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Lower Duwamish Waterway Group

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

QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR THE LOWER DUWAMISH WATERWAY UPPER REACH: PRE-DESIGN INVESTIGATION PHASE II

FINAL

For submittal to

The US Environmental Protection Agency
Region 10
Seattle, WA

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TITLE AND APPROVAL PAGE

Remedial Design of Upper Reach Pre-Design Investigation Quality Assurance Project Plan Addendum for Phase II Sampling

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TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

MAPS

ABBREVIATIONS

abbreviation	definition
AC	activated carbon
ASTM	American Society for Testing and Materials
BBP	butyl benzyl phthalate
BEHP	bis(2-ethylhexyl) phthalate
cPAH	carcinogenic polycyclic aromatic hydrocarbon
DER	data evaluation report
DQO	data quality objective
EF	exceedance factor
ENR	enhanced natural recovery
EPA	US Environmental Protection Agency
ESD	explanation of significant differences
FNC	Federal Navigation Channel
FS	feasibility study
GPS	global positioning system
ID	identification
LDW	Lower Duwamish Waterway
MLLW	mean lower low water
MTC	Materials Testing and Consulting, Inc.
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PDI	pre-design investigation
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAA	remedial action area
RAL	remedial action level
RD	remedial design
RI/FS	remedial investigation/feasibility study
RM	river mile
ROD	Record of Decision
SOP	standard operating procedure
TOC	total organic carbon

1 Introduction

This document is an addendum to the quality assurance project plan (QAPP) for pre-design investigations (PDIs) in the upper reach[1] of the Lower Duwamish Waterway (LDW) (Map 1-1) (Windward and Anchor QEA 2020). The QAPP describes the quality assurance (QA) objectives, methods, and procedures for PDI sampling and analysis. This work supports the remedial design (RD) for the upper reach per the Fourth Amendment to the Administrative Order on Consent for the LDW (EPA 2018), in accordance with the US Environmental Protection Agency's (EPA's) November 2014 Record of Decision (ROD) (EPA 2014).

This QAPP addendum presents a detailed study design for PDI Phase II sampling, including sampling locations, intervals, and analytes, as well as any updates to field collection methods, laboratory analysis methods, data management protocols, and reporting requirements. All other aspects of the PDI sampling and analysis are the same as those specified in the PDI QAPP and are not repeated in this document.

[1] The upper reach includes river mile (RM) 3.0 to 5.0 of the LDW.

2 Project Objectives and Description

2.1 Data Quality Objectives

Design sampling is being conducted in phases in the upper reach. Phase II sampling is being conducted to meet the Phase II data quality objectives (DQOs) outlined in Table 2-1. Phase I DQOs were met by Phase I sampling. Phase I results are presented herein or will be included in the upcoming Phase II data evaluation report (DER).

Table 2-1
DQOs for Phase II of the PDI in the Upper Reach

Phase II
DQO9 – If feasible, delineate RAL exceedances in areas under over-water structures.
DQO10 – Further delineate RAL exceedances,[1] as needed for unbounded areas.
DQO11 – Assess chemical and physical characteristics of banks (including topographic survey), as needed, depending on remedial technology selected for adjacent sediment and whether bank is erosional.
DQO12 – Delineate vertical elevation of RAL exceedances in dredge (and partial dredge and cap) areas and collect subsurface sediment chemistry data in cap areas where contamination under caps will remain.[2]
DQO13 – Collect geotechnical data as needed depending on technology proposed and/or physical characteristics of RAL exceedance areas.
DQO14 – Collect other engineering-applicable data as needed (e.g., structures inspection, utility location verification, thickness of sediment on top of riprap layers, groundwater velocities[3]).

Notes:
1. Benthic toxicity testing may be used to override chemical data in RAL delineation (DQO 10), per the ROD (EPA 2014).
2. Vertical delineation includes an assessment of whether an additional 1 ft of dredging in partial dredge and cap areas would be sufficient to achieve complete removal as shown in ROD Figure 20.
3. Groundwater velocity data may need to be collected during Phase III (following selection of remedial technologies and review of existing groundwater data) if needed for cap design.
DQO: data quality objective
PDI: pre-design investigation
RAL: remedial action level
ROD: Record of Decision

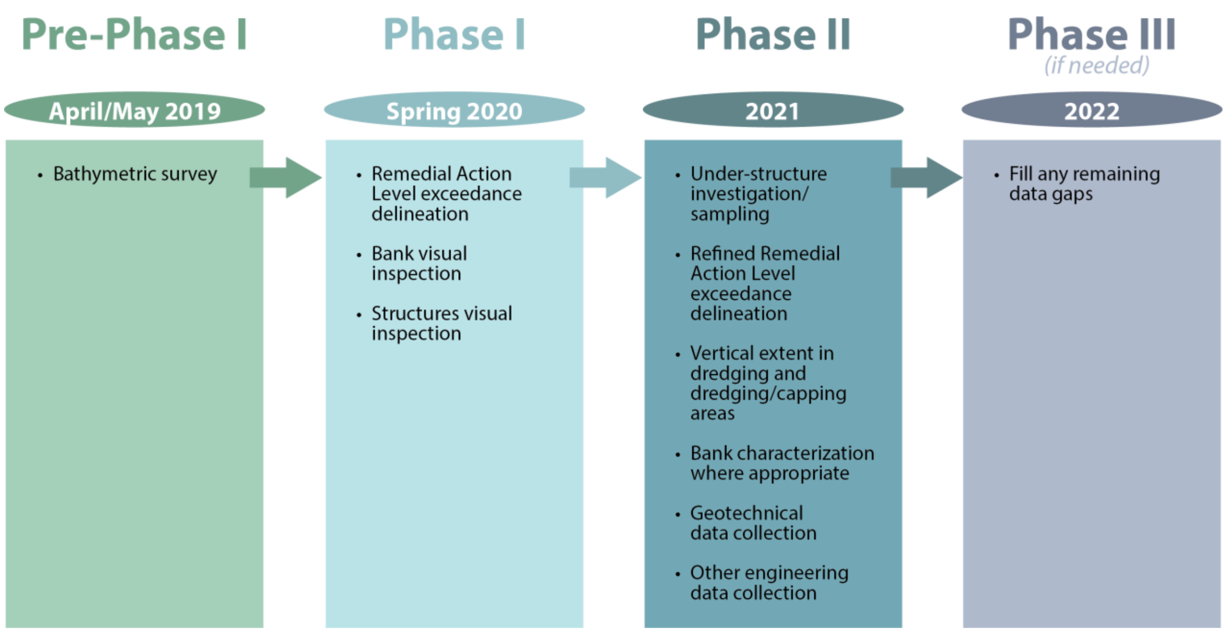
2.2 Project Description and Schedule

Phase II sampling, as presented in this addendum, will involve the collection and chemical analysis of sediment and bank samples to refine the delineation of remedial action level (RAL)[2] exceedances, assess the vertical extent of contamination in dredging or partial dredging and capping areas, and acquire area-specific engineering information needed for design (Figure 2-1). Following Phase II

[2] As stated in the ROD (EPA 2014), a RAL is a contaminant concentration above which remedial action is required. RALs for the LDW are defined in ROD Table 28, titled *Remedial Action Levels, ENR Upper Limits, and Areas and Depths of Application*. Revisions to carcinogenic polycyclic aromatic hydrocarbons (cPAH) RALs have been proposed in an explanation of significant differences (ESD) document (EPA 2021); cPAH RAL exceedances based on the ROD and the ESD are both shown in this addendum.

sampling, a Phase II DER will be prepared to interpret the results and guide the development of subsequent design activities.

Figure 2-1
Design Sampling Phases



The Tier 1 and Tier 2 results of the Phase I sediment sampling have been uploaded to ldwg.org as a data package. This upload will be supplemented with the complete Phase I sediment chemistry results (including Tier 3), and backup documentation. The complete Phase I dataset is also attached and mapped for reference in Attachment A. In addition, existing non-RAL interval data are included in this attachment to assist in locating Phase II sampling locations.

Results of the Phase I bank visual inspection and structures visual inspection will be attached to the Phase II DER, wherein they will be supplemented with any additional Phase II information. The results of the 2020 bathymetry survey, which was conducted to fill data gaps remaining from the 2019 survey presented in the QAPP, are included in Attachment B. Recovery categories were re-assessed based on the Phase I sediment chemistry data results and the complete bathymetric data (2019 and 2020); this assessment is presented in Attachment C.

The Phase I sediment chemistry results were combined with the existing design dataset per the data rules described in Attachment D and used to determine Phase I RAL exceedance areas, which are depicted in this QAPP Addendum to aid in the identification of Phase II sampling locations. RAL exceedance areas were developed based on a comparison to RALs in the ROD (Figure 28) (EPA 2014). An ESD has been proposed by EPA (EPA 2021) based on the final *Toxicological Review of*

Benzo(a)pyrene released by EPA on January 19, 2017. The results of this review "confirmed the benzo(a)pyrene is human carcinogen but that it is over 7 times less potent than previously estimated" (EPA 2021). Accordingly, EPA proposed updated cleanup levels and RALs for cPAHs. Until the ESD is finalized, RAL exceedance areas are defined for cPAHs by comparison to both sets of RALs. The salmon-colored RAL exceedance areas (shown on maps in this QAPP Addendum) are based on the ROD RALs for all contaminants, except for cPAH RALs, which are based on the RALs in the draft ESD. Additional areas that would have cPAH RAL exceedances based on the ROD RALs are shown in orange on RAL exceedance area maps. Once a final ESD is issued by EPA, data gaps will be assessed to determine if any remain for these areas, which are being further assessed as part of Phase II.

The preliminary methods used to derive the RAL exceedance areas for this purpose are summarized in Attachment E. These methods will be updated in 2021, as needed, prior to submittal of the Phase II DER in 2022, in order to interpolate final RAL exceedance area boundaries for use in developing the remedial action areas in 30% RD.

For each of the RAL exceedance areas determined using the Phase I design dataset, preliminary technology assignment options were identified in order to guide Phase II sampling needs. Selection of these options based on the technology selection flow charts in the ROD is presented in Attachment F, along with a table summarizing Phase II data needs.

An archaeological monitoring and inadvertent discovery plan describing the actions that will be performed during the Phase II investigations related to the unanticipated discovery of cultural resources, artifacts, or other archaeological features is provided as Attachment G. The monitoring and inadvertent discovery plan describes the locations where archaeological monitoring will take place and provides direction, contact information, and guidance for the proper procedures to follow should an inadvertent discovery occur. In addition, all data collection and sampling activities will be conducted in conformance with the updated health and safety plan (Attachment H).

Phase II sampling will begin in late June 2021 upon approval of this QAPP addendum. Sampling is anticipated to be completed by the end of August 2021. Sample analysis will be tiered, as described in Section 4.5; most of the analyses conducted will be Tier 1.

Sampling will be coordinated with past or continuing actions that could affect Phase II activities. These actions include the construction of the Duwamish River People's Park and Shoreline Habitat project (adjacent to and south of the Terminal 117 early action area), Section 404 actions by The Boeing Company along the shoreline, perimeter sampling near early action areas, sampling that has been conducted in the enhanced natural recovery (ENR)/activated carbon (AC) pilot study, and other shoreline construction and monitoring work.

3 Project Organization and Responsibilities

This section and Figure 3-1 in the PDI QAPP (Windward and Anchor QEA 2020) present the overall project organization and the individuals responsible for the various tasks required for PDI sampling and analysis, including contact information. The only changes to the information presented in the PDI QAPP are the addition of the following new suppliers:

- Geotechnical analyses: Materials Testing and Consulting, Inc. (MTC)
- Geotechnical drilling: Holocene Drilling, Gregory Drilling, and ConeTec, Inc.

4 Data Generation and Acquisition for Sediment and Bank Analytical Samples

This section presents the design for Phase II sampling. In addition, it supplements sample collection methods for vertical extent cores[3] and bank samples and associated sample identification protocol. Information regarding sample custody and shipping requirements; decontamination procedures; field-generated waste disposal; laboratory methods; sediment chemistry analytical DQOs and criteria and QA/quality control (QC); sediment benthic toxicity testing quality objectives and QA/QC; instrument/equipment testing, inspection, maintenance, and calibration; and analytical data management is presented in the PDI QAPP (Windward and Anchor QEA 2020).

4.1 Sampling Design for Sediment and Bank Samples

To address DQOs 9 through 12, this section discusses the design for sediment and bank sampling, including approaches and rationale for depth intervals,[4] tiering, analytes, sampling locations, and benthic toxicity testing. Many of the elements of the sampling design are consistent with the Phase I PDI as described in the PDI QAPP (Windward and Anchor QEA 2020).

4.1.1 General Principles for Identification of Locations

To determine specific sediment and bank sampling locations for Phase II sampling, the following five principles were applied based on the existing design data[5] for the upper reach.

- **Assess RAL exceedances at the upper reach northern boundary** – Collect sediment data within a 100-ft "buffer" area at the northern boundary of the upper reach (RM 3.0) to assess whether a RAL exceedance area crosses the boundary between the upper and middle reaches so that cleanup boundary decisions for the upper reach can be made during design.
- **Refine horizontal boundaries of Phase I RAL exceedance areas** – Collect additional sediment and bank data around the interpolated boundaries of areas with RAL exceedances to refine horizontal extents of RAL exceedance areas[6] and improve the interpolation. Sampling locations were selected based on area-specific considerations including spatial distribution of data, conceptual site model, bank type, presence of in-water structures, and bathymetric elevations and grades.

[3] Vertical extent cores are defined as cores that are deeper than the RAL intervals of 0–45 cm, 0–60 cm, and shoaling cores, as defined in ROD Table 28 (EPA 2014).
[4] The term "depth" is used throughout this document to refer to the depth of the samples to be collected below the mudline.
[5] The design dataset contains data from the remedial investigation/feasibility study (RI/FS), post-FS data, and Phase I PDI data. Phase II (and if collected, Phase III) data will be added to the design dataset when available.
[6] Locations with RAL EFs between 0.9 and 1.0 are identified, as are sample locations to address uncertainties associated with nearby horizontal boundaries.

- **Gather data in RAL exceedance areas defined only by interpolation** – Collect samples in or adjacent to RAL exceedance areas that are based on interpolated concentrations only (herein referred to as interpolation-only RAL exceedance areas). Specifically, these areas do not have any sample locations with RAL exceedances but show up as RAL exceedance areas because interpolated concentrations exceed RALs as they cross recovery category or shoaling area boundaries that have different RALs. See Area 4 on Map 4-1a as an example. In these interpolation-only areas, GIS was used to best place sampling locations. These locations are generally at elevations more similar to that of the sample with the concentration being interpolated (e.g., if the RAL exceedance was within the intertidal, it was generally more relevant to place the bounding sample within the intertidal).
- **Bound vertical extent** – Collect samples within RAL exceedance areas where needed for design (e.g., dredging or partial dredging/capping areas) to determine the vertical extent of contamination. Vertical extent data are not needed in ENR or thin-dredge cut areas (i.e., RAL exceedance areas with only 0–10-cm exceedances above the ENR upper limit and sufficient subsurface samples with no RAL exceedances).
- **Collect sediment for benthic toxicity testing** – Re-occupy locations that only exceed benthic RALs for toxicity testing that, if they pass benthic toxicity tests, would affect area boundaries or eliminate the need for remediation.
- **Collect sediment under over-water structures if needed** – There are eight locations with over-water structures within the upper reach. Three of these locations generally have narrow floats (e.g., marinas and Delta Marine), two are bridges, and three have pier structures. Two of these eight locations (South Park Bridge and Pier 2 within Slip 6) have RAL exceedance areas that extend into the footprint of an over-water structure. All eight locations were evaluated to assess the need for under-structure sampling in Phase II. In consultation with EPA, the decision was made to collect samples under the South Park Bridge, and to re-assess in the Phase II DER whether any additional under-structure sampling will be needed in Phase III.

Using these principles, Phase II sediment sampling is proposed at 217 locations, many of which will have more than one sample interval (Table 4-1). At least one sample from most of these locations will be analyzed in Phase II Tier 1 (upon collection); the remaining locations and/or samples will be archived and analyzed, if needed, in Phase II Tier 2 (see Section 4.1.3). Phase II sampling locations are shown on Maps 4-1a through 4-1j, with different symbols used to indicate the type(s) of samples to be collected at each location (as described in Table 4-1). Key considerations for each RAL exceedance area, the rationale for the placement of each sampling location, the sample intervals collected at each location, and applicable analytes (see Section 4.1.4) are presented in Tables I-1 and I-2 in Attachment I.

Table 4-1
Summary of Phase II Upper Reach Sampling Locations

Sample Type	Count of Design Dataset Locations: Count Prior to Phase II	Count of Design Dataset Locations: Count of Tier 1 Phase II Locations (Tier 2 Locations)[1]	Count of Design Dataset Locations: Total Count After Phase II (Including Phase II Tier 1 Locations)[2]	Map 4-1 Series Notes
Surface (0–10 cm)	756	71 (13)[3]	827	Indicated on maps by open circles (Tier 1 samples are purple and Tier 2 [archive] samples are gray.)
Intertidal subsurface (0–45 cm)	92	42 (10)[3, 4, 5]	134	Indicated on maps by open pentagons (Tier 1 samples are blue and Tier 2 [archive] samples are gray.)
Subtidal subsurface (0–60 cm) (not shoaling areas)	84	51 (8)[6]	135	Indicated on maps by open squares (Tier 1 samples are blue and Tier 2 [archive] samples are gray.)
Shoaling area subsurface (variable)	37	12 (4)[3, 7]	49	Indicated on maps by open blue squares with yellow rim
Vertical extent cores	78	69 (17)	147	Indicated on maps by a "V." Blue Vs indicate locations where one or more sample intervals will be analyzed as Tier 1, and gray Vs indicate locations where all sample intervals will be archived (Tier 2). Core profiles shown on the maps provide details regarding which sample intervals are Tier 1 and Tier 2 samples.

Notes:
1. This table presents the location counts by sample type for Phase II. The sample counts are higher than the location counts because many locations have results for multiple intervals.
2. Total count does not account for double counting of locations analyzed in both Phase I and Phase II.
3. Three of the Phase II surface sediment locations (128, 249, and 321), four of the Phase II intertidal subsurface locations (143, 321, 358, and 384), one of the Phase II subtidal subsurface locations (128), and four of the Phase II subsurface shoaling locations (163, 231, 249, and 254) shown on the Map 4-1 series are PDI Phase I archive locations. Thus, no sample collection is needed at these locations.
4. At each vertical extent location in an intertidal area where only a V is shown on the Map 4-1 series, a 0–45-cm archive (Tier 2) sample will also be collected as part of that core (but is not included in the counts in this table). Analysis of the 0–45-cm interval is not likely; it would depend on location-specific design questions to be discussed prior to Tier 2 analyses.
5. The four 0–45-cm locations on the ENR/AC pilot plots will be sampled to characterize the 0–45 cm from the surface as well as the 0–45 cm below the ENR layer.
6. At each vertical extent location in a subtidal area where only a V is shown on the Map 4-1 series, a 0–60-cm archive (Tier 2) sample will also be collected as part of that core (but is not included in the counts in this table). Analysis of the 0–60-cm interval is not likely; it would depend on location-specific design questions to be discussed prior to Tier 2 analyses.
7. Sampling depths for shoaling area cores vary depending on the thickness of shoal material at each location (see Figure 4-2). With one exception, shoaling cores will be collected to -17 ft MLLW in RAL exceedance areas that also include vertical extent cores, because the vertical extent cores will be used to characterize intervals below -17 ft MLLW. The Area 20 shoaling core (location 607) will include a Z-sample from -17 to -18 ft MLLW, because the Area 20 vertical extent core is not in the navigation channel.
ENR/AC: enhanced natural recovery/activated carbon
MLLW: mean lower low water
PDI: pre-design investigation
RAL: remedial action level

4.1.2 Depth Intervals

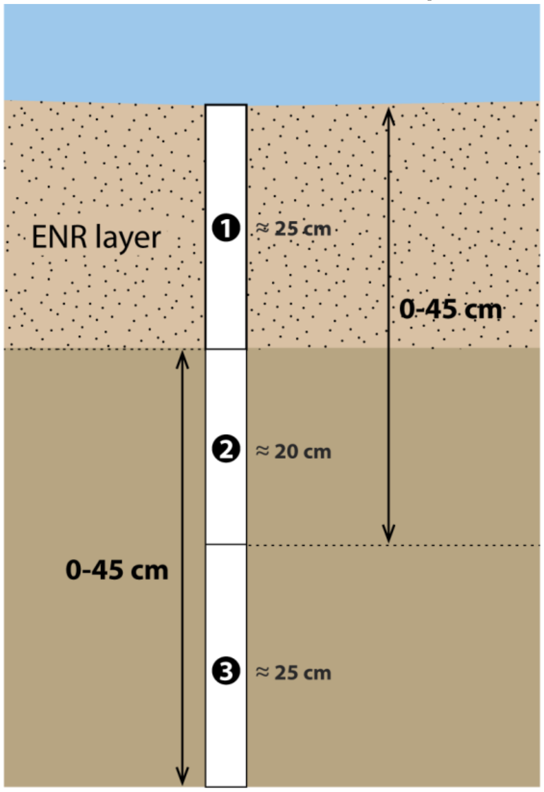
4.1.2.1 Horizontal Delineation

To refine the horizontal extent of RAL exceedances in sediment and in bank areas, samples will be collected from one or more of the RAL exceedance intervals, which include the following:

- Intertidal areas – 0–10- and 0–45-cm interval
- Subtidal areas – 0–10- and 0–60-cm interval
- Shoaling areas – the 0–10-cm interval and sediment down to -17 ft mean lower low water (MLLW); intervals will vary depending on the depth of the shoaled material, as discussed in the PDI QAPP (Windward and Anchor QEA 2020).

In the ENR/AC pilot intertidal plot, five locations will be sampled. At four of these locations (615, 618, 624, and 626), samples of both the 0–45-cm interval from the existing mudline and the 0–45-cm interval below the ENR layer will be collected. Each core in the plots will be sectioned into three intervals (Figure 4-1). The results from intervals 1 and 2 will be combined to calculate the concentrations for the 0–45-cm interval from the mudline. The results from intervals 2 and 3 will be combined to calculate the concentrations for the 0–45-cm interval below the ENR layer. At the fifth location (617), only the 0–45-cm interval from the mudline will be collected, because the 0–45-cm interval below the ENR layer has already been analyzed.

Figure 4-1
0–45 cm characterization in ENR/AC Pilot Plots



4.1.2.2 Vertical Extent Delineation

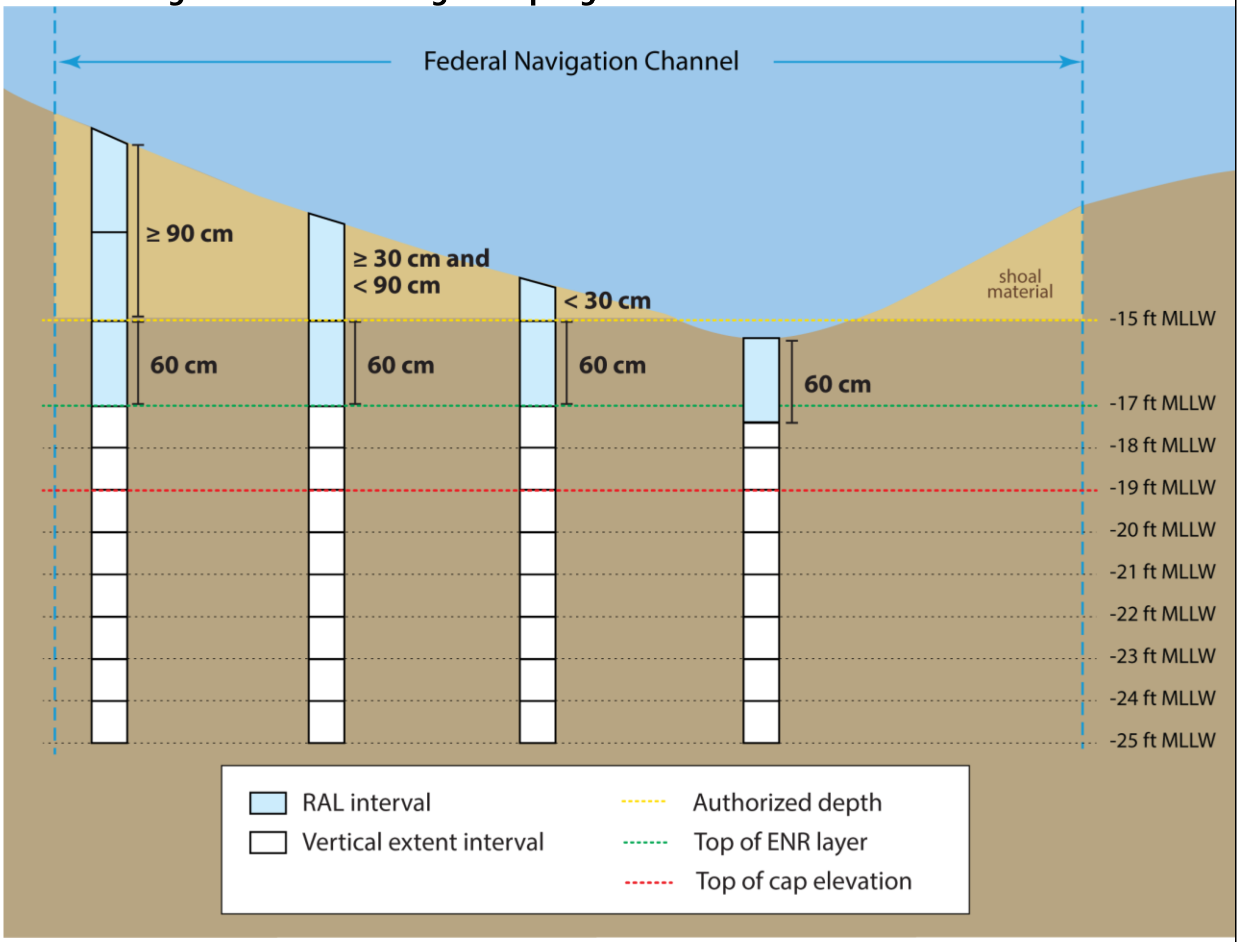
Cores deeper than 60 cm (referred to herein as vertical extent cores) will be collected to determine the depth of contamination below the sediment surface where needed for remedy design (i.e., in RAL exceedance areas with 0–45- or 0–60-cm RAL exceedances that have the potential to have dredging or partial dredging and capping technologies). In areas where Phase II bounding samples have RAL exceedances or if ENR bounding samples exceed the ENR upper limit, the vertical extent of the remedy will be determined during design based on the adjacent vertical extent data or, if needed, through the acquisition of Phase III data. The need for Phase III data will be evaluated with EPA during the Phase II DER. Tables I-2, I-3, and I-4 and Maps 4-1a through 4-1j show the depths of the cores to be collected at each location.

For vertical extent delineation within the Federal Navigation Channel (FNC), the ROD (Section 13.2.1.1) states: *All post-remedy surfaces within the FNC will be maintained at or below their current authorized depths. In order to avoid damage to a cap or ENR layer during federal maintenance dredging, the top of any ENR layer will be at least 2 ft and the top of any cap will be at least 4 ft below the authorized federal navigation channel depth* (EPA 2014).

The ROD assumed a cap thickness of 3 ft in subtidal areas and 4 ft in intertidal areas. These thicknesses are considered reasonable averages for an engineered cap. Because a typical cap may be designed to be 2 to 3.5 ft thick, the final constructed cap thickness can vary from an anticipated minimum thickness of 2 ft to an anticipated maximum thickness of less than 5 ft (accounting for construction tolerances). In addition, because the top of the cap elevation cannot be above -19 ft MLLW within the FNC (i.e., 4 ft below the authorized depth of -15 ft MLLW), the bottom of an engineered cap, if constructed, may vary between -21 and -24 ft MLLW (Figure 4-2). Therefore, within the FNC, the vertical extent cores will be collected to a target elevation of -25 ft MLLW, allowing for characterization of at least 1 ft of sediment below the anticipated maximum cap thickness. In addition, any sediment collected below the target elevation (or depth) will be archived in 30-cm (approximately 1-ft) intervals as described in Attachment J2. Vertical extent diagrams are shown on Maps 4a through 4j; these diagrams show the targeted depths (i.e., below the mudline) for each core based on its location and current mudline elevation.[7]

[7] For example, the vertical extent core at location 509 in the FNC with a mudline elevation of -16.8 ft MLLW would have a minimum core depth of 8.2 ft (i.e., from -16.8 ft to -25 ft MLLW); this depth is then rounded up to the nearest foot for a target depth of 9 ft. For the vertical extent core at location 514 with a mudline elevation of -17.2 ft MLLW, the minimum depth is 7.8 ft (i.e., -17.2 to -25 ft MLLW), rounded to a target depth of 8 ft.

Figure 4-2
Federal Navigation Channel Design Sampling

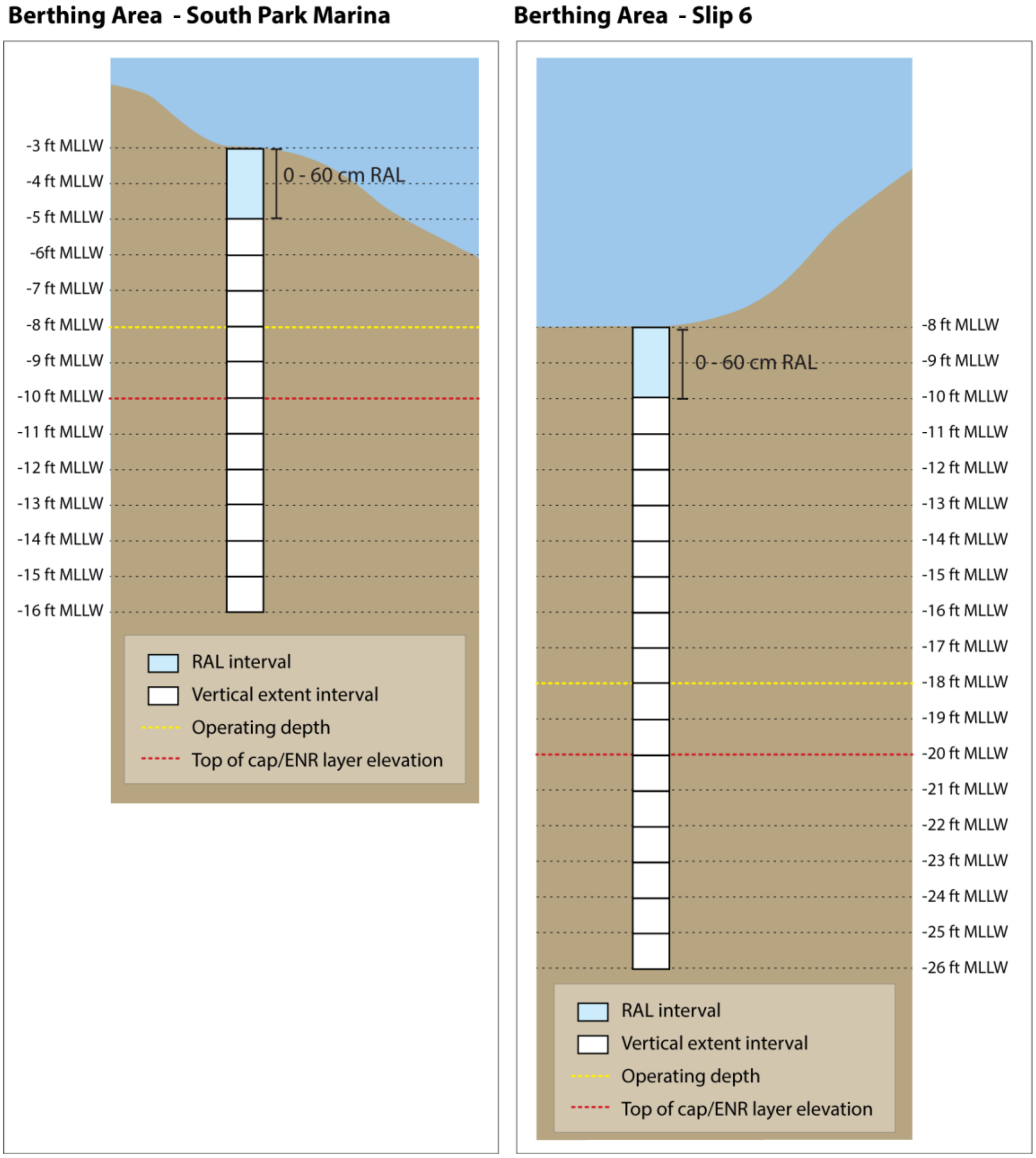


Contamination is not anticipated to extend down to -25 ft MLLW throughout the FNC in the upper reach, based on a review of the geology information presented in the LDW RI (Windward 2010), but even if contamination does extend to -25 ft MLLW or deeper, dredging below -24 ft MLLW will need to be carefully considered due to potential impacts on side slope stability in areas outside of the FNC, including habitat areas. As shown in Table I-4 of Attachment I, the depths of the cores will vary depending on the mudline elevation. Targeted core depths within the FNC range from 5 to 16 ft, with most cores targeting a depth of 6 to 9 ft. The six vertical extent cores in shoaling areas target depths of 12 to 16 ft.

Outside of the FNC, the ROD (Section 13.2.1.1) states: *For areas outside the FNC where depths are maintained by private or public entities (called berthing areas in this ROD, but could include slips, entrance channels, or restorations areas) the top of any cap or ENR layer will be a minimum of 2 ft below the operating depth* (EPA 2014). Thus, where vertical extent delineation is required within a berthing area outside of the FNC, vertical extent cores are targeted to extend at least 8 ft below the operating depth (i.e., obtaining 6 ft of vertical extent below the 2-ft buffer that is below the operating depth).

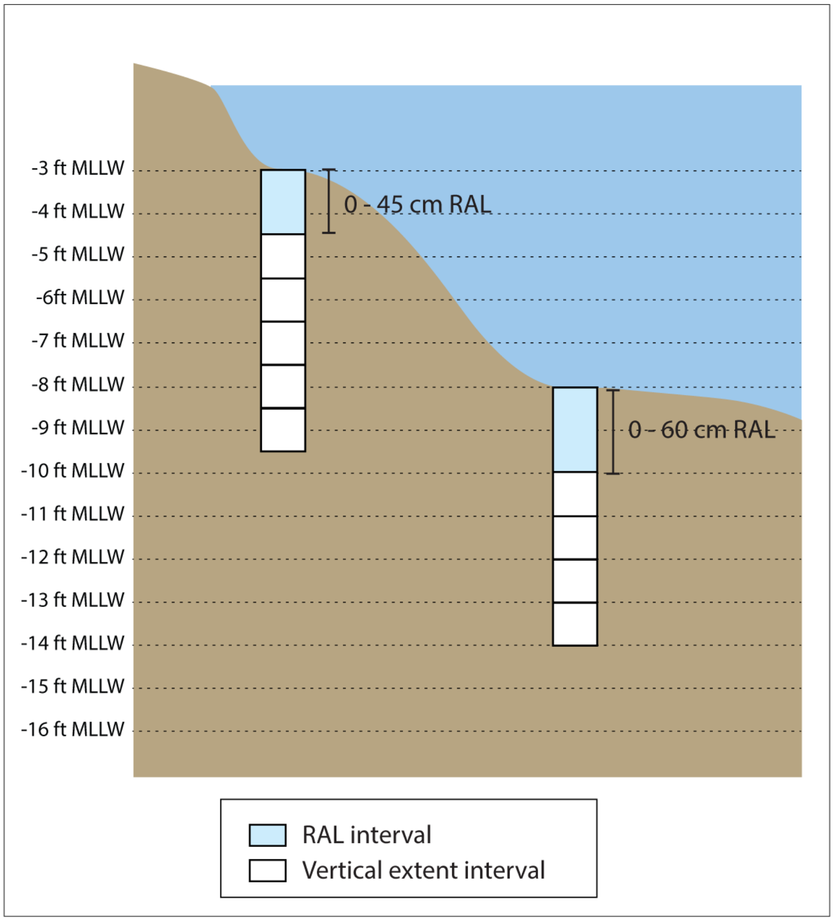
Outside the FNC, there are two areas that have historical documented berthing elevations within RAL exceedance areas (South Park Marina [Area 12] and Slip 6 [Area 32]). Core depths in Areas 12 and 32 will extend 8 ft below the historical documented operating depth (Figure 4-3). The need for these operating depths will be coordinated with the property owners during 30% design to confirm current and future needs to inform the RD. In the South Park Marina, where the historical documented operating depth was -8 ft MLLW, an elevation of -10 ft MLLW would represent the top of a cap/ENR layer if placed; therefore, the vertical extent core is targeted to extend to at least -16 ft MLLW. In Slip 6, where the historical documented operating depth was -18 ft MLLW, an elevation of -20 ft MLLW would represent the top of a cap/ENR layer if placed; therefore, the vertical extent core is targeted to extend to at least -26 ft MLLW.

Figure 4-3
Berthing Areas Outside the FNC Design Sampling



Within habitat areas (defined as areas above -10 ft MLLW in the ROD), the ROD states: *Post-remedy surfaces will be maintained at their current depth and backfilled or capped with suitable habitat materials* (EPA 2014). Thus, vertical extent cores in these areas would not include any buffer depth below the existing grade, and a targeted 6-ft core would provide sufficient vertical extent delineation to design a cap with habitat substrate on top (Figure 4-4).

Figure 4-4
Sampling Design for Habitat Areas Above -10 ft MLLW and Areas Outside of the FNC or Berthing Areas



The ROD does not require any specific elevation limits when placing ENR or caps in areas that are not within the FNC, berthing areas, or habitat areas (EPA 2014). Backfilling to grade is not required for non-habitat areas. However, some backfilling of a dredge area may be needed for slope stability, to avoid morphological changes, or for other reasons.

4.1.3 Tiered Sample Analysis

Tier 1 (for immediate analysis) and Tier 2 (for archive and potential analysis) samples will be collected during a single Phase II sampling effort. Tier 2 samples will be selected for analysis in consultation with EPA. Details regarding which samples will be designated as Tier 2 are shown on Maps 4-1a through 4-1j and in Attachment I (Tables I-2, I-3, and I-4).

In general, samples will be designated as Tier 2 for the following reasons:

- **Vertical extent delineation** – In general, the entire core will be continuously logged and sectioned into 30-cm (approximately 1-ft) sample intervals below the RAL intervals.[8]
  - RAL intervals – For Tier 1 vertical extent cores, RAL intervals (0–45 or 0–60 cm) will generally be archived (see locations with no square or hexagon around the V in Maps 4-1a through 4-1j). The top 0–45 or 0–60 cm will be analyzed in Tier 1 where needed to further define horizontal extent (e.g., locations 514 in Area 1, 539 in Area 5, and 543 in Area 7). Depending on the Tier 1 results, archived 0–45- and 0–60-cm intervals at vertical extent core locations may be analyzed in Tier 2 if needed to further define the horizontal extent of RAL exceedance areas.
  - 30-cm intervals – The top two 30-cm intervals below the RAL interval in vertical extent cores will be analyzed in Tier 1. Below that, in general, alternating sample intervals will be analyzed (down to native sediment) as part of Tier 1 to further define the vertical extent of RAL exceedances. The remaining intervals will be archived for potential analysis in Tier 2. Exceptions to the alternating interval rule, based on pre-PDI data, are described in Attachment I (Tables I-1 and I-4). In Tier 2, intervals will be selected for analysis such that each core will “tag clean” (i.e., have a bottom interval with no RAL exceedances), or result in analysis of all intervals. If some or all intervals have RAL exceedances and the contamination extends more than 1 ft below the anticipated cap thickness, the ROD dictates that the area will be partially dredged and capped (EPA 2014).
  - Core profile details – Table I-4 and Maps 4-1a through -4-1j provide details of Tier 1 and Tier 2 intervals for each vertical extent core.
  - Area 36 – In the case of Area 36, the horizontal extent samples (0–10- and 0–45-cm) will be collected first and analyzed with a one-week turnaround time. The unvalidated surface data will be used to determine whether additional vertical extent cores (beyond the vertical extent core at location 694) should be collected in this area as part of Phase II and if so, how many and where.
- **Horizontal delineation** – The majority of Phase II surface (0–10 cm) and subsurface (0–45 and 0–60 cm) samples will be analyzed as Tier 1. However, in some locations, RAL interval samples will be archived and analyzed in Tier 2 if needed to further define the horizontal delineation. For example, in Area 18, location 595 will likely only be analyzed if there are no RAL exceedances at locations 594 and 599. Specific Tier 2 locations are listed in Table I-2 of Attachment I and shown in gray on Maps 4-1a through 4-1j.
- **Vertical extent delineation in RAL exceedance areas defined only by interpolation** – The interpolation-only RAL exceedance areas were defined based on interpolations only and have

[8] Stratigraphy will be considered in logging and sectioning cores. See Section 4.3.

yet to be confirmed with samples within or adjacent to the interpolation-only RAL exceedance area. In areas where the interpolation is being confirmed and vertical extent cores are being collected (i.e., Tier 2 vertical extent cores), the deeper core intervals will be analyzed if there are RAL exceedances in the RAL intervals and the data are needed for design (see Maps 4-1a through 4-1j and Attachment I, Table I-4).

4.1.4 Analytes

In general, the analyte list for each Phase II sample is dependent on nearby RAL exceedances in the design dataset and on which RALs are applicable at a given location. Locations where RALs apply are summarized in Figure 4-2 of the PDI QAPP (Windward and Anchor QEA 2020) and Table 28 in the ROD (EPA 2014) and are based on bathymetry (e.g., intertidal or subtidal), sample interval, recovery category, shoaling areas, and other location-specific factors. To meet the objective of the Phase II sampling and analysis (i.e., to refine the areas with RAL exceedances), analyte lists for these samples will be limited to those contaminants with applicable RALs for a given area with nearby RAL exceedances. Analytes will also include contaminants with nearby exceedance factors (EFs) of > 0.9. See Maps 4-1a through 4-1j for contaminant-specific EFs.

For example, intertidal location 578 in Area 18 has a RAL for butyl benzyl phthalate (BBP) in the 0–10-cm interval but not the 0–45-cm interval (Recovery Category 2) and has a BBP RAL exceedance in a nearby 0–10-cm sample (LDW-SS112 [2005]). Therefore, it will be analyzed in the 0–10-cm interval of location 578 but not in the 0–45-cm interval.

An exception to the above guidelines applies to six locations proposed in Phase II as re-occupied design dataset locations (locations 599, 600, 602, 603, 613, and 703). Location 613 may also be toxicity tested (see Section 4.1.5). These locations are based on the results of Phase I data (see Table I-2, Attachment I). Samples from these six locations will be analyzed for all analytes (except dioxins/furans) to be consistent with the Phase I Tier 1 re-occupation approach. Samples near these locations all have dioxin/furan toxic equivalents (TEQs) < 5 ng/kg (see Map A-12 in Attachment A). However, because dioxin/furan TEQs are more variable on the eastern intertidal area between RM 3.8 and RM 4.1, one of the sampling locations just north of the ENR/AC plots will be analyzed for dioxins/furans (location 603).

Using these guidelines, nearly all[9] of the Phase II Tier 1 samples will be analyzed for polychlorinated biphenyls (PCBs) and total organic carbon (TOC) (Table 4-2) . Additional contaminants will be analyzed following the guidelines described above (i.e., nearby RAL exceedances or EFs > 0.9). For the vertical extent cores, analytes will be determined based on nearby RAL exceedances and whether there is a subsurface RAL at that location for that contaminant. Analytes and sample-specific details

[9] PCBs will be analyzed in all Tier 1 samples except the samples in Areas 34 and 35, where PAHs are the target, and Phase I location 321, which is being analyzed only for arsenic.

are summarized in Attachment I, Tables I-1 and I-2. See Section 4.1.5 for details regarding analyte lists for locations in Areas 34 and 35, where chemistry will be expedited for benthic toxicity testing and potentially tiered.

Table 4-2
Summary of Phase II Analytes by RAL Exceedance Area based on RAL Exceedances in the Design Dataset

RAL Exceedance Area	Contaminant[s] with RAL Exceedance(s) in the Design Dataset at Locations Within the RAL Exceedance Area		Analytes in Tier 1 Phase II Samples
	Surface (0–10 cm)	Subsurface (0–45 cm, 0–60 cm, or shoaling interval)	
1	No exceedances (PCBs in intertidal area north of RM 3)	PCBs	PCBs in all samples; PCBs, cPAHs, arsenic, dioxins/furans in 0–45 cm samples
2	No exceedances	PCBs	PCBs; also all metals in 0–10-cm sample and arsenic in 0–45-cm sample to west at toe of bank
3	No exceedances	PCBs	PCBs
4	No exceedances	No exceedances	PCBs (based on interpolation only)
5	PCBs	PCBs (BBP EF of 0.93)	PCBs; also BBP in select samples
6	PCBs	No exceedances	N/A (no Phase II samples)
7	PCBs	No exceedances	PCBs
8	No exceedances	PCBs	PCBs; also mercury and PAHs in westernmost sample to address Area 9 exceedances
9	No exceedances	mercury, fluoranthene	mercury, PAHs; also PCBs to address Area 8 exceedances
10	PCBs	No exceedances	PCBs
11	No exceedances	PCBs	PCBs
12	PCBs, 4-methylphenol	No data; no 0–60 cm RAL exceedances in surrounding PDI samples	PCBs; also 4-methylphenol in archive near existing RAL exceedance
13	No exceedances	PCBs	PCBs; also dioxins/furans at select locations
14	No exceedances	No exceedances	PCBs (based on interpolation only)
15	No data; no exceedances in nearby samples	PCBs	PCBs
16	PCBs	PCBs	PCBs
17	PCBs, mercury	No exceedances	PCBs, mercury

RAL Exceedance Area	Contaminant[s] with RAL Exceedance(s) in the Design Dataset at Locations Within the RAL Exceedance Area		Analytes in Tier 1 Phase II Samples
	Surface (0–10 cm)	**Subsurface (0–45 cm, 0–60 cm, or shoaling interval)**	
18	PCBs, arsenic, BBP, PAHs (zinc and BEHP EFs > 0.9)	No exceedances (limited data)	PCBs, arsenic, BBP; also PAHs, cPAHs, BEHP, dioxins/furans, and zinc in select samples; all contaminants (except dioxins/furans) at re-occupied locations
19	No exceedances	No exceedances	PCBs (based on interpolation only)
20	No exceedances	PCBs	PCBs
21	zinc	No exceedances	all contaminants (except dioxins/furans) at re-occupied location; expedited analysis prior to potential benthic toxicity testing (see Section 4.1.5)
22	No exceedances	No exceedances	PCBs (based on interpolation only)
23	PCBs, BBP, lead, mercury, zinc	No exceedances	PCBs, BBP, lead, mercury, zinc; also arsenic and dioxins/furans at select locations
24	No exceedances	PCBs	PCBs
25	PCBs	No data; no 0–45 cm RAL exceedances in surrounding PDI samples	N/A (no Phase II samples)
26	No exceedances	No exceedances	PCBs (based on interpolation only); also all metals in select samples
27	PCBs	PCBs, dioxins/furans	PCBs; also arsenic. cPAHs, , dioxins/furans, and BEHP at select locations
28	No exceedances	PCBs	PCBs
29	No exceedances	No exceedances	PCBs (based on interpolation only)
30	PCBs, BBP	No exceedances	PCBs; also arsenic, cPAHs, dioxins/furans, BBP, and BEHP at select locations
31	PCBs, dioxins/furans, mercury, phenol	PCBs	PCBs, dioxins/furans; also arsenic, mercury, and phenol in select samples
32	No exceedances	PCBs	PCBs
33	No exceedances	No exceedances	PCBs (based on interpolation only)
34	PAHs	PAHs (1,2,4-trichlorobenzene EF of 0.9)	PAHs; 1,2,4-trichlorobenzene in select samples; expedited analysis of bounding samples that may be tested for benthic toxicity (see Section 4.1.5)
35	PAHs	No exceedances	PAHs; cPAHs in one sample (location 384); expedited analysis in bounding samples that may be tested for benthic toxicity (see Section 4.1.5)
36	PCBs	No exceedances	PCBs

RAL Exceedance Area	Contaminant[s] with RAL Exceedance(s) in the Design Dataset at Locations Within the RAL Exceedance Area		Analytes in Tier 1 Phase II Samples
	Surface (0–10 cm)	Subsurface (0–45 cm, 0–60 cm, or shoaling interval)	
37	PCBs, benzoic acid, 1,4-dichlorobenzene	No exceedances	PCBs; benzoic acid in select samples; all contaminants (except dioxins/furans) at re-occupied location

Notes:
BBP: butyl benzyl phthalate
BEHP: bis(2-ethylhexyl) phthalate
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EF: exceedance factor
N/A: not applicable
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PDI: pre-design investigation
RAL: remedial action level
RM: river mile

4.1.5 Toxicity Testing Design

Per the ROD,[10] benthic toxicity testing can be used to help delineate remedial action areas (RAAs) if there are no human health RAL exceedances. If sediment is not toxic at a location based on benthic sediment cleanup objective biological criteria evaluated through site-specific sediment toxicity testing, then the toxicity result overrides the benthic RAL chemistry result in areas without human health RAL exceedances. Sediment for chemistry and benthic toxicity testing will be collected simultaneously; chemical analysis at the bounding locations will be expedited so that the benthic toxicity tests can be initiated within holding times (see Section 4.2.5 in the PDI QAPP (Windward and Anchor QEA 2020)). Two surface sediment grab samples and at least three 0–45-cm cores will be required to collect sufficient volume for benthic toxicity testing (see Attachments J1 and J2).

As part of Phase II, benthic toxicity testing may be conducted in three areas (Areas 21, 34, and 35) because locations in these areas had only benthic RAL exceedances (Maps 4-1a through 4-1j). Area 21 is designated as a RAL exceedance area because zinc had a RAL EF of 1.8 in a 2011 0–10-cm sample (Map 4-1d). This area is well bounded, and the benthic RAL exceedance was isolated. Because this isolated benthic RAL exceedance may have recovered naturally,[11] this location will be re-occupied and chemical analysis will be expedited to determine if RAL exceedance(s) remain. The analyte list will include all contaminants with benthic RALs (which include three of the four human health contaminants: PCBs, arsenic, and cPAHs), and benthic toxicity testing conventionals (i.e., ammonia, sulfides, grain size, and TOC). Analysis of dioxin/furans (the fourth human health contaminant) will not be conducted because dioxin/furan toxic equivalents in this area have all been

[10] ROD Table 20 has a footnote that states *Benthic SCO biological criteria (WAC 173-204-562, Table IV) may be used to override benthic SCO chemical criteria where human health-based RALs are not also exceeded* (EPA 2014).
[11] The LDW conceptual site model suggests natural recovery processes are expected in this area if sources are adequately controlled.

< 5 ng/kg (relative to a RAL of 25 ng/kg) (see Map 12 in the PDI QAPP (Windward and Anchor QEA 2020)). If any benthic RALs are exceeded (and human health RALs are not), this sample will be toxicity tested and ammonia and sulfides will be analyzed. If the sample passes the benthic toxicity test, Area 21 will be eliminated as a RAL exceedance area based on the toxicity testing result.

Area 34 is designated as a RAL exceedance area based on Phase I PDI sample data from location 379: benthic RAL EFs of up to 4.8 for individual polycyclic aromatic hydrocarbons (PAHs) in the 0–10-cm interval and up to 3.6 in the 0–45-cm interval (Map 4-1i). In Phase II, samples for potential benthic toxicity testing will be collected from the two Tier 1 bounding locations (Locations 680 and 685) and analyzed for PAHs and 1,2,4-trichlorobenzene,[12] with a rapid turnaround in order to determine if these locations have RAL exceedances. At the re-occupied Phase I PDI location 379 (Phase II location 682), sediments will be collected for benthic toxicity testing and analysis of toxicity testing conventionals. Depending on the expedited results at the bounding locations (number and magnitude of PAH RAL exceedances), benthic toxicity testing may also be conducted at the bounding locations at the same time as the toxicity testing of location 682.

A similar process will be followed for Area 35. Specifically, the three 0–10-cm bounding samples (at locations 687, 689, and 690) will be collected and analyzed for PAHs with a rapid turnaround in order to determine if these locations have PAH RAL exceedances. At the re-occupied Phase I PDI location 383 (Phase II location 688), sediments will be collected for benthic toxicity testing and analysis of toxicity testing conventionals. Depending on the expedited results at the bounding locations (number and magnitude of PAH RAL exceedances), benthic toxicity testing may also be conducted at the bounding locations at the same time as the toxicity testing of location 688.

4.1.6 Sample Collection

Samples will be collected following standard operating procedures [SOPs]. Sample collection SOPs provided in Appendix F of the PDI QAPP (Windward and Anchor QEA 2020) have been updated to include additional collection methods relevant for Phase II. Updated versions of SOPs for the collection of surface and subsurface samples are included in Attachments J1 and J2 respectively.

Updates to the surface sample collection SOP include descriptions for the collection of sediment overlying armored banks or in riprap interstices (i.e., large pockets of sediment). Updates to the subsurface sample collection SOP include descriptions for:

- Collection of 0–45- or 0–60-cm sediment for benthic toxicity testing (applicable only in in Recovery Category 1 areas)
- Collection of vertical extent cores, including by drill rig where required

[12] Both the 0–10- and the 0–45-cm intervals will be tested at location 685, but the bounding location further from the shoreline (location 680) will only be analyzed in the 0–60-cm interval because only the subsurface PAH polygon extends to that area (the 0–10-cm sample at location 680 will be archived) (Attachment I, Table I-2).

Most vertical extent cores are expected to be collected using a vibracoring method. However, collecting vertical extent cores by vibracoring may be difficult in some of the in-water areas where substrate characteristics do not allow for successful application of these methods. In these areas, after repeated attempts with a vibracorer (see SOP, Attachment J2), it may be necessary to use a different collection method such as a drill rig (described in the updated subsurface SOP in Attachment J2). While drill rigs are helpful in achieving depth in areas with challenging characteristics, they are less efficient than vibracoring (i.e., produce fewer samples per day) and so will be used only where necessary. In Slip 6, a drill rig will be used instead of a vibracorer because 1) there is a low probability of successfully collecting the full vertical extent required using a vibracorer, 2) there are logistical challenges of temporarily relocating tenant barges to create access for sampling, and 3) there is only a short timeframe available to complete the sampling within Slip 6. Vibracoring and drilling rigs deployed from a barge require sufficient water depth to access sample locations.

In bank areas, water depth may be insufficient for vibracoring or a drill rig. In such cases, it may be necessary to use a probe rig[13] or hand auger sampling methods for vertical extent cores. See Section 4.1.7. for further discussion of bank sampling. A new SOP for hand auger sampling is included as Attachment J5, and a new SOP for probe rig sample collection is included as Attachment J6.

As in Phase I, samples collected by boat or by land from within private property will necessitate access agreements with property owners; all parties (including tenants of Lower Duwamish Waterway Group parties) will be notified well in advance of sampling to coordinate access. The access agreement process commenced soon after the draft QAPP addendum was submitted to EPA. In the event that the Lower Duwamish Waterway Group and EPA cannot obtain access, alternative locations will be determined in consultation with EPA.

4.1.7 Special Considerations for Bank Sampling

Bank sampling can be more challenging than sampling within the waterway; banks can be steeply sloped, covered by hard materials, or difficult to access due to limited water depth. Before the sampling program begins, the field crew will inspect the bank to determine how areas could be accessed. If a target location listed in Table I-3 is not accessible, the field crew will move the sampling location to a nearby area within the same bank, as described in the SOP (Attachment J1). In addition to the proposed samples, additional samples will be collected at any location within a RAL exceedance area that appears to be a unique potential source.

[13] A probe rig collects soil samples by hydraulically pushing a sampler below ground to the sample depth interval of interest.

If the global positioning system (GPS) does not work in a bank area (e.g., due to poor satellite reception caused by structures obstructing satellite signals), bank samples will be collected as close to the target location as possible using Maps 4-1a through 4-1j as guidance. Sample locations will be recorded using distances measured from landmarks (e.g., pier structures and pilings). Additional photographs will be taken as needed in order to record the sample location.

Vertical extent cores on the bank will be collected by boat wherever possible, following protocols in the updated SOP (Attachment J2). However, water depths may limit the ability of the sampling boat to get close enough to the bank to collect bank samples, and bank physical conditions (e.g., debris, riprap) may limit the effectiveness of vibracoring or drill rig equipment. Drilling methods for vertical extent delineation sampling will be the same as those described in Section 5.2.3 for barge-based geotechnical drilling. The drill rig may be deployed from a barge, the bank slope, or the top of the bank, set back to provide a flat surface. The approach to be used will be determined prior to the field effort in consultation with EPA and the drilling company, based on site access and safety considerations. Where necessary, a probe rig may be deployed to collect vertical extent cores on the bank. Sample collection using a probe rig is described in Attachment J6.

If neither vibracoring nor collection using a drill rig or probe rig is feasible, it may be necessary to use hand auger sampling methods for vertical extent cores. The practical depth of hand augering is typically 2 to 3 ft. The use of hand augers, if needed, will be discussed with EPA during the field effort.

4.2 Processing Vertical Extent Cores

The procedures for processing sample intervals in vertical extent cores are provided in detail in the updated subsurface sample collection SOP included in Attachment J2. The RAL intervals in the vertical extent cores will be processed following the same methods used in the Phase I PDI. For Phase II, the deeper sample intervals will be processed as separate 30-cm (approximately 1-ft) intervals for archival or analysis. If any of the sediment cores contain at least 15 cm of sediment below the targeted depth, that sediment will also be archived. If more than 30 cm of sediment is collected in the core below the targeted depth, the sediment will be archived in 30-cm intervals (Attachment J2).

As discussed in Section 4.1.3, in general, the first two 30-cm sample intervals below the depth interval where RALs apply will be analyzed; then, each subsequent alternating interval will be archived or analyzed, until reaching the end of the core, native sediment, or the target depth. If native sediment is identified, native sediment will not be composited with non-native sediment. If the boundary with native sediment falls on an even 30-cm increment, starting at the top of the native sediment boundary, 30-cm interval archive samples will be collected. If the boundary does not fall at an even 30-cm increment, the 15-cm rule for material at the end of a core (described above) will be used to determine intervals. For example, if native material is encountered at 265 cm (8.7 ft) in a 366-cm (12-ft) subtidal core, the intervals would be as follows: Interval A would represent the 0–60-cm interval, intervals B through G would represent 30-cm intervals of non-native material, interval H would represent material 240–265-cm (i.e., the bottom of the non-native material), and intervals I through K would represent native material (intervals I and J would each be 30 cm, and interval K would be 41 cm because less than 15 cm would remain if a 30-cm interval was used). Table I-4 in Attachment I identifies the proposed analysis and archive intervals for each core sampling location.

Core interval delineation and Tier 2 assignments may be affected by stratigraphy. If a sample interval is changed to reflect a change in geologic unit, the decision will be made in the field during core processing and documented on the Sediment Core Processing Log (Attachment K). An experienced[14] field geologist or geotechnical engineer will either directly oversee or coordinate with the field geologist or geotechnical engineer during the sediment core logging process in order to identify major stratigraphic boundaries in vertical extent cores and to determine if native material is present in the core. Any changes to Tier 2 analysis assignments require EPA approval.

Grain size will be analyzed in one or more composite samples representing the full length of the core above any native material layer encountered. Grain size data will also be collected on native materials. The compositing interval(s) will be determined when the core is examined. Grain size analysis will not be needed for every core; during sediment core logging, the field geologist or geotechnical engineer will identify spatially representative cores from which to obtain the grain size composite(s).

4.3 Sample Identification

Unique alphanumeric identifications (IDs) will be assigned to each sample and recorded on the collection and processing forms (Attachment K).

The sample IDs for individual samples will include the following:

- Project area ID (i.e., LDW) and two-digit year (i.e., 21 for Phase II samples)
- Sample type:
  - SS – surface sediment samples (0 to 10 cm)
  - IT – intertidal subsurface samples, including 0–45-cm and deeper vertical extent samples
  - SC – subtidal subsurface samples, including 0–60-cm, shoaling, and deeper vertical extent samples
  - GT – geotechnical samples

[14] An "experienced" geologist or engineer has at least five years of field experience that includes geologic interpretation of sediment or soil cores.

- Location number (see Table I-2 in Attachment I); location numbers will start at 500.
- For subsurface cores (i.e., SC and IT), a sequential letter (e.g., A, B, etc.) will be used to identify the sample interval if there is more than one. The letter A will be used to indicate the targeted surface-most interval (i.e., 0–45 or 0–60-cm interval), while B, C, etc., will be used to indicate each subsequently deeper interval.
- For grain size composite samples from subsurface cores, samples will be identified as GS, with numbers indicating each subsequently deeper interval if there is more than one composite interval. For example, the first grain size composite interval will be GS1 and the next interval will be GS2.

For example, a surface sample from location 526 collected from the LDW in 2021 would be labeled LDW21-SS526. The first core interval sample (e.g., the 0–60-cm sample) from the subtidal core samples from that location would be labeled LDW21-SC526A, and the next core interval sample would be labeled LDW21-SC526B (if collected). A grain size composite sample would be labeled LDW21-SC526-GS1 from the top interval if there is more than one grain size composite sample at that location.

The number of RAL intervals at shoaling locations is dependent on the depth of the shoal material (Figure 4-2). In a shoaling core with more than 90 cm of shoal material, the surface-most three intervals are all RAL intervals and these intervals would be labelled A, B, and C.[15] In a shoaling core with less than 30 cm of shoal material, the surface-most interval is the only RAL interval; it would be labelled as the A interval.

Any field duplicate sample collected will have the same sample ID as its parent sample but will be appended with "-FD" to identify it as a field duplicate.

Geotechnical investigation locations and investigation methods will be numbered separately (starting with unique station 01). The method of geotechnical investigation will be appended to the location number as follows:

- GB – Rotosonic, hollow stem, or mud rotary boring
- GH – Hand auger boring
- GC – Cone penetrometer test
- GV – Vane shear test
- GD – Dynamic cone penetrometer test

For example, geotechnical investigation location 1 sampled by rotosonic drilling method would be LDW21-GT01-GB. At geotechnical boring and hand auger locations, multiple subsurface samples will

[15] The same naming convention will be used for the intervals in the 0–45-cm cores from the ENR/AC pilot study plots where three intervals are collected.

be collected. In these cases, the sample number will be appended to the exploration location sequentially as S1, S2, S3, etc., from the ground/mudline surface downward. For example, the first subsurface sample collected from geotechnical boring location LDW21-GT01-GB would be LDW21-GT01-GB-S1. Surface and subsurface samples collected from borings for geotechnical laboratory testing will be noted on the boring logs along with depth intervals (Attachment K).

4.4 Sample Analysis and Toxicity Testing

Analytical laboratory and benthic toxicity testing methods will be the same as those outlined in Section 4.9 of the PDI QAPP (Windward and Anchor QEA 2020). The analytical methods and containers are provided in Table 4-3 for reference. The analytical requirements for each analysis are provided in Section 4.9 of the PDI QAPP. See Table I-2 in Attachment I for a detailed analyte list for each location.

Table 4-3
Sediment and Bank Analyses to be Conducted at each Analytical Laboratory

Laboratory	Analyses to be Conducted	Methods	Container
ARI	TOC, percent solids	EPA 9060A, SM 2540G	4-oz glass jar
	metals	EPA 3050B, EPA 6020A, UCT-KED	4-oz glass jar
	mercury	EPA 7471B	
	PAHs/SVOCs	EPA 3546/ EPA 8270E and 8270E-SIM	8-oz glass jar
	hexachlorobenzene	EPA 3546/ EPA 8081B	
	PCB Aroclors	EPA 3546, Mod EPA 8082A	
	dioxin/furan congeners	EPA 1613b	4-oz amber glass jar
	ammonia	SM 4500-NH3 H-97	4-oz glass jar
	total sulfides	SM 4500-S2 D-0 PSEP prep	4-oz glass jar
	archive	N/A	8-oz glass jar
MTC	grain size	ASTM 422	16-oz HDPE
EcoAnalysts	benthic toxicity testing	Acute amphipod 10-day mortality test, acute 48-hr bivalve larvae combined mortality and abnormality test, and chronic 20-day juvenile polychaete survival and growth test	6 32-oz HDPE wide-mouth jars

Notes:
ARI: Analytical Resources, Inc.
ASTM: American Society for Testing and Materials
EPA: US Environmental Protection Agency
HDPE: high-density polyethylene
MTC: Materials Testing and Consulting, Inc.
N/A: not applicable
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PSEP: Puget Sound Estuary Program
SM: Standard Method
SVOC: semivolatile organic carbon
TOC: total organic carbon
UCT-KED: universal cell technology-kinetic energy discrimination

5 Data Generation and Acquisition of Engineering PDI Elements

This section discusses the study design and procedures for collecting, handling, and managing data that will be acquired in support of the engineering PDI elements by presenting the methods for the following elements:

- Focused topographic surveys and bank features (DQO 11)
- Collection of geotechnical data for use in RD; assessing material behavior; and conducting stability modeling for banks, structures, and dredge or capping areas (DQO 13)
- Inspections and evaluations of existing structures within or adjacent to RAL exceedance areas to develop design criteria for remedial activities that may impact existing structures (DQO 14)
- Collection of other engineering-applicable data (e.g., sediment thickness overlying the armoring layer in bank areas, waste characterization, and debris location and extents) as necessary to adequately characterize site conditions for engineering design and construction bid documents (DQO 14)

5.1 Topographic Survey and Bank Features

The Phase II PDI will build upon the Phase I visual bank inspection in the areas with RAL exceedances. To address DQO 11, Phase II will include focused topographic surveys to obtain elevation data and detailed identifications of bank features that may impact the design and construction of remedial actions.

The Phase II focused topographic survey will be performed by True North in the 11 RAL exceedance areas[16] with banks that may require remedial action (as shown on Maps 5-1a through 5-1g). Detailed topographic survey extents, methods and procedures are included in the Survey QAPP Addendum (Anchor QEA and Windward 2021). The topographic survey will overlap with the bathymetric survey to provide full elevation coverage of the upper reach in RAL exceedance areas and will also extend approximately 50 ft landward of the mean higher high water elevation line (+11.3 ft MLLW) to capture the top of bank.

In addition to collecting topographic survey elevation data, surveying activities will identify locations and extents of bank features found within the 11 RAL exceedances areas with banks, including the

[16] This number does not include the King County habitat area under the western extent of the South Park Bridge (Area 7) or the three RAL exceedances areas within the Duwamish River People's Park and Shoreline Habitat project (Areas 20, 21, and 25). No topographic survey or other detailed identification of bank features will be conducted in those areas, since they are constructed habitat restoration sites. The King County habitat area was constructed around 2014 and the Duwamish River People's Park and Shoreline Habitat project was constructed at the end of 2020. These areas are shown in Maps 5-2a and 5-2b.

following: woody vegetation extents, horizontal extents of bank armoring, aboveground utilities (e.g., outfalls, storm drains, groundwater monitoring wells), underground or submerged utility corridors that run through banks or cross the waterway (if they can be located), large surface debris, and structures (e.g., corner points of existing structures, fence lines, paved surfaces adjacent to top of bank).

During the topographic survey, field crew will locate and identify large surface debris in bank areas and describe the debris in the field inspection notes. Field crew will also inspect both the east and west bank areas between RM 3.2 and RM 3.4, where there potentially exists a submerged utility corridor crossing the LDW (identified on Map 5-3a as "cable area"), to try to locate any terminus locations for submerged utility crossings. The waterway user survey (Integral et al. 2018) noted the presence of this crossing corridor but was not able to find any evidence of submerged utilities.

