Lower Duwamish Waterway Group

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

NARRATIVE DESIGN REPORT

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

FINAL

Prepared for:

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

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, Washington

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
Ramboll Environ
Floyd|Snider
Geosyntec Consultants

December 2015

Project No. LY15160310

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

Page

FIGURES

APPENDICES

ABBREVIATIONS AND ACRONYMS

AC	activated carbon
AIRFA	American Indian Religious Freedom Act
AOC	Administrative Order on Consent (for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway)
ARAR	applicable or relevant and appropriate requirement
AWQC	ambient water quality criteria
BE	biological evaluation
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CQAPP	construction quality assurance project plan
DMMP	Dredged Materials Management Program
DOSH	Division of Occupational Safety and Health
Ecology	Washington State Department of Ecology
EFH	essential fish habitat
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery amended with activated carbon
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GAC	granular activated carbon
HASP	health and safety plan
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MTCA	Model Toxics Control Act
NAGPRA	Native American Graves Protection and Repatriation Act
NHPA	National Historic Preservation Act
NOAA Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Order Amendment	Second Amendment (July 2014) to the Administrative Order on Consent for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway
OSHA	Occupational Safety and Health Administration

ABBREVIATIONS AND ACRONYMS (Continued)

PCB	polychlorinated biphenyl
PCE	primary constituent element
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI	remedial investigation
ROD	record of decision
SMC	Seattle Municipal Code
SMS	Sediment Management Standards
SPI	sediment profile imagery
SPME	solid-phase microextraction
SQS	sediment quality standards
TMC	Tacoma Municipal Code
TOC	total organic carbon
TSCA	Toxic Substances Control Act
U.S.C.	United States Code
WAC	Washington Administrative Code
WCCA	Washington Clean Air Act
WQMP	water quality monitoring plan

NARRATIVE DESIGN REPORT
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 INTRODUCTION

The Lower Duwamish Waterway Group (LDWG) will conduct a pilot study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW). The study will determine whether Enhanced Natural Recovery (ENR) amended with granular activated carbon (AC) can be successfully applied to reduce the bioavailability of polychlorinated biphenyls (PCBs) in remediated contaminated sediment in the LDW. The study will compare the effectiveness of ENR with added AC (ENR+AC) with that of ENR without added AC in three areas (called "plots") in the LDW, which are referred to as the intertidal plot, subtidal plot, and scour plot. For the purposes of this project, ENR involves the placement of a thin layer of clean material (sand or gravelly sand) over subtidal or intertidal sediments. ENR+AC involves the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments. The purpose of the ENR and ENR+AC treatments is to reduce the exposure of aquatic organisms to contaminants of concern. The locations in which the pilot study will be conducted are shown in Figure 1.

A pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055, issued on December 20, 2000). The Second Amendment to the AOC, referred to as the Order Amendment, includes a statement of work for the pilot study, including a general overview of the work to be performed, a list of study steps/tasks, and a schedule for deliverables.

1.1 SCOPE AND PURPOSE OF STUDY

The general project goal of the pilot study is to place ENR material and ENR+AC over separate plots of the bottom sediments of the LDW to evaluate the performance of ENR+AC compared to ENR over a 3-year monitoring period.

The goals of the pilot study, as stated in the Order Amendment, are the following:

- Verify that ENR+AC can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percentage of carbon in a placed layer).

- Evaluate the performance of ENR+AC compared to ENR alone in locations with a range of PCB concentrations.
- Assess potential impacts on the benthic community in ENR+AC compared to ENR alone.
- Assess changes in bioavailability of PCBs in ENR+AC compared to ENR alone.
- Assess the stability of ENR+AC in scour areas (such as berthing areas).

1.2 Plot Design, Locations, and Summary of Conditions

The selection of the specific plot locations is described in the plot selection memorandum, which is included as Appendix A. These locations were approved by the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) on February 11, 2015. The three plots are shown in Figure 1 and described in the following subsections. The plot selection memorandum provides the sediment results for all contaminants of concern in the LDW, a physical description of each plot, and the rationale for its selection.

The selection of these plots for the pilot study met the study goal to evaluate performance of ENR+AC compared to ENR alone in locations with a range of PCB concentrations.

1.2.1 Subtidal Plot (River Mile 1.2)

The subtidal plot represents typical subtidal conditions in the LDW Superfund site. The location and bathymetry of the subtidal plot, the layout of its two subplots, and the surface-sediment PCB concentrations are shown in Figure 2. This plot is divided into two longitudinal subplots called the East Lane and the West Lane, for the ENR and ENR+AC applications, respectively.

1.2.2 Scour Plot (River Mile 0.1)

The scour plot is representative of areas throughout the site that may experience scour in berthing areas. The location and bathymetry of the scour plot, the layout of its two subplots, and the surface-sediment PCB concentrations are shown in Figure 3. This plot is divided into two almost square subplots called the upstream and downstream subplots, for the ENR and ENR+AC applications, respectively.

1.2.3 Intertidal Plot (River Mile 3.9)

The intertidal plot represents intertidal conditions throughout much of the site. Consistent with previous documents, the intertidal area in the LDW is defined as sediments above -4 feet mean lower low water. The location and bathymetry of the intertidal plot, the layout of its two subplots, and the surface-sediment PCB concentrations are shown in Figure 4. The plot is divided into two rectangular upstream and downstream subplots; ENR and ENR+AC applications, respectively. The two plots are separated by approximately 100 feet to avoid three shoreline outfalls and an area of debris.

1.3 DATA QUALITY OBJECTIVES

This section summarizes the data quality objectives (DQOs) for the pilot study monitoring program. Additional details for the DQOs are presented in the QAPP. The DQO process defines criteria that will be used to establish the final data collection design (U.S. EPA, 2006). Based on the study goals listed in Section 1.1, the DQOs were developed to support the selection of sampling and analysis methods and an overall study design that leads to data appropriate to answer the study questions.

The DQOs were developed with the recognition that ENR (and ENR+AC) are technologies that inherently work with processes that are ongoing in the LDW surface sediments. These include vertical mixing by bioturbation, redistribution and vertical mixing of surface sediments by waves and currents, sedimentation and minor erosion, and minor anthropogenic disturbances such as small boat anchors. ENR is not an engineered containment layer and the placed ENR layer is expected to physically change over time as a result of these riverine processes.

1.3.1 DQO-1: Verify the Placement of the ENR and ENR+AC Materials

This DQO verifies whether the ENR and ENR+AC layers can be placed in the subtidal, intertidal, and scour plots within the targeted specifications. This first DQO establishes the initial physical conditions of the ENR and ENR+AC layers immediately after placement and is used to support subsequent monitoring. This DQO addresses the thickness and evenness of the ENR and ENR+AC layers, the constructed AC content in the ENR+AC layer, and the distribution of carbon in the ENR+AC layer.

Investigative methods to measure the thickness and evenness of the layers will include physical assessment using tools such as bathymetric surveys, breakaway stakes, visual observation by divers, sediment profile imagery (SPI), and collection, logging, and analysis of shallow cores. The quality assurance/control (QA/QC) requirements are described in the monitoring Quality Assurance Project Plan (QAPP) and the Construction Quality Assurance Project Plan (CQAPP).

The achieved application rate of AC will be based on measures of post placement carbon content using methods for both total organic carbon (TOC) and AC. The general distribution of AC within the ENR+AC layer will be based on visual observations using diver-collected cores and SPI.

1.3.2 DQO-2: Evaluate the Stability of ENR and ENR+AC Materials

The second DQO addresses the long term stability (over the 3-year study period) of the ENR materials and the stability of the AC material in the ENR matrix in the scour plot. Loss of ENR and ENR+AC materials may occur as a result of erosional forces, such as propeller wash and high river flows. Depending upon the nature of the turbulence in the berthing areas, there is also the potential for the propwash currents to increase or decrease ENR processes (e.g., deposition of riverine sediments or mixing of the ENR and ENR+AC layers into the underlying sediment) compared to areas without propwash effects. Changes in ENR+AC stability at all the pilot study plots will be evaluated during post placement monitoring events using visual observations (diver survey and SPI) and/or diver-collected cores.

1.3.3 DQO-3: Assess Changes in Bioavailability in ENR+AC Compared to ENR Alone

This DQO assesses the potential changes in PCB bioavailability in ENR+AC compared to ENR alone. For the purposes of the pilot study, changes in bioavailability will be based on measurements of the bioavailable fraction of PCBs as represented by the PCB concentrations in porewater. Porewater PCB concentrations will be measured using solid-phase microextraction (SPME). Secondary measurements supporting the interpretation of bioavailability will include measurements of grain size, carbon content, and bulk sediment PCB congeners. In addition, an addendum to the pilot study QAPP will be prepared that will describe a tissue study to further assess changes in bioavailability.

1.3.4 DQO-4: Assess the Potential Impacts of AC on Benthic Communities

This DQO addresses the potential impacts of AC on benthic communities in the LDW. Although laboratory and field studies have generally shown few adverse effects on benthic organisms after the application of AC to contaminated sediments, effects have been associated with the use of small particle sizes (powdered activated carbon) or higher applications rates (generally greater than 5 percent AC).

To determine whether the use of AC, as proposed in the pilot study, could adversely affect the benthic communities in the LDW, a benthic macroinvertebrate survey will be conducted in Year 3. The benthic communities established in each of the ENR+AC subplots of the subtidal, intertidal, and scour plots will be compared to the benthic communities in their respective ENR subplots.

1.4 PROJECT SCHEDULE

All in-water construction work for ENR and ENR+AC placement is planned to be conducted during the authorized 2016–2017 in-water work window for the LDW, when salmonid species listed under the Endangered Species Act are least likely to be present. The construction is expected to occur in December 2016, after the completion of the Muckleshoot Indian Tribe's net fishery season. The baseline sampling (as described in the QAPP [Appendix E]), which is scheduled to precede placement by 60 to 90 days, would occur in September or October 2016, and the Year 0 (post placement) event would occur in January or February 2017. The Years 1, 2, and 3 monitoring events are anticipated to occur in the spring (March to May) of 2018, 2019, and 2020.

A draft Construction Report will be submitted to EPA and Ecology with the Draft Year 1 Monitoring Report per the Order. However, a courtesy copy of the construction sections of the Draft Year 1 Monitoring Report will be submitted to EPA and Ecology within 6 months of the completion of construction. The Year 3 Monitoring Report will include the results of the Year 2 monitoring.

Validated sampling data from the baseline event and Years 0, 1, and 2 sampling event will be provided to EPA and Ecology within 75 days after completion of the sampling event and Year 3 validated sampling data will be provided within 90 days.

1.5 Report Organization

This narrative design report is laid out to present the approach for design, construction, and monitoring of the pilot study, which addresses Task 2 of the AOC (Prepare the Design Package). The main body of this report is intended to summarize the various deliverables required by Task 2 of the AOC.

- Section 2.0 provides the basis of design and general approach to the construction of the pilot plots and summarizes the construction quality assurance project plan (CQAPP) and the plans and specifications.
- Section 3.0 summarizes the quality assurance project plan (QAPP) for the pilot study.
- Section 4.0 is an overview of the water quality monitoring plan (WQMP) for the pilot study.
- Section 5.0 is an overview of the health and safety plan (HASP) for the pilot study.
- Section 6.0 provides a project cost estimate and project schedule.
- Section 7.0 provides an analysis of the substantive compliance of the pilot study with applicable environmental regulations.
- Section 8.0 summarizes the biological evaluation (BE) prepared for the pilot study.
- Section 9.0 provides a list of the references cited in the narrative design report.

All of the design documents specified in the Order are provided in the appendices: the CQAPP (Appendix C), construction plans and specifications (Appendix D), the QAPP (Appendix E), the WQMP (Appendix F), the HASP (Appendix G), the cost estimate and project schedule (Appendix H), and the BE (Appendix B), all of which are summarized in the following sections.

2.0 DESIGN AND CONSTRUCTION

As outlined in Section 1.1, the goals of the pilot study include verifying that ENR and ENR+AC can be successfully applied over the LDW bottom sediments and evaluating the performance of ENR+AC compared to ENR.

The AC has a specific gravity similar to that of water and may be resuspended and sorted from the heavier sand and gravel ENR materials during placement. The criteria for the design and construction of the ENR and ENR+AC are the following:

- Place material in a manner intended to limit mixing with underlying river sediments.
- Limit segregation of the placed materials during placement.
- Limit winnowing/loss of the AC during placement.
- Place the materials accurately within the target areas at the target thickness.

Because this project is a pilot study comparison of ENR and ENR+AC, the 3-year monitoring program after material placement is intended to monitor performance over time. As a result, the design and placement of materials in the LDW in the three plots must meet the criteria stated above and be as consistent as possible throughout the plots and subplots. Since the placement objectives are critical to the long-term evaluation of this effort, the overall design considered how to best manage various aspects of placement to ensure the achievement of these criteria. Because this project is a pilot study with 3 years of monitoring of the subplots and because of the small size of the subplots, this design uses means and methods to ensure the highest degree of consistency in terms of the materials placed in the subplots within one plot. The exact construction approach and equipment used for the pilot study may not be the same as that typically used for a full-scale ENR+AC project in which the project scale would influence the selection of equipment and methods. However, this pilot study was designed to evaluate factors to be considered in designing placement methods for use in a full-scale ENR+AC project.

It should also be noted that there are limitations associated with the placement of material below the water surface in the tidally influenced LDW that result from the variability of the physical and chemical parameters in the waterway, the capability of the contractor and the contractor's equipment, and inherent difficulties related to placing materials with differences in specific gravities (i.e., AC and sand and gravel). Consequently, the thickness of the placed material will have some variability and the need for some level of adaptive management during construction is expected as a normal part of the pilot study, as described in Section 2.1.

2.1 Basis of Design

The pilot study will be conducted with three separate plots, each consisting of approximately 1 acre in the LDW: one in an intertidal area, one in a subtidal area, and one in a subtidal area of potential scour (Figures 1 through 4). Each of the three plots will be divided into two subplots, each consisting of approximately ½ acre. Within each plot, one of the subplots will be treated with ENR material only and the other will be treated with ENR+AC. To evaluate the performance of ENR+AC compared to ENR alone, these plots will be monitored for 3 years after their construction.

For the monitoring program to be effective, the design of the plots and the placement of materials must limit the potential for overlap or mixing of materials between the subplots to the extent reasonably practicable using conventional construction equipment and marine contractors. Monitoring of the subplots has been designed with an internal buffer zone between the area to be sampled in each subplot and adjacent subplot in case of any significant crossover of AC into the ENR subplot (see Figures 2 through 4). The area to be sampled in each subplot has been sized to leave a 5-foot-wide buffer around the edge of each subplot and, when the subplots are adjacent, a 15-foot-wide buffer between the ENR and ENR+AC subplots.

2.1.1 Material Thickness Criterion

The placement of ENR and ENR+AC materials under water using the available equipment will result in variability in material thickness. Based on industry experience, a 3-inch tolerance in placement thickness is the best that can be planned for and measured. Because of this anticipated variability, the material placement has been designed using the volume of material equivalent to a 9-inch-thick placement, with a goal for a thickness value of between 6 and 9 inches for 80% of a plot and with a minimum thickness of 4 inches over 100 percent of the plot. The design is based on a sound technical approach and a construction process that uses adaptive management to adjust the approach to varying in-water conditions.

2.1.2 ENR Materials

The proposed material for the ENR and ENR+AC will consist of sand for the subtidal plot and gravelly sand for the scour and intertidal plots. Figures 2 through 4 show the locations of the ENR and ENR+AC subplots. Sand has traditionally been used as ENR material; however, the locations of the intertidal and scour plots are anticipated to result in material movement as a result of boat wakes, wind-generated waves, propeller wash, sloping river bottoms, and currents. This can cause winnowing of AC in the ENR+AC subplots with loss of AC from the upper layer and transport of the AC out of the subplot. Therefore, a gravelly sand mix has been selected for use in the intertidal and potential scour plots to reduce the potential for movement of the ENR and ENR+AC material by waves and currents. Reducing movement of the placed materials is critical to reducing loss of the AC from the ENR+AC subplots and reducing the potential for any effects of the AC on the adjacent ENR subplots. Such transport is not an environmental concern per se, but may affect sample results and the interpretation of the study results.

A gravelly sand mix has been approved by the Natural Resource Trustees for use as a habitat substrate in restoration/creation projects on the LDW. For example, the backfill used in the Boeing sediment cleanup on the Duwamish Waterway required a gravelly mix in portions of the intertidal and scour areas to prevent erosion of the backfill. In areas where groundwater upwelling was occurring, even larger material sizes were required to prevent erosion.

In addition, the Port of Seattle is planning construction of a habitat restoration project along a portion of the South Park shoreline as part of a settlement with the Natural Resource Trustees where the shoreline slopes will be covered with a similar gravely sand mix.

A similar material was used for the pocket beach that was constructed at the Olympic Sculpture Park along the Elliott Bay shoreline. Post-construction monitoring was conducted over several years and shows that the pocket beach with gravelly substrate had high densities of harpacticoid copepods, amphipods, and overall epibenthic invertebrates (Toth el al., 2012).

Additional locations in the LDW where gravely sand has been used as a habitat substrate include the Slip 4 Early Action cleanup and the Duwamish/Diagonal sediment remediation project.

The gravelly sand used in the intertidal plot and the scour plot will consist of sand and rounded gravel with the following grain size characteristics:

- 100 percent passes a 1.5-inch sieve,
- 50 to 60 percent passes a No. 4 sieve, and
- less than 2 percent passes a No. 230 sieve.

For the sand used in the subtidal plot, 100 percent will pass through a No. 4 sieve, and it should contain less than 2 percent fines.

The source of carbon for the AC will be granular activated carbon (GAC), and it will be virgin (i.e., not regenerated carbon) from coconut fiber.

The AC gradation should be relatively well graded across the grain size range of 200 to 1000 microns and will be tested for PCBs and grain size before the material is accepted for use in the pilot study.

The ENR material must be approved for use by the EPA; therefore, chemical testing of the borrow source will be implemented per the requirements in the CQAPP. Materials acquired for use in the pilot study will be verified in terms of their gradation and chemistry before they are loaded onto the barge.

2.1.3 Target Percentage of Activated Carbon for ENR+AC Material

For the ENR+AC subplots, GAC will be blended with the sand or gravelly sand to result in approximately 4 percent AC by weight as described in Specification 02221 (Appendix D). The AC material grainsize specification will be relatively well graded across the grain size range of 200 to 1000 microns. The design AC concentration is based on previous studies which were designed to decrease bioavailability of PCBs without impacting benthic communities (see Section 6.7.2 of the Biological Evaluation [Appendix B]) but will be evaluated in the monitoring phase of this study. The target concentration is based on the dry weight of GAC and ENR material. To achieve the approximately 4 percent target concentration, 80 pounds of GAC will be required for every ton of ENR material. It should be noted that the range of AC percentage in the blended material can vary as a result of potential segregation such that although the overall average is approximately 4 percent, the percentage within any subsample can be variable.

The specific gravity of AC is very close to that of water and, therefore, some AC loss will occur during and after placement, resulting in a range of carbon percentages in the placed material.

It is expected that the pilot study will require approximately 7,100 tons (4,200 cubic yards) of ENR material and approximately 150 tons of AC. Details on the weights/volume of material are provided in Specification 02221 (Appendix D). Details on assessing the carbon content of the ENR+AC material prior to placement are provided in Specification 02221.

2.1.4 Material Preparation

Blending of GAC with the ENR material will be completed either at the borrow facility or on a barge, depending on the capabilities of the borrow facility. The blended material (ENR+AC) will be loaded onto a suitable clean, water-tight barge. Upon arrival at the plot, the blended material will be presoaked by flooding the barge with Duwamish River water for a minimum of 12 hours before material placement. The presoaking will wet the AC particles and reduce the amount of air in the AC pore spaces, and thus reduce the difference in density between the AC and the ENR material. The blended material will be kept saturated at all times before placement. The ENR material may be presoaked similar to the ENR+AC material. Water remaining on the barge after the blended material has been removed will be discharged back to the river after filtration of the water through a 1 micron bag filter.

2.1.5 Equipment and Material Placement

The ENR and ENR+AC materials will be placed using a fixed-arm excavator equipped with a sealed (relatively leak proof to the extent practicable) 3- to 6-cubic-yard clamshell bucket. The clamshell bucket will be in good condition, with overlapping side plates. The side plates and cutting edges will be replaced as necessary to limit leakage. Before placement of the ENR and ENR+AC materials, a test will be conducted to develop the optimal bucket placement grid, bucket overlap, and bucket fill factor. The test will consists of a trial placement of the material in designated demonstration areas within the intertidal zone of the Duwamish Waterway as described in the CQAPP (Appendix C; Specification 02221).

The ENR and ENR+AC materials will be placed to achieve a minimum thickness of 4 to 6 inches by placing a volume equivalent to a 9-inch lift that is spread as uniformly as practicable over the subplot area. To adjust for the variation in resulting thickness across the bucket footprint, the material will be placed in two lifts, using an offset grid bucket pattern, so that 80% of the plot will be 6 to 9 inch in thickness and 100% of the ENR and ENR+AC is at least 4 inch in thickness. To achieve a relatively uniform placement of material, the bucket volume and placement area covered upon release of the bucket contents will be known and adjusted as necessary to achieve an approximately 4.5-inch-thick lift over as much of the bucket footprint as practicable based on the bucket characteristics. Some portions of the placement area will be at least 4 inches thick, and some portions may be considerably thicker, especially near the center of the bucket footprint.

It is one of the goals of the pilot study to place the ENR or ENR+AC material placement thickness within the 6- to 9-inch target range, to the extent practicable based on the planned and approved placement method. In addition, the intent is to have no more than 12 inches of fill, to the extent possible given the limitations of the placement technology. However, placement thickness greater than the 6- to 9-inch target may result in some small localized areas due to a variety of factors including:

- existing site bathymetric features such as steeper slopes, localized depressions, or erosion channels;
- areas of debris; and
- localized areas of greater thickness resulting from variation in placement thickness from the volume of material placed by a single bucket (material placed by bucket is

anticipated to vary in thickness from the center of bucket [thicker placement from single bucket] out to the edge of the bucket [thinner placement from single bucket]).

Any localized areas of greater thickness are expected to be reduced by natural processes such as tides and currents following placement.

As is typical with the placement of materials at or near the mudline, the resulting placement surface will be uneven and hummocky immediately after placement. In addition, in areas where the existing bed of the waterway slopes, potentially thicker placements are expected near the toe of the slope due to the movement of the material down the slope. Neither of these occurrences is expected to adversely affect the performance of the ENR and ENR+AC applications or the ability to monitor their performance. Material from areas where the placement is too thick will only be relocated if it encroaches upon the existing Federal authorized navigation depth and thereby poses a hazard to navigation as determined in consultation with the U.S. Army Corps of Engineers.

The lift placement will be monitored by an electronic navigation and positioning system on the excavator arm and bucket that will be capable of the following:

- Accurately determining position of clamshell bucket (or similar equipment) to +/-4-inch accuracy in X, Y, and Z axes, relative to project datum, in real time. Accuracy will be verified at the beginning and end of every shift, at a minimum.
- Tracking bucket rotation/orientation.
- Tracking bucket open/close position.
- Displaying project area and features, bathymetry, water level, barge and/or dredge or work platform location and clamshell bucket (or similar equipment) in both plan and cross-sectional views in real time.
- Accounting for any effects of river current on clamshell bucket position underwater compared to position of navigation equipment above water and displaying proper position in real time relative to project specific datum.
- Recording actual bucket opening location (X, Y, and Z axes) for each bucket of material placed.

During the placement operations, a spud barge capable of holding equipment in place is expected to be used. To avoid disturbance of the ENR and ENR+AC material, the spuds, anchors, wires, chains, etc. will be prevented from coming in contact with the plots themselves once the material has been placed. In addition, tug maneuvering with the potential for disturbing the placed material will be avoided to the extent practicable.

At each plot location, material will be placed in the ENR+AC subplot before the material is placed in the corresponding ENR subplot to minimize potential migration of the low-density AC onto the surface of the ENR subplot.

A clamshell bucket (or similar equipment) will be used to remove material from material barge and quickly lower the bucket below the water surface to the appropriate horizontal position set approximately 2 feet above the riverbed. The bucket will not contact the riverbed at any time during material placement.

During placement, any excess ENR or ENR+AC material remaining on the barge after construction of the subplot is completed may be placed around the perimeter of the subplot as appropriate to slightly increase the plot area.

In the unlikely event that over placement of material occurs within a plot, at a thickness greater than the target placement thickness to such a degree that it may impact navigation, some of the placed material will be moved using the clamshell bucket and relocated to the perimeter of the appropriate subplot.

Water used to flood the material barge will be discharged to the Duwamish Waterway after the water has been passed through a 1 micron filter media. If for any reason the water cannot be discharged through a 1 micron bag filter, EPA will be consulted to determine if any monitoring beyond that already conducted at the early warning and compliance stations is required.

2.1.6 Placement Verification

Placement verification will be a multistep process, starting with test placement and development of a placement pattern and volume per bucket, followed by in-place measurements to verify the placed thickness. The placement verification process is outlined in the CQAPP developed for the pilot study (summarized in Section 2.1.8). The Amec Foster Wheeler consulting team (consulting team) will provide a full-time engineer (Field Engineer) on the floating plant to oversee placement. A King County project representative (engineer) will be on-site as necessary. As outlined in the CQAPP, EPA and Ecology will be involved in verification of all construction activities including placement of material.

2.1.7 Work Hours and Duration

Since the test plots will be constructed in winter of 2015/2016, work will likely be conducted during daylight and non-daylight hours with approval of EPA and Ecology. It is not practicable to limit work to daylight hours only due to time of year, available daylight hours, and need to inspect intertidal test placements at low tide.

2.1.8 Construction Quality Assurance Project Plan

The CQAPP developed for use during implementation of the pilot study is included in this report as Appendix C. It presents an overview of the pilot study, the components of the construction quality management, and the objectives of the CQAPP. It describes the organizations and key personnel involved in construction quality management, as well as their responsibilities/authorities. The CQAPP describes the QA activities for different elements of the construction work and discusses the procedure for tracking construction deficiencies, from the identification of a deficiency through the accepted corrective action. The CQAPP also presents the procedures for managing meeting and construction documentation and reporting and for revising the Contractor Quality Control Plan and CQAPP.

The CQAPP describes the personnel, procedures, and activities required to ensure that the construction work satisfies the engineering design and regulatory requirements and that reliable, accurate, and verifiable construction data are recorded during construction. Construction quality management consists of quality control (QC) by the contractors and QA by the construction oversight team. QA performed by the construction oversight team will consist of conducting specific measurements, along with monitoring and audits to verify that the contractor follows the applicable QC programs, verify the effectiveness of the QC programs, and provide assurance and documentation that the completed construction work satisfies the quality requirements specified in the construction contracts. The construction will be managed by King County, with engineering support provided by the consulting team, primarily Dalton, Olmsted & Fuglevand, Inc. Construction oversight will be provided by the Project Representative, the Field Engineer, and support staff. The CQAPP details personnel roles for both the construction oversight team and the contractor team.

2.2 CONSTRUCTION PLANS AND SPECIFICATIONS

The construction plans and specifications are included in this report as Appendix D. The construction plans and specifications have been developed to meet King County design and construction standards for public works construction bidding.

3.0 QUALITY ASSURANCE PROJECT PLAN

The Order Amendment requires the development of a QAPP for monitoring, which is included in this report as Appendix E. The QAPP details the sampling approach, the sample handling and custody protocols during the 3-year monitoring period of the pilot study, and the QA/QC process for data generation and acquisition. Finally, the QAPP describes the compliance assessments and oversight responsibilities for that portion of the project, including response actions for field sampling and corrective actions for laboratory analysis, and discusses the data validation and usability assessment of laboratory data.

The QAPP describes the monitoring program developed for the pilot study on the basis of the DQOs discussed in Section 1.3. Monitoring as described in the QAPP will be conducted during a baseline sampling event before construction of the plots, during a Year 0 sampling event after the plot construction, and during a sampling event in Years 1 through 3 after construction. In addition, a tissue study to further assess PCB bioavailability will be developed and presented in an addendum to this QAPP.

4.0 WATER QUALITY MONITORING PLAN

The WQMP for the pilot study is included in this report as Appendix F. It is assumed that water quality monitoring will be required during all in-water construction activities as a condition of the Clean Water Act (CWA) Section 401 water quality memo to be issued by the EPA.

Because the pilot study will involve the placement of only clean material, water quality monitoring for turbidity will be conducted during the in-water placement of the ENR and ENR+AC. Water samples will not be collected for chemical analysis because the ENR material will be obtained from a clean quarry source, and its quality will have been confirmed by chemical testing.

The objectives of the water quality monitoring and management activities are as follows:

- Ensure that the water quality performance criteria prescribed by the Section 401 water quality memo are met during implementation.
- Establish contingency measures and corrective action in the unlikely event that unacceptable conditions are detected.

These monitoring and management objectives will be achieved by means of the following activities, as described in the WQMP:

- The consultant team will conduct water quality monitoring during placement of material.
- Monitoring stations will be selected to evaluate compliance with the water quality objectives.
- If exceedances occur, corrective actions will be taken as outlined in Section 2.0 of the WQMP.
- Written reports documenting compliance with the performance standards will be prepared by the project team for submittal to the EPA as required by the Section 401 water quality memo.

Compliance with performance criteria will be evaluated using data from the compliance stations and a corresponding ambient station for each plot area. The ambient station will be located outside the area of influence of the construction activities. Details of the monitoring are provided in the WQMP (Appendix F).

5.0 HEALTH AND SAFETY PLAN

A site-specific HASP has been developed to address the health and safety practices and controls that will be implemented by teams performing construction oversight and various monitoring and sampling activities as part of the pilot study. The site-specific HASP is included in this report as Appendix G.

Because of the specialized nature of the many different site evaluation and construction activities that will be conducted at the pilot plots, each contractor involved in the work will develop and implement its own HASP and provide activity safety analyses that address the tasks that they are responsible for. Therefore, it should be stressed that the health and safety directives discussed in the site-specific HASP in Appendix G apply only to construction oversight management personnel engaged in the oversight activities mentioned in the previous paragraph.

Activities performed under this site-specific HASP will comply with applicable sections of Washington Administrative Code, Chapter 296-843 (WAC 296-843) for hazardous waste site work and all other relevant general occupational health regulations and construction safety standards established by the state Division of Occupational Safety and Health (DOSH). When appropriate, specific DOSH standards are referenced in the site-specific HASP to highlight additional health and safety requirements that are not otherwise discussed. These standards will be available on site by means of an Internet connection with the Washington State Occupational Safety and Health Administration (OSHA) Web site.

6.0 COST ESTIMATE AND PROJECT SCHEDULE

The cost estimate for the construction and monitoring of the pilot study and construction schedule are provided in Appendix H.

7.0 REGULATORY AND PERMIT REQUIREMENTS

The ENR/AC pilot study is under the jurisdiction of EPA Region 10 and Ecology; therefore, it must comply with any applicable or relevant and appropriate requirements (ARARs). ARARs are promulgated federal and stricter state environmental or facility siting laws and regulations that are either (1) applicable requirements, or (2) relevant and appropriate requirements. The EPA in conjunction with Ecology, as set forth in the National Oil and Hazardous Substances Contingency Plan (40 CFR 300), is required to identify ARARs that will be met during the implementation of the remedial action. The potential ARARs for the pilot study were developed by the EPA as part of the final record of decision (ROD) for the LDW Superfund site (U.S. EPA, 2014); they are summarized in the following subsections.

For CERCLA actions such as this pilot study, regulatory permits are not required for on-site actions, but on-site actions must be conducted in a manner that meets the substantive provisions of applicable regulatory requirements. Actions that take place off site are subject to all applicable requirements, including any administrative requirements (e.g., permit approval or reporting).

7.1 Federal Requirements

This section presents the federal ARARs that potentially apply to the pilot study.

7.1.1 Resource Conservation and Recovery Act, Subtitle C (Hazardous Waste)

The Resource Conservation and Recovery Act (RCRA) applies to the identification, generation, transportation, and disposal of any hazardous wastes generated by a project (42 U.S.C. §§ 6901–6992K; 40 CFR 260–273). The pilot study will not involve dredging or the generation of solid waste. Unanticipated circumstances could necessitate compliance with other hazardous/dangerous waste requirements. Based on the remedial investigation (RI) of the LDW (Windward, 2010) and the sampling results from the candidate plots for the pilot study (Windward, 2015), LDW sediments, should they be excavated and become a waste, are not expected to be characterized as hazardous/dangerous waste. In the unforeseen event that dangerous/hazardous waste is generated, the pilot study would comply with the state generator rules for accumulating or managing such waste on site for up to 90 days (40 CFR 262; WAC 173-17-202). State dangerous waste is defined more broadly than federal hazardous waste.

7.1.2 Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) establishes prohibitions of and requirements for the manufacture, processing, distribution in commerce, use, cleanup, storage, and disposal of PCBs after January 1, 1978 (15 U.S.C. § 2605; 40 CFR 761.61[c]). TSCA regulations for PCBs apply to materials containing concentrations of PCBs equal to or greater than 50 parts per million. The EPA evaluates the form and concentration of PCBs “as found” at the site, which is subject to disposal requirements (40 CFR 761.60[a][2]–761.60[a][5]) and storage requirements (40 CFR 761.65).

Dredging will not be a component of the pilot study, but based on the LDW RI and the sampling results from the candidate plots for the pilot study, encountering materials at the site with PCB remediation waste as defined in 40 CFR 761.3 is not expected. Any such material will be subject to the EPA-approved plans for all cleanup activities, including any sampling, as well as all on-site disposal-related activities. Risk-based disposal of PCB remediation wastes must not pose unreasonable risk of injury to human health or the environment. Written EPA approval is required for any off-site disposal of PCB remediation waste.

7.1.3 Solid Waste Disposal Act

Congress enacted the Solid Waste Disposal Act of 1965 to address the growing quantity of solid waste generated in the United States and to ensure its proper management (42 U.S.C. §§ 6901–6992K; 40 CFR 257–258). Subsequent amendments to the Solid Waste Disposal Act, such as RCRA, have substantially increased the federal government's involvement in solid waste management. The term solid waste, as defined by the statute, is very broad, including not only the traditional nonhazardous solid wastes, such as municipal garbage and industrial wastes, but also hazardous wastes. Hazardous waste, a subset of solid waste, is regulated under RCRA Subtitle C.

The pilot study will comply with the substantive requirements for nondangerous or nonhazardous waste that it generates, unless the wastes qualify for recycling or other exemptions.

7.1.4 Clean Water Act

The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters (33 U.S.C. § 1251 et seq. [1972]). The basis of the CWA, which was enacted in 1948, was called the Federal Water Pollution Control Act, but the act was significantly reorganized and expanded in 1972. Under the CWA, the EPA has implemented pollution control programs such as setting wastewater standards for industry and developing water quality standards for all contaminants in surface waters.

This section discusses the various parts of the CWA that constitute ARARs for the pilot study.

7.1.4.1 Ambient Water Quality Criteria

Section 304(a) of the CWA establishes ambient water quality criteria (AWQC) for the protection of aquatic organisms and human health (33 U.S.C. § 1314[a]; National Toxics Rule [40 CFR 131.36{b}{1})] as applied to Washington [40 CFR 131.36{d}{14}]). AWQC developed under the CWA are guidelines that identify protective concentrations of various chemical constituents in surface waters. Surface water criteria will be at least as stringent as all of the following: (1) all water quality standards in WAC 173-201A; (2) AWQC, unless it can be demonstrated that such criteria are not relevant and appropriate for the LDW or for a specific hazardous substance; and (3) the National Toxics Rule (see WAC 173-340-730[3][b], consistent with Sections 121[d][2][A][ii] and [B][i] of CERCLA and 40 CFR 300.430[e]).

Monitoring for relevant AWQC will occur during construction and will be addressed as part of the Section 401 water quality memo, as described in Section 4.0.

Best management practices (BMPs) are described in the WQMP (Appendix F) and the CQAPP (Appendix C). These BMPs primarily focus on reducing turbidity, which is the parameter that has the highest potential for exceeding the water quality criteria due to implementation of the pilot study.

7.1.4.2 Discharge of Dredged/Fill Material into Navigable Waters of the United States – Clean Water Act, Sections 401 and 404

Sections 401 and 404 of the CWA establish requirements for water quality certification and for dredging and placing fill materials in the waters of the United States, respectively (33 U.S.C. §§ 1341 and 1344; 40 CFR 121.2, 230, and 232; 33 CFR 320, 323, and 328–330). Sections 401 and 404 apply to the in-water actions of the pilot study. Because the proposed action will involve the placement of fill on site, the requirements of these laws and implementing regulations apply.

Compliance with Section 401 will be addressed as part of the water quality memo, as described in Section 4.0. The EPA will issue the equivalent of state certification assuring that the water quality standards will not be violated by remedial action discharges along with necessary conditions including any mixing zone parameters consistent with WAC 173-201A-400.

Section 404(b)(1) of the CWA instructs the EPA to promulgate guidelines for evaluating proposed projects involving such discharges, which are called the Section 404(b)(1) Guidelines (40 CFR 230). Under these guidelines, discharges of dredged or fill material may be permitted if there is no practicable alternative to the proposed discharge that would have a less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. The term “practicable” is defined in CWA regulations as “available and capable of being done after taking into consideration cost, existing technology, and logistics, in light of overall project purposes.” The Section 404(b)(1) Guidelines require demonstration that the placement of fill material (ENR and ENR+AC) will not do any of the following:

- Cause or contribute to violations of any applicable state water quality standard

- Violate any applicable toxic effluent standard or prohibition under Section 307 of the CWA
- Jeopardize the continued existence of any endangered or threatened species or contribute to the destruction or modification of any critical habitat for such species
- Contribute to significant degradation of the waters of the United States

The placement of fill material will avoid, to the fullest extent practicable, adverse effects on human health, aquatic ecosystems, and recreational, aesthetic, and economic values. The Section 404(b)(1) Guidelines also maintain that degradation or destruction of special aquatic sites represents an irreversible loss of valuable aquatic resources that should be avoided.

The EPA Region 10's Decision Framework for Determining Clean Water Act Section 404 Compliance at Superfund Sites (EPA 2000) requires that information be provided to address several findings. The findings and information related to them are presented below which demonstrate compliance with the substantive provisions of Sections 401 and 404 of the Clean Water Act.

1. **There are no other practicable alternatives that will result in less impact to the aquatic environment.**

   The pilot study is being conducted in areas contaminated with PCBs and other hazardous substances at concentrations determined in EPA's 2014 ROD to be harmful to human health and the environment. Under EPA's ROD, active remediation (ENR, capping, dredging, or partial dredging and capping) is required to remediate sediment contamination in these areas. Other remedial options (capping, dredging, or partial dredging and capping) would have more impact to the aquatic environment than the ENR and ENR+AC pilot. The construction of the study has been designed to minimize, to the extent practicable, the impacts on the aquatic environment. The proposed placement method of releasing the ENR and ENR+AC material within a few feet of the bottom will reduce impacts to adjacent aquatic habitats due to migration of material outside of the pilot study plots and will also reduce suspension of ENR and AC material into the water column as compared to alternate placement methods. Alternative placement methods would likely increase the footprint of the ENR and ENR+AC pilot plots due to migration of the placed material outside of the proposed boundaries of the study plots and increase the amount of material suspended in the water column.

2. **The discharge will not cause or contribute to violations of water quality standards or toxic effluent standards, jeopardize an endangered or threatened species, or destroy or adversely modify critical habitat, or impair a protected marine sanctuary.**

   As described above, the proposed construction methods are designed to minimize the potential for exceedances of ambient water quality as compared to alternate construction methods. Water quality monitoring will be conducted under an EPA approved Water Quality Monitoring Plan (Appendix F) to ensure compliance with relevant water quality standards during construction. The Water Quality Monitoring Plan has been developed in consultation with EPA and is designed to be consistent with the 401 memo to be issued by EPA. There are no toxic effluents associated with the construction or long-term monitoring of the project. All in-water construction work for ENR and ENR+AC placement is planned to be conducted during the authorized 2016–2017 in-water work window for the LDW, when salmonid species listed under the Endangered Species Act are least likely to be present. Based on concurrence by NOAA Fisheries and US Fish and Wildlife Service with the Biological Evaluation that was submitted to the services by EPA, the proposed action will not destroy or adversely modify critical habitat.

3. **The discharge will not result in significant degradation to waters of the United States.**

   As described above, the proposed construction methods are designed to minimize the potential for exceedances of ambient water quality as compared to alternate construction methods. Water quality monitoring will be conducted under an EPA approved Water Quality Monitoring Plan to ensure compliance with relevant water quality standards during construction as outlined in Appendix F.

   The ENR material sand and gravelly sand, will be “clean” quarry materials and the AC will be virgin; however, chemical analysis of the all quarry import and AC material will be conducted prior to placement to ensure that the initial physical and chemical composition and quality of the samples are known prior to placement. Once construction is complete, there will be no significant degradation of waters as a result of the project.

4. **Potential adverse impacts to the aquatic ecosystem are minimized to the extent practicable and appropriate.**

   As stated above, the construction methods are designed to minimize the impacts to the aquatic environment during placement. In addition, the grain-size and amount of AC that will be placed is not expected to have a long-term impact on benthic biota as described in the Biological Evaluation (Appendix B). The only unavoidable impact is that placement of ENR and ENR+AC materials will temporarily reduce the populations of the benthic and epibenthic invertebrate community by the burial and smothering of the benthic substrate in the pilot plot areas. It is expected that ENR and ENR+AC materials placed in the pilot plots will be rapidly recolonized by benthic fauna from adjacent areas.

7.1.5 Rivers and Harbors Appropriations Act, Section 10

Section 10 of the Rivers and Harbors Appropriations Act prohibits the unauthorized obstruction or alteration of any navigable waters of the United States (33 U.S.C. § 403), which includes all three of the project plots. Section 10 requires prior authorization from the U.S. Army Corps of Engineers (Corps) for structures and work in or affecting navigable waters of the U.S. Navigable waters of the U.S. are those waters that are subject to the ebb and flow of the tide or are presently used, or have been used in the past, or may be susceptible for use to transport interstate or foreign commerce. Procedures set forth by the Corps require an examination of the impact of the action (33 CFR 320 and 322), in this case the placement of ENR and ENR+AC.

Partial obstruction of portions of the navigational channel in the LDW may occur during placement of the ENR and ENR+AC due to the presence of boats and barges required for implementation; however, it is expected that there will be sufficient space within the federal navigation channel of the LDW to allow commercial and recreational vessels to maneuver around vessels during active placement of the ENR and ENR+AC. Operations will be coordinated and scheduled to reduce interference with commercial vessel traffic using the waterway.

Of the three proposed plots, only the subtidal plot will be located within the federal navigation channel of the LDW. Once in place, the subtidal plot will be approximately rectangular, 100 feet wide, 400 feet long, and an average of 9 inches (0.75 foot) thick. The surface of the pilot study will be similar to existing sediment in its material size gradation and hydraulic resistance to flow. The elevation of the ENR and ENR+AC will be at or below the authorized depth of the LDW federal navigation channel, such that the ENR and ENR+AC will not interfere with or hinder commercial and recreational traffic within the LDW. A memorandum has been prepared for the US Army Corps of Engineers that evaluates substantive compliance per requirements of 33 USC § 408 (Section 408) for the construction of an Enhanced Natural Recovery/Activated Carbon pilot study plot.

The intertidal plot will be located along the east bank of the LDW south of the Boeing Plant 2 facility. An evaluation was performed by Windward (2003) of available bathymetric surveys conducted by the Corps and other parties in the LDW. This review suggested that intertidal benches along the LDW appeared to be relatively stable over time with changes in bed elevations of less than 2 feet. The thickness of the ENR and ENR+AC at the intertidal plot will be between about 0.5 foot and 1.0 foot, with an average thickness of about 0.75 foot, a thickness that is within the normal range of elevation changes as reported by Windward (2003). Therefore, placement of ENR and ENR+AC at the intertidal plot is not expected to interfere with or hinder commercial or recreational vessel traffic within the LDW.

The scour plot will be located on the east shoreline of the LDW near the south end of Harbor Island and outside of the federal navigation channel. As with the other two pilot plot areas, the thickness of the ENR and ENR+AC at the scour plot will be between about 0.5 foot and 1.0 foot, with an average thickness of about 0.75 foot. The elevation of the scour plot is expected to be within the normal range of variability of sediment aggradation and scour at this location. In addition, changes in elevation from placement are not anticipated to interfere with operational use of this area. Therefore, placement of ENR and ENR+AC at the scour plot is not expected to interfere with or hinder commercial or recreational vessel traffic within the LDW.

7.1.6 Endangered Species Act

The Endangered Species Act (ESA) of 1973 is designed to protect critically imperiled species from extinction and the ecosystems upon which they depend (16 U.S.C. §§1531 and 1544; 50 CFR 17, 222–224, 226.212, and 402). The ESA forbids federal agencies from authorizing, funding, or conducting actions that may jeopardize endangered species or their critical habitats. Federal agencies must confer with the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries) and the U.S. Fish and Wildlife Service (collectively referred to as the Services) regarding any action that may impact listed species or their critical habitats.

Potential adverse effects of the proposed project on threatened and endangered species occupying the LDW, as well as conservation measures intended to prevent the adverse effects, were assessed in the BE that was performed for the ESA Section 7 consultation (Section 8.0 and Appendix B). No threatened or endangered resident species are expected to occupy the LDW in the project area; however, anadromous salmonids use the LDW as a migratory corridor and for foraging.

The project team, on behalf of the EPA, prepared a Biological Evaluation (BE) for the Services assessing the potential effects of the pilot study on listed species and their critical habitats. The BE concluded that the pilot study would not likely adversely affect federally listed ESA species or designated critical habitat. The EPA requested concurrence with the determination of the BE from the Services, who then conducted an Informal Section 7 Consultation and concurred with EPA that the pilot study is not likely to adversely affect federally listed ESA species or designated critical habitat (NMFS, 2015 and USFWS, 2015).

7.1.7 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act is not identified as an ARAR in the ROD but is included in this report because it is a requirement of the ESA consultation process. The Magnuson-Stevens Act and its implementing regulations require consideration of the effects of federal actions on essential fish habitat (EFH) for covered species, including salmon (16 U.S.C. § 1801 et seq.; 50 CFR 600). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include "aquatic areas and their associated physical, chemical, and biological properties that are used by fish." They may include aquatic areas historically used by fish. "Substrate" includes "sediment, hard bottom, structures underlying the waters, and associated biological communities." The Magnuson-Stevens Act requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect EFH. Projects that must also undergo Section 7 consultation under the ESA (see Section 7.1.6) can incorporate an EFH assessment as an attachment to the BE that is submitted for Section 7 consultation. Salmonid species covered under the Magnuson-Stevens Act occur in the LDW where the pilot study will be conducted; therefore, the act applies. The BE prepared for the pilot study includes an assessment of EFH.

7.1.8 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) governs the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests (16 U.S.C. §§ 703–712; 50 CFR 10 and 21). Section 703 of the Act makes it a crime to 'take' protected birds, a very large group of species, which are identified at 50 CFR Section 10.13, without regard to the species' rarity or viability (in contrast to bird species protected under the federal Endangered Species Act and equivalent state statutes as endangered or threatened). While the Act does not define "take," the rules implementing the Act define the term as conduct in which a person "pursues, hunts, shoots, wounds, kills, traps, captures or collects "(See 50 CFR Section 10.12). The proposed action is not expected to produce conditions in the LDW that would result in a take as defined under the MBTA. The proposed action will be consistent with other permitted activities occurring in the LDW (e.g., commercial shipping, dredging, industrial activities). A biological evaluation has been prepared for the project to address potential project impacts on ESA-listed species using the LDW. Based on information presented in the biological evaluation, project activities are anticipated to be consistent with the MBTA.

7.1.9 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA) of 1940 protects the bald eagle and the golden eagle by prohibiting, except under certain specified conditions, the taking, possession, and commerce of such birds (16 U.S.C. § 668; 50 CFR 22). "Take" under the BGEPA includes both direct taking of individuals and take due to disturbance where "disturb" is defined as: "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." (50 CFR 22.3). "In addition to immediate impacts, this definition also covers impacts that result from human-caused alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagles return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering." (USFWS, 2007).The 1972 amendments increased penalties for violating provisions of the act or regulations issued pursuant thereto and strengthened other enforcement measures. Rewards are provided for information leading to the arrest and conviction of individuals for violation of the act. There is no known golden eagle habitat within central Puget Sound (Watson and Davies 2009).

A search of the Washington Department of Fish and Wildlife's Priority Habitat and Species (PHS) web site (http://wdfw.wa.gov/mapping/phs/) was conducted to identify bald eagle habitats (e.g., nests, roosts, and forage) near the project site. A bald eagle nest was identified within 0.5 miles west of the Scour Plot site near Harbor Island on the bluff overlooking the west shoreline of the West Waterway.

The U.S. Fish and Wildlife Service (USFWS) in its 2007 National Bald Eagle Management Guidelines recommends distance buffers from bald eagle nest trees for different activities. As an example, for construction of multistory buildings, a buffer of 660 feet is recommended, whereas, for on-water activities such as the operation of motorized watercraft, a buffer zone of 330 feet is recommended. Because the nearest nest tree is located over 2,640 feet from the project site, the proposed action is considered to be compliant with the BGEPA.

7.1.10 Floodplain Management Procedures

The Floodplain Management Procedures (40 CFR 6, Appendix A, Section 6) and Executive Order 11988, entitled "Floodplain Management" and dated May 24, 1977, require federal agencies to evaluate the potential effects of actions that may take place in a floodplain to avoid adversely affecting floodplains wherever possible, to ensure that their planning programs and budget requests reflect consideration of flood hazards and floodplain management, including the restoration and preservation of such land areas as natural undeveloped floodplains, and to prescribe procedures to implement the policies and procedures of the executive order. Guidance for implementation of the executive order has been provided by the U.S. Water Resources Council (1978).

There are no anticipated impacts to floodplains due to construction of the pilot study. The elevation of the subtidal plot will be at or below the authorized navigation channel depth. Any changes in water surface elevation due to construction, will be within the range of the water surface elevations that would be expected from natural deposition of sediments within the navigation channel. The elevation of the scour and intertidal plots, as described in Section 7.1.5, will be within the range of elevations that are expected to occur through natural riverine processes.

7.1.11 Clean Air Act

The Clean Air Act was established in 1970, with major revisions in 1977 and 1990 (42 U.S.C. §§ 7401–7671q; 40 CFR 50). The Clean Air Act requires the EPA to establish national ambient air quality standards for certain common and widespread pollutants based on the latest science. The EPA has set air quality standards for six common "criteria pollutants": particulate matter (also known as particle pollution), ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead.

States are required to adopt enforceable plans to achieve and maintain air quality meeting the air quality standards. State plans also must control emissions that drift across state lines and degrade air quality in downwind states.

Reasonable precautions must be taken to (1) prevent the release of air contaminants; (2) prevent fugitive dust from becoming airborne, and (3) maintain and operate the source to minimize emissions (RCW 70.94; WAC 173-400-040). The ENR material will be obtained from an upland source and washed to remove fine soil particles before delivery to the site. The washing will remove most of the small particles that would have the greatest potential to cause fugitive dust; therefore, the pilot study is expected to comply with the Clean Air Act. The pilot study design calls for the blended ENR+AC material to be presoaked before placement, which will reduce the amount of any dust generated from the AC amendment.

7.1.12 Native American Graves Protection and Repatriation Act and American Indian Religious Freedom Act

The Native American Graves Protection and Repatriation Act (NAGPRA) and implementing regulations are intended to protect Native American graves from desecration by the removal and trafficking of human remains and "cultural items," including funerary and sacred objects (25 U.S.C. § 3001 et seq., 43 CFR 10; 42 U.S.C. § 1196 et seq.). To protect Native American burials and cultural items, the regulations require that if such items are inadvertently discovered during excavation, the excavation must cease, and the affiliated tribes must be notified and consulted.

The American Indian Religious Freedom Act (AIRFA) is a federal law and a joint resolution of Congress that was passed in 1978. It was created to protect and preserve the traditional religious rights and cultural practices of American Indians, Eskimos, Aleuts, and Native Hawaiians. These rights include, but are not limited to, access of sacred sites; repatriation of sacred objects held in museums; freedom to worship through ceremonial and traditional rites, including within prisons; and use and possession of objects considered sacred. AIRFA required policies of all governmental agencies to eliminate interference with the free exercise of Native religion, based on the First Amendment, and to accommodate access to and use of religious sites to the extent that the use is practicable and is not inconsistent with an agency's essential functions.

Executive Order 13007 requires federal agencies to avoid physical damage to tribal sacred sites, and interference with the access of tribes thereto. Compliance with Executive Order 13007 will be maintained throughout project implementation. No excavation or dredging will occur as a result of the pilot study; therefore, it is expected to be substantively compliant with both NAGPRA and AIRFA.

7.1.13 National Historic Preservation Act, Section 106

If Native American or other cultural materials are unearthed during project activities, the National Historic Preservation Act (NHPA) and implementing regulations will apply (16 U.S.C. § 470f; 36 CFR 60, 63, and 800). They require that federal agencies consider the possible effects of projects on historic sites. If an agency finds a potential adverse effect on historic sites or structures, the agency must evaluate alternatives to "avoid, minimize, or mitigate" the impact, in consultation with the State Historic Preservation Officer. Sediment-disturbing activities must cease should such materials be observed, and the appropriate agencies must be notified.

King County conducted a King County Historic Preservation Program Cultural Resources Review (08/27/15). The results of the review indicated that the project area has a low probability of containing intact archaeological sites because it is in an artificial river channel that has previously been dredged and because project-related ground disturbance will be relatively shallow. Although there is a low probability of disturbing any archaeological material, an Inadvertent Discovery Plan (IDP) has been prepared that details the actions that the contractor or monitoring personnel will take if potential archaeological resources are discovered.

Because sediment disturbance during the pilot study will be minimal (e.g., anchor/spud deployment), the plots do not contain any known historic sites or structures, and potential discoveries will be addressed through the IDP, the pilot study is expected to be substantively compliant with the NHPA and will be addressed by the IDP that has been developed for the pilot study.

7.2 State Laws and Regulations

This section presents the state ARARs that apply to the pilot study.

7.2.1 Model Toxics Control Act Regulations and Sediment Management Standards

Washington's hazardous waste cleanup law, the Model Toxics Control Act (MTCA) mandates that site cleanups protect the state's citizens and environment (RCW 70.105D; WAC 173-340-440). To implement this statutory mandate, Ecology has established cleanup standards and requirements for the cleanup of hazardous waste sites (cleanup actions). The pilot study must comply with the MTCA regulations and, as such, MTCA is an ARAR for the pilot study.

The Sediment Management Standards (SMS) criteria are used to "reduce and ultimately eliminate adverse effects on biological resources and significant health threats to humans from surface sediment contamination" (RCW 70.105D; WAC 173-204). The pilot study has been designed to reduce exposures of aquatic organisms from contaminants in sediments. The ENR material will not exceed the lowest cleanup levels for metals and PCBs shown in the Lower Duwamish Waterway Record of Decision (U.S. EPA 2014) Tables 19 and 20.

The pilot study design requires the use of imported "clean" material, which will be tested before placement in the plots. The ENR material will be required to have nondetectable concentrations of PCBs at or below 2 µg/kg dry-weight (the lowest LDW cleanup goal for PCBs) as measured by congeners). All ENR materials will be sampled and submitted for chemical analyses before it is authorized for use.

7.2.2 Water Pollution Control Act, Water Quality Standards, and Aquatic Life Criteria

The Washington State Water Pollution Control Act authorizes the state to maintain the highest possible standards to ensure the purity of all waters of the state consistent with public health and public enjoyment; the propagation and protection of wildlife, birds, game, fish, and other aquatic life; and the industrial development of the state (RCW 90.48). The state requires the use of all known available and reasonable methods by industries and others to prevent and control pollution of the waters of Washington.

Washington's water quality standards (WAC 173-201A) and numerical aquatic life criteria (WAC 173-201A-240) for surface waters establish water quality standards that are consistent with public health and public enjoyment of the waters and the propagation and protection of fish, shellfish, and wildlife, pursuant to the provisions of Chapter 90.48 RCW. The pilot study has the potential to intermittently alter water quality in the LDW on a short-term basis during construction and, therefore, must demonstrate compliance with the state water quality standards. Under CERCLA, the EPA will issue a Section 401 water quality memo. A WQMP has been prepared for the pilot study and will be implemented during in-water construction activities to ensure that project-related activities are conducted in such a way as to be consistent with the state's water quality standards.

The surface water criteria will be at least as stringent as all of the following: (1) all of the water quality standards in WAC 173-201A; (2) the ambient water quality criteria, unless it can be demonstrated that such criteria are not relevant and appropriate for the LDW or for a specific hazardous substance; and (3) the National Toxics Rule.

BMPs are described in the WQMP (Appendix F) and the CQAPP (Appendix C). These BMPs primarily focus on reducing turbidity, which is the parameter that has the highest potential for exceeding the water quality criteria.

7.2.3 Solid Waste Management Act

The Solid Waste Management Act regulations govern the disposal of nonhazardous waste generated during removal activities. The Solid Waste Management Act sets minimum functional performance standards for the proper handling and disposal of solid waste, identifies functions necessary to ensure effective solid waste handling at both the state and local level, and establishes priorities for the management of solid waste (RCW 70.95; WAC 173-350).

The pilot study will not be a removal action; however, small quantities of solid waste (i.e., residual sediments collected as part of sediment sampling) may be generated during post placement monitoring. Residual sediments collected as part of post placement monitoring are expected to be nonhazardous wastes and will be disposed in a manner consistent with the Solid Waste Management Act. Therefore, the pilot study is expected to be substantively compliant with the Solid Waste Management Act.

7.2.4 Dangerous Waste Management

The Dangerous Waste Management regulations establish a comprehensive statewide framework for the planning, regulation, control, and management of hazardous waste that will prevent land, air, and water pollution and conserve the natural, economic, and energy resources of the state (RCW 70.105; WAC 173-303). State dangerous waste is defined more broadly than federal hazardous waste.

Dredging or generation of solid waste, with the exception of small volumes of sediment generated during post placement monitoring, will not be components of the pilot study. Based on the LDW RI and the sampling results from the candidate plots for the pilot study, hazardous/dangerous waste is not expected in LDW sediments. If it is encountered, the pilot study will comply with the state generator rules for accumulating or managing such waste on site for up to 90 days (40 CFR 262; WAC 173-303-17-202). Unanticipated circumstances could necessitate compliance with other hazardous/dangerous waste requirements.

7.2.5 Construction Projects in State Waters and Hydraulics Project Approval Regulations

Regulations governing construction in state waters below the ordinary high water mark are established by RCW 77.55, Construction Projects in State Waters, and by the Hydraulic Code regulations (RCW 77.65; WAC 220-110). These regulations protect fish and shellfish during in-water construction. The requirements are being addressed by the conservation measures and BMPs that will be incorporated into the pilot study. The conservation measures and BMPs are described in the CQAPP (Appendix C), the WQMP (Appendix F), and the BE (Appendix B).

7.2.6 Dredged Materials Management Program

The Dredged Materials Management Program (DMMP) is an interagency program that oversees the disposal and beneficial use of sediments dredged from the waters of Washington (RCW 79.105.500; WAC 332-30-166). The program exists to facilitate navigation and maritime commerce, while guaranteeing the protection of Washington's aquatic environment.

Although listed as an ARAR in the ROD for the LDW Superfund site (U.S. EPA, 2014), dredging will not be a component of the pilot study; therefore, the DMMP will not apply for the pilot study. (Dredging is not an expected part of the pilot study except for potential material movement in the event of material over placement that interferes with navigation. In such case, recently placed material in excess of project activities would be relocated to the perimeter of the appropriate subplot.)

7.2.7 Bald Eagle Protection Rules

The purpose of the Bald Eagle Protection Rules is to protect the habitat and maintain the population of the bald eagle so that the species is not classified as threatened, endangered, or sensitive in Washington (RCW 77.12.655; WAC 232-12-292). This is accomplished by promoting cooperative efforts for managing eagle habitat needs by a process that is sensitive to the goals of the landowner.

Taking or harming eagles, their eggs, nests, or young is prohibited; the substantive requirements for the protection of bald eagle habitat including nesting, perching, and roosting sites will be met during implementation of the pilot study. The pilot study is not expected to have adverse impacts to bald eagles as described in Section 7.1.9.

7.2.8 Shoreline Management Act; City of Seattle Master Plan; City of Tukwila Master Plan

The Shoreline Management Act (SMA) manages appropriate uses and developments along shorelines of the state by means of state-monitored, locally administered permitting programs (RCW 90.58 and related rules). The act establishes preferences for water-dependent uses, protection of shoreline ecological resources, and public access within the shoreline jurisdiction, defined as aquatic areas and lands within 200 feet of the ordinary high water mark. Consistent with state Enrolled Senate Bill 1653, shoreline critical areas are regulated under the local Shoreline Master Program regulations (City of Seattle [SMC 23.60] and City of Tukwila [TMC 18.44]).

As stated in the beginning of this section, for CERCLA actions such as the pilot study, regulatory permits are not required for on-site actions, but on-site actions must be conducted in a manner that meets the substantive provisions of applicable regulatory requirements.

There are three basic policy areas to the SMA: shoreline use, environmental protection and public access. The SMA emphasizes accommodation of appropriate uses that require protection of shoreline environmental resources and protection of the public's right to access and use the shorelines. Under environmental protection, the SMA is intended to protect shoreline natural resources, including "...the land and its vegetation and wildlife, and the water of the state and their aquatic life..." against adverse effects (RCW 90.58.020). All allowed uses are required to mitigate adverse environmental impacts to the maximum extent feasible and preserve the natural character and aesthetics of the shoreline.

The pilot study will evaluate the effectiveness of ENR+AC compared to ENR alone as a remedial sediment cleanup action in three areas of the LDW in which sediments are contaminated with polychlorinated biphenyls (PCBs). The proposed action is expected to reduce exposure to PCBs in aquatic biota within the LDW over a total area of three acres. The intent and expected results of the pilot study will be consistent with the SMA, as well as the Shoreline Master Programs (SMP) of the cities of Seattle and Tukwila by:

- Protecting "…the water of the state and their aquatic life...";
- Protecting shoreline resources; and
- Not adversely affecting shoreline use or public access adjacent to the three plot areas.

7.2.9 Washington Clean Air Act

The Washington Clean Air Act (WCAA) was enacted to protect and enhance the air quality for current and future generations (RCW 70.94; WAC 173-400). The intent of the WCAA is to secure and maintain levels of air quality that protect human health and safety, including the most sensitive members of the population; to comply with the requirements of the federal Clean Air Act; to prevent injury to plants, animal life, and property; to foster the comfort and convenience of Washington's inhabitants; to promote the economic and social development of the state; and to facilitate the enjoyment of the natural attractions of the state.

Reasonable precautions must be taken to (1) prevent the release of air contaminants, (2) prevent fugitive dust from becoming airborne, and (3) maintain and operate the source to minimize emissions. The BMPs implemented as part of the pilot study, are expected to result in compliance with the WCAA.

7.2.10 Noise Control Act and City of Seattle and City of Tukwila Noise Ordinances

The Noise Control Act of 1974 controls noise levels that adversely affect the health, safety, and welfare of the people, the value of property, and the quality of the environment (RCW 70.107; WAC 173-60-040-050). Under this act, anti-noise measures have expanded efforts statewide to abate and control noise, considering the social and economic impact on the community and the state.

Maximum noise levels at specified times for specified durations have been established (WAC 173-60-040) and are subject to exemptions specified in WAC 173-60-050, including Section 050(3)(a) (sounds originating from temporary construction sites as a result of construction activity) and Section (3)(f) (sounds created by emergency equipment and work necessary in the interests of law enforcement or for health, safety, or welfare of the community).

During the construction of the pilot plots, noise monitoring is not expected to be conducted. Given the location of the pilot study in the heavily industrialized LDW, the construction of the plots is not expected to generate noise levels that are out of compliance with the Noise Control Act, the City of Seattle Noise Ordinance (SMC 25.08), or the City of Tukwila Noise Ordinance (TMC 8.22). In addition, work will likely take place on weekdays during daylight hours, further reducing the need for noise monitoring.

7.3 OTHER CONSIDERATIONS

7.3.1 Environment Justice

Environmental justice is defined by the EPA as "…the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." Through stakeholder engagement process, the EPA and Ecology will facilitate the involvement of Georgetown and South Park, which are environmental justice communities potentially affected by the pilot study. By means of stakeholder engagement, these communities and the public will have a forum to participate in decisions about the construction and monitoring associated with the pilot study.

7.3.2 Tribal Treaty Rights

Tribal rights are being respected by means of EPA consultation, stakeholder engagement, and additional coordination that is typical of King County construction projects within tribal usual and accustomed harvest areas. The Muckleshoot Indian Tribe and the Suquamish Tribe are members of the stakeholder group and have been involved in meetings with the EPA, Ecology, and LDWG. The construction and long-term monitoring associated with the pilot study will be coordinated with the Muckleshoot Indian and Suquamish Tribes to reduce impacts on tribal fishers. The contractor will not be allowed to perform in-water work associated with the placement of ENR and ENR+AC materials while tribal fishers are conducting netfishing activities in the LDW that are granted by treaty and they will be notified in advance of any construction activities at each plot.

8.0 BIOLOGICAL EVALUATION

A BE has been conducted for the pilot study; it is included in this report as Appendix B. The BE assessed potential effects of the pilot study on existing environmental conditions in the LDW, listed species using the LDW, and the critical habitats of listed species in the LDW. The BE included an assessment of potential impacts of the pilot study on EFH, which is described in an attachment to the BE.

The pilot study is not expected to substantially alter existing environmental conditions within the LDW. Potential impacts on existing environmental conditions in the action area defined for the BE are the following:

- Placement of ENR and ENR+AC may result in temporary and localized increases in water column turbidity.
- Physical (grain size) and organic carbon sediment characteristics of sediments within the three plots, covering a total of approximately 3 acres, may be altered in the short term when compared to those of the surrounding sediments. In the long term, these characteristics of the sediment are expected to return to current conditions by means of natural riverine processes and deposition.
- ENR and ENR+AC will reduce exposure of aquatic organisms to 3 acres of PCB-contaminated sediments.

- The ENR and ENR+AC materials placed during the pilot study will be approximately 6 to 9 inches thick and are not expected to substantially alter the bathymetry in the pilot plots.
- Placement of ENR and ENR+AC will bury 3 acres of benthic habitat; however, two of the pilot plots are located subtidally in areas unlikely to provide preferred foraging habitat for juvenile salmonids. Therefore, the temporary reduction in foraging opportunities for juvenile salmonids is expected to be restricted to just 1 acre at the intertidal plot.
- The pilot study will have no effect on access and refugia; flow, current patterns, and saltwater-freshwater mixing; marine macroalgae and macrophytes; forage fish; or ambient noise.

The pilot study **may affect, but is not likely to adversely affect** Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and Puget Sound steelhead trout. The **continued existence of Dolly Varden will not be jeopardized** by the pilot study. The pilot study will have **no effect** on three species of listed rockfish.

The pilot study **may affect, but is not likely to adversely affect** some of the primary constituent elements (PCEs) of the critical habitats for Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and Puget Sound steelhead trout, while having **no effect** on the remaining PCEs for the critical habitats of those species.

9.0 REFERENCES

National Marine Fisheries Service (NMFS). 2015. Section 7 Informal Consultation Letter of Concurrence Lower Duwamish Enhanced Natural Recovery/Activated Carbon Pilot. Issued by NMFS West Coast Region, Seattle, Washington. July 9, 2015.

U.S. Environmental Protection Agency (U.S. EPA). 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4).

U.S. Environmental Protection Agency (U.S. EPA). 2014. Record of Decision – Lower Duwamish Waterway Superfund Site. U.S. EPA, Region 10, Seattle, Washington. Available at: http://www.epa.gov/region10/pdf/sites/ldw/ROD_final_11-21-2014.pdf (accessed March 5, 2015).

U.S. Fish and Wildlife Service (USFWS). 2007. National bald eagle management guidelines. U.S. Department of the Interior, U.S. Fish and Wildlife Service (http://www.fws.gov/ northeast/EcologicalServices/ pdf/NationalBaldEagleManagementGuidelines.pdf (accessed September 14, 2015).

U.S. Fish and Wildlife Service (USFWS). 2015. Section 7 Informal Consultation Letter of Concurrence Lower Duwamish Enhanced Natural Recovery/Activated Carbon Pilot. Issued by Washington Fish and Wildlife Office, Lacey, Washington. July 23, 2015.

Toft, J., A Ogston, J. Cordell, E. Armbrust, C. Levy, and E. Morgan. 2012. Olympic Sculpture Park: Year 5 Monitoring of Shoreline Enhancements. Prepared for Seattle Public Utilities, City of Seattle, Washington, by School of Aquatic and Fishery Sciences, and School of Oceanography, University of Washington, Seattle, Washington.

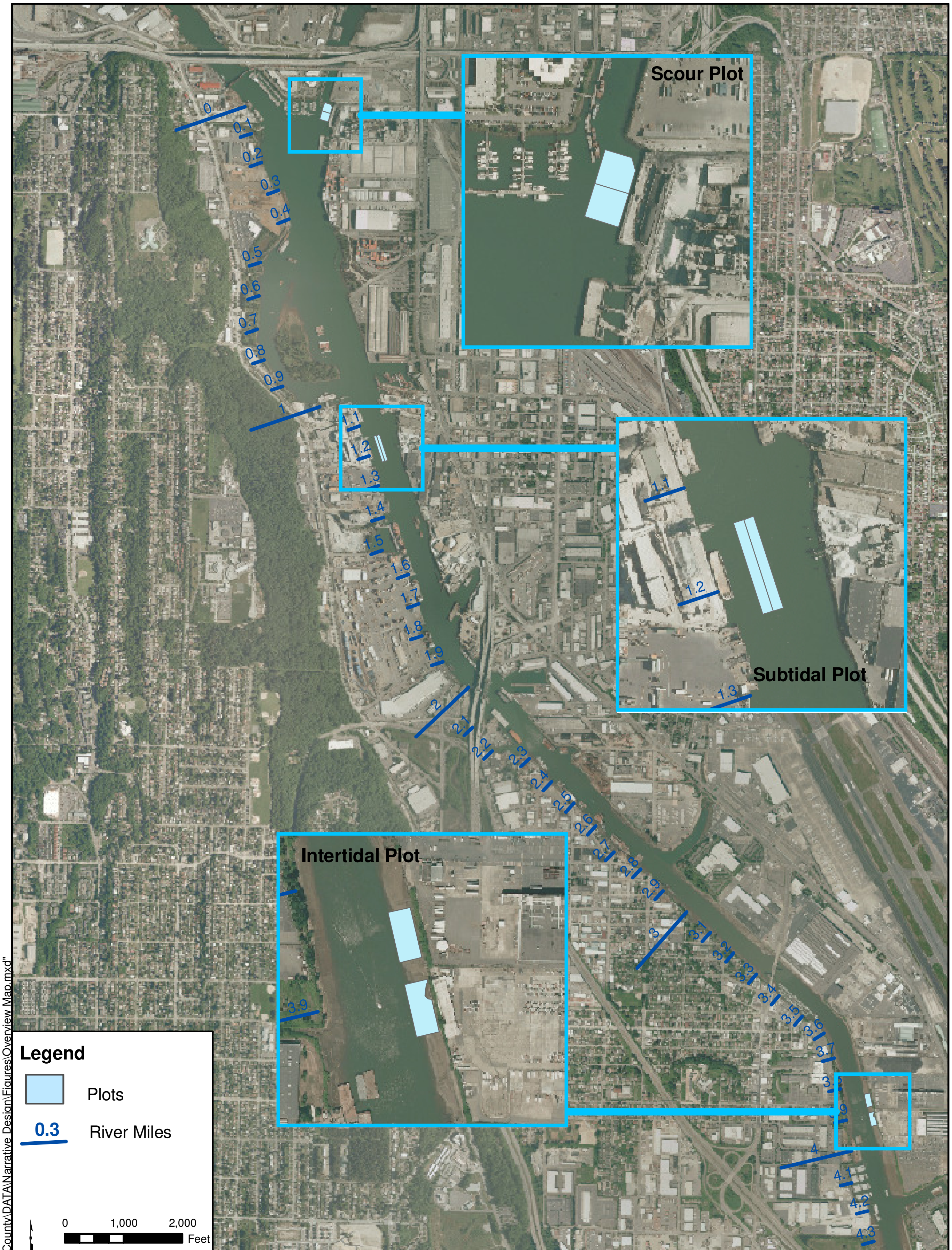
Windward (Windward Environmental, LLC). 2003. Lower Duwamish Waterway Group; phase I remedial investigation report, final. Prepared for the Lower Duwamish Waterway Group by Windward Environmental, LLC, Seattle, Washington.

U.S. Water Resources Council. 1978. Floodplain Management Guidelines for Implementing E.O. 11988. February 10.

Windward Environmental, LLC (Windward). 2010. Final Lower Duwamish Waterway Remedial Investigation Report. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington, and the Washington State Department of Ecology, Northwest Field Office, Bellevue, Washington.

Windward Environmental, LLC (Windward). 2015. Memorandum: Validated LDW Sediment Data for ENR-AC Pilot. Prepared for U.S. Environmental Protection Agency and Washington State Department of Ecology. Prepared by the Lower Duwamish Waterway Group.

FIGURES



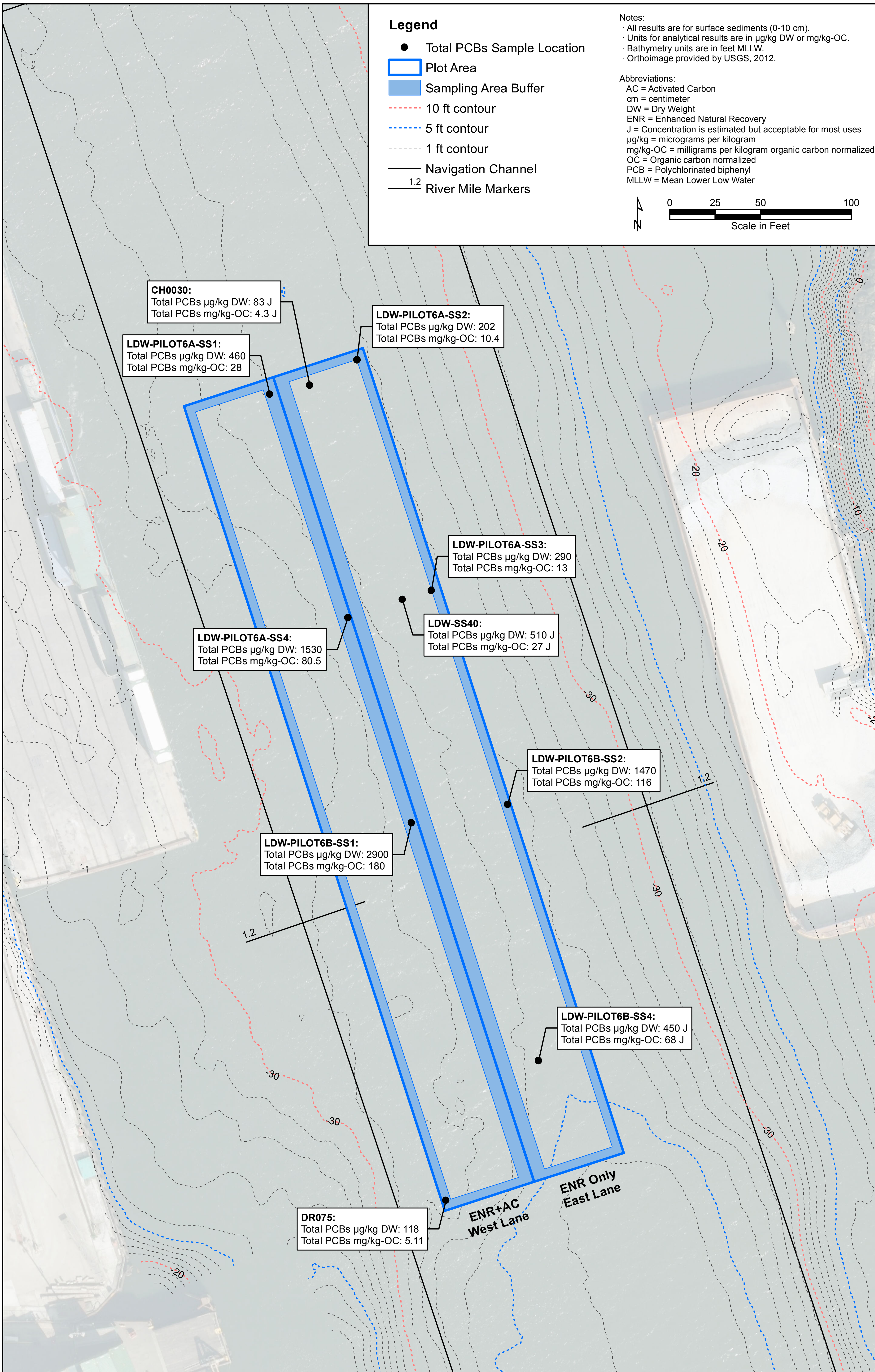
File path: "P:\King County\DATA\Narrative Design\Figures\Overview Map.mxd"

Lower Duwamish Waterway Group

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

ENR/AC Pilot Study
Narrative Design Report

Figure 1
Overview Map of Pilot Plot Areas

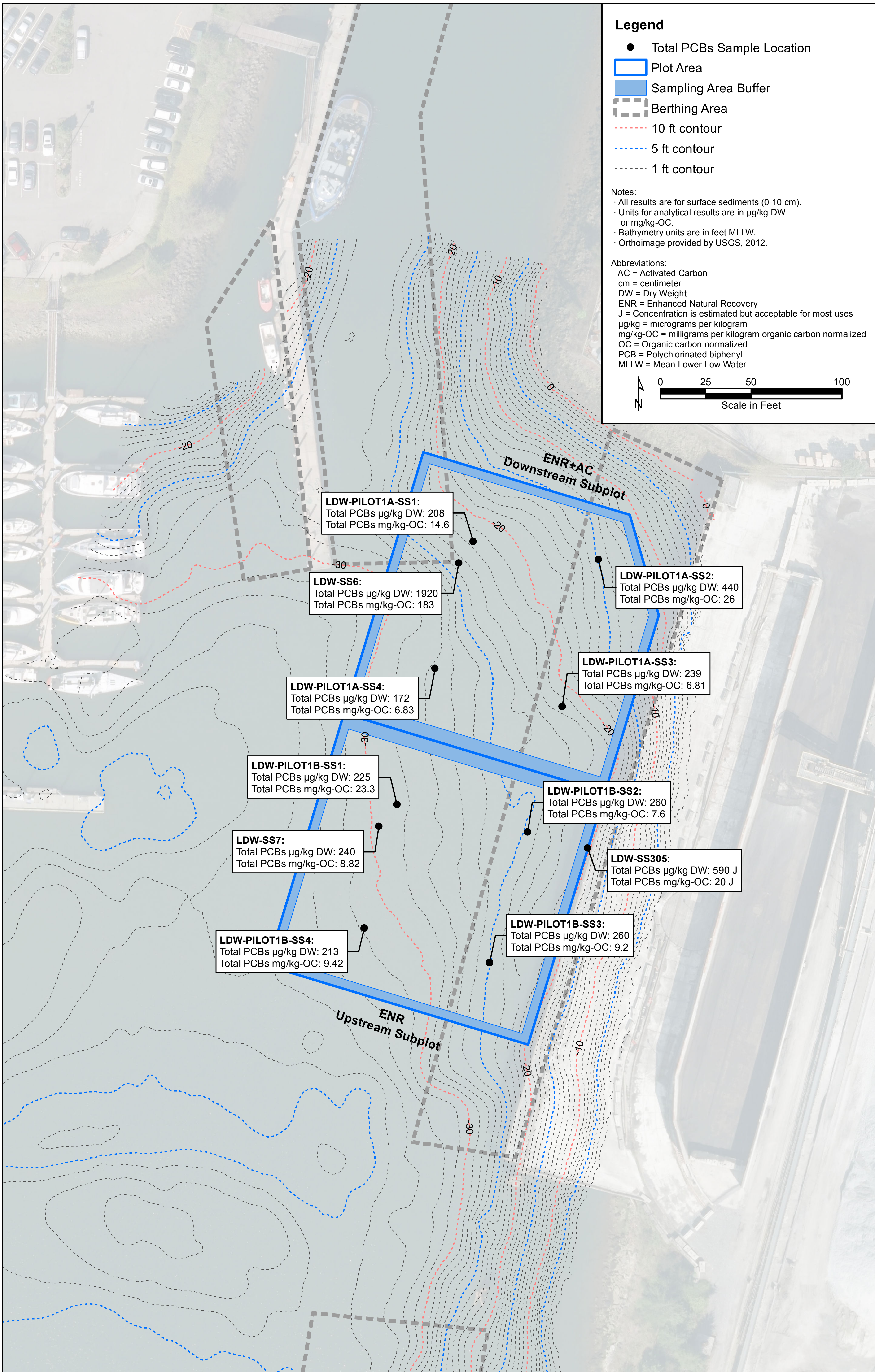


Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Narrative Design Report

Figure 2
Subtidal Plot

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 2 Subtidal Plot.mxd
10/19/2015

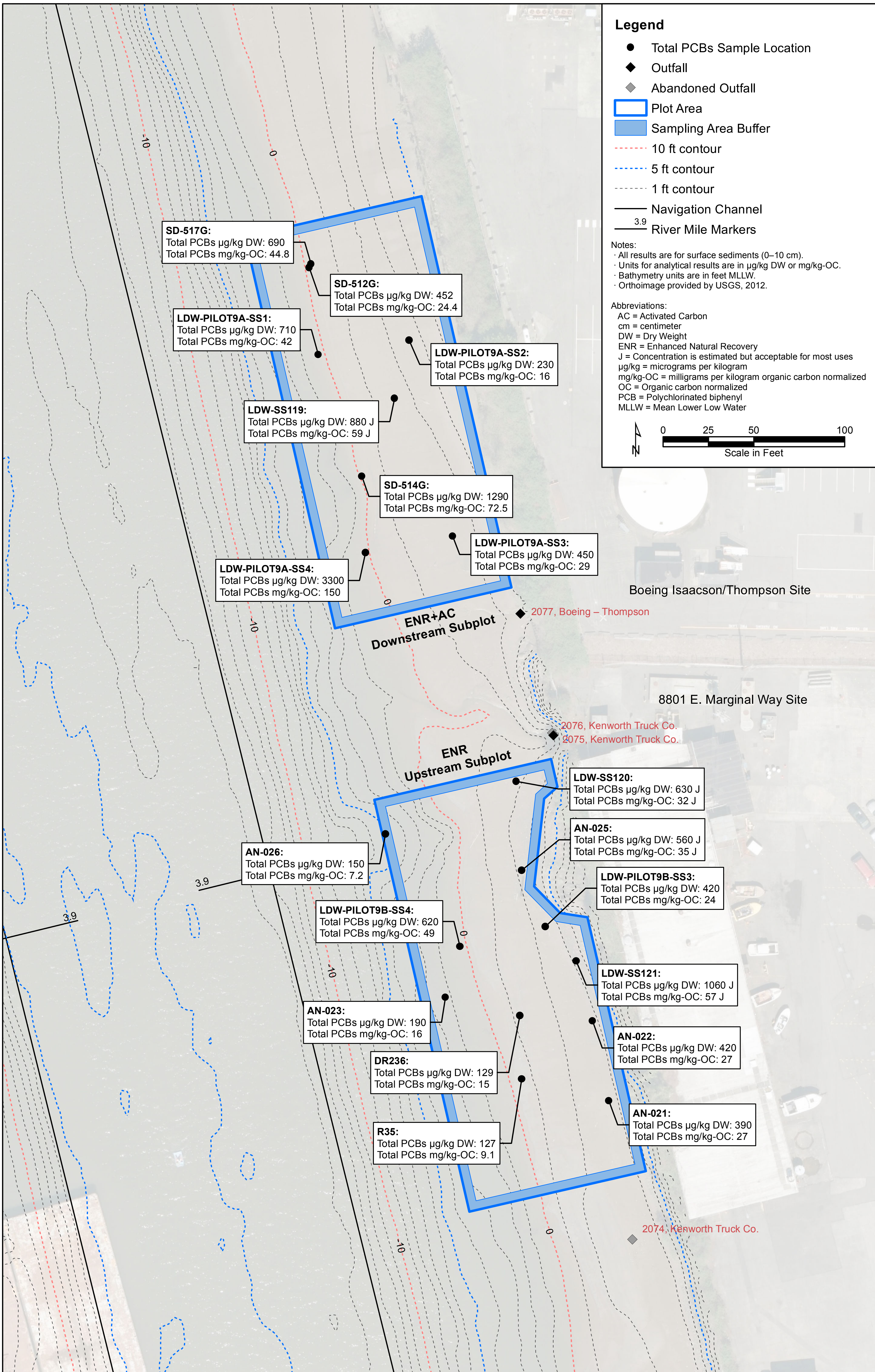


Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Narrative Design Report

Figure 3
Scour Plot

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 3 Scour Plot.mxd
10/19/2015



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

ENR/AC Pilot Study
Narrative Design Report

Figure 4
Intertidal Plot

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 4 Intertidal Plot.mxd
10/19/2015

APPENDIX A

Plot Selection Memorandum and U.S. Environmental Protection Agency Approval

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
ENVIRONMENTAL CLEANUP

February 11, 2015

Mike Johns
Windward Environmental
200 W Mercer St., Suite 401
Seattle, WA 98119

Re: Approval of plot locations for carbon amendment pilot study; Lower Duwamish Waterway Superfund Site; Seattle, Washington

Dear Mike:

EPA, the Washington State Department of Ecology (Ecology), and the US Army Corps of Engineers have reviewed the Lower Duwamish Waterway Group's (LDWG) February 3, 2015 memorandum proposing study plot locations for the Lower Duwamish Waterway (LDW) carbon amendment pilot study. This letter provides EPA and Ecology's approval of LDWG's proposed plot locations, including the revised plot configurations included in the memorandum.

Pursuant to the July 17, 2014 second amendment to the LDW Administrative Order on Consent (AOC), LDWG must submit to the agencies a draft design report 130 days after the date of this letter. In order to minimize the required revisions to the draft design report, we propose scheduling a series of meetings between now and June 2015 to discuss the details of the pilot study. We can discuss the frequency, content, and timing of those meetings at our upcoming February 26 meeting.

LDWG is not required to revise the February 3 memorandum, but this letter provides some feedback to consider in designing the study and interpreting study results.

Criteria used in the memorandum: We agree that it was appropriate to include information about cleanup criteria in the November 2014 Record of Decision (ROD) in the memorandum. However, it should have also included the criterion in the AOC, which is repeated in the ROD, that the study plots should have PCB concentrations between the SCO and the CSL. The ROD (page 128) states that "EPA may also consider ENR with in-situ treatment in areas with COC concentrations up to the CSL if it can be demonstrated that it will maintain its effectiveness over time." Average PCB concentrations in Plot 6 "Lane A" exceed this criterion, as do some of the individual data points in plots 6 and 9. We recognize that it is not always possible to find site locations that conform exactly to the desired study criteria, so we accept the proposed plots as containing concentrations reasonably close to the criteria in the AOC and ROD. In addition, we are concerned about how high subsurface contaminant concentrations in Area 9 may affect study results. This should be discussed during the design meetings discussed above.

Future cleanup decisions in areas selected for the AC pilot study: As we have discussed, selection of an area for the AC pilot study does not mean that ENR will ultimately be the technology assigned to the area, regardless of the pilot study results. For example, the technology assignments in the ROD for Areas 1 and 9 are a combination of dredging and capping. Although we are accepting these areas as acceptable for the pilot study, EPA may ultimately determine that dredging is required for these areas, including removal of the pilot study plots.

As a final point of clarification, LDWG's memorandum mentions that Ecology may request additional sampling at the "8801 site". Ecology is not aware of any plans to collect additional data at that location in the near future.

Feel free to contact me at (206) 553-2140 or hiltner.allison@epa.gov if you have any questions.

Sincerely,

Allison Hiltner

Allison Hiltner
Superfund Site Manager

cc: (electronic copies only):
Ron Timm, Ecology
Allison Crowley, City of Seattle
Dave Schuchardt, City of Seattle
Jeff Stern, King County
Debra Williston, King County
Brian Anderson, The Boeing Company
Kathy Bahnick, Port of Seattle
Cliff Whitmus, AMEC

PLOT SELECTION MEMORANDUM

Memorandum

To: Allison Hiltner, USEPA and Ron Timm, Ecology

From: Lower Duwamish Waterway Group

Date: February 3, 2015

Subject: **Final Plot Selections for Lower Duwamish Waterway Enhanced Natural Recovery-Activated Carbon Pilot Study**

This memorandum summarizes the rationale for the proposed Lower Duwamish Waterway (LDW) Pilot Study Plots discussed during our meeting with you on January 21, 2015. The initial screening for the proposed plots can also be found in the *"Candidate Plot Locations for Enhanced Natural Recovery-Activated Carbon Pilot Study (July 24, 2014)"* and in the *"Quality Assurance Project Plan: Enhanced Natural Recovery-Activated Carbon Candidate Plot Surface and Subsurface Sediment Sampling (October 24, 2014)."* The plot designations used in the Quality Assurance Project Plan (QAPP) have been retained for this memo. The table below cross-references plot numbers as they appeared in the July 2014 memo vs. the October 2014 QAPP.

Plot Number in 2014 QAPP and this Memo	Former Plot/Area Number in July 2014 Memo	Area Type
1	1	Scour Mitigation
2	2	Scour Mitigation
3	3	Intertidal
4	4	Subtidal
5	6	Scour Mitigation
6	8	Subtidal
7	10	Subtidal
8	12	Intertidal
9	13	Intertidal

There are three proposed plots, one for each of the following conditions:

- **Plot 1** - Subtidal sediments in a scour area
- **Plot 6** - Subtidal sediments
- **Plot 9 -** Intertidal sediments and subtidal sediments in a scour area.

Each plot consists of two side by side areas, one where an Enhanced Natural Recovery (ENR) layer will be placed and one where ENR with Activated Carbon (ENR-AC) layer will be placed. We have provided key tables and figures to aid in our explanation. Our analysis included data collected in Fall 2014 that is presented in the *"Validated LDW Sediment Data for ENR-AC Pilot (January 15, 2015)"*. Plot 9 also included new data from investigations at two adjacent uplands sites, as discussed below in the Plot 9 discussion.

Tables 1 and 2 contain analytical results for surface and subsurface sediment PCB analyses, respectively. For all plots, 2014 sediment data are presented; for the proposed plots, additional historical data are included. Table 3 contains tabulated summary statistics of PCB concentrations based on the 2014 surface sediment data; for Plot 9, historical data and sediment data from the adjacent sites were included to evaluate the proposed split option, which extends beyond the plots used for 2014 data characterization. Table 4 contains the remedial action levels (RALs) and ENR-upper limits (ULs) for the surface and subsurface sediments and Table 5 contains information on any surface and subsurface RAL and ENR-UL exceedances. For Plot 1, the Recovery Category 1 RALs have been used, but the Recovery Category 2/3 ENR-ULs have been used. For Plot 6, the Subtidal Recovery Category 2/3 RALs and ENR-ULs have been used. For Plot 9, the Intertidal Recovery Category 2/3 RALs and ENR-ULs have been used.

SCOUR PLOTS: Plot 1 proposed (Plots 1 and 2 considered)

Plots 1 and 2 are located near river mile 0.1. The chemistry in both Plots 1 and 2 are similar in PCB concentration ranges; the mudline elevations of the two plots are also similar. The primary differences are in the grainsize of the sediments and the facility operations in the berths. The grainsize of the sediments in Plot 1 were more uniform and contained little or no gravel, and resulted in better core recoveries than Plot 2 during sampling. This is expected to translate into more reliable deployment and recovery of the solid-phase micro-extraction (SPME) fibers. There is less potential of disruption of the ENR layer due to over-water activities at Plot 1 than Plot 2, including less potential for materials falling onto the layer during off-loading from upland operations. Finally, Plot 2 is expected to have more access restrictions due to the type and amount of operations at the pier. For these reasons, Plot 1 is recommended for the Pilot Study. Figure 1 shows the location of Plot 1, its subplots, PCB and other Sediment Management Standard (SMS) chemical exceedances in surface sediments, and bathymetry.

Ownership and access are still being assessed. Access is needed during the wintertime fish window for placement of materials. Direct access for sampling is needed to avoid diver-sampling in confined spaces (for example, under barges).

SUBTIDAL PLOTS: Plot 6 proposed (Plots 4, 6, and 7 considered)

PCB concentrations in Plot 7 are too low to meet study objectives; they are less than or equal to the RAL in all but one of the 2014 locations. The low concentrations make it more difficult to detect differences in PCB behavior between the subplots (the normal field and laboratory variability combined with concentrations near or below the reporting limits results in poor signal-to-noise ratios). Additionally, Plot 7 is near but not in an area of shoaling (This is easiest to see in Map 3-1d of the QAPP).

Plots 4 and 6 have similar PCB surface chemistry and PCB variability between subplots. The 2014 subsurface core in Plot 4A exceeds the subsurface RAL (290 > 195 mg/kg-OC), which is not exceeded in Plot 6. Plots 4 and 6 contain exceedances of the ENR-UL in some of the surface samples; however, the ability to distinguish differences between ENR and ENR-AC subplots is enhanced by the higher concentration levels. This ability can be further enhanced by lowering the variability between the subplots. The ability to distinguish the subplots is further improved by reconfiguring Plot 6 to be two long subplots; this change is recommended and decreases the variability by half. With this improvement, Plot 6 is recommended as the Subtidal Plot.

Figure 2 shows the location and revised layout of Plot 6, its subplots, PCB and other SMS chemical exceedances in surface sediments, and bathymetry.

INTERTIDAL PLOTS: Plot 9 Proposed (Plots 3, 8, and 9 considered)

The PCB concentrations in Plot 3 are too low (below or very near the RAL in all locations) resulting in decreased ability to discern differences between the subplots. Additionally, the location of Plot 3 behind Kellogg Island makes it representative of that area of the waterway, but less predictive of other intertidal areas (for example, groundwater discharge and exposure to wave/wake action behind Kellogg Island are expected to differ from conditions along the main waterway channel).

Similar to Plot 3, the PCBs concentrations in Plot 8 are too low (all but one location is below the RAL). The bathymetry difference at Plot 8 raises concerns. The intertidal bench, defined as that area between -4 MLLW and the toe of the bank, is more narrow at Plot 8 than Plot 9; this results in approximately 1/3 of the plot being representative of one set of conditions and the upper 2/3 another set of conditions (This is easiest to see in Map 3-1e of the QAPP and is summarized in the table below). The presence of multiple conditions within the test plot, decreases the ability to distinguish between the treatment options. In addition, the design of both placement of the ENR and monitoring are more complex. The following table outlines the differences in portions of Plot 8.

Example Characteristic	Nearshore 2/3 (elevation -5 ft MLLW or greater)	Nearchannel 1/3 (elevations lower than -5 ft MLLW
Groundwater discharge	Seeps and seep face likely	Little discharge expected
Porewater salinity	Brackish and variable	Saline
Potential scour process	Wave/wake	Wave/wake decreased in energy
Slope	Relatively flat, good place to check stability	Relatively steep, will likely require coarser material for stability.

	For comparability, the plots would need to be constructed of materials with similar grainsize throughout, resulting in the coarser materials used on the slopes being used throughout.
Benthic	Potential for different benthic communities due to depth, salinity, grain size and light; this will complicate benthic comparison between ENR and ENR-AC.
TOC normalization	Plot 8 has lower TOC than many of the other locations studied in the waterway; with some locations below the end point used for organic carbon normalization of the data. Having to compare OC-normalized to un-normalized dry weight data adds additional complexity to the study.

Plot 9 eliminates the concerns of variable conditions and low PCB concentrations that are present in Plots 3 and 8. Additionally, Plot 9 is also the most upstream location in the site, giving better overall spatial coverage in the design. Note that there are exceedances of the RAL and ENR-UL in Plot 9, but as discussed previously with the EPA this will allow for better evaluation of the effectiveness of ENR-AC.

Ecology has voiced concern over potential contamination associated with outfalls (#2075, 2076, and 2077) in the vicinity of Plot 9. A split has been placed between the subplots in order to avoid the outfall area; this is shown in Figure 3. In addition, discharges from the remaining two outfalls (#2075 and 2077) now undergo treatment, which could help reduce concerns about contamination from the outfall affecting study results. Outfall #2076 is inactive/abandoned. Sediments directly in front of the outfalls (sampling stations AN-027, AN-029, AN-045, and AN-046) have low concentrations of PCBs and other contaminants, except for two stations (AN-029 and AN-046) that contain a few high metals concentrations; only mercury is high at AN-049 and only lead and zinc are high at AN-046. Mr. Ron Timm, the Ecology Project Manager for the adjacent uplands sites, described a localized sediment area adjacent to the outfalls at the toe of a historical ramp containing surface concrete and metallic debris. It is within this debris area where the metal exceedances occurred; outside of this area all benthic sediment cleanup objective (SCO) RALs for metals are met.

Plot 9 has been reconfigured with a split between the subplots to avoid the area expected to be directly influenced by both the outfalls and the concrete/metal debris. The reconfigured version is shown in Figure 3. Figure 3 also contains contours of surface PCB concentrations. Contours and elevation of chemicals concentrations at Plot 9 utilized data from the LDW RI/FS data set, the Fall 2014 LDW sampling event, plus sediment data from the two adjacent uplands sites (the Boeing Isaacson/Thompson Site and the 8801 E. Marginal Way Site).

As with the other recommended plots, Figure 3 shows the location and revised layout of Plot 9, its subplots, PCB and other SMS chemical exceedances in surface sediments, and bathymetry.

The two adjacent uplands sites have both already conducted sediment sampling; however, we understand Ecology may request that the 8801 Site collect additional data. It is requested that any data needed for the 8801 site from within the area of the reconfigured Plot 9 subplots be collected before the ENR layer is placed in 2016.

Attachments

Table 1 – Surface Sediment PCB Results

Table 2 –Subsurface Sediment PCB Results

Table 3 –Surface Sediment PCB Data Summary for all Plots Considered

Table 4 – RALs and ENR-ULs Used for Table 5

Table 5 - Chemical Exceedances of RAL and ENR-UL in Surface and Subsurface Sediments for Proposed Plots

Figure 1 – Plot 1 Layout, Chemical Exceedances, and Bathymetry

Figure 2 – Plot 6 Revised Layout, Chemical Exceedances, and Bathymetry

Figure 3 – Plot 9 Revised Layout, Chemical Exceedances, and Bathymetry

Table 1
Surface Sediment PCB Results

Surface Sediment PCB Results from 2014 Pilot Study sampling; Proposed Plots also include historical surface data.

		PCBs											Conventionals	
	Analyte	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268	Total PCB Aroclors	Total PCB Aroclors	TOC	Total solids
	Unit	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	mg/kg OC	% dw	% ww
Sample ID	**Sample Date**													
Plot 1A (2014 Pilot Study and Historical Data)														
SD-DR001-0000	8/31/1998	20 U	40 U	20 U	20 U	20 U	46	53	--	--	99	3.3	3.0	--
LDW-SS6-010	3/10/2005	20 U	20 U	20 U	20 U	740	910	270	--	--	1920	183	1.1	62
LDW-PILOT1A-SS1	10/27/2014	9.4 U	9.4 U	9.4 U	9.4 U	65	78	65	9.4 U	9.4 U	208	15	1.4	59
LDW-PILOT1A-SS2	10/27/2014	9.8 U	9.8 U	9.8 U	9.8 U	160	160	120	9.8 U	9.8 U	440	26	1.7	50
LDW-PILOT1A-SS3	10/29/2014	9.2 U	9.2 U	9.2 U	9.2 U	64	98	77	9.2 U	9.2 U	239	6.8	3.5	46
LDW-PILOT1A-SS4	10/27/2014	9.4 U	9.4 U	9.4 U	9.4 U	48	70	54	9.4 U	9.4 U	172	6.8	2.5	48
Plot 1B (2014 Pilot Study and Historical Data)														
LDW-SS7-010	3/9/2005	19 U	19 U	19 U	19 U	62	92	86	--	--	240	8.8	2.7	47
LDW-SS305-010	10/3/2006	40 U	40 U	40 U	40 U	95 J	250 J	240 J	--	--	590 J	20 J	3.0	51
LDW-PILOT1B-SS1	10/27/2014	9.7 U	9.7 U	9.7 U	9.7 U	62	84	79	9.7 U	9.7 U	225	23	1.0	46
LDW-PILOT1B-SS2	10/29/2014	9.4 U	9.4 U	9.4 U	9.4 U	63	110	84	9.4 U	9.4 U	260	7.6	3.4	45
LDW-PILOT1B-SS3	10/29/2014	9.7 U	9.7 U	9.7 U	9.7 U	70	110	76	9.7 U	9.7 U	260	9.2	2.8	43
LDW-PILOT1B-SS4	10/27/2014	9.9 U	9.9 U	9.9 U	9.9 U	58	84	71	9.9 U	9.9 U	213	9.4	2.3	45
Plot 2A														
LDW-PILOT2A-SS1	10/27/2014	9.7 U	9.7 U	9.7 U	9.7 U	37	54	41	9.7 U	9.7 U	132	14	0.9	64
LDW-PILOT2A-SS2	10/28/2014	9.1 U	9.1 U	9.1 U	9.1 U	29	43	29	9.1 U	9.1 U	101	7.1	1.42 J	68
LDW-PILOT2A-SS3	10/28/2014	9.9 U	9.9 U	9.9 U	9.9 U	52	85	220	9.9 U	9.9 U	360	31	1.18 J	55
LDW-PILOT2A-SS4	10/27/2014	9.0 U	9.0 U	9.0 U	9.0 U	58	86	56	9.0 U	9.0 U	200	7.6	2.6	59
Plot 2B														
LDW-PILOT2B-SS1	10/27/2014	9.7 U	9.7 U	9.7 U	9.7 U	55	69	53	9.7 U	9.7 U	177	7.1	2.5	52
LDW-PILOT2B-SS2	10/28/2014	9.2 U	9.2 U	9.2 U	9.2 U	46	54	40	9.2 U	9.2 U	140	7.0	2.01 J	59
LDW-PILOT2B-SS3	10/28/2014	9.6 U	9.6 U	9.6 U	9.6 U	92	110	70	9.6 U	9.6 U	270	24	1.14 J	53
LDW-PILOT2B-SS4	10/28/2014	9.5 U	9.5 U	9.5 U	9.5 U	98	150	100	9.5 U	9.5 U	350	14	2.44 J	49
Plot 3A														
LDW-PILOT3A-SS1	10/27/2014	9.4 U	9.4 U	9.4 U	9.4 U	54	85	62	9.4 U	9.4 U	201	13	1.6	41
LDW-PILOT3A-SS2	10/27/2014	9.1 U	9.1 U	9.1 U	9.1 U	25	38	26	9.1 U	9.1 U	89	4.9	1.8	61
LDW-PILOT3A-SS3	10/27/2014	9.8 U	9.8 U	9.8 U	9.8 U	33	65	46	9.8 U	9.8 U	144	7.0	2.06 J	52
LDW-PILOT3A-SS4	10/27/2014	9.4 U	9.4 U	9.4 U	9.4 U	45	72	55	9.4 U	9.4 U	172	5.4	3.19 J	44
Plot 3B														
LDW-PILOT3B-SS1	10/27/2014	9.5 U	9.5 U	9.5 U	9.5 U	140 U	120	96	9.5 U	9.5 U	220	13	1.65 J	39
LDW-PILOT3B-SS2	10/27/2014	9.6 U	9.6 U	9.6 U	9.6 U	12 U	14	12	9.6 U	9.6 U	26	4.7	0.6	58
LDW-PILOT3B-SS3	10/27/2014	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	9.9 U	1.5 U	0.7	63
LDW-PILOT3B-SS4	10/27/2014	10 U	10 U	10 U	10 U	43	65	41	10 U	10 U	149	4.1	3.61 J	39
Plot 4A														
LDW-PILOT4A-SS1	10/27/2014	9.6 U	9.6 U	9.6 U	9.6 U	92	100	70	9.6 U	9.6 U	260	24	1.09 J	66
LDW-PILOT4A-SS2	10/27/2014	9.6 U	9.6 U	9.6 U	9.6 U	17	25	12	9.6 U	9.6 U	54	nc	0.261 J	76
LDW-PILOT4A-SS3	10/27/2014	9.9 U	9.9 U	9.9 U	9.9 U	110	140	80	9.9 U	9.9 U	330	26	1.28 J	63
LDW-PILOT4A-SS4	10/27/2014	8.9 U	8.9 U	8.9 U	8.9 U	57	90	50	8.9 U	8.9 U	197	11	1.81 J	63
Plot 4B														
LDW-PILOT4B-SS1	10/27/2014	9.1 U	9.1 U	9.1 U	9.1 U	430	330	180	9.1 U	9.1 U	940	45	2.08 J	61
LDW-PILOT4B-SS2	10/27/2014	10 U	10 U	10 U	10 U	74	100	37	10 U	10 U	210	17	1.26 J	62
LDW-PILOT4B-SS3	10/28/2014	9.6 U	9.6 U	9.6 U	9.6 U	20	21	10	9.6 U	9.6 U	51	6.0	0.846 J	58
LDW-PILOT4B-SS4	10/28/2014	9.8 U	9.8 U	9.8 U	9.8 U	720	660	260	9.8 U	9.8 U	1,640	109	1.51 J	63
Plot 6 - Lane A (2014 Pilot Studay and Historical Data)														
SD-DR089-0000	8/12/1998	20 UJ	40 U	20 U	33	20 U	142	96	--	--	271	14	1.9	--
LDW-SS40-010	1/18/2005	39 UJ	39 UJ	39 UJ	170 J	39 UJ	220	120	--	--	510 J	27 J	1.9	56
LDW-PILOT6A-SS1	10/28/2014	9.3 U	9.3 U	9.3 U	9.3 U	160	200	100	9.3 U	9.3 U	460	28	1.64 J	49
LDW-PILOT6A-SS4	10/28/2014	9.2 U	9.2 U	9.2 U	9.2 U	640	670	220	9.2 U	9.2 U	1,530	81	1.90 J	55
LDW-PILOT6B-SS1	10/29/2014	9.3 U	9.3 U	9.3 U	9.3 U	1,100	1,400	420	9.3 U	9.3 U	2,900	180	1.6	59
LDW-PILOT6B-SS4	10/29/2014	9.4 U	9.4 U	9.4 U	9.4 U	180	180 J	90	9.4 U	9.4 U	450 J	68 J	0.7	78
Plot 6 - Lane B (2014 Pilot Study and Historical Data)														
LDW-PILOT6A-SS2	10/28/2014	9.0 U	9.0 U	9.0 U	9.0 U	75	83	44	9.0 U	9.0 U	202	10	1.94 J	61
LDW-PILOT6A-SS3	10/28/2014	9.3 U	9.3 U	9.3 U	9.3 U	100	130	57	9.3 U	9.3 U	290	13	2.18 J	67
LDW-PILOT6B-SS2	10/29/2014	9.4 U	9.4 U	9.4 U	9.4 U	700	570	200	9.4 U	9.4 U	1,470	116	1.3	60
LDW-PILOT6B-SS3	10/29/2014	9.1 U	9.1 U	9.1 U	9.1 U	390	610	250	9.1 U	9.1 U	1,250	77	1.6	61

Prepared by Floyd|Snider

F:\projects\AMEC-KC-ENR\TASK 2 Meetings\2015-01-22 Work Shop 1\Package for EPA\
Tables 1 and 2_Tables from LDW ENR-AC Pilot Study Data Memo_020215.xlsx

Table 1
Surface Sediment PCB Results

Surface Sediment PCB Results from 2014 Pilot Study sampling; Proposed Plots also include historical surface data.

		PCBs											Conventionals	
	Analyte	Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268	Total PCB Aroclors	Total PCB Aroclors	TOC	Total solids
	Unit	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	mg/kg OC	% dw	% ww
Sample ID	Sample Date													
Plot 7A														
LDW-PILOT7A-SS1	10/29/2014	9.7 U	9.7 U	9.7 U	9.7 U	65	130	72	9.7 U	9.7 U	270	10	2.7	47
LDW-PILOT7A-SS2	10/29/2014	9.4 U	9.4 U	9.4 U	9.4 U	43	83	43	9.4 U	9.4 U	169	9	1.9	53
LDW-PILOT7A-SS3	10/29/2014	9.6 U	9.6 U	9.6 U	9.6 U	65	130	71	9.6 U	9.6 U	270	14	1.9	52
LDW-PILOT7A-SS4	10/29/2014	9.2 U	9.2 U	9.2 U	9.2 U	68	130	70	9.2 U	9.2 U	270	10	2.6	45
Plot 7B														
LDW-PILOT7B-SS1	10/29/2014	9.8 U	9.8 U	9.8 U	9.8 U	64	130	94	9.8 U	9.8 U	290	10	2.9	46
LDW-PILOT7B-SS2	10/29/2014	9.2 U	9.2 U	9.2 U	9.2 U	43	80	48	9.2 U	9.2 U	171	6.8	2.5	54
LDW-PILOT7B-SS3	10/29/2014	9.5 U	9.5 U	9.5 U	9.5 U	54	110	78	9.5 U	9.5 U	240	12	1.9	52
LDW-PILOT7B-SS4	10/29/2014	9.9 U	9.9 U	9.9 U	9.9 U	63	140	87	9.9 U	9.9 U	290	11	2.6	46
Plot 8A														
LDW-PILOT8A-SS1	10/28/2014	8.9 U	8.9 U	8.9 U	8.9 U	27	66	57	8.9 U	8.9 U	150	20	0.738 J	69
LDW-PILOT8A-SS2	10/28/2014	9.8 U	9.8 U	9.8 U	9.8 U	28	66	57	9.8 U	9.8 U	151	nc	0.410 J	71
LDW-PILOT8A-SS3	10/28/2014	9.1 U	9.1 U	9.1 U	9.1 U	9.1 U	21	13	9.1 U	9.1 U	34	nc	0.203 J	78
LDW-PILOT8A-SS4	10/28/2014	9.8 U	9.8 U	9.8 U	9.8 U	15	28	18	9.8 U	9.8 U	61	9.8	0.622 J	72
Plot 8B														
LDW-PILOT8B-SS1	10/28/2014	9.8 U	9.8 U	9.8 U	9.8 U	28	53	27	9.8 U	9.8 U	108	10.7	1.01 J	71
LDW-PILOT8B-SS2	10/28/2014	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	21	13	9.8 U	9.8 U	34	nc	0.454 J	73
LDW-PILOT8B-SS3	10/28/2014	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	35	20	9.8 U	9.8 U	55	9.7	0.566 J	72
LDW-PILOT8B-SS4	10/28/2014	9.4 U	9.4 U	9.4 U	9.4 U	30	54	37	9.4 U	9.4 U	121	11.9	1.02 J	66
Plot 9A-Split (2014 Pilot Study, Historical Data, and New Data)														
LDW-SS119-010	1/19/2005	120 U	120 U	120 U	120 U	180	460	240 J	--	--	880 J	59 J	1.5	54.1
SD-512G	2/7/2012	19 U	19 U	19 U	19 U	120	250	82	19 U	19 U	452	24	1.9	57
SD-514G	2/7/2012	20 U	20 U	20 U	20 U	360	750	180	20 U	20 U	1290	73	1.8	56
SD-517G	2/7/2012	19 U	19 U	19 U	19 U	220	360	110	19 U	19 U	690	45	1.5	59
LDW-PILOT9A-SS1	10/29/2014	9.5 U	9.5 U	9.5 U	9.5 U	160	450	100	9.5 U	9.5 U	710	42	1.7	58
LDW-PILOT9A-SS2	10/29/2014	9.7 U	9.7 U	9.7 U	9.7 U	45	120	60	9.7 U	9.7 U	230	16	1.4	56
LDW-PILOT9A-SS3	10/29/2014	9.8 U	9.8 U	9.8 U	9.8 U	84	280	82	9.8 U	9.8 U	450	29	1.5	51
LDW-PILOT9A-SS4	10/29/2014	9.3 U	9.3 U	9.3 U	9.3 U	920	2,100	230	9.3 U	9.3 U	3,300	150	2.2	59
Plot 9B-Split (2014 Pilot Study, Historical Data, and New Data)														
SD0017	10/11/1997	20 U	39 U	20 U	20 U	20 U	83	44	--	--	127	9.1	1.4	56
SD-DR236-0000	8/27/1998	20 UJ	40 U	20 U	20 U	20 U	85	44	--	--	129	15	0.9	--
LDW-SS120-010	1/19/2005	72 U	72 U	72 U	72 U	100	330	200 J	--	--	630 J	32 J	1.9	54
LDW-SS121-010	1/25/2005	20 U	20 U	20 U	20 U	20 U	700	360 J	--	--	1060 J	57 J	1.9	60
AN021-SS-061025	10/25/2006	65 U	65 U	65 U	65 U	65 U	290	97	65 U	65 U	390	27	1.4	62
AN022-SS-061025	10/25/2006	59 U	59 U	59 U	59 U	59 U	330	93	59 U	59 U	420	27	1.6	56
AN023-SS-061025	10/25/2006	9.8 U	9.8 U	9.8 U	9.8 U	9.8 U	140	50	9.8 U	9.8 U	190	16	1.2	60
AN025-SS-061025	10/25/2006	32 U	32 U	32 U	35 J	32 U	390	130	32 U	32 U	560 J	35 J	1.6	60
AN026-SS-061026	10/26/2006	9.7 U	9.7 U	9.7 U	20	9.7 U	73	58	9.7 U	9.7 U	150	7.2	2.1	46
LDW-PILOT9B-SS3	10/29/2014	9.8 U	9.8 U	9.8 U	9.8 U	71	280	73	9.8 U	9.8 U	420	24	1.7	58
LDW-PILOT9B-SS4	10/29/2014	9.1 U	9.1 U	9.1 U	9.1 U	120	430	67	9.1 U	9.1 U	620	49	1.3	66

Notes:
Depth range for all samples was 0 to 10 cm

Abbreviations:
dw Dry weight
ID Identification
nc Not calculated (TOC concentration is outside of the acceptable range of 0.5 to 4.0%)
OC Organic carbon
PCB Polychlorinated biphenyl
TOC Total organic carbon
ww Wet weight

Qualifiers:
J Estimated concentration.
U Not detected at given concentration.

Prepared by Floyd|Snider
F:\projects\AMEC-KC-ENR\TASK 2 Meetings\2015-01-22 Work Shop 1\Package for EPA\
Tables 1 and 2_Tables from LDW ENR-AC Pilot Study Data Memo_020215.xlsx

Table 2
Subsurface Sediment PCB Results

Subsurface Sediment PCB Results from 2014 Pilot Study sampling.

		Analyte	PCBs: Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260	Aroclor 1262	Aroclor 1268	Total PCB Aroclors	Total PCB Aroclors	Conventionals: TOC	Total solids
		Unit	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	µg/kg dw	mg/kg OC	% dw	% ww
Sample ID	Depth Range	Sampling Date													
Plot 1															
LDW-PILOT1A-SC1	0-2 ft	10/30/2014	9.7 U	9.7 U	9.7 U	9.7 U	110	150	93	9.7 U	9.7 U	350	23	1.5	51
LDW-PILOT1B-SC1	0-2 ft	10/30/2014	9.2 U	9.2 U	9.2 U	9.2 U	74	110	76	9.2 U	9.2 U	260	18	1.5	45
Plot 2															
LDW-PILOT2A-SC1	0-2 ft	10/31/2014	9.1 U	9.1 U	9.1 U	9.1 U	55	130	63	9.1 U	9.1 U	250	20	1.2	60
LDW-PILOT2B-SC1	0-1.5 ft	10/31/2014	9.5 U	9.5 U	9.5 U	9.5 U	190 U	240	150	9.5 U	9.5 U	390	20	2.0	53
Plot 3															
LDW-PILOT3A-SC1	0-1.5 ft	11/4/2014	8.9 U	8.9 U	8.9 U	8.9 U	13 U	38	20	8.9 U	8.9 U	58	7.8	0.7	70
LDW-PILOT3B-SC1	0-1.5 ft	11/4/2014	9.2 U	9.2 U	9.2 U	9.2 U	71	160	73	9.2 U	9.2 U	300	13	2.3	59
Plot 4															
LDW-PILOT4A-SC1	0-2 ft	11/4/2014	9.7 U	9.7 U	9.7 U	9.7 U	2,600	3,000	440	9.7 U	9.7 U	6,000	290	2.1	57
LDW-PILOT4B-SC1	0-2 ft	11/4/2014	9.5 U	9.5 U	9.5 U	9.5 U	960	1,800	280	9.5 U	9.5 U	3,000	140	2.1	58
Plot 6															
LDW-PILOT6A-SC1	0-2 ft	11/4/2014	9.7 U	9.7 U	9.7 U	9.7 U	1,200	1,400	260	9.7 U	9.7 U	2,900	140	2.0	59
LDW-PILOT6B-SC1	0-2 ft	11/4/2014	9.6 U	9.6 U	9.6 U	9.6 U	480 U	450	260	9.6 U	9.6 U	710	24	3.0	52
Plot 7															
LDW-PILOT7A-SC1	0-2 ft	11/3/2014	9.4 U	9.4 U	9.4 U	9.4 U	47	100	44	9.4 U	9.4 U	190	7.4	2.6	54
LDW-PILOT7B-SC1	0-2 ft	11/3/2014	9.0 U	9.0 U	9.0 U	9.0 U	50	98	57	9.0 U	9.0 U	205	7.19	2.9	55
Plot 8															
LDW-PILOT8A-SC1	0-1.5 ft	11/3/2014	9.0 U	9.0 U	9.0 U	9.0 U	81 U	420	170	9.0 U	9.0 U	590	70	0.8 J	71
LDW-PILOT8B-SC1	0-1.5 ft	11/3/2014	8.8 U	8.8 U	8.8 U	8.8 U	54	140	53	8.8 U	8.8 U	250	nc	0.5 J	70
Plot 9															
LDW-PILOT9A-SC1	0-1.5 ft	11/3/2014	9.9 U	9.9 U	9.9 U	9.9 U	1,000	2,700	340	9.9 U	9.9 U	4,000	190	2.1	56
LDW-PILOT9B-SC1	0-1.5 ft	11/3/2014	9.7 U	9.7 U	9.7 U	9.7 U	580 U	2,500	420	9.7 U	9.7 U	2,900	110	2.7	58

Abbreviations:
- dw Dry weight
- ID Identification
- nc Not calculated (TOC concentration is outside of the acceptable range of 0.5 to 4.0%
- OC Organic carbon
- PCB polychlorinated bipheny
- TOC total organic carbon
- ww Wet weight

Qualifications:
- J Estimated concentration.
- U Not detected at given concentration

Prepared by Floyd|Snider
\\merry\data\projects\AMEC-KC-ENR\TASK 2 Meetings\2015-01-22 Work Shop 1\Package for EPA\
Tables 1 and 2_Tables from LDW ENR-AC Pilot Study Data Memo_020215.xlsx

Table 3
Surface Sediment PCB Data Summary for all Plots Considered

Surface Sediment PCB Results from 2014 Pilot Study sampling; Plot 9 also includes historical data and data from adjacent sites.

Scour Plot	Plot 1A				Plot 1B				Comparison
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	172	440	265	120	213	260	240	24	-10%
Total PCBs (mg/kg-OC)	6.8	26	14	9.1	7.6	23	12	7.3	-9.1%
Total Organic Carbon (%)	1.4	3.5	2.3	0.94	0.97	3.4	2.4	1.0	3.2%
Scout Plot	Plot 2A				Plot 2B				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	101	360	198	115	140	350	234	95	17%
Total PCBs (mg/kg-OC)	7.1	31	15	11	7.0	24	13	8.0	-14%
Total Organic Carbon (%)	0.93	2.6	1.5	0.75	1.1	2.5	2.0	0.62	27%
Subtidal	Plot 4A				Plot 4B				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	54	330	210	117	51	1640	710	731	109%
Total PCBs (mg/kg-OC)	11	26	20	8.2	6	109	44	46	74%
Total Organic Carbon (%)	0.26	1.8	1.1	0.6	0.85	2.1	1.4	0.52	25%
Subtidal	Plot 6A - Original				Plot 6B - Original				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	202	1530	621	616	450	2900	1518	1021	84%
Total PCBs (mg/kg-OC)	10	81	33	33	68	180	110	51	108%
Total Organic Carbon (%)	1.6	2.2	1.9	0.22	0.66	1.6	1.3	0.45	-39%
Subtidal	Plot 6 - Lane A				Plot 6 - Lane B				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	450	2900	1335	1160	202	1470	803	650	-50%
Total PCBs (mg/kg-OC)	28	180	89	65	10	116	54	51	-49%
Total Organic Carbon (%)	0.66	1.9	1.4	0.5	1.3	2.2	1.8	0.39	19%
Subtidal	Plot 7A				Plot 7B				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	169	270	245	51	171	290	248	56	1%
Total PCBs (mg/kg-OC)	8.9	14	11	2.2	6.8	12	9.9	2.3	-7.6%
Total Organic Carbon (%)	1.9	2.7	2.3	0.45	1.9	2.9	2.5	0.4	8.8%
Intertidal	Plot 3A				Plot 3B				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	89	201	152	48	9.9	220	101	101	-40%
Total PCBs (mg/kg-OC)	4.9	13	7.5	3.5	1.5	13	5.8	5.0	-25%
Total Organic Carbon (%)	1.6	3.2	2.2	0.71	0.55	3.6	1.6	1.4	-29%
Intertidal	Plot 8A				Plot 8B				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	34	151	99	60	34	121	80	42	-22%
Total PCBs (mg/kg-OC)	9.8	20	15	7	9.7	11.9	11	1	-33%
Total Organic Carbon (%)	0.20	0.74	0.49	0.24	0.45	1.0	0.76	0.30	43%
Intertidal	Plot 9A - Split Configuration				Plot 9B - Split Configuration				
Analyte	Minimum	Maximum	Mean	Stan Dev	Minimum	Maximum	Mean	Stan Dev	% Difference
Total PCBs (µg/kg dry weight)	230	3300	1000	983	127	1060	438	274	-78%
Total PCBs (mg/kg-OC)	16	150	55	43	7.2	57	28	15	-65%
Total Organic Carbon (%)*	1.4	2.2	1.7	0.34	1.3	1.7	1.5	0.33	-12%

*2014 data only for TOC statistics

Abbreviations:

dw Dry weight
ID Identification
nc Not calculated (TOC concentration is outside of the acceptable range of 0.5 to 4.0%)
OC Organic carbon
PCB Polychlorinated biphenyl
TOC Total organic carbon
ww Wet weight

Qualifiers:

Estimated concentration.
Not detected at given concentration.

Table 4
RALs and ENR-ULs Used for Table 5

		Intertidal Sediments (Plot 9) - Category 2				Subtidal Sediments (Plot 6) - Category 3				Scour Mitigation (Plot 1) - Category 1/2, Subtidal				
		Category 2 and 3, Top 10 cm		Category 2 and 3, Top 1.5 ft		Category 2 and 3, Top 10 cm		Category 2 and 3, Top 2 ft		Category 1, Top 10 cm		Category 1, Top 2 ft		
Human Health COCs	**units**	**RAL**	**UL-ENR (3xRAL)**	**RAL**	**UL-ENR (3xRAL)**	**RAL**	**UL-ENR (3xRAL)**	**RAL**	**UL-ENR (3xRAL)**	**RAL**	**UL-ENR (Use Category 2/3)**	**RAL**	**UL-ENR (Use Category 2/3)**	**ROD Table[1]**
PCBs	mg/kg-OC	12	36	65	97	12	36	195	195	12	36	12	195	Table 28
cPAHs	µg TEQ/kg dw	1000	3000	900	1350	1000	3000	-	-	1000	3000	1000	-	Table 28
Arsenic	mg/kg dw	57	171	28	42	57	171	-	-	57	171	57	-	Table 28
Dioxins/Furans	ng TEQ/kg dw	25	75	28	42	25	75	-	-	25	75	25	-	Table 28
39 SMS Benthic COCs		**RAL (2xBenthic SCO)**	**UL-ENR (3xRAL)**	-	-	**RAL (2xBenthic SCO)**	**UL-ENR (3xRAL)**	-	-	**RAL (Benthic SCO)**	**UL-ENR (3xRAL)**	**RAL (Benthic SCO)**	-	Table 28
Metals														
Cadmium	mg/kg dw	10.2	30.6	-	-	10.2	30.6	-	-	5.1	15.3	5.1	-	Table 27
Chromium	mg/kg dw	520	1560	-	-	520	1560	-	-	260	780	260	-	Table 27
Copper	mg/kg dw	780	2340	-	-	780	2340	-	-	390	1170	390	-	Table 27
Lead	mg/kg dw	900	2700	-	-	900	2700	-	-	450	1350	450	-	Table 27
Mercury	mg/kg dw	0.82	2.46	-	-	0.82	2.46	-	-	0.41	1.23	0.41	-	Table 27
Silver	mg/kg dw	12.2	36.6	-	-	12.2	36.6	-	-	6.1	18.3	6.1	-	Table 27
Zinc	mg/kg dw	820	2460	-	-	820	2460	-	-	410	1230	410	-	Table 27
Polycyclic Aromatic Hydrocarbons (PAHs)														
2- Methylnaphthalene	mg/kg OC	76	228	-	-	76	228	-	-	38	114	38	-	Table 27
Acenaphthene	mg/kg OC	32	96	-	-	32	96	-	-	16	48	16	-	Table 27
Anthracene	mg/kg OC	440	1320	-	-	440	1320	-	-	220	660	220	-	Table 27
Benzo(a)anthracene	mg/kg OC	220	660	-	-	220	660	-	-	110	330	110	-	Table 27
Benzo(a)pyrene	mg/kg OC	198	594	-	-	198	594	-	-	99	297	99	-	Table 27
Benzo(g,h,i)perylene	mg/kg OC	62	186	-	-	62	186	-	-	31	93	31	-	Table 27
Total benzofluoranthenes	mg/kg OC	4650	13950	-	-	4650	13950	-	-	230	690	230	-	Table 27
Chrysene	mg/kg OC	220	660	-	-	220	660	-	-	110	330	110	-	Table 27
Dibenzo(a,h)anthracene	mg/kg OC	24	72	-	-	24	72	-	-	12	36	12	-	Table 27
Dibenzofuran	mg/kg OC	30	90	-	-	30	90	-	-	15	45	15	-	Table 27
Fluoranthene	mg/kg OC	320	960	-	-	320	960	-	-	160	480	160	-	Table 27
Fluorene	mg/kg OC	46	138	-	-	46	138	-	-	23	69	23	-	Table 27
Indeno(1,2,3-cd)pyrene	mg/kg OC	68	204	-	-	68	204	-	-	34	102	34	-	Table 27
Naphthalene	mg/kg OC	198	594	-	-	198	594	-	-	99	297	99	-	Table 27
Phenanthrene	mg/kg OC	200	600	-	-	200	600	-	-	100	300	100	-	Table 27
Pyrene	mg/kg OC	2000	6000	-	-	2000	6000	-	-	1000	3000	1000	-	Table 27
Total HPAHs	mg/kg OC	1920	5760	-	-	1920	5760	-	-	960	2880	960	-	Table 27
Total LPAHs	mg/kg OC	740	2220	-	-	740	2220	-	-	370	1110	370	-	Table 27
Phthalates														
Bis (2-ethylhexyl)phthalate	mg/kg OC	94	282	-	-	94	282	-	-	47	141	47	-	Table 27
Butyl benzyl phthalate	mg/kg OC	9.8	29.4	-	-	9.8	29.4	-	-	4.9	14.7	4.9	-	Table 27
Dimethyl phthalate	mg/kg OC	106	318	-	-	106	318	-	-	53	159	53	-	Table 27
Chlorobenzenes														
1,2,4- Trichlorobenzene	mg/kg OC	1.62	4.86	-	-	1.62	4.86	-	-	0.81	2.43	0.81	-	Table 27
1,2- Dichlorobenzene	mg/kg OC	4.6	13.8	-	-	4.6	13.8	-	-	2.3	6.9	2.3	-	Table 27
1,4- Dichlorobenzene	mg/kg OC	6.2	18.6	-	-	6.2	18.6	-	-	3.1	9.3	3.1	-	Table 27
Hexachlorobenzene	mg/kg OC	0.76	2.28	-	-	0.76	2.28	-	-	0.38	1.14	0.38	-	Table 27

Table 4
RALs and ENR-ULs Used for Table 5

		Intertidal Sediments (Plot 9) - Category 2				Subtidal Sediments (Plot 6) - Category 3				Scour Mitigation (Plot 1) - Category 1/2, Subtidal				
		Category 2 and 3, Top 10 cm		Category 2 and 3, Top 1.5 ft		Category 2 and 3, Top 10 cm		Category 2 and 3, Top 2 ft		Category 1, Top 10 cm		Category 1, Top 2 ft		
Human Health COCs	units	RAL	UL-ENR (3xRAL)	RAL	UL-ENR (3xRAL)	RAL	UL-ENR (3xRAL)	RAL	UL-ENR (3xRAL)	RAL	UL-ENR (Use Category 2/3)	RAL	UL-ENR (Use Category 2/3)	ROD Table[1]
Other SVOCs and COCs														
2,4- Dimethylphenol	µg/kg dw	58	174	-	-	58	174	-	-	29	87	29	-	Table 27
4-Methylphenol	µg/kg dw	1340	4020	-	-	1340	4020	-	-	670	2010	670	-	Table 27
Benzoic acid	µg/kg dw	1300	3900	-	-	1300	3900	-	-	650	1950	650	-	Table 27
Benzyl alcohol	µg/kg dw	114	342	-	-	114	342	-	-	57	171	57	-	Table 27
n-Nitrosodiphenylamine,	mg/kg OC	22	66	-	-	22	66	-	-	11	33	11	-	Table 27
Pentachlorophenol	µg/kg dw	720	2160	-	-	720	2160	-	-	360	1080	360	-	Table 27
Phenol	µg/kg dw	840	2520	-	-	840	2520	-	-	420	1260	420	-	Table 27

Notes:

- \- No limit given.
- 1 Tables referenced from *Record of Decision: Lower Duwamish Waterway Superfund Site,* United States Environmental Protection Agency Region 10, November 2014.

Abbreviations:

cm Centimeter
COC Contaminants of concern
cPAH Carcinogenic polycyclic aromatic hydrocarbon
dw Dry weight
ENR Enhanced natural recovery
ft Feet
kg Kilogram
mg Milligrams per kilogram
ng Nanogram
OC Organic carbon
PCB Polychlorinated biphenyl
RAL Remedial action level
SCO Sediment cleanup objective
SVOC Semivolatile organic compound
TEQ Toxic equivalent
UL Upper limit

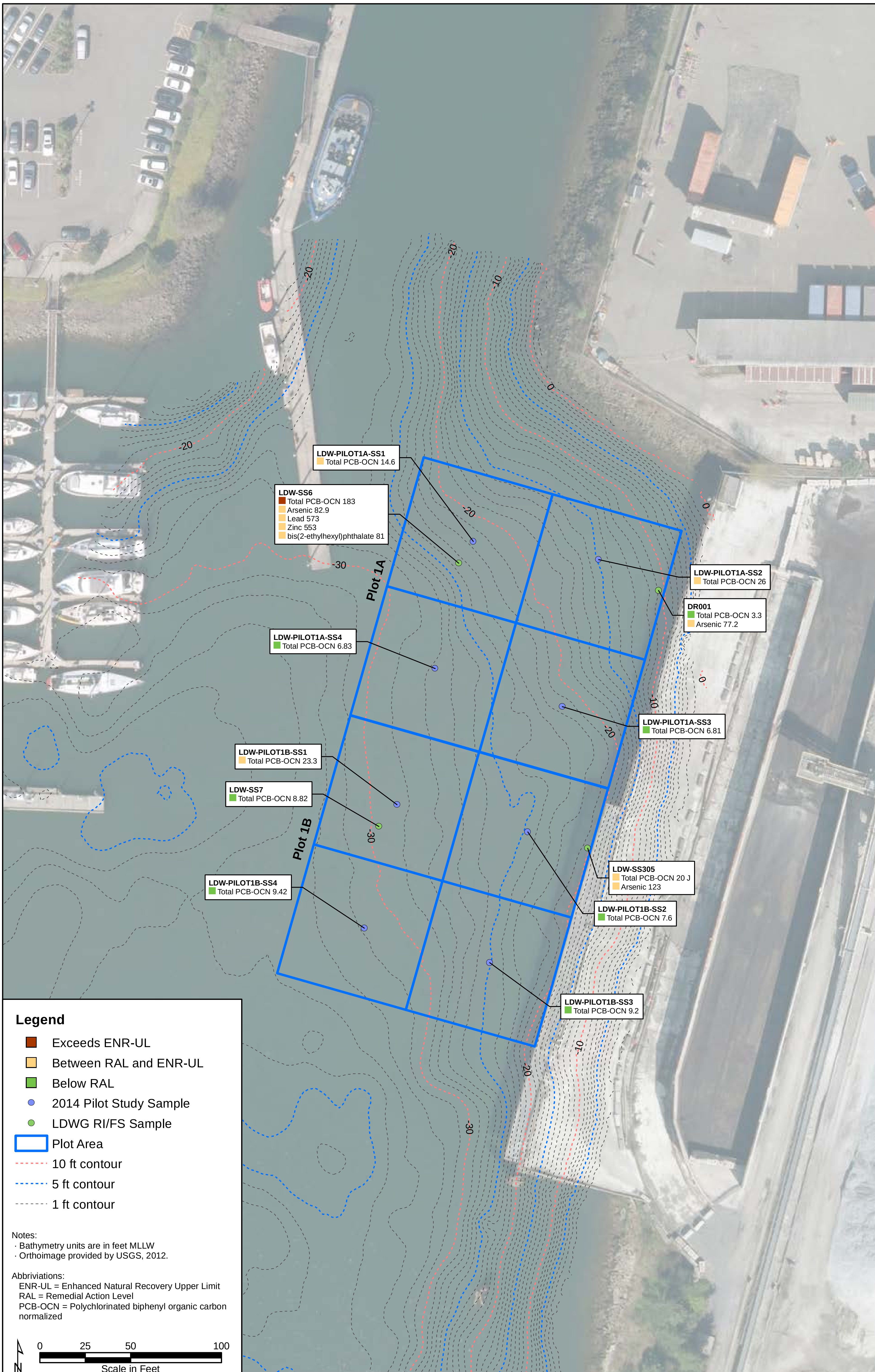
Table 5

Chemical Exceedances of RAL and ENR-UL in Surface and Subsurface Sediments for Proposed Plots

LocationName	SampleDate	Analyte	Result	Unit	Exceeds RAL?	Exceeds ENR-UL?
Scour Plot 1 - Surface Sediment						
DR001	8/31/1998	Arsenic	77.2	mg/kg dw	Yes	No
LDW-PILOT1A-SS1	10/27/2014	PCBs	14.6	mg/kg OC	Yes	No
LDW-PILOT1A-SS2	10/27/2014	PCBs	26	mg/kg OC	Yes	No
LDW-PILOT1B-SS1	10/27/2014	PCBs	23.3	mg/kg OC	Yes	No
LDW-SS305	10/3/2006	Arsenic	123	mg/kg dw	Yes	No
LDW-SS305	10/3/2006	PCBs	20 J	mg/kg OC	Yes	No
LDW-SS6	3/10/2005	Arsenic	82.9	mg/kg dw	Yes	No
LDW-SS6	3/10/2005	Bis(2-ethylhexyl)phthalate	81	mg/kg OC	Yes	No
LDW-SS6	3/10/2005	Lead	573	mg/kg dw	Yes	No
LDW-SS6	3/10/2005	PCBs	183	mg/kg OC	Yes	Yes
LDW-SS6	3/10/2005	Zinc	553	mg/kg dw	Yes	No
Scour Plot 1 - Subsurface Sediment						
LDW-PILOT1A-SC1	10/30/2014	PCBs	23	mg/kg OC	Yes	No
LDW-PILOT1B-SC1	10/30/2014	PCBs	18	mg/kg OC	Yes	No
Subtidal Plot 6 - Surface Sediment						
DR089	8/12/1998	PCBs	14.1	mg/kg OC	Yes	No
LDW-PILOT6A-SS1	10/28/2014	PCBs	28	mg/kg OC	Yes	No
LDW-PILOT6A-SS3	10/28/2014	PCBs	13	mg/kg OC	Yes	No
LDW-PILOT6A-SS4	10/28/2014	PCBs	80.5	mg/kg OC	Yes	Yes
LDW-PILOT6B-SS1	10/29/2014	PCBs	180	mg/kg OC	Yes	Yes
LDW-PILOT6B-SS2	10/29/2014	PCBs	116	mg/kg OC	Yes	Yes
LDW-PILOT6B-SS3	10/29/2014	PCBs	76.7	mg/kg OC	Yes	Yes
LDW-PILOT6B-SS4	10/29/2014	PCBs	68 J	mg/kg OC	Yes	Yes
LDW-SS40	1/18/2005	PCBs	27 J	mg/kg OC	Yes	No
Intertidal Plot 9 - Surface Sediment						
AN-021	10/25/2006	PCBs	27	mg/kg OC	Yes	No
AN-022	10/25/2006	PCBs	27	mg/kg OC	Yes	No
AN-023	10/25/2006	PCBs	16	mg/kg OC	Yes	No
AN-025	10/25/2006	Butyl benzyl phthalate	13	mg/kg OC	Yes	No
AN-025	10/25/2006	PCBs	35 J	mg/kg OC	Yes	No
AN-027	10/25/2006	Butyl benzyl phthalate	14	mg/kg OC	Yes	No
AN-027	10/25/2006	PCBs	14	mg/kg OC	Yes	No
AN-028	10/25/2006	PCBs	15 J	mg/kg OC	Yes	No
AN-029	10/25/2006	Mercury	6.8	mg/kg dw	Yes	Yes
AN-029	10/25/2006	PCBs	15	mg/kg OC	Yes	No
AN-046	2/11/2008	Lead	21700 J	mg/kg dw	Yes	Yes
AN-046	2/11/2008	Zinc	1050	mg/kg dw	Yes	No
AN-047	2/11/2008	Butyl benzyl phthalate	83	mg/kg OC	Yes	Yes
AN-047	2/11/2008	PCBs	110	mg/kg OC	Yes	Yes
DR236	8/27/1998	PCBs	15	mg/kg OC	Yes	No
EST143	9/25/1997	PCBs	28	mg/kg OC	Yes	No
LDW-PILOT9A-SS1	10/29/2014	PCBs	42	mg/kg OC	Yes	Yes
LDW-PILOT9A-SS2	10/29/2014	PCBs	16	mg/kg OC	Yes	No
LDW-PILOT9A-SS3	10/29/2014	PCBs	29	mg/kg OC	Yes	No
LDW-PILOT9A-SS4	10/29/2014	PCBs	150	mg/kg OC	Yes	Yes
LDW-PILOT9B-SS1	10/29/2014	PCBs	25	mg/kg OC	Yes	No
LDW-PILOT9B-SS2	10/29/2014	PCBs	53.8	mg/kg OC	Yes	Yes
LDW-PILOT9B-SS3	10/29/2014	PCBs	24	mg/kg OC	Yes	No
LDW-PILOT9B-SS4	10/29/2014	PCBs	49	mg/kg OC	Yes	Yes
LDW-SS119	1/19/2005	PCBs	59 J	mg/kg OC	Yes	Yes
LDW-SS120	1/19/2005	Butyl benzyl phthalate	12	mg/kg OC	Yes	No
LDW-SS120	1/19/2005	PCBs	32 J	mg/kg OC	Yes	No
LDW-SS121	1/25/2005	Butyl benzyl phthalate	17	mg/kg OC	Yes	No
LDW-SS121	1/25/2005	PCBs	57 J	mg/kg OC	Yes	Yes
SD-512G	2/7/2012	PCBs	24.4	mg/kg OC	Yes	No
SD-514G	2/7/2012	PCBs	72.5	mg/kg OC	Yes	Yes
SD-517G	2/7/2012	PCBs	44.8	mg/kg OC	Yes	Yes
Plot 9 - Subsurface Sediment						
LDW-PILOT9A-SC1	11/3/2014	PCBs	190	mg/kg OC	Yes	Yes
LDW-PILOT9B-SC1	11/3/2014	PCBs	110	mg/kg OC	Yes	Yes
LDW2006LDW-1211	2/7/2006	Arsenic	28	mg/kg dw	Yes	No
SD-517	2/3/2012	Arsenic	56.3	mg/kg dw	Yes	Yes
SD-512	2/3/2012	Arsenic	290	mg/kg dw	Yes	Yes

Abbreviations:

dw	Dry weight
ENR	Enhanced natural recovery
kg	Kilogram
µg	Microgram
mg	Milligrams per kilogram
OC	Organic carbon
PCB	Polychlorinated biphenyl
RAL	Remedial action level
SVOC	Semivolatile organic compound
UL	Upper limit

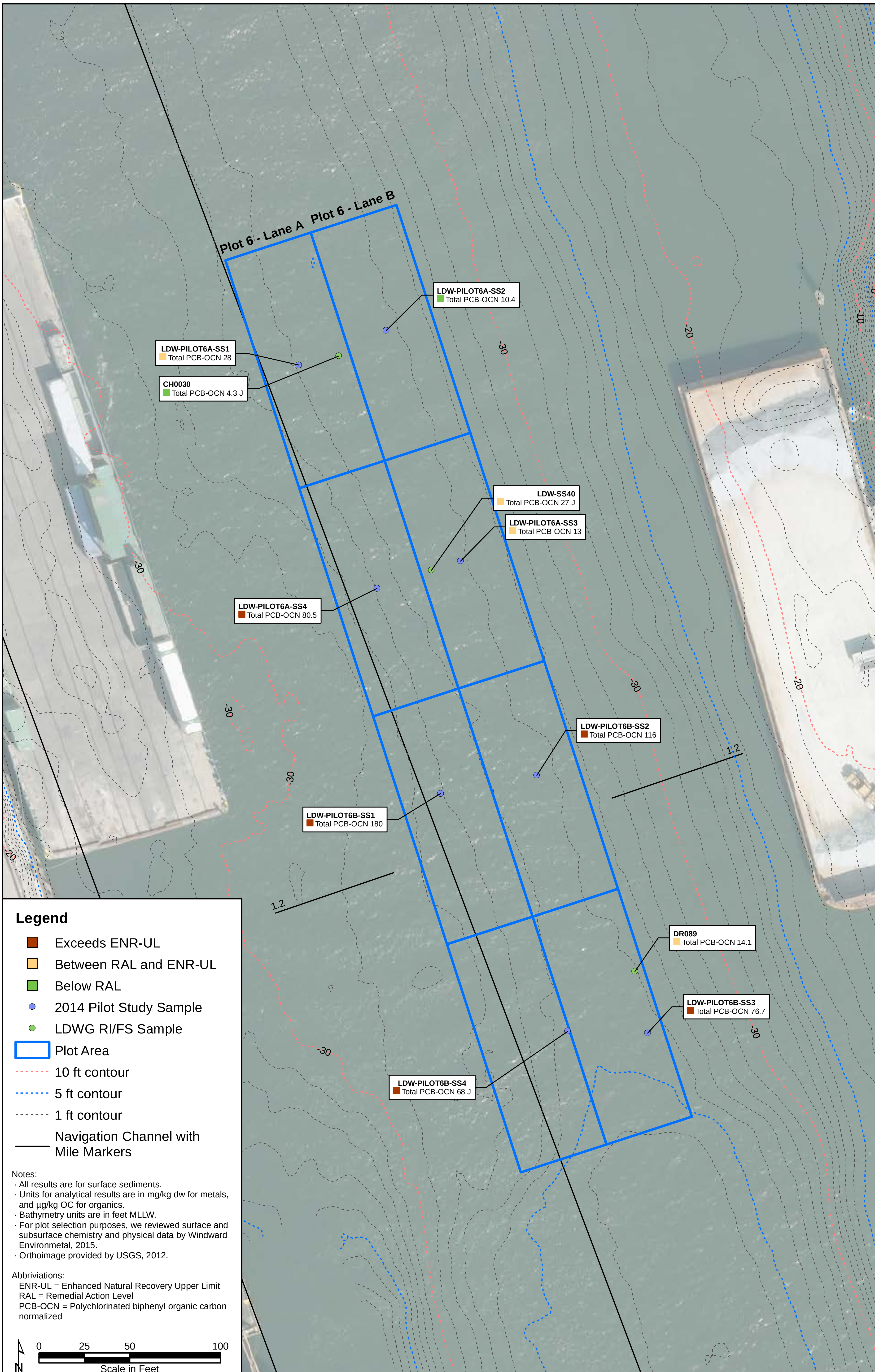


FLOYD | SNIDER
strategy • science • engineering

ENR-AC Pilot Study
Final Plot Selection Memo

Figure 1
Plot 1 Layout, Chemical Exceedances, and Bathymetry

I:\GIS\Projects\AMEC-KC-ENR\MXD\Figure 1 Plot 1 and Results.mxd
2/3/2015



Notes:
- All results are for surface sediments.
- Units for analytical results are in mg/kg dw for metals, and µg/kg OC for organics.
- Bathymetry units are in feet MLLW.
- For plot selection purposes, we reviewed surface and subsurface chemistry and physical data by Windward Environmental, 2015.
- Orthoimage provided by USGS, 2012.

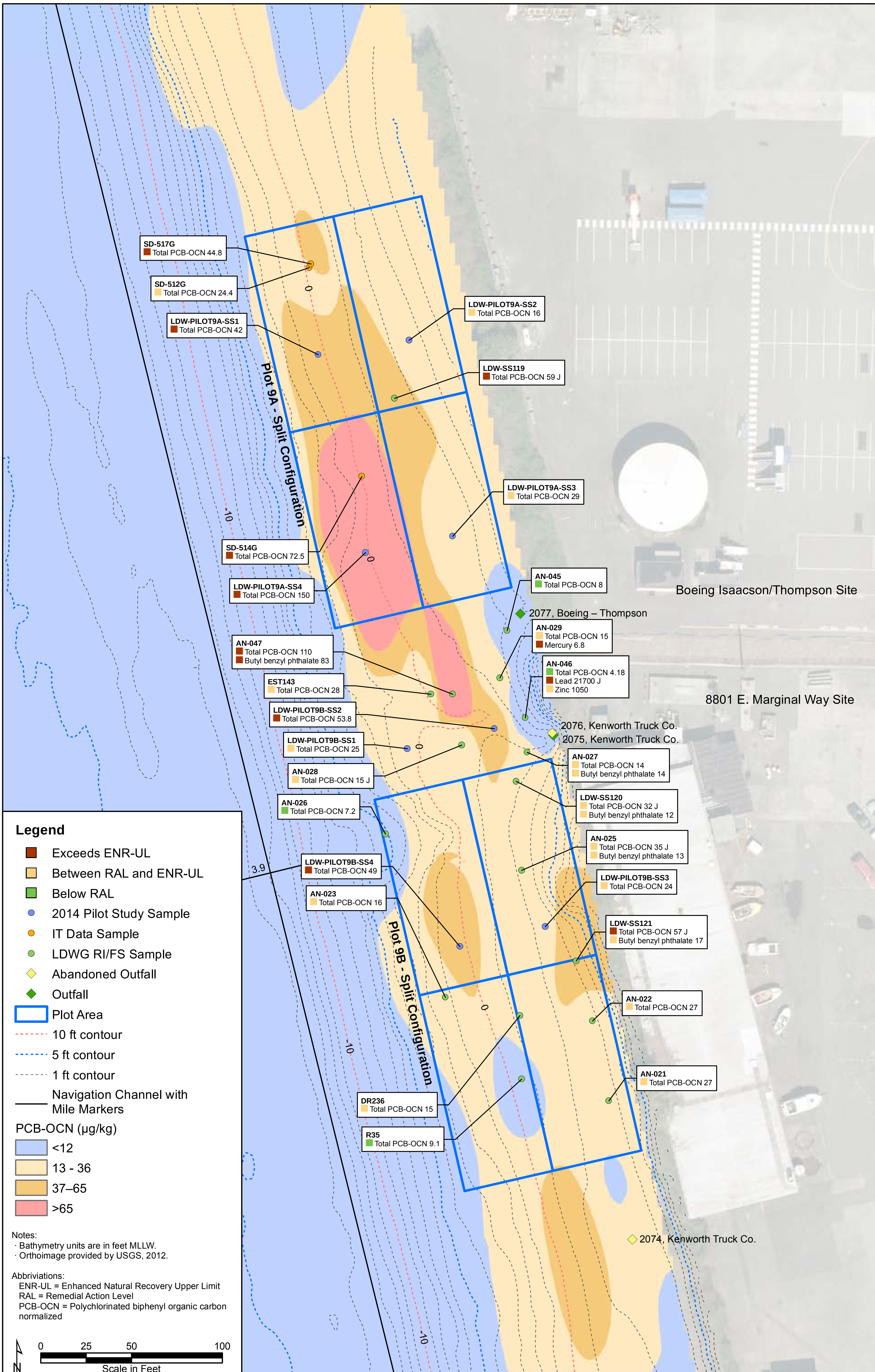
Abbriviations:
ENR-UL = Enhanced Natural Recovery Upper Limit
RAL = Remedial Action Level
PCB-OCN = Polychlorinated biphenyl organic carbon normalized

FLOYD | SNIDER
strategy • science • engineering

ENR-AC Pilot Study
Final Plot Selection Memo

Figure 2
Plot 6 Revised Layout, Chemical Exceedances, and Bathymetry

I:\GIS\Projects\AMEC-KC-ENR\MXD\Figure 2 Plot 6 and Results.mxd
2/3/2015



FLOYD | SNIDER
strategy • science • engineering

ENR-AC Pilot Study
Final Plot Selection Memo

Figure 3
Plot 9 Revised Layout, Chemical Exceedances, and Bathymetry

I:\GIS\Projects\AMEC-KC-ENR\MXD\Figure 3 Plot 9 and Results.mxd
2/3/2015

APPENDIX B

Biological Evaluation

*L*ower *D*uwamish *W*aterway *G*roup

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

DRAFT BIOLOGICAL EVALUATION

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

DRAFT

Prepared for:

The US Environmental Protection Agency
Region 10
Seattle, Washington

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
ENVIRON International Corporation
Floyd|Snider
Geosyntec Consultants

June 22, 2015

Project No. LY15160310

EXECUTIVE SUMMARY

The Lower Duwamish Waterway Group will conduct a Pilot Study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW) in Seattle, Washington. The study will evaluate whether enhanced natural recovery (ENR) material amended with activated carbon (AC) can be successfully applied to reduce bioavailability in remediated contaminated sediment in the LDW. The study will compare the effectiveness of reducing polychlorinated biphenyl (PCB) bioavailability in ENR material amended with AC (ENR+AC) to that of ENR material alone in three areas in the LDW, referred to as the intertidal, subtidal, and scour pilot plots.

This biological evaluation assessed potential effects of the Pilot Study on existing environmental conditions in the LDW, listed species that use the LDW, and the critical habitats of the listed species in the LDW.

The Pilot Study is not expected to substantially alter existing environmental conditions within the LDW. Potential impacts on existing environmental conditions in the Action Area defined for this biological evaluation are the following:

- Placement of ENR and ENR+AC materials may result in temporary and localized increases in turbidity in the water column.
- Physical and conventional sediment characteristics (e.g., grain size and total organic carbon) within the three pilot plot areas covering a total of approximately 3 acres may be altered in the short term relative to those of the surrounding sediments. In the long term, the physical and conventional sediment characteristics are expected to return to current conditions by means of natural riverine processes.
- Placement of ENR and ENR+AC on 3 acres of sediments that are contaminated with PCBs will reduce the exposure of aquatic organisms to PCBs within those areas.
- The ENR and ENR+AC materials placed during the Pilot Study will be approximately 6 to 9 inches thick and are not expected to substantially alter the bathymetry in the pilot plots.
- Placement of ENR and ENR+AC materials will bury 3 acres of benthic habitat; however, two of the pilot plot areas are subtidal, located in areas unlikely to provide preferred foraging habitat for juvenile salmonids. Therefore, the temporary reduction in foraging opportunities for juvenile salmonids is expected to be limited to 1 acre in the intertidal plot.
- The Pilot Study will have no effect on access and refugia; flow, water current patterns, saltwater-freshwater mixing; marine macroalgae and macrophytes; forage fish; or ambient noise.

The Pilot Study **may affect, but is not likely to adversely affect** Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and Puget Sound steelhead trout. The Pilot Study **will not jeopardize the continued existence of** Dolly Varden trout. The Pilot Study will have **no effect** on three listed species of rockfish.

The Pilot Study **may affect, but is not likely to adversely affect** some of the primary constituent elements (PCEs) of the critical habitats for Puget Sound Chinook salmon, Coastal/Puget Sound bull trout, and Puget Sound steelhead trout but will have **no effect** on the other PCEs for the critical habitats of those species.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

TABLES

FIGURES

ATTACHMENTS

ABBREVIATIONS AND ACRONYMS

AADT	average annual daily traffic
AC	activated carbon
AOC	Administrative Order on Consent
BE	biological evaluation
BMP	best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
dB	decibel
dBA	A-weighted noise level as decibels in air
dBrms	decibels root mean square
dBpeak	peak decibels
DPS	distinct population segment
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery with activated carbon
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FMO	foraging, migrating, and overwintering
FS	feasibility study
KCIA	King County International Airport
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
µm	micrometer
MLLW	mean lower low water
NOAA-Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	primary constituent element
PHS	Priority Habitat and Species (program)
PMU	primary monitoring unit

ABBREVIATIONS AND ACRONYMS (Continued)

RI	remedial investigation
RM	river mile
TMDL	total maximum daily load
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WQI	water quality improvement
WSDOT	Washington State Department of Transportation

DRAFT BIOLOGICAL EVALUATION

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 INTRODUCTION

An amendment to the Administrative Order on Consent (AOC) for Remedial Investigation/ Feasibility Study for the Lower Duwamish Waterway (EPA Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055 and Ecology Docket No. 00TCPNR-1895, issued on December 20, 2000) was issued in July 2014. Under this amendment, the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) require that a Pilot Study of enhanced natural recovery (ENR) material amended with activated carbon (AC) be conducted in the LDW, in King County, Washington (Figure 1). The Lower Duwamish Waterway Group (LDWG) will conduct this Pilot Study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the LDW. The study will determine whether ENR material amended with AC (ENR+AC) can be successfully used to reduce bioavailability in remediated contaminated sediment in the LDW. The Pilot Study will compare the effectiveness of reducing PCB bioavailability in ENR+AC to that of ENR without the addition of activated carbon.

Section 7 of the Endangered Species Act (ESA) states that actions of federal agencies should be "not likely to jeopardize the continued existence of any (listed) species or result in the destruction or adverse modification of habitat of such species." Because of the federal nexus (EPA), the Pilot Study qualifies as an action by a federal agency and must comply with Section 7 of the ESA. Under ESA Section 7(c), the EPA, as the lead federal agency for the Pilot Study, is required to produce a biological evaluation (BE) describing the potential effects of the action on listed species and their critical habitats. To assist in the evaluation of the potential effects of the Pilot Study on listed species, this BE has been prepared on behalf of the LDWG for EPA's use in the consultation process.

2.0 PROJECT LOCATION

Three plot areas for the Pilot Study, designated as the intertidal, subtidal, and scour plots, will be located in the LDW in Seattle and Tukwila, King County, Washington (Figures 1 and 2; Table 1).

3.0 PROJECT DESCRIPTION

This section provides a description of the Pilot Study, including the active placement of the ENR and ENR+AC materials, as well as pre- and post-implementation monitoring of the pilot plots.

