Section 5 – Data Validation and Usability
- Section 6 – References

2 Project Management and Data Quality Objectives

2.1 Project Organization

The bathymetric survey will be conducted by Northwest Hydro, Inc. (NWH), under the direction of Anchor QEA. Anchor QEA will be responsible for overall project coordination and for performing the administrative tasks needed to ensure timely and successful completion of the project. Anchor QEA will also be responsible for communicating with King County, the Lower Duwamish Waterway Group (LDWG), and EPA on schedule, any significant deviations from the QAPP, and administrative details. NWH will be responsible for conducting the survey, conducting post-processing of the survey data, and for reporting deviations from the QAPP to the Anchor QEA project manager.

Tom Wang will serve as the Anchor QEA project manager:

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James Glaeser will serve as the NWH field operations manager for the bathymetric survey:

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Jo Miller, of True North Land Surveying, Inc. (True North), will serve as the quality assurance manager for the bathymetric survey.

> Jo Miller
> True North Land Surveying, Inc.
> 1930 6th Avenue South, Suite 401
> Seattle, Washington 98134
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True North is part of the overall surveying team for the project, primarily responsible for topographic surveying, and is not directly involved in collecting bathymetric survey data.

2.2 Problem Definition and Background

The last sitewide bathymetry survey of the middle reach was completed in 2003. Updated[1] bathymetric survey data are required to inform the PDI and provide a base map for the RD. The bathymetric data are planned to be used to:

- Establish the current waterway bed elevations in the LDW middle reach.
- Develop an accurate base map, representative of current bathymetric conditions, which is needed to develop engineering drawings and quantity calculations.
- Provide physical conditions information, as noted in Table 23 of the Record of Decision (ROD), to help refine, if needed, areal designations of Recovery Categories, which is also based, in part, on the Sediment Transport Modeling completed during the LDW Feasibility Study (FS) in 2012; and the Waterway User Survey (Integral 2018) and contaminated trends analysis summarized in the Recovery Categories Recommendation Report (Integral 2019), completed during the LDW Third Amendment to the Administrative Order on Consent.
  - Update the delineation of potential vessel scour areas identified in the FS (AECOM 2012), to inform Recovery Category designation
  - Provide the data to generate new sun illumination maps that identify areas with scour from propellers and other vessel interactions with the sediment
  - Update the depth contours that define the upper and lower bounds for the propeller scour potential area
- Use updated bathymetric elevations to inform sampling locations for the PDI. Bed elevations will be considered when selecting sample locations.
- Use updated bathymetric survey to identify elevations of new surface and subsurface data.

2.3 Project Description

A multibeam bathymetric survey will be performed to produce an accurate, up-to-date bathymetric dataset containing bank-to-bank data (where possible) for the LDW middle reach RD, addressing the data needs identified in Section 2.2. As much as possible, the survey will be performed at high tide when surveying near shorelines, to allow collection of

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[1] The U.S. Army Corps of Engineers (USACE) periodically surveys the navigation channel of the LDW, and survey data from the USACE will be evaluated in the PDI.

data as high as possible on the banks of the waterway using bathymetric multibeam survey equipment. Limited use of single-beam equipment may need to be implemented in areas of very shallow water depth where the multibeam equipment may not be as effective. All single-beam data collection will occur as a separate survey event on separate calendar days.

Data coverage will be extended downstream of the LDW middle reach boundary to the extent practicable to provide overlap for potential future survey work and to allow for engineering evaluations along the boundaries of the study area. The bathymetric survey coverage area will extend from RM 1.5 to RM 3.0, as shown on Figure 1. The downstream coverage will extend 0.1 RM past RM 1.6 to ensure adequate survey coverage; the 2019 bathymetric survey of the LDW upper reach extended downstream of RM 3.0 to RM 2.75, so surveying to RM 3.0, the boundary between the upper and middle reaches, will provide overlap with the previous survey on the upstream boundary. Due to the potential that vessels or barges may limit survey access to some middle reach areas, more than one bathymetric survey event may be needed to provide full coverage of the middle reach.

Future topographic surveys may be needed in shoreline areas where remedial action is determined to be required and will be performed at low tide to allow overlap with the bathymetric survey data; topographic surveying methods will be described in a separate Survey QAPP addendum. Bathymetric data will be collected using methods described in Sections 3 through 5 of this QAPP, to meet the needs identified in Section 2.2.

The bathymetric survey will be performed as soon as practical after receiving EPA approval of this QAPP, considering factors such as the occurrence of daytime high tides, to allow for the use of the information in preparation of the middle reach RD and PDI Work Plans. The schedule for completing the survey and preparing deliverables is presented in Section 3.2.5.

2.4 Data Quality Objectives and Criteria

The data collection and targeted methods selected for this survey will be implemented using state-of-the-art equipment and technology and will meet the data needs presented in Sections 2.2 and 2.3. The completeness of final data (i.e., areal coverage) will be evaluated in consultation with EPA to determine if there are data gaps requiring further bathymetric surveying to support RD, and the need for alternative surveying methods (e.g., single-beam bathymetric survey or light detection and ranging [LiDAR]).

The overall data quality objectives (DQOs) for this project include the following elements:

1. Provide the bathymetric data to generate new sun illumination maps that identify areas with scour from propellers and other vessel interactions with the sediment; this information will be used to potentially modify the Recovery Category area designations.
2. Define the current bathymetry of the LDW middle reach with sufficient confidence (as presented in the accuracy discussion in this section) to inform selection of sampling locations for PDI data collection to support the RD.
3. Provide a base map, subject to modification with the addition of follow-up bathymetric and topographic survey data, if needed, for the RD.

The DQOs were developed in conformance with the *Guidance for the Data Quality Objectives Process* (EPA 2000) and are outlined in Table 1. Parameters used to assess data quality include precision, bias, accuracy, representativeness, comparability, completeness, and sensitivity. These data quality parameters are discussed as follows:

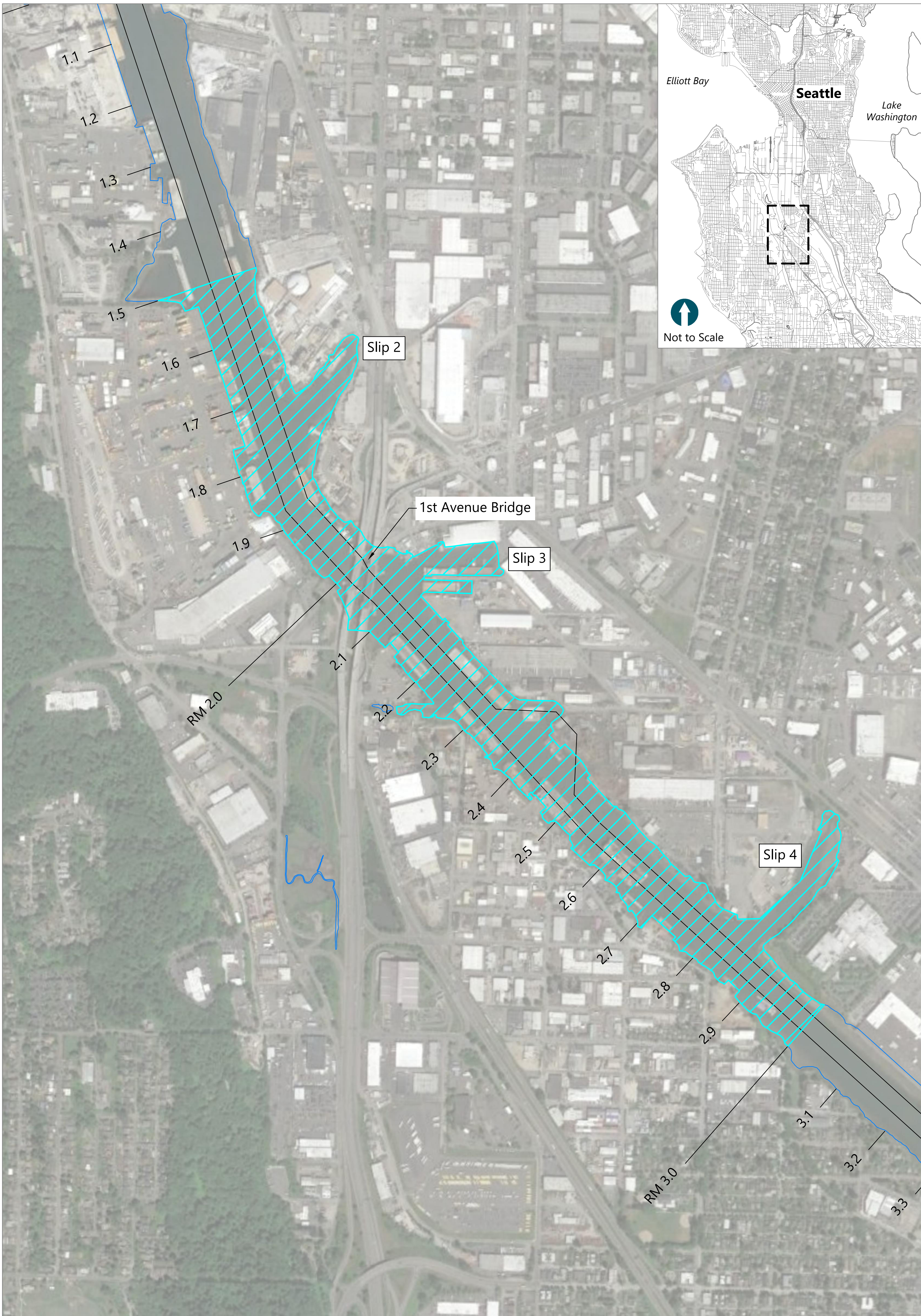
Precision: The measure of agreement among repeated measurements will be evaluated during data processing using a HyPack HySweep multibeam editor by comparing overlapping swaths. During swath editing, each individual swath will be color-coded to allow for comparison of horizontal and vertical features from swath to swath.

Bias: Bathymetric surveying methods are not prone to systemic or persistent distortions that cause errors in one direction. Corrections for various distortions are discussed in Section 3.2. Readings from the multibeam survey will be referenced to control points to tie into topographic surveys and for comparison to previous bathymetric information.

Accuracy: The target horizontal accuracy is 3 feet at a 95% confidence level, and target vertical accuracy is +/- 0.5 foot at a 95% confidence level.[2] These accuracy levels meet or exceed the minimum performance standards for measurement and payment level surveys for soft bottom material navigation and dredging support surveys in the U.S. Army Corps of Engineers (USACE) Hydrographic Surveying Engineering Manual (USACE 2013). Accuracy will be demonstrated in the cross-line analysis,[3] which provides a confidence level for each sonar beam. Additionally, Total Propagated Uncertainty (TPU) data will be calculated in

[2] Although data are collected and processed using metric units with the hydrographic information processing system (see Section 3.4), final maps will be produced in units of feet for consistency with previous surveys in the LDW.
[3] Cross-line analysis is a method of quality assurance that compares measurements made at intersecting points from survey lines run across the primary survey lines to the data obtained from the same points on the primary survey lines.

accordance with USACE Hydrographic Survey Manual – Appendix D. The horizontal and vertical datums for the survey are identified in Section 3.1.



SOURCE: Aerial by Google Earth dated 5/26/18.

LEGEND:

Bathymetric Survey Area

RM 3.0 — River Mile

0 800
Feet

Publish Date: 2021/09/22 9:51 AM | User: jbigsby
Filepath: K:\Projects\0067-King County\LDW Upper Reach Engineering Services\0067-RP-018 LDW Bathy-Middle Reach.dwg Figure 1

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Figure 1
Coverage for Bathymetric Survey of the Lower Duwamish Waterway Middle Reach

Table 1
DQO Process for Bathymetric Survey

DQO Step	DQO No. 1 Inform Recovery Category Designation Modifications	DQO No. 2 Inform Selection of Sampling Locations	DQO No. 3 Provide a Base Map for the Remedial Design
1. State the Problem	Recovery Categories were identified based on lines of evidence indicated in the ROD. These include using 2003 bathymetric data, sediment-transport modeling output, empirical chemistry data, and the waterway user survey. Bathymetric data are now more than 18 years old and may not reflect current navigational uses of the waterway.	The selection of sediment and geotechnical sampling locations for PDI and RD should be informed by bathymetric conditions. Establishing required elevations for remedial actions needs accurate bathymetry elevations.	The current site base map is based on bathymetric data that are more than 18 years old. Current data are needed to design activities such as dredging and capping, and to calculate accurate quantities.
2. Identify the Decision	Recovery Category designation areas will be reviewed during RD using new bathymetric data (sun illumination maps) to assess evidence of vessel scour or other disturbances to the bed (as one line of evidence to inform potential recovery category modifications).	The results of the bathymetric survey will be considered when selecting sampling locations. RD sampling data will be referenced to elevations from the new bathymetric survey.	Current bathymetry mapped to a contour interval of 1.0 foot will be used in the RD to define extents of remedial construction activities (such as dredging and capping), calculate quantities, and define water depths to inform contractor's equipment selection to perform construction activities.
3. Identify the Inputs to the Decision	The density of bathymetric survey data and the accuracy of the survey method will follow USACE hydrographic survey guidance for design-level surveys and be sufficient to have confidence that the bathymetric surface created from the survey is representative of actual conditions.		
4. Define the Boundaries of the Study	The boundaries of the study are defined by the Record of Decision, the Fifth Amendment to the Administrative Order on Consent, and the scope of work as RM 1.6 to .3.0. To the extent practicable, the sediment surface between RM 1.5 and 3.0 will be surveyed.		

DQO Step	DQO No. 1 Inform Recovery Category Designation Modifications	DQO No. 2 Inform Selection of Sampling Locations	DQO No. 3 Provide a Base Map for the Remedial Design
5. Develop a Decision Rule	Established techniques for collecting and processing bathymetric survey data, including QC and quality assurance, will be used to collect data. The techniques are described in Sections 3 through 5.		
6. Specify Tolerable Limits on Decision Errors	The probability of decision errors will be minimized through strategies to minimize statistical sampling errors and measurement errors. "Sampling errors," which in the context of a bathymetric survey are a failure to account for the variability of the bathymetry, are addressed by the data density in the design of the survey. Several techniques are used to detect and correct for measurement errors. Survey design is described in Section 3.1, QC techniques are described in Section 3.5, and data validation is described in Section 5.		
7. Optimize the Design for Obtaining Data	The bathymetric survey methods, equipment, and spacing of survey lines were selected to provide data that would meet the needs of the RD project. The details of the survey design are described in Section 3.1.		
8. Applicable Survey Method to Meet DQO	Bathymetric Survey	Bathymetric Survey	Bathymetric and Topographic Surveys

Representativeness: The overall degree to which the data appropriately reflect the LDW environment will be evaluated through visual analysis of the resulting sun-illuminated image to identify data anomalies or artifacts, and through comparison to prior surveys.

Comparability: The results of the 2003 and 2021 (and additional) surveys of the LDW middle reach should be directly comparable, given the similarities in the survey methods and equipment. Also, the results of the overlapping areas (RM 2.75 to 3.0) between the 2019 survey of the LDW upper reach and the 2021 survey of the LDW middle reach should be directly comparable. The same horizontal and vertical datums will be used for the 2021 survey as those used in 2003 and 2019 (as discussed in Section 3.1). Table 2 provides a summary of the equipment and software used and the target accuracies for the two surveys.

Table 2
Comparison of 2003, 2019, and 2021 Bathymetric Survey Methods

Feature	2003 Survey	2019 and 2021 Surveys
Multibeam Sonar System	Reason 8101	R2Sonic 2022
RTK GPS Inertial Navigation System	Applanix POS-MV	Applanix POS-MV
Hydrographic Processing Software	Caris Hydrographic Information Processing System	HyPack HySweep
Sounding Selection Method	1-foot by 1-foot average	1-foot by 1-foot average
Horizontal Accuracy	+/- 3 feet	+/- 3 feet
Vertical Accuracy	+/- 0.5 feet	+/- 0.5 feet
National Oceanographic Survey Tidal Epoch	1960 - 1978	1983 - 2001

Completeness: The objective of the survey is to provide bank-to-bank coverage where the survey vessel can safely navigate. The targeted water elevation for surveying shorelines is ≥5 feet above mean lower low water (MLLW). The following factors will affect the ability to collect bank-to-bank data:

- Tidal stage: increased water depth allows for increased coverage toward shore from the survey vessel. The progress of the survey will be timed to gather data from the banks at the time around the high tide and from deeper water within the channel when tide levels are not critical to data collection.
- Obstructions such as docks, moored vessels, or pilings, which may restrict vessel operations or block sonar signals. The survey vessel will work around existing

structures as they are encountered. LDWG may need to ask owners of moored vessels to move their vessels, but vessel owners may choose not to comply with requests from LDWG. Obstructions that prevent access for surveying will be noted in the field log and reported as explanatory notes with the final survey drawings. The nature of the obstruction and the size of the affected area will be noted.
- Bank slope: a long shallow bank will not be mapped as close to shore as a steep bank. The survey vessel operator will adjust survey methods to the extent practicable, as described in Section 3.2, to collect data as high as possible on shallowly sloped banks.

It is expected that there will be data gaps that cannot be avoided, such as those caused by obstructions[4] or shallow areas. These areas will be evaluated on a case-by-case basis, and an assessment will be made in consultation with EPA to determine whether further bathymetric surveying or alternative surveying methods (e.g., single-beam bathymetric survey or LiDAR) are required to fill data gaps to inform the RD.

Sensitivity: The sonar swath will be limited to 60° throughout the project area with the exception of shoreline banks and slopes under existing piers and floats. The hydrographer that is onboard during data acquisition will make the determination on when it is appropriate to use sonar beams beyond 60°.

2.5 Special Training and Certification

NWH personnel have specialized training and extensive experience in conducting high-resolution multibeam surveys. NWH's field operations manager is a certified hydrographer under the American Congress on Surveying and Mapping Hydrographer Certification Program. Additional specialized training includes the following:

- University of New Brunswick: Ocean Mapping Group Multibeam Sonar Training Course (March 2007)
- HyPack Annual Training (latest: January 2021)
- Caris Hydrographic Information Processing System (March 2010)

2.6 Documentation and Records

Prior to mobilization for the bathymetric survey, the approved QAPP will be provided to all field personnel for review. The Anchor QEA project manager or his designee will confirm

[4] LDWG does not have day-to-day control over the location of ships and barges in the LDW to enable removal of these types of obstructions prior to the survey.

that all field personnel receive the final QAPP, including any addenda and modifications. The leader of the field operations will be responsible for conducting the survey in conformance with the requirements of the approved QAPP, and the NWH field operations manager will be responsible for overall quality assurance of the bathymetric survey product.

Multibeam bathymetric data will be presented as a series of maps that will be overlaid on sun-illuminated images of the bathymetric digital terrain model (DTM). Drawings will be compiled in AutoCAD at a mutually agreed-upon scale, to be determined during design. The maps will be projected in North American Datum (NAD) 83 through the 1991 adjustment (NAD83/91) Washington State Plane North (feet) and will include 1-foot elevation contours in feet MLLW. The multibeam sun-illuminated maps will represent a full coverage survey over the area imaged and will provide details of riverbed features. Sun-illuminated images will be produced in color. The multibeam data will also be exported into an ASCII XYZ format for use in CAD and geographic information systems (GIS).

The following information will be provided in the bathymetric survey data report, which will be submitted following completion of surveying, including an anticipated data gaps survey data collection. The data gaps survey is expected to occur during the same timeframe as the middle reach Phase I PDI:

- Written report of the survey describing survey methodology, equipment (including the sensitivity of the equipment), and analysis methodology (submitted as draft and final versions)
- Documentation of QC checks, TPU and identification of QC issues
- Deviations from this QAPP
- Contour maps at a mutually agreed-upon scale, to be determined during design
- Sun-illuminated maps at the same scale and layout as contour maps
- Electronic versions of data products, which will include Portable Document Format (PDF) files for reports, AutoCAD files (DWG format) of contours and imagery, ArcMap shape files of contours, and georeferenced TIFF files of imagery
- ASCII files of 1-foot binned data sets that include appropriate metadata in the file header

3 Data Generation and Acquisition

3.1 Survey Design

The bathymetric survey of the LDW middle reach will collect precision data in the primary survey area covering approximately 1.5 miles of the waterway starting at RM 1.5 and extending upstream to RM 3.0, as shown on Figure 1.

The survey will be conducted using multibeam sonar over most of the project area. In areas with sufficient water depth (greater than 8 feet), multibeam sonar allows for the collection of data with up to 100% coverage of the riverbed, compared to single-beam methodology, which covers a single track directly below the survey vessel and allows for only partial coverage. This method allows for the collection of high-resolution bathymetric data. The multibeam bathymetric data will be used to create a digital terrain model of the riverbed morphology, from which sun-illuminated images will be generated.

Data will be collected by running several lines parallel to the shoreline. Several perpendicular crosstie lines will also be surveyed to confirm system calibration and document accuracy.

The survey will be conducted on an established coordinate system, referenced by monuments established or recovered during a geodetic control survey of the site. The same horizontal and vertical datums will be used for the 2021 survey as those used in 2003 and the 2019 survey of the upper reach. The horizontal datum for this survey is NAD83 through the 1991 adjustment (NAD83/91), State Plane Coordinate System, Washington North Zone, measured in U.S. Survey Feet. Vertical datum for this survey will be feet MLLW. The GEOID12B model will be used to relate soundings to North American Vertical Datum of 1988. As with the 2019 bathymetric surveys, the 2021 survey will be on the same National Tidal Datum Epoch. The target horizontal and vertical accuracy of the bathymetric survey is presented in Section 2.4.

3.2 Survey Methods

This section describes the survey vessel and crew, control network, positioning, and acquisition of multibeam data. Safe working practices for conducting this survey are described in the Health and Safety Plan (HASP; see Appendix A).

3.2.1 Survey Vessel and Crew

The survey vessel (S/V) will be the S/V *Soundwave*, or equivalent, an 8-meter custom aluminum survey boat owned and operated by NWH. This vessel is equipped with an integrated navigation and data acquisition system and a custom mount for the R2Sonic 2022 sonar head and is ideal for shallow-water survey operations in tight quarters. A smaller vessel will be used in areas with restricted overhead clearance. The same survey equipment and QC procedures will be used with either vessel. The bathymetric survey crew will consist of a lead hydrographer and an assisting hydrographer from NWH.

3.2.2 Control Network

Prior to the multibeam survey, True North will establish a control network along the LDW. This control network will be based on NAD83/91, Washington North Zone horizontal positions, and MLLW elevations. As the primary vertical control for this survey will be provided by real-time kinematic (RTK) GPS observations based on this control network, an accurate ellipsoid separation model, which is built into the Hypack software, will be used to provide on-the-fly conversion from the WGS84 ellipsoid (ellipsoid from which GPS heights are derived) to MLLW. This requires ties to existing monuments for which MLLW elevations and NAD83/91 positions are published and placement of new monuments along the project corridor.[5]

In addition, the control network will be expanded to include ties to staff gauging sites positioned approximately 0.5 mile apart within the study area. New gauges will be placed along the LDW at approximately RM 2.1 and 2.6. Exact locations will be determined in the field (as a standard practice) and documented in the hydrographer's field log. Adjustments will be computed for each staff gauge to allow for a real-time comparison to RTK GPS-derived water surface elevations, which will be recorded at 1-minute intervals at a temporary monitoring station set up for the bathymetric survey.

A geodetic control survey will be conducted using GPS techniques from monuments with published positions and elevations. A network of observations will be made with redundant comparisons to document accuracy of the survey.

[5] Upland survey monuments will be placed at each end of the study area and at two locations within the study area. In addition, staff gauging locations will be positioned approximately 1 mile apart within the study area.

Survey control will be tied into the existing control set for the upper reach bathymetry survey, as well as some primary GPS WSDOT monuments. RTK GPS will be used to establish the location of the new control points at the site, and elevation will be established by running levels across them using a digital level and published benchmarks. Accuracies of the control points are 0.02 foot horizontally and 0.04 foot vertically. The details of the geodetic control survey will be reported with the results of the bathymetric survey.

3.2.3 Positioning

Horizontal positions will be acquired with an Applanix Position and Orientation System for Marine Vessels (POS/MV) RTK positioning system and inertial navigation system. This system integrates two GPS receivers with a motion reference unit. Additionally, RTK GPS corrections will be input into the system to improve horizontal positioning accuracy to better than 0.5 meter (1.6 feet). The advantage of this system is that it not only provides motion information (i.e., heading, roll, pitch, and heave) to compute X, Y, Z data from the multibeam sonar measurements, but it also provides accurate inertial navigation through GPS outages for up to 30 seconds, which has been a major problem with conventional differential global positioning system (DGPS) equipment. These systems are preferred because the use of conventional equipment near bridges and alongside ships, a typical environment in the LDW, causes satellite signals to be blocked and/or reflected from these structures (multi-path), resulting in position jumps or large drifts in position, which can exceed survey tolerances. During these GPS signal outages, the inertial system takes over and provides accurate navigation until GPS signals are reestablished after passing the obstruction.

Position data will be used in real-time to provide navigation information to the vessel operator. A preliminary coverage plot will be generated in real-time to show multibeam swath coverage. The helmsman will be presented with a plan view of the survey area, with the vessel position and track. A color-coded swath of the multibeam coverage will be painted to the screen and used to navigate the survey vessel to fill the area. To check the accuracy of the positioning system and confirm that the geodetic parameters used in the real-time projection to the NAD83/91 Washington North Zone coordinate system are correct, a position check will be conducted daily on an established monument with a known position. Water surface measurements will be obtained by RTK GPS with on-the-fly ambiguity resolution, which is the ability to determine very accurate RTK GPS measurements while the survey vessel is moving. Water surface elevations obtained by RTK GPS will be checked against a primary National Oceanic and Atmospheric Administration (NOAA) tide station (9447130), located at the Colman Ferry Terminal in downtown Seattle, at staff gauges placed every 1 to 2 miles along the study corridor, and at an automated water-level gauge deployed by NWH in the middle of the study area. All soundings will be reduced to MLLW elevations in the delivered data set.

The automated water-level gauge will be deployed continuously during the survey to record and time-tag 1-minute water level observations at the middle reach of the study area. The gauge consists of a pressure transducer and a surface interface and recording device. The following procedures will be followed for deployment:

- A temporary staff gauge will be surveyed in at the gauging site.
- The system clock will be synchronized with the data acquisition computers aboard the survey vessel prior to the survey.
- The pressure transducer will be calibrated relative to the staff gauge.

During the survey, system clock checks and comparisons of staff gauge results to automated gauge results will be conducted at least three times (beginning, middle, and end) per day of survey.

3.2.4 Bathymetric Data Acquisition

Soundings, or precision water depth measurements, will be acquired with a R2Sonic 2022 broadband multibeam bathymetric sonar. Using a frequency of 450 kHz, the R2Sonic sonar illuminates up to a 160° (80° to starboard and 80° to port) by 1.0° swath along the riverbed, perpendicular to the ship's track, and resolves a slant-range measurement to the riverbed every 1.0° along the swath. Sonar ping rates vary, depending on the depth of the water and sonar range settings, but generally will be a minimum rate of 17 Hz as the vessel transits along the survey track line.

Multibeam data will be collected by running lines parallel with the shoreline. Although the R2Sonic multibeam sonar can acquire data out to 80° on both port and starboard sides under the standard deployment, data will not meet target vertical criteria beyond 60° on a flat bottom. During survey operations all lines offshore of the shoreline runs will have the sonar swath width limited to a maximum of 60° on both starboard and port beams (or less, depending on refraction and cross-line analysis) during processing. While collecting sloped shoreline and under-dock bathymetry, it may be necessary to tilt the multibeam sonar head, which is mounted on the starboard side of the vessel, to starboard 20°. In this configuration, shoreline data can be collected as far up the bank as possible, on a steep bank, by making shoreline runs with the starboard side toward shore. Survey lines offshore of the shoreline runs will limit the starboard beams at 60° (or less, depending on refraction and cross-line analysis) during processing.

Running with a 120° swath (60° to port and starboard), the system still provides 3.5 times the water depth coverage in a single pass. The total swath width of full coverage mapping in a single pass will vary with the water depth, the cross-line comparison, and refraction analysis. If ships or barges, which may obstruct a planned survey transect, are shallow draft and not too wide, it may be possible to survey under them with the wide swath of the R2Sonic 2022. The POS/MV system will enable the survey vessel to run near ships at berth with minimal loss of positioning integrity. In addition to several parallel lines down the channel, crosstie lines will be run over the main scheme lines to confirm system calibration and document the accuracy of the survey. In addition, single-beam comparison lines will be run in shallow water along the shore to confirm accuracy of the outer beams. To account for vessel heave (vertical movement), pitch and roll, an Applanix POS/MV motion reference sensor, or equivalent, will be utilized. The POS/MV system will also be used to record vessel heading (yaw) from which the sonar beam orientation is derived. The POS/MV provides a higher degree of accuracy for heading measurements than a conventional gyrocompass.

Multibeam data will be acquired with HyPack HySweep data acquisition software. HySweep acquires and time-tags all sensor data, including multibeam sonar, position, heading, heave, pitch, and roll. The navigation system provides navigation output to the vessel operator's monitor and manages the survey. The acquisition systems can also be used to replay the survey so that the coverage and quality of the data can be reviewed prior to demobilization from the site.

Detailed measurements of the sound velocity profile through the water column are crucial in multibeam surveys and will be measured at 0.5-meter depth intervals from the water surface to the mudline in the part of the survey area with the deepest water. Changes in the sound velocity profile will not only affect acoustic distance measurements but can also cause refraction or bending of the sonar path as it passes through layers in the water column at different velocities. Because the velocity of sound is directly related to the density and temperature of water, changes in the sound velocity profile are expected to occur in the LDW due to the mixing of fresh and salt water during tidal changes. For this survey, an AML

$BaseX_2$ sound velocity profiler, or equivalent, will be used to directly measure sound velocity profiles (SVP) of the water column. It is anticipated that the SVP will have spatial and temporal variation. To account for spatial variation, the LDW will be divided into subsections. The size of the survey subsections will be determined at the time of surveying by collecting SVP data and adjusting the length of a subsection so that similar results are obtained at each end. Temporal change will be addressed by taking SVP measurements as the subsection is surveyed. Initial SVP measurements will be taken at least hourly through at least one complete tidal cycle. Subsequent measurements may be extended to every 2 hours, at the discretion of the lead hydrographer, based on the tidal cycle and observed measurement differences.

To confirm alignment of the sensor data with the sonar swath and verify delay times applied to the time-tagged sensor data, a patch test will be conducted. A patch test is a series of lines run in a specific pattern that are used in pairs to analyze roll, pitch, and heading alignment angles with the sonar swath, as well as latency (time delays) in the time tagging of the sensor data. A bar check and lead line check will be conducted to confirm draft of the sonar head. These tests will be conducted at the beginning and end of the survey and any time there are changes in the instrument configuration.

Data acquisition involves setting the motion sensor to the survey conditions and running slow, uniform lines in a systematic pattern. Adjustments will be made to scale and gain settings, as required, to maximize resolution of the survey.

During the survey, preliminary multibeam bathymetric data will be displayed in real-time on the HyPack computer. Pixels color-coded by depth will be drawn on screen, showing the coverage and agreement between adjacent swaths.

The high-resolution multibeam sonar system will be used during data acquisition for the vast majority of the site. In shallow areas (i.e., water depths less than 8 feet deep at high tide, a single-beam sonar system will be used in lieu of the multibeam), due to limitations of the multibeam system in shallow water depths. Examples of these areas might include: shorelines with low-angle slopes that prevent the vessel from getting close to the actual edge-of-water, inter-tidal mudflats, and shallow Green River areas above the turning basin. Line spacing for single-beam transects (if used) will be kept small (as determined by the field operations manager, based on survey vessel safe access and size of the area) to develop accurate modeling of the sediment contours. Bathymetry data acquisition will be strategically planned to collect shallow-water data during daily high tide events to maximize the amount of high-resolution multibeam sonar coverage of the project area. Deeper, mid-channel multibeam bathymetry can be collected during any tidal state and will be the focus of data collection efforts during low tides.

3.2.5 Survey Schedule

It is anticipated that the bathymetric survey will be conducted in October 2021 (with potential data gap survey concurrent with middle reach Phase I PDI timeframe in 2022). Field work is expected to require approximately 8 days, subject to factors such as tide conditions and interference from larger vessels. Within the planned bathymetric survey period, the surveyor will return to an incomplete coverage area if a moored vessel is moved to provide survey vessel access. The survey results will be used by subsequent documents, such as the PDI Work Plan. Any deviations from this QAPP in acquiring the bathymetric data will be noted in the bathymetric survey data report, which will be submitted as part of the PDI Data Evaluation Report.

3.3 Data Processing Methods

Post-processing of multibeam data will be completed using HyPack HySweep multibeam editing and analysis software. Patch test data will be analyzed and any alignment corrections will be applied. Water-level data will be verified and applied to adjust all depth measurements to MLLW. Sound velocity profiles will be generated from the AML SVP measurements taken in the field and used to correct slant range measurements and compensate for ray path bending. Due to the variable and dynamic nature of sound velocity profiles in the project area, sound velocity profiles are collected every 30 minutes at a minimum, and more frequently if the hydrographer determines that site conditions require additional sound velocity measurements.

Processing will begin with review of each survey line using the HySweep swath editor. Verified water surface correctors will be applied to the data set at this time. Position and sensor data will be reviewed and accepted, if no outliers are present, or removed if erroneous data are observed. Sounding data will be reviewed and edited for data flyers such as bottom multiples, returns from pilings and passing vessel wakes. These data points will be removed and will not be used as part of the final data set. Sounding data, including sonar beams reflecting from sediment in the water column or noise due to aeration in the water column, will be carefully reviewed to determine if these data points should be removed.

After swath editing, all data will be reviewed through the HySweep's area-based editing tools to ensure no flyers remained in the data set. In the HySweep editor, a set of lines will be reviewed together for line-to-line comparison to ensure agreement to one another.

To take advantage of the level of detail the multibeam survey will provide, a 1-foot resolution sun-illuminated model and 1-foot gridded data set will be exported from HySweep. This gridding process will use an inverse weighted mean of all soundings within a 1-foot by 1-foot cell. The 1-foot grid size will allow for comparisons with previous bathymetric surveys that were conducted with similar high-resolution methods, in order to interpret the possibility of shoaling or scouring. All original data will be archived at full resolution. The cross-line analysis for selected soundings will be performed on the data set at this stage. The sun-illuminated images will be reviewed for survey coverage and analyzed to determine if subtle artifacts remain in the data set, which may require further processing. The sun-illuminated plots will be exported as a georeferenced TIFF file that can be imported into AutoCAD or any GIS program for final presentation and plotting.

Export of accepted multibeam data will be imported into TerraModel software for generation of a DTM, from which contours will be generated.

3.4 Quality Control

The acquisition system and survey protocols are designed with some redundancy to demonstrate that the required accuracy is being achieved during the survey and to provide a backup to primary systems. Data integrity will be monitored throughout the survey by redundant system comparisons and checks against known values. All raw data are recorded to allow for adjustments to be made to any of the data during postprocessing, based on the results of comparisons and checks. Sound velocity and tide correctors can be modified at any time during processing. Data removed manually or through filtering will not be deleted, and this approach allows for review of all data to confirm or disprove anomalies.

Positioning: Positions will be recorded and archived in WGS84 geographic coordinates and projected onto NAD83/91 Washington North Zone coordinate system. A geodetic control survey will be conducted to provide positions for monuments within the study area. A position confidence check will be conducted daily on a monument that is accessible from the water. The check will consist of placement of an RTK GPS antenna over a project survey control monument. The obtained position will be compared to the surveyed value to assure the target horizontal and vertical accuracies are being obtained.

Tides: RTK GPS derived heights will be checked daily during the position checks. In addition, staff gauge observations will be made and compared to RTK GPS derived water elevations twice per day. Backup tidal observations from the NOAA automated gauge and the NWH-deployed automated gauge will be used to confirm and evaluate any anomalous data in the RTK GPS tidal values.

Sonar draft:

- A bar check will be conducted at the beginning and end of the project to confirm multibeam and single-beam[6] (if used) sonar draft below the water line. A bar will be lowered below the sonar to specific intervals below the water surface using calibrated marks on the attached chain.
- Sonar draft marks will be observed with the vessel trimmed to zero roll angle to confirm the static draft of the sonar.
- A comparison of multibeam and single-beam depth soundings will be performed at the beginning and end of the project to confirm multibeam and single-beam sonar draft below the water line in conformance with the Hydrographic Surveying Engineering Manuals (USACE 2013).
- A leadline depth observation will be made at the beginning and end of the project to confirm multibeam and single-beam sonar draft and sound velocity observations.

Motion sensor, positioning system latency, and vessel heading calibration: A patch test will be conducted at the beginning and end of the project to confirm that the sensor mounting angles and timing bias are correctly applied to multibeam sonar data.

Cross-line analysis: A cross-line analysis will be conducted across the full width of the survey, when there is sufficient water depth, to confirm that the beams used meet target accuracy. In addition, single-beam comparison lines will be run in shallow water along the shoreline to confirm accuracy of outer beams. In areas of shallow water (i.e., less than 8-foot depth), cross-line analysis will be used for verification in conformance with the Hydrographic Surveying Engineering Manual (USACE 2013).

Sun-illuminated analysis: A sun-illuminated image will be generated from a DTM of the accepted bathymetric data set. The image will be reviewed for anomalous data and consistency between adjacent sonar swaths.

[6] Some selected single-beam lines may be run to confirm multibeam measurements.

3.5 Instrument/Equipment Testing, Inspection, and Maintenance

Prior to mobilization, the survey vessel and equipment will be inspected and confirmed to be in operating order. The vessel is inspected and maintained daily by the vessel operator.

During mobilization, instrumentation will be tested and system performance testing will be conducted. Performance testing will include a bar check, patch test, leadline comparison to multibeam, single-beam echosounder comparison to multibeam, and position confidence check.

3.6 Instrument/Equipment Calibration and Frequency

Equipment calibration is verified through system performance testing (e.g., bar checks, position checks, staff or automated gauge comparison, multibeam patch test, leadline comparison, single beam comparison, and cross-line analysis). The exception is the AML SVP profiler, which is calibrated prior to the survey, verified with a pre- and post-survey bar check, and compared weekly to an independent temperature sensor.

Frequency of observations is as follows:

- Bar check, sonar draft mark observations, leadline and single beam comparison: beginning and end of project or any change in sonar mounting
- Position checks: daily
- Staff or automated gauge comparison: three times daily
- SVP profile: minimum of twice daily
- Multibeam patch test: beginning and end of project or any change in instrumentation
- Cross-line analysis: once per project

3.7 Inspection/Acceptance of Supplies and Consumables

No significant consumables are required because all data are digitally recorded. The survey vessel is equipped with survey log forms for survey documentation and a supply of solid state external hard-drives for data backup.

3.8 Non-Direct Measurements

The geodetic control survey will be based on existing monuments with published positions and elevations. Horizontal positions and elevations based on the North American Vertical

Datum of 1988 will be based on National Geodetic Survey published monuments. MLLW elevations along the LDW will be based on NOAA tidal benchmarks at Station 9447130, Seattle, Washington, and the USACE tide datum at Station 92 on the LDW.

3.9 Data Management

Data from the survey vessel will be backed up to solid-state external hard drives at the end of each survey day. Data will not be removed from the acquisition computers until they have been loaded and verified on archived NWH data server located in the home office.

4 Assessment and Oversight

4.1 Assessments and Response Actions

EPA or its designees may observe the survey, as needed. If situations arise wherein there is a significant inability to follow the QAPP methods precisely, the NWH field operations manager will coordinate with the Anchor QEA project manager to determine the appropriate actions and consult with EPA if the issue is significant. No field audits are proposed for this work. The NWH field operations manager will audit system checks and sun-illuminated imagery during post-processing. True North will perform QA on the complete scope of the bathymetric survey.

4.2 Reports to Management

Primary communications will be through the NWH field operations manager and the Anchor QEA project manager. This correspondence will primarily consist of emails sent during survey operations, which will include coverage images, general overview of survey progress, and any problems encountered during surveying. Anchor QEA will send copies of all communication to the King County project manager and LDWG.

5 Data Validation and Usability

5.1 Data Review, Verification, and Validation

Data will be reviewed and verified by evaluation of sun-illuminated imagery, cross-line analysis, comparison of multibeam data to redundant depth measurement techniques and comparison to adjacent soundings.

5.2 Verification and Validation Methods

Verification of multibeam data will be performed by comparison to intersecting and overlapping swath soundings, single-beam data, and (in areas of firm material) leadline soundings. Patch test data will be analyzed and a cross-line analysis will be performed to document the system performance. In areas where only single-beam surveying is possible (e.g., where water depth is insufficient for effective multibeam survey), cross-line analysis will be used for verification in conformance with the Hydrographic Surveying Engineering Manual (USACE 2013).

Sun-illuminated images will be reviewed for anomalous data and inconsistency between adjacent sonar swaths. Artifacts in the image will be investigated in HyPack HySweep editor by comparing the data to adjacent soundings and swaths.

5.3 Reconciliation with Data Quality Objectives

Data quality objectives for accuracy will be achieved by meeting the target horizontal and vertical accuracies at a 95% confidence level for the survey. Methods outlined in Sections 3.5, 3.7, and 5.2, will verify that the target accuracies are being obtained. Other data quality indicators, including completeness, representativeness, and precision, will be evaluated with a color-by-depth, sun-illuminated, coverage image generated in HyPack HySweep. This image processing system provides tools for data quality review (i.e., swath-to-swath comparison, 3D presentation color-coded by swath, etc.). Final review by the lead hydrographer will include the evaluation of sun-illuminated images for artifacts from system bias, and comparison to prior surveys.

Table 3 summarizes the key targets and related datums for the bathymetric survey. Horizontal accuracy of the survey is affected by several factors, including the positioning accuracy of the survey vessel and factors that can affect sonar data acquisition, such as vessel heave, pitch, and roll and signal interferences.

Table 3
Key Targets and Related Datums

Description	Quantity or Datum
Horizontal Positioning Accuracy	1.6 feet minimum
Horizontal Survey Accuracy	3 feet at a 95% confidence interval
Horizontal Datum	NAD83/91 Washington North Zone
Vertical Survey Accuracy	+/- 0.5 feet at a 95% confidence interval
Vertical Datum	MLLW (Tidal epoch 1983-2001)

6 References

AECOM, 2012. *Final Feasibility Study Lower Duwamish Waterway*. Prepared for Lower Duwamish Waterway Group. October 2012.

EPA (U.S. Environmental Protection Agency), 2000. *Guidance for the Data Quality Objectives Process*. Office of Environmental Information. EPA/600/R-96/055; EPA QA/G-4. August 2000.

EPA, 2002. *Guidance for Quality Assurance Project Plans*. Office of Environmental Information. EPA/240/R-02/009. December 2002.

EPA, 2021. Fifth Amendment of the *Administrative Order on Consent/or Remedial Investigation/Feasibility Study*, U.S. EPA, Region 10, CERCLA Docket No. 10-2001-0055, Ecology Docket No 00TCPNR-1895 (12/20/2000). July 2021.

Integral (Integral Consulting Inc.), 2018. *Waterway User Survey and Assessment of In-Water Structures—Data Report*. Prepared for Lower Duwamish Waterway Group. July 2018.

Integral, 2019. *Recovery Categories Recommendation Report* for Lower Duwamish Waterway. Prepared for U.S. Environmental Protection Agency, Region 10. February 2019.

USACE (U.S. Army Corps of Engineers), 2013. *Engineering and Design: Hydrographic Surveying*. EM 1110-2-1003. Department of the Army, US Army Corps of Engineers. November 2013.

Appendix A
Health and Safety Plan

Updated Health and Safety Plan

By their signature, the undersigned certify that this Health and Safety Plan (HASP) is approved and that it will be used to govern health and safety aspects of fieldwork described in the Quality Assurance Project Plan to which it is attached.

Thomas Wang

October 19, 2021

Tom Wang, PE
Anchor QEA, LLC, Project Manager

Date

Timothy Shaner

October 19, 2021

Tim Shaner
Anchor QEA, LLC, Health and Safety Program Lead

Date

James Glaeser

October 19, 2021

James Glaeser
Northwest Hydro, Inc., Field Operations Manager/Health and Safety Officer

Date

ACRONYMS

CFR	Code of Federal Regulations
CPR	cardiopulmonary resuscitation
EPA	U.S. Environmental Protection Agency
FOM	Field Operations Manager
HASP	Health and Safety Plan
HAZMAT	hazardous materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HSM	Health and Safety Manager
HSO	Health and Safety Officer
HSPL	Health and Safety Program Lead
LDW	Lower Duwamish Waterway
MHHW	mean higher high water
OSHA	Occupational Safety and Health Administration
PFD	personal flotation device
PM	Project Manager
PPE	personal protective equipment
True North	True North Land Surveying, Inc.
USCG	U.S. Coast Guard
VHF	very high frequency

A.1.0 Introduction

This Health and Safety Plan (HASP) presents health and safety requirements and procedures that will be followed by personnel during survey work activities in the Lower Duwamish Waterway (LDW) (the site). This HASP was developed in accordance with Title 29 of the Code of Federal Regulations (CFR), Part 1910.120(b), and will be used in conjunction with applicable Health and Safety Programs. See Section A.1.1 for HASP modification procedures.

The provisions of this HASP are mandatory for all personnel assigned to the project. A copy of this HASP must be always maintained on site and available for employee review. Personnel assigned to work at the project site will be required to read this plan and must sign the HASP Acknowledgement Form (Attachment A.1) to confirm that they understand and agree to abide by the provisions of this HASP. During site work, this HASP will be implemented by the True North Land Surveying, Inc. (True North) Field Operations Manager (FOM), who is also the designated site Health and Safety Officer (HSO), in cooperation with the corporate Health and Safety Manager (HSM).

The objectives of this HASP are to identify potential physical, chemical, and biological hazards associated with field activities; establish safe working conditions and protective measures to control those hazards; define emergency procedures; and describe the responsibilities, training requirements, and medical monitoring requirements for site personnel.

Issuance of this approved HASP documents that the workplace has been evaluated for hazards. A hazard assessment was performed, and the adequacy of the personal protective equipment (PPE) selected was evaluated as required by 29 CFR 1910.132(d)—Personal Protective Equipment, General Requirements (General Industry); 29 CFR 1910.134—Respiratory Protection; 29 CFR 1926.28—Personal Protective Equipment (Construction Industry); and 29 CFR 1926.55—Gases, Vapors, Fumes, Dusts and Mist, and is duly noted by the signature(s) and date appearing on the certification page of this document.

A.1.1 Health and Safety Plan Modifications

This HASP will be modified by amendment, if necessary, to address changing field conditions or additional work tasks not already described in this document. Modifications will be proposed by the FOM/HSO using the Modification to Health and Safety Plan form included as Attachment A.2. Modifications will be reviewed by the HSM or authorized representative and approved by the Project Manager (PM).

The field team has the responsibility to immediately report any potentially unsafe or hazardous conditions to the FOM/HSO, and all members of the field team have STOP WORK AUTHORITY—the authority to stop or suspend work if conditions arise that pose an unacceptable health and safety risk to the field team or environment, or if conditions arise that warrant modifications to this HASP. It is critical that all field team members proactively communicate with the FOM/HSO to identify potential unsafe conditions.

A.2.0 Site Description and Project Scope

The surveying area is in the LDW (see Figure 1 in the attached QAPP). The area is affected by tidal fluctuations. The main activity covered by this HASP is bathymetric surveying, which will be conducted from a survey vessel and has a low likelihood of contact with sediment. This HASP also covers installation of survey monuments for the middle reach in the public right of way to support bathymetric survey controls. Survey monument installation will be performed by a topographic surveyor. No other topographic surveying is proposed for this phase of work.

A.3.0 Health and Safety Personnel

Key health and safety personnel and their responsibilities are described below. These individuals are responsible for the implementation of this HASP.

Anchor QEA Project Manager: The PM has overall responsibility for the successful outcome of the project. The PM will ensure that adequate resources and budget are provided for the health and safety staff to carry out their responsibilities during fieldwork. The PM, in consultation with the HSM, makes final decisions concerning implementation of the HASP.

NWH Field Operations Manager/Health and Safety Officer: Because of the limited scope and duration of fieldwork, the NWH FOM and HSO will be the same person. The FOM/HSO will direct field surveying activities, coordinate the technical components of the field program with health and safety components, and ensure that work is performed according to the QAPP.

The FOM/HSO will implement this HASP at the work location and will be responsible for all health and safety activities and the delegation of duties to a health and safety technician in the field, if appropriate. The FOM/HSO also has stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FOM/HSO or their designee shall be present during surveying operations.

True North Field Operations Manager/Health and Safety Officer: The True North FOM and HSO will be the same person. The FOM/HSO will direct field surveying activities, coordinate the technical components of the field program with health and safety components, and ensure that work is performed according to the Survey QAPP addendum.

The FOM/HSO will implement this HASP at the work location and will be responsible for all health and safety activities and the delegation of duties to a health and safety technician in the field, if appropriate. The FOM/HSO also has stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FOM/HSO or their designee shall be present during surveying operations.

Anchor QEA Corporate Health and Safety Program Lead: The HSPL has overall responsibility for preparation, approval, and revisions of this HASP. The HSPL will not necessarily be present during fieldwork, but will be readily available, if required, for consultation regarding health and safety issues during fieldwork.

Field Crew: All field crew members must be familiar with and comply with the information in this HASP. They also have the responsibility to report any potentially unsafe or hazardous conditions to the FOM/HSO immediately.

A.4.0 Hazard Evaluation and Control Measures

This section covers potential physical and chemical hazards that may be associated with the proposed project activities and presents control measures for addressing these hazards. The activity hazard analysis, Section A.4.3, lists the potential hazards associated with each site activity and the recommended site control to be used to minimize each potential hazard.

Confined space entry will not be necessary for this project. Therefore, hazards associated with this activity are not discussed in this HASP.

A.4.1 Physical Hazards

For this project, it is anticipated that physical hazards will present a greater risk of injury than chemical hazards. Physical hazards are identified and discussed below.

A.4.1.1 Slips, Trips, and Falls

As with all fieldwork sites, caution should be exercised to prevent slips on slick surfaces. In particular, surveying requires careful attention to minimize the risk of falling down. Bathymetric surveying will be performed on a boat and care will be taken to minimize the risk of falling overboard. Slips will be minimized by wearing boots with good tread, made of material that does not become overly slippery when wet.

Trips are always a hazard on the uneven deck of a boat or in a cluttered work area. Personnel will keep work areas as free as possible from items that interfere with walking.

Falls may be avoided by working as far from exposed edges as possible, by erecting railings, and by using fall protection when working on elevated platforms. For this project, no work is anticipated that would present a fall hazard. As with any work from a floating platform, there is a chance of falling overboard. Personal flotation devices (PFDs) will be worn while working on deck or working from an open boat. PFDs need not be worn while working inside an enclosed cabin, but must be readily available when going on deck from the cabin area. An individual in the water shall be considered a "person overboard" and appropriate rescue actions shall be taken immediately to prevent hypothermia. PFDs will be worn while working within 10 feet of the water's edge or on banks.

A.4.1.2 Manual Lifting

Equipment must be lifted and carried. Back strain can result if lifting is done improperly. During any manual handling tasks, personnel should lift with the load supported by their legs and not their backs. For heavy loads, an adequate number of people will be used, or if possible, a mechanical lifting/handling device will be used.

A.4.1.3 Heat Stress, Hypothermia, or Frostbite

The work crew and other personnel shall have adequate clothing and foul-weather gear in their possession prior to beginning work. Hypothermia is a potentially hazardous condition.

Hypothermia is characterized by pain in the extremities and loss of manual dexterity, with severe, uncontrollable shivering, and an inability to maintain the level of activity. Symptoms include excessive fatigue, drowsiness, irritability, or euphoria. Severe hypothermia includes clouded consciousness, low blood pressure, pupil dilation, cessation of shivering, unconsciousness, and possible death.

Move the individual to a warm, dry place. If the individual's clothing is wet, remove it and replace it with dry clothing. Keep the individual warm. Rewarming the individual should be gradual to avoid stroke symptoms. Dehydration, or the loss of body fluids, may result in a cold injury due to a significant change in blood flow to the extremities. If the individual is conscious and alert, warm sweet liquids should be provided. Coffee and other caffeinated liquids should be avoided because of diuretic and circulatory effects. Extremities affected by frostbite should be gradually warmed and returned to normal temperature. Moist compresses should be applied; begin with lukewarm compresses and slowly increase the temperature as changes in skin temperature are detected. Keep the individual warm and calm and move to a medical facility as soon as possible.

A.4.1.4 Weather

In general, field team members will be equipped for the normal range of weather conditions. Work shall be preceded by an evaluation of weather reports and conditions by the FOM/HSO and vessel pilot to ascertain that safe working conditions exist and safe refuge of personnel is assured. An alternate safe harbor shall be designated for emergency situations. Field personnel shall maintain monitoring of the local area weather broadcasts or other readily available weather forecasting services. Some conditions that might force work stoppage are electrical storms, high winds, or high waves resulting from winds.

A.4.1.5 Boating Operations

The following precautions shall be taken when conducting boating trailer and launch activities. These procedures are provided as a reference; NWH will follow their own internal boating safety procedures and consider the procedures below.

- Follow the trailer and boat manufacturers' instructions for securing the boat to the trailer.
- Follow the trailer manufacturer's instructions for securing the trailer to the towing vehicle.
- Prohibit site personnel from moving into trailer/vehicle pinch points without advising the vehicle operator.
- Use experienced operators when backing trailers on boat ramps.
- Wear proper work gloves when the possibility of pinching or other injury may be caused by moving or handling large or heavy objects.
- Maintain all equipment in a safe condition.
- Launch boats one at a time to avoid collisions.
- Use a spotter for vehicles backing boats to the launch area.
- Understand and review hand signals.
- Wear boots with non-slip soles when launching boats.
- Wear USCG-approved PFDs when working within 10 feet of the water.
- Keep ropes and lines coiled and stowed to eliminate trip hazards.
- Maintain three-point contact on dock/pier or boat ladders.
- Verify that drain plugs are in place.

The following precautions shall be followed when conducting boating operations:

- Maintain a current boater's license(s) as required.
- Wear USCG-approved PFDs for work activities within 10 feet of the water.
- Obtain and review information regarding dams that may be present in work areas, particularly with regard to "no boating" zones and safety buoys, cables, and warning signage.
- Maintain boat anchorage devices commensurate with anticipated currents, distance to shore, and water depths.
- Provide a floating ring buoy in the immediate boat launch/landing areas with at least 60 feet (18.3 meters) of line for a vessel less than 65 feet (19.8 meters) in length, or 90 feet (27.4 meters) of line for a vessel 65 feet (19.8 meters) or greater in length (see https://www.law.cornell.edu/cfr/text/46/117.70 for more information).
- Step into the center of the boat.
- Keep your weight low when moving on the boat.

- Move slowly and deliberately.
- Steer directly across other boat wakes at a 90-degree angle to avoid capsizing.
- Steer the boat facing forward.
- Watch for floating objects in the water.
- Right-of-way is yielded to vessels on your boat's right, or starboard, and vessels with limited ability to maneuver such as any wind-propelled vessel.

The following precautions shall be followed when working on a boat:

- Observe proper lifting techniques.
- Wear USCG-approved PFDs for work activities within 10 feet of the water.

The safety-related items listed in Table A-1 shall be available when conducting boating operations.

Table A-1
Safety equipment specific to in-water work

Additional Safety Equipment for Sampling Vessel per U.S. Coast Guard Requirements
• Proper vessel registration, numbering, and documentation (registered with state, certificate of vessel registration number displayed, and carrying a valid certificate of number) • USCG-approved personal flotation devices (PFDs; or life jackets) for every person on the sampling vessel (Type I, II, III, or V are required). High-visibility required by Anchor QEA. • Appropriate, non-expired, visual distress devices for day and night use from the following: – Three hand-held red flares (day and night), or – One hand-held red flare and two parachute flares (day and night), or – One hand-held orange smoke signal, two floating orange smoke signals (day), and one electric distress light (night only) • Alternate means of propulsion (oars or paddles) • Dewatering device (pump or bailer) • Properly maintained and inspected USCG-approved fire extinguishers (no fixed system = (2) B-1 or (1) B-2 type extinguishers; fixed system = (1) B-1 type extinguisher) • Proper ventilation of gasoline-powered vessels • Sound-producing device (whistle, bell, or horn) • VHF 2-way radio • Proper navigational light display • Throwable life ring with attached line (any vessel larger than 16 feet is required to carry one Type IV [throwable] PFD)

Additional Safety Equipment for Sampling Vessel per U.S. Coast Guard Requirements	
Additional USCG Recommended Equipment Includes:	
• Extra visual distress signals • Primary and spare anchor • Heaving line • Fenders • First aid kit • Flashlight • Mirror • Searchlight • Sunburn lotion • Tool kit • Spare fuel	• Boat hook • Spare propeller • Mooring line • Food and water • Binoculars • Spare batteries • Sunglasses • Marine hardware • Extra clothing • Spare parts • Pertinent navigational chart(s) and compass

A.4.1.6 Working in a Roadway

These procedures are provided as reference; NWH and True North will follow their own internal safety procedures for working in a roadway and consider the procedures below:

- Plan and conduct work in a manner that traffic may be continuously observed. This may require having a spotter equipped with a noise-making device such as an air horn or a whistle, as appropriate.
- Wear a high-visibility traffic vest and hardhat when a vehicle hazard exists. Include lighted elements when possible in high-hazard environments.
- Use cones, flag-mounted cones, caution tape, and/or barricades.
- Protect the work area with a vehicle or piece of heavy equipment if this does not pose an additional hazard. The vehicle should have a strobe light and operating headlights or running lights (if equipped).

A.4.2 Chemical Hazards

The Record of Decision identified polychlorinated biphenyl compounds, carcinogenic polycyclic aromatic compounds, arsenic, and dioxins/furans are contaminants of concern in sediments below mean higher high water (MHHW). Direct contact with contaminated sediment may occur when working from a boat if equipment is lowered to the sediment surface and raised back into the boat.