Detailed bank features will be identified by field crew via upland access;[17] this process will be integrated with the topographic survey activities to the extent practical. The inspection activities will occur at a tide level that allows for the entire bank area (i.e., toe of bank to top of bank) to be observed. The approximate toe of bank elevations in the RAL exceedance areas are identified on Maps 5-1a through 5-1g. In some cases, the toe of bank may be below the available low tide elevation during the field investigation period (e.g., RAL Exceedance Area 12). In such areas, observations will occur at as low a tidal elevation (e.g., 0 ft MLLW tide or lower) as is available during the field investigation period.

Detailed bank features will be located by the topographic surveyor and by other field crew using differential GPS equipment. Results of the detailed identification of bank features will be documented by RAL exceedance area in a tabular format and summarized in the Phase II DER. Photographs of bank features will be taken from the landside and provided in the Phase II DER. Methods used to collect detailed bank features are included in the Survey QAPP Addendum (Anchor QEA and Windward 2021).

5.2 Geotechnical Investigation

This section provides a summary of pre-PDI geotechnical data, the geotechnical investigation design for the Phase II PDI, and field and laboratory methods for completing the investigation. It supplements the geotechnical investigation design (including field and laboratory testing methods) for sediment and bank sample collection and analysis presented in Section 5.3 of the PDI QAPP (Windward and Anchor QEA 2020). SOPs for collecting geotechnical samples and *in situ* data are provided in Appendix F of the PDI QAPP.

[17] If upland access is restricted, then the field crew will access the bank from the water by boat.

5.2.1 Review of Pre-PDI Geotechnical Data

Pre-PDI geologic and geotechnical data for bank and in-water areas were reviewed after compiling information from several databases. Results of the existing geotechnical data review are summarized in Attachment L and were used to inform the geotechnical investigation design and locations for geotechnical data collection as part of the Phase II PDI. The locations of historical geotechnical investigations in the LDW upper reach are shown on Maps 5-4a and 5-4b.

5.2.2 Types of Geotechnical Data

Geotechnical data are developed through *in situ* and *ex situ* testing. *In situ* testing is conducted to measure shear strength, to support the evaluation of dredge cut and slope stability, as well as bearing capacity, to support any new loads imposed on the surface of the sediment (e.g., ENR and capping). *In situ* tests also support the evaluation of the seismic performance of sediment and soils. *In situ* test methods for shear strength include the standard penetration test, the cone penetrometer test, the dynamic cone penetrometer test, and the vane shear test.

Ex situ testing is conducted on selected samples at the geotechnical laboratory. *Ex situ* tests are performed to classify soil type (index testing), measure shear strength, and measure the compressibility of soils. These tests also support the evaluation of dredge cut and slope stability, bearing capacity, settlement, and seismic performance of sediments and soils. *Ex situ* index tests include moisture content, Atterberg Limits (plasticity), grain size, unit weight, and specific gravity. *Ex situ* strength tests include the consolidated undrained triaxial shear strength test, the unconsolidated undrained triaxial shear strength test, and the direct shear strength test as described in the PDI QAPP (Windward and Anchor QEA 2020). *Ex situ* compressibility tests include the one-dimensional consolidation test.

Geotechnical data investigation design and collection methods proposed for Phase II *in situ* data collection and *ex situ* laboratory testing are described in Sections 5.2.3 through 5.2.5.

5.2.3 Geotechnical Investigation Design

This section presents the general principles discussed in the PDI work plan (Windward and Anchor QEA 2019) used to identify specific sampling locations for geotechnical data collection, *in situ* testing for geotechnical properties, and *ex situ* geotechnical laboratory analyses; this work will address DQO 13. Like the Phase II sediment sampling design provided in Section 4.1, geotechnical sampling activities will be coordinated with other actions occurring within the upper reach.

The geologic history of the Duwamish Valley is presented in the LDW RI (Windward 2010). The general stratigraphy includes anthropogenic fill material within bank areas and recently deposited sediments (organic silt and sand), overlying upper alluvium (silt and sand), and overlying lower alluvium (sand and sand with silt interbeds). Remedial actions in the LDW upper reach will generally involve dredging, partial dredging/capping, capping, and ENR technologies within the recent sediments and upper alluvium. Proposed depths for geotechnical data collection as part of the geotechnical investigation design are focused within these geologic units and consider the vertical extent of potential remedial actions. Geotechnical data will be collected within these units to characterize the materials for dredgeability, bearing capacity, and slope stability. The experienced geotechnical engineer will review boring log information and *in situ* data and assign laboratory testing to characterize the lithologic units encountered.

The process for identifying geotechnical data collection locations is different than that described in Section 4.1 for identifying sediment sampling locations for chemical analysis. Geotechnical characteristics can be more broadly interpolated and extrapolated than can sediment chemistry; therefore, fewer geotechnical sampling locations are typically required to characterize a site sufficiently for RD.

Geotechnical data collection locations for the Phase II PDI were identified for each of the following areas: within the FNC, between the FNC and the toe of bank, and within the banks. The study designs for each of these areas are provided below.

Within the FNC. Geotechnical data to be collected within the FNC can be extrapolated to a greater distance than can data collected outside of the FNC, based on review of the existing geologic profile of the upper reach, and because part of the FNC (but not all) undergoes regular maintenance dredging. FNC geotechnical data collection will occur at locations spaced approximately 500 ft apart along portions of the FNC with RAL exceedance areas. The depth of geotechnical sampling in the FNC will be approximately 20 ft to assess any potential effects from dredging and capping in the FNC. Geotechnical assessment requires an understanding of the comprehensive geologic profile, even below zones of potential disturbance and beneath cap subgrades. These deeper geotechnical data are not affected by whether the FNC has been recently maintenance dredged.

Between the FNC and the toe of bank. Geotechnical data to be collected between the FNC and toe of bank are anticipated to be more variable than data collected within the FNC. Geotechnical data collection will occur at locations spaced approximately 250 ft apart within RAL exceedance area boundaries in these areas. Geotechnical data collection locations are targeted to collect data adjacent to existing structures, to better inform the engineering design within and adjacent to structure footprints. The depth of geotechnical sampling in the area between the FNC and toe of bank will be approximately 10 to 20 ft, to be inclusive of any potential effects from dredging or capping and thin layer placement within open-water areas and adjacent to existing structures.

Within banks. Geotechnical data to be collected in banks within RAL exceedance areas will be more variable than data collected within the FNC. Geotechnical data collection will occur at locations spaced approximately 250 ft apart in these areas. If it is not feasible (due to access constraints or safety considerations) to collect data directly on the bank slope, geotechnical data from banks may need to be collected above mean higher high water, on the flatter upland area above the top of bank. The bottom elevation of geotechnical sampling in the bank areas is targeted to be -10 ft MLLW, depending upon the ability to drill to that elevation, to be inclusive of any potential effects from dredging/excavation or capping and thin layer placement on banks and adjacent to existing structures.

In order to evaluate local and global static and seismic slope stability, geotechnical investigation locations will be oriented along profiles placed perpendicular to the shore to support the development of geotechnical data from the top of bank into the FNC (Maps 5-4a and 5-4b show all proposed geotechnical investigation locations). The rationale for selecting each data collection location, proposed field method for data collection, and *in situ* or laboratory testing method (as described in Section 5.2.4) is presented in Table M-1 in Attachment M. Sample collection and laboratory testing methods are described in Sections 5.2.4 and 5.2.5.

The experienced field geologist or geotechnical engineer will be responsible for overseeing the logging of geotechnical borings in the field using soil boring log forms (Appendix D of PDI QAPP (Windward and Anchor QEA 2020)) and will determine the appropriate types and numbers of samples to be assigned for testing, based on observed field conditions and best professional judgement. In addition, this individual may determine that depths of sampling and/or data collection locations need to be modified in the field based on observed conditions encountered during the exploration.

All geotechnical samples will be shipped to the laboratory and archived. A representative subset of samples will be assigned for *ex situ* testing so that the range of geotechnical characteristics within the LDW upper reach will be characterized for RD. The specific assignment of *ex situ* testing will be determined collaboratively between the geotechnical field team and the experienced geotechnical engineer.

5.2.4 Geotechnical Data Collection Field Methods

Surface and subsurface geotechnical data collection will be conducted using barge-mounted or land-based drilling and handheld testing equipment. Geotechnical field methods—including decontamination procedures, field-generated waste procedures, station location and positioning controls, and requirements for collecting geotechnical samples and data—were presented in PDI QAPP Sections 4.7, 4.8, and 5.3.2 and Appendix F of the PDI QAPP (Windward and Anchor QEA 2020). Supplemental method information is provided below.

5.2.4.1 Geotechnical Drilling Methods

Sampling methods for the collection of borings from within RAL exceedance areas will include the use of a rotosonic drill rig positioned on a float or barge, a hollow-stem auger drill rig, or a mud rotary drill rig. The rotosonic drill rig is the preferred method of collecting geotechnical samples, as this method is capable of drilling through hard strata and is not susceptible to refusal from heaving sand conditions that may be present in the LDW upper reach, particularly in the lower alluvium unit. Such conditions complicate the use of a hollow-stem auger drill rig. A mud rotary drill rig can better manage heaving sand conditions; however, this method requires the circulation of drilling mud, which then must be managed as investigation-derived waste. Additional details regarding the sampling methods for geotechnical data collection, including the collection of standard penetration test data and *in situ* data, are presented in Section 5.3.2.2 of the PDI QAPP (Windward and Anchor QEA 2020).

5.2.4.2 Geotechnical Data and Sample Collection Methods

Geotechnical data and samples will be collected from borings in the field using split spoon sampling and thin-walled sampling methods, in accordance with details presented in the PDI QAPP (Section 5.3.2.2) and in SOP F7 and SOP F8, respectively, in Appendix F of the PDI QAPP (Windward and Anchor QEA 2020). Where hand methods are needed for sample collection, hand augers will be used as described in Attachment J.

5.2.4.3 Geotechnical *In Situ* Testing

Geotechnical *in situ* testing methods are described in Sections 5.3.2.2 through 5.3.2.4 of the PDI QAPP (Windward and Anchor QEA 2020). SOPs for completing cone penetrometer tests, dynamic cone penetrometer tests, and vane shear tests are provided as SOP F9, SOP F10, and SOP F11, respectively, in Appendix F of the PDI QAPP.

5.2.5 Geotechnical Laboratory Methods

Geotechnical laboratory testing will be completed on field-collected geotechnical samples to identify sediment index, strength, and settlement/consolidation properties. Index testing will be conducted by the geotechnical laboratory (MTC) on samples selected by the experienced field geologist or geotechnical engineer after reviewing the complete field logs, in order to provide a representative number of tests for each major geologic unit encountered. The number of tests will be determined after review of the field logs; however, there will likely be a minimum of five samples analyzed per each major geologic unit.

Additional samples that are collected using the thin-walled collection method (described in Section 5.3.2.2 of the PDI QAPP (Windward and Anchor QEA 2020)) from a barge-mounted drill rig may also be designated for index testing (unit weight), strength testing (direct shear, unconsolidated undrained triaxial shear, and consolidated undrained triaxial shear), and settlement/consolidation testing (1-dimensional consolidation). Any such designation will occur in accordance with American Society for Testing and Materials international standard methods presented in Table 5-1 of the PDI QAPP, based on review of the complete field logs.

5.3 Other Engineering Data

Other engineering data will be collected during the Phase II PDI to support RD. This section describes the approaches to be used to obtain the required engineering data.

5.3.1 Structures

A Phase II structure inspection and evaluation will be conducted to build upon the information collected during the Phase I structures visual inspection. Phase I structures visual inspection data will be presented with the Phase II structures inspection data in the Phase II DER. The Phase II effort will focus on structures adjacent to or within RAL exceedance areas, as identified in Table 5-1. These structures consist of a variety of retaining (or bulkhead) wall types, bridge piers and abutments, groins, finger piers, and boat marinas. Additionally, dolphins and a number of isolated timber pile fields that are not listed in Table 5-1, but that are located within or adjacent to RAL exceedance areas, will be further inspected in Phase II.

Table 5-1
Structures Adjacent to or Within Areas of RAL Exceedances

RAL Exceedance Area	Adjacent Upland Property Owner	Structures Information	
		Description of Structure	Overall Condition Assessment from Phase I PDI[1]
5	N/A	South Park Bridge	Good
7	King County	South Park Bridge	Good
8	N/A	South Park Bridge	Good
9	N/A	South Park Bridge	Good
10	South Park Marina	Marina	Fair
11	South Park Marina	Marina	Fair
12	South Park Marina	Marina	Fair
13	South Park Marina	Marina	Fair
18	Boeing	Bulkhead	Fair
23	Boeing, Centerpoint Properties	Bulkhead	Fair
27	Centerpoint Properties	Bulkhead	Fair
28	National Industrial Holding	Pier, Dolphins	Fair
31	Northwest Container Services	Dolphins	Serious
32	Boeing	Pier and Wharf	Poor
33	Delta Marine Industries	Pier, Debris Deflector	Good

RAL Exceedance Area	Adjacent Upland Property Owner	Structures Information	
		Description of Structure	Overall Condition Assessment from Phase I PDI[1]
34	Boeing	Wharf	Poor
37	Boeing	Timber Groins	Poor

Notes:
ID: identification
PDI: Pre-Design Investigation
RAL: remedial action level
N/A: not applicable (RAL exceedance area not adjacent to an upland property)

Dredging or capping activities near structures require site-specific engineering evaluation in order to avoid the risk of slope instability or sliding failure, or pile drag due to capping. Protect-in-place, remove and replace, or offsetting the dredging or capping actions from structures are viable options to be developed during RD. The two main structure types that will be inspected during Phase II are in-/over-water structures and bulkheads.

In-/over-water piles and pile-supported structures consist of lateral load-resisting piles and vertical and lateral load-resisting piles. The design embedment depths of these piles are not known but may be available from as-built drawings to be obtained during 30% RD. Remedial actions within the vicinity of the piles that involve dredging or excavation could compromise or reduce the lateral load-resisting capacity of the piles. Capping around piling can cause pile drag that can reduce the vertical bearing capacity of piles. During Phase II inspection, additional information collected for in-/over-water structures within RAL exceedance areas will include:

- Vertical/overhead and lateral clearances around Structures 02, 04, 05, 07, 12, 16, and 20 (see Table 5-1)
- Condition of structures to support planned facility future use, maintenance, improvements or development as outlined in the waterway user survey (Integral et al. 2018)

Bulkheads consist of concrete, steel, or timber earth-retaining walls along the shoreline. They generally support and resist lateral loads by developing bearing pressures against the soil below the toe of the slope. Dredging or excavation activity near the toe of a bulkhead may compromise the lateral load-resisting capacity of the wall and could result in sliding, excessive rotation, or failure. Additional observations at bulkheads near RAL exceedance areas (i.e., Structure 03) will include:

- Type and condition of ground tieback anchors (if on exposed face)
- Plumbness and misalignment
- Impact damage
- Depression or settlement behind the wall (ground side), if accessible for inspection

The Phase II structure inspection will also include a detailed inspection of outfalls that are present on banks within RAL exceedance areas. The Phase I PDI compiled high-level descriptions of outfalls that were visible from the inspection vessel. During Phase II, outfalls within RAL exceedance areas that have been identified and documented during previous studies, most recently the *Lower Duwamish Outfall Inventory Update: January 2012 – February 2014* (Leidos 2014), will be inspected. Outfalls that are expected to be observed on banks within RAL exceedance areas are included in Table 5-2 and identified on Maps 5-3a and 5-3b.

Table 5-2
Outfalls Adjacent to or Within RAL Exceedances Area Banks

RAL Exceedance Area	Adjacent Upland Property Owner	Outfalls[1,2]
7	King County	2215
12	South Park Marina	2214
18	Boeing	2061 2062 2063 2072*
23	Boeing, Centerpoint Properties	2075 2076 2077
27	Centerpoint Properties	2074
30	Centerpoint Properties	2073
34	Boeing	BDC-2
37	Boeing	2092 2093 2094 (OF18) 2095 (Norfolk CSO/SD) 2096 2097 BDC-5

Notes:
1. Outfall identification corresponds to Ecology IDs presented in the *Lower Duwamish Outfall Inventory Update: January 2012 – February 2014* (Leidos 2014) and Appendix H of the LDW RI (Windward 2010).
2. Asterisks represent outfalls that are outside the RAL exceedance area but within 100 ft.
CSO/SD: combined sewer overflow/storm drain
Ecology: Washington State Department of Ecology
ID: identification
LDW: Lower Duwamish Waterway
PDI: pre-design investigation
RAL: remedial action level
RI: remedial investigation

Outfall pipe materials include cast-iron, steel, concrete, and plastic. The outfalls terminate at the bank or extend beyond it (overhang). In general, they are surrounded by armoring riprap. Dredging or excavation near these outfalls may cause slope instability or undermining beneath the pipeline and may result in damage to the outfall. If a section of the outfall is to be removed or replaced, a temporary bypass may be required to maintain service. During Phase II inspection, additional information collected at outfalls within RAL exceedance areas will include:

- Measurement of outfall pipe diameter and overhang (if existing)
- Identification of pipe material
- Observation of pipe condition, support condition, and armoring or revetment

Phase II structural inspection will focus on evaluating relevant structural elements or structures with integrity that may be impacted by remedial actions. The remedial action(s) and anticipated construction equipment and methods will be taken into consideration when evaluating existing structural conditions. This evaluation will focus on the condition assessment and stability of critical individual structural elements that are part of the structure and are within a RAL exceedance area, but it will not include structural analyses, code review, serviceability, load-carrying capacity, or service life assessments of the structures. In addition, no structural material sampling or material testing will be conducted. Geotechnical information, as discussed in Section 5.2, will be used to evaluate the effects of lost lateral bearing support that may result from dredging or bank excavation; the same information will be used to develop guidelines to limit such dredging or bank excavation to outside the load influence or critical zone. The critical zone is defined by the lateral limit within which soil excavation or ground slope does not impact the load-resisting capacity of an at- or below-grade structure.

The Phase II structural inspection will assess water- and land-accessible structures that were flagged in Phase I for detailed inspection. Efforts will be made to obtain available as-built drawings and documents related to these structures for RD, however, it is assumed that as-built drawings will not be available to review prior to Phase II inspection due to the age and condition of many of the structures to be inspected. The Phase II structural inspection will focus on the following objectives to address engineering considerations for dredging, partial dredging/capping, capping, and ENR adjacent to structures:

a. Noting any discrepancy or change in condition observable since the Phase I inspection

b. Identifying elements of structures or entire structures that:

    i. Appear to be derelict and could be removed

    ii. Would be cost efficient to remove

    iii. Could be protected in place during construction

c. Assessing construction equipment access to conduct remedial action(s), including dredging, partial dredging/capping, and ENR, including measuring deck clearance above MLLW

The same field inspection forms or checklists specific to an element or group of elements (example forms provided in the PDI QAPP (Windward and Anchor QEA 2020)) used in the Phase I PDI will be used to augment the inspection information collected in Phase I. Overall inspection procedures are based on American Society of Civil Engineers Manual of Practice No. 101 (Childs 2001): *Underwater Investigations, Standard Practice Manual*.

5.3.2 Sediment Thickness over Armored Banks

Some areas with RAL exceedances were classified as armored banks during the Phase I PDI. In these areas, measuring the thickness of sediment over the armor layer will be necessary to determine the location of the toe of the armored bank, and to be able to calculate the volume of sediment overlying the armor layer. Measuring sediment thickness will apply to four RAL exceedance areas: 12, 30, 31, and 32. Additionally, areas that were classified as unarmored (i.e., discontinuous armoring) based on visual observation will be field inspected to determine if sediment thickness probing is appropriate to assess whether there is more continuous armoring present under the mudline; such armoring may result in reclassification of the bank type.

For areas where the toe of bank armoring is expected to be located below the waterline during low tide or that are not accessible by foot, a sediment jet probe will be deployed from a vessel during a moderate or high tide to determine sediment thickness and attempt to locate the toe of bank armoring. The sediment jet probe consists of a push rod with a pneumatic jet nozzle and a penetrometer depth sensor. The SOP for using this method is included in Attachment J.

An alternate method for determining sediment thickness and toe of bank armoring location will be employed for areas that are accessible by foot at low tide. This method will involve hand probing the sediment in coordination with recording measurements and locations using differential GPS equipment. For this method, a rod marked with measurement ticks will be used to determine thickness of sediment over the armor layer. The SOP for this method is also included in Attachment J.

Sediment probing will occur along transects extending perpendicular to the shoreline and spaced between 50 and 100 ft apart; data will be collected approximately every 5 ft along the transect from the top of the armored bank to the toe of the armored bank. Prior to probing at each location along the transect, descriptions will be recorded that include the following (as applicable):

- Location ID
- Water depth measurement in feet and time of measurement (if applicable)
- Coordinates of each probe point

- Observed surface substrate type (e.g., rock, sand, silt, shell) and color
- Other observations of note (e.g., description of visible surface debris)

After documenting the surface conditions at the location, probing will commence. The field crew performing probing will document the probing observations, typically including the following:

- Sediment thickness/depth of layers penetrated/refusal depth
- Subsurface debris or obstructions encountered during probing
- Any other important observations noted during probing

Observations will be documented on field forms included in Attachment K.

5.3.3 Waste Characterization for Disposal

Commercial landfills typically require waste characterization testing to confirm that the material proposed for disposal meets any facility-specific design or permit limitations. Waste characterization testing will be performed after 30% RD using archived samples collected during the Phase II vertical extent delineation (Section 4.5). Waste characterization will be conducted as follows:

- A minimum of two regional commercial landfills will be contacted by the design team to confirm their facility-specific testing requirements.
- Representative samples from within an RAA dredge prism will be selected to produce an average concentration for the RAA; samples will be selected based on spatial and concentration results. Not every RAA will be analyzed for waste characterization, but representative RAAs will be selected based on bulk chemistry results from the design dataset.
- The representative samples from a representative RAA will be composited into a single test sample, which will be tested for the suite of analytes identified by the landfill. The results of the testing will be documented in the Basis of Design report.

The results of the testing will be evaluated to confirm compatibility with commercial landfill requirements. This information will be incorporated into the RD specifications as reference material to be used by the construction contractor.

5.3.4 Debris

Surface debris observed above MLLW in RAL exceedance area banks will be surveyed as part of the topographic survey to identify its location and extent, as described in Section 5.1. Multibeam bathymetric data collected during the Phase I PDI will be used to identify large surface debris below MLLW for RD in areas where remedial actions will occur.

6 Assessment and Oversight

Protocols outlined in Sections 7.1 and 7.2 of the PDI QAPP (Windward and Anchor QEA 2020) for compliance assessments and response actions and reports to management will be followed.

A Phase II DER will be prepared that will document all activities associated with the collection, handling, and analysis of Phase II samples, as specified in Fourth Amendment to the Administrative Order on Consent (EPA 2018). The report will document the sampling events and present and interpret the analytical results.

The following base information will be included in the Phase II DER:

- Summary of all field activities, including descriptions of any deviations from the approved QAPP
- Sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot
- Sample elevations (ft MLLW) and depths below mudline
- Summary of the chemical data QA/QC review
- Summary of field QC result evaluation
- Summary of bank visual inspection and structures visual inspection from Phase I PDI
- Results of structure inspections and sediment thickness probing surveys, including field inspection forms and structure condition ratings from Phase II PDI
- Results from the analyses of sediment and geotechnical samples and updated table with re-occupied results[18]
- Copies of field logs and photographs (appendix)
- Copies of chain of custody forms (appendix)
- Laboratory and data validation reports (appendix)
- Results of focused topographic surveys and additional shoreline/bank survey data collected

Once the data in the Phase II DER have been approved by EPA, the bioassay results and the chemistry database exports will be created from the project SQL Server database and submitted as specified in Section 7.3 of the PDI QAPP (Windward and Anchor QEA 2020).

As described in Section 6.1.4 of the RD work plan and Section 4.1 of the PDI work plan (Anchor QEA and Windward 2019; Windward and Anchor QEA 2019), the Phase II DER will contain an interpretation of the data in order to define RAL exceedance area boundaries, general vertical extent depth, the range of technologies, and remaining data needs for Phase III (if any).

[18] The table with re-occupied results prior to Phase II sampling is included in Attachment A.

In addition, prior to updating the design dataset with validated Phase II data, the interpolation methodology used to delineate RAL exceedance areas will be discussed with EPA to determine if any updates are appropriate. Any updates will be agreed upon 90 days before submittal of the draft Phase II DER to EPA.

7 References

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Attachment A
Phase I Data and Other Sediment Data

Attachment B
2020 Bathymetric Survey Data Report

Prepared by Northwest Hydro, Inc. and Anchor QEA, LLC

1 Introduction and Survey Design

The 2019 Survey Quality Assurance Project Plan (QAPP) described required bathymetric surveying coverage, methods, and quality control for the Lower Duwamish Waterway (LDW) upper reach (Anchor and Windward 2019). The 2019 bathymetric survey of the upper reach collected precision bathymetry data between River Mile (RM) 2.75 and RM 5.25. Two different survey-grade sonar systems were used to accurately map the project area and produce the final surface model of the LDW. The primary sonar system that collected a majority of the project bathymetry was a high-resolution multibeam sonar system. A single-beam sonar system was used in a few shallow intertidal areas that were too shallow for safe operation of the multibeam system. The 2019 survey results were reported in Appendix A of the Phase I Pre-Design Investigation (PDI) QAPP. Appendix A noted that there were limited data gaps in the 2019 survey coverage, due to the presence of large barges or vessels, that would be surveyed to fill in those data gap areas during the Phase I PDI in 2020. The 2020 bathymetric survey results combined with the 2019 survey results achieved the data quality objectives (DQOs) established in the Survey QAPP, (Anchor and Windward 2019) as follows:

- DQO 1 – *Provide the bathymetric data to generate new sun illumination maps … to potentially modify the recovery category area designations.* The 2019 bathymetric survey sufficiently addressed this DQO; however, the 2020 bathymetric survey filled in a few data gaps in coverage that are assessed in the Phase I data evaluation report (Anchor QEA and Windward 2021) for potentially modifying recovery category designations.
- DQO 2 – *Define the current bathymetry of the LDW Upper Reach with sufficient confidence … to inform selection of sampling locations for Pre-Design Investigation data collection to support the RD.* The 2019 bathymetric survey sufficiently addressed this DQO, and the full survey coverage (2019 and 2020) was used for Phase II QAPP Addendum preparation.
- DQO 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 2019 bathymetric survey did not completely address this DQO. The 2020 bathymetric survey filled in data gaps in the 2019 bathymetric survey and completed DQO 3 for aquatic areas of the site. The 2020 bathymetric survey was performed on June 15 and 16, 2020, by Northwest Hydro, Inc., which also performed the 2019 bathymetric survey. The equipment and methods used to perform the 2020 survey were the same as those used for the 2019 bathymetric survey, per the approved survey QAPP (Anchor and Windward 2019). The precision and accuracy of the two surveys were the same and yielded compatible data. There were no deviations from the survey QAPP in either survey. The key targets and related data for the 2019 and 2020 surveys are summarized in Table B-1.

Table B-1
Key Targets and Related Datums

Description	Quantity or Datum
Horizontal positioning accuracy	1.6 ft minimum
Horizontal survey accuracy	3 ft at a 95% confidence interval
Horizontal datum	North American Datum of 1983/1991 Washington North Zone
Vertical survey accuracy	+/- 0.5 ft at a 95% confidence interval
Vertical datum	MLLW

Notes:
Source: Table 3 of the Survey QAPP (Anchor and Windward 2019).
MLLW: mean lower low water
QAPP: quality assurance project plan

An updated three-dimensional bathymetric surface for the upper reach was created by combining the 2019 and 2020 Northwest Hydro, Inc. bathymetric surveys and part of the January 2020 US Army Corps of Engineers (USACE) Federal Navigation Channel (FNC) survey. USACE conducted maintenance dredging within the FNC from approximately RM 4.05 to RM 4.71 from December 2019 to January 2020. The USACE January 2020 survey results reflect the post-dredge condition within the dredged channel.

This report summarizes the 2020 bathymetric survey to fill in data gaps in survey coverage. It supplements the 2019 survey report by providing additional details on surveying methods, quality control, and data processing methods that were used for the both the 2019 and 2020 bathymetric surveys. There were no deviations from the Survey QAPP during the 2020 bathymetric survey. Bathymetric survey coverage in the upper reach is complete and no additional coverage data gaps exist. The areal extents of the 2019 and 2020 bathymetric surveys are shown on Figure B-1. The final combined bathymetric data were used to create a digital terrain model of the seafloor morphology, from which contours and sun-illuminated images were generated. The combined results of the bathymetric surveys are shown on Figures B-2a through B-2d.

Both the 2019 and 2020 surveys were conducted on an established coordinate system. All bathymetry data are referenced to monuments established by the Anchor QEA project team prior to bathymetry data acquisition. The horizontal datum for this survey is North American Datum of 1983, 1991 adjustment (NAD83/91), State Plane Coordinate System, Washington North Zone, measured in U.S. Survey Feet; the vertical datum for this survey is mean lower low water (MLLW). The 2019 bathymetric survey was conducted between April and May 2019. For the 2020 bathymetric survey, hydrographic survey operations were conducted on June 15 and 16, 2020. Data acquisition was performed during higher daylight tides to maximize bathymetry coverage within the shallow intertidal zone.

2 Survey Vessel and Crew

The Survey Vessel (S/V) *Soundwave*, a 26-foot custom aluminum survey boat, owned and operated by Northwest Hydro Inc. (NWH), was deployed for the project (both 2019 and 2020 bathymetric surveys). This vessel is equipped with an integrated navigation/data acquisition system and a custom mount for the R2Sonic 2022 multibeam sonar. This hydrographic survey system is ideal for shallow-water survey operations in tight quarters such as the LDW.

3 Positioning

Horizontal positions were acquired with an Applanix POS/MV combined inertial real-time kinematic global positioning system (RTK GPS) navigation system. This system integrates two GPS receivers with a motion reference unit. Additionally, RTK GPS corrections were 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. Position data were used in real time to provide navigation information to the vessel operator. To check the accuracy of the positioning system and confirm the RTK corrections, a position check was conducted daily on an established monument with a known position. Water level measurements were obtained by RTK GPS during data acquisition. Water surface elevations obtained by RTK GPS were verified against gauges placed within the project area, and with an automated water level gauge deployed by NWH within the project area for the duration of data collection. All soundings were reduced to MLLW elevations in the delivered data set.

4 Multibeam Data Acquisition

Soundings were acquired with a R2Sonic 2022 high-resolution 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 were at a minimum rate of 17 Hz as the vessel surveyed along each track line.

Multibeam data were collected by running lines parallel with the shorelines and dock structures. During survey operations, all lines offshore of the shoreline had the sonar swath width limited to a maximum of 60° on both starboard and port beams during processing.

To account for survey vessel heave (vertical movement), pitch, and roll, an Applanix POS/MV motion reference sensor was utilized. The POS/MV system was also used to record vessel heading (yaw) from which the sonar beam orientation is derived. Multibeam data were 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 data collection.

Detailed measurements of the sound-velocity profile (SVP) through the water column are critical in multibeam surveys. Sound-velocity profiles were 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 SVP 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 SVP are expected to occur in the LDW due to the mixing of fresh and saltwater during tidal changes. For this survey, an AML BaseX2 sound-velocity profiler was used to directly measure SVPs of the water column. The SVP has spatial and temporal variations, and to account for these variations, the LDW survey area was divided into subsections. The size of the survey subsections was determined at the time of surveying by collecting SVP data and adjusting the length of a subsection so that similar results were obtained at each end. Temporal change was addressed by taking SVP measurements as each section was mapped.

Data acquisition involves setting the motion sensor to the survey conditions and running slow, uniform lines in a systematic pattern. Adjustments were made to scale and gain settings, as required, to maximize resolution of the survey. During the survey, preliminary multibeam bathymetric data were displayed in real time on the Hypack computer. A real-time color matrix was drawn on the vessel's computer screens to show data coverage. Bathymetry data acquisition was 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.

5 Single-Beam Data Acquisition

Single-beam data were only collected in 2019 and complied with the Survey QAPP (Anchor and Windward 2019). The 2020 bathymetric survey to fill in data gaps only utilized multibeam survey methods.

6 Data Processing Methods

Post-processing of multibeam data in 2019 and 2020 was completed using Hypack Hysweep multibeam editing and analysis software. Patch test data were analyzed, and any alignment corrections were applied. Water level data were verified and applied to adjust all depth measurements to MLLW. SVPs were generated from the AML SVP measurements taken in the field and used to correct slant range measurements and compensate for ray path bending.

Processing began with a review of each survey line using the Hysweep swath editor. Verified water surface correctors were applied to the data set at this time. Position and sensor data were reviewed by qualified surveyors and accepted or removed if erroneous data were observed. Sounding data were reviewed and edited to remove bad data points such as bottom multiples or sonar returns from pilings. After swath editing, all data were reviewed through the Hysweep area-based editing tools to ensure no erroneous data points remained.

To take advantage of the level of detail the multibeam survey provides, a 1-ft resolution sun-illuminated model and 1-ft gridded data set were exported from Hysweep. This gridding process uses an inverse weighted mean of all soundings within a 1-ft by 1-foot cell. The 1-ft grid size allows for comparisons with previous bathymetric surveys that were conducted with similar high-resolution methods. The final accepted bathymetry data were imported into Autodesk Civil 3D for generation of a project digital terrain model and 1-ft contours.

7 Quality Control and Survey Accuracy

The acquisition system and survey protocols were designed with some redundancy to demonstrate that the required accuracy is being achieved during data acquisition. The following control methods and survey accuracies comply with the Survey QAPP (Anchor and Windward 2019) and were used for both the 2019 and 2020 bathymetric surveys.

Positioning: Positions were logged in WGS84 geographic coordinates and projected onto NAD83/91 Washington North Zone coordinate system. A geodetic control survey was conducted to provide positions for monuments within the study area. A position confidence check was conducted daily on a monument that is accessible from the water. Measured positions obtained during these checks were compared to the surveyed value to assure the target horizontal and vertical accuracies were being obtained.

Tides and Water Elevations: RTK GPS-derived water levels were checked daily by observing NWH staff gauges that were installed in the project area. The water level checks were made twice per day. Backup tidal observations from NWH deployed automated gauge that were used to confirm the RTK GPS tidal values.

Patch Test: 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 was 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 were conducted to confirm draft of the sonar head. These tests were conducted at the beginning and end of the survey and any time there were changes in the instrument configuration.

Sonar Draft: A bar check was conducted at the beginning and end of the project to confirm multibeam and single-beam sonar transducer draft below the water line. A bar was lowered below the sonar to specific intervals below the water surface, using calibrated marks on the attached chain. Onboard sonar depth measurements were confirmed to match the known depth of the bar.

Survey Accuracies: Bathymetry data were acquired to the USACE specification for soft-bottom dredge surveys (USACE 2013), which states an accuracy of +/- 0.5 foot vertically and 3 feet horizontally for 95% of all data points. These accuracies meet the approved Survey QAPP requirements. Our QA/QC checks during data collection indicate better accuracies were achieved.

8 References

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Attachment C

Recovery Categories Assessment

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 identify the appropriate spatial application of remedial action levels (RALs) and remedial technologies. Recovery category areas were developed in the feasibility study (FS) (AECOM 2012) based on the criteria shown in ROD Table 23 and depicted in ROD Figure 17; see Appendix A of the *Remedial Design Work Plan for the Lower Duwamish Upper Reach* (Anchor QEA and Windward 2019). Recovery categories are defined as the following:

- Category 1: Recovery presumed to be limited
- Category 2: Recovery less certain
- Category 3: Predicted to recover

Recovery category areas were delineated in the ROD based on the following physical and chemical criteria:

1. Identification of vessel-induced scour areas based on a visual review of sun-illuminated bathymetric survey maps
2. Identification of berthing areas based on berthing area information and documentation
3. Identification of sediment transport model (STM)-predicted 100-year high-flow event high-scour areas and STM-predicted net-scour areas
4. Empirical contaminant trends over time, used on a case-by-case basis to adjust recovery categories based on physical criteria (1 through 3)

Modifications to the LDW-wide ROD recovery category areas were made in 2019 at six locations based on criteria 2 and 4 in the *Recovery Category Recommendations Report* (Integral et al. 2019). An additional six modifications to the upper reach recovery category areas were made in Appendix B of the Pre-Design Investigation (PDI) Quality Assurance Project Plan (QAPP) (Windward and Anchor QEA 2020) based on criterion 1, using the 2019 bathymetric survey.

The purpose of this appendix is to assess whether any recovery category modifications in the upper reach are warranted based on a comparison of PDI chemistry data to pre-PDI data (including data from the remedial investigation [RI]/FS, post-FS, and pre-design baseline studies). For this analysis, surface sediment (0–10 cm) data from the PDI were compared with pre-PDI surface sediment data at re-occupied locations (i.e., station locations within 10 ft of each other). This analysis was performed using the same methodology outlined in the *Recovery Category Recommendations Report* (Integral et al. 2019) for criterion 4. Empirical contaminant trends were assessed in the context of the other recovery category criteria near each location. Data for the other criteria are presented in Appendix B of the PDI QAPP (Windward and Anchor QEA 2020), the *Recovery Category Recommendations Report* (Integral et al. 2019), and Appendices D and F to the FS (AECOM 2012).

In addition to the analysis based on chemistry, the review of sun-illuminated bathymetric survey maps (criterion 1) was completed for the three small areas of the upper reach that were not surveyed in 2019 due to vessel obstruction. These areas were surveyed during Phase I PDI sampling in 2020.

2 Contaminant Trend Evaluation

2.1 Methods

Empirical contaminant trends over time were evaluated using the methodology outlined in the *Recovery Category Recommendations Report* (Integral et al. 2019) following a three-step process. First, surface sediment locations within 10 ft of one another that had been re-occupied were identified. No cores were re-occupied as part of the Phase I PDI sampling. Second, concentration changes for total polychlorinated biphenyls (PCBs), carcinogenic polycyclic aromatic hydrocarbons (cPAHs), arsenic, and bis(2-ethylhexyl)phthalate (BEHP) in each location were mapped in one of four color categories:

- **Red**: Contaminant concentration **increased** more than 50% over previous concentration.
- **Gray**: **No trend** in concentration (defined as less than a 50% change relative to previous concentration).
- **Blue**: Contaminant concentration **decreased** more than 50% from previous concentration.
- **Green**: Both samples in the pair **were below** the Washington State Sediment Management Standard (SMS) benthic sediment cleanup objective (SCO) or lowest ROD RAL for cPAHs.[1]

Third, the data for each re-occupied location were interpreted in the context of potential recovery category modifications, consistent with the *Recovery Category Recommendations Report* (Integral et al. 2019), as follows:

- Areas with all contaminant concentrations increasing (red) could be adjusted to Recovery Category 1.
- Areas with mixed results by contaminant of concern (COC) or concentration changes less than 50% could be adjusted to Recovery Category 2.
- Areas with more than 50% decreases or a mix of decreases and changes of less than 50% could be adjusted to Recovery Category 3.

[1] This appendix used the ROD RAL for cPAHs rather than the revised RALs presented in the recently released draft EPA explanation of significant differences (ESD) (EPA 2021), which is expected to be finalized in 2021.

- Areas with concentrations below the benthic SCO or RAL (green) were also determined to be suitable for Recovery Category 3, because these areas have historically recovered or were not historically impacted by concentrations exceeding the benthic SCO or RAL.

Consistent with the *Recovery Category Recommendations Report* (Integral et al. 2019), total PCBs, arsenic, and cPAHs were selected because they are human health risk drivers. BEHP was selected because it had the second highest number of benthic SCO exceedances in the RI/FS dataset (following total PCBs). Three locations with pre-PDI dioxin/furan data were also re-occupied. None of the pre-PDI or PDI data exceeded the dioxin/furan RAL, so dioxins/furans were not evaluated further.

The comparisons of point sample concentrations were interpreted in the context of the other lines of evidence for recovery category designations (Section 1), and surrounding sediment concentration data. These other lines of evidence consider physical site conditions and contribute to conceptual site model understanding. In addition, uncertainties in point sample comparisons should be acknowledged, such as spatial heterogeneity in sediments, particularly in intertidal sediments; different sampling and analytical events; and analytical variance, which can be up to 25% in a concentration (an acceptability criterion by data validation processes).

2.2 Re-occupied Surface Sediment Data

During the Phase I PDI, several pre-PDI locations sampled during the RI/FS and post-FS sampling events between 1994 to 2018 were re-occupied in 2020 to obtain updated 0-10 cm concentrations for design. Surface concentrations can change over time from ongoing sedimentation and/or erosion processes. These data pairs provide temporal data to assess recovery. When the samples are collected within 10 ft of each other, they are considered to have been successfully re-occupied at the location (see Appendix H, Section 3 for details). Sample pairs identified as re-occupied within 10 ft of each other numbered 38 for cPAHs and BEHP, 44 for arsenic, and 50 for total PCBs. Of these sample pairs, 30 were located in intertidal areas, 20 were located in subtidal areas, and 6 were in the navigation channel.

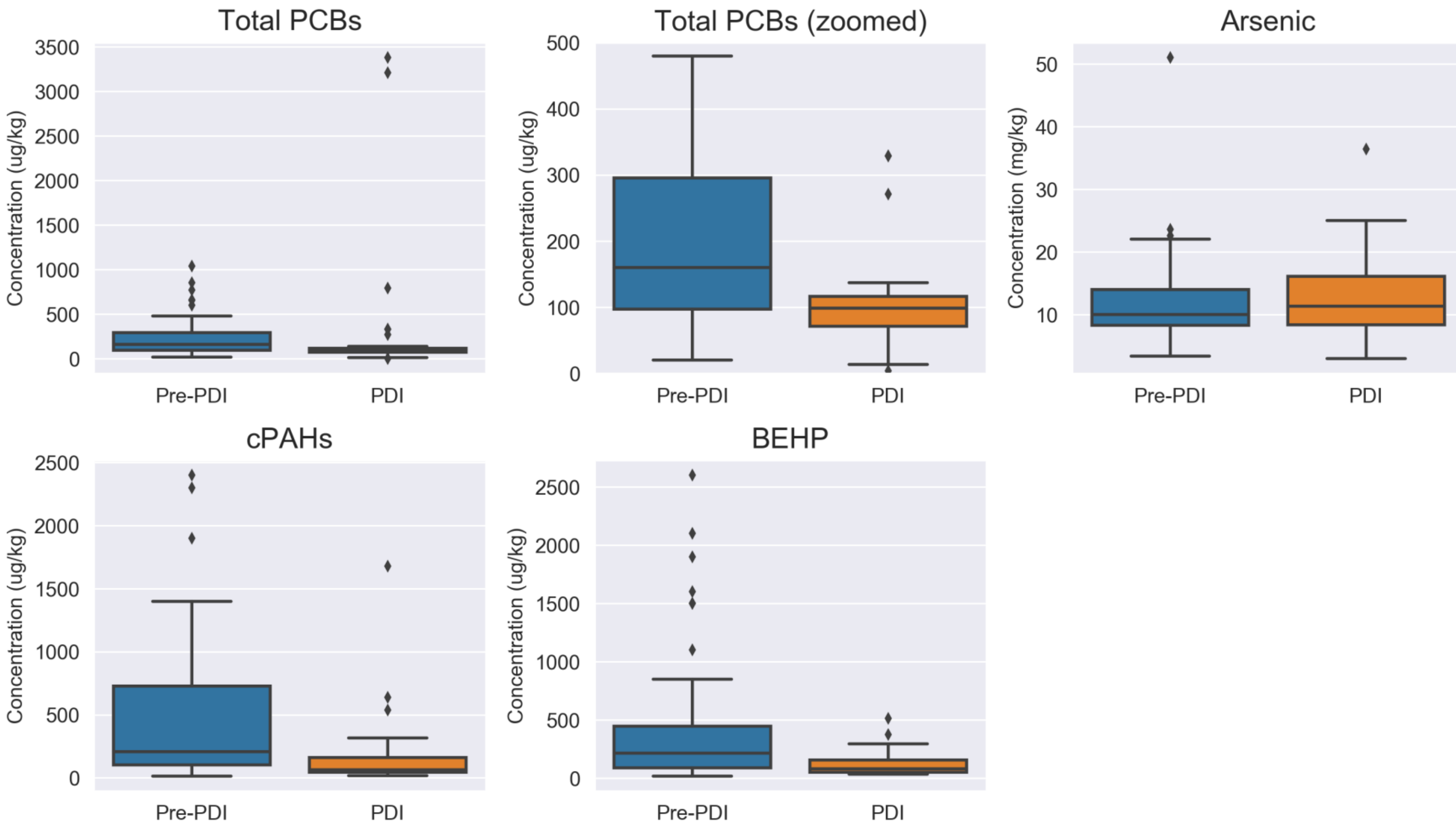
2.3 Upper Reach Summary

Map C-1, Figure C-1, and Table C-1 summarize the re-occupied surface sediment sampling locations for the upper reach. They show that concentrations have generally decreased over time in the upper reach, consistent with the conceptual site model of natural recovery due to sediment deposition from upstream of the site. The average number of years between sample pairs is 16 years. On average, the following concentration changes were observed (Figure C-1):

- Median PCB concentrations declined from 160 to 98 µg/kg, whereas average PCB concentrations at the re-occupied locations exhibited no change, because of two high PDI sample concentrations at locations LDW20-SS257 and LDW20-SS304.
- Average arsenic concentrations showed minimal changes over time (12 to 13 mg/kg) among paired samples, indicating that concentrations are in equilibrium.[2]
- The average cPAH toxic equivalent (TEQ) and BEHP concentrations among the re-occupied locations declined from 508 to 161 µg/kg for cPAHs and from 497 to 121 µg/kg for BEHP.

[2] Rounded mean concentrations of 12 and 13 mg/kg effectively indicate no change in concentration: the means and standard errors for the 44 resampled locations were 12.4+/-1.2 mg/kg and 13.0 +/-1.1 mg/kg, respectively.

Figure C-1
Trends in Resampled Surface Sediment



Considering the four re-occupied station categories described in Section 2.1 (red, gray, blue, green), the following concentration changes were observed (Table C-1):

- Total PCB concentrations were below the benthic SCO (green) for 23 of 50 re-occupied locations. Of the remaining 27 locations, 17 had concentrations that decreased by more than 50% (blue). Another six locations exhibited less than a 50% change (gray), and four locations increased in concentration by more than 50% (red).
- Arsenic concentrations were below the benthic SCO for all samples (green).
- cPAH TEQs decreased by more than 50% at six of the seven locations with TEQs greater than the RAL (blue) and one decreased by less than 50% (gray). The remaining 31 re-occupied stations were below the lowest ROD RAL (green).
- BEHP concentrations at the four locations exceeding the benthic SCO declined by more than 50% (blue). The remaining 31 re-occupied stations were below the benthic SCO (green).

2.4 Area-Specific Summaries

This section summarizes the data for re-occupied surface sediment locations within the upper reach, providing the river mile (RM), side of the LDW (east [E], federal navigation channel [FNC], and/or west [W]), current recovery category designation, empirical data, and any suggested modifications to the recovery category designation. These areas were delineated for the purpose of this analysis only, based on a logical grouping of re-occupied locations. Table C-2 summarizes the data for each area. Maps C-2 through C-7 depict the re-occupied locations, labeled by PDI location. Individual sample IDs, concentrations, and dates are provided for reference in Tables C-3 through C-7. The following bullets summarize the analysis:

- **Recovery Category Evaluation Area 1: RM 3.0 to RM 3.3.** Ten locations were reoccupied in this area, which was a mixture of Recovery Category 1 (FNC) and Recovery Category 3 (W) areas; the area is adjacent to the Boeing Plant 2 early action area (EAA) (E). With one exception, all location concentrations declined by more than 50% or were below the benthic SCO or cPAH RAL. The exception (LDW20-SS133) exhibited no change in concentration for total PCBs (124 to 120 µg/kg).[3] Overall, the trends are consistent with Recovery Category 3 throughout the area. However, no changes in recovery category designation are recommended (i.e., the Recovery Category 1 area is not recommended to be modified to Recovery Category 3) due to the potential for event-driven high-flow scour in the Recovery Category 1 areas based on the STM model.
- **Recovery Category Evaluation Area 2: RM 3.5 to RM 3.8.** Three locations were re-occupied in this area. The samples are located in Recovery Category 1 and 3 areas near three EAAs: Boeing Plant 2, Terminal 117, and Jorgensen Forge. All re-occupied location concentrations

[3] The concentration was just above the benthic SCO as compared to the organic carbon normalized concentration.

declined by more than 50% or were below the benthic SCO or cPAH RAL. These results are consistent with a Recovery Category 3 designation. However, no changes in recovery category designation are recommended in this evaluation area due to the potential for event-driven high-flow scour in the Recovery Category 1 areas based on the STM model.

- **Recovery Category Evaluation Area 3: RM 3.9 to RM 4.05(E).** Five locations were re-occupied in this area, which was a mixture of recovery categories. Three locations showed increasing concentrations for PCBs, from 770, 170, and 660 µg/kg in the pre-PDI samples to 3,380, 271, and 3,210 µg/kg in the PDI samples (LDW20-SS257, LDW20-SS266, and LDW20-SS304, respectively). The other COCs analyzed in both samples were below benthic SCOs or the cPAH RAL. The locations of increasing PCB concentrations were further investigated for location-specific context, including surrounding chemical data, bathymetric features, and aerial imagery.[4]

  The northernmost location (LDW20-SS257) is immediately adjacent to an enhanced natural recovery/activated carbon (ENR/AC) pilot study intertidal plot. At this location, the increase in PCB concentration may have been caused by a one-time localized disturbance during construction. From aerial imagery and bathymetry, the area near LDW20-SS257 (on the lower intertidal slope at an elevation of about 0 ft MLLW) appears to overlap with a localized morphological feature that may be in part due to a disturbance event (Map C-5). Note that the pilot study areas to the immediate north have remained stable over three years of monitoring (Wood et al. 2021). In addition, concentrations in adjacent samples are much lower than in LDW20-SS257. Based on these observations, it is recommended that two additional locations be re-occupied to further assess time trends in the area (i.e., B9b and AN-018). Additional locations with concentration increases could potentially indicate a local trend that may warrant changing a portion of this area to Recovery Category 1. The Phase II data evaluation report will present an assessment of the data in order to finalize the recovery category in this area.

  The middle location (LDW20-SS266) is located along the same lower intertidal slope as LDW20-SS257, at a similar elevation (-1 ft MLLW). There appears to be some localized change in elevation of less than 1 foot in this area, and as observed in an aerial (Map C-5), LDW20-SS266 is located close to a large sunken log. PCB concentrations in adjacent samples are variable. From this information it is recommended that one additional location (i.e., IAN-011) be re-occupied to further assess time trends in this area.

[4] Note that surrounding chemical data and aerial imagery are not criteria used for the determination of Recovery Categories, as specified in the ROD. They are consulted in this document only to provide context for the "case-by-case" interpretation of resampled sediment locations.

The southernmost location (LDW20-SS304) also has a localized PCB increase. In contrast to the two more northern re-sampled locations in the Recovery Category Evaluation Area 3, LDW20-SS304 is located in a stable mudflat with no signs of potential disturbance, and where the physical lines of evidence are consistent with the Recovery Category 3 designation. Adjacent samples have much lower concentrations and mixed trends with depth. Considering the mixed results for the four COCs that were part of this analysis, the patterns in surface sediment concentrations in the area (see Map A-5b in Attachment A)), and bathymetric evidence of sediment stability, the area is modified from Recovery Category 3 to Recovery Category 2, consistent with natural recovery being less certain. No additional sampling is recommended.

- **Recovery Category Evaluation Area 4: RM 4.05 to RM 4.15(E).** This area had seven locations re-occupied within the Recovery Category 3 area just north of Slip 6. All locations had concentrations below benthic SCOs or cPAH RAL, had a less than 50% change in concentration, or showed a greater than 50% decrease in concentration. No change is recommended for this area.
- **Recovery Category Evaluation Area 5: RM 4.15 to RM 4.25(E).** This area had 10 re-occupied locations in either Recovery Categories 1, 2, or 3 areas within Slip 6. Eight of the 10 locations had concentrations that were either below benthic SCOs or cPAH RAL or declining. Two locations had less than a 50% change in concentration for total PCBs. This is consistent with high deposition rate of more than 2 ft from 2003 to 2019 based on a comparison of bathymetric elevations (Windward and Anchor QEA 2020). While the chemistry data support modification of Recovery Category 1 to Recovery Category 2 due to a mixture of declining and unchanged concentrations, no change was made because (as noted in ROD Table 23) observed vessel scour in berthing areas is a physical criterion that requires Recovery Category 1 designation. Therefore, no modifications to the recovery category designations are recommended.
- **Recovery Category Evaluation Area 6: RM 4.3 to RM 4.8 (E and W).** This area had six re-occupied locations in Recovery Category 3 areas located near the Turning Basin. All locations showed declining concentrations or were below benthic SCOs or cPAH RAL, consistent with the Recovery Category 3 designation.
- **Recovery Category Evaluation Area 7: RM 4.8 to RM 5.0(E).** This area had eight re-occupied locations within Recovery Category 2 areas near the Norfolk EAA. Seven of the eight locations had concentrations that were declining or below benthic SCOs or cPAH RAL. One location's PCB concentration increased from 52 to 329 µg/kg. However, that location was co-located with a second historical sample from 1995, which had a concentration of 360 µg/kg (i.e., no change). These results may be consistent with a Recovery Category 3 designation, but other site conditions (e.g., presence of wingwall structures to help prevent

bank erosion) suggest natural recovery is less certain. Therefore, the recommendation is to not change the recovery category.

3 Bathymetric Survey Analysis

In addition to the chemistry analysis, the bathymetric survey evaluation was completed for three small portions of the upper reach that were not surveyed in 2019 due to vessel obstruction, and therefore were not evaluated in the PDI QAPP (Windward and Anchor QEA 2020). These areas were surveyed during Phase I PDI sampling in 2020. All three of these areas have frequent vessel traffic and were previously designated as Recovery Category 1. The additional bathymetric survey data do not suggest revising the recovery category designation in these areas.

4 Recommendations

The recovery categories are based on multiple lines of evidence, and have been evaluated in the FS, the *Recovery Category Recommendations Report* (Integral et al. 2019), and the PDI QAPP. This evaluation considered surface sediment data and bathymetric survey data from the PDI in the context of previous evaluations. Based on this evaluation, the area from RM 4.0 to RM 4.05 is recommended to be modified from Recovery Category 3 to Recovery Category 2 (Maps C-8 and C-9) due to increasing PCB concentrations at three locations and low and stable concentrations for other COCs. Three additional locations are recommended for re-sampling in the area from RM 3.9 to RM 4.0 to further evaluate natural recovery in the area (Map C-5). No other modifications are recommended at this time; Evaluation Area 3 will be re-evaluated in the Phase II DER after obtaining Phase II data.

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Appendix C Tables

See Excel files.

Appendix C Maps

FINAL

Attachment D

Data Management Rules

TABLE OF CONTENTS

TABLES

ABBREVIATIONS

cPAH	carcinogenic polycyclic aromatic hydrocarbon
EPA	US Environmental Protection Agency
GPS	global positioning system
HPAH	high-molecular-weight polycyclic aromatic hydrocarbon
HpCDD	heptachlorodibenzo-*p*-dioxin
HpCDF	heptachlorodibenzofuran
HxCDD	hexachlorodibenzo-*p*-dioxin
HxCDF	hexachlorodibenzofuran
LDW	Lower Duwamish Waterway
LPAH	low-molecular-weight polycyclic aromatic hydrocarbon
OCDD	octachlorodibenzo-*p*-dioxin
OCDF	octachlorodibenzofuran
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PDI	Pre-Design Investigation
PeCDD	pentachlorodibenzo-*p*-dioxin
PeCDF	pentachlorodibenzofuran
PEF	potency equivalency factor
RAL	remedial action level
RI/FS	remedial investigation/feasibility study
RL	reporting limit
SIM	selected ion monitoring
SMS	Washington State Sediment Management Standards
TCDD	tetrachlorodibenzo-*p*-dioxin
TCDF	tetrachlorodibenzofuran
TEF	toxic equivalency factor
TEQ	toxic equivalent
TOC	total organic carbon

This attachment summarizes data management rules being followed for the remedial design of the upper reach of the Lower Duwamish Waterway (LDW). The rules summarized herein are the same as those applied to the remedial investigation/feasibility study (RI/FS) and baseline pre-design studies datasets, except as noted in this attachment. The two data management rules that are different from the RI/FS data management rules are the treatment of field duplicates (Section 2) and the selection of best results when samples are analyzed for polychlorinated biphenyl (PCB) Aroclors and PCB congeners (Section 4).

1 Averaging Laboratory Duplicate or Replicate Samples

Contaminant concentrations obtained from the analysis of laboratory duplicates or replicates (i.e., two or more analyses on the same sample) will be averaged for a closer representation of the "true" concentration than that provided by the results of a single analysis. Averaging rules will be dependent on whether the individual results are detected concentrations or reporting limits (RLs) for non-detected analytes. If all concentrations are detected for a given parameter, the values will be simply averaged arithmetically. If all concentrations are non-detected for a given parameter, the minimum RL will be reported. If all concentrations are non-detected for a given parameter, the minimum RL will be reported. If the concentrations are a mixture of detected and non-detected concentrations, any two or more detected concentrations will be averaged arithmetically, and RLs for the non-detected results will be ignored. If there is one detected concentration and one or more non-detected results, the detected concentration will be reported. The latter two rules will be applied regardless of whether the RLs are higher or lower than the detected concentration.

2 Field Duplicate Results

Field duplicate results are collected to to assess environmental sample data variability. In the design dataset, the parent sample results will be selected to represent the location, unless the contaminant concentration in the field duplicate sample exceeds the remedial action level (RAL) and the contaminant concentration in the parent sample does not. In that case, the field duplicate results (all analytes) will be selected for the location.

3 Re-occupying Locations

Surface sediment locations are considered to have been successfully re-occupied if a more recent sample has been collected within 10 ft of an older sample. The results for the most recent sample are selected to represent the current conditions. If an older sample includes data for contaminants not analyzed in the more recent sample, then the results from the older sample for that contaminant are retained for that location. This approach has been followed consistently since the establishment of the RI dataset (LDW RI Appendix E (Windward 2003)). The purpose of this rule is to include the most current result available for the 0–10-cm interval, since contaminant concentrations in surface sediment can change over time as new sediment is deposited.

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 (PDI) and past sampling efforts. The differential GPS used for Phase I PDI 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 greater than 10 ft away from the old location, it was considered a separate sample location and the both the newer and older data were retained.

4 Selection of Preferred Results

In some instances, the laboratory will generate more than one result for a chemical for a given sample. Multiple results can occur for several reasons, including:

- The original result does not meet the laboratory's internal quality control guidelines, and a reanalysis is performed.
- The original result does not meet other project data quality objectives, such as a sufficiently low RL, and a reanalysis is performed.
- Two different analytical methods are used for that chemical.

In each case, a single result will be selected for use. The procedures for selecting the preferred result will differ depending on whether a single or multiple analytical methods are used for that chemical.

For the same analytical method, the results will be selected using the following guidance:

- If the results are detected and not qualified, then the result from the lowest dilution will be selected, unless multiple results from the same dilution are available, in which case the result with the highest concentration will be selected.
- If the results are a combination of estimated (J-flagged) and unqualified detected results, then the unqualified result will be selected. This situation most commonly occurs when the original result is qualified because the result is outside of the calibration range, thus requiring a dilution. The diluted result within the calibration range will be preferentially selected.
- If the results are all estimated, then the result will be 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 will be preferred to a qualified result that is outside the calibration range.

- If the results are a combination of detected and non-detected results, then the detected result will be selected. If there are more than one detected result, the applicable rules for multiple results (as discussed above) will be followed.
- If the results are all non-detected, then the lowest RL will be selected.

For different analytical methods (i.e., when a specific chemical is analyzed in the same sample using different methods), the following rules will be applied:

- For PCBs analyzed as congeners using US Environmental Protection Agency (EPA) Method 1668C and as Aroclors using EPA 8082A , the higher of the two PCB sums will be selected.
- For results analyzed using the semivolatile organic compound full-scan (EPA 8270) and selected ion monitoring (SIM) (EPA 8270-SIM) methods, the SIM results will be selected.
- For results analyzed using EPA Method 8081A and any 8270 method (i.e., hexachlorobenzene and hexachlorocyclopentadiene), the 8081A result will be selected.

The RI/FS database rules for the selection of preferred results between two methods (as described above) were revised for the compilation of the pre-design baseline data (i.e., after the RI/FS baseline data and before the design dataset) In the RI/FS, the preferred result was selected based on a comparison between the methods of the detection status, RL, and data qualifiers. The revised rules select the preferred result based on a preference for method.

5 Significant Figures and Rounding

The analytical laboratories report 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 will be explicitly stored in the project database as a record of the number of significant figures assigned by the laboratory. The tracking of significant figures will become important when calculating averages and performing other data summaries.

When a calculation involves addition, such as totaling PCBs or polycyclic aromatic hydrocarbons (PAHs), the calculation will be only as precise as the least precise number that goes into the calculation. For example (assuming two significant figures):

> 210 + 19 = 229 will be reported as 230 because 19 is only reported to 2 significant digits, and the enhanced precision of the trailing 0 in the number 210 is not significant.

When a calculation involves multiplication or division, such as carbon normalization, the original figures for each value are carried through the calculation (i.e., individual values are not adjusted to a standard number of significant figures; instead, the appropriate adjustment is made to the resultant value at the end of the calculation). The result is 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 will be reported as 72 because there are 2 significant figures in the number 1.2.

When rounding, if the number following the last significant figure is less than 5, the digit will be left unchanged. If the number following the last significant figure is equal to or greater than 5, the digit will be increased by 1.

6 Calculating Totals

Total PCBs, total PAHs, and total fines will be calculated by summing the detected values for the individual components (e.g., Aroclor mixtures or individual congeners for total PCBs). For samples in which none of the individual components are detected, the total value will be given as the highest RL of any individual component, and assigned a U-qualifier (no detected concentrations). No sum will be calculated in cases where 50% or less of the components are analyzed. Concentrations for analyte sums will be calculated using the following components:

- Total PCBs as the sum of Aroclors will be 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 are detected, total PCBs will be given a value equal to the highest RL of the Aroclors and assigned a U-qualifier (no detected concentrations).
- Total PCBs as the sum of PCB congeners will be calculated using only the detected congener values. For individual samples in which none of the congeners are detected, total PCBs will be given a value equal to the highest RL of the congeners and assigned a U-qualifier (no detected concentrations).
- Total low-molecular-weight PAHs (LPAHs), high-molecular-weight PAHs (HPAHs), PAHs, and benzofluoranthenes will also be calculated in accordance with the methods of the SMS. Total LPAHs will be the sum of detected concentrations for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. Total HPAHs will be 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 will be 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 will be typically calculated with only the b and k isomers. In cases where the laboratory provides total benzofluoranthenes instead of or in addition to the b and k isomers, the laboratory result will be reported, and no sum will be calculated. For samples in which

all individual compounds within any of the three groups described above are non-detected, the highest RL for that sample will represent the sum.

- Total fines will be calculated as the sum of clay and silt fractions (i.e. <62.5 µm).

7 Calculation of Dioxin/furan Congener TEQs

Dioxin/furan congener toxic equivalents (TEQs) will be calculated using the World Health Organization consensus TEF values for mammals (Van den Berg et al. 1998; Van den Berg et al. 2006) as presented in Table D-1. The TEQ will be calculated as the sum of each dioxin/furan congener concentration multiplied by the corresponding TEF value. When the dioxin/furan congener concentration is reported as non-detected, then the TEF will be multiplied by one-half the RL.

Table D-1
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
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

8 Calculation of Carcinogenic Polycyclic Aromatic Hydrocarbons

Carcinogenic polycyclic aromatic hydrocarbon (cPAH) values will be calculated using potency equivalency factor (PEF) values (California EPA 2009) based on the individual PAH component's relative toxicity to benzo(a)pyrene. PEF values are presented in Table D-2. The cPAH will be calculated as the sum of each individual PAH concentration multiplied by the corresponding PEF value. When the individual PAH component concentration are reported as non-detected, then the PEF will be multiplied by one-half the RL.

Table D-2
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
Dibenz(a,h)anthracene	0.4
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.
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EPA: US Environmental Protection Agency
PEF: potency equivalency factor

9 TOC Normalization

Most RALs are organic carbon (OC)-normalized values. Organic carbon-normalized concentrations are calculated by dividing the dry weight concentration by the percent total organic carbon (TOC) expressed as a fraction. For example, a dry weight PCB concentration of 240 µg/kg in a sample with 2% TOC has a TOC-normalized PCB concentration of 12 mg/kg OC, per Equation 1:

$$\frac{240\ \mu g/kg}{0.02} = 12{,}000\ \mu g/kg = 12\ mg/kg$$ **Equation 1**

Sediment samples with TOC content < 0.5% or > 3.5% will not be TOC normalized for comparison to the organic carbon-normalized RALs and SMS criteria (Ecology 2019). When TOC normalization is not possible, a dry weight equivalent concentration is used (see Table 8-1 in Ecology 2019).

10 References

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Attachment E
Interpolation Methods for Delineating Areas with RAL Exceedances

1 Introduction

One of the primary objectives of the Phase I data evaluation report (DER) is to delineate areas with remedial action level (RAL) exceedances using the design dataset in order to identify Phase II data gaps. Two data interpolation methods were used to identify areas with RAL exceedances: inverse distance-weighted (IDW) interpolations for polychlorinated biphenyls (PCBs) and Thiessen polygons for all other contaminants of concern (COCs). This attachment presents the interpolation methods and steps used in the Phase I DER to delineate the areas with exceedances of the RALs listed in Table 28 of the US Environmental Protection Agency's (EPA's) 2014 Record of Decision (ROD) (EPA 2014). The steps herein define the process used to identify areas with RAL exceedances of at least one COC.

The interpolation approach will be discussed in more detail and finalized with EPA prior to preparing the Phase II DER. In the Phase II DER, the final RAL exceedance areas will be presented using the final approach and the design dataset supplemented with Phase II data.

1.1 Step 1 – Interpolation of OC-Normalized PCB Concentrations

Using the design dataset presented in Attachment A, PCB concentrations in surface sediment (0–10-cm intervals) and subsurface sediment (0–45-cm, 0–60-cm, and shoaling intervals) were interpolated separately using IDW (Maps E-1 and E-2). The IDW interpolations for PCBs were conducted using the IDW parameterization used in the Lower Duwamish Waterway feasibility study (AECOM 2012).

The PCB data interpolation needed to be done on an organic carbon (OC)-normalized basis because the PCB RALs are OC-normalized in the ROD. Therefore, the first step was to create a PCB OC-normalized concentration interpolation for both surface and subsurface sediments.

Calculation of OC-normalized PCB concentrations was done in one of two ways, depending on the total organic carbon (TOC) percentage. For locations with TOC > 0.5% and < 3.5% (more than 90% of the dataset), dry weight PCB concentrations were OC normalized as follows: mg/kg OC = (µg/kg dry weight)/(% TOC dry weight x 1,000). For locations where TOC was outside the specified TOC range (< 10% of the design dataset), an equivalent OC-normalized PCB concentration was calculated based on a dry weight exceedance factor (EF) in order to have consistent concentration units for the interpolation.