The Pilot Study will evaluate the effectiveness of ENR+AC compared to ENR alone as a remedial sediment cleanup action in three areas of the LDW in which sediments are contaminated with polychlorinated biphenyls (PCBs); they are designated as the intertidal, subtidal, and scour plots. In each plot, two adjacent, half-acre areas will be evaluated, one in which only ENR material has been placed and the other in which ENR material amended with AC has been placed. The ENR material in the subtidal plot will consist of clean sand; the ENR material in the intertidal and scour plots will consist of a gravely sand mixture (1-1/2-inch minus with on the order of 50 percent sand). In all three plots, the ENR+AC material will also contain granular AC at a concentration of 1 to 3 percent. The proposed AC concentration is sufficient to sequester PCBs (and to reduce bioavailability) but is not expected to adversely affect benthic biota.

3.1 CONSTRUCTION ELEMENTS

It is anticipated that a barge-mounted fixed-arm excavator with a clamshell bucket will be used for submerged placement of the ENR and ENR+AC materials. The submerged release of the ENR and ENR+AC materials a few feet above the substrate will minimize the loss of AC as the ENR+AC material descends through the water column and will also minimize turbidity plumes that may result as fine particles in the ENR and ENR+AC materials become suspended in the water column and descend to the bottom substrate. The ENR+AC materials will be preblended to meet the target concentration of AC and presoaked prior to placement. Presoaking of the ENR+AC material will help to minimize the loss of AC as the ENR+AC materials descends through the water column during placement. The target thickness of the ENR and ENR+AC materials is at least 6 inches, with an average of approximately 9 inches placed over the existing substrate.

Precision navigation, as well as offset and staggered placement, will be used to ensure precise placement of the ENR and ENR+AC materials at each of the pilot plots.

Equipment that will used by the contractor includes, but is not limited to barges (with and without spuds), excavators, tugs, small work boats, and anchors. The disturbance of existing sediments will be limited to disturbance from anchors or barge spuds. The construction of the project does not require dredging of any sediment; however, in the event that material is overplaced within a plot above the placement thickness to such a degree that it may impact navigation, some placed material will be moved using the clamshell bucket and relocated to the perimeter of the appropriate subplot.

3.2 CONSTRUCTION TIMING

The completion of in-water construction activities for the Pilot Study will require 2 to 4 weeks. All in-water work associated with the placement of ENR and ENR+AC materials will be conducted during the authorized 2016–2017 in-water work window of October 1 through February 15 (Corps, 2012) for the LDW, when listed salmonid species are least likely to be present in the LDW. Construction will occur after the end of the Muckleshoot Indian Tribe's netfishery season. Construction is expected to begin in December 2016.

3.3 PRE- AND POST-IMPLEMENTATION MONITORING

Pre- and post-implementation monitoring of the three pilot plots will be conducted to assess baseline conditions prior to project activities and to periodically evaluate conditions of the three pilot plots after placement of the ENR and ENR+AC materials.

The following presents an overview of the monitoring activities during the Pilot Study:

- Collection of surficial sediment samples for chemical, physical, and benthic taxonomic analyses (benthic taxonomic analyses will be conducted only during Year 3).
- Analysis of PCBs in pore water using passive samplers.
- Use of sediment profile imaging to assess benthic recolonization.

Reports summarizing the results of the monitoring events will be provided to the EPA and Ecology.

3.4 CONSERVATION MEASURES AND BEST MANAGEMENT PRACTICES

A number of conservation measures and best management practices (BMPs) will be implemented to minimize and avoid impacts on listed species and the environment during in-water work activities:

- Restriction of all in-water work activities to the authorized in-water work window for the LDW, when listed salmonid species are least likely to be present in the Action Area;
- Use of submerged placement of the ENR and ENR+AC materials will minimize the loss of AC as the ENR+AC descends through the water column and will also prevent or minimize turbidity plumes that may result as fine material in the ENR and ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed;
- Prewetting of the ENR+AC material prior to placement to minimize loss of AC during placement of the ENR+AC materials; and

- Implementation of a water quality monitoring plan during the ENR and ENR+AC material placement to assess turbidity downcurrent of the pilot plots. The water quality monitoring results will be provided to Ecology and EPA.

The following BMPs will be implemented:

- All mechanized equipment will be maintained in proper operating condition, with equipment inspections occurring prior to each workday. Equipment found to be leaking petroleum products or hydraulic fluid will be removed from the site for maintenance.
- Drip pads or pans will be placed under mechanized equipment to contain any potential leaks of petroleum products or hydraulic fluids.
- To the extent possible, vegetable-based hydraulic fluids will be used.
- A spill kit will be kept on work vessels to contain any potential petroleum spills that might occur.
- Ecology and the U.S. Coast Guard will be contacted immediately in the event of a spill.
- Any project-related debris or wastes will be placed in appropriate containers for off-site disposal. No project-related debris or wastes will be allowed to enter the water.
- Barges and work vessels will not be allowed to run aground on the substrate. Work barges will be held on station with spuds or anchors.

4.0 ACTION AREA

The Action Area is the defined geographic area that may be directly or indirectly affected by the Pilot Study. For the purpose of establishing baseline conditions from which to evaluate the potential effects of the project, the project activities as well as the physical site conditions such as substrate composition and bathymetry were reviewed.

In-water and above-water Action Areas can be defined based on project activities that would result in noise, soil, or sediment disturbance and changes in water quality or air quality. The in-water and above-water Action Areas for the Pilot Study are described in Sections 4.1 and 4.2, respectively.

4.1 IN-WATER ACTION AREA

The in-water Action Area for the Pilot Study is defined primarily by the area of placement and potential impacts on water quality caused by increased turbidity during the placement of ENR and ENR+AC materials. Although there may be some underwater noise associated with the movement of tugs and barges, as well as that resulting from the placement of the ENR materials, the quality and level of underwater noise associated with these activities is not expected to be greater than the existing background conditions within the LDW.

Defining the extent of the in-water Action Area was based on water quality monitoring data associated with recent backfilling projects in the LDW, such as those for Terminal 117 (T-117) and the Boeing Company's Plant 2 project. Water quality monitoring was required to assess exceedances of the turbidity standards for each of these projects during the placement of backfill. The monitoring data indicate that any turbidity plumes associated with these operations was not likely to extend more than 500 feet downcurrent of the operations. Based on those data, the proposed in-water Action Area is defined as an area 500 feet downcurrent of each of the pilot plots (Figures 3, 4, and 5). The Action Area around each of the pilot plots will extend 500 feet both north and south of the plots to reflect the directions of the water currents during ebbing and flowing tides (Figures 3, 4 and 5).

4.2 ABOVE-WATER ACTION AREA

The U.S. Fish and Wildlife Service (USFWS) indicates that a number of listed terrestrial species occur in King County (Section 5.0); however, these species are very unlikely to occur within the project area. Therefore, no above-water Action Area has been designated.

5.0 LISTED SPECIES AND CRITICAL HABITAT

This section discusses species listed under the ESA that may occur in the Action Area, including specific life-history stages that may occur in the Action Area. The presence of critical habitat within the Action Area is also addressed. The National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries) (http://www.nmfs.noaa.gov/pr/species/esa/listed.htm#fish) and USFWS (http://www.fws.gov/wafwo/speciesmap/KING.html) were consulted for lists of ESA-listed species occurring in the Action Area (Attachment A). Additionally, the Washington Department of Fish and Wildlife's (WDFW) Priority Habitat and Species (PHS) program (http://wdfw.wa.gov/mapping/phs/) was contacted for a list of sensitive species and habitats within the site vicinity (Attachment A). The species that could potentially occur in the Action Area are listed in Table 2.

NOAA-Fisheries indicates the following listed species as occurring or potentially occurring in Puget Sound:

- Southern resident killer whale (*Orcinus orca*);
- Leatherback sea turtle (*Dermochelys coriacea*);
- Humpback whale (*Megaptera novaeangliae*);
- Pacific eulachon (*Thaleichthys pacificus*); and
- Southern distinct population segment (DPS) of green sturgeon (*Acipenser medirostris*).

Although these species occur or may occur in Puget Sound, it is highly unlikely that any of these species occur in the Action Area. The Pilot Study will likely have no effect on the southern resident killer whale, leatherback sea turtle, humpback whale, Pacific eulachon, or the southern DPS of green sturgeon.

The USFWS has determined that several listed species, other than those listed in Table 2, occur in King County:

- Canada lynx (*Lynx canadensis*);
- Gray wolf (*Canis lupus*);
- Grizzly bear (*Ursus arctos*);
- Marbled murrelet (*Brachyramphus marmoratus*); and
- Northern spotted owl (*Strix occidentalis caurina*).

With the exception of the grizzly bear, for which critical habitat has been proposed but has not yet been designated, designated critical habitat for the remaining species does not occur in the Action Area. It is extremely unlikely that these species occur in the Action Area. Of the above-listed species, only the marbled murrelet has the potential of occurring in the Action Area. Marbled murrelet monitoring conducted in Puget Sound during 2013 as part of the Northwest Forest Plan monitoring program reported a population density within Stratum 3 of Conservation Zone 1 (Puget Sound south of Whidbey Island and portions of Hood Canal) of less than one bird per square kilometer (Falxa et al., 2014). The primary monitoring unit (PMU) closest to the LDW is located on the western shore of Puget Sound between the south end of Bainbridge Island and the Kitsap Peninsula. Monitoring data for this PMU also indicated a murrelet density of less than one bird per square kilometer (Falxa et al., 2014). Under the Northwest Forest Plan, no murrelet monitoring is conducted within the LDW, and no other sources reporting the occurrence of marbled murrelet within the LDW were found; however, it is expected that marbled murrelets rarely occur in the LDW. Therefore, it was determined that the Pilot Study would have no effect on these species.

5.1 Life-History Stages of Listed Species Occurring in Action Area

Brief life histories of each of the listed species addressed in this BE are provided in Attachment B. This section presents information on the life-history stages of species that may occur in the Action Area.

5.1.1 Chinook Salmon

The Green/Duwamish River system supports summer/fall run Chinook salmon (*Oncorhynchus tshawytscha*), which is a historically native stock (WDFW, 2014). The adult escapement numbers for Green/Duwamish River Chinook from 1994 through 2014 are provided in Table 3. Broodstock from the original Soos Creek hatchery Chinook program came from native Green River adults captured on the river or diverted into Soos Creek in the early 1900s. Eggs from out-of-basin hatcheries have occasionally been imported to supplement egg takes at Soos Creek, but the hatchery stock has remained, to a very large extent, a local Soos Creek stock. There is a significant amount of genetic interchange between wild and hatchery-origin Chinook that return to the hatchery and spawn each year, as well as between stray hatchery adults and wild fish that intermingle on spawning grounds (WDFW, 2014).

Most Chinook spawning generally occurs in the mainstem Green River from river mile (RM) 25 to RM 61 and in the lower 6 miles of Newaukum and Soos creeks (WDFW, 2010). The run timing of the different freshwater phases of Chinook salmon in the Green/Duwamish River is indicated in Figure 6.

5.1.2 Steelhead Trout

Both summer and winter steelhead trout (*Oncorhynchus mykiss*) use the Green/Duwamish River. The summer steelhead stock is a non-native stock. Smolts originating from the Skamania hatchery (lower Columbia River Basin) were first released into the Green River in 1965. Before the introduction of hatchery-origin steelhead, there was no evidence that summer steelhead were present in this system. This stock is presumed to have arisen from uncaught hatchery-origin adults that spawn, with limited success, in the system. The stock status was listed as depressed in 2002 (WDFW, 2002).

The winter steelhead stock is a native stock with wild production. The hatchery winter steelhead program on the Green River uses fish originating from the Chambers Creek hatchery. Adult broodstock is trapped at the Palmer Rearing Ponds on the Green River and at out-of-basin hatcheries. Because hatchery-origin adults return to the river and spawn earlier than the native stock, it is believed that there has been very little genetic introgression between the hatchery-original fish and wild stocks. The stock status was listed as healthy in 2010 (WDFW, 2010).

The run timing of the different freshwater phases of both summer and winter steelhead in the Green/Duwamish River is indicated in Figure 6. The adult escapement numbers for Green/Duwamish River winter steelhead from 1994 through 2014 are provided in Table 3.

5.1.3 Coastal/Puget Sound Bull Trout and Dolly Varden

This section discusses both the Coastal/Puget Sound bull trout (*Salvelinus confluentus*) and the Dolly Varden trout (*S. malma*). The USFWS announced in January 2001 that it proposed to protect the Dolly Varden trout in the Coastal/Puget Sound region of Washington under the "similarity of appearance" provision of the ESA, because the Dolly Varden so closely resembles the bull trout.

Information on the presence, abundance, distribution, and life history of bull trout in the Green River basin is extremely limited. There is no information on the timing or distribution of spawning, if any, in the Green River. Howard Hanson Dam has been a complete barrier to the upstream passage of salmonids since its construction in 1961. The City of Tacoma's municipal water diversion has also been a barrier to anadromous fish since 1911. Anecdotal reports of bull trout harvested in the Green River may refer to fish that have strayed into the Green River but were produced in a different basin. There is no confirmation or quantitative measure of bull trout natural production or juvenile rearing in the Green River basin (WDFW, 2004).

Isolated observations of adult bull trout have been reported in the lower Duwamish, including one adult captured at RM 5 in 1994 and two adult bull trout/Dolly Varden (species unconfirmed) at RM 2.1 and 4.0 in the early 1980s. Eight adults were captured near Turning Basin 3 during two sampling events in August and September 2000. It is unknown whether these fish were of Green/Duwamish River origin, non-Green/Duwamish River fish temporarily in the Duwamish River, or strays attempting to recolonize the basin (SEA, 2004).

Although bull trout do not spawn in the Duwamish-Green River watershed, they may be attracted to the Duwamish River during periods of juvenile salmonid outmigration. The Action Area provides foraging, migrating, and overwintering (FMO) habitat for anadromous bull trout originating from other core areas, such as the Puyallup, Snohomish-Skykomish, and Skagit rivers. Non-core FMO habitat provides important foraging and overwintering opportunities and is essential to maintaining connectivity between the Puget Sound Management Unit's core areas and populations (USFWS, 2011).

It is expected that bull trout use the Action Area infrequently and in relatively low numbers. Available data suggest that bull trout presence in the Duwamish Waterway generally coincides with the outmigration of juvenile salmonids. Anadromous bull trout generally return to their core areas and natal waters by mid-fall, and bull trout presence in the Duwamish Waterway has never been documented during the previous in-water work window (November 1 to February 15) for maintenance dredging operations conducted by the U.S. Army Corps of Engineers (USFWS, 2011).

5.1.4 Puget Sound Rockfish

Three species of Puget Sound rockfish have been listed under the ESA (Table 2): bocaccio (*Sebastes paucispinis*), canary (*S. pinniger*), and yelloweye (*S. ruberrimus*). These species of rockfish are typically associated with deep water (at least 50 meters) marine habitats (NOAA-Fisheries, 2009a, 2009b, 2009c). A survey of nonsalmonid fishes in the Green/Duwamish River system did not report any rockfish species (SEA, 2004); however, the brown rockfish (*S. auriculatus*) and an unidentified rockfish species (*Sebastes* spp.) were reported to occur rarely in the LDW (Windward, 2010).

5.2 Critical Habitat within the Action Area

This section discusses the occurrence of critical habitat for salmonids and the primary constituent elements (PCEs) of species-specific critical habitats within the Action Area.

The Action Area contains critical habitats for the Puget Sound Chinook salmon and the Coastal/Puget Sound bull trout. The PCEs for each of these species are listed below, although not all of the PCEs listed occur within the Action Area.

The PCEs of critical habitat for Puget Sound Chinook salmon are the following:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, logjams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Of these PCEs for Puget Sound Chinook salmon, only the attributes described in PCE 4 occur in the Action Area. There are no freshwater or marine habitats within the Action Area.

The PCEs of critical habitat for Coastal/Puget Sound bull trout are the following:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
2. Migratory habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including, but not limited, to permanent, partial, intermittent, or seasonal barriers.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks, and substrates to provide a variety of depths, gradients, velocities, and structure.
5. Water temperatures ranging from 2 to 15 degrees Celsius (°C), or 36 to 59 degrees Fahrenheit (°F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shade, such as that provided by riparian habitat; and local groundwater influence.
6. Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 millimeter (0.03 inch) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.
7. A natural hydrograph, including peak, high, low, and base flows within historical and seasonal ranges or, if flows are controlled, they minimize departures from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Few or no non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); inbreeding (e.g., brook trout); or competitive (e.g., brown trout) species present.

Of the PCEs listed above for Coastal/Puget Sound bull trout, only the attributes described in PCE 6 would not apply in the Action Area.

Critical habitat for Puget Sound steelhead trout has not yet been designated, although critical habitat for this distinct population segment was proposed on January 14, 2013 (50 CFR 2726 2796).

Critical habitat was designated for the yelloweye rockfish, the canary rockfish, and the bocaccio in the Puget Sound/Georgia Basin in November 2014; however critical habitat for these species does not extend into the Action Area (NOAA-Fisheries, 2014).

6.0 ENVIRONMENTAL BASELINE

This section provides a brief description of the general habitat and environmental conditions within the project area and Action Area. It also provides descriptions of habitat elements, significant to the species being addressed, that could be affected by the Pilot Study or that would affect the use of the Action Area by listed species. The information provided in this section has been summarized primarily from the *Final Lower Duwamish Waterway Remedial Investigation Report* (Windward, 2010) and the *Final Feasibility Study, Lower Duwamish Waterway* (AECOM, 2012). The remedial investigation (RI) and feasibility study (FS) reports present extensive information on the history of development within the LDW, water current conditions, habitat, flora and fauna, and chemicals detected in surface water, sediment, and tissue samples collected throughout the LDW since the early 1990s. For more detailed information about the LDW in the vicinity of the Pilot Study sites, the RI and FS may be viewed online at http://www.ldwg.org/.

6.1 GENERAL

In the early years of the twentieth century, the last 6 miles of the Duwamish River were straightened and channelized into a commercial corridor for ship traffic, officially designated as the LDW and the East and West Waterways (located near the river mouth). A federally authorized navigation channel runs down the center of the LDW; it is 200 feet wide in the downstream reaches and 150 feet wide in the upstream reaches, where it terminates in the Upper Turning Basin at RM 4.6 to RM 4.65. This channel is maintained at depths between -30 feet mean lower low water (MLLW) in the downstream reaches and -15 feet MLLW in the upstream reach.

The proposed Pilot Study areas are located in the LDW, which was added to the National Priorities List as a Superfund site on September 13, 2001. The LDW Superfund site encompasses 441 acres, is about 5 miles long and approximately 400 feet wide (with many variations in width where slips and Kellogg Island occur), and consists of the downstream portion of the Duwamish River, excluding the East and West Waterways, which are part of the Harbor Island Superfund site.

Outside the navigation channel, the benches along the channel consist of sloped subtidal embankments created by the navigation channel deepening, shallow subtidal and intertidal areas (including five slips along the eastern shoreline, three embayments along the western shoreline), and an island, Kellogg Island, at the downstream end on the western side of the navigation channel. In addition, a comparatively deep area (up to -45 feet MLLW) is present outside the navigation channel between RM 0.0 and RM 0.4.

The Upper Turning Basin serves as a trap for most of the bed load sediment carried downstream by the Green/Duwamish River. The Upper Turning Basin and portions of the navigation channel just downstream of the Upper Turning Basin are dredged periodically to remove accumulated sediment, reduce sediment transport into the lower reaches of the LDW, and maintain appropriate navigation depths.

The LDW flows through an industrial and mixed-use residential area in Tukwila, unincorporated King County, and the southern portion of Seattle. The LDW corridor is one of Seattle's primary industrial areas. Two Seattle neighborhoods, South Park and Georgetown, are also adjacent to the LDW to the west and east, respectively. These neighborhoods support a mixture of residential, recreational, commercial, and industrial uses.

The LDW is used for vessel traffic, primarily bulk carriers, tugs, barges, small container ships, and, to a lesser extent, recreational vessels. The LDW supports considerable commercial navigation but is also used for various recreational activities such as boating, kayaking, fishing, and beach recreation. The LDW, which connects Puget Sound to the Green River, is also an important migratory pathway for salmon.

The LDW is frequently used by Native American tribes as a resource and for cultural purposes. The Muckleshoot Indian Tribe and the Suquamish Tribe, which are federally recognized tribes, are natural resource trustees for the Duwamish River. The Muckleshoot Indian Tribe currently conducts seasonal commercial, ceremonial, and subsistence netfishing operations in the LDW. The Suquamish Tribe actively manages resources north (downstream) of the Spokane Street bridge, located just north of the LDW Superfund site.

The slips on the east side of the LDW, originally old meander remnants, do not retain their natural character, having armored shorelines that have been filled to steep bank slopes. The shorelines of the slips are dominated by berthing areas and overwater structures. Approximately 3.7 miles of exposed bank are currently present in the LDW, of the approximate 18 miles of combined shoreline and dock face. Very little of this exposed bank is in the location of the original natural meandering riverbank.

Habitats along the LDW have been modified extensively since the late 1800s as the result of hydraulic changes, channel dredging, filling of surrounding floodplains, and construction of overwater and bank stabilization structures. The only evidence of the river's original, winding course is present in the remnants of some of the natural meanders along the LDW (several of which are now used as slips) and the area around Kellogg Island. Remnants of habitat also remain in the LDW, and portions of intertidal habitat are the focus of recent restoration efforts, some of which have already been completed.

The dominant natural habitat types in the LDW are intertidal mudflats, tidal marshes, and subtidal areas. About 98 percent of the approximately 1,270 acres of tidal marsh and 1,450 acres of mudflats and shallows, as well as all of the approximately 1,230 acres of tidal wetland historically present in the Duwamish estuary, have either been filled or dredged. Areas of remnant tidal marshes account for only 5 acres of the LDW, while mudflats account for only 54 acres.

Intertidal habitats are dispersed in relatively small patches downstream of RM 3.0, with the exception of the area around Kellogg Island, which represents the largest contiguous area of intertidal habitat remaining in the LDW. In these intertidal habitat areas, fish and wildlife can be exposed to contaminants either through direct contact with sediment or through consumption of prey. However, these areas also provide wildlife habitat in an otherwise industrial waterway.

Kellogg Island is currently designated as a wildlife refuge. Habitat associated with the island encompasses high and low marshes, intertidal mudflats, and filled uplands. A mixture of introduced and native plant and tree species has colonized this 17.3-acre island.

Approximately 208 direct discharge points are located along the LDW shoreline, of which 203 are public or private outfalls, and 5 are ditches, creeks, or streams. In addition, 7 major seeps and 22 abandoned outfalls have been identified during shoreline surveys.

Historical or current commercial and industrial operations include cargo handling and storage, marine construction, boat manufacturing, marina operation, paper and metals fabrication, food processing, and airplane manufacturing. Contaminants may have entered the LDW via several transport mechanisms, including spillage during product shipping and handling, direct disposal or discharge, contaminated groundwater discharge, surface water runoff, stormwater discharge, or contaminated soil erosion (EPA, 2001).

6.2 WATER QUALITY

This section describes existing conditions at each of the pilot plot areas and expected effects of the Pilot Study related to water quality and stormwater discharge to the LDW.

6.2.1 Existing Conditions

A search of Washington State's Water Quality Assessment [303(d) & 305(b) Integrated Report] (Ecology, 2012) for each of the pilot plot areas identified no water quality chemistry specific to these areas; however, the LDW has been listed as not meeting the state water quality criteria for ammonia nitrogen (Category 4A), bacteria (Category 5), bis(2-ethylhexyl) phthalate (Category 2), and dissolved oxygen (Category 5).

Ecology's water quality assessment list divides water body impairments into a number of categories. The category listings for each of the four constituents not meeting their respective state water quality criteria are defined as follows:

- Category 2 – Waters of concern: waters where there is some evidence of a water quality problem but not enough to require production of a water quality improvement (WQI) project (including total maximum daily load [TMDL]) at this time. There are several reasons why a water body would be placed in this category. A water body might have pollution levels that are not quite high enough to violate the water quality standards, or there may not have been enough violations to categorize it as impaired according to Ecology's listing policy. There might be data showing water quality violations, but the data were not collected using proper scientific methods. In all of these situations, these are waters that we want to continue to test.
- Category 4a – Water bodies that have an approved TMDL in place that is being actively implemented.
- Category 5 – Polluted waters that require a TMDL or other WQI project.

According to Washington State's Water Quality Assessment [303(d) & 305(b) Integrated Report] (Ecology, 2012), an area just below the Turning Basin in the LDW is listed as Category 5 for dissolved oxygen and bacteria.

Windward (2010) summarized surface water chemistry data for the LDW, reporting detectable concentrations of most metals, polycyclic aromatic hydrocarbons (PAHs), phthalate esters, phenol, total PCBs, and some pesticides but no exceedances of state or federal ambient water quality criteria for the protection of aquatic life for any of the chemicals.

6.2.2 Effects of the Action

The ENR and ENR+AC materials will consist of clean sand or clean gravelly sand (depending on the plot location) without and with activated carbon, respectively. Placement of both the ENR and ENR+AC materials may result in temporary and localized increases in turbidity as fine materials in the ENR and ENR+AC materials become suspended in the water column as the materials descend through the water column and settle on the substrate.

Turbidity (total suspended solids) may be increased on a temporary and localized basis during placement of the ENR and ENR+AC materials, but any increased turbidity would be very limited in extent and duration. Furthermore, concentrations of total suspended solids sufficient to cause adverse effects on the species of concern are not expected to occur (see Section 7.0). Therefore, the temporary increases in turbidity during placement of the ENR and ENR+AC materials are expected to be insignificant and are not expected to result in long-term degradation of the existing water quality conditions within the Action Area or to adversely affect listed species.

6.3 Shoreline and Bathymetry, Sediment and Substrates, and Habitat Diversity

This section describes existing conditions at each of the pilot plot areas and expected effects of the Pilot Study related to shoreline conditions, bathymetry, sediment and substrates, and habitat diversity within the Action Area

6.3.1 Existing Conditions

6.3.1.1 Shoreline and Bathymetry

The depths of the Pilot Study plots are provided in Table 1.

The scour plot will be located at RM 0.1 near the south end of Harbor Island on the eastern shoreline of the LDW and adjacent to an industrial pier (Figure 5). The eastern shoreline of the LDW near the scour plot is heavily industrialized, with no riparian vegetation adjacent to the scour plot. West of the scour plot and across the channel is a marina consisting of riprapped banks above which are landscaped areas consisting of some trees and grass. The areas west of the scour plot are primarily commercial.

The subtidal plot will be located at RM 1.2 toward the middle of the LDW in an area heavily industrialized on both the eastern and western shorelines (Figure 4). The western shoreline is dominated by industrial piers, and the eastern shoreline consists of a combination of industrial piers and riprapped banks, with some vegetation located on top of the banks.

The intertidal plot will be located at RM 3.9 in an industrialized area of the LDW on an intertidal bench on the eastern shoreline of the LDW (Figure 3). Wooden and steel bulkheads are located on the eastern bank above the bench, with some riparian vegetation located on top of the bank. The western shoreline is also industrialized and is similar to the eastern shoreline, with armored or bullheaded banks on top of which is riparian vegetation.

6.3.1.2 Sediment and Substrate

The Pilot Study will evaluate the effectiveness of ENR+AC compared to ENR alone in remediating contaminated sediments in the LDW. The contaminants of primary concern in the pilot plot areas are PCBs. The PCB concentrations in surface (0 to 10 centimeters) sediments in each of the pilot plot areas are summarized in Table 4. A more detailed presentation of sediment chemistry and remedial action levels for the three pilot plot areas is provided in the Final Plot Selection Memo (LDWG, 2015).

The ENR and ENR+AC materials will consist of various combinations of clean sand, gravel, and AC. Placement of the ENR and ENR+AC materials may change the sediment characteristics in the pilot plot areas. As an example, sediment in the intertidal plot consists primarily of fine, cohesive material (Table 1). The ENR and ENR+AC materials will alter the sediment characteristics over the three 1-acre pilot plots by covering the finer, cohesive sediments with coarser material.

It is expected that placement of the ENR and ENR+AC materials may alter the sediment physical and conventional characteristics (e.g., grain size and total organic carbon) in the areas being treated compared to those in the surrounding sediments. Because placement of the new material will not change the local depositional environment, it is expected that over time the physical characteristics of the sediments will return to those that existed prior to implementation of the Pilot Study due to the natural estuarine process and sedimentation. Placement of ENR and ENR/AC ENR+AC on 3 acres of sediments that are contaminated with PCBs will reduce the exposure of aquatic organisms to PCBs within those areas.

6.3.1.3 Habitat Diversity

Habitat diversity and complexity in the three pilot plots is limited, with the surrounding habitat at each plot lacking such features as side-channel habitat, floodplain connectivity, large woody debris, and sinuosity. The scour and subtidal plots are located in heavily industrialized areas of the LDW with both shorelines dominated by overwater structures and armored banks with little or no riparian vegetation. Although located in an industrialized area, the intertidal plot offers the greatest habitat diversity of the three pilot plot areas for juvenile salmonids, with shallow-water benches potentially providing foraging habitat and riparian vegetation providing shade, a source of terrestrial insects, and allochthonous organic material.

6.3.2 Effects of the Action

This section discusses the potential effects of the Pilot Study related to shoreline conditions, bathymetry, sediment and substrates, and habitat diversity within the Action Area.

6.3.2.1 Shoreline and Bathymetry

Installation of the intertidal plot may temporarily affect approximately 1 acre of intertidal shoreline, covering the existing sediments with clean sand and gravel with and without AC. The ENR material will not change the shoreline slope but could change the physical nature of the existing sediment, as well as the depth (less than 1 foot of elevation change) of the pilot plot during tidal inundation. Alteration of the bathymetry will be negligible and will affect only a small fraction of the total intertidal habitat within the LDW; the habitat will continue to be intertidal.

Placement of ENR and ENR+AC materials in the subtidal and scour plots may temporarily and slightly affect the bathymetry (less than 1 foot of elevation change) of the 2 acres making up the two plots. Alteration of the bathymetry will be negligible and will affect only a small fraction of the total subtidal habitat within the LDW; the habitat will continue to be subtidal.

6.3.2.2 Sediment and Substrate

Placement of ENR and ENR+AC may alter the physical characteristics of the sediment, such as grain size, over a total area of 3 acres within the LDW; however, this alteration will be temporary and minor in comparison to the total area of intertidal and subtidal habitats within the LDW. The mean percentage of fines for each of the pilot plot areas is provided in Table 1. The fines fraction of sediments consists of silts and clays and is defined as sediment particles with a diameter less than 63 micrometers (µm). The mean percentage of fines at the three pilot plots range from 32.9 to 63.8 percent. The fines fraction of the ENR and ENR+AC materials is expected to be less than 2 percent. The 3 acres of intertidal and subtidal habitats that will be affected by the Pilot Study represent only 0.68 percent of the 441 acres within the LDW Superfund site (AECOM, 2012). Sedimentation in the LDW will, over time, deposit sediments over the ENR and ENR+AC materials in the pilot plot areas, likely resulting in surficial sediments in the pilot plot areas that are identical to the surficial sediments in adjacent areas. The modeled net sedimentation rate for each of the pilot plots and the empirical net sedimentation rate for the intertidal plot are presented in Table 1. The alteration of the sediment physical characteristics is expected to be negligible because of the relatively small areas being treated and will affect only a small fraction of the total intertidal and subtidal habitats within the LDW.

6.3.2.3 Habitat Diversity

The Pilot Study is expected to have no effect on habitat diversity within the Action Area, because the Pilot Study will neither diminish nor increase the existing habitat diversity in the Action Area.

6.4 ACCESS AND REFUGIA

This section describes existing conditions and expected effects of the Pilot Study related to access by and refugia for listed species.

6.4.1 Existing Conditions

No fish passage barriers or other obstacles occur in the Action Area that would limit access by listed species or other aquatic species. The Action Area provides shallow-water habitat for migrating juvenile salmonids, as well as other fishes and aquatic biota. Refugia within the Action Area are limited to the existing nearshore structures or recently constructed habitat restoration projects. Refugia such as large woody debris, overhanging vegetation, and side-channel habitats are very limited to nonexistent within the Action Area.

6.4.2 Effects of the Action

The Pilot Study will be implemented during the authorized in-water work window when very few listed salmonid species are expected to occur in the Action Area. Construction activities may temporarily discourage listed species from approaching the construction areas during active construction, causing them to alter their course around the construction area, but the activities will not prevent their access to the Action Area. The Pilot Study will have no effect on access or refugia within the Action Area.

6.5 FLOW, CURRENT PATTERNS, SALTWATER–FRESHWATER MIXING

This section describes existing conditions and expected effects of the Pilot Study related to water flow, water current patterns, and saltwater-freshwater mixing within the LDW.

6.5.1 Existing Conditions

Water circulation within the LDW, a well-stratified estuary, is driven by tidal actions and river flow; the relative influence of each is highly dependent on seasonal river discharge volumes. Fresh water moving downstream overlies the tidally influenced salt water entering the system. Typical of tidally influenced estuaries, the LDW has a relatively sharp interface between the freshwater outflow at the surface and the saltwater inflow at depth (Windward, 2010).

The tidally influenced water (or salt wedge) area of the LDW typically extends from Harbor Island to near the head of the navigation channel. When freshwater inflow is greater than 28.3 cubic meters per second (1,000 cubic feet per second), the saltwater wedge does not extend upstream beyond the East Marginal Way South bridge (RM 6.3) regardless of the tide height (Windward, 2010). During high tide stages and periods of low freshwater inflow, the saltwater wedge has been documented as extending as far upstream as the Foster Bridge (RM 8.7). At the mouth of the

LDW at the northern end of Harbor Island, a salinity of 25 parts per thousand is typical for the entire water column; salinity decreases toward the upriver portion of the estuary. The thickness of the freshwater layer increases throughout the LDW as the river flow rate increases (Windward, 2010).

Dye studies indicate that downward vertical mixing over the length of the saltwater wedge is almost nonexistent (Windward, 2010). Studies in the LDW have described how the upstream location or "toe" of the saltwater wedge, typically located between Slip 4 and the head of the navigation channel, is determined by both tidal elevation and freshwater inflow. Fluctuations in tidal elevation also influence flow in the upper freshwater layer, which varies over the tidal cycle (Windward, 2010).

The U.S. Geological Survey measured the average net upstream transport of salt water below the Spokane Street bridge and reported it as approximately 5.4 cubic meters per second (190 cubic feet per second). This average net upstream flow was about 12 percent of the average downstream flow measured at the Tukwila gaging station. During seasonal low-flow conditions, saltwater inputs from the West Waterway of the LDW were more than one-third of the total discharge from the LDW (Windward, 2010).

6.5.2 Effects of the Action

The project is not expected to affect flow, current, or saltwater-freshwater mixing in the Action Area.

6.6 MARINE MACROALGAE AND MACROPHYTES

This section describes existing conditions relevant to macroalgae (e.g., laminarians) and macrophytes (e.g., eelgrass) and expected effects of the Pilot Study in the Action Area.

6.6.1 Existing Conditions

There have been no surveys conducted in the Action Area to quantify macroalgal or macrophyte communities; however, extensive trawling and anecdotal observations suggest that neither macroalgal nor macrophyte communities would likely occur within the Action Area because of the characteristics of each of the pilot plot areas. The subtidal plot is within the navigation channel, in deep water where light penetration for submerged aquatic plant growth is limited (approximately -30 feet MLLW). The scour plot is within a scour area where tugs/barges frequently operate and where establishment of submerged aquatic vegetation is unlikely due to sediment disturbance. The intertidal plot is located RM 3.9, which is farther upstream, and hence is less likely to support brackish/marine submerged aquatic vegetation.

6.6.2 Effects of the Action

The Pilot Study is expected to have no effect on macroalgal or macrophytes communities, because it is highly unlikely that such communities exist in the Action Area.

6.7 Benthic Fauna

This section describes existing conditions relevant to benthic fauna in the LDW and expected effects of the Pilot Study.

6.7.1 Existing Conditions

Numerous studies have investigated the use of the LDW by benthic invertebrates. The benthic invertebrate communities observed in the LDW consisted of 670 taxa, representing 178 families in 13 phyla. Typical of estuarine environments, the benthic invertebrate community was dominated by annelid worms, mollusks, and crustaceans. Crustaceans were the most diverse of these three groups in the LDW, including more than 250 taxa. Mollusks included various bivalves and snails. The most abundant large epibenthic invertebrates included slender crabs, crangon shrimp, and coonstripe shrimp. Dungeness crabs were also common, although their distribution was generally limited to the portions of the LDW with higher salinity (Windward, 2010).

Benthic invertebrates in the LDW form two distinct communities: the infaunal community and the epibenthic community. The infaunal community is typified by burrowing polychaetes and bivalves. At most sampling locations, the infaunal community was dominated by surface detrital/surface-deposit feeding organisms. The epibenthic community (invertebrates living on top of the sediment) consisted mainly of larger crustaceans (crabs and shrimps) and mussels and was dominated by surface detrital and surface filter-feeding organisms (Windward, 2010).

6.7.2 Effects of the Action

This section discusses the potential effects of the Pilot Study on the benthic faunal community of the Action Area.

6.7.2.1 Burial of Benthic Habitat and Temporary Decrease in Benthic Diversity

The Pilot Study will result in the placement of ENR and ENR+AC materials on a total of 3 acres of intertidal and subtidal habitats. The burial of sediments with contaminant concentrations greater than the Sediment Management Standards could have a net beneficial effect on benthic habitat. Post-implementation monitoring of the pilot plot areas will assess whether benthic recolonization differs between the ENR and ENR+AC materials.

It is expected that ENR and ENR+AC materials placed in the pilot plots will be rapidly recolonized by benthic fauna from adjacent areas. The placement of ENR and ENR+AC materials will temporarily reduce the populations of the benthic and epibenthic invertebrate community by the burial and smothering of the benthic substrate in the pilot plot areas. Invertebrate prey for juvenile salmonids and bottom fish will, thus, be temporarily reduced in the 3 acres covered by the pilot plots, although the potential impact on juvenile salmonids is likely to be greater at the intertidal plot because of its location in the shallow nearshore area, a preferred foraging habitat for juvenile salmonids (see Section 7.1.2.1). The concentration of total organic carbon will initially be slightly lower in surficial sediments in the pilot plot areas after placement of the ENR and ENR+AC materials. Thus, the amount of food (in the form of organic matter) available for benthic invertebrates in the pilot plot areas will be slightly reduced temporarily.

While benthic and epibenthic prey species will be temporarily displaced, benthic invertebrate abundance is expected to recover within 1 to 2 years after the placement activities are completed, with community diversity typically taking longer to recover. Adjacent undisturbed intertidal and subtidal habitats will continue to provide an established source of benthic and epibenthic invertebrates to colonize the ENR and ENR+AC materials. Because new benthic invertebrate communities are expected to recolonize the pilot plot areas, no long-term loss of biological productivity or prey base for juvenile salmonids or bottom fish is expected.

Discussions of recolonization of disturbed sediments and the secondary effect of AC on benthic communities are provided below.

Recolonization of Disturbed Sediments

Recolonization of disturbed sediments by benthic biota occurs via four mechanisms: vertical migration of buried assemblages from the underlying natural bottom, horizontal migration from the surrounding ambient bottom, larval recruitment from the plankton, and active and passive dispersion of adult organisms (Scott et al., 1987). The recolonization of disturbed sediments occurs in successional development of colonizing species. The early successional stage of colonization begins with relatively short-lived, shallow burrowing organisms. The second component of the recovery process, which may begin concurrently with the initial colonization, is the progressive development of subsurface bioturbation associated with the reestablishment of the long-lived species. The time scale of this process may be on the order of 1 to 2 years or more (Scott et al., 1987).

Guerra-García et al. (2003), studying benthic recovery after a small-scale (28,255 square feet) dredging project in a chemically polluted, enclosed harbor in North Africa, reported that the macrobenthic community recovered to near predredging conditions within 6 months. Merkel and

Associates (2009), studying benthic recolonization of dredged areas within the San Diego Harbor, reported that the benthic community recovered in 14 to 28 months. Kotta et al. (2009), studying the impacts of large-scale dredging (approximately 2 million cubic yards) on the recovery of benthic communities in the Gulf of Finland in the Baltic Sea, reported that dredging had weak but consistent effects on benthic invertebrate assemblages, and recovery of the communities took place within 1 year after dredging.

Secondary Effects of Activated Carbon on Benthic Communities

Beyond the primary goal of the Pilot Study to reduce contaminant availability and uptake into the tissues of benthic organisms, there may be both beneficial and adverse secondary effects of AC on benthic organisms. There have been a number of field and laboratory studies evaluating the potential secondary effects of AC on individual benthic organisms and benthic communities. Janssen and Buckingham (2013) and Kuprianchyk et al. (2015) provide comprehensive reviews of biological responses to AC and are summarized below.

Laboratory studies evaluating the potential effects of AC exposure on individual benthic organisms have included survival, growth, lipid content, and behavior endpoints in over 90 tests with 20 different species. For nearly all of the species tested (98 percent of tests reviewed), either survival increased with AC treatment or there was no decrease in survival in sediments amended with AC in the range of 1 to 30 percent. This includes studies with mysids, amphipods (*Ampelisca abdita*, *Corophium volutator*, and *Leptocheirus plumulosus*), polychaetes (*Neanthes arenaceodentata* and *Nereis* spp.), molluscs (*Macoma* spp.), and echinoderms. Decreased survival was observed only in studies with the amphipods *Gammarus pulex* (freshwater) and *Leptocheirus plumulosus* (marine). Decreased *L. plumulosus* survival was limited to exposures with carbon particles smaller than 38 µm and at relatively high concentrations (approximately 30 percent AC) (Kennedy et al., 2008). Effects in *G. pulex* were observed in clean sediments supplemented with 3 to 15 percent AC. However, additional studies showed improved *G. pulex* survival in PAH-contaminated sediments treated with 5 to 30 percent AC, indicating that the potential adverse effects observed in unpolluted sediments may be offset by the benefits of AC treatment of contaminated sediments.

Sublethal effects observed in laboratory studies appear to be species specific and were generally associated with higher AC doses and finer AC particle sizes. No effects on growth were observed in tests with amphipods (*L. plumulosus* and *G. pulex*), some polychaetes (*Nereis* spp.), clams (*Macoma* spp. [marine] and *Corbicula fluminea* [freshwater]), mussels (*Mytilus edulis*), snails (*Nassarius nitidus* [marine]), and brittle stars. For estuarine and marine species, adverse effects on growth and lipid content were limited to tests with the polychaete *N. arenaceodentata*. Decreases in both growth and lipid content in exposures to AC-amended sediments were equivocal and appeared to be sediment specific. One study (Janssen et al., 2011, 2012) showed both beneficial and adverse effects in different sediment treatments, with up to 20 percent AC (Janssen et al., 2012). Another study demonstrated growth inhibition with powdered AC at concentrations of 3.4 percent and higher (Millward et al., 2005). Data on the sublethal behavioral effects of AC amendments on estuarine and marine species are limited. One study conducted with *Corophium* spp. showed inconsistent results for avoidance, with effects observed in exposures to 4, 7, and 15 percent powdered AC but no effects in exposures to 25 percent powdered AC (Jonker et al., 2009).

Benthic community impacts have been evaluated after field applications of AC. No changes in benthic taxa richness, composition, or diversity were observed with applications of granulated AC (2 to 4 percent AC) in freshwater and estuarine wetland sediments (Beckingham and Ghosh, 2011; Cho et al., 2009, 2012) or powdered AC (3 to 5 percent AC) in both freshwater wetland and marine sediments (Conder et al., 2015; Menzie et al., 2014). In applications of powdered AC in Upper Canal Creek, Maryland, Menzie et al. (2014) also found no changes in vegetative cover and nutrient uptake by wetland plants, relative to control plots. In situ toxicity tests in conjunction with benthic community monitoring in sediments treated with 3 to 5 percent powdered AC resulted in no significant toxicity for polychaetes or clams (Conder et al., 2015). During in situ freshwater sediment tests with powdered AC mixed into clean sediments, Kupryianchyk et al. (2012) found no effects on community diversity and abundance or on short-term or long-term recruitment. There was a significant decrease in the abundance of oligochaete worms and Pisidiidae clams (freshwater); however, this appeared to be related to AC dose. Similarly, field trials in Trondheim Harbor, Norway, marine sediments showed decreased abundance in AC plots that was related to higher concentrations of powdered AC (up to 40 percent AC) (Cornelissen et al., 2011).

Overall, the laboratory and field studies indicate that secondary effects on benthic organisms and communities are limited. Whereas selected species may show some effects, they are generally associated with fine AC particle sizes and higher AC concentrations.

The AC that will be used during the Pilot Study will consist of larger particle-size granular AC at concentrations of 1 to 3 percent so that the potential effects on benthic organisms that may be associated with powdered AC and high doses is expected to be avoided. The temporary decreases in benthic and epibenthic prey within the pilot plot areas, resulting from both ENR and ENR+AC, are expected to cause an insignificant and discountable effect on local fish populations in the Action Area and are not expected have long-term adverse effects on listed fish species within the Action Area.

6.8 Forage Fish

This section describes existing conditions relevant to forage fish in the LDW and expected effects of the Pilot Study.

6.8.1 Existing Conditions

Pacific sand lances (*Ammodytes hexapterus*) and longfin smelts (*Spirinchus thaleichthys*), though known to be abundant in the LDW, were encountered infrequently in recent beach seine and trawling efforts, as were Pacific herring (*Clupea harengus pallasi*) and surf smelts (*Hypomesus pretiosus pretiosus*). Though these species were not encountered frequently during recent sampling, they are occasionally found in large numbers in the LDW (Windward, 2010).

The Action Area does not provide suitable substrate for Pacific sand lance or surf smelt spawning, and no eelgrass or macroalgal beds are located in the project area to provide spawning habitat for Pacific herring. The Action Area does not provide suitable spawning habitat for any of these species (WDFW, 2005; Pentilla, D., WDFW, email dated October 28, 2002).

6.8.2 Effects of the Action

The Pilot Study will not affect forage fish or their spawning habitats.

6.9 Ambient Noise

This section describes existing conditions relevant to existing underwater and above-water noise in the LDW and expected effects of the Pilot Study.

6.9.1 Existing Underwater Noise Conditions

The best available data indicate that the broadband background underwater sound level in Puget Sound in the nearshore areas (i.e., within 1 kilometer of the shoreline with frequent human activities and shipping or ferry lanes) is approximately 135 decibels – root mean square (dBrms) (WSDOT, 2014). Underwater background sound levels measured in the LDW during impact pile driving for the South Park Bridge Test Pile Project in 2010 were reported to range between 134 and 136 dBrms (WSDOT, 2011), noise levels consistent with the background underwater sound level of 135 dBrms in Puget Sound.

Ambient underwater noise levels in Puget Sound with no construction activity have been reported to range between 131 decibels – peak (dBpeak) and 136 dBpeak. With construction activity (excluding pile driving), the ambient underwater noise levels can range between 133 and 140 dBpeak (WSDOT, 2014). Noise levels produced by human or mechanical sources include those attributable to large tankers and naval ship engines (up to 198 decibels [dB]) and 180+ dB for depth sounders (WSDOT, 2014). Commercial sonar devices operate in a frequency range of 15 to 200 kilohertz and in an acoustical range of 150 to 215 dB (WSDOT, 2014).

6.9.2 Existing Above-Water Noise Conditions

The pilot plots are located in industrialized areas of the LDW. Ambient noise in the LDW is generated from multiple sources including manufacturing, commercial shipping, car and truck traffic, and commercial flight operations (King County International Airport [KCIA] and the approach for Seattle-Tacoma International Airport). KCIA is located approximately 1,500 feet east of the intertidal plot area. Three bridges cross the LDW: the Spokane Street bridge located immediately north of the scour plot area, the First Avenue South bridge located south of the subtidal plot area, and the South Park Bridge located north of the intertidal plot area. A noise survey published in 2004 reported that the estimated annual operations (i.e., take offs and landings) at KCIA in 2008 would be 322,951, or about 885 per day (BDC, 2004). Of the predicted 885 flights per day, 737 would occur during daylight hours, and the remaining 148 flights would occur at night. Additionally, the LDW is located within the approach path for Seattle-Tacoma International Airport, which had a total of 347,046 operations in 2007, or about 951 per day (Port of Seattle, 2008). Other sources of background noise in the vicinity of the project area are the following:

- Local road noise from sources such as East Marginal Way South, which is located east of the LDW with an average annual daily traffic (AADT) volume of 15,900 vehicles (SDOT, 2008);
- A railroad located east of the LDW pilot plot areas and paralleling East Marginal Way South;
- Bridges crossing the LDW, such as the South Park Bridge, which historically had an AADT volume of 18,100 vehicles (SDOT, 2008); and
- Commercial marine traffic within the LDW immediately adjacent to the pilot plots in the LDW.

Parsons Brinckerhoff, Inc. (2004) conducted a noise study in the South Park area as part of the environmental impact statement for the South Park Bridge Project. According to the study, automobile and truck traffic constituted a considerable portion of the noise in the study area, and aviation noise contributed to the overall noise environment in the area. The study monitored noise levels at eight locations, with 10- and 15-minute noise measurements collected at seven of the locations during one or more periods during daylight hours, and noise levels were monitored for a 24-hour period at the eighth location. The highest sound level reported (Parsons Brinckerhoff, 2004) at seven of the stations was 71 dBA (A-weighted noise level in air [WSDOT, 2011]), which was reported at a station located approximately 750 feet from the LDW, and the lowest sound level of 61 dBA was reported at a station located about 1,000 feet from the LDW. The sound level at a station located approximately 40 feet from the LDW was reported to be 62 dBA.

Parsons Brinckerhoff, Inc. (2004) reported sound levels at the eighth station, located approximately 500 feet from the LDW, for every hour over a 24-hour period. The sound levels during the day (0700 to 2200) ranged from a low of approximately 45 dBA to a high of approximately 72 dBA, and those at night (2200 to 0700) ranged from a low of approximately 40 dBA to a high of 80 dBA.

6.9.3 Effects of the Action

Considering the location of the pilot plot areas and the type of construction activities associated with the placement of the ENR+AC materials, noise associated with Pilot Study activities will likely be indistinguishable from the multiple sources of background noise in the industrialized areas of the pilot plots. There will be no pile driving and the clamshell bucket used to deposit the ENR+AC materials will be operated from the barge. Therefore, the Pilot Study is unlikely to affect either existing under-water or existing above-water noise levels.

7.0 EFFECTS OF THE ACTION ON LISTED SPECIES AND THEIR CRITICAL HABITATS

This section discusses long-term and short-term direct and indirect effects on listed species and their critical habitats attributable to project activities and concludes with an effects determination. It discusses only attributes of listed species that are relevant to the Action Area and likely to be affected by the project. Attachment C addresses essential fish habitat, describing habitat for federally managed commercial fish species, potential project impacts, and any proposed conservation measures.

7.1 PUGET SOUND CHINOOK SALMON

This section discusses short-term and long-term direct and indirect effects on Puget Sound Chinook salmon attributable to project activities.

7.1.1 Direct Effects

The long-term and short-term direct effects of the Pilot Study on Puget Sound Chinook salmon are described below.

7.1.1.1 Long-Term Effects

The Pilot Study is expected to result in a net long-term, beneficial direct effect on Puget Sound Chinook salmon by reducing exposure to PCB-contaminated sediments over a total area of 3 acres.

The Pilot Study is expected to have no direct, long-term adverse effects on Puget Sound Chinook salmon.

7.1.1.2 Short-Term Effects

The primary short-term direct effects of the Pilot Study will be temporary and localized water quality impairment (e.g., increased turbidity).

Increased turbidity could affect juvenile salmonids in the immediate project vicinity by decreasing visibility, which could affect behaviors such as foraging and homing, territoriality, and predator avoidance responses. Duration, timing, and particle size and shape have been shown to influence the potential effect of increased turbidity on juvenile Pacific salmon, but there is little specific information on thresholds of physical, physiological, or behavioral tolerances for particular species. It is unknown what threshold of turbidity might exist that serves as a cue to fish to avoid light-reducing turbidity. The primary determinant of risk level for a particular species is likely to lie in the spatial and temporal overlap between the area of increased turbidity, degree of increased turbidity, occurrence of the fish, and options available to fish for carrying out the critical function of their particular life-history stage (Nightingale and Simenstad, 2001).

The available evidence indicates that concentrations of total suspended solids sufficient to cause such effects would be limited in extent during the ENR and ENR+AC materials placement. LeGore and Des Voigne (1973) conducted 96-hour bioassays on juvenile coho salmon (*Oncorhynchus kisutch*) using resuspended estuarine sediments. Acute effects were not observed at suspended sediment concentrations up to 5 percent (28,800 milligrams per liter dry weight). Salo et al. (1979) reported a maximum of only 94 milligrams per liter of sediment in solution in the immediate vicinity of a working dredge in Hood Canal, a turbidity concentration that is extremely unlikely to occur during the ENR and ERN/AC materials placement. Palermo et al. (1986) reported that up to 1.2 percent of sediments dredged by clamshell became suspended in the water column. It is expected that any turbidity associated with the ENR and ENR+AC materials placement would be low because the materials will be cleaned and washed prior to placement on the bed.

However, to reduce potential adverse effects of turbidity on juvenile salmonids, even of limited duration, a number of conservation measures and BMPs will be implemented to help minimize turbidity (see Section 3.4), and project activities will be timed to occur during the approved in-water work window specifically to avoid juvenile outmigration periods. This timing will dramatically reduce the temporal overlap between possible localized increases in turbidity during project implementation and the presence of juvenile salmonids within the Action Area, thereby reducing the potential exposure of juveniles to harmful levels of turbidity to a negligible level. Any increased turbidity is expected to be localized and of short-term duration.

7.1.2 Indirect Effects

The long-term and short-term indirect effects of the Pilot Study on Puget Sound Chinook salmon are described below.

7.1.2.1 Long-Term Effects

The primary long-term indirect adverse effect of the Pilot Study on Puget Sound Chinook salmon will be the long-term (1 to 2 years), temporary disturbance of approximately 3 acres of benthic habitat. Of the three pilot plot areas, the intertidal plot area is likely the preferred foraging habitat potentially used most by juvenile Chinook salmon as foraging habitat. Although the scour and subtidal plots may be used by foraging juvenile salmon, their depths may preclude their use as preferred foraging habitats, as discussed below.

Of all the salmonid species using the Duwamish/Green River system, juvenile Chinook are among the most dependent on the nearshore environment. Although most juvenile Chinook spend only about 2 weeks in the heavily industrialized Duwamish estuary, depending on their life-history trajectory, some may spend months in the Duwamish estuary. Although the peak juvenile outmigration occurs in spring (March–June), juveniles commonly arrive earlier and may be present in the nearshore environment throughout the year if conditions are favorable (King County and WSCC, 2000). Ruggerone et al. (2006) conducted studies in the Duwamish River and estuary during 2005 to collect data on occurrence patterns of juvenile Chinook salmon in habitats of the lower Duwamish River and estuary to identify reaches and habitat types where restoration projects might be most effective. The results of the study indicated that natural subyearling Chinook salmon were considerably more abundant in the nearshore compared with the midchannel habitats of the Duwamish estuary during late January and February.

As discussed in Section 6.7.2, placement of the ENR and ENR+AC materials will temporarily impact benthic habitat by burying benthic and some epibenthic fauna within the pilot plot areas. After placement, the newly exposed sediment surface of the ENR and ENR+AC materials will have a depauperate benthic community, thereby reducing the prey abundance for foraging fish, particularly during the first outmigration period for salmonid fry. Of the three pilot plot areas, a reduction in foraging opportunities for juvenile Chinook salmon likely applies only to the intertidal plot area because of its location in a shallow intertidal area. Although benthic communities in the other two pilot plot areas will be buried, these locations are much less likely to provide preferred foraging habitat for juvenile Chinook salmon. It is unknown how long this condition will persist; however, the benthic community is expected to reestablish itself in the pilot plot areas within 1 to 2 years. During the recolonization period, foraging opportunities for Chinook salmon will be reduced in the pilot plot areas, although this is expected to be less of an issue in the scour and subtidal plot areas and more pronounced in the intertidal plot area. Fish will be forced to forage in adjacent areas of the LDW. The temporary disturbance of benthic habitat in the LDW will be over a relatively small area, with recovery time for the benthic community expected to occur within 1 to 2 years after project completion.

7.1.2.2 Short-Term Effects

No short-term indirect effects on Puget Sound Chinook salmon are expected as a result of the Pilot Study.

7.1.3 Effects Determination

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **may affect** Puget Sound Chinook salmon for the following reasons:

- Suitable Chinook migration and rearing habitats are present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work.
- Foraging opportunities will be temporarily reduced over an area of 1 acre in the intertidal plot area.

The Pilot Study is **not likely to adversely affect** Puget Sound Chinook salmon for the following reasons:

- In-water work activities are being timed to occur when Puget Sound Chinook salmon are least likely to occur in the Action Area.
- Reduced bioavailability of PCBs over 3 acres of PCB-contaminated sediment will be a beneficial effect.
- Water quality disturbances due to increased turbidity will be temporary and localized and will not persist after project completion.
- Temporary disruption of benthic habitat may reduce foraging habitat for juvenile Chinook salmon over an area of 1 acre in the intertidal plot area for up to 2 years.

7.1.4 Effects on Critical Habitat

The PCEs determined essential to the conservation of Puget Sound Chinook salmon are presented in Section 5.2. Of the listed PCEs, only PCE 4 occurs in the Action Area.

The Pilot Study will have no effect on the PCEs that do not occur in the Action Area.

A **may affect** determination is warranted for Puget Sound Chinook salmon critical habitat because the Pilot Study:

- Will occur within designated critical habitat for Puget Sound Chinook salmon;
- May result in reduced water quality in the Action Area due to localized and temporary increases in turbidity; and
- May temporarily reduce foraging habitat within the Action Area.

A **not likely to adversely affect** determination is warranted for Puget Sound Chinook salmon critical habitat because the Pilot Study:

- Will improve habitat conditions in the LDW by reducing exposure to contaminated sediments;
- May cause only temporary and localized increases in turbidity;
- Will result in a long-term (up to 2 years) temporary reduction in foraging habitat on only 1 acre of intertidal habitat; and
- Will be of only short duration, resulting in no long-term adverse impacts on Puget Sound Chinook salmon critical habitat.

7.2 Coastal/Puget Sound Bull Trout and Dolly Varden

This section discusses potential long- and short-term direct and indirect effects of the Pilot Study on Coastal/Puget Sound bull trout and Dolly Varden. When discussing potential project effects on Coastal/Puget Sound bull trout, it is assumed that Dolly Varden would be affected in a similar fashion; therefore, potential effects on Dolly Varden are not discussed separately. Potential project effects on bull trout may be somewhat similar to those described for Puget Sound Chinook salmon but certainly not identical.

7.2.1 Direct Effects

The long-term and short-term temporary direct effects of the Pilot Study on Coastal/Puget Sound bull trout are described below.

7.2.1.1 Long-Term Effects

The Pilot Study is expected to result in a net long-term, beneficial direct effect on Coastal/Puget Sound bull trout by reducing exposure to PCB-contaminated sediments over a total area of 3 acres.

The Pilot Study is expected to have no direct, long-term adverse effects on Coastal/Puget Sound bull trout.

7.2.1.2 Short-Term Effects

The primary short-term direct effects of the Pilot Study will be temporary and localized water quality impairment (e.g., increased turbidity).

As discussed in Section 7.1.1.2, increased turbidity could affect adult and subadult bull trout in the immediate project vicinity by decreasing visibility, which could affect behaviors such as foraging and homing, territoriality, and predator avoidance responses.

However, to reduce potential adverse effects of turbidity on Coastal/Puget Sound bull trout, even of limited duration, a number of conservation measures and BMPs will be implement to help minimize turbidity (see Section 3.4), and project activities will be timed to occur during the approved in-water work window specifically to avoid juvenile outmigration periods, when bull trout would also be most likely to occur in the Action Area. As piscivores, adult and subadult bull trout may enter rivers to prey upon outmigrating salmon smolts. This timing is expected to reduce the temporal overlap between possible localized increases in turbidity during project implementation and the presence of Coastal/Puget Sound bull trout within the Action Area, thereby reducing the potential exposure of bull trout to harmful levels of turbidity to a negligible level. Any increased turbidity is expected to be localized and of short-term duration.

7.2.2 Indirect Effects

The long-term and short-term indirect effects of the Pilot Study on Coastal/Puget Sound bull trout are described below.

7.2.2.1 Long-Term Effects

No long-term indirect effects on Coastal/Puget bull trout are expected as a result of the Pilot Study.

7.2.2.2 Short-Term Effects

Bull trout/Dolly Varden that may enter the Action Area are likely to be adults or subadults and primarily piscivorous. The temporary disturbance of approximately 3 acres of benthic habitat, with the 1-acre intertidal plot the only area that is likely used by juvenile salmon as foraging habitat, is unlikely to reduce the density of juvenile salmon available to foraging bull trout/Dolly Varden in the LDW. Therefore, no short-term indirect effects on Coastal/Puget Sound bull trout or Dolly Varden are expected as a result of the Pilot Project.

7.2.3 Effects Determination

This section presents the effects determinations for Coastal/Puget Sound bull trout and Dolly Varden. Individual effects determinations have to be made because the Coastal/Puget Sound bull trout is listed as threatened under the ESA, whereas, the Dolly Varden is proposed for listing.

7.2.3.1 Coastal/Puget Sound Bull Trout

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **may affect** Coastal/Puget Sound bull trout for the following reasons:

- Suitable bull trout migration and foraging habitats are present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work.

The Pilot Study is **not likely to adversely affect** Coastal/Puget bull trout for the following reasons:

- In-water work activities are being timed to occur when Coastal/Puget bull trout are least likely to occur in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres.
- Water quality disturbances due to increased turbidity will be temporary and localized and will not persist after project completion.

7.2.3.2 Dolly Varden

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **will not jeopardize the continued existence** of Dolly Varden for the following reasons:

- Suitable Dolly Varden foraging habitat is present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work but will not persist beyond project completion.
- In-water work activities are being timed to occur when Dolly Varden are least likely to occur in the Action Area.

7.2.4 Effects on Critical Habitat

This section presents the effects determination for Coastal/Puget Sound bull trout critical habitat. Critical habitat has not been designated for Dolly Varden; therefore, no effects determination is required for Dolly Varden.

The PCEs determined essential to the conservation of Coastal/Puget Sound bull trout are presented in Section 5.2. Of the PCEs listed for Coastal/Puget Sound bull trout in Section 5.2, only the attributes of PCEs 6 and 9 would not apply in the Action Area:

- **PCE 6.** Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 millimeter (0.03 inch) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.

Many of the attributes of the various PCEs for bull trout critical habitat are not well represented in or are absent from the Action Area:

- An abundant food base of riparian origin;
- Complex river, stream, lake, and reservoir aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates, to provide a variety of depths, gradients, velocities, and structure; and
- A natural hydrograph, including peak, high, low, and base flows within historical and seasonal ranges.

Although PCE 9 would apply in the Action Area, the proposed project will have **no effect** on the attributes of PCE 9 because the proposed project will not introduce nonnative predatory species or competitive species.

The Pilot Study may result in the following conditions:

- Localized and temporary increases in turbidity caused by in-water work; and
- Temporary disruption of foraging habitat used by bull trout prey species.

A **may affect** determination is warranted for Coastal/Puget Sound bull trout critical habitat because the Pilot Study:

- Will occur within designated critical habitat for Coastal/Puget Sound bull trout; and

- May temporarily affect foraging behavior within the Action Area and may result in reduced water quality in the Action Area due to localized and temporary increases in turbidity.

A **not likely to adversely affect** determination is warranted for Coastal/Puget Sound bull trout critical habitat because the Pilot Study:

- Will reduce bioavailability of PCBs over 3 acres of PCB-contaminated sediments after placement of the ENR and ENR+AC materials; and
- Will be of only short duration, resulting in no long-term adverse impacts on Coastal/Puget bull trout critical habitat.

7.3 PUGET SOUND STEELHEAD TROUT

This section discusses potential long- and short-term direct and indirect effects of the Pilot Study on Puget Sound steelhead trout. The project-related effects on Puget Sound steelhead trout are expected to be nearly identical to those described in Section 7.1 for Puget Sound Chinook salmon.

7.3.1 Effects Determination

When viewed as a whole, considering both long- and short-term direct and indirect effects, the Pilot Study **may affect** Puget Sound steelhead trout for the following reasons:

- Suitable steelhead migration and rearing habitats are present in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres after placement of the ENR and ENR+AC materials.
- Localized and temporary increases in turbidity may occur as a result of in-water work.
- Foraging opportunities will be temporarily reduced over a 1-acre area in the intertidal plot area.

The Pilot Study is **not likely to adversely affect** Puget Sound steelhead trout for the following reasons:

- In-water work activities are being timed to occur when Puget Sound steelhead trout are least likely to occur in the Action Area.
- Exposure to PCB-contaminated sediments will be reduced over an area of 3 acres.
- Water quality disturbances due to increased turbidity will be temporary and localized and will not persist after project completion.

- Temporary disruption of benthic habitat may reduce foraging habitat for juvenile steelhead trout over a small area of 1 acre in the intertidal plot area for a period of up to 2 years.

7.3.2 Effects on Critical Habitat

Critical habitat has only been proposed for Puget Sound steelhead trout.

The project will not destroy or adversely modify proposed Puget Sound steelhead critical habitat because:

- Anticipated habitat impacts within this proposed critical habitat area will affect non-suitable habitat and will not affect any PCEs.
- The conservation role of the habitat for the species will not be altered by the proposed project.

If Puget Sound steelhead critical habitat is designated prior to completion of this project, a provisional effect determination for critical habitat is the following:

- The project **may affect but is not likely to adversely affect** Puget Sound steelhead critical habitat.

A **may affect** determination is warranted for Puget Sound steelhead trout proposed critical habitat because the Pilot Study:

- Will occur within designated critical habitat for Puget Sound steelhead trout;
- May result in reduced water quality in the Action Area due to localized and temporary increases in turbidity; and
- May temporarily reduce foraging habitat within the Action Area.

A **not likely to adversely affect** determination is warranted for Puget Sound steelhead trout proposed critical habitat because the Pilot Study:

- Will improve habitat conditions in the LDW by reducing exposure to contaminated sediments;
- May cause only temporary and localized increases in turbidity;
- Will result in a temporary (up to 2 years) reduction in foraging habitat on only 3 acres of intertidal and subtidal habitat; and
- Will be of only short duration, resulting in no long-term adverse impacts on Puget Sound steelhead critical habitat.

7.4 Rockfish

Although it is possible that juveniles of the three listed species of rockfish could occur in the Action Area, their presence is highly unlikely. Therefore, no short-term or long-term direct or indirect effects on bocaccio, canary rockfish, or yelloweye rockfish are expected to occur as a result of the Pilot Study.

7.4.1 Effects Determination

The effects determination for the Pilot Study is that it will have **no effect** on bocaccio, canary rockfish, or yelloweye rockfish, because these species likely do not occur in the Action Area.

7.4.2 Effects on Critical Habitat

Although critical habitat has been designated for the three listed species of rockfish, the critical habitat does not extend into the Action Area; therefore, the Pilot Study will have **no effect** on rockfish critical habitat.

8.0 INTERRELATED/INTERDEPENDENT ACTIONS AND CUMULATIVE EFFECTS

Interdependent actions are those from actions with no independent utility apart from the Pilot Study. Interrelated actions include those that are part of a larger action and depend on the larger action for justification. Cumulative effects are those from state or private activities not involving activities of other federal agencies that are reasonably certain to occur within the area of the federal action subject to consultation (Code of Federal Regulations, Title 50, Section 402.02, Definitions).

The Pilot Study is not expected to result in any interdependent or interrelated actions.

Federal actions unrelated to the Pilot Study are not considered in this section because they require separate consultation pursuant to ESA Section 7.

There are no other state or private activities that are reasonably certain to occur within the Action Area as a result of the Pilot Study. Therefore, no cumulative effects are expected as a result of the Pilot Study.

9.0 SUMMARY

The Pilot Study has very low potential to affect listed species or their critical habitat, as discussed in Section 7.0. The determinations of effects for the Pilot Study for each listed species and their critical habitats that may occur in the Action Area are summarized in Table 5.

10.0 REFERENCES

AECOM. 2012. Final feasibility study – Lower Duwamish Waterway. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington and the Washington State Department of Ecology, Northwest Regional Office, Bellevue, Washington, http://www.ldwg.org/ (accessed April 1, 2015).

AECOM. 2014. Candidate plot locations for enhanced natural recovery-activated carbon pilot study. Memorandum to Allison Hiltner (EPA, Region 10) and Ron Timm (Ecology), dated July 24, 2014.

Barnard Dunkelberg & Company (BDC). 2004. Revised Supplement FAR Part 150 Study, King County International Airport/Boeing Field, Seattle, Washington. Prepared for the King County Department of Transportation, King County International Airport/Boeing Field, Seattle, Washington, http://your.kingcounty.gov/airport/noise/part150.stm (accessed June 24, 2010).

Beckingham, B., and Ghosh, U. 2011. Field-scale reduction of PCB bioavailability with activated carbon amendment to river sediments. Environment Science & Technology, v. 45, p. 10567-10574.

Cho, Y.M., Ghosh, U., Kennedy, A.J., Grossman, A., Ray, G., Tomaszewski, J.E., Smithenry, G.W., Bridges, T.S., and Luthy, R.G. 2009. Field application of activated carbon amendment for in-situ stabilization of polychlorinated biphenyls in marine sediment. Environment Science & Technology, v. 43(10), p. 3815-3823.

Cho, Y.M., Werner, D., Choi, Y., and Luthy, R. 2012. Long-term monitoring and modeling of the mass transfer of polychlorinated biphenyls in sediment following pilot-scale in-situ amendment with activated carbon. Journal of Contaminant Hydrology, v. 129, p. 130:25-37.

Conder, J., Grover, M., Kirtay, V., Chadwick, D.B., and Magar, V. 2015. Responses of a native benthic invertebrate community to an activated carbon amendment to sediment.

Presentation: 2014 Annual North America Meeting, Society Environmental Toxicology and Chemistry, Vancouver, British Columbia, Canada.

Cornelissen, G., Krusa, M., Breedveld, G., Eek, E., Oen, A., Arp, H., Raymond, C., Samuelsson, G., Hedman, J., Stokland, O., and Gunnarsson, J. 2011. Remediation of contaminated marine sediment using thin-layer capping with activated carbon – a field experiment in Trondheim Harbor, Norway. Environment Science & Technology, v. 45, p. 6110-6116.

Corps – see U.S. Army Corps of Engineers

Falxa, G., Baldwin, J., Lance, M., Lynch, D., Nelson, S.K., Pearson, S.F., Raphael, M.G., Strong, C., and Young, R. 2014. Marbled murrelet effectiveness monitoring, Northwest Forest Plan: 2013 summary report. http://www.reo.gov/monitoring/reports/marbled-murrelet-reports-publications.shtml (accessed April 1, 2015).

Guerra-García, J.M., Corzo, J., and García-Gómez, C. 2003. Short-term benthic recolonization after dredging in the Harbour of Ceuta, North Africa. Marine Ecology, v. 24, p. 217-229.

Janssen, E.M.L., and Buckingham, B.A. 2013. Biological responses to activated carbon amendments in sediment remediation. Environment Science & Technology, v. 47, p. 7595-7607.

Janssen, E.M., Choi, Y., and Luthy, R.G. 2012. Assessment of nontoxic, secondary effects of sorbent amendment to sediments on the deposit-feeding organism, *Neanthes arenaceodentata*. Environment Science & Technology, v. 46(7), p. 4134-4141.

Janssen, E.M.L., Oen, A.M.P., Luoma, S.N., and Luthy, R.G. 2011. Assessment of field-related influences on polychlorinated biphenyl exposures and sorbent amendment using polychaete bioassays and passive sampler measurement. Environmental Toxicology and Chemistry, v. 30(1), p.173-180.

Jonker, M.T.O., Suijkerbuijk, M.P.W., Schmitt, H., and Sinnige, T.L. 2009. Ecotoxicological effects of activated carbon addition to sediments. Environment Science & Technology, v. 43, p. 5959-5966.

Kennedy, A.J., Hull, M.S., Steevens, J.A., Donstova, K.M., Chappell, M.S., Gunter, J.C., and Weiss Jr., C.A. 2008. Factors influencing the partitioning and toxicity of nanotubes in the aquatic environment. Environment Science & Technology, v. 27(9), p. 1932-1941.

King County and Washington State Conservation Commission (King County and WSCC). 2000. Habitat limiting factors and reconnaissance assessment report - Green/Duwamish and Central Puget Sound watersheds (Water Resource Inventory Area 9 and Vashon Island): Volume II). King County Department of Natural Resources, Seattle, Washington and the Washington State Conservation Commission, Olympia, Washington.

Kotta, J., Herkül, K., Kotta, I., Orav-Kotta, H., and Alps, R. 2009. Response of benthic invertebrate communities to the large-scale dredging of Muuga Port. Estonian Journal of Ecology, v. 58, p. 286-296.

Kupryianchyk, D., Peeters, E.T.H.M., Rakowska, M.O., Reichman, E.P., Grotenhuis, J.T.C., and Koelmans, A.A. 2012. Long-term recovery of benthic communities in sediments amended with activated carbon. Environment Science & Technology, v. 46, p. 10735-10742.

Kupryianchyk D., Rakowska, M.I., Reible, D., Harmsen, J., Cornelissen, G., van Veggel, M., Hale, S.E., Grotenhuis, T., and Koelmans, A.A. 2015. Positioning activated carbon amendment technologies in a novel framework for sediment management. Integrated Environmental Assessment and Management. Article first published online: February 5, 2015 | DOI: 10.1002/ieam.1606.

LeGore, R.S., and Des Voigne, D.M. 1973. Absence of acute effects on threespine sticklebacks (*Gasterosteus aculeatus*) and coho salmon (*Oncorhynchus kisutch*) exposed to resuspended harbor sediment contamination. Journal of the Fisheries Research Board of Canada, v. 30, p. 1240-1242.

Lower Duwamish Waterway Group (LDWG). 2015. Final plot selection for Lower Duwamish Waterway enhanced natural recovery-activated carbon pilot study. Memorandum to Allison Hiltner (EPA, Region 10) and Ron Timm (Ecology), dated February 3, 2015.

Menzie, C., Amos, B., Kane-Driscoll, S., Ghosh, U., and Gilmour, C. 2014. Evaluating the Efficacy of a Low-Impact Delivery System for In-Situ Treatment of Sediments Contaminated with Methylmercury and Other Hydrophobic Chemicals. Environmental Security Technology Certification Program (ESTCP) Environmental Restoration, ER-200835, http://www.serdp.org/Program-Areas/Environmental-Restoration/Contaminated-Sediment/ER-200835.

Merkel and Associates, Inc. 2009. Post-Dredging Recolonization Study. Prepared for the National Marine Fisheries Service, Port of Los Angeles, Port of Long Beach, Port of San Diego, and U.S. Navy NAVFAC, http://www.port of sandiego.org/component/document/doc_download/ 2168-091009benthicpd.html (accessed March 9, 2011).

Millward, R.N., Bridges, T.S., Ghosh, U., Zimmerman, J.R., and Luthy, R.G. 2005. Addition of activated carbon to sediment to reduce PCB bioaccumulation by a polychaete (*Neanthes arenaceodentata*) and an amphipod (*Leptocheirus plumulosus*). Environment Science & Technology, v. 39(8), p. 2880-2887.

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2009a. Bocaccio (*Sebastes paucispinis*). NOAA-Fisheries, Office of Protected Species, Northwest Regional Office, Seattle, Washington, http://www.nmfs.noaa.gov/pr/species/fish/bocaccio.htm#status (accessed July 2, 2009).

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2009b. Yelloweye rockfish (*Sebastes ruberrimus*). NOAA-Fisheries, Office of Protected Species, Northwest Regional Office, Seattle, Washington, http://www.nmfs.noaa.gov/pr/species/fish/yelloweyerockfish.htm#status (accessed July 2, 2009).

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2009c. Canary rockfish (*Sebastes pinniger*). NOAA-Fisheries, Office of Protected Species, Northwest Regional Office, Seattle, Washington, http://www.nmfs.noaa.gov/pr/species/fish/canaryrockfish.htm#status (accessed July 2, 2009).

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2014. Canary rockfish (*Sebastes pinniger*). U.S. Department of Commerce, NOAA-Fisheries, Office of Protected Resources, Silver Springs, Maryland, http://www.nmfs.noaa.gov/pr/species/fish/canaryrockfish.htm#habitat (accessed February 22, 2015).

Nightingale, B., and Simenstad, C. 2001. White Paper, Dredging Activities – Marine Issues. Prepared for the Washington Department of Fish and Wildlife, Washington State Department of Ecology, and Washington Department of Natural Resources, Olympia.

Parsons Brinckerhoff, Inc. 2004. South Park Bridge Project – Noise Technical Report. Prepared for the King County Department of Transportation, Seattle, Washington, http://your.kingcounty.gov/kcdot/roads/cip/addlInfo.aspx?CIPID=300197&TopicPath=documents/ FEIS_300197.inc (accessed March 7, 2011).

Palermo, M.R., Brannon, J.M., Zappi, M.E., Skogerboe, J.G., Adamec, S.A., Sturgis, T.C., Wade, R., Gunnison, D., and Myers, T.E. 1986. Dredged Material Disposal Design Requirements for U.S. Navy Homeport at Everett, Washington. Prepared for the U.S. Army Corps of Engineers, Waterways Experimental Station, Vicksburg, Mississippi.

Port of Seattle. 2008. 2007 Seattle-Tacoma International Airport Activity Report. Port of Seattle, Seattle-Tacoma International Airport, Aviation Planning Department, Seattle, Washington, http://www.portseattle.org/downloads/seatac/2007activity.pdf (accessed June 24, 2010).

Ruggerone, G.T., Nelson, T.S., Hall, J., Jeanes, E., Cordell, J., Toft, J., Cooksey, M., and Gray, A. 2006. 2005 juvenile Chinook Duwamish River studies. Prepared for the WRIA 9 Technical Committee and the WRIA 9 Steering Committee, King County, Washington, http://your.kingcounty.gov/dnrp/library/2006/kcr1953.pdf (accessed April 6, 2015).

Salo, E.O., Prinslow, T.E., Campbell, R.A., Smith, D.W., and Snyder, B.P. 1979. Trident Dredging Study – The Effects of Dredging at the U.S. Naval Submarine Base at Bangor on Outmigrating Juvenile Chum Salmon, *Oncorhynchus keta*, in Hood Canal, Washington. Prepared for the University of Washington, College of Fisheries, Fisheries Research Institute, FRI-UW-7918, Seattle.

Scott, J., Rhoads, D., Rosen, J., Pratt, S., and Gentile, J. 1987. Field Verification Program (Aquatic Disposal) – Impact of Open-Water Disposal of Black Rock Harbor Dredged Material on Benthic Recolonization at the FVP Site. Prepared for the U.S. Army Corps of Engineers, Waterways Experiment Station, Technical Report D-87-4, Vicksburg, Mississippi.

Seattle Department of Transportation (SDOT). 2008. Traffic Flow Data and Maps. Seattle Department of Transportation, Seattle, Washington, http://www.seattle.gov/transportation/tfdmaps.htm (accessed June 25, 2010).

Striplin Environmental Associates (SEA). 2004. Lower Duwamish Waterway Slip 4 Early Action Area: Summary of Existing Information and Identification of Data Gaps. Prepared for the City of Seattle and King County, Seattle, Washington, http://www.duwamishcleanup.org/uploads/pdfs/Slip4InfoGaps.pdf (accessed June 28, 2010).

U.S. Army Corps of Engineers (Corps). 2012. Approved work windows for fish protection for all marine/estuarine areas excluding the mouth of the Columbia River (Baker Bay) by tidal reference area. Corps, Seattle District, Seattle, WA, http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20templates/Marine%20Fish%20Work%20Windows%20(8-14-12).pdf (accessed June 2, 2015).

U.S. Environmental Protection Agency (EPA). 2001. National Priorities List: NPL Site Narrative for Lower Duwamish Waterway. EPA, Washington, D.C., http://www.epa.gov/superfund/sites/npl/nar1622.htm (accessed June 28, 2010).

USFWS (U.S. Fish and Wildlife Service). 2011. Letter from Ken S. Berg (USFWS) to Evan R. Lewis (Seattle District, U.S. Army Corps of Engineers) – Upper Duwamish Waterway Maintenance Dredging 2012-2027. Reference No. 13410-2011-1-0340. August 19, 2011.

Washington State Department of Ecology (Ecology). 1980. Green-Duwamish River Basin Instream Resources Protection Program Including Proposed Administrative Rules and Supplemental Environmental Impact Statement (Water Resource Inventory Area 9) (W.W.I.R.P.P. Series - No. 4). Ecology, Water Resources Management Program, Olympia.

Washington State Department of Ecology (Ecology). 2012. Washington State's Water Quality Assessment [303(d) & 305(b) Integrated Report], Final 2012 Submittal. Ecology, Olympia, http://www.ecy.wa.gov/programs/wq/303d/currentassessmt.html (accessed February 22, 2015).

Washington Department of Fish and Wildlife (WDFW). 2002. Salmonid Stock Inventory 2002 (database updated September 2006). WDFW, Olympia.

Washington Department of Fish and Wildlife (WDFW). 2004. Washington State Salmonid Stock Inventory: Bull Trout/Dolly Varden. WDFW, Olympia.

Washington Department of Fish and Wildlife (WDFW). 2005. Marine Finfish, Shellfish, and Baseline GIS Coverages, Published Map Files, and the Web Version of Technical Report 79, June, 2005. WDFW, Olympia.

Washington Department of Fish and Wildlife (WDFW). 2010. SalmonScape. WDFW, Olympia, http://www.wdfw.wa.gov/mapping/salmonscape/index.html (accessed June 25, 2010).

Washington Department of Fish and Wildlife (WDFW). 2014. Salmon Stock Inventory Population Escapement – Duwamish/Green River Chinook and Green River (Duwamish) winter steelhead. WDFW, Olympia, https://data.wa.gov/Natural-Resources-Environment/WDFW-Salmonid-Stock-Inventory-Population-Escapemen/fgyz-n3uk? (accessed February 22, 2015).

Washington Department of Natural Resources (WNDR). 2015. Geographic Information System ESRI shapefile WA_Township_Subdivisions. WDNR, https://fortress.wa.gov/dnr/adminsa/DataWeb/dmmatrix.html (accessed March 3, 2015).

Windward Environmental, LLC (Windward). 2003. Phase I remedial investigation report – final. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington, and the Washington State Department of Ecology, Northwest Field Office, Bellevue, Washington.

Windward Environmental, LLC (Windward). 2010. Final Lower Duwamish Waterway remedial investigation report. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington, and the Washington State Department of Ecology, Northwest Field Office, Bellevue, Washington.

Washington State Department of Transportation (WSDOT). 2011. South Park Bridge Test Pile Project – King County: Underwater Sound Levels Associated with Driving Steel Piles at the South Park Bridge on the Duwamish River. WSDOT, Office of Air Quality and Noise, Seattle, Washington.

Washington State Department of Transportation (WSDOT). 2014. Biological Assessment Preparation for Transportation Projects – Advanced Training Manual. WSDOT, Olympia.

TABLES

TABLE 1

PILOT PLOT LOCATONS, DEPTHS, SEDIMENTATION RATES, AND PERCENTAGE OF FINES
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

	Locations[1]				Elevation in Footprint	Modeled Net Sedimentation	Empirical Net Sedimentation	Mean Percent Fines[4]
Plot Type	River Mile	Township	Range	Section	(feet MLLW)[2]	Rate (cm/yr)[3]	Rate (cm/yr)[3]	(<63 µm)
Scour	0.1	24	4E	18	-33 to -7	0.5	ND	63.8
Subtidal	1.2	24	4E	19	-36 to -31	1.7	ND	32.9
Intertidal	3.9	24	4E	33	-5 to +9	2.2	0.9 to 2.6	46.2

Notes:
1. Source: WDNR, 2015
2. Source: Windward, 2003
3. Source: AECOM, 2014
4. AECOM, 2012

Abbreviations:
cm/yr = centimeters per year
µm = micrometer
MLLW = mean lower low water
ND = not determined

TABLE 2

ESA-LISTED SPECIES POTENTIALLY OCCURRING IN THE ACTION AREA
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Species	Listing Status (Date)	Critical Habitat
Fish		
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened (03/24/99)	Designated
Coastal/Puget Sound bull trout (*Salvelinus confluentus*)	Threatened (06/10/98)	Designated
Dolly Varden (*Salvelinus malma*)	Proposed – Threatened (01/09/01	Not Designated
Puget Sound steelhead trout (*Oncorhynchus mykiss*)	Threatened (05/7/07)	Proposed
Bocaccio (*Sebastes paucispinis*)	Endangered (04/27/10)	Designated (not in Action Area)
Canary rockfish (*Sebastes pinniger*)	Threatened (04/27/10)	Designated (not in Action Area)
Yelloweye rockfish (*Sebastes ruberrimus*)	Threatened (04/27/10)	Designated (not in Action Area)

Abbreviation:
ESA = Endangered Species Act

TABLE 3

TOTAL ESCAPEMENT FOR GREEN/DUWAMISH RIVER CHINOOK AND WINTER STEELHEAD[1]

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

	Total Escapement	
Year	Chinook Salmon	Winter Steelhead Trout
1994	4,078	1,782
1995	7,939	2,198
1996	6,026	2,500
1997	9,967	1,882
1998	7,312	2,284
1999	11,025	5,480
2000	6,170	1,694
2001	7,975	1,402
2002	13,950	1,068
2003	5,864	1,615
2004	7,947	2,359
2005	2,523	1,298
2006	5,790	1,955
2007	4301	1,452
2008	5,971	833
2009	688	304
2010	2,092	423
2011	993	855
2012	3,090	392
2013	2,041	656
2014	NR	997

Note:
1. Source: WDFW, 2014

Abbreviation:
NR = not reported

TABLE 4

SURFICIAL (0 TO 10 CENTIMETERS) SEDIMENT PCB CONCENTRATIONS IN PILOT PLOT AREAS[1]

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Analyte	Scour Plot							
	North 0.5 Acre				South 0.5 Acre			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
Total PCBs (µg/kg DW)	172.0	440.0	265.0	120.0	213.0	260.0	240.0	24.0
Total PCBs (mg/kg OC)	6.8	26.0	14.0	9.1	7.6	23.0	12.0	7.3
% TOC	1.40	3.50	2.30	0.54	0.97	3.40	2.40	1.00
	Subtidal Plot							
	West 0.5 Acre				East 0.5 Acre			
Total PCBs (µg/kg DW)	202.0	1,530.0	621.0	616.0	450.0	2,900.0	1,518.0	1021.0
Total PCBs (mg/kg OC)	10.0	841.0	33.0	33.0	68.0	180.0	110.0	51.0
% TOC	1.60	2.20	1.90	0.22	0.66	1.60	1.30	0.45
	Intertidal Plot							
	North 0.5 Acre				South 0.5 Acre			
Total PCBs (µg/kg DW)	230.0	3,300.0	1,000.0	983.0	127.0	1,060.0	438.0	274.0
Total PCBs (mg/kg OC)	16.0	150.0	55.0	43.0	7.2	57.0	28.0	15.0
% TOC	1.40	2.20	1.70	0.34	1.30	1.70	1.50	0.33

Note:
1. Source: LDWG, 2015

Abbreviations:
µg/kg DW = micrograms per kilogram of dry weight sediment
mg/kg OC = millgrams per kilogram of organic carbon
PCB = polychlorinated biphenyl
Std. Dev. = standard deviation
TOC = total organic carbon

TABLE 5

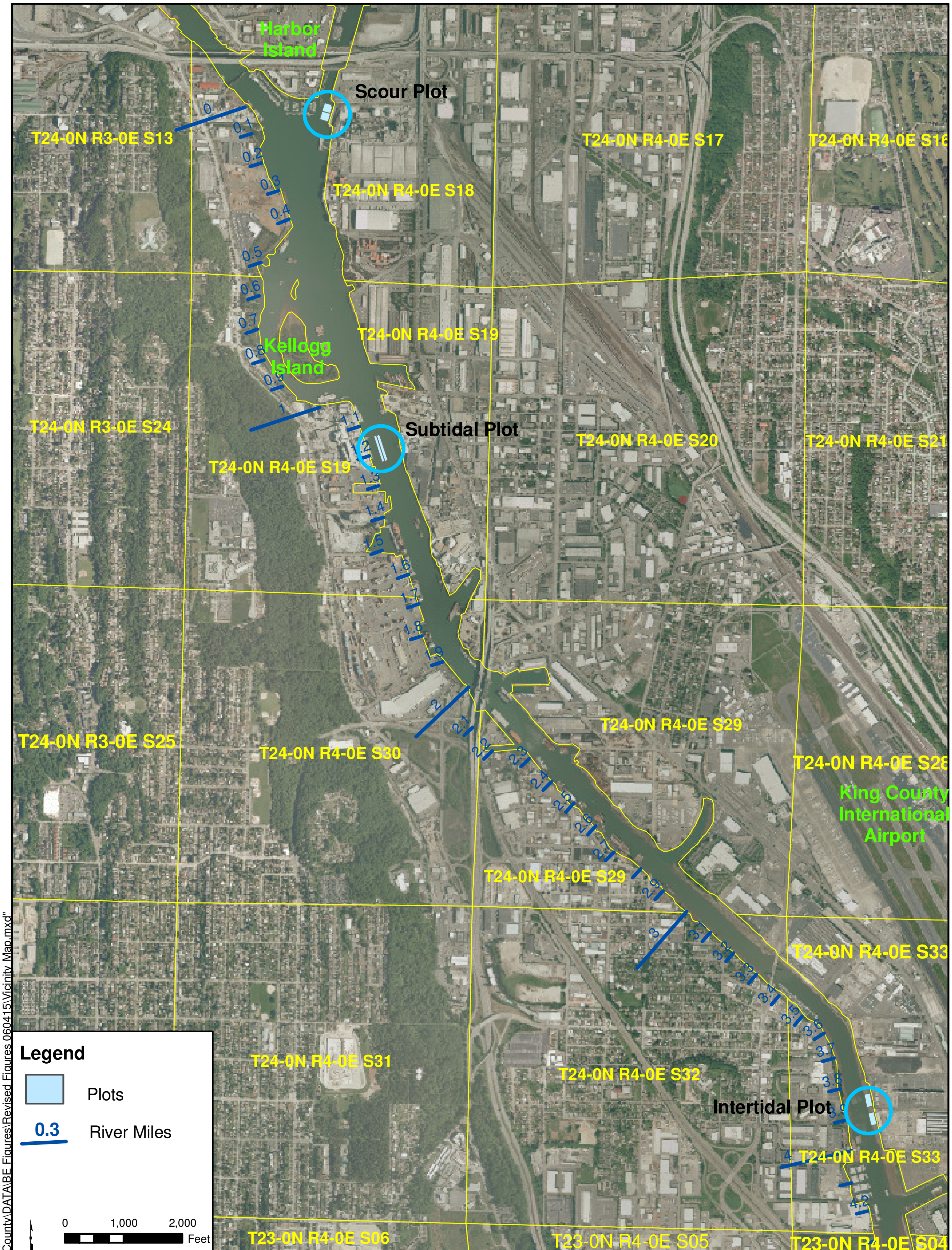
SUMMARY OF EFFECTS DETERMINATIONS FOR LISTED SPECIES AND THEIR CRITICAL HABITATS IN THE ACTION AREA

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Species/Critical Habitat PCEs	No Effect	May Affect, Not Likely to Adversely Affect	Will Not Jeopardize Continued Existence
Puget Sound Chinook salmon		X	
Critical habitat PCE 4		X	
Critical habitat PCEs 1, 2, 3, 5, and 6	X		
Coastal/Puget Sound bull trout		X	
Critical habitat PCEs 1, 2, 3, 4, 5, 7, and 8		X	
Critical habitat PCEs 6 and 9	X		
Dolly Varden (proposed)			X
Puget Sound steelhead trout		X	
Critical habitat (proposed)		X	
Rockfishes (bocaccio, canary, and yelloweye)	X		
Critical habitat	X		

Abbreviation:
PCE = primary constituent element

FIGURES



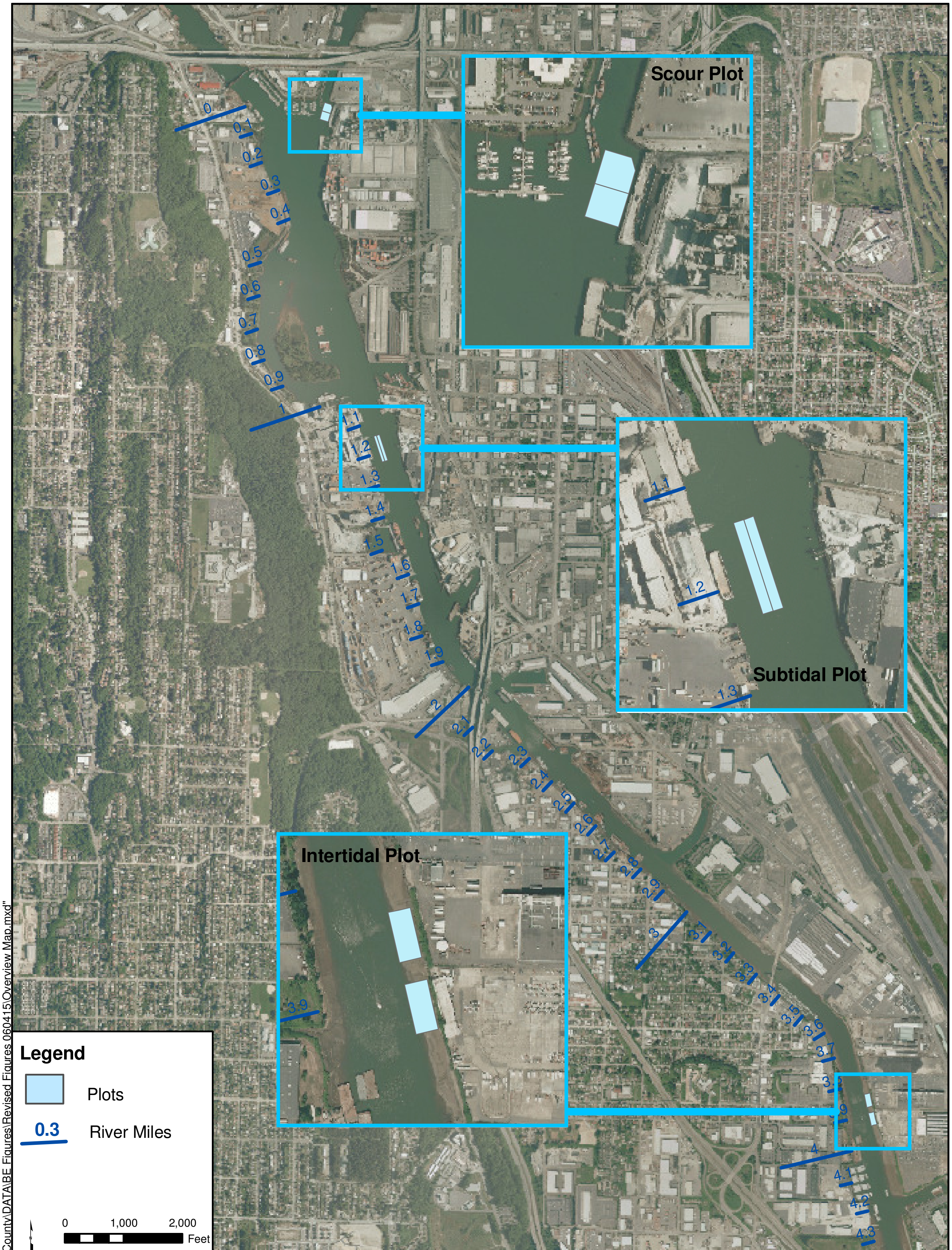
File path: "P:\King County\DATA\BE Figures\Revised Figures 060415\Vicinity Map.mxd"

Lower Duwamish Waterway Group

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

ENR/AC Pilot Study
Biological Evaluation
DRAFT

Figure 1
Vicinity Map



File path: "P:\King County\DATA\BE Figures\Revised Figures 060415\Overview Map.mxd"

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

ENR/AC Pilot Study
Biological Evaluation
DRAFT

Figure 2
Overview Map of Pilot Plot Areas

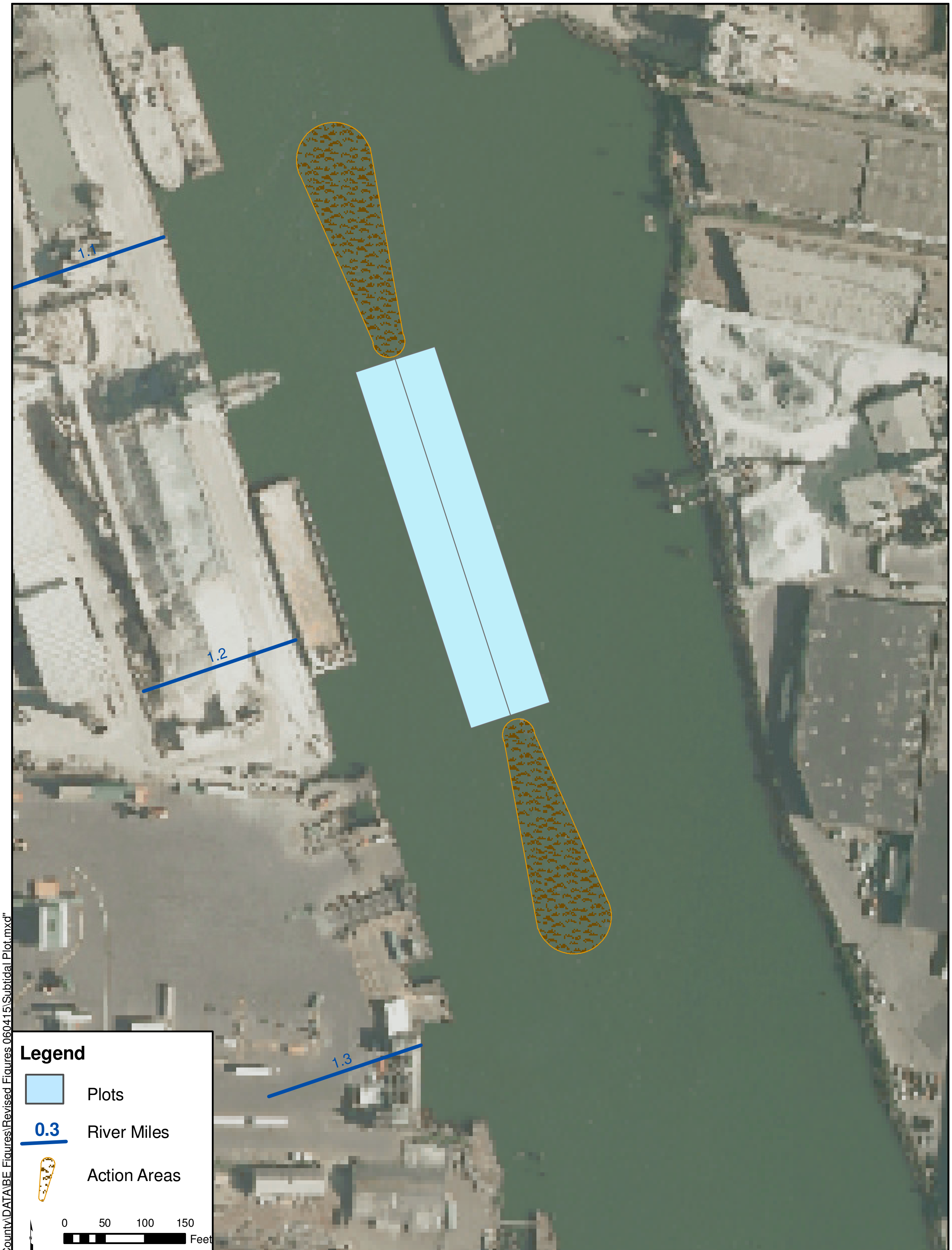
File path:"P:\King County\DATA\BE Figures\Revised Figures 060415\Intertidal Plot.mxd"

Lower Duwamish Waterway Group

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

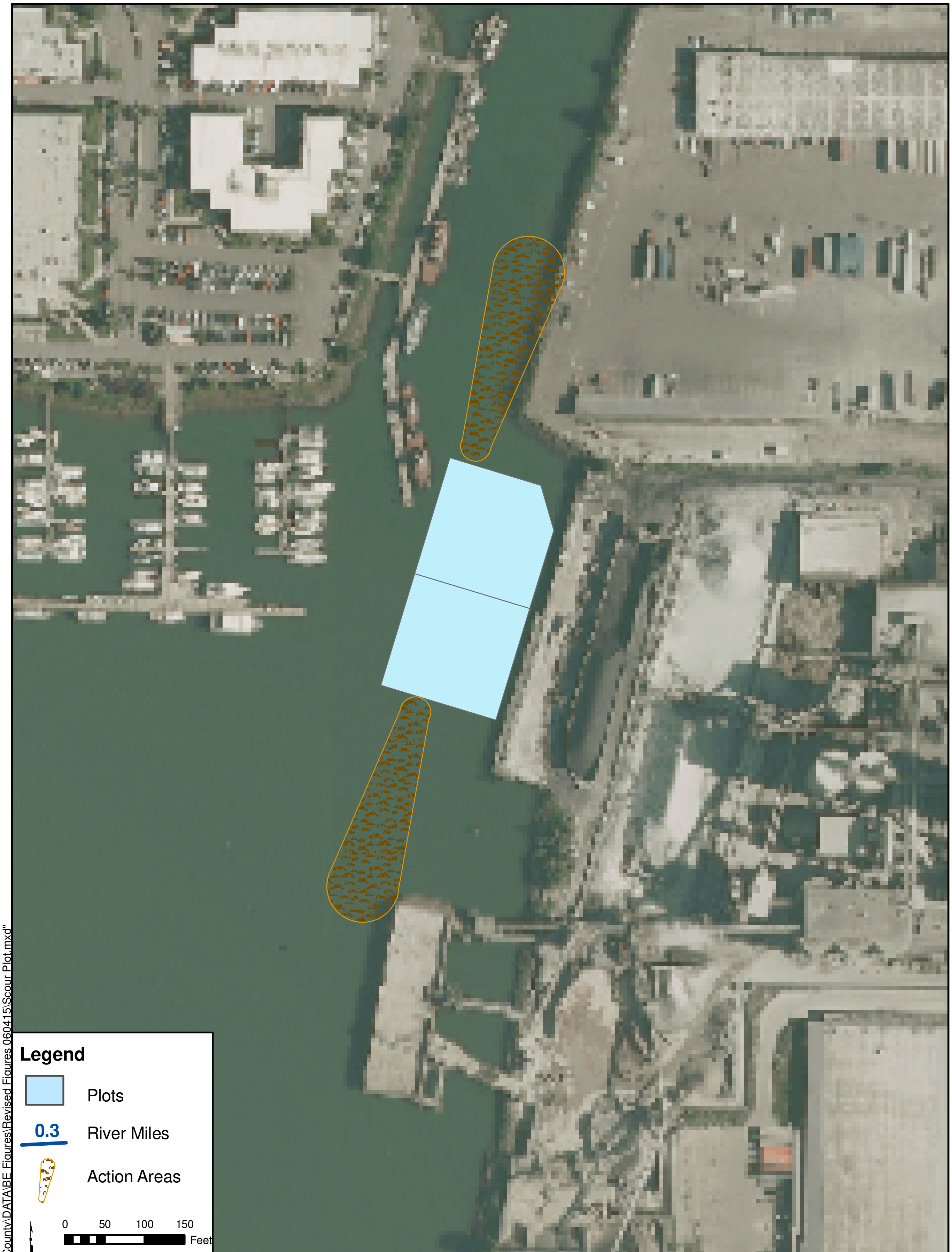
ENR/AC Pilot Study
Biological Evaluation
DRAFT

Figure 3
Intertidal Plot — Action Area



File path: "P:\King County\DATA\BE Figures\Revised Figures 060415\Subtidal Plot.mxd"

Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	ENR/AC Pilot Study Biological Evaluation DRAFT	Figure 4 Subtidal Plot — Action Area

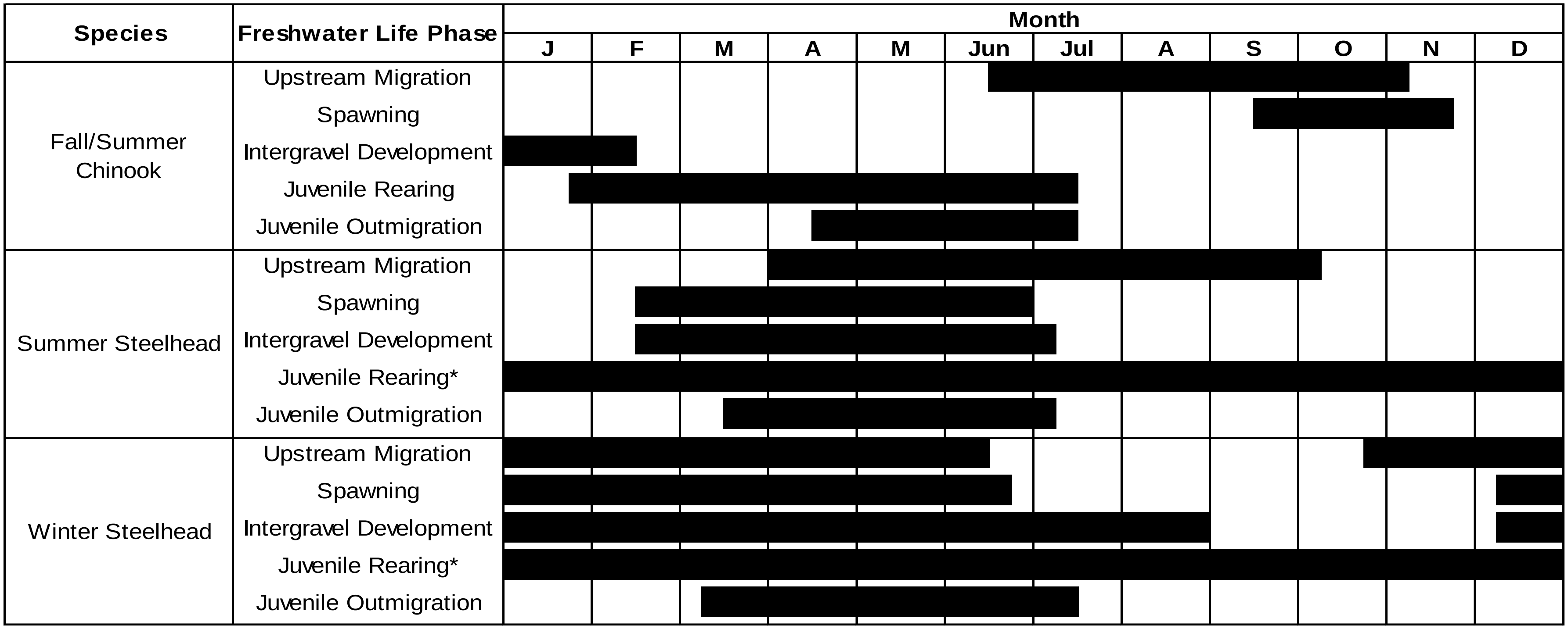


File path:"P:\King County\DATA\BE Figures\Revised Figures 060415\Scour Plot.mxd"

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

ENR/AC Pilot Study
Biological Evaluation
DRAFT

Figure 5
Scour Plot — Action Area



* Normally extends over a 2-year period

(Source: Ecology, 1980)

SALMON RUN TIMING IN THE
GREEN/DUWAMISH RIVER BASIN

Enhanced Natural Recovery/Activated Carbon
Lower Duwamish Waterway

By: RES	Date 06/04/15	Project No. LY15160310

Lower Duwamish Waterway Group

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

Figure 6 DRAFT

P:\King County

ATTACHMENT A

Species Lists from NOAA-Fisheries, USFWS, and WDFW PHS Program http://wdfw.wa.gov/conservation/endangered/esa/federally_listed_esa_fish.pdf

Accessed 02/21/15

Federally ESA listed fish species for Washington State

Family	Species	DPS / ESU	Status	As of	Critical Habitat Designated [1]	4(d) Protective Regulations [1]	Puget Sound	Washington Coast	Lower Columbia River	Middle Columbia River	Upper Columbia River	Snake River Basin
Acipeneridae	***Green Sturgeon***	Northern DPS	Species of concern	15-Apr-04	-	-	X	X	X			
		Southern DPS	***Threatened***	***6-Apr-05***	***X***	***I***	***X***	***X***	***X***			
Cluperidae	Pacific Herring	Cherry Point subpopulation	Not warranted	1-Jun-05	-	-	X	X				
		Georgia Basin DPS	Not warranted	1-Jun-05	-	-	X	X				
Gadidae	Pacific Cod	Pacific Cod DPS	Not warranted	24-Nov-00	-	-	X	X				
	Pacific Hake	Georgia Basin DPS	Species of concern	24-Nov-00	-	-	X	X				
	Walleye Pollack	Lower Boreal Pacific DPS	Not warranted	24-Nov-00	-	-	X	X				
Osmeridae	***Eulachon***	***Southern DPS***	***Threatened***	***17-May-10***	***I***	***I***	***X***	***X***	***X***			
Petromyzontidae	Pacific Lamprey	-	Not warranted	27-Dec-04	-	-	X	X	X	X	X	X
	River Lamprey	-	Not warranted	27-Dec-04	-	-	X	X	X	X	X	X
	Western Brook Lamprey	-	Not warranted	27-Dec-04	-	-	X	X	X	X	X	X
Salmonidae	***Bull Trout***	***Columbia River DPS***	***Threatened***	***10-Jul-98***	***X***	***X***			***X***	***X***	***X***	***X***
		Puget Sound / Coastal DPS	***Threatened***	***1-Dec-99***	***X***	***X***	***X***	***X***				
	Cutthroat Trout (Coastal)	Puget Sound / Strait of Georgia DPS	Not warranted	5-Apr-99	-	-	X					
		Olympic Peninsula DPS	Not warranted	5-Apr-99	-	-		X				
		SW Washington / Lower Columbia River DPS	Not warranted	25-Feb-10	-	-		X	X			
	Cutthroat Trout (Westslope)	-	Not warranted	14-Apr-00	-	-					X	X
	Chinook Salmon	***Lower Columbia River ESU***	***Threatened***	***24-Mar-99***	***X***	***X***			***X***			
		Middle Columbia River Spring-run ESU	Not warranted	9-Mar-98	-	-				X		
		Puget Sound ESU	***Threatened***	***24-Mar-99***	***X***	***X***	***X***					
		Snake River Fall-run ESU	***Threatened***	***22-Apr-92***	***X***	***X***						***X***
		Snake River Spring/Summer-run ESU	***Threatened***	***22-Apr-92***	***X***	***X***						***X***
		Upper Columbia River Spring-run ESU	***Endangered***	***22-Apr-99***	***X***	***X***					***X***	
		Upper Columbia River Summer/Fall-run ESU	Not warranted	9-Mar-98	-	-					X	
		Washington Coast ESU	Not warranted	9-Mar-98	-	-		X				
	Chum Salmon	***Columbia River ESU***	***Threatened***	***25-Mar-99***	***X***	***X***			***X***	***X***		
		Hood Canal Summer-run ESU	***Threatened***	***25-Mar-99***	***X***	***X***	***X***					
		Pacific Coast ESU	Not warranted	10-Mar-98	-	-		X				
		Puget Sound / Strait of Georgia ESU	Not warranted	10-Mar-98	-	-	X					
	Coho Salmon	***Lower Columbia River ESU***	***Threatened***	***28-Jun-05***	***I***	***X***			***X***			
		Olympic Peninsula ESU	Not warranted	25-Jul-95	-	-		X				
		Puget Sound / Strait of Georgia ESU	Species of concern	15-Apr-04	-	-	X	X				
		Southwest Washington ESU	Undetermined	-	-	-		X	X			
	Kokanee	Lake Sammamish DPS	Candidate	6-May-08	-	-	X					
	Pink Salmon	Even-year ESU	Not warranted	4-Oct-95	-	-	X					
		Odd-year ESU	Not warranted	4-Oct-95	-	-	X					
	Sockeye Salmon	Baker River ESU	Not warranted	25-Mar-99	-	-	X					
		Lake Pleasant ESU	Not warranted	10-Mar-98	-	-		X				
		Lake Wenatchee ESU	Not warranted	10-Mar-98	-	-					X	
		Okanogan River ESU	Not warranted	10-Mar-98	-	-					X	
		Ozette Lake ESU	***Threatened***	***25-Mar-99***	***X***	***X***		***X***				
		Quinault Lake ESU	Not warranted	10-Mar-98	-	-		X				
		Snake River ESU	***Endangered***	***20-Nov-91***	***X***	***X***						***X***
	Steelhead	***Lower Columbia River DPS***	***Threatened***	***19-Mar-98***	***X***	***X***			***X***			
		Middle Columbia River DPS	***Threatened***	***19-Mar-98***	***X***	***X***				***X***	***X***	
		Olympic Peninsula DPS	Not warranted	9-Aug-96	-	-		X				
		Puget Sound DPS	***Threatened***	***11-Jun-07***	***I***	***X***	***X***					
		Snake River Basin DPS	***Threatened***	***18-Aug-97***	***X***	***X***						***X***
		Southwest Washington DPS	Not warranted	9-Aug-96	-	-		X	X			
		Upper Columbia River DPS	***Threatened***	***24-Aug-09***	***X***	***X***					***X***	
Scorpaenidae	Black Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Blue Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Bocaccio	***Georgia Basin DPS***	***Endangered***	***27-Jul-10***	***I***	***I***	***X***					
	Brown Rockfish	Puget Sound population	Not warranted	3-Apr-01	-	-	X	X				
	Canary Rockfish	***Georgia Basin DPS***	***Threatened***	***27-Jul-10***	***I***	***I***	***X***					
	China Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Copper Rockfish	Puget Sound population	Not warranted	3-Apr-01	-	-	X	X				
	Greenstripe Rockfish	Puget Sound DPS	Not warranted	23-Apr-09	-	-	X					
	Quillback Rockfish	Puget Sound population	Not warranted	3-Apr-01	-	-	X	X				
	Redstripe Rockfish	Puget Sound DPS	Not warranted	23-Apr-09	-	-	X					
	Tiger Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Widow Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				
	Yelloweye Rockfish	***Georgia Basin DPS***	***Threatened***	***27-Jul-10***	***I***	***I***	***X***					
	Yellowtail Rockfish	Puget Sound population	Not warranted	21-Jun-99	-	-	X	X				

1 "-" - No designation; "I" - Designation in progress; "X" - Designation finalized

Endangered and Threatened Marine Species under NMFS' Jurisdiction

Approximately 2,215 species are listed as endangered or threatened under the ESA. Of these species, about 645 are foreign species, found only in areas outside of the U.S. and our waters.

We have jurisdiction over 125 endangered and threatened marine species, including 38 foreign species. We work with U.S. Fish and Wildlife Service (USFWS) to manage ESA-listed species. Generally, we manage marine species, while USFWS manages land and freshwater species.

- Marine Mammals
- Sea Turtles
- Fish (Marine and Anadromous)
- Marine Invertebrates and Plants


ESA Fact Sheet

» How does the ESA define "species"?

Marine Mammals (27 listed "species")

Manatees and sea otters are also listed under the ESA, but fall under the jurisdiction of the U.S. Fish and Wildlife Service.

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
Cetaceans				
dolphin, Chinese River / baiji (*Lipotes vexillifer*)	1989	E (F)	n/a	n/a
dolphin, Indus River (*Platanista minor*)	1991	E (F)	n/a	n/a
porpoise, Gulf of California harbor / vaquita (*Phocoena sinus*)	1985	E (F)	n/a	n/a
whale, beluga (1 listed DPS) (*Delphinapterus leucas*)				
• Cook Inlet	2008	E	final	in process
whale, blue (*Balaenoptera musculus*)	1970	E	n/a	final
whale, bowhead (*Balaena mysticetus*)	1970	E	n/a	n/a
whale, false killer (1 listed DPS) (*Pseudorca crassidens*)				
• Main Hawaiian Islands Insular	2012	E	no	no
whale, fin (*Balaenoptera physalus*)	1970	E	n/a	final
whale, gray (1 listed DPS) (*Eschrichtius robustus*)				
• Western North Pacific	1970	E (F)	n/a	n/a
whale, humpback (*Megaptera novaeangliae*)	1970	E	n/a	final
whale, killer (1 listed DPS) (*Orcinus orca*)				
• Southern Resident	2005	E	final	final
whale, North Atlantic right (*Eubalaena glacialis*)	2008	E	final	final
original listing as "northern right whale" -	1970	E		
whale, North Pacific right (*Eubalaena japonica*)	2008	E	final	final
original listing as "northern right whale" -	1970	E		
whale, sei (*Balaenoptera borealis*)	1970	E	n/a	final

whale, Southern right (*Eubalaena australis*)	1970	E (F)	n/a	n/a
whale, sperm (*Physeter macrocephalus*)	1970	E	n/a	final
Pinnipeds				
sea lion, Steller (1 listed DPS) (*Eumetopias jubatus*)				
• Western *original listing -*	1997 1990	E T	final	final
seal, bearded (1 listed DPS) (*Erignathus barbatus*)				
• Okhotsk	2012	T (F)	no	no
seal, Guadalupe fur (*Arctocephalus townsendi*)	1985	T	n/a	n/a
seal, Hawaiian monk (*Neomonachus schauinslandi*)	1976	E	final	final
seal, ringed (5 listed subspecies) (*Phoca hispida*)				
• Arctic (*Phoca hispida hispida*)	2012	T	no	no
• Baltic (*Phoca hispida botnica*)	2012	T (F)	no	no
• Okhotsk (*Phoca hispida ochotensis*)	2012	T (F)	no	no
• Ladoga (*Phoca hispida ladogensis*)	2012	E (F)	no	no
• Saimaa (*Phoca hispida saimensis*)	1993	E (F)	n/a	n/a
seal, Mediterranean monk (*Monachus monachus*)	1970	E (F)	n/a	n/a
seal, spotted (1 listed DPS) (*Phoca largha*)				
• Southern	2010	T (F)	n/a	n/a

Sea Turtles (16 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
green turtle (2 listed populations^) (*Chelonia mydas*)				
• Florida & Mexico's Pacific coast breeding colonies	1978	E	final	final
• all other areas » Hawaii population under review for delisting	1978	T	final	final
hawksbill turtle (*Eretmochelys imbricata*)	1970	E	final	final
Kemp's ridley turtle (*Lepidochelys kempii*)	1970	E	n/a	final
leatherback turtle (*Dermochelys coriacea*)	1970	E	final	final
loggerhead turtle (9 listed DPSs) (*Caretta caretta*) » *original listing - 1978*			*no*	*final*
• Mediterranean Sea	2011	E (F)	n/a	n/a

• North Indian Ocean	2011	E (F)	n/a	n/a
• North Pacific Ocean	2011	E	no	final
• Northeast Atlantic Ocean	2011	E (F)	n/a	n/a
• Northwest Atlantic Ocean	2011	T	final	final
• South Atlantic Ocean	2011	T (F)	n/a	n/a
• South Pacific Ocean	2011	E (F)	n/a	n/a
• Southeast Indo-Pacific Ocean	2011	T (F)	n/a	n/a
• Southwest Indian Ocean	2011	T (F)	n/a	n/a
olive ridley turtle (2 listed populations^) (*Lepidochelys olivacea*)				
• Mexico's Pacific coast breeding colonies	1978	E	n/a	final
• all other areas	1978	T	n/a	final

^ These populations were listed before the 1978 ESA amendments that restricted population listings to "distinct population segments of vertebrate species."

Fish (Marine & Anadromous) (57 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; XN = "nonessential experimental population"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
bocaccio (1 listed DPS) (*Sebastes paucispinis*)				
• Puget Sound/ Georgia Basin	2010	E	no	no
eulachon, Pacific / smelt (1 listed DPS) (*Thaleichthys pacificus*)				
• Southern DPS	2010	T	final	no
rockfish, canary (1 listed DPS) (*Sebastes pinniger*)				
• Puget Sound/ Georgia Basin	2010	T	no	no
rockfish, yelloweye (1 listed DPS) (*Sebastes ruberrimus*)				
• Puget Sound/ Georgia Basin	2010	T	no	no
salmon, Atlantic (1 listed DPS) (*Salmo salar*)				
• Gulf of Maine *original listing -*	2009 (expanded) 2000	E	final	final
salmon, Chinook (9 listed ESUs & 1 XN) (*Oncorhynchus tshawytscha*)				
• California coastal	1999**	T	final	in process
• Central Valley spring-run	1999**	T	final	final
• Central Valley spring-run in the San Joaquin River, CA	2013	XN	n/a	-
• Lower Columbia River	1999**	T	final	final
• Upper Columbia River spring-run	1999**	E	final	final
• Puget Sound	1999**	T	final	final
• Sacramento River winter-run	1994**	E	final	final
• Snake River fall-run	1992**	T	final	in process
• Snake River spring/ summer-run	1992**	T	final	in process
• Upper Willamette River	1999**	T	final	final
salmon, chum (2 listed ESUs) (*Oncorhynchus keta*)				
• Columbia River	1999**	T	final	final

• Hood Canal summer-run	1999**	T	final	final
salmon, coho (4 listed ESUs) (*Oncorhynchus kisutch*)				
• Central California coast	2005**	E	final	final
original listing -	1996**	T		
• Lower Columbia River	2005**	T	proposed	final
• Oregon coast	2008	T	final	in process
• Southern Oregon & Northern California coasts (SONCC)	1997**	T	final	final
salmon, sockeye (2 listed ESUs) (*Oncorhynchus nerka*)				
• Ozette Lake	1999**	T	final	final
• Snake River	1991**	E	final	draft
sawfish, dwarf (*Pristis clavata*)	2014	E	no	no
sawfish, green (*Pristis zijsron*)	2014	E	no	no
sawfish, largetooth (*Pristis pristis*) (formerly *P. perotteti*, *P. pristis*, and *P. microdon*)	2014	E	no	no
sawfish, narrow (*Anoxypristis cuspidata*)	2014	E	no	no
sawfish, smalltooth (2 listed DPSs) (*Pristis pectinata*)				
• U.S. portion of range	2003	E	final	final
• Non-U.S. portion of range	2014	E	no	no
shark, scalloped hammerhead (4 listed DPSs) (*Sphyrna lewini*)				
• Central & Southwest Atlantic	2014	T	no	no
• Eastern Atlantic	2014	E (F)	no	no
• Eastern Pacific	2014	E	no	no
• Indo-West Pacific	2014	T	no	no
sturgeon, Adriatic (*Acipenser naccarii*)	2014	E (F)	n/a	no
sturgeon, Atlantic (5 listed DPSs) (*Acipenser oxyrinchus oxyrinchus*)				
• Gulf of Maine	2012	T	no	no
• New York Bight	2012	E	no	no
• Chesapeake Bay	2012	E	no	no
• Carolina	2012	E	no	no
• South Atlantic	2012	E	no	no
sturgeon, Chinese (*Acipenser sinensis*)	2014	E (F)	n/a	no
sturgeon, European (*Acipenser sturio*)	2014	E (F)	n/a	no
sturgeon, green (1 listed DPS) (*Acipenser medirostris*)				
• Southern DPS	2006	T	final	in process
sturgeon, Gulf (*Acipenser oxyrinchus desotoi*)	1991	T	final	final
sturgeon, Kaluga (*Huso dauricus*)	2014	E (F)	n/a	no
sturgeon, Sakhalin (*Acipenser mikadoi*)	2014	E (F)	n/a	no
sturgeon, shortnose (*Acipenser brevirostrum*)	1967	E	n/a	final
	1979	E (F)	n/a	n/a

totoaba *(Totoaba macdonaldi)*				
trout, steelhead (11 listed DPSs & 1 XN) *(Oncorhynchus mykiss)*				
• Puget Sound	2007	T	in process	no
• Central California coast	1997**	T	final	in process
• Snake River Basin	1997**	T	final	in process
• Upper Columbia River *original listing -* *change in status -* *court reinstated status -*	2009+ 1997** 2006** 2007+	T E T E	final	final
+ reinstated to endangered status per U S District Court decision in June 2007.reclassified to threatened [pdf] per U S District Court order in June 2009				
• Southern California	1997**	E	final	final
• Middle Columbia River	1999**	T	final	final
• Middle Columbia River	2013	XN	n/a	
• Lower Columbia River	1998**	T	final	final
• Upper Willamette River	1999**	T	final	final
• Northern California	2000**	T	final	in process
• South-Central California coast	1997**	T	final	final
• California Central Valley	1998**	T	final	final

** All Pacific salmonid listings were revisited in 2005 and 2006. Only the salmonids whose status changed as a result of the review will show the revised date; for all others, only the original listing date is shown. For more information on the listing history, please click on the link for each ESU/DPS.

Marine Invertebrates (24 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
Abalone				
abalone, black *(Haliotis cracherodii)*	2009	E	final	no
abalone, white *(Haliotis sorenseni)*	2001	E	not prudent [pdf]	final
Corals				
coral, [no common name] *(Acropora globiceps)*	2014	T	no	no
coral, [no common name] *(Acropora jacquelineae)*	2014	T	no	no
coral, [no common name] *(Acropora lokani)*	2014	T (F)	n/a	no
coral, [no common name] *(Acropora pharaonis)*	2014	T (F)	n/a	no
coral, [no common name] *(Acropora retusa)*	2014	T	no	no
coral, [no common name] *(Acropora rudis)*	2014	T (F)	no	no
coral, [no common name] *(Acropora speciosa)*	2014	T	no	no
coral, [no common name] *(Acropora tenella)*	2014	T (F)	n/a	no
coral, [no common name] *(Acropora spinosa)*	2014	T (F)	n/a	no
coral, [no common name] *(Euphyllia paradivisa)*	2014	T	no	no
	2014	T	no	no

coral, [no common name] (*Isopora crateriformis*)				
coral, [no common name] (*Montipora australiensis*)	2014	T (F)	n/a	no
coral, [no common name] (*Pavona diffluens*)	2014	T (F)	no	no
coral, [no common name] (*Porites napopora*)	2014	T (F)	n/a	no
coral, [no common name] (*Seriatopora aculeata*)	2014	T	no	no
coral, boulder star (*Orbicella franksi*)	2014	T	no	no
coral, elkhorn (*Acropora palmata*)	2006	T	final	draft
coral, lobed star (*Orbicella annularis*)	2014	T	no	no
coral, mountainous star (*Orbicella faveolata*)	2014	T	no	no
coral, pillar (*Dendrogyra cylindrus*)	2014	T	no	no
coral, rough cactus (*Mycetophyllia ferox*)	2014	T	no	no
coral, staghorn (*Acropora cervicornis*)	2006	T	final	draft

Marine Plants (1 listed "species")

(E = "endangered"; T = "threatened"; F = "foreign"; n/a = not applicable)

Species	Year Listed	Status	Critical Habitat*	Recovery Plan*
Johnson's seagrass (*Halophila johnsonii*)	1999	T	final	final

* **NOTE:** Critical habitat cannot be designated in foreign waters; critical habitat is also not required for species listed prior to the 1978 ESA amendments that added critical habitat provisions. Recovery plans for sea turtles are developed and implemented by NMFS and USFWS; the plans have been written separately for turtles in the Atlantic and Pacific oceans (and East Pacific for the green turtle) rather than for each listed species. Bowhead whales are exempt from recovery planning.

Endangered and Threatened Species Under NMFS' Jurisdiction:

- All Endangered and Threatened Species under NMFS Jurisdiction
  - » Marine Mammals
  - » Sea Turtles
  - » Fish (Marine & Anadromous)
  - » Marine Invertebrates & Plants

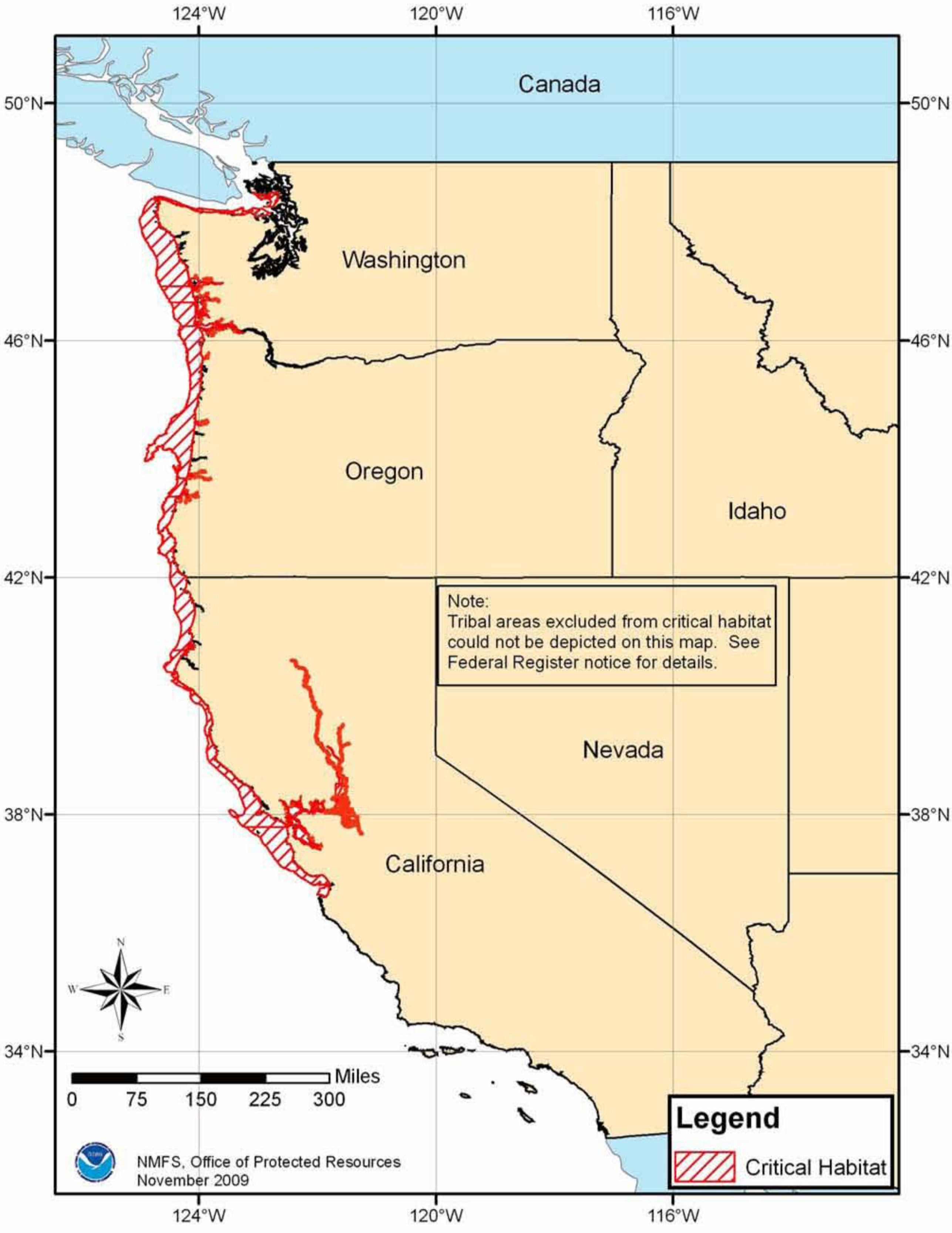
Additional Species:

- Species Petitioned for Listing under the ESA (awaiting 90-day findings)
- Candidates for ESA Listing
- Species Proposed for ESA Listing
- Species with "Not Warranted" 12-month findings (we reviewed the status, but determined that listing was not warranted)
- Delisted Species

Updated: January 21, 2015

http://www.nmfs.noaa.gov/pr/pdfs/criticalhabitat/greensturgeon.pdf
Accessed 02/21/15

Green Sturgeon Critical Habitat



LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CRITICAL HABITAT; CANDIDATE SPECIES; AND SPECIES OF CONCERN IN KING COUNTY AS PREPARED BY THE U.S. FISH AND WILDLIFE SERVICE WASHINGTON FISH AND WILDLIFE OFFICE

(Revised September 3, 2013)

LISTED

Bull trout *(Salvelinus confluentus)*
Canada lynx *(Lynx canadensis)*
Gray wolf *(Canis lupus)*
Grizzly bear *(Ursus arctos = U. a. horribilis)*
Marbled murrelet *(Brachyramphus marmoratus)*
Northern spotted owl *(Strix occidentalis caurina)*

Major concerns that should be addressed in your Biological Assessment of project impacts to listed animal species include:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.

3. Impacts from project activities and implementation (e.g., increased noise levels, increased human activity and/or access, loss or degradation of habitat) that may result in disturbance to listed species and/or their avoidance of the project area.

Castilleja levisecta (golden paintbrush) [historic]

Major concerns that should be addressed in your Biological Assessment of project impacts to listed plant species include:

1. Distribution of taxon in project vicinity.

2. Disturbance (trampling, uprooting, collecting, etc.) of individual plants and loss of habitat.

1. Changes in hydrology where taxon is found.

DESIGNATED

Critical habitat for bull trout
Critical habitat for the marbled murrelet
Critical habitat for the northern spotted owl

PROPOSED

North American wolverine *(Gulo gulo luteus)* – contiguous U.S. DPS
Oregon spotted frog *(Rana pretiosa)* [historical]

CANDIDATE

Fisher *(Martes pennanti)* – West Coast DPS
Yellow-billed cuckoo *(Coccyzus americanus)*
Pinus albicaulis (whitebark pine)

SPECIES OF CONCERN

Bald eagle *(Haliaeetus leucocephalus)*
Beller's ground beetle *(Agonum belleri)*
Cascades frog *(Rana cascadae)*
Hatch's click beetle *(Eanus hatchi)*
Larch Mountain salamander *(Plethodon larselli)*
Long-eared myotis *(Myotis evotis)*
Long-legged myotis *(Myotis volans)*
Northern goshawk *(Accipiter gentilis)*
Northern sea otter *(Enhydra lutris kenyoni)*
Northwestern pond turtle *(Emys (= Clemmys) marmorata marmorata)*
Olive-sided flycatcher *(Contopus cooperi)*
Pacific lamprey *(Lampetra tridentata)*
Pacific Townsend’s big-eared bat *(Corynorhinus townsendii townsendii)*
Peregrine falcon *(Falco peregrinus)*
River lamprey *(Lampetra ayresi)*
Tailed frog *(Ascaphus truei)*
Valley silverspot *(Speyeria zerene bremeri)*
Western toad *(Bufo boreas)*
Aster curtus (white-top aster)
Botrychium pedunculosum (stalked moonwort)
Cimicifuga elata (tall bugbane)

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE
PRIORITY HABITATS AND SPECIES REPORT

SOURCE DATASET: PHSPlusPublic
REPORT DATE: 02/21/2015 4.13

Query ID: P150221161315

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Alcids (possibly others)	SEATTLE W. SBirdCat 175022	Breeding Area Breeding area http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Catalog of Washington Seabirds Points
Bald eagle Haliaeetus leucocephalus	WEST MARGINAL WAY WS_OccurPoint 63325 March 22, 2002	Breeding Area Nest http://wdfw.wa. http://wdfw.wa.	1/4 mile (Quarter	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Bald eagle Haliaeetus leucocephalus	Not Given BaldEagle_Bf	Breeding Area Management buffer http://wdfw.wa.	NA	Fed Spp Concern Sensitive PHS Listed	N AS MAPPED	WDFW Wildlife Program Polygons
Bald eagle Haliaeetus leucocephalus	Not Given BaldEagle_Bf	Breeding Area Management buffer http://wdfw.wa.	NA	Fed Spp Concern Sensitive PHS Listed	N AS MAPPED	WDFW Wildlife Program Polygons
Biodiversity Areas And	CHEASTY GREENSPACE - PHSREGION 915024	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	WEST DUWAMISH PHSREGION 915023	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	CAMP LONG-LONGFELLOW PHSREGION 915030	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Biodiversity Areas And	DEARBORN PARK-MAPLE PHSREGION 915033	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	EAST DUWAMISH PHSREGION 915041	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Biodiversity Areas And	SEAHURST-INGLESEA PHSREGION 902290	Terrestrial Habitat N/A http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Bull Trout Salvelinus malma	Duwamish River SASI 8132	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Bull Trout Salvelinus malma	SASI 8132	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Bull Trout Salvelinus malma	Duwamish Waterway SASI 8132	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
California sea lion Zalophus californianus	PHSREGION 904461	Haulout Haulout N/A	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Chinook Oncorhynchus tshawytscha	Duwamish River SASI 1160	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Chinook Oncorhynchus tshawytscha	SASI 1160	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chinook Oncorhynchus tshawytscha	Duwamish Waterway SASI 1160	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish River SASI 2143	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish River SASI 2154	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	SASI 2143	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	SASI 2154	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish Waterway SASI 2143	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Chum Oncorhynchus keta	Duwamish Waterway SASI 2154	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Not Warranted N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Coho Oncorhynchus kisutch	Duwamish River FISHDIST 40726	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	Duwamish River FISHDIST 40727	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	FISHDIST 41160	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	FISHDIST 41509	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	FISHDIST 42624	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	FISHDIST 42625	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	FISHDIST 42698	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	Duwamish Waterway FISHDIST 43626	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Coho Oncorhynchus kisutch	FISHDIST 43875	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Coho Oncorhynchus kisutch	Duwamish River SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name / Scientific Name / Notes	Site Name / Source Dataset / Source Record / Source Date	Priority Area / Occurrence Type / More Information (URL) / Mgmt Recommendations	Accuracy	Federal Status / State Status / PHS Listing Status	Sensitive Data / Resolution	Source Entity / Geometry Type
Coho Oncorhynchus kisutch	Duwamish Waterway SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Coho Oncorhynchus kisutch	SASI 3140	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Candidate N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Dolly Varden/ Bull Trout Salvelinus malma	Duwamish River FISHDIST 40728	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Dolly Varden/ Bull Trout Salvelinus malma	Duwamish Waterway FISHDIST 43627	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
ESTUARINE INTERTIDAL	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
ESTUARINE INTERTIDAL	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
ESTUARINE INTERTIDAL	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
Esturine Zone	PHSREGION 904754	Aquatic Habitat N/A http://wdfw.wa.	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Fall Chinook Oncorhynchus tshawytscha	Duwamish River FISHDIST 40722	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chinook Oncorhynchus tshawytscha	Duwamish River FISHDIST 40723	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chinook Oncorhynchus tshawytscha	Duwamish Waterway FISHDIST 43624	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	Duwamish River FISHDIST 40724	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	Duwamish River FISHDIST 40725	Breeding Area Breeding area http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	 FISHDIST 41158	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Fall Chum Oncorhynchus keta	Duwamish Waterway FISHDIST 43625	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Great blue heron Ardea herodias	WEST SEATTLE WS_OccurPolygon 157 April 15, 2006	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	Standard buffer	N/A Monitored PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Great blue heron Ardea herodias	WEST SEATTLE WS_OccurPolygon 158 March 24, 2003	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	Standard buffer	N/A Monitored PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Osprey Pandion haliaetus	TERMINAL 105 WS_OccurPoint 69771 June 17, 2005	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	TERMINAL 18 SEATTLE WS_OccurPoint 69872 April 16, 2003	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	BOEING S SEATTLE WS_OccurPoint 69874 July 02, 2002	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	TERMINAL 115 WS_OccurPoint 69915 April 16, 2003	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Osprey Pandion haliaetus	INTERURBAN WS_OccurPoint 69917 April 16, 2003	N/A Nest N/A	1/4 mile (Quarter	N/A Monitored NOT A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
PALUSTRINE	N/A NWIPOLY	Aquatic Habitat Aquatic habitat http://www.ecy.wa.	NA	N/A N/A PHS Listed	N AS MAPPED	US Fish and Wildlife Service Polygons
Peregrine falcon Falco peregrinus	WEST SEATTLE BRIDGE WS_OccurPoint 60096 July 09, 2011	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Peregrine falcon Falco peregrinus	WEST SEATTLE BRIDGE WS_OccurPoint 60097 June 10, 2009	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Peregrine falcon Falco peregrinus	1ST AVENUE S. BRIDGE - WS_OccurPoint 106072 June 13, 2009	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	GPS	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Peregrine falcon Falco peregrinus	WEST SEATTLE BRIDGE WS_OccurPoint 112561 June 10, 2012	Breeding Area Nest http://wdfw.wa.gov/publications/pub.php?	GPS	Fed Spp Concern Sensitive PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Points
Pink Salmon Odd Year Oncorhynchus gorbuscha	Duwamish River FISHDIST 40729	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines

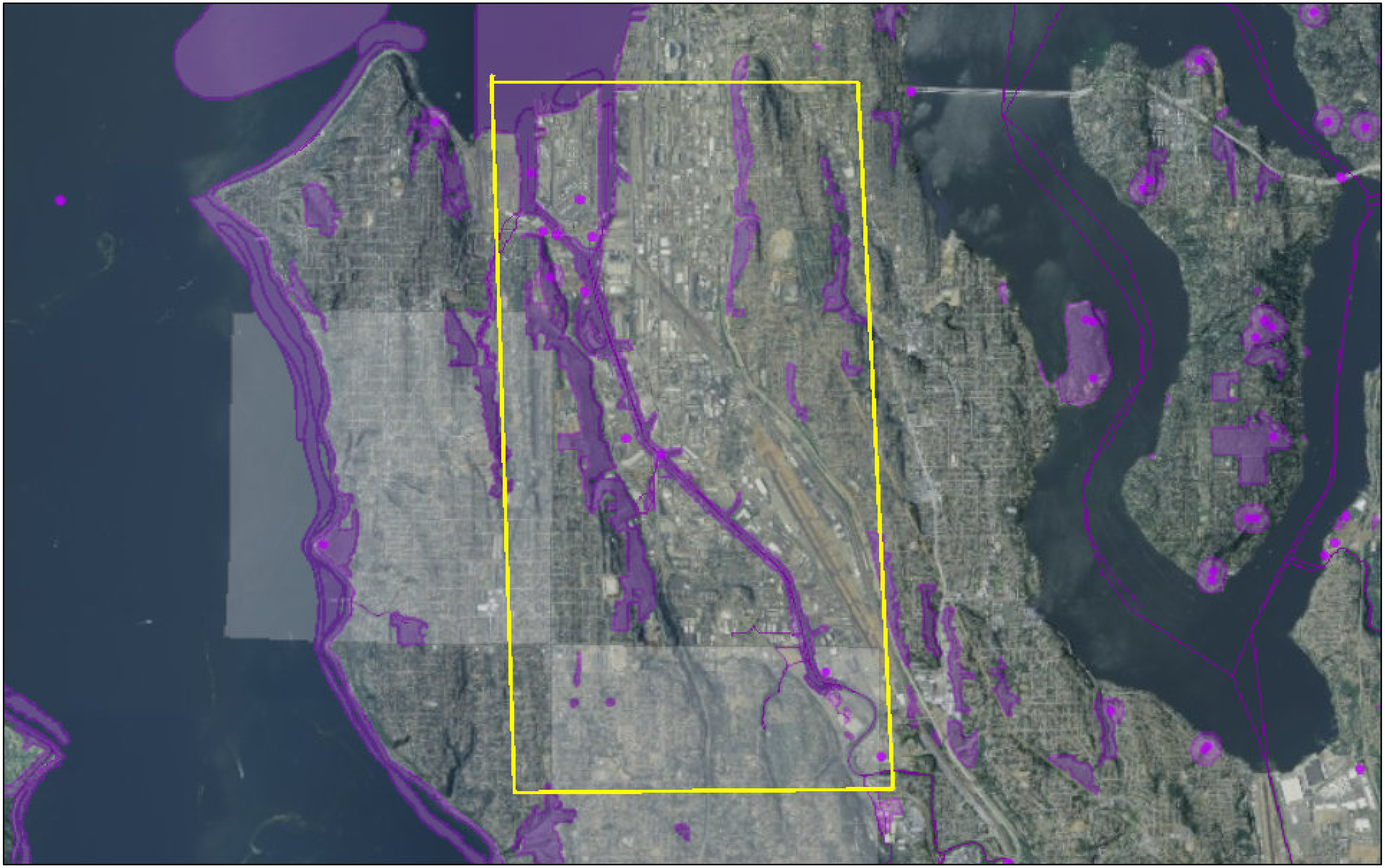
Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Pink Salmon Odd Year Oncorhynchus gorbuscha	Duwamish Waterway FISHDIST 43628	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Purple martin Progne subis	KELLOGG ISLAND WS_OccurPolygon 3831 August 04, 2004	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	GPS	N/A Candidate PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Purple martin Progne subis	TERMINAL 105 PARK WS_OccurPolygon 3832 August 04, 2004	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	GPS	N/A Candidate PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Purple martin Progne subis	JACK BLOCK PARK WS_OccurPolygon 3834 August 08, 2004	Breeding Area Colony http://wdfw.wa.gov/publications/pub.php?	GPS	N/A Candidate PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Resident Coastal Cutthroat Oncorhynchus clarki	Duwamish River FISHDIST 40721	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Resident Coastal Cutthroat Oncorhynchus clarki	FISHDIST 41156	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Resident Coastal Cutthroat Oncorhynchus clarki	FISHDIST 41575	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Resident Coastal Cutthroat Oncorhynchus clarki	Duwamish Waterway FISHDIST 43623	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Resident Coastal Cutthroat Oncorhynchus clarki	FISHDIST 43872	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Sockeye Oncorhynchus nerka	Duwamish River FISHDIST 40730	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Sockeye Oncorhynchus nerka	Duwamish Waterway FISHDIST 43629	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Steelhead Oncorhynchus mykiss	Duwamish River SASI 6168	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	Duwamish River SASI 6175	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	SASI 6168	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	SASI 6175	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Steelhead Oncorhynchus mykiss	Duwamish Waterway SASI 6168	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Steelhead Oncorhynchus mykiss	Duwamish Waterway SASI 6175	Occurrence Occurrence http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	Threatened N/A PHS Listed	N AS MAPPED	WDFW Fish Program Lines
Summer Steelhead Oncorhynchus mykiss	Duwamish River FISHDIST 40731	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Summer Steelhead Oncorhynchus mykiss	Duwamish Waterway FISHDIST 43630	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines
Western (Pacific) Pond Turtle Actinemys marmorata	WS_OccurPoint 18745 January 01, 2001	Occurrence Biotic detection http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A Endangered PHS LISTED	Y QTR-TWP	WA Dept. of Fish and Wildlife Points
Western (Pacific) Pond Turtle Actinemys marmorata	WS_OccurPoint 10065 July 01, 1988	Occurrence Biotic detection http://wdfw.wa.gov/publications/pub.php?	1/4 mile (Quarter	N/A Endangered PHS LISTED	Y QTR-TWP	WA Dept. of Fish and Wildlife Points
Wetlands	GREEN RIVER WETLANDS PHSREGION 902525	Aquatic Habitat N/A http://www.ecy.wa.	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Wetlands	REGION 4 SALTWATER PHSREGION 903606	Aquatic Habitat N/A http://www.ecy.wa.	1/4 mile (Quarter	N/A N/A PHS LISTED	N AS MAPPED	WA Dept. of Fish and Wildlife Polygons
Winter Steelhead Oncorhynchus mykiss	Duwamish River FISHDIST 40732	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	Lines

Common Name Scientific Name Notes	Site Name Source Dataset Source Record Source Date	Priority Area Occurrence Type More Information (URL) Mgmt Recommendations	Accuracy	Federal Status State Status PHS Listing Status	Sensitive Data Resolution	Source Entity Geometry Type
Winter Steelhead Oncorhynchus mykiss	 FISHDIST 41162	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines
Winter Steelhead Oncorhynchus mykiss	Duwamish Waterway FISHDIST 43631	Occurrence/Migration Occurrence/migration http://wdfw.wa.gov/wlm/diversty/soc/soc.htm http://wdfw.wa.gov/publications/pub.php?	NA	N/A N/A PHS LISTED	N AS MAPPED	 Lines

WDFW Test Map



February 21, 2015

PHS Report Clip Area
PT
LN
AS MAPPED
SECTION
QTR-TWP
TOWNSHIP

1:117,291

0 1 2 4 mi

0 1.5 3 6 km

WDFW

ATTACHMENT B

Species' Life Histories

SPECIES' LIFE HISTORIES

June 22, 2015

Project No. LY15160310

TABLE OF CONTENTS

Page

TABLE OF CONTENTS
(continued)

SPECIES' LIFE HISTORIES

1.0 INTRODUCTION

This document provides brief descriptions of the life histories of species listed under the Endangered Species Act (ESA), and those proposed for listing, that may occur in the action area of the proposed project. The species discussed herein include:

- Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*);
- Puget Sound steelhead trout (*O. mykiss*);
- Coastal/Puget Sound bull trout (*Salvelinus confluentus*) and Dolly Varden (*S. malma*);
- Bocaccio (*Sebastes paucispinis*);
- Yelloweye rockfish (*S. ruberrimus*); and
- Canary rockfish (*S. pinniger*).

2.0 CHINOOK SALMON

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for Puget Sound Chinook salmon.

2.1 SPECIES DESCRIPTION

The Chinook salmon is the largest of the Pacific salmon. Also known as "king" salmon, adult Chinook salmon migrate from a marine environment into freshwater streams and rivers of their birth where they spawn and die. Among Chinook salmon, two distinct races have evolved:

1. A "stream-type" Chinook is found most commonly in headwater streams. Stream-type Chinook salmon have a longer freshwater residency and perform extensive offshore migrations before returning to their natal streams in the spring or summer months.
2. An "ocean-type" Chinook is commonly found in coastal streams in North America. Ocean-type Chinook typically migrate to sea within the first 3 months of emergence, but they may spend up to a year in fresh water prior to emigration. They also spend their ocean life in coastal waters. Ocean-type Chinook salmon return to their natal streams or rivers as spring, winter, fall, summer, and late-fall runs, but summer and fall runs predominate (Healey, 1991).

The difference between these life history types is physical, with both genetic and morphological foundations (USACE, 2000).

2.2 HABITAT

Adult female Chinook will prepare a spawning bed, called a redd, in a stream area with suitable gravel composition, water depth, and velocity. Redds will vary widely in size and in location within the stream or river. The adult female Chinook may deposit eggs in four to five “nesting pockets” within a single redd. After laying eggs in a redd, adult Chinook will guard the redd from 4 to 25 days before dying. Chinook salmon eggs will hatch, depending upon water temperatures, between 90 to 150 days after deposition. Streamflow, gravel quality, and silt load all significantly influence the survival of developing Chinook salmon eggs. Juvenile Chinook may spend from 3 months to 2 years in fresh water after emergence and before migrating to estuarine areas as smolts, and then into the ocean to feed and mature. Juvenile ocean-type Chinook tend to utilize estuaries and coastal areas more extensively for juvenile rearing. Juvenile Chinook salmon feed primarily on aquatic insect larvae and terrestrial insects, typically in the nearshore areas. Puget Sound Chinook salmon hatch and rear in streams and rivers flowing into Puget Sound and the Dungeness River and its tributaries (USACE, 2000).

2.3 DISTRIBUTION

The Puget Sound Chinook Evolutionarily Significant Unit (ESU) is listed as threatened under the ESA. The range for the Puget Sound Chinook salmon ESU includes all marine, estuarine, and river reaches accessible to listed Chinook salmon in Puget Sound. Puget Sound marine areas include South Sound, Hood Canal, and North Sound to the international boundary at the outer extent of the Strait of Georgia, Haro Strait, and the Strait of Juan De Fuca to a straight line extending north from the west end of Freshwater Bay, inclusive. Excluded are areas above Tolt Dam (Washington), Lansburg Diversion (Washington), Alder Dam (Washington), and Elwha Dam (Washington) or above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years) (USACE, 2000).

Chinook salmon in the Puget Sound ESU spawn from Dakota Creek north of the Nooksack River in the north, through south Puget Sound, into Hood Canal, and out the Strait of Juan de Fuca to the Elwha River. These spawning distributions are relatively well known compared to information on the location of juvenile rearing areas and historical spawning distributions in most basins (Ruckelshaus et al., 2006).

Ruckelshaus et al. (2006) determined that the following 22 historical populations currently contain Chinook salmon:

1. North Fork Nooksack River
2. South Fork Nooksack River
3. Lower Skagit River
4. Upper Skagit River

5. Cascade River
6. Lower Sauk River
7. Upper Sauk River
8. Suiattle River
9. North Fork Stillaguamish River
10. South Fork Stillaguamish River
11. Skykomish River
12. Snoqualmie River
13. Sammamish River
14. Cedar River
15. Green/Duwamish River
16. White River
17. Puyallup River
18. Nisqually River
19. Skokomish River
20. Mid-Hood Canal Rivers
21. Dungeness River
22. Elwha River

2.4 POPULATION TRENDS

Overall, the natural spawning escapement estimates for Puget Sound Chinook salmon populations are improved relative to those at the time of the previous status review of Puget Sound Chinook salmon conducted with data through 1997. The differences between population escapement estimates based on status assessments using data from 1997 and the present assessment using data through 2002 could be due to (1) revised pre-1997 data, (2) differences in which fish are counted as part of a population, (3) new information on the fraction of natural spawners that are hatchery fish, or (4) true differences reflected in new data on natural spawners obtained over the most recent 5 years. The median across populations of the most recent 5-year geometric mean of natural escapement for the same 22 populations through 1997 was N = 438 (compared to N = 771 through 2002), and the range was 1 to 5,400. As was the case at the time of the previous status review, it is not possible to determine the status of the natural-origin, natural spawners in half the populations of Chinook salmon in Puget Sound. The most dramatic change in recent natural escapement estimates from the previous status assessment was in the Green River—the recent natural-origin escapement estimate is lower than the previous one by almost 5,000 spawners. This apparent drop in natural escapement is probably due primarily to new information about the fraction of hatchery fish that are spawning naturally (Good et al., 2005).

Throughout the ESU, the estimates of trends in natural spawning escapements for Puget Sound Chinook salmon populations are similar to the previous status review of Puget Sound Chinook salmon conducted with data through 1997. Some populations exhibit improvement in trends relative to the last status assessment, and others show more significant declines. The median across populations of the long-term trend in natural spawners was a 1.1% decline per year through 1997, compared to a median estimate indicating a flat trend through 2002. Twelve populations had declining long-term trends through 1997, and ten populations had declining long-term trends through 2002. Short-term trends were generally more positive in recent years—the median trend across 22 populations through 1997 was a 4% decline per year, and the median trend through 2002 was a 1.1% increase per year. Fourteen populations showed declining short-term trends at the time of the previous status reviews, and only four populations exhibited declining short-term trends in recent years. There is a lack information on the fraction of naturally spawning, hatchery-origin fish for 10 of the 22 populations of Chinook salmon in Puget Sound, so the understanding of the trend in natural-origin spawners among populations across the ESU is incomplete (Good et al., 2005).

2.5 THREATS

Habitat throughout the ESU has been blocked or degraded. In general, forest practices impacted upper tributaries, and agriculture or urbanization impacted lower tributaries and mainstem rivers. Diking for flood control, draining and filling of freshwater and estuarine wetlands, and sedimentation due to forest practices and urban development are problematic throughout the ESU. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in several basins. A variety of critical habitat issues exist for streams in the range of this ESU, including changes in flow regime, sedimentation, high temperatures, streambed instability, estuarine loss, loss of large woody debris, loss of pool habitat, and blockage or passage problems associated with dams or other structures (Good et al., 2005).

