City of Seattle

LOWER DUWAMISH WATERWAY
SLIP 4 EARLY ACTION AREA

Removal Action Completion Report

Submitted to
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Submitted by
City of Seattle

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ACRONYMS AND ABBREVIATIONS

AOC	administrative order on consent
ASAOC	administrative settlement agreement and order on consent
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
City	City of Seattle
Contractor, GCC	General Construction Company
CQA	construction quality assurance
CQAP	construction quality assurance plan
CQC	construction quality control
Crowley	Crowley Marine Services
CY	cubic yards
DAR	design analysis report
DTM	digital terrain model
EAA	early action area
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
eTrac	eTrac Engineering, LLC
GAC	granular activated carbon
GTSP	Georgetown Steam Plant
ICIP	institutional control implementation plan
ICIR	institutional control implementation report
Independent Metals	Independent Metals Recycling
Integral	Integral Consulting Inc.
ISIS	integrated site information system
Kangley	Stoneway Concrete Recycling (aka Kangley Rock & Recycling)
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group

LTMRP	long-term monitoring and reporting plan
MarVac	Marine Vacuum Services
MLLW	mean lower low water
MTCA	Model Toxics Control Act
NTU	nephelometric turbidity unit
OSR	off-site rule
PCB	polychlorinated biphenyl
Rabanco	Rabanco Roosevelt Regional Landfill
RACR	removal action completion report
RAWP	removal action work plan
RFI	request for information
SAP	sampling and analysis plan
SOW	statement of work
SQS	sediment quality standards
SSAR	sediment sampling and analysis report
TOC	total organic carbon
UECA	Uniform Environmental Covenants Act
Unifier	City of Seattle on-line construction document tracking database
WQMP	water quality monitoring plan
WQMR	water quality monitoring report

REPORT CERTIFICATION

The following certifications are provided pursuant to the Administrative Settlement Agreement and Order on Consent for Removal Action, Appendix A, Statement of Work, Task 4 - Removal Action Completion Report and Institutional Control Implementation Report.

CITY OF SEATTLE – PROJECT SPECIFIER CERTIFICATION

I, David Schuchardt, City of Seattle Project Specifier for the removal action work conducted at the Slip 4 Early Action Area, Lower Duwamish Waterway Superfund Site, hereby provide the following certification:

Under penalty of perjury under the laws of the United States, I certify that to the best of my knowledge, the removal action has been constructed in accordance with the drawings and specifications. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

7-17-12

David R. Schuchardt, P.E.
Project Specifier
City of Seattle

Date

EXECUTIVE SUMMARY

The City of Seattle (City) completed a non-time critical removal action to address contaminated sediment at the Slip 4 Early Action Area within the Lower Duwamish Waterway (LDW) Superfund site.

Slip 4 is a 6.4-acre navigational slip located 3 miles upstream from the confluence with Elliot Bay and Puget Sound. It is one of five priority early action sites identified within the 5.5-mile long LDW Superfund site. Approximately 3.5 acres of sediment within the slip was contaminated with polychlorinated biphenyls (PCBs), along with metals, organic compounds, and petroleum products.

The primary design elements included dredging and offsite disposal of contaminated nearshore soil, sediment, and debris; placement of capping materials; demolition of a large pier structure; and habitat improvements along the riverbank and intertidal areas. The primary objective of the Slip 4 removal action was to reduce the concentrations of PCBs and other chemicals in the post-cleanup surface sediments to below the Washington State Sediment Quality Standards.

The removal action design was prepared by Integral Consulting Inc. (Integral), of Seattle, WA, in coordination with the City. Removal action construction was performed by General Construction Company, of Federal Way, WA, under U.S. Environmental Protection Agency oversight. The City managed the removal action construction contract; construction quality assurance was provided by Integral. Construction was initiated on October 3, 2011, and was completed on February 7, 2012.

The primary construction elements included:

- Dredging and excavation of an estimated 10,256 CY of sediment and soil, based on the removal design
- Transloading and disposal of 17,334 tons of soil, sediment, and debris in a Subtitle D landfill
- Demolition of 20,019 SF of concrete pier structure
- Recycling of 3,278 tons of concrete and 79 tons of steel
- Importing and placing 53,006 tons of clean material to construct sediment caps and slope caps over 3.43 acres
- Constructing engineered soil covers with habitat enhancements over 0.15 acres in former upland areas.

1 INTRODUCTION

This removal action completion report (RACR) documents the implementation phase of the Slip 4 Early Action Area (EAA) cleanup, located within the Lower Duwamish Waterway (LDW) Superfund Site in Seattle, Washington (Figure 1-1) (EPA ID No. WA0002329803). The purpose of the removal action was to address contaminated sediments and adjacent shoreline bank areas within the Slip 4 EAA.

Selection of the Slip 4 removal action requirements are documented in the U.S. Environmental Protection Agency's (EPA) action memorandum (USEPA 2006a). The removal action was conducted as a non-time-critical removal action by the City of Seattle (City) under an administrative settlement agreement and order on consent (ASAOC) (USEPA 2006b). This RACR has been prepared in accordance with requirements set forth in the statement of work (SOW, Appendix A of the ASAOC) and the design analysis report (DAR) (Integral 2010a).

The RACR is intended to demonstrate that the work was accomplished in accordance with the construction contract documents and supporting documents, including the construction drawings (City of Seattle 2011a) and specifications (City of Seattle 2011b), removal action work plan (RAWP) (Integral and GCC 2011), construction quality assurance plan (CQAP) (Integral 2010b), water quality monitoring plan (WQMP) (Integral 2010c), and project schedule requirements.

1.1 REPORT ORGANIZATION

The primary purpose of this RACR is to document the work performed by the contactor and oversight activities performed during removal action implementation. The RACR provides a summary of the work performed, notes deviations made from the RAWP and contract documents, and outlines remaining post-construction tasks to be performed. The RACR also summarizes GCC's construction quality control (CQC) and the City's construction quality assurance (CQA) programs and related sampling and monitoring.

This RACR is organized as follows:

Section 1. Introduction—Introduction and overview of RACR organization, project background and site information, and project team organization.

Section 2. Chronology of Events—The actual timeline for implementation of the removal action construction activities.

Section 3. Summary of Removal Action Construction Activities—Brief summaries of the work performed for each removal action construction activity identified in the action memorandum.

Section 4. Construction Quality Assurance / Quality Control—A brief description of the CQA/CQC protocols followed during construction including cradle-to-grave tracking of waste materials, import material testing, health and safety observations, and final inspection protocols.

Section 5. Institutional Controls—A brief description of both planned and implemented institutional controls.

Section 6. Long-Term Monitoring and Reporting—A brief overview of concerns to be considered for development of the long-term monitoring and reporting plan (LTMRP).

Section 7. References.

Appendices.

As previously noted, the RACR is intended to satisfy reporting requirements set forth in the SOW. To assist EPA in its review of the RACR, Table 1-1 lists the minimum topic requirements set forth in the SOW and the corresponding section of the RACR where these topics are addressed.

1.2 SITE LOCATION AND DESCRIPTION

Slip 4 is located on the east bank of the LDW approximately 2.8 miles from the southern end of Harbor Island (Figure 1-1). The slip is approximately 1,400 ft long, with an average width of 200 ft. The slip encompasses approximately 6.4 acres, from the head of the slip to the confluence with the LDW main channel. The removal action boundary included 3.83 acres at the head of the slip. Of this area, 3.58 acres were covered with sediment caps, slope caps, and engineered soil covers. The remaining 0.25 acres consisted of slopes under the pier and bank area at the very head of the slip. These areas were within the removal boundary but did not receive caps. Cap armor and habitat mix were placed along the bank area. The pier was removed above the under-pier slope and habitat mix was placed over the existing rip-rap.

1.2.1 Bathymetry and Topography

Slip 4 is relatively shallow, with pre-removal action sediment surface elevations ranging from +5 ft U.S. Survey mean lower low water (MLLW) at the head of the slip to approximately –20 ft MLLW at the mouth. The shallowest depths occur at the head and along the eastern shoreline and gradually slope to the current and historical dredging boundary located at the approximate

midpoint of the slip channel. At low tide, bottom sediments are exposed at the head and along the eastern shoreline.

The top of bank elevation ranges from about +12 to +18 ft MLLW. Much of the bank is within the tidal range (the extreme low tide is approximately –4 ft MLLW; extreme high tide is approximately +13 ft MLLW; the mean higher high tide is approximately +11.1 ft MLLW). The bank on the west side of the slip includes steeply sloped riprap next to a vertical bulkhead. The bank slope was nearly vertical at the bulkheads located on the eastern shoreline at First South Properties, and steeply sloping at the head of the slip. The southern portion of the eastern shoreline on the Boeing property is steeply sloped and armored with riprap.

The upland areas adjacent to Slip 4 are mostly flat. A small manmade hill is located near the mouth of the slip in the landscaped park area at the adjacent Boeing property.

Tidal effects primarily control the water elevation in the LDW (King County 1999). Tidal elevations at Slip 4 range from extreme lows of approximately –4 ft MLLW to extreme highs of approximately +13 ft MLLW. River discharge (controlled by releases from the Howard Hanson Dam on the Green River) has a lesser influence on water elevation.

1.2.2 Structures and Debris

Crowley Marine Services (Crowley) owns a pier and berthing area along the western shoreline, south of the removal action area. The City acquired a portion of the pier within the removal action area, which was demolished in accordance with the contract documents. The pier was comprised of a concrete deck that extended over the water, supported by concrete piling. The berthing areas at the mouth of Slip 4 are still owned by Crowley and are currently used for barge loading and unloading. There are no other docks in Slip 4.

Portions of the east shoreline at First South Properties and the bank at the head of the slip were lined with discontinuous segments of dilapidated timber piles and wood-lagging-supported bulkheads and cinderblock bulkheads. Parts of a derelict wooden loading structure remained on the western shoreline between the Crowley pier and the head of the slip.

There was a considerable amount of concrete debris and partially buried logs and piling near the toe of the banks and around the head of the slip. There was also a series of large timber skids at the head of the slip, in the northwest corner. The skids were mostly buried by sediment. Debris existed throughout the removal area.

1.2.3 Outfalls

The following public outfalls are located at the head of Slip 4:

- I-5 storm drain, owned by Washington State Department of Transportation

- King County Airport storm drain, owned by King County
- North Boeing Field storm drain, owned by Boeing
- Georgetown Steam Plant (GTSP) storm drain (at former location of Georgetown flume), owned by the City.

There are also two private storm drains and piped outfalls located along the Slip 4 shorelines, serving Crowley and First South Properties. The dredging and capping elements of the removal action were configured to protect the existing outfalls and resist erosion from outfall flows.

1.3 REGULATORY BACKGROUND

The LDW was added to EPA's National Priorities List in September 2001 because of chemical contaminants in sediments. The key parties involved in the LDW site are the Lower Duwamish Waterway Group (LDWG) (composed of the City of Seattle, King County, the Port of Seattle, and The Boeing Company), EPA, and the Washington State Department of Ecology (Ecology). EPA is the lead regulatory agency for the sediment investigation and cleanup work under the Comprehensive Environmental Response, Compensation and Liability Act; Ecology is the lead regulatory agency for source control work. The LDWG is voluntarily conducting the LDW remedial investigation and feasibility study under an Administrative Order on Consent (AOC).

The City and King County performed the Slip 4 characterization and engineering evaluation/analysis under Tasks 9 and 10 of the LDWG AOC and associated SOW, and per requirements of the Slip 4 Revised Work Plan (Integral 2004). In May 2006, EPA issued an action memorandum representing its decision for the selected cleanup alternative for Slip 4 (USEPA 2006a). The design, construction, and post-construction activities for the removal action in Slip 4 are being conducted as a non-time-critical removal action under an ASAOC and associated SOW (USEPA 2006b).

1.3.1 Removal Action Objectives

The primary objective of the removal action was to reduce the concentrations of contaminants in post-cleanup surface sediments (biologically active zone [0–10 cm]) to below the sediment quality standards (SQS) for polychlorinated biphenyls (PCBs) and other chemicals, thereby reducing unacceptable risks to human health and the environment resulting from potential exposure to contaminants in sediments in Slip 4 (USEPA 2006a).

1.3.2 Cleanup Levels

The SQS for PCBs is 12 milligrams per kilogram organic carbon (mg/kg OC) when the total organic carbon (TOC) content is between 0.5 and 4.0 percent. Similarly, the cleanup screening

level for PCBs is 65 mg/kg OC. When TOC is less than 0.5 percent or greater than 4.0 percent, regulatory comparisons are made to the lowest apparent effect threshold concentration (130 μg/kg based on dry weight) and the cleanup screening level reported in the LDW feasibility study (1,300 μg/kg based on dry weight). The removal boundary for the early action was established to include sediments exceeding the SQS (USEPA 2006a).

The Slip 4 EAA removal action was not based on complete removal of contaminated sediments to the SQS. Instead, the removal action design included dredging and excavation to target elevations designed to remove the most highly contaminated sediments, create stable slopes, and improve and expand habitat. The entire EAA was then covered with an engineered sediment cap to protect human health and the environment from residual contaminants that may be left behind.

1.3.3 Selected Remedy

The selected removal action included a combination of excavating, dredging, and capping of sediments in Slip 4 and soil in adjacent bank areas; institutional controls; and long-term monitoring to achieve the objectives of the removal action (USEPA 2006a). The primary elements of the removal action design are illustrated in Figure 1-2. The EAA was subdivided into seven removal areas, as depicted in Figure 1-3. Design elements for the removal areas are summarized below:

- Dredging and offsite disposal of contaminated sediment in Removal Areas 1, 2, 3, and 4, targeting near-surface material with the highest concentrations of contaminants.
- Excavation and offsite disposal of bank material along the shore in Removal Areas 1, 2, 3, and 4, including creation of 0.15 acres of new habitat enhancement area in Removal Areas 1 and 2.
- Removal of asphalt, creosote-treated timbers and piles, and other debris present in sediments within Removal Areas 1, 2, 3, and 4.
- Removal of debris and failing bulkheads and grading of shoreline slopes in Removal Areas 1, 2, and 3 to improve slope stability and prepare the surface for capping.
- Demolition and removal of the northern portion of the pier structure located in Removal Areas 4, 5, and 7 to accommodate capping and to further improve habitat conditions at the site.
- Placement of engineered slope caps in Removal Areas 1, 2, and 3 for slope stabilization.
- Placement of engineered sediment caps in Removal Areas 4, 5, 6, and 7 to isolate residual contamination remaining at depth beneath the planned excavation prism.

1.4 REMOVAL DESIGN PREPARATION

The Slip 4 design documents were initially completed in February 2007. However, implementation of the removal action was delayed to allow completion of nearby upland source control activities at the North Boeing Field facility and GTSP. Actions for the GTSP flume are discussed in Section 2.3.3 of the DAR (Integral 2010a).

Accumulated sediment formerly present within the lowest segment of the GTSP flume (approximately 370 ft of the flume, up-gradient from the outfall) was removed by the City in 2009 (Herrera 2010).

The 2007 Slip 4 design documents were subsequently updated and reissued in August 2010 and approved by EPA on October 4, 2010. The design documents include the removal action construction drawings (City of Seattle 2011a) and technical specifications (City of Seattle 2011b), DAR (Integral 2010a), CQAP (Integral 2010b), and WQMP (Integral 2010c). The design documents were issued for bid on March 31, 2011.

The RAWP was prepared after contractor selection and approved by EPA on October 20, 2011. Subsequent addendums were issued on November 1, 2011 and January 5, 2012. Table 1-2 summarizes the significant removal action documents generated for Slip 4.

1.5 PROJECT TEAM ORGANIZATION

This section provides the organizational structure for agency, construction management and oversight, and construction contractor personnel who were responsible for implementing the Slip 4 removal action. Table 1-3 contains project team contact information.

1.5.1 Agency Personnel

EPA was the regulatory authority and responsible agency for overseeing and authorizing the removal action.

Remedial Project Manager—Karen Keeley, EPA Region 10

The remedial project manager was responsible for overseeing the removal action to ensure that the remedy was protective of human health and the environment and to ensure that the removal action was implemented in accordance with the SOW.

Agency Water Quality Manager—Erika Hoffman, EPA Region 10

The agency water quality manager supported the remedial project manager from the EPA Environmental Review and Sediment Management Unit, served as the agency water quality

monitoring contact, and made technical decisions regarding water quality monitoring results and response actions.

Agency Construction Oversight Manager—Amy Dahl / Amanda Rohrbaugh, TechLaw, Inc.

The agency construction oversight manager was responsible for ensuring that the construction activities complied with the SOW, design drawings and specifications, and approved RAWP.

1.5.2 Construction Management and Oversight Personnel

The removal action construction was managed by the City, overseen by the City's construction oversight manager, and executed by GCC. Responsibilities of key personnel are summarized below.

City Project Specifier—David Schuchardt, P.E., Seattle Public Utilities

The City project specifier was responsible for overall coordination of the removal action activities and assurance that all work was conducted in accordance with the EPA-approved final design, as amended. The project specifier was the primary point of contact for EPA.

City Project Manager—Chris Woelfel, Seattle Public Utilities

The City project manager took direction from the City project specifier, and was responsible for internal City coordination of contracting and construction management. The project manager was also the primary City point of contact for the public.

City Supervising Construction Manager—John Summers, P.E., Seattle Public Utilities

The City supervising construction manager was the City's construction management lead and supervised the City resident engineer to ensure the work was administered and performed in accordance with the contract documents.

City Resident Engineer—Cynthia Blazina, P.E., Seattle Public Utilities

The City resident engineer was responsible for the on-site aspects of construction management. The resident engineer was the City's primary point of contact for GCC.

City Oversight Contract Manager—Jennie Goldberg, Seattle City Light

The City oversight contract manager managed the contract, schedule, budget, and project deliverables for removal action oversight services provided by Integral Consulting Inc. (Integral). The City oversight contract manager also prepared the monthly progress reports to EPA.

City Construction Oversight Manager / Quality Assurance Officer—John Lally, P.E., Integral Consulting Inc. (Independent On-call Consultant)

The City's construction oversight manager/quality assurance officer provided oversight and management of construction activities and the CQA program during construction of the removal actions. The construction oversight manager/quality assurance officer was Integral's primary contact for the City. The construction oversight manager/quality assurance officer worked directly with the City resident engineer and project specifier.

Field Supervisor / Site Safety Officer—Eric Pilcher, P.E., Integral Consulting Inc.

The field supervisor reported to the construction oversight manager/quality assurance officer and was responsible for implementing the sampling and analysis work in the sampling and analysis plan (SAP) and WQMP. The field supervisor also served as Integral's site safety officer and implemented and oversaw the health and safety program for Integral personnel associated with completing the oversight activities.

Field Leads—Jane Sund / Bill Lawrence, Integral Consulting Inc.

The field leads reported to the field supervisor and were responsible for the collection of sediment and water samples and the performance of water quality monitoring as described in the SAP and WQMP.

Research Vessel Captains—Steve Saugen / Shawn Hinz / Mike Duffield, Gravity Environmental

Gravity Environmental provided the research vessel from which sediment and water sampling and water quality monitoring was conducted.

Analytical Quality Assurance Officer—Kim Magruder-Carlton, Integral Consulting Inc.

The analytical quality assurance officer reported to the construction oversight manager/quality assurance officer and was responsible for analytical laboratory coordination and data validation and evaluation.

Analytical Laboratory Services—Analytical Resources, Inc., Tukwila, Washington

The analytical laboratory performed sediment and water analyses for samples collected by Integral (under the direction of the construction oversight manager/quality assurance officer).

1.5.3 Removal Action Contractor

General Construction Company (GCC; Contractor) performed the removal construction activities, including pier demolition, removal of piles and debris, dredging, disposal of dredged sediments, placement of the sediment cap, and placement of outfall scour protection.

Contractor Project Manager / Quality Control Representative—Tom Jirava, General Construction Company

GCC's project manager provided management of and direction to the project Contractor personnel assigned to the construction project site. GCC's project manager also served as the construction quality control representative and was responsible for implementation and maintenance of the CQC plan.

Contractor Site Supervisor—Matthew Miller, General Construction Company

GCC's site supervisor provided onsite management of and direction to GCC personnel, including craft labor and subcontractors, and was responsible for executing the work in full compliance with the contract drawings and specifications.

Contractor Site Engineer—Tyler Waugh / Chris Gilleg, General Construction Company

GCC's site engineer was responsible for the daily performance of field CQC activities in support of the project.

Contractor Site Safety and Health Officer / Project Safety Manager—Ryan Gammons, General Construction Company

GCC's site safety and health officer / project safety manager was responsible for the implementation of the construction team's health and safety programs and procedures.

Subcontractors

Subcontractors that were involved in the removal action and CQC activities are listed below. The subcontractors underwent a vetting process and met the approval of the City and EPA. Copies of subcontractor approval applications are provided in Appendix D, Attachment F1.

- Allied Waste (Allied), Leslie Whiteman, Transport and Disposal Manager

  Coordinated transport of contaminated materials to a subtitle D landfill.
- Analytical Resources, Inc., Analytical Laboratory

  Performed analytical testing for waste characterization.
- BC Traffic

  Provided traffic control during pier demolition.
- Boyer Towing

  Transported barges to and from the site.
- Brothers Concrete Cutting

  Performed saw-cutting of pier.

- eTrac Engineering, LLC (eTrac), Mel Saunders, PLS / Chris Raymond, Independent Professional Land Surveyor
  - AES Surveying, Gary Chapman

  Performed surveying fieldwork and prepared milestone surveys, per the requirements of the contract documents.
- Greylock Consulting, Suzanne Dudziak, Field Sampling Lead

  Performed analytical testing of import materials.
- Lafarge North America (Lafarge), Jonathan Hall, Transloading Operations Manager
  - Mike Depew, Transloading Technical Manager
  - Sam Kranzthor, Transloading Field Superintendent

  Performed transloading of dredged and excavated material from barges to lined rail containers.
- Rhine Demolition (Rhine) , Gil Olson, Demolition Supervisor
  - Coastal Pile Cutters

  Performed demolition of pier.
- Silver Streak, Inc.

  Provided trucking for recycling of materials generated during pier demolition.

Disposal Facilities

The following facilities were used for disposal of materials generated from the removal action construction:

- Rabanco Roosevelt Regional Landfill (Rabanco), Roosevelt, WA
- Stoneway Concrete Recycling (also known as Kangley Rock & Recycling) (Kangley), Renton, WA
- Independent Metals Recycling (Independent Metals), Seattle, WA
- Marine Vacuum Services (MarVac), Seattle, WA.

Import Materials

All capping materials were supplied by CalPortland, Seattle, WA from their Pioneer Aggregates facility (#B 335) in DuPont, WA and their White River Quarry facility (#2A 487) in Enumclaw, WA.

2 CHRONOLOGY OF EVENTS

Slip 4 removal action construction primarily occurred between October 3, 2011, and February 7, 2012. It began with placement of the boundary berm on October 3 and 4, 2011, followed by dredging and excavation from October 5 to November 18, 2011. Capping occurred following completion of dredging, from November 21, 2011, to January 31, 2011. Pier demolition occurred simultaneously with capping, from November 28, 2011, to January 5, 2012. Lastly, boundary area material placement occurred on February 7, 2012. Table 2-1 provides a detailed chronological summary of all construction activities.

3 SUMMARY OF REMOVAL ACTION CONSTRUCTION ACTIVITIES

This section provides a summary description of the activities undertaken to construct and implement the removal action and summarizes corrective measures and deviations from the contract documents that occurred during construction.

The City awarded the removal action construction contract to GCC on May 18, 2011. Notice to proceed was issued on June 18, 2011, following receipt of required contractual documentation. An RAWP was prepared in accordance with the SOW and contract documents, to document GCC's proposed means and methods for executing the work. The RAWP was initially submitted to EPA on July 13, 2011. A revised version was conditionally approved on September 16, 2011 allowing work to commence. The final version was issued on October 19, 2011, and approved by EPA on October 20, 2011.

Two addendums were issued to the final RAWP during the course of removal action construction to correct known errors and to clarify specific construction practices and procedures. Addendum No. 1 was issued to EPA on November 1, 2011, and covered waste transport manifesting procedures, container liner installation procedures, and additional information on barge dewatering filter bags. Addendum No. 2 was issued on January 5, 2012, and approved by EPA on the same day. Addendum No. 2 updated the list of disposal facilities, updated the haul route map, described granular activated carbon (GAC) blending procedures for filter material, and described procedures for free liquid handling at the transloading facility.

The following subsections describe the specific removal action construction activities identified in the Action Memorandum (USEPA 2006a).

3.1 MOBILIZATION AND SETUP

GCC installed a tide gauge on August 24, 2011. The gauge was located at the existing Crowley pier, approximately 130 ft southwest of the limit of pier demolition. The gauge sensor was placed inside a vertical PVC pipe, which was affixed to an existing fender pile.

Mobilization of equipment occurred on the west bank from September 19 through September 30, 2011. A pre-construction walkthrough was held at the site on September 28, 2011, to evaluate the readiness of construction facilities, including demarcation of exclusion, contaminant reduction, and support zones; installation of a haul road constructed with filter fabric, crushed rock (west side only), and a berm using straw wattles; temporary stockpile containment cell; equipment and personnel decontamination stations; spill prevention kits; and first aid stations. As required by the ASAOC, the City transmitted meeting minutes, including key discussion points and action items, to all parties within 7 days of the meeting.

Equipment brought to the site included the DB *Anchorage* derrick barge, material barges *GC102* and *GC103*, Hitachi 450 long-reach excavator, John Deere 300D articulated truck, John Deere 644K loader, and a Bobcat skid-steer.

Work zones, spill prevention kits and best management practices, and decontamination stations were similarly set up at the Lafarge transloading facility between September 19 and 30, 2011. A pre-construction walkthrough was held at the transloading facility on October 4, 2011.

Additional mobilization and setup activities were performed on the east bank at various times, as necessary for excavation of Removal Areas 2 and 3. Temporary fencing was installed on October 11, 2011. A temporary stockpile containment cell, work zones, haul route, and decontamination stations were established between October 27 and 31, 2011.

3.2 PRE-CONSTRUCTION SURVEY

Before commencing with removal action construction, GCC submitted a topographic and bathymetric survey prepared by GCC's independent surveyor, eTrac. The pre-construction survey was completed in accordance with the contract documents and Section 4.5 of the RAWP on September 14, 2011. Bathymetric data were acquired using multi-beam echo sounding. The City team reviewed the pre-construction survey and found the lines and grades to be substantially similar to the 2004 survey used as the basis of design for dredging and excavation, as shown in the contract documents. No design modifications were warranted based on the pre-construction survey data.

A copy of the pre-construction survey (and AutoCAD file on CD) is provided in Appendix D, Attachment J.

3.3 PRE-CONSTRUCTION BOUNDARY AREA DOCUMENTATION SAMPLING

Integral performed pre-construction boundary area sampling on August 24, 2011 to document contaminant levels within sediments outside the removal action area prior to commencement of removal action construction. Pre-construction boundary area documentation sampling activities are described in Appendix A, Sediment Sampling and Analysis Report (SSAR). Appendix A also includes a summary of the analytical testing results and supporting documentation.

An analytical database is provided on CD in Attachment G of the SSAR (Appendix A), following Ecology's Environmental Information Management (EIM) format.

3.4 PLACEMENT OF BOUNDARY BERM

The boundary berm was placed within the southwestern limit of the removal action as part of the waterway cap. The placement occurred prior to any dredging and excavation activities, as an experimental approach to limit near-bottom transport of sediments suspended by the dredging. Placement of the boundary berm began on October 3, 2011.

To place cap armor, GCC used a loader to fill a specially designed rock placement box (Bombay box) and then used the DB *Anchorage* to guide the box into position (Photo 3-1). Based on review of the daily progress survey it was determined that an additional lift of cap armor was needed to meet the boundary berm design crest elevations. Additional cap armor was placed along the boundary berm on October 4, 2011, and determined to be in compliance with the design. Placement of the boundary berm is documented in the daily capping reports in Appendix D, Attachment C1.

Specific water quality monitoring events (described in Appendix B) were performed to assess the effects of the boundary berm on water quality during dredging. Monitoring on both sides of the berm did not detect elevated near-bottom turbidity, and thus the transport mechanism that the berm was designed to address was likely not significant for this project.

3.5 REMOVAL OF PILES AND DEBRIS

Fender piles and other miscellaneous timber piles were extracted in accordance with the contract documents and Section 4.2.2 of the RAWP. Pile removal occurred on October 12, 2011, using a PACO vibratory hammer with timber clamp (Photo 3-2). Timber piles were extracted and placed on the upland work area within the exclusion zone, where they were cut into 5-ft lengths. The cut piles were then placed on the barge to be transported with dredged sediment to the transloading facility.

During excavation and dredging of the slope in Removal Area 2 (Station 2+70 to 3+10) on October 31 and November 1, 2011, the contractor removed additional buried timber piles and structural timber beams from what appeared to be the remnants of an old bulkhead. The piles were extracted using the dredging bucket, and were subsequently cut into 5-ft lengths for offsite disposal.

The timber fender piles along the pier face were removed between November 28 and 30, 2011, prior to concrete demolition activities. The piles were extracted using an APE 150 vibratory hammer. Fender piles were cut into 10-ft lengths and placed into lined containers for transport from Allied's facility in Seattle, WA, to the Rabanco Subtitle D landfill.

3.6 DREDGING

In-water dredging began on October 6, 2011, and proceeded through November 18, 2011, in accordance with the contract documents and Section 4.4 of the RAWP. Four dredging buckets (7.5 CY Atlas environmental bucket, 3.7 CY Cable Arm clamshell bucket, 5 CY ESCO toothed digging bucket, and 7 CY McGinnis re-handle bucket) were on-site and available to GCC, depending on the sediment characteristics and presence of debris. As debris was present throughout the dredge prism, dredging was primarily performed using the ESCO bucket. The DB *Anchorage* placed dredge sediment and excavated bank material onto material barges *GC102* and *GC103* (Photo 3-3), where the material remained at the site a minimum of 8 hours to allow for gravity dewatering and decant water collection before being shipped downstream to the Lafarge transloading facility.

Plots showing the location of each bucket grab were provided on a nearly daily basis from October 6 to November 21, 2011. Copies of the bucket plots are provided in Appendix D, Attachment C3. Progress surveys were also provided on a nearly daily basis from October 6 to November 11, 2011. Copies of the progress surveys are provided in Appendix D, Attachment C4.

Sediment dewatering was accomplished on material barges by gravity drainage to a holding cell, and then pumping the decant water to a filtration system consisting of filter bags, filter fabric, and GAC on top of flexi-floats, as described in Section 4.4.3 of the RAWP (Photo 3-4). A cut sheet for the filter bags was submitted in RAWP Addendum 1 (Integral 2011). The filtration system was disconnected from the material barge prior to shipping the barge downstream to the transloading facility. It was reconnected to the material barge as soon as practicable upon its return. GCC ran the filtration system pumps periodically throughout the shift, as water accumulated within the holding cell. Water quality measurements were taken on October 14, 2011, to check the effectiveness of the filtration system, and noted a marked decrease in the turbidity of filtered decant water. The monitoring procedure and results are described in more detail in Appendix B, Water Quality Monitoring Report (WQMR).

Daily excavation and dredging reports are provided in Appendix D, Attachment C2.

3.7 BANK EXCAVATION

Bank excavation began on October 4, 2011 and proceeded through November 14, 2011, in accordance with the contract drawings and Section 4.4 of the RAWP. Excavated soil was temporarily stockpiled on site, and then loaded onto material barges for transport to the Lafarge transloading facility.

Excavation within Removal Area 1 was performed between October 4 and 21, 2011 using an excavator and articulated truck. The excavator was used to excavate and load bank soil and

debris into the truck, which travelled along the temporary haul road and dumped the material into a stockpile area. The stockpile area was constructed of ecology blocks and lined with heavy duty (40-mil) Visqueen, protected by metal plates (Photo 3-5). Soil and debris from the stockpile was transferred to material barges *GC102* and *GC103* by the DB *Anchorage*. Decant water, decontamination rinsate, and collected rainwater was pumped from the stockpile areas to Baker tanks, which were later collected by MarVac for disposal at its approved facility.

The west bank haul road and adjacent stockpile area were decommissioned between October 24 and 26, 2011. Decommissioning was temporarily suspended on October 24 when the teeth on the excavator's bucket tore the filter fabric that separated the haul road material from existing substrate soil. The toothed bucket was replaced with a smooth-edged bucket, which prevented tearing and allowed decommissioning of the haul road to commence without further incident.

Bank excavation equipment was decontaminated on the west bank between October 25 and 26, 2011, using a high pressure washer and the portable containment berm described in Section 4.1.3 of the RAWP. Decontamination water was collected within the containment berm and pumped to a Baker tank. The water in the Baker tank was sampled, tested, and collected by MarVac for disposal at its approved facility.

A haul road and temporary stockpile area was established along the east bank between October 27 and 31, 2011, for excavation in Removal Areas 2 and 3.

Excavation of bank material in Removal Area 2 occurred between October 27 and November 7, 2011, using an excavator and articulated truck. Excavation of bank material in Removal Area 3 occurred between November 7 and 9, 2011. Additional excavation in Removal Area 2 for habitat area anchor blocks occurred on November 10, 2011. All bank soil and debris from Removal Areas 2 and 3 was transferred to barges *GC102* and *GC103* by the DB *Anchorage*.

Bank excavation equipment was decontaminated on the east bank between November 11 and 15, 2011 using a high pressure washer and the portable containment berm described in Section 4.1.3 of the RAWP. Decontamination water was collected within the containment berm and pumped to a Baker tank. Water from the Baker tank was sampled, tested, and collected by MarVac for disposal at its approved facility.

The east bank haul road and stockpile area were decommissioned between November 14 and 16, 2011. The existing asphalt on Emerald Services property was pressure washed following decommissioning.

Daily excavation and dredging reports are provided in Appendix D, Attachment C2.

3.8 TRANSLOADING

Barges loaded with soil, sediment, and debris were transported by tug boats to the Lafarge transloading facility by Boyer Towing.

Dredged sediments were transloaded at Lafarge in accordance with the contract documents and Appendix A, Attachment 4.3-1 of the RAWP (transloading plan) (Photo 3-6). Lafarge used a tower crane with an articulating dribble chute to offload material from barges to a concrete containment vault, as described in Section 3.1.2 of the transloading plan. Minor drips of material from the crane bucket were captured on Visqueen, beneath the travel path of the crane bucket, and cleaned up at the end of each shift. Dredged sediment and debris was placed into lined containers using an excavator and shipped via rail to Rabanco Regional Landfill (Photo 3-7). Material handling, transport, and disposal are discussed in more detail in Section 4.2. Waste manifests are provided in Appendix D, Attachment D4.

3.9 BANK DOCUMENTATION SAMPLING

Integral performed post-excavation bank slope sampling on November 14 and 16, 2011, to document soil and sediment conditions following completion of dredge and excavation activities. Post-excavation bank slope sampling activities are described in Appendix A, SSAR. Appendix A also includes a summary of the analytical testing results and supporting documentation.

An analytical database is provided on CD in Attachment G of the SSAR (Appendix A), following Ecology's EIM format.

3.10 POST-DREDGE/EXCAVATION ACCEPTANCE SURVEY

Upon completion of dredging and bank excavation activities, GCC submitted a post-dredge/excavation acceptance survey containing topographic and bathymetric survey data, prepared by the independent surveyor, eTrac. The post-dredge/excavation acceptance survey was completed in accordance with the contract documents and Section 4.5 of the RAWP on November 15, 2011. Bathymetric data were acquired using single-beam echo sounding.

The City team reviewed the post-dredge/excavation acceptance survey and noted that dredge elevations did not appear to have been met (i.e., insufficient material was removed) in the area south of the I-5 outfall, between STA 0+40 & 0+50, offset 5 to 100 ft to the west of the project baseline.

In response to the above noted discrepancy and other review comments provided by the City team, GCC performed additional dredging and submitted a revised survey on November 23,

2011. Based on the City's review of the revised submittal, it was determined that the requirements for the post-dredge/excavation acceptance survey had been met. The survey was accepted on November 23, 2011.

A hard copy of the post-dredge/excavation acceptance survey (and AutoCAD file on CD) is provided in Appendix D, Attachment J.

3.11 BANK CAPPING

Bank slope capping began on November 21, 2011, with the placement of toe berms along the base of each bank slope, in accordance with the contract documents. Toe berms were placed by using a loader to fill the Bombay box and then using the DB *Anchorage* to guide the box into position. Toe berm placement was completed on December 1, 2011. Following completion of toe berm placement, low spots along the bank were raised using waterway cap material to provide a smooth transition and uniform sub-grade for capping**.**

Capping of the bank slopes with filter material containing GAC and cap armor began immediately after low spot filling (Photo 3-8). In general, cap armor was placed on the same day as the underlying filter material (Photo 3-9), in accordance with the contract documents, with the following exceptions:

- Receding tides and minimal allowable draft near the end of shift on December 6, 2011 prevented same day cap armor placement within a small portion of Removal Area 2.
- A mechanical failure on the DB *Anchorage* on December 8, 2011 prevented same day cap armor placement within a small portion of Removal Area 2.
- On December 13, 2011 a small portion of Removal Area 1was left un-capped as the volume of cap armor available on-site was not adequate for full coverage.

Based on observations of these areas during subsequent low-tides, it was determined that exposed bank areas remained stable and intact.

Filter material and cap armor placement began on December 5, 2011 and was completed on December 14. Filter material was placed using the ESCO bucket. Cap armor was placed using the Bombay box.

Habitat mix was placed over the cap armor at a rate of 3 tons per 100 sq ft, in accordance with the contract documents. GCC placed the habitat mix by broadcasting along the swing radius of the crane over the targeted slope areas with the McGinnis bucket.

In addition to bank slope capping, engineered soil covers were placed within Removal Areas 1 and 2 to create habitat enhancement areas comprised of beach sand and large woody debris

(Photo 3-10). The habitat enhancement areas were over-excavated to allow the installation of anchor blocks for the large, woody debris. The woody debris was then chained to the anchor blocks, which were backfilled with waterway cap material. An engineered soil cover was then placed, consisting of an additional 12 to 15 in. lift of waterway cap material and a 12 to 15 in. lift of beach sand, in accordance with the contract documents.

Bank slope capping is located in Removal Areas 1, 2 and 3 as shown in Figure 3-1. Daily capping reports are provided in Appendix D, Attachment C6.

3.12 OUTFALL AREA CAPPING

Outfall scour protection and capping began on November 11, 2011, with the placement of cap armor immediately adjacent to the outfalls. Placement was performed using the McGinnis bucket in accordance with the contract documents.

Filter material, cap armor, and heavy loose riprap were placed at the outfalls on December 12, 2011, in accordance with the contract documents. Filter material was placed using the McGinnis bucket. Cap armor and rip-rap were placed using the Bombay box.

Placement of filter material within Removal Area 4 began on December 14, 2011, and was completed on December 20, 2011, using the McGinnis bucket. Placement of cap armor within Removal Area 4 began on December 16, 2011, starting with the slope at the head of the slip. Cap armor placement continued through January 4, 2012, to complete the outfall settling basin and swale, in accordance with the contract documents. Fine grading occurred at low tide, as needed, to provide quality control for the shape and definition of the basin and swale (Photo 3-11).

Cap armor was placed in the northern portion of Removal Area 5 on January 6, 2012, to provide an armored cap at the swale outlet, in accordance with the contract documents. Habitat mix was placed over the cap armor at a rate of 3 tons per 100 sq ft, in accordance with the contract documents. Habitat mix was placed over the outfall settling basin and swale on December 28, 2011, and January 6, 2012.

Outfall area capping is located in Removal Area 4 as shown in Figure 3-1. Daily capping reports are provided in Appendix D, Attachment C6.

3.13 PIER DEMOLITION

Demolition of the pier was performed in accordance with the contract documents and Section 4.2.2 of the RAWP. Work commenced on November 22, 2011, with mobilization of Rhine demolition equipment and sawcutting of the existing bulkhead sheet pile cap by Brothers

Concrete Cutting. Sawcutting was completed on November 28, 2011. Rhine removed the top slab on November 29 and 30, 2011. Deck panels were removed from pile caps between November 30 and December 19, 2011 (Photo 3-12).

On November 30, 2011, a Hitachi 460L hydraulic excavator dropped one of the deck panels into the water. A Hitachi 750 hydraulic excavator was mobilized to the site on December 1, 2011, to retrieve the deck panel and perform all further deck panel removal operations.

Pile cap removal was performed between December 1 and 20, 2011 once deck panels were removed. Piles were cut to within 1 ft of the mudline between December 16 and 27, 2011, using a pile shear provided by Coastal Pile Cutters (Photo 3-13). Remaining piles were removed using Rhine's hydraulic shear between December 29, 2011, and January 5, 2012.

All demolished concrete was crushed and segmented onsite prior to being loaded onto trucks for transport for recycling at Kangley. Rebar from demolished concrete was loaded onto trucks and transported for recycling at Independent Metals.

On January 5, 2012, a fitting came off of the hydraulic shear, spilling a small amount of hydraulic fluid on a paved portion of the upland area. GCC shut down demolition operations and placed absorbent pads around the area to contain and clean up the spill. No hydraulic fluid was released to Slip 4.

3.14 WATERWAY CAPPING

Waterway cap material placement began on December 23, 2011, and proceeded through January 26, 2012. Waterway cap material was placed in Removal Areas 4, 5, 6, and 7, in accordance with the contract documents. The material was placed using the McGinnis bucket, and fine-graded during low tide, where accessible, using an excavator (Photos 3-14 and 3-15). The Bombay box was used to place cap armor in Removal Area 7 on January 27 and 31, 2012.

Habitat mix was spread over the existing rip-rap within the pier footprint on January 3, 12, and 13, 2012, at a rate of 3 tons per 100 sq ft, in accordance with the contract documents. Habitat mix was placed over the cap armor in Removal Area 7 on January 31, 2012.

Bank capping is located in Removal Areas 4, 5, 6 and 7 as shown in Figure 3-1. Daily capping reports are presented in Appendix D, Attachment C6.

3.15 WATERWAY CAP ACCEPTANCE SURVEY

On January 31, 2012, GCC submitted a waterway cap acceptance survey containing topographic and bathymetric survey data, prepared by the independent surveyor, eTrac. The cap

acceptance survey was provided in accordance with the contract documents and Section 4.5 of the RAWP and included bathymetric data acquired using a multi-beam sonar system.

The City team reviewed the cap acceptance survey and noted the following:

- Additional cap material placement was required in Removal Area 7.
- Small areas of the boundary berm in Removal Area 7 and toe berm in Removal Area 6 were approximately 1 ft low. This may have been attributable to consolidation of underlying sediments and differences in survey return signals from the comparatively rough cap armor. Based on consideration of the progress surveys, bucket plots, and daily capping reports, the City recommended approval of the areas as having met design requirements.
- There was a linear area along the boundary of Removal Area 5 and 6, which was approximately 1 ft low. This reflected the transition from 30-inch to 60-inch thick capping sections and indicated that the cap material had leveled out along a natural angle of repose. This was considered normal and the City recommended approval of the area as having met design requirements.
- A 5- by 5-ft area at the south corner of Removal Area 2 was lower than design. This reflected a cut remnant of the timber bulkhead where the cap transitioned to the bulkhead as referenced on sheet 16, note 14 of the contract drawings. The City recommended approval of this area as having met design requirements.
- A 20- by 20-ft area at the northern end of Removal Area 5, adjacent to the swale outlet, was approximately 1 ft low. Review of the pre-construction and post-dredge/excavation surveys indicated that there was a small mound of existing material outside the dredge prism. The existing mound resulted in a low spot in the uniformly graded cap surface.

  The area was not accessible for placement of additional material from shore. Furthermore, it was determined that mobilizing the derrick barge over the completed waterway cap would have posed a disproportionate risk of cap damage due to spudding, grounding, and prop scour. Therefore, the City recommended approval of the area with no corrections made.
- Two portions of the swale and outfall area cap in Removal Area 4 and a 60- by 40-ft transitional wedge between Removal Area 4 and Removal Area 6 were lower than design. These areas were low because GCC neglected to base its target capping surface data upon the design elevations shown in the contract drawings. However, in both of these locations, the removal design intent had been met based on minimum cap thickness, and hydraulic functionality had been met based on the constructed gradient of the swale. The City recommended approval of the cap in these areas with no corrections made.

- When comparing the cap acceptance survey to target design grades, various, small, fringe areas on steep slopes and near outfalls appeared to be lower than design. These areas were considered to be artifacts due to inter-survey errors on slopes or the presence of the outfall structures themselves. These fringe areas were visually observable at low tide and appeared to be sufficient. The City recommended approval of these areas as having met design requirements.
- A 10- by 5-ft area on the west side of Removal Area 7 was approximately 1 ft lower than design. This was attributed to an error in the pre-cap placement hydrographic survey data obtained adjacent to the pier. GCC submitted Request for Information (RFI)-01014 to explain that the target design grade under the former pier was not reflective of nominal cap thickness over the actual existing grade. The City concurred with GCC's findings and recommended approval of the cap in this area based on the revised design surface.

Additional cap armor was placed in Removal Area 7 on January 31, 2012. The revised cap acceptance survey was submitted on February 10, 2012. The EPA accepted the revised survey on February 13, 2012 with no further modifications. An analysis of the cap acceptance survey digital terrain model (DTM), compared to the target capping surface DTM, is provided in Figure 3-2.

A copy of the cap acceptance survey (and AutoCAD file on CD) is provided in Appendix D, Attachment J.

3.16 CAP VERIFICATION SAMPLING

Integral performed cap verification sampling on January 30 and February 1, 2012, following completion of bank capping and waterway capping activities to assess post-construction sediment characteristics. Cap verification sampling activities are described in Appendix A, SSAR. Appendix A also includes a summary of the analytical testing results and supporting documentation.

An analytical database is provided on CD in Attachment G of the SSAR (Appendix A), following Ecology's EIM format.

Review of laboratory results revealed that the cap within Removal Areas 1 through 7 met the removal action objective. Thus, no further cap material placement was necessary, based on analytical chemistry.

3.17 POST-CONSTRUCTION BOUNDARY AREA DOCUMENTATION SAMPLING AND MATERIAL PLACEMENT

Integral performed post-construction boundary area surface sediment sampling on February 1 and 2, 2012, following completion of bank capping and waterway capping activities, to compare to pre-construction boundary area sampling results. Post-construction boundary area confirmation sampling activities are described in Appendix A, SSAR. Appendix A also includes a summary of the analytical testing results and supporting documentation.

Review of the laboratory results revealed that contaminant concentrations had increased within the boundary area surface sediments during the course of construction activity. Accordingly, a nominal 9-in. layer of waterway cap material (referred to as "boundary area material") was placed over the boundary area on February 7, 2012 (Figure 3-1; Photo 3-16). Placement of this material covered the 200 ft width of Slip 4 to a distance of 100 ft beyond the boundary berm (Figure 3-1).

Subsequent boundary area sampling was performed on February 14, 2012 to document surface conditions following boundary area material placement. Review of laboratory results revealed that after boundary area material placement, sediment characteristics met the removal action objectives. The post-boundary area capping documentation sampling activities are described in Appendix A, SSAR.

An analytical database is provided on CD in Attachment G of the SSAR (Appendix A), following Ecology's EIM format.

3.18 DEMOBILIZATION AND CLEANUP

3.18.1 Haul Roads

Bank excavation equipment was decontaminated on the west bank between October 24 and 26, 2011. Equipment used for soil excavation in Removal Area 1 was decontaminated between October 25 and 26, 2011, using a high pressure washer and the portable containment berm described Section 4.1.3 of the RAWP. Decontamination water was collected within the containment berm, pumped to a Baker tank and later collected by MarVac for disposal at its approved facility.

Equipment used for soil excavation in Removal Areas 2 and 3 was decontaminated between November 11 and 15, 2011, in the same manner as described above.

The east bank haul road and stockpile area were decommissioned between November 14 and 16, 2011. The existing asphalt on Emerald Services property was pressure washed following decommissioning.

3.18.2 Material Barges

Decontamination of the *GC102* material barge occurred on November 15 and 16, 2011. A loader was placed on the barge at the Lafarge transloading facility to scrape and remove as much material as possible. The loader was later decontaminated at the Lafarge facility by using the tower crane to hoist it over the containment vault and spraying it with a high pressure washer. The barge was returned to the project site, where a Bobcat skid-steer was then placed on the barge to clean up remaining sediment and load it into a skip box. The material in the skip box was emptied into lined containers on the west bank using the DB *Anchorage*. The containers were trucked to Allied's facility at 3rd Avenue South and South Lander Street, Seattle, WA, for transport to Rabanco via rail. The ecology block baffles and tarps were removed from the barge, and the barge was rinsed at the site, prior to placement of cap material, using bucket loads of water delivered by the DB *Anchorage*.

Decontamination of the *GC103* material barge occurred on November 22 and 23, 2011, in the same manner as described above.

3.18.3 Transloading Facility

Prior to decontamination, excess standing water within the transloading vault was pumped to tanker trucks provided by Emerald Services. A total of five tankers were loaded between December 5 and 8, 2012 and transported to Rabanco for disposal. The total weight of water transported to Rabanco by tanker truck is 131.98 tons (approximately 31,600 gallons).

The Lafarge transloading facility was decontaminated between December 8 and 28, 2011, beginning with the tower crane, bucket and hopper. The crane bucket was high pressure washed over the vault while the tower crane's hopper and grizzly were partially filled with limestone dust for spill containment, and rinsed. Wash water was directed to the vault. Decontamination of the tower crane was completed on December 10, 2011.

The vault was decontaminated by pressure washing the side walls, floor, and entrance ramp, and using squeegees on the vault floor. Decontamination of the loader that had been used to scrape clean the vault floors was accomplished by picking it with the tower crane, high pressure washing from all sides, and removing it from the vault. Scraped material and wash water were pumped to a lined container to be transported to Rabanco.

Lafarge reported completion of transloading facility decontamination activities on December 28, 2011. Final activities included decontaminating the sump and piping from the vault sump, and disposal of decontamination equipment.

The field supervisor visited the Lafarge transloading facility on January 4, 2012, to observe the condition of the vault and surrounding areas. The vault had been thoroughly cleaned, and no visible traces of sediment were noted on either the sides or bottom. Some standing water was

present within the vault due to recent rain events. The water was clear. Areas along the perimeter of the vault were likewise free of sediment and debris.

3.18.4 Demobilization

Throughout construction of the removal action, equipment was removed from the site when it was no longer needed. Final demobilization began on February 8, 2012, following placement of the last barge load of waterway cap material. All equipment and supplies were removed from the site by February 16, 2012.

4 CONSTRUCTION QUALITY ASSURANCE / QUALITY CONTROL

CQA/CQC was managed in accordance with the CQAP and the contract documents. Key elements of CQA activities are summarized below. CQA was performed by Integral, under direction of the City. CQC was conducted under the direction of GCC's CQC officer.

4.1 QA/QC PROTOCOLS

This section describes the protocols that were followed during removal action construction activities to provide oversight and documentation of the work performed.

4.1.1 Submittal Management

All project submittals were distributed to the City team by means of the City's tracking database (Unifier). Once submittals were uploaded to Unifier, the City's team reviewed for accuracy and concurrence with the contract documents and either approved (with or without exception) or denied based on incorrect or insufficient information. Copies of subcontractor approval submittals are included in Appendix D, Attachment F1. Material cut sheet submittals are included in Appendix D, Attachment F2. Other relevant and specific submittals are discussed in other sections of this RACR.

4.1.2 Progress Meetings

Weekly progress meetings were held every Tuesday morning at 10:00 a.m. The meetings were held in GCC's job trailer and led by the resident engineer. Typical attendees included EPA's remedial project manager; the City's project specifier, project manager, construction oversight manager/quality assurance officer, and field supervisor; and GCC's project manager, site supervisor, and site engineer. Meeting agendas were distributed via e-mail in advance of each meeting, and later revised to become the meeting minutes following each meeting. Copies of the meeting minutes are included in Appendix D, Attachment B2.

4.1.3 Inspections, Sampling, and Verification Activities

CQA was performed by the City team for all construction activities. Routine observations of construction activities were made multiple times per day. Questions and concerns regarding construction practices were communicated directly to the site supervisor, who in turn coordinated with GCC as necessary to correct deficiencies.

Transloading at Lafarge was initially observed by City construction oversight personnel during offloading of each barge, either by routine visits to the facility, or from the project water quality monitoring vessel. As transloading work progressed and practices were determined to be acceptable, facility visits were scaled back to twice weekly. Questions and concerns regarding transloading practices were communicated directly to either the transloading technical manager or the transloading field superintendent.

Water quality monitoring was performed by the City team in accordance with the WQMP (WQMR in Appendix B).

Sediment sampling and analysis was performed by the City team in accordance with the sampling and analysis plan (Integral 2010d) (SSAR in Appendix A).

Dredging and capping progress surveys were performed by GCC on a near-daily basis. Daily progress survey cross sections were reviewed by the City team to determine if dredging and capping operations were meeting target elevations. Similarly, daily survey point data were used to create progress DTM surfaces for comparison against the target DTMs.

In addition to reviewing daily progress surveys, GCC submitted surveys, independently prepared by eTrac, at key points during removal action construction. Copies of independent surveys are provided in Appendix D, Attachment J. The independent surveys were used to verify that work had been performed in accordance with the contract drawings and to determine final payment quantities. DTM surfaces generated from pre-construction, post-dredge/excavation and post-capping surfaces are shown in Figure 4-1.

4.1.4 CQC/CQA Documentation and Reporting

GCC generated daily progress reports and provided them to the City team via e-mail. In addition to describing the activities that occurred onsite each day, the reports generally contained a dredging or capping summary report, dredging or capping bucket plots, and daily progress survey information. Similarly, Lafarge provided daily checklists describing transloading activities. Copies of the daily CQC reports and supporting attachments are provided in Appendix D, Attachments C1 through C8.

The City's team prepared weekly CQA reports that described the work that occurred and summarized the monitoring, sampling and verification activities that were performed. The CQA reports were generally submitted to the EPA via e-mail by close of business of Monday following each work week. Copies of the weekly CQA reports are provided in Appendix D, Attachment B1.

The City team also prepared monthly progress reports, which included a brief summary of construction activities, along with a description of community involvement/outreach activities.

The progress reports were submitted to the EPA via e-mail at the end of each month. Copies of the monthly progress reports are provided in Appendix D, Attachment A.

4.1.5 Field Change Documentation

No changed conditions were encountered that required the issuance of a field change to the contract documents. However, minor site conditions did result in the generation of RFIs and field memos. RFIs were generated by GCC and submitted to the City using Unifier to document questions encountered and suggest potential solutions. The City's team reviewed each RFI and responded accordingly. Similarly, field memos were issued by the City to GCC using Unifier, to clarify design intent or otherwise authorize tasks beyond the scope of the contract documents. Copies of RFIs and field memos are provided in Appendix D, Attachments G and H, respectively.

4.1.6 Post-Construction Documentation

Upon completion of work, GCC submitted "record drawings" and "as-built drawings." The record drawings were prepared by eTrac and are the final surveyed drawings following work completion. The record drawings are provided in Appendix D, Attachment J. The as-built drawings are marked up drawings maintained in the field by GCC. The as-built drawings are provided in Appendix D, Attachment K.

In addition to record and as-built drawings, various punch lists and inspection documentation were prepared near the end of project completion. These items are described in more detail in Section 4.2.5.

4.2 SUMMARY OF QA/QC OBSERVATIONS AND CORRECTIVE MEASURES

This section provides a summary of key QA/QC observations, and where necessary, corrective measures that were implemented to ensure the work was completed in accordance with the requirements and intent of the contract documents.

4.2.1 Material Removal, Handling, and Disposal

Generated wastes were transported and disposed in accordance with the contract documents and Sections 4.3 and 4.7 of the RAWP. All facilities receiving materials generated from the site were approved under EPA's off-site rule (OSR). Barge and container logs provided by Lafarge, and waste manifests provided by Allied, verify that all contaminated waste material has been properly accounted for.

4.2.1.1 Material Quantities

Quantities of material generated from the Slip 4 site during removal action construction are provided in Table 4-1. The values are documented by receipts from the respective disposal facilities (Appendix D, Attachments D4 though D6).

Concrete and steel from the pier were recycled. Soil, sediment, greenery, timbers, and other debris from the site were disposed offsite as contaminated waste at Rabanco. These materials were co-mingled during transloading, and therefore individual quantities are not available. Waste characterization for the contaminated material is provided in Appendix D, Attachment D1.

4.2.1.2 Dredging and Excavation

On October 5, 2011, it was noted that excavator bucket swing arcs along the haul road at Removal Area 1 extended beyond the demarcation of the exclusion zone. As a result, an additional 8-ft wide swath of filter fabric and exclusion zone demarcation was provided to extend the zone to the railroad tracks. This created an additional buffer area to prevent existing soil from being contaminated by loose material from the dump truck or excavator bucket.

The independent post-dredge acceptance survey was used to confirm dredging and excavation were complete. As described in Section 3.10, discrepancies were identified which required limited additional dredging and re-surveying for final acceptance.

4.2.1.3 Transloading

Soil, sediment, and dredged/excavated debris were placed on material barges and shipped to the Lafarge facility to be transloaded in accordance with Appendix A, Attachment A4.3-1 of the RAWP. A tower crane and bucket were used to offload the barges to a containment vault. An excavator was used to transfer the waste material to lined containers. The containers were placed onto railcars for transport to Rabanco.

Timber fender piles, minor miscellaneous debris, and some of the accumulated water within the transloading vault were trucked separately to Rabanco.

CQC included continuous visual monitoring of the transloading operations and daily reporting by Lafarge staff. Daily transloading reports are included in Appendix D, Attachment C5. CQA included periodic visual observations by City construction oversight personnel.

There were two incidents during transloading that required temporary shutdown. On October 6, 2011, a piece of concrete fell from the crane bucket and tore the Visqueen. On October 17, 2011, the crane bucket opened slightly prior to being positioned over the vault. In both instances, transloading operations were suspended immediately and emergency cleanup

and repair was performed. Lafarge personnel donned Tyvek suits and thoroughly cleaned the affected areas using a higher pressure washer, shovels, and brushes. Damaged Visqueen was patched or replaced. No material was released back to the river.

Based on early observations of rail container loading, there were initial concerns regarding tears that formed at locations where the liners were affixed to the containers. These were first observed on October 14, 2011, at the tie wires near the top of each container. Photo documentation of the containers arriving at Rabanco indicated that the tears had not worsened and had not been compromised by material movement during transport. Nevertheless, Lafarge refined the liner installation process to correct the problem. Revisions to the transloading plan and standard operating procedures on liner installation and liner tears were submitted in Addendum 1 to the RAWP on November 1, 2011.

On December 15, 2011, it was noted that one of the lined containers containing primarily decontamination rinsate at the Lafarge transloading facility did not have adequate (3-ft 3-in.) freeboard. To provide adequate freeboard, excess water from the overloaded container was pumped to a second lined container on December 16, 2011.

4.2.1.4 Disposal

In accordance with EPA's OSR, facilities receiving materials generated from Superfund sites must be approved in advance. GCC made use of four off-site disposal locations: Rabanco, MarVac, Kangley, and Independent Metals. All four locations were verified for continued acceptability by EPA, prior to shipment of materials. Relevant copies of email correspondence are provided in Appendix D, Attachment D2.

Table 4-1 provides a summary of the quantity and types of material removed, and their ultimate destination.

Lafarge maintained a log of the barges and estimated tonnage of material received for offloading at its facility. Lafarge also maintained a log of each container loaded with waste material, including its rail car number and estimated weight of material to be shipped. These logs are provided in Appendix D, Attachment D3. As stated, the Lafarge material logs provide an estimate of material weight. Actual quantities are based on tipping receipts at the Rabanco facility.

Rabanco generated disposal tickets for disposed materials at their facility. Copies of the tickets are provided in Appendix D, Attachment D4, together with monthly summary reports, prepared by Allied Waste. The container and railcar numbers in the summary reports match those of Lafarge's container log. In addition, the summary reports include waste material shipped by truck.

Runoff from temporary stockpiles and equipment decontamination at the Slip 4 site was collected and pumped to Baker tanks. The Baker tanks were transported to MarVac for disposal of runoff and rinsate.

The concrete pier was demolished and removed in accordance with the contract documents and Section 4.2 of the RAWP. Concrete panels, bents, and piers were broken up on site and transported to recycling facilities by trucks, in accordance with Section 4.7 of the RAWP.

Shipping orders and analytical chemistry data for collected wastewater are provided in Appendix D, Attachment D5. Disposal tickets generated by Kangley for recycled concrete and by Independent Metals for recycled steel are provided Appendix D, Attachment D6.

4.2.1.5 Cultural Resources

No cultural resources were encountered during construction of the removal action. As no cultural resources or artifacts were encountered, no resource personnel were contacted to evaluate buried items at the site.

Per an agreement with the Muckleshoot Indian Tribe, the City provided compensatory reimbursement for the relocation of fishing nets as necessary to allow transport of barges from the site to the transloading facility. A total of 37 net moves were required during dredge, excavation, and transloading activities. Recompense for net moves is included in the removal actions costs summarized in Appendix C.

4.2.2 Cap Material Import and Placement

4.2.2.1 Cap Material Quantities

Following dredging and excavation of contaminated soil and sediment, a bank and waterway cap was constructed, consisting of clean import material. The following quantities of import materials were placed within the Slip 4 site:

- Cap armor 10,871 tons
- Heavy, loose rip-rap 150 tons
- Waterway cap 33,411 tons
- Filter material (with GAC) 5,578 tons
- Filter material (without GAC) 169 tons
- Habitat mix 2,466 tons
- Beach sand 361 tons.

Import material tickets are provided in Appendix D, Attachment E1.

4.2.2.2 Cap Material Sources

Cap armor and heavy loose riprap were obtained from CalPortland's White River Quarry (#A-487) in Enumclaw, WA. These materials were tested for gradation, degradation, abrasion, and specific gravity and were found to be in compliance with the contract documents. A copy of the test results is provided in Appendix D, Attachment E2.

All other capping materials, including waterway cap, filter material, habitat mix and beach sand were obtained from CalPortland's Pioneer Aggregates facility (#B 335) in DuPont, WA. These materials were tested for gradation, density, semivolatile organic compounds, inorganic chemicals, PCBs, and TOC. The material gradations varied slightly from the contract specifications, but were accepted as being reasonably close and meeting cap design requirements (see Appendix D, Attachment G, RFI 01004).