A.4.2.1 Exposure Routes

Possible routes of exposure to the chemicals potentially encountered on this project include inhalation, dermal contact, and ingestion of dust, mist, gas, vapor, or liquid. Exposure will be minimized by using safe work practices and by wearing the appropriate PPE. A further discussion of PPE requirements is presented in Section A.7.0.

Inhalation

Inhalation of particulates, dust, mist, gas, or vapor during field activities is possible. Chemicals of concern at this site are not volatile and strongly adsorb to sediment, so the principal route of inhalation exposure is through contaminated particulate or dust. Wet sediment should generate little dust, but dried sediment may present a hazard of inhalation. Care should be taken when working in areas with contaminated sediment, generally below MHHW in the work areas, and when decontaminating personal protective equipment and survey equipment that has been in contact with sediment.

Dermal Contact

Dermal contact with potentially contaminated soil, sediment, or groundwater during field activities is possible. Direct contact will be minimized by using appropriate PPE and decontamination procedures.

Ingestion

Direct ingestion of contaminants can occur by inhaling airborne dust, mist, or vapors, or by swallowing contaminants trapped in the upper respiratory tract. Indirect ingestion can occur by introducing the contaminants into the mouth by way of food, tobacco, fingers, or other carriers. Although ingestion of contaminants can occur, proper hygiene, decontamination, and contamination reduction procedures should reduce the probability of this route of exposure.

Chemicals of Concern Profile

Table A-2 provides a summary profile for the chemicals of concern for this project. This profile is based on recent site history and site characterization information. For more detailed and specific information, always refer to the Safety Data Sheet.

Table A-2
Chemicals of Concern

Chemical	Exposure Routes	Symptoms	Target Organs	OEL (STEL)	Odor Threshold (ppm)	LEL (%)	Ionization Energy (eV)
PCBs (Chlorodiphenyls) (42% Cl / 53469-21-9) (54% Cl / 11097-69-1)	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, chloracne; liver damage; reproductive effects Potential occupational carcinogen	Skin, eyes, liver, reproductive system	0.001 mg/m^3 TWA8 Skin IDLH / Ca – 5 mg/m^3	N/A	N/A	N/A
Polycyclic aromatic hydrocarbons (PAHs) – as coal tar pitch volatiles. (Includes benzo(a)pyrene, chrysene, phenanthrene, fluoranthene, pyrene, acenaphthene, methylnaphthalenes, and anthracene)	Skin, eye, inhalation, and ingestion hazard	Direct contact or exposure to the vapors may be irritating to the eyes. Direct contact can be highly irritating to the skin and can cause dermatitis. Exposure to high vapor concentrations may cause headaches, nausea, vomiting, and other symptoms. Includes human carcinogens. Exposure to all routes should be carefully controlled to levels as low as possible. Confirmed animal carcinogen.	Respiratory system, skin, bladder, kidneys	0.2 mg/m^3 TWA8 0.1 mg/m^3 TWA8 (Cyclohexane-extractable fraction) IDLH / Ca – 80 mg/m^3	Varies	N/A	N/A
Dioxins/Furans (as 2,3,7,8-Tetrachloro-dibenzo-p-dioxin) - TCDD	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes; allergic dermatitis, chloracne; porphyria; gastrointestinal disturbance; possible reproductive, teratogenic effects; In Animals: liver, kidney damage; hemorrhage Potential occupational carcinogen	Eyes, skin, liver, kidneys, reproductive system	Lowest Feasible Concentration (LFC) Proposed OEL of 0.2 ng/m^3 Skin IDLH / Ca - LFC	N/A	N/A	N/A
Hydrogen Sulfide (H2S) (7783-06-04) 1 ppm = 1.40 mg/m3	Inhalation, skin and/or eye contact	Irritation eyes, respiratory system; apnea, coma, convulsions; conjunctivitis, eye pain, lacrimation (discharge of tears), photophobia (abnormal visual intolerance to light), corneal vesiculation; dizziness, headache, lassitude (weakness, exhaustion), irritability, insomnia; gastrointestinal disturbance; liquid: frostbite	Eyes, respiratory system, central nervous system	1 ppm TWA8 (5 ppm) C – 10 ppm (10-min over an 8-hr shift) IDLH - 100 ppm	0.03 ppm	4.0	10.46
Arsenic, and inorganic compounds as (7440-38-2)	Inhalation, skin absorption, skin and/or eye contact, ingestion	Ulceration of nasal septum, dermatitis, gastrointestinal disturbances, peripheral neuropathy, resp irritation, hyperpigmentation of skin Potential occupational carcinogen	Liver, kidneys, skin, lungs, lymphatic system	Ceiling limit of 0.002 mg/m^3 [15-Minute] IDLH / Ca – 5 mg/m^3	N/A	N/A	N/A
Barium and soluble compounds, as Ba, including Barium chloride (7440-39-3) (10361-37-2)	Inhalation, skin and/or eye contact	irritation eyes, skin, upper respiratory system; skin burns; gastroenteritis; muscle spasm; slow pulse, extrasystoles (heart contractions); hypokalemia (deficiency of potassium in the bloodstream).	Eyes, skin, respiratory system, heart, central nervous system	0.5 mg/m^3 TWA8 IDLH – 50 mg/m^3	N/A	N/A	N/A
Cadmium and compounds, as Cd (7440-43-9)	inhalation, ingestion	Pulmonary edema, dyspnea (breathing difficulty), cough, chest tightness, substernal (occurring beneath the sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia (loss of the sense of smell), emphysema, proteinuria, mild anemia Potential occupational carcinogen	respiratory system, kidneys, prostate, blood, prostatic & lung cancer	0.005 mg/m^3 TWA8 IDLH / Ca – 9 mg/m^3	N/A	N/A	N/A

Chemical	Exposure Routes	Symptoms	Target Organs	OEL (STEL)	Odor Threshold (ppm)	LEL (%)	Ionization Energy (eV)
Chromium (II) inorganic compounds, as Cr	Inhalation, ingestion, skin and/or eye contact	Irritation eyes; sensitization dermatitis	Eyes, skin	0.5 mg/m^3 TWA$_8$ IDLH – 250 mg/m^3	N/A	N/A	N/A
Chromium (III) inorganic compounds, as Cr (7440-47-3)	Inhalation, ingestion, skin and/or eye contact	Irritation eyes; sensitization dermatitis	Eyes, skin	0.5 mg/m^3 TWA$_8$ (total dust) 0.003 mg/m^3 TWA$_8$ (inhalable fraction) IDLH – 25 mg/m^3	N/A	N/A	N/A
Chromium (VI) inorganic compounds, as Cr (18540-29-9) (1333-82-0 as CrO3)	Inhalation, ingestion, skin and/or eye contact	Irritation respiratory system; nasal septum perforation; liver, kidney damage; leukocytosis (increased blood leukocytes), leukopenia (reduced blood leukocytes), eosinophilia; eye injury, conjunctivitis; skin ulcer, sensitization dermatitis Potential occupational carcinogen	Blood, respiratory system, liver, kidneys, eyes, skin, lung cancer	0.0002 mg/m^3 TWA$_8$ IDLH / Ca – 15 mg/m^3	N/A	N/A	N/A
Lead and inorganic compounds, as Pb (7439-92-1)	Inhalation, ingestion, skin and/or eye contact	Lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension	Eyes, gastrointestinal tract, central nervous system, kidneys, blood, gingival (gum) tissue	0.05 mg/m^3 TWA$_8$ IDLH – 100 mg/m^3	N/A	N/A	N/A
Mercury, elemental and inorganic compounds, as Hg (7439-97-6)	Inhalation, skin absorption, ingestion, skin and/or eye contact	Irritation eyes, skin; cough, chest pain, dyspnea (breathing difficulty), bronchitis, pneumonitis; tremor, insomnia, irritability, indecision, headache, lassitude (weakness, exhaustion); stomatitis (inflammation of mucous membranes of the mouth), salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria (abnormal quantities of protein in the urine)	Eyes, skin, respiratory system, central nervous system, kidneys	0.025 mg/m^3 TWA$_8$ C– 0.1 mg/m^3 Skin IDLH – 10 mg/m^3	N/A	N/A	N/A
Selenium compounds, as Se (7782-49-2)	Inhalation, ingestion, skin and/or eye contact	Irritation eyes, skin, nose, throat; visual disturbance; headache; chills, fever; dyspnea (breathing difficulty), bronchitis; metallic taste, garlic breath, gastrointestinal disturbance; dermatitis; eye, skin burns; In Animals: anemia; liver necrosis, cirrhosis; kidney, spleen damage	Eyes, skin, respiratory system, liver, kidneys, blood, spleen	0.2 mg/m^3 TWA$_8$ IDLH – 1 mg/m^3	N/A	N/A	N/A
Silver metal, and soluble compounds, as Ag (7440-22-4)	Inhalation, ingestion, skin and/or eye contact	Blue-gray eyes, nasal septum, throat, skin; irritation, ulceration skin; gastrointestinal disturbance	Nasal septum, skin, eyes	0.01 mg/m^3 TWA$_8$ IDLH – 10 mg/m^3	N/A	N/A	N/A

TWA$_8$ – 8-hour time weighted average
Skin – OEL based primarily on skin exposure hazard
C – Ceiling Limit
Ca – potential or confirmed human carcinogen
IDLH – Immediately Dangerous to Life or Health
LFC – Lowest Feasible Concentration
OEL– Occupational Exposure Limit
STEL– Short Term Exposure Limit
LEL– Lower Explosive Limit

A.4.3 Activity Hazard Analysis

The activity hazard analysis summarizes the field activities to be performed during the project, outlines the hazards associated with each activity, and presents controls that can reduce or eliminate the risk of the hazard occurring. Table A-3 presents the activity hazard analysis for conducting the bathymetric survey.

Table A-3
Activity Hazard Analysis

Required PPE: ANSI/ASTM compliant hard hat (if overhead hazards), high-visibility vest, safety glasses, safety shoes or boots, a face covering and the following as needed for hazards present: safety goggles, dust masks, gloves, hearing protection (if noise is 85 decibels or above), chaps, foul weather gear, PFD if on a boat or within 10 feet of water's edge on banks.[1]

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity and surveying	Slips, trips, and falls	• Avoid walking while writing or texting—maintain a heads-up posture. • Be aware of potentially slippery surfaces and tripping hazards. Use handrails where available. Wear footwear that has sufficient traction. • Maintain good housekeeping practices. Clean up all spills immediately. • Be aware of weather effects on the work area, including wet and/or frozen ground. • Jumping, running, and horseplay are prohibited. • Keep all areas clean and free of debris to prevent any trips and falls. • Be aware of and limit loose clothing or untied shoelaces that may contribute to slips, trip, and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.

Required PPE: ANSI/ASTM compliant hard hat (if overhead hazards), high-visibility vest, safety glasses, safety shoes or boots, a face covering and the following as needed for hazards present: safety goggles, dust masks, gloves, hearing protection (if noise is 85 decibels or above), chaps, foul weather gear, PFD if on a boat or within 10 feet of water's edge on banks.[1]

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity and surveying (continued)	Heat stress	• Adjust work schedules, as necessary, to avoid the hottest part of the day. • Take rest breaks as warranted. • Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods. • Maintain body fluids at normal levels. • Train workers to recognize the symptoms of heat-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions. • Monitor outside temperature versus worker activity.
	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite and hypothermia. • Use appropriate cold-weather gear, up to and including Mustang-type bib coveralls or jacket/bib combinations. • Consider additional precautions if working near water in cold weather. • Have a dry change of clothing available. • Train workers to recognize the symptoms of cold-related illness.	• Review weather forecast prior to field work. • Monitor workers' physical conditions and PPE. • Monitor outside and water temperature versus worker activity and PPE.
	Rain or snow	• Wear appropriate PPE (rain gear).	• Review weather forecast prior to field work. • Inspect PPE daily prior to use.

Required PPE: ANSI/ASTM compliant hard hat (if overhead hazards), high-visibility vest, safety glasses, safety shoes or boots, a face covering and the following as needed for hazards present: safety goggles, dust masks, gloves, hearing protection (if noise is 85 decibels or above), chaps, foul weather gear, PFD if on a boat or within 10 feet of water's edge on banks.[1]

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity and surveying (continued)		• Be aware of slip hazards, puddles, and electrical hazards when working in wet conditions. • If extremely cold conditions are forecast, consider additional precautions or postponing work activity.	• Routinely inspect work area for deteriorating conditions.
	Sunshine	• Have sunscreen available for ultraviolet protection. • Have abundant water available to prevent dehydration. • Consider wearing wide-brimmed headwear and light-colored, lightweight, sun-blocking clothing.	• Ensure that sunscreen and water are available.
	Lightning	• Do not begin or continue work until lightning subsides for at least 30 minutes. Disconnect and do not use or touch electronic equipment. • Immediately head for shore if on the water and lightning is observed. If not able to get to shore, disconnect and do not use or touch the major electronic equipment, including the radio, throughout the duration of the storm.	• Obtain weather forecast and updates as needed.
	High winds	• Wear goggles or safety glasses if dust or debris are visible.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are available.
	Biological hazards (flora [e.g., poison ivy and poison oak]	• Be aware of likely biological hazards in the work area.	• Ensure that insect repellent is available.

Required PPE: ANSI/ASTM compliant hard hat (if overhead hazards), high-visibility vest, safety glasses, safety shoes or boots, a face covering and the following as needed for hazards present: safety goggles, dust masks, gloves, hearing protection (if noise is 85 decibels or above), chaps, foul weather gear, PFD if on a boat or within 10 feet of water's edge on banks.[1]			
Work Activity	**Potential Hazards**	**Preventive or Corrective Measures**	**Inspection Requirements**
Outdoor, physical activity and surveying (continued)	and fauna [e.g., ticks, bees, spiders, mosquitoes, and snakes])	• Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellant. • Wear hand and arm protection when clearing plants or debris from the work area. • Be aware of potential wildlife and defensive behavior (e.g., nesting birds, or animals with young).	• Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.
	Noise exposure	• Wear hearing protection in high noise environments or when working around heavy machinery or equipment (action level of 85 decibels averaged over an 8-hour day).	• Ensure that hearing protection is available.
	SARS-CoV-2 virus (COVID-19)	All basic program elements in the General Coronavirus Prevention Under Stay at Home - Stay Healthy Guidelines (L&I 2020a) will be met, except for distancing more than 6 ft at all times (distances of less than 6 ft may occur at times on boats). Therefore, per L&I guidance referenced below, a hazard assessment was done to determine that this work site is a medium transmission risk. Based on this risk, the required PPE was identified and included in the alternative strategies in addition to basic program	• Confirm by observation that work conforms to preventive measures.

Required PPE: ANSI/ASTM compliant hard hat (if overhead hazards), high-visibility vest, safety glasses, safety shoes or boots, a face covering and the following as needed for hazards present: safety goggles, dust masks, gloves, hearing protection (if noise is 85 decibels or above), chaps, foul weather gear, PFD if on a boat or within 10 feet of water's edge on banks.[1]

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
		elements. In total, the following control actions will be taken. • Stay at home if sick or exhibiting COVID-19 symptoms. • Avoid group meetings in enclosed spaces. • Drive separately to/from work site. Monitor workers' temperatures for signs of fever. • Maintain social distancing (i.e., minimum 6-ft distance) to extent possible from other people. • Follow proper coughing and sneezing etiquette and personal hygiene (e.g., frequent and thorough handwashing or using sanitizer with at least 60% alcohol). • Avoid sharing tools and equipment and decontaminate/disinfect all tools, equipment, and supplies frequently. • Wear modified Level D PPE, including gloves and protective face coverings with safety glasses or face shields. • Limit number of personnel to minimum needed to complete the work and modify work spaces to allow greater distancing.	

Required PPE: ANSI/ASTM compliant hard hat (if overhead hazards), high-visibility vest, safety glasses, safety shoes or boots, a face covering and the following as needed for hazards present: safety goggles, dust masks, gloves, hearing protection (if noise is 85 decibels or above), chaps, foul weather gear, PFD if on a boat or within 10 feet of water's edge on banks.[1]			
Work Activity	**Potential Hazards**	**Preventive or Corrective Measures**	**Inspection Requirements**
		• Refer to Attachment A.3 for additional details.	
	Physical injury from moving heavy equipment	Follow procedures outlined in Section A.4.1.5 for safely launching a boat from a trailer.	• Confirm by observation that work conforms to preventive measures.
	Falling overboard	Use care in boarding/departing from vessel. Wear PFD when on deck. Follow safe work practices related to vessel operations specified in Section A.6.0.	• Confirm by observation that work conforms to preventive measures.

Note:
1. https://pdhonline.com/courses/l101/02_surveys.pdf

A.5.0 Work Zones and Shipboard Access Control

Direct contact with contaminated media may occur if retrieving equipment that has been in contact with contaminated sediment; however, no physical sample collection or processing will occur. The only designated contaminated work zone is below MHHW and will require minimal decontamination upon exit. Any security or access control problems will be reported to the property owner or appropriate authorities. When accessing other property through access agreements, HASP requirements will be coordinated with those owners and any other HASPs that may be applicable on that site.

Security and control of access to the boat will be the responsibility of the FOM/HSO and boat captain. Boat access will be granted only to necessary project personnel and authorized visitors. Visitors will be provided a copy of the HASP, a briefing on the project and related health and safety requirements, and an opportunity to ask questions about the HASP, and they will be required to sign the acknowledgement in Attachment A.1.

A.6.0 Safe Work Practices

Due to the nature of the bathymetric surveying, safe work practices are primarily related to slips, trips, and falls. Some operations may be performed from a boat or other floating platform, which would introduce additional potential hazards. All employees actively working on projects involving vessel operations will be thoroughly trained in the applicable safety, underway, docking, fueling, and various necessary operational procedures. The minimum responsibilities of the field crew members are as follows:

1. Do not climb over or under obstacles of questionable stability.
2. Work only in well-lighted spaces.
3. Make eye contact with equipment operators when moving within the range of their equipment.
4. Be aware of the movements of equipment when not in the operator's range of vision.
5. Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries.
6. Always use the buddy system.
7. Be alert to your own and other workers' physical condition.
8. Have contact information for the client or owner while on site. If unauthorized personnel or a homeless encampment is encountered during work, the individuals should not be disturbed, the field crew should leave the area, contact the client or owner, and notify the PM or field lead.
9. Report all accidents, no matter how minor, to the FOM/HSO.
10. Do not do anything dangerous or unwise even if ordered by a supervisor.

The following safety rules are specific to on-water operations:

1. During all vessel operations the boat captain is in charge and takes full responsibility for safe operation of the vessel.
2. All vessel operators shall have adequate knowledge of the US Coast Guard (USCG) regulations, "Rules of The Road" and shall be approved for vessel operation by the FOM.
3. Vessels over 20 feet shall be inspected annually by a qualified marine surveyor to ensure structural integrity and safe operating conditions exist. Records of inspections shall be maintained on the vessel for vessels over 20 feet and shall be available to the designated authority.
4. When the vessel is brought onto a job site, it shall be inspected and tested by the vessel crew and determined to be in safe operating condition prior to the initiation of prescribed work.
5. Any vessel found to be in an unsafe condition shall be taken out of service and its use prohibited until the specified unsafe conditions have been corrected.
6. Prior to vessel departure from the dock, all onboard personnel shall be familiar with their duties and responsibilities in the event of an emergency, and the location of the vessel's emergency first-aid and firefighting equipment, as verbally communicated by a qualified member of the vessel crew.
7. All vessels shall be equipped with a PFD for each person onboard, a VHF marine radio and all USCG required safety equipment.
8. Navigation lights, radar systems, radios, depth sounders, and other navigational equipment shall be operated, inspected, and recorded each week and prior to each job by qualified personnel to ensure their proper operation.
9. A detailed daily work schedule that includes the approximate times, site locations, access points and other pertinent information necessary to locate crew members in the event of emergency, will be filed with the local field office or appropriate shore-side personnel.
10. Prior to departure from the dock, the vessel's fuel capacity will be checked to ensure adequate fuel is available to complete the day's work and maintain sufficient fuel reserves to allow for a reasonable margin of safety.
11. Fuel used on the outbound trip to assigned work areas shall not exceed one-third of the total fuel reserves. The pilot shall monitor fuel consumption throughout the work day and begin the inbound transit when remaining fuel reserves approach 150% of the fuel quantity used during the outbound transit.
12. Coast Guard approved PFDs shall be worn by all personnel when on deck or in an open vessel, regardless of other safety devices utilized. All safety devices must be inspected for defects prior to each use and those found to be defective replaced immediately. PFDs need not be worn while working inside an enclosed cabin, but must be readily available when going on deck from the cabin area.

13. Additional emergency/rescue equipment onboard vessels will include, but not be limited to, throw rings, throw ropes, dye markers, strobes, flares, boat hooks, and other safety equipment required by the USCG.
14. Vessel fuel valves shall be in the closed position when shutting down boat operations for the night or more than 8 hours.
15. Smoking shall be prohibited on the boat at all times and/or within 20 feet of fuel tanks.
16. A minimum of one 10-pound A-B-C fire extinguisher will be properly certified, maintained, and located conspicuously onboard all motor-driven vessels.
17. Work areas and access-ways shall be kept clean and clear of obstructions at all times.
18. A proper watch shall be maintained in order to avoid other vessels, floating debris, deadheads, and other obstructions.
19. When conducting night operations or working in reduced visibility, proper navigation lights shall be displayed, a safe speed (as warranted by the conditions) shall not be exceeded, and a proper watch shall be posted.

A.7.0 Personal Protective Equipment and Safety Equipment

Appropriate PPE will be worn as protection against potential hazards. Specific PPE is outlined in the activity hazard analysis. In addition to PPE that will be worn by personnel, basic emergency and first aid equipment will also be provided. Equipment for the field team will include the following:

1. A copy of this HASP
2. First aid kit adequate for the number of personnel

The FOM/HSO will ensure that the safety equipment is utilized. Equipment will be checked daily to ensure its readiness for use.

A.8.0 Monitoring Procedures for Site Activities

For this project, the monitoring program will consist of all workers monitoring themselves and their co-workers for signs that might indicate physical stress or illness. All personnel will be instructed to look for and inform each other of any deleterious changes in their physical or mental condition during the performance of all field activities. Examples of such changes are as follows:

1. Headaches
2. Dizziness
3. Nausea
4. Symptoms of heat stress
5. Blurred vision
6. Cramps
7. Irritation of eyes, skin, or respiratory system

8. Changes in complexion or skin color
9. Changes in apparent motor coordination
10. Increased frequency of minor mistakes
11. Excessive salivation or changes in papillary response
12. Changes in speech ability or speech pattern
13. Shivering
14. Blue lips or fingernails

If any of these conditions develop, work shall be halted immediately and the affected person(s) evaluated. If further assistance is needed, personnel at the local hospital will be notified, and an ambulance will be summoned if the condition is thought to be serious. If the condition is the direct result of sample collection or handling activities, procedures will be modified to address the problem.

A.9.0 Decontamination

Bathymetric surveyors have a low likelihood of contact with contaminated sediment, but decontamination protocols will be followed if contact occurs. At a minimum, boots and equipment that contact contaminated sediment will require decontamination before leaving contaminated areas. Decontamination stations will be set up adjacent to the boat to clean boots, equipment, and any other contaminated gear and avoid tracking contamination into clean areas. The following measures will be observed to prevent or minimize exposure to potentially contaminated materials:

- Do not walk through spilled materials.
- Do not handle, touch, or smell environmental media directly.
- Make sure PPE has no cuts or tears prior to use.
- Protect and cover any skin injuries.
- Stay upwind of airborne dusts and vapors.
- Do not eat, drink, chew tobacco, or smoke in the work zones.

A.9.1 Decontamination Equipment

All equipment taken into potentially contaminated areas will be visually inspected and, if necessary, decontaminated prior to leaving the area. Rinsate from all decontamination activities will be collected for proper disposal. Decontamination of equipment and tools will take place within the contamination reduction zone.

The following supplies will be available to perform decontamination activities:

- Wash and rinse buckets
- Tap water and phosphate-free detergent
- Scrub brushes

- Distilled/deionized water
- Pressure washer/steam cleaner, if appropriate
- Paper towels and plastic garbage bags

A.9.2 Personnel Decontamination

The FOM will verify that all site personnel are familiar with personnel decontamination procedures as listed below. All personnel wearing PPE in a contaminated work area must undergo decontamination, as appropriate, prior to entering the Safe Zone. Personnel will perform the following decontamination procedures:

- Wash and rinse outer gloves and boots in portable buckets to remove gross contamination.
- If suit is heavily soiled, rinse it off.
- Remove outer gloves; inspect and discard if damaged. Leave inner gloves on. Personnel will remove their outer garment and gloves, dispose of them, and properly label container or drum. Personnel will then decontaminate, as appropriate, their hard hats and boots with an aqueous solution of detergent or other appropriate cleaning solution. These items then will be hand-carried to the next station. Remove inner gloves.
- Thoroughly wash hands and face if they came into contact with sediment before leaving an area with contamination.

A.9.3 Non-Disposable Personal Protective Equipment

Non-disposable PPE may include boots and gloves. When decontaminating boots and gloves, observe the following practices and procedures:

- Decontaminate the boots or gloves outside with a solution of detergent and water; rinse with water prior to leaving the site.
- Protect the boots or gloves from exposure by covering with disposable covers such as plastic to minimize required decontamination activities.

A.9.4 Emergency Personnel Decontamination

Personnel with medical problems or injuries may also require decontamination. There is the possibility that the decontamination may aggravate or cause more serious health effects. If prompt lifesaving, first aid, and medical treatment are required, decontamination procedures will be omitted. In either case, a member of the site management team will accompany contaminated personnel to the medical facility to advise on matters involving decontamination.

A.10.0 Disposal of Contaminated Materials

Contaminated materials must be contained and characterized for proper disposal. Anchor QEA will provide decontamination equipment and remove residue from decontamination.

A.11.0 Training Requirements

HAZWOPER training is not required for bathymetric surveying personnel since this work will be performed from a boat and there will be limited, if any, contact with contaminated sediment. Field team members must have first-aid and cardiopulmonary resuscitation (CPR) training. Documentation will be kept in the project health and safety files.

A.12.0 Medical Surveillance

A medical surveillance program conforming to the provisions of 29 CFR 1910§120(f) is not necessary for field team members because they do not meet any of the four criteria outlined in the regulations for implementation of a medical surveillance program:

- Employees who are or may be exposed to hazardous substances or health hazards at or above permissible exposure levels for 30 days or more per year (1910.120(f)(2)(I))
- Employees who must wear a respirator for 30 days or more per year (1910.120(f)(2)(ii))
- Employees who are injured or become ill due to possible overexposures involving hazardous substances or health hazards from an emergency response or hazardous waste operation (1910.120(f)(2)(iii))
- Employees who are members of HAZMAT teams (1910.120(f)(2)(iv))

As described in Section A.8, employees will monitor themselves and each other of any deleterious changes in their physical or mental condition during the performance of all field activities.

Specific attention will be given to the requirement to screen all workers at the beginning of their shifts by taking their temperatures and asking them if they have a fever, cough, shortness of breath, fatigue, muscle aches, or new loss of taste or smell. Thermometers used shall be 'no touch' or 'no contact' models to the greatest extent possible. If a 'no touch' or 'no contact' thermometer is not available, the thermometer will be properly sanitized between each use. Any worker with a temperature of 100.4°F or higher will be considered to have a fever and will be sent home.

As described in Section A.8, employees will monitor themselves and each other for any deleterious changes in their physical or mental conditions during the performance of all field activities.

Regarding monitoring exposures to the SARS-CoV-2 (COVID-19) virus, there are three possible scenarios:

- Primary exposure: When an employee has tested positive for the virus
- Secondary exposure: When an employee has had direct contact with someone diagnosed with COVID-19 within the last 14 days

- Tertiary exposure: When an employee has had direct contact with someone who has been quarantined due to close contact with someone else who has been diagnosed with or is being screened for COVID-19 within the last 14 days

The FC/HSO (or designee) will also act as the on-site COVID-19 Supervisor, and shall monitor the health of employees and enforce the measures established to minimize exposure to the SARS-CoV-2 virus. Workers are expected to inform the FC/HSO if they develop symptoms of or have been exposed to anyone with COVID-19.

A12.1 COVID-19 Primary Exposure

If an employee has tested positive for COVID-19, the FC/HSO will immediately take the following actions:

- The employee will be immediately sent away for isolation (i.e., until cleared by a healthcare professional) if they are at the site.
- The employee's steps will be traced to identify work areas with which the individual may have been in contact.
- All identified areas will be quarantined and marked as off limits to all site personnel, until a decontamination/disinfection process following CDC guidelines has been implemented.
- Employees who have been in direct/close contact (within 6 feet for 15 minutes or greater during a 24-hour period) with the infected individual will be asked to quarantine until released by a healthcare professional and may be asked to seek medical testing.

A12.2 COVID-19 Secondary Exposure

If an employee has had direct/close contact with someone who has been diagnosed with COVID-19 during a period as determined by a healthcare provider, the FC/HSO will immediately take the following actions:

- Immediately send the employee home until released by a healthcare professional.
- Consult with the Washington State Department of Health for additional guidance if the employee is diagnosed with COVID-19 and has been instructed to self-quarantine.
- Inform the CHSMs and PMs immediately.
- Follow up with the field team after test results for the potentially exposed employee have been received.
- Continue cleaning common touch areas with recommended disinfectants.
- Follow primary exposure scenario (Section A.12.1) if an employee is confirmed as positive for COVID-19.

A12.3 COVID-19 Tertiary Exposure

It is more difficult to manage tertiary exposure because there is innately less control in a situation wherein an employee may have had direct contact with an acquaintance who has been quarantined due to close contact with someone else who has been diagnosed with or is being screened for COVID-19 within the last 14 days. The FC/HSO will request that all site workers provide any relevant exposure information. If an employee is believed to have been subject to tertiary exposure, take the following actions:

- Consult with the Washington State Department of Health for additional guidance if the acquaintance who is diagnosed with or screened for COVID 19 has been instructed to self-quarantine.
- Inform the CHSMs and PMs immediately.
- Follow up with the field team after test results for the potentially exposed employee have been received.
- Continue cleaning common touch areas with recommended disinfectants.
- Follow secondary exposure scenario (Section A.12.2) if the acquaintance is confirmed as positive for COVID-19.

A12.4 COVID-19 Field Guidance

We must keep in mind that our underlying social distancing requirements and responsibilities are the foundation of all our activities. Do not come to work if you are feeling sick, and contact your Manager immediately if you have symptoms consistent with COVID-19, have tested positive for COVID-19, and/or suspect you have been exposed.

- If masks (i.e., N 95) are used, they should be used in accordance with OSHA 1910.120, stating, in part, that the user must be fit-tested and in a surveillance program.
- Prior to departing for the site, the Site Safety Officer should obtain enough supply of U.S. Environmental Protection Agency (EPA)-registered disinfectants, wipes, hand sanitizers, and gloves.
- Regardless of vaccination status, if staff feel that they are sick or showing symptoms, they are required to stay home and not report to work.
- All staff who work on the site will be required to undergo a site safety orientation (tailgate meeting), which will include information on specific measures to be followed to address efforts to prevent the spread of COVID-19. All field staff are required to vocalize concerns and ensure that protective measures that will slow the spread of COVID-19 are employed.
- Follow the site-specific HASP Personal Protective Equipment (PPE) requirements.
- One step to control spread of the virus at the project job site is focused on hygiene. All staff and management staff will follow CDC guidance regarding hand washing. https://www.cdc.gov/handwashing/index.html

- Hand wash stations and/or sanitizing wipes/sanitizing gel will be made readily available around the job site and within project office trailers. If these supplies are insufficient, work should be stopped until additional supplies are procured.
- Smart phones and radios should be wiped down frequently throughout the day and should not be shared to the greatest extent possible. If these items are shared, they are to be wiped down prior to handing off to another individual or placing in storage for the day.
- Field support areas, boats/vessels, and equipment cabs will be cleaned throughout the day and at every shift change. All "touch" surfaces will be thoroughly wiped clean using a disinfectant.
- Staff should follow published guidance to limit transmission at home and outside of work: https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-prevent-spread.html

A.13.0 Reporting and Record Keeping

Each member of the field crew will sign the HASP review form (see Attachment A.1). If necessary, accident/incident report forms will be completed by the FOM/HSO.

The FOM/HSO or a designee will note health- and safety-related details of the project in the field logbook and record. The logbook must be bound, and the pages must be numbered consecutively. Entries will be made with indelible ink. At a minimum, each day's entries must include the following information:

1. Project name or location
2. Names of all personnel onboard
3. Weather conditions
4. Type of fieldwork being performed

The person maintaining the entries will initial and date the bottom of each completed page. Blank space at the bottom of an incompletely filled page will be lined out. Each day's entries will begin on the first blank page after the previous work day's entries.

A.14.0 Emergency Response Plan

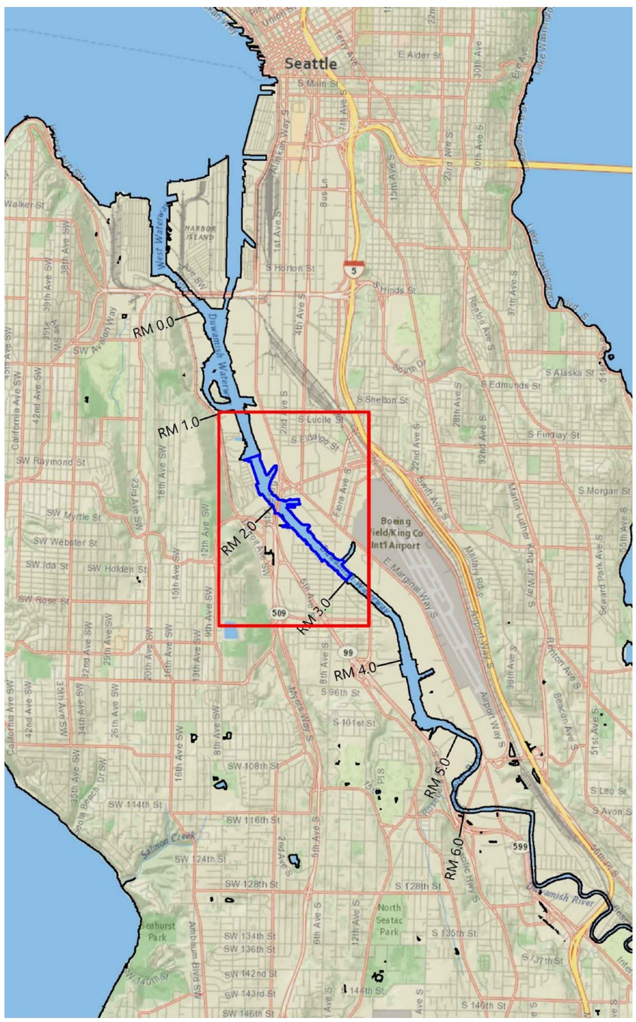
As a result of the hazards and the conditions under which operations will be conducted, the potential exists for an emergency situation to occur. Emergencies may include personal injury, fire, or explosion. Occupational Safety and Health Administration (OSHA) regulations require that an emergency response plan be available for use to guide actions in emergency situations.

The local fire department and ambulance service can provide timely response. Field personnel will be responsible for identifying an emergency situation, providing first aid if applicable, notifying the appropriate personnel or agency, and evacuating any hazardous area.

The following sections identify the onboard individual(s) who should be notified in case of emergency, provide a list of emergency telephone numbers, offer guidance for particular types of emergencies, and provide directions and a map for getting from any surveying location to a hospital.

Site Map

Figure A
General Site Location Overview



Category	Information
Possible Chemicals of Concern	Polychlorinated biphenyl compounds, carcinogenic polycyclic aromatic hydrocarbons, arsenic, dioxins/furans in sediment below MHHW
Minimum Level of Protection	Level D
Site Location	Lower Duwamish Waterway middle reach (between river miles 1.5 and 3.0)

A.14.1 Pre-Emergency Preparation

Before the start of field activities, the FOM/HSO will ensure that preparation has been made in anticipation of emergencies. Preparatory actions include the following:

1. Meeting with the FOM/HSO and equipment handlers concerning the emergency procedures in the event that a person is injured
2. A training session given by the FOM/HSO informing all field personnel of emergency procedures, locations of emergency equipment and their use, and proper evacuation procedures
3. A training session given by senior staff operating field equipment, to apprise field personnel of operating procedures and specific risks associated with that equipment
4. Ensuring that field personnel are aware of the existence of the emergency response plan in the HASP and ensuring that a copy of the HASP accompanies the field team

A.14.2 Project Emergency Coordinator

The FOM/HSO will serve as the Project Emergency Coordinator in the event of an emergency. They will designate their replacement for times when they are not onboard or not serving as the Project Emergency Coordinator. The designation will be noted in the logbook. The Project Emergency Coordinator will be notified immediately when an emergency is recognized. The Project Emergency Coordinator will be responsible for evaluating the emergency situation, notifying the appropriate emergency response units, coordinating access with those units, and directing interim actions onboard before the arrival of emergency response units. The Project Emergency Coordinator will notify the HSM and the PM as soon as possible after initiating an emergency response action. The PM will have responsibility for notifying the client.

A.14.3 Emergency Response Contacts

All onboard personnel must know whom to notify in the event of an emergency situation, even though the FOM/HSO has primary responsibility for notification. Table A-4 lists the names and phone numbers for emergency response services and individuals.

Table A-4
Emergency Response Contacts

Contact	Telephone Number
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	(206) 323-3074
Emergency Responders	
U.S. Coast Guard	
Emergency General information	(206) 286-5400 (206) 442-5295 UHF Channel 16
National Response Center	(800) 424-8802
EPA	(908) 321-6660
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	(206) 649-7000
Emergency Contacts	
King County Project Representative	
Bryahna Davis	(206) 263-2540 (office)
Project Manager	
Tom Wang	(206) 903-3314 (office) (206) 465-0900 (cell)
Corporate Health and Safety Director	
David Templeton	(206) 903-3312 (office) (206) 910-4279 (cell)
Health and Safety Program Lead	
Tim Shaner	(251) 375-5282 (Office) (251) 281-3386 (Cell)
Field Operations Manager/Field Health and Safety Officer	Site cellular telephone:
James Glaeser, Northwest Hydro, Inc.	(360) 241-7313
Jo Miller, True North Land Surveying, Inc.	(206) 332-0800 (Office) (253) 344-9069 (Cell)

A.14.4 Recognition of Emergency Situations

Emergency situations will generally be recognizable by observation. An injury or illness will be considered an emergency if it requires treatment by a medical professional and cannot be treated with simple first-aid techniques.

A.14.5 Emergency Procedures Related to Vessel Operations

In deteriorating weather/sea conditions, radio the field office or U.S. Coast Guard (USCG) with your location, direction of travel, and approximate speed before a dangerous situation can develop. In an emergency, contact the USCG on VHF channel 16. Emergency VHF radio broadcasts should be proceeded by "Pan-Pan, Pan-Pan, Pan-Pan" for non-life-threatening emergencies and "Mayday, Mayday, Mayday" for life-threatening situations. Be prepared to provide your vessel name, location, and the nature of the emergency. Don life jackets and/or survival suits, take necessary measures to prevent hypothermia, and wait for the search and rescue.

A.14.6 Fire

Field personnel will attempt to control only small fires, should they occur. If an explosion appears likely, personnel will follow evacuation procedures specified during the training session. If a fire cannot be controlled with a fire extinguisher on board that is part of the required safety equipment, personnel will either withdraw from the vicinity of the fire or evacuate the boat as specified in the training session.

A.14.7 Personal Injury

In the event of serious personal injury, including unconsciousness, possibility of broken bones, severe bleeding or blood loss, burns, shock, or trauma, the first responder will immediately do the following:

1. Administer first aid, if qualified.
2. If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit.
3. Notify the Project Emergency Coordinator of the incident, the name of the individual, the location, and the nature of the injury.
4. The Project Emergency Coordinator will immediately do the following:
    a. Notify the boat captain and the appropriate emergency response organization.
    b. Assist the injured individual.
    c. Follow the emergency procedures for retrieving or disposing equipment reviewed in the training session and leave the site en route to the predetermined land-based emergency pick-up.
    d. Designate someone to accompany the injured individual to the hospital.

e. If a life-threatening emergency occurs, i.e., injury where death is imminent without immediate treatment, the FOM/HSO or boat captain will call 911 and arrange to meet the Medic One unit at the nearest accessible dock. Otherwise, for emergency injuries that are not life threatening (i.e., sprains, minor lacerations, etc.) the Project Emergency Coordinator will follow the procedures outlined above and proceed to the Harbor Island Marina or to an alternative location of their choice if that would be more expedient.
f. Notify the HSM and the PM.

If the Project Emergency Coordinator determines that emergency response is not necessary, he or she may direct someone to transport the individual by vehicle to the nearest hospital. Directions and a map showing the route to the hospital are in Section A.14.10.

If a worker leaves the boat to seek medical attention, another worker should accompany them to the hospital. When in doubt about the severity of an injury or exposure, always seek medical attention as a conservative approach, and notify the Project Emergency Coordinator.

The Project Emergency Coordinator will have responsibility for completing all accident/incident field reports, OSHA Form 200s, and other required follow-up forms.

A.14.8 Overt Personal Exposure or Injury

No overt exposure to toxic materials is expected to occur. Accordingly, no emergency procedures related to such exposure are required for this project.

A.14.9 Spills and Spill Containment

No bulk chemicals or other materials subject to spillage are expected to be used during this project. Accordingly, no spill containment procedure is required for this project.

A.14.10 Emergency Route to the Hospital

The name, address, and telephone number of the hospital that will be used to provide medical care is as follows:

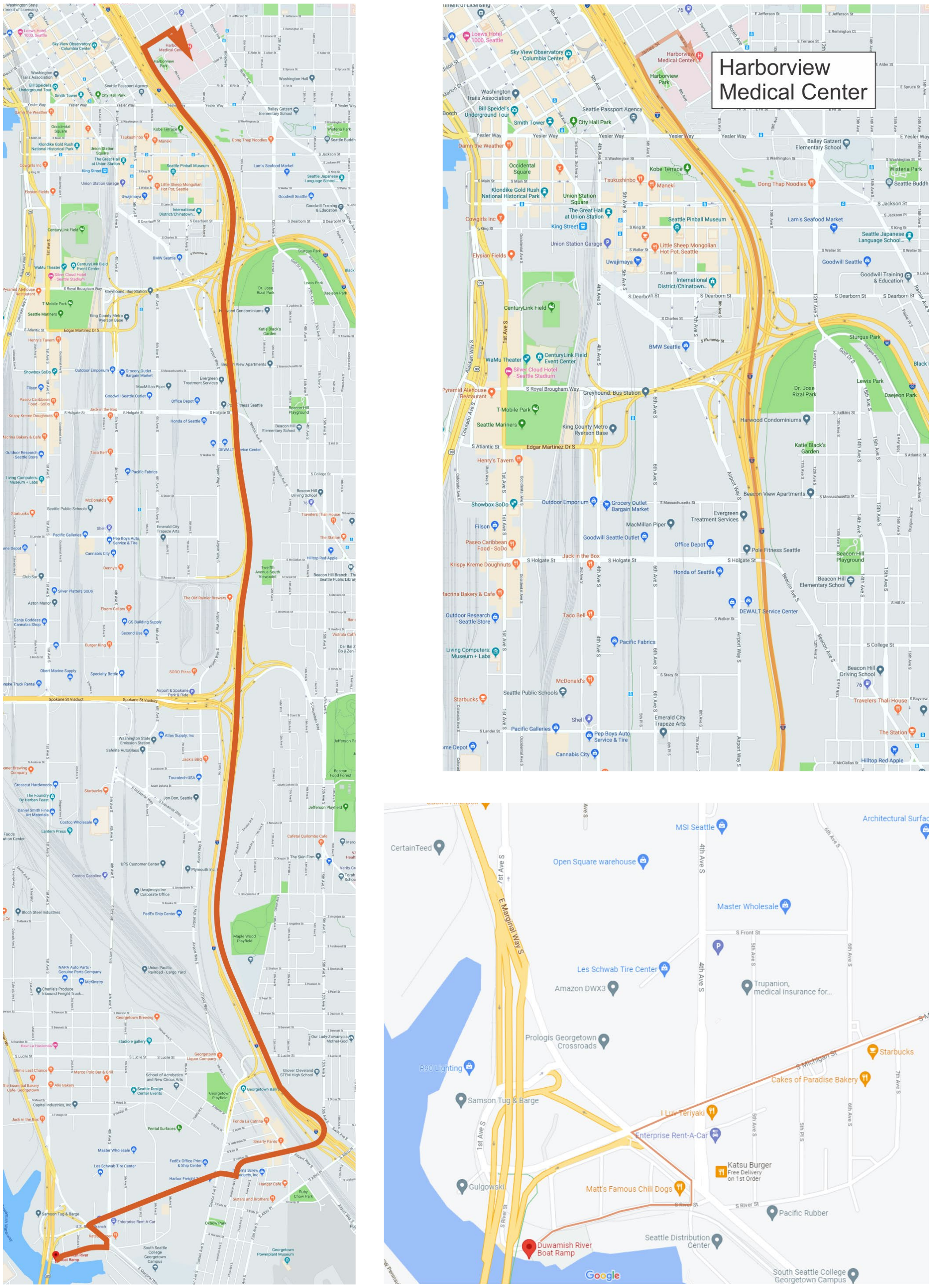
Harborview Medical Center
325 - 9th Ave.
Seattle, WA
(206) 323-3074

Directions from the Duwamish River Boat Ramp to Harborview Medical Center (Figure B) are as follows:

1. Dock the vessel at the 1st Avenue S boat launch (Duwamish River Boat Ramp).
2. Drive east on S River Street.

3. Turn left on 4th Avenue S.
4. Turn left on E Marginal Way S.
5. Turn right on S Michigan Street.
6. Look for entrance ramps to I-5 Northbound (left turn).
7. Head north on I-5.
8. Take the James Street exit.
9. Turn right on James Street to 9th Avenue.
10. Turn right on 9th Avenue.
11. Emergency entrance will be two blocks south on the right.

Figure B
Hospital Route Map



Attachment A.1
HASP Acknowledgement Form

Attachment A.1. HASP Acknowledgement Form

I have read a copy of the Health and Safety Plan, which covers field activities that will be conducted to investigate potentially contaminated areas in the LDW. I understand the health and safety requirements of the project, which are detailed in this Health and Safety Plan.

Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date
Signature	Date

Attachment A.2
Modification to Health and Safety Plan Form

Modification to Health and Safety Plan

ANCHOR QEA

Date: ____________________

Project No: ____________________

Project Name: ____________________

Modification: ____________________

____

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____

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Reason for Modification: ____________________

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Site Personnel Briefed

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Name: ____________________ **Date:** ____________________

Approvals

Field Lead: ____________________ ____________________ ____________________

Printed Name Signature Date

Project Manager: ____________________ ____________________ ____________________

Printed Name Signature Date

Attachment A.3
Phase I Construction Restart COVID-19
Job Site Requirements

Field Program COVID-19 Management Plan

Date: ______________________________
Project No: ______________________________
Project Name: ______________________________

In response to the global situation regarding Coronavirus Disease 2019 (COVID-19), Anchor QEA, LLC, has compiled the following guidance to support our ongoing field efforts, whether sediment sampling efforts, wetland delineations, groundwater evaluation, site visits, or construction management. Anchor QEA strongly encourages all staff to be fully vaccinated when they are eligible in the location where they reside. Anchor QEA also requests that, while not required, staff upload a record of their vaccination into the WorkCare screening portal.

This Field Program COVID-19 Management Plan (Plan) is an addendum to the existing project-specific Health and Safety Plan (HASP) for field activities and shall remain a portion of the HASP until superseded by other notification. All personnel who have previously signed acknowledging the HASP must sign off acknowledging this Plan. Acknowledgement of this Plan will be included with future acknowledgements of the overall HASP.

We must keep in mind that our underlying social distancing requirements and responsibilities are the foundation of all our activities. Do not come to work if you are feeling sick, and contact your Manager immediately if you have symptoms consistent with COVID-19, have tested positive for COVID-19, and/or suspect you have been exposed. We also need to be cognizant of changing state and local orders and directives (or removal of restrictions) associated with COVID-19. Specific field efforts will require discussions between the Project Manager, field staff, and client to address availability, travel, and other considerations. If necessary, specific state, local, or project-specific orders and directives can be included with this Plan after review by Health and Safety.

1. Field programs will follow this Field Program COVID-19 Management Plan unless the client, prime contractor, federal, state, or local government establish more restrictive measures, in which case the more restrictive measures will be followed.
2. For projects that do not have an established daily screening, the WorkCare screening portal is to be used.
3. Updated information can be found at the U.S. Centers for Disease Control and Prevention (CDC) website (https://www.cdc.gov/), as well as state and local health agency websites.
4. Staff traveling to certain locations may need to comply with specific testing or vaccination requirements. The company will coordinate with staff as appropriate to meet these requirements, realizing that staff selection for a specific project may be determined by these factors.
5. Nationwide, our community defense is to slow the spread of COVID-19, which may include not traveling between impacted areas and less impacted areas. Therefore, we will evaluate limiting

travel for field work on a case-by-case basis consistent with this community defense approach and following appropriate national, state, and local guidance. We expect that this situation will be fluid as conditions change in the country.

6. Field project schedules, modifications, and regulatory requirements will be discussed with the client representatives.

The objective of this Plan is to provide additional operational guidelines to the team that address the challenges presented by COVID-19 and ensure consistency in our response actions across the project team. These guidelines are consistent with and based on recommendations from the CDC, with multiple links provided throughout. All personnel have Stop Work Authority. If you should have questions or concerns, please direct those to your Field Lead, Staff Manager, or Project Manager.

Some site owners or prime contractors may conduct temperature screening prior to entering a site, which is in accordance with some current guidance. Some site owners or prime contractors may want to record actual temperature readings, test results, or information other than general yes or no questions related to travel, symptoms, vaccination status, etc. If you choose not to participate in the recording of screening information, the site owner or prime contractor may not allow you to access the site. You should immediately contact your Field Lead, Staff Manager, or your Project Manager to discuss alternative work and available options.

The following describes minimum measures to be followed by the project team:

Prior to Coming to the Site

- Travel is allowed.
- Understand the community exposure and travel history of all staff. If a staff member has traveled to an affected country outside the United States or has had close contact with an infected individual within the United States, we require that they be cleared by WorkCare.
  - The following link provides the CDC list of countries with Travel Health Notices in Place: https://wwwnc.cdc.gov/travel/notices
  - The following link provides CDC information on cases within the United States: https://www.cdc.gov/coronavirus/2019-ncov/cases-in-us.html
- If masks (i.e., N 95) are used, they should be used in accordance with OSHA 1910.120, stating, in part, that the user must be fit-tested and in a surveillance program.
- Prior to departing for the site, the Site Safety Officer should obtain enough supply of U.S. Environmental Protection Agency (EPA)-registered disinfectants, wipes, hand sanitizers, and gloves.
- Some projects may require temperature readings prior to entry to a project site. Anchor QEA supports privacy concerns, and if a temperature reading or vaccination status is recorded

(vs. a green light/red light approach based on a temperature threshold) we will take steps to document the confidentiality of that information. However, in some cases Anchor QEA cannot control the procedure nor document confidentiality. In these situations, Anchor QEA staff will need to acknowledge that if they choose to not comply in the future that is their right. If a staff member chooses to not comply, the Project Manager, Regional Lead, and Human Resources should be consulted.

- Some projects may require procedures to document a 14-day look-back period that is absent of symptoms consistent with COVID-19.
- Staff should be self-isolated, as necessary, prior to coming to the site in accordance with current federal, state, and local orders. Any staff member who has been exposed to any household member (including healthcare professionals) exhibiting COVID-19 symptoms or has tested positive for COVID-19 will not report to the site for work unless they have met the guidelines contained in this Plan.
- Exposure to, or close contact with, means being within 6 feet of an individual for 15 minutes or greater in a 24-hour period or being exposed to their cough or sneeze.
- If you meet the criteria listed for Primary or Secondary Exposure, listed below, do not report to work; contact your Manager, contact the Health and Safety representatives, and stay home until the appropriate return to work criteria are met.
- ***Regardless of vaccination status, if staff feel that they are sick or showing symptoms, they are required to stay home and not report to work (office or field).*** They should call their Manager immediately and notify them that they are sick. Showing up to work with symptoms will result in the staff being asked to leave to avoid potentially exposing others to the virus.
- If staff are showing symptoms, they are to contact WorkCare and their healthcare provider for medical advice. If staff feel the need to visit a medical professional, it is recommended that the medical office be contacted first to determine when it is appropriate to visit.
- If staff show any symptoms while on site, they will be asked to leave and not return until they have been cleared by WorkCare. They may be requested submit a physician's note, by WorkCare, releasing them back to work. The exception to this would be if their primary physician recommends more restrictive measures.
  - https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fspecific-groups%2Fguidance-business-response.html

Fully Vaccinated

The CDC defines "fully vaccinated" as greater than or equal to 2 weeks following the final dose in a two-dose series or following the initial dose in a single-dose vaccine.

Anchor QEA will follow CDC and Occupational Safety and Health Administration (OSHA) recommendations regarding fully vaccinated staff being able to forgo the face covering and social distancing requirements both in the office and field. For field work, reference the latest version of this Plan. Fully vaccinated staff must comply with the following guidelines:

- Complete an acknowledgement in Bamboo regarding the updated requirements as well as consent to share with Project Managers, Field Leads, Office Leads, and Staff Managers (who have a need to know) information related to being fully vaccinated if that information has been in accordance with the updated requirements.
- Vaccination information is uploaded into the WorkCare portal. This is to help us meet various state requirements for the employer to determine if the staff member is fully vaccinated.
- Staff who are fully vaccinated, even if information is uploaded to WorkCare, may still use face coverings and follow social distancing if they desire.
- Out of respect, all staff will have face coverings available and fully vaccinated staff will use face coverings if requested by others in close contact situations.
- Fully vaccinated staff are not required to use face coverings or follow social distancing during meetings, meals, or other close contact situations unless requested.
- All staff will still be required to complete the WorkCare daily screening or other project-specific screening.
- All laws, regulations, client requirements, field work requirements, building requirements, and other company requirements apply to all staff (e.g., air travel requirements).
- Fully vaccinated staff that have notified the company may sit together without social distancing or face coverings for meals.
- Food and beverages are allowed to be brought to the project site for sharing, if they are individually packaged.
- Travel is allowed to include sharing vehicles with others who are fully vaccinated.
- Staff must be considerate of others.
- If asymptomatic following close contact with a Primary Exposure, staff do not need to isolate but do need to follow up with WorkCare.

Staff are not required to obtain the vaccination or to notify the company if they have been vaccinated unless they wish to follow the above process. Fully vaccinated staff who have had close contact with a Primary Exposure or who have symptoms consistent with COVID-19 must be cleared to return to work following the processes outlined in the Case Response section below.

Not Fully Vaccinated

The CDC defines "fully vaccinated" as greater than or equal to 2 weeks following the final dose in a two-dose series or following the initial dose in a single-dose vaccine.

Anchor QEA will follow CDC and OSHA recommendations for staff who are not fully vaccinated regarding face covering and social distancing requirements both in the office and field. For field work, reference the latest version of this Plan. Staff who are not fully vaccinated must comply with the following guidelines:

- All staff will still be required to complete the WorkCare daily screening or project-specific screening.
- All laws, regulations, client requirements, field work requirements, building requirements, and other company requirements apply to all staff (e.g., air travel requirements).
- Avoid close contact (i.e., handshakes or other physical contact) and practice social distancing (stay at least 6 feet away from others).
- Meetings are allowed; however, those who are not fully vaccinated must adhere to social distancing requirements.
- If there is a chance that an unvaccinated staff member might have close contact with someone, such as being within 6 feet of an individual for 15 minutes or greater in a 24-hour period, or being exposed to their cough or sneeze, the staff member must wear a face covering in accordance with CDC guidance.
- Common areas (i.e., kitchens, break areas, conference rooms, entryways, restrooms, and copier and printer stations) are to be avoided to the greatest extent possible and social distancing must be observed by those not fully vaccinated.
- The use of communal coffee pots, microwaves, refrigerators, and similar items are allowed.
- Food and beverages are allowed to be brought to the project site for sharing, if they are individually packaged.
- Travel is allowed.
- Travel is preferred to be in individual vehicles.
- Staff should wear cloth face coverings in public settings, in addition to social distancing measures, including travel to the site or office, grocery stores, and picking up to-go food.
- Avoid restaurants if open; use drive-in or take-out services.
- The CDC recommends wearing cloth face coverings in public settings where other social distancing measures are difficult to maintain (e.g., grocery stores and pharmacies) especially in areas of significant community-based transmission.
- Staff must be considerate of others.

Staff are not required to obtain the vaccination or to notify the company if they have been vaccinated unless they wish to follow the process for fully vaccinated staff.

Visitors

- Visitors are allowed but must complete a WorkCare visitor screening or project-specific screening. They additionally must sign an affirmation statement if they wish to forgo the face covering and social distancing requirements.
- Meetings with outside parties should take place virtually, when possible.
- Delivery personnel should not remain in indoor settings for longer than 15 minutes without completing the visitor screening.
- For visitors to forgo the face covering and social distancing requirement, they must attest that they are fully vaccinated when signing in.
- All laws, regulations, client requirements, field work requirements, building requirements, and other company requirements apply to all visitors (e.g., air travel requirements).