The Puget Sound Salmon Stock Review Group of the Pacific Fishery Management Council (PFMC, 1997) provided an extensive review of habitat conditions for several stocks in this ESU. It concluded that reductions in habitat capacity and quality have contributed to escapement problems for Puget Sound Chinook salmon, citing evidence of direct losses of tributary and mainstem habitat due to dams, and of slough and side-channel habitat due to diking, dredging, and hydromodification. It also cited reductions in habitat quality due to land management activities. Eleven out of 29 stocks in this ESU are classified as being sustained, in part, through artificial propagation. Nearly 2 billion fish have been released into Puget Sound tributaries since the 1950s (Good et al., 2005). The vast majority of these fish were derived from local returning fall-run adults. Returns to hatcheries have accounted for 57% of total spawning escapement, although the hatchery contribution to spawner escapement is probably much higher than that due to hatchery-derived strays on the spawning grounds. Almost all releases into this ESU have come from stocks within this ESU, with the majority of within-ESU transfers coming from the Green River hatchery or hatchery broodstocks derived from Green River stock (Good et al., 2005). The electrophoretic similarity between Green River fall-run Chinook salmon and several other fall-run stocks in Puget Sound suggests that there may have been a significant effect from some hatchery transplants.

Overall, the pervasive use of Green River stock throughout much of the extensive hatchery network that exists in this ESU may reduce the genetic diversity and fitness of naturally spawning populations (Good et al., 2005).

Harvest impacts on Puget Sound Chinook salmon stocks were quite high. Ocean exploitation rates on natural stocks averaged 56 to 59%; total exploitation rates averaged 68 to 83% (1982 to 1989 brood years). Total exploitation rates on some stocks have exceeded 90% (Good et al., 2005).

Previous assessments of stocks within this ESU identified several stocks as being at risk or of concern (Good et al., 2005).

2.6 CONSERVATION EFFORTS

On January 19, 2007, the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Services (NOAA-Fisheries) adopted the final ESA-recovery plan for Puget Sound Chinook salmon. Under the ESA, a recovery plan must have quantitative recovery criteria and goals, identify threats to survival, site-specific management strategies and actions necessary to address the threats, cost estimates of the actions, and a schedule for implementation. A monitoring and adaptive management program is also included in the recovery plan. In addition to the general requirements, this plan was directed by the recovery criteria developed by the group of scientists appointed by NOAA-Fisheries and the Puget Sound Technical Recovery Team.

3.0 PUGET SOUND STEELHEAD TROUT

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for Puget Sound steelhead trout.

3.1 SPECIES DESCRIPTION

The life history of steelhead trout is one of the most complex of any of the salmonid species. The species exhibits both anadromous forms (steelhead) and resident forms (usually referred to as rainbow or redband trout). They reside in the marine environment for 2 to 3 years before returning to their natal stream to spawn as 4- or 5-year-old fish. Unlike Pacific salmon, steelhead trout are iteroparous or capable of spawning more than once before they die. However, it is rare for steelhead to spawn more than twice before dying, and those that do are usually females (USACE, 2000).

Biologically, steelhead can be divided into two reproductive ecotypes, based on their state of sexual maturity at the time of river entry. These two ecotypes are termed “stream-maturing” and “ocean-maturing.” Stream-maturing steelhead enter fresh water in a sexually immature condition and require from several months to a year to mature and spawn. These fish are often referred to as “summer-run” steelhead. Ocean-maturing steelhead enter fresh water with well-developed gonads and spawn shortly after river entry. These fish are commonly referred to as “winter-run” steelhead. In the Columbia River Basin essentially all steelhead that return to streams east of the Cascade Mountains are stream-maturing. Ocean-maturing fish are the predominate ecotype in coastal streams and lower Columbia River tributaries (USACE, 2000).

3.2 HABITAT

Native steelhead in California generally spawn earlier than those to the north with spawning beginning in December. Washington populations begin spawning in February or March. Native steelhead spawning in Oregon and Idaho is not well-documented. In the Clackamas River in Oregon, winter-run steelhead spawning begins in April and continues into June. In the Washougal River, Washington, summer-run steelhead spawn from March into June whereas summer-run fish in the Kalama River, Washington, spawn from January through April. Among inland steelhead, Columbia River populations from tributaries upstream of the Yakima River spawn later than most downstream populations.

Depending on water temperature, fertilized steelhead eggs may incubate in redds for 1.5 to 4 months before hatching as “alevins.” Following yolk sac absorption, young juveniles or “fry” emerge from the gravel and begin active feeding. Juveniles rear in fresh water for 1 to 4 years, then migrate to the ocean as smolts. Downstream migration of wild steelhead smolts in the lower Columbia River begins in April, peaks in mid-May and is essentially complete by the end of June (FPC, 1993, 1995, 1997). Previous studies of the timing and duration of steelhead downstream migration indicate that they typically move quickly through the lower Columbia River estuary with an average daily movement of about 21 kilometers (km) (Dawley et al., 1979 and 1980).

3.2.1 Winter-Run Steelhead

In general, winter-run, or ocean-maturing steelhead return as adults to the tributaries of Puget Sound from December to April (WDF et al., 1973). Spawning occurs from January to mid June, with peak spawning occurring from mid-April through May. Prior to spawning, maturing adults hold in pools or in side channels to avoid high winter flows.

Steelhead tend to spawn in moderate to high-gradient sections of streams. In contrast to semelparous Pacific salmon, steelhead females do not guard their redds or nests, but return to the ocean following spawning (Burgner et al., 1992). Spawned-out females that return to the sea are referred to as “kelts” (NOAA-Fisheries, 2005).

3.2.2 Summer-Run Steelhead

The life history of summer-run steelhead is highly adapted to specific environmental conditions. Because these conditions are not common in Puget Sound, the relative incidence and size of summer-run steelhead populations is substantially less than that for winter-run steelhead. Summer-run steelhead have also not been widely monitored; in part, because of their small population size and the difficulties in monitoring fish in their headwater holding areas. Sufficient information exists for only 4 of the 16 Puget Sound summer-run steelhead populations identified in the 2002 Salmon Steelhead Inventory (SaSI) to determine the population status (WDFW, 2002).

3.2.3 Juvenile Life History

The majority of steelhead juveniles reside in fresh water for 2 years prior to emigrating to marine habitats, with limited numbers emigrating as 1- or 3-year old smolts. Smoltification and seaward migration occur principally from April to mid-May (WDF et al., 1973). Two-year-old naturally produced smolts are usually 140 to 160 millimeters (mm) in length (Wydoski and Whitney, 1979; Burgner et al., 1992). The inshore migration pattern of steelhead in Puget Sound is not well understood; it is generally thought that steelhead smolts move quickly offshore (Hartt and Dell, 1986).

3.2.4 Ocean Migration

Steelhead oceanic migration patterns are poorly understood. Evidence from tagging and genetic studies indicates that Puget Sound steelhead travel to the central North Pacific Ocean (French et al., 1975; Hartt and Dell, 1986; Burgner et al., 1992). Puget Sound steelhead feed in the ocean for 1 to 3 years before returning to their natal stream to spawn. Typically, Puget Sound steelhead spend 2 years in the ocean, although, notably, Deer Creek summer-run steelhead spend only a single year in the ocean before spawning (NOAA-Fisheries, 2005).

3.3 DISTRIBUTION

Steelhead are found in most accessible larger tributaries to Puget Sound and the eastern Strait of Juan de Fuca. A survey of the Puget Sound District in 1929 and 1930, which did not include Hood Canal, identified steelhead in every major basin except the Deschutes River. The propensity for steelhead to spawn in side channels and tributaries during winter and spring months when flows are high and visibility is low would likely have resulted in an underreporting of steelhead sightings. Additionally, by the late 1920s steelhead abundance had already undergone significant declines and many marginal or ephemeral populations may have already disappeared (Hard et al., 2007).

3.4 POPULATION TRENDS

Declining trends in abundance have occurred despite widespread reductions in direct harvest of natural steelhead in this ESU since the mid-1990s. Natural run sizes (sum of harvest and escapement) for most populations show even more marked declining trends than indicated by escapements, indicating the substantially reduced harvest rates for natural fish since the early 1990s have not resulted in a rebound in steelhead production in Puget Sound. For many of the Puget Sound populations, the decline in adult recruits per spawner has been precipitous. Populations of summer-run steelhead occur throughout the Puget Sound ESU but are concentrated in the northern Puget Sound area, are generally small, and are characterized as isolated populations adapted to streams with distinct attributes (Hard et al., 2007).

3.5 THREATS

Habitat utilization by steelhead has been most affected by reductions in habitat quality and by fragmentation. A number of large dams in Puget Sound basins have affected steelhead. In addition to eliminating accessibility to habitat, dams affect habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and the movement of large woody debris. Many of the lower reaches of rivers and their tributaries in Puget Sound have been dramatically altered by urban development. Urbanization and suburbanization have resulted in the loss of historical land cover in exchange for large areas of imperious surface (buildings, roads, parking lots, etc.) (Hard et al., 2007).

The loss of wetland and riparian habitat has dramatically changed the hydrology of many urban streams, with increases in flood frequency and peak flow during storm events and decreases in groundwater-driven summer flows. Flood events result in gravel scour, bank erosion, and sediment deposition. Land development for agricultural purposes has also altered the historical land cover; however, because much of this development took place in river floodplains, there has been a direct impact on river morphology. River braiding and sinuosity have been reduced through the construction of dikes, hardening of banks with riprap, and channelizing the mainstem. Constriction of rivers, especially during high-flow events, increases likelihood of gravel scour and dislocation of rearing juveniles (Hard et al., 2007).

This ESU is likely to be at elevated risk due to the reduced complexity of spatial structure of its steelhead populations and, consequently, diminishing connectivity among them. The declines in natural abundance for most populations, coupled with large numbers of anthropogenic barriers such as impassable culverts, sharply reduce opportunities for natural adfluvial movement and migration between steelhead aggregations in different watersheds. Resident *O. mykiss* below migration barriers in watersheds throughout the ESU may provide short-term buffers against demographic stochasticity in many of these populations. Resident *O. mykiss* were considered to be a relatively minor component of these anadromous populations based on field surveys of juvenile fish in fresh water (Hard et al., 2007).

Reduced harvest levels and recent changes in management of natural steelhead, the recent onset of recovery efforts in Puget Sound and Hood Canal for Chinook salmon and summer run chum salmon (*O. keta*) prompted by the listing of those ESUs, and reduced off-site plantings of hatchery steelhead were all considered as recent actions that could positively affect Puget Sound steelhead. However, the continued releases of out-of-ESU hatchery summer run and winter run steelhead throughout the region, reductions in steelhead escapement goals to help support harvest opportunities in several systems, evidence for diminishing marine survival rates, a recent increase in the Pacific Decadal Oscillation Index reflecting a general change in climate in the region toward warmer and drier conditions, increases in pinniped populations in Puget Sound, degradation of water quality in Hood Canal and southern Puget Sound, and continued land development and urbanization with associated impacts on freshwater habitat are all likely to increase risk to this ESU (Hard et al., 2007).

3.6 Conservation Efforts

Reduced harvest levels and recent changes in management of natural steelhead, the recent onset of recovery efforts in Puget Sound and Hood Canal for Chinook salmon and summer run chum salmon prompted by the listing of those ESUs, and reduced off-site plantings of hatchery steelhead are recent actions that could positively affect Puget Sound steelhead (Hard et al., 2007).

4.0 COASTAL/PUGET SOUND BULL TROUT AND DOLLY VARDEN

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for Coastal/Puget Sound bull trout and Dolly Varden. Dolly Varden have been proposed as threatened under the ESA by the U.S. Fish and Wildlife Service because of the similarity of appearance to bull trout. It is assumed that Dolly Varden share many of the same life history characteristics of bull trout.

4.1 Species Description

Bull trout are native to western North America and are widespread throughout tributaries of the Columbia River Basin, including the headwaters in Montana and Canada. Bull trout are generally nonanadromous and live in a variety of habitats including small streams, large rivers, and lakes or reservoirs. However, Coastal/Puget Sound bull trout are anadromous, migrating and maturing in Puget Sound or the Pacific Ocean. They may spend the first 2 to 4 years in small natal streams and then migrate through the larger rivers, lakes, and reservoirs to Puget Sound and the Pacific Ocean (USACE, 2000).

Bull trout exhibit resident and migratory life history strategies through much of the current range (Rieman and McIntyre, 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. Migratory bull trout spawn in tributary streams where juvenile fish rear from 1 to 4 years before migrating to either a lake (adfluvial), river (fluvial), or in certain coastal areas, to salt water (anadromous), where maturity is reached in one of the three habitats (Fraley and Shephard, 1989; Goetz, 1989). Resident and migratory forms may be found together and it is suspected that bull trout give rise to offspring exhibiting either resident or migratory behavior (Rieman and McIntyre, 1993).

In some stocks of bull trout, maturing adults may begin migrating to spawning grounds in the spring or early summer. Female bull trout may deposit up to 5,000 or 10,000 eggs in redds they build, depending on their size. The embryos incubate during the fall, winter, and spring, and the surviving fry emerge from the redds in April and May. The rate of embryo development is dependent upon temperature. After they emerge, the young bull trout disperse upstream and downstream to find suitable areas to feed. Feeding areas for Coastal/Puget Sound bull trout include estuaries and nearshore marine waters. Young fish feed primarily on aquatic invertebrates in the streams during their first 2 or 3 years but become more piscivorous as they get larger (USACE, 2000).

The bull trout has been eliminated from some of its native range and seriously reduced in abundance in most of the remaining drainages. Excessive exploitation, habitat degradation, and introductions of exotic species are probably the major causes of the declines (USACE, 2000).

4.2 HABITAT

Bull trout have more specific habitat requirements compared to other salmonids (Rieman and McIntyre, 1993). Habitat components that appear to influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrates, and migratory corridors (Oliver, 1979; Pratt, 1984, 1992; Fraley and Shephard, 1989; Goetz, 1989; Hoelscher and Bjornn, 1989; Sedell and Everest, 1991; Rieman and McIntyre, 1993, 1995; Rich, 1996; Watson and Hillman, 1997). Bull trout typically spawn from August to November during periods of decreasing water temperatures. However, migratory bull trout frequently begin spawning migrations as early as April. Bull trout require spawning substrate consisting of loose, clean gravel relatively free of fine sediments (Fraley and Shephard, 1989). Depending on water temperature, incubation is normally 100 to 145 days (Pratt, 1992) and, after hatching, juveniles remain in the substrate. Time from egg deposition to emergence may surpass 200 days. Fry normally emerge from early April through May depending upon water temperatures and increasing streamflows (Pratt, 1992; Ratliff and Howell, 1992). Bull trout are opportunistic feeders with food habits primarily a function of size and life history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro zooplankton, and small fish (Boag, 1987; Goetz, 1989; Donald and Alger, 1993). Adult migratory bull trout are primarily piscivorous, known to feed on various fish species (Fraley and Shephard, 1989; Donald and Alger, 1993).

4.3 DISTRIBUTION

The Coastal/Puget Sound bull trout distinct population segment (DPS) is listed as threatened under the ESA. The Coastal/Puget Sound bull trout population segment encompasses all Pacific Coast drainages within Washington, including Puget Sound. This population segment is discrete because the Pacific Ocean and the crest of the Cascade Mountain Range geographically segregate it from subpopulations. The population segment is significant to the species as a whole because it is thought to contain the only anadromous forms of bull trout in the conterminous United States, thus, occurring in a unique ecological setting. No bull trout exist in coastal drainages south of the Columbia River (USACE, 2000).

4.4 POPULATION TRENDS

A 1998 Washington Department of Fish and Wildlife (WDFW) study found 80 bull trout/Dolly Varden populations in Washington: 14 (18%) were healthy, two (3%) were in poor condition, six (8%) were critical, and the status of 58 (72%) of the stocks were unknown. Bull trout are estimated to have occupied about 60% of the Columbia River Basin, and presently occur in 45% of the estimated historical range (Quigley and Arbelbide, 1997).

Although specific data on population abundance, trends, and spatial distribution is scarce, ample information exists to indicate that the bull trout are threatened. Population abundance and distribution has declined within many individual river basins, and habitat is severely fragmented in many instances (SSDC, 2007).

4.5 THREATS

Bull trout display a high degree of sensitivity to environmental disturbance and have been significantly impacted by habitat degradation similar to other listed and sensitive species. In addition to migratory barriers, such as dams or diversion structures which isolate populations, bull trout are threatened by poor water quality, sedimentation, harvest, and the introduction of nonnative species. Although several populations lie completely or partially within national parks or wilderness areas, these local populations are threatened by the presence of introduced brook trout or from habitat degradation outside of the park boundaries. Based on biological and genetic information, the U.S. Fish and Wildlife Service (USFWS) has delineated two management units in the Coastal/Puget Sound population segment. Olympic Peninsula bull trout populations are thought to differ from those in the Puget Sound management unit, which originate in watersheds on the western slopes of the Cascade Mountains. Although the two units are connected by marine waters, there is currently no evidence that bull trout from Puget Sound migrate to the Strait of Juan de Fuca or Hood Canal (SSDC, 2007).

Land and water management activities that degrade bull trout habitat and continue to threaten all of the bull trout population segments include dams, forest management practices, livestock grazing, agriculture, and roads and mining (Beschta et al., 1987; Chamberlain et al., 1991; Furniss et al., 1991; Meehan, 1991; Nehlsen et al., 1991; Sedell and Everest, 1991; Craig and Wissmar, 1993; MBTSG, 1998). Fish barriers, timber harvesting, agricultural practices, and urban development are thought to be major factors affecting “native char” in the Coastal/Puget Sound DPS (64 Federal Register 58909-58933).

4.6 CONSERVATION EFFORTS

The USFWS has subdivided the Coastal/Puget Sound bull trout DPS into two separate management units: the Puget Sound and the Olympic Peninsula (USFWS, 2004a,b). Individual draft recovery plans have been prepared for each of these management units. Volume I of the Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout covers the Puget Sound Management Unit, addressing bull trout populations in all watersheds within the Puget Sound Basin north of the Columbia River in Washington and the marine nearshore areas of Puget Sound. It also includes the Chilliwack River and associated tributaries flowing in British Columbia, Canada. Volume II covers the Olympic Peninsula Management Unit, including all watersheds within the Olympic Peninsula and the nearshore marine waters of the Pacific Ocean, Strait of Juan de Fuca, and Hood Canal.

The USFWS revised the draft recovery plan for the United States population of bull trout (USFWS, 2014). According to the USFWS (2014), specific recovery actions in Puget Sound may include removing or modifying structures such as riprap, dikes, and tide gates; restoring tidal flow to coastal wetlands; contaminant remediation; or restoring eelgrass or kelp beds. Active, ongoing partnerships such as the Puget Sound Partnership and Puget Sound Nearshore Ecosystem Restoration Project are already contributing to bull trout recovery through restoration projects.

Generally, salmon recovery actions also function to improve habitat for bull trout; often spawning and rearing habitat for salmon and steelhead is concurrently used as foraging, migrating, and overwintering (FMO) habitat by bull trout. Moreover, restoration of chinook and steelhead runs in Olympic Peninsula and Puget Sound core areas (e.g., the Elwha basin restoration in the Elwha core area, ongoing projects in Lewis and Skokomish core areas) also benefits bull trout by providing juvenile salmonids as forage fish (USFWS, 2014).

5.0 PUGET SOUND ROCKFISH SPECIES PROPOSED FOR LISTING UNDER THE ENDANGERED SPECIES ACT

On April 27, 2010, NOAA-Fisheries listed three species of Puget Sound rockfish under the ESA. The three species are:

- The Georgia DPS of bocaccio (*Sebastes paucispinis*), listed as endangered;
- The Georgia Basin DPS of the yelloweye rockfish (*S. ruberrimis*), listed as threatened; and
- The Georgia Basin DPS of the canary rockfish (*S. pinniger*), listed as threatened.

The following sections will present brief descriptions of the species' biology, their habitats, distribution, population trends, threats, and conservation efforts.

5.1 BOCACCIO

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for the bocaccio.

5.1.1 Species Description

Bocaccio are large Pacific Coast rockfish that reach up to 3 feet (1 meter [m]) in length with a distinctively long jaw extending to at least the eye socket. Their body ranges in color from olive to burnt orange or brown as adults. Young bocaccio are light bronze in color and have small brown spots on their sides (NOAA-Fisheries, 2009a).

Rockfish are unusual among the bony fish in that fertilization and embryo development is internal, and female rockfish give birth to live larval young. Larvae are found in surface waters, and may be distributed over a wide area extending several hundred miles offshore. Fecundity in female bocaccio ranges from 20,000 to over 2 million eggs, considerably more than many other rockfish species. Larvae and small juvenile rockfish may remain in open waters for several months, being passively dispersed by ocean currents (NOAA-Fisheries, 2009a).

Larval rockfish feed on diatoms, dinoflagellates, tintinnids, and cladocerans, and juveniles consume copepods and euphausiids of all life stages. Adults eat demersal invertebrates and small fishes, including other species of rockfish, associated with kelp beds, rocky reefs, pinnacles, and sharp dropoffs. Approximately 50% of adult bocaccio mature in 4 to 6 years. Bocaccio are difficult to age but are suspected to live as long as 50 years (NOAA-Fisheries, 2009a).

5.1.2 Habitat

Bocaccio are most common at depths between 160 and 820 feet (50 to 250 m), but may be found as deep as 1,560 feet (475 m). Adults generally move into deeper water as they increase in size and age but usually exhibit strong site fidelity to rocky bottoms and outcrops. Juveniles and subadults may be more common than adults in shallower water, and are associated with rocky reefs, kelp canopies, and artificial structures, such as piers and oil platforms (NOAA-Fisheries, 2009a).

5.1.3 Distribution

Bocaccio range from Punta Blanca, Baja California, to the Gulf of Alaska off the Krozoff and Kodiak Islands. They are most common between Oregon and northern Baja California. In Puget Sound, most bocaccio are found south of the Tacoma Narrows (NOAA-Fisheries, 2009a).

5.1.4 Population Trends

Recreational catch and effort data spanning 12 years from the mid-1970s to mid-1990s suggests possible declines in abundance in Washington. Additional data over this period show the number of angler trips increased substantially and the average number of rockfish caught per trip declined. Taken together, these data suggest declines in the population over time. Currently there are no survey data being taken for this species, but few of these fish are caught by fishermen and none have been caught by Washington state biological surveys in 20 years, suggesting very low population abundance. They are thought to be at an abundance that is less than 10% of their unfished abundance. A 2005 stock assessment by NOAA-Fisheries suggests bocaccio may have higher populations than was thought to be the case (NOAA-Fisheries, 2009a).

Bocaccio were infrequently recorded in the recreational catch data reported by Buckley (1967, 1968, and 1970) and Bargmann (1977) for Puget Sound Proper from the mid-1960s into the early 1970s. However, bocaccio were reported up to 8 to 9% of the catch in the late-1970s from the Washington State Sport Catch Reports (WDF, 1975-86). The majority of the catch (66%) during 1975 to 1986 was from punch card area 13 (south of the Tacoma Narrows) (as reported in the Washington Sport Catch Reports); Point Defiance and the Tacoma Narrows were historically reported as local areas of high bocaccio abundance in punch card area 13. Bocaccio appear to have declined in frequency, relative to other species, from the 1970s to the 1980s to the 1990s. From 1975 to 1979, bocaccio were reported as an average of 4.63% of the catch (sample size unknown; reference Washington State Sport Catch Reports). During 1980 to 1989, they were

0.24% of the 8,430 rockfish identified (Palsson et al., 2008). From 1996 to 2007, bocaccio have not been observed out of the 2,238 rockfish identified in the dockside surveys of the recreational catches (Palsson et al., 2008). In a sample this large, the probability of observing at least one bocaccio would be 99.5%, assuming it was at the same frequency (0.24%) as in the 1980s. Also (as expected as a result of their habitat preferences), bocaccio have not been observed in the WDFW fisheries independent trawl surveys (Palsson et al., 2008).

5.1.5 Threats

Bocaccio are fished directly and are often caught as bycatch in other fisheries, including those for salmon. Adverse environmental factors led to recruitment failures in the early to mid-1990s (NOAA-Fisheries, 2009a).

5.1.6 Conservation Efforts

Various state restrictions on fishing have been put in place over the years. Current regulations in the State of Washington, where the species is most at risk, limit the daily rockfish catch to three rockfish total (of any species). Because this species is so slow-growing, late to mature, and long-lived, recovery from the above threats will take many years, even if the threats are no longer affecting the species (NOAA-Fisheries, 2009a).

5.2 YELLOWEYE ROCKFISH

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for the yelloweye rockfish.

5.2.1 Species Description

Yelloweye rockfish are very large rockfish that reach up to 3.5 feet (~1 m) in length and 39 pounds (18 kilograms [kg]) in weight. They are orange-red to orange-yellow in color and may have black on their fin tips. Their eyes are bright yellow. Adults usually have a light to white stripe on the lateral line; juveniles have two light stripes, one on the lateral line and a shorter one below the lateral line (NOAA-Fisheries, 2009b).

Rockfish are unusual among the bony fish in that fertilization and embryo development is internal and female rockfish give birth to live larval young. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore. Fecundity in female yelloweye rockfish ranges from 1.2 to 2.7 million eggs, considerably more than many other rockfish species. Larvae and small juvenile rockfish may remain in open waters for several months being passively dispersed by ocean currents (NOAA-Fisheries, 2009b).

Larval rockfish feed on diatoms, dinoflagellates, tintinnids, and cladocerans, and juveniles consume copepods and euphausiids of all life stages. Adults eat demersal invertebrates and small fishes, including other species of rockfish, associated with kelp beds, rocky reefs, pinnacles, and sharp dropoffs. Approximately 50% of adult yelloweye rockfish are mature by 16 inches (41 centimeters [cm]) total length (about 6 years of age). Yelloweye rockfish are among the longest lived of rockfishes, living up to 118 years (NOAA-Fisheries, 2009b).

5.2.2 Habitat

Juveniles and subadults tend to be more common than adults in shallower water, and are associated with rocky reefs, kelp canopies, and artificial structures such as piers and oil platforms. Adults generally move into deeper water as they increase in size and age, but usually exhibit strong site fidelity to rocky bottoms and outcrops. Yelloweye rockfish occur in waters 80- to 1,560-feet (25- to 475-m) deep, but are most commonly found between 300 to 590 feet (91 to 180 m) (NOAA-Fisheries, 2009b).

5.2.3 Distribution

Yelloweye rockfish range from northern Baja California to the Aleutian Islands, Alaska, but are most common from central California northward to the Gulf of Alaska (NOAA-Fisheries, 2009b).

5.2.4 Population Trends

Recreational catch and effort data spanning 12 years from the mid-1970s to mid-1990s suggests possible declines in abundance. While catch data are generally constant over time, the number of angler trips increased substantially, and there was a decline in the average number of rockfish caught per trip. Taken together, these data suggest declines in the population over time. Currently there are no survey data being taken for this species, but few of these fish are caught by fishermen, suggesting low population abundance (NOAA-Fisheries, 2009b).

Yelloweye rockfish occur more consistently in the recreational catch than bocaccio but at lower frequency than canary rockfish and are still infrequently observed (typically 1 to 2% in Puget Sound Proper and 2 to 5% in north Puget Sound). The frequency of yelloweye rockfish in Puget Sound Proper appears to have increased from a frequency of 0.34% (sample size 8,430) in 1980 to 1989 to a frequency of 2.7% (sample size 550) in 1996 to 2001. There were 3 recent years (1999 to 2001) when yelloweye rockfish were not reported in the recreation catch; however, the sample sizes were low these years and zeros are expected for an infrequent species when sample sizes are low (NOAA-Fisheries, 2008).

In north Puget Sound, in contrast, the frequency of yelloweye rockfish decreased between the 1980s and 1990s in the catch surveys. From 1980 to 1989, they were reported at a frequency of 1.9% (sample size 3,910), and from 1996 to 2001, they were reported at a frequency of 0.65% (sample size 1,718). Since 2002, fishing for yelloweye rockfish is prohibited in Puget Sound and thus no frequency data are available since 2002 from the recreational fishery (NOAA-Fisheries, 2008).

The early stock data do not report sample size (number of individuals identified), thus the uncertainty in the early estimates cannot be calculated. Species misidentification should not be a problem for yelloweye rockfish, but their frequency may be affected by nonrandom reporting in the 1960s and early 1970s. Buckley and Bargmann (1965 to 1973) suggest that only a few (2 to 3) common species were being recorded in some punch card areas (NOAA-Fisheries, 2008).

As expected, yelloweye rockfish have been observed infrequently in the WDFW fisheries independent trawl surveys in Puget Sound Proper, and in north Puget Sound, yelloweye rockfish were not observed in the WDFW trawl survey in 1987 1989 1991, or 2001, but were caught in 2004 (0.65% of the catch). In the Reef Environmental Education Foundation (REEF) scuba survey data, yelloweye rockfish have been sighted consistently throughout the Puget Sound (north and south) since 2001 at an average frequency of 0.5% of dives in the south reporting a sighting of yelloweye rockfish and 2% of dives in the north reporting a sighting. There is no evidence of a decline in the probability of sightings during dives (NOAA-Fisheries, 2008).

In the Strait of Georgia, yelloweye rockfish are common in the recent recreational catches; the proportion of yelloweye rockfish in the 2006 and 2005 recreational catch (Department of Fisheries and Oceans Canada catch data) was 17.1% and 7.5%, respectively. The high frequency of yelloweye rockfish in the recreational catch may reflect targeting for this species, as yelloweye rockfish are a small proportion of the rockfish observed in the few fisheries independent surveys that are available. A genetic tagging study in 2003 (Yamanaka et al., 2004), where data were collected from tissue taken from hooks, 1% of samples were yelloweye rockfish. In a 2003 pilot camera study designed to estimate rockfish biomass (Yamanaka et al., 2006), 439 rockfish were observed, of which one (0.2%) was a yelloweye rockfish. Another survey in 2004 in the southern Strait of Georgia identified 105 rockfish species, of which 5 (4.8%) were yelloweye rockfish (NOAA-Fisheries, 2008).

There appears to be limited information on population trends yelloweye rockfish in the Strait of Georgia. Data from the recreational creel survey conducted by Department of Fisheries and Oceans Canada is of limited value because the species composition information and groundfish-targeted effort is lacking; salmon-targeted and groundfish-targeted trips are reported together.

Submersible surveys were conducted in 1984 and 2003 in the Strait of Georgia (Yamanaka et al. 2004). Between the two surveys, there was a decline in the mean number of yelloweye rockfish per transect (8.57 to 4.65), but the difference was not statistically significant. Trend data are also available from the commercial long-line fishery (Yamanaka et al., 2004), which show generally declining trends in catch-per-unit-effort (CPUE) from the late 1980s through the 1990s, but interpretation is difficult given the effects of market forces and management regulations on commercial fisheries (NOAA-Fisheries, 2008).

5.2.5 Threats

Yelloweye rockfish are targeted by recreational and commercial fisheries and are often caught as bycatch in other fisheries, including those for salmon. Adverse environmental factors led to recruitment failures in the early- to mid-1990s (NOAA-Fisheries, 2009b).

5.2.6 Conservation Efforts

Various state restrictions on fishing have been put in place over the years, leading to the current ban on retention of yelloweye rockfish in Washington in 2003. Because this species is slow-growing, late to mature, and long-lived, recovery from these threats will take many years, even if the threats are no longer affecting the species (NOAA-Fisheries, 2009b).

5.3 CANARY ROCKFISH

This section presents descriptions of the biology, habitat, distribution, population trend, threats, and conservation efforts for the canary rockfish.

5.3.1 Species Description

Canary rockfish are large rockfish that reach up to 2.5 feet (77 cm) in length and 10 pounds (4 kg) in weight. Adults have bright yellow to orange mottling over gray, three orange stripes across the head, and orange fins. Animals less than 14 inches long have dark markings on the posterior part of the spiny dorsal fin and gray along the lateral line (NOAA-Fisheries, 2009c).

Rockfish are unusual among the bony fish in that fertilization and embryo development is internal and female rockfish give birth to live larval young. Larvae are found in surface waters and may be distributed over a wide area extending several hundred miles offshore. Fecundity in female canary rockfish ranges from 260,000 to 1.9 million eggs, considerably more than many other rockfish species. Larvae and small juvenile rockfish may remain in open waters for several months, being passively dispersed by ocean currents (NOAA-Fisheries, 2009c).

Larval rockfish feed on diatoms, dinoflagellates, tintinnids, and cladocerans, and juveniles consume copepods and euphausiids of all life stages. Adults eat demersal invertebrates and small fishes, including other species of rockfish, associated with kelp beds, rocky reefs, pinnacles, and sharp dropoffs. Approximately 50% of adult canary rockfish are mature at 14 inches (36 cm) total length (about 5 to 6 years of age). Canary rockfish can live to be 75 years old (NOAA-Fisheries, 2009c).

5.3.2 Habitat

Canary rockfish primarily inhabit waters 160- to 820-feet (50- to 250-m) deep but may be found to 1,400 feet (425 m). Juveniles and subadults tend to be more common than adults in shallow water and are associated with rocky reefs, kelp canopies, and artificial structures, such as piers and oil platforms. Adults generally move into deeper water as they increase in size and age but usually exhibit strong site fidelity to rocky bottoms and outcrops where they hover in loose groups just above the bottom (NOAA-Fisheries, 2009c).

5.3.3 Distribution

Canary rockfish range between Punta Colnett, Baja California, and the Western Gulf of Alaska. Within this range, canary rockfish are most common off the coast of central Oregon (NOAA-Fisheries, 2009c).

5.3.4 Population Trends

Recreational catch and effort data spanning 12 years from the mid-1970s to mid-1990s suggests possible declines in abundance. While catch data are generally constant over this time period, the number of angler trips increased substantially, and the average number of canary rockfish caught per trip declined. Taken together, these data suggest declines in the population over time. Currently there are no survey data being taken for this species, but few of these fish are currently caught by fishermen, suggesting low population abundance. Canary rockfish used to be one of the three principal species caught in Puget Sound in the 1960s (NOAA-Fisheries, 2009c).

Canary rockfish occur more consistently in the recreational catch than bocaccio and yelloweye rockfish, but are still infrequently observed (typically 1 to 2% in Puget Sound Proper and 2 to 5% in north Puget Sound). Like bocaccio, canary rockfish appear to have become less frequent in the catch data since 1965 (NOAA-Fisheries, 2008). From 1980 to 1989, they were reported at a frequency of 1.1% (sample size 8,430) and 1.4% (sample size 3,910) in south and north Puget Sound, respectively. From 1996 to 2001, they were reported at a frequency of 0.73% (sample size 550) and 0.56% (sample size 1,718) in south and north Puget Sound, respectively (NOAA-Fisheries, 2008). The early stock data do not report sample size (number of individuals identified), thus the uncertainty in the early estimates cannot be calculated. Species misidentification should not be a problem for canary rockfish, but their reported frequency may be affected by nonrandom reporting of species in the catch in the 1960s and early 1970s. The data from Buckley and Bargmann (1967 to 1977) suggest that only a few (2 to 3) common species were being recorded in some punch card areas (NOAA-Fisheries, 2008).

Since 2002, fishing for canary rockfish in Puget Sound is prohibited and thus no frequency data are available from the recreational fishery since then. Canary rockfish have not been observed in the WDFW fisheries independent trawl surveys (Palsson et al., 2008). In REEF scuba survey data (REEF, 2008), canary rockfish were not observed in the first 3 years of the survey 1998 to 2000, when the number of dives was 100 to 130 per year. Since 2001, however, the number of dives per year has increased substantially, to 400 to 1,000 dives per year, and canary rockfish have been reported consistently since 2001 in 0.5 to 3.6% of dives with no evidence of a temporal decline in sightings (REEF, 2008). Canary rockfish have been documented in the Strait of Georgia, but the overwhelming research focus is on the large stocks that are commercially harvested off the west coast of Vancouver Island and in Queen Charlotte Strait (NOAA-Fisheries, 2008). The prevalence of this species in recreational fishing in the Strait of Georgia indicates that they are probably well-distributed but rare (1% of total rockfish catch) in enclosed waters and inlets (DFO, 2008). However, wide interannual variations in some recreational catch data suggests that catch estimates may be unreliable due to poor species identification and changing bag limits (NOAA-Fisheries, 2008). Recent long-line surveys throughout the Strait of Georgia collected 100 canary rockfish individuals from two shallow sets. All were adults (mean size 529 cm) in post-spawning condition (Lochead and Yamanaka, 2007). They have also been documented in Georgia Strait jig surveys (Yamanaka et al., 2006).

5.3.5 Threats

Canary rockfish are targeted by recreational and commercial fishers and are often caught as bycatch in other fisheries, including those for salmon. Adverse environmental factors led to recruitment failures in the early to mid-1990s (NOAA-Fisheries, 2009c).

5.3.6 Conservation Efforts

Various state restrictions on fishing have been put in place over the years, including banning retention of canary rockfish in all Washington marine waters in 2004. Because this species is slow-growing, late to mature, and long-lived, recovery from these threats will take many years, even if the threats are no longer affecting the species (NOAA-Fisheries, 2009c).

6.0 REFERENCES

Bargmann, G.G. 1977. The Recreational Hook and Line Fishery for Marine Fish in Puget Sound 1968-1973, Technical Report. Washington Department of Fish and Wildlife, Progress Report No. 33, Olympia (as cited in NOAA-Fisheries, 2008).

Beschta, R.L., Bilby, R.E., Brown, G.W., Holtby, L.B., and Hofstra, T.D. 1987. Stream temperature and aquatic habitat – fisheries and forest interaction, in Salo, E.O., and Cundy, T.W. (eds.), Streamside Management – Forestry and Fishery Interactions. University of Washington, Institute of Forest Resources, Contribution 57, Seattle, 41 p.

Boag, T.D. 1987. Food habits of bull charr, *Salvelinus confluentus*, and rainbow trout, *Salmo gairdneri*, coexisting in a foothills stream in Northern Alberta. Canadian Field-Naturalist, v. 101, p. 56-62.

Buckley, R.M. 1967. 1965 Bottomfish Sport Fishery, Technical Report. Washington State Department of Fisheries, Supplemental Progress Report, Olympia (as cited in NOAA-Fisheries, 2008).

Buckley, R.M. 1968. 1966 Bottomfish Sport Fishery Occurring in Washington Marine Punch Card Areas 2 through 12, Technical Report. Washington State Department of Fisheries, Supplemental Progress Report, Olympia (as cited in NOAA-Fisheries, 2008).

Buckley, R.M. 1970. 1967 Bottomfish Sport Fishery, Technical Report. Washington State Department of Fisheries, Supplemental Progress Report, Olympia (as cited in NOAA-Fisheries, 2008).

Burgner, R.L., Light, J.T., Margolis, L., Okazaki, T., Tautz, A., and Ito, S. 1992. Distribution and Origins of Steelhead Trout (*Oncorhynchus mykiss*) in Offshore Waters of the North Pacific. International North Pacific Fisheries Commission, Bulletin Number 51.

Chamberlain, T.W., Harr, R.D., and Everest, F.H. 1991. Timber harvesting, silviculture, and watershed processes, in Meehan, W.R. (ed.), Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society, Special Publication 19, 24 p.

Craig, S.D., and Wissmar, R.C. 1993. Habitat Conditions Influencing a Remnant Bull Trout Spawning Population, Gold Creek, Washington, Draft Report. Fisheries Research Institute, University of Washington, Seattle.

Dawley, E.M., Sims, C.W., Ledgerwood, R.D., Miller, D.R., and Thrower, F.P. 1979. A Study to Define the Migrational Characteristics of Chinook and Coho Salmon and Steelhead Trout in the Columbia River Estuary: 1978 Annual Report to Pacific Northwest Regional Commission, Northwest Fisheries Science Center, Seattle, Washington, 90 p.

Dawley, E.M., Sims, C.W., Ledgerwood, R.D., Miller, D.R., and Williams, J.G. 1980. A Study to Define the Migrational Characteristics of Chinook and Coho Salmon and Steelhead Trout in the Columbia River Estuary. 1979 Annual Report to Pacific Northwest Regional Commission, Northwest Fisheries Science Center, Seattle, Washington, 53 p.

Department of Fisheries and Oceans Canada (DFO). 2008. Pacific Region Regional Data Services Unit. DFO, Ottawa, Ontario (as cited in NOAA-Fisheries, 2008).

Donald, D.B., and Alger, J. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology, v. 71, p. 238-247.

Fish Passage Center (FPC). 1993. 1992 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Fish Passage Center (FPC). 1995. 1994 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Fish Passage Center (FPC). 1997. 1996 Annual Report. Fish Passage Center of the Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Fraley, J.J., and Shephard, B.B. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake river system, Montana. Northwest Science, v. 63, p. 133-143.

French, R.F., Bakkala, R.G., and Sutherland, D.F. 1975. Ocean Distribution of Stock of Pacific Salmon, *Oncorhynchus* spp., and Steelhead Trout, *Salmo gairdneri*, as Shown by Tagging Experiments. National Oceanic and Atmospheric Administration, Technical Report, National Marine Fisheries Service, MFS SSRF-689.

Furniss, M.J., Roelofs, T.D., and Yee, C.S. 1991. Road construction and maintenance, in Meehan, W.R. (ed.), Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19, 26 p.

Goetz, F. 1989. Biology of the Bull Trout, *Salvelinus confluentus*, a Literature Review. U.S. Department of Agriculture, Forest Service, Willamette National Forest, Eugene, Oregon.

Good, T.P., Waples, R.S., and Adams, P. (eds.). 2005. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Technical Memorandum NMFS-NWFSC-66, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington, http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/ loader.cfm?csModule=security/ getfile&pageid=21346) (accessed July 14, 2009).

Hard, J.J., Myers, J.M., Ford, M.J., Cope, R.G., Pess, G.R., Waples, R.S., Winans, G.A., Berejikian, B.A., Waknitz, F.W., Adams, P.B., Bisson, P.A., Campton, D.E., and Reisenbichler, R.R. 2007. Status Review of Puget Sound Steel Head (*Oncorhynchus mykiss*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Technical Memorandum NMFS-NWFSC-81, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington, http://www.nwfsc.noaa.gov/assets/ 25/6649_07312007_160715_SRSteelheadTM81Final.pdf (accessed July 14, 2009).

Hartt, A.C., and Dell, M.B. 1986. Early Oceanic Migrations and Growth of Juvenile Pacific Salmon and Steelhead Trout. International North Pacific Fisheries Commission, Bulletin Number 46.

Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*), in Groot, C., and Margolis, L. (eds.), Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, 82 p.

Hoelscher, B., and Bjornn, T.C. 1989. Habitat, Density, and Potential Production of Trout and Char in Pend Oreille Lake Tributaries: Idaho Department of Fish and Game, Project F 71-R-10, Subproject III, Job No. 8, Boise.

Lochead, J.K., and Yamanaka, K.L. 2007. Summary Report for the Inshore Rockfish (*Sebastes* spp.) Longline Survey Conducted in Statistical Areas 14 to 20, 28 and 29, from August 11 to September 6, 2005, Technical Report. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2690, Department of Fisheries and Oceans, Fisheries Research Branch, West Vancouver, British Columbia (as cited in NOAA-Fisheries, 2008).

Montana Bull Trout Scientific Group (MBTSG). 1998. The Relationship Between Land Management Activities and Habitat Requirements of Bull Trout. The Montana Bull Trout Restoration Team, Montana Fish, Wildlife and Parks, Helena.

Meehan, W.R. 1991. Introduction and overview, in Meehan, W.R. (ed.), Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society, Special Publication 19, 15 p.

Nehlsen, W., Williams, J.E., and Lichatowich, J.A. 1991. Pacific salmon at the crossroads – stocks at risk from California, Oregon, Idaho, and Washington: Fisheries, v. 16, p. 4 21.

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2005. Status Review Update for Puget Sound Steelhead. 2005 Puget Sound Steelhead Biological Review Team, NOAA-Fisheries, Northwest Fisheries Science Center, Seattle, Washington, http://www.nwr.noaa.gov/Publications/ Biological-Status-Reviews/upload/SR2005-steelhead.pdf (accessed May 10, 2007).

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2008. Preliminary Scientific Conclusions of the Review of the Status of 5 Species of Rockfish – Bocaccio (*Sebastes paucispinis*), Canary Rockfish (*Sebastes pinniger*), Yelloweye Rockfish (*Sebastes ruberrimus*), Greenstriped Rockfish (*Sebastes elongatus*) and Redstripe Rockfish (*Sebastes proriger*) in Puget Sound, Washington. NOAA-Fisheries, Northwest Fisheries Science Center, Seattle, Washington, http://www.nwr.noaa.gov/Other-Marine-Species/Puget-Sound-Marine-Fishes/upload/PS-rockfish-review-08.pdf (accessed July 2, 2009).

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2009a. Bocaccio (*Sebastes paucispinis*). NOAA-Fisheries, Office of Protected Species, Northwest Regional Office, Seattle, Washington, http://www.nmfs.noaa.gov/pr/species/fish/bocaccio.htm#status (accessed July 2, 2009).

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2009b. Yelloweye Rockfish (*Sebastes ruberrimus*). NOAA-Fisheries, Office of Protected Species, Northwest Regional Office, Seattle, Washington, http://www.nmfs.noaa.gov/pr/species/fish/yelloweyerockfish.htm#status (accessed July 2, 2009).

National Oceanic Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries). 2009c. Canary Rockfish (*Sebastes pinniger*). NOAA-Fisheries, Office of Protected Species, Northwest Regional Office, Seattle, Washington, http://www.nmfs.noaa.gov/pr/species/fish/canaryrockfish.htm#status (accessed July 2, 2009).

Oliver, G. 1979. A Final Report on the Present Fisheries Use of the Wigwam River with an Emphasis on the Migratory Life History and Spawning Behavior of Dolly Varden Char, *Salvelinus malma* (Walbaum). Fisheries Investigations in Tributaries of the Canadian Portion of Libby Reservoir, British Columbia Fish and Wildlife Branch, Victoria.

Palsson, W.A., Tsou, T.S., Barbman, G.G., Buckley, R.M., West, J.E., Mills, M.L., Cheng, Y.W., and Pacunski, R.E. 2008. The Biology and Assessment of Rockfishes in Puget Sound. Washington Department of Fish and Wildlife, Olympia (as cited in NOAA-Fisheries, 2008).

Pacific Fishery Management Council (PFMC). 1997. Review of the 1996 Ocean Salmon Fisheries. PFMC, Portland, Oregon (as cited in Good et al., 2005).

Pratt, K.P. 1984. Habitat Use and Species Interactions of Juvenile Cutthroat (*Salmo clarkii lewisi*) and Bull Trout (*Salvelinus confluentus*) in the Upper Flathead River Basin. M.S. Thesis, University of Idaho, Moscow.

Pratt, K.P. 1992. A review of bull trout life history, in Howell, P.J., and Buchanan, D.V. (eds.), Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, 4 p.

Quigley, T.M., and Arbelbide, S.J. 1997. An assessment of ecosystem components in the interior Columbia Basin and portion of the Klamath and Great basins, volume III, in Quigley, T.M. (ed.), The Interior Columbia Basin Ecosystem Management Project. Scientific Assessment, USDA Forest Service, PNW-GTR-405, Portland, Oregon, 656 p.

Ratliff, D.E., and Howell, P.J. 1992. The status of bull trout populations in Oregon, in Howell, P.J., and Buchanan, D.V. (eds.), Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, 7 p.

Reef Environmental Education Foundation (REEF). 2008. Scuba Survey Data. REEF, Key Largo, Florida, http://www.reef.org (as cited in NOAA-Fisheries, 2008).

Rich, C.F. 1996. Influence of Abiotic and Biotic Factors on Occurrence of Resident Bull Trout in Fragmented Habitats, Western Montana. M.S. Thesis, Montana State University, Bozeman.

Rieman, B.E., and McIntyre, J.D. 1993. Demographic and Habitat Requirements for Conservation of Bull Trout. U.S. Department of Agriculture, U.S. Forest Service, Intermountain Research Station, General Technical Report INT-308, Ogden, Utah.

Rieman, B.E., and McIntyre, J.D. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society, v. 124(3), p. 285-296.

Ruckelshaus, M.H., Currens, K.P., Graeber, W.H., Fuerstenberg, R.R., Rawson, K., Sands, N.J., and Scott, J.B. 2006. Independent Populations of Chinook Salmon in Puget Sound. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Technical Memorandum NMFS-NWFSC-78, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington, http://www.nwfsc.noaa.gov/trt/puget_docs/popidtm78final.pdf (accessed July 14, 2009).

Sedell, J.R., and Everest, F.H. 1991. Historic Changes in Pool Habitat for Columbia River Basin Salmon Under Study for TES Listing, Draft USDA Report. Pacific Northwest Research Station, Corvallis, Oregon.

Shared Strategy Development Committee (SSDC). 2007. Puget Sound Salmon Recovery Plan. SSDC, Seattle, Washington, http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Recovery-Plan.cfm (accessed July 14, 2009).

U.S. Army Corps of Engineers (USACE). 2000. Appendix B – Species Life Histories. USACE, Seattle, Washington, http://www.nws.usace.army.mil/publicmenu/DOCUMENTS/REG/appendix_b_-_general_fish_life_histories.pdf (accessed May 15, 2005).

U.S. Fish and Wildlife Service (USFWS). 2004a. Draft recovery plan for the Coastal-Puget Sound distinct population segment of bull trout (*Salvelinus confluentus*): volume I (of II) - Puget Sound Management Unit (including the Chilliwack River and associated tributaries flowing into British Columbia). U.S. Department of the Interior, USFWS, Portland, Oregon, http://www.fws.gov/pacific/bulltrout/RP/Puget%20Sound_Vol1_Puget%20Sound.pdf (accessed February 24, 2015).

U.S. Fish and Wildlife Service (USFWS). 2004b. Draft recovery plan for the Coastal-Puget Sound distinct population segment of bull trout (*Salvelinus confluentus*): volume I II (of II) – Olympic Peninsula Management Unit. U.S. Department of the Interior, USFWS, Portland, Oregon, http://www.fws.gov/pacific/bulltrout/RP/Olympic%20Penn_Vol2_Puget%20Sound.pdf (accessed February 24, 2015).

U.S. Fish and Wildlife Service (USFWS). 2014. Revised draft recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). U.S. Department of the Interior, USFWS, Portland, Oregon, http://ecos.fws.gov/docs/recovery_plan/20140904%20Revised%20Draft%20Bull%20Trout%20Recovery%20Plan.pdf (accessed February 24, 2015).

Watson, G., and Hillman, T.W. 1997. Factors affecting the distribution and abundance of bull trout – an investigation at hierarchical scales. North American Journal of Fisheries Management, v. 17, p. 237-252.

Washington Department of Fisheries (WDF), U.S. Fish and Wildlife Service, and Washington State Department of Game. 1973. Joint Statement Regarding the Biology, Status, Management, and Harvest of Salmon and Steelhead Resources, of the Puget Sound and Olympic Peninsula Drainage Areas of Western Washington. WDF, Olympia.

Washington Department of Fisheries (WDF). 1975-86. Washington State Sport Catch Reports, Technical Report. WDF, Olympia (as cited in NOAA-Fisheries, 2008).

Washington Department of Fish and Wildlife (WDFW). 2002. Salmonid Stock Inventory. WDFW, Olympia, http://www.wdfw.wa.gov/fish/sasi/ (accessed May 10, 2007).

Wydoski, R.S., and Whitney, R.R. 1979. Inland Fishes of Washington. University of Washington Press, Seattle.

Yamanaka, K.L., Lacko, L.C., Lochead, J.K., Martin, J., Haigh, R., Grandin, C., and West, K. 2004. Stock Assessment Framework for Inshore Rockfish. Fisheries and Oceans Canada, Canadian Advisory Secretariat, Research Document 2004/068, Nanaimo, British Columbia (as cited in NOAA-Fisheries, 2008).

Yamanaka, K.L., Lacko, L.C., Withler, R., Grandin, C., Lochead, J.K., Martin, J.C., Olsen, N., and Wallace, S.S. 2006. A Review of Yelloweye Rockfish *Sebastes ruberrimus* along the Pacific Coast of Canada – Biology, Distribution, and Abundance Trends. Fisheries and Oceans Canada, Canadian Advisory Secretariat, Research Document 2006/076, Nanaimo, British Columbia (as cited in NOAA-Fisheries, 2008).

ATTACHMENT C

Essential Fish Habitat Assessment (Magnuson-Stevens Fishery Conservation and Management Act)

ESSENTIAL FISH HABITAT ASSESSMENT

1.0 ACTION AGENCY

U.S. Environmental Protection Agency, Region 10, Seattle, Washington

2.0 LOCATION

Lower Duwamish Waterway, Seattle, King County, Washington (Township 24 North, Range 4 East, and Sections 18, 19, and 33).

3.0 PROJECT NAME

Enhanced Natural Recovery/Activated Carbon Pilot Study – Lower Duwamish Waterway

4.0 ESSENTIAL FISH HABITAT BACKGROUND

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), requires federal agencies to consult with the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA-Fisheries) on activities that may adversely affect essential fish habitat (EFH). EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." "Waters" include "aquatic areas and their associated physical, chemical, and biological properties that are used by fish." They may include aquatic areas historically used by fish. "Substrate" includes "sediment, hard bottom, structures underlying the waters, and associated biological communities" (NMFS, 1999).

The MSA requires consultation for all actions that may adversely affect EFH and does not distinguish between actions within and outside of EFH. Any reasonable attempt to encourage the conservation of EFH must take into account actions that occur outside of EFH, such as upstream and upslope activities that may have an adverse effect on EFH. Therefore, EFH consultation with NOAA-Fisheries is required by federal agencies undertaking, permitting, or funding activities that may adversely affect EFH, regardless of its location.

This assessment evaluates the impacts of the Pilot Study to determine whether it "may adversely affect" designated EFH for federally managed fisheries species in the proposed Action Area (see Section 4.1 of BE). The assessment also describes conservation measures to avoid, minimize, or otherwise offset potential adverse effects of the Pilot Study on designated EFH.

5.0 IDENTIFICATION OF EFH

The Pacific Fishery Management Council (PFMC) has designated EFH for federally managed fisheries within the waters of Washington, Oregon, and California. The designated EFH for groundfish (PFMC, 1998a; Casillas et al., 1998) and coastal pelagic species (PFMC, 1998b) encompasses all waters from the mean high water line and upriver extent of salt water to the boundary of the United States exclusive economic zones (370.4 kilometers [km]) (PFMC, 1998a, 1998b). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, California, and Idaho, except areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally impassable barriers (e.g., natural waterfalls in existence for several hundred years) (PFMC, 1999). In estuarine and marine areas, designated salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters to the full extent of the exclusive economic zone (370.4 km) offshore of Washington, Oregon, and California north of Point Conception, to the Canadian border (PFMC, 1999).

Groundfish, coastal pelagic, and salmonid fish species that have designated EFH in Puget Sound are listed in Table 1. Coastal pelagic species and pink salmon (*Oncorhynchus gorbuscha*) likely do not occur in the action area; however, some of the groundfish species may occur in the action area. Chinook (*O. tshawytscha*) and coho (*O. kisutch*) occur in the action area. Refer to the relevant EFH designations (Casillas et al., 1998; PFMC, 1998a, 1998b; PFMC, 1999) for life-history stages of these species that may occur in the action area. Assessment of the impacts on these species' EFH from the Pilot Study is based on this information.

6.0 DETAILED DESCRIPTION OF THE PROPOSED PROJECT

The Pilot Study includes the following project elements:

- A sediment remedial action that consists of placing enhanced natural recovery (ENR) material without and with activated carbon (ENR+AC) at three pilot plots (i.e., intertidal, subtidal, and scour) located in the Lower Duwamish Waterway. The total area of coverage will be 3 acres.
- Three years of post-implementation monitoring to assess the effectiveness of ENR and ENR+AC in reducing the bioavailability of polychlorinated biphenyls (PCBs) in contaminated sediments at the three pilot plot areas.

For a more detailed project description, please refer to Section 3.0 of the biological evaluation.

7.0 POTENTIAL ADVERSE EFFECTS OF PROPOSED PROJECT

The EFH designation for the Pacific salmon fishery includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except above the impassible barriers identified by PFMC (1999). In estuarine and marine areas, proposed designated EFH for salmon extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California north of Point Conception (PFMC, 1999).

The Pacific salmon management unit includes Chinook, coho, and pink salmon. All three of these species use Puget Sound for adult migration, juvenile outmigration, and rearing where suitable habitat is present. Resident coho and Chinook remain within Puget Sound throughout their entire life histories.

The EFH designation for groundfish and coastal pelagics is defined as those waters and substrate necessary to ensure the production needed to support a long-term sustainable fishery. The marine extent of groundfish and coastal pelagic EFH includes those waters from the nearshore and tidal submerged environment within Washington, Oregon, and California state territorial waters out to the exclusive economic zone (370.4 km [231.5 miles]) offshore between Canada and the Mexican border.

The West Coast groundfish management unit includes 83 species that typically live on or near the bottom of the ocean. Species groups include skates and sharks, rockfishes (55 species), flatfishes (12 species) and groundfish. Some groundfish, such as lingcod (*Ophiodon elongatus*), cabezon (*Scorpaenichthys marmoratus*), and species of rockfish (*Sebastes* spp.) could potentially occur in the action area.

Coastal pelagics are schooling fishes, not associated with the ocean bottom, that migrate in coastal waters. West Coast pelagics include the Pacific sardine (*Sardinops sagax*), Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), jack mackerel (*Trachurus symmetricus*), and market squid (*Loligo opalescens*). These fishes are primarily associated with the open-ocean and coastal areas (PFMC, 1998a) and are not likely to occur in the action area.

The Pacific sand lance (*Ammodytes hexapterus*) and the surf smelt (*Hypomesus pretiosus pretiosus*) are an important forage fish for Chinook and coho salmon. Loss of prey is considered an adverse effect on EFH. Both species have been reported to occur in the action area (Windward, 2010).

EFH for groundfish and Pacific salmon is present in the action area. The Pilot Study may result in a minor, localized reduction in foraging habitat until the area is recolonized by benthic macroinvertebrates. The existing shoreline is of marginal value, at best, as a foraging area for Pacific salmon and groundfish. There may also be some minor, temporary, and localized water quality impacts due to increased turbidity during placement of the ENR and ENR+AC materials. No permanent adverse effects on EFH for groundfish or Pacific salmonids or their prey species will result from the Pilot Study.

8.0 CONSERVATION MEASURES

Implementing the conservation measures specified in Section 3.4 of the biological evaluation will avoid and minimize any potential effects of the Pilot Study on EFH.

9.0 CONCLUSION

The Pilot Study will result in a minor, localized, and temporary (1 to 2 years) effect on approximately 3 acres of potential intertidal and subtidal foraging habitat for juvenile salmonids at the three pilot plot areas. There may also be some minor temporary and localized water quality impacts due to increased turbidity during placement of the ENR and ENR+AC materials. It is expected that the Pilot Study will result in an overall net benefit to EFH for Pacific salmonids and groundfish using the action area by reducing the bioavailability of PCBs in contaminated sediments at the three pilot plot areas. No permanent adverse effects on EFH for groundfish, Pacific salmonids, or their prey species will result from the Pilot Study.

10.0 REFERENCES

Casillas, E., Crockett, L., deReynier, Y., Glock, J., Helvey, M., Meyer, B., Schmitt, C., Yoklavich, M., Bailey, A., Chao, B., Johnson, B., and Pepperell, T. 1998. Essential Fish Habitat West Coast Groundfish Appendix. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Seattle, Washington.

National Marine Fisheries Service (NMFS). 1999. Essential Fish Habitat Consultation Guidance. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Office of Habitat Conservation, Silver Spring, Maryland.

Pacific Fishery Management Council (PFMC). 1998a. The Coastal Pelagic Species Fishery Management Plan: Amendment 8 (December 1998). PFMC, Portland, Oregon.

Pacific Fishery Management Council (PFMC). 1998b. Final Environmental Assessment/Regulatory Review for Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan (October 1998). PFMC, Portland, Oregon.

Pacific Fishery Management Council (PFMC). 1999. Amendment 14 to the Pacific Coast Salmon Plan, Appendix A – Description and Identification of Essential Fish Habitat, Adverse Impacts and Recommended Conservation Measures for Salmon (August 1999). PFMC, Portland, Oregon.

Windward. 2010. Lower Duwamish Waterway Remedial Investigation – Final Remedial Investigation Report. Prepared for the Lower Duwamish Waterway Group, Seattle, Washington.

APPENDIX C

Construction Quality Assurance Project Plan

Lower Duwamish Waterway Group

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

CONSTRUCTION QUALITY ASSURANCE PROJECT PLAN

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

FINAL

Prepared for:

The US Environmental Protection Agency
Region 10
Seattle, Washington

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, Washington

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
ENVIRON International Corporation
Floyd|Snider
Geosyntec Consultants

December 07, 2015

Project No. LY15160310

TABLE OF CONTENTS

Page

TABLE OF CONTENTS (Continued)

Page

TABLES

FIGURES

ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

AC	Activated Carbon
AFE	Assistant Field Engineer
AMEC	Amec Foster Wheeler
BMP	Best Management Practice
County	King County Project Team
CQA	Construction Quality Assurance
CQAPP	Construction Quality Assurance Project Plan
CQCP	Contractor Quality Control Plan
DOF	Dalton, Olmsted, & Fuglevand, Inc.
Ecology	Washington State Department of Ecology
ENR	Enhanced Natural Recovery
ENR+AC	Enhanced Natural Recovery with Activated Carbon
EPA	U.S. Environmental Protection Agency
FE	Field Engineer
GPS	global positioning system
HASP	Health and Safety Plan
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
Order	Administrative Order
PCB	Polychlorinated biphenyl
PE	Project Engineer
Project Representative	King County Project Representative
QA	Quality Assurance
QC	Quality Control
QCO	Quality Control Officer
USACE	U.S. Army Corps of Engineers
WQMP	Water Quality Monitoring Plan

CONSTRUCTION QUALITY ASSURANCE PROJECT PLAN
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 INTRODUCTION

This Construction Quality Assurance Project Plan (CQAPP) has been developed for use during implementation of the Enhanced Natural Recovery/Activated Carbon Pilot Study Project (Project) on the Duwamish Waterway. This CQAPP describes the personnel, procedures, and activities required to assure that the construction work satisfies the engineering design and regulatory requirements, and that reliable, accurate, and verifiable construction data are recorded during construction.

1.1 PROJECT SCOPE

The Lower Duwamish Waterway Group (LDWG) will conduct a pilot study of an innovative sediment remediation technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW). The study will determine whether Enhanced Natural Recovery (ENR) amended with granular activated carbon (AC) can be successfully applied to reduce the bioavailability of polychlorinated biphenyls (PCBs) in remediated contaminated sediment in the LDW. The study will compare the effectiveness of ENR with added AC (ENR+AC) with that of ENR without added AC in three areas (referred to as "plots") in the LDW, which are referred to as the intertidal plot, subtidal plot, and potential scour plot. For the purposes of this project, ENR involves the placement of a thin layer of clean material (sand or gravelly sand) over subtidal or intertidal sediments. ENR+AC involves the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments. The purpose of the ENR and ENR+AC treatments is to reduce the exposure of aquatic organisms to contaminants of concern.

A pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055, issued on December 20, 2000).

The goals of the pilot study, as stated in the Order, are the following:

- Verify that ENR+AC can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percent of carbon in a placed layer).

- Evaluate performance of ENR+AC compared to ENR alone in locations with a range of PCB concentrations.
- Assess potential impacts to the benthic community in ENR+AC compared to ENR alone.
- Assess changes in bioavailability of PCBs in ENR+AC compared to ENR alone.
- Assess the stability of ENR+AC in scour areas (such as berthing areas).

1.2 Construction Quality Management Overview

Construction quality management consists of quality control (QC) by the contractor and quality assurance (QA) by the King County Project Team (County) which includes work by Amec Foster Wheeler (AMEC), Dalton, Olmsted & Fuglevand (DOF), and subcontracted divers. The contractor is responsible for performing the work in accordance with the project plans and specifications, and the Contractor Work Plan. They are also responsible for the quality of work by their subcontractors. The contractor will establish an independent QC program, and prepare and implement a Contractor Quality Control Plan (CQCP). The CQCP may be part of the Contractors Work Plan or a stand-alone document.

The CQCP must specify:

- Testing and inspections to be done as directed in the project specifications,
- Any other testing and inspections required to verify that the work meets the project specifications,
- Procedures for controlling the quality of construction work,
- Procedures to document construction activities that affect the quality of work performed,
- QA/QC procedures for all construction project monitoring, and
- Specify corrective actions to be performed in the event of over-placement, under-placement, or placement outside of the specified area for the ENR and ENR+AC material.

The contractor shall have a copy of all its documents, including the CQCP, on site and available to its personnel, construction quality assurance (CQA) personnel, and agency personnel throughout the duration of the Project.

QA performed by the County and the Amec Foster Wheeler consulting team (consulting team) will consist of monitoring and audits to verify that the Contractor follows applicable QC programs, verify effectiveness of the QC programs, and provide assurance and documentation that the completed construction work satisfies quality requirements specified in the construction contracts. Construction oversight will be provided by the King County Project Representative (Project Representative), the CQA field staff, and support staff.

1.3 Construction Quality Assurance Project Plan Objectives

The purpose of the CQAPP is to provide assurance that the completed construction work meets the quality requirements in the project plans and specifications. The objectives of this CQAPP are to:

- Define project management organization and roles.
- Define the responsibilities and authorities of project QA/QC team members.
- Define procedures and methods to check the contractor's performance and work quality.
- Define procedures to implement corrective actions if performance standards or design criteria are not met.
- Define documentation procedures and requirements.

1.4 Document Organization

This CQAPP is organized into the following sections.

- Section 1.0 presents an overview of the Pilot Study, the components of the construction quality management, and objectives of the CQAPP.
- Section 2.0 describes the organizations and key personnel involved in construction quality management as well as their responsibilities authorities.
- Section 3.0 describes the QA activities for different elements of construction work.
- Section 4.0 describes the procedure for tracking construction deficiencies from the identification through the accepted corrective action.
- Section 5.0 presents the procedures for managing, meeting, and construction documentation and reporting.
- Section 6.0 describes the procedures for revising the CQCPs and CQAPP.

1.5 Distribution and Document Control

Copies of this CQAPP will be distributed to all supervisory personnel involved in Project implementation. All supervisory personnel working on the Project are required to read and familiarize themselves with this CQAPP prior to work at the Site. A current version of this CQAPP should be in the possession of all supervisory field personnel. If this CQAPP is updated, each distributed copy of the CQAPP will be replaced by the revised version.

Other documents describe the procedures, guidelines, and requirements for other aspects of the work that the CQA field staff will use in conjunction with this CQAPP. Those documents are:

- *Health and Safety Plan (HASP)*: Describes procedures, equipment, and monitoring requirements to protect the health and safety of the King County project personnel, including the CQA field staff.
- *Project Permits and Approvals*: Project permit and approval requirements include but are not limited to the Water Quality Memo and the U.S. Environmental Protection Agency (EPA) Approved Contractor Work Plan.

2.0 PROJECT ORGANIZATION

This section presents the structure of the project construction management and CQA team, the construction team including construction quality control, the roles of involved organizations, and the responsibilities and authorities of key personnel involved in QA/QC of the construction work (collectively referred to as the project team). Figure 1 shows the organization of the project team. The specific companies and responsible individuals in charge of CQA will be finalized prior to the start of construction, and the CQAPP will be updated as needed to reflect any changes in organization of the project team.

2.1 ORGANIZATIONAL ROLES AND RESPONSIBILITIES

This section presents the organization, roles, and responsibilities of the construction management and CQA team (CQA team) during construction. Full contact information can be found in Table 1.

The LDWG is the lead for conducting this work for EPA and the Washington State Department of Ecology (Ecology) and as such will be involved in all aspects of this project.

2.1.1 EPA and Ecology

EPA and Ecology as oversight agencies will review and approve of the CQAPP as well as perform oversight on any field activities, as needed. EPA and Ecology will be represented by their project managers (PMs) for this project, Elly Hale and Ron Timm, respectively. EPA and Ecology responsibilities and authorities include but are not limited to:

- Overall Project oversight and approval;
- Programmatic oversight of project quality assurance;

- Final approval of changes to CQAPP in coordination with LDWG/King County;
- Final decision making on compliance with water quality standards and BMPs; and
- Authority for stopping work for any reason deemed appropriate by EPA/Ecology.

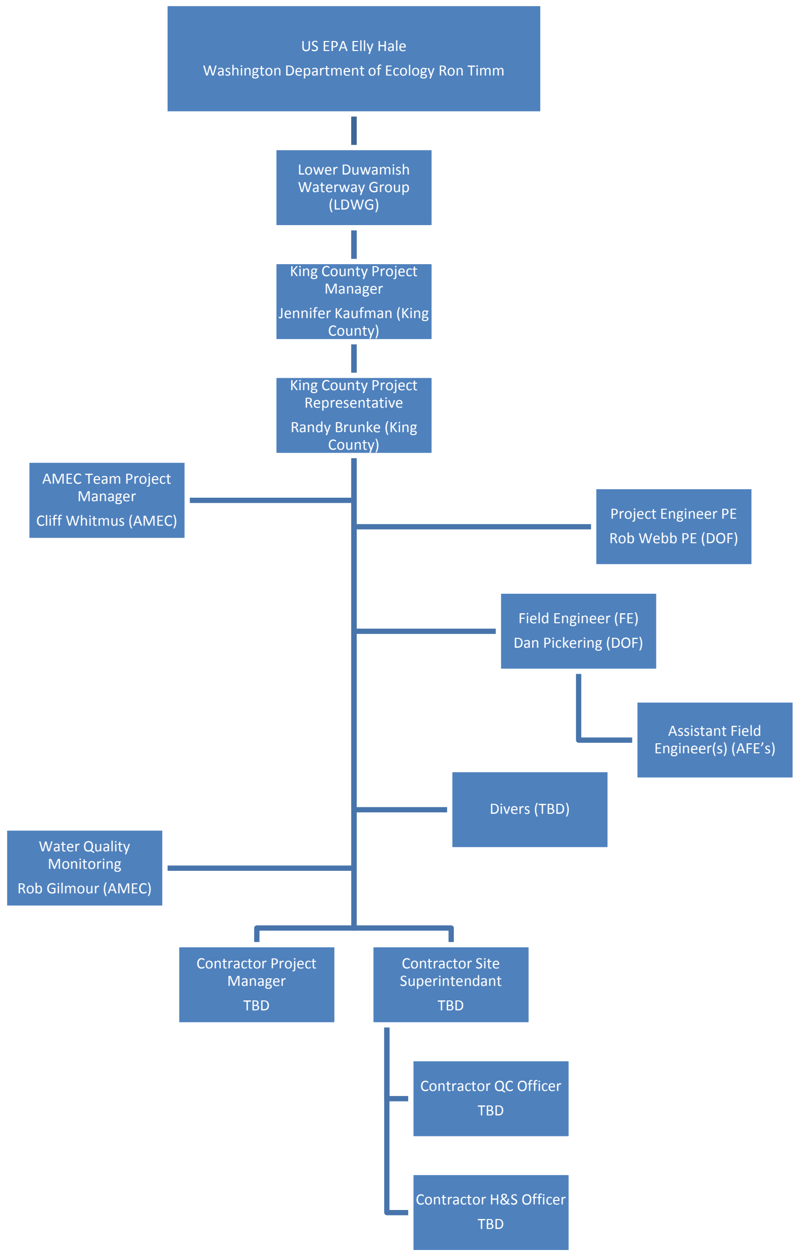


Figure 1 – CQAPP Project Organizational Chart

2.1.2 King County

King County is the owner of the Project, and the Project Representative will be responsible for overall construction management and coordination of the work. The Project Representative will coordinate administrative aspects of the activities between King County, LDWG, the consulting team, and the Construction Contractor, monitor the project schedule, maintain communications within King County and the other interested parties, and be responsible for all verbal or written direction to the contractor. Project Representative will report to King County Project Manager and will be supported by the CQA team.

2.1.2.1 King County Project Manager

The responsibilities and authorities of King County's Project Manager (King County PM) include, but are not limited to:

- Overall Project responsibility;
- Programmatic oversight of project quality assurance;
- Approval of changes to CQAPP in coordination with EPA
- Coordinate with LDWG on any major project deviations in accordance with LDWG agreements

The King County PM is Jennifer Kauffman.

2.1.2.2 King County Project Representative

The responsibilities and authorities of the King County, Project Representative, include, but are not limited to:

- Final approval of all submittals;
- Tracking schedules;
- Conducting progress meetings;
- Conducting all administrative activities during construction among the LDWG, the Project Engineer, Field Engineer and the Contractor;
- Performing all field inspections;
- Approving all import materials and equipment;
- Accepting or rejecting key personnel on the project;
- Provide all verbal or written direction to the contractor;

- Stopping work for any reason deemed appropriate;
- Auditing the project QA; and
- Approving in conjunction with the King County PM deviations from the requirements in the project plans and specifications.

The Project Representative is Randy Brunke.

2.1.3 Lower Duwamish Waterway Group

The LDWG consists of the City of Seattle, the Port of Seattle, King County and The Boeing Company. King County will regularly update the LDWG partners on the progress of this project, and LDWG will provide direction to King County on any major project deviations in accordance with LDWG agreements.

2.1.4 Engineering Consulting Team

King County has retained an engineering consulting team (consulting team) to provide field engineering and construction QA during the project.

The consulting team will be referred to as the CQA team in this document. Dalton, Olmsted & Fuglevand, Inc. (DOF) is the Engineer of Record and is a sub-consultant to AMEC Foster Wheeler who is the prime consultant to King County for this project (collectively referred to as the CQA team in this document). The CQA team reports to King County.

2.1.4.1 Consulting Team Project Manager

Cliff Whitmus of AMEC Foster Wheeler will serve as the consulting team Project Manager. The responsibilities of the consulting team Project Manager include, but are not limited to, the following:

- Overall project coordination;
- Providing oversight on planning and coordination, work plans, project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project;
- Coordinating with LDWG, EPA, and Ecology on schedule, deliverable, and other administrative details.

2.1.4.2 Project Engineer

Rob Webb of DOF will serve as the Project Engineer (PE) and the CQA team leader under direction from the Project Representative. Mr. Webb will provide technical assistance and perform limited field oversight during construction as necessary to support activities by the Field Engineer (FE). The PE's roles and responsibilities include, but are not limited to, the following:

- Overall responsibility of construction QA;
- Overall responsibility for CQA field staff;
- Resolve design issues during construction coordinating with the Project Representative;
- Coordinate technical aspects of the project with the Contractor, and
- Inform King County PM and Project Representative of issues encountered during construction.

2.1.4.3 Field Engineer

The FE reports to the Project Representative, works with the CQA field engineering staff, and monitors daily construction, inspections and monitoring activities to assure compliance with the CQAPP.

The Field Engineer will be Dan Pickering of DOF.

Responsibilities of the FE include, but are not limited to, the following:

- Coordinate activities with the Project Representative;
- Resolve any design and construction issues or conflicts with the Project Representative and the Contractor;
- Identify and resolve construction deficiency issues;
- Notify the Contractor's Site Safety Officer of any emergent safety issues;
- Notify the Project Representative of any needed direction to the Contractor; and
- Maintain project documentation.

2.1.4.4 Assistant Field Engineers/Inspectors

The FE may be assisted by Assistant Field Engineer(s) (AFE), who will assist in the inspection and documentation of daily activities. AFEs may include subcontractors such as divers for inspections.

Responsibilities and authorities of the Assistant Field Engineers and Inspectors include, but are not limited to:

- Review the Contractor's QC testing and inspection results of behalf of the FE and Project Representative;
- Document details of the work progress on the daily and weekly status reports;
- Inspect and document all construction activities;
- Document equipment and personnel on site daily;
- Conduct any QA testing;
- Perform water quality monitoring and documentation;
- Install grade stakes;
- Inspect plots using divers, and
- Coordinate and manage data from dive inspections of plots.

2.1.5 Construction Contractor

King County will retain a contractor to implement the pilot study. The Contractor's Project Manager (PM) will report to the Project Representative. The Contractor's Site Superintendent shall be onsite whenever work is being performed and will report to the Project Representative.

The Contractor is responsible for completing the construction in accordance with the design drawings and specifications, the approved Work Plan, CQCP, approved permits and substantive compliance conditions, and all approved changes to these documents, as well as conducting Quality Control including appropriate tests and inspections to verify that the work meets all of the design requirements.

The Contractor will furnish a Work Plan that includes a CQCP for review and approval by King County, LDWG, the CQA team and EPA/Ecology. The CQCP will identify the inspections, monitoring, surveys, and other actions to be taken by the Contractor as required by the plans and specifications to ensure that the work complies with all contract requirements. The CQCP needs to be approved by LDWG and EPA/Ecology before construction Notice to Proceed (NTP).

The Contractor will use methods described within their CQCP to ensure project performance and compliance with the approved design drawings and specifications. The Contractor will have a dedicated Quality Control Officer (QCO) on site throughout the duration of the Project. The QCO will have the ability and authority to ensure that the work is performed in accordance with the approved plans.

In addition, the Contractor will submit a site-specific Health and Safety Plan (HASP) that will cover the controls, work practices, personal protective equipment, 40-hour HAZWOPER (& 8 hour annual refresher as appropriate) certifications for all onsite Contractor personnel, and other health and safety requirements that will be implemented in connection with the construction work. A similar site-specific HASP will be required for all subcontractors. The Contractor will ensure that all their staff and subcontractors' staff follow the approved quality control, documentation, and health and safety procedures, and document as-built conditions.

2.1.5.1 Contractor's Project Manager

Contractor will employ a Project Manager (PM) with at least 8 years of remedial construction supervisory experience on sediment remediation projects including a minimum of one marine remediation project in the Puget Sound and one project using precision instrumented excavator for in water material placement.

The Contractor's Project Manager reports to the Project Representative, and is responsible for overseeing completion of the construction work in accordance with the project plans and specifications, design drawings, and the approved CQCP, or approved changes of the same. The Contractor's Project Manager is supported by the Contractors Site Superintendent, QC Manager, and Health and Safety Officer. The responsibilities and authorities of the Contractor's Project Manager include, but are not limited to:

- Ensure construction is conducted and completed in accordance with the plans and specifications;
- Ensure that the Contractor's staff follow the approved quality control and health and safety procedures;
- Ensure that required tests and inspections are conducted;
- Ensure that the Contractor's staff performing the tests and inspection are properly trained;
- Ensure that testing and inspection results meet QC requirements;
- Inform the FE and Project Representative of any new finds or changed conditions;
- Provide QC documentation to the FE and Project Representative; and
- Submit as-built conditions to the Project Representative.

The Contractor's Project Manager has the full authority to execute any and all actions necessary to ensure that the construction work complies with the project plans and specifications, and HASP.

2.1.5.2 Contractor's Site Superintendent

Contractor shall designate a Site Superintendent. The Site Superintendent should have at least 8 years of sediment remediation construction supervisory experience including a minimum of one marine remediation project in the Puget Sound and one project using precision instrumented excavator for material placement. The Site Superintendent will be on site full time whenever work is being performed and supports Contractor's PM. The responsibilities and authorities of the Site Superintendent include, but are not limited to:

- Ensure construction is conducted and completed in accordance with the plans and specifications;
- Ensure that the Contractor's staff follow the approved quality control and health and safety procedures;
- Ensure that required tests and inspections are conducted;
- Ensure that the Contractor's staff performing the tests and inspection are properly trained;
- Ensure that testing and inspection results meet QC requirements;
- Provide QC documentation to the Contractors Project Manager, for submittal to the FE and Project Representative, and
- Document as-built conditions.

2.1.5.3 Contractor's Quality Control Officer

Contractor will designate a full time Quality Control Officer (QCO) for the Project. The QCO will be an engineer or technician knowledgeable of standard QA/QC procedures for construction activities on aquatic environmental remediation projects with at least 2 years' experience including a minimum of one marine remediation project in the Puget Sound and one project using precision instrumented excavator for material placement. The Contractor's QCO is responsible for ensuring that the construction work meets the requirements in the project plans and specifications, communicates directly with the Project Representative or designee (specifically the FE and AFE), and reports to the Contractor's PM. The QCO's responsibilities include but are not limited to:

The QCO's responsibilities include:

- Implementing the approved CQCP;
- Adhering to project specifications, drawings, and field changes approved by the Project Representative;
- Performing required inspections specified in the CQCP;

- Ensuring that testing and inspection results meet QC requirements;
- Revising the CQCP as required and approved by the Project Representative;
- Maintaining QC documentation, and
- Providing QC documentation to the Contractor's Project Manager.

The QCO has the full authority to execute any and all actions necessary for implementing the QC program to ensure compliance with the project plans and specifications.

2.1.5.4 Health and Safety Officers

Each consultant and contractor will designate a Health and Safety Officer (HSO), who will be primarily responsible for implementing and overseeing that firm's HASP. Specific responsibilities of each HSO will include providing that firm's staff with the HASP that deals with project-specific hazards, ensuring that all employees are trained in appropriate safety techniques relevant to the project, ensuring that safe work procedures are followed at the job site, ensuring that proper safety equipment is available at the job site, and maintaining Health and Safety documentation and providing such documentation to the Project Representative.

3.0 QUALITY CONTROL AND QUALITY ASSURANCE ACTIVITIES

This section describes the QC and QA activities to be performed for different elements of the Project.

3.1 PROJECT BEST MANAGEMENT PRACTICES

The following best management practices (BMPs) have been developed for the Project and will be used for ENR material preparation and placement. These BMPs have been developed to improve material placement or meet other objectives such as water quality during placement. These BMPs are summarized in this document to provide quick reference, but are explained further in associated documents:

- Precision rigid arm excavator – Use precision, rigid arm excavator with real-time navigation and positioning system for material placement.
- Water-Tight Barges for ENR+AC Material – Verify barges are watertight to extent necessary prior to use. Perform hydrostatic test to verify and inspect for leaks as possible sources of turbidity during construction.
- Test Placement – Perform test placement, in location shown on plans, prior to actual plot placement to determine optimal bucket fill factor and bucket grid pattern to achieve thickness of placed material with thickness value of 6-9 inches at 80% of

locations with no single location less than 4 inches in the area where two lifts were placed.

- Bucket Fill Factor – Achieve uniform bucket fill factor, based on test placement, as practicable during in water material placement over Plot areas.
- Saturate AC – Monitor and adjust water level within ENR+AC material barge as needed to maintain flooded condition during and four a minimum of 12 hours prior to and during in water placement of ENR+AC Material.
- Clamshell Bucket Vertical Control – Place bucket approximately 2 to 2.5 feet above existing bottom grade as practicable during bucket opening without getting closer than 2 feet to bed at any time during placement operations.
- Clamshell Bucket Horizontal Position – Based on Test Placement, use bucket grid pattern developed to optimize material placement at target thickness. Pre-program pattern into navigation system prior to placement.
- Use of Spuds – Limit disturbance of Plot areas before and during construction due to spud operations, anchors, cables, and excessive tug maneuvering. Verify equipment is properly sized such that excavator can place a minimum of two bucket rows, as measured from front of barge outward, from each spud set location throughout full project depths. Do not place spuds in areas where ENR or ENR+AC material has already been placed. Other disturbances to plot areas by anchors, cables, prop wash, vessel grounding or similar shall be avoided.

Consistent with the Biological Evaluation the following BMPs will also be used:

- All mechanized equipment will be maintained in proper operating condition, with equipment inspections occurring prior to each workday. Equipment found to be leaking petroleum products or hydraulic fluid will be removed from the site for maintenance.
- Drip pads or pans will be placed under mechanized equipment to contain any potential leaks of petroleum products or hydraulic fluids.
- To the extent possible, vegetable-based hydraulic fluids will be used.
- A spill kit will be kept on work vessels to contain any potential petroleum spills that might occur.
- Ecology and the U.S. Coast Guard will be contacted immediately in the event of a spill.
- Any project-related debris or wastes will be placed in appropriate containers for off-site disposal. No project-related debris or wastes will be allowed to enter the water.
- Barges and work vessels will not be allowed to run aground on the substrate. Work barges will be held on station with spuds or anchors.

If there is a confirmed exceedance of the turbidity compliance criterion during construction monitoring, the Project Representative may direct the contractor to institute the following or other BMPs consistent with the Water Quality Monitoring Plan (WQMP; Appendix F of the Narrative Design Report):

- Review the documented operations at the time of the exceedance; specifically determine whether the in-water placement of ENR or ENR+AC or a non-project-related activity was occurring at the time of the exceedance.
- Once the activity resulting in the exceedance has been identified, determine the likely cause of the excess turbidity by reviewing the log of operations.
- The contractor may modify operations per direction from the Project Representative or designee (the FE). Potential modifications may include an adjustment to the placement process, including the following:
  - Decreasing the velocity of the bucket through the water column.
  - Pausing the bucket above the sediment surface before opening it.
  - Stopping work temporarily or increasing cycle time.
  - Modifying the position of barges to reduce potential grounding or scour from the tugs.
  - Modifying the ENR or ENR+AC material barge loading to reduce material spillage.

3.2 GENERAL QA ACTIVITIES

General QA activities include, reviewing the Contractor's construction and QC records, observing the Contractor's QC tests and inspections, and conducting independent testing and inspections.

3.2.1 Verification of Contractor's QC Program

The CQA team that includes the Project Representative, FE, and AFE will review the Contractor's construction and QC records on a daily basis and obtain QC documentation from the Contractor and provide the information to the Project Representative. The CQA team directed by the Project Representative will observe and provide oversight of the Contractor's QC testing and inspections to verify that:

- The frequency of testing and inspection meets CQCP requirements.
- Testing equipment is calibrated.
- Testing is performed properly.
- QC results meet CQCP requirements.

- Compliance with project BMPs.

3.2.2 Independent Testing and Inspections

As described in later subsections, the CQA team will perform independent testing and inspections as required by this CQAPP to verify:

- Equipment meets the project plans and specifications.
- Products (ENR and AC materials) meets the project plans and specifications.
- Placement including locations, dimensions, elevations, and tolerances indicated in the project plans and specifications.
- Water Quality Compliance.
- The CQA team will verify that all testing equipment and apparatus are in working order and properly calibrated.

3.2.3 Project Closeout

Prior to demobilization, the Project Representative and FE will verify that:

- Accurate as-built drawings are prepared.
- Corrective actions for construction deficiencies are completed and recorded.
- All QA/QC documents are complete and properly filed.

3.3 QA and QC of Products

3.3.1 Verification of AC Material

AC gradation requirements can be found in Specification Section 02221 Part 2. A minimum of 15 days prior to ordering AC material, the Contractor will submit the following information to the Project Representative for approval:

- AC Supplier's name and material type;
- A sample of the AC, as described in the Specifications, so the CQA team can submit for chemical analysis for PCB content;
- Results of gradation tests for the AC materials to be imported.

Upon delivery of AC material to the ENR material loading facility, the CQA team will inspect the material to verify that the materials are the same as what is proposed by the Contractor and a sample of which was previously submitted, analyzed and approved. When required by the CQAPP, the FE will obtain the manufacturer's certificate for each lot of material delivered, which will be signed by a responsible person employed by the manufacturer. The FE will verify that certificates are provided for all received material and that the certified properties meet design specifications.

The FE, in conjunction with the Project Representative, will reject incorrect material and verify that the rejected materials are either removed from the site or stored at a location separate from accepted material. Material that does not have the manufacturer's certificate will also be stored separately from accepted material until the certificates are received and approved by the FE. The FE will verify that all materials are stored with adequate safeguards to protect against damage.

3.3.2 Verification of Sand and Gravelly Sand Products

3.3.2.1 Contractor Verification of Sand and Gravelly Sand Products

The Contractor shall perform the following verification of sand and gravelly sand products:

- Provide source of products to the CQA team;
- Inspect source of products;
- Verify sieve analysis matches the criteria designated in the Specifications; and
- Provide sample(s) of the products, as described in the QAPP, to the CQA team at least 4 weeks prior to anticipated mobilization.

3.3.2.2 QA Verification of Sand and Gravelly Sand Products

The consultant CQA team including the FE, AFE, and the Project Representative shall perform the following verification of sand and gravelly sand products:

- Inspect source of products;
- Submit sample(s) for chemical analysis per QAPP; and
- Verify sieve analysis and chemical analysis matches the criteria designated in the Specifications.

3.3.3 Verification of AC-amended Sand and Gravelly Sand

3.3.3.1 Contractor Verification of AC-Amended Sand and Gravelly Sand

The Contractor shall perform the following verification of AC-amended sand and gravelly sand:

- Provide blend method in the Contractor Work Plan submittal;
- Provide weigh tickets of AC and sand or gravelly sand ENR Material (separate ticket for AC and for sand or gravelly sand; shall confirm specified% by weight AC) from the loading of each barge (or truck as appropriate);

- Provide sample(s) of blended material to the CQA team 1 week prior to expected mobilization; and
- Provide sample(s) to the CQA team periodically, as described in Specifications.

3.3.3.2 CQA Verification of AC-Amended Sand and Gravelly Sand

The CQA team shall perform the following verification of AC-amended sand and gravelly sand:

- Observe the blending/loading of the AC-amended sand and gravelly sand in real-time;
- Visually verify the consistency of the blended material;
- Verify that the blended material meets the acceptance criteria designated in the Specifications (target percent by weight) based on visual observations and scale tickets from barge loading operations; and
- Collect random samples of the AC amended ENR materials from barge prior to placement for information only to determine the detected range of AC in the blend.

3.4 QA AND QC PROCEDURES FOR ENR & ENR+AC PLACEMENT

This section presents QA/QC requirements for in-water placement of ENR material and ENR+AC material. Table 2 summarizes the anticipated QA/QC monitoring requirement for in-water work, including frequency and personnel responsible for performing monitoring. The results of these inspections and monitoring activities will be documented as specified in Section 5.0 of this document.

3.4.1 Prior to Construction

Prior to construction, the Contractor will do the following:

- Establish survey and positioning controls; and
- Ensure all equipment is functional and ready for mobilization.

The necessary inspections by CQA staff will be performed prior to the start of construction activities, including inspecting all equipment to be used by the Contractor that could affect the quality of the project and to verify compliance with the project specifications. Items to be specifically included during preconstruction inspections include ENR material plant and equipment, navigation and positioning equipment and display, tidal gauges, telemetry, and other individual or integrated systems on ENR material plant or survey vessel.

3.4.1.1 ENR/AC Material Inspection, Sampling, Analysis

As described in the QAPP, baseline sampling will be conducted to establish the conditions within each subplot prior to placement. During this timeframe, the Contractor will provide samples to the Project Representative who will have the QCA staff test the samples of the ENR and AC substrates. Those tests will follow the requirements described in the QAPP. ENR material will be tested for SMS compounds, TOC, and grain size and the AC material will be tested for PCB congeners, as described in the QAPP.

3.4.1.2 Equipment Inspection

Prior to the start of any construction, periodically throughout the project and after any change of equipment, the FE will inspect all equipment to be used. These inspections will include but not be limited to:

- Prior to loading any ENR material, Material barge bins will be tested by pumping water from the Duwamish Waterway into the bin up to a level of approximately 2 feet deep. Material bins on barges will be inspected for water tightness with minor weeping, as determined by the CQA team, being acceptable; any visible leak determined to be of unacceptable magnitude by the Project Representative, including any causing turbidity impacts, shall be repaired by Contractor and then re-inspected until no visible leaks of unacceptable magnitude occur;
- Verification and inspection of positioning/navigation equipment; and
- Verification that navigation and offsetting bucket files have been assembled.

3.4.1.3 Grade Stake Placement

Prior to ENR material placement within any subplot or test placement area, King County will install breakaway grade stakes within the subplot or test placement area. Within the Test Placement (Demonstration) areas, stakes will be installed at a rate of 1 per 100 square feet. In subplots, 15 stakes will be installed per subplot at approximate locations shown on the Project Plans. Stakes shall be placed within one week of planned material placement within a sub plot. Stakes will be placed by diver or possibly by foot access at low tide at the intertidal plot at location shown on plans. The location of the stakes will be surveyed in using either a global positioning system (GPS) rod placed directly on or adjacent to the stake or by diver using small buoy to display location on water surface where GPS can be used to survey.

It is anticipated that stakes will be made from 1-inch diameter PVC pipe or similar, as approved by the Project Representative prior to installation, driven approximately 1.5 feet (18 inches) to 3 feet (36 inches) into the existing waterway bed as practicable to prevent over turning based on sediment characteristics and extending 1.5 feet (18 inches) above the existing waterway bed.

Stakes shall be clearly marked in 1-inch increments from 0.0 feet (set at existing mudline) up to 1.5 feet (18 inches) at top of stake.

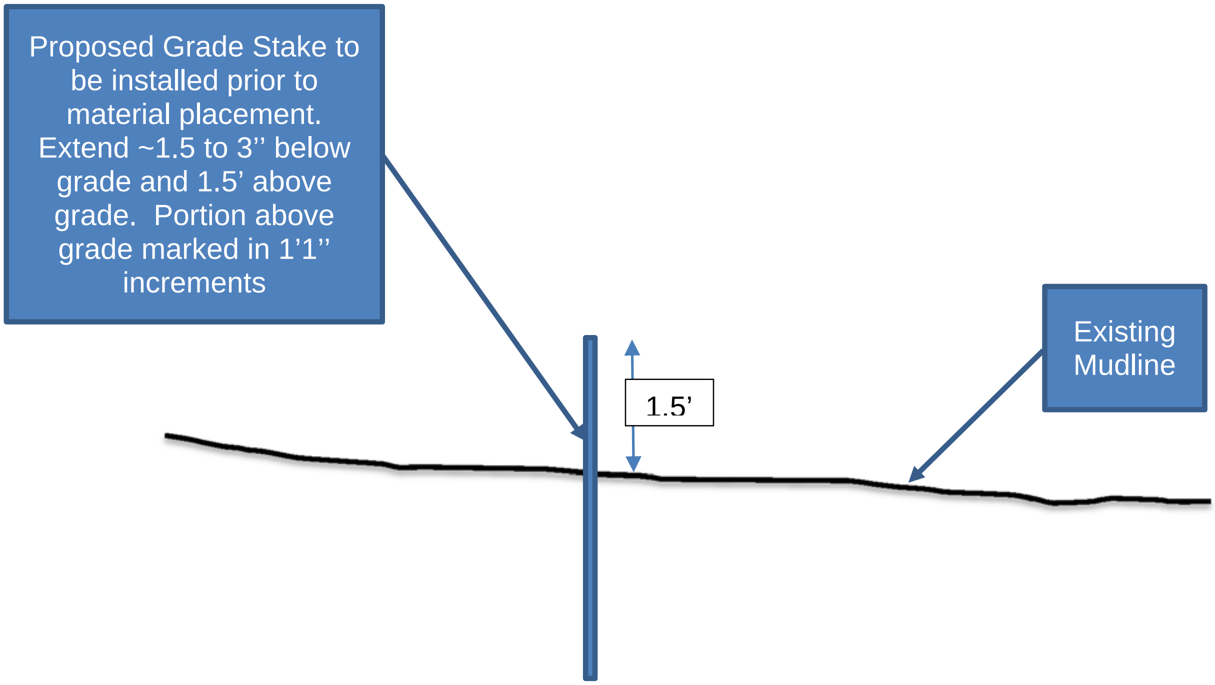


Figure 2 – Conceptual Grade Stake

3.4.2 ENR/AC Test Placement Demonstration

Prior to waterway placement, Contractor will perform test placement demonstrations in designated demonstration areas (as shown on Plans) within the intertidal zone of the Duwamish Waterway for both the AC amended sand ENR material and the gravelly sand ENR material. The test Placement Demonstration areas are located near and within the intertidal plot. Timing of the test placement will occur during one of the two timeframes: 1) November 29th, 2016 through December 1st, 2016; or 2) December 12th, 2016 through December 16th, 2016, where daytime high tides will allow access to the demonstration areas for floating equipment and evening low tides will allow access for visual inspection of material placement within the demonstration area. The purpose of the test placement is to evaluate material spread characteristics and behavior when placed underwater and then use that information to develop actual bucket placement pattern and bucket fill factor to be used for in water plot placement.

The Test Placement will occur in the following manner:

1. Using a water-tight material barge that has been inspected for leaks by the Project Representative, have material loading facility convey blended ENR+AC material into barge

(perform separately for sand ENR material and gravelly sand ENR material). Barge loading to be observed by Project Representative.

2. When at site, flood the material barge using saline water pumped from the Duwamish until the water level is approximately 1-2 inches above the ENR material; maintain flooded condition for the specified minimum time prior to placement.
3. Test placement to be performed during second high tide of day that precedes lower low tide of the day, which occurs later that evening.
4. Within each test placement area, Contractor shall place 2 lifts over approximately 75% of the test placement area and only one lift over approximately 25% of the test placement area such that the results of single lift placement and double lift placement can be evaluated and information used to adjust placement as necessary to meet project objectives. Within the test placement area located within the intertidal plot, the area where only one lift is placed during the Test Placement shall have a second lift placed as part of the placement within that sub plot.

   The first lift shall be intended to place approximately 4.5 inches of material over the placement area. The Second lift is intended to place an additional approximately 4.5 inches of material. The second lift shall be placed by offsetting bucket grid pattern by ½ bucket dimension in X & Y directions with target to achieve total target thickness of 6 to 9 inches over a minimum of 80% of the area and 100% of area is 4 inches or more in thickness.
5. As material is removed from the barge, pump water into or from the barge as necessary to maintain water level approximately a 1-2 inches water depth above the material. When discharging water to the Duwamish use a bag filter 1 micron opening size to remove turbidity and comply with Water Quality Memo. Alternately material in barge may be adjusted provided it does not create additional winnowing or segregation of material as determined by Project Representative.

The Project Representative will verify test placement thickness on low tide following placement by reading grade stakes within demonstration area and approving thickness of placed material within tolerance of 6 to 9 inches at 80%[1] of locations with no single location less than 4 inches in areas where two lifts were placed. The FE or AFE, on behalf of the Project Representative, will also monitor pumping during return of water used to saturate material in barge to the LDW following the test.

1 Excluding areas where existing bathymetric features or relief dictate potentially thicker localized resulting placement thickness.

This test is to be conducted once for AC amended sand and once for AC amended gravelly sand by the excavator operator assigned to perform placement at the sub plots. When method of placement of material is acceptable to the Project Representative, placement within subplots may begin.

3.4.3 During Construction

During construction, the AFE, at the direction of the Project Representative, will conduct regular monitoring and observations as needed to verify the quality of the work. Examples of these verifications and monitoring are described below. Table 2 has a complete list of QA monitoring activities to take place during construction.

- Verification of correct material type for placement area;
- Verify daily clamshell bucket positioning calibration tests;
- Daily bucket inspections;
- Bucket placement is within approved pattern and in correct order;
- Monitor lift thickness being placed through diver surveys (divers will place grade stakes prior to placement of material and read grade stakes upon completion of placement in each area);
- Verification that material placed within sub-plot is weight equivalent for area based on scale tickets and/or barge draft during placement as appropriate;
- Document placed layer characteristics through coring;
- Verify full coverage and uniform placement through continuous observation during placement;
- Verify that spuds are not used in areas where material has already been placed within the plots by making sure Contractor's grid pattern is properly executed.

3.4.3.1 Positioning/Navigation System

The excavator operated by the Contractor will be instrumented with DGPS and inclinometers so as to accurately determine the location of the bucket within +/- 4 inches in the X, Y, and Z axis (i.e., horizontally and vertically) including bucket rotation.

Positioning system will be inspected by the FE or AFE to confirm that system is consistent with Contractor's previous submittals describing system and that system meets required accuracy

3.4.3.2 Bucket Grid Pattern and Fill Factor

The following bucket grid pattern and fill factor will be performed by the Contractor:

1. Use bucket grid pattern and fill factor developed during test placement for in-water placement.
2. Spuds shall not be set within area where material has already been placed. This requires the placement of both lifts while stepping barge through the placement area once. In order to ensure that no spuds are used over an area where material has already been placed within each subplot, the Contractor shall use the grid pattern and stepping presented here (or similar as approved by Project Representative to prevent use of spuds within already placed plot areas): start placement at the end of placement lane within the subplot; start placement with farthest rows out from the excavator; complete two adjacent rows, then perform the second pass on the first row (consistent with the grid pattern deemed acceptable during the test placement); continue pattern until the closest row attainable by the excavator is reached; step or move backfill barge backwards (away from area just placed); repeat pattern.

The Project Representative designee (FE or AFE) will be on backfill barge at all times during material placement and will verify that the correct bucket grid pattern and approximate fill factor developed during test placement are being used and that buckets are being placed in the correct sequence.

3.4.3.3 Diver Inspection of Plots

To verify full coverage of each plot and qualitatively document placement results, CQA divers will swim at least 4 transects across each subplot, visually assessing placement results including coverage (percent of area based on visual observation) and relative surface uniformity or roughness. Additionally divers will report any observed abnormalities including presence of large debris that may be impacting placement or other features that may impact monitoring.

3.4.3.4 Thickness Verification of Placed ENR and ENR+AC Materials

Two methods will be used by the CQA team on behalf of the Project Representative to assess Contractor's successful placement of thickness within tolerances. These methods will be used for test placement areas and all subplots.

First, FE or AFE will calculate placement on a volumetric basis. FE will verify for each sub-plot that material placed in two 4.5 inch lifts within each sub-plot is weight equivalent to a 9-inch nominal layer for the area, based on scale tickets and/or barge draft during placement as appropriate. FE or AFE will also be continuously observing placement to confirm bucket patterns and locations are as defined in the Contractor's placement plan.

Second, CQA staff divers (or foot access in intertidal areas) will take direct measurements of thickness. Thickness grade stakes will be used determine placed thicknesses at specific points. To verify placement thickness within each subplot, suitable grade stakes will be placed by divers in the subplot prior to placement of ENR or ENR/AC Material within that subplot. Stakes will be placed at a density of 15 stakes per subplot (~1 stake per 0.03 acre). The grade stakes will be marked prior to deployment with an incremental mark every 1 inch with up to 1.5 feet above existing mudline prior to material placement. After ENR or ENR/AC Material placement, divers will be used to read off placement thickness. Stakes will be left in place for future monitoring.

The thickness acceptance criteria are:

- Placement thickness of 6-9 inches in 80%[2] of stake locations per subplot;
- Placement minimum thickness of 4 inches at approximately 100% of stake locations per subplot, and
- No placement that impedes navigation.

The visual diver observations described above may also be considered in determining compliance with the target thickness criteria. Should the thicknesses be determined out of compliance, the Project Representative will notify the Contractor of the need for corrective action, which may include placement or relocation of additional material, as directed by the Project Representative. These CQA tasks and any corrective actions must be complete before the Contractor is permitted to move to the next set of subplots. Material from areas where the placement it too thick will only be relocated if it shall encroach upon the existing Federal authorized navigation depth and thereby poses a hazard to navigation as determined in consultation with the U.S. Army Corps of Engineers (USACE).

Any extra ENR or ENR+AC material left over after acceptance of layer thicknesses for plots may be placed immediately adjacent to any of the plots within the areas specified on the Plans. All procedures for placement of material within the plots should be used for placement outside of the plots. ENR or ENR+AC materials would be placed adjacent to subplots of similar material.

2 Excluding areas where existing bathymetric features or relief dictate potentially thicker localized resulting placement thickness.

3.4.3.5 Documentation of Layer Characteristics

The CQA divers will collect push cores for visual observation of layering, carbon segregation, thickness, intermixing of native materials, etc. These would be performed for documentation only.

3.4.3.6 Hydrographic Surveys

Multibeam surveys are to be performed by the hydrographic surveyor retained by the Contractor both before and after placement of material. These surveys are for documentation only and will be used to create as-built surfaces for each plot. For intertidal plots, surveys will need to be performed during higher tides to allow full coverage up to the higher elevations within the plots.

The FE will review the surveys for major anomalies and potential interference with navigation requirements.

3.4.3.7 Water Quality Monitoring Compliance

Water quality monitoring is to be performed by the CQA team during in-water work to verify compliance with the Section 401 Water Quality Memo. Details of water quality monitoring are presented in the Water Quality Monitoring Plan (WQMP).

Water quality monitoring will be performed by sampling water upstream and downstream of the ENR or ENR/AC Material placement according to the requirements of EPAs Section 401 Water Quality Memo. Data will be routinely monitored to verify compliance. If water quality parameters are identified that do not meet the criteria listed in the Section 401 Water Quality Memo, and if these effects cannot be shown to be unrelated to the construction activities, the Contractor will be required to modify or suspend operations until water quality improves.

The CQA team will verify compliance with manufacturers' recommendations for equipment calibration. Calibration logs will be maintained for all instruments.

Water quality data will be reported to EPA on a weekly basis unless an exceedance event is recorded, as described in the WQMP.

3.4.3.8 Notification of Water Quality Exceedances

The communications and decision making roles for water quality exceedances are described in detail in the WQMP. In the event that any water quality criteria specified in the Section 401 Water Quality Memo are not met, EPA will be notified on the same day by the Project Representative via the point of contact designated in the Water Quality Memo.

3.4.4 Post Construction

The CQA team will verify that final ENR or ENR+AC Material placements have been completed and that final as-built conditions and other reporting requirements are properly documented.

4.0 CONSTRUCTION DEFICIENCIES

This section describes the procedures for identifying and correcting construction deficiencies, which consists of Contractor QC deficiency and construction quality deficiency. The Project Representative has the authority to approve corrective actions for construction deficiencies, subject to EPA approval.

4.1 CONTRACTOR QC DEFICIENCY

Contractor QC deficiency occurs when the Contractor fails to comply with their CQCP. When a Contractor QC deficiency is identified by the CQA team on any segment of the work, the CQA team may immediately stop the construction work on the affected segment, depending on the deficiency. Such deficiency will be immediately brought to the attention of the Project Representative and the Contractor's Project Manager for correction. Construction work may resume after the CQA team determines that the Contractor has met the QC requirements on the affected segment. The CQA team will document such deficiencies and Contractor's corrections in the daily/weekly reports, together with the corrective action taken or planned.

4.2 CONSTRUCTION QUALITY DEFICIENCY

Construction quality deficiency occurs when any material, work performed, or installation does not meet project plans and specifications. When a construction quality deficiency is identified by the CQA team at any time, the CQA team will immediately stop the construction work, and notify the Project Representative and the Contractor's Project Manager of such deficiency. King County's Project Manager will notify EPA where necessary. The CQA team will document that non-conforming material or installations are clearly marked or segregated, to the extent practical, from conforming material or installations by the Contractor. The Contractor will describe proposed corrective actions to the Project Representative in writing for approval. The corrective actions could include, for example, placement of additional ENR material in thin spots or replacing defective equipment. Corrective actions will use methods that will not compromise conforming work. The proposed corrective action will be reviewed, review responses will be consolidated, and the Contractor be notified that one of the following actions need to be taken:

- Approve – Proposed corrective actions meet contract requirements. The Contractor will implement corrective actions as proposed, subject to the same QA/QC testing and inspections as the original work.

- Approve As Noted – Proposed corrective actions meet contract requirements with minor changes. Contractor does not need to resubmit corrective actions, but must incorporate the required changes during implementation of corrective actions.
- Reject – Proposed corrective actions do not meet contract requirements. Contractor must propose alternative corrective actions.

The implemented corrective actions will be subject to the same QA/QC procedures as original construction. The Project Representative will be the primary point of contact with the Contractor in regard to construction quality deficiencies. EPA will be notified by the King County Project Manager if corrective actions may result in changes to EPA approved documents. Any proposed change to EPA approved documents must be reviewed and approved in writing by the EPA Project Manager.

5.0 MEETINGS AND DOCUMENTATION

This section describes the meetings and QA/QC documentation requirements:

- Pre-construction (Contractor Work Plans, Preconstruction meeting),
- During Construction (Daily operations meetings, weekly progress meetings),
- Post Construction.

5.1 WORK MEETINGS

This section describes the format and content of meetings to be conducted as part of the in-water work.

5.1.1 Preconstruction Meeting

A preconstruction meeting will be conducted prior to the start of field activities.

5.1.1.1 Attendance

The preconstruction meeting will be attended by the following personnel:

- EPA Site Manager and/or designated representatives,
- Ecology Site Manager and/or designated representatives,
- LDWG and King County representatives, as determined by each group,
- King County Project Manager and Project Representative,
- CQA team,

- Contractor's Project Manager,
- Contractor's Site Superintendent,
- Contractor's QC Manager,
- Contractor's key subcontractor representatives.

EPA may also invite other participants, such as representatives from the USACE or other agencies.

5.1.1.2 Purpose

The purposes of the preconstruction meeting are to:

- Establish lines of authority and communication within the Contract team;
- To discuss the administrative requirements of the Contract;
- Address project issues if needed;
- To define the duties and responsibilities of all parties;
- Review methods for documenting and reporting inspection data and compliance with construction documents, including methods for processing design changes and securing EPA review and approval of such changes as necessary;
- Review methods for distributing and storing documents and reports;
- Review work area security and safety protocols; and
- Demonstrate that construction management is in place, and discuss any appropriate modifications of the CQAPP to address site-specific considerations.

All meetings will be documented by the CQA team for the Project Representative and minutes will be transmitted to all parties within 7 working days of the meeting.

5.1.2 Daily Briefings and Planning Meetings

The FE or Project Representative will attend the Contractor's daily tailgate Health and Safety meeting prior to the start of work each day.

The FE or AFE on behalf of the Project Representative will run a daily meeting with the Dredging Contractor's Project Manager and Site Superintendent to review:

- Work performed since previous day's meeting;
- Schedule for the next 3 days;

- Health and Safety;
- Weather forecast for the next week and how it may impact work; and
- Any issues encountered and progress towards resolution.

Contractor's operators and other staff will be made available to attend meetings as requested by the Project Representative. When possible, meetings will be scheduled to coordinate with Contractor's shift changes so required personnel can attend. Any issues and progress towards resolution will be provided to the Project Representative within one business day.

5.1.3 Project Meetings (Progress Meetings)

Progress meetings will be held on a weekly basis unless King County agrees to a different schedule. The progress meetings will address the following issues:

- General progress over the past week, including:
  - General progress of construction;
  - Health and Safety issues, if encountered;
  - Problems encountered and associated action items;
  - Planned work for the upcoming week;
  - Pending design, personnel, or schedule changes requiring EPA review and approval;
- Results of ongoing water quality monitoring over the past week, including:
  - Recorded water quality data;
  - Observed non-construction-related events affecting water quality;
  - Summary of any violation of water quality criteria and corrective actions taken;
- Quality Assurance Monitoring over the past week, including:
  - Results of the FE QA inspections, testing, surveying, and monitoring activities;
  - Out-of-spec conditions that may have been encountered and the actions taken to correct the situation;
- Change Orders, including:
  - Change order status since the last report;

– Change orders approved since last meeting.

Minutes of the weekly project meeting will be prepared by the FE or AFE for the Project Representative. The minutes and a cover memo, providing any required clarifications or background information for the record will constitute a Weekly Progress Report (see Section 5.2.3.2).

5.2 WORK DOCUMENTATION

A variety of field recording mechanisms will be used during the project including electronic data files such as bucket placement files, and paper field notes and log books.

5.2.1 Contractor Submittals Prior to Construction

Prior to initiating construction activities, the Contractor will prepare and submit documents listed in the Design Drawings and Specifications. These will include the following submittals:

- Contractor Work Plan(s),
- Construction Project Schedule,
- Contractor Quality Control Plan,
- Environmental Protection Plan,
- Site HASP, and
- Examples of all QC forms, including daily and weekly progress reports.

These Contractor submittals will meet the requirements specified in this CQAPP and the design drawings and specifications. All documents will be provided to the Project Representative in accordance with the schedule listed in the submittal register. All elements of the Contractor Work Plan are subject to EPA approval prior to start of construction.

5.2.2 Contractor Submittals During Construction

5.2.2.1 Contractor Daily Reports

The Contractor will submit daily production and quality control reports to the Project Representative and FE. These reports will include details of the work performed that day (location, quantities, equipment, personnel), date, period covered by the report, downtime and delays to operation, safety, QC methods used, inspections and verifications performed, and field conditions encountered that could affect the quality of the completed project.

An example of this report is included in Attachment A. The actual format and content of the daily report will be developed by the Contractor and submitted as part of the required submittals prior to initiating the start of work.

The daily report will be submitted by the Contractor to the Project Representative and FE daily via e-mail (by 3 PM the day following the day covered by the report). Signed hard copies of each week's daily reports will be submitted at the end of each week.

5.2.2.2 Contractors Weekly Report

The Contractor will submit a weekly report to the Project Representative and FE. The weekly reports will:

- Summarize actual ENR and ENR+AC production per week over the course of the project to date and projected material production per week through the completion of the Project.
- Summarize the number of barges and tons of ENR material delivered per week over the course of the project to date and the projected barges/tons for the next 2 weeks.
- Summarize work planned for the upcoming week.
- Identify anticipated delays in completing the work on schedule, and recommend modifications to the work plan to mitigate delays.

An example of this report is included in Attachment B. The actual format and content of the weekly report will be developed by the Contractor and submitted as part of the required submittals prior to initiating the start of work.

5.2.2.3 Contractors Closeout Submittals

At conclusion of construction Contractor shall submit the following:

- As built surveys of plots; and
- Summary of construction including description of any difficulties encountered.

5.2.3 Contractor Quality Control Reporting

5.2.3.1 Daily Report by FE

The FE will prepare a daily Operations and QA report which will document site conditions, work done by the contractor, issues encountered and resolution for these issues, personnel on site and equipment used, and quantity of material placed during the shift. This report will also include photo documentation of activities performed and a progress map of work completed to date. Additional reports such as water quality and QA testing results will be documented but not included in the daily report unless there is an issue with QA testing, which would be summarized under the issues encountered section of the Operations and QA report. These reports would not be distributed on a daily basis but made available on site if needed.

5.2.3.2 Weekly Progress Reports

The FE will prepare a Weekly Progress Report and submit the report via e-mail to the Project Representative, who will distribute to EPA/Ecology Site Manager and LDWG representatives and Project Manager. The weekly report will document the following items:

- Weekly progress meetings and subjects discussed at the weekly progress meetings;
- General progress of construction with respect to the schedule;
- Problems encountered and associated action items;
- Results of ongoing water quality monitoring, including:
  - Time series plots of water quality data,
  - Observed non-construction-related events affecting water quality,
  - Summary of any violation of water quality criteria and actions taken;
- Outcome from QA monitoring, including:
  - Results of QA inspections, surveying, and monitoring activities performed by the CQA field engineering staff,
  - Out-of-spec conditions that may have been encountered and the actions taken to correct the situation; and
- Photographs of:
  - Typical construction activities during the period covered by the Weekly Progress Report;
  - Problems encountered, if any.

5.2.4 Change Orders

The Contractor will submit all change order requests to the Project Representative for review and approval. All submitted change order requests will include a description of the change, reason for the change, the schedule impacts of the change, and cost impacts of the change. Submitted change orders will be reviewed by the Project Representative. If the submitted change order request does not contain all information necessary for review, it will be returned to the Contractor for revision.

If the proposed change is acceptable to King County, King County will coordinate with LDWG on any major project deviations in accordance with LDWG agreements. Also, if the change requires a revision to the design drawings and/or specifications approved by EPA, King County will immediately or during the next weekly Progress Meeting, discuss with the EPA site representative. EPA will review and approve change orders as expeditiously as possible so to avoid delays in construction.

Change orders that do not materially change the scope of the remediation will not require formal EPA approval. The Contractor will then be notified of the acceptance of the change.

5.2.5 Construction Report

Upon completion of the construction work, a draft and final Construction Report will be prepared and submitted to the EPA as part of the Draft Year 1 Monitoring Report.

After completion of Pilot construction, the consulting team will prepare a draft Construction Report within 30 days and submit it to the King County PM, Project Representative, and LDWG. Once King County and LDWG approve the draft, the draft report will be submitted to EPA and Ecology with the Draft Year 1 Monitoring Report. A courtesy copy of the construction sections of the Draft Year 1 Monitoring Report will be submitted to EPA and Ecology within 6 months of the completion of construction. The objective of the construction report is to document that the Pilot is constructed in accordance with the project plans and specifications.

At a minimum, the Construction Report will include a description of the construction process, a list of any design revisions and their justifications, a list of major construction problems and their resolutions, laboratory test results, testing data sheets, and as-built drawings stamped and a certification statement signed and sealed by a professional engineer licensed in the State of Washington.

The consulting team will prepare a Final Construction Report for submittal to EPA and Ecology based on EPA/Ecology comments on the draft report.

5.3 Control of QA/QC Documentation

King County's Project Representative is responsible for controlling all QA/QC documentation, including daily and weekly logs, photographs, revisions to the design and specifications, monthly status reports, and record drawings. The FE/AFE will maintain a working set of record drawings where all deviations and changes are noted. All original documents will be maintained in the project file located at the construction site. A duplicate set will be maintained in King County's Project Representative off-site office. Each document will also be saved electronically on a server in the off-site office. The Project Representative will maintain a log of all QA/QC documents. The final storage of all project records will be performed in accordance with EPA requirements.

6.0 CHANGES TO QA/QC REQUIREMENTS

This section describes the procedure for making changes to the QA/QC requirements in the CQCP and CQAPP. Changes to the CQCP or this CQAPP will be required if:

- Deficiencies in the CQCP or CQAPP are identified;
- The scope of work has changed; or
- The QA/QC procedures are deemed to be excessively hindering work productivity.

6.1 CHANGES TO CQCP

The Project Representative or the Contractor may initiate changes to the CQCP. The Contractor is required to submit proposed changes in writing to the Project Representative for review and approval. The Project Representative has the authority to approve the Contractor's proposed changes or require the Contractor to make other changes to the CQCP. No changes will be made to the CQCP without the Project Representative's approval. The revised QC program is in effect immediately upon approval by the Project Representative. If the changes to the CQCP will result in changes to the CQAPP then the procedures in Section 6.2 will be followed to obtain agency approval.

6.2 CHANGES TO CQAPP

The FE or Project Representative may initiate revisions to the CQAPP. The FE will submit a revised CQAPP to the Project Representative for review and approval.

No changes will be made to the CQAPP without the approval of the Project Representative. The Project Representative will then coordinate changes to the CQAPP with EPA for their formal written approval. Any proposed change to EPA approved documents must be reviewed and approved in writing by the EPA Project Manager.

TABLES

TABLE 1

PROJECT CONTACT INFORMATION

	Project Role	Name	Company	Phone	Email
Agency	EPA Project Manager	Elly Hale	EPA	206.553.1215	hale.elly@epa.gov
Agency	Ecology Project Manager	Ron Timm	Ecology	425.649.7185	rtim461@ecy.wa.gov
Construction Management	King County Project Manager	Jennifer Kauffman	King County	206.477.5449	jennifer.kauffman@ kingcounty.gov
Construction Management	King County Project Representative	Randy Brunke	King County	206.477.5654	randy.brunke@ kingcounty.gov
CQA field staff	Project Engineer	Rob Webb	DOF	360.394.7917	rwebb@dofnw.com
CQA field staff	Field Engineer	Dan Pickering	DOF	360.394.7917	dpickering@ dofnw.com
CQA field staff	Assistant Field Engineer	TBD			
Consulting Team	Consultant Team Project Manager	Cliff Whitmus	AMEC Foster Wheeler	425.921.4023	cliff.whitmus@ amecfw.com
Construction Contractor	Contractor Project Manager	TBD			
Construction Contractor	Contractor Site Superintendent	TBD			
Construction Contractor	Contractor Quality Control Officer	TBD			
Construction Contractor	Contractor Site Safety Officer	TBD			

TABLE 2

QUALITY ASSURANCE MONITORING ELEMENTS AND FREQUENCY

Construction Element	Monitoring Requirement	Monitoring Performed By	Monitoring Frequency
Prior to Construction	Verification and inspection of all ENR material, surveying, positioning and navigation equipment. Material bins on barges will be inspected for appropriate water-tightness.	FE	Prior to start of construction
	ENR/AC material inspection, sampling, and analysis. Verification of initial blend ratios based on weight observations during barge loading.	FE or AFE	Prior to material placement or test placement
Prior to Material Placement	ENR/AC Test Placement. Verification that material can be placed in 4.5 inch lifts to achieve 6-9 inch target thickness at 80% of locations with no single location less than 4 inches in the area where two lifts were placed.	FE/Project Representative	Prior to in-water placement other than in test placement locations as shown on the plans
In-Water Placement	Visual observation of correct material type for placement area, verification of pre-soaking requirements, bucket fill factor, and bucket grid pattern.	FE	Continuous during in-water placement
	Verification of daily clamshell bucket positioning calibration tests.	FE	Daily during in-water placement
	Verification that material placed in subplot is weight equivalent for area based on scale tickets and/or barge draft during placement.	FE	Per each completed sub-plot
	Qualitative diver verification of placement results including coverage (%of area) and relative surface uniformity or roughness.	AFE	Per each completed sub-plot
	Quantitative verification of placement thickness by divers using grade stakes.	AFE	Grade stakes placed prior to material placement and read after completion of placement in each sub-plot
	Visual observation of layering, carbon segregation, and thickness of layer using push cores collected by divers.	AFE	For documentation only
	Water quality monitoring to ensure compliance with criteria listed in the Section 401 Water Quality Memo.	Design Team	Periodically as specified in the WQMP
	Review of hydrographic surveys.	FE or AFE	After completion of sub-plots; for documentation only

ATTACHMENT A

Sample Forms for Contractor Daily Report

Daily Construction and QC Report

Weather:
Max Temp:
Min Temp:
Site Conditions: ____
Winds: ____
Precipitation:

Report Information:
Date Submitted: ____
Work Date: ____
Shift:

Report Prepared By:

Personnel	Labor or Supervision	T&M Task, UP, or LS #	Hours	Start	Finish	Equip	T&M Task, UP, or LS #	No.	Run	Stdby	Comments

DESCRIPTION OF WORK (detail below):

DOWNTIME, DELAYS OR MAINTENANCE PERFORMED:

SUBCONTRACTORS ONSITE:

COMPANY	ACTIVITIES PERFORMED

MATERIALIMPORTED:

MATERIAL	QTY.	QTY. TO DATE	T&M Task, UP, or LS #	TECHNICAL SPECIFICATION NO. for Import Materials

COMMENTS :

DAILY QC INSPECTION & VERIFICATION LOG:

TYPE	TECHNICAL SPECIFICATION NO.	NATURE OF DEFECT	CORRECTIVE ACTION TAKEN OR PROPOSED	COMMENTS

SAFETY STATUS:

Accidents (if any):	
Illnesses (if any):	
Near-miss Incidents (if any):	
Corrective Action (if any):	
Other:	

Signatures acknowledging above:
Contractor:____________________ Date:____________
FE:_________________________ Date:____________

ATTACHMENT B

Sample Forms for Contractor Weekly Report

Weekly Construction and QC Report

Week Ending:	**Report Prepared By:**
General Site Conditions:	

SUMMARY OF WORK
DOWNTIME/DELAYS AND OTHER INFORMATION
SUMMARY OF WORK PLANNED FOR UPCOMING WEEK

PRODUCTION					
Location	Station Start	Station Stop	Est. Quantity this week	QTY to Date	Comments

GENERAL COMMENTS

MATERIALS IMPORTED				
Barge Loads	Material	Qty. to Date	Qty.	Qty. to Date

EQUIPMENT					
Date	Description	MOB Date	DEMOB Date	Down Time	Comments

Signatures acknowledging above:
Contractor:____________________ Date:____________
FE:_________________________ Date:____________

APPENDIX D

Construction Plans and Specifications

APPENDIX D

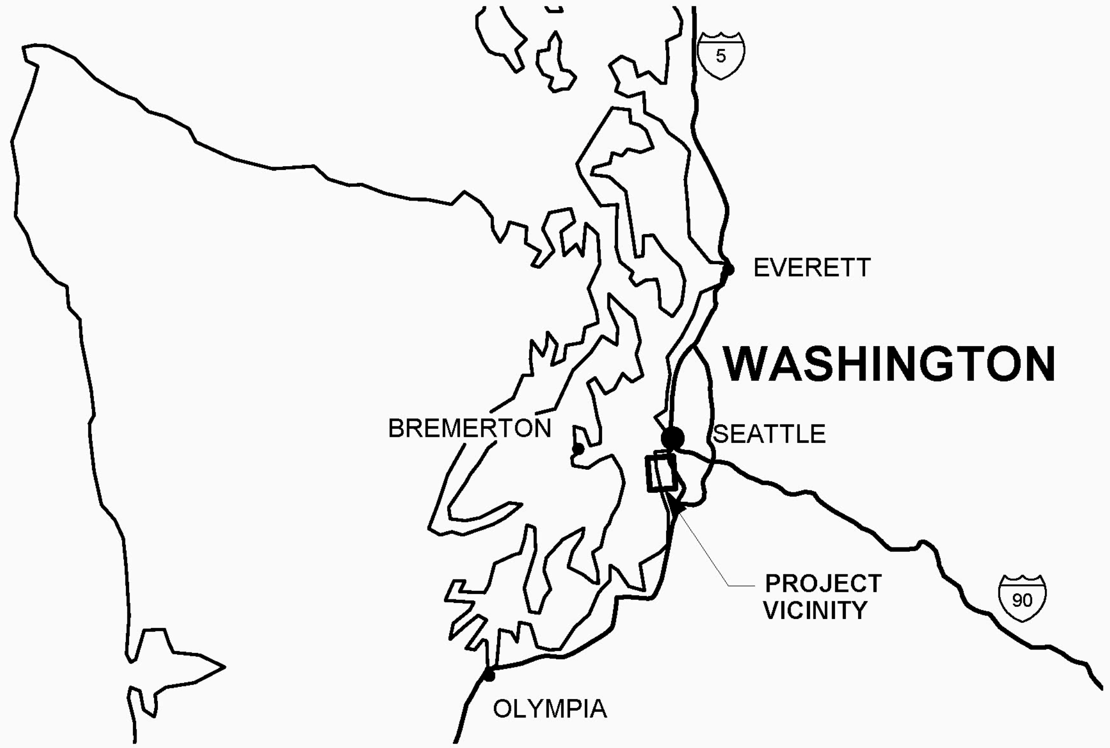
Construction Plans and Specifications

ENHANCED NATURAL RECOVERY/ ACTIVATED CARBON PILOT STUDY

CONTRACT NUMBER: C00992C15

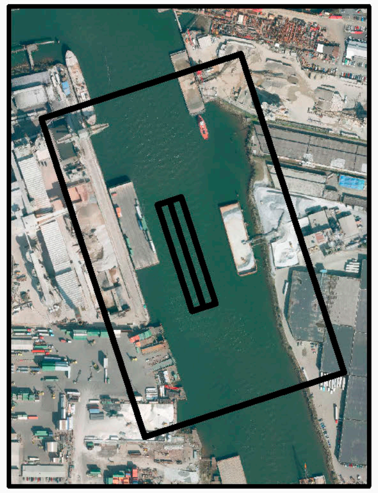
OCTOBER 2015

KING COUNTY
Department of Natural Resources and Parks
Wastewater Treatment Division

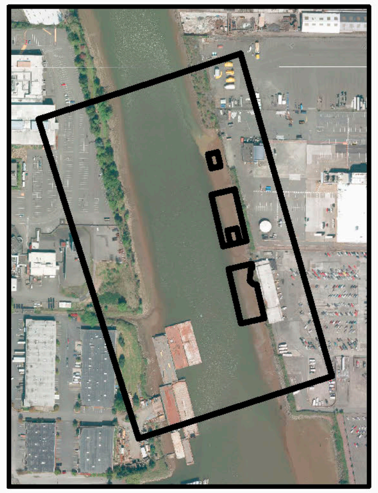


VICINITY MAP
SCALE: NTS

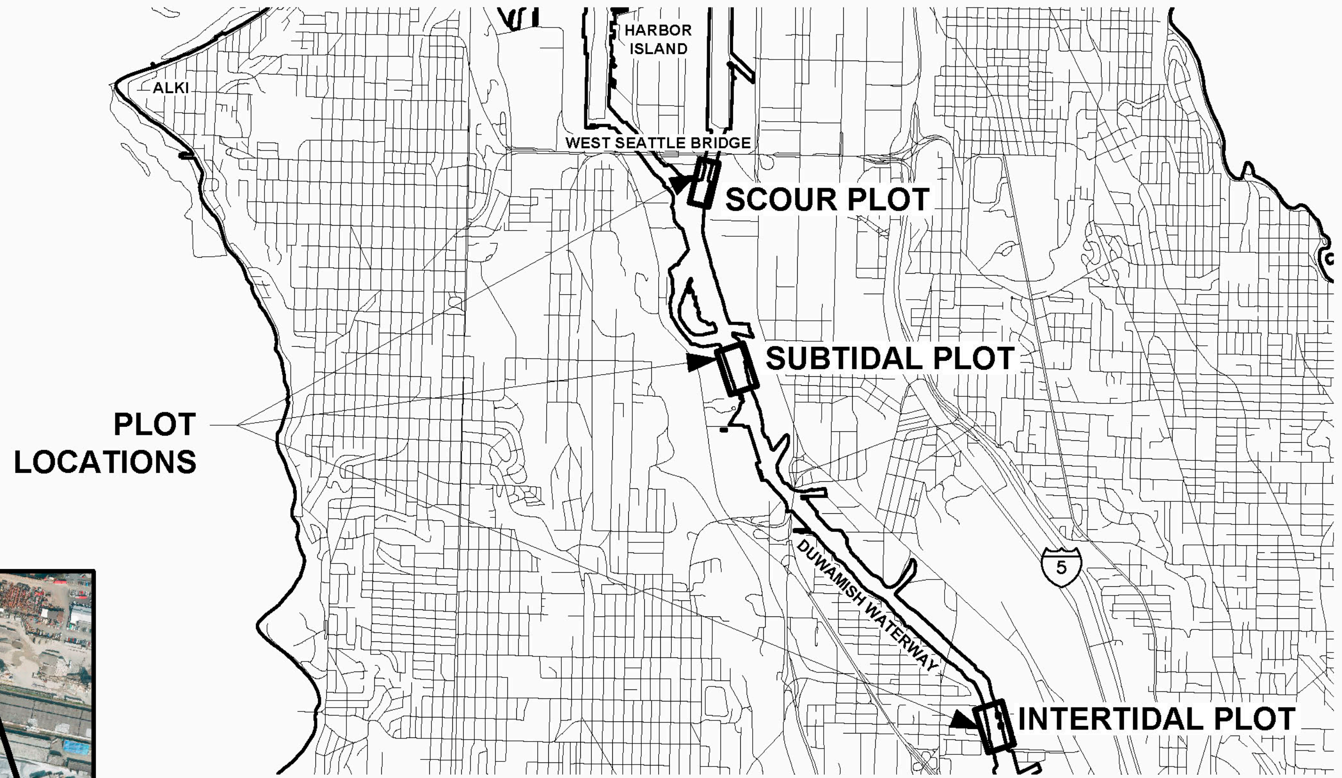
SCOUR PLOT



SUBTIDAL PLOT



INTERTIDAL PLOT



LOCATION MAP
SCALE: 1" = 3000'

ENHANCED NATURAL RECOVERY / ACTIVATED CARBON PILOT STUDY

DUWAMISH WATERWAY

CONTRACT NUMBER: C00992C15

DRAWING INDEX

SHT NO	DWG NO	DRAWING TITLE
01	G001	COVER SHEET, VICINITY AND LOCATION MAPS, DRAWING INDEX
02	C001	NOTES, SYMBOLS, AND ABBREVIATIONS
03	C002	SCOUR PLOT (RM 0.04 to 0.10) PLAN VIEW
04	C003	SUBTIDAL PLOT (RM 1.13 to 1.23) PLAN VIEW
05	C004	INTERTIDAL PLOT (RM 3.84 to 3.88 AND 3.90 to 3.94) PLAN VIEW
06	C005	SCOUR PLOT (RM 0.04 to 0.10) SECTION VIEWS
07	C006	SCOUR PLOT (RM 0.04 to 0.10) SECTION VIEWS
08	C007	SUBTIDAL PLOT (RM 1.13 to 1.23) SECTION VIEWS
09	C008	SUBTIDAL PLOT (RM 1.13 to 1.23) SECTION VIEWS
10	C009	INTERTIDAL PLOT (RM 3.84 to 3.88 AND 3.90 to 3.94) SECTION VIEWS
11	C010	INTERTIDAL PLOT (RM 3.84 to 3.88 AND 3.90 to 3.94) SECTION VIEWS

PROJECT WORK LOCATION:

FACILITY NAME: NA
STREET ADDRESS: DUWAMISH WATERWAY
CITY, STATE: SEATTLE & TUKWILA, WA

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: AS NOTED
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

COVER SHEET
VICINITY AND LOCATION MAPS
DRAWING INDEX

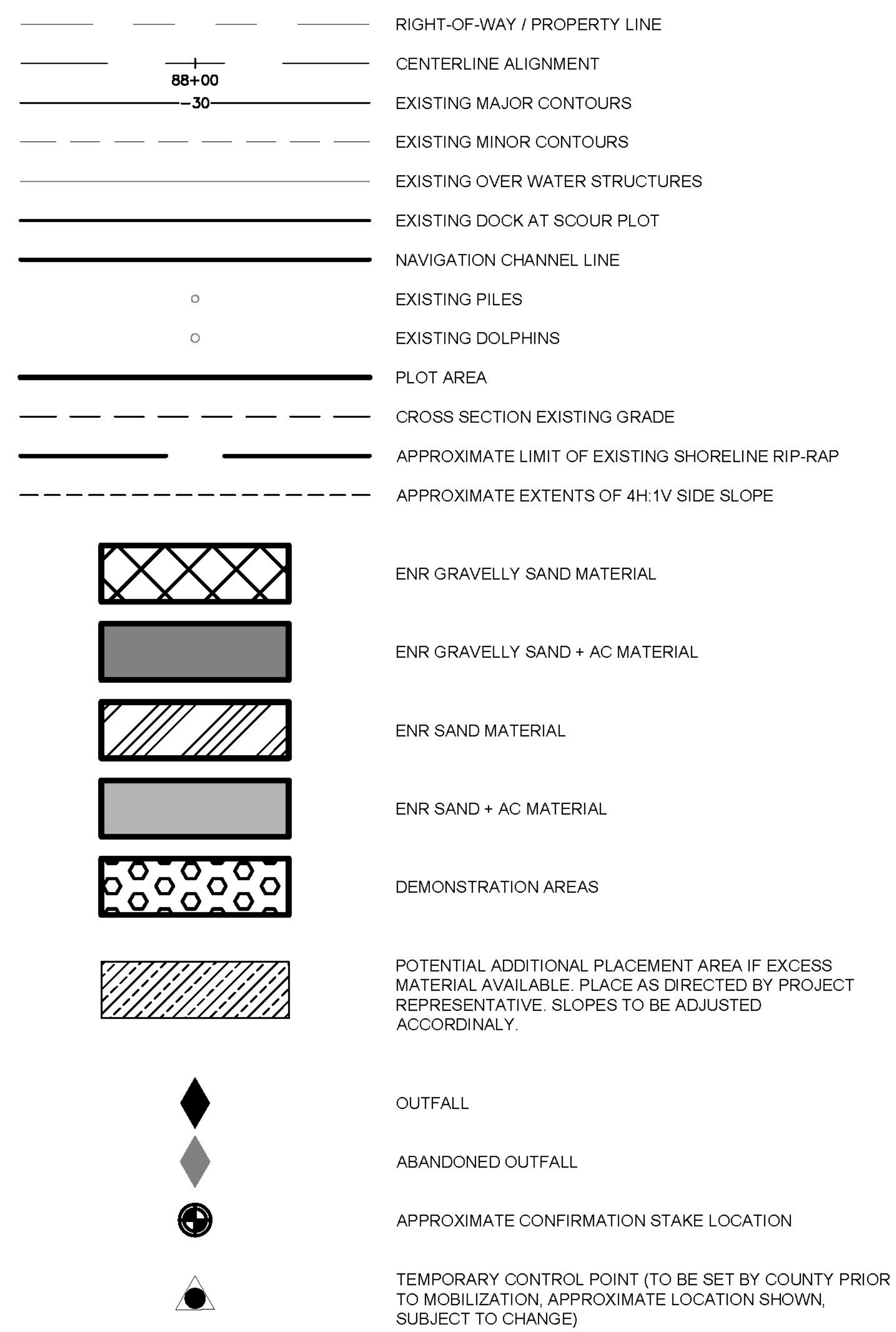
DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: G001
SHT NO / TOTAL: 01 / 11
REV NO: 0

BORDER FILE EDITION: KCWTD-2015R0-Dsize-TB-Border
D:\Projects\King Cnty GAC\Cad\Figures\2015-10\2015-10-14 02 G001 KC-ENR Index.dwg | Layout: G001 COVER SHEET
PLOTTED: Oct 14, 2015-05:05:39pm By srasmussen
XREFS: PlotAreas1_6&9-Dsize-TB-Border.dwg
IMAGES: rgb_22931_025.tif; rgb_23096_025.tif; rgb_23588_025.tif; rgb_23918_025.tif;

GENERAL NOTES:

1. ALL UTILITY INFORMATION SHOWN ON THE PLANS ARE APPROXIMATE. CONTRACTOR SHALL VERIFY THE LOCATION AND ELEVATION OF ALL THE UTILITIES BEFORE MOBILIZATION. THE CONTRACTOR SHALL CALL 1-800-424-5555 AT LEAST TWO BUSINESS DAYS (48 HOURS) BEFORE THE START OF THE WORK.
2. THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING EXISTING UNDERGROUND AND ABOVE GROUND UTILITIES AND PROMPT REPAIR IF DAMAGED.
3. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXTENT OF THE HAZARD CREATED BY OVERHEAD OR UNDERGROUND ELECTRICAL POWER IN ALL AREAS AND SHALL FOLLOW PROCEDURES DURING CONSTRUCTION, AS REQUIRED BY LAW REGULATIONS, UTILITY OWNER OR SAFE CONSTRUCTION PACKAGES. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL MEET WITH UTILITY OWNERS AND REMEDIAL MEASURES MAY BE REQUIRED.
4. THE FIRE DEPARTMENT SHALL BE NOTIFIED AT LEAST 24 HOURS IN ADVANCE OF ANY ACTIVITIES THAT WOULD PREVENT USE OF ANY FIRE HYDRANTS.
5. EXISTING SURFACE ELEVATIONS FOR THE SCOUR PLOT PROJECT AREA CREATED FROM THE MULTIBEAM BATHYMETRIC SURVEY CONDUCTED BY DAVID EVANS AND ASSOCIATES, INC. ON AUGUST 25-29, 2003.
6. EXISTING SURFACE ELEVATIONS FOR THE SUBTIDAL PLOT PROECT AREA CREATED FROM THE MULTIBEAM BATHYMETRIC SURVEY OF THE NAVIGATION CHANNEL CONDUCTED BY USACE ON JUNE 18-19, 2013.
7. EXISTING SURFACE ELEVATIONS FOR THE INTERTIDAL PLOT PROJECT AREA CREATED FROM A COMBINATION OF THE MULTIBEAM BATHYMETRIC SURVEY CONDUCTED BY DAVID EVANS AND ASSOCIATES, INC. ON AUGUST 25-29, 2003 FOR THE AREA THAT IS MORE THAN 40 FT OUTSIDE OF THE NAVIGATION CHANNEL AND THE MULTIBEAM BATHYMETRIC SURVEY OF THE NAVIGATION CHANNEL CONDUCTED BY USACE ON JUNE 18-19, 2013 FOR THE AREA INSIDE THE NAVIGATION CHANNEL WITH A 40 FT BUFFER.
8. HORIZONTAL DATUM: WASHINGTON NORTH AMERICAN DATUM (NORTH ZONE) 1983/1991 (NAD-83/91). U.S. SURVEY FEET.
9. VERTICAL DATUM: MEAN LOWER LOW WATER (MLLW), 1960-1978 EPOCH FOR THE DEA 2003 BATHYMETRY AND MLLW 1983-2001 EPOCH FOR THE USACE 2013 BATHYMETRY.
10. PROPERTY LINE PARCEL DATA WAS RECEIVED FROM AECOM USED IN THE 2012 FEASIBILITY STUDY.
11. CONTRACTOR SHALL PROTECT ALL EXISTING STRUCTURES, DOCKS, PILINGS, ETC. DURING PERFORMANCE OF THE WORK.
12. NO WORK SHALL BE PERFORMED PRIOR TO SUBMITTAL AND ACCEPTANCE OF CONTRACTORS REMEDIAL ACTION WORK PLAN (RAWP), HEALTH AND SAFETY PLAN (HASP) AND CONTRACTOR QUALITY CONTROL PLAN (CQCP) SEE SPEC SECTIONS 01300 AND 02221.
13. CONTRACTOR SHALL PERFORM ALL WORK IN ACCORDANCE WITH PLANS, SPECIFICATIONS, AND ACCEPTED RAWP. CONTRACTOR SHALL HAVE READ AND FAMILIARIZED THEMSELVES WITH SPECIFICATIONS PRIOR TO MOBILIZATION.
14. KING COUNTY PROJECT REPRESENTATIVE (PR) MUST APPROVE TEST PLACEMENTS OF SAND ENR MATERIAL WITH AC AND SANDY GRAVEL ENR MATERIAL WITH AC PRIOR TO ANY PLACEMENT OUTSIDE OF DESIGNATED DEMONSTRATION AREAS (SEE SPEC 02221).
15. CONTRACTOR SHALL NOT CAUSE DISTURBANCE OF PLOTS ONCE MATERIAL HAS BEEN PLACED (EITHER LIFT) BY ANY MEANS INCLUDING SPUDS, ANCHORS, PROP WASH, CLAMSHELL BUCKET CONTACTING BOTTOM, GROUNDING OF EQUIPMENT ETC. SEE SPEC SECTION 02221.
16. CONTRACTOR SHALL BE AWARE OF AND COORDINATE THEIR WORK WITH OTHER WATERWAY USERS INCLUDING TRIBAL FISHING, VESSEL BERTHING AT THE SCOUR SITE, GENERAL WATERWAY TRAFFIC ETC. PER SPEC SECTION 02221.

LEGEND:



ABBREVIATIONS:

Ø	DIAMETER
>	LESS THAN
<	GREATER THAN
AC	GRANULAR ACTIVATED CARBON
BTM	BOTTOM
℄	CENTERLINE
E	EASTING, EAST
ENR	ENHANCED NATURAL RECOVERY
MLLW	MEAN LOWER LOW WATER
N	NORTHING, NORTH
NA	NOT APPLICABLE
NTS	NOT TO SCALE
PL	PROPERTY LINE
RM	RIVER MILE
S	SOUTH
SEC	SECTION
STA	STATION
W	WEST
WA	WASHINGTON

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: AS NOTED
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

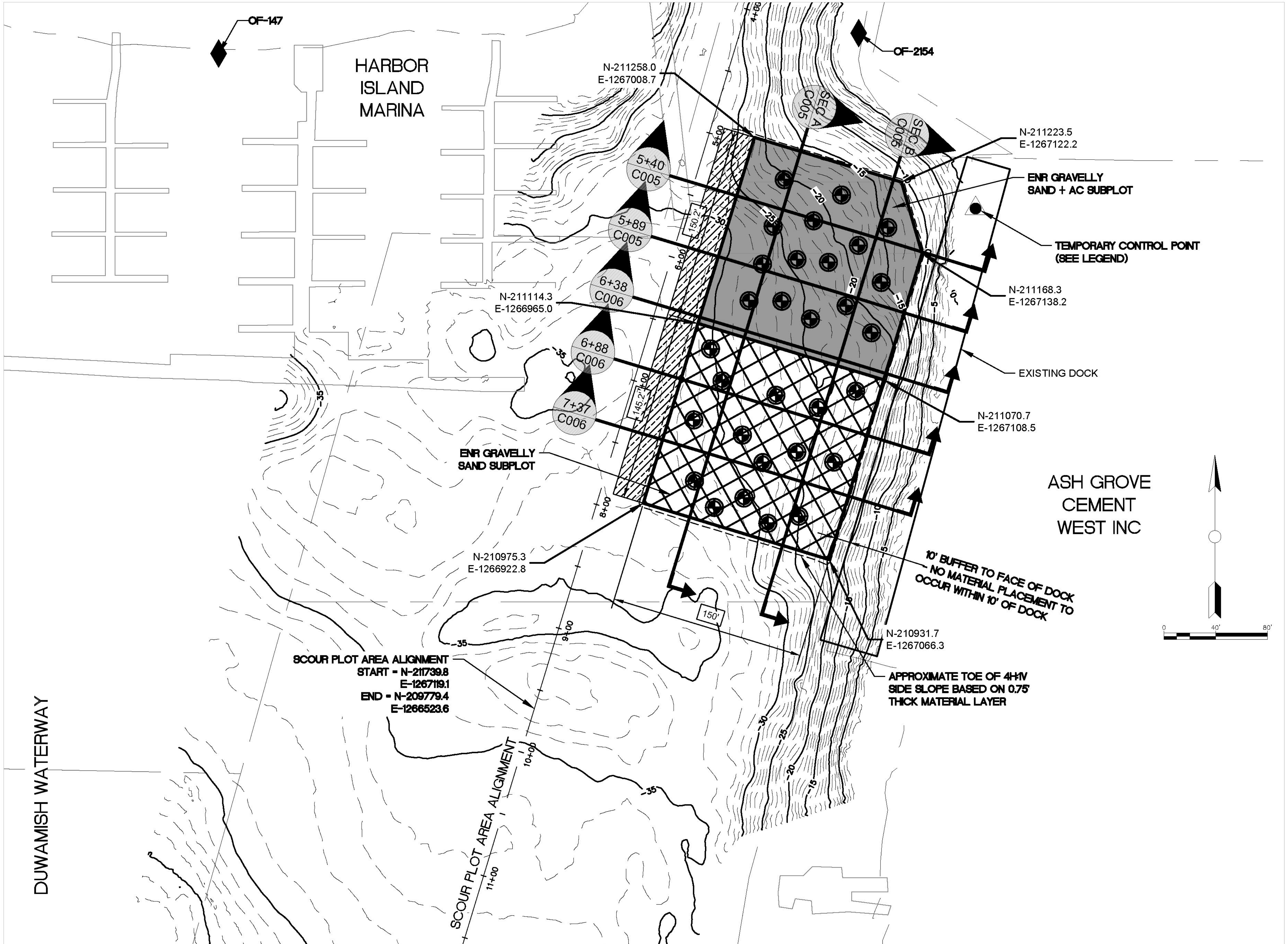
King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

NOTES, SYMBOLS, AND ABBREVIATIONS

DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C001
SHT NO 02 / TOTAL 11 REV NO: 0

BORDER FILE EDITION: KCWTD-2015R0-Dsize-TB-Border
D:\Projects\King Cnty GAC\Cad\Figures\2015-10\2015-10-14 03 C001 KC-ENR Notes Abbrev.dwg | Layout: C001 LEGEND NOTES ABBREV
PLOTTED: Oct 14, 2015-05:05:46pm By srasmussen
XREFS: PlotAreas1_888-Dsize-TB-Border.dwg
IMAGES:



NOTES

1. SEE SPECS SECTION 02221 FOR DETAILS ON MATERIAL PLACEMENT. AC AMENDED MATERIAL SHALL BE PLACED PRIOR TO NON AC AMENDED MATERIAL.
2. CONTRACTOR SHALL PERFORM ALL WORK IN ACCORDANCE WITH PLANS, SPECIFICATIONS, AND ACCEPTED RAWP. CONTRACTOR SHALL HAVE READ AND FAMILIARIZED THEMSELVES WITH SPECIFICATIONS PRIOR TO MOBILIZATION.
3. KING COUNTY PROJECT REPRESENTATIVE (PR) MUST APPROVE TEST PLACEMENTS OF SAND ENR MATERIAL WITH AC AND SANDY GRAVEL ENR MATERIAL WITH AC PRIOR TO ANY PLACEMENT OUTSIDE OF DESIGNATED DEMONSTRATION AREAS (SEE SPEC 02221).
4. CONTRACTOR SHALL NOT CAUSE DISTURBANCE OF PLOTS ONCE MATERIAL HAS BEEN PLACED (EITHER LIFT) BY ANY MEANS INCLUDING SPUDS, ANCHORS, PROP WASH, CLAMSHELL BUCKET CONTACTING BOTTOM, GROUNDING OF EQUIPMENT, ETC. (SEE SPEC 02221).
5. IF, AFTER COMPLETING PLACEMENT WITHIN SUBPLOT THERE IS ADDITIONAL ENR MATERIAL REMAINING IN BARGE IT MAY BE PLACED, UPON APPROVAL OF PROJECT REPRESENTATIVE, WITHIN AREA SHOWN USING SAME METHODS, PROCEDURES, ETC. AS USED FOR SUBPLOT PLACEMENT. ENR OR ENR+AC MATERIAL SHALL BE PLACED ADJACENT TO SUBPLOT OF SIMILAR MATERIAL.

LEGEND:

- PLACE ENR GRAVELLY SAND MATERIAL
- PLACE ENR GRAVELLY SAND + AC MATERIAL
- POTENTIAL ADDITIONAL PLACEMENT AREA IF EXCESS MATERIAL AVAILABLE. PLACE AS DIRECTED BY PROJECT REPRESENTATIVE. SLOPES TO BE ADJUSTED ACCORDINGLY
- OUTFALL
- APPROXIMATE CONFIRMATION STAKE LOCATION (TO BE INSTALLED BY COUNTY PRIOR TO CONSTRUCTION)
- TEMPORARY CONTROL POINT (TO BE SET BY COUNTY PRIOR TO MOBILIZATION, APPROXIMATE LOCATION SHOWN, SUBJECT TO CHANGE)
- APPROXIMATE EXTENTS OF 4H:1V SIDE OF SLOPE BASED ON 0.75' THICK MATERIAL LAYER (ACTUAL DISTANCE TO VARY BASED ON ACTUAL PLACEMENT THICKNESS AND STABLE SLOPE)

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 40'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

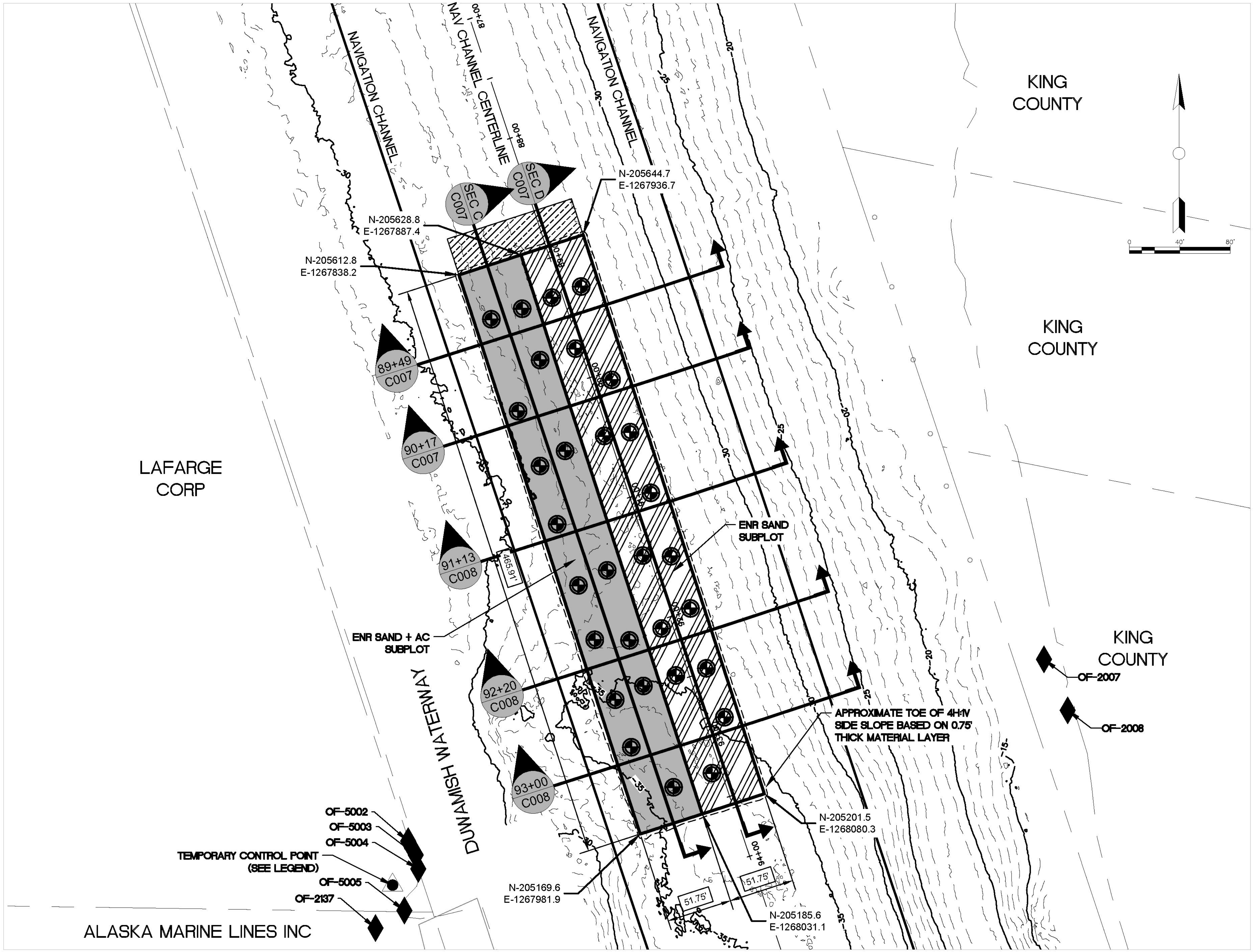
King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

SCOUR PLOT (RM 0.04 to 0.10) PLAN VIEW

DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C002
SHT NO 03 / TOTAL 11 REV NO: 0

BORDER FILE EDITION: KCWTD-2015R0-Dsize-TB-Border
D:\Projects\King Cnty GAC\CadFigures\2015-10\2015-10-14 04 C002-C004 KC-ENR Plans.dwg | Layout: C002 PLAN SCOUR PLOT
PLOTTED: Oct 14, 2015-05:06:06pm By srasmussen
XREFS: KingCntyGAC TM.dwg; PlotAreas1_6&9-Dsize-TB-Border.dwg; Outfalls from GIS.DWG
IMAGES: rgb_22930_025.tif; rgb_22931_025.tif; rgb_23095_025.tif; rgb_23096_025.tif; rgb_23258_025.tif; rgb_23259_025.tif; rgb_23260_025.tif; rgb_23423_025.tif; rgb_23424_025.tif; rgb_23587_025.tif; rgb_23588_025.tif; rgb_23752_025.tif; rgb_23753_025.tif; rgb_23918_025.tif;



NOTES

1. SEE SPECS SECTION 02221 FOR DETAILS ON MATERIAL PLACEMENT. AC AMENDED MATERIAL SHALL BE PLACED PRIOR TO NON AC AMENDED MATERIAL.
2. CONTRACTOR SHALL PERFORM ALL WORK IN ACCORDANCE WITH PLANS, SPECIFICATIONS, AND ACCEPTED RAWP. CONTRACTOR SHALL HAVE READ AND FAMILIARIZED THEMSELVES WITH SPECIFICATIONS PRIOR TO MOBILIZATION.
3. KING COUNTY PROJECT REPRESENTATIVE (PR) MUST APPROVE TEST PLACEMENTS OF SAND ENR MATERIAL WITH AC AND SANDY GRAVEL ENR MATERIAL WITH AC PRIOR TO ANY PLACEMENT OUTSIDE OF DESIGNATED DEMONSTRATION AREAS (SEE SPEC 02221).
4. CONTRACTOR SHALL NOT CAUSE DISTURBANCE OF PLOTS ONCE MATERIAL HAS BEEN PLACED (EITHER LIFT) BY ANY MEANS INCLUDING SPUDS, ANCHORS, PROP WASH, CLAMSHELL BUCKET CONTACTING BOTTOM, GROUNDING OF EQUIPMENT, ETC. (SEE SPEC 02221).
5. IF, AFTER COMPLETING PLACEMENT WITHIN SUBPLOT THERE IS ADDITIONAL ENR MATERIAL REMAINING IN BARGE IT MAY BE PLACED, UPON APPROVAL OF PROJECT REPRESENTATIVE, WITHIN AREA SHOWN USING SAME METHODS, PROCEDURES, ETC. AS USED FOR SUBPLOT PLACEMENT. ENR OR ENR+AC MATERIAL SHALL BE PLACED ADJACENT TO SUBPLOT OF SIMILAR MATERIAL.