For example, at location 300, where the TOC was > 3.5%, the dry weight PCB concentration (90.5 µg/kg) was divided by the dry weight equivalent PCB RAL of 1,000 µg/kg[1] to calculate an EF of 0.091 (i.e., 90.5/1,000) (Table E-1). This EF was then multiplied by the OC-normalized

[1] Outside of Recovery Category 1 areas, the 0–45-cm RAL for PCBs is 65 mg/kg OC. The dry weight equivalent is 1,000 µg/kg, per Ecology (2019).

RAL (65 mg/kg OC) to calculate an equivalent OC-normalized PCB concentration of 5.92 mg/kg OC (i.e., 0.091 × 65). If this approach had not been used, and the dry weight PCB concentration had been simply normalized based on the TOC, the PCB concentration would have been 1.31 mg/kg OC. Washington State Sediment Management Standards (SMS) do not use this simple normalization when TOC is outside the SMS range of < 0.5% or > 3.5%. Thus, because the OC-normalized PCB interpolation was needed to determine areas with exceedances of the OC-normalized RAL, the described equivalent approach was used. The same equivalent approach was used when the TOC was lower than the acceptable range (e.g., location 301; Table E-1). Maps E-1 and E-2 show the locations where the TOC was outside the OC-normalization range, and thus, equivalent OC-normalized PCB concentrations were used.

Table E-1
Example Calculations of equivalent OC-normalized PCB concentrations

Sample	TOC	PCB (µg/kg dw)	dw RAL	dw EF	OC-normalized RAL	PCB (mg/kg OC) (calculated equivalent for interpolation)	PCB (mg/kg OC) (for reference only)
IT300	6.9%	90.5	1000	0.091	65	5.92	1.31
IT301	0.14%	60.9	1000	0.061	65	3.96	43.5

Notes:
dw: dry weight
EF: exceedance factor
OC: organic carbon
PCB: polychlorinated biphenyl
RAL: remedial action level
TOC: total organic carbon

1.2 Step 2 - Compare Interpolated PCB Concentrations to RALs

The interpolated OC-normalized PCB concentrations derived in Step 1 were compared to PCB RALs applicable to surface and subsurface sediment (and associated depth and recovery category) to determine areas with PCB RAL exceedances. In surface sediment (0–10 cm), this exercise equated to delineating all areas with PCB concentrations > 12 mg/kg OC. The areas with surface PCB RAL exceedances are shown in Map E-3.

In subsurface sediment (0–45 cm, 0–60 cm, or shoaling intervals), this exercise was more complex, because the subsurface PCB RAL varies by location depending on the depth of the interval; whether the location is intertidal, subtidal, or in a shoaling area; and the associated recovery category. For example, Recovery Category 1 areas, where natural recovery is presumed to be limited, have lower RALs than do Recovery Category 2 or 3 areas. Thus, a PCB concentration in one location may exceed a subsurface RAL (such as 65 mg/kg OC), whereas the same concentration in another location (with a higher subsurface RAL such as 195 mg/kg OC) may not be an exceedance.

In the shoaling areas, a PCB RAL of 12 mg/kg OC applies to all depth intervals from the sediment surface to the top of the authorized navigation depth, including a 2-ft over-dredge depth. For the subsurface interpolation in shoaling areas, the sediment depth interval with the highest PCB RAL exceedance was used.

The areas with subsurface PCB RAL exceedances are shown in Map E-4.

1.3 Step 3 – Combine Surface and Subsurface PCB RAL Exceedance Areas

The delineated areas with PCB RAL exceedances in the surface and subsurface were combined in a geographic information system by essentially stacking the layers. As such, PCB RAL exceedance areas in the upper reach (Map E-5) are based on either surface or subsurface RAL exceedances, and in some cases, on both.

1.4 Step 4 – Determine RAL Exceedance Areas for Other COCs and Combine with PCB Areas

Locations with RAL exceedances of COCs other than PCBs were identified so they could be incorporated into the areas with RAL exceedances based on PCBs thus far.[2] These other COCs are listed in Table E-2. Thiessen polygons were used to interpolate these COCs in areas where they had RAL exceedances. The sizes of the polygons in the surface and subsurface were based on COC-specific data in each RAL exceedance area and were also dependent on the recovery category (Maps E-6a through E-6c). Thiessen polygon areas with RAL exceedances for these other COCs combined are shown on Map E-7. These polygon-based areas were then combined with PCB RAL exceedances areas (Map E-5) to define areas with any COC RAL exceedance in the upper reach (Map E-8). Many of the polygon-based areas exceeding RALs overlapped with PCB areas exceeding RALs; that is, there was only a small increase to the RAL exceedance areas based on COCs other than PCBs. All areas with RAL exceedances were then numbered to assist in Phase II data gaps identification.

Table E-2
Summary of COCs with at Least One RAL Exceedance in the Design Dataset

Chemical	Surface (0–10 cm)		Intertidal (0–45 cm)		Subtidal (0–60 cm)		Subtidal (shoal)	
	N	# > RAL	N	# > RAL	N	# > RAL	N	# > RAL
Human Health RALs								
Total PCBs	696	66	92	10	78	17	71	4

[2] If toxicity testing is conducted in Phase II and a location passes the toxicity tests, it will not be included in determining RAL exceedance areas.

Chemical	Surface (0–10 cm)		Intertidal (0–45 cm)		Subtidal (0–60 cm)		Subtidal (shoal)	
	N	# > RAL	N	# > RAL	N	# > RAL	N	# > RAL
Arsenic	548	8	76	0	27	0	38	0
cPAHs - mammal - half DL[1]	490	1	54	0	29	0	37	0
Dioxin/furan TEQ	114	2	38	3	8	0	19	0
Benthic RALs								
Metals[2]								
Lead	542	1	9	0	27	0	38	0
Mercury	544	3	9	0	29	0	39	1
Zinc	509	2	9	0	27	0	38	0
PAHs[3]								
Acenaphthene	490	2	9	1	29	0	37	0
Benzo(a)anthracene	490	2	9	1	29	0	37	0
Benzo(a)pyrene	489	2	9	1	29	0	37	0
Benzo(g,h,i)perylene	490	4	9	1	29	0	37	0
Total benzofluoranthenes	490	2	9	1	29	0	37	0
Chrysene	490	2	9	1	29	0	37	0
Dibenzo(a,h)anthracene	490	3	9	1	29	0	37	0
Fluoranthene	490	3	9	1	29	0	37	1
Fluorene	490	1	9	1	29	0	37	0
Indeno(1,2,3-cd)pyrene	490	3	9	1	29	0	37	0
Phenanthrene	490	4	9	1	29	0	37	0
Total high-molecular-weight PAHs	485	2	9	1	29	0	37	0
Total low-molecular-weight PAHs	485	1	9	1	29	0	37	0
Phthalates[4]								
BBP	449	8	9	0	27	0	36	0
Other SVOCs[5]								
1,4-Dichlorobenzene	447	1	9	0	27	0	36	0
4-Methylphenol	451	1	9	0	27	0	36	0
Benzoic acid	451	2	9	0	27	0	36	0
Phenol	458	1	9	0	27	0	36	0

Notes:
1. The cPAH TEQ RAL exceedance count in this table is based on the revised cPAH RALs in the 2021 cPAH ESD (EPA 2021). These RALs were used to determine the salmon-colored RAL exceedance areas on Map E-5. However, since the ESD is not yet final, ROD RALs were also used to determine areas with cPAH RAL exceedances. The three ROD-RAL exceedance areas are shown in orange on Map E-5.
2. Cadmium, copper, chromium, and silver concentrations did not exceed RALs in any samples.
3. 2-methyl naphthalene, anthracene, naphthalene, and pyrene did not exceed RALs in any samples.
4. BEHP and dimethyl phthalate did not exceed RALs in any samples.
5. 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 2,4-dimethylphenol, dibenzofuran, hexachlorobenzene, n-nitrosodiphenylamine, and pentachlorophenol did not exceed RALs in any samples.
BBP: butyl benzyl phthalate
BEHP: bis(2-ethylhexyl) phthalate
COC: contaminant of concern
cPAH: carcinogenic polycyclic aromatic hydrocarbon

DL: detection limit
ESD: explanation of significant differences
N: sample count
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
ROD: Record of Decision
SVOC: semivolatile organic compound
TEQ: toxic equivalent

2 References

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

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FINAL

Attachment F
Preliminary Technology Assignment Options for Areas with RAL Exceedances

1 Preliminary Remedial Technology Assignments

This attachment summarizes the rationale used to assign the preliminary remedial technology options[1] for each area with remedial action level (RAL) exceedances. Figures 19 and 20 in the Record of Decision (ROD)[2] describe the process by which remedial technologies are to be assigned during the design process. Figure 19 refers to the decision flowchart for intertidal areas, while Figure 20 refers to the decision flowchart for subtidal areas. A variety of factors govern the preliminary selection of applicable remedial technologies, including mudline elevation, RAL exceedance factor, depth of contamination, and recovery category designation.

Areas that span both intertidal and subtidal areas are presented below as distinct subareas within the RAL exceedance area since different flowcharts apply. Within the intertidal and subtidal subareas, different remedial technologies may apply as a result of other factors, including mixed sample results within the subarea or multiple recovery categories spanning the subarea. Engineering and constructability considerations will be evaluated during 30% and 60% remedial design to determine the final selected remedial technology in each area.

Potential remedial technologies identified in the ROD for intertidal and subtidal areas include the following:

- Intertidal:
  - Monitored natural recovery (MNR)
  - Area-specific technology[3]
  - Enhanced natural recovery (ENR)
  - Partial dredge and cap
  - Dredge and backfill
- Subtidal:
  - MNR
  - Area-specific technology
  - ENR
  - Partial dredge and cap
  - Dredge (with backfill in habitat areas)[4]
  - Cap or armored cap

[1] Multiple technologies could be used within a single area with RAL exceedances.
[2] Figure 20 was corrected after the ROD was published. Reference to Figure 20 herein refers to the corrected version, which was published in a memorandum from the US Environmental Protection Agency (EPA) dated August 26, 2015.
[3] In areas with structural or access restrictions, area-specific cleanup technologies will be applied as described in ROD Section 13.2.1.3.
[4] Habitat areas were defined in the FS as all areas above -10 ft MLLW.

Each area with RAL exceedances is presented below, along with the ROD flowchart questions and answers to select the preliminary remedial technology options. The preliminary remedial technology options and Phase II data gaps for each area are provided in Table F-1. In addition, Maps F-1a through F-1f provide cross sections to illustrate site features.

Table F-1
RAL Exceedance Areas, Preliminary Technology Assignments Options, and Phase II Data Gaps

[1] Area	[2] RM	[3] Recovery Category (Intertidal, Subtidal, or Shoal Area)	[4] Surface Sediment RAL Exceedance (see Maps 4-1a-i)	[5] Subsurface Sediment RAL Exceedance (see Maps 4-1a-i)	[6] Bank Type if Present	[7] Structures Present	[8] Preliminary Technology Assignment Options	Data Gaps for Phase II Sampling and Analysis (yes = data needed / no = no data needs/ or N/A)							
								Data Gaps to Refine the Areas with Sediment RAL Exceedances[1]			Data Gaps to Evaluate Bank Areas				
								Horizontal Extent of RAL Exceedance			Horizontal Extent of RAL Exceedance				
								[9] Surface	[10] Subsurface	[11] Vertical Extent	[12] Surface	[13] Subsurface	[14] Vertical Extent	[15] Geotech	[16] Topography or Other Engineering Information
1	3.0	1 (subtidal)	No (but PCB EF was 1.0 and PCBs exceed the RAL in intertidal area north of RM 3.0)	Yes	No bank	No structure	Dredge or partial dredge and cap	Yes	Yes	Yes	N/A				
2	3.05	1 (subtidal)	No	Yes	No bank	No structure	Dredge or partial dredge and cap	Yes	Yes	Yes	N/A				
3	3.1	1 (subtidal)	No	Yes	No bank	No structure	Dredge or partial dredge and cap	No	Yes	Yes	N/A				
4	3.15	1 (subtidal)	No data	No data	No bank	No structure	Need to confirm if exceedance; if so, dredge or partial dredge and cap	No	Yes	Depends on Tier 1	N/A				
5	3.1–3.3	1 (subtidal)	Yes	Yes	No bank	Overwater – Bridge on S end	Dredge or partial dredge and cap	Yes	Yes	Yes	N/A				
6	3.23W	3 (intertidal and subtidal)	Yes	No	No bank	No structure	ENR	No	No	No	N/A				
7	3.3W	3 (intertidal and subtidal)	Yes	No	Habitat restoration built during South Park Bridge construction, on bank above +7.4 MLLW	Overwater - Bridge	ENR, dredge, partial dredge and cap	Yes	Yes	Yes	No	No	No	No	No
8	3.35	1 (subtidal)	No	Yes	No bank	Overwater – Bridge on N end	Dredge or partial dredge and cap	Yes	Yes	Yes	N/A				
9	3.35	shoal	No	Yes	No bank	Overwater – Bridge on N end	Dredge or partial dredge and cap	No	Yes	Yes	N/A				
10	3.4	shoal	Yes	No	No bank	Marina floats	Dredge or partial dredge and cap	Yes	No	No	N/A				
11	3.4	shoal	No	Yes	No bank	Marina floats	Dredge or partial dredge and cap	No	Yes	Yes	N/A				
12	3.5W	3 (intertidal and subtidal)	Yes	No data within area but no RAL exceedances in 0-60 cm in surrounding PDI samples	Armored	Marina floats	ENR, dredge, or partial dredge and cap	No	No	Yes	Yes – interstitial sediment in armor	No	No	No	Topography; Sediment thickness probing
13	3.5	shoal	No	Yes	No bank	Marina floats	Dredge or partial dredge and cap	No	Yes	Yes	N/A				

								Data Gaps for Phase II Sampling and Analysis (yes = data needed / no = no data needs/ or N/A)							
								Data Gaps to Refine the Areas with Sediment RAL Exceedances[1]			Data Gaps to Evaluate Bank Areas				
								Horizontal Extent of RAL Exceedance			Horizontal Extent of RAL Exceedance				
[1] Area	[2] RM	[3] Recovery Category (Intertidal, Subtidal, or Shoal Area)	[4] Surface Sediment RAL Exceedance (see Maps 4-1a-i)	[5] Subsurface Sediment RAL Exceedance (see Maps 4-1a-i)	[6] Bank Type if Present	[7] Structures Present	[8] Preliminary Technology Assignment Options	[9] Surface	[10] Subsurface	[11] Vertical Extent	[12] Surface	[13] Subsurface	[14] Vertical Extent	[15] Geotech	[16] Topography or Other Engineering Information
14	3.55	shoal	No	No data	No bank	Dolphins	Need to confirm if exceedance; if so, dredge or partial dredge and cap	No	Yes	Depends on Tier 1	N/A				
15	3.6	1 (subtidal)	No data	Yes	No bank	No structure	Dredge or partial dredge and cap	No	Yes	Yes	N/A				
16	3.65	1 (subtidal) and shoal	Yes	Yes	No bank	No structure	Dredge or partial dredge and cap	Yes	Yes	Yes	N/A				
17	3.7	1 (subtidal) and shoal	Yes	No	No bank	No structure	Dredge or partial dredge and cap	Yes	Yes	Depends on Tier 1	N/A				
18	3.7–3.8E	2 (intertidal and subtidal) 1 (subtidal)	Yes	No (limited data)	Bulkhead; Unarmored – vegetated	Bulkhead	ENR, dredge, or partial dredge and cap	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Topography; Structure inspection
19	3.75W	shoal	No data	No data	No bank	No structure	Need to confirm if exceedance; if so, dredge or partial dredge and cap	No	Yes	No	N/A				
20	3.8W	3 (intertidal and subtidal) and shoal	No	Yes	Habitat restoration recently built on bank above a toe elevation ranging from +4 to +8 MLLW	No structure	Dredge or partial dredge and cap	No	Yes	Yes	No	No	No	No	No
21	3.8W	3 (intertidal)	Yes	No	Habitat restoration recently built on bank above a toe elevation ranging from +4 to +8 MLLW	No structure	ENR	Yes, to reoccupy if toxicity testing is needed	No	No	No	No	No	No	No
22	3.8	shoal	No	No data	No bank	No structure	Need to confirm, and if so, dredge or partial dredge and cap	No	Yes	No	N/A				
23	3.83E	2 (intertidal and subtidal) and 1 (subtidal)	Yes	No	Unarmored – vegetated; Bulkhead	Bulkhead	ENR, dredge or partial dredge and cap	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Topography; Structure inspection
24	3.88	1 (subtidal) and shoal	No	Yes	No bank	No structure	Dredge or partial dredge and cap	No	Yes	Yes	N/A				
25	3.9W	3 (intertidal)	Yes	No (in bounding samples)	Habitat restoration recently built on bank above a toe elevation ranging from +4 to +8 MLLW	No structure	ENR	No	No	No	No	No	No	No	No

[1] Area	[2] RM	[3] Recovery Category (Intertidal, Subtidal, or Shoal Area)	[4] Surface Sediment RAL Exceedance (see Maps 4-1a-i)	[5] Subsurface Sediment RAL Exceedance (see Maps 4-1a-i)	[6] Bank Type if Present	[7] Structures Present	[8] Preliminary Technology Assignment Options	Data Gaps for Phase II Sampling and Analysis (yes = data needed / no = no data needs/ or N/A)							
								Data Gaps to Refine the Areas with Sediment RAL Exceedances[1]			Data Gaps to Evaluate Bank Areas				
								Horizontal Extent of RAL Exceedance			Horizontal Extent of RAL Exceedance				
								[9] Surface	[10] Subsurface	[11] Vertical Extent	[12] Surface	[13] Subsurface	[14] Vertical Extent	[15] Geotech	[16] Topography or Other Engineering Information
26	3.85	1 (subtidal)	No	No data	No bank	No structure	Need to confirm if exceedance; if so, dredge or partial dredge and cap	No	Yes	Depends on Tier 1	N/A				
27	3.95E	2 (intertidal) and 1 (subtidal)	Yes	Yes	Bulkhead	Bulkhead	ENR, dredge or partial dredge and cap	Yes	Yes	Yes	N/A			Yes	Structure inspection
28	3.95W	1 (intertidal and subtidal)	No	Yes	No bank	Dolphin, pier to the S	Dredge or partial dredge and cap	No	Yes	Yes	N/A				
29	3.98	1 (subtidal)	No	No data	No bank	No structure	Need to confirm if exceedance; if so, dredge or partial dredge and cap	No	Yes	Depends on Tier 1	N/A				
30	4.0E	2 (intertidal and subtidal)	Yes	No	Armored	No structure	ENR	Yes	Yes	Depends on Tier 1	Yes – interstitial sediments in armor	No	No	No	Topography; Sediment thickness probing
31	4.0–4.1E	2 and 3 (intertidal)	Yes	Yes	Unarmored – discontinuous; Armored	Remnant piles and dolphins	ENR, dredge, or partial dredge and cap	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Topography; Sediment thickness probing
32	4.2E	1 (intertidal and subtidal)	No	Yes	Armored	Overwater pier and wharf	Dredge or partial dredge and cap	Yes	Yes	Yes	No	No	No	Yes	Topography; Sediment thickness probing; Structure inspection
33	4.25W	1 (intertidal and subtidal)	No data	No data	No bank	Pier, debris deflector	Need to confirm if exceedance; if so, dredge or partial dredge and cap	No	Yes	No	N/A				
34	4.6E	1 (intertidal and subtidal)	Yes	Yes	Unarmored – discontinuous	Nearby wharf	Dredge, partial dredge and cap, or cap/armored cap	Yes	Yes	Depends on Tier 1	Yes	Yes	Yes	Yes	Topography; Sediment thickness over armor; Structure inspection
35	4.7W	3 (intertidal)	Yes	No	Unarmored - vegetated	No structure	ENR	Yes	Yes	No	Yes	No	No	No	Topography; Sediment thickness probing
36	4.75W	1 and 3 (intertidal)	Yes	No	Unarmored - vegetated	No structure	ENR, dredge, or partial dredge and cap	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Topography; Sediment thickness probing

FINAL

[1] Area	[2] RM	[3] Recovery Category (Intertidal, Subtidal, or Shoal Area)	[4] Surface Sediment RAL Exceedance (see Maps 4-1a-i)	[5] Subsurface Sediment RAL Exceedance (see Maps 4-1a-i)	[6] Bank Type if Present	[7] Structures Present	[8] Preliminary Technology Assignment Options	Data Gaps for Phase II Sampling and Analysis (yes = data needed / no = no data needs/ or N/A)							
								Data Gaps to Refine the Areas with Sediment RAL Exceedances[1]			Data Gaps to Evaluate Bank Areas				
								Horizontal Extent of RAL Exceedance			Horizontal Extent of RAL Exceedance				
								[9] Surface	[10] Subsurface	[11] Vertical Extent	[12] Surface	[13] Subsurface	[14] Vertical Extent	[15] Geotech	[16] Topography or Other Engineering Information
37	4.9E	2 (intertidal and subtidal)	Yes	No	Unarmored - discontinuous	Timber groins	ENR, dredge, or partial dredge and cap	Yes	No	Yes	Yes	No	Yes	Yes	Topography; Sediment thickness over armor; Structure inspection

Notes:
1. Each individual area with RAL exceedances does not necessarily require a geotechnical sample. Representative geotechnical samples will be collected within subtidal and intertidal areas.

[1]: Table column number
EF: exceedance factor
ENR: enhanced natural recovery
MLLW: mean lower low water
N/A: not applicable
PCB: polychlorinated biphenyl
PDI: pre-design investigation
RAL: remedial action level
RM: river mile

Area 1: RAL Exceedance Area 1 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II pre-design investigation (PDI) data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 1.

Area 2: RAL Exceedance Area 2 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 2.

Area 3: RAL Exceedance Area 3 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.

- Is there room for a cap?
  No, the RC 1 area is within the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 3.

Area 4: RAL Exceedance Area 4 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, if the exceedance is confirmed **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 4.

Area 5: RAL Exceedance Area 5 is located in a subtidal area.

- Any sediment COC concentration >RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Bridge and cable crossing); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, a cap would impact the FNC or 10-ft buffer area.
- Would >1 ft of sediment with COCs >HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.

- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 5. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 6: RAL Exceedance Area 6 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  No samples are located within the subtidal subarea; area designation is based on interpolated data. Adjacent COC concentrations are below the ENR upper limit.
- Therefore, **ENR** may be applicable for the intertidal subarea within RAL Exceedance Area 6.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  No.
- Is there room for ENR?
  Yes.
- Therefore, **ENR** may be applicable for the subtidal subarea within RAL Exceedance Area 6.

Area 7: RAL Exceedance Area 7 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?

Potentially yes (South Park Bridge and cable crossing); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.

- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  There are multiple samples within the intertidal subarea. One sample exceeds the ENR upper limit; three samples do not exceed the ENR upper limit.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **ENR** may be applicable for a portion of the intertidal subarea, and **dredge and backfill or partial dredge and cap** may be applicable for other portions of the intertidal subarea within RAL Exceedance Area 7. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Bridge and cable crossing); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  No samples are located within the subtidal subarea; area designation is based on interpolated data where mixed results are present in the adjacent intertidal subarea. Adjacent COC concentrations are above and below the ENR upper limit (to be confirmed during Phase II PDI).
- Room for a cap?
  No, the subtidal region of Area 7 is above -10 ft MLLW and may be a habitat area per the ROD.
- Would > 1 ft of sediment with COCs > HH RALs or Benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Room for ENR?
  Yes.

- Therefore, **ENR, partial dredge and cap, or dredge (with backfill in habitat areas)** may be applicable for portions of the subtidal subarea within RAL Exceedance Area 7. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

<u>Area 8:</u> RAL Exceedance Area 8 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Bridge and cable crossing); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, the area is within the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 8. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

<u>Area 9:</u> RAL Exceedance Area 9 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Bridge and cable crossing); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  Not applicable; ENR is not an allowable remedial technology for shoal areas (per ROD Table 28).
- Room for cap?
  No, the area is within the FNC or 10-ft buffer area and within a shoal area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?

To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 9. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

<u>Area 10:</u> RAL Exceedance Area 10 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Marina floats), so there may be a need to apply area-specific technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  ENR is not an allowable remedial technology for shoal areas (per ROD Table 28). There are no samples located in the area outside the shoal area, and the area designation is based on interpolated data. Adjacent COC concentrations are below the ENR upper limit.
- Room for Cap or ENR?
  No, the area is within the FNC or 10-ft buffer area and within a shoal area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 10. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

<u>Area 11:</u> RAL Exceedance Area 11 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Marina floats), so there may be a need to apply area-specific technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  Not applicable; ENR is not an allowable remedial technology for shoal areas (per ROD Table 28).

- Room for Cap?
  No, the area is within the FNC or 10-ft buffer area and within a shoal area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 11. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 12: RAL Exceedance Area 12 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Marina floats); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  No.
- Therefore, **ENR** may be applicable for the intertidal subarea within RAL Exceedance Area 12. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Marina floats); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  Yes.
- Is there room for a cap?
  No, due to berthing depth needs for the marina.

- Would >1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for the subtidal subarea within RAL Exceedance Area 12. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 13: RAL Exceedance Area 13 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (South Park Marina floats); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  Not applicable; ENR is not an allowable remedial technology for shoal areas (per ROD Table 28).
- Room for Cap?
  No, area is located within the FNC or 10-ft buffer zone and within a shoal area.
- Would >1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 13. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 14: RAL Exceedance Area 14 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples exceeding COC concentrations are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?

Not applicable; ENR is not an allowable remedial technology for shoal areas (per ROD Table 28).

- Room for Cap?
  No, area is located within the FNC or 10-ft buffer zone and within a shoal area.
- Would >1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 14.

Area 15: RAL Exceedance Area 15 is located in a subtidal area.

- Any sediment COC concentration >RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for Cap?
  No, area is located within the FNC or 10-ft buffer zone.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 15.

Area 16: RAL Exceedance Area 16 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for Cap?
  No, area is located within the FNC or 10-ft buffer zone and a portion is located within the shoal area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?

To be determined following Phase II PDI data evaluation.

- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 16.

Area 17: RAL Exceedance Area 17 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for Cap?
  No, area is located within the FNC or 10-ft buffer zone and a portion is located within the shoal area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 17.

Area 18: RAL Exceedance Area 18 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (bulkheaded); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  Numerous sample concentrations above and below the ENR upper limits.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **ENR** may be applicable for a portion of the intertidal subarea, and **dredge and backfill or partial dredge and cap** may be applicable for other portions of the

intertidal subarea within RAL Exceedance Area 18. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for a cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for the subtidal subarea within RAL Exceedance Area 18.

Area 19: RAL Exceedance Area 19 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for Cap?
  No. area is located within the FNC or 10-ft buffer zone and within a shoal area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **partial dredge and cap or dredge (with backfill in habitat areas)** may be applicable for RAL Exceedance Area 19.

Area 20: RAL Exceedance Area 20 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?

Yes; MNR is not applicable.

- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  Yes.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge and backfill or partial dredge and cap** may be applicable for the intertidal subarea within RAL Exceedance Area 20.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the subtidal subarea; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Partially.
  - RC 1 area:
    - Is there room for a cap?
      No, area is located within the FNC or 10-ft buffer zone and within a shoal area.
  - Non-RC 1 area:
    - Sediment COC concentrations > ENR upper limits?
      No samples are located within the subtidal subarea; area designation is based on interpolated data. Adjacent COC concentrations are above the ENR upper limit.
    - Room for cap?
      No, cap would impact the FNC or 10-ft buffer zone.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for the subtidal subarea within RAL Exceedance Area 20.

Area 21: RAL Exceedance Area 21 is located in an intertidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  No.
- Therefore, **ENR** may be applicable for the intertidal subarea within RAL Exceedance Area 21.

Area 22: RAL Exceedance Area 22 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for Cap?
  No, area is located within a shoal area and the FNC or 10-ft buffer zone.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, if the exceedance is confirmed, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 22.

Area 23: RAL Exceedance Area 23 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (bulkheaded and this area is located between and adjacent to the AC Pilot plots); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?

No.

- Sediment COC concentrations > ENR upper limits?
  Six of twelve samples exceed the ENR upper limit.
  - Locations <ENR upper limit
    - Room for ENR?
      Yes.
  - Locations >ENR upper limit
    - Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
      To be determined following Phase II PDI data evaluation.
- Therefore, **ENR** may be applicable for a portion of the intertidal subarea, and **dredge and backfill or partial dredge and cap** may be applicable for other portions of the intertidal subarea within RAL Exceedance Area 23. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for the subtidal subarea within RAL Exceedance Area 23.

Area 24: RAL Exceedance Area 24 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.

- Room for Cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 24.

<u>Area 25:</u> RAL Exceedance Area 25 is located in a intertidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  No.
- Therefore, **ENR** may be applicable for the intertidal subarea within RAL Exceedance Area 25.

<u>Area 26:</u> RAL Exceedance Area 26 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples exceeding COC concentrations are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for Cap?
  No, area is located within the FNC or 10-ft buffer zone.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 26.

Area 27: RAL Exceedance Area 27 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (bulkheaded); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  There are samples with concentrations above and below the ENR upper limits within this area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **ENR** may be applicable for a portion of the intertidal subarea, and **dredge and backfill or partial dredge and cap** may be applicable for other portions of the intertidal subarea within RAL Exceedance Area 27. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the subtidal subarea; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for the subtidal subarea within RAL Exceedance Area 27.

Area 28: RAL Exceedance Area 28 is located in an intertidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (pier, dolphins); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  Yes.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge and backfill or partial dredge and cap** may be applicable for RAL Exceedance Area 28. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 29: RAL Exceedance Area 29 is located in a subtidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Room for Cap?
  No, cap would impact the FNC or 10-ft buffer area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for RAL Exceedance Area 29.

Area 30: RAL Exceedance Area 30 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.

- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  No.
- Therefore, **ENR** may be applicable for the intertidal subarea within RAL Exceedance Area 30.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples exceeding COC concentrations are located within the subtidal subarea; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  No samples are located within the subtidal subarea, but adjacent intertidal samples do not exceed the ENR upper limit.
- Therefore, **ENR** may be applicable for the subtidal subarea within RAL Exceedance Area 30.

Area 31: RAL Exceedance Area 31 is located in an intertidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (dolphins); there may be a need to apply area-specific remedial technology; to be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?
  There are samples with concentrations above and below the ENR upper limits in the intertidal area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.

- Therefore, **ENR** may be applicable to a portion of the intertidal subarea, and **dredge and backfill or partial dredge and cap** may be applicable for other portions of the intertidal subarea within RAL Exceedance Area 31. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 32: RAL Exceedance Area 32 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the intertidal subarea; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (Slip 6 pier structure); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  Yes.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge and backfill or partial dredge and cap** may be applicable for the intertidal subarea within RAL Exceedance Area 32. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (Slip 6 pier structure); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, current depth is above authorized berthing depth.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.

- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for the subtidal subarea within RAL Exceedance Area 32. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 33: RAL Exceedance Area 33 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration >RALs in appropriate depth interval?
  No samples are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (pier and debris deflector), so there may be a need to apply area-specific technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  Yes.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge and backfill or partial dredge and cap** may be applicable for the intertidal subarea within RAL Exceedance Area 33. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the RAL exceedance area; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  No, cap would impact the FNC or 10-ft buffer area and berthing area.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for the subtidal subarea within RAL Exceedance Area 33. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Area 34: RAL Exceedance Area 34 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (wharf); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  Yes.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **dredge and backfill or partial dredge and cap** may be applicable for the intertidal subarea within RAL Exceedance Area 34. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  No samples are located within the subtidal subarea; area designation is based on interpolated data. Based on interpolated data, MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Yes.
- Is there room for a cap?
  Yes, except for area near FNC and 10-ft buffer.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **cap or armored cap** may be applicable for a portion of the subtidal subarea, and **dredge (with backfill in habitat areas) or partial dredge and cap** may be applicable for other portions the subtidal subarea within RAL Exceedance Area 34.

Area 35: RAL Exceedance Area 35 is located in an intertidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?

No.

- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  No.
- Therefore, **ENR** is applicable for RAL Exceedance Area 35.

Area 36: RAL Exceedance Area 36 is located in an intertidal area.

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  Partially.
  - RC 1 area:
    - Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
      To be determined following Phase II PDI data evaluation.
  - Non-RC 1 area:
    - Sediment COC concentrations >ENR upper limits?
      There are samples with concentrations above and below the ENR upper limits in this area.
- Therefore, **ENR** may be applicable for a portion of the intertidal subarea, and **dredge and backfill or partial dredge and cap** may be applicable for other portions of the intertidal subarea within RAL Exceedance Area 36.

Area 37: RAL Exceedance Area 37 is in both intertidal and subtidal areas.

Intertidal subarea:

- Any sediment COC concentration > RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  Potentially yes (timber groins); there may be a need to apply area-specific remedial technology; this will be determined during 30% design.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations >ENR upper limits?

There are samples with concentrations above and below the ENR upper limits within this area.

- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.
- Therefore, **ENR, dredge and backfill, or partial dredge and cap** may be applicable for the intertidal subarea within RAL Exceedance Area 37. Since there is a structure within or adjacent to this area, an area-specific technology may be applicable.

Subtidal subarea:

- Any sediment COC concentration >RALs in appropriate depth interval?
  Yes; MNR is not applicable.
- Are there structural or access limitations?
  No.
- Is the area within a RC 1 area?
  No.
- Sediment COC concentrations > ENR upper limits?
  There are samples with concentrations above and below the ENR upper limits in this area.
  - Locations < ENR upper limit:
    - Room for ENR?
      Yes.
  - Locations > ENR upper limit:
    - Room for ENR?
      No.
- Would > 1 ft of sediment with COCs > HH RALs or benthic SCOs remain following partial dredging to accommodate a cap?
  To be determined following Phase II PDI data evaluation.

FINAL

Attachment G
Monitoring and Inadvertent Discovery Plan

Lower Duwamish Waterway Upper Reach Remedial Design Phase II Pre-Design Investigation Draft Archaeological Monitoring and Inadvertent Discovery Plan, King County, Washington

May 18, 2021

For submittal to:

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

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

Acronyms and Abbreviations

APE	Area of Potential Effect
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter(s)
CPT	Cone Penetration Testing
DAHP	Washington Department of Archaeology and Historic Preservation
DCP	Dynamic Cone Penetrometer
EPA	United States Environment Protection Agency
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
LDW	Lower Duwamish Waterway
LDWG	The Lower Duwamish Waterway Group
m	meter(s)
m^2	squared meter(s)
MHHW	Mean higher high water
MLLW	Mean lower low water
NHPA	National Historic Preservation Act of 1966, as amended
NRHP	National Register of Historic Places
PDI	Pre-Design Investigations
Project	Phase II sampling for the Lower Duwamish Waterway Sediment Cleanup
RAL	Remedial Action Level
ROD	Record of Decision
SCA	solarized colorless amethyst
SPT	Standard Penetration Test
Stell	Stell Environmental Enterprises, Inc.
U.S.	United States
USACE	United States Army Corps of Engineers
USC	United States Code
VST	Vane Shear Test

1. INTRODUCTION

1.1 PROJECT INFORMATION

Stell Environmental Enterprises, Inc. (Stell) was contracted by Anchor QEA to create an archaeological monitoring and inadvertent discovery plan to support the pre-design investigations (PDIs) Phase II sampling for the Lower Duwamish Waterway Sediment Cleanup Project (Project), located in King County, Washington (**Figure 1-1**) (see **Appendix A** for Inadvertent Discovery Plan). This project is being conducted in support of the Remedial Design for the upper reach per the Fourth Amendment to the Administrative Order on Consent for the Lower Duwamish Waterway (LDW) (United States [U.S.] Environmental Protection Agency [EPA] 2018), in accordance with the EPA's November 2014 Record of Decision (ROD) (EPA 2014).

1.2 PROJECT LOCATION

The Project Area of Potential Effect (APE) is located on the upper reach of the LDW, from 3 to 5 miles upstream from the mouth of the Duwamish River (RM3-5), in Sections 29, 30, 32, and 33 of Township 24 North, Range 4 East, and Section 4 of Township 23 North, Range 4 East, Willamette Meridian (**Figure 1-1** and **Figure 1-2**). The Project is locatedin King County, Washington. Detailed maps of the project area showing the planned sampling activities are in **Appendix B**.

1.3 PROJECT BACKGROUND

The LDW, located south of downtown Seattle, Washington, extends over the northern 5 miles of the Duwamish River to the southern tip of Harbor Island and includes upland sources of contamination as well as the waterway. The southernmost portion of the site is located in Tukwila, Washington. The Site was listed on the National Priorities List on September 13, 2001. The EPA identification number for the Site is WA00002329803. EPA and Ecology have divided lead agency responsibility for addressing the Site: EPA has the lead for the in-waterway portion, and Ecology has the lead for upland source control. The LDW and adjacent upland areas have served as Seattle's major water-dependent industrial corridor since the LDW was created by widening and straightening much of the Duwamish River in the early 1900s. The Duwamish River flows north through Tukwila and Seattle, splitting at the southern end of Harbor Island to form the East and West Waterways, which discharge into Elliott Bay in Seattle, Washington.

The upper reach includes the area between the mean higher high water (MHHW) elevation on banks on either side of the LDW. Upland area above MHHW on either bank is not part of the upper reach. The upper reach of the LDW extends from the area around the Norfolk Combined SewerOverflow/Storm Drain at the southern end of the LDW (RM 5) to Duwamish Waterway Park (RM 3) and includes the Upper Turning Basin at RM 4.6 (**Figure 1-2**). The portion of the upper reach downstream of the Upper Turning Basin is maintained as a federal navigation channel by the U.S. Army Corps of Engineers (USACE), and in this reach the authorized navigation channelwidth is 150 feet and depth is -15 feet mean lower low water (MLLW). The upper reach includes approximately 130 acres of intertidal and subtidal habitat. The average width of the LDW is 440 feet. Comprehensive descriptions of the LDW environmental and physical site characteristics are presented in the LDW Remedial Investigation Report (Windward 2010), Feasibility Study (AECOM 2012), and ROD (EPA 2014).

Figure 1-1. Project area location map projected on the USGS (2019) topographic quadrangle.

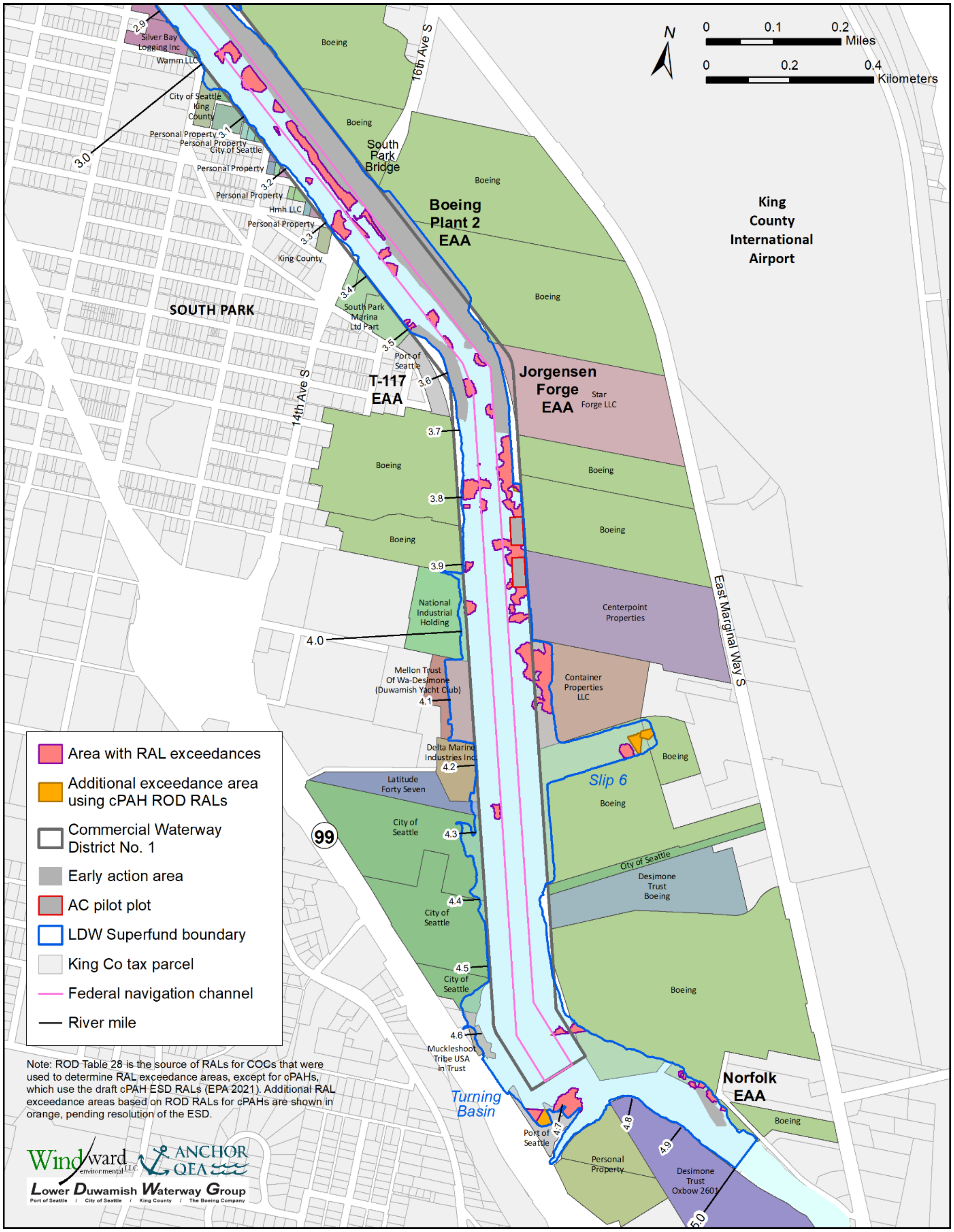

Figure 1-2. Property ownership map within the LDW Superfund APE boundary.

1.4 REGULATORY ENVIRONMENT

The EPA, Region 10, is the lead agency responsible for this project under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). As a federal undertaking being implemented pursuant to CERCLA, this Project is subject to the substantive requirements of Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA) and its implementing regulations, 36 Code of Federal Regulations (CFR) 800, regarding the protection of cultural and historic resources. The substantive requirements of Section 106 of the NHPA requires the lead federal agency to take into account the effects of the undertaking on historic properties.

The term “historic property” is defined in the NHPA as “any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in the National Register.” Historic properties include any artifacts, records, and remains that are related to such a district, site, building, structure, or object (16 United States Code [USC] 470[5]).
The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects of state and local importance that possess integrity of location, design, setting, materials, workmanship, feeling, and association. They:

a) are associated with events that have made a contribution to the broad pattern of our history;
b) are associated with the lives of people significant in our past;
c) embody the distinct characteristics of a type, period, or method of construction, representthe work of a master, possess high artistic values, or represent a significant and distinguishable entity whose components may lack individual distinction; or
d) have yielded, or are likely to yield, information important for understanding prehistory or history (36 CFR 60.4).

For federal projects, significance is evaluated in terms of eligibility for listing in the National Register of Historic Places (NRHP). Within the state of Washington, the NRHP program is administered by the Washington Department of Archaeology and Historic Preservation (DAHP) under the direction of the State Historic Preservation Officer. The EPA, as the lead agency, is responsible for tribal consultation and coordination.

2. CULTURAL RESOURCES BACKGROUND INFORMATION

The Project area is within an area designated as very highly likely to yield cultural materials by the DAHP predictive model. Numerous archaeological sites (including precontact, historic-era, and multicomponent sites) have been documented on the Duwamish River floodplain in the vicinity of the APE. These archaeological data illustrate the general character and depositional context of buried cultural materials that may potentially be exposed by ground disturbing activities within the APE.

All but one of these previously identified archaeological sites, the Hamm Creek Pilings Site (45KI01149), lie outside of the APE. This site consists of an alignment of pilings interpreted as a training-dike structure (Storey 2013). The feature stretches approximately 0.3 miles (500 meters [m]) along the left bank of the LDW and may have been constructed sometime between 1920 and 1940 to prevent the Duwamish River from returning to a natural meander-pattern channel. Storey (2013) recommended the site as potentially NRHP-eligible under significance Criterion D. Similar historic-era piling features are expected to be present within the APE.

Ten previous archaeological investigations have occurred near or within the APE. The earliest investigation occurred in 2001 by Kurt Roedel for the South Park Bridge Project. No significant archaeological resources were identified during excavation monitoring (Roedel 2001). In 2004, Historical Research Associates indicated there was a moderate potential for archaeological resources on either side of the South Park Bridge. They identified 12 NRHP-eligible structures (History Research Associates 2004). Astrida Blukis Onat returned in 2008 and documented three prehistoric archaeological sites along the western bank of the Duwamish River. The sites, 45KI815, 45KI816, and 45KI817 were determined to be prehistoric shell middens composed of mammal bones, fire-cracked rock, and charcoal deposited along an old meander of the Duwamish River (Demuth et al. 2008). The 45KI815 shell-midden site was identified between 50 and 240 centimeters (cm) below surface at 1430 S. Thistle Street. Jennifer Gilpin monitored work in 2006 along Slip 6 and observed a possible historic trash dump in a disturbed context and lacking archaeological integrity (Gilpin 2006). In 2013, two surveys occurred along the Lower Duwamish River. Margaret Berger surveyed the Seattle City Light Duwamish Substation North Property located between Highway 99 and the Duwamish River (Berger and Hartmann 2013). Part of the Seattle City Light Duwamish Substation is within the LDW Superfund boundary. Downstream from Berger’s survey, Jason Cooper monitored sediment dredging along the eastern bank of the Duwamish River at Township 24, Range 4, Section 29 on the Boeing property, which exposed a wooden wagon wheel which was recorded as Site 45KI01142 (Cooper 2013).

In 2014, archaeologists monitoring hydraulic work between Michigan Ave and 8th Avenue identified Site 45KI01183 consisting of bricks, whiteware, and charcoal (Lockwood and Hoyt 2014:3–7). Later that year, Jaqueline Marcotte monitored infrastructure improvement efforts along South Portland Street and 8th Avenue South Street (Marcotte and Johnson 2015). Carol Schultze monitored the South Park Bridge replacement project in 2014. Schultze extended the site boundary for 45KI815, the shell midden that was identified in 2008 (Schultze 2014). 45KI815 sites 46 m to the south of the Duwamish River. A geoarchaeological boring survey was conducted north of the APE at the 8th Avenue Terminals. No archaeological material was recovered, but it was recommended that deep excavations take place to understand the geomorphology and soil formation processes of the Duwamish River floodplain, and to identify any cultural deposits (Hodges 2015).

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3. PHASE 2 SAMPLING METHOD

The proposed Phase II sampling will include the collection and chemical analysis of sediment, collected from in-water or banks, to refine the delineation of remedial action level (RAL) exceedances and assess the vertical extent of contamination in dredging or partial dredging and capping areas. In addition, geotechnical investigation will be conducted to guide the engineering design of remedial actions within the upper reach. Phase II sampling is anticipated to begin at the end of June 2021 and be completed by the end of August 2021 (Windward, Anchor QEA 2021).

The Lower Duwamish Waterway Group (LDWG) anticipates conducting the Phase II PDI for sediment sampling and geotechnical sampling (both in-water and on banks), to help refine the RAL exceedance areas developed in the Phase I PDI and to delineate potential contaminant extents in bank areas that may need remediation that are located within RAL exceedance areas (i.e., Areas 12, 18 (east bank from river mile 3.72 to 3.83), 23 (east bank from river mile 3.83 to 3.95), 27, 30, 31, 32, 34, 35, 36 and 37).

For purposes of assessing the content of this Monitoring and Inadvertent Discovery Plan, we have conservatively identified anticipated types of samples, and a range of number of samples, that may be collected during Phase II PDI for geotechnical sampling. The attached figures (**Appendix B**) show the 37 RAL exceedance areas that were identified from the Phase I PDI that was conducted in summer 2019 and the property ownership of adjacent upland areas. Phase I PDI characterized surface (0–10 cm) and shallow subsurface (0–45 cm and 0– 60 cm) sediment conditions at in-water locations (banks areas were not characterized as part of the Phase I investigation).

3.1 TYPES OF GEOTECHNICAL SAMPLING FOR BANK AREAS

Geotechnical sampling locations to be determined (upland or bank) include one of the following four types of geotechnical sampling:

- Geotechnical borings advanced from a truck or track-mounted drill rig staged on the upland(above MHHW) or bank (slope area below MHHW)
    - Hollow stem auger, mud rotary or sonic drilling methods
    - Boring depths are to be determined but could range up to 40 feet below existing groundsurface
    - Boring diameters will be on the order of 4 inches
    - Sampling using split spoon and Standard Penetration Test (SPT) methods and undisturbed sample collection using a hydraulically advanced Shelby tube method
- Vibracore, geoprobe, or push core for collection of disturbed geotechnical samples
    - Smaller diameter than geotechnical borings (approximately 2 inches)
    - Maximum depth of boring is approximately 15 feet depending upon refusal
- Hand auger coring
    - Smaller diameter than geotechnical borings (approximately 2 inches)
    - Coring depth limited by sample refusal – typically 4–6 feet maximum depth
    - Upland and bank areas only – not used over water
    - Other geotechnical investigation that could be performed on upland or bank area
- Cone penetration testing (CPT) advanced from truck or track-mounted rig staged on theupland, bank, or a barge
    - In-situ test only—cone attached to a rod that is pushed through soil; no samples collected

    - CPT diameter is less than 2 inches
    - Maximum depth of penetration is approximately 50 feet but depends upon presence of debris and density of subsurface materials.
- Vane shear test (VST)—either downhole from the geotechnical boring rig, or hand
    - advanced
    - In-situ test only—rod with vanes attached at the bottom of the rod that is pushed intothe soil then rotated to assess the shear strength of the soil; no samples collected.
    - VST diameter is typically less than 4 inches
    - Maximum depth of penetration is approximately 10 feet, but depends upon presence of debris and density of subsurface materials

3.2 TYPES OF GEOTECHNICAL SAMPLING FOR IN-WATER AREAS

In-water geotechnical sampling locations would be spatially distributed to identify geotechnical conditions in the federal navigation channel and shallow subtidal/intertidal in areas where remedial action is anticipated to be required. Site-specific geotechnical data is not needed within any specific in-water RAL exceedance areas as the general waterway geotechnical conditions can be used to develop design criteria for in-water slope stability and dredge ability evaluations at the RAL exceedance areas locations. Specific types of geotechnical sampling for in-water areas include:

- Geotechnical borings advanced from a drill rig staged on a floating barge
    - Hollow stem auger, mud rotary or sonic drill methods
    - Depths are to be determined but could range up to 40 feet below the existing sediment surface
    - Boring diameters on the order of 4 inches
    - Sampling using split spoon and SPT methods and Shelby tube as described above
- Surface grabs for disturbed geotechnical samples
- Grab captures 0.1 square meters (m^2) to about 15 cm deep Dynamic cone penetrometer (DCP)—hand tool collection in very shallow water areas or bank areas
    - In-situ test only—cone pushed through sediment; no samples collected
    - Maximum depth is 15 feet
- DCP diameter is typically 1.5 inches

3.3 TYPES OF SEDIMENT SAMPLING FOR BANK AREAS

Of the potential bank areas listed above, only 7 out of the 11 bank areas adjacent to the RAL exceedance areas (i.e., 12, 31, 32, 34, 35, 36, and 37) have sloped banks. The other 4 banks (i.e.,18, 23, 27, 30) within RAL exceedance areas are mostly vertical bulkheads on the bank, therefore sediment sampling on the bank is likely not feasible. We anticipate that the number of sample locations within those 7 bank areas will vary based on sampling methods (type of sampling to be determined) as noted below:

- Vibracore or push core (barge mounted if water access, truck/track mounted if land access) will be used to collect sediment samples on the bank slope if coring equipment canaccess bank areas and if equipment can penetrate into ground surface.
    - Diameter of coring equipment may vary between (approximately 2–4 inches).
    - Vertical delineation is intended to locate the bottom elevation of contamination. However, due to equipment capabilities and anticipated maximum depth of

contamination, vibracores for deep subsurface samples are anticipated to be a maximum depth of 5–8 feet below the bank surface if coring equipment can penetrate into the bank slope.

- Surface grab samples and/or shallow hand-driven cores will be collected by hand on banks if coring equipment cannot access bank areas (due to steep slopes or lack of equipmentaccess [i.e., under pier areas]) or if the bank is made up of materials that coring equipmentcan't penetrate (i.e., riprap or debris covered slopes).
    - Equipment size is small, and samples will be collected with hand tools.
    - Maximum depth of sampling is a few inches to a maximum of three feet (though one feet would likely be typical).
    - If the bank area is armored with riprap, hand collection of interstitial sediment within the rock matrix may be the only feasible sampling method that can be used.

3.4 TYPES OF SEDIMENT SAMPLING FOR IN-WATER AREAS

Sediment sampling will be conducted in and around the RAL exceedance areas to refine the horizontal (i.e., lateral) boundaries of the RAL exceedance areas, and to delineate vertical extent of contamination in RAL exceedance areas requiring dredging or exposed by adjacent dredging. The horizontal extent sampling will include a combination of surface grabs (0–10 cm) and subsurface cores (0–45 cm and 0–60 cm cores). These horizontal extent sampling locations will be identified in the Phase II QAPP Addendum.

Vertical delineation will be conducted within each RAL exceedance areas. Vertical delineation is intended to locate the bottom elevation of contamination. However, due to equipment capabilities and anticipated maximum depth of contamination, vibracores for deep subsurface samples are anticipated to be approximately a maximum depth of 10 feet below the sediment bed (with a few that may extent to 14 feet); a significant portion of the site may only require 6 feet core depths but assuming 10 feet cores on average is considered conservative. At one location (i.e., Slip 6), a deeper core (up to 20 feet in length) will need to be collected that will require the use of a barge mounted drill rig. Currently, we anticipate that the number of deep cores collected forvertical delineation will vary based on sampling methods (type of sampling to be determined).

The typical types of environmental sediment sampling for in-water areas include the following:

- Vibracoring from a sediment sampling vessel will be used to collect subsurface (0–45 cm and 0–60 cm) plus deep subsurface (subsurface cores deeper than 0–45 cm or 0–60 cm) sediment samples for in-water areas
    - Diameter of coring equipment (approximately 4 inches)
    - Subsurface sampling depths are 0–45 cm (1.5 feet) and 0–60 cm (2 feet)
    - Deep subsurface sampling depth is anticipated to be a maximum of 10 feet below the sediment bed, but a few may need to be driven deeper
- Surface grab samples (0–10 cm) will be collected from a sediment sampling vessel
    - Grab captures 0.1 m^2 to about 15 cm deep

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4. ARCHAEOLOGICAL MONITORING

To satisfy the requirements of the EPA and Washington State DAHP, Stell will provide on-site monitoring, daily logs during monitoring activities, and a technical report at the close of monitoring for the project. Sarah M.H. Steinkraus, MS, RPA will be the lead archaeologist on this Project. Ms. Steinkraus meets the Secretary of the Interior's, and thus Washington State's, criteria for a Professional Archaeologist.

After review of project activities with King County Historic Preservation Program, the following sampling areas were determined to require an archaeological monitor on site during sampling (**Table 4-1**). For each of the sampling areas requiring a monitor, the archaeologist will be on site toobserve and record the sampling activity. In cases where bank samples are processed on a barge the archaeologist will be present to observe and document the samples. However, the vibracores extracted from in-water sampling locations and processed on a barge will not require an archaeologist to be present. Photographs and records of these in-water vibracore samples will be made available to the archaeologist to review.

Table 4-1. Sampling Locations Requiring Archaeological Monitoring.

RAL Exceedance Area	Type of Sampling	Sample Location	Notes
23	0–45 cm	614	Hand collection
23	0–45 cm	617	Hand collection
27	Geotech Boring	LDW21-GT24-GB	Upland location
31	Vertical	648	Push Core
31	Vertical	653	Push Core
31	Vertical	658	Push Core
31	Vertical	661	Push Core
31	Vertical	664	Push Core
31	Vertical	668	Push Core
32	Geotech Boring	LDW21-GT36-GB	Upland location
36	Vertical	692	Hand collection
36	0–45 cm	693	Hand collection
36	0–45 cm	694	Hand collection
37	Vertical	696	Potential for Push Core
37	Vertical	697	Potential for Push Core
37	Vertical	699	Potential for Push Core
37	Vertical	700	Potential for Push Core
37	Vertical	701	Potential for Push Core

Note: vertical sample depths are targeted to be 6 feet below surface. Geotechnical borings depths vary between 10 and 20 feet deep depending upon boring location.

An inadvertent discovery plan describing the actions that will be performed during the Phase II investigations related to the unanticipated discovery of cultural resources, artifacts, or other archaeological features is provided below as **Appendix A**. The inadvertent discovery plan provides direction, contact information, and guidance for the proper procedures to follow should an inadvertent discovery occur during monitoring, as well as during times when an archaeologist is not present (i.e., in-water sampling activities). In addition, all data collection and sampling activities will be conducted in conformance with the updated health and safety plan (Windward, Anchor QEA 2021).

4.1 ON-SITE MONITORING

The archaeological monitor will observe subsurface ground disturbing activities on banks and upland areas within the Project APE identified in Table 1. Surface ground disturbing activities (i.e., the 0–10 cm grab samples) will not be monitored. The monitor will closely look for any organic or shell midden deposits, signs of soil oxidation, lithic, wood or bone artifacts, or animal or human bones. If any bank vibracores cannot be visually inspected by the archaeological monitor at the sampling site (either 0–45 cm or vertical cores) they will be inspected aboard the processing barge. Additional areas may require monitoring depending on unknown variables such as access, debris obstructions, or potential sampling technique changes. For example, monitoring of Area 23 will depend on whether a sampling vessel will be able to access the site. If hand collected samples are required at Area 23 at additional locations not identified on Table 1, then those hand collected core samples (0–45 cm or vertical cores) will be monitored.

The archaeological monitor may from time to time request a temporary halt to work activities in order to document archaeological materials or to conduct a closer inspection of an area or spoils. Such documentation usually takes a few minutes (entailing photographs and written descriptions) but may take longer. If artifacts or other potential archaeological deposits are observed, the archaeological monitor will direct the sampling field crew to temporarily cease work in the immediate vicinity while the monitor conducts a close inspection. The archaeologist will give an estimate of the amount of time needed to document materials to the sampling field crew and will update them of any changes to the estimate.

If potentially significant archaeological deposits are discovered during the investigation while the archaeological monitor is on site, the monitor will direct the contractor to cordon off the area within 30 feet of the discovery and initiate the find reporting and evaluation processes described in the Inadvertent Discovery Plan (**Appendix A**). If evidence of cultural resources is found in exposed surfaces within the Project area, it will be further investigated to establish whether it is eligible for listing in the NRHP.

If human remains are encountered, the King County Sherriff and Medical Examiner will be immediately notified (**Appendix A**). If the remains are determined not to be associated with a criminal investigation, the DAHP will be immediately contacted, as well as any affected tribes, if applicable (**Appendix A**).

4.1.1 PRE-SAMPLING TRAINING/TAILGATE MEETING

Prior to the initiation of field activities, the archaeological monitors will provide a pre-sampling training that includes the necessary information for core processing crews to understand and identify what cultural materials may be encountered.

4.1.2 PROJECT COMMUNICATION

The archaeological monitor will complete a monitoring log for each monitoring session to document time in the field, the day's progress and findings, any difficulties encountered, and actions proposed or taken to alleviate them. Weekly summary monitoring logs will be provided to all interested parties (DAHP, King County, EPA, and Anchor QEA) and affected tribes (Duwamish Tribe of Indians, Muckleshoot Indian Tribe, Snoqualmie Tribe, Tulalip Tribes of

Washington, and Suquamish Tribe) addressing field activities for the preceding week. Tribal representatives are welcome to contact the EPA and project staff in order to coordinate onsite visits during the course of the project. Affected tribes will be notified of the project schedule regularly.

4.1.3 Monitoring Report

Following the conclusion of archaeological monitoring activities, Stell will prepare a report describing the conduct and findings of this work effort. The report will include a discussion of the Project, the methods used in monitoring, and observations about site geology, environmental history, and any cultural resources that were observed. Photographs, sketches, or maps may be included, as needed. The report will be submitted to Anchor QEA and King County in complete draft form prior to it being sent to the LDWG, Washington State DAHP, EPA, and affected tribes.

4.1.4 Health and Safety

Anchor QEA has developed a site-specific Health and Safety Plan (HASP). The updated HASP is included as Attachment H within the Lower Duwamish Waterway Pre-Design Investigation – Quality Assurance Project Plan Addendum (Windward, Anchor QEA 2021). Stell archaeologists will review and comply with the HASP during archaeological monitoring activities. Field staff will have all necessary training and certification prior to commencing monitoring activities including Hazardous Waste Operations and Emergency Response (HAZWOPER) training.

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APPENDIX A
Inadvertent Discovery Plan

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Inadvertent Discovery Plan for the Lower Duwamish Waterway Upper Reach Remedial Design, Phase II Pre-Design Investigation King County, Washington

1 INTRODUCTION

Anchor QEA is leading a team of consultants in the remediation of contaminated sediment throughout the project APE along the upper reach of the Lower Duwamish Waterway in King County, Washington. The Phase II pre-design investigation includes sampling and chemical analyses of sediment samples, both in-water and on the banks, to refine the delineation of RAL exceedance areas that were preliminarily interpolated during the Phase I pre-design investigation. After review of documentation and discussions with LDWG's remedial design team, King County Historic Preservation Program determined that the Project requires an archaeological monitor to observe geotechnical and sediment sampling activities within specific areas of the APE.

The following Inadvertent DiscoveryPlan (IDP) outlines procedures to follow, in accordance with federal laws, if archaeological materials or human remains are discovered. This inadvertent discovery plan provides direction, contact information, and guidance for the proper procedures to follow should an inadvertent discovery occur during monitoring, as well as during times when an archaeologist is not present (i.e., in-water sampling activities).

As a federal undertaking, this Project is subject to the provisions of Section 106 of the National Historic Preservation Act of 1966, as amended (NHPA) and its implementing regulations, 36 Code of Federal Regulations (CFR) 800, regarding the protection of cultural and historic resources. Section106 of the NHPA requires that a federal agency take into account the effects of any undertaking on historic properties and afford the Advisory Council on Historic Preservation an opportunity tocomment on these actions.

State laws are in place which protect archaeological resources. The Archaeological Sites and Resources law (RCW Chapter 27.53) outlines the protection of archaeological resources. Anchor QEA will act in accordance with State and Federal laws in dealing with the treatment of cultural resources and the consultation with the Affected Indian Tribes (Duwamish Tribe, Muckleshoot Tribe, Snoqualmie Tribe, Tulalip Tribes, and Suquamish Tribe), the Department of Archaeology & Historic Preservation (DAHP), the Environmental Protection Agency (EPA), King County, and the Lower Duwamish Waterway Group (LDWG).

The monitoring archaeologist will have the ability to halt ground disturbing activities if they observe or identify any cultural materials and will have adequate time to assess, record, and potentially analyze any resources that might be uncovered. DAHP will be notified of all discoveries that occur during the course of the Project. The results of this monitoring effort will be documented at the completion of the project.

This document serves as the plan for dealing with any discoveries of human skeletal remains, artifacts, sites, or any other cultural resources that are potentially eligible for listing in the National Register of Historic Places (NRHP). This plan is intended to provide guidance to Anchor QEA, so they can:

1. Comply with applicable local, State and Federal laws and regulations, particularly Title

27 RevisedCodes of Washington Chapter 27.44 Indian Graves and Records, Chapter 27.53 Archaeological Sites and Resources, and Title 68 Chapter 60.050 Protection of historic graves,

2. Describe to regulatory and review agencies the procedures that Anchor QEA will follow to prepare for and deal with inadvertent discoveries, and
3. Provide direction and guidance to project personnel on the proper procedures to be followed should an inadvertent discovery occur.

2 RECOGNIZING CULTURAL MATERIALS

A cultural resource discovery could be from the precontact or historic eras. Prior to the initiation of field activities, the archaeological monitor will provide a pre-sampling training that includes the necessary information for core processing crews to understand and identify what cultural materials may be encountered.

Examples include:

- An accumulation of shell, burned rocks, or other food related materials;
- Bones or small pieces of bone;
- An area of charcoal or very dark stained soil with artifacts;
- Stone tools or waste flakes (i.e., an arrowhead, or stone chips);
- Clusters of tin cans or bottles, logging or agricultural equipment that appears to be olderthan 50 years;
- Buried railroad tracks, decking, or other industrial materials; and
- Historic structures, portions of historic structures, or associated utilities aged 50 years orolder.

When in doubt, assume the material is a cultural resource.

3 ON-SITE RESPONSIBILITIES

STEP 1: STOP WORK. If any Anchor QEA employee, contractor, or subcontractor believes that they have uncovered cultural materials (as defined above) at any point during the project, all work adjacent to the discovery must stop. The discovery location should be secured at all times.

STEP 2: NOTIFY MONITOR. If there is an archaeological monitor for the project, notify the monitor of the discovery. The monitor will follow the established monitoring plan. If there is no archaeological monitor present the Project Manager (Anchor QEA) should be notified, at which time they shouldcontact the monitor or a professional archaeologist to examine the find and determine if it is a cultural resource or not and provide significance recommendations.

STEP 3: NOTIFY AND CONSULT WITH EPA. Immediately contact EPA to assist in the significance evaluation of all inadvertent discoveries of cultural resources. Any discovery deemed eligible for listing in the National Register of Historic Places (NRHP) will be assessed and treated per the provisions set forth in this document. EPA, in consultation with DAHP, affected tribes, and King County will determine if the discovery is an eligible cultural resource and any appropriate steps to resolve adverse effects. The discovery will be documented as an archaeological site or isolate using a site form.

Mitigation measures will be developed in consultation with LDWG, EPA, DAHP, King County, and the affected tribes (where appropriate), which could include avoidance through relocating sampling locations, conducting data recovery and/or relocating materials or remains. Agreed upon treatment measuresmay include protecting in place or data recovery such as mapping, photography, limited probing, and sample collection, or other measures. This information is covered by the Public Records Act (RCW 42.17.250) and specific components of the records are exempt from disclosure (RCW 42.17.310(1)(k)) to avoid the looting or depredation of such sites.

4 PROTOCOL FOR TREATMENT OF HUMAN REMAINS

As per RCW 68.50.645, in the event that human remains, or material evidence of burial sites are encountered within the Project APE, whether during planned ground disturbing activities, authorized archaeological excavations, or as a result of natural processes, the followingprotocol will be strictly followed:

1. If human skeletal remains are located within the Project APE, then all activity that may cause further disturbance to the remains will cease within at least 30 feet.
2. The area of the find will be secured and protected from further disturbance. Work can continue elsewhere.
3. The finding of human skeletal remains will be reported to the King County Medical Examiner and local law enforcement in the most expeditious manner possible. The remains will not be touched, moved, or further disturbed.
4. The county medical examiner will assume jurisdiction over the human skeletal remains and make a determination of whether those remains are forensic or non-forensic. If the county medical examiner determines the remains are non-forensic, then they will report that finding to the Department of Archaeology and Historic Preservation (DAHP) who will then take jurisdiction over the remains. If they are forensic, the site may be treated as a crime scene.
5. The DAHP will notify any appropriate cemeteries and all affected tribes of the find.
6. The State Physical Anthropologist will make a determination of whether the remains are Indian or Non-Indian and report that finding to any appropriate cemeteries and the affected tribes.
7. The DAHP will then handle all consultation with the affected parties as to the future preservation, excavation, and disposition of the remains.
8. Work at the location of the human remains may proceed after law enforcement and/or DAHP give their permission.