On-Site Preventative Measures and Cleaning Requirements

- All staff who work on the site will be required to undergo a site safety orientation (tailgate meeting), which will include information on specific measures to be followed to address efforts to prevent the spread of COVID-19. All field staff are required to vocalize concerns and ensure that protective measures that will slow the spread of COVID-19 are employed.
- Follow the site-specific HASP Personal Protective Equipment (PPE) requirements.
- One step to control spread of the virus at the project job site is focused on hygiene. All staff and management staff will follow CDC guidance regarding hand washing.
  - https://www.cdc.gov/handwashing/index.html
  - Hand wash stations and/or sanitizing wipes/sanitizing gel will be made readily available around the job site and within project office trailers. If these supplies are insufficient, work should be stopped until additional supplies are procured.
- Office trailers will also be cleaned at least twice a day using disinfectant to wipe all surfaces that may be touched by hand including desk and table surfaces. In addition, office trailer personnel (as directed by the Field Lead) will be responsible for multiple daily cleaning of the various field offices and related workspaces.
- Smart phones and radios should be wiped down frequently throughout the day and should not be shared to the greatest extent possible. If these items are shared, they are to be wiped down prior to handing off to another individual or placing in storage for the day.
- Field support areas, boats/vessels, and equipment cabs will be cleaned throughout the day and at every shift change. All "touch" surfaces will be thoroughly wiped clean using a disinfectant.
- Staff should follow published guidance to limit transmission at home and outside of work: https://www.cdc.gov/coronavirus/2019-ncov/hcp/guidance-prevent-spread.html

- The following links provide a list of U.S. Environmental Protection Agency recommended cleaning products able to kill the virus, as well as some initial guidance with alternatives if supplies run out. ***"Note: Inclusion on this list does not constitute an endorsement by EPA. Additional disinfectants may meet the criteria for use against SARS-CoV-2. EPA will update this list with additional products as needed."***
  - https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2
  - If these products are not available, then either a diluted bleach solution or 70% alcohol solution will work.
  - https://www.cdc.gov/coronavirus/2019-ncov/community/home/cleaning-disinfection.html
- If a staff member becomes ill while on site, they should return to their hotel room or local home, contact their healthcare provider, and follow their guidance. The staff member's Manager should be contacted immediately. Our Health and Safety representatives will follow up with the staff member. If the staff member has a confirmed or presumed case as determined by a healthcare provider, we will follow our procedures as outlined in this document. If the staff member is not able to transport themselves, local emergency responders will be called as per company protocol.

Case Response, and Equipment and Facility Decontamination

According to the CDC, symptoms can appear 2 to 14 days after exposure. Symptoms or combinations of symptoms that may be consistent with COVID-19 include cough, shortness of breath, difficulty breathing, fever (100.4°F [37.8°C] or greater), chills, repeated shaking with chills, muscle pain or body aches, headache, sore throat, congestion or runny nose, nausea or vomiting, diarrhea, or new loss of taste or smell.

If you have symptoms that are consistent with COVID-19 but have not tested positive, regardless of what your primary physician concludes, you are to self-isolate until you have been released to return to work by WorkCare. Immediately contact your Regional Lead and Project Manager. WorkCare may ask you to submit a physician's note releasing you back to work. The exception to this would be if your primary physician recommends more restrictive measures. In this case there is no need to alert or self-isolate any other staff.

Regarding COVID-19 exposures, there are three general scenarios:

- **Primary Exposure:** These are staff who have tested positive for the virus. If you have tested positive for COVID-19, you must be in self-isolation and an effort will be made to contact those people you had direct contact with in the last 14 days. You must not return to the work site until you have been released to return by WorkCare. The exception to this would be if your primary physician recommends more restrictive measures.

- **Secondary Exposure:** These are staff who, within the last 14 days, have had direct contact with someone who has tested positive for COVID-19. You must self-isolate until released by WorkCare to return. You are encouraged to seek medical care. If you start to have symptoms or test positive, follow the appropriate guidance for Primary Exposure noted above.
- **Tertiary Exposure:** These are staff who have had direct contact with someone that meets Secondary Exposure criteria or have been in the same general area. In this scenario, there is no requirement to isolate; however, the staff should self-monitor for the development of symptoms.

In the event there is a documented case of a staff member becoming infected with COVID-19 (Primary Exposure) the field management team will take immediate action as follows:

- The staff member should immediately self-isolate until they have been released to return by WorkCare.
- Notify the Project Manager, Human Resources, and Regional Lead immediately.
- The staff member's work steps will be traced back 14 days to identify work areas the individual may have contacted. All identified areas will be isolated and marked off limits to all site personnel, until a decontamination process can be implemented.
- All identified areas will be disinfected by qualified individuals following CDC guidelines.
- Staff who came in direct contact with the individual will be notified. The Regional Lead will work with the Project Manager and Human Resources to notify the Anchor QEA staff who were identified.
- The Project Manager, in coordination with the client, will notify subcontractors and vendors on the site who had direct contact with the individual.
- The Project Manager should notify the client immediately and inform them of our backup staffing plan as well as our notification plan.
- Confidentiality for the staff member should be maintained.

If a staff member, within the last 14 days, has had direct contact with someone diagnosed with COVID-19 (Secondary Exposure), the field management team will take immediate action as follows:

- Send staff home immediately and have them coordinate with WorkCare for their return.
- Let the Regional Lead and Project Manager know immediately.
- Continue cleaning of common touch areas with recommended disinfectants.
- If staff tests positive, this becomes a Primary Exposure scenario, and that guidance should then be followed.

Situations where a staff member may have had Tertiary Exposure are more difficult to manage. This involves having direct contact with someone who has had Secondary Exposure. In the event of Tertiary Exposure, the field management team will take immediate action as follows:

- Let the Regional Lead and Project Manager know immediately.
- No further notifications are necessary with this scenario.
- Continue cleaning of common touch areas with recommended disinfectants.
- This becomes a Secondary Exposure scenario if the acquaintance is confirmed to be infected, and that guidance should then be followed.

When staff are in self-isolation, their Manager or designee will follow up with them two times per week.

General Measures / Guidance

- Staff must follow the same prevention guidelines off site, which includes travel, hotel, and other activities, in order to address potential exposures outside the workplace.
- Travel, whether by train or plane, will be reviewed on a case-by-case basis. Mass transit should be avoided where social distancing is difficult.
- The virus may live on a variety of surfaces for some period of time; closely follow the cleaner/disinfectant contact time. Avoid combining products that are incompatible and may create toxic byproducts.
- When at hotels, disinfect your own room with EPA-registered cleaners or alternatives, and use the NO HOUSEKEEPING sign to minimize the people coming into your room.
- Catch coughs and sneezes with a disposable tissue, etc. and throw away, then wash hands. If tissues are not available, direct coughs and sneezes into elbow.
- Avoid touching your own mouth, nose, or eyes.
- Hand washing stations with soap and water will be available at all restroom facilities. Frequent hand washing is recommended throughout the day. Washing hands thoroughly for a minimum of 20 seconds with soap and water is one of the most effective ways to prevent the spread of germs. Personnel should wash their hands regularly, before and after going to the bathroom, before and after eating, and after coughing, sneezing, or blowing their nose.
- If soap and water are not available, use hand sanitizer with a minimum of 60% alcohol content.
- Anchor QEA will provide staff with face coverings that can be used for field projects and staff may also use their own face covering if they choose.
- Some projects, municipalities, counties, and states may implement additional requirements for the use of face coverings, gloves, or other items. Those requirements should be followed.

- Time spent in large groups in enclosed spaces will be avoided. Potential alternatives could include phone conferences or holding meetings outside (i.e., field crew safety meetings). Field activities, whether inside or outside, should be planned to minimize staff density in that location.
- Avoid use of shared beverage containers (e.g., coffee pots, water coolers) or food setups (e.g., pizza, buffets). For instance, bring an individual water bottle.
- Work requiring several or more staff will need to be evaluated and a determination will need to be made on how the work can be done safely with a few staff, if at all. If the work cannot be conducted safely, then it may have to be rescheduled for a later time.
- Disinfecting wipes will be located throughout the site for wiping down hard surfaces as required. Alternatives, such as bleach/water solutions, may be used in addition to or in place of disinfecting wipes.
- The frequency and scope of the cleaning program for project facilities (office trailers, bathrooms, other buildings, and work areas) will be reviewed and increased, as necessary.
- Areas where staff eat should be a focus of cleaning efforts.
- Field team equipment operators, vessel operators, and vehicle drivers (whether Anchor QEA equipment or subconsultant equipment) will be provided with disinfecting wipes to clean the enclosed spaces daily. Emphasis should be on hard surfaces that are commonly touched (steering wheel, door handles, levers, buttons).
- Alternates for critical job functions should be available.
- All staff will have their own PPE and will not share with others. Respirators and PPE will be cleaned/disinfected when doffing, along with a thorough arm, hand, and face washing when exiting.
- All staff need to be vigilant regarding potential exposure and transmission of COVID-19. Avoiding any complications related to this outbreak will be a team effort as much as any safety or production concerns related to the project.

COVID-19 Management Plan Acknowledgement

Project Number: ______________________________

Project Name: ______________________________

My signature below certifies that I have read and understand the policies and procedures specified in this Field Program COVID-19 Management Plan.

Date	Name (print)	Signature	Company

DOSH DIRECTIVE

Department of Labor and Industries
Division of Occupational Safety and Health
Keeping Washington Safe and Working

1.70 General Coronavirus Prevention Under Stay Safe - Stay Healthy Order

Updated: December 22, 2020

I. <u>Purpose</u>

This Directive provides enforcement policy when evaluating workplace implementation of social distancing, facial coverings and respiratory protection, sanitation and sick employee practices as required under the Governor's Stay Home – Stay Healthy Order. On December 10, 2020, the Governor amended this order to "Stay Safe-Stay Healthy" (Proclamation 20-25.9).

Under the Order, people are required to stay home except where the Governor has authorized regional or industry specific permission to restart operations or operate essential businesses. Employers who continue operations under the Order are required to maintain coronavirus prevention practices consistent with DOSH, OSHA and Department of Health guidance. **Coronavirus is recognized as a very serious workplace hazard.**

II. <u>Scope and Application</u>

A. Under the WISH Act and existing DOSH rules, employers are required to protect workers from hazards and implement programs to address known hazards in the workplace.

B. DOSH staff will limit actions related to infectious disease only when there is an aspect of exposure that is specific to the relationship between employers and workers. DOSH will do so in a manner consistent with public health orders and issued guidance.

C. There are extensive recommendations for healthcare workplaces with specific guidance related to treatment of COVID-19 patients and the related infectious disease control measures. This Directive will not normally be used by DOSH staff in specific healthcare delivery work task settings for hospital and clinic workers who are delivering care directly with COVID-19 patients. All other hospital and clinic work, such as maintenance, food preparation and delivery, administrative support, and supplies, are covered by this Directive.

D. This Directive does cover workers providing healthcare services for people not known or suspected of having COVID-19. This work must follow procedures for Universal or Standard Precautions, or equivalent programs, as recommended by the CDC. This includes current recommendations to address COVID-19 as a community transmission hazard and potential for transmission by asymptomatic people in specific healthcare specialties.

E. DOSH has updated this Directive to be consistent with current CDC guidance regarding quarantine and isolation. The guidance on workplace safety practices remains consistent with the Governor's Executive Orders regarding COVID-19. This updated Directive supersedes DD 1.70, dated September 25, 2020.

III. References

- Chapter 296-800 WAC, Safety and Health Core Rules
  - WAC 296-800-11005, Provide a workplace free from recognized hazards
  - WAC 296-800-140, Accident Prevention Program
  - WAC 296-800-22005, Keep your workplace clean
  - WAC 296-800-23025, Provide convenient and clean washing facilities
- Chapter 296-842 WAC, Respirators
- WAC 296-155-040, Safe Place Standards
- WAC 296-307-045, What are the requirements of the safe place standard?
- WAC 296-307-16102, Additional requirements to protect occupants in temporary worker housing from 2019 novel coronavirus (COVID-19) exposure.
- Annual Fit-Testing, Respiratory Protection and Face Coverings during COVID-19 Pandemic (DOSH Directive 11.80, issued 5/22/2020)
- Governor's Proclamation "Stay Safe-Stay Healthy" Order, issued December 10, 2020
- Governor’s COVID-19 Reopening Guidance for Businesses and Workers
- CDC Guidance: Infection Control in Healthcare Personnel
- CDC Coronavirus (COVID-19) Page
- Washington State Coronavirus Response (COVID-19) Page
- OSHA Publication 3990: Guidance on Preparing Workplaces for COVID-19.pdf (English)
- OSHA Publication 3992: Guidance on Preparing Workplaces for COVID-19.pdf (Spanish)
- Washington State Department of Health Recommendations for Temporary Worker Housing Facilities
- COVID-19 Guidance for Legionella and Building Water System Closures
- BOMA Guide “Getting Back to Work: Preparing Buildings for Re-Entry Amid COVID-19”
- COVID-19 Critical Infrastructure Sector Response Planning

IV. Background

Staff shall learn and consider the baseline expectations for employers to provide workers a safe workplace during the coronavirus (COVID-19) virus outbreak. Overt workplace specific practices by the employer must be continued in accordance with the Governor's Executive Order.

There are four basic categories of prevention elements that must be addressed during the inspection/investigation. Employers must:

1. Educate workers about coronavirus and how to prevent transmission in the language they understand best;
2. Maintain social distancing (at least 6 feet of distance) or effective engineering/administrative controls;
3. Increased regular cleaning and sanitization of common-touch surfaces;
4. Ensure frequent and adequate employee handwashing and facilities; and

5. Make sure sick employees stay home (or are isolated) or go home and have procedures for workers to report a suspected or confirmed case of COVID-19.

Employers must also provide basic workplace hazard education about coronavirus and how to prevent transmission in the language best understood by the employee. DOSH staff will need to be thoughtful on how these four elements are addressed based on the challenges that the specific worksite tasks present, but all four elements must be addressed in each operating workplace.

DOSH Staff shall ensure that employers and employees are made aware that it is against the law for any employer to take any adverse action (such as firing, demotion, or otherwise retaliate) against a worker they suspect for exercising safety and health rights such as raising safety and health concerns to their employer, participating in union activities concerning safety and health matters, filing a safety and health complaint or participating in a DOSH investigation. DOSH Staff will ensure workers are informed they have 30 days to file their complaint with L&I DOSH and/or with Federal OSHA.

Employers must institute these prevention program elements or equivalent protections to limit the spread of the disease within the workplace under DOSH rules and in connection to the Governor's Order. These procedures are specific to COVID-19 prevention and the related virus. If a workplace has a concern about exposures to another pathogen, Technical Services must be consulted on procedures specific to that pathogen.

A. Basic Program Elements.

The following **bold program elements are essential** to the program whenever applicable. Employers who can establish work rules consistent with this section are not required to have further active monitoring or ongoing assessment of their workplace unless required by a separate requirement. (See applicable Safe Start guidelines and Chapter 296-307 WAC, Part L, *Temporary Worker Housing (TWH)*.)

1. **Educate workers (and customers) about COVID-19 and how to prevent virus spread**.
   a. Post posters/information from the local health department, state Department of Health, Center for Disease Control and Prevention, and other authorities.
   b. Inform workers about the steps being taken in the workplace to establish social distancing, increased handwashing, and to prevent the spread of the virus.
   c. Make information for workers available in the language they understand best.
2. **Maintain at least 6 feet of spacing at all times**.
   a. Occupied workstations are separated by 6 feet or have physical barriers between human breathing zones.
   b. Only infrequent intermittent passing within 6 feet is allowed between employees without wearing coverings, masks or respiratory protection in accordance with DOSH Directive 11.80, *Annual Fit-Testing, Respiratory Protection and Face Coverings during COVID-19 Pandemic*.
   c. Provide personal protective equipment (PPE) such as gloves, goggles, face shields and face masks as appropriate or required, to employees for the activity being performed.
   d. Materials, product, or work items are transported between workers by mechanical means or by using staging points.

- Workers may be along a conveyor or production system carrying product.
- Workers may go to a central point one-at-a-time to drop off or pick up items that transfer between workers.
- Workers may have mailboxes, bins, or other surfaces at the periphery of their workspace where materials are left for them by other workers.
- Provisions must be made to clean objects handled by more than one worker when the items are transferred. Physically wiping the object with a disinfectant wipe or soap and water so it is visibly clean (no obvious soiling, smearing, or streaks) is sufficient.
- Social distancing must be maintained during breaks and at shift start and end, while workers are at the employer's worksite.
- Meetings with workers are limited by the maximum occupancy specified by the Safe Start guidelines for the business and phase the county is currently in, and are to maintain 6 foot spacing of all in attendance. If there are no Safe Start guidelines applicable to an establishment, the limits are: 10% occupancy for Phase 1; 30% occupancy for Phase 2; 50% occupancy for Phase 3; and limited by social distancing for Phase 4.

3. **Regular cleaning of area, frequent cleaning of common-touch surfaces.**

a. A cleaning schedule must be kept to maintain general housekeeping to prevent buildup of dirt and clutter.

b. The first step in cleaning is to remove buildups of dirt and other materials on surfaces. Water and soap or other cleaning fluids are used with wipes, clothes, brushes or other physical means of removing these materials so that there is no visible build-up, smears, or streaks on the surface. Disinfecting is the second step and is primarily needed for high touch surfaces. Effective diluted bleach solutions or an EPA approved disinfectant **must be used** to make sure this is effective. (See the list of approved disinfectants at https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2).

Surfaces that are commonly touched with the hands but difficult to clean (fabric, rough surfaces, and so forth) may need to be covered to make sure the environment is hygienic.

c. Cleaning supplies need to be available to workers to do spot cleaning when necessary.

d. Surfaces that are regularly touched by workers must be cleaned regularly to maintain a visibly clean state (no obvious soiling, smearing, or streaks).

- For surfaces touched by multiple workers, this can be on a frequent schedule, or between workers.
- For surfaces touched by a single worker, this needs to be done periodically, at least once per shift or when unclean, as a minimum.

4. **Workers must have facilities for frequent handwashing readily available**, including hot and cold (or tepid) running water and soap.

   a. DOSH staff must pay particular attention to transient outdoor work, delivery workers and non-fixed worksites where there are no exceptions being granted. Portable wash stations are readily available.

   b. To facilitate more frequent cleaning, secondary handwashing or sanitizing stations can be provided with either hand sanitizer, or wipes/towelettes.

   c. Gloves may be used to enhance hand hygiene and reduce spread of the COVID-19 virus, but must also be changed or cleaned frequently to be effective for this purpose. (Bare hand contact with the virus is not the concern. The concern is transferring the virus to the face or other surfaces with the hands. Gloved hands will transfer the virus as effectively as bare hands.)

   d. Workers must be able to wash their hands after touching any surface/tool suspected of being contaminated, before and after eating and using the restroom, and before touching their face.

5. **Sick employee and post- employee illness procedures**.

   DOSH staff will ensure employers have a program to prevent sick employees from entering the workplace and when recognized, that ill employees are sent home.

   a. Ensure a system for preventing sick employees to be present at work.
   b. Establish a process for deep cleaning after any worker leaves the workplace reporting a suspected or confirmed case of COVID-19.
   c. Thoroughly clean areas where the worker worked or would have stayed more than 10 minutes.
      - Wipe all accessible surfaces.
      - Clean up any visible soiling including any smears or streaks.
      - Sanitize common touch surfaces in the vicinity.

   d. Do not allow other workers into these areas until the cleaning is complete.

6. **Reopening closed facilities.**

   a. The COVID-19 virus is not persistent, so cleaning is only recommended prior to re-occupancy if there were confirmed cases at the time of closure, or if occasional visits by people were made without provisions for cleaning. Enhanced cleaning per this Directive must commence at the time of re-occupancy.

   b. Additional information on procedures for opening buildings can be found in the Department of Health and BOMA guidelines in the reference section.

B. Consider Possible Alternate Strategies.

Some industries may have challenges with basic elements, so one or more of the following alternatives may be used to provide protection for workers.

1. Engineering controls can be established and maintained to provide an effective distancing of employees when it is not feasible to fully separate them.
   a. Barriers must block direct pathways from face to face between individuals, and make it so any indirect air pathways are greater than 6 feet. Sneezes and coughs should not be directed into the air above someone within 6 feet.
   b. Covers can be used on common touch surfaces that cannot be easily cleaned. The covers may create a cleanable surface, or be something that can be changed out between individuals.
   c. Ventilation that provides a cleaned air supply to a worker's breathing zone.
2. Job modifications may be necessary to facilitate appropriate social distancing. Although an operation may be overall part of an essential industry or service, there may be portions of the work which can be deferred until a later time. In some cases, reorganizing the work may be necessary to break up tasks in a manner that facilitates social distancing or other protective measures.
3. Health surveillance can be done to identify early signs of infection, and separate workers who may present a risk to others.
   a. There will usually be an initial screening and then periodic review (probably daily with COVID-19).
   b. Initial screening will involve some review of the worker's history that may be relevant to their risk of contracting the disease. This may also include review of the worker's susceptibility to the disease and an education element on the disease and prevention.
   c. Periodic screening will involve tracking symptoms and ongoing risks for contracting the disease.
   d. The employer should set up surveillance in consultation with a physician or occupational health nurse and consider having ongoing participation or review by the healthcare professional.
   e. The employer needs to consult with health professionals and determine whether the program relies on self-reporting by workers or if someone will be actively reviewing worker health on a regular basis.
4. Personal protective equipment is helpful to prevent transmission of the disease.
5. Face shields can prevent direct exposure to expelled droplets and provide protection from disinfectants, in addition to coverings, masks and respirators.
6. Respirators require care in use and management under a program covered by the Respirator rule, Chapter 296-842 WAC. Respirators are not to be used in lieu of social distancing, but may be appropriate where workers must have close proximity to others for extended periods to accomplish work tasks that can be done no other way.

7. Surgical face masks (loose fitting cloth covers over the mouth and nose) do not prevent respiration of fine aerosols and are not protective in close proximity. The primary purpose for these devices are to prevent exposures to others and may have a use when individuals enter the workplace with a cough or sneeze.

C. Evaluate Special Circumstances.

There are situations where strict social distancing may not be generally feasible for employer provided housing and businesses with extensive public interaction. There are also exceptional situations where an essential activity worker may be permitted to continue work following potential exposure to COVID-19, to ensure continuity of operations of essential functions, such as when cessation of operation of a facility may cause serious harm or danger to public health or safety. The following sections provide additional considerations which are applicable in these specific situations.

1. **Employer provided worker housing** is provided by the employer in some circumstances such as agricultural workers, firefighters, and remote work areas. (An emergency rule for temporary worker housing in agriculture has been adopted in WAC 296-307-16102.)

   a. Workers may have limited control over their environment in some worker housing situations and to the extent that the employer controls conditions, the basic program elements should be maintained as feasible during non-working time.

   b. Social distancing **must be supported** for occupants during the time workers are housed, which may require additional resources. This includes accommodation of social distancing during cooking, sleeping, and in transportation.

   c. If strict social distancing is not feasible (including options for dedicated individual or family rooms or offsite accommodations) then health surveillance should be instituted (see above) prior to and during the housing period.

   d. Housing occupants **must be provided** cleaners and equipment to maintain a hygienic living space.

   e. **Plans for ill employees must be in place**. If a housing occupant becomes sick:

      - **Employers must provide them with accommodations that are separate from others.**
        - A separate building or room if available, or use barriers or distance to separate them from others.
        - Separate food and bathroom access is also necessary.
      - **Arrangement for medical access.**
        - Telemedicine resources should be utilized first to determine appropriate care.
        - **Provide for transportation**, if necessary in a manner that does not expose others.
        - The employer needs to consult with a physician or public health authority to monitor the situation and provide guidance on treatment and continued housing of all workers.

2. **Frequent customer/public interaction** may be necessary in some places of employment.
   a. To the extent feasible, establish social distancing with physical systems.
      - Set up tables that position people away from workers.
      - Place pay stations at a safe distance.
      - Install barriers between people.
      - Place markers and lane dividers to encourage appropriate distancing.

   b. Have managers or floor leads observing individuals in the workplace and prepared to address behaviors that may put workers at risk.

   c. Provide supplemental washing facilities to allow additional handwashing when workers handle objects after others, such as:
      - Hand sanitizer stations
      - Wipes or towelettes
      - Tepid water and soap in portable containers.

   NOTE: Gloves may be provided, but also must be washed regularly to prevent the spread of the virus. This may help for workers whose hands are bothered by frequent washing.

3. **Quarantine and isolation.** The requirements for people to quarantine or isolate are set by local health jurisdictions and apply to the individual. DOSH does not enforce these orders for individuals, but does expect employers to set rules to prevent people with known or potential COVID-19 virus infection, from entering the workplace. (Note that healthcare facilities may follow the CDC guidance specific to these settings--Interim U.S. Guidance for Risk Assessment and Work Restrictions for Healthcare Personnel with Potential Exposure to COVID-19.)

   Definitions

   - **Quarantine** refers to sequestering after contact with a suspected or known COVID-19 case. The safest quarantine period ends 14 days after the last close contact with someone who has COVID-19.
   - **Isolation** refers to sequestering when the individual is believed to be infected with SARS-CoV-2 (the virus that causes COVID-19) such as when someone has symptoms of COVID-19, or when someone tests positive for infection with SARS-CoV-2.

   CDC guidance on quarantine and isolation, including specifics of contact requiring quarantine and ending the quarantine or isolation are given here: https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/quarantine.html

   Essential activities workers with potential exposure to a suspected or confirmed COVID-19 case, coming to common workplaces.

   These workers may have an infection, but not be symptomatic. There is a risk that they could spread the infection to other workers

   a. No worker who should be in isolation may be allowed into a common workplace with other workers.

b. People who have been in close contact with someone else with COVID-19 must not be allowed into the common workplace with other workers within 14 days of their last contact, except under the following circumstances.

- When allowed by the local health jurisdiction, quarantine may be reduced to:
  - 10 days, **or**
  - No less than 7 days if the quarantined individual has a negative test result taken no more than 48 hours before ending quarantine.
- When a worker is vital for continuation of a critical infrastructure operation. **This option should be used as a last resort and only in limited circumstances, such as when cessation of operation of a facility may cause serious harm or danger to public health or safety.** Employers must determine whether it is appropriate for the worker to come to the workplace. Other alternatives, such as teleworking or reassigning duties should be considered. If the worker returns to the workplace during quarantine, there is a potential for exposing other workers in the critical operation. When no alternatives exist, employers must work with public health officials to manage the continuation of the work in a way that best protects the health of their workers and the general public, including the determination of quarantine options.

c. Employers of workers who have had contact but come to the workplace within 14 days of exposure must adhere to the following practices prior to and during each work shift:

- <u>Pre-Screen</u>: Determine the employee's temperature and assess symptoms prior to their starting work. Workers should be asked to pre-screen at home before travelling to work (including measuring temperature), and should not be permitted to enter the workplace if they have symptoms of COVID-19; temperature equal to or higher than 100.4 degrees Fahrenheit; or are waiting for the results of a viral test ordered because they are symptomatic or had close contact to a person known or suspected to have COVID-19 symptoms. Temperature checks must happen before the individual enters the facility.
- <u>Screen at the workplace:</u> Employers should conduct an on-site symptom assessment, including temperature screening, prior to each work shift. Screening should happen before the employee enters the facility.
- <u>Regular Monitoring</u>: As long as the employee doesn't have a temperature or symptoms, they should self-monitor. The employer's occupational health program or workplace COVID-19 coordinator or team must supervise self-monitoring. **Employers must consult with an occupational health provider and state and/or local health officials to ensure the medical monitoring is conducted appropriately**.

- Wear a Mask: The worker must wear a face mask while in the workplace unless there is a medical reason prohibiting its use. Employers can issue facemasks or can approve worker supplied cloth face coverings in the event of shortages. If required, respirators must still be used according to the requirements of Chapter 296-842 WAC.
- Social Distance: The worker must maintain 6 foot separation and practice social distancing as work duties permit in the workplace. Where duties do not permit social distancing, the employer must institute other controls as practicable to protect other workers. Barriers or fans may be effective in many circumstances.
- Disinfect and Clean Work Spaces: Clean and disinfect all areas such as offices, bathrooms, common areas, and shared electronic equipment routinely.

d. If the worker becomes sick during the shift, they should be sent home immediately. Surfaces in their workspace should be cleaned and disinfected. Information on persons who had contact with the ill employee during the time the employee had symptoms, and 2 days prior to symptoms, should be compiled. Others at the facility with close contact within 6 feet of the employee during this time would be considered exposed.

e. Employers considering allowing potentially exposed workers to remain at the workplace during quarantine should consider the following preparatory actions. (For further information consult the CDC guideline document [COVID-19 Critical Infrastructure Sector Response Planning])

- Workers must not share headsets or other objects that are near the mouth or nose.
- Employers must increase the frequency of cleaning commonly touched surfaces.
- Employers should work with facility maintenance staff to increase air exchanges in room.
- Workers must physically distance themselves when they take breaks together. Stagger breaks and don't congregate in the break room, and don't share food or utensils.

4. **Working with people in non-healthcare (human) settings who have suspect or confirmed COVID-19**. Generally, this situation should be avoided, using remote services or delaying work until the COVID-19 case is resolved. However, some cases such as emergency repairs in the residence of the patient, emergency pet veterinary services, or delivery of essential goods to the residence may require workers to be in the presence of an ill individual.

   a. Workers must be informed of the individual's health status.

   b. When practicable, the ill individual must wear a medical procedure mask.

   c. Workers must be provided and required to wear a respirator. A half-face elastomeric respirator with N-95 cartridges, or other respirator with the same or higher protection must be used. Fit-testing and other respirator program elements must be complied with. See chapter 296-842 WAC, *Respirators*.

d. Other personal protective equipment such as gloves, aprons, gowns, and head coverings should be considered to prevent contamination of the worker's body or street clothes. Handwashing and other hygiene resources must be available to the worker as needed during the work and at the conclusion.

D. Evaluation of respiratory protection for COVID-19 protection in healthcare when not treating suspect or known COVID-19 patients.

Healthcare facilities must follow social distancing guidelines including general provisions and any specific requirements set by the Governor. It is expected that all healthcare practitioners will follow Universal or Standard Precautions, or equivalent protocols to address infection control for all infectious diseases. The following specific requirements may be evaluated by DOSH staff when considering COVID-19 hazards:

1. **Patient rules and masking.**
   a. Evaluate patients at the time appointments are made and when arriving for signs and symptoms of COVID-19. If a patient is determined to have suspected or confirmed COVID-19, they should be asked to postpone medical treatment when appropriate and referred to healthcare providers for evaluation and treatment of their COVID-19.

   b. Patients and visitors to the medical facility must be required to wear cloth face coverings or other appropriate masks in the facility as practicable. Exceptions may be allowed for patients with conditions that may be aggravated by mask use or patients who have difficulty remaining masked due to mental acuity or youth.

   c. Masks may be removed briefly to facilitate specific examination elements for which they interfere. The procedures for the exam must minimize the period without the mask and time the medical workers must be in close proximity of the patient without a mask. In particular, face-to-face positioning of the patient and medical worker must be limited as practicable.

2. **Worker masking and respiratory protection.**
   a. Workers must wear, at minimum, cloth face coverings or procedure masks whenever working with others.

   b. Workers within 3 feet of a patient or equipment during an aerosol generating procedure must wear a fit-tested N95 filtering facepiece respirator or more protective respirator. (Particulate filters with any N, R, or P and 95, 99, or 100 rating are protective against the COVID-19 virus.) Examples of aerosol generating procedures include:

      - Dental work with an ultrasonic scaler, air/water syringe, or hand piece
      - Administering medicines with a nebulizer
      - Spirometry
      - Deep or forced breathing exercises

c. Employers must evaluate other procedures workers conduct involving close proximity to the patient breathing zone. Where workers have limited time of exposure (less than half hour per day), and patients are effectively masked during the procedures, and room conditions include effective ventilation and hygiene, then respirators may not be required. A surgical mask must be used when a respirator is not required. Examples of procedures that must be evaluated include:
- Tonometry during eye exams
- Visual examination of the oral and nasal cavities
- Visual examination of the eyes
- Swab sampling in the mouth or nose

3. **Evaluation of PPE other than respirators.**

a. Other personal protective equipment, such as gloves, gowns, face shields, and head covers, generally will be determined based on general clinical guidelines.

b. When there is a procedure which could predictably result in coughing or sneezing by the patient which could directly expose the worker, DOSH staff will review PPE to ensure it covers the workers body and street clothes and prevent soaking through. Scrubs may be worn as PPE if the employer allows workers to change out at the end of shift and launders the clothing.

c. Medical establishments may be required to meet health department or FDA standards for PPE. Compliance with these standards is not addressed by DOSH staff.

V. Enforcement Policy

Inspection findings will be reviewed on a case by case basis. Conditions related to COVID-19 and the virus are still emerging. Public health recommendations and orders are being regularly revised, and so any compliance action must take into consideration current understanding of the situation and current rules and guides. The following sections identify codes from chapter 296-800 WAC (Core Rules). When working in chapters 296-155 WAC (Construction) and 296-307 WAC (Agriculture), please use the comparable codes from those vertical standards.

A. Accident Prevention Programs.

1. Employers are not expected to have comprehensive COVID-19 prevention programs at this point. In conducting program reviews, DOSH staff must look at all documents used by the employer to communicate with workers to determine their overall program.

2. Where the employer is clearly implementing recommendations of the public health authorities, they do not need additional documentation of their program, except for program documentation specified in public health orders or the Governor's "Safe Start" phased guidelines for industries or general requirements. Any variation from strict social distancing, the Governor's programs, or health department guidelines must be clearly communicated in a written program. (Note that participating in early phases of the restart may be dependent on strictly following the industry specific requirements and guidance. Activities that cannot do so, must wait for a later phase to resume.)

3. Violations of the sections of WAC 296-800-140, *Accident Prevention Program*, should be considered where the employer does not communicate workplace specific expectations to workers or is not effective in implementing those expectations.
4. Serious violations should specifically be considered in cases where the employer adopts practices or policies that clearly contradict the goals of coronavirus prevention practices published by DOSH, OSHA or public health recommendations.
5. Accident prevention program violations must follow instructions in the Compliance Manual.

B. Housekeeping.

Where a workplace is not being cleaned and kept sanitary per public health guidance, a violation of WAC 296-800-22005, *Keep your workplace clean*, may be considered. A serious classification should be strongly considered.

C. Handwashing.

1. There is a requirement for handwashing facilities that applies to all workplaces at all times. A serious and potential willful violation of WAC 296-800-23025, *Provide convenient and clean washing facilities*, will be considered whenever workers do not have basic handwashing facilities available at all, or they are grossly inadequate in either number or maintenance.
2. Where employers cannot provide unlimited access to full handwashing facilities at all times, they **must provide alternate means** for frequent hand cleaning. A serious classification should be strongly considered if not adequate to achieve prevention. This is specifically necessary where workers regularly handle or touch objects or surfaces touched by others. Alternate hand cleaning may include:
   a. Portable wash stations with tepid water and soap.
   b. Wipes or towelettes with water and soap.
   c. Hand sanitizer stations.

D. Safe Place Violations.

1. Workplace conditions which have a direct potential for worker exposure to the COVID-19 virus may be cited under WAC 296-800-11005, *Provide a workplace free from recognized hazards*. This is the primary code to use for social distancing practice violations. This may include situations such as ineffective barrier or ventilation systems, or specifically allowing workers to be in close proximity, but where there is no written record of a policy or management decision. Masking violations requiring devices not normally considered respirators may be cited under this section (cloth face coverings or medical procedure masks).
2. Violations of this section are safe place violations in that they must be serious in classification and must follow the Compliance Manual instructions for safe place.
3. For construction inspections, use WAC 296-155-040 (1). For agriculture inspections, use WAC 296 307-045 (1).

E. Respirator Violations.

Violations involving proper use of respirators, including N95 filtering facepieces, PAPRs, and elastomeric facepiece respirators will normally be cited from chapter 296-842 WAC, *Respirators.* When these devices are used in place of a cloth face covering or medical procedure mask due to social distancing rules from public health authorities or the governor, the use will be considered voluntary use for compliance purposes. Protection from contaminated aerosols is required use.

F. Temporary Farmworker Housing.

Temporary worker housing in agriculture is covered under Chapter 296-307 WAC, Part L, *Temporary Worker Housing and Cherry Harvest Camps*. This rule has specific requirements for hygiene facilities and housekeeping. Employers must in general achieve adequate social distancing; frequent handwashing during work; sanitation practices during work; sufficient disinfection supplies in housing; and sick employee practices outlined above. Consult with Technical Services and Compliance Operations on application of these rules when there is a COVID-19 concern.

VI. Point of Contact

DOSH staff should contact Compliance Operations if there are questions about applicability of WISHA rules to an infectious disease in the workplace. Technical Services may be contacted with technical questions about workplace practices.

VII. Review and Expiration

DOSH will review this Directive, and it will remain effective until superseded or canceled.

Approved: ______________________

Anne F. Soiza, L&I Assistant Director
Division of Occupational Safety and Health

Results

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Memorandum

August 8, 2022

To: Lower Duwamish Waterway Group

From: Katy Gross, Anchor QEA

cc: Tom Wang, Anchor QEA

Re: LDW Middle Reach Bathymetric Survey Preliminary Data Summary

This memorandum documents the status of the middle reach bathymetric survey required as part of the Fifth Amendment to the Lower Duwamish Waterway (LDW) Administrative Order on Consent (AOC 5) (EPA 2021) with the U.S. Environmental Protection Agency (EPA). This work was performed in compliance with the amended AOC 5 and specifically included the following:

- Conduct bathymetric survey to support the Remedial Design (RD) for LDW river mile (RM) 1.6 to RM 3.0 consistent with the EPA remedy outlined in Section 13 of the EPA Record of Decision (EPA 2014).

A quality assurance project plan (QAPP) for the pre-design surveys of the LDW middle reach, herein referred to as the middle reach bathymetric survey QAPP, was prepared and approved by EPA before the survey was conducted (Anchor QEA and Windward 2021). This memorandum documents the completed work and areas surveyed to date, as well as any deviations from the middle reach bathymetric survey QAPP. The survey data are presented in Maps B-1 and B-2.

Summary of Work

Bathymetric survey data collection was performed over a period of several weeks during varying tidal conditions by Northwest Hydro, Inc. Survey data collection began on October 20, 2021, and was completed on November 18, 2021, from RM 1.6 to RM 3.0. Surveying activities were completed in accordance with the middle reach bathymetric survey QAPP and included a combination of multibeam and single-beam sonar data collection surveying techniques.

Prior to bathymetric surveying activities, True North Land Surveying, Inc. established a control network along the LDW at upland locations. These survey control points were installed on October 15, 2021.

Survey Coverage

Maps B-1 and B-2 show the survey coverage over the site. Approximately 68%[1] of the site (defined as RM 1.6 to RM 3.0 below the mean higher high water) was covered during the initial survey effort, the remainder of the site being impeded by barges or other access obstructions/limitations.

A supplemental survey to fill data gaps is anticipated to be completed in 2022 during Phase I PDI activities for the middle reach.

Deviations

No deviations from the middle reach bathymetric survey QAPP occurred during the surveying activities.

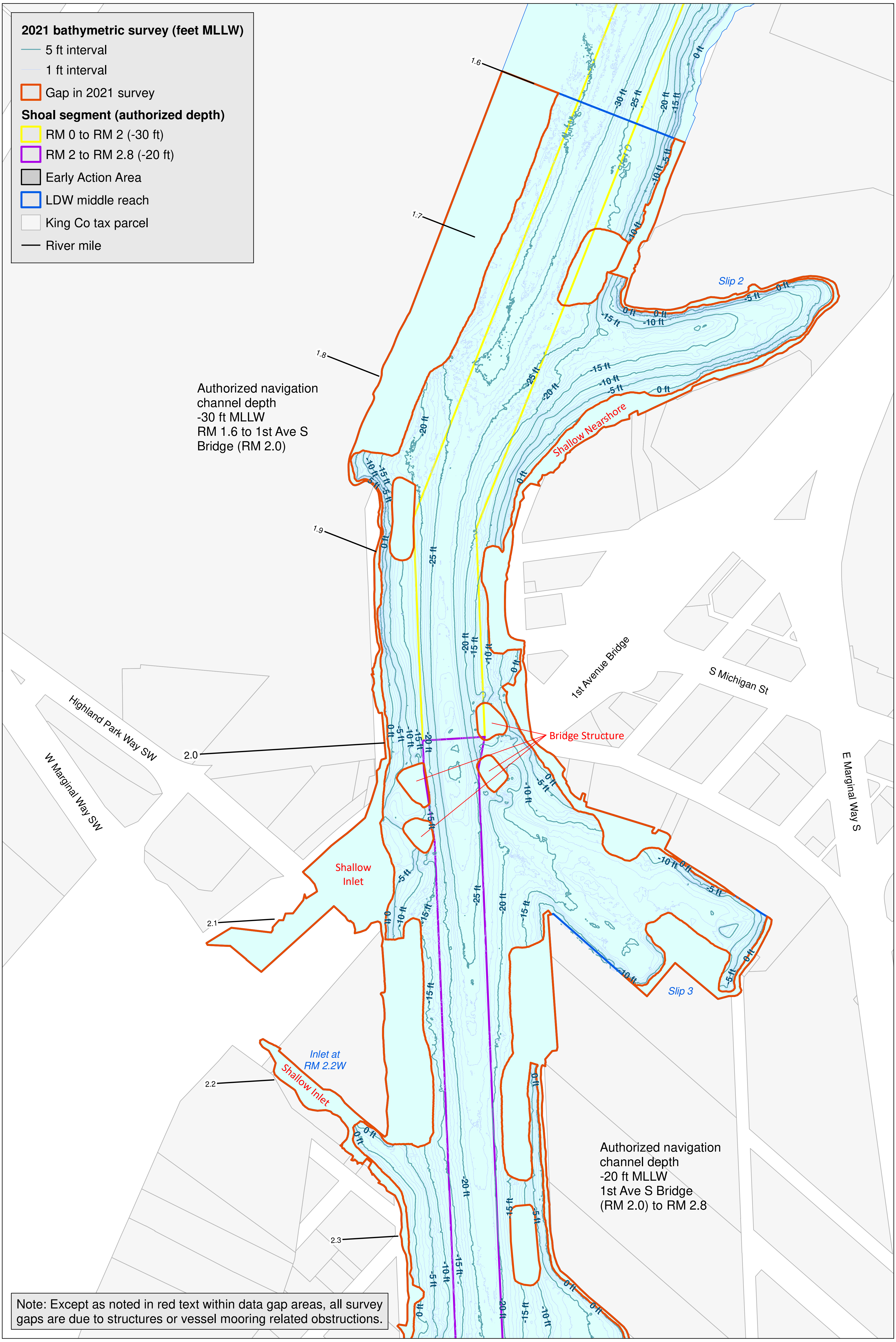
References

Anchor QEA, Windward. 2021. Quality assurance project plan: pre-design surveys of the Lower Duwamish Waterway middle reach. Final. Submitted to EPA October 19, 2021. Anchor QEA and Windward Environmental LLC, Seattle, WA.

EPA. 2014. Record of Decision. Lower Duwamish Waterway Superfund Site. US Environmental Protection Agency.

EPA. 2021. Fifth Amendment to the Administrative Order on Consent for remedial investigation/feasibility study (AOC) for the Lower Duwamish Waterway (LDW), CERCLA-10-2001-0055. US Environmental Protection Agency, Region 10, Olympia, WA.

[1]Calculated coverage area is based on preliminary surface area information provided by the surveyor. The total site surface area of the middle reach will be confirmed during the Pre-Design Investigation (PDI).



Windward environmental LLC

ANCHOR QEA

Lower Duwamish Waterway Group

Port of Seattle / City of Seattle / King County / The Boeing Company

N

0 250 500 Feet

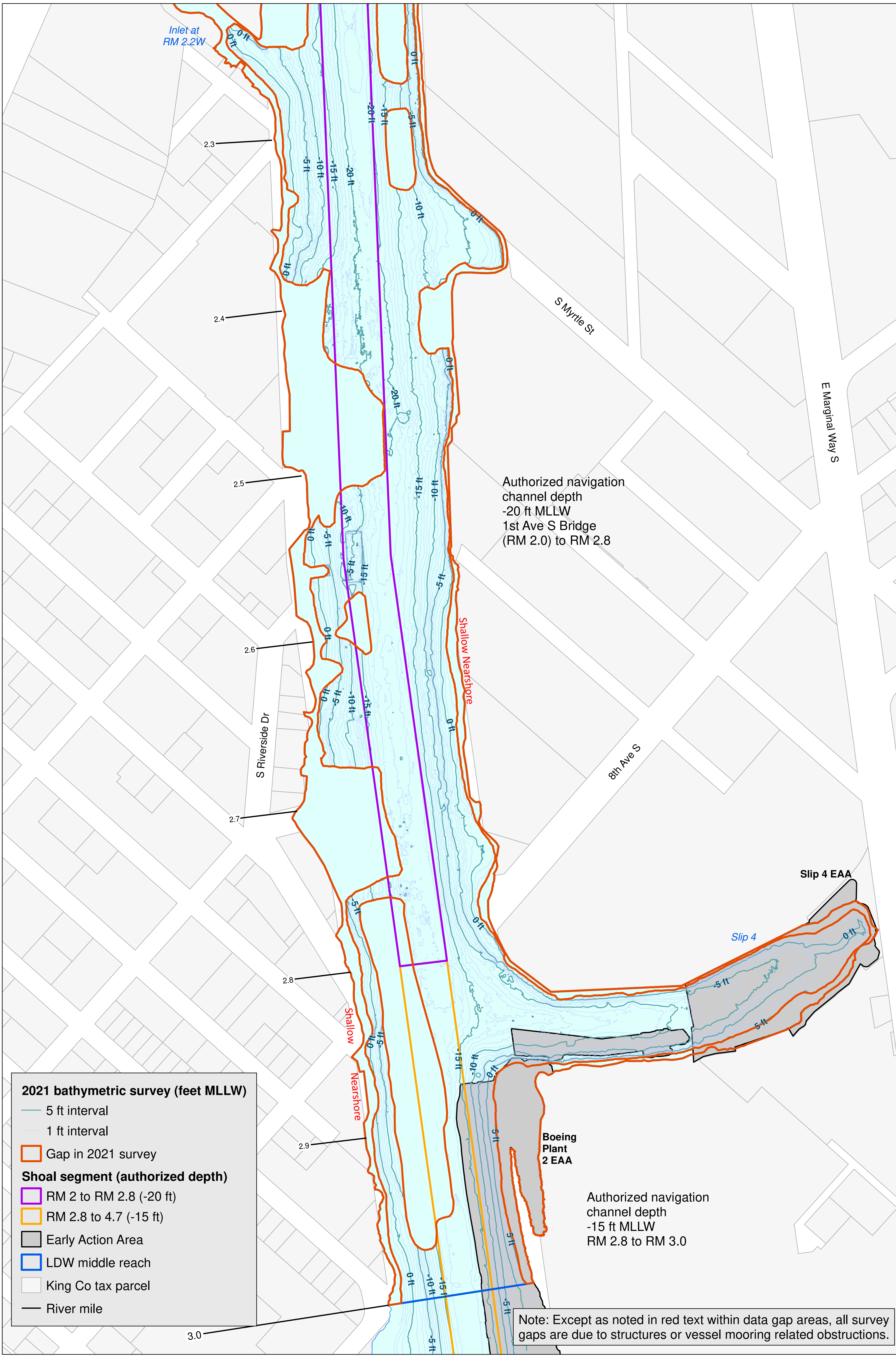
0 50 100 Meters

Map B-1a. 2021 bathymetric conditions, RM 1.6 to RM 2.3

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map B-1a 7421 2021 Bathymetric conditions RM1.6-2.3.mxd



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Map B-1b. 2021 bathymetric conditions, RM 2.3 to RM 3.0

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

FINAL

Attachment C
Recommended Recovery Category Modifications based on the 2021 Bathymetry Survey

C.1 Introduction

Recovery category areas are an important component of the remedial actions identified in the Lower Duwamish Waterway (LDW) Record of Decision (ROD) (EPA 2014) and are used to help determine the spatial application of remedial action levels (RALs) and selection of remedial technologies. Recovery categories are used to assign remedial technologies to specific areas based on information about the potential for sediment contaminant concentrations to be reduced through natural recovery, or for subsurface contamination to be exposed due to erosion or scour.

Recovery category areas were developed in the feasibility study (FS) (AECOM 2012) based on the criteria presented in ROD Table 23. As defined in the ROD, Recovery Category 1 refers to recovery that is presumed to be limited and locations where subsurface contamination is more likely to be exposed at the surface due to erosion or scour (EPA 2014). Recovery Category 2 refers to recovery that is uncertain. Recovery Category 3 refers to greater potential for sediment contaminant concentrations to be reduced through natural recovery that is predicted to occur with some confidence.

The recovery category areas depicted in ROD Figure 17 (see Appendix A of the Remedial Design Work Plan for the Lower Duwamish Middle Reach [RDWP]) (Anchor QEA and Windward 2022) were revised in the *Recovery Category Recommendations Report* (Integral et al. 2019) to serve as a starting point for this analysis of the middle reach (river mile [RM] 1.6 to RM 3.0) (Map C-1). Map C-1 also shows the "analysis areas" that are referenced in this attachment to allow for area-specific recovery category discussion. The use of recovery categories allows for more aggressive remedial technologies (such as capping and dredging) to be used in areas with less potential for natural recovery and a greater likelihood of scour or other disturbance, and for less aggressive remedial technologies (such as enhanced natural recovery [ENR] and monitored natural recovery [MNR]) to be used in areas where recovery is predicted to occur more readily and disturbance is less likely (EPA 2014).

The recovery category area designations provide a general representation of the location-specific conditions within the middle reach for the purpose of applying RALs and remedial technologies at this stage of the remedial design. During remedial design, additional remediation details and assumptions (e.g., dredge prism boundaries, slopes, and depths; and capping and ENR grain size specifications) may rely on location-specific hydrodynamic and bathymetry information to support design.

Recovery category areas are delineated based on the following physical and chemical criteria (EPA 2014) to estimate areas of recovery and scour potential:

1. Identification of observed vessel-induced scour areas based on a visual review of a sun-illuminated bathymetric survey map produced from a comprehensive site-wide bathymetric

survey. The 2003 bathymetric survey conducted for the remedial investigation (RI)/FS was used to delineate the recovery category areas defined in the ROD.
2. Identification of berthing areas based on waterway configuration (i.e., location of docks), review of the 2002 US Army Corps of Engineers Port Series report (USACE 2002), and review of the waterway user survey with its assessment of in-water structures (Integral et al. 2018).
3. Identification of sediment transport model (STM)-predicted 100-year high-flow event scour areas (> 10 cm) and STM-predicted net-scour and net-sedimentation areas as presented in the FS.
4. Empirical contaminant trends over time.

The 2019 modifications to the ROD recovery category areas made in the *Recovery Category Recommendations Report* (Integral et al. 2019) were based on review of criteria 2 and 4; new bathymetry data were not available at the time of this report (criterion 1).[1] No changes have been made based on criterion 3 since the ROD.

New bathymetric surveys were performed in 2021. This attachment uses the 2021 bathymetric survey to develop a sun-illumination map and reassess observed vessel-induced scour areas (criterion 1). In this attachment, the 2021 bathymetric survey results are also compared with the 2003 bathymetric survey results to empirically identify net changes to waterway elevations that have developed over the past 18 years. Neither the 2003 nor the 2021 bathymetric survey fully covered the middle reach due to moored vessels; therefore, survey comparisons were performed only for areas with overlapping coverage. Used in parallel with the primary criteria evaluations, this analysis provides supplemental lines of evidence that might identify net-scour areas that were not well captured in the sun-illumination map, and that should be considered in design.

Additional modifications to the recovery category areas within the middle reach may be identified based on Pre-Design Investigation (PDI) chemistry data (criterion 4) in the forthcoming PDI Phase I and Phase II data evaluation reports. The remainder of this attachment summarizes the methods used to evaluate the new bathymetry data and presents recommendations for recovery category modifications. No modifications were made for areas that fall within a bathymetry survey data gap. These areas will be reassessed during the PDI as access is gained from the various waterway users and property owners.

C.2 Methods

Northwest Hydro, Inc. collected multi-beam bathymetry data within the middle reach in October and November 2021, providing new data to assess observed vessel-induced scour areas. Vessel-induced scour near and in berthing areas was evaluated by examining a sun-illumination bathymetry map

[1] Empirical contaminant trends over time (criterion 4) were evaluated but did not result in changes to the recovery category areas.

(Map C-2), consistent with the analysis performed for the FS (FS Section 2.3.1.1). Multi-beam bathymetric soundings were converted into a digital terrain model of the three-dimensional mudline elevations, and the digital terrain model was used to generate a sun-illumination map. The outlines of ROD Recovery Categories 1 and 2 are shown for reference on Map C-2. Areas outside of Recovery Categories 1 and 2 are Recovery Category 3.

The highlights and shading on the sun-illumination map emphasize fine-scale features and vertical relief to aid in the visual identification of bedform features that may be due to scour from vessel propeller wash (propwash), vessel grounding, or anchoring or spudding from vessel operations. The features can include ridges and furrows, depressions, and other disturbance features. However, it is the actual vertical elevation difference that is important. This difference can be exaggerated in sun-illumination maps, because the angle of illumination can create shading for even very small elevation differences (e.g., inches), implying greater bed disturbance than is actually present.

Additionally, survey accuracy must be considered when evaluating bed disturbance. Changes in bathymetric elevation of +/- 4 in. are functionally considered to indicate no change in elevation, because the results are within the accuracy limits of the evaluation (vertical accuracy of individual RTK-GPS multibeam surveys in shallow water is in the range of +/- 0.3 ft (USACE 2013)). For this analysis and as a general guide, bed vertical disturbances (i.e., depressions in the bed as seen on the sun-illumination maps) of 6 in. or less were not considered sufficient to indicate scour.[2] This applied, for example, to marina areas where areas of shadowing could be seen on the sun-illumination map but were not deep enough to indicate vessel scour sufficient to trigger a change to Recovery Category 1.

In addition to the sun-illumination maps, two supplemental lines of evidence were assessed:

A. Analysis of changes in bed elevations between the 2003 and 2021 bathymetric surveys that could be indicative of net scour or deposition (or caused by other factors such as dredging or construction impacts) over the 18-year period
B. Consideration of waterway use based on the configuration of docks and infrastructure observed using maps and satellite imagery

In supplemental line of evidence A, empirical net-scour or deposition patterns were identified by changes in bathymetric elevation between the 2003 and 2021 bathymetric surveys depicted in an isopach map (Map C-3). Changes in bathymetry may have multiple causes: ongoing natural sedimentation processes; dredging, excavation, structure removal or construction, or material placement that occurred between the two surveys; bed erosion due to surface water flows; vessel-induced scour from vessel propwash; or bed disturbance from other vessel operations

[2] This approach for the middle reach is consistent with the upper reach approach, as described in Appendix B to the Upper Reach QAPP, *Recommended Recovery Category Modifications Based on the 2019 Bathymetry Survey* (Windward and Anchor QEA 2020).

(e.g., spudding, anchoring, grounding). The evidence from the isopach map can help identify areas of positive change (referred to as deposition), negative change (referred to as scour), or no net elevation change. While helpful, this empirical information is not used to override the predicted STM results (criterion 3) because of the longer-term duration of the STM analysis (which analyzes the impact of repetitive high-flow events, including a 100-year high-flow event). As discussed, surveys generally have a vertical accuracy of +/- 0.3 ft; this uncertainty is compounded when comparing two surveys. The accuracy of the comparison is reduced along slopes (e.g., adjacent to the FNC and along the shoreline), in areas of riprap or other armoring, and along the edges of the survey. Therefore, for purposes of this analysis, net elevation changes of +/-6 in. or less on the isopach map are considered non-significant changes with respect to net deposition or scour in flat areas. On slopes or within armored areas, net elevation changes of +/-12 in. or less are considered non-significant.

Supplemental line of evidence B was used to aid in the interpretation of bedform features, including site waterway use and recent construction activities within the middle reach. This line of evidence considered the configuration of overwater structures, berthing areas, dredging and material placement areas, bridges, piles, and dolphins. For example, some docks show evidence of high-frequency vessel traffic, while some dolphins and structures can block access to maneuvering vessels. In addition, construction projects have modified the bed features of the middle reach and can be observed on bathymetric surveys. For example, dredging and material placement were performed for two early action areas (EAAs) at Boeing Plant 2 and Slip 4 between 2011 and 2015.

For all discrete locations within the middle reach, the two supplemental lines of evidence were considered with criterion 1, engineering best professional judgment, and knowledge of site conditions to recommend modifications to the recovery category areas identified in the ROD. Recovery Category 1 areas based on the STM predictions (criterion 3) (i.e., 100-year high-flow event scour areas and net-scour areas) were not reduced in size or shape. Thus, only areas outside of STM 100-year high-flow event scour areas and net-scour areas were considered eligible for recovery category revision.

C.3 Recovery Category Modifications

All areas of the middle reach were evaluated and divided into 10 areas for detailed analysis; the EAAs were excluded. Table C-1 summarizes the evaluation for the analysis areas. It identifies each analysis area by river mile and side of the LDW (east, Federal Navigation Channel [FNC], and west), lists the current recovery category designation (Integral et al. 2019), summarizes criterion 1 and the two supplemental lines of evidence considered in this document, and proposes any recovery category area changes. As shown in Maps C-4 to C-10, nine locations within six analysis areas were identified for recovery category area modification or refinement based on this evaluation; these areas are discussed in the rest of this section.