LEGEND:

PLACE ENR SAND MATERIAL

PLACE ENR SAND + AC MATERIAL

POTENTIAL ADDITIONAL PLACEMENT AREA IF EXCESS MATERIAL AVAILABLE. PLACE AS DIRECTED BY PROJECT REPRESENTATIVE. SLOPES TO BE ADJUSTED ACCORDINGLY

OUTFALL

APPROXIMATE CONFIRMATION STAKE LOCATION (TO BE INSTALLED BY COUNTY PRIOR TO CONSTRUCTION)

TEMPORARY CONTROL POINT (TO BE SET BY COUNTY PRIOR TO MOBILIZATION, APPROXIMATE LOCATION SHOWN, SUBJECT TO CHANGE)

APPROXIMATE EXTENTS OF 4H:1V SIDE OF SLOPE BASED ON 0.75' THICK MATERIAL LAYER (ACTUAL DISTANCE TO VARY BASED ON ACTUAL PLACEMENT THICKNESS AND STABLE SLOPE)

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 40'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

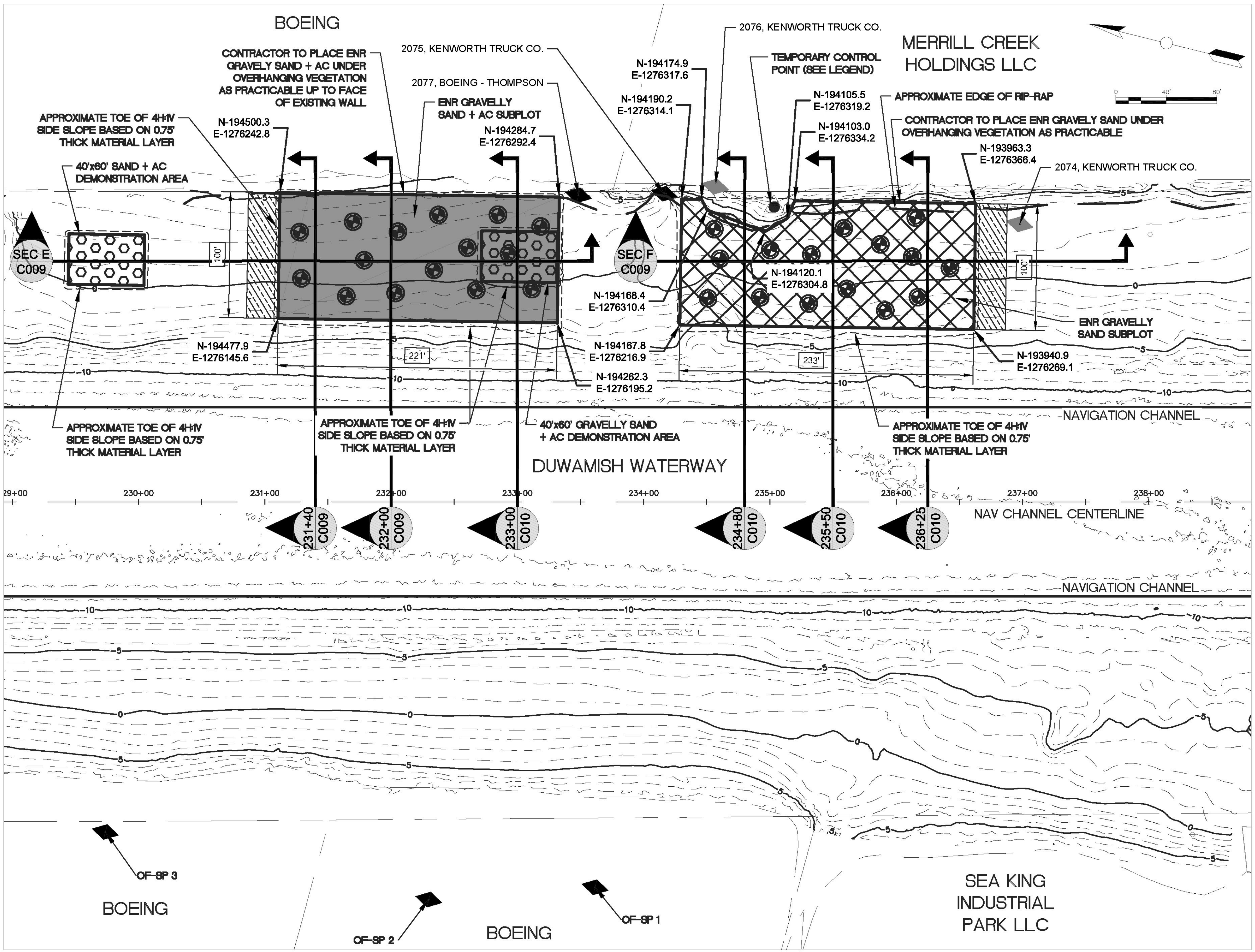
King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

SUBTIDAL PLOT (RM 1.13 to 1.23) PLAN VIEW

DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C003
SHT NO 04 / TOTAL 11 REV NO: 0

BORDER FILE EDITION: KCWTD-2015R0-Dsize-TB-Border
D:\Projects\King Cnty GAC\CadFigures\2015-10\2015-10-14 04 C002-C004 KC-ENR Plans.dwg | Layout: C003 PLAN SUBTIDAL PLOT
PLOTTED: Oct 14, 2015-05:06:14pm By srasmussen
XREFS: KingCntyGAC TM.dwg; PlotAreas1_6&9-Dsize-TB-Border.dwg; Outfalls from GIS.DWG
IMAGES: rgb_22930_025.tif, rgb_22931_025.tif, rgb_23095_025.tif, rgb_23096_025.tif, rgb_23258_025.tif, rgb_23259_025.tif, rgb_23260_025.tif, rgb_23423_025.tif, rgb_23424_025.tif, rgb_23587_025.tif, rgb_23588_025.tif, rgb_23752_025.tif, rgb_23753_025.tif, rgb_23918_025.tif



NOTES

1. SEE SPECS SECTION 02221 FOR DETAILS ON MATERIAL PLACEMENT. AC AMENDED MATERIAL SHALL BE PLACED PRIOR TO NON AC AMENDED MATERIAL.
2. CONTRACTOR SHALL PERFORM ALL WORK IN ACCORDANCE WITH PLANS, SPECIFICATIONS, AND ACCEPTED RAWP. CONTRACTOR SHALL HAVE READ AND FAMILIARIZED THEMSELVES WITH SPECIFICATIONS PRIOR TO MOBILIZATION.
3. KING COUNTY PROJECT REPRESENTATIVE (PR) MUST APPROVE TEST PLACEMENTS OF SAND ENR MATERIAL WITH AC AND SANDY GRAVEL ENR MATERIAL WITH AC PRIOR TO ANY PLACEMENT OUTSIDE OF DESIGNATED DEMONSTRATION AREAS (SEE SPEC 02221).
4. CONTRACTOR SHALL NOT CAUSE DISTURBANCE OF PLOTS ONCE MATERIAL HAS BEEN PLACED (EITHER LIFT) BY ANY MEANS INCLUDING SPUDS, ANCHORS, PROP WASH, CLAMSHELL BUCKET CONTACTING BOTTOM, GROUNDING OF EQUIPMENT, ETC. (SEE SPEC 02221).
5. ALL MATERIAL PLACEMENT TO BE PERFORMED "IN THE WET" DURING PERIODS WHEN WATER LEVEL IS AT LEAST 3' ABOVE PLACEMENT AREA BED ELEVATION (I.E. - PLACE MATERIAL WHEN WATER DEPTH IS 3' OR GREATER AT PLACEMENT LOCATION)
6. APPROXIMATE LOCATION OF RIP-RAP BASED ON VISUAL INTERPRETATION OF EARTH EXPLORER 2012 IMAGE.
7. IF, AFTER COMPLETING PLACEMENT WITHIN SUBPLOT THERE IS ADDITIONAL ENR MATERIAL REMAINING IN BARGE IT MAY BE PLACED, UPON APPROVAL OF PROJECT REPRESENTATIVE, WITHIN AREA SHOWN USING SAME METHODS, PROCEDURES, ETC. AS USED FOR SUBPLOT PLACEMENT. ENR OR ENR+AC MATERIAL SHALL BE PLACED ADJACENT TO SUBPLOT OF SIMILAR MATERIAL.
8. GRADE STAKES IN DEMONSTRATION AREAS TO BE INSTALLED BY COUNTY PRIOR TO PLACEMENT METHOD DEMONSTRATION.

LEGEND:

- PLACE ENR GRAVELLY SAND MATERIAL
- PLACE ENR GRAVELLY SAND PLUS AC MATERIAL
- DEMONSTRATION AREAS
- POTENTIAL ADDITIONAL PLACEMENT AREA IF EXCESS MATERIAL AVAILABLE. PLACE AS DIRECTED BY PROJECT REPRESENTATIVE. SLOPES TO BE ADJUSTED ACCORDINGLY
- OUTFALL
- ABANDONED OUTFALL
- APPROXIMATE CONFIRMATION STAKE LOCATION (TO BE INSTALLED BY COUNTY PRIOR TO CONSTRUCTION)
- TEMPORARY CONTROL POINT (TO BE SET BY COUNTY PRIOR TO MOBILIZATION, APPROXIMATE LOCATION SHOWN, SUBJECT TO CHANGE)
- APPROXIMATE EXTENTS OF 4H:1V SIDE OF SLOPE BASED ON 0.75' THICK MATERIAL LAYER (ACTUAL DISTANCE TO VARY BASED ON ACTUAL PLACEMENT THICKNESS AND STABLE SLOPE)
- APPROXIMATE LIMIT OF EXISTING SHORELINE RIP-RAP

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

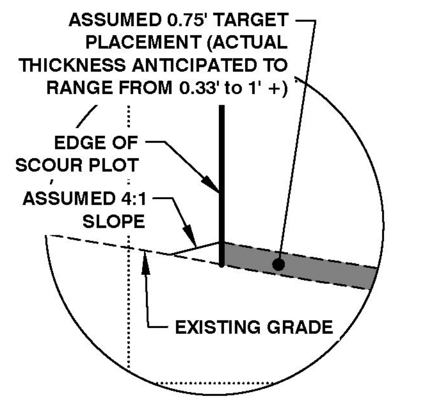
DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 40'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

King County

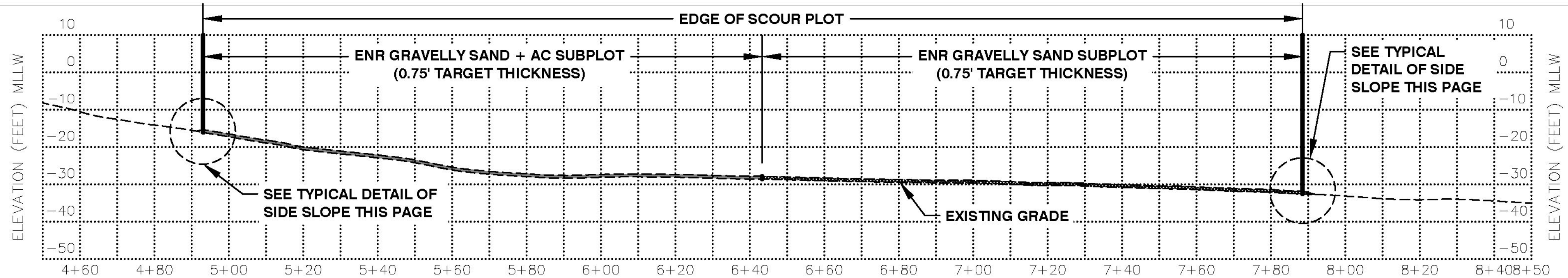
DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

INTERTIDAL PLOT (RM 3.84 to 3.88 AND 3.90 to 3.94) PLAN VIEW

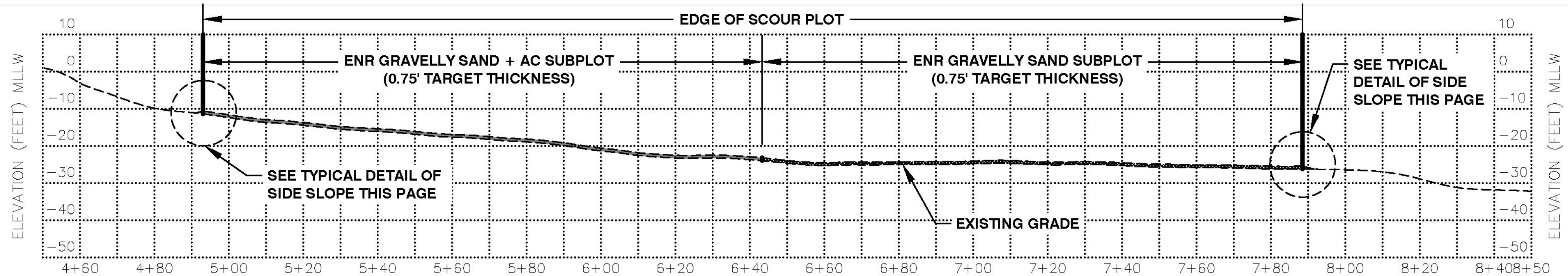
DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C004
SHT NO 05 / TOTAL 11 REV NO: 0



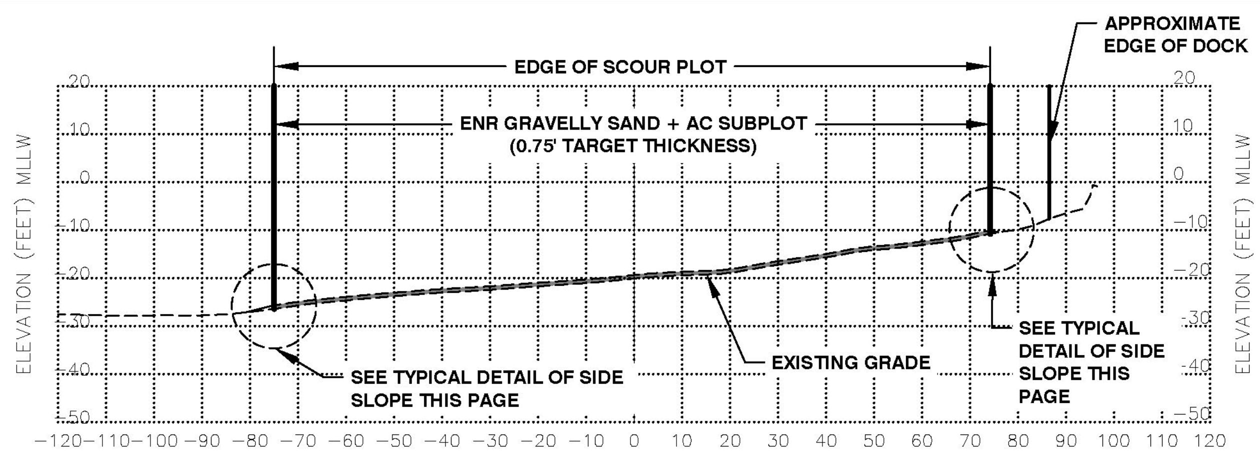
TYPICAL DETAIL OF SIDE SLOPE
(NOT TO SCALE)



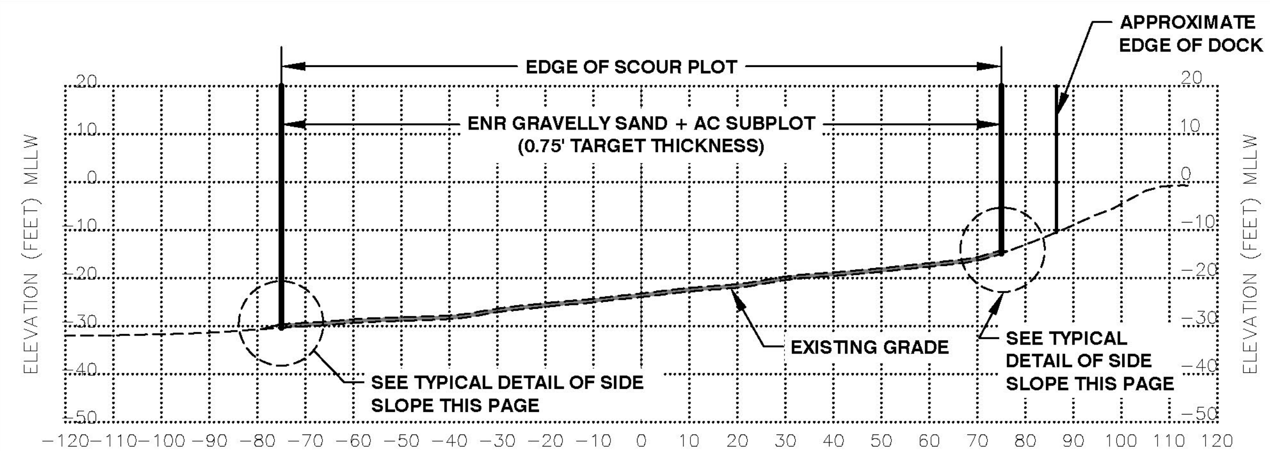
SECTION A



SECTION B



STA = 5+40



STA = 5+89

LEGEND:

PLACE ENR GRAVELLY SAND MATERIAL

PLACE ENR GRAVELLY SAND + AC MATERIAL

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

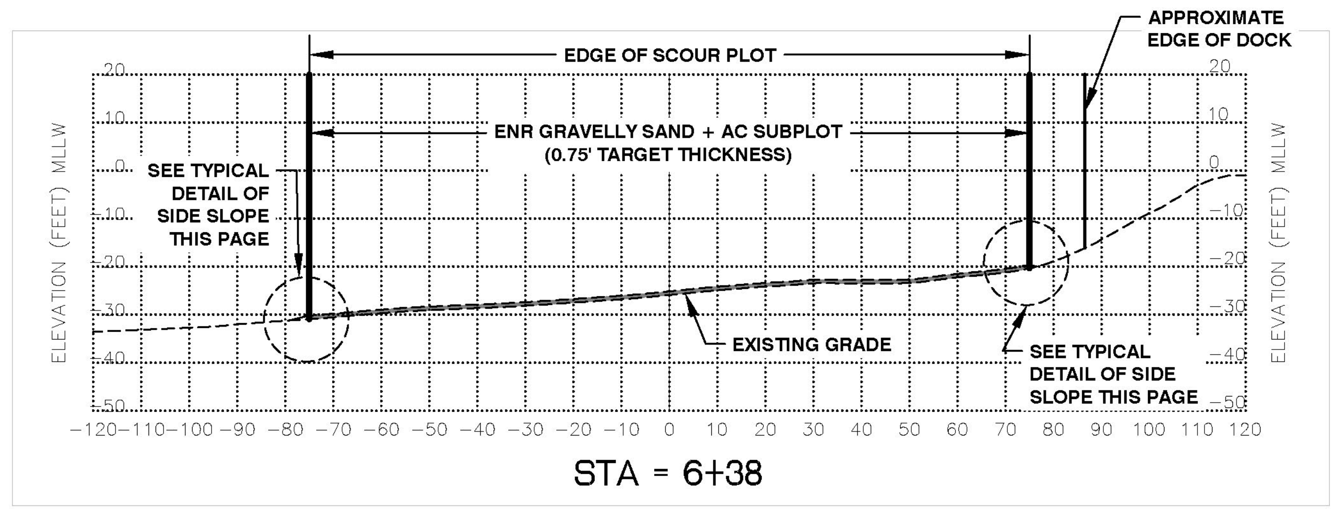
DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 20'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

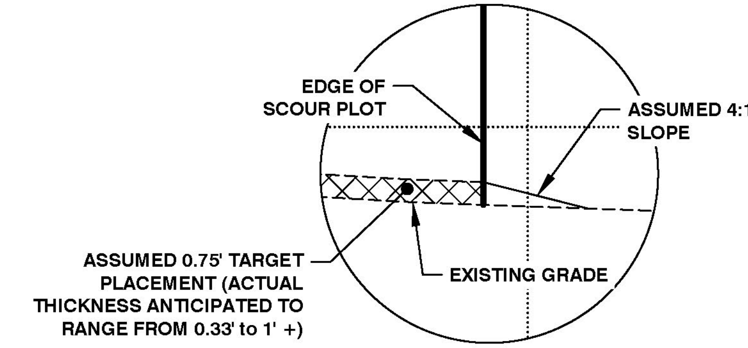
King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

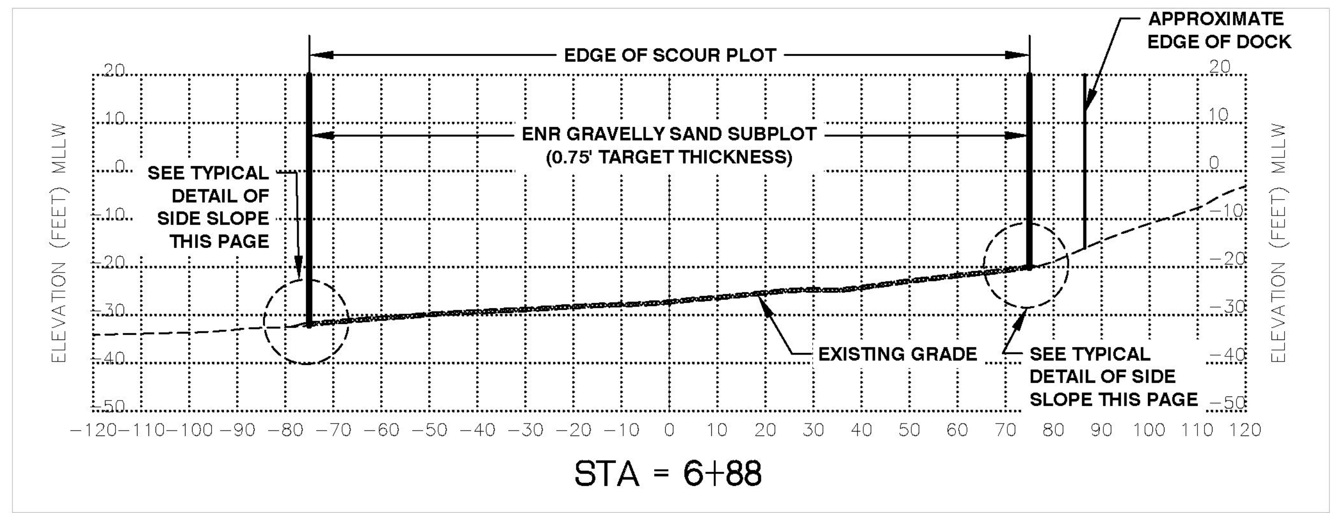
**SCOUR PLOT
(RM 0.04 to 0.10)
SECTION VIEWS**

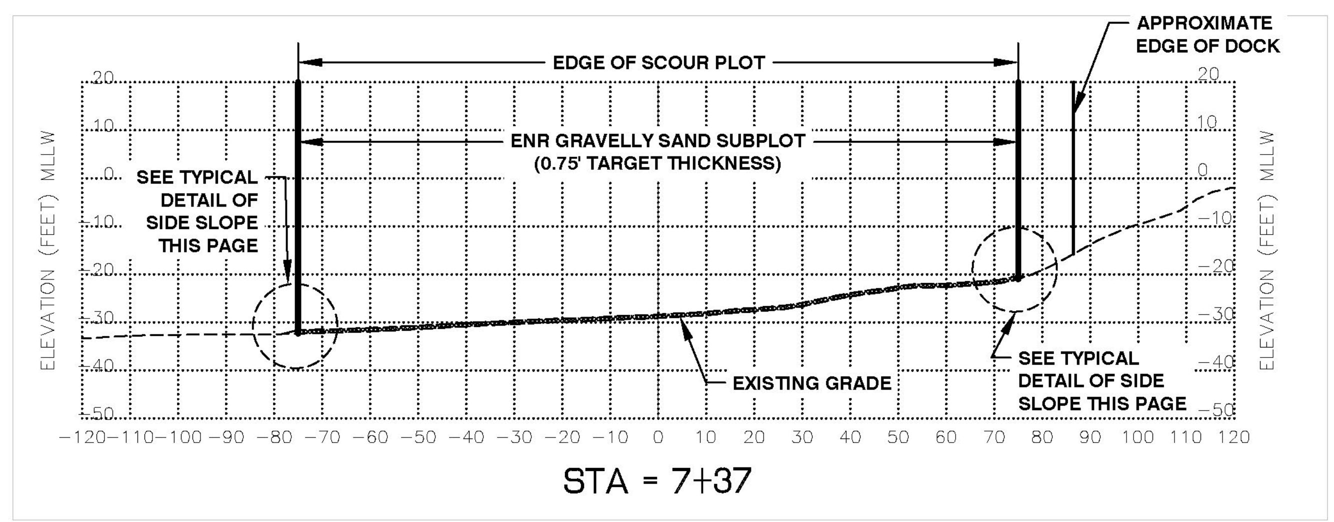
DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C005
SHT NO 06 / TOTAL 11 REV NO: 0





TYPICAL DETAIL OF SIDE SLOPE
(NOT TO SCALE)





LEGEND:

PLACE ENR GRAVELLY SAND MATERIAL

PLACE ENR GRAVELLY SAND + AC MATERIAL

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

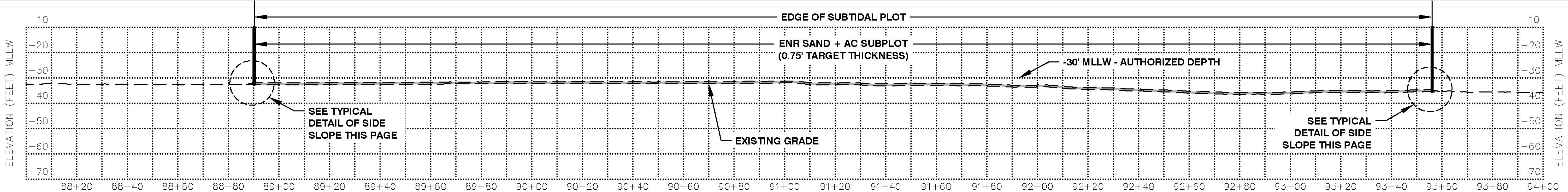
DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 20'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

King County

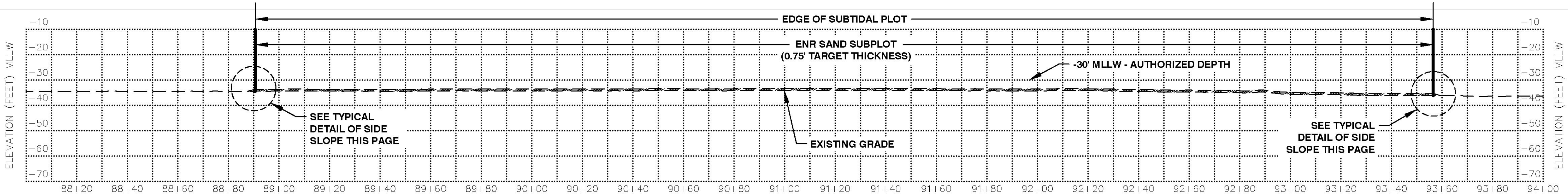
DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

SCOUR PLOT (RM 0.04 to 0.10) SECTION VIEWS

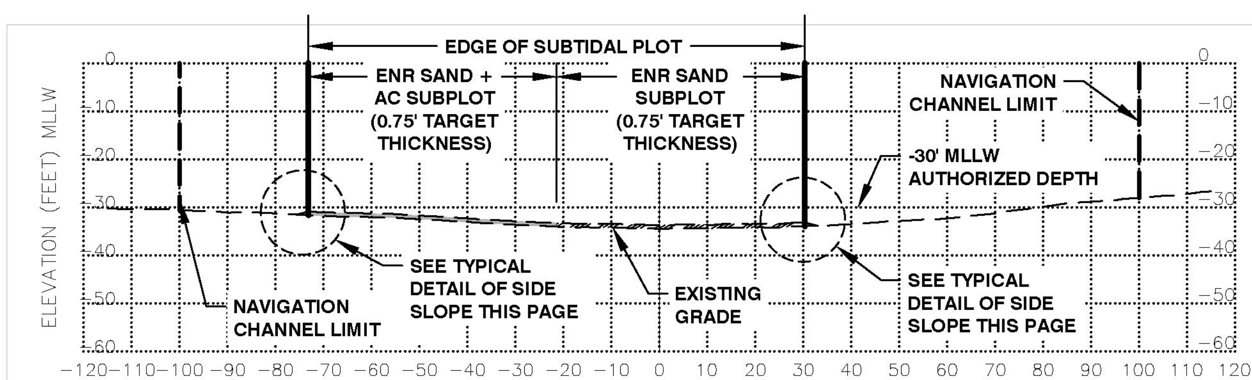
DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C006
SHT NO 07 / TOTAL 11 REV NO: 0



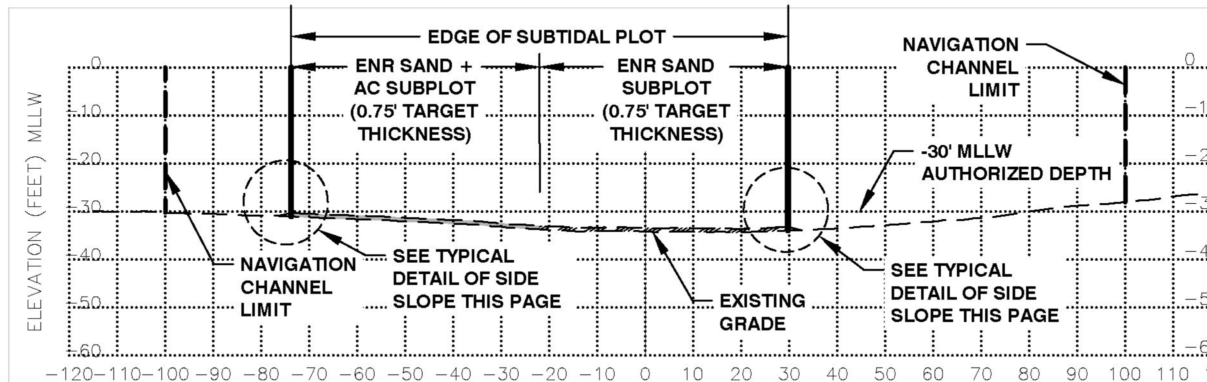
SECTION C



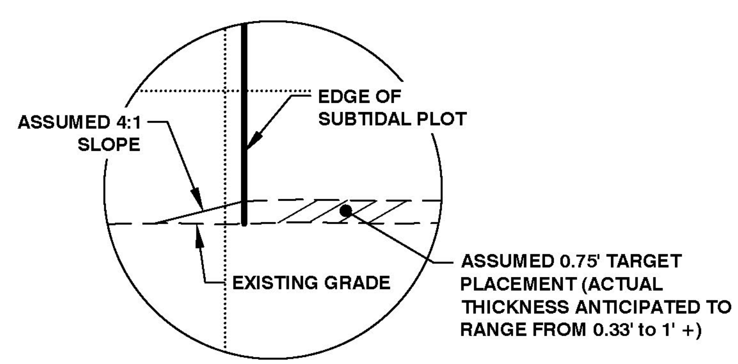
SECTION D



STA = 89+49



STA = 90+17



TYPICAL DETAIL OF SIDE SLOPE
(NOT TO SCALE)

LEGEND:

PLACE ENR SAND MATERIAL

PLACE ENR SAND + AC MATERIAL

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

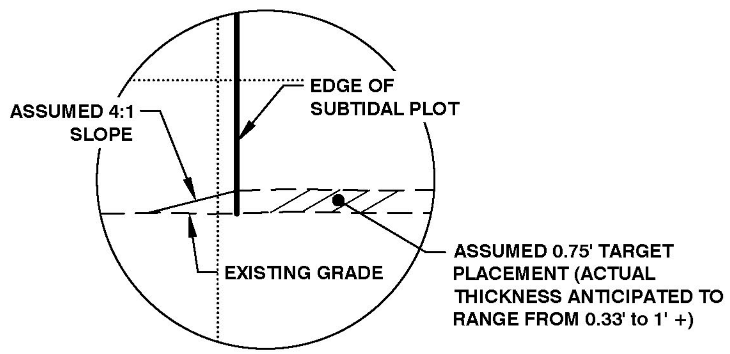
DESIGNED/DRAWN: SBR
CHECKED: RMM
PROJECT ENGINEER: RSW
SCALE: 1" = 20'
DESIGN APPROVAL: RSW
FACILITY NUMBER:
PROJECT ACCEPTANCE:
CONTRACT NO: E00334E14

King County

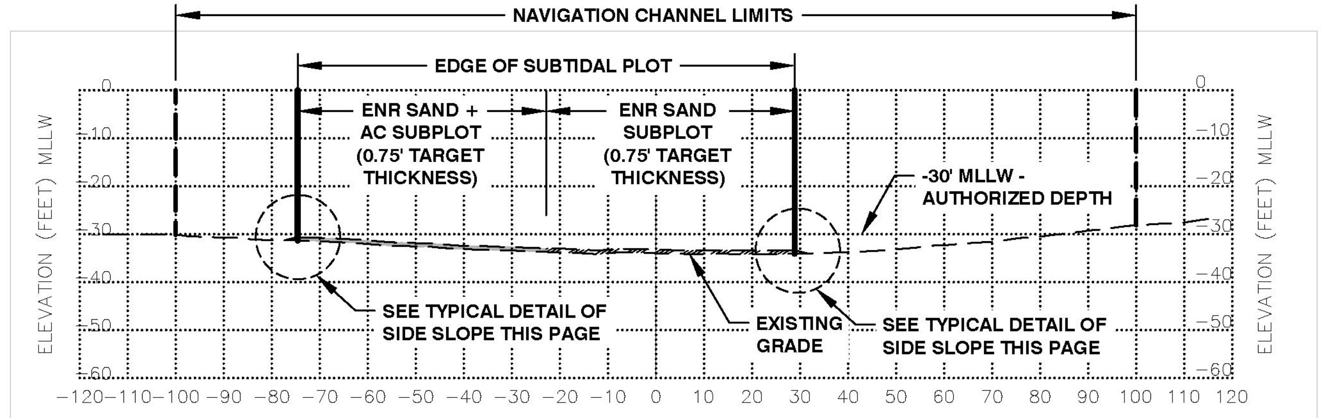
DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

SUBTIDAL PLOT (RM 1.13 to 1.23) SECTION VIEWS

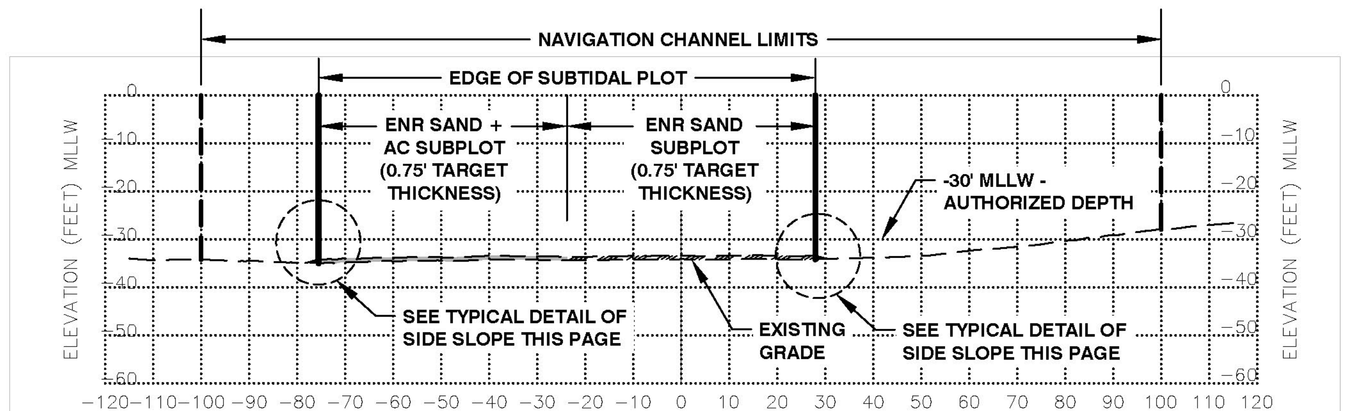
DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C007
SHT NO / TOTAL: 08 / 11
REV NO: 0



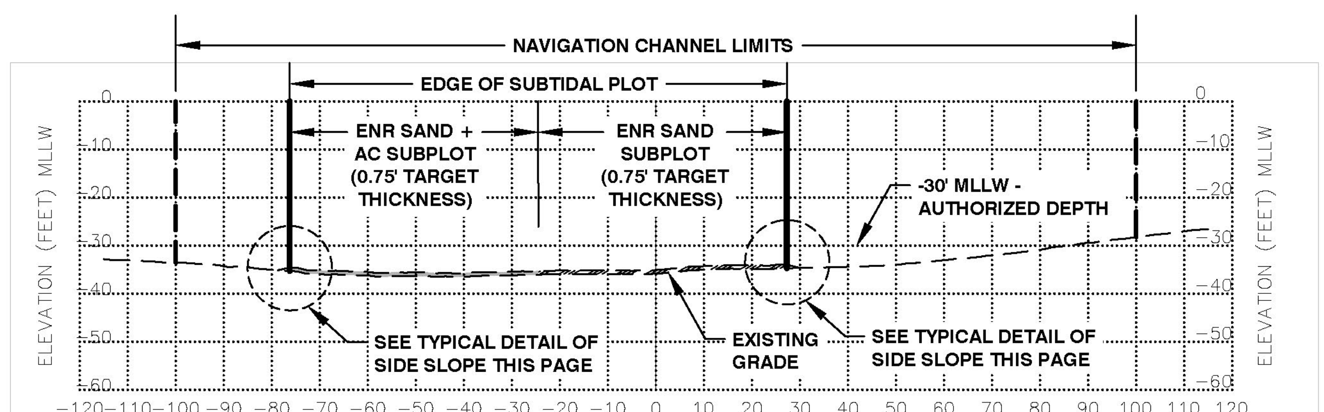
TYPICAL DETAIL OF SIDE SLOPE
(NOT TO SCALE)



STA = 91+13



STA = 92+20



STA = 93+00

LEGEND:

PLACE ENR SAND MATERIAL

PLACE ENR SAND + AC MATERIAL

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 20'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

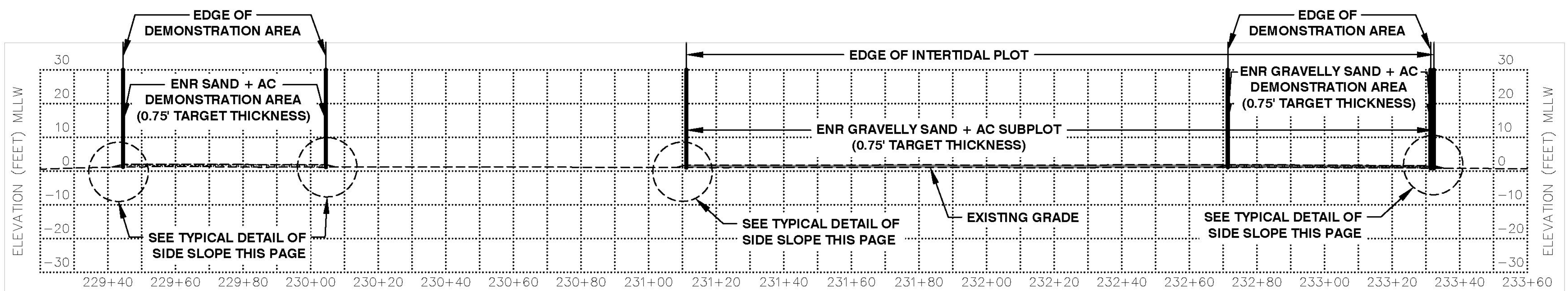
King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

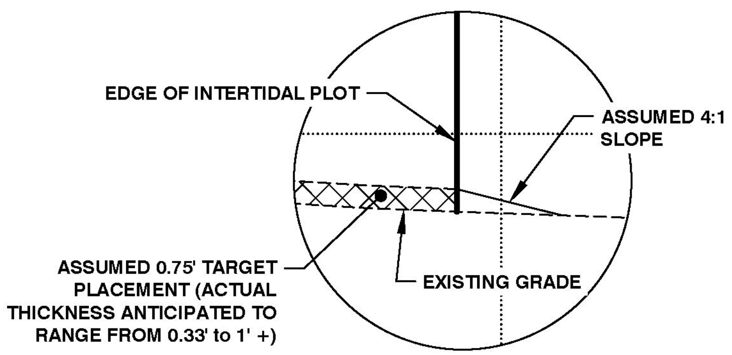
SUBTIDAL PLOT (RM 1.13 to 1.23) SECTION VIEWS

DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C008
SHT NO 09 / TOTAL 11 REV NO: 0

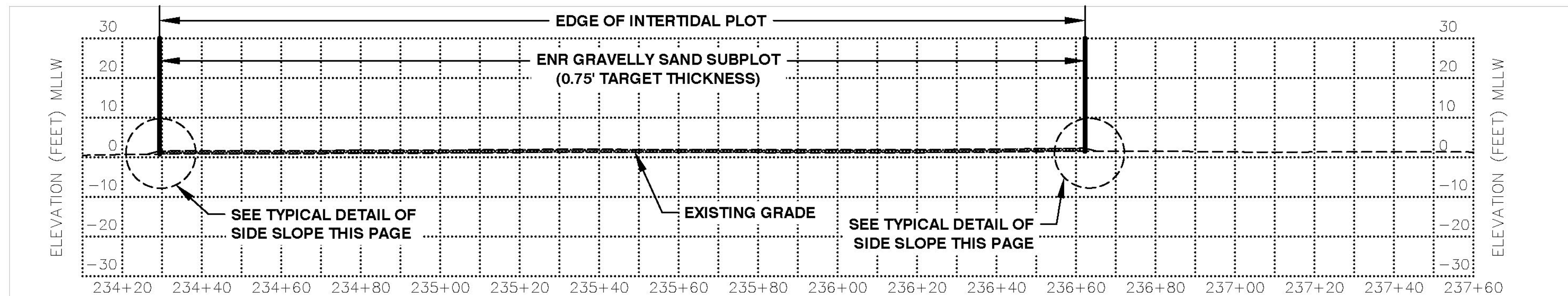
BORDER FILE EDITION: KCWTD-2015R0-Dsize-TB-Border



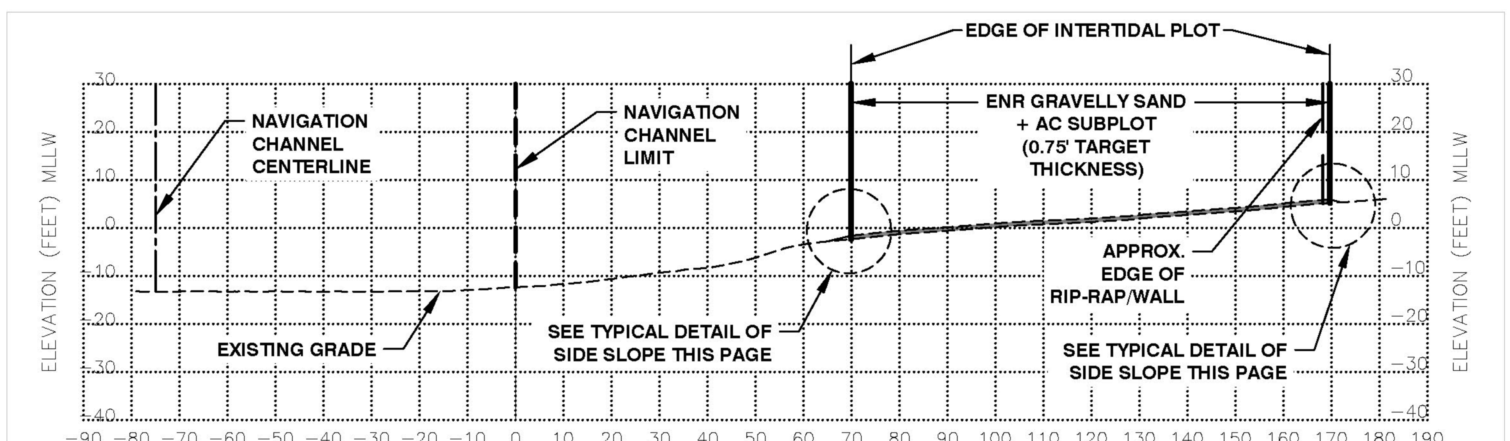
SECTION E



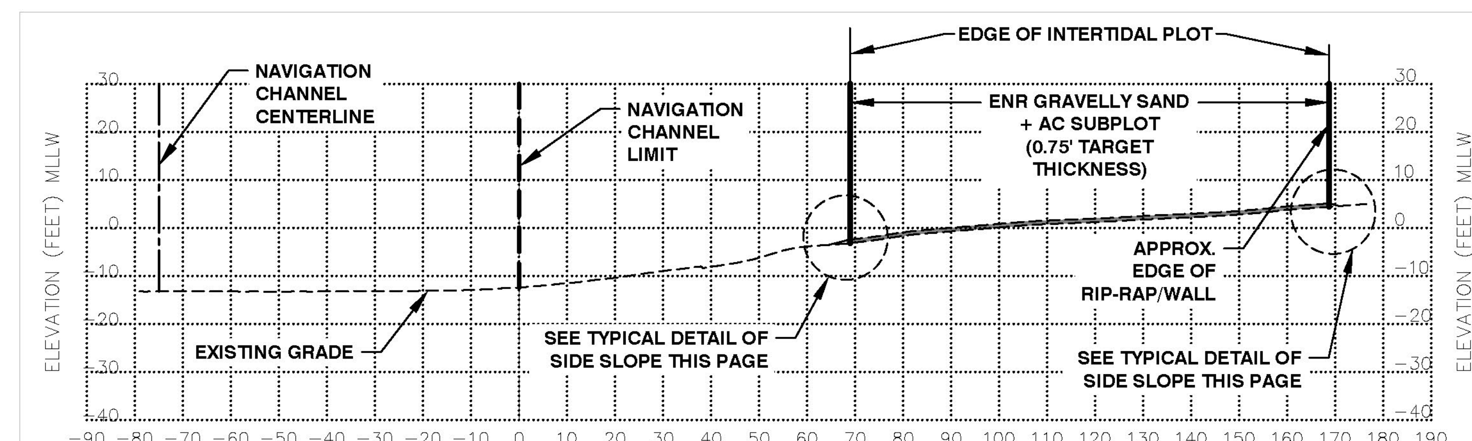
TYPICAL DETAIL OF SIDE SLOPE
(NOT TO SCALE)



SECTION F



STA = 231+40



STA = 232+00

LEGEND:

- PLACE ENR GRAVELLY SAND MATERIAL
- DEMONSTRATION AREA
- PLACE ENR GRAVELLY SAND + AC MATERIAL

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 20'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

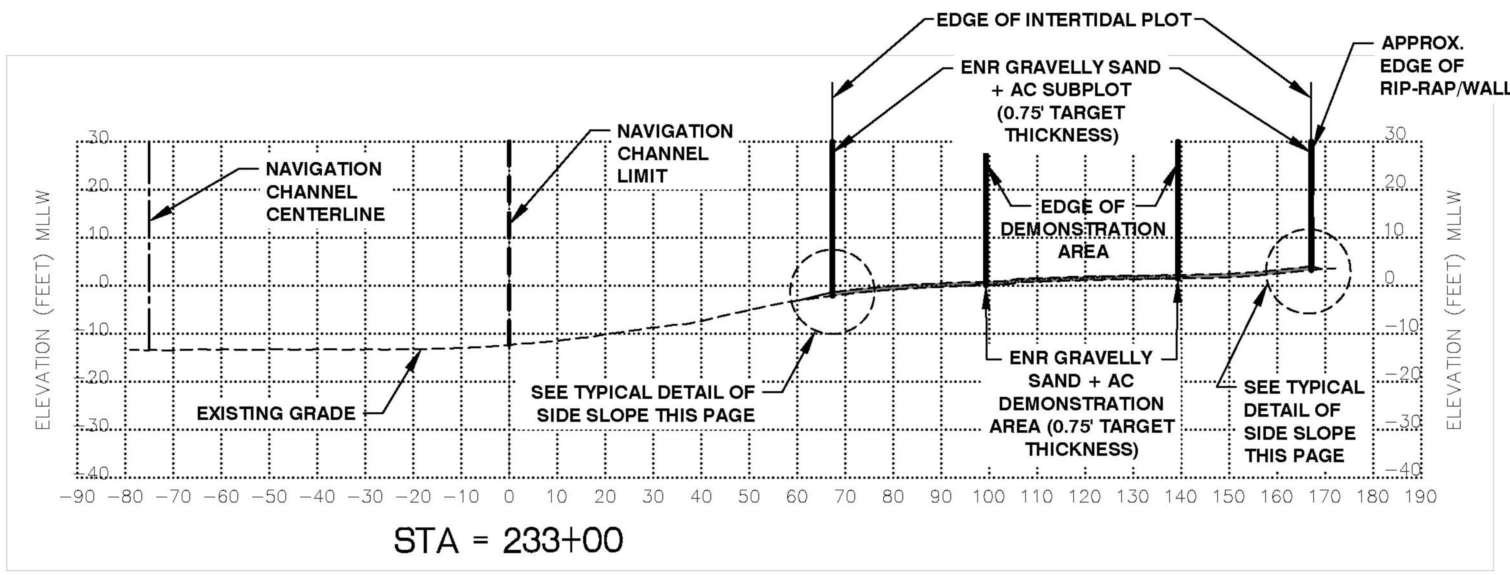
King County

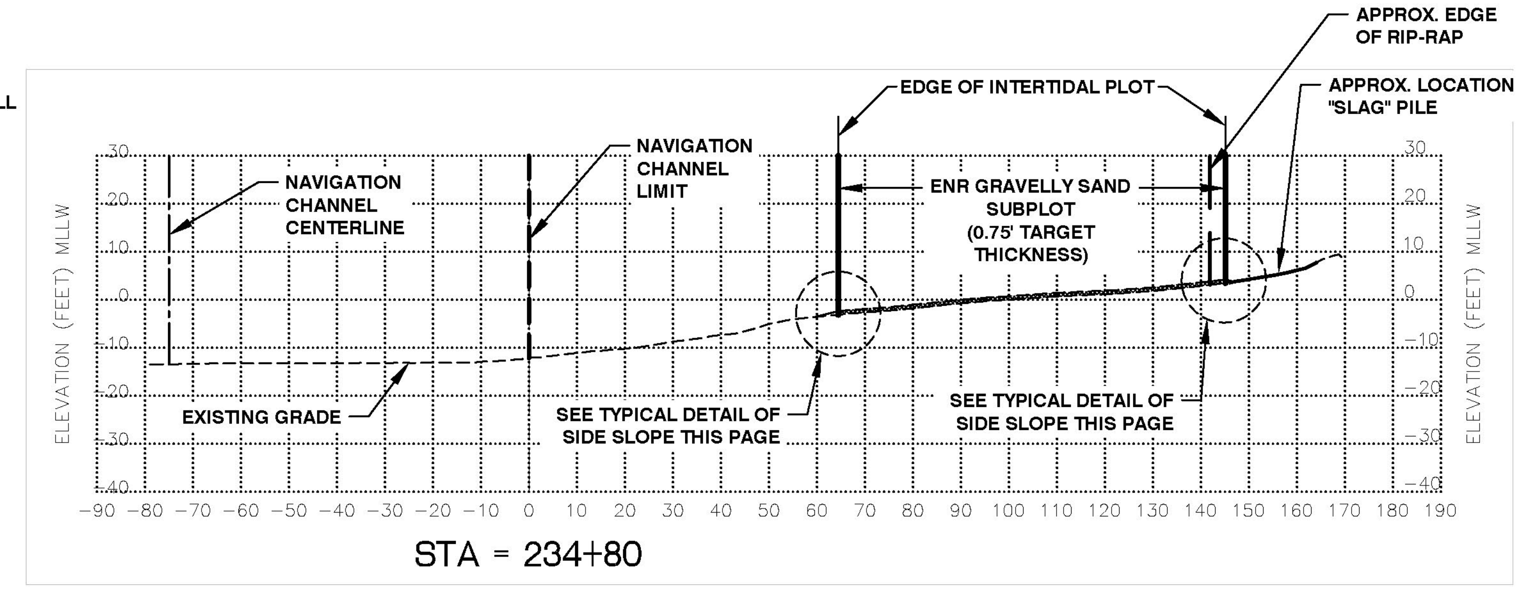
DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

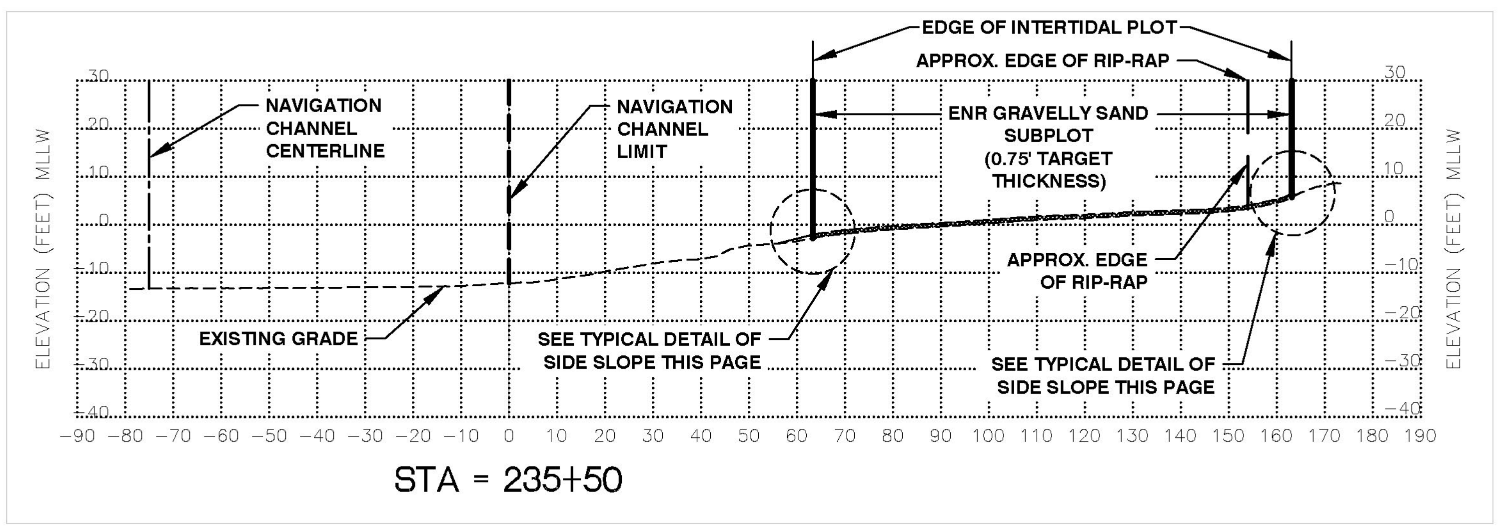
INTERTIDAL PLOT (RM 3.84 to 3.88 AND 3.90 to 3.94) SECTION VIEWS

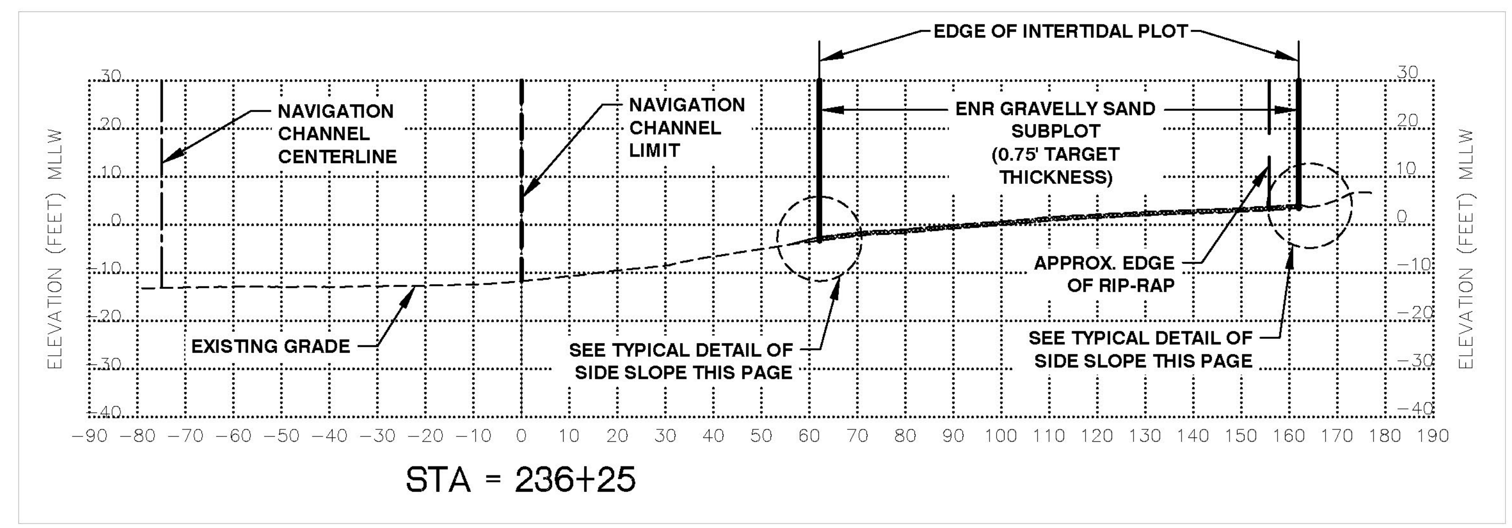
DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C009
SHT NO 10 / TOTAL 11 REV NO: 0

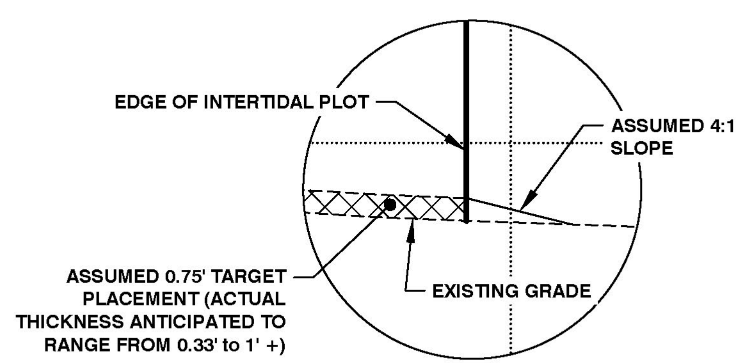
BORDER FILE EDITION: KCWTD-2015R0-Dsize-TB-Border
D:\Projects\King Cnty GAC\CadFigures\2015-10\2015-10-14 05 C005-C010 KC-ENR XSects.dwg | Layout: C009 PLOT-9 XSECT-1
PLOTTED: Oct 14, 2015-05:07:31pm By srasmussen
XREFS: KingCntyGAC TM.dwg; PlotAreas1_6&9-Dsize-TB-Border.dwg
IMAGES: rgb_22930_025.tif, rgb_22931_025.tif, rgb_23095_025.tif, rgb_23096_025.tif, rgb_23258_025.tif, rgb_23259_025.tif, rgb_23260_025.tif, rgb_23423_025.tif, rgb_23424_025.tif, rgb_23587_025.tif, rgb_23588_025.tif, rgb_23752_025.tif, rgb_23753_025.tif, rgb_23918_025.tif











TYPICAL DETAIL OF SIDE SLOPE
(NOT TO SCALE)

LEGEND:

- PLACE ENR GRAVELLY SAND MATERIAL
- PLACE ENR GRAVELLY SAND + AC MATERIAL
- DEMONSTRATION AREA

NO	REVISION DESCRIPTION	BY	APVD	DATE
0	INITIAL ISSUE			

DESIGNED/DRAWN: SBR	CHECKED: RMM
PROJECT ENGINEER: RSW	SCALE: 1" = 20'
DESIGN APPROVAL: RSW	FACILITY NUMBER:
PROJECT ACCEPTANCE:	CONTRACT NO: E00334E14

King County

DEPARTMENT OF NATURAL RESOURCES & PARKS
WASTEWATER TREATMENT DIVISION

INTERTIDAL PLOT (RM 3.84 to 3.88 AND 3.90 to 3.94) SECTION VIEWS

DATE: OCT 2015
PROJECT FILE NO: 15-xxxxxxx
DRAWING NO: C010
SHT NO 11 / TOTAL 11
REV NO: 0

SPECIFICATIONS

King County ENR Pilot Study
Specifications

TABLE OF CONTENTS

DIVISION 1 - GENERAL REQUIREMENTS

DIVISION 2 - SITE CONSTRUCTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. This Section contains a summary of the Work in this Contract and other known work in the vicinity of the Contract Work.

B. The Work to be performed under this Contract consists of furnishing all tools, equipment, materials, supplies, and manufactured articles; furnishing all labor, transportation, and services, including fuel, power, water, and essential communications; and performing all work or other operations required for the fulfillment of the Contract, in strict accordance with the Contract Documents. Provide all work, materials, and services not expressly indicated in the Contract Documents that may be necessary for the complete and proper construction of the Work and administration of the contract. The project work involves the placement of Enhanced Natural Recovery (ENR) materials, sand or gravelly sand, alone or either of the two blended with Granular Activated Carbon (AC) at three separate approximate one acre plots within the Lower Duwamish Waterway (LDW) in Seattle and Tukwila, WA. Each approximate one acre test plot placement includes an approximate ½ acre subplot of ENR material alone and a second approximate ½ acre subplot of ENR+AC. Within each plot a minimum of a 4 inch (0.333 foot) thick layer of ENR or ENR+AC material will result by uniformly placing a volume equivalent to a 9 inch (0.75 foot) thick layer over the area with the intent of achieving a target thickness of 6 to 9 inches (0.5 to 0.75 foot) over the placement area. Sand ENR material will be used at one plot location (Subtidal Plot) and gravelly sand ENR material at two plots (Scour Plot and Intertidal Plot).

C. The objective of the Work is to place the ENR materials in a manner that reduces potential for winnowing and loss of the AC during placement and results in plots that are as uniformly constructed as practicable. This includes releasing the ENR materials approximately 2' above bed to reduce potential for winnowing as material falls thru the water column. Constructed plots will be used for a 3 year monitoring study of the performance of ENR+AC compared to the ENR Material alone.

D. Granular Activated Carbon has material properties including a low specific gravity and a high void ratio that make placement of AC blended with sand or other aggregates more complex than placement of sand and gravel materials alone. Contractor is expected to understand the specific properties of AC as related to placement of AC blended with sand or sand and gravel in an aquatic environment prior to material placement. The low specific gravity of the AC will make it more prone to winnowing, loss and segregation than materials of a similar grainsize but having a higher specific gravity.

1.02 WORK OF THIS CONTRACT

A. The work of this Contract includes:

1. Preparation of Contractor Submittals.

2. Test placement of materials to develop optimal bucket placement grid, bucket overlap and bucket fill factor.

    a. Contractor shall perform Material Placement Testing to calibrate and verify appropriate clamshell bucket volume and fill factor, bucket pattern, resulting placement area, and thickness by trial placement of the material into a predefined area of the intertidal plot (for Gravelly Sand ENR Material) and an adjacent area (for sand ENR Material). Test Placement shall be completed and approved by Project Representative prior to any additional material placement within Plot areas

3. Placement of ENR Material and ENR+AC Material in three separate one-acre test plots. One plot is located within a sub tidal area of the Waterway at approximately River Mile (RM) 1.13 to 1.23 within the Navigation Channel (Subtidal Plot), one within an intertidal area at approximately RM 3.84 to 3.94 along the easterly bank of the waterway (Intertidal Plot), and

one in a scour area at approximately RM 0.04 to 0.10 at the Ash Grove Cement berth area (Scour Plot). Placement of ENR or ENR +AC shall be performed using a rigid arm excavator with clamshell bucket (or similar as approved by the Project Representative (PR)) and real time navigation and positioning system (or approved equal) capable of real time positioning of clamshell bucket to +/-4 inch accuracy in X, Y and Z axes.

a. ENR and ENR+AC Material shall be placed in a manner intended to limit mixing with underlying river sediments, limit segregation of the ENR or ENR+AC material during placement, limit winnowing/loss of the AC during placement, and accurately place the materials within the target areas at the target thickness with limited loss to adjacent areas.

4. Multi-beam hydrographic surveying.

5. All other work as defined in the Contract Documents.

B. Accomplishment of Work in the Contract Documents shall meet all requirements of the Contract including timeframes specified by Section 01014.

C. The above description is not intended to be complete. The work to be completed is provided in the entirety of the Contract Documents. The summary in this Section is not intended to relieve the Contractor of the responsibility for reading and understanding the Contract Documents.

1.03 SPECIFICATION LANGUAGE

A. Specifications are written mostly in imperative and streamlined form. Unless indicated otherwise, this imperative language is directed to the Contractor. Additionally, the words "shall be" shall be included by inference where a colon (:) is used within sentences or phrases.

1. Examples:

a. Aggregate: ASTM C33.

b. Adhesive: spread with notched trowel.

B. Related sections: Individual Specification sections may include a reference to other sections. Specification sections referenced are intended only to assist in identifying associated work and are not intended and shall not be considered to be all inclusive. The Contractor is responsible to perform all the work in the Contract Documents whether referenced in the specific specifications or not.

C. Whenever there is wording stating that an item is “as specified”, “as shown”, or “as indicated”, the reference is to all the Contract Documents. Stating “as specified”, “as shown”, or “as indicated” does not refer necessarily to a Drawing or Specification, but it refers to either.

D. The words “Provide” and “Furnish” shall mean supplying, installing, and incorporating into the Work including all labor, materials, supplies and equipment necessary to do so. The word “Supply” shall mean to acquire, deliver and transfer the item to the County as specified.

E. Unless otherwise indicated, all specified materials and equipment incorporated into the Work shall be new and free of defects.

1.04 REFERENCED SPECIFICATION

A. Whenever a Specification in this Contract references the specifications of WSDOT or Local Jurisdiction, it is to define the technical standards to be met for this Contract; only the technical standards are referenced. Administrative provisions such as Measurement and Payment of the referenced specification shall not apply to this Contract in any instance.

B. Federal, State and Local Laws, Statutes and Regulations are not individually referenced. This provision incorporates by reference the latest version of statutes, laws and regulations. In case of conflict between the requirements of the specifications and requirements of the statutes and regulations, the contractor shall bring them to the attention of the Project Representative. Lacking a specific response, the more stringent shall control. In no case can this contract be interpreted to override statutes and regulations of governing authorities.

C. Whenever an industry code or standard is referenced and not specifically addressed in an individual specification, it is referenced to define the industry standard of quality for workmanship and materials

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01012

REFERENCE MATERIAL

PART 1 GENERAL

1.01 SUMMARY

A. This Section lists reference materials relative to the project. Reference materials are provided for informational purposes only and are not to be considered Contract Documents.

B. The documents are available on the Procurement Website for this Project at: http://www.kingcounty.gov/procurement/.

C. For the work related to the Contract, the following are available reference materials:

a. AOC - ADMINISTRATIVE ORDER ON CONSENT FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY, USEPA Region 10 Docket # CERCLA-10-2001-0055

b. Candidate Plot Locations for Enhanced Natural Recovery-Activated Carbon Pilot Study, Lower Duwamish Waterway Group Memorandum to EPA and Washington Department of Ecology, July 24, 2014

c. Quality Assurance Project Plan: Enhanced Natural Recovery/Activated carbon Candidate Plot Surface and Subsurface Sediment Sampling for PCB Analyses for the Lower Duwamish Waterway Final, Submitted to EPA and Washington department of Ecology, October 24, 2014, prepared by Windward Environmental LLC for Lower Duwamish Waterway Group

d. Validated LDW Sediment Data for ENR-AC Pilot, Lower Duwamish Waterway Group Memorandum to EPA and Washington Department of Ecology, January 15, 2015

e. Final Plot Selections for Lower Duwamish Waterway Enhanced Natural Recovery-Activated Carbon Pilot Study, Lower Duwamish Waterway Group Memorandum to EPA and Washington Department of Ecology, February 3, 2015

f. Design Support Documents

i. Substantive Compliance Information

ii. Biological Evaluation

iii. Narrative Design Report

iv. Water Quality Monitoring Plan

v. Construction Quality Assurance Plan

PART 2 PRODUCTS [NOT USED]

PART 3 EXECUTION [NOT USED]

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01014

MILESTONES AND CONSTRAINTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies completion times, milestones, constraints and hours of work.

B. Schedule and conduct all work in a manner consistent with the Contract, and comply with the construction scheduling requirements, Contract milestones and constraints on the Work as specified.

C. This contract is divided into two Phases:

1. Phase 1 includes preparation and confirmation of pre-construction submittals. Phase 1 NTP authorizes the Contractor to start with the preparation of submittals described below and their transmittal to the Project Representative (PR) according to the schedule in 1.02.

    a. At a minimum, the Contractor shall submit the following submittals during Phase 1:

        i Specification Section 01063 – Health and Safety 1.03 D Site Specific HASP

        ii Specification Section 01300 – Schedule of Values

        iii Specification Section 01311 – Progress Schedules and Reports 1.02 C Construction Schedule

        iv Specification Section 01560—Environmental Management 1.03 B Environmental Protection Plan

        v Specification Section 02221—Backfill 1.03 A, B and K Construction Work Plan, Contractor Quality Control Plan (CQCP), and Material information

        vi AC material information and sample

    b. Phase 1 Work shall be considered complete when Contractor receives the Project Representative confirmation in writing indicating 'Review Action 1 or 2' to the submittals described in 1.01, C 1.

    c. As a condition precedent to issuing the Phase 2 NTP, the Contractor shall have completed the Work under Phase 1.

    d. Contractor shall procure materials as necessary during Phase 1 once materials are approved by the Project Representative

2. Phase 2 NTP authorizes the Contractor to begin mobilization, test placement, construction and to proceed with the Work of the Contract.

1.02 COMPLETION TIMES

A. Achieve Substantial Completion of Phase 1 – Submittals Period, within 120 days after the effective date of Phase 1 Notice to Proceed.

B. Achieve Substantial Completion of Phase 2 – Construction Period, within 120 days after the effective date of Phase 2 Notice to Proceed.

C. Achieve Final Acceptance within the time specified by the Project Representative.

1.03 CONSTRAINTS

A. In-water work shall be performed starting around November 29, 2016 and completed prior to February 15, 2017.

B. No in-water work shall be performed during period of tribal fishing.

1.04 HOURS OF WORK

A. Unless otherwise specified, conform with applicable jurisdictions and other pertinent ordinances regarding limitations on work hours or specific parts of the work.

B. Hours of work may be further modified by Section 01062.

C. Submit a schedule of planned working hours. Contractor shall typically plan on working 1 or 2 shifts per day, typically 10 hours per shift. Shifts shall be planned to coordinate with specific tidal periods or other conditions as necessary to safely and efficiently perform the work. King County Project Representative shall approve Contractors proposed work hours and may modify proposed schedule as appropriate. Hours per day may be variable and 10 hours per day are not guaranteed.

D. Contractor shall not perform any work unless Project Representative or designee is onsite.

E. Contractor shall provide notice at least 3 days in advance of any barge loading with project materials such that Project Representative or designee can be present.

F. Work outside of the scheduled work hours requires approval by the Project Representative 72 hours prior to the start of such work.

1. If the Contractor works unscheduled hours and/or if the Contractor has not obtained Project Representative's approval at least 72 hours prior to the start of unscheduled work, the contractor shall be liable for the costs of King County's overtime inspection at the rate of $107 for each hour for each person performing such inspection for the County.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01016

LABOR MANAGEMENT PLANPART 1 GENERAL

1.01 SUMMARY

A. This section specifies the requirement for submittal of a Labor Management Plan on Contracts with a Contract Price of one million dollars ($1,000,000) or more at time of Contract execution by King County.

1.02 CONTRACTOR RESPONSIBILITIES

A. The Contractor acknowledges that because this is a time of the essence contract, any work stoppage, strike, slow down, picket or other disruptive activity which impacts the timely and accurate completion of the Project may cause the County significant economic damage.

B. Contractor shall comply with the provisions set forth within Section 00700 - General Terms and Conditions, Article 10.6 - Notice to County of Labor Disputes.

1.03 LABOR MANAGEMENT SUBMITTALS

A. Contractor shall submit the following Labor Management Plan in accordance with Section 00700 - General Terms and Conditions, Article 4.4 - Submittals and Section 1300Submittal Procedures within 10 days following the Notice to Proceed with Work.

B. Provide a copy of the Contractor's collective bargaining agreements, if any, and their expiration dates.

C. Provide Contractor's labor relations history for both County and non-County projects of similar to types of work set forth in Contract Documents for this Project for the last five years. Include the following detail:

1. Name and dates of the project;
2. Description of the project.
3. Final cost of the construction contract for the project.
4. Description of any work stoppage, strike, picket, slow down or other labor disruption that occurred on the project, if any.
5. Description of impacts to contract price or schedule resulting from the labor disruption that occurred on the project, if any.
6. Description of the labor management methods used by the Contractor to prevent, mitigate or eliminate a labor disruption on the project.

D. Provide a description of any activities or events Contractor, or its Subcontractors, reasonably believe may cause a potential or actual work stoppage, strike, slow down or other labor disruption on the Project which may either (a) impact worker's performance at the Site or (b) impact the Contract Time or Contract Price for the Project.

E. Provide the plan(s) the Contractor and its Subcontractors will follow to prevent, mitigate or eliminate labor disruptions if they occur on the Project. Provide copies of any policies and procedures which support this plan(s).

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. This section includes a description of the requirements and procedures for measurement of Work performed, the documentation required to verify that amount of Work, and procedures for obtaining payment for the Work performed.

B. The Work, as described in the Construction Documents, for which payment will be made, is to be paid on a combination of Lump Sum, Unit Price for Materials and a Fully Loaded Daily (Shift) Rate as described in this section.

C. Complete costs for performing all work required by the Contract Documents are to be included in the bid items. No additional payment items will be considered.

1.02 BID MEASUREMENT AND PAYMENT

The Bidding Schedule is divided into numerous bid items whose definitions follow. Bid Item Numbers 1 through 5 represent the entire scope of work covered by the Contract Documents and shall contain all costs to perform the work.

A. **Bid Item 1: Lower Duwamish Waterway Pilot Project – LUMP SUM**

1. The lump sum bid price for "Lower Duwamish Waterway Pilot Project" shall include all work shown and specified in the Contract Documents except Bid Items 2, 3, 4 and 5.
2. Measurement shall be in accordance with a reasonable apportionment of the work as established in the Schedule of Values.
3. Payment will be based upon the percentage of completion for each item in the Schedule of Values.

B. **Bid Item 2: ENR Material Delivered to Site – Unit Price (Tons)**

1. This bid item is for all work necessary for acquiring, blending, loading into barge and transporting to Site the ENR materials (four types total - sand, sand mixed with Granular Activated Carbon, Gravelly Sand, and Gravelly Sand mixed with Granular Activated Carbon).
2. Measurement shall be by ton of material delivered to Site.
3. Estimated quantities of ENR Materials (sand, sand mixed with Granular Activated Carbon, Gravelly Sand, and Gravelly Sand mixed with Granular Activated Carbon) are provided in 00300 (the bid form).
4. Contractor shall not exceed base quantities of materials without written approval by the King County Project Representative.

C. **Bid Item 3: Placement Method Demonstration and Calibration – DAILY RATE (10 Hour Day)**

1. The lump sum bid price for "Placement Method Demonstration and Calibration" shall include all personnel, equipment and materials (except ENR Material) to successfully perform Placement Method Demonstration and Calibration as specified in the Contract Documents. ENR Material for use in performing Bid Item 3 is included in Bid Item 2.
2. Payment will be based upon each 10 hour day (shift if working 2 shifts per day) or portion thereof (prorated based on 10 hour day), as approved by the Project Representative. This may be for hours less than or greater than 10 hour per day. For example if work 9 hours receive 90% of 10 hour rate. If work 11 hours receive 110% of 10 hour rate. Contractors planned work hours shall be pre-approved by Project Representative.

3. All work associated with this item is described in Specification Section 02221, 3.02.
4. Additional days beyond base quantity on bid form may be required as directed by Project Representative and will be paid at Daily Rate on Bid Form for Bid Item 3.

D. **Bid Item 4: Placement of Material – DAILY RATE (10 Hour Day)**

A. This bid item is for fully burdened rates for all equipment and personnel necessary to properly, safely and efficiently perform the in water ENR material placement operations at the three plots.

B. This bid item is for all work days (shifts) after successful completion of Bid Item 3 Placement Method Demonstration and Calibration where the following conditions are all met, as determined by the Project Representative;

1. Contractor is actively and diligently performing the Work,
2. Contractor is performing Work in accordance with schedule approved by King County Project Representative,
3. Work is performed at the site,
4. All necessary equipment for safe and efficient material placement is onsite and in good operating condition (including navigation and positioning system),
5. Equipment is fully staffed for safe and proper operation,
6. In water placement of material is the focus of the day’s (shifts) activities. This includes work days (shifts) where no actual in water placement occurs but necessary preparation and support activities are effectively performed such as moving equipment from one Plot to another. This does not include days where only offsite work such as barge loading or similar is performed.

C. No payment for major equipment failure or Contractors inability to properly and efficiently perform the work due to equipment shortages or malfunction, crew shortages or improper project planning.

D. Payment will be based upon each 10 hour day (10 hour shift if working two shifts per day) or portion thereof (prorated based on 10 Hour Day) worked, this may be for hours less than or greater than 10 hours per day. For example if work 9 hours receive 90% of 10 hour rate. If work 11 hours receive 110% of 10 hour rate. Contractor shall not change or otherwise modify shift times from approved schedule without prior approval of Project Representative.

E. The estimated quantity of days (shifts) is provided in 00300 (the bid form).

E. **Bid Item 5: County Directed Standby DAILY RATE (10 Hour Day)**

A. This bid item is for King County directed project standby for days (shifts) when Contractor is not to perform any work for that shift. Contractor shall not be required to have project staffed on County directed standby shifts.

1. Measurement will be in shift (10 hour) increments.
2. Contractor shall be given notice of intended standby for upcoming shift no less than 12 hours in advance of typical shift start time.
3. Stand-by time does not include schedule impacts due to:
    a. Ongoing commercial activities at berth
    b. Tribal Fishing delays
    c. Adverse weather
    d. Equipment breakdown or damage

B. Payment for Stand-By will be made at the contract unit price per shift as stated in the Bid Form and shall constitute full compensation for all labor, materials, tools, and equipment necessary for stand-by period.

PART 2 MATERIALS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01050

SURVEY INFORMATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies survey work requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

1. Washington State requirements for Professional Land Surveying
2. NOAA Hydrographer Certification
3. USACE Hydrographic Surveying Manual (EM 1110-2-1003, 11/30/2013, US Army Corps of Engineers)

1.03 SUBMITTALS

A. Procedures: Specification Section 01300.

B. Qualifications of the hydrographic surveyor.

C. Description of proposed hydrographic survey system and all equipment and procedures to be used for data collection and data processing.

D. Hydrographic surveys as required.

a. Initial hydrographic multibeam survey prior to any material placement to show current condition and elevations of each sub plot or test placement area (pre-placement survey).

b. Daily hydrographic multibeam surveys to record progress and monitor placement thickness and coverage.

c. As-Built multi beam hydrographic survey of each sub plot. And test placement area.

1.04 SURVEY BY KING COUNTY

A. Hydrographic survey data showing pre-existing condition of each sub plot is shown on Plans included in the Contract Documents.

B. County will establish temporary control points in the vicinity of each plot in a relatively accessible area. This may be on the adjacent or nearby uplands or on a piling or other offshore structure. Approximate locations (subject to change) are shown on the Plans. It may be necessary to access points from uplands or from water depending upon final locations.

1.05 SURVEY BY CONTRACTOR

A. All hydrographic surveys shall be performed in accordance with USACE Hydrographic Survey Manual, EM 1110-2-1003, 11/30/2013. Appropriate equipment testing including bar tests (or similar) shall be performed before and after each survey.

B. The Contractor shall perform a multibeam hydrographic survey no more than 30 and not less than 3 days prior to starting the in water placement at each test placement area or sub plot to establish the pre-placement bathymetry of the test placement area or sub plot and to identify any significant changes (i.e. holes, slope changes, depth changes, additional structures) to pre-existing condition that may impact approach of construction.

C. Complete daily multibeam hydrographic surveys to monitor progress and placement thickness of material. Submit results of such surveys as plan view and cross sections showing comparison to pre-placement elevations to the King County Project Representative (KCPR) in pdf and electronic format (AutoCAD and XYZ point file) within 24 hours of performance. Contractor to include tabulated XY file of all locations where spuds were set (placed in contact with waterway bed) within the subplot.

D. Complete additional multi beam hydrographic surveys as requested by the Project Representative and as required for the Work.

E. Maintain and preserve all stakes and other marks established until authorized by the Project Representative to remove them. (Does not apply to break away grade stakes installed by County in sub plots for thickness monitoring).

F. Comply with the survey requirements for all monitoring as specified in other Specification Sections.

G. Provide new replacement monuments and boxes when removed or damaged during construction.

H. Re-establish all permanent survey control monuments prior to final inspection.

I. Surveys shall be performed and data processed to provide a minimum of 1 data point per square foot of surveyed area.

J. Complete as-built multibeam hydrographic surveys to document final elevations within sub plots and test placement areas. Perform field survey for as built within 3 days of request from King County Project Representative. Submit results of such surveys as plan view and cross sections showing comparison to pre-placement elevations to KCPR in pdf and electronic format (AutoCAD and XYZ point file) within 24 hours of performance.

K. Provide all requirements of the record drawings (as-builts) per Specification Section 01720.

1.06 SURVEYOR QUALIFICATIONS

A. Surveyor shall be a NOAA Certified hydrographic surveyor or a Professional Land Surveyor who is licensed in the state of Washington with demonstrated experience in multibeam hydrographic surveying.

B. The Project Representative reserves the right to disallow the person(s) selected by the Contractor for surveying if in the Project Representative's opinion the person is not qualified to do the work.

C. Project Representative may observe performance of hydrographic surveys at any time. Contractor shall make such access to survey vessel available as requested by the Project representative.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

3.01 GENERAL

A. Perform surveys based on control points as shown on the Drawings. Use surveys to establish elevation of sediment surface, mudline elevations at stake locations, and other reference and construction points.

B. Replaced monuments shall be set by a licensed surveyor, registered in the State of Washington.

C. All surveys shall be performed in conformance with USACE Hydrographic Survey Manual (EM 1110-2-1003, 11/30/2013, US Army Corps of Engineers).

D. Data shall be processed to a density no less than one data point per square foot for all multibeam hydrographic surveys.

E. Surveys shall cover a minimum of 30’ beyond subplots (unless prevented by obstructions), including the test placement plots and the potential excess material placement area as shown on the Plans.

F. Follow decontamination procedures should any equipment come into contact with sediment while performing survey.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01062

PERMITS, EASEMENTS, FEDERAL ENDANGERED SPECIES ACT AND RIGHT OF ENTRY AGREEMENTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies substantive compliance, right-of-entry agreement requirements, and other approvals.

1.02 PERMITS (SUBSTANTIVE COMPLIANCE)

A. This project is under the jurisdiction of the United States Environmental Protection Agency, Region 10, and the Washington Department of Ecology under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

1. Under CERCLA, the project is exempt from permitting requirements but must demonstrate substantive compliance with federal, state and local regulations.
2. The County has fulfilled substantive requirements for the following permits and approvals:
   a. USACE Section 408
   b. USACE Section 10 & 404 Permits
   c. Federal Endangered Species Act (ESA) Section 7 Consultation (BE)
   d. Section 401 Water Quality Memo (Date TBD)
   e. Washington State Coastal Zone Management Approval
   f. WDFW Hydraulic Project Approval
   g. City of Seattle Shoreline Substantial Development Permit
   h. City of Tukwila Shoreline Substantial Development Permit
3. Substantive compliance documents include the following:
   a. 401 Water Quality Memo (pending)
   b. 408 Navigation Memo (pending)
   c. US Fish and Wildlife Service ESA Section 7 Concurrence Letter
   d. National Oceanic and Atmospheric Administration ESA Section 7 Concurrence Letter

B. Copies of the substantive compliance documents obtained by the County are listed in 1.02 A 3 of this Section and included in Attachment A to this Section. Unless otherwise indicated, the terms, conditions and requirements of all substantive compliance documents listed in Part 1.02 A are requirements of this Contract and the Contractor shall be responsible for implementation of all terms and conditions.

C. In addition to the substantive compliance documentation obtained by the County and included in this Contract (if any), the Contractor shall obtain from the Authority Having Jurisdiction all other permits or documents required to perform the Contract Work. The Contractor shall obtain the needed approvals in accordance with Section 00700.

1.03 RIGHT-OF-ENTRY AGREEMENTS

A. The County has acquired the following easements and right-of-entry agreements:

1. Port of Seattle right-of-entry for in-water work.
2. WA State Department of Natural Resources right-of-entry for in-water work

3. LaFarge right-of-entry for survey control.
4. AshGrove right-of-entry for survey control (pending).

B. Copies of the right-of-entry agreements obtained by the County are included in Attachment B to this Section. Unless otherwise indicated, the terms, conditions and requirement of all easements and right-of-entry agreements included in Attachment B are requirements of this Contract and the Contractor shall comply with the terms, conditions and requirements contained in each easement and right of entry agreement.

C. The Contractor must include in the Baseline Schedule (as required in Section 01311) a dedicated activity for the Contractor to obtain each of the easements and/or right-of-entry agreements required to perform the Contract Work.

D. The County will provided to the Contractor the following right-of-entry agreements after execution of the Contract. The Contractor shall comply with the requirements of each easement. For the purposes of bidding the Contract shall assume the following requirements for each easement and/or right-of-entry agreement.

1. Right of entries for upland property access for survey control (pending)

1.04 PERMITS, EASEMENTS AND RIGHT-OF-ENTRY AGREEMENTS OBTAINED BY CONTRACTOR

A. Prepare and submit to the proper authority or owner all information required for access onto the following properties:

1. Notification of in-water work at barging facilities

B. Obtain from the Authority Having Jurisdiction all other easements and/or right-of-entry agreements required to perform the Contract Work.

1. Haul routes
2. Upland property access including docks (except for survey work as listed in G below).

C. Provide a copy of substantive requirements, easement and right of entry agreement to the Project Representative prior to pursuing any Work covered by the permit or easement.

D. When required, the Work shall be inspected as required by the issuing owner or agency (this is the owner or agency that issued the specific Permit, Easement or Right of Entry Agreement).

E. Provide a copy of the approval with the issuing agency acceptance or easement owner release.

F. Include in the Baseline Schedule the time to prepare, submit and obtain all Contractor obtained approvals, easements and right-of-entry agreements.

1.05 SUBMITTALS

A. Procedures: Specification Section 01300.

B. Substantive requirements, easements and right-of-entry agreements obtained by the Contractor.

C. All substantive requirements, easement or right-of-entry agreement compliance reports.

D. Contractor obtained approvals when work is complete.

1.06 CONSTRUCTION RESTORATION ACCEPTANCE FORM

A. Whenever Work is performed on property other than street right of way, provide a written easement restoration acceptance form from the easement grantor or easement grantors agent for each property, parcel, or area certifying that the restoration of structures and/or surfaces has been completed to the satisfaction of the property owner, and that the owner has no claims for damages on account of such restoration.

B. The easement restoration acceptance shall comply with the requirements as set forth in the form provided by the Project Representative. If, in the opinion of the Project Representative, the release is unreasonably withheld by the easement owner, the County may, at its sole discretion, not require the easement restoration acceptance to be completed.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

Specification Section 01062

Attachment A

Substantive Compliance

THIS PAGE LEFT INTENTIONALLY BLANK.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

JUL 23 2015

In Reply Refer To:
01EWFW00-2015-I-0752

Allison Hiltner, Remedial Project Manager
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, Suite 900
Seattle, Washington 98101-3140

Dear Ms. Hilter:

Subject: Lower Duwamish Enhanced Natural Recovery/Activated Carbon Pilot

This letter is in response to your June 24, 2015, request for our concurrence with your determination that the proposed action in the Lower Duwamish Waterway (LDW), King County, Washington, "may affect, but is not likely to adversely affect" federally listed species. We received your letter and Draft Biological Evaluation, providing information in support of "may affect, not likely to adversely affect" determinations, on July 6, 2015.

As required by the Environmental Protection Agency, the Lower Duwamish Waterway Group (LDWG) proposes to conduct a pilot study of using enhanced natural recovery (ENR) material amended with activated carbon (AC) to reduce the bioavailability of polychlorinated biphenyls (PCBs) in the LDW. The proposed action entails placing an average of 9 inches of ENR material, with and without AC over the existing sediment in three 1-acre plots using a barge-mounted fixed-arm excavator with a clamshell bucket for submerged placement of the material. In-water construction will take place over 2 to 4 weeks during the in-water work window between October 1, 2016 and February 15, 2017. Ongoing monitoring of the action includes collection of surficial sediment samples, sediment profile imaging, and using passive water quality stations.

Specifically, you requested informal consultation pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) for the federally listed species and critical habitat identified below.

- Bull trout (*Salvelinus confluentus*)

- Bull trout critical habitat

We believe that sufficient information has been provided to determine the effects of the proposed action and to conclude whether it would adversely affect federally listed species and/or designated critical habitat. Our concurrence is based on information provided by the action agency, best available science, and complete and successful implementation of agreed-upon conservation measures.

EFFECTS TO BULL TROUT

Effects and Disturbance

Temporary and/or long-term effects from the action are not expected to measurably disrupt normal bull trout behaviors (i.e., the ability to successfully feed, move, and/or shelter), and are therefore considered insignificant and/or discountable:

- The action is located in Green/Duwamish River below Tacoma's Headworks Diversion Dam where, at present, bull trout occurrence is rare or unlikely.
- The action will occur during the recommended in-water work window (October 1 to February 15), when bull trout are least likely to be present in the project area.
- The action will result in temporary impacts to water quality, including potential temporary increases in elevated levels of turbidity and chemicals. These effects will be intermittent and limited in physical extent and duration.

Effects to Bull Trout Habitat and Prey Sources

With successful implementation of the agreed-upon conservation measures, we expect that temporary impacts from the action will not measurably degrade or diminish habitat functions or prey resources in the action area, and effects are therefore considered insignificant and/or discountable:

- Construction methods and proposed permanent features may impact habitat that supports bull trout and/or their prey sources. These impacts will be limited in physical extent and/or duration, and will not measurably degrade habitat functions, including prey resources, that are important to bull trout within the action area:
    - The action will result in limited temporary and/or permanent impacts to native substrates, aquatic vegetation, the benthic invertebrate community, and complexity of instream or marine nearshore habitat. However, the action includes conservation measures, and/or a restoration component, which at least partially offset the action's unavoidable impacts to bull trout habitat and/or prey resources.
    - Sediment cleanup activities may result in periodic and/or temporary impacts to water quality through elevated levels of turbidity, and chemicals (e.g. activated carbon); however, these effects will be intermittent and of short duration.
    - This is a pilot study and active cleanup site.

EFFECTS TO BULL TROUT CRITICAL HABITAT

The final revised rule designating bull trout critical habitat (75 FR 63898 [October 18, 2010]) identifies nine Primary Constituent Elements (PCEs) essential for the conservation of the species. The proposed action may affect the PCEs listed below; however, effects to these PCEs are not expected measurably affect them and are therefore considered insignificant or discountable:

PCE 1: *Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.*

- The action will have no effect on this PCE.

PCE 2: *Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.*

- The action may temporarily introduce an impediment or barrier within migration habitat; however, it will not preclude bull trout movement through the area, either during or after construction, and any effects will be temporary. The migration habitat will not be permanently altered, destroyed, or degraded.

PCE 3: *An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.*

- The action may temporarily reduce the food base via a small reduction of prey resources, degradation of aquatic habitat, and/or removal or alteration of riparian vegetation. However, the impacts will be temporary and/or components of the project design will avoid, reduce, or compensate for them.

PCE 4: *Complex river, stream, lake, reservoir, and marine shoreline aquatic environments, and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.*

- The project will result in temporary impacts to substrates, but will not alter habitat complexity in the project area.

PCE 5: *Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.*

- The action will have no effect on this PCE.

PCE 7: *A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.*

- The action will have no effect on this PCE.

PCE 8: *Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.*

- The action may impact water quantity and/or quality. However, the effects will be temporary; components of the project design include actions to avoid, reduce, or compensate for the effects from the impacts; and/or we would be unable to meaningfully measure, detect, or evaluate the effects.

Conclusion

This concludes consultation pursuant to the regulations implementing the Endangered Species Act (50 CFR 402.13). Our review and concurrence with your effect determination is based on the implementation of the project as described. It is the responsibility of the Federal action agency to ensure that projects that they authorize or carry out are in compliance with the regulatory permit and/or the Endangered Species Act, respectively. If a permittee or the Federal action agency deviates from the measures outlined in a permit or project description, the Federal action agency has the obligation to reinitiate consultation and comply with section 7(d).

This project should be re-analyzed and re-initiation may be necessary if 1) new information reveals effects of the action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation, 2) if the action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, and/or 3) a new species is listed or critical habitat is designated that may be affected by this project.

This letter and its enclosures constitute a complete response by the U.S. Fish and Wildlife Service to your request for informal consultation. A complete record of this consultation is on file at the Washington Fish and Wildlife Office, in Lacey, Washington. If you have any questions about this letter or our joint responsibilities under the Endangered Species Act, please contact the consulting biologist identified below.

U.S. Fish and Wildlife Service Consultation Biologist:
Lee Corum (360-753-5835)

Sincerely,

Martha L. Jensen

for Eric V. Rickerson, State Supervisor
Washington Fish and Wildlife Office

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, Washington 98115

Refer to NMFS No:
WCR-2015-2949

July 9, 2015

Dennis McLerran
Regional Administrator
United State Environmental Protection Agency
Region 10
1200 Sixth Avenue, Ste 900
Seattle, WA 98101-3140

Attn: Allison Hiltner

Re: Endangered Species Act Section 7 Informal Consultation for conducting a Lower Duwamish Waterway Enhanced Natural Recovery/Activated Carbon Pilot Study in the Lower Duwamish Waterway in Seattle, King County, Washington (6th Field HUC 171100190203 and 171100130305, Lat: 47.569, Long: -122.346; Lat: 47.553, Long: -122.342; and Lat 47.523, Long: -122.307).

Dear Mr. McLerran:

On June 26, 2015, the National Marine Fisheries Service (NMFS) received your request for a written concurrence that the US Environmental Protection Agency (EPA) proposed action to perform a pilot study on capping for enhanced natural recover and activated carbon for the containment of contaminants in the Lower Duwamish Waterway is not likely to adversely affect (NLAA) species listed as threatened or endangered or critical habitats designated under the Endangered Species Act (ESA). The EPA is conducting the project under the authority and responsibility granted by a 2014 amended Administrative Order on Consent under the Comprehensive Environmental Response, Compensation, and Liability Act. This response to your request was prepared by NMFS pursuant section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402, and agency guidance for preparation of letters of concurrence.[1]

NMFS also reviewed the proposed action for potential effects on essential fish habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including conservation measures and any determination that you made regarding the potential effects of the action. This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to

[1] Memorandum from D. Robert Lohn, Regional Administrator, to ESA consultation biologists (guidance on informal consultation and preparation of letters of concurrence) (January 30, 2006).

complete EFH consultation.[2] The EPA did not request EFH consultation, and NMFS determined that the proposed action would have no adverse effect on EFH, and therefore is not conducting an MSA/EFH consultation at this time.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal year 2001, Public Law 106-554). A complete record of this consultation is on file at Oregon-Washington Coastal Office in Lacey, Washington.

Proposed Actions and the Action Areas

The EPA, in partnership with the Lower Duwamish Waterway Group is proposing to conduct a pilot study in the Lower Duwamish Waterway to test the comparative efficacy of enhanced natural recovery (ENR) caps and the use of activated carbon plus enhanced natural recovery (ENR+AC) caps for isolating contaminants in the substrate at sites contaminated with polychlorinated biphenyls (PCBs) and other materials. The study will consist of three pairs of plots located in three separate areas of the Lower Duwamish Waterway: intertidal, subtidal, and scour plots. Each plot is approximately ½ acre in size, for a total of 3 acres of test area. All plots will use ENR materials consisting of a gravel sand mixture (100 percent grain size less than 1.5 inches, and approximately 50 percent sand). One of the two plots at each location will also contain granular activated carbon at a concentration of 1 to 3 percent. ENR and ENR+AC materials will be placed by a barge mounted fixed-arm excavator with a clamshell bucket, which will release materials within a few feet of the substrate to minimize suspension of sediments and loss of activated carbon. The thickness of the ENR and ENR+AC will be a minimum of 6 inches, with an average thickness of 9 inches. Work will be conducted between October 1 and February 15 of the 2016-2017 work window to avoid periods when listed salmonids are likely to be present, and is expected to take 2 – 4 weeks to complete. The study plots will be tested with sediment and water sampling before and after cap placement activities to test the chemical, physical, and biological properties and any changes resulting from the study which will be reported to the EPA and Washington Department of Ecology. The project will use all best management practices as described in the BE, and no dredging will occur for this proposed action.

There are no interrelated or interdependent actions associated with this proposed action.

The proposed action is located at three separate sites along the Lower Duwamish Waterway in Seattle, King County, Washington (Scour Plot: 6th Field HUC 171100190203, Lat: 47.569, Long: -122.346, Subtidal and Intertidal Plots: 6th Field HUC 171100130305, Lat: 47.553, Long: -122.342 and Lat 47.523, Long: -122.307). The action area is determined by the greatest effects stemming from the project, in this case increased suspended sediments from ENR and ENR+AC placement. Increased sediments may extend downstream up to 500 feet from the project

[2] Memorandum from William T. Hogarth, Acting Administrator for Fisheries, to Regional Administrators (national finding for use of Endangered Species Act section 7 consultation process to complete essential fish habitat consultations) (February 28, 2001).

locations for a total action area of approximately 10 acres of estuarine waters. There is no documented forage fish spawning or submerged aquatic vegetation in the action area.

Consultation History

The EPA gave Biological Evaluations (BE) and MFS to NMFS for the project referenced above on June 26, 2015, with enough information to initiate informal consultation on that date. The EPA requested concurrence with the determinations of "may affect, not like to adversely affect" for Puget Sound Chinook salmon and PS steelhead trout, or designated critical habitat for PS Chinook salmon. A complete record of this consultation is on file at the Oregon and Washington Coastal Area Office in Lacey, Washington.

Table 1: Species considered in this consultation.

Species	Status	Listing	Date	Critical Habitat Designation	Date
Puget Sound Chinook	Threatened	64 FR 14308	3/24/1999	70 FR 52630	9/2/2005
Puget Sound Steelhead	Threatened	72 FR 26722	6/11/2007	Proposed (78 FR 2725)	1/14/2013

ENDANGERED SPECIES ACT

Effects of the Action

For purposes of the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is NLAA listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial.[3] Beneficial effects are contemporaneous positive effects without any adverse effects to the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

The action area is estuarine habitat for salmonids. However, based on life-history studies for salmonids summarized in the Regional Nearshore and Marine Aspects of Salmon Recovery in Puget Sound (2005) and related documents, we believe PS Chinook salmon and PS steelhead trout are very unlikely to be in the action area concurrent with capping activities. For listed salmonids, the work window (October 1 to February 15) avoids periods when salmonids are likely to be in the action area. Salmon grow rapidly in their first several months of life and emigrate towards the ocean (ocean type Chinook) or rear in riverine habitat and leave the watershed as subadults (stream type Chinook and steelhead). In either case, juvenile salmonids are generally not present in estuarine habitat during the work window for the proposed action. Additionally, the action area is a highly developed industrial waterway with low quality habitat and few habitat features that would support rearing, making juvenile salmonid presence even less likely. The work window also avoids periods when listed adult Chinook salmon and steelhead trout return to the river as adults.

[3] U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Act Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences. March, 1998. Final. p. 3-12.

The effects of the action are reasonably likely to include: increased suspended sediments from ENR and ENR+AC placement, disturbance to the benthic community from placement of capping materials, and water quality improvement from isolation of contaminated sediment from the water column.

For ESA listed species, the primary potential for, at most, minor effects is through increased suspended sediments. The project will result in increases in suspended sediments when placing ENR and ENR+AC materials over the 2 – 4 weeks that capping will occur. However, because the capping material will consist almost entirely of gravels and sands, the increases in suspended sediments will be localized and rapidly settle out of the water column, and will not occur for sufficient duration and at increased suspended levels as to pose a risk of injury to listed species. Activated carbon at low levels in the capped material is believed inert for bitoa.

Based on the above information, and the information contained in the BE provided by the EPA, the potential for effects on listed fishes is discountable.

The action area for the proposed action contains estuarine critical habitat for PS Chinook salmon. Water quality will be slightly affected by increased suspended sediment during ENR and ENR+AC placement activities, and those changes will occur for up to a four week period. However, suspended sediment is not expected to rise to levels that significantly reduce opportunity for forage, growth, and maturation for ESA-listed species: sediment levels are expected to return to background within a few hours of activities ceasing. The proposed study will also impact the benthic community, causing a temporary decrease in abundance of benthic organisms from burial. Many benthic organisms will be able to survive burial of 9 inches of material, and the activated carbon is expected to have no effect on organisms. The benthic community is expected to rapidly recover (Dernie et al. 2002), and will have no impact on prey availability or forage opportunities for PS Chinook salmon. The proposed action will also improve water quality through isolating contaminants in the sediment, and will reduce the accumulation of those contaminants in the food chain that would have the potential to impact listed species through food web linkages. There is no submerged aquatic vegetation at the project locations that will be affected by the proposed action. Thus, there will be minimal if any impact on the function of the primary constituent elements for salmon critical habitat, and the potential for effects on critical habitat function is insignificant.

Conclusion

Based on the above analysis, NMFS concludes that all potential effects of the proposed action are discountable or insignificant, and concurs with the EPA that proposed pilot study is not likely to adversely affect the subject ESA listed species or designated critical habitat.

Reinitiation of Consultation

Reinitiation of consultation is required and shall be requested by the Federal agency, or by NMFS, where discretionary Federal involvement or control over the action has been retained or is authorized by law and (1) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (2) the identified action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this concurrence letter; or if (3) a new species is listed or critical habitat designated that may be affected by the identified action (50 CFR 402.16). This concludes the ESA portion of this consultation.

This concludes consultation under the ESA. If you have questions concerning these consultations, please contact Zach Hughes of the Oregon and Washington Coastal Office at 360-753-6052, or by e-mail at zach.hughes@noaa.gov.

Sincerely,

for

William W. Stelle, Jr.
Regional Administrator

cc: Allison Hiltner, Environmental Protection Agency
Hiltner.Allison@epa.gov

References

Dernie, K.M.., M.J. Kaiser, E.A. Richardson, and R.M. Warwick. 2003. Recovery of Soft Sediment Communities and Habitats Following Physical Disturbance. Journal of Experimental Marine Biology and Ecology. 286: 415-434

Puget Sound Action Team. 2005. Regional Nearshore and Marine Aspects of Salmon Recovery in Puget Sound. Puget Sound Action Team. 246pp.

Specification Section 01062

Attachment B

Right-of-Entry Agreements

THIS PAGE LEFT INTENTIONALLY BLANK.

P.O. Box 1209
Seattle, WA 98111-1209

Tel: (206) 787-3000
Fax: (206) 787-3381

www.portseattle.org

Port of Seattle

March 10, 2015

Pamela Erstad
King County Water Quality Planner/Program Manager IV
Regulatory Compliance & Land Acquisition Services
Wastewater Treatment Division
201 South Jackson Street, Suite 505
Seattle, WA 98104-3855

Dear Ms. Erstad,

This letter is in response to King County's request for access authorization for submerged land in the Lower Duwamish Waterway (the "LDW) for the purpose of work required for an Enhanced Natural Recovery-Activated Carbon Pilot Study (the "Study").

The Study is being carried out by the Port of Seattle, City of Seattle, King County and the Boeing Company (collectively, the Lower Duwamish Waterway Group, or "LDWG") pursuant to an amendment to the U.S. Environmental Protection Agency and Washington Department of Ecology Administrative Order on Consent for the LDW Remedial Investigation/Feasibility Study (Second Amendment to CERCLA Docket No. 10-2001-0055). The Study will evaluate the effect of applying activated carbon to *in situ* contaminated sediments in plots at three LDW locations. King County is the contracting agent for the LDWG parties and is responsible for securing access on behalf of the contractor that will be performing the field work for the Study.

Ownership interests in the LDW property on which the Study will take place are unclear due to a variety of factors and the Port may, in fact, have no such interests for the Study plot locations. However, to the extent the Port has ownership interests in the submerged land at the three locations in the LDW where the Study will occur, the Port authorizes access and use of the submerged lands at those locations for all LDWG parties, including King County and its contractor to carry out the Study.

Sincerely,

Joe McWilliams
Managing Director, Real Estate Director

cc: Brian Anderson, The Boeing Company
Allison Crowely, Seattle City Light
Dave Schuchardt, Seattle Public Utilities
Jeff Stern, King County

April 27, 2015

Pamela Erstad, Program Manager
Regulatory Compliance & Land Acquisition Services
Wastewater Treatment Division
201 South Jackson Street, Suite 505
Seattle Washington 98104-3855

Dear Ms. Erstad:

I am writing in response to the County's request for access authorization for submerged land in the Lower Duwamish Waterway (the "LDW") for the purpose of work required for an Enhanced Natural Recovery-Activated Carbon Pilot Study (the "Study"). The Study is being carried out by the Port of Seattle, City of Seattle, King County and the Boeing Company (collectively, the Lower Duwamish Waterway Group, or "LDWG") pursuant to an amendment to the U.S. Environmental Protection Agency and Washington Department of Ecology Administrative Order on Consent for the LDW Remedial Investigation/Feasibility Study (Second Amendment to CERCLA Docket No. 10-2001-0055). The Study will evaluate the effect of applying activated carbon to *in situ* contaminated sediments in plots at three LDW locations. The County is the contracting agent for the LDWG parties and is responsible for securing access on behalf of the contractor that will be performing the field work for the Study.

Ownership interests in property on which the Study will take place are unclear due to a complex historical record and conflicting documentation. To the extent the State has ownership interests in the submerged land at the three locations in the LDW where the Study will take place, the Department of Natural Resources authorizes access and use of the submerged lands at those locations for all LDWG parties, including King County and its contractor, to carry out the Study.

Sincerely,

Kristin Swenddal, Manager
Aquatic Resources Division

RIGHT OF ENTRY AGREEMENT

Property Owner: Lafarge Corp.
Parcel Number: 192404-9003
Property Address: 5400 WEST MARGINAL WAY SW 98106

The undersigned property owner(s) or representative(s), hereinafter called the "Grantor", hereby grants a right of entry to King County, including its employees, contractors, consultants, invitees, and assigns to:

1. Survey in, and set a control point on or near dock face (Exhibit A.)
Access a control point as necessary to calibrate equipment operating within the Duwamish Waterway for the proposed Enhanced Natural Recovery/Activated Carbon Pilot Study. It is anticipated that such control point will need to be accessed daily for an approximate 2 week period during December 1, 2016 thru February 15, 2017. Access to the temporary control point may be needed from land or water approach.

This work shall be administered by King County and is subject to the following conditions:

1. This Right of Entry shall be in effect beginning October 1, 2016 and ending no later than February 15, 2017. King County shall provide at least 48 hours' notice (by email or phone call to Grantor's designee) prior to accessing the Property. Unless the term of this Right of Entry is extended by the parties hereto, this Right of Entry shall automatically terminate at the end of the period stated above without further action by the Grantor or King County.

2. If work activities require installing temporary control points, King County shall restore the surface of property disturbed by King County in installing the temporary control points as nearly as possible to the condition in which it existed at the commencement of this Right of Entry Agreement or leave such control point in place as set if approved by Owner.

3. Access to the site shall be in accordance with Lafarge policy and Lafarge safety training. All King County representatives must complete the Lafarge Safety Orientation Computer Based Training and complete a site walk through. All King County representatives must check in with the assigned Lafarge Contractor Coordinators prior to entering the property and when leaving for each visit. The assigned Lafarge Contractor Coordinators are: 1. Mike Depew (206) 380-7601; 2. Coy McElderry (206) 730-5199; 3. Jonathan Hall (206) 661-8240. The King County representatives must park in the designated area, and sign in on the contractor sign-in sheet.

4. King County agrees to defend, save and hold harmless Grantor from all claims, actions, costs, damages or expense of any nature whatsoever (including reasonable attorneys' fees and costs) for injuries, sickness or death of persons, or any damage to property caused by the negligent acts or omissions of King County, its agents or employees, in it is use of this Right of Entry. This obligation does not include such claims, actions, costs, damages or expenses which may be caused by the sole negligence of the Grantor and provided further that if the claims, actions, costs, damages or expenses are caused by or result from the concurrent negligence of (a) the Grantor and/or its agents or employees and (b) King County, its agents or employees, or involves those actions covered by RCW 4.24.115, then this defense and hold harmless provision shall be valid and enforceable only to the extent of the negligence of the King County, its employees, contractors, consultants, invitees, or assigns .

Dated this 17 day of Nov, 2015

ACCEPTED AND APPROVED:

Grantor (Lafarge Corp.):
Signature: Jonathan D Hall

King County:
Signature: Pamela Ed

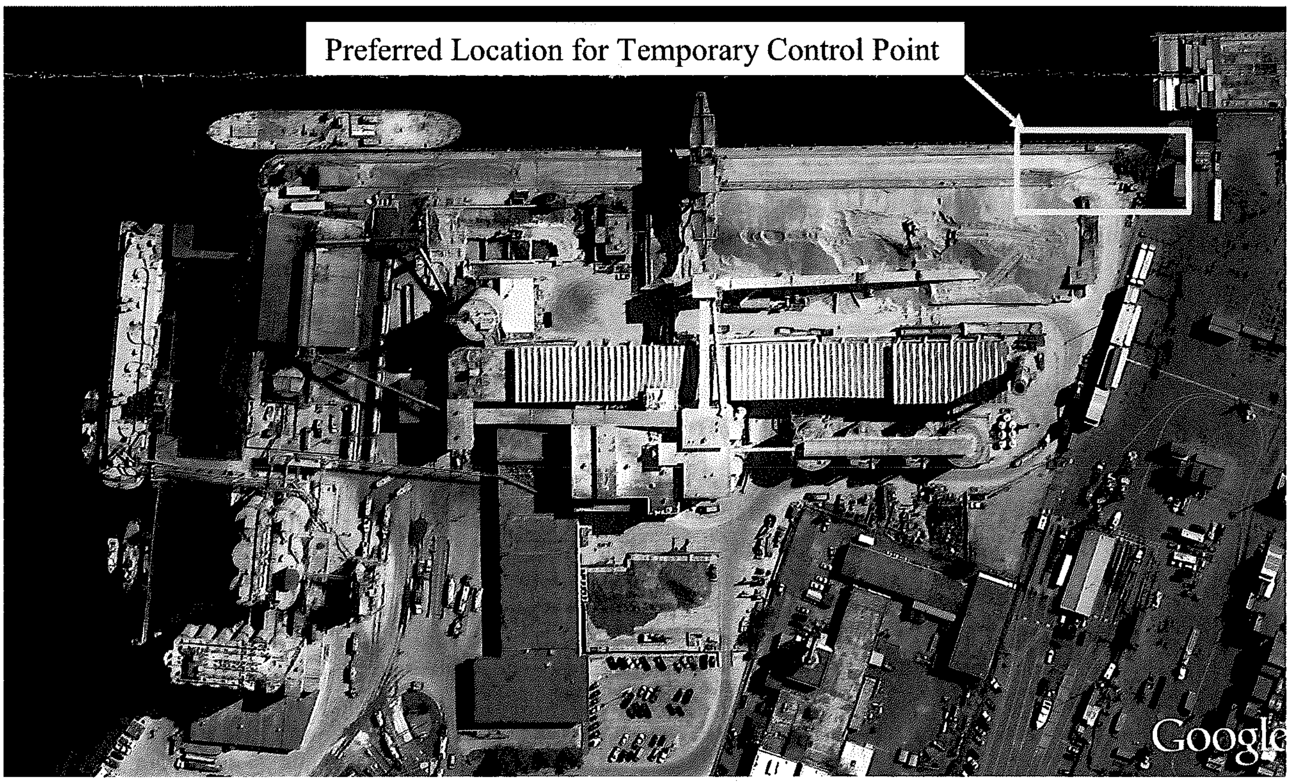
Printed Name: Jonathan Hall

Its: Operations Manager

Printed Name: Pamela Elsted

Its: Water Quality Planner / Program Manager

Exhibit A.



Specification Section 01062

Attachment C

Construction Restoration Acceptance Form

01062-A CONSTRUCTION RESTORATION ACCEPTANCE FORM

CONSTRUCTION CONTRACT NO. C________C

EASEMENT NAME ____

(Easement Name as identified in the Contract Documents)

EASEMENT GRANTOR: ____

EASEMENT AUTHORIZED REPRESENTATIVE: ______________________________

DATE CONTRACTOR ON SITE: ______________________

DATE CONTRACTOR OFF SITE: ______________________

<u>EASEMENT REPRESENTATIVE'S APPROVAL OF RESTORATION</u>

I/We, the undersigned Owner(s) or Representatives of property identified as

____

(Address or Property Description)

____

____

accept as complete the restoration work pursuant to the Easement requirements.

BY REPRESENTATIVE: ______________________________ DATE ____________

BY REPRESENTATIVE: ______________________________ DATE ____________

CONTRACTOR SGINATURE:______________________________ DATE:_________

SECTION 01063

HEALTH AND SAFETY

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies procedures for complying with applicable laws and regulations related to worker safety and health. Adhere to applicable federal, state and local safety and health standards

B. It is not the intent of the County to develop, manage, direct, and administer the safety and health programs of contractors or in any way assume the responsibility for the safety and health of their employees.

C. It is not the intent of King County to list and identify applicable safety codes, standards, and regulations requiring compliance by contractor and subcontractor groups. Contractor shall be solely responsible for identifying and determining all safety codes, standards, and regulations that are applicable to the work.

D. This Section addresses the Accident Prevention Program (APP) required in Chapter 296-800 WAC.

E. This Section describes the requirements for submittal of the Contractor's Site Specific Health and Safety Plan (HASP). A HASP is a supplement to a Contractor’s APP, however, it need not duplicate material in the APP. The HASP identifies all real and potential hazards during each phase of execution of the Work and provides a specific plan to deal with each hazard. Essentially, a HASP is a Job Hazard Analysis (JHA) of the entire project. A JHA is sometimes referred to as Job Safety Analysis (JSA) or Activity Hazard Analysis (AHA). The HASP shall clearly define responsibilities for Contractor and subcontractor employees per Chapter 296-155 WAC and WRD 27.00.

1.02 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
29 CFR 1910.146	Permit Required Confined Spaces
29 CFR 1910.147	Control of Hazardous Energy (lockout/tagout)
29 CFR 1926	Safety and Health Regulations for Construction (OSHA)
Chapter 49.17 RCW	Washington Industrial Safety and Health Act (WISHA)
Chapter 296-24 WAC	DOSH / WISHA General Safety and Health Standards
Chapter 296-37 WAC	DOSH / WISHA Safety Standards for Commercial Diving
Chapter 296-843 WAC	DOSH / WISHA Hazardous Waste Operations (HAZWOPER)
Chapter 296-155 WAC	DOSH / WISHA Construction Safety
Chapter 296-800 WAC	DOSH / WISHA Safety and Health Core Rules
Chapter 296-803 WAC	DOSH / WISHA Lockout Tagout (Hazardous Energy Control)
Chapter 296-809 WAC	DOSH / WISHA Permit Required Confined Spaces
WRD 27.00	DOSH / WISHA Regional Directive
RCW 39.04.180	Trench Safety Systems, Safety Systems Required

B. Qualifications:

1. Site Health and Safety Officer:

a. Possess a minimum of five years progressive safety experience in the field of in-water safety and demonstrate work experience on projects similar in nature to the work to be done on this Contract.

b. Be knowledgeable concerning all Federal and State regulations applicable to safety.

c. Completed the OSHA 40-hour Safety and Health Course (OSHA 500).

d. Possess competent person certification in construction safety disciplines related to the work to be performed and be able to identify competent persons required by State and Federal safety standards for which they are not certified.

e. Training and current certification for CPR and First Aid.

f. Possess training and be capable of performing accident investigations and developing a concise report.

g. Possess training in the development and presentation of safety training meetings.

2. Shift Safety Officers:

a. Possess a minimum of three years progressive safety experience in the field of in-water safety and demonstrate work experience on projects similar in nature to the work to be done on this Contract.

b. Be knowledgeable concerning all Federal and State regulations applicable to safety.

c. Completed the OSHA 10-hour Safety and Health Course.

d. Possess competent person certification in construction safety disciplines related to the work to be performed and be able to identify competent persons required by State and Federal safety standards for which they are not certified.

e. Trained in and possess current certification for CPR and First Aid.

3. Although not required, the following qualifications may be considered as contributing to the relevant experience required.

a. Certified Safety Professional (CSP) certification from the American Society of Safety Engineers.

b. Degree from an institution of higher learning in Occupational Safety and Health.

c. ASSE Certified Safety Technician (CST).

d. Qualification as an instructor in CPR/First Aid or the OSHA 30 hour program.

C. Work shall meet the requirements of:

1. 29 CFR 1926

2. Chapter 49.17 RCW

1.03 SUBMITTALS

A. Procedures: Specification Section 01300.

B. Qualifications.

C. Company Accident Prevention Plan (APP):

1. Update to reflect responses to Specification Section 00440 review comments in the bid evaluation.

2. Submit within five days of the effective date of the NTP.

3. Submit revisions during the execution of the work.

D. Site Specific Health and Safety Plan (HASP):

1. Submit specific to the scope of work prior to starting the related work.

2. Revised HASP that addresses changes in the Work.

E. Accident/Incident Report(s): provide within 24 hours.

F. Minutes and list of attendees of the pre-job safety meeting: provide within three days of the meeting.

G. Minutes and list of attendees of weekly safety tailgate meeting: provide within three days of the meeting.

H. Monthly Contractor Injury Summary Report: provide each month on Form 01063-A within ten days of the end of each month.

I. Weekly summary of the daily site safety walk-through

J. Notice and listing of flammable liquids and liquefied petroleum gases when they are planned to be used on the Site.

1.04 SITE SPECIFIC HEALTH AND SAFETY PLAN (HASP)

A. A comprehensive HASP covers all aspects of the Contractor's work activities related specifically and distinctly to the Work and site conditions. The HASP shall be based on a site specific hazard analysis and shall explain how the APP elements and site specific safety procedures shall be applied to the identified hazards in the work.

B. At a minimum, provide the HASP detailing the safe work procedures and the safety preventive measures to be taken to provide an appropriate work environment for its employees, as well as County staff on site.

C. The HASP shall be descriptive in nature, to provide the appropriate level of understanding for the potential hazards associated with the work to be performed at all stages and phases.

D. The HASP shall provide an appropriate work environment for all persons on Site including Contractor and subcontractor employees, County staff, and authorized individuals.

E. The HASP shall address all necessary personal protective equipment (PPE), atmospheric/air monitoring, safety equipment and tools, safety planning and coordination necessary to perform work safely.

F. During the work, update as an addendum to the HASP, changes in conditions or scope of work before continuing work.

G. Before beginning the work addressed in the HASP, meet the requirements of Specification Section 01300 that indicate a marking of a “1” or a “2”.

H. HASP organization:

1. Organized and bound to readily accept revisions and additions.

2. Outline form.

3. Table of contents.

4. Numbered pages.

I. Contractor and subcontractors are encouraged to use the consulting services of the State of Washington's Department of Labor and Industries (WISHA). The Seattle Field Office is located at:
315 5th Avenue South, Suite 200
Seattle, WA 98104-2607
(206) 515-2800
http://www.lni.wa.gov/wisha/
Call or write for assistance with the requirements of this Section.

1.05 CONTRACTOR SAFETY QUALITY ASSURANCE

A. Review the entire scope of work and applicable Contract requirements.

B. Inspect the work site location and adjacent structures and systems to ensure that all safety considerations and requirements are addressed and planned prior to the start of work in the site specific HASP.

C. Ensure that all Contractor and subcontractor employees comply with the APP and HASP.

D. Designate a Site Health and Safety Officer on site with appropriate training, responsibility, and full authority to coordinate, implement, and enforce the Contractor's APP and HASP for the duration of the Work.

E. In the APP and HASP, provide the name and telephone number of the Site Health and Safety Officer and the resume reflecting experience and training for the position. If there will be an alternate or additional staff with safety responsibilities, provide name and telephone number and qualifications in the APP and HASP.

F. Ensure that safe work principles and practices are followed in completing work tasks.

G. Document a daily site safety walk-through noting observations and corrective actions.

H. If the Health and Safety Officer is to be changed during the Contract, submit Qualifications per this Section of the proposed officer prior to implementation on the Contract.

I. Be responsible to correct hazardous conditions and practices. When more than one contractor is working within a given area, identify which personnel have the authority to take action to prevent physical harm and property damage.

1.06 HASP CONTENT

A. The following describes certain minimum precautions for consideration in developing a HASP. Include in the HASP all of the items which may apply to the work. There may be other items not indicated below which shall be addressed in the HASP. The items indicated below do not cover every possible situation or hazard. Items that are not needed shall be noted in the HASP as not applicable (N/A).

B. Hazardous Waste Operations (Chapter 296-843 WAC)

1. Specific Safety Plan Requirements apply to Hazardous Waste Clean-up Operations and Projects designated as Superfund sites on the Environmental Protection Agency’s (EPA) National Priority List (NPL) and State Priority Lists for sites covered under the Model Toxics Control Act (MTCA).

2. Provide a written program detailing how Contractor, Consultant and County staff on the site will be protected from the dangers of work associated with Hazardous Waste Site Operations. At a minimum, the program shall include at least the following;

a. Hazard analysis:

i. Identification and evaluation of on-site safety and health hazards.

ii. A safety and health risk (hazard) analysis for each site task and operation that is identified in the comprehensive work plan.

b. Organization chart:

i. An organizational structure that reflects current site operations, including the following:

- Establish and identify the chain of command.
- Identify the site safety and health supervisor and other personnel responsible for employee safety and health.
- Specify the overall responsibilities of supervisors and employees.

- Include the name and title of the person with responsibility and authority to direct all hazardous waste operations.
- Include a site safety and health supervisor responsible for developing and implementing the HASP and verifying compliance.
- Identify the functions and responsibilities of all personnel needed for hazardous waste operations and emergency response.
- Identify site specific lines of authority, responsibility, and communication.

c. Comprehensive work plan:

   i. A written comprehensive work plan of tasks, objectives, logistics, and resources for site operations, including the following:

   - Addresses anticipated clean-up activities and normal operating procedures unless that information is already available in another document.
   - Defines work tasks and objectives.
   - Describes how the work tasks and objectives will be accomplished.
   - Establishes the personnel requirements to implement the work plan.
   - Provides for implementation of training, briefings, and information as required by WAC 296-843-200.

d. Site control plan:

   i. An up-to-date site control plan before clean-up operations begin to minimize employee exposure to hazardous substances and including the following (unless it is available in another document):

   - A site map.
   - Establish site work zones.
   - How the “buddy system” is used.
   - The site communications plan, including how employees are alerted during emergencies.
   - The site's standard operating procedures (SOPs) or safe work practices.
   - Identification of the nearest medical assistance.

e. Personal protective equipment:

   i. A PPE plan that addresses all of the following:

   - Site hazards and activities.
   - Methods to evaluate the effectiveness of the PPE plan.
   - Criteria for selecting and fitting PPE, including work duration, use limitations of particular PPE, and medical considerations such as temperature extremes and heat stress.
   - Training on PPE use.
   - Procedures for putting on and taking off PPE.
   - PPE inspection procedures prior to, during, and after use.
   - Decontamination and disposal of PPE.
   - Maintenance and storage of PPE.

f. Additional elements:

   i. A sampling and monitoring plan (see WAC 296-843-130)

   ii. Site control measures (see WAC 296-843-140).

   iii. Decontamination procedures (see WAC 296-843-150).

iv. Spill containment plans (see WAC 296-843-180, Drum and container handling).

v. Standard operating procedures for sampling, managing, and handling drums and containers (see WAC 296-843-180).

vi. Entry procedures for tanks or vaults (see chapter 296-809 WAC, Confined spaces. Chapter 296-843 WAC Hazardous Waste Operations Safety and Health Core Rules

vii. A training, certification, briefings, and information plan (see WAC 296-843-200).

viii. A medical surveillance plan (see WAC 296-843-210), that includes site-specific medical surveillance requirements.

ix. Sanitation (see WAC 296-155-140).

x. Lighting (see WAC 296-800-210).

xi. Excavations (see chapter 296-155 WAC, Part N, Excavation, trenching and shoring).

xii. Any relationship or interaction between other programs and the site-specific program.

Note: The emergency response plan required by WAC 296-843-160, Emergency response for hazardous waste sites, is also included as a separate section in the HASP.

C. Hazard Communication (Chapter 296-800 WAC):

1. Contaminant gases that may be encountered.

2. Provide a written Hazard Communication Program and emergency management plan addressing these and other potential hazardous substances that may exist and be brought on site during the work.

3. For work requiring use of hazardous materials and chemicals, provide a list and corresponding Material Safety Data Sheets (MSDS)/Safety Data Sheets (SDS) for hazardous chemicals to be used on site. If no hazardous chemicals are to be used, provide statement to that effect.

D. Confined Space (Chapter 296-809 WAC):

1. All confined spaces are designated and classified as Permit Required Confined Spaces.

2. The nature of the work may expose workers to permit required confined spaces having possible explosive, toxic, and oxygen deficient atmospheric conditions.

3. Provide a written Permit Required Confined Space Safety Program that meets the requirements of 29 CFR 1910.146 and Chapter 296-809 WAC.

E. Lockout Tagout (Hazardous Energy Control) (Chapter 296-803 WAC):

1. The nature of the work may expose workers to hazardous energy sources that include, but are not limited to, electrical, mechanical, pneumatic, hydraulic, thermal, and computerized systems.

2. Provide a written plan outlining safe work practices addressing hazardous energy control procedures that meet the requirements of 29 CFR 1910.147 and Chapter 296-803 WAC.

F. Fall Prevention and Protection (Chapter 296-24 WAC Part J-1 and Chapter 296-155 WAC Part C-1):

1. The nature of the work may expose workers to fall hazards.

2. Provide a written Fall Prevention and Protection plan outlining safe work practices addressing fall hazards that meet the requirements of Chapter 296-24 WAC Part J-1 and Chapter 296-155 WAC Part C-1.

G. Personal Protective Equipment (PPE) (Chapter 296-800 WAC):

1. The nature of the work may expose workers to miscellaneous injury hazards that include, but are not limited to: head, hands, feet, body, eyes, and ears.

2. Provide a written PPE plan outlining safe work practices addressing the use of PPE and clothing that meet the requirements of Chapter 296-800 WAC.

H. Commercial Diving Operations (Chapter 296-37 WAC):

1. Due to the hazards associated with commercial diving operations, specific safety protocols and procedures are required to ensure worker and diver safety.

2. Provide a comprehensive Safe Practices Manual for Diving Operations that complies with Chapter 296-37 WAC.

I. Heavy Equipment Operations, Staging:

1. All vehicles shall have a service brake system, an emergency brake system, and a parking brake system. These systems shall be maintained in operable condition and may use common components.

2. Before leaving a motor vehicle unattended the motor shall be stopped. The parking brake shall be engaged and the wheels turned into curb or berm when parked on an incline. If parking on an incline and there is no curb or berm, the wheels shall be chocked or otherwise secured.

J. Suspect Material:

1. Unless otherwise indicated, promptly suspend work and notify the Project Representative of unusual conditions, including oily soil found on the Site. Work shall remain suspended until the Project Representative authorizes, in writing that the work may resume.

K. Traffic Control Plan:

1. The needs and control of all road users (motorists, bicyclists, and pedestrians) within the highway, or on private roads open to public travel, including persons with disabilities, through a temporary Traffic Control zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.

2. When the work requires the occupation of traffic lanes, parking lanes, parkways, or other public right-of way closures, it shall be per the Local Authority Having Jurisdiction See Specification Section 01570 for requirements.

L. Electrical Safety:

1. Use either ground-fault circuit interrupters or assured equipment grounding conductor program to protect employees on construction sites covering all cord sets, receptacles which are not a part of the building or structure, and equipment connected by cord and plug which are available for use or used by employees. These requirements are in addition to any other requirements for equipment grounding conductors per WAC 296-155-447.

2. In work areas where the exact location of underground electric power lines is unknown, no activity that may bring employees into contact with those power lines shall begin until the power lines have been positively and unmistakably de-energized and grounded.

3. Where overhead electric conductors are encountered in proximity to a work area be responsible for ascertaining the voltage and minimum clearance distance required and maintaining the minimum clearance distance per WAC 296-155-428.

4. Do not permit an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against electric shock by de-energizing the circuit and grounding it or by guarding it effectively by insulation or other means.
5. Work on energized equipment:

   a. Only qualified persons shall work on electric circuit parts of equipment that have not been de-energized under the procedures of WAC 296-155-429(4). Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, PPE, insulating and shielding materials, and insulated tools.

   b. Use of an Energized Electrical Work Permit shall be required to ensure all shock and arc flash hazard have been considered.

1.07 UTILITIES

A. Call the Utilities Underground Location Center (UULC) before you dig, phone number 811.

B. During the performance of the work, take appropriate precautions when working near, around, and with utilities, in order to protect the health and safety of the worker, the public, property, and the environment.

C. Provide a flagged warning line for all work conducted in proximity to power lines. Coordinate and meet the requirements of the utility owner for this work.

D. Coordinate and meet the requirements of the utility owner and the Project Representative to obtain approval to disconnect or reconnect utilities.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 SAFETY AND HEALTH COMPLIANCE

A. Implement the written APP as required by Chapter 296-800 WAC, submitted in the bid evaluation per Specification Section 00440 and accepted at the conclusion of the bid evaluation.

B. The Project Representative reserves the right to audit the Contractor's APP and implementation of the HASP.

C. Ongoing work and hazardous situations that are considered a health and safety risk by the Project Representative shall be corrected immediately.

D. Be responsible to stop that portion of the work that is determined to be an imminent or immediate threat to worker health and safety.

E. Ensure that necessary air monitoring, ventilation equipment; protective clothing, hazardous energy control devices, fall prevention, and other specified supplies and equipment are made readily available to employees to facilitate implementation of the APP and the HASP.

F. Incidents:
   1. Notify the Project Representative immediately of all near miss incidents and all incident accidents involving personal injury and property damage.

   2. Provide a written report known as the Incident Report within 24 hours of any incident. Report for each incident occurrence shall include:

      a. Description of the event.

      b. Names of personnel involved.

      c. Description of injuries and treatment required (short term and long term).

      d. Description of property damage.

      e. Site visits and inspections of other agencies as a result of an incident. Include names of the persons, purpose of the visit, and any other pertinent information.

G. Conduct a pre-job safety meeting with Contractor staff and with all subcontractor staff. Submit list of attendees and minutes of pre-job safety meeting.

H. Conduct all weekly safety tailgate meetings. Submit list of attendees and minutes of weekly safety tailgate meetings.

I. Submit a Monthly Contractor Injury Report on Form 01063-A in Specification Section 01999 consisting of a summary of the current month's injury accidents.

J. Use of intoxicants or of illegal or debilitating drugs while working on a County contract is prohibited.

K. Failure to comply with safety and health regulations may result in work suspension until adequate safety and health measures are implemented.

L. Use the Safety Officer that meets the requirements for implementation per Specification Section 01300. No Safety Officer shall be assigned that does not meet the requirements of Specification Section 01300 and this Section.

M. Submit all safety related citations received for Contract work immediately upon receipt. If appealed to the state of Washington, notify the Project Representative a minimum of every month updating the status of the appeal until resolved. Submit documentation of the findings when resolved.

3.02 SITE SPECIFIC HEALTH AND SAFETY PLAN REVISIONS

A. In the event that the Project Representative, regulatory agencies, or jurisdictions determine the HASP, associated documents, or organizational structure to be inadequate to protect employees and the public:

   1. Modify the APP and HASP to meet the requirements of said regulatory agencies, jurisdictions, and the Project Representative.

   2. Provide submittal for revisions to the APP and HASP within seven days of the notice of a required modification.

3. The revision shall meet the requirements of Specification Section 01300 prior to changing work practices.

3.03 POSTING

A. Provide and maintain a copy of the most up to date APP and the HASP at the Contractor's site office and at each of the subcontractors' offices.

3.04 COMPLIANCE

A. Failure to comply with this Section will result in work suspension until adequate safety and health measures are implemented.

3.05 TECHNICAL ASSISTANCE

A. Technical assistance is available from:
Wastewater Treatment Division
Safety and Hazardous Materials Program Office
201 South Jackson St.
Mail Stop: KSC-NR-0515
Seattle WA 98104

B. Contacts:
   1. Jim Faccone – WTD Safety and Hazardous Materials Program Manager
      Phone (206) 477-5379
   2. Terry Fiber – WTD Construction Safety Coordinator
      Phone (206) 477-5383

END OF SECTION

Specification Section 01063

Attachment A

Form 01063-A – Monthly Contractor Injury Summary Report

01063-A MONTHLY CONTRACTOR INJURY SUMMARY REPORT

Contract Name: ______________________________

Contract No: ____________________ Month: ____________________

Contractor: ______________________________

OSHA RECORDABLE CASES

WORK GROUP	NUMBER OF CASES	
	Reporting Month	Year-to-Date
Hourly Employees		
Supervisory Personnel		
TOTAL		

LOST TIME ACCIDENTS

WORK GROUP	NUMBER OF CASES		LOST WORKDAYS	
	Reporting Month	Year-to-Date	Reporting Month	Year-to-Date
Hourly Employees				
Supervisory Personnel				
TOTAL				

TOTAL HOURS WORKED AT CONTRACT SITE

Reporting Month	
Year-to-Date	

INCIDENT AND SEVERITY RATE

Date of last lost-time accident: ____________________

Number of hours worked since last lost-time accident: ____________________

$$\text{Incident Rate} = \frac{\text{Total Number of OSHA Recordable Cases x 200,000}}{\text{Total Hours Worked at King County Project Site}}$$

$$\text{Severity Rate} = \frac{\text{Total Number of Lost Workdays x 200,000}}{\text{Total Hours Worked at King County Project Site}}$$

RATES	Reporting Month	Year-to-Date
Incident Rate		
Severity Rate		

Monthly Incident Summary

DATE	NAME	TRADE	COMPANY	INCIDENT	Contributors and Preventive Measures

SECTION 01200

CONTRACT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies Contract meetings prior to and during construction.

1.02 PHASE 1 PRECONSTRUCTION MEETING

A. The King County Project Representative or their designee will chair a meeting of representatives of the Contractor, County staff and Consultants, and other affected agencies prior to beginning construction. The purpose of the meeting will be to:

1. Establish lines of authority and communication within the Contract team.
2. To discuss the administrative requirements of the Contract.
3. Address project issues if needed.
4. To define the duties and responsibilities of all parties.
5. To review Contractor required submittals

B. Agenda

1. Preparation of Contractors Work Plan and other submittals
2. Project Schedule

C. Attendance at Phase 1 Preconstruction Meeting

1. Attendance is required from:
   a. Project Representative and other County staff or consultants.
   b. Field Engineer (FE).
   c. Contractor's Project Manager and Site Superintendent.
   d. Subcontractors, as pertinent to agenda.
   f. Representatives of governmental agencies, other regulatory agencies, or utilities as determined by KC.

1.03 PHASE 2 PRECONSTRUCTION MEETING

A. The King County Project Representative or their designee will chair a meeting of representatives of the Contractor, County staff and Consultants, and other affected agencies prior to beginning construction. The purpose of the meeting will be to:

1. Establish lines of authority and communication within the Contract team.
2. To discuss the administrative requirements of the Contract.
3. Address project issues if needed.
4. To define the duties and responsibilities of all parties.
5. Review methods for documenting and reporting inspection data and compliance with construction documents, including methods for processing design changes and securing EPA review and approval of such changes as necessary;
6. Review methods for distributing and storing documents and reports;
7. Review work area security and safety protocols; and
8. Demonstrate that construction management is in place, and discuss any appropriate modifications of the CQAPP to address site-specific considerations.

B. Agenda:

1. Schedule.
2. Health and safety.
3. Mobilization plan.
4. Equal employment regulations.
5. Apprenticeship programs.
6. Administrative procedures of the Contract.

7. Permits, easements, community relations.
8. Other issues agreed between Contractor and County.
9. Site Access.

C. Ensure that the Contractor's Project Manager, superintendent, Safety Officer, and representatives of all major subcontractors are present at the meeting.

1.04 PROGRESS MEETINGS

A. General
   1. Attend Daily Briefings to review project operations of previous day, ongoing operations being performed that day and review operations planned for next 3 days.
   2. Attend weekly progress meetings to discuss the issues and progress of the project. Meetings may be more or less frequent depending on the progress and status of the work.
   3. Arrange for attendance of subcontractors as necessary at Daily Briefings and Progress Meetings to discuss job progress.
   4. Meeting times to be mutually agreed to between the King County Project Representative and Contractor Project Manager and Site Superintendent.

B. Attendance at Daily Briefings and Project Meetings
   1. Attendance is required from:
      a. Project Representative and other County staff or consultants.
      b. Field Engineer (FE).
      c. Contractor's Project Manager and Site Superintendent.
      d. Subcontractors, as pertinent to agenda.
      e Contractor Safety Officer.
      f. Representatives of governmental agencies, other regulatory agencies, or utilities as determined by KC.

C. Agenda for Daily Briefings
   In general the agenda for each meeting is to be agreed by Contractor and Project Representative and may include items such as:
      a. Work performed previous day
         a. Any issues encountered
         b. Results
         c. Review of water quality monitoring data
      b. Work being performed today
         a. Ongoing status
         b. Any issues Encountered
         c. H&S
      c. Work Planned for next three days
         a. Schedule
         b. Potential issues/constraints
         c. Schedule for diver inspections
         d. Schedule for hydrographic surveys

D. Agenda for Progress Meetings
   1. In general the agenda for each meeting is to be agreed by Contractor and Project Representative and may include items such as:
      a. Review progress on action items from prior meetings.
      b. Review work progress since last meeting compared to the look ahead schedule.
      c. Look ahead schedule for upcoming period.
      d. Identification of problems that might impede planned progress.
      e. Construction deficiencies.
      f. Contract administrative including:
         1) RFI status
         2) Submittal status
         3) RCO status
         4) RCP status
         5) as-built status

g. Coordination of projected work with other contractors.
h. Project Safety.
i. Other items as required by the Project Representative or the Contractor.

1.05 OTHER MEETINGS

A. Contractor shall participate in additional meetings as requested by the Project Representative. Contractor attendance at additional meetings shall be as requested by Project Representative

PART 2 PRODUCTS

2.01 MEETING RECORD

A. The FE will record:
1. List of issues discussed
2. Agreements
3. Follow-up action items required by either the Contractor or the County
4. Construction deficiencies noted
5. Contract administrative deficiencies noted
6. Project safety issues

PART 3 EXECUTION

Not Used.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01300

SUBMITTALS PROCEDURE

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies procedures and requirements for all submittals, substitutions, deviations, and the master submittal list required by the Specifications.

B. In addition to submittals required by individual Specification Sections, submit information on Contractor chosen items to be included in the Work, including items shown on the drawings but not specified.

C. Submit information on all repair and corrective work required of or generated by the Contractor such that the acceptability of the quality of the repair or correction can be assessed before it is performed.

D. Submit descriptive information that will enable the King County Project Representative (Project Representative) to assess whether the proposed materials, equipment, or methods of work are in required conformance with the work and in compliance with the Contract.

E. Specifically identify and annotate any deviation or substitutions in the submittal. Contractor shall not make any substitutions without written approval from the Project Representative prior to making such substitution.

F. No fabrication or construction work shall occur on a specific submittal item without a submittal Review Action of “1” NO EXCEPTIONS TAKEN or “2” NOTE MARKINGS.

G. Unless specified otherwise in this Contract, preparation and revisions of submittals is to be an incidental expense and not a pay item.

1.02 MASTER SUBMITTAL LIST

A. Prepare and submit within 10 days after the effective date of the Notice to Proceed (NTP), a Master Submittal List listing all items for which submittals are required by the Specifications. Organize the Master Submittal List by Specification Section number and include the following information for all listed items:

1. Item identification.

2. Specification Section number.

3. Planned submittal date.

4. Identification of those items that are substitutions or contain deviations from the Specifications. No substitutions may be made without written approval by the Project Representative.

5. Identification of those items that require other jurisdictional agency review and approval.

6. The List shall include columns for future use as information becomes available for the following items:

   a. Trade name, model, and catalog designation.

   b. The scheduled need dates for control purposes.

   c. Date submitted.

d. The date approval is needed.

e. The date on which material is needed.

1.03 CONTRACTOR RESPONSIBILITIES

A. Be responsible for the accuracy and completeness of the information contained in each submittal.

B. Verify that the material and equipment described in each submittal conforms to the requirements of the Contract prior to submittal.

C. Ensure that the material, equipment and methods of work used are described in the submittal.

D. Coordinate and integrate all submittal dates with the Baseline Schedule.

E. Annotate on the Submittal Transmittal Form 1300-A if the submittal conflicts or may affect the work with other submittals.

F. Ensure coordination of submittals among the suppliers, related crafts, subcontractors, and with the planned work. The Contractor will be held responsible for any cost or schedule impact caused by a submittal coordination failure.

G. Submit a request for all substitutions using Form 01300-B received from the Project Representative.

H. Call out all deviations from the Contract on the Submittal Form 01300-A transmitted to Project Representative and note where applicable in the body of the submittal.

1.04 SUBMITTALS ON ITEMS DIFFERING FROM THAT REQUIRED BY THE CONTRACT DOCUMENTS

A. APPROVED EQUAL

1. Definition: An item of material or equipment proposed by the Contractor that has the same function, quality, durability, appearance, strength, and design characteristics equal to that named, that meets the requirements of the Specification, and is sufficiently similar so that no change in related work is required. The item of material or equipment shall reliably perform at least equally well for the function imposed by the design concept of the completed work as a functioning whole. In general, approved equal applies to manufactured items.

2. Clearly note on the submittal Form 1300-A if any items are submitted as an equal.

3. Acceptance is at the Project Representative's sole discretion and the decision regarding acceptance or rejection shall be final. If the Contractor disagrees, a Request for a Change Order shall be filed in accordance with contract provisions. Do not assume acceptance at any time prior to the rendering of decision by the Project Representative.

B. SUBSTITUTION

1. Definition: An item of difference in materials, equipment, means, method, technique, dimension, sequence, or procedure which functionally meets the Contract requirements, but does not meet the Specification(s) and is equal to or better than the specified item.

2. A submittal shall be provided for each substitution request, must be submitted using Form 01300 – B, and shall address all items on the form. The request shall include complete specifications or means and methods for the item including procurement, operational and maintenance cost data. Substitution Request forms shall be numbered sequentially beginning with the number No. 1.

3. Any Substitution not identified on a submittal is not accepted or approved regardless of any action taken on the submittal by the County. Action taken by the County on the submittal shall not relieve the Contractor from complying with the original Contract requirements.

4. Acceptance is at the Project Representative's sole discretion and the decision regarding acceptance or rejection of the substitution shall be final. If the substitution is rejected, proceed with the contract specifications without delay. Do not assume acceptance at any time prior to the rendering of a written decision by the Project Representative.

C. DEVIATIONS

1. Definition: A minor change or omission to a specified material, procedure or product proposed by the Contractor that does not fully conform to the requirements specified, but conforms to dimensional, operational, and maintenance requirements and can be shown to accomplish the functional and operational and maintenance performance of the specified item.

2. Annotate in the submittal all deviations from stated requirements in the Contract. Any deviation not identified on the submittal is not accepted or approved regardless of any subsequent action on the submittal by the County. Failure of the County to comment on the deviation shall not relieve the Contractor from complying with the original Contract requirements.

3. Acceptance is at the Project Representative's sole discretion and the decision regarding acceptance or rejection shall be final. Do not assume acceptance at any time prior to the rendering of a decision by the Project Representative.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

3.01 TRANSMITTAL PROCEDURE

A. General:

1. Submittals shall be accompanied by Submittal/Transmittal Form 01300-A. An electronic blank copy of this form will be provided by the Project Representative. Equipment numbers shall be listed on Form 01300-A for items being submitted. A separate form shall be used for each specific item, class of material, equipment, and items specified in separate, discrete sections for which a submittal is required. Submittals for various items shall be made with a single form when the items taken together constitute a manufacturer's package, or are so functionally related that expediency indicates checking or review the group or package as a whole. No multiple-Section submittals will be allowed except where previously approved by the Project Representative.

2. A unique number, sequentially assigned, shall be noted on the transmittal form accompanying each item submitted. Original submittal numbers shall have the following format: “XXX”; where “XXX” is the sequential number assigned by the Contractor. Resubmittals shall have the following format: “XXX-Y”; where “XXX” is the originally assigned submittal number and “Y” is a sequential letter assigned for re submittals, i.e., A, B, or C being the 1st, 2nd, and 3rd resubmittals, respectively. Submittal 25B, for example, is the second resubmittal of Submittal 25.

3. Submit all proposed approved equals as a part of the submittal process.

4 Transmit one electronic pdf document of each submittal or resubmittal to the Project Representative. The electronic document must be accompanied with a completed Submittal/Transmittal Form 01300-A, and include all submittal materials. The electronic documents may be attached to an e-mail, the Project Representative will provide the e-mail address. Digital files in excess of 5 MB will not be transmitted via e-mail and may be sent using a King County FTP site. The Project Representative will provide instructions for use of the King County FTP site.

5. Transmit one reproducible exact replica of the electronic documents via hand delivery or mail to King County within seven days from transmittal of the electronic submittal document. The reproducible documents shall not exceed 22 inches x 34 inches. Product samples and color samples may not be transmitted electronically.

B. Samples: Submit the number requested in the Specification Section with the submittal form.

C. Certificates: Will be considered as information. No copy shall be returned.

D. “Submit for information only”: No copy shall be returned.

3.02 REVIEW PROCEDURE

A. Unless otherwise specified in the Technical Specifications, within 30 days after receipt of each submittal or resubmittal, one electronic copy of the County’s identified Review Action and any review comments will be transmitted to the Contractor. This will be followed with one paper replica of the electronic document within seven days from the transmittal of the electronic document.

The returned submittal will indicate one of the following actions:

1. If the review indicates that the submittal is in general conformance with the Contract, the submittal copies shall be marked "No Exceptions Taken" and given a Review Action of "1." In this case, implement the work covered in the submittal.

2. If the review indicates that the submittal requires limited corrections, the submittal copies will be marked "Note Markings" and given a Review Action of "2." In this case, begin to implement the work covered in the submittal in accordance with the markings noted. Where submittal information is to be incorporated in O&M data, a corrected copy shall be resubmitted; otherwise, no further action is required.

3. If the review reveals the submittal is insufficient and contains incorrect data and the comments are of a nature that can be confirmed, the submittal copies shall be marked "Comments Attached --Confirm" and given a Review Action of "3." A Review Action “3” does not allow implementation of the work covered by the submittal until the information requested to be confirmed in the submittal has been revised, submitted, and returned to the Contractor with a Review Action of either "1" or "2.”

4. If the review reveals the submittal is insufficient or contains incorrect data and the comments require that the submittal be revised and resubmitted, the submittal copies shall be marked "Comments Attached --Resubmit" and given a Review Action of "4.” . A Review Action “4” does not allow implementation of the work covered by the submittal until the information in the submittal has been revised, resubmitted, and returned to the Contractor with a Review Action of either "1" or "2.”

5. If the review reveals that the submittal is not in general conformance with the Contract, or if the submittal is incomplete, the submittal copies shall be marked "Rejected" and given a Review Action of "5." Submittals containing deviations or substitutions from Contract which have not been clearly identified by the Contractor fall into this category. A Review Action

“5” does not allow implementation of the work covered by the submittal until the information in the submittal has been revised, resubmitted, and returned with a Review Action of either "1" or "2.”

B. Contractor’s Work Plan and Contractor Quality Control Plan will be reviewed by both the County and the U.S. Environmental Protection Agency.

1. County review: The contractor shall complete submittals (per Section 02221 1.03 A and B) in accordance with the following procedure.

   a. Submit the draft submittal within 30 days of Phase 1 Notice to Proceed for County initial review.

   b. Address comments and submit revised draft within 15 days of receipt of comments.

2. EPA review: The U.S. EPA will review and comment on the Contractor Work Plan and Contractor Quality Control Plan (per Section 02221 1.03 A and B)

   a. King County will transmit the submittals to U.S. EPA for review and comment (anticipated to be 30 days).

   b. Address comments on revised draft and submit final draft within 15 days.

3. Work covered by the submittal may progress when the submittal is returned with a Review Action of 1 or 2.

3.03 EFFECT OF REVIEW OF SUBMITTALS

A. Review of submittals shall not relieve the Contractor of its responsibility for errors or omission therein and shall not be regarded as an assumption of risks or liability by King County.

B. Unless Contractor specifically identifies and King County accepts a Deviation or Substitution on the submittal, no disposition of the submittal by King County changes the requirements of the Specification and Drawings.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

Specification Section 01300

Attachment A

Submittal Transmittal Form 1300-A

Submittal Transmittal Form 01300-A

Date Stamp

Contract Number: C__________C

Submittal No. ________________

Date ________________

KING COUNTY

WASTEWATER
TREATMENT DIVISION

Is this a Resubmittal? YES ☐ NO ☐

If resubmittal, prior submittal number ________________

Does submittal contain deviations from the specifications YES ☐ NO ☐

CONTRACTOR ____

Subcontractor or Supplier: ____________________________

						This Section to Be Completed By King County	
Item No.	**P/C**	**Spec. Paragraph**	**Contractor's Cat. or Dwg. No.**	**Description of Item**	**Copies Submit**	**Review Action**	**Contractor Deviation**

Contractor certifies to review of submittal, verification of field measurements, and compliance with Contract Document unless noted otherwise in the submittal.

By: Date:

Reviewer Remarks

Legend-Review Action

1 No exceptions taken ☐
2 Note Markings ☐
3 Comments Attached-Confirm ☐
4 Comments Attached-Resubmit ☐
5 Rejected ☐

P - Partial
C- Complete

Distribution:	**By (Print)**	**Date**
Initial Review Completed		
Project Representative		
Returned To Contractor		

Specification Section 01300

Attachment B

Substitution Request Form 1300-B

FORM 01300-B **SUBSTITUTION REQUEST FORM**

TO:____

CONTRACT NO. C_________C: CONTRACT NAME: __________________________

We hereby submit for your consideration the following item instead of the specified item or procedure:

<u>Section</u>	<u>Paragraph</u>	<u>Specified Item</u>
________	_____________	________________________________

Proposed Substitution:

____

____

____

____

Attach complete data, including laboratory tests, if applicable. Include complete information on changes to Contract Drawings and/or Specifications which proposed substitution would require for its proper installation.

Fill in blanks below:

A. How will substitution affect dimensions shown on Drawings?

____

____

B. What effect does the substitution have on the Baseline or Update Schedule?

____

____

C. State quality and performance differences between proposed substitution and specified item or procedure.

____

____

____

D. List the cost differences between proposed substitution and specified item or procedure. (Attach estimate/quote and indicate net change).

____

____

SUBSTITUTION REQUEST FORM

E. List manufacturer's name and address, trade name of product, and model or catalog number.

____

____

____

F. Other information as required by the Project Representative.

____

____

____

G. The undersigned states that the function, appearance and quality of the proposed substitution are equivalent or superior to those of the specified item and authorizes the payment to the County for all design changes including Project Representative, detailing, and County processing costs.

____

____

H. The undersigned states that there is a waiver of all claims for additional costs related to the substitution which may subsequently arise during the work.

____

I. Manufacturer's guarantees the proposed and specified items are:

_______ Same ______ Different (explain on attachment)

Submitted by:

____
Contractor Signature

____
Firm

____
Address

____

Date: ________

For use by Project Representative

____ Accepted ____ Accepted as Noted

____ Not Accepted ____ Received Too Late

By: ____________

Date:____________

Remarks: ______________________________

NOTE: WHEN REQUIRED BY THE PROJECT REPRESENTATIVE, ALL SUBSTITUTIONS TO BE STAMPED AND SIGNED BY A PROFESSIONAL ENGINEER LICENSED IN THE STATE OF WASHINGTON.

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 01311

PROGRESS SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies requirements and procedures for preparing construction schedules, schedule of values, and reports.

B. The purpose of the construction schedules, schedule of values and reports are to ensure adequate planning and execution of the work by the Contractor, to establish the standard against which satisfactory completion of the work shall be judged, to assist in monitoring progress, to determine progress payments and to assess the impact of Change Orders on the construction schedule.

1.02 SUBMITTALS

A. Procedures: Specification Section 01300.

B. Draft construction schedule: Submit for review at the Phase 1 pre-construction conference.

C. Construction Baseline Schedule: Submit within 15 days of receiving review comments on the Draft Construction Schedule.

D. Weekly progress reports: Submit weekly progress and one week look ahead reports for discussion at weekly progress meetings.

E. Monthly report: Submit with Application for Payment.

1.03 CONSTRUCTION SCHEDULES

A. Draft construction schedule: Include material and equipment procurement and construction work. Clearly indicate major milestones and the time(s) for completion which are required to be met under the terms of the Contract. Include the bar chart and a draft schedule of values.

B. Construction schedule: Include the bar chart, schedule of values, and cash flow projection. The schedule submitted shall be considered the Baseline Schedule.

C. Time scaled bar chart based on the construction schedule prepared on 11-inch x 17-inch sheets. Band by activities, indicated in the schedule of values, or as approved by King County's Project Representative (Project Representative).

D. Activities: Show on construction bar charts at their early start/finish period.

E. Include Submittal and procurement activities including preparation and submittal of shop drawings, product data, samples, fabrication, delivery, as-built drawings, O&M manuals.

F. Dates indicated on the schedule by the Contractor shall not be binding on the Project Representative.

G. Failure of the Contractor to include an element of work required for the performance of this Contract shall not excuse the Contractor from completing the work as described in the Contract.

H Provide a list of the holidays and non-work days applicable to the schedule.

1.04 SCHEDULE OF VALUES

A. Submit a balanced schedule of values for the Lump Sum Bid items. At a minimum, break up the Lump Sum bid item work into units for payment as described below. The total value of the activities shall equal the Contract Lump Sum bid amount. Overhead and profit shall be prorated to the activities. Activity values shall be rounded to the nearest dollar.

1. Schedule of Values
   a. Phase 1
      i. Submittals
   b. Phase 2
      i. Mobilization
      ii. As-builts and Project documentation
      iii. Demobilization
         - Punch List
      iv. Completion of As-builts and Demobilization: 5%

B. The value to be allocated to the mobilization activity shall not exceed 18% percent of the original Contract Price.

C. If, in the opinion of the Project Representative, the schedule of values is unbalanced, present documentation substantiating the cost allocations of those activities believed to be unbalanced.

D. Include all values as required by other sections in the Specifications.

1.05 WEEKLY PROGRESS REPORT

A. Contractor shall submit weekly progress report to the Project Representative.

B. Summarize actual ENR and ENR+AC production per week over the course of the project to date and projected material production per week through the completion of the Project.

C. Summarize the number of barges and tons of ENR material delivered per week over the course of the project to date and the projected barges/tons for the next 2 weeks.

D. Summarize work planned for the upcoming week

E. Identify anticipated delays in completing the work on schedule, and recommend modifications to the work plan to mitigate delays.

1.06 MONTHLY REPORT

A. Include an updated construction bar chart, schedule of values, cash flow projection and narrative summary.

B. The narrative summary briefly describes the progress of the project. The report will describe how the project is progressing towards its completion. It shall identify milestones completed, major equipment deliveries and problems arising during the month. The report should project the work anticipated during the coming month, including major deliveries and submittals.