Failure to follow this human remains protocol is a misdemeanor in Washington State.

5 PROTOCOL FOR RESPONSE TO VANDALISM

Vandalism consists of disturbance to historic properties, including unauthorized digging into archaeological sites or collection of artifacts. The probability for vandalism within the project is low; however, if at any time, employees or contractors encounter unauthorized visitors who appear to be digging or collecting materials from the ground surface, or are in possession of excavation equipment, or if an Anchor QEA representative encounters evidence of recent unauthorized excavations or abandoned digging equipment (such as screens or shovels), the following protocol will be implemented.

1. If a possible vandal or looter is present, the Anchor QEA representative will note information about the person, their equipment, and their vehicle and immediately relay the information to the work supervisor, who will confirm the information and notify the King County Sheriff's Office.
2. If the Anchor QEA representative notes abandoned excavations or digging equipment, they will notify the King County Sheriff's Office and the DAHP within 24 hours. The cultural resources coordinator will visit the site as soon as possible to assess any damage.
3. If a Native American site has been vandalized, the Anchor QEA representative will notify the potentially concerned parties including the Lower Duwamish Waterway Group (LDWG) and representatives of the affected tribes including the Duwamish Tribe, Muckleshoot Tribe, Snoqualmie Tribe, Tulalip Tribes, and Suquamish Tribe, as well as the Department of Archaeology & Historic Preservation (DAHP), the Environmental Protection Agency (EPA), King County, about this assessment and will invite them to attend the site inspection.
4. The assessment of impact will be described in a formal letter report from Anchor QEA to King County, affected tribes, and DAHP, if applicable.
5. In consultation with the King County, EPA, LDWG, affected tribes, and DAHP, Anchor QEA will identify what actions, if any, should be taken to mitigate damage to an affected site and/or prevent further damage.
6. Any act of vandalism or looting that involves human remains will also trigger the protocol for the treatment of human remains outlined above.
7. All acts of vandalism or looting will be referred to the King County Sheriff for investigation and possible prosecution.

6 PROTOCOL FOR EMERGENCY RESPONSE

A number of events can occur within the Project that require a rapid response in order to safeguard facilities, provide for protection of wildlife habitat, protect public and private property, and prevent serious injury or loss of human life. These include, but are not limited to; wildfire, wind and electrical storms, mass wasting events (erosion), flood, earthquake, and dam or other Project facility failure. The emergency response protocol is designed to be implemented after such eventshave occurred.

1. The LDWG will notify the Anchor QEA representative of the location and nature of the emergency activities.
2. The Anchor QEA representative will check relevant databases for historic properties in the vicinity of the emergency.
3. If historic properties are in the area of the emergency or the response (for example, both the area of the wildfire and the location of the construction of a fire line), then the Anchor QEA representative be responsible for conducting a professional review by aqualified person of the condition of those properties.
4. The Anchor QEA representative will use existing documentation as a comparison to a field visit to determine if historic properties and/or cultural resources have been destroyed,damaged, or endangered by the emergency event or the response. If any of these conditionsexist, then the Anchor QEA representative will document them in the field with mapping,photographs, and, in the case of imminent loss, collection of artifacts. The Anchor QEA representative will prepare a report documenting the nature and location of the emergency event, the nature of the response, the impact on the historic properties and/or cultural resources, and any proposals to prevent further damage to the properties and to mitigate for the loss. This report will be submitted to King County for review and comment. After a 30-day comment period, the comments of all of the consulting parties will be incorporated into a final report and copies will be sent to all of the participating parties.
5. If no alteration to the condition of the properties has occurred, a letter to that effect notingthe date(s) of the field visit(s) will be placed on file in lieu of the formal report.

7 AGENCY CONTACTS

Anchor QEA, LLC
Primary Contact: Tom Wang
Mobile: 206-465-0900

Stell, Cultural Resource Consultant
Primary Contact: Sarah Steinkraus, Principal Investigator/ Senior Archaeologist
Mobile: 360-620-5840

Environmental Protection Agency
Primary Contact: Elly Hale
Office: 206-553-1215

King County Historic Preservation Program Archaeologist
Primary Contact: Philippe D. LeTourneau
Contact Number: 206-477-4529

King County Medical Examiner

Contact Number: 206-731-3232

King County Sheriff

Contact Number: 206-296-3311 or 911

City of Seattle Police Department

Contact Number: 206-625-5011

City of Tukwila Police Department

Contact Number: 206 433-1808

Department of Archaeology & Historic Preservation Office
Primary Contact: Rob Whitlam, State Archaeologist
Office: 360-890-2615
Secondary Contact: Dr. Guy Tasa, State Physical Anthropologist
Office: 360-586-3534

Tribal Contacts:

Duwamish Tribe
Primary Contact: Cecile Hansen, Chairwoman
Office: 206-431-1582

Suquamish Tribe
Primary Contact: Dennis Lewarch, Tribal Historic Preservation Officer
Office: 360-394-8529

Muckleshoot Indian Tribe
Primary Contact: Laura Murphy, Archaeologist
*Offi*ce: 253-876-3272

Contact: Warren King George
Email: warren.kinggeorge@muckleshoot.nsn.us

Tulalip Tribes
Primary Contact: Richard Young, Cultural Resources
Office: 360-716-2652

Contact: Gene Enick
Email: genick@tulaliptribes-nsn.gov

Snoqualmie Tribe
Primary Contact: Steven Mullen-Moses, Director of Archaeology and Historic Preservation
Office: 425-495-6097

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APPENDIX B:
Detailed Sampling Location Maps

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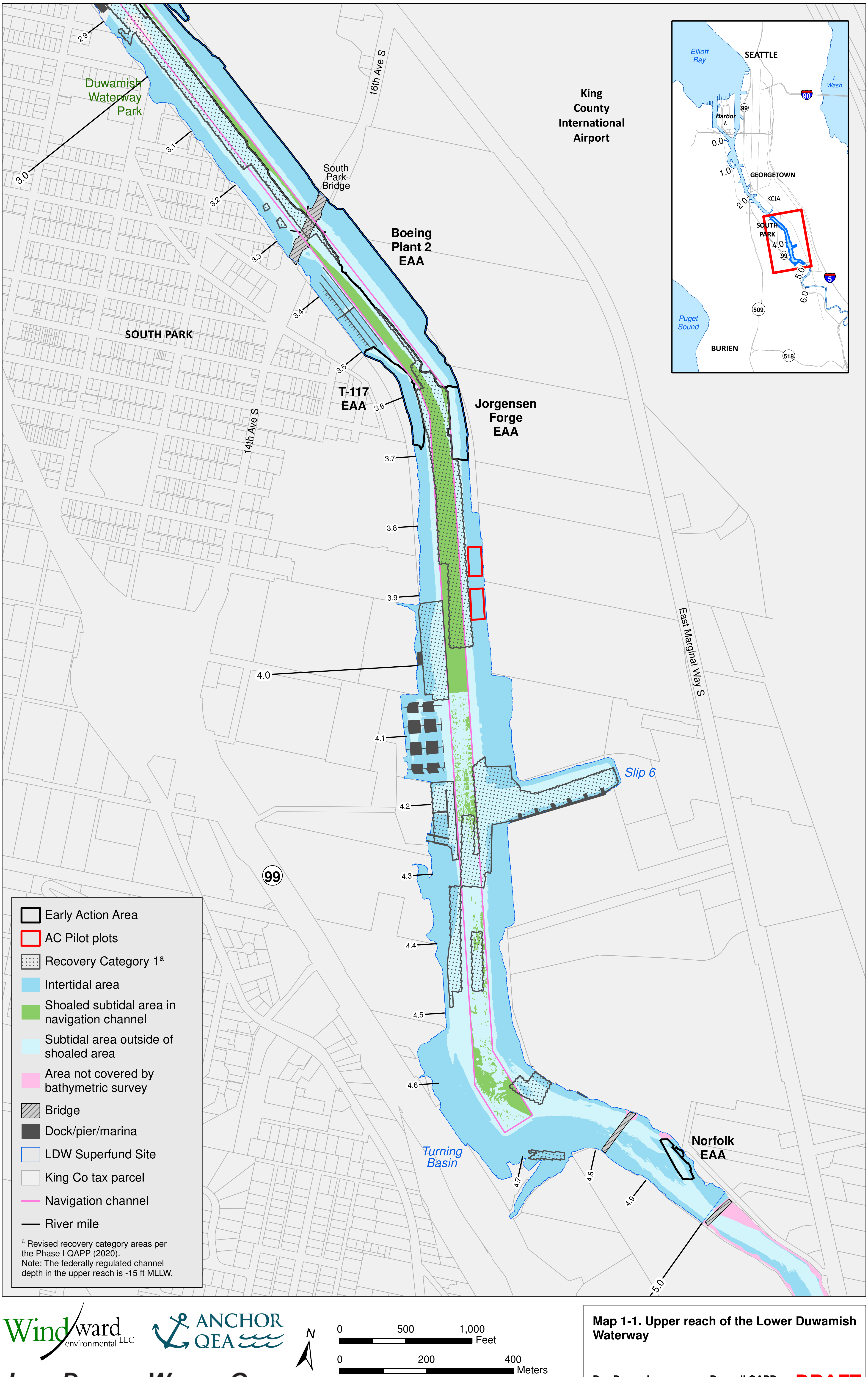

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Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

Map 1-1. Upper reach of the Lower Duwamish Waterway

PRE-DESIGN INVESTIGATION PHASE II QAPP ADDENDUM FOR THE LDW UPPER REACH

DRAFT

Prepared by craigh, 5/5/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II QAPP Addendum\Map 1-1 7059 Upper Reach.mxd

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ANCHOR QEA

Lower Duwamish Waterway Group

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

Map 5-1a. Area of potential surveying and bank sampling/investigation at RAL Exceedance Area 12

PRE-DESIGN INVESTIGATION PHASE II QAPP ADDENDUM FOR THE LDW UPPER REACH

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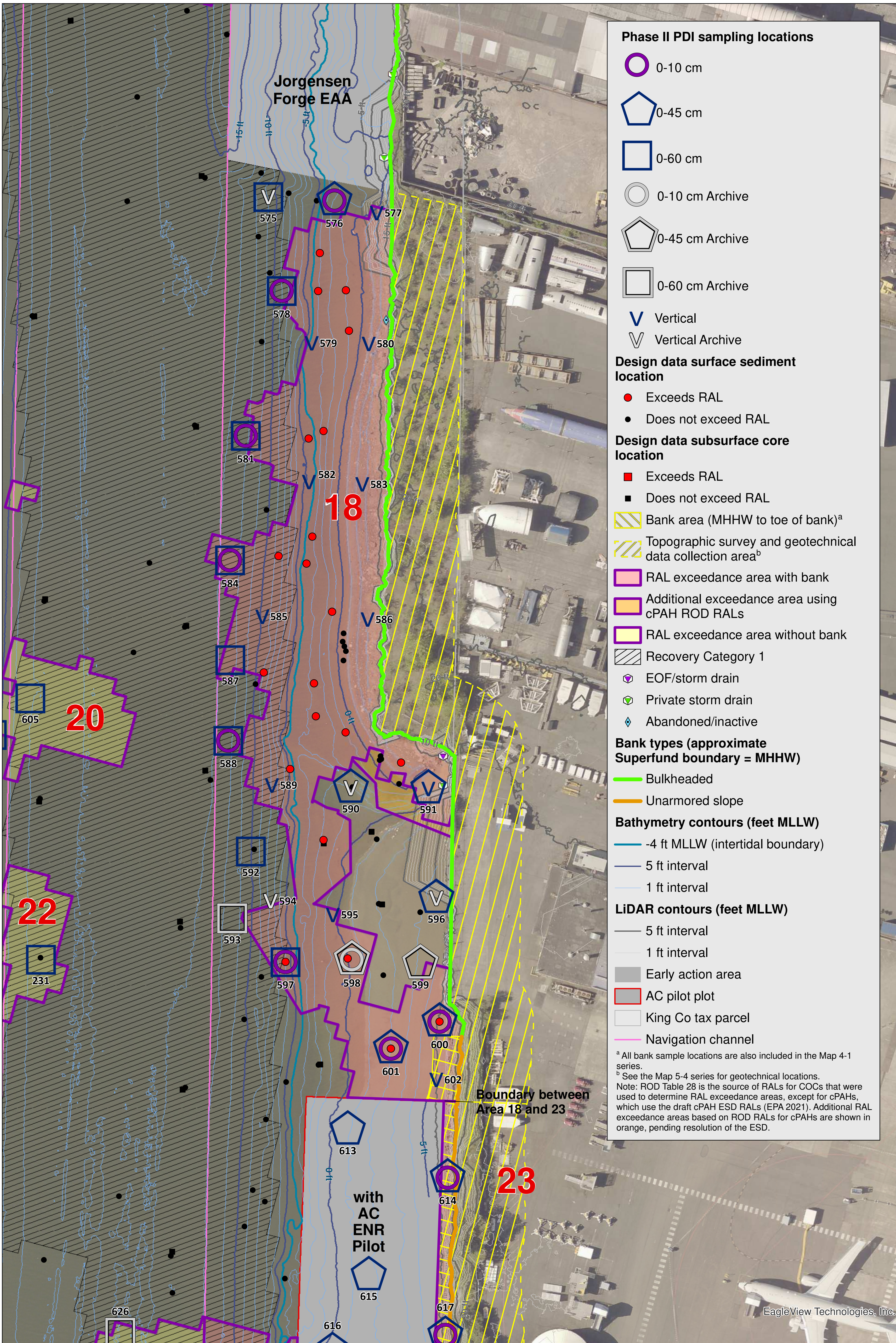
Prepared by craigh, 5/17/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II QAPP Addendum\Map 5-1a 7266 Banks - 12.mxd



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N

0 50 100 Feet

0 10 20 Meters

Map 5-1b. Area of potential surveying and bank sampling/investigation at RAL Exceedance Area 18

PRE-DESIGN INVESTIGATION PHASE II QAPP ADDENDUM FOR THE LDW UPPER REACH

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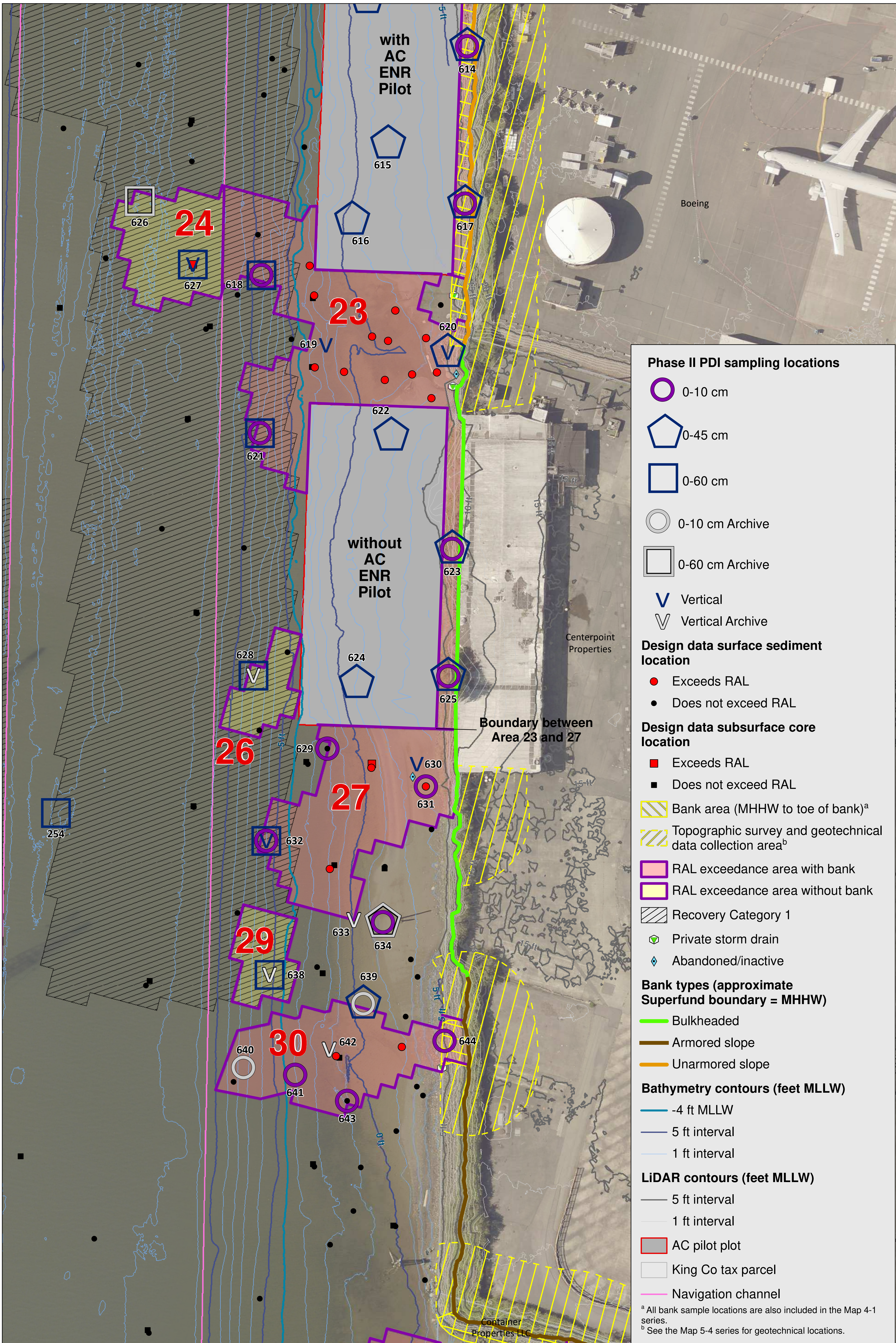
Prepared by craigh, 5/17/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II QAPP Addendum\Map 5-1b 7266 Banks - 18.mxd



Windward environmental LLC

ANCHOR QEA

N

0 50 100 Feet

0 10 20 Meters

Map 5-1c. Area of potential surveying and bank sampling/investigation at RAL Exceedance Areas 23, 27, and 30

PRE-DESIGN INVESTIGATION PHASE II QAPP ADDENDUM FOR THE LDW UPPER REACH

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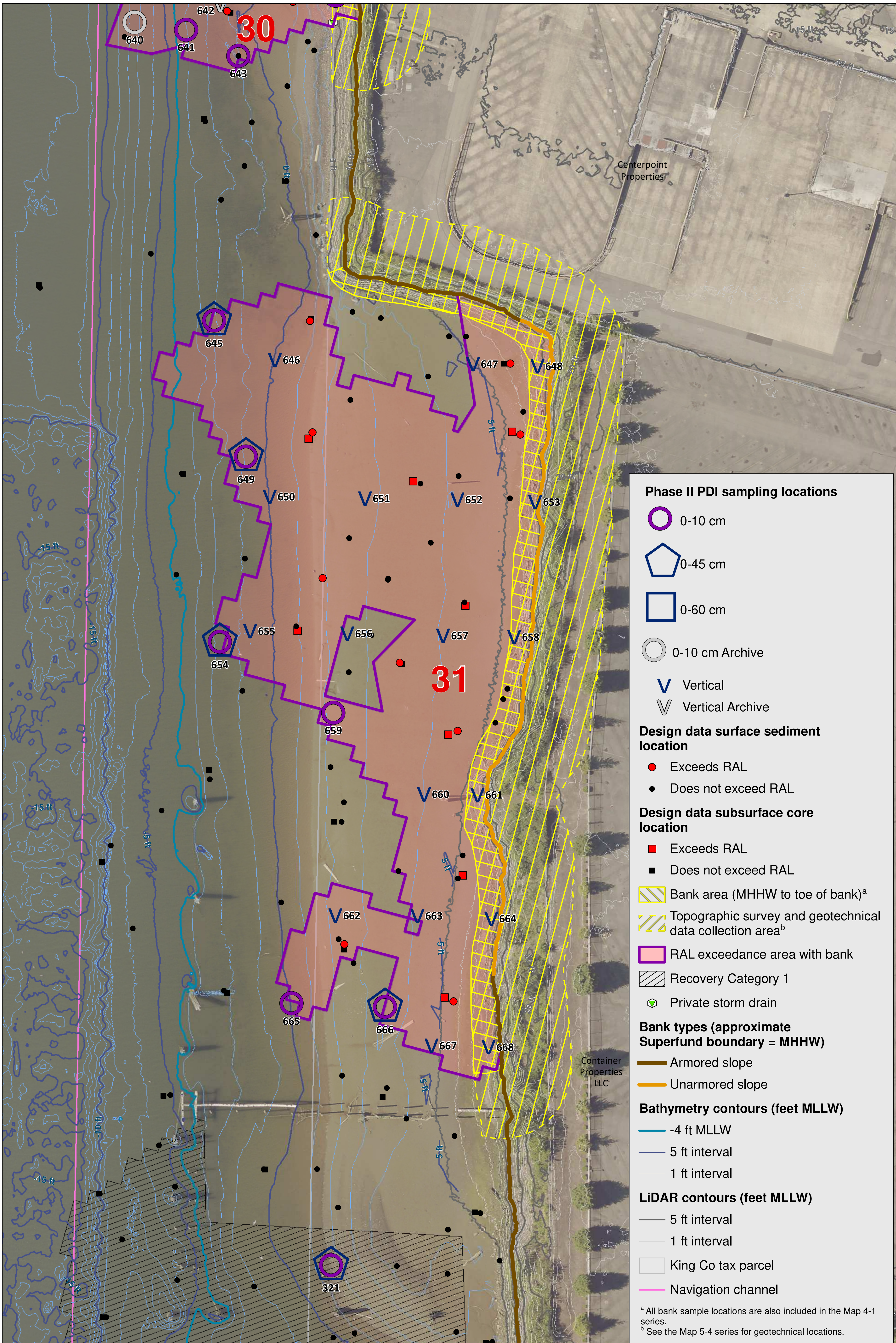

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0 50 100 Feet

0 10 20 Meters

Map 5-1d. Area of potential surveying and bank sampling/investigation at RAL Exceedance Area 31

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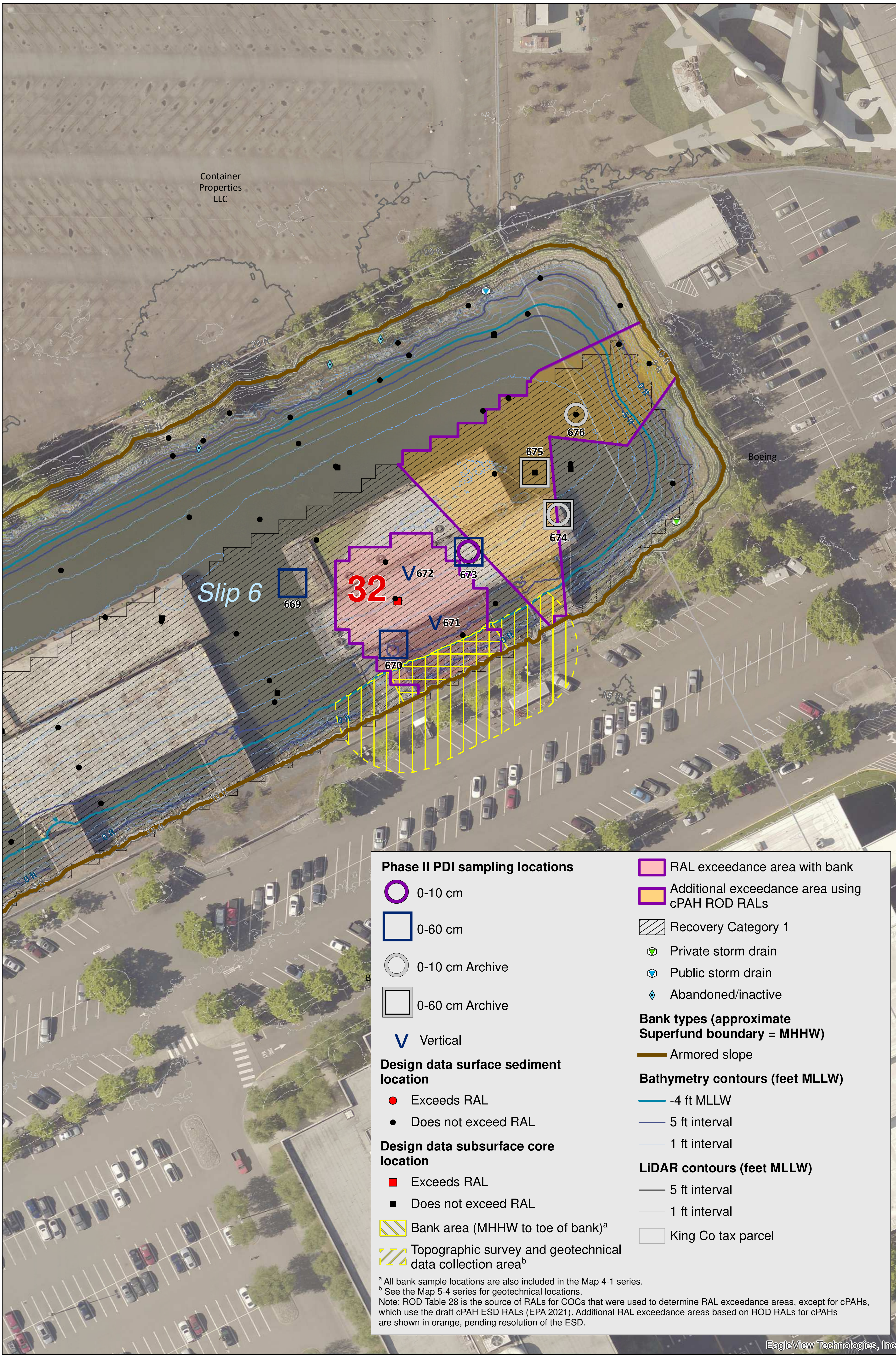

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N

0 50 100 Feet

0 10 20 Meters

Map 5-1e. Area of potential surveying and bank sampling/investigation at RAL Exceedance Area 32

Pre-Design Investigation Phase II QAPP Addendum for the LDW Upper Reach

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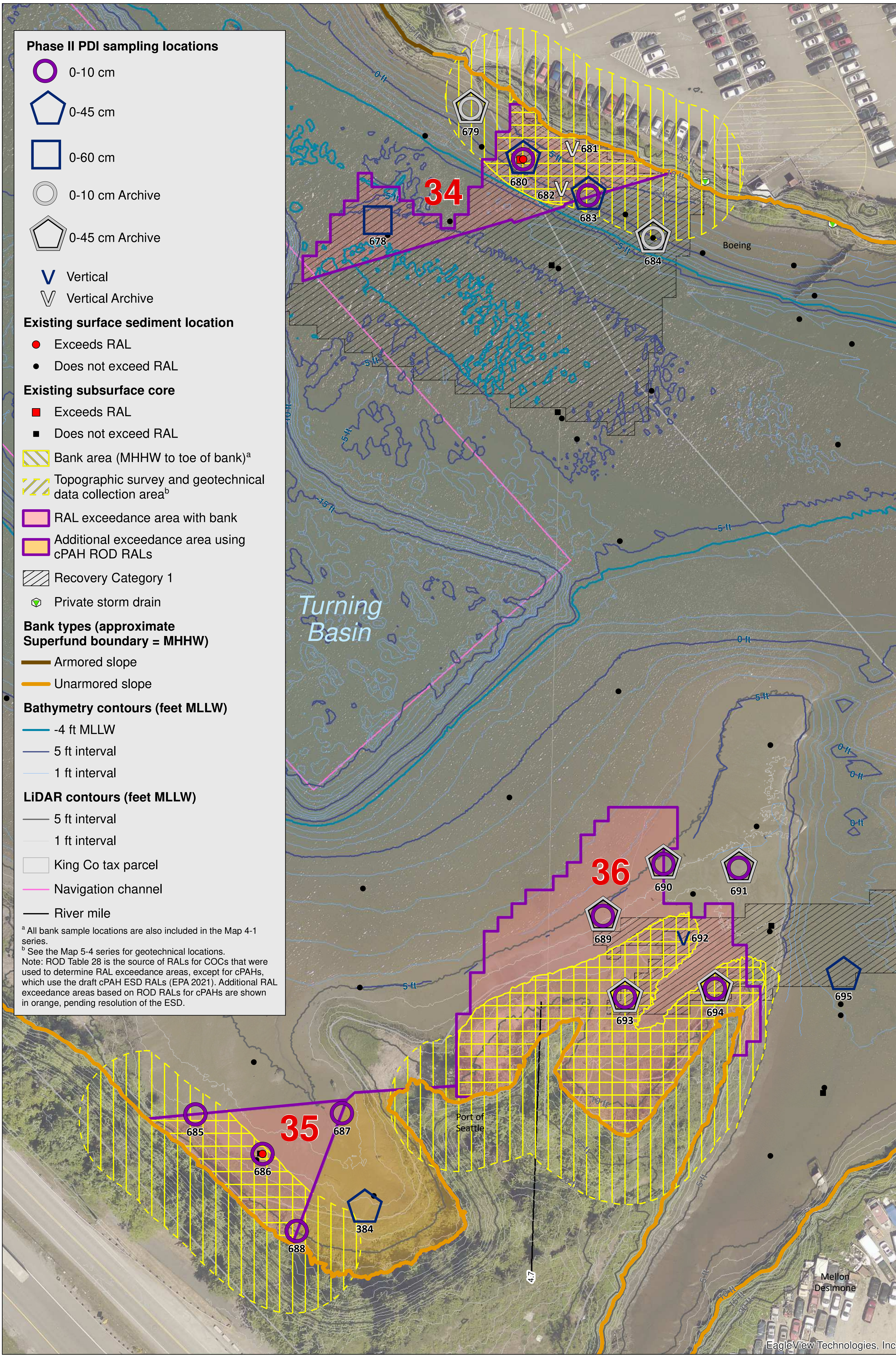
Prepared by: craigh, 5/17/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II QAPP Addendum\Map 5-1e 7266 Banks - 32.mxd



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N

0 50 100 Feet

0 10 20 Meters

Map 5-1f. Area of potential surveying and bank sampling/investigation at RAL Exceedance Areas 34, 35, and 36

Pre-Design Investigation Phase II QAPP Addendum for the LDW Upper Reach

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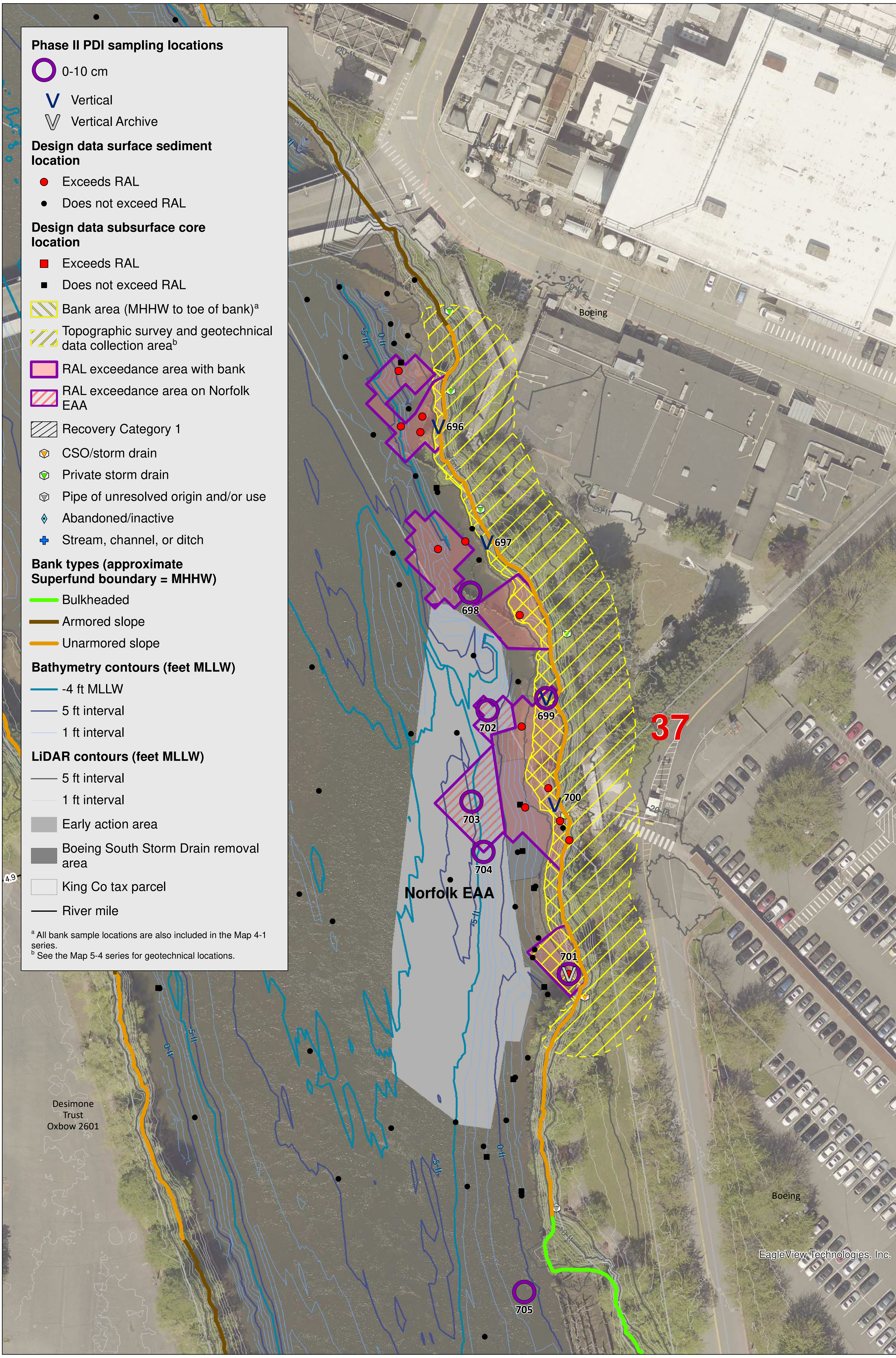
Prepared by craigh, 5/17/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II QAPP Addendum\Map 5-1f 7266 Banks - 34-35-36.mxd



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0 50 100 Feet

0 10 20 Meters

Map 5-1g. Area of potential surveying and bank sampling/investigation at RAL Exceedance Area 37

PRE-DESIGN INVESTIGATION PHASE II QAPP ADDENDUM FOR THE LDW UPPER REACH

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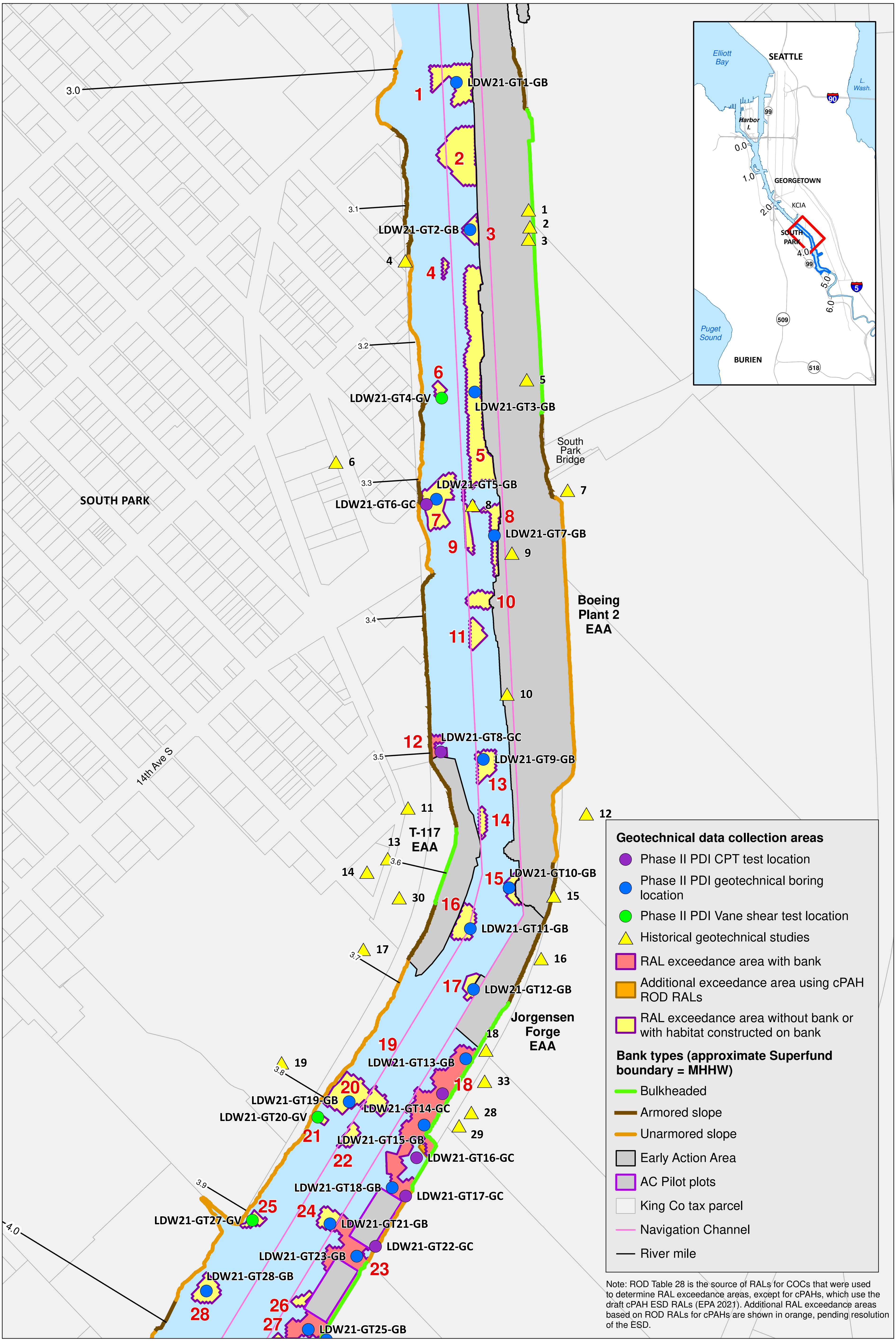
Prepared by craigh, 5/17/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II\QAPP Addendum\Map 5-1g 7266 Banks - 37.mxd



Windward environmental LLC

ANCHOR QEA

N

0 250 500 Feet

0 100 200 Meters

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Map 5-4a. Phase II Geotechnical data collection areas, RM 3.0 to RM 4.0

PRE-DESIGN INVESTIGATION PHASE II QAPP ADDENDUM FOR THE LDW UPPER REACH

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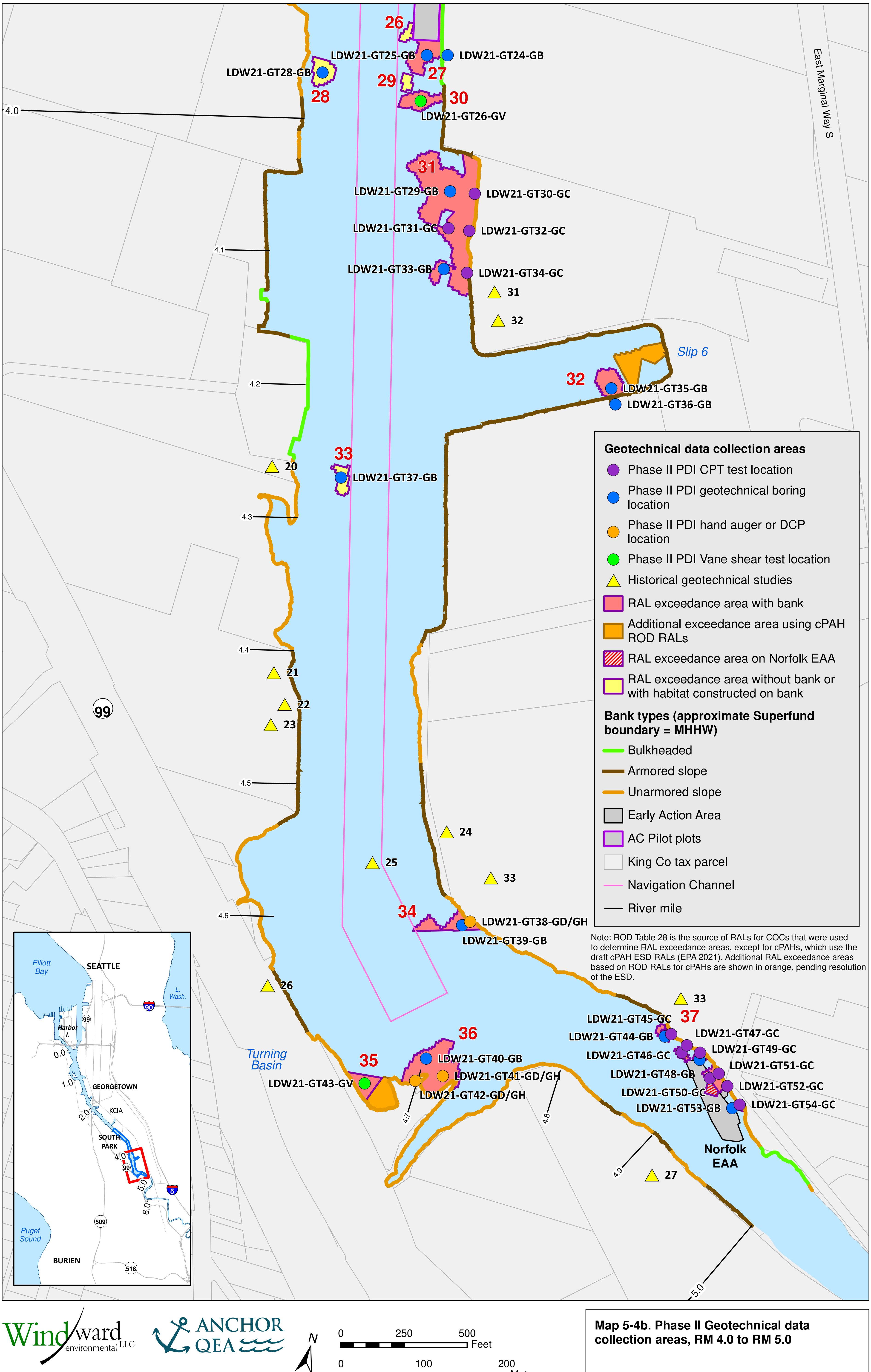
Prepared by craigh, 5/17/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II\QAPP Addendum\Map 5-4a 7281 Geotech locations RM3-4.mxd



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Map 5-4b. Phase II Geotechnical data collection areas, RM 4.0 to RM 5.0

PRE-DESIGN INVESTIGATION PHASE II QAPP ADDENDUM FOR THE LDW UPPER REACH

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Prepared by craigh, 5/17/21; W:\Projects\Duwamish AOC4\GIS\Maps and Analyses\Phase II QAPP Addendum\Map 5-4b 7281 Geotech locations RM4-5.mxd

FINAL

Attachment H
Updated Health and Safety Plan

FINAL

Lower Duwamish Waterway Group

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

LOWER DUWAMISH WATERWAY PRE-DESIGN INVESTIGATION - QUALITY ASSURANCE PROJECT PLAN: ATTACHMENT H: HEALTH AND SAFETY PLAN

FINAL

Prepared for

Lower Duwamish Waterway Group

For submittal to

US Environmental Protection Agency

June 2021

Prepared by:

Windward environmental LLC

200 West Mercer Street • Suite 401
Seattle, Washington • 98119

in association with

ANCHOR QEA

1201 3rd Avenue • Suite 2600
Seattle, Washington • 98101

FINAL

Title and Approval Page: LDW Pre-Design Investigation Health and Safety Plan

By their signature, the undersigned certify that this health and safety plan 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

June 22, 2021
Date

Tom Wang
Anchor QEA Project Manager

June 22, 2021
Date

Kathy Godtfredsen
Windward Project Manager

June 22, 2021
Date

David Templeton
Corporate Health and Safety Manager

June 22, 2021
Date

Thai Do
Windward Field Coordinator/Health and Safety Officer

Matt Woltman

June 22, 2021
Date

Matt Woltman
Anchor QEA Field Coordinator/Health and Safety Officer

HEALTH AND SAFETY PLAN ACKNOWLEDGEMENT FORM

Project Number: 180067-02.02

Project Name: Lower Duwamish Waterway Upper Reach Remedial Design

My signature below certifies that I have read and understand the policies and procedures specified in this Health and Safety Plan (HSP). For non-Anchor QEA and Windward employees, this HSP may include company-specific appendices to this plan developed by entities other than Anchor QEA and Windward. A copy of this HSP must be always maintained, kept on-site, and available for employee review.

Date	Name (print)	Signature	Company

Site Emergency Procedures

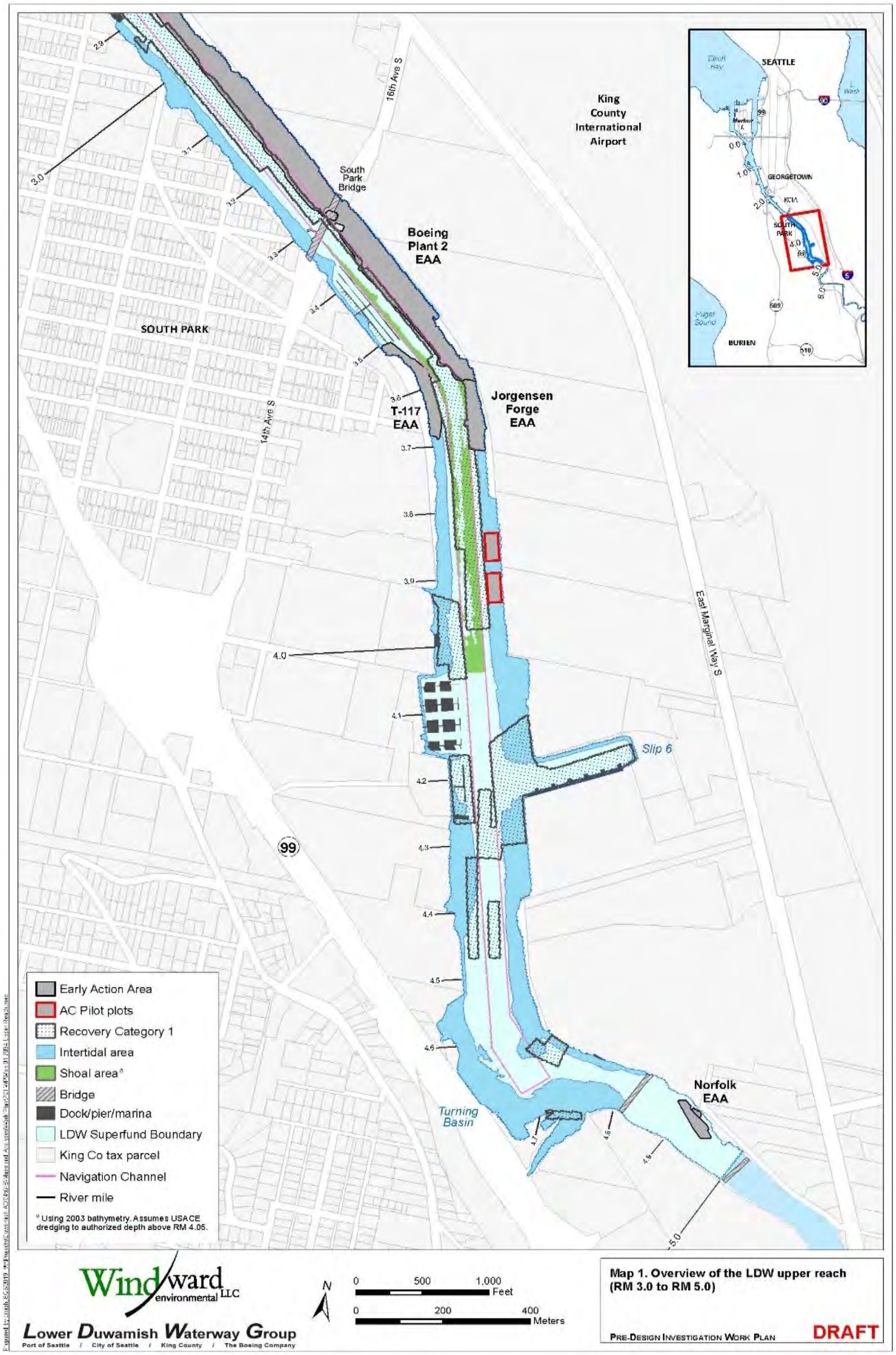

Figure H-i. General site location overview

Emergency Contact Information

Table H-i. Site emergency form and emergency phone numbers

Category	Information	
Possible Chemicals of Concern	Metals, PCBs, PAHs, dioxin/furans, hydrogen sulfide	
Minimum Level of Protection	Modified Level D PPE	
Site(s) Location Address	Lower Duwamish Waterway, Seattle, Washington	
Emergency Phone Numbers		
Ambulance	911	
Fire	911	
Police	911	
Poison Control	(800) 222-1222	
PM	Tom Wang	Office: (206) 903-3314 Cell: (206) 465-0900
Windward FC/H&S Coordinator	Thai Do	Office: (206) 812-5407 Cell: to be provided
Anchor QEA FC/H&S Coordinator	Matt Woltman	Office: (206) 903-3327 Cell: to be provided
Anchor QEA CHSM	David Templeton	Office: (206) 287-9130 Cell: (206) 910-4279
Anchor Health and Safety Program Lead	Tim Shaner	Office: (251) 375-5282 Cell: (251) 281-3386
USCG	Emergency: (206) 286-5400 General Information: (206) 442-5295 VHF Channel 16	
Ecology NW Region Spill Response (24-hr emergency line)	(206) 649-7000	

In the event of any emergency, contact the PM and FC.
For local resources, please visit: http://www2.epa.gov/emergency-response/emergency-response-my-community. The National Response Center hotline is 1-800-424-8802.

CHSM – Corporate Health and Safety Manager
Ecology – Washington State Department of Ecology
FC – field coordinator
PCB – polychlorinated biphenyls
PAH – polycyclic aromatic hydrocarbons
PM – project manager
PPE – personal protective equipment
USCG – US Coast Guard

Table H-ii. Hospital information

Category	Information
Hospital Name	Harborview Medical Center
Address	325 9th Avenue
City, Province	Seattle, Washington 98104
Phone	(206) 323-3074
Emergency Phone	911

HOSPITAL ROUTE MAP AND DRIVING DIRECTIONS

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 Avenue
Seattle, WA
206.323.3074

Directions from the vicinity of the LDW to Harborview Medical Center are as follows (Figure H-ii):

From the Duwamish River boat ramp (at South River Street, beneath the 1st Avenue South bridge):

- Drive east on South River Street.
- Turn left on Occidental Avenue South.
- Turn left on East Marginal Way South.
- Turn right on South Michigan Street.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

From the Harbor Island Marina (1001 Southwest Klickitat Way):

- From marina parking lot, turn sharp right onto Klickitat Way Southwest.
- Turn slight right onto Southwest Spokane Street
- Turn slight left to take the ramp toward WA-99 N/I-5/Columbian Way.
- Keep left at the fork in the ramp.
- Stay straight to go onto West Seattle Bridge.
- Merge onto I-5 North via the ramp on the left.
- Take the James Street exit.
- Head east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

From South Park Marina (8604 Dallas Ave South):

- From marina parking lot, turn right onto Dallas Avenue South.
- Turn right onto 16th Avenue South.
- Turn left on East Marginal Way South.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

Phase II investigation work will also require work from the upland bank areas. Directions from the vicinity of the LDW to Harborview Medical Center at upland investigation areas are as follows:

When performing investigation activities on the **west bank:**

- From upland work area, proceed north on West Marginal Way South.
- Merge onto Highway 509 north.
- Exit right on South Michigan Street.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

When performing investigation activities on the **east bank**:

- From upland work area, proceed north on East Marginal Way South.
- Turn right on South Michigan Street.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

Figure H-ii. Hospital route map

PERSONAL INCIDENT RESPONSE PROCEDURES

In the event of an emergency, immediate action must be taken by the first person to recognize the event. Use the following steps as a guideline and refer to Figure H-iii:

- Survey the situation to verify that it is safe for you and the victim. Do not endanger your own life. Do not enter an area to rescue someone who has been overcome unless properly equipped and trained. Verify that all protocols are followed.
- Call the appropriate emergency number (911, if available) or direct someone else to do this immediately (see Table H-i). Explain the physical injury, chemical exposure, fire, or release and location of the incident.
- Have someone retrieve the nearest first aid kit (containing appropriate items for the particular work scope) and Automated External Defibrillator (AED), if available. Note: Only use an AED if you have been properly trained and are currently certified to do so.
- Decontaminate the victim without delaying life-saving procedures.
- Administer first aid and cardiopulmonary resuscitation (CPR), if properly trained, until emergency responders arrive.
- In the event that evacuation is required, the FL must perform a head count to verify that all Anchor QEA and Windward personnel are accounted for.
- Notify the Field Coordinator (FC) and Project Manager (PM); the PM will notify the client contact. The PM will also contact the Corporate Health and Safety Manager (CHSM). The CHSM will facilitate the incident investigation. All client requirements pertinent to personal incident reporting will also be adhered to.
- Complete the appropriate incident investigation reports.

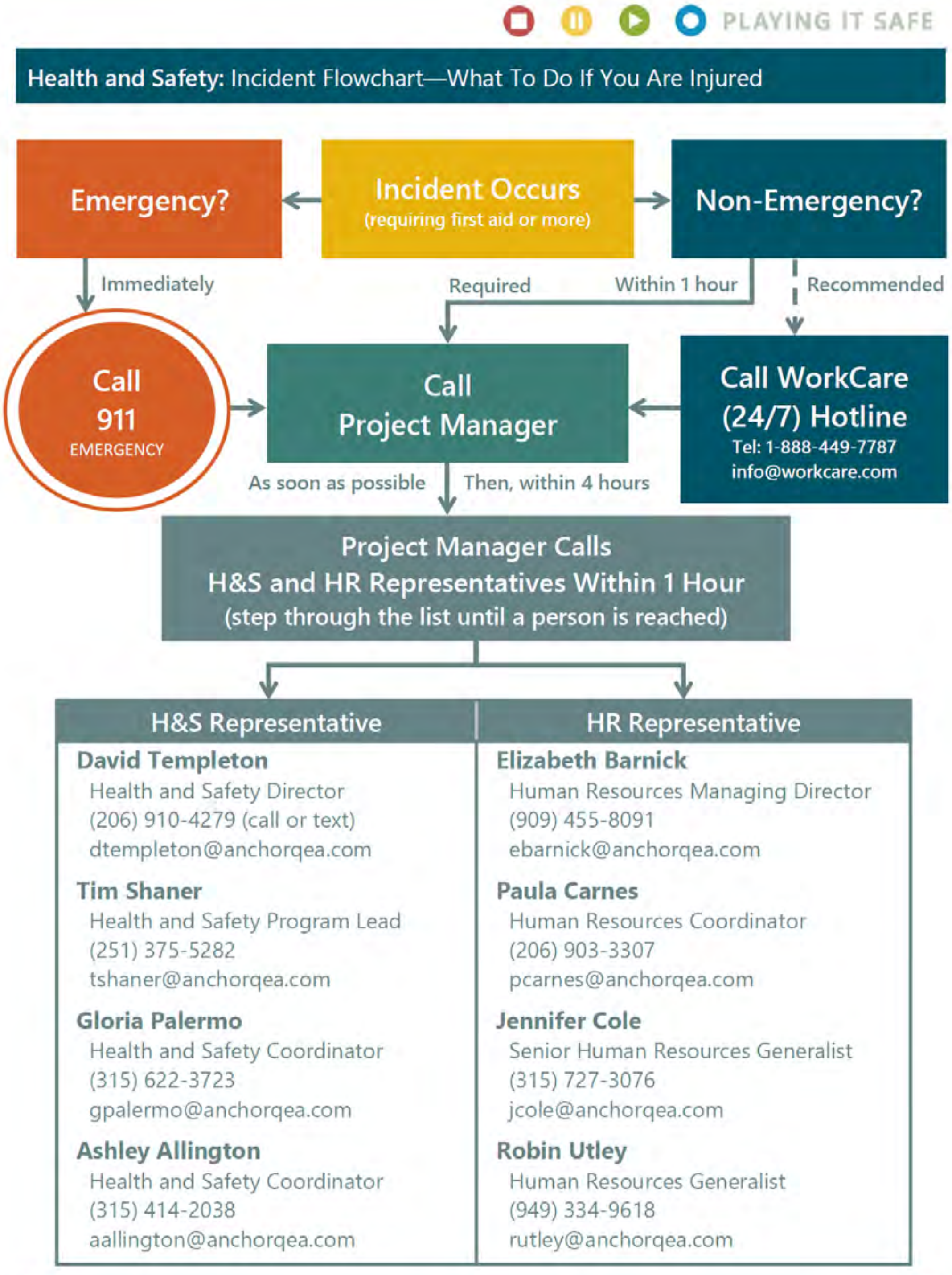

Figure H-iii. Incident flowchart

Non-Personal Incident Response Procedures

All incidents including, but not limited to, fire, explosion, property damage, or environmental release will be responded to in accordance with the site-specific HSP. In general, this includes securing the site appropriate to the incident, turning control over to the emergency responders, or securing the site and summoning appropriate remedial personnel or equipment. Anchor QEA will immediately notify the client of any major incident, fire, equipment or property damage, or environmental incident with a preliminary report. A full report will be provided within 72 hours.

Spills and Releases of Hazardous Materials

- When required, notify the National Response Center Hotline (800-424-8802) and the US Coast Guard (USCG) (206-286-5400; VHF Channel 16). The following information should be provided: Name and telephone number
- Name and address of incident location
- Time and type of incident
- Name and quantity of materials involved, if known
- Extent of injuries
- Possible hazards to human health or the environment outside of the facility

If hazardous waste is released or produced through control of the incident, verify the following:

- Waste is collected and contained
- Containers of waste are removed or isolated from the immediate site of the emergency
- Treatment or storage of the recovered waste, contaminated soil or surface water, or any other material that results from the incident or its control is provided
- No waste that is incompatible with released material is treated or stored in the facility until cleanup procedures are completed

Verify that all emergency equipment used is decontaminated, recharged, and fit for its intended use before operations are resumed.

Near-miss Reporting

All near-miss incidents (i.e., those that could have reasonably led to an injury, environmental release, or other incident) must be reported to the FL and PM immediately, so action can be taken to verify that such conditions that led to the near-miss incident are readily corrected to prevent future occurrences.

Table of Contents

Tables

Figures

Exhibits

Acronyms

CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CHSM	corporate health and safety manager
COVID-19	coronavirus disease 2019
CPR	cardiopulmonary resuscitation
EPA	US Environmental Protection Agency
FC	field coordinator
HSO	health and safety officer
HSP	health and safety plan
JSA	job safety analysis
LDW	Lower Duwamish Waterway
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PFD	personal flotation device
PM	project manager
PPE	personal protective equipment
QAPP	quality assurance project plan
SVOC	Semivolatile organic compound
TCDD	tetrachlorodibenzo-*p*-dioxin
USCG	US Coast Guard
WAC	Washington Administrative Code
Windward	Windward Environmental LLC

1 Introduction

This site-specific health and safety plan (HSP) describes safe working practices for conducting field activities at potentially hazardous sites and for handling potentially hazardous materials/waste products. This HSP covers elements specified in 29 Code of Federal Regulations (CFR) 1910§120 and the Washington Administrative Code (WAC) Chapter 296-843. The procedures and guidelines contained herein are based on generally recognized health and safety practices. Any changes or revisions to this HSP will be made by a written amendment that will become a permanent part of this document. The goal of this HSP is to establish procedures for safe working practices for all field personnel and visitors.

This HSP addresses all field activities associated with the pre-design sampling in the upper reach of the Lower Duwamish Waterway (LDW). During site work, this HSP is to be implemented by the field coordinator (FC), who is also the designated site health and safety officer (HSO), in cooperation with the Anchor QEA, LLC (Anchor QEA) health and safety manager (HSM) and the Anchor QEA and Windward Environmental, LLC (Windward) project managers (PMs). All personnel involved in fieldwork on this project are required to comply with this HSP. The contents of this HSP reflect anticipation of the types of activities to be performed, knowledge of the physical characteristics of the site, and consideration of preliminary chemical data from previous investigations at the site. This HSP may be revised based on new information and/or changed conditions during site activities. Revisions will be documented in the project records.

This HSP 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 FC using the modification to HSP form included as Exhibit 1. Modifications will be reviewed by the HSM or authorized representative and approved by the PM.

2 Site Description and Project Scope

2.1 Site Description

The sampling area is in the upper reach of the LDW (see Figure H-i). The QAPP to which this HSP is appended provides complete details of the sampling program. This section summarizes the types of work that will be performed during field activities.

2.2 Scope of Work

Design sampling will be conducted in phases. Phase I will focus on defining the extent of sediment remedial action level (RAL) exceedances in sediment in order to identify initial remedial action areas and make initial technology assignments. Phase II will consist of the collection of data for potential additional RAL delineation, for assessment of vertical contamination in dredging/capping areas, and for obtaining area-specific information needed for design. Phase III will be conducted if data gaps remain after Phase II. Specific activities included in the QAPP are as follows:

- Collection of sediment samples from a boat using a pneumatic grab sampler
- Collection of sediment core samples from a boat using a vibracorer
- Collection of sediment samples in under pier areas (if feasible)
- Collection of sediment samples from intertidal areas using a shovel or hand corer
- Collection of soil samples from bank areas using pneumatic grab sampler, vibracorer, or shovel or hand corer (dependent on bank location and elevation)
- Sample handling, processing, and shipping
- Collection of geotechnical data from a barge using a hollow-stem auger drilling rig or cone penetrometer sampling rig
- Collection of geotechnical data from land using a hand auger or sampling rig
- Visual inspection of banks from a vessel or from walking the shoreline in a subset of the areas
- Inspection of structures (via observations from a vessel or shoreline access), verification of utility locations, and assessment of thickness of sediment on top of riprap layers (via hand digging or use of jet probes)

Additional details on sampling design and methods are provided in Sections 4 and 5 of the QAPP.

3 Health and Safety Personnel

Key health and safety personnel and their responsibilities are described below. These individuals are responsible for the implementation of this HSP; they will be responsible for informing all individuals who are assigned to work on the site, or who visit the site, of the contents of this plan, and for ensuring that each person signs the Health and Safety Plan Acknowledgment Form (see front matter). By signing the Health and Safety Plan Acknowledgment Form, individuals recognize the site health and safety hazards, known or suspected, and agree to adhere to the protocols required to minimize exposure to such hazards.

Project Managers: The Anchor QEA PM will have 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. In consultation with the CHSM, the PM will make final decisions concerning implementation of the HSP and resolution of site health and safety issues. The PM will report directly to LDWG. The Windward PM will ensure proper implementation of the QAPP.

Field Coordinator/Health and Safety Officer: The FC/HSO will direct field sampling 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 FC/HSO will implement this HSP 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 FC/HSO will also have stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation. The FC/HSO or their designee will be present during sampling and operations.

Corporate Health and Safety Manager and Health and Safety Program Lead: The CHSM and HSPL will have overall responsibility for preparation, approval, and revisions of this HSP. The CHSM and 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 and comply with the information in this HSP. They will also have the responsibility to report any potentially unsafe or hazardous conditions to the FC/HSO immediately. All field crew members will also have stop-work authority, to be used if there is an imminent safety hazard or potentially dangerous situation.

Site Visitors: Authorized visitors may come to the site to observe the sample collection/inspection activities. Visitors may be from the city, state, and federal regulatory and resource agencies that have a specific interest in the project, or visitors may be invited by the client, site contractors, or regulatory agencies. Visitors will be briefed on the hazards of the site, contents of the site-specific HSP, site safety rules, hazard control measures, and required personal protective equipment (PPE). They will be escorted at all times by the field coordinator or a designated representative when entering work areas to observe the operations. Visitors will be expected to comply with all of the site health and safety requirements.

4 Hazard Evaluation and Control Measures

This section covers potential physical, biological (i.e., viral), and chemical hazards that may be associated with the proposed project activities, and presents control measures for addressing these hazards. An activity hazard analysis table, summarizing the potential hazards associated with each site activity and the recommended site controls for minimizing each potential hazard is presented in Section 4.4.

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

4.1 Physical Hazards

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

4.1.1 Slips, trips, and falls

As with all field work, caution should be exercised to prevent slips on slick surfaces. In particular, sampling from a boat or other floating platform requires careful attention to minimize the risk of falling down or overboard. Extra care should be used in rainy conditions or on the shoreline where slick rocks or debris can be found. Slips can 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, in a cluttered work area, or in the intertidal zone where uneven substrate is common. 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, open hatches may present a fall hazard, so hatches will remain closed when not being accessed for storage. Personnel should be aware of the area around any open hatches and use extra caution when accessing them.

4.1.2 Sediment sampling and geotechnical equipment deployment

A pneumatic grab sampler deployed from a sampling vessel will be used to collect surface sediment samples and a vibracorer deployed from a sampling vessel will be used to collect subsurface sediment cores. These sampling devices and the mechanical equipment used to deploy the devices, such as motorized winches, may have rotating and reciprocating parts that if left unguarded, could pose hazards.

A pneumatic grab sampler, vibracorer, shovel, or hand corer will be used for the collection of soil samples from bank areas. This equipment can pose hazards if not properly guarded or utilized appropriately.

A drill rig from a barge or on land will be utilized for geotechnical work. The rotation of the drill rig components can pose a hazard to personnel. These components should be guarded or personnel otherwise suitably protected from the hazard. Additionally, care should be taken to identify any underground utilities that may be in the area.

Before sampling activities or geotechnical work begins, there will be a training session for all field personnel to identify the potential hazards of the equipment and deployment devices utilized used for sediment sampling or geotechnical work. To control these hazards, work areas will be inspected to identify any potential pinch, grab, crush, and struck-by hazards. All field personnel will use caution and be aware of overhead and gear hazards such as the grab sampler, vibracorer, A-frame, or drill rig.

All field personnel will wear a hard hat and modified Level D PPE when working around equipment. Corrective actions may involve installing guards over exposed, rotating parts; isolating or de-energizing equipment; establishing exclusion zones around high-hazard areas; and constructing guardrails around mechanical equipment to prevent inadvertent contact. Until such time as these hazards can be controlled or eliminated, project team members will avoid working in any areas where the hazard exists.

4.1.3 Falling overboard

Most sampling activities will be conducted from a boat. As with any work from a floating platform, there is a chance of falling overboard. USCG-approved Type II or III personal flotation devices (PFDs) will be worn while working on the deck of the boat. If a person falls overboard into the water, a life ring will be thrown to the person immediately. One onboard person (a spotter) will keep an eye on the victim and shout the distance (boat lengths) and direction (o'clock) of the victim from the vessel. All work will stop work and the vessel will be used to retrieve the person in the water; the person in the water will be approached from downstream.

4.1.4 Manual lifting

Equipment and samples 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.

4.1.5 Heat stress

Heat stress could be an issue during hot days. Heat-related problems include heat rash, heat cramps, heat exhaustion, and heat stroke. The causes, symptoms, and first aid recommended by the National Institute for Occupational Health and Safety for each type of heat stress category are summarized in Table H-1. Workers should be aware of the key differences between the signs and symptoms of heat stroke and those of heat exhaustion, such as the lack of sweating, the color of the skin (red), and the rise in body temperature associated with the former. Heat stroke is a medical emergency that requires immediate medical attention.

