Lower Duwamish Waterway Group

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

CONSTRUCTION REPORT

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

FINAL

Prepared for:

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

Washington State Department of Ecology
Northwest Regional Office
Bellevue, Washington

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Project No. LY15160310

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ACRONYMS AND ABBREVIATIONS

AC	activated carbon
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
AOC	Administrative Order on Consent for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act Docket No. 10-2001-0055)
BC	black carbon
BRH	Bush Roed & Hitchings Inc
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
Contractor	Pacific Pile and Marine
CP	control point
CQA	construction quality assurance
CQAPP	construction quality assurance project plan
CQCP	contractor quality control plan
DGPS	digital global positioning system
ENR	enhanced natural recovery
ENR+AC	enhanced natural recovery with activated carbon
EPA	U.S. Environmental Protection Agency
EWT	effective working time
GAC	granulated activated carbon
GPS	global positioning system
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
mg	milligram
MLLW	mean lower low water
NAD83	North American Datum of 1983
NEWT	non-effective working time
ng/kg dry-weight	nanograms per kilogram dry weight
ng TEQ/kg dry-weight	nanograms TEQ per kilogram dry weight
NTU	nephelometric turbidity units
OPUS	Online Positioning User Service
Order Amendment	Second Amendment (July 2014) to the Administrative Order on Consent for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act Docket No. 10-2001-0055)

ACRONYMS AND ABBREVIATIONS (Continued)

PCB	polychlorinated biphenyl
PEX	cross-linked polyethylene
QAPP	quality assurance project plan
QA	quality assurance
QC	quality control
RTK	real-time kinematic
SPI	sediment profile imaging
SPME	solid phase micro extraction
SVOC	semivolatile organic compound
TEQ	toxic equivalency quotient
TOC	total organic carbon
TVS	total volatile solids
WSDOT	Washington State Department of Transportation
µg/kg dry-weight	micrograms per kilogram dry weight
USACE	U.S. Army Corps of Engineers

CONSTRUCTION REPORT
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1.0 INTRODUCTION

The Lower Duwamish Waterway Group (LDWG) is conducting a field pilot study to evaluate the potential effectiveness of an innovative sediment technology in the Lower Duwamish Waterway (LDW). The study will determine whether Enhanced Natural Recovery (ENR) material amended with granular activated carbon (AC) can be successfully applied to reduce the bioavailability of polychlorinated biphenyls (PCBs) in remediating contaminated sediments in the LDW. The study will compare the effectiveness of ENR with added AC (ENR+AC) versus ENR without added AC in three areas (called *plots*) in the LDW. The three study plots are referred to as the (1) intertidal plot, (2) subtidal plot, and (3) scour plot. Each plot comprises two subplots, one with ENR alone, the other with ENR+AC.

For the purposes of this project, ENR involved placement of a thin layer of clean material (sand or gravelly sand) over subtidal and intertidal sediments. ENR+AC involved placement of a thin layer of clean material augmented with AC over subtidal and intertidal sediments. The purpose of the ENR and ENR+AC treatments is to reduce the exposure of aquatic organisms to contaminants of concern. The locations where the pilot study plots were constructed are shown in Figure 1.

The pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent for Remedial Investigation/Feasibility Study for the Lower Duwamish Waterway (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 10-2001-0055, issued on December 20, 2000 [AOC]). The construction activities described in this report were performed consistent with the Order Amendment.

1.1 SCOPE AND PURPOSE OF STUDY

The goal of the pilot study is to place ENR material and ENR+AC material over separate subplots of bottom sediments in the LDW to evaluate the performance of ENR+AC compared to ENR in reducing the bioavailability of PCBs over a 3-year monitoring period.

The construction report evaluates one of the following pilot study goals from the Order Amendment: Verify that ENR+AC can be successfully applied in the LDW by monitoring the success of physical placement (uniformity of coverage and percentage of AC in the placed layer).

The percentage of AC in the placed layer is evaluated using the Year 0 (or post-construction) monitoring data. The other goals of the Pilot Study will be evaluated in Year 1 and 3 Monitoring data reports.

1.2 PILOT STUDY PLACEMENT TOLERANCES

The criteria for the design and construction of the ENR and ENR+AC are the following:

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

1.3 MATERIAL THICKNESS CRITERION

The placement of ENR and ENR+AC materials under water using the available equipment resulted in variability in material thickness. Based on industry experience, a 3-inch tolerance in placement thickness was the best that could be planned for and measured. The goal for this pilot project was to place the material as uniformly as practicable while targeting a thickness value of between 6 and 9 inches (15.2 and 22.9 cm) in 80% of stake/probe locations per subplot and with a minimum thickness of 4 inches (10.2 cm) at 100% of stake/probe locations per subplot.

This placement was designed to be as uniform as possible to facilitate the solid phase micro extraction (SPME) measurements for pilot study, and is not necessarily the placement approach or tolerance limits that will be used for full-scale application of ENR in the LDW.

2.0 CONSTRUCTION QUALITY ASSURANCE

Construction quality assurance (CQA) was provided in accordance with the Construction Quality Assurance Project Plan (CQAPP) (Amec Foster Wheeler et al., 2015a) and CQAPP Addendum 1 (Amec Foster Wheeler et al., 2016a), which were approved by the U.S. Environmental Protection (EPA) and Washington State Department of Ecology in letters dated November 12, 2015, and November 23, 2016, respectively. A Certification Statement for the construction is provided in Attachment 1. Dan Pickering, P.E., served as the Field Engineer and was on site full time during material placement to monitor and document the placement of all ENR and ENR+AC material and verify work was consistent with EPA-approved project documents. Rob Webb, P.E. (Project Engineer), and Rich May, P.E. (Assistant Field Engineer), observed the loading of all ENR and ENR+AC material at CalPortland's Pioneer Aggregates facility located in DuPont, Washington. Chris Mack (King County Construction Project Manager) provided final approval of all submittals, supervised field inspections conducted by Stand Burns and Mark Palmer (King County Construction Inspectors), approved all imported materials and equipment, provided all verbal or written direction to the Contractor, audited the project QA, and approved in conjunction with Jennifer Kauffman, PMP (King County Project Manager).

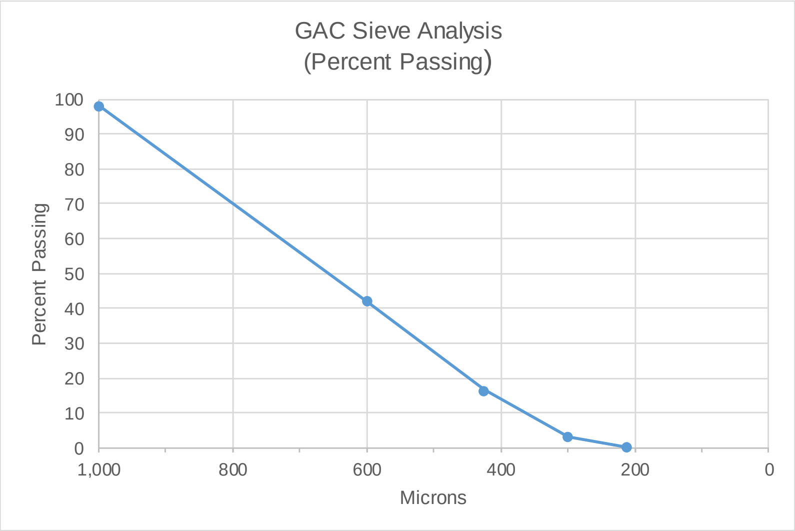
CQA activities were conducted as described in this section. Selected photos recorded during construction activities are provided in Attachment 2.

2.1 QUALITY ASSURANCE AND QUALITY CONTROL OF PRODUCTS

All material products used for the pilot study were evaluated for quality assurance (QA) and quality control (QC) purposes.

2.1.1 Verification of AC Material

Prior to construction, the CQA team approved Calgon Carbon Corporation as the AC supplier and approved the material type. The material (product number OLC 18X70 Coconut Fine Mesh Activated Carbon) was analyzed for the PCB congeners using EPA Method 1668C. Three congeners (PCB-11, PCB-28, and PCB-31) were detected. The sum of the detected congeners was 0.035 micrograms per kilogram dry weight (µg/kg dry-weight), below 2 µg/kg dry-weight (the lowest LDW cleanup goal for PCBs). In addition, the grain size distribution of the AC material showed the material was well graded across the size range 200 to 1,000 microns as shown below.



Based on the results, the AC met the specifications for the source material. Following construction, a sample of the AC material was submitted for an elemental analysis and was 93.93% carbon.[1]

AC material was visually inspected to verify that the materials were the same as what was proposed by the Contractor (Pacific Pile and Marine) and a sample of which was previously submitted, analyzed, and approved.

2.1.2 Verification of Sand and Gravelly Sand Products

The ENR and ENR+AC pilot study was conducted using two different material types: gravelly sand and sand.

Gravelly sand consisted of granular material which generally met Washington State Department of Transportation (WSDOT) Standard Specification 9-03.11 for Streambed Aggregates, but modified to contain a minimum of 50% sand (<4.75-millimeter particle size [No. 4 sieve], as defined by the American Association of State Highway and Transportation Officials). The gravelly sand material met the following gradation specifications.

Gravelly Sand ENR Material Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight	Actual Percent Passing by Dry Weight
1-1/2”	100	100
¾”	80-90	89
3/8”	50-80	62
U.S. No. 4	50% minimum	53
U.S. No. 16	10-30	16
U.S. No. 200	0-2	0

The sand used for the pilot study consisted of granular material meeting WSDOT Standard Specification 9-03.1(2)B for “Class 2 Sand,” with the following gradation.

Sand ENR Material Gradation

U.S. Standard Sieve Size	Percent Passing by Dry Weight	Actual Percent Passing by Dry Weight
3/8”	100	~100 (per graph)
U.S. No. 4	95-100	99.8 (per table)
U.S. No. 16	45-80	~75 (per graph)
U.S. No. 50	10-30	~22 (per graph)
U.S. No. 100	2-10	~4 (per graph)
U.S. No. 200	0-2	1.8 (per table)

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[1] The elemental analysis was added to assist in data interpretation of the organic carbon analysis.

The CQA team inspected the sand and gravel products prior to and during material loading. Prior to construction, the source quarry for the sand and gravelly sand products was inspected to verify that the materials were the correct type approved for the project and free of debris or recycled materials. The material was also analyzed for the PCB congeners using EPA Method 1668C, dioxins and furans using EPA Method 1613, semivolatile organics using EPA Method 8270D, and metals (with the exception of mercury) using EPA Method 6020A. Mercury was analyzed using EPA Method 7474. Total organic carbon was analyzed using EPA Method 9060A.

Eight PCB congeners were detected in the gravelly sand ENR material. The total PCBs were 37.0 nanograms per kilogram dry weight (ng/kg dry-weight; 0.0370 µg/kg dry-weight). Eleven PCB congeners were detected in the sand ENR material. The total PCBs were 31.2 ng/kg dry-weight (0.0312 µg/kg dry-weight). The calculated toxic equivalency quotient (TEQ) for the dioxin/furan congeners was 0.000867 nanograms TEQ per kilogram dry weight (ng TEQ/kg dry-weight) for the gravelly sand ENR material and 0.000603 ng TEQ/kg dry-weight for the sand ENR material. The results for the additional testing for total organic carbon, grain size, metals, and semivolatile organic compounds (SVOCs) are presented in Table 1.

The analysis results (Table 1) indicate the ENR materials met the requirements for imported material outlined in the Construction Plans and Specifications.

The CQA team was present on site during all barge-loading and field operations to observe loading and placement of material and monitor for compliance with project specifications.

2.1.3 Verification of AC-Amended Sand and Gravelly Sand Products

Consistent with the Contractor Quality Control Plan, the CQA team observed loading of all AC-amended materials in real-time. These inspections were conducted to:

- Visually verify the consistency of the blended material, and
- Verify that the blended material met the acceptance criteria designated in the project specifications (target percent of AC by weight) based on visual observations and scale tickets from barge-loading operations.

While material was being loaded onto the barge, samples of the AC-amended material were collected for analysis for informational purposes only. Samples were collected at approximately 500-ton increments of AC-amended material in order to determine the range of AC concentrations in the blend, as required by the CQAPP and Section 02221 2.03 A of the contract documents. These samples were collected through the use of an automated, belt-cut sampler (Attachment 2, Photo 6) located about 20 feet past the auger. The belt-cut sampler collected an approximate

2-gallon cross-section sample directly from the conveyor. Samples of sand ENR+AC were sent directly to the lab (Alpha Analytical) for analysis. Gravelly sand ENR+AC samples were sieved at a materials lab, and the portion passing the No. 4 sieve was forwarded to Alpha Analytical for total organic carbon (TOC) and black carbon (BC) analysis. For the sieved samples, the percentage TOC and BC for the complete sample was calculated using the reported weight percent of the original sample material retained by and passing the No. 4 sieve.

The results of the BC analysis (using Gustafsson et al., 1997) and TOC analyses consistently underestimated the percentage of BC and TOC in the samples when compared to the calculated percentages based on the weight of AC added to each barge load of ENR material. The BC and TOC results in the barge samples were lower than what was expected.[2] To investigate the cause of these biased low results, a sample of pure AC (the same material used in the pilot study) was analyzed by the BC method and found to be completely combusted at 375°C (during the "pre-combustion" burn), indicating this natural sourced AC was not being measured by the BC method at all. Standards were made in the lab consisting of the sand matrix, with AC added at 0.5, 2.0, 4.0, 6.0, and 8.0% by weight. These standards were also analyzed by the BC method and confirmed the natural sourced AC could not be quantified using the Gustafsson et al. method due to the required pre-combustion burn step at 375°C. These standards were also analyzed using both TOC and total volatile solids [TVS] methods. The TOC method resulted in biased low quantification of the AC in the standards; this was determined to be due to smaller sample aliquot used with the analytical instrument. Because of the grain size of the ENR materials, it was difficult to get a representative sample from the small aliquot that is typically used for TOC analyses (10 to 20 milligrams [mg]). However, the TVS method, which used a larger sample size, was able to reproduce the standards correctly. In response, the pre-construction samples were analyzed for total volatile solids (TVS) to evaluate the percent AC in the ENR material.

The sand material which was amended with 4% AC by weight had an average TVS of 4.0%. The gravelly sand material amended with 4% AC had an average TVS of 2.7% which was lower than expected. The results of the TVS analyses are presented in Table 2. The scale tickets were reviewed to verify that 4% AC by weight was added to the gravely sand material. Since the gravelly sand material needed to be sieved to remove large particles from the sample prior to analysis, it is likely that some AC was retained on the larger gravel fraction during sieving. Assuming no loss of AC during placement, it would be expected that the TVS in the gravelly sand ENR+AC subplot would be 2.7%.

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[2] The TOC method bias was addressed for Year 0 samples by using a larger instrument sample size. See QAPP Addendum 3 (Amec Foster Wheeler et al., 2018a) and Section 3.5 of this report for a discussion of the issue and its resolution.

2.1.4 Barge Loading

Barge loading for the project took place between November 23, 2016, and January 13, 2017. During this time frame, six barge loadouts occurred at the supplier's (CalPortland) Pioneer Aggregates facility located in DuPont, Washington. Project CQA personnel were on site during each of the six barge loadouts to verify the correct product was being loaded and to observe the blending of ENR+AC material. The Pioneer Aggregates facility includes a barge-loading dock located on Puget Sound (Attachment 2, Photo 1) capable of loading aggregate and sand through the use of a computerized conveyor system. Material flow rates are controlled and monitored through the central control room (Attachment 2, Photo 2). For this project, the Contractor used two flat-deck barges with steel-bin walls for the transportation of either ENR+AC (KP-2 barge) or ENR material without AC (KP-3 barge). To prevent residual AC from being mixed with ENR-only material, the KP-2 barge was used to transport only the ENR+AC material, and the KP-3 barge carried only ENR material without AC. Table 3 summarizes the six barge loadouts during the project. Daily barge loading reports are presented in Attachment 3.

AC was blended with ENR materials at the supplier's facility during loadout through the use of a hopper and auger system (Attachment 2, Photo 3). The system was used to feed AC onto the conveyor at a rate predetermined by the supplier as ENR material passed under the end of the auger (Attachment 2, Photo 4) to produce the 4% AC content required by the specifications. As the ENR+AC material traveled the 3,000+ feet from the auger to the dock, both materials were blended together as they passed through several transition points where the ENR+AC falls from one conveyor belt to the next. AC was delivered to the supplier in 500-kilogram bulk bags. The supplier calculated the quantity of AC required for a barge load, and placed it in the stockpile prior to the start of loading (Attachment 2, Photo 5). The Assistant Field Engineer counted the number of bags of AC used for each barge load of ENR+AC to verify the proper quantity of AC was added to the ENR material.

Due to subfreezing temperatures during loading, the loading of sand ENR material during barge load six was extended by several hours. This delay was caused by sand that had become frozen into slab-shaped pieces of sufficient size to cut off the flow of this ENR material onto the conveyor as it was fed from the stockpile. As a result, loading was interrupted while the frozen material was cleared, increasing the loading time from approximately 1 hour to about 3 hours.

2.2 QA AND QC PROCEDURES FOR ENR AND ENR+AC PLACEMENT

This section presents the QA/QC monitoring and inspections for in-water placement of ENR material and ENR+AC material.

2.2.1 Pre-Construction Activities

The CQA team was present in the field to observe field activities related to establishment of study plots and placement of material.

2.2.1.1 Temporary Control Points

Bush Roed & Hitchings Inc (BRH) established two brass monument temporary control points (CPs) for each of the three study plots: scour, subtidal, and intertidal. The location of each CP monument was established using static global positioning system (GPS) observations. Results were derived utilizing Online Positioning User Service (OPUS)[3] GPS processing. For quality control, real-time kinematic (RTK) GPS observations employing the Washington State Reference Network were also used.

Horizontal and vertical datum coordinate values were established based upon the North American Datum of 1983 (NAD83), 2011 Epoch 2016.84132. See Table 4 for the coordinates and elevations for each CP. The CPs were established at the following locations:

- *Scour plot*: The CPs for the scour plot were established on the sidewalk adjacent to the Harbor Island Marina.
- *Subtidal plot*: The CPs for the subtidal plot were established on the south end of the Lafarge North America dock.
- *Intertidal plot*: The CPs for the intertidal plot were established on a slag pile that is located in the waterway adjacent to the Insurance Auto Auctions International facility.

2.2.1.2 Equipment Inspection

Prior to construction activities all equipment and barges were inspected.

Material Barges—The two material barges (KP-2 and KP-3) used to transport and soak the ENR and ENR+AC material were tested for water tightness prior to construction. Each barge was partially flooded with approximately 2 feet of water from the waterway and then visually inspected for leaks that could prevent the ability to maintain water levels in the barge as specified in the design specifications. Minor weeping from the barges was allowed. Both barges passed the water tightness test. The barges were then monitored throughout the construction process. There were four observed leaks during the construction period and they were addressed promptly upon observation. The leaks were sealed using quick setting mortar on the outside of the bin walls.

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[3] https://www.ngs.noaa.gov/OPUS/.

Positioning and Navigation—All positioning and navigation equipment was visually inspected to verify that the equipment was installed, met project specifications, and matched the required equipment described in the Contractor Work Plan.

Bucket Placement Grid Files—The bucket grid files were AutoCAD drawings (.dwg) that contained the bucket placement grid for each plot. An example of this can be seen in Figure 2, the bucket placement grid used for the subtidal plot. This file was uploaded to the excavators DredgePack software. The bucket placement grid was shown on the operator's screen so the operator would know the location and orientation for each bucket placement. The Contractor provided this file for verification prior to placement in each plot.

2.2.1.3 ENR/AC Test Placement

Prior to placement of ENR and ENR+AC material in the three study plots, the Contractor performed a test placement with sand ENR+AC and gravelly sand ENR+AC in designated demonstration plots near and within the intertidal plot. Test placement activities are detailed below in Section 3.2.1.

2.2.1.4 Grade Stake Placement

Per the EPA-approved CQAPP, grade stakes were used to measure thicknesses of the placed ENR and ENR+AC material in the demonstration, scour, and intertidal plots. Prior to placement of ENR material, 24 stakes were placed in each of the two demonstration plots (48 total), and 60 grade stakes total were placed in the scour and intertidal plots (30 stakes in each plot [15 stakes per subplot]). Intertidal grade stakes were placed during tidal events that dropped water level to below 0 feet mean lower low water (MLLW). These tidal events exposed the intertidal plot and made it accessible by foot. The location of each grade stake was surveyed in the field using a hand-held Trimble GeoXH GPS unit that had submeter accuracy. Grade stakes were placed in the scour plot by divers. A vessel equipped with a submeter accuracy Trimble GPS unit was positioned over the location where the grade stake was to be installed and a weighted buoy was dropped to provide a guide for the diver.

The grade stakes were constructed of 18-inch-long, ¾-inch-diameter cross-linked polyethylene (PEX) piping that was threaded onto a 10-inch-long piece of ¾-inch-diameter all-thread rod (Attachment 2, Photo 22). The pipe was then attached to a 6-inch-square plate with approximately 8 inches of the all-thread extending past the plate as a stinger. In cases when it was thought necessary due to soft sediments, an additional section of all-thread was attached to extend the stinger to keep the grade stake in place and upright during material placement. This extensive hardware was developed to ensure accurate measurement of placement thickness regardless of subsidence to meet study objectives, and is not necessarily the measurement approach that should be used for full-scale application of ENR in the LDW.

Grade stakes were not placed within the subtidal plot, in accordance with the CQAPP Addendum 1 (Amec Foster Wheeler et al., 2016a; Attachment 4 to this report). At the subtidal plot, disturbance of the surface sediment thought to be caused by the dragging of tow bridles on ocean going barges, precluded the installation of the grade stakes. At the subtidal plots, material thickness was measured by a diver using a probe to detect the textural change in the material as the probe was inserted into the substrate.

2.2.2 Supporting Measurements of ENR and ENR+AC Material Placement

Sediment profile imaging (SPI) was conducted at 24 locations in each of the intertidal, scour, and subtidal plots (72 locations total) following material placement to collect semi-quantitative information on the sediment types and thickness of placed material present at each site (Attachment 5). Three replicate profile and plan view images were collected at each location. Sediment profile images were reviewed and the penetration of the prism into the placed material was measured and the depth of the native sediments (if visible) was noted. The depth of penetration of the prism is a function of the grain size and consolidation of the placed ENR material. It is typically less than the target ENR thickness depth for sandy or cobble-sand material. Additional supporting evidence of the thickness of the placed material was available from field measurements of layer thickness made during the post-construction collection of shallow cores (12-inch depth) collected at the intertidal (during low tides) and scour plots (by divers). Thickness of the ENR material was also estimated using the grab samples collected at the subtidal plots during the Year 0 post-construction monitoring based on depth of native sediments (if visible).

2.2.3 Construction Activities

During construction, regular monitoring and observations were conducted as needed to verify the quality of the work. Verifications and monitoring included but were not limited to:

- The correct material type was used for the placement area.
- Daily bucket positioning calibration tests were performed.
- Full coverage of the bucket placement pattern was achieved for each plot.
- Bucket fill factor was verified.
- Spuds were not used within the plot where ENR or ENR+AC material had already been placed.

3.0 SUMMARY OF MATERIAL PLACEMENT ACTIVITIES

This section documents the activities and observations during placement of the ENR and ENR+AC materials in the three study plots and the demonstration plot.

3.1 EQUIPMENT

Equipment used for material placement included an excavator, positioning equipment, clamshell bucket, and barges.

3.1.1 Excavator

An excavator capable of reaching 46 feet below the waterline was used for all ENR and ENR+AC placement. Equipment specifications for the excavator are shown in the table below.

Excavator Specifications	
Make	Hitachi
Model	EX 1200-6
Year	2015
Net Power	760 Horsepower
Operating Weight	265,000 pounds
Boom/Stick, Length	Jewell, 70 feet

3.1.2 Positioning Equipment

The Contractor's excavator was equipped with eTrac inclinometers on the boom and clamshell bucket, on-board monitors, and a computer operating Hypack & DredgePack 2016 software. In addition to the above sensors, two GPS antennae mounted on the rear of the excavator provided positioning and directional data. An electronic tide gauge was used to determine the real-time water surface elevation during the work. The tide gauge was installed in the vicinity of each plot during placement at that plot, resulting in the tide gauge being located within 1,000 feet of the plot where placement was occurring.

Navigation control was provided using a Topcon Hyper-V RTK base station located at one of the temporary control points established near each placement area.

3.1.3 Bucket

A modified 5-yard Young Environmental clamshell bucket was utilized for placement of all ENR and ENR+AC material. The bucket was modified to reduce its capacity to the equivalent of approximately 4.5 inches (11.4 centimeters [cm]) of material over the footprint of the open bucket by welding baffles inside the bucket (Attachment 2, Photos 7 and 8). In addition to reducing bucket capacity, the baffles also helped distribute the material more evenly over the bucket footprint.

Equipment specifications for the clamshell bucket are shown in the table below.

Bucket Details			
Bucket Type	**Capacity**	**Open Footprint**	**Manufacturer**
Environmental Clamshell	5 cubic yards	12 feet by 7.2 feet	Young

3.1.4 Barges

Three barges were used to complete the in-water work: one spud barge as a work platform, and two materials barges to transport the ENR and ENR+AC materials to the study plots.

3.1.4.1 Spud Barge

The Contractor's spud barge (Web) was used as the working platform for all of the ENR and ENR+AC material placement activities. The barge measured 142 feet long by 58 feet wide and 13 feet deep. The barge drafted approximately 8 feet with all equipment onboard.

3.1.4.2 Material Barges

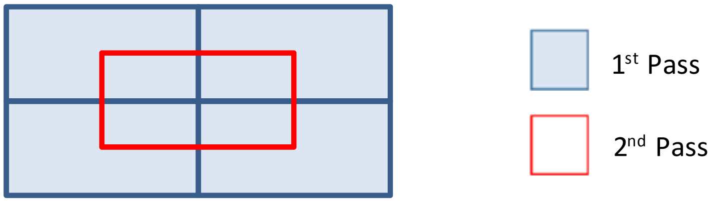
ENR and ENR+AC materials were transported by two identical materials barges named KP-2 and KP-3. Each barge measures 180 feet by 50 feet. The barges had concrete wear decks and 5-foot-high steel-bin walls around the perimeter.

3.1.5 Equipment Testing

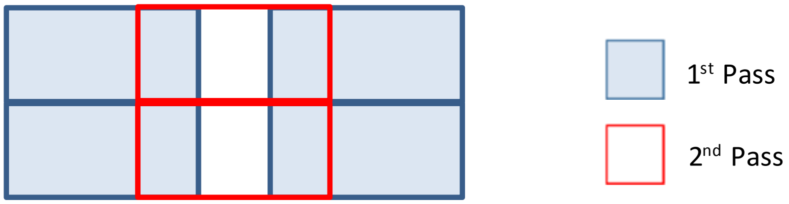
Prior to the in-water placement demonstration of the ENR+AC material, the Contractor performed several test placements of sand ENR material (in the dry) on their dock to test the equipment and placement patterns (see Attachment 2, Photos 9 to 14). Two different placement patterns were tested with dry material, being cognizant that the in-place material density once saturated would increase by approximately 20 to 25% from previous experience. The first pattern was an offset overlapping bucket pattern as detailed in the Specifications. As the bucket opened, an initial surge of material was observed leaving the bucket, with a slower rate of escapement as the bucket opened and a final surge of material as the bucket reached its maximum open position. This pattern resulted in a hummocky surface, with in an average thickness of approximately 14 inches (35.6 cm).

Based on results of the first test pattern, a second pattern was developed using a modified overlapping bucket pattern. This pattern was intended to locate the initial and final surges of material to fill in the thinner placement areas within each bucket footprint that occurred between material surges. This pattern produced an average thickness of approximately 10 inches (25.4 cm).

The two placement patterns are shown below.



Overlapping Bucket Placement Pattern as Detailed in the Project Specifications
(Placement two buckets thick in overlap pattern was extended to or beyond limits of the plots.)



Modified Overlapping Bucket Placement Pattern
(Placement two buckets thick in overlap pattern was extended to or beyond limits of the plots.)

3.2 ENR AND ENR+AC PLACEMENT SUMMARY

For the duration of the project, the Contractor worked 10-hour days, 5 days a week (Monday through Friday). A total of 39 working days were required to complete the placement of all plots, including 2 days for the demonstration placement. Performance metrics similar to those used for dredging projects were tracked during the placement of ENR and ENR+AC materials. These metrics included effective and non-effective working time. Effective working time (EWT) is the time during which the floating plant is actively placing ENR or ENR+AC material. Non-effective working time (NEWT) is the time during which the floating plant is operational but not placing ENR or ENR+AC material. Examples of activities that result in non-effective working time are stepping or relocating the floating plant, fleeting the material barge, standing by for marine traffic or bathymetric survey, maintenance, and minor operating repairs. The EWT for the duration of the project was approximately 46%. Over the duration of the project, approximately 3,300 buckets of material were placed in the waterway, for an average cycle time of about 3.25 minutes per bucket. Cycle times for this pilot project were determined using the bucket marks tracked by DredgePack. Each bucket mark in DredgePack had a time, date, and elevation recorded each time the operator placed a bucket. Cycle times were determined by calculating the difference in time between buckets. Cycle times that included NEWT were excluded in the calculation of average cycle time.

Cycle times are higher than what would typically be expected for an ENR project due to the comparatively precise thickness tolerances specified for the ENR layers to accommodate the intensive monitoring component of the pilot study (e.g., SPME placement and comparisons between two subplots).

Prior to placement, all ENR+AC was soaked (Attachment 2, Photo 16) for a minimum of 12 hours to saturate the AC material. Each barge load of the ENR+AC material took between 2 and 3 hours of controlled flooding of the material bin to submerge the material while at the same time limiting segregation of the ENR and AC material while water was being pumped into the bin. While the water was being pumped into the barge, the excavator leveled the material, flattening the windrows that were formed during the loading process. The ENR material without the AC was also soaked prior to placement, but did not have the 12-hour soaking period requirement.

Once the ENR or ENR+AC material was ready for placement, the floating plant (Web barge) and material barge were moved into position by tugboat using the onboard digital GPS (DGPS) system for guidance. The barges were then held in place by two spuds on the Web barge. Spuds are square, approximately 3.5 feet on each side, with a diagonal measurement of approximately 5 feet. The barge position was adjusted many times by lifting one spud and rotating the barge on the other spud (spud rotates within the mud). Typical spuds are not perfectly straight up and down and when the barge rotated on a spud it was assumed that the hole in the waterway floor was approximately 6 feet in diameter. The spud locations in and near each plot were tracked and are shown on Figures 3 through 5. The spuds were never placed in an area where ENR or ENR+AC material had already been placed. The number of times the spuds were placed within each plot was also limited to the extent practicable.

A bucket placement grid was loaded into the DredgePack software prior to the start of placement for each plot. The operator guided the excavator bucket into position for placement using the DredgePack software. A monitor mounted in the excavator operator’s cab showed the location of the bucket in relation to the plot and its elevation above the mudline in near real-time.

To place material in each plot, the operator retrieved approximately 1.2 cubic yards of saturated ENR or ENR+AC material from the material barge, based on a predetermined fill depth within the bucket. The operator then positioned the bucket in the water approximately 2 feet above the mudline and within the placement grid location preloaded into the DredgePack software. The operator then marked the bucket placement location in DredgePack (Attachment 2, Photo 17). DredgePack in turn recorded the coordinates, elevation, and time of placement for each bucket. The marked bucket placement locations in relation to the placement grid for the plots are shown on Figures 5 through 7.

Weekly construction reports are provided in Attachment 6.

3.2.1 In-Water Demonstration Placement

The Contractor performed two test placement demonstrations, one with the sand ENR+AC and one with the gravelly sand ENR+AC. The placement demonstrations occurred on November 29 and 30, 2016. The demonstration test plots were located in the designated intertidal test plots shown in the project plans and on Figure 6. The first placement pattern tested on the dock (Section 3.1.5) and detailed in the Specifications was used for the first day of demonstration placements. This method was chosen even though the modified placement pattern produced better on-land results because it was unknown if submerging the material would decrease the thickness placement. Moreover, even if over-placement still occurred, the pattern could be modified.

On the first day of the demonstration placement, sand ENR+AC was placed on two-thirds of the sand ENR+AC test plot, and gravelly sand ENR+AC was placed on one-third of the gravelly sand ENR+AC test plot. The remaining areas within each test plot were to be used to test modifications to the placement pattern or bucket fill factor as deemed necessary based on results of visual inspection performed during low tide after the first day's demonstration placement. The visual inspection was performed by the construction management team with representatives from the U.S. Army Corps of Engineers (USACE) and LDWG present. Results of the visual inspection are detailed in Section 3.4.1. Based on the inspection it was determined that the original placement pattern and fill factor as detailed in the project specifications would be used for the remainder of the demonstration placement.

In shallower areas where the bucket was not fully submerged during test placement, large amounts of material were observed exiting the bucket all at once after the bucket was fully open. It is believed this surge was caused by a vacuum that formed when the material was packed into the corners where the baffles and bucket walls meet, causing the bucket to release material inefficiently into the water column. To relieve the effects of the vacuum, vents were cut in the baffle plates allowing the bucket to vent freely (Attachment 2, Photo 15). The Young environmental bucket already had vents installed at the top of the bucket, so modifications to the bucket itself were not necessary. Material appeared to leave the bucket more efficiently after venting of the baffles was completed.

3.2.2 Intertidal Plot

Placement in the Intertidal plot occurred between December 1, 2016, and December 19, 2016. Bathymetric surveys were performed daily during material placement. Water quality monitoring occurred during at least 2 days in each Intertidal subplot and is detailed in Section 3.3.1.

Effective working time for the intertidal plot was approximately 39%. Four events (day of pumping water, alternator failure on excavator, waiting for additional ENR material, and demob from plot) had a significant impact on overall EWT.

3.2.2.1 ENR+AC Subplot

Placement in the ENR+AC subplot started on December 1, 2016, and was completed on December 15, 2016. The initial load of ENR+AC material designated for the subplot ran out before a full two-pass coverage had been completed over approximately 10% of the subplot. Approximately 60 additional tons of ENR+AC material from barge load No. 3 was used to complete the subplot. The shortage of material was caused by over-placement and placement of one lift of material approximately one-half bucket in width which extended outside the perimeter of the subplot. The same operator and placement method were used to place the ENR+AC material in both the successful demonstration test plot and the intertidal subplot. Upon discovery of over-placement in the ENR+AC subplot, the operator slightly reduced the fill factor in the bucket to limit over-placement. In addition, the number of buckets that extended one-half bucket width outside of the subplot were reduced as practicable to still achieve a uniform thickness and coverage over the entire subplot to meet project requirements. Approximately 1,235 tons of the ENR+AC material was placed in the intertidal ENR+AC subplot. The average bucket cycle time in the ENR+AC subplot was approximately 3.1 minutes.

3.2.2.2 ENR Subplot

The ENR subplot was started on December 8, 2016 prior to completion of the ENR+AC subplot. As described in Section 3.2.2.1, additional material was required to complete the ENR+AC plot; therefore, while additional ENR+AC material was being delivered to the site, placement at the ENR plot was started. Material placement was scheduled to be completed on December 16, 2016, but was not completed until December 19, 2016, due to a shortage of material. The shortage of material was caused by over-placement over the first half of the subplot and denser than necessary bucket placement pattern. The over-placement was not recognized until after results of the December 12, 2016, hydrographic survey were received at the end of shift on December 13, 2016, at which point more than half of the subplot placement had been completed.

The operator was using the same modified placement methods used in the ENR+AC subplot to reduce the fill factor. It is unknown why the fill factor increased with the ENR material versus the ENR+AC material. During placement of the material for the pilot study, the operator grabbed material from a flooded material barge where the operator could not see the top of the material being taken with the bucket. The operator adopted the procedure to reduce over-placement by filling the bucket and then cracking open the bucket above the water while still in the barge to confirm the correct fill factor.

Data from the bathymetric surveys performed after modifying the placement process indicated that the adjustment in fill factor was producing a thickness closer to 9 inches (22.9 cm); while reducing the area in which more than 12 inches (30.5 cm) of material had been placed. The initial quantity of ENR material ran out with approximately 10% of the subplot not having any ENR material placed. Barge load No. 2, which was designated for the scour subplot, had an additional 200 tons of ENR material loaded on to it. This material was used to complete the intertidal ENR subplot. Approximately 1,366 tons of ENR material was placed in the ENR subplot. Average cycle time in the ENR subplot was approximately 2.7 minutes.

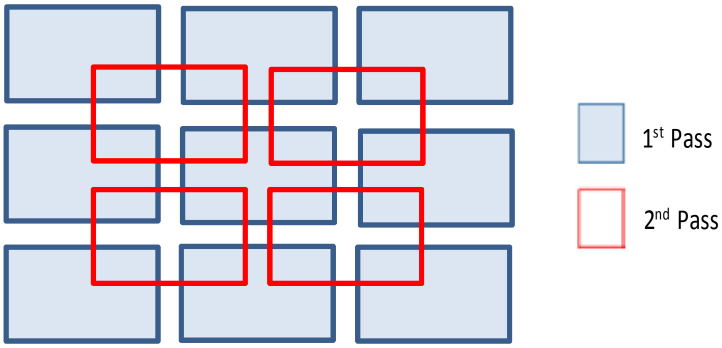
3.2.3 Scour Plot

Placement in the scour plot took place between December 20, 2016, and January 6, 2017. Bucket placement locations are shown on Figure 7. Bathymetric surveys were performed daily during material placement. Water quality monitoring occurred for a minimum of 2 days in each scour subplot, as detailed in Section 3.3.2.

Effective working time for the scour plot was approximately 46%. The average EWT for the ENR+AC subplot was approximately 43%. The average EWT for the ENR plot was approximately 51%. The lower EWT for the ENR+AC subplot can be primarily attributed to the extra time it took to manage the stockpile of material within the barge bin walls to reduce the amount of listing of the barge. The barge would list, exposing the ENR+AC material, making it difficult to keep the material saturated during construction.

The river bed within the scour plot consisted of softer grained material that allowed the Web barge's spuds to penetrate up to 20 feet below the mudline in both subplots. In many cases, the spud winches were locked, keeping the spud wire in tension to prevent the spud from penetrating deeper. Spudding down into the soft material allowed the barge to move more than when the barge was spudded down in the firmer sediments of the intertidal area. Also, when bringing the spuds up, the river current and/or the tugboat would drag the spuds through the sediment before they had cleared the mudline, disturbing a larger area than the spud itself.

The placement grids for both scour subplots were modified based on observations during material placement in the intertidal subplots. The bucket spacing was increased, providing approximately 1 foot in all directions between each target bucket placement location, as shown in the figure below. This new grid pattern helped to reduce the total area where more than 12 inches (30.5 cm) of material was placed while also leaving no areas with less than 4 inches (10.2 cm) of material, based on comparing the pre-placement bathymetric survey and the as-built bathymetric survey.



Modified Bucket Placement Pattern Used to Help Reduce Over Placement
(Placement two buckets thick in overlap pattern was extended to or beyond limits of the plots.)

3.2.3.1 ENR+AC Subplot

Material placement in the ENR+AC subplot was started on December 20, 2016, and completed on December 28, 2016. Approximately 1,085 tons of ENR+AC material was placed in the subplot. Approximately 110 tons of excess ENR+AC material remained after the subplot placement was completed. The excess material was then placed in spud holes within the subplot that were created prior to ENR+AC placement (as requested by EPA and USACE) and in the designated additional material placement area adjacent to the subplot. Figure 7 identifies 25 bucket placement locations where the excess ENR+AC material was placed within the subplot and 38 placement locations within the designated excess material placement area. Average cycle time in the ENR+AC subplot was approximately 3.6 minutes. Cycle times in this plot were greater than the cycle times at the Intertidal plot due to a combination of working in deeper water and the learning curve needed after changing of excavator operators.

3.2.3.2 ENR Subplot

Material placement in the ENR subplot was started on December 29, 2016, and was completed on January 6, 2017. A total of 1,090 tons of ENR material was placed in the subplot.

Approximately 70 tons of excess ENR material remained after the subplot placement was completed. The excess material was then placed in spud holes (as requested by EPA and USACE) and other areas in the subplot that appeared to have less than 4 inches (10.2 cm) of material based on the bathymetric survey performed on January 5, 2017. Figure 7 identifies the 35 bucket placement locations within the subplot where additional ENR material was placed. Average cycle time in the ENR subplot was approximately 3.2 minutes.

3.2.4 Subtidal Plot

Placement in the subtidal plot took place between January 9, 2017 and January 26, 2017. Bucket placement locations are shown on Figure 8. Bathymetric surveys were performed daily during material placement. Water quality monitoring occurred for at least 2 days in each subtidal subplot and is detailed in Section 3.3.3.

Effective working time for the subtidal plot was approximately 52%. The EWT for the ENR+AC and ENR subplots were within 1% of each other.

The placement grids for both subtidal subplots were modified based on the intertidal placement results. The bucket spacing was increased to provide less than 1 foot of space in all directions between each target bucket placement location, as shown above. It is believed that the grid pattern helped minimize the total area with over-placement of material.

Because the subtidal plot was located within the authorized navigation channel, the tug captain was in constant contact with Seattle marine traffic and coordinated directly with other tug captains on the waterway so that placement operations would not impede vessel traffic on the waterway. Operations were impacted by river traffic a total of 10 times, for a total delay of approximately 5.4 hours of non-effective working time due to marine traffic over the duration of the subtidal plot placement. However, on many other occasions barge traffic was able to navigate around where placement was occurring to the east. This ability to avoid placement operations was possible only when no barge was docked at the CalPortland or J.A. Jack & Sons facilities located on the eastern shore of the waterway.

Marine traffic is believed to have affected the ENR and ENR+AC material after placement in the subtidal plot. Several barges were observed passing over or near the plot with tow bridles hanging from the bow into the water. Several barges moored upstream of the plot were moved between shifts, and they may have had bridles hanging from their bows (Attachment 2, Photos 32, 33, and 34) into the waterway as they moved up or down the waterway.

3.2.4.1 ENR+AC Subplot

Placement in the ENR+AC subplot started on January 9, 2017, and was completed on January 19, 2017. A total of 1,302 tons of ENR+AC material was placed in the subplot. Hydrographic surveys were performed daily during material placement.

During placement in the ENR+AC subplot, several heavy rain events resulted in higher than predicted water elevations throughout the week of January 16, 2017. The deeper depths make it difficult to effectively reach the required elevation above mudline to place material. Additional movements and spudding down were required to position the barge and excavator for material placement during this time, as the horizontal reach from each spud position was reduced. Operations had to be stopped several times due to water levels that were too high and prevented the bucket from reaching the target elevation above the mudline before placement.

Approximately 180 tons of ENR+AC material remained after the initial subplot placement was completed. The excess material was then placed in spud holes and other areas in the subplot that appeared to have less than 4 inches (10.2 cm) of material based on the bathymetric survey performed on January 18, 2017. Figure 8 identifies the 95 bucket placement locations within the subplot where additional ENR+AC material was placed. Average cycle time in the ENR+AC subplot was approximately 3.7 minutes.

3.2.4.2 ENR Subplot

Material placement in the ENR subplot started on January 20, 2017, and was completed on January 26, 2017. A total of approximately 1,160 tons of ENR material was placed in the subplot. Approximately 140 tons of the total 1,300 tons of ENR material remained after the initial subplot placement was completed. The excess material was then placed in spud holes and other areas in the subplot that appeared to have less than 4 inches (10.2 cm) of material based on the bathymetric survey performed on January 25, 2017. Figure 8 identifies the 74 bucket placement locations within the subplot where additional ENR material was placed. Average cycle time in the ENR subplot was approximately 3.1 minutes.

3.3 WATER QUALITY MONITORING

Water quality monitoring was conducted as required by EPA’s Clean Water Act §401 Substantive Water Quality Requirements Memorandum (EPA, 2016) and as described in the Water Quality Monitoring Work Plan (Amec Foster Wheeler et al., 2015b). Prior to the start of water quality monitoring for the pilot study, the water quality instrument (a YSI Model 6820 data sonde with an optical turbidity probe) was calibrated using the manufacturer’s recommended procedures (see Attachment 7). The calibration was rechecked at 1-month intervals. In addition, prior to each round of water quality monitoring, the pressure (depth) transducer was calibrated to compensate for the contemporaneous barometric pressure.

Water quality monitoring was initiated on November 29, 2017, at the intertidal demonstration plots. Attachment 7 includes summaries of the water quality monitoring results for each day of monitoring and the field data sheets for each monitoring round. Water quality compliance monitoring was conducted for a minimum of 1 hour after the start of material placement.

Prior to the start of material placement at the demonstration placement test plots, the USACE representative requested that a round of water quality monitoring be conducted to establish baseline conditions. A round of water quality monitoring was conducted using the procedures outlined in the Water Quality Monitoring Work Plan (Amec Foster Wheeler et al., 2015b). The turbidity results upstream and downstream of the construction barges were similar to the turbidities measured at the ambient station located on the west side of the waterway and upstream of the test plots.

One or more rounds of water quality monitoring were conducted on 16 days (for a total of 32 full or partial rounds of monitoring). Exceedances of the turbidity criterion (an increase of 5 nephelometric turbidity units [NTU] over the ambient turbidity at the 150-foot compliance stations) occurred during 10 of the 32 rounds of monitoring. The construction management team was informed of the results of each round of monitoring immediately following completion of the round. Additional monitoring was conducted following each round of monitoring with a turbidity exceedance to determine the lateral extent of the resulting turbidity plume or to determine the persistence of the plume. When the turbidity exceedances occurred, the EPA Project Manager and the EPA Water Quality Specialist were informed as soon as possible. The monitoring activities and results for each of the study plots are summarized below.

3.3.1 Demonstration Plots and Intertidal Plot

Elevated turbidity readings were expected at the demonstration and the intertidal test plots given the nature of the material being placed (a washed sand/gravel material) and the shallow water depth. Even though the ENR material was washed, enough residual fines appeared to be present in the material to create turbidity exceedance. At Boeing Plant 2, Slip 4, Diagonal/Duwamish, and other projects on the LDW, washed material was used as backfill, and elevated turbidities were also observed during placement. Based on these observations, turbidity exceedances were expected during placement of ENR material in the waterway, and especially during placement in shallow water.

Turbidity exceedances occurred during eight monitoring rounds while placing the sand/gravel ENR+AC and the sand/gravel ENR material in the demonstration plot and the intertidal plot. The bed elevation of the demonstration and intertidal test plots was between approximately +5 feet MLLW and -4 feet MLLW. Due to the elevation of the intertidal plot, material placement and water quality monitoring were conducted in water depths that were generally less than 15 feet and at times in water depths that were less than 8 feet. Visible turbidity plumes were regularly observed during intertidal material placement. During placement of the ENR+AC material, black AC material was periodically noticeable on the water surface.

During material placement operations when a turbidity plume was readily visible or when measured turbidity exceedances occurred at 150 feet from the placement activities, the turbidity plume was also apparent at 300 feet and occasionally extended to 450 feet from the placement activity. Visible turbidity plumes always extended downstream from the material placement and appeared to be consistently confined to a narrow band either directly downstream of the material placement or along the shoreline.

After the initial week of monitoring, the EPA representative directed that if a turbidity exceedance occurred at a compliance station (150 feet from the placement activity), then monitoring would also be conducted at the 300-foot station. If the turbidity at the 300-foot station was also above the turbidity compliance criterion, then material placement would be stopped until the turbidity at the 150-foot compliance station dropped below the turbidity threshold. If the turbidity at the 300-foot monitoring station was below the turbidity threshold, then material placement could continue with additional monitoring rounds conducted to confirm that the turbidity at 300 feet remained below the turbidity threshold.

Placement of material was temporarily halted three times during the first week of water quality monitoring and an additional three times during the second week following an exceedance of the turbidity criterion (Attachment 7). Work was suspended for variable lengths of time (from 13 minutes to 68 minutes). The total length of time that material placement was suspended included time for the turbidity to dissipate and additional time for opportunistic barge movements and survey activities.

3.3.2 Scour Plot

Monitoring was conducted for 3 days at the scour test plot during placement of gravelly sand ENR+AC material. Slight exceedances of the turbidity criterion occurred at the 150-foot compliance station during the second day of monitoring; however, the turbidity at 300 feet from material placement was below the turbidity compliance criterion, and material placement was allowed to continue. Water quality monitoring using the data sonde was suspended after 3 days with the approval of EPA and visual monitoring for turbidity plumes was started. Additional rounds of turbidity monitoring were not conducted during the remaining placement of sand/gravel ENR+AC and sand/gravel ENR material at the scour plot per the Water Quality Monitoring Work Plan (Amec Foster Wheeler et al., 2015b).

3.3.3 Subtidal Plot

Monitoring was also conducted for 3 days at the subtidal test plot during placement of sand ENR+AC material. No exceedances of the turbidity criterion were observed but intermittent plumes of AC were noted on the water surface during monitoring on January 9, 2017. Water quality monitoring using the data sonde was suspended after 3 days with the approval of EPA and visual monitoring for turbidity plumes was started. Additional rounds of turbidity monitoring were not conducted during the placement of the remaining sand ENR+AC and sand ENR material at the subtidal plot per the Water Quality Monitoring Work Plan (Amec Foster Wheeler et al., 2015b).

3.4 POST-PLACEMENT INSPECTIONS AND MEASUREMENTS

Visual inspections and measurements were performed following placement in each of the test and demonstration plots to assess conformance with project specifications as described in Table 5.

3.4.1 Sand and Gravely Sand ENR+AC Demonstration Test Plots

Construction management representatives performed visual inspections of the demonstration test plots, measured grade stakes to determine placed thickness, and took photos of the placed material during low tide after each demonstration placement. After performing the visual inspections and stake measurements for each plot after the first day of demonstration placement, it was determined that no additional testing or modifications were necessary and plot placement should proceed. Figure 9 identifies the stake locations and associated thickness measurement at each location for both demonstration plots.

3.4.1.1 Sand ENR+AC Demonstration Test Plot

The plot had a slightly hummocky topography without any high spots standing out from other high spots. Of the 24 thickness measurements in the plot, only two stake locations had less than 4 inches (10.2 cm) of material. Both of these locations had 3 inches (7.6 cm) of material. A maximum thickness of 12 inches (30.5 cm) was measured at one location. The average thickness of the placed materials was 7 inches (17.8 cm). Table 6 summarizes the measurements at each location.

3.4.1.2 Gravelly Sand ENR+AC Demonstration Test Plot

The plot had a slightly hummocky topography without any excessive high spots. All 24 thickness measurements in the plot were within the 4- to 12-inch (10.2- to 30.5-cm) target. The maximum and minimum thicknesses measured were 11 inches (28.0 cm) and 5 inches (12.7 cm), respectively. The average thickness of the placed materials was 8 inches (20.3 cm). Table 7 summarizes the measurements at each location.

3.4.2 Intertidal Plot

Prior to placement of ENR/ENR+AC material at the intertidal subplots, grade (confirmation) stakes were placed by foot during low tidal events (as described in Section 2.2.1.4) at locations shown in

Figure 9. Following completion of construction, construction management representatives took advantage of low tides at night and performed a visual inspection of the intertidal plots grade stakes to measure and document placed material thickness on December 13, 15, and 27, 2016 (1 to 8 days following completion of construction). In addition, shallow cores (12-inch [30.5-cm] depth) were collected as part of the Year 0 monitoring at 18 locations within each plot. Additionally, estimates of the placed material thickness at each location were made during core collection and retrieval or from the stratigraphy of the collected cores.

3.4.2.1 Gravelly Sand ENR+AC Subplot

Similar to the demonstration test plots, the gravelly sand ENR+AC intertidal subplot had a slightly hummocky topography without any high spots standing out from other high spots. All but one of the stake thickness measurements were within the target thickness of 4 to 12 inches (10.2 to 30.5 cm), with the one location measuring 14 inches (35.6 cm). The minimum thickness measured was 6 inches (15.2 cm) and the average thickness of the placed materials was 9.7 inches (24.6 cm). Thickness measurements are summarized in Table 8 and shown on Figure 10.

Triplicate SPI images were taken approximately 27 days after construction completion at 12 locations (n=36) within the intertidal ENR+AC subplot (Attachment 5). At all stations and all replicates the thickness of the ENR+AC material exceeded the prism penetration depth. Prism penetration depths ranged from 2.2 inches (5.5 cm) to 4.3 inches (10.8 cm) and the average prism penetration depth was 3.1 inches (8.0 cm).

During visual inspection of the subplot, it was noted that a thin veneer of fine AC material was present over parts of the subplot as well as upstream and downstream of the subplot. It was also noted that when submerged ENR+AC material was disturbed, fine-grained AC particles were suspended in the water column and even floated to the surface. These particles remained suspended in the water column for some period of time (Attachment 2, Photo 27).