Table C-1
Middle Reach Recovery Category Evaluation Summary

Evaluation Area	RM	Portion of Waterway	River Side	Current Recovery Category Designation	RC Criterion 1: Vessel-Induced Scour (Analysis of Bed Sediment Disturbance Using the Sun-Illumination Map) [1]	Supplemental Lines of Evidence: A) Analysis of Changes in Bathymetry from 2003 to 2021 Using the Isopach Map	Supplemental Lines of Evidence: B) Waterway Usage[2]	Conclusion and Rationale
1	1.6 to 1.79	Main waterway	west	RC2 and RC3	No significant vessel-induced scour features. (Limited bathymetric survey coverage.)	Area is depositional.	Vessel berthing.	No changes to RCs.
			FNC	RC3	No significant vessel-induced scour features.	Mostly depositional with a small area of no change at RM 1.77.	FNC vessel transiting.	No changes to RCs.
2	1.6 to 1.84	Slip 2	east (north of Slip 2)	RC1 (berthing areas); RC3 (shoreline)	No significant vessel-induced scour features.	Area is depositional.	Vessel berthing.	RC1 changed to RC3 in the intertidal area just north of Slip 2. No evidence for vessel scour, and vessels cannot access due to mooring piles and water depth.
			east (mouth of Slip 2)	RC1	Possible vessel-induced scour features in the northern subtidal portion of the mouth of the slip within existing RC1. No vessel-induced scour features in the intertidal based on the sun-illumination map and intertidal observations and satellite imagery where survey data were not available	Areas of deepening, deposition, and no change.	Vessel berthing.	RC1 changed to RC3 in the intertidal areas adjacent to structure on the southern end of the slip. No evidence for vessel scour, and vessels cannot access due to the dock, mooring dolphins, and water depth.
			east (head of Slip 2)	RC3	Possible vessel-induced scour features in the subtidal.	Mostly depositional with some pockets of deepening in the northern berth.	Vessel berthing.	RC3 changed to RC1 in the northern berthing area of Slip 2 (western portion of northern berth) due to both net erosion and observed vessel scour.
3	1.79 to 1.95	Main waterway	west	RC1 (RM 1.8 to RM 1.86) RC2 and RC3 (rest of the area)	No significant vessel-induced scour features. (Limited bathymetric survey coverage.)	Area is depositional.	Vessel berthing.	RC1 changed to RC3 in a small intertidal corner with no evidence for vessel scour and where vessels cannot access due to a dolphin and water depth.
			FNC	RC3	No significant vessel-induced scour features.	Area is depositional.	FNC vessel transiting.	No changes to RCs.
			east	RC2 and RC3	No significant vessel-induced scour features. (Limited bathymetric survey coverage.)	Area is depositional.	Vessel berthing.	No changes to RCs.
4	1.95 to 2.12	Main waterway near 1st Avenue Bridge	west	RC2 and RC3	Bridge-structure features apparent on the bathymetric survey (i.e., limited bathymetric survey coverage). Vessel-induced features south of the bridge in berthing area less than 6 in. deep.	Mostly depositional with patches of no change.	1st Avenue Bridge/support structure and under-bridge mudflat.	No changes to RCs.
			FNC	RC3	Tidal flow/ bridge-induced bathymetric features.	Mostly deepening.	FNC vessel transiting.	RC3 changed to RC1 in the portion of the waterway that shows net erosion and constricted flow/bridge-induced bathymetric features.

Evaluation Area	RM	Portion of Waterway	River Side	Current Recovery Category Designation	RC Criterion 1 Vessel-Induced Scour (Analysis of Bed Sediment Disturbance Using the Sun-Illumination Map) [1]	Supplemental Lines of Evidence A) Analysis of Changes in Bathymetry from 2003 to 2021 Using the Isopach Map	Supplemental Lines of Evidence B) Waterway Usage[2]	Conclusion and Rationale
			east	RC2 and RC3	Bridge-structure features apparent on the bathymetric survey. (Limited bathymetric survey coverage.) Possible vessel-induced scour features due to transit from Slip 3; scour less than 6 in. deep.	Mostly depositional with patches of no change.	Vessel berthing.	No changes to RCs.
5	2.0 to 2.15	Slip 3	east (mouth of Slip 3)	RC2 and RC3	Possible vessel-induced scour features. Evidence of vessel maneuvering toward the FNC to the southern slip. All scour features less than 6 in. deep.	Area is depositional.	Vessel berthing.	No changes to RCs.
			east (head of Slip 3)	RC2 and RC3	Possible localized construction-related disturbance.	Mostly depositional with small area of no change at RM 2.1.	Vessel berthing.	No changes to RCs.
6	2.12 to 2.31	Main waterway	west (including inlet at RM 2.2 W)	RC2 and RC3	No significant vessel-induced scour features. (Limited bathymetric survey coverage.)	Mostly depositional and areas of no change.	Vessel berthing.	No changes to RCs.
			FNC	RC3	No significant vessel-induced scour features.	Mostly depositional and areas of no change.	FNC vessel transiting.	No changes to RCs.
			east	RC2	No significant vessel-induced scour features. (Limited bathymetric survey coverage.)	Depositional from RM 2.12 to RM 2.2. Deepening and no change associated with berthing area from RM 2.2 to RM 2.31.	Vessel berthing.	No changes to RCs.
7	2.31 to 2.55	Main waterway	west	RC1 (RM 2.35 to RM 2.45) RC2 and RC3 (rest of the area)	Possible vessel-induced scour features. Scour features less than 6 in. depth. (Limited bathymetric survey coverage.)	Mostly depositional with isolated small areas of no change at RM 2.36 (limited bathymetric survey coverage).	Vessel berthing.	No changes to RCs.
			FNC	RC3	No significant vessel-induced scour features. (Sunken barge at RM 2.55.)	Area is depositional.	FNC vessel transiting.	No changes to RCs.
			east	RC1	Possible vessel-induced scour features. Scour features less than 6 in. deep.	Mixture of no change and areas of deposition and deeper bathymetry elevations.	Vessel berthing.	RC1 changed to RC3 in the intertidal strip with no evidence for vessel scour and where vessels cannot access due to dolphins and water depth.
8	2.55 to 2.85	Main waterway	west	RC1 (RM 2.7 to RM 2.79) RC2 and RC3 (rest of the area)	Possible vessel-induced scour features. Scour features less than 6 in. deep. (Limited bathymetric survey coverage.)	Mostly depositional.	Vessel berthing.	No changes to RCs.
			FNC	RC2 and RC3	No significant vessel-induced scour features.	Mixed areas of deposition and no change.	FNC vessel transiting.	No changes to RCs.

Evaluation Area	RM	Portion of Waterway	River Side	Current Recovery Category Designation	RC Criterion 1 Vessel-Induced Scour (Analysis of Bed Sediment Disturbance Using the Sun-Illumination Map) [1]	Supplemental Lines of Evidence A) Analysis of Changes in Bathymetry from 2003 to 2021 Using the Isopach Map	Supplemental Lines of Evidence B) Waterway Usage[2]	Conclusion and Rationale
			east	RC2 and RC3	Possible vessel-induced or river flow scour features. Scour features greater than 1 ft in depth.	Significant deepening of the eastern slope area potentially due to redirection of waterway flow due to moored barges on western half of the waterway. Intertidal areas no change.	Vessel berthing.	RC2/3 changed to RC1 in the subtidal portion east of the FNC that shows net erosion and sun illumination-observed scour. RC1 changed to RC2 in the small intertidal area along the corner of Slip 4 where there is no evidence for vessel scour and large vessels cannot access due to a dock and water depth.
9	2.79 to 2.88	Slip 4	east (mouth of Slip 4)	RC1, RC2, and RC3	Possible vessel-induced scour features. Scour features less than 6 in. deep. Bank armoring along the northern corner of slip connecting to the main waterway.	Mostly depositional.	Vessel berthing.	No changes to RCs.
10	2.85 to 3.0	Main waterway	west	RC1 (RM 2.85 to RM 2.88; eastern half of the area from RM 2.88 to RM 3.0) RC3 (rest of the area)	No significant vessel-induced scour features. (Limited bathymetric survey coverage.)	Mixture of depositional and no change areas. (Limited bathymetric survey coverage.)	Vessel berthing.	RC1 changed to RC3 where there is no evidence for vessel scour and the dock configuration has changed since the RC1 area was designated.
			FNC	RC1 (RM 2.88 to RM 3.0) RC3 (rest of the area)	No significant vessel-induced scour features. (Limited bathymetric survey coverage.)	Mixture of depositional and no change areas.	FNC vessel transiting.	No changes to RCs.

Notes:
1. The term "significant" is used in the analysis to denote areas where natural recovery is presumed to be limited (consistent with the definition of Recovery Category 1) due to ongoing mixing from vessel scour.
2. The listed waterway usage may apply to only a portion of the evaluation area.
FNC: Federal Navigation Channel
RC: recovery category
RM: river mile

C.3.1 Evaluation Area 2, RM 1.6 to RM 1.84: Slip 2

Evaluation Area 2 includes the eastern shoreline north of Slip 2 and Slip 2. The area was designated in the FS as a mixture of Recovery Categories 1 and 3, depending on the location (Map C-4).

Based on new information, Recovery Category 1 is recommended to be extended into Slip 2 to include portions of the northern berthing area. The sun-illumination map showed vessel scour tracks between several inches and 1 ft in depth (criterion 1) associated with the berthing area on the north side of Slip 2. Similarly, bed deepening in the transit lane on the western portion of the berth area was evident from the isopach map (supplemental line of evidence A).

In addition, two intertidal areas on either side of the mouth of Slip 2 are recommended to be changed from Recovery Category 1 to Recovery Category 3. Both locations lack evidence of vessel scour (criterion 1) based on the sun-illumination map or visual observation (see QAPP Appendix D, Table D-7), and both are located behind mooring piles/dolphins in shallow water, which restricts vessel access (supplemental line of evidence B). Consistent with Table 28, note c, in the ROD, the change to Recovery Category 3 is limited to areas above -4 ft MLLW, which are not susceptible to significant vessel scour. The northern area is at RM 1.7 on the northern corner of the mouth of Slip 2, and the southern area is at RM 1.8 on the southern corner of the mouth of Slip 2.

C.3.2 Evaluation Area 3, RM 1.79 to RM 1.95W

Evaluation Area 3 includes the western portion of the LDW (Map C-5). The southern tip of the Recovery Category 1 area is recommended to be changed from Recovery Category 1 to Recovery Category 3 where there is no evidence of vessel scour (criterion 1) and limited vessel access, because the area is intertidal and located behind a mooring dolphin (supplemental line of evidence B). Consistent with Table 28, note c, in the ROD, the change to Recovery Category 3 is limited to areas above -4 ft MLLW, which are not susceptible to significant vessel scour.

C.3.3 Evaluation Area 4, RM 1.95 to RM 2.12: 1st Avenue S Bridge

Evaluation Area 4 includes the FNC under and directly to the north and south of the 1st Avenue S bridge, extending slightly to the east (outside of the FNC) south of the bridge (Map C-6). The isopach map (supplemental line of evidence A) shows deeper bed elevations in the area in 2021 than in 2003, likely the result of flows accelerated by channel restrictions caused by the bridge structure. Structures were not accounted for in the STM, and thus hydrodynamic scour around the bridge was not predicted in model output. Sun-illumination maps indicated some vessel disturbance; however, the depths of the ridges were less than 6 in. away from the FNC towards Slip 3. It is recommended that the portions of the bed disturbance areas that show net erosion and significant vessel disturbance be changed to Recovery Category 1.

Evaluation Area 4 also includes a berth just southwest of the 1st Avenue S bridge. The features captured in the map are likely indicative of vessel impacts; however, the ridges represent changes in bed elevation of less than 6 in.

C.3.4 Evaluation Area 7, RM 2.31 to RM 2.55E

Evaluation Area 7 includes the eastern portion of the LDW from RM 2.31 to 2.55 (Map C-7). The intertidal shoreline in this area is recommended to be changed from Recovery Category 1 to Recovery Category 3, because there is no evidence of vessel scour (criterion 1) and vessel access is restricted because the area is intertidal and located behind a row of mooring dolphins (supplemental line of evidence B). Within the inlet at RM 2.35E, the area is also shallowing (supplemental line of evidence A). Consistent with Table 28, note c, in the ROD, the change to Recovery Category 3 is limited to areas above -4 ft MLLW, which are not susceptible to significant vessel scour. While the isopach analysis indicates deepening along the eastern shoreline between the two wharves, this slope is heavily armored with rock and concrete. As previously stated, any comparison of surveys on slopes with this substrate is of limited accuracy, particularly in shallow water depths. The indicated deepening in this case is an artifact of limitations of the isopach evaluation.

C.3.5 Evaluation Area 8, RM 2.55 to RM 2.85E

Evaluation Area 8 includes the eastern portion of the LDW from RM 2.55 to RM 2.85 including the area of the main channel at the mouth of Slip 4 (Map C-8).

The eastern subtidal portion of this area show evidence of disturbance on the sun-illumination map (criterion 1). Additionally, the isopach map (supplemental line of evidence A) shows deeper bed elevations in the area along the lower slope to the east of the FNC in 2021 than in 2003. Changes in the steepness of the slope in this area may be due to increased or deflected river flows resulting from large moored barges on the west side of the channel, or propwash from transiting vessel traffic that needs to maneuver to the east side of the channel due to the moored barges that extend into the FNC (supplemental line of evidence B). It is recommended that this area be changed to Recovery Category 1.

In addition, Recovery Category 1 is recommended to be changed to Recovery Category 2 in a small intertidal area on the north shoreline of Slip 4 connecting to the main waterway at RM 2.8. This location lacks evidence of vessel scour on the sun-illumination map (criterion 1) and is located behind a dock in shallow water, which restricts large vessel access (supplemental line of evidence B).

C.3.6 Evaluation Area 10, RM 2.85 to RM 3.0W

Evaluation Area 10 includes the western portion of the LDW from RM 2.85 to RM 3.0 (Map C-9). A portion of the Recovery Category 1 area from RM 2.93 to RM 2.96 is recommended to be modified to Recovery Category 3. The initial Recovery Category 1 designation of this area resulted from a fixed dock that has since been removed and will not be replaced (supplemental line of evidence B). In addition, the sun-illumination map did not show any evidence of vessel scour in this area (criterion 1). Additionally, the isopach map (supplemental line of evidence A) showed shallowing or no change to bed elevations in the area between 2003 and 2021.

C.3.7 Summary and Next Steps

In summary, criterion 1 and two supplemental lines of evidence have been reviewed and engineering judgment has been applied to recommend nine modifications to the recovery category areas, as summarized in Map C-7. Table C-2 summarizes the acreage changes to the recovery category areas.

Table C-2
Recovery Category Area Acreages in the Middle Reach from ROD and Recommended Changes

Recovery Category Areas	Acreages from ROD Figure 17	Acreages After Recommended Modifications
1	18.3	22.6
2	18.7	17.9
3	66.8	62.5

Notes:
EAA: early action area
ROD: Record of Decision

In consultation with EPA, recovery category designations will be used in implementing the ROD remedy by determining the appropriate RALs and remedial technologies for areas of the site. These changes have been applied to the sampling described in the PDI Work Plan to which this document is an attachment. These changes are also reflected in the PDI QAPP.

As noted in the introduction, additional modifications to the recovery category areas within the middle reach may be identified in the PDI Phase I and II data evaluation reports, based on bathymetric survey data to be collected in data gap areas during Phase I PDI, as well as PDI chemistry data (criterion 4). Bathymetry data gaps will be filled during the Phase I PDI unless the survey can be conducted sooner without disrupting operations. The results of the completed bathymetry survey will be used, consistent with the approach presented in this attachment, to further evaluate recovery categories prior to the selection of Tier 2 analyses.

C.4 References

AECOM. 2012. Final feasibility study, Lower Duwamish Waterway. Prepared for Lower Duwamish Waterway Group. AECOM, Seattle, WA.

Anchor QEA, Windward. 2022. Remedial design work plan for the Lower Duwamish Waterway - Middle Reach. Draft. Anchor QEA LLC and Windward Environmental LLC, Seattle, WA.

EPA. 2014. Record of Decision, Lower Duwamish Waterway Superfund Site. Part 3. Responsiveness summary. US Environmental Protection Agency, Region 10, Seattle, WA.

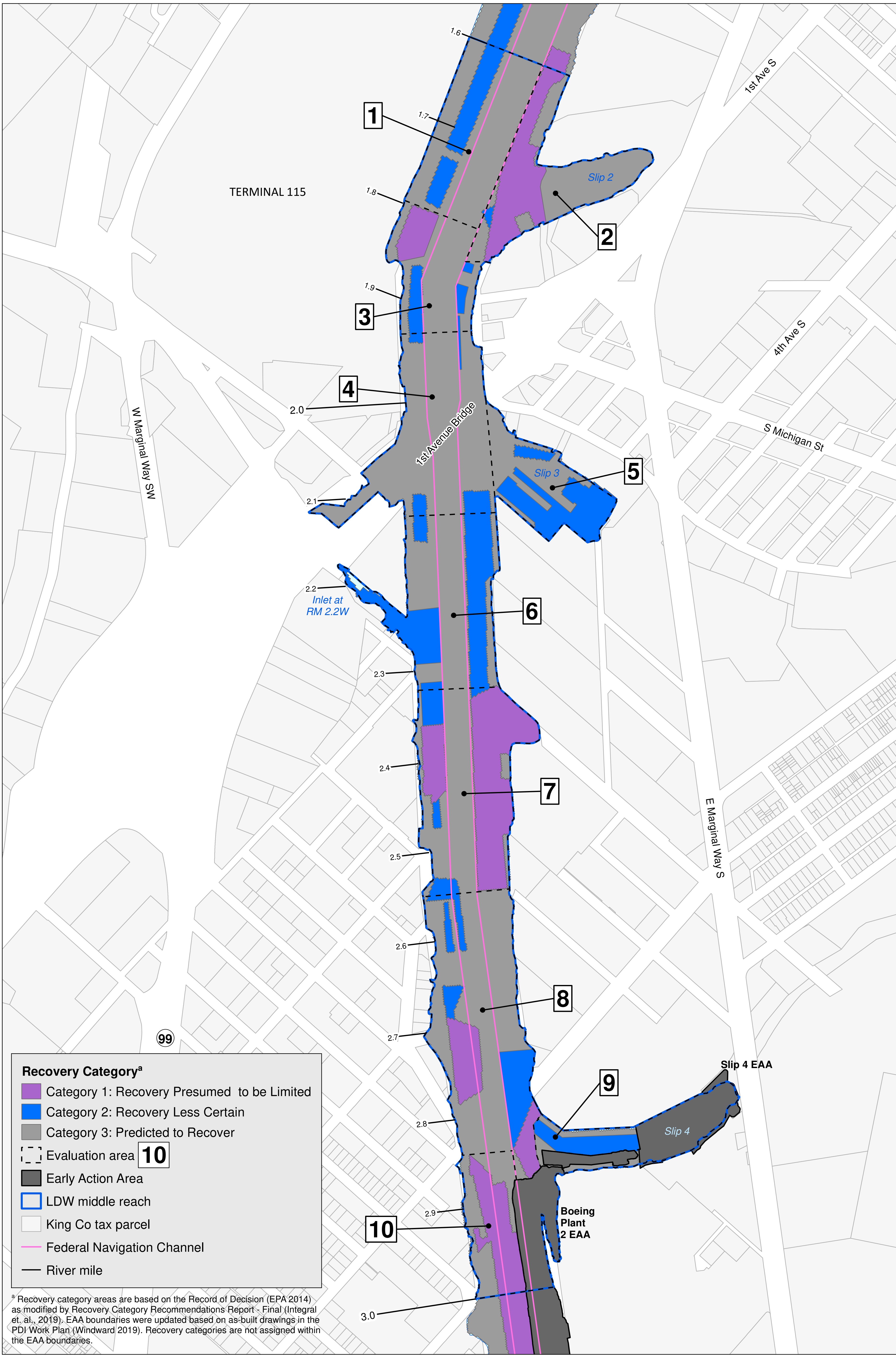
Integral, Anchor QEA, Windward. 2019. Recovery category recommendations report. Final. Integral Consulting Inc., Anchor QEA, and Windward Environmental LLC, Seattle, WA.

Integral, Moffat & Nichol, Windward. 2018. Waterway user survey and assessment of in-water structures - data report. Integral Consulting Inc., Moffan & Nichol, and Windward Environmental LLC, Seattle, WA.

USACE. 2002. Dredging summary and analysis report, Duwamish Waterway maintenance dredging, January-February 2002. US Army Corps of Engineers. Seattle District, Seattle, WA.

USACE. 2013. Engineering and design. Hydrographic surveying. EM 1110-2-1003. US Arny Corps of Engineers.

Windward, Anchor QEA. 2020. Lower Duwamish Waterway quality assurance project plan for remedial design of Upper Reach: pre-design investigation. Final. Submitted to EPA May 19, 2020. Windward Environmental LLC and Anchor QEA, Seattle, WA.



[a] Recovery category areas are based on the Record of Decision (EPA 2014) as modified by Recovery Category Recommendations Report - Final (Integral et. al., 2019). EAA boundaries were updated based on as-built drawings in the PDI Work Plan (Windward 2019). Recovery categories are not assigned within the EAA boundaries.

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0 500 1,000 Feet
0 100 200 Meters

Map C-1. Middle reach recovery category designations prior to 2021 bathymetric survey, including evaluation areas

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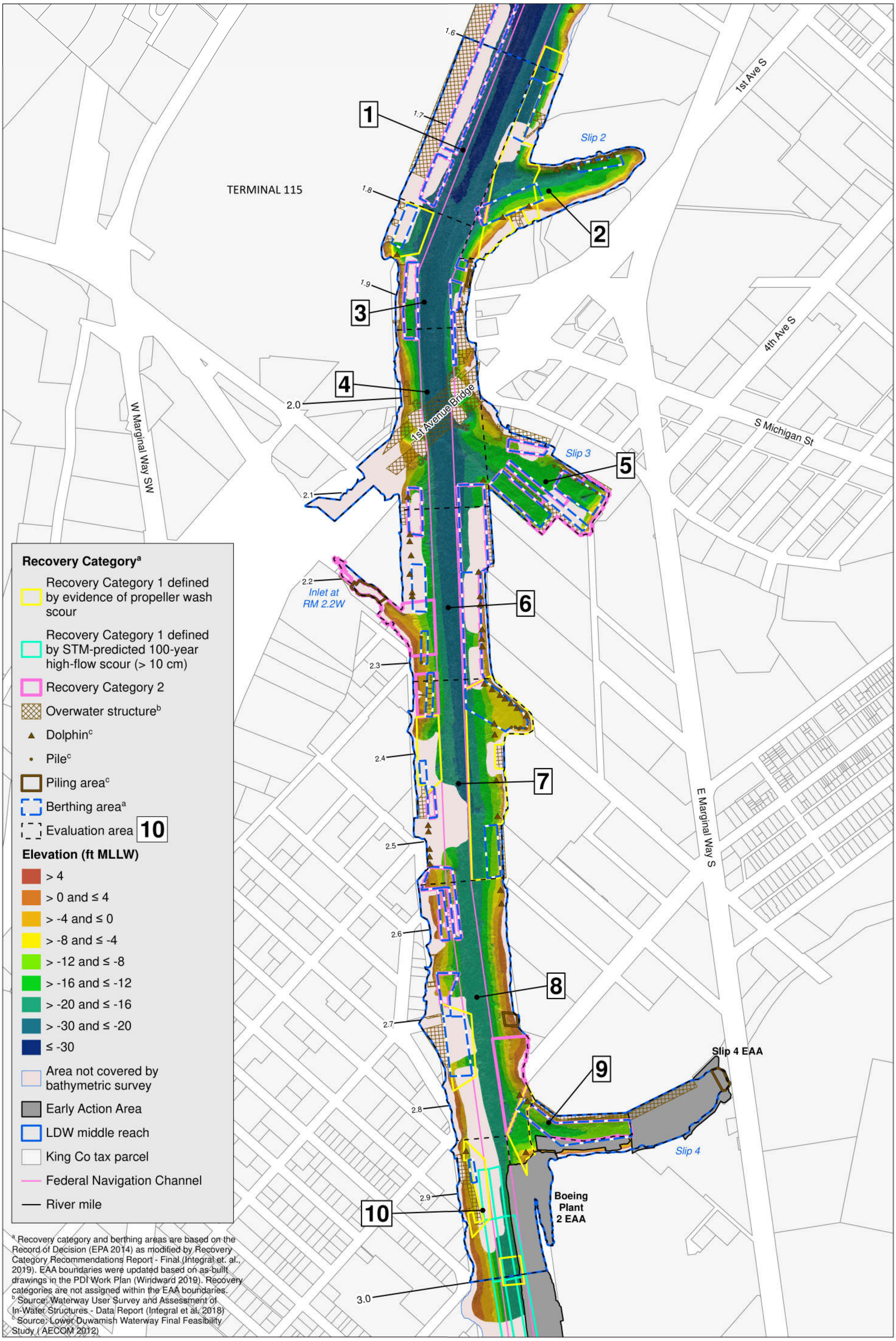

[a] Recovery category and berthing areas are based on the Record of Decision (EPA 2014) as modified by Recovery Category Recommendations Report - Final (Integral et. al., 2019). EAA boundaries were updated based on as-built drawings in the PDI Work Plan (Windward 2019). Recovery categories are not assigned within the EAA boundaries.
[b] Source: Waterway User Survey and Assessment of In-Water Structures - Data Report (Integral et al. 2018)
[c] Source: Lower Duwamish Waterway Final Feasibility Study (AECOM 2012)

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map C-2 7078 Bathy sun illumination.mxd

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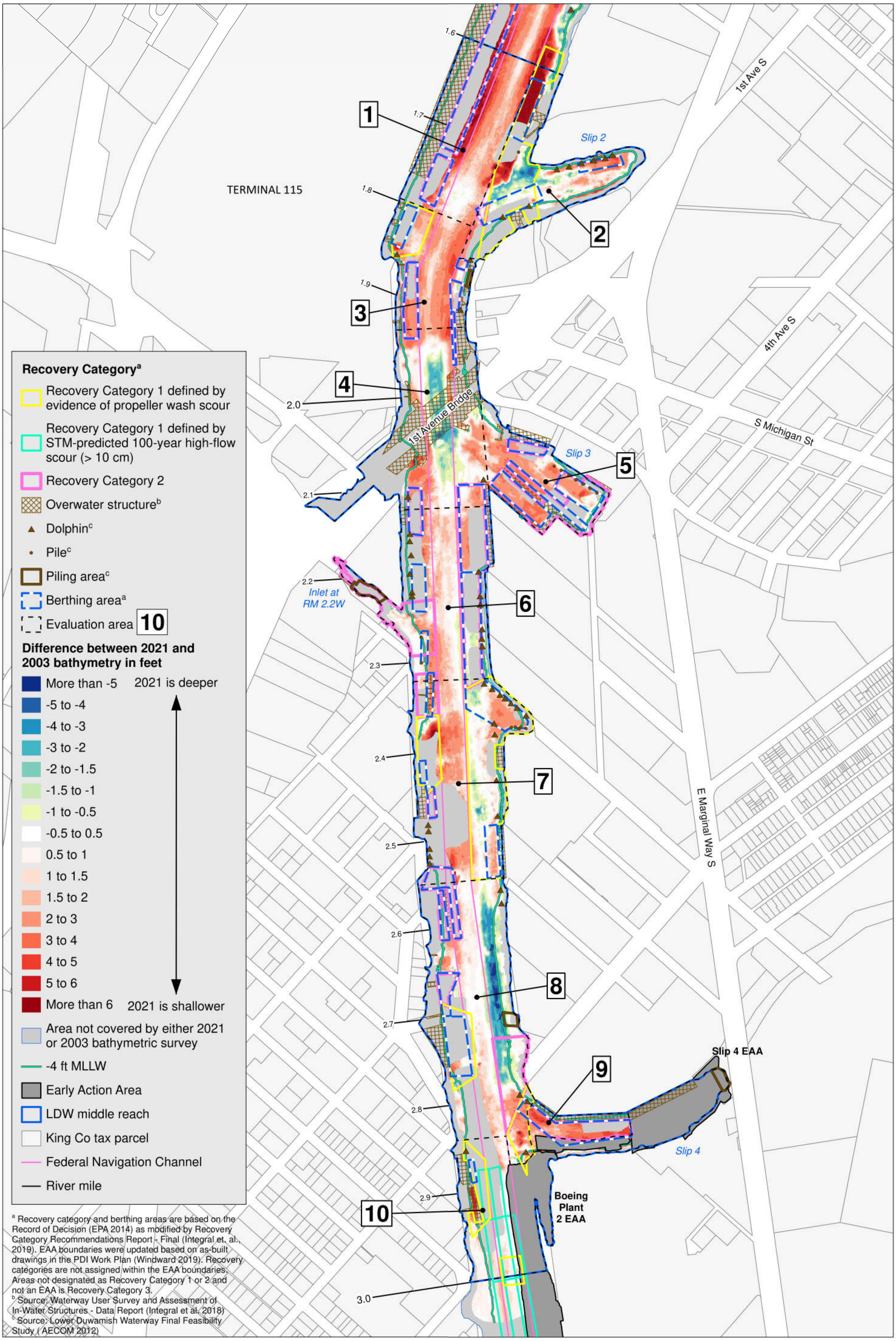
Map C-2. Sun-illuminated 2021 bathymetry in the middle reach



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Map C-3. Difference between 2003 and 2021 bathymetry in the middle reach

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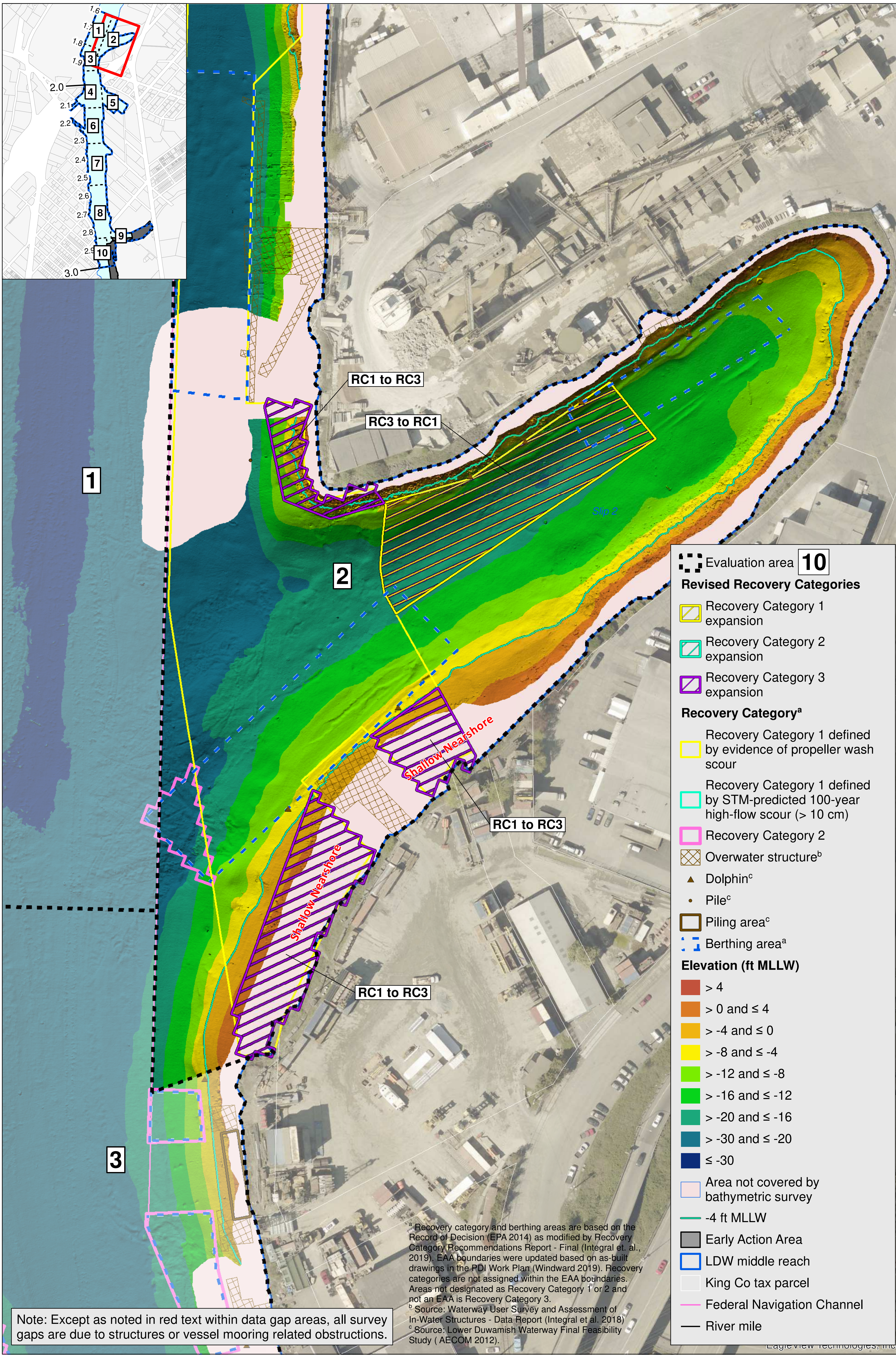

[a] Recovery category and berthing areas are based on the Record of Decision (EPA 2014) as modified by Recovery Category Recommendations Report - Final (Integral et. al., 2019). EAA boundaries were updated based on as-built drawings in the PDI Work Plan (Windward 2019). Recovery categories are not assigned within the EAA boundaries. Areas not designated as Recovery Category 1 or 2 and not an EAA is Recovery Category 3.
[b] Source: Waterway User Survey and Assessment of In-Water Structures - Data Report (Integral et al. 2018)
[c] Source: Lower Duwamish Waterway Final Feasibility Study (AECOM 2012).

Map C-4. Potential recovery category modifications, Evaluation Area 2

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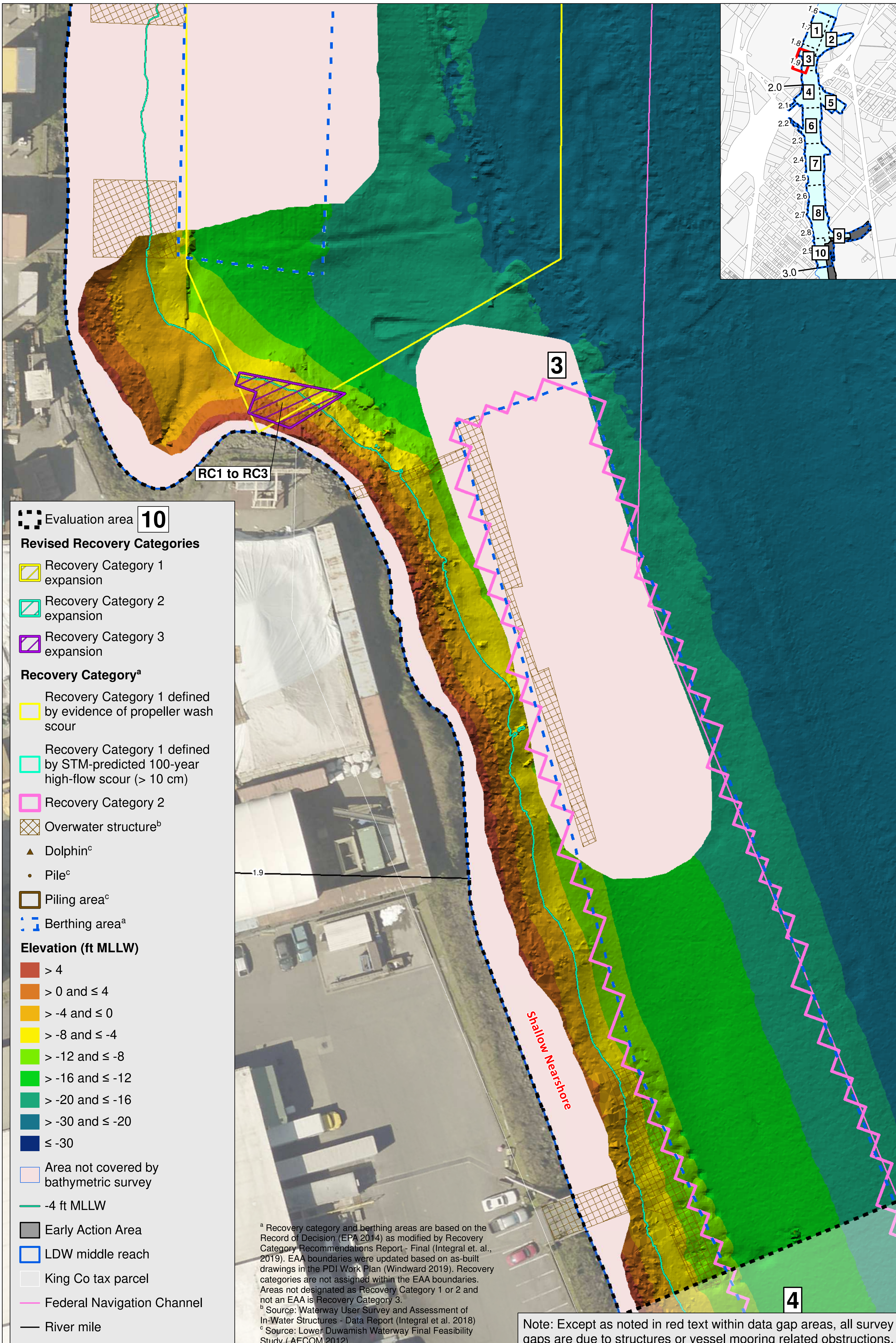

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Map C-5. Potential recovery category modifications, Evaluation Area 3

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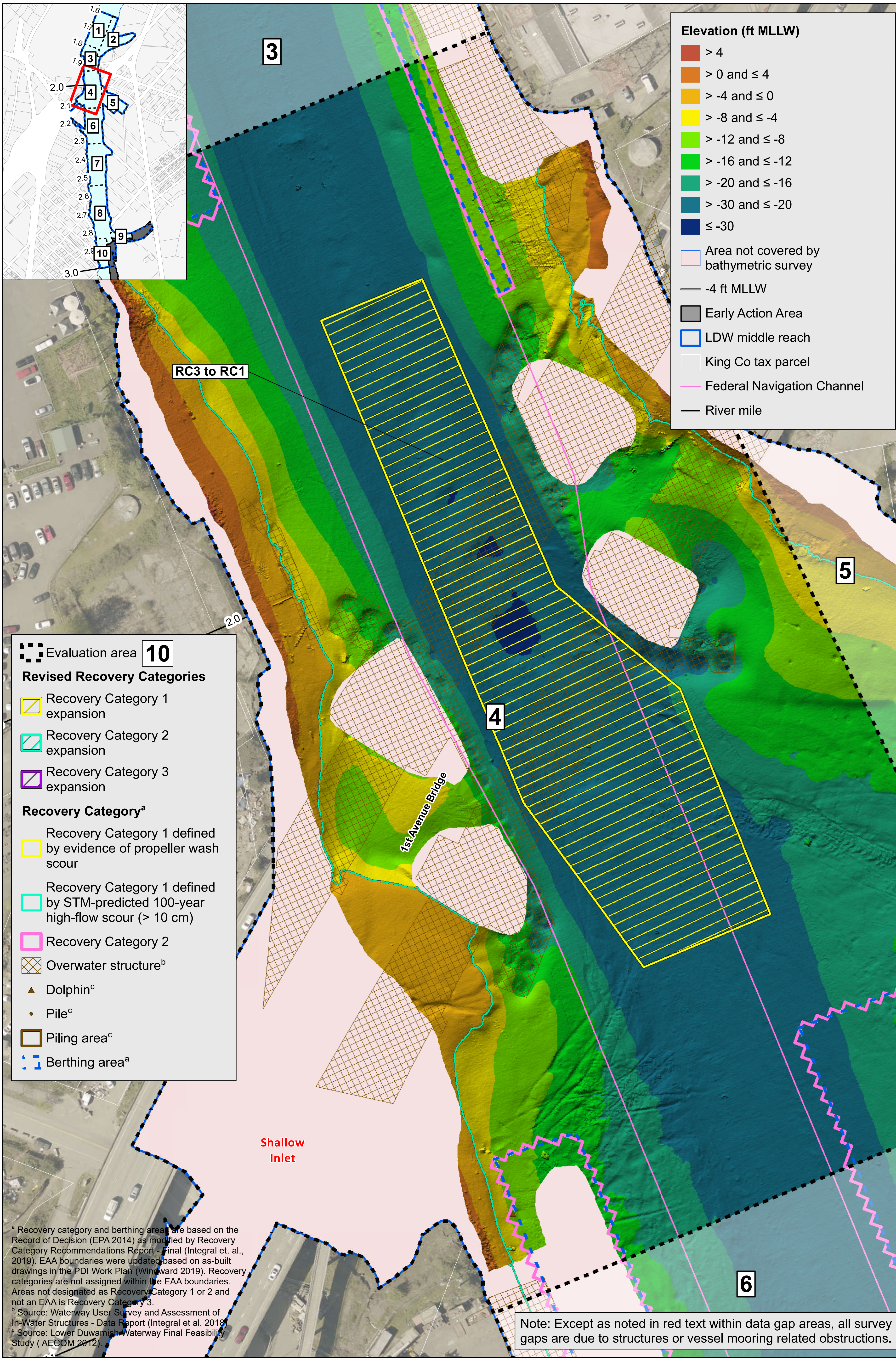

[a] Recovery category and berthing areas are based on the Record of Decision (EPA 2014) as modified by Recovery Category Recommendations Report - Final (Integral et. al., 2019). EAA boundaries were updated based on as-built drawings in the PDI Work Plan (Windward 2019). Recovery categories are not assigned within the EAA boundaries. Areas not designated as Recovery Category 1 or 2 and not an EAA is Recovery Category 3.
[b] Source: Waterway User Survey and Assessment of In-Water Structures - Data Report (Integral et al. 2018)
[c] Source: Lower Duwamish Waterway Final Feasibility Study (AECOM 2012)

0 80 160 Feet
0 20 40 Meters

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Map C-6. Potential recovery category modifications, Evaluation Area 4

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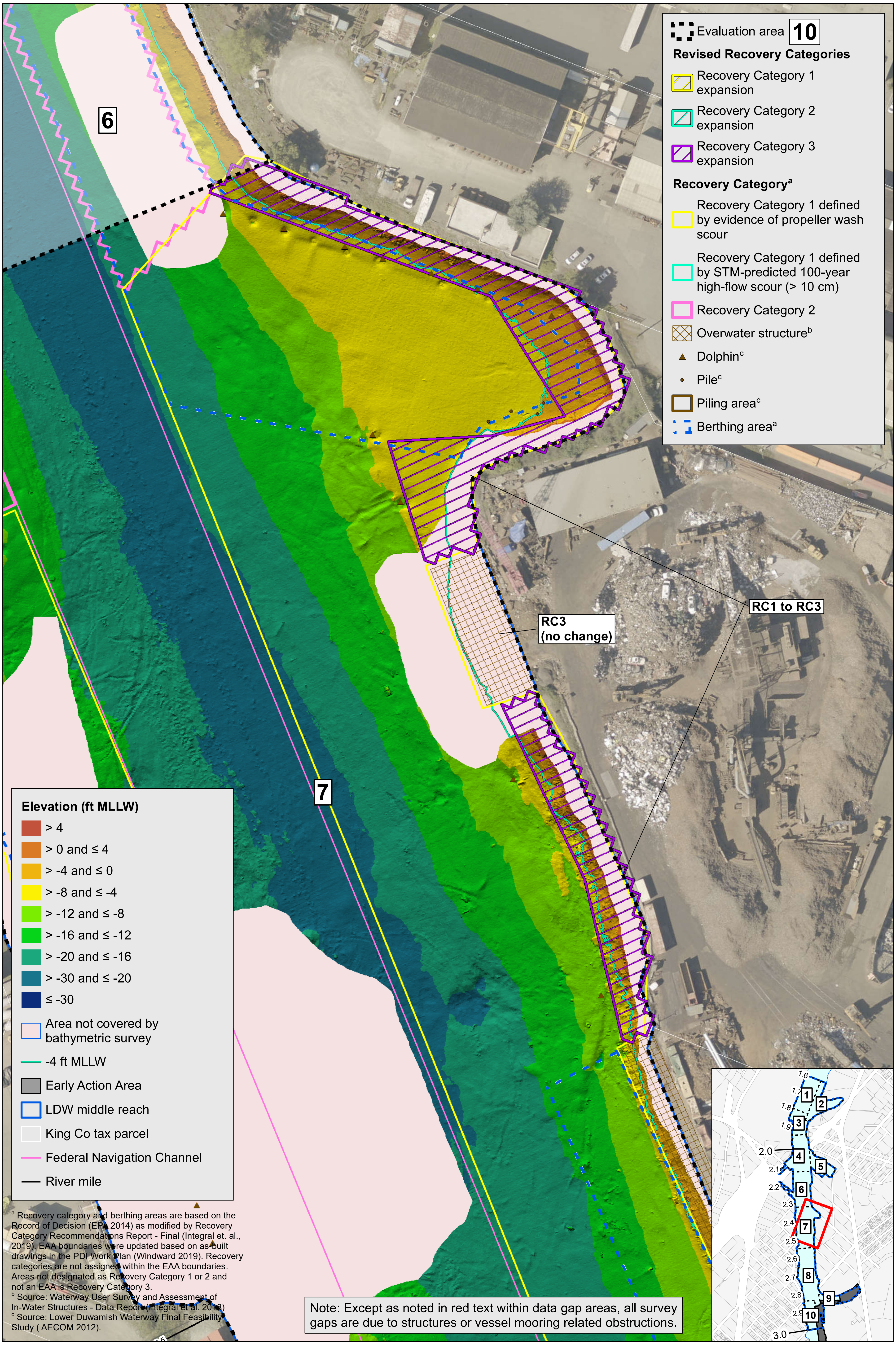

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Map C-7. Potential recovery category modifications, Evaluation Area 7

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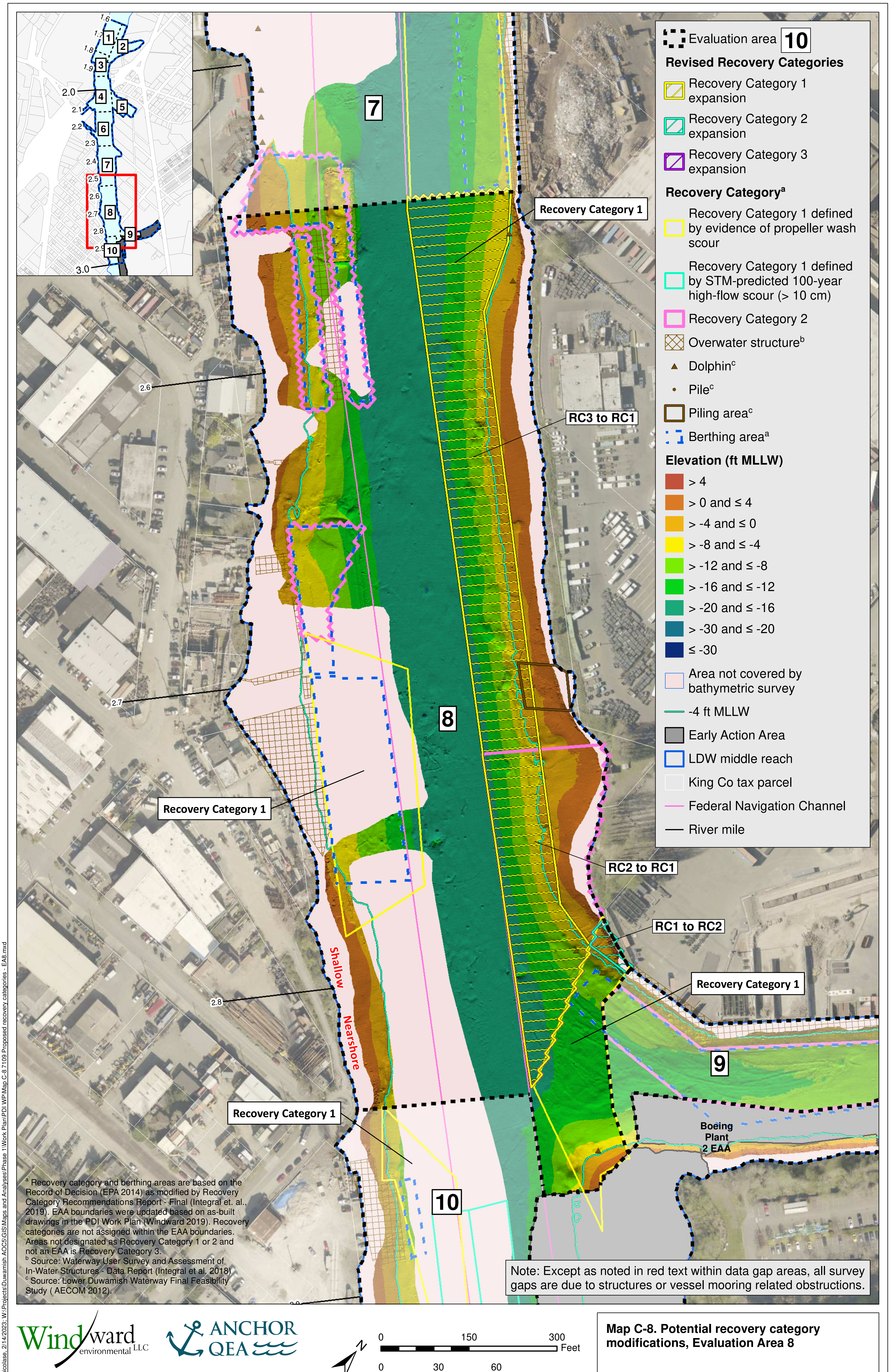

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Map C-8. Potential recovery category modifications, Evaluation Area 8

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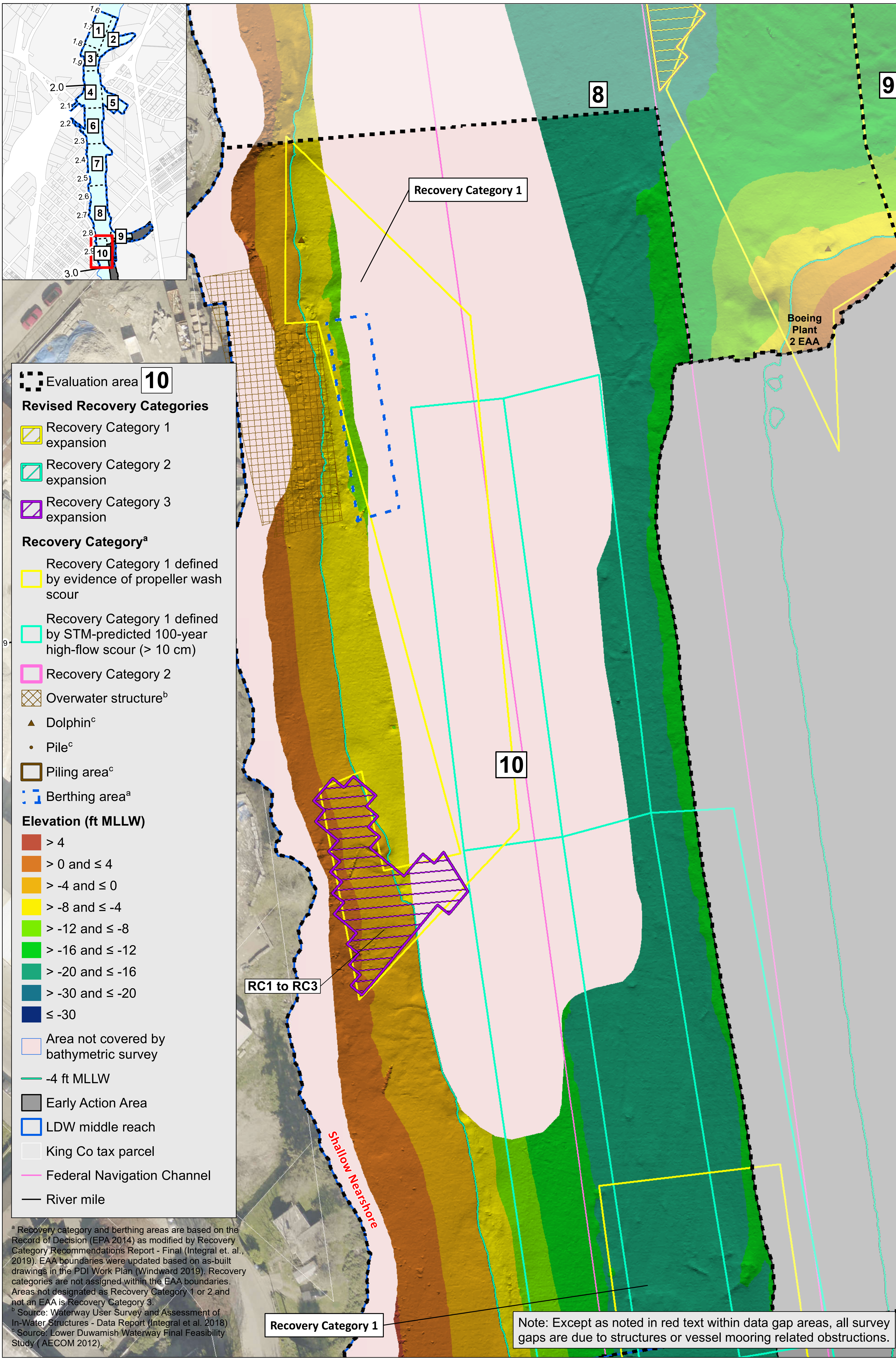

[a] Recovery category and berthing areas are based on the Record of Decision (EPA 2014) as modified by Recovery Category Recommendations Report - Final (Integral et. al., 2019). EAA boundaries were updated based on as-built drawings in the PDI Work Plan (Windward 2019). Recovery categories are not assigned within the EAA boundaries. Areas not designated as Recovery Category 1 or 2 and not an EAA is Recovery Category 3.
[b] Source: Waterway User Survey and Assessment of In-Water Structures - Data Report (Integral et al. 2018)
[c] Source: Lower Duwamish Waterway Final Feasibility Study (AECOM 2012).

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Map C-9. Potential recovery category modifications, Evaluation Area 10

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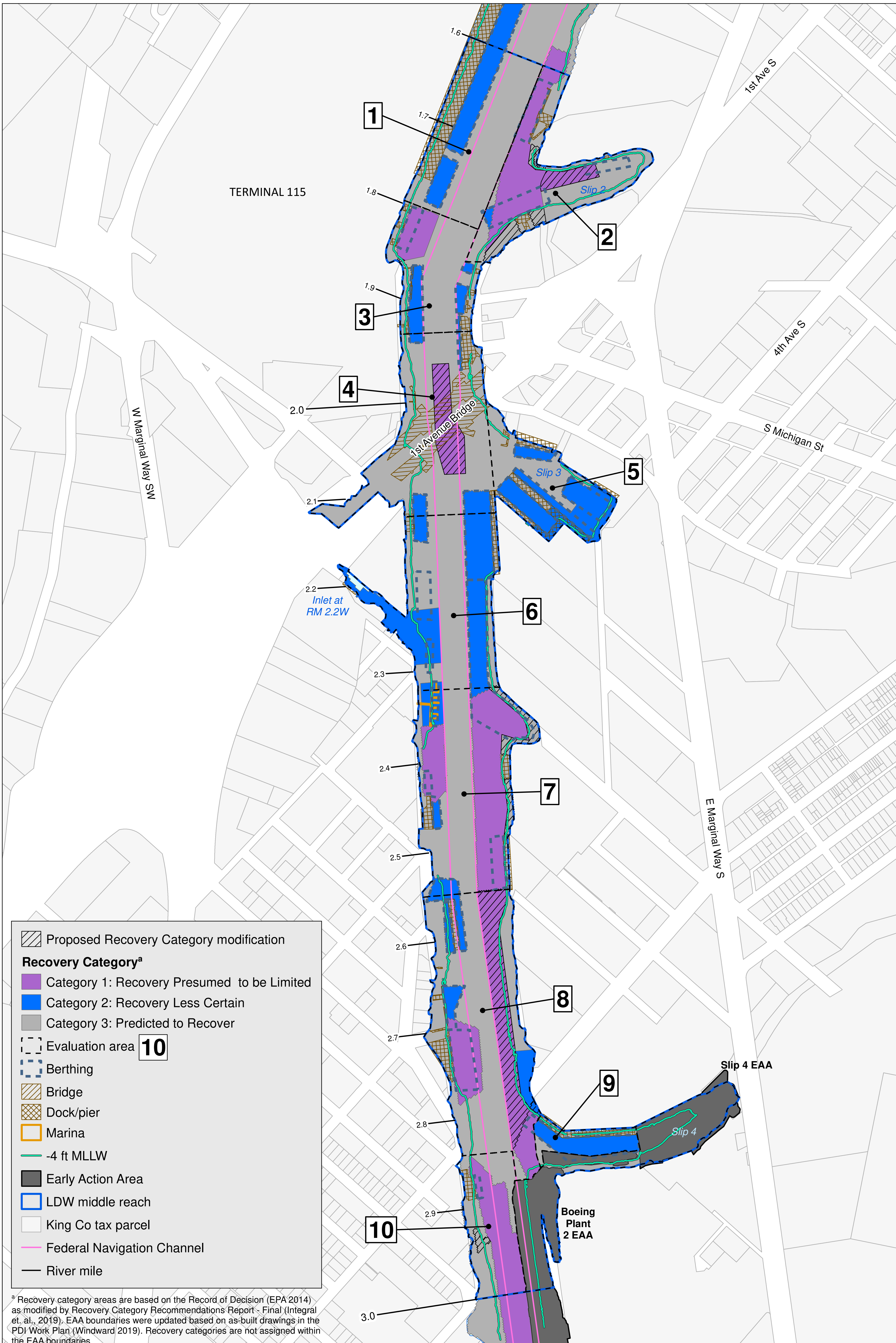

[a] Recovery category areas are based on the Record of Decision (EPA 2014) as modified by Recovery Category Recommendations Report - Final (Integral et. al., 2019). EAA boundaries were updated based on as-built drawings in the PDI Work Plan (Windward 2019). Recovery categories are not assigned within the EAA boundaries.

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Map C-10. Proposed recovery category modifications for the middle reach

FINAL

Attachment D

Data Management Rules

This attachment presents data management rules for the Lower Duwamish Waterway (LDW) database and the middle reach design dataset (including trumping rules).

D.1 Data Management Rules for the LDW Database

The data management rules for the middle reach data compilation for the LDW database are described in this section. The rules are consistent with those used in the development of the upper reach data compilation in 2019 (Anchor QEA and Windward 2019) and Pre-Design Studies data compilation conducted in 2018 for the LDW (Windward and Integral 2018).

D.1.1 Organic Carbon Normalization

Many of the sediment remedial action levels (RALs)—such as those for polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and phthalates—are total organic carbon (TOC)-normalized values. The Record of Decision (ROD) does not provide direction regarding the TOC range that is appropriate for TOC normalization (EPA 2014). Thus, the range for TOC normalization was from 0.5 to 3.5%, based on the Washington State Department of Ecology's (Ecology's) Sediment Cleanup User's Manual (Ecology 2021). Concentrations in samples with TOC values outside of this range were compared to dry weight equivalent values, which are the lowest apparent effects threshold values listed in Table 8-1 of Ecology's Sediment Cleanup User's Manual.