Imported granular materials were also subjected to analytical testing of chemical characteristics. While there were metals detected above the reporting limits, concentrations were below acceptance criteria as defined in the contract specifications. Copies of the results for both physical and chemical testing are provided in Appendix D, Attachment E3.

GAC was incorporated into the filter material using GAC material from a stockpile at CalPortland's Pioneer Aggregates facility (#B 335) in DuPont, WA. The GAC was tested for gradation and was found to meet the requirements of the contract specifications. The GAC was blended into the filter material in accordance with the contract documents and Section 4.8.1 of the RAWP, as amended. GAC gradation and belt scale calibration are provided in Appendix D, Attachment E4.

The quantity of GAC provided in each load of filter material is indicated on the relevant loading tickets provided in Appendix D, Attachment E1. Load numbers 15444 (11/29/2011), 15454 (12/5/2011), 15460 (12/7/2011), 15464 (12/9/2011), and 15475 (12/15/2011) each contain GAC within the filter material mix, in excess of 0.5 percent by weight, per the contract documents.

4.2.2.3 Cap Material Placement

Cap materials were placed in accordance with the work sequence and means and methods described in Section 4.8 of the RAWP. For bank cap areas, cap armor was placed over the top of filter material on the same work day, except as noted in Section 3.11. To verify that adequate thickness of filter material had been achieved, the City construction oversight personnel accompanied the contractor to field check the thickness based on instantaneous survey readings.

During placement of waterway cap material in Removal Area 7 on January 24, 2012, water quality monitoring between the ambient and compliance stations during ebb tide indicated a turbidity increase in excess of acceptable levels. The field lead recorded a turbidity increase of 17.4 NTUs at 10:20 a.m. A second reading was conducted at 11:35 a.m., and recorded an increase of 15.9 NTUs. Based on visual surface observations, the color of the turbidity plume in the vicinity of the compliance station appeared to match that of the waterway capping material. GCC was directed to modify its operations to reduce turbidity by placing cap material at reduced production rates, and closer to the waterline. There were no further turbidity exceedances during the slack tide monitoring event later that afternoon or during monitoring on the following day. Water quality monitoring is described in more detail in Appendix B, WQMR.

Progress verification of total cap thickness was performed by comparing daily progress surveys to a target elevation based on minimum cap thickness from the post-dredge/excavation acceptance survey and/or final design grade.

As described in Section 3.15, the final acceptance of constructed caps was based on an independent survey. Additional placement of cap material was required in Removal Area 7. Several minor variations in cap thicknesses were noted and accepted by EPA and the City.

4.2.3 Sediment and Water Quality Sampling and Monitoring

The following field sampling and monitoring activities included (refer to Section 3):

- Boundary area sediment sampling
- Post excavation surface sediment sampling
- Final cap surface sediment sampling
- Water quality monitoring during in-water construction activities.

The management and reporting of field and laboratory data was conducted in general accordance with the procedures outlined in the SAP (Integral 2010d) and the WQMP (Integral 2010c). All laboratory results were validated in accordance with the sampling plans. Data quality review is described in more detail in Appendix A, SSAR and Appendix B, WQMR.

4.2.4 Health and Safety

4.2.4.1 Health and Safety Plans

GCC and its subcontractors performed the work in accordance with the site-specific health and safety plan, submitted as Appendix B1 of the RAWP. Similarly, transloading of dredged/material at the Lafarge facility was performed in accordance with the health and safety plan for dredge material handling, submitted as Appendix B2 of the RAWP.

Construction oversight and quality assurance activities were performed in accordance with the health and safety plan for water quality monitoring, verification sediment sampling, and construction oversight, revised August 22, 2011 and submitted as Appendix B of the WQMP.

4.2.4.2 Daily Safety Meetings

GCC's site safety and health officer (or a designated alternate) conducted daily safety meetings prior to the beginning of work for each shift. Topics covered for each meeting are included on GCC's daily quality control reports in Appendix D, Attachment C1.

4.2.4.3 Reportable Incidents and Near Misses

On August 24, 2011, a surveyor was observed within the (not yet demarcated) exclusion zone without required personal protective equipment. The surveyor was notified of the risk and provided with rinse water for cleaning his boots. GCC was notified of the incident and reminded of the need to have its health and safety program fully operational.

Work was temporarily shut down on October 7, 2011, to address inconsistent use of decontamination stations. GCC's Site Safety Manager reviewed decontamination procedures with the crew to address proper personal protective equipment within exclusion zones and decontamination of boots and equipment.

On December 15, 2011, a demolition subcontractor tripped over an exposed picking-eye wire on one of the deck panels and extended his hand as he fell. The worker went to the planned medical clinic and was treated for deep tissue bruising and tendon damage to his right palm.

4.2.5 Final Inspections

4.2.5.1 Pre-final Inspection

On January 24, 2012, GCC provided a punch list to the City listing those items which did not yet conform to the drawings and specifications. The punch list also included estimated dates for when the work would be complete. This information was provided in accordance with Section 01 45 00, paragraph 3.04.A of the contract specifications.

A pre-final inspection was held on January 31, 2012. An owner pre-final punch list was generated based on the findings of the pre-final inspection and issued to GCC on February 2, 2012. The construction quality control representative and owner punch lists are provided in Appendix D, Attachment I.

4.2.5.2 Final Inspection

A final inspection was held on February 22, 2012 at 10:30 a.m. With the exception of demobilizing office trailers and sanitary facilities, all physical removal action construction activities had been met.

4.3 DESIGN MODIFICATIONS, EXCEPTIONS, AND DEVIATIONS

The following design modifications, exceptions and deviations were made during the course of construction. Supplemental documentation for these items is located in Appendix D, Attachments G and H.

- Minor material substitutions were accepted for filter material, waterway cap, habitat mix and beach sand based on the City's review of actual gradation data provided from the DuPont site, as noted:
  - Filter material contained 41 percent passing 0.5-in. sieve (vs. specified maximum of 40 percent)
  - Waterway cap contained 42 percent passing 0.5-in. sieve (vs. specified maximum of 40 percent)
  - Habitat mix contained 99 percent passing 1.5-in. sieve (vs. specified maximum of 95 percent)
  - Beach sand contained only 1 percent passing #200 sieve (vs. specified minimum of 10 percent).
- Several unused concrete piles were uncovered lying on the ground surface when vegetation was removed from Removal Area 1. The concrete piles were broken into smaller pieces and transloaded with other bank soil and debris for disposal at Rabanco.
- On October 11, 2011, a 6-inch concrete pipe segment was uncovered to the west of the I-5 outfall. A second, similar concrete pipe was uncovered further up the bank on October 20, 2011. The City directed GCC to plug both pipes in accordance with the contract documents.
- On October 17, 2011, the City directed GCC to grade upland surface soils in the area above the I-5 outfall at the head of the slip, to create a more even surface. The operation did not remove additional soil from the site.
- The timber fender pile to the west of the I-5 outfall was determined to be located within the Removal Area 1 excavation prism between stations 0+30 and 0+40. It was decided, upon authorization from the Washington State Department of Transportation, that the fender pile be removed due to its dilapidated condition.

- Steel sheet piles were discovered in front of the I-5 outfall, preventing dredge/excavation immediately in front of the outfall apron. The limit of dredge/excavation was modified to allow for a 2 ft buffer in front of the sheet piles.
- Isolated low spots that were below the dredge/excavation prism prior to dredging were backfilled with waterway cap material instead of filter material. A 12-in. minimum thick layer of standard filter material, containing GAC, was then placed over the top of the low spot fill, per the design intent.
- Post-dredge scour protection placement took place outside of the 8-hour post-dredge window specified in the contract documents. As no precipitation was forecast for the evening, the City allowed an extension of the 8-hour window and the material was placed during the following day shift.
- During demolition of the pier, five timber piles were discovered beneath the former pier location. The City directed GCC to cut the piles as close to the mudline as possible.
- The City and EPA agreed to waive additional gradation and analytical testing requirements for every 12,000 tons of each material type, as the import material was generated from discrete and consistent sources at the Pioneer Aggregate Quarry in DuPont.
- The City agreed to waive the requirement to chamfer the top and bottom edges of the existing bulkhead concrete cap. Instead of chamfering, GCC installed 6- x 6- x 5/16-in. galvanized angle iron along the top edge.
- Pipe penetrations in the sheet pile wall were not welded shut with metal plates. Instead, the City authorized the use of polyvinyl chloride (Fernco) caps over the ends of the pipes after they were cut back to be nearly flush with the wall.

4.4 LESSONS LEARNED

4.4.1 Community/ Outreach

Approaches that worked well:

- Early outreach with community during initiation and design
- Project staff attendance at community meetings
- Focused presentation on the community's concerns
- Posting information on the EPA website
- Holding a media kick-off event
- Door-to-door delivery of information to neighbors at the start of construction.

Suggestions for improvement:

- None.

4.4.2 Design

Approaches that worked well:

- Design to remove sediment to a defined prism, rather than a particular contamination concentration. This provided certainty in scope, ability to estimate schedule, and avoided downtime awaiting sample results.
- Flexibility with transloading to allow the contractor to propose efficient options
- Consistency of lead designer involvement with the project
- Specification of reasonable tolerances for removal and capping
- Payment was structured by volume of removed material based on comparison of pre- and post-dredge surveys, not by tonnage.

Suggestions for improvement:

- Perform future progress and acceptance bathymetric surveys using multi-beam equipment
- Consider more closely spaced bathymetric survey transects to avoid gaps at transition points
- Provide a design surface DTM of the excavation/dredge prism with the bid package to minimize the need for contractor interpretation.

4.4.3 Contractor Awareness

Approaches that worked well:

- Shut down the work when site safety positions are not adequately staffed or protocols are not being followed.

Suggestions for improvement:

- Review pre-bid site walk notes with the actual construction operations team (rather than the contractor's bidding team)
- Review health and safety protocols with contractor to emphasize Superfund expectations for contaminated materials
- Ensure subcontractors are aware of site contaminants and follow health and safety procedures. This is especially important for work that may occur prior to mobilization and establishment of zones (e.g., pre-construction documentation surveying)

- Ensure exclusion zones encompass full swing radius and operating envelope of equipment used to excavate and handle contaminated materials
- Verify that HAZWOPER and WAC references are up to date
- Clarify expectation that the contractor's safety officer or alternate needs to be on-site whenever work is occurring. The assigned personnel should not have other major roles (e.g., site superintendent).

4.4.4 Staffing/Coordination

Approaches that worked well:

- Full-time site presence by the resident engineer, construction oversight manager, or field supervisor
- Key City, EPA, and consultant design staff well qualified and experienced
- The Contractor's crane and excavator operators were generally very experienced.

Suggestions for improvement:

- Remind contractor that it is in their interest to make sure subcontractors file necessary paperwork with state agencies, because that affects their payment
- Reinforce that the contractor is responsible for collecting required documentations from all subcontractors.

4.4.5 Property and Access Issues

Approaches that worked well:

- Access agreements were negotiated with property owners in a timely manner, well in advance of construction
- A tribal agreement to move fishing nets helped minimize net-related delays and impacts to Tribal fishers.

Suggestions for improvement:

- Include a larger estimate for the cost to displace businesses for several months
- Consider impacts beyond access, as the adjoiner's loss of rail spur usage was a unique and very expensive event.

4.4.6 Construction

Approaches that worked well:

- Lafarge was an excellent site for transloading as it reduced truck traffic and minimized the chance for accidental spills
- The Contractor's dewatering system (a separate barge designed to treat decant water) was helpful in reducing turbidity.
- There was flexibility to change protocols when necessary (e.g., the environmental bucket was unable to function successfully due to debris)
- Change orders were minimal
- Weather was unseasonably mild, which helped the schedule.

Suggestions for improvement:

- Clarify that loads transported by rail do not need to be covered, but they do need to be lined
- Review protocol relating to cracking the dredge bucket to allow excess water to drain
- Develop sampling plan contingencies for grabbing samples over areas covered by coarse gravel, spalls and riprap.

4.4.7 Removal Action Work Plan

Approaches that worked well:

- The City provided an annotated outline, which set the report organization and provided the Contractor with key prompts for details
- The sections provided by the Contractor were written by the construction team, rather than a consultant. Therefore, those overseeing the work were familiar with the contents.
- The importance of the RAWP, its length, and expected number of revisions was reinforced during the bid process and after award.
- EPA staff provided very swift turn around.

Suggestions for improvement:

- Several review and comment cycles are to be expected; additional time between contract award and mobilization would be desirable.

5 INSTITUTIONAL CONTROLS

The action memorandum for Slip 4 includes institutional controls as part of the overall remedy for the Slip 4 EAA (USEPA 2006a). The term "institutional controls" refers to non-engineering measures intended to ensure the protectiveness of the remedy and to affect human activities and ecological receptors by preventing or reducing the potential for exposure to contaminated media (USEPA 2000). Implementation of institutional controls will be required because some hazardous substances remain onsite at levels that do not allow unrestricted use. At Slip 4, institutional controls are intended to augment and not substitute the active response measures. The institutional control implementation plan (ICIP) was provided as Section 10 of the final DAR (Integral 2010a).

The specific objectives of the institutional controls are to:

- Prevent any uncontrolled excavation or construction that may compromise the integrity of the sediment cap, slope caps, or engineered soil covers
- Prevent any current or future land and waterway uses that could compromise the integrity of the sediment cap, slope caps, or engineered soil covers
- Require notification of the state and EPA prior to development actions at the site that may damage the sediment cap, slope caps, or engineered soil covers
- Ensure that these restrictions will run with the land.

Institutional controls will not preclude the Muckleshoot Tribe from exercising treaty-protected fishing activities in the removal action area in the future.

This section presents the current status of implementing specific controls to help ensure the long-term integrity of the remedy. Documentation that these institutional controls have been implemented will be provided in the institutional controls implementation report (ICIR), to be submitted in accordance with the schedule set forth in Section 5.2 of this RACR.

5.1 INSTITUTIONAL CONTROL PROGRESS TO DATE

The institutional controls proposed for implementation at Slip 4 EAA are summarized in Table 5-1 and are presented in detail below. Figure 5-1 illustrates the property boundaries and ownership to which these ICs apply. These institutional controls offer an overall layered approach as well as a succession of applicable time frames.

5.1.1 Governmental Controls

Governmental controls impose restrictions on land use or resource use, using the authority of a government entity. Typical governmental controls include zoning, building codes and ordinances, and state, tribal, or local ground water use regulations. The City is applying for an EPA sponsored U.S. Coast Guard regulated navigation area (RNA) demarcation for the sediment cap in Slip 4. A RNA is a water area within a defined boundary for which regulations for vessels navigating within the area are established under 33 CFR 165. The purpose of the RNA is to protect the integrity of the sediment cap by restricting activities that would disturb the cap surface, such as anchoring, grounding, or spudding.

5.1.2 Proprietary Controls

5.1.2.1 Property Purchase

The City purchased the inner slip from Crowley at a significant cost so that the City can control the use of the inner slip as a fee owner. The City will directly manage land use, conduct and observe monitoring activities, curtail trespassing, and determine whether any additional ICs are appropriate for specific situations that may arise.

The City is currently in negotiation to acquire the affected 0.23-acre area of First South Properties land on the east side of the slip. This is expected to be accomplished with a lot line adjustment to expand the City's parcel, and if completed will put that property under the City's control and negate the need for any ICs to be implemented by First South Properties, the current landowner of the 0.23 acre area.

The affected portion of the Boeing parcel is expected to be retained by Boeing.

5.1.2.2 Restrictive Covenants

Slip 4 is comprised of three separately owned parcels: (1) the bed of Slip 4 is owned by the City (purchased from Crowley in 2007); (2) a small parcel on south shoreline of Slip 4 is owned by First South, Inc.; and (3) a small parcel on the southwest shoreline of Slip 4 is owned by the Boeing Company. The City will grant a Model Toxics Control Act (MTCA) restrictive covenant in accordance with the Uniform Environmental Covenants Act (UECA), with Ecology named as the grantee, and EPA being a beneficiary with full enforcement rights for City-owned property at Slip 4. The purpose of UECA is to ensure that the remedies and ICs established for a site are legally valid and enforceable and will be effective over the life of the cleanup (RCW 64.70.005). The environmental covenant under UECA is intended to restrict the property to uses consistent with remedies carried out and habitat areas created on the site and to attach those restrictions to the property in perpetuity (or until terminated, pursuant to UECA). The environmental covenant under UECA will run with the land through transfers of property rights. The

covenant will also provide that the City shall notify Ecology and EPA of any proposed changes in ownership interests in the subject property.

EPA and Ecology will be given the opportunity to review and comment on the restrictive covenants and their attachments (e.g., land parcels, metes and bounds, drawings). The City expects that similar MTCA restrictive covenants will also be executed and recorded for the other two parcels at Slip 4. However, as described above, the City is expecting to acquire the affected First South Properties area. The City's restrictive covenants would then address that area.

Specifically, the restrictive covenants will prevent the property owners from conducting any uncontrolled activity that may result in the release of or exposure to the contamination contained by the cap or soil cover. Specific prohibited activities will include, but not be limited to (a) altering, modifying or removing the cap or cover without appropriate controls and approvals; (b) removing or installing piling; (c) dredging or excavating in the cap or cover area; (d) allowing anchorage in the cap area; and (e) grounding vessels within the cap area.

In addition to restrictions to protect the cap and cover, the covenant will also include the following provisions:

A. Owner(s) must give advance written notice to EPA and Ecology of any pending sale of the property, and notify the prospective owner of the covenant requirements, and the prospective owner's obligation to comply with the covenant;

B. Owner(s) must notify EPA and Ecology of any use of the property inconsistent with the terms of the covenants, with the understanding that providing such notice does not in any way relieve anyone from the obligation to fully comply with the covenant;

C. The covenant(s) shall grant to EPA, Ecology and the City, the right to enter the property at reasonable times to inspect, perform operations and maintenance activities, and collect samples to evaluate the effectiveness of the remedies and compliance with the covenant(s);

D. Owner(s) must restrict leases of the property to uses consistent with the covenant requirements, and must notify all lessees of the restrictions on use of the property. A copy of the restrictive covenant must be included in any lease, deed, license, easement, permit or other use authorization;

E. Owner(s) must record the restrictive covenant and deed notice with the King County Recorder's Office within 10 days of the execution of the covenant.

Restrictive covenants must be recorded according to state statute. They must be approved by the environmental agency that approved of the environmental response action (i.e., EPA), and

must identify the location of the administrative record for the environmental response action. The covenants must contain a legally sufficient description of the property affected by the restrictions, and a right of access to property granted in connection with implementation of or enforcement of a covenant.

Restrictive covenants will be established through mutual agreement between the City and the other parcel owners. The City is currently engaged in negotiations with First South, Inc. and the Boeing Company in an effort to secure restrictive covenants on their respective properties. If agreement is not reached with either party, the City and County will confer with EPA regarding alternative approaches, such as EPA enforcement orders, exercise of eminent domain, or litigation.

The respective owners will be responsible for drafting, signing and recording the restrictive covenant and deed notice for their respective property, as well as enforcing the covenants independent of EPA and Ecology's enforcement rights or authority. All restrictive covenants will be entered into the environmental covenant registry within Ecology's integrated site information system (ISIS).

5.1.3 Agency Enforcement Tools and Administrative Orders

EPA and Ecology have statutory enforcement authority under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) and MTCA, respectively, to protect human health and the environment (e.g., protect the remedial cap) that can be used in lieu of, or in addition to, other ICs. Such authority can be exercised to access, inspect, monitor and sample to ensure protection of the removal action, or for any other authorized purpose.

The Slip 4 removal action was conducted under an ASAOC, which requires long-term monitoring to be implemented by the City. EPA will review the effectiveness of the remedy, including monitoring results and IC implementation, no less frequently than every five years, as required by CERCLA. This review process is a significant IC component.

5.1.4 Informational Devices

5.1.4.1 Deed Notices

The City will file and record a Deed Notice in the King County Recorder's Office, and file a copy with the Seattle Department of Planning and Development. The Deed Notice will describe the restriction on the property to protect the cap and will remain in effect until EPA or Ecology states in writing that a change in site condition(s) warrant revocation of the Deed Notice. The Deed Notice and the Restrictive Covenant may be incorporated into a single document to be

recorded with King County and filed with the Seattle Department of Planning and Development.

It is anticipated that the other property owners (First South, Inc. and the Boeing Company) will also file and record a Deed Notice with the King County Recorder's Office and file a copy with the Seattle Department of Planning and Development (refer to Section 5.1.2.2, item E).

5.1.4.2 State Registry

Three mechanisms managed by Ecology compile contaminated site information related to Slip 4 and the LDW in a central database that is available for public research. The first is the Hazardous Sites list that provides a current status of cleanup plans. The second is the Site Registry, which is a semi-monthly publication that provides notices of enforcement activity, releases, public meetings, public comment periods, hearings and any other information related to the Slip 4 removal action. The third is the ISIS database, which contains information on state cleanup sites and an environmental covenant registry. These registries will provide easily accessible resources to provide current information about Slip 4 until a No Further Action notice is issued by Ecology.

5.1.4.3 Fish Consumption Advisories

The remediation of the LDW Superfund Site will likely include fish consumption advisories to reduce human health risks associated with consumption of seafood from the LDW. There is currently a Washington State Department of Health public fish advisory recommending no consumption of resident fish (i.e. shiner perch, rockfish, English sole), shellfish or clams from the LDW due to chemical contamination. Non-resident fish such as salmon are not included in the advisory.

Fish consumption advisories are an IC subject to informed voluntary compliance by the public. The advisory referenced currently applies to the Slip 4 EAA, and is anticipated to remain in effect until completion of the LDW remedial action. Monitoring and maintenance of this advisory are outside the scope of the Slip 4 removal action and are being addressed in the larger LDW remedial investigation and feasibility study decision-making process.

5.2 INSTITUTIONAL CONTROLS SCHEDULE

Fish consumption advisories are already established. The remaining institutional controls require implementation that will be documented in the ICIR. The ICIR will document complete implementation of the ICIP, including copies of all relevant paperwork (i.e., permit application forms, easements, covenants, deed notices, state registries, and public advisories). This report will be submitted to EPA and Ecology under requirements of the ASAOC for removal action for the Slip 4 EAA.

The proposed schedule is as follows:

- Agreement with Boeing on restrictive covenants requirements: Aug 2012
- Draft restrictive covenant language to EPA and Ecology: Sept 2012
- Draft regulated navigation area application to EPA and Coast Guard: Sept 2012
- Complete First South Properties lot line adjustment: Dec 2012
- File covenants: Feb 2013
- File and record deed notice: Feb 2013
- Record covenants in ISIS database: March 2013
- Draft ICIR: April 2013
- Final ICIR: within 30 days of EPA comments on Draft ICIR

6 LONG-TERM MONITORING AND REPORTING

Long-term monitoring and reporting will be performed to ensure that the site remains protective of human health and the environment. The City will prepare an LTMRP for the removal action and submit it to EPA for review no later than 60 days following approval of the final RACR. The goal of the LTMRP will be to monitor the long-term effectiveness of the remedy. The LTMRP will describe the required monitoring activities, including inspections and analyses, and associated schedules; the responsible party for performing each activity; the specific reporting requirements, and the process to be followed for addressing any contingency or corrective actions.

The LTMRP will include monitoring objectives, an overview of the monitoring approach, design of the monitoring program (e.g., sampling strategy, station locations and replication, field sampling methods, laboratory methods), data analysis and interpretation, reporting requirements, and a schedule. The plan will include, as appropriate, visual inspections, bathymetric surveys, sediment deposition monitoring, chemical monitoring, and sediment sampling in capped and non-capped areas (including excavated areas) to monitor for recontamination.

The LTMRP will also include a description of monitoring of institutional controls to ensure that all requirements remain in place and that the ICIP continues to work effectively. The plan will include notification requirements to EPA when an institutional control fails or a land use restriction is violated, and provisions shall be included that describe what actions should be taken in the event of a failure or violation, and what entity should be responsible for addressing the problem.

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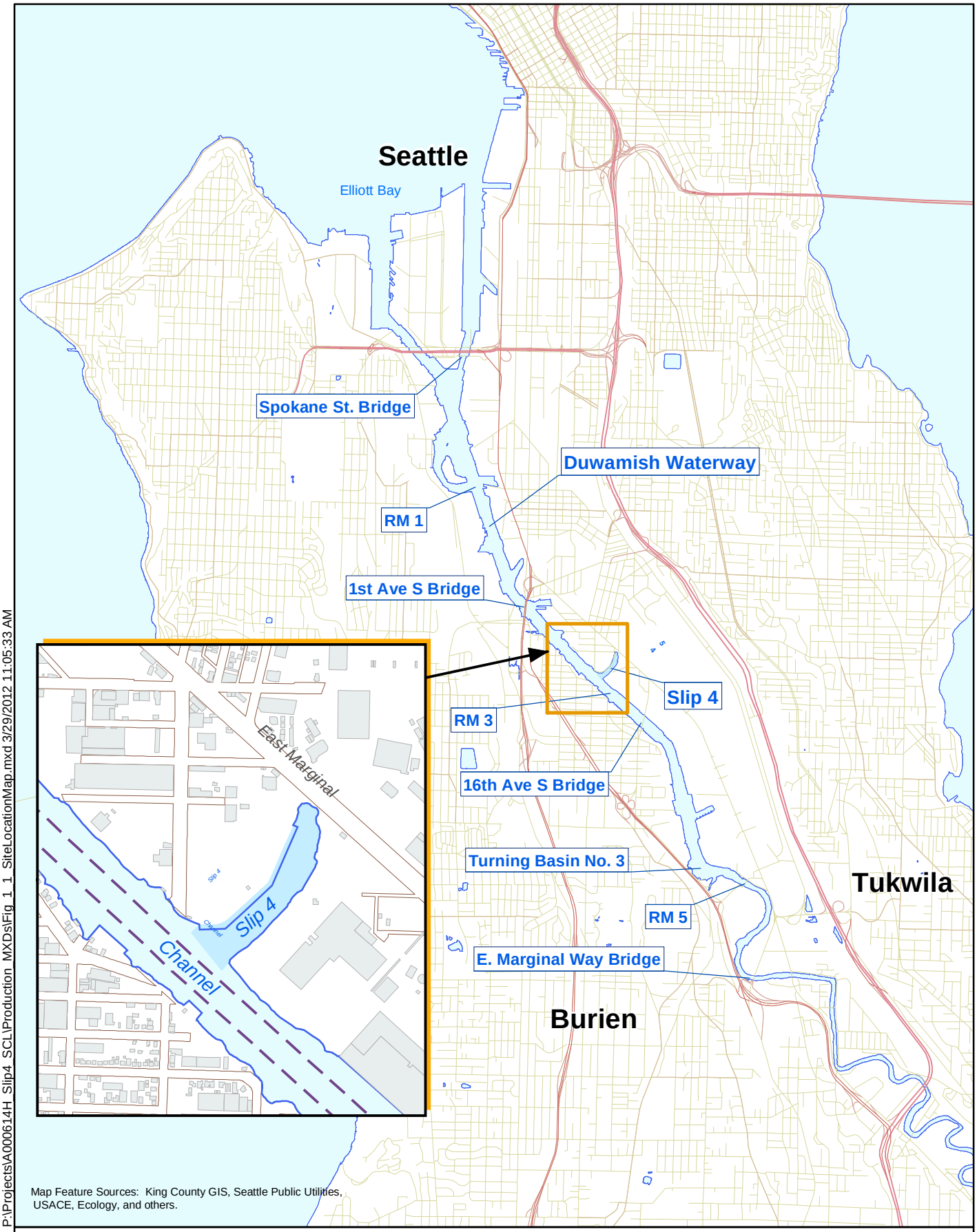
USEPA. 2006a. Action Memorandum for a Non-Time-Critical Removal Action at the Slip 4 Early Action Area of the Lower Duwamish Waterway Superfund Site, Seattle, Washington. U.S. Environmental Protection Agency, Region 10, Seattle, WA. May 3.

USEPA. 2006b. Administrative Settlement Agreement and Order on Consent for Removal Action, Lower Duwamish Waterway Superfund, Slip 4 Early Action Area, Seattle, Washington. U.S. Environmental Protection Agency, Region 10, Seattle, WA. September 28.

FIGURES



P:\Projects\A000614H_Slip4_SCL\Production_MXDs\Fig_1_1_SiteLocationMap.mxd 3/29/2012 11:05:33 AM

integral consulting inc.

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Miles

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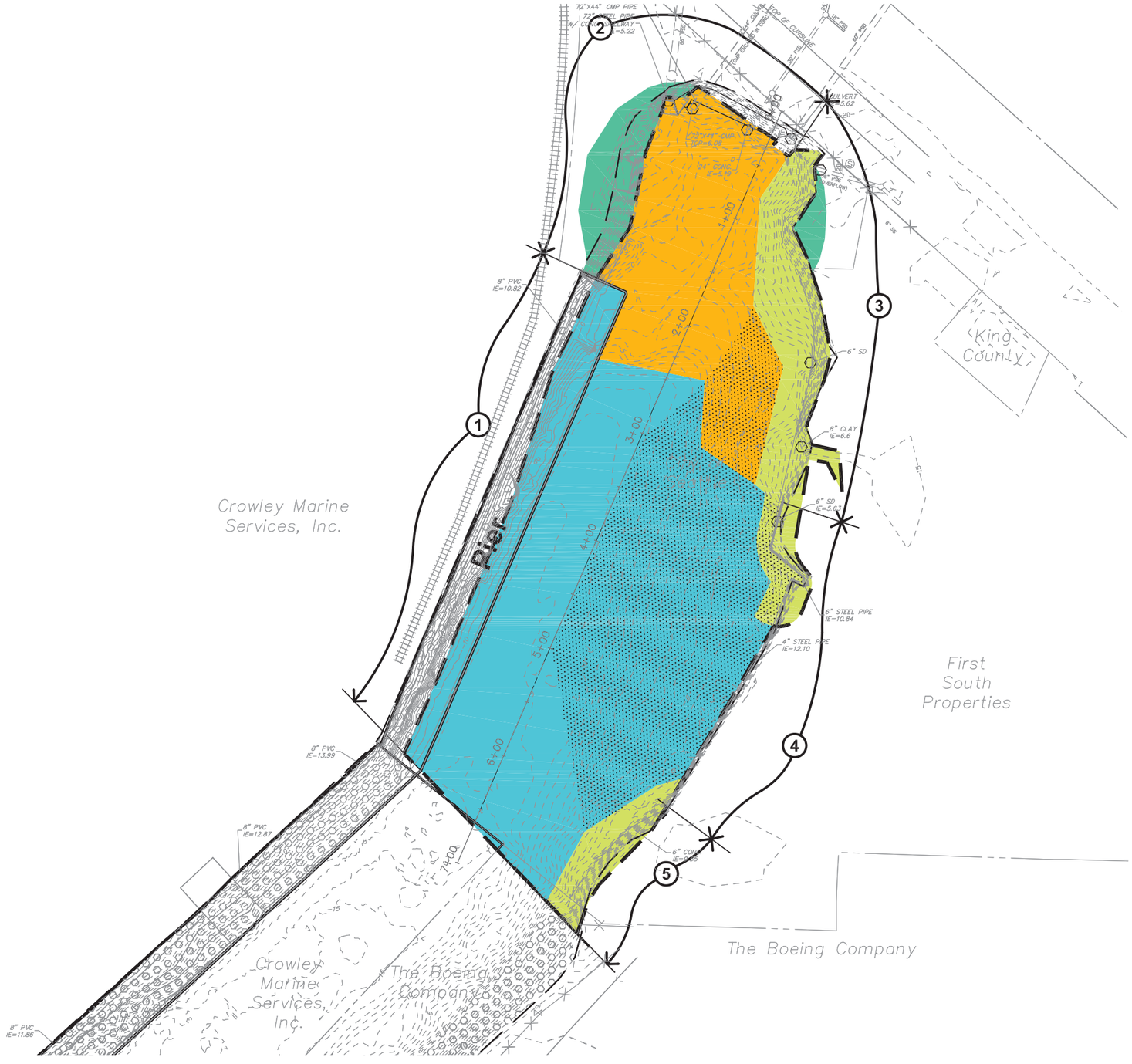
Figure 1-1.
Vicinity Map
Slip 4 Removal Design



LEGEND

- MAJOR OUTFALL
- POWER POLE
- SANITARY MANHOLE
- LUMINARE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- 19.41WALL — SPOT ELEVATION
- 5–FOOT CONTOUR INTERVAL
- 1–FOOT CONTOUR INTERVAL
- TOP OF BANK
- REMOVAL BOUNDARY
- APPROXIMATE PROPERTY LINE
- 1+00 — PROJECT BASELINE
- 4 — SHORELINE ZONE

- DREDGE 3–6 FEET. CAP TO GRADE WITH EROSION PROTECTION
- BANK EXCAVATION AND SLOPE CAP
- SAND/GRAVEL CAP
- HABITAT CREATION: FILL REMOVAL AND SLOPE COVER / SLOPE CAP
- HABITAT ENHANCEMENT: CAP THICKENED TO OPTIMIZE INTERTIDAL HABITAT

Note:
Drawing source: Lower Duwamish Waterway, Slip 4 Early Action Area, 100% Design Submittal, Design Analysis Report, Figure 1-6, Integral 2010.

The features shown reflect existing conditions and proposed improvements, prior to Removal Action construction. Please refer to As-built Drawings in Removal Action Completion Report, Appendix D, Attachment K for constructed conditions.

N

NAD 83/91 WSPC NZ

0 50 100 Feet

integral consulting inc.

Figure 1-2.
Summary of the Selected Alternative
Slip 4 Removal Action

Map Document: (Figure 1-3_Removal Areas.dwg) - Layout: Fig. 1-3 Removal Areas
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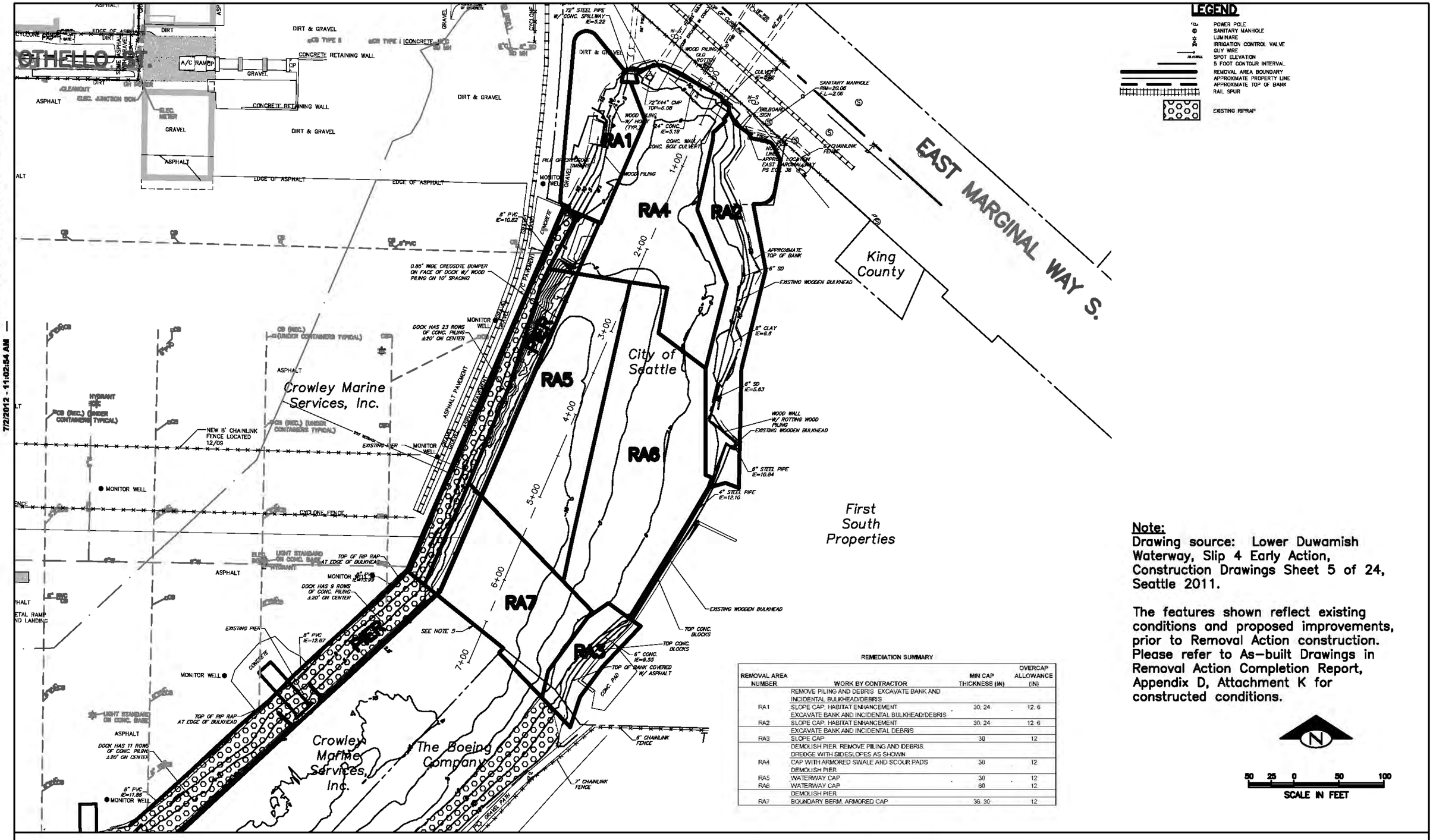

REMEDIATION SUMMARY

REMOVAL AREA NUMBER	WORK BY CONTRACTOR	MIN CAP THICKNESS (IN)	OVERCAP ALLOWANCE (IN)
	REMOVE PILING AND DEBRIS. EXCAVATE BANK AND INCIDENTAL BULKHEAD/DEBRIS.		
RA1	SLOPE CAP, HABITAT ENHANCEMENT. EXCAVATE BANK AND INCIDENTAL BULKHEAD/DEBRIS	30, 24	12, 6
RA2	SLOPE CAP, HABITAT ENHANCEMENT.	30, 24	12, 6
	EXCAVATE BANK AND INCIDENTAL DEBRIS.		
RA3	SLOPE CAP	30	12
	DEMOLISH PIER. REMOVE PILING AND DEBRIS. DREDGE WITH SIDESLOPES AS SHOWN		
RA4	CAP WITH ARMORED SWALE AND SCOUR PADS. DEMOLISH PIER.	30	12
RA5	WATERWAY CAP	30	12
RA6	WATERWAY CAP	60	12
	DEMOLISH PIER.		
RA7	BOUNDARY BERM, ARMORED CAP	36, 30	12

Note:
Drawing source: Lower Duwamish Waterway, Slip 4 Early Action, Construction Drawings Sheet 5 of 24, Seattle 2011.

The features shown reflect existing conditions and proposed improvements, prior to Removal Action construction. Please refer to As-built Drawings in Removal Action Completion Report, Appendix D, Attachment K for constructed conditions.

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Figure 1-3.
Removal Areas
Slip 4 Removal Action

Map Document: (Figure 3-1_Cap Material Locations.dwg) - Layout: Figure 3-1_Cap Material Locations
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S. OTHELLO ST.

HABITAT ENHANCEMENT AREA

SLOPE IMPROVEMENTS

OUTFALL SCOUR PROTECTION (TYP)

HABITAT ENHANCEMENT AREA

EAST MARGINAL WAY S.

RA1

SLOPE CAP & SOIL COVER 24–33 INCHES THICK

RA4

RA2

WATERWAY CAP 30–54 INCHES THICK

SLOPE CAP & SOIL COVER 24–33 INCHES THICK

King County

RA5

WATERWAY CAP 30 INCHES THICK

City of Seattle

RA6

WATERWAY CAP 60 INCHES THICK

Crowley Marine Services, Inc.

First South Properties

RA7

WATERWAY CAP 30–36 INCHES THICK

BOUNDARY BERM

RA3

SLOPE CAP 30–33 INCHES THICK

BOUNDARY AREA PLACEMENT 9 INCHES THICK

Crowley Marine Services, Inc.

The Boeing Company

The Boeing Company

LEGEND

- EXISTING RIPRAP
- OUTFALL AREA CAP – OUTFALL SCOUR PROTECTION MATERIAL
- SLOPE CAP W/ HABITAT MIX
- WATERWAY CAP – ARMORED
- WATERWAY CAP
- OUTFALL AREA CAP – ARMORED
- OUTFALL AREA CAP – UNARMORED
- BOUNDARY BERM CAP – ARMORED
- CAP ARMOR W/HABITAT MIX
- WATERWAY CAP MATERIAL W/ BEACH SAND
- SLOPE CAP ARMOR W/ BEACH SAND
- BOUNDARY AREA MATERIAL (NON-CAP)

Note:
Original drawing source: Lower Duwamish Waterway, Slip 4 Early Action, Construction Drawings Sheet 16 of 24, Seattle 2011.

Refer to As–built Drawings in Removal Action Completion Report, Appendix D, Attachment K for further details on constructed conditions.

Refer to Final Capping Acceptance Survey in Removal Action Completion Report, Appendix D, Attachment J3 for additional information on cap thickness.

N

50 25 0 50 100
SCALE IN FEET

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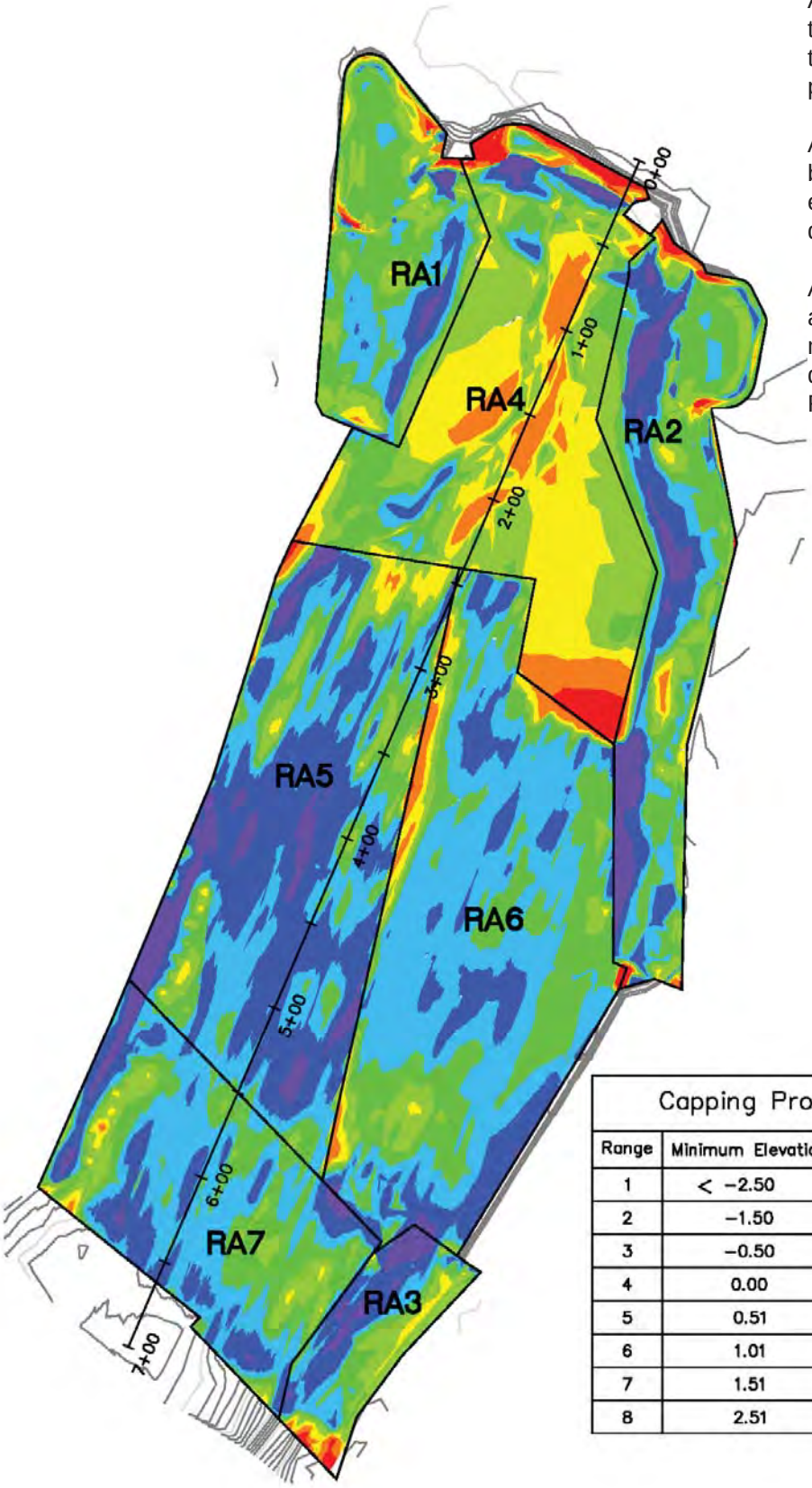
Figure 3–1.
Sediment Cap and Soil Cover Material Locations
Slip 4 Removal Action



NOTES:
Areas depicted in green are within the tolerance between minimum cap thickness and 1-foot allowable over-placement.

Areas depicted in light blue, dark blue, and purple have thicknesses in excess of the 1-foot allowable pay quantity for over-placement.

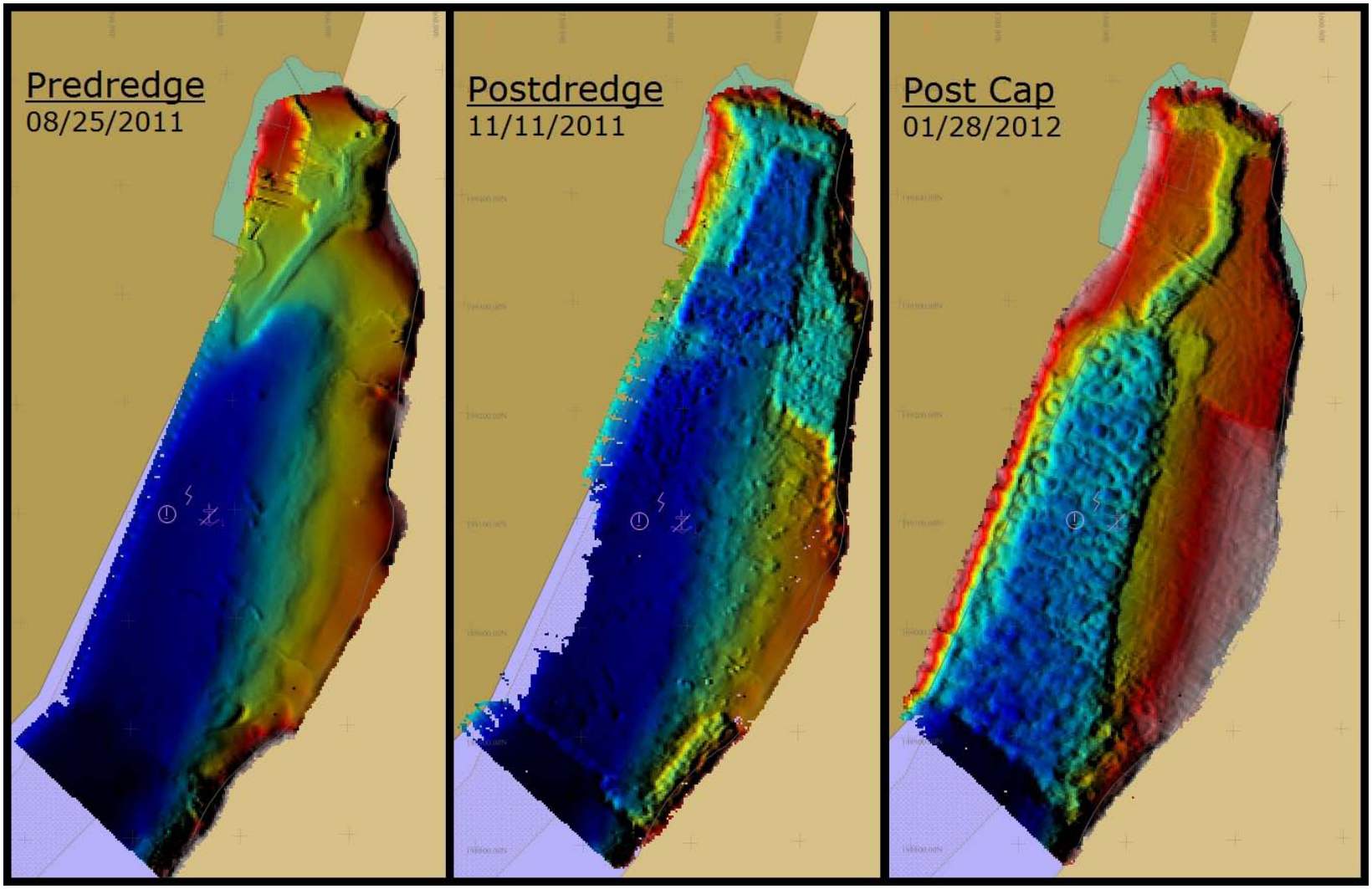
Areas depicted in yellow, orange, and red have thicknesses less than minimum design. These areas are described in Section 3.15 of the Removal Action Completion Report.

Capping Progress vs. Target Surface

Range	Minimum Elevation	Maximum Elevation	Square Feet	Color
1	< −2.50	−1.51	1388	
2	−1.50	−0.51	6032	
3	−0.50	−0.01	13588	
4	0.00	0.50	22865	
5	0.51	1.00	35201	
6	1.01	1.50	40174	
7	1.51	2.50	28818	
8	2.51	> 3.50	4654	

integral consulting inc.

Figure 3-2.
Cap Acceptance Survey Analysis
Slip 4 Removal Action



integral consulting

Figure 4-1.
Independent Survey Digital Terrain Models
Slip 4 Removal Action

Map Document: (Figure 5-1_Property Boundaries and Ownership.dwg) - Layout: Fig. 5-1 Property Boundaries and Ownership
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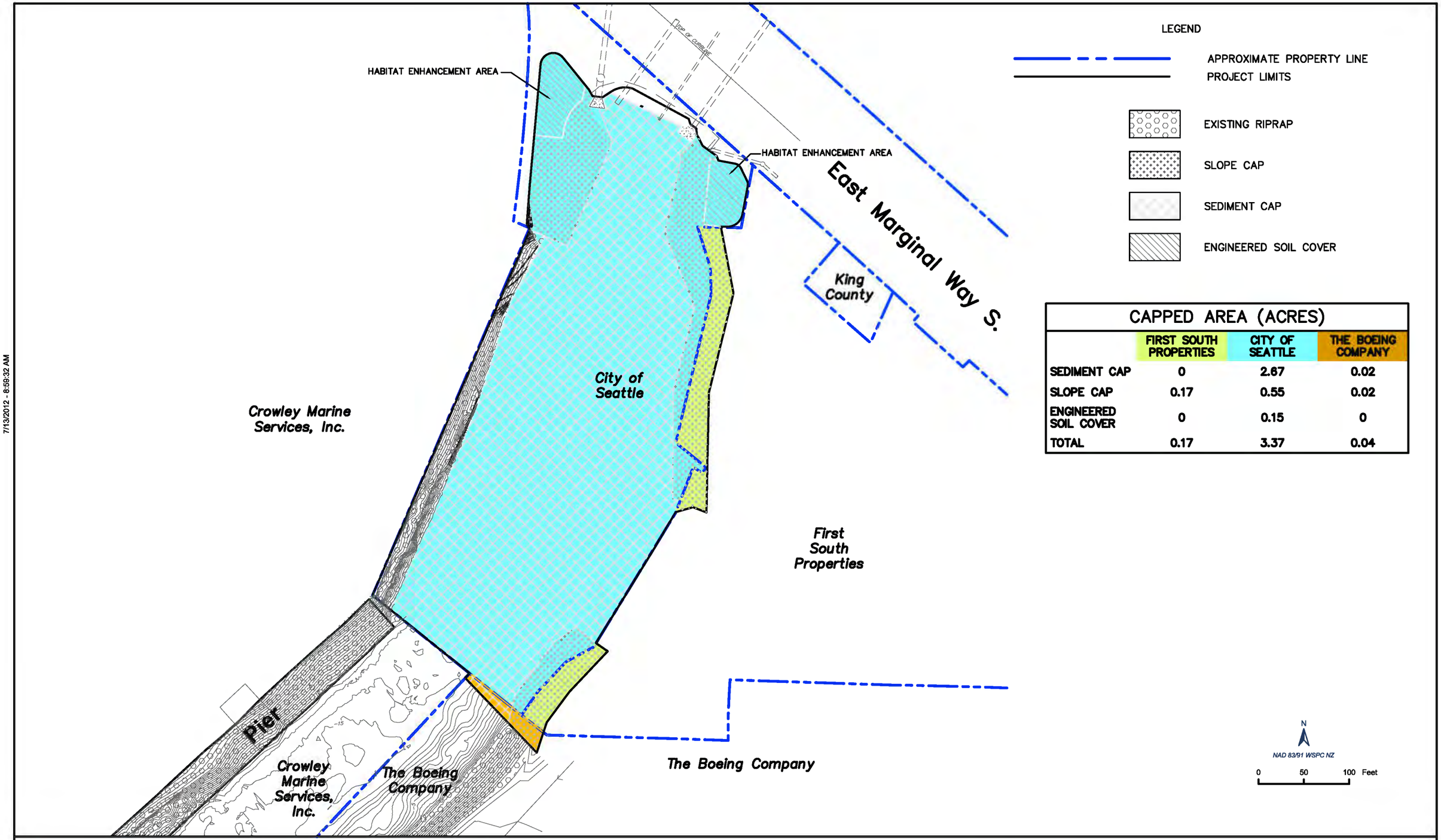


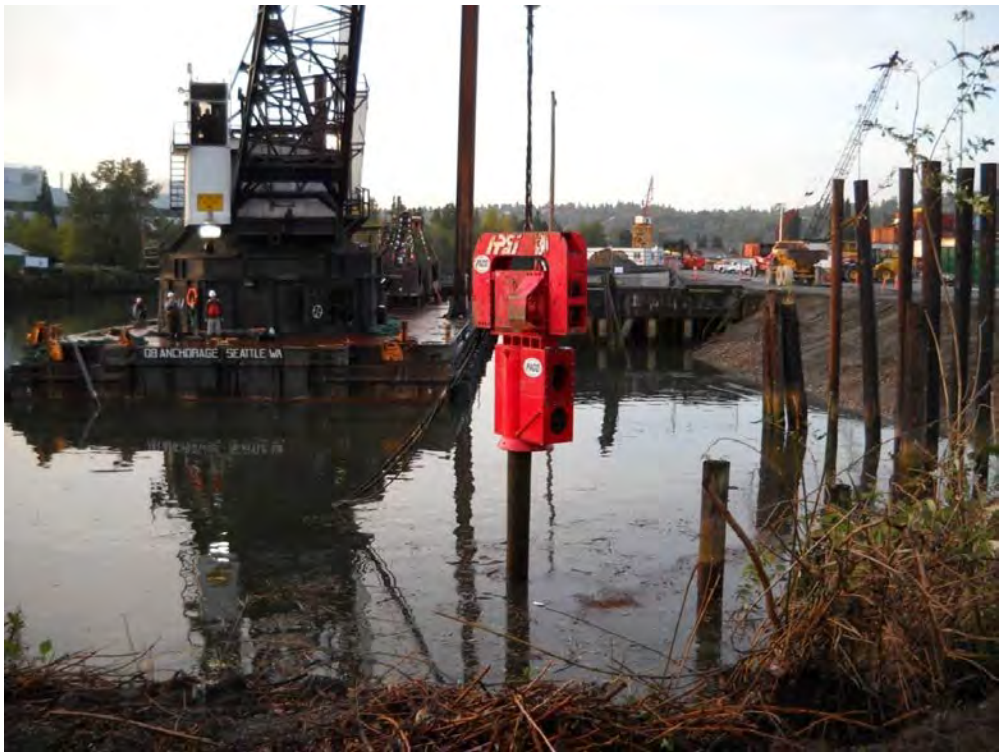
CAPPED AREA (ACRES)			
	FIRST SOUTH PROPERTIES	CITY OF SEATTLE	THE BOEING COMPANY
SEDIMENT CAP	0	2.67	0.02
SLOPE CAP	0.17	0.55	0.02
ENGINEERED SOIL COVER	0	0.15	0
TOTAL	0.17	3.37	0.04

integral consulting inc.