Construction management representatives also noted the observance of objects that appeared to look like rounded rock on and near the subplot. Upon further investigation, these rock-shaped objects appeared to be collections of fine-grained AC with soft-grained sediment adhering to the outer perimeter. These rock-shaped objects ranged in size from 1- to 2-inches (2.5- to 5.1-cm) in diameter up to 8- to 10-inches (20.3- to 25.4-cm) in diameter. The larger objects were generally found downgradient from the shoreline, and smaller objects were congregated in depressions in the riverbed (Attachment 2, Photo 28).

3.4.2.2 Gravelly Sand ENR Subplot

Similar to the demonstration test plots, the ENR intertidal subplot had a slightly hummocky topography without excessive high spots. The measured thickness was greater than 12 inches (30.5 cm) at four measurement locations. These four locations are all located in the upstream half of the subplot area, where placement occurred before the bucket fill factor was adjusted. The maximum and minimum thicknesses measured were 14 inches (35.6 cm) and 8 inches (20.3 cm), respectively. The average thickness of the placed materials was 10.9 inches (27.7 cm). Thickness measurements are summarized in Table 9 and shown on Figure 10.

Triplicate SPI images were taken approximately 23 days after construction completion at 12 locations (n=36) within the ENR subplot (Attachment 5). Prism penetration depths ranged from 2.1 inches (5.4 cm) to 5 inches (12.6 cm) and the average prism penetration depth was 2.9 inches (7.45 cm). The thickness of the ENR material exceeded the prism penetration depth in all images except for a single replicate that showed a thin incomplete veneer of ENR over the native fine-grained sediments.

3.4.3 Scour Plot

Prior to placement of ENR/ENR+AC material at the scour subplots, grade (confirmation) stakes were placed by divers (as described in Section 2.2.1.4) at locations shown in the project documents. Fifteen grade stakes were placed in each subplot by divers, with observations regarding significant bottom conditions recorded. Within the scour plot, 24 of the 30 confirmation stakes were installed with a stinger extension (as described in Section 2.2.1.4) due to soft sediment conditions reported by divers during installation. Installation of grade stakes occurred on December 12 and 13, 2016. ENR/ENR+AC thickness readings in each subplot were taken on January 9, 2017, 3 to 12 days after construction completion.

3.4.3.1 Gravelly Sand ENR+AC Subplot

During placement of grade stakes, sediment varied from cobbles, gravel, and/or sand at the edge of the subplot nearest E Dock at the Harbor Island Marina where tugs are berthed, to soft silt throughout the rest of the subplot. During grade stake measurements, divers reported that the topography of the ENR+AC subplot was mostly relatively flat, with isolated ridges of material up to several feet high. These ridges were attributed to material displaced by the barge’s spuds prior to material placement. The maximum and minimum thicknesses measured were 13 inches (30.0 cm) and 7 inches (17.8 cm), respectively. Average thickness of placed ENR+AC material was 9.5 inches (24.1 cm). Thickness measurements are summarized in Table 10 and shown on Figure 11.

Triplicate SPI images were taken at 12 locations (n=36) within the scour ENR+AC subplot 19 days after construction (Attachment 5). The ENR+AC material was observed at all stations and all replicates. The ENR+AC was present at thicknesses that exceeded the prism penetration depth at all locations and all replicates except for a single replicate; at this location the thickness of the ENR+AC material was 3 inches (7.5 cm) over fine-grained native sediments. The other two replicate images at the location had thicknesses of ENR+AC material greater than the prism penetration depth. Prism penetration depths ranged from 2.6 inches (6.5 cm) to 7.5 inches (19.1 cm) and the average prism penetration depth was 3.9 inches (9.9 cm). It should be noted SPI locations were not collocated with the stake locations; therefore, there may be differences between SPI observations and stake measurements.

3.4.3.2 Gravelly Sand ENR Subplot

During placement of grade stakes in the ENR subplot, divers reported that sediment was a soft silt, which warranted extenders be placed on all grade stakes in this subplot. During post-placement measurement of the grade stakes, divers reported that the ENR scour subplot topography was more hummocky than what was observed at the ENR+AC subplot. Two of the 15 grade stakes placed in the ENR subplot were not located by the divers. At these locations, a hand probe was used to measure placed ENR thickness. Of the 15 locations in the subplot, 6 had a measured ENR thickness greater than 12 inches (30.5 cm; maximum thickness of 18 inches [45.7 cm] measured with a hand probe). The minimum thickness was 7 inches (17.8 cm) and the average thickness of the placed ENR material was 11.5 inches (29.2 cm; Table 11 and Figure 11).

Triplicate SPI images were taken at 12 locations (n=36) within the scour ENR subplot 10 days after construction completion (Attachment 5). The ENR+AC material was observed at all stations and all replicates in thicknesses that exceeded the prism penetration depth. Prism penetration depths ranged from 2.4 inches (6.2 cm) to 6.5 inches (16.4 cm) and the average prism penetration depth was 3.9 inches (9.9 cm).

3.4.4 Subtidal Plot

Prior to material placement, during deployment and attempted retrieval of the solid-phase microextraction sampler for baseline sampling at the subtidal plot, divers reported that the waterway bottom appeared to be disturbed, with furrows and ridges on the order of 1- to 1.5-feet oriented parallel to the river flow. The suspected cause of these furrows and ridges were oceangoing barges dropping their tow bridles prior to being pushed by tugs up the waterway. Under the approved Addendum 1 of the CQAPP it was determined that the use of grade stakes, as was done for the intertidal and scour plots, would not be practicable.

Instead, prior to material placement, divers performed qualitative, visual observations regarding the pre-placement condition of the plot regarding roughness, signs of recent disturbance, and other physical characteristics that could affect material placement (Attachment 8). These observations were made at each of the locations shown in the project plans where grade stakes were to be placed within the subtidal plot. During the pre-placement inspection, divers noted that during the outgoing tide, river velocity increased to an extent that fine sediment on the bottom of the waterway would become suspended and transported, effectively reducing visibility in this plot. This decreased visibility due to resuspension of sediment was not observed at the scour plot. Upon completion of ENR/ENR+AC placement, each of these locations was revisited by a diver for a second qualitative visual inspection (Attachment 9). In addition, during the post-placement inspection, divers used a hand probe to measure the thickness of ENR/ENR+AC material based upon material type differences detectable to the diver (see Section 3.4.4.1 below). This method may have biased high the depth measurements as it is difficult to precisely know when the change in resistance representing the boundary with native sediments is first noticed.

Pre-placement visual inspection of the subtidal plot occurred on January 4 and 5, 2017 (Attachment 8). Post-placement visual inspection of the subtidal subplot occurred on January 30 and 31, 2017 (Attachment 9). As part of the post-placement summary, data from the U.S. Coast Guard Navigation Center Automated Identification System for the period of plot construction was requested and reviewed for vessel traffic across the subtidal plot from January 9 – 26, 2017 (Attachment 10). The figures show that over the 14-day placement period, 91 non-project related vessels transited over the subtidal plot, demonstrating that the subtidal plot area is subject to a significant amount of vessel traffic, which may play a role in the pilot data observations of the disturbed waterway bottom. Additionally, estimates of the placed material thickness at each location were made during core collection and retrieval or from the stratigraphy of the collected cores.

3.4.4.1 Sand ENR+AC Subplot

During the pre-placement inspection, divers observed that the bottom sediments were disturbed at 9 of the 15 inspection locations within the ENR+AC subplot. These disturbances were typically furrows or ridges up to a half foot in height and oriented parallel with the navigation channel. During the post-placement inspection (11 to 12 days after construction completion), no ridges or furrows were observed by the diver, but one hummock (mound) was observed while the diver was traveling between stations in the ENR+AC subplot. At one location within the subplot, the diver reported fine-grained carbon at the surface of the sand. Fine-grained sediment, assumed to be from the waterway and not placed, was observed at two locations. Using a hand probe, the average thickness of ENR+AC in this subplot was 13.7 inches (34.8 cm) with no measurements less than 11 inches (27.9 cm); however, 13 of the 15 locations had measurements of 13 inches (33.0 cm) or more with a maximum thickness of 16 inches (40.6 cm; Table 12 and Figure 12).

Triplicate SPI images were taken at 12 locations (n=36) within the subtidal ENR+AC subplot 13 days after construction (Attachment 5). The thickness of the ENR+AC material was greater than the prism penetration depth except for a single location. At this location, two of the three replicates showed sand ENR+AC material overlying fine-grained native sediments. The thickness of the ENR+AC material in these two replicates was 5.3 inches (13.5 cm) and 5.1 inches (13.0 cm). Prism penetration depths ranged from 2.6 inches (6.6 cm) to 8 inches (20.4 cm) and the average prism penetration depth was 4.3 inches (10.8 cm). As stated above, SPI locations were not collocated with the probe locations; therefore, there may be differences between SPI observations and stake measurements.

3.4.4.2 Sand ENR Subplot

During the pre-placement inspection of the subtidal ENR subplot, divers observed disturbed bottom sediments similar to those described at the ENR+AC subplot at 5 of the 15 locations in the subplot. During the post-placement inspection (4 to 5 days after construction completion), divers observed very shallow furrows on the order of less than 1 inch that may be remnants of pre-placement furrows. At Station 67 (see Figure 12), the diver was unable to discern a difference between the ENR material and underlying fine-grained sediment. At this location only, a Universal Core Head with a nominal 3-inch-diameter polycarbonate barrel was used to determine ENR thickness. At all other locations within the subplot, a hand probe was used to determine ENR thickness. Average ENR thickness within this subplot was 12.7 inches (32.3 cm), with a minimum thickness of 6 inches (15.2 cm) and a maximum thickness of 16 inches (40.6 cm). Of the 15 locations within the subplot, 9 locations had 13 inches (33.0 cm) or more of placed material (Table 13 and Figure 12).

Triplicate SPI images were taken at 12 locations (n=36) within the subtidal ENR subplot 6 days after construction (Attachment 5). The ENR material was observed in the profile images at all stations and all replicates in thicknesses that exceeded the prism penetration depth. Prism penetration depths ranged from 2.4 inches (6.1 cm) to 6.3 inches (16.0 cm) and the average prism penetration depth was 4.1 inches (10.5 cm).

3.5 YEAR 0 POST-CONSTRUCTION SAMPLING OF ENR+AC AND ENR MATERIALS

The Year 0 Data Package (Amec Foster Wheeler et al., 2018b) provides the validated results for grain size (ASTM D422), TOC (EPA Method 9060), and TVS (SM2540E). As described in the QAPP Addendum 3 (Amec Foster Wheeler et al., 2018a), the original BC testing method is no longer being used following the testing of barge material pre-placement (see Section 2.1.3). TVS was used during Year 0 sampling as an alternative to BC for measuring AC content in the plots. The TVS also allows for a consistent comparison of barge samples collected pre-placement with the Year 0 samples. As discussed in the QAPP Addendum 3, a larger instrument sample size is used with the TOC method for the Year 0 sampling event to address sample heterogeneity.

Sediment samples were collected within the ENR+AC and ENR subplots at the intertidal, scour, and subtidal plots. Hand cores were collected in the intertidal and scour plots. Samples in the subtidal plot were collected using a stainless-steel grab sampler. Sediments representing the ENR and the ENR+AC material were collected and air dried. Samples of the gravelly sand ENR material from the intertidal and scour plots were initially sieved to remove the coarser gravel fractions. The weight of the coarse fractions (No. 4 sieve and larger) and the weight of the finer fractions (less than the No. 4 sieve) were recorded. The size fraction passing the No. 4 sieve (sand, silt, and clay fractions) were retained for further analysis. Sediments from the subtidal plot were not pre-sieved prior to compositing and analysis because no gravel sized material was included in the ENR material at this plot.

Within each subplot sediments from three discrete sample groups (representing ‘A”, “B”, and “C”) were composited together to form the A, B, and C composite samples. The compositing scheme follows the procedures outlined in the QAPP (Amec Foster Wheeler et al., 2016b). The sample results are presented for TVS and TOC in Table 13, and for grain size in Table 15.

The laboratory results from the pre-sieved intertidal and scour plot samples were subsequently adjusted to account for the average weight of the gravel removed prior to TVS and TOC analysis (Table 14). In addition, the discrete samples from the ENR+AC subplots were analyzed for TVS and TOC to investigate variability within the subplots (Table 14).

In order to understand whether there was been a preferential loss of fine-sized AC during placement, in addition to TOC measured in the bulk sample, TOC was also measured in the material passing a No. 50 sieve (less than 300 microns) in the ENR+AC composite samples.

3.5.1 Intertidal Plot

Sediment core samples for TVS and TOC analysis were collected from the ENR+AC subplot 28 to 29 days after construction completion and from the ENR subplot 24 to 25 days after construction completion. The average TVS in the intertidal ENR+AC and ENR subplot composite samples was 2.6% and 0.51%, respectively. TVS in the discrete samples collected in the ENR+AC subplot ranged from 0.81 to 5%, with an average of 2.6%. TOC in the intertidal ENR subplot was undetected at a reporting limit of 0.1%, while TOC in the intertidal ENR+AC subplot averaged 1.8%

for the composite samples. TOC in the discrete samples collected in the ENR+AC subplot ranged from 0.87 to 3.4%, with an average of 2%.

In the ENR+AC subplot, TOC in the material passing the No. 50 sieve was 0.12%, 0.18%, and 0.21%, which was 7.3%, 8.4% and 15%, respectively, of the TOC in the bulk samples.

3.5.2 Scour Plot

Sediment core samples were collected from the ENR+AC subplot 20 to 26 days after construction completion and from the ENR subplot 11 to 17 days after construction completion. The average TVS in the scour ENR+AC and ENR subplot composite samples was 2.4% and 0.49%, respectively. TVS in the discrete samples collected in the ENR+AC subplot ranged from 1.3 to 3.3%, with an average of 2.4%. TOC in the scour ENR subplot was undetected at a reporting limit of 0.05%, while TOC in the scour ENR+AC subplot averaged 1.8% in the composite samples. TOC in the discrete samples collected in the ENR+AC subplot ranged from 0.62 to 2.5%, with an average of 1.8%.

In the ENR+AC subplot, TOC in the material passing the No. 50 sieve was 0.19%, 0.20%, and 0.26%, which was 9.2%, 13.3%, and 13.9%, respectively, of the TOC in the bulk samples.

3.5.3 Subtidal Plot

Sediment core samples were collected from the ENR+AC subplot 14 to 15 days after construction completion and from the ENR+AC subplot 7 to 8 days after construction completion. The average TVS in the subtidal ENR+AC and ENR subplot composite samples was 3% and 1.1%, respectively. TVS in the discrete samples collected in the ENR+AC subplot ranged from 2.1 to 3.5%, with an average of 2.9%. TOC in the subtidal ENR subplot was undetected at a reporting limit of 0.1% in two of the composite samples and 0.12% in the remaining composite sample. TOC in the subtidal ENR+AC subplot composite samples averaged 1.76%. TOC in the discrete samples collected in the ENR+AC subplot ranged from 1.05 to 2.98%, with an average of 1.93%.

In the ENR+AC subplot, TOC in the material passing the No. 50 sieve was 0.046%, 0.046%, and 0.072%, which was 2.6%, 2.9%, and 3.7%, respectively, of the TOC in the bulk samples.

4.0 CONCLUSION

Presented below is a discussion and summary of the construction and Year 0 sampling.

4.1 MATERIAL PLACEMENT SUMMARY

One of the goals of the ENR/AC pilot study is to verify that ENR amended with AC can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percent of AC in a placed layer) using stake (intertidal and scour plot) and probe (subtidal plot) measurements. Based on the observations throughout the placement process and inspections performed after the placement in each plot was complete, it was confirmed that the ENR+AC material can be successfully applied in the LDW.

The thickness of the placed material based on stake measurements at the intertidal and scour plots and probe measurement at the subtidal plot is presented in Tables 6 to 13, on Figures 8 to 11, and summarized below. Per the CQAPP, the goal for this pilot project was to place the material as uniformly as practicable while targeting a placement minimum thickness of 4 inches (10.2 cm) at approximately 100% of stake/probe locations per subplot and a placement thickness between 6 and 9 inches (15.2 and 22.9 cm) in 80% of stake/probe locations per subplot. Excluding the demonstration plots, based on the stake and diver probe measurements, the goal of a minimum thickness of 4 inches (10.2 cm) was met in all the test plots.

It should be noted that the supplemental SPI imagery information indicated that there may have been isolated locations where the thickness was less than 4 inches (10.2 cm). Of the SPI images collected across the 3 plots, 0.05% (4 out of 216) showed less than 4 inches (10.2 cm) of ENR or ENR+AC material. In most SPI images, the prism could not penetrate the full thickness of the ENR or ENR+AC material; therefore, the SPI was not useful as a supplemental tool for measuring the placed thickness of the ENR and ENR+AC material (note that this was not a designated use in the QAPP).

A summary of the stake and diver probe measurements are presented below.

Plot	Subplot	Average Thickness (Inches)	Minimum Thickness (Inches)	Maximum Thickness (Inches)	Percent Less than 6 Inches	Percent Between 6 and 9 Inches	Percent Greater than 9 Inches
Intertidal	ENR	10.9	8	14	0%	27%	73%
	ENR+AC	9.7	6	14	0%	47%	53%
	Combined	10.3	6	14	0%	37%	63%
Scour	ENR	11.5	7	18	0%	47%	53%
	ENR+AC	9.5	7	13	0%	53%	47%
	Combined	10.5	7	18	0%	50%	50%
Subtidal	ENR	12.7	6	16	0%	20%	80%
	ENR+AC	13.7	11	16	0%	0%	100%
	Combined	13.2	6	16	0%	10%	90%

The goal of 80% of the stake/probe measurements to be between 6 to 9 inches (15.2 and 22.9 cm) was not met, with the intertidal and scour plots having 37 to 50% of the measurements within the range of 6 to 9 inches (15.2 and 22.9 cm). At the ENR+AC subtidal plot all the measured thicknesses of material were greater than the 6- to 9-inch (15.2 and 22.9 cm) goal. The average thickness of the placed material in the intertidal, scour, and subtidal plots was 10.3, 10.5, and 13.2 inches (26.2, 26.7, and 33.5 cm), respectively. Based on the thickness of the material placed at the plots, the methods used to place the material in combination with the uneven, native surface sediment layer did not have the precision to meet the overly restrictive specifications despite the careful placement and equipment used. However, the material was placed with enough precision to allow for comparison between each area's subplots for the purposes of the Pilot Study.

4.2 AC CONTENT OF MATERIAL

The expected AC as measured by percent TVS in the ENR+AC gravelly sand subplots (intertidal and scour) was 2.7% based on the samples collected from each barge load (see Section 2.1.3). The table below shows the average TVS and average TOC measurements of the placed material in each of the subplots. The measured post-placement average percent TVS in the intertidal and scour ENR+AC subplots was 2.6 and 2.4%, respectively, indicating that there was little loss of AC during placement (these measurements are very close to the 2.7% measured in the barge samples). The expected percent TVS at the subtidal ENR+AC was 4.0% (based on samples from each barge load; see Section 2.1.3) and the average measured post-placement percent TVS was 3.0%. These data suggest that there was some loss of AC during placement or subsequent to placement but prior to Year 0 sample collection at the subtidal plot. The average TVS in the ENR only plots indicate minimal presence of some carbonaceous or inorganic carbonate material. The average TOC in the intertidal and scour ENR subplots was non-detected and at the subtidal ENR subplot was 0.11%. If TOC is used as surrogate method for AC, it appears that no AC from the intertidal and scour plot ENR+AC subplots was deposited in the ENR subplots. At the subtidal ENR subplot, TOC was only detected at a very low percent in one of three composite samples, indicating there was little or no deposition of AC from the ENR+AC subplot. The detectable TOC in the one sample may have been a result of deposition of riverine sediment that was observed during plot inspection.

As shown in the summary table below, in the intertidal and scour plots, 10.3% and 12.1%, respectively, of the total TOC was in the fraction passing the No. 50 sieve (the average percentage of TOC passing the No. 50 sieve [300 microns] to the average TOC). At the subtidal ENR+AC subplot, the average percent of the AC less than 300 microns was 3.1%, which is lower than both the intertidal and scour ENR+AC subplots. Although barge sample measurements of the average percentage of TOC passing the No. 50 sieve to average TOC were not made, the granulated activated carbon (GAC) manufacturer's grain size distribution can provide insight as to what could have been expected when the material was placed. Based on the grain size distribution of the GAC from the manufacturer, about 3% of the GAC was less than 300 microns (less than the No. 50 sieve). The 3.1% TOC at the sand subtidal plot is in the range of what would be expected based on the grain size distribution of the GAC. Therefore, this may suggest that any loss of AC during placement (or subsequent bottom disturbance from vessels) was not preferential for smaller AC particles. The 10.3% and the 12.1% TOC in the gravely sand intertidal and scour plots, respectively, are higher than would be expected based on the grain size distribution of the GAC. A potential explanation of the higher than expected TOC in the intertidal and scour plots is the fraction of the material passing the No. 50 sieve (% fine sand and below) in the gravely sand material is considerably lower than the sand material (see Section 2.1.2 and Table 1); therefore, the GAC may contribute a higher proportion of the gravely sand ENR material passing the No. 50 sieve as compared to the sand ENR material.

Plot	**Material Type**	**Subplot**	**Average TVS of Placed Material from Composite Samples (%)**	**Average TOC of Placed Material from Composite Samples (%)**	**Average Ratio of TOC Passing No. 50 Sieve to TOC in Total Sample (%)**
Intertidal	Gravelly Sand	ENR+AC	2.6	1.8	10.3
		ENR	0.51	0.1 U	
Scour	Gravelly Sand	ENR+AC	2.4	1.8	12.1
		ENR	0.49	0.054 U	
Subtidal	Sand	ENR+AC	3	1.76	3.1
		ENR	1.1	0.11	

Note: See Table 14 for complete data.

Together, the thickness and carbon content results indicate that the pilot placement method was effective at delivering the ENR+AC blend with minimal AC loss and fairly uniform distribution in the placed layer. The pilot placement method was less effective at achieving the thickness tolerances specified for this pilot (i.e., thickness between 6 and 9 inches [15.2 and 22.9 cm] in 80% of stake/probe locations per subplot and with a minimum thickness of 4 inches [10.2 cm] at approximately 100% of stake/probe locations per subplot). These tolerances were specified for the purpose of maximizing the success of the planned porewater measurement techniques in this pilot, but are not necessarily required for the successful performance of ENR+AC as a remedy. The AC delivery results also indicate that flexibility in the design of full-scale placement techniques is possible while still achieving target AC levels. Design factors that can be considered for more practicable full-scale implementation include:

- Less stringent thickness tolerances
- Alternative equipment types and placement techniques

- Alternative AC products

4.3 ADDITIONAL OBSERVATIONS

There were only a few observable or measurable differences in water quality during placement of the amended ENR material versus the non-amended material at any of the plot locations. In the shallow-water depths of the intertidal plot, visibly darker plumes were noticed during ENR+AC placement. At the subtidal plot, a surface layer of AC was seen one day during ENR+AC placement. The slow cycle time during placement helped to reduce water quality impacts, although turbidity criteria were still exceeded in 10 of the 32 rounds of monitoring. Water quality impacts (turbidity >5 NTU over background) at a 150-foot point of compliance are to be expected if similar ENR materials are used in remedy implementation.

Intertidal stake placement and thickness measurements at the intertidal plot were initially planned to be conducted by divers. These activities were performed on foot during low tide instead. The change in method made the inspection, thickness measurement, and documentation of plot conditions after material placement safer and more efficient. Visual inspections by divers in the scour and subtidal plots were impeded by poor visibility at times.

Blending of ENR+AC and loading of material is weather dependent. As discussed in Section 2.1.4, freezing temperatures impact the ability to blend and load all ENR material. Rain could have also impacted the blending operations due to the AC gradation used for the project. Wet AC would not be transported through the auger as well or “bridge” while in the hopper compared to a dry product, which could produce a lower AC percentage in the ENR material. These concerns were addressed during the project by keeping bulk bags, the hopper, and stockpile area covered when not in use and by rescheduling barge loading of ENR+AC materials if freezing weather was anticipated.

In summary, the means and methods used for this pilot project were appropriate for placement on a pilot scale, but would not be practicable for full-scale implementation. In order to make full-scale placement practicable, higher production rates would need to be achieved. Results of this pilot suggest this is feasible while attaining AC target levels. Site conditions and other objectives will determine which methods are best suited for specific locations. Ongoing monitoring results will inform about site conditions that could affect long-term retention of this AC material.

5.0 REFERENCES

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TABLES

TABLE 1
RESULTS OF CHEMICAL TESTING OF GRAVELLY SAND AND SAND ENR MATERIALS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Conventionals			
Total Organic Carbon (%)	--	0.169	0.032
Grain Size			
Cobbles	--	0.1 U	0.1 U
% Coarse Gravel	--	0.1 U	0.1 U
% Fine Gravel	--	36.7	0.2
% Total Gravel	--	36.7	0.2
% Coarse Sand	--	28.7	15.5
% Medium Sand	--	27.4	49.9
% Fine Sand	--	6.2	32.6
% Total Sand	--	62.3	98
% Silt Fine	--	1	1.6
% Clay Fine	--	0.1 U	0.2
% Total Fines	--	1	1.8
Metals (mg/kg-dw)			
Arsenic	57	2.24	1.85
Cadmium	5.1	0.036	0.04
Chromium	260	14.3	13.9
Copper	390	12.1	13
Lead	450	1.06	1.66
Mercury	0.41	0.007 J	0.009 J
Silver	6.1	0.025 J	0.047
Zinc	410	21.3	0.26
Semivolatile Organic Compounds (SVOCs, µg/kg-dw)			
Naphthalene	2100	34 U	34.1 U
Acenaphthene	500	34 U	34.1 U
Fluorene	540	34 U	34.1 U
Phenanthrene	1500	34 U	34.1 U
Anthracene	960	34 U	34.1 U
2-Methylnaphthalene	670	34 U	34.1 U
Fluoranthene	1700	34 U	34.1 U
Pyrene	2600	34 U	34.1 U
Benz[a]anthracene	1300	34 U	34.1 U
Chrysene	1400	34 U	34.1 U
Total benzofluoranthenes	3200	34 U	34.1 U
Benzo[a]pyrene	1600	34 U	34.1 U
Indeno[1,2,3-c,d]pyrene	600	34 U	34.1 U
Dibenzo[a,h]anthracene	230	34 U	34.1 U
Benzo[g,h,i]perylene	670	34 U	34.1 U
1,2-Dichlorobenzene	35	34 U	34.1 U
1,4-Dichlorobenzene	110	34 U	34.1 U

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Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Semivolatile Organic Compounds (SVOCs, µg/kg-dw) cont.			
1,2,4-Trichlorobenzene	31	34 U	34.1 U
Hexachlorobenzene	22	34 U	34.1 U
Dimethyl phthalate	71	34 U	34.1 U
Butyl benzyl phthalate	63	34 U	34.1 U
Bis[2-ethylhexyl] phthalate	1300	34 U	34.1 U
Dibenzofuran	540	34 U	34.1 U
N-nitrosodiphenylamine	28	34 U	34.1 U
Phenol	420	34 U	34.1 U
4-Methylphenol	670	34 U	34.1 U
2,4-Dimethylphenol	29	34 U	34.1 U
Pentachlorophenol	360	204 U	204 U
Benzyl alcohol	57	68.1 U	68.2 U
Benzoic acid	650	2,040 U	2,040 U
Polychlorinated Biphenyls (PCBs, ng/kg-dw)			
PCBs (Total, Congeners)	2000	37.0	31.2
PCB-001	--	0.43 U	0.553 U
PCB-002	--	0.651 U	0.851 U
PCB-003	--	0.695 U	0.914 U
PCB-004	--	0.396 U	0.403 U
PCB-005	--	2.88 J	2.74 J
PCB-006	--	0.435 U	0.427 U
PCB-007	--	0.442 U	0.434 U
PCB-008	--	0.512 U	0.502 U
PCB-009	--	0.457 U	0.448 U
PCB-010	--	0.455 U	0.447 U
PCB-011	--	15.5	6.61
PCB-012	--	0.507 U	0.497 U
PCB-013	--	0.575 U	0.564 U
PCB-014	--	0.458 U	0.449 U
PCB-015	--	0.609 U	0.593 U
PCB-016	--	0.901 U	0.919 U
PCB-017	--	1.02 U	1.04 U
PCB-018	--	3.94	3.66 J
PCB-019	--	1.07 U	1.09 U
PCB-020	--	2.63 J	2.43 J
PCB-021	--	2.63 J	2.43 J
PCB-022	--	1.59 U	1.24 U
PCB-023	--	1.54 U	1.2 U
PCB-024	--	0.744 U	0.759 U
PCB-025	--	1.32 U	1.04 U

TABLE 1
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Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Polychlorinated Biphenyls (PCBs, ng/kg-dw) cont.			
PCB-026	--	1.69 U	1.32 U
PCB-027	--	0.809 U	0.825 U
PCB-028	--	3.2 J	3.54 J
PCB-029	--	1.64 U	1.28 U
PCB-030	--	0.758 U	0.773 U
PCB-031	--	3.54 J	2.22 J
PCB-032	--	0.916 U	0.934 U
PCB-033	--	2.63 J	2.43 J
PCB-034	--	1.86 U	1.46 U
PCB-035	--	1.92 U	1.51 U
PCB-036	--	1.78 U	1.39 U
PCB-037	--	1.58 U	1.24 U
PCB-038	--	1.68 U	1.31 U
PCB-039	--	1.78 U	1.39 U
PCB-040	--	1.84 U	1.05 U
PCB-041	--	1.09 U	0.626 U
PCB-042	--	1.17 U	0.672 U
PCB-043	--	1.44 U	0.823 U
PCB-044	--	1.6 U	0.916 U
PCB-045	--	1.56 U	0.89 U
PCB-046	--	1.63 U	0.934 U
PCB-047	--	1.19 U	0.678 U
PCB-048	--	1.14 U	0.649 U
PCB-049	--	1.44 U	0.823 U
PCB-050	--	1.34 U	0.768 U
PCB-051	--	1.36 U	0.775 U
PCB-052	--	1.11 U	1.75 J
PCB-053	--	1.36 U	0.776 U
PCB-054	--	0.979 U	0.56 U
PCB-055	--	0.887 U	0.615 U
PCB-056	--	0.926 U	0.988 U
PCB-057	--	0.82 U	0.633 U
PCB-058	--	0.783 U	0.605 U
PCB-059	--	1.17 U	0.672 U
PCB-060	--	0.926 U	0.988 U
PCB-061	--	0.764 U	0.59 U
PCB-062	--	1.19 U	0.683 U
PCB-063	--	0.823 U	0.635 U
PCB-064	--	1.09 U	0.626 U
PCB-065	--	1.1 U	0.631 U

TABLE 1
RESULTS OF CHEMICAL TESTING OF GRAVELLY SAND AND SAND ENR MATERIALS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Polychlorinated Biphenyls (PCBs, ng/kg-dw) cont.			
PCB-066	--	0.785 U	0.606 U
PCB-067	--	0.898 U	0.693 U
PCB-068	--	1.07 U	0.612 U
PCB-069	--	1.11 U	1.75 J
PCB-070	--	0.764 U	0.59 U
PCB-071	--	1.09 U	0.626 U
PCB-072	--	1.09 U	0.626 U
PCB-073	--	1.13 U	0.644 U
PCB-074	--	0.808 U	0.623 U
PCB-075	--	1.14 U	0.649 U
PCB-076	--	0.785 U	0.606 U
PCB-077	--	1.15 U	1.24 U
PCB-078	--	1.07 U	1.14 U
PCB-079	--	1 U	1.07 U
PCB-080	--	0.725 U	0.559 U
PCB-081	--	0.887 U	0.94 U
PCB-082	--	1.56 U	1.54 U
PCB-083	--	1.11 U	1.09 U
PCB-084	--	1.3 U	1.28 U
PCB-085	--	1.05 U	1.04 U
PCB-086	--	1.38 U	1.36 U
PCB-087	--	0.986 U	0.972 U
PCB-088	--	1.13 U	1.15 U
PCB-089	--	1.3 U	1.28 U
PCB-090	--	1.13 U	1.11 U
PCB-091	--	1.13 U	1.15 U
PCB-092	--	1.3 U	1.28 U
PCB-093	--	1.36 U	1.38 U
PCB-094	--	1.27 U	1.29 U
PCB-095	--	1.15 U	1.17 U
PCB-096	--	0.881 U	0.895 U
PCB-097	--	1.09 U	1.07 U
PCB-098	--	0.97 U	0.985 U
PCB-099	--	1.14 U	1.12 U
PCB-100	--	1.06 U	1.08 U
PCB-101	--	1.13 U	1.11 U
PCB-102	--	0.97 U	0.985 U
PCB-103	--	1.01 U	1.03 U
PCB-104	--	0.784 U	0.796 U
PCB-105	--	0.85 U	0.94 U

TABLE 1
RESULTS OF CHEMICAL TESTING OF GRAVELLY SAND AND SAND ENR MATERIALS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Polychlorinated Biphenyls (PCBs, ng/kg-dw) cont.			
PCB-106	--	0.758 U	0.968 U
PCB-107	--	0.731 U	0.864 U
PCB-108	--	0.731 U	0.864 U
PCB-109	--	0.955 U	0.941 U
PCB-110	--	0.856 U	0.843 U
PCB-111	--	0.824 U	0.811 U
PCB-112	--	1.11 U	1.09 U
PCB-113	--	0.946 U	0.932 U
PCB-114	--	0.762 U	0.89 U
PCB-115	--	0.824 U	0.811 U
PCB-116	--	1.05 U	1.04 U
PCB-117	--	0.986 U	0.972 U
PCB-118	--	0.758 U	0.968 U
PCB-119	--	0.892 U	0.878 U
PCB-120	--	0.877 U	0.864 U
PCB-121	--	0.913 U	0.927 U
PCB-122	--	0.758 U	0.896 U
PCB-123	--	0.67 U	0.785 U
PCB-124	--	0.782 U	0.924 U
PCB-125	--	0.986 U	0.972 U
PCB-126	--	1.12 U	1.49 U
PCB-127	--	0.833 U	0.984 U
PCB-128	--	0.715 U	0.701 U
PCB-129	--	0.976 U	0.957 U
PCB-130	--	0.937 U	0.919 U
PCB-131	--	0.763 U	0.748 U
PCB-132	--	0.677 U	0.664 U
PCB-133	--	0.763 U	0.748 U
PCB-134	--	0.768 U	0.753 U
PCB-135	--	0.716 U	0.702 U
PCB-136	--	0.586 U	0.719 U
PCB-137	--	0.783 U	0.768 U
PCB-138	--	0.589 U	0.577 U
PCB-139	--	0.691 U	0.678 U
PCB-140	--	0.73 U	0.716 U
PCB-141	--	0.762 U	0.747 U
PCB-142	--	0.867 U	0.85 U
PCB-143	--	0.768 U	0.753 U
PCB-144	--	0.735 U	0.721 U
PCB-145	--	0.598 U	0.734 U

TABLE 1
RESULTS OF CHEMICAL TESTING OF GRAVELLY SAND AND SAND ENR MATERIALS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Polychlorinated Biphenyls (PCBs, ng/kg-dw) cont.			
PCB-146	--	0.636 U	0.624 U
PCB-147	--	0.709 U	0.695 U
PCB-148	--	0.842 U	1.03 U
PCB-149	--	0.691 U	0.678 U
PCB-150	--	0.567 U	0.696 U
PCB-151	--	0.774 U	0.76 U
PCB-152	--	0.574 U	0.704 U
PCB-153	--	0.654 U	0.642 U
PCB-154	--	0.706 U	0.867 U
PCB-155	--	0.517 U	0.635 U
PCB-156	--	0.669 U	0.635 U
PCB-157	--	0.687 U	0.646 U
PCB-158	--	0.597 U	0.586 U
PCB-159	--	0.595 U	0.583 U
PCB-160	--	0.597 U	0.586 U
PCB-161	--	0.677 U	0.664 U
PCB-162	--	0.715 U	0.701 U
PCB-163	--	0.589 U	0.577 U
PCB-164	--	0.589 U	0.577 U
PCB-165	--	0.636 U	0.624 U
PCB-166	--	0.635 U	0.623 U
PCB-167	--	0.637 U	0.655 U
PCB-168	--	0.581 U	0.57 U
PCB-169	--	0.784 U	0.791 U
PCB-170	--	0.902 U	0.848 U
PCB-171	--	0.737 U	0.693 U
PCB-172	--	0.798 U	0.75 U
PCB-173	--	0.819 U	0.77 U
PCB-174	--	0.703 U	0.661 U
PCB-175	--	0.668 U	0.628 U
PCB-176	--	0.5 U	0.47 U
PCB-177	--	0.774 U	0.727 U
PCB-178	--	0.706 U	0.664 U
PCB-179	--	0.471 U	0.443 U
PCB-180	--	0.605 U	0.569 U
PCB-181	--	0.689 U	0.647 U
PCB-182	--	0.619 U	0.581 U
PCB-183	--	0.627 U	1.66 J
PCB-184	--	0.45 U	0.423 U
PCB-185	--	0.707 U	0.664 U

TABLE 1
RESULTS OF CHEMICAL TESTING OF GRAVELLY SAND AND SAND ENR MATERIALS

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Polychlorinated Biphenyls (PCBs, ng/kg-dw) cont.			
PCB-186	--	0.494 U	0.465 U
PCB-187	--	0.619 U	0.581 U
PCB-188	--	0.475 U	0.479 U
PCB-189	--	0.651 U	0.57 U
PCB-190	--	0.626 U	0.589 U
PCB-191	--	0.596 U	0.56 U
PCB-192	--	0.58 U	0.545 U
PCB-193	--	0.551 U	0.518 U
PCB-194	--	0.618 U	0.66 U
PCB-195	--	0.67 U	0.716 U
PCB-196	--	1.04 U	1.06 U
PCB-197	--	0.682 U	0.695 U
PCB-198	--	1.03 U	1.05 U
PCB-199	--	1.18 U	1.2 U
PCB-200	--	0.733 U	0.747 U
PCB-201	--	0.732 U	0.746 U
PCB-202	--	0.721 U	0.735 U
PCB-203	--	1.04 U	1.06 U
PCB-204	--	0.701 U	0.714 U
PCB-205	--	0.487 U	0.52 U
PCB-206	--	0.563 U	0.912 U
PCB-207	--	0.495 U	0.67 U
PCB-208	--	0.487 U	0.567 U
PCB-209	--	0.377 U	0.547 U
Dioxins/Furans (ng/kg-dw)			
Total TEQ (ng TEQ/kg-dw)	2	0.000867	0.000603
2,3,7,8-TCDD	--	0.167 U	0.175 U
1,2,3,7,8-PeCDD	--	0.359 U	0.31 U
1,2,3,4,7,8-HxCDD	--	0.478 U	0.442 U
1,2,3,6,7,8-HxCDD	--	0.529 U	0.463 U
1,2,3,7,8,9-HxCDD	--	0.488 U	0.438 U
1,2,3,4,6,7,8-HpCDD	--	0.648 U	0.588 U
OCDD	--	2.89 J	2.01 J
2,3,7,8-TCDF	--	0.121 U	0.11 U
1,2,3,7,8-PeCDF	--	0.245 U	0.282 U
2,3,4,7,8-PeCDF	--	0.243 U	0.288 U
1,2,3,4,7,8-HxCDF	--	0.183 U	0.226 U
1,2,3,6,7,8-HxCDF	--	0.186 U	0.237 U
1,2,3,7,8,9-HxCDF	--	0.291 U	0.353 U
2,3,4,6,7,8-HxCDF	--	0.216 U	0.259 U

TABLE 1

RESULTS OF CHEMICAL TESTING OF GRAVELLY SAND AND SAND ENR MATERIALS

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

Analyte	Criteria[1] (dry weight)	Gravelly Sand[2]	Sand[2]
Dioxins/Furans (ng/kg-dw) cont.			
1,2,3,4,6,7,8-HpCDF	--	0.266 U	0.283 U
1,2,3,4,7,8,9-HpCDF	--	0.415 U	0.461 U
OCDF	--	0.531 U	0.532 U

Notes:

1. SMS SQS for metals and SVOCs, Lower Duwamish Waterway Record of Decision for PCBs and dioxins/furans.
2. Data validation qualifiers as follows:
   J = Analyte was detected, concentration is considered to be an estimate.
   U = Not detected at the estimated detection limit.

Abbreviations:

ENR = Enhanced natural recovery
mg/kg-dw = milligrams per kilogram dry weight
ng/kg-dw = nanograms per kilogram dry weight
ng TEQ/kg-dw = nanograms TEQ per kilogram dry weight
PCB = Polychlorinated biphenyl
SMS = Sediment Management Standards
SQS = Sediment Quality Standards
SVOC = Semivolatile organic compound
µg/kg-dw = micrograms per kilogram dry weight

TABLE 2
TVS CONTENT IN GRAVELLY SAND AND SAND ENR+AC MATERIAL—BY BARGE LOAD
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Sample	Total % TVS Gravelly Sand[1]	Total % TVS Sand
Initial Sample	3.9	4.9
0 – 500 tons	2.3	3.8
500 – 1,000 tons	2.3	4.6
1,000 - 1,500 tons	3.1	2.5
1,500 – 2,000 tons	2.6	—
2,000 – 2,500 tons	1.7	—
Average	2.7	4.0

Note(s):

1. TVS adjusted for the percent gravel (percent retained on a No. 4 sieve) removed from the sample prior to analysis.
2. — indicates samples not collected.

Abbreviation(s):

ENR+AC = enhanced natural recovery amended with activated carbon
TVS = total volatile solids

TABLE 3
ENR AND ENR+AC LOAD SUMMARY (AS REPORTED BY CALPORTLAND)
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Load No.	Date	Barge Designation	Tons Loaded			Barge Total (tons)	AC Content [1] %
			AC	Sand	Gravelly Sand		
1	11/23/2016	KP-2	53	138	1,127	1,318	4.0
2	12/05/2016	KP-3			1,166	1,166	0.0
3	12/13/2016	KP-2	48		1,147	1,195	4.0
4	12/16/2016	KP-3			1,363	1,363	0.0
5	12/30/2016	KP-2	52	1,251		1,303	4.0
6	1/13/2017	KP-3		1,341		1,341	0.0

Note(s):

1. Percent AC based on scale tickets.

Abbreviation(s):

AC = activated carbon

ENR+AC = enhanced natural recovery amended with activated carbon

TABLE 4
COORDINATES AND ELEVATIONS FOR EACH PLOT'S CONTROL POINTS AS PROVIDED BY BRH, INC.

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

	Scour Plot		**Subtidal Plot**		**Intertidal Plot**	
Control Point	**Harbor Island 1**	**Harbor Island 2**	**Lafarge 1**	**Lafarge 2**	**Slag 1**	**Slag 2**
Northing	211360.936	211361.93	205146.676	205410.865	194112.357	194112.026
Easting	1266838.995	1,266,775.35	1267798.908	1267710.952	1276323.484	1276325.646
Elevation	15.507	15.647	16.987	16.732	8.565	8.555

TABLE 5

CONSTRUCTION AND YEAR 0 MONITORING EVENT SCHEDULE SUMMARY

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

		Activity									
		Material Placement			Stake Measurement/Observation				Year 0 Sediment Collection		
Plot	Subplot	Start	Finish	Duration (days)	Start	Finish	Post-Placement (days)	SPI/PV Date	Start	Finish	Post-Placement (days)
Demonstration	Sand ENR+AC	11/29/16	11/30/16	2	11/29/16	11/30/16	1	NA	NA	NA	NA
	Gravely Sand ENR+AC										
Intertidal	ENR+AC	12/01/16	12/15/16	7	12/13/16	12/27/16	1	01/11/17	01/12/17	01/13/17	28-29
	ENR	12/08/16	12/19/16	6.5			1-8				24-25
Scour	ENR+AC	12/20/16	12/28/16	6	01/09/17	01/09/17	12	01/16/17	01/17/17	01/23/17	20-26
	ENR	12/29/16	01/06/17	6			3				11-17
Subtidal	ENR+AC	01/09/17	01/19/17	8	01/30/17	01/31/17	11-12	02/01/17	02/02/17	02/03/17	14-15
	ENR	01/20/17	01/26/17	5			4-5				7-8

Abbreviations:
ENR = Enhanced natural recovery
ENR +AC = Enhanced natural recovery amended with activated carbon
SPI/PV = sediment profile imaging/plan view

TABLE 6
SAND ENR+AC DEMONSTRATION PLOT STAKE MEASUREMENTS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Demonstration Test Plot Location ID (TP-xx)	Stake # (S-xx)	Stake Length above Plate (inches)	Exposed Stake Length (measured) (inches)	Placed ENR Thickness (inches)
TP-01	S-43	18	14	4
TP-02	S-47	18	14	4
TP-03	S-45	18	14	4
TP-04	S-56	18	12	6
TP-05	S-39	18	14	4
TP-06	S-32	18	15	3
TP-07	S-29	18	10	8
TP-08	S-21	18	10	8
TP-09	S-49	18	10	8
TP-10	S-42	18	11	7
TP-11	S-27	18	11	7
TP-12	S-66	18	15	3
TP-13	S-55	18	6	12
TP-14	S-63	18	11	7
TP-15	S-73	18	9	9
TP-16	S-17	18	11	7
TP-17	S-60	18	10	8
TP-18	S-54	18	11	7
TP-19	S-72	18	11	7
TP-20	S-59	18	11	7
TP-21	S-48	18	9	9
TP-22	S-62	18	8	10
TP-23	S-53	18	11	7
TP-24	S-65	18	11	7
			AVERAGE THICKNESS	6.8
			MINIMUM THICKNESS	3
			MAXIMUM THICKNESS	12

Abbreviation(s):

ENR = enhanced natural recovery
ENR+AC = enhanced natural recovery amended with activated carbon

TABLE 7
GRAVELLY SAND ENR+AC DEMONSTRATION PLOT STAKE MEASUREMENTS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Demonstration Test Plot Location ID (TP-xx)	Stake # (S-xx)	Stake Length above Plate (inches)	Exposed Stake Length (measured) (inches)	Placed ENR Thickness (inches)
TP-25	S-29	18	11	7
TP-26	S-75	18	12	6
TP-27	S-41	18	12	6
TP-28	S-34	18	13	5
TP-29	S-37	18	11	7
TP-30	S-44	18	13	5
TP-31	S-50	18	8	10
TP-32	S-61	18	11	7
TP-33	S-35	18	8	10
TP-34	S-31	18	9	9
TP-35	S-46	18	8	10
TP-36	S-23	18	13	5
TP-37	S-51	18	9	9
TP-38	S-69	18	9	9
TP-39	S-70	18	9	9
TP-40	S-58	18	9	9
TP-41	S-57	18	9	9
TP-42	S-74	18	12	6
TP-43	S-67	18	9	9
TP-44	S-68	18	8	10
TP-45	S-64	18	8	10
TP-46	S-77	18	7	11
TP-47	S-52	18	10	8
TP-48	S-40	18	12	6
			AVERAGE THICKNESS	8
			MINIMUM THICKNESS	5
			MAXIMUM THICKNESS	11

Abbreviation(s):

ENR = enhanced natural recovery
ENR+AC = enhanced natural recovery amended with activated carbon

TABLE 8
GRAVELLY SAND ENR+AC INTERTIDAL SUBPLOT STAKE MEASUREMENTS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Location ID (IT-ENR-AC-xx)	Stake # (S-xx)	Stake Length above Plate (inches)	Exposed Stake Length (measured) (inches)	Placed ENR Thickness (inches)
IT-ENR-AC-01	S-31	18	10	8
IT-ENR-AC-02	S-61	18	4	14
IT-ENR-AC-03	S-41	18	6	12
IT-ENR-AC-04	S-37	18	7	11
IT-ENR-AC-05	S-70	18	7	11
IT-ENR-AC-06	S-69	18	9	9
IT-ENR-AC-07	S-29	18	12	6
IT-ENR-AC-08	S-56	18	8	10
IT-ENR-AC-09	S-100	18	8	10
IT-ENR-AC-10	S-57	18	10	8
IT-ENR-AC-11	S-76	18	10	8
IT-ENR-AC-12	S-35	18	10	8
IT-ENR-AC-13	S-45	18	8	10
IT-ENR-AC-14	S-44	18	7	11
IT-ENR-AC-15	S-34	18	9	9
			AVERAGE THICKNESS	9.7
			MINIMUM THICKNESS	6
			MAXIMUM THICKNESS	14

Abbreviation(s):

ENR = enhanced natural recovery

ENR+AC = enhanced natural recovery amended with activated carbon

TABLE 9
GRAVELLY SAND ENR INTERTIDAL SUBPLOT STAKE MEASUREMENTS[1]

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Location ID (IT-ENR-AC-xx)	Stake # (S-xx)[2]	Stake Length above Plate (inches)	Exposed Stake Length (measured) (inches)	Placed ENR Thickness (inches)
IT-ENR-16	S-10	18	9	9
IT-ENR-17	S-5	18	4	14
IT-ENR-18	S-11	18	6	12
IT-ENR-19	S-38	18	10	8
IT-ENR-20	S-19	18	10	8
IT-ENR-21	S-20	18	8	10
IT-ENR-22	S-16	18	4	14
IT-ENR-23	S-14*	18	8	10
IT-ENR-24	S-7	18	8	10
IT-ENR-25	S-28	18	7	11
IT-ENR-26	S-14*	18	9	9
IT-ENR-27	S-6	18	4	14
IT-ENR-28	S-33	18	5	13
IT-ENR-29	S-1	18	8	10
IT-ENR-30	S-18	18	6	12
			AVERAGE THICKNESS	10.9
			MINIMUM THICKNESS	8
			MAXIMUM THICKNESS	14

Note(s):

1. Other than over-placement of material, no features of interest were observed in the plot.
2. * Demonstration Test Plot Locations IT-ENR-23 and IT-ENR-26 both have stake number S-14.3.

Abbreviation(s):

ENR = enhanced natural recovery

TABLE 10
GRAVELLY SAND ENR+AC SCOUR SUBPLOT STAKE MEASUREMENTS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Location ID (IT-ENR-AC-xx)	Stake # (S-xx)	Stake Length above Plate (inches)	Exposed Stake Length (measured) (inches)	Placed ENR Thickness (inches)
IT-ENR-AC-31	S-36	18	9	9
IT-ENR-AC-32	S-23	18	10	8
IT-ENR-AC-33	S-43	18	8	10
IT-ENR-AC-34	S-77	18	10	8
IT-ENR-AC-35	S-47	18	9	9
IT-ENR-AC-36	S-75	18	8	10
IT-ENR-AC-37	S-17	18	8	10
IT-ENR-AC-38	S-9	18	8	10
IT-ENR-AC-39	S-3	18	8	10
IT-ENR-AC-40	S-58	18	10	8
IT-ENR-AC-41	S-65	18	9	9
IT-ENR-AC-42	S-2	18	9	9
IT-ENR-AC-43	S-120	18	11	7
IT-ENR-AC-44	S-45	18	5	13
IT-ENR-AC-45	S-121	18	6	12
			AVERAGE THICKNESS	9.5
			MINIMUM THICKNESS	7
			MAXIMUM THICKNESS	13

Abbreviation(s):

ENR = enhanced natural recovery

ENR+AC = enhanced natural recovery amended with activated carbon

TABLE 11
GRAVELLY SAND ENR SCOUR SUBPLOT STAKE MEASUREMENTS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Location ID (IT-ENR-AC-xx)	Stake # (S-xx)	Stake Length above Plate (inches)	Exposed Stake Length (measured) (inches)[1]	Placed ENR Thickness (inches)
IT-ENR-46	S-4	18	3	15
IT-ENR-47	S-26	18	11	7
IT-ENR-48	S-54	18	2	16
IT-ENR-49	S-32	18	10	8
IT-ENR-50	S-25	18	4	14
IT-ENR-51	S-27	18	6	12
IT-ENR-52	S-22	18	9	9
IT-ENR-53	S-42	18	*	18
IT-ENR-54	S-60	18	*	15
IT-ENR-55	S-73	18	9	9
IT-ENR-56	S-122	18	7	11
IT-ENR-57	S-124	18	11	7
IT-ENR-58	S-21	18	9	9
IT-ENR-59	S-56	18	5	13
IT-ENR-60	S-15	18	9	9
			AVERAGE THICKNESS	11.5
			MINIMUM THICKNESS	7
			MAXIMUM THICKNESS	18

Note(s):

1. Diver was unable to find grade stakes at locations IT-ENR-53 and IT-ENR-54. ENR thickness is from sediment probe measurement.