D.1.2 Averaging Laboratory Duplicate or Replicate Samples

Contaminant concentrations obtained from the analysis of laboratory duplicates or replicates (i.e., two or more analyses of the same sample) were averaged for a closer representation of the "true" concentration than that provided by the results of a single analysis. Averaging rules were dependent on whether the individual results were detected concentrations or reporting limits (RLs) for non-detected analytes. If all concentrations were detected for a given parameter, the values were simply averaged arithmetically. If all concentrations were non-detected for a given parameter, the minimum RL was reported. If the concentrations were a mixture of detected concentrations and RLs, any two or more detected concentrations were averaged arithmetically, and RLs were ignored. If there was one detected concentration and one or more RLs, the detected concentration was reported. The latter two rules were applied regardless of whether the RLs were greater or less than the detected concentration.

D.1.3 Selection of Preferred Results

In some instances, the laboratory generated more than one result for a chemical for a given sample. Multiple results occurred for several reasons, including:

- The original result did not meet the laboratory's internal quality control guidelines, and a reanalysis was performed.

- The original result did not meet other project data quality objectives, such as a sufficiently low RL, and a reanalysis was performed.
- Two different analytical methods were used for that chemical.

In each case, a single result was selected for use. The procedures for selecting the preferred result differed depending on whether a single or multiple analytical methods had been used for that chemical.

For the same analytical method, the results were selected using the following guidance:

- If the results were detected and not qualified, then the result from the lowest dilution was selected, unless multiple results from the same dilution were available, in which case the result with the highest concentration was selected.
- If the results were a combination of estimated and unqualified detected results, then the unqualified result was selected. This situation most commonly occurred when the original result was outside of the calibration range, thus requiring a dilution. The diluted result within the calibration range was preferentially selected.
- If the results were all estimated, then the result was selected using best professional judgment and considering the rationale for qualification. For example, a result qualified based on laboratory replicate results outside of quality control objectives for precision was preferred to a qualified result that was outside the calibration range.
- If the results were a combination of detected and non-detected results, then the detected result was selected. If there was more than one detected result, the applicable rules for multiple results (discussed above) were followed.
- If the results were all non-detected, then the lowest RL was selected.

For different analytical methods (i.e., when a specific chemical was analyzed in the same sample using different methods), the following rules were applied:

- For results analyzed using the semivolatile organic compound (SVOC) full-scan (US Environmental Protection Agency [EPA] 8270) and selected ion monitoring (SIM) (EPA 8270-SIM) methods, the SIM results were selected.
- For results analyzed using EPA Method 8081A and any 8270 method (i.e., hexachlorobenzene and hexachlorocyclopentadiene), the 8081A results were selected.
- For results analyzed using the SVOC EPA 8270 and volatile organic compound (EPA 8260) methods, the 8260 results were selected.

D.1.4 Significant Figures and Rounding

The analytical laboratories reported results with various numbers of significant figures depending on the instrument, parameter, and concentration relative to the RL. The reported (or assessed) precision of each observation was explicitly stored in the project database as a record of the number of significant figures assigned by the laboratory. The tracking of significant figures became important when calculating averages and performing other data summaries.

When a calculation involved addition, such as totaling PCBs or PAHs, the calculation was only as precise as the least precise number that went into the calculation. For example (assuming two significant figures):

> 210 + 19 = 229 was reported as 230 because 19 was only reported to 2 significant digits, and the enhanced precision of the trailing 0 in the number 210 was not significant.

When a calculation involved multiplication or division, such as carbon normalization, the original figures for each value were carried through the calculation (i.e., individual values were not adjusted to a standard number of significant figures; instead, the appropriate adjustment was made to the resultant value at the end of the calculation). The result was rounded at the end of the calculation to reflect the value with the fewest significant figures used in the calculation. For example:

> 59.9 x 1.2 = 71.88 was reported as 72 because there were 2 significant figures in the number 1.2.

When rounding, if the number following the last significant figure was less than 5, the digit was left unchanged. If the number following the last significant figure was equal to or greater than 5, the digit was increased by 1.

D.1.5 Calculating Totals

Total PCBs, total dichlorodiphenyltrichloroethanes (DDTs), total PAHs, total chlordane, total xylenes, and total nitrosamines were calculated by summing the detected values for the individual components. For samples in which none of the individual components were detected, the total value was given as the highest RL of any individual component and assigned a U-qualifier (no detected concentrations). No sum was calculated when 50% or less of the components were analyzed. Concentrations for analyte sums were calculated using the following components:

- Total PCBs were calculated, in accordance with the methods of the Washington State Sediment Management Standards (SMS), using only detected values for all Aroclor mixtures. For individual samples in which none of the Aroclor mixtures were detected, total PCBs were given a value equal to the highest RL of the Aroclors and assigned a U-qualifier (no detected concentrations). When PCBs were analyzed as 209 individual congeners, the same summing method was applied.
- Total low-molecular-weight polycyclic aromatic hydrocarbons (LPAHs), high-molecular-weight polycyclic aromatic hydrocarbons (HPAHs), PAHs, and benzofluoranthenes were also

calculated in accordance with the methods of the SMS. Total LPAHs were the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Total HPAHs were the sum of detected concentrations for fluoranthene, pyrene, benzo(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3,-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene. Total benzofluoranthenes were the sum of the b (i.e., benzo(b)fluoranthene), j, and k isomers.
Because the j isomer is rarely quantified, the total benzofluoranthenes sum was typically calculated using only the b and k isomers. When the laboratory provided total benzofluoranthenes instead of or in addition to the b and k isomers, the laboratory result was reported, and no sum was calculated. For samples in which all individual compounds within any of the three groups described above were non-detected, the highest RL for that sample represented the sum.

- Total DDTs were calculated using only detected values for the DDT isomers: 2,4′-dichlorodiphenyldichloroethane (DDD); 4,4′-DDD; 2,4′-dichlorodiphenyldichloroethylene (DDE); 4,4′-DDE; 2,4′-DDT; and 4,4′-DDT. For individual samples in which none of the isomers were detected, total DDTs were given a value equal to the highest RL among the six isomers and assigned a U-qualifier (no detected concentrations).
- Total chlordane was calculated using only detected values for the following compounds: alpha-chlordane, gamma-chlordane, oxychlordane, cis-nonachlor, and trans-nonachlor. For individual samples in which none of these compounds were detected, total chlordane was given a value equal to the highest RL among the five compounds listed and assigned a U-qualifier (no detected concentrations).
- Total xylene was calculated using only detected values for m,p-xylene and o-xylene. For individual samples in which neither of these compounds were detected, total xylene was given a value equal to the higher RL of the two compounds listed and assigned a U-qualifier (no detected concentrations).

D.1.6 Calculation of PCB Congener Toxic Equivalents

PCB congener toxic equivalents (TEQs) were calculated using the World Health Organization (WHO) consensus toxic equivalency factor (TEF) values for mammals (Van den Berg et al. 1998; Van den Berg et al. 2006), as presented in Table D-1. The TEQ was calculated as the sum of each PCB congener concentration multiplied by the corresponding TEF value. When the PCB congener concentration was reported as non-detected, then the TEF was multiplied by one-half the RL.

Table D-1
PCB Congener TEF Values

PCB Congener No.	TEF Value for Mammals (unitless)[1]
77	0.0001
81	0.0003
105	0.00003
114	0.00003
118	0.00003
123	0.00003
126	0.1
156	0.00003
157	0.00003
167	0.00003
169	0.03
189	0.00003

Notes:
[1] From Van den Berg et al. (2006).
PCB: polychlorinated biphenyl
TEF: toxic equivalency factor

D.1.7 Calculation of Dioxin/furan Congener TEQs

Dioxin/furan congener TEQs were calculated using the WHO consensus TEF values for mammals (Van den Berg et al. 1998; Van den Berg et al. 2006), as presented in Table D-2. The TEQ was calculated as the sum of each dioxin/furan congener concentration multiplied by the corresponding TEF value. When the dioxin/furan congener concentration was reported as non-detected, then the TEF was multiplied by one-half the RL.

Table D-2
Dioxin/furan Congener TEF Values

Dioxin/Furan Congener	TEF Value for Mammals (unitless)[1]
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,6,7,8-HpCDD	0.01
1,2,3,4,7,8,9-HpCDF	0.01
1,2,3,4,7,8-HxCDF	0.1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDD	0.1

Dioxin/Furan Congener	TEF Value for Mammals (unitless)[1]
1,2,3,7,8,9-HxCDF	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,7,8-PeCDF	0.03
1,2,3,7,8-PeCDD	1
2,3,4,6,7,8-HxCDF	0.1
2,3,4,7,8-PeCDF	0.3
2,3,7,8-TCDF	0.1
2,3,7,8-TCDD	1
OCDF	0.0003
OCDD	0.0003

Notes:
[1] From Van den Berg et al. (2006).
HpCDD: heptachlorodibenzo-*p*-dioxin
HpCDF: heptachlorodibenzofuran
HxCDD: hexachlorodibenzo-*p*-dioxin
HxCDF: hexachlorodibenzofuran
OCDD: octachlorodibenzo-*p*-dioxin
OCDF: octachlorodibenzofuran
PeCDD: pentachlorodibenzo-*p*-dioxin
PeCDF: pentachlorodibenzofuran
TCDD: tetrachlorodibenzo-*p*-dioxin
TCDF: tetrachlorodibenzofuran
TEF: toxic equivalency factor

D.1.8 Calculation of Carcinogenic Polycyclic Aromatic Hydrocarbons

cPAH values were calculated using potency equivalency factor (PEF) values (California EPA 2009) based on the individual PAH component's toxicity relative to the toxicity of benzo(a)pyrene. PEF values are presented in Table D-3. The cPAH TEQ was calculated as the sum of each individual PAH concentration multiplied by the corresponding PEF value. When the individual PAH component concentration was reported as non-detected, then the PEF was multiplied by one-half the RL.

Table D-3
cPAH PEF Values

cPAH	PEF Value (unitless)[1]
Benzo(a)pyrene	1
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.1
Chrysene	0.01

cPAH	PEF Value (unitless)[1]
Dibenz(a,h)anthracene	0.4[2]
Indeno(1,2,3-cd)pyrene	0.1

Notes:
1. PEFs for cPAHs are defined by California EPA (2009) by dividing the inhalation unit risk factor for the compound by the inhalation unit risk factor for benzo[a]pyrene.
2. The PEF value for dibenz(a,h)anthracene is based on the inhalation unit risk factors provided by California EPA (1994). This PEF was used in the LDW Remedial Investigation (Windward 2010).
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: US Environmental Protection Agency
LDW: Lower Duwamish Waterway
PEF: potency equivalency factor

D.2 Data Management Rules for Design Datasets

The LDW database includes all data that have been compiled for the LDW. A subset of these data has been selected to be used in the design; this dataset is referred to as the design dataset. There is a design dataset for each LDW reach. The design dataset includes sediment data that are used in geostatistical models to delineate areas with RAL exceedances, as well as data used to establish the depth of contamination. This dataset will be expanded throughout the design process as PDI and other sediment data become available. The data in the LDW database that are not included in the design dataset are referred to as supplemental data. The supplemental data are used to inform the sampling design and the remedial design but not to delineate areas with RAL exceedances.

A design dataset has been constructed for the middle reach following the same data management rules used to develop the design dataset for the upper reach, as described in Appendix D of the Phase II Pre-Design Investigation (PDI) Quality Assurance Project Plan (QAPP) Addendum (Windward and Anchor QEA 2021). The middle reach design dataset includes surface sediment collected from 2011 to the present (post-FS data) and subsurface data collected from 1990 to the present (remedial investigation/feasibility study [RI/FS] and post-FS data), as discussed in Section 3.1 of the PDI Work Plan. The steps followed in creating the design dataset are as follows:

- Identify all samples that have been analyzed for chemicals with RALs.
- Exclude any samples that are:
  - Located within early action areas (EAAs)
  - Located within areas that have been dredged since the sample was collected
  - Collected as part of a monitoring program and superseded by newer data (e.g., data from monitoring year 1 are superseded by those from monitoring year 2)
  - Collected from a depth interval shallower than 5 cm (data that may be helpful for vertical extent are retained, even if they do not represent a RAL interval) (e.g., 0–2 cm)
  - Composite samples, as they do not provide location-specific information

For subtidal locations with multiple sample depths within the 0- to 60-cm RAL interval, the results were averaged to create a single concentration per contaminant representing the 0- to 60-cm interval (i.e., results from a 0- to 30-cm sample and a 30- to 60-cm sample were averaged to represent the 0- to 60-cm interval).

With respect to field duplicates, parent sample results were selected when both parent and field duplicate results were reported, except when a RAL exceedance occurred only in the field duplicate and not in the parent. In such a case, the field duplicate results were selected for all analytes.[1] This rule applied to all field duplicate samples, including those from duplicate cores reported with coordinates slightly different from the parent core.

For PCBs, both PCB Aroclor and congener sums were compared to the PCB RAL. When a sample was analyzed for both, the greater of the two sums was selected for the design dataset.

D.3 Summary of Trumping for the Design Dataset

The Fifth Amendment to the Administrative Order on Consent (AOC) specifies that the approach to be used to override existing data with new results shall be identified in the PDI work plan, including criteria for overriding subsurface data in limited cases, proximity requirements, and a process for evaluating discrepancies between existing and new data that will be identified for discussion and approval by EPA.

The rule that was used for re-occupied locations in the LDW RI and the upper reach design dataset was used to develop the initial middle reach design dataset. For surface sediment locations that have been re-occupied, more recent data (if collected within 10 ft)[2] are selected to represent current conditions. If an older sample includes data for contaminants not analyzed in the newer sample, the older chemistry is retained in the dataset. The purpose of this rule is to include the most current result available for the 0- to 10-cm interval for comparison to RALs, since surface sediments can change over time as new sediment is deposited.

The compilation of the middle reach design dataset included an evaluation of surface sediment locations that have been re-occupied. A complete summary of the re-occupied locations is in the Excel file that accompanies this attachment (Exhibit D-1). Table D-4 lists all samples and chemicals for which there was a RAL exceedance associated with either the older data or the more recent data at

[1] If a RAL exceedance were to occur for one or more chemicals in the parent sample, and a RAL exceedance were to occur for a different chemical (or chemicals) in the field duplicate, the parent sample results would be selected for all chemicals except those that had a RAL exceedance in the field duplicate.

[2] The 10-ft rule is consistent with inherent measurement error in the differential global positioning systems (GPSs) used in sampling surveys for the Phase I Pre-Design Investigation and past sampling efforts. The differential GPS used for Phase I surface sediment sampling has a measurement error of approximately 3–6 ft. Given the inherent measurement error, it is not possible to definitively distinguish different sampling locations within 10 ft of one another for samples collected after 2001. Prior to 2001, GPS technology was less accurate, so measurement errors may have been greater. If a re-occupied station location was more than 10 ft away from the old location, it was considered a separate sample location and the older data were retained.

re-occupied locations. Most of the locations are within Slip 4 and the Inlet at RM 2.2W. The data for re-occupied locations were discussed with EPA. All sample replacements were approved for use in the middle reach design dataset.

Table D-4
Summary of re-occupied locations with a RAL exceedance in either the older data or the more recent data

RM	Older Data				Recent Data		
	Sample Name	Sample Date	Chemical	RAL EF	Sample Name	Sample Date	RAL EF
2.2W - inlet	ICS-DSS-21-SE-070212	7/2/2012	PCBs	**6.6**	LDW18-SS-180	2/28/2018	**4.6**
2.2W - inlet	ICS-DSS-26-SE-070212	7/2/2012	Lead	**1.9**	ICS-DSS26-SE-091914	9/19/2014	0.74
2.2W - inlet	ICS-DSS-26-SE-070212	7/2/2012	Mercury	**1.0**	ICS-DSS26-SE-091914	9/19/2014	0.57
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Arsenic	**1.2**	STM-BS-3	5/10/2011	0.89
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Zinc	**1.1**	STM-BS-3	5/10/2011	**1.4**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Anthracene	0.44	STM-BS-3	5/10/2011	**1.8**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Benzo(a)anthracene	0.20	STM-BS-3	5/10/2011	**1.8**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Benzo(a)pyrene	0.34	STM-BS-3	5/10/2011	**1.9**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Benzo(g,h,i)perylene	**2.3**	STM-BS-3	5/10/2011	**7.5**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Total benzofluoranthenes	0.36	STM-BS-3	5/10/2011	**1.6**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Chrysene	0.34	STM-BS-3	5/10/2011	**2.3**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Dibenzo(a,h)anthracene	**1.2**	STM-BS-3	5/10/2011	**4.8**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Fluoranthene	0.26	STM-BS-3	5/10/2011	**3.8**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Indeno(1,2,3-cd)pyrene	**1.8**	STM-BS-3	5/10/2011	**6.3**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Phenanthrene	0.12	STM-BS-3	5/10/2011	**1.1**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Pyrene	0.21	STM-BS-3	5/10/2011	**2.1**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Total HPAHs	0.53	STM-BS-3	5/10/2011	**3.0**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	cPAH TEQ	0.33	STM-BS-3	5/10/2011	**1.7**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	Butyl benzyl phthalate	0.45	STM-BS-3	5/10/2011	**180**
2.2E - Slip 3	LDW-SS2025-A	4/15/2011	2,4-Dimethylphenol	0.64	STM-BS-3	5/10/2011	**5.7**
2.8E - Slip 4	SD0058	10/31/2012	PCBs	**1.6**	SD-PER510-0315	3/11/2015	**2.3**[1]
2.8E - Slip 4	SD0059	10/31/2012	PCBs	**2.5**	SD-PER513-0315	3/11/2015	**4.2**
2.8E - Slip 4	SSED-04	12/10/2014	PCBs	0.92	SD-PER511-0315	3/16/2015	**1.3**
2.8E - Slip 4	SD0062	10/31/2012	PCBs	**1.4**	SD-PER511-0315	3/16/2015	**1.3**
2.8E - Slip 4	SD0063	10/31/2012	PCBs	**2.0**	SD-PER511-0315	3/16/2015	**1.3**

Notes:

Bold indicates RAL EF >1.
1. PCBs were compared on an organic carbon-normalized basis in older data and on a dry weight basis in the more recent data, because the TOC associated with the recent data was outside the TOC normalization range (0.5% to 3.5%).
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EF: exceedance factor
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
RM: river mile
TEQ: toxic equivalent
TOC: total organic carbon

D.4 References

Anchor QEA, Windward. 2019. Remedial design work plan for the Lower Duwamish Waterway upper reach. Final. Submitted to EPA December 16, 2019. Anchor QEA, Inc. and Windward Environmental LLC, Seattle, WA.

California EPA. 1994. Health effects of benzo(a)pyrene. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Berkeley, CA.

California EPA. 2009. Technical support document for cancer potency factors: methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures. Air Toxicology and Epidemiology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA.

Ecology. 2021. Sediment cleanup user's manual. Guidance for implementing the cleanup provisions of the sediment management standards, Chapter 173-204 WAC. Third revision December 2021. Pub. No. 12-09-057. Toxics Cleanup Program, Washington State Department of Ecology, Olympia, WA.

EPA. 2014. Record of Decision. Lower Duwamish Waterway Superfund Site. US Environmental Protection Agency.

Van den Berg M, Birnbaum L, Bosveld ATC, Brunström B, Cook P, Feeley M, Giesy JP, Hanberg A, Hasegawa R, Kennedy S, Kubiak T, Larsen JC, van Leeuwen FXR, Djien Liem AK, Nolt C, Peterson RE, Poellinger L, Safe S, Schrenk D, Tillitt D, Tysklind M, Younes M, Waern F, Zacharewski T. 1998. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environ Health Perspect 106(12):775-792.

Van den Berg M, Birnbaum LS, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, Peterson RE. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicol Sci 93(2):223-241.

Windward. 2003. Lower Duwamish Waterway remedial investigation. Phase 1 remedial investigation report. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2010. Lower Duwamish Waterway remedial investigation. Remedial investigation report. Final. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward, Integral. 2018. Technical memorandum: Compilation of existing data. Final. Submitted to EPA on November 19, 2018. Windward Environmental LLC and Integral Consulting Inc., Seattle, WA.

Windward, Anchor QEA. 2021. Attachment D. Data management rules. Quality assurance project plan addendum for the Lower Duwamish Waterway Upper Reach: Pre-Design Investigation Phase II. Draft final. For submittal to the US Environmental Protection Agency. Windward Environmental LLC and Anchor QEA, Seattle, WA.

D.5 Exhibits

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

		Older Data															
RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Arsenic	13.3		mg/kg	Yes	13.3	mg/kg	57	No	0.23
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Cadmium	0.7	U	mg/kg	No	0.7	mg/kg	10.2	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Chromium	32		mg/kg	Yes	32	mg/kg	520	No	0.062
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Copper	59		mg/kg	Yes	59	mg/kg	780	No	0.076
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Lead	32		mg/kg	Yes	32	mg/kg	900	No	0.036
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Mercury	0.12		mg/kg	Yes	0.12	mg/kg	0.82	No	0.15
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Silver	0.7	U	mg/kg	No	0.7	mg/kg	12.2	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Metals	Zinc	120		mg/kg	Yes	120	mg/kg	820	No	0.15
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	2-Methylnaphthalene	20		ug/kg	Yes	1.1	mg/kg OC	76	No	0.014
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Acenaphthene	170		ug/kg	Yes	9.4	mg/kg OC	32	No	0.29
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Anthracene	180		ug/kg	Yes	10	mg/kg OC	440	No	0.023
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Benzo(a)anthracene	710		ug/kg	Yes	39	mg/kg OC	220	No	0.18
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Benzo(a)pyrene	580		ug/kg	Yes	32	mg/kg OC	198	No	0.16
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Benzo(g,h,i)perylene	300		ug/kg	Yes	17	mg/kg OC	62	No	0.27
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Total benzofluoranthenes	1390		ug/kg	Yes	77	mg/kg OC	460	No	0.17
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Chrysene	870		ug/kg	Yes	48	mg/kg OC	220	No	0.22
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Dibenzo(a,h)anthracene	150		ug/kg	Yes	8.3	mg/kg OC	24	No	0.35
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Dibenzofuran	120		ug/kg	Yes	6.7	mg/kg OC	30	No	0.22
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Fluoranthene	2900		ug/kg	Yes	160	mg/kg OC	320	No	0.5
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Fluorene	150		ug/kg	Yes	8.3	mg/kg OC	46	No	0.18
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Indeno(1,2,3-cd)pyrene	310		ug/kg	Yes	17	mg/kg OC	68	No	0.25
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Naphthalene	26		ug/kg	Yes	1.4	mg/kg OC	198	No	0.0071
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Phenanthrene	850		ug/kg	Yes	47	mg/kg OC	200	No	0.24
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Pyrene	1800		ug/kg	Yes	100	mg/kg OC	2000	No	0.05
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Total HPAHs	9000		ug/kg	Yes	500	mg/kg OC	1920	No	0.26
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	Total LPAHs	1400		ug/kg	Yes	78	mg/kg OC	740	No	0.11
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PAHs	cPAHs - mammal - half DL	890		ug/kg	Yes	890	ug/kg	5500	No	0.16
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Phthalates	Bis(2-ethylhexyl)phthalate	440		ug/kg	Yes	24	mg/kg OC	94	No	0.26
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Phthalates	Butyl benzyl phthalate	48	J	ug/kg	Yes	2.7	mg/kg OC	9.8	No	0.28
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Phthalates	Dimethyl phthalate	19	U	ug/kg	No	1.1	mg/kg OC	106	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	1,2,4-Trichlorobenzene	19	U	ug/kg	No	1.1	mg/kg OC	1.62	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	1,2-Dichlorobenzene	19	U	ug/kg	No	1.1	mg/kg OC	4.6	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	1,4-Dichlorobenzene	19	U	ug/kg	No	1.1	mg/kg OC	6.2	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	2,4-Dimethylphenol	19	U	ug/kg	No	19	ug/kg	58	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	4-Methylphenol	19	U	ug/kg	No	19	ug/kg	1340	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	Benzoic acid	190	UJ	ug/kg	No	190	ug/kg	1300	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	Benzyl alcohol	19	UJ	ug/kg	No	19	ug/kg	114	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	Hexachlorobenzene	1.9	J	ug/kg	Yes	0.11	mg/kg OC	0.76	No	0.14
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	n-Nitrosodiphenylamine	19	U	ug/kg	No	1.1	mg/kg OC	22	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	Pentachlorophenol	97	UJ	ug/kg	No	97	ug/kg	720	na	na
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	Other SVOCs	Phenol	27		ug/kg	Yes	27	ug/kg	840	No	0.032

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

		Older Data														
RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
1.9	Boeing SiteChar	R5	SD0055	N	15-Oct-97	PCBs	Total PCB Aroclors	159	J	ug/kg	Yes	8.8	mg/kg OC	12	No	0.73
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Arsenic	12.7		mg/kg	Yes	12.7	mg/kg	57	No	0.22
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Cadmium	0.33		mg/kg	Yes	0.33	mg/kg	10.2	No	0.032
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Chromium	31		mg/kg	Yes	31	mg/kg	520	No	0.06
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Copper	57		mg/kg	Yes	57	mg/kg	780	No	0.073
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Lead	54.5		mg/kg	Yes	54.5	mg/kg	900	No	0.061
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Mercury	0.17		mg/kg	Yes	0.17	mg/kg	0.82	No	0.21
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Silver	0.35		mg/kg	Yes	0.35	mg/kg	12.2	No	0.029
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Metals	Zinc	114		mg/kg	Yes	114	mg/kg	820	No	0.14
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	2-Methylnaphthalene	20	U	ug/kg	No	0.74	mg/kg OC	76	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Acenaphthene	40		ug/kg	Yes	1.5	mg/kg OC	32	No	0.047
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Anthracene	180		ug/kg	Yes	6.7	mg/kg OC	440	No	0.015
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Benzo(a)anthracene	350		ug/kg	Yes	13	mg/kg OC	220	No	0.059
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Benzo(a)pyrene	270		ug/kg	Yes	10	mg/kg OC	198	No	0.051
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Benzo(g,h,i)perylene	170		ug/kg	Yes	6.3	mg/kg OC	62	No	0.1
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Total benzofluoranthenes	640		ug/kg	Yes	24	mg/kg OC	460	No	0.052
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Chrysene	520		ug/kg	Yes	19	mg/kg OC	220	No	0.086
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Dibenzo(a,h)anthracene	50		ug/kg	Yes	1.9	mg/kg OC	24	No	0.079
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Dibenzofuran	40		ug/kg	Yes	1.5	mg/kg OC	30	No	0.05
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Fluoranthene	1000		ug/kg	Yes	37	mg/kg OC	320	No	0.12
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Fluorene	50		ug/kg	Yes	1.9	mg/kg OC	46	No	0.041
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Indeno(1,2,3-cd)pyrene	160		ug/kg	Yes	5.9	mg/kg OC	68	No	0.087
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Naphthalene	20	U	ug/kg	No	0.74	mg/kg OC	198	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Phenanthrene	320		ug/kg	Yes	12	mg/kg OC	200	No	0.06
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Pyrene	730		ug/kg	Yes	27	mg/kg OC	2000	No	0.014
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Total HPAHs	3900		ug/kg	Yes	140	mg/kg OC	1920	No	0.073
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	Total LPAHs	590		ug/kg	Yes	22	mg/kg OC	740	No	0.03
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PAHs	cPAHs - mammal - half DL	410		ug/kg	Yes	410	ug/kg	5500	No	0.075
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Phthalates	Bis(2-ethylhexyl)phthalate	2500		ug/kg	Yes	93	mg/kg OC	94	No	0.99
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Phthalates	Butyl benzyl phthalate	40		ug/kg	Yes	1.5	mg/kg OC	9.8	No	0.15
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Phthalates	Dimethyl phthalate	20		ug/kg	Yes	0.74	mg/kg OC	106	No	0.007
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	1,2,4-Trichlorobenzene	20	U	ug/kg	No	0.74	mg/kg OC	1.62	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	1,2-Dichlorobenzene	20	U	ug/kg	No	0.74	mg/kg OC	4.6	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	1,4-Dichlorobenzene	20	U	ug/kg	No	0.74	mg/kg OC	6.2	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	2,4-Dimethylphenol	20	U	ug/kg	No	20	ug/kg	58	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	4-Methylphenol	20	U	ug/kg	No	20	ug/kg	1340	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	Benzoic acid	200	U	ug/kg	No	200	ug/kg	1300	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	Benzyl alcohol	50	U	ug/kg	No	50	ug/kg	114	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	Hexachlorobenzene	20	U	ug/kg	No	0.74	mg/kg OC	0.76	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	n-Nitrosodiphenylamine	40	U	ug/kg	No	1.5	mg/kg OC	22	na	na
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	Pentachlorophenol	100	U	ug/kg	No	100	ug/kg	720	na	na

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

		Older Data														
RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	Other SVOCs	Phenol	60		ug/kg	Yes	60	ug/kg	840	No	0.071
1.9	EPA SI	DR155	SD-DR155-0000	N	13-Aug-98	PCBs	Total PCB Aroclors	106	J	ug/kg	Yes	3.93	mg/kg OC	12	No	0.33
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Arsenic	15.5		mg/kg	Yes	15.5	mg/kg	57	No	0.27
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Cadmium	0.6		mg/kg	Yes	0.6	mg/kg	10.2	No	0.059
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Chromium	35		mg/kg	Yes	35	mg/kg	520	No	0.067
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Copper	85.5		mg/kg	Yes	85.5	mg/kg	780	No	0.11
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Lead	50		mg/kg	Yes	50	mg/kg	900	No	0.056
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Mercury	0.3		mg/kg	Yes	0.3	mg/kg	0.82	No	0.37
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Silver	0.6	U	mg/kg	No	0.6	mg/kg	12.2	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Metals	Zinc	152		mg/kg	Yes	152	mg/kg	820	No	0.19
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	2-Methylnaphthalene	99	U	ug/kg	No	3.9	mg/kg OC	76	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Acenaphthene	99	U	ug/kg	No	3.9	mg/kg OC	32	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Anthracene	200		ug/kg	Yes	7.9	mg/kg OC	440	No	0.018
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Benzo(a)anthracene	410		ug/kg	Yes	16	mg/kg OC	220	No	0.073
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Benzo(a)pyrene	330		ug/kg	Yes	13	mg/kg OC	198	No	0.066
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Benzo(g,h,i)perylene	59	J	ug/kg	Yes	2.3	mg/kg OC	62	No	0.037
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Total benzofluoranthenes	1030		ug/kg	Yes	40.6	mg/kg OC	460	No	0.088
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Chrysene	600		ug/kg	Yes	24	mg/kg OC	220	No	0.11
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Dibenzo(a,h)anthracene	99	U	ug/kg	No	3.9	mg/kg OC	24	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Dibenzofuran	99	U	ug/kg	No	3.9	mg/kg OC	30	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Fluoranthene	1100		ug/kg	Yes	43	mg/kg OC	320	No	0.13
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Fluorene	58	J	ug/kg	Yes	2.3	mg/kg OC	46	No	0.05
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Indeno(1,2,3-cd)pyrene	17		ug/kg	Yes	0.67	mg/kg OC	68	No	0.0099
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Naphthalene	99	U	ug/kg	No	3.9	mg/kg OC	198	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Phenanthrene	240		ug/kg	Yes	9.4	mg/kg OC	200	No	0.047
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Pyrene	920		ug/kg	Yes	36	mg/kg OC	2000	No	0.018
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Total HPAHs	4500	J	ug/kg	Yes	180	mg/kg OC	1920	No	0.094
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	Total LPAHs	500	J	ug/kg	Yes	20	mg/kg OC	740	No	0.027
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PAHs	cPAHs - mammal - half DL	500		ug/kg	Yes	500	ug/kg	5500	No	0.091
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Phthalates	Bis(2-ethylhexyl)phthalate	400		ug/kg	Yes	16	mg/kg OC	94	No	0.17
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Phthalates	Butyl benzyl phthalate	6.5	U	ug/kg	No	0.26	mg/kg OC	9.8	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Phthalates	Dimethyl phthalate	6.5	U	ug/kg	No	0.26	mg/kg OC	106	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	1,2,4-Trichlorobenzene	6.5	U	ug/kg	No	0.26	mg/kg OC	1.62	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	1,2-Dichlorobenzene	6.5	U	ug/kg	No	0.26	mg/kg OC	4.6	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	1,4-Dichlorobenzene	6.5	U	ug/kg	No	0.26	mg/kg OC	6.2	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	2,4-Dimethylphenol	6.5	U	ug/kg	No	6.5	ug/kg	58	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	4-Methylphenol	99	U	ug/kg	No	99	ug/kg	1340	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	Benzoic acid	65	U	ug/kg	No	65	ug/kg	1300	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	Benzyl alcohol	33	U	ug/kg	No	33	ug/kg	114	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	Hexachlorobenzene	0.99	U	ug/kg	No	0.039	mg/kg OC	0.76	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	n-Nitrosodiphenylamine	6.5	U	ug/kg	No	0.26	mg/kg OC	22	na	na

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

		Older Data														
RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	Pentachlorophenol	33	U	ug/kg	No	33	ug/kg	720	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	Other SVOCs	Phenol	99	U	ug/kg	No	99	ug/kg	840	na	na
1.9	LDWRI-SurfaceSedimentRound1	LDW-SS72	LDW-SS72-010	N	24-Jan-05	PCBs	Total PCB Aroclors	82	J	ug/kg	Yes	3.2	mg/kg OC	12	No	0.27
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Arsenic	16.9		mg/kg	Yes	16.9	mg/kg	57	No	0.3
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Cadmium	0.7		mg/kg	Yes	0.7	mg/kg	10.2	No	0.069
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Chromium	36		mg/kg	Yes	36	mg/kg	520	No	0.069
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Copper	94	J	mg/kg	Yes	94	mg/kg	780	No	0.12
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Lead	55		mg/kg	Yes	55	mg/kg	900	No	0.061
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Mercury	0.34	J	mg/kg	Yes	0.34	mg/kg	0.82	No	0.41
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Silver	0.6	U	mg/kg	No	0.6	mg/kg	12.2	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Metals	Zinc	163		mg/kg	Yes	163	mg/kg	820	No	0.2
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	2-Methylnaphthalene	59	U	ug/kg	No	2.3	mg/kg OC	76	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Acenaphthene	59	U	ug/kg	No	2.3	mg/kg OC	32	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Anthracene	220		ug/kg	Yes	8.4	mg/kg OC	440	No	0.019
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Benzo(a)anthracene	350		ug/kg	Yes	13	mg/kg OC	220	No	0.059
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Benzo(a)pyrene	390		ug/kg	Yes	15	mg/kg OC	198	No	0.076
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Benzo(g,h,i)perylene	94		ug/kg	Yes	3.6	mg/kg OC	62	No	0.058
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Total benzofluoranthenes	1290		ug/kg	Yes	49.4	mg/kg OC	460	No	0.11
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Chrysene	580		ug/kg	Yes	22	mg/kg OC	220	No	0.1
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Dibenzo(a,h)anthracene	59	U	ug/kg	No	2.3	mg/kg OC	24	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Dibenzofuran	59	U	ug/kg	No	2.3	mg/kg OC	30	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Fluoranthene	980		ug/kg	Yes	38	mg/kg OC	320	No	0.12
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Fluorene	63		ug/kg	Yes	2.4	mg/kg OC	46	No	0.052
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Indeno(1,2,3-cd)pyrene	130		ug/kg	Yes	5	mg/kg OC	68	No	0.074
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Naphthalene	59	U	ug/kg	No	2.3	mg/kg OC	198	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Phenanthrene	290		ug/kg	Yes	11	mg/kg OC	200	No	0.055
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Pyrene	790		ug/kg	Yes	30	mg/kg OC	2000	No	0.015
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Total HPAHs	4600		ug/kg	Yes	176	mg/kg OC	1920	No	0.092
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	Total LPAHs	610	J	ug/kg	Yes	23	mg/kg OC	740	No	0.031
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PAHs	cPAHs - mammal - half DL	580		ug/kg	Yes	580	ug/kg	5500	No	0.11
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Phthalates	Bis(2-ethylhexyl)phthalate	440		ug/kg	Yes	17	mg/kg OC	94	No	0.18
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Phthalates	Butyl benzyl phthalate	6.5	U	ug/kg	No	0.25	mg/kg OC	9.8	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Phthalates	Dimethyl phthalate	6.5	U	ug/kg	No	0.25	mg/kg OC	106	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	1,2,4-Trichlorobenzene	6.5	U	ug/kg	No	0.25	mg/kg OC	1.62	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	1,2-Dichlorobenzene	6.5	U	ug/kg	No	0.25	mg/kg OC	4.6	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	1,4-Dichlorobenzene	6.5	U	ug/kg	No	0.25	mg/kg OC	6.2	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	2,4-Dimethylphenol	6.5	U	ug/kg	No	6.5	ug/kg	58	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	4-Methylphenol	59	U	ug/kg	No	59	ug/kg	1340	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	Benzoic acid	65	U	ug/kg	No	65	ug/kg	1300	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	Benzyl alcohol	33	U	ug/kg	No	33	ug/kg	114	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	Hexachlorobenzene	0.99	U	ug/kg	No	0.038	mg/kg OC	0.76	na	na

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

		Older Data														
RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	n-Nitrosodiphenylamine	7.2		ug/kg	Yes	0.28	mg/kg OC	22	No	0.013
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	Pentachlorophenol	33	U	ug/kg	No	33	ug/kg	720	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	Other SVOCs	Phenol	59	U	ug/kg	No	59	ug/kg	840	na	na
1.9	LDWRI-SurfaceSedimentRound2	LDW-SS69b	LDW-SS69b-010	N	16-Mar-05	PCBs	Total PCB Aroclors	340		ug/kg	Yes	13	mg/kg OC	12	Yes	1.1
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	Metals	Arsenic	12.3	J	mg/kg	Yes	12.3	mg/kg	57	No	0.22
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	Metals	Chromium	27.7	J	mg/kg	Yes	27.7	mg/kg	520	No	0.053
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	Metals	Lead	59	J	mg/kg	Yes	59	mg/kg	900	No	0.066
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	Metals	Mercury	0.106	J	mg/kg	Yes	0.106	mg/kg	0.82	No	0.13
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	2-Methylnaphthalene	10.1	J	ug/kg	Yes	0.352	mg/kg OC	76	No	0.0046
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Acenaphthene	7.87	J	ug/kg	Yes	0.274	mg/kg OC	32	No	0.0086
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Anthracene	33.3	J	ug/kg	Yes	1.16	mg/kg OC	440	No	0.0026
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Benzo(a)anthracene	80.8	J	ug/kg	Yes	2.82	mg/kg OC	220	No	0.013
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Benzo(a)pyrene	90.6	J	ug/kg	Yes	3.16	mg/kg OC	198	No	0.016
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Benzo(g,h,i)perylene	126	J	ug/kg	Yes	4.39	mg/kg OC	62	No	0.071
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Total benzofluoranthenes	183	J	ug/kg	Yes	6.38	mg/kg OC	460	No	0.014
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Chrysene	150	J	ug/kg	Yes	5.23	mg/kg OC	220	No	0.024
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Dibenzo(a,h)anthracene	19.1	J	ug/kg	Yes	0.666	mg/kg OC	24	No	0.028
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Dibenzofuran	12.6	J	ug/kg	Yes	0.439	mg/kg OC	30	No	0.015
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Fluoranthene	215	J	ug/kg	Yes	7.49	mg/kg OC	320	No	0.023
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Fluorene	14.9	J	ug/kg	Yes	0.519	mg/kg OC	46	No	0.011
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Indeno(1,2,3-cd)pyrene	96.7	J	ug/kg	Yes	3.37	mg/kg OC	68	No	0.05
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Naphthalene	14.4	J	ug/kg	Yes	0.502	mg/kg OC	198	No	0.0025
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Phenanthrene	92.5	J	ug/kg	Yes	3.22	mg/kg OC	200	No	0.016
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Pyrene	195	J	ug/kg	Yes	6.79	mg/kg OC	2000	No	0.0034
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Total HPAHs	1156	J	ug/kg	Yes	40.3	mg/kg OC	1920	No	0.021
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	Total LPAHs	170.5	J	ug/kg	Yes	5.94	mg/kg OC	740	No	0.008
2.1	ECY-NOAA LDW Sediment (split s	LDW18-SS-091	1905049-AU	N	28-Feb-18	PAHs	cPAHs - mammal - half DL	136	J	ug/kg	Yes	136	ug/kg	5500	No	0.025
2.2	EPA SI	DR139	SD-DR139-0000	N	14-Sep-98	PCBs	Total PCB Aroclors	2840		ug/kg	Yes	95.9	mg/kg OC	12	Yes	8
2.2	Industrial Container Services	EAA2-SED-4	SED-4	N	07-May-07	Metals	Arsenic	3.7		mg/kg	Yes	3.7	mg/kg	57	No	0.065
2.2	Industrial Container Services	EAA2-SED-4	SED-4	N	07-May-07	Metals	Cadmium	0.71		mg/kg	Yes	0.71	mg/kg	10.2	No	0.07
2.2	Industrial Container Services	EAA2-SED-4	SED-4	N	07-May-07	Metals	Chromium	28.5		mg/kg	Yes	28.5	mg/kg	520	No	0.055
2.2	Industrial Container Services	EAA2-SED-4	SED-4	N	07-May-07	Metals	Lead	137		mg/kg	Yes	137	mg/kg	900	No	0.15
2.2	Industrial Container Services	EAA2-SED-4	SED-4	N	07-May-07	Metals	Mercury	0.2	J	mg/kg	Yes	0.2	mg/kg	0.82	No	0.24
2.2	Industrial Container Services	EAA2-SED-4	SED-4	N	07-May-07	Metals	Silver	0.13	J	mg/kg	Yes	0.13	mg/kg	12.2	No	0.011
2.2	Industrial Container Services	EAA2-SED-4	SED-4-FD	FD	07-May-07	Metals	Arsenic	2.3		mg/kg	Yes	2.3	mg/kg	57	No	0.04
2.2	Industrial Container Services	EAA2-SED-4	SED-4-FD	FD	07-May-07	Metals	Cadmium	0.6		mg/kg	Yes	0.6	mg/kg	10.2	No	0.059
2.2	Industrial Container Services	EAA2-SED-4	SED-4-FD	FD	07-May-07	Metals	Chromium	22.6		mg/kg	Yes	22.6	mg/kg	520	No	0.043
2.2	Industrial Container Services	EAA2-SED-4	SED-4-FD	FD	07-May-07	Metals	Lead	115		mg/kg	Yes	115	mg/kg	900	No	0.13
2.2	Industrial Container Services	EAA2-SED-4	SED-4-FD	FD	07-May-07	Metals	Mercury	0.17	J	mg/kg	Yes	0.17	mg/kg	0.82	No	0.21
2.2	Industrial Container Services	EAA2-SED-4	SED-4-FD	FD	07-May-07	Metals	Silver	0.23	J	mg/kg	Yes	0.23	mg/kg	12.2	No	0.019
2.2	Industrial Container Services (EA	2154-DSS-21	ICS-DSS-21-SE-070212	N	02-Jul-12	PCBs	Total PCB Aroclors	1520		ug/kg	Yes	79.2	mg/kg OC	12	Yes	6.6

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

		Older Data														
RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
2.2	Industrial Container Services (EA	2154-DSS-26	ICS-DSS-26-SE-070212	N	02-Jul-12	Metals	Arsenic	12.6		mg/kg	Yes	12.6	mg/kg	57	No	0.22
2.2	Industrial Container Services (EA	2154-DSS-26	ICS-DSS-26-SE-070212	N	02-Jul-12	Metals	Cadmium	1.6		mg/kg	Yes	1.6	mg/kg	10.2	No	0.16
2.2	Industrial Container Services (EA	2154-DSS-26	ICS-DSS-26-SE-070212	N	02-Jul-12	Metals	Chromium	268		mg/kg	Yes	268	mg/kg	520	No	0.52
2.2	Industrial Container Services (EA	2154-DSS-26	ICS-DSS-26-SE-070212	N	02-Jul-12	Metals	Lead	1690		mg/kg	Yes	1690	mg/kg	900	Yes	1.9
2.2	Industrial Container Services (EA	2154-DSS-26	ICS-DSS-26-SE-070212	N	02-Jul-12	Metals	Mercury	0.83		mg/kg	Yes	0.83	mg/kg	0.82	Yes	1
2.2	Industrial Container Services (EA	2154-DSS-26	ICS-DSS-26-SE-070212	N	02-Jul-12	Metals	Silver	0.4		mg/kg	Yes	0.4	mg/kg	12.2	No	0.033
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Arsenic	70		mg/kg	Yes	70	mg/kg	57	Yes	1.2
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Cadmium	1		mg/kg	Yes	1	mg/kg	10.2	No	0.098
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Chromium	62	J	mg/kg	Yes	62	mg/kg	520	No	0.12
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Copper	201	J	mg/kg	Yes	201	mg/kg	780	No	0.26
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Lead	119		mg/kg	Yes	119	mg/kg	900	No	0.13
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Mercury	0.04		mg/kg	Yes	0.04	mg/kg	0.82	No	0.049
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Silver	1	U	mg/kg	No	1	mg/kg	12.2	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Metals	Zinc	919		mg/kg	Yes	919	mg/kg	820	Yes	1.1
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	2-Methylnaphthalene	22		ug/kg	Yes	22	ug/kg	1340	No	0.016
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Acenaphthene	31		ug/kg	Yes	31	ug/kg	1000	No	0.031
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Anthracene	840		ug/kg	Yes	840	ug/kg	1920	No	0.44
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Benzo(a)anthracene	530		ug/kg	Yes	530	ug/kg	2600	No	0.2
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Benzo(a)pyrene	1100		ug/kg	Yes	1100	ug/kg	3200	No	0.34
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Benzo(g,h,i)perylene	3100		ug/kg	Yes	3100	ug/kg	1340	Yes	2.3
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Total benzofluoranthenes	2300		ug/kg	Yes	2300	ug/kg	6400	No	0.36
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Chrysene	940		ug/kg	Yes	940	ug/kg	2800	No	0.34
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Dibenzo(a,h)anthracene	560		ug/kg	Yes	560	ug/kg	460	Yes	1.2
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Dibenzofuran	28		ug/kg	Yes	28	ug/kg	1080	No	0.026
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Fluoranthene	900		ug/kg	Yes	900	ug/kg	3400	No	0.26
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Fluorene	37		ug/kg	Yes	37	ug/kg	1080	No	0.034
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Indeno(1,2,3-cd)pyrene	2100		ug/kg	Yes	2100	ug/kg	1200	Yes	1.8
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Naphthalene	44		ug/kg	Yes	44	ug/kg	4200	No	0.01
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Phenanthrene	370		ug/kg	Yes	370	ug/kg	3000	No	0.12
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Pyrene	1100		ug/kg	Yes	1100	ug/kg	5200	No	0.21
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Total HPAHs	12600		ug/kg	Yes	12600	ug/kg	24000	No	0.53
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	Total LPAHs	1710		ug/kg	Yes	1710	ug/kg	10400	No	0.16
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PAHs	cPAHs - mammal - half DL	1800		ug/kg	Yes	1800	ug/kg	5500	No	0.33
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Phthalates	Bis(2-ethylhexyl)phthalate	380		ug/kg	Yes	380	ug/kg	2600	No	0.15
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Phthalates	Butyl benzyl phthalate	57	J	ug/kg	Yes	57	ug/kg	126	No	0.45
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Phthalates	Dimethyl phthalate	18		ug/kg	Yes	18	ug/kg	142	No	0.13
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	1,2,4-Trichlorobenzene	4.6	U	ug/kg	No	4.6	ug/kg	62	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	1,2-Dichlorobenzene	4.6	U	ug/kg	No	4.6	ug/kg	70	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	1,4-Dichlorobenzene	4.6	U	ug/kg	No	4.6	ug/kg	220	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	2,4-Dimethylphenol	37	J	ug/kg	Yes	37	ug/kg	58	No	0.64
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	4-Methylphenol	82		ug/kg	Yes	82	ug/kg	1340	No	0.061

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

RM	Trumped Task	Older Data														
		Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	Benzoic acid	270		ug/kg	Yes	270	ug/kg	1300	No	0.21
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	Benzyl alcohol	20		ug/kg	Yes	20	ug/kg	114	No	0.18
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	Hexachlorobenzene	4.6	U	ug/kg	No	4.6	ug/kg	44	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	n-Nitrosodiphenylamine	5.8		ug/kg	Yes	5.8	ug/kg	56	No	0.1
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	Pentachlorophenol	94	J	ug/kg	Yes	94	ug/kg	720	No	0.13
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	Other SVOCs	Phenol	86		ug/kg	Yes	86	ug/kg	840	No	0.1
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A	N	15-Apr-11	PCBs	Total PCB Aroclors	63		ug/kg	Yes	63	ug/kg	130	No	0.48
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Arsenic	100		mg/kg	Yes	100	mg/kg	57	Yes	1.8
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Cadmium	1		mg/kg	Yes	1	mg/kg	10.2	No	0.098
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Chromium	63	J	mg/kg	Yes	63	mg/kg	520	No	0.12
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Copper	209	J	mg/kg	Yes	209	mg/kg	780	No	0.27
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Lead	156		mg/kg	Yes	156	mg/kg	900	No	0.17
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Mercury	0.09		mg/kg	Yes	0.09	mg/kg	0.82	No	0.11
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Silver	1	U	mg/kg	No	1	mg/kg	12.2	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Metals	Zinc	891		mg/kg	Yes	891	mg/kg	820	Yes	1.1
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	2-Methylnaphthalene	28		ug/kg	Yes	28	ug/kg	1340	No	0.021
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Acenaphthene	46		ug/kg	Yes	46	ug/kg	1000	No	0.046
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Anthracene	930		ug/kg	Yes	930	ug/kg	1920	No	0.48
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Benzo(a)anthracene	560		ug/kg	Yes	560	ug/kg	2600	No	0.22
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Benzo(a)pyrene	1200		ug/kg	Yes	1200	ug/kg	3200	No	0.38
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Benzo(g,h,i)perylene	3200		ug/kg	Yes	3200	ug/kg	1340	Yes	2.4
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Total benzofluoranthenes	2500		ug/kg	Yes	2500	ug/kg	6400	No	0.39
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Chrysene	1000		ug/kg	Yes	1000	ug/kg	2800	No	0.36
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Dibenzo(a,h)anthracene	580		ug/kg	Yes	580	ug/kg	460	Yes	1.3
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Dibenzofuran	40		ug/kg	Yes	40	ug/kg	1080	No	0.037
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Fluoranthene	980		ug/kg	Yes	980	ug/kg	3400	No	0.29
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Fluorene	53		ug/kg	Yes	53	ug/kg	1080	No	0.049
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Indeno(1,2,3-cd)pyrene	2200		ug/kg	Yes	2200	ug/kg	1200	Yes	1.8
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Naphthalene	55		ug/kg	Yes	55	ug/kg	4200	No	0.013
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Phenanthrene	510		ug/kg	Yes	510	ug/kg	3000	No	0.17
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Pyrene	1200		ug/kg	Yes	1200	ug/kg	5200	No	0.23
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Total HPAHs	13400		ug/kg	Yes	13400	ug/kg	24000	No	0.56
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	Total LPAHs	2000		ug/kg	Yes	2000	ug/kg	10400	No	0.19
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PAHs	cPAHs - mammal - half DL	2000		ug/kg	Yes	2000	ug/kg	5500	No	0.36
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Phthalates	Bis(2-ethylhexyl)phthalate	490		ug/kg	Yes	490	ug/kg	2600	No	0.19
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Phthalates	Butyl benzyl phthalate	120	J	ug/kg	Yes	120	ug/kg	126	No	0.95
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Phthalates	Dimethyl phthalate	23		ug/kg	Yes	23	ug/kg	142	No	0.16
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	1,2,4-Trichlorobenzene	4.8	U	ug/kg	No	4.8	ug/kg	62	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	1,2-Dichlorobenzene	4.8	U	ug/kg	No	4.8	ug/kg	70	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	1,4-Dichlorobenzene	4.8	U	ug/kg	No	4.8	ug/kg	220	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	2,4-Dimethylphenol	40	J	ug/kg	Yes	40	ug/kg	58	No	0.69

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
		Older Data														
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	4-Methylphenol	78		ug/kg	Yes	78	ug/kg	1340	No	0.058
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	Benzoic acid	230		ug/kg	Yes	230	ug/kg	1300	No	0.18
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	Benzyl alcohol	15	J	ug/kg	Yes	15	ug/kg	114	No	0.13
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	Hexachlorobenzene	4.8	U	ug/kg	No	4.8	ug/kg	44	na	na
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	n-Nitrosodiphenylamine	5.3		ug/kg	Yes	5.3	ug/kg	56	No	0.095
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	Pentachlorophenol	92	J	ug/kg	Yes	92	ug/kg	720	No	0.13
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	Other SVOCs	Phenol	70		ug/kg	Yes	70	ug/kg	840	No	0.083
2.2	LDW outfall sediment survey	LDW-SS2025-A	LDW-SS2025-A-2	FD	15-Apr-11	PCBs	Total PCB Aroclors	114		ug/kg	Yes	114	ug/kg	130	No	0.88
2.2	LDWRI-Benthic	B5a-2	LDW-B5a-S2	N	24-Sep-04	Metals	Arsenic	7.41	J	mg/kg	Yes	7.41	mg/kg	57	No	0.13
2.2	LDWRI-Benthic	B5a-2	LDW-B5a-S2	N	24-Sep-04	Metals	Cadmium	0.296		mg/kg	Yes	0.296	mg/kg	10.2	No	0.029
2.2	LDWRI-Benthic	B5a-2	LDW-B5a-S2	N	24-Sep-04	Metals	Chromium	27		mg/kg	Yes	27	mg/kg	520	No	0.052
2.2	LDWRI-Benthic	B5a-2	LDW-B5a-S2	N	24-Sep-04	Metals	Lead	74.7		mg/kg	Yes	74.7	mg/kg	900	No	0.083
2.2	LDWRI-Benthic	B5a-2	LDW-B5a-S2	N	24-Sep-04	Metals	Mercury	0.16		mg/kg	Yes	0.16	mg/kg	0.82	No	0.2
2.2	LDWRI-Benthic	B5a-2	LDW-B5a-S2	N	24-Sep-04	Metals	Silver	0.168	J	mg/kg	Yes	0.168	mg/kg	12.2	No	0.014
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	Metals	Arsenic	12.3	J	mg/kg	Yes	12.3	mg/kg	57	No	0.22
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	Metals	Chromium	27.4	J	mg/kg	Yes	27.4	mg/kg	520	No	0.053
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	Metals	Lead	13.3	J	mg/kg	Yes	13.3	mg/kg	900	No	0.015
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	Metals	Mercury	0.1	J	mg/kg	Yes	0.1	mg/kg	0.82	No	0.12
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	2-Methylnaphthalene	12.6	J	ug/kg	Yes	0.545	mg/kg OC	76	No	0.0072
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Acenaphthene	4.2	J	ug/kg	Yes	0.182	mg/kg OC	32	No	0.0057
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Anthracene	12	J	ug/kg	Yes	0.519	mg/kg OC	440	No	0.0012
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Benzo(a)anthracene	36.7	J	ug/kg	Yes	1.59	mg/kg OC	220	No	0.0072
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Benzo(a)pyrene	39.8	J	ug/kg	Yes	1.72	mg/kg OC	198	No	0.0087
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Benzo(g,h,i)perylene	42.7	J	ug/kg	Yes	1.85	mg/kg OC	62	No	0.03
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Total benzofluoranthenes	79.3	J	ug/kg	Yes	3.43	mg/kg OC	460	No	0.0075
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Chrysene	66.1	J	ug/kg	Yes	2.86	mg/kg OC	220	No	0.013
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Dibenzo(a,h)anthracene	9.05	J	ug/kg	Yes	0.392	mg/kg OC	24	No	0.016
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Dibenzofuran	8.86	J	ug/kg	Yes	0.384	mg/kg OC	30	No	0.013
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Fluoranthene	95.7	J	ug/kg	Yes	4.14	mg/kg OC	320	No	0.013
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Fluorene	8.45	J	ug/kg	Yes	0.366	mg/kg OC	46	No	0.008
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Indeno(1,2,3-cd)pyrene	38.2	J	ug/kg	Yes	1.65	mg/kg OC	68	No	0.024
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Naphthalene	8.7	J	ug/kg	Yes	0.377	mg/kg OC	198	No	0.0019
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Phenanthrene	56	J	ug/kg	Yes	2.42	mg/kg OC	200	No	0.012
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Pyrene	87.9	J	ug/kg	Yes	3.81	mg/kg OC	2000	No	0.0019
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Total HPAHs	495.5	J	ug/kg	Yes	21.5	mg/kg OC	1920	No	0.011
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	Total LPAHs	92.2	J	ug/kg	Yes	3.99	mg/kg OC	740	No	0.0054
2.4	ECY-NOAA LDW Sediment (split s	LDW18-SS-101	1905049-87	N	28-Feb-18	PAHs	cPAHs - mammal - half DL	59.5	J	ug/kg	Yes	59.5	ug/kg	5500	No	0.011
2.8	Slip 4 8th Avenue Terminals	SG18	SD0058	N	31-Oct-12	PCBs	Total PCB Aroclors	620		ug/kg	Yes	19	mg/kg OC	12	Yes	1.6
2.8	Slip 4 8th Avenue Terminals	SG20	SD0059	N	31-Oct-12	PCBs	Total PCB Aroclors	320		ug/kg	Yes	320	ug/kg	130	Yes	2.5
2.8	Slip 4 8th Avenue Terminals	SG21	SD0060	N	30-Oct-12	PCBs	Total PCB Aroclors	140		ug/kg	Yes	4.18	mg/kg OC	12	No	0.35
2.8	Slip 4 EAA Removal Action Comp	BD-5	SD0052	N	14-Feb-12	PCBs	Total PCB Aroclors	4	U	ug/kg	No	4	ug/kg	130	na	na

Exhibit D-1

RAL Status Comparison for Older (Replaced) Surface Sediment vs. Recent Data in the Middle Reach