Table H-1. Heat stress symptoms and recommended first aid

Type of Heat Stress	Cause	Symptoms	First Aid
Heat rash	Heat rash is a skin irritation caused by excessive sweating during hot, humid weather.	Formation of rash (red cluster of pimples or small blisters) usually on the neck and upper chest, in the groin, under the breasts, and/or in elbow creases.	Try to work in a cooler, less humid environment when possible. Keep the affected area dry. Dusting powder may be used to increase comfort.
Heat cramps	Heat cramps usually affect workers who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture levels. Low salt levels in muscles cause painful cramps. Heat cramps may also be a symptom of heat exhaustion.	Muscle pain or spasms, usually in the arms, legs, and abdomen.	Have the person stop working and move him or her to a cool, shady area. Have the person drink clear juice or a sports beverage. Do not let person return to work until a few hours after cramps subside. Seek medical attention immediately if: (1) the person has heart problems, (2) the person is on a low sodium diet, or (3) the cramps do not subside within 1 hour.
Heat exhaustion	Heat exhaustion is the body's response to an excessive loss of water and salt, usually through excessive sweating. Workers most prone to heat exhaustion are those who are elderly or have high blood pressure, and those working in a hot environment.	Heavy sweating, extreme weakness or fatigue, dizziness or confusion, nausea, clammy moist skin, pale or flushed complexion, muscle cramps, slightly elevated body temperature, and fast and shallow breathing.	Have the person stop working and move him or her to a cool, shady area. Give the person plenty of water, juice, or other cool nonalcoholic beverages to drink. Have the person take a cool shower, bath, or sponge bath.
Heat stroke	Heat stroke is the most serious heat-related disorder. It occurs when the body becomes unable to control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. When heat stroke occurs, the body temperature can rise to 106 degrees Fahrenheit or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability if emergency treatment is not given.	Hot dry skin (no sweating), hallucinations, chills, throbbing headache, high body temperature, confusion/dizziness, and slurred speech.	Call 911 immediately. Have the person stop working and move him or her to a cool, shady area. Cool the person using methods such as (1) soaking person’s clothes with water, (2) spraying, sponging, or showering person with room temperature water, and/or (3) fanning person’s body. Ice or cold packs may also be used.

Source: CDC (2018), as modified in Amec et al. (2015).

4.1.6 Cold stress

Hypothermia occurs when the body's core temperature falls below 95°F. There is a risk of hypothermia if a crew member fails to dress warmly in cold weather, gets wet from rain or splashes, or falls into the water. To prevent hypothermia, all personnel will wear protective clothing appropriate for the weather conditions and physical activity. The FC/HSO will monitor all crew members for early symptoms of hypothermia (e.g., shivering, muscle incoordination, mild confusion). If such symptoms are observed, the FC/HSO will take immediate steps to reduce heat loss by providing extra layers of clothing, or by temporarily moving the affected crew member to a warmer environment. Other immediate steps that can be taken to reduce the symptoms of hypothermia include minimizing exposure to cold and wet conditions, limiting sitting or standing still for long periods, rehydration with warm fluids, and the removal of any wet outer layers of clothing to permit sweat evaporation during rest periods in a warm environment.

Sampling operations and conditions that might result in the occurrence of frostbite are not anticipated. The sampling will take place during the time of year when extreme weather conditions are not expected to occur.

4.1.7 Weather

In general, field team members will be equipped for the normal range of weather conditions. The FC/HSO will be aware of current weather conditions, and of the potential for those conditions to pose a hazard to the field crew. Some conditions that might force work stoppage are electrical storms, high winds, or high waves resulting from winds.

4.1.8 Small-boat Operations

Boat operations are associated with various risks, such as: 1) passengers or crew members falling overboard/drowning, 2) coming in contact with other vessels or being contacted by other vessels operating in the area, 3) losing power or steering capability and drifting into hazardous areas (i.e., shores, bridges, industrial facilities, etc.), and 4) encountering severe weather and dangerous water conditions. The risk of a boating accident can be reduced by ensuring that the boat operators are experienced, operating the vessel in compliance with USCG rules and regulations, maintaining the vessel in good mechanical order, avoiding bad weather and dangerous water conditions, and ensuring that required emergency equipment is available onboard.

Safety precautions that will be implemented as part of boat operations for this project include the following:

- The vessels must have required USCG safely equipment onboard in good conditions, including a life jacket for each project team member, a first aid kit, fire extinguishers, distress flares, a throw-able life ring, navigation charts for the work area, running lights and a horn.

- Smoking is not permitted onboard the vessels.
- All crew members must be trained so that they know the location and use of onboard safety equipment.
- For vessels less than 25 feet long, at least one fire extinguisher must be onboard. For vessels greater than 26 feet in length but less than 40 feet, at least two fire extinguishers must be onboard.
- A life jacket must be worn by project team members at all times while working on boats, piers, docks that are not equipped with guardrails, and vessels when not tied to shore.
- The VHF radio must be turned on and monitored.
- Crew members should not untie mooring lines until instructed to do so by the vessel operator.
- Crew members should never jump between the vessel and the dock or other vessels.
- Docks, piers and shoreline areas should be approached slowly. The boat should never be fended off by placing your body between the boat and any object.
- All crew members should watch for hazards such as approaching vessels or wakes. It should never be assumed that other crew members see such hazards; therefore, they should be alerted to any potential risks that are observed.
- Crew members should be aware of overhead power lines and underwater utility corridors.
- If lightening or thunder occurs before the crew is able to get safely off the water, the 30/30 rule should be used: if the time between seeing the lightening and hearing thunder is 3 seconds or less, the boat should be moved near a tall structure such as a bridge and remain there until 30 minutes after the last thunder is heard.
- If refueling is necessary, the engine should be turned off and allowed to cool before fueling is attempted.

4.1.9 Vessel traffic

Because of the high volume of vessel traffic on the LDW, precautions and safe boating practices will be implemented to ensure that the field boat does not interrupt such traffic. As practical, the field boat will stay out of the navigation channel. Vessel traffic will be monitored on VHF channel 16.

4.1.10 Diving

No diving is anticipated to be conducted as part of the sampling and inspection activities conducted for this project.

4.1.11 Homeless Encampment

Field staff will have contact information for the project field lead and project manager while performing all field investigation activities. If a homeless encampment is encountered during implementation of the planned work, the encampment residents will not be disturbed, and the field crew will leave the area. From a safe location, the field crew lead will notify the project manager who in turn will notify LDWG representatives to evaluate next steps.

4.2 Biological Hazards

In response to the global public health emergency regarding Coronavirus Disease 2019 (COVID-19), and to address the safe practices requirements mandated by the State of Washington Office of the Governor's Phase 1 Construction Restart – Proclamation 20-25, its supporting Phase 1 Construction Restart COVID-19 Job Site Requirements (Inslee 2020a, b), and the General Coronavirus Prevention Under Stay at Home-Stay Healthy guidelines (L&I 2020a), this section describes basic steps to reduce the risk of worker exposure to SARS-CoV-2, the virus that causes COVID-19, during field operations. The COVID-19 safe practices requirements provided by the state are provided in Exhibit 3.

COVID-19 is a contagious respiratory disease caused by the SARS-CoV-2 virus (OSHA 2020). Infection with SARS-CoV-2 can cause mild to severe illness and can be fatal. Symptoms typically include fever (>100.4°F), coughing, and shortness of breath, but some people have reported experiencing other non-respiratory symptoms—such as chills, repeated shaking with chills, muscle pain, headache, sore throat, and a loss of taste or smell—while still others have been asymptomatic and experienced no symptoms at all. According to the US Department of Health and Human Services Centers for Disease Control and Prevention (CDC), symptoms of COVID-19 may appear in as few as 2 days or as long as 14 days after exposure (CDC 2020). The virus is primarily spread via inhalation and from person-to-person, including:

- Between people within close contact distance of one another (within approximately 6 ft)
- Through respiratory droplets, which may land in or be inhaled via the mouths or noses of people who are nearby when an infected person coughs or sneezes

The virus may also be transmitted by touching a surface or object that has SARS-CoV-2 on it and then one's own mouth, nose, or eyes, but this method is not believed to be the primary route by which the virus spreads. It is believed that people are most contagious when they are most symptomatic (i.e., experiencing fever, cough, and/or shortness of breath), but transmission may be possible before symptoms are evident (CDC 2020).

As appropriate, site workers will implement good hygiene and infection control practices, including:

- Staying home when sick or showing symptoms[1]
  - If employees are showing symptoms, it is recommended that they contact their health care provider for medical advice. Further steps taken may include an examination and testing as recommended by their health care provider.
  - If employees are showing any symptoms, they will be asked to leave the site and not return for a minimum of 14 days or until released by a health care professional.
- Limiting field personnel to the minimum individuals required to safely complete the work
- Limiting time spent in groups in enclosed spaces to the extent possible
- Driving separately to and from the work site
- Arriving at work site with face coverings donned
- Monitoring workers' temperatures for signs of fever
- Following respiratory etiquette, including covering coughs and sneezes
- Washing hands frequently and thoroughly. If soap and running water are not immediately available, alcohol-based sanitizer containing at least 60% alcohol will be used.
- Wearing disposable PPE during sampling and properly disposing of PPE items as often as necessary
- Increasing physical distance among and between employees and others (i.e., use of social distancing strategies)
- Providing additional barriers to exposure, such as face coverings, face shields, and protective eyewear, when social distancing cannot be maintained at all times
- Not using any of the following alone as a substitute for COVID-19 face coverings: bandanas, gaiters, buffs, vented masks, and face shields
- Avoiding sharing personal items and using other workers' phones, pens, work tools, and equipment, when possible, or wiping down between use
- Maintaining regular housekeeping practices, including routine cleaning and disinfecting of surfaces, equipment, and other elements of the work environment utilizing chemicals listed on the EPA list N as being suitable for COVID-19

[1] If an employee has traveled to an affected country outside the United States or has had close contact (within 6 feet for 15 minutes or greater in a 24-hour period) to infected individuals within the United States, a minimum 14-day self-quarantine from the project site is required to determine if symptoms develop or if testing is positive for COVID-19.

- Considering alternative strategies to reduce exposure, such as staggering work shifts and breaks and covering common touch areas with cleanable materials
- Following the same prevention guidelines while off-site including while traveling, at a hotel, and participating in other activities in order to address potential exposures outside the workplace

Additional compliance measures adhering to the State of Washington Office of the Governor's Phase 1 Construction Restart – Proclamation 20-25, its supporting Phase 1 Construction Restart COVID-19 Job Site Requirements (Inslee 2020a, b), and the General Coronavirus Prevention Under Stay at Home-Stay Healthy guidelines (L&I 2020a) are integrated throughout the subsequent sections of this HSP, including the hazard analysis in Section 4.4.

4.3 Chemical Hazards

Previous investigations have shown that some chemicals are present at higher-than-background concentrations in the sampling area. For the purposes of discussing the potential exposure of individuals to chemicals in sediments, the chemicals of concern are metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), dioxins/furans, and hydrogen sulfides. Detailed information on exposure routes and chemical hazards is included in Table H-2.

4.3.1 Exposure routes

Potential routes of chemical exposure include inhalation, dermal contact, and ingestion. Exposure will be minimized by using safe work practices (Section 6) and by wearing the appropriate PPE. Further discussion of PPE requirements is presented in Section 7.

4.3.1.1 Inhalation

Inhalation is not expected to be an important route of exposure, because sampling will be conducted outside on a boat, in the field, or in a well-ventilated area.

4.3.1.2 Dermal exposure

Dermal exposure to hazardous substances associated with sediments, surface water, or equipment decontamination will be controlled by the use of PPE, and by adherence to detailed sampling and decontamination procedures.

4.3.1.3 Ingestion

Incidental ingestion of sediment or surface water is not considered a major route of exposure for this project. Accidental ingestion of surface water is possible. However, careful handling of equipment and containers while onboard the boat should prevent water from splashing or spilling during sample collection and handling activities.

4.3.2 Description of chemical hazards

4.3.2.1 Metals

Exposure to metals at this site may occur via ingestion or skin contact. As mentioned above, neither is a likely exposure route. Metal fumes or metal-contaminated dust will not be encountered during field and sample handling activities. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Momentary skin contact allows little, if any, opportunity for metals to pass into the body. Field procedures require immediate washing of sediments from exposed skin.

4.3.2.2 Polycyclic aromatic hydrocarbons and semivolatile organic compounds

Exposure to PAHs or SVOCs at this site may occur via ingestion or skin contact. Inhalation, the most important human health exposure pathway for this group of chemicals, is not expected to occur at this site. Large amounts of sediment would need to be ingested for any detrimental effects to occur. Some PAHs may be carcinogenic after long periods of skin contact. However, momentary skin contact allows little, if any, opportunity for compounds to pass into the body. Field procedures require immediate washing of sediments from exposed skin.

4.3.2.3 Polychlorinated biphenyls

Exposure to PCBs at this site may occur via ingestion or skin contact. Acute and chronic exposure can damage the liver and cause symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. PCBs are a suspected human carcinogen, although large amounts of sediment would need to be ingested for any detrimental effects to occur. Prolonged skin contact with PCBs may cause acne-like symptoms known as chloracne. Irritation to eyes, nose, and throat may also occur. However, momentary skin contact allows little, if any, opportunity for compounds to pass into the body. Field procedures require immediate washing of sediments from exposed skin.

4.3.2.4 Dioxins/furans

Exposure to dioxins/furans at this site may occur via ingestion or skin contact. Acute and chronic exposure can damage the liver, increase the risk of diabetes and abnormal glucose tolerance, and possibly increase the risk for reproductive and developmental effects. 2,3,7,8-TCDD is a possible human carcinogen, and a mixture of dioxins/furans with six chlorine atoms (four of the six chlorine atoms at the 2-, 3-, 7-, and 8-positions) is a probable human carcinogen. However, large amounts of sediment would need to be ingested for any detrimental effects to occur. Prolonged skin contact with dioxins/furans may cause acne-like symptoms known as chloracne. Other effects on the skin, such as red skin rashes, have been reported to occur in people following exposure to high concentrations of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD). Momentary skin contact allows little, if any, opportunity for the passage of any of the compounds into the body. Field procedures require the immediate washing of sediments from exposed skin.

4.3.2.5 Hydrogen sulfides

Exposure to hydrogen sulfides at this site may occur primarily via inhalation or eye and skin contact. At lower concentrations typically found in sediments, hydrogen sulfides emit a rotten egg odor. Acute and chronic exposure to this odor can irritate the respiratory tract and eyes and cause symptoms of headaches, dizziness, nausea, and abdominal pains. Exposure to high concentrations may result in bronchitis, bronchial pneumonia, coma, unconsciousness, or respiratory arrest. However, momentary skin contact allows little, if any, opportunity for compounds to pass into the body. Field procedures require adequate ventilation and immediate washing of sediments from exposed skin.

Table H-2. Chemicals of Concern

Chemical	Exposure Routes	Symptoms	Target Organs	OEL (STEL)	Odor Threshold (ppm)	LEL (%)	Ionization Potential (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 TWA$_8$ Skin IDLH / Ca – 5 mg/m^3	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 TWA$_8$ 0.1 mg/m^3 TWA$_8$ (Cyclohexane-extractable fraction) IDLH / Ca – 80 mg/m^3	Varies	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	?	?
Hydrogen Sulfide (H2S) (7783-06-04) 1 ppm = 1.40 mg/m^3	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 TWA$_8$ (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 TWA$_8$ 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 TWA$_8$ IDLH / Ca – 9 mg/m^3	N/A	N/A	N/A
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

Chemical	Exposure Routes	Symptoms	Target Organs	OEL (STEL)	Odor Threshold (ppm)	LEL (%)	Ionization Potential (eV)
Chromium (VI) inorganic compounds, as Cr (18540-29-9) (1333-82-0 as CrO_3)	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

4.4 ACTIVITY HAZARD ANALYSIS

The activity hazard analysis summarizes the hazards associated with pre-design sampling activities and along with the controls that can reduce or eliminate the risk of these hazards occurring (Table H-3). Job safety analysis (JSA) sheets are also included in Exhibit 2 for description of potential hazards that may be encountered during implementation of the environmental sediment sampling (including sediment sample collection and core processing), visual shoreline inspection, geotechnical sediment sampling, and structures inspections. JSAs associated with completion of focused topographic surveys and other surveys (as necessary) will be included in the surveying HSP.

Table H-3. Activity hazard analysis

Hazard[1]	Control
Slips and trips	Use extra care when walking on uneven and unstable surfaces along the shoreline, and under wet/slippery conditions. Wear boots with good tread.
Falling overboard	Use care in boarding/departing from the vessel. Wear a PFD. Provide and make readily accessible on each boat a life ring to throw to the person in the water. Have one onboard person (a spotter) keep an eye on the victim and shout the distance (boat lengths) and direction (o'clock) of the victim from the vessel. Stop work and use the vessel to retrieve the person in the water. Approach the person from downstream.
Skin or eye contact with contaminated sediments or liquids	Wear modified Level D PPE. Immediately wash sediments from exposed skin. Use an eyewash, if necessary, for contaminated or foreign debris in the eyes.
Back strain	Use appropriate technique for lifting equipment and samples, or seek help.
Overhead hazards	Use caution and be aware of overhead and gear hazards such as the grab sampler, A-frame, and geotechnical drill rig. Wear a hard hat and modified Level D PPE when working around this equipment.
Open hatches	Keep hatches closed when not being accessed. Be aware around hatch area and use caution when entering/exiting hatch.
Heat stress	Monitor crew members for signs/symptoms of heat stress. Remove person to cool area and remove extra layers of clothing. Promote evaporative cooling and rehydrate with electrolytic fluids.
Cold stress	Monitor crew members for signs/symptoms of hypothermia. Minimize prolonged exposure to wet and cold conditions. Remove person to warm area and remove wet clothing. Rehydrate with warm fluids.
Weather	Monitor weather forecast and local conditions. Stop work if conditions pose a hazard (e.g., electrical storms, high winds) and resume work when safe to do so.
Fatigue	Take regular breaks, and limit repeated excessively long work days.
Pinch points and cuts	Be aware of pinch points and potential for cuts during sample collection and processing. Handle equipment and tools with care, Use safety knives if necessary, and follow instruction manuals for any power tools.
Working at night	Make sure all lights are functional (navigation lights, flashlights, PDF lights, contractor-supplied lighting, etc.). Routinely inspect work area for unsafe conditions.

Hazard[1]	Control
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 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.

Notes:

1. Responses to boat emergencies are addressed in Table H-5.
2. A medium transmission risk work site condition includes a condition where large crews are outside and at least a 6-ft distance is mostly maintained, but some job tasks require several minutes of less than 6-ft distance several times a day. Under these conditions, the following masks are acceptable: dust mask, foreign system non-NIOSH approved filtering face piece respirator (such as KN95), or medical procedure masks (L&I 2020b).

COVID-19 – coronavirus disease 2019

PFD – personal flotation device

PPE – personal protective equipment

5 Work Zones and Shipboard Access Control

During sampling and sample handling activities, work zones will be established to identify where sample collection and processing are actively occurring. The intent of the zones is to limit the migration of sample material out of its zone, and to restrict unauthorized access to active work areas by defining work zone boundaries. The work zones are described below.

5.1 Sampling Zone

A sampling work zone will encompass the exclusion area where sample collection and handling activities are being performed. The FC/HSO will delineate the work zone as a particular area onboard the collection vessel or at each intertidal shoreline sampling location. Only persons with appropriate training, PPE, and authorization from the FC/HSO will be allowed to enter this zone while work is in progress.

5.2 Decontamination Zone

A decontamination zone where personnel will clean soiled boots and/or PPE prior to leaving the work zone will be set up. The zone will have the buckets, brushes, soapy water, rinse water, or wipes necessary to clean boots, PPE, or other equipment leaving the work zone. Plastic bags will be provided for expendable and disposable materials. If the sampling location does not allow for the establishment of a decontamination zone, the FC/HSO will provide alternatives to prevent the spread of contamination.

Decontamination of the boat will be completed at the end of each work day. Cockpit and crew areas will be rinsed down with water to minimize the accumulation of sediment.

5.3 Support Zone

The support zone is any work area beyond the sampling work zone and decontamination zone boundaries where sample collection and processing do not occur. Activities in this zone include boat operations (e.g., piloting the boat and remotely controlling sampling equipment), administrative work (e.g., observing the field effort, taking notes, filling out paperwork, communicating with project managers, and directing field staff), and rest breaks. Prior to entering the support zone, personnel are required to decontaminate or dispose of soiled PPE or equipment to limit the spread of contamination into the clean area.

5.4 Access Control

Security and control of access to the boat will be the responsibility of the FC/HSO and boat captain. Boat access will be granted to necessary project personnel and authorized visitors only. Any security or access control problems will be reported to the client or appropriate authorities.

6 Communications and Safe Work Practices

Communications at the job site will occur by verbal direction, use of hand signals, radio, or a combination of all three. Site personnel will carry cellular telephones and a list of emergency telephone numbers included in this HSP. These telephone numbers are listed in Section 14.3 of this HSP and in the front matter of the document. Boat operators will have VHF radios that are capable of communicating with USCG emergency services and with other vessels operating in the immediate work area. An air horn will be staged at each work area to initiate an evacuation of the site in an emergency, should other means of communication (i.e., radio, telephone, etc.) fail. Site personnel will be informed of site emergency procedures and communication protocols during their initial site orientation.

Following common sense will minimize the risk of exposure or accidents at this work site. The following general safety rules will be adhered to on-site:

- Do not climb over or under obstacles of questionable stability (e.g., docks, piers).
- Do not eat, drink, smoke, or perform other hand-to-mouth transfers in the work zone.
- Work only in well-lighted spaces.
- Never enter a confined space without the proper training, permits, and equipment.
- Make eye contact with vessel/sampling equipment operators when moving within the range of their equipment.
- Be aware of the movements of shipboard equipment when not in the operator's range of vision.
- Get immediate first aid for all cuts, scratches, abrasions, or other minor injuries.
- Use the established sampling and decontamination procedures.
- Always use the buddy system.
- Be alert to your own and other workers' physical conditions.
- Report all accidents, no matter how minor, to the FC/HSO.
- Do not do anything dangerous or unwise even if ordered by a supervisor.

7 Personal Protective Equipment and Safety Equipment

Appropriate PPE will be worn as protection against potential hazards. In addition, a PFD will be required when working onboard the boat. Prior to donning PPE, the field crew will inspect their PPE for any defects that might render the equipment ineffective.

Fieldwork will be conducted in Level D or modified Level D PPE, as discussed in Sections 7.1 and 7.2. Situations requiring PPE beyond modified Level D are not anticipated. Should the FC/HSO determine that PPE beyond modified Level D is necessary, the HSM will be notified and an alternative selected. This HSP also acknowledges that site conditions may change during implementation of the work, possibly leading to a change in exposure pathways or chemicals of concern. If changes are observed, evaluation for potential changes in PPE needs will be completed.

New personnel or visitors will be informed of PPE requirements during their initial site briefing (see Section 3).

7.1 Level D Personal Protective Equipment

Workers performing general activities during which skin contact with contaminated materials is unlikely will wear Level D PPE. Level D PPE includes the following:

- Protective clothing
- Chemical-resistant steel-toed boots
- Chemical-resistant gloves
- Safety glasses
- High-visibility vests
- ANSI/ASTM compliant hard hats
- Face covering

7.2 Modified Level D Personal Protective Equipment

Workers performing activities during which skin contact with contaminated materials is possible, and during which inhalation risks are not expected, will be required to wear an impermeable outer suit. The type of outerwear will be chosen according to the types of chemical contaminants that might be encountered. Modified Level D PPE includes the following:

- Impermeable outer garb such as rain gear
- Waterproof and chemical-resistant steel-toed boots
- Waders and wader boots
- Chemical-resistant outer gloves
- Heavy-duty waterproof gloves

- High-visibility vests
- Hard hats
- Safety glasses
- Protective face covering (as needed)

When the ability to remain socially distant (i.e., minimum 6 ft apart) is limited (on boats), workers will be expected to don safety glasses and protective fabric or disposable face coverings during field activities to comply with the Phase 1 Construction Restart COVID-19 Job Site Requirements (Inslee 2020b), the General Coronavirus Prevention Under Stay at Home-Stay Healthy guidelines (L&I 2020a), and CDC recommendations for reducing exposure to COVID-19 in public spaces. Workers will be provided with safety glasses and disposable medical face masks designed to reduce the transfer of saliva and respiratory droplets to others and to help block potentially infectious materials from reaching the skin, eyes, mouth, or nose of the wearer during daily activities. Workers will be expected to change disposable masks at least halfway through each work day and as frequently as necessary (i.e., when soiled or damaged). Face shields will also be available as an additional option for protection from COVID-19 exposure.

7.3 Safety Equipment

In addition to PPE that will be worn by shipboard personnel, basic emergency and first aid equipment will be provided. Equipment for the field team will include:

- A copy of this HSP
- A first aid kit adequate for the number of personnel
- Emergency eyewash
- Sunscreen
- Fire extinguisher

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

8 Monitoring Procedures for Site Activities

A monitoring program that addresses the potential site hazards will be maintained. For this project, air, dust, and noise monitoring will not be necessary. The sampled media will be wet and will not pose a dust hazard, and none of the equipment will emit high-amplitude (> 85 dBA) sound. 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:

- Headaches
- Dizziness
- Nausea
- Fever
- Coughing
- Shortness of breath (difficulty breathing)
- Muscle pain
- Sore throat
- Loss of sense of taste or smell
- Symptoms of heat stress
- Blurred vision
- Cramps
- Irritation of eyes, skin, or respiratory system
- Changes in complexion or skin color
- Changes in apparent motor coordination
- Increased frequency of minor mistakes
- Excessive salivation or changes in papillary response
- Changes in speech ability or speech pattern
- Shivering
- Blue lips or fingernails

If personnel develop any of these conditions, work will 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.

9 Decontamination

Decontamination is necessary to prevent the migration of contaminants from the work zone(s) into the surrounding environment, and to minimize the risk of exposure of personnel to contaminated materials that might adhere to PPE. The following sections discuss personnel and equipment decontamination. The following supplies will be available to perform decontamination activities:

- Wash buckets
- Rinse buckets
- Scrub brushes
- Clean water sprayers
- Paper towels
- Plastic garbage bags
- Alconox® or similar decontamination solution

9.1 Minimization of Contamination

The first step in addressing contamination is to prevent or minimize exposure to biological hazards and existing contaminated materials and the spread of those materials. During field activities, the FC/HSO will enforce the following measures:

Personnel:

- Limit field staff to minimum number required to safely complete the work.
- Wash hands frequently and thoroughly. Use alcohol-based sanitizer with at least 60% alcohol if soap and running water are not readily available.
- Follow proper coughing and sneezing etiquette.
- Avoid sharing personal items.
- Avoid group gatherings in enclosed spaces.
- Maintain proper social distance (i.e., minimum 6 ft) to extent possible.
- Follow the same prevention guidelines off site including while traveling, at a hotel, and participating in other activities in order to address potential exposures outside the workplace.
- Do not walk through areas of obvious or known contamination, if avoidable.
- Do not handle, touch, or smell contaminated materials directly.
- Make sure PPE has no cuts or tears prior to use.
- Fasten all closures on outer clothing, covering with tape if necessary.
- 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.

Sampling equipment and boat:

- Avoid or minimize handling of equipment, tools, and supplies by multiple people.
- Clean or disinfect touch surfaces, handheld equipment, tools, and supplies frequently.
- Place clean equipment on a plastic sheet or aluminum foil to avoid direct contact with contaminated media.
- Keep contaminated equipment and tools separate from clean equipment and tools.
- Clean boots before entering the boat.

9.2 Personnel Decontamination

The FC/HSO will ensure that all site personnel are familiar with personnel decontamination procedures. Personnel will perform the following decontamination procedures, as appropriate, before eating lunch, taking a break, or leaving the work location:

1. If outer suit is heavily soiled, rinse it off.
2. Remove outer suit.
3. Wash and rinse outer gloves and boots with soapy water.
4. Remove outer gloves; inspect and discard if damaged.
5. Remove inner gloves and discard.
6. Wash hands.

Before returning to work, personnel will re-don all necessary PPE. If leaving for the day, personnel will dispose of soiled, expendable PPE.

9.3 Sampling Equipment Decontamination

Sampling equipment will be decontaminated, as described in Section 4.6 of the QAPP, to minimize sample contamination and worker exposure to contamination from samples and potential exposure to the SARS-CoV-2 (COVID-19) virus. The following practices will be followed:

- Shared equipment or supplies and workspaces will be disinfected frequently or between uses, as appropriate.

- Safety glasses and face shields will be assigned to a single user, and will be disinfected frequently, at the end of the day, or between uses, and be stored in a clean sealable bag.
- All utensils or equipment used directly in handling sediment (e.g., such as the grab sampler, hand corers, shovels, spoons and bowls) will be scrubbed with Alconox® detergent, rinsed with deionized water, and stored wrapped in aluminum foil until use.
- Sample processing surfaces will be cleaned and lined with aluminum foil to prevent direct contact with samples.
- Ice chests will be scrubbed with Alconox® detergent and rinsed with deionized water prior to any sampling activities. Lids and handles will be cleaned frequently throughout each day.
- Wet ice used for sample storage during field activities will be contained in separate plastic bags, and samples will be placed in resealable, waterproof plastic bags to avoid contamination from melting ice.
- Sampling equipment will be free from contaminants such as oils, grease, and fuels.

10 Disposal of Contaminated Materials

Contaminated materials that may be generated during field activities include PPE and excess sample material. These contaminated materials will be disposed of as an integral part of the project.

10.1 Personal Protective Equipment

All disposable sampling materials and PPE—such as disposable coveralls, gloves, and paper towels used in sample processing—will be placed in heavyweight garbage bags. Filled garbage bags will be placed in a normal refuse container for disposal as solid waste.

10.2 Excess Sample Materials

At each sampling location, excess or unwanted sediment collected will be returned to the collection site.

11 Training Requirements

Individuals performing work at locations where potentially hazardous materials and conditions may be encountered must meet specific training requirements. It is not anticipated that hazardous concentrations of contaminants will be encountered in sampled material, so training will consist of site-specific instruction for all personnel and oversight of inexperienced personnel by an experienced person for one working day. The following sections describe the training requirements for this fieldwork.

11.1 Project-specific Training

In addition to HAZWOPER training, as described in Section 3.6 of the QAPP, field personnel will undergo training specifically for this project. All personnel and visitors must read this HSP and be familiar with its contents before beginning work or providing oversight. They must acknowledge reading the HSP by signing the HSP review form (see front matter). The signed form will be kept in the project files.

The boat captain and FC/HSO will also be required to have the US Coast Guard (USCG) Auxiliary Boating Safety certification. The boat captain or a designee will provide project-specific training prior to the first day of fieldwork and whenever new workers arrive. Field personnel will not be allowed to begin work until project-specific training has been completed and documented by the FC/HSO. Training will address the HSP and all health and safety issues and procedures pertinent to field operations. Training will include, but not be limited to, the following topics:

- Activities with the potential for exposure to chemicals
- Activities that pose physical hazards, and actions to control the hazards
- Ship access control and procedures
- Use and limitations of PPE
- Decontamination procedures
- Emergency procedures
- Use and hazards of sampling equipment
- Location of emergency equipment on the vessel
- Vessel safety practices
- Vessel evacuation and emergency procedures

11.2 Daily Safety Briefings

The FC/HSO or a designee and the boat captain will present safety briefings before the start of each day's activities. These safety briefings will outline the activities expected for the day, update work practices and hazards, verify that medical screening has been completed, explain protective measures, address any specific concerns associated with the work location, and review emergency procedures and routes. Social distancing will be maintained during safety briefings, and COVID-19 safety requirements will be visibly posted at the work site (Inslee 2020b; L&I 2020a).

The FC/HSO or designee will document all safety briefings using the daily safety briefing form included in Exhibit 2.

11.3 First Aid and CPR

At least two members of the field team must have first aid and cardiopulmonary resuscitation (CPR) training. Documentation of which individuals possess first aid and CPR training will be kept in the project health and safety files.

12 Medical Surveillance

A medical surveillance program conforming to the provisions of 29 CFR 1910§120(f) is not necessary for field team members on this project, because they do not meet any of the following 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 as a result of 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)).

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 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:[2]

- 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

[2] Adapted from (Anchor 2020).

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.

12.1 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., 14-day self-quarantine, 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 close contact (within 6 feet for 15 minutes or greater during a 24-hour period) with the infected individual will be asked to quarantine for 14 days or until released by a healthcare professional and may be asked to seek medical testing.

12.2 COVID-19 Secondary Exposure

If an employee has had close contact with someone who has been diagnosed with COVID-19 within the last 14 days, the FC/HSO will immediately take the following actions:

- Immediately send the employee home for 14-day self-quarantine or 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 12.1) if an employee is confirmed as positive for COVID-19.

12.3 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 12.2) if the acquaintance is confirmed as positive for COVID-19.

13 Reporting and Record Keeping

Each member of the field crew will sign the HSP review form (see front matter). If necessary, accident/incident report forms and Occupational Safety and Health Administration (OSHA) Form 200s will be completed by the FC/HSO.

The FC/HSO or a designee will maintain a health and safety field logbook with daily records of health- and safety-related details for the project. The logbook will utilize daily safety briefing forms (Exhibit 2) and 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:

- Project name or location
- Names of all personnel onboard
- Weather conditions
- 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 workday's entries.

Additionally, for COVID-19 tracking purposes, a record of all site workers and visitors and their contact information (i.e., phone numbers and e-mail addresses) will be kept on file for a minimum for four weeks from the last day they were on site.

14 Emergency Response Plan

As a result of the hazards onboard the sampling vessels and the conditions under which operations will be conducted, the potential exists for an emergency situation to occur. Emergencies may include personal injury, exposure to hazardous substances, fire, explosion, or release of toxic or non-toxic substances (spills). OSHA regulations require that an emergency response plan be available for use onboard to guide actions in emergency situations.

Hazards may also be encountered with shore-based activities and sampling. Emergencies may include personal injury, exposure to hazardous substances, fire, explosion, or release of toxic or non-toxic substances (spills). OSHA regulations require that an emergency response plan be available for use on site to guide actions in emergency situations.

Onshore organizations will be relied upon to respond to emergency situations. Given the location of the site, 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. Shipboard personnel will attempt to control only very minor hazards that could present an emergency situation, such as a small fire; otherwise, all personnel will rely on outside emergency response resources.

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 sampling location to a hospital.

14.1 Pre-Emergency Preparation

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

- Meeting between the FC/HSO and equipment handlers concerning emergency procedures in the event that a person is injured
- A training session given by the FC/HSO informing all field personnel of emergency procedures, locations of emergency equipment and its uses, and proper evacuation procedures
- A training session given by senior staff on operating field equipment to apprise field personnel of operating procedures and specific risks associated with that equipment
- Ensuring that field personnel are aware of the existence of the emergency response plan in the HSP, and ensuring that a copy of the HSP including all attachments accompanies the field team

14.2 PROJECT EMERGENCY COORDINATOR

The FC/HSO will serve as the project emergency coordinator in the event of an emergency. They will designate their replacement during those times when they are not onboard the vessel, on site, or are 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 before the arrival of emergency response units. The project emergency coordinator will notify the HSM and the PMs as soon as possible after initiating an emergency response action. The PMs will have responsibility for notifying the client.

14.3 EMERGENCY RESPONSE CONTACTS

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

Table H-4. Emergency response contacts

Contact	Telephone Number
Emergency Numbers	
Ambulance	911
Police	911
Fire	911
Harborview Medical Center	206.323.3074
Emergency Responders	
US Coast Guard Emergency General information	 206.286.5400 206.442.5295 VHF Channel 16
National Response Center	800.424.8802
US Environmental Protection Agency	800.424.8802
Washington State Department of Ecology – Northwest Region Spill Response (24-hour emergency line)	206.649.7000
Emergency Contacts	
Anchor QEA Project Manager	
Tom Wang	206.903.3314
Windward Project Manager	
Kathy Godtfredsen	206.812.5413
Corporate Health and Safety Manager	
David Templeton	206.910.4279

Contact	Telephone Number
Health and Safety Program Lead	
Tim Shaner	251.281.3386
Field Coordinator/ Field Health and Safety Officer	
Thai Do (Windward)	206.812.5407
Matt Woltman (Anchor QEA)	206.903.3327

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.

14.5 Decontamination

In the case of evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. If an injured individual is also heavily contaminated and must be transported by emergency vehicle, the emergency response team will be informed of the type of contamination. To the extent possible, contaminated PPE will be removed from the injured individual, but only if doing so does not exacerbate the injury. Plastic sheeting will be used to reduce the potential for spreading contamination to the inside of the emergency vehicle.

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 the available fire extinguisher that is part of the required safety equipment, personnel will either withdraw from the vicinity of the fire or evacuate the boat or area as specified in the training session.

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:

- Designate an individual to call 911 and administer first aid, if qualified.
- If not qualified, seek out an individual who is qualified to administer first aid, if time and conditions permit.
- Notify the project emergency coordinator of the incident, the name of the injured individual(s), the location of the individual, and the nature of the injury.

The FC/HSO or designee will immediately do the following:

- Notify the boat captain and the appropriate emergency response organization.
- Assist the injured individual(s).
- Follow the emergency procedures for retrieving or disposing of equipment reviewed in the training session, and leave the site en route to the predetermined land-based emergency pickup.
- Designate someone to accompany the injured individual to the hospital.
- If a life-threatening emergency occurs (i.e., injury where death is imminent without immediate treatment), the FC/HSO or boat captain will call 911 and arrange to meet the ambulance unit at the nearest accessible dock or other appropriate location.
- If a non-life-threatening emergency occurs (i.e., broken bones, 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.
- Notify the HSM and the PM.

If the project emergency coordinator determines that an emergency response is not necessary, they may direct someone to decontaminate and transport the individual by vehicle to the nearest hospital. Directions showing the route to the hospital are in Section 14.11.

If a worker leaves the boat or site to seek medical attention, another worker should accompany him 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 be responsible for completing all accident/incident field reports, OSHA Form 300s, and other required follow-up forms.

14.8 Overt Personal Exposure or Injury

If an overt exposure to toxic materials occurs, the first responder to the victim will initiate actions to address the situation. The following actions should be taken, depending on the type of exposure.

14.8.1 Skin contact

- Wash/rinse the affected area thoroughly with copious amounts of soap and water.
- If eye contact has occurred, rinse the eyes for at least 15 minutes using the eyewash that is part of the onboard emergency equipment.

- After initial response actions have been taken, seek appropriate medical attention.

14.8.2 Inhalation

- Move victim to fresh air.
- Seek appropriate medical attention.

14.8.3 Ingestion

- Seek appropriate medical attention.

14.8.4 Puncture wound or laceration

- Seek appropriate medical attention.

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. If crew members encounter a spill created by any others, they will immediately notify the contractor in charge of the spill areas so they can initiate a cleanup action.

14.10 Boating Emergency Hazards

Emergency responses to boating hazards are described in Table H-5. Boat operators will have VHF radios that are capable of communicating with US Coast Guard emergency services and with other boats operating in the immediate work area. USCG monitors channel 16.

Table H-5. Potential boat emergency hazards and responses

Potential Emergency Hazard	Response
Fire or explosion	If manageable, attempt to put out a small fire with a fire extinguisher. Otherwise, call the USCG or 911, evacuate the area (by life rafts, rescue boat, or swimming), and meet at a designated location. The HSO will take roll call to make sure everyone has evacuated safely. Emergency meeting locations will be determined in the field during the daily safety briefings.
Medical emergency/ personal injury	At least two people with current first aid and CPR training will be onboard the vessel at all times. This person will attempt to assess the nature and critical path of the injury, call 911 immediately, and apply first aid/CPR if necessary. Stop work and wait for medical personnel to arrive. Fill out a site accident report.
Falling into an open hatch	Stop work and rescue the person, if safe and necessary. Assess the nature of the injury, and follow the response for medical emergency/personal injury.
Person overboard	Immediately throw a life ring to the person in the water. Have one onboard person(a spotter) keep an eye on the victim and shout the distance (boat lengths) and direction (o'clock) of the victim from the vessel. Stop work and use the vessel to retrieve the person in the water. Approach the person from downstream.
Sinking vessel	Call the USCG immediately. If possible, wait for a rescue boat to arrive to evacuate vessel personnel. See fire/explosion section (above) for emergency evacuation procedures. The HSO will take roll call to make sure everyone has evacuated safely.
Hydraulic oil spill or leak	If the leak/spill is small, immediately apply absorbent pads to control the leak and continue work. If the leak/spill is uncontainable, stop work, call 911 immediately, and wait for assistance. The vessel operator will assess the personal safety hazard associated with the leak/spill and begin evacuation procedures if necessary.
Lack of visibility	If navigation visibility or personal safety is compromised because of smoke, fog, or other unanticipated hazards, stop work immediately. The vessel operator and HSO will assess the hazard and, if necessary, send out periodic horn blasts to notify other vessels potentially in the area of the sampling vessel's location. Move to a secure location (i.e., berth) and wait for visibility to clear.
Loss of power	Stop work and call the USCG for assistance. Vessel personnel should watch for potential collision hazards and notify vessel operator if hazards exist. Secure vessel to a berth, dock, or mooring as soon as possible.
Collision	Stop work and call the USCG for assistance. HSO and vessel operator will assess damage and potential hazards. If necessary, vessel will be evacuated and secured until repairs can be made.

CPR – cardiopulmonary resuscitation
HSO – health and safety officer
USCG – US Coast Guard

14.11 Emergency Routes 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 Avenue
Seattle, WA
206.323.3074

Directions from the vicinity of the LDW to Harborview Medical Center are as follows (Figure H-ii):

From the Duwamish River boat ramp (at South River Street, beneath the 1st Avenue South bridge):

- Drive east on South River Street.
- Turn left on Occidental Avenue South.
- Turn left on East Marginal Way South.
- Turn right on South Michigan Street.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

From the Harbor Island Marina (1001 Southwest Klickitat Way):

- From marina parking lot, turn sharp right onto Klickitat Way Southwest.
- Turn slight right onto Southwest Spokane Street
- Turn slight left to take the ramp toward WA-99 N/I-5/Columbian Way.
- Keep left at the fork in the ramp.
- Stay straight to go onto West Seattle Bridge.
- Merge onto I-5 North via the ramp on the left.
- Take the James Street exit.
- Head east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

From South Park Marina (8604 Dallas Ave South):

- From marina parking lot, turn right onto Dallas Avenue South.
- Turn right onto 16th Avenue South.
- Turn left on East Marginal Way South.
- Look for entrance ramps to I-5 Northbound.
- Drive north on I-5.
- Take the James Street exit.
- Drive east on James Street to 9th Avenue.
- Turn right on 9th Avenue.
- Emergency entrance will be two blocks south on the right.

15 References

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16 Modifications to Health and Safety Plan

Modification to Health and Safety Plan

Date: June 23, 2021
Project No: 180067-02.02
Project Name: Lower Duwamish Waterway Upper Reach Phase II Investigation

Modification: The following amendments and updates are being made to the Health and Safety Plan (HASP) as currently referenced in the HASP document, Exhibit 3, and JSAs.

Masks and Vaccinations – Allow for fully vaccinated staff to not wear masks (if they choose to do so and provided the crews whom they work with are also comfortable with it). Each firm (prime and subconsultants) involved in the work is responsible to follow Washington State Labor and Industries (L&I) Guidance. Key updates can be found in Publication F414-179-000 [06-2021] at https://lni.wa.gov/forms-publications/F414-179-000.pdf. Individuals will have to sign a formal attestation of their vaccination or provide proof of vaccination to their employer in accordance with these requirements. Employers must be able to demonstrate they have verified vaccination status for workers who are not masked or physically distanced. Verification methods may include:

- Creating a log of workers who have verified they've been vaccinated and the date of verification,
- Checking vaccination status each day as workers enter a jobsite, or
- Other methods demonstrating an employer has verified worker vaccination status may also meet the standard.

This is not a mandatory process and individuals can elect to not sign a form or provide information if they prefer to do so. Everyone will still need to have a mask/face covering with them in the event crews find themselves in a situation where wearing a mask would be appropriate, such as being in close contact with others, when requested. These processes will be implemented in accordance with current state and county allowances and L&I requirements.

Short Sleeve Shirts – Field staff will be allowed to wear short sleeve shirts while completing various field sampling/handling/processing activities. We will maintain the goal of preventing dermal contact with contaminated sediments, and ask that individuals who elect to wear short sleeve shirts also wear a longer glove to help prevent contact from occurring. We'll also be asking individuals to maintain good cleaning practices, washing arms/exposed skin at any time sediment may come in contact with someone's skin. If it is found that dermal contact is unavoidable in these situations, other protective measures will need to be implemented. The goal is to prevent dermal contact with contaminated sediment.

Modification to Health and Safety Plan

Reason for Modification:

Masks and Vaccinations – State of Washington and King County guidance has recent changes to Covid guidance to allow for fully vaccinated individuals to not wear face coverings in work settings if they choose to do so, as long as the employer approves and has verified vaccination status. This change to the HASP requirements is being made to provide consistency with Washington State and King County guidance and also with L&I requirements.

Short Sleeve Shirts – due to forecasted high temperatures, this change to the HAPS is being implemented to reduce the potential for field staff to develop heat stress or other heat related issues during implementation of the field work.

Site Personnel Briefed

Name:	Windward Environmental	**Date:**	June 25, 2021
Name:	SEE	**Date:**	June 25, 2021
Name:	Gravity Marine	**Date:**	June 25, 2021
Name:	Holocene Drilling	**Date:**	June 25, 2021
Name:	ConeTec	**Date:**	June 25, 2021
Name:	Northern Marine	**Date:**	June 25, 2021
Name:	Bright Engineering	**Date:**	June 25, 2021
Name:	True North Land Surveying	**Date:**	June 25, 2021
Name:	Stell	**Date:**	June 25, 2021
Name:		**Date:**	
Name:		**Date:**	

Approvals

Field Lead:	Matt Woltman Printed Name	Matt Woltman Signature	June 25, 2021 Date
Project Manager:	Tom Wang Printed Name	Thomas Wang Signature	June 25, 2021 Date

Responsibility is taken, not given. Take responsibility for safety.

EXHIBIT 1.
MODIFICATION TO HEALTH AND SAFETY PLAN FORM

Modification to Health and Safety Plan

Date: ______________________

Project No: 180067-02.02

Project Name: Lower Duwamish Waterway Upper Reach Remedial Design

Modification: ______________________

Reason for Modification: ______________________

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

EXHIBIT 2.
DAILY SAFETY BRIEFING FORM AND JOB SAFETY ANALYSIS SHEETS

Daily Safety Briefing Form

Date: ______________________________

Project No: 180067-02.02

Project Name: Lower Duwamish Waterway Upper Reach Remedial Design

Person Conducting Meeting: ______________ **Health & Safety Officer:** David Templeton **Project Manager:** Tom Wang

TOPICS COVERED:

☐ Emergency Procedures and Evacuation Route	☐ Lines of Authority	☐ Lifting Techniques
☐ Directions to Hospital	☐ Communication	☐ Slips, Trips, and Falls
☐ HASP Review and Location	☐ Site Security	☐ Hazard Exposure Routes
☐ Safety Equipment Location	☐ Vessel Safety Protocols	☐ Heat and Cold Stress
☐ Proper Safety Equipment Use	☐ Work Zones	☐ Overhead and Underfoot Hazards
☐ Employee Right-to-Know/ SDS Location	☐ Vehicle Safety and Driving/ Road Conditions	☐ Chemical Hazards
☐ Fire Extinguisher Location	☐ Equipment Safety and Operation	☐ Flammable Hazards
☐ Eye Wash Station Location	☐ Proper Use of PPE	☐ Biological Hazards
☐ Buddy System	☐ Decontamination Procedures	☐ Eating/Drinking/Smoking
☐ Self and Coworker Monitoring	☐ Near Miss Reporting Procedures	☐ Reviewed Prior Lessons Learned

☐ Field Team Medical Conditions for Emergency Purposes (Confidential): ______________________

☐ Other: ______________________

Weather Conditions: ______________________

Daily Work Scope: ______________________

Site-specific Hazards: ______________________

Safety Comments: ______________________

Attendees

Printed Name	Signature

End of Day Wellness Check

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JSA Addendum

Exhibit 2 of Attachment H: Updated Health and Safety Plan

This document is an addendum to the JSAs (Job Safety Analyses) prepared as Exhibit 2 of Attachment H (Health and Safety Plan) of the Lower Duwamish Waterway Pre-design Investigation Quality Assurance Project Plan Addendum (PDI QAPP Addendum). The following new requirement is being added for upcoming Phase II PDI field work, and applies to the Field Activities, Sediment Sampling, Decontamination Activities, Investigation-Derived Waste Management, Structure and Bank Inspection, Sample and Laboratory Glassware Handling JSAs and Field Activities – Night Work:

- A PFD is required PPE when working within 10 feet of water's edge (when no railing present) or when working on banks.

The following table will be used to document review and approval of JSAs prior to Phase II field activities.

JSA Number	JSA	Date Reviewed	Reviewed by	Date Approved	Approved by
001	Field Activities				
002	Sediment Sampling				
003	General Boating Activities				
004	Decontamination				
006	Anchor QEA Motor Vehicle Operation				
007	Investigation-derived Waste Management				
008	Structure and Bank Inspection				
009	Sample and Laboratory Glassware Handling				
010	Field Activities – Night Work				

Job Safety Analysis

Field Activities

Project Name: Lower Duwamish Waterway Remedial Design	**Project Number:** 180067-02.01	**JSA Number:** 001	**Issue Date:** May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Envronmental, LLC	**Analysis by:** K. Gross	**Analysis Date:** May 29, 2020
Work Operation: Field activities	**Superintendent/Competent Person:** M. Woltman	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • Modified Level D—Long pants, long sleeves, and/or Tyvek coveralls if handling potentially contaminated media, and steel-toed footwear conforming to ASTM International (ASTM) F2412-05/ASTM F2413-05, safety glasses/splash goggles, nitrile gloves, high-visibility safety vest, and protective face mask • Depending on activity, the following PPE may also be required: hard hat, outer gloves, face shield, and, if boating, U.S. Coast Guard-approved personal flotation device (PFD; see cold stress section for cold-weather PFD information)		**Reviewed by:** M. Woltman **Approved by:** T. Shaner	**Reviewed Date:** May 29, 2020 **Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
General	COVID-19	• Refer to Health and Safety Plan (HSP).	Refer to HSP.
If boating		• Follow the Job Safety Analysis (JSA) for boating activities.	
Outdoor, physical activity	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.

PLAYING IT SAFE

Job Safety Analysis

Field Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity (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). • 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.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • 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.

PLAYING IT SAFE

Field Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity (continued)	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] and fauna [e.g., bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • 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).	• Ensure that insect repellent is available. • 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.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state or provincial boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Sediment Sampling

Project Name: Lower Duwamish Waterway Remedial Design	**Project Number:**	**JSA Number:** 002	**Issue Date:** May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Envronmental, LLC	**Analysis by:** T. Do	**Analysis Date:** May 29, 2020
Work Operation: Sediment sampling	**Superintendent/Competent Person:** T. Do	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • Modified Level D—Long pants, long sleeves, and/or Tyvek coveralls if handling potentially contaminated media, steel-toed footwear conforming to American Society for Testing and Materials International (ASTM) F2412-05/ASTM F2413-05, safety glasses/splash goggles, hard hat, high-visibility safety vest, medical face mask, and nitrile gloves • Depending on activity, the following personal protective equipment (PPE) may also be required: waders and wader boots, face shield, and, if boating, U.S. Coast Guard-approved personal flotation device (PFD).		**Reviewed by:** S. McGroddy **Approved by:** S. McGroddy	**Reviewed Date:** May 29, 2020 **Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
General	COVID-19	• Refer to Health and Safety Plan (HSP) (Attachment H).	Refer to HSP (Attachment H).
If boating		• Follow the Job Safety Analysis (JSA) for boating activities.	
If using glassware		• Follow the JSA for handling glassware.	

PLAYING IT SAFE

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Sediment sample retrieval and processing	Injury from hand and power tool operation (e.g., spatula or drill)	• Be aware of sharp edges on hand tools (e.g., spatulas, knives, drill bits, and saw blades). • Be aware of electrical connections and water hazards when working with electric or battery-operated tools. • Ensure that all tools are working properly; repair or replace defective tools. Repair any defective tools when unplugged and off. • Keep guards on power tools when not in use. • Corrective actions may involve installing guards over exposed, rotating parts; isolating or de-energizing equipment; establishing exclusion zones around high-hazard areas; and constructing guardrails around mechanical equipment to prevent inadvertent contact.	• Inspect tools to ensure that they are in good working order. • Inspect electrical connections (if applicable). • Inspect tools periodically to ensure dry and clean operation. • Identify potential pinch, grab, crush, and struck-by hazards.
Sediment sample retrieval and processing (continued)	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.
	Slips, trips, and falls	• Avoid walking while writing or texting—maintain a heads-up posture. • Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants/seaweed, thick mud, 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. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.
	Ingestion of contaminants, or skin or eye contact with contaminants	• Wear appropriate PPE to prevent/reduce exposure. • Contact 911, as necessary; perform CPR if breathing stops. • Move exposed person away from source of contamination and rinse mouth. If exposure to skin occurs, promptly wash contaminated skin using soap or mild detergent and water. Rinse eyes with large amounts of water. • Follow decontamination procedures as outlined in the HSP.	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off of the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.

Job Safety Analysis

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Pinch points	• If boating, secure any unsecured objects on deck; unsecured items may shift on deck quickly in wave, current, or engine acceleration conditions. • Maintain a safe distance from closing mechanisms and moving parts on sampling gear. • Avoid placing hands or self between boat and dock/piles.	
Sediment sample retrieval and processing (continued)	Wading	• Be aware of potentially slippery surfaces and tripping hazards such as fallen brush, logs, rocks, and other debris. Wear footwear that has sufficient traction. • Be aware of water depth and potential drop-offs. • Be aware of existing and projected river flows. • Wear knee or chest waders as appropriate for traction and to protect against cold water. • Keep extra dry clothes on hand, including socks. • Consider carrying a walking staff for balance. • Always wear a PFD, even if water looks shallow or slow; drop-offs occur and water is often moving faster than it looks.	• Inspect work area for tripping hazards visible from streambank. • Inspect waders for leaks. • Check depths and flows before wading. • Ensure that a change of dry clothes is available if wading in cold weather or cold water conditions. • Inspect PFDs for integrity, particularly the cartridge charge on inflatable PFDs.
	Diving	• Follow safety checklists for diving operations. • Assign responsibilities for all dive team members. • Comply with all applicable requirements of Washington Department of Labor & Industry Standards for Commercial Diving Operations (Washington Administrative Code [WAC] 296-37). • Provide a safe practices manual for each diving mode per WAC 296-37-530 before beginning dive operations.	• Contractor will produce a site-specific dive plan for each diving operation; the plan will that specifyies the means and methods that will be used to comply with all required elements of Washington State's diving standards.
Working outdoors	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.

Sediment Sampling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors (continued)	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite, hypothermia, and other cold-related illness. • 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.	• 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). • 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.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • 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 has ceased for 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 (fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellant.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state or provincial boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity, and to review it with their supervisor during their daily safety meeting.

Job Safety Analysis

General Boating Activities

Project Name: Lower Duwamish Waterway Remedial Design	Project Number: 180067-02.01	JSA Number: 003	Issue Date: May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Envronmental, LLC	**Analysis by:** K. Gross	**Analysis Date:** May 29, 2020
Work Operation: General boating activities	**Superintendent/Competent Person:** M. Woltman	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • U.S. Coast Guard (USCG)-approved personal flotation device (PFD; see cold stress section for cold-weather PFD information)		**Reviewed by:** M. Woltman	**Reviewed Date:** May 29, 2020
		Approved by: T. Shaner	**Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
General	COVID-19	• Refer to Health and Safety Plan (HSP).	• Refer to HSP.
Walking on deck	Pinch points	• Secure any unsecured objects on deck; they may shift quickly in wave, current, or engine acceleration conditions. • Maintain a safe distance from closing mechanisms and moving parts, such as on sampling gear. • Avoid placing your hands or yourself between the boat and the dock or piles.	• Docks, piers and shoreline areas should be approached slowly.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Slips, trips, and falls	• Avoid walking while writing or texting—maintain a heads-up posture. • Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants or seaweed, thick mud, 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. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions. • Keep rope lines neatly coiled and stowed. Avoid stepping on or over lines.	• Routinely inspect work area for unsafe conditions. • All crew members should watch for hazards such as approaching vessels or wakes. It should never be assumed that other crew members see such hazards.
	Exceeding boat capacity	• Keep the number of passengers and equipment as posted on boat placards within limits at all times. If conditions warrant, reduce capacity to maintain boat stability.	• Ensure that field team is aware of limits and adheres accordingly.
Walking on deck (continued)	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.
Working outdoors	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. • If the combined air and water temperature is below 90 degrees Fahrenheit (˚F), wear a USCG-approved float coat, Mustang-type bib coveralls, or one-piece survival suit. • 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.

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Rain or snow	• Wear appropriate PPE (rain gear). • 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.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • 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 onboard.
	Fog	• Wait for fog to lift for adequate visibility.	• Review weather forecast prior to field work.
Working outdoors (continued)	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. • If the time between seeing the lightening and hearing thunder is 3 seconds or less, the boat should be moved near a tall structure such as a bridge and remain there until 30 minutes after the last thunder is heard.	• Obtain weather forecast and updates as needed.
	High river flows or high waves	• Be aware of waves and forecasts and recent rainfall in your watershed.	• Have forecast available.
	High winds	• Wear goggles or safety glasses if dust or debris are visible. • Stow or secure loads or equipment that could be moved by wind, particularly when underway.	• Review weather forecast prior to field work. • Ensure that goggles or safety glasses are onboard.
	Biological hazards (e.g., mosquitoes)	• Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent.	• Ensure that insect repellent is onboard.

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Vessel emergencies	Person overboard	If you witness someone fall overboard: • Yell, "Person overboard!" • Throw a flotation device immediately. • If the engine is running, take it out of gear and swing the stern clear to keep from hitting the person. • Call 911 or USCG as appropriate. • Assign a spotter to keep the person in sight at all times. • Contact nearby vessels for assistance. • Recover the person from the water. If you fall overboard: • Hold your mouth and nose closed and protect your head. • When you reach the surface, look for movement, listen for sounds, and call for help. Use the whistle attached to the PFD and activate the beacon light. • It is only sensible to swim if there is reason to believe you have a chance of reaching your destination. Too much movement in cold water causes hypothermia.	• Ensure that flotation devices are available. • Ensure that team wears PFDs. • Inspect PFDs for integrity, particularly the cartridge charge on inflatable PFDs. • All crew members must be trained so that they know the location and use of onboard safety equipment.
Vessel emergencies (continued)	Fire, abandon ship	• Be prepared to abandon ship in case of major fire (too large to control with a fire extinguisher), or other emergency. • Only the boat captain can order abandon ship. • Communicate intent to abandon ship to all personnel onboard. • Notify USCG and nearby vessels of intent to abandon ship. • Call 911. • Notify the Project Manager and Field Lead, if time permits. • Be aware of the propeller position before abandoning ship. • Identify a rally point for all personnel. • Know the dangers of hypothermia. • Use the buddy system to support injured personnel.	• For vessels less than 25 feet long, at least one fire extinguisher must be onboard. For vessels greater than 26 feet in length but less than 40 feet, at least two fire extinguishers must be onboard. • Review abandon ship procedures with field team prior to work.
Navigation	Boat traffic	• Maintain a safe operating distance from shoreline and other vessels.	• Be aware of on-water surroundings. • The VHF radio must be turned on and monitored.

PLAYING IT SAFE

Job Safety Analysis

General Boating Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Motor vehicle operation and trailering	Boat not secured properly	• Ensure that latches, straps, antennas, and onboard gear are secure. Ensure that motor is up and lights are plugged in for driving. • Follow Job Safety Analysis (JSA) for motor vehicle operation. • Crew members should not untie mooring lines until instructed to do so by the vessel operator.	• Inspect around entire boat before driving.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If professional captained vessel is not in use, boat operators must take appropriate state or provincial boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Decontamination Activities

Project Name: Lower Duwamish Waterway Remedial Design	Project Number:	JSA Number: 004	Issue Date: May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Environmental, LLC	**Analysis by:** T. Do	**Analysis Date:** May 29, 2020
Work Operation: Decontamination activities	**Superintendent/Competent Person:** T. Do	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • Modified Level D—Long pants, long sleeves, and/or Tyvek coveralls if handling potentially contaminated media, steel-toed footwear conforming to American Society for Testing and Materials International (ASTM) F2412-05/ASTM F2413-05, safety glasses/splash goggles, high-visibility safety vest, medical face mask, and nitrile gloves • Depending on activity, the following personal protective equipment (PPE) may also be required: hard hat, face shield, and, if boating, U.S. Coast Guard-approved personal flotation device (PFD).		**Reviewed by:** S. McGroddy **Approved by:** S. McGroddy	**Reviewed Date:** May 29, 2020 **Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
General	COVID-19	• Refer to Health and Safety Plan (HSP) (Attachment H)	Refer to HSP (Attachment H).
If boating		• Follow the Job Safety Analysis (JSA) for boating activities.	
Decontamination area set up	Vehicle, heavy equipment traffic, or boat traffic in work area	• Wear high-visibility safety vest and hard hat PPE. • Be alert when working around heavy equipment and/or other boats, especially if wearing hearing protection.	• Ensure that safety vests are available for staff and visitors.
	Muscle strain or injuries from improper lifting	• Use proper lifting techniques or ask for assistance with heavy objects. • If boating, avoid carrying objects directly onto or off of the boat; rather, load/unload objects while on the boat to/from the pier/shore.	• Evaluate weight and center of gravity of heavier items prior to lifting or moving.
	Biological hazards (fauna [e.g., ticks, bees, spiders, and mosquitoes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent.	• Ensure that insect repellent is available. • Inspect clothing and skin for insects (e.g., ticks) after working in insect-prone areas.

Job Safety Analysis

Decontamination Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Decontamination activities	Injury from hand and power tool operation (e.g., spatula or drill)	• Be aware of sharp edges on hand tools (e.g., spatulas, knives, drill bits, and saw blades). • Be aware of electrical connections and water hazards when working with electric- or battery-operated tools. • Ensure that all tools are working properly; repair or replace defective tools. Repair any defective tools when unplugged and off. • Keep guards on power tools when not in use.	• Inspect tools to ensure that they are in good working order. • Inspect electrical connections (if applicable). • Inspect tools periodically to ensure dry and clean operation.
	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.
	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. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.
	Ingestion of contaminants or decontamination fluids, or skin or eye contact with contaminants or decontamination fluids	• Wear appropriate PPE to prevent/reduce exposure. • Contact 911, as necessary; perform CPR if breathing stops. • Move exposed person away from source of contamination and rinse mouth. If exposure to skin occurs, promptly wash contaminated skin using soap or mild detergent and water. Rinse eyes with large amounts of water. • Follow decontamination procedures as outlined in the HSP.	• Ensure that decontamination procedures are on hand and are reviewed. • Ensure that PPE and rinsing water are available.
Working outdoors	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.

PLAYING IT SAFE

Job Safety Analysis

Decontamination Activities

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors (continued)	Cold stress	• Provide shelter (enclosed, heated environment) to protect personnel during rest periods. • Educate workers to recognize the symptoms of frostbite, hypothermia and other cold-related illness. • 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.	• 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). • 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.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • 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 has ceased for at least 30 minutes. Disconnect and do not use or touch electronic equipment.	• 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.