Figure 5-1.
Property Boundaries and Ownership
Slip 4 Removal Design

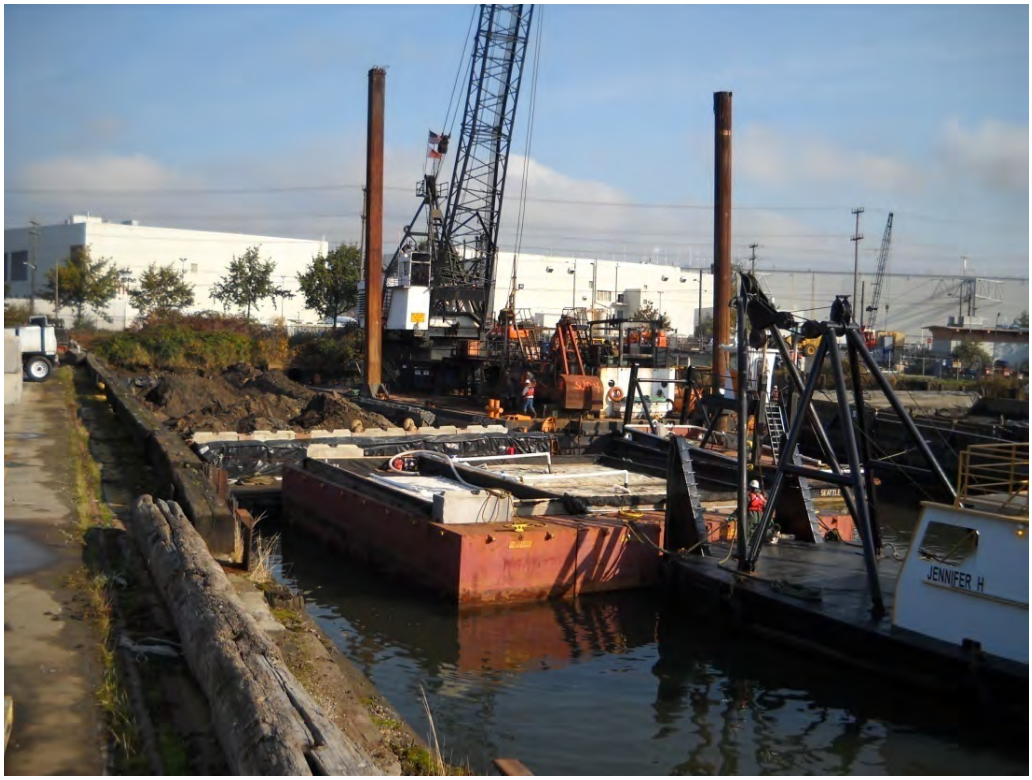
PHOTOGRAPHS

Photograph 3-1. Placement of Boundary Berm with “Bombay Box” (October 3, 2011)



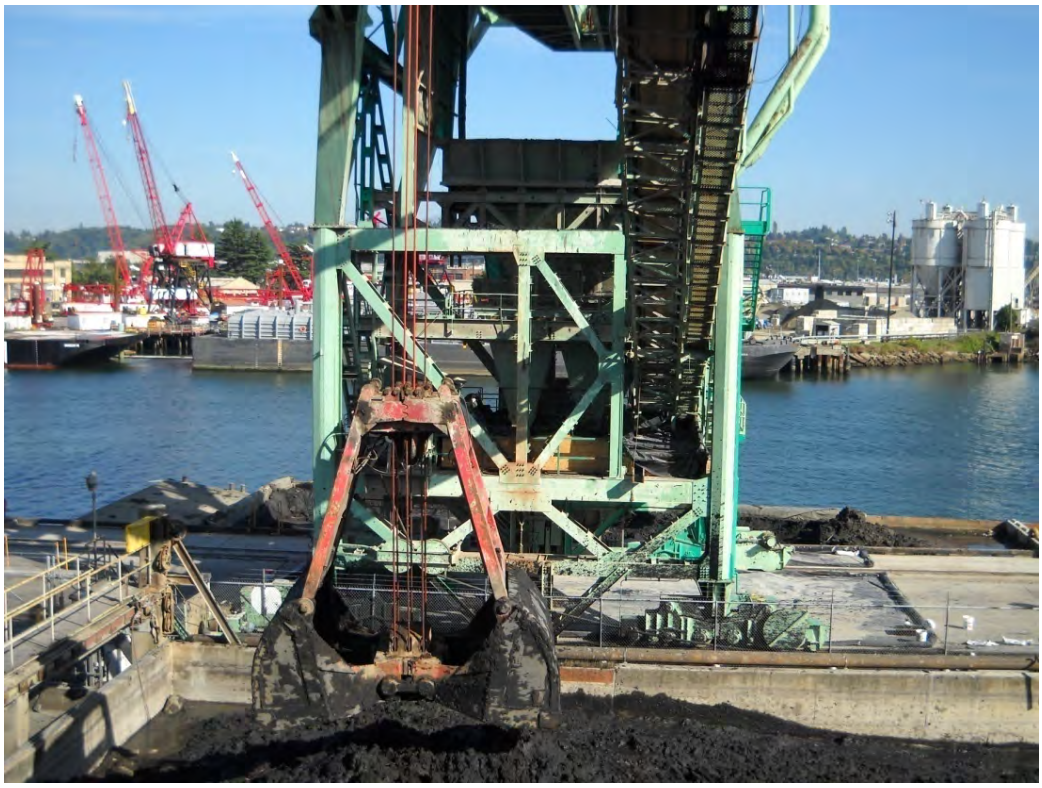
Photograph 3-2. Pile Removal with Vibratory Hammer (October 12, 2011)

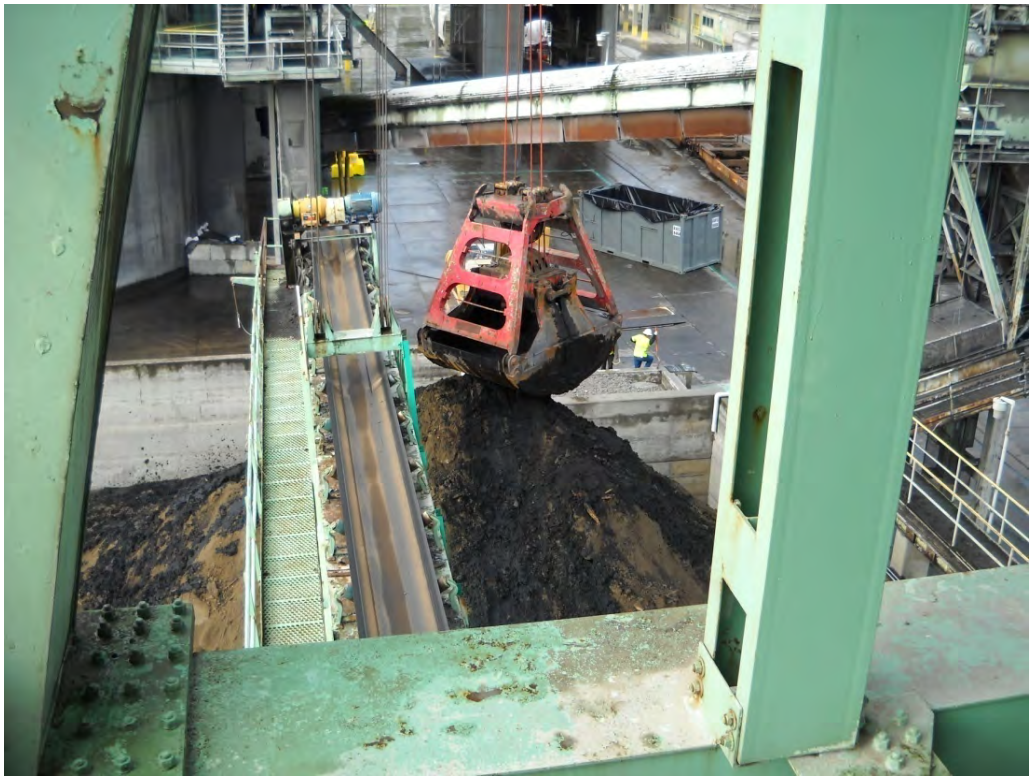
Photograph 3-3. Dredging of Sediment (November 10, 2011)



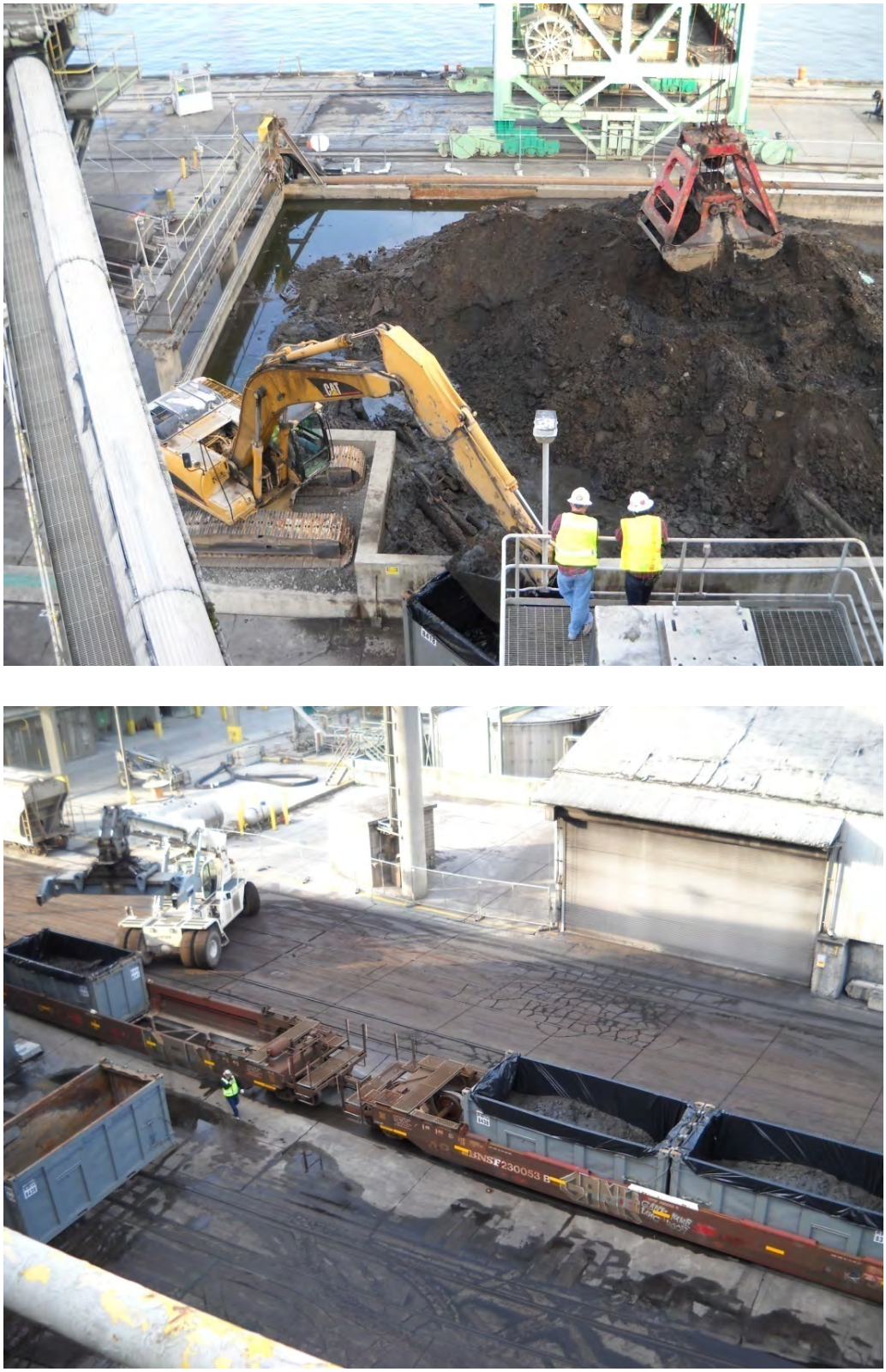
Photograph 3-4. Barge Dewatering (*top*: October 12, 2011; *bottom*: October 27, 2011)

Photograph 3-5. Bank Excavation (October 5, 2011)

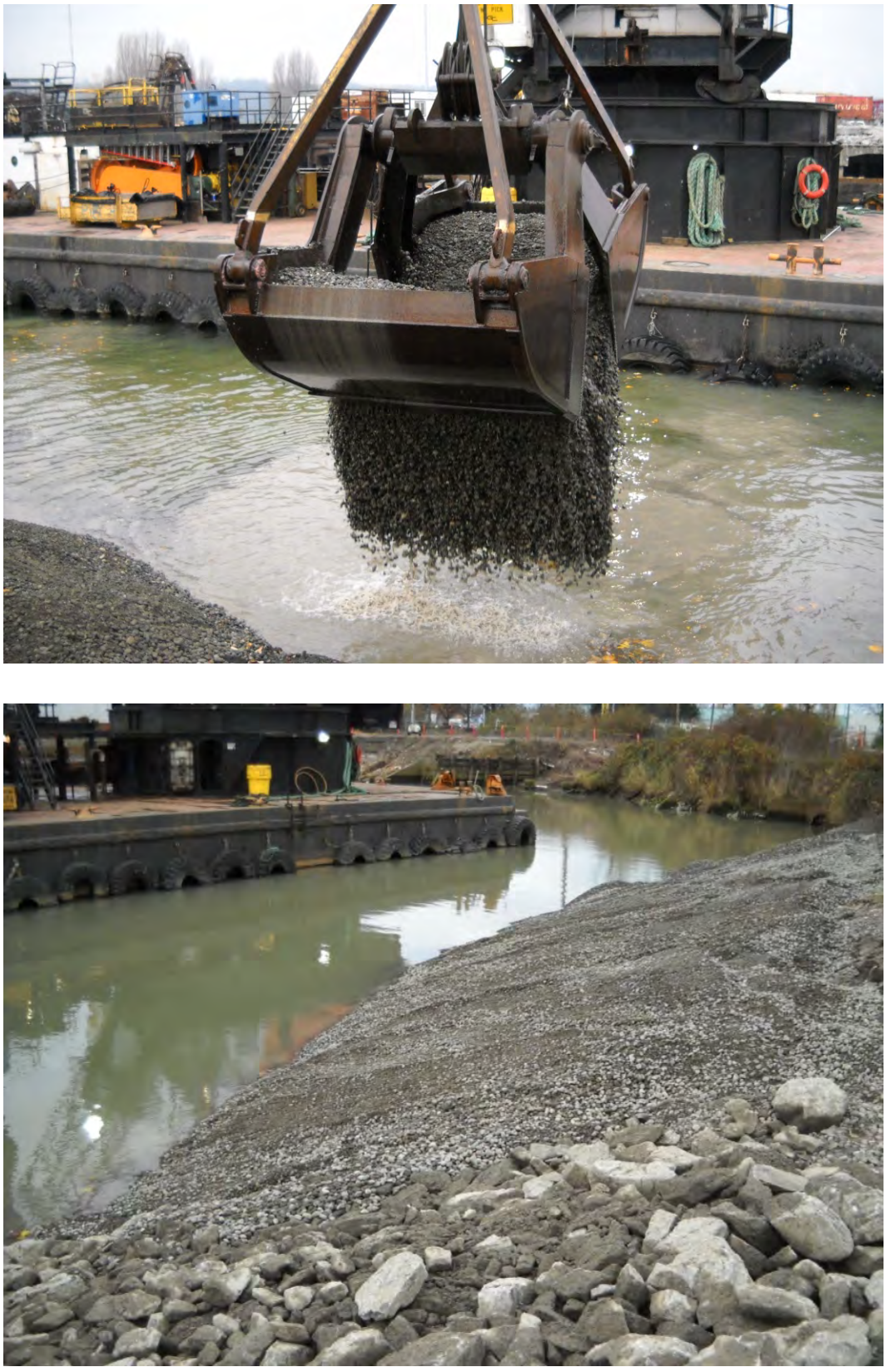




Photograph 3-6. Transloading from Barge to Vault (*top*: October 17, 2011; *bottom*: October 7, 2011)



Photograph 3-7. Transloading from Vault to Containers (November 9, 2011)



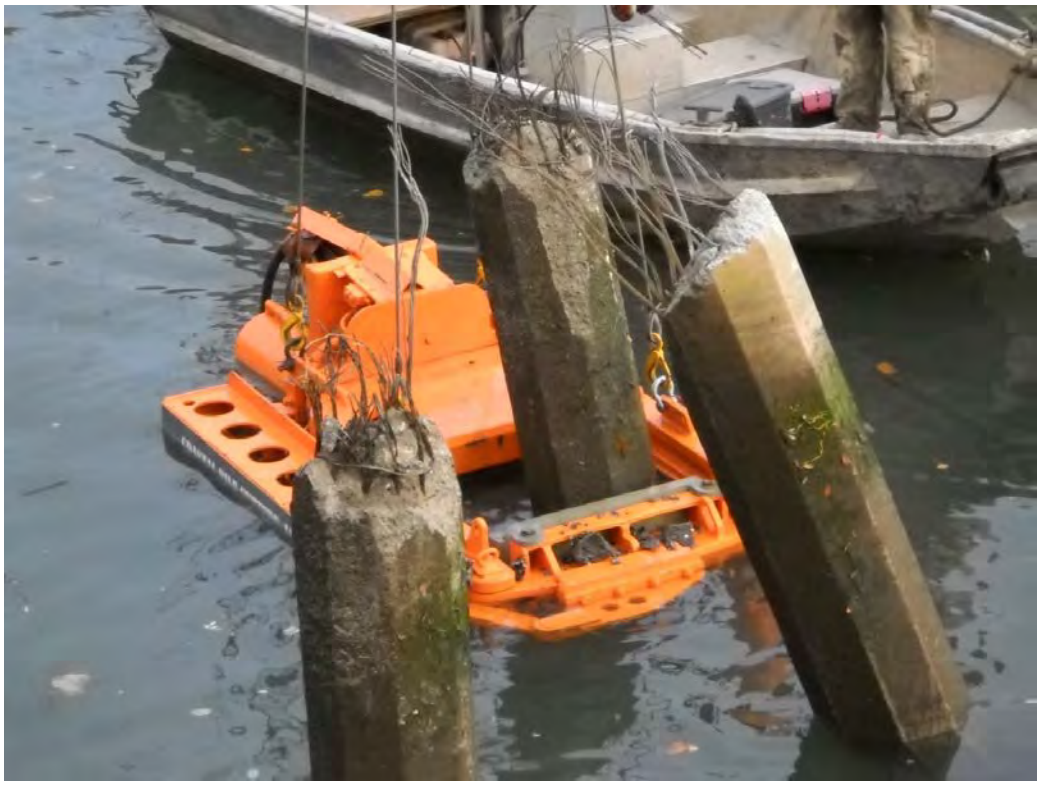
Photograph 3-8. Bank Capping—Filter Material (*top*: December 6, 2011; *bottom*: December 8, 2011)

Photograph 3-9. Bank Capping—Cap Armor (December 8, 2011)

Photograph 3-10. Bank Capping—Habitat Enhancement (*top*: December 9, 2011; *bottom:* January 4, 2012)

Photograph 3-11. Outfall Area Capping (December 22, 2011)

Photograph 3-12. Pier Demolition (*top*: December 7, 2011; *bottom:* December 5, 2012)



Photograph 3-13. Pier Demolition—Pile Cutting with Shear (December 16, 2011)

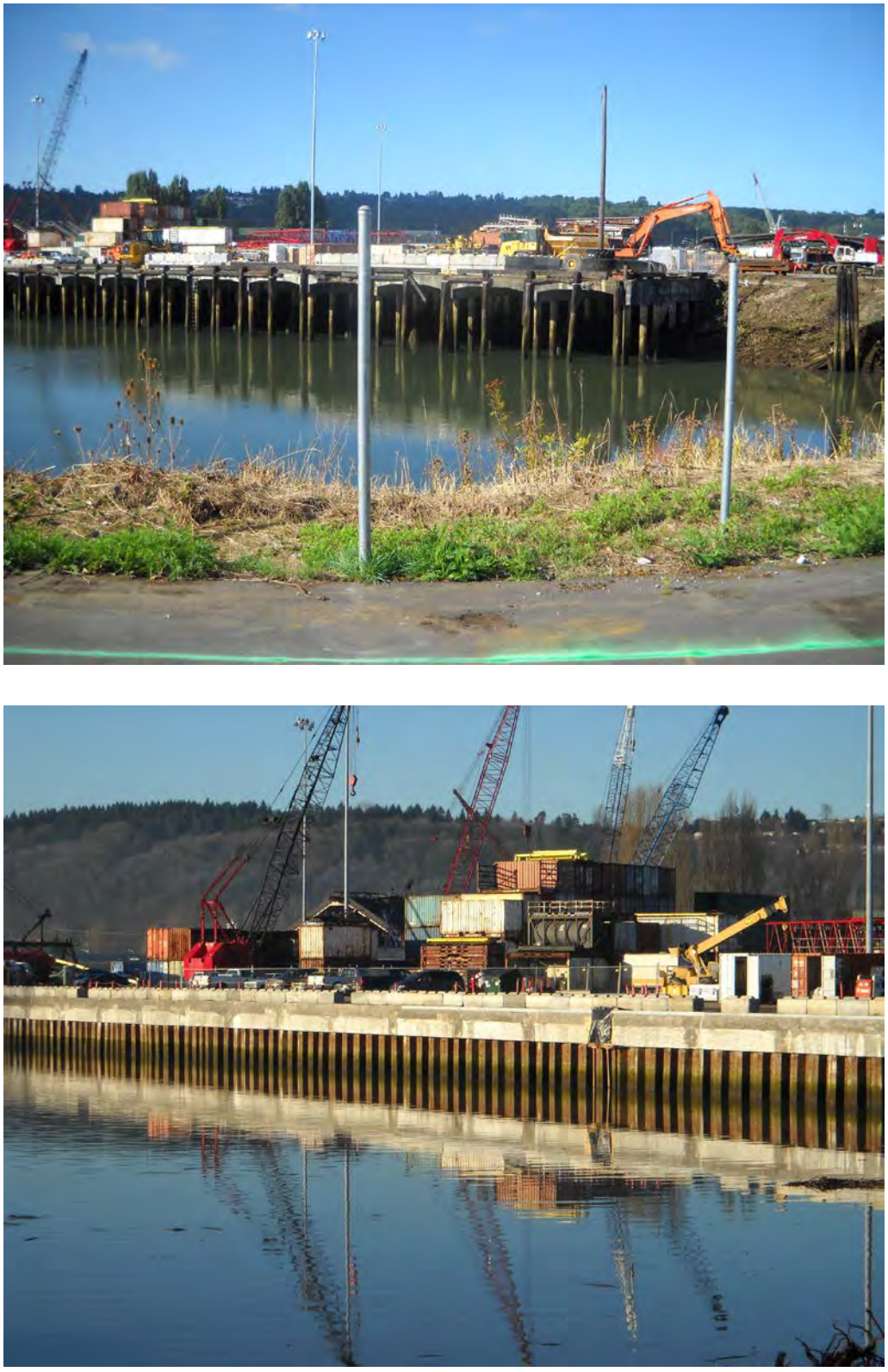
Photograph 3-14. Waterway Capping (*top*: January 10, 2012; *bottom:* February 13, 2012)

Photograph 3-15. Waterway Capping (January 27, 2012)

Photograph 3-16. Boundary Area Material Placement (February 7, 2012)

Photograph 3-17. Before and After (*top*: October 3, 2011; *bottom*: January 27, 2012)

Photograph 3-18 Before and After (*top*: September 28, 2011; *bottom*: January 27, 2012)



Photograph 3-19. Before and After (*top*: September 28, 2011; *bottom*: February 3, 2012)

Photograph 3-20. Before and After (*top*: September 28, 2011; *bottom*: January 13, 2012)

TABLES

Table 1-1. Elements of the Removal Action Completion Report Required by the Statement of Work

Elements Required by Statement of Work	Corresponding Removal Action Completion Report Section
• Description of the work described in the removal action work plan	Section 3
• Description of the work that was actually performed	Section 3
• Professional engineer's certification	p. *xv*
• Sealed and signed record drawings	Appendix D, Attachment J4
• Good faith estimate of total cost / statement of actual costs	Appendix C
• Quantities and types of material removed offsite or handled on site	Section 4.2.1.1
- Ultimate destinations of materials	Section 4.2.1.4
- Analytical results of sampling and testing	Appendix D, Attachment D1
- Supporting documentation (e.g., manifests, invoices)	Appendix D, Attachments D4, D5, and D6
• Water quality monitoring report	Appendix B
• Continuing obligations	
- Post-removal site controls	Section 5
- Monitoring	Section 6
- Schedule for continuing obligations	To be submitted with long-term monitoring and reporting plan
• Description of institutional controls to date	Section 5.1
- Implementing documentation	To be submitted with institutional control implementation report
• Schedule for completion of outstanding tasks in the institutional control implementation plan	Section 5.2
• Proposed submittal dates for draft and final institutional control implementation reports	Section 5.2
• Report certification	p. *xv*

Table 1-2. Project Documents

Document Title	Date
Action Memorandum for a Non-Time-Critical Removal Action	May 3, 2006
Administrative Settlement Agreement and Order on Consent	September 28, 2006
Biological Assessment	February 9, 2007
Removal Design	August 30, 2010
• Volume I: Design Analysis Report	August 30, 2010
• Volume II: Construction Quality Assurance Plan and Water Quality Monitoring Plan	August 30, 2010
– Sampling and Analysis Plan (SAP)	August 30, 2010
– SAP Addendum No. 1	August 18, 2011
– Quality Assurance Project Plan	August 30, 2010
– Health and Safety Plan (Integral)	August 22, 2011
• Volume III: Technical Specifications	August 30, 2010
• Technical Drawings	August 30, 2010
401 Water Quality Certification	May 23, 2011
Removal Action Work Plan (RAWP)	October 19, 2011
• Dredge Material Handling Plan (Lafarge)	October 19, 2011[a]
• Field Sampling Plan (Greylock)	September 13, 2011
• Health and Safety Plan (General)	October 19, 2011[a]
• Health and Safety Plan (Lafarge)	September 23, 2011
RAWP Addendum No. 1	November 1, 2011
RAWP Addendum No. 2	January 5, 2012

Notes:

[a] The document does not have a specific date, but was issued as an attachment to the RAWP on the date indicated.

Table 1-3. Project Team Contact Information

Organization	Individual	Project Role	Phone	Mobile	Fax	Email
EPA Region 10	Karen Keeley	Remedial Project Manager	206-553-2141	206-437-3284	206-553-0124	keeley.karen@epa.gov
	Erika Hoffman	Agency Water Quality Manager	360-753-9540			hoffman.erika@epa.gov
	Ginna Grepo-Grove	Quality Assurance Manager	206-553-1632		206-553-8210	grepo-grove.gina@epa.gov
TechLaw Inc.	Amy Dahl	Agency Construction Oversight Manager	206-577-3050			adahl@techlawinc.com
	Amanda Rohrbaugh		206-557-3054	916-698-8069		arohrbaugh@techlawinc.com
City of Seattle	David Schuchardt	Project Specifier	206-615-1642		206-684-4631	dave.schuchardt@seattle.gov
	Jennie Goldberg	Oversight Contract Manager	206-684-3167		206-386-4589	jennie.goldberg@seattle.gov
	Chris Woelfel	Project Manager	206-684-7599		206-233-1532	chris.woelfel@seattle.gov
	John Summers	Supervising Construction Manager	206-684-5074		206-684-8581	john.summers@seattle.gov
	Cynthia Blazina	Resident Engineer	206-255-8407	206-255-8407	206-684-8581	cynthia.blazina@seattle.gov
	Shaunie Cochran	Resident Engineer (alternate)	206-255-6713	206-255-6713	206-684-8581	shaunie.cochran@seattle.gov
Integral Consulting Inc.	Reid Carscadden	Consultant Team Principal in Charge	206-957-0350	206-713-4372	206-230-9601	rcarscadden@integral-corp.com
	Eric Pilcher	Field Supervisor / Site Safety Officer	206-957-0337	253-370-5894	206-230-9601	epilcher@integral-corp.com
	Jane Sund	Field Lead	503-284-5545 ext 615	512-779-3172	503-284-5755	jsund@integral-corp.com
	Bill Lawrence	Field Lead	206-957-0326	253-691-2216	206-230-9601	blawrence@integral-corp.com
	Kim Magruder-Carlton	Laboratory Coordinator / Analytical QA Manager	360-756-9296			kmagruder@integral-corp.com
	Tom Schulz	Data Manager	360-705-3534 ext 17		360-705-3669	tschulz@integral-corp.com
	John Lally (Independent On-Call Consultant)	Construction Oversight Manager / QA Officer	206-325-0274	206-369-2478	206-325-0252	john.lally@lallyconsulting.com
Gravity Environmental	Steve Saugen	Research Vessel Captain	425-281-1471			steve@gravityenv.com
Analytical Resources, Inc.	Sue Dunnihoo	Laboratory Project Manager	206-695-6207		206-621-7523	sued@arilabs.com
	Dave Mitchell	Laboratory QA Manager	206-695-6205		206-621-7523	davem@arilabs.com
	Mark Harris	Laboratory Project Manager	206-695-6210			markh@arilabs.com
General Construction	Tom Coultas	Project Sponsor	360-340-0932			
	Tom Jirava	Project Manager / Quality Control Representative	253-943-4200	253-606-6548		Tom.Jirava@kiewit.com
	Matthew Miller	Site Supervisor	253-943-4200	206-510-6554		Matthew.Miller@kiewit.com
	Ryan Gammons	SSHO / Project Safety Manager	253-943-4200	206-786-6237		Ryan.Gammons@kiewit.com
	Tyler Waugh	Site Engineer	253-943-4200	253-306-3397		Tyler.Waugh@kiewit.com
Rhine Demolition	Gil Olson	Demolition Supervisor		253-606-4806		
Lafarge North America	Jonathan Hall	Transloading Operations Manager	206-336-0962	206-661-8240	206-932-3803	jonathan.hall@lafarge-na.com
	Mike Depew	Transloading Technical Manager	206-973-8025 ext 1313	206-380-7601	206-932-3803	mike.depew@lafarge-na.com
	Sam Kranzthor	Transloading Field Superintendant	206-937-8025 ext 1324	206-396-3600		
Allied Waste	Leslie Whiteman	Transport & Disposal Manager	206-332-7711	206-391-1389		lwhiteman@republicservices.com
AES Surveying	Gary Chapman	Surveyor of Record		360-930-2080		
eTrac Engineering LLC	Mel Saunders	Hydographic Survey Supervisor		907-229-7351		
Greylock Consulting	Suzanne Dudziak	Contractor Field Sampling Lead	253-661-3520	253-266-2838		greylockllc@comcast.net

Table 2-1. Removal Action Chronology

Activity	Date(s)
Initial Completion of 100% Design Documents	February 9, 2007
Reissuance of 100% Design Documents	August 30, 2010
EPA Approval of 100% Design	October 4, 2010
Completion of Final Bid Documents	March 25, 2011
Advertise for Bid	March 31, 2011
Pre-Bid Site Meetings	April 5 & 7, 2011
Issue Bid Addendum No. 1	April 12, 2011
Issue Bid Addendum No. 2	April 15, 2011
Issue Bid Addendum No. 3	April 18, 2011
Opening of Bids	April 20, 2011
Contract Awarded	May 18, 2011
Pre-Construction Conference	June 9, 2011
Notice to Proceed	June 18, 2011
Submittal of Draft RAWP [a]	July 13, 2011
Pre-Construction Boundary Area Documentation Sampling	August 24, 2011
Installation of Tide Gauge	August 24, 2011
Submittal of Pre-Construction Survey	September 14, 2011
Conditional Approval of RAWP	September 16, 2011
Mobilization & Setup (West Bank & Lafarge)	September 19 – 30, 2011
Pre-Construction Walkthrough (Slip 4)	September 28, 2011
Placement of Boundary Berm	October 3 & 4, 2011
Pre-Construction Walkthrough (Lafarge)	October 4, 2011
Bank Excavation	October 4 – November 14, 2011
Dredging	October 6 – November 18, 2011
Removal of Miscellaneous Timber Piles	October 12, 2011
Approval of Final RAWP	October 20, 2011
Haul Road/Stockpile Decommissioning & Equipment Decontamination (West bank)	October 24 – 26, 2011
Mobilization & Setup (East Bank)	October 27 – 31, 2011
RAWP Addendum No. 1	November 1, 2011
Outfall Area Capping – Scour Protection	November 11, 2011
Haul Road/Stockpile Decommissioning & Equipment Decontamination (East Bank)	November 14 – 16, 2011
Post-Excavation Bank Slope Documentation Sampling	November 14 & 16, 2011
Submittal of Post-Dredge/Excavation Acceptance Survey	November 15, 2011

Table 2-1. Removal Action Chronology

Activity	Date(s)
Barge Decontamination (GC102)	November 15 & 16, 2011
Bank Toe-Berm Placement	November 21 – December 1, 2011
Mobilization – Demolition Equipment	November 22, 2011
Barge Decontamination (GC103)	November 22 & 23, 2011
Approval of Post-Dredge/Excavation Acceptance Survey	November 23, 2011
Removal of Timber Fender Piles	November 28 – 30, 2011
Pier Demolition	November 28, 2011 – January 5, 2012
Bank Slope Capping	December 5 – December 14, 2011
Lafarge Decontamination (Tower Crane)	December 8 – 10, 2011
Outfall Area Capping – Settling Basin	December 12, 2011 – January 6, 2012
Lafarge Decontamination (Grounds and Vault)	December 13 – 28, 2011
Waterway Capping	December 23, 2011 – January 31, 2012
RAWP Addendum No. 2	January 5, 2012
Submittal of Punch List	January 24, 2012
Cap Verification Sampling	January 30 & February 1, 2012
Submittal of Waterway Cap Acceptance Survey	January 31, 2012
Pre-Final Inspection	January 31, 2012
Post-Construction Boundary Area Documentation Sampling	February 1 & 2, 2012
Boundary Area Material Placement	February 7, 2012
Demobilization	February 8 – 16, 2012
Approval of Waterway Cap Acceptance Survey	February 10, 2012
Post-Capping Boundary Area Documentation Sampling	February 14, 2012
Final Inspection	February 22, 2012

Notes:

[a] The RAWP contains related appendices and attachments, including:

- Appendix A, Attachment A4.3-1. Dredge Material Handling Plan (Lafarge Transloading Plan)
- Appendix A, Attachment A4.9-6. Field Sampling Plan (Greylock)
- Appendix B1. Health and Safety Plan (General Construction Company)
- Appendix B2. Health and Safety Plan (Lafarge)

Table 4-1. Disposal Facilities

Waste/ Recycle Type	Description	Quantity	Disposal/Recycle Location	Facility Type	Address	Phone Number	EPA ID # / RCRA #
Contaminated Waste	Fender Piling Creosote Timbers Upland Greenery Dredged Sediment Excavated Soil Debris	17,202 tons [a]	Rabanco Roosevelt Regional Landfill	Subtitle D Landfill	500 Roosevelt Grade Rd Roosevelt, WA 99356	(509) 384-5641	20-001 / NA
Concrete	Pier Deck Concrete Panels Bents Concrete Piles	3,278 tons	Stoneway Concrete Recycling (Kangley Rock & Recycling)	Recycling Facility	510 Monster Rd S. Renton, WA 98005	(425) 226-1000	NA / NA
Steel	Rebar Crane Rail Misc. Steel	79 tons	Independent Metals Recycling	Recycling Facility	816 S. Kenyon St. Seattle, WA 98108	(206) 763-9033	NA / NA
Wastewater	Stockpile Runoff Decon Water	2,900 gallons	Marine Vacuum Services, Inc.	Water Treatment	1516 S. Graham St. Seattle, WA 98108	(206) 762-0240	NA / WAD980974521
	Excess Water from Transloading Vault	132 tons	Rabanco Roosevelt Regional Landfill	Subtitle D Landfill	500 Roosevelt Grade Rd Roosevelt, WA 99356	(509) 384-5641	20-001 / NA

Notes:

NA = not applicable

[a] The quantity reflects the sum total of all scale receipts for material transported to the Subtitle D landfill (except for excess water transported by tanker trucks). As materials were co-mingled during transloading, individual quantities are not available.

Table 5-1. Status of Implementation of Slip 4 Institutional Controls

Institutional Control	Objective	Ownership	Mechanism	Status as of July 2012	Monitoring	Enforcement	Responsibility	Termination
Governmental Controls								
Local Permits	Restrict construction and other intrusive actions	A, B, C	Permitting Procedures	Permit requirements under the Clean Water Act and Washington State Shoreline Management Act are already in place.	Applies before, during and soon after the construction period of the proposed project.	Review of construction plans and inspecting the site during and after construction	Ecology, U.S. Army Corps of Engineers	Indefinite life until legislative change made
Regulated Navigation Area	Protect the integrity of the sediment cap by restricting vessel operations (e.g., anchoring, grounding, spudding)	A	Application to U.S. Coast Guard	The City of Seattle is in process of preparing the application, with EPA sponsorship	Violations may be reported to the Captain of the Port, Puget Sound, Seattle, Washington	Those found in violation may be subject to civil or criminal penalties as provided for in 33 U.S. Code 1232	U.S. Coast Guard	Indefinite
Proprietary Controls								
Property Purchase	Allow control over all land uses and monitoring	A	Fee-Simple Purchase	The City of Seattle aquired the property on October 12, 2007	Not required	None	City of Seattle - Seattle Public Utilities	Indefinite
Restrictive Covenants	Restrict landowners from activities that might compromise the sediment caps, slope caps, and engineered soil covers	A, B, C	Uniform Environmental Covenant Act	Restrictive Covenants are expected to be recorded by February 2013	Environmental covenants will be recorded in the Integrated Site Information System (ISIS) database. Ecology will monitor the covenants by confirming they are filed along with the publicly available property records	Landowners have a vested interest in enforcing the covenants upon themselves in order to avoid fines for breaching the covenant	Although Ecology has an interest in the covenants, the land owners bear responsibility for maintaining them	
Enforcement and Permit Tools								
Administrative Orders	A government agency exercises authority by mandating a party to take action and/or restrict use	A, B, C	EPA or Ecology administers directive	An Administative Settlement Agreement and Order on Consent was issued on September 28, 2006	EPA will review long-term monitoring results no less frequently than every five years	Administrative orders are enforceable in a court of law	EPA is enforcing the Slip 4 Administrative Settlement Agreement and Order on Consent; The City of Seattle and King County are responsible for implementing all aspects of the removal action	Although an administrative order may be terminated at the completion of remediation, periodic reviews ensure the institutional controls for the site remains in place
Informational Devices								
Deed Notices	Provides public information	A	Land owner voluntarily files a notice with public land records	Deed notices are expected to be recorded by February 2013	The deed notice is monitored by confirming it has been filed	Informational devices are not legally enforceable and primary serve to inform the public	The landowner is responsible for filing the notice	The notice remains on file indefinitely until a change in conditions warrants its removal
State Registry	Compiles a database of sites of concern for public viewing	A	Ecology has established the Site Register, the Hazardous Sites list, and the ISIS database	The Lower Duwamish Waterway and Slip 4 are already listed on the Hazardous Sites list, and ISIS. Public notices will be published in the Site Register as needed. Environmental covenants will be recorded in the ISIS database by March 2013	Ecology monitors sites listed on the Hazardous Sites list		Ecology maintains the database	A site is removed from the Site Register upon reaching a No Further Action status
Advisories	Information is dispersed notifying the public of health risks	Addressed in the Lower Duwamish Waterway sitewide remediation objectives	Signs, pamphlets, website, etc. (translated into regional languages)	Already in place for Lower Duwamish Waterway Superfund site. Additional Site-wide advisories may be implemented under EPA and/or Ecology Consent Decree (s) pursuant to the LDW ROD.	The Washington State Department of Health will review data periodically to determine if the advisory should remain in place		Advisories are created by government agencies (i.e., Department of Health)	Advisories can be terminated when monitoring activities prove the risk has reach an acceptable level

Notes: Ownership (see Figure 5-1)

A - City of Seattle
B - The Boeing Company
C - First South Properties

APPENDIX A

SEDIMENT SAMPLING AND ANALYSIS REPORT

City of Seattle

LOWER DUWAMISH WATERWAY
SLIP 4 EARLY ACTION AREA

Sediment Sampling and Analysis Report

Submitted to
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Submitted by
City of Seattle

Prepared by
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411 1st Avenue S.
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Seattle, WA 98104

July 26, 2012

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ACRONYMS AND ABBREVIATIONS

City	City of Seattle
CQAP	construction quality assurance plan
CSL	cleanup screening level
EIM	environmental information management
EPA	U.S. Environmental Protection Agency
MLLW	mean lower low water
PCB	polychlorinated biphenyl
SAP	sampling and analysis plan
SOP	standard operating procedure
SMS	sediment management standards
SQS	Washington State Sediment Quality Standards
SVOC	semivolatile organic compound
TOC	total organic carbon
WAC	Washington Administrative Code

1 INTRODUCTION

This sediment sampling and analysis report is a part of the removal action completion report for the removal action of contaminated marine sediments and adjacent bank areas at the Slip 4 Early Action Area of the Lower Duwamish Waterway Superfund Site located in Seattle, Washington (Figure 1-1). The removal action implemented U.S. Environmental Protection Agency's (EPA's) selected alternative as defined in EPA's Action Memorandum (USEPA 2006). The City of Seattle (City) conducted the Slip 4 sediment removal action. The construction quality assurance plan (CQAP) (Integral 2010a) outlined the overall construction project approach to quality assurance and the role of the sediment sampling activities in relation to other project elements.

Within the Slip 4 Early Action Area, polychlorinated biphenyls (PCBs) were the chemicals of concern in sediments. The removal boundary encompassed approximately 3.6 acres. The primary objective of the removal action was to reduce the concentrations of contaminants in post-cleanup surface sediments (biologically active zone [0–10 cm]) to below the Washington State Sediment Quality Standards (SQS) for PCBs and other chemicals. The removal alternative included removal of contaminated sediments at the head of the slip, construction of an engineered sediment cap over the entire Slip 4 removal area, and long-term monitoring of the capped area (USEPA 2006). The sediment removal action significantly reduced unacceptable risks to the aquatic environment resulting from potential exposure to contaminants in sediments in the slip. This cleanup also reduced potential human health risks associated with PCBs in sediment within the Lower Duwamish Waterway.

Surface sediments/soils and bank cap materials were sampled as part of the removal action for the following purposes:

1. Document the pre- and post-construction boundary area conditions
2. Document the post-excavation bank slope conditions
3. Confirm post-construction sediment quality throughout Slip 4 and along the adjacent side slope areas.

1.1 REPORT OBJECTIVES

This report documents the field activities associated with the collection of data needed to verify the completeness of the removal action in Slip 4 including the field activities associated with sediment sampling, resulting data, and associated quality assurance summary of the data.

1.2 REPORT ORGANIZATION

The remaining sections of this document describe sediment sampling and analysis activities as described in the CQAP (Integral 2010a). Section 2 provides a description of the field sampling activities. Section 3 discusses deviations from the sampling and analysis plan (SAP) (Integral 2010b). Section 4 provides details of field changes. Quality assurance/quality control results are described in Section 5. References are provided in Section 6.

Supporting information is provided in the following attachments:

- **Attachment A.** Sample Collection Forms
- **Attachment B.** Field Notes
- **Attachment C.** Photo Documentation
- **Attachment D.** Laboratory Reports
- **Attachment E**. Comparison of Post-excavation Bank Slope Samples to Historical Data
- **Attachment F**. Data Validation Reports.
- **Attachment G**. An analytical database of Slip 4 sample data provided in Ecology's environmental information management (EIM) format.

2 SEDIMENT SAMPLING

The following sampling programs were completed to support the Slip 4 removal action:

1. Pre-construction sediment sampling in the boundary area
2. Post-construction sediment sampling in the boundary area, including additional sampling following placement of additional material
3. Post-excavation bank slope sampling
4. Post-construction bank slope cap sampling
5. Post-construction waterway cap sampling.

Details of these sampling programs are described in this section. Sample locations and PCB data are shown on Figures 2-1 through 2-5. The types of samples required, the rationale, and analyses are listed in Table 2-1 of the SAP (Integral 2010b). The location coordinates for the intertidal bank samples and surface subtidal grab samples are provided in Table 2-1. Laboratory results are summarized in Tables 2-2 through 2-6, including comparison to SQS criteria.

The SQS concentration level for PCBs is 12 milligrams per kilogram organic carbon (mg/kg OC) when the total organic carbon (TOC) is between 0.5 and 4.0 percent. Similarly, the cleanup screening level (CSL) for PCBs is 65 mg/kg OC. When TOC is outside the normalization range, comparison is made to the lowest apparent effect threshold of 130 μg/kg based on dry weight, and the CSL reported in the Lower Duwamish Waterway feasibility study of 1,300 μg/kg based on dry weight.

Additional field observations, including sampling times, weather conditions, water conditions, and other anecdotal information were noted on sediment sample collection forms (Attachment A) and in field notes (Attachment B). Photos documenting sample collection are presented in Attachment C. The complete laboratory reports are provided in Attachment D.

2.1 PRE- AND POST-CONSTRUCTION BOUNDARY AREA SAMPLING

Sediment samples from the removal area boundary were collected before initiation of the removal action and after completion of in-water construction. On August 24, 2011, prior to in-water construction, surface sediments (0–10 cm horizon) were collected from eight stations in Slip 4 (Figure 2-1). These samples were analyzed for TOC, metals, PCBs, and semivolatile organic compounds (SVOCs) per the SAP. Pre-construction boundary area sediment data is presented in Table 2-2, with comparisons to Washington State Department of Ecology's Sediment Management Standards (SMS; WAC 173-204).

On February 1 and 2, 2012, after completion of in-water construction, surface (0−10 cm) sediment samples were collected near the same eight locations with the exception of Station BD-4, which had a 30-ft location variance. The samples were submitted for the same suite of analyses. These samples were submitted for fast (48-hour) turnaround of verbal results to provide data for field decision-making. Laboratory results for the post-construction samples indicated elevated concentrations of PCBs above the SQS and other organic compounds at all locations (Figure 2-2, Table 2-3).

Upon review of these data, the City and EPA agreed that corrective action was warranted. A 9-in. nominal lift of waterway cap material was placed over the boundary area on February 7, 2012. Follow-up sampling was conducted on February 14, 2012 near the locations sampled on February 1 and 2, 2012, with the exception of Station BD-4, which was sampled near its August 24, 2011 location. Samples were submitted for analysis of PCBs and TOC on a standard (30-day) turnaround time. All total PCB results for the final boundary area confirmation sample results were below SMS criteria (Figure 2-3, Table 2-4).

2.2 POST-EXCAVATION BANK SLOPE SAMPLING

Bank sediment/soil samples were collected on November 14 and 16, 2011 following excavation but before placement of the slope caps. Twelve of 14 surface sediment/soil (0–10 cm horizon) samples were collected from discrete bank slope locations in Slip 4 (Figure 2-4). The target locations were at approximately +4 and +12 ft mean lower low water (MLLW). The remaining two samples (i.e., Stations PE-3 and PE-6) were four-point composite samples of surface sediment/soil collected from the subsample locations indicated on Figure 2-4. All of the bank sediment/soil samples were submitted for TOC, metals, PCB, and SVOC analyses. Data are presented in Table 2-5. Standard turnaround times were used for these samples because no field decisions were to be made based on the results.

Laboratory results showed that some post-excavation bank slope samples contained elevated concentrations of PCBs (Table 2-5). At EPA's request, a comparison of the current sample data for Stations PE-2 and PE-4 to historical data was conducted to determine if the exposed material was similar to the previously sampled sediment or if it was indicative of upland bank material. The results of the comparative analysis, which is provided in Attachment E, suggest that these stations generally represent natural waterway sediment, not upland soil.

2.3 POST-CONSTRUCTION SLOPE CAP CONFIRMATION SAMPLING

Confirmation samples were collected on January 30, 2012 following placement of the slope caps. A three-point composite sample of slope cap material (0–10 cm horizon) was collected from six stations in Slip 4 (Figure 2-5). The composite slope cap samples were submitted for analysis of TOC, metals, PCBs, and SVOCs, and the data are presented in Table 2-6 (SC-X samples). These samples were submitted for fast (48-hour) turnaround of verbal results to provide data for field decision-making. All post-construction slope cap confirmation sample results were below SMS criteria (Table 2-6).

2.4 POST-CONSTRUCTION WATERWAY CAP CONFIRMATION SAMPLING

Confirmation samples were collected on January 30 and February 1, 2012 after the placement of the final lift of capping material in the slip to confirm that the sediment cap met the design criteria. Discrete samples of surface sediment (0–10 cm sediment horizon) were collected from each of eight stations (Figure 2-5). The waterway cap confirmation sediment samples were submitted for analysis of TOC, metals, PCBs, and SVOCs, and the data are presented in Table 2-6 (WC-X samples). These samples were submitted for fast (48-hour) turnaround of verbal results to provide data for field decision-making. All post-construction waterway cap confirmation sample results were below SMS criteria (Table 2-6).

3 SAMPLING PLAN DEVIATIONS

In general, the design for collection and documentation of sediment samples presented in the CQAP (Integral 2010a) and detailed in the SAP (Integral 2010b) and associated appendices and standard operating procedures (SOPs) were followed during sediment sampling activities. During the course of the project, however, several deviations from the plan occurred.

EPA requested modification of boundary area sample stations to collect new data from locations that had indicated exceedances of chemicals of concern during or prior to the site characterization. In response, three stations (BD-4, BD-7, and BD-8) were moved slightly to occupy former sample locations.

The collection of many intertidal and bank sediment samples was accomplished by hand-held implements (stainless-steel spoon). A description of this method was not originally included in the surface sediment sampling SOP provided in Attachment A of the SAP (Integral 2010b). At the request of the EPA, Integral revised the SOP to include language discussing sample collection by hand-held implements, removal of 0.5-in. or larger rocks, and the use of a stainless-steel ruler during sample collection. The revised SOP was approved by EPA and all samples were collected using hand-held implements followed the methods described in the revised SOP.

Other specific deviations are described in the remainder of this section.

3.1 GENERAL SEDIMENT SAMPLING DEVIATIONS

General deviations that applied to all sampling efforts included:

- The removal action SAP specified that decontamination of the stainless-steel spoon, bowl, or grab sampler include a rinse with methanol. On August 22, 2011, Integral notified EPA of a field change to the SAP to indicate that if equipment decontamination required removal of residual oils, hexane would be used instead of methanol.
- The SAP specified that sample coolers would be maintained at a temperature of 4°C (±2°C) (Integral 2010b). One cooler delivered to the laboratory on February 14, 2012 was relinquished at a temperature of 1.9°C. This minor deviation did not affect data usability.
- The SAP specified that sample coolers would be sealed with three chain-of-custody seals, *This End Up* and *Fragile* labels. This labeling was not done because all coolers were hand-delivered to the laboratory by the sample team.

- Subtidal surface sediment samples were collected with a stainless-steel power grab sampler as opposed to the 0.1-m^2 van Veen grab sampler specified in the SAP, with the exception of samples SL4-SG-PE2 and SL4-SG-PE4.

3.2 POST-EXCAVATION BANK SLOPE SAMPLING

- Post-excavation subtidal Station PE-11 was to be sampled using a stainless-steel 0.1-m^2 van Veen grab sampler. This location was exposed at the time sampling was being conducted and was therefore collected with a stainless-steel spoon.
- Post-excavation intertidal Stations PE-5, PE-7, PE-9 and PE-13 were submerged at the time of sampling of therefore changed to subtidal surface sediment (0–10 cm horizon) stations. Samples were collected with the power grab sampler.

3.3 PRE- AND POST-CONSTRUCTION BOUNDARY AREA SAMPLING

- Pre-construction intertidal Station BD-8 was to be sampled using stainless-steel spades and/or spoons during low tide. This location was submerged at the time sampling was being conducted and was therefore collected with the power grab sampler.
- For pre-construction boundary area samples, sample penetration depth for location BD-1 was measured via calibration on a stainless-steel spoon. A plastic ruler was used in lieu of a stainless steel ruler to measure sample penetration depths for BD-2 thru BD-8. Care was taken to ensure that sediments in contact with the ruler were not part of the collected sample.
- Post-construction intertidal Stations BD-4 and BD-8 were to be collected using stainless-steel spades and/or spoons during low tide. These locations were submerged during the February 1 and 2 sampling event and were therefore sampled with the power grab sampler. During the follow-up post-construction sampling event on February 14, 2012, only Station BD-8 was submerged and thus sampled with the power grab sampler. The sample at Station BD-4 was collected with a stainless-steel spoon during low tide.
- Minor variations in the actual sample locations occurred throughout the project due to factors such as wind, currents, and occasional traffic within the slip. All of the post-construction boundary area samples were collected within 20 ft of the pre-construction sample locations except for Station BD-4 which was approximately 30 ft northwest of the pre-construction sample location. All of the follow-up post-construction boundary area samples were collected within 20 ft of the initial post-construction sample locations. The data collected for pre- and

post-construction sampling are believed to be comparable for each sample location with the possible exception of Station BD-4, due to its 30 ft location variance.

- During the follow-up post-construction sampling event on February 14, 2012, Samples BD-2, BD-6, and BD-8 were collected after several rejected grabs due to limited (estimated to be less than 10 percent) quantities of fine-grained material. To collect samples at these locations, the full contents of the power grab (that had penetrated 10 cm) were transferred to a bowl and the material greater than 0.5 in. was removed prior to placing the sample in jars. Photos of the grab contents for these samples are provided in Attachment C, Photos 375, 379, and 380.

3.4 POST-CONSTRUCTION SLOPE CAP CONFIRMATION SAMPLING

- Slope cap confirmation subsample locations planned for +2 ft MLLW were modified to +4ft MLLW to allow for intertidal sampling methods to be used, as the +2ft MLLW locations were nearly all submerged during the sampling event.
- Due to a lack of fines at the +4 and +8ft MLLW locations, subsamples of slope cap confirmation Station SC-5 were collected at +5 and +9ft MLLW locations.

3.5 POST-CONSTRUCTION WATERWAY CAP CONFIRMATION SAMPLING

- Waterway cap confirmation Stations WC-1, WC-2, WC-4, WC-6, and WC-8 were changed to subtidal surface sediment (0–10 cm horizon) stations and samples were collected with the power grab sampler. Stations WC-3, WC-5, and WC-7 were collected as subtidal stations as planned.
- Many waterway cap samples could not be collected at the target locations due to insufficient amounts of finer-grained sediment (material less than 0.5 in. in diameter). Rejected grabs contained either large rock (cap armor) or clean fine to coarse gravel (Attachment C, photo 333 and photo 334). In these situations, multiple grabs were attempted around the target sample location. When an acceptable grab could not be collected, the distance away from the target sample location was increased until an acceptable grab was collected. Acceptable grab samples generally had to have greater than 5 percent of the material volume less than 0.5 in. in diameter. The number of grabs rejected at a particular sample station was recorded in the field notes, but geographic positioning system coordinates were not collected for every rejected grab location. Stations WC-2,

WC-5, WC-6, WC-7, and WC-8 were sampled at locations greater than 20 ft from the target locations.

4 DATA MANAGEMENT AND REPORTING

The management and reporting of field and laboratory data generally followed the procedures outlined in the CQAP (Integral 2010a) and SAP (Integral 2010b). Changes or additions to those procedures are discussed below.

4.1 FIELD QUALITY CONTROL SAMPLES

Field quality control samples were used to assess sample variability and evaluate potential sources of contamination. Field quality control samples included field split samples and equipment rinsate blanks. Detailed information on quality assurance/quality control procedures, limits, and reporting are described in detail in the quality assurance project plan (Appendix B to the CQAP). The field quality control samples that were collected are listed in Tables 2-2 through 2-6. No corrective actions were required to meet the project's data quality objectives.

4.2 DATA QUALITY REVIEW

All laboratory results underwent data validation by an independent validator. Laboratory provided data packages for each sample delivery group or analysis are provided in Attachment D. Data validation packages for each sample delivery group or analysis are provided in Attachment F.

Full data validation reviews were completed for each of the seven data packages received from the laboratory. The data were generally acceptable. A total of three results for benzyl alcohol were rejected due to low to no recovery in the matrix spike/matrix spike duplicate analyses. Rejected data are not to be used for any purpose. Select data were qualified as estimated or nondetect based on matrix interferences or method blank contamination. Qualified data points may have a larger associated bias or may be less precise than unqualified data, but are usable for the intended purpose.

5 REFERENCES

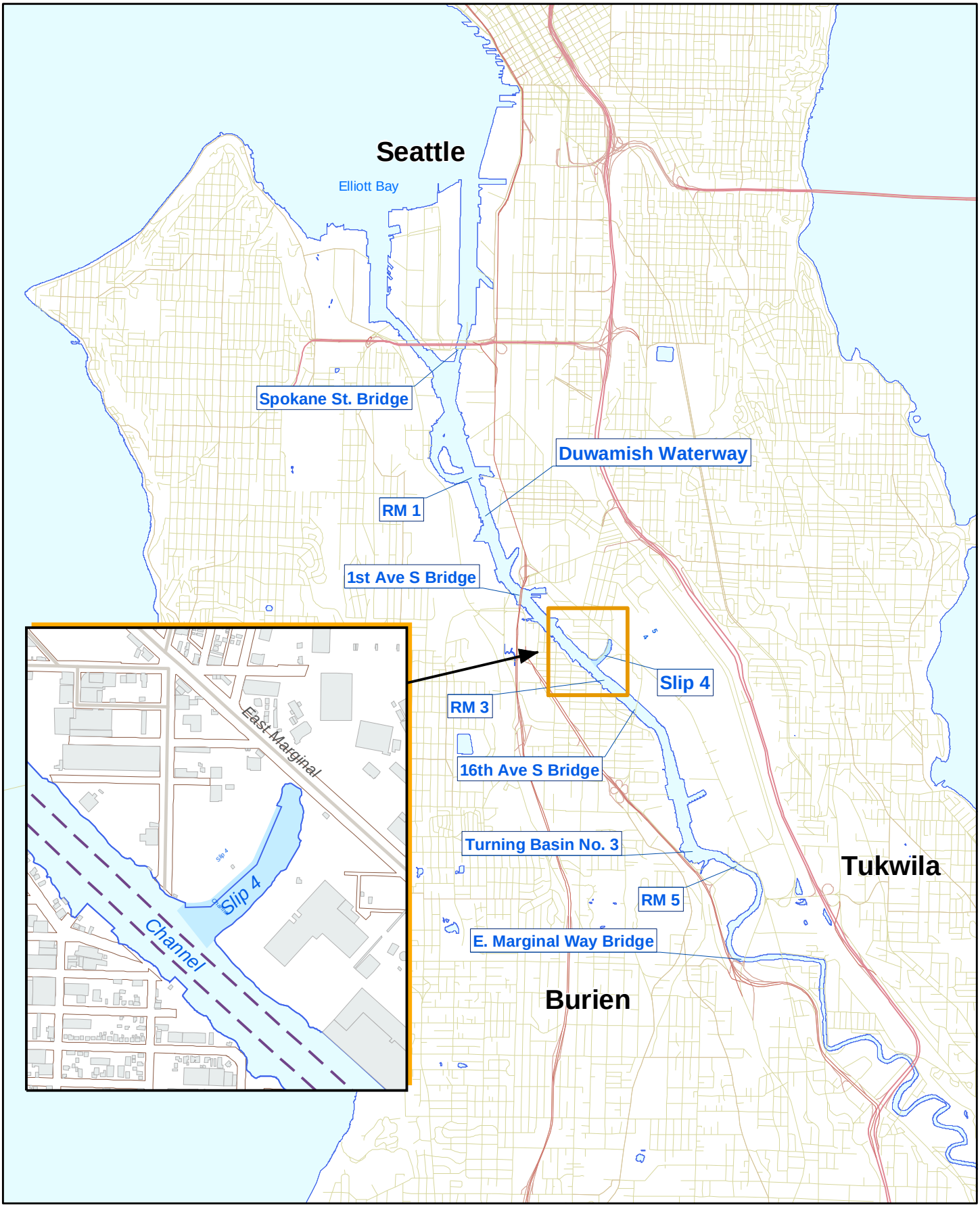
Integral. 2010a. Lower Duwamish Waterway Slip 4 Early Action Area: 100% Design Submittal, Construction Quality Assurance Plan. Prepared for City of Seattle and King County. Integral Consulting Inc., Seattle, WA.

Integral. 2010b. Lower Duwamish Waterway Slip 4 Early Action Area: 100% Design Submittal, Removal Action Sampling and Analysis Plan. Prepared for City of Seattle and King County. Integral Consulting Inc., Seattle, WA.

USEPA. 2006. Action memorandum for non-time critical removal action at the Slip 4 Early Action Area of the Lower Duwamish Waterway Superfund Site, Seattle, Washington, dated May 3, 2006. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

USEPA. 2011. Clean Water Act §401 Water Quality Certification, Removal Action of Contaminated Marine Sediments and Bank Areas at Slip 4 Early Action Area, Lower Duwamish Waterway Superfund Site, Seattle, Washington, dated May 23, 2011. U.S. Environmental Protection Agency, Region, 10, Seattle, WA.

FIGURES

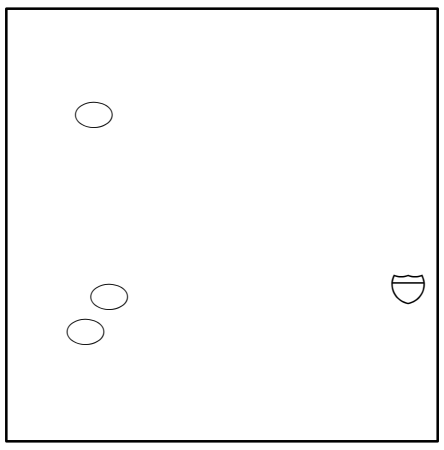


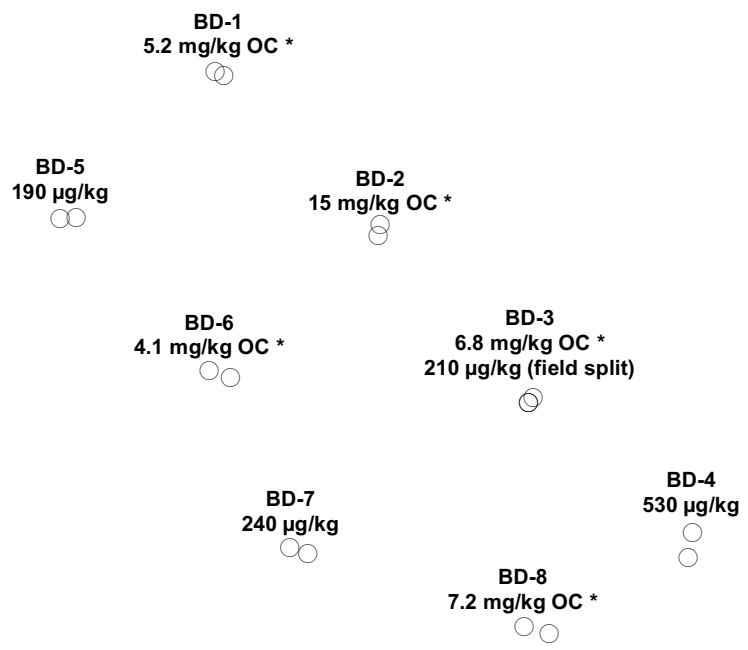
Map Document: (O:\Projects\Duwamish_OLY\Projects\Slip4_60%_DAR\SiteLocationMap.mxd)

integral consulting inc.

Map Feature Sources: King County GIS, Seattle Public Utilities, USACE, Ecology, and others.

Figure 1-1
Vicinity Map
Slip 4 Removal Design





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Actual Sample Location (08/24/2011)
- >CSL
- >SQS
- No Exceedance

Target Sample Location

* Numerical value is normalized to organic carbon when TOC is between 0.5 and 4.0 percent.

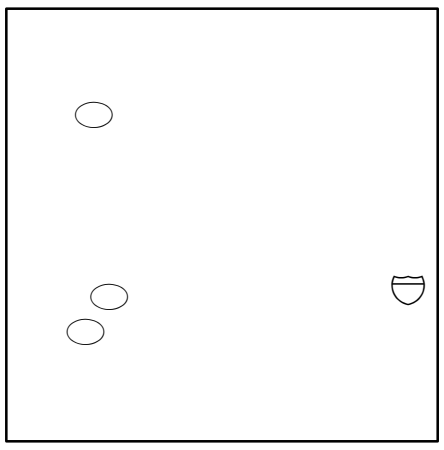
Background imagery is for reference purposes only, is courtesy of the City of Seattle and is dated 2005.

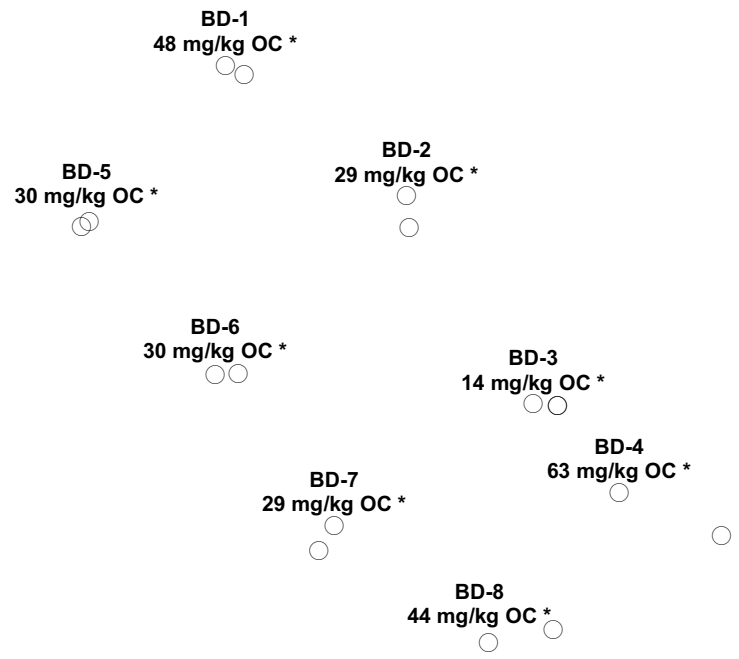
0 25 50
Feet

N

integral consulting inc

Figure 2-1.
PCB Concentrations in Surface Sediments Outside the Slip 4 Removal Boundary Prior to Construction
Slip 4 Removal Action





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Actual Sample Location (02/01/2012 and 02/02/2012)

- >CSL
- >SQS
- No Exceedance

Target Sample Locations (Collections From 08.24.2011)

* Numerical value is normalized to organic carbon when TOC is between 0.5 and 4.0 percent.

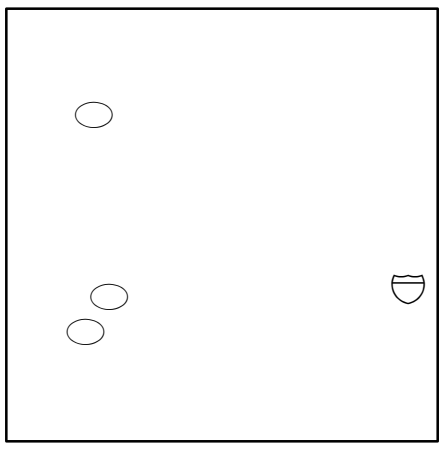
Background imagery is for reference purposes only, is courtesy of the City of Seattle and is dated 2005.