		Older Data														
RM	Trumped Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical Group	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit	RAL	**Exceeds RAL**	**RAL EF**
2.8	Slip4-EarlyAction	SG18	SG18	N	08-Apr-04	Metals	Mercury	0.17		mg/kg	Yes	0.17	mg/kg	0.82	No	0.21
2.8	Slip4-EarlyAction	SG18	SG18	N	08-Apr-04	PCBs	Total PCB Aroclors	130	N	ug/kg	Yes	4.1	mg/kg OC	12	No	0.34
2.8	Slip4-EarlyAction	SG18	SG18	N	08-Apr-04	PCBs	Total PCB Aroclors	130	N	ug/kg	Yes	4.1	mg/kg OC	12	No	0.34
2.8	Slip4-EarlyAction	SG20	SG20	N	08-Apr-04	Metals	Mercury	0.2		mg/kg	Yes	0.2	mg/kg	0.82	No	0.24
2.8	Slip4-EarlyAction	SG20	SG20	N	08-Apr-04	PCBs	Total PCB Aroclors	179	JN	ug/kg	Yes	5.79	mg/kg OC	12	No	0.48
2.8	Slip4-EarlyAction	SG20	SG20	N	08-Apr-04	PCBs	Total PCB Aroclors	179	JN	ug/kg	Yes	5.79	mg/kg OC	12	No	0.48
2.8	Slip4-EarlyAction	SG21	SG21	N	08-Apr-04	Metals	Mercury	0.2		mg/kg	Yes	0.2	mg/kg	0.82	No	0.24
2.8	Slip4-EarlyAction	SG21	SG21	N	08-Apr-04	PCBs	Total PCB Aroclors	158	N	ug/kg	Yes	5.34	mg/kg OC	12	No	0.45
2.8	Slip4-EarlyAction	SG21	SG21	N	08-Apr-04	PCBs	Total PCB Aroclors	158	N	ug/kg	Yes	5.34	mg/kg OC	12	No	0.45
2.8	Slip4-EarlyAction	SG24	SG24	N	09-Apr-04	Metals	Mercury	0.1		mg/kg	Yes	0.1	mg/kg	0.82	No	0.12
2.8	Slip4-EarlyAction	SG24	SG24	N	09-Apr-04	PCBs	Total PCB Aroclors	99	N	ug/kg	Yes	3.4	mg/kg OC	12	No	0.28
2.8	Slip4-EarlyAction	SG25	SG25	N	09-Apr-04	Metals	Mercury	0.13		mg/kg	Yes	0.13	mg/kg	0.82	No	0.16
2.8	Slip4-EarlyAction	SG25	SG25	N	09-Apr-04	PCBs	Total PCB Aroclors	116	JN	ug/kg	Yes	4.55	mg/kg OC	12	No	0.38
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Arsenic	15.5		mg/kg	Yes	15.5	mg/kg	57	No	0.27
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Cadmium	0.4		mg/kg	Yes	0.4	mg/kg	10.2	No	0.039
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Chromium	28		mg/kg	Yes	28	mg/kg	520	No	0.054
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Copper	59		mg/kg	Yes	59	mg/kg	780	No	0.076
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Lead	25.8		mg/kg	Yes	25.8	mg/kg	900	No	0.029
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Mercury	0.17		mg/kg	Yes	0.17	mg/kg	0.82	No	0.21
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Silver	0.283	J	mg/kg	Yes	0.283	mg/kg	12.2	No	0.023
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	Metals	Zinc	123		mg/kg	Yes	123	mg/kg	820	No	0.15
2.9	Crowley Marine Services 8th Ave	DENW6721-SSED-04-20	SSED-04	N	10-Dec-14	PCBs	Total PCB Aroclors	370		ug/kg	Yes	11	mg/kg OC	12	No	0.92
2.9	Slip 4 8th Avenue Terminals	SG22	SD0061	N	30-Oct-12	PCBs	Total PCB Aroclors	170		ug/kg	Yes	5.82	mg/kg OC	12	No	0.49
2.9	Slip 4 8th Avenue Terminals	SL4-3	SD0062	N	31-Oct-12	PCBs	Total PCB Aroclors	540		ug/kg	Yes	17	mg/kg OC	12	Yes	1.4
2.9	Slip 4 8th Avenue Terminals	SL4-3	SD0063	FD	31-Oct-12	PCBs	Total PCB Aroclors	680		ug/kg	Yes	24	mg/kg OC	12	Yes	2
2.9	Slip4-EarlyAction	SG22	SG22	N	08-Apr-04	Metals	Mercury	0.18		mg/kg	Yes	0.18	mg/kg	0.82	No	0.22
2.9	Slip4-EarlyAction	SG22	SG22	N	08-Apr-04	PCBs	Total PCB Aroclors	145	N	ug/kg	Yes	5.16	mg/kg OC	12	No	0.43
2.9	Slip4-EarlyAction	SG22	SG22	N	08-Apr-04	PCBs	Total PCB Aroclors	145	N	ug/kg	Yes	5.16	mg/kg OC	12	No	0.43
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Arsenic	6.8		mg/kg	Yes	6.8	mg/kg	57	No	0.12
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Cadmium	0.3	U	mg/kg	No	0.3	mg/kg	10.2	na	na
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Chromium	20		mg/kg	Yes	20	mg/kg	520	No	0.038
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Copper	30.9		mg/kg	Yes	30.9	mg/kg	780	No	0.04
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Lead	27		mg/kg	Yes	27	mg/kg	900	No	0.03
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Mercury	0.09		mg/kg	Yes	0.09	mg/kg	0.82	No	0.11
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Silver	0.5	U	mg/kg	No	0.5	mg/kg	12.2	na	na
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	Metals	Zinc	66		mg/kg	Yes	66	mg/kg	820	No	0.08
3.0	LDWRI-SurfaceSedimentRound1	LDW-SS99	LDW-SS99-010	N	19-Jan-05	PCBs	Total PCB Aroclors	20	U	ug/kg	No	1.6	mg/kg OC	12	na	na

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
			Recent Data										
1.9	HH RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Arsenic	20		mg/kg	Yes	20	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Cadmium	0.5		mg/kg	Yes	0.5	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Chromium	31		mg/kg	Yes	31	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Copper	51		mg/kg	Yes	51	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Lead	23		mg/kg	Yes	23	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Mercury	0.13		mg/kg	Yes	0.13	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Silver	0.6	U	mg/kg	No	0.6	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Zinc	136		mg/kg	Yes	136	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	2-Methylnaphthalene	30		ug/kg	Yes	1.1	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Acenaphthene	150		ug/kg	Yes	5.3	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Anthracene	190		ug/kg	Yes	6.7	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Benzo(a)anthracene	560		ug/kg	Yes	20	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Benzo(a)pyrene	340		ug/kg	Yes	12	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Benzo(g,h,i)perylene	210		ug/kg	Yes	7.4	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Total benzofluoranthenes	1200		ug/kg	Yes	42	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Chrysene	1100		ug/kg	Yes	39	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Dibenzo(a,h)anthracene	72		ug/kg	Yes	2.5	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Dibenzofuran	100		ug/kg	Yes	3.5	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Fluoranthene	2400		ug/kg	Yes	84	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Fluorene	110		ug/kg	Yes	3.9	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Indeno(1,2,3-cd)pyrene	220		ug/kg	Yes	7.7	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Naphthalene	52		ug/kg	Yes	1.8	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Phenanthrene	780		ug/kg	Yes	27	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Pyrene	1600		ug/kg	Yes	56	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Total HPAHs	7700		ug/kg	Yes	270	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Total LPAHs	1310		ug/kg	Yes	46	mg/kg OC
1.9	HH ESD RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	cPAHs - mammal - half DL	580		ug/kg	Yes	580	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Bis(2-ethylhexyl)phthalate	570		ug/kg	Yes	20	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Butyl benzyl phthalate	31		ug/kg	Yes	1.1	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Dimethyl phthalate	2.6	J	ug/kg	Yes	0.091	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	1,2,4-Trichlorobenzene	4.6	U	ug/kg	No	0.16	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	1,2-Dichlorobenzene	4.6	U	ug/kg	No	0.16	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	1,4-Dichlorobenzene	4.6	U	ug/kg	No	0.16	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	2,4-Dimethylphenol	4.2	J	ug/kg	Yes	4.2	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	4-Methylphenol	250		ug/kg	Yes	250	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Benzoic acid	220		ug/kg	Yes	220	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Benzyl alcohol	210		ug/kg	Yes	210	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Hexachlorobenzene	4.6	U	ug/kg	No	0.16	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	n-Nitrosodiphenylamine	5.8	J	ug/kg	Yes	0.2	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Pentachlorophenol	12	J	ug/kg	Yes	12	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Phenol	95		ug/kg	Yes	95	ug/kg

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Recent Data									
			Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
1.9	HH RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SS2122-D	LDW-SS2122-D	N	08-Mar-11	Total PCB Aroclors	45		ug/kg	Yes	1.6	mg/kg OC
1.9	HH RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Arsenic	14.3		mg/kg	Yes	14.3	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Cadmium	0.34		mg/kg	Yes	0.34	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Chromium	30		mg/kg	Yes	30	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Copper	60.5		mg/kg	Yes	60.5	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Lead	31.2		mg/kg	Yes	31.2	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Mercury	0.151		mg/kg	Yes	0.151	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Silver	0.26	J	mg/kg	Yes	0.26	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Zinc	123		mg/kg	Yes	123	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	2-Methylnaphthalene	19.6	U	ug/kg	No	0.879	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Acenaphthene	11.8	J	ug/kg	Yes	0.529	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Anthracene	42.8		ug/kg	Yes	1.92	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Benzo(a)anthracene	94.9		ug/kg	Yes	4.26	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Benzo(a)pyrene	95.4		ug/kg	Yes	4.28	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Benzo(g,h,i)perylene	80.7		ug/kg	Yes	3.62	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Total benzofluoranthenes	259		ug/kg	Yes	11.6	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Chrysene	191		ug/kg	Yes	8.57	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Dibenzo(a,h)anthracene	43.1	J	ug/kg	Yes	1.93	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Dibenzofuran	9.5	J	ug/kg	Yes	0.43	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Fluoranthene	252		ug/kg	Yes	11.3	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Fluorene	16.2	J	ug/kg	Yes	0.726	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Indeno(1,2,3-cd)pyrene	75.9		ug/kg	Yes	3.4	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Naphthalene	12	J	ug/kg	Yes	0.538	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Phenanthrene	82		ug/kg	Yes	3.68	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Pyrene	218		ug/kg	Yes	9.78	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Total HPAHs	1310	J	ug/kg	Yes	58.7	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Total LPAHs	175.4	J	ug/kg	Yes	7.87	mg/kg OC
1.9	HH ESD RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	cPAHs - mammal - half DL	158	J	ug/kg	Yes	158	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Bis(2-ethylhexyl)phthalate	203		ug/kg	Yes	9.1	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Butyl benzyl phthalate	41.1		ug/kg	Yes	1.84	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Dimethyl phthalate	19.6	U	ug/kg	No	0.879	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	1,2,4-Trichlorobenzene	4.9	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	1,2-Dichlorobenzene	4.9	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	1,4-Dichlorobenzene	1.9	J	ug/kg	Yes	0.085	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	2,4-Dimethylphenol	24.5	U	ug/kg	No	24.5	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	4-Methylphenol	19.6	U	ug/kg	No	19.6	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Benzoic acid	20.1	J	ug/kg	Yes	20.1	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Benzyl alcohol	62.1		ug/kg	Yes	62.1	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Hexachlorobenzene	4.9	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	n-Nitrosodiphenylamine	4.9	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Pentachlorophenol	19.6	UJ	ug/kg	No	19.6	ug/kg

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
			Recent Data										
1.9	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Phenol	21.1	J	ug/kg	Yes	21.1	ug/kg
1.9	HH RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 2018	LDW18-SS-183	LDW18-SS-183	N	02-Mar-18	Total PCB Aroclors	197.3		ug/kg	Yes	8.85	mg/kg OC
1.9	HH RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Arsenic	20		mg/kg	Yes	20	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Cadmium	0.4		mg/kg	Yes	0.4	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Chromium	28		mg/kg	Yes	28	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Copper	47.5		mg/kg	Yes	47.5	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Lead	18		mg/kg	Yes	18	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Mercury	0.11		mg/kg	Yes	0.11	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Silver	0.6	U	mg/kg	No	0.6	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Zinc	99		mg/kg	Yes	99	mg/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	2-Methylnaphthalene	20	U	ug/kg	No	0.66	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Acenaphthene	19	J	ug/kg	Yes	0.63	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Anthracene	23		ug/kg	Yes	0.76	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Benzo(a)anthracene	70		ug/kg	Yes	2.3	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Benzo(a)pyrene	46		ug/kg	Yes	1.5	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Benzo(g,h,i)perylene	16	J	ug/kg	Yes	0.53	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Total benzofluoranthenes	140		ug/kg	Yes	4.7	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Chrysene	79		ug/kg	Yes	2.6	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Dibenzo(a,h)anthracene	7.4		ug/kg	Yes	0.25	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Dibenzofuran	20	U	ug/kg	No	0.66	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Fluoranthene	200		ug/kg	Yes	6.6	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Fluorene	17	J	ug/kg	Yes	0.56	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Indeno(1,2,3-cd)pyrene	18	J	ug/kg	Yes	0.6	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Naphthalene	20	U	ug/kg	No	0.66	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Phenanthrene	73		ug/kg	Yes	2.4	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Pyrene	150		ug/kg	Yes	5	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Total HPAHs	730	J	ug/kg	Yes	24	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Total LPAHs	132	J	ug/kg	Yes	4.39	mg/kg OC
1.9	HH ESD RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	cPAHs - mammal - half DL	73	J	ug/kg	Yes	73	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Bis(2-ethylhexyl)phthalate	63		ug/kg	Yes	2.1	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Butyl benzyl phthalate	8.4		ug/kg	Yes	0.28	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Dimethyl phthalate	5	U	ug/kg	No	0.17	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	1,2,4-Trichlorobenzene	5	U	ug/kg	No	0.17	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	1,2-Dichlorobenzene	5	U	ug/kg	No	0.17	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	1,4-Dichlorobenzene	5	U	ug/kg	No	0.17	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	2,4-Dimethylphenol	5	U	ug/kg	No	5	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	4-Methylphenol	110		ug/kg	Yes	110	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Benzoic acid	160	J	ug/kg	Yes	160	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Benzyl alcohol	170		ug/kg	Yes	170	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Hexachlorobenzene	5	U	ug/kg	No	0.17	mg/kg OC
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	n-Nitrosodiphenylamine	5	U	ug/kg	No	0.17	mg/kg OC

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Recent Data										
			Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Pentachlorophenol	25	U	ug/kg	No	25	ug/kg
1.9	Benthic RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Phenol	86		ug/kg	Yes	86	ug/kg
1.9	HH RAL (10cm, RC2)	LDW outfall sediment survey	LDW-SSPSF-D	LDW-SSPSF-D	N	07-Mar-11	Total PCB Aroclors	46		ug/kg	Yes	1.5	mg/kg OC
1.9	HH RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Arsenic	10	J	mg/kg	Yes	10	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Cadmium	0.5		mg/kg	Yes	0.5	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Chromium	31		mg/kg	Yes	31	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Copper	52.3	J	mg/kg	Yes	52.3	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Lead	29		mg/kg	Yes	29	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Mercury	0.14		mg/kg	Yes	0.14	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Silver	0.6	U	mg/kg	No	0.6	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Zinc	107	J	mg/kg	Yes	107	mg/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	2-Methylnaphthalene	17	J	ug/kg	Yes	0.78	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Acenaphthene	19		ug/kg	Yes	0.88	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Anthracene	190		ug/kg	Yes	8.8	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Benzo(a)anthracene	200		ug/kg	Yes	9.2	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Benzo(a)pyrene	130		ug/kg	Yes	6	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Benzo(g,h,i)perylene	80	J	ug/kg	Yes	3.7	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Total benzofluoranthenes	330		ug/kg	Yes	15	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Chrysene	300		ug/kg	Yes	14	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Dibenzo(a,h)anthracene	26		ug/kg	Yes	1.2	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Dibenzofuran	22		ug/kg	Yes	1	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Fluoranthene	680		ug/kg	Yes	31	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Fluorene	36		ug/kg	Yes	1.7	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Indeno(1,2,3-cd)pyrene	73	J	ug/kg	Yes	3.4	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Naphthalene	19		ug/kg	Yes	0.88	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Phenanthrene	200		ug/kg	Yes	9.2	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Pyrene	540		ug/kg	Yes	25	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Total HPAHs	2360	J	ug/kg	Yes	109	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Total LPAHs	460		ug/kg	Yes	21	mg/kg OC
1.9	HH ESD RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	cPAHs - mammal - half DL	200	J	ug/kg	Yes	200	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Bis(2-ethylhexyl)phthalate	170		ug/kg	Yes	7.8	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Butyl benzyl phthalate	18		ug/kg	Yes	0.83	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Dimethyl phthalate	4.8	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	1,2,4-Trichlorobenzene	4.8	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	1,2-Dichlorobenzene	4.8	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	1,4-Dichlorobenzene	4.8	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	2,4-Dimethylphenol	4.8	U	ug/kg	No	4.8	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	4-Methylphenol	36		ug/kg	Yes	36	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Benzoic acid	290		ug/kg	Yes	290	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Benzyl alcohol	240		ug/kg	Yes	240	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Hexachlorobenzene	4.8	U	ug/kg	No	0.22	mg/kg OC

Exhibit D-1

RAL Status

			Recent Data										
RM	Trumped RAL Criteria	Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	n-Nitrosodiphenylamine	4.8	U	ug/kg	No	0.22	mg/kg OC
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Pentachlorophenol	7.3	J	ug/kg	Yes	7.3	ug/kg
1.9	Benthic RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Phenol	42		ug/kg	Yes	42	ug/kg
1.9	HH RAL (10cm, RC3)	LDW outfall sediment survey	LDW-SS2022-D	LDW-SS2022-D	N	24-Mar-11	Total PCB Aroclors	370		ug/kg	Yes	17	mg/kg OC
2.1	HH RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Arsenic	13.5		mg/kg	Yes	13.5	mg/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Chromium	32.9		mg/kg	Yes	32.9	mg/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Lead	60.9		mg/kg	Yes	60.9	mg/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Mercury	0.0937		mg/kg	Yes	0.0937	mg/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	2-Methylnaphthalene	15.1	J	ug/kg	Yes	15.1	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Acenaphthene	15.8	J	ug/kg	Yes	15.8	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Anthracene	57.9		ug/kg	Yes	57.9	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Benzo(a)anthracene	72.1		ug/kg	Yes	72.1	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Benzo(a)pyrene	100		ug/kg	Yes	100	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Benzo(g,h,i)perylene	132		ug/kg	Yes	132	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Total benzofluoranthenes	228		ug/kg	Yes	228	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Chrysene	134		ug/kg	Yes	134	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Dibenzo(a,h)anthracene	37.5	J	ug/kg	Yes	37.5	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Dibenzofuran	11.9	J	ug/kg	Yes	11.9	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Fluoranthene	223		ug/kg	Yes	223	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Fluorene	19.8		ug/kg	Yes	19.8	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Indeno(1,2,3-cd)pyrene	96.7		ug/kg	Yes	96.7	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Naphthalene	18.7	J	ug/kg	Yes	18.7	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Phenanthrene	109		ug/kg	Yes	109	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Pyrene	225		ug/kg	Yes	225	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Total HPAHs	1200	J	ug/kg	Yes	1200	ug/kg
2.1	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	Total LPAHs	236	J	ug/kg	Yes	236	ug/kg
2.1	HH ESD RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-091	LDW18-SS-091	N	28-Feb-18	cPAHs - mammal - half DL	200	J	ug/kg	Yes	200	ug/kg
2.2	HH RAL (10cm, RC2)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-181	LDW18-SS-181	N	28-Feb-18	Total PCB Aroclors	6900		ug/kg	Yes	6900	ug/kg
2.2	HH RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Arsenic	6	U	mg/kg	No	6	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Cadmium	0.3	U	mg/kg	No	0.3	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Chromium	17.7		mg/kg	Yes	17.7	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Lead	30		mg/kg	Yes	30	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Mercury	0.06		mg/kg	Yes	0.06	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Silver	0.4	U	mg/kg	No	0.4	mg/kg
2.2	HH RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Arsenic	6	U	mg/kg	No	6	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Cadmium	0.3	U	mg/kg	No	0.3	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Chromium	17.7		mg/kg	Yes	17.7	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Lead	30		mg/kg	Yes	30	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Mercury	0.06		mg/kg	Yes	0.06	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	SED4	ICS-SED4-SE-091914	N	19-Sep-14	Silver	0.4	U	mg/kg	No	0.4	mg/kg
2.2	HH RAL (10cm, RC2)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-180	LDW18-SS-180	N	28-Feb-18	Total PCB Aroclors	1420		ug/kg	Yes	55.7	mg/kg OC

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Recent Data										
			Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
2.2	HH RAL (10cm, RC2)	Industrial Container Services (EAA 2)	DSS26	ICS-DSS26-SE-091914	N	19-Sep-14	Arsenic	20	U	mg/kg	No	20	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	DSS26	ICS-DSS26-SE-091914	N	19-Sep-14	Cadmium	0.9		mg/kg	Yes	0.9	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	DSS26	ICS-DSS26-SE-091914	N	19-Sep-14	Chromium	151		mg/kg	Yes	151	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	DSS26	ICS-DSS26-SE-091914	N	19-Sep-14	Lead	665		mg/kg	Yes	665	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	DSS26	ICS-DSS26-SE-091914	N	19-Sep-14	Mercury	0.47		mg/kg	Yes	0.47	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	DSS26	ICS-DSS26-SE-091914	N	19-Sep-14	Silver	1	U	mg/kg	No	1	mg/kg
2.2	HH RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Arsenic	51		mg/kg	Yes	51	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Cadmium	2		mg/kg	Yes	2	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Chromium	85		mg/kg	Yes	85	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Copper	272		mg/kg	Yes	272	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Lead	120		mg/kg	Yes	120	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Mercury	0.09		mg/kg	Yes	0.09	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Silver	2	U	mg/kg	No	2	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Zinc	1120		mg/kg	Yes	1120	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	2-Methylnaphthalene	49		ug/kg	Yes	49	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Acenaphthene	170		ug/kg	Yes	170	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Anthracene	3500		ug/kg	Yes	3500	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzo(a)anthracene	4800		ug/kg	Yes	4800	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzo(a)pyrene	6000		ug/kg	Yes	6000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzo(g,h,i)perylene	10000		ug/kg	Yes	10000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total benzofluoranthenes	10000		ug/kg	Yes	10000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Chrysene	6300		ug/kg	Yes	6300	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Dibenzo(a,h)anthracene	2200		ug/kg	Yes	2200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Dibenzofuran	120		ug/kg	Yes	120	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Fluoranthene	13000		ug/kg	Yes	13000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Fluorene	210		ug/kg	Yes	210	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Indeno(1,2,3-cd)pyrene	7600		ug/kg	Yes	7600	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Naphthalene	86		ug/kg	Yes	86	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Phenanthrene	3200		ug/kg	Yes	3200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Pyrene	11000		ug/kg	Yes	11000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total HPAHs	71000		ug/kg	Yes	71000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total LPAHs	8100		ug/kg	Yes	8100	ug/kg
2.2	HH ESD RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	cPAHs - mammal - half DL	9200		ug/kg	Yes	9200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Bis(2-ethylhexyl)phthalate	1200		ug/kg	Yes	1200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Butyl benzyl phthalate	23000		ug/kg	Yes	23000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Dimethyl phthalate	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	1,2,4-Trichlorobenzene	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	1,2-Dichlorobenzene	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	1,4-Dichlorobenzene	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	2,4-Dimethylphenol	330	J	ug/kg	Yes	330	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	4-Methylphenol	520		ug/kg	Yes	520	ug/kg

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
			Recent Data										
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzoic acid	610	J	ug/kg	Yes	610	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzyl alcohol	31	J	ug/kg	Yes	31	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Hexachlorobenzene	9.5	U	ug/kg	No	9.5	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	n-Nitrosodiphenylamine	57	UJ	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Pentachlorophenol	120	J	ug/kg	Yes	120	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Phenol	280		ug/kg	Yes	280	ug/kg
2.2	HH RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total PCB Aroclors	76	J	ug/kg	Yes	76	ug/kg
2.2	HH RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Arsenic	51		mg/kg	Yes	51	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Cadmium	2		mg/kg	Yes	2	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Chromium	85		mg/kg	Yes	85	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Copper	272		mg/kg	Yes	272	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Lead	120		mg/kg	Yes	120	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Mercury	0.09		mg/kg	Yes	0.09	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Silver	2	U	mg/kg	No	2	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Zinc	1120		mg/kg	Yes	1120	mg/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	2-Methylnaphthalene	49		ug/kg	Yes	49	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Acenaphthene	170		ug/kg	Yes	170	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Anthracene	3500		ug/kg	Yes	3500	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzo(a)anthracene	4800		ug/kg	Yes	4800	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzo(a)pyrene	6000		ug/kg	Yes	6000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzo(g,h,i)perylene	10000		ug/kg	Yes	10000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total benzofluoranthenes	10000		ug/kg	Yes	10000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Chrysene	6300		ug/kg	Yes	6300	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Dibenzo(a,h)anthracene	2200		ug/kg	Yes	2200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Dibenzofuran	120		ug/kg	Yes	120	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Fluoranthene	13000		ug/kg	Yes	13000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Fluorene	210		ug/kg	Yes	210	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Indeno(1,2,3-cd)pyrene	7600		ug/kg	Yes	7600	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Naphthalene	86		ug/kg	Yes	86	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Phenanthrene	3200		ug/kg	Yes	3200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Pyrene	11000		ug/kg	Yes	11000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total HPAHs	71000		ug/kg	Yes	71000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total LPAHs	8100		ug/kg	Yes	8100	ug/kg
2.2	HH ESD RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	cPAHs - mammal - half DL	9200		ug/kg	Yes	9200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Bis(2-ethylhexyl)phthalate	1200		ug/kg	Yes	1200	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Butyl benzyl phthalate	23000		ug/kg	Yes	23000	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Dimethyl phthalate	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	1,2,4-Trichlorobenzene	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	1,2-Dichlorobenzene	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	1,4-Dichlorobenzene	57	U	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	2,4-Dimethylphenol	330	J	ug/kg	Yes	330	ug/kg

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
			Recent Data										
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	4-Methylphenol	520		ug/kg	Yes	520	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzoic acid	610	J	ug/kg	Yes	610	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Benzyl alcohol	31	J	ug/kg	Yes	31	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Hexachlorobenzene	9.5	U	ug/kg	No	9.5	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	n-Nitrosodiphenylamine	57	UJ	ug/kg	No	57	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Pentachlorophenol	120	J	ug/kg	Yes	120	ug/kg
2.2	Benthic RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Phenol	280		ug/kg	Yes	280	ug/kg
2.2	HH RAL (10cm, RC2)	Lower Duwamish Waterway Bank Sampling	Sea Tac Marine-3	STM-BS-3	N	10-May-11	Total PCB Aroclors	76	J	ug/kg	Yes	76	ug/kg
2.2	HH RAL (10cm, RC2)	Industrial Container Services (EAA 2)	B5a2	ICS-B5a2-SE-091914	N	19-Sep-14	Arsenic	8	U	mg/kg	No	8	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	B5a2	ICS-B5a2-SE-091914	N	19-Sep-14	Cadmium	0.6		mg/kg	Yes	0.6	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	B5a2	ICS-B5a2-SE-091914	N	19-Sep-14	Chromium	55.5		mg/kg	Yes	55.5	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	B5a2	ICS-B5a2-SE-091914	N	19-Sep-14	Lead	136		mg/kg	Yes	136	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	B5a2	ICS-B5a2-SE-091914	N	19-Sep-14	Mercury	0.18		mg/kg	Yes	0.18	mg/kg
2.2	Benthic RAL (10cm, RC2)	Industrial Container Services (EAA 2)	B5a2	ICS-B5a2-SE-091914	N	19-Sep-14	Silver	0.5	U	mg/kg	No	0.5	mg/kg
2.4	HH RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Arsenic	11		mg/kg	Yes	11	mg/kg
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Chromium	23.8		mg/kg	Yes	23.8	mg/kg
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Lead	12.2		mg/kg	Yes	12.2	mg/kg
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Mercury	0.0878		mg/kg	Yes	0.0878	mg/kg
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	2-Methylnaphthalene	10.9	J	ug/kg	Yes	0.727	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Acenaphthene	20	U	ug/kg	No	1.33	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Anthracene	15.2	J	ug/kg	Yes	1.01	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Benzo(a)anthracene	37.3		ug/kg	Yes	2.49	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Benzo(a)pyrene	41.7		ug/kg	Yes	2.78	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Benzo(g,h,i)perylene	37.5		ug/kg	Yes	2.5	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Total benzofluoranthenes	103		ug/kg	Yes	6.87	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Chrysene	58.9		ug/kg	Yes	3.93	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Dibenzo(a,h)anthracene	20	U	ug/kg	No	1.33	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Dibenzofuran	20	U	ug/kg	No	1.33	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Fluoranthene	85.4		ug/kg	Yes	5.69	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Fluorene	8.1	J	ug/kg	Yes	0.54	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Indeno(1,2,3-cd)pyrene	32.1		ug/kg	Yes	2.14	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Naphthalene	12.9	J	ug/kg	Yes	0.86	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Phenanthrene	59.2		ug/kg	Yes	3.95	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Pyrene	90.2		ug/kg	Yes	6.01	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Total HPAHs	486		ug/kg	Yes	32.4	mg/kg OC
2.4	Benthic RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	Total LPAHs	95.4	J	ug/kg	Yes	6.36	mg/kg OC
2.4	HH ESD RAL (10cm, RC3)	LDW AOC3 in-water sediment sampling 201	LDW18-SS-101	LDW18-SS-101	N	28-Feb-18	cPAHs - mammal - half DL	63.5		ug/kg	Yes	63.5	ug/kg
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER510	SD-PER510-0315	N	11-Mar-15	Total PCB Aroclors	300		ug/kg	Yes	300	ug/kg
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER513	SD-PER513-0315	N	11-Mar-15	Total PCB Aroclors	550		ug/kg	Yes	550	ug/kg
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER515	SD-PER515-0315	N	13-Mar-15	Total PCB Aroclors	310		ug/kg	Yes	11	mg/kg OC
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER508	SD-PER508-0315	N	11-Mar-15	Total PCB Aroclors	340		ug/kg	Yes	10	mg/kg OC

Exhibit D-1

RAL Status

RM	Trumped RAL Criteria	Task	Location Name	Sample Name	Sample Type	Sample Date	Chemical	Value	Qualifier	Unit	Detected	RAL Compared Value	RAL Unit
			Recent Data										
2.8	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER510	SD-PER510-0315	N	11-Mar-15	Mercury	0.18		mg/kg	Yes	0.18	mg/kg
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER510	SD-PER510-0315	N	11-Mar-15	Total PCB Aroclors	300		ug/kg	Yes	300	ug/kg
2.8	HH RAL (10cm, RC2)	Slip 4 8th Avenue Terminals	SG18	SD0058	N	31-Oct-12	Total PCB Aroclors	620		ug/kg	Yes	19	mg/kg OC
2.8	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER513	SD-PER513-0315	N	11-Mar-15	Mercury	0.16		mg/kg	Yes	0.16	mg/kg
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER513	SD-PER513-0315	N	11-Mar-15	Total PCB Aroclors	550		ug/kg	Yes	550	ug/kg
2.8	HH RAL (10cm, RC2)	Slip 4 8th Avenue Terminals	SG20	SD0059	N	31-Oct-12	Total PCB Aroclors	320		ug/kg	Yes	320	ug/kg
2.8	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER515	SD-PER515-0315	N	13-Mar-15	Mercury	0.16	J	mg/kg	Yes	0.16	mg/kg
2.8	HH RAL (10cm, RC2)	Slip 4 8th Avenue Terminals	SG21	SD0060	N	30-Oct-12	Total PCB Aroclors	140		ug/kg	Yes	4.18	mg/kg OC
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER515	SD-PER515-0315	N	13-Mar-15	Total PCB Aroclors	310		ug/kg	Yes	11	mg/kg OC
2.8	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER518	SD-PER518-0315	N	12-Mar-15	Mercury	0.14		mg/kg	Yes	0.14	mg/kg
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER518	SD-PER518-0315	N	12-Mar-15	Total PCB Aroclors	240	J	ug/kg	Yes	240	ug/kg
2.8	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER517	SD-PER517-0315	N	13-Mar-15	Mercury	0.16		mg/kg	Yes	0.16	mg/kg
2.8	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER517	SD-PER517-0315	N	13-Mar-15	Total PCB Aroclors	260		ug/kg	Yes	8.8	mg/kg OC
2.9	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Arsenic	9.6		mg/kg	Yes	9.6	mg/kg
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Cadmium	0.6		mg/kg	Yes	0.6	mg/kg
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Chromium	28.5		mg/kg	Yes	28.5	mg/kg
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Copper	46.8		mg/kg	Yes	46.8	mg/kg
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Lead	18		mg/kg	Yes	18	mg/kg
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Mercury	0.075		mg/kg	Yes	0.075	mg/kg
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Silver	0.5	U	mg/kg	No	0.5	mg/kg
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Zinc	76		mg/kg	Yes	76	mg/kg
2.9	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Total PCB Aroclors	240		ug/kg	Yes	15	mg/kg OC
2.9	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER514	SD-PER514-0315	N	13-Mar-15	Total PCB Aroclors	270		ug/kg	Yes	9.9	mg/kg OC
2.9	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Total PCB Aroclors	240		ug/kg	Yes	15	mg/kg OC
2.9	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER511	SD-PER511-0315	N	16-Mar-15	Total PCB Aroclors	240		ug/kg	Yes	15	mg/kg OC
2.9	Benthic RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER514	SD-PER514-0315	N	13-Mar-15	Mercury	0.11		mg/kg	Yes	0.11	mg/kg
2.9	HH RAL (10cm, RC2)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER514	SD-PER514-0315	N	13-Mar-15	Total PCB Aroclors	270		ug/kg	Yes	9.9	mg/kg OC
2.9	HH RAL (10cm, RC2)	Slip 4 8th Avenue Terminals	SG22	SD0061	N	30-Oct-12	Total PCB Aroclors	170		ug/kg	Yes	5.82	mg/kg OC
3.0	HH RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Arsenic	6.4		mg/kg	Yes	6.4	mg/kg
3.0	Benthic RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Cadmium	0.3		mg/kg	Yes	0.3	mg/kg
3.0	Benthic RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Chromium	18.2		mg/kg	Yes	18.2	mg/kg
3.0	Benthic RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Copper	24.6		mg/kg	Yes	24.6	mg/kg
3.0	Benthic RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Lead	17		mg/kg	Yes	17	mg/kg
3.0	Benthic RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Mercury	0.06		mg/kg	Yes	0.06	mg/kg
3.0	Benthic RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Silver	0.4	U	mg/kg	No	0.4	mg/kg
3.0	Benthic RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Zinc	54		mg/kg	Yes	54	mg/kg
3.0	HH RAL (10cm, RC3)	Boeing Plant 2 Perimeter monitoring - End o	SD-PER206	SD-PER206-0315	N	18-Mar-15	Total PCB Aroclors	93		ug/kg	Yes	18	mg/kg OC

Exhibit D-1

RAL Status

RM	RAL	Exceeds RAL	RAL EF	RAL Criteria	Recovery Category	Older exceedance replaced by recent non-exceedance	Older non-exceedance replaced by recent exceedance	Exceedance for older or more recent sample
1.9	57	No	0.35	HH RAL (10cm, RC3)	3	No	No	No
1.9	10.2	No	0.049	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	520	No	0.06	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	780	No	0.065	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	900	No	0.026	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	0.82	No	0.16	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	12.2	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	820	No	0.17	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	76	No	0.014	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	32	No	0.17	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	440	No	0.015	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	220	No	0.091	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	198	No	0.061	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	62	No	0.12	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	460	No	0.091	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	220	No	0.18	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	24	No	0.1	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	30	No	0.12	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	320	No	0.26	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	46	No	0.085	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	68	No	0.11	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	198	No	0.0091	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	200	No	0.14	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	2000	No	0.028	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1920	No	0.14	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	740	No	0.062	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	5500	No	0.11	HH ESD RAL (10cm, RC3)	3	No	No	No
1.9	94	No	0.21	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	9.8	No	0.11	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	106	No	0.00086	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1.62	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	4.6	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	6.2	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	58	No	0.072	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1340	No	0.19	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1300	No	0.17	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	114	Yes	1.8	Benthic RAL (10cm, RC3)	3	No	Yes	Yes
1.9	0.76	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	22	No	0.0091	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	720	No	0.017	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	840	No	0.11	Benthic RAL (10cm, RC3)	3	No	No	No

Exhibit D-1

RAL Status

RM	RAL	Exceeds RAL	RAL EF	RAL Criteria	Recovery Category	Older exceedance replaced by recent non-exceedance	Older non-exceedance replaced by recent exceedance	Exceedance for older or more recent sample
1.9	12	No	0.13	HH RAL (10cm, RC3)	3	No	No	No
1.9	57	No	0.25	HH RAL (10cm, RC3)	3	No	No	No
1.9	10.2	No	0.033	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	520	No	0.058	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	780	No	0.078	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	900	No	0.035	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	0.82	No	0.18	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	12.2	No	0.021	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	820	No	0.15	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	76	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	32	No	0.017	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	440	No	0.0044	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	220	No	0.019	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	198	No	0.022	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	62	No	0.058	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	460	No	0.025	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	220	No	0.039	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	24	No	0.08	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	30	No	0.014	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	320	No	0.035	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	46	No	0.016	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	68	No	0.05	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	198	No	0.0027	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	200	No	0.018	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	2000	No	0.0049	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1920	No	0.031	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	740	No	0.011	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	5500	No	0.029	HH ESD RAL (10cm, RC3)	3	No	No	No
1.9	94	No	0.097	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	9.8	No	0.19	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	106	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1.62	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	4.6	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	6.2	No	0.014	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	58	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1340	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	1300	No	0.015	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	114	No	0.54	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	0.76	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	22	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	720	na	na	Benthic RAL (10cm, RC3)	3	No	No	No

Exhibit D-1

RAL Status

RM	RAL	Exceeds RAL	RAL EF	RAL Criteria	Recovery Category	Older exceedance replaced by recent non-exceedance	Older non-exceedance replaced by recent exceedance	Exceedance for older or more recent sample
1.9	840	No	0.025	Benthic RAL (10cm, RC3)	3	No	No	No
1.9	12	No	0.74	HH RAL (10cm, RC3)	3	No	No	No
1.9	57	No	0.35	HH RAL (10cm, RC2)	2	No	No	No
1.9	10.2	No	0.039	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	520	No	0.054	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	780	No	0.061	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	900	No	0.02	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	0.82	No	0.13	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	820	No	0.12	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	76	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	32	No	0.02	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	440	No	0.0017	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	220	No	0.01	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	198	No	0.0076	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	62	No	0.0085	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	460	No	0.01	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	220	No	0.012	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	24	No	0.01	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	30	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	320	No	0.021	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	46	No	0.012	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	68	No	0.0088	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	198	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	200	No	0.012	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	2000	No	0.0025	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1920	No	0.013	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	740	No	0.0059	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	5500	No	0.013	HH ESD RAL (10cm, RC2)	2	No	No	No
1.9	94	No	0.022	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	9.8	No	0.029	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	106	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1.62	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	4.6	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	6.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	58	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1340	No	0.082	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1300	No	0.12	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	114	Yes	1.5	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
1.9	0.76	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	22	na	na	Benthic RAL (10cm, RC2)	2	No	No	No

Exhibit D-1

RAL Status

RM	RAL	**Exceeds RAL**	**RAL EF**	RAL Criteria	Recovery Category	**Older exceedance replaced by recent non-exceedance**	**Older non-exceedance replaced by recent exceedance**	**Exceedance for older or more recent sample**
1.9	720	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	840	No	0.1	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	12	No	0.13	HH RAL (10cm, RC2)	2	No	No	No
1.9	57	No	0.18	HH RAL (10cm, RC2)	2	No	No	No
1.9	10.2	No	0.049	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	520	No	0.06	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	780	No	0.067	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	900	No	0.032	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	0.82	No	0.17	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	820	No	0.13	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	76	No	0.01	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	32	No	0.028	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	440	No	0.02	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	220	No	0.042	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	198	No	0.03	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	62	No	0.06	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	460	No	0.033	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	220	No	0.064	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	24	No	0.05	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	30	No	0.033	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	320	No	0.097	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	46	No	0.037	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	68	No	0.05	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	198	No	0.0044	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	200	No	0.046	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	2000	No	0.013	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1920	No	0.057	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	740	No	0.028	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	5500	No	0.036	HH ESD RAL (10cm, RC2)	2	No	No	No
1.9	94	No	0.083	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	9.8	No	0.085	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	106	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1.62	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	4.6	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	6.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	58	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1340	No	0.027	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	1300	No	0.22	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	114	Yes	2.1	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
1.9	0.76	na	na	Benthic RAL (10cm, RC2)	2	No	No	No

Exhibit D-1

RAL Status

RM	RAL	Exceeds RAL	RAL EF	RAL Criteria	Recovery Category	Older exceedance replaced by recent non-exceedance	Older non-exceedance replaced by recent exceedance	Exceedance for older or more recent sample
1.9	22	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	720	No	0.01	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	840	No	0.05	Benthic RAL (10cm, RC2)	2	No	No	No
1.9	12	Yes	1.4	HH RAL (10cm, RC2)	2	No	No	Yes
2.1	57	No	0.24	HH RAL (10cm, RC3)	3	No	No	No
2.1	520	No	0.063	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	900	No	0.068	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	0.82	No	0.11	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	1340	No	0.011	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	1000	No	0.016	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	1920	No	0.03	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	2600	No	0.028	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	3200	No	0.031	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	1340	No	0.099	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	6400	No	0.036	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	2800	No	0.048	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	460	No	0.082	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	1080	No	0.011	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	3400	No	0.066	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	1080	No	0.018	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	1200	No	0.081	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	4200	No	0.0045	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	3000	No	0.036	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	5200	No	0.043	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	24000	No	0.05	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	10400	No	0.023	Benthic RAL (10cm, RC3)	3	No	No	No
2.1	5500	No	0.036	HH ESD RAL (10cm, RC3)	3	No	No	No
2.2	130	Yes	53	HH RAL (10cm, RC2)	2	No	No	Yes
2.2	57	na	na	HH RAL (10cm, RC2)	2	No	No	No
2.2	10.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	520	No	0.034	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	900	No	0.033	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	0.82	No	0.073	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	57	na	na	HH RAL (10cm, RC2)	2	No	No	No
2.2	10.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	520	No	0.034	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	900	No	0.033	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	0.82	No	0.073	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	12	Yes	4.6	HH RAL (10cm, RC2)	2	No	No	Yes

Exhibit D-1

RAL Status

RM	RAL	Exceeds RAL	RAL EF	RAL Criteria	Recovery Category	Older exceedance replaced by recent non-exceedance	Older non-exceedance replaced by recent exceedance	Exceedance for older or more recent sample
2.2	57	na	na	HH RAL (10cm, RC2)	2	No	No	No
2.2	10.2	No	0.088	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	520	No	0.29	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	900	No	0.74	Benthic RAL (10cm, RC2)	2	Yes	No	Yes
2.2	0.82	No	0.57	Benthic RAL (10cm, RC2)	2	Yes	No	Yes
2.2	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	57	No	0.89	HH RAL (10cm, RC2)	2	Yes	No	Yes
2.2	10.2	No	0.2	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	520	No	0.16	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	780	No	0.35	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	900	No	0.13	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	0.82	No	0.11	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	820	Yes	1.4	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	1340	No	0.037	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	1000	No	0.17	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	1920	Yes	1.8	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	2600	Yes	1.8	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	3200	Yes	1.9	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	1340	Yes	7.5	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	6400	Yes	1.6	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	2800	Yes	2.3	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	460	Yes	4.8	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	1080	No	0.11	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	3400	Yes	3.8	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	1080	No	0.19	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	1200	Yes	6.3	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	4200	No	0.02	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	3000	Yes	1.1	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	5200	Yes	2.1	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	24000	Yes	3	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	10400	No	0.78	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	5500	Yes	1.7	HH ESD RAL (10cm, RC2)	2	No	Yes	Yes
2.2	2600	No	0.46	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	126	Yes	180	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	142	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	62	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	70	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	220	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	58	Yes	5.7	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	1340	No	0.39	Benthic RAL (10cm, RC2)	2	No	No	No

Exhibit D-1

RAL Status

RM	RAL	Exceeds RAL	RAL EF	RAL Criteria	Recovery Category	Older exceedance replaced by recent non-exceedance	Older non-exceedance replaced by recent exceedance	Exceedance for older or more recent sample
2.2	1300	No	0.47	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	114	No	0.27	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	44	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	56	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	720	No	0.17	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	840	No	0.33	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	130	No	0.58	HH RAL (10cm, RC2)	2	No	No	No
2.2	57	No	0.89	HH RAL (10cm, RC2)	2	Yes	No	Yes
2.2	10.2	No	0.2	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	520	No	0.16	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	780	No	0.35	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	900	No	0.13	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	0.82	No	0.11	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	820	Yes	1.4	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	1340	No	0.037	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	1000	No	0.17	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	1920	Yes	1.8	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	2600	Yes	1.8	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	3200	Yes	1.9	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	1340	Yes	7.5	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	6400	Yes	1.6	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	2800	Yes	2.3	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	460	Yes	4.8	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	1080	No	0.11	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	3400	Yes	3.8	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	1080	No	0.19	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	1200	Yes	6.3	Benthic RAL (10cm, RC2)	2	No	No	Yes
2.2	4200	No	0.02	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	3000	Yes	1.1	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	5200	Yes	2.1	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	24000	Yes	3	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	10400	No	0.78	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	5500	Yes	1.7	HH ESD RAL (10cm, RC2)	2	No	Yes	Yes
2.2	2600	No	0.46	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	126	Yes	180	Benthic RAL (10cm, RC2)	2	No	Yes	Yes
2.2	142	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	62	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	70	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	220	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	58	Yes	5.7	Benthic RAL (10cm, RC2)	2	No	Yes	Yes

Exhibit D-1

RAL Status

RM	RAL	**Exceeds RAL**	**RAL EF**	RAL Criteria	Recovery Category	**Older exceedance replaced by recent non-exceedance**	**Older non-exceedance replaced by recent exceedance**	**Exceedance for older or more recent sample**
2.2	1340	No	0.39	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	1300	No	0.47	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	114	No	0.27	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	44	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	56	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	720	No	0.17	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	840	No	0.33	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	130	No	0.58	HH RAL (10cm, RC2)	2	No	No	No
2.2	57	na	na	HH RAL (10cm, RC2)	2	No	No	No
2.2	10.2	No	0.059	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	520	No	0.11	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	900	No	0.15	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	0.82	No	0.22	Benthic RAL (10cm, RC2)	2	No	No	No
2.2	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.4	57	No	0.19	HH RAL (10cm, RC3)	3	No	No	No
2.4	520	No	0.046	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	900	No	0.014	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	0.82	No	0.11	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	76	No	0.0096	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	32	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	440	No	0.0023	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	220	No	0.011	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	198	No	0.014	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	62	No	0.04	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	460	No	0.015	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	220	No	0.018	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	24	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	30	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	320	No	0.018	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	46	No	0.012	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	68	No	0.031	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	198	No	0.0043	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	200	No	0.02	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	2000	No	0.003	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	1920	No	0.017	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	740	No	0.0086	Benthic RAL (10cm, RC3)	3	No	No	No
2.4	5500	No	0.012	HH ESD RAL (10cm, RC3)	3	No	No	No
2.8	130	Yes	2.3	HH RAL (10cm, RC2)	2	No	No	Yes
2.8	130	Yes	4.2	HH RAL (10cm, RC2)	2	No	No	Yes
2.8	12	No	0.92	HH RAL (10cm, RC2)	2	No	No	No
2.8	12	No	0.83	HH RAL (10cm, RC2)	2	No	No	No

Exhibit D-1

RAL Status

RM	RAL	**Exceeds RAL**	**RAL EF**	RAL Criteria	Recovery Category	**Older exceedance replaced by recent non-exceedance**	**Older non-exceedance replaced by recent exceedance**	**Exceedance for older or more recent sample**
2.8	0.82	No	0.22	Benthic RAL (10cm, RC2)	2	No	No	No
2.8	130	Yes	2.3	HH RAL (10cm, RC2)	2	No	Yes	Yes
2.8	12	Yes	1.6	HH RAL (10cm, RC2)	2	No	Yes	Yes
2.8	0.82	No	0.2	Benthic RAL (10cm, RC2)	2	No	No	No
2.8	130	Yes	4.2	HH RAL (10cm, RC2)	2	No	Yes	Yes
2.8	130	Yes	2.5	HH RAL (10cm, RC2)	2	No	Yes	Yes
2.8	0.82	No	0.2	Benthic RAL (10cm, RC2)	2	No	No	No
2.8	12	No	0.35	HH RAL (10cm, RC2)	2	No	No	No
2.8	12	No	0.92	HH RAL (10cm, RC2)	2	No	No	No
2.8	0.82	No	0.17	Benthic RAL (10cm, RC2)	2	No	No	No
2.8	130	Yes	1.8	HH RAL (10cm, RC2)	2	No	Yes	Yes
2.8	0.82	No	0.2	Benthic RAL (10cm, RC2)	2	No	No	No
2.8	12	No	0.73	HH RAL (10cm, RC2)	2	No	No	No
2.9	57	No	0.17	HH RAL (10cm, RC2)	2	No	No	No
2.9	10.2	No	0.059	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	520	No	0.055	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	780	No	0.06	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	900	No	0.02	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	0.82	No	0.091	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	12.2	na	na	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	820	No	0.093	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	12	Yes	1.3	HH RAL (10cm, RC2)	2	No	Yes	Yes
2.9	12	No	0.83	HH RAL (10cm, RC2)	2	No	No	No
2.9	12	Yes	1.3	HH RAL (10cm, RC2)	2	No	No	Yes
2.9	12	Yes	1.3	HH RAL (10cm, RC2)	2	No	No	Yes
2.9	0.82	No	0.13	Benthic RAL (10cm, RC2)	2	No	No	No
2.9	12	No	0.83	HH RAL (10cm, RC2)	2	No	No	No
2.9	12	No	0.49	HH RAL (10cm, RC2)	2	No	No	No
3.0	57	No	0.11	HH RAL (10cm, RC3)	3	No	No	No
3.0	10.2	No	0.029	Benthic RAL (10cm, RC3)	3	No	No	No
3.0	520	No	0.035	Benthic RAL (10cm, RC3)	3	No	No	No
3.0	780	No	0.032	Benthic RAL (10cm, RC3)	3	No	No	No
3.0	900	No	0.019	Benthic RAL (10cm, RC3)	3	No	No	No
3.0	0.82	No	0.073	Benthic RAL (10cm, RC3)	3	No	No	No
3.0	12.2	na	na	Benthic RAL (10cm, RC3)	3	No	No	No
3.0	820	No	0.066	Benthic RAL (10cm, RC3)	3	No	No	No
3.0	12	Yes	1.5	HH RAL (10cm, RC3)	3	No	Yes	Yes

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Attachment E
Supplemental RI/FS Surface Sediment Data and Data from Deepened Areas

This attachment provides a summary of the remedial investigation/feasibility study (RI/FS) surface sediment data and the data associated with areas that have experienced >1.5 ft of deepening since 2003 (based on an isopach map developed from 2003 and 2021 bathymetric surveys). These data are not included in the design dataset, as described in Section 3.1 of the Pre-Design Investigation work plan, and they will not be included in the data interpolation to define remedial action level (RAL) exceedance areas. Instead, these supplemental data are presented herein because they are useful for informing the sampling design. For example, two RI/FS surface sediment locations with RAL exceedance factors greater than 4 will be re-occupied (see Section 4.1.3 in the middle reach Quality Assurance Project Plan).

The numbers of locations for each RAL interval in these supplemental data relative to those in the design dataset are summarized in Table E-1. The RAL exceedances for both the supplemental data and the design dataset locations are presented in Map E-1. Maps E-2 and E-3 present the supplemental and design dataset data by age to provide additional context.

Table E-1
Summary of the supplemental data and the Middle Reach Design Dataset locations

Sediment Sample Interval	Supplemental Data Locations		Design Dataset Locations
	RI/FS (1990–2010)	Deepened Areas	
Surface (0–10 cm)	239	8	227
Intertidal subsurface (0–45 cm)	0	1[1]	2[1]
Subtidal subsurface (0–60 cm)	0	3	28
Shoaling (depth varies)	0	0	8[2]
Non-RAL intervals (including deeper intervals)[3]	0	5[4]	40

Notes:

1. The 0–45-cm core in the deepened area and one of the design dataset locations were only analyzed for PCBs.
2. Two shoaling area locations characterized only the top portion of the shoal (i.e., the top 4 ft and top 2 ft).
3. Includes intertidal and subtidal core locations with sample intervals that characterize sediment deeper than 60 cm (e.g., 3–4-ft or 4–6-ft intervals). Some core locations in this category are also included in the 0–60-cm count. In addition, this category includes subsurface samples that are not RAL-defined intervals (e.g., 0–3-ft cores). Details regarding these samples are presented in Attachment G.
4. Three locations have 0–60-cm intervals as well and are also counted as subtidal subsurface locations.

FS: feasibility study
PCB: polychlorinated biphenyl
RAL: remedial action level
RI: remedial investigation

The number of samples analyzed for each of the risk drivers and the number of RAL exceedances in each specific depth interval are summarized in Table E-2 for the supplemental data. For each contaminant, samples were only counted for a given analyte if there was a RAL for that interval.

Table E-2
Summary of Supplemental Data Associated with RI/FS Surface Sediment Samples and Deepened Areas

Risk Driver Chemical	Sediment Interval[1]	Supplemental data samples: Total Count[1] – RI/FS	Supplemental data samples: Total Count[1] – Deepened Areas	Supplemental data samples: Count with RAL Exceedances[2] – RI/FS	Supplemental data samples: Count with RAL Exceedances[2] – Deepened Areas
Total PCBs	Surface (0–10 cm)[3]	232	8	52	4
	Intertidal subsurface (0–45 cm)	no data	1	-	1
	Subtidal subsurface (0–60 cm)	no data	3	-	1
cPAH TEQ	Surface (0–10 cm)[3]	150	4	0	0
	Intertidal subsurface (0–45 cm)	no data	no data	-	-
	Subtidal subsurface (0–60 cm)	no data	3	-	0
Dioxin/ Furan TEQ	Surface (0–10 cm)[3]	24	2	2	0
	Intertidal subsurface (0–45 cm)	no data	no data	-	-
	Subtidal subsurface (0–60 cm)	no data	no data	-	-
Arsenic	Surface (0–10 cm)[3]	147	4	1	1
	Intertidal subsurface (0–45 cm)	no data	no data	-	-
	Subtidal subsurface (0–60 cm)	no data	3	-	0
Other Benthic Risk Drivers[4]	Surface (0–10 cm)[3]	156	4	15	0
	Intertidal subsurface (0–45 cm)[5]	no data	no data	-	-
	Subtidal subsurface (0–60 cm)[5]	no data	3	-	0

Notes:

1. Only discrete samples are included in the design dataset. Information regarding composite samples is presented in Attachment H.
2. The total count includes only samples with a RAL for that risk driver in that interval. For example, there is one additional 0–60-cm sample with dioxin/furan data in a Recovery Category 3 area, which does not have a 0–60-cm RAL for dioxin/furan. Therefore, this sample is not included in the number of dioxin/furan samples for that interval. RAL exceedances are defined as detected COC concentrations greater than the RALs in the 2014 ROD RAL and 2021 cPAH ESD.
3. Surface samples include those in intertidal and subtidal areas.
4. These drivers include all benthic risk drivers except PCBs and arsenic, which are summed separately as human health risk drivers. Because benzyl alcohol is not a CERCLA hazardous substance, benzyl alcohol data will not be included in the DERs. Benzyl alcohol data obtained through routine SVOC analysis of the PDI sediment samples will be provided to EPA.
5. Benthic RALs for these sediment intervals only apply in Recovery Category 1 and shoal areas.