Decontamination Activities

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state or provincial boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity, and to review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Project Name: Lower Duwamish Waterway Remedial Design	**Project Number:** 180067-02.01	**JSA Number:** 006	**Issue Date:** May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Envronmental, LLC	**Analysis by:** K. Gross	**Analysis Date:** May 29, 2020
Work Operation: Anchor QEA motor vehicle operation	**Superintendent/Competent Person:** Vehicle Driver	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • Wear seat belt at all times • Make sure that clothing will not interfere with driving		**Reviewed by:** M. Woltman	**Reviewed Date:** May 29, 2020
		Approved by: T. Shaner	**Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Anchor QEA motor vehicle operation	Unfamiliar with the vehicle	• Allow yourself some time to get familiar with an Anchor QEA vehicle, a rental vehicle, or one not used often. • Test the lights, windshield wipers, hazard lights, horn, parking brake, and other important functions. • Review the dashboard controls, steering radius, and overhead and side clearances. • Allow extra side, front, and back space around the vehicle while driving or parking an unfamiliar vehicle. • Adjust mirrors and the seat while the vehicle is in park. • Drive slowly in confined locations, as in a parking garage, parking lots, or industrial settings. Confirm adequate clearances by sight before turning or backing up in tight or unfamiliar locations. • Use a second person to be a spotter outside the vehicle if needed in tight spaces.	• Inspect fluid levels and air pressure in tires, adjust mirrors and seat positions appropriately, monitor the fuel level, and fill up when the fuel level is low

PLAYING IT SAFE

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Speed and braking	• Fasten and properly adjust the seat belt. • Obey all posted and designated speed limits. • Radar detectors are prohibited in all company-owned, leased, or rented vehicles. • Reduce travel speed during hazardous conditions (e.g., rain, fog, or snow). • Identify whether your vehicle has Anti-Lock Brakes (ABS). If it does, DO NOT pump the brakes to stop when the vehicle has begun to skid. Apply steady pressure to the brakes. If the vehicle does not have ABS, pump the brakes to stop during slippery conditions.	• Seatbelt • Identify designated speed limits • Determine if vehicle has ABS
Anchor QEA motor vehicle operation (continued)	Distance spacing	• Continually check your rear and side view mirrors. • Use the 3-second rule to keep a safe distance between vehicles. • Increase the 3-second rule as necessary during hazardous travel conditions. • Regularly scan the area you will be entering in the next 10 to 12 seconds. • Always leave yourself an "out" during travel. • When stopping, make sure that you leave enough distance between you and the car in front of you. You should be able to see the rear tires of the vehicle in front when stopped. • Obey the speed limit and traffic regulations. • When at a red light and it turns green, use the "delayed start" technique, by counting to three before you take your foot off the brake. • DO NOT TAILGATE. • Keep headlights (and running lights, if available) on for maximum visibility.	• Seatbelt
	Skids	• If the vehicle has begun to skid out of control, turn the steering wheel in the direction of the skid and re-adjust the wheel, as necessary. • Reduce speed during hazardous travel conditions. • Use 4-wheel drive, if available, when driving vehicles off-road, on steep inclines, or in muddy conditions. • Do not take vehicles off-road if they cannot be operated safely in such conditions.	• Seatbelt
	Blind spots	• Become familiar with any blind spots associated with your vehicle. • Adjust mirrors to give the maximum viewing area. • Use your directional devices to signal all turns and when changing lanes; check rear and side view mirror and glance over your shoulder to check that the lane is clear. • Avoid other driver's blind spots; slow down and let the other vehicle pass. • If parked for an extended period and staying in the vehicle, be sure to inspect the area for changed conditions (e.g., a car that moved in behind you) before leaving.	• Seatbelt • Mirrors

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Backing	• Back into parking spaces upon arrival whenever possible. • Perform a 360-degree walk around the vehicle before backing to identify any new conditions or obstructions. • Use a spotter when backing whenever possible. • Understand hand signals. • Sound the horn prior to backing. • Check the rear and side view mirrors prior to backing. • Back slowly in areas of obstructed vision. • Anticipate others who may be backing out into your pathway and adjust accordingly.	• Seatbelt • Mirrors
Anchor QEA motor vehicle operation (continued)	Distractions (e.g., cell phones, reading maps or directions, eating)	• Do not engage in distracted driving—focus on operating the vehicle, and on your surroundings (e.g., road conditions and other drivers). • Obey state or local laws regarding cell phone use, at a minimum. • Certain clients prohibit cell phone use regardless of the state you are operating in—know your client's policy. • Use hands-free devices (not hand-held cellular phones) while driving. • Pull over to the side of the road when making a call or checking directions.	• Seatbelt • Hands-free devices connected and ready for use
	Accidents	• In the event of an accident, use the following procedures: – Stop, call for medical assistance, notify police, and complete an accident report and submit it to your supervisor. – Notify the Project Manager (PM) and Field Lead (FL). – Complete the appropriate incident investigation reports. – Contact Sara Weiskotten, Operations Liaison, at (857) 445-4987. – Contact Diana Reynolds, Insurance Liaison, at (302) 236-8403.	• Seatbelt
	Influenced by drugs or alcohol	• NEVER DRIVE UNDER THE INFLUENCE OF DRUGS OR ALCOHOL. • Keep in mind that the person in another vehicle may be under the influence of controlled substances, and be prepared for erratic or sudden driving changes on their part.	• Seatbelt
	Driver attitude	• Do not operate any vehicle when abnormally tired, temporarily disabled (i.e., injured), or under the influence of drugs or alcohol. • Keep an even temper when driving. Do not let the actions of others affect your attitude. • Do not allow yourself to become frustrated, rushed, distracted, or drowsy.	• Seatbelt

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
	Fatigue	• Stop and rest if fatigued. Exit the road and enter a safe area. Rest until fully refreshed. • Be aware that certain medications (such as cold or allergy medicines) may make you drowsy when driving a vehicle.	• Seatbelt
	Vehicle loading	• DO NOT OVERLOAD the vehicle. • Secure all equipment and supplies within the body of the vehicle using proper tie-downs. • Do not block side view mirrors with the load. • Do not transport U.S. Department of Transportation (DOT)-manifested hazardous materials. • Dispatch all equipment and personnel with proper forms and identification.	• Seatbelt
Anchor QEA motor vehicle operation (continued)	Equipment failure	• Perform daily inspections of your vehicle. • Maintain vehicle safety equipment (e.g., mirrors, alarms, horns, wipers, lights, and brakes). • Maintain the vehicle (e.g., tire pressure and fluid levels). • Any vehicle with mechanical defects that may endanger the safety of the driver, passengers, or the public shall not be used. • Ensure that appropriate safety equipment is in the vehicle. Safety equipment should include a spare tire, jack, first-aid kit, fire extinguisher, and flashlight. Flares and/or reflective triangles should be available in larger trucks. • Ensure that the proper documentation is in the vehicle. Documentation should include an operations manual for the vehicle, insurance card, vehicle registration, and accident forms.	• Inspect and maintain the vehicle

Training Requirements:

- All drivers are required to have a valid driver's license, and all vehicles must have appropriate state vehicle registration and inspection stickers. The use of hand-held wireless devices is prohibited while driving any vehicle for business use at any time, for personal use during business hours, and as defined by law.
- **If operating a vehicle or vehicle and trailer with a capacity greater than 10,000 pounds, U.S. Department of Transportation regulations may apply. Contact the PM prior to any travel in this configuration.**

Anchor QEA Motor Vehicle Operation

- All assigned employees are required to read, familiarize themselves with the contents of this Job Safety Analysis, and sign the signature page before the operation of an Anchor QEA vehicle, and review it with their supervisor during their daily safety meeting.
- All assigned employees are required to enroll and complete the Smith System Virtual Driving training programs (*Distracted Driving* and *Small Vehicle Forward - Five Keys to Safe Driving*) prior to driving an Anchor QEA vehicle.

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Vehicle Operation Job Safety Analysis Acknowledgement Form

The Anchor QEA Motor Vehicle Operation Job Safety Analysis must be read, understood, and signed before the operation of any Anchor QEA vehicle. My signature below certifies that I have read and understand the procedures presented in the Anchor QEA Motor Vehicle Operation Job Safety Analysis and have completed the Smith System Virtual Driving *Distracted Driving* and *Small Vehicle Forward - Five Keys to Safe Driving* training programs.

Date	Name (print)	Signature

Job Safety Analysis

Anchor QEA Motor Vehicle Operation

Date	Name (print)	Signature

Job Safety Analysis

Investigation-derived Waste Management

Project Name: Lower Duwamish Waterway Remedial Design	Project Number:	JSA Number: 007	Issue Date: May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Environmental, LLC	**Analysis by:** T. Do	**Analysis Date:** May 29, 2020
Work Operation: Investigation-derived waste management	**Superintendent/Competent Person:** T. Do	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • Modified Level D— Long pants, long sleeves, and/or Tyvek coveralls if handling potentially contaminated media, steel-toed footwear conforming to American Society for Testing and Materials International (ASTM) F2412-05/ASTM F2413-05, safety glasses/splash goggles, high-visibility safety vest, medical face mask, and nitrile gloves • Depending on activity, the following personal protective equipment (PPE) may also be required: hard hat, face shield, and, if boating, U.S. Coast Guard-approved personal flotation device (PFD).		**Reviewed by:** S. McGroddy **Approved by:** S. McGroddy	**Reviewed Date:** May 29, 2020 **Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
IDW management – general	Splash	• Wear the required PPE at all times. • Use care to minimize splashing or smearing of IDW during handling and containerization.	• Inspect PPE upon donning and periodically during tasks.
	COVID-19	• Refer to Health and Safety Plan (HSP) (Attachment H)	• Refer to HSP (Attachment H)
Containerizing investigation-derived waste (IDW) at the source	Lifting	• Use care when lifting IDW to redistribute from one container (e.g., bowls and buckets) to another at the source. • Seek assistance if loads are too heavy, or if you are experiencing fatigue. • Fill containers only to the degree that will be manageable in the future (e.g., half full) and to limit weight.	• Inspect containers for competency (i.e., no cracks, and handles in good repair).
	Pinch points	• Wear hand protection when closing containers.	• Inspect containers for rust or sharp edges prior to opening or closing.

PLAYING IT SAFE

Job Safety Analysis

Investigation-derived Waste Management

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Relocating or staging IDW containers	Lifting	• Use task-specific tools whenever possible to move full containers (i.e., hoists, dollies, and vehicles). • When task-specific tools are not available, use the buddy system to move containers that are reasonable to lift. • Stage containers in areas protected from heavy traffic and weather, if possible.	• Ensure tools are in good repair. • Assess IDW container weight prior to moving.
Relocating or staging IDW containers (continued)	Pinch points or crushing	• Use tools to achieve the final arrangement when staging containers—do not place hands on the edges of containers while moving them into place. • Stand well clear of containers being moved in case they become dislodged from their handling tool during transport. • Do not stack IDW containers, as this poses a risk for container toppling and damage. • Place containers on a wooden pallet for easy transfer using a pallet jack, if possible.	• Inspect containers for evidence of cracks or rust.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity, and to review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Structure and Bank Inspection

Project Name: Lower Duwamish Waterway Remedial Design	**Project Number:** 180067-02.01	**JSA Number:** 008	**Issue Date:** May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLCand Windward Envronmental, LLC	**Analysis by:** K. Gross	**Analysis Date:** May 29, 2020
Work Operation: Inspection of structures and banks	**Superintendent/Competent Person:** M. Woltman	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • Modified Level D—Long pants, long sleeves, and/or Tyvek coveralls if handling potentially contaminated media, and steel-toed footwear conforming to ASTM International (ASTM) F2412-05/ASTM F2413-05, safety glasses/splash goggles, hard hat, nitrile gloves, high-visibility safety vest, and protective face mask • If boating, U.S. Coast Guard-approved personal flotation device (PFD; see cold stress section for cold-weather PFD information)		**Reviewed by:** M. Woltman **Approved by:** T. Shaner	**Reviewed Date:** May 29, 2020 **Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
General	COVID-19	• Refer to Health and Safety Plan (HSP).	Refer to HSP.
If boating		• Follow the Job Safety Analysis (JSA) for boating activities.	
Walking and working in natural environments	Slips, trips, and falls	• Avoid walking while writing or texting—maintain a heads-up posture. • Be aware of potentially slippery surfaces, including boat decks, riprap, muddy or algae-covered rocks, shoreline plants or seaweed, thick mud, and tripping hazards such as vines and logs. • 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. • Be cautious when entering or exiting the vessel, and load/unload items onto/off of the pier or shore once boarded. • Keep all areas clean and free of debris to prevent any trips and falls. • Notify the field team members of any unsafe conditions.	• Routinely inspect work area for unsafe conditions.

Job Safety Analysis

Structure and Bank Inspection

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Walking and working in natural environments (continued)	Wading	• Be aware of potentially slippery surfaces and tripping hazards such as fallen brush, logs, rocks, and other debris. Wear footwear that has sufficient traction. • Be aware of the water depth and potential drop-offs. • Be aware of existing and projected river flows. • Wear knee or chest waders as appropriate for traction and to protect against cold water. • Keep extra dry clothes on hand, including socks. • Consider carrying a walking staff for balance. • Always wear a PFD, even if water looks shallow or slow; drop-offs occur and water is often moving faster than it looks.	• Inspect work area for tripping hazards visible from streambank. • Inspect waders for leaks. • Check depths and flows before wading. • Ensure that change of dry clothes is available if wading in cold weather or cold water conditions. • Inspect PFDs for integrity, particularly the cartridge charge on inflatable PFDs.
	Diving	• Follow safety checklists for diving operations. • Assign responsibilities for all dive team members. • Comply with all applicable requirements of Washington Department of Labor & Industry Standards for Commercial Diving Operations (WAC 296-37). • Provide a safe practices manual for each diving mode per WAC 296-37-530 before beginning dive operations.	• Contractor will produce a site-specific dive plan for each diving operation that specifies the means and methods that will be used to comply with all required elements of Washington State's diving standards.
	Biological hazards (flora [e.g., poison ivy and poison oak] and fauna [e.g., bees, spiders, mosquitoes, and snakes])	• Be aware of likely biological hazards in the work area. • Wear appropriate clothing (i.e., hat, long-sleeve shirt, long pants, leather gloves, boots, and Tyvek coveralls, as appropriate), and apply insect repellent. • 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).	• Ensure that insect repellent is available. • 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.

Job Safety Analysis

Structure and Bank Inspection

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Working outdoors	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). • 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.	• Review weather forecast prior to field work. • Inspect PPE daily prior to use. • 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.	• 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.

Structure and Bank Inspection

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state or provincial boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Sample and Laboratory Glassware Handling

Project Name: Lower Duwamish Waterway Remedial Design	**Project Number:**	**JSA Number:** 009	**Issue Date:** May 29, 2020
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Envronmental, LLC	**Analysis by:** T. Do	**Analysis Date:** May 29, 2020
Work Operation: Sample and laboratory glassware handling	**Superintendent/Competent Person:** T. Do	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • Modified Level D—Long pants, long sleeves, and/or Tyvek coveralls if handling potentially contaminated media, steel-toed footwear conforming to American Society for Testing and Materials International (ASTM) F2412-05/ASTM F2413-05, safety glasses/splash goggles, high-visibility safety vest, medical face mask, and nitrile gloves • Depending on activity, the following personal protective equipment (PPE) may also be required: hard hat, face shield,, and, if boating, U.S. Coast Guard-approved personal flotation device (PFD).		**Reviewed by:** S. McGroddy **Approved by:** S. McGroddy	**Reviewed Date:** May 29, 2020 **Approved Date:** May 29, 2020

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
General	COVID-19	• Refer to Health and Safety Plan (HSP) (Attachment H).	• Refer to HSP (Attachment H).
Transporting and using glassware	Breakage of containers during field activities	• Use appropriately sized tubs or bottle carriers with dividers to prevent bottle-to-bottle contact during transport. • Consider using coated glassware, if practicable. • Carry oversized bottles in tubs or bottle carriers, using both hands during transfer, to the sampling vessel and whenever the vessel is underway.	• Ensure dividers are sufficient and will remain in place during transport.
	Faulty glassware	• Replace any glassware that is chipped, nicked, or cracked.	• Inspect glassware before use.
	Impact with equipment and other objects	• Use care when loading and unloading sampling equipment. • Minimize the handling of individual containers to the extent possible.	

PLAYING IT SAFE

Job Safety Analysis

Sample and Laboratory Glassware Handling

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Filling sample containers	Over-tightening of bottle lids causing breakage	• Avoid use of excessive force to tighten bottle caps (i.e., finger tight).	
	Breakage during sample collection	• Place containers in plastic tubs between aliquots to limit contact with hard surfaces. • Place containers on a stable and non-slip surface during collection. • Use the buddy system as needed to hold bottles during filling.	
Filling sample containers (continued)	Contact with sediment sample	• Wear nitrile gloves and protective eyewear to prevent skin and eye contact if a container is damaged. • Do not open preserved bottles until necessary.	• Change gloves when damaged or soiled
Packing samples for shipment	Breakage during packing and shipment	• Use bottle wraps, foam sleeves, or bubble wrap to prevent bottle contact in the cooler. • Pack coolers snugly, but do not over pack.	• Ensure glass bottles do not touch to minimize potential breakage during transport.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including, but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity, and to review it with their supervisor during their daily safety meeting.

Job Safety Analysis

Field Activities – Night Work

Project Name: Lower Duwamish Waterway Remedial Design	Project Number: 180067-02.02	JSA Number: 010	Issue Date: 6/14/21
Location: Seattle, Washington	**Contractor:** Anchor QEA, LLC and Windward Environmental, LLC	**Analysis by:** G. Timm	**Analysis Date:** 6/14/21
Work Operation: Field activities – night work	**Superintendent/Competent Person:** M. Woltman	**Revised by:** NA	**Revised Date:** NA
Required Personal Protective Equipment (PPE): • PPE in accordance with other JSAs and the HASP		**Reviewed by:** C. Janisch	**Reviewed Date:** 6/14/21
		Approved by: T. Shaner	**Approved Date:** 6/14/21

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
If boating	Poor lighting	• Follow the Job Safety Analysis (JSA) for boating activities. • Utilize navigation lights. • Utilize flashlights and other lights on board when working. • Illuminate the boat deck when working on the boat (subcontractor-provided). • If working on a barge, illuminate the deck of the barge (subcontractor-provided). • Utilize lights on PFDs. • Account for all staff prior to moving any large equipment. • Periodically account for all staff. • PFDs to be worn at all times.	• Make sure navigation lights are functional. • Make sure flashlights and other lights are available and working. • Make sure PFD lights are functioning. • Make sure contractor-supplied lighting is acceptable.

Job Safety Analysis

Field Activities – Night Work

Work Activity	Potential Hazards	Preventive or Corrective Measures	Inspection Requirements
Outdoor, physical activity	Poor Lighting	• 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. • Do not enter the water after sunset or before sunrise.	• Routinely inspect work area for unsafe conditions. • Make sure all lights are functioning and in good order.

Training Requirements:

- All personnel working on hazardous waste sites must receive appropriate training as required by 29 Code of Federal Regulations (CFR) 1910.120(e), including but not limited to initial 40-hour, 8-hour supervisor, and annual 8-hour refresher trainings.
- Medical clearance must be received on an annual basis as required by 29 CFR 1910.120(f).
- If boating is involved, and a professional captained vessel is not in use, boat operators must take the appropriate state or provincial boater safety courses.
- All assigned employees are required to familiarize themselves with the contents of this JSA before starting a work activity and review it with their supervisor during their daily safety meeting.

EXHIBIT 3.
PHASE 1 CONSTRUCTION RESTART COVID-19 JOB SITE REQUIREMENTS

Field Program COVID-19 Management Plan

Date:
Project No: 180067-02.02
Project Name: Lower Duwamish Waterway Upper Reach Remedial Design

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. 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.

<u>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.</u> 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 management plan after review by Health and Safety. In summary:

1. Field programs will follow this Field Program COVID-19 Management Plan.
2. 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.
3. Travel will be reviewed on a case-by-case basis with the preferred method being individual vehicles. All forms of travel must still follow social distancing, applicable face covering, and other relative guidance. If it is believed that travel by plane, bus, or train is necessary for field efforts, the following evaluation process must be followed:
    a. Is there a reasonable alternative? (other staff that could drive, subcontractor, delay work, etc.)
    b. Are there travel restrictions in place for where the travel would be from or to? (not allowed in, self-isolation period, etc.)
    c. Are there remote options? (FaceTime, WebEx, Zoom, subcontractor, etc.)
    d. Collaborate with the regional lead and H&S for review and consideration.
4. 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.

5. Field project schedules, modifications, and regulatory requirements will be discussed with the client representatives.
6. Human Resources is coordinating options for staff who have workload limited by travel restrictions.

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, 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

- Understand the community exposure and travel history of all employees. If an employee has traveled to an affected country outside the United States or has had exposure to infected individuals within the United States, we require a self-isolation period or testing as determined in coordination with WorkCare.
  - The following link provides the CDC list of countries to avoid non-essential travel: 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
- 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.

- Travel will be reviewed on a case-by-case basis with the preferred method being individual vehicles. Wear cloth face coverings in public settings, in addition to social distancing measures, including travel to the site, grocery stores, and picking up to-go food.
- A significant percentage of people with COVID-19 are asymptomatic; therefore, the use of masks or cloth face coverings is required when social distancing cannot be maintained. 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.
- If employees feel that they are sick or showing symptoms, they are required to stay home and not report to work. They should call their manager and Project Manager immediately and notify them that they are sick. Showing up to work with symptoms will result in the employee being asked to leave to avoid potentially exposing others to the virus.
- If employees are showing symptoms, it is recommended that they contact their healthcare provider for medical advice. This could include an examination and testing as recommended by their healthcare provider. If you feel the need to visit a medical professional, it is recommended that you contact their office first to determine when you should visit.
- If employees show any symptoms, they will be asked to leave and not return until they have been released by WorkCare to return. It is requested that they submit a physician's note 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
- Some projects may require temperature readings prior to entry to a project site. Anchor QEA supports privacy concerns, and if a temperature reading 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.
- For projects that do not have an established daily screening, the WorkCare screening portal is to be used.
- 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.

- Symptoms include cough, difficulty breathing, fever, losing sense of taste or smell, or common cold or flu symptoms.
- 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.

On-Site Preventative Measures and Cleaning Requirements

- All employees 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.
- The first step to control spread of the virus at the project job site is focused on hygiene. All employees 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.
- Employees 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 an employee becomes ill while on site, they should return to their hotel room or local home, contact their healthcare provider, and follow their guidance. The employee's manager should be contacted immediately. Our Health and Safety representatives will follow up with the employee. If the employee has a confirmed or presumed case as determined by a healthcare provider, we will follow our procedures as outlined in this document. If the employee is not able to transport themselves, local emergency responders will be called as per company protocol.

Case Response and Equipment & 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, sore throat, or new loss of taste or smell. Some of the less common symptoms that have been reported are gastrointestinal symptoms like nausea, vomiting, or diarrhea.

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. It is requested that you 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 employees.

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

- **Primary Exposure:** These are employees 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 employees 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 employees who have had direct contact with someone that meets Secondary Exposure criteria. In this scenario, there is no requirement to isolate; however, the employee should self-monitor for the development of symptoms.

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

- The employee should immediately self-isolate until they have been released to return by WorkCare.
- Notify the Project Manager, Human Resources, and Regional Lead immediately.
- The employee'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.
- Employees 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 employees 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 employee should be maintained.

If an employee, 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 employee home immediately and have them coordinate with WorkCare for their return.
- Determine if the diagnosed individual has been instructed to self-isolate by the local Health Department and, if so, consult with the Health Department for guidance.
- Let the Regional Lead and Project Manager know immediately.
- Continue cleaning of common touch areas with recommended disinfectants.
- If employee tests positive, this becomes a Primary Exposure scenario and that guidance should then be followed.

Situations where an employee 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:

- Determine if the diagnosed or screened individual has been instructed to self-isolate by the local Health Department and, if so, consult with the Health Department for guidance.
- 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 employees are in self-isolation, their manager or designee will follow up with them two times per week.

General Measures / Guidance

- Employees 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 with the preferred method being individual vehicles. Mass transit should be avoided where social distancing is difficult.
- Wear cloth face coverings to cover the nose and mouth in public settings.
- Diligent application of underlying social distancing requirements and responsibilities (they are and will be the foundation of all our activities):
  - Cloth face coverings will be used in site settings where social distancing measures are difficult to maintain, including travel to and from the site
  - Maintaining at least 6 feet of distance and social distancing as a foundation of all our activities
- The virus may live on a variety of surfaces for many days; closely follow the cleaner/disinfectant contact time. Avoid combining products that are incompatible and may create toxic byproducts.
- Avoid restaurants if open; use drive-in or take-out services.
- 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.
- Employees should avoid close contact with other employees and practice social distancing (i.e., maintain more than 6 feet distance from others).
- Handshaking will be avoided, and only non-contact greetings should be used.
- 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.
- 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. Cloth face coverings fashioned from household items or made at home from common materials can be used as a voluntary public health measure. The cloth face coverings recommended are not surgical masks or N-95 respirators, which are critical supplies that must continue to be reserved for healthcare workers and other medical first responders, as recommended by CDC guidance.
- 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 employee 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 re-scheduled 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 employees 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 employees 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 employees 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.

Fully Vaccinated Staff

In accordance with public health recommendations for fully vaccinated people as issued by CDC, this guidance is based on the level of community spread of SARS-CoV-2, the proportion of the population that is fully vaccinated, and the rapidly evolving science on COVID-19 vaccines.

For the purposes of this document and in accordance with CDC, people are considered fully vaccinated for COVID-19 ≥2 weeks after they have received the second dose in a two-dose series, or ≥2 weeks after they have received a single-dose vaccine.

Fully vaccinated staff are to continue to follow all guidance in this document except for testing and quarantining following a known exposure if they are asymptomatic. If fully vaccinated staff begin to experience COVID-19 symptoms, the above guidance in Case Response and Equipment & Facility Decontamination will be followed.

Staff are encouraged to get vaccinated when they are eligible in the location where they reside. They are also encouraged, while not required, to upload record of their vaccination into the WorkCare screening portal.

ANCHOR QEA

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

FINAL

Attachment I

Phase II Sampling Locations and Rationale

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
1	No exceedances (PCBs in intertidal area N of RM 3.0)	PCBs	500–514	PCBs in all samples; PCBs, cPAHs, arsenic, dioxins/furans in 0–45-cm samples	• Bound subsurface RAL exceedances to the N, S, and W (including whether this area extends into the intertidal area); E boundary defined by EAA. • Assess area within 100 ft N of boundary to determine if RAL exceedance area extends across boundary. • Collect surface samples at N and S boundaries to address uncertainty of PCB RAL EFs of 0.92 and 1.0 in surface samples. • Delineate vertical extent in dredging/partial dredging and capping area (vertical extent N of the RM 3.0 boundary will be defined [if needed] by cores closest to RM 3.0).
2	No exceedances	PCBs	515–523	PCBs; also all metals in 0–10-cm sample and arsenic in 0–45-cm sample to west at toe of bank	• Bound subsurface RAL exceedances to the N, S, and W (E boundary defined by EAA). • Collect surface sample to address uncertainty of PCB RAL EF of 0.9 in NW part of area and in subsurface sample W of PCB RAL EF of 0.98. • Delineate vertical extent in dredging/partial dredging and capping area. • Sample toe of bank area near elevated arsenic in soils
3	No exceedances	PCBs	524–528	PCBs	• Bound subsurface RAL exceedance to the N, S, and W (E boundary defined by EAA). • Delineate vertical extent in dredging/partial dredging and capping area.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
4	No exceedances	No exceedances	529	PCBs (based on interpolation only)	• Area exists because of subsurface interpolation of PCBs in IT120 (24 mg/kg OC) and SC121 (18 mg/kg OC) extending Recovery Category 1 area where RAL is less (12 mg/kg OC). • Note SS121 [7.54 mg/kg OC]), so no surface sample needed. • Collect subsurface sample (and archive vertical extent core) in Recovery Category 1 area; specific location selected by GIS to refine interpolation. • Extent of area to W defined by Recovery Category 1 boundary and existing data. •
5	PCBs	PCBs	530–541, 128	PCBs; also BBP in 2 most northern samples	• Bound subsurface RAL exceedances and uncertainty of BBP EF of 0.93 to the N; bound subsurface RAL exceedances to the S (near bridge). • Extent of area to E defined by EAA boundary; W edge is bounded by clean samples in the N. • Bound W of the Recovery Category 1 area. • Collect surface sample under bridge to assess surface at pre-PDI core with no RAL exceedances. • Delineate vertical extent in dredging/partial dredging and capping area.
6	PCBs	No exceedances	none	N/A (no Phase II samples)	• Area anticipated to be ENR, and low uncertainty in interpolation; thus no further delineation (horizontal or vertical) is needed.
7	PCBs	No exceedances	542–547, 143	PCBs	• Bound surface RAL exceedances to the N, S, E (including along bridge footings), and W (surface sediment and vertical at toe of bank area). • Collect 0–45-cm data in area with PDI surface exceedance (0–45 cm was not analyzed in Phase I). • Delineate vertical extent since remedy may include dredging/partial dredging and capping area. • Bank was addressed in King County habitat restoration project.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
8	No exceedances	PCBs	550–554	PCBs; also mercury and PAHs in western-most sample to address Area 9 exceedances	• Bound subsurface RAL exceedances to the N (near bridge) and to the S. • Collect 0–60-cm data in NW area due to interpolation from Phase I location 148 into Recovery Category 1 boundary. • Evaluate uncertainty in mercury and PAH interpolation from Area 9. • Extent of area to E defined by EAA and extent to W defined by Recovery Category 1 boundary. Collect surface sample in area deeper than -18-ft MLLW to assess area. • Delineate vertical extent in dredging/partial dredging and capping area.
9	No exceedances	mercury, fluoranthene	548–549	mercury, PAHs; also PCBs to address Area 8 exceedances	• Bound subsurface RAL exceedances in shoaling area to N and S (note that shape of area is based on the shape of the shoaling area). • Delineate vertical extent in dredging/partial dredging and capping area.
10	PCBs	No exceedances	555–556	PCBs	• Bound surface RAL exceedances to the E and W (along South Park Marina dock). • No vertical needed because Phase I shoaling location 155 had no subsurface exceedances.
11	No exceedances	PCBs	557-558	PCBs	• Re-sample vertical extent at LDW13 (2012 sample) to better understand depth of contamination in shoaling area. • Collect archive sample in shoaling area to N to analyze if needed. • Extent of area to W defined by shoaling area boundary and 0–60-cm samples in marina.
12	PCBs, 4-methylphenol	No data; no 0–60 cm RAL exceedances in surrounding PDI samples	559–560	PCBs; also 4-methylphenol in archive near existing RAL exceedance	• Bound RAL exceedances to W (interstitial material on armored slope). • Delineate vertical extent in area without subsurface data. • South Park Marina berthing area has an authorized depth of -8 ft in inner marina area, so collect vertical extent core down to -16 ft MLLW.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
13	No exceedances	PCBs	561–564, 163	PCBs; also dioxins/furans at select location	• Re-sample vertical extent at LDW14 (2012 sample) to better understand depth of contamination in shoaling area. • Collect archive samples and analyze if needed to further bound subsurface RAL exceedance to the E and NE (extent of area to W defined by shoaling area boundary). • Analyze Phase I archived sample to the N. • Collect subsurface sample to NE of Area 13 to evaluate Recovery Category 1 area along EAA.
14	No exceedances	No exceedances	565	PCBs (based on interpolation only)	• Area exists because of subsurface interpolation from nearby core (T117-SE-15-SC with 16.5 mg/kg-OC) into shoaling area where RAL is lower (12 mg/kg OC). • Collect sample in shoal area to confirm; location placement selected to help refine interpolation. • Collect archive samples and analyze if needed to delineate vertical extent. • Collection of additional samples to bound area will be done in Phase III if needed.
15	No data; no exceedances in nearby samples	PCBs	566–569	PCBs	• Bound subsurface RAL exceedance to the N, W, and S (boundary to E defined by EAA). • Delineate vertical extent in dredging/partial dredging and capping area next to EAA.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
16	PCBs	PCBs	570–573	PCBs	• Bound subsurface RAL exceedance in all directions and surface RAL exceedance to N. • Delineate vertical extent; core T117-SE-35-SC (within 10 ft of FNC) was a 10-ft core with PCB concentrations greater than the 12 mg/kg OC at a depth of 8 ft (i.e., to -19 ft MLLW). Based on existing information, the target depth for the eastern core (located just inside the FNC) is -25 ft MLLW. For the western core, the target depth of 6 ft following the standard rule for cores outside the FNC.
17	PCBs, mercury	No exceedances	574–576	PCBs, mercury	• Bound surface RAL exceedances to the NW. Recent perimeter sampling (2018) bounds area to S. • Collect subsurface sample to N of area to address uncertainty of PCB RAL EF of 0.92. • Extent of area to E defined by EAA boundary. • Delineate vertical extent in dredging/partial dredging and capping area next to EAA.
18	PCBs, arsenic, BBP, PAHs	No exceedances (limited data)	577–604	PCBs, arsenic, BBP; also PAHs, cPAHs, BEHP, dioxins/furans, and zinc in select samples; all contaminants (except dioxins/furans) at re-occupied locations; dioxin/furan at one re-occupied location	• Collect surface and subsurface data to the N, W, and S to better understand the horizontal extent of contamination in this area (note pre-PDI subsurface data did not include samples from RAL intervals). • Based on Phase I PDI results, re-sample surface at EIT060, R26, and R27 (1997 samples), as well as at SD-510G (2012 sample). • Analyze BEHP and zinc in samples as appropriate to evaluate uncertainty associated with EFs of 0.9 or greater. • Delineate vertical extent, including to E along bulkhead. Cores are arranged as transects perpendicular to the bank across intertidal.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
19	No exceedances	No exceedances	605	PCBs (based on interpolation only)	• Area exists because of subsurface interpolation from intertidal (IT221 had 486 µg/kg dw PCBs and 0.49% TOC) into shoal area where RAL is lower (12 mg/kg OC). • Collect intertidal subsurface sample; specific location selected by GIS to refine interpolation. Other shoaling samples in area all below RALs. • If needed, vertical extent and shoaling area will be assessed in Phase III.
20	No exceedances	PCBs	606–612	PCBs	• Bound subsurface RAL exceedance to the N, S, and E (specific locations to E selected by GIS to refine interpolation). • Bound area to W to determine whether area extends to Port of Seattle habitat restoration area. • Delineate vertical extent in this area that may include dredging.
21	Zinc	No exceedances	613	all contaminants (except dioxins/furans) at re-occupied location	• Re-occupy SSSP3-A (2011 sample) and potentially toxicity test pending expedited analytical results. • No vertical extent data are needed because area anticipated to be ENR if a remedy is needed.
22	No exceedances	No exceedances	614, 231	PCBs (based on interpolation only)	• Area exists because of interpolation from intertidal sample (IT232 with PCBs at 15.1 mg/kg OC) into shoal area where RAL is lower (12 mg/kg OC). • Analyze Phase I archive sample in shoaling area to refine interpolation. • Collect archive subtidal subsurface sample to further refine interpolation if needed; specific location selected by GIS. • If needed, vertical extent will be assessed in Phase III.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
23	PCBs, BBP, lead, mercury, zinc	No exceedances	615–627	PCBs, BBP, lead, mercury, zinc; also arsenic and dioxins/furans at select locations	• Area is in between ENR/AC intertidal subplots. • Collect bank data adjacent to ENR/AC subplots. • Bound surface and subsurface (0–60 cm) RAL exceedances to the W; specific locations selected by GIS to refine interpolation. • Collect 0–45-cm samples at 4 locations in the ENR/AC pilot Intertidal plots to characterize 0–45 cm from mudline and 0–45 cm below the ENR layer. • Collect one sample in the northern ENR/AC pilot intertidal plot to characterize the 0-45-cm interval from the mudline (data in the 0-45-cm interval below the ENR already exist)..
24	No exceedances	PCBs	628-629	PCBs	• Re-sample vertical extent at LDW17 (2012 sample) to better understand contamination in shoaling area. • Collect archive samples and analyze if needed to bound subsurface RAL exceedance to the NW.
25	PCBs	No data; no 0–45 cm RAL exceedances in surrounding PDI samples	none	na (no Phase II samples)	• No vertical extent data needed since anticipated to be ENR. • No further horizontal bounding needed. • W boundary is defined by Port of Seattle habitat restoration area.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
26	No exceedances	No exceedances	630, 249	PCBs (based on interpolation only); also all metals in Phase I archive sample to west	• Area exists because of subsurface interpolation from intertidal sample (IT257 with 202 mg/kg OC) into shoal area where RAL is lower (12 mg/kg OC). • Sample in subtidal area; specific location selected by GIS to refine interpolation. • Extent of area to E defined by Recovery Category 1 boundary and existing shoaling cores. • Collect archive samples to potentially assess surface sediment and delineate vertical extent. • Analyze Phase I sample for spatial coverage of PCBs and metals.
27	PCBs	PCBs, dioxins/furans	631–636, 254	PCBs; also dioxins/furans, arsenic, cPAHs, and BEHP at select locations	• Bound surface and subsurface RAL exceedances to the W in the subtidal area and to the S in the intertidal area. • Analyze Phase I sample in shoaling area on W side of FNC. • Horizontal extent to the E is defined by the bulkhead along the shoreline. • Delineate vertical extent in area. • Reoccupy 2 locations to evaluate recovery category designation.
28	No exceedances	PCBs	637–639	PCBs	• Bound subsurface RAL exceedance to the S and E. • Extent of area to W defined by Recovery Category 1 boundary. • Delineate vertical extent due to subsurface exceedance.
29	No exceedances	No exceedances	640	PCBs (based on interpolation only)	• Area exists because of PCB interpolation from intertidal samples (IT260 with 17.6 mg/kg OC and IT266 with 23.1 mg/kg OC) into Recovery Category 1 area where RAL is lower (12 mg/kg OC). • Sample in subtidal area; specific location selected by GIS to refine interpolation. • Collect archive samples to delineate vertical extent if needed. • Extent of area to E and S defined by Recovery Category 1 boundary.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
30	PCBs, BBP	No exceedances	641–646	PCBs, BBP; also dioxins/furans, arsenic; cPAHs, and BEHP at select location	• Bound surface RAL exceedance to the W and collect archive sample further W to analyze if needed. • Collect subsurface sample to N near historical sample with elevated PCBs in non-RAL interval. • Bound to the E to determine if extends to the bank. • Collect archive samples to delineate vertical extent if needed. • Reoccupy one location to evaluate recovery category designation.
31	PCBs, dioxins/furans, mercury, phenol	PCBs	647–670, 321	PCBs, dioxins/furans; also arsenic, mercury, and phenol in select samples	• Bound RAL exceedances to the W and to the S. • Delineate vertical extent, including in bank area. • Cores are arranged as transects perpendicular to the bank across the intertidal. • Analyze arsenic in Phase I archive sample to S of Area 31 near historical sample with elevated arsenic in non-RAL interval.
32	No exceedances	PCBs	671–678	PCBs	• Bound subsurface RAL exceedance to the E, W, and at toe of bank area (to S). • Collect surface samples to W to address uncertainty of PCB RAL EFs > 0.9 in nearby surface samples. • Delineate vertical extent where dredging will be needed in berthing area. • Slip 6 has a historical documented berth depth of -18 ft MLLW, so core to -26 ft MLLW. • Note that the OC in Slip 6 is > 3.5% (but < 4.0%), so EFs are based on dry weight concentrations. • Slip 6 has had more than 2 ft of sedimentation since 2003 based on comparison of the 2003 and 2019 bathymetric surveys. • Collect archive samples for potential cPAH analysis pending a decision on EPA's proposed ESD for cPAHs.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Contaminant[s] with RAL exceedance(s) in Design Dataset: Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
33	No exceedances	No exceedances	679, 358	PCBs (based on interpolation only)	• Area exists because of interpolation from intertidal sample (IT359 with PCB concentration of 15.6 mg/kg OC) into Recovery Category 1 area where the RAL is lower (12 mg/kg OC). • Collect sample in Recovery Category 1 area; the specific location was selected by GIS to refine interpolation. • Retain Phase I archive (location 358) as Tier 2 location; analyze if needed to refine interpolation. • Extent of area to E, S, and W defined by Recovery Category 1 area boundary. • If confirmed, vertical extent will be assessed in Phase III.
34	PAHs	PAHs	680–686	PAHs and 1,2,4-trichlorobenzene	• Bound surface and subsurface PAH RAL exceedances to the S and the subsurface to the W within Recovery Category 1 area. Expedite analytical results at these locations prior to potential toxicity testing. • Collect additional archive samples to the N and S to further bound PAH RAL exceedances if needed. • Analyze 1,2,4-trichlorobenzene in subsurface to evaluate uncertainty associated with EF of 0.9. • Re-occupy SS379/IT379 (2020 samples) and toxicity test. • Extent of area to N defined by Recovery Category 1 boundary. • Collect archive samples to potentially delineate vertical extent.

Table I-1
Overview of Phase II Sampling Design by RAL Exceedance Area

Area No.	Contaminant[s] with RAL exceedance(s) in Design Dataset: Surface (0–10 cm)	Subsurface Sediment (0–45 cm, 0–60 cm, or shoal)	Location Numbers	Phase II Analytes (Tier 1 Samples)	Sample Design Objectives and Considerations (IT = intertidal 0–45-cm sample, SC = subtidal 0–60-cm sample, SS = surface [0–10 cm] sample)[1]
35	PAHs	No exceedances	687–690, 384	PAHs, cPAHs	• Bound surface RAL exceedance to the N, S, and E. Expedite analytical results at these locations prior to potential toxicity testing. • Re-occupy SS383 (2020 sample) and toxicity test. • Analyze Phase I archive location 384 for cPAHs in the 0-45-cm interval pending cPAH ESD resolution. • No vertical extent delineation needed because no dredging anticipated and because no RAL exceedances in subsurface sediment.
36	PCBs	No exceedances	691–697	PCBs	• Collect surface and subsurface samples to bound bank sample BNK6-1 (2018 sample at approximately +8.8 ft MLLW) in all directions. Archive subsurface samples pending surface results. • Collect subsurface sample to S near historical sample with elevated PCBs in non-RAL interval. . • Delineate vertical extent if needed (specific number and locations of vertical extent cores in this area will be determined based on expedited 0–10-cm interval data).
37	PCBs, benzoic acid, 1,4-dichlorobenzene	No exceedances	698–707	PCBs; also benzoic acid in select samples; all contaminants (except dioxins/furans) at re-occupied location	• Bound surface RAL exceedances along the shoreline, including collecting surface samples on Norfolk cap (bounding SS415 and SS416). • Re-occupy R88 (1997 sample); expedite chemistry to determine if necessary to collect a vertical extent core at this location. • Collect surface sample at RM 5 to address uncertainty of PCB RAL EF of 0.9. • Delineate vertical extent of contamination within bank (note that Norfolk cap is sand, and thus no vertical extent samples needed in cap area).

Notes:
1. Depths of vertical extent cores are detailed in Table C-4.
AC: activated carbon
BBP: butyl benzyl phthalate
BEHP: bis(2-ethylhexyl) phthalate

cPAH: carcinogenic polycyclic aromatic hydrocarbon
dw: dry weight
EAA: early action area
EF: exceedance factor
ENR: enhanced natural recovery
ESD: explanation of significant differences
FNC: Federal Navigation Channel
GIS: geographic information system
MLLW: mean lower low water
N/A: not applicable
OC: organic carbon
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
PDI: pre-design investigation
RAL: remedial action level
RM: river mile
TOC: total organic carbon

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type				Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1]							
					0-10 cm	0-45 cm	0-60 cm	Vertical									0-10 cm Samples		0-45 cm Samples		0-60 cm Samples or Shoaling Intervals		Deeper Samples	
																	PCBs	Other	PCBs	Other	PCBs	Other	PCBs	Other
500	3	Subtidal	2 (archive)	1	a		a		1	-	-	-	-	-12.6		Assessing remediation boundary for upper reach. Analyze depending on results of Tier 1 samples in this area.	a	-	--	--	a	-	--	--
501	3	Subtidal	2 (archive)	1	a		a		1	-	-	Yes	-	-16.9		Assessing remediation boundary for upper reach. Analyze depending on results of Tier 1 samples in this area.	a	-	--	--	a	-	--	--
502	3	Subtidal	2 (archive)	1	a		a		1	-	-	Yes	-	-17.0		Assessing remediation boundary for upper reach. Analyze depending on results of Tier 1 samples in this area.	a	-	--	--	a	-	--	--
503	3	Intertidal	1	1	x	a			3	-	-	-	-	5.9		Assessing remediation boundary for upper reach.	x	-	a	a (arsenic, cPAHs, dioxins/furans)	--	--	--	--
504	3	Intertidal	1	1	x	a			3	-	-	-	-	-2.8		Assessing remediation boundary for upper reach.	x	-	a	a (arsenic, cPAHs, dioxins/furans)	--	--	--	--
505	3	Subtidal	1	1	x		x		1	-	Yes	-	-	-13.0		Assessing remediation boundary for upper reach.	x	-	--	--	x	-	--	--
506	3	Subtidal	1	1	x		x		1	-	Yes	Yes	-	-15.7		Assessing remediation boundary for upper reach.	x	-	--	--	x	-	--	--
507	3	Intertidal	1	1	x	x			3	-	-	-	-	-2.2		Assessing remediation boundary for upper reach. Location intended to characterize whether area extends into intertidal.	x	-	x	x (arsenic, cPAHs, dioxins/furans)	--	--	--	--
508	3	Subtidal	1	1	x		x		1	-	Yes	Yes	-	-17.4		Assessing remediation boundary for upper reach.	x	-	--	--	x	-	--	--
509	3	Subtidal	1	1			a	x	1	-	Yes	Yes	-	-16.8	9		--	--	--	--	a	-	x	-
510	3	Subtidal	1	1			a	x	1	-	Yes	-	-	-11.6	6		--	--	--	--	a	-	x	-
511	3	Subtidal	1	1	a		x		1	-	Yes	-	-	-10.2			a	-	--	--	x	-	--	--
512	3	Intertidal	2 (archive)	1		a			3	-	-	-	-	-2.6		Location intended to characterize whether area extends into intertidal.	--	--	a	a (arsenic, cPAHs, dioxins/furans)	--	--	--	--
513	3	Subtidal	1	1	x		x	a	1	-	Yes	Yes	-	-16.7	9	Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	x	-	--	--	x	-	a	-
514	3	Subtidal	1	1	x		x	x	1	-	Yes	Yes	-	-17.2	8		x	-	--	--	x	-	x	-
515	3	Subtidal	1	2			x		1	-	Yes	Yes	-	-17.4			--	--	--	--	x	-	--	--
516	3.1	Subtidal	1	2	x		x		1	-	Yes	Yes	-	-16.9			x	-	--	--	x	-	--	--
517	3.1	Subtidal	1	2			a	x	1	-	Yes	Yes	-	-16.8	9		--	--	--	--	a	-	x	-
518	3.1	Intertidal	1	2	x	x			3	-	-	-	-	0.3		Additional location to the west of Area 2 to evaluate toe of bank.	x	x (metals)	x	x (arsenic)				
519	3.1	Subtidal	1	2			x	a	1	-	Yes	Yes	-	-12.2	6	Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	--	--	--	--	x	-	a	-
520	3.1	Subtidal	1	2			a	x	1	-	Yes	Yes	-	-17.2	8		--	--	--	--	a	-	x	-
521	3.1	Subtidal	1	2			a	x	1	-	Yes	Yes	-	-15.7	10		--	--	--	--	a	-	x	-
522	3.1	Subtidal	1	2			x		1	-	Yes	Yes	-	-17.4			--	--	--	--	x	-	--	--
523	3.1	Subtidal	1	2			x		1	-	Yes	Yes	-	-17.0							x	-		
524	3.1	Subtidal	1	3			x		1	-	Yes	Yes	-	-16.2			--	--	--	--	x	-	--	--
525	3.1	Subtidal	1	3			a		1	-	Yes	-	-	-13.3			--	--	--	--	a	-	--	--
526	3.1	Subtidal	1	3			x		1	-	Yes	Yes	-	-17.9			--	--	--	--	x	-	--	--
527	3.1	Subtidal	1	3			a	x	1	-	Yes	Yes	-	-16.0	9		--	--	--	--	a	-	x	-
528	3.1	Subtidal	1	3			x		1	-	Yes	Yes	-	-16.4			--	--	--	--	x	-	--	--
529	3.1	Subtidal	1	4			x	a	1	-	Yes	-	-	-12.0	6	Location intended to evaluate interpolation uncertainty. Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	--	--	--	--	x	-	a	-

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type: 0-10 cm	Location Type: 0-45 cm	Location Type: 0-60 cm	Location Type: Vertical	Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1]: 0-10 cm Samples: PCBs	0-10 cm Samples: Other	0-45 cm Samples: PCBs	0-45 cm Samples: Other	0-60 cm Samples or Shoaling Intervals: PCBs	0-60 cm Samples or Shoaling Intervals: Other	Deeper Samples: PCBs	Deeper Samples: Other
530	3.1	Subtidal	1	5			x		1	-	Yes	Yes	-	-17.3			--	--	--	--	x	x (BBP)	--	--
531	3.2	Subtidal	1	5			a	x	1	-	Yes	Yes	-	-17.0	8		--	--	--	--	a	a (BBP)	x	x (BBP)
532	3.2	Subtidal	1	5			a	x	1	-	Yes	Yes	-	-17.1	8		--	--	--	--	a	-	x	-
128	3.2	Subtidal	1	5	x		x		3	-	Yes	-	-	-7.0		Phase I archive location to be analyzed as part of Phase II. No sample collection needed; lab will be informed not to discard in June.	x	-	--	--	x	-	--	--
533	3.2	Subtidal	1	5			a	x	1	-	Yes	Yes	-	-16.5	9		--	--	--	--	a	-	x	-
534	3.2	Subtidal	1	5			a	x	1	-	Yes	Yes	-	-17.2	8		--	--	--	--	a	-	x	-
535	3.2	Subtidal	1	5			a	x	1	-	Yes	Yes	-	-18.2	7		--	--	--	--	a	-	x	-
536	3.3	Subtidal	1	5	x		x		3	-	Yes	Yes	-	-17.0			x	-	--	--	x	-	--	--
537	3.3	Subtidal	1	5			a	x	1	-	Yes	Yes	-	-18.3	7		--	--	--	--	a	-	x	-
538	3.3	Subtidal	1	5			a	x	1	-	-	Yes	-	-19.3	6		--	--	--	--	a	-	x	-
539	3.3	Subtidal	1	5			x	x	1	-	-	Yes	-	-19.7	6		--	--	--	--	x	-	x	-
540	3.3	Subtidal	1	5			x		1	-	-	Yes	-	-19.8			--	--	--	--	x	-	--	--
541	3.3	Subtidal	2 (archive)	5	a				1	-	-	Yes	-	-22.4		Collecting surface sample co-located with LDW-SC48 (subsurface).	a	-	--	--	--	--	--	--
143	3.3	Intertidal	2 (archive)	7		a			3	-	-	-	-	3.7		Phase I archive location that may be analyzed as part of Phase II depending on results of Tier 1 samples in this area. No sample collection is needed; lab will be informed to not discard in June.	--	--	a	-	--	--	--	--
542	3.3	Intertidal	1	7	x	x			3	-	-	-	-	-2.5		Location intended to evaluate whether area extends into subtidal.	x	-	x	-	--	--	--	--
543	3.3	Intertidal	1	7		x		x	3	-	-	-	-	-2.6	6.5	Location intended to evaluate whether area extends into subtidal.	--	--	x	-	--	--	x	-
544	3.3	Subtidal	1	7	x				3	-	Yes	-	-	-7.0		Location intended to characterize conditions along bridge footing.	x	-	--	--	--	--	--	--
545	3.3	Intertidal	1	7		a		x	3	-	-	-	-	5.7	6.5	Location placed at toe of bank.	--	--	a	-	--	--	x	-
546	3.3	Subtidal	1	7	x				3	-	Yes	-	-	-8.3		Location intended to characterize conditions along bridge footing.	x	-	--	--	--	--	--	--
547	3.3	Intertidal	1	7	x				3	-	-	-	-	6.5		Location placed at toe of bank.	x	-	--	--	--	--	--	--
548	3.3	Subtidal	1	9			x		3	Yes	Yes	Yes	-	-14.3			--	--	--	--	x	x (PAHs, mercury)	--	--
549	3.4	Subtidal	1	9			x	x	3	Yes	Yes	Yes	-	-13.0	12		--	--	--	--	x	x (PAHs, mercury)	x	x (PAHs, mercury)
550	3.3	Subtidal	1	8			x		1	-	-	Yes	-	-21.8			--	--	--	--	x	x (PAHs, mercury)	--	--
551	3.3	Subtidal	1	8			x		1	-	-	Yes	-	-22.3			--	--	--	--	x	-	--	--
552	3.3	Subtidal	1	8	x				3	-	-	Yes	-	-20.9			x	-	--	--	--	--	--	--
553	3.3	Subtidal	1	8			a	x	1	-	-	Yes	-	-21.4	5		--	--	--	--	a	-	x	-
554	3.4	Subtidal	1	8			x	x	1	-	-	Yes	-	-19.8	6		--	--	--	--	x	-	x	-
555	3.4	Subtidal	1	10	x				3	-	Yes	Yes	-	-16.4			x	-	--	--	--	--	--	--
556	3.4	Subtidal	1	10	x				3	Yes	Yes	Yes	-	-7.1		Location intended to characterize conditions in RAL exceedance area along South Park Marina dock.	x	-	--	--	--	--	--	--
557	3.4	Subtidal	2 (archive)	11			a		3	Yes	Yes	Yes	-	-10.7		Analyze depending on results of Tier 1 sample in this area.	--	--	--	--	a	-	--	--
558	3.4	Subtidal	1	11			x	x	3	Yes	Yes	Yes	-	-9.1	16	Reoccupying LDW13 (subsurface) to better understand depth of contamination in shoaling area.	--	--	--	--	x	-	x	-

Table I-2
Sample Location Rationale and Analytes

					Location Type												Analytes by Sample Type[1]							
																	0-10 cm Samples		0-45 cm Samples		0-60 cm Samples or Shoaling Intervals		Deeper Samples	
Location No.	RM	Area Type	Tier	RAL Exceedance Area	0-10 cm	0-45 cm	0-60 cm	Vertical	Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	PCBs	Other	PCBs	Other	PCBs	Other	PCBs	Other
559	3.5	Intertidal	1	12	x				3	-	-	-	Yes	5.6		Location targeting interstitial material in bank.	x	-	--	--	--	--	--	--
560	3.5	Intertidal	1	12			a	x	3	-	-	-	-	-2.7	14	Collect 0- to 60-cm interval subsurface sample rather than 0- to 45-cm sample because subtidal conditions are consistent with the intended use for the South Park Marina. Collect vertical extent data to -16 ft MLLW based on authorized depth of -8 ft MLLW for inner marina.	--	--	--	--	a	a (4-methyl-phenol)	x	-
163	3.5	Subtidal	1	13			x		3	Yes	Yes	Yes	-	-12.5		Phase I archive location that will be analyzed as part of Phase II to evaluate shoal between Areas 11 and 13. No sample collection is needed; lab will be informed to not discard in June.	--	--	--	--	x	-	--	--
561	3.5	Subtidal	1	13			x		1	-	Yes	Yes	-	-18.2		Collecting subsurface sample to evaluate Recovery Category 1 area along EAA.	--	--	--	--	x	-	--	--
562	3.5	Subtidal	2 (archive)	13			a		3	Yes	Yes	Yes	-	-11.6		Analyze depending on results of Tier 1 sample in this area.	--	--	--	--	a	-	--	--
563	3.5	Subtidal	2 (archive)	13			a		3	Yes	Yes	Yes	-	-14.9		Analyze depending on results of Tier 1 sample in this area.	--	--	--	--	a	-	--	--
564	3.5	Subtidal	1	13			x	x	3	Yes	Yes	Yes	-	-9.8	16	Reoccupying LDW14 (subsurface) to better understand depth of contamination in shoaling area.	--	--	--	--	x	x (dioxins/furans)	x	x (dioxins/furans)
565	3.6	Subtidal	1	14			x	a	3	Yes	Yes	Yes	-	-9.6	16	Location intended to evaluate interpolation uncertainty. Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	--	--	--	--	x	-	a	-
566	3.6	Subtidal	1	15			x		1	-	-	Yes	-	-18.8			--	--	--	--	x	-	--	--
567	3.6	Subtidal	1	15			x		1	-	Yes	Yes	-	-15.8			--	--	--	--	x	-	--	--
568	3.6	Subtidal	1	15			a	x	1	-	Yes	Yes	-	-18.1	7		--	--	--	--	a	-	x	-
569	3.6	Subtidal	1	15			x		1	-	Yes	Yes	-	-15.9			--	--	--	--	x	-	--	--
570	3.6	Subtidal	1	16	x		x		1	-	Yes	-	-	-9.0			x	-	--	--	x	-	--	--
571	3.6	Subtidal	1	16			x	x	1	-	Yes	-	-	-6.9	6		--	--	--	--	x	-	x	-
572	3.6	Subtidal	1	16			x	x	1	Yes	Yes	Yes	-	-13.0	12	Based on existing data in this area, the RAL intervals and first two one-ft intervals will be analyzed; the remaining intervals will be archived.	--	--	--	--	x	-	x	-
573	3.6	Subtidal	1	16			x		1	-	Yes	-	-	-8.5			--	--	--	--	x	-	--	--
574	3.7	Subtidal	1	17			x		1	-	Yes	Yes	-	-16.7			--	--	--	--	x	x (mercury)	--	--
575	3.7	Subtidal	1	17	x				1	Yes	Yes	Yes	-	-14.5			x	x (mercury)	--	--	--	--	--	--
576	3.7	Subtidal	1	17			x	a	1	-	Yes	Yes	-	-16.7	9	Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	--	--	--	--	x	x (mercury)	a	a (mercury)
577	3.7	Subtidal	1	18			x	a	1	-	Yes	-	-	-11.3	6	Collect to characterize area near existing core without RAL interval. Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	--	--	--	--	x	x (arsenic, BBP)	a	a (arsenic, BBP)
578	3.7	Intertidal	1	18	x	x			2	-	-	-	-	-1.9			x	x (arsenic, BBP)	x	x (arsenic)	--	--	--	--
579	3.7	Intertidal	1	18		a		x	2	-	-	-	-	0.8	6.5		--	--	a	a (arsenic)	--	--	x	x (arsenic)
580	3.7	Subtidal	1	18	x		x		1	-	Yes	-	-	-9.4			x	x (arsenic, BBP)	--	--	x	x (arsenic, BBP)	--	--
581	3.7	Subtidal	1	18			a	x	2	-	Yes	-	-	-3.5	6		--	--	--	--	a	-	x	-
582	3.7	Intertidal	1	18		a		x	2	-	-	-	-	1.0	6.5		--	--	a	a (arsenic)	--	--	x	x (arsenic)

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type: 0-10 cm	Location Type: 0-45 cm	Location Type: 0-60 cm	Location Type: Vertical	Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1]: 0-10 cm Samples: PCBs	0-10 cm Samples: Other	0-45 cm Samples: PCBs	0-45 cm Samples: Other	0-60 cm Samples or Shoaling Intervals: PCBs	0-60 cm Samples or Shoaling Intervals: Other	Deeper Samples: PCBs	Deeper Samples: Other
583	3.7	Subtidal	1	18	x		x		1	-	Yes	-	-	-12.6			x	x (arsenic, BBP, BEHP)	--	--	x	x (arsenic, BBP, BEHP)	--	--
584	3.8	Subtidal	1	18			a	x	2	-	Yes	-	-	-4.7	6		--	--	--	--	a	-	x	-
585	3.7	Intertidal	1	18		a		x	2	-	-	-	-	2.7	6.5		--	--	a	a (arsenic)	--	--	x	x (arsenic)
586	3.8	Subtidal	1	18	x		x		1	-	Yes	-	-	-12.7			x	x (arsenic, BBP, zinc, BEHP)	--	--	x	x (arsenic, BBP, zinc, BEHP)	--	--
587	3.8	Subtidal	1	18			a	x	1	-	Yes	-	-	-10.1	6		--	--	--	--	a	a (arsenic, BBP, zinc)	x	x (arsenic, BBP, zinc)
588	3.8	Intertidal	1	18		a		x	2	-	-	-	-	2.9	6.5		--	--	a	a (arsenic, cPAHs)	--	--	x	x (arsenic, cPAHs)
589	3.8	Subtidal	1	18			x		1	-	Yes	-	-	-12.7			--	--	--	--	x	x (arsenic, BBP, zinc. PAHs)	--	--
590	3.8	Subtidal	1	18	x		x		1	-	Yes	-	-	-12.6			x	x (arsenic, BBP, zinc, PAHs)	--	--	x	x (arsenic, BBP, zinc, PAHs)	--	--
591	3.8	Subtidal	1	18			a	x	1	-	Yes	-	-	-8.2	6		--	--	--	--	a	a (arsenic, BBP, PAHs)	x	x (arsenic, BBP, PAHs)
592	3.8	Intertidal	1	18		x		a	2	-	-	-	-	-1.9	6.5	Archiving vertical extent core co-located with SD-508; analyze depending on results of Tier 1 samples in this area.	--	--	x	x (arsenic, cPAHs)	--	--	a	a (arsenic, cPAHs)
593	3.8	Intertidal	1	18		x		x	2	-	-	-	-	-2.1 (est)	6.5		--	--	x	x (arsenic, cPAHs)	--	--	x	x (arsenic, cPAHs)
594	3.8	Subtidal	1	18			x		1	-	Yes	-	-	-10.5			--	--	--	--	x	x (arsenic, BBP)	--	--
595	3.8	Subtidal	2 (archive)	18			a		1	-	Yes	-	-	-11.9		Analyze depending on results of Tier 1 samples in this area.	--	--	--	--	a	a (arsenic, BBP)	--	--
596	3.8	Subtidal	2 (archive)	18			a	a	1	-	Yes	-	-	-8.1	6	Analyze depending on results of Tier 1 samples in this area.	--	--	--	--	a	a (arsenic, BBP)	a	a (arsenic, BBP)
597	3.8	Intertidal	1	18		a		x	2	-	-	-	-	-0.4	6.5		--	--	a	a (arsenic)	--	--	x	x (arsenic)
598	3.8	Intertidal	1	18		x		a	2	-	-	-	-	4.8	6.5	Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area..	--	--	x	x (arsenic)	--	--	a	a (arsenic)
599	3.8	Subtidal	1	18	x		x		2	-	Yes	-	-	-6.0		Reoccupying R26 (surface) based on Phase I results; analyze surface sample for all chemicals with benthic RALs following Phase I sample rules.	x	x (all chemicals with benthic RAL)	--	--	x	-	--	--
600	3.8	Intertidal	2 (archive)	18	a	a			2	-	-	-	-	0.3		Reoccupying SD-510 (surface) based on Phase I results; analyze surface sample for all chemicals with benthic RALs following Phase I sample rules. Analyze depending on results of Tier 1 samples in this area.	a	a (all chemicals with benthic RAL)	a	a (arsenic)	--	--	--	--
601	3.8	Intertidal	2 (archive)	18		a			2	-	-	-	-	3.2		Analyze depending on results of Tier 1 samples in this area.	--	--	a	a (arsenic)	--	--	--	--
602	3.8	Intertidal	1	18	x	x			2	-	-	-	-	5.1		Reoccupying EIT060 (surface) based on Phase I results; analyze surface sample for all chemicals with benthic RALs following Phase I sample rules.	x	x (all chemicals with benthic RAL)	x	x (arsenic)	--	--	--	--
603	3.8	Intertidal	1	18	x	x			2	-	-	-	-	2.0		Reoccupying R27 (surface) based on Phase I results; analyze surface sample for all chemicals with benthic RALs following Phase I sample rules.	x	x (all chemicals with benthic RAL, dioxins/furans)	x	x (arsenic, dioxins/furans)	--	--	--	--
604	3.8	Intertidal	1	18		a		x	2	-	-	-	Yes	5.0	6.5		--	--	a	a (arsenic)	--	--	x	x (arsenic)
605	3.8	Intertidal	1	19		x			3	-	-	-	-	-1.0		Location intended to evaluate interpolation uncertainty between intertidal location and interpolation-only RAL exceedance area; location will also evaluate whether area extends into subtidal.	--	--	x	-	--	--	--	--

FINAL

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type: 0-10 cm	Location Type: 0-45 cm	Location Type: 0-60 cm	Location Type: Vertical	Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1]: 0-10 cm Samples: PCBs	0-10 cm Samples: Other	0-45 cm Samples: PCBs	0-45 cm Samples: Other	0-60 cm Samples or Shoaling Intervals: PCBs	0-60 cm Samples or Shoaling Intervals: Other	Deeper Samples: PCBs	Deeper Samples: Other
606	3.8	Intertidal	1	20		x			3	-	-	-	-	6.0		Location placed at toe of bank.	--	--	x	-	--	--	--	--
607	3.8	Subtidal	1	20			x		1	Yes	Yes	Yes	-	-12.2		Location intended to evaluate whether area extends into subtidal. Z-layer sample (-17 to -18 ft MLLW) will also be collected at this location.	--	--	--	--	x	-	--	--
608	3.8	Intertidal	1	20		x		a	3	-	-	-	-	5.0	6.5	Location placed at toe of bank. Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	--	--	x	-	--	--	a	-
609	3.8	Intertidal	1	20		a		x	3	-	-	-	-	-3.1	6.5		--	--	a	-	--	--	x	-
610	3.8	Subtidal	1	20			x		3	-	Yes	-	-	-9.6		Location intended to evaluate whether area extends into subtidal.	--	--	--	--	x	-	--	--
611	3.8	Intertidal	1	20		x			3	-	-	-	-	4.8		Location placed at toe of bank.	--	--	x	-	--	--	--	--
612	3.8	Subtidal	1	20			x		3	-	Yes	-	-	-5.5		Location intended to evaluate whether area extends into subtidal.	--	--	--	--	x	-	--	--
613	3.8	Intertidal	1	21	x				3	-	-	-	-	1.5		Reoccupying LDW-SSSP3-A (surface); analyze surface sample for all chemicals with benthic RALs following Phase I sample rules. Expedite chemistry and potentially toxicity test if RAL exceedances remain. Collect toxicity testing conventionals.	x	x (all chemicals with benthic RALs)	--	--	--	--	--	--
614	3.8	Subtidal	2 (archive)	22			a		3	-	Yes	-	-	-8.4		Analyze depending on results of Tier 1 sample in this area. Location intended to evaluate interpolation uncertainty between intertidal location and interpolation-only RAL exceedance area.	--	--	--	--	a	-	--	--
231	3.8	Subtidal	1	22			x		1	Yes	Yes	Yes	-	-12.8		Phase I archive location that will be analyzed as part of Phase II to evaluate interpolation uncertainty (shoaling and Z-layer samples will be analyzed). No sample collection is needed; lab will be informed to not discard in June.	--	--	--	--	x	-	--	--
615	3.8	Intertidal	1	23		x			na	-	-	-	-	0.8		Reoccupying SD-512 (subsurface) to characterize conditions in ENR/AC plot. As described in Section 4.1.2.1, 3 samples will be collected here to allow for characterization of the 0–45-cm interval, both including and below the ENR layer.	--	--	x	x (arsenic)	--	--	--	--
616	3.8	Intertidal	1	23	x	x			2	-	-	-	Yes	6.6		Location intended to collect bank material behind toe wall. Will collect material below 45 cm using hand auger if possible.	x	x (BBP, mercury, zinc, lead)	x	-	--	--	--	--
617	3.9	Intertidal	1	23		x			na	-	-	-	-	1.7		Reoccupying LDW-PILOT9A-SC1 (subsurface) to characterize conditions in ENR/AC plot. At this location, only the 0-45 cm interval including the ENR layer will be sampled.	--	--	x	x (arsenic)	--	--	--	--
618	3.9	Intertidal	1	23		x			2	-	-	-	-	0.6		Reoccupying pre-construction pilot 0-10 cm location (LDW-Pilot9A-SS4) to verify post-construction 0-45 cm RAL condition. As described in Section 4.1.2.1, 3 samples will be collected here to allow for characterization of the 0–45-cm interval, both including and below the ENR layer.	--	--	x	x (arsenic)	--	--	--	--
619	3.9	Intertidal	1	23	x	x			2	-	-	-	Yes	6.5		Location intended to collect bank material behind toe wall. Will collect material below 45 cm using hand auger if possible.	x	x (BBP, mercury, zinc, lead)	x	-	--	--	--	--
620	3.9	Subtidal	1	23	x		x		1	-	Yes	-	-	-9.6		Location intended to evaluate whether area extends into subtidal.	x	x (BBP, mercury, zinc, lead)	--	--	x	x (BBP, mercury, zinc, lead)	--	--

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type: 0-10 cm	Location Type: 0-45 cm	Location Type: 0-60 cm	Location Type: Vertical	Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1]: 0-10 cm Samples: PCBs	0-10 cm Samples: Other	0-45 cm Samples: PCBs	0-45 cm Samples: Other	0-60 cm Samples or Shoaling Intervals: PCBs	0-60 cm Samples or Shoaling Intervals: Other	Deeper Samples: PCBs	Deeper Samples: Other
621	3.9	Intertidal	1	23		a		x	2	-	-	-	-	-1.9	6.5		--	--	a	-	--	--	x	-
622	3.9	Intertidal	1	23		x		x	2	-	-	-	-	5.5	6.5		--	--	x	x (dioxins/furans)	--	--	x	x (dioxins/furans)
623	3.9	Subtidal	1	23	x		x		1	-	Yes	-	-	-9.1		Location intended to evaluate whether area extends into subtidal.	x	x (BBP, mercury, zinc, lead)	--	--	x	x (BBP, mercury, zinc, lead)	--	--
624	3.9	Intertidal	1	23		x			na	-	-	-	-	1.9		Reoccupying LDW-SC52 (subsurface) to characterize conditions in ENR/AC plot. As described in Section 4.1.2.1, 3 samples will be collected here to allow for characterization of the 0–45-cm interval, both including and below the ENR layer.	--	--	x	x (arsenic)	--	--	--	--
625	3.9	Intertidal	1	23	x	x			2	-	-	-	-	8.0		Location intended to characterize area between ENR/AC pilot plot and bulkhead.	x	x (arsenic, BBP, mercury, zinc, lead)	x	x (arsenic)	--	--	--	--
626	3.9	Intertidal	1	23		x			na	-	-	-	-	1.1		Location intended to characterize conditions in ENR/AC plot. As described in Section 4.1.2.1, 3 samples will be collected here to allow for characterization of the 0–45-cm interval, both including and below the ENR layer.	--	--	x	x (arsenic)	--	--	--	--
627	3.9	Intertidal	1	23	x	x			2	-	-	-	-	4.3 (est)		Location intended to characterize area between ENR/AC pilot plot and bulkhead.	x	x (arsenic, BBP, mercury, zinc, lead)	x	x (arsenic)	--	--	--	--
628	3.9	Subtidal	2 (archive)	24			a		1	Yes	Yes	Yes	-	-13.5		Analyze depending on results of Tier 1 sample in this area.	--	--	--	--	a	-	--	--
629	3.9	Subtidal	1	24			x	x	1	Yes	Yes	Yes	-	-13.3	12	Reoccupying LDW17 (subsurface) to better understand depth of contamination in shoaling area.	--	--	--	--	x	-	x	-
630	3.9	Subtidal	1	26			x	a	1	-	Yes	-	-	-8.7	6	Location intended to evaluate interpolation uncertainty. Archiving vertical extent core; analyze depending on results of Tier 1 samples in this area.	--	--	--	--	x	-	a	-
249	3.9	Subtidal	1	26	x		x		1	Yes	Yes	Yes	-	-13.4		Phase I archive location to be analyzed as part of Phase II (shoaling and Z-layer samples will be analyzed). No sample collection needed; lab will be informed not to discard in June.	x	x (metals)			x	x (metals)		
631	4	Intertidal	1	27	x				2	-	-	-	-	-2.3		Reoccupying B9b (surface) to provide additional information regarding recovery category designation in this area.	x	x (arsenic, cPAHs, BEHP)	--	--	--	--	--	--
632	4	Intertidal	1	27		a		x	2	-	-	-	-	2.5	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
633	4	Intertidal	1	27	x				2	-	-	-	-	2.8		Reoccupying AN-018 (surface) to provide additional information regarding recovery category designation in this area.	x	a (arsenic, cPAHs, dioxins/furans, BEHP)	--	--	--	--	--	--
634	4	Subtidal	1	27	x		x	x	1	-	Yes	-	-	-6.4	6	Location intended to evaluate whether area extends into subtidal.	x	x (dioxins/furans)	--	--	x	x (dioxins/furans)	x	x (dioxins/furans)
635	4	Intertidal	1	27		a		a	2	-	-	-	-	0.2	6.5	Analyze depending on results of Tier 1 samples in this area.			a	a (dioxins/furans)	--	--	a	a (dioxins/furans)
636	4	Intertidal	1	27	x	a			2	-	-	-	-	1.4			x	-	a	a (dioxins/furans)	--	--	--	--
254	4	Subtidal	1	27			x		1	Yes	Yes	Yes	-	-13.3		Phase I archive location that will be analyzed as part of Phase II. No sample collection is needed; lab will be informed to not discard in June.	--	--	--	--	x	-	--	--
637	4	Intertidal	1	28		a		x	1	-	-	-	-	0.5	6.5		--	--	a	-	--	--	x	-