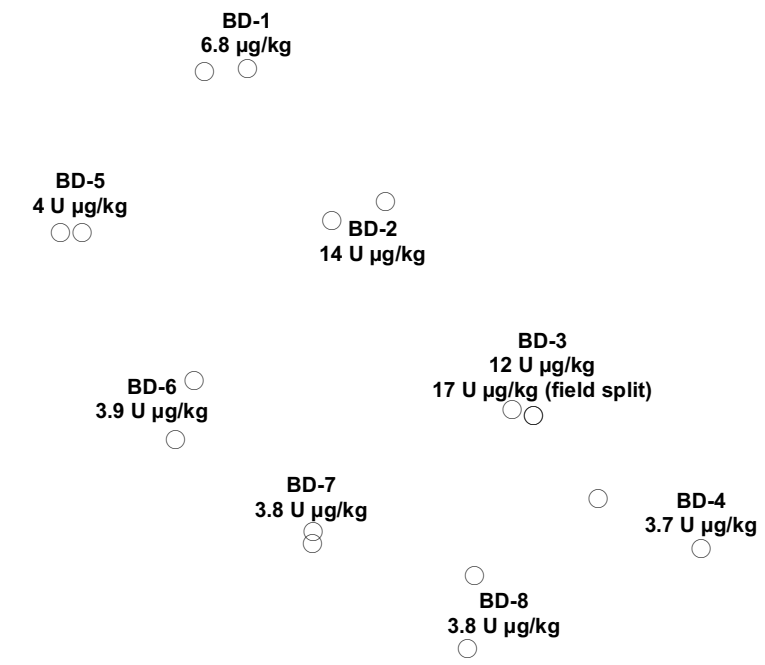
0 25 50
Feet

N

integral consulting inc

Figure 2-2.
PCB Concentrations in Surface Sediments Outside of Slip 4 Removal Boundary Following Construction
Slip 4 Removal Action





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Actual Sample Location (02/14/2012)
- >CSL
- >SQS
- No Exceedance

Target Sample Location (Collections from 2/01/2012 and 2/02/2012)

U = Not detected above the reported sample quantitation limit.

Background imagery is for reference purposes only, is courtesy of the City of Seattle and is dated 2005.

0 25 50
Feet

N

integral consulting inc

Figure 2-3.
PCB Concentrations in Surface Sediments Outside the Slip 4 Removal Boundary Following Additional Material Placement
Slip 4 Removal Action

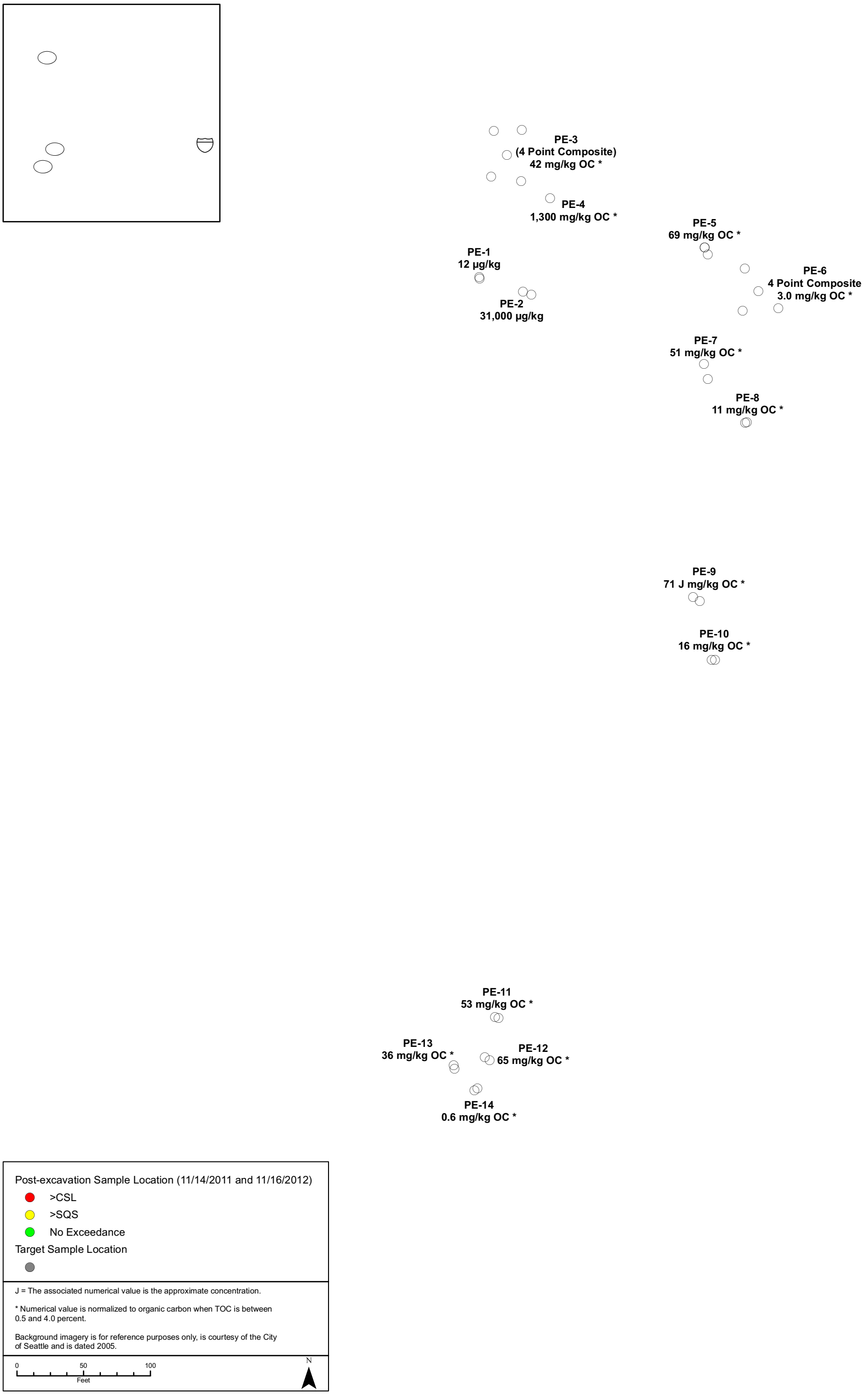

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Figure 2-4.
PCB Concentrations in Post Dredge/Excavation
Slope Samples Prior to Capping
Slip 4 Removal Action

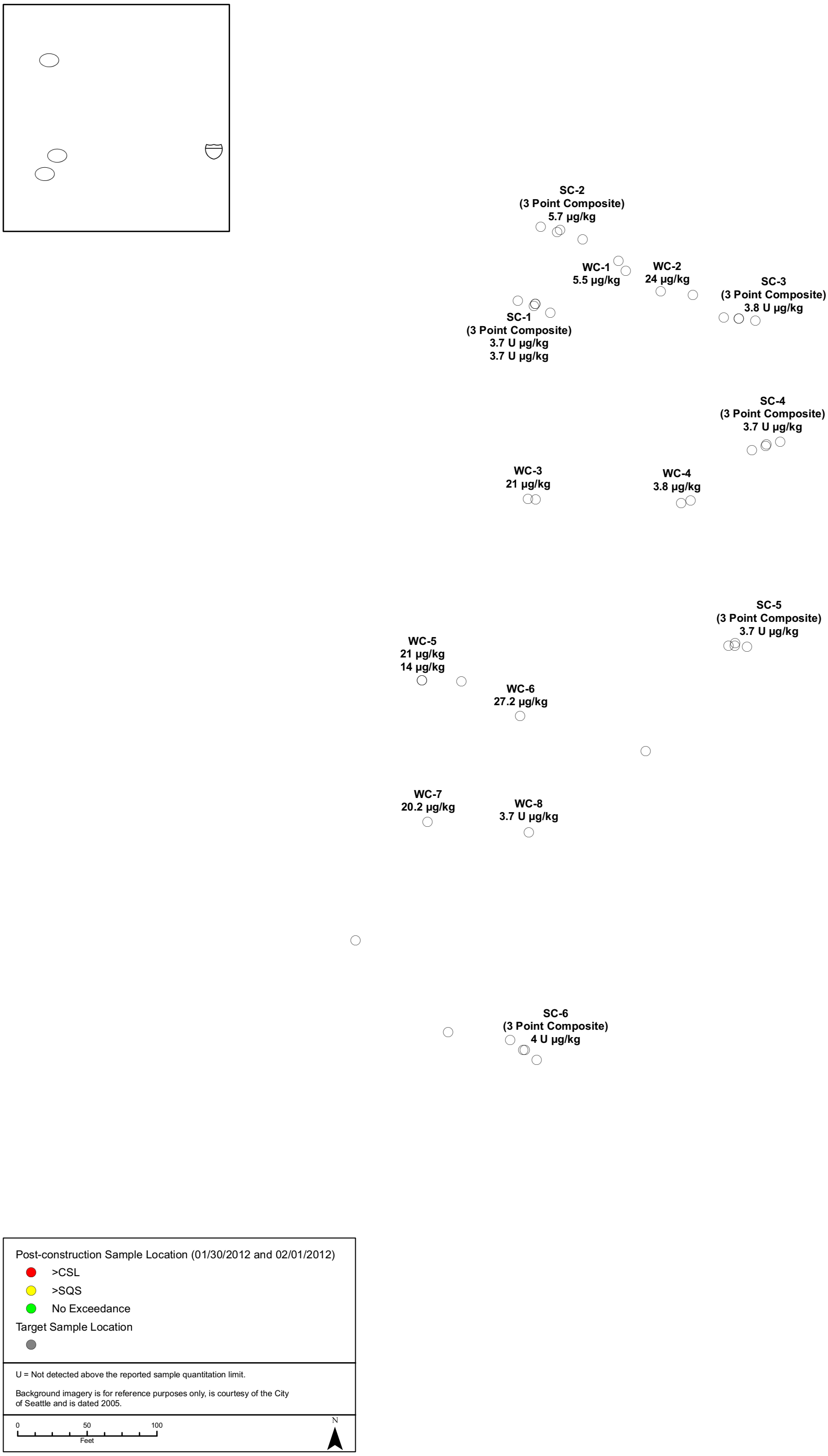

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Figure 2-5.
PCB Concentrations in Cap Material
Slip 4 Removal Action

TABLES

Table 2-1. Station Coordinates

	Target Coordinates		Actual Coordinates	
Station ID	Northing	Easting	Northing	Easting
Boundary Area Documentation Stations[a]				
BD-1	198904.61	1273232.52	198905.40	1273230.36
BD-2	198865.39	1273270.23	198868.14	1273270.66
BD-3	198826.17	1273307.95	198824.75	1273306.88
BD-4	198786.95	1273345.67	198793.15	1273346.79
BD-5	198869.95	1273196.48	198869.65	1273192.61
BD-6	198830.73	1273234.20	198832.46	1273228.95
BD-7	198788.00	1273253.00	198789.40	1273248.63
BD-8	198768.57	1273311.92	198770.05	1273305.82
Post-Excavation Bank Slope Documentation Stations				
PE-1	199401.16	1273383.76	199400.12	1273384.13
PE-2	199388.05	1273422.74	199390.12	1273416.54
PE-3a	199510.45	1273394.59	199510.66	1273388.39
PE-3b	199511.32	1273415.73	199510.36	1273417.28
PE-3c	199476.28	1273392.80	199470.75	1273416.81
PE-3d	199472.83	1273415.05	199474.57	1273395.46
PE-3	**	**	199492.56[e]	1273404.63[e]
PE-4	199456.40	1273437.32	199460.40	1273436.75
PE-5	199418.07	1273554.94	199423.43	1273552.44
PE-6a	199407.30	1273603.36	199405.34	1273580.59
PE-6b	199407.65	1273582.48	199406.21	1273602.94
PE-6c	199376.19	1273580.87	199375.58	1273605.16
PE-6d	199378.01	1273607.47	199376.19[d]	1273580.87[d]
PE-6	**	**	199390.63[e]	1273592.50[e]
PE-7	199324.94	1273554.95	199336.31	1273552.06
PE-8	199292.22	1273582.80	199292.66	1273583.82
PE-9	199158.84	1273548.71	199162.06	1273543.67
PE-10	199114.99	1273557.63	199115.20	1273560.18
PE-11	198847.98	1273395.72	198847.08	1273398.43
PE-12	198817.97	1273387.93	198815.39	1273391.69
PE-13	198809.01	1273365.27	198811.72	1273364.59
PE-14	198792.89	1273380.27	198794.62	1273382.43
Slope Cap Confirmation Stations				
SC-1-4	199391.46	1273401.02	199385.77	1273421.43
SC-1-8	199389.26	1273408.22	199390.53	1273408.82
SC-1-12	199392.79	1273396.70	199395.58	1273397.44
SC-1	**	**	199390.63[e]	1273409.23[e]
SC-2-4	199464.46	1273420.41	199437.24	1273443.05
SC-2-8	199442.18	1273424.87	199444.40	1273426.03
SC-2-12	199445.83	1273412.94	199449.10	1273411.69
SC-2	**	**	199443.58[e]	1273426.92[e]
SC-3-4	199413.54	1273566.20	199380.61	1273544.05
SC-3-8	199380.02	1273554.97	199378.60	1273555.46
SC-3-12	199378.81	1273566.91	199381.17	1273565.44
SC-3	**	**	199380.13[e]	1273554.99[e]
SC-4-4	199290.77	1273580.39	199288.08	1273564.50
SC-4-8	199288.94	1273574.33	199290.10[d]	1273574.32[d]
SC-4-12	199292.03	1273584.57	199292.79	1273585.85
SC-4	**	**	199289.94[e]	1273574.89[e]
SC-5-5	199145.76	1273547.47	199144.03	1273539.67

Table 2-1. Station Coordinates

	Target Coordinates		Actual Coordinates	
Station ID	Northing	Easting	Northing	Easting
SC-5-9	199145.71	1273552.15	199152.76	1273556.02
SC-5-12	199145.25	1273560.86	199145.86	1273561.82
SC-5	**	**	199147.55[e]	1273552.50[e]
SC-6-4	198853.95	1273403.40	198861.16	1273390.59
SC-6-8	198856.05	1273400.56	198858.25	1273403.83
SC-6-12	198848.99	1273410.13	198849.03	1273410.77
SC-6	**	**	198856.15[e]	1273401.73[e]
Waterway Cap Confirmation Stations				
WC-1	199421.60	1273468.82	199414.43	1273474.09
WC-2	199397.17	1273522.08	199399.42	1273499.06
WC-3	199250.46	1273409.34	199251.02	1273403.73
WC-4	199249.89	1273520.55	199247.87	1273513.70
WC-5	199120.27	1273356.30	199120.96	1273327.97
WC-6	199070.38	1273488.14	199095.26	1273398.35
WC-7	198934.48	1273280.20	199019.44	1273332.04
WC-8	198868.97	1273346.65	199012.05	1273404.64
Boundary Area Documentation Stations[b]				
BD-1	198905.40	1273230.36	198907.79	1273225.87
BD-2	198868.14	1273270.66	198875.87	1273270.02
BD-3	198824.75	1273306.88	198825.23	1273300.96
BD-4	198793.15	1273346.79	198803.67	1273321.79
BD-5	198869.65	1273192.61	198868.45	1273190.72
BD-6	198832.46	1273228.95	198832.38	1273223.37
BD-7	198789.40	1273248.63	198795.54	1273252.43
BD-8	198770.05	1273305.82	198767.01	1273290.06
Boundary Area Documentation Stations[c]				
BD-1	198907.79	1273225.87	198908.39	1273236.39
BD-2	198875.87	1273270.02	198871.43	1273256.97
BD-3	198825.23	1273300.96	198823.90	1273306.14
BD-4	198803.67	1273321.79	198791.32	1273347.00
BD-5	198868.45	1273190.72	198868.36	1273196.09
BD-6	198832.38	1273223.37	198817.98	1273218.88
BD-7	198795.54	1273252.43	198792.66	1273252.33
BD-8	198767.01	1273290.06	198784.78	1273291.73

Notes: Horizontal Datum: Washington State Plane Coordinate System, North Zone (NAD-83/91), U.S. Feet

[a] Pre-Construction Boundary Area Documentation Stations

[b] Post-Construction Boundary Area Documentation Stations - target coordinates based on Pre-Construction Actuals

[c] Post-Placement Boundary Area Documentation Stations - target coordinates based on Post-Construction Actuals

[d] Station location is estimated based on visual observations as no location was recorded with the GPS

[e] Station location is estimated based on calculated centroid for composite samples

Table 2-2. Validated Analytical Results for Slip 4 Pre-Construction Boundary Area Samples

			Sample ID	BD-1		BD-2		BD-3		BD-3 (field split)		BD-4		BD-5		BD-6		BD-7		BD-8	
			Lab ID	SD0001		SD0002		SD0003		SD0004		SD0005		SD0006		SD0007		SD0008		SD0009	
			Sample Date	8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011	
Chemical Name	Method	SQS	CSL																		
PCB Aroclors																					
Aroclor 1016	SW8082			3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	19 *U*	µg/kg	3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	3.8 *U*	µg/kg
Aroclor 1221	SW8082			3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	19 *U*	µg/kg	3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	3.8 *U*	µg/kg
Aroclor 1232	SW8082			3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	19 *U*	µg/kg	3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	3.8 *U*	µg/kg
Aroclor 1242	SW8082			3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	19 *U*	µg/kg	3.8 *U*	µg/kg	3.9 *U*	µg/kg	3.8 *U*	µg/kg	3.8 *U*	µg/kg
Aroclor 1248	SW8082			54	µg/kg	100	µg/kg	62	µg/kg	58	µg/kg	190 *U*	µg/kg	54	µg/kg	42	µg/kg	64	µg/kg	78	µg/kg
Aroclor 1254	SW8082			82	µg/kg	150	µg/kg	97	µg/kg	91	µg/kg	310	µg/kg	80	µg/kg	64	µg/kg	100	µg/kg	130	µg/kg
Aroclor 1260	SW8082			61	µg/kg	97	µg/kg	70	µg/kg	64	µg/kg	220	µg/kg	59	µg/kg	41	µg/kg	80	µg/kg	76	µg/kg
Total Aroclors	Calculated	130	1300 [a]	200	µg/kg	350	µg/kg	230	µg/kg	210	µg/kg	530	µg/kg	190	µg/kg	150	µg/kg	240	µg/kg	280	µg/kg
Total Aroclors OC	Calculated	12	65	5.2	mg/kg-oc	15	mg/kg-oc	6.8	mg/kg-oc	--	mg/kg-oc	--	mg/kg-oc	--	mg/kg-oc	4.1	mg/kg-oc	--	mg/kg-oc	7.2	mg/kg-oc
Conventionals																					
Total organic carbon	Plumb1981			3.88	percent	2.36	percent	3.37	percent	5.1	percent	6.51	percent	4.2	percent	3.67	percent	5.18	percent	3.87	percent
Total solids	E160.3			30.3	percent	40.8	percent	41.4	percent	41.4	percent	41.4	percent	35.5	percent	39.3	percent	41.9	percent	44.1	percent
Metals																					
Arsenic	SW6010B	57	93	20 *U*	mg/kg	20	mg/kg	20	mg/kg	20	mg/kg	30	mg/kg	20	mg/kg	20	mg/kg	20	mg/kg	10	mg/kg
Cadmium	SW6010B	5.1	6.7	0.7	mg/kg	0.8	mg/kg	0.7	mg/kg	0.7	mg/kg	0.8	mg/kg	0.8	mg/kg	0.7	mg/kg	0.8	mg/kg	0.7	mg/kg
Chromium	SW6010B	260	270	35	mg/kg	37	mg/kg	35	mg/kg	35	mg/kg	39	mg/kg	36	mg/kg	37	mg/kg	37	mg/kg	35	mg/kg
Copper	SW6010B	390	390	62.6	mg/kg	68.8	mg/kg	65.3	mg/kg	64.7	mg/kg	78.3	mg/kg	68.1	mg/kg	64.8	mg/kg	66.4	mg/kg	61.7	mg/kg
Lead	SW6010B	450	530	22	mg/kg	27	mg/kg	25	mg/kg	25	mg/kg	47	mg/kg	26	mg/kg	25	mg/kg	25	mg/kg	25	mg/kg
Mercury	SW7471	0.41	0.59	0.16 *J*	mg/kg	0.17 *J*	mg/kg	0.31 *J*	mg/kg	0.16 *J*	mg/kg	0.13 *J*	mg/kg	0.17 *J*	mg/kg	0.17 *J*	mg/kg	0.16 *J*	mg/kg	0.15 *J*	mg/kg
Silver	SW6010B	6.1	6.1	0.9 *U*	mg/kg	0.7 *U*	mg/kg	0.7 *U*	mg/kg	0.7 *U*	mg/kg	0.7 *U*	mg/kg	0.8 *U*	mg/kg	0.7 *U*	mg/kg	0.7 *U*	mg/kg	0.6 *U*	mg/kg
Zinc	SW6010B	410	960	126 *J*	mg/kg	150 *J*	mg/kg	128 *J*	mg/kg	135 *J*	mg/kg	215 *J*	mg/kg	131 *J*	mg/kg	132 *J*	mg/kg	128 *J*	mg/kg	116 *J*	mg/kg
SVOCs																					
1,2,4-Trichlorobenzene	SW8270D	0.81 mg/kg-oc / 31 µg/kg	1.8 mg/kg-oc / 51 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
1,2-Dichlorobenzene	SW8270D	2.3 mg/kg-oc / 35 µg/kg	2.3 mg/kg-oc / 50 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
1,3-Dichlorobenzene	SW8270D	170	170	19 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	20 *U*	µg/kg
1,4-Dichlorobenzene	SW8270D	3.1 mg/kg-oc / 110 µg/kg	9 mg/kg-oc / 110 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
1-Methylnaphthalene	SW8270D	NA	NA	19 *U*	µg/kg	20 *U*	µg/kg	13 *J*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	20 *U*	µg/kg
2,4-Dimethylphenol	SW8270D	29	29	39 *U*	µg/kg	39 *U*	µg/kg	39 *U*	µg/kg	38 *U*	µg/kg	38 *U*	µg/kg	38 *U*	µg/kg	39 *U*	µg/kg	38 *U*	µg/kg	39 *U*	µg/kg
2-Methylnaphthalene	SW8270D	38 mg/kg-oc / 670 µg/kg	64 mg/kg-oc / 670 µg/kg	0.46 *J*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.45 *J*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	13 *J*	µg/kg	0.52 *U*	mg/kg-oc	12 *J*	µg/kg	0.31 *J*	mg/kg-oc
2-Methylphenol	SW8270D	63	63	19 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	20 *U*	µg/kg
4-Methylphenol	SW8270D	670	670	39 *U*	µg/kg	39 *U*	µg/kg	39 *U*	µg/kg	38 *U*	µg/kg	35 *J*	µg/kg	19 *J*	µg/kg	39 *U*	µg/kg	23 *J*	µg/kg	39 *U*	µg/kg
Acenaphthene	SW8270D	16 mg/kg-oc / 500 µg/kg	57 mg/kg-oc / 500 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	24	µg/kg	0.52 *U*	mg/kg-oc	13 *J*	µg/kg	0.52 *U*	mg/kg-oc
Acenaphthylene	SW8270D	66 mg/kg-oc / 1300 µg/kg	66 mg/kg-oc / 1300 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
Anthracene	SW8270D	220 mg/kg-oc / 960 µg/kg	1200 mg/kg-oc / 960 µg/kg	0.41 *J*	mg/kg-oc	0.59 *J*	mg/kg-oc	0.39 *J*	mg/kg-oc	12 *J*	µg/kg	34	µg/kg	33	µg/kg	0.52 *U*	mg/kg-oc	27	µg/kg	0.41 *J*	mg/kg-oc
Benz(a)anthracene	SW8270D	110 mg/kg-oc / 1300 µg/kg	270 mg/kg-oc / 1600 µg/kg	1.2	mg/kg-oc	2.1	mg/kg-oc	0.80	mg/kg-oc	34	µg/kg	90	µg/kg	180	µg/kg	0.79	mg/kg-oc	71	µg/kg	1.4	mg/kg-oc
Benzo(a)pyrene	SW8270D	99 mg/kg-oc / 1600 µg/kg	210 mg/kg-oc / 1600 µg/kg	0.67	mg/kg-oc	1.9	mg/kg-oc	0.86	mg/kg-oc	38	µg/kg	88	µg/kg	130	µg/kg	0.74	mg/kg-oc	78	µg/kg	1.6	mg/kg-oc
Benzo(g,h,i)perylene	SW8270D	31 mg/kg-oc / 670 µg/kg	78 mg/kg-oc / 720 µg/kg	0.41 *J*	mg/kg-oc	1.7	mg/kg-oc	0.83	mg/kg-oc	35	µg/kg	81	µg/kg	71	µg/kg	0.57	mg/kg-oc	69	µg/kg	1.4	mg/kg-oc
Benzofluoranthenes	SW8270D	230 mg/kg-oc / 3200 µg/kg	450 mg/kg-oc / 3600 µg/kg	1.8	mg/kg-oc	5.5	mg/kg-oc	2.3	mg/kg-oc	100	µg/kg	250	µg/kg	430	µg/kg	1.8	mg/kg-oc	200	µg/kg	4.1	mg/kg-oc
Benzoic acid	SW8270D	650	650	310 *J*	µg/kg	400	µg/kg	170 *J*	µg/kg	200 *J*	µg/kg	390	µg/kg	340 *J*	µg/kg	160 *J*	µg/kg	400	µg/kg	460	µg/kg

Table 2-2. Validated Analytical Results for Slip 4 Pre-Construction Boundary Area Samples

			Sample ID	BD-1		BD-2		BD-3		BD-3 (field split)		BD-4		BD-5		BD-6		BD-7		BD-8	
			Lab ID	SD0001		SD0002		SD0003		SD0004		SD0005		SD0006		SD0007		SD0008		SD0009	
			Sample Date	8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011		8/24/2011	
Chemical Name	Method	SQS	CSL																		
Benzyl alcohol	SW8270D	57	73	280	µg/kg	320	µg/kg	160	µg/kg	170	µg/kg	230	µg/kg	340	µg/kg	170	µg/kg	380	µg/kg	380	µg/kg
Bis(2-ethylhexyl) phthalate	SW8270D	47 mg/kg-oc / 1300 µg/kg	78 mg/kg-oc / 3100 µg/kg	1.5 *U*	mg/kg-oc	5.9 *U*	mg/kg-oc	2.9 *U*	mg/kg-oc	120 *U*	µg/kg	160 *U*	µg/kg	230	µg/kg	2.3 *U*	mg/kg-oc	280	µg/kg	4.9	mg/kg-oc
Butylbenzyl phthalate	SW8270D	4.9 mg/kg-oc / 63 µg/kg	64 mg/kg-oc / 900 µg/kg	0.49 *U*	mg/kg-oc	0.47 *J*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	49	µg/kg	9.5 *J*	µg/kg	0.52 *U*	mg/kg-oc	14 *J*	µg/kg	0.28 *J*	mg/kg-oc
Chrysene	SW8270D	110 mg/kg-oc / 1400 µg/kg	460 mg/kg-oc / 2800 µg/kg	1.6	mg/kg-oc	2.8	mg/kg-oc	1.3	mg/kg-oc	56	µg/kg	220	µg/kg	260	µg/kg	1.2	mg/kg-oc	140	µg/kg	2.4	mg/kg-oc
Di-n-octyl phthalate	SW8270D	58 mg/kg-oc / 6200 µg/kg	4500 mg/kg-oc / 6200 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	25	µg/kg	0.52 *U*	mg/kg-oc	20	µg/kg	0.70	mg/kg-oc
Dibenz(a,h)anthracene	SW8270D	12 mg/kg-oc / 230 µg/kg	33 mg/kg-oc / 230 µg/kg	0.49 *U*	mg/kg-oc	0.55 *J*	mg/kg-oc	0.59 *U*	mg/kg-oc	10 *J*	µg/kg	16 *J*	µg/kg	33	µg/kg	0.52 *U*	mg/kg-oc	24	µg/kg	0.54	mg/kg-oc
Dibenzofuran	SW8270D	15 mg/kg-oc / 540 µg/kg	58 mg/kg-oc / 540 µg/kg	0.59	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	9.6 *J*	µg/kg	21	µg/kg	0.52 *U*	mg/kg-oc	16 *J*	µg/kg	0.34 *J*	mg/kg-oc
Dibutyl phthalate	SW8270D	220 mg/kg-oc / 1400 µg/kg	1700 mg/kg-oc / 5100 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
Diethyl phthalate	SW8270D	61 mg/kg-oc / 200 µg/kg	110 mg/kg-oc / 1200 µg/kg	1.2 *U*	mg/kg-oc	2.1 *U*	mg/kg-oc	1.5 *U*	mg/kg-oc	47 *U*	µg/kg	48 *U*	µg/kg	48 *U*	µg/kg	1.3 *U*	mg/kg-oc	47 *U*	µg/kg	1.3 *U*	mg/kg-oc
Dimethyl phthalate	SW8270D	53 mg/kg-oc / 71 µg/kg	53 mg/kg-oc / 160 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
Fluoranthene	SW8270D	160 mg/kg-oc / 1700 µg/kg	1200 mg/kg-oc / 2500 µg/kg	4.6	mg/kg-oc	5.1	mg/kg-oc	2.0	mg/kg-oc	88	µg/kg	320	µg/kg	430	µg/kg	2.1	mg/kg-oc	210	µg/kg	3.9	mg/kg-oc
Fluorene	SW8270D	23 mg/kg-oc / 540 µg/kg	79 mg/kg-oc / 540 µg/kg	0.62	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	12 *J*	µg/kg	15 *J*	µg/kg	0.52 *U*	mg/kg-oc	10 *J*	µg/kg	0.52 *U*	mg/kg-oc
HPAH	CALC	960 mg/kg-oc / 12000 µg/kg	5300 mg/kg-oc / 17000 µg/kg	15 *J*	mg/kg-oc	25 *J*	mg/kg-oc	11	mg/kg-oc	464 *J*	µg/kg	1353 *J*	µg/kg	1956	µg/kg	9.3 *J*	mg/kg-oc	1008	µg/kg	20	mg/kg-oc
Hexachlorobenzene	SW8270D	0.38 mg/kg-oc / 22 µg/kg	2.3 mg/kg-oc / 70 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
Hexachlorobutadiene	SW8270D	3.9 mg/kg-oc / 11 µg/kg	6.2 mg/kg-oc / 120 µg/kg	2.5 *U*	mg/kg-oc	4.2 *U*	mg/kg-oc	2.9 *U*	mg/kg-oc	95 *U*	µg/kg	96 *U*	µg/kg	95 *U*	µg/kg	2.6 *U*	mg/kg-oc	94 *U*	µg/kg	2.5 *U*	mg/kg-oc
Hexachloroethane	SW8270D	NA	NA	19 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	20 *U*	µg/kg
Indeno(1,2,3-cd)pyrene	SW8270D	34 mg/kg-oc / 600 µg/kg	88 mg/kg-oc / 690 µg/kg	0.36 *J*	mg/kg-oc	1.5	mg/kg-oc	0.71	mg/kg-oc	28	µg/kg	68	µg/kg	72	µg/kg	0.44 *J*	mg/kg-oc	56	µg/kg	1.2	mg/kg-oc
LPAH	CALC	370 mg/kg-oc / 5200 µg/kg	780 mg/kg-oc / 5200 µg/kg	4.9 *J*	mg/kg-oc	2.9 *J*	mg/kg-oc	1.2 *J*	mg/kg-oc	57.5 *J*	µg/kg	149 *J*	µg/kg	209 *J*	µg/kg	0.74	mg/kg-oc	147 *J*	µg/kg	2.2 *J*	mg/kg-oc
N-Nitrosodiphenylamine	SW8270D	11 mg/kg-oc / 28 µg/kg	11 mg/kg-oc / 40 µg/kg	0.49 *U*	mg/kg-oc	0.85 *U*	mg/kg-oc	0.59 *U*	mg/kg-oc	19 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	0.52 *U*	mg/kg-oc	19 *U*	µg/kg	0.52 *U*	mg/kg-oc
Naphthalene	SW8270D	99 mg/kg-oc / 2100 µg/kg	170 mg/kg-oc / 2100 µg/kg	0.28 *J*	mg/kg-oc	0.59 *J*	mg/kg-oc	0.59 *U*	mg/kg-oc	9.5 *J*	µg/kg	12 *J*	µg/kg	17 *J*	µg/kg	0.52 *U*	mg/kg-oc	20	µg/kg	0.39 *J*	mg/kg-oc
Pentachlorophenol	SW8270D	360	690	190 *U*	µg/kg	200 *U*	µg/kg	200 *U*	µg/kg	190 *U*	µg/kg	190 *U*	µg/kg	190 *U*	µg/kg	190 *U*	µg/kg	190 *U*	µg/kg	200 *U*	µg/kg
Phenanthrene	SW8270D	100 mg/kg-oc / 1500 µg/kg	480 mg/kg-oc / 1500 µg/kg	3.6	mg/kg-oc	1.7	mg/kg-oc	0.86	mg/kg-oc	36	µg/kg	91	µg/kg	120	µg/kg	0.74	mg/kg-oc	77	µg/kg	1.4	mg/kg-oc
Phenol	SW8270D	420	1200	24	µg/kg	46	µg/kg	19 *J*	µg/kg	19	µg/kg	32	µg/kg	29	µg/kg	16 *J*	µg/kg	39	µg/kg	76	µg/kg
Pyrene	SW8270D	1000 mg/kg-oc / 2600 µg/kg	1400 mg/kg-oc / 3300 µg/kg	3.9	mg/kg-oc	4.2	mg/kg-oc	1.8	mg/kg-oc	75	µg/kg	220	µg/kg	350	µg/kg	1.7	mg/kg-oc	160	µg/kg	3.1	mg/kg-oc

Notes:

[a] The cleanup screening level is as reported in the Lower Duwamish Waterway feasibility study.

-- = No calculation performed because total organic carbon was outside of range.

J = The associated numerical value is the approximate concentration.

U = Not detected above the reported sample quantitation limit.

Results were OC-normalized for samples with TOC concentrations ranging from 0.5 to 4.0%. Results for samples that had TOC concentrations below or above this range were compared to SQS/CSL values.

Result exceeds LAET/SQS value.

Result exceeds 2LAET/CSL value.

Table 2-3. Validated Analytical Results for Slip 4 Post-construction Boundary Area Samples

			Sample ID	BD-1		BD-2		BD-3		BD-4		BD-5		BD-6		BD-7		BD-8	
			Lab ID	SD0041		SD0042		SD0043		SD0044		SD0045		SD0046		SD0047		SD0048	
			Sample Date	2/2/2012		2/2/2012		2/2/2012		2/2/2012		2/1/2012		2/1/2012		2/1/2012		2/1/2012	
Chemical Name	Method	SQS	CSL																
PCB Aroclors																			
Aroclor 1016	SW8082			19 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg
Aroclor 1221	SW8082			19 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg
Aroclor 1232	SW8082			19 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg
Aroclor 1242	SW8082			19 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg
Aroclor 1248	SW8082			340	µg/kg	220	µg/kg	110	µg/kg	340	µg/kg	180	µg/kg	180	µg/kg	180	µg/kg	230	µg/kg
Aroclor 1254	SW8082			680	µg/kg	420	µg/kg	200	µg/kg	950	µg/kg	360	µg/kg	330	µg/kg	390	µg/kg	520	µg/kg
Aroclor 1260	SW8082			190	µg/kg	120	µg/kg	100	µg/kg	270	µg/kg	110	µg/kg	120	µg/kg	110	µg/kg	130	µg/kg
Total Aroclors	Calculated	130	1300 [a]	1200	µg/kg	760	µg/kg	410	µg/kg	1600	µg/kg	650	µg/kg	630	µg/kg	680	µg/kg	880	µg/kg
Total Aroclors OC	Calculated	12	65	48	mg/kg-oc	29	mg/kg-oc	14	mg/kg-oc	63	mg/kg-oc	30	mg/kg-oc	30	mg/kg-oc	29	mg/kg-oc	44	mg/kg-oc
Conventionals																			
Total organic carbon	Plumb1981			2.52	percent	2.58	percent	2.92	percent	2.53	percent	2.15	percent	2.08	percent	2.37	percent	2.00	percent
Total solids	E160.3			48.2	percent	45.4	percent	41.1	percent	49.5	percent	45.2	percent	43.7	percent	42.6	percent	55.8	percent
Metals																			
Arsenic	SW6010B	57	93	20	mg/kg	20	mg/kg	10	mg/kg	10	mg/kg	20	mg/kg	20	mg/kg	20	mg/kg	10	mg/kg
Cadmium	SW6010B	5.1	6.7	0.8	mg/kg	0.8	mg/kg	0.8	mg/kg	0.7	mg/kg	0.8	mg/kg	0.8	mg/kg	0.8	mg/kg	0.6	mg/kg
Chromium	SW6010B	260	270	37	mg/kg	35	mg/kg	34	mg/kg	32	mg/kg	35	mg/kg	36	mg/kg	35	mg/kg	25.8	mg/kg
Copper	SW6010B	390	390	65.4	mg/kg	64.7	mg/kg	64.7	mg/kg	68.1	mg/kg	63.1	mg/kg	79.9	mg/kg	68.6	mg/kg	48.2	mg/kg
Lead	SW6010B	450	530	32	mg/kg	28	mg/kg	27	mg/kg	33	mg/kg	25	mg/kg	26	mg/kg	26	mg/kg	24	mg/kg
Mercury	SW7471	0.41	0.59	0.13 *J*	mg/kg	0.14 *J*	mg/kg	0.15 *J*	mg/kg	0.12 *J*	mg/kg	0.12 *J*	mg/kg	0.11 *J*	mg/kg	0.12 *J*	mg/kg	0.1 *J*	mg/kg
Silver	SW6010B	6.1	6.1	0.6 *U*	mg/kg	0.7 *U*	mg/kg	0.7 *U*	mg/kg	0.6 *U*	mg/kg	0.6 *U*	mg/kg	0.7 *U*	mg/kg	0.7 *U*	mg/kg	0.5 *U*	mg/kg
Zinc	SW6010B	410	960	159 *J*	mg/kg	116 *J*	mg/kg	118 *J*	mg/kg	112 *J*	mg/kg	111 *J*	mg/kg	112 *J*	mg/kg	119 *J*	mg/kg	84 *J*	mg/kg
SVOCs																			
1,2,4-Trichlorobenzene	SW8270D	0.81 mg/kg-oc / 31 µg/kg	1.8 mg/kg-oc / 51 µg/kg	0.79 *U*	mg/kg-oc	0.78 *U*	mg/kg-oc	0.68 *U*	mg/kg-oc	0.79 *U*	mg/kg-oc	0.88 *U*	mg/kg-oc	0.91 *U*	mg/kg-oc	0.84 *U*	mg/kg-oc	0.95 *U*	mg/kg-oc
1,2-Dichlorobenzene	SW8270D	2.3 mg/kg-oc / 35 µg/kg	2.3 mg/kg-oc / 50 µg/kg	0.79 *U*	mg/kg-oc	0.78 *U*	mg/kg-oc	0.68 *U*	mg/kg-oc	0.79 *U*	mg/kg-oc	0.88 *U*	mg/kg-oc	0.91 *U*	mg/kg-oc	0.84 *U*	mg/kg-oc	0.95 *U*	mg/kg-oc
1,3-Dichlorobenzene	SW8270D	170	170	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg
1,4-Dichlorobenzene	SW8270D	3.1 mg/kg-oc / 110 µg/kg	9 mg/kg-oc / 110 µg/kg	0.79 *U*	mg/kg-oc	0.78 *U*	mg/kg-oc	0.68 *U*	mg/kg-oc	0.79 *U*	mg/kg-oc	0.88 *U*	mg/kg-oc	0.91 *U*	mg/kg-oc	0.84 *U*	mg/kg-oc	0.95 *U*	mg/kg-oc
1-Methylnaphthalene	SW8270D	NA	NA	680	µg/kg	35	µg/kg	130	µg/kg	20	µg/kg	42	µg/kg	30	µg/kg	32	µg/kg	13 *J*	µg/kg
2,4-Dimethylphenol	SW8270D	29	29	20 *UJ*	µg/kg	20 *UJ*	µg/kg	20 *UJ*	µg/kg	20 *UJ*	µg/kg	19 *UJ*	µg/kg	19 *UJ*	µg/kg	20 *UJ*	µg/kg	19 *UJ*	µg/kg
2-Methylnaphthalene	SW8270D	38 mg/kg-oc / 670 µg/kg	64 mg/kg-oc / 670 µg/kg	48	mg/kg-oc	2.5	mg/kg-oc	8.2	mg/kg-oc	1.5	mg/kg-oc	3.3	mg/kg-oc	2.6	mg/kg-oc	2.4	mg/kg-oc	1.1	mg/kg-oc
2-Methylphenol	SW8270D	63	63	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg
4-Methylphenol	SW8270D	670	670	25 *J*	µg/kg	19 *J*	µg/kg	23 *J*	µg/kg	18 *J*	µg/kg	16 *J*	µg/kg	17 *J*	µg/kg	18 *J*	µg/kg	11 *J*	µg/kg
Acenaphthene	SW8270D	16 mg/kg-oc / 500 µg/kg	57 mg/kg-oc / 500 µg/kg	67	mg/kg-oc	6.6	mg/kg-oc	23	mg/kg-oc	4.3	mg/kg-oc	9.8	mg/kg-oc	7.7	mg/kg-oc	6.8	mg/kg-oc	3.4	mg/kg-oc
Acenaphthylene	SW8270D	66 mg/kg-oc / 1300 µg/kg	66 mg/kg-oc / 1300 µg/kg	1.9	mg/kg-oc	0.78 *U*	mg/kg-oc	0.68 *U*	mg/kg-oc	0.75 *J*	mg/kg-oc	0.79 *J*	mg/kg-oc	0.58 *J*	mg/kg-oc	0.63 *J*	mg/kg-oc	0.55 *J*	mg/kg-oc
Anthracene	SW8270D	220 mg/kg-oc / 960 µg/kg	1200 mg/kg-oc / 960 µg/kg	25	mg/kg-oc	5.8	mg/kg-oc	14	mg/kg-oc	7.1	mg/kg-oc	11	mg/kg-oc	7.7	mg/kg-oc	6.3	mg/kg-oc	4.5	mg/kg-oc
Benzo(a)anthracene	SW8270D	110 mg/kg-oc / 1300 µg/kg	270 mg/kg-oc / 1600 µg/kg	28	mg/kg-oc	10	mg/kg-oc	14	mg/kg-oc	13	mg/kg-oc	17	mg/kg-oc	13	mg/kg-oc	11	mg/kg-oc	10	mg/kg-oc
Benzo(a)pyrene	SW8270D	99 mg/kg-oc / 1600 µg/kg	210 mg/kg-oc / 1600 µg/kg	15	mg/kg-oc	7.0	mg/kg-oc	7.2	mg/kg-oc	9.9	mg/kg-oc	8.8	mg/kg-oc	7.7	mg/kg-oc	6.8	mg/kg-oc	8.0	mg/kg-oc
Benzo(g,h,i)perylene	SW8270D	31 mg/kg-oc / 670 µg/kg	78 mg/kg-oc / 720 µg/kg	5.6	mg/kg-oc	4.3	mg/kg-oc	2.7	mg/kg-oc	3.9	mg/kg-oc	4.0	mg/kg-oc	4.4	mg/kg-oc	3.7	mg/kg-oc	4.1	mg/kg-oc
Benzofluoranthenes	SW8270D	230 mg/kg-oc / 3200 µg/kg	450 mg/kg-oc / 3600 µg/kg	34	mg/kg-oc	16	mg/kg-oc	17	mg/kg-oc	22	mg/kg-oc	19	mg/kg-oc	18	mg/kg-oc	16	mg/kg-oc	18	mg/kg-oc

Table 2-3. Validated Analytical Results for Slip 4 Post-construction Boundary Area Samples

				Sample ID	BD-1		BD-2		BD-3		BD-4		BD-5		BD-6		BD-7		BD-8	
				Lab ID	SD0041		SD0042		SD0043		SD0044		SD0045		SD0046		SD0047		SD0048	
				Sample Date	2/2/2012		2/2/2012		2/2/2012		2/2/2012		2/1/2012		2/1/2012		2/1/2012		2/1/2012	
Chemical Name	Method	SQS	CSL																	
Benzoic acid	SW8270D	650	650		140 *J*	µg/kg	170 *J*	µg/kg	270 *J*	µg/kg	120 *J*	µg/kg	120 *J*	µg/kg	120 *J*	µg/kg	170 *J*	µg/kg	130 *J*	µg/kg
Benzyl alcohol	SW8270D	57	73		210 *J*	µg/kg	180 *J*	µg/kg	220 *J*	µg/kg	160 *J*	µg/kg	200 *J*	µg/kg	140 *J*	µg/kg	190 *J*	µg/kg	98 *J*	µg/kg
Bis(2-ethylhexyl) phthalate	SW8270D	47 mg/kg-oc / 1300 µg/kg	78 mg/kg-oc / 3100 µg/kg		22	mg/kg-oc	16	mg/kg-oc	13	mg/kg-oc	17	mg/kg-oc	14	mg/kg-oc	20	mg/kg-oc	17	mg/kg-oc	16	mg/kg-oc
Butylbenzyl phthalate	SW8270D	4.9 mg/kg-oc / 63 µg/kg	64 mg/kg-oc / 900 µg/kg		0.75 *J*	mg/kg-oc	0.66 *J*	mg/kg-oc	0.75	mg/kg-oc	0.59 *J*	mg/kg-oc	0.56 *J*	mg/kg-oc	0.67 *J*	mg/kg-oc	0.68 *J*	mg/kg-oc	0.50 *J*	mg/kg-oc
Chrysene	SW8270D	110 mg/kg-oc / 1400 µg/kg	460 mg/kg-oc / 2800 µg/kg		34	mg/kg-oc	13	mg/kg-oc	18	mg/kg-oc	17	mg/kg-oc	22	mg/kg-oc	17	mg/kg-oc	15	mg/kg-oc	13	mg/kg-oc
Di-n-octyl phthalate	SW8270D	58 mg/kg-oc / 6200 µg/kg	4500 mg/kg-oc / 6200 µg/kg		2.5	mg/kg-oc	1.2	mg/kg-oc	0.79	mg/kg-oc	1.6	mg/kg-oc	6.5	mg/kg-oc	2.3	mg/kg-oc	1.9	mg/kg-oc	1.6	mg/kg-oc
Dibenzo(a,h)anthracene	SW8270D	12 mg/kg-oc / 230 µg/kg	33 mg/kg-oc / 230 µg/kg		2.7	mg/kg-oc	1.7	mg/kg-oc	1.2	mg/kg-oc	1.7	mg/kg-oc	1.3	mg/kg-oc	1.8	mg/kg-oc	1.6	mg/kg-oc	1.8	mg/kg-oc
Dibenzofuran	SW8270D	15 mg/kg-oc / 540 µg/kg	58 mg/kg-oc / 540 µg/kg		52	mg/kg-oc	6.2	mg/kg-oc	21	mg/kg-oc	3.9	mg/kg-oc	8.4	mg/kg-oc	7.2	mg/kg-oc	6.3	mg/kg-oc	2.4	mg/kg-oc
Dibutyl phthalate	SW8270D	220 mg/kg-oc / 1400 µg/kg	1700 mg/kg-oc / 5100 µg/kg		0.79 *U*	mg/kg-oc	0.78 *U*	mg/kg-oc	0.62 *J*	mg/kg-oc	0.79 *U*	mg/kg-oc	0.88 *U*	mg/kg-oc	0.67 *J*	mg/kg-oc	0.84 *U*	mg/kg-oc	0.95 *U*	mg/kg-oc
Diethyl phthalate	SW8270D	61 mg/kg-oc / 200 µg/kg	110 mg/kg-oc / 1200 µg/kg		1.9 *U*	mg/kg-oc	1.9 *U*	mg/kg-oc	1.7 *U*	mg/kg-oc	1.9 *U*	mg/kg-oc	2.2 *U*	mg/kg-oc	2.3 *U*	mg/kg-oc	2.1 *U*	mg/kg-oc	2.4 *U*	mg/kg-oc
Dimethyl phthalate	SW8270D	53 mg/kg-oc / 71 µg/kg	53 mg/kg-oc / 160 µg/kg		0.79 *U*	mg/kg-oc	0.78 *U*	mg/kg-oc	0.68 *U*	mg/kg-oc	0.79 *U*	mg/kg-oc	0.88 *U*	mg/kg-oc	0.91 *U*	mg/kg-oc	0.84 *U*	mg/kg-oc	0.95 *U*	mg/kg-oc
Fluoranthene	SW8270D	160 mg/kg-oc / 1700 µg/kg	1200 mg/kg-oc / 2500 µg/kg		190	mg/kg-oc	38	mg/kg-oc	92	mg/kg-oc	47	mg/kg-oc	65	mg/kg-oc	53	mg/kg-oc	42	mg/kg-oc	33	mg/kg-oc
Fluorene	SW8270D	23 mg/kg-oc / 540 µg/kg	79 mg/kg-oc / 540 µg/kg		67	mg/kg-oc	8.9	mg/kg-oc	28	mg/kg-oc	6.7	mg/kg-oc	15	mg/kg-oc	11	mg/kg-oc	9.7	mg/kg-oc	4.0	mg/kg-oc
HPAH	CALC	960 mg/kg-oc / 12000 µg/kg	5300 mg/kg-oc / 17000 µg/kg		440	mg/kg-oc	120	mg/kg-oc	210	mg/kg-oc	150.00	mg/kg-oc	200	mg/kg-oc	160	mg/kg-oc	130	mg/kg-oc	120	mg/kg-oc
Hexachlorobenzene	SW8270D	0.38 mg/kg-oc / 22 µg/kg	2.3 mg/kg-oc / 70 µg/kg		0.79 *U*	mg/kg-oc	0.78 *U*	mg/kg-oc	0.68 *U*	mg/kg-oc	0.79 *U*	mg/kg-oc	0.88 *U*	mg/kg-oc	0.91 *U*	mg/kg-oc	0.84 *U*	mg/kg-oc	0.95 *U*	mg/kg-oc
Hexachlorobutadiene	SW8270D	3.9 mg/kg-oc / 11 µg/kg	6.2 mg/kg-oc / 120 µg/kg		0.39 *UJ*	mg/kg-oc	0.38 *UJ*	mg/kg-oc	0.33 *UJ*	mg/kg-oc	0.39 *UJ*	mg/kg-oc	0.45 *UJ*	mg/kg-oc	0.46 *UJ*	mg/kg-oc	0.41 *UJ*	mg/kg-oc	0.48 *UJ*	mg/kg-oc
Hexachloroethane	SW8270D	NA	NA		20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg	19 *U*	µg/kg	20 *U*	µg/kg	19 *U*	µg/kg
Indeno(1,2,3-cd)pyrene	SW8270D	34 mg/kg-oc / 600 µg/kg	88 mg/kg-oc / 690 µg/kg		5.6	mg/kg-oc	3.6	mg/kg-oc	2.8	mg/kg-oc	3.6	mg/kg-oc	3.8	mg/kg-oc	3.9	mg/kg-oc	3.5	mg/kg-oc	3.7	mg/kg-oc
LPAH	CALC	370 mg/kg-oc / 5200 µg/kg	780 mg/kg-oc / 5200 µg/kg		490	mg/kg-oc	60 *J*	mg/kg-oc	200	mg/kg-oc	51 *J*	mg/kg-oc	110 *J*	mg/kg-oc	78 *J*	mg/kg-oc	65 *J*	mg/kg-oc	31 *J*	mg/kg-oc
N-Nitrosodiphenylamine	SW8270D	11 mg/kg-oc / 28 µg/kg	11 mg/kg-oc / 40 µg/kg		1.3	mg/kg-oc	0.78 *U*	mg/kg-oc	0.82	mg/kg-oc	0.79 *U*	mg/kg-oc	0.88 *U*	mg/kg-oc	0.91 *U*	mg/kg-oc	0.84 *U*	mg/kg-oc	0.95 *U*	mg/kg-oc
Naphthalene	SW8270D	99 mg/kg-oc / 2100 µg/kg	170 mg/kg-oc / 2100 µg/kg		63	mg/kg-oc	2.3	mg/kg-oc	6.5	mg/kg-oc	1.7	mg/kg-oc	5.1	mg/kg-oc	3.4	mg/kg-oc	2.9	mg/kg-oc	1.4	mg/kg-oc
Pentachlorophenol	SW8270D	360	690		200 *U*	µg/kg	200 *U*	µg/kg	200 *U*	µg/kg	200 *U*	µg/kg	190 *U*	µg/kg	190 *U*	µg/kg	200 *U*	µg/kg	190 *U*	µg/kg
Phenanthrene	SW8270D	100 mg/kg-oc / 1500 µg/kg	480 mg/kg-oc / 1500 µg/kg		262	mg/kg-oc	36 *J*	mg/kg-oc	134	mg/kg-oc	30	mg/kg-oc	70	mg/kg-oc	48	mg/kg-oc	39	mg/kg-oc	17	mg/kg-oc
Phenol	SW8270D	420	1200		25	µg/kg	25	µg/kg	35	µg/kg	17 *J*	µg/kg	23	µg/kg	20	µg/kg	23	µg/kg	11 *J*	µg/kg
Pyrene	SW8270D	1000 mg/kg-oc / 2600 µg/kg	1400 mg/kg-oc / 3300 µg/kg		127	mg/kg-oc	29	mg/kg-oc	51	mg/kg-oc	36	mg/kg-oc	56	mg/kg-oc	38	mg/kg-oc	31	mg/kg-oc	26	mg/kg-oc

Notes:

[a] The cleanup screening level is as reported in the Lower Duwamish Waterway feasibility study.

J = The associated numerical value is the approximate concentration.

U = Not detected above the reported sample quantitation limit.

UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate.

Results were OC-normalized for samples with TOC concentrations ranging from 0.5 to 4.0%. Results for samples that had TOC concentrations below or above this range were compared to SQS/CSL values.

Result exceeds LAET/SQS value.

Result exceeds 2LAET/CSL value.

Table 2-4. Validated Analytical Results for Slip 4 Post-placement Boundary Area Samples

					Sample ID	BD-1	BD-2	BD-3	BD-3 (field split)	BD-4	BD-5	BD-6	BD-7	BD-8
					Lab ID	SD0056	SD0054	SD0049	SD0050	SD0057	SD0052	SD0051	SD0053	SD0055
					Sample Date	2/14/2012	2/14/2012	2/14/2012	2/14/2012	2/14/2012	2/14/2012	2/14/2012	2/14/2012	2/14/2012
Chemical Name	Method	Unit	SQS	CSL										
PCB Aroclors														
Aroclor 1016	SW8082	µg/kg				3.7 *U*	3.9 *U*	3.9 *U*	3.7 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Aroclor 1221	SW8082	µg/kg				16 *U*	14 *U*	12 *U*	17 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Aroclor 1232	SW8082	µg/kg				3.7 *U*	3.9 *U*	3.9 *U*	3.7 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Aroclor 1242	SW8082	µg/kg				3.7 *U*	3.9 *U*	3.9 *U*	3.7 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Aroclor 1248	SW8082	µg/kg				3.7 *U*	3.9 *U*	3.9 *U*	3.7 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Aroclor 1254	SW8082	µg/kg				6.8	3.9 *U*	3.9 *U*	3.7 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Aroclor 1260	SW8082	µg/kg				3.7 *U*	3.9 *U*	3.9 *U*	3.7 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Total Aroclors	Calculated	µg/kg	130	1300 [a]		6.8	14 *U*	12 *U*	17 *U*	3.7 *U*	4 *U*	3.9 *U*	3.8 *U*	3.8 *U*
Total Aroclors OC	Calculated	mg/kg-oc	12	65		--	--	--	--	--	--	--	--	--
Conventionals														
Total organic carbon	Plumb 1981	percent				0.241	0.162	0.191	0.124	0.154	0.085	0.171	0.073	0.099
Total solids	E160.3	percent				83	89.5	88	90.5	94.3	89.5	90.6	94.6	90.8

Notes:
[a] The cleanup screening level is as reported in the Lower Duwamish Waterway feasibility study.
-- = No calculation performed because total organic carbon was outside of range.
U = Not detected above the reported sample quantitation limit.

Results were OC-normalized for samples with TOC concentrations ranging from 0.5 to 4.0%. Results for samples that had TOC concentrations below or above this range were compared to SQS/CSL values.