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act
COC: contaminant of concern
cPAH: carcinogenic polycyclic aromatic hydrocarbon
DER: data evaluation report
EPA: US Environmental Protection Agency

ESD: Explanation of Significant Differences
FS: feasibility study
PCB: polychlorinated biphenyl
RAL: remedial action level
RI: remedial investigation
ROD: Record of Decision
SVOC: semivolatile organic compound
TEQ: toxic equivalent

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0 200 400 Feet

0 50 100 Meters

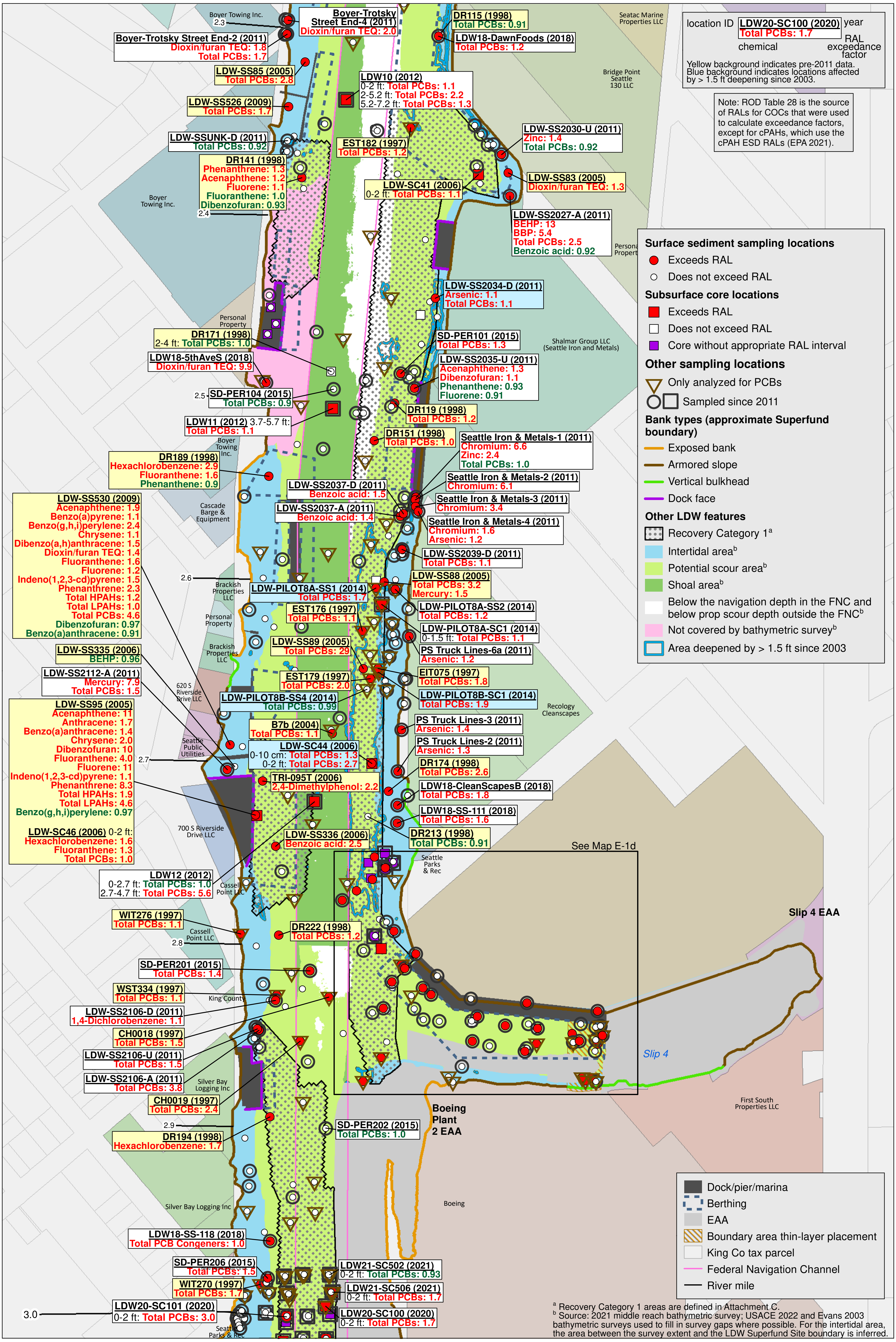
N

Map E-1a. Sediment RAL exceedances for all data in LDW database, RM 1.6 to RM 2.3

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map E-1a 7321 Middle reach RM1.6-2.3.mxd



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0 200 400 Feet
0 50 100 Meters

Map E-1b. Sediment RAL exceedances for all data in LDW database, RM 2.3 to RM 3.0

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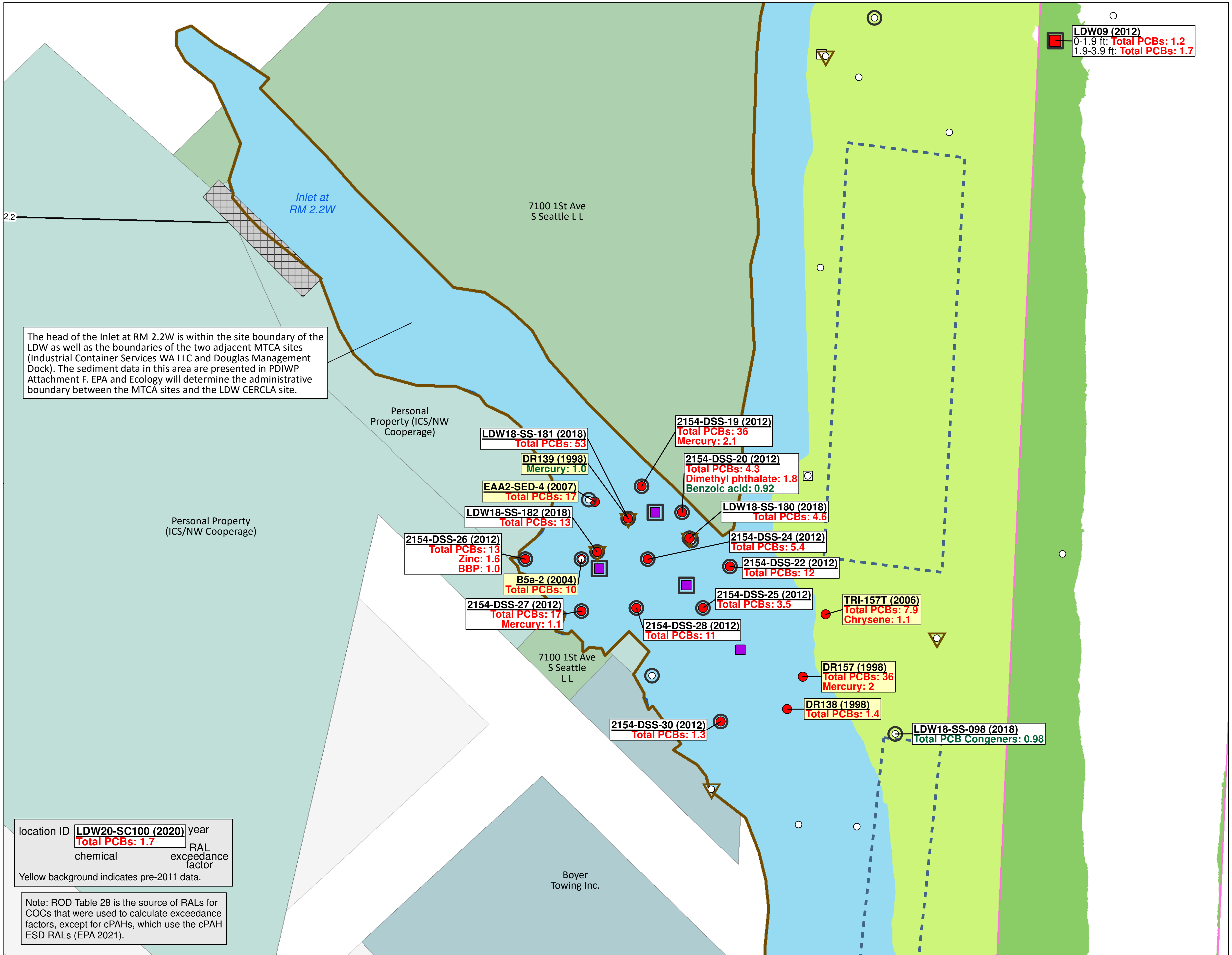

Surface sediment sampling locations

- Exceeds RAL
- Does not exceed RAL

Subsurface core locations

- Exceeds RAL
- Does not exceed RAL
- Core without appropriate RAL interval

Other sampling locations

- Only analyzed for PCBs
- Sampled since 2011

Bank types (approximate Superfund boundary)

- Armored slope

Middle reach bathymetry[a]

- Intertidal area
- Potential scour area
- Shoal area
- Below the navigation depth in the FNC and below prop scour depth outside the FNC
- Dock/pier
- Berthing
- King Co tax parcel
- Federal Navigation Channel
- River mile

[a] Source: 2021 middle reach bathymetric survey; USACE 2022 and Evans 2003 bathymetric surveys used to fill in survey gaps where possible. For the intertidal area, the area between the survey extent and the LDW Superfund Site boundary is inferred.

0 10 20 Yards

0 10 20 Meters

Map E-1c. Sediment RAL exceedances for all data in LDW database east of the preliminary administrative boundary within and adjacent to the Industrial Container Services MTCA site

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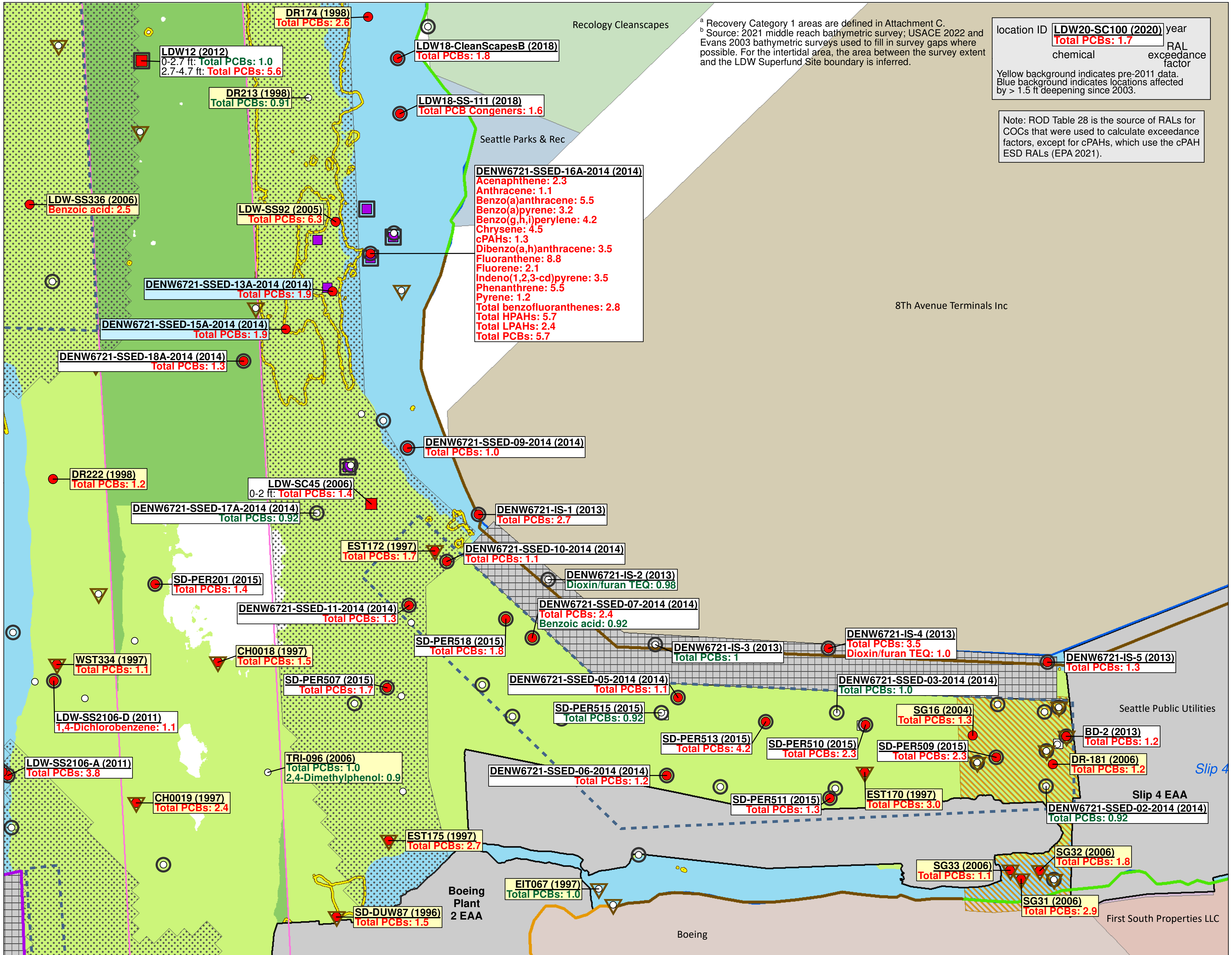

Surface sediment sampling locations
- Exceeds RAL
- Does not exceed RAL

Subsurface core locations
- Exceeds RAL
- Does not exceed RAL
- Core without appropriate RAL interval

Other sampling locations
- Only analyzed for PCBs
- Sampled since 2011

Bank types (approximate Superfund boundary)
- Exposed bank
- Armored slope
- Vertical bulkhead
- Dock face

Other LDW features
- Recovery Category 1[a]
- Intertidal area[b]
- Potential scour area[b]
- Shoal area[b]
- Below the navigation depth in the FNC and below prop scour depth outside the FNC[b]
- Not covered by bathymetric survey[b]
- Area deepened by > 1.5 ft since 2003
- Early Action Area
- Boundary area thin-layer placement
- Dock/pier
- Berthing
- King Co tax parcel
- Federal Navigation Channel

0 20 40 Yards
0 20 40 Meters

Map E-1d. Sediment RAL exceedances for all data in LDW database in the vicinity of Slip 4

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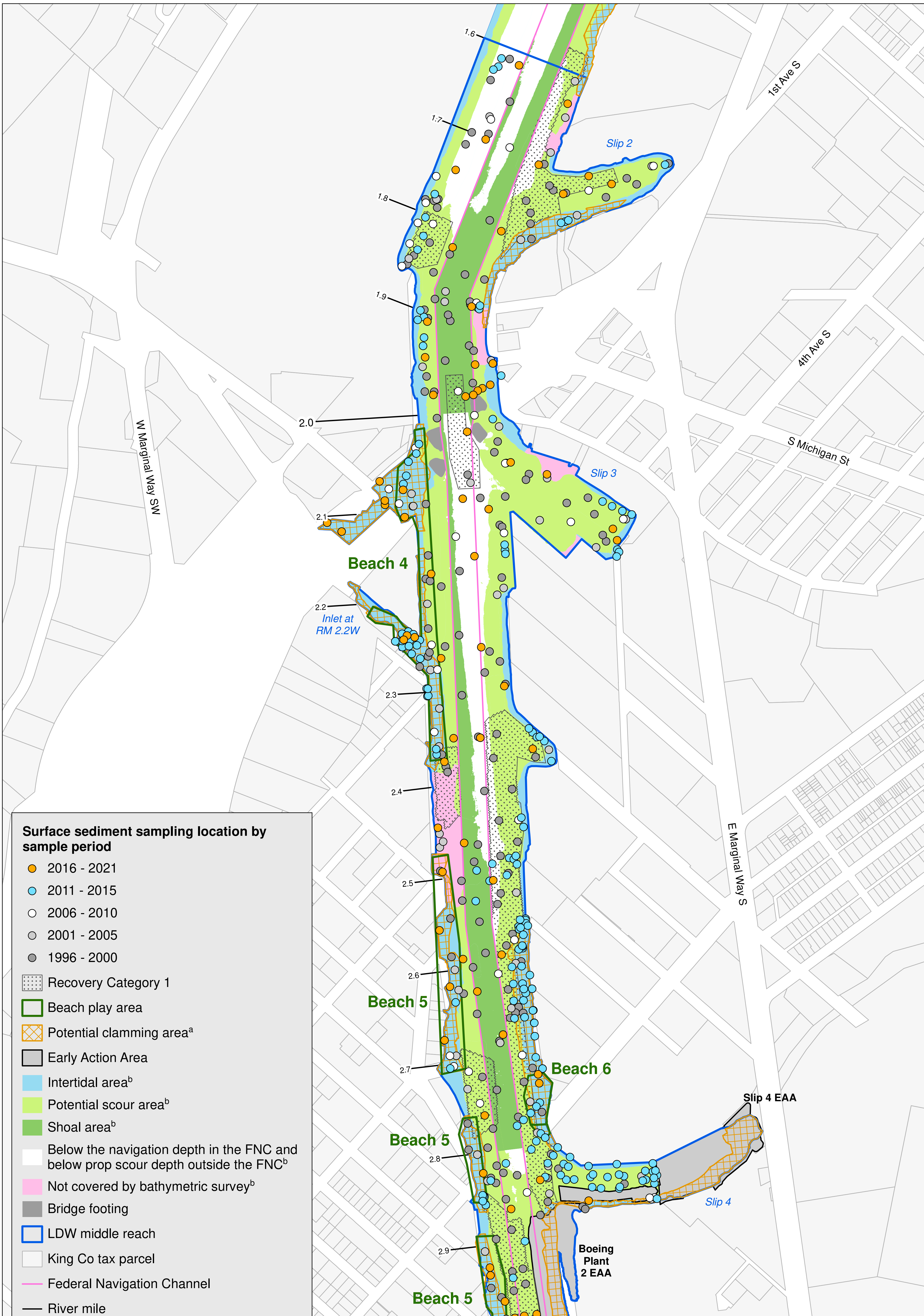

[a] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012).
[b] Source: 2021 middle reach bathymetric survey; USACE 2022 and Evans 2003 bathymetric surveys used to fill in survey gaps where possible. For the intertidal area, the area between the survey extent and the LDW Superfund Site boundary is inferred.

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0 500 1,000 Feet
0 100 200 Meters

Map E-2. Existing surface sediment sampling locations in the LDW middle reach by sample period

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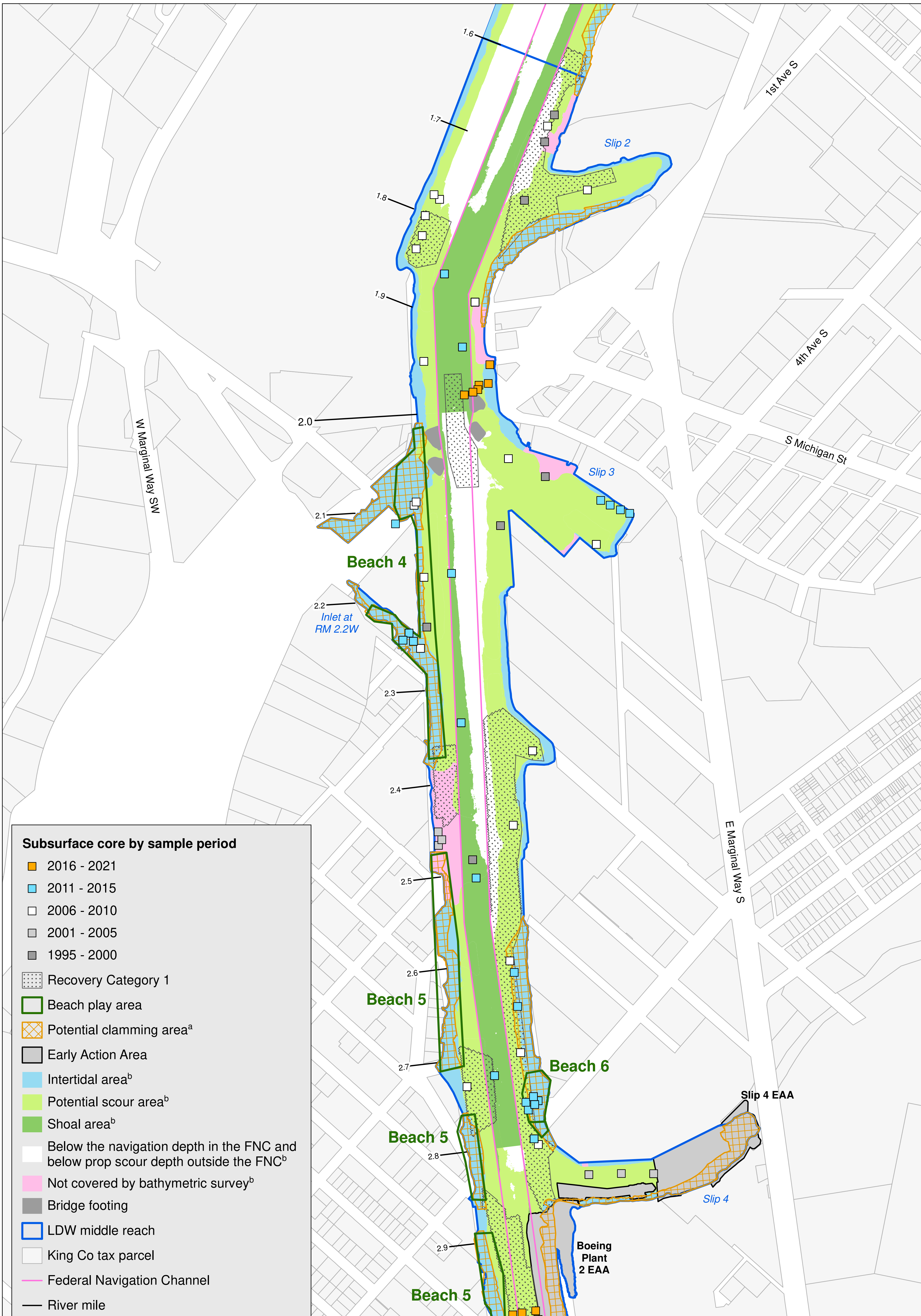
FEBRUARY 14, 2023

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map E-2 7321 Middle reach sediment by date - surface.mxd



[a] Conditions depicted in this figure are representative of information and criteria provided in the Intertidal Clam Survey Data Report (2004, Figure 1d) as updated and presented in the Lower Duwamish Waterway Final Feasibility Study (2012).
[b] Source: 2021 middle reach bathymetric survey; USACE 2022 and Evans 2003 bathymetric surveys used to fill in survey gaps where possible. For the intertidal area, the area between the survey extent and the LDW Superfund Site boundary is inferred.

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Map E-3. Existing subsurface sediment sampling locations in the LDW middle reach by sample period

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FEBRUARY 14, 2023

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Attachment F
Data for RM 2.2W Inlet

F.1 Industrial Container Services Inlet Sediment Data

The inlet at river mile 2.2W is within the upland Model Toxics Control Act (MTCA) site boundaries for two adjacent upland cleanup sites: Industrial Container Services NW LLC (ICS) and the Douglas Management dock. The Washington State Department of Ecology entered into an Agreed Order with Herman and Jacqualine Trotsky (owners) and ICS (operators) in 2010 (Ecology 2010). The order required a remedial investigation/feasibility study to define the nature and extent of contamination in soil, groundwater, surface water, and sediment. A Public Review draft remedial investigation report has been prepared; the draft feasibility study is in progress.

A significant amount of data has been collected in the ICS MTCA site, which includes an inlet of the Lower Duwamish Waterway (LDW) at river mile 2.2W. The sediment in this area has been extensively characterized for the remedial investigation of the ICS site (DOF 2022). The sediment data for the inlet are summarized in this attachment. The LDW Record of Decision addresses contaminated sediment below the mean higher high water level for the LDW; the Washington State Department of Ecology and US Environmental Protection Agency are discussing whether this inlet area of the middle reach will be remediated under MTCA site orders or under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site cleanup orders, and if so, where the administrative boundary would be. Pending this decision, only data from the eastern half of the inlet have been included in the design dataset summarized herein. The rest of the data are in the LDW database as supplemental data and will be added to the design dataset if the entire area is to be addressed under CERCLA.

The contaminants of concern in the inlet include polychlorinated biphenyls, polycyclic aromatic hydrocarbons, dioxins/furans, lead, mercury, volatile organic compounds, petroleum hydrocarbons, and pesticides. The draft remedial investigation (DOF 2022) contains figures for surface sediment concentrations of polychlorinated biphenyls, lead, mercury, and petroleum hydrocarbons. These figures are provided in Figures F-1 through F-4.

Figure F-1

PCBs in Surface Sediment in the ICS Inlet (DOF 2022)

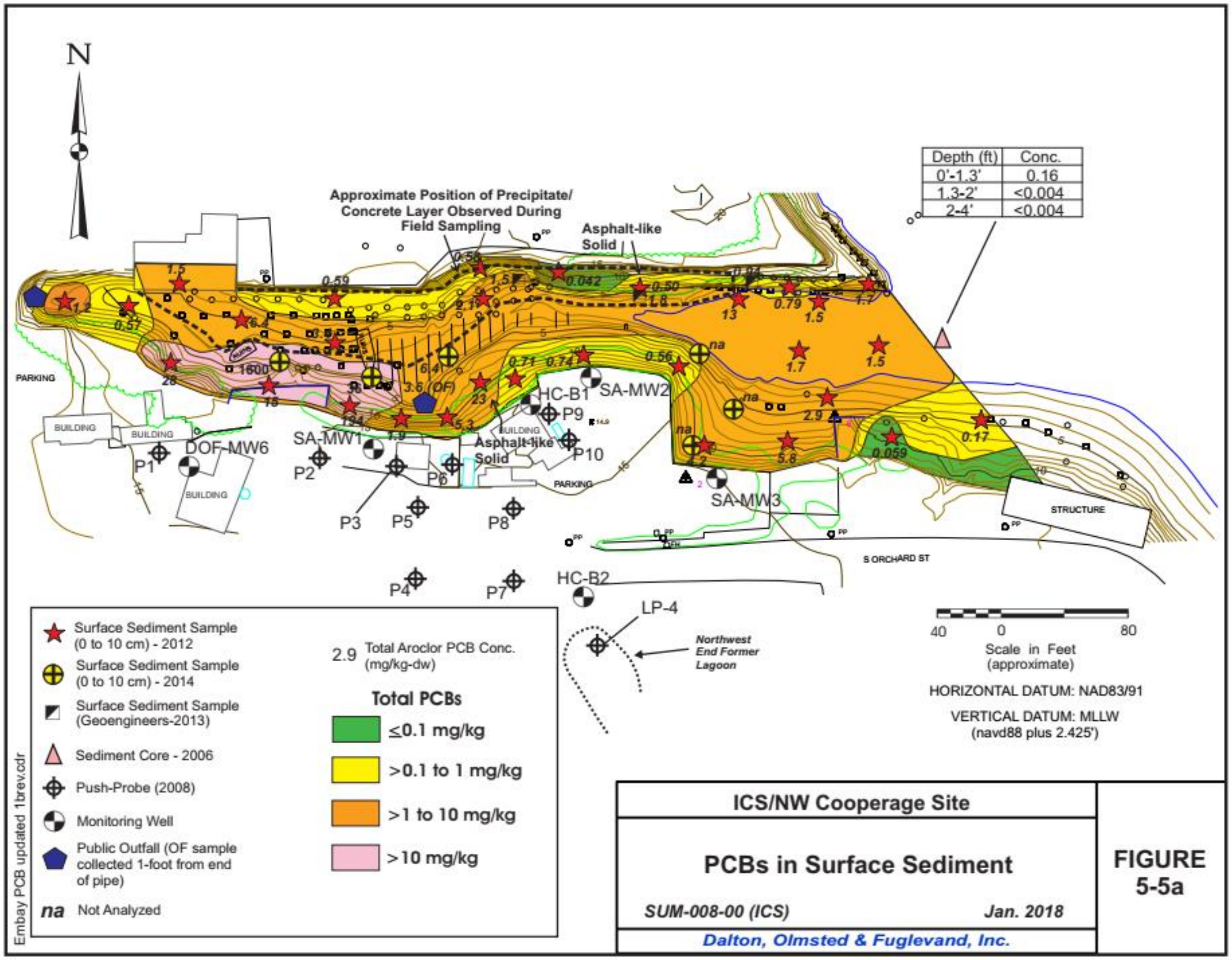


Figure F-2

Lead in Surface Sediment in the ICS Inlet (DOF 2022)

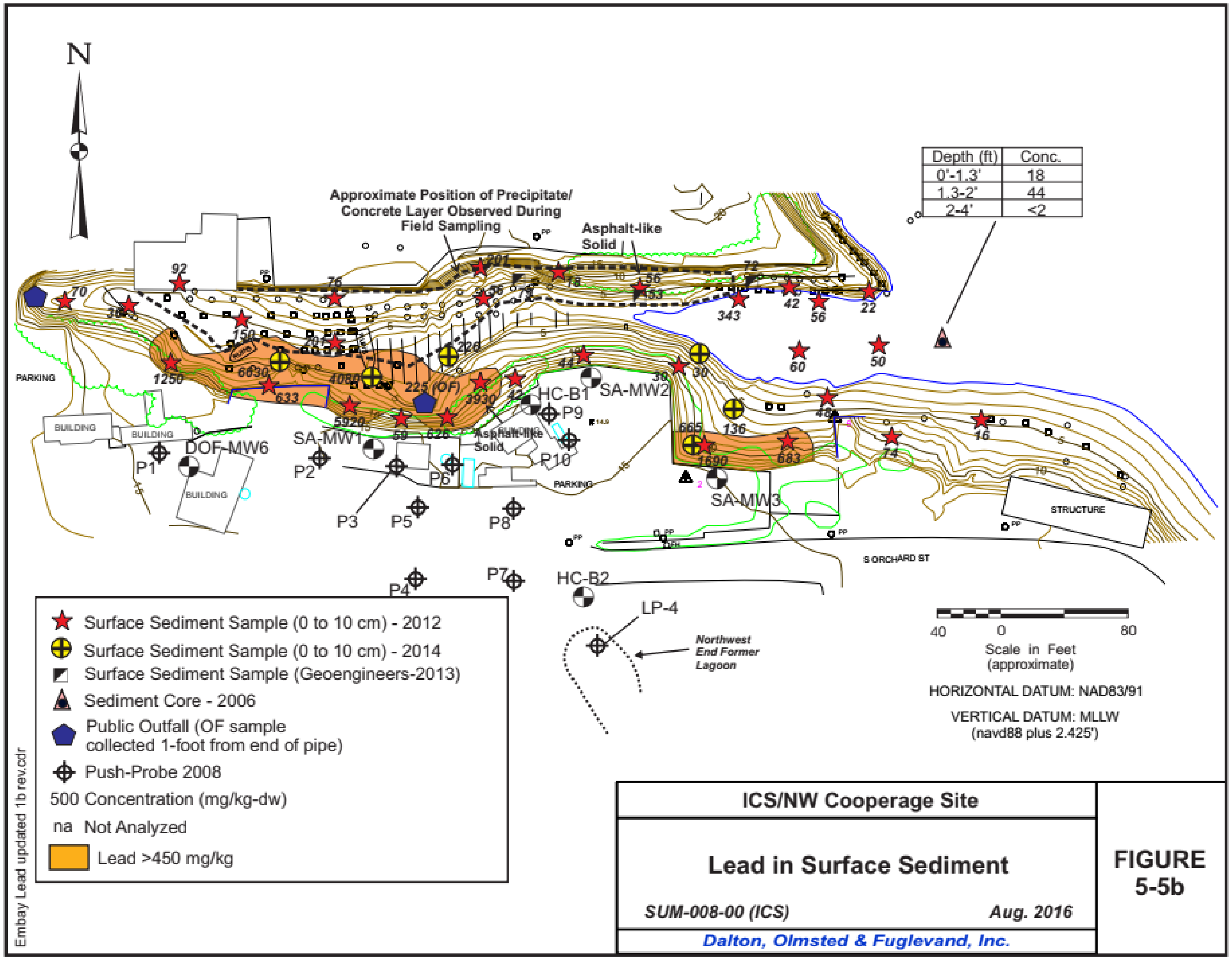


Figure F-3

Mercury in Surface Sediment in the ICS Inlet (DOF 2022)

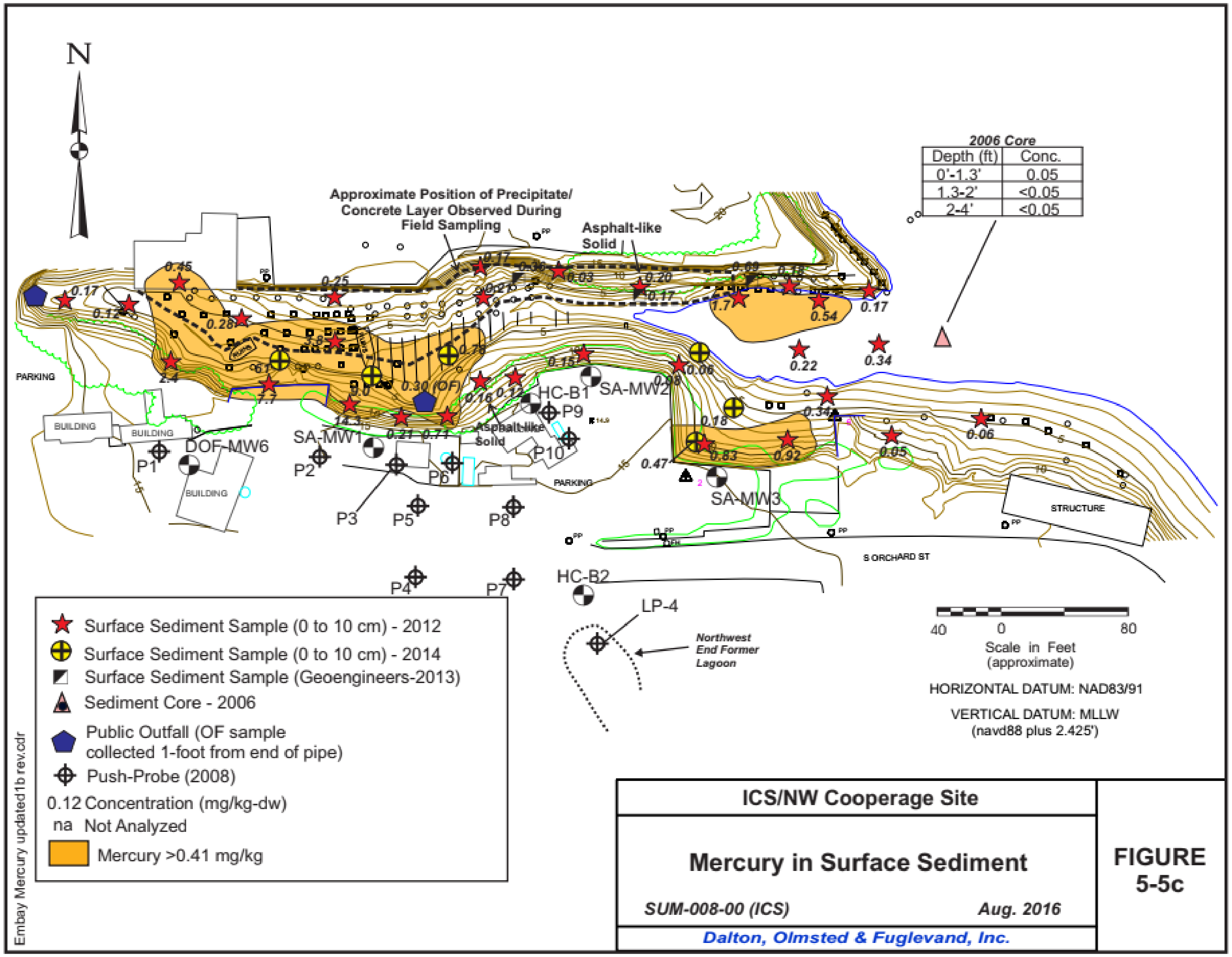
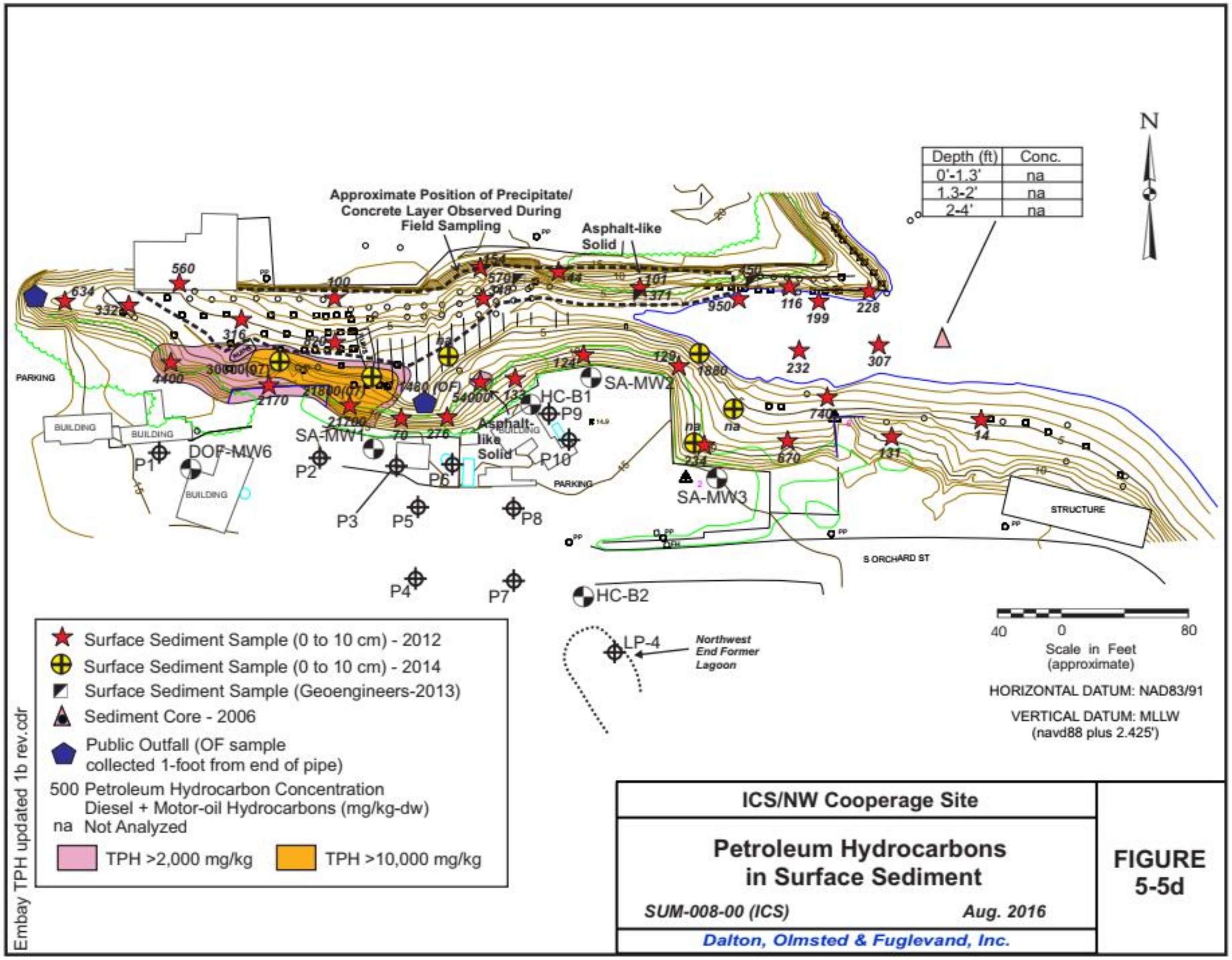


Figure F-4

Petroleum Hydrocarbon in Surface Sediment in the ICS Inlet (DOF 2022)



F.2 References

DOF. 2022. Personal communication (email from M. Dalton, DOF, to S. McGroddy, Windward, regarding ICS Embayment Figures). Dalton, Olmsted & Fuglevand, Inc. March 15, 2022.

Ecology. 2010. Agreed Order No. DE 6720. Washington State Department of Ecology.

Attachment G
Vertical Cores without RAL Intervals

G.1 Non-RAL Interval Data

Vertical sediment cores without applicable remedial action level (RAL) intervals are useful to consider with regard to developing the conceptual site model for the middle reach, as well as understanding vertical contamination. These samples are included in the middle reach design dataset because they represent useful location-specific information; they are summarized herein to assist with the interpretation of Pre-Design Investigation results. Details regarding the non-RAL interval samples are presented in Table G-1 and Map G-1.

Table G-1
Summary of Locations Without RAL Intervals in the Design Dataset

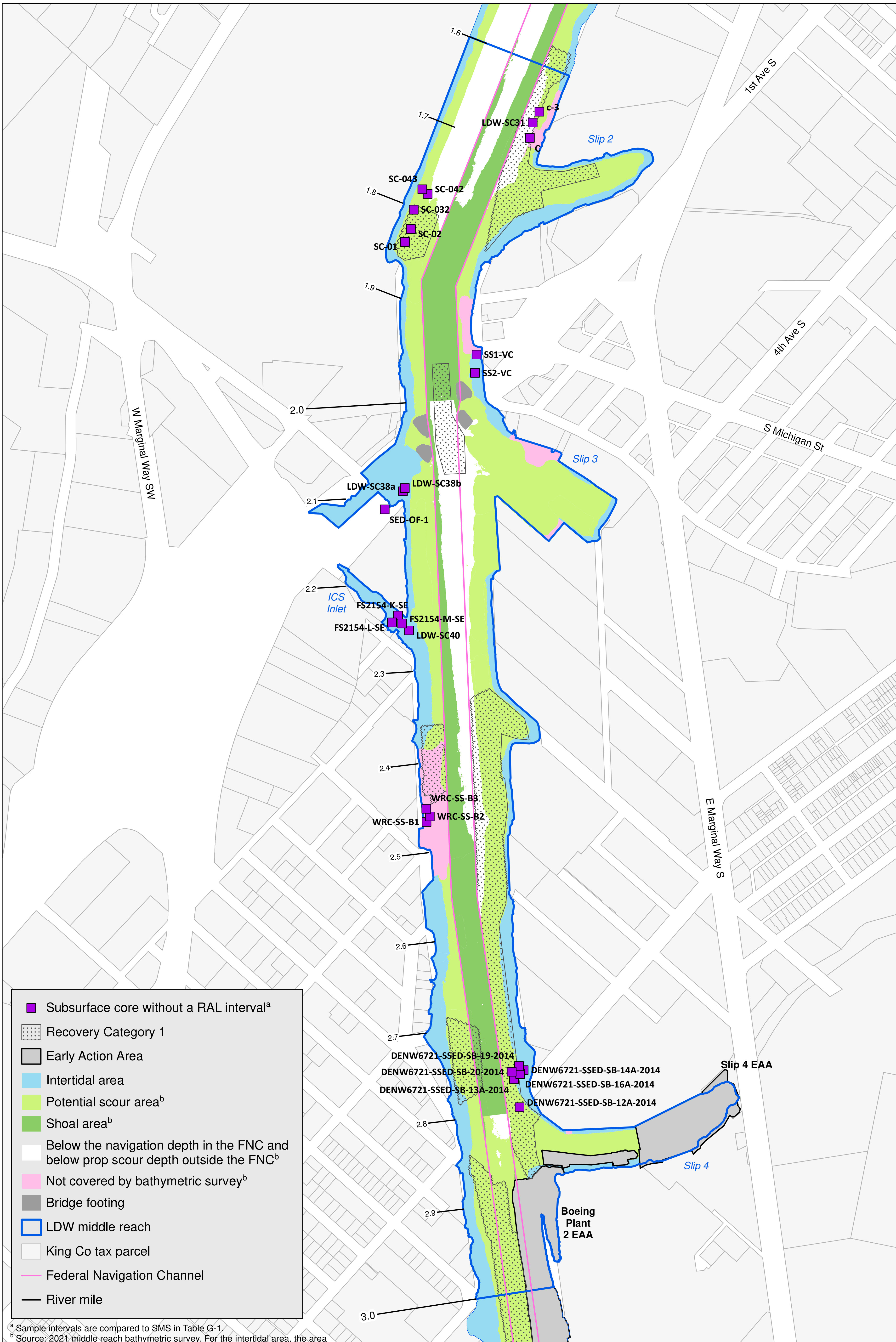
Location ID	Year	RM	Area Type	Interval (ft)	COCs with concentrations greater than SMS[1] (Detected Values)
c-3	1995	1.6 E	subtidal	0–4.6	none
LDW-SC31	2006	1.7 E	subtidal	0–1	PCBs > SCO (15 mg/kg OC)
				1–2.8	PCBs > SCO (15 mg/kg OC)
				2.8–4	none
C	1999	1.7 E	subtidal	0–3	1 PAH > SCO
SC-01[2]	2010	1.8 W	subtidal	1–2	PCBs > SCO (15 mg/kg OC)
				2–3	PCBs > SCO (21 mg/kg OC), 1 phthalate > SCO
				3–4	PCBs > LAET (590 µg/kg dw)[3]
				4–5	PCBs > SCO (43 mg/kg OC), 2 PAHs > SCO
SC-02[2]	2010	1.8 W	subtidal	1–2	PCBs > SCO (14 mg/kg OC)
				2–3	PCBs > SCO (15 mg/kg OC), 1 phthalate > SCO
				3–4	none
				4–5	none
SC-032[2]	2010	1.8 W	subtidal	1–2	PCBs > SCO (16 mg/kg OC)
				2–3	PCBs > SCO (23 mg/kg OC), 3 PAHs > SCO
				3–4	PCBs > LAET (540 µg/kg dw)[c]
				4–4.7	none
SC-042[2]	2010	1.8 W	subtidal	1–2	none
				2–3	none
				3–4	none
				4–5	none
SC-043[2]	2010	1.8 W	subtidal	1–2	PCBs > SCO (25 mg/kg OC)
SS1-VC	2016	1.9 E	intertidal	0-2	PCBs > CSL (202 mg/kg OC), 1 phthalate > SCO
SS2-VC	2016	2.0 E	intertidal	0-2	PCBs > LAET (219 µg/kg)[3]
LDW-SC38a	2006	2.1 W	intertidal	0–1	PCBs > SCO (23 mg/kg OC)
				1–2	PCBs > SCO (52 mg/kg OC)
				2–3	PCBs > CSL (230 mg/kg OC), mercury and 2 PAHs >SCO

Location ID	Year	RM	Area Type	Interval (ft)	COCs with concentrations greater than SMS[1] (Detected Values)
LDW-SC38b	2006	2.1 W	intertidal	3–3.3	none
SED-OF-1	2013	2.1 W	intertidal	0.5–1.5	none
FS2154-K-SE	2012	2.2 W	intertidal	1.4–2.8	PCBs > CSL (549 mg/kg OC), mercury > CSL
				4.4–6.7	none
				6.7–7.4	none
FS2154-L-SE	2012	2.2 W	intertidal	1.4–2.5	PCBs > CSL (139 mg/kg OC)
				2.8–4.3	mercury > CSL
				4.3–5.9	none
FS2154-M-SE	2012	2.2 W	intertidal	0–1.2	PCBs > SCO (43.5 mg/kg OC)
				1.2–2.2	none
				2.2–3.4	none
LDW-SC40	2006	2.3 W	intertidal	0–1.3	PCBs > SCO (21 mg/kg OC)
				1.3–2	none
				2–4	none
WRC-SS-B1	2004	2.5 W	intertidal	1–2	none
WRC-SS-B2	2004	2.5 W	subtidal	1–2	none
WRC-SS-B3	2004	2.5 W	intertidal	1–2	none
DENW6721-SSED-SB-19-2014	2014	2.7 E	intertidal	2–4	none
				4–6	none
				7–9	none
DENW6721-SSED-SB-12A-2014	2014	2.8 E	subtidal	2–4	PCBs > SCO (22 mg/kg OC), 1 SVOC > CSL
				4–6	none
				6–7.7	PCBs > SCO (35 mg/kg OC)
				8–10	PCBs > LAET (170 μg/kg)[3]
DENW6721-SSED-SB-14A-2014	2014	2.8 E	intertidal	0.5–2	PCBs > CSL (110 mg/kg OC), dioxin/furan TEQ > RAL (47.5 ng/kg), 1 PAH > CSL, 6 PAHs > SCO
				2–4	none
				4–6	none
				7–9	none
DENW6721-SSED-SB-16A-2014	2014	2.8 E	intertidal	1–2.7	PCBs > SCO (37 mg/kg OC), cPAH TEQ > RAL (16,000 μg/kg), 14 PAHs > CSL, 2 PAHs > SCO
				4–6	none

Notes:
1. There are no SMS for dioxins/furans or cPAHs (two of the LDW human health risk drivers). The samples presented in this table were compared with the lowest RALs for these chemicals (i.e., 25 ng/kg dw and 5,500 μg/kg dw, respectively).
2. Cores were collected after dredging was conducted in this area but prior to the placement of a 1-ft-deep sand cap. Depths for sampled intervals represent post-sand cap core collection (i.e., are approximately 1 ft below the new sediment surface).
3. Presented as μg/kg dw because TOC is outside the range for comparison to the SCO; value exceeds the dry weight equivalent LAET.

cPAH: carcinogenic polycyclic aromatic hydrocarbon
CSL: cleanup screening level

dw: dry weight
LAET: lowest apparent effects threshold
LDW: Lower Duwamish Waterway
OC: organic carbon
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
RM: river mile
SCO: benthic sediment cleanup objective
SMS: Washington State Sediment Management Standards
SVOC: semivolatile organic compound
TEQ: toxic equivalent
TOC: total organic carbon



[a] Sample intervals are compared to SMS in Table G-1.
[b] Source: 2021 middle reach bathymetric survey. For the intertidal area, the area between the survey extent and the LDW Superfund Site boundary is inferred.

Prepared by nicolase, 2/14/2023; W:\Projects\Duwamish AOC5\GIS\Maps and Analyses\Phase 1\Work Plan\PDI WP\Map G-1 7444 Cores without RAL intervals.mxd

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Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

0 500 1,000 Feet
0 100 200 Meters

Map G-1. Subsurface sediment sampling locations without RAL intervals

PRE-DESIGN INVESTIGATION WORK PLAN FOR THE LDW MIDDLE REACH

FEBRUARY 14, 2023

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Attachment H
Composite Sample Data

H.1 Composite Samples Excluded from the Design Dataset

As described in Attachment D, composite samples are supplemental data that are not included in the design dataset because they do not provide location-specific information. This section presents an overview of the composite samples that, although excluded from the design dataset for the middle reach, include information useful for developing the conceptual site model for the middle reach. Table H-1 presents a summary of the sampling events with composite samples; additional details are provided in the subsections that follow.

Table H-1
Summary of Events with Composite Samples

Event Name	Year	Study Area	Number of Composites	Sample Interval(s)	Samples per Composite
PSDDA Sediment Characterization of the FNC	1999	RM 1.8 to RM 2.9 (in the FNC)	18[1]	0–4 ft, 4–8 ft	3
Hurlen-Boyer Dredge Material Characterization	1998	RM 2.4 to RM 2.8 West	6	0–3.3 ft to 0–4.2 ft	2
James Hardie Nearshore Sediment Sampling	2000	RM 1.7 East (North of Slip 2)	2[2]	0–10 cm	4
LDW Sediment Sampling	2010	RM 1.6 to RM 3.0	2	0–10 cm or 0–45 cm	8
LDW Pre-Design Studies	2018	RM 1.6 to RM 3.0	6 (surface sediment)	0–10 cm	7
			5 (cPAH clam investigation)	0–10 cm	3
			9 (beach play)[3]	0–45 cm	3 to 9

Notes:
1. Two additional composites collected as part of this study were collected above RM 3.0 (i.e., in the upper reach of the LDW).
2. Three additional composites collected as part of this study were collected below RM 1.6 (i.e., in the lower reach of the LDW).
3. Samples collected as part of the LDW Pre-Design Studies covered the entire LDW. A total of 18 additional surface sediment composite samples, 11 additional cPAH clam investigation composite samples, and 15 additional beach play composite samples were collected outside of the middle reach.
cPAH: carcinogenic polycyclic aromatic hydrocarbon
FNC: Federal Navigation Channel
LDW: Lower Duwamish Waterway
PSDDA: Puget Sound dredged disposal analysis
RM: river mile

H.1.1 PSDDA Sediment Characterization of the FNC

Sediment characterization was conducted in 1999 ahead of potential dredging by the US Army Corps of Engineers (USACE) of the Federal Navigation Channel (FNC), which was tentatively planned for 2000. Sediment cores were collected in a total of 20 dredge material management units (DMMUs), 18 of which were located within the middle reach (Figure H-1a and H-1b; reproduced from SEA (2000)), to determine the suitability of dredged sediment for open-water disposal. Each composite sample consisted of three cores collected from a given DMMU; the size of the area sampled varied depending on the amount of shoaled material present. These USACE cores were excluded from the design database because they were intended to represent average concentrations in an area and thus do not provide location-specific information (see Section B.2). Information regarding these composite samples is summarized in Table H-2.

Table H-2
PSDDA 1999 Sediment Characterization Sample Summary

Sample ID[1]	Approx. Location	Samples per Composite	Approx. Distance between Samples in Composite (ft)	Interval Sampled (ft)	SMS Exceedances[2] (Detected Values)
Surface layer composites (0–4 ft)					
S1	RM 1.8	3	175	0–4	none
S2	RM 1.8	3	100	0–4	none
S3	RM 1.8	3	125	0–4	none
S4	RM 1.8	3	125	0–4	none
S5	RM 1.8	3	125	0–4	none
S6	RM 1.9	3	100	0–4	none
S7	RM 1.9	3	100	0–4	none
S8	RM 1.9	3	100	0–4	none
S9	RM 1.9	3	110	0–4	none
S10	RM 1.9	3	100	0–4	none
S11	RM 2.0	3	100	0–4	PCBs > SCO (36 mg/kg OC)
S12	RM 2.0	3	110	0–4	PCBs > SCO (28 mg/kg OC)
S13	RM 2.2	3	400	0–4	none
S14	RM 2.4	3	400	0–4	none
S15	RM 2.5	3	150	0–4	PCBs > SCO (13 mg/kg OC)
S16	RM 2.5-2.9	3	2,000	0–4	none
Deeper composites (4–8 ft)					
B1	RM 1.9	3	450	4–8	PCBs > SCO (15 mg/kg OC)
B2	RM 2.0 to RM 2.3	3	2,100	4–8	PCBs > SCO (18 mg/kg OC)

Notes:
1. Two additional composite samples collected as part of this study were collected above RM 3.0 (i.e., in the upper reach of the LDW).
2. There are no SMS for dioxins/furans or cPAHs (two of the LDW human health risk drivers). The samples presented in this table were not analyzed for dioxins/furans, and all cPAH TEQs were below the lowest ESD RAL of 5,500 ug/kg dw.

cPAH: carcinogenic polycyclic aromatic hydrocarbon
dw: dry weight
ESD: explanation of significant differences
ID: identification
LDW: Lower Duwamish Waterway
OC: organic carbon
PCB: polychlorinated biphenyl
PSDDA: Puget Sound dredged disposal analysis
RAL: remedial action level
RM: river mile
SCO: benthic sediment cleanup objective
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent

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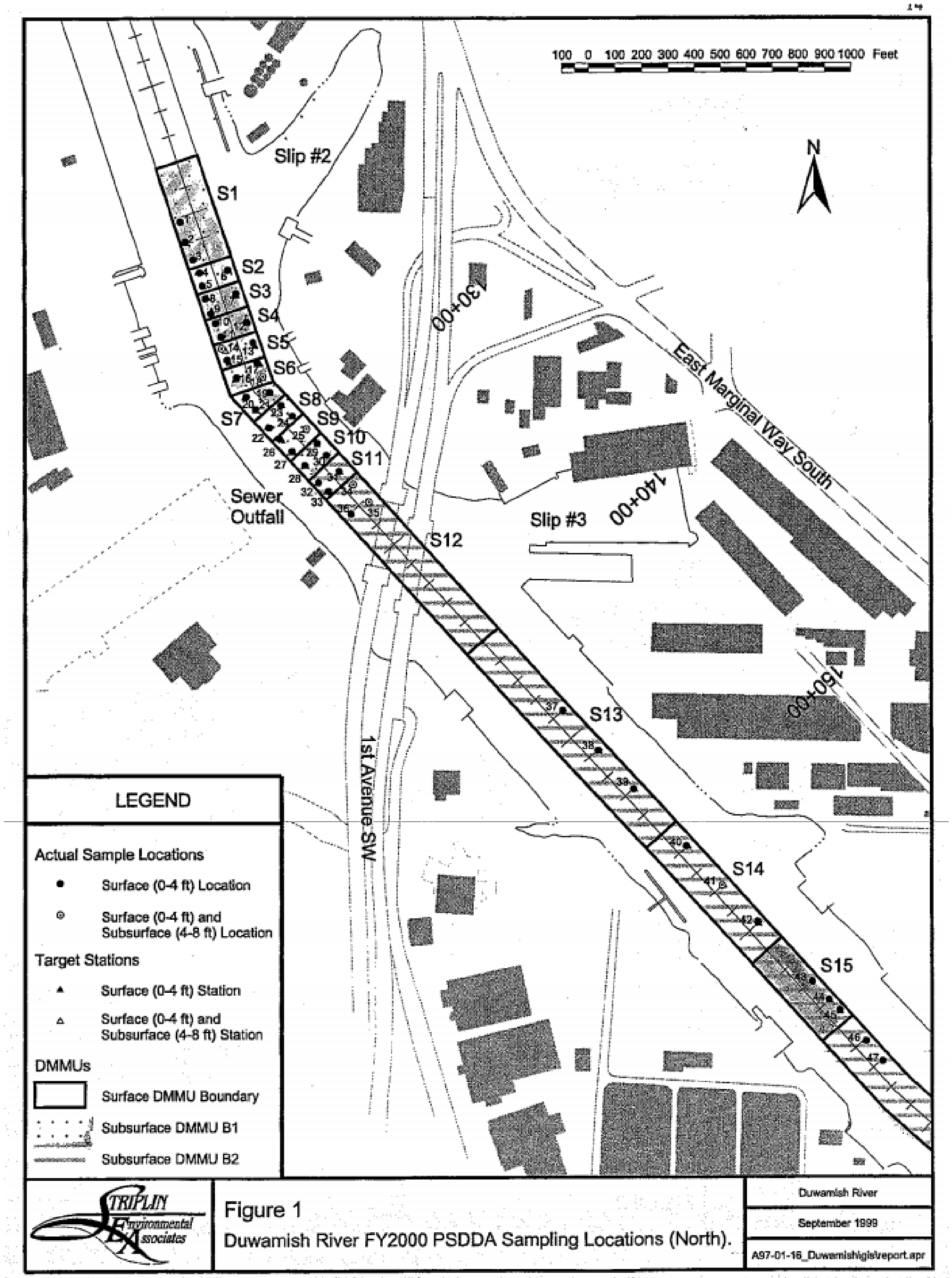
Figure H-1a
Sampling Locations for 1999 PSDDA Sediment Characterization of the FNC (North)



Note: Figure reproduced from SEA (2000)); used with permission from USACE.