1.07 CASH FLOW REPORT

A. Include a forecast, by month, based on the current schedule, of cash requirements to complete the Contract.

PART 2 PRODUCTS

2.01 NOT USED.

PART 3 EXECUTION

3.01 GENERAL

A. Provide a construction schedule and narrative summary so the Project Representative may use them as a basis for determining the Contractor's compliance with the Contract regarding progress payments, Contract Time extensions, change order prices and impacts, and the overall progress of the work. Failure to comply with the requirements of this Section will be a cause for delay in the review and acceptance of the progress payment requests.

3.02 UPDATES

A. If actual progress is observed to deviate from the construction schedule by 1 week behind or 1 week ahead, update and submit a revised construction schedule. In the case of the work being behind schedule, submit, along with the revised construction schedule, a written plan for completing the work within the milestone and Contract Time and before closure of in water work period.

B. Requests for extensions in time resulting from changes issued by the County shall be accompanied by a narrative report explaining the impacts and costs associated with the extension.

C. On approval of a change order by King County, the approved change shall be reflected in both time and value in the next submission of progress reports and schedule updates. Contract Time extensions and schedule revisions shall be incorporated into the monthly updated construction schedule and schedule of values.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

SECTION 01500

CONTRACTOR'S CONSTRUCTION FACILITIES

PART 1 GENERAL

1.01 SUMMARY

A. General
   1. This project primarily includes on water work using a floating plant (instrumented excavator with clamshell or equivalent) to place ENR materials at three different Plots within the Duwamish Waterway. The three Plots are located in geographically different areas of the Lower Duwamish Waterway with no common upland area. King County does NOT have property available for Contractors use for office, lay down, parking, docking or any other use. Contractor is solely responsible for making all arrangements for suitable upland access, parking, offices, laydown area and vessel moorage and dock for safe and efficient transfer of personnel, equipment and supplies as needed. This shall include safe access from provided secure upland parking area to dock, vessel and operator for prompt, safe and efficient transport of King County Project Staff and Representatives including Construction Quality Assurance (CQA) staff and agency inspectors, LDWG members and personnel from dock to work areas and equipment as necessary throughout the project.

B. This Section specifies the following Contractor temporary construction facilities and construction requirements for:

   1. Utilities: power, heating, ventilation, telephone, water, and sanitary facilities.

   2. Work site access control: concrete barriers, fencing, and security.

   3. Miscellaneous items: parking, staging, cleaning, project signage, and Contractor office.

   4. Roads: haul roads, haul routes, and access roads. (for any materials delivered by truck)

   5. Contractor Site Office

   6. Contractor Provided Offices for King County Project Representative (Project Representative)/Project Engineer, both on floating plant and onshore.

   7. Parking

   8. Other as required by the Contractor

   9. Dock for safe personnel and equipment transfer from upland parking area to Contractor provided vessel (with operator) for transport to/from floating plant as requested. Contractor shall have suitable vessel capable of carrying up to ten people from dock to work areas and floating plant.

C. Unless otherwise noted, be responsible for all costs for utility usage and permitting associated with the requirements of this Section.

D. Unless otherwise noted, the County will not furnish any materials, facilities, utilities or services.

1.02 SANITARY FACILITIES

A. Provide clean and sanitary toilet and wash-up facilities for the work force at the site (Both on floating plant and at Site office onshore). Comply with applicable laws, ordinances, and regulations pertaining to the public health and sanitation of dwellings and camps.

1.03 CONTRACTOR'S SECURITY

A. Provide security and facilities to protect all temporary and existing facilities from unauthorized entry, vandalism, or theft.

1.04 HAUL ROADS AND LOCATIONS

A. Submit all haul locations for all types and classification of material to be imported to the worksite. If haul locations are to be added or location of material haul location is changed, submit new haul location and types and classification of material.

B. Submit in weekly report the type and amount of material imported to the site.

C. Repair any damage to roadway surfaces from the direct or indirect result of the Contractor's operation to the requirements of the responsible agency.

D. Obtain all necessary street use permits in connection with Contractor's operations.

1. When hauling is done over highways or city streets, the loads shall be trimmed and the vehicle shelf areas shall be cleaned after each loading. The loads shall be watered after trimming to minimize dust.

2. Maintain traffic patterns in the existing structural filled areas which preserve the stability of the soil under all future structural foundations or paved areas.

1.05 RESTORATION OF ROADS

A. Clean and repair roads used by the Contractor as required during and completion of the work.

B. Unless otherwise noted, resurface paved roadways, and bring to original grade and section roads which are not paved, where the surface is removed, broken, damaged, caved, or settled during the work.

1.06 MAINTENANCE OF TRAFFIC

A. Conduct the work to interfere minimally with public travel, whether vehicular or pedestrian.

1.07 PARKING AND STAGING AREA

A. Be responsible for obtaining and maintaining parking and staging areas unless otherwise specified.

B. Provide a minimum of four (4) dedicated parking spaces for King County Representative, personnel and consultants at Contractor Project Office location and at dock for vessel access (if different location than Contractor Project Office).

1.08 CLEANING

A. All streets used for hauling to be kept in clean swept condition daily.

B. Contractor to remove all trash from site on daily basis.

1.09 CONTRACTOR'S OFFICE

A. Maintain a suitable office near the site of the work to be the headquarters of the contractor's representative authorized to receive drawings, instructions or other communication or articles.

B. Communications given by the Project Representative or delivered at the site office in the Contractor's absence shall be deemed to have been delivered to the Contractor.

C. Copies of the Drawings, Specifications, permits, APP and HASP per Section 01063, regulatory required items, and other Contract Documents shall be kept at the site office and in office on floating plant used for material placement and available for use at all times.

1.10 TRANSPORTATION ROUTE

A. Select transportation route for hauling materials and equipment without creating traffic congestion.

B. Provide details on material to be transported by barge and by truck.

1.11 ROAD CLOSURES

A. Temporary detours and road closures due to work of others shall be anticipated by the Contractor. Contractor is responsible to plan and coordinate all its operations to work with possible temporary detours and road closures.

B. Be responsible for all additional costs resulting from temporary road closures.

1.12 PRIVATE ACCESS (GENERAL)

A. Where required by the Contract, or by choice of the Contractor, access may be over private land, in which case the access shall be maintained by and at the expense of the Contractor. Comply with all requirements of Specification Section 01062.

1.13 CONSTRUCTION SIGNS

A. Commercial or advertising signs shall not be allowed on the site.

1.14 Contractor Provided Office(s) for King County Project Representative and CQA staff

A. Contractor shall provide suitable office space both on land (minimum 10' x 20' & within 1 mile of dock for project use) and on Floating Plant (minimum 10'x 10') where in water work is being performed.

B. Offices shall have suitable HVAC for safe and comfortable working conditions.

C. Offices shall have suitable, safe and reliable electrical power to operate basic office equipment including computer, printer, lights and similar.

D. On floating plant, Contractors navigation system display available to operator shall be available to Engineer in office provided by Contractor for Engineers use. Contractor shall provide all necessary hardware, (including minimum 24" monitor) software etc. for proper display of navigation system data in real time consistent with operator display. Contractor shall not perform any placement of ENR materials unless this system is operational and approved by the Project Representative

E. On floating plant Contractor shall provide effective means of real time audio communication between Engineer and Operator.

1.15 Transportation from Shore to Contractor Floating Plant

A. Contractor shall provide all transportation by suitable, contractor operated vessel from dock to contractors floating plant, to observe operations or to inspect barges or materials by Project Representative, Field Engineer (FE), and other CQA Staff, Lower Duwamish Waterway Group (LDWG) members or other County Staff or Agency representatives. Contractor shall promptly provide such access as requested by the Project Representative.

PART 2 PRODUCTS

2.01 NOT USED.

PART 3 EXECUTION

3.01 RESPONSIBILITIES

A. Ensure all subcontractors, suppliers and individuals associated with Contract activities use approved routes.

B. Provide required signage and Contractor oversight for approved route to ensure compliance with traffic routing requirements. If Contractor fails to abide by the approved haul routes, Project Representative will assign City off-duty police officers for enforcement of haul route restrictions at the expense of the Contractor.

C. Inspect haul routes daily to assure compliance with Specification Section 01560.

3.02 IMPROVEMENT, MAINTENANCE AND RESTORATION OF HAUL ROUTES

A. Be responsible for any improvements, maintenance and restoration of haul routes related to construction use.

B. Share haul routes with business traffic and maintain in good condition. Haul routes shall remain smooth, level and suitable for owner or the public to drive passenger cars on without damage to vehicles. If pavement damage is minor due to Contractor's work, plane existing asphalt and resurface. If pavement damage is major due to Contractor's work, remove existing asphalt and replace with a minimum of 4 inches of asphalt.

C. Restore haul routes to their initial condition after they are no longer needed for construction purposes.

END OF SECTION

SECTION 01560

ENVIRONMENTAL MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies environmental controls and requires a plan to describe how Contractor will manage environmental mitigation and temporary environmental controls required to be maintained during construction.

B. The majority of the work will be performed from floating plant (excavator on spud barge, supported by material barges, tug boat(s), work skiff, survey vessels and similar) working within the Lower Duwamish Waterway (LDW) in Seattle and Tukwila, WA.

1.02 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revisions of the following documents. They are part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

	Reference	Title
1.	KCC Title 9	King County Stormwater Pollution Prevention Manual
2.	KCC Title 12	King County Noise Ordinance
3.	WAC 173-201A	Water Quality Standards for Surface Waters of the State of Washington
4.	RCW 90.48	Water Pollution Control Standards
5.	16 U.S.C. § 1531 et seq	Endangered Species Act
6.	WSDOE	Stormwater Management Manual for Western Washington
7.	WAC 173-60	Noise Levels
8.	RCW 70.105	Hazardous Waste Management
9.	National Historic Preservation Act of 1966, 36 CFR 800	
10.	Executive Order 05-05 on cultural resources	
11.	Various	Local codes, regulations

1.03 SUBMITTALS

A. Procedures: Specification Section 01300.

B. Environmental Mitigation Plan and all its revisions.

C. Waste disposal logs.

1.04 ENVIRONMENTAL MITIGATION PLAN (PLAN)

A. Develop and maintain for the duration of the Contract a Plan which will effectively describe methods to incorporate and implement all required environmental protection precautions. Use the form provided by the King County Project Representative (Project Representative).

B. Appoint an employee who is qualified and authorized to supervise and enforce compliance with the Plan. Ensure that all necessary pollution control equipment, supplies, or materials are available to implement the Plan.

C. Plan: Address the issues in the format provided which include:

1. Person Responsible
2. Conservation Measures

    A. Restriction of all in-water work activities to the authorized in-water work window for the LDW, when listed salmonid species are least likely to be present in the Action Area;

B. Use of submerged, near bottom release by clamshell for placement of the Enhanced Natural Recovery (ENR) and ENR with granulated activated carbon added (ENR+AC) materials. This is intended to reduce the loss of granulated activated carbon (AC) as the ENR+AC descends through the water column when compared to release from above the surface. This will also limit turbidity plumes that may result as fine material in the ENR and ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed;

C. Prewetting of the ENR+AC material prior to placement to minimize loss of AC during placement of the ENR+AC materials; and

D. Complying with water quality monitoring plan, implemented by KC during the ENR and ENR+AC material placement to assess turbidity down current of the pilot plots. The water quality monitoring results will be provided to Ecology and EPA. Contractor shall modify procedures as necessary, in consultation with Project Representative, to meet water quality criteria.

3. Best Management Practices (BMPs)

A. All mechanized equipment shall be maintained in proper operating condition, with equipment inspections occurring prior to each workday. Equipment found to be leaking petroleum products or hydraulic fluid shall be removed from the site for maintenance.

B. Inspection of the material barge to determine whether there are significant leaks that could contribute to the exceedance of the turbidity criterion as determined by Project Representative. Contractor shall promptly repair any such leaks as identified by Project Representative.

C. Drip pads or pans shall be placed under mechanized equipment to contain any potential leaks of petroleum products or hydraulic fluids.

D. To the extent possible, vegetable-based hydraulic fluids shall be used.

E. A spill kit shall be kept on work vessels to contain any potential petroleum spills that might occur.

F. Ecology and the U.S. Coast Guard (USCG) will be contacted immediately in the event of a spill. Project Representative should also be notified immediately of any spills.

G. Any project-related debris or wastes shall be placed in appropriate containers for off-site disposal. No project-related debris or wastes will be allowed to enter the water.

H. Barges and work vessels shall not be aground on the substrate. Work barges will be held on station with spuds or anchors. Spuds, anchors or other contractor equipment shall not disturb any plot area once ENR materials have been placed in that area.

4. Site Maintenance Program per requirements of this section and permits

5. Waste Disposal per Contract requirements and requirements of the Local Authority Having Jurisdiction [LAHJ] and permits.

6. Street Cleaning per requirements of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits

7. Water and Erosion Control

8. Air Pollution Control Measures per the requirements of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits.

9. Noise Control Measures per requirements of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits

10. Vibration Control and Settlement Monitoring.

11. Tree and Plant Protection

12. Water Quality Protection and Stormwater Control

13. Petroleum Spill Prevention Measures per requirements of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits, including procedures for proper notification in event of spill on floating plant

14. Chemical Storage per requirements of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits

15. Cultural Resources per requirements of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits

16. Erosion and Sediment Control per requirements of Specification Section 02270 and other specification sections of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits.

17. Traffic Control per requirements of Specification Section 01570 and other specification sections of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits.

18. Worker Protection per requirements of Specification Section 01063 and other specification sections of this Contract, the Local Authority Having Jurisdiction [LAHJ] and permits

19. Lighting

20. Other issues specific to the Contract Work.

D. Submit Plan prior to initiating work activities.

E. In the event that the County, regulatory agencies or jurisdictions determine the Plan or the Contractor's activities to be inadequate to protect environment:

1. Stop the work in progress until adequate environmental protection measures are implemented.

2. Modify the Plan to meet the requirements of regulatory agencies, jurisdictions, and the County.

3. Submit the revisions to the Plan prior to restarting work.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

3.01 PERSON RESPONSIBLE

A. Provide a person responsible for environmental management with authority to take appropriate action to safeguard the environment.

B. Provide person's name and 24 hour access phone number.

3.02 SITE MAINTENANCE

A. Keep the work site, including staging areas and Contractors' facilities, clean, neat and free from rubbish and debris. Remove materials and equipment from the site when they are no longer necessary. Upon completion of the work and before request for inspection, clear the work site of equipment, unused materials, and rubbish to present a clean and neat appearance.

B. Do not allow waste material to remain on the site of the work or on adjacent streets. Collect, carry off the site and legally dispose of such materials daily, weekly, or as otherwise specified by the Project Representative.

C. Be responsible for obtaining necessary permits or approval for the Contractor's disposal sites.

D. In the event that waste material, refuse, debris, and rubbish are not removed from the work site, King County reserves the right to have the waste material, refuse, debris and rubbish removed.

E. Handle paints, solvents, fuels, oils, greases and other construction materials with care to prevent entry of contaminants into storm drains, surface waters, or soils.

F. Unless otherwise indicated, restore ground surface to its pre-construction condition. Restore disturbed areas by replanting or repaving as soon as practical after construction.

3.03 WASTE DISPOSAL

A. Be responsible for managing and disposal of all waste generated by Contractor's activities including existing site materials required to be removed, waste from excess materials brought to the site and not incorporated into the work and waste products from the Contractor's operation such as contaminated waste solvents.

B. Identify an employee who is responsible for managing wastes and their proper, legal disposal.

C. Identify all wastes leaving the project site and the disposition of the waste.

D. Submit record logs of disposition of all disposal material leaving the site

3.04 STREET CLEANING

A. Use sealed trucks for the removal of all contaminated or flowing running spoils from the construction site.

B. Prevent dirt and dust from escaping trucks departing the work site, by covering dusty loads, washing truck tires before leaving the site, using crushed rock at entrances, or other reasonable methods.

C. When working dump trucks and other equipment on paved streets and roadways, clean the streets no later than at the end of each day's operations and at such additional interim periods as required. Clean the area using a vacuum sweeping truck. Cleaning equipment shall be available 24 hours per day, while haul routes are in use.

D. Contractor may use power washing trucks to clean street surface only after receiving approval from the Project Representative and only if following the best management practices to prevent exceedance of Washington State Water Quality Standards.

E. All streets in the construction area used by Contractor's trucks or any other equipment hauling material to and from the area, whether within the Contract limits or adjacent thereto, shall be kept clean and shall be continuously serviced by the Contractor's use of sprinkling trucks to control dust.

F. Violations of the above requirements are sufficient grounds for the Project Representative to order the streets in question to be cleaned by others with all cost withheld from the Application for Payment.

G. Flush no untreated solid material or soils or water containing solid material or soils into receiving waters including catch basins, ditches, streams, lakes or wetlands.

3.05 WATER AND EROSION CONTROL

A. Do not allow site erosion to cause violation of the Washington State Water Quality Standards.

B. Temporary drainage: conform to the regulations and requirements of legally authorized surface water management agencies.

C. Prevent solids or turbid runoff from entering storm drains or local surface waters.

D. Erosion control measures shall be installed prior to excavation, clearing, or grading activities.

E. Erosion and sedimentation control measures shall be in place prior to any clearing or grading activity. Disturbed areas and spoils piles shall be covered, bermed, or otherwise secured when runoff from rain is or would be likely to cause turbid water that may enter local water bodies. Work shall be suspended if it cannot be performed without causing turbid runoff to leave the construction area or enter local water bodies.

F. Temporary Dams

1. Except in times of emergency, earth dams are not acceptable at catch basin openings, local depressions, or elsewhere.

2. Temporary dams of sand bags, asphaltic concrete, or other acceptable material will be permitted when necessary to protect the work; however, their use should not create a hazard or nuisance to the public.

3. Remove such dams from the site as soon as they are no longer necessary.

3.06 AIR POLLUTION CONTROL

A. Do not discharge smoke, dust, and other contaminants into the atmosphere that violate the regulations of legally constituted authorities. Do not allow internal combustion engines to idle for prolonged periods of time. Maintain construction vehicles and equipment in good repair. When exhaust emissions are determined to be excessive, repair or replace equipment.

B. Use electrically-powered equipment where practical.

C. Minimize dust nuisance by cleaning, sweeping, and sprinkling with water, or other means. The use of water, in amounts which result in mud on public streets, is not acceptable as a substitute for sweeping or other methods. Make equipment for this operation available at all times.

3.07 NOISE CONTROL

A. Noise complaints received by the Project Representative during the Work will be shared with the contractor. Contractor shall work with the Project Representative, as required, to promptly resolve noise related complaints.

B. Noisy operations shall be scheduled to minimize their impact.

C. Unless otherwise indicated through a noise variance, comply with local controls and noise level rules, regulations and ordinances, which apply to work performed.

D. Each internal combustion engine, used on the job or related to the job, shall be equipped with a muffler of a type recommended by the manufacturer. No internal combustion engine shall be operated without said muffler.

E. Noise levels for scrapers, pavers, graders and trucks shall not exceed 90 dBA and pile drivers shall not exceed 95 dBA at 50 feet as measured under the noisiest operating conditions. For other equipment, noise levels shall not exceed 85 dBA. Equipment that cannot meet these levels shall be quieted by use of improved exhaust mufflers, noise attenuation barriers or other means.

F. Use electric or hydraulic tools whenever practical to reduce noise.

G. Provide notification of special circumstances or emergency conditions that require work beyond the hours specified as follows:

1. Notify the Project Representative and local authority in advance of any proposed extended work hours for preauthorization. Include a written request for authorization per Section 01014 to perform work specified and the circumstances that warrant this request. Include any additional measures to mitigate noise generated by this construction activity if deemed necessary by the Project Representative.

2. If an emergency situation occurs that warrants extended hours, notify the Project Representative immediately upon determining the need for this work.

3.08 VIBRATION CONTROL AND SETTLEMENT CONTROL

A. Coordinate construction activities with business operations within the work corridor that may be sensitive to construction-related vibrations.

B. Limit construction activities around vibration-sensitive businesses or buildings. Where appropriate, use construction techniques that modify the propagation paths of the ground waves associated with vibration.

3.09 TREE AND PLANT PROTECTION

A. Unless specified to be removed, protect existing trees from damage by construction activities. Include a perimeter barrier fence (polyfence) at each tree, located at the drip-line of the tree. Unless otherwise indicated, trees may not be removed within construction limits without written approval from the Project Representative. Unless otherwise indicated, if a tree is damaged or destroyed by construction, replace in species, size and grade with a healthy tree. Should it not be practical to replace the tree, pay for damages to trees in accordance with requirements of the owner or the County, as required by the Project Representative.

B. Restore damaged landscaped areas and other surface improvements as nearly as possible to their original condition.

C. Minimize vegetation removal. Do not clear areas until construction activities require the work.

D. Restore stream banks promptly to minimize erosion.

3.10 WATER QUALITY PROTECTION AND STORMWATER CONTROL

A. Conform to the regulations and requirements of legally authorized surface water management agencies. Do not allow any discharge to exceed the state Water Quality Standards.

B. For Contract activities disturbing over one acre of soil, prepare and implement a Storm Water Pollution Prevention Plan (SWPPP) as required by Washington Department of Ecology (WSDOE). These requirements and a template for a SWPPP are on the WSDOE website.

C. If water quality standards or permit conditions are violated, shut down work causing the violation until protection and remediation is completed. Be responsible for all associated impacts.

D. Be responsible for the overflow of any storm drains resulting from the addition of flow from Contractor's activities and any damages associated with such overflow.

E. Conduct operations in such a manner as to prevent sediment, construction equipment wash water, and other pollutants from reaching existing sewers, storm drains, wetlands, and surface waters.

F. Inspect, maintain, and repair all Best Management Practices (BMPs) on a weekly basis to assure continued performance of their intended function. The Department of Ecology requires all on-site erosion and sediment control measures be inspected at least once every seven days and within 24 hours after any storm event of greater than 0.5 inches of rain per 24 hour period measured at SeaTac International Airport. Keep a weekly log of the inspections for review by the Project Representative.

G. Prevent additional construction wastes such as paper, wood, garbage, sanitary wastes, and fertilizer, from leaving the site and entering waterways. Dispose of all debris on land in such a manner that it cannot enter a waterway or cause water quality degradation.

3.11 PETROLEUM SPILL PREVENTION AND CONTROL

A. Prevent, contain, and clean the spilling of oil, fuel, and other petroleum products used. Discharge of oil from equipment or facilities into state waters or onto adjacent land is not permitted and violates state water quality regulations.

B. At a minimum, perform the following measures regarding oil spill prevention, containment and clean-up:

1. Inspect fuel hoses, lubrication equipment, hydraulically-operated equipment, oil drums, and other equipment and facilities regularly for drips, leaks, or signs of damage, and maintain and store properly to prevent spills. Maintain proper security to discourage vandalism.

2. Dike or locate all land-based oil and products storage tanks so as to prevent spills from escaping into the water. Line dikes and subsoils with impervious material to prevent oil from seeping through the ground and dikes.

3. Immediately contain all visible floating oils with booms, dikes, or other appropriate means and remove from the water prior to discharge into state waters. Immediately contain all visible oils on land using dikes, straw bales, or other appropriate means and remove using sand, ground clay, sawdust, or other absorbent material, and properly dispose of waste materials. Temporarily store waste materials in drums or other leak-proof containers after clean-up and during transport to disposal. Dispose of waste materials off property at a legal site.

4. In the event of <u>any</u> oil or product discharges into public waters, or onto land with a potential for entry into public waters, immediately notify the Project Representative and the following agencies at their listed 24-hour response numbers:

    a. WDOE, Northwest Regional Office: (425) 649-7000.

    b. U.S. Coast Guard: (206) 286-5540.

5. As a minimum, maintain on floating plant, and restock as necessary to ensure an adequate and continuous supply, the following materials:

    a. Oil-absorbent booms: 8 each, 50 feet long each.

    b. Oil-absorbent pads or bulk material, adequate for coverage of 200 square feet of surface area.

    c. Oil-skimming system, if appropriate.

    d. Oil absorbent material, such as kitty litter or sawdust, for material spills on land or deck, gloves for use when performing the work and plastic bags to collect the used material.

3.12 CHEMICAL STORAGE

A. Store solid chemicals, liquid chemicals, paints, petroleum products, caustic solutions, and waste materials including batteries and electronic components to prevent entry of contaminants into all waters including groundwater.

B. Store to prevent spillage in the event of overfilling, tipping or rupture.

C. Store on impervious surfaces with impervious berms able to contain 110% of the storage volume.

D. Protect from vandalism

E. Cover stored liquids

F. Designate waste storage areas with the appropriate hazardous labels.

G. Segregate non-compatible or reactive chemicals to prevent possibility of mixing

H. Store all 'empty' containers not cleaned in upright secure manner.

3.13 CULTURAL RESOURCES

A. Attention is directed to the National Historic Preservation Act of 1966, 36 CFR 800 and Governor's Executive Order 05-05 which provide for the preservation of potential historical, architectural, archaeological or cultural resources (herein termed "cultural resources").

B. King County intends to conform to the applicable requirements of the National Historic Preservation Act of 1966 as it relates to the preservation of cultural resources and fair compensation to the Contractor for delays resulting from such cultural resources investigations.

C. In the event potential cultural resources are uncovered during subsurface excavations at the worksite, the following procedures will be instituted:

1. Reference Inadvertent Discovery Plan included as an attachment to 01560.

2. King County will issue a Work Suspension Order directing the Contractor to cease all construction operations at the location of a potential cultural resources discovery. King County will contact a professional archaeologist to evaluate the significance of the find.

3. Such Work Suspension Order will be effective until such time as the qualified archaeologist can evaluate the potential cultural resources for their significance and make recommendations to the State Historic Preservation Officer. Any Work Suspension Order will contain the following:

   a. A clear description of the work to be suspended.

   b. Any instructions regarding issuance of further orders by the Contractor for material services.

   c. Guidance as to action to be taken by subcontractors.

   d. Specific direction to the Contractor to minimize the work suspension costs (i.e., work elsewhere while archaeologist is evaluating find).

   e. Estimated duration of the temporary suspension.

4. If the archaeologist determines that the cultural resource is eligible for the National Register of Historic Places, King County will extend the duration of the Work Suspension Order in writing.

D. Inadvertent Discovery of Potential Archaeological Resources: *Contractor Responsibilities – Immediately Upon Discovery:*

1. If workers discover a potential archaeological resource, the Contractor is responsible for taking the following steps:

a. Immediately securing and protecting the discovery by suspending all ground disturbing activities within approximately 30 feet of the discovery, and cordoning off the discovery area;

b. Securing all spoils piles or trucks that may contain materials originating from the discovery area;

c. Collecting basic information (date/time, location and depth of discovery, personnel and equipment involved, general description of discovery), with photographs or illustrations if possible; and

d. Immediately notifying the Project Representative.

3.14 Light

A. Complaints about lighting and spillage onto adjacent properties received by the Project Representative during the Work will be shared with the contractor. Contractor shall work with the Project Representative, as required, to promptly resolve light related complaints.

B. Control excess light and light spillage from project area into adjacent properties.

C. Promptly address any light complaints or concerns to satisfaction of the Project Representative.

3.15 FINES

A. Be responsible for all fines incurred from non-compliance with regulations of governing authorities.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK

Specification Section 01560

Attachment A

Inadvertent Discovery Plan

THIS PAGE LEFT INTENTIONALLY BLANK

INADVERTENT DISCOVERY PLAN

ENHANCED NATURAL RECOVERY/ACTIVATED CARGON PILOT STUDY LOWER DUWAMISH WATERWAY

Introduction

The Lower Duwamish Waterway Group (LDWG) will conduct a pilot study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW) in Seattle, WA. The study will evaluate whether enhanced natural recovery (ENR) material amended with activated carbon (AC) can be successfully applied to reduce bioavailability in remediated contaminated sediment in the LDW.

Area of Potential Effects

Three plot areas for the pilot study designated as intertidal, subtidal, and scour plots, will be located in the LDW at approximately river mile 0.01, 1.2 and 3.9 in Seattle and Tukwila, King County, Washington. The project will require the placement of ENR material and ENR+ AC material in the LDW using a barge mounted fixed arm excavator with a clamshell bucket and does not require dredging of any sediments.

King County Historic Preservation Program (HPP) reviewed this project in August 2015, and concluded that the area of potential effects (APE) has a low probability of containing intact archaeological resources because all sites are located within the active river channel. HPP recommended that King County Wastewater Treatment Division WTD have an inadvertent discovery plan (IDP) in place during construction.

This IDP outlines procedures to follow if archaeological materials or human remains are discovered during construction associated with the project.

Regulatory Context

LDWG is conducting the project under an Administrative Order on Consent with the US Environmental Protection Agency (EPA) and the Washington State Department of Ecology (DOE); therefore EPA is the lead agency for this project. Because the project is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) action, regulatory permits are not required but the project must be conducted in a manner that meets substantive provisions of applicable regulatory requirements.

The project is also subject to state laws governing cultural resources, including Archaeological Sites and Resources (RCW 27.53), Indian Graves and Records (RCW 27.44), Human Remains Law (RCW 68.50), and Abandoned and Historic Cemeteries and Historic Graves (RCW 68.60). HPP reviewed the project for potential impacts to cultural resources as required by King County Executive Procedures for Cultural Resources (LUD 16-1 AEP).

Archaeological Resources

Archaeological resources include artifacts and features (such as prehistoric hearths). It is important to remain alert to unusual things, since every situation is unique. When in doubt, assume the material is an archaeological resource.

Some examples of potential archaeological resources are listed below. Photographs of typical archaeological resources are shown in Exhibit B.

Prehistoric Archaeological Resources

- Arrowheads or other stone tools, such as flakes of fine-grained stone
- Fragments of basketry, cordage, nets, or traps made of wood or bark
- Dark, slightly greasy layers of soil, perhaps with charcoal and/or broken rocks
- Soil with fragments of bone (fish, bird, mammal) and/or shell (freshwater or marine)
- Fire-darkened or -reddened rock, usually broken, and/or fire-reddened layers of soil

Historic Archaeological Resources

- Glass that is thicker or of different colors than modern beverage bottles
- Clusters of tin cans or bottles
- Brick
- Ceramics/pottery
- Wood posts or clusters of timber
- Logging or agricultural equipment that appears to be older than 50 years
- Constructed grades

Inadvertent Discovery of Potential Archaeological Resources

Contractor Responsibilities – Immediately Upon Discovery

If workers discover a potential archaeological resource, the Contractor is responsible for taking the following steps:

1. Immediately securing and protecting the discovery by suspending all ground disturbing activities within approximately 30 feet of the discovery, and cordoning off the discovery area if possible;
2. Securing all spoils piles, barges or trucks that may contain materials originating from the discovery area;
3. Collecting basic information (date/time, location and depth of discovery, personnel and equipment involved, general description of discovery), with photographs or illustrations if possible; and
4. Notifying the WTD Project Representative or Inspector.

Protecting the Discovery Area

Apart from actions immediately needed to assess or protect the discovery, such as covering or stabilizing soil, *ground-disturbing activity must be stopped within 30 feet of the discovery site*; construction may continue outside this area. Ground-disturbing activity within this 30-foot buffer may not resume until:

1. a professional archaeologist recommends a more situation-appropriate buffer to adequately protect the potential archaeological site, which is approved by HPP;
2. the discovery has been determined not significant by the Washington State Historic Preservation Officer (SHPO); or
3. the discovery has been determined significant and WTD, LDWG, HPP, EPA, SHPO, and consulting parties including affected Tribes have agreed upon a course of action.

WTD Responsibilities – Immediately Upon Discovery

The WTD Project Representative or Inspector will contact the WTD Environmental Planner and WTD Project Manager assigned to the project immediately. If possible, the WTD Project Representative or Inspector will provide photographs or illustrations of the discovery and information on its geographical location.

The WTD Environmental Planner will then contact HPP (Archaeologist Phil LeTourneau or Preservation Planner Charlie Sundberg) and other professional archaeologists as necessary to determine whether the discovery represents an archaeological site.

Archaeological Sites and Eligible Archaeological Resources

Federal, state, and local laws protect all prehistoric archaeological sites and those historic archaeological sites that have been listed OR determined eligible for listing in National Register of Historic Places (NRHP). Determining the eligibility of newly identified archaeological sites for listing in the NRHP generally requires two steps: 1) evaluation by and recommendation from a professional archaeologist and 2) concurrence from SHPO.

Isolated artifacts, both prehistoric and historic, are not considered “sites” under state and federal law and may not require special protection. *The determination of whether a discovery represents an archaeological site is the responsibility of a professional archaeologist.*

WTD Responsibilities – Determining Appropriate Course of Action

If HPP, or another professional archaeologist contacted by the WTD Environmental Planner at the time of the discovery, makes a preliminary determination that the discovery is an archaeological site, the WTD Environmental Planner will arrange, in coordination with the WTD Project Representative, WTD Project Manager and LDWG, for a professional archaeologist to document and evaluate the discovery. *On-site evaluation will occur within one day of its preliminary determination as an archaeological site.* The professional archaeologist will provide the WTD

Environmental Planner and the WTD Project Representative with a description of the discovery and a preliminary determination of whether or not it is significant. If the find is determined not significant, work may proceed without further delay. If it is determined to be significant, it will be recorded by a professional archaeologist on State of Washington inventory forms. Site overviews, features, and artifacts will be photographed; stratigraphic profiles and soil/sediment descriptions will be prepared for subsurface exposures. Discovery locations will be documented on scaled site plans and site location maps.

If the find is determined to be significant the WTD Environmental Planner will then communicate this information to EPA, who will contact SHPO unless EPA has delegated this responsibility to WTD. SHPO will determine whether additional archaeological work is necessary at the site If SHPO determines the discovery is eligible for listing, the WTD Project Representative will issue a formal Stop Work order within the buffer recommended by the professional archaeologist who evaluated the site. The buffer will be adequate to provide for the total security, protection, and integrity of the site. The buffer will be of a size and extent practicable to provide maximum protection to the resource while allowing for agency functions mandated by law, related to health, safety or environmental concerns. The archaeologist may direct work away from the site to work in other areas prior to contacting the concerned parties.

Discovery of Human Remains

Any human skeletal remains, regardless of antiquity or ethnic origin, will at all times be treated with dignity and respect.

Contractor Responsibilities – Immediately Upon Discovery of Human Remains

If workers believe they have discovered human skeletal remains, the Contractor is responsible for taking the following steps:

1. Immediately securing and protecting the discovery by suspending all ground disturbing activities within approximately 50 feet of the discovery, and cordoning off the discovery area; and
2. Notifying the WTD Project Representative or Inspector immediately.

WTD Responsibilities – Immediately Upon Discovery of Human Remains

The WTD Project Representative or Inspector shall first notify the King County Medical Examiner's Office and Seattle Police Department, and then notify the WTD Environmental Planner. The WTD Environmental Planner will contact HPP (Archaeologist Phil LeTourneau or Preservation Planner Charlie Sundberg) and EPA. A 50-foot work stoppage area shall be maintained around the discovery. Vehicles, equipment, and unauthorized personnel shall not be permitted to traverse or enter the discovery site. Construction excavations may continue outside the 50-foot work stoppage area. Remains will be covered with a tarp or other materials (not soil or rocks) for temporary protection in place and to shield them from being photographed. Employees and contractors will not call 911 or speak with the media regarding such a discovery.

The Medical Examiner will assume jurisdiction over the human skeletal remains and make a determination as to whether those remains are forensic or non-forensic. These persons will wear appropriate personal protective equipment (e.g., Tyvek suit, boot covers, and latex gloves) and will be escorted by an individual with 40-hour HAZWOPER training. Law enforcement or the coroner may require remains to leave the site without decontamination.

If the remains are forensic, the Medical Examiner will determine appropriate procedures for their disposition. If the remains are non-forensic, the State Physical Anthropologist (at the Department of Archaeology and Historic Preservation (DAHP)) will assume jurisdiction over the remains. The State Physical Anthropologist will make a determination as to whether the remains are Indian or Non-Indian and report that finding to EPA and appropriate Tribes and cemeteries. EPA will handle all consultation with SHPO and the affected parties as to the future preservation, excavation, and disposition of the remains.

No persons other than the proper law enforcement personnel, professional archaeologists, HPP staff, and SHPO staff shall be authorized direct access to the discovery location after the area is secured.

Contact Information

King County Wastewater Treatment Division	
Meredith Redmon, Environmental Planner	(206) 477-5488 office
Randy Brunke, Project Representative	(206) 477-5654
Jennifer Kauffman, Project Manager	(206) 477-5449 office
King County Historic Preservation Program	
Philippe D. LeTourneau, Archaeologist	(206) 477-4529
Charlie Sundberg, Preservation Planner	(206) 477-4538
Department of Archaeology and Historic Preservation	
Dr. Rob Whitlam, State Archaeologist	(360) 586-3080
Stephenie Kramer, Assistant State Archaeologist	(360) 586-3083
Dr. Guy Tasa, State Physical Anthropologist	(360) 586-3534
EPA	
Allison Hiltner, Project Manager	(206) 553-2140
[TBD], Archaeologist	[TBD]
King County Medical Examiner's Office	(206) 731-3232
Seattle Police Department (non-emergency)	(206) 625-5011

Potentially Affected Tribes – TO BE CONTACTED ONLY BY WTD
[TBD by LDWG]

Exhibit A. Area of Potential Effects

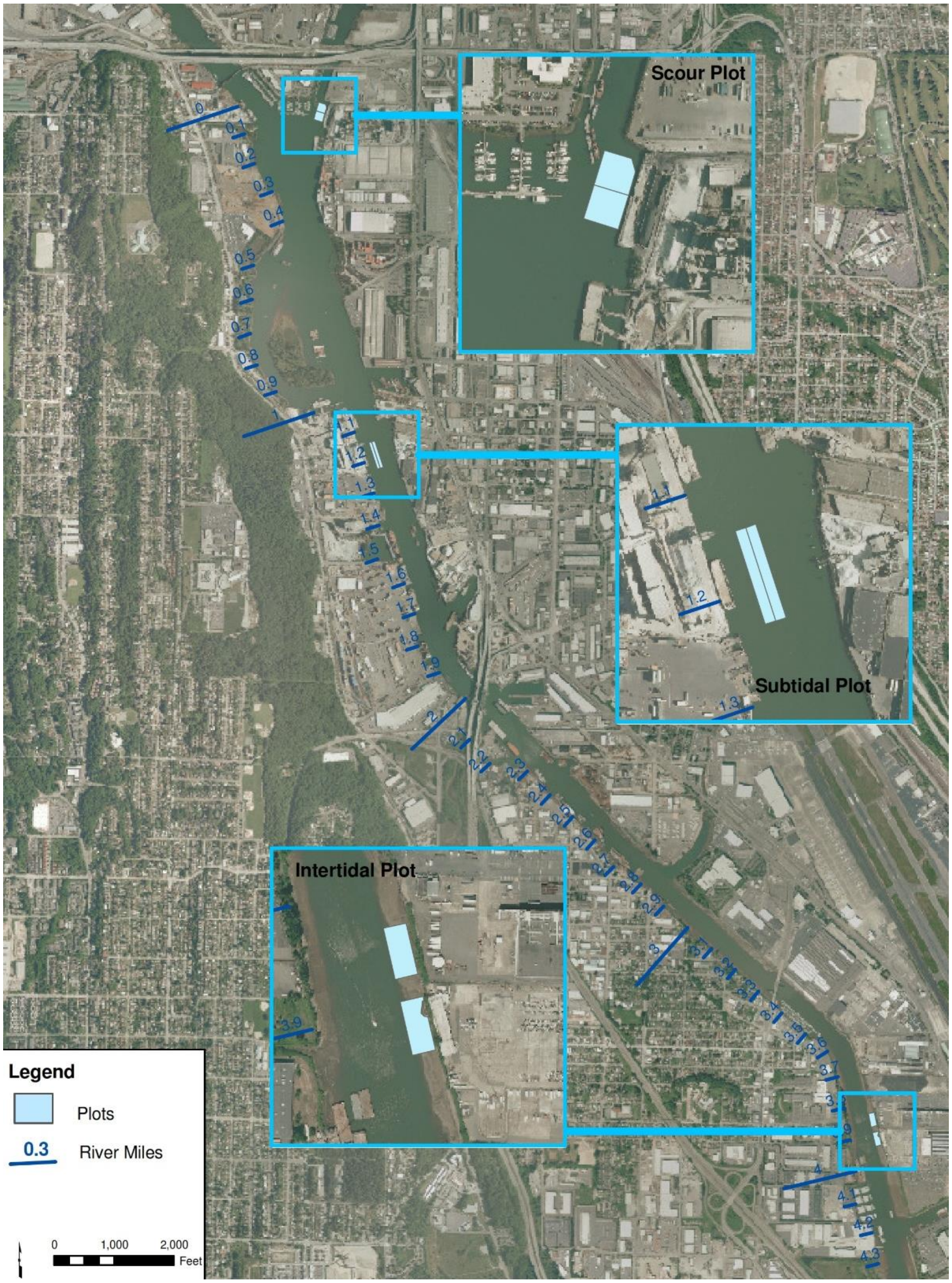


Exhibit B. Examples of Buried Cultural Resources

Stone artifacts

Fiber artifacts

Historic artifacts

Distinct layers of shells or historic debris

Unusual groupings of rocks, or fire-modified rocks

SECTION 01720

AS-BUILT DRAWINGS

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies providing as-built drawings and other record documents and information. For this Contract, the terms as-built drawings and record drawings are considered interchangeable and synonymous.

1.02 SUBMITTALS

A. Procedures: Specification Section 1300.

B. As specified:

1. For CAD produced electronic files of as constructed information: external USB drive or equal.

PART 2 PRODUCTS

2.01 GENERAL

A. Marked-up Contract Documents: Continuously maintain, update and correct mark-up information in dwg format. As-Built drawings and information shall be continuously updated to show:

1. Work accomplished to verify payment due.

2. Field changes of dimensions and details made by Contractor.

3. Changes made by Change Order, responses to Request for Information or Field Directives.

4. Dimensional location of all embedded, buried and concealed features as discovered or placed by Contractor. Items not located or shown on the Drawings but placed by Contractor shall be recorded and provided to the County as prescribed in this Section.

5. Locations of all spud sets within the Plot boundaries shall be recorded and provided to the County as prescribed in this section.

B. Record to the level of detail and accuracy and in units consistent with the Contract Drawings

2.02 SUPPLEMENTAL CONTRACTOR PRODUCED DOCUMENTS

A. When technical specifications require Contractor to produce information supplemental to that in the bid documents, produce and submit per the following CAD Construction Detail Drawings and Records requirements:

1. Submit Hard copy as well as electronic format copy:

   a. Drawings shall be AutoCAD 2010 or newer ".dwg" format files.

   b. Drawings on 11-inch by 17-inch paper.

   c. Information prepared by the Contractor for construction or installation which is supplemental to the information and detail on the Contract Drawings and as required in the Specifications.

   d. Reference appropriate Contract Drawings which show the work.

PART 3 EXECUTION

3.01 MARK UP COLORS

A. For mark-ups to the Contract set of Documents use CAD as required to maintain as-built drawings described in this section using the following color coding:

1. Red: Document changes

2. Orange: Dimensional and other notations

3. Green: Work deleted

3.02 ELECTRONIC MEDIA DRAWINGS

A. All drawings provided in electronic format shall be provided on an external USB flash drive in AutoCAD, Release 2010 or newer, "dwg" and in “PDF” format files with borders and title blocks clearly identifying the Contract and drawing number. Each file shall include the drawing number and drawing title in the filename. The equipment and the scope of the drawing shall be as required in the specifications.

B. Drawing quality and size of presentation legible at a 50 percent reduction of such drawings; reduced drawings will be used for insertion in operations and maintenance manuals.

C. Text size: 0.125 inch for 22 x 34 inch drawings, 0.063 inch for 11 x 17 inch drawings.

D. When requested by the Contractor, the Project Representative will provide electronic copies of the original Contract Drawings in AutoCAD “dwg” format.

3.03 RECORDING

A. Record information concurrently with construction progress. No work shall be concealed until the required information is recorded.

3.04 DELIVERY TO PROJECT REPRESENTATIVE

A. As-Built drawings will be used to verify and document progress as stated in progress payment request per Specification Section 01311. Work not included in the As-Built drawings is not documented as performed and will not be included for payment in progress payment requests.

B. Prior to request for notice for substantial completion of any area or system on the project, transmit document including Contract title, date, Contractor's name and address, index with title and number of each record document, statement indicating completion of record information for specific areas or, if for project close-out, that the documentation is completed and in compliance with Contract requirements attested by the signature of the Contractor or the Contractor's authorized representative.

C. Acceptance will not begin until draft copies of electronic and hard copy As-built documents are received and approved by the Project Representative. Revise As-built documents as a result of any changes made or discovered during commissioning.

END OF SECTION

SECTION 02221

BACKFILL (ENR & ENR + AC MATERIAL PLACEMENT)

PART 1 GENERAL

1.01 SUMMARY

A. The Work includes thin layer placement (6 to 9 inch target thickness) of Enhanced Natural Recovery (ENR) material or ENR material with granular activated carbon added (ENR+AC) at three locations (Plots) in the Lower Duwamish Waterway (LDW) using precision, instrumented fixed arm excavator with clamshell bucket, modified as necessary (or alternate to clamshell as approved by the Project Representative). This Section specifies requirements for the performance of the Work.

1. Each Plot area is roughly 1 acre in total size. Plots will be monitored by others for three years following construction. All Plots must be constructed in similar manner to provide similar baseline for monitoring at the various Plots. At each of the three plot locations, two separate subplots will be constructed. Each subplot is roughly ½ acre in size. At each plot location, one subplot will be constructed of ENR Material only (Sand or Gravelly Sand) and one subplot with the same ENR Material (Sand or Gravelly Sand) blended with Activated Carbon (AC) at 4% by weight. Sand ENR Material or Sand plus AC ENR Material shall be used at the subtidal plot and gravelly sand ENR Material or gravelly sand plus AC ENR Material shall be used at the Intertidal and Scour plots.

1.02 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revision of the following documents. These references are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of a listed document, the requirements of this Section shall prevail.

Reference	Title
Chapter 296-62 WAC	WISHA General Occupational Health Standards
Chapter 296-67 WAC	WISHA Process Safety Management Standards
Chapter 296-155 WAC	WISHA Safety Standards for Construction
RCW 49.17	Washington Industrial Safety and Health Act (WISHA)
EM 1110-2-1003	USACE Hydrographic Surveying Manual (EM 1110-2-1003, 11/30/2013, US Army Corps of Engineers)

1.03 SUBMITTALS

A. Contractor Work Plan as detailed in Part 1.07 of this Section and Specification Section 01300.

B. Contractor Quality Control (CQC) Plan as detailed in this Section.

C. Contractor’s Construction Schedule (to be updated weekly throughout performance of Work), as detailed in Specifications Section 01311.

D. Daily Reports as described in Specification Section 01300.

E. Weekly Reports as described in Specification Section 01300.

F. Monthly Report as described in Specification Section 01300

G. Environmental Protection Plan (EPP) including Spill Contingency Plan as described in Specification Section 01560.

H. Contractors Health and Safety Plan as described in Specification Section 01300.

I. ENR & ENR + AC Positioning and Navigation Systems Equipment List, Specifications, System description and verification methods as detailed in Specifications Section 02221 Part 3.03.

J. All Progress Surveys and Post- ENR & ENR + AC Placement Surveys performed by Contractor as detailed in Specifications Section 02221 Part 3.01 of this Specifications section.

K. ENR & ENR + AC material: Submit sample for each source and type of ENR & ENR + AC material to be used in the work.

L. Multibeam bathymetric survey results as detailed in Specifications Section 01050, section 3.05 of this Specification Section and Specification Section 01300.

M. Daily bucket placement files for ENR material placement in test placement areas or sub plots.

1.04 BACKFILLING (ENR & ENR + AC MATERIAL PLACEMENT)

A. The Project Area consists of three placement areas called "Plots", each approximately one acre in size, located within the Lower Duwamish Waterway. The three plots are referred to as the Intertidal Plot, Subtidal Plot and Scour Plot and are shown on the project Plans.

B. Each Plot has been subdivided into two subplots, each approximately ½ acre in size. At each Plot site, one subplot will be constructed using ENR Material and the second subplot constructed using ENR+AC material. The ENR Material will be Sand for the Subtidal Plot and Gravelly Sand for the Intertidal and Scour Plots.

C. Materials shall be placed using an instrumented, precision, fixed arm excavator with rotating clamshell bucket, modified as necessary to meet project objectives (or alternate as approved by Project Representative) and real time navigation system.

D. Real Time Navigation system may consist of any combination of positioning equipment including RTK GPS, gyro-compasses, angle indicators, computers, software or other equipment necessary to achieve +/-4" accuracy in X, Y, and Z axis, relative to the Project Datums, of the clamshell bucket in real time throughout ENR & ENR + AC placement operations.

1. Navigation system shall provide the operator real time digital information and graphical display of the equipment position, existing bathymetry, design placement elevation and actual bucket elevation. The system shall record the horizontal position and elevation at which the bucket is opened on each ENR & ENR + AC placement (each bucket position recorded at time of opening). The system shall display both plan view and cross section view of the placement area, floating platform including spuds and excavator, and the clamshell bucket.
2. The Contractor shall provide and set-up all equipment necessary to provide real time telemetry of all operator available data to the Project Representative at the office on floating plant for use by Project Representative. This includes data telemetry and all computer and display equipment.
3. The Contractor shall promptly provide all required service to the positioning and the telemetry systems for the duration of the Work. Contractor shall have personnel qualified in the systems' operations, setup and troubleshooting onsite whenever Work is being performed.
4. Contractor shall not perform material placement if navigation and positioning system is not fully operational and performing as required.

E. The Work consists of installing a suitable indoor work station for an ENR & ENR + AC placement observer (Field Engineer) on the ENR & ENR + AC placement plant in the vicinity of the equipment operator. This work station shall be equipped with:

1. Real time display of navigation system similar to operator display in cab on screen at least 24” size.
2. Suitable AC power for computer, lights and similar
3. Adequate line of sight to observe placement operations including unobstructed view of the material barge, placement location and clamshell bucket when above water surface. Location shall allow observer to see into the material barge to see bucket pick up material from within material barge.
4. Small desk or table and chair.

1.05 UTILITIES (UNDERGROUND, OVERHEAD ETC.)

A. It is the Contractor's responsibility to ascertain the locations and depths of any and all utilities or pipelines that may be buried below the waterway in the work area as well as potential overhead utilities in the work area or crossing the Waterway itself. It will also be the Contractor's responsibility to repair, at the Contractor’s expense, any damage to overhead or buried utilities or pipelines caused by the placement operations or other related vessel operations to the pre-project condition.

1.06 MISPLACED MATERIAL

A. Should the Contractor, during the execution of the work, lose, dump, throw overboard, sink or misplace anything whether it is material (includes sediment, debris etc.) or equipment, the dredge, barge, machinery, or an appliance, the Contractor shall promptly recover and remove the same. The Contractor shall give immediate verbal notice, followed by written confirmation, of the description and location of such material or equipment to the Project Representative and shall mark and buoy same until they are removed. Should the Contractor refuse, neglect, or delay compliance with this requirement, such material or equipment may be removed by the Project Representative, and the cost of such operations may be deducted from any money due to the Contractor, or may be recovered from his bond. The liability of the Contractor for the removal of a vessel wrecked or sunk without his fault or negligence shall be limited to that provided in Sections 15, 19, and 20 of the River and Harbor Act of 3 March 1899 (33 U.S.C. 410 et seq.).

1.07 CONTRACTOR WORK PLAN

A. Not later than 30 calendar days after the Notice to Proceed, the Contractor shall submit to the Project Representative a detailed, written project Contractor Work Plan. The outline for the Contractor’s Work Plan is included as Attachment A to this Specification Section and shall be used by Contractor in preparing their Work Plan. Contractor shall meet with Project Representative (Work Plan Meeting) prior to Work Plan preparation to review Work Plan contents and address any Contractor questions.

B. As shown in the outline, the plan shall contain the following:

1. Source of ENR & ENR + AC materials and the methods, procedures and equipment to be used for ENR + AC blending and transportation to site and storage of material. This should include details of any material rehandling steps.

2. Methods, procedures, and equipment for coordinating and performing multi beam hydrographic surveys. Provide details on survey equipment to be used (Manufacturer, Model, Year, Frequency (if applicable), Transducer Type (if applicable))

3. Methods, procedures, and equipment for placing ENR & ENR + AC material including:

   a. Excavator - Description of fixed arm excavator including type, size, model, year, boom and stick configuration, maximum depth below waterline for bucket pattern full width of barge, in 2 placement rows.

b. Navigation and positioning system – provide details on each component (Manufacturer, Model, Year, Accuracy, and resulting accuracy at clamshell bucket. Include Manufacturers specification sheet for each piece of navigation system.

c. Clamshell bucket type, size and manufacturer (or similar if other than clamshell is proposed by Contractor. Contractor may propose alternate to clamshell bucket for review and approval by Project Representative). Detail any proposed or potential modifications to clamshell bucket to improve material placement.

d. Spud Barge for excavator – description of spud barge on which excavator will be operated from, including barge dimensions (L, W, D), draft (when loaded and ready to perform placement operations).

e. Detailed description of how demonstration placement will be performed and how placement will be adjusted during demonstration to achieve project objectives.

f. Description of how ENR + AC material will be blended, loaded, handled, pre-soaked in barge and then placed to achieve project objectives.

g. Placement grid – initial grid based on bucket footprint and target 4.5” lift thickness which will then be tested during placement test and adjusted prior to placement of additional material within the Duwamish Waterway beyond limits of test plot area.

h. ENR & ENR + AC barges – details on ENR & ENR + AC barge size, load table, type, configuration, bin depth, capacity, draft (empty and loaded).

i. Barge Water Handling Equipment – description of equipment and procedures for pumping saline water from Duwamish Waterway into barges to pre-saturate AC, method to pump water from barges thru 1 micron bag filters prior to discharge to waterway. Barge Water Handling System including pumps, filters, pipelines etc. and shall be capable of 800 GPM flow rate during use.

j. Tugs - details on tug size, draft, drive type, horsepower.

4. Order in which the work is to be performed, indicating the work sequence; number, types, and capacity of equipment to be used; hours of operation; methods of operation; and the time required to complete each activity (based on each subplot). A list of key personnel and supervisory chain and contact information (email and cell phone) will be included.

5. Methods, procedures, and equipment for environmental protection and monitoring, including procedures for emergency spill containment and removal operations.

6. Contingency actions that will be used in the event that ENR or ENR + AC placement causes water quality exceedances.

7. Notification and procedures to be used for moving ENR & ENR + AC materials and equipment to accommodate commercial vessel traffic using the waterway. Operations will be coordinated and scheduled to reduce interference with this traffic.

C. Contractor shall submit in accordance with Submittals Specification Section 01300. Not later than 45 calendar days after the Notice to Proceed, the Contractor shall submit to the Project Representative a revised Contractor Work Plan in general conformance of the Contract (Review Action 1 or Review Action 2 with all markings incorporated).

1.08 CONTRACTOR QUALITY CONTROL PLAN

A. As an Attachment to the Contractor Work Plan, Contractor shall prepare and submit Contractor Quality Control Plan (CQCP).

1. In the CQCP Contractor shall detail:

   a. Testing and inspections to be done by the Contractor as directed in the project specifications,

      i. Methods for daily verification of Navigation and Positioning System

   b. Any other testing and inspections required to verify that the work meets the project specifications,

   c. Procedures for controlling the quality of construction work,

      i. Methods to control fill factor in bucket during placement

      ii. Methods to control water level within ENR+AC material barge during placement

   d. Procedures to document construction activities that affect the quality of work performed,

      i. Details of Hydrographic Survey Equipment, procedures, lead surveyor qualifications and licensing

   e. QA/QC procedures for all construction project monitoring, and

   f. Specify corrective actions to be performed in the event of over-placement, under-placement, or placement outside of the specified area for the ENR and ENR+AC material.

PART 2 MATERIALS

2.01 IMPORTED MATERIALS

A. Granular Activated Carbon (AC): Virgin, not regenerated carbon – Coconut fiber as source material. Sample of material, vendors name, manufacturers name, manufacturer's specification sheet, grain size testing results shall be submitted to Project Representative no more than 21 days after Phase 1 Notice to Proceed and at least 15 days prior to ordering AC for review and approval of proposed AC material. AC shall be relatively well graded across the grain size range of 200 to 1000 microns and approved by Project Representative. Contractor shall not order AC material for project until they have received written approval from the Project Representative.

B. Contractor shall leave sufficient time to determine alternate source, resubmit new sample and required submittals as described above and receive approval from Project Representative without delaying project, should first source be rejected by Project Representative for any reason.

C. AC - Total PCBs must not exceed lowest cleanup levels shown in LDW Record of Decision Tables 19 and 20, based on analysis to be performed by County. The Contractor shall provide samples of all material as requested by the Project Representative for QA testing.

D. Gravelly Sand ENR Material: Granular material which meets WSDOT Standard Specification 9-03.11 for Streambed Aggregates with the following gradation (modified from WSDOT standard) to contain minimum 50% sand (<4.75mm [#4 sieve] AASHTO):

GRAVELLY SAND ENR MATERIAL	
U.S. Standard Sieve Size	Percent Passing by Dry Weight
1-1/2”	100
¾”	80-90
3/8”	50-80
U.S. No. 4	50% min
U.S. No. 16	10-30
U.S. No. 200	0-2

E. Sand ENR Material: Granular material meeting WSDOT Standard Specification 9-03.1(2)B for “Class 2 Sand”, with gradation as follows:

SAND ENR MATERIAL	
U.S. Standard Sieve Size	Percent Passing by Dry Weight
3/8”	100
U.S. No. 4	95-100
U.S. No. 16	45-80
U.S. No. 50	10-30
U.S. No. 100	2-10
U.S. No. 200	0-2

F. ENR Materials (Sand and Gravelly Sand) must not exceed Washington State Department of Ecology SMS for Metals and total PCB’s must not exceed lowest cleanup levels shown in LDW Record of Decision Tables 19 and 20. The Contractor shall provide samples of all material as requested by the Project Representative in quantity and format requested for analyses to be performed by the County

2.02 BORROW SOURCE

A. ENR & ENR + AC material shall be from sources approved by the Project Representative and EPA/Ecology. Borrow supplier must have capability of thoroughly blending AC with borrow material with certified weight conveyors as material is loaded onto a barge.

B. All Granular material must be tested and determined to meet project specifications prior to blending or import. The Contractor shall provide samples to the Project Representative for testing.

C. The Contractor shall insure imported materials are natural, native, virgin materials of good quality, free of contaminants, including debris or recycled materials, and meet contract specifications. The Project Representative maintains the right to reject any materials which do not comply with the stated standards. In the event of rejection, it shall be the responsibility of the Contractor to remove all rejected material from the site and replace with suitable material.

D. The Contractor shall provide documentation of origin of borrow source material and maps identifying specific location of borrow source to the Project Representative.

E. The Contractor shall inspect the borrow source prior to material import. During the inspection, the Contractor shall assure that the materials to be delivered to the site are likely to meet the appropriate specifications. Contractor shall provide Project Representative one week's notice of such inspections. At Project Representative’s discretion, Project Representative may accompany the Contractor to witness such inspections. This witnessing shall in no way release the Contractor from complying with the specifications and in no way shall be construed as approval of any particular source of material.

F. Upon selection of a source of Sand and gravelly sand materials to be imported, Project Representative will visit the source and collect sample(s) for analyses to verify compliance with Project criteria.

G. At time of ENR material and AC blending, Project Representative will observe blending and collect samples of blended material to verify AC content. Contractor shall provide Project Representative at least 3 days' notice, by email, of all AC blending and barge loading activities. Any barges loaded without proper notification to the Project Representative may result in rejection of material at Project Representatives discretion at sole expense of contractor.

H. The Contractor shall visually inspect each barge of imported material upon delivery prior to placement. Material shall be inspected for presence of foreign, recycled, or reprocessed material. Project Representative may at any and all times perform an independent inspection. Material may be rejected due to identification of material not meeting the contract specifications or as a result of test results not meeting the contract specifications. Materials may be segregated for testing based on appearance or odor. Segregated material may be tested according to designated procedures at the discretion of Project Representative.

2.03 MATERIAL PREPARATION

A. ENR Material (Sand or Gravelly Sand as required) + AC shall be thoroughly pre-blended to reach uniform, target concentration (nominal 4% AC, dry weight basis based on blend quantities of ENR and AC) at time of barge loading. AC content to be measured by Project Representative in roughly 1 sample per every 500 tons collected by Project Representative at time of barge loading This is for information purposes only as acceptance criteria will be based on dry weight blend quantities.

B. Prior to placement, blended ENR+AC Material shall be loaded onto a suitable, watertight barge. Barge shall be capable of holding appropriate quantity of soaked material for efficient placement with adequate freeboard to prevent overtopping.

C. Blended ENR+AC Material shall be pre-soaked within flooded, water tight (bin) barge for a minimum of 12 hours prior to placement, or placement demonstration as described in 3.02. Water level in barge should be kept at least 1-2 inches above the material, as practicable (can be slightly deeper provided barge stability is not a concern). As material is removed from the barge, pump the water from the barge (using a bag filter 1 micron sizing to remove turbidity and comply with WQ Memo) in order to maintain approximately a 1-2" water depth above the material

D. Once on-site, ENR+AC Material shall be kept saturated at all times to extent practicable prior to and during placement.

E. ENR material that is not amended with AC should be loaded in suitable barge capable of holding appropriate quantity of material for efficient placement with adequate freeboard to prevent overtopping. Pre-soaking of ENR material that is not amended with AC is required.

2.04 MATERIAL QUANTITY

Quantities shown below are the Base Quantity for the Contractor to blend and mobilize to the site. Additional material may be needed, as directed by the Project Representative.

A. Base quantity determined using 9 inches (0.75 feet) average thickness over the placement area, a 1:4 slope (V:H) of ENR material around plot to meet existing grade, 5% loss allowance (material left on barge, lost during test placement, lost during placement) and 1.7 tons per cubic yard conversion factor (in water placed density of ENR material), and a 4% by weight AC addition. Actual quantity required to complete plots may vary based on actual field conditions, placement tolerance and accuracy, quantity lost on barge during demonstration and placement and similar. If base quantity results in extra material remaining on barge after required placement area is completed to PR satisfaction, extra material shall be placed adjacent to plots as shown on the Plans after approval from PR to perform such placement. If Base Quantity is insufficient Contractor shall import additional material as directed by the Project Representative.

ENR Material Quantity Estimate	**Intertidal Plot**		**Sub Tidal Plot**		**Scour Plot**	
Sub Plot Type	**ENR**	**ENR+AC**	**ENR**	**ENR+AC**	**ENR**	**ENR+AC**
Sub Plot Width (Feet)	100	100	52	52	145	150
Sub Plot Length(Feet)	221	221	466	466	150	150
Sub Plot Perimeter (Feet)	642	642	1035	1035	590	600
Sub-Plot Area (SF)	22,090	22,090	24,111	24,111	21,780	22,536
Average Thickness (FT)	0.75	0.75	0.75	0.75	0.75	0.75
Slope at edge of Plot (Assumed 1:4)	4	4	4	4	4	4
CY ENR per Sub Plot	649	649	727	727	638	659
Tons/CY (placed, in water, Estimated)	1.7	1.7	1.7	1.7	1.7	1.7
Tons Material per sub plot	1,110	1,110	1,240	1,240	1,090	1,130
Contingency (%)	5%	5%	5%	5%	5%	5%
Tons Material per sub plot (including contingency)	**1166**	**1166**	**1302**	**1302**	**1145**	**1187**

AC Quantity						
AC % (to be blended)	0%	4%	0%	4%	0%	4%
AC (Tons) per sub-plot	**0**	**47**	**0**	**52**	**0**	**47**

ENR Material (Sand or Gravelly Sand)						
% by weight	100%	96%	100%	96%	100%	96%
ENR Material (Sand or Gravelly Sand) Tons	**1,166**	**1,119**	**1,302**	**1,250**	**1,145**	**1,140**

B. In addition to ENR and AC Material quantities listed above, Contractor shall supply an additional 141 tons of sand plus 4% AC (6 tons AC, 135 tons sand)) ENR material for in water test placement of sand plus AC ENR material.

PART 3 EXECUTION

3.01 ENR & ENR + AC PLACEMENT EQUIPMENT

A. A spud barge capable of holding equipment in place during placement operations while keeping spuds, anchors, chains, wires, etc. from contacting or disturbing areas where ENR or ENR+AC material has been placed shall be used for ENR & ENR+AC operations.

B. The spud barge shall be equipped with a fixed arm excavator that meets the following criteria:

1. The contractor shall provide excavator that is less than 5 years old (Model year 2010 or newer) and have less than 5,000 operating hours, in good operating condition, and with no visible leaks. All hydraulic hoses and fitting shall be in new or like new condition to reduce potential for leaks.

2. The contractor shall provide excavator that is capable of placing a full bucket at the extended reach and is capable of placing at least two bucket rows, measured from front of barge out, at full project depths (based on up to +8 MLLW tide) from a single spud setting.

3. Navigation system as described in E below.

C. Tug boat of appropriate size and draft capable of positioning the spud barge and material barge. Tug captain is to be aware of tide elevations, mudline elevations, and tug draft requirements. Tug shall not disturb the river bed with prop wash causing the underlying sediment to be suspended in the water column prior to or during ENR/AC placement or disturbing the ENR/AC after placement. Observations of turbidity resulting from tug boat operations shall require modification of operations by tug boat. Project Representative will observe operations of tugs in areas of test placement and plots and provide notice to contractor of any observed turbidity resulting from tug operations.

D. Material shall be placed using sealed clamshell bucket (or alternate as approved by the Project Representative).

1. Clamshell (if used) shall be in good condition with overlapping side plates, relatively leak proof to extent practicable and necessary (based on visual observation by Project Representative before and throughout material placement. Bucket shall be properly vented to prevent loss of material during descent through the water column.

2. Side plates and cutting edges shall be replaced as necessary to limit leakage.

3. Volume of bucket and placement area achieved upon opening of bucket shall be known and adjusted as necessary to achieve an approximate 4.5 inch lift over as large of the bucket footprint area as practicable based on bucket characteristics such that when material is placed in two lifts, using an offset grid bucket pattern, an approximate 9 inch lift is achieved over the plot area as practicable. Contractor shall modify clamshell as appropriate for venting air from bucket and for adjusting placement thickness to meet project objectives. Such modifications may need to be done during the test placement operations. Contractor shall have all required materials, personnel and equipment onsite during test placement to make such modifications as necessary. Contractors work plan shall describe how they intend to initially attempt to meet project objectives and will modify equipment and factors such as bucket pattern to meet project objectives.

E. The excavator shall be equipped with an Electronic Navigation and Positioning System capable of:

1. Accurately determining position of clamshell bucket (or similar) to +/- 4 inch accuracy in X, Y and Z axis, relative to project datum, in real time. Accuracy shall be verified at start and end of every shift, at a minimum.

2. Bucket rotation/orientation.

3. Bucket open/close position.

4. Displaying project area and features, bathymetry, water level, barge and/or dredge or work platform location (to include spuds) and clamshell bucket (or similar) in both plan and cross section views in real time.

5. Accounting for any effects of river current on clamshell bucket position underwater compared to position of navigation equipment above water and displaying proper position in real time relative to project datum.

6. Record actual bucket opening location (X, Y and Z) and time for each bucket of material placed.

7. Electronic tide gauge shall be used to determine real time water surface elevation.

3.02 PLACEMENT METHOD DEMONSTRATION AND CALIBRATION

A. Prior to placement in subplots, Contractor shall demonstrate and verify intended placement method to demonstrate ability to meet specifications to Project Representative's satisfaction.

B. Contractor shall test, calibrate and verify bucket volume, required fill factor, placement area and placement thickness by trial placement of the material in designated demonstration areas prior to placement in designated subplots.

1. Contractor shall schedule placement demonstration to take place within one of the two timeframes (1) November 29th, 2016 through December 1st, 2016 or (2) December 12th, 2016 through December 16th, 2016.

2. Contractor shall complete all necessary mobilization and equipment testing prior to any in water test placement. The placement demonstration shall be performed by the Contractor during the second high tide of the day in a minimum of 5 foot[1] water depth at the test placement area.

3. Contractor Supervisory staff including Project Manager, Superintendent, Project Engineer and operator who performed placement shall be onsite to evaluate placement during low tide that occurs during night time hours on day that test placement was performed. Contractor shall provide suitable boat transportation to and from test placement area for night time field inspection including transportation of King Count, LDWG or agency representatives as necessary. Contractor shall provide suitable lighting for safe operations and inspection.

4. Test placement shall occur only in the designated demonstration area and cover the demonstration area in its entirety as directed by the Project Representative

5. Demonstration area shall have clearly marked breakaway grade stakes installed by King County so placement thickness may be verified. Grade stakes will be placed approximately 1 every 100 ft^2. Contractor shall coordinate with King County for installation of grade stakes at test placement area.

6. Contractor shall prepare demonstration ENR+AC material (both for Sand + AC and Sandy Gravel +AC) by filling water-tight (verified no leaks) barge with blended ENR + AC material to an appropriate depth, then filling the barge with water pumped from the Duwamish Waterway up to a level approximately 1-2 inches above the material. Material shall be soaked underwater for a minimum of 12 hours prior to demonstration.

7. Within each test placement area Contractor shall place 2 lifts over approximately 75% of the test placement area and only one lift over approximately 25% of the test placement area such that the results of single lift placement and double lift placement can be evaluated and information used to adjust placement as necessary to meet project objectives. Within the test placement area located within the intertidal plot the area where only one lift is placed during

---

[1] Except in higher elevation portions of intertidal plot where 5 foot water depth is not practicable due to limits of mean higher tide. Placement in such locations shall be done during periods of high tide as approved by Project Representative.

the Test Placement shall have a second lift placed as part of the placement within that sub plot.

8. The Contractor shall place the second lift such that the bucket is offset by one half the bucket's length and width from the first lift. Contractor shall work proactively with Project Representative throughout test placement to develop final placement pattern and methodology that is consistent with project objectives.

   a. Contractor and Project Representative to inspect test placement for coverage, uniformity of placement, and minimum and maximum thicknesses. Project Representative will verify test placement thickness by reading grade stakes during the following low tide in the demonstration areas and approve thickness of placed material with thickness value of 6-9 inches at 80% of locations with no single location less than 4 inches in the area where two lifts were placed. Note that this low tide will occur during night time hours.

   b. If required thicknesses are not achieved to satisfaction of Project Representative, Contractor shall adjust bucket grid pattern and/or bucket size or capacity as necessary to improve performance such that as large an area as practicable has a placement thickness of approximately 4.5 inches, with a second offset placement resulting in a total placement thickness of approximately 9 inches overall in a demonstration area designated by the Project Representative on the second high tide of the following day.

C. Contractor shall assume 1 full day (10 hours) of demonstration placement and adjustment for each of two material types (Sand + AC and Sandy Gravel +AC) for a total of two demonstration days (actual demonstration placement, not including setup, barge or equipment movement, or preparation). Additional days may be necessary as determined by the Project Representative to develop procedure that meets project objectives.

D. Water used to flood material barge may be discharged to the Duwamish Waterway after passing thru filter media of 1 micron (project representative to approve of filtration method and operation), provided that water quality exceedances do not result, as verified by Project Representative.

3.03 PLACEMENT METHOD

A. All floating equipment shall be positioned and spudded without disturbing Plot Areas beyond minimum necessary. Spuds shall not contact Plot areas once ENR or ENR+AC material has been placed within that Plot area.

B. Contractor shall not disturb plots in any way once material has been placed.

C. At any plot location, the Contractor shall place and complete the AC amended subplot first, prior to placing the NON-AC amended subplot.

1. Pre-Soaked material (ENR+AC) shall be kept saturated during placement to extent practicable.

2. ENR material without the amended AC shall be pre-soaked similar to AC amended material unless otherwise approved by the Project Representative.

3. For ENR + AC material, clamshell (or similar) shall remove pre-soaked material from material barge and quickly lower bucket below the Duwamish Waterway surface to appropriate vertical position approximately 2 feet above river bed. Bucket shall not contact river bed at any time during placement. Material shall not be released from above the water surface or from higher than 2' above bed without approval by the Project Representative.

a. If Project Representative approves use of non-pre-wetted ENR material, Contractor shall use clamshell (or similar) to remove dry material from material barge and lower bucket to just below the Duwamish Waterway surface; Contractor shall then pause the bucket so that it can saturate before lowering to appropriate vertical position approximately 2' above river bed. Bucket shall not contact bed at any time during placement.

D. With bucket approximately 2 feet above river bed, and properly positioned horizontally over the intended target area, bucket shall be opened in a manner intended to produce as uniform a layer of material on the bottom as possible. Bucket shall be held in position and not swung during placement.

E. In order to avoid the use of spuds over areas where material has already been placed, the Contractor shall use the following grid pattern, unless otherwise approved by the Project Representative: start placement at the far end of the plot; start placement with farthest rows out from the excavator; complete two adjacent rows, then perform the second pass on the first row (consistent with the second pass grid pattern deemed acceptable during the Demonstration Placement); continue pattern until the closest row attainable by the excavator is reached; step or move material barge backwards (away from area just placed); repeat pattern.

F. Contractor shall not set spuds more than necessary to efficiently perform the work within any Plot. Contractor shall record locations of ALL spud set locations within plots and provide X, Y data file listing all spud set locations by subplot by date.

G. Adjacent buckets shall be placed with pre-determined overlap, as developed during demonstration placement procedure, intended to produce uniform 4.5 inch lift thickness to extent practicable.

1. Material shall be placed using 2 lifts of approximately 4.5 inches each, with lifts offset in X & Y direction by ½ bucket dimension (Length or Width as appropriate) in each direction.

2. During placement operations, operator shall use precise navigation system and real time display to place each clamshell bucket (or similar) within pre-planned grid area. Buckets shall be placed in sequential fashion.

3. In areas of steeper slopes, material shall be placed starting from toe of slope and proceeding upslope to extent practicable, without setting spuds in areas where ENR material has already been placed.

4. Navigation system shall display pre-programmed bucket placement locations for each bucket to be placed to guide operator during placement

5. System shall record position (X, Y and Z) for each bucket of material placed to data file. Placed buckets shall be displayed on screen using separate colors for each lift as placed. Bucket placement files shall be provided to Project Representative daily.

6. Operator visible data shall be telemetried in real time to Project Representative/Project Engineer office provided by Contractor on floating plant for Project Representative monitoring.

7. During active placement operations bucket cycle times of 50 to 90 seconds are to be targeted, pending water quality impacts or other issues identified by the Project Representative. Cycle times exceeding 120 seconds will require action by Contractor to reduce cycle time as appropriate, potentially including replacement of operator, as requested by the Project Representative.

3.04 PLACEMENT VERIFICATION

A. Thickness of placed material will be verified after construction using breakaway grade stakes set by King County prior to ENR material placement by Contractor.

   1. Prior to placement of ENR material in the waterway, King County will place grade stakes at 15 locations within each subplot, as shown on the Plans. Stakes will be installed to protrude 1.5 feet (18 inches) above existing grade at each location. Stakes will be clearly marked in 1 inch increments prior to installation and the reading at the mudline recorded at time of installation. Stakes will be installed with appropriate embedment length for sediment properties in order to resist overturning during placement of ENR material.

   2. Contractor shall then perform material placement as required, taking care to keep bucket a minimum of 2' above river bed bottom elevation at all times, using navigation system for guidance.

   3. Contractor shall complete 100% coverage of sub plot as observed by Project Representative and documented by navigation system and recorded bucket placement data file recorded by contractor and provided to Project Representative.

   4. Placement thickness and coverage will then be confirmed by Project Representative's diver's measurements of the grade stakes after material placement is completed, as directed by the Project Representative. Divers will record placed thickness as shown on each grade stake. Divers will also swim transects across Plot to visually verify coverage to extent practicable based on field conditions including visibility.

B. Acceptance Criteria

   1. The acceptance criteria for ENR or ENR+AC Material placement thickness and coverage are:

   2. Material placed within each sub-plot is weight equivalent to a 9 inch nominal layer for the area, based on scale tickets and/or barge draft during placement, as measured by the Project Representative, or as directed by the Project Representative.

   3. Placement thickness of 6-9 inches in 80% of stake locations per plot; and

   4. Placement minimum thickness of 4 inches at 100% of stake locations per plot.

   5. No placement that impedes navigation based on exceeding authorized channel depth within authorized navigation channel (i.e. if authorized channel depth is -30 MLLW, final placement within plot will be below elevation -30 MLLW).

   6. Acceptance criteria will be verified by King County divers from the reading of pre-placed grade stakes.

C. If results of diver measurements, as evaluated by the Project Representative indicate areas that do not meet the minimum thickness criteria, Contractor shall work with Project Representative to determine where additional material shall be placed and how much material shall be placed.

   1. Additional diver measurements would then be performed in area of additional material placement.

D. Divers will also perform visual survey of general placement surface variation, coverage and roughness. Based on observations and discussions with Project Representative, divers may be directed to perform additional investigation in areas including diver probes or hand cores. If areas of thin placement (less than 4 inches) are noted, Project Representative will direct Contractor to place additional material as necessary.

E. If Project Representative determines that over placement has occurred based on grade stakes or hydrographic surveys such over placement shall be addressed as described below in section 3.05 below.

3.05 OVERPLACEMENT

A. Contractor shall target placement of relatively uniform 9 inch layer over entire subplot area (placing volume equivalent to 9 inch layer). In the event that material is over placed to the extent that it interferes with navigation or presents a safety hazard, as determined solely by the Project Representative based on grade stakes or hydrographic surveys and known navigation requirements or other information, excess material shall be immediately relocated using the instrumented excavator and clamshell bucket. If over placement is due to Contractor error, relocation shall be at Contractors sole expense and shall be performed to satisfaction of Project representative

   1. Material relocated in this manner shall be relocated to the perimeter of the subplot and then placed as an enlargement of the subplot.

B. In slope areas it is anticipated that some sloughing of the required materials may occur and that over placement near bottom of slope may result at no fault of Contractor.

C. In areas of debris or significant grade changes it is anticipated that placement thicker than 1' may be necessary to achieve minimum thickness in adjacent area.

3.06 MULTI-BEAM HYDROGRAPHIC SURVEYS

A. Contractor shall perform multi-beam hydrographic surveys as described in Specifications Section 01050.

   1. Pre and post material placement surveys to be performed a minimum of 50' beyond each sub plot or test placement area unless access is restricted by docks, vessels, other hazards or navigable depth.

   2. Pre and post surveys will be used by the Project Representative to help evaluate placement thickness within each sub-plot or test placement area.

   3. Daily surveys of the day's placement area to help evaluate placement results, coverage, thickness and slope sloughage as practicable.

   4. As-built survey shall be performed of each sub Plot at completion of placement within that sub Plot.

3.07 WATER QUALITY MONITORING

A. Water Quality monitoring will be performed by King County per the EPA approved Water Quality Monitoring Plan referenced in Specification Section 01012.

B. The Project Representative will monitor the Contractor's placement activities for compliance with the requirements of the Section 401 Water Quality Memo and other substantive requirements. Compliance will be measured and determined by the Project Representative.

C. If water quality exceedances at any of the monitoring stations are noted, the Contractor will be required to adjust or modify its operations until compliance is achieved. This may include slowing of placement operations. In the event of a water quality exceedance as defined in the EPA issued 401 Water Quality Memo, Contractor may be required to cease work until water quality improves.

D. The Contractor may be required to make modifications that include, but are not limited to, installation of silt curtains or debris booms.

END OF SECTION

THIS PAGE LEFT INTENTIONALLY BLANK.

ATTACHMENT A

Outline for Contractors Work Plan

THIS PAGE LEFT INTENTIONALLY BLANK

Attachment A: Contractor Work Plan Outline

1.0 Introduction

2.0 Contractor Organization

2.1 Organization Chart

2.2 Key Personnel - List of key personnel, their responsibilities, and supervisory chain and contact information (email and cell phone).

3.0 Safety

4.0 Approach Overview

4.1 Work Sequence

4.2 Schedule

4.3 Layout

4.4 Dock Location

4.5 Project Office Location

5.0 Work Approach Narrative

5.1 Mobilization

5.1.1 Staging and Stockpile Area Location and Setup

5.1.2 TESCs for Stockpile Area

5.1.3 Site Security

5.2 Materials (ENR and ENR + AC)

5.2.1 Source of ENR and AC Materials

5.2.2 Source, Certifications, Gradation for AC

5.2.3 Materials, methods, procedures and equipment to be used for ENR + AC blending, barge loading and transportation to Site

5.2.4 Storage of ENR and ENR + AC to include protection of material against erosion bot on barge and prior to barge loading or other stockpiling

5.2.5 Material Handling including ENR + AC soaking procedure

5.3 Equipment Used for Placing ENR and ENR + AC Material

5.3.1 Excavator- Description of excavator to include type, size, model, year, boom, stick, and column (if applicable) configuration, maximum depth below water line for bucket pattern full width of barge, into placement rows. Tide limitations of excavator with proposed boom, stick, and bucket configuration.

5.3.2 Clamshell Bucket- Type, size, and manufacturer (or similar if other than clamshell is proposed by Contractor. Contractor may propose alternate to clamshell bucket for review and approval by Project Representative or designee). Detail any proposed or potential modifications to clamshell bucket to improve material placement.

5.3.3 Navigation and Positioning System – provide details on each component (Manufacturer, Model, Year, Accuracy, Location on Equipment, and resulting accuracy at clamshell bucket. Include Manufacturers specification sheet for each piece of navigation system.

5.3.4 ENR and ENR + AC Material Barges – Details on ENR and ENR + AC barge size, load table, type, configuration, bin depth, capacity, draft (empty and loaded).

5.3.5 Barge Water Handling Equipment – Description of equipment all used (to include valves, piping/hoses, bag filters, pumps, etc.) for pumping of saline water. Documentation or calculations to demonstrate that system is capable of 800 gpm flowrate during use.

5.3.6 Spud Barge for excavator – description of spud barge on which excavator will be operated from, including barge dimensions (L, W, D), draft (when loaded and ready to perform placement operations).

5.3.7 Tugs - details on tug size, draft, drive type, horsepower.

5.4 Methods and Procedures to be during ENR and ENR + AC Placement

5.4.1 Description of how ENR + AC material will be blended, loaded, handled, pre-soaked in barge and then placed to achieve project objectives.

5.4.2 Detailed description of how demonstration placement will be performed and how placement will be adjusted during demonstration to achieve project objectives.

5.4.3 Placement grid – initial grid and fill factor based on bucket footprint and target 4.5” lift thickness which will then be tested during placement test and adjusted prior to placement of additional material within the Duwamish Waterway beyond limits of test plot areas. Contractor to provide details on proposed bucket, why selected, anticipated coverage footprint and related fill factor intended to meet project objectives.

5.4.4 Order in which the work is to be performed, indicating the work sequence; number, types, and capacity of equipment to be used;

hours of operation; methods of operation; and the time required to complete each activity (based on each subplot).

5.4.5 Methods, procedures, and equipment for environmental protection and monitoring, including procedures for emergency spill containment and removal operations.

5.4.6 Contingency actions that will be used in the event that ENR or ENR + AC placement causes water quality exceedances.

5.4.7 Notification and procedures to be used for moving ENR & ENR + AC materials and equipment to accommodate commercial vessel traffic using the waterway. Operations will be coordinated and scheduled to reduce interference with this traffic and work within scheduled daily bridge closure windows.

5.5 Hydrographic Survey

5.5.1 Methods

5.5.2 Procedures (Survey and Quality Control)

5.5.3 Equipment used (Manufacturer, Model, Year, Frequency (if applicable), and Transducer Type (if applicable)).

5.5.4 Anticipated survey schedule

5.6 Refueling procedures both on and off water

5.7 Noise control and response to noise complaints

THIS PAGE LEFT INTENTIONALLY BLANK.

SECTION 408 MEMORANDUM

Substantive Compliance Memorandum
for Placement of Subtidal Pilot Plot in the Federal Navigation Channel

THIS PAGE LEFT INTENTIONALLY BLANK.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

October 21, 2015

Ms. Ellen Hale
Environmental Protection Agency, Region 10
1200 Sixth Avenue
Suite 900, MS ECL-122
Seattle, WA 98101

Dear Ms. Hale:

The Seattle District, U.S. Army Corps of Engineers (District) conducted an agency technical review of the proposed alteration to the Lower Duwamish Waterway – Seattle Harbor Federal Navigation Project. The review ensured substantive compliance with 33 CFR 408 (Section 408) and excluded the procedural requirements of the policy. Per the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 42 USC 9621(e)(1), a permit from the Corps under Section 408 is not required for the proposed action to alter the authorized Federal navigation project. Therefore, this letter serves as notice that the District has completed a technical review and determined the proposed project is in compliance with the substantive requirements of Section 408.

The District's technical review included the proposed Lower Duwamish Waterway Enhanced Natural Recovery and Activated Carbon Pilot Study's potential to adversely impact: 1) the authorized purpose of the Federal navigation channel; 2) the District's ability to operate and maintain the project; and, 3) public interest. Based upon the District's technical review, the District determined that the designs and analyses provided for review are adequate, and that the proposed alteration will not have adverse impacts to the function of the authorized Federal navigation project, will not impair the usefulness of the authorized Federal navigation project, and will not be injurious to the public interest.

The District further notes the following responsibilities and clarifying actions as this Pilot Study moves forward toward construction and into the final remedial actions:

- The District requires the grade stakes to be made of a flexible material such as thin walled PVC, which will deform if impacted by a vessel. The District further requests the Environmental Protection Agency (EPA) to coordinate location of grade stakes with the local Coast Guard station to ensure mariners are aware of their presence in the channel. Grade stakes should be clearly marked and removed at the end of the Pilot Study.
- The District will require all final designs to be coordinated with the District staff prior to construction.

- All final as-builts will be required to be turned over to the Seattle District Navigation Program Manager, Elizabeth Chien, who can be reached at (206) 316-3968 and via email at Elizabeth.A.Chien@usace.army.mil.
- EPA and the Lower Duwamish Waterway Group (LDWG) are responsible for all O&M and Monitoring activities for the proposed Pilot Study. The District and the Port of Seattle will remain responsible for all operations and maintenance activities of the Lower Duwamish Waterway navigation project.
- The District will require that LDWG and EPA keep the District aware of construction schedule and efforts. Please contact Elizabeth Chien, Navigation Program Manager, at (206) 316-3968 or Elizabeth.A.Chien@usace.army.mil to coordinate prior to and during construction.
- The District notes that any dredging maintenance activities conducted by the District could remove portions of the clean Enhanced Natural Recovery (ENR) and ENR+Activated Carbon layer placed in the sub-tidal plot within the boundaries of the Federal navigation channel. The District will not be responsible for replacing any of the removed materials.
- This Section 408 ATR is only to support the Pilot Study. The review conducted does not preclude any future Section 408 technical reviews and does not automatically grant future permissions or compliance determinations to support the Superfund project.
- No Regulatory Permit actions under the direct authority of the Corps of Engineers were required to support the proposed alteration.

This determination reflects the information available at the time of review of the LDWG's submittal, *U.S. Army Corps of Engineers – Section 408 Substantive Compliance Memorandum for Placement of Sub-tidal Pilot Plot in the Federal Navigation Channel* dated September 23, 2015. Enclosed is the District's Finding of Summary developed by the District's agency review team. Consequently, should the proposed project be modified prior to implementation, the LDWG and EPA should advise the District of any alterations and allow the District an opportunity to review further.

Should you have any questions regarding this evaluation and action, please contact Keely Brown, Section 408 Coordinator, at email keely.n.brown@usace.army.mil or (206) 764-3434.

Sincerely,

for Frances E. Coffey, P.E, PMP
Chief, Operations Division
Seattle District

Encl

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

CENWS-EN

MEMORANDUM FOR RECORD

SUBJECT: Summary of Findings - Lower Duwamish Waterway Enhanced Natural Recovery and Activated Carbon Pilot Study Substantive Compliance Section 408 Review

1. <u>References.</u>

a. EC 1165-2-216, 31 July 2014, Policy and Procedural Guidance for Processing Requests To Alter US Army Corps of Engineers Civil Works Projects Pursuant to 33 USC 408.

2. <u>Overview of Summary of Findings and Conclusions For Recommending Approval.</u>

This Summary of Findings documents the U.S. Army Corps of Engineers (NWS) agency technical review (ATR) of the alteration or temporary occupation of the NWS completed project, Lower Duwamish Waterway –Seattle Harbor Navigation Project and the proposed alteration's compliance with the substantive requirements of 33 USC 408 (Section 408). In accordance with reference 1a, NWS conducted its ATR to determine whether the proposed project – Lower Duwamish Waterway (LDW) Enhanced Natural Recovery and Activated Carbon (ENR+AC) Pilot Study Project (Pilot Study) is not injurious to the public interest or affects the Federal project's ability to meet its authorized purpose. The review ensured substantive compliance with reference 1a, and excluded the procedural requirements identified in reference 1a such as public notices to accept funding, implementation of memorandum of agreements, and NEPA compliance. As a Federal agency, the Environmental Protection Agency (EPA) ensured environmental compliance for the Pilot Study.

Based upon the technical reviews, NWS has determined that the proposed alteration to the Federal navigation channel will meet U.S. Army Corps of Engineers (USACE) engineering and safety standards and will not have significant adverse affects on the function of the LDW Federal navigation channel and its authorized purpose. The design of the proposed modifications is adequate, technically feasible, not injurious to the public, and will not impair the usefulness of Federal navigation project.

3. <u>Substantive Requirements for CERCLA Projects.</u>

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9621(e)(1) states that, "no Federal, state, or local permit shall be required for the portion of any removal or remedial action conducted entirely onsite, where such remedial action is selected and carried out in compliance with this section". Further, implementing regulation for EPA's hazardous substance response at 40 CFR

300.400(e) provides, "permit requirements. (1) No Federal, state, or local permits are required for on-site response actions conducted pursuant to CERCLA sections 104, 106, 120, 121, or 122. The term on-site means the area extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the response action."

NWS and the Northwestern Division Office of Counsel advised that a Section 408 permit or permission is not required for the LDW Superfund Project. Section 408 provides the authority for the Chief of Engineers to grant permission for the alteration or permanent occupation or use of any USACE completed works when in the judgment of the Secretary such occupation or use will not be injurious to the public interest and will not impair the usefulness of such work. Therefore, the Section 408 "permission" is the type of procedural requirement that 40 USC 9621(e) envisioned as not being required for Superfund actions.

Although 40 USC 9621(e) waives purely procedural requirements for CERCLA removal and remedial actions, substantive compliance with applicable regulations is required. Per OSWER Directive 9355.7-03, Lower Duwamish Waterway Group (LDWG) and EPA are required to consult and coordinate with NWS to ensure compliance with the substantive requirements of Section 408 guidance, EC 1165-2-216. In particular, the work should not result in increased Operations and Maintenance (O&M) costs to the Corps, nor should it change the dimensions of the authorized Federal navigation project, and not be injurious to the public interest. As a part of the appropriate consultation and coordination approach of EPA's substantive review, NWS conducted an agency technical review to ensure the proposed alteration does not injure the public interest or affect the ability of the project to meet its authorized purpose per EC 1165-2-216.

Therefore, the agency technical review was not conducted to grant a permit or permission action; rather, it was conducted as a part of EPA's coordination and consultation efforts to comply with the substantive requirements of Section 408. EPA was requested to fund the review as a part of our Superfund support through an existing Interagency Agreement.

Overall, the purpose of the Section 408 review ensures that the proposed modification does not adversely impact 1) the ability of the project to meet its authorized purpose, 2) the usefulness of the project, 3) public interest, 4) demonstrates legal compliance, and 5) meets the requirements as set forth in EC 1165-2-216. This review further ensures substantive compliance and does not require the development of any NEPA documents or public notices or require a formal Section 408 approval by the NWS District Commander. However, NWS will send a notice of Section 408 substantive compliance to the EPA to implement the proposed project. The notice will also document that the review was completed and identify clarifying actions as the proposed project is implemented.

4. Section 408 Submittal Document
EPA submitted a Section 408 Memorandum dated 29 July 2015, requesting a technical evaluation of the Section 408 substantive requirements to alter the Lower Duwamish Waterway – Seattle Harbor Federal Navigation Channel Project. The Section 408 Memorandum addresses the substantive compliance of the construction of the Pilot Study plot. The Pilot Study is being performed by the Lower Duwamish Waterway Group (LDWG) per the Second Amendment to the Administrative Order on Consent For Remedial Investigation / Feasibility Study (AOC) for the LDW, CERCLA Docket No. 10-2001-0055, issued on 20 December 2000. The request accompanied 65% designs and analyses of the proposed alteration. EPA revised the Section 408 Memorandum on 23 September 2015 in response to NWS's ATR Comments **(Enclosure 1)**. The LDWG consists of the City of Seattle, King County, Port of Seattle, and the Boeing Company.

Summary of Proposed Project Alteration - The proposed alteration supports the construction of an Enhanced Natural Recovery and Activated Carbon Pilot Study Plot. The Pilot Study will evaluate the effectiveness of Enhanced Natural Recovery and Activated Carbon (ENR+AC) compared to Enhanced Natural Recovery (ENR) alone as a remedial sediment cleanup action in three areas of the LDW in which sediments are contaminated with polychlorinated biphenyls (PCBs); they are designated as the intertidal, subtidal, and scour plots. Only the subtidal plot is within the navigation channel and subject to Section 408 substantive compliance. In each plot, two adjacent, half-acre areas will be evaluated, one in which only ENR material has been placed and the other in which ENR material amended with activated carbon has been placed. The ENR material in the subtidal plot will consists of clean sand. In all three plots, the ENR+AC material will also contain granular activated carbon.

The proposed project further includes pre-and post- implementation monitoring. Pre- and post- implementation monitoring of the three pilot plots will be conducted to assess baseline conditions prior to project activities and to periodically evaluate conditions of the three pilot plots after placement of the ENR and ENR+AC materials. Monitoring activities include bathymetric survey, sediment sampling, and benthic recolonization assessment.

Site History – The Lower Duwamish Waterway Superfund Site is a 5 mile stretch of the Duwamish River that flows into Elliot Bay in Seattle, Washington. The Waterway is flanked by industrial corridors, as well as the South Park and Georgetown neighborhoods. The site was added to EPA's National Priorities List in 2001.

A century of heavy industrial use has left the waterway contaminated with toxic chemicals from many sources – industries along its banks, stormwater pipes, and runoff from upland activities, streets and roads. Pollution in the river sediments includes PCBs, dioxins/furans, carcinogenic polycyclic aromatic hydrocarbons, and arsenic. Many of these chemicals stay in the environment for a long time, and have built up to unsafe levels in resident fish and shellfish. The EPA and the Washington Department of Ecology are working to clean up contaminated sediment and control sources of additional contamination in the waterway.

5. Physical and function description of the existing project. The LDW is a Federal navigation channel, authorized under the River and Harbor Act of 1919 and modified by subsequent Acts. As such, it performs functions that must not be adversely affected by other actions. The USACE is responsible for maintaining the navigation channel to the following authorized depths and widths:

- -30 feet mean lower low water (MLLW) and 200 feet wide from Harbor Island (River Mile (RM) 0.0) to the First Avenue South Bridge (RM 2.0), also known as the Harbor Island and Georgetown reaches.
- -20 feet MLLW and 150 feet wide from the First Avenue South Bridge (RM 2.0) to Slip 4 (RM 2.8), also known as the First Avenue South Reach.
- -15 feet MLLW and 150 feet wide from Slip 4 (RM 2.8) to the Upper Turning Basin (RM 4.7), also known as the South Park and 14th Avenue Bridge Reaches. The authorized dimensions of the navigation channel portion of the Upper Turning Basin are 250 feet wide by 500 feet long.

USACE conducts maintenance dredging every 1 to 3 years in the upstream areas. The area typically dredged under this program is the Upper Turning Basin and downstream to approximately RM 4.0. Dredging shoaled material from the Upper Turning Basin minimizes the need for maintenance dredging in the lower portion of the LDW. The navigation channel downstream of RM 3.35 has not been subjected to maintenance dredging since 1984, and that was only for a small portion of the navigation channel near Kellogg Island.

6. Project Authorizations.
The Rivers and Harbors Act of 2 March 1919, 65 Pub Law 323; 40 Stat 1275, authorized the dredging and maintenance of the Seattle Harbor Navigation Project, modified by subsequent Acts. The Project provides for dredging of the Duwamish Waterway – 200 feet wide and 30 feet deep between First and Eighth Avenue South with a turning basin 600 by 350 feet and 20 feet deep south a the First Avenue bridge, 150 feet wide by 15 feet deep to a point about 1.4 miles above Fourteenth Avenue South Bridge, with a turning basin 500 by 250 feet and 15 feet deep, and a settling basin with capacity of about 100,000 cubic yards at the upper end of the waterway. The total length of the improvement in Duwamish Waterway is 5.112 miles and of all waterways included in the Seattle Harbor, about 7.5 miles. All depths refer to the plane of mean lower low water.

The project was completed in 1931, except for the settling basin, the turning basin south of the First Avenue Bridge, and East Waterway above the 750-foot section, which was deauthorized in 1986.

7. Impact to the Usefulness of the USACE Project and Public Interest Determination.
The NWS ATR Team conducted a substantive review of the proposed alteration submittal comprised of technical analyses and 65% designs to determine technical adequacy of the designs and to ensure the project was not injurious to the public. The ATR was completed between August 13 and August 20, 2015. The ATR determined that the proposed alterations to the completed Federal navigation channel are technically feasible, will not be injurious to the public interest, and will not impair the usefulness of such Federal facilities. The ATR comments are documented in **NWS ATR Comments (Enclosure 2)**.

The design of the pilot study was prepared by a group of expert scientist and engineers using standard scientific and engineering practices. The Pilot Study was designed to place the minimum amount of ENR and ENR+AC to meet the goals of the project and considered the placement precision of various types of equipment that may be used during the construction. Prior to implementation the design will require approval by the Washington State Department of Ecology and EPA.

The District's engineering review details the following:

Placing ENR and ENR+AC Material within an Authorized Navigation Channel
EC 1165-2-216 recommends that project specific setbacks be used as the preliminary evaluation criteria to determine if a project is likely to impact the usefulness of the Federal navigation projects or be injurious to the public interested under Section 408. For this project an acceptable setback distance would be equivalent to the overdredge allowance of 2 ft below the authorized depth. The authorized depth in the vicinity of the proposed project is -30 ft MLLW so the corresponding overdredge/setback depth would be -32 ft MLLW. Anything shallower than -32 ft MLLW could have the potential to impact the usefulness of the project.

Figure 1 shows a typical section of the channel within the proposed project footprint looking downstream. Based on the most recent (May 2015) surveys there are no areas within the proposed project footprint that are shallower than -30 ft MLLW. There are some areas within the overdredge allowance depth indicating a general trend of sediment deposition within the channel. The right (east) side of the channel which is outside of the proposed project footprint does contain some areas shallower -30 ft within the navigation channel.

For analysis purposes the worst case assumption of a uniform 12" thick ENR and ENR+AC layer was assumed. Under this scenario the proposed project will place ENR and ENR+AC layer within the established setback area and would result in a small (400 FT2) area shallower than the authorized depth of -30 ft. This area in general would only be shallower than -30 ft by less than 6 inches with shallowest depth of -29.6 ft MLLW.

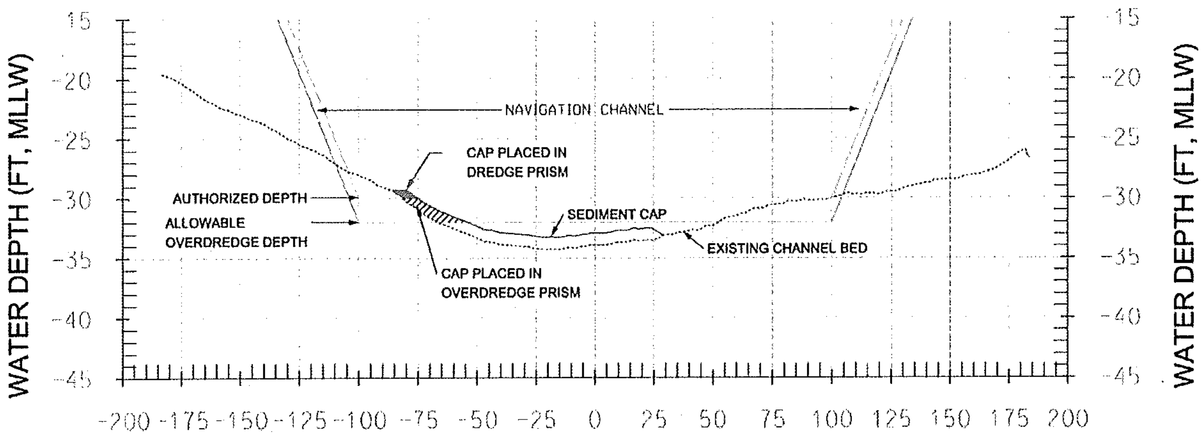


Figure 1: Typical Section of Navigation Channel in Proposed Project Footprint (Looking Downriver)

Vessel Usage

As stated in the Section 408 Memorandum the use of this portion of the channel by vessels with drafts of 30 ft is infrequent and episodic. Typically vessels with drafts in this range will transit the channel at a high tide to ensure sufficient under keel clearance. The vessels will then spend the majority of their time outside of the navigation channel in a deeper berthing area while they are loaded/unloaded. Once loading/unloading is complete the vessels will wait for high tide to again transit the channel out to deep water. The placement of the ENR and ENR+AC layer is not likely to affect vessel movement within the channel assuming vessels maintain their current method of operations.

Maintenance Dredging

As stated in the Section 408 Memorandum this portion of the channel has not been dredged in more than 30 years and there are no immediate plans to dredge this portion of the channel. It is well known that the sediment in this part of the channel does not meet open-water disposal standards and would require special dredging techniques and upland disposal. At this point in time the small areas which are shallower than the authorized depth do not have a significant enough impact on navigation in the channel to justify the cost of dredging. The additional 400 ft^2 of channel which could become shallower than the authorized depth is not likely to change this determination.

The proposed ENR and ENR+AC layer consists of sand which can easily be dredged, if dredging were found to be necessary in the future. If dredging was found to be necessary in the future, and subsequently the effectiveness of the ENR and ENR+AC layer was compromised, the Performing Parties that implement the remedy (in this case the ENR and ENR+AC layer) would be responsible for any needed repairs. Based on the above discussion the ENR and ENR+AC layer placement is not expected to affect the USACE O&M of the Federal navigation channel.

Grade Stakes

One of the methods proposed for measuring the ENR and ENR+AC layer thickness is the installation of Grade Stakes protruding 1.5 ft above the existing surface into the authorized channel. These may impact the usefulness of the channel by effectively reducing the navigational depth in the areas they are installed. These stakes will need to be made of a flexible material such as a thin walled pvc so they can deform if impacted by a vessel. These will also need to be coordinated with the local Coast Guard station to ensure mariners are aware of their presence in the channel. As long as these stakes are clearly marked and removed at the end of the pilot project they should not affect the usefulness of the navigation channel.

Public Interest Determination

Whether the proposed project is injurious to the public interest is determined by balancing the project's foreseeable benefits and detriments. Many of the factors usually considered in the public interest determination, such as historic properties, recreation, flood risk, etc, are not applicable in this circumstance since the project will occur entirely on the submerged river bottom and will have little effect on the surrounding area. The foreseeable benefits of the project include accelerated remediation of contaminated aquatic sediments in the Lower Duwamish Waterway and scientific data on the efficacy of the use of activated carbon in enhanced natural recovery methods. The potential detriments of the project include the potential effects to navigation discussed above, temporary increases in water turbidity during material placement, and temporary disruption of the benthic community in the placement area. Effects to navigation have been determined to be minor and are not expected to impair the function of the federal navigation project. Potential detrimental environmental effects are likewise minor, and are outweighed by the potential environmental benefits of accelerated remediation. The increase in scientific knowledge that will result from the project will be a benefit to the public. Considering all these factors, it has been determined that the proposed project will be a net benefit to the public and is not injurious to the public interest.

8. Agency Technical Review Team

The technical review was 100% funded by EPA as a part of the Superfund Support project. Other than providing guidance to the Port, the NWS engineering and operations team participated only in a review capacity for the designs and analyses.

NWS technical review team included the following disciplines:

Technical Team Member	Technical Review
Keely Brown, PM and Planner	Reviewed the document to ensure consistency with USACE policy for modification of completed USACE projects.
Kristen Kerns, Physical Scientist	Review included ensuring design adequacy to support handling, removal, and monitoring of contaminated materials, assessment of potential impacts to the Federal project, and ensuring the proposed project was consistent with USACE design standards.

Scott Brown, Coastal Engineer	Review included ensuring that the hydraulic effectiveness of the navigation project was not compromised, no adverse impacts to the floodplain, and that the designs support USACE hydraulic design standards.
Doris Cope, Realty Specialist	Reviewed the proposed project scope to determine minimum real estate interest required to support the modifications.
Elizabeth Chien, Navigation Project Manager	Review included ensuring the proposed modifications does not impact the operations of LWSC and that the mitigation proposed is supportive of the recreational features and environmental habitat of LWSC.

9. Policy Compliance Certification.
All policy and technical issues have been addressed and resolved through the ATR and its certification. An ATR certification ensures appropriate quality control and assurance has been conducted for the project and confirms that the proposed alteration and technical review is consistent with policy and is adequate to support the type of alteration and project complexity **(Enclosure 3)**.

10. Certification of Legal Sufficiency from NWS Office of Counsel.
A legal review was conducted to ensure legal sufficiency of the proposed alteration and the review. All legal concerns have been resolved and are based upon conditions as stated in the letter of permission signed by the NWS District Commander. The ATR Certification depicts the legal sufficiency of the proposed alteration **(Enclosure 3)**.

11. Certification by the Chief of the NWS Real Estate Division that the real estate documentation is adequate.
A real estate analysis was conducted to ensure minimum real estate interests per the proposed project scope. The Washington Department of Natural Resources issued a letter dated April 27, 2015, granting the proponents access to the aquatic lands **(Enclosure 4)** for project implementation. Since the proposed project will not interfere with vessel traffic or future O&M dredging, no additional real estate is necessary to ensure continued use, operation or maintenance of the existing Federal navigation project. The Chief of Real Estate's certification is enclosed **(Enclosure 3)**.

12. A description of any related, ongoing USACE studies, including how the proposed alteration may impact those studies.

- **Seattle Harbor Deep Draft Navigation General Investigation**
  The Corps and Port of Seattle initiated a Feasibility Study evaluating navigation improvements to Seattle Harbor's East and West Waterways. The on-going Deep Draft Navigation Feasibility Study does not include improvements to the Lower Duwamish Waterway portion of the Seattle Harbor Navigation Project.

- **Seattle Harbor O&M Projects**
  NWS will conduct maintenance dredging within the Lower Duwamish Waterway during the months of December 2015 and January 2016. The dredging will not occur within the same project areas as the proposed alteration and therefore will not impact the proposed alteration.

13. Summary of any changes to the O&M manual. If NWS has determined that USACE would assume O&M responsibilities as part of its responsibilities for the USACE project, include the rationale and any anticipated increase in USACE O&M costs.

The proposed project will not increase or require additional O&M responsibilities on behalf of NWS. The placement of the ENR and ENR+AC layer in the subtidal plot will not impact NWS's ability to maintain the authorized navigation channel. As with all ENR areas identified in EPA's LDW Record of Decision, if future disturbances to the ENR areas including disturbances created by maintenance dredging, impact the effectiveness of the remedy, the Performing Parties that implement the remedy will be responsible for any needed repairs.

The letter signed by the NWS District Commander to the EPA and LDWG will incorporate the requirements for O&M to be the responsibility of the LDWG and the EPA.

14. Summary of any changes to a project partnership agreement (PPA) or local cooperation agreement (LPA), if applicable;

There is no existing PPA or LPA for the existing Federal navigation project; therefore, there are no applicable revisions required.

15. Applicable environmental compliance documentation including but not limited to NEPA documentation, Endangered Species Act documentation, and other necessary documentation.

Environmental compliance review and consultation for the proposed modification has been conducted by EPA. The CERCLA process is considered to be functionally equivalent to the NEPA process. Documentation of this process can be found in EPA's Record of Decision published in November 2014. No additional NEPA process is required for this substantive compliance review, as based upon 42 USC 9621(e) no Corps permit is required.

EPA prepared a biological evaluation (BE) for the Pilot Study for Section 7 consultation under the Endangered Species Act. The Pilot Study is not expected to substantially alter existing environmental conditions within the LDW. A number of environmental impacts were identified and EPA has identified the appropriate conservation measures and BMPs to minimize and avoid impacts on listed species and the environment during in-water work.

16. Finding of No Significant Impact or Record of Decision

As previously discussed, 40 USC 9621(e) waives the requirement to perform a formal NEPA evaluation. The substantive equivalent of NEPA documentation, including the FONSI, is contained in EPA's Record of Decision published in November 2014.

17. Summary of the acceptance and use of funds pursuant to Section 214

This review was not conducted to grant a permit or permission action; therefore, funds were not requested under WRDA 214 for the agency technical review. The agency technical review was conducted as a part of EPA's coordination and consultation efforts to comply with the substantive requirements of the project. EPA provided 100% of the funds to our Superfund Support through an existing interagency agreement in order for NWS to do this Section 408 substantive review.

18. Any additional Final Conclusions or information, including any associated controversial issues.

Based on the technical review of the design drawings and supporting documentation, NWS has determined that the proposed modifications to the Federal navigation channel are technically adequate and not an impairment to the usefulness of the existing Federal project. The proposed project is in accordance with environmental statutes; is without significant adverse hydraulic impacts; and is not injurious to the public interest.

NWS also notes the following responsibilities and clarifying actions as this Pilot Study moves forward toward construction and into the final remedial actions:

- NWS requires the grade stakes to be made of a flexible material such as thin walled PVC, which will deform if impacted by a vessel. NWS further requests EPA to coordinate location of grade stakes with the local Coast Guard station to ensure mariners are aware of their presence in the channel. Grade stakes should be clearly marked and removed at the end of the Pilot Study.
- NWS will require all final designs to be coordinated with the NWS Operations Support Branch prior to construction.
- All final As-Builts will be required to be turned over to the NWS Operations Support Branch.
- EPA and the Lower Duwamish Waterway Group are responsible for all O&M and Monitoring activities for the proposed Pilot Study.
- NWS will require that LDWG and EPA keep NWS aware of construction efforts.
- NWS notes that any dredging maintenance activities conducted by NWS could remove portions of the clean ENR and ENR and AC layer placed in the subtidal plot within the boundaries of the navigation channel.
- This Section 408 ATR is only to support the Pilot Study. The review conducted does not preclude any future Section 408 technical reviews and does not automatically grant future permissions to support the Superfund project.

- No Regulatory Permit actions were required to support the proposed alteration.

19. Final Recommendation.

Pursuant to 33 USC 408, NWS has sufficiently and adequately conducted an Agency Technical Review to the proposed alterations to the Lower Duwamish Waterway – Seattle Harbor Navigation Project. The technical review is commensurate to the level of risk and complexity inherent in the proposed project, as well as the project phase indicated. The technical review was also conducted to comply with the substantive requirements of EC 1165-2-216. Upon considering the engineering, environmental, real estate, and legal aspects of the proposed alterations, as described herein, it has been determined that the Lower Duwamish Waterway Enhanced Natural Recovery and Activated Carbon Pilot Study is not injurious to the public interest and does not impair the usefulness of the authorized project.

This recommendation reflects the information available and USACE policies at the time of review. Consequently, should the proposed project be modified prior to implementation, the Lower Duwamish Waterway Group and EPA should advise NWS of any modifications and allow NWS an opportunity to review further.

JoAnn T. Walls

JOANN T. WALLS, P.E
Chief, Engineering Division

21 Oct 2015
Date

Encls
Enclosure 1: Substantive Compliance Section 408 Memorandum
Enclosure 2: NWS ATR Comments
Enclosure 3: ATR Certification
Enclosure 4: DNR Letter

ENCLOSURE 1

LDW ENR+AC PILOT STUDY SECTION 408 MEMORANDUM

Memorandum

To: Lower Duwamish Waterway Group

From: Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmstead & Fuglevand, Inc.
Ramboll Environ
Floyd|Snider
Geosyntec Consultants

Date: September 23, 2015

Subject: **U.S. Army Corps of Engineers – Section 408 Substantive Compliance Memorandum for Placement of Subtidal Pilot Plot in the Federal Navigation Channel**

This memorandum is intended to evaluate substantive compliance per requirements of 33 USC § 408 (Section 408) for the construction of an Enhanced Natural Recovery/Activated Carbon pilot study plot. This memorandum was generated using Engineering Circular guidance (EC 1165-2-216) as per the U.S. Army Corps of Engineers (USACE) request. The pilot study is being performed by the Lower Duwamish Waterway Group (LDWG) per the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055, issued on December 20, 2000).

Because the intertidal and scour plot areas are not located within the federal navigation channel, this memorandum will only addresses potential effects of the subtidal plot (Figure 1) as per requirements of 33 USC § 408 (Section 408).

The memorandum consists of the following sections:

- Section 1.0 – Project Description and the LDW Federal Navigation Channel.
- Section 2.0 – Analysis of Federal Navigation Function.
- Section 3.0 – Technical Analysis and Adequacy of Design.
- Section 4.0 – Real Estate Analysis.
- Section 5.0 – Environmental Risk.
- Section 6.0 – Floodplain Management Considerations.
- Section 7.0 – Residual Risk Analysis.

- Section 8.0 – Impacts to Corps of Engineers Operations and Maintenance.
- Section 9.0 – Summary and Conclusions.
- Section 10.0 – References.

1.0 PROJECT DESCRIPTION AND THE LDW FEDERAL NAVIGATION CHANNEL

This section provides brief descriptions of the pilot plot study and the Lower Duwamish Waterway (LDW) federal navigation channel. The complete Draft Design Package for the pilot study was provided to EPA on July 22, 2015.

1.1 PILOT PLOT STUDY

This section provides a description of the pilot study, including the active placement of the ENR and ENR+AC materials, as well as pre- and post-implementation monitoring of the pilot plots.

The pilot study will evaluate the effectiveness of ENR+AC compared to ENR alone as a remedial sediment cleanup action in three areas of the LDW in which sediments are contaminated with polychlorinated biphenyls (PCBs); they are designated as the intertidal, subtidal, and scour plots. In each plot, two adjacent, half-acre areas will be evaluated, one in which only ENR material has been placed and the other in which ENR material amended with AC has been placed. The ENR material in the subtidal plot will consist of clean sand. In all three plots, the ENR+AC material will also contain granular AC at a concentration of 1 to 3 percent. The proposed AC concentration is sufficient to sequester PCBs (and to reduce bioavailability) but is not expected to adversely affect benthic biota.

Conservation measures and best management practices (BMPs) for the construction of the pilot study are described in Section 5.0.

1.1.1 Construction Elements

It is anticipated that a barge-mounted fixed-arm excavator with a clamshell bucket will be used for submerged placement of the ENR and ENR+AC materials. The submerged release of the ENR and ENR+AC materials a few feet above the substrate will minimize the loss of AC as the ENR+AC material descends through the water column and will also minimize turbidity plumes that may result as fine particles in the ENR and ENR+AC materials become suspended in the water column and descend to the bottom substrate. The ENR+AC material will be preblended to meet the target concentration of AC and presoaked prior to placement. Presoaking of the ENR+AC material will help to minimize the loss of AC as the ENR+AC material descends through the water column during placement. The target thickness of the ENR and ENR+AC materials is 6 inches and at least 4 inches, and an average of approximately 9 inches placed over the existing substrate.

Precision navigation, as well as offset and staggered placement, will be used to ensure precise placement of the ENR and ENR+AC materials at each of the pilot plots.

Equipment that will used by the contractor includes, but is not limited to, barges (with and without spuds), excavators, tugs, small work boats, and anchors. The disturbance of existing sediments will be limited to disturbance from anchors or barge spuds. The construction of the project does not require dredging of any sediment; however, in the event that material is overplaced within a plot above the placement thickness to such a degree that it may impact navigation, some placed material will be moved using the clamshell bucket and relocated to the perimeter of the appropriate subplot.

Based on field data presented in the Lower Duwamish Waterway Sediment Transport Modeling (STM) Report (Quantitative Environmental Analysis, LLC 2008) during a high-flow event that was in the top 1 percent of measured discharges since 1990, the maximum velocities 1 meter above the bed in the vicinity of the subtidal plot are up to approximately 18 cm/sec. The velocities near the bed are likely to be lower than the 18 cm/sec. Based on Hjulsröm's Diagram, at a velocity of 18 cm/sec, sand sized particles that will be used at the subtidal plot are anticipated to be stable.

1.1.2 Construction Timing

The completion of in-water construction activities for the pilot study will require 2 to 4 weeks. All in-water work associated with the placement of ENR and ENR+AC materials will be conducted during the authorized 2016–2017 in-water work window of October 1 through February 15 (USACE, 2012) for the LDW, when listed salmonid species are least likely to be present in the LDW. Construction will occur after the end of the Muckleshoot Indian Tribe’s netfishery season. Construction is expected to begin in December 2016.

1.1.3 Pre- and Post-Implementation Monitoring

Pre- and post-implementation monitoring of the three pilot plots will be conducted to assess baseline conditions prior to project activities and to periodically evaluate conditions of the three pilot plots after placement of the ENR and ENR+AC materials.

The following presents an overview of the monitoring activities during the pilot study:

- Bathymetric survey to document pre- and post-placement elevations and Sediment Profiling Imaging to document thickness of placed material;
- Collection of surficial sediment samples for chemical, physical, and benthic taxonomic analyses (benthic taxonomic analyses will be conducted only during Year 3);
- Analysis of PCBs in pore water using passive samplers;
- Use of Sediment Profile Imaging to assess benthic recolonization;
- Use of submerged placement of the ENR and ENR+AC materials will minimize the loss of AC as the ENR+AC material descends through the water column and will also prevent or minimize turbidity plumes that may result as fine material in the ENR and

ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed;

- Prewetting of the ENR+AC material prior to placement to minimize loss of AC during placement of the ENR+AC material; and
- Implementation of a water quality monitoring plan during the ENR and ENR+AC materials placement to assess turbidity downcurrent of the pilot plots. The water quality monitoring results will be provided to the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA).

1.2 LDW Federal Navigation Channel

The LDW is a federal navigation channel, authorized under the River and Harbor Act of 1919 and modified by subsequent Acts. As such, it performs functions that must not be adversely affected by other actions.

The USACE is responsible for maintaining the navigation channel to the following authorized depths and widths (Figure 1):

- -30 feet mean lower low water (MLLW) and 200 feet wide from Harbor Island (RM 0.0) to the First Avenue South Bridge (RM 2.0), also known as the Harbor Island and Georgetown Reaches.
- -20 feet MLLW and 150 feet wide from the First Avenue South Bridge (RM 2.0) to Slip 4 (RM 2.8), also known as the First Avenue South Reach.
- -15 feet MLLW and 150 feet wide from Slip 4 (RM 2.8) to the Upper Turning Basin (RM 4.7), also known as the South Park and 14th Avenue Bridge Reaches. The authorized dimensions of the navigation channel portion of the Upper Turning Basin are 250 feet wide by 500 feet long (USACE, 2005).

To maintain the navigation channel at the authorized depths, the USACE conducts maintenance dredging every 1 to 3 years in the upstream areas. The area typically dredged under this program is the Upper Turning Basin and downstream to approximately RM 4.0. Maintenance dredging is discussed in more detail later in this document.

Without routine maintenance dredging, shoaling would create a shallower channel and inhibit the safe passage of vessels. The Upper Turning Basin acts as a settling basin for sediments that would normally migrate downstream. In this area, the river channel cross section sharply expands from a somewhat natural section to an engineered channel maintained to be significantly larger than its natural analog. The sharp transition and enlarged channel results in greatly reduced flow velocities, which promotes sediment deposition. Routine maintenance dredging keeps sediments from accumulating beyond the holding capacity of the basin. In the absence of maintenance dredging, the sediment would continue to migrate downstream via bed load transport and settle in downstream areas. Therefore, dredging the shoaled material from the Upper Turning Basin minimizes the need for maintenance dredging in the lower portion of the LDW. The navigation channel downstream of RM 3.35 has not been subjected to maintenance dredging since 1984, and that was only for a small portion of the navigation channel near Kellogg Island.

Table 1 summarizes USACE maintenance dredging events in the LDW navigation channel between 1986 and 2014. The yearly volumes of sediment dredged from the LDW have varied widely, from a minimum of 34,000 cubic yards (cy) dredged in 1986 to a maximum of 200,000 cy in 1992.

2.0 ANALYSIS OF FEDERAL NAVIGATION FUNCTION

This section assesses whether the design of the proposed pilot plot study: (1) is consistent with the authorized navigation channel, (2) impairs the usefulness of the navigation channel, and (3) is “injurious to the public interest.”

2.1 VESSEL TRAFFIC IN THE LDW NAVIGATION CHANNEL

A variety of commercial and recreational vessels operate within the LDW navigation channel, including tugboats moving alone or with barges/derricks, fishing vessels, bulk cargo vessels, recreational vessels such as sailboats and motor yachts, and miscellaneous vessels such as fireboats, passenger boats, and research vessels. The LDW is also used by recreational boaters in kayaks.

General information about vessel traffic in the LDW is presented in Riley (2006) and Takasaki (2006). Based on information contained in those two memoranda, vessel traffic in the LDW may be summarized as follows:

- A variety of barges are used in the LDW, typically traveling at speeds of 2 to 3 knots, with a maximum speed of 5 knots. Those that are 400 feet long and 100 feet wide with 14-foot drafts travel to just upstream of the First Avenue Bridge, while those that are 286 feet long and 76 feet wide with 12-foot drafts travel no farther upstream than the South Park Bridge (approximately RM 3.3). There is relatively infrequent barge traffic upstream of RM 3.3, although General Construction Company does have a barge storage area upstream of the South Park Bridge at approximately RM 4.2.
- Ocean-going vessels are always under tug assistance in the LDW, although these vessels may also be self-propelled and do not travel farther upstream than the First Avenue Bridge (approximately RM 2.0). These vessels typically travel at a speed of 2 to 3 knots, with a maximum speed of 5 knots. These vessels are unable to turn around in the LDW, so are towed into Elliott Bay when out-bound.
- The Pilot’s Association indicated that two large vessels travel up to the James Hardie and Glacier docking areas, which are located at approximately RM 1.6. These vessels are 85 feet wide and 600 feet long, with drafts of 20 feet (unloaded) and 30 feet (loaded).
- Yachts traveling to and from Delta Marine, located near RM 4.2, range in length from 100 feet to 160 feet, with drafts of 5.5 feet to 10 feet.

An estimate of the volume of large vessels using the LDW navigation channel can be derived from the number of bridge openings of the five bridges spanning the LDW and the West Waterway. Three are located on the West Waterway: the high-level West Seattle Bridge; a railroad bridge, which remains open unless a train is traversing the waterway; and the Spokane Street Bridge. Two bridges span the LDW: the First Avenue Bridge and the South Park Bridge. Bridges are opened periodically to allow for the passage of vessels that exceed clearance heights. Bridge opening logs provide information on the number, duration, and frequency at which large vessels move under the bridges while open. Records for the Spokane Street, First Avenue, and South Park bridges were reviewed, as presented in the FS, to assess the degree to which vessel traffic varies throughout portions of the LDW (SDOT, 2006; KCDOT, 2006; WSDOT, 2006).

Spokane Street Bridge: The Spokane Street Bridge (downstream of the LDW near its mouth) is operated by the Seattle Department of Transportation (SDOT). Bridge opening logs for this bridge, which has a 55-foot clearance above mean high water, record the number of vessels entering and exiting the LDW through the West Waterway and every occasion the bridge is opened. For the purposes of this analysis, only openings for large motorized vessels other than sailboats were considered. Motorized vessels include tugboats and container ships. Vessels with a low clearance do not require the bridge to be opened and are not captured by bridge opening logs.

Monthly bridge openings for large motorized vessels for the period from 2003 to 2005 ranged from 93 openings in February 2005 to 261 openings in March 2003 (Table 2). The average number of monthly openings during this period was 146, or approximately 5 per day. Most of these openings were for tugboat-escorted vessels and barges, representing 75 to 140 per month, with a monthly average of 104, or approximately 3 per day (SDOT, 2006). The logs show that regular vessel traffic is spaced from 1 to several hours apart.

First Avenue Bridge: The First Avenue Bridge (at RM 2.0) is a drawbridge operated by the Washington State Department of Transportation (WSDOT). It has a 41-foot clearance at the center span and a 24-foot clearance at the side spans. It opened over 1,300 times annually in both 2005 and 2006, averaging less than 4 openings daily.

South Park Bridge: South Park Bridge (RM 3.3); also referred to as the 14th Avenue Bridge, is operated by the King County Department of Transportation (KCDOT). It has a 34-foot clearance at the center span. It was opened between 700 and 800 times annually in 2005 and 2006, approximately twice daily.

2.2 Consistency with Authorized Navigation Channel

Of the three pilot plot areas, only the subtidal plot area will be located in the federal navigation channel at RM 1.2. Two adjacent, half-acre areas (Figure 2) will be evaluated, one in which only ENR material has been placed and the other in which ENR material amended with AC has been placed. The ENR material in the subtidal plot will consist of clean sand. The target thickness of the ENR and ENR+AC materials is 6 inches with at least 4 inches, and an average of approximately 9 inches placed over the existing substrate and a maximum thickness not to exceed 12 inches.

The west edge of the subtidal plot area will be aligned with and approximately 25 feet from the west edge of the federal navigation channel. Each half-acre area is about 50 feet wide by 465 feet long. The two half-acre areas will be immediately adjacent to one another and aligned in a north-south direction paralleling the federal navigation channel. The combined width of the two half-acre test plots will be 100 feet, so that the west edge of the test plot will be at approximately 30.9 feet MLLW or deeper and the east edge of the test plot at a depth of -36.8 feet MLLW (Figure 2).

Placement of ENR and ENR+AC will decrease the water depth over the one acre of the subtidal plot by an average of 9 inches (0.67 feet), with water depths in some locations along the test plot possibly being decreased by up to 1 foot. Assuming a worst-case scenario that ENR and ENR+AC will be placed at a uniform thickness of 12 inches across the entire subtidal plot, there are seven areas where the modeled depths will be -29.9 feet MLLW. The combined area of these seven locations is approximately 41 square feet. Thus, water depth after placement of the ENR and ENR+AC over the one acre area of the subtidal plot could range from -29.9 feet MLLW to -35.8 feet MLLW across the subtidal plot area. Figures 3a through 3d, which are based on the latest available bathymetry data and the assumption of a uniform ENR and ENR+AC thickness of 1 foot, depict eight cross-sectional views through the ENR and ENR+AC subtidal plots at 50-foot intervals beginning 50 feet from the north end of the proposed subtidal plots.

The available information indicate that the largest vessels using the LDW travel up to the James Hardie and Glacier docking areas, which are located at approximately RM 1.6. These two vessels are 85 feet wide and 600 feet long, with drafts of 20 feet (unloaded) and 30 feet (loaded). When loaded, it is most likely that these vessels would depart their moorages on a high tide to avoid contact with the substrate. The mean high water in the LDW is +10.24 feet MLLW (USACE, 2000); therefore at mean high water, the water depth at the shallowest points along the subtidal plot would be 40.14 feet, providing sufficient clearance between the hulls of these large vessels and the highest point along the subtidal plot.

The modeled net sedimentation rate in the LDW at the proposed location of the subtidal plot is 1.7 centimeters (0.67 inch) per year. Therefore it would require approximately 18 years for another foot of sediment to deposit over the subtidal plot. Assuming a uniform thickness of 1 foot of ENR and ENR+AC over the area covered by the subtidal plot, adding another foot of sediment deposition over the subtidal plot would result in water depths ranging from 39.1 feet to 46.0 feet at mean high water. This depth range would still provide sufficient clearance between the substrate and hulls of the largest ships currently using this reach of the LDW.

Other shallower-draft vessels, both commercial and recreational, navigating the reach of the LDW where the subtidal plot will be located are not expected to be affected by placement of the subtidal plot. Therefore, the subtidal plot is not expected to affect the usefulness of the navigation channel or to be inconsistent with the authorized navigation channel.

Placement of the subtidal plot is not expected to be injurious to the public interest.

3.0 TECHNICAL ANALYSIS AND ADEQUACY OF DESIGN

The design of the pilot study was prepared by a group of expert scientist and engineers using standard scientific and engineering practices. The pilot study was designed to place the minimum amount of fill to meet the goals of the project and considered the placement precision of various types of equipment that may be used during the construction. Prior to implementation the design will require approval by Ecology and EPA.

4.0 REAL ESTATE ANALYSIS

There are no real property interests required to support the proposed alteration of the navigation channel (per page 12 of EC 1165-2-216); therefore, no analysis of real estate is required.

5.0 ENVIRONMENTAL RISK

A biological evaluation (BE) was prepared for the pilot study for Section 7 consultation under the Endangered Species Act. Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Puget Sound steelhead trout (*O. mykiss*), Coastal/Puget Sound bull trout (*Salvelinus confluentus*), and Dolly Varden trout (*S. malma*) are listed salmonids using the LDW and were the primary species addressed in the BE. The BE assessed potential effects of the pilot study on existing environmental conditions in the LDW, listed species that use the LDW, and the critical habitats of the listed species in the LDW.

The pilot study is not expected to substantially alter existing environmental conditions within the LDW. Potential impacts on existing environmental conditions in the Action Area defined for this biological evaluation are the following:

- Placement of ENR and ENR+AC materials may result in temporary and localized increases in turbidity in the water column.
- Physical and conventional sediment characteristics (e.g., grain size and total organic carbon) within the pilot plot areas may be altered in the short term relative to those of the surrounding sediments. In the long term, the physical and conventional sediment characteristics are expected to return to current conditions by means of natural riverine processes.
- Placement of ENR and ENR+AC on sediments that are contaminated with PCBs will reduce the exposure of aquatic organisms to PCBs within those areas.
- The ENR and ENR+AC materials placed during the pilot study will be approximately 6 to 9 inches thick, with a maximum thickness of 12 inches, and are not expected to substantially alter the bathymetry in the pilot plots.

- Placement of ENR and ENR+AC materials will bury benthic habitat in the pilot plots; however, two of the pilot plot areas are subtidal, located in areas unlikely to provide preferred foraging habitat for juvenile salmonids.
- The pilot study will have no effect on access and refugia; flow, water current patterns, saltwater-freshwater mixing; marine macroalgae and macrophytes; forage fish; or ambient noise within the LDW.

A number of conservation measures and BMPs will be implemented to minimize and avoid impacts on listed species and the environment during in-water work activities:

- The completion of in-water construction activities for the pilot study will require 2 to 4 weeks. All in-water work associated with the placement of ENR and ENR+AC materials will be conducted during the authorized 2016–2017 in-water work window of October 1 through February 15 (USACE, 2012) for the LDW, when listed salmonid species are least likely to be present in the LDW.
- Construction will occur after the end of the Muckleshoot Indian Tribe's salmonid netfishery season. Construction is expected to begin in late December 2016.
- Use of submerged placement of the ENR and ENR+AC materials will decrease the spread of material outside the placement boundaries and minimize the loss of AC as the ENR+AC descends through the water column and will also prevent or minimize turbidity plumes that may result as fine material in the ENR and ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed.
- Prewetting of the ENR+AC material prior to placement will minimize loss of AC during placement of the ENR+AC materials. and
- Implementation of a water quality monitoring plan during the ENR and ENR+AC material placement will assess turbidity downcurrent of the pilot plots. The water quality monitoring results will be provided to Ecology and EPA.

The following BMPs will also be implemented to minimize and avoid impacts on listed species and the environment during in-water activities:

- All mechanized equipment will be maintained in proper operating condition, with equipment inspections occurring prior to each workday. Equipment found to be leaking petroleum products or hydraulic fluid will be removed from the site for maintenance.
- Drip pads or pans will be placed under mechanized equipment to contain any potential leaks of petroleum products or hydraulic fluids.
- To the extent possible, vegetable-based hydraulic fluids will be used.
- A spill kit will be kept on work vessels to contain any potential petroleum spills that might occur.
- Ecology and the U.S. Coast Guard will be contacted immediately in the event of a spill.

- Any project-related debris or wastes will be placed in appropriate containers for off-site disposal. No project-related debris or wastes will be allowed to enter the water.
- Barges and work vessels will not be allowed to run aground on the substrate. Work barges will be held on station with spuds or anchors.

The placement of the subtidal plot within the authorized navigation channel is unlikely to adversely affect the environment within the LDW, but is expected to have a net beneficial effect through reducing exposure of aquatic biota to PCB-contaminated sediments covered by the ENR and ENR+AC in the subtidal plot area.

6.0 FLOODPLAIN MANAGEMENT CONSIDERATIONS

There are no anticipated impacts to floodplains due to construction of the pilot study. The elevation of the subtidal plot will be at or below the authorized navigation channel depth. Any changes in water surface elevation due to construction of the pilot study plot will be within the range of the water surface elevations that would be expected from natural deposition of sediments within the navigation channel.

7.0 RESIDUAL RISK ANALYSIS

Little, if any, residual risk is expected as a result of the proposed action. As discussed in the above sections, the placement of the proposed subtidal plot in the federal navigation channel is not expected to affect the usefulness or the functionality of the federal navigation channel, thus allowing commercial and recreational vessels to safely use the channel. Furthermore, the proposed action is not expected to adversely affect the environmental conditions within the federal navigation channel, nor is the proposed action expected to adversely affect the floodplain.

8.0 IMPACTS TO CORPS OF ENGINEERS OPERATIONS AND MAINTENANCE

The placement of the fill in the subtidal plot will not impact the ability of the Corps of Engineers to maintain the authorized navigation channel. The material to be placed is comprised of sand and is easily dredged. If this reach of the navigation channel is dredged in the future, localized portions of the clean ENR material placed by this project could be incidentally removed by the navigation dredging, depending on the overdepth specifications, equipment selection, and operational controls of the navigation dredging project. However, based on the Corps dredging records presented in Table 1, this area has not been dredged in the last 30 years and it is unlikely to be dredged in the foreseeable future.

The issue discussed above would not affect USACE O&M of the federal channel. As with all ENR areas identified in EPA's LDW ROD; if future disturbances to the ENR areas affect the protectiveness of the remedy, the Performing Parties that implement the remedy will be responsible for any needed repairs.

9.0 SUMMARY AND CONCLUSIONS

The placement of the proposed subtidal plot in the federal navigation channel is not expected to adversely affect the usefulness or functionality of the channel.

10.0 REFERENCES

Dredged Materials Management Program (DMMP). 2009. Determination Regarding the Suitability of Federal Operation and Maintenance Dredged Material from the Duwamish River, Section 13 – References Seattle, King County, Washington (Public Notice CENWS-OD-TS-NS-26) Evaluated Under Section 404 of the Clean Water Act for Beneficial Use or Unconfined Openwater Disposal at the Elliott Bay Nondispersive Site. October 15, 2009.

King County Department of Transportation (KCDOT). 2006. South Park Bridge Opening Records 2005, 2006. Provided by Bridge/Structures Maintenance & Operations Manager. December 18, 2006.

Riley, M.J. 2006. Personal communication between Michael Riley of SS Papadopulos & Associates, Inc. and RETEC via memorandum regarding ship and barge traffic on the LDW. Prepared for RETEC, Preliminary Screening of Alternatives. August 11, 2006.

Seattle Department of Transportation (SDOT). 2006. Spokane Street Bridge Opening Logs for 2003 to 2005. Provided by Dave Chew, Bridge/Structures Maintenance and Operations Manager to AECOM. November 15, 2006.

Takasaki, K. 2006. Personal communication between Kym Takasaki of U.S. Army Corps of Engineers and Allison Hiltner, U.S. Environmental Protection Agency Region 10, regarding boat traffic information on the Lower Duwamish Waterway. August 29, 2006.

U.S. Army Corps of Engineers (USACE). 2000. Historical Datum Regions: North Puget Sound – Duwamish Waterway. USACE, Seattle District, Seattle, Washington. Available at: http://www.nws.usace.army.mil/About/Offices/Engineering/HydraulicsandHydrology/HistoricalDatumRegions/NorthPugetSound/DuwamishWaterway.aspx (accessed June 26, 2015).

U.S. Army Corps of Engineers (USACE). 2005. Dredge Summary and Analysis Reports. Lower Duwamish Waterway. 1986 to 2005. U.S. Army Corps of Engineers, Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 2010. Payment Summary for fiscal year 2009 dredging of Lower Duwamish Waterway navigation channel. April 13, 2010. USACE, Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 2012. Approved Work Windows for Fish Protection for All Marine/Estuarine Areas Excluding the Mouth of the Columbia River (Baker Bay) by Tidal Reference Area. Corps, Seattle District, Seattle, Washington. Available at: http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20templates/Marine%20Fish%20Work%20Windows%20(8-14-12).pdf (accessed June 2, 2015).

Washington State Department of Transportation (WSDOT). 2006. First Avenue Bridge opening records. 2005, 2006. Provided by Williams, T., Northwest Region Bridge/Structures Maintenance & Operations Manager. December 18, 2006.

Attachments

Table 1 – Lower Duwamish Waterway Navigation Channel Maintenance Dredging (1986-2010)
Table 2 – Number of Monthly Lower Duwamish Waterway Bridge Opening (2003-2006)

Figure 1 – Vicinity Map
Figure 2 – Plan View of Subtidal Plot Area
Figures 3a to 3d – Cross Sections

TABLES

TABLE 1

LOWER DUWAMISH WATERWAY NAVIGATION CHANNEL MAINTENANCE DREDGING (1986-2010) [1]

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

River Mile	Dredge Date		Volume Dredged (cubic yards)
	Begin	End	
4.19 to 4.38	03/11/86	03/29/86	33,637
4.38 to 4.65	06/19/86	07/15/86	126,470
4.38 to 4.65	02/24/87	03/24/87	80,160
3.97 to 4.65	02/28/90	03/30/90	127,619
3.34 to 4.65	02/06/92	03/21/92	199,361
4.33 to 4.65	03/07/94	03/28/94	57,243
4.02 to 4.48	02/22/96	03/30/96	90,057
4.26 to 4.65	02/05/97	03/31/97	89,011
3.43 to 4.65	03/11/99	06/29/99	165,116
4.27 to 4.65	01/14/02	02/09/02	96,523
4.33 to 4.75	01/15/04	02/16/04	75,770
4.27 to 4.65	12/11/07	01/10/08	140,608
4.18 to 4.65	02/19/10	03/30/10	60,371
4.00 to 4.61	12/01/11	02/09/12	152,349
4.02 to 4.03	01/28/13	02/17/13	4,640
4.03 to 4.61	12/27/13	02/01/14	67,552
-0.03 to 0.00	12/27/13	02/01/14	2,300

Note(s)
1 Sources: USACE, 2005; USACE, 2010; DMMP, 2009, David Fox Chief, DMMO personal communication July 17, 2015.

TABLE 2

NUMBER OF MONTHLY LOWER DUWAMISH WATERWAY BRIDGE OPENING (2003-2006)

Enhanced Natural Recover/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

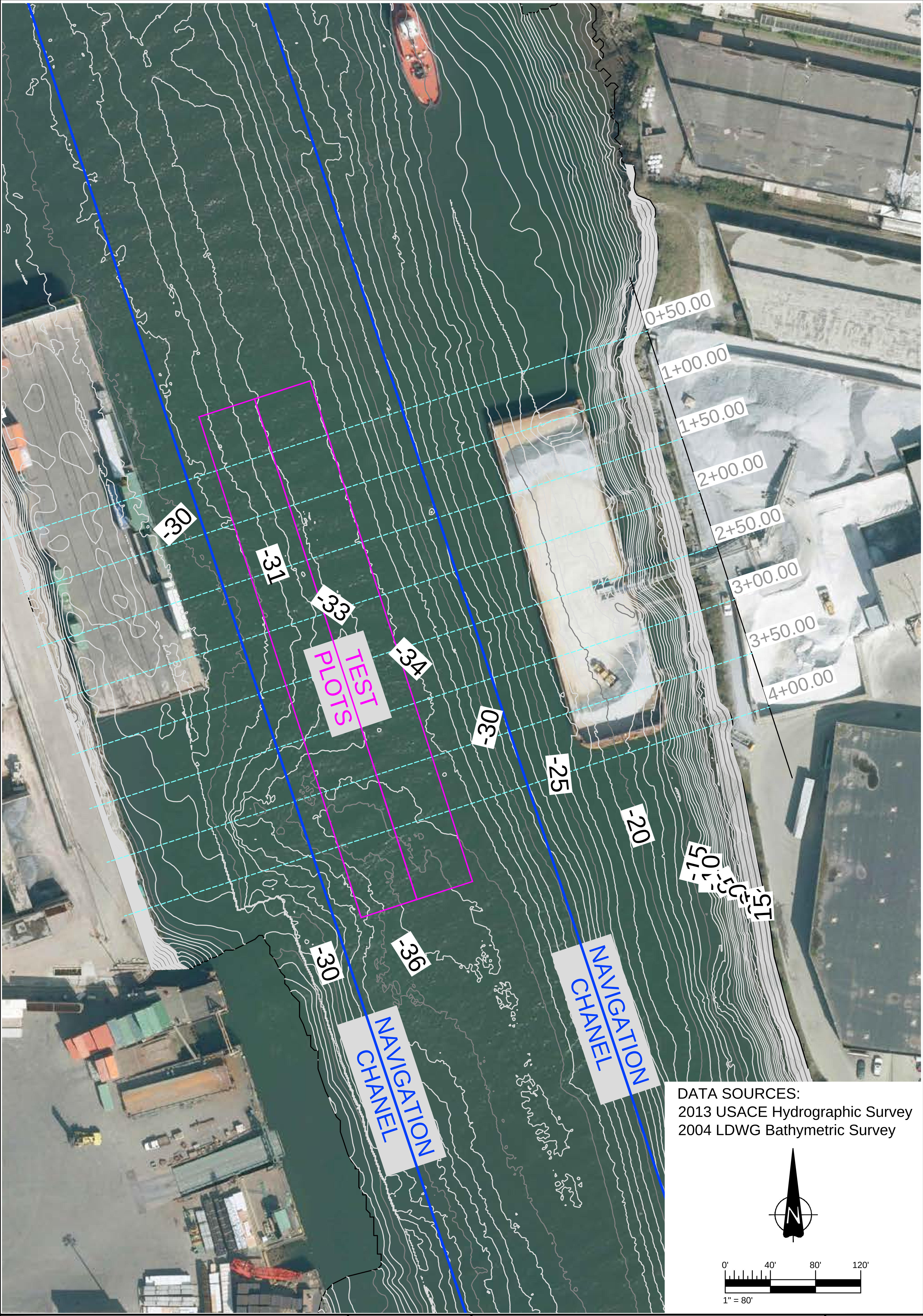
Year	Openings	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average	Daily Average
Spokane Street Bridge [1]															
2003	All motorized vessels	228	208	261	207	193	165	133	139	95	143	122	103	166	5.5
	Tugboat-escorted vessels and barges	93	83	124	106	140	112	105	113	76	109	84	79	102	3.4
	Openings within 1 hour	68	41	81	58	50	42	20	31	16	17	21	17	39	1.3
2004	All motorized vessels	121	105	133	139	138	145	164	115	112	149	152	152	135	4.5
	Tugboat-escorted vessels and barges	95	85	97	113	111	101	133	105	98	109	94	110	104	3.4
	Openings within 1 hour	16	9	18	23	35	26	40	8	16	23	37	23	23	0.8
2005	All motorized vessels	117	93	142	133	152	166	131	160	142	143	136	105	135	4.4
	Tugboat-escorted vessels and barges	80	77	115	113	112	131	104	132	115	103	107	75	105	3.5
	Openings within 1 hour	19	10	26	29	34	33	15	38	19	22	27	10	24	0.8
First Avenue Bridge [2]															
2005	All openings	108	119	175	158	168	147	116	135	115	92	93	124	129	4.3
2006		112	83	129	145	155	142	182	146	139	125	—	—	136	4.5
South Park Bridge [3]															
2005	All openings	39	63	76	47	42	59	95	76	80	53	35	46	59	2
2006		39	42	42	82	101	88	125	98	81	59	—	—	76	2.5

Note(s)
1. Source: SDOT, 2006.
2. Source: WDOT, 2006.
3. Source: KCDOT, 2006.

FIGURES

Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	ENR/AC Pilot Study	Figure 1 Vicinity Map

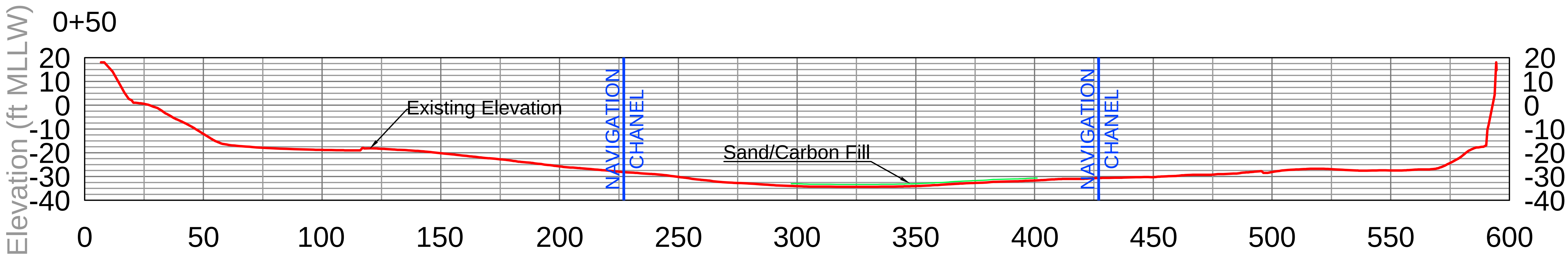
File path: "P:\King County\DATA\BE Figures\Revised Figure 070615\Vicinity Map071715.mxd"

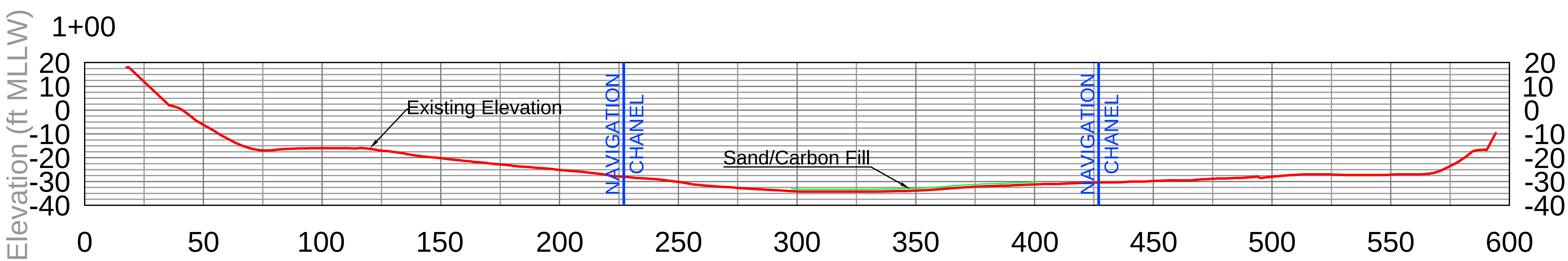


LOWER DUWAMISH WATERWAY GROUP	amec foster wheeler	Enhanced Natural Recovery/Activated Carbon Pilot Study	DATE July 17, 2015 SCALE 1" = 80'
Amec Foster Wheeler Environment & Infrastructure, Inc. 3500 188th St SW, Suite 601 Lynnwood, WA 98037		Plan View of Subtidal Plot Area	PROJECT NO. LY15160310.300.328 FIGURE 2

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Plan View Fig 2 - Jul. 17, 2015 2:23pm - gary.maxwell





View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP

Amec Foster Wheeler
Environment & Infrastructure, Inc.
3500 188th St SW, Suite 601
Lynnwood, WA 98037

amec foster wheeler

Enhanced Natural Recovery/Activated Carbon Pilot Study

Cross Sections

DATE July 17, 2015

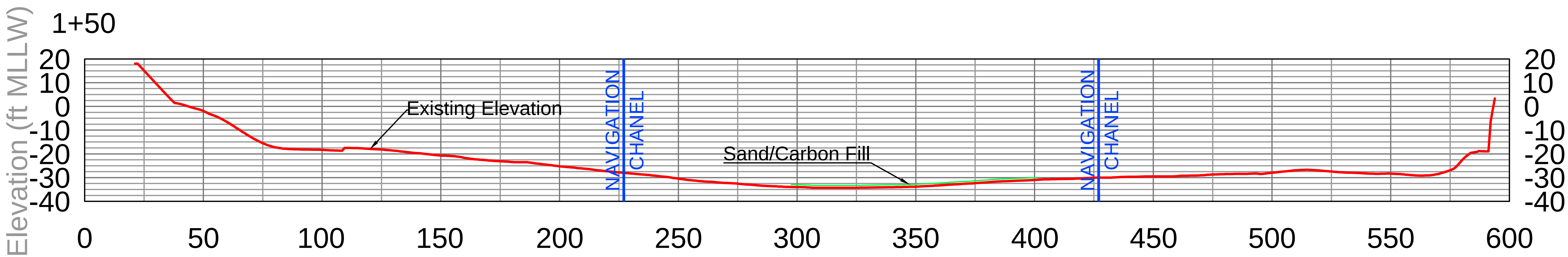
SCALE

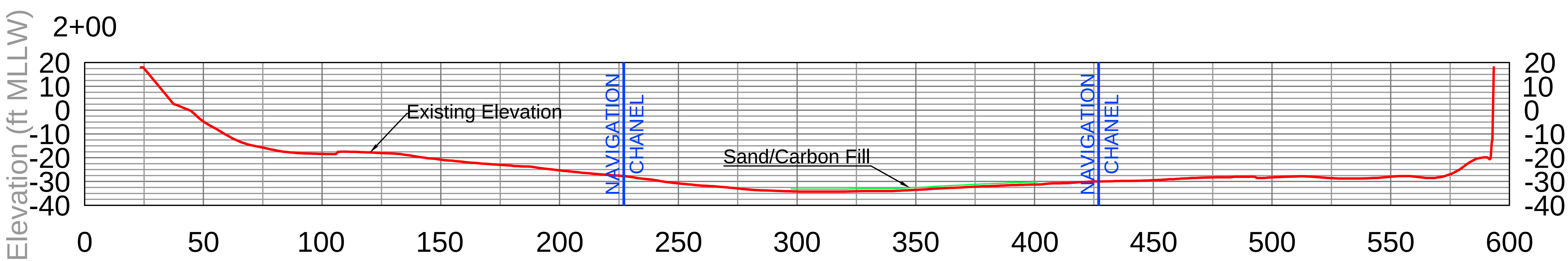
PROJECT NO. LY15160310.300.328

FIGURE 3a

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3a - Jul. 17, 2015 1:36pm - gary.maxwell



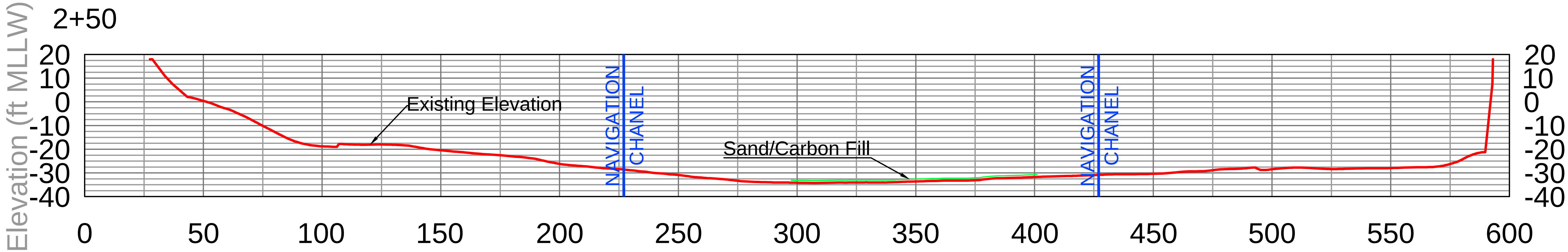


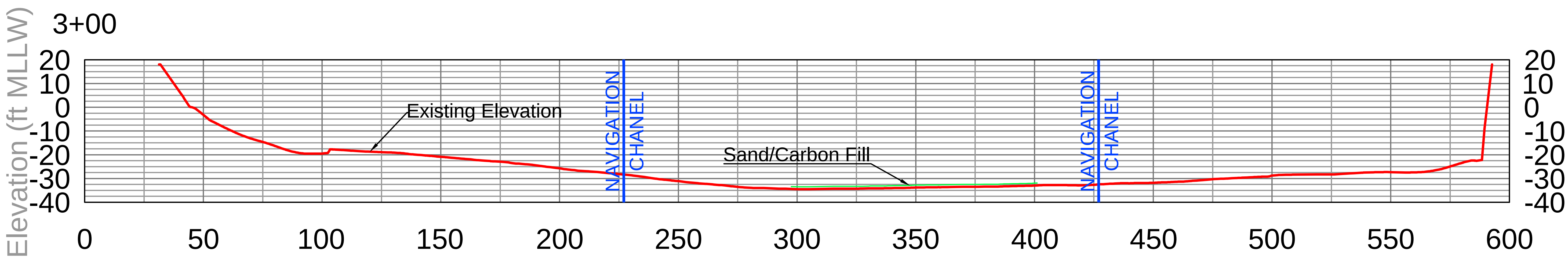
View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP	amec foster wheeler	Enhanced Natural Recovery/Activated Carbon Pilot Study	DATE July 17, 2015 SCALE
Amec Foster Wheeler Environment & Infrastructure, Inc. 3500 188th St SW, Suite 601 Lynnwood, WA 98037		Cross Sections	PROJECT NO. LY15160310.300.328 FIGURE 3b

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3b - Jul. 17, 2015 1:36pm - gary.maxwell



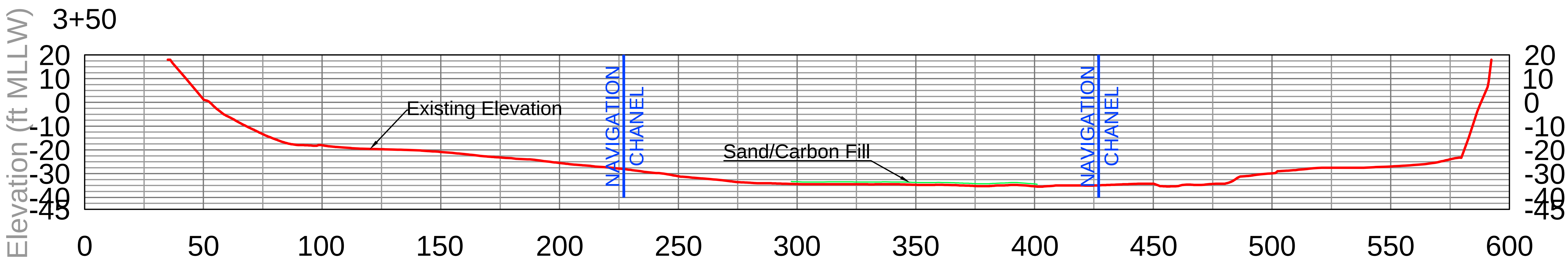


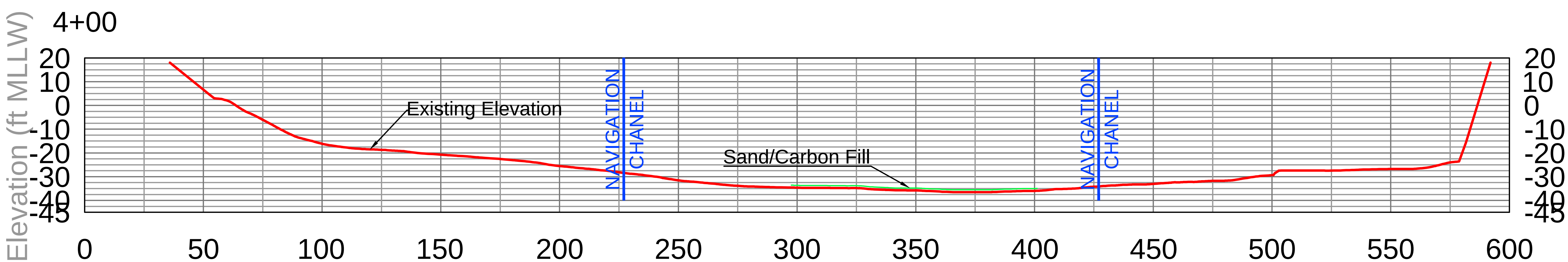
View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP	amec foster wheeler	Enhanced Natural Recovery/Activated Carbon Pilot Study	DATE July 17, 2015 SCALE
Amec Foster Wheeler Environment & Infrastructure, Inc. 3500 188th St SW, Suite 601 Lynnwood, WA 98037		Cross Sections	PROJECT NO. LY15160310.300.328 FIGURE 3c

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3c - Jul. 17, 2015 1:36pm - gary.maxwell





View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP	amec foster wheeler	Enhanced Natural Recovery/Activated Carbon Pilot Study	DATE July 17, 2015 SCALE
Amec Foster Wheeler Environment & Infrastructure, Inc. 3500 188th St SW, Suite 601 Lynnwood, WA 98037		Cross Sections	PROJECT NO. LY15160310.300.328 FIGURE 3d

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3d - Jul. 17, 2015 1:36pm - gary.maxwell

ENCLOSURE 2

NWS ATR TEAM COMMENTS

NWS Section 408 ATR Team Comments

Lower Duwamish Waterway ENR+AC Pilot Study

The following questions were submitted to the Environmental Protection Agency on August 28, 2015, with a request to revise the Section 408 memorandum to address these questions. The EPA re-submitted a revised Section 408 Memorandum to NWS on September 23, 2015. The revised document adequately addressed all questions identified below.