Abbreviation(s):

AC = activated carbon
ENR = enhanced natural recovery

TABLE 12
SAND ENR+AC SUBTIDAL SUBPLOT PROBE MEASUREMENTS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Location ID (IT-ENR-AC-xx)	Probe Measurement (inches)
IT-ENR-AC-62	11
IT-ENR-AC-64	15
IT-ENR-AC-66	13
IT-ENR-AC-68	13
IT-ENR-AC-70	15
IT-ENR-AC-72	14
IT-ENR-AC-74	16
IT-ENR-AC-76	13
IT-ENR-AC-78	14
IT-ENR-AC-80	11
IT-ENR-AC-82	14
IT-ENR-AC-84	14
IT-ENR-AC-86	15
IT-ENR-AC-88	14
IT-ENR-AC-90	13
AVERAGE THICKNESS	13.7
MINIMUM THICKNESS	11
MAXIMUM THICKNESS	16

Abbreviation(s):

AC = activated carbon
ENR = enhanced natural recovery
ENR+AC = enhanced natural recovery amended with activated carbon

TABLE 13
SAND ENR SUBTIDAL SUBPLOT PROBE MEASUREMENTS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Location ID (IT-ENR-AC-xx)	Probe Measurement (inches)[1]
IT-ENR-61	9
IT-ENR-63	10
IT-ENR-65	14
IT-ENR-67	6*
IT-ENR-69	16
IT-ENR-71	14
IT-ENR-73	8
IT-ENR-75	16
IT-ENR-77	13
IT-ENR-79	14
IT-ENR-81	14
IT-ENR-83	14
IT-ENR-85	16
IT-ENR-87	14
IT-ENR-89	12
AVERAGE THICKNESS	12.7
MINIMUM THICKNESS	6
MAXIMUM THICKNESS	16

Note(s):

1. Diver was unable to discern a difference between the ENR material and underlying fine-grained sediment. At this location only, a Universal Core Head with a nominal 3-inch-diameter polycarbonate barrel was used to determine ENR thickness.

Abbreviation(s):

ENR = enhanced natural recovery

TABLE 14
TOTAL VOLATILE SOLIDS AND TOTAL ORGANIC CARBON RESULTS FOR BULK SEDIMENT
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

							Pre-Analytical Laboratory Submission Sieving to Remove Gravel Fraction				Analytical Laboratory Sieving			Total Volatile Solids[1] (TVS)			Total Organic Carbon[1] (TOC)					
Plot	Subplot	Sample Type	Sample ID	Sample Date	Plot	Analyte	Total Mass	Mass on 3/8" Sieve	Mass on No. 4 Sieve	Mass Passing No. 4	Total Mass	Mass on No. 50 Sieve	Mass Passing No. 50	TVS without Gravel Fraction (Average)	Corrected TVS with Gravel Fraction (Average)[2]	TVS Passing No. 50 Sieve (Average)[3]	TOC without Gravel Fraction (Average)	TOC RPD	Corrected TOC with Gravel Fraction (Average)[2]	TOC Passing No. 50 Sieve (Average)	Corrected TOC Passing No. 50 Sieve (Average)[4]	Ratio of TOC Passing No. 50 Sieve to TOC in Total Sample
						Sub Plot	g	g	g	g	g	g	g	%	%	%	%	%	%	%	%	%
Subtidal	ENR	Composite of "A" Locations	LDW-Y0-SU-ENR-CA-CORE	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**1.1**	N/A	1.1	**0.12**	0	N/A	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-1-A-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-2-A-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-3-A-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-4-A-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-5-A-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-6-A-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Composite of "B" Locations	LDW-Y0-SU-ENR-CB-CORE	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**1.0**	N/A	1.0	**0.10 U**	0	N/A	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-1-B-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-2-B-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-3-B-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-4-B-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-5-B-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-6-B-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Composite of "C" Locations	LDW-Y0-SU-ENR-CC-CORE	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**1.1**	N/A	1.0	**0.10 U**	0	N/A	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-1-C-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-2-C-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-3-C-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-4-C-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-5-C-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-6-C-COR	4/13/2017	Subtidal	ENR	N/A	N/A	N/A	N/A	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Subtidal	ENR+AC	Composite of "A" Locations	LDW-Y0-SU-ENR+AC-CA-CORE	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	511.91	450.11	61.8	**3.0**	N/A	2.3 J	**1.61**	-0.6	N/A	0.38	0.046	2.9
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-1-A-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.1**	--	--	**1.21**	2	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-2-A-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.5**	--	--	**2.50**	2	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-3-A-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.9**	--	--	**1.96**	0.5	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-4-A-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.1**	--	--	**2.17**	6	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-5-A-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.1**	--	--	**1.05**	-6	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-6-A-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.1**	--	--	**1.81**	0	N/A	--	--	
Subtidal	ENR+AC	Composite of "B" Locations	LDW-Y0-SU-ENR+AC-CB-CORE	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	511.86	453.24	58.62	**3.0**	N/A	4.9	**1.93**	2	N/A	0.63	0.072	3.7
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-1-B-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.0**	--	--	**2.35**	0	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-2-B-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.1**	--	--	**1.78**	1	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-3-B-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.3**	--	--	**2.03**	3	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-4-B-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.2**	--	--	**2.98**	0.7	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-5-B-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.5**	--	--	**2.40**	-3	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-6-B-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.8**	--	--	**1.51**	5	N/A	--	--	
Subtidal	ENR+AC	Composite of "C" Locations	LDW-Y0-SU-ENR+AC-CC-CORE	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	509.09	446.32	62.77	**3.0**	N/A	4.8	**1.76**	0	N/A	0.375	0.046	2.6
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-1-C-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.1**	--	--	**1.87**	-2	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-2-C-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.1 J**	--	--	**2.22**	-0.9	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-3-C-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.7**	--	--	**1.68**	-2	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-4-C-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.9**	--	--	**1.90**	0.5	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-5-C-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3.1**	--	--	**1.96**	-7	N/A	--	--	
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-6-C-COR	4/13/2017	Subtidal	ENR+AC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**2.4**	--	--	**1.39**	4	N/A	--	--	

TABLE 14
TOTAL VOLATILE SOLIDS AND TOTAL ORGANIC CARBON RESULTS FOR BULK SEDIMENT
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

							Pre-Analytical Laboratory Submission Sieving to Remove Gravel Fraction				Analytical Laboratory Sieving			Total Volatile Solids[1] (TVS)			Total Organic Carbon[1] (TOC)					
Plot	Subplot	Sample Type	Sample ID	Sample Date	Plot	Analyte Sub Plot	Total Mass	Mass on 3/8" Sieve	Mass on No. 4 Sieve	Mass Passing No. 4	Total Mass	Mass on No. 50 Sieve	Mass Passing No. 50	TVS without Gravel Fraction (Average)	Corrected TVS with Gravel Fraction (Average)[2]	TVS Passing No. 50 Sieve (Average)[3]	TOC without Gravel Fraction (Average)	TOC RPD	Corrected TOC with Gravel Fraction (Average)[2]	TOC Passing No. 50 Sieve (Average)	Corrected TOC Passing No. 50 Sieve (Average)[4]	Ratio of TOC Passing No. 50 Sieve to TOC in Total Sample
							g	g	g	g	g	g	g	%	%	%	%	%	%	%	%	%
Scour	ENR	Composite of "A" Locations	LDW-Y0-SC-ENR-CA-CORE[5]	4/13/2017	Scour	ENR	--	--	--	--	N/A	N/A	N/A	1.0 J	**0.55 J**	1.2	0.10 U	0	**0.055 U**	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-1-A-COR	4/13/2017	Scour	ENR	10,905	3,395	915	6,585	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-2-A-COR	4/13/2017	Scour	ENR	7,925	2,725	680	4,515	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-3-A-COR	4/13/2017	Scour	ENR	13,880	5,030	1,090	7,770	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-4-A-COR	4/13/2017	Scour	ENR	7,670	2,605	615	4,450	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-5-A-COR	4/13/2017	Scour	ENR	10,250	3,540	940	5,770	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-6-A-COR	4/13/2017	Scour	ENR	13,025	5,600	1,315	6,110	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Composite of "B" Locations	LDW-Y0-SC-ENR-CB-CORE	4/13/2017	Scour	ENR	--	--	--	--	N/A	N/A	N/A	0.87	**0.46**	1.1	0.10 U	0	**0.053 U**	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-1-B-COR	4/13/2017	Scour	ENR	14,395	5,170	1,125	8,090	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-2-B-COR	4/13/2017	Scour	ENR	9,255	3,710	845	4,695	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-3-B-COR	4/13/2017	Scour	ENR	6,560	3,305	560	2,700	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-4-B-COR	4/13/2017	Scour	ENR	8,235	3,070	800	4,365	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-5-B-COR	4/13/2017	Scour	ENR	12,085	4,655	930	6,500	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-6-B-COR	4/13/2017	Scour	ENR	9,385	3,095	810	5,485	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Composite of "C" Locations	LDW-Y0-SC-ENR-CC-CORE[6]	4/13/2017	Scour	ENR	--	--	--	--	N/A	N/A	N/A	0.87 J	**0.46 J**	1.1	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-1-C-COR	4/13/2017	Scour	ENR	12,305	4,185	1,000	7,120	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-2-C-COR	4/13/2017	Scour	ENR	9,490	4,175	775	4,545	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-3-C-COR	4/13/2017	Scour	ENR	6,220	1,975	535	3,715	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-4-C-COR	4/13/2017	Scour	ENR	13,995	5,140	1,105	7,750	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-5-C-COR	4/13/2017	Scour	ENR	9,175	3,785	780	4,615	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR	Discrete	LDW-Y0-SC-ENR-6-C-COR	4/13/2017	Scour	ENR	12,290	5,745	1,015	5,535	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Scour	ENR+AC	Composite of "A" Locations	LDW-Y0-SC-ENR+AC-CA-CORE	4/13/2017	Scour	ENR+AC	--	--	--	--	339.24	318.51	20.73	5.0	**2.8**	4.6	3.64	-4	**2.1**	3.095	0.19	9.2
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-1-A-COR	4/13/2017	Scour	ENR+AC	9,580	3,190	680	5,710	N/A	N/A	N/A	4.0	**2.4**	--	3.37	-5	**2.0**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-2-A-COR	4/13/2017	Scour	ENR+AC	12,945	5,670	1,005	6,280	N/A	N/A	N/A	4.4	**2.1**	--	3.58	-2	**1.7**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-3-A-COR	4/13/2017	Scour	ENR+AC	12,710	4,395	1,065	7,240	N/A	N/A	N/A	4.7	**2.7**	--	2.94	0	**1.7**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-4-A-COR	4/13/2017	Scour	ENR+AC	12,165	4,125	945	7,080	N/A	N/A	N/A	3.9 J	**2.3 J**	--	3.94	-4	**2.3**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-5-A-COR	4/13/2017	Scour	ENR+AC	11,930	4,170	840	6,915	N/A	N/A	N/A	4.2	**2.4**	--	3.12	-3	**1.8**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-6-A-COR	4/13/2017	Scour	ENR+AC	7,935	2,400	625	4,915	N/A	N/A	N/A	5.0	**3.1**	--	3.28	-2	**2.0**	--	--	
Scour	ENR+AC	Composite of "B" Locations	LDW-Y0-SC-ENR+AC-CB-CORE	4/13/2017	Scour	ENR+AC	--	--	--	--	343.74	321.82	21.92	2.9 J	**1.6 J**	4.6	2.86	-3	**1.5**	3.2	0.20	13.3
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-1-B-COR	4/13/2017	Scour	ENR+AC	11,535	3,945	1,085	6,510	N/A	N/A	N/A	2.9	**1.6**	--	1.10	-3	**0.62**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-2-B-COR	4/13/2017	Scour	ENR+AC	14,040	4,790	1,295	7,960	N/A	N/A	N/A	3.9	**2.2**	--	3.18	3	**1.8**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-3-B-COR	4/13/2017	Scour	ENR+AC	8,750	3,230	710	4,815	N/A	N/A	N/A	5.0	**2.8**	--	2.90	-0.7	**1.6**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-4-B-COR	4/13/2017	Scour	ENR+AC	11,860	4,195	945	6,700	N/A	N/A	N/A	3.6 J	**2.0 J**	--	2.69	-2	**1.5**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-5-B-COR	4/13/2017	Scour	ENR+AC	10,430	4,660	765	5,010	N/A	N/A	N/A	4.6	**2.2**	--	4.35	-0.2	**2.1**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-6-B-COR	4/13/2017	Scour	ENR+AC	9,745	4,070	850	4,830	N/A	N/A	N/A	2.7	**1.3**	--	1.74	2	**0.86**	--	--	
Scour	ENR+AC	Composite of "C" Locations	LDW-Y0-SC-ENR+AC-CC-CORE	4/13/2017	Scour	ENR+AC	--	--	--	--	300.96	279.98	20.98	5.1	**2.9**	5.4	3.29	0.6	**1.9**	3.7	0.26	13.9
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-1-C-COR	4/13/2017	Scour	ENR+AC	12,425	4,795	1,005	6,600	N/A	N/A	N/A	5.0	**2.7**	--	3.68	0	**2.0**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-2-C-COR	4/13/2017	Scour	ENR+AC	11,270	3,140	865	7,265	N/A	N/A	N/A	5.1	**3.3**	--	3.41	-1	**2.2**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-3-C-COR	4/13/2017	Scour	ENR+AC	11,685	4,155	870	6,670	N/A	N/A	N/A	4.4	**2.5**	--	4.41	0.7	**2.5**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-4-C-COR	4/13/2017	Scour	ENR+AC	7,945	2,580	730	4,640	N/A	N/A	N/A	5.1	**3.0**	--	3.20	0.3	**1.9**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-5-C-COR	4/13/2017	Scour	ENR+AC	12,120	4,305	1,025	6,795	N/A	N/A	N/A	5.2	**2.9**	--	4.17	-2	**2.3**	--	--	
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-6-C-COR	4/13/2017	Scour	ENR+AC	9,825	4,020	885	4,920	N/A	N/A	N/A	2.6 J	**1.3 J**	--	1.59	-2	**0.79**	--	--	

TABLE 14
TOTAL VOLATILE SOLIDS AND TOTAL ORGANIC CARBON RESULTS FOR BULK SEDIMENT
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

							Pre-Analytical Laboratory Submission Sieving to Remove Gravel Fraction				Analytical Laboratory Sieving			Total Volatile Solids[1] (TVS)			Total Organic Carbon[1] (TOC)					
Plot	Subplot	Sample Type	Sample ID	Sample Date	Plot	Analyte Sub Plot	Total Mass	Mass on 3/8" Sieve	Mass on No. 4 Sieve	Mass Passing No. 4	Total Mass	Mass on No. 50 Sieve	Mass Passing No. 50	TVS without Gravel Fraction (Average)	Corrected TVS with Gravel Fraction (Average)[2]	TVS Passing No. 50 Sieve (Average)[3]	TOC without Gravel Fraction (Average)	TOC RPD	Corrected TOC with Gravel Fraction (Average)[2]	TOC Passing No. 50 Sieve (Average)	Corrected TOC Passing No. 50 Sieve (Average)[4]	Ratio of TOC Passing No. 50 Sieve to TOC in Total Sample
							g	g	g	g	g	g	g	%	%	%	%	%	%	%	%	%
Intertidal	ENR	Composite of "A" Locations	LDW-Y0-IN-ENR-CA-CORE	4/13/2017	Intertidal	ENR	--	--	--	--	N/A	N/A	N/A	0.97	**0.55**	0.90	0.10 U	0	**0.1 U**	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-1-A-COR	4/13/2017	Intertidal	ENR	12,330	5,050	1,080	6,190	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-2-A-COR	4/13/2017	Intertidal	ENR	14,220	4,670	1,265	8,280	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-3-A-COR	4/13/2017	Intertidal	ENR	13,590	3,720	1,210	8,655	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-4-A-COR	4/13/2017	Intertidal	ENR	15,260	5,765	1,305	8,105	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-5-A-COR	4/13/2017	Intertidal	ENR	12,910	4,785	900	7,225	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-6-A-COR	4/13/2017	Intertidal	ENR	13,900	4,105	1,315	8,470	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Composite of "B" Locations	LDW-Y0-IN-ENR-CB-CORE	4/13/2017	Intertidal	ENR	--	--	--	--	N/A	N/A	N/A	0.87	**0.49**	1.0	0.10 U	0	**0.1 U**	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-1-B-COR	4/13/2017	Intertidal	ENR	13,870	5,645	1,050	7,175	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-2-B-COR	4/13/2017	Intertidal	ENR	13,600	4,265	1,220	8,120	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-3-B-COR	4/13/2017	Intertidal	ENR	13,810	5,630	1,270	6,895	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-4-B-COR	4/13/2017	Intertidal	ENR	14,535	5,475	1,210	7,830	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-5-B-COR	4/13/2017	Intertidal	ENR	12,680	2,905	1,265	8,600	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-6-B-COR	4/13/2017	Intertidal	ENR	13,435	5,145	1,135	7,145	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Composite of "C" Locations	LDW-Y0-IN-ENR-CC-CORE	4/13/2017	Intertidal	ENR	--	--	--	--	N/A	N/A	N/A	0.93	**0.50**	0.90	0.10 U	0	**0.1 U**	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-1-C-COR	4/13/2017	Intertidal	ENR	15,740	5,410	1,330	9,000	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-2-C-COR	4/13/2017	Intertidal	ENR	14,100	4,825	1,175	8,095	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-3-C-COR	4/13/2017	Intertidal	ENR	13,995	4,705	1,295	7,990	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-4-C-COR	4/13/2017	Intertidal	ENR	13,300	4,865	1,170	7,250	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-5-C-COR	4/13/2017	Intertidal	ENR	14,975	5,845	1,310	7,820	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-6-C-COR	4/13/2017	Intertidal	ENR	15,905	7,160	1,370	7,365	N/A	N/A	N/A	--	--	--	--	--	--	--	--	
Intertidal	ENR+AC	Composite of "A" Locations	LDW-Y0-IN-ENR+AC-CA-CORE	4/13/2017	Intertidal	ENR+AC	--	--	--	--	604.21	565.85	38.36	4.2	**2.4**	4.3	2.46	0	**1.4**	3.3	0.21	15.1
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-1-A-COR	4/13/2017	Intertidal	ENR+AC	13,865	4,220	1,030	8,525	N/A	N/A	N/A	8.2	**5.0**	--	5.60	-0.2	**3.4**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-2-A-COR	4/13/2017	Intertidal	ENR+AC	10,610	4,690	820	5,105	N/A	N/A	N/A	3.3	**1.6**	--	2.06	-2	**0.99**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-3-A-COR	4/13/2017	Intertidal	ENR+AC	11,845	4,220	790	6,840	N/A	N/A	N/A	5.1	**2.9**	--	4.21	0	**2.4**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-4-A-COR	4/13/2017	Intertidal	ENR+AC	14,725	4,400	1,125	9,200	N/A	N/A	N/A	3.1	**1.9**	--	3.43	2	**2.1**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-5-A-COR	4/13/2017	Intertidal	ENR+AC	14,330	6,755	1,125	6,445	N/A	N/A	N/A	1.8	**0.81**	--	1.94	-3	**0.87**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-6-A-COR	4/13/2017	Intertidal	ENR+AC	14,375	4,190	1,015	9,165	N/A	N/A	N/A	6.4	**4.1**	--	5.29	0.6	**3.4**	--	--	
Intertidal	ENR+AC	Composite of "B" Locations	LDW-Y0-IN-ENR+AC-CB-CORE	4/13/2017	Intertidal	ENR+AC	--	--	--	--	588.5	555.41	33.09	4.6	**2.6**	4.2	3.08	-0.6	**1.7**	2.2	0.12	7.3
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-1-B-COR	4/13/2017	Intertidal	ENR+AC	14,205	5,360	865	7,990	N/A	N/A	N/A	5.2 J	**2.9 J**	--	4.07	-2	**2.3**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-2-B-COR	4/13/2017	Intertidal	ENR+AC	12,875	4,770	952	7,135	N/A	N/A	N/A	5.4	**3.0**	--	4.31	0.2	**2.4**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-3-B-COR	4/13/2017	Intertidal	ENR+AC	15,050	5,850	1,240	7,955	N/A	N/A	N/A	2.7	**1.4**	--	1.91	2	**1.0**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-4-B-COR	4/13/2017	Intertidal	ENR+AC	13,370	4,390	1,090	7,885	N/A	N/A	N/A	3.6	**2.1**	--	2.83	-4	**1.7**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-5-B-COR	4/13/2017	Intertidal	ENR+AC	12,455	4,800	945	6,710	N/A	N/A	N/A	3.5	**1.9**	--	3.19	1	**1.7**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-6-B-COR	4/13/2017	Intertidal	ENR+AC	11,810	4,155	895	6,755	N/A	N/A	N/A	4.5	**2.6**	--	2.06	-2	**1.2**	--	--	
Intertidal	ENR+AC	Composite of "C" Locations	LDW-Y0-IN-ENR+AC-CC-CORE	4/13/2017	Intertidal	ENR+AC	--	--	--	--	602.02	562.1	39.92	5.3	**3.0**	4.5	3.92	-0.8	**2.2**	2.8	0.18	8.4
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-1-C-COR	4/13/2017	Intertidal	ENR+AC	15,670	5,030	1,197	9,432	N/A	N/A	N/A	7.0	**4.2**	--	4.50	-2	**2.7**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-2-C-COR	4/13/2017	Intertidal	ENR+AC	10,597	3,465	715	6,407	N/A	N/A	N/A	5.2	**3.1**	--	4.53	2	**2.7**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-3-C-COR	4/13/2017	Intertidal	ENR+AC	13,590	5,165	952	7,460	N/A	N/A	N/A	4.6	**2.5**	--	5.16	-0.6	**2.8**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-4-C-COR	4/13/2017	Intertidal	ENR+AC	14,730	6,875	1,045	6,810	N/A	N/A	N/A	3.6 J	**1.7 J**	--	3.33	-2	**1.5**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-5-C-COR	4/13/2017	Intertidal	ENR+AC	12,765	4,600	1,105	7,055	N/A	N/A	N/A	4.4 J	**2.4 J**	--	2.38	-1	**1.3**	--	--	
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-6-C-COR	4/13/2017	Intertidal	ENR+AC	11,930	3,730	925	7,270	N/A	N/A	N/A	4.2	**2.6**	--	2.45	-1	**1.5**	--	--	

TABLE 14
TOTAL VOLATILE SOLIDS AND TOTAL ORGANIC CARBON RESULTS FOR BULK SEDIMENT
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

							Pre-Analytical Laboratory Submission Sieving to Remove Gravel Fraction				Analytical Laboratory Sieving			Total Volatile Solids[1] (TVS)			Total Organic Carbon[1] (TOC)					
						Analyte	Total Mass	Mass on 3/8" Sieve	Mass on No. 4 Sieve	Mass Passing No. 4	Total Mass	Mass on No. 50 Sieve	Mass Passing No. 50	TVS without Gravel Fraction (Average)	Corrected TVS with Gravel Fraction (Average)[2]	TVS Passing No. 50 Sieve (Average)[3]	TOC without Gravel Fraction (Average)	TOC RPD	Corrected TOC with Gravel Fraction (Average)[2]	TOC Passing No. 50 Sieve (Average)	Corrected TOC Passing No. 50 Sieve (Average)[4]	Ratio of TOC Passing No. 50 Sieve to TOC in Total Sample
Plot	Subplot	Sample Type	Sample ID	Sample Date	Plot	Sub Plot	g	g	g	g	g	g	g	%	%	%	%	%	%	%	%	%

Notes:
1. Data validation qualifiers as follows:
   J = Analyte was detected, concentration is considered to be an estimate.
   U = Analyte was not detected at the given reporting limit.
2. Samples collected from the intertidal and scour plots were sieved with a No. 4 sieve prior to analysis to remove the gravel fraction as the ENR substrate for those plots is gravelly sand. Samples from the subtidal plots were not sieved with a No. 4 sieve prior to analysis as the ENR substrate for that plot was sand only. TOC and TVS results were corrected to account for the mass of material removed by the #4 sieve (the gravel fraction). Reportable results for TOC and TVS are bolded/shaded.
3. TVS Passing No. 50 Sieve could not be corrected because the lab did not report weights of sample fractions.
4. TOC results were corrected to account for the mass of material removed by the No. 50 sieve.
5. Sample LDW-Y0-SC-ENR-CA-CORE was analyzed in triplicate for grain size only, the average result was used for corrections of sieved samples.
6. Sample LDW-Y0-SC-ENR-CC-CORE was not analyzed for TOC because sample volume was insufficient as a result of multiple unexpected analyses.

-- Not measured

BOLD Bolded/shaded values are the reportable value for TVS and TOC. Subtidal samples were not sieved, and thus did not need the correction that the scour and intertidal samples needed to remove the gravel fraction prior to analysis.

Abbreviations:

ENR = Enhanced natural recovery
ENR+AC = Enhanced natural recovery amended with activated carbon
g = gram(s)
NA = Not applicable
RPD = Relative percent difference
TOC = Total organic carbon
TVS = Total volatile solids

TABLE 15
GRAIN SIZE RESULTS FOR BULK SEDIMENT
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

							Grain Size[1]											Corrected Grain Size with Gravel Fraction[2]					
Plot	Subplot	Sample Type	Sample ID	Sample Date	Plot	Analyte Sub Plot	Cobbles	Total Gravel	Coarse Gravel	Fine Gravel	Total Sand	Coarse Sand	Medium Sand	Fine Sand	Total Fines	Silt Fine	Clay Fine	Total Gravel	Total Sand	Coarse Sand	Medium Sand	Fine Sand	Total Fines
							%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Subtidal	ENR	Composite of "A" Locations	LDW-Y0-SU-ENR-CA-CORE	4/13/2017	Subtidal	ENR	**0.1 U**	**0.6**	**0.1 U**	**0.6**	**98.1**	**21.7**	**46.7**	**29.7**	**1.3 J**	**1.3**	**0.1 U**	N/A	N/A	N/A	N/A	N/A	N/A
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-1-A-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-2-A-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-3-A-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-4-A-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-5-A-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-6-A-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Composite of "B" Locations	LDW-Y0-SU-ENR-CB-CORE	4/13/2017	Subtidal	ENR	**0.1 U**	**1**	**0.1 U**	**1**	**97.9**	**21.2**	**50.9**	**25.8**	**1.1 J**	**0.1 U**	**0.1 U**	N/A	N/A	N/A	N/A	N/A	N/A
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-1-B-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-2-B-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-3-B-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-4-B-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-5-B-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-6-B-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Composite of "C" Locations	LDW-Y0-SU-ENR-CC-CORE	4/13/2017	Subtidal	ENR	**0.1 U**	**0.5**	**0.1 U**	**0.5**	**97.4**	**23.6**	**48**	**25.8**	**2.1 J**	**0.1 U**	**0.1 U**	N/A	N/A	N/A	N/A	N/A	N/A
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-1-C-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-2-C-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-3-C-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-4-C-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-5-C-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR	Discrete	LDW-Y0-SU-ENR-6-C-COR	4/13/2017	Subtidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Composite of "A" Locations	LDW-Y0-SU-ENR+AC-CA-CORE	4/13/2017	Subtidal	ENR+AC	**0.1 U**	**0.2**	**0.1 U**	**0.2**	**98.8**	**20.9**	**51.9**	**26**	**1 J**	**0.1 U**	**0.1 U**	N/A	N/A	N/A	N/A	N/A	N/A
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-1-A-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-2-A-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-3-A-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-4-A-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-5-A-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-6-A-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Composite of "B" Locations	LDW-Y0-SU-ENR+AC-CB-CORE	4/13/2017	Subtidal	ENR+AC	**0.1 U**	**0.6**	**0.1 U**	**0.6**	**97.7**	**22.9**	**50.1**	**24.7**	**1.7 J**	**0.1 U**	**0.1 U**	N/A	N/A	N/A	N/A	N/A	N/A
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-1-B-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-2-B-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-3-B-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-4-B-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-5-B-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-6-B-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Composite of "C" Locations	LDW-Y0-SU-ENR+AC-CC-CORE	4/13/2017	Subtidal	ENR+AC	**0.1 U**	**1**	**0.1 U**	**1**	**97.4**	**21.7**	**49.8**	**25.9**	**1.6 J**	**1.6**	**0.1 U**	N/A	N/A	N/A	N/A	N/A	N/A
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-1-C-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-2-C-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-3-C-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-4-C-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-5-C-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtidal	ENR+AC	Discrete	LDW-Y0-SU-ENR+AC-6-C-COR	4/13/2017	Subtidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 15
GRAIN SIZE RESULTS FOR BULK SEDIMENT
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

							Grain Size[1]											Corrected Grain Size with Gravel Fraction[2]					
Plot	Subplot	Sample Type	Sample ID	Sample Date	Plot	Analyte Sub Plot	Cobbles	Total Gravel	Coarse Gravel	Fine Gravel	Total Sand	Coarse Sand	Medium Sand	Fine Sand	Total Fines	Silt Fine	Clay Fine	Total Gravel	Total Sand	Coarse Sand	Medium Sand	Fine Sand	Total Fines
							%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Scour	ENR	Composite of "A" Locations	LDW-Y0-SC-ENR-CA-CORE[3]	4/13/2017	Scour	ENR	0.1 U	1.4	0.1 U	1.4	98	31	53.5	13.5 J	0.6	0.1 U	0.1 U	**45.0**	**54.6**	**17.3**	**29.8**	**7.5**	**0.3**
							0.1 U	1.2	0.1 U	1.2	98.2	40.1	49.9	8.2 J	0.6	0.1 U	0.1 U	**44.9**	**54.8**	**22.4**	**27.8**	**4.6**	**0.3**
							0.1 U	1.2	0.1 U	1.2	98.2	38.1	51.3	8.8 J	0.6	0.1 U	0.1 U	**44.9**	**54.8**	**21.2**	**28.6**	**4.9**	**0.3**
Scour	ENR	Discrete	LDW-Y0-SC-ENR-1-A-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-2-A-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-3-A-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-4-A-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-5-A-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-6-A-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Composite of "B" Locations	LDW-Y0-SC-ENR-CB-CORE	4/13/2017	Scour	ENR	0.1 U	0.9	0.1 U	0.9	98.6	32.3	53.5	12.8	0.5	0.5	0.1 U	**48.2**	**51.5**	**16.9**	**27.9**	**6.7**	**0.3**
Scour	ENR	Discrete	LDW-Y0-SC-ENR-1-B-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-2-B-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-3-B-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-4-B-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-5-B-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-6-B-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Composite of "C" Locations	LDW-Y0-SC-ENR-CC-CORE	4/13/2017	Scour	ENR	0.1 U	2.4	0.1 U	2.4	97	34.3	52.1	10.6	0.6	0.6	0.1 U	**48.6**	**51.1**	**18.1**	**27.5**	**5.6**	**0.3**
Scour	ENR	Discrete	LDW-Y0-SC-ENR-1-C-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-2-C-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-3-C-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-4-C-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-5-C-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR	Discrete	LDW-Y0-SC-ENR-6-C-COR	4/13/2017	Scour	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Composite of "A" Locations	LDW-Y0-SC-ENR+AC-CA-CORE	4/13/2017	Scour	ENR+AC	0.1 U	1.8	0.1 U	1.8	97.3	38.2	46.9	12.2	0.9	0.9	0.1 U	**43.8**	**55.7**	**21.8**	**26.8**	**7.0**	**0.5**
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-1-A-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-2-A-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-3-A-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-4-A-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-5-A-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-6-A-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Composite of "B" Locations	LDW-Y0-SC-ENR+AC-CB-CORE	4/13/2017	Scour	ENR+AC	0.1 U	1.8	0.1 U	1.8	97.5	37.9	50.4	9.2	0.7	0.7	0.1 U	**47.3**	**52.4**	**20.4**	**27.1**	**4.9**	**0.4**
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-1-B-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-2-B-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-3-B-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-4-B-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-5-B-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-6-B-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Composite of "C" Locations	LDW-Y0-SC-ENR+AC-CC-CORE	4/13/2017	Scour	ENR+AC	0.1 U	2.3	0.1 U	2.3	96.7	33.4	46.3	17	1	1	0.1 U	**44.8**	**54.7**	**18.9**	**26.2**	**9.6**	**0.6**
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-1-C-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-2-C-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-3-C-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-4-C-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-5-C-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Scour	ENR+AC	Discrete	LDW-Y0-SC-ENR+AC-6-C-COR	4/13/2017	Scour	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 15

GRAIN SIZE RESULTS FOR BULK SEDIMENT

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

							Grain Size[1]											Corrected Grain Size with Gravel Fraction[2]					
Plot	Subplot	Sample Type	Sample ID	Sample Date	Plot	Analyte Sub Plot	Cobbles %	Total Gravel %	Coarse Gravel %	Fine Gravel %	Total Sand %	Coarse Sand %	Medium Sand %	Fine Sand %	Total Fines %	Silt Fine %	Clay Fine %	Total Gravel %	Total Sand %	Coarse Sand %	Medium Sand %	Fine Sand %	Total Fines %
Intertidal	ENR	Composite of "A" Locations	LDW-Y0-IN-ENR-CA-CORE	4/13/2017	Intertidal	ENR	0.1 U	1.7 J	0.1 U	1.7 J	97.7	35.4	49.9	12.4	0.6	0.1 U	0.1 U	**43.9**	**55.7**	**20.2**	**28.5**	**7.1**	**0.3**
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-1-A-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-2-A-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-3-A-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-4-A-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-5-A-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-6-A-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Composite of "B" Locations	LDW-Y0-IN-ENR-CB-CORE	4/13/2017	Intertidal	ENR	0.1 U	1.1 J	0.1 U	1.1 J	98.4	31.8	49.9	16.7	0.5	0.1 U	0.1 U	**44.6**	**55.1**	**17.8**	**28.0**	**9.4**	**0.3**
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-1-B-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-2-B-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-3-B-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-4-B-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-5-B-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-6-B-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Composite of "C" Locations	LDW-Y0-IN-ENR-CC-CORE	4/13/2017	Intertidal	ENR	0.1 U	1.9 J	0.1 U	1.9 J	97.5	44.2	41.6	11.7	0.6	0.1 U	0.1 U	**46.9**	**52.8**	**23.9**	**22.5**	**6.3**	**0.3**
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-1-C-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-2-C-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-3-C-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-4-C-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-5-C-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR	Discrete	LDW-Y0-IN-ENR-6-C-COR	4/13/2017	Intertidal	ENR	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Composite of "A" Locations	LDW-Y0-IN-ENR+AC-CA-CORE	4/13/2017	Intertidal	ENR+AC	0.1 U	1.4 J	0.1 U	1.4 J	98	42.2	46.9	8.9	0.6	0.1 U	0.1 U	**44.4**	**55.3**	**23.8**	**26.5**	**5.0**	**0.3**
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-1-A-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-2-A-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-3-A-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-4-A-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-5-A-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-6-A-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Composite of "B" Locations	LDW-Y0-IN-ENR+AC-CB-CORE	4/13/2017	Intertidal	ENR+AC	0.1 U	1 J	0.1 U	1 J	98.3	41.6	46.8	9.9	0.7	0.7	0.1 U	**44.8**	**54.8**	**23.2**	**26.1**	**5.5**	**0.4**
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-1-B-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-2-B-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-3-B-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-4-B-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-5-B-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-6-B-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Composite of "C" Locations	LDW-Y0-IN-ENR+AC-CC-CORE	4/13/2017	Intertidal	ENR+AC	0.1 U	1.7 J	0.1 U	1.7 J	97.3	39.4	45.6	12.3	1	1	0.1 U	**44.6**	**54.8**	**22.2**	**25.7**	**6.9**	**0.6**
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-1-C-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-2-C-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-3-C-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-4-C-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-5-C-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Intertidal	ENR+AC	Discrete	LDW-Y0-IN-ENR+AC-6-C-COR	4/13/2017	Intertidal	ENR+AC	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:

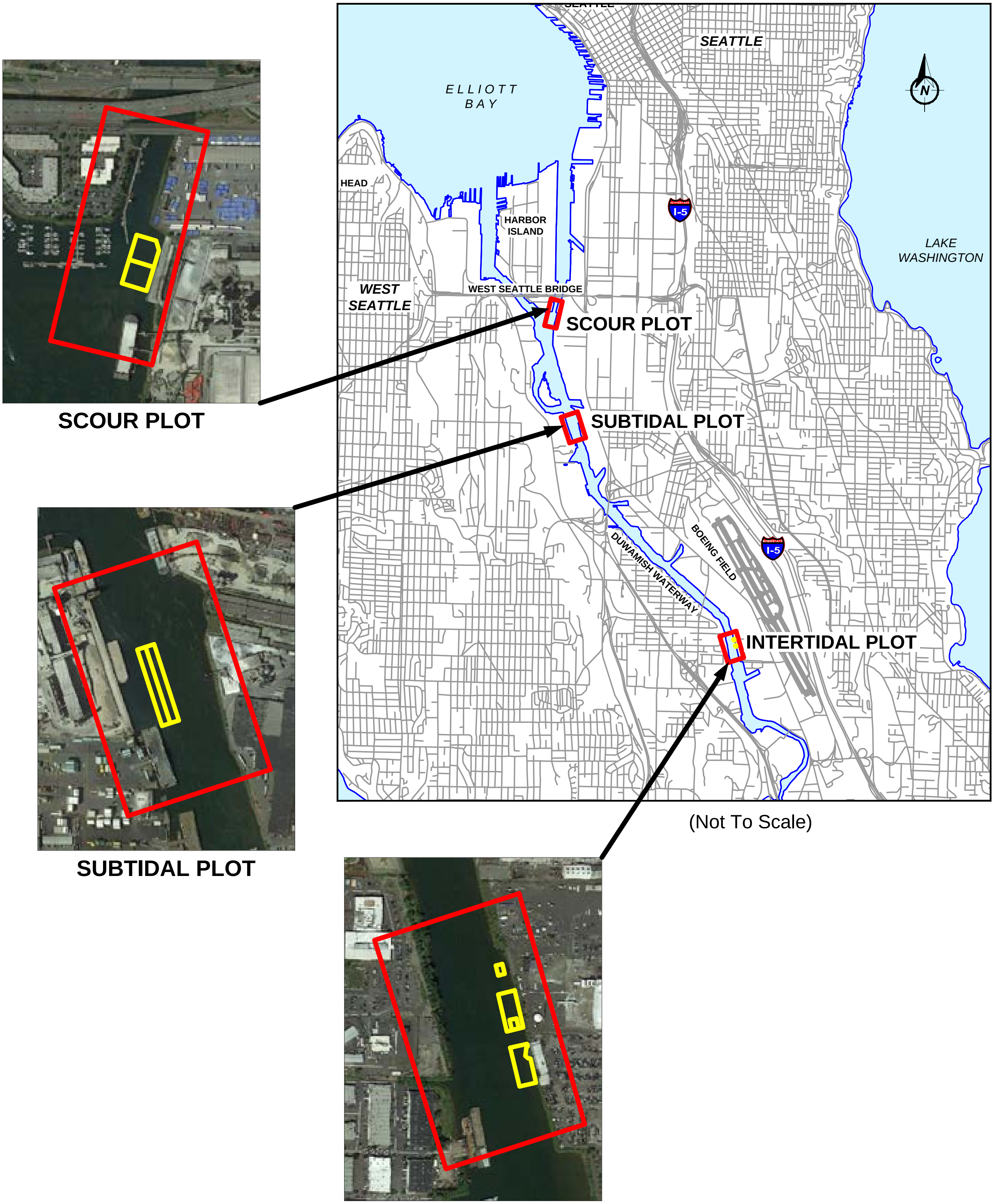
1. Data validation qualifiers as follows:
   J = Analyte was detected, concentration is considered to be an estimate.
   U = Analyte was not detected at the given reporting limit.
2. Samples collected from the intertidal and scour plots were sieved with a No. 4 sieve prior to analysis to remove the gravel fraction as the ENR substrate for those plots is gravelly sand. Samples from the subtidal plots were not sieved with a No. 4 sieve prior to analysis as the ENR substrate for that plot was sand only. Grain size results were corrected to account for the mass of material removed by the No. 4 sieve (the gravel fraction). Reportable results for grain size are bolded/shaded.
3. Sample LDW-Y0-SC-ENR-CA-CORE was analyzed in triplicate for grain size only.

--	Not measured
BOLD	Bolded/shaded values are the reportable value for TVS and TOC. Subtidal samples were not sieved, and thus did not need the correction that the scour and intertidal samples needed to remove the gravel fraction prior to analysis.

Abbreviations:

ENR = Enhanced natural recovery
ENR +AC = Enhanced natural recovery amended with activated carbon
g = gram(s)
NA = Not applicable
RPD = Relative percent difference
TOC = Total organic carbon
TVS = Total volatile solids

FIGURES



(Not To Scale)

Lower Duwamish Waterway Group

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ENR/AC Pilot Study
Construction Report
Lower Duwamish Waterway

Figure 1
Cover Sheet

PLOT TIME: 3/2/2017 1:14 PM MOD TIME: 3/2/2017 1:01 PM USER: Lee Barras DWG: D:\Projects\King Cnty GAC\Cad\Figures\2017-03\Construction Report\2017-03-02 KC-ENR Const Rpt Cover.dwg

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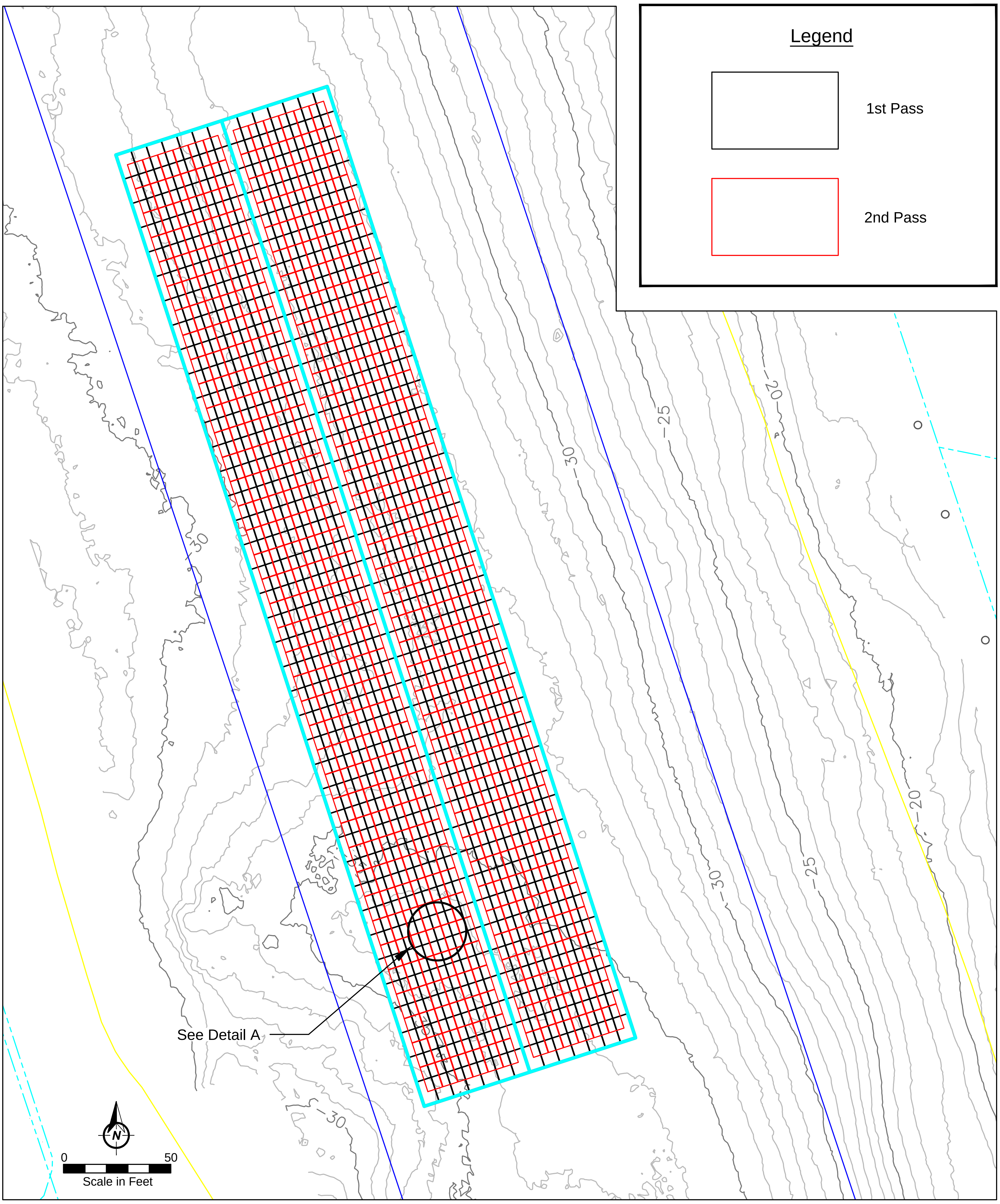

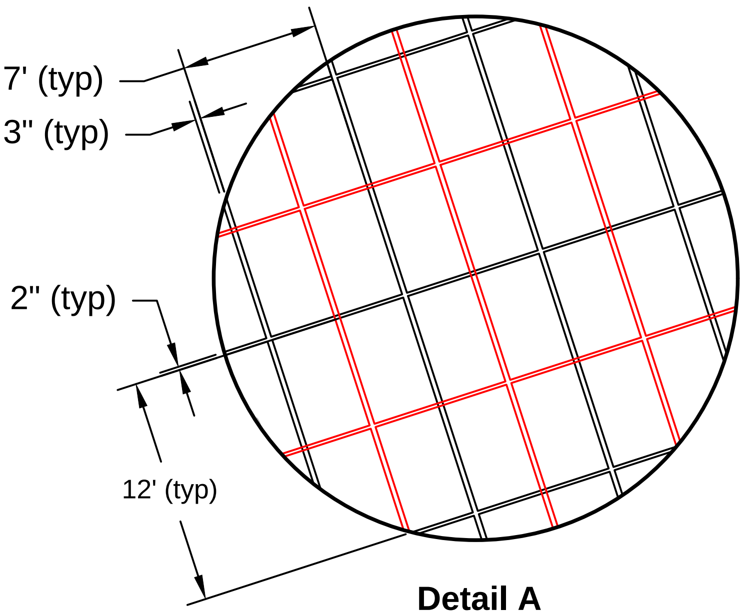

Detail A

Scale: 1"=10'

Lower Duwamish Waterway Group

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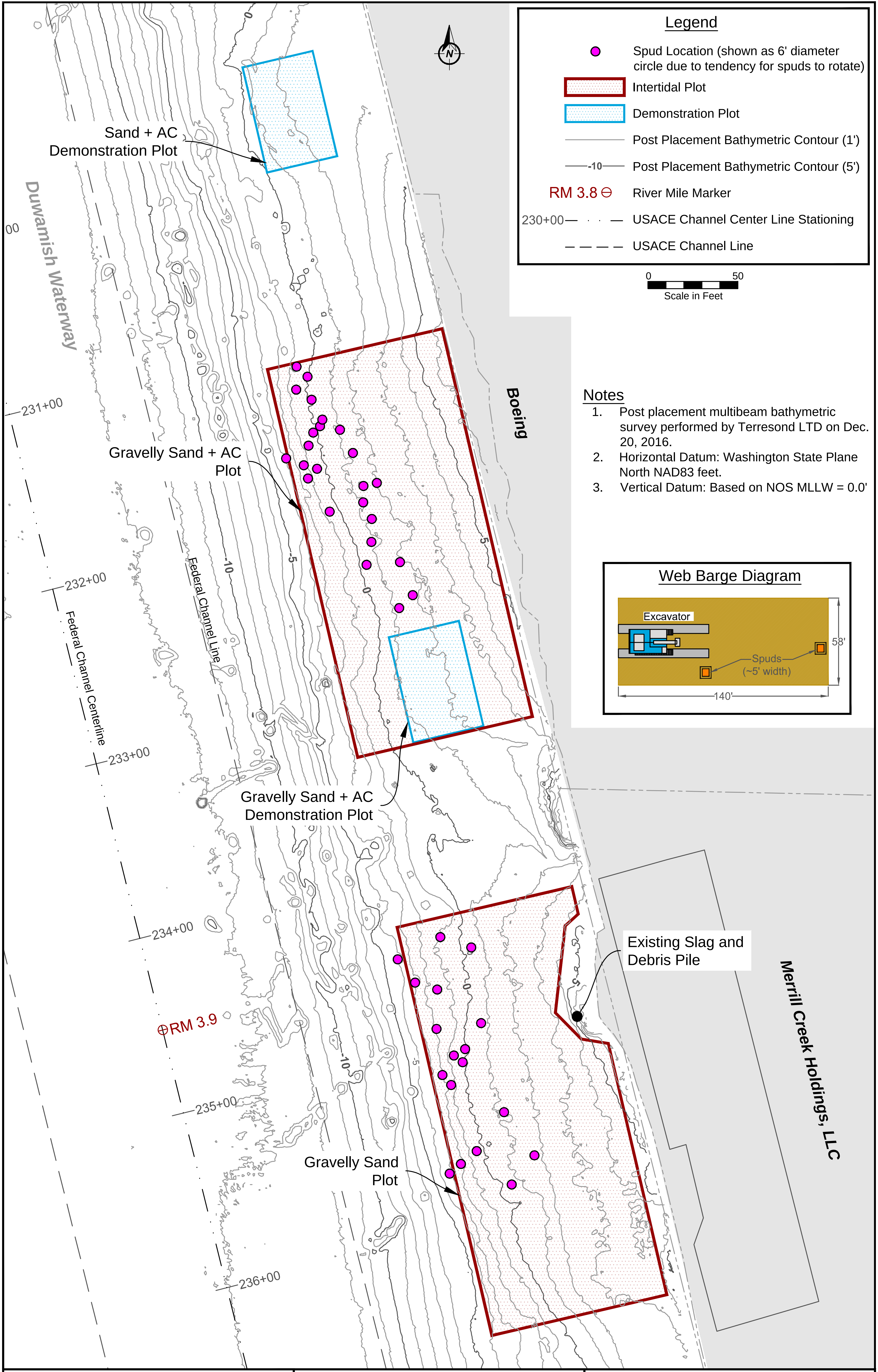
ENR/AC Pilot Study
Construction Report
Lower Duwamish Waterway

Figure 2
Subtidal Modified Bucket
Placement Grid



Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Dec. 20, 2016.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

Lower Duwamish Waterway Group

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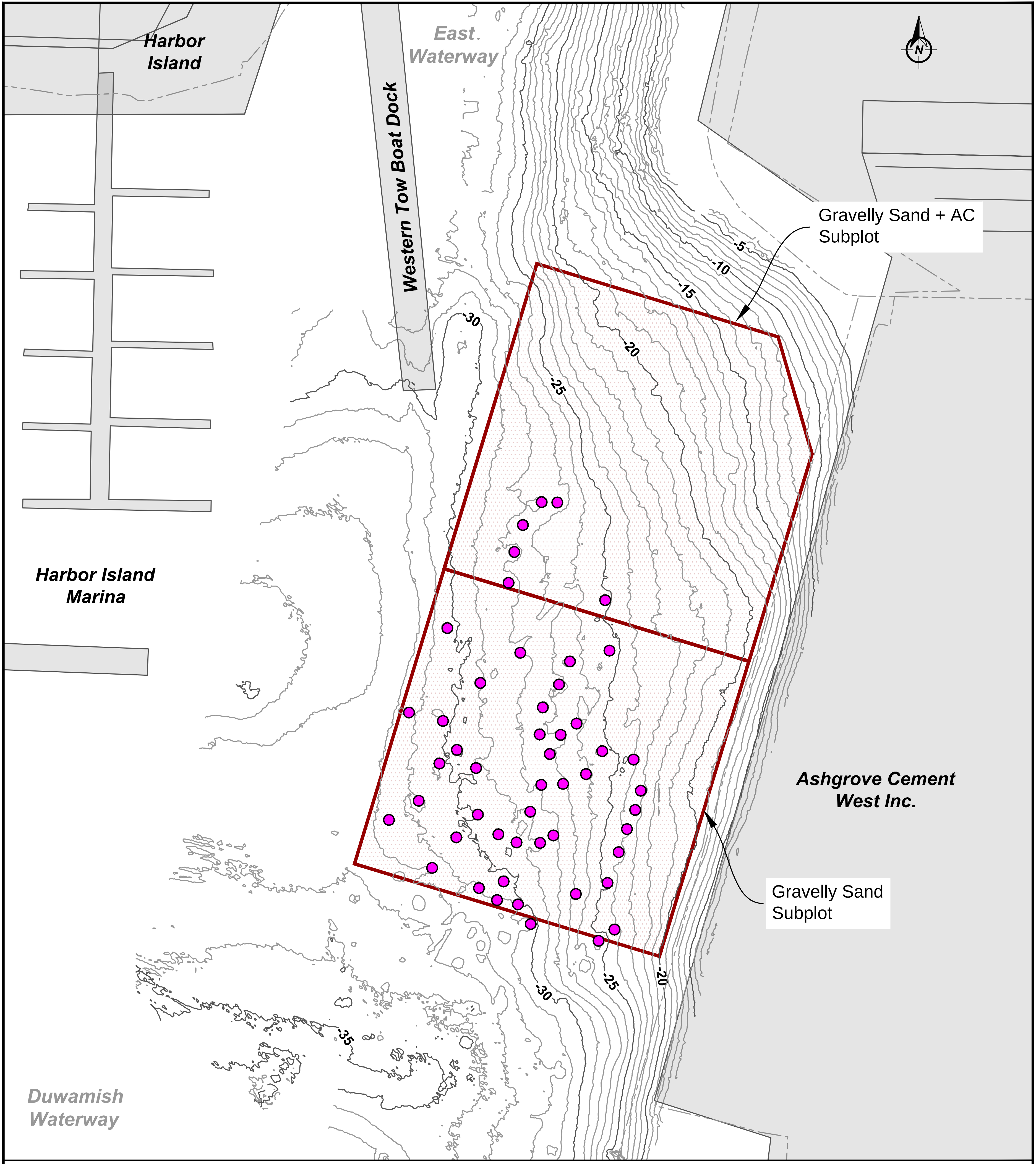
ENR/AC Pilot Study
Construction Report
Lower Duwamish Waterway