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type: 0-10 cm	Location Type: 0-45 cm	Location Type: 0-60 cm	Location Type: Vertical	Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1]: 0-10 cm Samples: PCBs	0-10 cm Samples: Other	0-45 cm Samples: PCBs	0-45 cm Samples: Other	0-60 cm Samples or Shoaling Intervals: PCBs	0-60 cm Samples or Shoaling Intervals: Other	Deeper Samples: PCBs	Deeper Samples: Other
638	4	Intertidal	1	28		x			1	-	-	-	-	-3.7		Location intended to evaluate whether area extends into subtidal.	--	--	x	-	--	--	--	--
639	4	Intertidal	1	28		x			1	-	-	-	-	-1.5			--	--	x	-	--	--	--	--
640	4	Subtidal	1	29			x	a	1	-	Yes	-	-	-5.3	6	Location intended to evaluate interpolation uncertainty. Archive vertical extent core; analyze depending on results of Tier 1 sample in this area.	--	--	--	--	x	-	a	-
641	4	Intertidal	1	30	a	x			2	-	-	-	-	0.3		Collect sample with appropriate subsurface RAL interval near AN-041.	a	a (BBP)	x	-	--	--	--	--
642	4	Subtidal	2 (archive)	30	a				2	-	Yes	-	-	-7.9		Analyze depending on results of Tier 1 samples in this area.	a	a (BBP)	--	--	--	--	--	--
643	4	Intertidal	1	30	x				2	-	-	-	-	-3.0		Location intended to evaluate whether area extends into subtidal.	x	x (BBP)	--	--	--	--	--	--
644	4	Intertidal	2 (archive)	30		a		a	2	-	-	-	-	-1.2	6.5	Analyze depending on results of Tier 1 samples in this area.	--	--	a	-	--	--	a	-
645	4	Intertidal	1	30	x				2	-	-	-	-	-1.0		Reoccupying AN-011 (surface) to provide additional information regarding recovery category designation in this area.	x	x (arsenic, cPAHs, dioxins/furans, BBP, BEHP)	--	--	--	--	--	--
646	4	Intertidal	1	30	x				2	-	-	-	Yes	5.1		Location placed at toe of bank.	x	x (dioxins/furans, BBP)	--	--	--	--	--	--
647	4	Intertidal	1	31	x	x			3	-	-	-	-	-2.1			x	x (dioxins/furans, mercury)	x	x (dioxins/furans)	--	--	--	--
648	4	Intertidal	1	31		a		x	3	-	-	-	-	0.1	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
649	4	Intertidal	1	31		a		x	3	-	-	-	-	5.4	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
650	4	Intertidal	1	31		a		x	3	-	-	-	Yes	8.9	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
651	4	Intertidal	1	31	x	x			3	-	-	-	-	-0.9			x	x (dioxins/furans, mercury)	x	x (dioxins/furans)	--	--	--	--
652	4.1	Intertidal	1	31		a		x	3	-	-	-	-	0.1	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
653	4.1	Intertidal	1	31		a		x	3	-	-	-	-	2.8	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
654	4.1	Intertidal	1	31		a		x	3	-	-	-	-	4.1	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
655	4.1	Intertidal	1	31		a		x	3	-	-	-	Yes	9.2	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
656	4.1	Intertidal	1	31	x	x			3	-	-	-	-	-1.8			x	x (dioxins/furan)	x	x (dioxins/furans)	--	--	--	--
657	4.1	Intertidal	1	31		a		x	3	-	-	-	-	-0.8	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
658	4.1	Intertidal	1	31		a		x	3	-	-	-	-	2.6	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
659	4.1	Intertidal	1	31		a		x	3	-	-	-	-	4.1	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
660	4.1	Intertidal	1	31		a		x	3	-	-	-	Yes	5.5	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
661	4.1	Intertidal	1	31	x				3	-	-	-	-	2.2			x	x (dioxins/furans, phenol)	--	--	--	--	--	--
662	4.1	Intertidal	1	31		a		x	3	-	-	-	-	4.0	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
663	4.1	Intertidal	1	31		a		x	3	-	-	-	Yes	8.1	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
664	4.1	Intertidal	1	31		a		x	3	-	-	-	-	2.2	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
665	4.1	Intertidal	1	31		a		x	3	-	-	-	-	4.2	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
666	4.1	Intertidal	1	31		a		x	3	-	-	-	Yes	7.8	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
667	4.1	Intertidal	1	31	x				3	-	-	-	-	0.1			x	x (dioxins/furans)	--	--	--	--	--	--
668	4.1	Intertidal	1	31	x	x			3	-	-	-	-	3.6			x	x (dioxins/furans)	x	x (dioxins/furans)	--	--	--	--
669	4.1	Intertidal	1	31		a		x	3	-	-	-	-	4.8	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type: 0-10 cm	Location Type: 0-45 cm	Location Type: 0-60 cm	Location Type: Vertical	Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1] 0-10 cm Samples: PCBs	0-10 cm Samples: Other	0-45 cm Samples: PCBs	0-45 cm Samples: Other	0-60 cm Samples or Shoaling Intervals: PCBs	0-60 cm Samples or Shoaling Intervals: Other	Deeper Samples: PCBs	Deeper Samples: Other
670	4.1	Intertidal	1	31		a		x	3	-	-	-	Yes	8.1	6.5		--	--	a	a (dioxins/furans)	--	--	x	x (dioxins/furans)
321	4.2	Intertidal	1	31	x	x			1	-	-	-	-	1.5		Phase I archive location that will be analyzed as part of Phase II to evaluate area south of Area 31. No sample collection is needed; lab will be informed to not discard in June.	-	x (arsenic)	-	x (arsenic)	--	--	--	--
671	4.2	Subtidal	1	32			x		1	-	Yes	-	-	-8.7			--	--	--	--	x	-	--	--
672	4.2	Subtidal	1	32			x		1	-	Yes	-	-	-5.2			--	--	--	--	x	-	--	--
673	4.2	Subtidal	1	32			a	x	1	-	Yes	-	-	-6.0	20	Collect vertical extent data to -26 ft MLLW based on authorized depth of -18 ft MLLW in Slip 6 berthing area.	--	--	--	--	a	-	x	-
674	4.2	Subtidal	1	32			a	x	1	-	Yes	-	-	-8.5	18	Collect vertical extent data to -26 ft MLLW based on authorized depth of -18 ft MLLW in Slip 6 berthing area.	--	--	--	--	a	-	x	-
675	4.2	Subtidal	1	32	x		x		1	-	Yes	-	-	-8.3			x	-	--	--	x	-	--	--
676	4.2	Subtidal	2 (archive)	32	a		a		1	-	Yes	-	-	-7.6		Analyze depending on results of Tier 1 samples in this area.	a	-	--	--	a	-	--	--
677	4.2	Subtidal	2 (archive)	32			a		1	-	Yes	-	-	-8.6		Reoccupying LDW-SC53 (subsurface). Analyze depending on results of Tier 1 samples in this area and pending cPAH ESD resolution.	--	--	--	--	a	a (cPAHs)	--	--
678	4.2	Subtidal	2 (archive)	32	a				1	-	Yes	-	-	-8.4		Reoccupying R41 (surface). Analyze depending on results of Tier 1 samples in this area and pending cPAH ESD resolution.	a	a (cPAHs)	--	--	--	--	--	--
679	4.3	Intertidal	1	33		x			1	-	-	-	-	-2.8			--	--	x	-	--	--	--	--
358	4.3	Intertidal	2 (archive)	33		a			3	-	-	-	-	-0.6		Phase I archive location that may be analyzed as part of Phase II to evaluate interpolation uncertainty. No sample collection is needed; lab will be informed to not discard in June.	--	--	a	-	--	--	--	--
680	4.6	Subtidal	1	34	a		x		1	-	Yes	-	-	-4.6		Expedite chemistry for subsurface sample; potential toxicity testing location. Collect toxicity testing conventionals. Surface sample is a Tier 2 bounding sample.	a	a (PAHs)	--	--	a	x (PAHs, 1,2,4-trichlorobenzene)	--	--
681	4.6	Intertidal	2 (archive)	34	a	a			3	-	-	-	-	3.8		Bounding archive sample.	a	a (PAHs)	a	a (cPAHs)	--	--	--	--
682	4.6	Intertidal	1	34	x	x			1	-	-	-	Yes	2.2		Reoccupying LDW20-SS379 (surface) for toxicity testing. Collect toxicity testing conventionals.	--	--	--	--	--	--	--	--
683	4.7	Intertidal	2 (archive)	34		a		a	1	-	-	-	Yes	6.8	6.5	Analyze depending on results of Tier 1 samples in this area.	--	--	a	a (PAHs, 1,2,4-trichlorobenzene)	--	--	a	a (PAHs, 1,2,4-trichlorobenzene)
684	4.7	Intertidal	2 (archive)	34		a		a	1	-	-	-	Yes	0.7	6.5	Analyze depending on results of Tier 1 samples in this area.	--	--	a	a (PAHs, 1,2,4-trichlorobenzene)	--	--	a	a (PAHs, 1,2,4-trichlorobenzene)
685	4.7	Intertidal	1	34	x	x			1	-	-	-	Yes	2.1		Expedite chemistry; potential toxicity testing location. Collect toxicity testing conventionals.	a	x (PAHs)	a	x (PAHs, 1,2,4-trichlorobenzene)	--	--	--	--
686	4.7	Intertidal	2 (archive)	34	a	a			1	-	-	-	-	-0.2		Bounding archive sample.	a	x (PAHs)	a	x (PAHs, 1,2,4-trichlorobenzene)	--	--	--	--
687	4.7	Intertidal	1	35	x				3	-	-	-	Yes	7.4		Expedite chemistry; potential toxicity testing location. Collect toxicity testing conventionals.	a	x (PAHs)	--	--	--	--	--	--
688	4.7	Intertidal	1	35	x				3	-	-	-	Yes	6.9		Reoccupying LDW20-SS383 (surface) for toxicity testing. Collect toxicity testing conventionals.	--	---	--	--	--	--	--	--
689	4.7	Intertidal	1	35	x				3	-	-	-	-	5.5		Expedite chemistry; potential toxicity testing location. Collect toxicity testing conventionals.	a	x (PAHs)	--	--	--	--	--	--
690	4.7	Intertidal	1	35	x				3	-	-	-	Yes	9.9		Expedite chemistry; potential toxicity testing location. Collect toxicity testing conventionals.	a	x (PAHs)	--	--	--	--	--	--

Table I-2
Sample Location Rationale and Analytes

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Location Type				Recovery Category	Shoaling Area?	Potential Vessel Scour Area	In FNC?	Bank Sample?	Mudline (ft MLLW)	Estimated Core Depth (ft)	Location Notes and Rationale (In Addition to Bounding Known RAL Exceedance)	Analytes by Sample Type[1]							
																	0-10 cm Samples		0-45 cm Samples		0-60 cm Samples or Shoaling Intervals		Deeper Samples	
					0-10 cm	0-45 cm	0-60 cm	Vertical									PCBs	Other	PCBs	Other	PCBs	Other	PCBs	Other
384	4.7	Intertidal	1	35		x			3	-	-	-	Yes	7.5		Phase I archive location. No sample collection needed; lab will be informed not to discard in June. Analyze 0–45-cm archive sample per EPA request, pending cPAH ESD resolution.	--	---	a	x (cPAHs)	--	---	--	---
691	4.7	Intertidal	1	36	x	x			3	-	-	-	-	5.7		Expedite surface and subsurface sediment chemistry to determine number and location of vertical extent cores.	x	-	x	-	--	--	--	--
692	4.7	Intertidal	1	36	x	x			3	-	-	-	-	5.3		Expedite surface and subsurface sediment chemistry to determine number and location of vertical extent cores.	x	-	x	-	--	--	--	--
693	4.7	Intertidal	1	36	x	x			3	-	-	-	-	6.5		Expedite surface and subsurface sediment chemistry to determine number and location of vertical extent cores.	x	-	x	-	--	--	--	--
694	4.7	Intertidal	1	36		a		x	1	-	-	-	Yes	8.8	6.5	Collecting deeper intervals co-located with LDW18-BNK6-1 (surface).	--	--	a	-	--	--	x	-
695	4.7	Intertidal	1	36	x	x			1	-	-	-	Yes	8.9		Expedite surface and subsurface sediment chemistry to determine number and location of vertical extent cores.	x	-	x	-	--	--	--	--
696	4.7	Intertidal	1	36	x	x			1	-	-	-	Yes	9.0		Expedite surface and subsurface sediment chemistry to determine number and location of vertical extent cores.	x	-	x	-	--	--	--	--
697	4.7	Intertidal	1	36		x			1	-	-	-	-	1.6		Collect sample with appropriate subsurface RAL interval.	--	--	x	-	--	--	--	--
698	4.9	Intertidal	1	37		a		x	2	-	-	-	Yes	8.4	6.5		--	--	a	-	--	--	x	-
699	4.9	Intertidal	1	37		a		x	2	-	-	-	Yes	8.0	6.5		--	--	a	-	--	--	x	-
700	4.9	Subtidal	1	37	x				2	-	-	-	-	-8.1 (est)			x	x (benzoic acid)	--	--	--	--	--	--
701	4.9	Intertidal	1	37	x	a		x	2	-	-	-	Yes	8.1	6.5		x	x (benzoic acid)	a	-	--	--	x	-
702	4.9	Intertidal	1	37		a		x	2	-	-	-	Yes	7.7	6.5		--	--	a	-	--	--	x	-
703	4.9	Intertidal	1	37	x	a		a	2	-	-	-	Yes	4.8	6.5	Reoccupying R88 (surface); analyze surface sample for all chemicals with benthic RALs following Phase I sample rules. Expedite surface sample chemistry to determine if vertical extent core will be collected (if RAL exceedances above ENR limit remain).	x	x (all chemicals with benthic RALs)	a	a	--	--	a	a
704	4.9	Intertidal	1	37	x				na	-	-	-	-	-2.1		Bounding shoreline exceedances.	x	-	--	--	--	--	--	--
705	4.9	Subtidal	1	37	x				2	-	-	-	-	-4.8		Bounding shoreline exceedances.	x	-	--	--	--	--	--	--
706	4.9	Intertidal	1	37	x				na	-	-	-	-	-2.8		Bounding shoreline exceedances.	x	-	--	--	--	--	--	--
707	5.0	Intertidal	1	37	x				2	-	-	-	-	-0.6		Bounding upstream of PCB EF of 0.9.	x	-	--	--	--	--	--	--

Notes:
1. The columns indicating analytes by sample type use green shading to show that sample intervals will be collected. A single dash (-) indicates that the sample will not be analyzed for any additional chemicals. A double dash (--) indicates that a given interval will not be collected.
a: Tier 2 archive sample
BBP: butyl benzyl phthalate
BEHP: bis(2-ethylhexyl) phthalate
cPAH: carcinogenic polycyclic aromatic hydrocarbon
EAA: early action area
EF: exceedance factor
EPA: US Environmental Protection Agency
ENR/AC: enhanced natural recovery/activated carbon
ESD: explanation of significant differences
FNC: Federal Navigation Channel

MLLW: mean lower low water
PAH: polycyclic aromatic hydrocarbon
PCB: polychlorinated biphenyl
RAL: remedial action level
RM: river mile
x: Tier 1 sample to be analyzed

Table I-3
Sample Location Details

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Sample Type(s) Surface (0-10 cm)	Intertidal Subsurface (0-45 cm)	Subtidal Subsurface (0-60 cm)	Subtidal Subsurface in Shoaling Area	Vertical Core	In FNC?	Bank Sample?	Mudline (ft MLLW)	Est. Shoal Thickness (No. RAL Interval Samples)	Est. Core Depth (ft)	Notes for Field Crew	Target Coordinates X	Y	Longitude	Latitude
500	3	Subtidal	2 (archive)	1	a		a			No	No	-12.6				1273165	197749	-122.320056	47.532395
501	3	Subtidal	2 (archive)	1	a		a			Yes	No	-16.9				1273201	197791	-122.319913	47.532510
502	3	Subtidal	2 (archive)	1	a		a			Yes	No	-17.0				1273248	197844	-122.319729	47.532657
503	3	Intertidal	1	1	x	a				No	No	5.9				1273127	197624	-122.320199	47.532048
504	3	Intertidal	1	1	x	a				No	No	-2.8				1273171	197680	-122.320028	47.532205
505	3	Subtidal	1	1	x		x			No	No	-13.0				1273206	197721	-122.319887	47.532319
506	3	Subtidal	1	1	x		x			Yes	No	-15.7				1273289	197816	-122.319559	47.532585
507	3	Intertidal	1	1	x	x				No	No	-2.2				1273207	197636	-122.319880	47.532086
508	3	Subtidal	1	1	x		x			Yes	No	-17.4				1273289	197722	-122.319555	47.532326
509	3	Subtidal	1	1			a		x	Yes	No	-16.8		9	target elevation (-25 ft MLLW)	1273335	197772	-122.319370	47.532465
510	3	Subtidal	1	1			a		x	No	No	-11.6		6	RAL (0–60 cm) + 4 intervals	1273265	197659	-122.319645	47.532152
511	3	Subtidal	1	1	a		x			No	No	-10.2				1273297	197620	-122.319512	47.532047
512	3	Intertidal	2 (archive)	1		a				No	No	-2.6				1273279	197576	-122.319583	47.531925
513	3	Subtidal	1	1	x		x		a	Yes	No	-16.7		9	target elevation (-25 ft MLLW)	1273376	197625	-122.319194	47.532065
514	3	Subtidal	1	1	x		x		x	Yes	No	-17.2		8	target elevation (-25 ft MLLW)	1273422	197677	-122.319012	47.532209
515	3	Subtidal	1	2			x			Yes	No	-17.4				1273477	197592	-122.318782	47.531979
516	3.1	Subtidal	1	2	x		x			Yes	No	-16.9				1273483	197531	-122.318753	47.531812
517	3.1	Subtidal	1	2			a		x	Yes	No	-16.8		9	target elevation (-25 ft MLLW)	1273528	197588	-122.318577	47.531971
518	3.1	Intertidal	1	2	x	x				No	No	0.3				1273409	197394	-122.319044	47.531433
519	3.1	Subtidal	1	2			x		a	No	No	-12.2		6	RAL (0–60 cm) + 4 intervals	1273499	197456	-122.318682	47.531608
520	3.1	Subtidal	1	2			a		x	Yes	No	-17.2		8	target elevation (-25 ft MLLW)	1273535	197495	-122.318540	47.531717
521	3.1	Subtidal	1	2			a		x	Yes	No	-15.7		10	target elevation (-25 ft MLLW)	1273651	197485	-122.318070	47.531697
522	3.1	Subtidal	1	2			x			Yes	No	-17.4				1273635	197443	-122.318132	47.531579
523	3.1	Subtidal	1	2			x			Yes	No	-17.0				1273645	197379	-122.318085	47.531406
524	3.1	Subtidal	1	3			x			Yes	No	-16.2				1273749	197386	-122.317667	47.531430
525	3.1	Subtidal	2 (archive)	3			a			No	No	-13.3				1273714	197268	-122.317798	47.531105
526	3.1	Subtidal	1	3			x			Yes	No	-17.9				1273760	197310	-122.317615	47.531222
527	3.1	Subtidal	1	3			a		x	Yes	No	-16.0		9	target elevation (-25 ft MLLW)	1273795	197349	-122.317477	47.531330
528	3.1	Subtidal	1	3			x			Yes	No	-16.4				1273829	197309	-122.317335	47.531222
529	3.1	Subtidal	1	4			x		a	No	No	-12.0		6	RAL (0–60 cm) + 4 intervals	1273814	197162	-122.317383	47.530819
530	3.1	Subtidal	1	5			x			Yes	No	-17.3				1273883	197235	-122.317109	47.531023
531	3.2	Subtidal	1	5			a		x	Yes	No	-17.0		8	target elevation (-25 ft MLLW)	1273947	197184	-122.316849	47.530888
532	3.2	Subtidal	1	5			a		x	Yes	No	-17.1		8	target elevation (-25 ft MLLW)	1274022	197124	-122.316538	47.530727
128[1]	3.2	Subtidal	1	5	x		x			No	No	-7.0				1273968	196984	-122.316747	47.530340
533	3.2	Subtidal	1	5			a		x	Yes	No	-16.5		9	target elevation (-25 ft MLLW)	1274103	197060	-122.316207	47.530555
534	3.2	Subtidal	1	5			a		x	Yes	No	-17.2		8	target elevation (-25 ft MLLW)	1274176	196976	-122.315904	47.530328
535	3.2	Subtidal	1	5			a		x	Yes	No	-18.2		7	target elevation (-25 ft MLLW)	1274250	196893	-122.315598	47.530106

FINAL

Table I-3
Sample Location Details

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Sample Type(s): Surface (0-10 cm)	Sample Type(s): Intertidal Subsurface (0-45 cm)	Sample Type(s): Subtidal Subsurface (0-60 cm)	Sample Type(s): Subtidal Subsurface in Shoaling Area	Sample Type(s): Vertical Core	In FNC?	Bank Sample?	Mudline (ft MLLW)	Est. Shoal Thickness (No. RAL Interval Samples)	Est. Core Depth (ft)	Notes for Field Crew	Target Coordinates: X	Target Coordinates: Y	Target Coordinates: Longitude	Target Coordinates: Latitude
536	3.3	Subtidal	1	5	x		x			Yes	No	-17.0				1274293	196777	-122.315417	47.529789
537	3.3	Subtidal	1	5			a		x	Yes	No	-18.3		7	target elevation (-25 ft MLLW)	1274338	196825	-122.315237	47.529923
538	3.3	Subtidal	1	5			a		x	Yes	No	-19.3		6	target elevation (-25 ft MLLW)	1274423	196754	-122.314888	47.529734
539	3.3	Subtidal	1	5			x		x	Yes	No	-19.7		6	target elevation (-25 ft MLLW)	1274501	196713	-122.314569	47.529625
540	3.3	Subtidal	1	5			x			Yes	No	-19.8				1274478	196654	-122.314658	47.529463
541	3.3	Subtidal	2 (archive)	5	a					Yes	No	-22.4				1274533	196659	-122.314436	47.529479
143[1]	3.3	Intertidal	2 (archive)	7		a				No	No	3.7				1274345	196540	-122.315187	47.529144
542	3.3	Intertidal	1	7	x	x				No	No	-2.5				1274389	196590	-122.315011	47.529282
543	3.3	Intertidal	1	7		x			x	No	No	-2.6		6.5	RAL (0–45 cm) + 5 intervals	1274432	196543	-122.314837	47.529155
544	3.3	Subtidal	1	7	x					No	No	-7.0				1274452	196514	-122.314754	47.529076
545	3.3	Intertidal	1	7		a			x	No	No	5.7		6.5	RAL (0–45 cm) + 5 intervals	1274417	196458	-122.314888	47.528923
546	3.3	Subtidal	1	7	x					No	No	-8.3				1274503	196470	-122.314540	47.528960
547	3.3	Intertidal	1	7	x					No	No	6.5				1274479	196413	-122.314635	47.528803
548	3.3	Subtidal	1	9				x		Yes	No	-14.3	21 cm shoal (1)			1274545	196550	-122.314379	47.529181
549	3.4	Subtidal	1	9				x	x	Yes	No	-13.0	61 cm shoal (2)	12	target elevation (-25 ft MLLW)	1274653	196465	-122.313936	47.528953
550	3.3	Subtidal	1	8			x			Yes	No	-21.8				1274571	196596	-122.314278	47.529309
551	3.3	Subtidal	1	8			x			Yes	No	-22.3				1274607	196636	-122.314134	47.529420
552	3.3	Subtidal	1	8	x					Yes	No	-20.9				1274653	196537	-122.313940	47.529150
553	3.3	Subtidal	1	8			a		x	Yes	No	-21.4		5	target elevation (-26 ft MLLW)	1274679	196569	-122.313837	47.529239
554	3.4	Subtidal	1	8			x		x	Yes	No	-19.8		6	target elevation (-25 ft MLLW)	1274762	196491	-122.313494	47.529031
555	3.4	Subtidal	1	10	x					Yes	No	-16.4				1274820	196382	-122.313252	47.528734
556	3.4	Subtidal	1	10	x					Yes	No	-7.1				1274799	196309	-122.313332	47.528534
557	3.4	Subtidal	2 (archive)	11				a		Yes	No	-10.7	130 cm shoal (3)			1274838	196299	-122.313171	47.528507
558	3.4	Subtidal	1	11				x	x	Yes	No	-9.1	180 cm shoal (3)	16	target elevation (-25 ft MLLW)	1274899	196237	-122.312922	47.528341
559	3.5	Intertidal	1	12	x					No	Yes	5.6				1275082	195829	-122.312149	47.527233
560[2]	3.5	Intertidal	1	12			a		x	No	No	-2.7		14	target elevation (-16 ft MLLW)	1275121	195825	-122.311990	47.527224
163[1]	3.5	Subtidal	1	13				x		Yes	No	-12.5	76 cm shoal (2)			1275115	196081	-122.312034	47.527926
561	3.5	Subtidal	1	13			x			Yes	No	-18.2				1275244	196061	-122.311510	47.527876
562	3.5	Subtidal	2 (archive)	13				a		Yes	No	-11.6	103 cm shoal (3)			1275248	195953	-122.311486	47.527582
563	3.5	Subtidal	2 (archive)	13				a		Yes	No	-14.6	12 cm shoal (1)			1275293	195950	-122.311305	47.527574
564	3.5	Subtidal	1	13				x	x	Yes	No	-9.8	158 cm shoal (3)	16	target elevation (-25 ft MLLW)	1275295	195890	-122.311292	47.527411
565	3.6	Subtidal	1	14				x	a	Yes	No	-9.6	166 cm shoal (3)	16	target elevation (-25 ft MLLW)	1275433	195753	-122.310722	47.527042
566	3.6	Subtidal	1	15			x			Yes	No	-18.8				1275654	195699	-122.309823	47.526907
567	3.6	Subtidal	1	15			x			Yes	No	-15.8				1275668	195622	-122.309763	47.526696
568	3.6	Subtidal	1	15			a		x	Yes	No	-18.1		7	target elevation (-25 ft MLLW)	1275695	195653	-122.309654	47.526782
569	3.6	Subtidal	1	15			x			Yes	No	-15.9				1275736	195617	-122.309484	47.526686

Table I-3
Sample Location Details

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Sample Type(s): Surface (0-10 cm)	Intertidal Subsurface (0-45 cm)	Subtidal Subsurface (0-60 cm)	Subtidal Subsurface in Shoaling Area	Vertical Core	In FNC?	Bank Sample?	Mudline (ft MLLW)	Est. Shoal Thickness (No. RAL Interval Samples)	Est. Core Depth (ft)	Notes for Field Crew	Target Coordinates: X	Y	Longitude	Latitude
570	3.6	Subtidal	1	16	x		x			No	No	-9.0				1275619	195488	-122.309949	47.526325
571	3.6	Subtidal	1	16			x		x	No	No	-6.9		6	RAL (0–60 cm) + 4 intervals	1275635	195417	-122.309879	47.526132
572	3.6	Subtidal	1	16				x	x	Yes	No	-13.0	60 cm shoal (2)	12	target elevation (-25 ft MLLW)	1275700	195420	-122.309618	47.526143
573	3.6	Subtidal	1	16			x			No	No	-8.5				1275665	195365	-122.309753	47.525992
574	3.7	Subtidal	1	17			x			Yes	No	-16.7				1275832	195339	-122.309074	47.525928
575	3.7	Subtidal	1	17	x					Yes	No	-14.5				1275822	195300	-122.309115	47.525822
576	3.7	Subtidal	1	17			x		a	Yes	No	-16.7		9	target elevation (-25 ft MLLW)	1275859	195276	-122.308962	47.525758
577	3.7	Subtidal	1	18			x		a	No	No	-11.3		6	RAL (0–60 cm) + 4 intervals	1275950	195101	-122.308578	47.525282
578	3.7	Intertidal	1	18	x	x				No	No	-1.9				1275997	195110	-122.308389	47.525311
579	3.7	Intertidal	1	18		a			x	No	No	0.8		6.5		1276029	195110	-122.308260	47.525311
580	3.7	Subtidal	1	18	x		x			No	No	-9.4				1275977	195037	-122.308464	47.525110
581	3.7	Subtidal	1	18			a		x	No	No	-3.5		6	RAL (0–60 cm) + 4 intervals	1276008	195006	-122.308337	47.525026
582	3.7	Intertidal	1	18		a			x	No	No	1.0		6.5		1276048	195017	-122.308176	47.525056
583	3.7	Subtidal	1	18	x		x			No	No	-12.6				1275979	194929	-122.308448	47.524813
584	3.8	Subtidal	1	18			a		x	No	No	-4.7		6	RAL (0–60 cm) + 4 intervals	1276032	194909	-122.308232	47.524760
585	3.7	Intertidal	1	18		a			x	No	No	2.7		6.5		1276070	194917	-122.308080	47.524785
586	3.8	Subtidal	1	18	x		x			No	No	-12.7				1275992	194839	-122.308391	47.524567
587	3.8	Subtidal	1	18			a		x	No	No	-10.1		6	RAL (0–60 cm) + 4 intervals	1276025	194805	-122.308254	47.524477
588	3.8	Intertidal	1	18		a			x	No	No	2.9		6.5		1276099	194823	-122.307955	47.524529
589	3.8	Subtidal	1	18			x			No	No	-12.7				1276011	194769	-122.308309	47.524376
590	3.8	Subtidal	1	18	x		x			No	No	-12.6				1276024	194712	-122.308248	47.524221
591	3.8	Subtidal	1	18			a		x	No	No	-8.2		6	RAL (0–60 cm) + 4 intervals	1276063	194689	-122.308089	47.524160
592	3.8	Intertidal	1	18		x			a	No	No	-1.9		6.5	RAL (0–45 cm) + 5 intervals	1276119	194702	-122.307865	47.524198
593	3.8	Intertidal	1	18		x			x	No	No	-2.1 (est)		6.5	RAL (0–45 cm) + 5 intervals	1276173	194716	-122.307646	47.524239
594	3.8	Subtidal	1	18			x			No	No	-10.5				1276061	194639	-122.308095	47.524022
595	3.8	Subtidal	2 (archive)	18			a			No	No	-11.9				1276061	194589	-122.308093	47.523884
596	3.8	Subtidal	2 (archive)	18			a		a	No	No	-8.1		6	RAL (0–60 cm) + 4 intervals	1276084	194608	-122.307999	47.523938
597	3.8	Intertidal	1	18		a			x	No	No	-0.4		6.5	RAL (0–45 cm) + 5 intervals	1276130	194610	-122.307812	47.523946
598	3.8	Intertidal	1	18		x			a	No	No	4.8		6.5	RAL (0–45 cm) + 5 intervals	1276200	194641	-122.307534	47.524035
599	3.8	Subtidal	1	18	x		x			No	No	-6.0				1276106	194568	-122.307907	47.523830
600	3.8	Intertidal	2 (archive)	18	a	a				No	No	0.3				1276152	194582	-122.307722	47.523871
601	3.8	Intertidal	2 (archive)	18		a				No	No	3.2				1276200	194594	-122.307528	47.523906
602	3.8	Intertidal	1	18	x	x				No	No	5.1				1276225	194555	-122.307425	47.523801
603	3.8	Intertidal	1	18	x	x				No	No	2.0				1276196	194527	-122.307540	47.523722
604	3.8	Intertidal	1	18		a			x	No	Yes	5.0		6.5	RAL (0–45 cm) + 5 intervals	1276234	194514	-122.307387	47.523688
605	3.8	Intertidal	1	19		x				No	No	-1.0				1275788	194798	-122.309211	47.524442
606	3.8	Intertidal	1	20		x				No	No	6.0				1275751	194700	-122.309354	47.524173

Table I-3
Sample Location Details

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Sample Type(s): Surface (0-10 cm)	Sample Type(s): Intertidal Subsurface (0-45 cm)	Sample Type(s): Subtidal Subsurface (0-60 cm)	Sample Type(s): Subtidal Subsurface in Shoaling Area	Sample Type(s): Vertical Core	In FNC?	Bank Sample?	Mudline (ft MLLW)	Est. Shoal Thickness (No. RAL Interval Samples)	Est. Core Depth (ft)	Notes for Field Crew	Target Coordinates: X	Target Coordinates: Y	Target Coordinates: Longitude	Target Coordinates: Latitude
607	3.8	Subtidal	1	20				x		Yes	No	-12.2	84 cm shoal (2)[3]			1275878	194705	-122.308841	47.524193
608	3.8	Intertidal	1	20		x			a	No	No	5.0		6.5	RAL (0–45 cm) + 5 intervals	1275763	194642	-122.309303	47.524015
609	3.8	Intertidal	1	20		a			x	No	No	-3.1		6.5	RAL (0–45 cm) + 5 intervals	1275820	194657	-122.309072	47.524059
610	3.8	Subtidal	1	20			x			No	No	-9.6				1275858	194672	-122.308919	47.524102
611	3.8	Intertidal	1	20		x				No	No	4.8				1275775	194559	-122.309245	47.523789
612	3.8	Subtidal	1	20			x			No	No	-5.5				1275851	194594	-122.308941	47.523888
613	3.8	Intertidal	1	21	x					No	No	1.5				1275807	194505	-122.309113	47.523642
231[1]	3.8	Subtidal	1	22				x		Yes	No	-12.8	66 cm shoal (2)			1275935	194524	-122.308598	47.523700
614	3.8	Subtidal	2 (archive)	22			a			No	No	-8.4				1275883	194539	-122.308808	47.523739
615	3.8	Intertidal	1	23		x				No	No	0.8				1276181	194462	-122.307596	47.523543
616	3.8	Intertidal	1	23	x	x				No	Yes	6.6				1276260	194447	-122.307275	47.523507
617	3.9	Intertidal	1	23		x				No	No	1.7				1276223	194364	-122.307418	47.523277
618	3.9	Intertidal	1	23		x				No	No	0.6				1276212	194304	-122.307458	47.523112
619	3.9	Intertidal	1	23	x	x				No	Yes	6.5				1276288	194337	-122.307153	47.523205
620	3.9	Subtidal	1	23	x		x			No	No	-9.6				1276159	194248	-122.307668	47.522957
621	3.9	Intertidal	1	23		a			x	No	No	-1.9		6.5	RAL (0–45 cm) + 5 intervals	1276217	194211	-122.307430	47.522858
622	3.9	Intertidal	1	23		x			x	No	No	5.5		6.5	RAL (0–45 cm) + 5 intervals	1276304	194229	-122.307081	47.522912
623	3.9	Subtidal	1	23	x		x			No	No	-9.1				1276188	194137	-122.307544	47.522654
624	3.9	Intertidal	1	23		x				No	No	1.9				1276280	194160	-122.307172	47.522721
625	3.9	Intertidal	1	23	x	x				No	No	8.0				1276344	194092	-122.306909	47.522539
626	3.9	Intertidal	1	23		x				No	No	1.1				1276302	193980	-122.307068	47.522229
627	3.9	Intertidal	1	23	x	x				No	No	4.3 (est)				1276365	194002	-122.306816	47.522293
628	3.9	Subtidal	2 (archive)	24				a		Yes	No	-13.5	46 cm shoal (2)			1276060	194278	-122.308071	47.523031
629	3.9	Subtidal	1	24				x	x	Yes	No	-13.3	52 cm shoal (2)	12	target elevation (-25 ft MLLW)	1276109	194243	-122.307870	47.522939
630	3.9	Subtidal	1	26			x		a	No	No	-8.7		6	RAL (0–60 cm) + 4 intervals	1276229	193966	-122.307365	47.522188
249[1]	3.9	Subtidal	1	26	x			x		Yes	No	-13.4	48 cm shoal (2)			1276090	194014	-122.307928	47.522310
631	4	Intertidal	1	27	x					No	No	-2.3				1276294	193929	-122.307097	47.522088
632	4	Intertidal	1	27		a			x	No	No	2.5		6.5	RAL (0–45 cm) + 5 intervals	1276359	193935	-122.306833	47.522108
633	4	Intertidal	1	27	x					No	No	2.8				1276370	193921	-122.306789	47.522070
634	4	Subtidal	1	27	x		x		x	No	No	-6.4		6	RAL (0–60 cm) + 4 intervals	1276269	193853	-122.307194	47.521879
635	4	Intertidal	1	27		a			a	No	No	0.2		6.5	RAL (0–45 cm) + 5 intervals	1276345	193814	-122.306883	47.521776
636	4	Intertidal	1	27	x	a				No	No	1.4				1276365	193818	-122.306800	47.521787
254[1]	4	Subtidal	1	27				x		Yes	No	-13.3	53 cm shoal (2)			1276116	193833	-122.307809	47.521816
637	4	Intertidal	1	28		a			x	No	No	0.5		6.5	RAL (0–45 cm) + 5 intervals	1275935	193737	-122.308536	47.521542
638	4	Intertidal	1	28		x				No	No	-3.7				1275981	193750	-122.308351	47.521582
639	4	Intertidal	1	28		x				No	No	-1.5				1275962	193682	-122.308420	47.521394

FINAL

Table I-3
Sample Location Details

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Sample Type(s)					In FNC?	Bank Sample?	Mudline (ft MLLW)	Est. Shoal Thickness (No. RAL Interval Samples)	Est. Core Depth (ft)	Notes for Field Crew	Target Coordinates			
					Surface (0-10 cm)	Intertidal Subsurface (0-45 cm)	Subtidal Subsurface (0-60 cm)	Subtidal Subsurface in Shoaling Area	Vertical Core							X	Y	Longitude	Latitude
640	4	Subtidal	1	29			x		a	No	No	-5.3		6	RAL (0–60 cm) + 4 intervals	1276296	193760	-122.307076	47.521625
641	4	Intertidal	1	30	a	x				No	No	0.3				1276367	193757	-122.306788	47.521621
642	4	Subtidal	2 (archive)	30	a					No	No	-7.9				1276295	193690	-122.307074	47.521433
643	4	Intertidal	1	30	x					No	No	-3.0				1276333	193694	-122.306922	47.521447
644	4	Intertidal	2 (archive)	30		a			a	No	No	-1.2		6.5	RAL (0–45 cm) + 5 intervals	1276352	193719	-122.306847	47.521515
645	4	Intertidal	1	30	x					No	No	-1.0				1276374	193686	-122.306755	47.521426
646	4	Intertidal	1	30	x					No	Yes	5.1				1276431	193746	-122.306529	47.521595
647	4	Intertidal	1	31	x	x				No	No	-2.1				1276407	193496	-122.306607	47.520908
648	4	Intertidal	1	31		a			x	No	No	0.1		6.5	RAL (0–45 cm) + 5 intervals	1276457	193480	-122.306404	47.520866
649	4	Intertidal	1	31		a			x	No	No	5.4		6.5	RAL (0–45 cm) + 5 intervals	1276596	193514	-122.305843	47.520967
650	4	Intertidal	1	31		a			x	No	Yes	8.9		6.5	RAL (0–45 cm) + 5 intervals	1276641	193525	-122.305660	47.520999
651	4	Intertidal	1	31	x	x				No	No	-0.9				1276455	193407	-122.306407	47.520665
652	4.1	Intertidal	1	31		a			x	No	No	0.1		6.5	RAL (0–45 cm) + 5 intervals	1276479	193383	-122.306308	47.520601
653	4.1	Intertidal	1	31		a			x	No	No	2.8		6.5	RAL (0–45 cm) + 5 intervals	1276546	193400	-122.306038	47.520651
654	4.1	Intertidal	1	31		a			x	No	No	4.1		6.5	RAL (0–45 cm) + 5 intervals	1276610	193416	-122.305777	47.520699
655	4.1	Intertidal	1	31		a			x	No	Yes	9.2		6.5	RAL (0–45 cm) + 5 intervals	1276665	193429	-122.305556	47.520737
656	4.1	Intertidal	1	31	x	x				No	No	-1.8				1276471	193272	-122.306330	47.520297
657	4.1	Intertidal	1	31		a			x	No	No	-0.8		6.5	RAL (0–45 cm) + 5 intervals	1276490	193285	-122.306254	47.520334
658	4.1	Intertidal	1	31		a			x	No	No	2.6		6.5	RAL (0–45 cm) + 5 intervals	1276559	193302	-122.305978	47.520383
659	4.1	Intertidal	1	31		a			x	No	No	4.1		6.5	RAL (0–45 cm) + 5 intervals	1276626	193318	-122.305706	47.520432
660	4.1	Intertidal	1	31		a			x	No	Yes	5.5		6.5	RAL (0–45 cm) + 5 intervals	1276676	193331	-122.305505	47.520468
661	4.1	Intertidal	1	31	x					No	No	2.2				1276564	193244	-122.305953	47.520224
662	4.1	Intertidal	1	31		a			x	No	No	4.0		6.5	RAL (0–45 cm) + 5 intervals	1276643	193204	-122.305631	47.520118
663	4.1	Intertidal	1	31		a			x	No	Yes	8.1		6.5	RAL (0–45 cm) + 5 intervals	1276680	193213	-122.305480	47.520146
664	4.1	Intertidal	1	31		a			x	No	No	2.2		6.5	RAL (0–45 cm) + 5 intervals	1276603	193102	-122.305782	47.519838
665	4.1	Intertidal	1	31		a			x	No	No	4.2		6.5	RAL (0–45 cm) + 5 intervals	1276661	193117	-122.305551	47.519882
666	4.1	Intertidal	1	31		a			x	No	Yes	7.8		6.5	RAL (0–45 cm) + 5 intervals	1276713	193129	-122.305340	47.519918
667	4.1	Intertidal	1	31	x					No	No	0.1				1276589	193032	-122.305834	47.519646
668	4.1	Intertidal	1	31	x	x				No	No	3.6				1276655	193047	-122.305568	47.519690
669	4.1	Intertidal	1	31		a			x	No	No	4.8		6.5	RAL (0–45 cm) + 5 intervals	1276695	193029	-122.305405	47.519642
670	4.1	Intertidal	1	31		a			x	No	Yes	8.1		6.5	RAL (0–45 cm) + 5 intervals	1276735	193039	-122.305244	47.519671
321[1]	4.2	Intertidal	1	31	x	x				No	No	1.5				1276666	192856	-122.305510	47.519167
671	4.2	Subtidal	1	32			x			No	No	-8.7				1277284	192848	-122.303009	47.519177
672	4.2	Subtidal	1	32			x			No	No	-5.2				1277357	192803	-122.302710	47.519059
673	4.2	Subtidal	1	32			a		x	No	No	-6.0		20	target elevation (-26 ft MLLW)	1277387	192819	-122.302589	47.519104
674	4.2	Subtidal	1	32			a		x	No	No	-8.5		18	target elevation (-26 ft MLLW)	1277368	192855	-122.302669	47.519201
675	4.2	Subtidal	1	32	x		x			No	No	-8.3				1277411	192871	-122.302495	47.519246

Table I-3
Sample Location Details

Location No.	RM	Area Type	Tier	RAL Exceedance Area	Sample Type(s): Surface (0-10 cm)	Sample Type(s): Intertidal Subsurface (0-45 cm)	Sample Type(s): Subtidal Subsurface (0-60 cm)	Sample Type(s): Subtidal Subsurface in Shoaling Area	Sample Type(s): Vertical Core	In FNC?	Bank Sample?	Mudline (ft MLLW)	Est. Shoal Thickness (No. RAL Interval Samples)	Est. Core Depth (ft)	Notes for Field Crew	Target Coordinates: X	Target Coordinates: Y	Target Coordinates: Longitude	Target Coordinates: Latitude
676	4.2	Subtidal	2 (archive)	32	a		a			No	No	-7.6				1277476	192898	-122.302234	47.519323
677	4.2	Subtidal	2 (archive)	32			a			No	No	-8.6				1277459	192928	-122.302306	47.519406
678	4.2	Subtidal	2 (archive)	32	a					No	No	-8.4				1277489	192970	-122.302188	47.519522
679	4.3	Intertidal	1	33		x				No	No	-2.8				1276442	192190	-122.306362	47.517330
358[1]	4.3	Intertidal	2 (archive)	33		a				No	No	-0.6				1276416	192127	-122.306464	47.517155
680	4.6	Subtidal	1	34	a		x			No	No	-4.6				1277238	190570	-122.303019	47.512931
681	4.6	Intertidal	2 (archive)	34	a	a				No	No	3.8				1277305	190651	-122.302753	47.513156
682	4.6	Intertidal	1	34	x	x				No	Yes	2.2				1277343	190614	-122.302596	47.513057
683	4.7	Intertidal	2 (archive)	34		a			a	No	Yes	6.8		6.5	RAL (0–45 cm) + 5 intervals	1277378	190622	-122.302453	47.513080
684	4.7	Intertidal	2 (archive)	34		a			a	No	Yes	0.7		6.5	RAL (0–45 cm) + 5 intervals	1277371	190593	-122.302482	47.513000
685	4.7	Intertidal	1	34	x	x				No	Yes	2.1				1277390	190588	-122.302404	47.512988
686	4.7	Intertidal	2 (archive)	34	a	a				No	No	-0.2				1277437	190557	-122.302212	47.512906
687	4.7	Intertidal	1	35	x					No	Yes	7.4				1277106	189921	-122.303503	47.511145
688	4.7	Intertidal	1	35	x					No	Yes	6.9				1277154	189892	-122.303304	47.511069
689	4.7	Intertidal	1	35	x					No	No	5.5				1277212	189922	-122.303074	47.511153
690	4.7	Intertidal	1	35	x					No	Yes	9.9				1277179	189837	-122.303200	47.510917
384[1]	4.7	Intertidal	1	35		x				No	No	7.5				1277228	189853	-122.303002	47.510965
691	4.7	Intertidal	1	36	x	x				No	No	5.7				1277401	190065	-122.302321	47.511556
692	4.7	Intertidal	1	36	x	x				No	No	5.3				1277445	190103	-122.302146	47.511661
693	4.7	Intertidal	1	36	x	x				No	No	6.5				1277499	190100	-122.301925	47.511656
694	4.7	Intertidal	1	36		a			x	No	Yes	8.8		6.5	RAL (0–45 cm) + 5 intervals	1277459	190049	-122.302083	47.511514
695	4.7	Intertidal	1	36	x	x				No	Yes	8.9				1277417	190006	-122.302252	47.511395
696	4.7	Intertidal	1	36	x	x				No	Yes	9.0				1277482	190012	-122.301988	47.511415
697	4.7	Intertidal	1	36		x				No	No	1.6				1277575	190022	-122.301612	47.511446
698	4.9	Intertidal	1	37		a			x	No	Yes	8.4		6.5	RAL (0–45 cm) + 5 intervals	1278273	190399	-122.298816	47.512517
699	4.9	Intertidal	1	37		a			x	No	Yes	8.0		6.5	RAL (0–45 cm) + 5 intervals	1278357	190364	-122.298473	47.512426
700	4.9	Subtidal	1	37	x					No	No	-8.1 (est)				1278375	190330	-122.298400	47.512333
701	4.9	Intertidal	1	37	x	a			x	No	Yes	8.1		6.5	RAL (0–45 cm) + 5 intervals	1278468	190315	-122.298022	47.512296
702	4.9	Intertidal	1	37		a			x	No	Yes	7.7		6.5	RAL (0–45 cm) + 5 intervals	1278527	190265	-122.297780	47.512161
703	4.9	Intertidal	1	37	x	a			a	No	Yes	4.8		6.5	RAL (0–45 cm) + 5 intervals	1278621	190185	-122.297393	47.511948
704	4.9	Intertidal	1	37	x					No	No	-2.1				1278444	190279	-122.298115	47.512196
705	4.9	Subtidal	1	37	x					No	No	-4.8				1278483	190224	-122.297955	47.512046
706	4.9	Intertidal	1	37	x					No	No	-2.8				1278515	190204	-122.297825	47.511994
707	5	Intertidal	1	37	x					No	No	-0.6				1278761	189999	-122.296811	47.511445

Notes:
1. Location is a Phase I archive sample that will be analyzed as part of Phase II. Thus, no sample collection is needed at this location.
2. A 0- to 60-cm subsurface sample will be collected at this location (rather than 0- to 45-cm sample) because subtidal conditions are consistent with the intended use for the South Park Marina.
3. A Z-layer sample (-17 to -18 ft MLLW) will also be collected at this location.

a: Tier 2 archive sample
FNC: Federal Navigation Channel
MLLW: mean lower low water
RAL: remedial action level
RM: river mile
x: Tier 1 sample to be analyzed

Table I-4a
Vertical Extent Core Profiles (Areas 1 through 7)

Area 1

Loc ID	509	510	513	514
Mudline	-16.8	-11.6	-16.7	-17.2
(core depth)	(9 ft)	(6 ft)	(9 ft)	(8 ft)
A	a (0-60)	a (0-60)	x (0-60)	x (0-60)
B	x	x	a	x
C	x	x	a	x
D	a	a	a	a
E	x	x	a	x
F	a		a	a
G	x		a	x
H	a		a	

Area 2

Loc ID	517	519	520	521
Mudline	-16.8	-12.2	-17.2	-15.7
(core depth)	(9 ft)	(6 ft)	(8 ft)	(10ft)
A	a (0-60)	x (0-60)	a (0-60)	a (0-60)
B	x	a	x	x
C	x	a	x	x
D	a	a	a	a
E	x	a	x	x
F	a		a	a
G	x		x	x
H	a			a
I				x

Area 3

Loc ID	527
Mudline	-16.0
(core depth)	(9 ft)
A	a (0-60)
B	x
C	x
D	a
E	x
F	a
G	x
H	a

Area 4

Loc ID	529
Mudline	-12.0
(core depth)	(6 ft)
A	x (0-60)
B	a
C	a
D	a
E	a
F	
G	
H	

Area 5

Loc ID	531	532	533	534	535	537	538	539
Mudline	-17.0	-17.1	-16.5	-17.2	-18.2	-18.3	-19.3	-19.7
(core depth)	(8 ft)	(8 ft)	(9 ft)	(8 ft)	(7 ft)	(7 ft)	(6 ft)	(6 ft)
A	a (0–60)	a (0–60)	a (0–60)	a (0–60)	a (0–60)	a (0–60)	a (0–60)	x (0–60)
B	x	x	x	x	x	x	x	x
C	x	x	x	x	x	x	x	x
D	a	a	a	a	a	a	a	a
E	x	x	x	x	x	x	x	x
F	a	a	a	a	a	a		
G	x	x	x	x				
H			a					

Core Intervals

Notes:
Mudline elevation shown in ft MLLW. Sample interval measurements are in cm unless otherwise indicated (i.e., for the -15 to -17 ft MLLW interval).
Cell colors indicate the following: x – Tier 1 sample to be analyzed; a – Tier 2 sample to be archived for potential analysis.
ID: identification
MLLW: mean lower low water

FINAL

Table I-4b
Vertical Extent Core Profiles (Areas 8 through 17)

	Area 7		Area 8		Area 9	Area 11	Area 12	Area 13	Area 14	Area 15	Area 16	
Loc ID	**543**	**545**	**553**	**554**	**549**	**558**	**560**	**564**	**565**	**568**	**571**	**572**
Mudline	-2.6	5.7	-21.4	-19.8	-13.0	-9.1	-2.7	-9.8	-9.6	-18.1	-6.9	-13.0
(core depth)	(6.5 ft)	(6.5 ft)	(5 ft)	(6 ft)	(12 ft)	(16 ft)	(14 ft)	(16 ft)	(16 ft)	(7 ft)	(6 ft)	(12 ft)
Core Intervals A	x (0–45)	a(0–45)	a (0–60)	x (0–60)	x (SH 0-61)	x (SH 0-90)	a (0–60)	x (SH 0-79)	x (SH 0-83)	a (0–60)	x (0–60)	x (SH 0-60)
B	x	x	x	x	x (-15 to -17 ft)	x (SH 91-180)	x	x (SH 80-158)	x (SH 84-166)	x	x	x (-15 to -17 ft)
C	x	x	x	x		x (-15 to -17 ft)	x	x (-15 to -17 ft)	x (-15 to -17 ft)	x	x	
D	a	a	a	a	x	x	a	a	a	a	a	x
E	x	x		x	x	x	x	x	a	x	x	x
F	a	a			a	a	a	a	a	a		a
G					x	x	x	x	a			a
H					a	a	a	a	a			a
I					x	x	x	x	a			a
J					a	a	a	a	a			a
K					x	x	x	x	a			a
L							a					
M							x					

Notes:

Mudline elevation shown in ft MLLW. Sample interval measurements are in cm unless otherwise indicated (i.e., for the -15 to -17 ft MLLW interval).
Cell colors indicate the following: x – Tier 1 sample to be analyzed; a – Tier 2 sample to be archived for potential analysis.
ID: identification
MLLW: mean lower low water
SH: shoal interval

Table I-4c
Vertical Extent Core Profiles (Areas 18 through 23)

	Area 17	Area 18															Area 20	
Loc ID	576	577	579	581	582	584	585	587	588	591	592	593	596	597	598	604	608	609
Mudline	-16.7	-11.3	0.8	-3.5	1.0	-4.7	2.7	-10.1	2.9	-8.2	-1.9	-2.1	-8.1	-0.4	4.8	5.0	5.0	-3.1
(core depth)	(9 ft)	(6 ft)	(6.5 ft)	(6 ft)	(6.5 ft)	(6 ft)	(6.5 ft)	(6 ft)	(6.5 ft)	(6 ft)	(6.5 ft)	(6.5 ft)	(6 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)
Core Intervals A	x (0–60)	x (0-60)	a (0-45)	a (0-60)	a (0-45)	a (0-60)	a (0-45)	a (0-60)	a (0-45)	a (0-60)	x (0-45)	x (0-45)	a (0-60)	a (0-45)	x (0-45)	a (0-45)	x (0–45)	a (0–45)
B	a	a	x	x	x	x	x	x	x	x	a	x	a	x	a	x	a	x
C	a	a	x	x	x	x	x	x	x	x	a	x	a	x	a	x	a	x
D	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
E	a	a	x	x	x	x	x	x	x	x	a	x	a	x	a	x	a	x
F	a		a		a		a		a		a	a		a	a	a	a	a
G	a																	
H	a																	

Notes:
Mudline elevation shown in ft MLLW. Sample interval measurements are in cm unless otherwise indicated (i.e., for the -15 to -17 ft MLLW interval).
Cell colors indicate the following: x – Tier 1 sample to be analyzed; a – Tier 2 sample to be archived for potential analysis.
ID: identification
MLLW: mean lower low water

FINAL

Table I-4d
Vertical Extent Core Profiles (Areas 23 through 28)

	Area 23		Area 24	Area 26	Area 27			Area 28	Area 29	Area 30
Loc ID	**621**	**622**	**629**	**630**	**632**	**634**	**635**	**637**	**640**	**644**
Mudline	-1.9	5.5	-13.3	-8.7	2.5	-6.4	0.2	0.5	-5.3	-1.2
(core depth)	(6.5 ft)	(6.5 ft)	(12 ft)	(6 ft)	(6.5 ft)	(6 ft)	(6.5 ft)	(6.5 ft)	(6 ft)	(6.5 ft)
Core Intervals A	a (0–45)	x (0–45)	x (SH 0–52)	x (0–60)	a (0–45)	x (0–60)	a (0–45)	a (0–45)	x (0–60)	a (0–45)
B	x	x	x (-15 to -17 ft)	a	x	x	a	x	a	a
C	x	x	x	a	x	x	a	x	a	a
D	a	a	x	a	a	a	a	a	a	a
E	x	x	a	a	x	x	a	x	a	a
F	a	a	x		a		a	a		a
G			a							
H			x							
I			a							
J			x							

Notes:
Mudline elevation shown in ft MLLW. Sample interval measurements are in cm unless otherwise indicated (i.e., for the -15 to -17 ft MLLW interval).
Cell colors indicate the following: x – Tier 1 sample to be analyzed; a – Tier 2 sample to be archived for potential analysis.
ID: identification
MLLW: mean lower low water

Table I-4e
Vertical Extent Core Profiles (Area 31)

Area 31																		
Loc ID	**648**	**649**	**650**	**652**	**653**	**654**	**655**	**657**	**658**	**659**	**660**	**662**	**663**	**664**	**665**	**666**	**669**	**670**
Mudline	0.1	5.4	8.9	0.1	2.8	4.1	9.2	-0.8	2.6	4.1	5.5	4.0	8.1	2.2	4.2	7.8	4.8	8.1
(core depth)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)
Core Intervals A	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)
B	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
C	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
D	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
E	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
F	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a

Notes:
Mudline elevation shown in ft MLLW. Sample interval measurements are in cm unless otherwise indicated (i.e., for the -15 to -17 ft MLLW interval).
Cell colors indicate the following: x – Tier 1 sample to be analyzed; a – Tier 2 sample to be archived for potential analysis.
ID: identification
MLLW: mean lower low water

Table I-4f
Vertical Extent Core Profiles (Areas 32 through 37)

	Area 32		Area 34		Area 36	Area 37				
Loc ID	**673**	**674**	**683**	**684**	**694**	**698**	**699**	**701**	**702**	**703**
Mudline	-6.0	-8.5	6.8	0.7	8.8	8.4	8.0	8.1	7.7	4.8
(core depth)	(20 ft)	(18 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)	(6.5 ft)
Core Intervals										
A	a (0–60)	a (0–60)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)	a (0–45)
B	x	x	a	a	x	x	x	x	x	a
C	x	x	a	a	x	x	x	x	x	a
D	a	a	a	a	a	a	a	a	a	a
E	x	x	a	a	x	x	x	x	x	a
F	a	a	a	a	a	a	a	a	a	a
G	x	x								
H	a	a								
I	x	x								
J	a	a								
K	x	x								
L	a	a								
M	x	x								
N	a	a								
O	x	x								
P	a	a								
Q	x	x								
R	a									
S	x									

Notes:
Mudline elevation shown in ft MLLW. Sample interval measurements are in cm unless otherwise indicated (i.e., for the -15 to -17 ft MLLW interval).
Cell colors indicate the following: x – Tier 1 sample to be analyzed; a – Tier 2 sample to be archived for potential analysis.
ID: identification
MLLW: mean lower low water

FINAL

Attachment J
New and Revised Standard Operating Procedures

- Updated Standard Operating Procedure J1: Surface Sediment Collection
- Updated Standard Operating Procedure J2: Subsurface Sediment Collection
- Standard Operating Procedure J3: Sediment Thickness over Armored Bank: Jet Probe
- Standard Operating Procedure J4: Sediment Thickness over Armored Bank: Hand Probe
- Standard Operating Procedure J5: Hand Auger Sampling
- Standard Operating Procedure J6: Push Probe Sampling

UPDATED STANDARD OPERATING PROCEDURE J1

SURFACE SEDIMENT COLLECTION

A Introduction

Surface and bank sediment samples (0- to 10-cm) will be collected from a boat or from land and processed following standardized procedures as described in the Washington State Department of Ecology's Sediment Cleanup User's Manual II (Ecology 2017) and Puget Sound Estuary Program. The applicable standard operating procedures are described below.

B Sample Collection by Boat

The primary method for surface sediment sample collection will be to use a pneumatic grab sampler deployed from a sampling vessel. Surface sediment samples will be collected as described in the following steps:

1. Using a differential global positioning system (DGPS)[1] with sub-meter accuracy, maneuver the sampling vessel to the sampling location.
2. Open the decontaminated grab sampler jaws to the deployment position.
3. Guide the sampler overboard until it is clear of the vessel.
4. Using DGPS, position the sampling vessel such that the DGPS receiver (located on top of the sampling frame) is within 3 m (10 ft) of the target sampling location.
5. Lower the sampler through the water column to the bottom at a speed of approximately 0.3 m/s.
6. Record the DGPS location of the boat when the sampler reaches the bottom.
7. Record the water depth and tidal elevation (i.e., raw data), as well as the calculated mudline elevation of each sampling location relative to mean lower low water.
8. Retrieve the sampler, raising it at a speed of approximately 0.3 m/s.
9. Guide the sampler aboard the vessel and place it on the work stand on the deck, taking care to avoid jostling that might disturb the integrity of the sample.
10. Examine the sample using the following sediment acceptance criteria:

   - Sample contains sediment; samples that are predominately gravel, rock, or debris will be rejected.

[1] A Trimble© SPS461 or similar DGPS receiver unit will be employed for the various sampling methods outlined in the quality assurance project plan. The DGPS receiver will be calibrated daily to ensure that it is accurately recording positions from known benchmarks and functioning within the individual unit's factory specifications.

- Sediment is not extruding from the upper face of the sampler (indicating sampler was advanced deeper than the target penetration depth).
- Overlying water is present (indicating minimal leakage).
- Sediment surface is relatively flat (indicating minimal disturbance or winnowing).
- A penetration depth of at least 11 cm has been achieved.

If these sample acceptance criteria are not met, the sample will be rejected. In addition, if there is any indication that the sediment has been recently disturbed, the grab sample will be rejected. If the initial attempt to collect a sample is not successful due to difficult substrate (e.g., presence of riprap or other debris), up to three subsequent attempts will be made within 10 m (32 ft) of the proposed location. If the initial attempt and three subsequent attempts do not result in a sample that meets the appropriate acceptance criteria, a different sampling location may be selected in consultation with the US Environmental Protection Agency and Lower Duwamish Waterway Group.

After sample acceptance, the following observations will be noted in the field logbook or surface sediment collection form:

- Elevation of bed at sampling location
- DGPS location
- Depth as read by the boat's depth sounder and sample collection time
- Maximum penetration depth (nearest 0.5 cm)

C Sample Collection from Shore

For intertidal and bank locations that cannot be sampled from a boat and must be manually sampled from the shoreline during a lower tide, sediment will be collected by scooping sediment directly from the 0- to 10-cm depth with a clean, stainless steel spoon into a clean, stainless steel bowl.

When collecting surface sediment from armored or unarmored (or discontinuously armored) banks, a minimum of 10 cm of overlying material or material within riprap interstices (i.e., large pockets of sediment) is needed to collect a sample. Sediment will not be scraped off the riprap or rocks to obtain the sample. Sediment depth will be determined by hand probing prior to sampling. If the sample location has less than 10 cm of undisturbed sediment available for sampling, the field crew may identify a new location within the bank area (i.e., between mean higher high water and the toe of the bank [or +2 ft if the toe is not discernable]) and no more than 6 m (20 ft) from the target location. If acceptable sediment cannot be located, no sample will be collected at that location.

The following observations will be noted in the field logbook or surface sediment collection form:

- Estimated elevation of bed at sampling location
- DGPS location
- Sample collection time
- Depth of overlying material (for armored or discontinuously armored banks)

D Sample Processing

After sediment collection has occurred, the following steps will be completed to process the sediment samples:

1. **Record information** – Information will be recorded on the sediment collection forms regarding the depth of the sample (generally 10 cm), sediment characteristics (e.g., color, smell, grain size, presence of debris, redox layer [if visible], etc.), and any necessary revisions to the sampling location or comments relative to sample quality. Take photographs of anything of note and document any deviations from the approved sampling plan on a Protocol Modification Form (Attachment E).
2. **Collect and homogenize sample sediment** – The sediment at each location will be transferred directly from the grab sampler (or hole, if collected manually from shore) into a pre-cleaned stainless steel bowl or cauldron and stirred with a clean, dedicated, stainless steel spoon or spatula until texture and color homogeneity have been achieved (Ecology 2017). At locations identified for bioassay testing, multiple grab samples will be collected and composited in order to collect sufficient sediment volume. Any large non-sediment items, such as gravel, shells, wood chips, or organisms (e.g., clams), will be removed prior to homogenization.
3. **Dispense into jars** – Sediment will be dispensed into clean and labelled jars. For any location where toxicity testing is planned, samples will be dispensed from the bowl of homogenized sample material for both toxicity testing and (in separate jars) sulfides and ammonia analysis. These analyses will be expedited in order to have data available prior to the initiation of toxicity testing. Subsamples for sulfides and ammonia will be collected from the homogenized composite sample. The sulfide subsample will be placed in a 4-oz jar with a Teflon® septa, filled so that there is zero headspace. The sample jar will contain 5 mL of 2 Normal zinc acetate per 30 g of sediment as a preservative. The sulfide sample in the jar will be covered and shaken vigorously to completely expose the sediment to the zinc acetate.

The jar will be labeled to indicate that zinc acetate has been added and stored in the dark at 0 to 6°C.

4. **Label jars** – A complete sample label will be affixed to each individual sample jar. Sample labels will include the project number, sampling personnel, date, time, and sample identification. Labels will be filled out as completely as possible prior to each sampling event.
5. **Quality control jars and forms** – All sample containers will be thoroughly checked for proper identification, analysis type, and lid tightness. The field coordinator will be responsible for reviewing sediment sample information recorded on field forms (Attachment E) and will correct any improperly recorded information.
6. **Prepare for delivery to the analytical laboratory** – Each container will be packed carefully to prevent breakage and placed inside a cooler with ice for storage at the proper temperature (≤ 4 ± 2°C) for delivery to the analytical laboratory.
7. **A chain of custody form will accompany all samples to the analytical laboratory** – Custody procedures described in Section 4.6.1 of the pre-design investigation quality assurance project plan will be followed.