Hydraulic/Hydrologic Impacts

1. Has there been a hydraulic analysis performed in the design of the project?
2. Specifically looking to answer the following three questions in regards to the hydraulic modeling.
3. What are the maximum velocities in the project footprint?
4. Is the sand proposed for placemen stable under those velocities?
5. Will the placement of the cap result in substantial adverse changes in water surface profiles or flow velocities within the channel? (This should answer the floodplain management considerations section, as well.)

ENCLOSURE 3

ATR CERTIFICATION

Certification of Legal Sufficiency

The ATR Legal Certification depicts the legal sufficiency of the proposed alteration. All legal concerns have been resolved with the proposed Lower Duwamish Waterway Enhanced Natural Resources and Activated Carbon Pilot Study Section 408 substantive review.

RYAN.VIRGINIA.K.1369747491

Digitally signed by RYAN.VIRGINIA.K.1369747491
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=RYAN.VIRGINIA.K.1369747491
Date: 2015.10.19 09:49:49 -07'00'

Virginia K. Ryan
Assistant District Counsel

Real Estate Compliance Certification

This ATR Certification demonstrates that the real estate documentation reviewed by the ATR team is adequate and the review is complete. No real estate is necessary for the alteration.

10-13-2015

Chris Borton, Real Estate Division Chief **Date**

Policy Compliance Certification

This ATR certification ensures appropriate quality control and assurance has been conducted for the project and confirms that the proposed alteration and technical review is consistent with policy and is adequate to support the type of alteration and project complexity. All policy and technical issues have been addressed and resolved through the ATR.

[signature]	10/9/15
for Valerie Ringold, Planning Branch Chief	Date
Carolyn Fitzgerald, H&H Branch Chief	Date
Travis Shaw, Technical Services Branch	Date
Amy Reese, Operations Support Branch	Date

Policy Compliance Certification

This ATR certification ensures appropriate quality control and assurance has been conducted for the project and confirms that the proposed alteration and technical review is consistent with policy and is adequate to support the type of alteration and project complexity. All policy and technical issues have been addressed and resolved through the ATR.

_____________________________ ___________________

Valerie Ringold, Planning Branch Chief Date

FITZGERALD.CAROLYN.J.1231720223

Digitally signed by FITZGERALD.CAROLYN.J.1231720223
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=FITZGERALD.CAROLYN.J.1231720223
Date: 2015.10.13 09:55:01 -07'00'

Carolyn Fitzgerald, H&H Branch Chief Date

_____________________________ ___________________

Travis Shaw, Technical Services Branch Date

_____________________________ ___________________

Amy Reese, Operations Support Branch Date

Policy Compliance Certification

This ATR certification ensures appropriate quality control and assurance has been conducted for the project and confirms that the proposed alteration and technical review is consistent with policy and is adequate to support the type of alteration and project complexity. All policy and technical issues have been addressed and resolved through the ATR.

Valerie Ringold, Planning Branch Chief	Date
Carolyn Fitzgerald, H&H Branch Chief	Date
SHAW.TRAVIS.C.1231596115 Digitally signed by SHAW.TRAVIS.C.1231596115 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=SHAW.TRAVIS.C.1231596115 Date: 2015.10.13 16:07:06 -07'00'	13 Oct 2015
Travis Shaw, Technical Services Branch	Date
Amy Reese, Operations Support Branch	Date

Policy Compliance Certification

This ATR certification ensures appropriate quality control and assurance has been conducted for the project and confirms that the proposed alteration and technical review is consistent with policy and is adequate to support the type of alteration and project complexity. All policy and technical issues have been addressed and resolved through the ATR.

Valerie Ringold, Planning Branch Chief — Date

Carolyn Fitzgerald, H&H Branch Chief — Date

Travis Shaw, Technical Services Branch — Date

E-Signed by REESE.AMY.R.1161223596
VERIFY authenticity with ApproveIt
REESE.AMY.R.1161223596

Amy Reese, Operations Support Branch — Date

ENCLOSURE 4

DNR Letter

April 27, 2015

Pamela Erstad, Program Manager
Regulatory Compliance & Land Acquisition Services
Wastewater Treatment Division
201 South Jackson Street, Suite 505
Seattle Washington 98104-3855

Dear Ms. Erstad:

I am writing in response to the County's request for access authorization for submerged land in the Lower Duwamish Waterway (the "LDW") for the purpose of work required for an Enhanced Natural Recovery-Activated Carbon Pilot Study (the "Study"). The Study is being carried out by the Port of Seattle, City of Seattle, King County and the Boeing Company (collectively, the Lower Duwamish Waterway Group, or "LDWG") pursuant to an amendment to the U.S. Environmental Protection Agency and Washington Department of Ecology Administrative Order on Consent for the LDW Remedial Investigation/Feasibility Study (Second Amendment to CERCLA Docket No. 10-2001-0055). The Study will evaluate the effect of applying activated carbon to *in situ* contaminated sediments in plots at three LDW locations. The County is the contracting agent for the LDWG parties and is responsible for securing access on behalf of the contractor that will be performing the field work for the Study.

Ownership interests in property on which the Study will take place are unclear due to a complex historical record and conflicting documentation. To the extent the State has ownership interests in the submerged land at the three locations in the LDW where the Study will take place, the Department of Natural Resources authorizes access and use of the submerged lands at those locations for all LDWG parties, including King County and its contractor, to carry out the Study.

Sincerely,

Kristin Swenddal, Manager
Aquatic Resources Division

Memorandum

To: Lower Duwamish Waterway Group

From: Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmstead & Fuglevand, Inc.
Ramboll Environ
Floyd|Snider
Geosyntec Consultants

Date: September 23, 2015

Subject: **U.S. Army Corps of Engineers – Section 408 Substantive Compliance Memorandum for Placement of Subtidal Pilot Plot in the Federal Navigation Channel**

This memorandum is intended to evaluate substantive compliance per requirements of 33 USC § 408 (Section 408) for the construction of an Enhanced Natural Recovery/Activated Carbon pilot study plot. This memorandum was generated using Engineering Circular guidance (EC 1165-2-216) as per the U.S. Army Corps of Engineers (USACE) request. The pilot study is being performed by the Lower Duwamish Waterway Group (LDWG) per the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055, issued on December 20, 2000).

Because the intertidal and scour plot areas are not located within the federal navigation channel, this memorandum will only addresses potential effects of the subtidal plot (Figure 1) as per requirements of 33 USC § 408 (Section 408).

The memorandum consists of the following sections:

- Section 1.0 – Project Description and the LDW Federal Navigation Channel.
- Section 2.0 – Analysis of Federal Navigation Function.
- Section 3.0 – Technical Analysis and Adequacy of Design.
- Section 4.0 – Real Estate Analysis.
- Section 5.0 – Environmental Risk.
- Section 6.0 – Floodplain Management Considerations.
- Section 7.0 – Residual Risk Analysis.

- Section 8.0 – Impacts to Corps of Engineers Operations and Maintenance.
- Section 9.0 – Summary and Conclusions.
- Section 10.0 – References.

1.0 PROJECT DESCRIPTION AND THE LDW FEDERAL NAVIGATION CHANNEL

This section provides brief descriptions of the pilot plot study and the Lower Duwamish Waterway (LDW) federal navigation channel. The complete Draft Design Package for the pilot study was provided to EPA on July 22, 2015.

1.1 PILOT PLOT STUDY

This section provides a description of the pilot study, including the active placement of the ENR and ENR+AC materials, as well as pre- and post-implementation monitoring of the pilot plots.

The pilot study will evaluate the effectiveness of ENR+AC compared to ENR alone as a remedial sediment cleanup action in three areas of the LDW in which sediments are contaminated with polychlorinated biphenyls (PCBs); they are designated as the intertidal, subtidal, and scour plots. In each plot, two adjacent, half-acre areas will be evaluated, one in which only ENR material has been placed and the other in which ENR material amended with AC has been placed. The ENR material in the subtidal plot will consist of clean sand. In all three plots, the ENR+AC material will also contain granular AC at a concentration of 1 to 3 percent. The proposed AC concentration is sufficient to sequester PCBs (and to reduce bioavailability) but is not expected to adversely affect benthic biota.

Conservation measures and best management practices (BMPs) for the construction of the pilot study are described in Section 5.0.

1.1.1 Construction Elements

It is anticipated that a barge-mounted fixed-arm excavator with a clamshell bucket will be used for submerged placement of the ENR and ENR+AC materials. The submerged release of the ENR and ENR+AC materials a few feet above the substrate will minimize the loss of AC as the ENR+AC material descends through the water column and will also minimize turbidity plumes that may result as fine particles in the ENR and ENR+AC materials become suspended in the water column and descend to the bottom substrate. The ENR+AC material will be preblended to meet the target concentration of AC and presoaked prior to placement. Presoaking of the ENR+AC material will help to minimize the loss of AC as the ENR+AC material descends through the water column during placement. The target thickness of the ENR and ENR+AC materials is 6 inches and at least 4 inches, and an average of approximately 9 inches placed over the existing substrate.

Precision navigation, as well as offset and staggered placement, will be used to ensure precise placement of the ENR and ENR+AC materials at each of the pilot plots.

Equipment that will used by the contractor includes, but is not limited to, barges (with and without spuds), excavators, tugs, small work boats, and anchors. The disturbance of existing sediments will be limited to disturbance from anchors or barge spuds. The construction of the project does not require dredging of any sediment; however, in the event that material is overplaced within a plot above the placement thickness to such a degree that it may impact navigation, some placed material will be moved using the clamshell bucket and relocated to the perimeter of the appropriate subplot.

Based on field data presented in the Lower Duwamish Waterway Sediment Transport Modeling (STM) Report (Quantitative Environmental Analysis, LLC 2008) during a high-flow event that was in the top 1 percent of measured discharges since 1990, the maximum velocities 1 meter above the bed in the vicinity of the subtidal plot are up to approximately 18 cm/sec. The velocities near the bed are likely to be lower than the 18 cm/sec. Based on Hjulsröm's Diagram, at a velocity of 18 cm/sec, sand sized particles that will be used at the subtidal plot are anticipated to be stable.

1.1.2 Construction Timing

The completion of in-water construction activities for the pilot study will require 2 to 4 weeks. All in-water work associated with the placement of ENR and ENR+AC materials will be conducted during the authorized 2016–2017 in-water work window of October 1 through February 15 (USACE, 2012) for the LDW, when listed salmonid species are least likely to be present in the LDW. Construction will occur after the end of the Muckleshoot Indian Tribe’s netfishery season. Construction is expected to begin in December 2016.

1.1.3 Pre- and Post-Implementation Monitoring

Pre- and post-implementation monitoring of the three pilot plots will be conducted to assess baseline conditions prior to project activities and to periodically evaluate conditions of the three pilot plots after placement of the ENR and ENR+AC materials.

The following presents an overview of the monitoring activities during the pilot study:

- Bathymetric survey to document pre- and post-placement elevations and Sediment Profiling Imaging to document thickness of placed material;
- Collection of surficial sediment samples for chemical, physical, and benthic taxonomic analyses (benthic taxonomic analyses will be conducted only during Year 3);
- Analysis of PCBs in pore water using passive samplers;
- Use of Sediment Profile Imaging to assess benthic recolonization;
- Use of submerged placement of the ENR and ENR+AC materials will minimize the loss of AC as the ENR+AC material descends through the water column and will also prevent or minimize turbidity plumes that may result as fine material in the ENR and

ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed;

- Prewetting of the ENR+AC material prior to placement to minimize loss of AC during placement of the ENR+AC material; and
- Implementation of a water quality monitoring plan during the ENR and ENR+AC materials placement to assess turbidity downcurrent of the pilot plots. The water quality monitoring results will be provided to the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA).

1.2 LDW Federal Navigation Channel

The LDW is a federal navigation channel, authorized under the River and Harbor Act of 1919 and modified by subsequent Acts. As such, it performs functions that must not be adversely affected by other actions.

The USACE is responsible for maintaining the navigation channel to the following authorized depths and widths (Figure 1):

- -30 feet mean lower low water (MLLW) and 200 feet wide from Harbor Island (RM 0.0) to the First Avenue South Bridge (RM 2.0), also known as the Harbor Island and Georgetown Reaches.
- -20 feet MLLW and 150 feet wide from the First Avenue South Bridge (RM 2.0) to Slip 4 (RM 2.8), also known as the First Avenue South Reach.
- -15 feet MLLW and 150 feet wide from Slip 4 (RM 2.8) to the Upper Turning Basin (RM 4.7), also known as the South Park and 14^{th} Avenue Bridge Reaches. The authorized dimensions of the navigation channel portion of the Upper Turning Basin are 250 feet wide by 500 feet long (USACE, 2005).

To maintain the navigation channel at the authorized depths, the USACE conducts maintenance dredging every 1 to 3 years in the upstream areas. The area typically dredged under this program is the Upper Turning Basin and downstream to approximately RM 4.0. Maintenance dredging is discussed in more detail later in this document.

Without routine maintenance dredging, shoaling would create a shallower channel and inhibit the safe passage of vessels. The Upper Turning Basin acts as a settling basin for sediments that would normally migrate downstream. In this area, the river channel cross section sharply expands from a somewhat natural section to an engineered channel maintained to be significantly larger than its natural analog. The sharp transition and enlarged channel results in greatly reduced flow velocities, which promotes sediment deposition. Routine maintenance dredging keeps sediments from accumulating beyond the holding capacity of the basin. In the absence of maintenance dredging, the sediment would continue to migrate downstream via bed load transport and settle in downstream areas. Therefore, dredging the shoaled material from the Upper Turning Basin minimizes the need for maintenance dredging in the lower portion of the LDW. The navigation channel downstream of RM 3.35 has not been subjected to maintenance dredging since 1984, and that was only for a small portion of the navigation channel near Kellogg Island.

Table 1 summarizes USACE maintenance dredging events in the LDW navigation channel between 1986 and 2014. The yearly volumes of sediment dredged from the LDW have varied widely, from a minimum of 34,000 cubic yards (cy) dredged in 1986 to a maximum of 200,000 cy in 1992.

2.0 ANALYSIS OF FEDERAL NAVIGATION FUNCTION

This section assesses whether the design of the proposed pilot plot study: (1) is consistent with the authorized navigation channel, (2) impairs the usefulness of the navigation channel, and (3) is “injurious to the public interest.”

2.1 VESSEL TRAFFIC IN THE LDW NAVIGATION CHANNEL

A variety of commercial and recreational vessels operate within the LDW navigation channel, including tugboats moving alone or with barges/derricks, fishing vessels, bulk cargo vessels, recreational vessels such as sailboats and motor yachts, and miscellaneous vessels such as fireboats, passenger boats, and research vessels. The LDW is also used by recreational boaters in kayaks.

General information about vessel traffic in the LDW is presented in Riley (2006) and Takasaki (2006). Based on information contained in those two memoranda, vessel traffic in the LDW may be summarized as follows:

- A variety of barges are used in the LDW, typically traveling at speeds of 2 to 3 knots, with a maximum speed of 5 knots. Those that are 400 feet long and 100 feet wide with 14-foot drafts travel to just upstream of the First Avenue Bridge, while those that are 286 feet long and 76 feet wide with 12-foot drafts travel no farther upstream than the South Park Bridge (approximately RM 3.3). There is relatively infrequent barge traffic upstream of RM 3.3, although General Construction Company does have a barge storage area upstream of the South Park Bridge at approximately RM 4.2.
- Ocean-going vessels are always under tug assistance in the LDW, although these vessels may also be self-propelled and do not travel farther upstream than the First Avenue Bridge (approximately RM 2.0). These vessels typically travel at a speed of 2 to 3 knots, with a maximum speed of 5 knots. These vessels are unable to turn around in the LDW, so are towed into Elliott Bay when out-bound.
- The Pilot’s Association indicated that two large vessels travel up to the James Hardie and Glacier docking areas, which are located at approximately RM 1.6. These vessels are 85 feet wide and 600 feet long, with drafts of 20 feet (unloaded) and 30 feet (loaded).
- Yachts traveling to and from Delta Marine, located near RM 4.2, range in length from 100 feet to 160 feet, with drafts of 5.5 feet to 10 feet.

An estimate of the volume of large vessels using the LDW navigation channel can be derived from the number of bridge openings of the five bridges spanning the LDW and the West Waterway. Three are located on the West Waterway: the high-level West Seattle Bridge; a railroad bridge, which remains open unless a train is traversing the waterway; and the Spokane Street Bridge. Two bridges span the LDW: the First Avenue Bridge and the South Park Bridge. Bridges are opened periodically to allow for the passage of vessels that exceed clearance heights. Bridge opening logs provide information on the number, duration, and frequency at which large vessels move under the bridges while open. Records for the Spokane Street, First Avenue, and South Park bridges were reviewed, as presented in the FS, to assess the degree to which vessel traffic varies throughout portions of the LDW (SDOT, 2006; KCDOT, 2006; WSDOT, 2006).

Spokane Street Bridge: The Spokane Street Bridge (downstream of the LDW near its mouth) is operated by the Seattle Department of Transportation (SDOT). Bridge opening logs for this bridge, which has a 55-foot clearance above mean high water, record the number of vessels entering and exiting the LDW through the West Waterway and every occasion the bridge is opened. For the purposes of this analysis, only openings for large motorized vessels other than sailboats were considered. Motorized vessels include tugboats and container ships. Vessels with a low clearance do not require the bridge to be opened and are not captured by bridge opening logs.

Monthly bridge openings for large motorized vessels for the period from 2003 to 2005 ranged from 93 openings in February 2005 to 261 openings in March 2003 (Table 2). The average number of monthly openings during this period was 146, or approximately 5 per day. Most of these openings were for tugboat-escorted vessels and barges, representing 75 to 140 per month, with a monthly average of 104, or approximately 3 per day (SDOT, 2006). The logs show that regular vessel traffic is spaced from 1 to several hours apart.

First Avenue Bridge: The First Avenue Bridge (at RM 2.0) is a drawbridge operated by the Washington State Department of Transportation (WSDOT). It has a 41-foot clearance at the center span and a 24-foot clearance at the side spans. It opened over 1,300 times annually in both 2005 and 2006, averaging less than 4 openings daily.

South Park Bridge: South Park Bridge (RM 3.3); also referred to as the 14th Avenue Bridge, is operated by the King County Department of Transportation (KCDOT). It has a 34-foot clearance at the center span. It was opened between 700 and 800 times annually in 2005 and 2006, approximately twice daily.

2.2 CONSISTENCY WITH AUTHORIZED NAVIGATION CHANNEL

Of the three pilot plot areas, only the subtidal plot area will be located in the federal navigation channel at RM 1.2. Two adjacent, half-acre areas (Figure 2) will be evaluated, one in which only ENR material has been placed and the other in which ENR material amended with AC has been placed. The ENR material in the subtidal plot will consist of clean sand. The target thickness of the ENR and ENR+AC materials is 6 inches with at least 4 inches, and an average of approximately 9 inches placed over the existing substrate and a maximum thickness not to exceed 12 inches.

The west edge of the subtidal plot area will be aligned with and approximately 25 feet from the west edge of the federal navigation channel. Each half-acre area is about 50 feet wide by 465 feet long. The two half-acre areas will be immediately adjacent to one another and aligned in a north-south direction paralleling the federal navigation channel. The combined width of the two half-acre test plots will be 100 feet, so that the west edge of the test plot will be at approximately 30.9 feet MLLW or deeper and the east edge of the test plot at a depth of -36.8 feet MLLW (Figure 2).

Placement of ENR and ENR+AC will decrease the water depth over the one acre of the subtidal plot by an average of 9 inches (0.67 feet), with water depths in some locations along the test plot possibly being decreased by up to 1 foot. Assuming a worst-case scenario that ENR and ENR+AC will be placed at a uniform thickness of 12 inches across the entire subtidal plot, there are seven areas where the modeled depths will be -29.9 feet MLLW. The combined area of these seven locations is approximately 41 square feet. Thus, water depth after placement of the ENR and ENR+AC over the one acre area of the subtidal plot could range from -29.9 feet MLLW to -35.8 feet MLLW across the subtidal plot area. Figures 3a through 3d, which are based on the latest available bathymetry data and the assumption of a uniform ENR and ENR+AC thickness of 1 foot, depict eight cross-sectional views through the ENR and ENR+AC subtidal plots at 50-foot intervals beginning 50 feet from the north end of the proposed subtidal plots.

The available information indicate that the largest vessels using the LDW travel up to the James Hardie and Glacier docking areas, which are located at approximately RM 1.6. These two vessels are 85 feet wide and 600 feet long, with drafts of 20 feet (unloaded) and 30 feet (loaded). When loaded, it is most likely that these vessels would depart their moorages on a high tide to avoid contact with the substrate. The mean high water in the LDW is +10.24 feet MLLW (USACE, 2000); therefore at mean high water, the water depth at the shallowest points along the subtidal plot would be 40.14 feet, providing sufficient clearance between the hulls of these large vessels and the highest point along the subtidal plot.

The modeled net sedimentation rate in the LDW at the proposed location of the subtidal plot is 1.7 centimeters (0.67 inch) per year. Therefore it would require approximately 18 years for another foot of sediment to deposit over the subtidal plot. Assuming a uniform thickness of 1 foot of ENR and ENR+AC over the area covered by the subtidal plot, adding another foot of sediment deposition over the subtidal plot would result in water depths ranging from 39.1 feet to 46.0 feet at mean high water. This depth range would still provide sufficient clearance between the substrate and hulls of the largest ships currently using this reach of the LDW.

Other shallower-draft vessels, both commercial and recreational, navigating the reach of the LDW where the subtidal plot will be located are not expected to be affected by placement of the subtidal plot. Therefore, the subtidal plot is not expected to affect the usefulness of the navigation channel or to be inconsistent with the authorized navigation channel.

Placement of the subtidal plot is not expected to be injurious to the public interest.

3.0 TECHNICAL ANALYSIS AND ADEQUACY OF DESIGN

The design of the pilot study was prepared by a group of expert scientist and engineers using standard scientific and engineering practices. The pilot study was designed to place the minimum amount of fill to meet the goals of the project and considered the placement precision of various types of equipment that may be used during the construction. Prior to implementation the design will require approval by Ecology and EPA.

4.0 REAL ESTATE ANALYSIS

There are no real property interests required to support the proposed alteration of the navigation channel (per page 12 of EC 1165-2-216); therefore, no analysis of real estate is required.

5.0 ENVIRONMENTAL RISK

A biological evaluation (BE) was prepared for the pilot study for Section 7 consultation under the Endangered Species Act. Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), Puget Sound steelhead trout (*O. mykiss*), Coastal/Puget Sound bull trout (*Salvelinus confluentus*), and Dolly Varden trout (*S. malma*) are listed salmonids using the LDW and were the primary species addressed in the BE. The BE assessed potential effects of the pilot study on existing environmental conditions in the LDW, listed species that use the LDW, and the critical habitats of the listed species in the LDW.

The pilot study is not expected to substantially alter existing environmental conditions within the LDW. Potential impacts on existing environmental conditions in the Action Area defined for this biological evaluation are the following:

- Placement of ENR and ENR+AC materials may result in temporary and localized increases in turbidity in the water column.
- Physical and conventional sediment characteristics (e.g., grain size and total organic carbon) within the pilot plot areas may be altered in the short term relative to those of the surrounding sediments. In the long term, the physical and conventional sediment characteristics are expected to return to current conditions by means of natural riverine processes.
- Placement of ENR and ENR+AC on sediments that are contaminated with PCBs will reduce the exposure of aquatic organisms to PCBs within those areas.
- The ENR and ENR+AC materials placed during the pilot study will be approximately 6 to 9 inches thick, with a maximum thickness of 12 inches, and are not expected to substantially alter the bathymetry in the pilot plots.

- Placement of ENR and ENR+AC materials will bury benthic habitat in the pilot plots; however, two of the pilot plot areas are subtidal, located in areas unlikely to provide preferred foraging habitat for juvenile salmonids.
- The pilot study will have no effect on access and refugia; flow, water current patterns, saltwater-freshwater mixing; marine macroalgae and macrophytes; forage fish; or ambient noise within the LDW.

A number of conservation measures and BMPs will be implemented to minimize and avoid impacts on listed species and the environment during in-water work activities:

- The completion of in-water construction activities for the pilot study will require 2 to 4 weeks. All in-water work associated with the placement of ENR and ENR+AC materials will be conducted during the authorized 2016–2017 in-water work window of October 1 through February 15 (USACE, 2012) for the LDW, when listed salmonid species are least likely to be present in the LDW.
- Construction will occur after the end of the Muckleshoot Indian Tribe's salmonid netfishery season. Construction is expected to begin in late December 2016.
- Use of submerged placement of the ENR and ENR+AC materials will decrease the spread of material outside the placement boundaries and minimize the loss of AC as the ENR+AC descends through the water column and will also prevent or minimize turbidity plumes that may result as fine material in the ENR and ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed.
- Prewetting of the ENR+AC material prior to placement will minimize loss of AC during placement of the ENR+AC materials. and
- Implementation of a water quality monitoring plan during the ENR and ENR+AC material placement will assess turbidity downcurrent of the pilot plots. The water quality monitoring results will be provided to Ecology and EPA.

The following BMPs will also be implemented to minimize and avoid impacts on listed species and the environment during in-water activities:

- All mechanized equipment will be maintained in proper operating condition, with equipment inspections occurring prior to each workday. Equipment found to be leaking petroleum products or hydraulic fluid will be removed from the site for maintenance.
- Drip pads or pans will be placed under mechanized equipment to contain any potential leaks of petroleum products or hydraulic fluids.
- To the extent possible, vegetable-based hydraulic fluids will be used.
- A spill kit will be kept on work vessels to contain any potential petroleum spills that might occur.
- Ecology and the U.S. Coast Guard will be contacted immediately in the event of a spill.

- Any project-related debris or wastes will be placed in appropriate containers for off-site disposal. No project-related debris or wastes will be allowed to enter the water.
- Barges and work vessels will not be allowed to run aground on the substrate. Work barges will be held on station with spuds or anchors.

The placement of the subtidal plot within the authorized navigation channel is unlikely to adversely affect the environment within the LDW, but is expected to have a net beneficial effect through reducing exposure of aquatic biota to PCB-contaminated sediments covered by the ENR and ENR+AC in the subtidal plot area.

6.0 FLOODPLAIN MANAGEMENT CONSIDERATIONS

There are no anticipated impacts to floodplains due to construction of the pilot study. The elevation of the subtidal plot will be at or below the authorized navigation channel depth. Any changes in water surface elevation due to construction of the pilot study plot will be within the range of the water surface elevations that would be expected from natural deposition of sediments within the navigation channel.

7.0 RESIDUAL RISK ANALYSIS

Little, if any, residual risk is expected as a result of the proposed action. As discussed in the above sections, the placement of the proposed subtidal plot in the federal navigation channel is not expected to affect the usefulness or the functionality of the federal navigation channel, thus allowing commercial and recreational vessels to safely use the channel. Furthermore, the proposed action is not expected to adversely affect the environmental conditions within the federal navigation channel, nor is the proposed action expected to adversely affect the floodplain.

8.0 IMPACTS TO CORPS OF ENGINEERS OPERATIONS AND MAINTENANCE

The placement of the fill in the subtidal plot will not impact the ability of the Corps of Engineers to maintain the authorized navigation channel. The material to be placed is comprised of sand and is easily dredged. If this reach of the navigation channel is dredged in the future, localized portions of the clean ENR material placed by this project could be incidentally removed by the navigation dredging, depending on the overdepth specifications, equipment selection, and operational controls of the navigation dredging project. However, based on the Corps dredging records presented in Table 1, this area has not been dredged in the last 30 years and it is unlikely to be dredged in the foreseeable future.

The issue discussed above would not affect USACE O&M of the federal channel. As with all ENR areas identified in EPA's LDW ROD; if future disturbances to the ENR areas affect the protectiveness of the remedy, the Performing Parties that implement the remedy will be responsible for any needed repairs.

9.0 SUMMARY AND CONCLUSIONS

The placement of the proposed subtidal plot in the federal navigation channel is not expected to adversely affect the usefulness or functionality of the channel.

10.0 REFERENCES

Dredged Materials Management Program (DMMP). 2009. Determination Regarding the Suitability of Federal Operation and Maintenance Dredged Material from the Duwamish River, Section 13 – References Seattle, King County, Washington (Public Notice CENWS-OD-TS-NS-26) Evaluated Under Section 404 of the Clean Water Act for Beneficial Use or Unconfined Openwater Disposal at the Elliott Bay Nondispersive Site. October 15, 2009.

King County Department of Transportation (KCDOT). 2006. South Park Bridge Opening Records 2005, 2006. Provided by Bridge/Structures Maintenance & Operations Manager. December 18, 2006.

Riley, M.J. 2006. Personal communication between Michael Riley of SS Papadopulos & Associates, Inc. and RETEC via memorandum regarding ship and barge traffic on the LDW. Prepared for RETEC, Preliminary Screening of Alternatives. August 11, 2006.

Seattle Department of Transportation (SDOT). 2006. Spokane Street Bridge Opening Logs for 2003 to 2005. Provided by Dave Chew, Bridge/Structures Maintenance and Operations Manager to AECOM. November 15, 2006.

Takasaki, K. 2006. Personal communication between Kym Takasaki of U.S. Army Corps of Engineers and Allison Hiltner, U.S. Environmental Protection Agency Region 10, regarding boat traffic information on the Lower Duwamish Waterway. August 29, 2006.

U.S. Army Corps of Engineers (USACE). 2000. Historical Datum Regions: North Puget Sound – Duwamish Waterway. USACE, Seattle District, Seattle, Washington. Available at: http://www.nws.usace.army.mil/About/Offices/Engineering/HydraulicsandHydrology/HistoricalDatumRegions/NorthPugetSound/DuwamishWaterway.aspx (accessed June 26, 2015).

U.S. Army Corps of Engineers (USACE). 2005. Dredge Summary and Analysis Reports. Lower Duwamish Waterway. 1986 to 2005. U.S. Army Corps of Engineers, Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 2010. Payment Summary for fiscal year 2009 dredging of Lower Duwamish Waterway navigation channel. April 13, 2010. USACE, Seattle District, Seattle, Washington.

U.S. Army Corps of Engineers (USACE). 2012. Approved Work Windows for Fish Protection for All Marine/Estuarine Areas Excluding the Mouth of the Columbia River (Baker Bay) by Tidal Reference Area. Corps, Seattle District, Seattle, Washington. Available at: http://www.nws.usace.army.mil/Portals/27/docs/regulatory/ESA%20forms%20and%20templates/Marine%20Fish%20Work%20Windows%20(8-14-12).pdf (accessed June 2, 2015).

Washington State Department of Transportation (WSDOT). 2006. First Avenue Bridge opening records. 2005, 2006. Provided by Williams, T., Northwest Region Bridge/Structures Maintenance & Operations Manager. December 18, 2006.

Attachments

Table 1 – Lower Duwamish Waterway Navigation Channel Maintenance Dredging (1986-2010)
Table 2 – Number of Monthly Lower Duwamish Waterway Bridge Opening (2003-2006)

Figure 1 – Vicinity Map
Figure 2 – Plan View of Subtidal Plot Area
Figures 3a to 3d – Cross Sections

THIS PAGE LEFT INTENTIONALLY BLANK.

TABLES

THIS PAGE LEFT INTENTIONALLY BLANK.

TABLE 1

LOWER DUWAMISH WATERWAY NAVIGATION CHANNEL MAINTENANCE DREDGING (1986-2010) [1]

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

River Mile	Dredge Date Begin	Dredge Date End	Volume Dredged (cubic yards)
4.19 to 4.38	03/11/86	03/29/86	33,637
4.38 to 4.65	06/19/86	07/15/86	126,470
4.38 to 4.65	02/24/87	03/24/87	80,160
3.97 to 4.65	02/28/90	03/30/90	127,619
3.34 to 4.65	02/06/92	03/21/92	199,361
4.33 to 4.65	03/07/94	03/28/94	57,243
4.02 to 4.48	02/22/96	03/30/96	90,057
4.26 to 4.65	02/05/97	03/31/97	89,011
3.43 to 4.65	03/11/99	06/29/99	165,116
4.27 to 4.65	01/14/02	02/09/02	96,523
4.33 to 4.75	01/15/04	02/16/04	75,770
4.27 to 4.65	12/11/07	01/10/08	140,608
4.18 to 4.65	02/19/10	03/30/10	60,371
4.00 to 4.61	12/01/11	02/09/12	152,349
4.02 to 4.03	01/28/13	02/17/13	4,640
4.03 to 4.61	12/27/13	02/01/14	67,552
-0.03 to 0.00	12/27/13	02/01/14	2,300

Note(s)
1 Sources: USACE, 2005; USACE, 2010; DMMP, 2009, David Fox Chief, DMMO personal communication July 17, 2015.

TABLE 2

NUMBER OF MONTHLY LOWER DUWAMISH WATERWAY BRIDGE OPENING (2003-2006)

Enhanced Natural Recover/Activated Carbon Pilot Study
Lower Duwamish Waterway
Seattle, Washington

Year	Openings	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Monthly Average	Daily Average
Spokane Street Bridge [1]															
2003	All motorized vessels	228	208	261	207	193	165	133	139	95	143	122	103	166	5.5
	Tugboat-escorted vessels and barges	93	83	124	106	140	112	105	113	76	109	84	79	102	3.4
	Openings within 1 hour	68	41	81	58	50	42	20	31	16	17	21	17	39	1.3
2004	All motorized vessels	121	105	133	139	138	145	164	115	112	149	152	152	135	4.5
	Tugboat-escorted vessels and barges	95	85	97	113	111	101	133	105	98	109	94	110	104	3.4
	Openings within 1 hour	16	9	18	23	35	26	40	8	16	23	37	23	23	0.8
2005	All motorized vessels	117	93	142	133	152	166	131	160	142	143	136	105	135	4.4
	Tugboat-escorted vessels and barges	80	77	115	113	112	131	104	132	115	103	107	75	105	3.5
	Openings within 1 hour	19	10	26	29	34	33	15	38	19	22	27	10	24	0.8
First Avenue Bridge [2]															
2005	All openings	108	119	175	158	168	147	116	135	115	92	93	124	129	4.3
2006		112	83	129	145	155	142	182	146	139	125	—	—	136	4.5
South Park Bridge [3]															
2005	All openings	39	63	76	47	42	59	95	76	80	53	35	46	59	2
2006		39	42	42	82	101	88	125	98	81	59	—	—	76	2.5

Note(s)
1. Source: SDOT, 2006.
2. Source: WDOT, 2006.
3. Source: KCDOT, 2006.

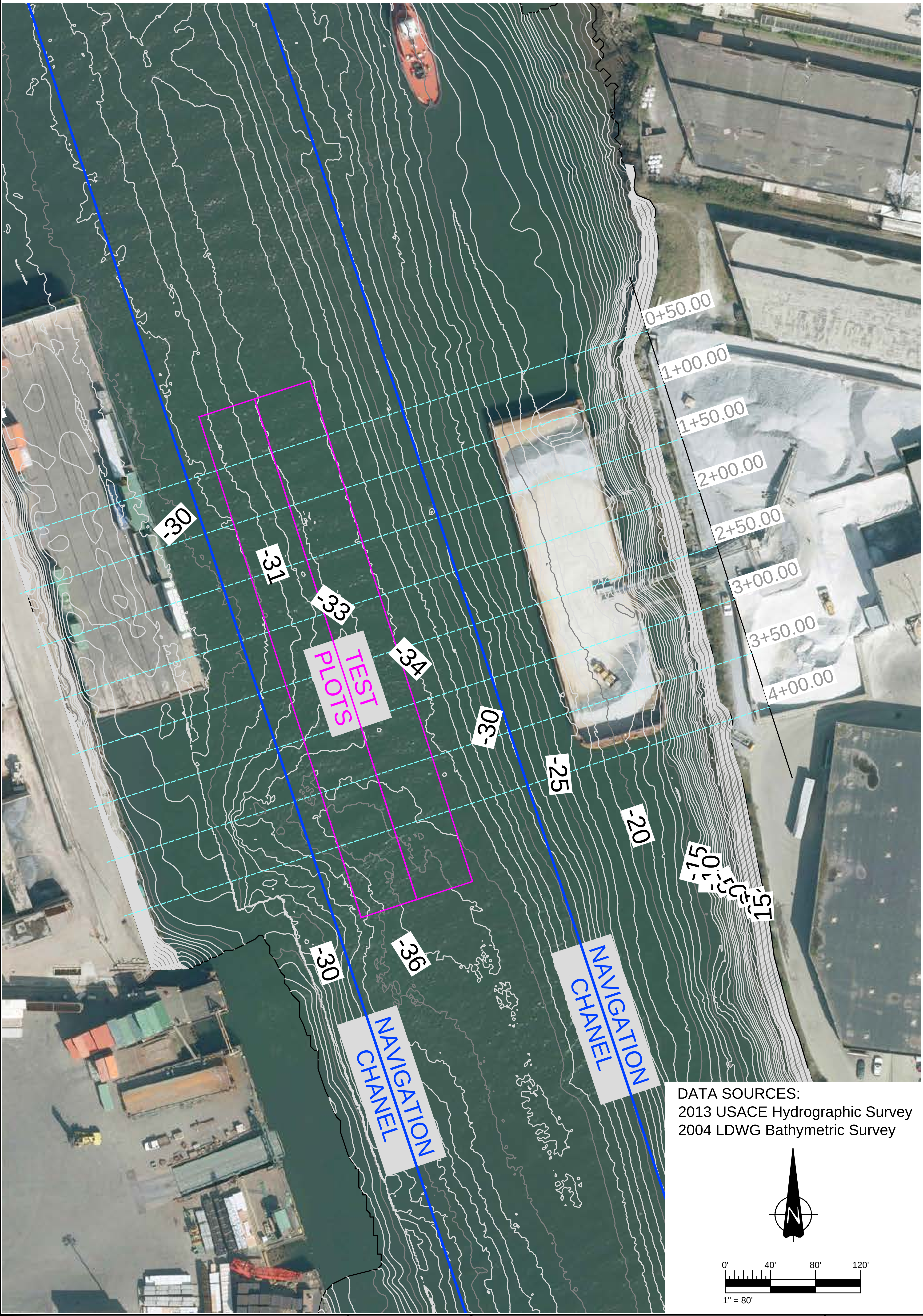
FIGURES

THIS PAGE LEFT INTENTIONALLY BLANK.

File path: "P:\King County\DATA\BE Figures\Revised Figure 070615\Vicinity Map071715.mxd"

Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	ENR/AC Pilot Study	Figure 1 Vicinity Map

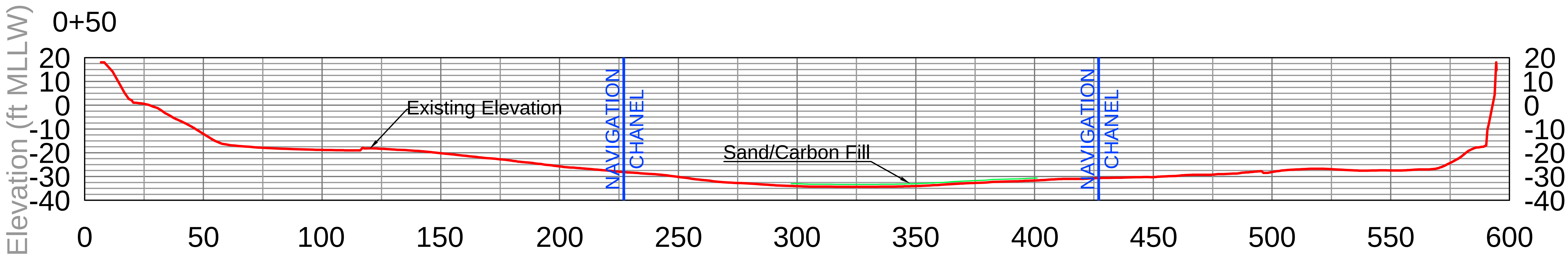
THIS PAGE LEFT INTENTIONALLY BLANK.

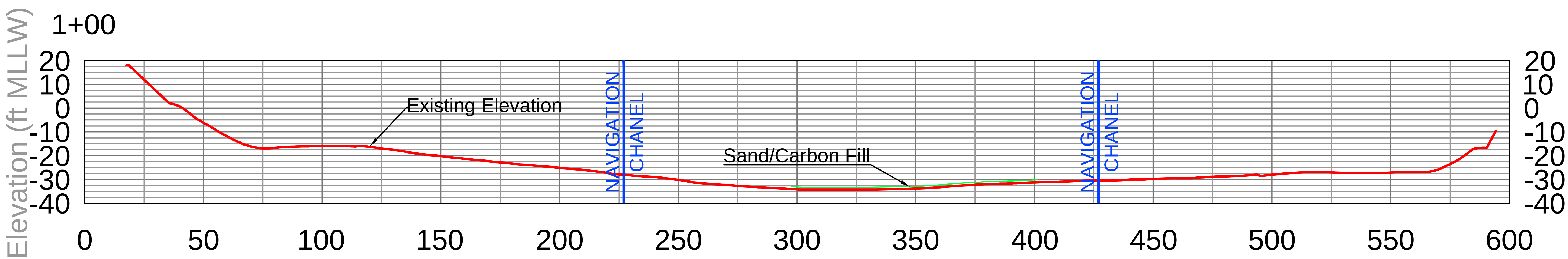


LOWER DUWAMISH WATERWAY GROUP	amec foster wheeler	Enhanced Natural Recovery/Activated Carbon Pilot Study	DATE July 17, 2015 SCALE 1" = 80'
Amec Foster Wheeler Environment & Infrastructure, Inc. 3500 188th St SW, Suite 601 Lynnwood, WA 98037		Plan View of Subtidal Plot Area	PROJECT NO. LY15160310.300.328 FIGURE 2

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Plan View Fig 2 - Jul. 17, 2015 2:23pm - gary.maxwell





View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP

Amec Foster Wheeler
Environment & Infrastructure, Inc.
3500 188th St SW, Suite 601
Lynnwood, WA 98037

amec foster wheeler

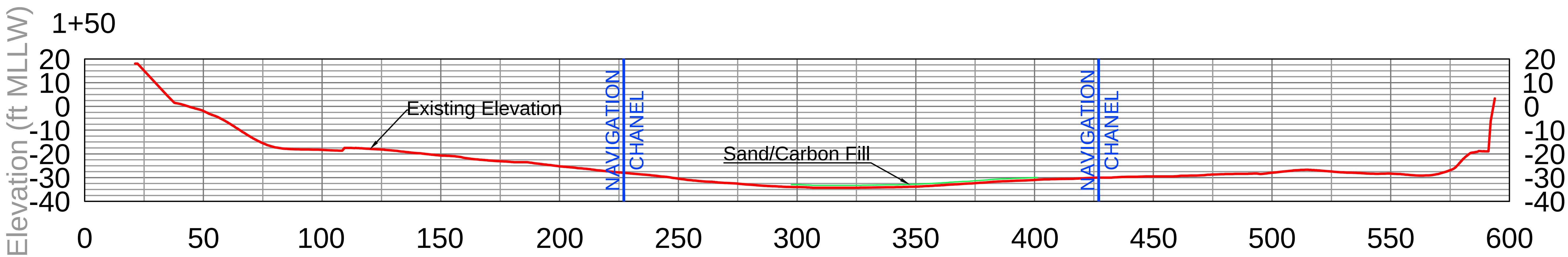
Enhanced Natural Recovery/Activated Carbon Pilot Study

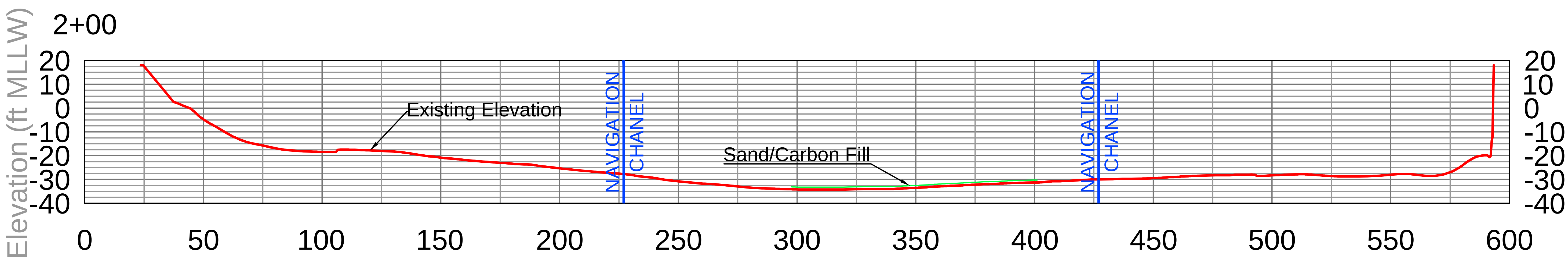
Cross Sections

DATE	July 17, 2015
SCALE	
PROJECT NO.	LY15160310.300.328
FIGURE	3a

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3a - Jul. 17, 2015 1:36pm - gary.maxwell





View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP

Amec Foster Wheeler
Environment & Infrastructure, Inc.
3500 188th St SW, Suite 601
Lynnwood, WA 98037

amec foster wheeler

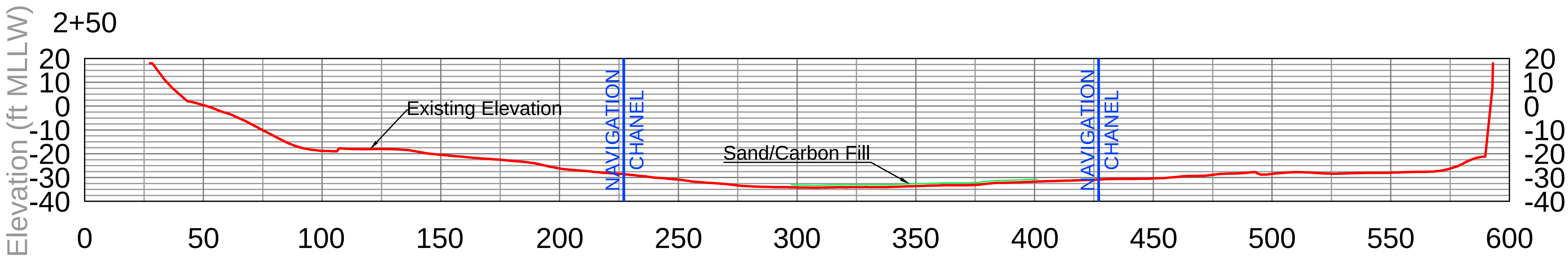
Enhanced Natural Recovery/Activated Carbon Pilot Study

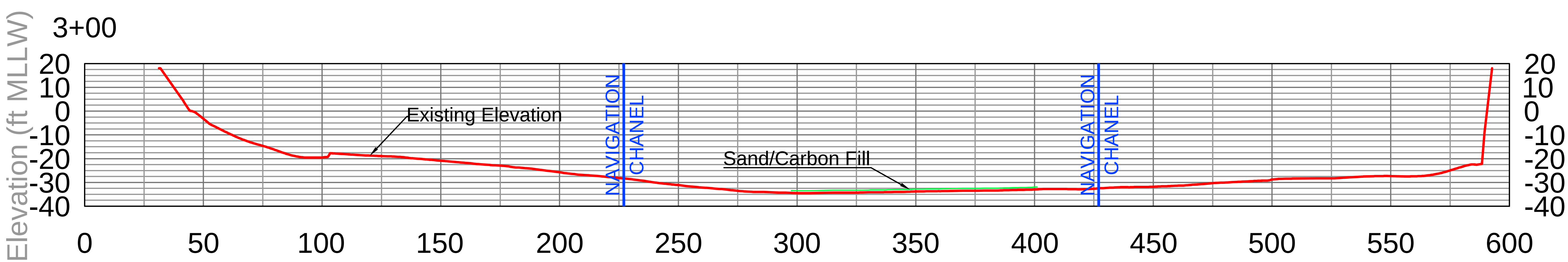
Cross Sections

DATE	July 17, 2015
SCALE	
PROJECT NO.	LY15160310.300.328
FIGURE	3b

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3b - Jul. 17, 2015 1:36pm - gary.maxwell



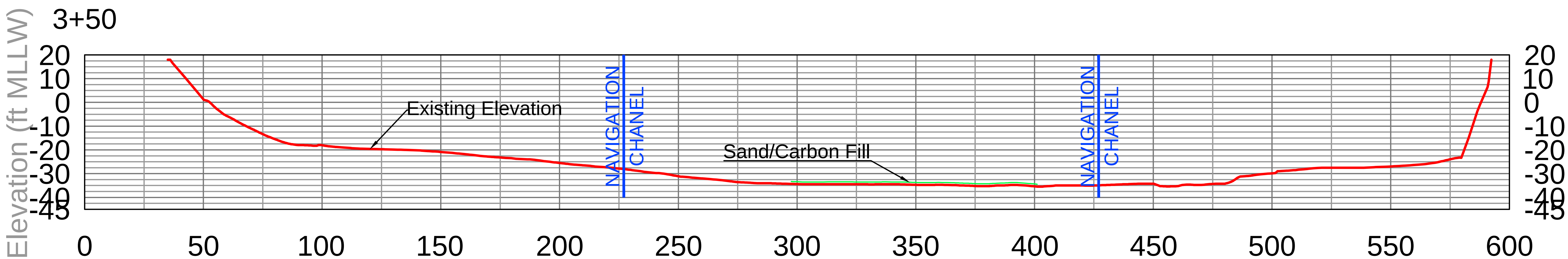


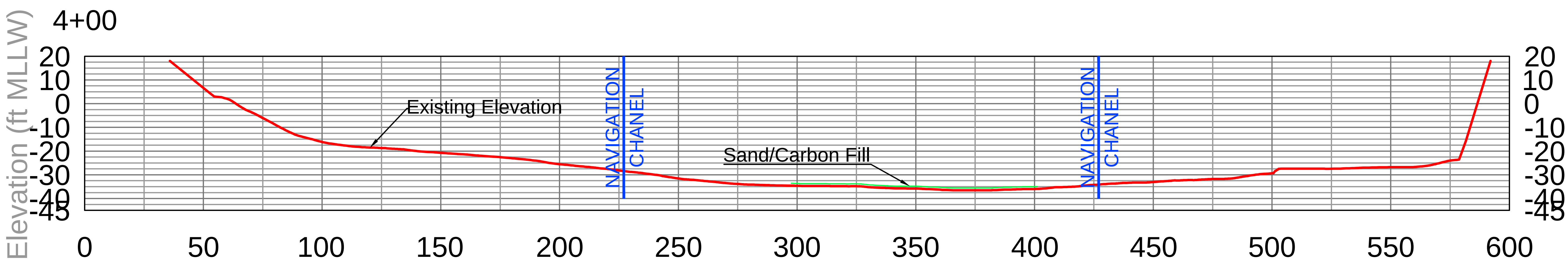
View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP	amec foster wheeler	Enhanced Natural Recovery/Activated Carbon Pilot Study	DATE July 17, 2015
			SCALE
Amec Foster Wheeler Environment & Infrastructure, Inc. 3500 188th St SW, Suite 601 Lynnwood, WA 98037		Cross Sections	PROJECT NO. LY15160310.300.328
			FIGURE 3c

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3c - Jul. 17, 2015 1:36pm - gary.maxwell





View Looking Upstream

LOWER DUWAMISH WATERWAY GROUP	amec foster wheeler	Enhanced Natural Recovery/Activated Carbon Pilot Study	DATE July 17, 2015	SCALE
Amec Foster Wheeler Environment & Infrastructure, Inc. 3500 188th St SW, Suite 601 Lynnwood, WA 98037		Cross Sections	PROJECT NO. LY15160310.300.328	FIGURE 3d

DRAWN BY: GSM CHECKED BY: CJW

P:\King County\DATA\Corps Shoaling Areas\CAD\Cross Sections.dwg - Xsections 3d - Jul. 17, 2015 1:36pm - gary.maxwell

APPENDIX E

Quality Assurance Project Plan

*L*ower *D*uwamish *W*aterway *G*roup

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

QUALITY ASSURANCE PROJECT PLAN

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

FINAL

Prepared for:

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

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, Washington

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
Ramboll Environ
Floyd|Snider
Geosyntec Consultants

February 22, 2016

Project No. LY15160310

Title and Approval Page
Enhanced Natural Recovery/Activated Carbon Pilot Study
Quality Assurance Project Plan

AMEC Foster Wheeler Project Manager	Cliff Whitmus	February 22, 2016 Date
AMEC Team Quality Assurance Manager	Teri A. Floyd	February 22, 2016 Date
U.S. Environmental Protection Agency Project Manager	Elly Hale	2/23/16 Date
U.S. Environmental Protection Agency Quality Assurance Manager	Donald M. Brown	2/25/16 Date
Washington State Department of Ecology Project Manager	Ron Timm	3/1/16 Date

Distribution List

This list identifies all individuals to receive a copy of the approved Quality Assurance Project Plan, either in hard copy or electronic format, as well as any subsequent revisions.

Agency Team

Elly Hale, U.S. Environmental Protection Agency Project Manager

Ron Timm, Washington State Department of Ecology Project Manager

Vacant, U.S. Environmental Protection Agency Quality Assurance Manager

Allison Hiltner, U.S. Environmental Protection Agency Past-Project Manager

Consultant Team

Cliff Whitmus, Amec Foster Wheeler, Amec Team Project Manager

Teri A. Floyd, Floyd|Snider, Amec Team Quality Assurance Officer

Victor Magar, Ramboll Environ, Amec Team Monitoring Lead

Bill Gardiner, Ramboll Environ, Amec Team Field Coordinator

Jason Conder, Geosyntec Consultants, Passive Sampling Expert

Lower Duwamish Waterway Group:

Brian Anderson, The Boeing Company

Kathy Bahnick, Port of Seattle

Jeff Stern and Debra Williston, King County

Pete Rude, Dave Schuchardt, and Allison Crowley, City of Seattle

Laboratories and Field Support

Brad Silverbush, Frontier Analytical

Liz Porter, Alpha Analytical

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

TABLE OF CONTENTS

Page

TABLES

FIGURES

TABLE OF CONTENTS

Page

APPENDICES

ABBREVIATIONS AND ACRONYMS

AC	activated carbon
Alpha	Alpha Analytical Laboratory
AOC	Administrative Order on Consent for Remedial Investigation/Feasibility Study
CD	compact disc
CF	correction factor
CFPRC	correction factor for a performance reference compound
COC	chain of custody
CQAPP	construction quality assurance project plan
°C	degrees Celsius
DGPS	digital global positioning system
DOT	U.S. Department of Transportation
DQO	data quality objective
DVD	digital video disc
Ecology	Washington State Department of Ecology
EDD	electronic data deliverable
EIM	Environmental Information Management
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery amended with activated carbon
EPA	U.S. Environmental Protection Agency
FC	field coordinator
FGW	field-generated waste
Frontier	Frontier Analytical Laboratory
GAC	granular activated carbon
GPS	global positioning system
L	liter
LCS	laboratory control sample
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
LOD	limit of detection
LOQ	limit of quantification
µg/kg	micrograms per kilogram
MDL	method detection limit
mg/kg	milligrams per kilogram

ABBREVIATIONS AND ACRONYMS (Continued)

mg/kg-OC	milligrams (of chemical) per kilogram of organic carbon (in soil)
mL	milliliter
MLLW	mean lower low water
MS	matrix spike
MSD	matrix spike duplicate
ng	nanogram
Order Amendment	Second Amendment (July 2014) to the Administrative Order on Consent for Remedial Investigation/Feasibility Study
PCB	polychlorinated biphenyl
PDMS	polydimethylsiloxane
pg	picogram
PPE	personal protective equipment
PM	project manager
PRC	performance reference compound
PSEP	Puget Sound Estuary Program (protocols)
QA	quality assurance
QAO	quality assurance officer
QAC	quality assurance criterion (criteria)
QAPP	quality assurance project plan
QC	quality control
redox	oxidation-reduction
RL	reporting limit
RPD	relative percent difference
RSD	relative standard deviation
SMS	Sediment Management Standards
SOP	standard operating procedure
SPI	sediment profile imagery
SPME	solid-phase microextraction
SVOC	semivolatile organic compound
TOC	total organic carbon

QUALITY ASSURANCE PROJECT PLAN
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 PROJECT DESCRIPTION AND OBJECTIVES

The Lower Duwamish Waterway Group (LDWG) will conduct a pilot study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW). The study will determine whether enhanced natural recovery (ENR) amended with activated carbon (AC) can be successfully used to decrease bioavailability of contaminants in sediment in the LDW. The study will compare the effectiveness of ENR amended with AC (ENR+AC) against that of ENR without added AC. This will be tested in three habitat types: the subtidal, the intertidal, and an area where vessel scour is possible. For the purposes of this project, ENR involves the placement of a thin layer of clean material over subtidal or intertidal sediments. ENR+AC involves the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments.

This pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent for Remedial Investigation/Feasibility Study (AOC) for the Lower Duwamish Waterway, CERCLA Docket No. 10-2001-0055, issued on December 20, 2000. The Second Amendment to the AOC, which is referred to as the Order Amendment, included a statement of work for the pilot study, including a general overview of the work to be performed, a list of study steps/tasks, and a schedule for deliverables.

The goals of the pilot study, as stated in the Order Amendment, are the following:

- Verify that ENR amended with AC (ENR+AC) can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percent of carbon in a placed layer).
- Evaluate performance of ENR+AC compared to ENR alone in locations with a range of polychlorinated biphenyl (PCB) concentrations.
- Assess potential impacts to the benthic community in ENR+AC compared to ENR alone.
- Assess changes in bioavailability in ENR+AC compared to ENR alone.
- Assess the stability of ENR and ENR+AC in scour areas (such as berthing areas).

This quality assurance project plan (QAPP) briefly describes the pilot study plot locations and treatment design, discusses the data quality objectives (DQOs) for the study, describes the overall monitoring design, and provides details of the methods and procedures for the measurement tools used in the study.

1.1 Plot Design, Locations, and Summary of Conditions

Consistent with the AOC and the Order Amendment, the ENR and ENR+AC layers will be placed on sediments in plots that represent three habitat types: a subtidal, an intertidal, and a subtidal area that may be influenced by propeller wash, which is referred to as the scour plot. Because the goal of the pilot study is to evaluate the performance of ENR augmented with AC as compared with that of ENR alone, the pilot study will evaluate side-by-side subplots. At each of the three plot locations, a 6- to 9-inch-thick layer of sand or gravelly sand will be added. Both subplots will receive the same material, at the same thicknesses. In one subplot, granular activated carbon (GAC) will be added at 4 percent (by weight) GAC/mass of gravelly sand or sand. Details of the ENR and ENR+AC layer addition and specifications are provided in the Narrative Design Report and the plans and specifications for the pilot study. This QAPP is an attachment to the Narrative Design Report.

The selection of the specific plot locations is described in the Plot Selection Memorandum (LDWG 2015), which is included as an appendix of the Narrative Design Report. These locations were approved by the U.S. Environmental Protections Agency (EPA) and the Washington State Department of Ecology (Ecology) on February 11, 2015. The three plots are shown in Figures 1.1 through 1.3, and each plot area is described in the following subsections. The plot selection memorandum provides sediment results for all contaminants of concern for the LDW, a physical description of the plot, and provides the selection rationale.

The selection of these plots for the pilot study met the study goal to evaluate performance of ENR+AC compared to ENR alone in locations with a range of PCB concentrations.

1.1.1 Subtidal Plot (River Mile 1.2)

The subtidal plot represents subtidal conditions in the LDW Superfund site. The location and bathymetry of the subtidal plot, the layout of its two subplots, and the surface-sediment PCB concentrations are shown in Figure 1.1. This plot is divided into two longitudinal subplots called the East Lanes and the West Lane, for the ENR and ENR+AC applications, respectively.

PCB concentrations in surface sediments at this plot range from approximately 4 milligrams per kilogram of organic carbon (mg/kg-OC) to 180 mg/kg-OC.

1.1.2 Scour Plot (River Mile 0.1)

The scour plot is representative of areas throughout the site that may experience scour in berthing areas. The location and bathymetry of the scour plot, the layout of its two subplots, and the surface-sediment PCB concentrations are shown in Figure 1.2. This plot is divided into two almost square subplots called the upstream and downstream subplots, for the ENR and ENR+AC applications, respectively.

PCB concentrations in surface sediments at this plot range from approximately 7 to 180 mg/kg-OC.

1.1.3 Intertidal Plot (River Mile 3.9)

The intertidal plot represents intertidal conditions throughout much of the site. Consistent with previous documents, the intertidal area in the LDW is defined as sediments above -4 feet mean lower low water (MLLW). The location and bathymetry of the intertidal plot, the layout of its two subplots, and the surface-sediment PCB concentrations are shown in Figure 1.3.

PCB concentrations at this plot range from approximately 7 to 150 mg/kg-OC.

1.2 DATA QUALITY OBJECTIVES

This section presents the data quality objectives (DQOs) for the pilot study monitoring program. The DQO process defines criteria that will be used to establish the final data collection design (U.S. EPA 2006). Based on the study goals listed in Section 1.0, the DQOs were developed to support the selection of sampling and analysis methods and an overall study design that leads to data appropriate to answer the study questions. The DQOs developed for the pilot study, the data types, and the analytical approaches are presented in the following subsections. Specific performance goals, referred to as Data Quality Indicators, for the individual analytical methods are discussed in Section 3.0 after the methods have been introduced.

The DQOs were developed with the recognition that ENR (and ENR+AC) are technologies that inherently work with natural recovery processes that are ongoing in the LDW surface sediments. These include vertical mixing by bioturbation, redistribution and vertical mixing of surface sediments by waves and currents, sedimentation and minor erosion, and minor anthropogenic disturbances such as small boat anchors. ENR is not an engineered containment layer and the placed ENR layer is expected to physically change over time as a result of these riverine processes.

1.2.1 DQO-1: Verify the Placement of the ENR and ENR+AC Materials

The first DQO is to determine whether the ENR and ENR+AC layers can be placed in the subtidal, intertidal, and scour plots within the targeted specifications. This first DQO establishes the initial physical conditions of the ENR and ENR+AC layers immediately after placement and is used to support subsequent monitoring. This DQO addresses the thickness and evenness of the ENR and ENR+AC layers, the constructed AC content in the ENR+AC layer, and the distribution of carbon in the ENR+AC layer.

Investigative methods to measure the thickness and evenness of the layers will include physical assessment by the contractor during placement using tools such as bathymetric survey and breakaway stakes. The QA/QC requirements for the tools used by the contractor and LDWG team during construction are described in the Construction Quality Assurance Project Plan (CQAPP). The QC by the contractor will be augmented by QA checks by the LDWG team using visual observation by divers, sediment profile imagery (SPI), and collection, logging, and analysis of shallow cores.

The achieved concentration of AC in the ENR+AC subplots will be based on measures of post placement carbon content using methods for both total organic carbon (TOC) and black carbon. The general distribution of AC within the ENR+AC layer will be based on visual observations using diver-collected cores and SPI. Measurements supporting DQO-1 will be made within 30 days of placement at each subplot.

A baseline event to collect information on the bathymetry, grain size, and carbon content of the *in-situ* sediments will also be conducted 60 to 90 days before placement to assist in assessing the success of the placement.

1.2.2 DQO-2: Evaluate the Stability of ENR and ENR+AC Materials

The second DQO addresses the stability of the ENR materials and the stability of the AC material in the ENR matrix in the scour plot. Loss of ENR and ENR+AC materials may occur as a result of erosional forces, such as propeller wash. Depending upon the nature of the turbulence in the berthing areas, there is also the potential for an increase in stability from the deposition of riverine sediments or for integration of the ENR and ENR+AC layers into the underlying sediment. Changes in ENR+AC stability will be evaluated during post placement monitoring events in Years 1, 2, and 3 using visual observations (diver survey and SPI), and diver-collected cores.

Winnowing of the AC materials from the ENR layer can occur when the ENR material becomes suspended in the water column by erosional forces such as propeller wash in the scour plot. When the ENR matrix re-deposits on the riverbed, the more buoyant AC can be lost to the water column and potentially transported out of the plot. Combined visual observations (diver-collected cores and SPI) and measurements of black carbon will be used to evaluate the distribution and concentration of AC in the ENR+AC layer. AC measurements in the ENR+AC layer will be evaluated in Years 1, 2, and 3 after initial placement of the ENR+AC layer and compared to the conditions seen in Year 0.

1.2.3 DQO-3: Assess Changes in Bioavailability in ENR+AC Compared to ENR Alone

The third DQO assesses the potential changes in PCB bioavailability in ENR+AC compared to ENR alone. For the purposes of the Pilot Study, changes in bioavailability will be based on measurements of the bioavailable fraction of PCBs as represented by the porewater PCB concentrations.

Sediment and porewater concentrations collected prior to placement of the ENR layers will be used to establish a baseline partitioning relationship between sediment (normalized for carbon content) and porewater. The same types of data (sediment and porewater PCBs, TOC, and AC) will be collected in Years 1, 2, and 3 monitoring events (post placement). These data will be analyzed to see if the addition of AC to the ENR matrix results in different partitioning of PCBs into porewater relative to ENR alone. If the addition of AC causes the PCBs to remain in the sediment matrix (adhered to the increased carbon content), then the amount of PCBs dissolved in porewater will be less, and the availability of PCBs to aquatic organisms will be less.

Porewater PCB concentrations will be measured using Solid-Phase Microextraction (SPME) fibers deployed in the top 10 cm of the sediment surface. Secondary measurements supporting interpretation of bioavailability will include measurements of grain size, carbon content, and bulk sediment PCB congeners in the top 10 cm of the sediment.

Porewater PCB concentrations will also be measured at the top 1 cm of the sediment (approximate sediment-water interface) in Years 2 and 3 to assess temporal variability at the sediment surface and the effect of recently deposited sediment on the effectiveness of ENR and ENR+AC. LDWG may request to EPA and Ecology that the sediment-water interface PCB porewater measurement at Year 3 be omitted in the scour plot if evidence indicates that there is no sediment accumulation in Years 2 and 3 and Year 2 data indicate there is no difference in sediment-water interface SPME PCB concentrations in the ENR+AC versus ENR plots.

1.2.4 DQO-4: Assess the Potential Impacts of AC on Benthic Communities

The fourth DQO addresses the potential impacts of AC on benthic communities in the LDW. Although laboratory and field studies have generally shown few adverse effects on benthic organisms after the application of AC to contaminated sediments, effects have been associated with the use of small particle sizes (powdered activated carbon) or higher applications rates (generally greater than 5 percent AC).

To determine whether the use of AC, as proposed in the pilot study, could adversely affect the benthic communities in the LDW, a benthic survey will be conducted in Year 3. The benthic communities established in each of the ENR+AC subplots of the subtidal, intertidal, and scour plots will be compared to the benthic communities in their respective ENR subplots.

1.3 Project Schedule

As discussed in further detail in the next section, data for this project will be collected in five events. The first event, referred to as the baseline event, will occur 60 to 90 days before placement of the ENR and ENR+AC layers. The second event, Year 0, will occur within 30 days post placement at each plot; and the next three events will occur annually approximately 1, 2, and 3 years after the Year 0 event.

All in-water construction work for ENR and ENR+AC placement is planned to be conducted during the authorized 2016–2017 in-water work window for the LDW, when salmonid species listed under the Endangered Species Act are least likely to be present. It is anticipated that the construction would occur in December 2016, after the completion of the Muckleshoot Indian Tribe's net fishery season. Baseline sampling, scheduled to precede placement by 60 to 90 days, would occur in September or October 2016, with Year 0 sampling occurring in January or February 2017. The Narrative Design Report and its appendices contain more details on the scheduling of the placement of the ENR and ENR+AC layers.

The Year 1, 2, and 3 Monitoring Events are anticipated to occur in the spring (March to May) of 2018, 2019, and 2020. Shifting the annual events from January (Year 0) to the spring increases the number of daylight hours available for the field staff to collect and process samples and should be during a time of relative stability in the benthic populations in Year 3 (prior to late spring recruitment which add extra variability to the conditions.

1.4 QAPP Organization

This QAPP is organized into the following sections:

- Section 1 – Project Description and Objectives
- Section 2 – Project Organization and Responsibility
- Section 3 – Data Generation and Acquisition
- Section 4 – Sampling Handling and Custody Documentation
- Section 5 – Assessment and Oversight
- Section 6 – Reporting

- Section 7 – References

The representative field forms are included as Attachment A. Attachment B is a technical memorandum that includes additional detail on the use of the SPME fibers for porewater sampling. Attachment C contains the preliminary requirements for the electronic data deliverables file from the laboratories.

Separate health and safety plans are being prepared for construction and monitoring. These plans are an appendix to the Narrative Design Report. A separate Dive Plan will be available for tasks requiring diver support as described in Section 4.2.6 of Appendix G of the Narrative Design Report.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

This section describes the overall management of the project, including key personnel, project description, problem definition and background, quality objectives and criteria, special training and certification requirements, and documents and record keeping.

2.1 Management Responsibilities

Figure 2.1 shows the overall project organization for the activities described in this QAPP, along with contact information (telephone numbers and email addresses) for key staff. Responsibilities of project team members and laboratory project managers are described in the following sections.

2.1.1 Project Management

LDWG is the lead for conducting this work for EPA and Ecology and, as such, will be involved in all aspects of this project. EPA and Ecology as oversight agencies will review and approve the QAPP as well as perform oversight on any field activities, as needed. EPA and Ecology will be represented by their project managers (PMs) for this project, Elly Hale and Ron Timm, respectively.

Cliff Whitmus of AMEC Foster Wheeler will serve as the consultant team PM, responsible for overall project coordination and providing oversight related to planning and coordination, work plans, project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. He also will be responsible for coordinating with LDWG, EPA, and Ecology on schedule, deliverables, and other administrative details. Mr. Whitmus can be reached as follows:

Cliff Whitmus
AMEC Foster Wheeler
3500 188th Street SW, Suite 601

Lynwood, WA 98037
Tel: 425.921.4023
cliff.whitmus@amecfw.com

2.1.2 Project Engineer

Rob Webb of Dalton, Olmsted & Fuglevand, Inc. (DOF) will serve as the project engineer (PE); his responsibilities are focused on the design and placement of the ENR layers, including construction quality assurance/quality control (QA/QC). The CQAPP outlines the QA/QC elements for the placement of the ENR layers and includes testing performed by the contractor to demonstrate that the requirements of the construction contract have been met. The PE is responsible for overseeing contractor QC elements and conducting QA elements associated with construction, including acceptability of placed materials and verification of placement in Year 0 Events.

The PE reports to the PM. However, coordination, between the PE and his CQAPP and this QAPP, is needed during, the baseline and Year 0 events, as follows:

- As part of the baseline event, the materials that will be used for the ENR layers will be tested for all Sediment Management Standards (SMS) benthic chemicals of concern and the GAC will be tested for PCB congeners. Requirements for this testing are part of this QAPP and will be performed by the consultant team and not the contractor. This testing will be scheduled by the PE to occur early enough in the process to allow for alternative sources of materials to be identified if contamination is found to be a problem.
- For the Year 0 event, the PE will notify rest of the team when the contractor is done with the verification of physical placement of the layers (as discussed in the CQAPP). The monitoring team will then schedule Year 0 sampling of the new layers as described in this QAPP to occur within 30 days of notification for each Plot.

Mr. Webb can be reached as follows:

Rob Webb, PE
Dalton, Olmsted & Fuglevand, Inc.
1236 NW Finn Hill Road
Poulsbo, WA 98370
Tel: 360.394.7917
rwebb@dofnw.com

2.1.3 Monitoring Lead

Dr. Victor Magar of Ramboll Environ US Corporation (Ramboll Environ) will serve as the monitoring lead (ML), responsible for the overall design and implementation of the monitoring program. The monitoring team reports to the ML. The Quality Assurance Officer (see next section) reports to both the ML and PM any out-of-compliance event with the potential to affect data quality or project objectives. The ML reports to the PM.

Dr. Magar can be reached as follows:

Victor Magar, PhD, PE
Ramboll Environ
333 West Wacker Drive, Suite 2700
Chicago, IL 60606
Tel: 312.288.3840
vmagar@ramboll.com

2.2 QUALITY ASSURANCE RESPONSIBILITIES

The overall goal of the QA program is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality and can be used to achieve the DQOs in Section 1.2.

Dr. Teri Floyd of Floyd|Snider will serve as the QA officer (QAO) for the monitoring program. This will include being the analytical lead responsible for laboratory coordination, overall QA/QC of the monitoring, and supervision of data validation, database management, and electronic data reporting. The QAO will report any QA/QC problems to the PM and the ML immediately, propose resolutions, and see that they are implemented. Dr. Floyd can be reached as follows:

Teri Floyd, PhD
Floyd|Snider
601 University Street, Suite 600
Seattle, WA 98101
Tel: 206.292292-2078
teri.floyd@floydsnider.com

Dr. Floyd is supported by Dr. Gretchen Heavner (of Floyd|Snider) for field-to-laboratory coordination and by Cari Sayler of Sayler Data Solutions, who will provide an independent third-party review and validation of analytical chemistry data. Ms. Sayler will also manage the project database (using the existing LDWG template), apply qualifiers, perform the calculations for calculated results, import data from electronic laboratory deliverables, and produce any electronic data deliverables (EDDs). She can be reached as follows:

Cari Sayler
Sayler Data Solutions
14257 93rd Court NE
Kirkland, WA 98034
Tel: 425.820.7504
cari@saylerdata.com

Significant deviations from this QAPP will be reported in a timely manner to representatives of LDWG, EPA, and Ecology.

2.3 FIELD WORK

Field work and sample collection roles are identified in this section.

2.3.1 Field Coordinator

Bill Gardiner of Ramboll Environ will serve as the field coordinator (FC). The FC is responsible for managing field activities and performing field QA/QC oversight. Mr. Gardiner will ensure that appropriate protocols for sample collection, preservation, and holding times are observed and will oversee delivery of environmental samples to the designated laboratories for chemical and benthic macroinvertebrate analyses. Deviations from this QAPP will be reported to the PM, with concurrent notification to the ML and QAO for consultation.

For the benthic survey in Year 3, Mr. Gardiner, in his role as FC, will collect and stabilize the benthic samples and, in his role as Manager of the Ramboll Environ lab (section 2.5), will lead the benthic macro-invertebrate analysis. If problems are encountered in the benthic work, Mr. Gardiner will assess the situation, report it immediately to the PM, ML, and QAO, propose solutions, and implement corrective measures if needed.

Mr. Gardiner is supported by Dr. Jack Word (of Ramboll Environ) who act as a benthic expert assisting with sampling design and benthic data interpretation.

Mr. Gardiner can be reached as follows:

William Gardiner
Ramboll Environ
P.O. Box 216
4729 NE View Drive
Port Gamble, WA 98364
Tel: 360.297.6080
bgardiner@ramboll.com

Significant deviations from the monitoring program will be reported to representatives of LDWG, EPA, and Ecology.

2.3.2 Field Support

The FC is supported in the field by staff from the consultant team, by experts such as Drs. Jason Conder and Jack Word (discussed below) and by vendors with specialized equipment or expertise.

2.4 Specialized Expertise

Dr. Jason Conder of Geosyntec Consultants is an expert in the use of SPME sampling techniques for in situ porewater analyses. This expertise includes preparation of the fibers in the laboratory, the addition of special internal standards, deployment and retrieval of the fibers in the field, and extraction of the fibers before analysis, and interpretation of the results. Dr. Conder will work closely with the QAO during the preparation and extraction steps and then will transfer custody of the extracts to the FC for transportation to the analytical laboratory. During the deployment and retrieval of the fibers, he will work closely with the FC. Dr. Conder can be reached as follows:

Jason Conder, PhD
Geosyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648
Tel: 714.465.1226
JConder@Geosyntec.com

2.5 Laboratory Responsibilities

Dr. Teri Floyd of Floyd|Snider will serve as the overall laboratory coordinator for the monitoring program. Each of the laboratories utilized will accomplish the following:

- Adhere to the methods outlined in this QAPP, including those methods referenced for each procedure
- Adhere to documentation, custody, and sample logbook procedures
- Implement QA/QC procedures defined in this QAPP
- Meet reporting requirements
- Deliver electronic data files as specified in this QAPP
- Meet turnaround times for deliverables as described in this QAPP
- Allow EPA and the QA/QC third-party auditors to perform laboratory and data audits

2.5.1 SPME Preparation Laboratory (Ramboll Environ Laboratory)

Dr. Jason Conder will oversee the preparation of the SPME fibers before deployment and the extraction of the fibers after deployment. This work will be performed in the Ramboll Environ Laboratory in Port Gamble, Washington. The preparation procedures are presented in Appendix B and discussed in Section 3.0. The laboratory PM is Bill Gardiner, who is also the Field Coordinator for this study.

2.5.2 Benthic Infauna Laboratory

Bill Gardiner will oversee laboratory and field preparations for the benthic infauna analyses prior to field collection of benthic sediment samples. Benthic infaunal counts will be performed in the Ramboll Environ Lab in Port Gamble, Washington. The laboratory PM is Bill Gardiner, who is also the Field Coordinator for this study.

2.5.3 Analytical Testing Laboratories

Dr. Teri Floyd of Floyd|Snider will serve as the laboratory coordinator for the analytical chemistry laboratories. She is also the QAO for the monitoring program. The analytical laboratories are not yet under contract, and may change. If the analytical laboratories change, the affected pages of the QAPP will be resubmitted for review and approval. At this time, it is expect that Frontier Analytical Laboratory (Frontier) in El Dorado Hills, California will perform the PCB congener analyses of the SPME extracts and sediment samples. Likewise, it is expected that Alpha Analytical Laboratory (Alpha) will perform the other analyses on the sediment samples. The Frontier laboratory PM can be reached as follows:

Dr. Brad Silverbush
Frontier Analytical Laboratory
5172 Hillsdale Circle
El Dorado Hills, CA 95762
Tel: 916.934.0900
brads@frontieranalytical.com

The Alpha laboratory PM can be reached as follows:

Liz Porta
Alpha Analytical Laboratory
8 Walkup Drive
Westborough, MA 01581
Tel: 508.844.4100
eporta@alphalab.com

2.6 SPECIAL TRAINING AND CERTIFICATION

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. The federal regulation requires training to provide employees with the knowledge and skills enabling them to perform their jobs safely and with minimum risk to their personal health (Code of Federal Regulations, Title 29, Section 1910.120 [29 CFR 1910.120]). All sampling personnel will have completed the 40-hour HAZWOPER training course and 8-hour refresher courses, as necessary, to satisfy the requirements of the Occupational Safety and Health Administration regulations.

2.7 DOCUMENTS AND RECORDS

The following documents and records specific to this QAPP will be retained for this study and incorporated in the Administrative Record for the LDW Superfund sites:

- Final QAPP, which covers baseline and long-term monitoring for the pilot study. If it is necessary to amend this QAPP in the future, those amendments will also be included.
- Field sampling forms and records (as discussed in Section 3.0) will be presented on electronic media (compact disc [CD] or digital video disc [DVD]) as an appendix to the reports, as discussed in Section 6.0, Reporting. This will include the reporting of any deviations that occurred in the field and during sample preparation for laboratory submittal.
- Final laboratory reports, including the Laboratory Information Management System (LIMS) data necessary for data validation, will be presented on electronic media (CD or DVD) as an appendix to the reports, as discussed in Section 6.0. This will include the reporting of any deviations that occurred in the laboratory, and the identification of out-of-control events, if any, and their resolution.
- Final validated data will be submitted to Ecology's Environmental Information Management (EIM) system, in the format required by Ecology for data submittals. A printed summary of the data will also be included in the reports, as discussed in Section 6.0.

3.0 DATA GENERATION AND ACQUISITION

This section describes the collection and handling of porewater, sediment, and biological samples for analysis. Elements include sampling events, sampling design, station location, sampling and analysis methods, QA/QC, and data custody and management.

3.1 OVERVIEW OF THE MONITORING PROGRAM

This section describes the sampling events, the design of the monitoring program, and the sequencing of the work.

3.1.1 Sampling Events

There will be a total of five sampling events in support of the pilot study monitoring program. The events begin with a baseline event before ENR and ENR+AC placement, a Year 0 event immediately after ENR and ENR+AC placement, and three annual events after the Year 0 event at intervals of one year (i.e., Years 1, 2, and 3). The types of samples and the DQOs supported by the activities performed during each of these events are described in this section and summarized in Table 3.1. Additional details of sampling design and measurement tools are provided throughout Sections 3.0 and 4.0.

3.1.1.1 Baseline Event

Baseline sampling will be conducted to establish the conditions in sediment and porewater within each plot prior to placement. Data collected during the baseline sampling event will include concentrations of PCB congeners in porewater and bulk sediment; bulk sediment grain size, TOC, and black carbon[1]; porewater salinity; and visual observations of benthic community successional stages using sediment profile imagery (SPI). The data will be collected 30 to 60 days before placement of the layers.

As part of the baseline event, the sand and gravelly sand that will be used for the ENR layers will be tested the chemicals listed below; the GAC will be tested for PCB congeners. The sampling and analysis consists of the following:

- Three to five grab samples will be collected by the contractor of each material intended for use as ENR layer materials (sand and gravelly sand) from material that is representative of the materials to be used in the project. The samples will be given under chain-of-custody paperwork to the PE, who will relay them to the FC, for transportation to the lab. The samples should be placed in 8-ounce wide-mouth jars with Teflon-lined lids, but zip lock bags are acceptable. The samples will be tested for all chemicals listed in Lower Duwamish Waterway Record of Decision (U.S. EPA, 2014) Tables 19 and 20, TOC, and grain size as discussed in Section 3.5.

- One representative sample of the GAC material that will be used in this project will be tested for PCB congeners. The sample will be acquired by the contractor from the Vendor for this testing and shipped directly to the FC for transportation to the lab. The sample must be collected from the same "batch" of GAC intended for use in this pilot

1 Black carbon is the name of the analytical method that is used to quantify the activated carbon content of the sediments. It includes both the added GAC and naturally occurring carbon with a high sorption capacity such as soot.

study. The sample must be received from the vendor in a 4-ounce (or larger) wide-mouth glass jar with a Teflon-lined lid accompanied with documentation of material batch number(s).

This testing will be scheduled by the PE to occur early enough in the process to allow for alternative sources of materials to be identified if contamination is found to be a problem.

3.1.1.2 Placement Confirmation (Year 0)

Post placement monitoring will occur within 30 days after the placement of the ENR layer in each plot. This event is separate from and follows contractor's performance verification requirements specified in the CQAPP. This event is intended to document the thickness and evenness of the ENR and ENR+AC layers and the distribution and content of the AC in the placed ENR+AC layer.

Measurements collected during this event will be limited to physical sediment properties (grain size, TOC, and black carbon) and visual observations of the thickness and general condition of the ENR and ENR+AC layers, using diver observations and SPI.

3.1.1.3 Post Placement Events – Year 1 and Year 2

These two events are intended to gather data on the stability and performance of the ENR+AC layer over time relative to the ENR layer. The sampling is intended to be conducted during the same time of year to limit seasonal variations and to be conducted 1 year apart for 2 years after layer placement. The events are expected to occur between March and May of 2018 and 2019.

Data collected during these monitoring events will include measurements of PCB congeners in porewater and bulk sediment; an evaluation of conventional sediment properties (TOC, BC, and grain size); measurement of porewater salinity; observations of ENR layer stability; and an assessment of the extent of overlying sediment deposition using SPI images, diver observations, and physical logging of the shallow sediment cores. Year 2 monitoring will also include measurement of PCB congeners in sediment-water interface porewater. SPI and plan view images will also be used during Years 1 and 2 to assess the benthic community recolonization in the ENR/AC layers over time.

3.1.1.4 Post Placement Events – Year 3

The final monitoring event will occur 3 years after construction and is intended to gather data on the stability and performance of the ENR+AC layer over time relative to the ENR layer (similar to Years 1 and 2) and the potential effects of AC on the benthic communities. Year 3 monitoring will occur during the same season as Year 1 and 2 monitoring events (between March and May of

2020). The March time period should represent a period of low inherent variability in the benthic communities.

Data collected during the Year 3 monitoring event will include measurements of PCB congeners in porewater and bulk sediment; an evaluation of conventional sediment properties (TOC, BC, and grain size); measurement of porewater salinity; observations of ENR layer stability; an assessment of the extent of overlying sediment deposition; and an assessment of the benthic communities. Year 3 monitoring will include measurement of PCB congeners in sediment-water interface porewater. LDWG may request to EPA and Ecology that the sediment-water interface PCB porewater measurement at Year 3 be omitted in the scour plot if evidence indicates that there is no sediment accumulation in Years 2 and 3 and Year 2 data indicate there is no difference in sediment-water interface SPME PCB concentrations in the ENR+AC versus ENR plots.

A tissue study is proposed for Year 3 to evaluate potential differences in PCB uptake into benthic infaunal tissues between the two plot types. The nature and scope of this phase of the investigation is being developed and an amendment to this QAPP will be prepared to address the tissue investigations.

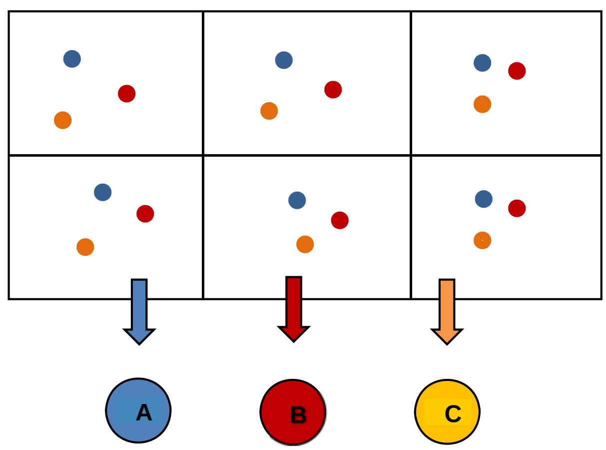
3.1.2 Sampling Design

This section describes the sampling design developed to meet the data needs supporting the objectives defined in Section 1.2. The sampling design includes the number of samples and the sampling locations for individual samples, as well as the compositing strategies to generate analytical samples. Section 3.3 discusses future conditions that could warrant changes in the design of the monitoring program.

For 0 to 10 cm sediment porewater, sediment-water interface porewater (0 to 1 cm), and bulk sediment sample collection, a subplot will be represented by three composite samples made up of sediment or porewater from six locations. Each composite will be considered to be “representative” of the subplot and the use of three composites will allow for a measure of the variability within the subplot. To form the composites, each subplot is divided into six grid cells to ensure that there is good sampling coverage throughout the subplot. To avoid sampling in areas potentially influenced by untreated sediments and to avoid influence from the adjacent subplot, no samples will be collected from locations within 5 feet of the edge of a subplot, and a 15-foot buffer will be maintained between the ENR and ENR+AC subplots.

The location of the subplots and the grid cells within the subplots are shown in Figures 3.1, 3.2, and 3.3. Each grid cell has been further divided into approximately 24 locations. This division into 24 locations results in small rectangular “location” cells that are approximately 10 by 10 ft. This size is large enough to collect multiple samples without removing too much of the ENR layer as part of sampling and large enough to use hand-held GPS to confirm that the diver is at one location and not an adjacent one. A random number generator was used to identify 3 locations within each of the six grid cells for a total of 18 locations per subplot. Figures 3.1, 3.2, and 3.3 show this for one of the events; Table 3.2 lists the locations that have been randomly selected for each event. In each event, there will be 18 locations identified in a subplot, but the specific locations within a grid cell will change for each event so that the area is not oversampled (too much material removed or disturbed) during the study.

In each subplot, six of the locations have been assigned the letter A, six the letter B, and six the letter C. The sediment (or SPME fibers deployed in the top 10 cm of the surface layer, or the SPME fibers deployed at the sediment-water interface) collected from each of the “A” locations within a subplot will be composited for the “A” composite for that subplot; likewise for the sediment from the “B” and “C” locations will be composited to form the “B” and “C” composites, respectively. Conceptually, it works like the schematic below.



This sampling design was derived using a statistical power analysis based on variability in the concentrations of total PCBs in sediment samples collected during remedial investigation and candidate plot identification process (Windward, 2010; LDWG, 2014). The design enables the detection of approximately a 50% or more reduction in concentrations of PCBs in porewater as a result of the treatment.

In the baseline event and the annual events in Years 1 through 3, the three composited sediment samples will be analyzed for PCB congeners, TOC, black carbon, and grain size. During those same events, three composited SPME porewater samples deployed in the top 10 cm layer will be analyzed for PCB congeners. In addition, during Years 2 and 3, three composited SPME porewater samples deployed at the sediment-water interface (0 to 1 cm) will also be analyzed for PCB congeners. Visual observations (by divers) will be recorded at each of the 18 locations (A, B, and C locations) sampled in each of the subplots during years 0 through 3.

During the baseline event, two additional composite SPME porewater samples (deployed in the top 10 cm layer) will be collected from each subplot (D and E locations - see Table 3.2). These samples will be processed and stored as described below, and may be analyzed pending an analysis and review of the statistical power indicated by the analysis of the three baseline composite SPME porewater samples. Measurements of PCBs in porewater in the top 10 cm layer for Years 1 through 3 will be based on three composites, unless the statistical power evaluation from the Baseline Event indicates that additional composites are needed to attain the desired level of statistical power. Additionally, measurements of PCBs in porewater at the sediment-water interface (Years 2 and 3) will also be based on the same number of composites required for the top 10 cm samples (three composites, unless the top 10 cm power analysis indicates more samples are needed).

Sediment conditions at each of the sediment sampling locations will be logged and porewater salinity will be measured. Salinity measurements will be made using a field probe of porewater collected approximately 10 cm below mudline during the Baseline Event; and 10 to 20 cm below mudline in subsequent events to assess the salinity of upwelling water. If salinities are consistently saline within a plot (greater than 20 parts per thousand), then LDWG may request to EPA and Ecology that the number of salinity measurements be reduced for that plot in future events.

SPI and plan view images will be collected from 6 locations per subplot (the A locations) during the baseline sampling to provide a general sense of the substrate and benthic community (e.g., successional stages) prior to ENR/AC placement; the SPI images are collected as triplicate images. In Year 0 through 3, SPI images (in triplicate) are collected at 12 locations per subplot (the A and B locations).

In Year 0, the primary DQO is to understand how the AC is distributed in the ENR+AC subplots. Bioavailability of PCBs is not of interest because the ENR and ENR+AC layers will not have had time to come into steady state with their surroundings. For this reason, only TOC, black carbon, and grain size are being analyzed. The sediment composites from each subplot will be analyzed for TOC, BC, and grain size. In the ENR+AC subplots, each of the 18 locations (6 per subplot) will be analyzed separately for BC to gather additional information about the distribution of the AC in the ENR+AC subplots. No porewater samples will be collected.

The benthic macro-invertebrate survey in Year 3 will not employ the compositing scheme described in 3.1.2.1; instead it will be performed on sediment grab samples collected specifically for the benthic survey. Five samples will be collected from each subplot; the locations were chosen using a random number generator as with the sediment and porewater locations. The selected locations are shown on Figures 3.1, 3.2, and 3.3.

3.1.3 Sequencing of Tasks within an Event

The following sequence of field activities will be used in the events.

1. SPI and plan view camera images will be collected first. They will be processed and used to gather a preliminary overview of current conditions at each subplot.
2. SPME fibers will be deployed using a diver as described later in Section 3.2.
3. Four weeks later (see Section 3.2.5), the SPME fibers will be retrieved by a diver, who will also collect the shallow sediment cores at the same location.
4. Benthic grab samples collected in Year 3 will be collected after the SPI and SPME retrieval.

The SPI, SPME, and sediment cores are co-located within location cells that are approximately 10- by 10-foot areas; the SPMEs and sediment cores are then composited as described in the Sampling Design above, and in more detail in Section 3.2 below.

3.2 Sampling Methods

This section describes the sampling methods utilized in the monitoring program. Section 3.3 describes the analysis methods.

3.2.1 ENR Material Testing

As part of the baseline event, materials intended for use as ENR will be tested. The material samples will be collected by the Contractor (see Section 3.1.1) and submitted to the PE who will relay the materials to the FC for packaging and submittal to the analytical labs. The FC will place the sand and gravelly sand samples into the jars listed below; the sample jars (two jars per sample for the sand and gravelly sand) will be transferred to the sediment laboratory under chain-of-custody. Preservation or chilling is not required.

Jar Order	Analysis	Laboratory	Jar Size
1	SMS Metals, SVOCs Total solids Total organic carbon Black carbon	Sediment Laboratory	16 oz.
2	Grain size	Sediment Laboratory	8 oz. (full)
3	PCB congeners Dioxins/Furans	Congener Laboratory	4 oz

A sample of GAC will also be acquired by the PE (see Section 3.1.1) and given to the FC for packaging and submittal to the analytical laboratory. The GAC will be tested for PCB congeners by the PCB congener laboratory. It will be submitted to the lab in a wide-mouth amber 4-ounce glass jar with a Teflon liner; the jar will be supplied by the PCB congener laboratory. A sample of the GAC will be placed in the jar and shipped to the laboratory under chain-of-custody. Preservation or chilling is not required.

3.2.2 Location Positioning

The center of the locations presented in Table 3.2 (and shown in Figures 3.1, 3.2, and 3.3 for one of the events) will be converted to digital global positioning system (DGPS) coordinates georeferenced to the datum used by the DGPS equipment. This information will be available to the field team at the beginning of each event.

The field team may relocate to another location within a grid cell if the location in Table 3.2 is found to have been adversely affected by conditions that are not intended to be part of the study. Such conditions could include spud holes created during construction, debris that has settled on the site, etc. – first preference would be to remain at the "location" but position the sample to avoid the problem, but if the adverse condition is more wide-spread (typically greater than 5-feet across), then a new location may be selected. The field staff will be given three additional locations per grid cell to those in listed in Table 3.2 as "contingent" locations; the contingent locations will also have been selected randomly. Finally, it also acceptable to adjust locations if localized areas of ENR loss (scour) occur; if the scour is wide-spread across the plot, then Section 3.3 should be consulted.

Station positioning for diver-deployed sampling will use temporary marker buoys for deployment. Immediately before sampling, the stations will be located using the vessel's DGPS. Once the designated coordinates have been reached, the station will be marked with a weighted marker buoy. The station location will be recorded once the marker buoy is in place. The DGPS receiver will be capable of accurately surveying positions to within 2 meters. A similar approach is used for the intertidal plot although the diver may be wading and/or walking along the mudflat during part of the sampling.

For vessel-deployed work (SPI and plan view images and benthic sample collection), the DGPS receiver will be placed above the deployment boom of the sampling device to accurately record the position of the sampling device. At surface sediment grab stations, once the sampling device has been deployed, the actual position will be recorded when the device reaches the sediment surface. At that point, there is typically less than 5 degrees of wire angle.

Before field work is initiated, a control checkpoint such as a dock or piling that can be accessed by the sampling vessel will be established. At the beginning and end of each day, the coordinates and elevation of the checkpoint will be determined from the vessel, averaged, and compared to the known coordinates and elevation. The two position readings should agree within the limits of survey vessel's operational mobility and the instrument specifications.

Horizontal coordinates will be projected to the Washington State Plane (North) coordinate system under the North American Datum of 1983 (NAD 83). The vertical datum will be the National Ocean Service MLLW datum. Vertical control measured by the vessel depth finder will be corrected for tidal influence after the field activities are completed (Ecology, 2008). Tidal elevation will be determined by calling the National Ocean Service for data from its automated tide gage located at Pier 54 (206.749.9218).

Water depth will be measured during all sampling events using the vessel fathometer, the diver depth gauges, or a traditional lead line.

For diver-collected samples (SPME and sediment cores), depth will be determined by diver depth gauges. Divers will note the water depth and time at the sampling location while placing or retrieving the SPME fibers. The water depth from the diver's depth gauge and the tide at the time of sampling will be recorded on the field log. Tides will be converted to MLLW by subtracting the tidal height from the measured water depth.

For benthic grab samples, a lead line or vessel fathometer will be used to measure water depth. For lead-line readings, the line will be lowered to the sediment mudline. Once the lead line has reached the sediments, the distance to the surface of the water will be recorded, as well as the tide and time of the recorded depth. Tides will be corrected to MLLW by subtracting the tidal height from the measured water depth.

Forms: Location information will be recorded on a sampling station location log that may be a Microsoft Excel® table. The table will include information on the weather and waterway conditions; position checks with the fixed control checkpoint; and station-specific information (DGPS coordinates, water depth, date, and time). If the station is occupied for more than 1 hour or for the collection of more than one type of sample, the information will be measured and recorded again for the additional samples so that no more than 1 hour passes between measurements.

3.2.3 Sediment Profile Imaging and Plan View Imagery

SPI will be used to evaluate the thickness and physical characteristics of the ENR and ENR+AC layers, the thickness of newly deposited material (if any), the oxidation-reduction (redox) conditions, and the establishment of biological communities. Plan view images will be used to assist in understanding surface conditions, erosion and deposition and the nature of the biological communities.

The SPI camera will provide semi-quantitative data regarding sediment type, mixing of the AC, presence of depositional layers, and benthic community characteristics. In some cases, SPI data collection may be limited by penetration depth in firm substrates or substrates with heavy debris, and may be unable to show the interface with the ENR/AC layer and the native sediment. Furthermore, benthic community data will be limited in scope and only provides an indication of benthic community recolonization and successional stage, but does not provide quantitative data on benthic taxa (e.g., abundance, diversity). Both SPI and plan view imagery will be considered as a line of evidence used in conjunction with other data types collected during the field investigations.

3.2.3.1 Image Collection

The in-water camera work will be performed by a specialty vendor under the direction of the FC. The SPI operator will deploy SPI camera from a marine sampling vessel owned and operated by Research Support Services, using a prism-mounted camera system that is lowered into the sediment surface. The camera produces a cross-sectional photograph of the sediment/water interface and near-surface sediment (a 15- by 20-centimeter area). The SPI camera consists of a wedge-shaped prism with a Plexiglas faceplate and a back mirror mounted at a 45-degree angle. Light is provided by an internal strobe. The back mirror reflects the image of the sediment/water interface profile to a digital camera mounted on top of the prism. Plan view images will also be collected for each station using a down-looking underwater camera mounted on the SPI camera frame.

SPI surveys will be conducted in all three plots during the baseline and Year 0 through 3 monitoring events. Because SPI sample collection disturbs the surface sediments, the station locations listed in Table 3.2 actually represent an area of approximately 10 by 10 feet (they differ slight from plot type to plot type due to the geometry of the plots); samples collected within the cell are considered co-located. The actual locations will be tabulated as discussed in the previous section.

At each location the SPI camera will be lowered to the sediment surface. Immediately prior to making contact, a plan-view image of the sediment surface will be collected. Once the SPI frame is resting on the bottom, a hydraulic piston will push the camera prism into the surface sediments. To minimize the disturbance of the sediment-water interface, the rate of descent of the prism will be limited to 6 centimeters/second. After an image is collected, the camera will be raised from the sediment; a wiper blade automatically cleans off sediment adhering to the prism faceplate. The camera is raised several feet above the riverbed and the winch moved laterally. The camera is then lowered to the sediment surface to collect a replicate plan-view and SPI image. A total of three replicate images for analysis will be collected at each location.

The SPI and plan view images will be labeled with sample IDs (see Section 4.1.1 for naming protocols) along with the date and time.

Forms: A photograph log (Appendix A) will be completed in the field. The log will tie the SPI and plan view images to the time, date, and station where they were recorded.

3.2.3.2 Image Analysis

The images will be processed by SPI operator and Ramboll Environ staff. The primary focus of the analysis of the SPI images is to determine the thickness of the ENR and ENR+AC layers, the distribution of GAC within the ENR+AC layers, and the presence of organisms in surface sediments. For each of the three replicate images at each location, a computer-based image analysis system will be used to measure the following parameters:

- Prism penetration depth and thickness of the ENR and ENR+AC layers
- Distribution of GAC, if observable
- Apparent redox potential discontinuity
- Quantity and relative size of feeding voids at three depths (0 to 2 centimeters, 2 to 5 centimeters, and 5 to 10 centimeters)

The prism penetration depth of the SPI camera is determined by measuring both the largest and the smallest linear distance between the sediment-water interface and the bottom of the SPI image. Camera prism penetration depths provide a qualitative, relative measure of sediment-bearing capacity. The thickness of the ENR and ENR+AC layers will be determined on the basis of the largest and smallest linear distance between the sediment-water interface and the bottom of the ENR material. If possible the bottom of the ENR and ENR+AC layers will be noted by a transition to areas of unconsolidated, water-rich, fine-grained sediments.

When observable, the distribution of GAC will be noted. GAC may appear as dark particles or layers of particles in the ENR+AC layers.

The apparent redox potential discontinuity estimates the depth of oxygenation in the upper sediment column and can be considered the depth of biological mixing by infaunal organisms. The upper surface of aerobic fine-grained sediments has a higher light reflectance value than the underlying hypoxic or anoxic sediments. This is apparent in SPI images and is due to oxidized surface sediment that contains minerals in an oxidized state (typically an olive color), and the reduced sediments below this oxygenated layer are generally dark gray or black. The boundary between these layers is called the apparent redox potential discontinuity, which provides an estimate of the biogenic sediment mixing depth because bioturbating organisms mix the oxidized sediment particles downward into the sediment column. Bioturbation also vertically transports buried reduced compounds to the sediment surface and exposes them to an oxidized water column (Aller, 1982).

SPI images can assist in understanding how recolonization of the ENR and ENR+AC layers differ over the first three years after placement, and support the more definitive benthic macroinvertebrate survey planned for Year 3. Benthic infaunal communities generally follow a three-stage succession after a disturbance of the seafloor (Pearson and Rosenberg, 1978; Rhoads and Germano, 1986). Stage I infauna typically are the first organisms to colonize the sediment surface. These opportunistic organisms may consist of small, tubicolous, surface-dwelling polychaetes. Stage II organisms typically are shallow-dwelling bivalves or tube-dwelling amphipods. Stage II communities are considered a transitional community before reaching Stage III, the high-order successional stage consisting of long-lived, infaunal deposit-feeding organisms. Stage III invertebrates may feed at depth in a head-down orientation and create distinctive feeding voids that are visible in SPI images. The evaluation of SPI survey results may be used by a trained biologist to qualitatively identify the presence of Stage I, II, and III communities after construction.

Feeding voids observed in SPI images will provide an indication of the presence of head-down, deposit feeding, bioturbating organisms in surface sediments. The quantity and relative size of the feeding voids will be determined at three depth intervals for each SPI image: 0 to 2 centimeters, 2 to 5 centimeters, and 5 to 10 centimeters. The relative size classifications for the feeding voids will be based on the approximate height of the feeding voids: small voids (height less than 0.15 centimeters), medium voids (0.16 to 0.50 centimeters), and large voids (greater than 0.51 centimeters).

The plan view images will be used to assist in understanding the ENR/AC layer conditions, sediment erosion/deposition, and recolonization of the benthic community. Plan view images will be scored for surface smoothness, sediment type, and surface features (e.g., sand waves, soft deposits, detritus and/or wood). Evidence of biological activity will include the presence/absence of epifauna (e.g., demersal fish and invertebrates), burrows, tracks, tubes, and mudclasts.

3.2.4 Sediment Core Collection and Field Processing

The physical and chemical characteristics of the bulk sediment will be measured in sediment composites generated from hand-collected sediment cores.

3.2.4.1 Core Collection and Logging

As indicated in Section 3.1, 18 locations have been defined in each subplot to form a total of three composites made up of material from up to 6 locations each, labeled A, B, and C, which will be analyzed for PCB congeners, TOC, black carbon, and grain size.

Shallow sediment core samples will be collected from the subtidal and intertidal plots by divers (who may be wading during intertidal plot sampling), using a precleaned 2- to 4-inch-diameter, 1 to 2-foot-long cellulose acetate butyrate (CAB) core liner. The core tubes will be marked on the top with brightly colored duct tape or electrical tape. The core liner will also be marked to indicate the depth of insertion. Before deployment, the core liners will be decontaminated with warm soapy water using laboratory-grade detergent (e.g., Alconox), triple-rinsed with deionized water, and then sealed to prevent contamination.

To collect the sediment core, a core liner will be unsealed and then inserted directly into the sediment surface and gently pushed down into the sediment until the mark is flush with the sediment surface. The target depth for core collection will be 12 inches. This sampling depth allows an evaluation of presence of a deposition layer and the depth of the ENR layers. Even though only the upper 10 cm will be composited, the whole depth of the core will be described on the sediment core log.

The core liner will not be tilted back and forth into the sediment, although gentle vertical twisting of the core liner into the sediment is acceptable. If the core liner cannot penetrate the sediment, the diver may move the location slightly until the target penetration can be reached. If the target penetration cannot be reached after two tries, a new location will be selected using the procedures in Section 3.2.2. Once the core liner has been inserted to the target depth, the diver will retrieve the core by pulling the core liner out of the sediment and immediately capping the bottom the liner, preventing the release of sediment from the bottom of the core liner. A hand may be placed on the bottom of the core to prevent sediment from being released until the bottom of the core has been capped. A cap will then be placed on the top of the core liner. If necessary, the top cap of the core liner may be pierced to increase the ease of cap placement. For diver safety, this hole would need to be created in the cap before the diver enters the water. The diver must keep the core upright after collection and while bringing it to the surface of the water.

In order to get enough sample volume, co-located cores will likely need to be collected as follows:

- In the ENR and ENR+AC layers using sand, one 4-in core or two 2-in cores should provide sufficient material for the composite.
- In the ENR and ENR+AC layers using gravelly sand, one 4-in core or three 2-in cores should provide sufficient material for the composite.

Once the core has been brought to the water surface, the on-board crew will inspect the retrieved core length to ensure that the core fully penetrated the ENR layer and that the upper 10-centimeter layer is intact. If the percent recovery of a short core is not acceptable or the core shows significant disturbance during sampling, the core will be recollected in an adjacent location using a new core tube. Once the core has been accepted, a hole will be drilled into the core liner above the top of the sediment to drain any overlying water; and care will be taken not to disturb the surface of the core sample and suspended sediment will be allowed to settle before the overlying water is drained. The core caps at both ends and any drain holes will then be sealed with electrical/duct tape. The core sample will be labeled with the sample ID (see Section 4.1.1 for naming protocols), date and time, and an arrow pointing toward the top of the core. Intact sediment cores will be stored upright in an ice-filled container (e.g., a cooler) or refrigerator (4 degrees Celsius [C]) before processing.

Form: The field technician will complete a surface sediment core sample collection form (QAPP Attachment A) for each core collected. Photographs will be recorded on the photograph log form and cross-referenced to the surface sediment core sample collection form.

3.2.4.2 Porewater Salinity Measurements

Porewater salinity measurements will be made by the diver at the time of the collection of sediment cores from a co-located position. The measurement will be made using a field probe to measure specific conductance that has been calibrated to salinity. The measurement will be made at approximately 10 cm below mudline during the Baseline Event; and 10 to 20 cm below mudline in subsequent events. This depth was selected to assess the salinity of upwelling water.

Measurements will be made using an underwater probe that can be inserted directly into the sediments. If the probe is unable to penetrate the sediments, then a porewater sample will be collected by the diver using a stainless-steel syringe, and the porewater will be measured in the boat using a standard specific conductance or salinity meter.

If salinities are uniform within a plot, then the number of salinity measurements maybe reduced for that plot in future events.

3.2.4.3 Bulk Sediment Processing and Compositing

Core processing, compositing, and subsampling for chemical analysis will be performed in the field, either on board the sampling vessel or in a land-based work area. All cores will be stored in the dark at 4°C (±2°C) before processing. The core samples from each subplot will be organized into groups of six core samples labeled by letter “A,” “B,” or “C” (one core sample from each grid cell).

Before compositing, each A core sample (a total of six from each subplot) will be split vertically to evaluate stratigraphy and the distribution of carbon in the ENR+AC subplot. To split the core, electrical tin snips will be used to remove a strip of the core liner vertically from the bottom to the top. The core will be carefully rotated 180 degrees, and a strip of the core liner will be removed from the other side. The core will be carefully divided in half with a stainless-steel spatula. The core will be photographed and characterized in terms of its length and visual geotechnical characteristics (presence of depositional layers, depth of ENR+AC layer, grain size, and presence of carbon).

To form the composite, sediment from the top 10 centimeters will be removed from both halves of the core liner with clean stainless-steel utensils and placed in a clean, stainless-steel mixing bowl for homogenization. Care will be taken not to scrape the core liner to avoid getting liner material in the sample. In the same manner, sediment cores from the other subplots will be placed in the stainless-steel bowl for processing. A similar volume from each of the six samples will be composited.

Each composite sample will be homogenized until uniformity throughout the sample has been achieved. The sample jars for grain size analysis and the archive sample will then be filled. Then the weight of the bowl and sediment will be recorded. If gravel is present, the composite (after the removal of the samples for grain size and archiving) will be press-sieved with a 3/8-inch stainless-steel mesh to remove large gravel. (The scour and intertidal plots are expected to have gravel because of the use of gravelly sand; no gravel is expected in the subtidal plot where sand will be used.) The bowl and sieved sediment will be reweighed and the difference will be recorded and assumed to be the weight of the removed gravel.

The sediment will be used to fill the jars at least half full, in the order shown below:

Jar Order	Analysis	Laboratory	Jar Size
1	Grain size	Sediment Laboratory	8 oz. (full)
2	Archive	PCB Laboratory	8 oz.

Jar Order	Analysis	Laboratory	Jar Size
Sample composite is now field sieved to remove gravel			
3	PCB congeners Total solids	PCB Laboratory	8 oz.
4	Total organic carbon Black carbon	Sediment Laboratory	4-oz.

Unused sediment material including the gravel will be disposed appropriately (see Section 3.2.8).

The work surface cover will be changed between the preparations of each composite sample, and all tools and utensils that come in contact with the core sample will be cleaned with detergent and rinsed with laboratory-provided deionized water; to the extent practicable, disposable materials will be used for sampling to minimize potential cross-contamination. The sample container will be maintained on ice or in a refrigerator (4°C) until it is shipped to the analytical laboratories in accordance with the procedures in Section 4.3.1.

Forms: Compositing information will be recorded on the Sediment Composite Log. Chain-of-custody forms will also be completed for transfer of the sample jars to the laboratories under custody (see Section 4.3.1).

3.2.5 Porewater Sampling

Dissolved PCB congeners in sediment porewater will be measured with the use of SPME fibers using a method that has been successfully applied to measure PCB availability before and after an AC amendment at a site in Puget Sound (Conder et al., 2013; Conder et al., 2015). The method is based on the work of Conder et al. (2003), You et al. (2007), Yang et al. (2008), Lu et al. (2011), Oen et al. (2011), and Harwood et al. (2012).

The SPME sampler consists of a steel-mesh envelope containing SPME fibers that is attached to a steel plate to allow its insertion into the sediment. As described in the following subsections, SPME samplers will be deployed in situ within surface sediments and at the sediment-water interface at the plots, providing a surface onto which PCBs present in porewater will sorb. The fibers will be retrieved, extracted, and analyzed for PCBs. PCB concentrations in the SPME fibers will be used to calculate the concentrations of dissolved PCBs present in porewater during the in situ exposure. The remainder of this section details SPME sampler preparation, deployment, retrieval, and fiber extraction (to recover the sorbed PCBs). Section 3.5 will discuss the analysis of PCBs in the extracts; and the estimation of dissolved PCB concentrations in sediment porewater.

3.2.5.1 SPME Porewater Sampler Preparation

SPME fibers are commercially available optical fibers composed of a 10-micrometer-thick polydimethylsiloxane (PDMS) coating around a 210-micrometer-diameter silica core (Fiber-guide Industries, Stirling, New Jersey). The fibers will be cut to 10-centimeter lengths (±0.5 centimeters). For each sample station, eight fibers (80 centimeters total) will be placed in a 2-by-11-centimeter steel-mesh envelope (with 110-micrometer mesh openings) to protect the fibers from loss and breakage (Figure 3.4). The SPME envelopes (containing SPME fibers) will be rinsed in a 50:50 solution of acetonitrile and water, followed by three rinses with ultrapure water to remove trace impurities.

The cleaned SPME envelopes will be placed in a solution containing performance reference compounds (PRCs). Because of the duration of time needed for the SPME fibers to reach full equilibrium for all congeners, PRCs are used to allow non-equilibrium conditions to be quantified between the porewater and the SPME medium. With the use of PRCs, the SPME envelope can be deployed for shorter time periods, which has been found to decrease the risk of lost or destroyed fibers and biological fouling. Details of the PRCs and how they are used for quantitation are provided in more detail in QAPP Attachment B. The PRCs include one to two PCB congeners from each of the tri-, tetra-, penta-, hexa-, hepta-, and octa-chlorinated biphenyl homolog series. As discussed in the attachment, the selected PRCs will be PCBs that are not routinely detected in the LDW. After a period of time sufficient to allow the PRCs to sorb to the PDMS coating on the SPME fibers (24 hours), the SPME envelopes will be blotted dry, wrapped separately in rinsed aluminum foil, and stored at 4°C until deployment. The envelopes will be deployed within 2 weeks of preparation.

Forms: The analyst will complete a SPME preparation form (QAPP Attachment A) for each batch of SPME fibers. The form will document the source of the base fibers, their purchase date, reference vendor-supplied information, reference to the analysis of the cleaned fiber, a list of the PRCs used and their concentrations in the soaking solutions, and a reference to the analysis of the PRC-loaded fiber.

3.2.5.2 SPME Porewater Sampler Deployment and Retrieval

Immediately, but no more than 15 minutes before deployment, the SPME envelopes will be removed from cold storage, unwrapped from their aluminum foil layers, and attached to a corrosion-resistant steel plate (Figure 3.4). Three samplers will be labeled with the same grid cell number, and a reflective, fluorescent marker or small buoy will be attached to the sampler's steel plate. The three samplers will be placed in a labeled gallon-sized sealable plastic bag and handed to a diver. Within each grid cell in a subplot, the diver will go to the locations listed in Table 3.2 and insert the steel plates vertically into the sediment so that the tops of the SPME envelopes are just below the sediment-water interface and the bottoms of the SPME envelopes are approximately 10 centimeters (±1 centimeter) below the sediment-water interface.

For the Years 2 and 3 monitoring events, an additional SPME envelope will be attached to the steel plate (via an additional smaller steel plate or support as necessary) to enable measurement of PCBs in porewater at the sediment-water interface. This additional SPME envelope will be attached to the upper portion of the steel plate in a horizontal/landscape orientation (i.e., oriented perpendicularly to the primary SPME envelope that will be exposed to the 0 to 10 cm layer). The resulting design will be a steel plate with two SPME envelopes attached. This "Year 2 and 3" sampler configuration will be inserted into the sediment such that one SPME envelope will be exposed vertically to the top 10 cm of sediment (as in the previous Baseline and Year 1 events), while the second SPME envelope will be exposed horizontally to the sediment-water interface, approximately 1 cm below the sediment surface.

This deployment of SPME samplers at three pre-selected locations will be repeated in each of the six grid cells in a subplot. In every monitoring event, extra samplers may be deployed in some grid cells as a contingency for the potential loss of samplers. Additionally, during the baseline sampling event, five (not three) SPME samplers will be deployed in each of the six grid cells in a subplot.

Figure 3.4. SPME Porewater Sampler

The SPME samplers will remain embedded in situ for a 4-week/28-day period, during which PCBs from the surrounding sediment porewater will sorb to the PDMS coating of the fiber, while the PRCs contained within the PDMS will desorb from the fiber coating. A 4-week exposure period is an optimal balance of providing the adequate time period required for the PCBs in porewater to come to a sufficient proportion of equilibrium (approximately 20 percent or greater) and minimizing the risk of sampler loss, fouling, or vandalism, which is likely with longer deployment periods. After the 4-week exposure period, divers will return to each sampler location, remove the sampler plate from the sediment, place the sampler plate in an individual sealable plastic bag, and return it to the surface. If the SPME has been disturbed during its deployment and this is visible to the diver, this will be noted on the field record. At the surface, the samplers will be immediately removed from the plastic bags. The SPME envelope(s) will be removed from the steel plate, wrapped individually in a layer of aluminum foil, placed in individual labeled sealable plastic bags, and stored at 4°C until processing and extraction. The SPME envelopes will be labeled with the sample ID (see Section 4.1.1 for naming protocols) and the date and time of collection. The SPME envelopes will be placed inside a protective box in the cooler (e.g., Tupperware or similar container) to protect the SPME envelopes from breakage when contacting bags of ice or reusable ice packs.

For the Baseline, Year 1, Year 2, and Year 3 events, eighteen (18) SPME envelopes exposed to the 0-10 cm layer will be obtained from each subplot during each monitoring event; these 18 SPME envelopes will be composited to yield three six-point composite samples per subplot. In the baseline monitoring event, an additional twelve (12) baseline contingency SPME envelopes will also be obtained from each subplot to yield a total of five six-point composite samples per subplot. The same locations that were composited to form the A, B, and C surface sediment composites (per subplot) will be used to form the SPME composites. The additional 12 SPME samples will be composited into 2 composites of 6 samples and will be stored until the first three composites have been analyzed, a power analysis completed, and EPA and Ecology have concurred on whether the additional composites are required. Any samplers that were deployed to account for possible sample losses that are not necessary for the 3 to 5 composite samples will be retrieved but not retained.

For Year 2 an additional eighteen (18) SPME envelopes exposed to the sediment-water interface will be obtained from each subplot; these 18 SPME envelopes will be composited to yield three six-point composite samples per subplot. However, if the power analysis conducted on the SPME envelopes exposed to the 0-10 cm layer in the baseline event indicates that more samples are needed, the same number of SPME envelopes will be used at the sediment-water interface as for the 0-10 cm layer. The same locations that were composited to form the A, B, and C surface sediment composites and the 0-10 cm SPMEs (per subplot) will be used to form the sediment-water interface SPME composites. The same compositing approach will be repeated for Year 3 if no modifications are made following review of Year 2 results.

Trip blanks will be collected and analyzed with SPME samples to ensure that the samples do not become contaminated prior to or after deployment. The use of trip blanks as a field quality control procedure is described in Section 3.5.1 – Field Quality Control Procedures.

Forms: SPME deployment and recovery forms (Appendix A) will be used to record the batch ID, discrete and composite sample IDs, SPME type (i.e., 0-10 cm deployment or sediment-water interface deployment, coordinates, dates and times of deployment and retrieval, water depths, depth of ENR or ENR/AC and diver observations for each sample.

3.2.5.3 SPME Fiber Compositing, Processing, and Extraction

The SPME fibers will be processed as soon as possible after the termination of deployment but no later than 2 weeks after their retrieval. Under clean conditions in a laboratory, the SPME envelopes exposed to the 0-10 cm layer from each subplot will be separated into three groups of six samples (six samples from the “A” location for the A-composite, six samples from the “B” location for the B-composite, etc.). Fibers from the six SPME envelopes used for each composite sample will be removed from the plastic bags, the steel-mesh envelopes will be unfolded, and the SPME fibers will be removed from the envelopes. The fibers will be gently wiped with moistened lint-free tissue (e.g., Kimwipes®) to remove any fine particulate matter, cut into small (e.g., 1-centimeter pieces), and placed in a labeled, pre-weighed 2-milliliter (mL) amber glass vial. Clean, power- and dust-free nitrile gloves will be used during the handling of the SPME fibers.

Each vial will contain fiber from all six SPME envelopes for each respective composite and will represent a composite sample of approximately 480 centimeters (80 centimeters per envelope multiplied by six envelopes) of SPME fiber—the loss of some fibers during deployment may result in less than 480 centimeters in some vials, which will be noted in the laboratory logbook. The vial will be reweighed to determine the total weight of the fiber in the vial, and this fiber mass measurement will be used to infer the total length of the SPME fiber present in the composite sample. Hexane (1.8 mL) will be added to the vial, and the vial will be stored and shipped to the analytical laboratory and stored at 4°C ± 2°C until further extract processing and analysis occurs at the analytical laboratory. Baseline contingency SPME extracts will not receive additional processing and analysis steps until the decision is made to proceed with the full PCB analysis of these samples. This decision will be made after a review of the data provided by analysis of the primary baseline SPME samples.

The SPME envelopes exposed to the sediment-water interface from each subplot will be separated into three groups of six samples (six samples from the “A” location for the A-composite, six samples from the “B” location for the B-composite, etc.) and processed separately in an manner analogous to the SPMEs exposed to the 0-10 cm layer in all monitoring events.

Forms: The compositing step will be documented on the SPME extraction and compositing form (QAPP Attachment A).

3.2.6 Benthic Macroinvertebrate Survey Surface Sediment Collection and Field Processing

At the end of the 3-year pilot study, a benthic macroinvertebrate survey will be used to compare the benthic communities that are established in each of the ENR+AC subplots to the benthic communities in the corresponding ENR subplots. Five replicate surface-sediment samples will be collected from each subplot for benthic analysis using a 0.1-square-meter van Veen grab sampler. At each plot, the observations during the benthic macroinvertebrate survey will be compared between the two subplots.

Sediment for benthic macroinvertebrate analysis will be collected using a van Veen grab sampler deployed with a hydraulic winch. Before sampling begins, the grab sampler will be cleaned with a non-phosphate laboratory soap (e.g., Alconox) and rinsed with site water. The sampler will be attached to the winch cable by a ball-bearing swivel and shackles. If necessary, weights may be attached to the sampler to achieve proper sampling depth. The grab sampler will then be cocked and lowered through the water column at a rate that is slow enough (approximate 1 meter per second) to prevent bow wake disturbance of surface sediments. Once the grab sampler has reached the bottom, the time and location of the sample will be recorded. The grab sampler will be closed slowly and lifted to the surface. Once at the surface, the grab sampler will be lowered into its stand, secured, and visually inspected for acceptability. An acceptable grab sample is one with relatively level, intact sediment over the entire area of the grab and, generally, a sediment depth at the center of the sampler in excess of the depth required to sample more than 90 percent of the species and individuals in the upper 10 centimeters of sediment. Grabs containing no sediment, partially filled grab samplers, grabs with grossly slumped surfaces, or grabs that leak are unacceptable. Grabs that completely fill the sampler to the top, where the sediment is pushed through the door screens, may also be unacceptable.

Once a grab sample has been accepted, a description of the collected material will be recorded in field sampling forms, including such information as penetration depth, color, texture, odor, biological structures, and any other notable features.

The sediment from each grab will be processed in the field. The samples will be sieved on board through a 1.0-millimeter screen. The water used to sieve the organisms from the sediments will be obtained from the LDW and filtered to remove organisms that might have been picked up from the water column. Organisms and debris that are collected on the screen will be placed in a magnesium sulfate solution to relax the organisms, and then this material will be preserved using seawater-buffered formalin solutions of at least 8 to 10 percent. The samples will be labeled internally and externally and placed in a container appropriate for the volume of the sample. Samples with a volume less than100 mL will be placed in plastic Whirl-Pak® bags. Larger samples will be placed in larger containers made of either glass or plastic. Each sample or each group of samples from a single grab will be stored together in a separate container. Field notes and chain-of-custody (COC) records will be maintained to indicate the number and size of sample containers obtained from each grab sample. Samples will be sent by courier to Ramboll Environ's benthic laboratory (Port Gamble, Washington) for further analysis and archiving. The sample containers can be stored at ambient temperature. The grab sampler, sieve, and utensils should be rinsed with site water between sampling locations.

Forms: Information related to the collection of the grab samples for benthic macroinvertebrate analysis will be recorded on the Sediment Grab Log. Chain-of-custody forms will be completed for transfer of the sample jars to the Ramboll Environ laboratory. Benthic taxa identified during the sorting and identification will be recorded on "infaunal sample identification and sorting" sheets.

3.2.7 Decontamination Procedures

Working surfaces, utensils, tools, equipment, mixing bowls, and other items that come in contact with the sample must have been cleaned before use, between composite samples, and between sampling events involving samples collected for chemical data. The decontamination procedure is as follows:

1. Prewash rinse with tap or site water.
2. Wash with solution of warm tap water or site water and detergent (e.g., Alconox).
3. Rinse with tap or site water.
4. Rinse thoroughly with laboratory-provided deionized water.
5. Store in a clean, closed container.

All dilute detergents, residual solvent (from the benthic sampling), and deionized rinsate will be captured separately at each location and handled according to the procedures described in Section 3.2.8.

3.2.8 Field-Generated Waste Disposal

EPA mandates the management of field-generated waster (FGW) to ensure the protection of the environment and of human health. FGW from this project may include the following:

- Used personal protective equipment (PPE): sampling gloves, Tyvek® suits, and shoe covers
- Packaging and storage materials, plastic bags, foil, and deionized water containers
- Liquids or solids from field decontamination procedures

The field team will manage the individual waste streams in a similar manner, with the goal of minimizing the volume of FGW. The following procedures will be used for waste.

Used PPE, disposable sampling equipment, and packaging materials will be managed together and minimized whenever possible. These wastes are not considered hazardous and can be sent to a municipal landfill. These wastes will be stored in heavy-duty, rip-stop trash bags until the bags are filled to 80 percent capacity. The bags will be compacted by manual pressure; standing air will be removed to the extent practical and the bags will be taped shut. If a bag contains sharp objects or there is a potential for the bag to rip, the bag will be isolated with an outer over-pack bag.

Decontamination fluids will include residual solvents, deionized water, a dilute solution (2 to 5 percent) of Alconox non-phosphate detergent, water from the LDW, and sediment (both solids and porewater). They will be handled as follows:

- Fluids contain residual solvents (from benthic sampling) will be captured at each plot, returned to the shore for storage, testing, and disposal (based on the test results).
- Deionized water, dilute Alconox, water from the LDW and residual sediment and porewater mixed with them will be returned to the waterway at the downgradient edge of the plot.

Excess sediment that is collected in cores and van Veen samplers that is not used for analysis will also be returned to the waterway at the downgradient edge of each plot.

3.3 Contingent Sampling Design Modification

As the pilot study progresses two potential conditions have been identified that could require modification to the monitoring design. Other conditions could occur in the future that would also require an evaluation of the study DQOs and design.

3.3.1 Significant Deposition of New Sediment

If a significant buildup of fresh sediment occurs at a plot as a distinct layer rather than mixing in with the ENR and ENR+AC layer, this material could impact the study results. Minor buildup is considered a normal condition and not a concern, although it will be noted on SPI interpretations and the surface sediment core logs if encountered. Isolated deposition, such as in-filling of the spud holes created during construction, will be avoided whenever possible. For example, the spud holes will be designated with DGPS coordinates and would result in the moving of locations in Table 3.2 to avoid the locations with spud effects.

If a significant buildup of fresh sediment occurs across a plot, a composite of the material (one per subplot) will be collected and tested for PCB congeners, TOC, black carbon, and grain size. The physical observations of the depositional layer and the chemistry results will be shared with the EPA and Ecology and the DQOs reviewed. If appropriate, modifications may be suggested, approved, and implemented in subsequent monitoring events based on this discussion.

3.3.2 Significant Scour of ENR Layer

If significant loss of ENR layers has occurred such that the results would no longer be relevant for achieving the DQOs, further testing of that plot may not be useful and a request may be made to terminate testing in that plot or to modify the sampling plan to avoid the eroded area. Termination in one plot would not affect the decision to continue or terminate in another plot. Termination of the study in a plot would require concurrence from EPA and Ecology.

3.4 ANALYTICAL METHODS

The analyses to be performed are summarized in Table 3.3. As discussed above there are four sample matrices that are being analyzed: a sand and gravelly sand matrix that represent ENR substrate, an activated carbon matrix that represents the GAC being added the ENR substrate for the ENR+AC subplots, the sediment matrix, and the SPME extracts. Table 3.3 lists the methods, the sample preservation, the holding times, the minimum sample size, and the sample container preferred for shipment and storage.

Tables 3.4 through 3.6 summarize the quality assurance goals (QAGs) for the solid samples (ENR substrate, GAC, surface sediment) collected for chemical analysis are described in this section.

3.4.1 ENR and GAC Material Analysis

The sand and gravelly sand samples are to be analyzed for all chemicals listed in Lower Duwamish Waterway Record of Decision (U.S. EPA, 2014) Tables 19 and 20, percent solids, TOC, black carbon, and grain size. Detection limits will be low enough for the materials to be compared the lowest cleanup levels shown in the Lower Duwamish Waterway Record of Decision (U.S. EPA, 2014) Tables 19 and 20. The methods are listed in Table 3.3. Tables 3.4 and 3.6 contain the quality assurance criteria that the sediment laboratory is to meet for each of the conventional, and SMS chemical analytical methods.

The GAC material will be analyzed for PCB congeners only; analysis will use EPA Method 1668C. Because the GAC is expected to contain particles that are larger than 1 mm, the sample will require grinding and compositing as part of EPA Method 1668. This will be performed at the laboratory using clean equipment intended for the processing of PCB congener samples. Table 3.5 contains the QAC that are applicable to sediment samples for the PCB congeners. Because of the strong sorption capacity of the GAC, it is possible that the quality assurance recoveries targeted for sediment samples may not be met with the GAC. Therefore, laboratory has been directed to take reasonable measures to meet the QACs for the GAC sample, and will specify any necessary modifications in the narrative section of the laboratory report for the analysis.

Table 3.7 and Section 3.5 identify the laboratory QA samples that will be used for the analyses.

3.4.2 Bulk Sediment Preparation and Analyses

The bulk sediment samples will have been composited in the field before shipment to the analytical laboratories as discussed in Section 3.2.4. Sediment composite samples for grain size and archiving will represent material “as-is” from the subplot; the sediment composite samples for PCB congeners, TOC, and black carbon will have been press sieved in the field to remove gravel greater than 3/8-inch; however, smaller gravel and coarse sand will remain in the samples from the scour and intertidal plots. The small sample volumes used for the analysis give rise of the following concerns and their proposed solutions:

- Will the ENR+AC layer in Year 0 (and maybe Year 1) contain GAC that has not had the opportunity to disperse and is still somewhat clumpy? If so, there is a potential to introduce a significant error in the laboratory when removing a small aliquot (10-20 grams) from the sample for analysis of black carbon and TOC. If this situation is observed in the field during sample compositing (or later during the laboratory sample preparation), then the laboratory will be instructed to take a larger sample (~100 grams), crush it, homogenize the result, and then sample the smaller aliquot for the analysis. This can be performed on a damp or dry sample, depending on the requirements of the underlying analytical method. If this is still a problem in Year 1, then the sample aliquot for PCB congeners (not performed in Year 0), will undergo the same process. The PCB congener method includes instructions for crushing and handling the sample.
- Will the ENR and ENR+AC layers that are using gravelly sand contain a significant amount of material in the fraction between coarse sand and 3/8-inch gravel (the sieve size used in the field for press-sieving prior to compositing)? If so, the laboratories will be instructed to handle the sample as described in item 1 above. This will apply to PCB congeners, TOC, and black carbon. This crushing and sample handling will comply with the requirements in Method 1668C.

3.4.2.1 Total Organic Carbon, Grain Size, and Other Physical Analyses

The sediment samples will be analyzed for TOC by SW-846 9060, for black carbon by Gustafsson et al. (1997), and for grain size by ASTM D422. Black carbon refers to the analytical method used to measure the more sorptive forms of carbon in the sediments. The black carbon measurement will include both the GAC added to the ENR material and any naturally occurring active carbon present (such as soot in the existing sediments).

In order to understand whether there has been a preferential loss of fine-sized carbon, TOC will be measured in both the bulk sediment and in the material passing a #50 sieve (300 microns). The measurements passing the #50 sieve will be made in the Year 0 Event (just after placement) and in the Year 3 Event. If there is too little material passing the #50 sieve for the analysis, then a #40 sieve may be used instead.

Table 3.7 in Section 3.5 identifies the laboratory QA samples that will be used for the analyses. Because the precision and reproducibility of the black carbon method is not as well understood as the other methods, one of the composite samples in each of the ENR+AC subplots will be analyzed in triplicate (two laboratory duplicates) in the Year 0 event.

3.4.2.2 PCB Congener Analysis

The sediment composite samples will be analyzed for PCB congeners by EPA Method 1668C. Method 1668 defines quality assurance goals for a subset of congeners rather than for all 209 congeners. All 209 congeners will be reported in this project. Meeting the requirements for the subset of congeners is deemed by the method as sufficient to demonstrate acceptable performance for all 209 congeners. Per the method, internal standards and recovery standards will be used by the analytical laboratory for calibration to account for analyte loss during analysis. Laboratory QA/QC requirements are presented in Table 3.7 and provided in Section 3.5. EPA Method 1668C contains extensive requirements for laboratory QC. These will be performed as required by the method and reported as part of the laboratory report (and in the EDD).

3.4.2.3 Archived Sediment Composites

In addition to the analyses specified, additional sediment from each sediment composite will be archived (at the temperatures indicated in Table 3.4) for 6 months after the final data package is received from the laboratory for that event.

3.4.3 SPME Porewater Sampler Extract Processing and PCB Congener Analysis

At the PCB congener laboratory, the 1.8-mL hexane extracts will be spiked with radio-isotope labeled-PCB analytical recovery standards and internal standards, and the extracts will be concentrated to a volume of approximately 100 microliters under a stream of nitrogen. This concentrated extract will be analyzed for PCB congeners, including the radio-isotope labeled congeners, using EPA Method 1668C. Because Method 1668 involves a significant amount of sample handling, reported concentrations are quantified using a combination of isotope dilution and internal standard correction. Details are contained in the method. Additional information on laboratory performance, QC, and reporting is provided in Section 3.5.

3.4.4 Benthic Infauna Analysis

Benthic sorting and identification will be conducted at the Ramboll Environ benthic laboratory.

Within 2 weeks of preservation, the samples will be transferred to 70 percent ethanol for storage. Each sample will be poured into an appropriately sized sieve (500 microns or less) over a bowl or pan to collect the formalin. The formalin will then be disposed in a hazardous waste drum. The sample will then be washed gently with tap or distilled water, as will the sample container. Care should be taken not to splash the sample. Once the rinse water has drained from the sieve, the sample will be rinsed gently with 70 percent ethanol from a squirt bottle and returned to the sample container. The sieve will be checked to ensure that the entire sample has been returned to the jar. The sample container will then be filled to ~90 percent of its capacity with 70 percent ethanol, sealed, and gently shaken and inverted to ensure proper mixing.

Before removal and sorting of the organisms, the alcohol will be rinsed from the samples, and the retained organisms will be placed in water. The removal and sorting will be performed under a dissecting microscope using ~10 to 20X amplification and small quantities of sample (~5 mL). The organisms removed from the sample will be sorted into major taxonomic categories (e.g., mollusks, arthropods, annelids, echinoderms, and miscellaneous phyla). The organisms will be preserved in 70 percent ethyl alcohol with 5 percent glycerin added for longer term storage. The sorting efficiency is expected to be at least 95 percent. Samples with sorting rates falling below that rate will be resorted, and a second outside QA review will be performed.

The percent sorting efficiency will be calculated as follows:

% sorting efficiency = [1 – (# in QA resort/(# sorted originally + # in QC resort)] x 100

Organisms will be identified to the lowest practicable taxonomic level, generally species level, by qualified taxonomists with specialized expertise in each of the major taxonomic categories. Most of these identifications will be made by Ramboll Environ with additional help from taxonomists with key specialties for specific groups of species. Two forms of QA will occur. A reference collection of representative individuals for each of the identified species will be submitted for verification by Biological Environmental Services of Victoria, British Columbia, Canada, and other outside taxonomists from British Columbia, Alaska, Washington, Oregon, and California. Secondly, to maintain internal consistency with historical sets and ensure the current taxonomic conventions, the LDW data set will be evaluated to ensure consistent naming conventions for each species among the various taxonomic groups. All of the identified individuals, their abundance, and biomass will be entered into a Microsoft Excel® workbook.

All identified organisms from a discrete sample will be held in labeled glass vials containing 70 percent ethyl alcohol and 5 percent glycerin for storage (for 1 year after EPA and Ecology approval of the Year 3 data report).

3.4.5 Quality Assurance Criteria

The parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity. The specific QAGs for laboratory chemical analyses of sediment samples are shown in Tables 3.4 through 3.6. These parameters are discussed in more detail in the following subsections.

The analysis of a regional reference material for PCB congeners is not included as part of this pilot study. Frontier does run reference materials from Puget Sound on a routine basis, and this information is available on request, and their record of successful analyses was considered in selecting them to perform the PCB congener analyses for the Pilot Study.

3.4.5.1 Precision

Precision is the measure of the reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Precision is assessed by performing multiple analyses on a sample and is expressed as a relative percent difference (RPD) when duplicate analyses are performed and as a percent relative standard deviation (% RSD) when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed by laboratory duplicate analyses (duplicate samples, MSDs, and laboratory control sample [LCS] duplicates) for all parameters. When duplicate samples are not available or spiking of the matrix is inappropriate, precision is assessed by the analysis of laboratory triplicate analyses (e.g., TOC). Precision measurements can be affected by the nearness of a chemical concentration to the method detection limit (MDL), where the percent error (expressed as either % RSD or RPD) increases. The QAG for precision varies depending on the analyte (Table 3.4 through 3.6). The equations used to express precision are as follows:

$$RPD = \frac{(measured\ conc - measured\ duplicate\ conc)}{(measured\ conc + measured\ duplicate\ conc)/2} \times 100$$

$$\%RSD = ({}^{SD}/_{D_{ave}}) \times 100$$

where:

$$SD = \sqrt{\left(\frac{(\sum D_n - D_{ave})^2}{(n-1)}\right)}$$

SD = standard deviation

D = sample concentration

Dave = average sample concentration

n = number of samples

3.4.5.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy is expressed as a percent recovery for MS, surrogate spike, and LCS analyses. The QAG for accuracy varies, depending on the analyte (Table 3.4 through 3.6). The equation used to express accuracy for spiked samples is as follows:

$$Percent\ recovery = \frac{spike\ sample\ result - unspiked\ sample\ result}{amount\ of\ spike\ added} \times 100$$

3.4.5.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an environmental condition. The sampling approach was designed to address the specific data needs described in Section 1.2. Assuming that those needs are met, the collected samples should be considered adequately representative of the environmental conditions they are intended to characterize.

3.4.5.4 Comparability

Comparability expresses the confidence with which one data set can be evaluated in relation to another data set. The sample collection and chemical and physical testing will adhere to the most recent Puget Sound Estuary Program (PSEP) QA/QC procedures (PSWQAT, 1997) and EPA and PSEP analytical protocols.

3.4.5.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. Completeness is calculated as follows:

$$Completeness = \frac{number\ of\ valid\ measurements}{total\ number\ of\ data\ points\ planned} \times 100$$

The QAG for completeness for all components of this project is 95 percent. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

3.4.5.6 Sensitivity

Analytical sensitivity is a measure of both the ability of the analytical method to detect the analyte and the concentration that can be reliably quantified. The minimum concentration of the analyte that can be detected is the MDL, or limit of detection (LOD). The minimum concentration that can be reliably quantified is the reporting limit (RL), or limit of quantification (LOQ).

Frontier will report detected concentrations greater than the RL/LOQ without qualification and will report detected concentrations between the MDL/LOD and the RL/LOQ with a “J” qualifier, indicating that the concentration is estimated. The RLs/LOQs and MDLs/LODs are presented in Tables 3.4 through 3.6.

3.4.6 Laboratory Records, Reports, and Electronic Deliverables

This section describes the various laboratory record requirements for the sediment chemistry data. The laboratories selected for the various analytical methods are accredited for those methods that are accredited by Ecology. Specifically, Frontier is accredited for PCB congeners in water and sediments, and Alpha is accredited for sediment analyses using the methods referenced in Ecology’s Sediment Cleanup User’s Manual. There are no accreditation programs for the black carbon method and the preparation and extraction method for SPME fibers; however, these methods will follow available SOPs for peer-reviewed methods being used at laboratories that are accredited for other methods.

The chemistry laboratory will be responsible for internal checks on sample handling and analytical data reporting and will correct errors identified during the QA review.

The laboratory data package will be submitted electronically and will include the following:

- **Project narrative** – This summary, in the form of a cover letter, will present any problems encountered during any aspect of the analysis. The summary will include, but not be limited to, a discussion of QC, sample shipment, sample storage, and analytical difficulties. Problems encountered by the laboratory, and their resolutions, will be documented in the project narrative.

- **Records** – Legible copies of the COC forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.

- **Sample results** – The data package will summarize the results for each sample analyzed. The summary will include the following information, when applicable:

  - Field sample identification code and the corresponding laboratory identification code

- Sample matrix
- Date of sample extraction/digestion
- Date and time of analysis
- Weight and/or volume used for analysis
- Final dilution volumes or concentration factor for the sample
- Total solids in the samples
- Identification of the instruments used for analysis
- Identification of cleanup procedures used on sample extracts
- MDLs/LODs and LOQs/RLs
- All data qualifiers and their definitions

- **QA/QC summaries** – These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). The laboratory will make no recovery corrections other than those required in EPA Method 1668. The laboratory will make no corrections for blank contamination or SPME equilibrium. The contents of the required QA summaries are included in QAPP Attachment C, Laboratory Deliverables.

The contract laboratories for this project will submit data electronically, in Microsoft Excel® or delimited-text format. The guidelines for EDDs for chemical data are also included in QAPP Attachment C, Laboratory Deliverables.

3.5 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

This section presents an overview of the QA/QC information that will be used to track procedures in the field and lab. Table 3.7 summarizes the QA/AC samples by methods, but is not intended to capture to full level of detail that is contained within the methods.

3.5.1 ENR and GAC Materials Testing

Prior to the placement of ENR material, samples of the materials to be used during construction, sand and gravelly sand samples, as well as GAC samples will undergo analytical testing to ensure that the initial physical and chemical composition and quality of the samples are known prior to placement. The analyses to be performed on the ENR materials are discussed in Section 3.4.1, and the QA/QC requirements are shown in Table 3.7.

The ENR material samples are "clean" quarry rock and the SDG will consist of only a few samples, which means that it is likely that they will be batched with other samples for analysis. The MS/MSD, where required, may be performed on a sample other than the ENR material sample. For the GAC sample analyzed for PCB congeners, the method performs recovery correction using standards that are added to each sample, allowing for correction of matrix effects.

3.5.2 Field QC for Collection of Sediment and SPME Samples

3.5.2.1 Bulk Sediment

The three composites per subplot are equivalently representative of the subplot and, therefore, act as field replicates and provide data regarding site heterogeneity and variability from sample handling. Additional sample volume will not be collected for matrix spike/matrix spike duplicates because EPA Method 1668 uses isotope dilution to measure the congener recovery from the matrix and as the sample moves through sampling handling steps. This is discussed more in Section 5.4.3.

3.5.2.2 SPME Porewater Sampling

As with the sediment composites, the three composite samples per subplot act as field replicates; therefore, no additional field duplicate will be necessary. Matrix spike and matrix spike duplicates are also not needed because of a combination of the PRCs used to access recovery from the fiber and the use labeled congeners in EPA Method 1668 to monitor congener recoveries. As described below, two types of QC samples will be collected for SPMEs: material and trip blanks.

Material QC: For each deployment, a sample of the SPME fiber after initial cleaning (before exposure to the PRCs) will be analyzed for PCB congener, and the results will be attached to the SPME preparation form. Cleaned fiber is not expected to contain PCBs. This sample will serve as a SPME fiber blank and be used to identify any artifacts of fiber handling, storage, or shipping, prior to preparation for deployment (where the trip blank is used).

SPME Trip Blanks: Trip blanks are needed for the SPME fibers because their high sorption capacity makes field contamination prior to and after deployment a concern. For each deployment and at each plot, a trip blank composite will be created from six trip blanks. The trip blanks are created at the same time and using the same methods as the SPME samplers. These trip blanks will be transported to the plot during deployment of the SPME samplers, unwrapped from their foil, and exposed to air for approximately 5 minutes. After exposure, the envelope will be wrapped in rinsed aluminum foil and stored at 4°C ± 2°C. Within 2 weeks, the trip blank fibers will be processed and extracted.

3.5.3 Sample Delivery Group

Traditionally, a sample delivery group (SDG) is defined as no more than 20 samples or a group of samples received at the laboratory within a 2-week period. For this project, the following SDGs are defined:

Event	Basis for SDG	Expected Sample Count
Baseline	1 SDG for construction materials (ENR substrate)	3 to 5
	1 SDG for GAC	1
	1 SDG for composite sediment samples	18
	1 SDG for composite SPME extracts from subtidal and scour plots	12 + TBs
	1 SDG for composite SPME extracts from intertidal plot	6 + TBs
Years 0 through 3	1 SDG for composite sediment samples	18
	1 SDG for composite SPME extracts from subtidal and scour plots	12 + TBs
	1 SDG for composite SPME extracts from intertidal plot	6 + TBs

Note: If conditions in the field cause a time lag of more than a week between sampling at the different plots, then smaller, more frequent SDGs will be used for the composite sediment samples. All composites from a plot will be in the same SDG.

3.5.4 Laboratory QA/QC Criteria

The analyst will review the results of QC analyses (described below) from each SDG immediately after a SDG has been analyzed. The QC sample results will then be evaluated to determine whether control limits have been exceeded. If control limits have been exceeded in the sample group, the project QAO will be contacted immediately, and corrective action, such as method modifications followed by reprocessing of the affected samples, will be initiated before a subsequent group of samples is processed.

The following subsections summarize the procedures that will be used to assess data quality throughout the sample analysis. The QC procedures and sample analyses to be performed by the laboratory are summarized in Table 3.7. The associated control limits for precision and accuracy are summarized in Table 3.4 through 3.6.

In addition to the QC samples discussed in Table 3.7, the PCB Congener Laboratory has analyzed the Puget Sound CRM for other projects and their results for the CRM are available.

EPA Method 1668C contains extensive requirements for laboratory QC. These will be performed as required by the method and reported as part of the laboratory report (and in the EDD). Additionally, PRCs added to the SPME fibers, while not a laboratory QC component, will be analyzed and reported by the laboratory using the protocols in EPA Method 1668C because they are a critical part of the QC of the SPME absorption and extraction steps.

3.5.4.1 Definitions

Matrix Replicates (including Lab Duplicates)

Analytical replicates provide information on the precision of the analysis and are useful in assessing potential sample heterogeneity and matrix effects. Analytical replicates are subsamples of the original sample that are prepared and analyzed as a separate sample, assuming sufficient sample matrix is available.

Matrix Spikes and Matrix Spike Duplicates

The analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing duplicate MS analyses, information on the precision of the method is also provided for organic analyses. These are not necessary when using isotope dilution.

Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis.

Surrogate Spikes

All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values, except for PCB congener analysis. PCB congener analyses will be performed using isotope dilution methods, which does recovery correct the concentrations of the congeners.

Laboratory Control Samples

LCSs are analyzed as a measure of the accuracy of the analyses. LCS recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

3.5.5 Estimated MDLs/LOQs for PCB Congeners in Porewater Using SPME

A list of the PCB congeners that will be quantified by means of this method is provided in Table 3.5. In Table 3.8, expected MDLs/LODs are calculated for porewater using the SPME fibers for sample collection.

Lowest Achievable MDL in Porewater at Complete Equilibrium Exposure

The lowest possible MDL in porewater for the SPME experimental design proposed in this study can be calculated based on the following information: (1) the lowest mass of PCBs that the analytical instrument can detect (0.50 ng), the volume of the PDMS layer on the SPME fiber (34 µL for 480 cm of fiber in a composite), and the partitioning coefficient between seawater and the PDMS layer (from Smedes et al., 2009). This results in porewater concentrations between 0.4 and 58 pg/L, depending on congener.

Effective MDL in 4-week Exposure Study

The study proposed has only a 4-week exposure, which is not long enough for full equilibrium to be reached for all congeners; therefore, the effective MDLs in the shorter study will be lower. In the pilot study, measured responses of the PRCs will be used to track how close to equilibrium the study was able to reach and will be used to calculate actual MDLs. Since this information is not yet available, the percent to equilibrium from the recent work at Bremerton, Washington was used; their study design is very similar with respect to SPME exposures and PCBs congeners. When these rates are applied in Table 3.8, the effective MDLs for PCB congeners in porewater decreases to 2.7 to 66 pg/L, depending on the congener. Concentrations of octa-chlorinated biphenyls may be designated as “estimated” because these compounds may not reach at least 20% of steady state concentrations during the 4-week exposure time.

Comparison to Expected Baseline Conditions

To access whether the effective MDLs are sufficient for this study, the MDLs were compared first to likely existing porewater concentrations in the LDW near the test plots. The data used to estimate these concentrations are presented in QAPP Attachment B, which contains details on the SPME method development and its assumptions. Since there are no PCB congener results for porewater samples, they were estimated from sediment PCB congener results and default equilibrium partitioning coefficients for organic carbon. The resultant estimated porewater concentrations under current (baseline) conditions are shown in Table 3.8. In general, the MDLs are 5 to 100 times lower than the predicted baseline concentrations in porewater, indicating that the SPME fibers should be able to quantify PCB congeners in porewater under baseline conditions.

Comparison to Expected Study Conditions

Once the ENR layers (with and without AC) have been applied, the concentrations of PCBs in surface sediment will decrease to very low levels because the ENR substrate is not expected to have PCBs in its matrix. Over time, the ENR layers will interact with underlying sediment, porewater, newly deposited sediment, and the water column such that concentrations of PCBs in the layer will reach measureable concentrations. Rather than make a series of rough assumptions about when this would occur, a different question was asked: if the application of ENR (with or without AC) were to reduce estimated baseline porewater concentrations by a factor of 80 to 90% would the SPME method proposed in this study be able to detect the concentrations? The final columns in Table 3.8 indicate the effective MDLs will allow detections of PCBs and will support being able to measure an 85 to 95% reduction in porewater concentrations from the predicted baseline concentrations.

If baseline or Year 1 measurements indicate that a 4 week duration and amount of SPME fiber is not sufficient to approximate the MDLs on which Table 3.8 is based, a modification of the SPME method may be considered for subsequent monitoring events. If this occurs, this will be discussed with the Agencies at the time when the data are delivered to the Agencies.

3.6 Field Instrument/Equipment Testing, Inspection, and Maintenance

Field equipment will be inspected before each field event to ensure proper maintenance and operation. This includes, but is not limited to, grab sampling devices, core sampling devices, electrical tin snips, GPS units, and digital cameras.

The FC will be responsible for overseeing the testing, inspection, and maintenance of all field equipment. The laboratory PM will be responsible for ensuring that laboratory equipment testing, inspection, and maintenance requirements are met. The methods used in calibrating the analytical instrumentation are described in Section 3.7.

3.7 Laboratory Instrument/Equipment Calibration and Frequency

Laboratory instrument calibration will be conducted in accordance with the QC requirements identified in the manufacturers' instructions and the laboratory SOPs. General requirements are discussed the following subsections.

3.7.1 Laboratory Instruments

Calibration of all analytical instrumentation is required to ensure that the analytical system is operating correctly and functioning at the sensitivity required to meet the project objectives. Each instrument will be calibrated with standard solutions appropriate for the instrument and analytical method, in accordance with the method specified and at the QC frequency specified in the laboratory SOPs.

The calibration and maintenance history of the fixed laboratory instrumentation is an important aspect of the project's overall QA/QC program. As such, all initial and continuing calibration procedures will be implemented by trained personnel in accordance with the manufacturer's instructions and applicable EPA protocols to ensure the equipment is functioning within the tolerances established by the manufacturer and the method-specific analytical requirements.

3.7.2 Standard Solutions

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology, Environmental Resource Associates, National Research Council of Canada, or other documented, reliable, commercial sources. The accuracy of the standards will be verified by comparison with an independent standard. Laboratory QC standards are verified in a multitude of ways. Second-source calibration verifications are run (i.e., same standard, two different vendors) for calibrations. New working standard mixes (e.g., calibrations and spikes) are verified against the results of the original solution and must be within 10 percent. Newly purchased standards are verified against current data. Any impurities found in the standard will be documented.

The laboratories will maintain a written record of the supplier, lot number, purity/concentration, receipt/preparation date, preparer's name, method of preparation, expiration date, and all other pertinent information for all standards, standard solutions, and individual standard preparation logs.

Reagents will be examined for purity by subjecting an aliquot or subsample to the corresponding analytical method as well.

3.8 Inspection/Acceptance of Supplies and Consumables

The FC will be responsible for ensuring that all supplies necessary to conduct the sampling, including collecting, processing, and transporting samples, are available and in good working order at the beginning of the field work. The FC will monitor supplies and equipment throughout the sampling and replenish or replace them as necessary.

Likewise, the laboratory managers are responsible for ensuring that all supplies necessary to perform the analyses are available and uncontaminated, that equipment is in good working order and conforms to the QA protocols, and that the procedures, including the laboratory's QA plan are documented and followed.

3.9 Data Reduction

Data reduction is the process by which original data are converted or reduced to a specified format or unit to the facilitate analysis of the data. For example, a final analytical concentration may need to be calculated from a diluted sample result. Data reduction requires that all aspects of sample preparation that could affect the test result, such as sample volume analyzed or dilutions required, be taken into account in the final result. It is the laboratory analyst's responsibility to reduce the data, which are subjected to further review by the laboratory PM, the consultant team PM, the project QAO, and independent reviewers. The data will be generated in a form amenable to review and evaluation. Data reduction may be performed manually or electronically. If performed electronically, all software used must be demonstrated to produce accurate calculations that are free from unacceptable error.

3.9.1 Samples with Multiple Dilutions

During chemical analysis, samples are occasionally diluted after the initial analysis if the estimated concentration curve for one or more of the target analytes is above the calibration curve. In these instances, concentrations from the initial analysis will be identified as the "best result" for all target analytes other than the chemical that was originally above the calibration range. The "best result" for this qualified analyte will be taken from the diluted sample. The data validator may overrule this approach but, if so, must include an explanation in the data validation report. The results that are not used will be qualified as "R1," indicating that they have been rejected in favor of a more accurate value.