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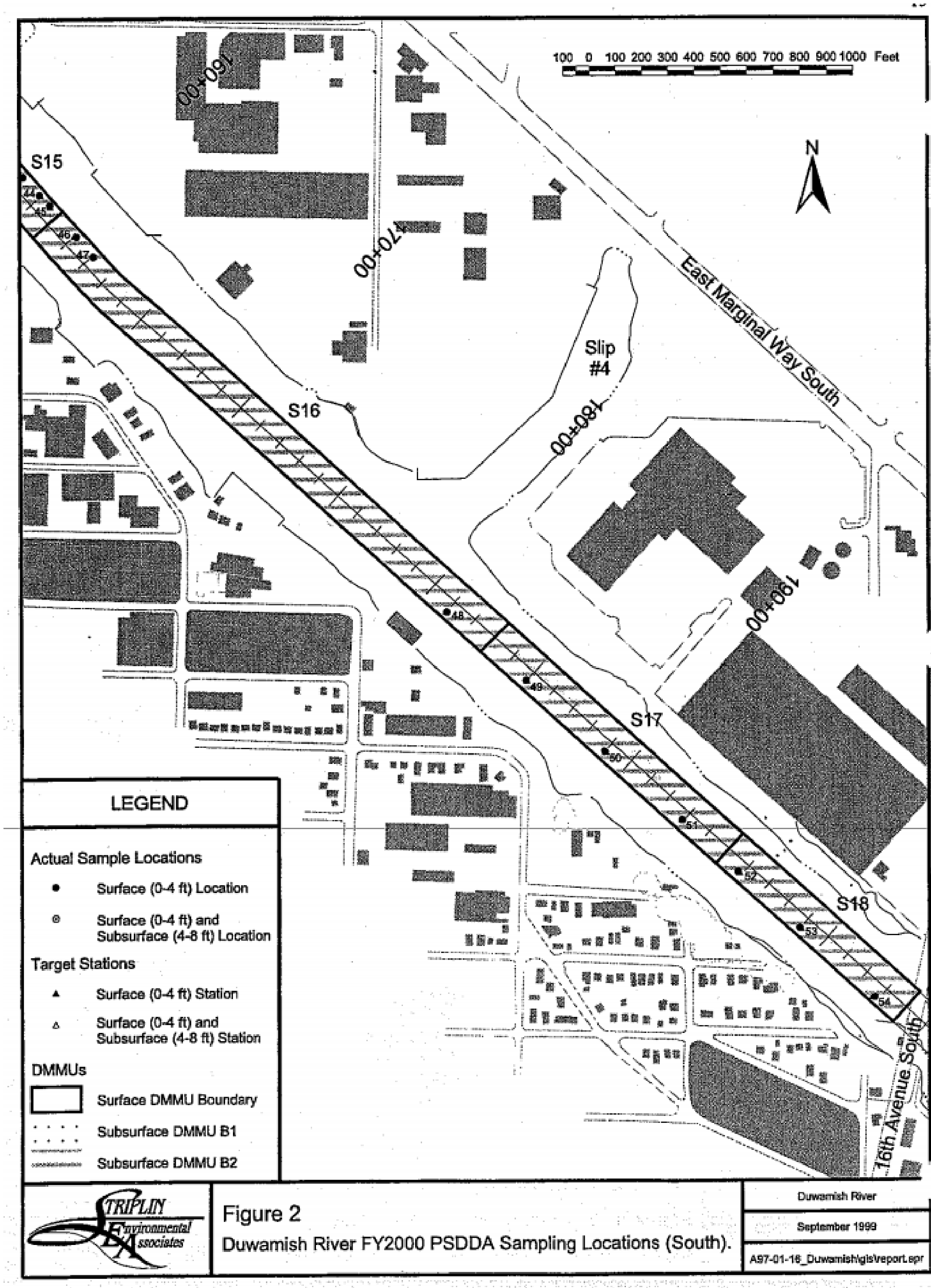
Figure H-1b
Sampling Locations for 1999 PSDDA Sediment Characterization of the FNC (South)



Note: Figure reproduced from SEA (2000)); used with permission from USACE.

H.1.2 Hurlen-Boyer Dredge Material Characterization

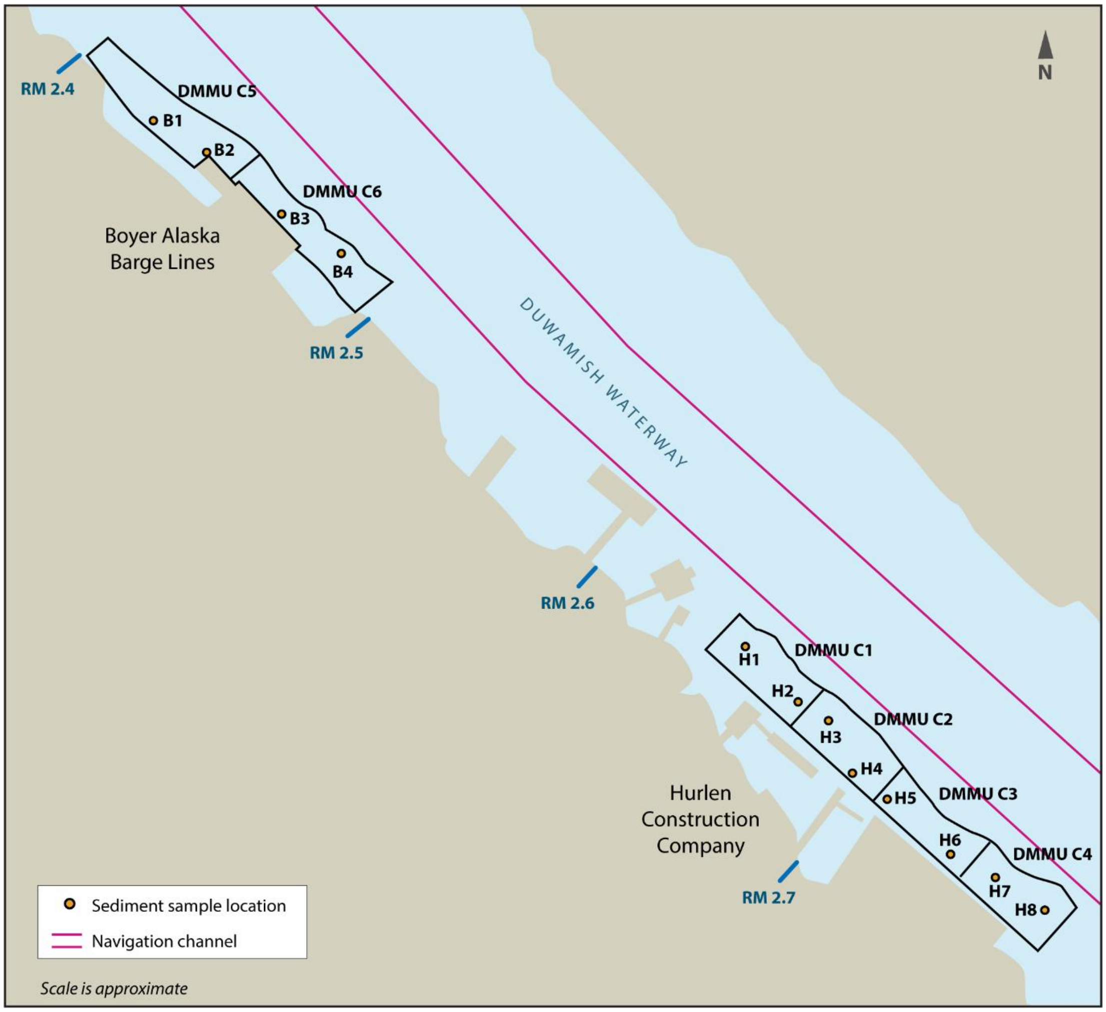
Consistent with Puget Sound dredged disposal analysis (PSDDA) requirements, sediment characterization was conducted in 1998 to support maintenance dredging at the Hurlen Construction Company (Hurlen) berthing area at RM 2.7 to RM 2.8 West and the Boyer Alaska Barge Lines (Boyer) berthing area at RM 2.4 to RM 2.5 W (Hart Crowser 1998)). Two sediment cores were composited from each of six DMMUs (Figure H-2, based on maps available from Hart Crowser (1998)). These samples were excluded from the design database because they are intended to represent average concentrations in an area and thus do not provide location-specific information (see Section B.2). Information regarding these composite samples is summarized in Table H-3.

Table H-3
Hurlen-Boyer 1998 Dredge Material Characterization sample summary

Sample ID	Approx. Location	Samples per Composite	Approx. Distance between Samples in Composite (ft)	Interval Sampled (ft)	SMS Exceedances[1] (Detected Values)
Hurlen berthing area					
C1	RM 2.7 W	2	110	0–3.7	none
C2	RM 2.7 W	2	100	0–4.2	2 PAHs > SCO
C3	RM 2.7 W	2	130	0–3.3	1 PAH > CSL, 8 PAHs > SCO
C4	RM 2.8 W	2	100	0–3.3	none
Boyer berthing area					
C5	RM 2.4 W	2	100	0–3.3	none
C6	RM 2.5 W	2	100	0–3.8	PCBs > SCO (16 mg/kg OC)

Notes:
1. There are no SMS for dioxins/furans or cPAHs (two of the LDW human health risk drivers). The samples presented in this table were not analyzed for dioxins/furans and all cPAH TEQs were below the lowest ESD RAL of 5,500 ug/kg dw.
Boyer: Boyer Alaska Barge Lines
cPAH: carcinogenic polycyclic aromatic hydrocarbon
CSL: cleanup screening level
dw: dry weight
ESD: explanation of significant differences
Hurlen: Hurlen Construction Company
ID: identification
LDW: Lower Duwamish Waterway
OC: organic carbon
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
RM: river mile
SCO: benthic sediment cleanup objective
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent

Figure H-2
Sampling Locations for Hurlen-Boyer 1998 Dredge Material Characterization



Note: Figure based on information from Hart Crowser (1998).

H.1.3 James Hardie Nearshore Sediment Sampling

Surface sediment samples were collected in 2000 as part of a study characterizing sediment and outfall quality along the James Hardie Gypsum property, which is located just north of Slip 2 (Weston 2000). Two outfall samples, two seep samples, and composite sediment samples from five intertidal areas were collected as part of this study. Only the two southern-most intertidal area composite samples were within the middle reach (the remaining samples were collected downstream of RM 1.6) (Figure H-3; based on maps from Weston (2000)). Each of the intertidal composite samples consisted of four surface sediment samples collected from the intertidal area at low tide. Information regarding these composite samples is summarized in Table H-4.

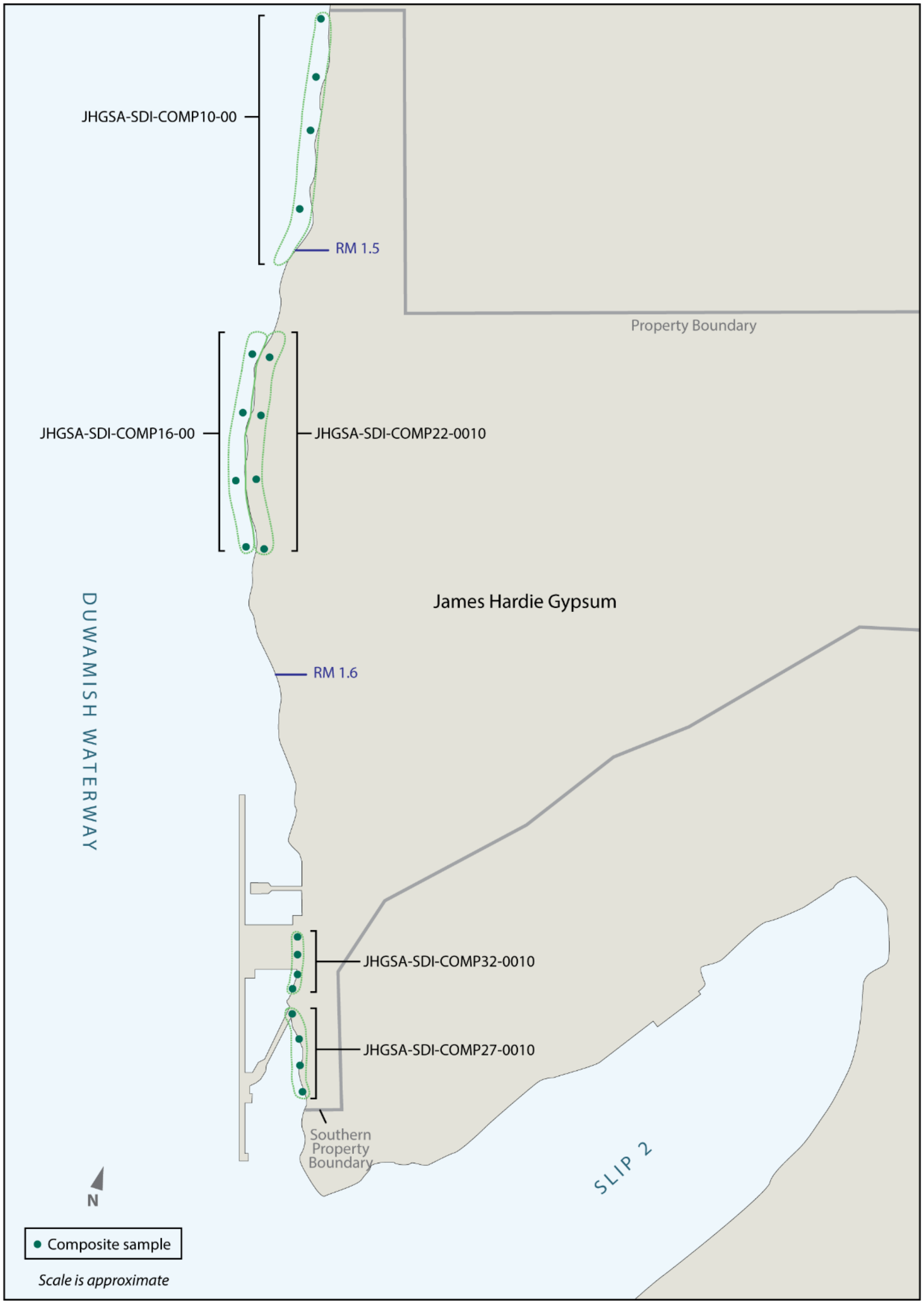
Table H-4
James Hardie 2000 Nearshore Sediment Sample Summary

Sample ID	Approx. Location	Samples per Composite	Approx. Distance between Samples in Composite (ft)	Interval Sampled (cm)	SMS Exceedances[2] (Detected Values)
JHGSA-SDI-COMP10-00[1]	RM 1.5E	4	200	0–10	none
JHGSA-SDI-COMP16-00[1]	RM 1.55E	4	200	0–10	none
JHGSA-SDI-COMP22-00[1]	RM 1.55E	4	200	0–10	none
JHGSA-SDI-COMP27-00	RM 1.7E	4	100	0–10	none
JHGSA-SDI-COMP32-00	RM 1.7E	4	75	0–10	PCBs > CSL (68 mg/kg OC)

Notes:
1. These three intertidal composite samples were collected downstream of RM 1.6 (i.e., in the lower reach of the LDW). Results for these samples are provided herein for additional context.
2. There are no SMS for dioxins/furans or cPAHs (two of the LDW human health risk drivers). The samples presented in this table were not analyzed for dioxins/furans and all cPAH TEQs were below the lowest RAL of 5,500 ug/kg dw.

cPAH: carcinogenic polycyclic aromatic hydrocarbon
CSL: cleanup screening level
dw: dry weight
ID: identification
LDW: Lower Duwamish Waterway
OC: organic carbon
PCB: polychlorinated biphenyl
RAL: remedial action level
RM: river mile
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent

Figure H-3
Sampling Locations for the James Hardie 2000 Nearshore Sediment Sampling



Note: Figure based on information from Weston (2000).

H.1.4 LDW Sediment Sampling

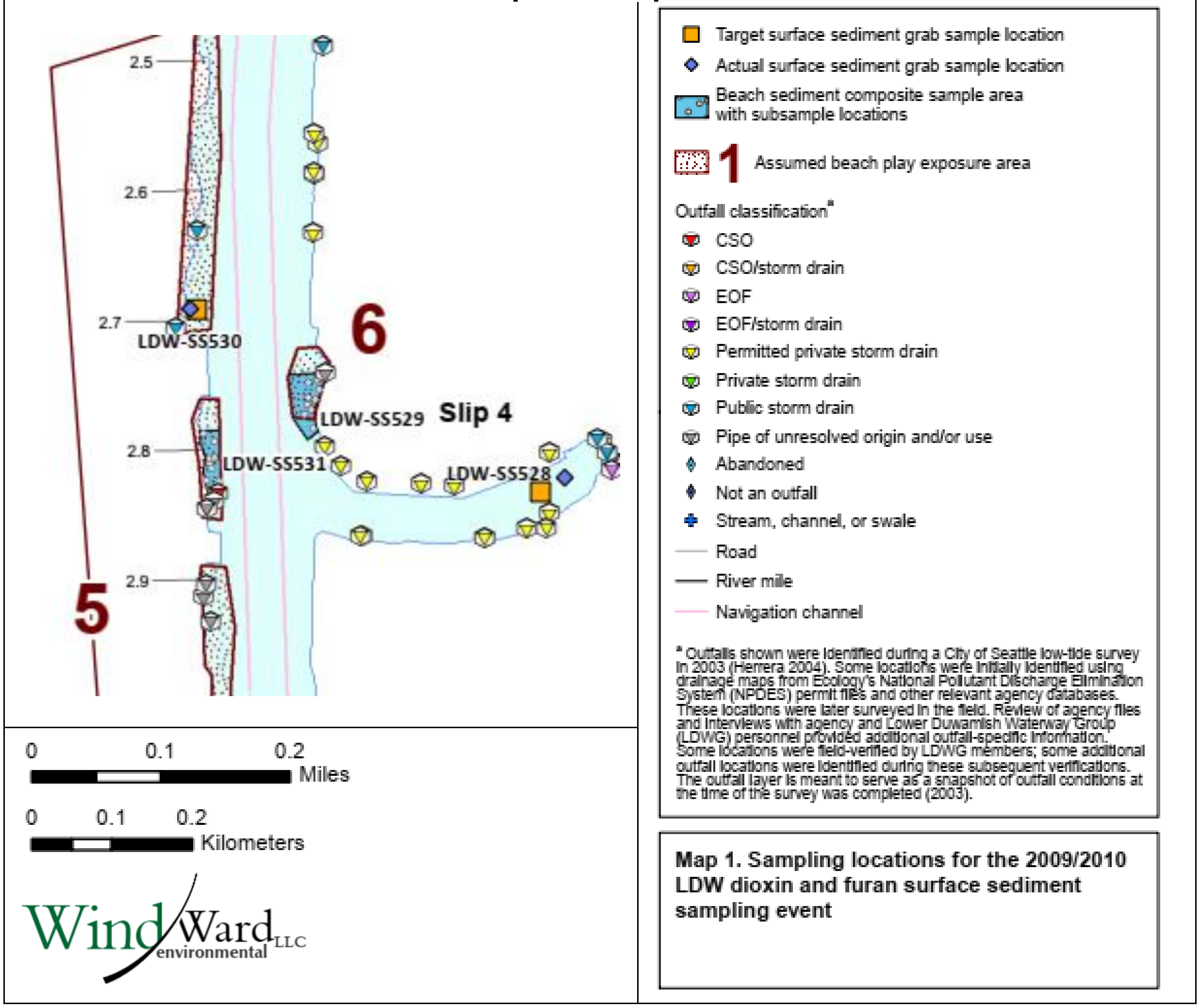
In January 2010, composites samples were collected from two beach play areas located in the middle reach (Windward 2010). These composites samples were collected from the central portion of Beach 5 at RM 2.8W and at Beach 6 at RM 2.75E (Figure H-4; reproduced from Windward (2010)). The sample depths were 0 to 45 cm for the Beach 6 composite and 0 to 10 cm for the Beach 5 composite. Samples were analyzed for the human health risk drivers (Table H-5).

Table H-5
LDW 2010 Surface Sediment Composite Samples

Sample ID	Approx. Location	Samples per Composite	Approx. Distance between Samples in Composite (ft)	Interval Sampled (cm)	SMS Exceedances (detected values)[1]
LDW-SS529 (Beach 6)	RM 2.75 E	8	composite covers area approximately 250 ft in length	0–45 cm	Arsenic > SCO HPAHs and 7 PAHs >CSL[2] 2 PAHs > SCO[2] Total PCBs > SCO (58.5 mg/kg OC)
LDW-SS531 (Beach 5)	RM 2.8 W	8	composite covers area approximately 250 ft in length	0–10 cm	none

Notes:
1. Dioxin/furan TEQs in both samples were less than the lowest RAL of 25 ng/kg.
2. Seven individual PAHs also exceeded CSLs (benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, total benzofluoranthenes, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene) and two individual PAHs exceeded the SCO (acenaphthylene, fluoranthene). The cPAH TEQ for this sample (7,100 µg/kg) was greater than the lowest cPAH RAL of 5,500 µg/kg.
CSL: cleanup screening level
dw: dry weight
HPAH: high molecular weight polycyclic aromatic hydrocarbon
ID: identification
LDW: Lower Duwamish Waterway
OC: organic carbon
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
RM: river mile
SCO: benthic sediment cleanup objective
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent

Figure H-4
Locations of the 2010 LDW Beach Composite Samples (Windward 2010)



H.1.5 LDW Pre-Design Studies

Composite sediment samples were collected in 2018 as part of the LDW Pre-Design Studies conducted to address the third amendment to the AOC to establish area-weighted baseline concentrations. Three different types of composite samples were collected as part of the Pre-Design Studies:

- **Surface sediment composites** – Sediment was collected from the top 0 to 10 cm at locations throughout the LDW to characterize surface sediment concentrations. A total of 24 composites, each consisting of 7 grab samples, were collected in the LDW. Six of these composites were located within the middle reach (Figure H-5; reproduced from Windward (2020)).

- **Beach play area composites** – Sediment was collected from the top 0 to 45 cm at eight designated intertidal potential beach play areas in the LDW. For each of the three beach play areas located within or partly within the middle reach (i.e., Areas 4, 5, and 6), three composite samples were created for each potential beach play area; each consisting of three to nine samples, depending on depending on the size of the area (Figure H-6; reproduced from Windward (2020)).
- **cPAH clam investigation composites** – As part of an investigation to evaluate the potential linkage between cPAHs in clam tissue and sediment, composite samples were created with sediment co-located with clam tissue and analyzed for cPAHs. Each of these composite samples consisted of surface sediment (0 to 10 cm) from three locations. Five of the 16 cPAH clam investigation composite samples were located within the middle reach (Figure H-7a and H-7b; reproduced from Windward (2019)).

The Pre-Design Studies sediment composite samples were excluded from the design database, because they are intended to represent average concentrations in an area and thus do not provide location-specific information (see Section B.2). Information regarding these composite samples is summarized in Table H-6.

Table H-6
LDW Pre-Design Studies Sample Summary

Sample ID[2]	Approx. Location	Samples per Composite	Approx. Distance between Samples in Composite (ft)	Summary of Concentrations[1]				
				Total PCBs (mg/kg OC)	Dioxins/ Furans TEQ (ng/kg dw)	cPAH TEQ (µg/kg dw)	Arsenic (mg/kg dw)	Other SMS Exceedances (Detected Values)
Surface sediment composites (0–10 cm)								
LDW18-SS-Comp12	RM 1.6 to RM 1.8	7	880	8.08 J	8.92 J	132	13.4	none
LDW18-SS-Comp13	RM 1.9 to RM 2.2	7	1,400	11.8 J	10.4	189	15.8	none
LDW18-SS-Comp14	RM 1.8 to RM 2.3	7	2,300	**14.4 J**	7.78 J	91.7	13.5	none
LDW18-SS-Comp15	RM 2.2 to RM 2.5	7	1,200	**13.7 J**	4.98 J	116	11.5	none
LDW18-SS-Comp16	RM 2.5 to RM 2.8	7	1,200	7.07 J	3.88 J	118	10.3	none
LDW18-SS-Comp17	RM 2.8 to RM 3.1	7	1,200	5.05 J	3.09 J	64.3	10.2	none
Intertidal beach play area composites (0–45 cm)								
LDW18-IT45-B4-Comp1	Beach 4 (RM 2.0 to RM 2.4 West)	5	1,600	**332 J (µg/kg)[3]**	12 J	57.1	8.51 J	none
LDW18-IT45-B4-Comp2		5	1,400	**58 JN**	**73.4 J**	55.8	6.14 J	none
LDW18-IT45-B4-Comp3		5	1,600	**21**	4.68 J	23.5	4.08 J	none
LDW18-IT45-B5-Comp1	Beach 5 (RM 2.5 to RM 3.4 West)	9	3,000	5.89 JN	4.4 J	357	5.52 J	none
LDW18-IT45-B5-Comp2		9	2,800	**15 J**	6.41 J	41.9	12.4 J	none
LDW18-IT45-B5-Comp3		9	2,400	9.1 JN	5.07 J	3,050	8.31 J	3 PAHs > CSL, 2 PAHs > SCO
LDW18-IT45-B6-Comp1	Beach 6 (RM 2.7 to RM 2.8 East)	3	350	**16 J**	8.86 J	1,240	**68.1**	2 PAHs > SCO
LDW18-IT45-B6-Comp2		3	260	**55.6 J**	21.7 J	1,480	28.8	none
LDW18-IT45-B6-Comp3		3	250	**510 (µg/kg)[3]**	9.16 J	1,310	37	1 PAH > 2LAET[4]
cPAH clam investigation composites (0–10 cm)								
LDW18-SSCL-A09	RM 1.8 E	3	<50	na	na	47.9	na	na
LDW18-SSCL-A10	RM 1.8 E	3	<50	na	na	56.0	na	na

Sample ID[2]	Approx. Location	Samples per Composite	Approx. Distance between Samples in Composite (ft)	Summary of Concentrations[1]				
				Total PCBs (mg/kg OC)	Dioxins/ Furans TEQ (ng/kg dw)	cPAH TEQ (µg/kg dw)	Arsenic (mg/kg dw)	Other SMS Exceedances (Detected Values)
LDW18-SSCL-A11	RM 2.1 W	3	<50	na	na	90.1	na	na
LDW18-SSCL-A12	RM 2.8 W	3	<50	na	na	25.9 J	na	na
LDW18-SSCL-A13	RM 2.9 W	3	<50	na	na	76.6	na	na

Notes:
[1] **Bold** text indicates SMS exceedance. For dioxin/furan TEQ and cPAH TEQ, bold text indicates concentrations greater than the lowest RAL (i.e., 25 ng/kg dw and 5,500 ug/kg dw, respectively) because there are no SMS for these chemicals.
[2] Eighteen additional surface sediment, 11 additional cPAH clam investigation, and 11 additional beach play composites were collected outside of the middle reach.
[3] Presented as µg/kg dw because TOC is outside the range for comparison to the SCO; value exceeds the dry weight equivalent LAET.
[4] TOC is outside the range for comparison to the CSL; value exceeds the dry weight equivalent 2LAET.
2LAET: second lowest apparent effects threshold
cPAH: carcinogenic polycyclic aromatic hydrocarbon
CSL: cleanup screening level
dw: dry weight
ID: identification
J: estimated concentration
JN: tentative identification and estimated concentration
LAET: lowest apparent effects threshold
LDW: Lower Duwamish Waterway
na: not applicable (not analyzed)
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
RM: river mile
SCO: benthic sediment cleanup objective
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent
TOC: total organic carbon

Figure H-5
Locations of Surface Sediment Composite Samples Collected in 2018 (Windward 2020)

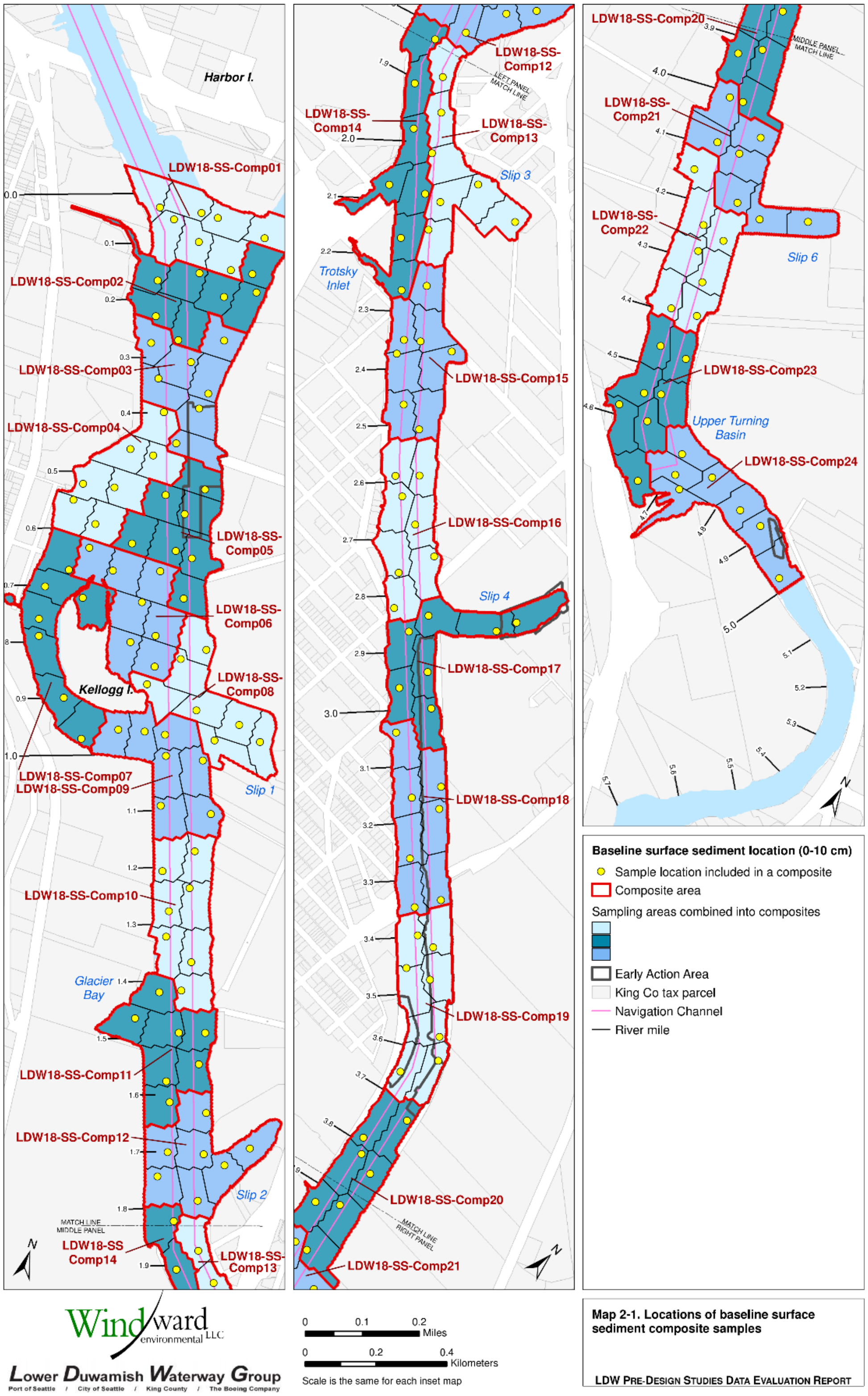


Figure H-6
Locations of Beach Play Area Intertidal Sediment Composite Samples Collected in 2018 (Windward 2020)

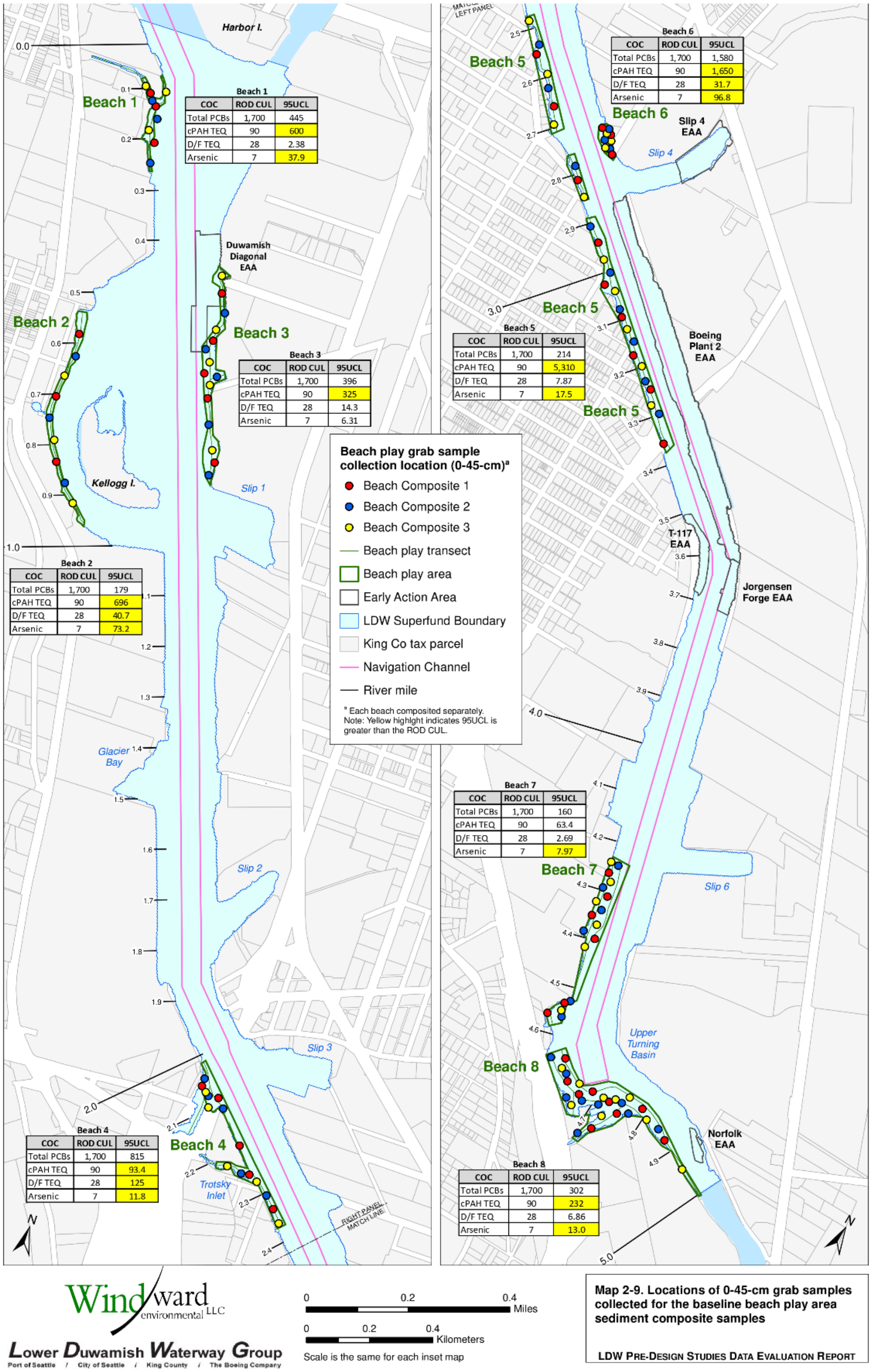


Figure H-7a
Locations of Clam cPAH Sediment Composite Samples Collected in 2018 (Windward 2019)

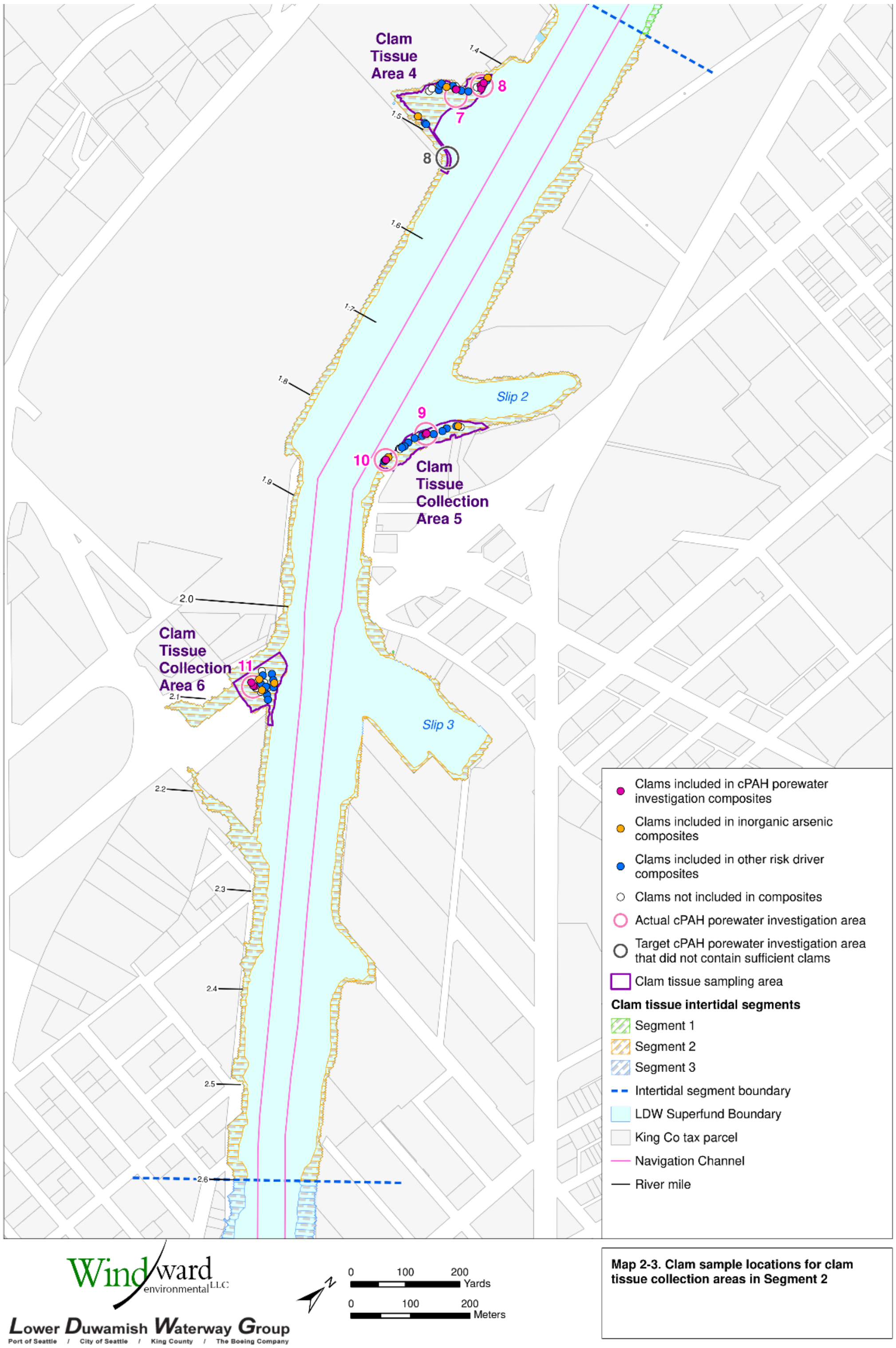


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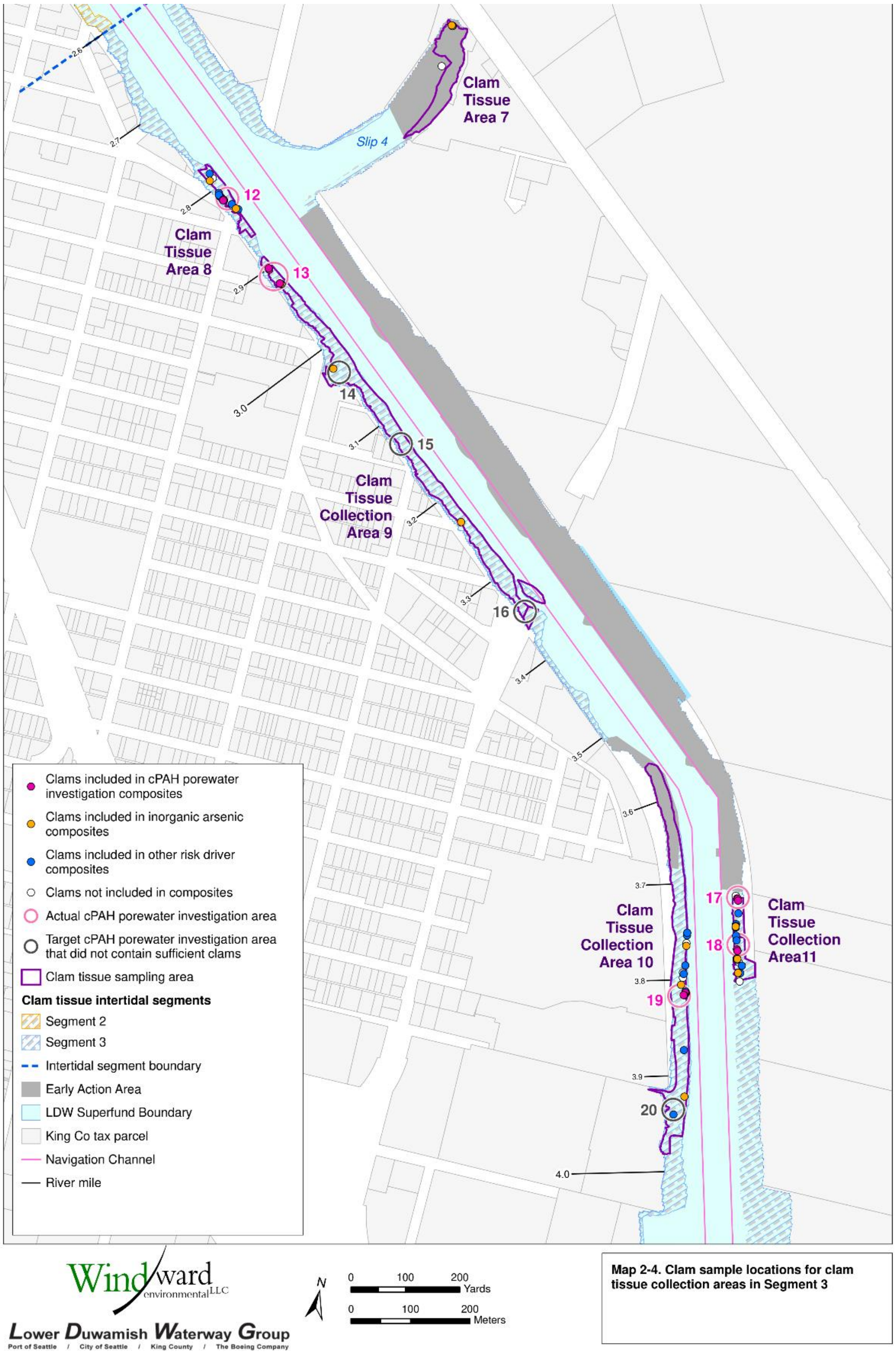
Figure H-7b
Locations of Clam cPAH Sediment Composite Samples Collected in 2018 (Windward 2019)



H.2 References

Hart Crowser. 1998. Dredge material characterization, Hurlen Construction Company and Boyer Alaska Barge Lines Berthing Areas, Duwamish Waterway, Seattle, Washington. Prepared for Peratrovich, Nottingham & Drage. Hart Crowser, Inc., Seattle, WA.

SEA. 2000. PSDDA sediment characterization of Duwamish River navigation channel: FY2000 operations and maintenance dredging data report. Prepared for US Army Corps of Engineers, Seattle District. Striplin Environmental Associates, Inc., Olympia, WA.

Weston. 2000. Outfall and nearshore sediment sampling report, Duwamish facility. Prepared for James Hardie Gypsum, Seattle, Washington. Roy F. Weston, Inc., Seattle, WA.

Windward. 2010. Lower Duwamish Waterway remedial investigation. Technical memorandum: 2009/2010 surface sediment sampling results for dioxins and furans and other chemicals. Prepared for Lower Duwamish Waterway Group. Windward Environmental LLC, Seattle, WA.

Windward. 2019. Lower Duwamish Waterway clam data report. Final. Submitted to EPA on February 28, 2019. Windward Environmental LLC, Seattle, WA.

Windward. 2020. Lower Duwamish Waterway pre-design studies data evaluation report (Task 6). Final. Windward Environmental LLC, Seattle, WA.

Attachment I
Pre- and Post-dredging Data for T-115

Attachment I

Pre- and Post-dredging Data for T-115

I.1 Terminal 115 Berth 1 Maintenance Dredging

This attachment was prepared to summarize the pre- and post-dredge data collected at Terminal 115 Berth 1 associated with maintenance dredging conducted in 2009. The pre-dredge cores were used to create composite core samples for the dredged intervals and individual cores analyzed for Z-intervals. The pre-dredge data are supplemental data that are not included in the middle reach design dataset because they represent sediment that has been removed through maintenance dredging projects.

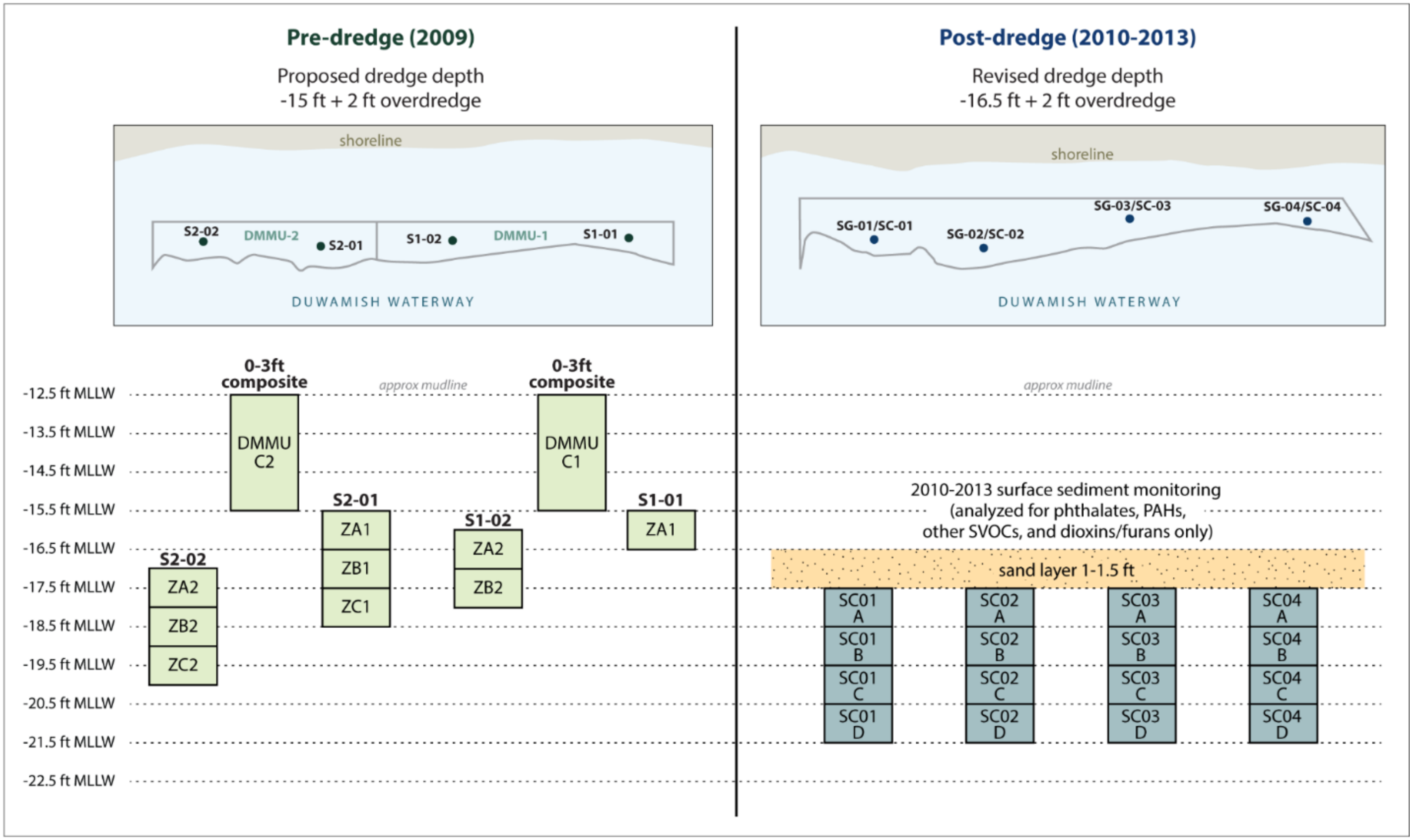
After the dredging was completed, post-dredge cores were collected prior to the placement of an approximately 1- to 1.5-ft-deep sand layer. Surface sediment monitoring was conducted annually for three years following the placement of the sand layer. The most recent surface sediment data are included in the design dataset, and the post-dredge cores are included in the design dataset as non-remedial action level (RAL) interval cores.

The proposed dredge depth for the 2009 Terminal 115 Berth 1 maintenance dredging was -15 ft mean lower low water (MLLW) with 2 ft of overdredge (i.e., a total dredge depth of -17 ft MLLW). The proposed dredge interval was less than 4 ft, so two surface sediment dredged material management units (DMMUs) (i.e., DMMU-1 and DMMU-2) were characterized. Four cores were collected within the dredge area (two in each DMMU) (Figure I-1). Two composite samples were analyzed to characterize the 0- to 3-ft dredge interval. In addition, 1-ft Z-samples from each of the four individual cores were analyzed to characterize the potential post-dredge sediment surface. DMMU-1 and DMMU-2 were determined to be unsuitable for open-water disposal because the concentrations of dioxins/furans, polycyclic aromatic hydrocarbons (PAHs), bis(2-ethylhexyl) phthalate, and polychlorinated biphenyls (PCBs) exceeded Dredged Material Management Program screening-level criteria (USACE et al. 2009). The concentrations of PAHs, bis(2-ethylhexyl phthalate, and PCBs also exceeded Washington State Sediment Management Standards (SMS) values (Table I-1). In addition, the dioxin/furan concentrations in the Z-samples for both DMMUs and PCB concentrations in Z-samples for DMMU-2 were not in compliance with Washington State anti-degradation policy.

Figure I-1

Pre-and Post-dredge Locations for the Terminal 115 Berth 1 Maintenance Dredging (RM 1.8 to 1.85 W)

Terminal 115 Berth 1



Note: Elevations shown in this figure are approximate. See Tables I-1 through I-3 for details regarding chemistry results.

Table I-1
Terminal 115 Berth 1 Pre-dredge Subsurface Sediment Samples

Sample Location	Sample Identification	Elevation (ft MLLW)	Sample Interval	Dioxin/furan TEQ[1] (ng/kg dw)	SMS Exceedances
DMMU-1 (north)					
S1-01 and S1-02	DMMU C1 (0–3-ft composite)	-12.5 to -15.5 (approximate)	0-3 ft	20.1	7 PAHs > SCO (3 of which were > CSL)
S1-01	S1-01 ZA1	-15.5 to -16.5	3-4 ft	12.9	none
S1-02	S1-02 ZA2	-16 to -17	3-4 ft	14.5	3 PAHs > SCO
	S1-02 ZB2	-17 to -18	4-5 ft	**39.3**	none
DMMU-2 (south)					
S2-01 and S2-02	DMMU C2 (0–3-ft composite)	-12.5 to -15.5 (approximate)	0-3 ft	24.1	bis(2-ethylhexyl)phthalate > SCO
S2-01	S2-01 ZA1	-15.7 to -16.7	3-4 ft	**32.9**	PCBs > SCO (13 mg/kg OC)
	S2-01 ZB1	-16.7 to -17.7	4-5 ft	**28.2**	PCBs > SCO (14 mg/kg OC)
	S2-01 ZC1	-17.7 to -18.7	5-6 ft	23.5	PCBs > LAET (180 µg/kg dw)
S2-02	S2-02 ZA2	-17.1 to -18.1	3-4 ft	24.6	bis(2-ethylhexyl)phthalate > SCO
	S2-02 ZB2	-18.1 to -19.1	4-5 ft	**29.4**	PCBs > LAET (320 J µg/kg dw), 2 PAHs > LAET
	S2-02 ZC2	-19.1 to -20.1	5-6 ft	23.0	PCBs > LAET (234 µg/kg dw), 2 PAHs > LAET

Notes:

1. There are no SMS for dioxin/furan TEQ (one of the LDW human health risk drivers). **Bold** text indicates concentrations greater than the lowest RAL (i.e., 25 ng/kg dw).
2. There are no SMS for cPAHs (one of the LDW human health risk drivers). The cPAH TEQs for all of the samples presented in this table were below the lowest ESD RAL of 5,500 µg/kg dw.

cPAH: carcinogenic polycyclic aromatic hydrocarbon
CSL: cleanup screening level
DMMU: dredged material management unit
DMMP: Dredged Material Management Program
dw: dry weight
ESD: explanation of significant differences
J: estimated concentration
LAET: lowest apparent effects threshold
LDW: Lower Duwamish Waterway
MLLW: mean lower low water
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
SCO: benthic sediment cleanup objective
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent

To comply with the anti-degradation policy, the Port of Seattle agreed to place approximately 1 to 1.5 ft of clean sand cover material over the entire dredge area after the completion of dredging. In order to accommodate the sand cover thickness, the dredge depth was revised from the originally planned -17 ft MLLW to -18.5 ft MLLW (including the 2 ft of overdredge) (Figure I-1). Dredging was conducted from January 20 to February 12, 2010.

After dredging had been completed, four post-dredge cores were collected to characterize the 0- to 4-ft interval prior to placement of the sand cover. Sand cover placement then occurred from February 20 through 23, 2010. PCB concentrations in most of the core intervals were greater than the Dredged Material Management Program screening levels, and dioxin/furan TEQ concentrations were less than the pre-dredge Z-sample dioxin/furan TEQ concentrations (SEE 2010). The dioxins/furans and PCB concentrations in the post-dredge cores prior to placement of the sand cover layer are provided in Table I-2. The post-dredge core data are included in the middle reach design dataset to provide information regarding deeper (i.e., non- RAL) intervals.

Table I-2
Terminal 115 Berth 1 Post-dredge Subsurface Sediment Samples

Core[1]	Interval	Elevation (ft MLLW)	Pre-sand Cap Sample Interval[2]	Dioxin/Furan TEQ (ng/kg dw)[3]	Total PCBs (mg/kg OC)[4]	Other SMS Exceedances[5]
SC01	A	-17.6 to -18.6	0–1 ft	2.70	**15.4**	none
	B	-18.6 to -19.6	1–2 ft	20.2	**21.6**	BBP > SCO
	C	-19.6 to -20.6	2–3 ft	24.1	**12.6**	none
	D	-20.6 to -21.6	3–4 ft	6.39	**42.1**	2 PAHs > SCO
SC02	A	-17.3 to -18.3	0–1 ft	8.23	**14.3**	none
	B	-18.3 to -19.3	1–2 ft	6.35	**15.2**	BBP > SCO
	C	-19.3 to -20.3	2–3 ft	5.56	7.00	none
	D	-20.3 to -21.3	3–4 ft	10.1	9.77	none
SC03	A	-17.1 to -18.1	0–1 ft	7.32	**16.5**	none
	B	-18.1 to -19.1	1–2 ft	12.6	**23.2**	2 PAHs > SCO
	C	-19.1 to -20.1	2–3 ft	2.89	**540** µg/kg dw	none
	D	-20.1 to -21.1	3–4 ft	0.19	not detected	none
SC04	A	-15.8 to -16.8	0–1 ft	not detected	not detected	none
	B	-16.8 to -17.8	1–2 ft	0.19	not detected	none
	C	-17.8 to -18.8	2–3 ft	not detected	not detected	none
	D	-18.8 to -19.8	3–4 ft	not detected	not detected	none

Notes:
1. Shading added to differentiate between cores.
2. Sample intervals are prior to the placement of the sand cover.

3. There are no SMS for dioxin/furan TEQ (one of the LDW human health risk drivers); all TEQs were below the lowest RAL of 25 ng/kg dw.
4. **Bold** text indicates concentrations greater than the SMS.
5. There are no SMS for cPAHs (one of the LDW human health risk drivers). The cPAH TEQs for all of the samples presented in this table were below the lowest ESD RAL of 5,500 µg/kg dw.

BBP: butyl benzyl phthalate
cPAH: carcinogenic polycyclic aromatic hydrocarbon
dw: dry weight
ESD: explanation of significant differences
LDW: Lower Duwamish Waterway
MLLW: mean lower low water
OC: organic carbon
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
SCO: benthic sediment cleanup objective
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent

In addition to the post-dredge cores, post-dredge surface sediment monitoring was conducted after maintenance dredging of Berth 1 at Terminal 115. Three years of monitoring were required under U.S. Army Corps of Engineers Permit NWS-2008-1496-WRD. Surface sediment samples (0 to 10 cm) were collected from four locations in 2010, 2011, and 2013 (Figure I-1) and analyzed for select chemicals. Samples collected in 2010 were analyzed for phthalates, PAHs, other semivolatile organic compounds (SVOCs), and dioxin/furans (SEE 2010). Phthalates and other SVOCs were generally not detected, and all were below SMS criteria. Samples collected in 2011 and 2013 were analyzed only for PAHs and dioxins/furans (SEE 2013). None of the samples were analyzed for PCBs or metals.

The results for low-molecular-weight PAHs, high-molecular-weight PAHs, and dioxin/furan TEQs are summarized in Table I-3. In all samples,[1] PAH concentrations were less than SMS criteria and dioxin/furan TEQ concentrations were less than the applicable sediment RALs. The results for the most recent sample at each location (i.e., the 2013 results) are included in the design dataset for the middle reach.

[1] Locations SG01, SG02, and SG03 are located in a Recovery Category 1 area; Location SG04 is located in a Recovery Category 3 area.

Table I-3
Terminal 115 Berth 1 Post-dredge Surface Sediment (0–10 cm) Monitoring Results

Location	Depth of Sediment on Sand Cover (cm)		LPAHs[1]			HPAHs[1]			Dioxin/Furan TEQ (ng/kg dw)[1]		
	2011	2013	2010 (µg/kg dw)[2]	2011 (mg/kg OC)	2013 (mg/kg OC)	2010 (µg/kg dw)[2]	2011 (mg/kg OC)	2013 (mg/kg OC)	2010	2011	2013
SG01A	9.5	>28	2.94	3.30	4.60	21.8	22.2	37.3	0.13	0.31	6.82
SG02A	13	>26	27.1	7.20	6.10	481	28.0	53.2	0.14	1.12	6.48
SG03A	27	5.0	11.0	5.80	5.40	82.7	30.6	48.6	0.65	0.62	7.36
SG04A	15	>26	1.60	5.20	6.60	18.1	29.6	50.1	0.45	0.26	6.77

Notes:
1. Values were compared with the SMS (for LPAHs and HPAHs) and with the lowest RAL for dioxin/furan TEQ (because there is no SMS). All values were below the applicable thresholds.
2. TOC was below the threshold for TOC normalization in 2010, so PAH concentrations are reported as dry weight.
dw: dry weight
HPAH: high-molecular-weight polycyclic aromatic hydrocarbon
LPAH: low-molecular-weight polycyclic aromatic hydrocarbon
OC: organic carbon
PAH: polycyclic aromatic hydrocarbon
RAL: remedial action level
SMS: Washington State Sediment Management Standards
TEQ: toxic equivalent
TOC: total organic carbon