Figure 3
Spud Locations During Material Placement Intertidal Plot



Legend

● Spud Location (shown as 6' diameter circle due to tendency for spuds to rotate)

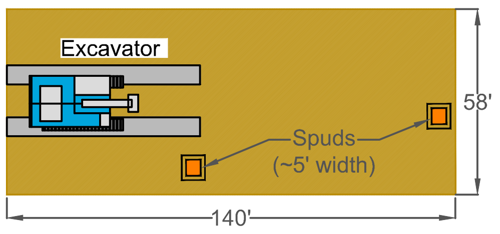
▨ Scour Plot

—— Post Placement Bathymetric Contour (1')

—-10— Post Placement Bathymetric Contour (5')

0 50
Scale in Feet

Web Barge Diagram



Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Jan. 06, 2017.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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Construction Report
Lower Duwamish Waterway

Figure 4
Spud Locations During
Material Placement
Scour Plot

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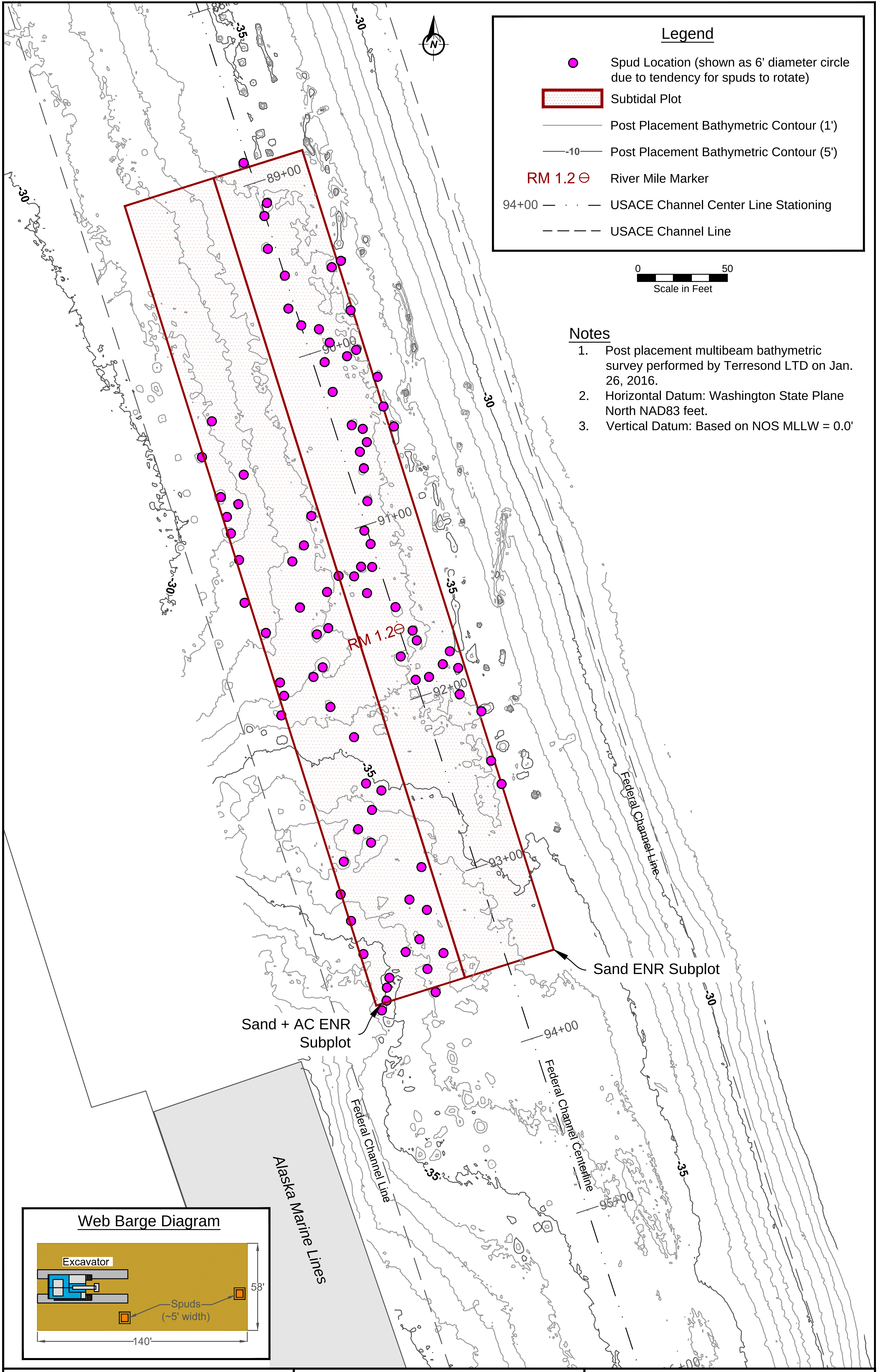

Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Jan. 26, 2016.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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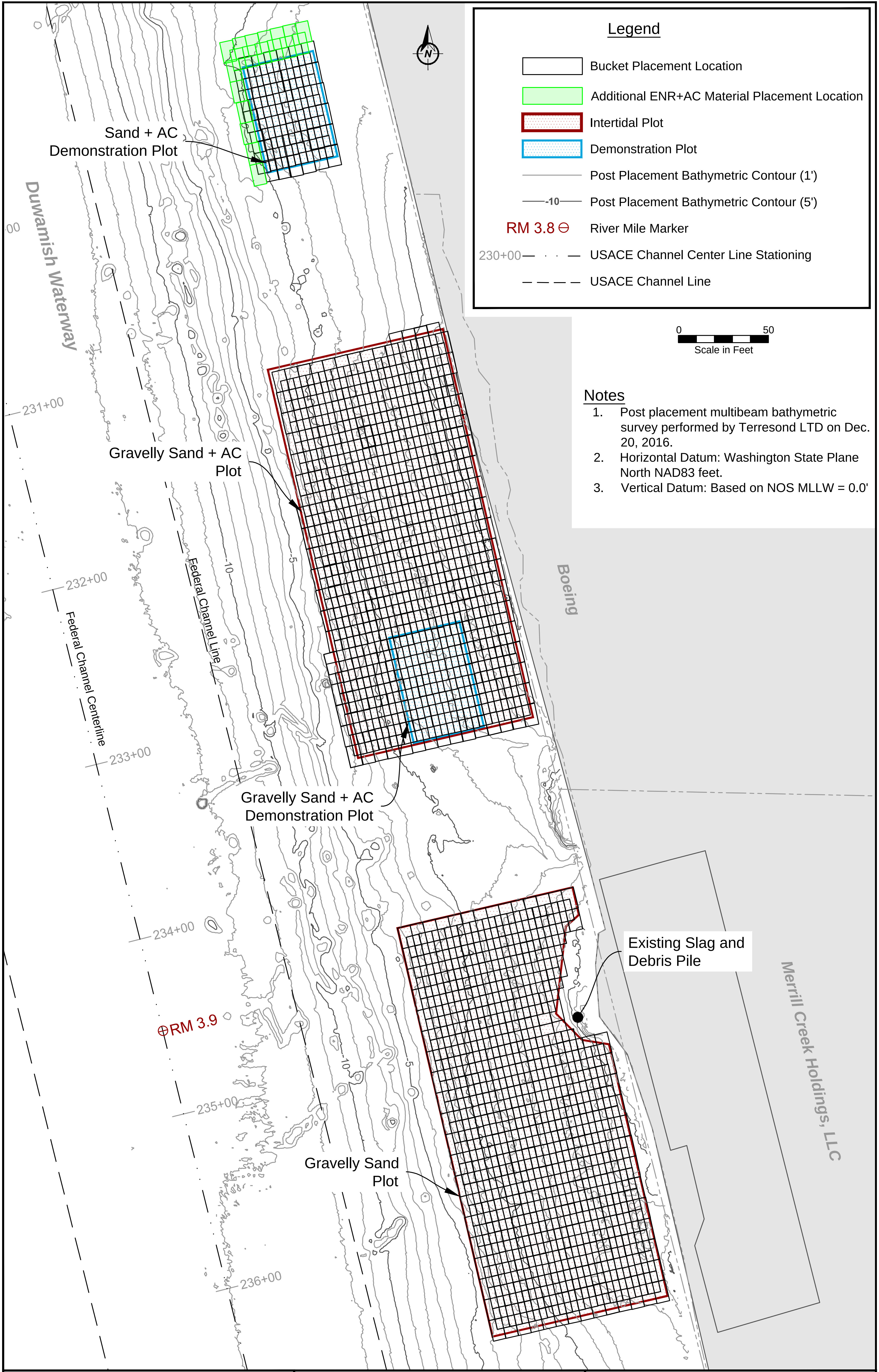
Construction Report
Lower Duwamish Waterway

Figure 5
Spud Locations During
Material Placement
Subtidal Plot



Notes
1. Post placement multibeam bathymetric survey performed by Terresond LTD on Dec. 20, 2016.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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Construction Report
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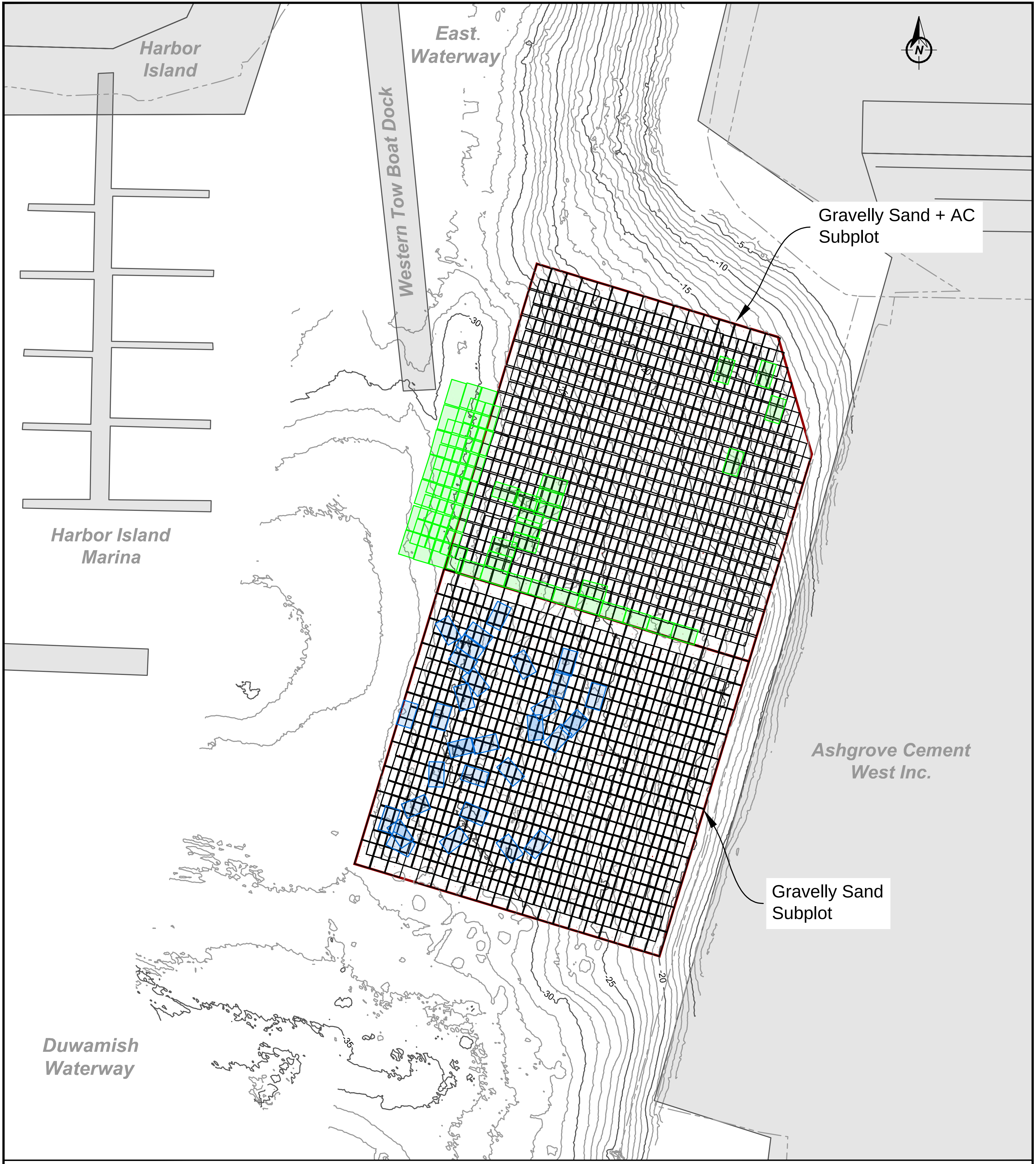
Figure 6
Bucket Placement Locations
Intertidal Plot

PLOT TIME: 3/14/2018 5:10 PM MOD TIME: 3/13/2018 4:26 PM DWG: D:\Projects\King Cnty GAC\Cad\Figures\2018-03\Construction Report\2017-03-02 KC-ENR Const Rpt Bucket Locs and Measmts.dwg



Legend

- ☐ Bucket Placement Location
- 🟩 Additional ENR+AC Material Placement Location
- 🟦 Additional ENR Material Placement Location
- ▨ Scour Plot
- —— Post Placement Bathymetric Contour (1')
- —-10— Post Placement Bathymetric Contour (5')

0 50
Scale in Feet

Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Jan. 06, 2017.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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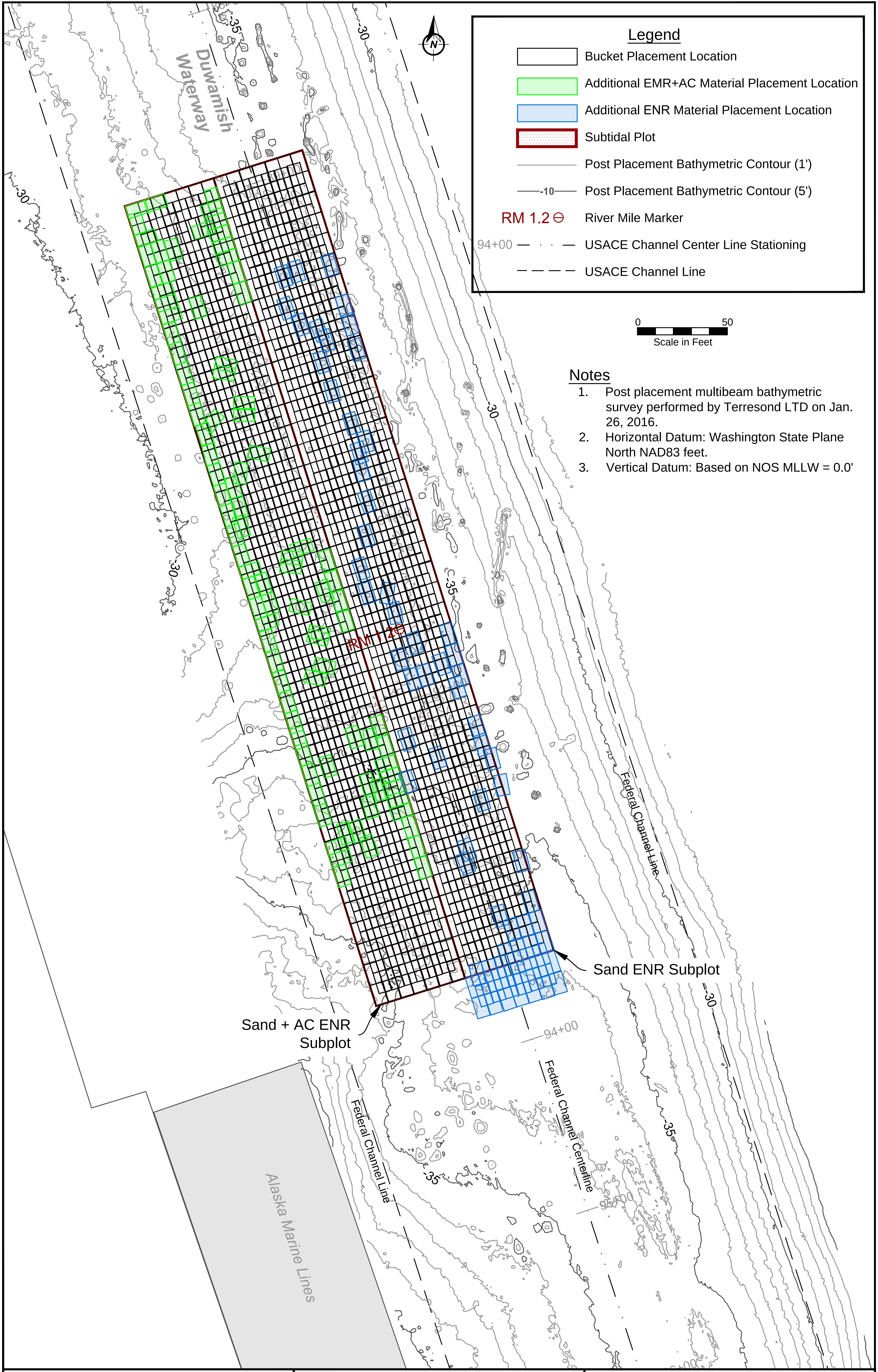
Construction Report
Lower Duwamish Waterway

Figure 7
Bucket Placement Locations
Scour Plot

PLOT TIME: 3/14/2018 5:10 PM   MOD TIME: 3/13/2018 4:26 PM   DWG: D:\Projects\King Cnty GAC\Cad\Figures\2018-03\Construction Report\2017-03-02 KC-ENR Const Rpt Bucket Locs and Measmts.dwg



Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Jan. 26, 2016.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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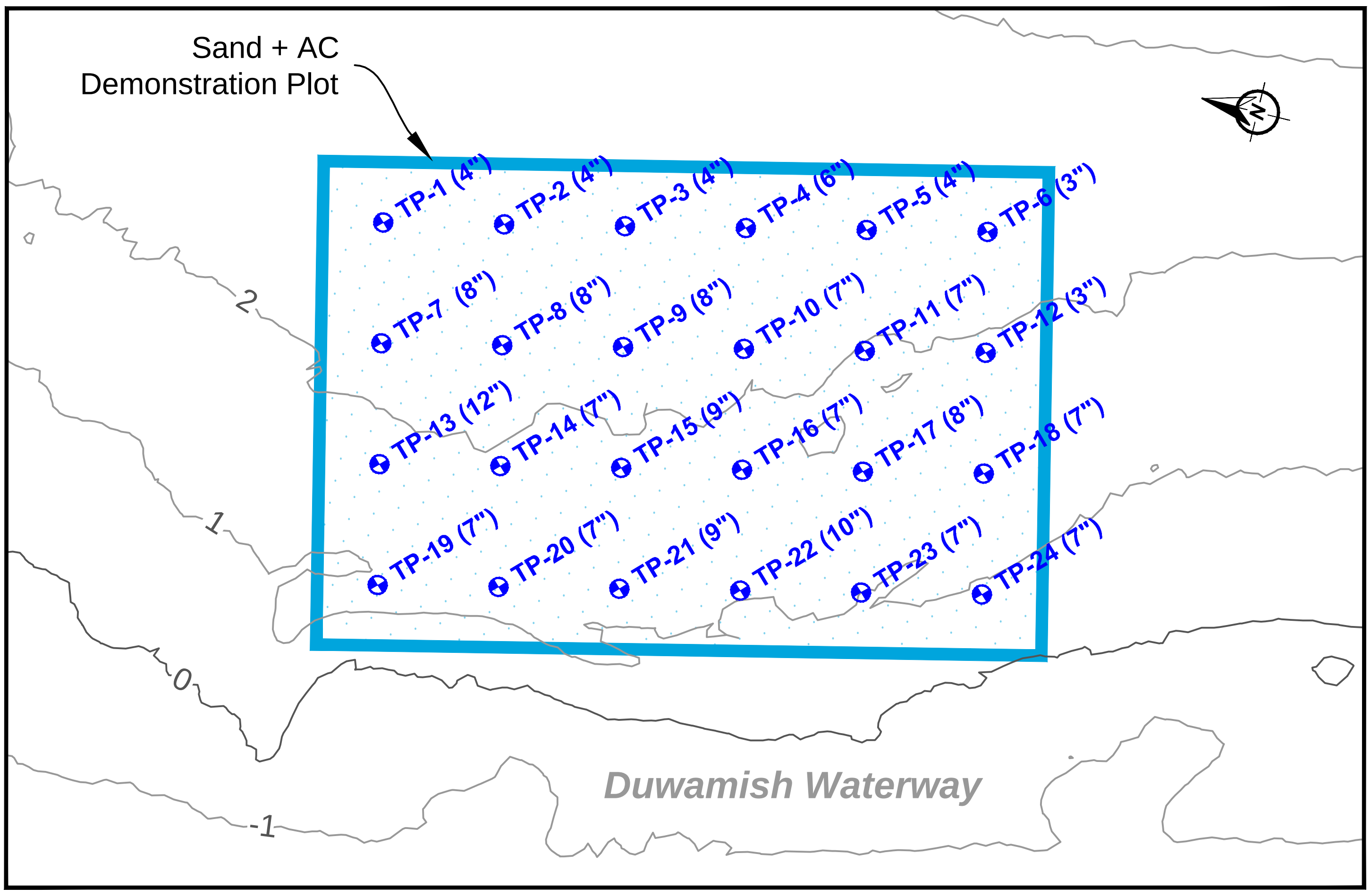
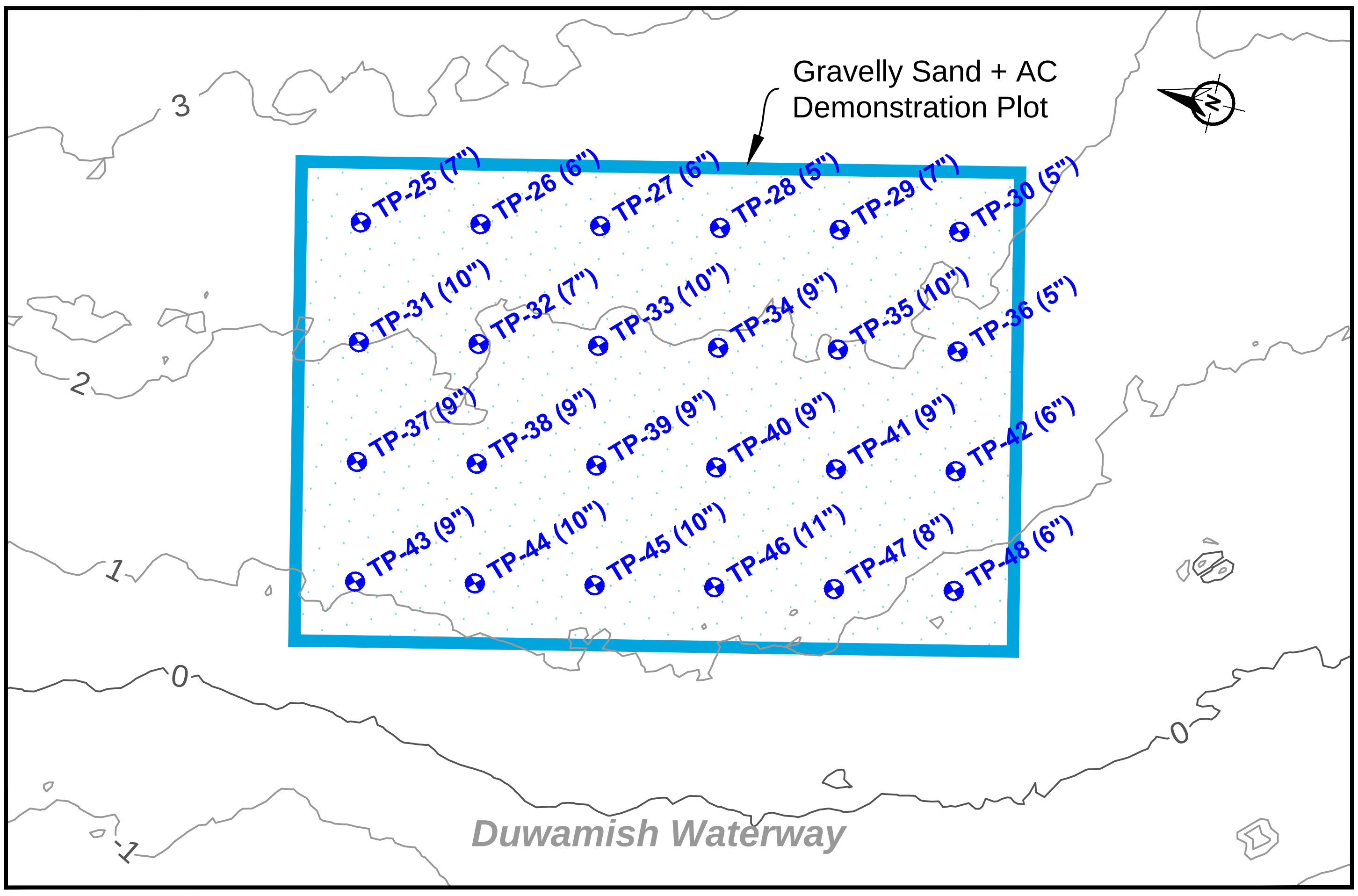
Figure 8
Bucket Placement Locations
Subtidal Plot

PLOT TIME: 3/13/2018 4:25 PM MOD TIME: 3/2/2017 1:13 PM DWG: D:\Projects\King Cnty GAC\Cad\Figures\2017-03\Construction Report\2017-03-02 KC-ENR Const Rpt Bucket Locs and Measmts.dwg

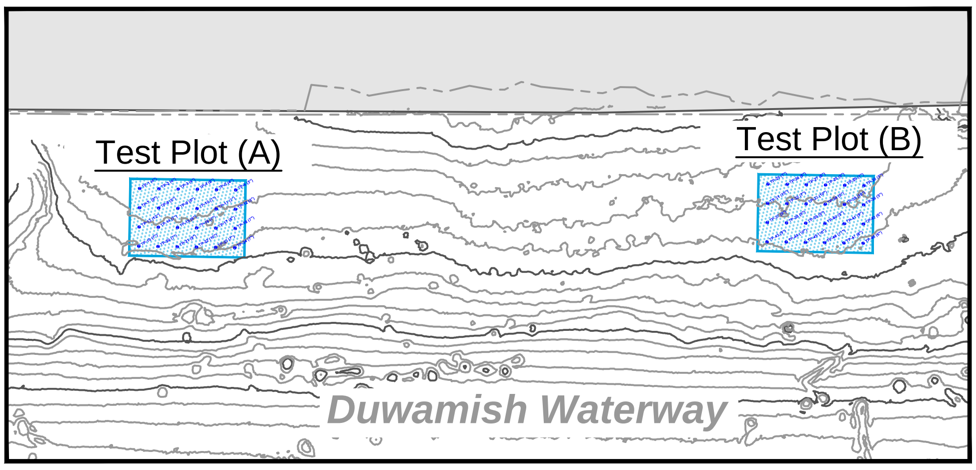


Test Plot
(Location A)



Test Plot
(Location B)

0 10
Scale in Feet



Overview (NTS)

Legend

⊕ **TP-1 (8")**	Stake Location (Thickness Measurement)
▭	Demonstration Plot
—	Post Placement Bathymetric Contour (1')
—-10—	Post Placement Bathymetric Contour (5')

Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Dec. 20, 2016.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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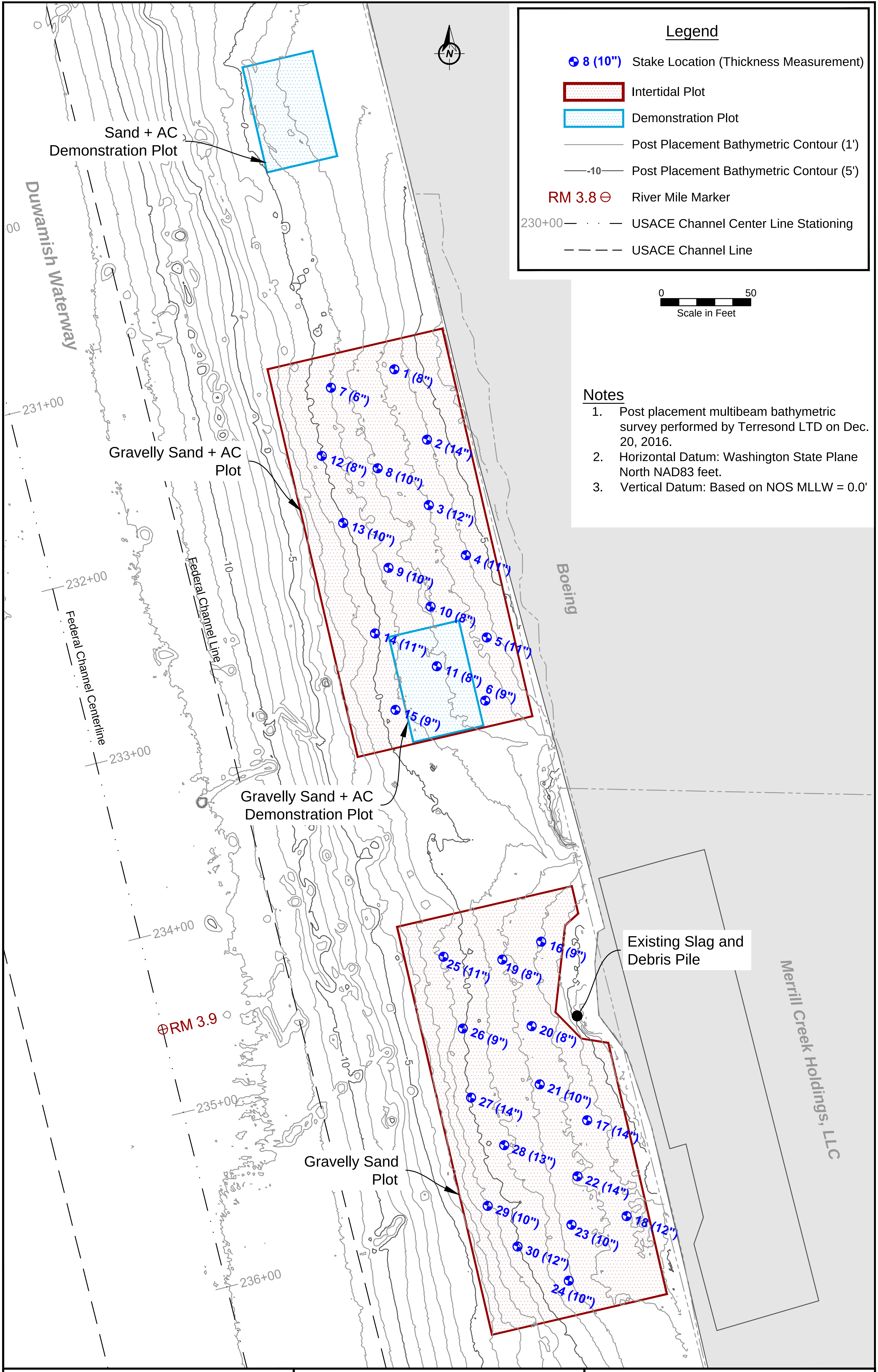
ENR/AC Pilot Study
Construction Report
Lower Duwamish Waterway

Figure 9
Stake Locations &
Field Thickness Measurements
Intertidal Demonstration Plots



Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Dec. 20, 2016.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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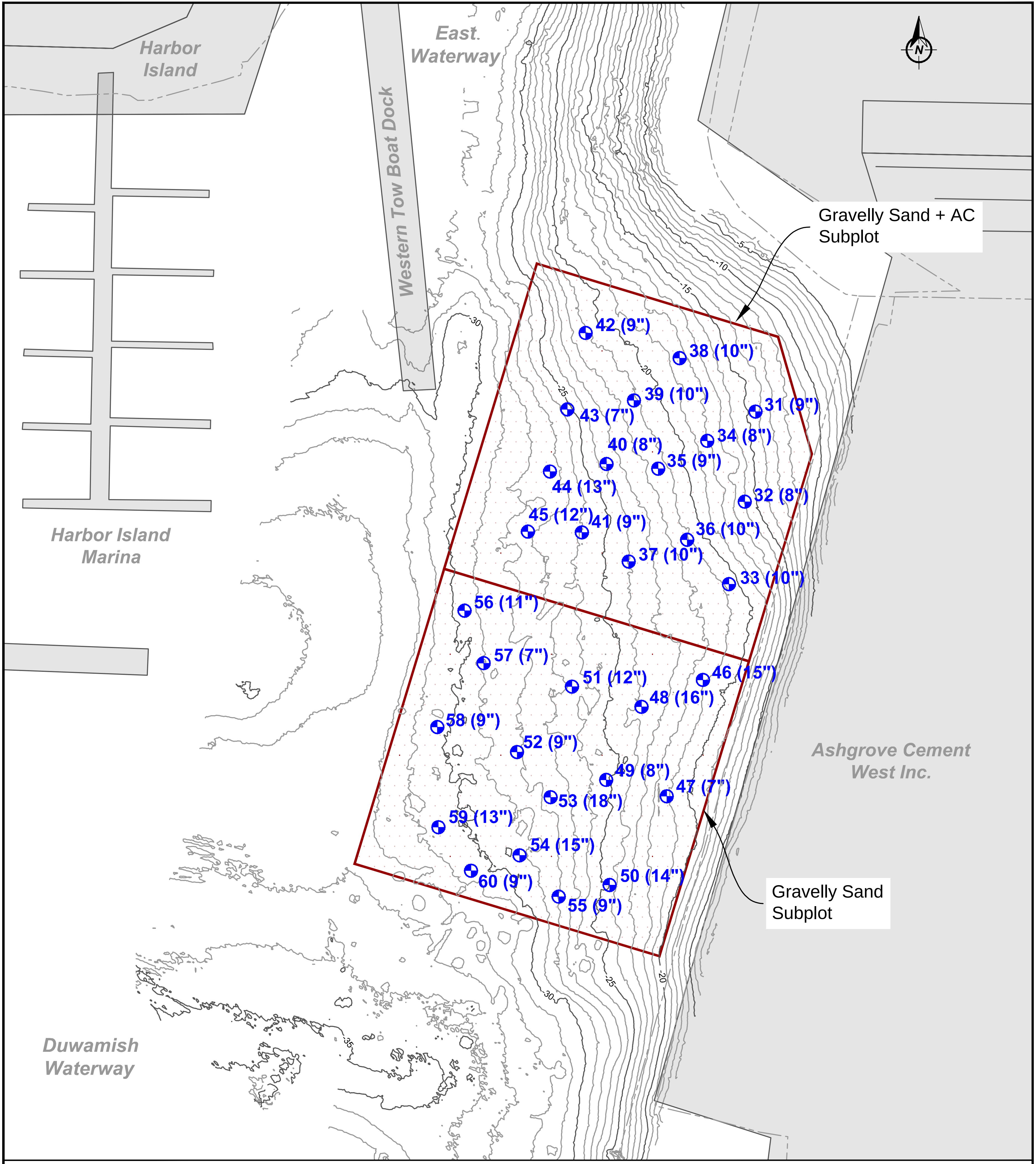
Construction Report
Lower Duwamish Waterway

Figure 10
Stake Locations &
Field Thickness Measurements
Intertidal Plot

PLOT TIME: 3/13/2018 4:25 PM MOD TIME: 3/2/2017 1:13 PM DWG: D:\Projects\King Cnty GAC\Cad\Figures\2017-03\Construction Report\2017-03-02 KC-ENR Const Rpt Bucket Locs and Measmts.dwg



Legend

⊕ **1 (8")** Stake Location (Thickness Measurement)

▨ Scour Plot

Post Placement Bathymetric Contour (1')

-10 Post Placement Bathymetric Contour (5')

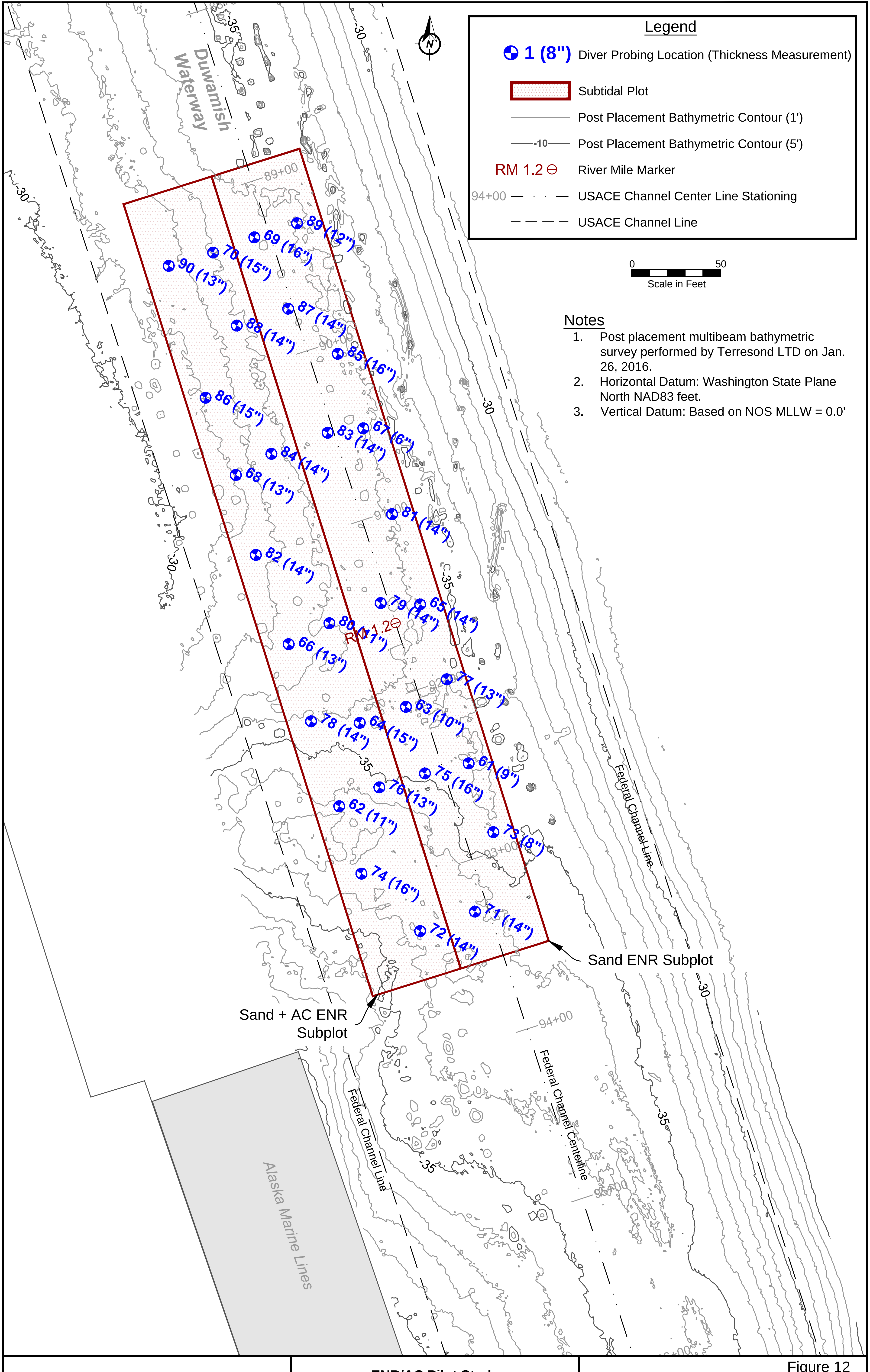
0 50

Scale in Feet

Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Jan. 06, 2017.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

Lower Duwamish Waterway Group Port of Seattle / City of Seattle / King County / The Boeing Company	**ENR/AC Pilot Study** **Construction Report** **Lower Duwamish Waterway**	Figure 11 Stake Locations & Field Thickness Measurements Scour Plot



Notes

1. Post placement multibeam bathymetric survey performed by Terresond LTD on Jan. 26, 2016.
2. Horizontal Datum: Washington State Plane North NAD83 feet.
3. Vertical Datum: Based on NOS MLLW = 0.0'

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Construction Report
Lower Duwamish Waterway

Figure 12
Diver Probing and ENR Thickness
Subtidal Plot

ATTACHMENT 1

Certification Statement

CERTIFICATION STATEMENT

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

The Enhanced Natural Recovery/Activated Carbon (ENR/AC) pilot project was constructed as detailed above in the King County ENR Construction Report. The ENR/AC material was placed as specified in the contract documents approved by the U.S. Environmental Protection Agency (EPA). Any modifications to the construction process were approved by EPA prior to implementation and are detailed above in the King County ENR Construction Report.

ATTACHMENT 2

Field Photographs

FIELD PHOTOGRAPHS
Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

LIST OF PHOTOGRAPHS

Photo 1 KP-3 barge being loaded with ENR material at CalPortland's Pioneer Aggregates barge-loading dock.

Photo 2 Control room for conveyor system at Pioneer Aggregates in DuPont, Washington.

FIELD PHOTOGRAPHS

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Photo 3 Hopper and auger used for blending AC with ENR material.

Photo 4 Black AC on top of brown ENR material moving down conveyor. Both materials are blended as they pass through several transition points prior to arriving at barge-loading dock.

Photo 5 500-kilogram bulk bag of AC being emptied into feed pile by CalPortland employee prior to blending with ENR.

Photo 6 Belt cut sampler used to collect an approximate 2-gallon cross-section sample of ENR+AC directly from the belt.

Photo 7 Baffle welded into left half of bucket to reduce bucket volume.

Photo 8 Baffle welded into right half of bucket to reduce bucket volume.

Photo 9 Bucket testing on dock with dry sand ENR.

Photo 10 Placement test on deck. Note hummocky surface.

Photo 11 Thickness measurement (~17 inches) after placing offset overlapping fifth bucket.

Photo 12 Modified overlapping bucket placement pattern after first two buckets placed.

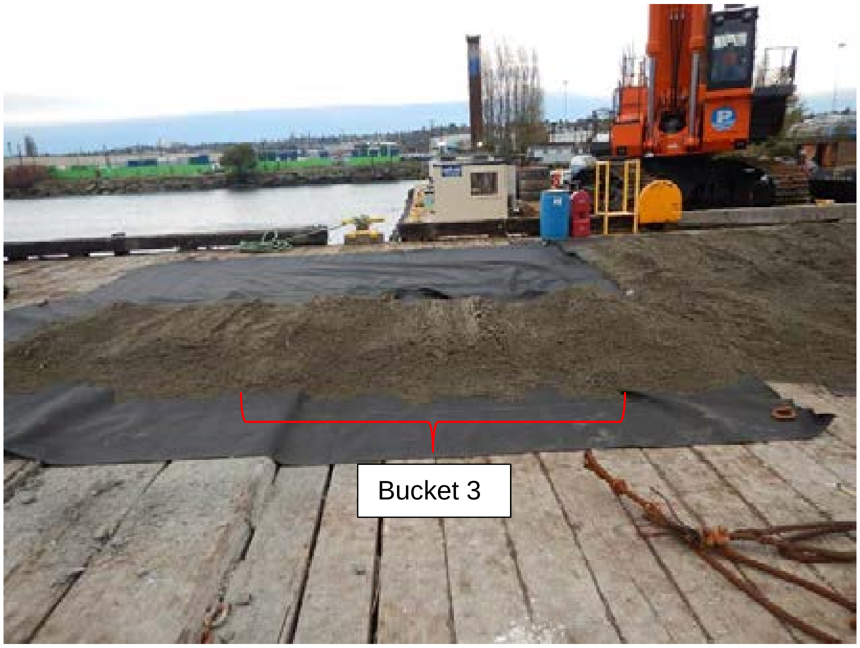


Photo 13 Modified overlapping bucket placement pattern after third bucket placed.

Photo 14 Thickness measurement (~14 inches) after placing third bucket using modified overlapping bucket placement pattern.

Photo 15 Three vents cut into baffles to allow bucket to vent freely.

Photo 16 Pumping of water into the barge to soak ENR+AC material overnight. Excavator is knocking down wind rows and leveling material.

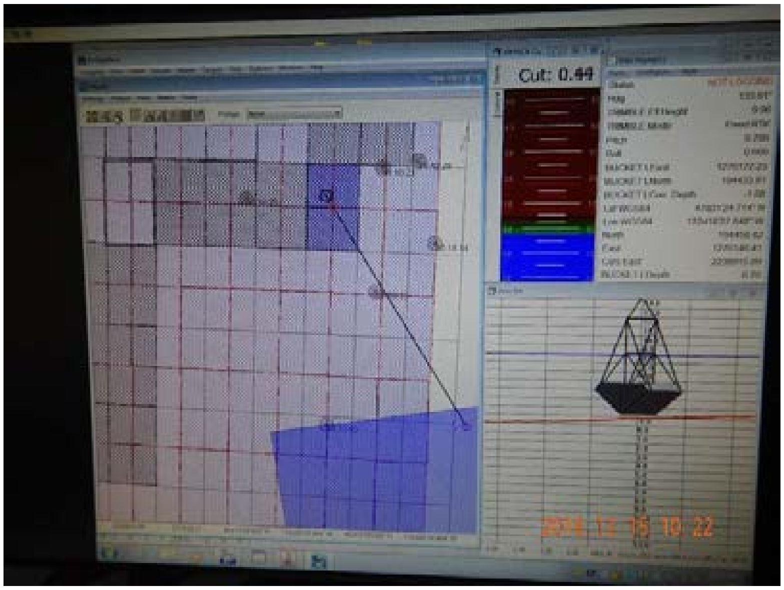


Photo 17 Operator DredgePack operating screen used to direct placement. The right side of the screen shows the target placement grid and the bucket location in near real time. The bottom left corner shows the open/close position. Above the bucket is a maroon, green, and blue indicator bar for elevation, with the green area representing the target elevation (2 feet +/- 0.25 feet) for the bucket to be opened.

Photo 18 Excavator taking from the material barge. GPS antennas and sensors used for bucket positioning are circled in red and green, respectively.

Photo 19 Placement of material in the intertidal plot.

Photo 20 Excavator grabs a bucket of submerged ENR+AC material.

Photo 21 DOF representative surveys grade stake location.

Photo 22 Grade stake placed in the intertidal plot prior to material placement.

Photo 23 Sand ENR+AC demonstration plot after material placement.

Photo 24 Gravelly sand ENR+AC demonstration plot after material placement.


2016 11 30 22:09

Photo 25 Spud mark offshore of the intertidal plot.


2016 11 30 22:27

Photo 26 Thin veneer of fine-grained AC observed downstream of the intertidal plot.

FIELD PHOTOGRAPHS

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway

Photo 27 Fine-grained AC floating to the surface after the underlying ENR+AC material was disturbed by the shovel.

Photo 28 AC ball found in the Intertidal plot.

Photo 29 Water treatment plant for all water that is pumped out of the barges.

Photo 30 Water quality monitoring vessel downstream of the placement.

Photo 31 Cargo vessel being towed out to Elliott Bay by Foss tug boats.

Photo 32 Alaska Marine Lines barge Whittier Provider is taken upstream. Note the tow bridles hanging in the water.

Photo 33 Alaska Marine Lines barge Fairbanks Provider being brought upstream.

Photo 34 Barge Fairbanks Provider travels over the subtidal plot as it heads down river with its tow bridle hanging in the water. It is assumed that the bridle is dragging across the river floor based on the scope of the bridle.

ATTACHMENT 3

Barge Loading Reports

DALTON
OLMSTED
FUGLEVAND

Barge Loading Report No. 001

Prepared By: RMM
Work Date: Nov. 23, 2016

Project: Enhanced Natural Recovery / Activated Carbon Pilot Study
Location: CalPortland- Pioneer Aggregates Plant, DuPont, WA

Time On Site:

DOF:
Start Time: 8:30 Stop Time: 12:30

Comments: Loading KP-2 barge with split load of Sand + AC and Gravelly Sand + AC.

Day's Site Conditions:

Weather data from National Weather Service for Tacoma Narrows Airport and field observations.

Weather: Partial clouds until around noon. Cloudy with showers after noon.

Temperature:
Low: 44° F at 09:00
High: 46° F at 12:00

Wind: 13 to 16 mph, gusts to 24 mph

Precipitation:
During Shift: 0.07”
24-hr Total: 0.20”

Predicted Tide During Loading (DuPont Wharf):
High: +13.8’ MLLW at 13:28
Low: +6.4’ MLLW at 09:00

Barges Loading Information:

Barge ID	Material Type		Sample(s) Collected?	Tons Loaded
☒ KP-2	☒ Sand + AC	☒ Gravelly Sand + AC	Yes	144/1,174 tons
☐ KP-3	☐ Sand + AC	☐ Gravelly Sand + AC		tons

Staff On Site:

DOF:
☒ Rich May ☐ Teal Dreher ☐ Dan Pickering ☐ Rob Webb

CalPortland POC:
☐ Sean Smith ☒ Jarod Pedroza (CalPortland Q.C. technician)

Visitors to Project: ☒None ☐See Below:

Name	Organization	Reason for Visit	Comments

Summary of Work Performed This Shift:

- KP-2 arrived at Pioneer Aggregates dock the morning of the 23rd. Boyer tug Diane H., which brought the KP-1 from Seattle to DuPont, stayed on site until loading was complete.
- Prior to starting to load the KP-2, CalPortland crew built up feed pile of AC and charged (filled) the AC hopper. There were several "dry runs" of the conveyors prior to loading to insure they were running at the proper speed for the revolutions in which the AC auger was running to get required percentage of AC in blend.
- KP-2 barge was loaded with 144 tons of sand + AC and 1,174 tons of gravelly sand + AC. Tonnage goal was 141 tons sand + AC and 1,166 tons gravelly sand + AC.
- Information only samples LDW-BA-BL-GrvSand-0-500 and LDW-BA-BL-GrvSand-500-1000 were collected and delivered to Material Testing Consultants, Inc, to be sieved with the portion passing the no. 4 sieve to be analyzed for TOC and Black Carbon at Alpha. Weights of portions passing and retained by the no. 4 will be reported to Floyd|Snider and AMEC Foster Wheeler.

Other Issues Encountered: ☐ None ☒ See Comments below:

- CalPortland was concerned about loading sand + AC and gravelly sand + AC too close to the steel plate bulkhead constructed by PPM to separate the two materials. Materials were loaded with only the toe of the windrow against the bulkhead. Prior to soaking sand + AC it may be desirable to flatten peak of material so that less water will be required to saturate. See photo 2016-11-23 11.25.28 in this report.

Samples Collected: ☐ None ☒ See below:

Sample ID	Material Type	Analytical Parameter
LDW-BA-BL-GrvSand-0-500	Gravelly Sand + AC	TOC, black carbon
LDW-BA-BL-GrvSand-500-1000	Gravelly Sand + AC	TOC, black carbon

Daily Photo Log: Nov. 23, 2016

DOF DALTON OLMSTED FUGLEVAND

2016-11-23 09.23.29 AC hopper and auger which delivers AC to ENR material. ENR and AC are blended as both materials pass through transition points while enroot to the loading wharf.

2016-11-23 08.59.33 Cross section sampler used to collect samples directly off the conveyor. Volume of each sample is approximately two gallons.

Daily Photo Log: Nov. 23, 2016

2016-11-23 10.51.43 Gravelly sand + AC being loaded onto the KP-2 barge.

2016-11-23 11.25.28 Sand + AC was loaded at the stern of the KP-2 barge. CalPortland loaded the material so that just the toe of the windrow was against the bulkhead between the two materials.