Table 2-5. Validated Analytical Results for Slip 4 Post-dredge/Excavation Documentation Samples

			Sample ID	PE-1	PE-2	PE-3	PE-4	PE-5	PE-5 (field split)	PE-6	PE-7	PE-8	PE-9	PE-10	PE-11	PE-12	PE-13	PE-14
			Lab ID	SD0018	SD0010	SD0023	SD0011	SD0012	SD0013	SD0024	SD0014	SD0019	SD0015	SD0020	SD0016	SD0021	SD0017	SD0022
			Sample Date	11/14/2011	11/16/2011	11/14/2011	11/16/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011
Chemical Name	Method	SQS	CSL															
PCB Aroclors																		
Aroclor 1016	SW8082			3.5 *U* µg/kg	1800 *U* µg/kg	37 *U* µg/kg	1200 *U* µg/kg	38 *U* µg/kg	200 *U* µg/kg	3.9 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	40 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	3.7 *U* µg/kg
Aroclor 1221	SW8082			3.5 *U* µg/kg	1800 *U* µg/kg	37 *U* µg/kg	1200 *U* µg/kg	38 *U* µg/kg	200 *U* µg/kg	3.9 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	40 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	3.7 *U* µg/kg
Aroclor 1232	SW8082			11 *U* µg/kg	1800 *U* µg/kg	37 *U* µg/kg	1200 *U* µg/kg	38 *U* µg/kg	200 *U* µg/kg	3.9 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	40 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	3.7 *U* µg/kg
Aroclor 1242	SW8082			3.5 *U* µg/kg	1800 *U* µg/kg	37 *U* µg/kg	1200 *U* µg/kg	38 *U* µg/kg	200 *U* µg/kg	3.9 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	40 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	3.7 *U* µg/kg
Aroclor 1248	SW8082			3.5 *U* µg/kg	22000 *U* µg/kg	55 *U* µg/kg	7200 *U* µg/kg	150 *U* µg/kg	200 *U* µg/kg	3.9 *U* µg/kg	160 *U* µg/kg	38 *U* µg/kg	400 *U* µg/kg	78 *U* µg/kg	130 *U* µg/kg	120 *U* µg/kg	96 *U* µg/kg	3.7 *U* µg/kg
Aroclor 1254	SW8082			7.3 µg/kg	26000 µg/kg	390 µg/kg	23000 µg/kg	820 µg/kg	1100 µg/kg	12 *U* µg/kg	420 µg/kg	220 µg/kg	1300 µg/kg	320 µg/kg	750 µg/kg	980 µg/kg	460 µg/kg	3.7 *U* µg/kg
Aroclor 1260	SW8082			4.7 µg/kg	4600 µg/kg	98 µg/kg	1700 *U* µg/kg	390 µg/kg	270 µg/kg	25 µg/kg	68 µg/kg	78 µg/kg	230 *J* µg/kg	210 µg/kg	610 µg/kg	1100 µg/kg	110 µg/kg	7.4 µg/kg
Total Aroclors	Calculated	130	1300 [a]	12 µg/kg	31000 µg/kg	490 µg/kg	23000 µg/kg	1200 µg/kg	1400 µg/kg	25 µg/kg	490 µg/kg	300 µg/kg	1500 *J* µg/kg	530 µg/kg	1400 µg/kg	2100 µg/kg	570 µg/kg	7.4 µg/kg
Total Aroclors OC	Calculated	12	65	-- mg/kg-oc	-- mg/kg-oc	42 mg/kg-oc	1300 mg/kg-oc	69 mg/kg-oc	98 mg/kg-oc	3.0 mg/kg-oc	51 mg/kg-oc	11 mg/kg-oc	71 mg/kg-oc	16 mg/kg-oc	53 mg/kg-oc	65 mg/kg-oc	36 mg/kg-oc	0.6 mg/kg-oc
Conventionals																		
Total organic carbon	Plumb1981			0.361 *J* percent	4.86 *J* percent	1.18 *J* percent	1.71 *J* percent	1.74 *J* percent	1.43 *J* percent	0.829 *J* percent	0.952 *J* percent	2.62 *J* percent	2.1 *J* percent	3.39 *J* percent	2.63 *J* percent	3.25 *J* percent	1.57 *J* percent	1.32 *J* percent
Total solids	E160.3			91 percent	40.9 percent	82 percent	69.7 percent	75.5 percent	74.6 percent	88.1 percent	72.8 percent	91.4 percent	74.1 percent	92.6 percent	84.7 percent	92 percent	74.6 percent	87.7 percent
Metals																		
Arsenic	SW6010B	57	93	5 *U* mg/kg	20 mg/kg	10 mg/kg	7 mg/kg	6 *U* mg/kg	6 *U* mg/kg	7 mg/kg	7 *U* mg/kg	7 mg/kg	9 mg/kg	6 mg/kg	10 mg/kg	10 mg/kg	6 *U* mg/kg	6 mg/kg
Cadmium	SW6010B	5.1	6.7	0.2 *U* mg/kg	2.4 mg/kg	0.5 mg/kg	1 mg/kg	0.3 *U* mg/kg	0.2 *U* mg/kg	0.4 mg/kg	0.3 *U* mg/kg	0.5 mg/kg	1.2 mg/kg	0.3 mg/kg	0.3 mg/kg	0.4 mg/kg	0.2 *U* mg/kg	0.3 mg/kg
Chromium	SW6010B	260	270	26.3 mg/kg	55 mg/kg	23.2 mg/kg	23 mg/kg	15.7 mg/kg	15.7 mg/kg	19.7 mg/kg	15.7 mg/kg	28.4 mg/kg	32.2 mg/kg	28.3 mg/kg	34.7 mg/kg	33.9 mg/kg	15.7 mg/kg	16.9 mg/kg
Copper	SW6010B	390	390	15.5 mg/kg	113 mg/kg	35.4 mg/kg	33.7 mg/kg	23.2 mg/kg	22.4 mg/kg	25.6 mg/kg	23.2 mg/kg	38.2 mg/kg	36.1 mg/kg	30.3 mg/kg	42.3 mg/kg	43.4 mg/kg	19.2 mg/kg	30.6 mg/kg
Lead	SW6010B	450	530	6 mg/kg	222 mg/kg	46 mg/kg	50 mg/kg	25 mg/kg	35 mg/kg	20 mg/kg	15 mg/kg	25 mg/kg	51 mg/kg	26 mg/kg	31 mg/kg	45 mg/kg	23 mg/kg	33 mg/kg
Mercury	SW7471	0.41	0.59	0.02 mg/kg	0.69 mg/kg	0.05 mg/kg	0.15 mg/kg	0.04 mg/kg	0.04 mg/kg	0.11 mg/kg	0.06 mg/kg	0.19 mg/kg	0.34 mg/kg	0.12 mg/kg	0.06 mg/kg	0.07 mg/kg	0.03 mg/kg	0.07 mg/kg
Silver	SW6010B	6.1	6.1	0.3 *U* mg/kg	4.9 mg/kg	0.4 *U* mg/kg	2 mg/kg	0.4 *U* mg/kg	0.4 *U* mg/kg	0.3 *U* mg/kg	0.4 *U* mg/kg	0.3 *U* mg/kg	1.4 mg/kg	0.3 *U* mg/kg	0.3 *U* mg/kg	0.3 *U* mg/kg	0.3 *U* mg/kg	0.3 *U* mg/kg
Zinc	SW6010B	410	960	46 mg/kg	339 mg/kg	118 mg/kg	106 mg/kg	56 mg/kg	62 mg/kg	108 mg/kg	46 mg/kg	83 mg/kg	99 mg/kg	96 mg/kg	88 mg/kg	84 mg/kg	59 mg/kg	99 mg/kg
SVOCs																		
1,2,4-Trichlorobenzene	SW8270D	0.81 mg/kg-oc / 31 µg/kg	1.8 mg/kg-oc / 51 µg/kg	18 *U* µg/kg	59 *U* µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
1,2-Dichlorobenzene	SW8270D	2.3 mg/kg-oc / 35 µg/kg	2.3 mg/kg-oc / 50 µg/kg	18 *U* µg/kg	59 *U* µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
1,3-Dichlorobenzene	SW8270D	170	170	18 *U* µg/kg	59 *U* µg/kg	55 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	59 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg
1,4-Dichlorobenzene	SW8270D	3.1 mg/kg-oc / 110 µg/kg	9 mg/kg-oc / 110 µg/kg	18 *U* µg/kg	59 *U* µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
1-Methylnaphthalene	SW8270D	NA	NA	18 *U* µg/kg	150 µg/kg	77 µg/kg	44 µg/kg	12 *J* µg/kg	12 *J* µg/kg	16 *J* µg/kg	18 *U* µg/kg	58 *U* µg/kg	110 µg/kg	82 µg/kg	46 *J* µg/kg	59 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg
2,4-Dimethylphenol	SW8270D	29	29	37 *UJ* µg/kg	120 *U* µg/kg	110 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	37 *U* µg/kg	37 *U* µg/kg	37 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	38 *U* µg/kg	37 *U* µg/kg
2-Methylnaphthalene	SW8270D	38 mg/kg-oc / 670 µg/kg	64 mg/kg-oc / 670 µg/kg	18 *U* µg/kg	260 µg/kg	6.5 mg/kg-oc	3.6 mg/kg-oc	0.92 *J* mg/kg-oc	1.0 *J* mg/kg-oc	2.4 mg/kg-oc	1.5 *J* mg/kg-oc	1.2 *J* mg/kg-oc	10 mg/kg-oc	2.9 mg/kg-oc	1.2 *J* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
2-Methylphenol	SW8270D	63	63	18 *UJ* µg/kg	59 *U* µg/kg	55 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	59 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg
4-Methylphenol	SW8270D	670	670	37 *UJ* µg/kg	44 *J* µg/kg	110 *U* µg/kg	39 *U* µg/kg	38 *U* µg/kg	37 *U* µg/kg	37 *U* µg/kg	37 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	120 *U* µg/kg	38 *U* µg/kg	37 *U* µg/kg
Acenaphthene	SW8270D	16 mg/kg-oc / 500 µg/kg	57 mg/kg-oc / 500 µg/kg	18 *U* µg/kg	460 µg/kg	34 mg/kg-oc	6.4 mg/kg-oc	1.5 mg/kg-oc	1.7 mg/kg-oc	2.2 *U* mg/kg-oc	2.5 mg/kg-oc	5.7 mg/kg-oc	41 *J* mg/kg-oc	6.2 mg/kg-oc	1.2 *J* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Acenaphthylene	SW8270D	66 mg/kg-oc / 1300 µg/kg	66 mg/kg-oc / 1300 µg/kg	18 *U* µg/kg	38 *J* µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	0.54 *J* mg/kg-oc	0.65 *J* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.0 *J* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	2.0 mg/kg-oc
Anthracene	SW8270D	220 mg/kg-oc / 960 µg/kg	1200 mg/kg-oc / 960 µg/kg	18 *U* µg/kg	310 µg/kg	17 mg/kg-oc	4.5 mg/kg-oc	2.0 mg/kg-oc	1.8 mg/kg-oc	2.2 *U* mg/kg-oc	1.9 mg/kg-oc	9.2 mg/kg-oc	30 mg/kg-oc	18 mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.3 *J* mg/kg-oc
Benzo(a)anthracene	SW8270D	110 mg/kg-oc / 1300 µg/kg	270 mg/kg-oc / 1600 µg/kg	18 *U* µg/kg	950 µg/kg	35 mg/kg-oc	8.2 mg/kg-oc	3.7 mg/kg-oc	4.4 mg/kg-oc	2.4 mg/kg-oc	3.9 mg/kg-oc	16 mg/kg-oc	38 *J* mg/kg-oc	5.9 mg/kg-oc	2.1 *J* mg/kg-oc	1.8 *U* mg/kg-oc	1.3 mg/kg-oc	3.6 mg/kg-oc
Benzo(a)pyrene	SW8270D	99 mg/kg-oc / 1600 µg/kg	210 mg/kg-oc / 1600 µg/kg	18 *U* µg/kg	1000 µg/kg	22 mg/kg-oc	7.0 mg/kg-oc	4.0 mg/kg-oc	5.2 mg/kg-oc	3.4 mg/kg-oc	4.6 mg/kg-oc	16 mg/kg-oc	28 *J* mg/kg-oc	5.6 mg/kg-oc	2.2 mg/kg-oc	1.7 *J* mg/kg-oc	1.3 mg/kg-oc	6.0 mg/kg-oc
Benzo(g,h,i)perylene	SW8270D	31 mg/kg-oc / 670 µg/kg	78 mg/kg-oc / 720 µg/kg	18 *U* µg/kg	690 µg/kg	13 mg/kg-oc	2.1 mg/kg-oc	3.3 mg/kg-oc	3.9 mg/kg-oc	2.7 mg/kg-oc	2.6 mg/kg-oc	7.3 mg/kg-oc	17 *J* mg/kg-oc	1.8 mg/kg-oc	2.4 mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	3.2 mg/kg-oc
Benzofluoranthenes	SW8270D	230 mg/kg-oc / 3200 µg/kg	450 mg/kg-oc / 3600 µg/kg	15 *J* µg/kg	2100 µg/kg	46 mg/kg-oc	15 mg/kg-oc	5.7 mg/kg-oc	8.4 mg/kg-oc	6.9 mg/kg-oc	8.2 mg/kg-oc	28 mg/kg-oc	48 *J* mg/kg-oc	11 mg/kg-oc	4.6 mg/kg-oc	1.8 *U* mg/kg-oc	2.7 mg/kg-oc	7.6 mg/kg-oc
Benzoic acid	SW8270D	650	650	370 *UJ* µg/kg	1200 *U* µg/kg	1100 *U* µg/kg	390 *U* µg/kg	380 *U* µg/kg	370 *U* µg/kg	370 *U* µg/kg	370 *U* µg/kg	1200 *U* µg/kg	1200 *UJ* µg/kg	1200 *U* µg/kg	1200 *U* µg/kg	1200 *U* µg/kg	380 *U* µg/kg	370 *U* µg/kg
Benzyl alcohol	SW8270D	57	73	18 *UJ* µg/kg	62 µg/kg	55 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg	18 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	59 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg
Bis(2-ethylhexyl) phthalate	SW8270D	47 mg/kg-oc / 1300 µg/kg	78 mg/kg-oc / 1900 µg/kg	20 *U* µg/kg	1700 µg/kg	5.8 *U* mg/kg-oc	15 mg/kg-oc	2.3 *U* mg/kg-oc	3.1 *U* mg/kg-oc	2.9 *U* mg/kg-oc	4.8 *U* mg/kg-oc	2.7 *U* mg/kg-oc	4.3 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.5 *U* mg/kg-oc	2.3 *U* mg/kg-oc	1.5 *U* mg/kg-oc	1.3 *U* mg/kg-oc
Butylbenzyl phthalate	SW8270D	4.9 mg/kg-oc / 63 µg/kg	64 mg/kg-oc / 900 µg/kg	18 *U* µg/kg	120 µg/kg	4.2 *J* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Chrysene	SW8270D	110 mg/kg-oc / 1400 µg/kg	460 mg/kg-oc / 2800 µg/kg	10 *J* µg/kg	1300 µg/kg	38 mg/kg-oc	8.2 mg/kg-oc	5.3 mg/kg-oc	5.5 mg/kg-oc	3.9 mg/kg-oc	6.6 mg/kg-oc	19 mg/kg-oc	44 *J* mg/kg-oc	12 mg/kg-oc	5.3 mg/kg-oc	1.5 *J* mg/kg-oc	1.8 mg/kg-oc	4.6 mg/kg-oc
Di-n-octyl phthalate	SW8270D	58 mg/kg-oc / 6200 µg/kg	4500 mg/kg-oc / 6200 µg/kg	18 *U* µg/kg	86 µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Dibenzo(a,h)anthracene	SW8270D	12 mg/kg-oc / 230 µg/kg	33 mg/kg-oc / 230 µg/kg	18 *U* µg/kg	200 µg/kg	3.5 *J* mg/kg-oc	1.1 *U* mg/kg-oc	0.80 *J* mg/kg-oc	1.0 *J* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.0 *J* mg/kg-oc	4.3 mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Dibenzofuran	SW8270D	15 mg/kg-oc / 540 µg/kg	58 mg/kg-oc / 540 µg/kg	18 *U* µg/kg	360 µg/kg	23 mg/kg-oc	4.9 mg/kg-oc	1.0 *J* mg/kg-oc	1.1 *J* mg/kg-oc	1.2 *J* mg/kg-oc	1.7 *J* mg/kg-oc	2.0 *J* mg/kg-oc	16 mg/kg-oc	3.2 mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Dibutyl phthalate	SW8270D	220 mg/kg-oc / 1400 µg/kg	1700 mg/kg-oc / 5100 µg/kg	18 *U* µg/kg	1300 µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	0.77 *J* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	1.3 *J* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Diethyl phthalate	SW8270D	61 mg/kg-oc / 200 µg/kg	110 mg/kg-oc / 1200 µg/kg	46 *U* µg/kg	150 *U* µg/kg	12 *U* mg/kg-oc	2.4 *J* mg/kg-oc	2.7 *U* mg/kg-oc	4.2 mg/kg-oc	5.5 *U* mg/kg-oc	7.0 mg/kg-oc	5.3 *U* mg/kg-oc	7.1 *U* mg/kg-oc	4.4 *U* mg/kg-oc	5.3 *U* mg/kg-oc	4.6 *U* mg/kg-oc	3.1 *U* mg/kg-oc	3.5 *U* mg/kg-oc
Dimethyl phthalate	SW8270D	53 mg/kg-oc / 71 µg/kg	53 mg/kg-oc / 160 µg/kg	18 *U* µg/kg	32 *J* µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Fluoranthene	SW8270D	160 mg/kg-oc / 1700 µg/kg	1200 mg/kg-oc / 2500 µg/kg	9.2 *J* µg/kg	3000 µg/kg	150 mg/kg-oc	31 mg/kg-oc	9.2 mg/kg-oc	11 mg/kg-oc	5.3 mg/kg-oc	12 mg/kg-oc	37 mg/kg-oc	148 mg/kg-oc	16 mg/kg-oc	4.6 mg/kg-oc	1.7 *J* mg/kg-oc	2.8 mg/kg-oc	7.0 mg/kg-oc
Fluorene	SW8270D	23 mg/kg-oc / 540 µg/kg	79 mg/kg-oc / 540 µg/kg	18 *U* µg/kg	580 µg/kg	43 mg/kg-oc	8.8 mg/kg-oc	1.1 mg/kg-oc	1.3 mg/kg-oc	2.2 *U* mg/kg-oc	2.5 mg/kg-oc	4.6 mg/kg-oc	45 mg/kg-oc	8.0 mg/kg-oc	1.2 *J* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
HPAH	CALC	960 mg/kg-oc / 12000 µg/kg	5300 mg/kg-oc / 17000 µg/kg	34.2 *J* µg/kg	12950 µg/kg	440 *J* mg/kg-oc	98 mg/kg-oc	42 *J* mg/kg-oc	52 *J* mg/kg-oc	31 mg/kg-oc	49 *J* mg/kg-oc	165 *J* mg/kg-oc	460 *J* mg/kg-oc	70 *J* mg/kg-oc	27 *J* mg/kg-oc	6.3 *J* mg/kg-oc	13 mg/kg-oc	43 mg/kg-oc
Hexachlorobenzene	SW8270D	0.38 mg/kg-oc / 22 µg/kg	2.3 mg/kg-oc / 70 µg/kg	18 *U* µg/kg	59 *U* µg/kg	4.7 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	2.8 *U* mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Hexachlorobutadiene	SW8270D	3.9 mg/kg-oc / 11 µg/kg	6.2 mg/kg-oc / 120 µg/kg	92 *U* µg/kg	300 *U* µg/kg	24 *U* mg/kg-oc	5.7 *U* mg/kg-oc	5.4 *U* mg/kg-oc	6.5 *U* mg/kg-oc	11 *U* mg/kg-oc	9.7 *U* mg/kg-oc	11 *U* mg/kg-oc	14 *U* mg/kg-oc	8.6 *U* mg/kg-oc	11 *U* mg/kg-oc	9.2 *U* mg/kg-oc	6.1 *U* mg/kg-oc	7.0 *U* mg/kg-oc
Hexachloroethane	SW8270D	NA	NA	18 *U* µg/kg	59 *U* µg/kg	55 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg	18 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	59 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg
Indeno(1,2,3-cd)pyrene	SW8270D	34 mg/kg-oc / 600 µg/kg	88 mg/kg-oc / 690 µg/kg	18 *U* µg/kg	610 µg/kg	11 mg/kg-oc	1.9 mg/kg-oc	2.3 mg/kg-oc	2.6 mg/kg-oc	2.2 mg/kg-oc	1.8 *J* mg/kg-oc	5.3 mg/kg-oc	12.9 *J* mg/kg-oc	1.5 *J* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	2.6 mg/kg-oc
LPAH	CALC	370 mg/kg-oc / 5200 µg/kg	780 mg/kg-oc / 5200 µg/kg	18 *U* µg/kg	3728 *J* µg/kg	270 *J* mg/kg-oc	44 mg/kg-oc	13 *J* mg/kg-oc	13 *J* mg/kg-oc	6.9 *J* mg/kg-oc	17 *J* mg/kg-oc	52 *J* mg/kg-oc	280 *J* mg/kg-oc	53 mg/kg-oc	5.8 *J* mg/kg-oc	1.7 *J* mg/kg-oc	2.0 mg/kg-oc	9.2 *J* mg/kg-oc
N-Nitrosodiphenylamine	SW8270D	11 mg/kg-oc / 28 µg/kg	11 mg/kg-oc / 40 µg/kg	18 *U* µg/kg	59 *U* µg/kg	4.7 *U* mg/kg-oc	2.2 mg/kg-oc	1.1 *U* mg/kg-oc	1.3 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.9 *U* mg/kg-oc	2.2 *U* mg/kg-oc	3.2 mg/kg-oc	1.7 *U* mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	1.4 *U* mg/kg-oc
Naphthalene	SW8270D	99 mg/kg-oc / 2100 µg/kg	170 mg/kg-oc / 2100 µg/kg	18 *U* µg/kg	340 µg/kg	4.4 *J* mg/kg-oc	4.1 mg/kg-oc	1.0 *J* mg/kg-oc	1.1 *J* mg/kg-oc	1.9 *J* mg/kg-oc	1.6 *J* mg/kg-oc	2.7 mg/kg-oc	29 mg/kg-oc	2.7 mg/kg-oc	2.2 *U* mg/kg-oc	1.8 *U* mg/kg-oc	1.2 *U* mg/kg-oc	0.91 *J* mg/kg-oc
Pentachlorophenol	SW8270D	360	690	180 *UJ* µg/kg	590 *U* µg/kg	550 *U* µg/kg	190 *U* µg/kg	190 *U* µg/kg	190 *U* µg/kg	180 *U* µg/kg	180 *U* µg/kg	580 *U* µg/kg	580 *U* µg/kg	580 *U* µg/kg	580 *U* µg/kg	590 *U* µg/kg	190 *U* µg/kg	180 *U* µg/kg
Phenanthrene	SW8270D	100 mg/kg-oc / 1500 µg/kg	480 mg/kg-oc / 1500 µg/kg	18 *U* µg/kg	2000 µg/kg	170 mg/kg-oc	20 mg/kg-oc	6.3 mg/kg-oc	6.7 mg/kg-oc	4.9 mg/kg-oc	8.6 mg/kg-oc	31 mg/kg-oc	140 mg/kg-oc	18 mg/kg-oc	3.4 mg/kg-oc	1.7 *J* mg/kg-oc	2.0 mg/kg-oc	5.0 mg/kg-oc
Phenol	SW8270D	420	1200	18 *UJ* µg/kg	38 *J* µg/kg	55 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg	18 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	58 *U* µg/kg	59 *U* µg/kg	19 *U* µg/kg	18 *U* µg/kg
Pyrene	SW8270D	1000 mg/kg-oc / 2600 µg/kg	1400 mg/kg-oc / 3300 µg/kg	18 *U* µg/kg	3100 µg/kg	120 mg/kg-oc	25 mg/kg-oc	8.0 mg/kg-oc	9.8 mg/kg-oc	4.8 mg/kg-oc	10.2 mg/kg-oc	33 mg/kg-oc	120 mg/kg-oc	17 mg/kg-oc	6.1 mg/kg-oc	1.5 *J* mg/kg-oc	2.7 mg/kg-oc	8.3 mg/kg-oc

Notes:

Table 2-5. Validated Analytical Results for Slip 4 Post-dredge/Excavation Documentation Samples

				Sample ID	PE-1	PE-2	PE-3	PE-4	PE-5	PE-5 (field split)	PE-6	PE-7	PE-8	PE-9	PE-10	PE-11	PE-12	PE-13	PE-14
				Lab ID	SD0018	SD0010	SD0023	SD0011	SD0012	SD0013	SD0024	SD0014	SD0019	SD0015	SD0020	SD0016	SD0021	SD0017	SD0022
				Sample Date	11/14/2011	11/16/2011	11/14/2011	11/16/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011	11/14/2011
Chemical Name		Method	SQS	CSL															

[a] The cleanup screening level is as reported in the Lower Duwamish Waterway feasibility study.

-- = No calculation performed because total organic carbon was outside of range.

J = The associated numerical value is the approximate concentration.

U = Not detected above the reported sample quantitation limit.

UJ = The analyte was not detected above the reported sample quatitation limit. However, the reported quantitation limit is approximate.

Results were OC-normalized for samples with TOC concentrations ranging from 0.5 to 4.0%. Results for samples that had TOC concentrations below or above this range were compared to SQS/CSL values.

Result exceeds LAET/SQS value.

Result exceeds 2LAET/CSL value.

Table 2-6. Validated Analytical Results for Slip 4 Cap Confirmation Samples

				Sample ID	SC-1	SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	WC-1	WC-2	WC-3	WC-4	WC-5	WC-5 (field split)	WC-6	WC-7	WC-8
				Lab ID	SD0034	SD0035	SD0036	SD0037	SD0038	SD0039	SD0040	SD0025	SD0026	SD0027	SD0028	SD0029	SD0030	SD0031	SD0032	SD0033
				Sample Date	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	2/1/2012	2/1/2012	2/1/2012
Chemical Name	Method	Unit	SQS	CSL																
PCB Aroclors																				
Aroclor 1016	SW8082	µg/kg			3.7 *U*	3.7 *U*	3.7 *U*	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	3.8 *U*	19 *U*	20 *U*	3.8 *U*	19 *U*	3.8 *U*	3.9 *U*	3.8 *U*	3.7 *U*
Aroclor 1221	SW8082	µg/kg			3.7 *U*	3.7 *U*	3.7 *U*	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	3.8 *U*	19 *U*	20 *U*	3.8 *U*	19 *U*	3.8 *U*	3.9 *U*	3.8 *U*	3.7 *U*
Aroclor 1232	SW8082	µg/kg			3.7 *U*	3.7 *U*	3.7 *U*	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	3.8 *U*	19 *U*	20 *U*	3.8 *U*	19 *U*	3.8 *U*	3.9 *U*	3.8 *U*	3.7 *U*
Aroclor 1242	SW8082	µg/kg			3.7 *U*	3.7 *U*	3.7 *U*	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	3.8 *U*	19 *U*	20 *U*	3.8 *U*	19 *U*	3.8 *U*	3.9 *U*	3.8 *U*	3.7 *U*
Aroclor 1248	SW8082	µg/kg			3.7 *U*	3.7 *U*	3.7 *U*	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	3.8 *U*	19 *U*	20 *U*	3.8 *U*	19 *U*	7.6 *U*	9.6 *U*	7.5 *U*	3.7 *U*
Aroclor 1254	SW8082	µg/kg			3.7 *U*	3.7 *U*	5.7	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	5.5	24	21	3.8	21	14	21	15	3.7 *U*
Aroclor 1260	SW8082	µg/kg			3.7 *U*	3.7 *U*	3.7 *U*	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	3.8 *U*	19 *U*	20 *U*	3.8 *U*	19 *U*	3.8 *U*	6.2	5.2	3.7 *U*
Total Aroclors	Calculated	µg/kg	130	1300 [a]	3.7 *U*	3.7 *U*	5.7	3.8 *U*	3.7 *U*	3.7 *U*	4 *U*	5.5	24	21	3.8	21	14	27.2	20.2	3.7 *U*
Total Aroclors OC	Calculated	mg/kg-oc	12	65	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Conventionals																				
Total organic carbon	Plumb1981	percent			0.186	0.112	0.336	0.147	0.461	0.059	0.082	0.242	0.421	0.27	0.111	0.122	0.246	0.474	0.341	0.057
Total solids	E160.3	percent			95.5	95.5	94	95	95.5	96.2	97	91.1	87.4	87.9	89.4	85.2	83.2	81.1	84.7	94.4
Metals																				
Arsenic	SW6010B	mg/kg	57	93	5 *U*	5 *U*	5 *U*	5 *U*	5 *U*	5 *U*	5 *U*	5 *U*	5 *U*	5 *U*	5 *U*	6 *U*	6 *U*	6 *U*	6 *U*	5 *U*
Cadmium	SW6010B	mg/kg	5.1	6.7	0.2	0.2	0.2	0.2	0.2 *U*	0.2	0.2	0.2	0.2	0.2 *U*	0.2	0.2	0.3	0.2 *U*	0.2 *U*	0.2 *U*
Chromium	SW6010B	mg/kg	260	270	16.2	17.2	22.3	18.1	16.5	13.5	17	16.1	18.1	15.5	18.8	14.7	32.1	16.8	16.1	16.3
Copper	SW6010B	mg/kg	390	390	17.8	16	16.8	15	14.8	15	18.3	15.4	16.6	17	17.3	17.8	20.1	17.4	16.9	14.7
Lead	SW6010B	mg/kg	450	530	2	2 *U*	3	2 *U*	2 *U*	2 *U*	2 *U*	2	3	3	3	2 *U*	3	4	3	2 *U*
Mercury	SW7471	mg/kg	0.41	0.59	0.02 *U*	0.02 *U*	0.02 *U*	0.02 *U*	0.02 *U*	0.02 *U*	0.02 *U*	0.02 *U*	0.03 *U*	0.02 *U*	0.02 *U*	0.05	0.02 *U*	0.02	0.02 *U*	0.02 *U*
Silver	SW6010B	mg/kg	6.1	6.1	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.3 *U*	0.4 *U*	0.3 *U*	0.3 *U*
Zinc	SW6010B	mg/kg	410	960	29	34	36	30	28	27	33	31	34	31	37	31	35	32	36	28
SVOCs																				
1,2,4-Trichlorobenzene	SW8270D	µg/kg	0.81 mg/kg-oc / 31 µg/kg	1.8 mg/kg-oc / 51 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
1,2-Dichlorobenzene	SW8270D	µg/kg	2.3 mg/kg-oc / 35 µg/kg	2.3 mg/kg-oc / 50 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
1,3-Dichlorobenzene	SW8270D	µg/kg	170	170	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
1,4-Dichlorobenzene	SW8270D	µg/kg	3.1 mg/kg-oc / 110 µg/kg	9 mg/kg-oc / 110 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
1-Methylnaphthalene	SW8270D	µg/kg	NA	NA	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	11 *J*	19 *U*	19 *U*
2,4-Dimethylphenol	SW8270D	µg/kg	29	29	19 *UJ*	18 *UJ*	19 *UJ*	18 *UJ*	18 *UJ*	18 *UJ*	18 *UJ*	18 *UJ*	19 *UJ*	19 *UJ*	19 *UJ*	19 *UJ*	18 *UJ*	19 *UJ*	19 *UJ*	19 *UJ*
2-Methylnaphthalene	SW8270D	µg/kg	38 mg/kg-oc / 670 µg/kg	64 mg/kg-oc / 670 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	12 *J*	19 *U*	19 *U*
2-Methylphenol	SW8270D	µg/kg	63	63	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *UJ*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
4-Methylphenol	SW8270D	µg/kg	670	670	38 *U*	37 *U*	37 *U*	36 *U*	36 *U*	36 *UJ*	37 *U*	37 *U*	38 *U*	39 *U*	37 *U*	38 *U*	36 *U*	39 *U*	37 *U*	38 *U*
Acenaphthene	SW8270D	µg/kg	16 mg/kg-oc / 500 µg/kg	57 mg/kg-oc / 500 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	24	17 *J*	46	19 *U*	19 *U*
Acenaphthylene	SW8270D	µg/kg	66 mg/kg-oc / 1300 µg/kg	66 mg/kg-oc / 1300 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Anthracene	SW8270D	µg/kg	220 mg/kg-oc / 960 µg/kg	1200 mg/kg-oc / 960 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	22	14 *J*	40	11 *J*	19 *U*
Benzo(a)anthracene	SW8270D	µg/kg	110 mg/kg-oc / 1300 µg/kg	270 mg/kg-oc / 1600 µg/kg	19 *U*	18 *U*	20	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	28	20	19 *U*	25	19	52	28	19 *U*
Benzo(a)pyrene	SW8270D	µg/kg	99 mg/kg-oc / 1600 µg/kg	210 mg/kg-oc / 1600 µg/kg	19 *U*	18 *U*	11 *J*	18 *U*	10 *J*	18 *U*	18 *U*	18 *U*	20	12 *J*	19 *U*	11 *J*	9.9 *J*	21	14 *J*	19 *U*
Benzo(g,h,i)perylene	SW8270D	µg/kg	31 mg/kg-oc / 670 µg/kg	78 mg/kg-oc / 720 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	14 *J*	20 *U*	19 *U*	19 *U*	18 *U*	12 *J*	19 *U*	19 *U*
Benzofluoranthenes	SW8270D	µg/kg	230 mg/kg-oc / 3200 µg/kg	450 mg/kg-oc / 3600 µg/kg	9.4 *J*	12 *J*	28	18 *U*	31	18 *U*	18 *U*	11 *J*	49	30	19 *U*	27	24	53	34	19 *U*
Benzoic acid	SW8270D	µg/kg	650	650	380 *UJ*	370 *UJ*	370 *UJ*	360 *UJ*	360 *UJ*	360 *UJ*	370 *UJ*	370 *UJ*	380 *UJ*	390 *UJ*	370 *UJ*	380 *UJ*	360 *UJ*	390 *UJ*	370 *UJ*	380 *UJ*
Benzyl alcohol	SW8270D	µg/kg	57	73	NA *R*	18 *U*	19 *U*	18 *U*	18 *U*	18 *UJ*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	NA *R*	18 *U*	19 *UJ*	19 *UJ*	NA *R*
Bis(2-ethylhexyl) phthalate	SW8270D	µg/kg	47 mg/kg-oc / 1300 µg/kg	78 mg/kg-oc / 1900 µg/kg	24 *U*	23 *U*	100 *U*	22 *U*	23 *U*	22 *U*	23 *U*	68 *U*	120 *U*	61 *U*	31 *U*	39 *U*	32 *U*	64	35	24 *U*
Butylbenzyl phthalate	SW8270D	µg/kg	4.9 mg/kg-oc / 63 µg/kg	64 mg/kg-oc / 900 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Chrysene	SW8270D	µg/kg	110 mg/kg-oc / 1400 µg/kg	460 mg/kg-oc / 2800 µg/kg	19 *U*	11 *J*	26	18 *U*	25	18 *U*	18 *U*	10 *J*	41	27	19 *U*	27	23	55	33	19 *U*
Di-n-octyl phthalate	SW8270D	µg/kg	58 mg/kg-oc / 6200 µg/kg	4500 mg/kg-oc / 6200 µg/kg	19 *U*	18 *U*	19	18 *U*	18 *U*	18 *U*	18 *U*	13 *J*	30	12 *J*	19 *U*	19 *U*	18 *U*	9.6 *J*	19 *U*	19 *U*
Dibenzo(a,h)anthracene	SW8270D	µg/kg	12 mg/kg-oc / 230 µg/kg	33 mg/kg-oc / 230 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Dibenzofuran	SW8270D	µg/kg	15 mg/kg-oc / 540 µg/kg	58 mg/kg-oc / 540 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	21	15 *J*	45	19 *U*	19 *U*

Table 2-6. Validated Analytical Results for Slip 4 Cap Confirmation Samples

				Sample ID	SC-1	SC-1	SC-2	SC-3	SC-4	SC-5	SC-6	WC-1	WC-2	WC-3	WC-4	WC-5	WC-5 (field split)	WC-6	WC-7	WC-8
				Lab ID	SD0034	SD0035	SD0036	SD0037	SD0038	SD0039	SD0040	SD0025	SD0026	SD0027	SD0028	SD0029	SD0030	SD0031	SD0032	SD0033
				Sample Date	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	1/30/2012	2/1/2012	2/1/2012	2/1/2012
Chemical Name	Method	Unit	SQS	CSL																
Dibutyl phthalate	SW8270D	µg/kg	220 mg/kg-oc / 1400 µg/kg	1700 mg/kg-oc / 5100 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Diethyl phthalate	SW8270D	µg/kg	61 mg/kg-oc / 200 µg/kg	110 mg/kg-oc / 1200 µg/kg	47 *U*	46 *U*	47 *U*	45 *U*	46 *U*	44 *U*	46 *U*	46 *U*	47 *U*	49 *U*	47 *U*	48 *U*	45 *U*	48 *U*	47 *U*	47 *U*
Dimethyl phthalate	SW8270D	µg/kg	53 mg/kg-oc / 71 µg/kg	53 mg/kg-oc / 160 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Fluoranthene	SW8270D	µg/kg	160 mg/kg-oc / 1700 µg/kg	1200 mg/kg-oc / 2500 µg/kg	11 *J*	19	53	18 *U*	35	18 *U*	18 *U*	19	67	89	20	140	100	270	120	31 *J*
Fluorene	SW8270D	µg/kg	23 mg/kg-oc / 540 µg/kg	79 mg/kg-oc / 540 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	33	22	65	10 *J*	19 *U*
HPAH	CALC	µg/kg	960 mg/kg-oc / 12000 µg/kg	5300 mg/kg-oc / 17000 µg/kg	20.4 *J*	53 *J*	179 *J*	18 *U*	137 *J*	18 *U*	18 *U*	52 *J*	263 *J*	233 *J*	29.3 *J*	318 *J*	239.9 *J*	632.6 *J*	307 *J*	50 *J*
Hexachlorobenzene	SW8270D	µg/kg	0.38 mg/kg-oc / 22 µg/kg	2.3 mg/kg-oc / 70 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Hexachlorobutadiene	SW8270D	µg/kg	3.9 mg/kg-oc / 11 µg/kg	6.2 mg/kg-oc / 120 µg/kg	9.4 *UJ*	9.2 *UJ*	9.3 *UJ*	9 *UJ*	9.1 *UJ*	8.9 *UJ*	9.2 *UJ*	9.3 *UJ*	9.5 *UJ*	9.8 *UJ*	9.3 *UJ*	9.6 *UJ*	9 *UJ*	9.6 *UJ*	9.3 *UJ*	9.5 *UJ*
Hexachloroethane	SW8270D	µg/kg	NA	NA	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Indeno(1,2,3-cd)pyrene	SW8270D	µg/kg	34 mg/kg-oc / 600 µg/kg	88 mg/kg-oc / 690 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	10 *J*	20 *U*	19 *U*	19 *U*	18 *U*	9.6 *J*	19 *U*	19 *U*
LPAH	CALC	µg/kg	370 mg/kg-oc / 5200 µg/kg	780 mg/kg-oc / 5200 µg/kg	19 *U*	18 *U*	12 *J*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	12 *J*	33	19 *U*	240 *J*	148 *J*	441	64 *J*	16 *J*
N-Nitrosodiphenylamine	SW8270D	µg/kg	11 mg/kg-oc / 28 µg/kg	11 mg/kg-oc / 40 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Naphthalene	SW8270D	µg/kg	99 mg/kg-oc / 2100 µg/kg	170 mg/kg-oc / 2100 µg/kg	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	11 *J*	18 *U*	19 *U*	19 *U*	19 *U*
Pentachlorophenol	SW8270D	µg/kg	360	690	190 *U*	180 *U*	190 *U*	180 *U*	180 *U*	180 *UJ*	180 *U*	180 *U*	190 *U*	200 *U*	190 *U*	190 *U*	180 *U*	190 *U*	190 *U*	190 *U*
Phenanthrene	SW8270D	µg/kg	100 mg/kg-oc / 1500 µg/kg	480 mg/kg-oc / 1500 µg/kg	19 *U*	18 *U*	12 *J*	18 *U*	18 *U*	18 *U*	18 *U*	18 *U*	12 *J*	33	19 *U*	150	95	290	43	16 *J*
Phenol	SW8270D	µg/kg	420	1200	19 *U*	18 *U*	19 *U*	18 *U*	18 *U*	18 *UJ*	18 *U*	18 *U*	19 *U*	20 *U*	19 *U*	19 *U*	18 *U*	19 *U*	19 *U*	19 *U*
Pyrene	SW8270D	µg/kg	1000 mg/kg-oc / 2600 µg/kg	1400 mg/kg-oc / 3300 µg/kg	19 *U*	11 *J*	41	18 *U*	36	18 *U*	18 *U*	12 *J*	34	55	9.3 *J*	88	64	160	78	19 *J*

Notes:

[a] The cleanup screening level is as reported in the Lower Duwamish Waterway feasibility study.

-- = No calculation performed because total organic carbon was outside of range.

J = The associated numerical value is the approximate concentration.

NA = Not available.

R = Rejected.

U = Not detected above the reported sample quantitation limit.

UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate.

Results were OC-normalized for samples with TOC concentrations ranging from 0.5 to 4.0%. Results for samples that had TOC concentrations below or above this range were compared to SQS/CSL values.

APPENDIX B

WATER QUALITY MONITORING REPORT

City of Seattle

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION AREA

Water Quality Monitoring Report

Submitted to
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, WA 98101

Submitted by
City of Seattle

Prepared by
integral consulting inc
411 1st Avenue S.
Suite 550
Seattle, WA 98104

July 26, 2012

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ACRONYMS AND ABBREVIATIONS

BMP	best management practice
COC	chemical of concern
EAA	early action area
EPA	U.S. Environmental Protection Agency
LDW	Lower Duwamish Waterway
NBF	North Boeing Field
NTU	nephelometric turbidity unit
PCB	polychlorinated biphenyl
RACR	removal action completion report
SAP	sampling and analysis plan
TSS	total suspended solids
WAC	Washington Administrative Code
WQMP	water quality monitoring plan

1 INTRODUCTION

This water quality monitoring report is a part of the removal action completion report (RACR) for the removal action of contaminated marine sediments and adjacent bank areas at the Slip 4 Early Action Area (EAA) of the Lower Duwamish Waterway (LDW) Superfund Site located in Seattle, Washington (Figure 1-1). The removal action implemented the U.S. Environmental Protection Agency's (EPA's) selected alternative as defined in its Action Memorandum (USEPA 2006). The City of Seattle (City) conducted the Slip 4 sediment removal action. The construction quality assurance plan (Integral 2010a) outlined the overall approach to construction quality assurance and the role of the water quality monitoring activities in relation to other project elements. The water quality monitoring plan (WQMP) outlined specific protocols for performing quality assurance activities related to in-water work (Integral 2010b).

Within the Slip 4 EAA, polychlorinated biphenyls (PCBs) were the chemicals of concern (COC) in the sediments. The defined removal boundaries encompassed approximately 3.6 acres. The primary objective of the removal action was to reduce the concentrations of contaminants in post-cleanup surface sediments (biologically active zone [0–10 cm]) to below the Washington State Sediment Quality Standards for PCBs and other chemicals. This was accomplished by dredging contaminated sediments followed by placement of overlying clean capping material. The sediment removal action is expected to significantly reduce unacceptable risks to the aquatic environment resulting from potential exposure to contaminants in sediments in the slip. This cleanup is also expected to reduce potential human health risks associated with PCBs in sediment within the LDW.

On May 23, 2011, EPA issued a Clean Water Act Section 401 Water Quality Certification that defined required water quality monitoring requirements and applicable water quality criteria as performance standards (USEPA 2011). The Contractor was required to conduct all operations in compliance with these performance standards.

1.1 REPORT OBJECTIVES

This report documents the results of monitoring activities that were performed to assess potential impacts to surface water resulting from in-water construction activities at Slip 4, and presents data that was collected to ensure compliance with water quality criteria. The report also describes how construction activities were modified to ensure protection of the environment when exceedances of water quality criteria occurred.

The report also summarizes the water quality monitoring procedures and related quality assurance protocols, and describes best management practices (BMPs) that were employed to reduce potential water quality impacts during the work.

1.2 REPORT ORGANIZATION

The remaining sections of this document describe the field monitoring program and sampling that was conducted during the construction activities described in the WQMP (Integral 2010b). Section 2 discusses the BMPs employed during the project to protect water quality. Section 3 provides a description of the field sampling activities. Section 4 discusses deviations from the WQMP. Section 5 describes the field changes and contingency BMPs. Quality assurance/quality control samples are described in Section 6. References are provided in Section 7.

Supporting information is provided in the following attachments:

- **Attachment A.** Field Notes and Calibration Information
- **Attachment B.** Water Quality Monitoring Forms
- **Attachment C.** Surface Water Sample Collection Forms
- **Attachment D.** Surface Water Laboratory Reports
- **Attachment E**. Photos of Water Quality Monitoring and Surface Water Sampling.

2 BEST MANAGEMENT PRACTICES

A variety of physical and operational BMPs were identified in the biological assessment (Integral 2007) as a means of reducing potential water quality impacts during all phases of the removal action. This section provides a brief evaluation of their use during removal action construction, as well as additional BMPs employed by the Contractor.

BMPs identified in the biological assessment and/or provided by the Contractor are listed below, in bold. A summary of the use and effectiveness of each BMP is provided.

- **Sequencing dredging and capping activities to reduce the duration that dredged/excavated surfaces remain exposed before capping.**

  Given the need for post-dredge/excavation document sampling and verification survey, it was necessary to complete 100 percent of the dredging and bank excavation prior to capping. This also limited the number of material barges that needed to be within the slip at any given time. However, scour protection capping was provided in front of the outfalls during the shift immediately following dredging within the same area.

- **Requiring excavation from the top of the slope down, and capping from the bottom of the slope upward, to reduce the potential for sloughing.**

  The Contractor was observed to sequence slope excavation and slope capping in the manner stated above. Some minor sloughing of bank filter material did occur during placement, but this did not appear to impact water quality conditions.

- **Requiring bulkhead demolition concurrent with bank excavation to reduce the potential for sloughing.**

  The Contractor was observed to perform bank excavation behind bulkheads, prior to demolition, as stated above.

- **Using an environmental dredge bucket to the extent practical, considering debris and other site conditions and with the overall goal of minimizing sediment resuspension during dredging.**

  The Contractor attempted to use an environmental bucket at the outset of dredging operations. However, due to the heterogeneous nature of the sediments and debris within the slip, the bucket proved ineffectual. "Bites" often failed to fully close, resulting in released sediment from the bucket. When the bucket did fully close, it tended to capture an excessive amount of water, which would then need to be decanted from the barge. Given that there had been no turbidity exceedances prior to the use of the environmental bucket, and for the reasons

stated above; the Contractor was allowed to switch back to the standard digging bucket.

- **Eliminating multiple bites with the dredge bucket.**

  The Contractor was observed to take only single bites of material during dredging.

- **Eliminating sweeping with the bucket or stockpiling of dredged material on the bottom.**

  The Contractor was not observed to sweep the bottom while dredging, nor stockpile dredged material on the bottom. Bank material was stockpiled above the water line.

- **Eliminating the use of grading equipment below the water line.**

  Grading equipment was observed to stay above the water line at all times.

- **Requiring the filtering of return water entering Slip 4 from the materials barge, as material is dewatered on the barge. Material may be mounded on the materials barge to promote drainage.**

  The Contractor provided a barge dewatering and filtration system, which included ballasting the barge toward a water collection cell, providing a baffle consisting of ecology blocks and straw wattles between the main portion of the barge and the collection cell, providing a pump system from the holding cell to a flexi-float supported geotextile bag filter, on top of a drainage mat consisting of GAC placed between layers of geofabric.

- **Eliminating overfilling of the materials barge.**

  Barge loads were observed to be held to roughly 800 CY/barge based on observable draft. Material loading was restricted to the top of bin walls, with no significantly uneven mounding.

- **Avoiding or minimizing tug activity in Crowley's middle berth during dredging (to be coordinated between the City and Crowley).**

  While increased barge traffic was observed at the middle berth on November 3 and December 8, 2011, neither occurrence coincided with the Contractor's barge movements. No significant increase in turbidity was reported during these occurrences.

- **Anticipating relatively low dredge production rates of 400–1,000 CY/day.**

  Typically, the Contractor shipped roughly 800 CY of material (one barge load) per day.

- **Controlling liquids and avoiding spillage from transloading activities.**

  Barges remained in the slip to dewater for at least 8 hours prior to shipping. In addition, water was pumped to the filtration system from the holding cell and standing pools in the main containment area prior to transport.

  The tower crane at the transloading facility was equipped with a dribble chute. The chute captured any dripped material from the crane bucket and directed it back to the material barge.

  Material spilled from the excavator bucket during the loading of containers was hosed off with a pressure washer and directed to a sump where it was then pumped back to the containment vault.

- **Placement of a rock berm at the southern boundary of the removal action area before dredging, to potentially limit offsite transport of "mud wave" turbidity.**

  The boundary berm was placed on October 3 and 4, 2011, prior to any in-water dredging or excavation. On October 17 and 19, 2011, turbidity measurements were taken near the sediment elevation, both upstream and downstream of the boundary berm. This monitoring event is described in more detail in Section 3.1.1. The measurement results indicate that the boundary berm likely had no significant effect in reducing turbidity; however, it is still likely a beneficial BMP to prevent migration of dredge-generated residuals.

- **Operational controls.**

  The Contractor utilized a variety of techniques to reduce potential impacts to water quality. These include specific measures as dredging at the head of slip during low tide, excavating bank areas "in the dry", and adjusting the rate of release for cap materials to better pluviate material in thinner lifts.

  Following a turbidity exceedance on January 24, 2012, operational controls were adjusted to bring turbidity back into compliance (refer to Section 5).

- **Constructing and maintaining a containment berm or other confinement method in the re-handling area.**

  Temporary stockpiles were created adjacent to bank excavation work zones. All excavated soil and debris were transferred from the stockpiles to the barge for transport to the off-site transloading facility. Equipment did not routinely enter and exit exclusions zones, eliminating the need for traditional wheel-wash systems.

Equipment was decontaminated following bank excavation. A portable containment berm and wash pad was used to collect decontamination water from pressure washers.

- **Collecting liquids from upland containment areas.**

  Stockpile runoff and decontamination water was pumped to a Baker tank and collected by Marine Vacuum Service for disposal at its facility.

- **Cutting of pier piling.**

  Concrete piles were cut to within 1 ft of the mudline using a pile shear.

- **Avoidance of disturbance to subsurface materials.**

  Disturbance of the boundary area outside the project limit was unavoidable given the need for the derrick barge to spud down prior to placing cap material. Pre- and post-construction analytical sampling within the boundary area indicated that the disturbance led to an increase in contaminant concentrations within that area.

  As a contingency, a thin layer (9-in. nominal) of waterway cap material was placed in the boundary area (refer to Section 3.17 of the RACR).

3 WATER QUALITY MONITORING ACTIVITIES

Water quality monitoring took place during removal action construction to monitor surface water quality within Slip 4 and ensure that all in-water construction activities were conducted in compliance with 401 Certification, including general water use and criteria classes (WAC 173-201A-030) for turbidity, dissolved oxygen, toxic conditions, and the numeric toxic substances criteria (WAC 173-201A-040). In-water removal action construction activities occurred between October 3, 2011 and February 7, 2012. In general, water quality monitoring followed the design and methods described in the WQMP. Deviations from the WQMP are described in Section 4.

Observations of transloading operations were conducted on a regular basis to ensure compliance with the RAWP (Integral 2011) and the 401 Certification. Details of the transloading observations are provided in Section 3.3.

Additional field observations, including sampling times, weather conditions, water conditions, and other anecdotal information were noted in field notes (Attachment A) and on water quality monitoring forms (Attachment B). Representative photos showing field activities are presented in Attachment E.

3.1 WATER QUALITY MONITORING

Two pre-established monitoring/sampling stations were used. The compliance sampling station was located mid-slip at 100 m from the removal action boundary. The ambient sampling station was located at the entrance of the slip just off the LDW main channel (Figure 3-1). *In situ* water quality values and laboratory results from water samples were compared to state water quality standards for compliance, as defined in the 401 Certification.

In situ water quality measurements were collected during bank excavation, sediment dredging, and barge dewatering, pier demolition and capping construction activities. The frequencies of measurement are described in detail for each type of construction activity in the following subsections. *In situ* water quality measurements included turbidity, dissolved oxygen, temperature, salinity, pH, and conductivity. Water quality monitoring forms are included in Attachment B. Water quality readings are summarized in Table 3-1. Real-time turbidity measurements were used to monitor compliance with the water quality standards and to determine appropriate response actions in the event of a water quality exceedance. The real-time turbidity measurements were also used to assess the need for collection water quality samples for COC analysis.

3.1.1 Bank Excavation, Sediment Dredging, and Barge Dewatering

Bank excavation and sediment dredging occurred concurrently, eliminating the need for separate monitoring frequencies as previously described in the WQMP. During the first 10 days of active, in-water work, *in situ* water quality measurements were generally collected twice daily at both the ambient and compliance stations. After the first 10 days, *in situ* water quality measurements were taken twice daily at the ambient and compliance stations, on two non-consecutive days per week (Table 3-1). Turbidity measurements did not indicate any exceedances within the slip during dredging and excavation activities. No distressed/dying fish or large silt plumes attributable to dredging and excavation activities were observed. There were no significant spills.

Dredged materials were required to gravity drain on decant barges within the removal area boundary for a minimum of 8 hours to reduce free draining liquids, prior to being transported for disposal. The dewatering generally occurred concurrent with dredging and excavation activities and in the same work area; therefore, water quality monitoring also assessed potential impacts from return water released from the decant barge.

The Contractor utilized a barge dewatering/filtration system consisting of a water holding cell separated form the main barge area by a filtration baffle, a pump from the holding cell to a filtration bag, and a drainage mat beneath the filtration bag consisting of granular activated carbon (GAC) sandwiched between layers of geofabric (Figure 3-2). On October 14, 2011 turbidity measurements were taken at four locations along the dewatering/ filtration system to evaluate its effectiveness. The measured turbidity in the main barge area was 92.4 nephelometric turbidity units (NTUs). Turbidity in the barge holding cell was 87.4 NTUs. Turbidity of water discharging from the filter bag measured 39.0 NTUs. Lastly, turbidity of discharge through the GAC drainage mat was 28.5 NTUs. These results suggest that the barge dewatering/filtration system was effective at reducing the turbidity of the return water.

On October 17-19, 2011 turbidity measurements were collected upstream and downstream of the boundary berm during dredging activities. These measurements were intended to determine if the berm had any effect on the turbidity leaving the removal area, associated with near-bottom nepheloid or "mud wave" transport often encountered from resuspension during dredging projects. Turbidity measurements were collected at three paired locations in two transects; one upstream and one downstream of the berm (Figure 3-3). The first set of measurements was collected approximately 3 ft above mudline. The change in turbidity between the upstream and downstream locations was small: 1.2, 0.0, and 1.5 NTUs (Attachment C, pp. 29-30). The second set of measurements was collected on October 19, but from approximately 0.5 ft above mudline. The change in turbidity between the upstream and downstream location was again small: –0.4, –1.5, and –1.2 NTUs. All turbidity measurements were relatively low, ranging from 2.9 to 5.6 NTU.

These results indicate that nepheloid or "mud wave" transport was not likely a significant transport mechanism for residuals near the boundary berm, since the dredging was several hundred feet away from the berm. Thus, the near-bottom transport that the boundary berm was intended to reduce was not an active process.

3.1.2 PIER DEMOLITION AND CAPPING

Pier demolition and capping occurred concurrently, eliminating the need for separate monitoring frequencies as previously described in the WQMP. *In situ* water quality measurements were taken twice daily at the ambient and compliance stations, on non-consecutive days per week during the pier demolition and capping activities that occurred in 2011 and twice daily at the ambient and compliance stations approximately one day per week in 2012 (Table 3-1). A turbidity exceedance at the compliance station occurred on January 24, during the placement of capping materials. The contingency procedures for documentation, agency notification, and modification of construction operations were followed as specified in the WQMP and are described in detail in Section 5. No additional WQ exceedances were observed during the pier demolition.

3.2 SURFACE WATER SAMPLING

Surface water grab samples for laboratory analysis were collected on October 7, 11, and 13, 2011. In general, surface water sampling followed the methods and procedures described in the WQMP. Deviations from the WQMP are described in Section 4. Sample collection was accomplished with a Niskin bottle and the samples were submitted for analysis of COCs (total suspended solids [TSS] and PCB Aroclor concentrations). Water sample collection corresponded approximately to the third, fifth, and seventh days after initiation of in-water bank excavation and the third and fifth days after initiation of sediment dredging. On each of these days, one water grab sample was collected from both the ambient and compliance stations at the depth with maximum turbidity (Figure 3-4). On October 7 and 13, replicate samples were also collected and analyzed. All TSS and PCB analyses were performed on a rush basis (24–48 hours) in order to provide timely information about possible exceedances of the 10 μg/L PCB acute water quality standard, and allow for appropriate modifications to the construction activities. The TSS results were utilized for assessing general water quality; however; no numeric water quality standard was established for TSS in the 401 Certification.

Laboratory results show a range of TSS values from 5.1 to 21.3 mg/L and all PCB concentrations were below laboratory detection limits (Table 3-2). The complete laboratory reports are provided in Attachment D.

3.3 TRANSLOADING OBSERVATIONS

Transloading of material from barges occurred at the Lafarge transloading facility, approximately 2 miles downstream of Slip 4. Observations of the transloading operations were conducted twice weekly, on non-consecutive days, in October and November during the time that bank excavation and dredge materials were being transported from Slip 4. During observations of the transloading process, no liquids or solids were observed being released to the river. Observations are summarized in field notes, which are located in Attachment C.

4 MONITORING PLAN DEVIATIONS

Water quality monitoring was conducted in general accordance with the WQMP. During the course of the project, however, several deviations from the plan occurred and are noted in the following sections.

4.1 WATER QUALITY MONITORING

- Minor variations in the compliance and ambient sample locations occurred throughout the project due to factors such as wind, current, and occasional obstructions (barges) that blocked access to the sample locations. All of the measurements are near the center of the channel and within 50 ft of the proposed sample locations. The data collected are believed to be representative of the proposed sample locations.
- The WQMP sampling scheme specified that water quality measurements would occur at slack and ebb tides. Due to the daily variability of the construction activities and the shifting tide schedule, water quality measurements were not always collected during those times and resulted in some measurements being collected during flood tide. Flood tide water quality measurements were collected on October 4, 7, 10, 12, and 28, and November 10, 2011.
- The WQMP specified that *in situ* water quality data for conventional parameters would be obtained with a YSI multiprobe. On October 4, 2011, a Hydrolab MS5 multiprobe was used to measure water quality parameters due to a shipping delay of the YSI multiprobe.
- Some water quality parameters are missing in Table 3-1 for pH on October 4, 2011, and salinity on October 5, 2011, due to a failure to record these parameters in the field notes.

4.2 SURFACE WATER SAMPLE COLLECTION

- The WQMP specified that decontamination of the Niskin bottle include a rinse with methanol. A field change to the sampling and analysis plan (SAP) was issued on August 22, 2011, to indicate that if equipment decontamination required removal of residual oils, hexane would be used instead of methanol.
- The WQMP specified that decontaminated Niskin bottles be stored in a plastic bag when not in use. To avoid potential contamination that could have been introduced during storage, the Niskin bottle was fully decontaminated when taken out of storage, immediately prior to its deployment for sample collection.

- The removal action SAP specified that sample coolers would be maintained at a temperature of 4°C (±2°C) (Integral 2010c). One cooler delivered to the laboratory on October 7, 2011, was relinquished at a temperature of 8.9°C. This deviation did not affect data usability for this project, as none of the surface water samples in this cooler were analyzed.
- The SAP specified that sample coolers would be sealed with three chain-of-custody seals, *This End Up* and *Fragile* labels. This labeling was not done because all coolers were hand-delivered to the laboratory by the sample team.

5 CHANGES TO OPERATIONAL CONTROLS

A water turbidity exceedance of more than 10 NTUs over ambient conditions occurred at the compliance station at 10:20 a.m. on January 24, 2012. The recorded turbidity increase of near surface water during ebb tide was 17.4 NTUs (22.0 NTUs at the compliance station and 4.6 NTUs at the ambient station) (Table 3-1). Prior to this measurement, waterway cap placement in Removal Area 5 had been under way for approximately 3 hours. This exceedance prompted action following the water quality response mechanisms presented in Section 4.4 of the WQMP and described below.

Additional water quality monitoring was conducted at 11:35 a.m. near slack tide and the turbidity exceedance was verified with an observed near bottom turbidity increase of 15.9 NTUs (19.5 NTUs at the compliance station and 3.6 NTUs at the ambient station). Additional visual observations of potential turbidity sources were conducted within the slip, near the outfalls at the head of the slip (North Boeing Field [NBF] [60-in.], King County [24-in.], and I-5 [72-in.]), and the main river channel. Two discretionary turbidity monitoring locations were also added at the NBF and I-5 outfalls to help assess whether the source of the turbidity exceedance was related to Contractor operations or other possible sources (i.e., stormwater).

From visual surface observations of the turbidity plume in the vicinity of the compliance station, it was noted that the plume color appeared to match that of the waterway capping material. In addition, the Lower Duwamish main channel appeared generally less turbid than Slip 4. At the outfalls, which were all in nearly neutral flow conditions, stormwater entering the slip was relatively clear.

Turbidity was measured at the NBF and I-5 outfalls. Due to the nearly neutral flow conditions and difficulty in positioning the meter close enough to the outfalls to avoid conditions where mixing between the clear stormwater and the cloudy Slip 4 water was occurring, turbidity readings reflect mixing conditions. A first attempt at measuring stormwater turbidity at the NBF outfall resulted in a reading of 20.4 NTUs. A second attempt (from land) resulted in a turbidity reading of 15.7 NTUs. A single attempt at collecting a turbidity reading at the I-5 outfall resulted in a reading of 38.1 NTUs (Table 3-1). These readings were all observed to reflect mixing conditions between the high turbidity water in Slip 4 and low turbidity stormwater. Based on the visual observations and turbidity measurements, it was concluded that the elevated turbidity in the slip was directly attributable to capping operations.

Based on results of the monitoring activities, the Contractor was directed to modify its operations to reduce turbidity generation. The Contractor slowed the production rate about 10–20 percent and began to open the bucket closer to the waterline when placing cap material. Water quality monitoring was conducted the following day to assess the

effectiveness of the modified construction operations. Turbidity monitoring on both the ebb tide and slack tide on January 25, 2012, indicated no water quality exceedances at the Slip 4 compliance station. Based on these results, the construction modifications appeared to be appropriate for reducing turbidity generation in the vicinity of the capping operation and Slip 4.

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6 DATA MANAGEMENT AND REPORTING

The management and reporting of field and laboratory data generally follows the procedures outlined in the SAP (Integral 2010c) and the WQMP (Integral 2010b). Changes or additions to those procedures, based on the specific requirements of the WQMP, are discussed below.

Due to the rush nature of all analyses and their use in making immediate real-time decisions about construction activities, the laboratory results did not undergo data validation by an independent validator. The laboratory has provided a data package for each sample delivery group or analysis batch that is comparable in content to a full Contract Laboratory Program package (Attachment D). These packages contain all information required for a complete quality assurance review, including all the associated raw data so formal validation could be performed if subsequently required.

Preliminary data quality reviews were completed for each of the three data packages received from the laboratory. Results of the review indicate that all laboratory quality control limits were met for all analyses, with the exception of laboratory replicate analyses for TSS in sample delivery packages TQ80 and TS00. Relative percent difference values for total suspended solids in TQ80 and TS00 were 24.9 and 23.3, respectively. TSS results for these two data sets may have an associated bias or may be less precise, but are considered acceptable for project purposes. Affected TSS data include Samples SW0001, SW0002, SW0003, SW0012, SW0013, and SW0014.

7 REFERENCES

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Integral. 2010b. Lower Duwamish Waterway Slip 4 Early Action Area: 100% Design Submittal, Water Quality Monitoring Plan. Prepared for City of Seattle and King County. Integral Consulting Inc., Seattle, WA.

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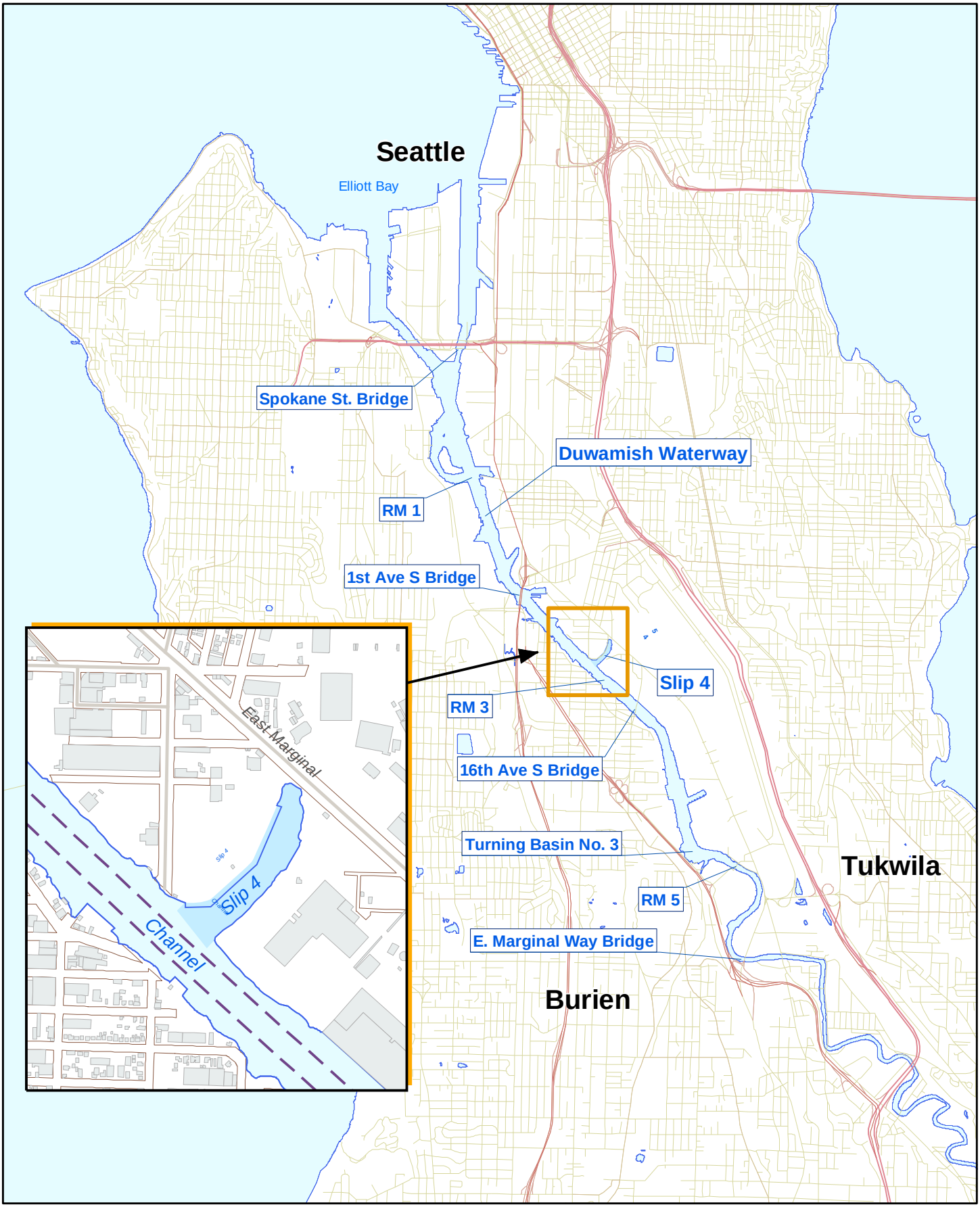
FIGURES



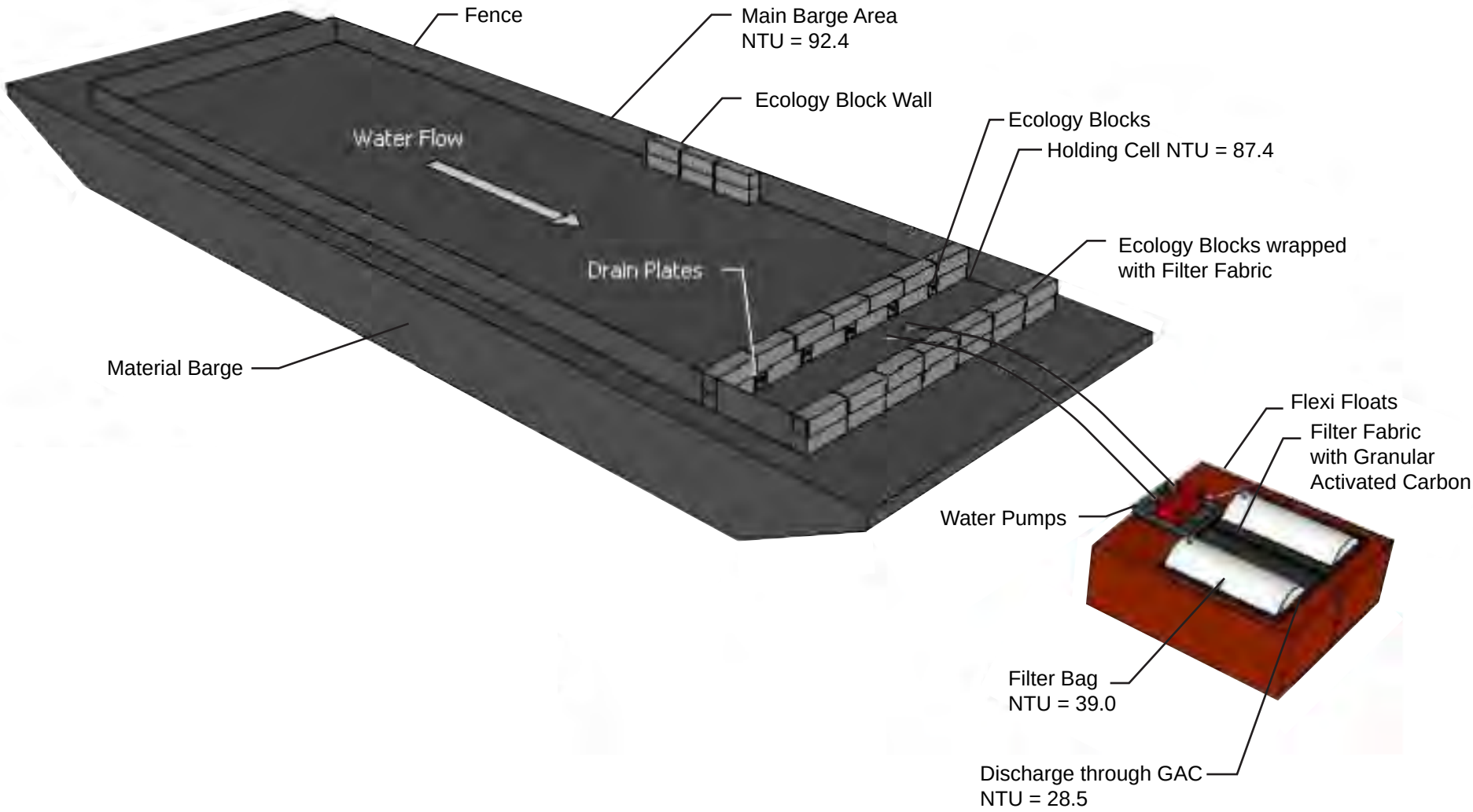
Map Document: (O:\Projects\Duwamish_OLY\Projects\Slip4_60%_DAR\SiteLocationMap.mxd)

integral consulting inc.