3.9.2 Summation and Normalization

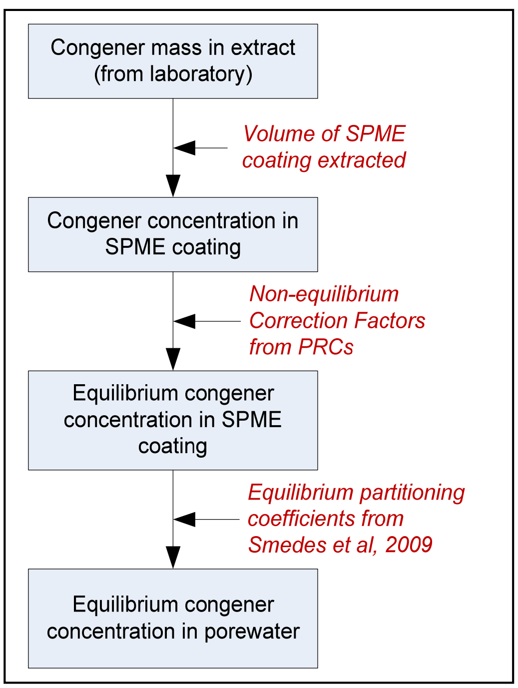
After third-party data validation, total PCBs will be calculated using only detected values for the 209 congeners. For individual samples in which none of the 209 congeners are detected, total PCBs will be given a value equal to the highest RL of the 209 congeners and assigned a U-qualifier, indicating the lack of detected concentration by the laboratory. Consistent with EPA Region 10 rules for data validation of PCB congeners, congeners that did not meet QA requirements and were reported as estimated maximum possible concentrations (qualified with either the K or EMPC qualifier), will be qualified as not detected ("U") not be included in the summation.

PCB concentrations will be reported as dry weight for sediment and as solution concentrations for porewater. Carbon normalization of the sediment data will be evaluated following the methods of the Washington State SMS, but may include modification to incorporate the following: samples from the ENR+AC subplots may have TOC contents higher than 4% due to the addition of GAC. For these samples the normal 4 percent cutoff used in Washington State is not appropriate and normalization will be performed at the higher TOC levels. Additionally, carbon normalization using the black carbon value, rather than the TOC, may yield results that are more predictive of porewater concentrations and bioavailability; therefore, normalization by black carbon content will also be evaluated.

3.9.3 Significant Figures

The laboratories report results with different numbers of significant figures, depending on the instrument, the parameter, and the concentration relative to the RL. The reported (or assessed) precision of each observation is explicitly stored in the project database as a record of the number of significant figures assigned by the laboratory. However, due to inherent field and laboratory variability, the data are rarely precise to more than plus or minus 20 percent. When a calculation involves addition, such as totaling PCBs, the calculation is only as precise as the least precise number that went into the calculation. For example (assuming two significant figures), 210 + 19 = 229. However, this would be reported as 230 because the number 19 is reported only to two significant figures, and the enhanced precision of the trailing zero in the number 210 is not significant.

When a calculation involves multiplication or division, such as the calculation used in carbon normalization, the original significant figures for each were carried through the calculation. That is, individual values will not be adjusted to a standard number of significant figures; instead, the appropriate adjustment will be made to the resultant value at the end of the calculation. The result will be rounded at the end of the calculation to reflect the value used in the calculation with the fewest significant figures. For example, 59.9 x 1.2 = 71.88 would be reported as 72 because there are two 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.

3.9.4 Sediment Porewater Data Reduction

When the PCB congener laboratory reports the "SPME" data they are reporting the concentration of the PCB congeners in the extract, not in the porewater. This is appropriate because the laboratory receives an "extract" not a porewater sample to analyze.

The conversion of the extract concentration to the porewater concentration is performed by the SPME Expert, Dr. Jason Conder, and reviewed as part of data validation by Cari Sayler. The following paragraphs describe how the conversion from extraction concentrations to porewater concentrations occurs. Attachment B, Passive Sampling Method

Development, contains additional detail on the congener distribution in the Lower Duwamish Waterway, on the reporting of PCB congener data, and on calculations used to convert SPME extract results into porewater results. It contains additional details not presented below that may be of interest to some readers.

The PCB congener laboratory reports the concentration of each PCB congener in the SPME extracts. By knowing the volume of the extract (100 microliters) and the radio-isotope labeled internal and recovery standards added to the extract, the laboratory calculates the mass of the PCB congener extracted from the fiber. This value is reported by the laboratory.

This mass of PCB congeners in the extract is converted to a porewater concentration in three major steps as shown below.

In Step 1, the measured mass of fiber present in the vial before hexane extraction and the manufacturer's information on coating thickness is used to calculate the volume of PDMS coating that was extracted. Dividing the mass of PCB congener extracted by the volume of the coating results in concentration of PCBs present in the PDMS (i.e., nanograms of PCBs per microliter of PDMS [ng PCBs/µL PDMS]).

In Step 2: The concentration in the coating is corrected for non-equilibrium concentrations using methods used by Tomaszewski and Luthy (2008), Oen et al. (2011), Lohmann (2012). Correction is necessary because the 4-week deployment is unlikely to be sufficient for the PDMS coating to reach steady-state equilibrium with the porewater for all congeners.

First, the concentrations of PRCs in the PDMS coating of the SPME fibers will be used to calculate elimination rate constants for each PRC (PRC k_es) using the following equation (Lohmann, 2012):

$$PRC\ \ k_e = \ln\left(\frac{[PDMS_{\ t=0}]}{[PDMS_{\ t=28}]}\right) \div 28\ days$$

where:

$PDMS_{t\,=\,28}$ = the concentration of the PRC in the PDMS after the 28-day field deployment (obtained from the SPME sampler exposed in situ for 28 days), and

$PDMS_{t\,=\,0}$ = the average concentration of the PRC in the PDMS at the beginning of the field exposure (obtained from measurement of the trip blanks)

k_es for each of the PCB analyte congeners[2] (non-PRCs) detected in the field-deployed SPME samplers will be calculated from a linear regression model of the sampler-specific PRC k_es versus PDMS-solution partition coefficients (both values Log_{10}-transformed, per Tomaszewski and Luthy, 2008).

As a default, predicted k_es less than 0.008 d^{-1} will result in analytical results that will be flagged as "estimated" (J-qualified) due to analytical limitations (PDMS did not come to sufficient equilibrium with porewater). For example, k_es less than 0.008 d^{-1} indicate the concentration of the PRC at the end of the 28-day deployment period was 80 percent (or greater) of the initial (pre-deployment) concentration. Because the two analytical results are only 20 percent different (or less), the two measurements may be within the range of measurement variability for PCB quantification and, therefore, may not be truly different. In these cases, the results fail to indicate any measurable loss of PRCs from the SPME PDMS during the 28-day deployment and/or a possible overestimation of the steady-state equilibrium concentrations of non-PRC PCBs due to analytical variability. This criterion may be adjusted based on a statistical evaluation of actual measurement variability in PRC results during the study. For example, if PRC analytical variability is sufficiently precise as to suggest that measurements with differences of 10% are likely distinct, a k_e criterion value of 0.004 d^{-1} may be applied.

Sampling rate correction factors (CFs) for each PCB in the composited sample will be calculated via the following equation, adapted from Lohmann (2012):

$$CF = \frac{1}{1 - e^{-k_e \times 28\ days}}$$

CFs will be multiplied by the concentration of PCB congeners in the PDMS of each SPME composite to determine the steady-state concentration of PCBs present in the PDMS coating of the SPME fibers (i.e., ng PCBs/L PDMS).

In Step 3: the steady-state concentrations of PCBs in the PDMS coating of the SPME fibers will be divided by PCB congener-specific PDMS-solution partition coefficients (Smedes et al., 2009) to provide a concentration of dissolved PCBs in sediment porewater (e.g., picograms (pg) of

2 The term used here "analyte congeners" refers to all of the other congeners that were not used as PRC and can therefore be quantified in porewater. The PRC used for this study are specific PCB congeners that are rarely found in sediment and tissue, including those in Puget Sound. These are identified in QAPP Attachment B. Once they are used as PRCs, their concentrations are controlled by the spiked concentration.

dissolved PCBs/L porewater). At this stage, the PCB congener results for each SPME composite are now expressed as PCB congener porewater concentrations in contact with the SPME fibers.

The concentrations of dissolved tri-, tetra-, penta-, hexa-, hepta-, and octa-chlorinated biphenyls will be summed to estimate total dissolved PCBs in sediment porewater. The tri- to octa-chlorinated biphenyls include 99.7 percent of the bioavailable PCB congeners detected in tissue samples obtained from the LDW (QAPP Attachment B). Quantification of mono-, di-, nona-, and deca-chlorinated biphenyls is not practical with the SPME method that will be applied in this pilot study due to the low accumulation rates for these congeners. As noted in the QAPP Attachment B quantification of dissolved octa-chlorinated biphenyls in sediment porewater may be reported as "estimated" (J-qualified) values due to the low proportion of steady state obtained in the sampling time (i.e., the absorption of octa-chlorinated biphenyls and desorption of the octa-chlorinated PRC during the allotted sampling period may be too minimal to be reliably measured). Octa-chlorinated biphenyls are estimated to represent only 0.03 percent of the total available PCB homologs in porewater within the plot areas; therefore, the effect of including or excluding octa-chlorinated biphenyl in the summation of dissolved PCBs in sediment porewater will be minimal and within the range of standard analytical measurement variation.

3.10 DATA AND RECORDS MANAGEMENT

This section discusses data recording and data management.

3.10.1 Field Observations and Measurements

Field activities will be recorded in a field logbook maintained by the FC. The field logbook will provide a description of all sampling activities, conferences associated with field sampling activities, sampling personnel, and weather conditions, plus a record of all modifications to the procedures and plans identified in this QAPP. The field logbook will consist of bound, numbered pages. All entries will be made in indelible ink. The field logbook is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

In addition to the field logbook, many of the field steps used specific forms for that collecting field information. These were discussed in Section 3.2 and representative forms are included in QAPP Attachment A.

Complete copies of the completed field forms, including the chain-of-custody forms, and all completed pages of the field logbook will be maintained at AMEC Foster Wheeler offices (as the Prime for the project team) for 10 years.

3.10.2 Photographs (including SPI)

Photographs will be assigned a unique identifier using procedures similar to those for the sediment samples and SPME fibers. They will be logged into the photograph log, with the date, time, and location (DGPS, verbal description, or sample station ID and replicate, depending on the purpose and type of the photograph), as well as a brief description of the intent or subject of the photograph.

An accurate and complete set of the photographs and associated logs will be maintained at AMEC Foster Wheeler offices (as the Prime for the project team) for 10 years.

3.10.3 Laboratory Records Retention and Management

A full record of laboratory analyses of samples for this project will be maintained and available for review for ten years from the time of analysis of the samples. The records must document no only the analyses of the samples, but the QA systems that support them. Information for each of the laboratories are given below.

3.10.3.1 Frontier Analytical

Frontier Analytical retains records of all raw data, derived data, test reports, logbook sheets, certificates, calibration and maintenance records for at least 5 years. After 5 years, hardcopy documents will be destroyed unless specifically requested by a client. A permanent record will be maintained on their server and a portable USB drive. Their record keeping system is described in Section 5.0 of their Quality Systems Manual, last revised on December 12, 2014. This document, along with laboratory standard operating procedures and related components of their QA system are available for review.

3.10.3.2 Alpha Analytical

Alpha Analytical has a record system that produces accurate records, which document all laboratory activities. The laboratory retains records of all original observations, calculations and derived data, calibration records and a copy of the test for ten years minimum. Their record keeping system is described in Section 12 of their Quality Systems Manual, last revised on April 1, 2015. This document, along with laboratory standard operating procedures and related components of their QA system are available for review.

3.10.3.3 Ramboll Environ Laboratory for Sample Preparation

Archived information and access logs are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources. All electronic records are backed-up daily (onsite) and weekly (offsite storage). Access to protected records is limited to laboratory management or their designees to prevent unauthorized access or amendment. Records are disposed according to applicable regulation, client request, or after five years. For this project, the SPME processing records will be transferred AMEC Foster Wheeler as part of the "field" records for the project.

3.10.3.4 Ramboll Environ Laboratory for Benthic Macroinvertebrate Analysis

Archived information and access logs are protected against fire, theft, loss, environmental deterioration, vermin, and in the case of electronic records, electronic or magnetic sources. All electronic records are backed-up daily (onsite) and weekly (offsite storage). Access to protected records is limited to laboratory management or their designees to prevent unauthorized access or amendment. Records are disposed according to applicable regulation, client request, or after five years. For this project, the contract with the laboratory will require that records be retained for 10 years.

4.0 SAMPLE HANDLING AND CUSTODY DOCUMENTATION

This section discusses sample handling and chain of custody documentation, including sample nomenclature; sample chain of custody; sample preservation, handling, and transport; and sample receipt procedures.

4.1 SAMPLE NOMENCLATURE

Sample nomenclature is defined for the SPME porewater samples, the surface sediment cores, and the benthic macroinvertebrate samples.

4.1.1 SPME Porewater and Surface Sediment Samples

Each sample will be assigned a unique alphanumeric ID number that will consist of seven to nine components identifying various aspects of the sample, with each component separated by a hyphen ("-"). The hyphen will allow for ease in electronic data entry from the field forms into the database.

The sample ID components are summarized in Table 4.1.

Table 4.1 SPME Porewater, SPI, and Surface Sediment Sample ID Components

Order	Component	Definition
1st	Project area	"LDW" = Lower Duwamish Waterway
2nd	Monitoring event	"BA" = baseline "Y0" = Year 0 after layer placement "Y1" = Year 1 (one year after placement) "Y2" = Year 2 (two years after placement) "Y3" = Year 3 (three years after placement)
3rd	Plot type	"SU" = subtidal plot "SC" = scour plot "IN" = intertidal plot
4th	Subplot	"ENR" = enhanced natural recovery only "ENR+AC" = enhanced natural recovery with activated carbon
5th	Grid cell number	A single number between 0 and 6: "0" = composite "1" to "6" = indicates a un-composited sample collected from the grid cell indicated by the number
6th	Location or composite number	If the sample is a composite, this is a two-character code for the composite number: "CA," "CB," or "CC." If the sample is a grab sample, this is the location (generally between 1 and 30) within the grid cell from which the sample was collected.
7th	Sample medium	"CORE" = short sediment core tube (used for chain of custody between sampler and compositing) "S010" = SPME fibers in envelopes and vials collected from 0 to 10 cm (used for chain of custody between sampler and preparation laboratory) "SSWI" = SPME fibers in envelopes and vials collected from the surface water interface (0 to 1 cm) (used for chain of custody between sampler and preparation laboratory) "SS" = surface sediment to be analyzed for conventionals or PCB congeners (used for samples to be sent to analytical laboratories) "SPI" = Sediment Profile Imagery
8th (as needed)	Collocated sample	Single-digit numbers from 1 to 5, if needed to ensure that enough volume is available for analysis, collocated cores or SPME envelopes may be collected.
9th (as needed)	Field QC sample	"FD" = field duplicate (TOC and BC) "TB" = trip blank (SPME) "R1" to "R5" = field replicates for BC in Year 0

Abbreviations:

BC Black carbon
SPME Solid-phase microextraction
TOC Total organic carbon

The first component of the sample ID will represent the LDW project area ("LDW"). The second component will represent the monitoring event. The third through sixth components will represent the location (plot and subplot) and the type of sample (grab, core, or composite). The seventh component will represent the sample medium. The field sample collector (dive team) will use

"SPME" and "CORE" on the sample collection forms, as discussed in Section 3.3. The sample preparation team will then use the "CORE" surface sediment samples to prepare the surface sediment composites ("SS") in the field for placement in the jars and shipment to the analytical laboratories. Likewise, the "SPME" fibers will be composited and extracted, and the extract will be shipped to the analytical laboratories as porewater ("PW").

The last two ID components will be needed only under certain conditions. The eighth component will allow the collection of collocated sediment cores or SPME fibers to increase the sample volume, and the ninth component will represent the field QC samples.

The sediment core tubes will also be marked with electrical tape to indicate the top of the core (see Section 3.3 for details).

Attachment A, which contains the field forms, includes a table with several examples of the naming protocols to help clarify how they are to be used.

4.1.2 Benthic Macroinvertebrate Community Survey

Each sample will be assigned a unique alphanumeric ID number will consist of six components identifying various aspects of the sample, with each component separated by a hyphen ("-"). The hyphen will allow for ease in electronic data entry from the field forms into the database.

The sample ID components are summarized in Table 4.2, and follow the same general approach as that used for the sediment and porewater samples. The first component of the sample ID will represent the LDW project area ("LDW"). The second component will represent the monitoring event. The third through five components will represent the location, and the sixth component represents the sample medium.

Table 4.2 Benthic Macroinvertebrate Survey Sample ID Components

Order	Component	Definition
1st	Project area	"LDW" = Lower Duwamish Waterway
2nd	Monitoring event	"Y3" = Year 3 (three years after placement)
3rd	Plot type	"SU" = subtidal plot "SC" = scour plot "IN" = intertidal plot
4th	Subplot	"ENR" = enhanced natural recovery only "ENR+AC" = enhanced natural recovery with activated carbon
5th	Location number	A single-digit number between 0 and 5 that corresponds to a location on Figures 3.1 through 3.3
6th	Medium	"BEN" = benthic macroinvertebrate survey

4.2 SAMPLE CHAIN-OF-CUSTODY

Samples will be collected, handled, and shipped in accordance with COC procedures. These procedures document the transfer of the custody of samples from the point of collection in the field to the laboratory. Samples are considered to be in custody if they are (1) in the custodian's possession or view, (2) retained in a secured place (under lock) with restricted access, or (3) placed in a container and secured with an official seal or seals such that the sample cannot be reached without breaking the seal(s). Custody procedures will be used for all samples throughout the collection, transport, and analyses, and for all data and data documentation whether in hard copy or electronic format.

Each sample sent to the laboratory for analysis will be recorded on a COC form, which will include instructions to the laboratory for analytical services and special turnaround times. The COC form will be a triplicate carbon copy form. The form will include, at a minimum, the following information:

- Project name
- Unique sample identifier
- Sampling location
- Collection date and time
- Collector name and initials
- Date sent to the laboratory
- Number of sample containers
- Sample matrix
- Analyses required
- Remarks, including preservatives, special conditions, or specific QC measures
- Turnaround time and person to receive laboratory report
- Release signature of sampler(s) and signatures of all people assuming custody
- Condition of samples, including temperature, when received by laboratory
- Shipping company and waybill number

Each person who has custody of the samples will sign the COC form and ensure that the samples are not left unattended unless properly secured. The time and date at the time of custody transfer to the laboratory or shipping will be noted on the forms. The original COC form will accompany the sample containers to the analytical laboratory. The shipping company (e.g., Federal Express or UPS) will not sign the COC forms as a receiver; instead the laboratory will sign as a receiver when the samples are received. A duplicate copy of the COC form will be retained for the project records and included as appendices to QA/QC reports and data reports. The COC form will be sealed inside a plastic sealable bag within the ice chest, and the chest will be sealed with custody tape that has been signed and dated by the last person listed on the COC form. Blank spaces on the COC form will be crossed out and initialed by the sampler between the last sample listed and the signatures at the bottom of the form.

The FC will be responsible for all sample tracking and custody procedures for samples in the field. The FC will be responsible for final sample inventory and will maintain sample custody documentation. The FC will also complete the COC forms before removing the samples from the sampling area. At the end of each day, and before transfer, COC entries will be made for all samples. The information on the labels will be checked against the sample log entries and the sample tracking forms, and a final sample jar count made before sealing the cooler for transport. The FC will ensure that the laboratory has accepted delivery of the shipment at the specified time.

Upon receipt of the samples, the laboratories will ensure that the COC forms have been properly signed and will note questions or observations concerning the sample integrity on the COC forms. The laboratories will contact the FC and QAO immediately if a discrepancy between the COC form and the sample shipment is discovered upon receipt of the samples.

The laboratory will ensure that a sample-tracking record follows each sample through all stages of laboratory processing. The sample-tracking record must contain, at a minimum, the name/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analysis, and the types of analyses performed.

4.3 Sample Preservation, Handling, and Transport

Sample preservation, handling, and transport includes discussion of surface sediment core samples for bulk PCB analysis, SPME samples for porewater PCB analyses, and benthic macroinvertebrate samples.

4.3.1 Surface Sediment Composites

Samples will be placed in pre-cleaned, laboratory-provided 8-oz wide-mouth amber glass jars leaving a minimum of approximately 1 centimeter of headspace to prevent breakage during shipping and storage. The sample containers will be stored cool (not frozen) in a refrigerator or cooler with ice at less than or equal to 4°C until received by the laboratory.

Samples jars must be appropriately labelled with waterproof, self-adhering labels. Each sample label will contain the project number, sample identification (Section 4.1), preservation technique, analyses, date, and time of collection, and initials of the person(s) filling the sample jar. A completed sample label will be affixed to each sample container. The labels will be covered with clear tape immediately after their completion to protect them from stains or deterioration due to water and sediment.

Samples will be shipped in accordance with state and federal regulations as well as U.S. Department of Transportation (DOT) standards. They must be packed securely for shipment, according to the following guidelines:

- Using duct tape, secure the outside and inside the drain plug at the bottom of the cooler that is used for sample transport.
- Place 1 to 2 inches of bubble wrap or other cushioning material at the bottom of the cooler.
- Individually wrap each sample jar in bubble wrap or other cushioning material and place securely in the cooler.
- Place ice on top of and in between sample containers. Package wet ice in sealable plastic bags. When packing ice, leave space for the addition of sufficient cushioning material.
- Fill the remaining space in the cooler with cushioning material.
- Close the cooler Place the completed COC forms in a sealable plastic bag and tape the forms to the inside of the cooler lid.
- lid and fasten with duct tape.
- Wrap duct tape around both ends of the cooler at least twice.
- Mark the cooler on the outside with the following information: return address, “Fragile” labels on the top and on one side, and arrows indicating “This Side Up” on two adjacent sides.
- Include temperature blanks as applicable.

Environmental samples will be shipped via an express carrier, overnight or within 24 hours, to ensure that the samples are retained at the appropriate temperature. If samples are unable to be shipped daily, samples will be held in the dark at 4°C ±2°C prior to shipping.

4.3.2 SPME Extracts for PCB Analysis

The transport of SPME fibers from the field to the extraction laboratory is discussed in Section 3.3. This section discusses the shipment of the extracts to the analytical laboratory for PCB congener analysis.

The 2 mL vials with fibers and 1.8 mL of hexane will be wrapped in bubble wrap and shipped in a cooler containing double-bagged wet ice at 4°C with sufficient cushioning material. The samples will be shipped in accordance with state and federal regulations as well as DOT standards using the same procedures as those for the sediment samples.

4.3.3 Benthic Macroinvertebrate Survey Grab Samples

Benthic macroinvertebrate samples will be preserved in 10 percent buffered formalin solution. Samples will be maintained at ambient air temperatures once preserved in formalin solution.

Samples will be appropriately labelled with waterproof, self-adhering labels. A completed sample label will be affixed to each sample container. The labels will be covered with clear tape immediately after their completion to protect them from stains or deterioration due to water and sediment. An internal sample label made of waterproof paper will also be placed in each sample container. This internal label will be used by the taxonomic laboratory to identify samples in addition to the external label on the sample container.

Samples will be packed securely for transport by field personnel or a courier. Samples will be individually wrapped in bubble wrap or other cushioning material and placed securely in the cooler. The completed COC forms will be placed in a sealable plastic bag and taped to the inside of the cooler lid. The lid should be tightly sealed.

4.4 Sample Receipt

Upon arrival at the laboratory, the samples will be logged into the inventory system, and the sample numbers will be verified with the COC form. Any discrepancies will be resolved at this point. In most cases, when samples are sent to a testing laboratory, an Acknowledgment of Sample Receipt form is faxed to the project QAO the day the samples are received by the laboratory. The person receiving this form is responsible for reviewing it, making sure that the laboratory has received all the samples that were sent, and verifying that the correct analyses were requested. If an error is found, the QAO will call the laboratory immediately and document any decisions made during the telephone conversation, in writing, on the Acknowledgment of Sample Receipt form. In addition, the COC form will be corrected as needed and faxed to the laboratory to document the decisions made.

The Acknowledgment of Sample Receipt and COC forms, including any modifications, become part of the project documents as discussed in Section 6.1.

5.0 ASSESSMENT AND OVERSIGHT

EPA, Ecology, or their designees may observe field activities during each sampling event, as needed. If situations arise in which there is an inability to follow the QAPP methods, the PM will determine the appropriate actions and/or consult EPA and Ecology if the issue is significant.

5.1 COMPLIANCE ASSESSMENTS

Laboratory and field performance assessments consist of on-site reviews conducted by EPA or Ecology of QA systems and equipment for sampling, calibration, and measurement. EPA or Ecology personnel may conduct a laboratory audit before sample analysis. Pertinent laboratory audit reports will be made available to the project QAO. Analytical laboratories are required to have written procedures addressing internal QA/QC; these procedures will be submitted for review by the QAO to ensure compliance with the QAPP. All laboratories and the QAO are required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

5.2 RESPONSE ACTIONS FOR FIELD SAMPLING

The FC, or a designee, will be responsible for correcting equipment malfunctions throughout the duration of field sampling and for resolving situations in the field that may result in nonconformance or noncompliance with this QAPP. All corrective measures will be immediately documented in the field logbook, and protocol modification forms will be completed.

5.3 CORRECTIVE ACTION FOR LABORATORY ANALYSES

Analytical laboratories are required to comply with the SOPs previously submitted to the QAO. Laboratory SOPs that implement EPA Methods are required to be consistent with the EPA Methods. The laboratory PMs will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP, their internal QA program, their SOPs, and the EPA Method (where appropriate). All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data.

The QAO will be notified immediately if any QC sample exceeds the project-specified data quality indicators (Tables 3.4 through 3.7). The analyst will identify and correct the anomaly before continuing with the sample analysis. The laboratory PM will document the corrective action taken in a memorandum that will be submitted to the QAO within 5 days of the initial notification. A narrative describing the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, or re-extraction) will be submitted by the QAO with the data package using the protocol modification form.

5.4 Reports to Management

After each monitoring event, the FC will prepare a summary documenting the sample coordinates and whether any QAPP deviations occurred in the field. When the analyses have been completed, the QAO will also prepare a summary documenting any laboratory deviations.

5.5 Data Validation

The data validation process begins within the laboratory with the review and evaluation of data by supervisory personnel or QA specialists. The laboratory analyst is responsible for ensuring that the analytical data are correct and complete, that appropriate procedures have been followed, and that QC results are within the acceptable limits. The laboratory performs an initial qualification of the data, applying laboratory qualifiers.

Data are not considered final until validated. Data validation will be conducted following EPA National and Region 10 guidance (U.S. EPA 1995, 2008, 2010, 2011, 2014a and 2014b). This review will be performed in accordance with the QA requirements of the project and the technical specifications of the analytical methods indicated in Table 3.4 through 3.7. The EPA PM may have EPA peer review the third-party validation or perform data assessment/validation on a percentage of the data.

The QAO is responsible for checking to see that all analyses performed by the laboratories are correct, properly documented, and complete, and that they comply with the project QAGs specified in this QAPP to the extent possible, and that deviations are identified and documented.

Independent third-party data validation will be conducted by Cari Sayler of Sayler Data Solutions, including the following based on levels defined in EPA's Guidance for Labelling Externally Validated Laboratory Analytical Data for Superfund Use (EPA 2009):

6. Data review and compliance screening (Stage 2a) validation of TOC, black carbon, and grain size for all sediment samples, and TOC, black carbon, grain size, and benthic SMS constituents for the ENR fill materials.
7. PCB congeners by EPA Method 1668C in sediment and porewater extracts will be validated using Stage 4 validation. The calculations checks will focus on the dioxin-like PCBs congeners and 10 of the most commonly detected PCBs congeners. These

calculations will include representative congeners that are quantified using isotope dilution as well as those quantified using internal standards.

8. A calculation verification check on the conversion of SPME extracts to porewater concentrations using PRCs (see Section 3.9.4).

Taxonomic identification for benthic samples will be conducted by Ramboll Environ. At least one specimen for each species identified will be placed in a vial with 70 percent ethanol for outside validation. Once all of the organisms from all of the samples have been identified, the library of specimens will be verified by Biological Environmental Services of Victoria, British Columbia, Canada, and other outside taxonomists from British Columbia, Alaska, Washington, Oregon, and California.

5.6 Data Usability Statement

The data usability assessment considers four questions:

1. Are the data from a known source with adequate documentation to evaluate their relevance and quality?
2. Are the analytical methods and detection limits sensitive and selective enough for the data to be usable for their intended purpose?
3. Were the QAGs met, and if not, can the error or bias be quantified sufficiently for the data to still be usable?
4. Does a review of the data collection and laboratory analyses steps, including any reports to the QAO, indicate that the data are not representative of the conditions that were intended to be measured?

The purpose of this QAPP is to collect data that satisfy the first two requirements. The data validation step is intended to identify any issues that need to be considered for the third question. The consistent use of field forms by qualified and experienced staff is intended to address the last question. At the end of each field event, a short usability evaluation will be performed and included in the data report, as specified in Section 6.0. Special consideration will be given to rejected data, if any, and their consequences; to whether estimated data have a known bias and their potential consequence; and to whether field conditions indicate that the data are not representative of the conditions intended to be tested. The last condition may occur if significant sedimentation occurs at one of the pilot plots and covers the ENR layer.

5.7 RECONCILIATION WITH DATA QUALITY OBJECTIVES

A meaningful usability assessment is based on an understanding of the DQOs of the study; therefore, the usability assessment will consider the DQOs defined in Section 1.2.

6.0 REPORTING AND RECORD RETENTION

6.1 DATA SUBMITTALS AND MONITORING REPORTS

Reporting associated with this pilot study will evaluate the performance of ENR+AC compared to ENR alone in locations with a range of PCB concentrations and under three conditions representative of the waterway (i.e., intertidal, subtidal, and scour).

Validated sampling data will be provided to EPA and Ecology within 75 days after the completion of each sampling event (90 days after the Year 3 event). The validated sampling data will be provided in two formats: (1) printed compilation and (2) LWDG database format. The LDWG database format will contain the sample coordinates cross referenced against the sample location and sample IDs. The data report will include a short description of the event, a tabulated analytical schedule for the event, and a tabulated definition of data qualifiers (which is consistent across all events, but may vary by analysis type).

Two monitoring reports will be prepared; one after the Year 1 event and the other after the Year 3 event, consistent with the reporting requirements from the Order Amendment. The monitoring reports will be submitted to EPA and Ecology initially in draft form for their review. The reports will be revised and finalized and approved according to the following schedule:

Year 1 draft monitoring report	Submitted 90 days after data validation of the Year 1 monitoring event.
Year 1 final monitoring report	Submitted 30 days from the receipt of EPA/Ecology comments.
Year 3 draft monitoring report	Submitted 90 days after data validation of the Year 3 monitoring event.
Year 3 final monitoring report	Submitted 30 days from the receipt of EPA/Ecology comments.

The Year 1 monitoring report will include the baseline data, the construction completion details, the Year 0 results immediately after construction, and the Year 1 monitoring results. The focus of the report will be on the placement of the ENR layers, their stability, and their impact on PCB bioavailability, as measured by PCB concentrations in porewater.

The Year 3 monitoring report will include the results from the Year 2 and Year 3 monitoring events and will focus on longer term assessments of ENR layer stability and PCB bioavailability and on any potential impacts of AC on the benthic communities.

6.2 RECORD MAINTENANCE AND STORAGE

All documents relating to the project will be controlled to ensure proper distribution, filing, and retrieval.

Project records will be stored and maintained by LDWG. The task manager and office staff are responsible for organizing, storing, and cataloging all project information and for collecting records and supporting data from project team members. Once project records have been catalogued, LDWG will ensure that they are appropriately filed by category in the correct project file. Filed documents will be available to LDWG staff through the checkout procedures developed to ensure the integrity of the project file. Individual project team members may maintain separate files or notebooks for individual tasks. These files or notebooks will be transferred to the task manager as part of project closeout. The archived files will be stored and maintained by LDWG.

Field sampling forms and logs, daily field notes, laboratory deliverables, laboratory electronic deliverables, the chemical database, the calculation spreadsheets, and an abbreviated data dictionary will be placed saved on DVDs for long-term storage as readable, searchable Adobe Acrobat files. They will be maintained by AMEC Foster Wheeler.

7.0 REFERENCES

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

Aller, R.C. 1982. The effects of macrobenthos on chemical properties of marine sediments and overlying water. In: McCall, P.L., and Tevesz, M.J.S. (Eds.), Animal–Sediment Relations. Plenum Press, New York, pp. 53–102

ASTM. 2001. Standard practice for classification of soils for engineering purposes (unified soil classification system). D-2487-00. ASTM annual book of standards. Vol 04.08. American Society for Testing and Materials, Consohocken, PA.

Conder, J.M., La Point, T.W., Lotufo, G.R., and Steevens, J.A. 2003. Nondestructive, minimal-disturbance, direct-burial solid phase microextraction fiber technique for measuring TNT in sediment. Environ. Sci. Technol. 37:1625-1632.

Conder et al. 2013. Interim Report – Project ER-201131. Short-Term Performance of an Activated Carbon Amendment to Reduce PCB Bioavailability at an Active Naval Shipyard. August 2014. Submitted to Environmental Security Technology Certification Program.

Conder, J.M., Grover, M., Rosen, G., Kirtay, V., Chadwick, D.B., and Magar, V.M. 2015. Evaluation of PCBs Availability in Sediment after Application of an Activated Carbon Amendment at an Active Naval Shipyard. Battelle Eighth International Conference on Remediation of Contaminated Sediments, New Orleans, LA. January.

Ecology. 2008. Guidance on the Development of Sediment Sampling and Analysis Plans Meeting the Requirements of the Sediment Management Standards (Chapter 173-204 WAC). Ecology Publication No. 03-09-043. February. Sediment Sampling and Analysis Plan Appendix.

Gustafsson, Ö., Haghseta, F., Chan, C., MacFarlane, J., and Gschwend, P.M. 1997. Quantification of the dilute sedimentary soot phase: Implications for PAH speciation and bioavailability. Environ. Sci. Technol. 31: 203-209.

Harwood, A.D., Landrum, P.F., and Lydy, M.J. 2012. A comparison of exposure methods for SPME-based bioavailability estimates. Chemosphere 86: 506-511.

LDWG. 2014. Candidate plot locations for enhanced natural recovery-activated carbon pilot study. Lower Duwamish Waterway Group, Seattle, WA.

Lohmann, R. 2012. Critical review of low-density polyethylene's partitioning and diffusion coefficients for trace organic contaminants and implications for its use as a passive sampler. Environ. Sci. Technol.: 46:606-618.

Lu, X., Skwarski, A., Drake, B., and Reible, D.D. 2011. Predicting bioavailability of PAHs and PCBs with porewater concentrations measured by solid-phase microextraction fibers. Environ. Toxicol. Chem. 30: 1109-1116.

Oen, A.M.P., Janssen, E.M.L., Cornelissen, G., Breedveld, G.D., Eek, E., and Luthy, R.G. 2011. In situ measurement of PCB pore water concentration profiles in activated carbon-amended sediment using passive samplers. Environ. Sci. Technol. 45: 4053-4059.

Pearson, T.H., and Rosenburg, R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr Mar Biol Annu Rev 16:229-311.

PSEP. 1986. Recommended protocols for measuring conventional sediment variables in Puget Sound. Prepared for the Puget Sound Estuary Program, US Environmental Protection Agency, Region 10. Tetra Tech, Seattle, WA.

PSEP. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound. Prepared for the Puget Sound Estuary Program, US Environmental Protection Agency, Region 10. King County (METRO) Environmental Laboratory, Seattle, WA.

PSWQAT. 1997. Recommended quality assurance and quality control guidelines for the collection of environmental data in Puget Sound. Prepared for U.S. Environmental Protection Agency Region 10. Puget Sound Water Quality Action Team, Olympia, WA.

Rhoads, D.C., and Germano, J.D. 1986. Interpreting long-term changes in benthic community structure: a new protocol. Hydrobiologia 142:291-308.

Smedes, P., Geerstma, R. W., van der Zande, T., and Booij, K. 2009. Polymer-water partition coefficients of hydrophobic compounds for passive sampling: Application of cosolvent models for validation. Environ. Sci. Technol. 43:7047-7054.

Tomaszewski, J.E., and Luthy, R.G. 2008. Field deployment of polyethylene devices to measure PCB concentrations in pore water of contaminated sediment. Environ. Sci. Technol. 42:6086-6091.

USEPA. Ecology. 2000. Administrative Order on Consent for Remedial Investigation/Feasibility Study, Lower Duwamish Waterway; Port of Seattle, King County, City of Seattle, The Boeing Company, respondents. US EPA docket no. CERCLA-10-2001-0055; Ecology docket no. 00TCPNR-1895. US Environmental Protection Agency, Region 10, Seattle, WA; State of Washington Department of Ecology, Olympia, WA.

USEPA. Ecology. 2014. Second Amendment to the Administrative Order on Consent for remedial investigation/feasibility study (AOC) for the Lower Duwamish Waterway (LDW), CERCLA-10-2001-0055. US Environmental Protection Agency, Region 10, Seattle, WA; State of Washington Department of Ecology, Olympia, WA.

USEPA. (U.S. Environmental Protection Agency). 1995. Region 10 SOP For the Validation of Method 1668 Toxic, Dioxin-like, PCB Data EPA Region EPA Region 10, Environmental Services Division, 1200 Sixth Avenue Seattle, WA 98101, Revision 1.0, December 8.

USEPA. 2002. Guidance for quality assurance project plans. QA/G-5. EPA/240/R-02/009. Office of Environmental Information, US Environmental Protection Agency, Washington, DC.

USEPA. 2004. Region III Interim Guidelines for the Validation of Data Generated Using Method 1668 PCB Congener Data EPA Region III Quality Assurance Team Environmental Science Center Ft. Meade, MD Revision 0, April 21.

USEPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4. EPA/240/B-06/001. February 2006.

USEPA. 2008. USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (SOM01.2). OSWER 9240.1-48; EPA-540-R-08-01. Office of Superfund Remediation and Technology Innovation. June 2008

USEPA. 2009. Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use. OSWER No 9200.1-85, EPA 540-R-08-005, 13 Jan 2009.

USEPA. 2010. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (ISM01.2). OSWER 9240.1-51; EPA 540-R-10-011. Office of Superfund Remediation and Technology Innovation. January 2010.

USEPA. 2010. Method 1668C, Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS, April 2010, U.S. Environmental Protection Agency, Office of Water Office of Science and Technology, Engineering and Analysis Division (4303T) 1200 Pennsylvania Avenue, NW Washington, DC 20460. EPA-820-R-10-005.

USEPA. 2011. USEPA Contract Laboratory Program (CLP) National Functional Guidelines for Chlorinated Dibenzo-p-Dioxin (CDDs) and Chlorinated Dibenzofurans (CDFs) Data Review. OSWER 9240.1-53; EPA-540-R-11-016. Office of Superfund Remediation and Technology Innovation. September 2011.

USEPA. 2014a. National Functional Guidelines for Superfund Organic Methods Data Review (SOM02.2). OSWER 9355.0-132; EPA 540-R-014-002. Office of Superfund Remediation and Technology Innovation. August 2014.

USEPA. 2014b. National Functional Guidelines for Inorganic Superfund Data Review (ISM02.2). OSWER 9355.0-131; EPA 540-R-013-001. Office of Superfund Remediation and Technology Innovation. August 2014.

Windward (Windward Environmental, LLC). 2010. Final Lower Duwamish Waterway Remedial Investigation Report. Prepared for Lower Duwamish Waterway Group. Windward, Seattle, WA.

Yang, Z., Maruya, K.A., Greenstein, D., Tsukada, D., and Zeng, E.Y. 2008. Experimental verification of a model describing solid phase microextraction (SPME) of freely dissolved organic pollutants in sediment porewater. Chemosphere 72: 1435-1440.

You, J., Pehkonen, S., Landrum, P.F., and Lydy, M.J. 2007. Desorption of hydrophobic compounds from laboratory-spiked sediments measured by Tenax absorbent and matrix solid-phase microextraction. Environ. Sci. Technol. 41: 5672-5678.

TABLES

Table 3.1
Subplot Analytical Schedule and DQOs by Monitoring Event and Subplot

Analytical Schedule by Event (Counts per Subplot)								
		Surface Sediment Cores			Porewater			Benthic Survey
					PCB Congeners by SPME			
Events	Sediment Profile Image Locations	Physical Description[1]	PCB Congeners[2]	TOC, BC, and GS[3]	0 to 10 cm	0 to 1 cm	Salinity by Probe	Benthic Counts
Baseline[4]	6 ("A" locations)	18	3 composites	3 composites	3-5 composites[6]		18[9]	
Year 0	12 ("A" and "B" locations)	18		9 grab samples[5]				
Year 1	12 ("A" and "B" locations)	18	3 composites	3 composites	3 composites[7]		18[9]	
Year 2	12 ("A" and "B" locations)	18	3 composites	3 composites	3 composites[7]	3 composites[8]	18[9]	
Year 3	12 ("A" and "B" locations)	18	3 composites	3 composites	3 composites[7]	3 composites[8]	18[9]	5 grab samples
DQOs Addressed in Each Event by Data Collected								
Baseline		1 & 2	3	1, 2 & 3	3			
Year 0	1 & 2	1 & 2		1, 2 & 3				
Year 1	1, 2 & 4	2	3	2 & 3	3			
Year 2	1, 2 & 4	2	3	2 & 3	3			
Year 3	1, 2 & 4	2	3	2, 3 & 4	3			4

Notes:

This table addresses analyses on samples from the test plots. Section 3.1.1.1 also includes testing of the ENR materials during the Baseline Event prior to acceptance for use.

1. The physical description includes diver observations, that will be recorded on the diver core log.
2. The composited sediment samples will also be analyzed for total solids.
3. The composited sediment samples from the intertidal plots will also be analyzed for salinity.
4. Prior to construction, the ENR sand and gravelly sand fill will be tested for all chemicals listed in Lower Duwamish Waterway Record of Decision (U.S. EPA, 2014) Tables 19 and 20, and the granulated activated carbon will be tested for PCB congeners.
5. In year 0, individual samples will be tested for TOC, BC, and grain size to document the success of layer placement and how uniform the layer.
6. During Baseline, five composites will the collected. Initially, three composites will be analyzed and two composites will be archived. If power analysis using results from the three Baseline composites indicates that more than three composites are needed, the additional two samples will be analyzed. See text for details.
7. Three composites are currently planned, although more composites may be required, pending analyses of the Baseline data. See text for details.
8. In Years 2 and 3, SPMEs will also be collected to the 0 to 1 cm depth to represent the sediment to surface water interface. These samples are in addition to the 0 to 10 cm samples. See text for details.
9. Salinity measurements will be made using a field probe of porewater collected approximately 10 cm below mudline during the Baseline Event; and 10 to 20 cm below mudline in subsequent events to assess the salinity of upwelling water.

DQOs:

DQO 1 Initial placement
DQO 2 Stability
DQO 3 PCB bioavailability
DQO 4 Effects on benthic

Abbreviations:

BC Black carbon
DQO Data quality objective
ENR Enhanced natural recovery
GS Grain size
PCB Polychlorinated biphenyl
SMS Sediment Management Standards
SPI Sediment profile Image
SPME Solid-phase microextraction
TOC Total organic carbon

Table 3.2
Location-Specific Information by Monitoring Event

Subtidal Plot: East Lane					
Treatment: ENR					
Baseline	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	19	6	12	18	11
Cell 2	13	11	9	16	10
Cell 3	19	9	7	12	13
Cell 4	19	4	3	11	13
Cell 5	9	14	2	24	12
Cell 6	12	8	11	3	9
Year 0	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	10	24	13	5	7
Cell 2	23	6	18	8	19
Cell 3	6	21	23	5	14
Cell 4	1	20	18	2	12
Cell 5	16	11	21	23	19
Cell 6	6	5	23	16	22
Year 1	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	15	20	1	9	16
Cell 2	20	7	15	3	2
Cell 3	3	22	18	16	20
Cell 4	16	22	5	23	7
Cell 5	7	20	15	1	5
Cell 6	20	2	13	24	1
Year 2	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	21	8	23	7	4
Cell 2	1	12	5	6	14
Cell 3	11	8	10	8	1
Cell 4	14	10	17	12	21
Cell 5	10	4	3	8	4
Cell 6	15	24	10	21	14
Year 3	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	2	14	22	17	3
Cell 2	17	21	4	22	24
Cell 3	17	24	2	4	15
Cell 4	24	15	6	9	8
Cell 5	13	6	17	22	18
Cell 6	4	19	17	18	7

Subtidal Plot: West Lane					
Treatment: ENR+AC					
Baseline	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	23	16	6	21	20
Cell 2	10	23	2	13	18
Cell 3	10	7	24	11	20
Cell 4	6	18	3	5	22
Cell 5	18	11	12	19	9
Cell 6	18	1	22	19	8
Year 0	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	7	13	4	19	12
Cell 2	11	12	22	1	24
Cell 3	4	16	6	23	22
Cell 4	10	15	21	13	16
Cell 5	6	4	15	7	23
Cell 6	10	9	13	23	17
Year 1	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	8	5	9	15	11
Cell 2	9	8	15	20	7
Cell 3	5	9	8	18	14
Cell 4	9	12	8	24	7
Cell 5	8	13	20	17	14
Cell 6	4	2	24	15	12
Year 2	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	7	17	1	2	18
Cell 2	4	20	3	17	19
Cell 3	1	21	14	12	19
Cell 4	20	11	19	14	6
Cell 5	16	2	10	24	10
Cell 6	6	20	16	7	14
Year 3	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	3	24	22	14	10
Cell 2	5	16	21	6	14
Cell 3	3	13	15	2	17
Cell 4	2	4	1	17	23
Cell 5	22	5	1	21	3
Cell 6	3	5	11	21	16

Scour Plot: Upstream Subplot					
Treatment: ENR					
Baseline	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	3	24	1	6	9
Cell 2	10	12	19	17	3
Cell 3	6	10	19	9	23
Cell 4	7	9	13	1	15
Cell 5	1	12	4	20	18
Cell 6	20	3	6	23	8
Year 0	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	12	20	14	23	7
Cell 2	15	9	1	7	2
Cell 3	2	12	24	8	3
Cell 4	24	3	21	5	23
Cell 5	23	14	9	15	21
Cell 6	22	11	7	24	14
Year 1	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	11	19	13	8	2
Cell 2	21	23	6	11	24
Cell 3	14	7	5	18	20
Cell 4	6	14	20	11	19
Cell 5	3	8	11	6	13
Cell 6	5	16	10	2	19
Year 2	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	15	18	21	4	5
Cell 2	4	8	14	22	2
Cell 3	8	11	13	22	21
Cell 4	18	8	8	4	16
Cell 5	16	18	7	10	17
Cell 6	4	13	18	15	9
Year 3	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	22	10	17	4	16
Cell 2	18	5	20	13	16
Cell 3	1	17	4	15	16
Cell 4	2	22	12	17	10
Cell 5	24	5	22	19	2
Cell 6	12	13	1	17	21

Scour Plot: Downstream Subplot					
Treatment: ENR+AC					
Baseline	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	11	7	21	12	24
Cell 2	8	14	20	13	11
Cell 3	20	8	19	15	23
Cell 4	1	7	15	8	14
Cell 5	17	8	11	6	5
Cell 6	2	6	7	1	23
Year 0	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	10	4	6	9	17
Cell 2	5	18	24	4	21
Cell 3	21	2	13	1	10
Cell 4	19	9	4	11	24
Cell 5	12	9	1	16	3
Cell 6	9	21	12	22	24
Year 1	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	23	1	8	5	3
Cell 2	19	23	7	1	12
Cell 3	14	4	24	18	17
Cell 4	2	6	18	13	10
Cell 5	24	4	2	18	23
Cell 6	8	17	10	18	14
Year 2	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	19	15	20	18	14
Cell 2	16	15	20	6	9
Cell 3	3	15	16	7	12
Cell 4	23	22	16	12	6
Cell 5	3	12	17	5	9
Cell 6	13	20	4	19	16
Year 3	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	13	20	22	2	16
Cell 2	3	17	22	10	2
Cell 3	9	6	5	22	11
Cell 4	3	21	17	20	5
Cell 5	24	10	9	10	8
Cell 6	3	11	15	5	16

Intertidal Plot: Upstream Subplot					
Treatment: ENR					
Baseline	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	23	22	1	21	15
Cell 2	23	22	20	14	17
Cell 3	3	17	7	1	9
Cell 4	8	2	3	4	10
Cell 5	7	14	22	17	10
Cell 6	21	22	18	24	16
Year 0	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	17	16	4	8	10
Cell 2	13	3	1	18	10
Cell 3	20	15	12	2	10
Cell 4	7	5	6	1	9
Cell 5	6	2	15	4	1
Cell 6	14	12	8	17	5
Year 1	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	12	3	14	13	2
Cell 2	16	8	9	12	15
Cell 3	11	21	5	19	23
Cell 4	5	13	1	6	13
Cell 5	21	24	9	12	18
Cell 6	10	9	20	4	3
Year 2	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	6	21	18	11	20
Cell 2	7	19	23	2	11
Cell 3	18	18	16	14	13
Cell 4	10	6	2	4	7
Cell 5	24	3	18	23	5
Cell 6	1	13	19	12	2
Year 3	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	19	7	24	9	5
Cell 2	21	5	6	24	4
Cell 3	22	8	6	24	4
Cell 4	13	10	5	6	1
Cell 5	11	16	5	8	3
Cell 6	11	7	15	23	6

Intertidal Plot: Downstream Subplot					
Treatment: ENR+AC					
Baseline	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	11	23	20	6	5
Cell 2	21	12	10	7	2
Cell 3	22	23	3	14	10
Cell 4	1	23	19	5	17
Cell 5	3	5	1	12	23
Cell 6	18	2	14	17	12
Year 0	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	21	8	16	9	12
Cell 2	1	14	9	23	24
Cell 3	20	17	1	6	19
Cell 4	18	24	22	12	4
Cell 5	24	16	18	17	21
Cell 6	16	11	21	23	20
Year 1	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	7	10	15	1	2
Cell 2	3	20	15	4	13
Cell 3	12	18	11	5	9
Cell 4	10	6	16	9	13
Cell 5	15	19	13	14	7
Cell 6	3	10	24	9	6
Year 2	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	9	24	4	17	14
Cell 2	6	18	8	22	8
Cell 3	2	7	24	21	15
Cell 4	24	8	11	21	15
Cell 5	2	22	6	8	11
Cell 6	4	5	8	1	13
Year 3	Comp A	Comp B	Comp C	Comp D	Comp E
Cell 1	22	19	3	13	18
Cell 2	5	19	16	17	11
Cell 3	16	8	7	4	13
Cell 4	3	7	14	20	2
Cell 5	8	10	20	4	9
Cell 6	19	15	5	7	22

Notes:

1. Locations were selected by dividing the subplot into a 4-by-6 grid, numbering the grid cells 1 through 24, and then using a random number generator to select the location of each sample. The GPS coordinates of the center of the selected cell will be presented in the database expressed as Northings and Eastings in state plane coordinates according to the procedures in Section 3.0.
2. During Baseline, five composites will the collected; three will be analyzed (A, B, and C); two will be archived (D and E). If the Power Analysis during baseline indicates that more than three composites are needed, subsequent events will be modified to reflect the change. See text for details.

Abbreviations:

Comp Composite
ENR Enhanced natural recovery
ENR+AC Enhanced natural recovery amended with activated carbon
GPS Global positioning system

Table 3.3
Analytical Parameters, Methods, Laboratories, Sample Containers, and Sample Preservation

Parameter	Analytical Method	Laboratory	Sample Preservation	Technical Holding Time	Minimum Sample Size	Sample Container(s)
Surface Sediment Composites (Baseline Event and Years 1, 2, and 3) and GAC Sample (Baseline Event Only)						
PCB congeners	EPA 1668C	Frontier	Transport: less than 6°C. Storage: less than -10°C.	1 year	20 grams	8-oz. AWMG jar
Total solids					10 grams	
ENR Substrate (Baseline Event Only)						
SMS Metals (except Hg)	EPA 6020A	Alpha	Transport: less than 6°C. Storage: less than -10°C.	180 days	10 g	16-oz. AWMG jar
SMS Hg	EPA 7474			28 days	5 g	
SMS SVOCs	SW-846-8270D			Extract w/in 14 days of collection; analyze w/in 40 days of extraction	50 g dry wt.	
PCB congeners	EPA 1668C	Frontier		1 year	20 g	4-oz. AWMG jar
Dioxins/Furans	EPA 1613		Transport: less than 4°C. Storage: less than -10°C.	1 year	10 g	
Sediment (Baseline Event and Years 0, 1, 2, and 3) and ENR Substrate (Baseline Event Only)						
Total organic carbon	EPA 9060	Alpha	Cool to 4°C ± 2°C.	28 days	20 grams	4-oz. AWMG jar
Black carbon	Gustafsson et al. (1997)			28 days	20 grams	
Grain size	ASTM D422		None	6 months	200 grams	8-oz. AWMG jar
Salinity	EPA 9050A (field version)	Field	None	NA	NA	None
SPME Fiber Extracts (Baseline Event and Years 1, 2, and 3)						
PCB congeners	EPA 1668C	Frontier	Transport: less than 6°C. Storage: less than 4°C.	1 year	Entire hexane extract	2-mL amber glass vial

Abbreviations:

Alpha	Alpha Analytical Laboratory
AWMG	Amber, wide-mouth glass with teflon-lined lid
ASTM	American Society for Testing Materials
°C	Degrees Celsius
EPA	U.S. Environmental Protection Agency
Frontier	Frontier Analytical Laboratory
PCB	Polychlorinated biphenyl
SPME	Solid-phase microextraction
SIM	Selective Ion Monitoring
ENR	Enhanced Natural Recovery

Table 3.4
Methods and Acceptable Quality Assurance Goals for Conventionals in Sediment Samples

Parameter	Analytical Method	Lab	Expected Range	Units	Sensitivity [1]		Precision[2]	Accuracy[3]	Completeness[4]
					RL/LOQ	MDL/LOD			
Black carbon	Gustafsson et al. (1997)	Alpha	0.1 to 4.0	%	0.01	0.01	±25%	75 - 125%	95%
Grain size	ASTM D422	Alpha	Clay to gravel	%	NA	NA	±25%	NA	95%
Salinity	EPA 9050	Field	1 to 32	SU	0.01	0.005	±20%	80 - 120%	95%
TOC	SW-846 9060	Alpha	1 to 6	%	0.01	0.01	±25%	75 - 125%	95%

Notes:

1. Sensitivity is assessed by the use of initial and continuing calibration and laboratory control samples.
2. Precision is assessed by the use of laboratory control samples and laboratory duplicates.
3. Accuracy is assessed by calibration, laboratory control samples, and matrix spikes (TOC and black carbon only). For TOC, the laboratory control sample is NIST standard reference material with a certified value of 4.4% TOC.
4. Completeness is measured as the number of results that are acceptable for use vs. the number of samples analyzed.

Abbreviations:

Alpha Alpha Analytical Laboratory
ASTM American Society for Testing Materials
EPA U.S. Environmental Protection Agency
Frontier Frontier Analytical Laboratory
LOD Limit of detection
LOQ Limit of quantification
MDL Method detection limit
NA Not applicable
NIST National Institute of Standards and Technology
PCB Polychlorinated biphenyl
RL Reporting limit
SU Salinity Unit
TOC Total organic carbon

Table 3.5
Methods and Acceptable Quality Assurance Goal for PCB Congeners in Sediment and SPME Extracts

PCB Congener by Frontier Using EPA 1668C	Co-elution[2]	Units	Sediment Samples: Sensitivity: Analysis of 5-Gram Sample[2]		Sediment Samples: Sensitivity: Analysis of 10-Gram Sample		Acceptance Criteria for Native PCBs					Acceptance Criteria for Labeled PCBs					
			RL/LOQ	MDL/LOD	RL/LOQ	MDL/LOD	Test Conc.	VER Recovery	IPR: RSD	IPR: Mean Recovery	OPR Recovery	Test Conc.	VER Recovery	IPR: RSD	IPR: Mean Recovery	OPR Recovery	Sample Recovery
PCB-1	NA	pg/g	4	0.06	2	0.03	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-3	NA	pg/g	4	0.06	2	0.03	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-4	NA	pg/g	4	0.39	2	0.19	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-15	NA	pg/g	4	0.22	2	0.11	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-19	NA	pg/g	4	0.15	2	0.077	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-28	NA	pg/g	4	0.11	2	0.056	50	75 - 125%	25%	70 - 130%	60 - 135%	100	65 -135%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-37	NA	pg/g	4	0.089	2	0.044	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-54	NA	pg/g	4	0.099	2	0.049	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	70%	20 - 135%	15 - 145%	5 - 145%
PCB-77	NA	pg/g	4	0.11	2	0.056	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-81	NA	pg/g	4	0.13	2	0.064	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-104	NA	pg/g	4	0.12	2	0.062	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-105	NA	pg/g	4	0.11	2	0.057	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-106	118	pg/g	4	0.12	2	0.06	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-111	115	pg/g	4	0.12	2	0.058	50	75 - 125%	25%	70 - 130%	60 - 135%	100	75 -125%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-114	NA	pg/g	4	0.13	2	0.066	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-118	106	pg/g	4	0.12	2	0.06	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-123	NA	pg/g	4	0.13	2	0.063	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-126	NA	pg/g	4	0.091	2	0.045	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-155	NA	pg/g	4	0.11	2	0.053	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-156	NA	pg/g	4	0.11	2	0.057	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-157	NA	pg/g	4	0.13	2	0.066	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-167	NA	pg/g	4	0.12	2	0.06	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-169	NA	pg/g	4	0.089	2	0.045	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-178	NA	pg/g	4	0.19	2	0.093	50	75 - 125%	25%	70 - 130%	60 - 135%	100	75 -125%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-188	NA	pg/g	4	0.11	2	0.056	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-189	NA	pg/g	4	0.083	2	0.042	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-202	NA	pg/g	4	0.11	2	0.054	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-205	NA	pg/g	4	0.06	2	0.03	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-206	NA	pg/g	4	0.098	2	0.049	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-208	NA	pg/g	4	0.068	2	0.034	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%
PCB-209	NA	pg/g	4	0.049	2	0.024	50	75 - 125%	25%	70 - 130%	60 - 135%	100	50 -145%	50%	45 - 135%	40 - 145%	10 - 145%

Notes:

1. Method 1668 defines quality assurance goals for the subset of congeners above rather than for all 209 congeners. All 209 congeners will be reported in this project. Meeting the requirements for the congeners tabulated above is deemed by the method as sufficient to demonstrate acceptable performance for all 209 congeners.
2. Chromatographic co-elution occurs when two (or more) compounds do not chromatographically separate due to the fact that both species have retention times that differ by less than the resolution of the method. The concentration is reported for the first co-eluting congener only. All co-eluting congeners receive a qualifier that indicates the congener that receives the value.

Abbreviations:

Conc. Concentration
EPA U.S. Environmental Protection Agency
IPR Initial precision and recovery
LOD Limit of detection
LOQ Limit of quantification
MDL Method detection limit
NA Not applicable
OPR Ongoing precision and recovery
PCB Polychlorinated biphenyl
pg/g Picograms per gram
RL Reporting limit
RSD Relative standard deviation
SPME Solid-phase microextraction
VER Calibration verification

Table 3.6
Methods and Acceptable Quality Assurance Criteria for Chemistry in Sediment Samples

Parameter	Analytical Method	Lab	Units	Sensitivity [1] RL/LOQ	Sensitivity [1] MDL/LOD	Precision[2]	Accuracy[3]	Completeness[4]
Metals								
Arsenic	EPA 6020A	Alpha	mg/kg dw	0.05	0.0062	20%RPD	75-125%R	95%
Cadmium	EPA 6020A	Alpha	mg/kg dw	0.02	0.0026	20%RPD	75-125%R	95%
Chromium	EPA 6020A	Alpha	mg/kg dw	0.2	0.047	20%RPD	75-125%R	95%
Copper	EPA 6020A	Alpha	mg/kg dw	0.2	0.011	20%RPD	75-125%R	95%
Lead	EPA 6020A	Alpha	mg/kg dw	0.06	0.019	20%RPD	75-125%R	95%
Mercury	EPA 7474	Alpha	mg/kg dw	0.013	0.0016	20%RPD	80-120%R	95%
Silver	EPA 6020A	Alpha	mg/kg dw	0.05	0.0011	20%RPD	75-125%R	95%
Zinc	EPA 6020A	Alpha	mg/kg dw	1	0.26	20%RPD	75-125%R	95%
Organic Compounds								
4-methylphenol	EPA 8270D	Alpha	µg/kg dw	33	4	30%RPD	30-130%	95%
2,4-dimethylphenol	EPA 8270D	Alpha	µg/kg dw	33	5	30%RPD	30-130%	95%
Benzoic acid	EPA 8270D	Alpha	µg/kg dw	2000	420	30%RPD	40-140%	95%
Benzyl alcohol	EPA 8270D	Alpha	µg/kg dw	67	22	30%RPD	40-140%	95%
Pentachlorophenol	EPA 8270D	Alpha	µg/kg dw	200	60	30%RPD	30-130%	95%
Phenol	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	30-130%	95%
Acenaphthene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Anthracene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Benzo(a)pyrene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Benz(a)anthracene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Total benzofluoranthenes	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Benzo(g,h,i)perylene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Chrysene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Dibenz(a,h)anthracene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Indeno(1,2,3-cd)pyrene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Fluoranthene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Fluorene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Naphthalene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%

Table 3.6
Methods and Acceptable Quality Assurance Criteria for Chemistry in Sediment Samples

Parameter	Analytical Method	Lab	Units	Sensitivity [1] RL/LOQ	Sensitivity [1] MDL/LOD	Precision[2]	Accuracy[3]	Completeness[4]
Organic Compounds (continued)								
Phenanthrene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Pyrene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Bis(2-ethylhexyl)phthalate	EPA 8270D	Alpha	µg/kg dw	33	9	30%RPD	40-140%	95%
Butyl benzyl phthalate	EPA 8270D	Alpha	µg/kg dw	33	7	30%RPD	40-140%	95%
Dimethyl phthalate	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
1,2-dichlorobenzene	EPA 8270D	Alpha	µg/kg dw /kg OC	33	7	30%RPD	40-140%	95%
1,4-dichlorobenzene	EPA 8270D	Alpha	µg/kg dw	33	7	30%RPD	40-140%	95%
1,2,4-trichlorobenzene	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
2-methylnaphthalene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
Dibenzofuran	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Hexachlorobenzene	EPA 8270D	Alpha	µg/kg dw	33	3	30%RPD	40-140%	95%
n-Nitrosodiphenylamine	EPA 8270D	Alpha	µg/kg dw	33	2	30%RPD	40-140%	95%
Polychlorinated biphenyls Congeners[5]								
PCB Congeners	EPA 1668C	Frontier	ng/kg dw	16	16	50%RPD	40-140%R	95%
Dioxins/Furans Congeners[6]								
2,3,7,8-TCDD	EPA 1613	Frontier	ng/kg dw	0.5	0.0276	67-158	78-129	95%
1,2,3,7,8-PeCDD	EPA 1613	Frontier	ng/kg dw	2.5	0.0348	70-142	78-130	95%
1,2,3,4,7,8-HxCDD	EPA 1613	Frontier	ng/kg dw	2.5	0.0329	70-164	78-128	95%
1,2,3,6,7,8-HxCDD	EPA 1613	Frontier	ng/kg dw	2.5	0.0361	76-134	78-128	95%
1,2,3,7,8,9-HxCDD	EPA 1613	Frontier	ng/kg dw	2.5	0.0328	64-162	82-122	95%
1,2,3,4,6,7,8-HpCDD	EPA 1613	Frontier	ng/kg dw	2.5	0.0964	70-140	86-116	95%
OCDD	EPA 1613	Frontier	ng/kg dw	5	0.175	78-144	79-126	95%
2,3,7,8-TCDF	EPA 1613	Frontier	ng/kg dw	0.5	0.0255	75-158	84-120	95%
1,2,3,7,8-PeCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.0267	80-134	82-120	95%
2,3,4,7,8-PeCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.0268	68-160	82-122	95%

Table 3.6
Methods and Acceptable Quality Assurance Criteria for Chemistry in Sediment Samples

Parameter	Analytical Method	Lab	Units	Sensitivity [1] RL/LOQ	Sensitivity [1] MDL/LOD	Precision[2]	Accuracy[3]	Completeness[4]
Dioxins/Furans (continued)								
1,2,3,4,7,8-HxCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.0237	72-134	90-112	95%
1,2,3,6,7,8-HxCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.0232	84-130	88-114	95%
1,2,3,7,8,9-HxCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.027	78-130	90-112	95%
2,3,4,6,7,8-HxCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.0335	70-156	88-114	95%
1,2,3,4,6,7,8-HpCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.0398	82-122	90-110	95%
1,2,3,4,7,8,9-HpCDF	EPA 1613	Frontier	ng/kg dw	2.5	0.0489	78-138	86-116	95%
OCDF	EPA 1613	Frontier	ng/kg dw	5	0.0876	63-170	63-159	95%

Notes:

1. Sensitivity is assessed by the use of initial and continuing calibration and laboratory control samples.
2. Precision is assessed by the use of laboratory control samples and laboratory duplicates.
3. Accuracy is assessed by calibration, laboratory control samples, and matrix spikes/matrix spike duplicates.
4. Completeness is measured as the number of results that are acceptable for use vs. the number of samples analyzed.
5. Precision and accuracy are assessed following procedures in Section 9 of the method; values shown above are within the method criteria of Table 6 of the method.
6. Precision and accuracy are assessed following procedures in Section 9 of the method; values shown above based on Table 6 of the method.

Abbreviations:

Alpha Alpha Analytical Laboratory
EPA U.S. Environmental Protection Agency
LOD Limit of detection
LOQ Limit of quantification
MDL Method detection limit
mg/kg dw Milligrams per kilogram dry weight
NA Not applicable
ng/kg dw Nanograms per kilogram dry weight
PCB Polychlorinated biphenyl
R Recovery
RL Reporting limit
RPD Relative percent difference
µg/kg dw Micrograms per kilogram dry weight

Table 3.7
Laboratory QA/QC Requirements

Parameter	Analytical Method	Initial Calibration	Continuing Calibration	Method Blanks	Laboratory Control Samples	Sample Matrix Quality Control: Matrix Spike	Sample Matrix Quality Control: Matrix Spike Duplicate	Sample Matrix Quality Control: Laboratory Duplicate or Triplicate	Surrogate Spikes
Sediment									
PCB congeners	EPA 1668C	Prior to analysis	Every 10 to 20 analyses or 12 hours	1 per batch[1]	1 per batch[1]	Handled by use of isotope dilution in EPA 1668C		NA	Each sample
ENR Substrate (Baseline Event Only)[2]									
SMS Metals (except Hg)	EPA 6020A	Prior to analysis	Every 10 samples	1 per batch[1]	1 per batch[1]	1 per SDG[1]	NA	1 per 20 samples	NA
SMS Hg	EPA 7474	Prior to analysis	Every 10 samples	1 per batch[1]	1 per batch[1]	1 per SDG[1]	1 per SDG[1]	NA	NA
SMS SVOCs	EPA 8270D	Prior to analysis	Every 12 hours	1 per batch[1]	1 per batch[1]	1 per SDG[1]	1 per SDG[1]	NA	Each sample
PCB congeners	EPA 1668C	Prior to analysis	Every 10 to 20 analyses or 12 hours	1 per batch[1]	1 per batch[1]	Handled by use of isotope dilution in EPA 1668C		NA	Each sample
Dioxins/Furans	EPA 1613	Prior to analysis	Beginning and end of every analytical run	1 per batch[1]	1 per batch[1]	Handled by use of isotope dilution in EPA 1613		NA	Each sample
Sediment and ENR Substrate (Baseline Event Only)[2]									
Total organic carbon	EPA 9060	Daily	Every 10 samples	1 per batch[1]	1 per batch[1]	1 per SDG[1]	NA	duplicate per SDG	N/A
Black carbon	Gustafsson et al. (1997)	Daily	Every 10 samples	1 per batch[1]	1 per batch[1]	1 per SDG[1]	NA	duplicate per SDG	N/A
Grain size	ASTM D422	NA	NA	NA	NA	NA	NA	triplicate per SDG	N/A

Table 3.7
Laboratory QA/QC Requirements

Parameter	Analytical Method	Initial Calibration	Continuing Calibration	Method Blanks	Laboratory Control Samples	Sample Matrix Quality Control: Matrix Spike	Sample Matrix Quality Control: Matrix Spike Duplicate	Sample Matrix Quality Control: Laboratory Duplicate or Triplicate	Surrogate Spikes
SPME Fiber Extracts									
PCB congeners	EPA 1668C	Prior to analysis	Every 10 to 20 analyses or 12 hours	1 per batch[1]	1 per batch[1]	Handled by use of isotope dilution in EPA 1668C		NA	Each sample

Notes:

1. Project SDGs are expected to range in size from 1 sample to 20 samples. Batches are groups of 20 or fewer samples that move through sample preparation and analysis together. A batch formed at the lab may include samples from more than one SDG, and the SDGs in a batch may be from multiple projects. In the table above "per SDG" indicates that the "batch" QC must be run on a sample from the SDG from the project.
2. Granular activated carbon will be analyzed for PCB congeners only.

Abbreviations:

ASTM American Society for Testing Materials
EPA U.S. Environmental Protection Agency
ENR Enhanced natural recovery
Hg Mercury
NA Not applicable
PAHs Polycyclic Aromatic Hydrocarbons
PCB Polychlorinated biphenyl
SDG Sample Delivery Group
SMS Sediment Management Standards
SPME Solid-phase microextraction
SU Salinity Unit

Table 3.8
Average Method Detection Limits for Freely-Dissolved PCB Congeners (by Homolog) in Sediment Porewater

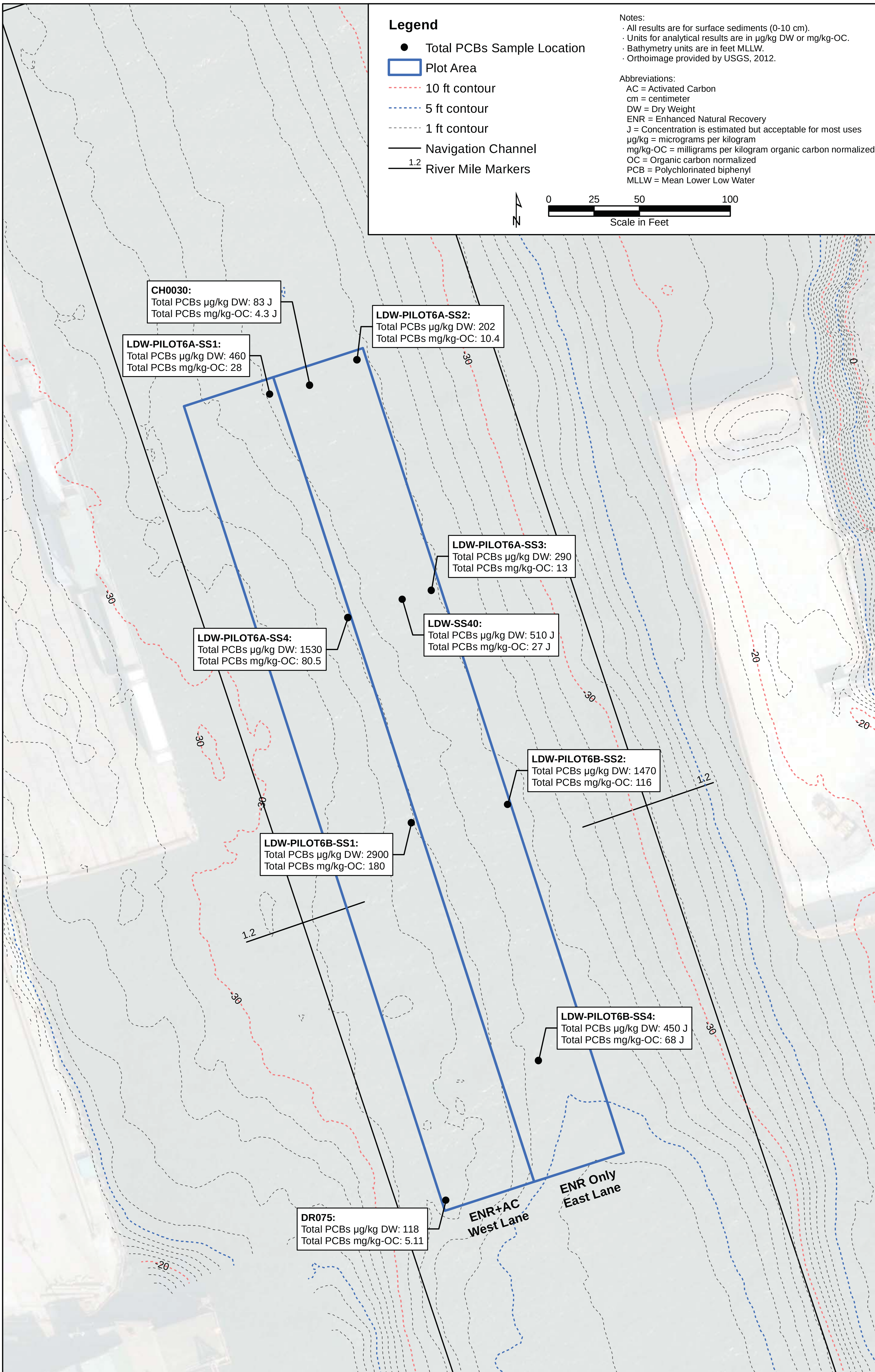
						Lowest Achievable MDL in Porewater (Complete Equilibrium Exposure)	MDL in Porewater (4-Week Exposure)		Expected Average Pilot Study Concentrations of PCB in Porewater (pg/L)		
Length Fiber (cm)	PCB Homolog	MDL[1] (ng)	K_{fs}[2] (L/L_{PDMS})	Volume of PDMS on Fiber (µL)	Concentration of PCB in PDMS (ng/L)	Concentration of PCB in Porewater (pg/L)	Percent to Equilibrium[3]	Concentration of PCB in Porewater (pg/L)	Baseline[4]	Post-Treatment[5]	Method Sensitivity
480	Tri	0.50	260,000	33.17	15,075	58	87%	66	970	97 - 194	Adequate
480	Tetra	0.50	700,000	33.17	15,075	22	71%	30	740	74 - 148	Adequate
480	Penta	0.50	2,000,000	33.17	15,075	7.5	52%	15	1,300	130 - 260	Adequate
480	Hexa	0.50	5,000,000	33.17	15,075	3.0	37%	8.2	400	40 - 80	Adequate
480	Hepta	0.50	13,000,000	33.17	15,075	1.2	25%	4.7	60	6 - 12	Adequate
480	Octa	0.50	36,000,000	33.17	15,075	0.4	**15%**	2.7	7.0	0.7 - 1.4	Some results may be flagged as estimated values, and most post-treatment results likely to below detection limit.

Notes:
1. 5 picograms per 1 µL injection is the MDL. The 1800-µL SPME hexane extract is concentrated to approximately 100 µL.
2. Approximate average for homolog group as referenced from Smedes et al. (2009).
3. Based on sampling results from a sampling event at Bremerton, WA activated carbon amendment site. When the percentage is less than 20% (**bold and red font**), analytical results for congeners within those homologs may be flagged as estimated (J-flag or equivalent) values.
4. Calculations are provided in Table 5.c. Average Concentration of PCB Congener Detections in Porewater, as Estimated by Two-Carbon Model.
5. Assuming 80-90% reduction in PCBs from baseline.

Abbreviations:

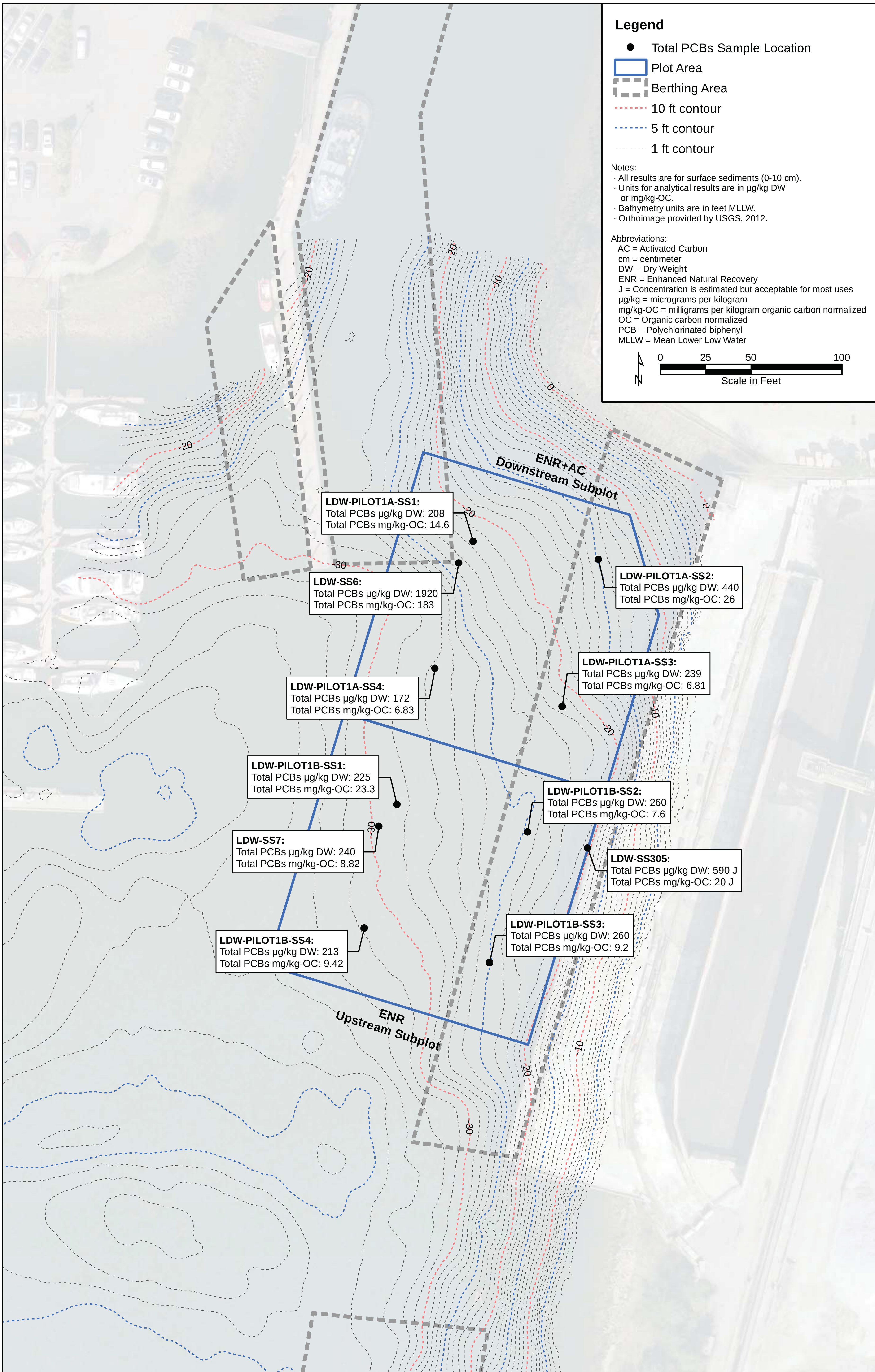
µL Microliter
cm Centimeter
K_{fs} Fiber PDMS-Solution Water Partition Coefficient
L Liter
MDL Method detection limit
ng Nanogram
PCB Polychlorinated biphenyl
PDMS Polydimethylsiloxane
pg Picogram
SPME Solid-phase microextraction

FIGURES



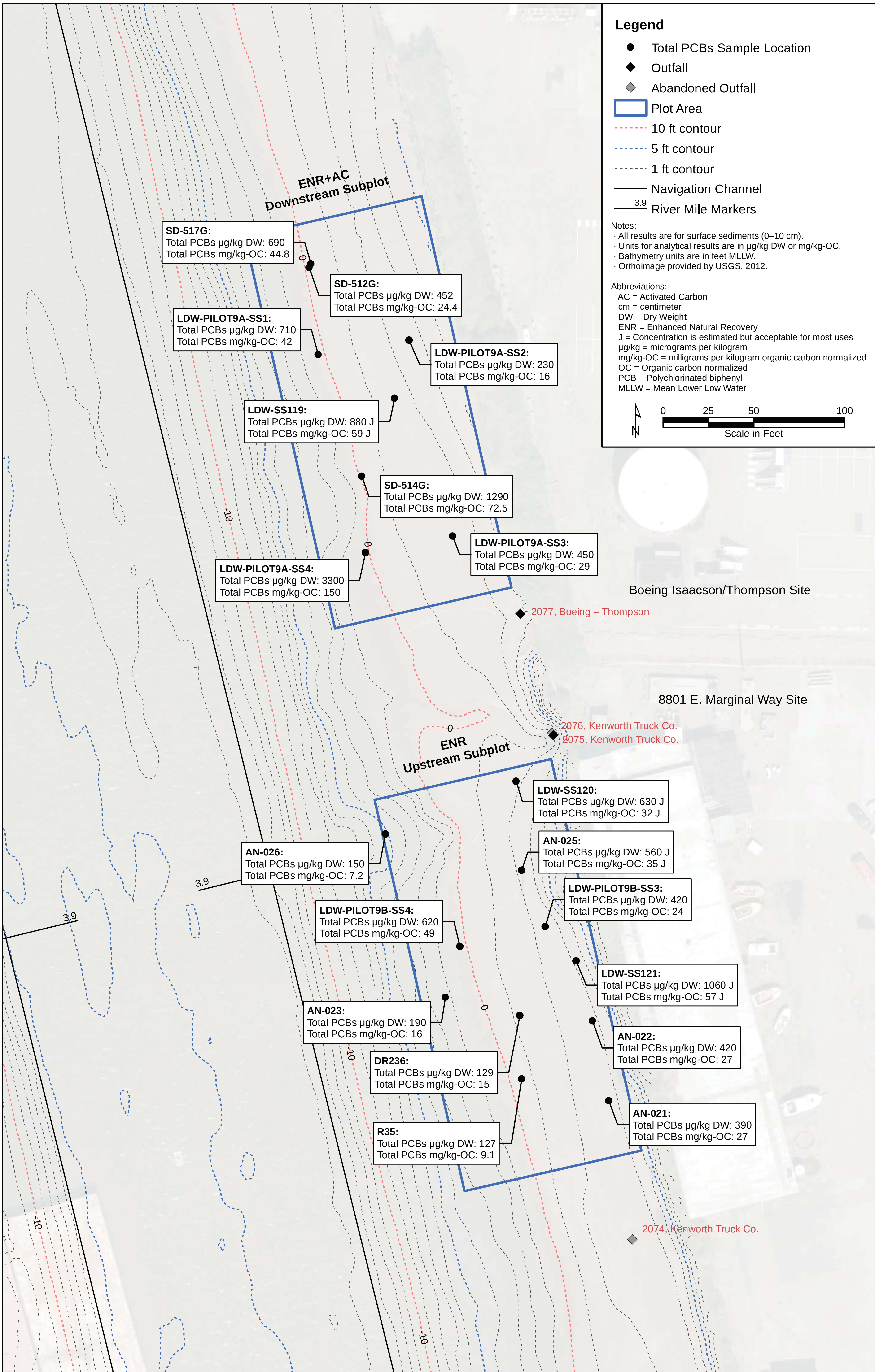
Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	**ENR/AC Pilot Study** **Quality Assurance Project Plan** Lower Duwamish Waterway	**FINAL**	Figure 1.1 Subtidal Plot

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 1.1 Subtidal Plot.mxd
6/12/2015



Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	**ENR/AC Pilot Study** **Quality Assurance Project Plan** Lower Duwamish Waterway	**FINAL** Figure 1.2 Scour Plot

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 1.2 Scour Plot.mxd
6/12/2015



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

ENR/AC Pilot Study
Quality Assurance Project Plan
Lower Duwamish Waterway

FINAL

Figure 1.3
Intertidal Plot

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 1.3 Intertidal Plot.mxd
6/12/2015

FINAL

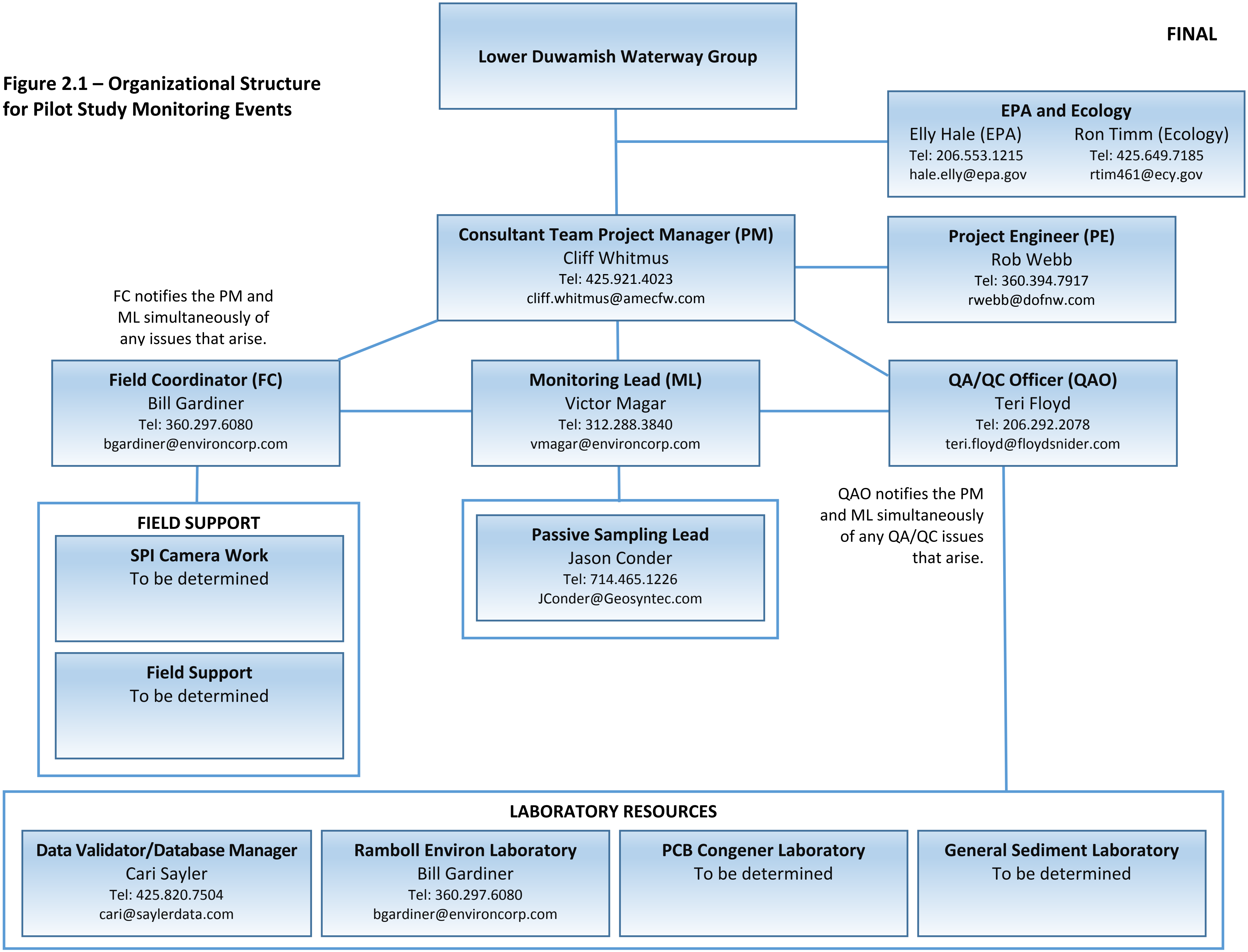
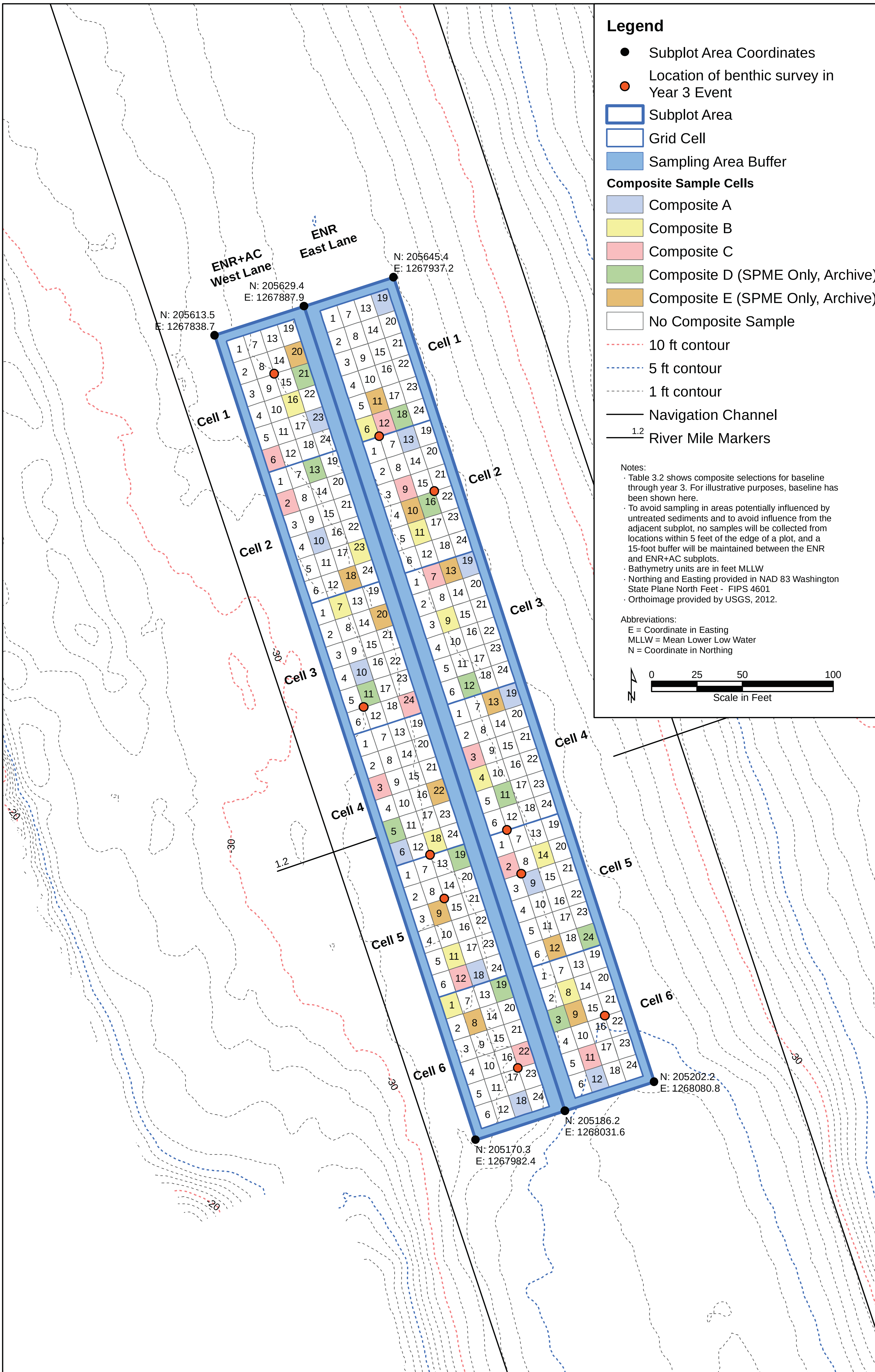


Figure 2.1 – Organizational Structure for Pilot Study Monitoring Events



Legend

- Subplot Area Coordinates
- Location of benthic survey in Year 3 Event
- Subplot Area
- Grid Cell
- Sampling Area Buffer

Composite Sample Cells

- Composite A
- Composite B
- Composite C
- Composite D (SPME Only, Archive)
- Composite E (SPME Only, Archive)
- No Composite Sample
- 10 ft contour
- 5 ft contour
- 1 ft contour
- Navigation Channel
- 1.2 River Mile Markers

Notes:
- Table 3.2 shows composite selections for baseline through year 3. For illustrative purposes, baseline has been shown here.
- To avoid sampling in areas potentially influenced by untreated sediments and to avoid influence from the adjacent subplot, no samples will be collected from locations within 5 feet of the edge of a plot, and a 15-foot buffer will be maintained between the ENR and ENR+AC subplots.
- Bathymetry units are in feet MLLW
- Northing and Easting provided in NAD 83 Washington State Plane North Feet - FIPS 4601
- Orthoimage provided by USGS, 2012.

Abbreviations:
E = Coordinate in Easting
MLLW = Mean Lower Low Water
N = Coordinate in Northing

0 25 50 100
Scale in Feet

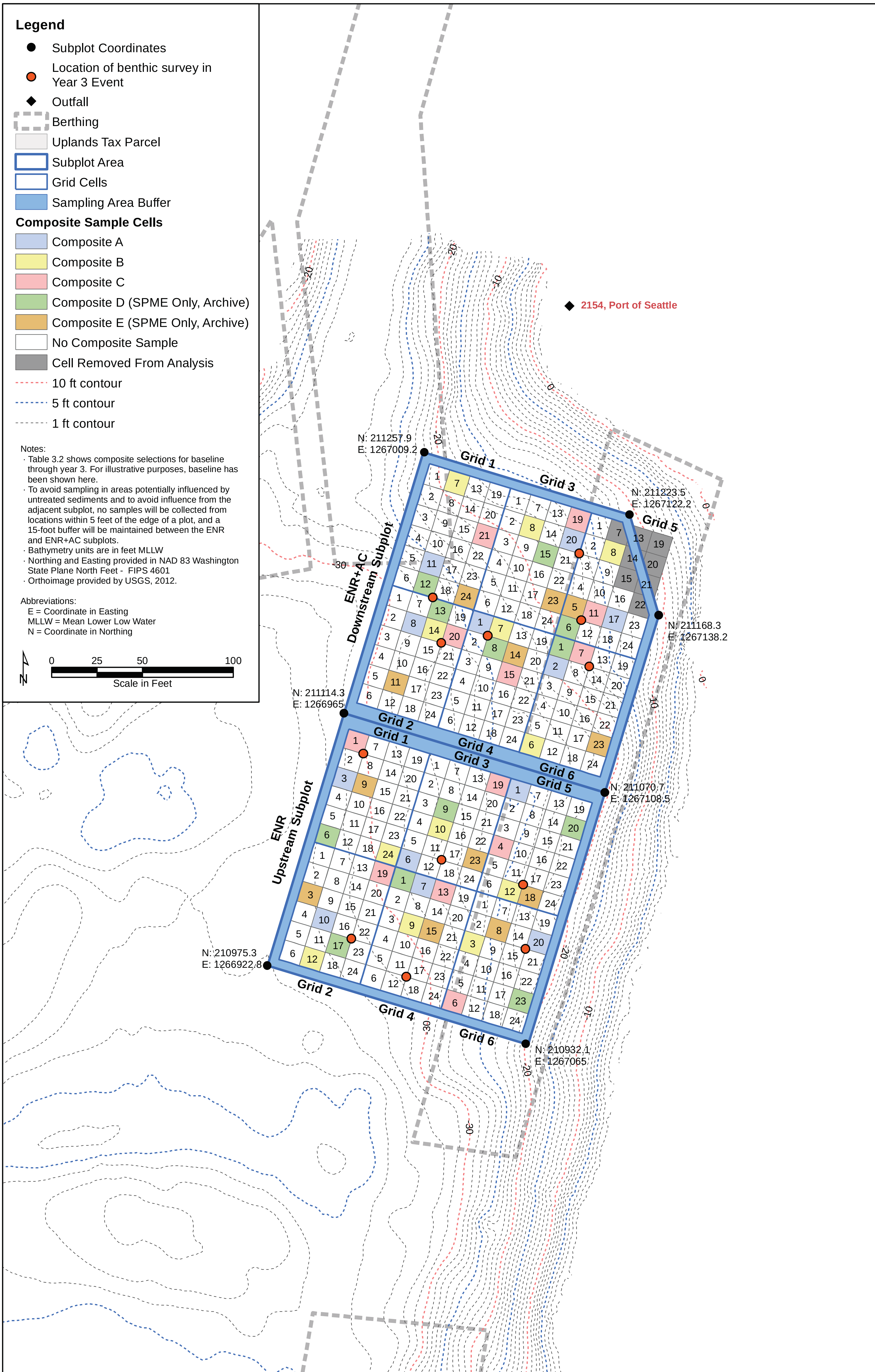
Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Quality Assurance Project Plan
Lower Duwamish Waterway

FINAL

Figure 3.1
Subtidal Plot
Sample Composite Grid

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 3.1 Subtidal Plot with Sample Composite Grid.mxd
10/19/2015

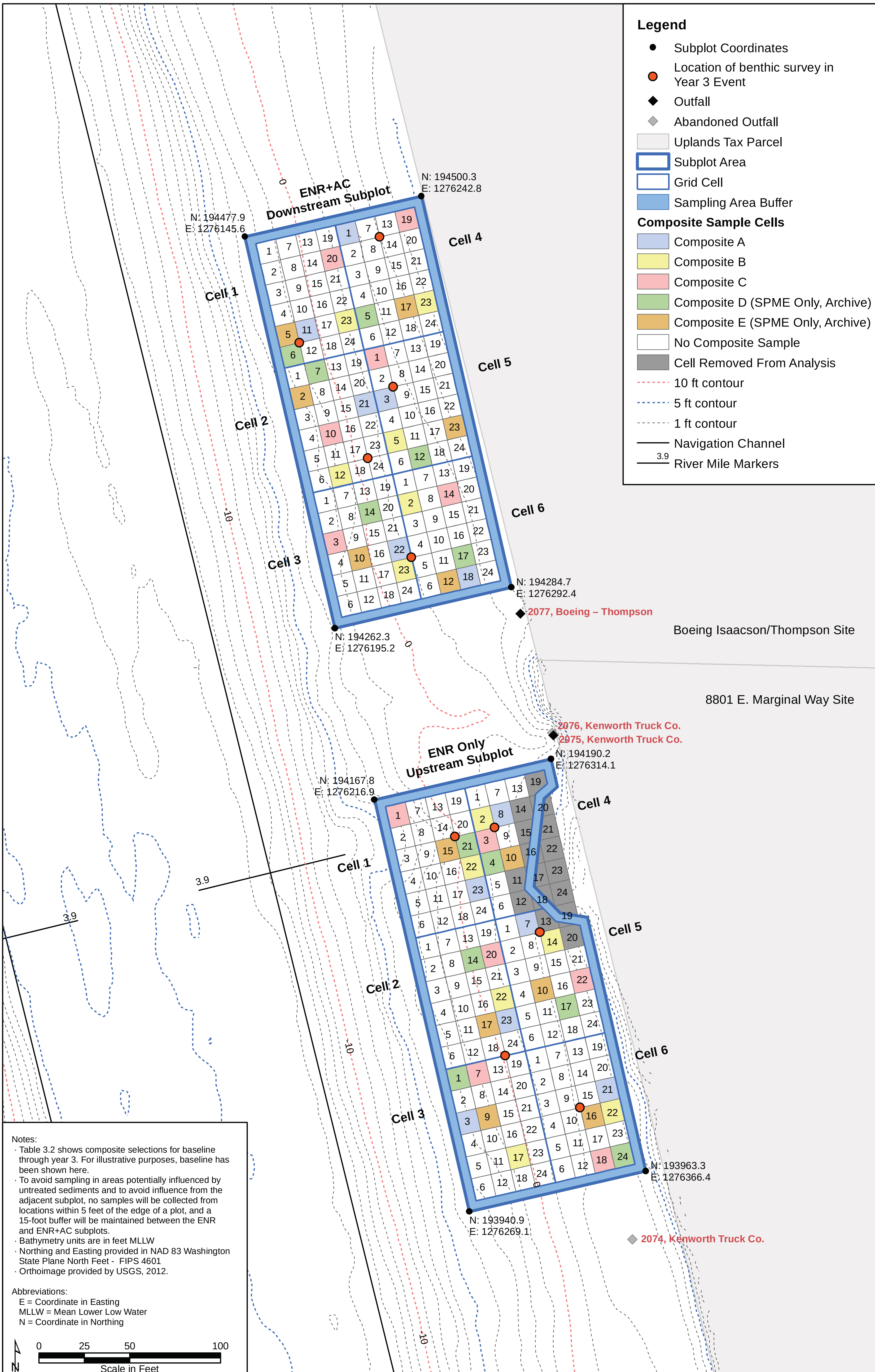


Lower Duwamish Waterway Group
Port of Seattle / City of Seattle / King County / The Boeing Company

ENR/AC Pilot Study
Quality Assurance Project Plan
Lower Duwamish Waterway

FINAL

Figure 3.2
Scour Plot
Sample Composite Grid



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

ENR/AC Pilot Study
Quality Assurance Project Plan
Lower Duwamish Waterway

FINAL

Figure 3.3
Intertidal Plot
Sample Composite Grid

I:\GIS\Projects\AMEC-KC-ENR\MXD\Document 2015_0422\Figure 3.3 Intertidal Plot with Sample Composite Grid.mxd
10/19/2015

ATTACHMENT A

Field Forms

QUALITY ASSURANCE PROJECT PLAN

Attachment A – Sample Forms for Contractor Daily Report
Lower Duwamish Waterway

1.0 INTRODUCTION

The forms contained in this Attachment are representative forms that have been used on previous projects. The actual field forms will be similar but may differ and may evolve during the course of the multi-year monitoring program. It is also expected that several of the forms will become electronic forms designed for direct input into project electronic records and database.

1.1 LOCATION INFORMATION

Location information will be recorded on a sampling station location log that may be a Microsoft Excel® table. The table will include information on the weather and waterway conditions; position checks with the fixed control checkpoint; and station-specific information (DGPS coordinates, water depth, date, and time). If the station is occupied for more than 1 hour or for the collection of more than one type of sample, the information will be measured and recorded again for the additional samples so that no more than 1 hour passes between measurements.

The log will include the DGPS coordinates for the proposed sampling location that is developed from the information in Table 3.2 of the QAPP. No example form is included.

1.2 PHOTOGRAPHIC INFORMATION

Three types of photographic information may be collected for this project:

- Paired In-water images of one or more sediment profile images and a plan view image of the location where the sediment profile image(s) are collected.
- Images of the shallow sediment cores as they are being processed to document the conditions encountered.
- Occasional photographs collected in the field to augment field notes.

All photographs will be assigned a unique number and will be entered into the photo log. A representative photo log is attached.

1.3 Sediment Sampling Information

Sediment sampling information for this project will be collected from shallow sediment cores collected by diver (or wader in the case of the intertidal plot). The field technician will complete a surface sediment core sample collection (attached). Photographs of the core during processing will be recorded on the photograph log form and cross-referenced to the surface sediment core sample collection form.

1.4 Sediment and Porewater Compositing Forms

Forms: Compositing information will be recorded on the Sediment Composite Log. Chain-of-custody forms will also be completed for transfer of the sample jars to the laboratories under custody (see Section 4.3.1).

Forms: The analyst will complete a SPME preparation form (QAPP Attachment A) for each batch of SPME fibers. The form will document the source of the base fibers, their purchase date, reference vendor-supplied information, reference to the analysis of the cleaned fiber, a list of the PRCs used and their concentrations in the soaking solutions, and a reference to the analysis of the PRC-loaded fiber.

Forms: SPME deployment and recovery forms (Appendix A) will be used to record the batch ID, discrete and composite sample IDs, coordinates, dates and times of deployment and retrieval, water depths, depth of ENR or ENR/AC and diver observations for each sample.

Forms: The compositing step will be documented on the SPME extraction and compositing form (QAPP Attachment A).

Forms: Information related to the collection of the grab samples for benthic macroinvertebrate analysis will be recorded on the Sediment Grab Log. Chain-of-custody forms will be completed for transfer of the sample jars to the Ramboll Environ laboratory. Benthic taxa identified during the sorting and identification will be recorded on “infaunal sample identification and sorting” sheets.

FORMS

Lower Duwamish Waterway Group

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

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

Photo Log

Photo File Number	Date	Time	SPI	Plan View Aquatic	Other activity (describe)	Location Description

Lower Duwamish Waterway Group

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

Diver Core Log

PROJECT/SURVEY	DATE	SAMPLER	RECORDER
STATION ID	NAV DATUM	LATITUDE	LONGITUDE

ATTEMPT	TIME STARTED	TIME FINISHED	WATER DEPTH (FT)	TIDE (FT)	MLLW (FT) = WATER DEPTH - TIDE
of					

DRIVE METHOD	PENETRATION DEPTH (cm)	TARGET CORE LENGTH (cm)	RECOVERY (cm)	CORE DIAMETER (cm)

Depth (cm)	SEDIMENT TYPE	ODOR	COLOR	SAMPLE ID BY DEPTH	MISC
5					
10					
15					
20					
25					
30					
35					
40					
45					
50					

NOTES

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

COMPOSITE CREATION FORM

COMPOSITE ID: ____________________

Media:	☐ Sediment ☐ SPME Fibers	**Sampling Event:**	☐ Baseline ☐ Year 0	☐ Year 1 ☐ Year 2	☐ Year 3 ☐ EXTRA
Date of Sampling:		**Plot:**	☐ Subtidal ☐ Scour ☐ Intertidal	**Subplot:**	☐ ENR Only ☐ ENR+AC
Date of Composing:					
Sampling Personnel:		**Compositing Personnel:**			

Discrete Sample ID	**Bowl/vial weight (g)**	**Sample Notes**	**FOR SEDIMENT COMPOSITES ONLY:**	
	Tare wt		**Pre-sieve Jars to fill:**	☐ Grain size ☐ Archive ☐ Salinity (intertidal)
Sample ID 1	*With Sample 1*			
Sample ID 2	*With Sample 2*		**Total wt pre sieve (g)**	*Reweighted bowl*
Sample ID 3	*With Sample 3*		**Weight of gravel (g)**	*Wt of gravel removed*
Sample ID 4	*With Sample 4*		**Total wt post sieve (g)**	*difference*
Sample ID 5	*With Sample 5*		**Post-sieve jars to fill:**	☐ TOC + BC ☐ PCB congeners ☐ Sieved archive (optional)
Sample ID 6	*With Sample 6*			
Extra sample (optional)	*Total bowl + composite*			

Additional Compositing Notes:

Representative Form
The format of the final form may be different and may evolve during the multi-year monitoring project.

SPME PREPARATION FORM				
Basic Information				
Batch ID:		Number of Envelopes per Batch:		
Fiber Silica Diameter (µm):	Fiber PDMS Coating Thickness (µm):	Envelope Steel Mesh Specifications (mesh size, mesh opening):		
Length of Individual Fibers (cm):		Number of Fibers per Envelope:		
Vendor:		Purchase Date:		
Vendor Supplied Fiber Information:				
Fiber Pre-Cleaning				
Date:		Personnel:		
Last Blank Fiber Analysis Date (attach analytical results):				
Performance Reference Compound Loading				
Date of Removal from PRC Soaking Solution:		Personnel:		
PCB Congeners Used as PRCs (Concentration in Soaking Solution):				
Duration of PRC Loading:		Roller Rotations per Minute:		
Expected PRC Concentration in PDMS (ng PCB/L PDMS):				
Storage Conditions				

Location	Start Date	End Date	Temperature (˚C)	Notes

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

SPME DEPLOYMENT FORM										
Sampling Event:				Plot:					Subplot:	
Date:				Personnel:						
Grid Cell	Batch ID	Discrete Sample ID	Latitude	Longitude	Time	Water Depth (ft)	Tide (ft)	Water Depth (ft MLLW)	Depth of ENR or ENR/AC [1]	Diver Observations
1										
2										
3										
4										
5										
6										

[1] Depth of ENR or ENR/AC must be 80% of target depth to be an acceptable SPME sample location

Deployment Notes:

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

SPME RETRIEVAL FORM							
Sampling Event:		Plot:			Subplot:		
Date:		Personnel:					
SPME Envelope Deployment Position – Check one box: ☐ 0-10 cm SPMEs -or- ☐ 0-1 cm sediment-water interface SPMEs							
Grid Cell	Discrete Sample ID	Time	Length of SPME Envelope Above Sediment Surface (cm)	Length of SPME Envelope Below Sediment Surface (cm)	SPME Envelope Condition	Diver Observations	
1							
2							
3							
4							
5							
6							

Retrieval Notes:

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

SPME COMPOSITING FORM					
Sampling Event:		Plot:		Subplot:	
Date:		Personnel:			
SPME Envelope Deployment Position – Check one box: ☐ 0-10 cm SPMEs -or- ☐ 0-1 cm sediment-water interface SPMEs					
Vial ID	Composite Sample ID	Vial Weight - Without Fibers (g)	Discrete Sample ID	Fiber Notes	Vial Weight - With Fibers (g)

Notes:

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

Lower Duwamish Waterway Group

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

STATION COORDINATE LOG
For Van Veen

Project:_________________________________ **Recorder:**___________________________________

DATE	TIME	STATION	DROP NO.	LATITUDE	LONGITUDE	DEPTH (m)	RECOVERY DEPTH (cm)	COMMENTS

Representative Form
The format of the final form may be different and may evolve during the multi-year monitoring project.

INFAUNAL SAMPLE IDENTIFICATION AND SORTING SHEET

I. Sample Identification

Project Title ____________________ Survey ____________________

Location ____________________ Station __________ Replicate ____________________

Depth ________ Screen Size ________ Date Sample Collected ____________________

Sample Sed. Vol. (mL) ____________________ No./Type Contr. __________ Sampler __________

II. Sorting

Sort Criteria ________ % Sorted By ________ Date(s) Sorted ____________________

Total Sort Time ____________________ Total No. Animals ____________________

Sorter Comments ____

____

Distribution of Sorted Material

	# of Vials	# of Jars
Annelids	________	________
Bivalvia	________	________
Other Mollusca	________	________
Amphipods	________	________
Copepods	________	________
Other Crustaceans	________	________
Insects	________	________
Nematodes	________	________
Miscellaneous	________	________
________	________	________
________	________	________
________	________	________
________	________	________

III. Sorting QA/QC

Sort Criteria ____________________ %

QA/QC By ____________________ Pass/Re-Sort __________ Date __________

QA/QC Time ____________________ Re-Sort Time __________ Re-Sort Date __________

No. of Animals QA/QC ____________________

No. of Animals Re-Sort ____________________

IV. Sample Qualification Comments (Circle One)

1. Single Major Component:

Shellhash Tubes Wood Algae Seeds

Fibers Coarse Sand Fine Sand Pea Gravel Organic Material

Macrodetritus Other:________________

2. Comment: ____

____

____

____

____

____

____

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

CHAIN OF CUSTODY

Destination:	Sample Originator (Organization):	Report Results To:	Phone:
Destination Contact:	**PERSON WHO COLLECTED SAMPLE:**	Contact Name:	Fax:
Date:	Address:	Address:	Email:
Turn-Around-Time:			
Project Name:	Phone:		
	Fax:		
Contract/PO:	E-mail		

Analyses:

Invoicing To:

Comments or Special Instructions:

No.	Sample ID	Matrix	Volume & Type of Container	Date & Time							Preservation	Sample Temp Upon Receipt	LAB ID
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													

Representative Form

The format of the final form may be different and may evolve during the multi-year monitoring project.

Relinquished by:	Received by:	Relinquished by:	Received by:	Matrix Codes
Print Name:	Print Name:	Print Name:	Print Name:	SPME =
Signature:	Signature:	Signature:	Signature:	SB = Salt & Brackish Water
Affiliation:	Affiliation:	Affiliation:	Affiliation:	SS = Soil & Sediment
Date/Time:	Date/Time:	Date/Time:	Date/Time:	

DEVIATION FROM QAPP

Representative Form
The format of the final form may be different and may evolve during the multi-year monitoring project.

Nature of deviation:						
Reported by:		Date:		Documentation:	*e.g., field form, field log book, "attached"*	
Potential to impact study objectives: ❑ YES ❑ NO						
How:						
Assessed by:		Date:		Additional documentation attached:	❑ YES ❑ NO	
Is corrective action warranted: ❑ YES ❑ NO						
Rationale:						
Assessed by:		Date:		Additional documentation attached:	❑ YES ❑ NO	
Was corrective action taken: ❑ YES ❑ NO						
Was it successful:						
Assessed by:		Date:		Additional documentation attached:	❑ YES ❑ NO	
Project Team Approvals:	**QAO:**	*Signature and date*	**Additional Approvals:** (if warranted by the nature of the deviation.)	LDWG	*Signature and date*	
	ML:	*Signature and date*		EPA	*Signature and date*	
	PM:	*Signature and date*		Ecology	*Signature and date*	

ATTACHMENT B

Passive Sampling Method Development

Passive Sampling Method Development
Attachment B
QUALITY ASSURANCE PROJECT PLAN

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

FINAL

Prepared for:

The US Environmental Protection Agency
Region 10
Seattle, Washington

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, Washington

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
ENVIRON International Corporation
Floyd|Snider
Geosyntec Consultants

February 22, 2016

TABLE OF CONTENTS

FIGURES

TABLES

PASSIVE SAMPLING METHOD DEVELOPMENT
ATTACHMENT B TO THE
QUALITY ASSURANCE PROJECT PLAN

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 INTRODUCTION

Concentrations of dissolved polychlorinated biphenyl (PCB) congeners in sediment porewater will be measured at the subplots in the baseline and three monitoring events as described in the Quality Assurance Project Plan, to which this document is an attachment. The concentrations will be used to evaluate the potential additional reduction in available PCBs when activated carbon (AC) is present in the enhanced natural recovery (ENR) layer. Dissolved PCBs in sediment porewater will be measured by passive sampling with solid phase microextraction (SPME) fibers placed *in situ* within surface sediments (0 to 10 centimeters [cm]) below the sediment-water interface). This attachment supplies additional detail related to the design of the SPME monitoring, including the selection of Performance Reference Compounds and the estimated sensitivity of the SPME fibers as deployed in this study.

The SPME sampling method is principally based on equilibrium partitioning of PCB congeners between the polydimethylsiloxane (PDMS) coating on the SPME fiber and the sediment porewater. When deployed in sediment under static (unmixed) conditions, the PDMS absorbs PCBs. The concentration of PCBs in the PDMS increases with exposure time until the concentration reaches steady state equilibrium with the surrounding sediment porewater. If the concentration of a particular PCB congener in the PDMS is measured at steady state, the concentration of dissolved PCB in sediment porewater can be estimated by dividing the concentration of the PCB congener in the PDMS by a partition coefficient (obtained from literature sources).

Most PCB congeners require several weeks to several months to reach steady state concentrations in PDMS (or other passive sampling devices). The more hydrophobic PCBs require the longest sampling times, while the less hydrophobic PCBs reach steady state more rapidly. Unfortunately, it is not practical to leave samplers deployed at active river sites for more than a few weeks because shifting benthic conditions, ship traffic, or vandalism/theft would result in the loss of many samplers. To shorten sampling time, while still producing useable data, Performance Reference Compounds (PRCs) can be impregnated into the PDMS prior to deployment so that the *in situ* sampling rates can be quantified. The rates of desorption of the PRCs can be applied to the measured concentrations in PDMS to provide estimates of the concentrations of PCBs that would have been present at steady state had the sampler been allowed to remain *in situ* for several weeks or months. For example, if a sampler loses approximately 50% of the concentration of a PRC during its deployment time, concentrations of PCBs with similar hydrophobicities that have absorbed into the sampler from the sediment porewater could be multiplied by 2 to estimate steady state concentrations. As noted above, this steady state concentration is used to determine the concentration of dissolved PCB in sediment porewater. For this approach to be most accurate, a general rule is at least 20% of the concentrations of a PRC should be lost from the SPME during the deployment time (i.e., the sampling conditions indicate at least 20% of steady state is obtained).

The most hydrophobic PCBs (nona- and decachlorinated biphenyls) are not likely to attain at least 20% of steady state during a practical for deployment time (1 month) for the Lower Duwamish Pilot Study. At the other end of the spectrum, the PCB congeners with the least number of chlorines (e.g. mono- and dichlorinated biphenyls) tend to be relatively water soluble and do not sorb to PDMS strongly. Although the concentrations of mono- and dichlorinated biphenyls are likely reach at steady state within a 1-month deployment time in the Lower Duwamish, they may not be present at concentrations in the PDMS above method detection limits.

It is not practical or necessary to design a one-size-fits all sampler to measure all PCBs. The purpose of this document is to evaluate the outcome of potentially low accuracy (for nona- and decachlorinated biphenyls) and relatively high method detection limits (for mono- and dichlorinated biphenyls) on study objectives related to measuring dissolved concentrations of PCBs in sediment porewater. Additionally, the document confirms the sampler design sensitivity for the tri-, tetra-, penta-, hexa-, hepta-, and octachlorinated biphenyls.

2.0 MEASURED CONCENTRATIONS OF PCBS CONGENERS IN LOWER DUWAMISH ENVIRONMENTAL SAMPLES

The ultimate use for the concentration of dissolved PCBs in sediment porewater is to evaluate the change in PCB availability expected as a result of adding activated carbon to an Enhanced Natural Recovery (ENR) layer. The premise is this reduction in availability relates directly to a reduction in the concentration of PCBs in organisms that will inhabit the ENR layers, resulting in an overall decrease in environmental risk to humans and wildlife. This section evaluates the PCB congener composition of PCBs detected in Lower Duwamish tissues to understand which groups of PCB congeners are most bioaccumulative and/or present at the highest levels. This section also includes a prediction of concentrations of PCBs congeners in sediment porewater. Data were obtained from samples of tissues from the Lower Duwamish Waterway and sediments in the Pilot Study plot locations, as provided in the EIM, Boeing, and LDWG databases.

2.1 Measured Concentrations of PCBs in Tissue

The concentrations of tri-, tetra-, penta-, hexa-, hepta-, and octachlorinated biphenyls comprise 99.7% of total PCBs in fish and invertebrate tissues measured throughout the Lower Duwamish Waterway. The concentration of PCB homologs in fish tissue (Table 1.a.), as referenced from the EIM and LDWG databases, were used to calculate the percent contribution of PCB homologs in total PCBs (Table 1.b.). The average percent contribution of each homolog to total PCBs in fish tissue is shown in Figure 1 below. The percent contribution of each homolog in total PCBs in invertebrate tissue is similar to fish tissue, as shown in Figure 2 (Tables 2.a. and 2.b.).

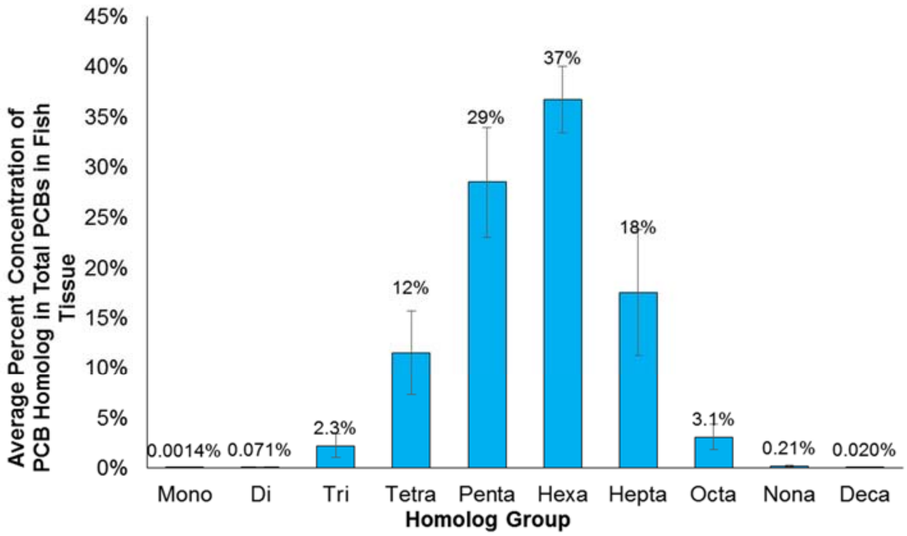


Figure 1. Average Percent Contribution of Each Homolog in Total PCBs in Fish Tissue

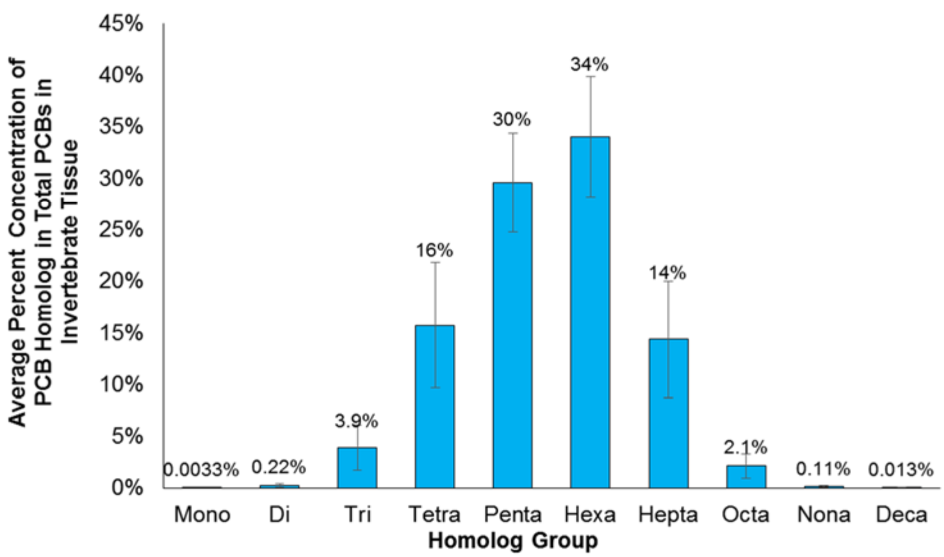


Figure 2. Average Percent Contribution of Each Homolog in Total PCBs in Invertebrate Tissue

2.2 MEASURED CONCENTRATIONS OF PCBS IN SEDIMENT

Concentrations of PCBs in surface sediment were measured at two sample locations in the scour plot, three sample locations in subtidal plot, and 4 sample locations in intertidal plot (Figure 3). The concentrations of PCB congeners measured in the surface sediment (from 0 cm to 10 cm or 60.96 cm below sediment-water interface) were referenced from the Boeing, EIM, and LDWG databases (Table 3). The concentration of PCB homologs in surface sediment (Table 4.a.) were used to calculate the percent contribution of each homolog to the concentration of total PCBs (Table 4.b.) by sample. The average percent contribution was adjusted to total 100% since the number of detected PCB congeners was not consistent among the samples (Table 4.c.). The tri- to octachlorinated biphenyls comprise 98.8% of the total quantified PCBs in surface sediments of the plots (Figure 4).

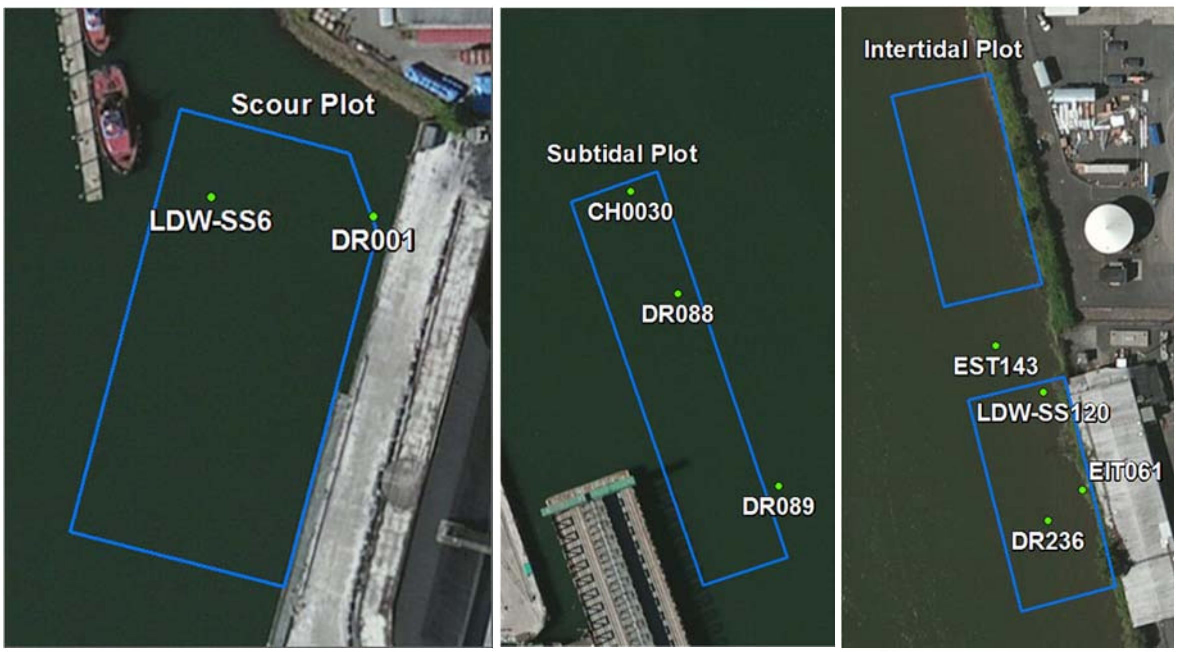


Figure 3. Sample Locations of the Sediment Samples in Plot Areas

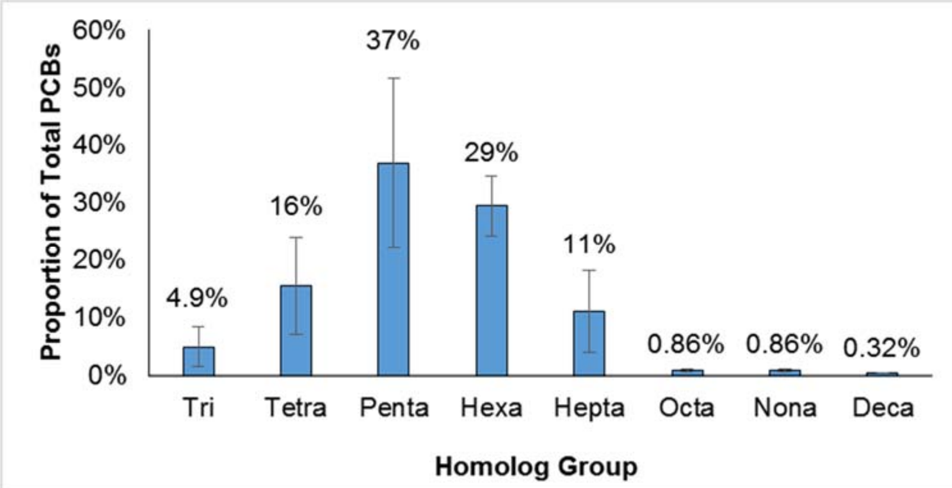


Figure 4. Average Proportion of Each Homolog Group in Total PCBs in Sediment

3.0 PREDICTED CONCENTRATIONS OF PCBS CONGENERS IN LOWER DUWAMISH SEDIMENT POREWATER

Using the sediment PCB data described above, a two-carbon model was used to estimate concentrations of dissolved tri- to octachlorinated biphenyls in sediment porewater as referenced from Perron et al. (2010). The model is principally based on the assumption that the fraction of nonpyrogenic organic carbon and black carbon are responsible for the sorption of PCBs to sediments (Hawthorne et al. 2011). The model estimates concentrations of PCBs in porewater based on the concentrations of PCBs in sediment, the fraction of nonpyrogenic organic carbon in sediment, the fraction of black carbon in sediment, and the partitioning coefficients for nonpyrogenic organic carbon and black carbon.

Total organic carbon content at the sample locations shown in Figure 3 were referenced from the Boeing and LDWG databases. The average black carbon content was referenced from *Assessing Bioavailability of Sediment Contaminants to Support Selecting Remedies* (Wakeman 2014). To calculate the concentration of dissolved PCBs in sediment porewater (C_d), the concentration of PCB congeners in the sediment (C_S) at sample locations in the plot areas (Figure 3, Table 5.a.) are divided by the sum of the product of the fraction of nonpyrogenic organic carbon (f_{NPOC}) and the partition coefficient of nonpyrogenic organic carbon (K_{NPOC}) and the product of the fraction of black carbon (f_{BC}) and the partition coefficient of black carbon (K_{BC}, Table 5.b). The equation for the two carbon model is shown in Equation 1 below.

Equation 1

$$C_d = \frac{C_S}{(f_{NPOC}K_{NPOC} + f_{BC}K_{BC})}$$

The K_{NPOC} and K_{BC} are calculated as shown in Equations 2 and 3 below, as referenced from Hawker and Connell (1988) and Hawthorne et al (2011).

Equation 2

$$Log\ K_{OC} = 0.74 \times Log\ K_{OW} + 0.15$$

Equation 3

$$Log\ K_{BC} = 0.91 \times Log\ K_{OW} + 1.37$$

K_{NPOC} is assumed to be equal to the partition coefficient for organic carbon (K_{OC}). K_{OW} is the octanol-water partition coefficient (Hawker and Connell 1988).

The predicted concentrations of PCBs in sediment porewater (Table 5.b) are difficult to interpret due to widely ranging detection limits for PCB congeners in the sediment samples. However, some information can be gleaned from examining samples with detectable levels of PCBs. For example, the average concentration of the tri- to octachlorinated congeners in sediment porewater are estimated to be approximately 970 picograms per liter (pg/L), 740 pg/L, 1,300 pg/L, 390 pg/L, 60 pg/L, and 4 pg/L for tri-, tetra-, penta-, hexa-, hepta-, and octachlorinated biphenyls, respectively. These are likely to represent approximate values for porewater that will be encountered in the baseline monitoring event.

4.0 AVERAGE METHOD DETECTION LIMITS FOR DISSOLVED PCB CONGENERS IN SEDIMENT POREWATER

This section estimates the approximate minimum concentrations of dissolved PCB congeners that will be detectable using the SPME method that has been proposed for the Pilot Study. Average method detection limits (MDLs) for dissolved PCB congeners in sediment porewater were estimated based on Frontier Analytical Laboratory method detection limit for analysis of PCB congeners by gas chromatography (United States Environmental Protection Agency [US EPA] Method 1668). The PCB congeners sorbed to PDMS during field deployment will be extracted in 1,800 microliters (µL) of hexane. The hexane extract is concentrated by Frontier Analytical Laboratories to approximately 100 µL, of which 1 µL is injected into the GC for analysis. This method has a detection limit of 5 picograms per 100 µL concentrated extract (0.5 ng).

The average concentration of tri- to octachlorinated biphenyls in porewater at equilibrium was calculated based on the volume of PDMS and the approximate average PDMS fiber partition coefficient (K_{fs}, Smedes et al. 2009) as shown in Equations 4 and 5.

Equation 4

$$C_{PDMS} = \frac{MDL}{Volume\ PDMS}$$

Equation 5

$$C_{PW} = \frac{C_{PDMS}}{K_{fs}}$$

C_{PDMS} is the concentration in PDMS and C_{PW} is the concentration in porewater. This is the lowest achievable method detection limit using 480 cm length of SPME fibers with a 10-micrometer (µm) thick PDMS coating. The field deployment will be for a duration of 4 weeks. Steady state equilibrium will not be reached after 4 weeks deployment. The percent to steady state concentration attained during the deployment period was estimated based on the sampling results from a SPME passive sampling event at an activated carbon demonstration site in Bremerton, Washington.

Approximate method detection limits for the proposed SPME deployment are shown in Table 6. The 4-week exposure is sufficient to detect approximate concentrations of dissolved concentrations of 70, 30, 15, 8, 5, and 3 pg/L for tri-, tetra-, penta-, hexa-, hepta-, and octachlorinated biphenyls, respectively. These levels are approximate and actual method detection limits will vary based on the characteristics of individual PCB congeners, site conditions that affect sampling rate, the amount of SPME fiber recovered (Table 6 assumes all 6 composite fiber subsamples will be available to comprise the 480-cm composite sample), and analytical conditions during quantification of the PCBs. Octachlorinated biphenyls absorbing into the SPME are predicted to only reach approximately 15% of steady state concentrations during the 4-week deployment. This is less than the ideal level of 20%, and thus, results of octachlorinated biphenyls may be flagged as estimated. This slight imprecision is not expected to interfere with the comparison of total dissolved PCBs in sediment porewater between the ENR and ENR+AC subplots at each location, as octachlorinated biphenyls are estimated to only comprise approximately 0.1% of the predicted concentrations of total PCBs in porewater (Table 5.c).

As shown in Table 6, approximate average MDLs for dissolved PCB congeners in sediment porewater using the SPME approach proposed for the Pilot Study are adequate to detect the average predicted concentration of dissolved PCBs present in sediment porewater predicted to be encountered during the baseline monitoring event. Additionally, assuming the baseline concentrations of dissolved PCBs in sediment porewater are reduced by approximately 80 to 90% by the ENR and/or ENR+AC treatments, the SPME approach MDLs are also adequate to detect expected concentrations of tri-, tetra-, penta-, hexa-, and heptachlorinated biphenyls following application of the amendment (Table 6). Concentrations of post-treatment octachlorinated biphenyls in sediment porewater may be below the detection limit. As noted above, octachlorinated biphenyls are estimated to comprise a contribution to total PCBs in porewater that is relatively inconsequential with regards to Pilot Study goals.

5.0 CONCLUSIONS

From a review of the best available PCB congener data in organism tissue and sediment, the proposed SPME method for measuring dissolved PCBs in sediment porewater will be adequate for providing high quality data for meeting Pilot Study objectives in comparing PCB availability between the ENR and ENR+AC treatments.

The proposed SPME method is optimized for monitoring tri-, tetra-, penta-, hexa-, hepta-, and octachlorinated biphenyls. Congeners belonging to these PCB homolog groups represent approximately 99.7% of the PCBs found in organisms in the Lower Duwamish. Thus, these compounds represent those driving PCB risk concerns associated with aquatic organism, wildlife, and human exposures, and are most important for evaluating potential sediment remedies. Although mono-, di-, nona-, and decachlorinated biphenyls will be measured with the proposed SPME method, data for these compounds may be semi-quantitative or limited by high detection limits due to the SPME passive sampling method selected for this Pilot Study. Data of higher uncertainty for mono-, di-, nona-, and decachlorinated biphenyls will not compromise Pilot Study objectives in comparing PCB availability between the ENR and ENR+AC treatments. Additionally, attempting to optimize the method to capture these relatively inconsequential compounds would jeopardize the overall study due to the extremely long *in situ* sampler deployment times needed for nona- and decachlorinated biphenyls as well as complicate sampling to incorporate multiple sampler configurations to provide additional sampler types needed to capture mono- and dichlorinated biphenyls.

6.0 REFERENCES

Hawker, D.W. and D.W. Connell. 1988. Octanol-Water Partition Coefficients of Polychlorinated Biphenyl Congeners. Environ. Sci. Technol. 1988, 22, 382-387.

Hawthorne, S.B., C.B. Grabanski, D.J. Miller, and H.P.H. Arp. 2011. Improving Predictability of Sediment-Porewater Partitioning Models using Trends Observed with PCB-Contaminated Field Sediments. Environ. Sci. Technol. 2011, 45, 7365–7371.

Perron, M.M., R.M. Burgess, K.T. Ho, M.C. Pelletier, M.G. Cantwell, and J.P. Shine. 2010. Bioavailability Assessment of a Contaminated Field Sediment from Patrick Bayou, Texas, USA: Toxicity Identification Evaluation and Equilibrium Partitioning. Environmental Toxicology and Chemistry 29(3): 742–750.

Smedes, F., R.W. Geertsma, T. Van Der Zande, and K. Booji. 2009. Polymer-Water Partition Coefficients of Hydrophobic Compounds for Passive Sampling: Application of Cosolvent Models for Validation. Environ. Sci. Technol. 2009, 43, 7047–7054.

Wakeman, J. 2014. Assessing Bioavailability of Sediment Contaminants to Support Selecting Remedies. Presentation. Seattle District. 2014 Environmental Cleanup Conference. 9 June 2014.