E Equipment Decontamination Procedures

All sediment sampling and homogenizing equipment, including the mixing bowl and stainless steel implements, will be decontaminated between sampling locations per Washington State Department of Ecology guidelines (2017) and the following procedures:

1. Rinse with site water and wash with a scrub brush until free of sediment.
2. Wash with phosphate-free detergent.
3. Rinse with site water.
4. Rinse with distilled water.

Acid or solvent washes will not be used in the field because of safety considerations and problems associated with rinsate disposal and sample integrity, specifically:

- Use of acids or organic solvents may pose a safety hazard to the field crew.
- Disposal and spillage of acids and solvents during field activities pose an environmental concern.
- Residues of solvents and acids on sampling equipment may affect sample integrity for chemical testing.

Any sampling equipment that cannot be cleaned to the satisfaction of the field coordinator will not be used for further sampling activities.

F References

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.

UPDATED STANDARD OPERATING PROCEDURE J2

SUBSURFACE SEDIMENT COLLECTION

A Introduction

Subsurface sediment core samples will be collected primarily from a sampling vessel (using a vibracorer or drill rig), or they will be manually collected from shore in intertidal or bank areas where access from a vessel is not possible. Procedures for these two access options are described below.

B Sample Collection by Boat

B1 Collect Sediment

When sampling from a boat, most of the sediment cores will be collected using a vibracorer. A small number of vertical cores in areas that have been difficult to sample in the past will be collected via drill rig. The vibracorer will be deployed from the sampling vessel using an A-frame with a hydraulic winch system. The vibracorer consists of a vibrating power head attached to a 4-in.-diameter core barrel (length to be dependent on the target core depth). Where used, the drill rig will be stationed on a barge or similar floating platform. The drill rig will use rotary sonic methods to advance a core barrel to the depth of sampling. Once the sample depth is reached, an outer casing will be advanced to the same depth as the core barrel, and the core barrel will be retrieved for sample processing. Continuous sediment cores will be collected using the vibracorer and the drill rig.

Sediment core samples will be collected and processed according to the following procedures:

1. The sampling vessel will be maneuvered to the proposed sampling location.
2. The vibracorer with decontaminated[1] core tube or drill rig with decontaminated core barrel will be deployed.
3. Continuous core samples will be collected to the project depth requirement or until refusal.
4. The depth of core penetration will be measured and recorded.
5. The sample core tube will be extracted, and the assembly will be retrieved aboard the vessel.
6. The core sample will be evaluated at the visible ends of the core tube to verify retention of the sediment in the core tube.

[1] All equipment will be decontaminated following procedures described in Section D of this attachment.

7. If the sediment core is acceptable (see criteria below), the core will be capped, labelled, and held vertically pending transfer to a processing crew.
8. The top of the core will be decanted and the top of the mudline will be marked on the core tube when possible.

Acceptance criteria for a sediment core sample are as follows:

- The material is collected to the target depth within the first three attempts.
- Recovery is at least 75% of the penetration depth.
- The core appears to be intact without obstructions or blocking.

If sample acceptance criteria are not achieved, the sample will be rejected. If repeated deployment (i.e., maximum three attempts) does not result in a sample that meets the acceptance criteria, or if deployment hits refusal before reaching the target depth, the sample with the best penetration depth will be retained.

Field forms and notes for all core samples will be maintained as samples are collected. The following information will be included in the sediment core collection forms and field notes:

- Water depth and tidal elevation (i.e., raw data), as well as the calculated mudline elevation of each sediment core location relative to mean lower low water
- Location of each sediment core as determined using a differential global positioning system with sub-meter accuracy
- Date and time of collection for each sediment core
- Names of field supervisor and person(s) collecting and logging the sample
- Core penetration and recovery measurements
- Designation of each coring attempt as "accepted" or "rejected"
- Observations made during sample collection, including weather conditions, complications, ship traffic, and other details associated with the sampling effort
- Core location identification (ID)
- Photographs of anything of note
- Any deviations from the approved sampling plan (on a Protocol Modification Form [Attachment E])

B2 Process Core

Sediment cores collected from a boat will be processed as soon as possible after a core has been collected that meets the acceptance criteria. A field geologist or geotechnical engineer will oversee the sediment core logging process. The steps for processing the samples are as follows:

1. Prior to processing, evaluate the amount of compaction that may have occurred, and calculate the compaction correction factor (CCF) to be applied during core processing.
   - Measure the core depth (i.e., the compacted depth).
   - To calculate the CCF, divide the compacted depth by the penetration depth (i.e., the depth recorded during core collection and acceptance).
   - Example: If the core depth (i.e., compacted depth) at the time of processing is 2.83 ft (i.e., 2 ft 10 in.), and the core penetration depth (i.e., the core depth recorded at the time of collection) was 3.33 ft (i.e., 3 ft 3 in.), the CCF would be 0.85.
2. Where rotary sonic drilling is used, extrude the sample from the core barrel into a plastic liner.
3. Carefully cut along the core tube or liner to expose the sediment core for processing and photograph each core.
4. A field geologist or geotechnical engineer will examine the core for major stratigraphic boundaries and to evaluate if "native" material is present in the core. If native material is observed, then the first interval containing native material may be analyzed, and all material below this interval will be archived. Core intervals may also be modified if native stratigraphy or significant discontinuities in stratigraphy above native material are encountered. If an interval is changed to reflect a change in geologic unit, the decision will be made in the field during core processing and documented on the sediment core processing log.
   Cores collected to characterize 0–45 cm in the enhanced natural recovery (ENR)/activated carbon pilot plots will have three intervals in order to characterize 0–45 cm below the mudline and 0–45 cm below the ENR layer. The first core interval will be the ENR layer, the second interval will be sediment below the ENR layer to 45 cm from the mudline, and the third interval will include sediment from the bottom of the second interval to 45 cm below the ENR layer.
5. Record the description of each core on the sediment core processing log, including the following parameters, as appropriate, and take photographs of anything of note.

- Core penetration depth (from the sediment core collection form)
- Compacted core depth and calculated CCF
- Corrected sample depth interval for each sample
- Sediment grain size description following American Society for Testing and Materials (ASTM) visual-manual classification (ASTM D2488)
- Odor (e.g., hydrogen sulfide, petroleum)
- Vegetation
- Debris
- Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen
- Any other distinguishing characteristics or features.

6. For each core, separate the material from each target depth interval, applying (i.e., multiplying) the CCF to the target sample depth that will constitute the sample for laboratory analysis. For example, if the CCF for a subtidal sediment core is 0.85, the sample material to collect for a 0- to 60-cm analysis will come from the 0- to 51-cm interval (i.e., 60 cm × 0.85 = 51 cm).
7. Transfer each sediment sample into a separate stainless steel bowl for homogenization.

    - For intertidal sediment cores, the target sample depth interval is 0 to 45 cm.
    - For subtidal sediment cores, the target sample depth interval is 0 to 60 cm.
    - For shoaling areas, the target sample depth interval is dependent on the thickness of the shoaled material (see Attachment C for estimated shoal depths).
    - For vertical extent cores (i.e., cores collected to target depths that are deeper than the remedial action level [RAL] intervals described in the first three bullets of this step), sample processing will occur as follows:
        i. Samples will also be collected from 30-cm intervals beyond the RAL depth intervals for archive or analysis. Generally, the first two 30-cm intervals below the RAL interval will be analyzed, and then each subsequent alternating interval will be archived or analyzed, until reaching the end of the core, native sediment, or the target depth. Attachment C (Table C-4) identifies the analysis and archive intervals for each vertical extent core.
        ii. If more than 15 cm of sediment is collected below the target depth for a given core, additional interval(s) will be archived. If there is more than 45 cm of sediment, then multiple intervals will be archived.

   iii. For vertical extent cores, grain size will be analyzed in one or more composite samples representing the full length of the core above any native material layer encountered. The compositing interval(s) will be determined when the core is examined. Grain size analysis will not be needed for every core; during sediment core logging, the field geologist or geotechnical engineer will identify cores to obtain the grain size composite(s) that will be spatially representative.

- If multiple cores are collected to meet minimum volume requirements (e.g., for chemistry and toxicity analyses), the target sample intervals from all cores will be composited prior to homogenization.

8. Homogenize the sediment using clean stainless steel spoons until texture and color homogeneity have been achieved, removing large non-sediment items such as gravel, shells, wood chips, or organisms (e.g., clams) (Ecology 2017).
9. Affix a complete sample label to each individual sample jar. Sample labels will contain the project number, sampling personnel, date, time, and sample ID. Labels will be filled out as completely as possible prior to each sampling event.
10. Dispense sediment into clean and labelled jars. For any location where toxicity testing is planned, dispense samples from the bowl of homogenized sample material for both toxicity testing and (in separate jars) sulfides and ammonia analysis. These analyses will be expedited in order to have data available prior to the initiation of toxicity testing. Collect subsamples for sulfides and ammonia from the homogenized composite sample. Place each sulfide subsample in a 4-oz. jar with a Teflon® septa, filled so that there is zero headspace. The sample jar will contain 5 mL of 2 Normal zinc acetate per 30 g of sediment as a preservative. Cover the sulfide sample in the jar and shake vigorously to completely expose the sediment to the zinc acetate. Label the jar to indicate that zinc acetate has been added and store in the dark at 0 to 6°C.
11. Thoroughly check all sample containers for proper identification, analysis type, and lid tightness. The field coordinator will be responsible for reviewing sediment sample information recorded on field forms (Attachment E) and will correct any improperly recorded information.
12. Pack each container carefully to prevent breakage and place inside a cooler with ice for storage at the proper temperature (≤ 4 ± 2°C) for delivery to the analytical laboratory.

C Sample Collection from Shore

If an intertidal or bank sediment core cannot be collected from the boat due to site access conditions (e.g., too shallow), then the core may be manually collected from shore during a lower tide. At the discretion of the field crew, one of the following three sampling options will be used, whichever is most suitable to the sampling location conditions. In addition, the field crew may use a combined or hybrid approach of the three methods, if necessary. The bank core locations may need to be adjusted in the field to account for site conditions, such as debris or armoring, that do not allow for sampling.

C1 Option 1: Use Shovel to Dig 45-cm-deep Hole

The first sampling option is to dig a hole using a shovel and collect the sample directly from the sidewall of the hole. The process for this option is as follows.

1. **Dig hole** – Using a transplanting spade (i.e., a shovel with a narrow blade), dig a 45-cm-deep hole at the identified location. If it is not possible to reach a depth of 45 cm within three attempts, the deepest hole among the attempts will be sampled using the methodology described below, and the depth of refusal will be recorded on the sediment core collection form. At least one side of the hole should be approximately vertical to allow for the collection of the sample. Record any necessary revisions of the sampling location.

2. **Prepare for sampling** – Divide the vertical extent of the hole into three 15-cm sections (i.e., the bottom section 30 to 45 cm below the surface, the middle section 15 to 30 cm below the surface, and the top section from the surface down to 15 cm). If possible, use a spoon to draw a line in the sidewall of the hole at these breakpoints. Sample the bottom section first to ensure that the sample is collected prior to the hole filling with water.

3. **Collect and homogenize sample** – Collect the same amount of sediment from each of the three 15-cm subsections along the vertical extent of the hole; collect sufficient sediment to fill a 16-oz stainless steel measuring cup. When filling the measuring cup (as described in steps 3a through 3c), exclude any debris larger than approximately 5 mm in width. If differences pertaining to the diameter of the hole are apparent (e.g., the presence of differently colored material), the resulting sample should proportionally represent all material in the hole.

    a. Starting with the bottom section of the hole (i.e., 45 to 30 cm), use a small, clean stainless steel spoon to carefully collect an even amount of sediment from the sidewall by scraping the sidewall from the bottom of the hole to the marked 30-cm line. Fill the 16-oz measuring cup using this method, and dispense the contents into a large stainless steel bowl.

b. Repeat process in the middle section of the hole (i.e., scrape the sidewall from the 30-cm to the 15-cm line) to fill the measuring cup, and dispense the contents into the bowl containing the sediment from step 3a.

c. Repeat process in the top section of the hole (i.e., 15 cm to the surface) to again fill the measuring cup, making sure to capture the full extent of this layer, including the surface material. Dispense the contents into the bowl containing the sediment from steps 3a and 3b.

d. Homogenize the contents of the bowl with a stainless steel spoon until texture and color homogeneity have been achieved, and dispense the contents into clean and labelled jars.

The procedures for processing shore-collected cores are presented below.

C2 Option 2: Use Hand-core Tube to Collect 45-cm Core

The second sampling option is to use a hand-core tube to collect a 45-cm core, extrude the core, and then collect the sample from the interior of the core. This process for this option is as follows:

1. **Collect core** – Drive the decontaminated hand-core tube (internal diameter of 7 cm) into the sediment to a depth of 45 cm at the identified location, or as near as possible based on the substrate and debris. Cap the top of the tube and pull the core out of the sediment. If it is not possible to reach a depth of 45 cm on the first attempt, up to three attempts should be made in that area (initial attempts will be retained in the core tube or extruded onto a piece of foil). After the third attempt, sample the deepest core using the methodology described below, and record the depth of refusal on the surface sediment collection form (Attachment E). Record any necessary movement of the sampling location.

2. **Collect and homogenize sample** – Extrude the contents of the core into a pre-cleaned stainless steel bowl and homogenize with a clean stainless steel spoon until texture and color homogeneity have been achieved. Discard any debris wider than approximately 5 mm.

The procedures for processing shore-collected cores are presented below.

C3 Option 3: Use Land-based Drilling Methods

The third option is to use land-based drilling methods to collect a vertical core. Rotary sonic drilling methods will be used with a land-based drill rig. Continuous vertical samples will be collected and extruded from the drill rig core barrel. The process for this option is as follows:

1. **Collect core** – Advance the decontaminated core barrel into the sediment to the target depth at the identified location, or as near as possible based on access, substrate, and debris. Advance the outer casing to the same depth as the core barrel. Pull the core barrel out of the sediment.

2. **Extrude core** – Extrude the sample from the core barrel into a plastic liner. Log observed lithology and notable features, as described in Section B2.

3. **Collect and homogenize sample** – Subsample the core and place sampled materials in a pre-cleaned stainless steel bowl. Homogenize materials with a clean stainless steel spoon until texture and color homogeneity have been achieved. Discard any debris wider than approximately 5 mm.

The procedures for processing shore-collected cores are presented below.

C4 Processing Cores Collected from Shore

After sediment collection and homogenization have occurred, the following steps will be completed to process the sediment cores:

1. **Record information** – Record information regarding the depth of the core, sediment characteristics (e.g., color, smell, grain size, presence of debris, etc.), and necessary revisions to the sampling location on the sediment core collection and processing forms. Take photographs of anything of note and document any deviations from the approved sampling plan on a Protocol Modification Form (Attachment E).
2. **Dispense into jars** – Affix a complete sample label to each individual sample jar. Sample labels will contain the project number, sampling personnel, date, time, and sample ID. Labels will be filled out as completely as possible prior to each sampling event. Dispense sediment into labeled sample containers.
3. **QC jars and forms** – Thoroughly check all sample containers for proper identification, analysis type, and lid tightness. The field coordinator will be responsible for reviewing sediment sample information recorded on field forms (Attachment E) and will correct any improperly recorded information.

4. **Prepare for delivery to the analytical laboratory** – Pack each container carefully to prevent breakage and place inside a cooler with ice for storage at the proper temperature (≤ 4 ± 2°C) for delivery to the analytical laboratory.

D Equipment Decontamination Procedures

All sediment sampling and homogenizing equipment, including the mixing bowl and stainless steel implements, will be decontaminated between sampling locations per Washington State Department of Ecology guidelines (2017) and the following procedures:

1. Rinse with site water and wash with a scrub brush until free of sediment.
2. Wash with phosphate-free detergent.
3. Rinse with site water.
4. Rinse with distilled water.

Acid or solvent washes will not be used in the field because of safety considerations and problems associated with rinsate disposal and sample integrity, specifically:

- Use of acids or organic solvents may pose a safety hazard to the field crew.
- Disposal and spillage of acids and solvents during field activities pose an environmental concern.
- Residues of solvents and acids on sampling equipment may affect sample integrity for chemical testing.

Any sampling equipment that cannot be cleaned to the satisfaction of the field coordinator will not be used for further sampling activities.

E References

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.

STANDARD OPERATING PROCEDURE J3
SEDIMENT THICKNESS OVER ARMORED BANK: JET PROBE

A Scope and Application

The following standard operating procedure details the steps involved in the survey of sediment thickness using a Gravity Marine Services's (Gravity) sediment jet probe device.

A1 Station Access

Prior to entering select locations, such as private beaches, embayments, or areas in proximity to docks, it may be necessary to acquire permission from the landowner to access the property. Access permission must be acquired in advance of the sampling program and may require a written agreement.

A2 Station Location and Sampling Safety Procedures

Sediment probe data will be collected at specific transects identified in the pre-design investigation quality assurance project plan.

A differential global positioning system will be used aboard the sampling vessel for accurate location positioning. Once the vessel is anchored in place, the actual position will be recorded for each probe taken and/or attempted. Horizontal coordinates should be recorded in either latitude and longitude (WGS 1984, decimal degrees) or x and y coordinates in WGS1984 UTM (meters). Water depths will be recorded in feet from the vessel sonar if applicable, or with the use of a lead line.

Sampling personnel will follow standard safety procedures while on board the sampling vessel. The vessel skipper will have ultimate responsibility for safety while the vessel is underway. During deployment of equipment, the operator and the skipper must communicate with one another to avoid potential loss of the instrument due to propeller interface with the underwater field cable.

B Summary of Method

The Gravity sediment jet probe is designed to measure soft sediment thickness by utilizing a push rod with a pneumatic jet nozzle and penetrometer depth sensor. The push rod is deployed from the vessel manually by a surveyor and lowered to the seafloor. A safety line is attached to the probe to ensure it is not dropped, or to be used if sediment suction requires a winch to recover the probe. Once the probe contacts the seabed, the penetrometer sensor is turned on to log depth. If the sediment is soft, the probe rod maybe manually pushed until a hard layer is reached. In areas with harder substrates, such as clays and gravels, a pneumatic jet can be activated that allows the probe rod to penetrate the sediments more easily. As the probe is advanced, the penetrometer logs depth until refusal. As a redundancy to the penetrometer, the probe has a lead line attached to the rod to monitor final push depth below ground surface.

The vessel should be equipped with the necessary equipment to safely operate and navigate and complete the required sampling tasks. Additionally, the proper vessel should be selected for stations in shallow areas that may preclude larger vessels due to draft limitations.

C Procedures

The survey team should comprise three people. Two people are needed to conduct the survey and a third person is required to keep track of sample logging and processing. In addition, the third person may be responsible for collecting the data parameters.

C1 Equipment

The following equipment is necessary for sampling surface sediments:

- Gravity sediment probe
- Penetrometer
- Air compressor and sufficient air hose (50 ft)
- Sufficient line to lower instrument to seafloor and retrieve
- Decontamination equipment for cleaning between stations, such as Alconox® detergent, cleaning brushes, and distilled or deionized water
- Nitrile gloves
- Differential global positioning system for station positioning
- Field notebook/field log sheets

C2 Sample Collection

Once the vessel has navigated to position and been securely anchored, the probe will be deployed over the side of the vessel.

C3 Deployment Checks

- Ensure the probe jet tip is fully cleaned and has no materials in it.
- Ensure probe pressure valve is fully closed.
- Inspect all bolts for tightness.
- Test penetrometer on vessel deck.

After inspection, the probe can be advanced into the sediment until full penetration or refusal. Once the probe has been recovered to the vessel, the equipment should be inspected.

C4 Recording

A survey point will be considered acceptable if there has been sufficient penetration and the penetrometer data record has been saved. Information to be recorded by the field crew includes the following:

- Remedial action level exceedance area
- Transect identification
- Date
- Location identification

- Distance along transect (ft)
- Water depth time
- Water depth (ft)
- Probing time
- Observed substrate (if discernable)
- Sediment thickness/probe penetration (ft)
- Assumed refusal reason
- Coordinates (and datum)
- Other notable observations/comments (e.g., notes on push/drive)

In addition to the above-noted information to be hand-recorded by the field crew, sample date and time, station coordination, probe penetration, and water depth will be electronically recorded and stored on the tablet computer aboard the vessel.

C5 Weekly Sampler Inspection

The probe should be inspected weekly for wear and tear using the following steps:

- Check airline for leaks or tears.
- Check regulator and ensure that it does not leak air underwater.
- Inspect tanks for leaks or hairline cracks.
- Check all bolts for tightness.
- Check all straps for wear; if straps appear sun bleached, replace them.
- Ensure all lifting shackles are set for direct load (do not allow side loading of shackles).

D Data Quality Assurance/Quality Control

To ensure the quality of sample data, the penetrometer depth sensor will be verified at the start of each day with a sonar depth sensor or lead line to ensure accurate seabed elevations are being logged.

E Reporting

Field notes will be taken during all survey activities in a field notebook, which will be kept with the lead sampler. Included in the field notes will be the following information:

- Names of persons collecting and logging samples
- Names of persons operating vessel and/or equipment
- Weather conditions (and/or any changes in weather)
- Mudline elevation of each sampling station
- Sample location number and actual coordinates
- Any deviations from the approved sampling plan
- Photo identification for each sample

Field notes will be kept in a single, bound, weatherproof notebook.

STANDARD OPERATING PROCEDURE J4

SEDIMENT THICKNESS OVER ARMORED BANKS: HAND PROBE

A Introduction

The following standard operating procedure details the steps involved to survey sediment thickness by land using a hand-operated sediment probe device.

B Station Location and Positioning

Sediment hand probing will be performed along transects at specified intervals as identified in the pre-design investigation quality assurance project plan addendum to which this is an attachment. Positioning will be determined using a handheld differential global positioning system receiver to locate each transect. Horizontal coordinates will be recorded in either latitude and longitude or x and y coordinates. Once a transect starting point is determined and coordinates are recorded, a measuring tape will be placed perpendicular to the shoreline from mean higher high water (or as far up the slope as possible, based on presence of vegetation, fencing, or other access limitations) to the apparent toe of slope to provide a reference line for collecting the data points.

Property access agreements must be in place before entering survey areas located on private property.

C Equipment and Supplies Required

The following equipment is necessary for sediment hand probing:

- Steel rod or equivalent, sharpened at one end and calibrated in 2-in. intervals (note: a specific probe will be selected during field preparation activities)
- Measuring tape
- Handheld differential global positioning system receiver
- Field note book/log sheets

D Procedures

Sediment hand probing should be conducted within two hours of low tide. Probing will occur as follows:

1. Start at the beginning of the transect (i.e., mean higher high water or as far up slope as possible) and record starting position.

2. Advance the probe into the sediment if sediment is visible, noting depth of penetration and type of resistance met by the probe (if discernable). If no sediment is on the surface, note 0 ft as sediment thickness.

3. Record information in field notebook/log sheets.

4. Move to next location downslope along the transect at a maximum spacing of 5 ft horizontally and repeat. At the bottom of the bank slope, attempt to locate the downslope edge of any buried armoring by probing. The presence of the edge may be indicated by the probe penetrating fully into the bank without encountering refusal.

STANDARD OPERATING PROCEDURE J5
HAND AUGER SAMPLING

A Introduction

Soils can be sampled using a hand-held steel auger where site access precludes other sampling methods. Hand augers can be manually operated or powered with an electric or gasoline motor.

Manual hand augers consist of an auger bucket, shafts of various lengths, and a T-grip handle. Auger buckets come in various sizes but are typically 3 in. in diameter and collect soil samples at a 6-in. depth interval. All parts are either threaded and screwed together or held together with pins. The nose of the bucket is shaped so that it threads into the soil, and soil is forcefully driven into the bucket as the handle is twisted in a corkscrew action.

Electric- or gasoline-powered hand augers typically consist of a continuous flight of auger that bores an open hole to the sample depth of interest. Flight diameters of 4, 6, and 8 in. are commonly available, with auger lengths on the order of 3 to 4 ft. Once the top of the sample interval is reached, the sample can be collected using the manual hand auger bucket tool.

Hand auger sampling is limited to near-surface depths. Refusal occurs when the augers bind and cannot be further advanced by the strength of the field technician or the power of the motor.

The following procedures define the steps to be taken when sampling with a manual or powered hand auger.

A1 Manual Hand Auger Equipment and Supplies Required

- Hand auger field kit, including T-handle, extension rods, and bucket tips
- Minimum of two wrenches for connecting and disconnecting handle, extension rods, and bucket tips
- Tape measure
- Tape for visually marking depth intervals on assembled auger
- Small shovel, prybar, or post-hole digger for clearing debris from sampling location
- Global positioning system for marking sampling location
- Field sampling forms

A2 Powered Hand Auger Equipment and Supplies Required

- Power auger field kit including power head, extension rods, and auger flights
- Power source: gasoline or batteries and battery charger
- Wrenches for connecting and disconnecting power head, extension rods, and auger flights
- Tape measure
- Tape for visually marking depth intervals on assembled auger

- Small shovel, prybar, or post-hole digger for clearing debris from sampling location
- Global positioning system for marking sampling location
- Field sampling forms
- Polyvinyl chloride (PVC) pipe of the same diameter as auger flight for sacrificial casing, total length greater than the total of all proposed hand auger depths
- Powered saw for cutting PVC pipe
- Rubber mallet to assist in manually advancing PVC pipe sections as casing

A3 Sample Processing Equipment and Supplies Required

- Large stainless steel mixing bowl and spoon
- Laboratory-supplied sample containers, insulated coolers, and ice
- Chain of custody forms, custody seals, and sample labels
- Ziploc® bags
- Camera
- Tape measure
- Field logbook, surface soil field collection form, and pens
- Project-specific field sampling plan and health and safety plan
- Personal protective equipment (safety glasses, steel-toed boots, nitrile gloves, leather work gloves, and any other items required by the project-specific health and safety plan)
- Decontamination equipment

B Procedures

B1 Sample Collection

1. Locate the sample station. Label containers with sample labels prior to filling.
2. Expose the soil surface by clearing an approximately 1-ft^2 area at the sampling location of any rocks or organic material greater than approximately 3 in. in size. Note any material removed from the sampling location in the field logbook.
3. Excavate or auger the soil to the top of the sampling interval specified using a decontaminated sampling tool (i.e., manual hand auger, power hand auger, shovel, scoop, trowel, or spoon)
4. If caving soils are a problem, cut a length of PVC pipe to the length of the sample depth and push it into the excavated hole. Clean out the base of the hole with a shovel, scoop, trowel, spoon, or post-hole digger, taking care not to excavate into the elevation range of the sample interval.

   For an auger hole with multiple depth intervals, lengths of PVC casing can be sequentially stacked on top of one another and advanced to the top of each sampling depth interval prior to sample collection. The sample hole should always be cleaned out after advancing the casing.

5. Using a long-handled stainless steel hand auger and starting at the top of the sampling interval, advance the hand auger bucket to the depth of the sample interval. If the sample interval is longer than the bucket length, the auger bucket can be replaced by a newly decontaminated auger bucket by unscrewing the bucket from the long handle bar.
6. Mark the handle of the auger to confirm proper sampling depths are achieved.
7. Advance a thoroughly cleaned and decontaminated bucket auger into the soil incrementally by twisting the handle in a clockwise motion.
8. Exercise proper back care when pulling a stuck auger out of a hole or when turning an auger for long periods. Wear work gloves to prevent blisters.
9. After sampling is complete, backfill the sample location with excess soil. The PVC casing does not need to be retrieved.

B2 Sample Processing

1. Once the auger bucket is full or has attained the penetration depth specified, use a decontaminated stainless steel spoon to transfer the soil into a decontaminated stainless steel bowl, and cover the bowl with foil until all sample volume has been collected for that sample interval.
2. If the soil is difficult to remove from the auger bucket, the contents can be loosened by carefully tapping on the outside of the bucket with a separate implement from the one used to collect and composite the sample (i.e., the decontaminated spoon). Care should always be taken to ensure that any substance on the outside of the corer does not enter the sample collection bowl.
3. Process the sample as described in SOP D1 – Surface Sediment Collection.

B3 Quality Assurance and Quality Control

1. Complete all pertinent field quality assurance/quality control documentation, logbooks, sample labels, and field data sheets. Record any deviations from the specified sampling procedures or any obstacles encountered.
2. Photograph the sample location and document it in the logbook.
3. Decontaminate all sampling equipment in accordance with the project-specific field sampling plan.
4. A rinsate sample may be appropriate or required. Collect the equipment rinsate between sampling locations and after the device has been decontaminated. The rinsate sample should be analyzed for the same parameters for which soils are analyzed.

STANDARD OPERATING PROCEDURE J6
PUSH PROBE SAMPLING

A Introduction

Soils can be sampled using a push probe advanced below the ground or sediment surface from a coring rig. Sample sizes may vary depending on the tooling available, site conditions, and the capabilities of the coring rig. The attached literature describes the available samplers and sampling methods used for push probe sampling.

Ranger-46/66

Soil Sampling System

Geomil equipment

World's first manufacturer of CPT equipment

Geomil Equipment's Ranger series is a push in soil sampler deployed using CPT push equipment.

The Ranger allows the user to acquire undisturbed soil samples using any CPT rig. This enables a more complete ground investigation program without the need for extra machines to be mobilised to site.

The undisturbed samples are suitable for lab tests including triaxial stress tests and simple shear tests. The Ranger-46 and Ranger-66 acquire 46 mm and 66 mm diameter samplers respectively.

Sampling is carried out in discontinuous lengths of 0.5 m or 1 m. The sampler is pushed to the required depth using the CPT push frame and either CPT or casing tubes.

The Ranger-46 can be advanced using 36 mm CPT tubes as the driving rod, while the Ranger-66 is preferably pushed with 55 mm casing tubes.

Once the required depth is reached the sampler is unlocked using a wireline overshot that is lowered through the pushing tubes. To collect the sample the Ranger is then advanced using the CPT system while the conical tip remains stationary.

The barrel is lined with a sampling tube of either stainless steel or PVC. Upon reaching the surface the tube is removed from the barrel without compromising the sample and sealed to retain moisture content.

Split tube liners are also available to allow easy removal of the sample from the tube.

Coupled with existing CPT equipment the Ranger series enables the quick deployment of a high quality soil sampling system. It allows geotechnical contractors to take their ground investigation capabilites to the next level with only a small investment compared with a stand alone soil sampling system.

The main features of the Ranger are:

- undisturbed soil sampler
- 46 mm and 66 mm sample diameters available
- easy to set up and operate
- no need to extract the sample from the liner
- 0.5 m or 1 m samples
- can be deployed with almost all CPT rigs
- soil retainer basket ensures sample recovery

For more technical information or a quotation based on your specific requirements please contact sales@geomil.com or call us at +31 172 427 800.

D075_00

www.geomil.com

a.p. van den berg
The CPT factory

MOSTAP Soil Samplers

for high quality in-situ soil samples

features

- proven push sampling technique; thick-walled piston samplers
- used in combination with a CPT system or other pushing system
- samples with a diameter of 35, 65 or 70 mm
- suitable versions for various soil types
- special versions for contaminated soil
- 70 mm samples can be extended with 1 m-sections

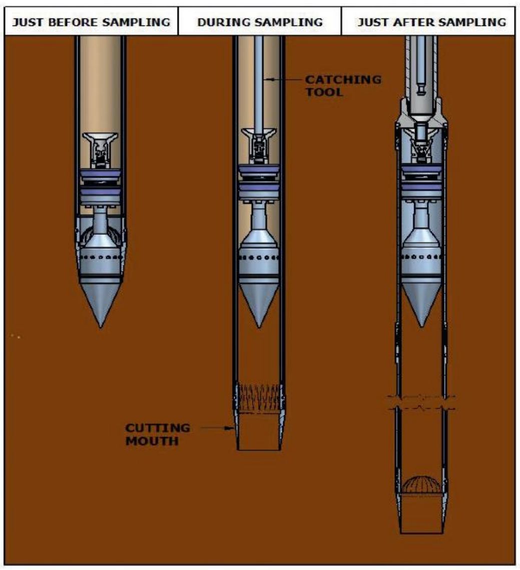
creating tools that move your business

MOSTAP Soil Samplers, for high quality in-situ soil samples

introduction

Soil sampling is a fundamental part of geotechnical soil investigation. Many geotechnical laboratory tests require "undisturbed" soil samples. The MOSTAP soil sampler is a fixed-piston sampler with a proven technique of minimizing soil disturbance and able to obtain samples of various diameters and lengths.

how the MOSTAP works



The MOSTAP is pushed by CPT rods or casing tubes to the required starting depth. A wire-line catching tool is lowered inside the string and unlocks the cutting mouth.

Subsequently, the MOSTAP is pushed down while the conical tip is held stable by the wire-line, acting as a piston. The MOSTAP sample tube slides beyond the conical tip. Once the tube reaches the required end depth, the catching tool releases the tip and can be pulled out. Then the string including the MOSTAP with soil sample can be retracted (to remove the sample). The use of a core catcher and sock is optional and will depend on the soil type and sample conditions.

sample length

The MOSTAP 70 provides the option to extend the sample length with portions of 1 m. The sample tubes are 1 m and positioned at the same height as the outer tubes and therefore dismountable one by one.

ensuring sample quality

For MOSTAP 35/65/70:

- a nylon sock ensures minimal friction during sampling; the nylon sock is cut to the required size and slides into a plastic liner tube
- closing caps and a plastic liner tube ensure minimal loss during transportation and storage

For MOSTAP 70, to ensure less distrurbances of the soil:

- an apex angle of 40 degrees
- a cutting shoe with a 6 degree cutting edge
- an internal drain that eliminates the negative pressure created during retraction

MOSTAP Soil Samplers categorized

In the standards EN 1997-2:2007 and NEN-EN-ISO 22475- 1:2006 three sampling method categories are defined (table 3.1, page 34). For regular soil conditions the MOSTAP 35, 65 & 70 fall into sampling category B that can achieve quality class 2 samples. In favourable soil conditions these thick-walled piston samplers can be ranked in category A achieving class 1 samples.

	MOSTAP 35	MOSTAP 65	MOSTAP 70
Sample diameter (mm)	35	65	70
Apex angle (degrees)	60		40
Cutting shoe (degrees)	30		6
Sample lengths (mm)	995 or 1,495 or 1,995		1,000 extendable by 1 m sections
Weight per sample length (kg)	12 or 14.8 or 17.5	21 or 24.5 or 30	24 + 12 kg per 1 m extension
Length tool per sample length (mm)	1,559 or 2,059 or 2,559	1,676 or 2,176 or 2,676	1,740 + 1 m per extension
Diameter sampler tool (mm)	60	90	
Pushed by means of	36 mm CPT rods	56 mm casing tubes	36 mm CPT rods or 56 mm casing tubes
Samples suitable for	profiling & material identification	shear/oedometer/triaxial tests	
Recommended for use in	sand, silt, clays	soft-stiff cohesive/organic soils	soft-stiff cohesive/organic soils & sensitive soils
For polluted soil	stainless steel sample tube	not available	stainless steel sample tube

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The CPT factory

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Da-8 / 09-2019

Attachment K
New and Revised Field Forms

Forms included in this attachment are:

- LDW Upper Reach Phase II PDI: Sediment Thickness Over Armored Banks (Hand Probe)
- LDW Upper Reach Phase II PDI: Sediment Thickness Over Armored Banks (Jet Probe)
- Sediment Core Collection Form
- Sediment Core Processing Log
- Surface Sediment Collection Form

LDW Upper Reach Phase II PDI: Sediment Thickness Over Armored Banks (Hand Probe)

RAL Exceedance Area ______________________________

Transect # ______________________________

Date ______________________________

Location ID	Distance Along Transect (ft)	Probing Time	Observed substrate (e.g., rock, sand, silt, shell)	Sediment Thickness (ft)	Assumed refusal reason	Surface Debris or Obstructions Encountered	Lat	Long	Other Notable Observations

LDW Upper Reach Phase II PDI: Sediment Thickness Over Armored Banks (Hand Probe)

LDW Upper Reach Phase II PDI: Sediment Thickness Over Armored Banks (Jet Probe)

RAL Exceedance Area ______________________

Transect # ______________________

Date ______________________

Location ID	Distance Along Transect (ft)	Water Depth Time	Water Depth (ft)	Probing Time	Observed substrate (e.g., rock, sand, silt, shell)	Sediment Thickness (ft)	Assumed refusal reason	Lat	Long	Other Notable Observations

LDW Upper Reach Phase II PDI: Sediment Thickness Over Armored Banks (Jet Probe)

Sediment Core Collection Form

Project:
Date:
Weather:
Logged By:

Location ID:
Attempt No.:
Core Type: Intertidal Subtidal Shoaling
Field Staff:

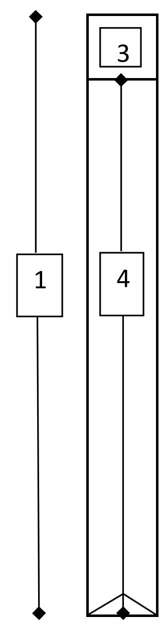
Field Collection Coordinates:
Lat/Northing:
Long/Easting:

A. Water Depth
DTM Depth Sounder:
DTM Lead Line:

B. Water Level Measurements
Time:
Height:
Source:

C. Mudline Elevation (ft MLLW)

Recovery Measurements (prior to cuts)



Core Sections To Process:
A:
B:
C:
D:

Core Collection Recovery Details:
1. Core Tube Length:
2. Penetration Depth: ft cm
3. Headspace Measurement:
4. Field Recovery Depth: ft cm
5. Field Recovery Percentage:
6. Core Accepted: Yes / No
7. Processing Recovery Depth: ft cm
8. Adjusted Recovery Percentage:

Drive Notes:

Shoe Description:

Core Field Observations and Description:	Sediment type, moisture, color, minor modifier, MAJOR modifier, other constituents, odor, sheen, layering, anoxic layer, debris, plant matter, shells, biota

Notes:

Sediment Core Processing Log

ANCHOR QEA

Job: AOC4 Duwamish	Station ID:
Job No. 180067-02.02	Date/Time:
No. of Sections:	Core Logged By:
Drive Length:	Attempt #:
Recovery:	Type of Core ☐ Mudmole ☐ Vibracore ☐ Diver Core
% Recovery:	Diameter of Core (inches)
Notes:	Core Quality ☐ Good ☐ Fair ☐ Poor ☐ Disturbed

Recovered Length (ft)	Size % Gravel	Size % Sand	Size % Fines	**Classification and Remarks** (Density, Moisture, Color, Minor Constituent, MAJOR Constituent, with Additional Constituents, Sheen, Odor)	Recovered Length (ft)	Sample	Summary Sketch

SURFACE SEDIMENT COLLECTION FORM

Project Name: ____________________ **Project no.:** ____________________

Date: ____________________ **Weather:** ____________________

Sampling Method: ____________________ **Crew:** ____________________

GRAB DATA	**Location ID:**			
	On armored slope (Y/N)?			**Depth of overlying sediment, if known (cm):**
Latitude/Northing(Y):				**Longitude/Easting(X):**
Grab time	**Bottom depth (m or ft)**	**Penetration depth (cm)**	**Acceptable grab (Y/N)**	**Comments**
SAMPLE DATA	**Sample ID:**			

Pre-homogenization analyses (circle): VOC Sulfides Ammonia AVS/SEM TPH-P Other:

Sediment type	**Sediment color**	**Sediment odor**		**Comments:**
cobble	brown surface	none	H_2S	
gravel	drab olive	slight	petroleum	
sand (F M C)	brown	moderate	other:	
silt	gray	strong		
clay	black			

FINAL

Attachment L

Existing Geotechnical Studies

Attachment L. Existing Geotechnical Studies

Section 5.2.1 summarizes the review of pre-PDI geotechnical data. This attachment provides a more descriptive summary of existing geotechnical data and includes a tabular summary of the individual reports that were identified and reviewed during preparation of the QAPP Addendum.

Data Sources

Pre-PDI geologic and geotechnical data for bank and in-water areas were reviewed after compiling information from several databases, including the LDWG Portal Project Library (LDW RI/FS), the Washington Department of Natural Resources Geology Portal, existing completed studies, and specific documents obtained from LDWG members. In addition, Washington State Department of Ecology and EPA site managers for cleanup properties adjacent to RAL exceedance areas were contacted to obtain available geotechnical information for those properties. Table L-1 summarizes the historical geotechnical investigations and geologic information obtained.

Table L-1
Historical Geotechnical Investigations and Geologic Information

File Title	Identification No.[1]	River Mile	Document Title	Document type	Date Document Creation	Project Location	Sample Types/Report Info	Author
RM 2.9_Boeing_east bank	1	2.9	n/a	partial report/figures	9.11.1990	1135 S. Webster Street (Boeing Company), east bank	CPT logs, MW logs, grain size analysis, boring logs	Geoengineers
Boeing Plant 2_east bank	2, 8, 9, 10	3.1-3.5	Appendix C: Geotechnical Engineering Report, Habitat Project	report	10.2012	Boeing Plant 2 (Seattle/Tukwila)	Subsurface conditions, seismic conditions, liquefaction and lateral spreading analysis, slope stability analysis, shoreline excavation and dredging	AMEC, Floyd Snider, Dalton Olmsted & Fuglevand
RM 3.1-3.3 Boeing Technology Complex_east bank	3	3.1-3.3	Report of Geotechnical Investigation, Proposed Boeing Materials Technology Complex	report	8.13.1992	Boeing North Duwamish Campus, East Bank	Site conditions, subsurface/groundwater conditions, CPT logs, grain size, excavations, pile foundations, seismic aspects	Dames & Moore
RM 3.02_S Monroe St_west bank	4	3.12	Site plan	figures	8.22.1986	South Monroe Street, southwest side Duwamish	Site plan, 2 boring logs with blow counts, observation well install	Geoengineers
RM 3.3-3.6_Boeing Plant 2_east bank	5	3.3-3.6	Boeing Plant 2 RFI	figures (site thickness map, boring logs)	07.3.1997	Boeing Plant 2 (E Marginal Way S and 16th Ave S)	Boring logs, silt thickness and till units	Weston
RM 3_South Park Neighborhood_west bank	6	3.3	South Park Neighborhood Development Program Subsurface Investigations	report	8.1973	South Park Neighborhood	11 test boings (HSA), SPTs, 2 observation well installs, cross sections	Shannon & Wilson
RM 3.33-South Park Bridge	7	3.3	South Park Bridge Replacement Volume 3: Geotechnical Report	compiled reports	8.2007	South Park Bridge	Full geotechnical study (boring logs, seismic, liquefaction, soil motion, soil surface response spectra, shear wave velocity, rock input, etc.)	PB Americas, Shannon & Wilson
Terminal 117 Site Restoration GT Report - Rev 1	11	3.55	Terminal 117 Site Restoration	report	05.07.2014	Terminal 117: Duwamish waterway to the east, Dallas Avenue to the south. South Park marina to the north, parking lot to the west. (Flat around 15 ft)	Subsurface/surface conditions, GW, SPTs, earthquake engineering, liquefaction, design soil parameters, slope stability, ground improvement, shallow foundations, pile design, retaining walls, site development and earthwork	Geoengineers
RM 4.4_Transmission Towers	12	3.5-3.6	Geotechnical and Environmental Engineering Design Study Proposed Duwamish Transmission Towers	report	9.19.2003	Boeing Plant 2. Each bank of the Duwamish River south of the 14th Street bridge (south park bridge)	2 borings, existing geotechnical data, soil/GW subsurface, engineering analysis: seismic, foundations, deep foundations, SPTs	Hart Crowser
RM 3.6 Basin Oil_west bank	13	3.6	Geotechnical Engineering Study for Basin Oil	partial report/logs	02.07.1994	Basin Oil: 8661 Dallas Avenue South, Seattle	Site map and log	Lorilla Engineering
RM 3.6 _Dallas Ave S_west bank	14	3.6	Geotechnical Memorandum	memo	06.10.2014	Dallas Avenue South	10 test pits, 10 pilot infiltration tests, includes figures and logs, grain size	Seattle Public Utilities Geotechnical Engineering
RM 3.6_Jorgensen Forge MWs_east bank	15	3.6	Jorgensen Forge Boring Logs	figure/logs	12.05.1994	8531 E. Marginal Way, Seattle	2 HSA borings to 30 ft	SECOR
Final Inv Data Summ Rpt_021306	16	3.65	Final Investigation Data Summary Report Jorgensen Forge Facility	report	2.13.2006	Jorgenson: 8531 East Marginal Way South	Surface/subsurface samples analyzed for grain size (no deviations)	Farallon Consulting and Anchor Environmental

File Title	Identification No.[1]	River Mile	Document Title	Document type	Date Document Creation	Project Location	Sample Types/Report Info	Author
RM 3.7_Boeing S Park Facility_west bank	17	3.7	Report of Foundation Investigation	figures/logs	06.17.1980	1420 S. Trenton Street	7 boring logs and figures	Dames & Moore
Boeing Plant 2 CPT Locations	18	3.7	CPT Locations	figure	02.09.2015	POS Parcel Boeing Isaacson	CPTs (up to 60 feet bgs)	Kennedy/Jenks
RM 3.8_1600 S Henderson St_west bank	19	3.8	Supplemental Laboratory Testing	figures/logs	09.20.1984	South Park Site: 1600 S. Henderson St.	7 boring logs	Dames & Moore
RM 4.25_Delta Boat Lift Pier_west bank	20	4.25	Limited Geotechnical Engineering Report	report	5.8.2002	Boat Lift Pier 1608 S 96th Street	1 bore hole, two grain size, 200-wash analysis, Atterberg limits	AMEC
RM_4.4_Duwamish Substation_west bank	21	4.4	Geotechnical Report Duwamish Substation Bank 79 Foundation Retrofit	report	2.28.2003	Bank 79 Transformer: (near west marginal way)	1 PCPT, 2 geophysical surveys, 3 soil borings and analysis, borings completed for MWs	Earth Technology Corporation
RM_4.4_Duwamish Substation_west bank2	22	4.4	n/a	figures/logs	10.07.1969	Duwamish Substation	47 borings (logs with coordinates)	Seattle Engineering Department
Draft Duwamish Substation Geotech Rpt	23	4.45	Draft Geotechnical Report Seattle Substation Evaluation	draft report	11.2012	Duwamish Substation	Surface/subsurface conditions, environmentally critical areas, seismic considerations, foundations, earthwork	Seattle Public Utilities Geotechnical Engineering
RM 4.4-4.6_Boeing_east bank	24	4.4-4.6	Boeing Developmental Center Logs	figures/logs	2.1.2001	East Marginal Way South (Boeing Developmental Center)	MW well as-builts, site map, lithology logs (about 30 wells)	Landau Associates
USACE Dredging 2018	25	4.0-4.7	Memorandum For Record: DMMP Suitability Determination	report	05.24.2018	Duwamish River: Stations 242+00 and 275+56 (turning basin and navigation channel)	Vibracore samples (grain size/conventional) page 18	USACE
RM 4.6-7.7_Hwy 99_west bank	26	4.6-7.7	Report on Geotechnical Exploration	report	05.30.1985	Renton Effluent Transfer System. West Marginal Way Southwest, extending from about 1,500 south of South 102nd Street to 800 feet north of Des Moines Way South	Plan and profile maps, 21 exploration borings, trench excavation, chemical testing, GW conditions, geotechnical impacts	Converse Consultants
RM 5_Oxbow bridge	27	5.0	Geotechnical Design Report	report	4.1988	North Oxbow Bridge, Boeing Developmental Center	Surface/subsurface conditions, SPTs, GW, seismic considerations, vertical/lateral pile capacity, liquefaction potential, excavation	Rittenhouse-Zeman & Associates
RM +5_Boeing Oxbow Parking Lot_west bank	South of study area	5.1	Report of Geotechnical Investigation	report	7.23.1985	Boeing Developmental Center Oxbow Parking lot (west side Duwamish)	2 CPT, 5 borings, deepest boring 54.0 ft	Converse Consultants
LDW-Final-FS-Sections-8-13_october-31-2012_ADA	n/a	n/a	Lower Duwamish Waterway Final Feasibility Study (sections 8-13)	report	10.2012	Duwamish River	Table 8-6: prior geotechnical analyses from projects in the LDW, around Harbor Island, and adjacent Elliott Bay	LDWG
LDW-Final-FS-Sections-1-7_october-31-2012_ADA	n/a	n/a	Lower Duwamish Waterway Final Feasibility Study (sections 1-7)	report	10.2012.	Duwamish River	Section 2.6: additional considerations, sediment physical properties: grain size, Atterberg limits, TOC, porosity, bulk density, etc.	LDWG

File Title	Identification No.[1]	River Mile	Document Title	Document type	Date Document Creation	Project Location	Sample Types/Report Info	Author
Final_LDW-RI	n/a	n/a	Lower Duwamish Waterway Remedial Investigation Report	report	7.9.2010	Duwamish River	Section 2.5.4: sediment lithology: geotechnical parameter tests and results (moisture, specific gravity, Atterberg limits, bulk density, porosity). Also physical properties. Section 9.1.6: bank erosion	LDWG
2015_11_POS_Silver_DSR_Ecology	28	3.8	Boeing Isaacson-Thompson Site, Port of Seattle Sliver Data Summary Report	report	11.12.2015	Port of Seattle Sliver Property located west of the Boeing Isaacson Property	10 soil borings (direct push) to 25 ft bgs. 41 soil samples collected. No geotechnical analysis. Includes section on lithologic conditions of site and borings logs, page 5.	Kennedy/Jenks Consultants
Boeing_I-T_Landau_042114_Final_RI	29	3.8	Final Remedial Investigation Report Boeing Isaacson-Thompson Site	report	4.21.2014	Boeing Isaacson-Thompson Site	No geotechnical analysis. Descriptions of Geologic Conditions on page 107. Discuss soil conditions at 50 exploratory locations. Summary of depth to alluvium documented in Table 9 page 290	Landau Associates, AMEC
AppJ_Basin of Design Report_08162012	30	3.5 - 3.7	Appendix J Geotechnical Basis of Design Report (Terminal 117 Cleanup Design Sediment and Upland Areas)	report	8.1.2012	Port of Seattle, Terminal 117	Six borings and 8 CPTs. 3 completed on barge, 3 completed upland. 5 SPTs completed on barge, 3 completed in upland (locations figure 1 page 23). Geologic soil units described page 10. Engineering soil properties section 3 page 14. Subsurface profile figures begin page 25.	Crete Consulting, Jacobs Associates
2012_12-19_Final Shoreline Investigation	31	4.1-4.2	Shoreline Soil and Groundwater Characterization Report	report	3.12.2012	Former Rhone-Poulenc Site, Tukwila Washington: 9229 East Marginal Way	15 direct push upland borings for soil/GW from shoreline areas. 5 areas collected geotechnical samples between 11 and 15 feet. Section 3.1 soil lithology (page 14). Section 3.5 geotechnical analysis (moisture, density, grain size, atterberg). Results table 8 page 43. Geotech locations figure 3 page 47.	AMEC
Final Interm Measures Contruction Work Plan V1/V2	32	4.1-4.2	Final Interm Measures Contruction Work Plan V1/V2	report	10.25.2002	Former Rhone-Poulenc Site, Tukwila Washington: 9229 East Marginal Way	Samples to confirm depth and characterisics of uppermost aquitard. CPTs for soil strength at 3 locations alongside borings GT-5, B-1-02, B-7-02 (Section 2.4 Geotech Characterization page 15). Figures page 21. Table 2-1 summarizes analytical. V2: Appendix B: Geotechnical Data	URS
2021.03.05 Figures AppA-1_B-Boeing DC Thompson Geotech Report-01052021_Final_reduced	33	3.7; 4.6; 4.9	Boeing DC Thompson Geotech Report	figures/logs	1.5.2021	Boeing Thompson Site	3 CPTs at Thompson site; 3 CPTs at Boeing Development Center; 3 CPTs near Norfolk outfall	Golder
8801 Final FS July 27, 2020	34	3.9-4.0	Final Feasibility Study 8801 East Marginal Way S., Tukwila, Washington	report	7.27.2020	Centerpoint Properties	Geologic cross sections perpendicular and parallel to the river bank through Centerpoint Properties	Shannon & Wilson

Notes:
1. The study identification number is shown on Maps 5-2a and 5-2b. Studies with "n/a" in this field are site-wide studies.
CPT: cone penetration testing
DMMP: Dredged Material Management Program
GW: groundwater
HSA: hollow stem auger
LDW: Lower Duwamish Waterway
MW: monitoring well

n/a: not applicable
RFI: request for information
RI: remedial investigation
RM: river mile
SPT: standard penetration test
USACE: US Army Corps of Engineers

Key Studies

Table L-1 summarizes more than 30 existing studies that include subsurface geologic information for the upper reach. Several of these studies include in-water and upland explorations that provide geotechnical data that will support RD for specific RAL exceedance areas.

Of the studies summarized in Table L-1, several are particularly relevant to understanding geotechnical conditions for RD. For generalized subsurface lithology in the upper reach, the LDW RI (Windward 2010) depicts a subsurface geologic profile along the centerline of the FNC, and an east-west subsurface profile through the river and banks at approximately RM 3.9, near preliminary RAL exceedance areas 23, 24, and 25. This study includes 19 subsurface cores and 3 upland cores within the upper reach, which include relevant information that describes the thicknesses of geologic units, approximate densities, and field observations regarding each of the major stratigraphic horizons.

With respect to preliminary areas with RAL exceedances, specific studies in Table L-1 are particularly helpful in supporting geotechnical evaluations for upper reach RD:

- At preliminary RAL exceedance area 7, several bank and in-water geotechnical explorations completed for the South Park Bridge will supplement the data collected during Phase II PDI (Table L-1 reference ID number 7).
- At preliminary RAL exceedance areas 12, 14, and 16, studies conducted to support T-117 design provide supplemental geotechnical data (Table L-1 reference ID numbers 11 and 30).
- At preliminary RAL exceedance areas 18 and 23, studies conducted for Boeing Isaacson-Thompson provide supplemental geotechnical information (Table L-1 reference ID numbers 18, 28, 29, and 33).
- At preliminary RAL exceedance areas 23, 27, and 30, subsurface profiles depicted in the 8801 East Marginal Way Feasibility Study will supplement geotechnical investigations in this area (Table L-1 reference ID number 34).
- At preliminary RAL exceedance area 31, geologic profiles developed for the former Rhone Poulenc site will supplement RD geotechnical evaluations conducted in this area (Table L-1 reference ID numbers 31 and 32).
- At preliminary RAL exceedance areas 34 and 37, geotechnical data collected for the Boeing Development Center site will provide supplemental information to support geotechnical evaluations in these areas during RD (Table L-1 reference ID numbers 24 and 33).

Results of the existing geotechnical data review were used to inform the geotechnical investigation design and the selection of locations for geotechnical data collection for the Phase II PDI.

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Attachment M
Geotechnical Data Collection Locations and Rationale

Table M-1
Proposed Geotechnical Data Collection Details

Location	RM	RAL Exceedance Area(s)	Preliminary Remedial Technology	Geotechnical Data Location			Geotechnical Data Collection Method				Target Bottom Elevation in Feet (MLLW)	Rationale (See Notes)	Lab Testing Approach (See Notes)
				Within FNC	Between FNC & Toe of Bank	Within Banks	Boring	CPT	Vane Shear	DCP/HA			
LDW21-GT1-GB	3.0	1,2	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT2-GB	3.1	2,3,4,5	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT3-GB	3.2	5	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT4-GV	3.2	6	ENR		X				X		Shallow**	2	
LDW21-GT5-GB	3.3	7	ENR, dredge, or partial dredge/cap		X		X				-20	3	4
LDW21-GT6-GC	3.3	7	ENR, dredge, or partial dredge/cap		X			X			-20	3	
LDW21-GT7-GB	3.3	8,9,10,11	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT8-GC	3.5	12	ENR, dredge, or partial dredge/cap		X			X			-20	3	
LDW21-GT9-GB	3.5	13,14	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT10-GB	3.6	15	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT11-GB	3.6	16	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT12-GB	3.7	17	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT13-GB	3.7	18	ENR, dredge, or partial dredge/cap (depending on subarea)		X		X				-20	3	4
LDW21-GT14-GC	3.7	18	ENR, dredge, or partial dredge/cap (depending on subarea)		X			X			-20	3	
LDW21-GT15-GB	3.8	18	ENR, dredge, or partial dredge/cap (depending on subarea)		X		X				-20	3	4
LDW21-GT16-GC	3.8	18	ENR, dredge, or partial dredge/cap (depending on subarea)		X			X			-20	3	
LDW21-GT17-GC	3.8	18	ENR, dredge, or partial dredge/cap (depending on subarea)			X		X			-20	3	
LDW21-GT18-GB	3.8	18	ENR, dredge, or partial dredge/cap (depending on subarea)		X		X				-20	3	4
LDW21-GT19-GB	3.8	20,22	Dredge or partial dredge/cap		X		X				-20	3	4
LDW21-GT20-GV	3.8	21	ENR			X			X		Shallow**	2	
LDW21-GT21-GB	3.9	24	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT22-GC	3.9	23	ENR, dredge or partial dredge/cap			X		X			-20	3	
LDW21-GT23-GB	3.9	23,24	ENR, dredge or partial dredge/cap		X		X				-20	3	4
LDW21-GT24-GB	4.0	27	Dredge or partial dredge/cap			Upland*	X				-10	3	4
LDW21-GT25-GB	4.0	26,27	Dredge or partial dredge/cap		X		X				-20	3	4
LDW21-GT26-GV	4.0	30	ENR		X				X		Shallow**	2	
LDW21-GT27-GV	3.9	25	ENR			X			X		Shallow**	2	
LDW21-GT28-GB	4.0	28	Dredge or partial dredge/cap		X		X				-20	3	4
LDW21-GT29-GB	4.0	31	ENR, dredge, or partial dredge/cap (depending on subarea)		X		X				-20	3	4
LDW21-GT30-GC	4.0	31	ENR, dredge, or partial dredge/cap (depending on subarea)			X		X			-20	3	
LDW21-GT31-GC	4.1	31	ENR, dredge, or partial dredge/cap (depending on subarea)		X			X			-20	3	
LDW21-GT32-GC	4.1	31	ENR, dredge, or partial dredge/cap (depending on subarea)			X		X			-20	3	

Location	RM	RAL Exceedance Area(s)	Preliminary Remedial Technology	Geotechnical Data Location			Geotechnical Data Collection Method				Target Bottom Elevation in Feet (MLLW)	Rationale (See Notes)	Lab Testing Approach (See Notes)
				Within FNC	Between FNC & Toe of Bank	Within Banks	Boring	CPT	Vane Shear	DCP/HA			
LDW21-GT33-GB	4.1	31	ENR, dredge, or partial dredge/cap (depending on subarea)		X		X				-20	3	4
LDW21-G34-GC	4.1	31	ENR, dredge, or partial dredge/cap (depending on subarea)			X		X			-20	3	
LDW21-G35-GB	4.2	32	Dredge or partial dredge/cap; Area-specific technology under pier		X		X				-20	3	4
LDW21-G36-GB	4.2	32	Dredge or partial dredge/cap; Area-specific technology under pier			Upland*	X				-10	3	4
LDW21-G37-GB	4.3	33	Dredge or partial dredge/cap	X			X				-25	1	4
LDW21-GT38-GD/GH	4.6	34	Dredge or partial dredge/cap			X				X	Shallow**	3	
LDW21-GT39-GB	4.6	34	Dredge or partial dredge/cap			X	X				-10	3	4
LDW21-GT40-GB	4.7	36	ENR, dredge, or partial dredge/cap (depending on subarea)		X		X				-20	3	4
LDW21-GT41-GD/GH	4.7	36	ENR, dredge, or partial dredge/cap (depending on subarea)			X				X	Shallow**	3	
LDW21-GT42-GD/GH	4.7	36	ENR, dredge, or partial dredge/cap (depending on subarea)			Upland*				X	Shallow**	3	
LDW21-GT43-GV	4.7	35	ENR		X				X		Shallow**	2	
LDW21-GT44-GB	4.8	37	ENR, dredge, or partial dredge/cap			X	X				-10	3	4
LDW21-GT45-GC	4.8	37	ENR, dredge, or partial dredge/cap			X		X			-20	3	
LDW21-GT46-GC	4.9	37	ENR, dredge, or partial dredge/cap		X			X			-20	3	
LDW21-GT47-GC	4.9	37	ENR, dredge, or partial dredge/cap			X		X			-20	3	
LDW21-GT48-GB	4.9	37	ENR, dredge, or partial dredge/cap			X	X				-10	3	4
LDW21-GT49-GC	4.9	37	ENR, dredge, or partial dredge/cap			X		X			-20	3	
LDW21-GT50-GC	4.9	37	ENR, dredge, or partial dredge/cap			X		X			-10	3	
LDW21-GT51-GC	4.9	37	ENR, dredge, or partial dredge/cap			X		X			-20	3	
LDW21-GT52-GC	4.9	37	ENR, dredge, or partial dredge/cap			X		X			-20	3	
LDW21-GT53-GB	4.9	37	ENR, dredge, or partial dredge/cap			X	X				-10	3	4
LDW21-GT54-GC	4.9	37	ENR, dredge, or partial dredge/cap			X		X			-20	3	

Notes:
Upland* - no bank is present in this area; geotechnical data collection will be completed in the adjacent upland area
Shallow** - vane shear data to be collected to an approximate depth of 5 feet below mudline; DCP data to be collected to a target depth of 10 feet below mudline
1 - Geotechnical data collected within the FNC will focus on assessment of dredgeability and sediment strength for slope stability.
2 - Vane shear data will focus on assessment of sediment strength to support the ENR remedial technology.
3 - Geotechnical data collected in areas between the FNC and toe of bank and in bank areas will focus on sediment properties to support dredging, capping, ENR, slope stability, and structural considerations (as applicable).
4 - Assignment of ex-situ geotechnical tests as described in Sections 5.2.4. and 5.2.5. of the PDI QAPP Addendum for Phase II (Windward and Anchor QEA 2021) and Section 5.3.3, Table 5-1 of the PDI QAPP (Windward and Anchor QEA 2020) will be coordinated by the field geologist/geotechnical engineer and Lead Geotechnical Engineer based on geologic conditions observed in the field.
CPT: cone penetration testing
DCP: dynamic cone penetrometer
ENR: enhanced natural recovery
FNC: Federal Navigation Channel
HA: hand auger
MLLW: mean lower low weight
RAL: remedial action level

Attachment N
Relevant Photographs of the Upper Reach

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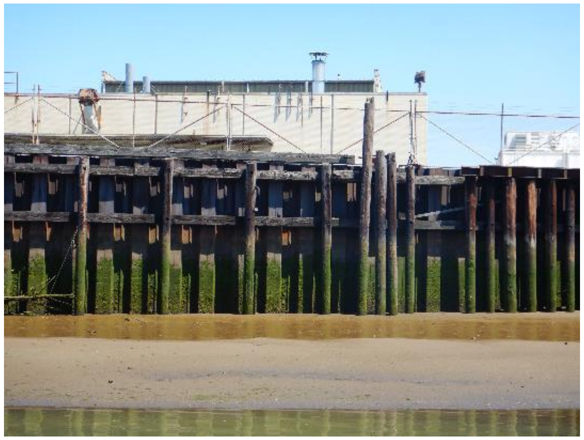
Table N-1
Relevant Photographs of the Upper Reach

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
12 (west bank)	Armored	 1. DSCN0787, 6/23/20 11:02 a.m.	 2. DSCN0785, 6/23/20 11:02 a.m.
18 (east bank)	Bulkheaded, unarmored (vegetated)	 1. DSCN0592, 6/18/20 10:25 a.m.	 2. DSCN0587, 6/18/20, 10:24 a.m.

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
18 (east bank)	Bulkheaded, unarmored (vegetated)	 3. DSCN0851, 6/26/20 1:59 p.m.	 4. DSCN0849, 6/26/20 1:59 p.m.
		 5. DSCN0848, 6/26/20 1:58 p.m.	 6. DSCN0847, 6/26/20 1:58 p.m.

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RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
23 (east bank)	Bulkheaded, unarmored (vegetated)	 1. DSCN0845, 6/26/20 1:58 p.m.	 2. DSCN0842, 6/26/20 1:57 p.m.
		 3. DSCN0840, 6/26/20 1:57 p.m.	 4. DSCN0837, 6/26/20 1:57 p.m.

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
23 (east bank)	Bulkheaded, unarmored (vegetated)	 5. DSCN0835, 6/26/20 1:57 p.m.	 6. DSCN0833, 6/26/20 1:56 p.m.
27 (east bank)	Bulkheaded	 1. DSCN0832, 6/26/20 1:56 p.m.	 2. DSCN0831, 6/26/20 1:56 p.m.

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
30 (east bank)	Armored	 1. DSCN0827, 6/26/20 1:55 p.m.	
31 (east bank)	Armored, unarmored (discontinuous)	 1. DSCN0823, 6/26/20 1:55 p.m.	 2. DSCN0819, 6/26/20 1:54 p.m.

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
31 (east bank)	Armored, unarmored (discontinuous)	 3. DSCN0816, 6/26/20 1:54 p.m.	 4. DSCN0814, 6/26/20 1:53 p.m.
32 (east bank, south side of Slip 6)	Armored	 1. DSCN0056, 6/16/20 8:09 a.m.	 2. DSCN0055, 6/16/20 8:09 a.m.

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
32 (east bank, south side of Slip 6)	Armored	 3. DSCN0107, 6/16/20 8:23 a.m.	
34 (east bank)	Unarmored (discontinuous)	 1. DSCN0465, 6/18/20 9:46 a.m.	 2. DSCN0462, 6/18/20 9:46 a.m.

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
35 (west bank)	Unarmored (vegetated)	 1. DSCN0361, 6/18/20 9:20 a.m.	 2. DSCN0360, 6/18/20 9:20 a.m.
36 (west bank)	Unarmored (vegetated)	 1. DSCN0366, 6/18/20 9:23 a.m.	 2. DSCN0364, 6/18/20 9:21 a.m.

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RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
36 (west bank)	Unarmored (vegetated)	 3. DSCN0363, 6/18/20 9:21 a.m.	
37 (east bank)	Unarmored (discontinuous)	 1. DSCN0435, 6/18/20 9:41 a.m.	 2. DSCN0433, 6/18/20 9:40 a.m.

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
37 (east bank)	Unarmored (discontinuous)	 3. DSCN0431, 6/18/20 9:40 a.m.	 4. DSCN0430, 6/18/20 9:40 a.m.
		 5. DSCN0428, 6/18/20 9:40 a.m.	 6. DSCN0426, 6/18/20 9:40 a.m.

FINAL

RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
South Park Bridge footings near RAL exceedance area 7	n/a	 1. DSCN0949 (looking S), 8/4/21 2:52 p.m.	 2. DSCN0955 (looking NW), 8/4/21 2:51 p.m.
T117 dolphin and debris deflector near RAL exceedance area 14	n/a	 1. DSCN1079 (looking NW), 8/4/21 3:41 p.m.	

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RAL Exceedance Area	Bank Type	Photographs[1,2,3]	
Delta Marine debris deflector near RAL exceedance area 33	n/a	 1. N/A[4] (looking SW), 6/15/20 11:34 a.m.	 2. DSCN0987 (looking W), 8/4/21 3:26 p.m.

Notes:
1. Photographs were taken during the Phase I PDI and are included in Appendix E of the Phase I DER (Anchor QEA and Windward 2021a).
2. Photographs are listed numerically showing the bank from left to right (when facing the bank). Therefore, the photographs show the bank from north to south on the east bank, and from south to north on the west bank.
3. All bank photographs included in this attachment were taken at approximate tide elevations of 0-ft to 2-ft MLLW.
4. Photograph taken during structures inspection and not included in Appendix E of the Phase I DER.