Map Feature Sources: King County GIS, Seattle Public Utilities, USACE, Ecology, and others.

Figure 1-1
Vicinity Map
Slip 4 Removal Design

Figure 3-1.
Water Quality Compliance Monitoring
Target and Actual Locations – Conventional Parameters
Slip 4 Removal Action



Source: General Construction Company

integral consulting

Figure 3-2.
Barge Dewatering Turbidity Sampling
Slip 4 Removal Action

N:\GIS\Projects\A0006 City of Seattle\14 Slip4\Production MXDs\RAComplianceRpt AppBWater\Fig3 3 BBermTurbidity 03302012.mxd - 7/2/2012 @ 5:00:43 PM

Figure 3-3.
Boundary Berm Turbidity Sampling
Slip 4 Removal Action

Figure 3-4.
Water Quality Compliance Monitoring
Target and Actual Locations – PCB and TSS Analysis
Slip 4 Removal Action

TABLES

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Flood	10/4/2011	11:40	Ambient	3	7	7.08	--	8.24	13790	13.4	Low Tide	5:06	
		11:49	Ambient	21.5	11	5.91	--	20.98	33491	11.97	High Tide	12:50	
		12:10	Compliance	3	6	8.51	--	6.72	11898	13.44	Low Tide	18:24	
		12:21	Compliance	23.3	8	6.47	--	21.01	33547	11.95	High Tide	23:07	
Slack	10/4/2011	12:58	Ambient	3	7	8.23	--	6.89	12732	13.51			
		12:59	Ambient	23.7	7	6.41	--	20.98	33489	11.97	Bank Excavation	8:30	16:30
		13:17	Compliance	3	11	8.08	--	8.57	14367	13.48			
		13:18	Compliance	20.5	9	6.51	--	20.94	33449	11.96			
Ebb	10/4/2011	14:20	Ambient	3	7	7.55	6.73	11.92	20500	13.64			
		14:22	Ambient	22.6	11	6.55	7.26	20.97	33491	11.96			
		14:41	Compliance	3	7	7.88	7.07	11.97	17454	13.25			
		14:42	Compliance	20	7	6.72	7.27	20.97	33516	12.01			
Slack	10/5/2011	14:14	Ambient	3	1.7	8.37	7.17	--	15706	13.35	Low Tide	6:17	
		14:16	Ambient	22.8	3	6.71	7.47	--	40550	12.11	High Tide	13:54	
		14:31	Compliance	3	2	8.12	7.26	--	14410	13.46	Low Tide	19:53	
		14:33	Compliance	18.5	2.5	7.11	7.51	--	40394	12.14			
Ebb	10/5/2011	15:39	Ambient	3	1.4	8.5	7.31	8.95	14776	13.36	Bank Excavation	7:45	15:00
		15:42	Ambient	22.6	2.8	6.7	7.54	25.97	40668	12.12			
		15:49	Compliance	3	2.5	8.41	7.33	8.9	15323	13.48			
		15:50	Compliance	20	3.1	6.29	7.57	26.03	40739	12.11			
Slack	10/6/2011	14:50	Ambient	3	2.1	11.09	7.15	8.02	14161	13.29	High Tide	0:39	
		14:52	Ambient	22.6	1.9	9.59	7.51	25.87	40496	12.12	Low Tide	7:27	
		14:59	Compliance	3	2.7	11.18	7.28	8.59	14527	13.37	High Tide	14:47	
		15:01	Compliance	22.3	3	9.8	7.61	25.94	40612	12.11	Low Tide	20:55	
Ebb	10/6/2011	WQ Monitoring not conducted									Bank Excavation Dredging	8:00 14:00	14:30 14:30
Flood	10/7/2011	11:34	Ambient	3	2.1	10.97	7.2	5.04	9033	13.17	High Tide	2:08	
		11:36	Ambient [b]	16	4.9	9.11	7.55	25.49	39630	12.16	Low Tide	8:30	
		11:57	Compliance	3	3	11.64	7.51	5.46	9638	13.26	High Tide	15:29	
		11:59	Compliance [b]	17.7	7.5	9.33	7.81	26.08	40802	12.15	Low Tide	21:41	
Slack	10/7/2011	16:00	Ambient	3	2.4	13.15	7.83	9.13	15702	13.15	Bank Excavation	7:00	10:10
		16:02	Ambient	22.5	2.5	12.12	8.15	26.28	41090	12.12	Bank Excavation	11:45	12:30
		15:40	Compliance	3	3.9	13.48	7.84	7.94	13695	13.32	Dredging	8:50	10:00
		15:42	Compliance	19.3	2.7	11.85	8.14	26.23	41029	12.13	Dredging	12:30	14:30
Ebb	10/7/2011	16:46	Ambient	3	2.6	10.45	7.88	13.07	21530	13.17			
		16:48	Ambient	21.9	1.9	9.01	8.19	26.26	41074	12.17			
		16:30	Compliance	3	3.6	10.35	7.92	12.06	20305	13.15			
		16:32	Compliance	18.8	2.6	8.6	8.15	26.13	40887	12.15			
Flood	10/10/2011	14:32	Compliance	3	2.2	8.45	6.51	6.35	8627	13.04	High Tide	5:06	
		14:34	Compliance	20.4	5.9	5.82	6.79	28.48	33107	11.86	Low Tide	10:48	
		14:46	Ambient	3	2.2	8.35	7.17	7.25	9302	13.06	High Tide	16:44	
		14:48	Ambient	20.3	5.2	5.85	6.99	28.54	33174	11.87	Low Tide	23:18	

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Slack (High)	10/10/2011	16:41	Compliance	3	2.3	8.09	7.21	7.43	9932	13.1			
		16:42	Compliance	22.8	4.5	5.84	7.14	28.6	33227	11.84	Bank Excavation	7:35	14:45
		16:50	Ambient	3	1.9	8.13	7.31	7.43	10171	13.16	Dredging	13:30	14:30
		16:53	Ambient	23.1	4.1	5.96	7.05	28.66	33243	11.84			
Ebb	10/10/2011	WQ Monitoring not conducted											
Ebb	10/11/2011	10:30	Compliance	3	3.5	8.42	6.56	7.22	9645	12.73	High Tide	5:47	
		10:32	Compliance	14.2	4.3	5.66	6.71	26.68	31322	12.02	Low Tide	11:25	
		10:56	Ambient	3	3.4	8.43	7.43	7.32	9732	12.75	High Tide	17:06	
		10:58	Ambient	14.7	4.1	5.88	7.37	26.53	31170	11.99	Low Tide	23:43	
Slack (Low)	10/11/2011	11:31	Compliance	3	3.3	8.38	7.57	7.41	9733	12.87			
		11:33	Compliance [b]	15.5	6.4	5.68	7.37	26.76	31285	12.01	Bank Excavation	7:30	14:30
		11:48	Ambient	3	3.2	8.4	7.64	7.4	9934	12.87	Dredging	9:30	13:00
		11:50	Ambient [b]	13	5.5	6.08	7.36	24.66	29115	12.11			
Flood	10/12/2011	15:01	Compliance	3	4.1	8.78	5.97	6.87	8432	12.93	High Tide	6:25	
		15:03	Compliance	19.6	4.1	6.00	6.27	28.65	33285	11.78	Low Tide	12:01	
		15:11	Ambient	3	3.9	8.41	6.99	6.13	8839	12.95	High Tide	17:29	
		15:14	Ambient	17	3.7	6.01	6.91	28.9	32186	11.85			
Slack (High)	10/12/2011	WQ Monitoring not conducted									Pile Removal	8:30	9:30
											Pile Removal	13:30	14:15
Ebb	10/13/2011	10:32	Compliance	3	2.8	8.76	6.71	5.18	6992	12.43	Low Tide	0:10	
		10:35	Compliance [b]	17.2	3.1	6.05	6.57	28.15	32723	11.81	High Tide	7:01	
											Low Tide	12:37	
		11:00	Ambient	3	3	9.01	7.45	4.76	6391	12.44	High Tide	17:56	
		11:03	Ambient [b]	16	2.4	6.14	6.94	27.96	32498	11.83			
Slack (Low)	10/13/2011	12:35	Compliance	3	3	8.61	7.3	4.51	6201	12.59	Dredging	10:15	11:30
		12:37	Compliance	17.6	3.1	6.08	7.03	27.05	31617	11.88	Bank Excavation	21:00	0:00
		12:53	Ambient	3	2.7	8.93	7.41	4.49	6184	12.74			
		12:55	Ambient	15	2.3	6.29	7.01	26.58	31081	11.91			
Ebb	10/14/2011	10:31	Compliance	3	2.4	8.85	6.22	5.1	6835	12.05	Low Tide	0:40	
		10:33	Compliance	17.6	3	6.18	6.62	28.43	32985	11.75	High Tide	7:38	
		10:45	Ambient	3	2.3	8.94	7.18	5.08	6814	12.03	Low Tide	13:14	
		10:47	Ambient	18.5	2.4	6.2	7.1	28.53	33058	11.75	High Tide	18:25	
Slack (Low)	10/14/2011	13:11	Compliance	3	2.7	8.91	7.47	4.7	6496	12.16			
		13:15	Compliance	16.7	3.4	6.4	7.3	26.98	28944	11.82	Bank Excavation	0:00	1:00
		13:25	Ambient	3	2.4	8.98	7.56	4.48	6119	12.16	Dredging	8:30	13:30
		13:28	Ambient	15.5	2.8	6.25	7.34	27.86	32403	11.78			
Ebb	10/17/2011	11:18	Compliance	3	2.5	8.72	7.18	6.76	8618	11.08	Low Tide	2:33	
		11:22	Compliance	20.4	3.3	5.84	7.14	29.04	33468	11.58	High Tide	9:51	
		11:37	Ambient	3	3.5	8.35	7.16	7.96	9871	11.15	Low Tide	15:29	
		11:40	Ambient	16.5	2.5	6	7.23	28.7	33137	11.59	High Tide	20:07	

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Slack (Low)	10/17/2011	15:17	Compliance	3	1.9	9.18	7.43	4.91	6482	11.46			
		15:20	Compliance	17.6	2.6	6.35	7.28	28.35	32801	11.61	Bank Excavation	12:45	13:45
		15:30	Ambient	3	2.1	9.17	7.45	4.79	6679	11.53	Dredging	7:50	14:00
		15:33	Ambient	17.3	2.1	6.2	7.42	28.48	32918	11.6			
	10/18/2011	WQ Monitoring not conducted											
Slack (High)	10/19/2011	11:47	Compliance	3	3.6	8.51	6.9	9.5	11991	11.59	Low Tide	4:12	
		11:49	Compliance	21.8	2.8	6.43	7.1	29.03	33417	11.54	High Tide	11:47	
		11:58	Ambient	3	4.4	8.35	7.18	8.71	10968	11.59	Low Tide	17:51	
		12:01	Ambient	20.9	2	6.48	7.18	29	33415	11.54	High Tide	22:10	
Ebb	10/19/2011	13:12	Compliance	3	7	8.47	7.39	7.94	9764	11.69			
		13:15	Compliance	20.4	2.5	6.17	7.4	29.02	33419	11.55	Dredging	7:30	14:00
		13:24	Ambient	3	6.6	8.03	7.18	8.68	11249	11.67			
		13:27	Ambient	19.8	2.3	6.18	7.48	28.91	33319	11.55			
	10/20/2011	WQ Monitoring not conducted											
Slack (High)	10/21/2011	13:31	Compliance	3	2.7	8.07	6.21	10.79	13589	11.74	Low Tide	6:14	
		13:34	Compliance	22.3	2.9	6.45	6.79	28.8	33213	11.54	High Tide	13:34	
		13:43	Ambient	3	2.3	8.07	7.12	9.88	13675	11.74	Low Tide	20:03	
		13:45	Ambient	22.2	2.2	6.5	7.23	28.78	33186	11.54			
Ebb	10/21/2011	15:05	Compliance	3	3	7.69	7.26	14.95	19818	11.7			
		15:09	Compliance	20.6	1.6	6.44	7.42	28.69	33085	11.54	Bank Excavation	7:10	12:00
		15:19	Ambient	3	2.4	7.96	7.43	11.63	14434	11.79	Dredging	7:30	10:00
		15:21	Ambient	20.3	2.1	6.44	7.44	28.73	33134	11.54			
Slack (High)	10/24/2011	15:22	Compliance	3	6.8	7.8	6.22	10.99	13943	12.33	High Tide	3:28	
		15:25	Compliance	22.7	2.9	6.44	6.92	29.01	33434	11.59	Low Tide	9:16	
		15:32	Ambient	3	4	8.05	7.13	8.57	11221	12.35	High Tide	15:25	
		15:35	Ambient	21.4	1.8	6.5	7.24	29.12	33568	11.6	Low Tide	22:06	
Ebb	10/24/2011	16:25	Compliance	3	3.7	8.3	7.24	7.66	10517	12.57			
		16:28	Compliance	21.6	2.1	6.48	7.23	28.93	33384	11.6	Dredging	13:00	15:00
		16:34	Ambient	3	3.4	8.31	7.42	7.78	10654	12.44			
		16:36	Ambient	19.5	1.6	6.54	7.32	28.89	33346	11.61			
	10/25/2011 to 10/27/2011	WQ Monitoring not conducted											
Slack (Low)	10/28/2011	13:08	Compliance	3	2.5	9.81	7	6.64	8231	9.68	Low Tide	0:11	
		13:11	Compliance	17.5	2.1	6.72	6.96	27.48	31566	11.21	High Tide	7:13	
		13:22	Ambient	3	2.5	9.54	7.38	7.31	9091	9.77	Low Tide	12:43	
		13:25	Ambient	17.2	2.1	6.61	7.31	27.47	31550	11.21	High Tide	17:56	
Flood	10/28/2011	14:48	Compliance	3	3.4	--	7.6	8.97	10924	9.89			
		14:51	Compliance	18.8	7.1	--	7.49	28.37	32520	11.25	Bank Excavation	8:45	12:00
		14:56	Ambient	3	2.3	9.82	7.74	8.62	10533	9.9			
		14:58	Ambient	20.4	5.3	--	7.55	28.57	32680	11.27			
	10/29/2011 to 10/31/2011	WQ Monitoring not conducted											

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Slack (High)	11/1/2011	11:21	Compliance	3	2.8	--	6.48	6.77	7856	9.43	Low Tide	3:27	
		11:25	Compliance	20.7	1.9	--	6.72	29.08	33201	11.2	High Tide	11:03	
		11:29	Ambient	3	2.5	--	7.05	8.11	9825	9.61	Low Tide	17:09	
		11:31	Ambient	23.2	1.5	--	7.01	29.07	33194	11.19	High Tide	21:39	
Ebb	11/1/2011	12:33	Compliance	3	2.1	9.88	6.48	3.91	5059	9.27			
		12:36	Compliance	21.5	1.7	6.5	6.44	28.95	33044	11.19	Bank Excavation	7:30	13:30
		12:37	Ambient	3	2.4	9.71	6.99	4.89	6150	9.38	Dredging	9:00	15:30
		12:39	Ambient	22.3	1.9	--	7.03	29.02	33143	11.2			
	11/2/2011	WQ Monitoring not conducted											
Slack (High)	11/3/2011	13:03	Compliance	3	6.1	9.77	6.63	5.99	7043	8.41	Low Tide	5:26	
		13:05	Compliance	21.6	1.4	6.47	6.63	39.8	43962	11.12	High Tide	12:59	
		13:15	Ambient	3	1.6	10.48	5.99	3.27	4090	8.34	Low Tide	19:46	
		13:18	Ambient	25.2	7	5.57	6.41	40.01	44153	11.15			
Ebb	11/3/2011	14:29	Compliance	3	5	10.07	5.87	4.96	6394	8.49			
		14:32	Compliance	21	1.5	5.75	6.11	39.55	43671	11.14	Bank Excavation	8:35	15:30
		14:41	Ambient	3	1.1	10.49	7.05	3.49	4367	8.27	Dredging	9:00	13:00
		14:44	Ambient	22.6	1	5.73	6.87	39.63	43807	11.14			
	11/4/2011 to 11/7/2011	WQ Monitoring not conducted											
Slack (High)	11/8/2011	14:46	Ambient	3	1.8	9.68	6.71	7.5	8676	8.01	High Tide	4:15	
		14:48	Ambient	22.5	2.5	6.25	7.03	28.02	31902	10.93	Low Tide	9:26	
		14:55	Compliance	3	2.4	9.48	7.31	8.49	9972	8.18	High Tide	14:48	
		14:57	Compliance	19.9	2.5	6.27	7.22	27.91	31778	10.89	Low Tide	21:44	
Ebb	11/8/2011	16:01	Ambient	3	1.4	10.09	7.15	5.54	6637	7.93			
		16:03	Ambient	22.2	1.7	6.35	7.06	28.03	31882	10.91	Bank Excavation	8:00	15:00
		16:08	Compliance	3	3.7	9.35	7.48	8.23	9646	8.17	Dredge	13:00	16:00
		16:11	Compliance	19.7	3.4	6.54	7.37	27.93	31799	10.88			
	11/9/2011	WQ Monitoring not conducted											
Flood	11/10/2011	14:45	Ambient	3	2.7	9.46	6.95	6.2	7648	9.15	High Tide	5:31	
		14:50	Ambient	21.9	1.5	7.42	7.52	27.86	31916	11.415	Low Tide	10:48	
		15:01	Compliance	3	2.9	9.22	6.94	7.27	8791	9.01	High Tide	15:43	
		15:05	Compliance	18.6	1.3	6.5	7.4	27.51	31528	11.13	Low Tide	22:40	
Slack (High)	11/10/2011	15:46	Ambient	3	1.1	9.41	7.3	6.57	7856	8.99			
		15:49	Ambient	23	1.5	6.34	6.45	28.16	32223	11.17	Bank Excavation	7:50	13:30
		15:55	Compliance	3	7.6	8.9	7.35	8.99	10710	9.2	Dredging	11:30	14:00
		15:57	Compliance	21.3	1.2	6.25	6.37	28.12	32201	11.15	Significant floating debris entering Slip		
	11/11/2011	WQ Monitoring not conducted											
Slack (High)	11/22/2011	13:30	Compliance	3	3.2	10.29	7.13	8.27	9258	6.62	High Tide	8:38	
		13:33	Compliance	23.8	1	6.16	7.5	41.9	45287	10.49	Low Tide	7:48	
		13:38	Ambient	3	3.9	10.42	7.43	8.07	9103	6.65	High Tide	13:36	
		13:40	Ambient	24.7	0.7	6.93	7.54	42.04	45440	10.51	Low Tide	20:40	

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Ebb	11/22/2011	14:58	Compliance	3	5.3	10.37	7.4	7.64	8696	6.6			
		15:01	Compliance	22.4	0.9	5.9	7.57	41.81	45155	10.49	Barge Decon	11:00	15:00
		15:05	Ambient	3	3.4	10.5	7.52	7.03	7933	6.47			
		15:07	Ambient	20.7	0.4	5.96	7.55	41.47	4805	10.45			
	11/23/2011 to 11/28/2011	WQ Monitoring not conducted											
Slack (High)	11/29/2011	8:46	Ambient	3	4.7	11.26	6.37	2.3	2809	6.48	Low Tide	1:10	
			Ambient	25	0.1	6.36	7.47	45.36	48172	10.15	High Tide	8:38	
		8:57	Compliance	2	4.7	11.22	6.6	2.26	2720	6.52	Low Tide	14:35	
			Compliance	23.4	0.1	6.25	7.49	45.13	47065	10.16	High Tide	19:12	
Ebb	11/29/2011	10:08	Ambient	3	5.1	10.99	7.21	2.47	2997	6.54			
			Ambient	24.5	0.2	6.34	7.52	45.08	47918	10.15	Pile Extraction	7:10	17:00
		10:20	Compliance	3	5.5	11.12	7.41	2.3	2824	6.53			
			Compliance	22.6	0.3	6.23	7.58	45.17	47967	10.17			
	11/30/2011	WQ Monitoring not conducted											
Slack (High)	12/1/2011	10:04	Compliance	3	2.1	11.45	7.05	2.13	2463	6.18	Low Tide	2:47	
		10:08	Compliance	23	1.2	6.48	7.51	45.02	47761	10.1	High Tide	10:08	
		10:12	Ambient	3	1.9	11.44	7.49	1.81	2277	6.16	Low Tide	16:53	
		10:14	Ambient	23.5	1.1	6.64	7.54	45.02	47786	10.12	High Tide	21:39	
Ebb	12/1/2011	11:36	Compliance	3	0.9	11.26	7.1	3.68	4362	6.39			
		11:39	Compliance	20.2	3.4	6.53	7.5	44.43	47194	10.06	Toe Berms	9:00	10:30
		11:43	Ambient	3	2.5	11.24	7.38	3.8	4502	6.38	Toe Berms	13:00	17:30
		11:45	Ambient	22.7	2	6.57	7.51	44.82	47572	10.1			
	12/2/2011 to 12/5/2011	WQ Monitoring not conducted											
Slack (High)	12/6/2011	13:33	Compliance	3	5.1	11.35	7.13	4.09	4571	4.59	High Tide	3:30	
		13:35	Compliance	20.7	0.09	6.21	7.4	44.86	47300	9.87	Low Tide	8:10	
		13:39	Ambient	3	0.9	11.41	7.44	4.47	4984	4.57	High Tide	13:23	
		13:41	Ambient	22.3	0.6	6.3	7.53	44.87	47415	9.88	Low Tide	20:41	
Ebb	12/6/2011	14:52	Compliance	3	3.2	10.88	7.22	8.64	7004	4.85			
		14:54	Compliance	19.3	1.1	6.34	7.51	44.82	47357	9.89	Filter Material	8:00	13:00
		14:56	Ambient	3	2.6	11.11	7.43	6.65	6998	4.85	Cap Armor	14:00	17:30
		14:58	Ambient	21.3	2.4	6.1	7.52	44.86	47404	9.88			
	12/7/2011	WQ Monitoring not conducted											
Slack (High)	12/8/2011	14:45	Ambient	3	1.2	10.87	7.2	11.25	7378	5.38	High Tide	4:59	
		14:48	Ambient	21.4	2.6	6.91	7.53	38.82	41366	9.58	Low Tide	9:58	
		14:52	Compliance	3	2	9.78	7.37	13.31	13771	6.5	High Tide	14:32	
		14:54	Compliance	21.1	1.9	6.77	7.52	38.7	41287	9.56	Low Tide	21:42	

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Ebb	12/8/2011	16:02	Compliance	3	1.6	10.42	7.04	10.84	11658	5.93			
		16:04	Compliance	19	1.5	6.94	7.45	38.6	41105	9.55	Filter Material	8:30	11:00
		16:06	Ambient	3	1.4	10.57	7.54	9.01	9432	5.67			
		16:08	Ambient	19.8	2.3	7.07	7.36	38.45	40906	9.54			
	12/9/2011 to 12/12/2011	WQ Monitoring not conducted											
Ebb	12/13/2011	9:03	Compliance	3	1.7	9.71	6.73	16.72	17492	5.88	Low Tide	0:06	
		9:05	Compliance	22.1	0.4	6.4	7.46	49.41	51182	9.5	High Tide	7:33	
		9:10	Ambient	3	0.7	9.49	7.24	16.3	16726	5.85	Low Tide	13:13	
		9:12	Ambient	22.7	0.2	6.19	7.58	49.34	51054	9.5	High Tide	17:44	
Slack (Low)	12/13/2011	13:19	Compliance	3	1.3	10.21	7.26	11.27	12072	5.45			
		13:21	Compliance	18.5	1.6	6.46	7.43	48.01	49489	9.31	Filter Material	8:30	12:00
		13:23	Ambient	3	1.7	10.21	7.48	11.36	12088	5.46	Cap Armor	13:30	17:30
		13:25	Ambient	18.9	1.2	6.44	7.53	47.8	49334	9.26			
	12/14/2011	WQ Monitoring not conducted											
Ebb	12/15/2011	10:12	Ambient	3	2.0	9.1	6.77	18.95	21945	6.43	Low Tide	1:28	
		10:14	Ambient	23	1.1	6.67	7.52	45.4	47321	9.38	High Tide	8:43	
		10:18	Compliance	3	3.9	9.7	7.45	15.03	15844	5.72	Low Tide	14:50	
		10:20	Compliance	18.7	1.3	6.41	7.54	45.37	47256	9.38	High Tide	19:35	
Slack (Low)	12/15/2011	14:41	Ambient	3	1.0	10.01	7.51	13.69	14440	5.73			
		14:43	Ambient	17.3	0.1	7.3	7.56	43.26	44999	9.08	Habitat Mix	8:00	15:00
		14:46	Compliance	3	1.7	9.96	7.62	13.73	14546	5.75			
		14:48	Compliance	15.7	2.3	7.24	7.49	42.37	44147	8.97			
	12/16/2011	WQ Monitoring not conducted											
Slack (High)	12/19/2011	11:23	Ambient	3	3.3	10.46	6.52	8.04	8957	6.1	Low Tide	4:55	
		11:25	Ambient	22.5	0.7	6.47	7.46	46.21	48151	9.45	High Tide	11:23	
		11:29	Compliance	3	1.6	9.93	7.41	8.5	9496	6.17	Low Tide	18:37	
		11:31	Compliance	22	0.9	6.55	7.5	46.06	47974	9.43			
Ebb	12/19/2011	12:49	Compliance	3	2.2	9.72	7.16	9.29	10517	6.37			
		12:51	Compliance	21.1	2.4	6.43	7.5	46.17	48019	9.4	Work Delay / Mechanical Breakdowns		
		12:55	Ambient	3	1.3	10.12	7.44	8.07	8431	6.35	Filter Material	15:00	16:00
		12:57	Ambient	22.4	0.5	6.45	7.42	46.04	47943	9.44			
	12/20/2011	WQ Monitoring not conducted											
Slack (High)	12/21/2011	12:56	Compliance	3	2.1	9.37	6.85	16.37	17675	7.13	High Tide	2:53	
		12:57	Compliance	20	0.3	6.68	7.49	43.76	45827	9.42	Low Tide	7:28	
		12:59	Ambient	3	1.2	9.41	7.45	12.78	14615	6.9	High Tide	12:56	
		13:02	Ambient	23.6	0.7	6.46	7.52	43.83	45883	9.41	Low Tide	20:18	

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Ebb	12/21/2011	14:21	Compliance	3	1.7	9.62	7.28	12.86	14088	6.89			
		14:23	Compliance	21.5	3.0	7.06	7.52	43.92	45984	9.42	Fix High Spots	8:30	11:30
		14:26	Ambient	3	0.9	9.81	7.48	10.57	11716	6.75	Swale Cap Armor	14:00	14:30
		14:27	Ambient	22.5	0.6	6.72	7.55	43.94	45993	9.43			
	12/22/2011 to 1/2/2012	WQ Monitoring not conducted											
Slack (High)	1/3/2012	11:40	Ambient	3	7.4	11.49	7.03	2.92	3383	5.61	River water is off-color (brownish)		
		11:42	Ambient	23.4	2.0	6.51	7.38	47.04	48476	9.1	High Tide	2:08	
		11:49	Compliance	3	7.4	11.37	7.75	3.08	3577	5.6	Low Tide	6:09	
		11:51	Compliance	21.9	1.7	6.32	7.49	46.96	48368	9.08	High Tide	11:52	
Ebb	1/3/2012	13:14	Ambient	3	7.5	11.52	7.15	2.65	3130	5.74	Low Tide	19:20	
		13:16	Ambient	22.9	1.5	6.37	7.49	47.07	48489	9.1			
		13:22	Compliance	3	9.2	11.43	7.72	2.87	3487	5.74	Waterway Cap	9:00	13:00
		13:25	Compliance	19.3	1.6	6.43	7.43	46.87	48177	9.04	Habitat Mix	13:00	15:00
	1/4/2012 to 1/9/2012	WQ Monitoring not conducted											
Ebb	1/10/2012	8:01	Compliance	3	3.6	11.04	6.95	4.37	4981	6.19	High Tide	6:29	
		8:04	Compliance	19.1	1.1	6.71	7.31	45.94	47106	8.78	Low Tide	12:03	
		8:06	Ambient	3	2.7	11.05	7.73	3.72	4384	6.08	High Tide	16:56	
		8:08	Ambient	22.6	0.7	6.75	7.53	46.03	47209	8.79	Low Tide	23:47	
Slack (Low)	1/10/2012	11:58	Compliance	3	8.3	10.84	7.09	5.13	5852	6.28			
		12:00	Compliance	17.5	2.7	6.95	7.36	41.05	41688	8.57	Waterway Cap	8:15	10:45
		12:03	Ambient	3	3.6	11.05	7.35	6.84	8651	6.37	Waterway Cap	13:15	16:15
		12:05	Ambient	17.2	1.6	6.84	7.56	43.83	45090	8.6			
	1/11/2012 to 1/23/2012	WQ Monitoring not conducted											
Ebb	1/24/2012	10:16	Compliance	3.0	**22.0**	11.16	6.67	7.44	7972	4.54	High Tide	6:20	
		10:18	Compliance	17.9	10.8	7.01	7.41	48.89	48328	7.75	Low Tide	12:06	
		10:20	Ambient	3.0	**4.6**	11.38	7.66	7.39	8134	4.48	High Tide	17:11	
		10:22	Ambient	19.9	5.8	7.07	7.56	50.28	49858	7.90	Low Tide	23:47	
Ebb	1/24/2012	11:30	Compliance	3.0	5.3	11.16	7.28	7.82	8407	4.54			
		11:32	Compliance	17.8	**19.5**	7.09	7.29	47.90	47493	7.68	Waterway Cap	7:00	11:30
		11:34	Ambient	3.0	7.0	10.85	7.57	10.30	10776	4.74	Waterway Cap	13:00	17:00
		11:36	Ambient	18.8	**3.6**	7.06	7.53	48.82	48230	7.77			
Outfalls	1/24/2012	11:49	NBF	1.0	20.4	--	--	--	--	--			
		11:52	I-5	1.0	38.1	--	--	--	--	--			
		12:09	NBF	0.5	15.7	--	--	--	--	--			
Slack (Low)	1/24/2012	12:13	Compliance	3.0	11.7	11.05	7.12	8.85	9403	4.74			
		12:15	Compliance	17.8	8.0	7.10	7.40	47.75	47610	7.69			
		12:18	Ambient	3.0	4.6	11.03	7.60	8.85	9332	4.68			
		12:20	Ambient	18.9	3.2	7.02	7.56	48.36	48109	7.72			

Table 3-1. Water Quality Monitoring Results

Tide	Date	Time	Station	Water Depth (ft)	Turbidity (NTU) [a]	Dissolved Oxygen (mg/L) [a]	pH [a]	Salinity (ppt) [a]	Conductivity (µS/cm) [a]	Temp (^{0}C) [a]	Daily Notes	Time	
Ebb	1/25/2012	9:57	Compliance	3.0	5.4	11.47	6.19	5.98	6533	4.86	High Tide	6:48	
		9:59	Compliance	20.0	5.1	7.03	7.36	51.09	50512	7.95	Low Tide	12:47	
		10:03	Ambient	3.0	4.1	11.34	7.41	6.58	7391	4.88	High Tide	18:00	
		10:05	Ambient	20.6	5.0	7.08	7.5	51.43	51991	8.01			
Slack (Low)	1/25/2012	12:40	Compliance	3.0	9.2	10.81	7.27	10.1	10672	5.43	Waterway Cap	7:00	11:30
		12:42	Compliance	16.7	17.9	8.10	7.45	38.47	40627	7.1	Waterway Cap	13:00	17:00
		12:47	Ambient	3.0	6.2	10.8	7.59	9.95	10692	5.43			
		12:49	Ambient	17.8	10.4	7.31	7.52	43.95	44504	7.45			
	1/26/2012 to 1/27/2012	WQ Monitoring not conducted											

Notes

[a] WQ measurements on 10/4/11 were collected using a Hydrolab MS5. WQ measurements from 10/5/11 to 11/08/11 were collected with a YSI 6920/650 MDS. WQ measurements from 11/11/2011 to 1/25/12 were collected with a replacement YSI 6920/650 MDS.

[b] Sample was sent for chemical analyses.

-- = No water quality measurements were recorded.
Bold = Indicates exceedance of 401 Certification Standard for turbidity (turbidity at compliance location in excess of 10 NTU over ambient turbidity).

Table 3-2. Analytical Results for Slip 4 Water Quality Monitoring Samples

		Sample ID	SW-02	SW-01	SW-01	SW-01	SW-02	SW-01	SW-01	SW-02
		Lab ID	SW0001	SW0002	SW0003	SW0010	SW0011	SW0012	SW0013	SW0014
		Sample Date	10/7/2011	10/7/2011	10/7/2011	10/11/2011	10/11/2011	10/13/2011	10/13/2011	10/13/2011
		Time	11:40:00 AM	12:05:00 PM	12:10:00 PM	11:35:00 AM	11:55:00 AM	10:40:00 AM	10:45:00 AM	11:05:00 AM
		Tide	Flood	Flood		Slack	Slack	Ebb		Ebb
		Station	Ambient	Compliance		Compliance	Ambient	Compliance		Ambient
		Depth (ft)[a]	16	17.7		15.5	13	17.2		16
Chemical Name	Method	Unit								
Field Parameters										
Turbidity	Field[b]	NTU	4.9	7.5		6.4	5.5	3.1		2.4
Dissolved Oxygen	Field[b]	mg/L	9.11	9.33		5.68	6.08	6.05		6.14
pH	Field[b]	pH	7.55	7.81		7.37	7.36	6.57		6.94
Salinity	Field[b]	ppt	25.49	26.08		26.76	24.66	28.15		27.96
Conductivity	Field[b]	µS/cm	39630	40802		31285	29115	32723		32498
Temperature	Field[b]	^{0}C	12.16	12.15		12.01	12.11	11.81		11.83
PCB Aroclors										
Aroclor 1016	SW8082	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.008 *U*	0.010 *U*	0.010 *U*
Aroclor 1221	SW8082	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.008 *U*	0.010 *U*	0.010 *U*
Aroclor 1232	SW8082	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.011 *Y*	0.015 *Y*	0.010 *U*
Aroclor 1242	SW8082	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.008 *U*	0.010 *U*	0.010 *U*
Aroclor 1248	SW8082	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.008 *U*	0.010 *U*	0.010 *U*
Aroclor 1254	SW8082	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.008 *U*	0.010 *U*	0.010 *U*
Aroclor 1260	SW8082	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.008 *U*	0.010 *U*	0.010 *U*
Total Aroclors	Calculated	µg/L	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.010 *U*	0.011 *Y*	0.015 *Y*	0.010 *U*
Conventionals										
Total solids	E160.2	mg/L	12.5	20.8	21.3	11.1	10.7	7.2	7.9	5.1

Notes

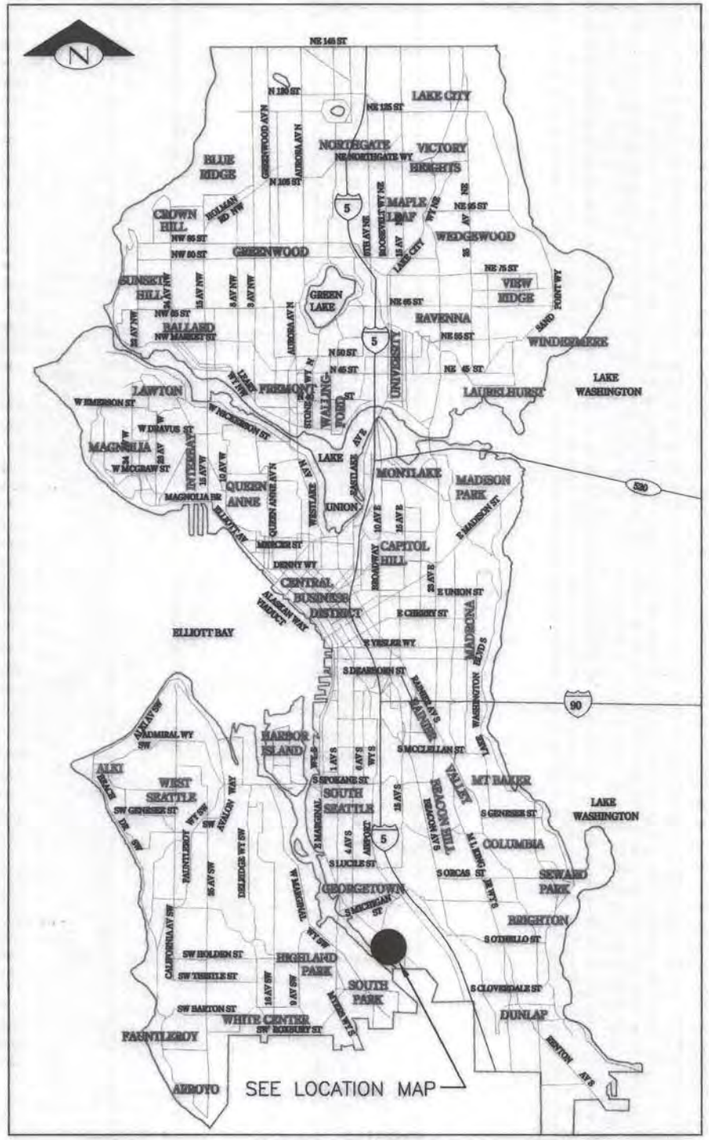
[a] Depth below water surface.

[b] Field parameters were collected with a YSI 6920/650 MDS.

U - Indicates that the targeta analyte was not detected at the reported concentration.

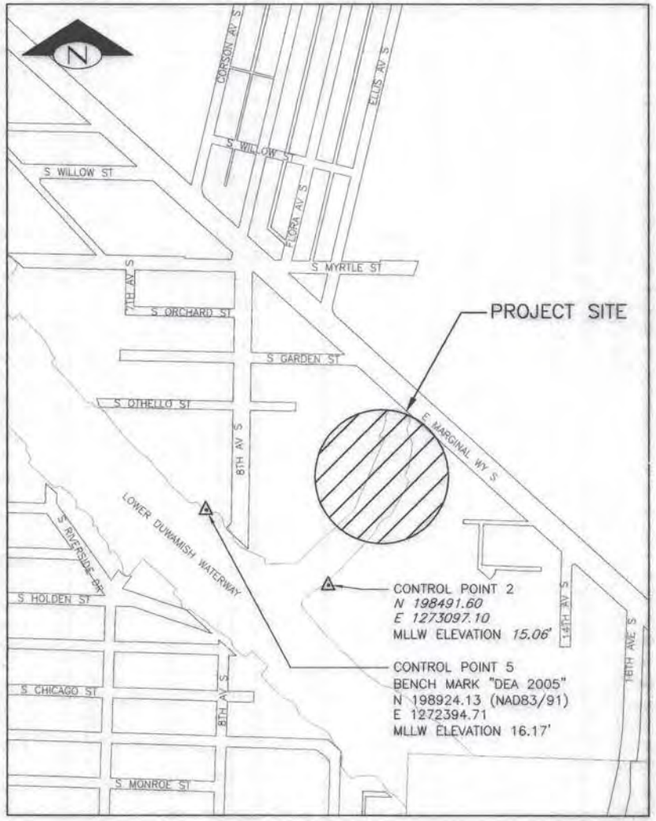
Y - The analyte is not detected at or above the reported concentration. The reporting limit is raised due to chromatographic interference. The Y flag is equivalent to the U flag with a raised reporting limit.

Note: This document has been scanned from the Contractor's field red-line set and is presented at best available quality.



VICINITY MAP

SCALE: 1" = 1 MILE



LOCATION MAP

SCALE: 1" = 400'

H: NAD 1983/91
V: MLLW

BASIS OF BEARING:

CITY DATUM/MLLW DIFFERENCE: -12.23 FT

PROJECT FIELD BOOK(S):

BENCH (NAVD-88) FIELDBOOK/PAGE: SNV-2533

BENCH (COS) FIELDBOOK/PAGE:

COORDINATE BASIS:
MONUMENT (1) HELD:
FOR LOCATION: Y FOR AZIMUTH: N
MONUMENT (2) HELD:
FOR LOCATION: Y FOR AZIMUTH: Y
MONUMENT (3) HELD: NA
FOR LOCATION: N FOR AZIMUTH: N

DETAIL AND SECTION REFERENCING

4/9 — DETAIL REFERENCE NUMBER / SHEET ON WHICH DETAIL APPEARS

(TITLE) (SCALE) 4/9 — DETAIL REFERENCE NUMBER / SHEET FROM WHICH DETAIL WAS TAKEN

("TYP" SPECIFIES THAT DETAIL IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED.)
("VAR" SPECIFIES THAT DETAIL WAS TAKEN FROM SEVERAL SHEETS.)

A A 32 — SECTION A-A IS SHOWN ON SHEET 32.

SECTION A-A 30 — SECTION A-A IS TAKEN FROM SHEET 30.

SHEET INDEX

ADV: 3/31/11

VICINITY MAP, LOCATION MAP, DETAIL AND SECTION REFERENCING, DATUM, & SHEET INDEX

NO.	DATE	MARK	NATURE OF REVISIONS
			MADS CHK'D REV'D

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ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

DAVID R. SCRUGGS — STATE OF WASHINGTON — 21603 — REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities — City of Seattle — Ray Hoffman, Director

ORDINANCE NO. APPROVED
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SCALE: H. 1"=20', V. 1"=10' INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 1 OF 24

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VAULT SHEET NO.	DATE	MARK	MAJOR REVISIONS	MADE CHK'D	REV'D
3575					

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DAVID R. SCHUDLER — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
ORDINANCE NO.
FUND: DWF/SCL
SCALE: NONE

City of Seattle
Ray Hoffman, Director
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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 2 OF 24

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ABBREVIATIONS

ABBREVIATION	DESCRIPTION
APPROX	APPROXIMATELY OR APPROXIMATE
AC	ASPHALT CONCRETE
℄	CENTERLINE
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
EL	ELEVATION
EOF	EMERGENCY OVERFLOW
FL	FLOOR
FT	FEET
GND	GROUND
IE	INVERT ELEVATION
IN	INCHES
MAX	MAXIMUM
MIN	MINIMUM
MLLW	MEAN LOWER LOW WATER
NAD	NORTH AMERICAN DATUM
NOM	NOMINAL
NTS	NOT TO SCALE
PL	PROPERTY LINE
PSEOF	PUMP STATION EMERGENCY OVERFLOW
PSD	PUBLIC STORM DRAIN
RA	REMOVAL AREA
RAWP	REMOVAL ACTION WORK PLAN
RE	RESIDENT ENGINEER
SD	STORM DRAIN
SS	SANITARY SEWER
STA	BASELINE STATION
TC	TOP OF CONCRETE
TYP	TYPICAL
VAR	VARIOUS

LEGEND:

SECTIONS:

- EXISTING MUDLINE
- REQUIRED DREDGE DEPTH
- DREDGE OVERDEPTH ALLOWANCE
- CAPPING LINE

PLAN VIEWS:

- POWER POLE
- SANITARY MANHOLE
- CATCH BASIN
- LUMINARE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- SPOT ELEVATION
- 1 FOOT CONTOUR INTERVAL
- 5 FOOT CONTOUR INTERVAL
- FINAL GRADE
- PROJECT BASELINE
- APPROXIMATE PROPERTY LINE
- APPROXIMATE BOUNDARY OF TENANT LEASE AREAS
- APPROXIMATE EXISTING TOP OF BANK
- PROJECT LIMITS
- DREDGE LIMITS
- RAIL SPUR
- (-3) REQUIRED DREDGE ELEVATION (FT MLLW)
- ■106 COORDINATE LOCATION
- LARGE WOODY DEBRIS
- (1) PHOTO VIEW
- SURVEY CONTROL POINT

- EXISTING CONCRETE
- EXISTING RIPRAP

CAP MATERIALS:

- FILTER MATERIAL
- WATERWAY CAP MATERIAL
- CAP ARMOR
- HEAVY LOOSE RIPRAP
- BEACH SAND

CAP TYPES:

- OUTFALL SCOUR PROTECTION
- SLOPE CAP
- ARMORED CAP
- WATERWAY CAP
- OUTFALL AREA CAP – ARMORED
- OUTFALL AREA CAP–UNARMORED
- BOUNDARY BERM
- BOUNDARY AREA MATERIAL (NON–CAP)

MADE FOR D RECD	NATURE	DATE	MARK	REVISIONS

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DAVID R. SCHUCHART — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
ORDINANCE NO.
FUND: DWF/SCL
SCALE: AS NOTED

City of Seattle
Ray Hoffman, Director
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ABBREVIATIONS AND LEGEND

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776–294
SHEET 3 OF 24

S. OTHELLO ST

ABANDONED PIPE CUT AND PLUGGED PER SPEC.
NORTHING: 199519.73
EASTING: 1273104.17
T.O.P.: 10.07

ABANDONED PIPE CUT AND PLUGGED PER SPEC.
NORTHING: 199424.49
EASTING: 1273135.83
T.O.P.: 8.90

APPROX. LOCATION EAST MARGINAL WAY PS EOF, 36" (SEE NOTE 5 AND 6)
PID NOT FIND IN FIELD

NORTHING: 199450.11
EASTING: 1273553.36
EL. 4.72 - KING COUNTY AIRPORT SD SPILL APRON CORNER

NORTHING: 199460.04
EASTING: 1273540.21
EL. 4.91 - KING COUNTY AIRPORT SD SPILL APRON CORNER

PID NOT FIND IN FIELD

10" TIDEFLEX CHECKMATE VALVE INSTALLED, SEE ~~SPECIFICATIONS ON SHT 1 OF SHEET~~ Removal Action Completion Report, Appendix D, Attachment F2, pages 9-16.

T.O.P.: 7.52
NORTHING: 199202.91
EASTING: 1273560.95

T.O.P.: 8.65
NORTHING: 199139.68
EASTING: 1273559.75
PIPE CUT AND PLUGGED PER SPEC.

T.O.P.: 11.44
NORTHING: 199096.29
EASTING: 1273565.04
PIPE CUT AND PLUGGED PER SPEC.

LOCATION FIELD VERIFIED PIPE PLUGGED PER SPEC.

PID NOT FIND IN FIELD

EAST MARGINAL WAY S.

Crowley Marine Services, Inc.

King County

First South Properties

The Boeing Company

PIER

LEGEND

- POWER POLE
- SANITARY MANHOLE
- CATCH BASIN
- LUMINAIRE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- SPOT ELEVATION
- 5 FOOT CONTOUR INTERVAL
- PROJECT BASELINE
- APPROXIMATE PROPERTY LINE
- APPROXIMATE EXISTING TOP OF BANK
- PROJECT LIMITS
- RAIL SPUR
- EXISTING RIPRAP

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE COORDINATE SYSTEM, NORTH ZONE (NAD–83/91), U.S. FEET.
2. CONTOURS ARE SHOWN IN FEET AT AN INTERVAL OF 5 FEET AND INDICATE ELEVATIONS IN REFERENCE TO MEAN LOWER LOW WATER (MLLW).
3. REFER TO SHEET 6 FOR BASEMAP SURVEY NOTES.
4. KNOWN STORM DRAIN FEATURES ARE SHOWN. CONTRACTOR TO LOCATE/VERIFY ALL UTILITIES IN ACCORDANCE WITH THE SPECIFICATIONS.
5. APPROXIMATE LOCATION OF EAST MARGINAL WAY PUMP STATION EOF OUTFALL (36–INCH) IS SHOWN.
6. LOCATE AND PROTECT ALL EXISTING OUTFALLS.
7. CUT OUTFALL FLUSH WITH EXCAVATED SURFACE AND GROUT IN ACCORDANCE WITH SPECIFICATIONS. SEE DETAIL 1 SHEET 21.
8. EXISTING STORM DRAIN IS PLUGGED. LOCATION OBTAINED FROM BUSH, ROED & HITCHINGS, INC. 2009 MINOT AVENUE EAST, SEATTLE, WA 98102, BRH JOB# 99322.02; BRH DRAWING NAME: XGRD.DWG. STORM DRAIN AND OUTFALL NOTED AS NOT FOUND IN FIELD
9. PROTECT WOOD PILING FENDER WALLS AT I–5 OUTFALL.

N

50 25 0 50 100
SCALE IN FEET

PROJECT SITE PLAN – EXISTING CONDITIONS AND STORM DRAINAGE OUTFALLS

VAULT SERIAL NO.	DATE	MARK	REVISIONS
345375			

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DAVID R. SCHUCHART — STATE OF WASHINGTON — 20080 — REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
ORDINANCE NO.
FUND: DWF/SCL
SCALE: AS NOTED

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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. C309045
PC
R/W
CO
VAULT PLAN NO. 776–294
SHEET 4 OF 24

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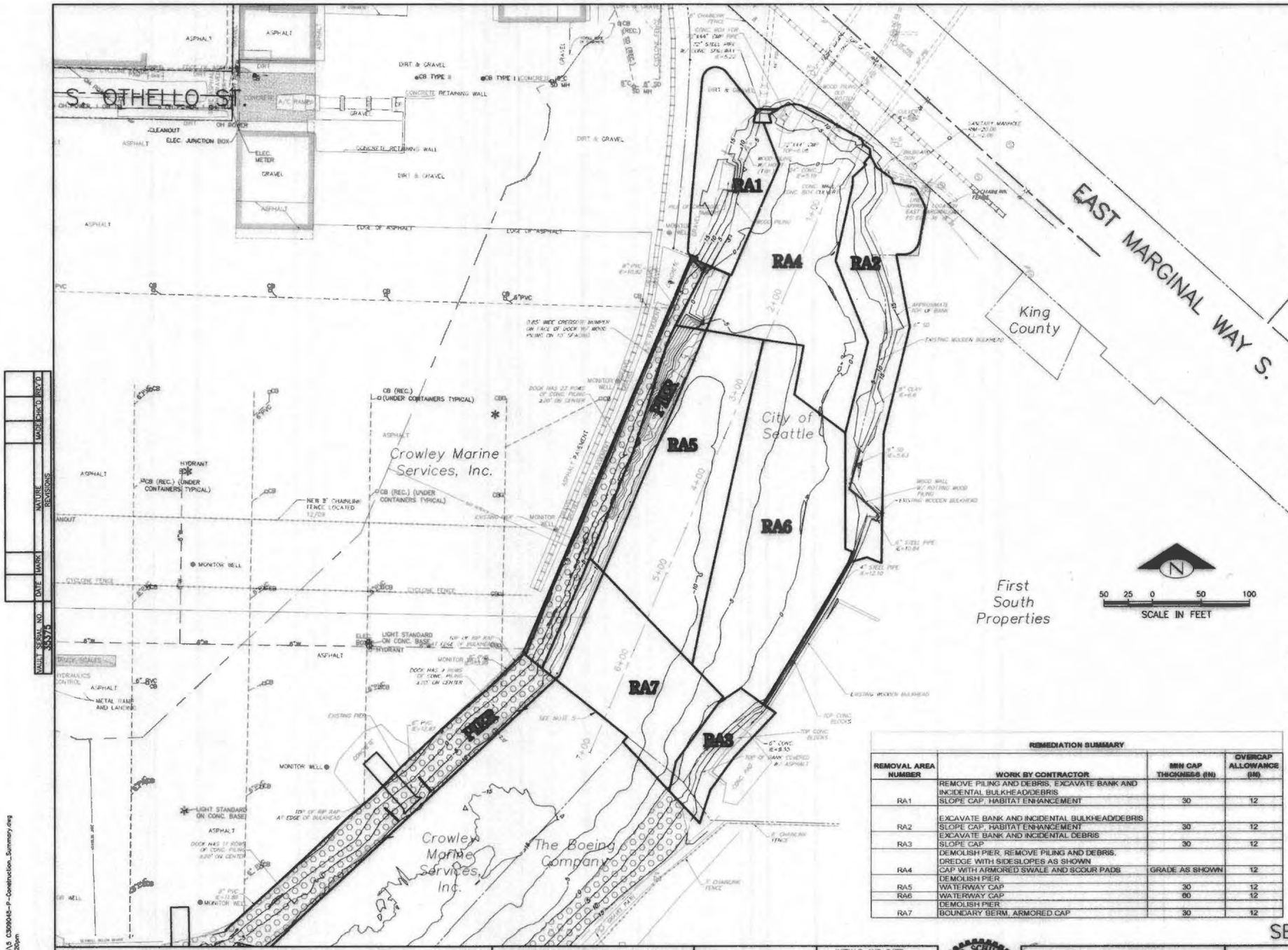

LEGEND

- POWER POLE
- SANITARY MANHOLE
- LUMINAIRE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- SPOT ELEVATION
- 5 FOOT CONTOUR INTERVAL
- REMOVAL AREA BOUNDARY
- APPROXIMATE PROPERTY LINE
- APPROXIMATE TOP OF BANK
- RAIL SPUR
- EXISTING RIPRAP

CONSTRUCTION SEQUENCING NOTES:

1. CONTRACTOR SUBMITTALS INCLUDING RAWP MUST BE APPROVED PRIOR TO THE START OF ANY SITE WORK.
2. PERFORM ALL WORK IN ACCORDANCE WITH THE SEQUENCING DEFINED IN THE APPROVED RAWP.
3. COMPLETE PRECONSTRUCTION SURVEY PRIOR TO THE START OF DREDGING AND EXCAVATION, IN ACCORDANCE WITH THE SPECIFICATIONS.
4. REMOVE VISIBLE DERELICT PILING AND LARGE DEBRIS BEFORE DREDGING.
5. PLACE BOUNDARY BERM AT STA 6+70 BEFORE DREDGING.
6. REMOVE BULKHEAD STRUCTURES THAT RETAIN BANK SOILS AS BANK EXCAVATION PROCEEDS.
7. ALLOW ENGINEER ACCESS TO EXCAVATED BANKS FOR DOCUMENTATION SAMPLING. NO ADDITIONAL DREDGING OR EXCAVATION WILL BE REQUIRED BASED ON THE DOCUMENTATION SAMPLING.
8. COMPLETE POST-DREDGE ACCEPTANCE SURVEY PRIOR TO THE START OF BANK OR OUTFALL AREA CAPPING.
9. ALL DREDGING AND EXCAVATION SHALL BE COMPLETED PRIOR TO THE START OF ANY CAPPING WORK.
10. SEE SHEET 16 FOR CAPPING SEQUENCE.
11. DEMOLISH PIER BEFORE PLACING CAP MATERIAL IN PIER FOOTPRINT OR IN RA5, 6, OR 7.
12. COMPLETE CAP ACCEPTANCE SURVEY, PREFINAL, AND FINAL INSPECTIONS. ENGINEER WILL COLLECT CAP VERIFICATION AND BOUNDARY AREA DOCUMENTATION SAMPLES.
13. COMPLETE RESPONSE ACTIONS AS DETERMINED BY THE ENGINEER FOR ANY OUT OF COMPLIANCE WORK, IN ACCORDANCE WITH SECTION 352324 OF THE SPECIFICATIONS.
14. ENGINEER MAY DIRECT ADDITIONAL WATERWAY CAP MATERIAL PLACEMENT BASED ON BOUNDARY AREA DOCUMENTATION SAMPLING.

GENERAL NOTES:

1. PERFORM ALL IN-WATER WORK IN ACCORDANCE WITH THE WINDOW REFERENCED IN SECTION 01 11 00 OF THE SPECIFICATIONS.
2. MODIFY OPERATIONS AS NEEDED TO COMPLY WITH WATER QUALITY CRITERIA DEFINED IN THE CLEAN WATER ACT 401 CERTIFICATION. COMPLIANCE WILL BE DETERMINED BY THE ENGINEER.
3. CONTAIN AND REMOVE ANY SHEENS OR FLOATABLE MATERIAL RELEASED TO THE WATER AS A RESULT OF CONSTRUCTION ACTIVITIES.
4. PROTECT ALL EXISTING OUTFALL STRUCTURES NOT DESIGNATED FOR DEMOLITION.
5. ALL CAP MATERIALS SHALL BE PLACED IN ACCORDANCE WITH THE SPECIFICATIONS WITH THE GOAL OF PRODUCING UNIFORM LIFTS WITH MINIMAL DISTURBANCE OF, OR INTERMINGLING WITH, THE EXISTING BOTTOM SEDIMENTS.
6. PERFORM ALLL WORK IN ACCORDANCE WITH THE SPECIFICATIONS AND THE APPROVED RAWP.