TABLES

Table 1a: Concentration of PCB Homolog in Fish Tissue by Sample (ng/kg, ww) [1]

Sample ID	Species	Homolog Group										
		Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca	Total
07DU-ESM01	Parophrys vetulus	4.52	88	2,742	26,852	92,465	121,397	57,372	13,057	1,325	236	315,539
07DU-ESM02	Parophrys vetulus	3.51	100	2,995	28,182	81,753	103,358	52,230	10,465	967	168	280,221
07DU-ESM03	Parophrys vetulus	3.46	82	2,673	24,969	87,547	125,301	60,264	13,838	1,382	225	316,285
07DU-ESM04	Parophrys vetulus	3.88	80	2,561	28,353	105,987	161,805	77,707	17,997	1,704	263	396,460
07DU-ESM05	Parophrys vetulus	3.84	93	2,292	24,031	84,109	116,773	63,381	15,350	1,491	208	307,732
07DU-ESM06	Parophrys vetulus	5.76	88	2,461	22,479	77,426	114,826	50,228	9,691	965	165	278,336
LDW-05-T1-B-SS-WB-Comp1	Shiner perch	13.56	375	13,982	68,601	190,836	283,682	104,066	20,116	1,488	161	683,320
LDW-05-T1-M-ES-WB-Comp3	English sole	20.17	921	33,787	262,471	766,738	987,564	428,793	98,298	10,809	1,050	2,590,451
LDW-05-T2-B-SS-WB-Comp1	Shiner perch	16.51	375	16,603	111,445	321,218	412,423	154,188	29,083	1,840	170	1,047,361
LDW-05-T2-M-ES-WB-Comp3	English sole	38.82	2,065	65,911	411,383	985,856	1,175,233	481,549	86,205	5,781	596	3,214,617
LDW-05-T3-D-SS-WB-Comp1	Shiner perch	26.53	682	23,737	150,153	511,759	844,607	432,996	80,186	4,108	179	2,048,433
LDW-05-T3-M-ES-WB-Comp2	English sole	24.52	1,133	30,414	191,464	461,255	531,682	180,892	34,408	1,802	273	1,433,347
LDW-07-T1-B-SS-WB-comp1	Cymatogaster aggregata	15.99	282	7,848	38,552	203,827	401,184	277,179	42,664	3,081	213	974,845
LDW-07-T1-C-SS-WB-comp1	Cymatogaster aggregata	8.81	189	7,275	42,905	127,876	208,044	98,709	18,372	1,364	143	504,885
LDW-07-T1-M-ES-WB-comp3	Parophrys vetulus	7.16	487	15,300	106,257	305,116	462,803	224,177	46,488	4,353	549	1,165,537
LDW-07-T1-M-ES-WB-comp5	Parophrys vetulus	20.31	582	12,993	58,610	170,555	318,789	173,292	35,981	3,223	378	774,423
LDW-07-T2-A-ES-WB-comp2	Parophrys vetulus	10.49	1,327	41,548	230,574	510,838	578,849	226,215	40,588	2,723	277	1,632,950
LDW-07-T2-A-ES-WB-comp4	Parophrys vetulus	17.23	1,140	27,597	116,290	464,692	632,464	304,897	52,395	3,344	405	1,603,240
LDW-07-T2-B-SS-WB-comp1	Cymatogaster aggregata	10.99	203	7,125	38,394	101,569	156,855	81,453	15,185	1,068	105	401,968
LDW-07-T2-E-SS-WB-comp1	Cymatogaster aggregata	22.63	418	9,650	40,246	141,113	267,285	161,756	26,755	1,464	126	648,836
LDW-07-T3-E-SS-WB-comp1	Cymatogaster aggregata	9.18	224	6,134	32,412	141,479	487,244	368,426	65,188	2,721	107	1,103,944
LDW-07-T3-F-SS-WB-comp1	Cymatogaster aggregata	43.78	589	10,713	79,874	378,550	905,202	896,036	182,974	8,819	164	2,462,964
LDW-07-T3-M-ES-WB-comp4	Parophrys vetulus	34.00	2,035	57,673	255,547	906,908	1,106,136	520,198	74,714	4,807	429	2,928,481
LDW-07-T3-M-ES-WB-comp6	Parophrys vetulus	8.39	650	19,084	97,878	252,272	370,003	191,139	39,759	2,716	283	973,793
LDW-M-M-0843	Rhacochilus vacca	3.05	87	6,197	28,358	62,993	64,684	24,938	4,250	484	42	192,036
LDW-M-M-9739	Embiotoca lateralis	3.24	99	7,564	45,142	128,536	169,552	78,805	12,026	614	38	442,379
LDW-M-M-PP-FL-comp-1	Pile perch	3.06	87	6,214	28,366	63,153	64,751	24,941	4,251	485	42	192,292
LDW-M-M-SP-FL-comp-1	Striped perch	3.25	99	7,564	45,142	128,536	169,552	78,805	12,026	614	38	442,379
LDW-T1-A0448	Cymatogaster aggregata	4.96	275	17,019	91,510	207,035	257,978	108,115	17,029	1,082	126	700,173
LDW-T1-A-SS-WB-comp-1	Shiner perch	4.96	275	17,019	91,510	207,035	257,978	108,115	17,029	1,082	126	700,173
LDW-T1-D7136	Leptocottus armatus	5.74	542	17,352	66,647	137,114	185,801	105,366	18,533	1,091	76	532,526
LDW-T1-D-PS-WB-comp-1	Pacific Staghorn Sculpin	5.75	542	17,352	66,647	137,114	185,801	105,366	18,533	1,091	76	532,526
LDW-T1-F2000	Cymatogaster aggregata	14.85	382	25,353	119,517	269,122	308,500	129,823	22,515	1,429	140	876,795
LDW-T1-F4288	Leptocottus armatus	5.45	416	16,620	84,578	189,409	246,845	111,202	18,366	1,105	105	668,651
LDW-T1-F-PS-WB-comp-1	Pacific Staghorn Sculpin	5.46	416	16,620	84,578	189,409	246,845	111,202	18,366	1,105	105	668,651
LDW-T1-F-SS-WB-comp-1	Shiner perch	14.85	382	25,353	119,517	269,122	308,500	129,823	22,515	1,429	140	876,795
LDW-T1-M4762	Parophrys vetulus	28.93	1,348	39,921	187,711	351,610	374,610	134,607	27,213	2,339	257	1,119,645
LDW-T1-M4763	Parophrys vetulus	18.08	966	32,112	138,726	253,208	297,922	112,334	19,916	1,513	190	856,904
LDW-T1-M5683	Parophrys vetulus	29.90	5,314	132,679	462,573	755,006	769,484	296,838	55,029	4,178	401	2,481,532
LDW-T1-M5693	Parophrys vetulus	17.96	1,939	58,186	263,503	510,404	532,658	206,079	38,561	2,970	290	1,614,608
LDW-T1-M-ES-FL-comp-1	English sole	28.93	1,348	39,921	187,711	351,610	374,610	134,607	27,213	2,339	257	1,119,645
LDW-T1-M-ES-FL-comp-2	English sole	19.56	967	32,180	138,829	253,420	298,072	112,508	19,933	1,518	190	857,636
LDW-T1-M-ES-WB-comp-2	English sole	17.96	1,939	58,186	263,503	510,404	532,658	206,079	38,561	2,970	290	1,614,608
LDW-T1-M-ES-WB-comp-4	English sole	29.90	5,314	132,679	462,573	755,006	769,484	296,838	55,029	4,178	401	2,481,532
LDW-T2-B7328	Cymatogaster aggregata	17.26	487	16,855	117,785	399,015	352,740	143,844	22,817	1,862	136	1,055,559
LDW-T2-B-SS-WB-comp-1	Shiner perch	17.26	487	16,855	117,785	399,015	352,740	143,844	22,817	1,862	136	1,055,559
LDW-T2-C1168	Leptocottus armatus	9.45	438	11,124	59,467	141,265	178,211	78,910	11,510	651	56	481,642
LDW-T2-C-PS-WB-comp-1	Pacific Staghorn Sculpin	9.45	438	11,124	59,467	141,265	178,211	78,910	11,510	651	56	481,642
LDW-T2-E6032	Cymatogaster aggregata	36.21	9,317	398,680	2,348,658	5,363,843	3,402,790	632,154	68,558	3,935	221	12,228,192
LDW-T2-E-SS-WB-comp-1	Shiner perch	36.21	9,317	398,680	2,348,658	5,363,843	3,402,790	632,154	68,558	3,935	221	12,228,192
LDW-T2-F9744	Leptocottus armatus	3.53	273	8,922	62,141	148,660	178,882	84,207	12,610	707	55	496,462
LDW-T2-F-PS-WB-comp-1	Pacific Staghorn Sculpin	3.53	273	8,922	62,141	148,660	178,882	84,207	12,610	707	55	496,462

Table 1a: Concentration of PCB Homolog in Fish Tissue by Sample (ng/kg, ww) [Continued]

		Homolog Group										
Sample ID	Species	Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca	Total
LDW-T2-M1140	Parophrys vetulus	29.09	3,360	87,085	385,616	678,093	687,883	238,749	42,468	2,791	280	2,126,354
LDW-T2-M1150	Parophrys vetulus	20.99	2,266	73,877	370,789	825,624	962,627	400,184	71,746	4,579	456	2,712,170
LDW-T2-M8394	Parophrys vetulus	16.19	989	33,501	183,493	432,624	427,022	161,859	27,402	2,037	224	1,269,166
LDW-T2-M8395	Parophrys vetulus	23.93	1,409	45,926	221,571	405,571	397,049	162,142	29,030	1,871	193	1,264,785
LDW-T2-M-ES-FL-comp-1	English sole	16.19	989	33,501	183,493	432,624	427,022	161,859	27,402	2,037	224	1,269,166
LDW-T2-M-ES-FL-comp-2	English sole	23.93	1,409	45,926	221,571	405,571	397,049	162,142	29,030	1,871	193	1,264,785
LDW-T2-M-ES-WB-comp-3	English sole	20.99	2,266	73,877	370,789	825,624	962,627	400,184	71,746	4,579	456	2,712,170
LDW-T2-M-ES-WB-comp-5	English sole	29.09	3,360	87,085	385,616	678,093	687,883	238,749	42,468	2,791	280	2,126,354
LDW-T3-C4336	Cymatogaster aggregata	69.10	1,097	13,409	82,233	278,421	371,369	221,089	39,825	2,062	118	1,009,692
LDW-T3-C-SS-WB-comp-1	Shiner perch	69.10	1,097	13,409	82,233	278,421	371,369	221,089	39,825	2,062	118	1,009,692
LDW-T3-D8048	Leptocottus armatus	10.50	322	11,333	101,787	397,417	717,509	546,213	123,724	6,646	118	1,905,079
LDW-T3-D-PS-WB-comp-1	Pacific Staghorn Sculpin	9.70	315	11,344	101,899	397,735	718,149	547,433	123,834	6,652	118	1,907,489
LDW-T3-E1488	Cymatogaster aggregata	15.66	474	16,036	101,771	747,717	3,565,751	3,129,729	438,905	13,030	188	8,013,617
LDW-T3-E3776	Leptocottus armatus	18.02	416	10,330	58,034	197,349	445,449	286,768	47,622	2,115	76	1,048,177
LDW-T3-E-PS-WB-comp-1	Pacific Staghorn Sculpin	18.02	416	10,330	58,034	197,349	445,449	286,768	47,622	2,115	76	1,048,177
LDW-T3-E-SS-WB-comp-1	Shiner perch	15.66	474	16,036	101,771	747,717	3,565,751	3,129,729	438,905	13,030	188	8,013,617
LDW-T3-F2912	Cymatogaster aggregata	15.92	458	17,091	151,741	772,501	1,279,993	1,066,913	221,802	11,370	197	3,522,082
LDW-T3-F-SS-WB-comp-1	Shiner perch	15.92	458	17,091	151,741	772,501	1,279,993	1,066,913	221,802	11,370	197	3,522,082
LDW-T3-M3850	Parophrys vetulus	3.80	364	11,624	68,472	189,859	236,235	112,359	20,249	1,281	107	640,553
LDW-T3-M3851	Parophrys vetulus	16.44	808	30,567	152,835	338,624	350,517	127,191	21,096	1,327	108	1,023,090
LDW-T3-M6605	Parophrys vetulus	19.09	1,108	34,446	176,676	431,125	521,158	216,235	36,420	2,258	236	1,419,681
LDW-T3-M6606	Parophrys vetulus	15.95	1,554	44,500	262,335	709,784	961,136	407,190	67,732	3,478	246	2,457,969
LDW-T3-M-ES-FL-comp-1	English sole	3.73	363	11,637	68,596	190,025	236,411	112,440	20,265	1,281	107	641,130
LDW-T3-M-ES-FL-comp-2	English sole	16.44	808	30,567	152,835	338,624	350,517	127,191	21,096	1,327	108	1,023,090
LDW-T3-M-ES-WB-comp-2	English sole	19.09	1,108	34,446	176,676	431,125	521,158	216,235	36,420	2,258	236	1,419,681
LDW-T3-M-ES-WB-comp-3	English sole	15.95	1,554	44,500	262,335	709,784	961,136	407,190	67,732	3,478	246	2,457,969
LDW-T4-B9056	Cymatogaster aggregata	5.40	341	13,993	80,837	227,731	299,293	125,329	20,129	1,746	299	769,704
LDW-T4-B-SS-WB-comp-1	Shiner perch	5.41	341	13,993	80,837	227,731	299,293	125,329	20,129	1,746	299	769,704
LDW-T4-C5216	Leptocottus armatus	3.20	167	5,204	32,916	103,411	140,068	58,278	8,998	526	39	349,610
LDW-T4-C-PS-WB-comp-1	Pacific Staghorn Sculpin	3.22	167	5,204	32,916	103,411	140,068	58,278	8,998	526	39	349,610
LDW-T4-D3795	Leptocottus armatus	5.23	417	12,597	62,152	148,182	185,885	82,353	12,668	718	53	505,030
LDW-T4-D6080	Cymatogaster aggregata	8.07	420	11,350	51,192	147,954	211,101	94,997	14,504	918	77	532,521
LDW-T4-D-PS-WB-comp-2	Pacific Staghorn Sculpin	5.24	417	12,597	62,152	148,182	185,885	82,353	12,668	718	53	505,030
LDW-T4-D-SS-WB-comp-1	Shiner perch	8.07	420	11,350	51,192	147,954	211,101	94,997	14,504	918	77	532,521
LDW-T4-M1382	Platichthys stellatus	5.49	481	14,555	52,738	85,018	98,437	37,375	6,082	475	53	295,221
LDW-T4-M2518	Parophrys vetulus	3.56	435	13,258	65,968	160,929	180,501	75,618	12,451	769	96	510,028
LDW-T4-M4096	Platichthys stellatus	7.84	663	17,208	65,279	129,026	163,297	68,693	12,932	885	109	458,099
LDW-T4-M5232	Parophrys vetulus	17.01	1,445	44,882	211,338	420,555	464,487	185,649	31,127	1,862	149	1,361,510
LDW-T4-M-ES-FL-comp-1	English sole	3.58	435	13,258	65,968	160,929	180,501	75,618	12,451	769	96	510,028
LDW-T4-M-ES-WB-comp-1	English sole	17.01	1,445	44,882	211,338	420,555	464,487	185,649	31,127	1,862	149	1,361,510
LDW-T4-M-SF-FL-comp-1	Starry Flounder	5.50	481	14,555	52,738	85,018	98,437	37,375	6,082	475	53	295,221
LDW-T4-M-SF-WB-comp-1	Starry Flounder	7.85	663	17,208	65,279	129,026	163,297	68,693	12,932	885	109	458,100
	Average	**15.24**	**1,021**	**33,254**	**175,749**	**435,767**	**540,951**	**274,180**	**46,613**	**2,625**	**191**	**1,510,366**
	Standard Deviation	**12.44**	**1,545**	**59,496**	**338,438**	**766,669**	**686,788**	**468,758**	**70,430**	**2,694**	**147**	**2,038,084**

Table 1b: Percent Concentration of PCB Homolog in Total PCBs in Fish Tissue by Sample (%) [2]

Sample ID	Species	Homolog Group									
		Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca
07DU-ESM01	Parophrys vetulus	0%	0%	1%	9%	29%	38%	18%	4%	0%	0%
07DU-ESM02	Parophrys vetulus	0%	0%	1%	10%	29%	37%	19%	4%	0%	0%
07DU-ESM03	Parophrys vetulus	0%	0%	1%	8%	28%	40%	19%	4%	0%	0%
07DU-ESM04	Parophrys vetulus	0%	0%	1%	7%	27%	41%	20%	5%	0%	0%
07DU-ESM05	Parophrys vetulus	0%	0%	1%	8%	27%	38%	21%	5%	0%	0%
07DU-ESM06	Parophrys vetulus	0%	0%	1%	8%	28%	41%	18%	3%	0%	0%
LDW-05-T1-B-SS-WB-Comp1	Shiner perch	0%	0%	2%	10%	28%	42%	15%	3%	0%	0%
LDW-05-T1-M-ES-WB-Comp3	English sole	0%	0%	1%	10%	30%	38%	17%	4%	0%	0%
LDW-05-T2-B-SS-WB-Comp1	Shiner perch	0%	0%	2%	11%	31%	39%	15%	3%	0%	0%
LDW-05-T2-M-ES-WB-Comp3	English sole	0%	0%	2%	13%	31%	37%	15%	3%	0%	0%
LDW-05-T3-D-SS-WB-Comp1	Shiner perch	0%	0%	1%	7%	25%	41%	21%	4%	0%	0%
LDW-05-T3-M-ES-WB-Comp2	English sole	0%	0%	2%	13%	32%	37%	13%	2%	0%	0%
LDW-07-T1-B-SS-WB-comp1	Cymatogaster aggregata	0%	0%	1%	4%	21%	41%	28%	4%	0%	0%
LDW-07-T1-C-SS-WB-comp1	Cymatogaster aggregata	0%	0%	1%	8%	25%	41%	20%	4%	0%	0%
LDW-07-T1-M-ES-WB-comp3	Parophrys vetulus	0%	0%	1%	9%	26%	40%	19%	4%	0%	0%
LDW-07-T1-M-ES-WB-comp5	Parophrys vetulus	0%	0%	2%	8%	22%	41%	22%	5%	0%	0%
LDW-07-T2-A-ES-WB-comp2	Parophrys vetulus	0%	0%	3%	14%	31%	35%	14%	2%	0%	0%
LDW-07-T2-A-ES-WB-comp4	Parophrys vetulus	0%	0%	2%	7%	29%	39%	19%	3%	0%	0%
LDW-07-T2-B-SS-WB-comp1	Cymatogaster aggregata	0%	0%	2%	10%	25%	39%	20%	4%	0%	0%
LDW-07-T2-E-SS-WB-comp1	Cymatogaster aggregata	0%	0%	1%	6%	22%	41%	25%	4%	0%	0%
LDW-07-T3-E-SS-WB-comp1	Cymatogaster aggregata	0%	0%	1%	3%	13%	44%	33%	6%	0%	0%
LDW-07-T3-F-SS-WB-comp1	Cymatogaster aggregata	0%	0%	0%	3%	15%	37%	36%	7%	0%	0%
LDW-07-T3-M-ES-WB-comp4	Parophrys vetulus	0%	0%	2%	9%	31%	38%	18%	3%	0%	0%
LDW-07-T3-M-ES-WB-comp6	Parophrys vetulus	0%	0%	2%	10%	26%	38%	20%	4%	0%	0%
LDW-M-M-0843	Rhacochilus vacca	0%	0%	3%	15%	33%	34%	13%	2%	0%	0%
LDW-M-M-9739	Embiotoca lateralis	0%	0%	2%	10%	29%	38%	18%	3%	0%	0%
LDW-M-M-PP-FL-comp-1	Pile perch	0%	0%	3%	15%	33%	34%	13%	2%	0%	0%
LDW-M-M-SP-FL-comp-1	Striped perch	0%	0%	2%	10%	29%	38%	18%	3%	0%	0%
LDW-T1-A0448	Cymatogaster aggregata	0%	0%	2%	13%	30%	37%	15%	2%	0%	0%
LDW-T1-A-SS-WB-comp-1	Shiner perch	0%	0%	2%	13%	30%	37%	15%	2%	0%	0%
LDW-T1-D7136	Leptocottus armatus	0%	0%	3%	13%	26%	35%	20%	3%	0%	0%
LDW-T1-D-PS-WB-comp-1	Pacific Staghorn Sculpin	0%	0%	3%	13%	26%	35%	20%	3%	0%	0%
LDW-T1-F2000	Cymatogaster aggregata	0%	0%	3%	14%	31%	35%	15%	3%	0%	0%
LDW-T1-F4288	Leptocottus armatus	0%	0%	2%	13%	28%	37%	17%	3%	0%	0%
LDW-T1-F-PS-WB-comp-1	Pacific Staghorn Sculpin	0%	0%	2%	13%	28%	37%	17%	3%	0%	0%
LDW-T1-F-SS-WB-comp-1	Shiner perch	0%	0%	3%	14%	31%	35%	15%	3%	0%	0%
LDW-T1-M4762	Parophrys vetulus	0%	0%	4%	17%	31%	33%	12%	2%	0%	0%
LDW-T1-M4763	Parophrys vetulus	0%	0%	4%	16%	30%	35%	13%	2%	0%	0%
LDW-T1-M5683	Parophrys vetulus	0%	0%	5%	19%	30%	31%	12%	2%	0%	0%
LDW-T1-M5693	Parophrys vetulus	0%	0%	4%	16%	32%	33%	13%	2%	0%	0%
LDW-T1-M-ES-FL-comp-1	English sole	0%	0%	4%	17%	31%	33%	12%	2%	0%	0%
LDW-T1-M-ES-FL-comp-2	English sole	0%	0%	4%	16%	30%	35%	13%	2%	0%	0%
LDW-T1-M-ES-WB-comp-2	English sole	0%	0%	4%	16%	32%	33%	13%	2%	0%	0%
LDW-T1-M-ES-WB-comp-4	English sole	0%	0%	5%	19%	30%	31%	12%	2%	0%	0%
LDW-T2-B7328	Cymatogaster aggregata	0%	0%	2%	11%	38%	33%	14%	2%	0%	0%
LDW-T2-B-SS-WB-comp-1	Shiner perch	0%	0%	2%	11%	38%	33%	14%	2%	0%	0%
LDW-T2-C1168	Leptocottus armatus	0%	0%	2%	12%	29%	37%	16%	2%	0%	0%
LDW-T2-C-PS-WB-comp-1	Pacific Staghorn Sculpin	0%	0%	2%	12%	29%	37%	16%	2%	0%	0%
LDW-T2-E6032	Cymatogaster aggregata	0%	0%	3%	19%	44%	28%	5%	1%	0%	0%
LDW-T2-E-SS-WB-comp-1	Shiner perch	0%	0%	3%	19%	44%	28%	5%	1%	0%	0%
LDW-T2-F9744	Leptocottus armatus	0%	0%	2%	13%	30%	36%	17%	3%	0%	0%
LDW-T2-F-PS-WB-comp-1	Pacific Staghorn Sculpin	0%	0%	2%	13%	30%	36%	17%	3%	0%	0%

Table 1b: Percent Concentration of PCB Homolog in Total PCBs in Fish Tissue by Sample (%) [Continued]

Sample ID	Species	Homolog Group									
		Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca
LDW-T2-M1140	Parophrys vetulus	0%	0%	4%	18%	32%	32%	11%	2%	0%	0%
LDW-T2-M1150	Parophrys vetulus	0%	0%	3%	14%	30%	35%	15%	3%	0%	0%
LDW-T2-M8394	Parophrys vetulus	0%	0%	3%	14%	34%	34%	13%	2%	0%	0%
LDW-T2-M8395	Parophrys vetulus	0%	0%	4%	18%	32%	31%	13%	2%	0%	0%
LDW-T2-M-ES-FL-comp-1	English sole	0%	0%	3%	14%	34%	34%	13%	2%	0%	0%
LDW-T2-M-ES-FL-comp-2	English sole	0%	0%	4%	18%	32%	31%	13%	2%	0%	0%
LDW-T2-M-ES-WB-comp-3	English sole	0%	0%	3%	14%	30%	35%	15%	3%	0%	0%
LDW-T2-M-ES-WB-comp-5	English sole	0%	0%	4%	18%	32%	32%	11%	2%	0%	0%
LDW-T3-C4336	Cymatogaster aggregata	0%	0%	1%	8%	28%	37%	22%	4%	0%	0%
LDW-T3-C-SS-WB-comp-1	Shiner perch	0%	0%	1%	8%	28%	37%	22%	4%	0%	0%
LDW-T3-D8048	Leptocottus armatus	0%	0%	1%	5%	21%	38%	29%	6%	0%	0%
LDW-T3-D-PS-WB-comp-1	Pacific Staghorn Sculpin	0%	0%	1%	5%	21%	38%	29%	6%	0%	0%
LDW-T3-E1488	Cymatogaster aggregata	0%	0%	0%	1%	9%	44%	39%	5%	0%	0%
LDW-T3-E3776	Leptocottus armatus	0%	0%	1%	6%	19%	42%	27%	5%	0%	0%
LDW-T3-E-PS-WB-comp-1	Pacific Staghorn Sculpin	0%	0%	1%	6%	19%	42%	27%	5%	0%	0%
LDW-T3-E-SS-WB-comp-1	Shiner perch	0%	0%	0%	1%	9%	44%	39%	5%	0%	0%
LDW-T3-F2912	Cymatogaster aggregata	0%	0%	0%	4%	22%	36%	30%	6%	0%	0%
LDW-T3-F-SS-WB-comp-1	Shiner perch	0%	0%	0%	4%	22%	36%	30%	6%	0%	0%
LDW-T3-M3850	Parophrys vetulus	0%	0%	2%	11%	30%	37%	18%	3%	0%	0%
LDW-T3-M3851	Parophrys vetulus	0%	0%	3%	15%	33%	34%	12%	2%	0%	0%
LDW-T3-M6605	Parophrys vetulus	0%	0%	2%	12%	30%	37%	15%	3%	0%	0%
LDW-T3-M6606	Parophrys vetulus	0%	0%	2%	11%	29%	39%	17%	3%	0%	0%
LDW-T3-M-ES-FL-comp-1	English sole	0%	0%	2%	11%	30%	37%	18%	3%	0%	0%
LDW-T3-M-ES-FL-comp-2	English sole	0%	0%	3%	15%	33%	34%	12%	2%	0%	0%
LDW-T3-M-ES-WB-comp-2	English sole	0%	0%	2%	12%	30%	37%	15%	3%	0%	0%
LDW-T3-M-ES-WB-comp-3	English sole	0%	0%	2%	11%	29%	39%	17%	3%	0%	0%
LDW-T4-B9056	Cymatogaster aggregata	0%	0%	2%	11%	30%	39%	16%	3%	0%	0%
LDW-T4-B-SS-WB-comp-1	Shiner perch	0%	0%	2%	11%	30%	39%	16%	3%	0%	0%
LDW-T4-C5216	Leptocottus armatus	0%	0%	1%	9%	30%	40%	17%	3%	0%	0%
LDW-T4-C-PS-WB-comp-1	Pacific Staghorn Sculpin	0%	0%	1%	9%	30%	40%	17%	3%	0%	0%
LDW-T4-D3795	Leptocottus armatus	0%	0%	2%	12%	29%	37%	16%	3%	0%	0%
LDW-T4-D6080	Cymatogaster aggregata	0%	0%	2%	10%	28%	40%	18%	3%	0%	0%
LDW-T4-D-PS-WB-comp-2	Pacific Staghorn Sculpin	0%	0%	2%	12%	29%	37%	16%	3%	0%	0%
LDW-T4-D-SS-WB-comp-1	Shiner perch	0%	0%	2%	10%	28%	40%	18%	3%	0%	0%
LDW-T4-M1382	Platichthys stellatus	0%	0%	5%	18%	29%	33%	13%	2%	0%	0%
LDW-T4-M2518	Parophrys vetulus	0%	0%	3%	13%	32%	35%	15%	2%	0%	0%
LDW-T4-M4096	Platichthys stellatus	0%	0%	4%	14%	28%	36%	15%	3%	0%	0%
LDW-T4-M5232	Parophrys vetulus	0%	0%	3%	16%	31%	34%	14%	2%	0%	0%
LDW-T4-M-ES-FL-comp-1	English sole	0%	0%	3%	13%	32%	35%	15%	2%	0%	0%
LDW-T4-M-ES-WB-comp-1	English sole	0%	0%	3%	16%	31%	34%	14%	2%	0%	0%
LDW-T4-M-SF-FL-comp-1	Starry Flounder	0%	0%	5%	18%	29%	33%	13%	2%	0%	0%
LDW-T4-M-SF-WB-comp-1	Starry Flounder	0%	0%	4%	14%	28%	36%	15%	3%	0%	0%
	Average	**0.0014%**	**0.071%**	**2.3%**	**12%**	**29%**	**37%**	**18%**	**3.1%**	**0.21%**	**0.020%**
	Standard Deviation	**0.0010%**	**0.043%**	**1.2%**	**4.2%**	**5.4%**	**3.3%**	**6.2%**	**1.3%**	**0.088%**	**0.015%**
	Sum of the Average Percent Contributions for Tri-, Tetra-, Penta-, Hexa-, Hepta-, and Octa-CBs			**99.70%**							

Notes
1. The concentration of PCB homologs in tissue was calculated as the sum of the average concentration of PCB congener.
2. Percent concentration of PCB homolog in total PCBs in invertebrate tissue was calculated as the concentration of each homolog divided by the concentration of total PCBs for each sample.
3. Abbreviations: % = percent ng/kg, ww = nanograms per kilogram, wet weight

Table 2a: Concentration of PCB Homolog in Invertebrate Tissue by Sample (ng/kg, ww) [1]

		Homolog Group										
Sample ID	Species	Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca	Total
LDW-07-T1-M-DC-EM-comp1	Metacarcinus magister	1.54	136.05	1,998.02	6,877.29	14,140.05	18,507.05	6,977.14	808.12	57.86	7.77	49,510.88
LDW-07-T1-M-DC-HP-comp1	Metacarcinus magister	12.71	495.10	10,976.99	46,610.37	168,239.43	267,449.73	103,057.66	14,448.87	876.60	107.00	612,274.46
LDW-07-T1-M-DC-WB-comp1 Calculated	Dungeness crab	5.01	239.42	4,775.30	19,181.25	61,871.16	95,806.83	36,786.91	5,036.49	311.20	38.50	224,052.06
LDW-07-T1-M-SC-EM-comp2	Cancer gracilis	0.69	85.94	2,756.58	15,825.03	30,736.05	44,239.57	16,266.97	1,991.82	99.91	12.70	112,015.27
LDW-07-T2-M-SC-EM-comp1	Cancer gracilis	1.01	141.50	2,826.03	13,030.53	26,243.27	32,304.35	10,344.24	1,266.09	63.03	8.07	86,228.13
LDW-07-T3-M-DC-EM-comp3	Metacarcinus magister	1.81	192.30	2,932.76	11,433.37	23,752.01	32,293.21	13,670.49	1,887.84	93.96	5.51	86,263.25
LDW-B10a1370	Melitidae	1.34	75.19	1,390.88	5,328.81	9,585.57	10,438.16	4,523.58	722.07	60.59	13.30	32,139.49
LDW-B10a-T	Benthic Invertebrates	1.35	75.20	1,390.89	5,328.82	9,585.59	10,438.19	4,523.59	722.07	60.59	13.30	32,139.59
LDW-B1b-5551	Melitidae	8.44	348.18	5,933.95	25,559.91	56,893.32	79,928.72	36,590.38	6,814.32	677.00	139.00	212,893.22
LDW-B1b-T	Benthic Invertebrates	8.44	348.18	5,933.96	25,559.93	56,893.32	79,928.74	36,590.38	6,814.32	677.00	139.00	212,893.27
LDW-B2a-1711	Melitidae	4.02	359.35	5,472.77	23,143.66	50,502.21	51,539.37	19,487.33	3,448.95	250.90	44.40	154,252.96
LDW-B2a-T	Benthic Invertebrates	4.02	359.36	5,472.79	23,143.67	50,502.22	51,539.39	19,487.35	3,448.96	250.90	44.40	154,253.05
LDW-B3b-7359	Melitidae	13.09	1,086.42	15,238.43	62,301.08	127,342.71	106,086.09	29,548.35	5,154.18	483.40	120.00	347,373.75
LDW-B3b-T	Benthic Invertebrates	13.09	1,086.43	15,238.43	62,301.09	127,342.71	106,086.11	29,548.36	5,154.18	483.40	120.00	347,373.80
LDW-B4b-8799	Melitidae	18.11	1,048.79	11,997.57	43,516.95	77,800.54	83,035.71	35,101.61	6,688.17	493.80	81.10	259,782.35
LDW-B4b-T	Benthic Invertebrates	18.11	1,048.80	11,997.58	43,516.97	77,800.55	83,035.72	35,101.62	6,688.18	493.80	81.10	259,782.43
LDW-B5a-4959	Melitidae	62.61	2,604.36	50,656.36	195,029.76	200,097.28	178,578.08	89,188.44	15,309.83	724.90	63.80	732,315.42
LDW-B5a-T	Benthic Invertebrates	62.61	2,604.36	50,656.36	195,029.77	200,097.30	178,578.10	89,188.45	15,309.84	724.90	63.80	732,315.49
LDW-B8a-2671	Melitidae	5.31	333.73	7,357.96	47,092.81	202,194.58	574,865.66	421,026.74	88,926.70	4,479.00	75.00	1,346,357.49
LDW-B8a-T	Benthic Invertebrates	5.32	333.74	7,357.97	47,092.83	202,194.60	574,865.67	421,026.74	88,926.70	4,479.00	75.00	1,346,357.57
LDW-B9b-8319	Melitidae	2.30	91.70	1,898.87	9,367.07	23,017.15	21,908.16	6,463.60	1,024.62	74.55	9.08	63,857.10
LDW-B9b-T	Benthic Invertebrates	2.32	91.72	1,898.89	9,367.08	23,017.17	21,908.17	6,463.61	1,024.62	74.55	9.08	63,857.21
LDW-C10-0494	Mya arenaria	8.69	332.38	3,924.73	14,008.36	37,526.43	113,231.81	82,334.32	12,916.30	335.95	6.53	264,625.48
LDW-C10-T1	Softshell clam	8.80	332.62	3,927.84	14,031.65	37,563.10	113,287.54	82,360.30	12,927.30	336.50	6.53	264,782.19
LDW-C1-T	Softshell clam	2.36	168.08	2,543.45	8,481.93	12,389.11	11,949.53	4,846.71	655.13	14.33	2.23	41,052.86
LDW-C1-T7656	Mya arenaria	2.35	168.07	2,543.44	8,481.91	12,389.09	11,949.51	4,846.70	655.13	14.33	2.23	41,052.76
LDW-C2-T2	Softshell clam	2.01	165.16	3,130.45	10,153.70	14,956.41	15,577.11	6,540.30	907.70	23.14	2.25	51,458.23
LDW-C2-T7210	Mya arenaria	2.00	165.15	3,130.45	10,153.68	14,956.39	15,577.08	6,540.28	907.70	23.14	2.25	51,458.12
LDW-C4-T	Softshell clam	2.00	177.06	3,290.85	10,193.21	14,281.75	12,820.79	4,988.05	719.81	19.12	4.80	46,497.44
LDW-C4-T8424	Mya arenaria	1.99	177.05	3,290.84	10,193.20	14,281.73	12,820.76	4,988.03	719.80	19.12	4.80	46,497.32
LDW-C6-T	Softshell clam	4.55	210.75	3,636.72	11,614.51	15,187.07	14,279.88	6,165.95	957.53	27.33	3.17	52,087.45
LDW-C6-T7912	Mya arenaria	4.54	210.74	3,636.70	11,614.49	15,187.06	14,279.85	6,165.94	957.52	27.33	3.17	52,087.34
LDW-C7-T1	Softshell clam	4.67	571.49	19,767.49	83,583.74	118,738.42	67,972.48	15,891.73	1,964.39	61.09	4.22	308,559.72
LDW-C7-T6731	Mya arenaria	4.66	571.49	19,767.48	83,583.73	118,738.41	67,972.47	15,891.71	1,964.39	61.09	4.22	308,559.65
LDW-C8-T	Softshell clam	117.10	7,182.45	103,814.73	307,198.75	322,309.40	158,003.68	27,404.30	3,670.36	234.10	18.30	929,953.17
LDW-C8-T9448	Mya arenaria	117.10	7,182.45	103,814.73	307,198.74	322,309.39	158,003.67	27,404.29	3,670.36	234.10	18.30	929,953.13
LDW-C9-T	Softshell clam	2.52	237.97	4,633.43	16,122.43	25,262.81	21,908.12	9,531.64	1,287.45	31.28	3.29	79,020.94
LDW-C9-T9704	Mya arenaria	2.52	237.96	4,633.42	16,122.42	25,262.80	21,908.10	9,531.62	1,287.44	31.28	3.29	79,020.85
LDW-T1-M6960	Cancer gracilis	15.18	1,018.10	19,145.94	101,252.77	234,356.50	298,346.27	120,201.39	15,176.85	891.20	118.00	790,522.20
LDW-T1-M8396	Metacarcinus magister	2.76	308.11	5,846.80	19,311.84	31,152.30	37,054.66	14,562.54	2,529.70	216.80	28.50	111,014.01
LDW-T1-M8761	Cancer gracilis	11.25	209.02	3,726.96	24,111.12	53,121.77	73,927.04	27,795.35	3,168.31	140.80	17.30	186,228.90
LDW-T1-M8764	Cancer gracilis	1.47	333.92	6,638.00	28,668.30	53,583.13	60,901.15	21,824.48	2,678.99	142.70	17.50	174,789.64
LDW-T1-M-DC-EM-comp-2	Dungeness crab	2.76	308.12	5,846.80	19,311.85	31,152.31	37,054.67	14,562.56	2,529.71	216.80	28.50	111,014.07
LDW-T1-M-SC-EM-comp-1	Slender Crab	21.75	244.16	3,729.14	24,128.20	53,144.39	74,078.05	27,813.94	3,170.31	140.90	17.30	186,488.14
LDW-T1-M-SC-EM-comp-2	Slender Crab	1.49	333.95	6,638.03	28,668.32	53,583.13	60,901.16	21,824.49	2,678.99	142.70	17.50	174,789.76
LDW-T1-M-SC-HP-comp-1	Slender Crab	15.18	1,018.10	19,145.95	101,252.77	234,356.50	298,346.27	120,201.39	15,176.86	891.20	118.00	790,522.21
LDW-T1-M-SC-WB-comp-1 Calculated	Slender Crab	19.71	479.95	8,508.39	48,012.77	109,231.33	143,537.65	56,422.63	6,898.68	373.10	48.50	373,532.71
LDW-T1-M-SC-WB-comp-2 Calculated	Slender Crab	4.79	545.10	10,511.42	51,150.66	109,620.72	134,521.90	52,290.82	6,556.97	374.50	48.70	365,625.58
LDW-T2-M0589	Cancer gracilis	17.43	1,018.19	28,967.45	150,856.87	332,926.38	380,528.50	137,634.17	14,863.89	576.90	48.90	1,047,438.68
LDW-T2-M5125	Cancer gracilis	1.58	174.78	4,651.18	28,020.03	59,816.20	63,771.54	22,006.97	2,087.82	73.59	6.59	180,610.28
LDW-T2-M5128	Cancer gracilis	2.01	218.54	4,091.48	19,532.02	41,439.93	45,965.30	16,554.69	1,814.87	67.29	5.62	129,691.75
LDW-T2-M-SC-EM-comp-5	Slender Crab	1.60	174.80	4,651.21	28,020.04	59,816.21	63,771.55	22,006.98	2,087.83	73.59	6.59	180,610.39

Table 2a: Concentration of PCB Homolog in Invertebrate Tissue by Sample (ng/kg, ww) [Continued]

Sample ID	Species	Homolog Group										
		Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca	Total
LDW-T2-M-SC-EM-comp-6	Slender Crab	2.02	218.56	4,091.49	19,532.03	41,439.93	45,965.32	16,554.70	1,814.88	67.29	5.62	129,691.85
LDW-T2-M-SC-HP-comp-2	Slender Crab	17.43	1,018.19	28,967.46	150,856.87	332,926.38	380,528.50	137,634.17	14,863.89	576.90	48.90	1,047,438.69
LDW-T2-M-SC-WB-comp-5 Calculated	Slender Crab	5.34	433.41	12,180.16	66,052.55	144,388.69	161,950.85	57,889.43	6,046.84	229.60	19.70	449,196.57
LDW-T2-M-SC-WB-comp-6 Calculated	Slender Crab	6.80	463.15	11,793.92	60,235.66	131,816.65	149,748.60	54,121.75	5,859.51	225.60	19.00	414,290.64
LDW-T3-M5680	Metacarcinus magister	17.72	2,226.00	68,265.21	440,684.46	1,016,562.15	1,406,545.20	645,690.83	97,939.07	4,813.00	318.00	3,683,061.64
LDW-T3-M9305	Metacarcinus magister	4.20	470.90	8,078.22	25,343.56	44,171.16	48,706.44	19,484.20	2,954.03	168.30	11.80	149,392.81
LDW-T3-M9676	Cancer gracilis	1.44	148.03	3,807.57	20,739.08	46,477.32	45,887.15	15,493.03	1,689.78	62.44	4.40	134,310.24
LDW-T3-M-DC-EM-comp-1	Dungeness crab	4.20	470.91	8,078.22	25,343.57	44,171.16	48,706.45	19,484.21	2,954.04	168.30	11.80	149,392.86
LDW-T3-M-DC-HP-comp-1	Dungeness crab	17.72	2,226.00	68,265.21	440,684.46	1,016,562.15	1,406,545.21	645,690.83	97,939.07	4,813.00	318.00	3,683,061.65
LDW-T3-M-DC-WB-comp-1 Calculated	Dungeness crab	8.40	1,012.45	26,730.77	151,077.57	345,727.05	469,780.89	213,597.71	32,379.97	1,606.00	107.00	1,242,027.81
LDW-T3-M-SC-EM-comp-2	Slender Crab	1.45	148.05	3,807.59	20,739.09	46,477.33	45,887.16	15,493.05	1,689.79	62.44	4.40	134,310.34
LDW-T4-M4336	Metacarcinus magister	23.08	1,480.60	39,921.85	264,948.77	966,626.08	1,389,547.68	812,951.80	136,479.64	6,266.00	368.00	3,618,613.50
LDW-T4-M7975	Metacarcinus magister	2.99	265.01	3,986.35	15,304.60	38,537.76	57,439.86	28,366.47	4,536.67	249.90	21.80	148,711.41
LDW-T4-M-DC-EM-comp-1	Dungeness crab	2.99	265.03	3,986.37	15,304.61	38,537.77	57,439.88	28,366.48	4,536.67	249.90	21.80	148,711.49
LDW-T4-M-DC-HP-comp-1	Dungeness crab	23.08	1,480.60	39,921.85	264,948.77	966,626.08	1,389,547.68	812,951.80	136,479.64	6,266.00	368.00	3,618,613.50
LDW-T4-M-DC-WB-comp1 Calculated	Dungeness crab	9.22	639.44	15,127.55	92,604.13	326,163.35	470,912.09	271,540.06	45,430.25	2,111.00	129.00	1,224,666.10
	Average	**11.88**	**744.53**	**14,628.74**	**67,721.64**	**146,260.29**	**189,452.17**	**92,020.71**	**14,747.04**	**731.50**	**53.90**	**526,372.42**
	Standard Deviation	**21.67**	**1,270.21**	**21,520.45**	**97,585.30**	**232,796.16**	**331,817.58**	**180,886.29**	**30,693.67**	**1,460.71**	**83.27**	**861,783.44**

Table 2b: Percent Concentration of PCB Homolog in Total PCBs in Invertebrate Tissue by Sample (%) [2]

Sample ID	Species	Homolog Group									
		Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca
LDW-07-T1-M-DC-EM-comp1	Metacarcinus magister	0%	0%	4%	14%	29%	37%	14%	2%	0%	0%
LDW-07-T1-M-DC-HP-comp1	Metacarcinus magister	0%	0%	2%	8%	27%	44%	17%	2%	0%	0%
LDW-07-T1-M-DC-WB-comp1 Calculated	Dungeness crab	0%	0%	2%	9%	28%	43%	16%	2%	0%	0%
LDW-07-T1-M-SC-EM-comp2	Cancer gracilis	0%	0%	2%	14%	27%	39%	15%	2%	0%	0%
LDW-07-T2-M-SC-EM-comp1	Cancer gracilis	0%	0%	3%	15%	30%	37%	12%	1%	0%	0%
LDW-07-T3-M-DC-EM-comp3	Metacarcinus magister	0%	0%	3%	13%	28%	37%	16%	2%	0%	0%
LDW-B10a1370	Melitidae	0%	0%	4%	17%	30%	32%	14%	2%	0%	0%
LDW-B10a-T	Benthic Invertebrates	0%	0%	4%	17%	30%	32%	14%	2%	0%	0%
LDW-B1b-5551	Melitidae	0%	0%	3%	12%	27%	38%	17%	3%	0%	0%
LDW-B1b-T	Benthic Invertebrates	0%	0%	3%	12%	27%	38%	17%	3%	0%	0%
LDW-B2a-1711	Melitidae	0%	0%	4%	15%	33%	33%	13%	2%	0%	0%
LDW-B2a-T	Benthic Invertebrates	0%	0%	4%	15%	33%	33%	13%	2%	0%	0%
LDW-B3b-7359	Melitidae	0%	0%	4%	18%	37%	31%	9%	1%	0%	0%
LDW-B3b-T	Benthic Invertebrates	0%	0%	4%	18%	37%	31%	9%	1%	0%	0%
LDW-B4b-8799	Melitidae	0%	0%	5%	17%	30%	32%	14%	3%	0%	0%
LDW-B4b-T	Benthic Invertebrates	0%	0%	5%	17%	30%	32%	14%	3%	0%	0%
LDW-B5a-4959	Melitidae	0%	0%	7%	27%	27%	24%	12%	2%	0%	0%
LDW-B5a-T	Benthic Invertebrates	0%	0%	7%	27%	27%	24%	12%	2%	0%	0%
LDW-B8a-2671	Melitidae	0%	0%	1%	3%	15%	43%	31%	7%	0%	0%
LDW-B8a-T	Benthic Invertebrates	0%	0%	1%	3%	15%	43%	31%	7%	0%	0%
LDW-B9b-8319	Melitidae	0%	0%	3%	15%	36%	34%	10%	2%	0%	0%
LDW-B9b-T	Benthic Invertebrates	0%	0%	3%	15%	36%	34%	10%	2%	0%	0%
LDW-C10-0494	Mya arenaria	0%	0%	1%	5%	14%	43%	31%	5%	0%	0%
LDW-C10-T1	Softshell clam	0%	0%	1%	5%	14%	43%	31%	5%	0%	0%
LDW-C1-T	Softshell clam	0%	0%	6%	21%	30%	29%	12%	2%	0%	0%
LDW-C1-T7656	Mya arenaria	0%	0%	6%	21%	30%	29%	12%	2%	0%	0%
LDW-C2-T2	Softshell clam	0%	0%	6%	20%	29%	30%	13%	2%	0%	0%
LDW-C2-T7210	Mya arenaria	0%	0%	6%	20%	29%	30%	13%	2%	0%	0%
LDW-C4-T	Softshell clam	0%	0%	7%	22%	31%	28%	11%	2%	0%	0%
LDW-C4-T8424	Mya arenaria	0%	0%	7%	22%	31%	28%	11%	2%	0%	0%
LDW-C6-T	Softshell clam	0%	0%	7%	22%	29%	27%	12%	2%	0%	0%
LDW-C6-T7912	Mya arenaria	0%	0%	7%	22%	29%	27%	12%	2%	0%	0%
LDW-C7-T1	Softshell clam	0%	0%	6%	27%	38%	22%	5%	1%	0%	0%
LDW-C7-T6731	Mya arenaria	0%	0%	6%	27%	38%	22%	5%	1%	0%	0%
LDW-C8-T	Softshell clam	0%	1%	11%	33%	35%	17%	3%	0%	0%	0%
LDW-C8-T9448	Mya arenaria	0%	1%	11%	33%	35%	17%	3%	0%	0%	0%
LDW-C9-T	Softshell clam	0%	0%	6%	20%	32%	28%	12%	2%	0%	0%
LDW-C9-T9704	Mya arenaria	0%	0%	6%	20%	32%	28%	12%	2%	0%	0%
LDW-T1-M6960	Cancer gracilis	0%	0%	2%	13%	30%	38%	15%	2%	0%	0%
LDW-T1-M8396	Metacarcinus magister	0%	0%	5%	17%	28%	33%	13%	2%	0%	0%
LDW-T1-M8761	Cancer gracilis	0%	0%	2%	13%	29%	40%	15%	2%	0%	0%
LDW-T1-M8764	Cancer gracilis	0%	0%	4%	16%	31%	35%	12%	2%	0%	0%
LDW-T1-M-DC-EM-comp-2	Dungeness crab	0%	0%	5%	17%	28%	33%	13%	2%	0%	0%
LDW-T1-M-SC-EM-comp-1	Slender Crab	0%	0%	2%	13%	28%	40%	15%	2%	0%	0%
LDW-T1-M-SC-EM-comp-2	Slender Crab	0%	0%	4%	16%	31%	35%	12%	2%	0%	0%
LDW-T1-M-SC-HP-comp-1	Slender Crab	0%	0%	2%	13%	30%	38%	15%	2%	0%	0%
LDW-T1-M-SC-WB-comp-1 Calculated	Slender Crab	0%	0%	2%	13%	29%	38%	15%	2%	0%	0%
LDW-T1-M-SC-WB-comp-2 Calculated	Slender Crab	0%	0%	3%	14%	30%	37%	14%	2%	0%	0%
LDW-T2-M0589	Cancer gracilis	0%	0%	3%	14%	32%	36%	13%	1%	0%	0%
LDW-T2-M5125	Cancer gracilis	0%	0%	3%	16%	33%	35%	12%	1%	0%	0%
LDW-T2-M5128	Cancer gracilis	0%	0%	3%	15%	32%	35%	13%	1%	0%	0%
LDW-T2-M-SC-EM-comp-5	Slender Crab	0%	0%	3%	16%	33%	35%	12%	1%	0%	0%

Table 2b: Percent Concentration of PCB Homolog in Total PCBs in Invertebrate Tissue by Sample (%) [Continued]

Sample ID	Species	Homolog Group									
		Mono	Di	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca
LDW-T2-M-SC-EM-comp-6	Slender Crab	0%	0%	3%	15%	32%	35%	13%	1%	0%	0%
LDW-T2-M-SC-HP-comp-2	Slender Crab	0%	0%	3%	14%	32%	36%	13%	1%	0%	0%
LDW-T2-M-SC-WB-comp-5 Calculated	Slender Crab	0%	0%	3%	15%	32%	36%	13%	1%	0%	0%
LDW-T2-M-SC-WB-comp-6 Calculated	Slender Crab	0%	0%	3%	15%	32%	36%	13%	1%	0%	0%
LDW-T3-M5680	Metacarcinus magister	0%	0%	2%	12%	28%	38%	18%	3%	0%	0%
LDW-T3-M9305	Metacarcinus magister	0%	0%	5%	17%	30%	33%	13%	2%	0%	0%
LDW-T3-M9676	Cancer gracilis	0%	0%	3%	15%	35%	34%	12%	1%	0%	0%
LDW-T3-M-DC-EM-comp-1	Dungeness crab	0%	0%	5%	17%	30%	33%	13%	2%	0%	0%
LDW-T3-M-DC-HP-comp-1	Dungeness crab	0%	0%	2%	12%	28%	38%	18%	3%	0%	0%
LDW-T3-M-DC-WB-comp-1 Calculated	Dungeness crab	0%	0%	2%	12%	28%	38%	17%	3%	0%	0%
LDW-T3-M-SC-EM-comp-2	Slender Crab	0%	0%	3%	15%	35%	34%	12%	1%	0%	0%
LDW-T4-M4336	Metacarcinus magister	0%	0%	1%	7%	27%	38%	22%	4%	0%	0%
LDW-T4-M7975	Metacarcinus magister	0%	0%	3%	10%	26%	39%	19%	3%	0%	0%
LDW-T4-M-DC-EM-comp-1	Dungeness crab	0%	0%	3%	10%	26%	39%	19%	3%	0%	0%
LDW-T4-M-DC-HP-comp-1	Dungeness crab	0%	0%	1%	7%	27%	38%	22%	4%	0%	0%
LDW-T4-M-DC-WB-comp1 Calculated	Dungeness crab	0%	0%	1%	8%	27%	38%	22%	4%	0%	0%
	Average	**0.0033%**	**0.22%**	**3.9%**	**16%**	**30%**	**34%**	**14%**	**2.1%**	**0.11%**	**0.013%**
	Standard Deviation	**0.0029%**	**0.15%**	**2.2%**	**6.0%**	**4.8%**	**5.8%**	**5.6%**	**1.2%**	**0.075%**	**0.013%**
	Sum of the Average Percent Contributions for Tri-, Tetra-, Penta-, Hexa-, Hepta-, and Octa-CBs			**99.66%**							

Notes

1. The concentration of PCB homologs in tissue was calculated as the sum of the average concentration of PCB congener.
2. Percent concentration of PCB homolog in total PCBs in invertebrate tissue was calculated as the concentration of each homolog divided by the concentration of total PCBs for each sample.
3. Abbreviations: % = percent ng/kg, ww = nanograms per kilogram, wet weight

Table 3 Concentration of PCB Congeners in Sediment (ng/kg, dw)

		Tri	Tri	Tetra	Tetra	Tetra	Tetra	Tetra	Penta	Penta	Penta	Penta	Penta	Penta	Penta	Penta	Hexa	Hexa	Hexa
Location ID	**Sample ID**	**PCB-018**	**PCB-028**	**PCB-044**	**PCB-052**	**PCB-066**	**PCB-077**	**PCB-081**	**PCB-090**	**PCB-101**	**PCB-105**	**PCB-110**	**PCB-114**	**PCB-118**	**PCB-123**	**PCB-126**	**PCB-128**	**PCB-129**	**PCB-138**
CH0030	CH09-01						< 310			23000	2900	5500		5100		< 280	4000		5100
EIT061	EIT06-02						< 640			570000	110000	340000		270000		< 580	140000		240000
EST143	EST09-03						< 590			100000	14000	45000		31000		< 530	11000		28000
LDW-SS120	LDW-SS120-010					8040	1060	34	32200		11800	40100	610	28400	551	163		48400	
LDW-SS6	LDW-SS6-010					87300	7630	450	136000		55800	142000	3650	118000	2250	169		120000	
DR001	SD-DR001-0000	< 1000	1000	1000	2000	4000	< 1000	< 1000		3000	1000		< 1000	3000	< 1000	< 1000	1000		7000
DR088	SD-DR088-0000	< 17000	28000	19000	25000	39000	< 1000	< 1000		28000	10000		< 2000	22000	< 1000	< 1000	6000		36000
DR089	SD-DR089-0000	2000	4000	5000	7000	< 15000	< 1000	< 1000		10000	5000		< 1000	10000	< 2000	< 1000	3000		< 19000
DR236	SD-DR236-0000	< 1000	1000	2000	4000	7000	< 1000	< 1000		7000	2000		< 1000	6000	< 1000	< 1000	2000		10000

Table 3 Concentration of PCB Congeners in Sediment (ng/kg, dw) [Continued]

Hexa	Hexa	Hexa	Hexa	Hexa	Hepta	Hepta	Hepta	Hepta	Octa	Nona	Deca	Total
PCB-153	**PCB-156**	**PCB-157**	**PCB-167**	**PCB-169**	**PCB-170**	**PCB-180**	**PCB-187**	**PCB-189**	**PCB-195**	**PCB-206**	**PCB-209**	**PCBs [1]**
18000	690	< 220		< 710	5300	8300		< 320				77890
340000	28000	18000		< 1400	88000	93000		< 650				2237000
75000	3300	< 410		< 1300	8000	9400		< 600				324700
33100	5200		1790	< 17.4		11600		239				223287
87600	16400		4400	< 91.3		38300		840				820789
6000	< 1000	< 1000	< 1000	< 1000	2000	4000	3000	< 1000	< 1000	< 1000	< 1000	38000
24000	4000	1000	2000	< 1000	8000	14000	9000	< 1000	2000	2000	1000	280000
12000	2000	< 1000	2000	< 1000	6000	9000	6000	< 1000	1000	1000	< 1000	85000
6000	< 1000	< 1000	< 1000	< 1000	< 1000	3000	2000	< 1000	< 1000	< 1000	< 1000	52000

Notes:

1.) Calculated as the sum of the detected congeners.

2.) Abbrevi ng/kg, dw = nanograms per kilogram, dry weight

PCB = polychlorinated biphenyls

Table 4.a. Concentration of Homolog Groups in Sediment (ng/kg, dw) [1]

Station	Sample ID	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca	Total PCBs
CH0030	CH09-01			36,500	27,790	13,600				77,890
EIT061	EIT06-02			1,290,000	766,000	181,000				2,237,000
EST143	EST09-03			190,000	117,300	17,400				324,700
LDW-SS120	LDW-SS120-010		9,134	113,824	88,490	11,839				223,287
LDW-SS6	LDW-SS6-010		95,380	457,869	228,400	39,140				820,789
DR001	SD-DR001-0000	1,000	7,000	7,000	14,000	9,000				38,000
DR088	SD-DR088-0000	28,000	83,000	60,000	73,000	31,000	2,000	2,000	1,000	280,000
DR089	SD-DR089-0000	6,000	12,000	25,000	19,000	21,000	1,000	1,000		85,000
DR236	SD-DR236-0000	1,000	13,000	15,000	18,000	5,000				52,000

Table 4.b. Percent of the Concentration of Each Homolog Group in Total PCB Concentrations in Sediment for Each Sample (%)

Station	Sample ID	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca	Total
CH0030	CH09-01			47%	36%	17%				
EIT061	EIT06-02			58%	34%	8.1%				
EST143	EST09-03			59%	36%	5.4%				
LDW-SS120	LDW-SS120-010		4.1%	51%	40%	5.3%				
LDW-SS6	LDW-SS6-010		12%	56%	28%	4.8%				
DR001	SD-DR001-0000	2.6%	18%	18%	37%	24%				
DR088	SD-DR088-0000	10%	30%	21%	26%	11%	0.71%	0.71%	0.36%	
DR089	SD-DR089-0000	7.1%	14%	29%	22%	25%	1.2%	1.2%		
DR236	SD-DR236-0000	1.9%	25%	29%	35%	10%				
Average of Percentages		5.4%	17%	41%	33%	12%	0.95%	0.95%	0.36%	110.5%
Standard Deviation of Percentages		3.8%	9.3%	16.2%	5.8%	7.8%	0.33%	0.33%	-	
Average of Percentages (100% by ratio) [2]		4.9%	16%	37%	29%	11%	0.86%	0.86%	0.32%	100%
Standard Deviation (100% by ratio)		3.5%	8.4%	15%	5.2%	7.1%	0.30%	0.30%	-	

Table 4.c. Count of PCB Congeners Measured in Each Homolog Group

Station	Sample ID	Tri	Tetra	Penta	Hexa	Hepta	Octa	Nona	Deca
CH0030	CH09-01	0	1 ND	5 (1 ND)	6 (2 ND)	3 (1 ND)	0	0	0
EIT061	EIT06-02	0	1 ND	5 (1 ND)	6 (1 ND)	3 (1 ND)	0	0	0
EST143	EST09-03	0	1 ND	5 (1 ND)	6 (2 ND)	3 (1 ND)	0	0	0
LDW-SS120	LDW-SS120-010	0	3	7	5 (1 ND)	2	0	0	0
LDW-SS6	LDW-SS6-010	0	3	7	5 (1 ND)	2	0	0	0
DR001	SD-DR001-0000	2 (1 ND)	5 (2 ND)	6 (3 ND)	7 (4 ND)	4 (1 ND)	1 ND	1 ND	1 ND
DR088	SD-DR088-0000	2 (1 ND)	5 (2 ND)	6 (3 ND)	7 (1 ND)	4 (1 ND)	1	1	1
DR089	SD-DR089-0000	2	5 (3 ND)	6 (3 ND)	7 (3 ND)	4 (1 ND)	1	1	1 ND
DR236	SD-DR236-0000	2 (1 ND)	5 (2 ND)	6 (3 ND)	7 (4 ND)	4 (2 ND)	1 ND	1 ND	1 ND

<u>Notes:</u>

1.) Calculated as the sum of the detected congeners.

2.) The average of percentages totals 110.5% since each sample did not contain the same number of congeners and some were non-detect.
To adjust for this, the average of the percentages were multiplied by the ratio of 100% over 110.5%

3.) Abbreviations: % = percent; ng/kg, dw = nanograms per kilogram, dry weight; ND = not detected; PCB = polychlorinated biphenyls

Table 5.a. Concentrations of PCB Congeners in Sediment (ng/kg, dw)

Station ID	Sample ID	Tri PCB-018	Tri PCB-028	Tetra PCB-044	Tetra PCB-052	Tetra PCB-066	Tetra PCB-077	Tetra PCB-081	Penta PCB-090	Penta PCB-101	Penta PCB-105	Penta PCB-110	Penta PCB-114	Penta PCB-118
CH0030	CH09-01						< 310			23000	2900	5500		5100
EIT061	EIT06-02						< 640			570000	110000	340000		270000
EST143	EST09-03						< 590			100000	14000	45000		31000
LDW-SS120	LDW-SS120-010					8040	1060	34	32200		11800	40100	610	28400
LDW-SS6	LDW-SS6-010					87300	7630	450	136000		55800	142000	3650	118000
DR001	SD-DR001-0000	< 1000	1000	1000	2000	4000	< 1000	< 1000		3000	1000		< 1000	3000
DR088	SD-DR088-0000	< 17000	28000	19000	25000	39000	< 1000	< 1000		28000	10000		< 2000	22000
DR089	SD-DR089-0000	2000	4000	5000	7000	< 15000	< 1000	< 1000		10000	5000		< 1000	10000
DR236	SD-DR236-0000	< 1000	1000	2000	4000	7000	< 1000	< 1000		7000	2000		< 1000	6000

Table 5.b. Concentrations of PCB Congeners in Porewater Estimated by Two-Carbon Model (ng/L) [3]

Station ID	Sample ID	TOC [1] (%)	BC [2] (%)	Tri PCB-018	Tri PCB-028	Tetra PCB-044	Tetra PCB-052	Tetra PCB-066	Tetra PCB-077	Tetra PCB-081	Penta PCB-090	Penta PCB-101	Penta PCB-105	Penta PCB-110	Penta PCB-114	Penta PCB-118
			Log K_{OC} (L/kg OC) [4]	4.0	4.3	4.4	4.5	4.7	4.9	4.9	4.9	4.9	5.1	4.9	5.1	5.1
			Log K_{BC} (L/kg BC) [5]	6.1	6.5	6.6	6.7	7.0	7.2	7.2	7.2	7.2	7.4	7.3	7.4	7.5
CH0030	CH09-01	1.94%	0.23%						< 0.009			0.654	0.047	0.127		0.069
EIT061	EIT06-02	1.67%	0.23%						< 0.019			16.309	1.793	7.898		3.648
EST143	EST09-03	1.38%	0.23%						< 0.018			2.879	0.229	1.052		0.421
LDW-SS120	LDW-SS120-010	1.94%	0.23%					0.333	0.031	0.001	0.955		0.191	0.926	0.010	0.382
LDW-SS6	LDW-SS6-010	1.05%	0.23%					3.686	0.231	0.014	4.111		0.920	3.341	0.060	1.613
DR001	SD-DR001-0000	3.01%	0.23%	< 0.294	0.121	0.102	0.170	0.162	< 0.029	< 0.029		0.083	0.016		< 0.016	0.040
DR088	SD-DR088-0000	1.68%	0.23%	< 5.21	3.511	2.017	2.201	1.623	< 0.03	< 0.03		0.801	0.163		< 0.033	0.297
DR089	SD-DR089-0000	1.92%	0.23%	0.608	0.498	0.527	0.612	< 0.621	< 0.03	< 0.03		0.285	0.081		< 0.016	0.134
DR236	SD-DR236-0000	0.85%	0.23%	< 0.315	0.128	0.217	0.360	0.297	< 0.03	< 0.03		0.204	0.033		< 0.017	0.082

Table 5.c. Average Concentration of PCB Congener Detections in Porewater, as Estimated by Two-Carbon Model (pg/L)

	Tri	Tetra	Penta	Hexa	Hepta	Octa	Total PCBs
Average	973	740	1,313	387	57	4	3,475
Percentage of Total	28%	21%	38%	11%	2%	0.11%	

Table 5.a. Concentrations of PCB Congeners in Sediment (ng/kg, dw) [Continued]

Penta	Penta	Hexa	Hexa	Hexa	Hexa	Hexa	Hexa	Hexa	Hexa	Hepta	Hepta	Hepta	Hepta	Octa
PCB-123	**PCB-126**	**PCB-128**	**PCB-129**	**PCB-138**	**PCB-153**	**PCB-156**	**PCB-157**	**PCB-167**	**PCB-169**	**PCB-170**	**PCB-180**	**PCB-187**	**PCB-189**	**PCB-195**
	< 280	4000		5100	18000	690	< 220		< 710	5300	8300		< 320	
	< 580	140000		240000	340000	28000	18000		< 1400	88000	93000		< 650	
	< 530	11000		28000	75000	3300	< 410		< 1300	8000	9400		< 600	
551	163		48400		33100	5200		1790	< 17.4		11600		239	
2250	169		120000		87600	16400		4400	< 91.3		38300		840	
< 1000	< 1000	1000		7000	6000	< 1000	< 1000	< 1000	< 1000	2000	4000	3000	< 1000	< 1000
< 1000	< 1000	6000		36000	24000	4000	1000	2000	< 1000	8000	14000	9000	< 1000	2000
< 2000	< 1000	3000		< 19000	12000	2000	< 1000	2000	< 1000	6000	9000	6000	< 1000	1000
< 1000	< 1000	2000		10000	6000	< 1000	< 1000	< 1000	< 1000	< 1000	3000	2000	< 1000	< 1000

Table 5.b. Concentrations of PCB Congeners in Porewater Estimated by Two-Carbon Model (ng/L) [3] [Continued]

Penta	Penta	Hexa	Hexa	Hexa	Hexa	Hexa	Hexa	Hexa	Hexa	Hepta	Hepta	Hepta	Hepta	Octa	
PCB-123	**PCB-126**	**PCB-128**	**PCB-129**	**PCB-138**	**PCB-153**	**PCB-156**	**PCB-157**	**PCB-167**	**PCB-169**	**PCB-170**	**PCB-180**	**PCB-187**	**PCB-189**	**PCB-195**	
5.1	5.2	5.1	5.1	5.2	5.3	5.5	5.5	5.5	5.6	5.6	5.6	5.5	5.9	5.7	**Total PCBs**
7.5	7.6	7.5	7.5	7.6	7.7	7.9	7.9	8.0	8.1	8.1	8.1	7.9	8.4	8.2	
	< 0.003	0.054		0.057	0.166	0.004	< 0.001		< 0.002	0.017	0.031		< 0.001		1.2
	< 0.006	1.892		2.688	3.156	0.151	0.097		< 0.005	0.288	0.345		< 0.001		38
	< 0.005	0.149		0.315	0.700	0.018	< 0.002		< 0.004	0.026	0.035		< 0.001		5.8
0.007	0.002		0.664		0.306	0.028		0.008	< 0.0001		0.043		0.000		3.9
0.031	0.002		1.675		0.822	0.089		0.020	< 0.0003		0.143		0.002		17
< 0.013	< 0.01	0.013		0.077	0.054	< 0.005	< 0.005	< 0.004	< 0.003	0.006	0.015	0.016	< 0.002	< 0.002	0.88
< 0.014	< 0.01	0.081		0.403	0.223	0.022	0.005	0.009	< 0.003	0.026	0.052	0.050	< 0.002	0.005	11
< 0.027	< 0.01	0.040		< 0.212	0.111	0.011	< 0.005	0.009	< 0.003	0.020	0.033	0.033	< 0.002	0.002	3.0
< 0.014	< 0.01	0.027		0.114	0.057	< 0.005	< 0.005	< 0.005	< 0.003	< 0.003	0.011	0.011	< 0.002	< 0.002	1.5

Notes:

1.) TOC is referenced from Boeing and LDWG databases

2.) Black carbon was calculated as the average of 5 stations as referenced from *Assessing Bioavailability of Sediment Contaminants to Support Selecting Remedies* (Wakeman 2014)

3.) Porewater is calculated as $C_d = C_s \div [(f_{NPOC} \times K_{NPOC}) + (f_{BC} \times K_{BC})]$; where f_{NPOC} = fraction of nonpyrogenic organic carbon in sediment, f_{BC} = fraction of black carbon, K_{NPOC} = chemical- nonpyrogenic organic carbon partition coefficient, K_{BC} = chemical- black carbon partition coefficient, C_d = concentration of PCBs in porewater, C_s = concentration of PCBs in sediment, as referenced from Perron et al (2010).

4.) Log K_{OW} referenced from Hawker and Connell (1988). Log $K_{OC} = 0.74 \times \log K_{OW} + 0.15$ (Hawker and Connell 1988, Hawthorne et al. 2011).

5.) Log K_{OW} referenced from Hawker and Connell (1988). Log $K_{BC} = 0.91 \times \text{Log } K_{OW} + 1.37$ (Hawker and Connell 1988, Hawthorne et al. 2011).

6.) Abbreviations:

% = percent
BC = black carbon
L/kg = liters per kilogram
ng/kg, dw = nanograms per kilogram, dry weight
ng/L = nanograms per liter
OC = organic carbon
PCB = polychlorinated biphenyls
TOC = total organic carbon

Table 6. Average Method Detection Limits for Freely-Dissolved PCB Congeners (by Homolog) in Sediment Porewater

						Lowest Achievable MDL in Porewater (Complete Equilibrium Exposure)	MDL in Porewater (4-Week Exposure)		Expected Average Pilot Study Concentrations of PCB in Porewater (pg/L)		
Length Fiber (cm)	PCB Homolog	MDL [1] (ng)	K_{fs} [2] (L/L_{PDMS})	Volume of PDMS on Fiber (µL)	Concentration of PCB in PDMS (ng/L)	Concentration of PCB in Porewater (pg/L)	Percent to Equilibrium [3]	Concentration of PCB in Porewater (pg/L)	Baseline [4]	Post-Treatment [5]	Method Sensitivity
480	Tri	0.50	260,000	33.17	15,075	58	87%	66	970	97 - 194	Adequate
480	Tetra	0.50	700,000	33.17	15,075	22	71%	30	740	74 - 148	Adequate
480	Penta	0.50	2,000,000	33.17	15,075	7.5	52%	15	1,300	130 - 260	Adequate
480	Hexa	0.50	5,000,000	33.17	15,075	3.0	37%	8.2	400	40 - 80	Adequate
480	Hepta	0.50	13,000,000	33.17	15,075	1.2	25%	4.7	60	6 - 12	Adequate
480	Octa	0.50	36,000,000	33.17	15,075	0.4	**15%**	2.7	7.0	0.7 - 1.4	Some results may be flagged as estimated values, and most post-treatment results likely to below detection limit.

Notes

1.) 5 picograms per 1 µL injection is the MDL. The 1800-µL SPME hexane extract is concentrated to approximately 100 µL.
2.) Approximate average for homolog group as referenced from Smedes et al. (2009).
3.) Based on sampling results from a sampling event at Bremerton, WA activated carbon amendment site. When the percentage is less than 20% (**bold and red font**), analytical results for congeners within those homologs may be flagged as estimated (J-flag or equivalent) values.
4.) Calculations are provided in Table 5.c. Average Concentration of PCB Congener Detections in Porewater, as Estimated by Two-Carbon Model.
5.) Assuming 80-90% reduction in PCBs from baseline.
6.) Abbreviations:

µL = microliter
cm = centimeter
K_{fs} = Fiber PDMS-Solution Water Partition Coefficient
L = liter
MDL = method detection limit
ng = nanogram
PCB = polychlorinated biphenyl
PDMS = polydimethylsiloxane
pg =picogram
SPME = solid phase microextraction

ATTACHMENT C

Electronic Deliverable Requirements for Laboratory Reporting

QUALITY ASSURANCE PROJECT PLAN
Attachment C – Electronic Data Deliverables Requirements
Lower Duwamish Waterway

1.0 INTRODUCTION

The purpose of electronic data deliverables (EDD) is to eliminate the potential for transcription errors between the entry of samples at the analytical laboratory and the entry of sample results into the client's project-specific data base. This assumes that the laboratory has a Laboratory Information Management System (LIMS) that is tracking this information electronically from sample receipt to final reporting. It also assumes that the project-specific data base tracks information from the field collection step to final reporting.

All laboratories being used in this project have LIMS and are certified by Washington Department of Ecology for those methods that are used in this project and that Ecology certifies. The project-specific data base for the Lower Duwamish Waterway Superfund Site was developed as part of the Remedial Investigation and Feasibility Study and has been in use for almost a decade.

The final EDDs for the PCB congener laboratory and for the general sediment laboratory are being developed as part of contracting with the laboratories. Floyd|Snider (the Lead for analytical) and Sayler Data Solutions (the Lead for data validation and data base management) have both worked with the laboratories that are being used for this project on past projects, and are comfortable that final EDD requirements can be met by both the laboratories and by the Sayler Data Solutions. Draft final versions are attached.

1.1 EDD REQUIREMENTS

The chemistry laboratory will be responsible for internal checks on sample handling and analytical data reporting, and will correct errors identified during the QA review. The laboratory data package will be submitted electronically and will include the following:

- Project narrative – This summary, in the form of a cover letter, will present any problems encountered during any aspect of analysis. The summary will include, but not be limited to, discussion of quality control, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory, and their resolutions, will be documented in the project narrative.

- Records – Legible copies of the chain-of-custody (COC) forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.

- Sample results – The data package will summarize the results for each sample analyzed. The summary will include the following information, when applicable:
  - Field sample identification code and the corresponding laboratory identification code
  - Sample matrix
  - Date of sample extraction/digestion
  - Date and time of analysis
  - Weight and/or volume used for analysis
  - Final dilution volumes or concentration factor for the sample
  - Total solids in the samples
  - Identification of the instruments used for analysis
  - Identification of cleanup procedures used on sample extracts
  - Method detection and reporting limits
  - All data qualifiers and their definitions

- QA/QC summaries – These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). The laboratory will make no recovery or blank corrections. The required summaries are listed below.
  - The calibration data summary will contain the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation, relative percent differences (RPD), and the retention time for each analyte will be listed, as appropriate. Results for standards to indicate instrument sensitivity will be reported.
  - The internal standard area summary will report the internal standard areas, as appropriate.
  - The method blank analysis summary will report the method blank analysis associated with each sample and the concentrations of all compounds of interest identified in these blanks.

- The surrogate spike recovery summary will report all surrogate spike recovery data for organic analyses. The names and concentrations of all compounds added, percent recoveries, and QC limits will be listed.
- The matrix duplicate summary will report the RPD for all matrix duplicate analyses. The QC limits for each compound or analyte will be listed.
- The laboratory control analysis summary will report the results of the analyses of laboratory control samples. The QC limits for each compound or analyte will be included in the data package.
- The relative retention time summary will report the relative retention times for the primary and confirmational columns of each analyte detected in the samples, as appropriate.

The contract laboratories for this project will submit data electronically, in Microsoft Excel® or delimited-text format. Guidelines for electronic data deliverables for chemical data are as follows:

- Each row of data will contain only one analyte result for a given sample. Therefore, one complete sample will require multiple rows.
- Each row should contain the following information at a minimum: LDWG sample identifier, sample matrix, laboratory sample identifier (if used), date of sampling, date of laboratory analysis, laboratory method, analyte name, measured result, laboratory qualifiers, units, and measurement basis.
- If using a spreadsheet file to produce the electronic deliverable, the value representing the measured concentration or detection limit will be rounded to show the correct number of significant figures and will not contain any trailing digits that are hidden in the formatting.
- If using a database program to produce the electronic deliverable, the value representing the measured concentration or detection limit will be stored in a character field, or a field in addition to the numeric result field will be provided to define the correct number of significant figures.
- If an analyte is not detected then the laboratory qualifier will be U, and the value in the result column will be the sample-specific reporting limit (RL). Quantified results between the detection limit and the RL will be laboratory J-qualified.

- Analytical results of laboratory samples for QA/QC will be included and clearly identified in the file with unique laboratory sample identifiers. Additional columns may be used to distinguish the sample type (e.g., matrix spike, matrix spike duplicate).

- If replicate analyses are conducted on a submitted field sample, the laboratory sample identifier must distinguish among the replicates.

- Wherever possible, all analytes and replicates for a given sample will be grouped together.

An example of the acceptable organization of the electronic deliverable for PCB congener chemical data is provided in Table 1. An example of the acceptable organization of the electronic deliverable for SMS constituents, TOC, black carbon, grain size, and salinity chemical data is provided in Table 2.

TABLES

Table 1
Required and Optional Fields of the Electronic Data Deliverable for PCB Congeners

File	Pos#	Field Name	DataType	Primary Key	Required	Field Definition
Smp	1	sys_sample_code	Text(40)	PK	Y/K	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. The laboratory and the EQuIS Chemistry user have considerable flexibility in the methods they use to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS Chemistry.
Smp	2	sample_type_code	Text(20)		Y	Code which distinguishes between different types of sample. For example, normal field samples must be distinguished from laboratory method blank samples, etc. IRPIMS-style sample type codes (see table X01) are understood by EQuIS Chemistry, and other valid sample types can be added by the EQuIS Chemistry user. Field sample types (e.g., field duplicates, field blanks, etc.) might be submitted blind to the laboratory; in such cases the laboratory may report all field samples as if they were all normal field samples. The laboratory is not required to export data for a spike if a spike duplicate is exported (unless the EQuIS Chemistry project manager requests all spikes).
Smp	3	sample_matrix_ code	Text(10)		Y	Code which distinguishes between different types of sample matrix. For example, soil samples must be distinguished from ground water samples, etc. IRPIMS-style sample matrix codes (see table X02) are understood by EQuIS Chemistry, and other valid sample types can be added by the EQuIS Chemistry user. The matrix of the sample as analyzed may be different from the matrix of the sample as retrieved (e.g. leachates), so this field is required at the sample level.
Smp	4	sample_source	Text(10)		Y	Must be either "Field" for field samples or "Lab" for internally generated laboratory QC samples. No other values are allowed. For example, a matrix spike duplicate sample would be a "Lab" sample, while its parent (i.e., the field sample it was derived from) would be a "Field" sample.
Tst	1	sys_sample_code	Text(40)	PK	Y/K	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. The laboratory and the EQuIS Chemistry user have considerable flexibility in the methods they use to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS Chemistry.

Table 1
Required and Optional Fields of the Electronic Data Deliverable for PCB Congeners

File	Pos#	Field Name	DataType	Primary Key	Required	Field Definition
Tst	2	lab_anl_method_ name	Text(35)	PK	Y/K	Laboratory analytic method name or description. A controlled vocabulary (i.e., list of valid method names) is not required for the laboratory EDD unless otherwise specified by the EQuIS Chemistry project manager. The method name should be sufficient to reflect operation of the laboratory. For example both "SW8080-pest" and "SW8080-PCB" may be necessary to distinguish between laboratory methods, while "SW8080" may not provide sufficient detail.
Tst	3	analysis_date	Date	PK?	Y/K?	Date of sample analysis in MM/DD/YY format. May refer to either beginning or end of the analysis as required by EQuIS Chemistry project manager. This field is not always required, but most users will want it.
Tst	4	analysis_time	Text(5)	PK?	Y/K?	Time of sample analysis in 24-hr (military) HH:MM format. May refer to either beginning or end as required by EQuIS Chemistry project manager. This field might be required, depending on the test primary key used by the EQuIS Chemistry user. Note that this field, combined with the "analysis_date" field is used to distinguish between retests and reruns (if reported). Please ensure that retests have "analysis_date" and/or "analysis_time" different from the original test event (and fill out the test_type field as needed).
Tst	5	total_or_dissolved	Text(1)	PK?	Y/K?	If required, then it must be either "T" for total [metal] concentration, "D" for dissolved or filtered [metal] concentration, or "N" for organic (or other) constituents for which neither "total" nor "dissolved" is applicable. This field might be required, depending on the test primary key used by the EQuIS Chemistry user.
Tst	6	column_number	Text(2)	PK?	Y/K?	If required, then it must be either "1C" for first column analyses, "2C" for second column analyses, or "NA" for analyses for which neither "1C" nor "2C" is applicable. Second column data may not be required, depending on the needs identified by the EQuIS Chemistry project manager, in which case all results may be reported as "NA". However, if any "2C" tests are reported, then there must be corresponding "1C" tests present also. Also, laboratories typically can report which of the two columns is to be considered "primary". This distinction is handled by the "reportable_result" field in the result table. This field might be required, depending on the test primary key used by the EQuIS Chemistry user.
Tst	7	test_type	Text(10)	PK?	Y/K?	Type of test. Valid values include "initial", "reextract", and "reanalysis".

Table 1
Required and Optional Fields of the Electronic Data Deliverable for PCB Congeners

File	Pos#	Field Name	DataType	Primary Key	Required	Field Definition
Res	1	sys_sample_code	Text(40)	PK	Y/K	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. The laboratory and the EQuIS Chemistry user have considerable flexibility in the methods they use to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS Chemistry.
Res	2	lab_anl_method_ name	Text(35)	PK	Y/K	Laboratory analytic method name or description. A controlled vocabulary (i.e., list of valid method names) is not required for the laboratory EDD unless otherwise specified by the EQuIS Chemistry project manager. The method name should be sufficient to reflect operation of the laboratory. For example both "SW8080-pest" and "SW8080-PCB" may be necessary to distinguish between laboratory methods, while "SW8080" may not provide sufficient detail.
Res	3	analysis_date	Date	PK?	Y/K?	Date of sample analysis in MM/DD/YY format. May refer to either beginning or end of the analysis as required by EQuIS Chemistry project manager. This field is not always required, but most users will want it.
Res	4	analysis_time	Text(5)	PK?	Y/K?	Time of sample analysis in 24-hr (military) HH:MM format. May refer to either beginning or end as required by EQuIS Chemistry project manager. This field might be required, depending on the test primary key used by the EQuIS Chemistry user. Note that this field, combined with the "analysis_date" field is used to distinguish between retests and reruns (if reported). Please ensure that retests have "analysis_date" and/or "analysis_time" different from the original test event (and fill out the test_type field as needed).
Res	5	total_or_dissolved	Text(1)	PK?	Y/K?	If required, then it must be either "T" for total [metal] concentration, "D" for dissolved or filtered [metal] concentration, or "N" for organic (or other) constituents for which neither "total" nor "dissolved" is applicable. This field might be required, depending on the test primary key used by the EQuIS Chemistry user.

Table 1
Required and Optional Fields of the Electronic Data Deliverable for PCB Congeners

File	Pos#	Field Name	DataType	Primary Key	Required	Field Definition
Res	6	column_number	Text(2)	PK?	Y/K?	If required, then it must be either "1C" for first column analyses, "2C" for second column analyses, or "NA" for analyses for which neither "1C" nor "2C" is applicable. Second column data may not be required, depending on the needs identified by the EQuIS Chemistry project manager, in which case all results may be reported as "NA". However, if any "2C" tests are reported, then there must be corresponding "1C" tests present also. Also, laboratories typically can report which of the two columns is to be considered "primary". This distinction is handled by the "reportable_result" field in the result table. This field might be required, depending on the test primary key used by the EQuIS Chemistry user.
Res	7	test_type	Text(10)	PK?	Y/K?	Type of test. Valid values include "initial", "reextract", and "reanalysis".
Res	8	cas_rn	Text(15)	PK	Y	Chemical Abstracts Registry Number for the parameter if available. Otherwise use the IRPIMS PARLABEL. Other chemical identifier codes may be allowed by the EQuIS Chemistry project manager.
Res	9	chemical_name	Text(60)		Y	Chemical name is used only in review of EDD. The cas-rn field is the only chemical identity information actually imported in EQuIS Chemistry.
Res	12	result_type_code	Text(10)		Y	Must be either "TRG" for a target or regular result, "TIC" for tentatively identified compounds, "SUR" for surrogates, "IS" for internal standards, or "SC" for spiked compounds. Not all of these result types may be required, depending on the needs of the EQuIS Chemistry project manager.
Res	13	reportable_result	Text(10)		Y	Must be either "Yes" for results which are considered to be reportable, or "No" for other results. This field has many purposes. For example, it can be used to distinguish between multiple results where a sample is retested after dilution. It can also be used to indicate which of the first or second column result should be considered primary. The proper value of this field in both of these two examples should be provided by the laboratory (only one result should be flagged as reportable). Also, the EQuIS Chemistry project manager can also use this field as needed. For example, benzene may be detected by several test methods requested for a sample, all but one can be flagged as not reportable if desired.

Table 1
Required and Optional Fields of the Electronic Data Deliverable for PCB Congeners

File	Pos#	Field Name	DataType	Primary Key	Required	Field Definition
Res	14	detect_flag	Text(2)		Y	Maybe either "Y" for detected analytes or "N" for non-detects. At the request of the EQuIS Chemistry project manager, other valid values may be used as necessary. These include "TR" for trace (above detection limit but below the quantitation limit) or ">" and "<" for tests such as flash point. Note that "<" must not be used to indicate non-detects (use "N" for non-detects instead).
Res	20	result_unit	Text(15)		Y	units of measurement for the result. IRPIMS-style unit of measurement codes (see table X02) are recognized by EQuIS Chemistry; other codes may be allowed by the EQuIS Chemistry project manager.
Bch	1	sys_sample_code	Text(40)	PK	Y/K	Unique sample identifier. Each sample must have a unique value, including spikes and duplicates. Laboratory QC samples must also have unique identifiers. The laboratory and the EQuIS Chemistry user have considerable flexibility in the methods they use to derive and assign unique sample identifiers, but uniqueness throughout the database is the only restriction enforced by EQuIS Chemistry.
Bch	2	lab_anl_method_ name	Text(35)	PK	Y/K	Laboratory analytic method name or description. A controlled vocabulary (i.e., list of valid method names) is not required for the laboratory EDD unless otherwise specified by the EQuIS Chemistry project manager. The method name should be sufficient to reflect operation of the laboratory. For example both "SW8080-pest" and "SW8080-PCB" may be necessary to distinguish between laboratory methods, while "SW8080" may not provide sufficient detail.
Bch	3	analysis_date	Date	PK?	Y/K?	Date of sample analysis in MM/DD/YY format. May refer to either beginning or end of the analysis as required by EQuIS Chemistry project manager. This field is not always required, but most users will want it.
Bch	4	analysis_time	Text(5)	PK?	Y/K?	Time of sample analysis in 24-hr (military) HH:MM format. May refer to either beginning or end as required by EQuIS Chemistry project manager. This field might be required, depending on the test primary key used by the EQuIS Chemistry user. Note that this field, combined with the "analysis_date" field is used to distinguish between retests and reruns (if reported). Please ensure that retests have "analysis_date" and/or "analysis_time" different from the original test event (and fill out the test_type field as needed).

Table 1
Required and Optional Fields of the Electronic Data Deliverable for PCB Congeners

File	Pos#	Field Name	DataType	Primary Key	Required	Field Definition
Bch	5	total_or_dissolved	Text(1)	PK?	Y/K?	If required, then it must be either "T" for total [metal] concentration, "D" for dissolved or filtered [metal] concentration, or "N" for organic (or other) constituents for which neither "total" nor "dissolved" is applicable. This field might be required, depending on the test primary key used by the EQuIS Chemistry user.
Bch	6	column_number	Text(2)	PK?	Y/K?	If required, then it must be either "1C" for first column analyses, "2C" for second column analyses, or "NA" for analyses for which neither "1C" nor "2C" is applicable. Second column data may not be required, depending on the needs identified by the EQuIS Chemistry project manager, in which case all results may be reported as "NA". However, if any "2C" tests are reported, then there must be corresponding "1C" tests present also. Also, laboratories typically can report which of the two columns is to be considered "primary". This distinction is handled by the "reportable_result" field in the result table. This field might be required, depending on the test primary key used by the EQuIS Chemistry user.
Bch	7	test_type	Text(10)	PK?	Y/K?	Type of test. Valid values include "initial", "reextract", and "reanalysis".
Bch	8	test_batch_type	Text(10)	PK	Y	Lab batch type. Valid values include "Prep", "Analysis", and "Leach". Additional valid values may optionally be provided by the EQuIS Chemistry project manager. This is a required field for all batches.
Bch	9	test_batch_id	Text(20)		Y	Unique identifier for all lab batches. Must be unique within EQuIS Chemistry database. For example, the same identifier can not be used for a prep batch and an analysis batch. The EQuIS Chemistry project manager and the laboratory have the flexibility to devise a scheme to ensure unique values of this field. The EQuIS Chemistry project manager will determine which, if any, batch types are to be required in the EDD.

Abbreviations:
PK Field is a primary key of the table
PK? Field may be included as part of a unique key on *dt_test*
Y/K Field is required and is a key of the table
Y/K? Field is required and may be included as part of a unique key on *dt_test*

Table 2
Required and Option Fields of the Electronic Data Deliverable for Analytes Other Than PCB Congeners
Template Data Dictionary

Field Name	Data Type	Requirement	Comments
CLIENT	Text	Required	The name of the client as listed in the chain of custody (COC) form.
PROJECT NAME	Text	Required	The project name as listed in the COC.
EVENT NAME	Text	Required	The event or task name as listed in the COC.
SAMPLE ID	Text	Required	The sample identifier.
LAB NUMBER	Text	Required	The tracking number that appears on various reports and bench sheets produced by the lab.
MATRIX	Text	Required	The sample matrix.
COLLECTION DATE/TIME	Date/Time	Required	Date and time of sample collection.
RECEIPT DATE/TIME	Date/Time	Required	Date and time that the sample was received by laboratory.
FIELD QC TYPE	Text	Conditional	Required only if sample is a field quality control sample. Typical codes can include 'Trip Blank', 'Rinsate', etc.
EXTRACTION METHOD	Text	Required	Extraction method. If an extraction method is not applicable for this analysis then 'NA' is acceptable.
EXTRACTION BATCH	Text	Conditional	Extraction batch identifier. Required if extraction method is not labeled 'NA'.
EXTRACTION DATE/TIME	Date/Time	Conditional	Date and time of extraction. Required if extraction method is not labeled 'NA'.
ANALYSIS METHOD	Text	Required	The analysis performed by the laboratory.
METHOD COMMENT	Text	Optional	Comments that further clarify the method used. For example, in cases were a EPA method is modified.
ANALYSIS BATCH	Text	Required	Analysis batch identifier.
DATE/TIME ANALYZED	Date/Time	Required	Date and time that the sample was analyzed.
ANALYTE	Text	Required	The analyte name as the lab reports it.
CAS NUMBER	Text	Required	The CAS registry number. If no CAS number exists, then 'NA' is acceptable.
DETECTION LIMIT	Number	Required	The instrument detection limit.
REPORTING LIMIT	Number	Required	This is the 'non-detected' limit used by the lab for this analyte.
REPORTING LIMIT TYPE	Text	Required	Source of the reporting limit. For example, 'IDL' (Instrument Detection Limit, 'MDL' (Method Detection Limit), or 'PQL' (Practical Quantitation Limit).
SAMPLE RESULT	Number	Required	Sample Result may only contain the detected concentration or the reporting limit (for non-detected samples).
LAB QUALIFIER	Text	Required	Lab qualifiers as assigned by the laboratory during analysis. (A list of definitions is required separately.)

Table 2

Required and Option Fields of the Electronic Data Deliverable for Analytes Other Than PCB Congeners

Template Data Dictionary

Field Name	Data Type	Requirement	Comments
UNITS	Text	Required	The units in which the sample is reported.
RESULT BASIS	Text	Required	The basis upon which the results were calculated. For example 'Dry', 'Wet', 'OC' (Organic Carbon Normalized).
FRACTION	Text	Required	The fraction of the result. 'Total', 'Dissolved', 'NA'.
DILUTION	Number	Required	Sample dilution.
RESULT SIGFIG	Number	Required	Number of significant figures.
INSTANCE	Number	Optional	An incremental number that helps distinguish samples that have been reanalyzed.
PERCENT MOISTURE	Number	Optional	Percent moisture.
LABORATORY	Text	Required	Laboratory where analysis was conducted.
ANALYST	Text	Required	Laboratory analyst conducting analysis.
LAB NOTES	Text	Optional	Any pertinent information related to that result.
Quality Control Specific			
PARENT SAMPLE ID	Text	Optional	For laboratory duplicates this is the Sample ID of the parent sample.
PREPARED DATE/TIME	Date/Time	Required	Date/Time QC sample was prepared.
LAB QC TYPE	Text	Required	Quality control type. Typical codes can include 'Surrogate', 'Lab Duplicate', 'Matrix Spike', etc.
TRUE VALUE	Number	Conditional	The true amount of analyte added. Required for samples where the true value is known, for example spiked samples.
PERCENT RECOVERY	Number	Conditional	The recovery of an analyte expressed as a percentage of the amount added. Required for surrogates and internal standards.
PR LOWER LIMIT	Number	Conditional	The acceptable lower limit of recovery. Required if result is reported for percent recovery.
PR UPPER LIMIT	Number	Conditional	The acceptable upper limit of recovery. Required if result is reported for percent recovery.
RPD	Number	Conditional	The relative percent difference. Required for samples were a duplicate was measured. For example Matrix Spike/Matrix Spike Duplicate.
RPD LIMIT	Number	Conditional	The acceptable limit of percent different. Required if result is reported for RPD.

To be Provided:

QUALITY ASSURANCE PROJECT PLAN
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

APPENDIX F

Water Quality Monitoring Plan

*L*ower *D*uwamish *W*aterway *G*roup

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

WATER QUALITY MONITORING PLAN

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

FINAL

Prepared for:

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

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
Ramboll Environ
Floyd|Snider
Geosyntec Consultants

December 7, 2015

Project No. LY15160310

TABLE OF CONTENTS

FIGURE

ATTACHMENT

ABBREVIATIONS AND ACRONYMS

AC	activated carbon
BMP	best management practice
Ecology	Washington State Department of Ecology
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery with activated carbon
EPA	U.S. Environmental Protection Agency
FE	Field engineer
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
Order	Administrative Order on Consent
PE	Project engineer

WATER QUALITY MONITORING PLAN

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 INTRODUCTION

The Lower Duwamish Waterway Group will conduct the Pilot Study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW). The study will determine if Enhanced Natural Recovery (ENR) amended with granular activated carbon (ENR+AC) can be successfully applied to reduce the bioavailability of remediated contaminated sediment in the LDW. The study will compare the effectiveness of ENR+AC against ENR without added activated carbon (AC) in three areas in the LDW: intertidal, subtidal, and subtidal potential scour area plots. For the purposes of this project, ENR involves the placement of a thin layer of clean material (sand or gravelly sand) over subtidal or intertidal sediments. ENR+AC involves placement of a thin layer of clean material augmented with activated carbon over subtidal or intertidal sediments. The purpose of the ENR and ENR+AC treatments are to reduce the exposure of aquatic organisms to contaminants of concern. Figure 1 shows the locations for the Pilot Study.

A Pilot Study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway, CERCLA Docket No. 10-2001-0055, issued on December 20, 2000. This Water Quality Monitoring Plan details the water quality monitoring that will be conducted during construction of the pilot study plots.

A barge-mounted, fixed-arm excavator with a clamshell bucket is expected to be used for the submerged placement of ENR and ENR+AC. Submerged release of the ENR and ENR+AC several feet above the substrate will minimize the loss of AC as the ENR+AC descends through the water column and will also prevent or minimize turbidity plumes that may result as fine material in the ENR and ENR+AC becomes suspended in the water column upon its release and descent to the sediment bed. The ENR+AC will be preblended to meet the target concentration of AC and will be presoaked prior to placement. Presoaking of the ENR+AC will help to minimize the loss of AC as the ENR+AC descends through the water column during placement. The target thickness of the ENR and ENR+AC is between 6 and 9 inches.

Precision navigation, as well as offset and staggered placement, will be used to ensure precise placement of the ENR and ENR+AC at each of the three pilot plots.

Construction of the pilot plots is expected to be completed during the authorized 2016–2017 in-water work window for the LDW during which listed salmonid species are least likely to be present in the area. The construction activities are expected to be completed within one to two months.

Prior to construction of the pilot study plots, a test of the placement methods will be conducted. This demonstration placement will be used to calibrate and verify bucket volume, placement area and thickness of the material in designated demonstration areas prior to placement in pilot study test plots. There will be two demonstration placements conducted; one with sand+AC and one with gravely sand+AC. The two areas will be approximately 40 by 60 feet in size (Figure 1). The sand+AC demonstration plot will be located downstream of the intertidal pilot study plots and the gravely sand+AC demonstration plot will be located within the gravely sand+AC pilot study plot (Figure 1). The demonstration placements is expected to take 2 days.

During both the demonstration placement and construction of the pilot study plots the ENR+AC material will be pre-soaked within a flooded, water tight barge for a minimum of 12 hours prior to placement. As the ENR+AC material is removed from the barge, the overlying water will be pumped to the Duwamish Waterway through a 1 micron bag filter to control turbidity.

Water quality monitoring for turbidity will be conducted during the in-water placement of the ENR and ENR+AC. Water samples will not be collected for chemical analysis because the ENR material will be obtained from a clean quarry source, and the AC will be virgin.

The objectives of the water quality monitoring and management activities are as follows:

- Ensure that the water quality performance criteria prescribed by the 401 Water Quality Memo (Attachment 1) developed by EPA are met during implementation of the remedial action.
- Establish contingency measures and corrective actions in the unlikely event that unacceptable conditions are detected.

These monitoring and management objectives will be achieved by means of the following activities, as described in this plan:

- The Lower Duwamish Waterway Group (LDWG) consulting team will conduct water quality monitoring during placement of the ENR and ENR+AC materials.
- Monitoring stations will be selected to demonstrate compliance with the water quality objectives.

Written reports documenting compliance with the performance standards will be prepared by the LDWG consultant team for submittal to the EPA as required in the 401 Water Quality Memo.

2.0 WATER QUALITY MONITORING

Water quality monitoring will be conducted during the demonstration placement and construction of the pilot study plots. Compliance with the performance standards will be demonstrated with the use of data from the compliance stations and a corresponding ambient station for each monitoring event. The ambient station will be located outside the area of influence of the construction activities. During ebb tide, the ambient station will likely be located upstream of the construction activities. During flood tide, surface water flows at the scour and subtidal plots will be predominantly downstream (freshwater surface flow) and bottom flows will be upstream (in the salt wedge); therefore the ambient station may be located in a lateral direction from the construction activities or at least 1,000 feet upstream of the construction activities.

At each monitoring station and ambient station, turbidity will be measured at approximately 2-foot intervals from 2 feet below the water surface to no closer than 3 feet above the sediment surface. Turbidity measurements will not be recorded closer to the bottom than 3 feet to minimize the potential for resuspended sediment disturbed by the water quality instrument and the weight attached to the retrieval line from influencing the near-bottom readings.

During each round of monitoring an ambient station with a depth range similar to the proposed monitoring stations will be selected. Monitoring stations will be established 75 feet (early warning station) and 150 feet (compliance station) from the in-water work. Monitoring at the 75-foot station will not be conducted if the positioning of construction equipment precludes safe access. Water quality monitoring of the in-water work during demonstration placement and construction of the pilot study plots will be conducted both downstream and upstream of the activity. Monitoring will be conducted twice per day during daylight hours when construction is being conducted.

Compliance with the performance standards will be demonstrated with the use of data from the compliance stations and a corresponding ambient station for each pilot plot. The turbidity at each depth interval sampled at the compliance stations (150 feet) will be compared to the equivalent depth interval sampled at ambient stations and evaluated for compliance with the turbidity marine numeric criterion for excellent quality waters designated by Washington State Department of Ecology (Ecology) (Washington Administrative Code, Section 173-201A-210]), as indicated in the following table.

Parameter	Excellent Quality – Water Quality Standards Marine Numeric Criteria
Turbidity	If background <50 NTU, <5 NTU greater than background If background >50 NTU, <10% increase

Abbreviations:
NTU = nephelometric turbidity unit

If there is an apparent exceedance of the turbidity criterion at a compliance station, the sampling team will conduct additional monitoring as described below.

If an exceedance is observed, the LDWG sampling team will immediately notify the project engineer (PE) and the King County Project Representative (Project Representative), and EPA will be notified within 6 hours. The PE, Project Representative, and contractor will assess the exceedance and determine appropriate modifications to operations and/or best management practices (BMPs).

The standard BMPs to be followed are described in the construction quality assurance project plan and will be described in the contractor's work plan. If there is a confirmed exceedance of the turbidity compliance criterion during construction monitoring, the construction team may institute the following or other BMPs:

- Review the documented operations at the time of the exceedance; specifically determine whether the in-water placement of ENR or ENR+AC or a non-project-related activity was occurring at the time of the exceedance.
- Inspection of the material barge to determine whether there are significant leaks that could contribute to the exceedance of the turbidity criterion.
- The contractor may modify operations per direction from the Project Representative. Potential modifications may include an adjustment to the placement process, including the following:
  - Decreasing the velocity of the bucket through the water column
  - Pausing the bucket above the sediment surface before opening it
  - Stopping work temporarily or increasing cycle time
  - Modifying the position of barges to reduce potential grounding or scour from the tugs

In response to an exceedance of the turbidity criterion at any depth interval at the 150 foot compliance stations, an attempt will be made to determine the areal extent of elevated turbidities. In the direction of the exceedance (either upstream or downstream depending on the direction of the water flow), turbidity readings (with measurements made at 2-foot depth intervals) will be collected at approximately 150-foot intervals from the construction. Every 150 feet, paired profiles (inshore and offshore) of the water column will be collected to determine the width of the “plume”. Stations will be occupied every 150 feet in the direction of the exceedance until turbidities are below the water quality criterion.

2.1 Demonstration Placement

It is expected that the demonstration placement will take 2 days to complete. For the duration of the demonstration placement, monitoring will be conducted twice daily with at least 2 hours between monitoring events. In the event that there is a confirmed exceedance of the turbidity criterion during the first monitoring event of the day, the second sampling event may not be conducted if sampling is being conducted to determine the areal extent of the turbidity plume or there is insufficient daylight time complete a round of sampling.

2.2 Pilot Study Plot Construction

During the first 2 days of the construction of each of the pilot study plots (i.e., intertidal, subtidal, and subtidal potential scour plots) water quality monitoring will be conducted twice daily with at least 2 hours between monitoring events. The first 2 days of plot construction will be during the time that the ENR+AC material is being placed which would have the greatest potential for turbidity exceedances. If during the first 2 days of monitoring there are no exceedances of the turbidity criterion, then water quality monitoring will not be conducted for the duration of that plot’s construction. If there is a turbidity criterion exceedance, then monitoring will be conducted until there are two consecutive days without a turbidity exceedance or for the remainder of the plot construction. If there are exceedances on 2 consecutive days during placement of the ENR+AC material within a plot (i.e., intertidal, subtidal, and subtidal potential scour), then monitoring of the ENR only subplots may be conducted to provide information about the relative difference in turbidity generated with placement of the different material types.

The duration or frequency of monitoring may be changed in consultation with EPA.

2.3 Water Discharge from Barge

Monitoring of the discharge of the water used for the presoaking of the ENR+AC will not be conducted if the water is discharged through a 1 micron bag filter. If for any reason the water cannot be discharged through a 1 micron bag filter, EPA will be consulted to determine if any monitoring beyond that already conducted at the early warning and compliance stations is required.

2.4 VISUAL TURBIDITY PLUME

If a gross turbidity plume is observed during placement of the ENR or ENR+AC material during days when active water quality monitoring is not being conducted, EPA will be consulted as soon as practicable to determine an appropriate course of action.

2.5 RELOCATION OF AC + ENR MATERIAL

In the unlikely event that over placement of ENR or ENR+AC material requires the material to be relocated to the perimeter of a subplot, the decision on whether turbidity monitoring will be required during material relocation will be determined in consultation with EPA.

3.0 WATER QUALITY COMPLIANCE MONITORING METHODS

In situ monitoring of turbidity will be conducted using a submersible multiparameter water quality measurement and data collection system. A YSI Model 6820 or 6920 data sonde connected by a cable to a YSI Model 650 Multiparameter Display System, or an equivalent submersible multi-parameter water quality instrument, will be used for monitoring.

Before the monitoring activities for the pilot study begin, the water quality instrument will be calibrated using the manufacturer’s recommended procedures, and the calibration documentation will be recorded for the project files. In addition, before the beginning of each round of monitoring, the pressure transducer (or another type of equipment or instrument for measuring water depth) will be adjusted to compensate for the current barometric pressure.

Each round of water quality compliance monitoring will include the collection of data at an ambient station and at the 75- and 150-foot stations located directly downstream and upstream of the in-water construction activity. The sampling boat will be positioned at each sampling station by means of a laser rangefinder. Turbidity and depth data (at approximately 2-foot intervals) will be collected at each early warning (75 feet) or compliance station (150 feet) unless the total water depth is less than 8 feet.

If the water depth at the early warning or compliance station is 8 feet or less, readings (including depth) will be recorded at the mid-depth (at least 2 feet below the surface but less than or equal to 4 feet below the surface) after allowing any sediments potentially resuspended by the water quality instrument to dissipate.

At each station where the total water depth is greater than 8 feet, the data sonde will be lowered to 2 feet below the surface. The reading displayed on the Multiparameter Display System will be allowed to stabilize for approximately 30 seconds, and the values for turbidity will be recorded on a field form. The data sonde will then be lowered an additional 2 feet, allowed to stabilize, and the turbidity readings recorded. This process of data collection will continue at each station until the data sonde is 3 to 4 feet above the sediment surface (a weight will be suspended approximately 4 feet below the bottom of the instrument probes) after allowing any sediment potentially resuspended by the water quality instrument to dissipate at the deepest depth. A comparison of the turbidity readings recorded at a compliance station (150 feet) with those recorded at the ambient station (nearest comparable water depth reading) will indicate if the turbidity criteria have been exceeded at each recorded depth interval.

If there are no exceedances of the turbidity criterion during 2 full rounds of monitoring (downstream and upstream, if required), additional rounds of monitoring are not required that day. An exceedance of the turbidity criterion at 150 feet will require additional monitoring to determine the areal extent of the elevated turbidities. Additional rounds of water quality monitoring will also be conducted until there are no additional exceedances or until approaching dusk requires that the monitoring be discontinued until the next workday, or as directed otherwise by the EPA. If an exceedance is identified, the sampling team will immediately notify the Project Engineer and the King County Project Representative. The EPA will be notified within 6 hours.

4.0 DELIVERABLES AND SUBMITTALS

The LDWG consultant team will prepare a daily water quality monitoring report for submission to the field engineer (FE) and the EPA. The daily report will include a description of the water quality monitoring and in-water activities conducted and the field measurements collected. It will be submitted to the EPA within 48 hours if no confirmed water quality exceedances occurred.

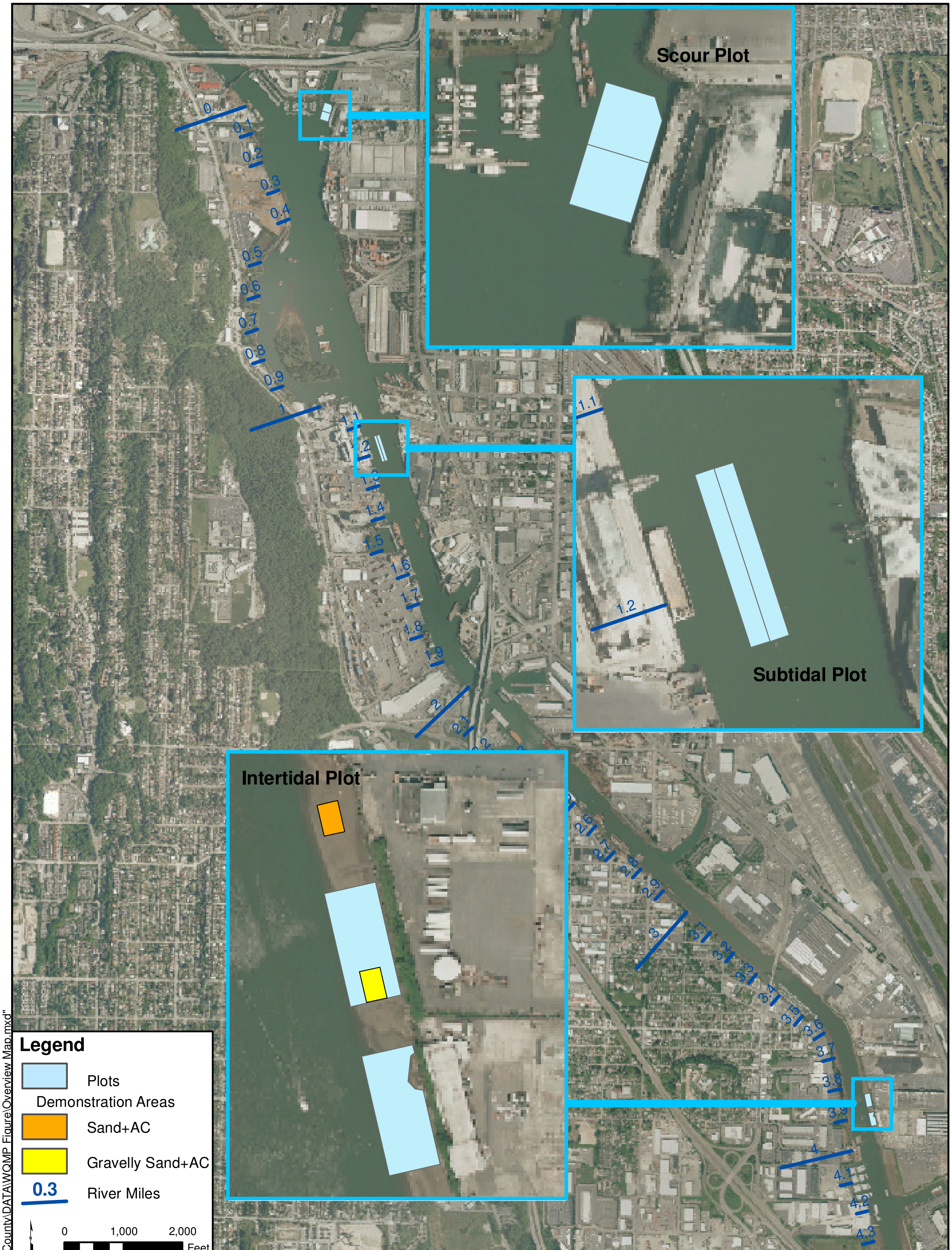
In the event of a confirmed exceedance, the FE will provide the daily report to the EPA within 24 hours of the exceedance. In addition to the daily report, the FE will provide the purported cause of the exceedance, the specific corrective measures initially implemented, the rationale for those measures, and the results of follow-up readings.

A summary of the water quality monitoring program will be included in the construction report[1]. This summary will include a description of the field effort (e.g., procedures, sampling locations and depths, and observations), descriptions and rationale for any deviations from the water quality monitoring plan or the 401 Water Quality Memo, a detailed discussion of any data quality issues, tabulated field data with comparisons to criteria and to background (ambient station) levels, and

1 The construction report will be submitted to the EPA and Ecology as part of the Year 1 monitoring report.

any corrective actions (e.g., changes in BMPs or stopped work) implemented as a result of these data.

FIGURE



Lower Duwamish Waterway Group

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

ENR/AC Pilot Study
Water Quality Monitoring Plan

Figure 1
Pilot Plot Areas

File path: "P:\King County\DATA\WQMP Figure\Overview Map.mxd"

ATTACHMENT 1

CWA Section 401 Water Quality Memorandum
(When EPA completes the Section 401 Memorandum, it will be included as Attachment 1)

APPENDIX G

Health and Safety Plan

Lower Duwamish Waterway Group

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

SITE-SPECIFIC HEALTH AND SAFETY PLAN

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

FINAL

Prepared for:

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

The Washington State Department of Ecology
Northwest Regional Office
Bellevue, Washington

Prepared by:

Amec Foster Wheeler Environment & Infrastructure, Inc.
Dalton, Olmsted & Fuglevand, Inc.
Ramboll-Environ
Floyd|Snider
Geosyntec Consultants
Stephen Frost & Associates

December 7, 2015

Project No. LY15160310

TABLE OF CONTENTS

TABLE OF CONTENTS

Page

TABLES

ATTACHMENTS

ABBREVIATIONS AND ACRONYMS

AC	activated carbon
bpm	beats per minute
CRZ	contamination reduction zone
°F	degrees Fahrenheit
DOF	Dalton, Olmsted & Fuglevand, Inc.
DOSH	Division of Occupational Safety and Health
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery amended with activated carbon
HASP	health and safety plan
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
Order Amendment	Second Amendment (July 2014) to the Administrative Order on Consent for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway
PCB	polychlorinated biphenyl
PFD	personal flotation device
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
SDS	Safety Data Sheet
SHSO	site health and safety officer
WAC	Washington Administrative Code

SITE-SPECIFIC HEALTH AND SAFETY PLAN
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

1.0 INTRODUCTION

This site-specific health and safety plan (HASP) addresses the health and safety practices and controls that will be implemented by members of the Lower Duwamish Waterway (LDW) oversight management team from Amec Foster Wheeler and Dalton, Olmsted & Fuglevand, Inc. (DOF) during their construction and long-term monitoring oversight activities on the Enhanced Natural Recovery (ENR)/Activated Carbon (AC) Pilot Study. Their work activities include monitoring all phases of the construction of the pilot study, including the collection of surface sediment and porewater samples; the placement and distribution of cover material consisting of ENR and ENR amended with AC (ENR+AC) during the construction phase of the pilot study; and the collection of bathymetric survey data in the study area (the areas where the pilot project plots are constructed). They will also monitor postconstruction activities, such as, benthic infauna and sediment profile imagery camera surveys and evaluations of the physical condition of the cover material over time.

Because of the specialized nature of the many different site evaluation, construction activities, and long-term monitoring that will be conducted in the study area, each sub-contractor involved in the work will develop and implement its own HASP and provide activity safety analyses that address the tasks that they are responsible for. These subcontractor plans will be provided as attachments to this site-specific HASP and will be reviewed by Amec Foster Wheeler health and safety management for general conformance with applicable regulatory and site-specific health and safety requirements. Therefore, it should be stressed that the health and safety directives discussed herein apply only to Amec Foster Wheeler and DOF construction oversight management personnel who are engaged in the oversight activities mentioned in the previous paragraph. All personnel participating in or overseeing sampling or construction activities must be covered under a site-specific HASP. Regulatory personnel must follow the requirements in this HASP unless they are covered in a site-specific HASP developed by their agency. If regulatory personnel use this HASP to cover their field oversight activities, it is the responsibility of their agency to ensure that all required training and medical surveillance is conducted as per the requirements of this HASP. In addition, all regulatory personnel will be required to provide all required personal protective equipment for their use. Furthermore, this plan was developed specifically for this project and should not be used in whole or in part for any other project unless such application is reviewed and approved by the Lower Duwamish Waterway Group (LDWG). This plan, however, will be updated as appropriate to account for changes in the scope of work and for new hazards discovered at the job site once work is underway.

Activities performed under this site-specific HASP will comply with the applicable sections of Washington Administrative Code, Chapter 296-843 (WAC 296-843) for hazardous waste site work and all other relevant Division of Occupational Safety and Health (DOSH) general occupational health regulations and construction safety standards. When appropriate, specific DOSH standards are referenced within the plan to highlight additional health and safety requirements that are not otherwise discussed. These standards will be available on site by means of an Internet connection with the Washington State Department of Labor and Industries Safety & Health web site.

The content of this plan and any relevant DOSH standards will be discussed with all oversight management personnel before work begins. However, said management does not guarantee the health or safety of any person entering this site. Because of the nature of this site and the many different activities occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury at this site.

As stated above, this plan covers Amec Foster Wheeler and DOF construction oversight management personnel who are engaged in the oversight activities. This plan does not cover diving that may be required for the construction oversight. A site-specific diving Construction Monitoring Health and Safety Plan will be developed by the diving sub-contractor when the scope of the activity is fully defined. The diving HASP will be an attachment (Attachment E) to this plan and will be provided for review later in 2015.

In addition, this plan does not cover water quality or other monitoring activities that will be conducted. Site-specific HASPs for the monitoring to be conducted will be provided when the scope of the activities have been fully defined and the subcontractors have been selected. Each subcontractor will provide a HASP that covers the activities that they will be conducting and will be attachments to this plan. It is anticipated that the following plans will be attached:

- Construction Water Quality Monitoring Health and Safety Plan (Attachment F),
- Monitoring Diving Health and Safety Plan (Attachment G),
- Sampling Health and Safety Plan (Attachment H), and
- Sediment Profile Imaging Health and Safety Plan (Attachment I)

These HASPs will be provided later in 2015.

2.0 DESCRIPTION OF PROJECT

LDWG will conduct a pilot study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the LDW. The study will determine whether ENR+AC reduce the bioavailability of polychlorinated biphenyls (PCBs) in remediated contaminated sediment in the LDW. The study will compare the effectiveness of ENR with added AC (ENR+AC) with that of ENR without added AC in three areas in the LDW, which are referred to as the intertidal, subtidal, and scour plots. For the purposes of this project, ENR involves the placement of a thin layer of clean material over subtidal or intertidal sediments. ENR+AC involves the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments. The purpose of the ENR and ENR+AC treatments is to reduce the exposure of aquatic organisms to the contaminants of concern.

A pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055, issued on December 20, 2000).

The goals of the pilot study, as stated in the Order Amendment, are the following:

- Verify that ENR+AC can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percentage of carbon in a placed layer).
- Evaluate the performance of ENR+AC compared to ENR alone in locations with a range of PCB concentrations.
- Assess potential impacts on the benthic community in ENR+AC compared to ENR alone.
- Assess changes in bioavailability of PCBs in ENR+AC compared to ENR alone.
- Assess the stability of ENR+AC in scour areas (such as berthing areas).

Achieving these goals will involve the collection of pre- and postconstruction sediment and porewater samples from the three pilot plots in the LDW, placing ENR and ENR+AC material in the pilot plots, conducting bathymetric and visual surveys of the pilot plots, and evaluating marine benthic communities in the LDW subsequent to placement of the cover material.

Mechanical dredging equipment will be used to place the cover material, and commercial divers will conduct visual surveys of the pilot plots, install and retrieve porewater samplers, and collect bulk samples of the sediments before and after cover placement. Small boats will also be operated at the site to conduct bathymetric surveys, collect sediment samples, and transport personnel to active work areas on the LDW. Specialty contractors will be hired to do this work. As indicated, the LDW oversight management team will be responsible for monitoring these work activities without participating in them directly.

When visiting the work area, oversight management team members will stay within designated areas of the site in coordination with the contractor. If it is necessary for them to enter controlled work areas, they will first notify the contractor in charge of the site, review the contractor's site-specific HASP, and comply with all health and safety requirements established by the contractor for entering its work areas.

3.0 HEALTH AND SAFETY PROJECT ORGANIZATION

3.1 Project Manager

The project manager, Cliff Whitmus (Amec Foster Wheeler) is responsible for overall administration of site operations. His duties include directing the oversight management personnel; tracking the budget; ensuring that adequate resources are available to complete the oversight work; resolving site health and safety issues related to oversight management personnel, project planning, monitoring compliance with applicable environmental regulations, DOSH standards, and other client-specific requirements; and maintaining communications between oversight management personnel and site contractors, regulatory agencies, the client, and off-site resources. The project manager will report directly to LDWG.

3.2 Field Oversight Management Personnel

Amec Foster Wheeler with support from DOF will provide oversight management of the project. The project organizational structure consists of a project engineer, Rob Webb, and a field technical lead/site health and safety officer (SHSO), Rich May or an equivalent alternate/substitute, along with field support staff whose specific roles and responsibilities are described in this paragraph. They will comply with and keep informed about the information, instructions, and emergency response actions included in this site-specific HASP and comply with all rules, regulations, and procedures established by other site contractors when entering or working in areas under their control. They will also inform the site contractors of any apparent health and safety hazards or unsafe work practices that could jeopardize the health and wellbeing of their workers. All field personnel including, most particularly, oversight management personnel, have the authority to stop work whenever they identify conditions or work activities that pose an unreasonable risk of injury or illness. The aforementioned oversight management personnel will report directly to their company health and safety manager and secondarily to the overall project manager.

3.3 SITE HEALTH AND SAFETY OFFICER

DOF's field technical lead, Rich May or his alternate/substitute, will act as the SHSO for DOF's oversight management activities on the project. This individual will meet the SHSO training requirements listed in Section 8.0 of this HASP and perform the emergency coordinator duties discussed in Section 13, as necessary. His or her site-specific health and safety duties will apply only to the oversight management team (not other contractors doing the work) and will include the following:

- Providing on-site monitoring to determine the appropriate levels and use of personal protective equipment (PPE)
- Ensuring that relevant sections of the site-specific HASP are being applied to the work
- Providing site surveillance, hazard identification, and health risk analysis related to oversight activities
- Initiating changes to the site-specific HASP, as necessary
- Ensuring that appropriate site control and decontamination measures are being implemented
- Conducting and documenting weekly health and safety briefings
- Maintaining health and safety field logbooks
- Conducting incident investigations
- Informing oversight management personnel of the contents of the site-specific HASP
- Maintaining medical clearance letters and training documentation for the oversight management team
- Conducting regular site safety inspections
- Exercising stop work authority when warranted by conditions
- Verifying that team members are adequately trained and qualified for the work

The SHSO will report directly to DOF's project engineer, Rob Webb.

3.4 TECHNICAL STAFF

Each member of DOF's and Amec Foster Wheeler's oversight management technical staff will be responsible for reporting any unsafe or potentially hazardous situations to the SHSO. The field technical staff will comply with and keep informed about the information, instructions, and emergency response actions contained in this HASP and comply with all rules, regulations, and procedures established by other site contractors when entering or working in areas under their control. All field technical staff are expected to stop work and contact their supervisor whenever they believe their work, or that of their coworkers, poses an uncontrolled hazard or unreasonable risk of injury or illness. Furthermore, all field technical staff are expected and encouraged to participate in the implementation of the environmental safety and health process by participating in meetings, incident reporting and investigations, inspections, hazard identification, and hazard analyses.

3.5 SITE VISITORS

On occasion, appropriately authorized visitors may come to the site to observe the oversight management activities. Visitors may be from city, state, and federal regulatory and resource agencies that have a specific interest in the project, or they may be invited by the client, site contractors, or regulatory agencies.

Visitors intending to observe operations included in this HASP will be required to sign into the job site before being allowed access to their work area. Visitors will be briefed on the hazards of the site, contents of the site-specific HASP, site safety rules, hazard control measures, and required PPE. They will be escorted at all times by an oversight management team representative when entering active work areas to observe site operations. Visitors are expected to fully comply with all of the site health and safety requirements.

4.0 SITE CHARACTERIZATION

This section presents an assessment of the chemical and physical hazards that may be encountered during the tasks specified in Section 1.0 of this site-specific HASP. Additional hazard control information is provided in Attachment A and Attachment B. All site personnel will be informed of these hazards and the means that will be taken to control them before beginning work.

4.1 CHEMICAL CONTAMINANTS

In the fall of 2014, LDWG conducted extensive sediment sampling within the study area to characterize the nature and extent of contaminants present at the site (Windward, 2015). The samples were analyzed for PCBs; data for other contaminants, such as, metals (lead, arsenic, zinc, and mercury), bis(2-ethylhexyl)phthalate, and butyl benzyl phthalate, have also been collected during previous sampling efforts. The highest recorded PCB concentration in the study area was 4.0 parts per million (ppm), and lead, arsenic, zinc, and mercury were detected at the following maximum concentrations: 21,700 ppm, 290 ppm, 1,050 ppm, and 6.8 ppm, respectively. The compound bis(2-ethylhexyl)phthalate was detected in one sample at a maximum concentration of 81 ppm, and butyl benzyl phthalate was detected at 83 ppm.

Although all of the aforementioned contaminant concentrations exceeded the remedial action levels, none of them realistically poses a significant exposure hazard to oversight management personnel given that these substances are contained in wet sediments and are not likely to become airborne and thereby present an inhalation exposure hazard. Furthermore, oversight management activities do not involve contacting contaminated sediments to any significant degree. If, however, it is necessary for oversight management personnel to enter work areas where exposure to site contaminants is possible, they will comply with the work practice and personal protective measures required by the contractor in control of the job site.

4.2 PHYSICAL HAZARDS

Oversight management personnel are likely to encounter several physical hazards when they visit the job site to conduct their inspections. These hazards include exposure to noise; slips, trips, and falls; cold stress; possible contact with heavy, mechanical equipment operating at the job site; and boating-related injuries.

These hazards are discussed in the following subsections and in Attachment A.

4.2.1 Noise

The noise levels may exceed 85 decibels (dBs) at certain locations near the floating cranes used to place the cover material, the sediment sampling equipment, and the motorized boats. If oversight management personnel must work around these noise sources for the majority of their shift, they will be required to wear hearing protection, such as, ear plugs or muffs. Hearing protection will also be worn when required by the contractor in charge of the job site. Noise warning signs will be posted around each high-noise hazard area.

4.2.2 Slips, Trips, and Falls

There are likely to be slip, trip, and fall hazards onboard floating cranes and sample collection boats due to wet walkways, unsecured equipment left on deck, open hatches, and pitching and rolling actions of the vessels in rough water. These hazards may also exist on the dock where the boats will be moored. Uneven walking surfaces on shore and equipment left on the ground in the work area can also pose a slip and trip hazard for workers. These hazards will be controlled by keeping the work area and walkways free of debris and other litter. In addition, boat operators will ensure that all floor hatches are closed during normal operations and all stairways, walkways, and elevated work platforms are equipped with guard railings. Oversight management personnel will wear high-traction, steel-toed safety boots and pay careful attention to surface conditions to prevent injuries due to trips and falls. The work area will be inspected before the start of work to identify any hazards that could cause injury. The results of these inspections will be communicated to site personnel at the start of each shift.

U.S. Coast Guard–approved personal flotation devices (PFDs) will be worn at all times when riding in boats, working within 6 feet of unguarded edges of docks, and over or near the water. All PFDs will be equipped with whistles. If used after dark, they will be fitted with retroreflective tape and water-activated strobe lights. They will be inspected after use and at intervals sufficient to ensure that they are well maintained and fully functional.

4.2.3 Heat and Cold Stress

Because all planned work activities will be conducted outside where the temperature conditions can vary greatly, there is a risk that site personnel could develop heat or cold stress; however, it is anticipated the construction will take place in the fall/winter when cold stress is more likely. The likelihood of heat or cold stress depends on the environmental conditions, the level of work activity, and the personal control measures that are used to manage heat loads (work/rest cycles, use of appropriate clothing and/or cooling devices, hydration, etc.).

4.2.3.1 Heat Stress

Heat-related injuries fall into three major categories: heat stroke, heat exhaustion, and heat cramps. 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 1.

TABLE 1

HEAT STRESS SYMPTOMS AND RECOMMENDED FIRST AID

Type of Heat Stress	Cause	Symptoms	First Aid
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.

TABLE 1

HEAT STRESS SYMPTOMS AND RECOMMENDED FIRST AID

Type of Heat Stress	Cause	Symptoms	First Aid
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 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 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.

Source: http://www.cdc.gov/niosh/topics/heatstress/#_Heat_Stroke (accessed June 2015)

The following control measures will be taken to manage concerns related to heat stress:

- The SHSO will ensure that site personnel are trained in the recognition and treatment of heat stress symptoms.
- Ambient temperatures in the work area will be monitored to establish work and rest schedules.
- Physiological monitoring of representative workers will be conducted as appropriate.
- Heat stress illness will be treated if it develops.

- Shaded rest areas, chilled beverages, reduced workloads, and frequent breaks will be provided to allow workers to cool down when conditions conducive to heat stress exist.
- The "buddy system" will be used to monitor coworkers for signs of heat stress.

Workers will also be encouraged to self-limit their exposures to heat stress conditions. Those who take medications that may compromise normal physiologic functioning will be counseled and monitored for heat stress.

Of particular concern in monitoring for heat stress is the use of personal protective clothing, which decreases natural body ventilation and greatly increases the temperature and humidity of the skin. If visual monitoring indicates that a worker is suffering from heat stress, or if the conditions and PPE requirements warrant it, workers will be evaluated for heat stress by monitoring their heart rate, body core temperature, and symptoms of heat stress. Excessive heat stress may be marked by one or more of the following conditions, and if any of these conditions are noted in an individual, the cause(s) will be rectified:

- Sustained heart rate is in excess of 180 beats per minute (bpm) minus the individual's age in years, for individuals with assessed normal cardiac performance.
- Recovery heart rate at 1 minute after a peak work effort is greater than 110 bpm.
- Body core temperature—as measured with an infrared ear drum scanner—is greater than 100.4 degrees Fahrenheit (°F).
- There are symptoms of sudden and severe fatigue, nausea, dizziness, or lightheadedness.

First aid will be administered by trained site personnel. Immediate medical attention will be sought for workers exhibiting signs of heat stroke. Workers exhibiting signs of heat exhaustion will be treated and monitored by trained workers to determine whether medical intervention is required.

4.2.3.2 Cold Stress

There is also a risk that site personnel could become hypothermic if they fail to dress warmly in cold weather, or they get wet from rain, water splashes associated with the sediment sampling, or falling into the water. Staying dry and warm is crucial to preventing the development of hypothermia. The signs, symptoms, and treatments for cold stress (hypothermia) are discussed in the following text.

Signs and Symptoms of Hypothermia

Mild hypothermia (body temperature of 98°F–90°F)

- Shivering
- Lack of coordination, stumbling, and fumbling hands
- Slurred speech
- Memory loss
- Pale, cold skin

Moderate hypothermia (body temperature of 90°F–86°F)

- Cessation of shivering
- Inability to walk or stand
- Confusion and irrationality

Severe hypothermia (body temperature of 86°F–78°F)

- Severe muscle stiffness
- Very sleepy or unconscious
- Ice-cold skin
- Death

Stabilization and Basic Life Support

Mild hypothermia

- Move to a warm area.
- Stay active.
- Remove wet clothes and replace them with dry clothes or blankets and cover the head.
- Drink a warm (not hot) sugary drink.

Moderate hypothermia

All of the above, plus the following:

- Call the SHSO (Table 3) and transport to a medical facility.
- Completely cover all extremities.
- Place very warm objects, such as hot packs or water bottles on the head, neck, chest, and groin.

Severe hypothermia

- Call the SHSO (Table 3) and transport to a medical facility.
- Treat the victim very gently.
- Do not attempt to rewarm (victim should receive treatment in a medical facility).

Special Considerations

- Early recognition of hypothermia is imperative.
- Shivering does not occur when core body temperature is less than 90°F; at 90°F the victim may not even feel cold.
- At a body temperature less than 86°F, the heart may fibrillate. CPR may be necessary for extended periods.
- CPR is unnecessary if the patient has even a faint pulse and occasional respirations. In hypothermia, metabolic demands are greatly reduced. CPR is needed when there is no heart beat or when there is ventricular fibrillation.
- Airway manipulation should be avoided, if possible, because it may induce ventricular fibrillation in a hypothermic victim.
- Do not assume the victim is dead; full recovery has occurred even after periods of cardiac arrest.

4.2.4 Contact with Mechanical Equipment

Mechanical equipment, such as, sediment and core samplers, motorized winches, crane barges, and small boats will be used on this project to collect sediment samples, construct the pilot plots, and transport project personnel within the work area. These devices have gears and motors with rotating and reciprocating parts that if left unguarded, could pose a pinch and grab hazard. Boat passengers and crew can also be injured by ropes and cables used onboard to set anchors and tie off the vessel.

To control these hazards, the SHSO will inspect each work area where employees will be working to identify potential pinch, grab, crush, and struck-by hazards. If such hazards are found, the contractor responsible for the condition will be notified and asked to correct the problem. Corrective actions may involve installing guards over exposed, rotating parts; isolating or deenergizing equipment; establishing exclusion zones around high-hazard areas, establishing controlled vehicle traffic lanes; and constructing guardrails around mechanical equipment to prevent inadvertent contact. Until such time as these contact hazards can be controlled or eliminated, oversight management personnel will avoid working in any areas where the hazard exists.

4.2.5 Small-Boat Operations

Boat operations are associated with various risks, for example: (1) passengers or crew members falling overboard and possibly drowning, (2) striking other vessels or being struck by other vessels operating in the area, (3) losing power or steering capability and drifting into hazardous areas (i.e., shore, marine facilities, etc.), and (4) encountering severe weather and dangerous seas. The risk of a boating accident can be reduced by ensuring that the boat operators are experienced, operating the vessel in compliance with U.S. Coast Guard rules and regulations, maintaining the vessel in good mechanical order, avoiding bad weather and dangerous seas; and ensuring that emergency equipment is available onboard (i.e., life vests, life rings, life boats, fire extinguishers, communication equipment, etc.). Other safety precautions that will be taken during boat operations include the following:

- The vessels must have required U.S. Coast Guard safety equipment onboard in good operating condition, including a life jacket for each crew member, a first aid kit, fire extinguisher(s), distress flares, a throwable 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 instructed so that they know the location and use of onboard safety equipment.
- For vessels less than 26 feet long, at least one fire extinguisher must be onboard. For vessels 26 feet or more in length but less than 40 feet, at least two fire extinguishers must be onboard.
- A life jacket must be worn by crew members at all times while working on boats, piers, or docks that are not equipped with guardrails.
- 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 member should never jump between the vessel and the dock.
- Docks should be approached slowly. The boat should never be fended off by placing your body between the boat and an 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 you observe.
- In case of a serious emergency such as fire or imminent sinking, the vessel should not be abandoned unless no other option is available. Preferably the boat should be run aground, or a rescue by another vessel should be attempted.

- Crew member should be aware of overhead power lines and underwater utility corridors.

- If lightning or thunder occurs, the 30/30 rule should be used. If the time between seeing lightning and hearing thunder is 30 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.

- In case of oil spill, absorbent pads should be used to contain the spill. All oil spills must be promptly reported to the National Response Center (1-800-424-8802 or 202-267-2675).

Oversight management team members will not be operating small boats on this project; therefore, they will rely on the boat operators of the vessels they board to operate their boats safely and in accordance with U.S. Coast Guard regulations, as well as the safe maintenance, operation, and inspection practices in the previous list. Oversight management personnel will not board or work from vessels that do not meet these requirements.

4.2.6 Diving

As indicated in Section 2.0, commercial divers will conduct visual surveys of the pilot plots, install and retrieve porewater samplers, and collect bulk samples of the sediments before and after cover placement. This diving work will be conducted by a specialty contractor without direct involvement by the oversight management team. Therefore, this site-specific HASP does not address the hazards and controls associated with this diving work. Nonetheless, oversight management (Amec Foster Wheeler) will require that the diving contractor provide a site-specific diving HASP and comply with all applicable requirements of Washington Department of labor & Industries Standards for Commercial Diving Operations (WAC 296-37) and provide a safe practices manual for each diving mode per WAC 296-37-530 before beginning diving operations. This manual must include the following:

- Safety procedures and checklists for diving operations

- Assignments and responsibilities of the dive team members

- Equipment procedures and checklists

- Emergency procedures for fire, equipment failure, adverse environmental conditions, and medical illness and injury

In addition, the 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 DOSH's diving standard, the main requirements of which state the following:

- All diving activities must be conducted with two comparably equipped scuba divers in the water in constant communication or by surface-supplied air divers who are continuously tended and in two-way voice communication with a surface dive team member. A standby diver will also be in attendance during all dives.
- All diving will be from boats.
- No night diving will be conducted.
- All diving will be conducted with scuba equipment or with surface-supplied air diving apparatus. Decompression dives are not permitted. A depth-time profile, including any breathing gas changes, must be maintained for each diver during the dive.
- No diving will be conducted in enclosed or physically confining spaces.
- No diving will be conducted against currents exceeding 1 knot unless line-tended.
- No diving will take place if surface visibility is less than 200 feet at that particular location.
- The diver must terminate a scuba dive while there is still sufficient cylinder pressure remaining (generally, 500 pounds per square inch [psi]) to allow the diver to safely reach the surface.
- Dives must also be terminated whenever communication is lost with the diver, the diver fails to respond to a communication, or the diver requests that the dive be terminated.
- Surface-supplied air diving operations must have a primary breathing gas supply sufficient to support divers for the duration of the planned dive including decompression. A diver-carried reserve breathing gas supply must be provided whenever the diver is prevented by the configuration of the dive area from ascending directly to the surface.

A list of the telephone or call numbers of the following must be kept at the dive location: an operational decompression chamber, accessible medical facility, available physician, available means of transportation, and the nearest U.S. Coast Guard Rescue Coordination Center.

A first aid kit appropriate for the diving operation and approved by a physician must be available at the dive location along with an American Red Cross standard first aid handbook.

Each diver must possess a nationally recognized diving certificate. Each diver will be assigned tasks in accordance with his or her experience and training. Each diver must be trained, qualified, and authorized for the diving mode and specialized equipment being used, the diving activity to be performed, and the depths at which the dive is to be conducted.

All dive team members must be trained in CPR and first aid (American Red Cross standard course or equivalent).

The planning of each diving operation will include an assessment of the health and safety aspects of each task. The planning elements will include the following:

- Diving mode
- Surface and underwater conditions and hazards
- Breathing gas supply (including reserves)
- Thermal protection
- Diving equipment and systems
- Dive team assignments and physical fitness of dive team members
- Emergency procedures
- Coordination with other activities in the vicinity that could potentially interfere with the diving operation

5.0 SITE CONTROL MEASURES

The work areas that oversight management personnel will be visiting when they perform their site inspections will be managed and controlled by the contractors who are performing the work. Therefore, site control measures for these areas will be provided in the respective site-specific HASPs submitted by the contractors in charge of the work. When inspecting active work areas at the pilot plots, oversight management personnel will comply with all PPE requirements; site access restrictions; vessel operation, emergency response, and decontamination procedures; and communication protocols established by the vessel operator and study area construction contractors. They will familiarize themselves with applicable sections of the contractor's site-specific HASP and participate in on-site health and safety briefings and emergency drills, such as, man overboard, fire, and emergency evacuation exercises. Oversight management personnel will also maintain direct line of sight or immediate verbal communications with at least one other site worker at all times while working on site and have ready access to off-site communications by telephone or radio in the event of an emergency. They will note the location of all emergency telephone numbers and equipment, such as, PFDs, life rings, fire alarms, fire extinguishers, man overboard retrieval gear, first aid kits, and spill response equipment. As a minimum, oversight management personnel will wear hard hats, safety glasses with side shields, hearing protection (as needed), high-traction steel-toed boots, reflective safety vests, and PFDs when working on open vessel decks that are unequipped with guardrails.

The DOF oversight personnel are not expected to come into close contact with site contaminants during their work because they will only be observing site operations. However, if they must enter contaminated areas to perform their work and they become contaminated, they will undergo personnel decontamination in regulated decontamination areas (contamination reduction zones [CRZs]) established by the contractor in control of the job site. The location and operation of these CRZs will be described in the individual site-specific HASPs submitted by each contractor participating in the project.

6.0 COMMUNICATIONS

Communications at the job site will be by verbal command, hand signals, radio, or a combination of all three. Oversight personnel will carry cellular telephones and a list of emergency telephone numbers. These telephone numbers are listed in Section 8.0 of this plan.

Boat operators will have VHS radios that are capable of communicating with U.S. Coast Guard emergency services and with other boats 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. Evacuation procedures are described in Section 13. Site personnel will be informed of site emergency procedures and communication protocols during their initial site orientation.

7.0 TRAINING REQUIREMENTS

7.1 GENERAL SITE WORKER TRAINING

Oversight management personnel will have received 40 hours of general site worker training per WAC 296-843 before beginning work. The SHSO will also complete an additional 8 hours of relevant supervisory health and safety training. Those employees who complete this training more than 12 months before the start of the project will have completed an 8-hour refresher course within the past 12 months.

A copy of the training completion certificates for each field oversight management team member will be maintained at the site. All oversight management personnel will receive site orientation training as described in Section 8.2. At least two site workers who have current first aid/CPR training will be on site at all times when work is underway. The names and telephone numbers of all first aid/CPR-qualified site personnel will be posted at the site. The aforementioned training requirements and other mandatory training and certifications required for this project are summarized in Table 2.

TABLE 2

TRAINING REQUIREMENTS FOR OVERSIGHT MANAGEMENT PERSONNEL

Personnel	Requirements
Oversight management personnel	40-hour general site worker training, current 8-hour refresher training, and site orientation training
Site health and safety officer	40-hour general site worker training, 8-hour supervisor training, site orientation training, and first aid/CPR training
At least two workers on site	First aid/CPR and blood-borne pathogens

7.2 SITE-SPECIFIC ORIENTATION TRAINING

The SHSO will provide and document site-specific orientation training during the project kickoff meeting and whenever new oversight workers arrive on site. No worker will be allowed to begin work on site until the site-specific training is completed and documented by the SHSO. This training will address this site-specific HASP and all health and safety requirements and procedures pertinent to site operations.

As part of the site-specific orientation training, the following topics will also be covered:

- Project introduction and orientation
- Potential site hazards and controls (chemical, physical, and biological)
- Hazard communication for chemicals brought onto the site
- Selection, use, and limitation of PPE
- Emergency procedures
- Blood-borne pathogen briefing
- Content of the site-specific HASP

7.3 SAFETY MEETINGS

The SHSO will conduct site safety meetings for project personnel each time they visit the site. During these sessions, workers will be encouraged to share their observations, thoughts, and experiences on health and safety issues that are pertinent to the job site. This venue also allows site management to share important hazard communication topics with the workers, such as, required use of PPE, decontamination procedures, emergency procedures, safe work practices, and changes to the site-specific HASP, to name a few.

The SHSO will conduct these briefings, or oversight management personnel will attend the safety briefings conducted by the contractor in charge of the work areas they will be visiting. Site briefings may be conducted anytime if new hazards arise that must be communicated expeditiously to site personnel or if new workers arrive on site. A site briefing form will be used to document these meetings and will include a list of topics discussed, hazards identified, recommended remedial controls, other pertinent issues, and the names of all attendees (Attachment C). The information gathered during these sessions will be used to correct any unsafe conditions or work practices at the job site and amend the site-specific HASP as appropriate. Copies of the site briefing forms will be maintained at the job site.

7.4 HAZARD COMMUNICATIONS

Safety Data Sheets (SDS) will be kept on file at the job site for each hazardous chemical used by oversight management team members during the project. These SDSs will be made available to each applicable employee on request. Employees will also be informed about any site operations involving the use of hazardous chemicals, the hazardous nature of the chemicals used, and the location of the SDSs. Workers who will be exposed to hazardous chemicals will be trained to recognized chemical contact hazards in the workplace, the physical properties and health hazards of hazardous chemicals, and the personal protective measures that will be taken to control exposures. All chemical containers used to store hazardous chemicals will also be marked or labeled with the name of the chemical and its hazard warning.

8.0 MEDICAL SURVEILLANCE

Because oversight management personnel are not expected to be exposed to site contaminants in at concentrations in excess of their respective permissible exposure limits, they are not required to be enrolled in a medical surveillance program for this project. However, any team members who have a known medical condition that puts them at risk of injury related to their assigned work must disclose this condition to site management so that accommodations can be made to ensure that their work can be conducted in a safe and healthful manner.

9.0 PERSONAL PROTECTIVE EQUIPMENT

The PPE to be used will be selected to protect oversight management personnel from the potential exposure hazards they are likely to encounter as identified in Section 5.0 of this plan. Due to the nature of the tasks involved and the size of the site, the SHSO will review work assignments daily and choose the appropriate PPE based on the operation, the location, and the hazards involved in each task. The level of PPE protection will be upgraded or downgraded based on changes in site conditions. Factors that may indicate the need to reevaluate site conditions and PPE selection include the following:

- Discovery of previously unidentified contaminants
- Commencement of a new work phase
- Change in job tasks during a work phase
- Change of season/weather

Two levels of PPE will be available for use during the planned project activities: Level D and modified Level D. The PPE components that make up these levels are discussed in Sections 10.1 and 10.2.

Visitors to the site will be escorted at all times and kept well away from hazardous or restricted work areas. Therefore, they will not be required to wear the PPE specified in Section 10.1 and 10.2. However, it is recommended that visitors wear hard hats, safety glasses, and reflective work vests while on site.

9.1 Level D

As a minimum, all oversight management personnel, except those entering regulated work areas where significant dermal contact with site contaminants is likely, will wear Level D PPE consisting of the following:

- Cotton coveralls or standard work clothing, a hard hat, and safety glasses with side shields
- Leather work boots with steel toes
- Hearing protection as needed
- PFDs for those working in boats, on unguarded sections of docks, and over water
- High-visibility traffic vests if not wearing reflective PFDs

9.2 Modified Level D

Modified Level D PPE will be worn by team members who will come into direct contact with contaminated sediments, as required by the contactor controlling the work areas they will be visiting. Modified Level D PPE will consist of the following items:

- Disposable Tyvek coveralls or lightweight polyvinyl chloride (PVC) rain gear
- Chemical-resistant gloves and PVC steel-toed boots
- Hard hat
- Safety glasses with side shields
- Hearing protection as needed
- U.S. Department of Transportation–approved high-visibility safety vest if not wearing reflective PFDs
- PFD with attached whistle for those working in boats, on unguarded sections of docks, and over water

Modified Level D PPE will be worn when their monitoring activities put a team member at risk of incurring significant exposure to contaminated sediments It is unlikely that oversight management personnel will be required to wear respiratory protective equipment and associated protective clothing (Level C). This would be necessary only if required by a contractor in control of a particular work area that oversight management team members must enter. Should the use of respirators become necessary, this site-specific HASP will be amended to include requirements for fit testing, inspection, selection, use, limitations, maintenance, and storage of respiratory equipment as mandated by the respiratory protection standard of the Washington Industrial Safety and Health Act (WISHA).

Visitors to the site will be escorted at all times and kept well away from hazardous or restricted work areas. Therefore, they will not be required to wear the PPE specified in Section 10.1 and 10.2. However, it is recommended that visitors wear hard hats, safety glasses, and reflective work vests while on site.

10.0 DECONTAMINATION

Decontamination for site personnel wearing Level D PPE will consist of having all workers remove their hard hats, safety glasses, hearing protection, PFDs, and outer protective garments before leaving the site and storing them in a clean area for reuse the next day.

Site personnel contacting contaminated sediments while wearing Modified Level D PPE will be required to have their boots and gloves washed, rinsed, and removed before leaving the site. They will also remove their Tyvek coveralls and place them in a plastic bag for disposal. Reusable PVC rain gear, if worn, will be rinsed clean with water, removed, and stored on site for later use.

Personnel decontamination will be conducted in a CRZ situated adjacent to and contiguous with the regulated work area. A large wash tub will be placed in the CRZ for workers to stand in while their outer protective clothing is washed and rinsed. Scrub brushes and soap solution may be used to remove mud and soil from clothing. All wash and rinse water will be disposed of in accordance with the waste management practices described in the construction quality assurance project plan for the project.

The SHSO will ensure that the above-mentioned decontamination procedures are effectively controlling the spread of contamination in the work area by periodically inspecting the recently cleaned clothing and equipment for evidence of residual contamination. The work area will also be examined to detect any sign of contamination outside the work zones. Should it become apparent that contamination is being dispersed into clean areas of the site, access to contaminated areas will be restricted until more effective decontamination methods can be devised.

11.0 AIR MONITORING

It is unlikely that oversight management personnel will be exposed to site contaminants at concentrations greater than their respective permissible exposure limits during their site inspections; therefore, no special air monitoring requirements are needed for their work. Nonetheless, all site assessment contractors in control of the work area will be expected to evaluate site conditions at their job sites and inform oversight management team members of any potential exposure hazards so that appropriate air monitoring and exposure control measures can be implemented if and when they enter these areas.

12.0 EMERGENCY RESPONSE

Because the project responsibilities are limited primarily to oversight management, the risk of encountering a significant emergency associated with the work is minimal. However, oversight management personnel will be working in regulated areas controlled by other site contractors where workplace hazards do exist and emergencies could occur. In these cases, oversight management team members will comply with the emergency procedures established by the contractors controlling their own job sites. These discrete emergency procedures will be included in each contractor's site-specific HASP, which will be thoroughly reviewed by oversight management personnel before they are allowed to enter the contractor's work areas.

There is also a possibility that oversight management personnel could experience a medical emergency in the normal course of their work or, perhaps, encounter a fire or hazardous material spill. For such emergencies, this section of the site-specific HASP constitutes the emergency response plan. It will be discussed with all oversight management personnel during their initial site orientation training and rehearsed periodically throughout the duration of the project. The rehearsal will include a staged personnel injury and/or fuel spill or fire. At the completion of the emergency response exercise, the project manager and the SHSO will evaluate the effectiveness of the emergency response procedures and amend the site-specific HASP as appropriate.

A copy of the emergency response plan (this section) and a map to the emergency medical facility (Attachment D) will be posted at the site.

The emergency response contacts for this project are indicated in Table 3.

TABLE 3

EMERGENCY RESPONSE CONTACTS

Site Address: (locations of job sites have not yet been defined)	
Medical Facility:	
U.S. HealthWorks Medical Group Clinic 3223 First Avenue South, Suite C Seattle, WA 98134	206-624-3651
EMT/ambulance	911
King County Sheriff's Department:	
Emergency	911
Business	206-296-3333
Seattle Fire Department:	
Emergency	911
Business	206-386-1400
U.S. Coast Guard	206-217-6000 or VHF channel 16
National Response Center	1-800-424-8802
Washington Emergency Management Division	1-800-258-5990
Washington Poison Center	1-800-222-1222
Agency for Toxic Substances and Disease Registry	1-888-422-9737
Washington State Department of Ecology	1-800-258-5990
Vessel Assist (private vessel rescue services)	1-800-391-4869
Amec Foster Wheeler project manager, Cliff Whitmus	Cell: 206-300-0520
Amec Foster Wheeler project health and safety officer, Tim Reinhardt	Cell: 425-241-5816
Amec Foster Wheeler West U.S. health and safety manager, Chad Barnes	Cell: 480-495-9846
Dalton, Olmsted & Fuglevand, Inc., field technical lead/site health and safety officer, Rich May	Cell: 360-621-9505

12.1 Emergency Coordinator

The SHSO will be the designated emergency coordinator responsible for implementing this emergency response plan. He will notify emergency responders (ambulance, medical facility, etc.) during a medical emergency or spill/fire incident and ensure that the client and all affected project contractors are made aware of any emergencies occurring on site. He will initiate emergency evacuation procedures, as appropriate, and ensure that injured oversight management personnel are given emergency medical treatment and transported to the medical facility for follow-up treatment.

The emergency coordinator will conduct an inspection of emergency response equipment every month. This equipment includes fire extinguishers, first aid kits, and spill control equipment. As part of the daily site walk-through, he will pay close attention to potential fire hazards, spill potentials, and individual work practices. Emergency response equipment will be stored at the waterway access dock. The monthly fire extinguisher checks will be documented, either on the fire extinguisher or in the SHSO logbook.

12.2 Site Evacuation

Should a serious or catastrophic situation arise on site, such as but not limited to, an uncontrollable fire, airborne release of flammable or toxic chemical, hazardous liquid spill on the waterway, significant injury of site personnel, or major earthquake or explosion, the job site will be evacuated. Site personnel will be notified of an evacuation either by direct radio communications or by air horn signals. Air horns will be staged at each major work area.

If an evacuation is necessary, the emergency coordinator will sound three long blasts on the air horn, and then all site personnel will proceed immediately to a designated assembly area. A head count of all assembled site personnel will be taken by the emergency coordinator. Once everyone is accounted for, they will evacuate farther to the safe area designated during the site orientation training, and the emergency coordinator will assess the situation and outline the actions to be taken. One long blast of the horn will be the “all clear” signal, indicating that personnel can once again reenter the site and resume work.

During the emergency, the emergency coordinator will:

- Ensure injured personnel are given first aid treatment, as appropriate.
- Shut down equipment that could cause a hazard or act as an ignition source.
- Notify applicable emergency response services.

- Prohibit unauthorized personnel from entering the evacuated area.
- Provide emergency equipment as appropriate.
- Notify the project manager and client of the incident.

12.3 Environmental Incident (Spill)

All contractors working on site will be responsible for containing, controlling, and cleaning up any spills they create. Oversight management personnel will not be engaged in any work activities that could result in the release of hazardous materials into the environment. If oversight management personnel encounter a spill created by others, they will immediately notify the contractor in charge of the spill area so they can initiate a cleanup action.

12.4 Explosions

In the event of an explosion, all nonessential personnel will be evacuated from the site and the work area will be secured. No one will be allowed to reenter the site, except to possibly save a life, until cleared by the emergency coordinator. If adjacent properties are threatened by the explosion, local emergency response authorities will be called to evaluate the situation and possibly initiate an evacuation of the surrounding community.

12.5 Personal Injury

In the event of serious personnel injury (fatality, unconsciousness, possibility of broken bones, severe bleeding, burns, blood loss, shock, or trauma), the first person on the scene will immediately:

- Administer first aid if qualified; if not qualified, seek out a person qualified to administer first aid.
- Notify the emergency coordinator of the name of the injured party, his or her location, and the nature of the injury.

The emergency coordinator, upon receipt of notification of the injury, will immediately:

- Notify emergency response services and provide the appropriate information about and location of the injured party.
- Assist the injured party as deemed appropriate.
- Designate someone to accompany the injured party to the medical facility and to provide Material Safety Data Sheets (if applicable) to the emergency medical team.
- Notify the project manager.

- Complete an injury report.

If the emergency coordinator determines that emergency medical services are not necessary (minor injury such as sprain or abrasion or patient is conscious and can be moved), he may direct someone to transport the injured party by vehicle to the medical facility. A map showing the medical facility will be located in the office trailer and all major work areas.

12.6 ADVERSE WEATHER

Weather conditions in Washington are typically punctuated by severe winds and rain. In the event of adverse weather, the SHSO working with the King County project representative will determine whether work can continue without compromising the health and safety of field personnel. Conditions to be considered before determining whether work should continue include the following:

- Extreme cold and wind
- Heavy precipitation
- Limited visibility
- Potential for accidents

12.7 EMERGENCY EQUIPMENT

The following emergency response equipment will be stored at the DOF's onshore office:

- First aid kits for 10 people
- Ten-pound ABC fire extinguishers (to be inspected monthly)
- An air horn
- Portable, emergency eyewash
- Spill equipment (as mentioned in Section 13.3)
- Cellular telephones and/or radios

This equipment will be inspected monthly by the SHSO. It will be cleaned, inspected, and replenished immediately after each use.

Postings related to the emergency response plan will be placed in the office trailer and each major work area. The following information from the emergency response plan will be highlighted on these postings:

- Emergency telephone numbers for fire, ambulance, medical facilities, and police
- Location of fire extinguishers and emergency equipment
- Map to the medical facility

13.0 REFERENCE

Windward Environmental, LLC (Windward). 2015. Memorandum: Validated LDW Sediment Data for ENR-AC Pilot. Prepared for U.S. Environmental Protection Agency and Washington State Department of Ecology. Prepared by the Lower Duwamish Waterway Group.

14.0 HEALTH AND SAFETY PLAN CERTIFICATION

By their signature, the following undersigned individuals certify that this plan has been read or otherwise communicated to them. They further certify that they completely understand this plan and will follow its procedures for the protection of the health and safety of all persons entering this site.

Name (Printed)	Signature	Company	Date

ATTACHMENT A

Activity Hazard Analysis Table

ACTIVITY HAZARD ANALYSIS

Project: Enhanced Natural Recovery/Activated Carbon Pilot Study **Location: Lower Duwamish Waterway**
Activity: General Oversight Management **Approved by: ___________________**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Working near heavy equipment operations	Being struck by heavy equipment or other vehicles operating at the site	- Maintain eye contact with operators before approaching equipment. - Do not approach equipment from blind spots. - Do not enter vehicle traffic lanes or control zones established around mechanical equipment. - Do not stand behind mobile equipment and be mindful of backup alarms. - Wear U.S. DOT-approved high-visibility safety vest when working around mobile equipment. - Stay out of area between moving equipment and other fixed objects. - Stay out from underneath hoisted loads. - Wear hard hat, steel-toed boots, and safety glasses at all times.
	Contact with exposed gears or pulleys	- Inspect mechanical equipment for unguarded moving parts and inform responsible contractor of hazard. - Maintain safe distance from unguarded mechanical equipment until hazard can be corrected. - Ensure area around equipment is secured and hazard warning signs are displayed or have defective equipment taken out of service.
	Noise	- Collect sound level measurements in the work area, as necessary. - Wear hearing protection if noise levels exceed 85 decibels. - Have regulated areas established around high-noise areas and post noise warning signs. - Implement hearing conservation measures for employees exposed to noise levels in excess of 85 decibels
	Being struck by flying debris	- Wear impact-resistant, ANSI-approved safety glasses with side shields.
Walking/working at ground level	Slips or trips on equipment and debris left on the ground	- Clear work area and walkways of debris. - Wear high-traction, safety-toe footwear. - Keep walkways dry or surface with slip-resistant materials. - Post exit signs and evacuation routes. - Ensure portable ladders are properly placed and secured. - Inspect work areas daily.

ACTIVITY HAZARD ANALYSIS

Project: Enhanced Natural Recovery/Activated Carbon Pilot Study Activity: General Oversight Management		**Location: Lower Duwamish Waterway Approved by: ____________________**
PRINCIPAL STEPS	**POTENTIAL SAFETY/ HEALTH HAZARDS**	**RECOMMENDED CONTROLS**
Walking/working at ground level (continued)	Being struck by dropped, flying objects	- Wear ANSI-approved hard hat, safety glasses, safety-toe footwear.
	Slips/trips/falls while changing elevations	- Provide stairs, ladders, or ramps when elevation changes greater than 19 inches are necessary. - Use three-points-of-contact ascending and descending stairs and ladders.
	Falls to lower level, e.g., through open hatches or from docks or overwater platforms, etc.	- Have vessel operators close all open hatches. - Do not approach openings unless they are appropriately guarded. - Wear PFD when working onboard vessels, on docks, or on overwater platforms that are unguarded.
	Inadequate communications	- Carry a portable radio and cell phone at all times to communicate with site contractors, site security, and main office.
Walking/working at elevations	Falls from elevations	- Do not use elevated (more than 6-foot high) catwalks, aisleways, stairways, or work platforms that are unequipped with guardrails. - Do not use unguarded, fixed ladders. - Ensure all floor openings are covered before accessing work areas. - Have elevated surfaces that are not designed as work platforms evaluated by a qualified person for structural capacity before using as a work platform.
Working outside in the natural environment	Thermal (heat and cold) stress	- Monitor environmental temperatures and level of work activity. - Track thermal loads. - Provide shaded rest areas, water, and work-rest cycles during conditions conducive to heat stress. - Wear thermally insulted clothing during conditions conducive to cold stress. - Inform personnel of thermal stress symptoms, treatments, and controls (see Section 5.2.3 of site-specific HASP). Use “buddy system” to monitor team members for thermal stress.

ACTIVITY HAZARD ANALYSIS

Project: Enhanced Natural Recovery/Activated Carbon Pilot Study **Location: Lower Duwamish Waterway**
Activity: General Oversight Management **Approved by: ____________________**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Working from small boat	Overboard falls and drowning	- Ensure boat has guardrails as appropriate. - Do not stand or lean over edge of boat. - Rehearse man overboard drill. - Ensure that water rescue is available. - Ensure that vessel has at least one throwable PFD (Type IV PFD) with 90 feet of line attached. - While onboard vessel, wear a PFD.
	Collisions with other boats operating in area	- Maintain vigilance and ensure boat has proper running lights. - Notify other site contractors of work location. - Comply with U.S. Coast Guard right-of-way rules. - Use horn to signal or warn other boats as appropriate. - Suspend work during bad weather or poor visibility. - Have experienced boat crews operate vessel.
	Vessel mechanical failure or onboard emergency (i.e., fire, loss of power, breach of hull, etc.)	- Inspect vessel for mechanical integrity before each use. - Communicate fire and emergency evacuation procedures to all boat occupants. - Ensure that radio communications with U.S. Coast Guard are available. - Ensure that emergency flares, life rings, and life vests are available. - Verify presence and working order of fire extinguishers.
	Heavy lifting	- Limit lifting to 50 pounds/person or less. - Use proper lifting techniques. - Use mechanical equipment when feasible. - Have others help lift heavy loads.
	Dermal contact with contaminated sediments	- Wear modified Level D PPE if necessary.
	Thermal (heat and cold) stress	- Wear thermally insulated clothing as appropriate. - Wear rain gear when needed. - Take frequent warm-up breaks in heated boat cabin or car. - Review thermal stress treatments and controls with personnel. - See Section 5.2.3 of site-specific HASP. - Keep dry.

ACTIVITY HAZARD ANALYSIS

Project: Enhanced Natural Recovery/Activated Carbon Pilot Study **Location: Lower Duwamish Waterway**
Activity: General Oversight Management **Approved by: ____________________**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Working from small boat (continued)		- Assume overboard victims are hypothermic and treat as such. - Take frequent rest breaks in shaded areas to control heat stress. - Drink plenty of fluids.
	Contact with exposed gears, pulleys, and other rotating or reciprocating mechanical equipment	- Ensure that all mechanical equipment with exposed gears, pulleys, and other rotating or reciprocating parts are guarded, isolated, or taken out of service. - Keep hands and fingers away from actuating mechanisms on sediment sampling equipment. Use safety locking devices or pins when handling this equipment.
	Being struck by hoisted loads	- Stay clear of hoisted loads. - Use tag lines to direct placement of hoisted loads. - Do not operate davits or winches in heavy seas when boat is pitching and listing. - Secure loads that are brought onboard boat. - Stow lines and other trip hazards on deck. - Keep hands out of pinch or crush points when handling hoisted loads or stowing equipment. - Wear hard hat.
Observing ENR and ENR+AC construction work from crane barge	Overboard falls and drowning	- Wear PFD when working on areas of the barge that do not have guardrails. During night operations, wear a reflective PFD equipped with flashing beacons. - Inform barge crew of your whereabouts at all times. Carry a portable radio and cell phone for communications at all times. - Do not stand or lean over edge of barge. - Rehearse man overboard drill. - Ensure that a rescue skiff is available at the barge. - Ensure that vessel has at least one throwable PFD (Type IV PFD) with 90 feet of line attached. - Do not work alone. Observe the “buddy rule.”

ACTIVITY HAZARD ANALYSIS

Project: Enhanced Natural Recovery/Activated Carbon Pilot Study **Location: Lower Duwamish Waterway**
Activity: General Oversight Management **Approved by: ___________________**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Observing ENR and ENR+AC construction work from crane barge (continued)	Being struck by crane	- Remain clear of swing radius of excavator/crane bucket and counterweight. - Maintain eye contact with crane operator when approaching equipment. - Ensure that work areas on barge are adequately lighted. - Wear high-intensity work vest, as well as, hard hat, steel-toed boots, and safety glasses when working onboard vessel.
	Contact with exposed gears or pulleys	- Inspect mechanical equipment for unguarded moving parts and inform barge crew of hazard. - Maintain safe distance from unguarded mechanical equipment until hazard can be corrected. - Stay clear of deck lines under tension and other exposed pulleys, shackles, and pinch/grab points.
	Noise	- Collect sound level measurements in the work area. - Wear hearing protection if noise levels exceed 85 decibels. - Implement hearing conservation measures for employees exposed to noise levels in excess of 85 decibels.
	Being struck by flying debris	- Wear impact-resistant, ANSI-approved safety glasses with side shields.
Observing cap construction work from crane barge	Falls from elevations	- Do not use elevated (more than 6-foot high) catwalks, aisleways, stairways, or work platforms that are unequipped with guardrails. - Do not use unguarded, fixed ladders. - Ensure that all hatches are closed before accessing work areas. - Have elevated surfaces that are not designed as work platforms evaluated by a qualified person for structural capacity before using as a work platform.
	Thermal (heat or cold) stress	- Monitor environmental temperatures and level of work activity. - Track thermal loads. - Provide shaded rest areas, water, and work-rest cycles during conditions conducive to heat stress.

ACTIVITY HAZARD ANALYSIS

Project: Enhanced Natural Recovery/Activated Carbon Pilot Study **Location: Lower Duwamish Waterway**
Activity: General Oversight Management **Approved by: ___________________**

PRINCIPAL STEPS	POTENTIAL SAFETY/ HEALTH HAZARDS	RECOMMENDED CONTROLS
Observing cap construction work from crane barge (continued)		- Wear thermally insulted clothing during conditions conducive to cold stress. - Inform personnel of thermal stress symptoms, treatments, and controls (see Section 5.2.3 of site-specific HASP.

Abbreviations:
ANSI = American National Standards Institute
DOT = Department of Transportation
PFD = personal flotation device

ATTACHMENT B

General Site Work Rules

GENERAL SITE WORK RULES

1. Oversight management personnel must attend weekly site briefings and other scheduled meetings.
2. Any individual taking prescribed drugs must inform the site health and safety officer (SHSO) of the type of medication and any possible adverse side effects that could affect the health and well-being of the worker while performing his or her jobs. The SHSO will decide whether the employee can safely work on site while taking the medication.
3. The personal protective equipment (PPE) specified by the SHSO and in the site-specific health and safety plan(s) (HASP[s]) must be worn by oversight management personnel. This includes hard hats, safety glasses, and steel-toed boots, as a minimum.
4. Facial hair (beards, long sideburns, or mustaches) that may interfere with a satisfactory fit of a respirator mask is not allowed on any person who may be required to wear a respirator.
5. All personnel must sign the site log when visiting the job site.
6. Personnel must follow proper decontamination procedures.
7. Eating, drinking, chewing tobacco or gum, smoking, and any other practice that may increase the possibility of hand-to-mouth contact is prohibited in regulated areas of the job site.
8. All lighters, matches, cigarettes, and other forms of tobacco are prohibited in regulated areas of the job site.
9. All signs and demarcations must be followed. Such signs and demarcation must not be removed except as authorized by the site superintendent.
10. No one will enter a permit-required confined space without approval from the site superintendent and SHSO.
11. All personnel must use the “buddy system” when working in regulated areas.
12. All personnel must follow the work-rest regimens and other practices to minimize heat stress.
13. All personnel must follow lockout/tagout procedures when working on equipment involving moving parts or hazardous energy sources.
14. No person will operate equipment unless trained and authorized.
15. Ladders must be solidly constructed, in good working condition, and inspected prior to use. No one may use defective ladders.

16. Fall protection or fall arrest systems must be in-place when working at elevations greater than 6 feet for temporary working surfaces and 4 feet for fixed platforms.
17. Safety belts, harnesses, and lanyards must be selected by the SHSO. The user must inspect the equipment prior to use. No defective personal fall protection equipment will be used. Personal fall protection equipment that has been shock loaded must be discarded.
18. Hand and portable power tools must be inspected prior to use. Defective tools and equipment will not be used.
19. Ground fault interrupters must be used for cord and plug equipment used outdoors or in damp locations. Electrical cords must be kept out of walkways and puddles unless they are protected and rated for the service.
20. Improper use, mishandling, or tampering with health and safety equipment and samples is prohibited.
21. Horseplay of any kind is prohibited.
22. Possession or use of alcoholic beverages or controlled substances on site is forbidden.
23. All incidents, no matter how minor, must be reported immediately to the site superintendent.
24. All personnel will be familiar with the site emergency response plan.
25. All personnel will report any unsafe conditions or practices to site management immediately upon discovery.

The above work rules are not all inclusive, and each employee is responsible for complying with all applicable regulations set forth by the Washington Industrial Safety and Health Act (WISHA), project management, the site-specific HASP, the client, Amec Foster Wheeler, the SHSO, and the controlling contractor's work rules and health and safety requirements.

ATTACHMENT C

Site Briefing Form

SITE SAFETY BRIEFING

Date: ____________________ **Time:** ___________ **Location:** ____

Shift: ________________________ **Person Conducting Briefing:** __________________________

1. HEALTH AND SAFETY CONCERNS (i.e., use of PPE, chemical, physical, or biological hazards, unsafe conditions, unsafe work practices, communication problems, safety equipment, training issues, etc.):

____

____

____

____

2. RECENT INCIDENTS (i.e., near misses, first aid cases, serious injuries, environmental spills, etc.):

____

____

____

3. HAZARD CONTROL MEASURES (PPE changes, new site control requirements, recommended work practices, etc.):

____

____

____

4. OTHER ISSUES:

____

____

____

5. ATTENDEES (Print Name):

1.	7.
2.	8.
3.	9.
4.	10.
5.	11.
6.	12.

ATTACHMENT D

Map and Directions to Medical Facility

NOTE: TO BE DETERMINED
SPECIFIC JOB SITES HAVE NOT BEEN IDENTIFIED AT THIS TIME

ATTACHMENT E

Construction Monitoring Diving Health and Safety Plan

NOTE: TO BE PROVIDED

ATTACHMENT F

Construction Water Quality Monitoring Health and Safety Plan

NOTE: TO BE PROVIDED

ATTACHMENT G

Monitoring Diving Health and Safety Plan

NOTE: TO BE PROVIDED

ATTACHMENT H

Sampling Health and Safety Plan

NOTE: TO BE PROVIDED

ATTACHMENT I

Sediment Profile Imaging Health and Safety Plan

NOTE: TO BE PROVIDED

APPENDIX H

Cost Estimate and Project Schedule

LDWG (King County) ENR/Activated Carbon Pilot Study
AACE Class 3 Estimate (Pre-Design)

Date: September 16, 2015
Prepared by Dalton, Olmsted, & Fuglevand, Inc.

Item No.	Description of Item	QTY	UOM	Unit Price	Extended Price
1	Submittals	1	LS	$27,000	$27,000
2	Mobilization	1	LS	$391,900	$391,900
3	Test Placement	2	Day	$27,000	$54,000
4	Material Procurement, Mixing, and Transport	1	LS	$859,600	$859,600
5	Placement of Material	36	Day	$25,970	$934,920
6	Demobilization	1	LS	$222,500	$222,500
	Base Bid Subtotal				$2,489,920
	Base Bid Total + 9.5% (WSST)				$2,726,600
	Contingency (20%) + 9.5% (WSST)				$545,300
	Total Construction Cost with Contingency + 9.5% (WSST)				$3,271,900

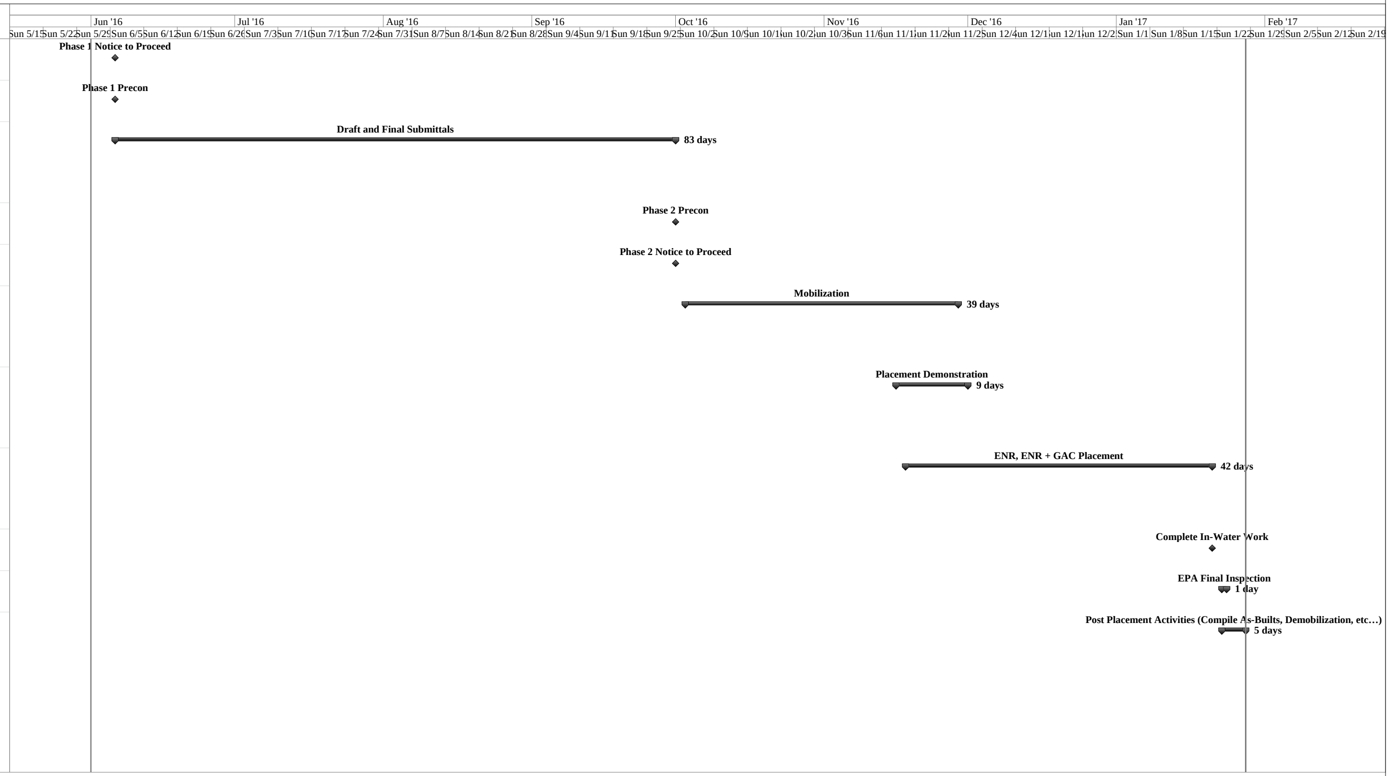
Monitoring

	Monitoring (Baseline, Year 0 - 3 Events)	1	LS	TBD	TBD
	Monitoring Total				TBD

LDWG - Lower Duwamish Waterway Group
ENR - Enhanced Narural Recovery
AACE - Association for the Advancement of Cost Engineering
QTY - Quantity
UOM - Unit of Measure
LS - Lump Sum
WSST - Washington State Sales Tax
TBD - To Be Determined

King County ENR + AC Pilot Study (Engineer's Estimate of Construction Schedule)

ID	Task Mode	Task Name	Duration	Start	Finish
1		Phase 1 Notice to Proceed	0 days	Mon 6/6/16	Mon 6/6/16
2		Phase 1 Precon	0 days	Mon 6/6/16	Mon 6/6/16
3		**Draft and Final Submittals**	**83 days**	**Mon 6/6/16**	**Fri 9/30/16**
6		Phase 2 Precon	0 days	Fri 9/30/16	Fri 9/30/16
7		Phase 2 Notice to Proceed	0 days	Fri 9/30/16	Fri 9/30/16
8		Mobilization	39 days	Mon 10/3/16	Mon 11/28/16
17		Placement Demonstration	9 days	Wed 11/16/16	Wed 11/30/16
22		ENR, ENR + GAC Placement	42 days	Fri 11/18/16	Fri 1/20/17
36		Complete In-Water Work	0 days	Fri 1/20/17	Fri 1/20/17
37		EPA Final Inspection	1 day	Mon 1/23/17	Mon 1/23/17
39		Post Placement Activities (Compile As-Builts, Demobilization, etc...)	5 days	Mon 1/23/17	Fri 1/27/17



Notes:

1) Durations shown in schedule are represented in work days. Phases 1 and 2 are each 120 calendar days in duration.

2) In-water work to occur during the scheduled in-water work window for fish protection and also to avoid tribal fishing. Anticipated in-water work to be between November 29th and January 20th.

Revision Date: 10/09/2015

Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Deadline | Critical | Critical Split | Progress

All Tasks King County ENR GAC Pilot Study_10-09-15_Rollup.mpp