GLACIER NORTHWEST

Phone (253) 912-8500
Fax (253) 912-8510

Today's Loading Schedule DUPONT

Date: 11/23/2016 Time: 10:06

Hauler: 999

Barge # : KP3

Customer: 1018032 Pacific Pile Contracting

Order: Lower Duwamish

P.O.: 9099

Customer	Ticket #	Product	Ordered	Loaded
Sand	1501142	7725	135	138
GAC added	1501144	92000011	51	51
Gravelly sand	1501111	7404	1119	1127
GAC added	1501112	92000011	47	45
GAC added	1511118	92000011		2
		TOTALS:	1352	1363

Load Number: 18653 Capacity: 0

Comments:

Sand: 138 tons, Gravelly Sand: 1,127 tons, AC blended with ENR: 53 tons, Total ENR+AC: 1,318 tons

% AC = 100(53 ton/ 1318 ton) = 4%

Future summaries will report AC quantities in tons that are blended.

-RM

User: rstabler 12/14/2016

DALTON
OLMSTED
FUGLEVAND

Barge Loading Report No. 002

Prepared By: RMM
Work Date: Dec. 05, 2016

Project: Enhanced Natural Recovery / Activated Carbon Pilot Study
Location: CalPortland- Pioneer Aggregates Plant, DuPont, WA

Time On Site:

DOF:
Start Time: 9:00 Stop Time: 13:00

Comments: Loading KP-3 barge with Gravelly Sand.

Day's Site Conditions: Weather data from National Weather Service for Tacoma Narrows Airport and field observations.

Weather: Cold and overcast with some snow flurries in the morning. Snow did not stick to the ground.

Temperature:
Low: 36° F at 09:00
High: 37° F at 12:00

Wind: 8 to 14 mph, gusts to 23 mph

Precipitation:
During Shift: 0.00”
24-hr Total: 0.44”

Predicted Tide During Loading (DuPont Wharf):
High: +14.1’ MLLW at 10:45
Low: +11.6’ MLLW at 12:30

Barges Loading Information:

Barge ID	Material Type		Sample(s) Collected?	Tons Loaded
☐ KP-2	☐ Sand + AC	☐ Gravelly Sand + AC		tons
☒ KP-3	☐ Sand	☒ Gravelly Sand	No	1,166 tons

Staff On Site:

DOF:
☒ Rich May ☐ Teal Dreher ☐ Dan Pickering ☐ Rob Webb

CalPortland POC:
☒ Sean Smith ☐ Jarod Pedroza (CalPortland Q.C. technician)

Visitors to Project: ☒None ☐See Below:

Name	Organization	Reason for Visit	Comments

Barge Loading Report No. 002

Prepared By: RMM
Work Date: Dec. 05, 2016

Summary of Work Performed This Shift:

- KP-3 barge was at Pioneer Aggregates mooring buoy at 9:00 when DOF representative arrived on site. The KP-3 barge was the third of six barges to be loaded at CalPortland's dock for the day.
- The Boyer tug Diane H. brought the KP-3 barge to CalPortland's dock for loading and remained on site until loading was complete.
- Loading of the KP-3 barge was originally scheduled for 10:00 but started at approximately 11:00. Loading of the KP-3 was complete at about 12:30.
- 1,166 tons of Gravelly Sand was loaded onto the KP-3.
- Diane H. towed the KP-3 back to PPM's dock in Seattle.
- Prior to and during barge loading the activated carbon (AC) blending and stockpile area was visited by DOF and CalPortland representatives. AC which is still in super-sacks is placed on pallets and the AC feed pile and hopper have been tarped.
- CalPortland expecting to receive the final load of AC for the project on 12/5/16.

Other Issues Encountered: ☒ None ☐ See Comments below:

- None

Samples Collected: ☒ None ☐ See below:

Sample ID	Material Type	Analytical Parameter

Daily Photo Log: Dec. 05, 2016

DALTON
OLMSTED
FUGLEVAND

2016-12-05 11.33.01 Overhead view of the KP-3 barge being loaded with Gravelly Sand ENR material at CalPortland's dock in DuPont.

2016-12-05 11.25.40 Bow of KP-3 barge being loaded with Gravelly Sand ENR material at CalPortland's DuPont dock with conveyor near full extension.

Daily Photo Log: Dec. 05, 2016

2016-12-05 11.40.35 AC feed pile and hopper for auger that feeds AC onto conveyor tarped when not in use.

2016-12-05 11.42.24 AC placed on pallets to keep the super sacks out of the standing water.

Barge Loading Report No. 003

Prepared By: RMM
Work Date: Dec. 13, 2016

Project: Enhanced Natural Recovery / Activated Carbon Pilot Study
Location: CalPortland- Pioneer Aggregates Plant, DuPont, WA

Time On Site:

DOF:
Start Time: 11:00 Stop Time: 14:00

Comments: Loading KP-2 barge with Gravelly Sand + AC

Day's Site Conditions: Weather data from National Weather Service for Tacoma Narrows Airport and field observations.

Weather: Cold and overcast.

Temperature: Wind: 9 to 14 mph, gusts to 22 mph

Low: 37° F at 11:00 High: 38° F at 12:00

Precipitation:
During Shift: 0.00”
24-hr Total: 0.00”

Predicted Tide During Loading (DuPont Wharf):
High: +11.0’ MLLW at 13:30
Low: +7.1’ MLLW at 11:30

Barges Loading Information:

Barge ID	Material Type		Sample(s) Collected?	Tons Loaded
☒ KP-2	☐ Sand + AC	☒ Gravelly Sand + AC	Yes	1,195 tons
☐ KP-3	☐ Sand	☐ Gravelly Sand	No	tons

Staff On Site:

DOF:
☐ Rich May ☐ Teal Dreher ☐ Dan Pickering ☒ Rob Webb

CalPortland POC:
☐ Sean Smith ☒ Jarod (CalPortland Q.C. technician)

Visitors to Project: ☒None ☐See Below:

Name	Organization	Reason for Visit	Comments

Barge Loading Report No. 003

Prepared By: RMM
Work Date: Dec. 13, 2016

Summary of Work Performed This Shift:

- KP-2 barge loaded with 1,195 tons of Gravelly Sand + AC
- Three ENR+AC samples collected to represent the 1,000 to 1,500 ton interval, the 1,500 to 2,000 ton interval, and the 2,000 to 2,500 ton interval of Gravelly Sand +AC.
- Samples will need to be sieved to separate material above and below the no. 4 sieve at Materials Testing Consultants prior to being sent to Alpha Analytical for TOC and black carbon

Other Issues Encountered: ☒ None ☐ See Comments below:

- None

Samples Collected: ☐ None ☒ See below:

Sample ID	Material Type	Analytical Parameter
LDW-BA-BL-GrvSand-1k-1.5k	Gravelly Sand + AC	TOC, Black Carbon
LDW-BA-BL-GrvSand-1.5k-2k	Gravelly Sand + AC	TOC, Black Carbon
LDW-BA-BL-GrvSand-2k-2.5k	Gravelly Sand + AC	TOC, Black Carbon

Daily Photo Log: Dec. 13, 2016

20161213_124124 Activated carbon being loaded into the feed hopper and placed onto the Gravelly Sand material.

20161213_130734 Gravelly Sand + AC loaded onto the KP-2 barge.

GLACIER NORTHWEST

Phone (253) 912-8500
Fax (253) 912-8510

Today's Loading Schedule DUPONT

Date: 12/13/2016 Time: 11:58

Hauler: 999

Barge # : KP2

Customer: 1018032 Pacific Pile Contracting

Order: Lower Duwamish

P.O.: 9099

Ticket #	Product	Ordered	Loaded
1511100	7404	1140	1147
1511102	92000011	48	48
	TOTALS:	1188	1195

Load Number: 18685

Capacity: 0

Comments:

Gravelly Sand: 1,147 tons, AC blended with Gravelly Sand: 48 tons, Total ENR+AC: 1,195 tons
% AC = 100(48 ton/ 1,195 ton) = 4%
-RM

User: rstabler 12/14/2016

DALTON OLMSTED FUGLEVAND

Barge Loading Report No. 004

Prepared By: RMM
Work Date: Dec. 16, 2016

Project: Enhanced Natural Recovery / Activated Carbon Pilot Study
Location: CalPortland- Pioneer Aggregates Plant, DuPont, WA

Time On Site:

DOF:
Start Time: 17:00 Stop Time: 18:20

Comments: Loading KP-3 barge with Gravelly Sand during CalPortland's night shift. Gravelly Sand to be used to complete placement at Intertidal ENR subplot and for Scour ENR subplot.

Day's Site Conditions: Weather data from National Weather Service for Tacoma Narrows Airport and field observations.

Weather: Cold and clear. Ice observed on ground.
Temperature: Wind: Calm
Low: 25º F High: 25º F
at 17:00 at 18:00

Precipitation:
During Shift: 0.00"
24-hr Total: 0.00"

Predicted Tide During Loading (DuPont Wharf):
High: +12.8' MLLW at 17:45
Low: +11.8' MLLW at 17:00

Barges Loading Information:

Barge ID	Material Type		Sample(s) Collected?	Tons Loaded
☐ KP-2	☐ Sand + AC	☐ Gravelly Sand + AC	No	tons
☒ KP-3	☐ Sand	☒ Gravelly Sand	No	1,363 tons

Staff On Site:

DOF:
☒ Rich May ☐ Teal Dreher ☐ Dan Pickering ☐ Rob Webb

CalPortland POC:
☐ Sean Smith ☒ Jeremy Auman (CalPortland Night Foreman)

Visitors to Project: ☒None ☐See Below:

Name	Organization	Reason for Visit	Comments

Summary of Work Performed This Shift:

- KP-3 barge loaded with 1,363 tons of Gravelly Sand.
- With only ENR being loaded onto the KP-3 barge, CalPortland was able to increase the belt speed so that barge was loaded quicker than an ENR+AC barge. When a barge is loaded with ENR+AC the belt speed must be reduced to get the proper ratio of ENR to AC.
- Counted remaining super sacks of AC remaining at CalPortland. 108 super sacks remaining with bags labeled as 500 kilograms each for approximately 59.5 tons of AC remaining at CalPortland.

Other Issues Encountered: ☒ None ☐ See Comments below:

- None

Samples Collected: ☒ None ☐ See below:

Sample ID	Material Type	Analytical Parameter

Daily Photo Log: Dec. 16, 2016

2016-12-16 17.25.05 KP-3 Barge was loaded with 1,363 tons of Gravelly Sand during the evening of the 16th.

2016-12-16 17.39.40 108 super sacks of AC remain at CalPortland with the bags labeled with a weight of 500 kgs each.

Barge Loading Report No. 005

Prepared By: RMM
Work Date: Dec. 30, 2016

Project: Enhanced Natural Recovery / Activated Carbon Pilot Study
Location: CalPortland- Pioneer Aggregates Plant, DuPont, WA

Time On Site:

DOF:
Start Time: 8:15 Stop Time: 11:30

Comments: Loading KP-2 barge with Sand + AC

Day's Site Conditions: Weather data from National Weather Service for Tacoma Narrows Airport and field observations.

Weather: Clear at the beginning of loading with clouds increasing throughout the morning.

Temperature: Wind: Clam to 6 mph

Low: 32º F	High: 39º F
at 09:00	at 10:58

Precipitation:

During Shift:	0.00"
24-hr Total:	0.04"

Predicted Tide During Loading (DuPont Wharf):

High:	+12.8' MLLW	at 09:00
Low:	+09.1' MLLW	at 11:00

Barges Loading Information:

Barge ID	Material Type		Sample(s) Collected?	Tons Loaded
☒ KP-2	☒ Sand + AC	☐ Gravelly Sand + AC	Yes	1,303 tons
☐ KP-3	☐ Sand	☐ Gravelly Sand	No	tons

Staff On Site:

DOF:
☒ Rich May ☐ Teal Dreher ☐ Dan Pickering ☐ Rob Webb

CalPortland POC:
☐ Sean Smith ☒ Jarod Pedroza (CalPortland Q.C. technician)

Visitors to Project: ☒None ☐See Below:

Name	Organization	Reason for Visit	Comments

Barge Loading Report No. 005

Prepared By: RMM
Work Date: Dec. 30, 2016

Summary of Work Performed This Shift:

- Loading of the KP-2 barge was rescheduled from the first week of Jan. 2017 to Dec. 30, 2016 due to forecast temperatures in the 20's and below for the first week of Jan.
- KP-2 barge loaded with 1,303 tons of Sand + AC
- Three ENR+AC samples collected to represent the 0 to 500 ton interval, the 500 to 1,000 ton interval, and the 1,000 to 5,500 ton interval of Sand +AC.

Other Issues Encountered: ☒ None ☐ See Comments below:

- None

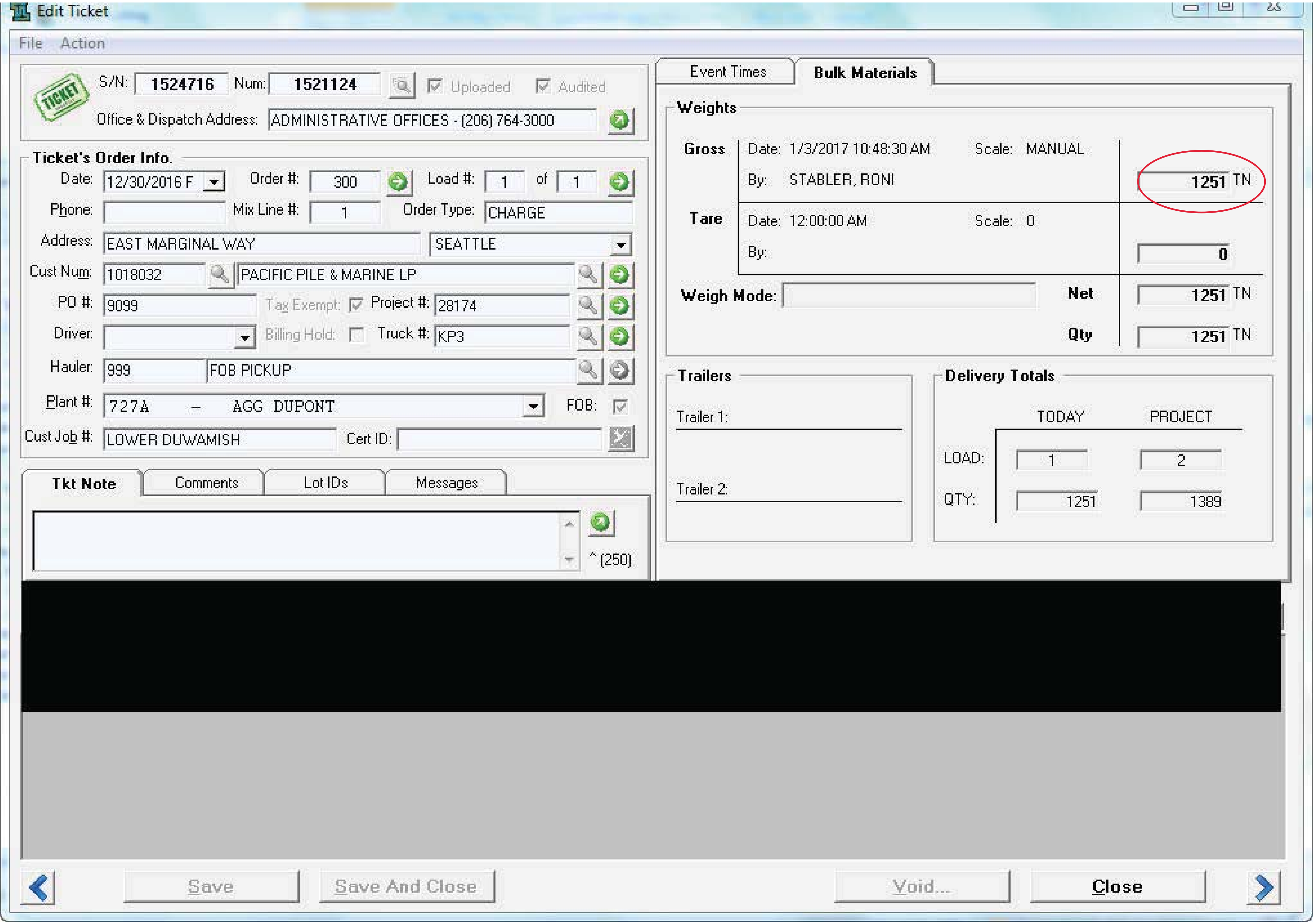
Samples Collected: ☐ None ☒ See below:

Sample ID	Material Type	Analytical Parameter
LDW-BA-BL-Sand-0-500	Sand + AC	TOC, Black Carbon
LDW-BA-BL-Sand-500-1k	Sand + AC	TOC, Black Carbon
LDW-BA-BL-Sand-1k-1.5k	Sand + AC	TOC, Black Carbon

Daily Photo Log: Dec. 30, 2016

2016-12-30 10.09.00 CalPortland quality control technician preparing to collect ENR+AC sample from the belt. For safety reasons, only CalPortland personnel were authorized to operate the cross-belt sampler.

2016-12-30 10.09.31 ENR+AC sample representing the 1,000 to 1,500 ton interval prior to homogenizing.



S/N: 1524716 Num: 1521124 ☑ Uploaded ☑ Audited

Office & Dispatch Address: ADMINISTRATIVE OFFICES - (206) 764-3000

Ticket's Order Info.

Date: 12/30/2016 F

Order #: 300

Load #: 1 of 1

Phone:

Mix Line #: 1

Order Type: CHARGE

Address: EAST MARGINAL WAY SEATTLE

Cust Num: 1018032 PACIFIC PILE & MARINE LP

PO #: 9099

Tax Exempt: ☑

Project #: 28174

Driver:

Billing Hold: ☐

Truck #: KP3

Hauler: 999 FOB PICKUP

Plant #: 727A – AGG DUPONT

FOB: ☑

Cust Job #: LOWER DUWAMISH

Cert ID:

^ (250)

Weights

Gross Date: 1/3/2017 10:48:30 AM Scale: MANUAL

By: STABLER, RONI 1251 TN

Tare Date: 12:00:00 AM Scale: 0

By: 0

Weigh Mode:

Net 1251 TN

Qty 1251 TN

Trailers

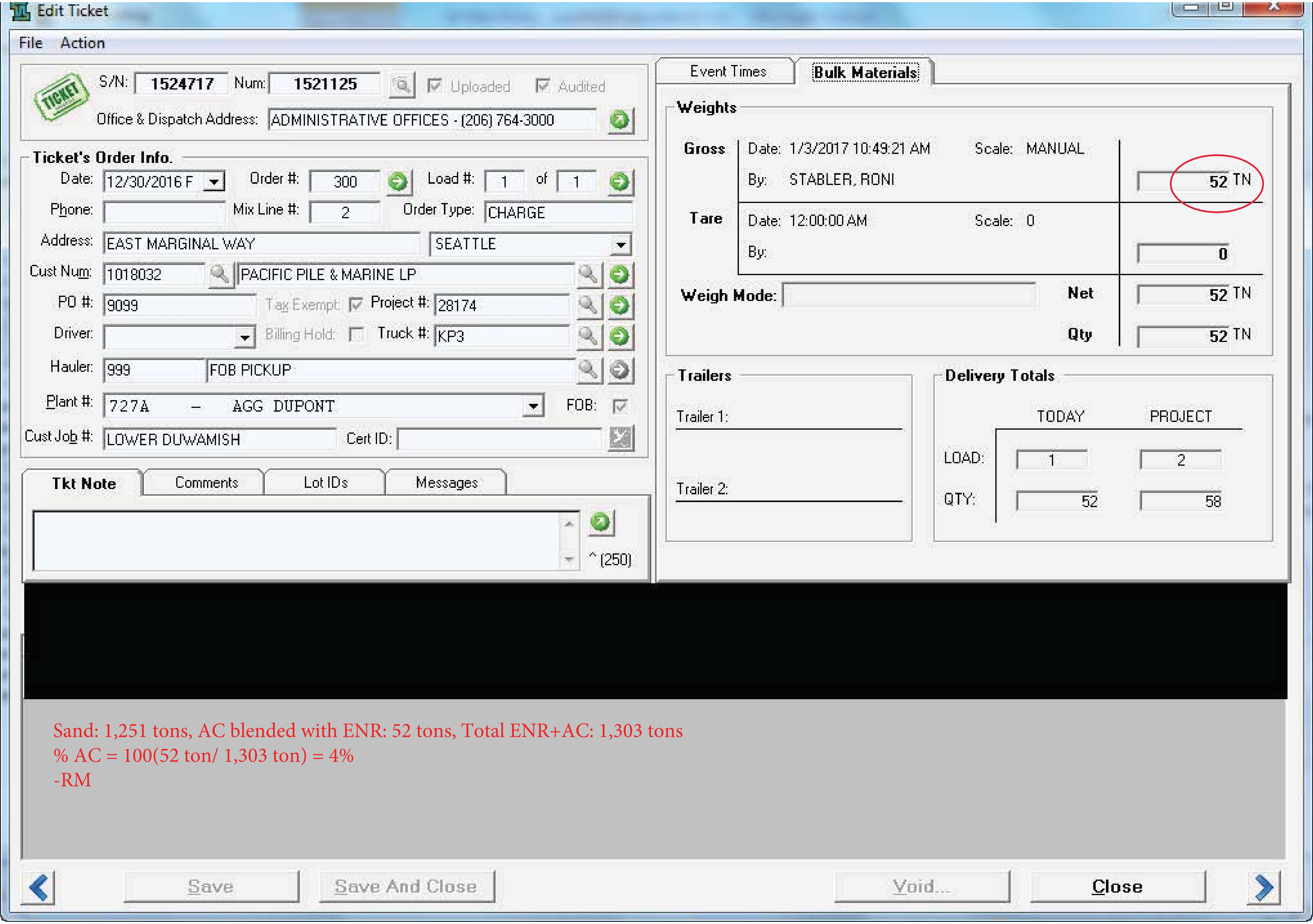
Trailer 1:

Trailer 2:

Delivery Totals

	TODAY	PROJECT
LOAD:	1	2
QTY:	1251	1389

[redacted]



S/N: 1524717 Num: 1521125 ☑ Uploaded ☑ Audited

Office & Dispatch Address: ADMINISTRATIVE OFFICES - (206) 764-3000

Ticket's Order Info.

Date: 12/30/2016 F Order #: 300 Load #: 1 of 1

Phone: Mix Line #: 2 Order Type: CHARGE

Address: EAST MARGINAL WAY SEATTLE

Cust Num: 1018032 PACIFIC PILE & MARINE LP

PO #: 9099 Tax Exempt: ☑ Project #: 28174

Driver: Billing Hold: ☐ Truck #: KP3

Hauler: 999 FOB PICKUP

Plant #: 727A – AGG DUPONT FOB: ☑

Cust Job #: LOWER DUWAMISH Cert ID:

^ (250)

Weights

Gross Date: 1/3/2017 10:49:21 AM Scale: MANUAL
By: STABLER, RONI 52 TN

Tare Date: 12:00:00 AM Scale: 0
By: 0

Weigh Mode: **Net** 52 TN

Qty 52 TN

Trailers

Trailer 1:

Trailer 2:

Delivery Totals

	TODAY	PROJECT
LOAD:	1	2
QTY:	52	58

[redacted]

Sand: 1,251 tons, AC blended with ENR: 52 tons, Total ENR+AC: 1,303 tons
% AC = 100(52 ton/ 1,303 ton) = 4%
-RM

DOF DALTON OLMSTED FUGLEVAND

Barge Loading Report No. 006

Prepared By: RMM
Work Date: Jan. 13, 2017

Project: Enhanced Natural Recovery / Activated Carbon Pilot Study
Location: CalPortland- Pioneer Aggregates Plant, DuPont, WA

Time On Site:

DOF:
Start Time: 9:30 Stop Time: 12:30

Comments: Loading KP-3 barge with ENR (sand). Due to freezing weather the road leading down to the loading dock was closed off to all vehicles and restricted to foot traffic only. Even when walking down to the loading dock, personnel had to watch their footing for ice.

Day's Site Conditions: Weather data from National Weather Service for Tacoma Narrows Airport and field observations.

Weather: Cold and clear.
Temperature: Wind: Calm to 5 mph
Low: 28° F High: 35° F
at 09:30 at 12:30

Precipitation:
During Shift: 0.00”
24-hr Total: 0.44”

Predicted Tide During Loading (DuPont Wharf):
High: +14.1’ MLLW at 10:45
Low: +11.6’ MLLW at 12:30

Barges Loading Information:

Barge ID	Material Type		Sample(s) Collected?	Tons Loaded
☐ KP-2	☐ Sand + AC	☐ Gravelly Sand + AC		tons
☒ KP-3	☒ Sand	☐ Gravelly Sand	No	1,341 tons

Staff On Site:

DOF:
☒ Rich May ☐ Teal Dreher ☐ Dan Pickering ☐ Rob Webb

CalPortland POC:
☐ Sean Smith ☒ Jarod Pedroza (CalPortland Q.C. technician)

Visitors to Project: ☒None ☐See Below:

Name	Organization	Reason for Visit	Comments

Summary of Work Performed This Shift:

- KP-3 barge was at CalPortland's dock in DuPont at 09:30 when DOF representative arrived. See Issues Encountered section of this report.
- The Boyer tug Kristen H. remained on site until loading was complete and then departed.
- 1,341 tons of Sand ENR material was loaded onto the KP-3.
- At the conclusion of loading, the Kristen H. departed CalPortland's dock with the KP-3.
- Prior to and at the conclusion of loading, DOF and CalPortland representatives checked and confirmed that the AC blending area (used if ENR+AC was to be loaded) tarped and inactive.

Other Issues Encountered: ☐ None ☒ See Comments below:

- KP-3 barge was at the loading dock at 09:00 however loading of the barge was delayed until 10:20 due to ice. Throughout the morning, loading of the KP-3 barge was paused due to masses of frozen sand getting caught between the grizzly's bars (at the stockpile) and requiring removal.
- Future projects which involve the blending with AC with ENR material using a feed auger as is done at CalPortland will need to consider the time of year that the work is being scheduled. Blending of AC with ENR material relies on both the ENR moving down the belt and the AC being fed through the auger to be at consistent rates. Interruptions, due to frozen material, in the feed rate of either AC or ENR will lead to a product that may not meet the desired ratio of AC to ENR as required by project requirements. Since only ENR material was being loaded on the 13th, the consequences of the freezing weather was limited to a longer loading barge loading time than anticipated.

Samples Collected: ☒ None ☐ See below:

Sample ID	Material Type	Analytical Parameter

Daily Photo Log: Jan. 13, 2017

DOF DALTON
OLMSTED
FUGLEVAND

2017-01-13 09.53.54 Prior to barge loading DOF and CalPortland QC representatives checked and confirmed that AC blending area was tarped and inactive.

2017-01-13 10.25.30 Empty KP-3 barge prior to loading (sand) ENR material. Residual water remaining on the barge is frozen from temperatures in the teens to 30s over the past week.

Daily Photo Log: Jan. 13, 2017

DALTON
OLMSTED
FUGLEVAND

2017-01-13 11.10.53 KP-3 barge being loaded with (sand) ENR material. Tug Kristen H. in position to assist in fleeting barge if needed during loading.

2017-01-13 11.38.46 Clumps of frozen sand at the stockpile caused loading of the KP-3 barge to be interrupted several times. The clumps would get caught in the bars of the grizzly; effectively blinding off the hopper below until removed.

ATTACHMENT 4

Construction Quality Assurance Project Plan
Addendum 1

CONSTRUCTION QUALITY ASSURANCE
PROJECT PLAN (CQAPP) ADDENDUM 1

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
ENR Layer Thickness Measurement during Construction at the Subtidal Plot
and Grade Stakes at Test, Intertidal, and Scour Plots

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

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

CONSTRUCTION QUALITY ASSURANCE PROJECT PLAN (CQAPP) ADDENDUM 1

Enhanced Natural Recovery/Activated Carbon Pilot Study

Lower Duwamish Waterway

ENR Layer Thickness Measurement during Construction at the Subtidal Plot and Grade Stakes at Test, Intertidal, and Scour Plots

FINAL

Prepared for:

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

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

Prepared by:

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

November 23, 2016

Project No. LY15160310

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CONSTRUCTION QUALITY ASSURANCE PROJECT PLAN
ADDENDUM 1

Enhanced Natural Recovery/Activated Carbon Pilot Study
Lower Duwamish Waterway
ENR Layer Thickness Measurement during Construction at the Subtidal Plot and Grade Stakes at Test, Intertidal, and Scour Plots

1.0 INTRODUCTION

This CQAPP Addendum serves as an addendum to the Construction Quality Assurance Project Plan, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway (Pilot Study CQAPP, AMEC et al., 2015). This Addendum details the following:

1. Modified construction monitoring method for the subtidal plot described in CQAPP Sections 3.4.1 and 3.4.3 and Table 2.
2. Modified grade stakes to be used at test, intertidal, and scour plots as described in CQAPP Section 3.4.1.3.

2.0 SUBTIDAL PLOT

The following sections described observed conditions at the subtidal plot and proposed modifications to construction monitoring.

2.1 OBSERVED CONDITIONS

During solid-phase microextraction (SPME) deployment and attempted retrieval at the subtidal plot, divers reported that the waterway bottom appeared very disturbed, with furrows and ridges on the order of 1- to 1.5-feet oriented parallel to the river flow. They appeared to be mechanically created as typical sand waves are oriented perpendicular to the flow. Additional investigation by the field crew led to the hypothesis that when large, ocean going barges enter the Duwamish Waterway, they lower and drag their bow mounted tow bridles as they are pushed by tugs up the waterway.

These tow bridles, consisting of very large chains and cables, span the width of the barge and are thought to be lying flat on the waterway bottom across all or a portion of the barge width. During SPME retrieval, the vast majority of the diver's location stakes, ground lines, and the majority of

SPMEs were not recovered or found in a different location than originally placed. Due to the channel's parallel orientation of the subtidal plot, it is possible for a single barge to drag across a large portion of the plot in a single passage.

For thickness monitoring during construction, the CQAPP requires that divers place grade stakes prior to ENR material placement, then return to read the stakes after initial placement to determine thickness. If the placement does not meet acceptance criteria, additional placement and measurements may be needed. This will require stakes to remain in place for approximately 3 weeks, if installed just prior to subtidal plot placement, and longer if all stakes are placed concurrently in all plots prior to any construction. Any barge traffic during this time has the potential to damage or remove installed stakes, making this method as currently included in the CQAPP not practicable for the subtidal plot.

2.2 PLOT LOCATION

The alternate construction monitoring method described below will be implemented at the subtidal plot.

2.3 MODIFIED ENR THICKNESS MEASUREMENT PROTOCOLS AT SUBTIDAL PLOT

Based on conditions observed by the divers during SPME installation and retrieval as previously described, the use of grade stakes at the subtidal plot as described in CQAPP Sections 3.4.1.3 and 3.4.3.4 is not practicable. Therefore, as discussed with EPA and USACE during a conference call on October 27, 2016, the alternate method described below will be implemented.

2.3.1 Multiple Lines of Evidence for ENR Placed Thickness

As discussed during the call, in additional to the multiple lines of evidence, monitoring will be performed continuously during placement. The subtidal plot, the subject of this Addendum, is planned to be the last plot constructed, so experience gained from placement at the test plot and the other two plots will be incorporated into placement at the subtidal plot. Other lines of evidence include full-time observation of placement by project quality control and oversight staff, electronic tracking in real time of each bucket placed, observations of bucket loading during placement, and known total quantity to be placed over the plot and corresponding volume per unit area.

2.3.2 Initial Inspection

Prior to placement, divers will perform qualitative, visual observations of the subtidal plot and record their observations regarding current condition of plot, roughness, signs of recent disturbance, and other physical characteristics that could affect placement. Observations made by the diver will be recorded by the diver support crew on a field form. Features that will be noted on the field form include but are not limited to presence of biota, presence of debris and type, major and minor substrate constituents, and bathymetric features. In addition, photographs of unique features (e.g., large debris) will be taken as visibility allows to supplement the data recorded on the field form.

2.3.3 ENR Placement

ENR materials will then be placed per the approved project plans incorporating any adaptive management or other modifications made during placement at test plot and other plots, as approved by EPA during implementation.

Potential chain drag disturbance of ENR material during the construction period will be assessed prior to final inspection. Any potential transit of the construction plot by barges during the construction period will be noted by the Field Engineer (FE) if visually observed, and the U.S. Coast Guard Navigation Center Automatic Identification System (AIS) database will also be reviewed for information on vessel transits within the subtidal plot area. This information will provide context for interpreting the final inspection.

2.3.4 Final Inspection and Corrective Measures

Once ENR material placement at the subtidal plot has been completed, divers will revisit the subtidal plot and perform a second qualitative, visual inspection and record their observations on the field form. In addition to types of observations performed pre-placement, post-placement observations shall also include notes on and locations of any areas that do not visually appear to have been covered by the ENR material. In addition, photographs of unique post-placement features will be taken as visibility allows to supplement the data recorded on the field form.

Additionally, divers shall use a steel ruler (or similar) to probe the placed ENR material and attempt to measure placed thickness based on material type differences as detectable by the diver. This probing shall be performed at the 10 randomly-selected stake locations within each sub plot at the subtidal plot (20 locations total), as shown in the Project Plans.

Post-placement diver observations and probing results will be communicated to the project representative for review with EPA and USACE oversight personnel immediately following completion of the dive. Areas within the plot where no coverage was observed may receive a corrective measure of additional material placement as needed to achieve project objectives, based on discussions with EPA and USACE staff following review of diver observations and other placement records. (For example, if it appears that a tow bridle was drug across the plot during placement [actual material placement but before diver inspection], disturbing the ENR material and creating areas less than minimum thickness, additional placement would not occur. Whereas if it appeared that otherwise undisturbed areas do not meet thickness acceptance criteria, then additional material placement may be performed.)

3.0 GRADE STAKE MODIFICATION FOR TEST, INTERTIDAL, AND SCOUR PLOTS

The EPA-approved CQAPP includes use of PVC grades stakes for use during construction to measure placed ENR material thickness. During subsequent discussions with the Muckleshoot Tribe, the need for a stake that was more flexible than the PVC grade was preferred in order to reduce potential for interference to Tribal fishing.

In response to requirement for a stake constructed of material more flexible than PVC pipe, numerous other materials were considered and evaluated. Materials need to be rigid enough to meet project objectives and be installable by divers but flexible enough to prevent net interference.

In order to meet these requirements, the proposed alternate stake is made of two materials. The upper section is cross-linked polyethylene (PEX) pipe, which is flexible. The lower portion consists of a small steel plate and rod. The PEX pipe is attached to the steel rod above the steel plate. The steel rod then passes through the small steel plate, which is held in place with two nuts, and then extends below the plate, providing an anchoring stake when driven into the sediment. The small steel plate provides a driving surface for divers to use during installation and a fixed point which is set flush with the pre-construction mudline. (See photographs below showing constructed stake and flexibility of PEX pipe in constructed stake.) The length of the stake protruding below the steel plate will be adjusted based on the firmness of the substrate (i.e., the stakes may be shorter in firmer substrates as compared to softer substrates). Each of the stakes will be labeled at the top of the PEX pipe with a location number using an indelible marker in such a way that if the top of the stake was cut off or otherwise to be removed the diver would notice.

The stakes will all be made to a fixed length of 18 inches above the steel plate. Divers will then be able to measure from top of stake down to the top of the ENR material to determine placed thickness of ENR material (18 inches minus the measurement from top of stake equals the placed thickness of ENR material). In addition, at several locations adjacent to a stake location, divers will attempt to measure the thickness of the placed material using a probe to detect the textural change in the material as a probe is inserted into the substrate. If the diver can detect a change in the

substrate texture, a measurement of the depth to the textural change will be made. The probing will also be conducted at locations where a stake was deployed but was missing when material thickness is being assessed.

These type of stakes will be used at the test plot, intertidal plot, and scour plot.

4.0 REFERENCE

AMEC et al. (Amec Foster Wheeler; Dalton, Olmsted & Fuglevand, Inc.; ENVIRON International Corporation; Floyd|Snider; and Geosyntec Consultants). 2015. Construction Quality Assurance Project Plan, Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Lower Duwamish Waterway Group, Seattle, WA. December 22.

ATTACHMENT 5

Year 0 SPI/PV Data Report

2018

YEAR 0 SPI/PV DATA REPORT

ENHANCED NATURAL RECOVERY/ACTIVATED CARBON PILOT STUDY LOWER DUWAMISH WATERWAY

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Contents

1.0 INTRODUCTION

1.1 Background

The Lower Duwamish Waterway Group is conducting a pilot study of an innovative sediment technology in the field to evaluate the potential effectiveness of the technology in the Lower Duwamish Waterway (LDW). The study will determine whether enhanced natural recovery (ENR) amended with activated carbon (AC) can be successfully used to decrease bioavailability of contaminants in sediment in the LDW. The study will compare the effectiveness of ENR amended with AC (ENR+AC) against that of ENR without added AC. This will be tested in three habitat types: the subtidal, the intertidal, and an area where vessel scour is possible. For the purposes of this project, ENR involves the placement of a thin layer of clean material over subtidal or intertidal sediments. ENR+AC involves the placement of a thin layer of clean material augmented with AC over subtidal or intertidal sediments.

This pilot study was specified under the Second Amendment (July 2014) to the Administrative Order on Consent (Order) for Remedial Investigation/Feasibility Study for the LDW, CERCLA Docket No. 10-2001-0055, issued on December 20, 2000.

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

- Verify that ENR+AC can be successfully applied in the LDW by monitoring physical placement success (uniformity of coverage and percent of carbon in a placed layer).
- Evaluate performance of ENR+AC compared to ENR alone in locations with a range of polychlorinated biphenyl (PCB) concentrations.
- Assess potential impacts to the benthic community in ENR+AC compared to ENR alone.
- Assess changes in bioavailability in ENR+AC compared to ENR alone.
- Assess the stability of ENR and ENR+AC in scour areas (such as berthing areas).

The sediment profile imaging monitoring work described in this report was performed consistent with the *Quality Assurance Project Plan* (Amec et al. 2016a).

1.2 Goals of the Year 0 Sediment Profile Imaging/Plan View Survey

The goal of the Year 0 sediment profile imaging/plan view (SPI/PV) survey of the pilot project is to collect semi-qualitative information on the sediment types present and depth of placed material at each pilot area immediately following the application of ENR and ENR+AC amendments. Specifically, this event is one of several methods used to address DQO-1[1]: Verify placement of the ENR and ENR+AC materials (Amec et al. 2016a). In addition, this event provides a baseline for the evaluation of DQO-2: Evaluate the stability of ENR and ENR+AC materials in monitoring Years 1, 2, and 3.

The Year 0 SPI/PV survey is intended as one method to document the thickness and evenness of the ENR and ENR+AC layers. Measurements collected during the SPI/PV surveys will be

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[1] Methods used to measure the thickness and evenness of the layers will include physical assessment by the contractor during placement using tools such as bathymetric survey and breakaway stakes as described in the *Construction Quality Assurance Project Plan* (Amec et al. 2015, 2016b). These measurements by the contractor will be augmented by quality assurance checks by the design team using visual observation by divers, SPI and collection, logging, and analysis of shallow cores.

limited to physical sediment properties (grainsize) and visual observations of the thickness and general condition of the ENR and ENR+AC layers. These data will be used to help evaluate the success of placement of the ENR and ENR+AC material (DQO-1).

The SPI/PV surveys also will be used for evaluating the stability of the ENR and ENR+AC layers (DQO-2) in subsequent monitoring years after placement; once the ENR and ENR+AC material have been in place for a longer elapsed time.

The observations for biological activity included in this Year 0 SPI/PV data evaluation are limited because construction of the pilot plots was completed just prior to SPI/PV survey work. In addition, other features such as stratigraphy, physical disturbance features, and sediment fabric (the orientation of sediment particles within the sediment column reflective of depositional, biological or physical processes) may also be evaluated to deduce benthic processes at the placement areas.

2.0 METHODS

2.1 Field Collections

The Year 0 SPI/PV survey of the LDW pilot areas was conducted 6 to 23 days following construction of each plot. Specifically, the Year 0 SPI/PV survey was conducted on January 11, 2017 for the intertidal plot (23 days after construction), on January 16, 2017 for the scour plot (10 days after construction), and on February 1, 2017 for the subtidal plot (6 days after construction). These surveys were conducted following construction so that conditions at each plot could be measured shortly after the placement of ENR and ENR+AC materials. Each survey took one day to complete.

All three surveys were conducted aboard the R/V Carolyn Dow, owned and operated by Research Support Services (RSS) of Bainbridge Island, WA. All positioning and navigation during the survey was conducted by RSS using a digital global positioning system (DGPS). Scientists from Amec Foster Wheeler provided oversight of navigation and positioning during the survey as well as record keeping. Scientists from Browning Environmental Services (BES) operated the sediment profile and plan view camera apparatus, kept field notes, and ensured successful image acquisition.

A total of 72 stations, 24 from each pilot plot, were occupied using the SPI/PV camera during the Year 0 monitoring event. At each station, the research vessel was piloted to the target location and the SPI/PV system was lowered to the sediment bed only when within 3 meters of the target location. A minimum of three replicate image sets were collected at each target location with the exception of one PV station replicate in the intertidal ENR subplot (LDW-Y0-IN-ENR-4-A-PV-R1). Therefore, accounting for triplicate image sets, a total of 72 SPI/PV images were collected at each pilot plot. For all pilot plots, the 24 stations were apportioned such that 12 stations were occupied in the ENR only subplot and 12 stations were occupied in the ENR+AC subplot. The 12 stations were collected from “A” and “B” cells during the Year 0 sampling event. The SPI/PV locations for each plot are shown in Figures 2-1, 2-2, and 2-3. The SPI/PV images are provided electronically in Exhibit 1 (provided as DVDs 1, 2, and 3).

Acquisition of high-resolution sediment profile images was accomplished using a Nikon D7100 digital single-lens reflex (SLR) camera with a 24.1-megapixel image sensor mounted inside an Ocean Imaging Model 3731 pressure housing system. Camera settings were f8, ISO 640, and 1/320 shutter speed. A total of 216 sediment profile images were selected for analysis (3 replicate images from each of 72 stations).

Plan view images were collected using a Nikon D7100 SLR camera with a 24.1-megapixel image sensor mounted inside an Ocean Imaging Model DSC2400 camera housing. For the baseline SPI/PV survey, a focal distance of 3 feet was utilized. However, based on the results of the baseline SPI/PV survey and higher turbidity levels expected in the Duwamish Waterway during winter run-off events, a shorter trigger wire of 2 feet was utilized to minimize the focal length through turbid water. This decreased the effective area covered by the PV images but allowed increased clarity of the sediment bed features. In the subtidal and some intertidal areas, ambient turbidity prevented clear images from being collected. Also, turbidity clouds generated from the replicate point sampling often negatively affected the second and third replicate PV images collected at a target station. Throughout the survey, all images were downloaded in the field by BES to ensure successful image acquisition.

2.2 Sediment Profile and Plan View Image Analysis

Following completion of the field operations, the raw image files were white light equalized and converted to jpegs. The raw images were then converted to high-resolution Photoshop Document (PSD) format files using the minimal amount of image file compression, maintaining an Adobe RGB (1998) color profile. The PSD images were then calibrated and analyzed in Adobe Photoshop®. Calibration information was determined by measuring 1-centimeter (cm) gradations from the Kodak® Color Separation Guide. Linear and area measurements were recorded as raw pixel counts and then converted to scientific units using the calibration information. Measured parameters were recorded on a Microsoft Excel© spreadsheet. A brief description of analytical and interpretive parameters is provided below.

Sediment Profile Imaging Parameters

Sediment Grain Size and Sediment Type

The sediment grain-size major mode and range were visually estimated from the color images by overlaying a grain-size comparator at the same scale. This comparator was prepared by photographing a series of Udden-Wentworth size classes (equal to or less than coarse silt up to granule and larger sizes) with the SPI camera. Seven grain-size classes were on this comparator: >4 phi (silt-clay), 4-3 phi (very fine sand), 3-2 phi (fine sand), 2-1 phi (medium sand), 1-0 phi (coarse sand), 0-(-1) phi (very coarse sand), and <-1 phi (granule and larger).

The lower limit of optical resolution of the photographic system is about 62 microns, allowing recognition of grain sizes equal to, or greater than, coarse silt (≥4 phi). The accuracy of this method has been documented by comparing SPI estimates with grain-size statistics determined from laboratory sieve analyses (Germano et al. 2011).

The comparison of the SPI images with Udden-Wentworth sediment standards photographed through the SPI optical system was also used to map near-surface stratigraphy such as sand-over-mud and mud-over-sand. When mapped on a local scale, this stratigraphy can provide information on relative transport magnitude and frequency.

Prism Penetration Depth

SPI prism penetration depth was measured as the entire cross-sectional sediment represented in the image. The area of the image represented by sediment resting upon the faceplate was digitized and this digitized area was divided by the calibrated linear width of the image to determine the mean penetration depth for a given image. Linear maximum and minimum depths of penetration were also measured. All three measurements (maximum, minimum, and average penetration depths) were recorded in the data file.

Prism penetration is a noteworthy parameter; if the number of weights used in the camera remains constant throughout a survey, the camera functions as a penetrometer. Comparative penetration values provide an indication of the relative water content or bearing strength of the sediment. Highly bioturbated sediments and unconsolidated rapidly deposited sediments oftentimes have the highest water contents, lowest load bearing capacities, and greatest prism penetration depths.

Seasonal changes in camera prism penetration at the same station have been observed in studies and are related to the control of sediment geotechnical properties by bioturbation

(Rhoads and Boyer 1982). The effect of water temperature on bioturbation rates appears to be important in controlling both biogenic surface relief and prism penetration depth (Rhoads and Germano 1982).

Small-Scale Boundary Roughness

Surface boundary roughness was determined by measuring the difference between the highest and lowest points of the sediment-water interface. The surface boundary roughness (sediment surface relief) measured over the width of sediment profile images typically ranges from 0.02 to 3.8 cm, and may be related to either physical structures (ripples, rip-up structures, mud clasts) or biogenic features (burrow openings, fecal mounds, foraging depressions).

The camera must be level to take accurate boundary roughness measurements. In sandy sediments, boundary roughness can be a measure of sand wave height. On silt-clay bottoms, boundary roughness values often reflect biogenic features such as fecal mounds or surface burrows. The size and scale of boundary roughness values can have dramatic effects on both sediment erodibility and localized oxygen penetration into the bottom (Huettel et al. 1996).

Apparent Redox Potential Discontinuity Depth

Aerobic near-surface marine sediments typically have higher reflectance relative to underlying hypoxic or anoxic sediments. Surface sands washed free of mud also have higher optical reflectance than underlying muddy sands. These differences in optical reflectance are easily seen; oxidized surface sediment contains particles coated with ferric hydroxide (an olive or tan color), while reduced and muddy sediments below this oxygenated layer are darker, generally gray to black (Fenchel 1969; Lyle 1983). The boundary between the colored ferric hydroxide surface sediment and underlying gray to black sediment is called the apparent redox potential discontinuity (aRPD).

The depth of the aRPD in the sediment column is an important time-integrator of dissolved oxygen conditions within sediment porewaters. Time-series aRPD measurements following a disturbance can be a critical diagnostic element in monitoring the degree of recolonization in an area by the ambient benthos (Rhoads and Germano 1986).

The mean aRPD depth also can be affected by local erosion. Scouring can wash away fines and shell or gravel lag deposits, and can result in a very thin surface oxidized layer. During storm periods, erosion may completely remove any evidence of the aRPD (Fredette et al. 1988).

Because the determination of the aRPD requires discrimination of optical contrast between oxidized and reduced particles, it is difficult, if not impossible, to determine the depth of the aRPD in well-sorted sands of any size that have little to no silt or organic matter in them. When using SPI technology on sand bottoms, little information other than grain size, prism penetration depth, and boundary roughness values can be measured. While oxygen has no doubt penetrated the sand beneath the sediment-water interface just due to physical forcing factors acting on surface roughness elements (Ziebis et al. 1996; Huettel et al. 1998), estimates of the mean aRPD depths in these types of sediments are indeterminate with conventional white light photography.

Infaunal Successional Stage

The mapping of infaunal successional stages is readily accomplished with SPI technology. These stages are recognized in SPI images by the presence of dense assemblages of near-surface polychaetes and/or the presence of subsurface feeding voids; both may be present in the same image. Mapping of successional stages is based on the theory that organism-sediment interactions in fine-grained sediments follow a predictable sequence after a major sediment bed perturbation. This theory states that primary succession results in “the predictable appearance of macrobenthic invertebrates belonging to specific functional types following a benthic disturbance. These invertebrates interact with sediment in specific ways. Because functional types are the biological units of interest, our definition does not demand a sequential appearance of particular invertebrate species or genera” (Rhoads and Boyer 1982). This theory is presented in Pearson and Rosenberg (1978) and further developed in Rhoads and Germano (1982) and Rhoads and Boyer (1982).

This continuum of change in animal communities after a disturbance (primary succession) has been divided subjectively into four stages: Stage 0, indicative of a sediment column that is largely devoid of macrofauna, occurs immediately following a physical disturbance or in close proximity to an organic enrichment source; Stage 1 is the initial community of tiny, densely populated polychaete assemblages; Stage 2 is the start of the transition to head-down deposit feeders; and Stage 3 is the mature, equilibrium community of deep-dwelling, head-down deposit feeders.

While the successional dynamics of invertebrate communities in fine-grained sediments have been well-documented, the successional dynamics of invertebrate communities in sand and coarser sediments are not well-known. Subsequently, biological community structures and dynamics in sandy or coarse-grained bottoms are limited.

Using SPI to Evaluate Sedimentary and Biological Processes

The sediment bed may generally be considered a long-term time integrator of sediment and overlying water quality; values for any variable measured in the sediment column are the result of physical, chemical, and biological interactions on time scales longer than those present in the overlying water column. Thus, the sediment bed is a good indicator of environmental quality, both for historical impacts as recorded in the sediment column and potential future trends.

Physical measurements made with the SPI system from profile images provide background information about gradients in physical disturbance through maps of sediment grain size, boundary roughness, sediment textural fabrics, and sediment structures.

The aRPD depth is useful in assessing the quality of a habitat for epifauna and infauna from both physical and biological points of view. The aRPD depth in profile images can be directly correlated to the quality of the benthic habitat in polyhaline and mesohaline estuarine zones (Rhoads and Germano 1986; Revelas et al. 1987; Valente et al. 1992). Controlling for differences in sediment type and physical disturbance factors, aRPD depths <1 cm can indicate chronic benthic environmental stress or recent catastrophic disturbance.

The distribution of successional stages in the context of the mapped disturbance gradients is one of the most sensitive indicators of the ecological quality of the sediment bed (Rhoads and Germano 1986). The presence of Stage 3 equilibrium taxa (mapped from subsurface feeding voids as observed in profile images) can be a good indication of high benthic habitat stability and relative quality. A Stage 3 assemblage indicates that the sediment surrounding these organisms has not been disturbed severely in the recent past. Because Stage 3 species tend to have relatively conservative rates of recruitment, intrinsic population increase, and ontogenetic growth, they may not reappear for several years once they are excluded from an area.

The presence of Stage 1 seres (in the absence of Stage 3 seres) can indicate that the bottom is an advanced state of organic enrichment, has received high contaminant loading, or experienced a substantial physical disturbance. Unlike Stage 3 communities, Stage 1 seres have a relatively high tolerance for organic enrichment and contaminants. These opportunistic species have high rates of recruitment, high ontogenetic growth rates, and live and feed near the sediment-water interface, typically in high densities. Stage 1 seres often co-occur with Stage 3 seres in marginally enriched areas. In this case, Stage 1 seres feed on labile organic detritus settling onto the sediment surface, while the subsurface Stage 3 seres tend to specialize on the more refractory buried organic reservoir of detritus.

Identification of ENR Material or Depositional Layers

Depositional layers or allochthonous sediment deposits can be identified and measured using SPI, providing the optical properties of the depositional or allochthonous sediments are different from those of the native sediments at an area. Features which may be used to differentiate sediment layers or introduced material include grain size, color, porosity, sedimentary fabric, redox state, and sediment texture.

Placement thickness or the thickness of a depositional layer, once the layer is identified by physical, textural, or material properties, is measured as the entire cross-sectional amount of sediment or depositional layer represented in an image. The area of the image represented by sediment/depositional layering resting upon the faceplate was digitized and this digitized area was divided by the calibrated linear width of the image to determine the mean thickness of sediment/depositional layer for a given image.

Plan View Image Analysis

The PV images provide a much larger field of view than the sediment profile images and provide valuable information about the landscape ecology and sediment topography in the area where the pinpoint “optical core” of the sediment profile was taken. Surface sediment layers/ textures or structures observed from the sediment-profile images can be evaluated in the larger context of the PV images. Also, the PV images were evaluated for coverage ENR and ENR+AC material and any subsequent deposition.