REMEDIATION SUMMARY

REMOVAL AREA NUMBER	WORK BY CONTRACTOR	MIN CAP THICKNESS (IN)	OVERCAP ALLOWANCE (IN)
RA1	REMOVE PILING AND DEBRIS, EXCAVATE BANK AND INCIDENTAL BULKHEAD/DEBRIS SLOPE CAP, HABITAT ENHANCEMENT	30	12
RA2	EXCAVATE BANK AND INCIDENTAL BULKHEAD/DEBRIS SLOPE CAP, HABITAT ENHANCEMENT	30	12
RA3	EXCAVATE BANK AND INCIDENTAL DEBRIS SLOPE CAP	30	12
RA4	DEMOLISH PIER, REMOVE PILING AND DEBRIS, DREDGE WITH SIDESLOPES AS SHOWN CAP WITH ARMORED SWALE AND SCOUR PADS	GRADE AS SHOWN	12
RA5	DEMOLISH PIER WATERWAY CAP	30	12
RA6	WATERWAY CAP	60	12
RA7	DEMOLISH PIER BOUNDARY BERM, ARMORED CAP	30	12

CONSTRUCTION SUMMARY, SEQUENCING, AND GENERAL NOTES

NO.	DATE	MARK	NATURE REVISIONS
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DAVID R. SCHNICKER STATE OF WASHINGTON PROFESSIONAL ENGINEER

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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

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VAULT PLAN NO. 776-294
SHEET 5 OF 24

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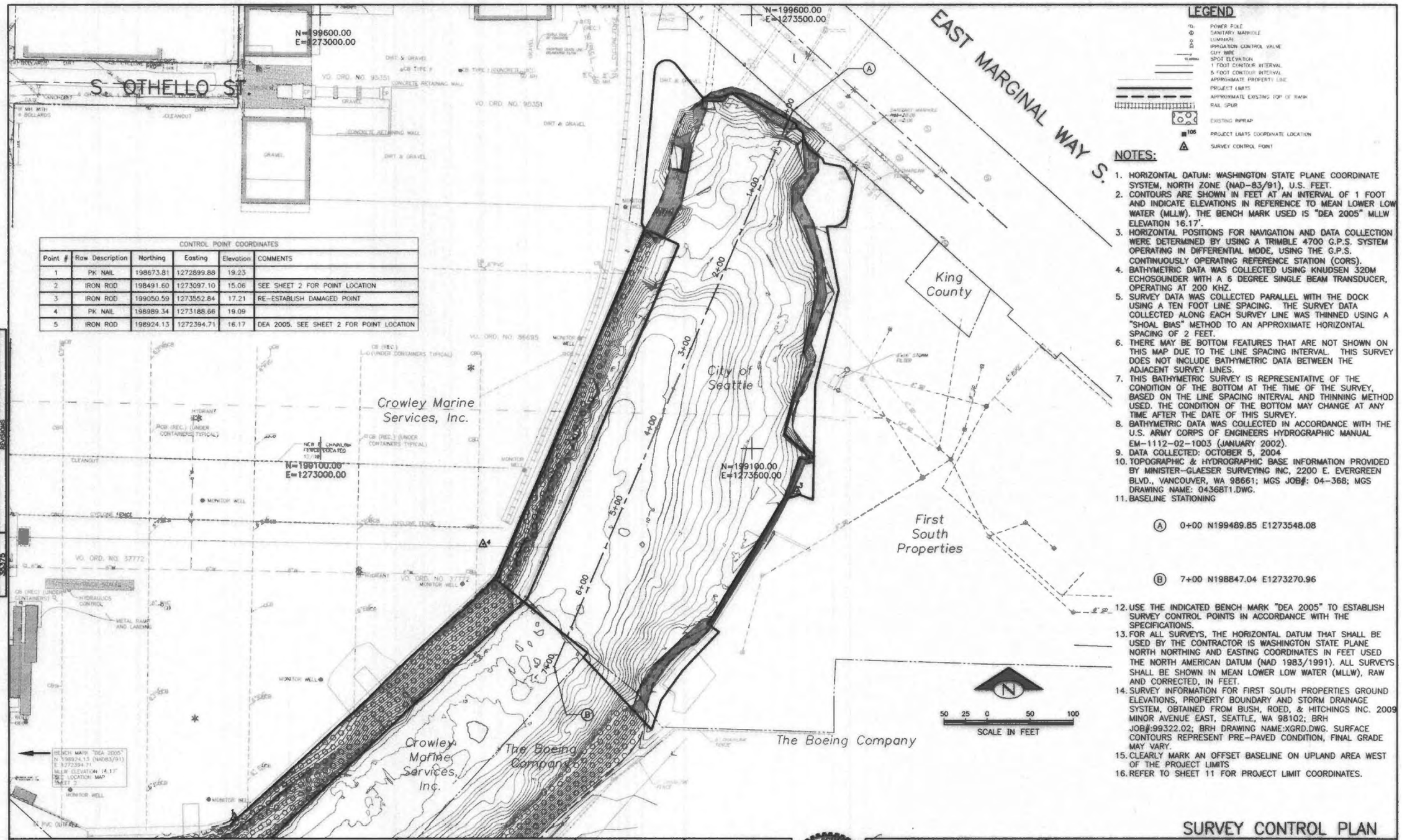

CONTROL POINT COORDINATES

Point #	Raw Description	Northing	Easting	Elevation	COMMENTS
1	PK NAIL	198673.81	1272899.88	19.23	
2	IRON ROD	198491.60	1273097.10	15.06	SEE SHEET 2 FOR POINT LOCATION
3	IRON ROD	199050.59	1273552.84	17.21	RE-ESTABLISH DAMAGED POINT
4	PK NAIL	198989.34	1273188.66	19.09	
5	IRON ROD	198924.13	1272394.71	16.17	DEA 2005. SEE SHEET 2 FOR POINT LOCATION

LEGEND

- POWER POLE
- SANITARY MANHOLE
- LUMINAIRE
- IRRIGATION CONTROL VALVE
- CITY WIRE
- SPOT ELEVATION
- 1 FOOT CONTOUR INTERVAL
- 5 FOOT CONTOUR INTERVAL
- APPROXIMATE PROPERTY LINE
- PROJECT LIMITS
- APPROXIMATE EXISTING TOP OF BANK
- RAIL SPUR
- EXISTING RIPRAP
- 105 PROJECT LIMITS COORDINATE LOCATION
- SURVEY CONTROL POINT

NOTES:

1. HORIZONTAL DATUM: WASHINGTON STATE PLANE COORDINATE SYSTEM, NORTH ZONE (NAD-83/91), U.S. FEET.
2. CONTOURS ARE SHOWN IN FEET AT AN INTERVAL OF 1 FOOT AND INDICATE ELEVATIONS IN REFERENCE TO MEAN LOWER LOW WATER (MLLW). THE BENCH MARK USED IS "DEA 2005" MLLW ELEVATION 16.17'.
3. HORIZONTAL POSITIONS FOR NAVIGATION AND DATA COLLECTION WERE DETERMINED BY USING A TRIMBLE 4700 G.P.S. SYSTEM OPERATING IN DIFFERENTIAL MODE, USING THE G.P.S. CONTINUOUSLY OPERATING REFERENCE STATION (CORS).
4. BATHYMETRIC DATA WAS COLLECTED USING KNUDSEN 320M ECHOSOUNDER WITH A 6 DEGREE SINGLE BEAM TRANSDUCER, OPERATING AT 200 KHZ.
5. SURVEY DATA WAS COLLECTED PARALLEL WITH THE DOCK USING A TEN FOOT LINE SPACING. THE SURVEY DATA COLLECTED ALONG EACH SURVEY LINE WAS THINNED USING A "SHOAL BIAS" METHOD TO AN APPROXIMATE HORIZONTAL SPACING OF 2 FEET.
6. THERE MAY BE BOTTOM FEATURES THAT ARE NOT SHOWN ON THIS MAP DUE TO THE LINE SPACING INTERVAL. THIS SURVEY DOES NOT INCLUDE BATHYMETRIC DATA BETWEEN THE ADJACENT SURVEY LINES.
7. THIS BATHYMETRIC SURVEY IS REPRESENTATIVE OF THE CONDITION OF THE BOTTOM AT THE TIME OF THE SURVEY, BASED ON THE LINE SPACING INTERVAL AND THINNING METHOD USED. THE CONDITION OF THE BOTTOM MAY CHANGE AT ANY TIME AFTER THE DATE OF THIS SURVEY.
8. BATHYMETRIC DATA WAS COLLECTED IN ACCORDANCE WITH THE U.S. ARMY CORPS OF ENGINEERS HYDROGRAPHIC MANUAL EM-1112-02-1003 (JANUARY 2002).
9. DATA COLLECTED: OCTOBER 5, 2004
10. TOPOGRAPHIC & HYDROGRAPHIC BASE INFORMATION PROVIDED BY MINISTER-GLAESER SURVEYING INC, 2200 E. EVERGREEN BLVD., VANCOUVER, WA 98661; MGS JOB#: 04-368; MGS DRAWING NAME: 04368T1.DWG.
11. BASELINE STATIONING

    (A) 0+00 N199489.85 E1273548.08

    (B) 7+00 N198847.04 E1273270.96

12. USE THE INDICATED BENCH MARK "DEA 2005" TO ESTABLISH SURVEY CONTROL POINTS IN ACCORDANCE WITH THE SPECIFICATIONS.
13. FOR ALL SURVEYS, THE HORIZONTAL DATUM THAT SHALL BE USED BY THE CONTRACTOR IS WASHINGTON STATE PLANE NORTH NORTHING AND EASTING COORDINATES IN FEET USED THE NORTH AMERICAN DATUM (NAD 1983/1991). ALL SURVEYS SHALL BE SHOWN IN MEAN LOWER LOW WATER (MLLW), RAW AND CORRECTED, IN FEET.
14. SURVEY INFORMATION FOR FIRST SOUTH PROPERTIES GROUND ELEVATIONS, PROPERTY BOUNDARY AND STORM DRAINAGE SYSTEM, OBTAINED FROM BUSH, ROED, & HITCHINGS INC. 2009 MINOR AVENUE EAST, SEATTLE, WA 98102; BRH JOB#:99322.02; BRH DRAWING NAME:XGRD.DWG. SURFACE CONTOURS REPRESENT PRE-PAVED CONDITION, FINAL GRADE MAY VARY.
15. CLEARLY MARK AN OFFSET BASELINE ON UPLAND AREA WEST OF THE PROJECT LIMITS
16. REFER TO SHEET 11 FOR PROJECT LIMIT COORDINATES.

SURVEY CONTROL PLAN

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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO.	PC C309045 R/W CO
VAULT PLAN NO.	776-294
SHEET	6 OF 24

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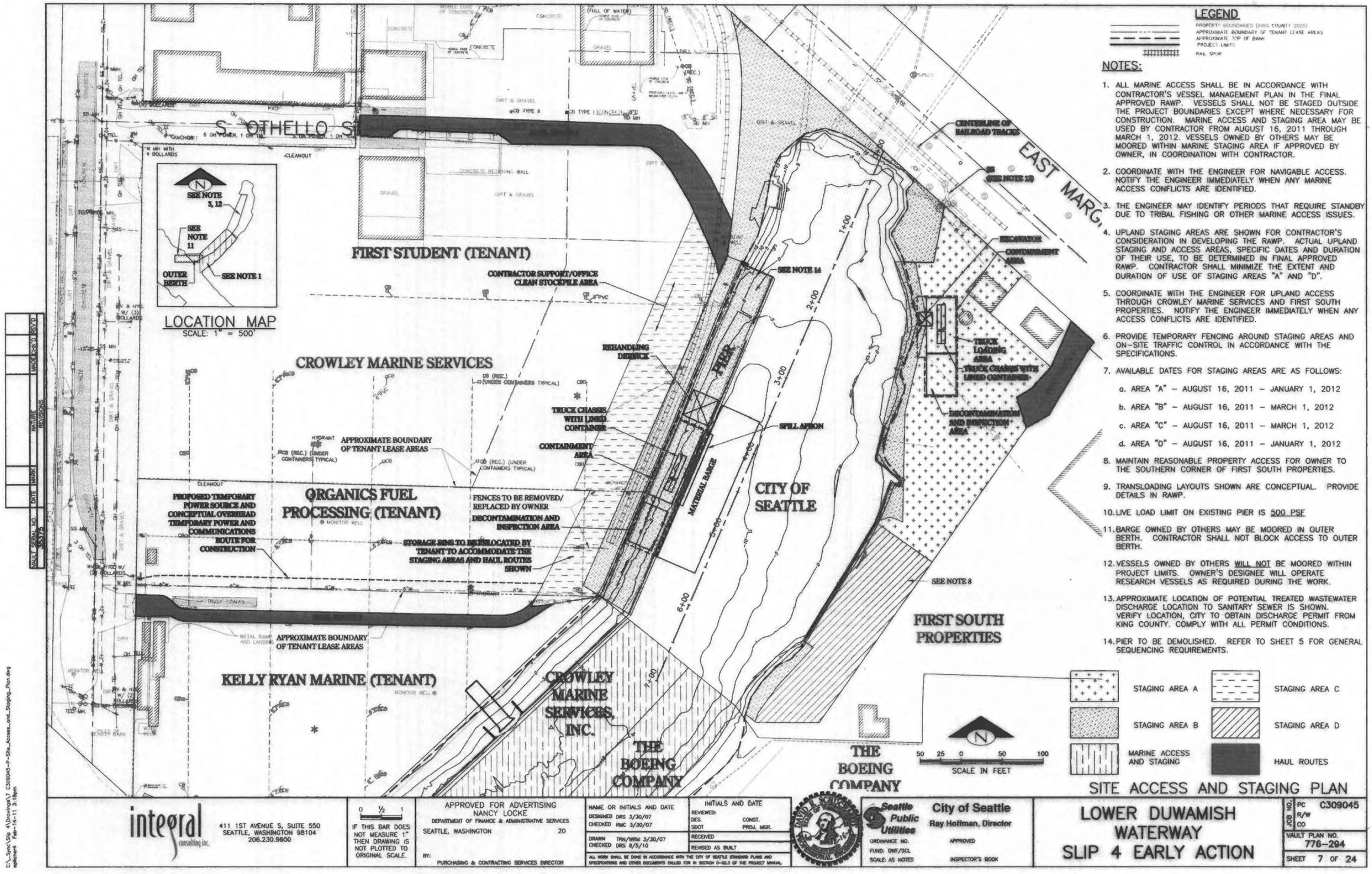

LEGEND

- PROPERTY BOUNDARIES (KING COUNTY 2005)
- APPROXIMATE BOUNDARY OF TENANT LEASE AREAS
- APPROXIMATE TOP OF BANK
- PROJECT LIMITS
- RAIL SPUR

NOTES:

1. ALL MARINE ACCESS SHALL BE IN ACCORDANCE WITH CONTRACTOR'S VESSEL MANAGEMENT PLAN IN THE FINAL APPROVED RAWP. VESSELS SHALL NOT BE STAGED OUTSIDE THE PROJECT BOUNDARIES EXCEPT WHERE NECESSARY FOR CONSTRUCTION. MARINE ACCESS AND STAGING AREA MAY BE USED BY CONTRACTOR FROM AUGUST 16, 2011 THROUGH MARCH 1, 2012. VESSELS OWNED BY OTHERS MAY BE MOORED WITHIN MARINE STAGING AREA IF APPROVED BY OWNER, IN COORDINATION WITH CONTRACTOR.
2. COORDINATE WITH THE ENGINEER FOR NAVIGABLE ACCESS. NOTIFY THE ENGINEER IMMEDIATELY WHEN ANY MARINE ACCESS CONFLICTS ARE IDENTIFIED.
3. THE ENGINEER MAY IDENTIFY PERIODS THAT REQUIRE STANDBY DUE TO TRIBAL FISHING OR OTHER MARINE ACCESS ISSUES.
4. UPLAND STAGING AREAS ARE SHOWN FOR CONTRACTOR'S CONSIDERATION IN DEVELOPING THE RAWP. ACTUAL UPLAND STAGING AND ACCESS AREAS, SPECIFIC DATES AND DURATION OF THEIR USE, TO BE DETERMINED IN FINAL APPROVED RAWP. CONTRACTOR SHALL MINIMIZE THE EXTENT AND DURATION OF USE OF STAGING AREAS "A" AND "D".
5. COORDINATE WITH THE ENGINEER FOR UPLAND ACCESS THROUGH CROWLEY MARINE SERVICES AND FIRST SOUTH PROPERTIES. NOTIFY THE ENGINEER IMMEDIATELY WHEN ANY ACCESS CONFLICTS ARE IDENTIFIED.
6. PROVIDE TEMPORARY FENCING AROUND STAGING AREAS AND ON-SITE TRAFFIC CONTROL IN ACCORDANCE WITH THE SPECIFICATIONS.
7. AVAILABLE DATES FOR STAGING AREAS ARE AS FOLLOWS:
   a. AREA "A" – AUGUST 16, 2011 – JANUARY 1, 2012
   b. AREA "B" – AUGUST 16, 2011 – MARCH 1, 2012
   c. AREA "C" – AUGUST 16, 2011 – MARCH 1, 2012
   d. AREA "D" – AUGUST 16, 2011 – JANUARY 1, 2012
8. MAINTAIN REASONABLE PROPERTY ACCESS FOR OWNER TO THE SOUTHERN CORNER OF FIRST SOUTH PROPERTIES.
9. TRANSLOADING LAYOUTS SHOWN ARE CONCEPTUAL. PROVIDE DETAILS IN RAWP.
10. LIVE LOAD LIMIT ON EXISTING PIER IS 500 PSF
11. BARGE OWNED BY OTHERS MAY BE MOORED IN OUTER BERTH. CONTRACTOR SHALL NOT BLOCK ACCESS TO OUTER BERTH.
12. VESSELS OWNED BY OTHERS WILL NOT BE MOORED WITHIN PROJECT LIMITS. OWNER'S DESIGNEE WILL OPERATE RESEARCH VESSELS AS REQUIRED DURING THE WORK.
13. APPROXIMATE LOCATION OF POTENTIAL TREATED WASTEWATER DISCHARGE LOCATION TO SANITARY SEWER IS SHOWN. VERIFY LOCATION, CITY TO OBTAIN DISCHARGE PERMIT FROM KING COUNTY. COMPLY WITH ALL PERMIT CONDITIONS.
14. PIER TO BE DEMOLISHED. REFER TO SHEET 5 FOR GENERAL SEQUENCING REQUIREMENTS.

SITE ACCESS AND STAGING PLAN

NATURE	MADE/CHK'D	REVD
REVISIONS		

VAULT SERIAL NO.	DATE	MARK
365375		

integral consulting inc.
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SEATTLE, WASHINGTON 98104
206.230.9800

0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT PLOTTED TO ORIGINAL SCALE.

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SDOT	PROJ. MGR.
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Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO. APPROVED
FUND: DWF/SCL
SCALE: AS NOTED INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO.	
PC	C309045
R/W	
CO	
VAULT PLAN NO.	776-294
SHEET	7 OF 24

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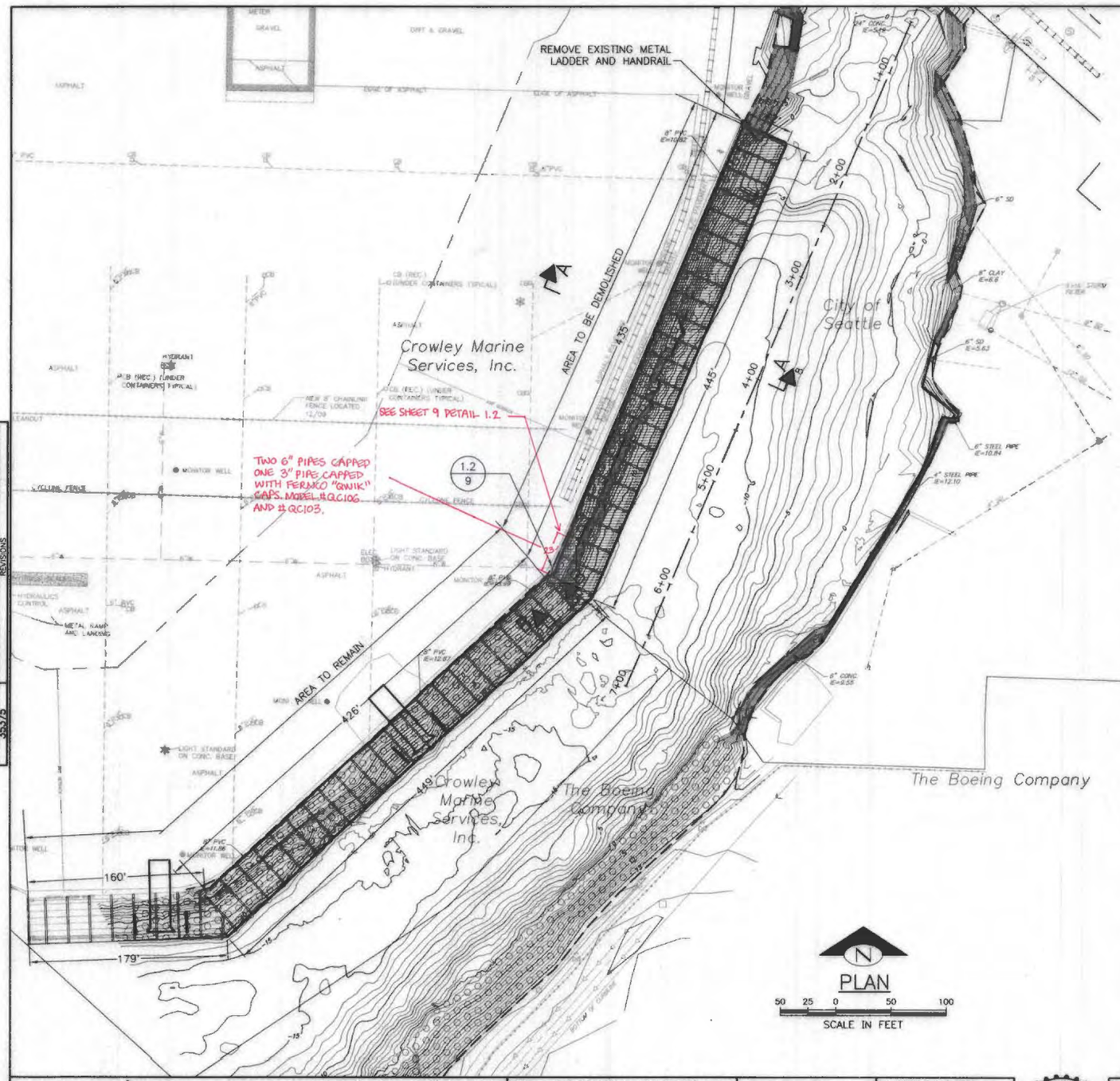

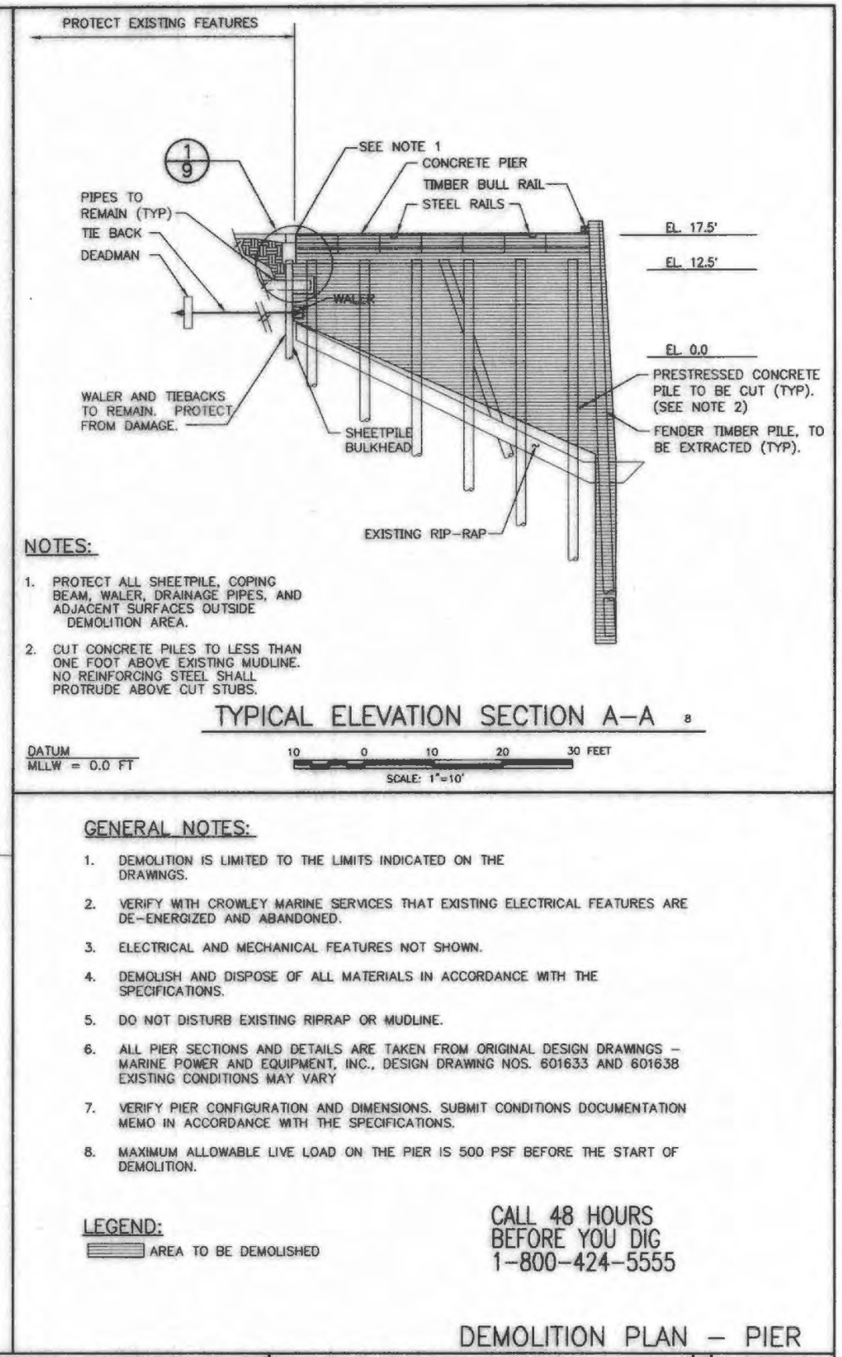

NOTES:

1. PROTECT ALL SHEETPILE, COPING BEAM, WALER, DRAINAGE PIPES, AND ADJACENT SURFACES OUTSIDE DEMOLITION AREA.
2. CUT CONCRETE PILES TO LESS THAN ONE FOOT ABOVE EXISTING MUDLINE. NO REINFORCING STEEL SHALL PROTRUDE ABOVE CUT STUBS.

TYPICAL ELEVATION SECTION A–A 8

GENERAL NOTES:

1. DEMOLITION IS LIMITED TO THE LIMITS INDICATED ON THE DRAWINGS.
2. VERIFY WITH CROWLEY MARINE SERVICES THAT EXISTING ELECTRICAL FEATURES ARE DE-ENERGIZED AND ABANDONED.
3. ELECTRICAL AND MECHANICAL FEATURES NOT SHOWN.
4. DEMOLISH AND DISPOSE OF ALL MATERIALS IN ACCORDANCE WITH THE SPECIFICATIONS.
5. DO NOT DISTURB EXISTING RIPRAP OR MUDLINE.
6. ALL PIER SECTIONS AND DETAILS ARE TAKEN FROM ORIGINAL DESIGN DRAWINGS – MARINE POWER AND EQUIPMENT, INC., DESIGN DRAWING NOS. 601633 AND 601638 EXISTING CONDITIONS MAY VARY
7. VERIFY PIER CONFIGURATION AND DIMENSIONS. SUBMIT CONDITIONS DOCUMENTATION MEMO IN ACCORDANCE WITH THE SPECIFICATIONS.
8. MAXIMUM ALLOWABLE LIVE LOAD ON THE PIER IS 500 PSF BEFORE THE START OF DEMOLITION.

LEGEND:

AREA TO BE DEMOLISHED

CALL 48 HOURS BEFORE YOU DIG 1-800-424-5555

DEMOLITION PLAN – PIER

NO.	DATE	MARK	NATURE REVISIONS	DRN'D	CHK'D
VAULT SERIAL NO. 35375					

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DRAWN TRN/WRM 3/30/07	
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City of Seattle
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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 8 OF 24

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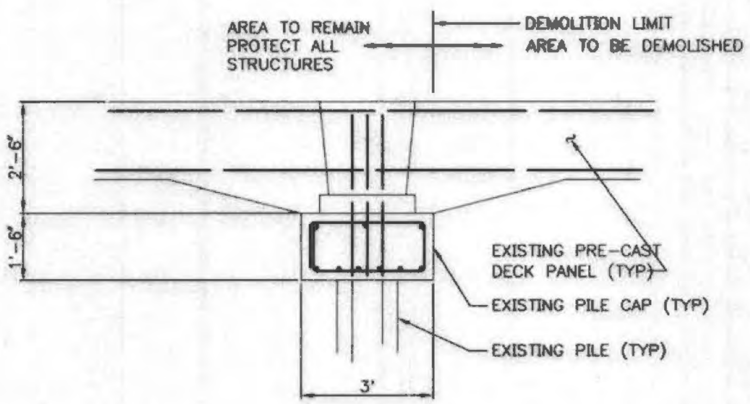
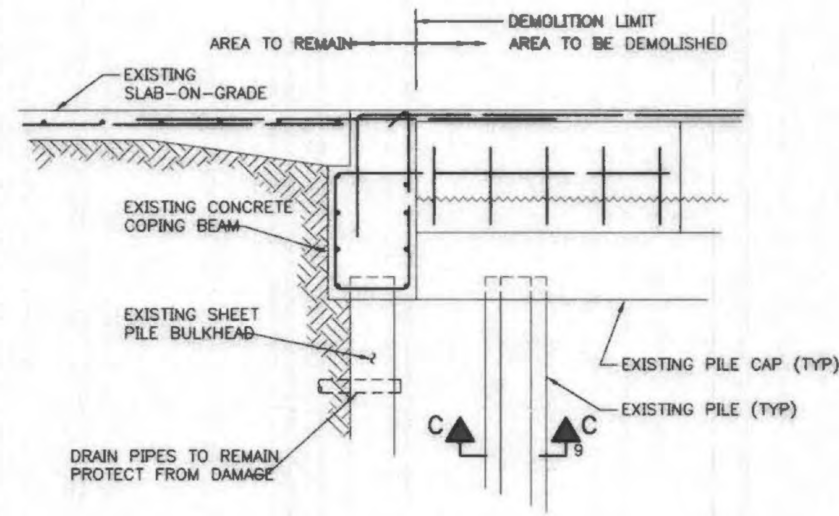
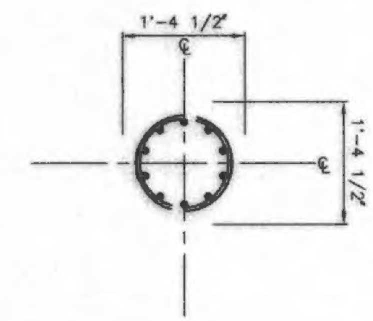


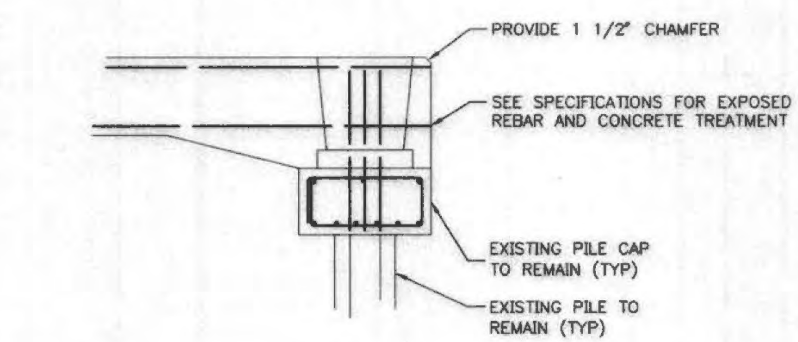
SECTION B–B 8
SCALE: NONE
EXISTING CONDITION



DETAIL 1/8
SCALE: NONE
EXISTING CONDITION

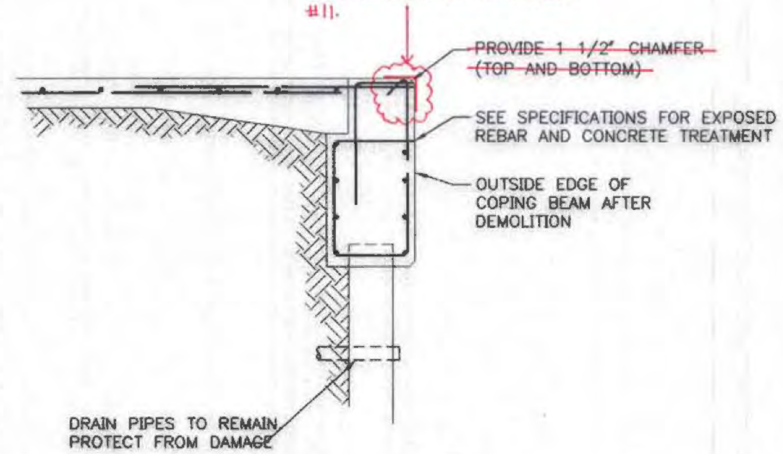


SECTION C–C 9
SCALE: NONE
TYPICAL EXISTING REINFORCED CONCRETE PILE SECTION



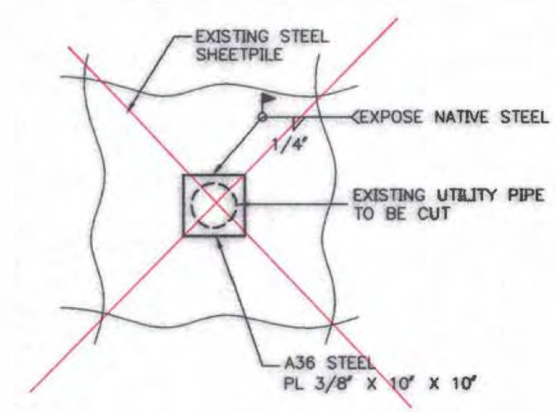
SECTION B.1–B.1 8
SCALE: NONE
POST DEMOLITION

6"x6"x5/16" ANGLE IRON INSTALLED ON PIER EDGE PER FIELD MEMO #11.



DETAIL 1.1/8
SCALE: NONE
POST DEMOLITION

PER RFI #013 TWO 6" PIPES AND ONE 3" PIPE WERE CUT BACK AND CAPPED WITH FERNCO "QWIK" CAPS. MODEL # QC106 AND QC103. (SEE SPECIFICATIONS ON BACK OF SHEET 8)



DETAIL 1.2/8
SCALE: NONE
TYPICAL DETAIL OF SEALING SHEETPILE AT TERMINATED PIPES

VAULT SERIAL NO.	DATE	MARK	NATURE REVISIONS	MADE	CHK'D	REV'D
35375						

DEMOLITION DETAILS – PIER

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DES. CONST.
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IBRAHIM R. SOUDY — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

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LOWER DUWAMISH WATERWAY
SLIP 4 EARLY ACTION

JOB NO. PC C309045
R/W
CO
VAULT PLAN NO. 776-294
SHEET 9 OF 24

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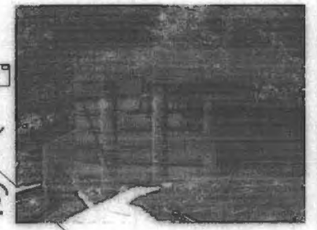

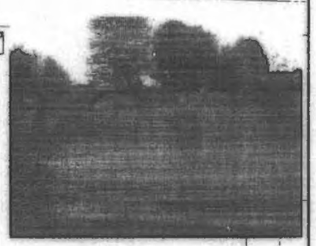

LEGEND

- POWER POLE
- SANITARY MANHOLE
- LUMINAIRE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- SPOT ELEVATION
- 5 FOOT CONTOUR INTERVAL
- PROJECT LIMITS
- APPROXIMATE PROPERTY LINE
- APPROXIMATE EXISTING TOP OF BANK
- RAIL SPUR
- EXISTING RIPRAP
- PHOTO NUMBER
- PHOTO VIEW

NOTES:

1. HANDLE ALL WOOD DEBRIS THAT APPEARS TO BE CHEMICALLY TREATED IN ACCORDANCE WITH CONTRACTOR'S DISPOSAL PLAN. CONDUCT ANY SAMPLING AND ANALYSIS OF DEBRIS AS REQUIRED BY THE DISPOSAL FACILITY.
2. EXTRACT ALL WOODEN PILING BY VIBRATORY EXTRACTION OR DEAD LINE PULL (PHOTOS 1,3,9).
3. PROTECT EXISTING WOODEN BULKHEAD OUTSIDE OF EXCAVATION LIMITS.
4. SEE SHEETS 8–9 FOR PIER DEMOLITION PLANS AND DETAILS.
5. REMOVE ALL VISIBLE DERELICT PILING AND DEBRIS, INCLUDING TIMBER SKIDS AND SUPPORT PILING, PRIOR TO DREDGING (PHOTOS 1,3,4,9).
6. REMOVE BULKHEADS THAT CURRENTLY RETAIN SOILS DURING BANK EXCAVATION (PHOTOS 1,2,6,7,8). EXCAVATE AFFECTED BANK AREAS ON SAME DAY THAT BULKHEAD IS REMOVED TO LIMIT EROSION.
7. PROTECT ALL OUTFALLS DURING DEMOLITION.
8. ECOLOGY BLOCKS AND TANKS TO BE REMOVED BY OWNER, REMOVE DEBRIS DURING BANK EXCAVATION (PHOTO 5).
9. SAW CUT CONCRETE PAD OR EXISTING A/C PAVMENT AT TOP OF EXCAVATION LIMITS, WHERE PRESENT (PHOTO 5)
10. PROTECT EXISTING WOOD PILE FENDERS ON EAST ~~AND WEST~~ SIDE OF I-5 OUTFALL (PHOTO 10)

N

50 25 0 50 100
SCALE IN FEET

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DEMOLITION PLAN
MUDFLATS AND BANKS

MARK	DATE	NATURE OF REVISIONS	MADE/CHK'D
VAULT SERIAL NO. 353,774			

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CHECKED RMC 3/30/07	RECEIVED
DRAWN TRN/WRM 3/30/07	
CHECKED DRS 8/5/10	REVISED AS BUILT

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City of Seattle
Ray Hoffman, Director
ORDINANCE NO.
FUND: DWF/SCL
SCALE: AS NOTED
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INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 10 OF 24

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S. OTHELLO ST.

DREDGE/EXCAVATION COORDINATES			DREDGE/EXCAVATION COORDINATES		
Point #	Northing	Easting	Point #	Northing	Easting
100	199808.12	1273352.49	128	199486.67	1273459.47
101	199803.37	1273357.05	129	199488.86	1273441.21
102	199837.87	1273359.37	130	199500.17	1273445.34
103	199834.31	1273364.20	131	199542.08	1273413.22
104	199897.43	1273403.33	132	199538.08	1273387.95
105	199893.05	1273407.56	133	199456.85	1273380.95
106	199913.15	1273428.19	134	199401.35	1273375.86
107	199909.40	1273431.33	135	199359.30	1273372.76
108	199775.52	1273383.73	136	199352.24	1273378.27
109	199809.06	1273394.78	137	199334.90	1273417.88
110	199842.59	1273419.61	138	199448.64	1273467.02
111	199857.54	1273482.01	139	199482.12	1273444.88
112	199055.42	1273533.91	140	199478.50	1273474.83
113	199041.00	1273537.00	141	199444.45	1273548.21
114	199048.53	1273566.15	142	199348.61	1273524.66
115	199040.73	1273571.07	143	199297.10	1273557.75
116	199173.17	1273573.82	144	199173.65	1273534.26
117	199282.75	1273600.83	145	199212.68	1273481.88
118	199356.00	1273587.35	146	199263.04	1273461.55
119	199369.85	1273610.78	147	199278.76	1273381.50
120	199401.13	1273618.67	148	199325.44	1273439.82
121	199420.77	1273609.02	149	199440.63	1273480.26
122	199434.13	1273582.24	150	199428.29	1273522.91
123	199457.78	1273580.45	151	199849.15	1273522.47
124	199488.02	1273543.89	152	199833.48	1273521.98
125	199485.85	1273480.09	153	199863.06	1273309.66
126	199468.11	1273474.71	154	199857.89	1273304.82
127	199483.71	1273484.58			

DID NOT FIND IN FIELD
POSSIBLE 36" ABANDONED WATERLINE (SEE NOTE 18)

ABANDONED PIPE CUT AND PLUGGED PER SPEC.
NORTHING: 199519.73
EASTING: 1273404.17
T.O.P.: 10.07

ABANDONED PIPE CUT AND PLUGGED PER SPEC.
NORTHING: 199494.49
EASTING: 1273435.83
T.O.P.: 8.90

2/21 OUTFALL SCOUR PROTECTION (TYP) (SEE NOTE 5)

36" PSEOF OVERFLOW OUTFALL (SEE NOTE 14)

DID NOT FIND IN FIELD

EAST MARGINAL WAY S.

King County

EMERALD SERVICES SD 8" (SEE NOTE 17)

10" PVC

EXISTING DUCKBILL TIDE-CHECK VALVE WAS REPLACED WITH A 10" TIDEFLEX CHECKMATE VALVE.

(SEE NOTE 16)

City of Seattle

Crowley Marine Services, Inc.

SEE NOTE 15

First South Properties

SEE NOTE 2

DID NOT FIND IN FIELD (SEE NOTE 16)

BOUNDARY BERM 4/21

(120° CW) The Boeing Company

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50 25 0 50 100
SCALE IN FEET

LEGEND

- POWER POLE
- SANITARY MANHOLE
- LUMINAIRE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- SPOT ELEVATION
- 5 FOOT CONTOUR INTERVAL (EXISTING)
- 1 FOOT CONTOUR INTERVAL (EXISTING)
- FINAL GRADE
- APPROXIMATE PROPERTY LINE
- APPROXIMATE EXISTING TOP OF BANK
- PROJECT LIMITS
- DREDGE LIMITS
- (-3) REQUIRED DREDGE ELEVATION (FT MLLW)
- 105 DREDGE COORDINATE LOCATION
- EXISTING RIPRAP
- BOUNDARY BERM
- RAIL SPUR

NOTES:

1. EXISTING BATHYMETRIC CONTOURS SHOWN. REFER TO SHEET 6 FOR BASEMAP SURVEY NOTES.
2. COMPLETE PRE-DREDGE SURVEY BEFORE START OF DREDGING, IN ACCORDANCE WITH THE SPECIFICATIONS. PLACE BOUNDARY BERM BEFORE START OF DREDGING.
3. SLOPE DREDGING/EXCAVATION SHALL PROCEED FROM THE TOP OF THE SLOPE DOWNWARD TO THE INDICATED LINES AND CONTROL POINTS. EXCAVATED SLOPES SHALL BE UNIFORM AND NO STEEPER THAN 2H:1V EXCEPT WHERE OTHERWISE SPECIFIED. SLOPE CALLOUTS ARE APPROXIMATE.
4. PRIOR TO CAPPING, REMOVE ANY MATERIALS THAT HAVE SLOUGHED OR SETTLED AT THE TOE OF THE SLOPE DURING OR SUBSEQUENT TO THE DREDGING.
5. PROVIDE A MINIMUM 18-INCH THICK LAYER OF CAP ARMOR ON CUT SLOPES IN FRONT OF OUTFALLS WITHIN 8 HOURS OF DREDGING THE OUTFALL AREA, AS SHOWN ON SHEET 21.
6. COMPLETE POST-DREDGE SURVEY WITHIN 24 HOURS OF COMPLETION OF THE DREDGING, IN ACCORDANCE WITH THE SPECIFICATIONS.
7. CONDUCT ADDITIONAL DREDGING AND RE-SURVEYING IF THE POST DREDGE SURVEY INDICATES THE REQUIRED DEPTHS AND GRADES HAVE NOT BEEN MET.
8. DREDGE OVERDEPTH ALLOWANCE IS 1 FOOT.
9. COORDINATE WITH ENGINEER FOR ACCESS, TIMING, AND MOVEMENT OF VESSELS.
10. WITHIN 48 HOURS AFTER ALL DREDGING IS COMPLETE AND ACCEPTED, PLACE SLOPE CAP ON EMBANKMENT IN RA3.
11. PROTECT ALL EXISTING STRUCTURES TO REMAIN.
12. EXISTING DEBRIS NOT SHOWN.
13. HANDLE, TRANSPORT, AND DISPOSE OF ALL DREDGED MATERIAL IN ACCORDANCE WITH THE SPECIFICATIONS.
14. APPROXIMATE LOCATION OF EAST MARGINAL WAY PUMP STATION EOF OUTFALL (36-INCH) IS SHOWN. LOCATE AND PROTECT EXISTING OUTFALL.
15. TIMBER BULKHEAD TO REMAIN BETWEEN COORDINATES 112 AND 113.
16. CUT OUTFALL FLUSH WITH EXCAVATION AND GROUT IN ACCORDANCE WITH SPECIFICATIONS.
17. LOCATE AND PROTECT EMERALD SERVICES SD AND PUBLIC OUTFALLS AT HEAD OF SLIP.
18. ABANDONED WATER LINE MAY BE ENCOUNTERED IN THIS AREA. WATERLINE IS BELIEVED TO BE 36" WOOD STAVE CONSTRUCTION. IF ENCOUNTERED, REMOVE TO 3 FEET BEYOND THE LIMITS OF THE EXCAVATION SHOWN AND PLUG PIPE ENDS WITH A MINIMUM OF 2 CUBIC YARDS OF FILTER MATERIAL.

DREDGING/EXCAVATION PLAN

NATURE	DATE	MADE	CHK'D	DRW'D
REVISIONS				

VAULT SERIAL NO. 353775

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206.230.9800

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SEATTLE, WASHINGTON 20
BY:
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CHECKED	RMC 3/30/07
DRAWN	TRN/WRM 3/30/07
CHECKED	DRS 8/5/10

INITIALS AND DATE	
REVIEWED: DES.	CONST.
SDOT	PROJ. MGR.
RECEIVED	
REVISED AS BUILT	

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DAVID E. SCRUGGS STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
ORDINANCE NO.
FUND: DWF/SCL
SCALE: AS NOTED

City of Seattle
Ray Hoffman, Director
APPROVED
INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

CON NO. / JOB	PC C309045
	R/W
	CO
VAULT PLAN NO.	776-294
SHEET	11 OF 24

C:_Sync\Slip 4\Drawings\11 C309045-P-Dredging_and_Excavation_Plan.dwg
spitcher4 Feb-14-11 3:15pm

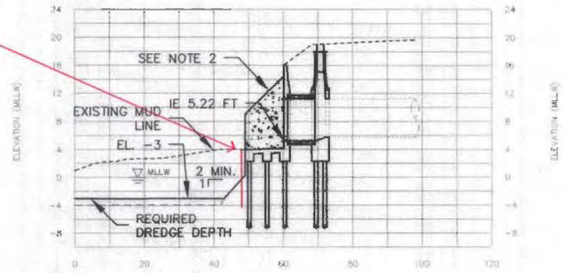
NOTES:

1. GEORGETOWN FLUME RE-PIPE IS 24" HDPE INSIDE 44"X72" CMP.
2. EXCAVATE EXISTING SEDIMENT ACCUMULATIONS FROM I-5 SPILL APRON.
3. PROTECT EXISTING OUTFALLS

LEGEND:

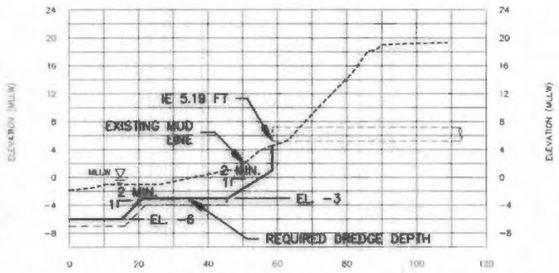
- EXISTING MUDLINE
- REQUIRED DREDGE DEPTH
- DREDGE OVERDEPTH ALLOWANCE

I-5 STORM DRAIN, 72"



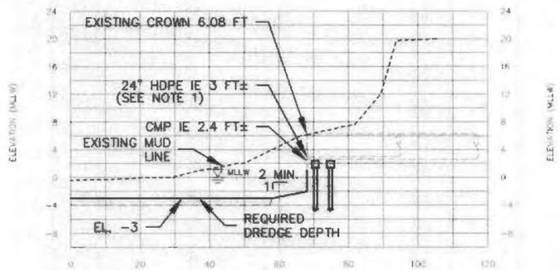
SECTION A-A

NORTH BOEING FIELD S.D., 24"



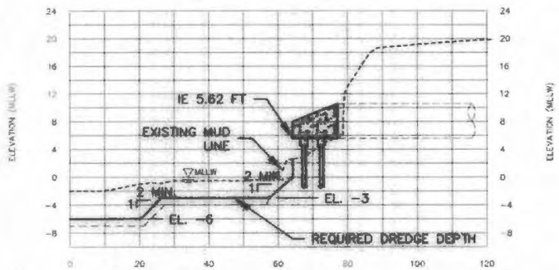
SECTION C-C

GEORGETOWN FLUME, 44"X72" CMP

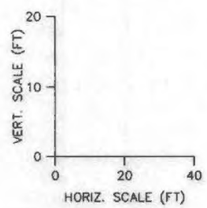


SECTION B-B

KING COUNTY AIRPORT
S.D.#3/PS44 EOF, 60"



SECTION D-D



DREDGING/EXCAVATION SECTIONS A-D

integral consulting inc. 411 1ST AVENUE S, SUITE 550 SEATTLE, WASHINGTON 98104 206.230.9600	APPROVED FOR ADVERTISING NANCY LOCKE DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES SEATTLE, WASHINGTON 20 BY: PURCHASING & CONTRACTING SERVICES DIRECTOR	NAME OR INITIALS AND DATE DESIGNED DRS 3/30/07 CHECKED RMC 3/30/07 DRAWN TRN/WRM 3/30/07 CHECKED DRS 8/5/10 ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.	INITIALS AND DATE REVIEWED: DES. CONST. SDOT PROJ. MGR. RECEIVED REVISED AS BUILT
DAVID R. SCHUCHART STATE OF WASHINGTON 36080 REGISTERED PROFESSIONAL ENGINEER	Seattle Public Utilities Ray Hoffman, Director ORDINANCE NO. APPROVED FUND: DWF/SCL SCALE: H. 1"=40', V. 1"=20' INSPECTOR'S BOOK	LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION	JOB NO. PC C309045 R/W CO VAULT PLAN NO. 776-294 SHEET 12 OF 24

VAULT SERIAL NO	DATE	MARK	REVISIONS
35375			MADE PAY'D REV'D

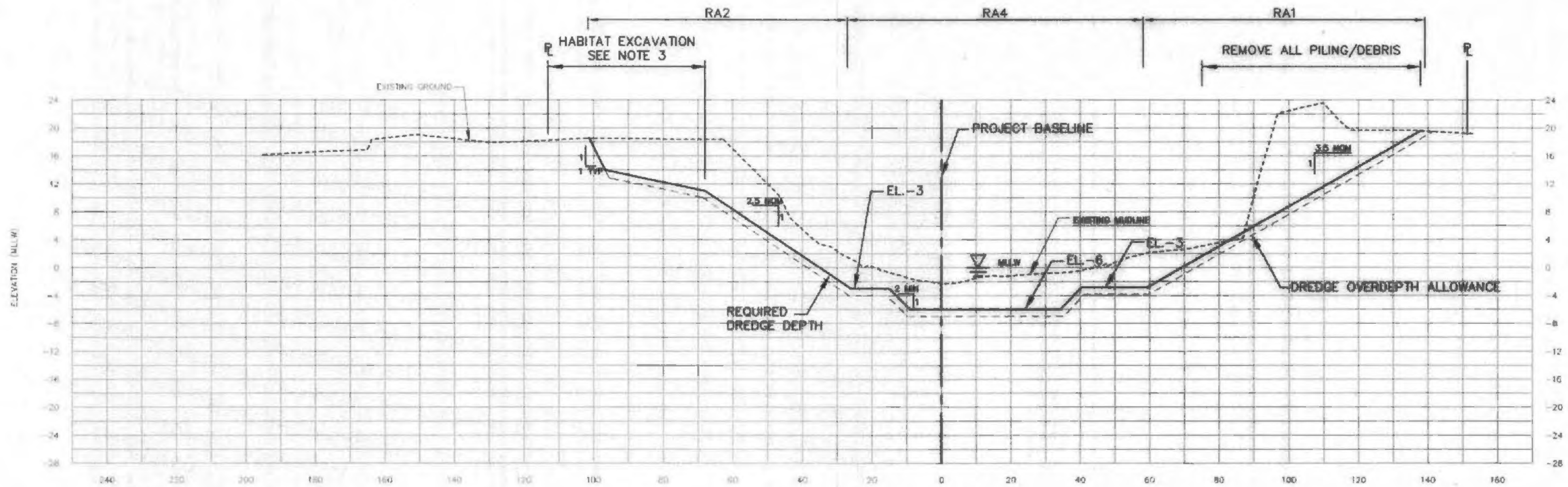
C:_Sync\Slip 4\Drawings\12 C309045-P-Dredging_Excavation_XSection_A-D.dwg
epichard Feb-14-11 3:11pm

NOTES:

1. BULKHEAD, REVETMENT, AND FENDER PILE DETAILS FROM MARINE POWER AND EQUIPMENT CO., INC. DESIGN DRAWING NO. 533-YD5-42CP. UNDER-PIER PILING NOT SHOWN. AS-BUILT CONDITIONS MAY VARY.
2. REFER TO SHEET 11 FOR DREDGING AND EXCAVATION NOTES.
3. EXCAVATE HABITAT EXCAVATION AREAS TO CONTOURS SHOWN ON SHEET 11.

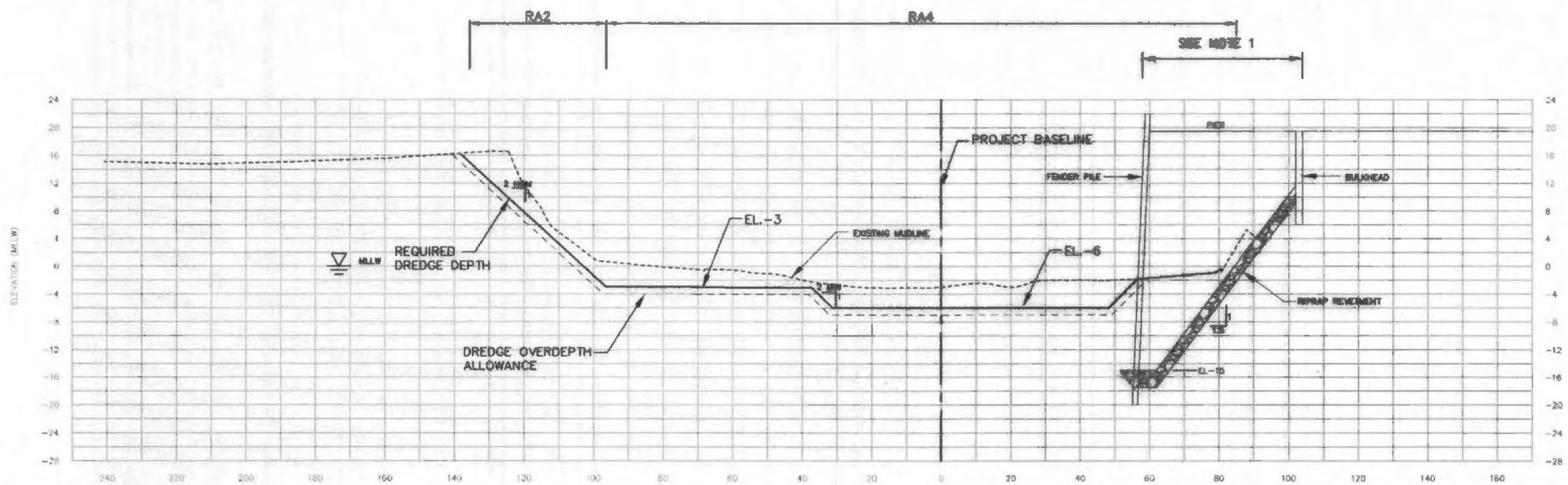
LEGEND:

- - - - - - - - EXISTING MUDLINE
———————— REQUIRED DREDGE DEPTH
— — — — — — DREDGE OVERDEPTH ALLOWANCE



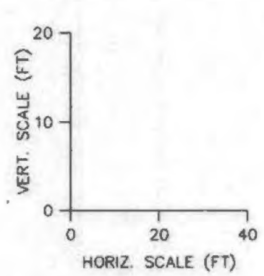
SECTION E–E 11

STA 1+00 (LOOKING UPSTATION, TYP)



SECTION F–F 11

STA 2+00



DATE	MARK	NATURE REVISIONS	MADE	CHK'D	REV'D

VAULT SERIAL NO. 35375

C:_Sync\Slip 4\Drawings\13 C309045-P-Dredging_Excavation_XSection_E-F.dwg epilcher4 Feb-14-11 3:10pm

DREDGING/EXCAVATION SECTIONS E–F

integral consulting inc.
411 1ST AVENUE S, SUITE 550
SEATTLE, WASHINGTON 98104
206.230.9600

APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20
BY:
PURCHASING & CONTRACTING SERVICES DIRECTOR

NAME OR INITIALS AND DATE
DESIGNED DRS 3/30/07
CHECKED RMC 3/30/07
DRAWN TRN/WRM 3/30/07
CHECKED DRS 8/5/10

INITIALS AND DATE
REVIEWED:
DES. CONST.
SDOT PROJ. MGR.
RECEIVED
REVISED AS BUILT

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL

DAVID R. SCHUCHARDT, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO. APPROVED
FUND: DWF/SCL
SCALE: H. 1"=40', V. 1"=20' INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY
SLIP 4 EARLY ACTION

JOB NO. PC C309045
R/W
CO
VAULT PLAN NO. 776-294
SHEET 13 OF 24

NOTES:

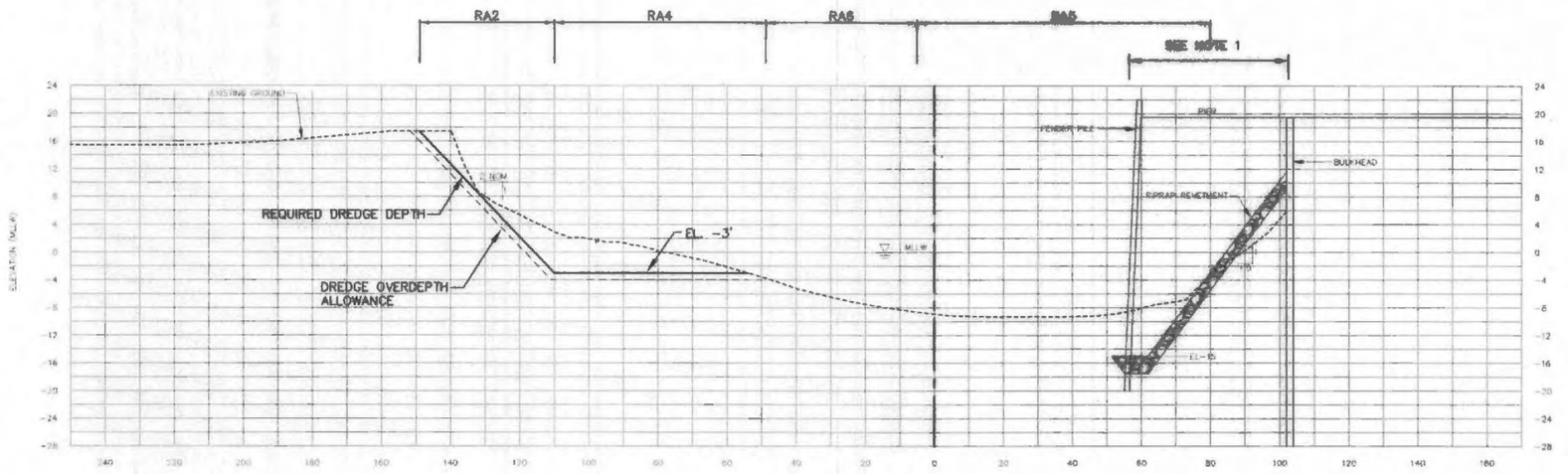
1. BULKHEAD, REVETMENT, AND FENDER PILE DETAILS FROM MARINE POWER AND EQUIPMENT CO., INC. DESIGN DRAWING NO. 533-YD5-42CP. UNDER-PIER PILING NOT SHOWN. AS-BUILT CONDITIONS MAY VARY.
2. REFER TO SHEET 11 FOR DREDGING AND EXCAVATION NOTES.
3. BULKHEAD TO REMAIN FROM STA 4+00 TO STA 5+80, 2H:1V EXCAVATION EXTENDS UPSTATION BEHIND REMAINING BULKHEAD FOR GRADE TRANSITION, AS SHOWN ON SHEET 11.

LEGEND:

---------- EXISTING MUDLINE

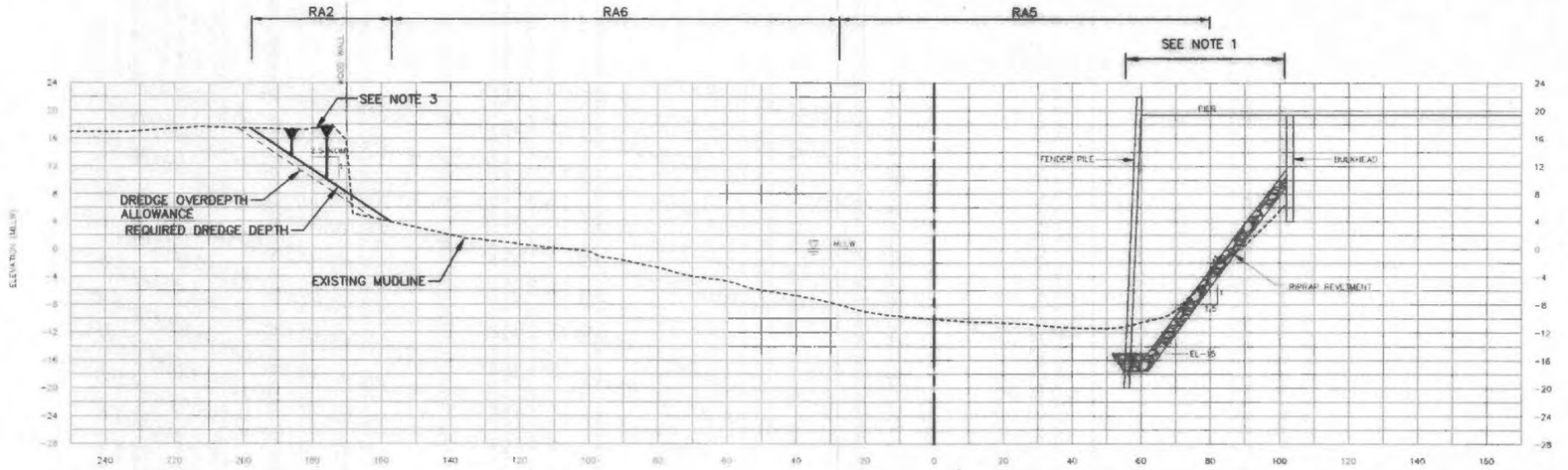
———————— REQUIRED DREDGE DEPTH

- - - - - - - - - - DREDGE OVERDEPTH ALLOWANCE



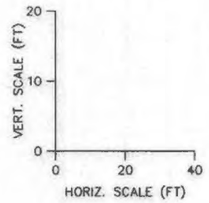
SECTION G-G 11

STA 2+80 (LOOKING UPSTATION, TYP.)