3.0 RESULTS

Tabulated results for each pilot plot and ENR and ENR+AC subplots for each pilot study plot area are presented in Tables 3-1 through 3-6. Results detailing the coverage and sediment attributes for each pilot plot area are discussed below. Although apparent redox potential discontinuity (aRPD) and infaunal successional stages are measured and reported, their distribution is not discussed in this section because the images were captured shortly after construction of the plots and represent the post-disturbance baseline to compare to future monitoring events.

3.1 Intertidal Plot

Intertidal ENR Subplot

At the time of the Year 0 SPI/PV survey after ENR and ENR+AC placement, the substrate at the intertidal ENR subplot is sandy gravel in all replicates from all stations except for one replicate at Station LDW-Y0-IN-ENR-1-A-SPI-R2. Representative SPI and PV images showing typical ENR sediments from the intertidal ENR area are shown in Figures 3-1 and 3-2. SPI and PV images from the lone replicate that did not exhibit a full cover of ENR material are presented in Figure 3-3. ENR sediment observed from the intertidal subplot was almost exclusively sub-rounded to rounded, lithic, sands and gravels. The thickness of ENR material at all stations and all replicates exceeded the prism penetration depth, except for the lone replicate image LDW-Y0-IN-ENR-1-A-SPI-R2. Very little fine-grained sediments (silts and clays) were observed within the sediment column at those stations that were solely comprised of ENR material. However, at multiple stations a thin veneer of recently deposited fine-grained sediment can be seen overlying the ENR material. The PV images from the intertidal ENR subplot indicate that the presence of post-placement, recently deposited material is patchy within a single station and within a single replicate (Figures 3-2 and 3-3).

Mean prism penetration depths ranged from 5.4 cm to 12.63 cm and the average mean penetration depth was 7.45 cm (n=36). Prism penetration was entirely dependent upon the grain size and consolidation of the applied ENR material. Throughout the survey of the intertidal subplot, the maximum amount of weight in the SPI weight carriages was used to achieve maximum possible prism penetration.

Intertidal ENR+AC Subplot

The substrate at the intertidal ENR+AC subplot is sandy gravel in all replicates from all stations. Representative SPI images from the intertidal ENR+AC subplot are shown in Figures 3-4 and 3-5. Representative PV images showing typical ENR+AC sediment surface from the intertidal ENR+AC area are shown in Figures 3-6 and 3-7. ENR sediment observed from the intertidal subplot was nearly exclusively lithic sands and gravels. ENR+AC material was observed at all stations and all replicates in thicknesses that exceeded the prism penetration depth. In addition, small patches of recently deposited fine-grained sediment were observed in several of the SPI and PV images (Figures 3-5 and 3-7).

Mean prism penetration depths in the intertidal ENR+AC subplot ranged from 5.55 cm to 10.78 cm and the average mean penetration depth was 7.97 cm (n=36). Prism penetration was entirely dependent upon the grain size and consolidation of the applied ENR+AC material.

Throughout the survey of the intertidal subplot, the maximum amount of weight in the SPI weight carriages was used to achieve maximum possible prism penetration.

3.2 Scour Plot

Scour ENR Subplot

At the time of the Year 0 SPI/PV survey after ENR and ENR+AC placement, the substrate at the scour ENR subplot is sandy gravel in all replicates from all stations. Representative SPI images showing typical ENR sediments from the scour ENR area are shown in Figure 3-8. A representative PV image from the scour subplot is shown in Figure 3-9. ENR sediment observed from the scour subplot was almost exclusively sub-rounded to rounded, lithic, sands and gravels. The thickness of ENR material at all stations and all replicates exceeded the prism penetration depth. Very little fine-grained sediments (silts and clays) were observed within the sediment column at those stations that were solely comprised of ENR material. However, at a few stations a thin veneer of recently deposited sediment can be seen overlying the ENR material. The PV image in Figure 3-9 shows a sediment surface that is free of any recently deposited or adhering fine-grained sediment.

Mean prism penetration depths ranged from 6.15 cm to 16.44 cm and the average mean penetration depth was 9.88 cm (n=36). Prism penetration was entirely dependent upon the grain size and consolidation of the applied ENR material. Throughout the survey of the scour subplots, the maximum amount of weight in the SPI weight carriages was used to achieve maximum possible penetration.

Scour ENR+AC Subplot

The substrate at the scour ENR+AC subplot is sandy gravel in all replicates from all stations. Representative SPI images from the scour ENR+AC subplot are shown in Figures 3-10 and 3-11. The ENR+AC material was present at thicknesses greater than SPI camera prism penetration at nearly all stations within the ENR+AC scour subplot with one exception. The exception was a single replicate from Station LDW-Y0-SC-ENR+AC-5-A-SPI-R2 where there was 7.5 cm of the material overlying muddy native sediments; the other two replicates at this station exhibited ENR+AC thicknesses that exceeded prism penetration. SPI and PV images from Station LDW-Y0-SC-ENR+AC-5-A-SPI-R2 are shown in Figure 3-12. In both the SPI and PV images there was 100% cover of ENR+AC material over native sediment.

Representative PV images showing typical ENR+AC sediment surface from the scour subplot are shown in Figures 3-13 and 3-14. Several notable features were observed in the PV images including occasional sediment washing, bedforms (ripples), and patchy, thin accumulations of recently deposited sediment. Bedforms are evident in the PV image shown in Figure 3-14 and indicate periodic sediment resuspension. The distribution of these features was patchy within a single station as well as across the subplot.

Mean prism penetration depths in the scour ENR+AC subplot ranged from 6.5 cm to 19.09 cm and the average mean penetration depth was 9.87 cm (n=36). Prism penetration was almost entirely dependent upon the grain size and consolidation of the applied ENR+AC material. However, at the station replicate that had the greatest mean penetration, there was 7.5 cm of the material overlying softer native sediments. Throughout the survey of the scour subplot, the maximum amount of weight in the SPI weight carriages was used to achieve maximum possible penetration.

3.3 Subtidal Plot

Subtidal ENR Subplot

The base substrate at the subtidal area ENR subplot is predominantly coarse sand with scattered gravel and a well-defined surficial layer of recently deposited fine-grained sediment. Representative SPI and PV images from the subtidal ENR subplot are shown in Figure 3-15 and 3-16, respectively. The thickness of the recently deposited fine-grained sediment layer on top of the ENR material was typically approximately 1 cm thick (Figure 3-15). ENR material from the subtidal subplot can only be positively identified using the SPI images. In the PV images, ENR material in the subtidal subplot cannot be seen due to the drape of recently deposited sediment obscuring the ENR material through burial.

ENR sediment observed from the subtidal ENR subplot was almost exclusively sub-rounded to rounded, lithic, sands and some fine gravels. The thickness of ENR material at all stations and all replicates exceeded the prism penetration depth.

Mean prism penetration depths ranged from 6.09 cm to 16 cm and the average mean penetration depth was 10.49 cm (n=36). The thickness of ENR material at all stations and all replicates exceeded the prism penetration depth.

Subtidal ENR+AC Subplot

The substrate at the subtidal ENR+AC subplot is predominantly coarse sand with scattered fine gravel in all replicates from all stations. At nearly all stations, the ENR+AC material was covered with a thin layer of recently deposited fine-grained sediment. Representative SPI images from the subtidal ENR+AC subplot are shown in Figures 3-17, 3-18, and 3-19. A representative PV image from the subtidal ENR+AC subplot is shown in Figure 3-20.

Within the subtidal ENR+AC subplot, material was present at thicknesses greater than SPI camera prism penetration at all but one station. At this station, Station LDW-Y0-SU-ENR+AC-4-B, two of the three replicates collected show ENR+AC material overlying fine-grained native silt/clays (Figure 3-18). The average ENR+AC thickness at replicates 1 and 2 were 13.52 cm and 12.99 cm, respectively. The ENR+AC material provided 100% cover of the underlying native sediments in both replicate images. A portion of the layer in each of the replicate SPI images exceeded the minimum penetration depth reported for the station but the thickness was not uniform across the image. The minimum ENR+AC material thickness was 4.4 cm and this thickness was only measured for a linear distance of 2.5 cm across the width of the SPI image. At Station LDW-Y0-SU-ENR+AC-6-A (Figure 3-19) a thin layer of fine-grained sediment overlies the ENR+AC material and there are several clasts of clay admixed with the ENR+AC material.

Mean prism penetration depths in the subtidal ENR+AC subplot ranged from 6.56 cm to 20.44 cm and the average mean penetration depth was 10.76 cm (n=36). Prism penetration was almost entirely dependent upon the grain size and consolidation of the applied ENR+AC material. However, at the station replicate that had the greatest mean penetration, there was ENR+AC material overlying softer, native sediments.

4.0 DISCUSSION

The goal of the Year 0 SPI/PV survey of the pilot project is to collect semi-qualitative information on the sediment types present and depth of placed material at each pilot area immediately following the application of ENR and ENR+AC amendments. The Year 0 SPI/PV survey documents the status of surface sediments and the upper portion of the sediment column at the pilot plots and forms one basis to which further monitoring can be compared, for both physical and biological conditions.

The ENR and ENR+AC materials were easily identified and differentiated from pre-covered native sediments documented in the baseline SPI/PV survey due their much coarser particle size and their mineral and lithic composition.

The results of the Year 0 SPI/PV survey indicate that at the scour plot and the subtidal plot, there was 100% coverage of placed material over native sediments at the stations sampled. At the intertidal plot, only one replicate image from one station showed incomplete coverage of placed material; all other images showed complete coverage. This replicate image, LDW-Y0-IN-ENR-1-A-SPI-R2, exhibited incomplete ENR coverage in both the SPI and PV images (Figure 3-3); however, in the PV image, ENR sands and gravels surround the area where no ENR material (~ <0.1 square meters) was observed within the co-located SPI image.

The measured thickness of the ENR and ENR+AC layers at most pilot plot areas was greater than the penetration of the SPI prism into the sediment column. The exception was at two stations (four of the 216 images collected and analyzed). In three of these images, the placed material forms a well-defined layer that overlies the native sediment documented during the baseline SPI/PV survey (Figures 3-12 and 3-18; the fourth image LDW-Y0-IN-ENR-1-A-SPI-R2 is discussed above). As a result, excepting these three images in which the placed material overlies native sediment in a distinct layer, the reported thickness values (penetration depth of the SPI prism) represent minimum measured values of ENR layer thickness.

As part of documenting the sediment types, the ENR and ENR+AC materials were evaluated to determine sediment grain-size major mode. At the intertidal and scour pilot plots, the observed ENR material was coarse sand and gravels that were mineral or lithic in composition. In addition, the morphology of the ENR sediment grains was either rounded or sub-rounded. The ENR material documented in SPI images from the subtidal plots was dominantly coarse sands of mineral and lithic composition and sub-rounded to rounded particle morphology. Fine gravels were sparsely seen in the SPI images from the subtidal plots.

At both the ENR and ENR+AC subtidal subplots, there was a distinct layer of recently deposited, oxidized, fine-grained sediments over the coarser ENR sediments. Furthermore, small clasts of allochthonous cohesive clay were observed in the layer of recently deposited sediment (Figures 3-19 and 3-20). At the subtidal pilot plot, the layer of recently deposited sediment was thick enough to prevent the ENR materials from being seen in the PV images. The presence of ENR materials at the subtidal pilot plot could only be identified using SPI.

Due to the very short elapsed time between construction completion and the Year 0 SPI/PV survey, very little recolonization of the infaunal benthic community was observed, although a few infaunal and epifaunal organisms were seen in several SPI and PV images from each pilot plot. The functional role of the infauna could not be deduced based on the few infaunal organisms observed, resulting in the infaunal successional stage being designated as indeterminate for all SPI replicate images from all stations. The indeterminate infaunal successional stage designations are not an indicator of habitat quality or benthic health for the pilot plots at the time of the Year 0 SPI/PV survey. They only indicate that there has been insufficient time since construction was completed and the time at which the survey was conducted for the infaunal community to recolonize the pilot plots in ways where the animal-sediment relations indicate function. The results of the Year 0 SPI/PV survey do provide a snapshot in time of the faunal conditions immediately after construction was completed. Subsequent monitoring can be compared to this condition to evaluate benthic recolonization and benthic community development over time after the placement of the ENR materials.

The ability to measure aRPDs during the Year 0 SPI/PV survey was dependent upon the presence of fine-grained sediment at the sampling locations as well as the fines being oxidized and present in a coherent layer that can be measured. Only very small amounts of fine-grained sediment were observed in association with ENR and ENR+AC materials. The majority of fine-grained sediment seen during the Year 0 SPI/PV survey appeared to be recent deposition of oxidized, fine-grained sediment. At the intertidal and scour pilot plots, very few aRPD measurements could be made due to the absence of fine-grained sediment in coherent layers. However, at the subtidal subplot, the distinct layers of recently deposited, oxidized fine-grained sediments were sufficiently thick and continuous across the SPI image so that aRPDs could be measured. At the subtidal ENR and ENR+AC subplots, the thickness of the post-construction and recent sediment deposit approximates the measured depth of the aRPD.

5.0 REFERENCES

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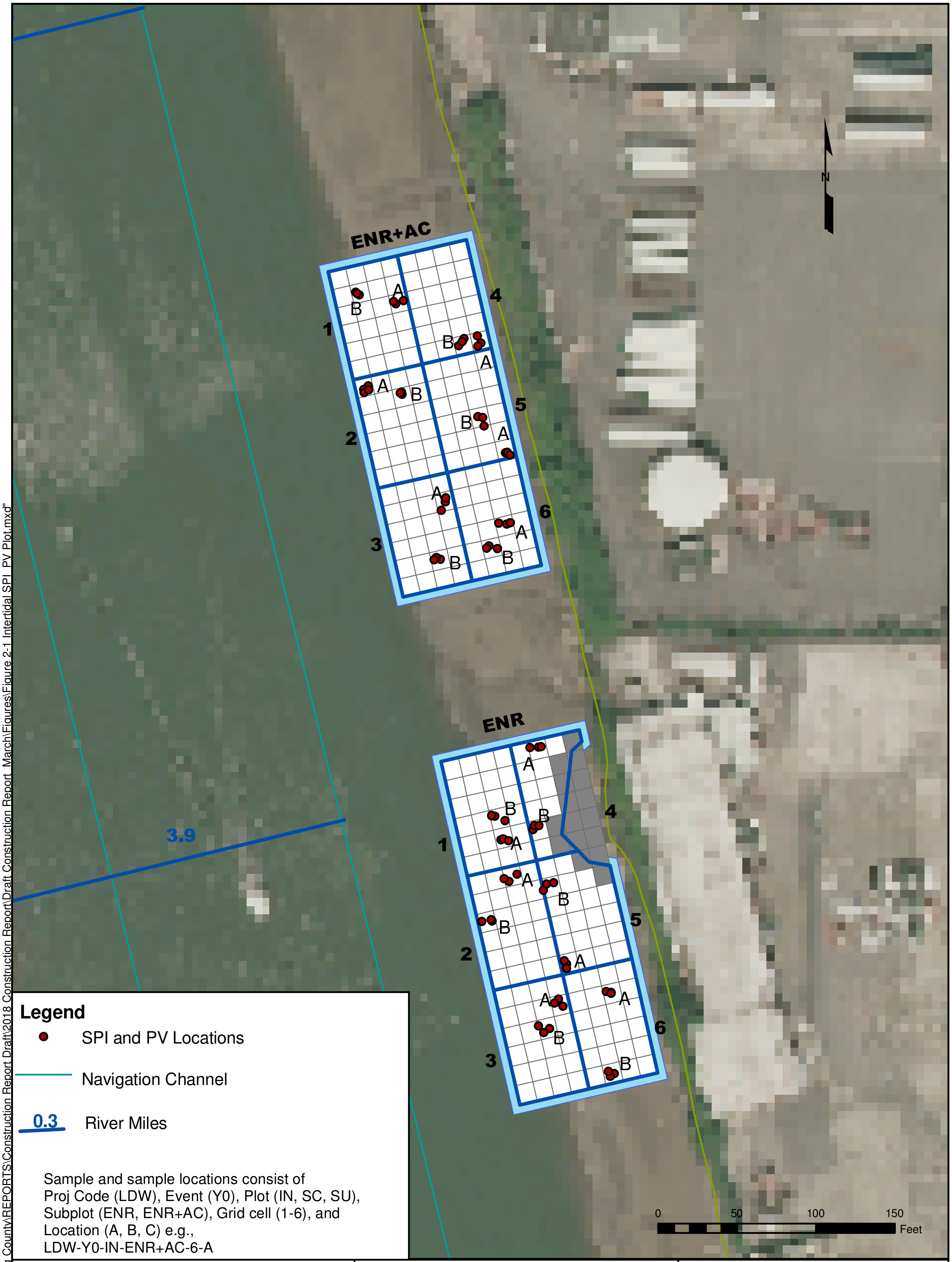
Figures



Sample and sample locations consist of Proj Code (LDW), Event (Y0), Plot (IN, SC, SU), Subplot (ENR, ENR+AC), Grid cell (1-6), and Location (A, B, C) e.g., LDW-Y0-IN-ENR+AC-6-A

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Figure 2-1
ENR/AC Pilot Study
Intertidal Plot

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Legend

● SPI and PV Locations

Navigation Channel

0.3 River Miles

Sample and sample locations consist of
Proj Code (LDW), Event (Y0), Plot (IN, SC, SU),
Subplot (ENR, ENR+AC), Grid cell (1-6), and
Location (A, B, C) e.g.,
LDW-Y0-IN-ENR+AC-6-A

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Figure 2-2
ENR/AC Pilot Study
Scour Plot

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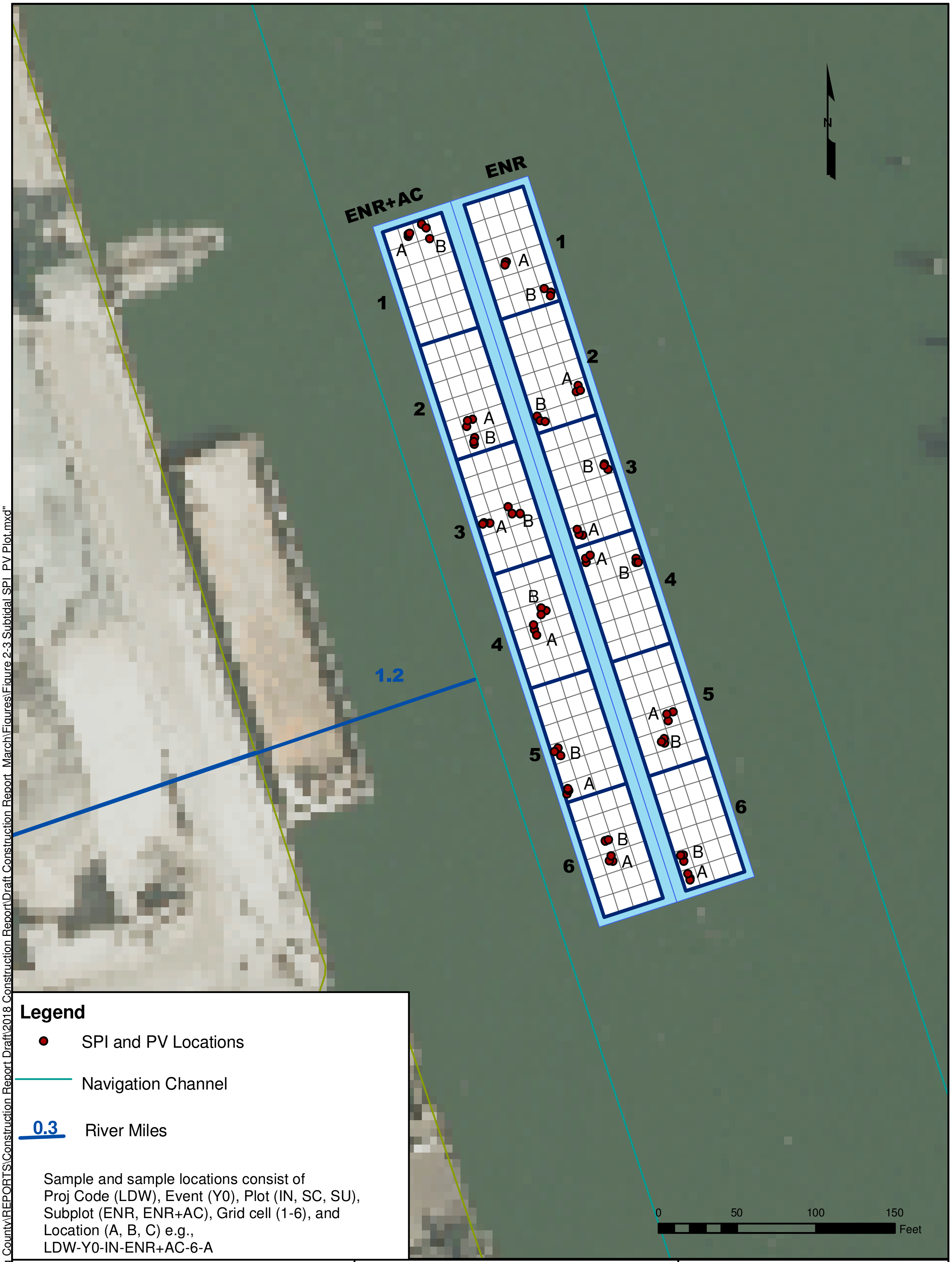

Legend

● SPI and PV Locations

Navigation Channel

0.3 River Miles

Sample and sample locations consist of
Proj Code (LDW), Event (Y0), Plot (IN, SC, SU),
Subplot (ENR, ENR+AC), Grid cell (1-6), and
Location (A, B, C) e.g.,
LDW-Y0-IN-ENR+AC-6-A

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Figure 2-3
ENR/AC Pilot Study
Subtidal Plot

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KEY FOR IDENTIFYING SPI/PV IMAGE LOCATIONS

Component	Definition
Project Area	**LDW** = Lower Duwamish Waterway
Monitoring Event	**Y0** = Year 0 after layer placement
Plot Type	**SU** = subtidal plot; **SC** = scour plot; **IN** = intertidal plot
Subplot	**ENR** = enhanced natural recovery only **ENR+AC** = enhanced natural recovery with activated carbon.
Grid Cell Number	Indicates grid cell number between 1 and 6: **1** to **6** = indicates grid cell number
Location Cell	Indicates the cell: **A** or **B**
Camera View	SPI = Sediment Profile Imaging; PV = Plan View
Replicate Number	Indicates the replicate number between 1 and 3: **1**, **2**, or **3**

Figure 3-1. Representative SPI images from Stations LDW-Y0-IN-ENR-2-B-SPI-R1 (left) and LDW-Y0-IN-ENR-4-B-SPI-R1 (right) showing ENR sands and gravels typical of the intertidal ENR subplot. SPI images are 14.42 cm in width.

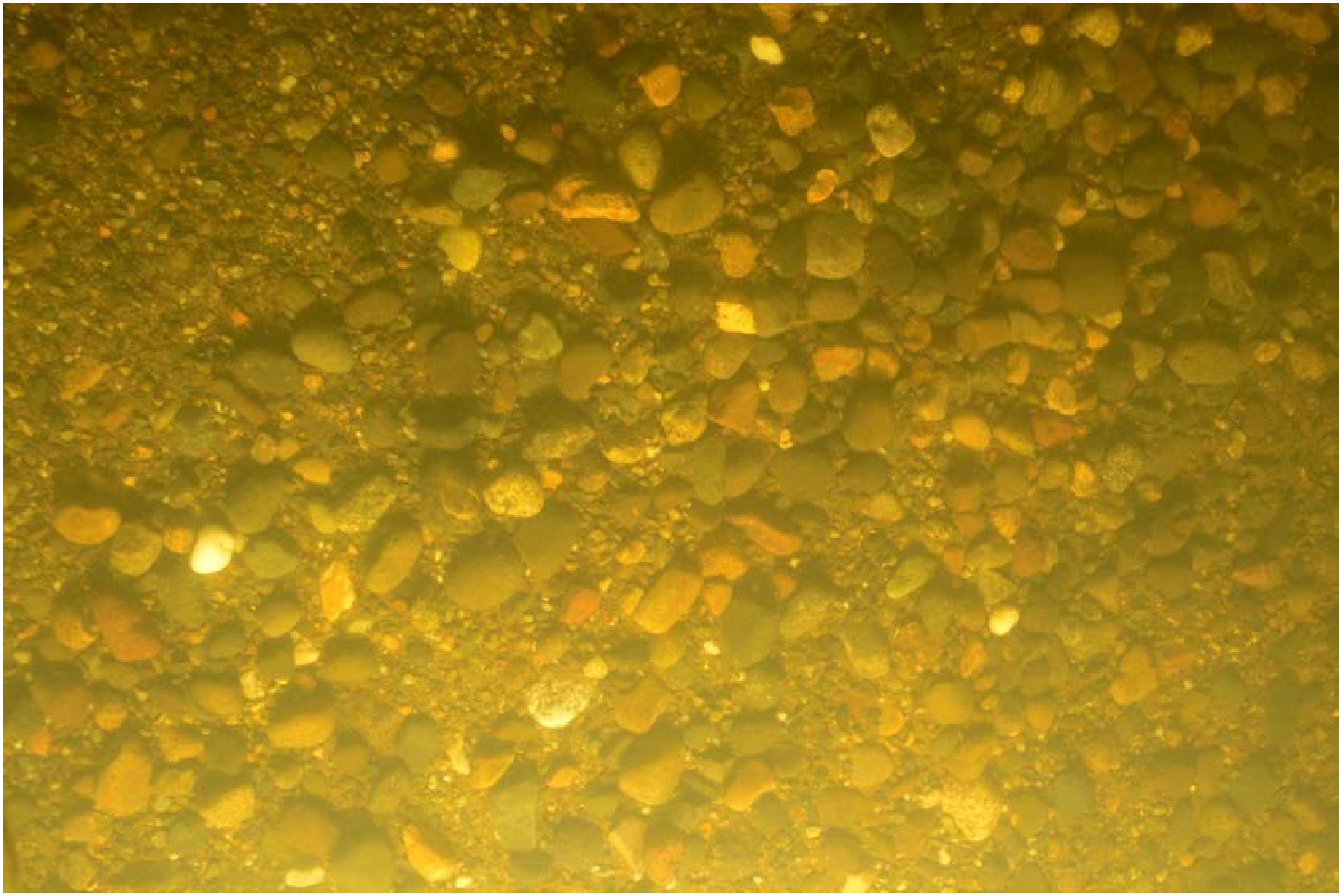

Figure 3-2. Representative PV image from Station LDW-Y0-IN-ENR-3-A-PV-R1 showing ENR sands and gravels typical of the intertidal ENR subplot at 100% cover.

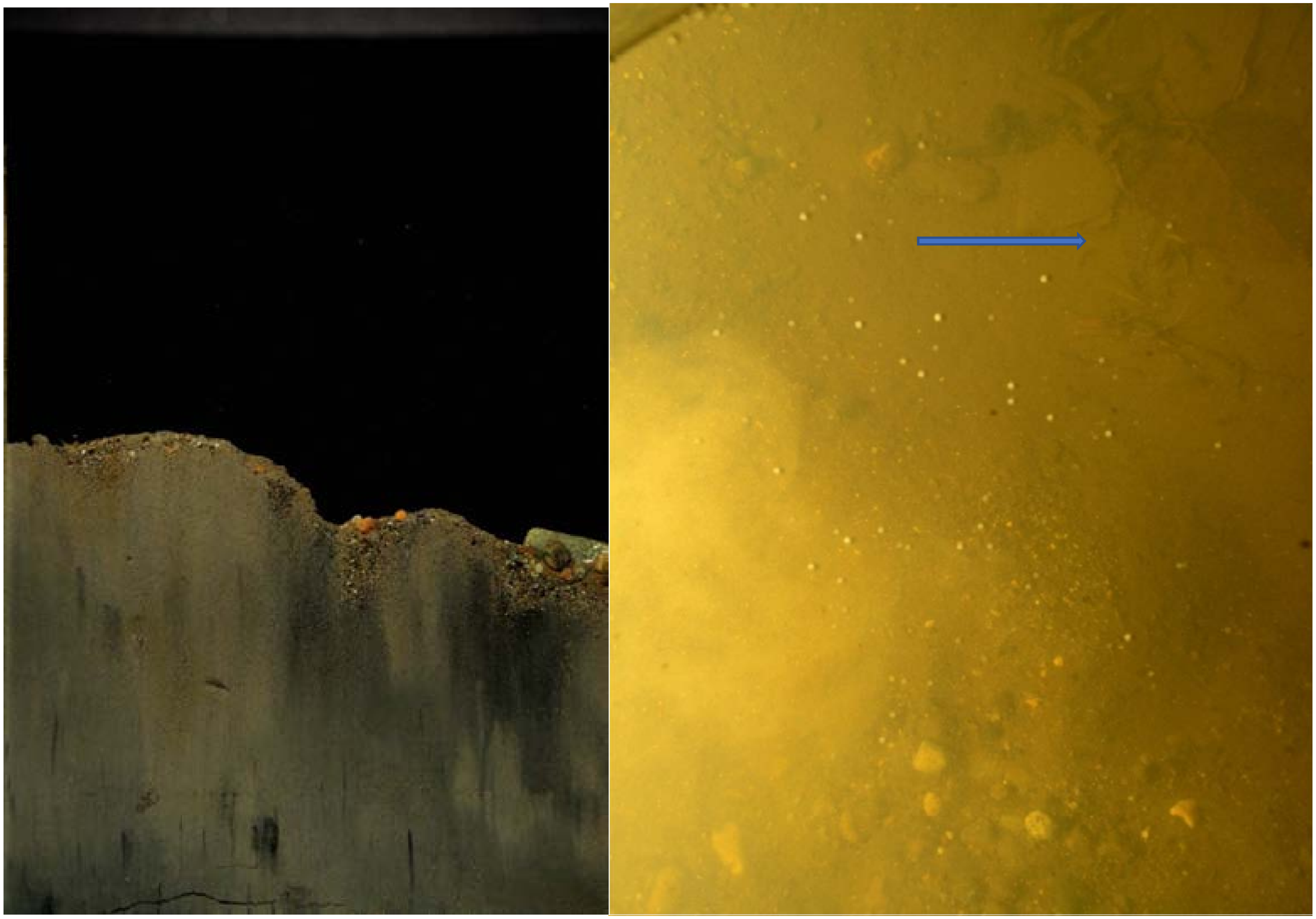

Figure 3-3. Representative SPI and PV images from Stations LDW-Y0-IN-ENR-1-A-SPI-R2/LDW-Y0-IN-ENR-1-A-PV-R2 showing a thin veneer of ENR material in the SPI image and incomplete cover of sand and gravels in the PV image. There is a noticeable change in elevation in the PV area that is not covered by gravel. Approximate location of the SPI image is denoted by the arrow. SPI images are 14.42 cm in width.

Figure 3-4. Representative images from Stations LDW-Y0-IN-ENR+AC-1-B-SPI-R3 and LDW-Y0-IN-ENR+AC-5-B-SPI-R3 that show ENR+AC sediments from the intertidal plot. SPI images are 14.42 cm in width.

Figure 3-5. Representative SPI images from LDW-Y0-IN-ENR+AC-6-A-SPI-R1 and LDW-Y0-IN-ENR+AC-3-B-SPI-R3 showing the variability in recent deposition observed. At LDW-Y0-IN-ENR+AC-6-A-SPI-R1, there is abundant recent deposition that has been smeared down. At LDW-Y0-IN-ENR+AC-3-B-SPI-R3 there is only a trace amount of post-placement recent deposition. SPI images are 14.42 cm in width.

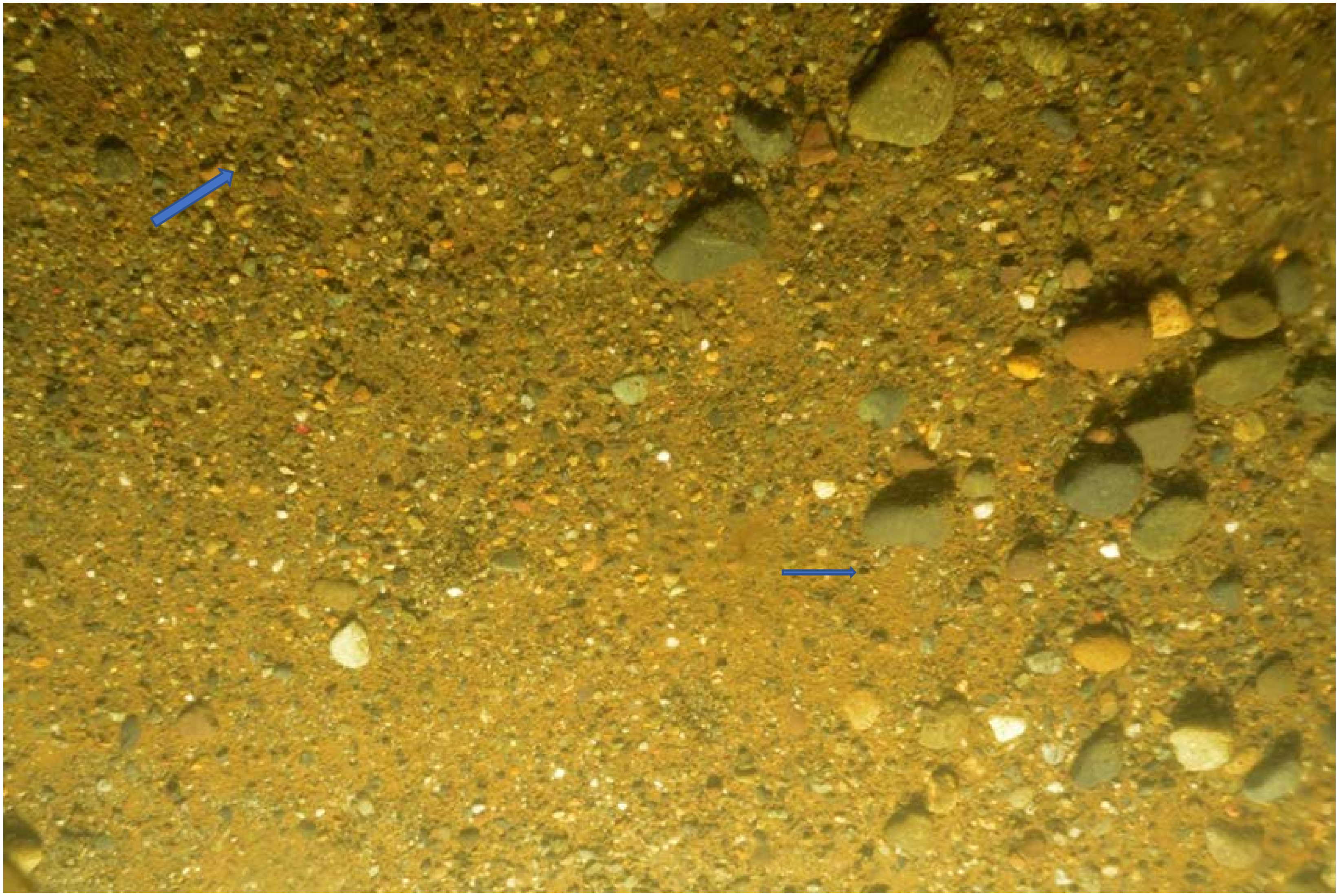

Figure 3-6. Representative PV image from Station LDW-Y0-IN-ENR+AC-2-A-PV-R2 showing sand and gravels from the intertidal ENR+AC subplot. Scattered small sand-sized black particles can be seen at the sediment surface. At this station and replicate, the sediment surface is mostly free of recently deposited post-placement sediment. Scaling lasers (red dots) are 26 cm apart.

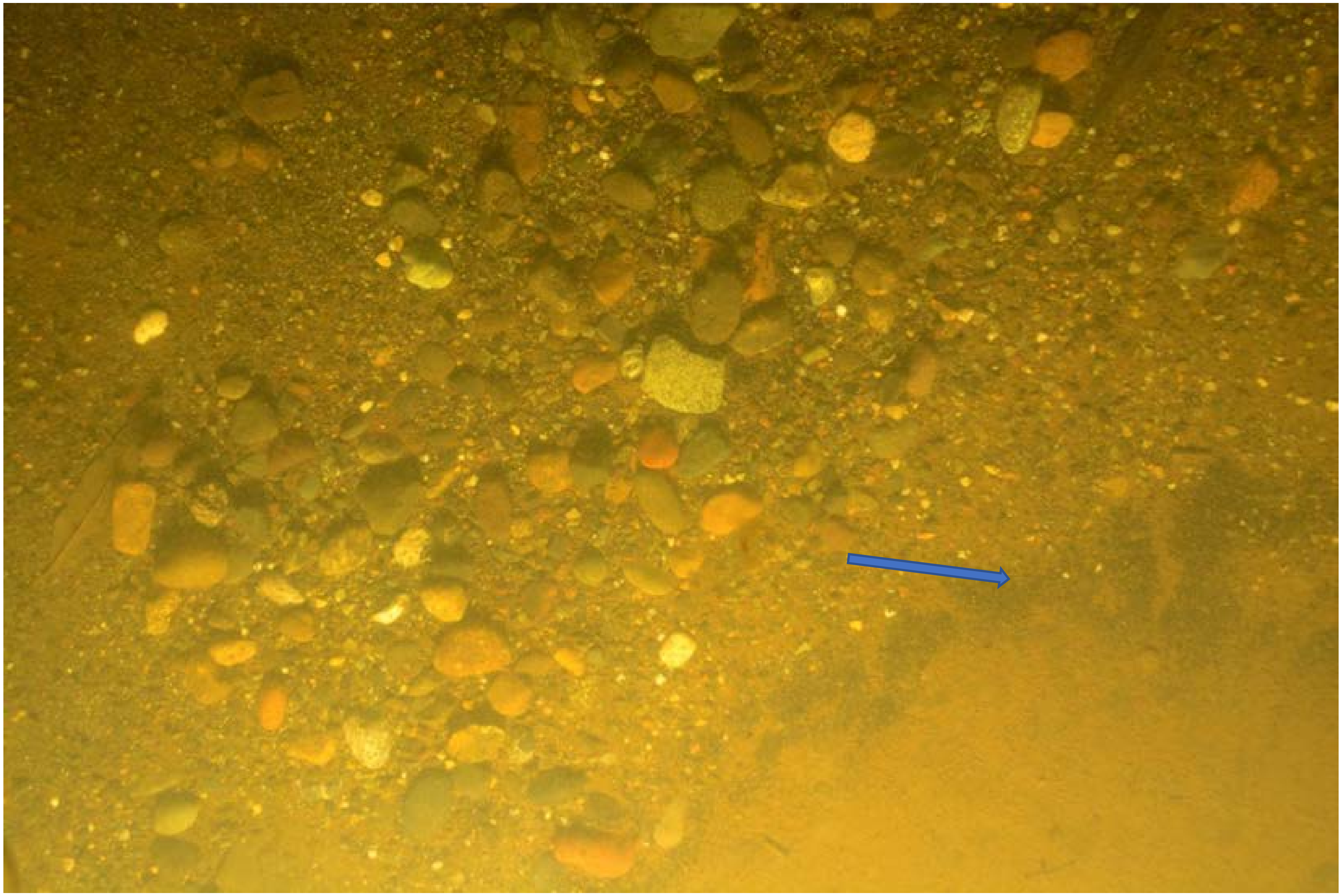

Figure 3-7. Representative PV image from Station LDW-Y0-IN-ENR+AC-6-A-PV-R1 showing ENR+AC sands and gravels from the ENR+AC subplot. Small sand-sized black particles can be seen at the sediment surface and in a band at the lower right. At this station and replicate, there are patches of recently deposited fine-grained sediment that obscure the ENR+AC material (lower right). Scaling lasers (red dots) are 26 cm apart.

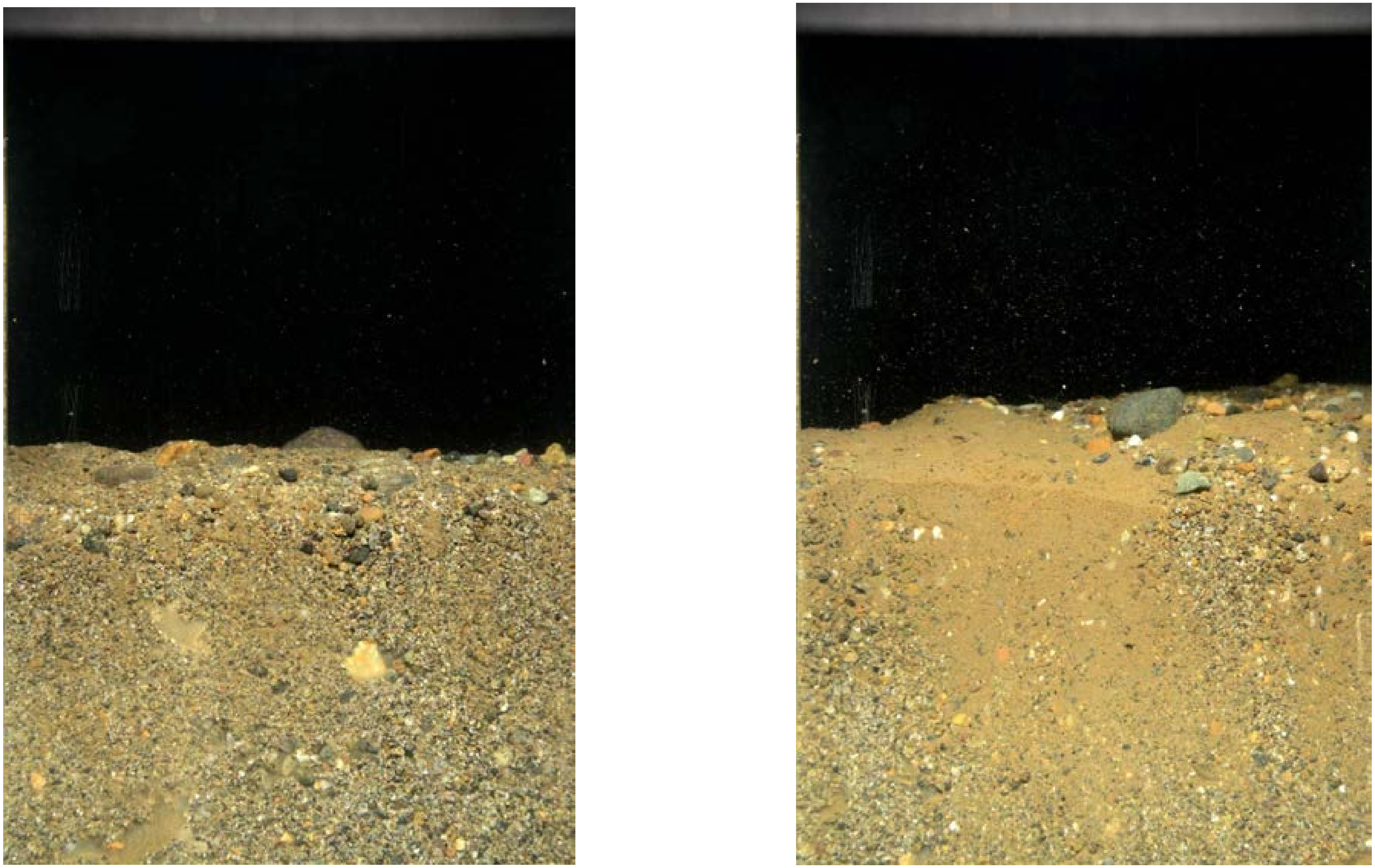

Figure 3-8. Representative SPI images from Stations LDW-Y0-SC-ENR-1-A-SPI-R3 (left) and LDW-Y0-SC-ENR-3-A-SPI-R1 (right) showing typical ENR sediments from the scour ENR subplot. In both images material thickness extends beyond the prism penetration. The image on the right shows a thin band of recently deposited sediment overlying the ENR material. SPI images are 14.42 cm in width.

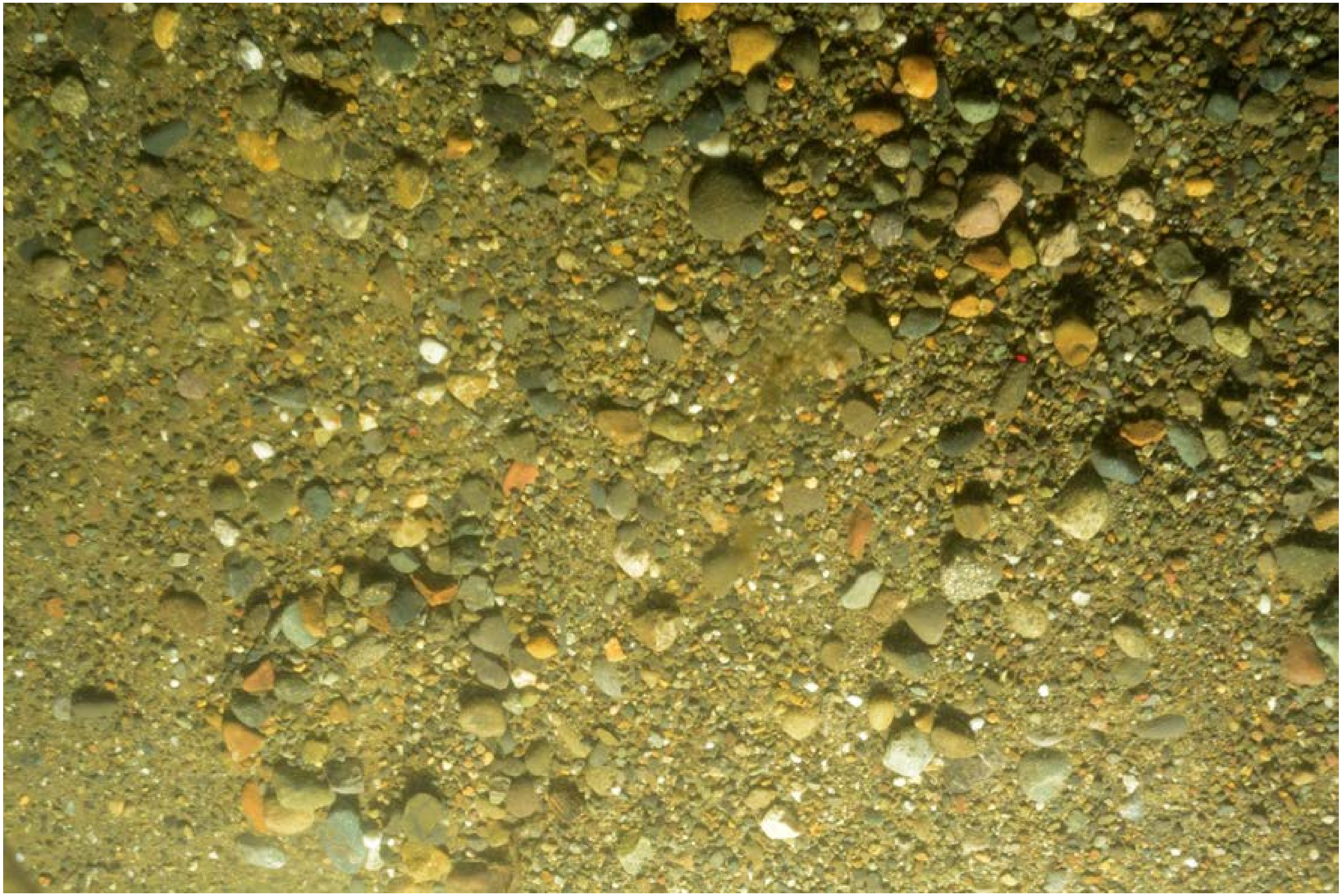

Figure 3-9. PV image from Station LDW-Y0-SC-ENR-2-B-PV-R1 showing typical ENR sediments from the scour ENR subplot. ENR materials are lithic sands and gravels. The sediment surface is mostly free of fine-grained sediment. Scaling lasers (red dots) are 26 cm apart.

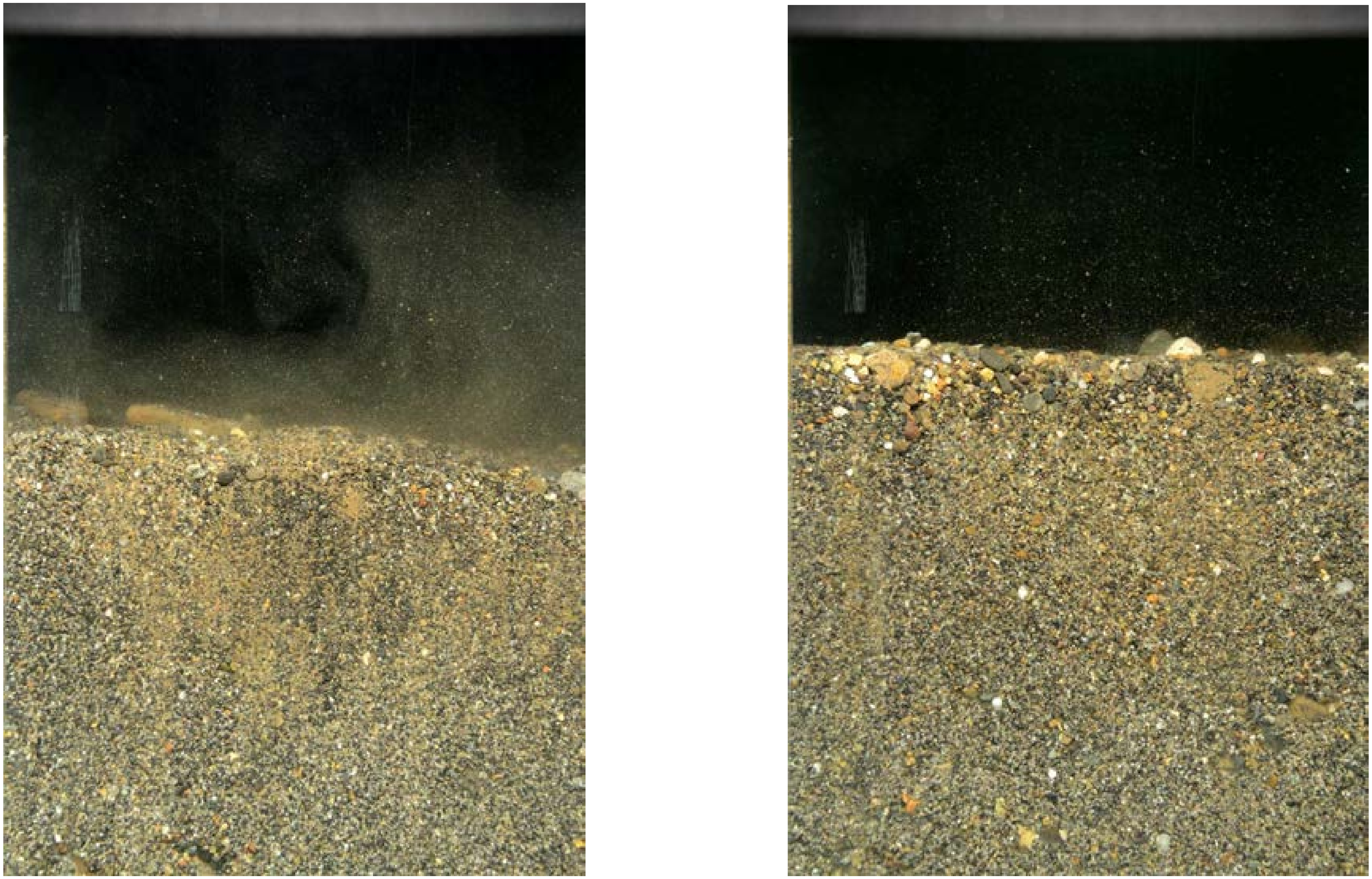

Figure 3-10. Representative SPI images from Stations LDW-Y0-SC-ENR+AC-2-A-SPI-R3 (left) and LDW-Y0-SC-ENR+AC-3-B-SPI-R1 (right) showing typical ENR+AC material from the scour subplot. In both images, ENR+AC material extends beyond the depth of camera prism penetration. Small, fine sand-sized, black, low reflectance particles are interspersed throughout the sediment column and its extent into the sediment column persists beyond the depth of prism penetration. SPI images are 14.42 cm in width.

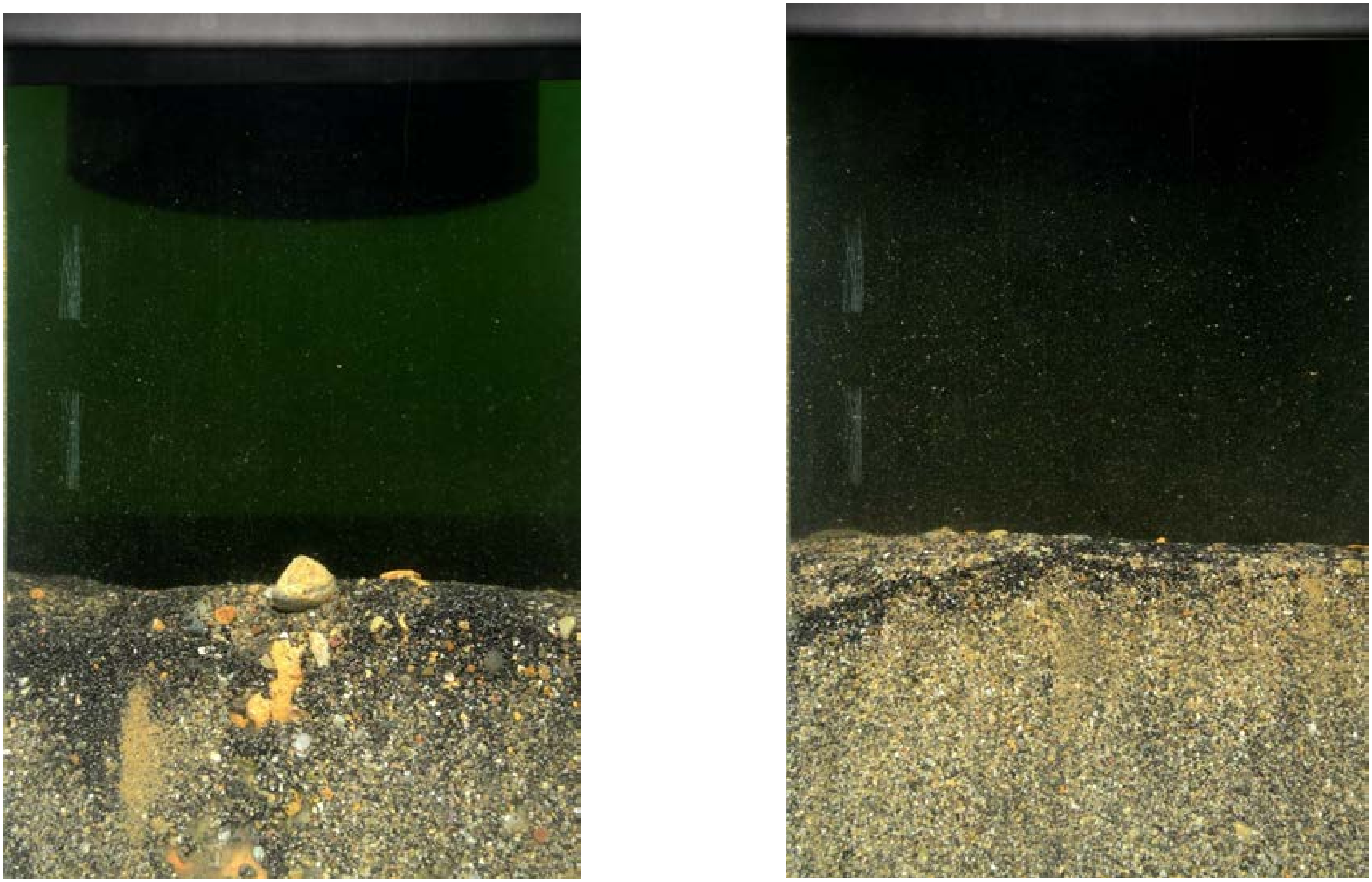

Figure 3-11. Representative SPI images from Stations LDW-Y0-SC-ENR+AC-5-B-SPI-R1 (left) and LDW-Y0-SC-ENR+AC-3-A-SPI-R3 (right) showing ENR+AC material from the scour subplot. ENR+AC extends into the sediment column beyond the depth of prism penetration although in both images there is a thin band of black particles at the sediment-water interface. At both stations, there is little to no recently deposited sediment. SPI images are 14.42 cm in width.

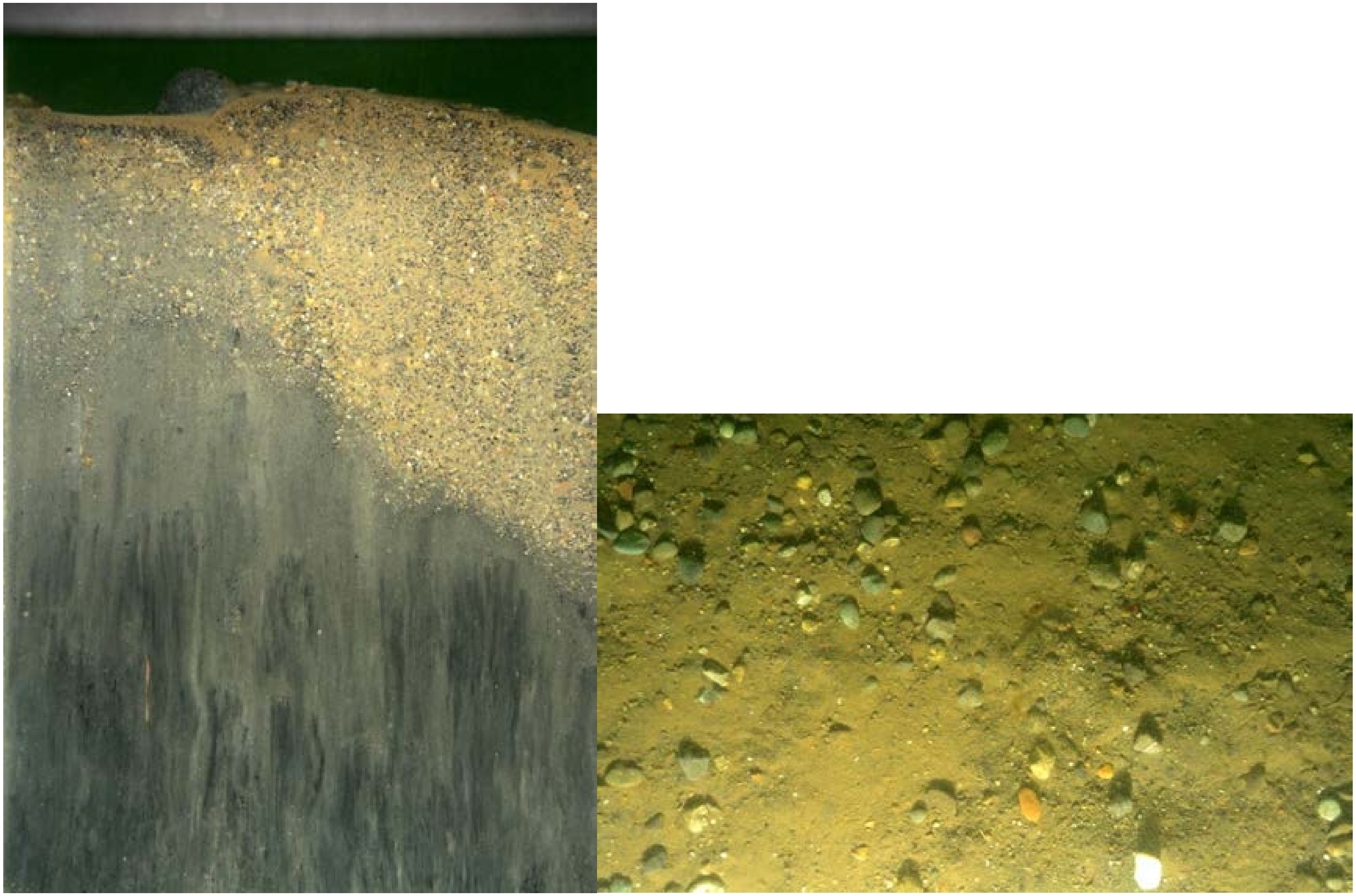

Figure 3-12. SPI and PV images from Station LDW-Y0-SC-ENR+AC-5-A-SPI-R2. The SPI image shows a layer of ENR+AC material over native sediment. The PV image shows 100% cover of ENR+AC material and a patch of recently deposited sediment in the lower center of the frame. This is the only location in the scour subplot where the thickness of ENR or ENR+AC was less than camera prism penetration.

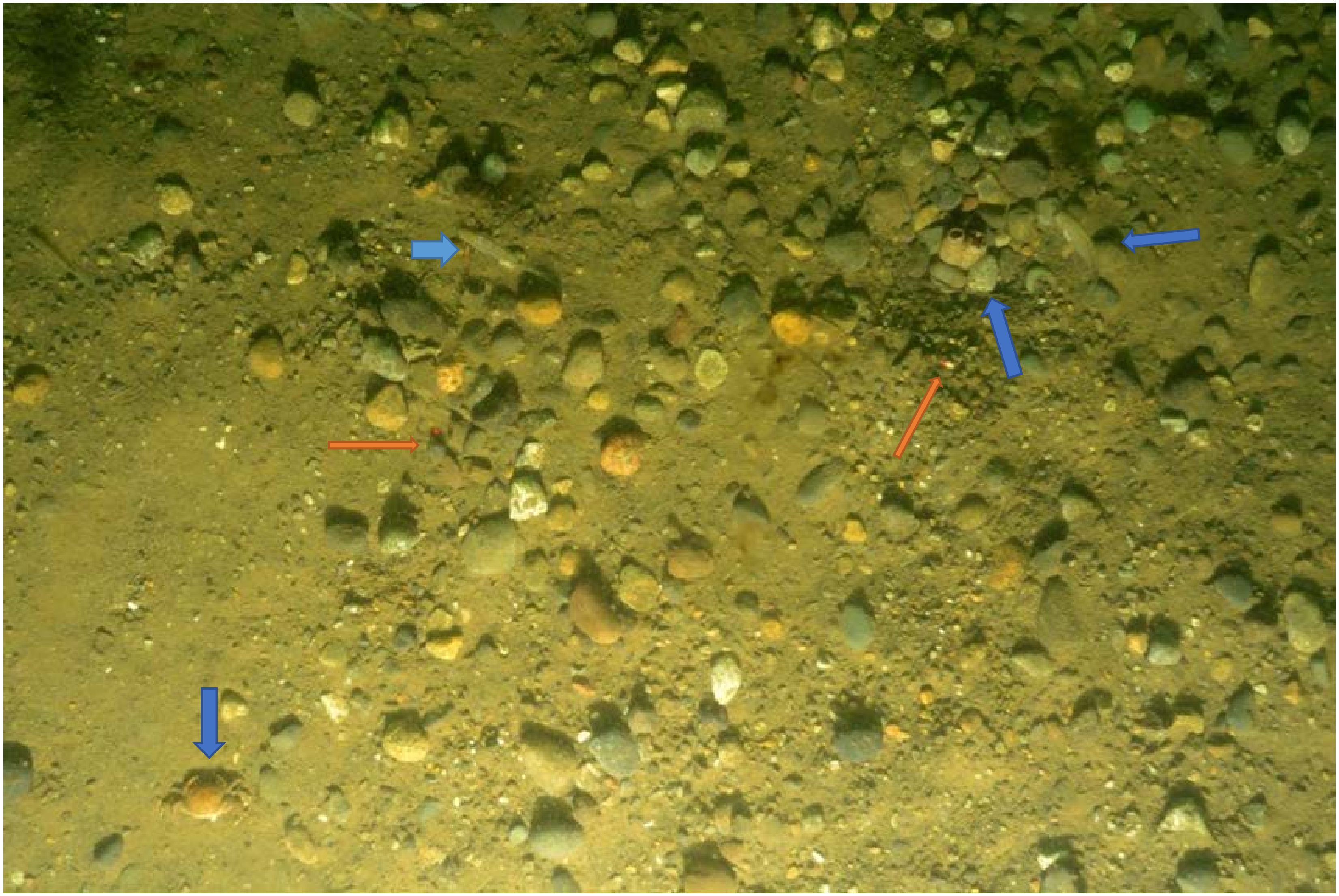

Figure 3-13. PV image from Station LDW-Y0-SC-ENR+AC-5-A-PV-R1 showing ENR+AC material (sands and gravels) and some patchy recent deposition of fine-grained sediment. Two fish, a crab, and a bivalve siphon can be seen in the image (arrows). Scaling lasers (red dots) are 26 cm apart.

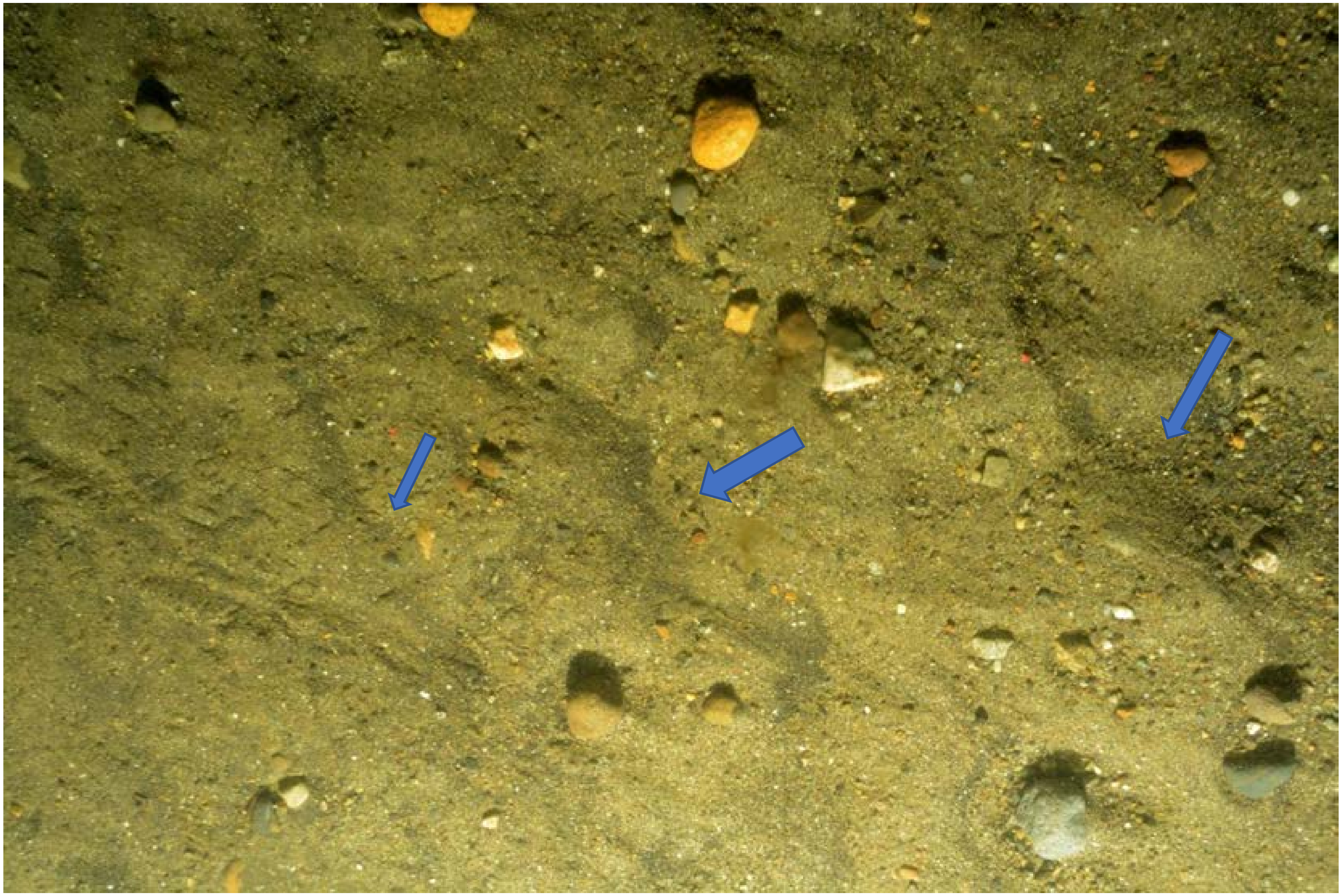

Figure 3-14. PV image from Station LDW-Y0-SC-ENR+AC-2-A-PV-R1 showing ENR+AC material. The sediment surface is faintly rippled and small accumulations of black particles can be seen on the lee side of the ripples. Scaling lasers (red dots) are 26 cm apart.

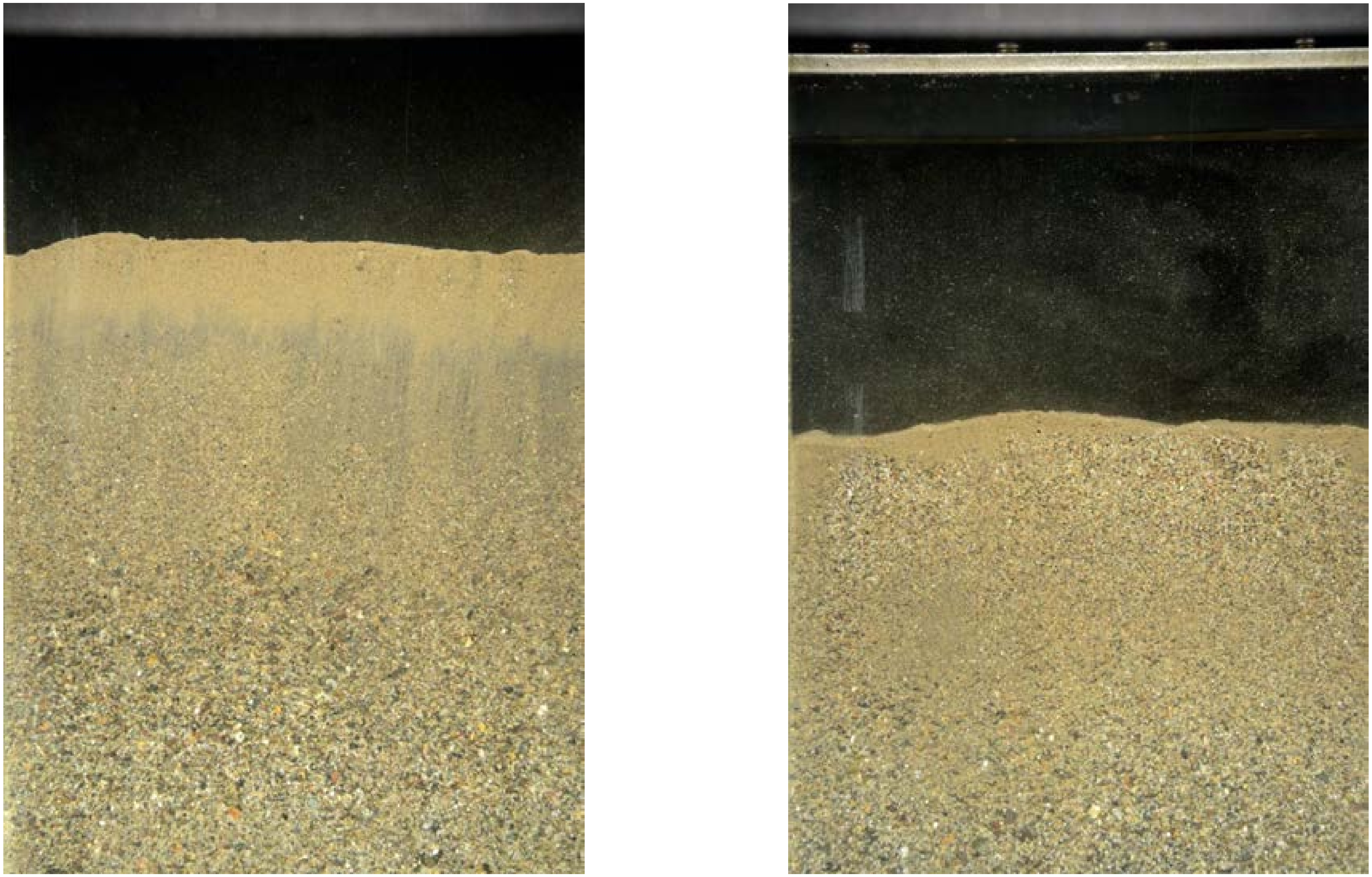

Figure 3-15. Representative SPI images from Stations LDW-Y0-SU-ENR-1-B-SPI-R1 (left) and LDW-Y0-SU-ENR-3-B-SPI-R3 (right) showing ENR material typical of the subtidal plot. In both images, the thickness of ENR material extends beyond the penetration of the prism into the sediment column. A distinct layer of fine-grained sediment has been deposited on the sediment in the elapsed period between the cessation of placement and start of the SPI/PV survey of the subtidal plot. SPI images are 14.42 cm in width.

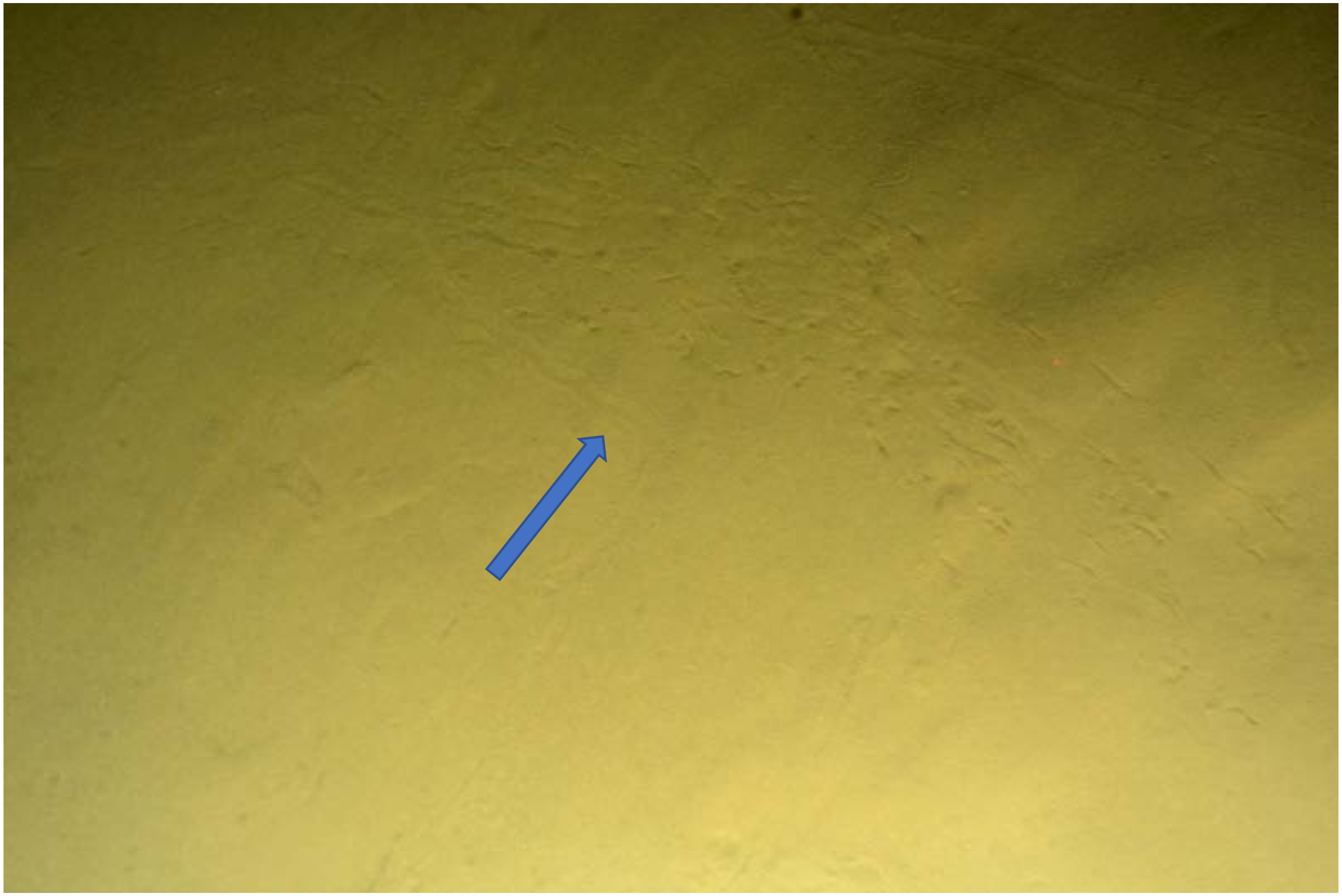

Figure 3-16. PV image from Station LDW-Y0-SU-ENR-1-B-PV-R1 showing typical surface sediments encountered at the subtidal ENR subplot. Surface sediments seen in the PV image are fine-grained silts and clays with some epifaunal tracks (arrow). ENR sands and gravels are not visible through the veneer of the recently deposited sediment. The SPI image from this replicate is shown in Figure 3-14. Scaling lasers (red dots) are 26 cm apart.

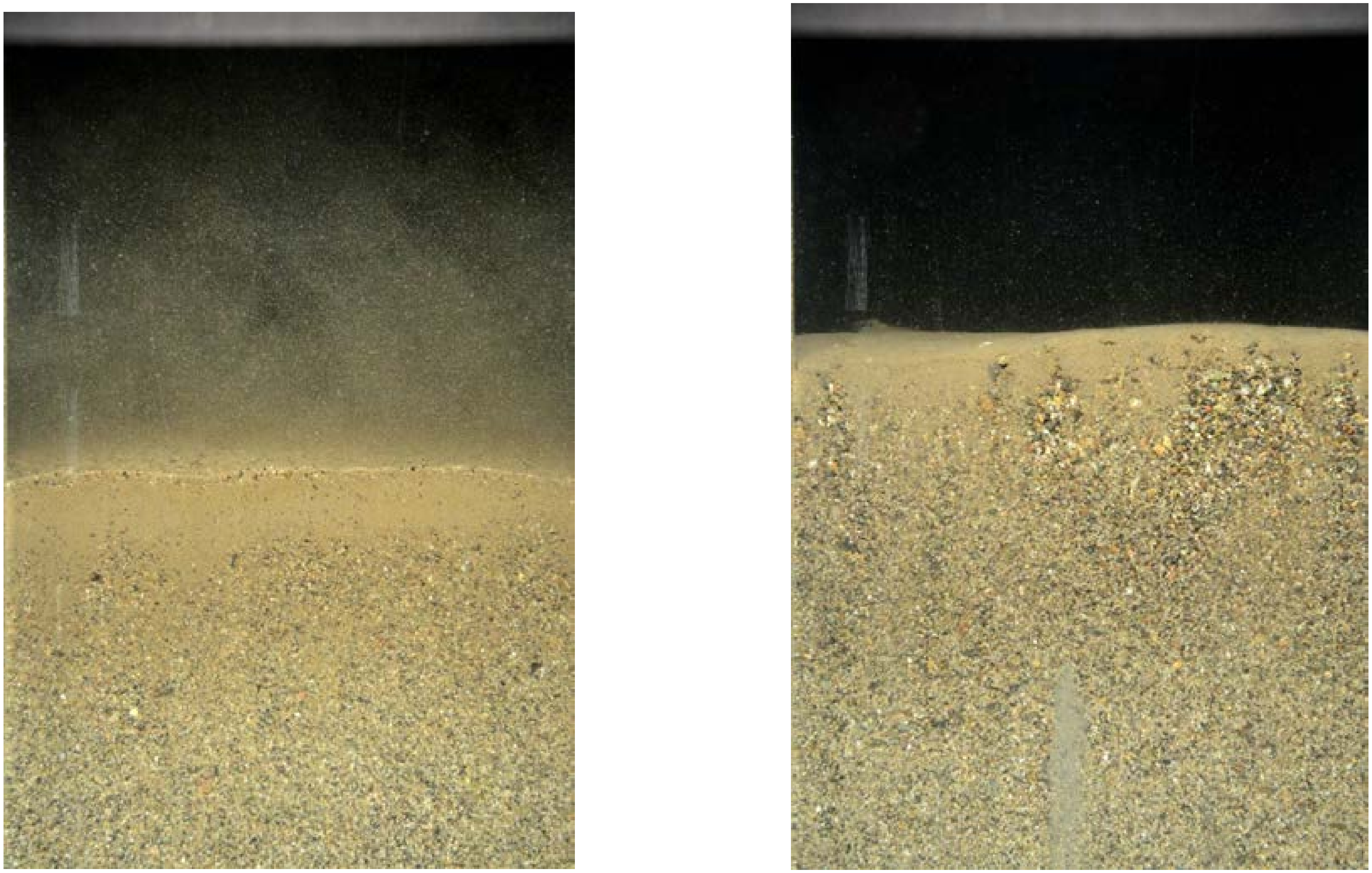

Figure 3-17. Representative SPI images from Stations LDW-Y0-SU-ENR+AC-4-A-SPI-R1 (left) and LDW-Y0-SU-ENR+AC-6-A-SPI-R1 showing ENR+AC materials from the subtidal ENR+AC subplot. ENR+AC material extends into the sediment column beyond the depth of prism penetration. There is a thin band (~1 cm) of recently deposited sediment at the top of the sediment column. SPI images are 14.42 cm in width.

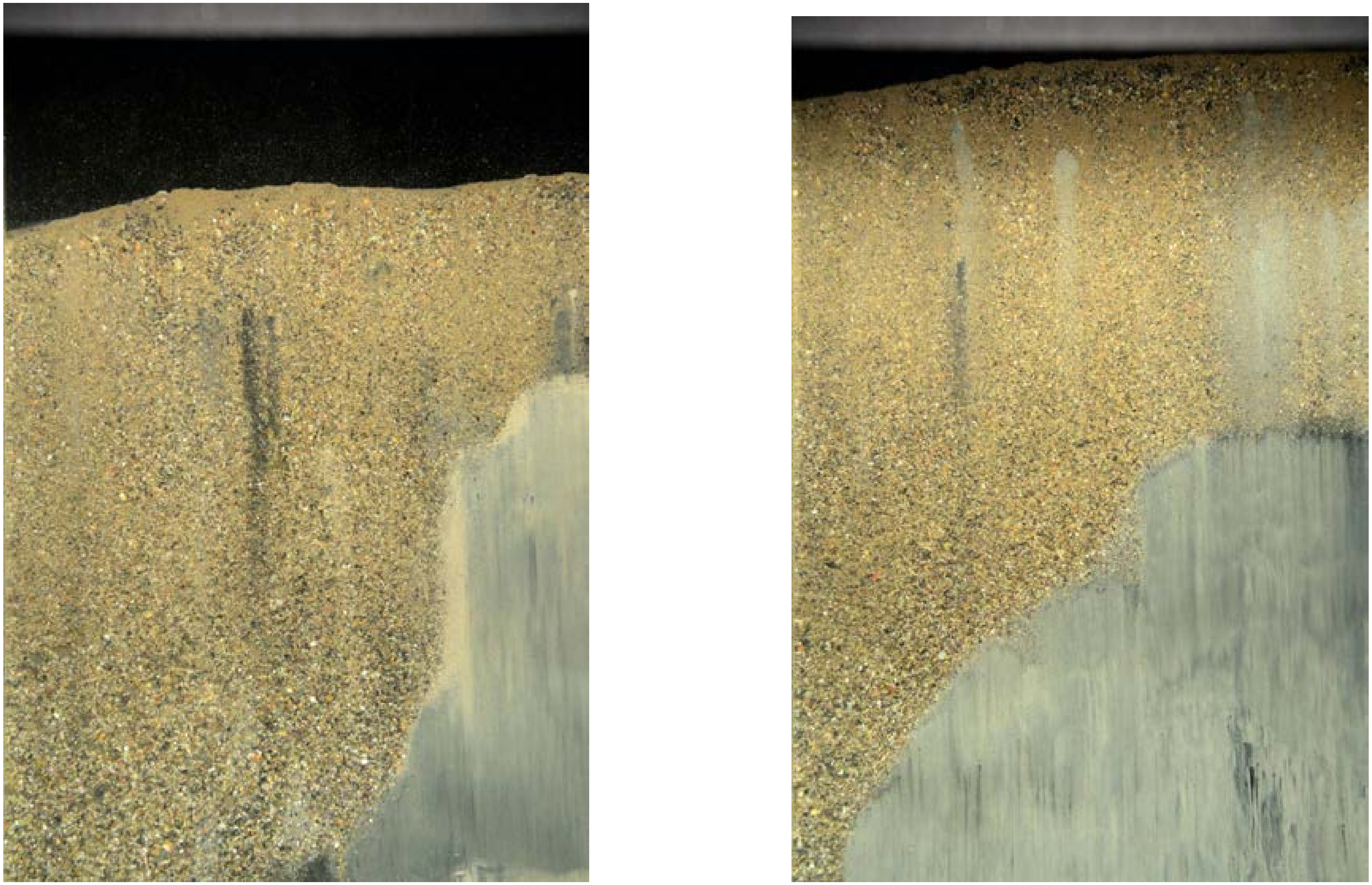

Figure 3-18. Representative SPI images from Stations LDW-Y0-SU-ENR+AC-4-B-SPI-R1 (left) and LDW-Y0-SU-ENR+AC-4-B-SPI-R1 (right) from the subtidal ENR+AC subplot. ENR+AC material overlies gray, reduced native sediments providing 100% cover. These are the only two replicates from this subplot (from the same station) where the ENR+AC thickness is less than prism penetration. SPI images are 14.42 cm in width.

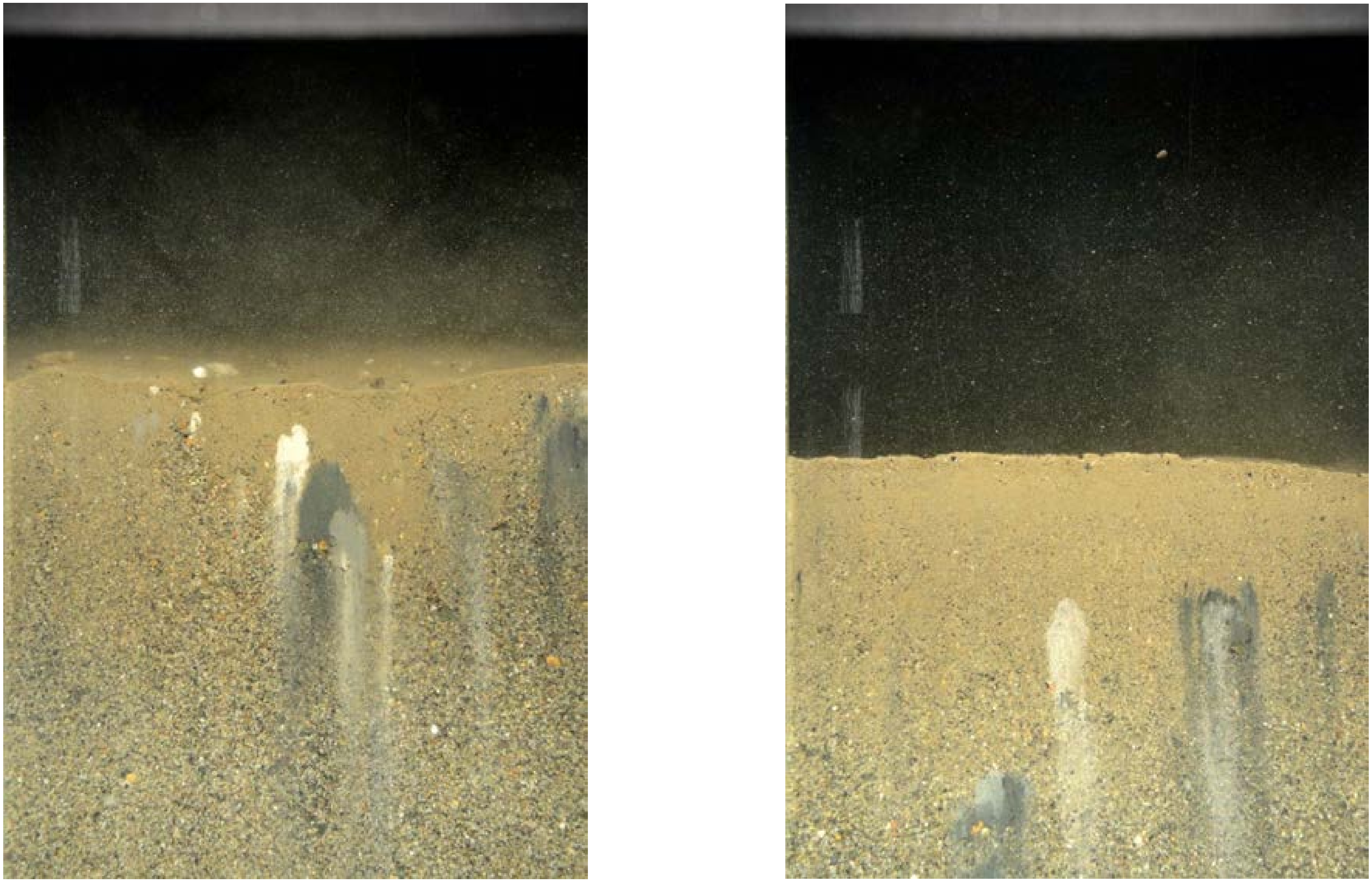

Figure 3-19. SPI images from Stations LDW-Y0-SU-ENR+AC-6-A-SPI-R2 (left) and LDW-Y0-SU-ENR+AC-6-B-SPI-R2 (right) showing ENR+AC material from the subtidal plot, which is overlain by a thin, 1- to 2-cm deposit of recently deposited sediment that contains distinct balls of allochthonous clay. SPI images are 14.42 cm in width.

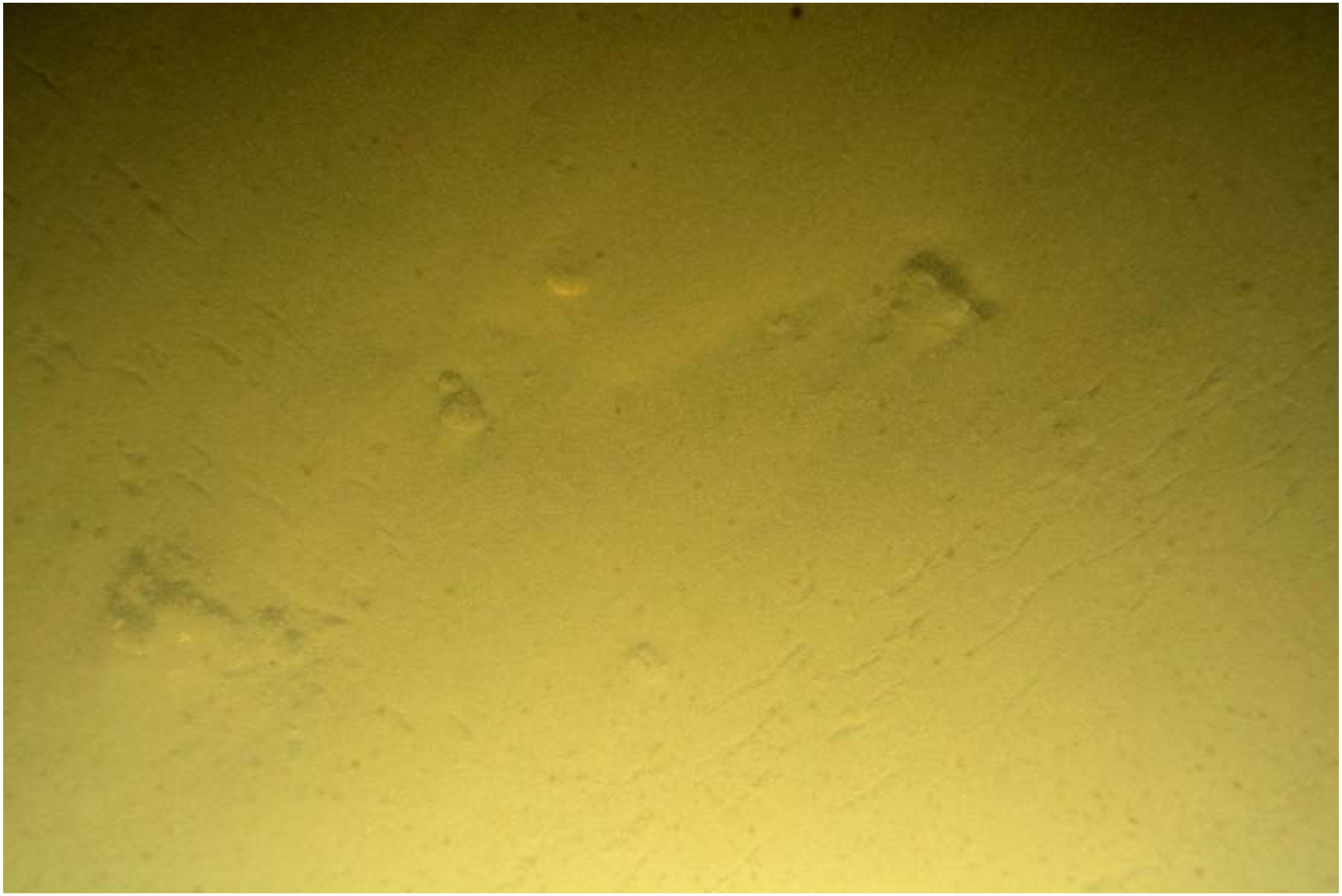

Figure 3-20. PV image from Station LDW-Y0-SU-ENR+AC-3-A-PV-R1 showing soft, fine-grained recently deposited sediment and mud clast deposited over and obscuring ENR+AC material. ENR+AC material is only visible in the SPI images from this station.

Tables

Table 3-1. Year 0 Intertidal ENR Pilot Subplot SPI Results

Station/Replicate	Mean Penetration (cm)	Minimum Penetration (cm)	Maximum Penetration (cm)	Boundary Roughness (cm)	Apparent RPD (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Infaunal Successional Stage	Methane		Mean Placement Material Thickness (cm)	Mean Recent Post-Placement Deposition (cm)
LDW-Y0-IN-ENR-1-A-SPI-R1	8.45	7.63	8.78	1.15	IND	0 - -1	>4	-5.00	IND	0.00	>	8.45	0
LDW-Y0-IN-ENR-1-A-SPI-R2	10.17	8.06	11.52	3.47	IND	1-0/>4	>4	-3.00	IND	0.00		0.57	0
LDW-Y0-IN-ENR-1-A-SPI-R3	10.59	10.08	11.09	1.01	IND	0 - -1	>4	-2.00	IND	0.00	>	10.59	Trace
LDW-Y0-IN-ENR-1-B-SPI-R1	6.32	4.33	7.10	2.77	IND	0 - -1	>4	-5.00	IND	0.00	>	6.32	Trace
LDW-Y0-IN-ENR-1-B-SPI-R2	7.94	6.24	8.80	2.56	IND	0 - -1	>4	-5.00	IND	0.00	>	7.94	Trace
LDW-Y0-IN-ENR-1-B-SPI-R3	7.24	5.31	8.20	2.89	IND	0 - -1	>4	-5.00	IND	0.00	>	7.24	0
LDW-Y0-IN-ENR-2-A-SPI-R1	7.52	6.44	8.46	2.02	IND	0 - -1	>4	-5.00	IND	0.00	>	7.52	Trace
LDW-Y0-IN-ENR-2-A-SPI-R2	8.60	7.34	9.13	1.79	IND	0 - -1	>4	-5.00	IND	0.00	>	8.60	Trace
LDW-Y0-IN-ENR-2-A-SPI-R3	6.03	5.81	6.30	0.49	IND	1 - 0	>4	-2.00	IND	0.00	>	6.03	0.22
LDW-Y0-IN-ENR-2-B-SPI-R1	6.50	5.20	7.80	2.60	IND	0 - -1	>4	-5.00	IND	0.00	>	6.50	Trace
LDW-Y0-IN-ENR-2-B-SPI-R2	7.26	6.44	7.73	1.29	IND	-2 - -3	>4	-6.00	IND	0.00	>	7.26	0.00
LDW-Y0-IN-ENR-2-B-SPI-R3	6.96	6.24	7.62	1.39	IND	-2 - -3	>4	-6.00	IND	0.00	>	6.96	0
LDW-Y0-IN-ENR-3-A-SPI-R1	7.78	5.55	8.98	3.44	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.78	0
LDW-Y0-IN-ENR-3-A-SPI-R2	6.19	5.52	6.78	1.26	IND	-1 - -2	>4	-3.00	IND	0.00	>	6.19	0
LDW-Y0-IN-ENR-3-A-SPI-R3	7.53	4.74	8.09	3.35	IND	-1 - -2	>4	-4.00	IND	0.00	>	7.53	0
LDW-Y0-IN-ENR-3-B-SPI-R1	6.38	4.68	6.93	2.25	IND	-1 - -2	>4	-5.00	IND	0.00	>	6.38	Trace
LDW-Y0-IN-ENR-3-B-SPI-R2	12.63	9.62	13.60	3.99	IND	-1 - -2	>4	-5.00	IND	0.00	>	12.63	Trace
LDW-Y0-IN-ENR-3-B-SPI-R3	6.57	4.62	7.08	2.45	IND	-1 - -2	>4	-5.00	IND	0.00	>	6.57	0
LDW-Y0-IN-ENR-4-A-SPI-R1	6.97	6.30	7.28	0.98	IND	-1 - -2	>4	-3.00	IND	0.00	>	6.97	0
LDW-Y0-IN-ENR-4-A-SPI-R2	7.97	6.24	8.69	2.45	IND	-2 - -3	>4	-6.00	IND	0.00	>	7.97	0
LDW-Y0-IN-ENR-4-A-SPI-R3	6.38	4.10	7.27	3.17	IND	-2 - -3	>4	-6.00	IND	0.00	>	6.38	0
LDW-Y0-IN-ENR-4-B-SPI-R1	6.22	5.98	6.64	0.66	IND	-1 - -2	>4	-5.00	IND	0.00	>	6.22	0
LDW-Y0-IN-ENR-4-B-SPI-R2	6.25	5.03	6.84	1.82	IND	-1 - -2	>4	-5.00	IND	0.00	>	6.25	0
LDW-Y0-IN-ENR-4-B-SPI-R3	9.20	9.04	9.39	0.35	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.20	Trace
LDW-Y0-IN-ENR-5-A-SPI-R1	7.53	6.01	7.86	1.85	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.53	Trace
LDW-Y0-IN-ENR-5-A-SPI-R2	6.82	5.89	7.45	1.56	IND	-1 - -2	>4	-5.00	IND	0.00	>	6.82	Trace
LDW-Y0-IN-ENR-5-A-SPI-R3	8.19	5.66	9.67	4.01	IND	-1 - -2	>4	-5.00	IND	0.00	>	8.19	0
LDW-Y0-IN-ENR-5-B-SPI-R1	7.16	6.27	8.09	1.82	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.16	0
LDW-Y0-IN-ENR-5-B-SPI-R2	7.44	4.97	8.12	3.15	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.44	0
LDW-Y0-IN-ENR-5-B-SPI-R3	7.91	6.82	8.23	1.41	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.91	Trace
LDW-Y0-IN-ENR-6-A-SPI-R1	5.40	5.05	6.82	1.76	IND	0 - -1	>4	-2.00	IND	0.00	>	5.40	Trace
LDW-Y0-IN-ENR-6-A-SPI-R2	5.94	4.48	7.02	2.54	IND	-1 - -2	>4	-5.00	IND	0.00	>	5.94	0.19
LDW-Y0-IN-ENR-6-A-SPI-R3	6.71	4.94	7.16	2.22	IND	-2 - -3	>4	-6.00	IND	0.00	>	6.71	0
LDW-Y0-IN-ENR-6-B-SPI-R1	6.55	6.15	6.84	0.69	IND	-1 - -2	>4	-4.00	IND	0.00	>	6.55	Trace
LDW-Y0-IN-ENR-6-B-SPI-R2	7.26	6.53	7.91	1.38	IND	-1 - -2	>4	-3.00	IND	0.00	>	7.26	0
LDW-Y0-IN-ENR-6-B-SPI-R3	7.73	6.82	8.26	1.44	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.73	0
Mean	7.45	6.11	8.15	2.04					Mean	0.00		7.19	
Std Dev	1.43	1.41	1.49	0.98					Std Dev	0.00		1.77	
Count	36.00	36.00	36.00	36.00					Count	36.00		36.00	
Min	5.40	4.10	6.30	0.35					Min	0.00		0.57	
Max	12.63	10.08	13.60	4.01					Max	0.00		12.63	

IND=Indeterminate	Trace=Present but not in measurable quantity
NA=Not Analyzed	Surface = at the sediment surface

Table 3-2. Year 0 Intertidal ENR+AC Pilot Subplot SPI Results

Station/Replicate	Mean Penetration (cm)	Minimum Penetration (cm)	Maximum Penetration (cm)	Boundary Roughness (cm)	Apparent RPD (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Infaunal Successional Stage	Methane		Mean Placement Material Thickness (cm)	Mean Recent Post-Placement Deposition (cm)
LDW-Y0-IN-ENR+AC-1-A-SPI-R1	6.07	5.03	6.58	1.56	IND	-1 - -2	>4	-6.00	IND	0.00	>	6.07	Trace
LDW-Y0-IN-ENR+AC-1-A-SPI-R2	7.94	5.05	8.78	3.73	IND	-1 - -2	>4	-6.00	IND	0.00	>	7.94	0
LDW-Y0-IN-ENR+AC-1-A-SPI-R3	6.05	3.78	6.67	2.89	IND	-1 - -2	>4	-6.00	IND	0.00	>	6.05	Trace
LDW-Y0-IN-ENR+AC-1-B-SPI-R1	9.43	8.78	9.82	1.04	IND	-1 - -2	>4	-6.00	IND	0.00	>	9.43	Trace
LDW-Y0-IN-ENR+AC-1-B-SPI-R2	9.95	8.35	10.25	1.91	3.33	0 - -1	>4	-2.00	IND	0.00	>	9.95	0.76
LDW-Y0-IN-ENR+AC-1-B-SPI-R3	9.94	8.32	10.89	2.57	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.94	Trace
LDW-Y0-IN-ENR+AC-2-A-SPI-R1	8.90	5.66	9.39	3.72	IND	-1 - -2	>4	-6.00	IND	0.00	>	8.90	Trace
LDW-Y0-IN-ENR+AC-2-A-SPI-R2	9.78	8.49	10.48	1.99	IND	-1 - -2	>4	-6.00	IND	0.00	>	9.78	Trace
LDW-Y0-IN-ENR+AC-2-A-SPI-R3	10.78	9.13	11.38	2.25	IND	-1 - -2	>4	-6.00	IND	0.00	>	10.78	Trace
LDW-Y0-IN-ENR+AC-2-B-SPI-R1	6.98	5.86	7.51	1.65	IND	0 - -1	>4	-2.00	IND	0.00	>	6.98	Trace
LDW-Y0-IN-ENR+AC-2-B-SPI-R2	7.16	6.33	7.65	1.33	IND	0 - -1	>4	-4.00	IND	0.00	>	7.16	Trace
LDW-Y0-IN-ENR+AC-2-B-SPI-R3	7.97	6.70	9.66	2.96	IND	-1 - -2	>4	-6.00	IND	0.00	>	7.97	0.11
LDW-Y0-IN-ENR+AC-3-A-SPI-R1	7.12	5.72	7.51	1.79	IND	0 - -1	>4	-4.00	IND	0.00	>	7.12	Trace
LDW-Y0-IN-ENR+AC-3-A-SPI-R2	8.90	7.25	9.86	2.61	IND	-1 - -2	>4	-4.00	IND	0.00	>	8.90	Trace
LDW-Y0-IN-ENR+AC-3-A-SPI-R3	7.89	7.25	8.26	1.01	IND	-1 - -2	>4	-3.00	IND	0.00	>	7.89	Trace
LDW-Y0-IN-ENR+AC-3-B-SPI-R1	6.52	5.81	6.89	1.08	IND	0 - -1	>4	-4.00	IND	0.00	>	6.52	Trace
LDW-Y0-IN-ENR+AC-3-B-SPI-R2	6.79	5.98	7.39	1.41	IND	0 - -1	>4	-4.00	IND	0.00	>	6.79	Trace
LDW-Y0-IN-ENR+AC-3-B-SPI-R3	7.67	5.75	7.86	2.11	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.67	0.00
LDW-Y0-IN-ENR+AC-4-A-SPI-R1	6.97	4.71	8.20	3.49	IND	-2 - -3	>4	-5.00	IND	0.00	>	6.97	Trace
LDW-Y0-IN-ENR+AC-4-A-SPI-R2	7.59	6.44	7.86	1.41	IND	0 - -1	>4	-2.00	IND	0.00	>	7.59	Trace
LDW-Y0-IN-ENR+AC-4-A-SPI-R3	8.21	7.57	8.52	0.95	IND	-1 - -2	>4	-3.00	IND	0.00	>	8.21	Trace
LDW-Y0-IN-ENR+AC-4-B-SPI-R1	6.52	5.55	7.17	1.62	IND	0 - -1	>4	-4.00	IND	0.00	>	6.52	0
LDW-Y0-IN-ENR+AC-4-B-SPI-R2	8.63	6.27	9.13	2.86	IND	0 - -1	>4	-4.00	IND	0.00	>	8.63	Trace
LDW-Y0-IN-ENR+AC-4-B-SPI-R3	7.33	5.72	8.75	3.03	IND	0 - -1	>4	-4.00	IND	0.00	>	7.33	0
LDW-Y0-IN-ENR+AC-5-A-SPI-R1	8.90	7.14	9.70	2.57	IND	-1 - -2	>4	-5.00	IND	0.00	>	8.90	0
LDW-Y0-IN-ENR+AC-5-A-SPI-R2	6.32	5.23	7.13	1.91	IND	-2 - -3	>4	-5.00	IND	0.00	>	6.32	0
LDW-Y0-IN-ENR+AC-5-A-SPI-R3	9.23	5.92	9.47	3.55	IND	-1 - -2	>4	-5.00	IND	0.00	>	9.23	0
LDW-Y0-IN-ENR+AC-5-B-SPI-R1	7.25	5.49	8.29	2.80	IND	-1 - -2	>4	-5.00	IND	0.00	>	7.25	Trace
LDW-Y0-IN-ENR+AC-5-B-SPI-R2	9.03	6.27	9.79	3.52	IND	-2 - -3	>4	-6.00	IND	0.00	>	9.03	0
LDW-Y0-IN-ENR+AC-5-B-SPI-R3	5.55	3.87	7.10	3.23	IND	0 - -1	>4	-5.00	IND	0.00	>	5.55	0
LDW-Y0-IN-ENR+AC-6-A-SPI-R1	8.83	8.12	9.53	1.42	4.27	0 - -1	>4	-2.00	IND	0.00	>	8.83	0.77
LDW-Y0-IN-ENR+AC-6-A-SPI-R2	8.32	6.56	8.69	2.14	IND	-2 - -3	>4	-6.00	IND	0.00	>	8.32	Trace
LDW-Y0-IN-ENR+AC-6-A-SPI-R3	8.85	8.20	9.50	1.30	IND	1 - 0	>4	-2.00	IND	0.00	>	8.85	Trace
LDW-Y0-IN-ENR+AC-6-B-SPI-R1	10.02	9.56	10.45	0.90	IND	0 - -1	>4	-4.00	IND	0.00	>	10.02	0.18
LDW-Y0-IN-ENR+AC-6-B-SPI-R2	5.67	4.30	7.02	2.71	IND	1 - 0	>4	-3.00	IND	0.00	>	5.67	0.09
LDW-Y0-IN-ENR+AC-6-B-SPI-R3	7.88	7.19	8.49	1.30	IND	1 - 0	>4	-2.00	IND	0.00	>	7.88	Trace
Mean	7.97	6.48	8.66	2.18	3.80				Mean	0.00		7.97	
Std Dev	1.35	1.46	1.30	0.88	0.67				Std Dev	0.00		1.35	
Count	36.00	36.00	36.00	36.00	2.00				Count	36.00		36.00	
Min	5.55	3.78	6.58	0.90	3.33				Min	0.00		5.55	