SECTION H-H 11

STA 4+00



DREDGING/EXCAVATION SECTIONS G-H

integral consulting inc. 411 1ST AVENUE S, SUITE 550 SEATTLE, WASHINGTON 98104 206.230.9600	APPROVED FOR ADVERTISING NANCY LOCKE DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES SEATTLE, WASHINGTON 20 BY: PURCHASING & CONTRACTING SERVICES DIRECTOR	NAME OR INITIALS AND DATE DESIGNED DRS 3/30/07 CHECKED RMC 3/30/07 DRAWN TRN/WRM 3/30/07 CHECKED DRS 8/5/10 ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.	INITIALS AND DATE REVIEWED: DES. CONST. SDOT PROJ. MGR. RECEIVED REVISED AS BUILT
DAVID R. SCHUSTERT STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER	Seattle Public Utilities City of Seattle Ray Hoffman, Director ORDINANCE NO. APPROVED FUND: DWF/SCL SCALE: H. 1"=40', V. 1"=20' INSPECTOR'S BOOK	LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION	JOB NO. PC C309045 R/W CO VAULT PLAN NO. 776-294 SHEET 14 OF 24

MARK	DATE	NATURE REVISIONS	MADE CHK'D	REV'D
VAULT SERIAL NO. 35575				

C:_Sync\Slip 4\Drawings\14 C309045-P-Dredging_Excavation_XSection_G-H.dwg
sphchen4 Feb-14-11 2:47pm

NOTES:

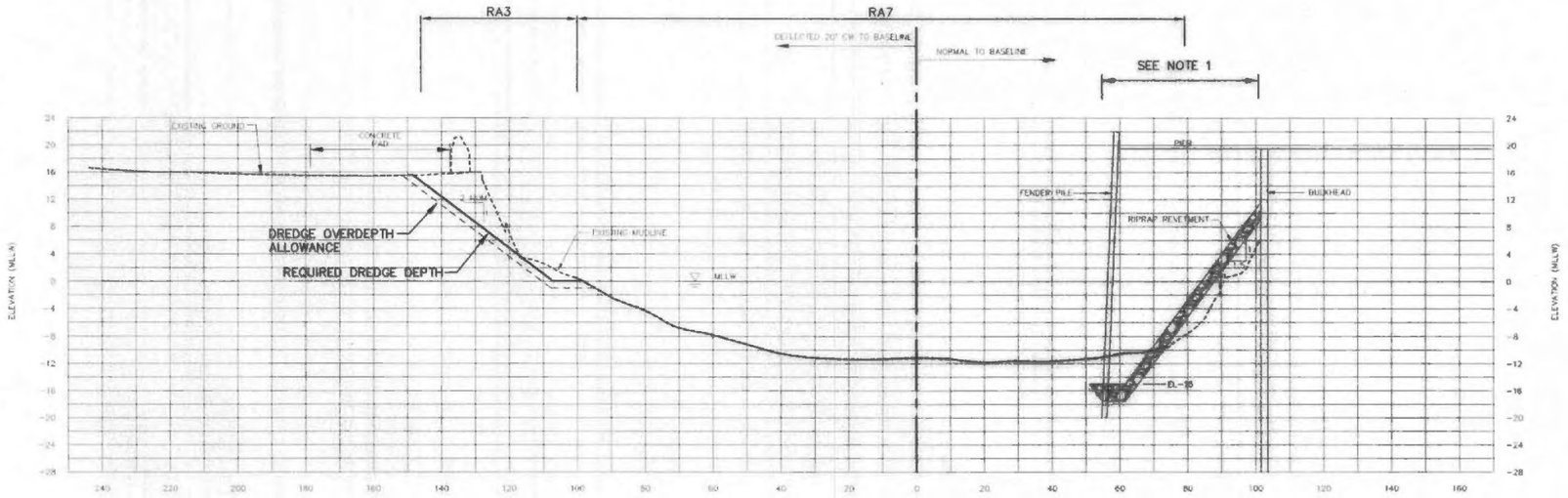
1. BULKHEAD, REVETMENT, AND FENDER PILE DETAILS FROM MARINE POWER AND EQUIPMENT CO., INC. DESIGN DRAWING NO. 533-YD5-42CP. UNDER-PIER PILING NOT SHOWN.
   AS-BUILT CONDITIONS MAY VARY.
2. REFER TO SHEET 11 FOR DREDGING AND EXCAVATION NOTES.

LEGEND:

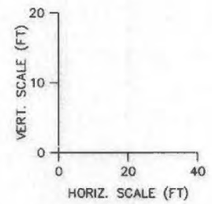
---------- EXISTING MUDLINE

———————— REQUIRED DREDGE DEPTH

- - - - - - - - - - DREDGE OVERDEPTH ALLOWANCE



SECTION I-I STA 6+00 (LOOKING UPSTATION)



DREDGING/EXCAVATION SECTION I

VAULT SERIAL NO. 35575	DATE	MARK	NATURE REVISIONS	MADE	CHK'D	REV'D

integral consulting inc.
411 1ST AVENUE S. SUITE 550
SEATTLE, WASHINGTON 98104
208.230.9600

APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20
BY:
PURCHASING & CONTRACTING SERVICES DIRECTOR

NAME OR INITIALS AND DATE		INITIALS AND DATE	
DESIGNED DRS 3/30/07		REVIEWED: DES.	CONST.
CHECKED RMC 3/30/07		SDOT	PROJ. MGR.
DRAWN TRN/MRM 3/30/07		RECEIVED	
CHECKED DRS 8/5/10		REVISED AS BUILT	

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

DAVID R. SCHUCHERT STATE OF WASHINGTON 30003 REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO. APPROVED
FUND: DWF/SCL
SCALE: H. 1"=40', V. 1"=20' INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 15 OF 24

C:_Sync\35ty 4\Drawings\15 C309045-P-Dredging_Excavation_XSection_I.dwg
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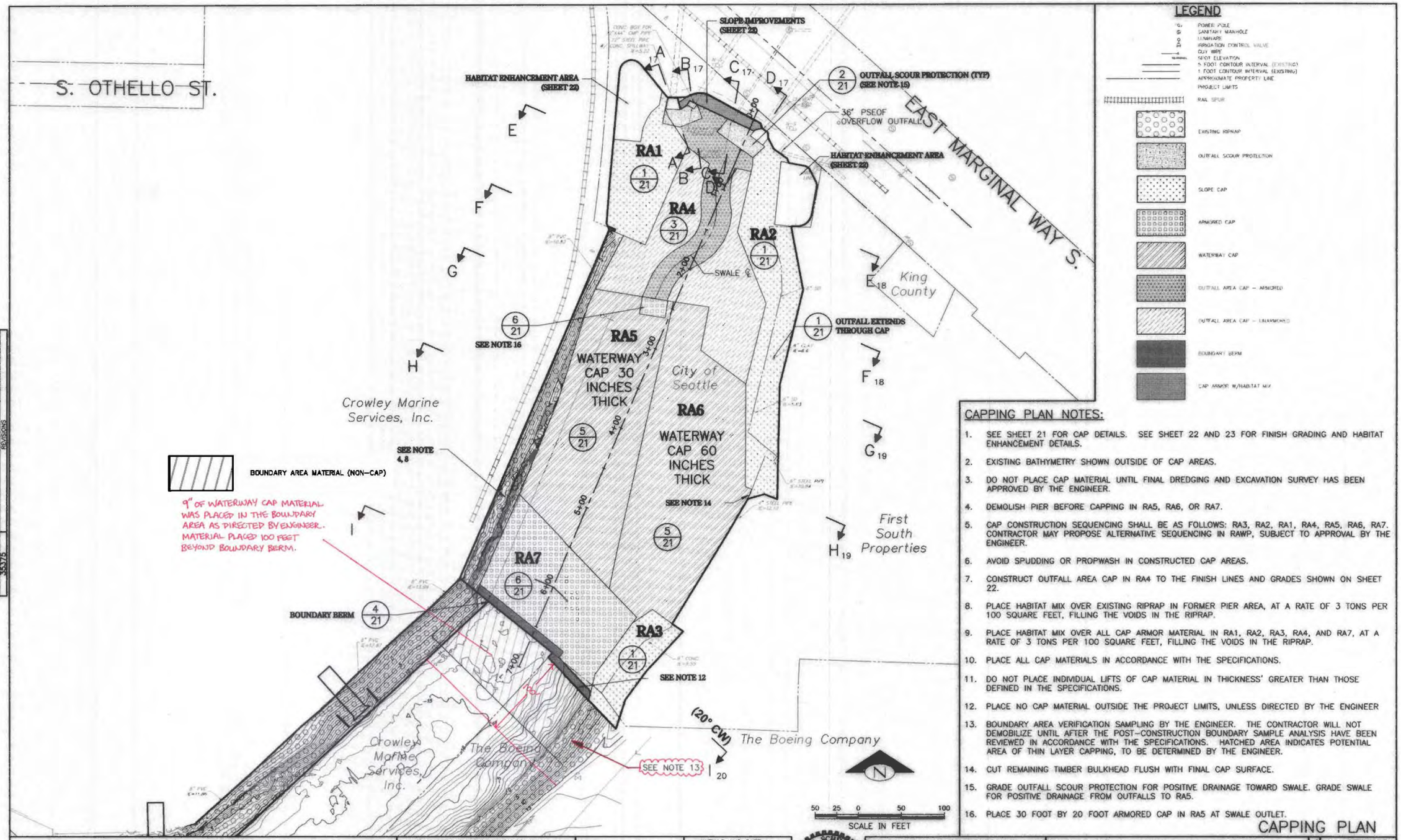

CAPPING PLAN NOTES:

1. SEE SHEET 21 FOR CAP DETAILS. SEE SHEET 22 AND 23 FOR FINISH GRADING AND HABITAT ENHANCEMENT DETAILS.
2. EXISTING BATHYMETRY SHOWN OUTSIDE OF CAP AREAS.
3. DO NOT PLACE CAP MATERIAL UNTIL FINAL DREDGING AND EXCAVATION SURVEY HAS BEEN APPROVED BY THE ENGINEER.
4. DEMOLISH PIER BEFORE CAPPING IN RA5, RA6, OR RA7.
5. CAP CONSTRUCTION SEQUENCING SHALL BE AS FOLLOWS: RA3, RA2, RA1, RA4, RA5, RA6, RA7. CONTRACTOR MAY PROPOSE ALTERNATIVE SEQUENCING IN RAWP, SUBJECT TO APPROVAL BY THE ENGINEER.
6. AVOID SPUDDING OR PROPWASH IN CONSTRUCTED CAP AREAS.
7. CONSTRUCT OUTFALL AREA CAP IN RA4 TO THE FINISH LINES AND GRADES SHOWN ON SHEET 22.
8. PLACE HABITAT MIX OVER EXISTING RIPRAP IN FORMER PIER AREA, AT A RATE OF 3 TONS PER 100 SQUARE FEET, FILLING THE VOIDS IN THE RIPRAP.
9. PLACE HABITAT MIX OVER ALL CAP ARMOR MATERIAL IN RA1, RA2, RA3, RA4, AND RA7, AT A RATE OF 3 TONS PER 100 SQUARE FEET, FILLING THE VOIDS IN THE RIPRAP.
10. PLACE ALL CAP MATERIALS IN ACCORDANCE WITH THE SPECIFICATIONS.
11. DO NOT PLACE INDIVIDUAL LIFTS OF CAP MATERIAL IN THICKNESS' GREATER THAN THOSE DEFINED IN THE SPECIFICATIONS.
12. PLACE NO CAP MATERIAL OUTSIDE THE PROJECT LIMITS, UNLESS DIRECTED BY THE ENGINEER
13. BOUNDARY AREA VERIFICATION SAMPLING BY THE ENGINEER. THE CONTRACTOR WILL NOT DEMOBILIZE UNTIL AFTER THE POST-CONSTRUCTION BOUNDARY SAMPLE ANALYSIS HAVE BEEN REVIEWED IN ACCORDANCE WITH THE SPECIFICATIONS. HATCHED AREA INDICATES POTENTIAL AREA OF THIN LAYER CAPPING, TO BE DETERMINED BY THE ENGINEER.
14. CUT REMAINING TIMBER BULKHEAD FLUSH WITH FINAL CAP SURFACE.
15. GRADE OUTFALL SCOUR PROTECTION FOR POSITIVE DRAINAGE TOWARD SWALE. GRADE SWALE FOR POSITIVE DRAINAGE FROM OUTFALLS TO RA5.
16. PLACE 30 FOOT BY 20 FOOT ARMORED CAP IN RA5 AT SWALE OUTLET.

CAPPING PLAN

NO.	DATE	MARK	REVISIONS
		MADE/CHK'D	NATURE

VAULT SERIAL NO. 383778

integral consulting inc.
411 1ST AVENUE S, SUITE 550
SEATTLE, WASHINGTON 98104
206.230.9600

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NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20
BY:
PURCHASING & CONTRACTING SERVICES DIRECTOR

NAME OR INITIALS AND DATE	
DESIGNED	DRS 3/30/07
CHECKED	RMC 3/30/07
DRAWN	TRN/WRM 3/30/07
CHECKED	DRS 8/5/10

INITIALS AND DATE	
REVIEWED: DES.	CONST.
SDOT	PROJ. MGR.
RECEIVED	
REVISED AS BUILT	

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

DAVID R. SCHUCHMAN — STATE OF WASHINGTON — 21616 — REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO.
FUND: DWF/SCL
SCALE: AS NOTED
APPROVED
INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

BOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 16 OF 24

C:_Sync\Slip 4\Drawings\16 C309045-P-Capping_Plan.dwg
epilchert Feb-14-11 2:48pm

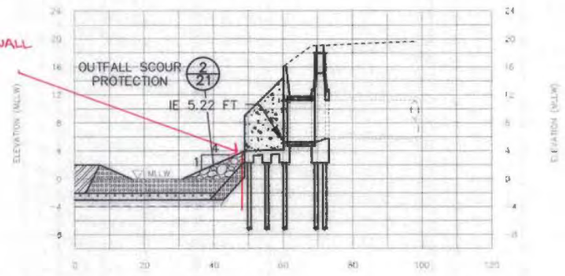
NOTES:

1. PLACE MIN 18" (MAX 24") THICK LAYER OF CAP ARMOR MATERIAL ON OUTFALL AREA SLOPES BETWEEN ELEVATION +5 AND ELEVATION +12.

LEGEND:

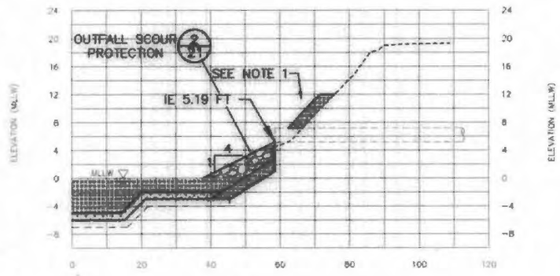
- EXISTING MUDLINE
- REQUIRED DREDGE DEPTH
- DREDGE OVERDEPTH ALLOWANCE
- HEAVY LOOSE RIPRAP
- CAP ARMOR
- FILTER MATERIAL
- WATERWAY CAP MATERIAL

I-5 STORM DRAIN, 72"



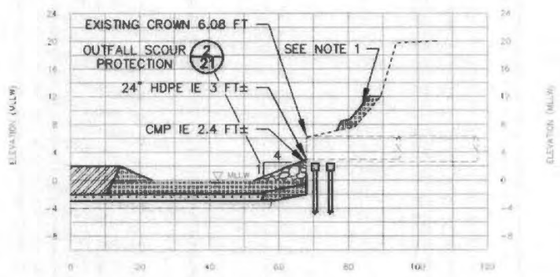
SECTION A-A 16

NORTH BOEING FIELD S.D., 24"



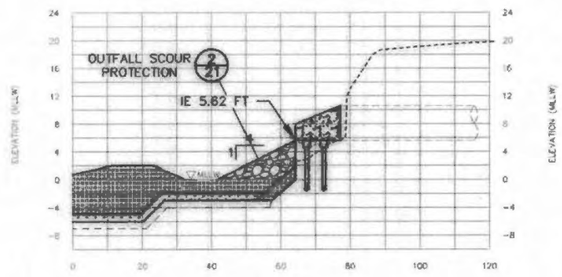
SECTION C-C 16

GEORGETOWN FLUME, 44"X72" CMP

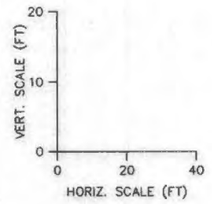


SECTION B-B 16

KING COUNTY AIRPORT
S.D.#3/PS44 EOF, 60"



SECTION D-D 16



VAULT SERIAL NO.	DATE	MARK	NATURE OF REVISIONS
35375			MADE CHK'D REV'D

C:_Sync\Slip 4\Drawings\17 C309045-P-Capping_Sections_A-D.dwg
epichert Feb-14-11 2:43pm

CAPPING SECTIONS A-D

integral consulting inc.
411 1ST AVENUE S, SUITE 550
SEATTLE, WASHINGTON 98104
206.230.9600

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NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20
BY:
PURCHASING & CONTRACTING SERVICES DIRECTOR

NAME OR INITIALS AND DATE	INITIALS AND DATE
DESIGNED DRS 3/30/07	REVIEWED:
CHECKED RMC 3/30/07	DES. CONST.
	SDOT PROJ. MGR.
DRAWN TRN/WRM 3/30/07	RECEIVED
CHECKED DRS 8/5/10	REVISED AS BUILT

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

DAVID R. SCHUCHART STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO. APPROVED
FUND: DWF/SCL
SCALE: H. 1"=40', V. 1"=20' INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

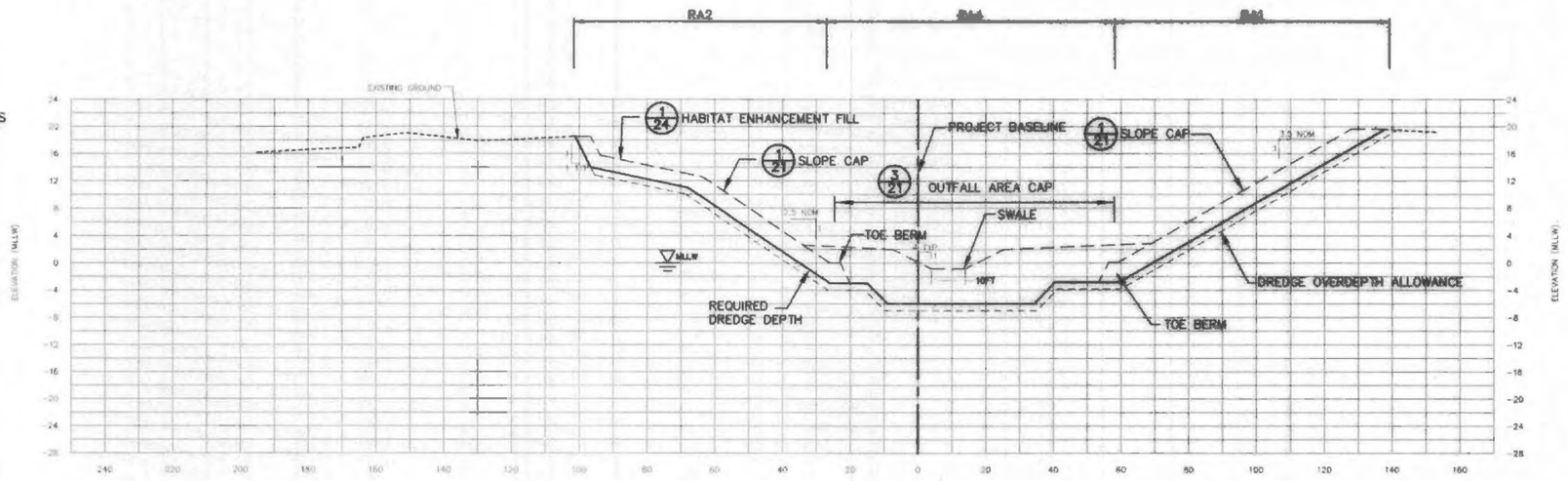
JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 17 OF 24

NOTES:

1. DEMOLISH PIER BEFORE CAPPING IN RA5, 6, OR 7.
2. CONSTRUCT OUTFALL AREA CAP IN RA4 TO FINAL LINES AND GRADES SHOWN ON SHEET 16.

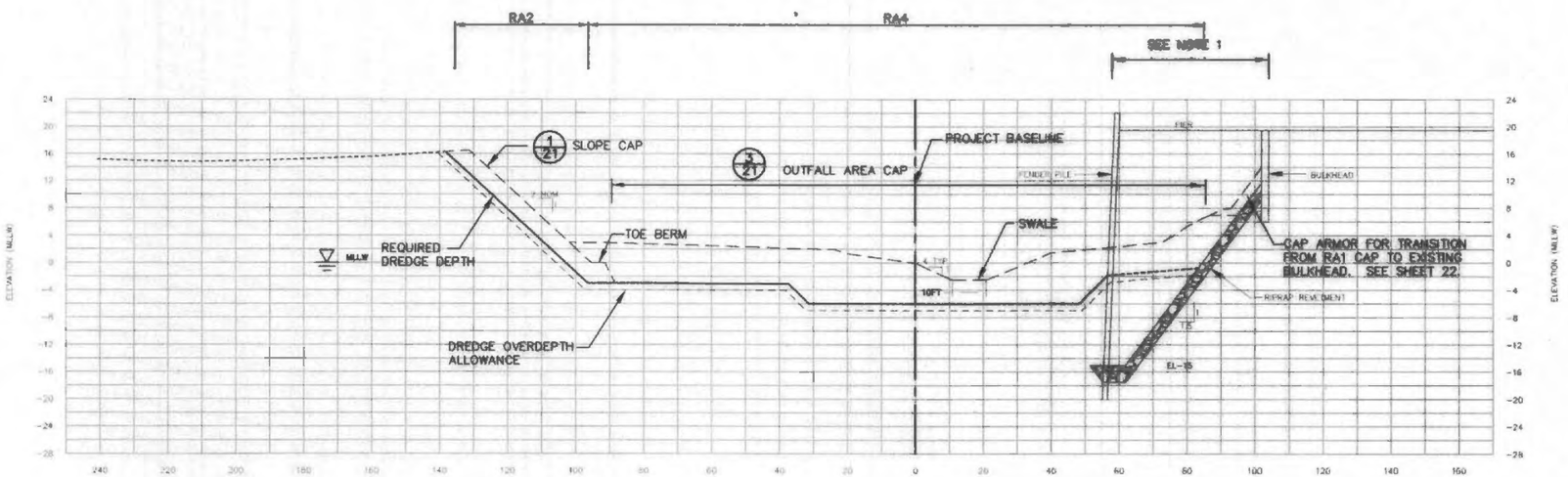
LEGEND:

- EXISTING MUDLINE
- REQUIRED DREDGE DEPTH
- DREDGE OVERDEPTH ALLOWANCE
- CAPPING LINE



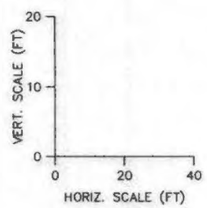
SECTION E–E 16

STA 1+00 (LOOKING UPSTATION, TYP)



SECTION F–F 16

STA 2+00



NO.	DATE	MARK	REVISIONS	MADE	CHK'D	REV'D
VAULT SERIAL NO. 55475			NATURE			

integral consulting inc.
411 1ST AVENUE S, SUITE 550
SEATTLE, WASHINGTON 98104
206.230.9600

APPROVED FOR ADVERTISING
NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20
BY:
PURCHASING & CONTRACTING SERVICES DIRECTOR

NAME OR INITIALS AND DATE	
DESIGNED DRS 3/30/07	
CHECKED RMC 3/30/07	
DRAWN TRM/WRM 3/30/07	
CHECKED DRS 8/5/10	

ALL WORK SHALL BE DONE IN ACCORDANCE WITH THE CITY OF SEATTLE STANDARD PLANS AND SPECIFICATIONS AND OTHER DOCUMENTS CALLED FOR IN SECTION 0-02.3 OF THE PROJECT MANUAL.

INITIALS AND DATE	
REVIEWED:	
DES.	CONST.
SDOT	PROJ. MGR.
RECEIVED	
REVISED AS BUILT	

DAVID R. SCHUCHART STATE OF WASHINGTON REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO. APPROVED
FUND: DWF/SCL
SCALE: H. 1"=40', V. 1"=20' INSPECTOR'S BOOK

CAPPING SECTIONS E–F

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

CN 800	PC C309045
	R/W
	CO
VAULT PLAN NO.	776-294
SHEET	18 OF 24

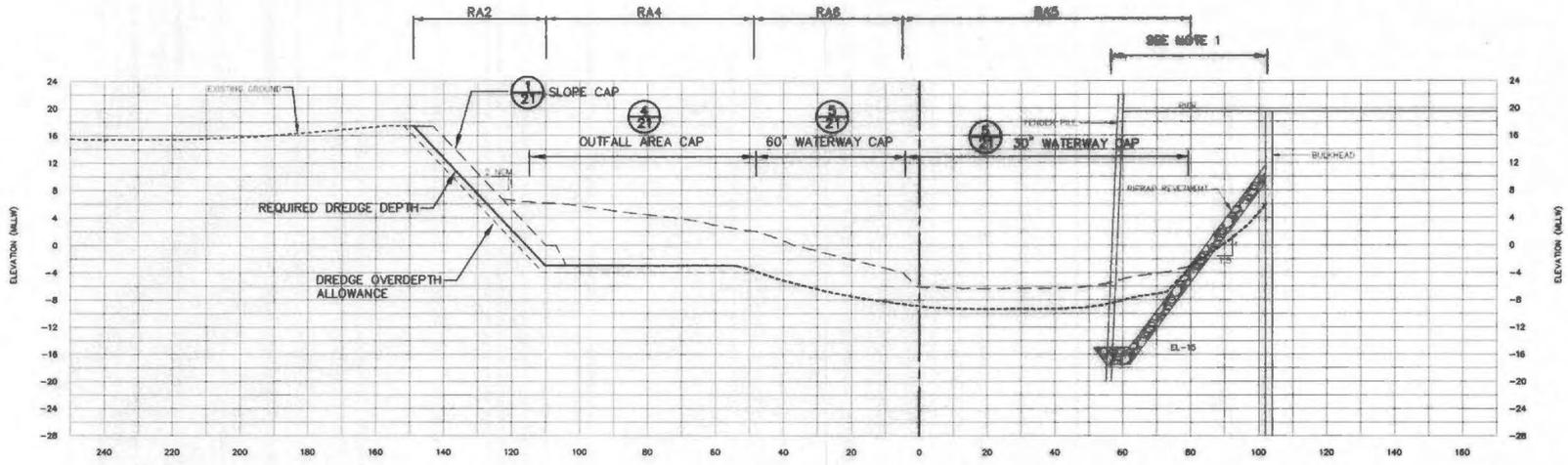
C:_Sync\Slip 4\Final for Mylar\18 C309045-F-Capping_Sections_E-F.dwg
epicher4 Mar-22-11 1:42pm

NOTES:

1. DEMOLISH PIER BEFORE CAPPING IN RA5, 6, OR 7.
2. BULKHEAD TO REMAIN FROM STA 4+00 TO 5+80.

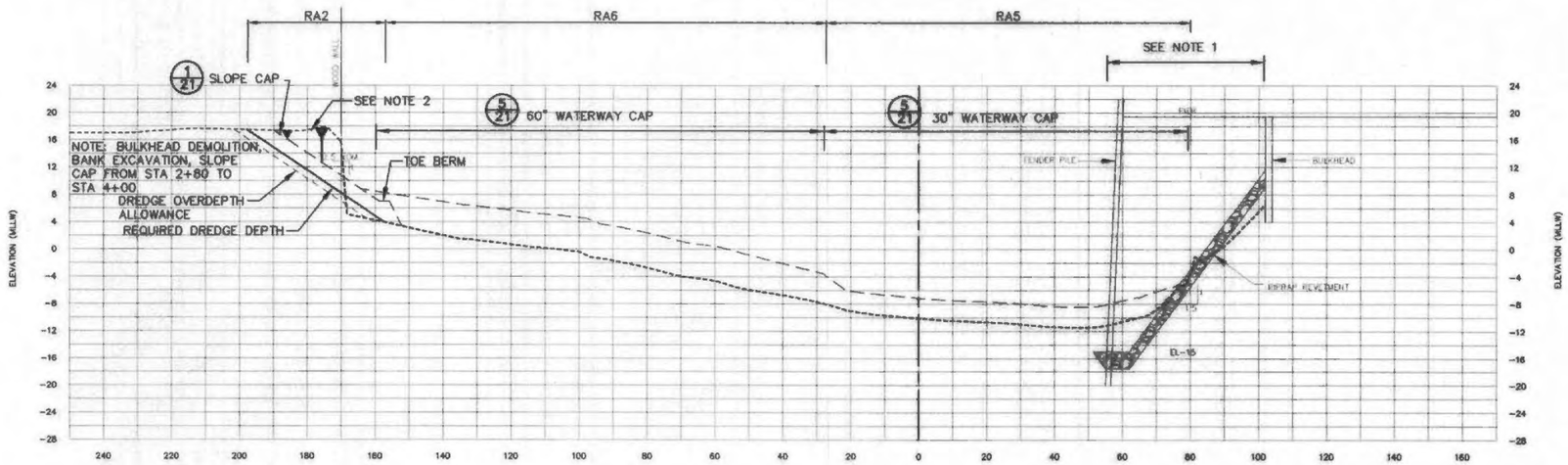
LEGEND:

- EXISTING MUDLINE
- REQUIRED DREDGE DEPTH
- DREDGE OVERDEPTH ALLOWANCE
- CAPPING LINE



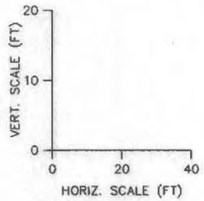
SECTION G–G 16

STA 2+80 (LOOKING UPSTATION, TYP.)



SECTION H–H 16

STA 4+00



MAULT SERIAL NO. 35375	DATE	MARK	NATURE REVISIONS	MADE CHK'D DES'D

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CAPPING SECTIONS G–H

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SEATTLE, WASHINGTON 98104
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NANCY LOCKE
DEPARTMENT OF FINANCE & ADMINISTRATIVE SERVICES
SEATTLE, WASHINGTON 20
BY: PURCHASING & CONTRACTING SERVICES DIRECTOR

NAME OR INITIALS AND DATE	INITIALS AND DATE
DESIGNED DRS 3/30/07	REVIEWED:
CHECKED RMC 3/30/07	DES. CONST.
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DAVID R. SCHUCHART — STATE OF WASHINGTON — REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO. APPROVED
FUND: DWF/SCL
SCALE: H. 1"=40', V. 1"=20' INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

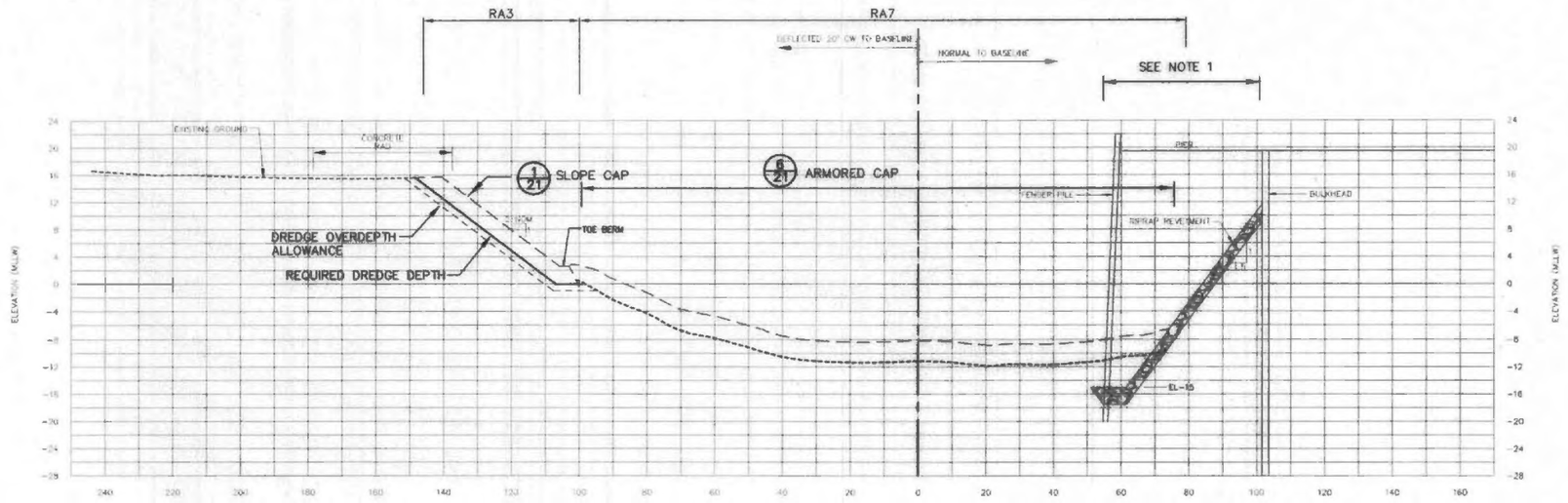
JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 19 OF 24

NOTES:

1. DEMOLISH PIER BEFORE CAPPING IN RA5, 6, OR 7.

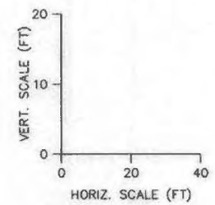
LEGEND:

- EXISTING MUDLINE
- REQUIRED DREDGE DEPTH
- DREDGE OVERDEPTH ALLOWANCE
- CAPPING LINE



SECTION 1–1 16

STA 6+00 (LOOKING UPSTATION)



CAPPING SECTION 1

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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776–294
SHEET 20 OF 24

NATURE	MADE THIS D REV'D
REVISIONS	
MARK	
DATE	
NO.	
VAULT SERVICE NO.	38375

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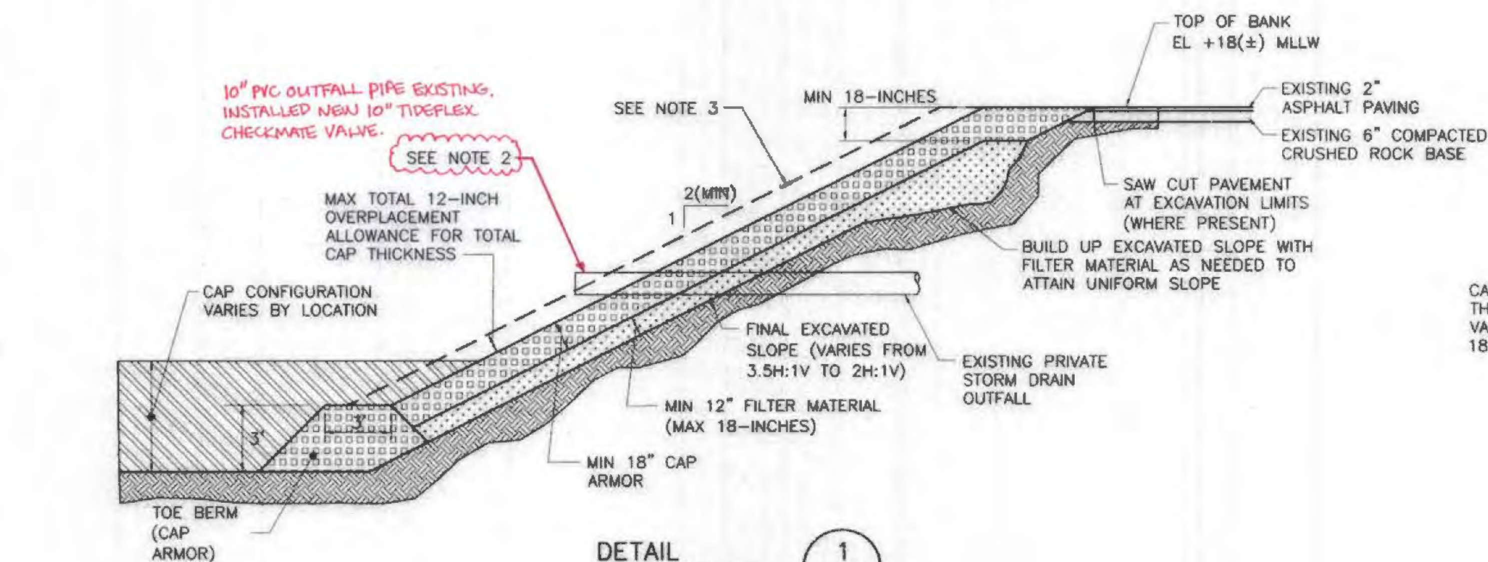
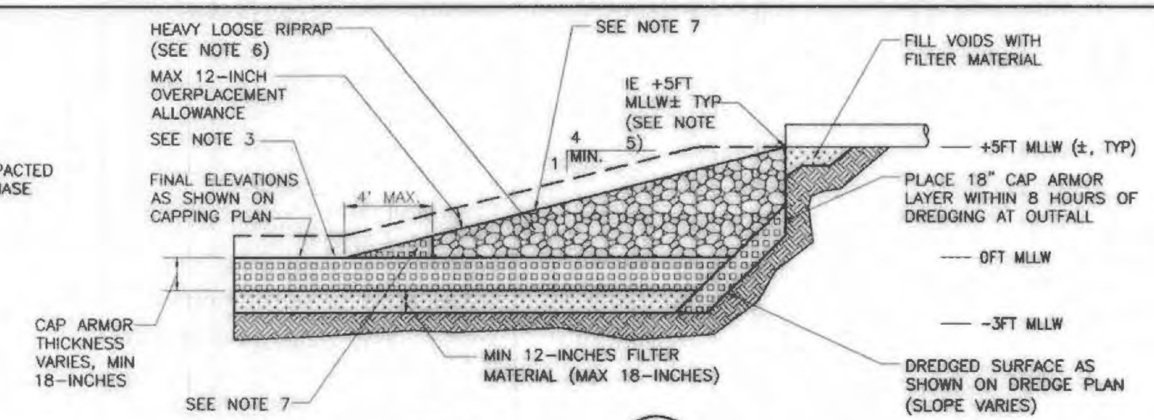


DETAIL 1/VAR
SCALE: NONE
TYPICAL SECTION - SLOPE CAP



DETAIL 2/VAR
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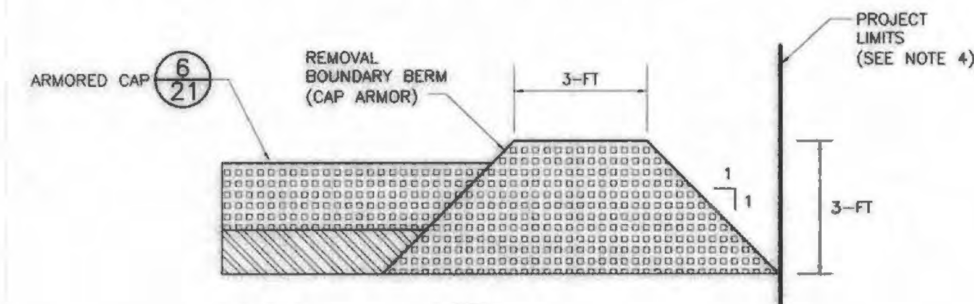
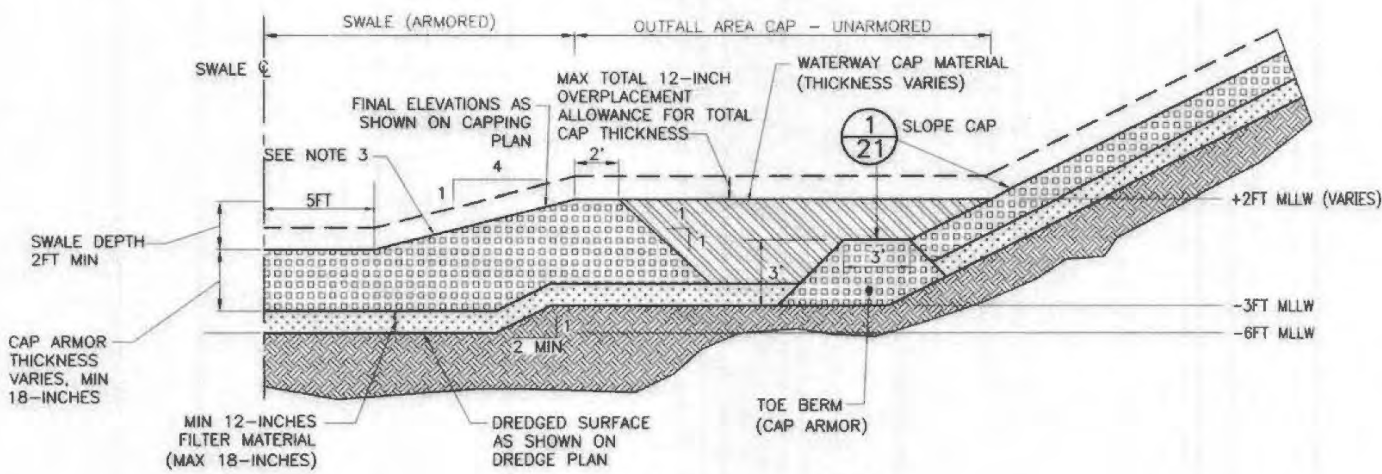
TYPICAL SECTION - OUTFALL SCOUR PROTECTION



DETAIL 4/VAR
SCALE: NONE
TYPICAL SECTION - BOUNDARY BERM



DETAIL 3/VAR
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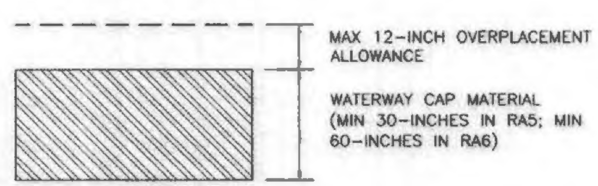
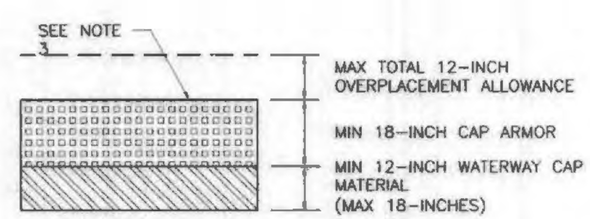
TYPICAL SECTION - OUTFALL AREA CAP



DETAIL 5/VAR
SCALE: NONE
TYPICAL SECTION - WATERWAY CAP

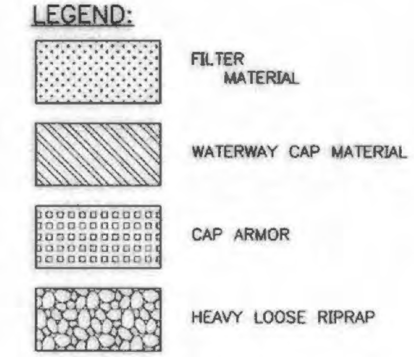


DETAIL 6/VAR
SCALE: NONE
TYPICAL SECTION - ARMORED CAP

NOTES:

1. FOR SLOPE CAPS, FILTER MATERIAL AND CAP ARMOR SHALL BE PLACED IN THE FOLLOWING SEQUENCE:
   A. PLACE TOE BERM.
   B. START PLACEMENT OF FILTER MATERIAL AND CAP ARMOR FROM THE TOE BERM AND WORK UPSLOPE.
   C. COVER FILTER MATERIAL WITH CAP ARMOR MATERIAL THE SAME DAY IT IS PLACED.
2. FOR EMERALD SERVICES 8" CLAY PIPE OUTFALL - CUT EXISTING OUTFALL SUCH THAT 6 TO 12 INCHES OF PIPE PROTRUDES FROM FINISHED SURFACE. REPLACE TIDE FLEX CHECK VALVE AS PER MANUFACTURER'S SPECIFICATIONS. FOR OTHER PRIVATE OUTFALLS - AS INDICATED, CUT FLUSH WITH EXCAVATED SURFACE AND GROUT IN ACCORDANCE WITH SPECIFICATIONS.
3. HABITAT MIX SHALL BE APPLIED OVER CAP ARMOR AT THE RATE OF 3 TONS PER 100 SQUARE FEET.
4. PLACE NO MATERIAL OUTSIDE PROJECT LIMITS.
5. DO NOT PLACE HEAVY LOOSE RIPRAP AT ELEVATIONS ABOVE OUTFALL INVERT.
6. HEAVY LOOSE RIPRAP SHALL COMPRISE THE MAXIMUM PRACTICABLE PORTION OF THE SCOUR PROTECTION, IN PLAN AND SECTION, IN ACCORDANCE WITH THE SPECIFICATIONS.
7. APPLY CAP ARMOR TO SURFACE OF HEAVY LOOSE RIPRAP TO FILL VOIDS, SMOOTH GRADES, AND FEATHER TRANSITION TO CAP SURFACE.

LEGEND:



CAP AND OUTFALL SCOUR PROTECTION DETAILS

MADE	CHK'D	REV'D	NATURE	REVISIONS
DATE	MARK			
VAULT SERIAL NO. 35375				

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DAVID E. SCHUCHARDT, STATE OF WASHINGTON, REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
City of Seattle
Ray Hoffman, Director
ORDINANCE NO. APPROVED
FUND: DWF/SCL
SCALE: AS NOTED INSPECTOR'S BOOK

LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045
R/W
CO
VAULT PLAN NO. 776-294
SHEET 21 OF 24

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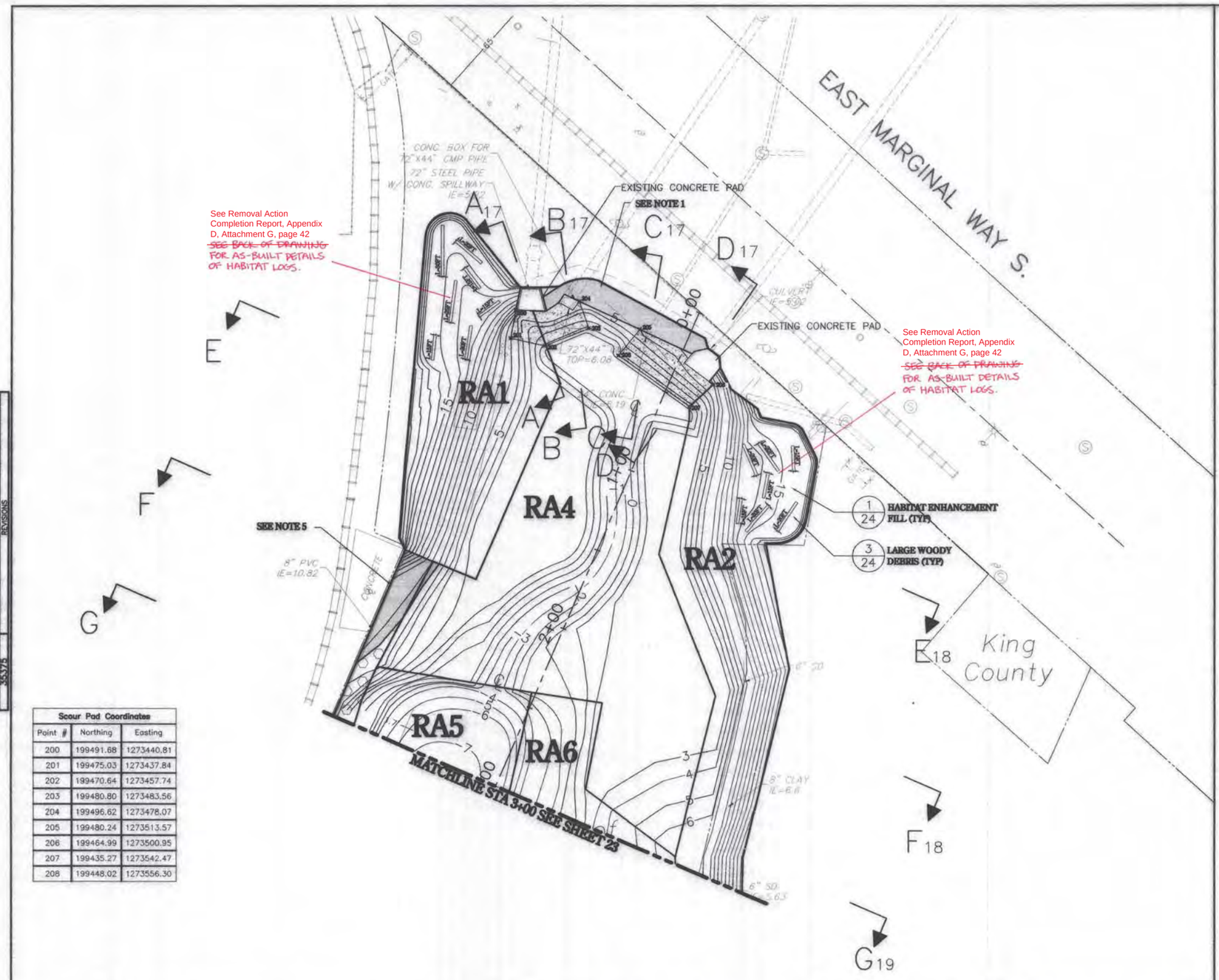

Scour Pad Coordinates		
Point #	Northing	Easting
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201	199475.03	1273437.84
202	199470.64	1273457.74
203	199480.80	1273483.56
204	199496.62	1273478.07
205	199480.24	1273513.57
206	199464.99	1273500.95
207	199435.27	1273542.47
208	199448.02	1273556.30

LEGEND

- POWER POLE
- SANITARY MANHOLE
- LUMINAIRE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- SPOT ELEVATION
- 5 FOOT CONTOUR INTERVAL (EXISTING)
- 1 FOOT CONTOUR INTERVAL (EXISTING)
- FINAL GRADE
- APPROXIMATE PROPERTY LINE
- PROJECT LIMITS
- RAIL SPUR
- MATCHLINE
- LARGE WOODY DEBRIS
- EXISTING RIPRAP
- OUTFALL SCOUR PROTECTION
- CAP ARMOR W/HABITAT MIX
- EXISTING CONCRETE

NOTES:

1. SLOPE IMPROVEMENTS IN SHADED REGION (TO +12FT) PLACE 18-IN TO 24-IN LAYER OF CAP ARMOR MATERIAL. PLACE HABITAT MIX OVER CAP ARMOR MATERIAL AT A RATE OF 3 TONS PER 100 SQUARE FEET.
2. CONSTRUCT OUTFALL AREA CAP IN RA4 TO THE FINISH LINES AND GRADES AS SHOWN
3. FINISH LINES AND GRADES SHOWN IN RA1, RA2, RA5, AND RA6 ARE APPROXIMATE. CONSTRUCT CAPS TO SPECIFIED THICKNESSES AND TOLERANCES.
4. GRADE SWALE FOR POSITIVE DRAINAGE FROM OUTFALLS TO RA5. NO PONDING SHALL OCCUR AT LOW TIDE.
5. PLACE CAP ARMOR FOR TRANSITION FROM RA1 CAP TO EXISTING SHEET PILE BULKHEAD. MAXIMUM SLOPE 1.5H:1V FOR TRANSITION. PLACE HABITAT MIX OVER CAP ARMOR MATERIAL AT A RATE OF 3 TONS PER 100 SQUARE FEET.

N

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SCALE IN FEET

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VAULT SERIAL NO. 35375

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FINAL GRADING AND HABITAT ENHANCEMENT PLAN – SHEET 1

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DAVID R. SCHUCKMAN STATE OF WASHINGTON 22992 REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities | City of Seattle | Ray Hoffman, Director
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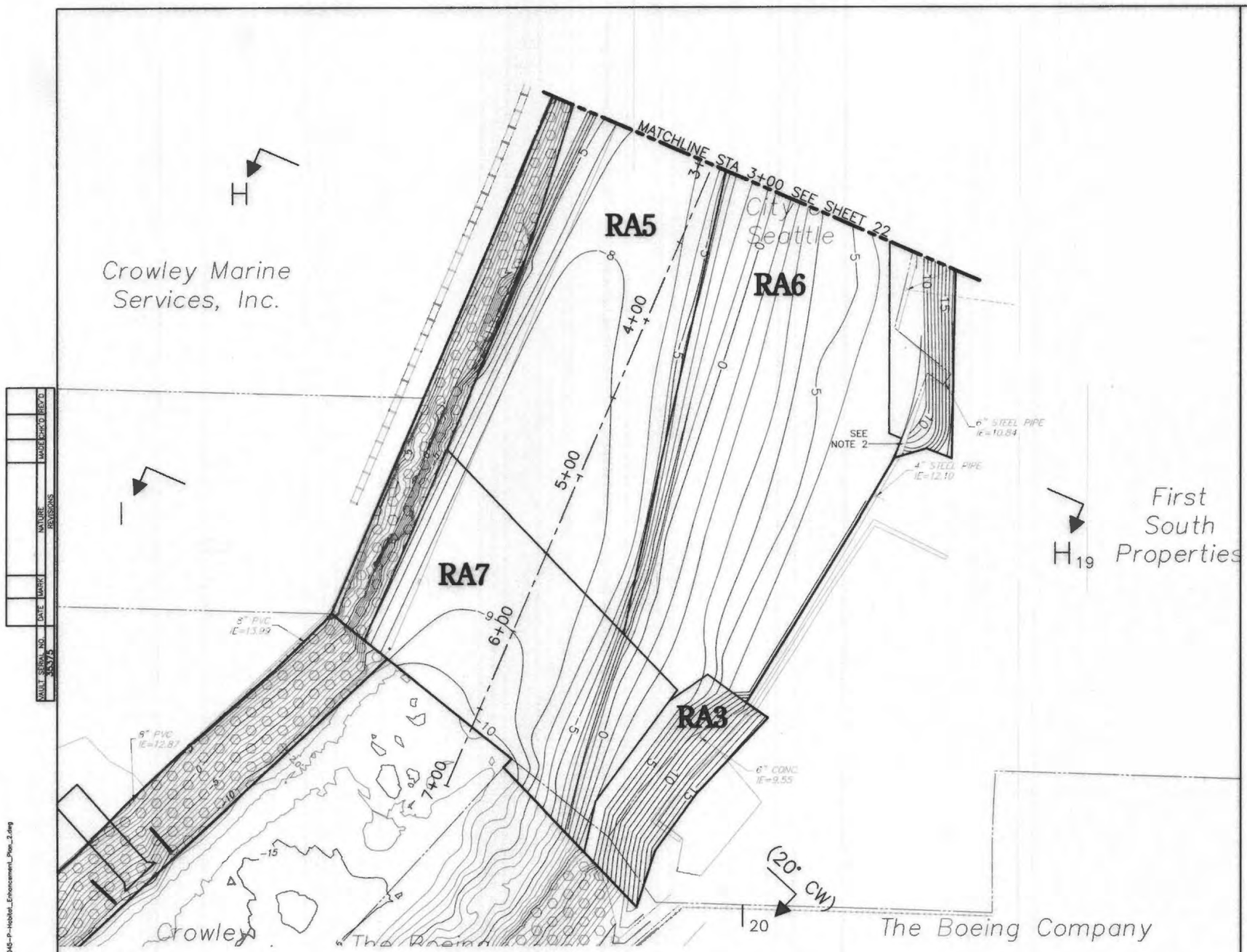
SCALE: AS NOTED

LOWER DUWAMISH WATERWAY
SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 22 OF 24



LEGEND

- POWER POLE
- SANITARY MANHOLE
- LUMINAIRE
- IRRIGATION CONTROL VALVE
- GUY WIRE
- SPOT ELEVATION
- 5 FOOT CONTOUR INTERVAL (EXISTING)
- 1 FOOT CONTOUR INTERVAL (EXISTING)
- FINAL GRADE
- APPROXIMATE PROPERTY LINE
- PROJECT LIMITS
- RAIL SPUR
- MATCHLINE
- EXISTING RIPRAP

NOTES:

1. FINISH LINES AND GRADES SHOWN ARE APPROXIMATE. CONSTRUCT CAPS TO SPECIFIED THICKNESSES AND TOLERANCEES.
2. CUT REMAINING TIMBER BULKHEAD FLUSH WITH FINAL CAP SURFACE.

N

30 15 0 30 60
SCALE IN FEET

FINAL GRADING AND HABITAT ENHANCEMENT PLAN – SHEET 2

NATURE	DATE	MARK
REVISIONS		
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Seattle Public Utilities
ORDINANCE NO.
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SCALE: AS NOTED

City of Seattle
Ray Hoffman, Director
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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 23 OF 24

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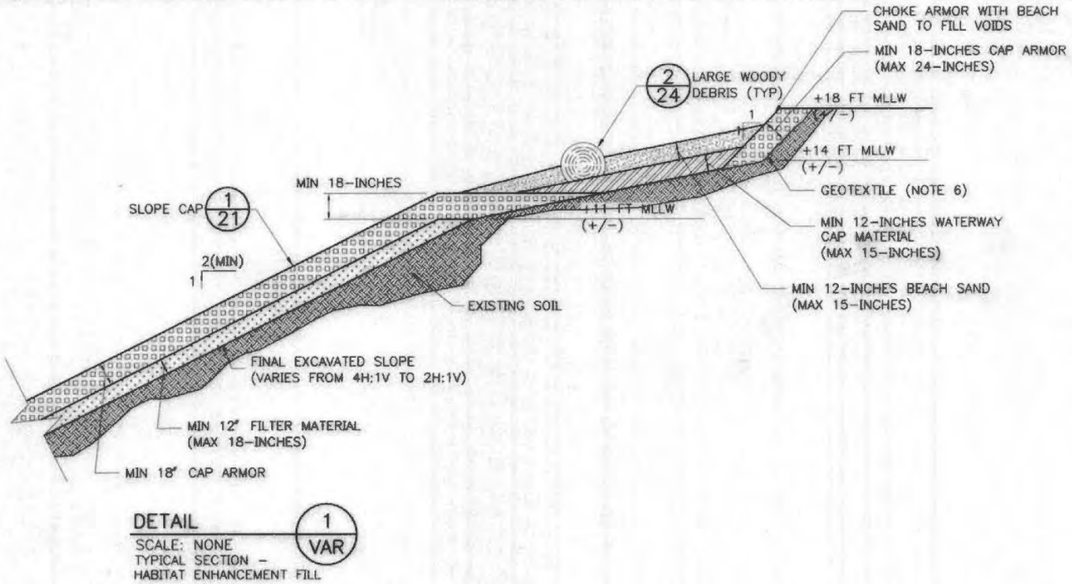


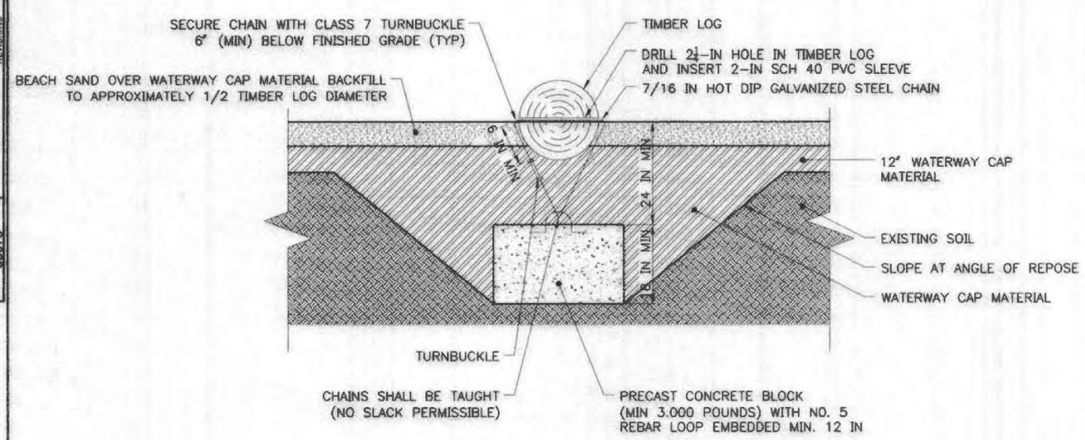
DETAIL 1/VAR
SCALE: NONE
TYPICAL SECTION - HABITAT ENHANCEMENT FILL

NOTES:

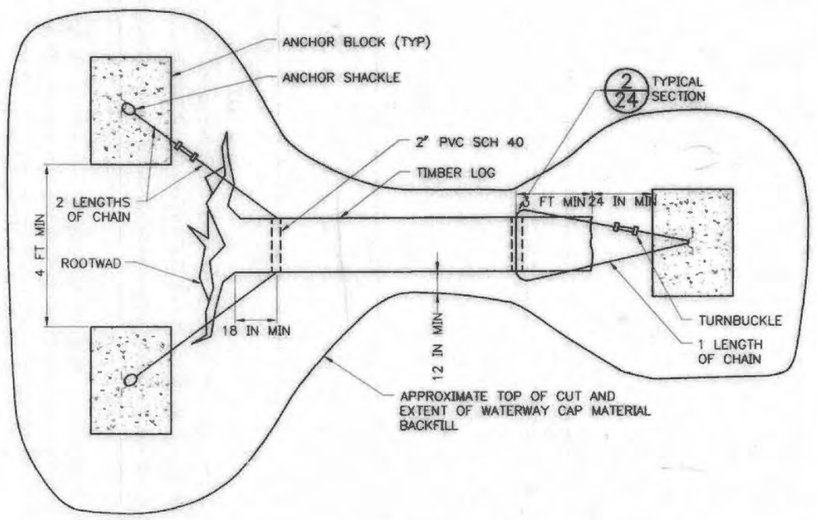
1. ALL TIMBER LOGS SHALL BE CEDAR OR FIR
2. ALL TIMBER LOGS SHALL HAVE A NOMINAL DIAMETER OF 21 TO 36 INCHES.
3. TIMBER LOG LENGTHS SPECIFIED DO NOT INCLUDE LENGTH OF ATTACHED ROOTWAD. ACTUAL LENGTH MAY BE -1FT TO +4FT OF SPECIFIED LENGTH.
4. THE END OF THE TIMBERLOG WITH NO ROOTWAD SHALL BE ROUGHENED WITH CHAINSAW OR EQUIVALENT.
5. CAST IN PLACE CONCRETE ANCHOR BLOCKS MAY BE USED THAT MEET OR EXCEED THE WEIGHT REQUIREMENTS SHOWN ON THE DRAWINGS. ENGINEER MUST APPROVE USE OF CAST IN PLACE ANCHOR BLOCKS.
6. GEOTEXTILE SHALL MEET WSDOT STANDARD SPECIFICATIONS 9-33.2 TABLE 3 (SEPARATION). INSTALL IN ACCORDANCE WITH WSDOT STANDARD SPECIFICATIONS 2-12.3.

LEGEND:

- CONCRETE ANCHOR BLOCK
- WATERWAY CAP MATERIAL
- CAP ARMOR
- BEACH SAND



DETAIL 2/24
SCALE: NONE
TYPICAL SECTION - LARGE WOODY DEBRIS



DETAIL 3/22
SCALE: NONE
TYPICAL PLAN - LARGE WOODY DEBRIS

HABITAT ENHANCEMENT DETAILS

VAULT SERIAL NO. 35375 | DATE | MARK | NATURE OF REVISIONS | MADE SCHED REV'D

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DAVID R. SCHUCHART STATE OF WASHINGTON 20083 REGISTERED PROFESSIONAL ENGINEER

Seattle Public Utilities
ORDINANCE NO.
FUND: DWF/SCL
SCALE: AS NOTED

City of Seattle
Ray Hoffman, Director
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LOWER DUWAMISH WATERWAY SLIP 4 EARLY ACTION

JOB NO. PC C309045 R/W CO
VAULT PLAN NO. 776-294
SHEET 24 OF 24