IND=Indeterminate

NA=Not Analyzed

Trace=Present but not in measurable quantity

Surface = at the sediment surface

Table 3-3. Year 0 Scour ENR Pilot Subplot SPI Results

Station/Replicate	Mean Penetration (cm)	Minimum Penetration (cm)	Maximum Penetration (cm)	Boundary Roughness (cm)	Apparent RPD (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Infaunal Successional Stage	Methane		Mean Placement Material Thickness (cm)	Mean Recent Post-Placement Deposition (cm)
LDW-Y0-SC-ENR-1-A-SPI-R1	9.52	8.00	10.28	2.28	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.52	0
LDW-Y0-SC-ENR-1-A-SPI-R2	10.90	10.25	11.29	1.04	IND	-1 - -2	>4	-3.00	IND	0.00	>	10.90	Trace
LDW-Y0-SC-ENR-1-A-SPI-R3	9.75	8.50	10.19	1.70	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.75	Trace
LDW-Y0-SC-ENR-1-B-SPI-R1	7.10	6.27	7.88	1.62	IND	-1 - -2	>4	-4.00	IND	0.00	>	7.10	Trace
LDW-Y0-SC-ENR-1-B-SPI-R2	9.01	7.83	10.77	2.95	IND	-1 - -2	>4	-4.00	IND	0.00	>	9.01	Trace
LDW-Y0-SC-ENR-1-B-SPI-R3	6.89	6.30	8.16	1.86	IND	-1 - -2	>4	-4.00	IND	0.00	>	6.89	Trace
LDW-Y0-SC-ENR-2-A-SPI-R1	8.98	8.09	9.25	1.16	IND	0 - -1	>4	-3.00	IND	0.00	>	8.98	Trace
LDW-Y0-SC-ENR-2-A-SPI-R2	9.42	8.29	10.71	2.42	IND	0 - -1	>4	-4.00	IND	0.00	>	9.42	Trace
LDW-Y0-SC-ENR-2-A-SPI-R3	11.57	10.77	12.35	1.58	IND	0 - -1	>4	-4.00	IND	0.00	>	11.57	Trace
LDW-Y0-SC-ENR-2-B-SPI-R1	9.05	7.13	9.42	2.28	IND	-1 - -2	>4	-4.00	IND	0.00	>	9.05	Trace
LDW-Y0-SC-ENR-2-B-SPI-R2	6.15	3.93	6.87	2.95	IND	-1 - -2	>4	-5.00	IND	0.00	>	6.15	Trace
LDW-Y0-SC-ENR-2-B-SPI-R3	9.16	8.29	10.43	2.14	IND	-1 - -2	>4	-6.00	IND	0.00	>	9.16	Trace
LDW-Y0-SC-ENR-3-A-SPI-R1	9.81	9.04	10.60	1.56	IND	0 - -1	>4	-3.00	IND	0.00	>	9.81	0.28
LDW-Y0-SC-ENR-3-A-SPI-R2	8.79	7.66	9.18	1.53	IND	0 - -1	>4	-3.00	IND	0.00	>	8.79	Trace
LDW-Y0-SC-ENR-3-A-SPI-R3	7.44	5.29	8.37	3.09	IND	0 - -1	>4	-3.00	IND	0.00	>	7.44	Trace
LDW-Y0-SC-ENR-3-B-SPI-R1	14.92	13.17	16.12	2.95	IND	-1 - -2	>4	-4.00	IND	0.00	>	14.92	Trace
LDW-Y0-SC-ENR-3-B-SPI-R2	6.99	6.15	7.68	1.53	IND	-1 - -2	>4	-4.00	IND	0.00	>	6.99	Trace
LDW-Y0-SC-ENR-3-B-SPI-R3	8.31	6.99	8.92	1.93	IND	-1 - -2	>4	-4.00	IND	0.00	>	8.31	Trace
LDW-Y0-SC-ENR-4-A-SPI-R1	10.99	9.62	11.58	1.96	IND	-1 - -2	>4	-4.00	IND	0.00	>	10.99	Trace
LDW-Y0-SC-ENR-4-A-SPI-R2	13.79	13.34	14.15	0.81	IND	0 - -1	>4	-3.00	IND	0.00	>	13.79	Trace
LDW-Y0-SC-ENR-4-A-SPI-R3	16.44	15.65	17.68	2.03	IND	0 - -1	>4	-3.00	IND	0.00	>	16.44	Trace
LDW-Y0-SC-ENR-4-B-SPI-R1	9.19	7.91	9.99	2.08	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.19	Trace
LDW-Y0-SC-ENR-4-B-SPI-R2	12.35	11.64	13.03	1.39	IND	-1 - -2	>4	-3.00	IND	0.00	>	12.35	Trace
LDW-Y0-SC-ENR-4-B-SPI-R3	9.01	8.81	9.65	0.84	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.01	Trace
LDW-Y0-SC-ENR-5-A-SPI-R1	9.30	8.61	10.08	1.47	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.30	Trace
LDW-Y0-SC-ENR-5-A-SPI-R2	8.66	7.80	9.81	2.01	IND	-1 - -2	>4	-3.00	IND	0.00	>	8.66	Trace
LDW-Y0-SC-ENR-5-A-SPI-R3	6.94	5.57	7.51	1.93	IND	-1 - -2	>4	-4.00	IND	0.00	>	6.94	Trace
LDW-Y0-SC-ENR-5-B-SPI-R1	9.09	8.09	9.62	1.53	IND	0 - -1	>4	-3.00	IND	0.00	>	9.09	Trace
LDW-Y0-SC-ENR-5-B-SPI-R2	7.63	7.08	8.26	1.18	IND	0 - -1	>4	-3.00	IND	0.00	>	7.63	0.44
LDW-Y0-SC-ENR-5-B-SPI-R3	7.57	7.47	7.99	0.52	IND	0 - -1	>4	-3.00	IND	0.00	>	7.57	Trace
LDW-Y0-SC-ENR-6-A-SPI-R1	9.53	8.95	10.11	1.16	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.53	Trace
LDW-Y0-SC-ENR-6-A-SPI-R2	9.71	9.10	11.06	1.96	IND	-1 - -2	>4	-4.00	IND	0.00	>	9.71	Trace
LDW-Y0-SC-ENR-6-A-SPI-R3	9.51	8.67	10.28	1.62	IND	-1 - -2	>4	-4.00	IND	0.00	>	9.51	Trace
LDW-Y0-SC-ENR-6-B-SPI-R1	14.96	13.17	15.57	2.40	IND	-1 - -2	>4	-4.00	IND	0.00	>	14.96	Trace
LDW-Y0-SC-ENR-6-B-SPI-R2	12.65	11.38	13.75	2.37	IND	-1 - -2	>4	-4.00	IND	0.00	>	12.65	Trace
LDW-Y0-SC-ENR-6-B-SPI-R3	14.72	13.32	15.94	2.62	IND	0 - -1	>4	-3.00	IND	0.00	>	14.72	Trace
Mean	9.88	8.84	10.68	1.85					Mean	0.00		9.88	
Std Dev	2.54	2.57	2.62	0.63					Std Dev	0.00		2.54	
Count	36.00	36.00	36.00	36.00					Count	36.00		36.00	
Min	6.15	3.93	6.87	0.52					Min	0.00		6.15	
Max	16.44	15.65	17.68	3.09					Max	0.00		16.44	

IND=Indeterminate

NA=Not Analyzed

Trace=Present but not in measurable quantity

Surface = at the sediment surface

Table 3-4. Year 0 Scour ENR+AC Pilot Subplot SPI Results

Station/Replicate	Mean Penetration (cm)	Minimum Penetration (cm)	Maximum Penetration (cm)	Boundary Roughness (cm)	Apparent RPD (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Infaunal Successional Stage	Methane		Mean Placement Material Thickness (cm)	Mean Recent Post-Placement Deposition (cm)
LDW-Y0-SC-ENR+AC-1-A-SPI-R1	7.38	6.56	7.74	1.18	IND	-1 - -2	>4	-4.00	IND	0.00	>	7.38	0
LDW-Y0-SC-ENR+AC-1-A-SPI-R2	10.00	8.12	10.66	2.54	IND	-1 - -2	>4	-2.00	IND	0.00	>	10.00	0
LDW-Y0-SC-ENR+AC-1-A-SPI-R3	9.58	8.55	10.22	1.67	IND	-1 - -2	>4	-4.00	IND	0.00	>	9.58	0
LDW-Y0-SC-ENR+AC-1-B-SPI-R1	8.09	6.82	9.24	2.43	IND	-1 - -2	>4	-4.00	IND	0.00	>	8.09	Trace
LDW-Y0-SC-ENR+AC-1-B-SPI-R2	8.45	6.87	9.10	2.22	IND	-1 - -2	>4	-4.00	IND	0.00	>	8.45	Trace
LDW-Y0-SC-ENR+AC-1-B-SPI-R3	9.83	7.31	11.05	3.74	IND	-1 - -2	>4	-5.00	IND	0.00	>	9.83	Trace
LDW-Y0-SC-ENR+AC-2-A-SPI-R1	7.49	6.10	8.52	2.42	IND	0 - -1	>4	-4.00	IND	0.00	>	7.49	Trace
LDW-Y0-SC-ENR+AC-2-A-SPI-R2	9.21	8.58	9.70	1.13	IND	0 - -1	>4	-2.00	IND	0.00	>	9.21	Trace
LDW-Y0-SC-ENR+AC-2-A-SPI-R3	10.77	9.65	11.18	1.53	IND	0 - -1	>4	-4.00	IND	0.00	>	10.77	Trace
LDW-Y0-SC-ENR+AC-2-B-SPI-R1	8.77	7.34	9.27	1.93	IND	-1 - -2	>4	-3.00	IND	0.00	>	8.77	Trace
LDW-Y0-SC-ENR+AC-2-B-SPI-R2	8.51	7.97	8.95	0.98	IND	-1 - -2	>4	-3.00	IND	0.00	>	8.51	Trace
LDW-Y0-SC-ENR+AC-2-B-SPI-R3	10.11	9.13	10.71	1.59	IND	-1 - -2	>4	-3.00	IND	0.00	>	10.11	Trace
LDW-Y0-SC-ENR+AC-3-A-SPI-R1	9.61	7.88	10.17	2.28	IND	-1 - -2	>4	-4.00	IND	0.00	>	9.61	Trace
LDW-Y0-SC-ENR+AC-3-A-SPI-R2	9.41	8.43	10.21	1.78	IND	-1 - -2	>4	-4.00	IND	0.00	>	9.41	Trace
LDW-Y0-SC-ENR+AC-3-A-SPI-R3	7.80	7.59	8.17	0.58	IND	-1 - -2	>4	-3.00	IND	0.00	>	7.80	Trace
LDW-Y0-SC-ENR+AC-3-B-SPI-R1	12.96	12.82	13.26	0.44	IND	-1 - -2	>4	-4.00	IND	0.00	>	12.96	Trace
LDW-Y0-SC-ENR+AC-3-B-SPI-R2	11.28	7.25	11.72	4.47	IND	-1 - -2	>4	-4.00	IND	0.00	>	11.28	Trace
LDW-Y0-SC-ENR+AC-3-B-SPI-R3	10.74	9.91	10.92	1.01	IND	-1 - -2	>4	-4.00	IND	0.00	>	10.74	0
LDW-Y0-SC-ENR+AC-4-A-SPI-R1	8.83	8.20	9.65	1.44	IND	0 - -1	>4	-4.00	IND	0.00	>	8.83	0.25
LDW-Y0-SC-ENR+AC-4-A-SPI-R2	10.76	9.88	11.40	1.53	IND	0 - -1	>4	-3.00	IND	0.00	>	10.76	0.13
LDW-Y0-SC-ENR+AC-4-A-SPI-R3	7.90	7.19	8.49	1.30	IND	0 - -1	>4	-3.00	IND	0.00	>	7.90	Trace
LDW-Y0-SC-ENR+AC-4-B-SPI-R1	8.87	7.83	9.47	1.65	0.95	-1 - -2	>4	-4.00	IND	0.00	>	8.87	0.46
LDW-Y0-SC-ENR+AC-4-B-SPI-R2	9.55	8.18	10.51	2.33	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.55	Trace
LDW-Y0-SC-ENR+AC-4-B-SPI-R3	8.42	7.83	9.01	1.18	1.25	-1 - -2	>4	-4.00	IND	0.00	>	8.42	0.37
LDW-Y0-SC-ENR+AC-5-A-SPI-R1	17.42	15.08	17.91	2.83	IND	-1 - -2	>4	-4.00	IND	0.00	>	17.42	0.16
LDW-Y0-SC-ENR+AC-5-A-SPI-R2	19.09	18.72	19.64	0.92	IND	1 - 0/>4	>4	-4.00	IND	0.00		7.54	0.09
LDW-Y0-SC-ENR+AC-5-A-SPI-R3	9.01	8.70	9.42	0.72	IND	0 - -1	>4	-3.00	IND	0.00	>	9.01	Trace
LDW-Y0-SC-ENR+AC-5-B-SPI-R1	6.91	6.41	7.39	0.98	IND	-1 - -2	>4	-3.00	IND	0.00	>	6.91	Trace
LDW-Y0-SC-ENR+AC-5-B-SPI-R2	9.22	7.71	9.98	2.27	IND	-1 - -2	>4	-3.00	IND	0.00	>	9.22	Trace
LDW-Y0-SC-ENR+AC-5-B-SPI-R3	10.83	9.79	11.46	1.67	IND	0 - -1	>4	-3.00	IND	0.00	>	10.83	Trace
LDW-Y0-SC-ENR+AC-6-A-SPI-R1	8.78	8.12	9.27	1.16	0.55	0 - -1	>4	-3.00	IND	0.00	>	8.78	0.31
LDW-Y0-SC-ENR+AC-6-A-SPI-R2	8.31	7.80	9.08	1.28	IND	0 - -1	>4	-4.00	IND	0.00	>	8.31	Trace
LDW-Y0-SC-ENR+AC-6-A-SPI-R3	12.15	10.83	12.79	1.96	0.58	0 - -1	>4	-4.00	IND	0.00	>	12.15	0.18
LDW-Y0-SC-ENR+AC-6-B-SPI-R1	6.50	5.17	7.02	1.85	IND	0 - -1	>4	-3.00	IND	0.00	>	6.50	0.14
LDW-Y0-SC-ENR+AC-6-B-SPI-R2	8.11	9.07	9.10	0.03	IND	0 - -1	>4	-3.00	IND	0.00	>	8.11	Trace
LDW-Y0-SC-ENR+AC-6-B-SPI-R3	14.53	13.83	15.34	1.50	IND	0 - -1	>4	-3.00	IND	0.00	>	14.53	Trace
Mean	9.87	8.81	10.49	1.68	0.83				Mean	0.00		9.55	
Std Dev	2.65	2.64	2.62	0.87	0.33				Std Dev	0.00		2.15	
Count	36.00	36.00	36.00	36.00	4.00				Count	36.00		36.00	
Min	6.50	5.17	7.02	0.03	0.55				Min	0.00		6.50	
Max	19.09	18.72	19.64	4.47	1.25				Max	0.00		17.42	

IND=Indeterminate

NA=Not Analyzed

Trace=Present but not in measurable quantity

Surface = at the sediment surface

Table 3-5. Year 0 Subtidal ENR Pilot Sublot SPI Results

Station/Replicate	Mean Penetration (cm)	Minimum Penetration (cm)	Maximum Penetration (cm)	Boundary Roughness (cm)	Apparent RPD (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Infaunal Successional Stage	Methane		Mean Placement Material Thickness (cm)	Mean Recent Post-Placement Deposition (cm)
LDW-Y0-SU-ENR-1-A-SPI-R1	13.84	12.71	14.82	2.11	1.54	>4/0 - -1	>4	-2.00	IND	0.00	>	13.84	0.78
LDW-Y0-SU-ENR-1-A-SPI-R2	8.52	7.91	8.72	0.81	1.88	>4/0 - -1	>4	-2.00	IND	0.00	>	8.52	1.27
LDW-Y0-SU-ENR-1-A-SPI-R3	9.69	9.24	9.91	0.66	1.43	>4/0 - -1	>4	-2.00	IND	0.00	>	9.69	0.92
LDW-Y0-SU-ENR-1-B-SPI-R1	15.64	15.36	15.91	0.55	1.97	>4/0 - -1	>4	-2.00	IND	0.00	>	15.64	1.31
LDW-Y0-SU-ENR-1-B-SPI-R2	11.10	10.69	11.70	1.01	1.09	>4/0 - -1	>4	-2.00	IND	0.00	>	11.10	0.93
LDW-Y0-SU-ENR-1-B-SPI-R3	11.24	10.83	11.97	1.14	1.59	>4/0 - -1	>4	-2.00	IND	0.00	>	11.24	1.04
LDW-Y0-SU-ENR-2-A-SPI-R1	9.61	9.33	10.29	0.96	IND	0 - -1	>4	-2.00	IND	0.00	>	9.61	Trace
LDW-Y0-SU-ENR-2-A-SPI-R2	12.30	10.92	13.40	2.48	IND	1 - 0	>4	-1.00	IND	0.00	>	12.30	Trace
LDW-Y0-SU-ENR-2-A-SPI-R3	7.24	6.15	7.54	1.39	IND	1 - 0	>4	-1.00	IND	0.00	>	7.24	Trace
LDW-Y0-SU-ENR-2-B-SPI-R1	16.00	15.65	16.32	0.66	IND	1 - 0	>4	-1.00	IND	0.00	>	16.00	Trace
LDW-Y0-SU-ENR-2-B-SPI-R2	8.30	7.08	9.50	2.43	IND	0 - -1	>4	-2.00	IND	0.00	>	8.30	Trace
LDW-Y0-SU-ENR-2-B-SPI-R3	9.06	8.81	9.36	0.55	IND	1 - 0	>4	-1.00	IND	0.00	>	9.06	0
LDW-Y0-SU-ENR-3-A-SPI-R1	13.23	12.19	13.78	1.59	IND	>4/0 - -1	>4	-2.00	IND	0.00	>	13.23	Trace
LDW-Y0-SU-ENR-3-A-SPI-R2	8.16	7.77	8.61	0.84	IND	>4/0 - -1	>4	-2.00	IND	0.00	>	8.16	Trace
LDW-Y0-SU-ENR-3-A-SPI-R3	8.52	8.20	8.81	0.61	1.86	>4/0 - -1	>4	-2.00	IND	0.00	>	8.52	0.44
LDW-Y0-SU-ENR-3-B-SPI-R1	11.70	10.40	12.65	2.25	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	11.70	0.31
LDW-Y0-SU-ENR-3-B-SPI-R2	10.20	10.69	10.95	0.26	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	10.20	Trace
LDW-Y0-SU-ENR-3-B-SPI-R3	11.04	10.76	11.32	0.56	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	11.04	0.22
LDW-Y0-SU-ENR-4-A-SPI-R1	9.85	8.72	10.74	2.01	IND	>4/0 - -1	>4	-2.00	IND	0.00	>	9.85	Trace
LDW-Y0-SU-ENR-4-A-SPI-R2	6.09	5.49	6.61	1.13	IND	0 - -1	>4	-2.00	IND	0.00	>	6.09	Trace
LDW-Y0-SU-ENR-4-A-SPI-R3	7.56	7.51	8.09	0.57	IND	>4/0 - -1	>4	-2.00	IND	0.00	>	7.56	Trace
LDW-Y0-SU-ENR-4-B-SPI-R1	9.16	9.01	9.50	0.49	1.99	>4/1 - 0	>4	-1.00	IND	0.00	>	9.16	1.26
LDW-Y0-SU-ENR-4-B-SPI-R2	9.44	8.72	10.02	1.30	1.91	>4/1 - 0	>4	-1.00	IND	0.00	>	9.44	1.08
LDW-Y0-SU-ENR-4-B-SPI-R3	9.13	8.52	9.50	0.98	1.29	>4/1 - 0	>4	-1.00	IND	0.00	>	9.13	1.12
LDW-Y0-SU-ENR-5-A-SPI-R1	11.76	10.14	12.82	2.69	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	11.76	0.09
LDW-Y0-SU-ENR-5-A-SPI-R2	8.28	8.03	8.46	0.43	1.50	>4/1 - 0	>4	-1.00	IND	0.00	>	8.28	1.02
LDW-Y0-SU-ENR-5-A-SPI-R3	9.68	8.75	10.57	1.82	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	9.68	0.83
LDW-Y0-SU-ENR-5-B-SPI-R1	10.08	9.65	10.57	0.92	1.22	>4/1 - 0	>4	-1.00	IND	0.00	>	10.08	0.49
LDW-Y0-SU-ENR-5-B-SPI-R2	8.18	8.00	8.58	0.58	1.43	>4/1 - 0	>4	-1.00	IND	0.00	>	8.18	0.86
LDW-Y0-SU-ENR-5-B-SPI-R3	9.62	9.37	10.17	0.80	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	9.62	Trace
LDW-Y0-SU-ENR-6-A-SPI-R1	12.00	11.84	12.16	0.32	1.55	>4/1 - 0	>4	-1.00	IND	0.00	>	12.00	0.85
LDW-Y0-SU-ENR-6-A-SPI-R2	11.46	11.01	12.22	1.11	0.75	>4/1 - 0	>4	-1.00	IND	0.00	>	11.46	0.37
LDW-Y0-SU-ENR-6-A-SPI-R3	8.05	7.71	8.20	0.49	0.25	>4/1 - 0	>4	-1.00	IND	0.00	>	8.05	0.29
LDW-Y0-SU-ENR-6-B-SPI-R1	14.58	14.15	15.28	1.13	1.74	>4/1 - 0	>4	-1.00	IND	0.00	>	14.58	1.05
LDW-Y0-SU-ENR-6-B-SPI-R2	15.00	14.73	15.25	0.52	1.66	>4/1 - 0	>4	-1.00	IND	0.00	>	15.00	1.11
LDW-Y0-SU-ENR-6-B-SPI-R3	12.36	11.47	13.45	1.99	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	12.36	1.04
Mean	10.49	9.93	11.05	1.11	1.48				Mean	0.00		10.49	
Std Dev	2.45	2.44	2.52	0.68	0.45				Std Dev	0.00		2.45	
Count	36.00	36.00	36.00	36.00	18.00				Count	36.00		36.00	
Min	6.09	5.49	6.61	0.26	0.25				Min	0.00		6.09	
Max	16.00	15.65	16.32	2.69	1.99				Max	0.00		16.00	

IND=Indeterminate

NA=Not Analyzed

Trace=Present but not in measurable quantity

Surface = at the sediment surface

Table 3-6. Year 0 Subtidal ENR+AC Pilot Subplot SPI Results

Station/Replicate	Mean Penetration (cm)	Minimum Penetration (cm)	Maximum Penetration (cm)	Boundary Roughness (cm)	Apparent RPD (cm)	Grain Size Major Mode (phi)	Grain Size Minimum (phi)	Grain Size Maximum (phi)	Infaunal Successional Stage	Methane		Mean Placement Material Thickness (cm)	Mean Recent Post-Placement Deposition (cm)
LDW-Y0-SU-ENR+AC-1-A-SPI-R1	9.69	9.42	9.94	0.52	0.94	>4/1 - 0	>4	-1.00	IND	0.00	>	9.69	0.79
LDW-Y0-SU-ENR+AC-1-A-SPI-R2	11.20	10.60	11.52	0.92	1.04	>4/1 - 0	>4	-1.00	IND	0.00	>	11.20	0.68
LDW-Y0-SU-ENR+AC-1-A-SPI-R3	10.86	10.43	11.18	0.75	0.99	>4/1 - 0	>4	-1.00	IND	0.00	>	10.86	1.01
LDW-Y0-SU-ENR+AC-1-B-SPI-R1	13.38	12.56	13.91	1.35	IND	1 - 0	>4	-1.00	IND	0.00	>	13.38	0.25
LDW-Y0-SU-ENR+AC-1-B-SPI-R2	17.31	16.69	17.79	1.10	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	17.31	0.49
LDW-Y0-SU-ENR+AC-1-B-SPI-R3	10.94	10.34	11.75	1.42	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	10.94	0.38
LDW-Y0-SU-ENR+AC-2-A-SPI-R1	11.72	11.49	11.99	0.49	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	11.72	0.29
LDW-Y0-SU-ENR+AC-2-A-SPI-R2	13.77	13.05	14.53	1.47	0.92	>4/1 - 0	>4	-1.00	IND	0.00	>	13.77	0.32
LDW-Y0-SU-ENR+AC-2-A-SPI-R3	12.32	10.66	13.60	2.95	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	12.32	0.51
LDW-Y0-SU-ENR+AC-2-B-SPI-R1	9.95	9.65	10.14	0.49	1.07	>4/1 - 0	>4	-1.00	IND	0.00	>	9.95	0.68
LDW-Y0-SU-ENR+AC-2-B-SPI-R2	9.96	8.52	11.55	3.03	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	9.96	0.46
LDW-Y0-SU-ENR+AC-2-B-SPI-R3	7.63	7.13	7.97	0.84	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	7.63	0.22
LDW-Y0-SU-ENR+AC-3-A-SPI-R1	13.40	13.26	13.64	0.38	1.51	>4/1 - 0	>4	-1.00	IND	0.00	>	13.40	0.44
LDW-Y0-SU-ENR+AC-3-A-SPI-R2	11.71	11.00	12.33	1.33	1.39	>4/1 - 0	>4	-1.00	IND	0.00	>	11.71	0.36
LDW-Y0-SU-ENR+AC-3-A-SPI-R3	9.04	7.51	9.70	2.19	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	9.04	0.27
LDW-Y0-SU-ENR+AC-3-B-SPI-R1	10.18	9.96	10.89	0.92	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	10.18	0.33
LDW-Y0-SU-ENR+AC-3-B-SPI-R2	9.48	9.42	9.73	0.31	1.04	>4/1 - 0	>4	-1.00	IND	0.00	>	9.48	0.74
LDW-Y0-SU-ENR+AC-3-B-SPI-R3	10.62	9.73	11.12	1.39	0.49	>4/1 - 0	>4	-1.00	IND	0.00	>	10.62	0.38
LDW-Y0-SU-ENR+AC-4-A-SPI-R1	10.04	9.79	10.19	0.40	1.74	>4/1 - 0	>4	-1.00	IND	0.00	>	10.04	0.66
LDW-Y0-SU-ENR+AC-4-A-SPI-R2	8.71	8.43	9.27	0.84	1.49	>4/1 - 0	>4	-1.00	IND	0.00	>	8.71	0.58
LDW-Y0-SU-ENR+AC-4-A-SPI-R3	8.68	7.91	9.16	1.24	0.70	0 - -1	>4	-3.00	IND	0.00	>	8.68	Trace
LDW-Y0-SU-ENR+AC-4-B-SPI-R1	16.94	16.47	17.52	1.05	IND	1 - 0/>4	>4	-1.00	IND	0.00		13.52	0.16
LDW-Y0-SU-ENR+AC-4-B-SPI-R2	20.44	19.58	20.88	1.30	IND	1 - 0/>4	>4	-1.00	IND	0.00		12.99	0.1
LDW-Y0-SU-ENR+AC-4-B-SPI-R3	10.07	9.68	10.54	0.87	IND	>4/1 - 0	>4	-1.00	IND	0.00	>	10.07	0.15
LDW-Y0-SU-ENR+AC-5-A-SPI-R1	9.43	8.43	10.08	1.65	2.28	>4/1 - 0	>4	-1.00	IND	0.00	>	9.43	0.81
LDW-Y0-SU-ENR+AC-5-A-SPI-R2	8.51	7.94	9.01	1.07	2.06	>4/1 - 0	>4	-1.00	IND	0.00	>	8.51	0.99
LDW-Y0-SU-ENR+AC-5-A-SPI-R3	7.68	7.11	8.23	1.13	1.42	>4/0 - -1	>4	-2.00	IND	0.00	>	7.68	0.91
LDW-Y0-SU-ENR+AC-5-B-SPI-R1	6.56	6.21	6.84	0.64	2.65	>4/0 - -1	>4	-2.00	IND	0.00	>	6.56	1.22
LDW-Y0-SU-ENR+AC-5-B-SPI-R2	6.69	5.75	7.71	1.96	2.18	>4/0 - -1	>4	-2.00	IND	0.00	>	6.69	1.01
LDW-Y0-SU-ENR+AC-5-B-SPI-R3	9.70	9.51	11.00	1.49	1.29	>4/1 - 0	>4	-1.00	IND	0.00	>	9.70	0.96
LDW-Y0-SU-ENR+AC-6-A-SPI-R1	13.13	12.74	13.43	0.69	0.92	>4/0 - -1	>4	-2.00	IND	0.00	>	13.13	0.48
LDW-Y0-SU-ENR+AC-6-A-SPI-R2	12.27	12.19	12.66	0.47	1.48	>4/0 - -1	>4	-2.00	IND	0.00	>	12.27	0.75
LDW-Y0-SU-ENR+AC-6-A-SPI-R3	8.73	7.71	9.27	1.56	IND	0 - -1	>4	-3.00	IND	0.00	>	8.73	Trace
LDW-Y0-SU-ENR+AC-6-B-SPI-R1	9.31	8.90	9.76	0.87	2.02	>4/1 - 0	>4	-1.00	IND	0.00	>	9.31	0.56
LDW-Y0-SU-ENR+AC-6-B-SPI-R2	10.39	9.99	10.60	0.61	1.90	>4/1 - 0	>4	-1.00	IND	0.00	>	10.39	0.94
LDW-Y0-SU-ENR+AC-6-B-SPI-R3	7.06	6.90	7.31	0.40	1.81	>4/1 - 0	>4	-1.00	IND	0.00	>	7.06	0.99
Mean	10.76	10.19	11.30	1.11	1.45				Mean	0.00		10.46	
Std Dev	2.97	2.97	2.98	0.65	0.56				Std Dev	0.00		2.30	
Count	36.00	36.00	36.00	36.00	23.00				Count	36.00		36.00	
Min	6.56	5.75	6.84	0.31	0.49				Min	0.00		6.56	
Max	20.44	19.58	20.88	3.03	2.65				Max	0.00		17.31	

IND=Indeterminate

NA=Not Analyzed

Trace=Present but not in measurable quantity

Surface = at the sediment surface

Exhibit 1

Year 0 SPI/PV Images
are provided as electronic file submission due to large file size

ATTACHMENT 6

Weekly Construction Reports

ATTACHMENT 6

Weekly Construction Reports

Due to the large file size, Attachment 6 is provided as a separate .pdf file

ATTACHMENT 7

Water Quality Monitoring

WATER QUALITY MONITORING
DAILY SUMMARY AND FIELD NOTES—DEMONSTRATION PLOTS

Date: November 29, 2016

Test Area: Pre-construction test placement

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

At the request of the Corps representative we conducted a round of water quality monitoring prior to the start of Sand/ Activated Carbon mixture at the downstream demonstration plot. We measured turbidity at mid depth upstream of the barge (on a flood tide). Water depths were 8 feet or less. Turbidity at approximately 4 feet was less than 3 NTUs at the 75 foot upstream station and at the 150 foot upstream station. The 75 foot downstream station was under the barge and was not sampled. The 150 foot downstream station was monitored at 2, 4, and 6 feet below the surface with the highest turbidity of 3.1 NTUs.   Turbidities at an ambient station located on the west side of the navigation channel approximately 600 feet upstream of the construction equipment were between 2.5 and 2.7 NTUs (2, 4, 6, and feet below the surface).

Placement of Sand/ Activated Carbon began at 13:05. Round 1 of monitoring began at 14:05. Upstream monitoring was conducted at 75 feet and 150 feet at 2 foot and 4 foot water depth. The highest turbidity was 5.3 NTUs. Downstream monitoring was conducted 75 feet and 150 feet. At 75 feet downstream the turbidity increased with depth (from 9.9 NTUs at 2 feet to 37 NTUs at 8 feet) At 150 feet downstream (a compliance station) the turbidity increased with depth (9 NTUs at 2 feet to 26.1 NTUs at 6 feet). Ambient turbidities ranged from 2.5 to 3.4 NTUs. Turbidities were exceeded at all three depths at the 150 feet downstream station. Additional monitoring of the plume was conducted at a 150 foot downstream offshore station. The station was on the channel side of materials barge rafted to the excavator barge. All of the turbidities were below 4.1 NTUs. There wasn't room to do an inshore station at 150 foot downstream. At 300 feet downstream and inshore the highest turbidity was 8.1 NTUs, an apparent exceedance. The 300 foot downstream offshore station was in the prop wash of the tug repositioning the materials and equipment barge upstream. Monitoring at the 450 foot downstream locations (inshore and offshore) did not have any apparent exceedances (highest turbidity was 7.1 NTUs). With the equipment moved, the placement of Sand Gravel and Activated Carbon was started about 15:20. Additional monitoring was not conducted due to approaching dusk.

The field forms follow.

WQ Monitoring Field Form

Job #: LY15160310.1400.1405

Date: 11/29/16 **Round:** Pre

Sheet: of

Crew: RG TS

Site (circle): [✓ Demonstration] Scour Subtidal Intertidal

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' upstream		150' upstream		150' downstream				lateral
Start Time:	12:50		12.53		12:59				13:05
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS Flood		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2					2.6				@2.0ft 2.5
4	@3.5ft 2.5		3.0		2.8				@3.5ft 2.5
6					3.1				@4.0ft 2.5
8									@6.0ft 2.7
10									
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Depth 7 ft Depth 8 ft Depth 9 ft

Comments: 75' up - pre-placement, sampling before work start

75 ft Downstream under barge No monitoring

Ambient on west side of channel 600 ft upstream

1305 starting placement of Sand + AC material

WQ Monitoring Field Form

Sheet: 1 of 2

Job #: LY15160310.1400.1405

Date: 11/29/16 Round: 1

Crew: RG, TS

Site (circle): [✓ Demonstration] Scour Subtidal Intertidal

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	150' upstream		75' upstream		75' downstream		150' downstream		
Start Time:	14:05		14:11		14:19		14:28		14:32
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.6		3.2		9.9		9.0	X	2.5
4	5.3		5.1		12.2		12.4	X	2.6
6					25.0		26.1	X	2.8
8					37.0				2.8
10									3.4
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Depth 8.5 Ft Depth 8.0 ft Depth 10.5 Depth 8.5

Comments: Placing ENR + AC material

WQ Monitoring Field Form

Sheet: 2 of 2

Job #: LY15160310.1400.1405 **Date:** 11/29/16 **Round:** 1 **Crew:** RG TS

Site (circle): [✓ Demonstration] Scour Subtidal Intertidal

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	150' downst. + offshore		300' downst. + inshore		450' downst + inshore		450' downst + offshore		
Start Time:	14:46		14:49		14:59		15:03		14:32
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.4		6.8		6.2		2.5		2.5
4	2.5		8.1	X	3.4		3.5		2.6
6	2.6		5.5		5.4		5.2		2.8
8	2.7				7.1		6.1		2.8
10	2.4						6.2		3.4
12	2.6						4.7		
14	2.9						4.3		
16	3.1						2.7		
18	3.4						2.7		
20	4.1						3.4		
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Depth 9.0 ft

Comments: 150' down + off location was on channel-side of materials barge. At 14:50, work stopped to move barge. 300' downst. + offshore location was in tug propwash. At 450' down + offshore halocline was between 8'-10' depth (7 ppt → 21 ppt)

Equipment moved, placement of material recommensed @ ≈ 15:20

Date: November 30, 2016

Test Area: Pre-construction test placement

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

Material placement of Sand/Gravel + Activated Carbon started around 09:17. The first round of water quality monitoring was started approximately 1 hour later. Highest turbidity was 5 NTUs at the 150 foot downstream station at 2 feet below the surface. Turbidity at the ambient station was 3.2 NTUs at 2 feet. Sampling was on an ebb tide in shallow water.

The second round of sampling was started at 13:31 after the barges were moved at approximately 12:00 to the Sand + AC plot. Material placement was restarted at 12:30. Monitoring conducted at the 150 foot downstream station had turbidity exceedances of 10.5 NTUs above the ambient at the 2 feet below surface (13.5 vs 3.0 NTUs) and 8 NTUs above the ambient at 4 feet below the surface (11.1 vs 3.1 NTUs). Additional plume tracking was conducted at 300 feet downstream and 450 feet downstream at inshore and offshore locations. The barge was not placing material during the monitoring. The barge was moving downstream 20 feet. There were no apparent exceedances of the turbidity criteria. The maximum turbidity was 6.7 NTUs at the 450 foot downstream inshore station at 6 feet of water depth.

Upstream monitoring was not conducted during the second round of monitoring. Surface water flows were down river. The barge was not placing material from 13:40 to 14:08 when 1 or 2 buckets were placed. Construction oversight personnel asked for measurement of turbidity downstream of the material placement location to check turbidity values prior to placing the final 9 buckets of Sand+AC material. Maximum measured turbidity was 2.9 NTUs at 75 feet downstream of the excavator.

The field forms follow.

WQ Monitoring Field Form

Job #: LY15160310.1400.1405 **Date:** 11/30 **Round:** 1 **Sheet:** 1 of 1 **Crew:** RG & TS

Site (circle): [✓ Demonstration] Scour Subtidal Intertidal

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' downstream		150' downstream		150' upstream		75' upstream		opposite side of river
Start Time:	10:15		10:18		10:25		10:30		
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	4.9		5.0				3.3		3.2
4	4.5		3.6		@3.0ft 3.3		3.3		3.3
6									
8									
10									
12									
14									
16									
18									
20									
22									@3.0ft 3.3
24									
26									
28									
30									
32									
34									
36									
38									
40									
	Depth 7.5ft		Depth 8.0ft		Depth 6.0ft		Depth 8.0ft		

Comments: Material placement started @ 0917

Placing sand + gravel + A.C.

WQ Monitoring Field Form

Job #: LY15160310.1400.1405

Date: 11/30/16 **Round:** 2

Sheet: 1 of 2

Crew: RG & TS

Site (circle): [✓ Demonstration] Scour Subtidal Intertidal

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' downstream		150' downstream		300ft Down In		300ft down off (120 ft)		390' upstream opposite side
Start Time:	13:31		13;37		13:51		13:54		13:42
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	11.8		13.5	X	5.0		4.0		3.0
4	13.2		@ 4.5 ft 11.1	X	6.5		4.0		3.1
6	12.4						4.3		3.2
8							5.2		4.1
10							3.8		4.8
12							2.9		
14							2.8		
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									
	Depth 9.5 ft		Depth 6.5 ft						

Comments: Barge moved ~ 12:00 Resumed placing material @ 1230 Sand & AC plot. Pressure sensor adjusted for barometric Pressure. Moving barges 20ft downstream @ 1340

WQ Monitoring Field Form

Job #: LY15160310.1400.1405

Date: 11/30/16 **Round:** 2

Sheet: 2 of 2

Crew: RG TS

Site (circle): [✓ Demonstration] Scour Subtidal Intertidal

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	450' down in		450' down off						
Start Time:	14:00		14:05 (100 ft)						
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	4.9		3.4						
4	5.5		3.7						
6	6.7		4.1						
8			4.8						
10			4.5						
12			2.3						
14			2.5						
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Comments: Resumed placing material 1408 / stopped after 1 or 2 buckets Upstream monitoring not conducted. Halocline @ 10ft

WQ Monitoring Field Form

Job #: LY15160310.1400.1405 **Date:** 11/30/16 **Round:** 3 **Sheet:** 1 of 1 **Crew:** RG & TS

Site (circle): [✓ Demonstration] Scour Subtidal Intertidal

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' down		150' down						
Start Time:	1428		14:33						
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.8		2.8						
4	2.7		2.8						
6	2.8								
8	2.9								
10									
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Depth 7.5

Comments: 14:28 Not placing material, monitoring. Contractor will only place 9 more buckets of matrial. Additional monitoring not conducted.

WATER QUALITY MONITORING
DAILY SUMMARY AND FIELD NOTES—INTERTIDAL PLOTS

Date: December 1, 2016

Test Area: Intertidal

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

Two rounds of water quality monitoring during placement of Sand/Gravel +AC at the intertidal plot was conducted. Placement of material started at approximately 8:30 but was stopped at approximately 10:00 with GPS problems. Placement resumed at 10:34. The first round of monitoring was conducted starting at 11:34. There was an exceedance of the turbidity criterion at the 150 feet downstream station. The turbidity was measured at middepth (3 feet depth) in the water column. Turbidity was 8 NTUs vs 2.7 NTUs at the ambient station on the west side of the river. Material placement was stopped and the barge was moved as we were finishing the upstream stations. The construction management team requested monitoring of the turbidity alongside the barge to see if there was persistent turbidity plume once the material placement was stopped. The turbidity was measured at middepth at the approximate position of the exceedance. The turbidity was 6 NTUs (ambient would have been 2.6 NTUs). No visible plume was present. Additional plume tracking was not conducted.

The second round of monitoring was conducted 1 hour after resumption of material placement. There were turbidity exceedances at the 150 foot downstream monitoring station at 2, 4, and 6 foot of water depth. Highest turbidity was at 6 feet below the surface (13.1 NTUs vs 3.1 NTUs at the ambient). Upstream monitoring was not conducted. Material placement was stopped.

Plume tracking was conducted at 300 feet, 450 feet, and 600 feet downstream of the area where the material was being placed.

At 300 feet, profiles were collected at inshore, offshore, and directly downstream locations. Profiles at the inshore and offshore locations did not have any apparent exceedances. At the directly downstream location, the turbidity readings at 2, 4, and 6 feet below the surface had apparent turbidity exceedances with the highest turbidity (15.9 NTUs vs 2.9 NTUs) measured at the 4 foot depth.

Monitoring at 450 feet downstream of the material placement site showed a similar pattern with inshore and offshore station with no exceedances and directly downstream showing apparent exceedances at 2 depth (2 and 6 feet) with the highest turbidity at 2 feet (8.4 NTUs vs 2.6 NTUs). There were no apparent exceedances at 600 feet downstream.

Monitoring of the barge dewatering discharge saw highest turbidity (5.7 NTUs) at 8 feet below the surface at 75 feet downstream of the discharge. Monitoring at 150 feet downstream of the discharge had the highest turbidity of 4.4 NTUs at 6 feet below the surface.

The field forms follow.

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310.1400.1405 **Date:** 12/1/16 **Round:** 1 **Crew:** RG & SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft Downstream		150ft Downstrm		150ft upstream		75ft upstream		162yd upstr
Start Time:					1141		11:45		1152
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS Ebb [✓ LS] Flood		HS Ebb [✓ LS] Flood		HS Ebb [✓ LS] Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	@3ft 10.5		@3ft 8.0	X	2.9		2.9		2.7
4					2.9		2.0		2.8
6					3.1		3.1		2.9
8					3.1		3.6		3.0
10	total		total		3.2		3.4		3.0
12	Depth		Depth		3.2				2.9
14	:6.5ft		:6ft						3.2
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensated

Comments: Placing Sand/Gravel and AC started @ 0827

Stopped work @ 1000 for GPS troubles, Restart placing material @

1034 Stopped working and moved barge @ 1145

WQ Monitoring Field Form Comments

Job #: LY15160310.1400.1405 **Date** 12/1/16 **Crew** RG & SW

@ 1210 Dan Pickering asked we monitor alongside the barge to see if a persistent turbidity plume remained. Maximum turbidity was 4 NTUs at 2 ft at the stern (downstream) end of the barge. there was no visible turbidity plume observed. Plume tracking was not conducted.

WQ Monitoring Field Form

Job #: LY15160310.1400.1405 **Date:** 12/01/16 **Round:** 2 **Sheet:** 2 of 2 **Crew:** Swa RG

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstream		150ft downstream		300ft dwnstrm		300ft dwnstrm		1/2 yd upstrm
Start Time:	1328		13:33		13:56 inshore		13:53		13:42
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	*Turbidity (NTU)	Exceedance	+Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	12.2		9.8	x	3.0		13.0	x	2.6
4	17.3		10.0	x			15.9	x	2.9
6			13.1	x			11.3	x	3.1
8									3.0
10									3.0
12									26
14									28
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Comments: material placement recommenced @ 12:23

*35ft from bulkhead +off tug (40 yds from Bulkhead)

WQ Monitoring Field Form

Job #: LY15160310.1400.1405 **Date:** 12/01/16 **Round:** 2

Sheet: 3 of 2 **Crew:** AG+SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	300ft dnstream		450ft dwnstrm		450ft dwnstrm		3450ft dnstm		600ft Dn
Start Time:	13:56 offshore		14:03		14:08 inshore		14:12 offshore		14:17
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	°Turbidity (NTU)	Exceedance	X Turbidity (NTU)	Exceedance	* Turbidity (NTU)	Exceedance	X Turbidity (NTU)	Exceedance	° ~~Ambient~~ Turbidity (NTU)
2	3.9		8.4	y	2.8		3.0		3.0
4	4.5		7.0		3.2		3.4		3.3
6	4.0		8.1	x	5.7		4.2		6.2
8	3.5		5.0				3.7		4.3
10	3.9		4.3				3.6		4.1
12	3.0		3.0				2.9		3.2
14	2.5		2.7				2.9		2.9
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Comments:

° 65yd from bulkhead X 40yd from bulkhead * 22yds from bulkhead

WQ Monitoring Field Form

Job #: LY15160310.1400.1405 **Date:** 12/01/16 **Round:** — **Sheet:** 4 of 1 **Crew:** RG + SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, down stream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	150ft downstream		75ft [illegible]		150ft downstream				
Start Time:			14:38		14:50				
Tide Cycle:	HS Ebb LS Flood		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	0 Turbidity (NTU)	Exceedance	0 Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2			3.4		3.5				
4			3.4		3.5				
6			4.5		4.4				
8			5.7		4.3				
10			4.1		3.8				
12			3.0		2.7				
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Comments: Barge dewatering pump discharge

0 downstream of pump discharge at request of DOF

Date: December 2, 2016

Test Area: Intertidal

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

Material placement of Sand/Gravel+AC was started at 08:40. The first round of monitoring was started at 10:05. Monitoring was conducted at mid depth at 2.5 feet at the 75 foot downstream station and at 2 feet at the 150 foot downstream station. The highest turbidity was at the 150 foot downstream station (5.2 NTUs vs 3 NTUs at ambient). Monitoring was conducted at the 150 foot upstream station with the highest turbidity at 2 feet below the surface (3 NTUs vs 3 NTUs at the ambient.

Monitoring was not conducted at the 75 foot upstream station. Work was suspended as the materials barge was being moved and the field crew cleared the area for safety considerations. There were no turbidity exceedances during the 1st round of sampling.

The second round of monitoring was begun at 12:15. The turbidity at 2 feet below the surface (approximately mid depth) at the 75 foot downstream station was 5 NTUs (3 NTUs at ambient). At 150 feet downstream of the material placement the turbidity at 2 feet was 7 NTUs and at 4 feet below the surface was 6.7 NTUs. At the ambient station the turbidity at 2 feet and 4 feet below the surface was 3 NTUs. The highest turbidity measured at the upstream stations was 3.6 NTUs measured at 10 feet below the surface. Turbidity at the ambient station at 10 feet below the surface was 3.4 NTUs. There were no turbidity exceedances during the 2nd round of monitoring.

Since there were no exceedances during the 2 rounds of monitoring, no further monitoring was conducted for the day as per the approved Water Quality Monitoring Plan.

The field forms follow.

WQ Monitoring Field Form

Job #: LY15160310

Date: 12/2/16 **Round:** 1

Sheet: 1 of 1

Crew: RG & SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstream		150ft down		75ft up		150ft up		Ambient
Start Time:	10:05		10:04				10:21		1012
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2 @0.5	3.7 [illegible]		@ 6.2		not		3.0		3.0
4					collected		2.9		3.0
6					many		2.8		2.8
8					material				2.9
10					Barge				2.6
12	Total depth 5.5ft		Total Depth 4ft						2.9
14									3.2
16									3.1
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments: Material placement started @ 0840

WQ Monitoring Field Form

Job #: LY15160310 **Date:** 12/2/16 **Round:** 2 **Sheet:** 1 of 1 **Crew:** RG & SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	150 ft downstream		75 ft downstream		75ft upstream		150ft upstream		Ambient
Start Time:	12:17		12:22		12:36		12:42		12:27
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	7.0		5.0		2.9		31		3.0
4	6.7						33		30
6							34		3.1
8			Total watcrdep ft. 55+				34		3.3
10							3.6		3.4
12									34
14									39
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments: High low @ 1308

Date: December 5, 2016

Test Area: Intertidal

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

Material placement of the Sand/Gravel +AC was started at 08:21. The first round of monitoring was started approximately 2 hours after material placement began. The tide was ebbing.

Turbidity at 3 feet below the surface (mid depth) at the 75 foot downstream monitoring station was 8 NTUs vs 7.6 NTUs at the ambient at 4 feet below the surface. There was a turbidity exceedance at 2 feet below the surface at 150 feet downstream of the material placement (16.3 NTUs vs 7.4 NTUs). Additional monitoring was conducted at 300 feet downstream of the material placement. The maximum turbidity was 9.9 NTUs at 2 feet below the surface (vs 7.4 at 2 feet at the ambient). The construction management team was informed and material placement continued. The turbidity at the upstream stations were only slightly above the readings at the ambient station (a maximum of 8.2 NTUs vs 7.4 NTUs at the 2 foot depth at the 75 foot upstream station).

During the second round of monitoring the highest turbidity was 9.8 NTUs at 2 feet below the surface at the 150 foot downstream station (vs 8.4 NTUs at the ambient). There were no turbidity exceedances during the second round of monitoring.

During the third round of monitoring the highest turbidity was at 3.5 feet below the surface (mid depth) at the 75 foot downstream station (30 NTUs vs 10.2 NTUs at the ambient station). At 150 feet downstream from the material placement the turbidity was 20.5 NTUs at 4 feet below the surface (vs 10.2 NTUs at the ambient station), an exceedance of the turbidity criterion. Turbidity at 300 feet downstream showed a turbidity value of 19.5 NTUs at 6 feet below the surface (vs 11.4 NTUs at the ambient). The construction management team was notified at 14:40 of the turbidity exceedance and work was suspended. Monitoring at 150 feet downstream was conducted at 14:50 and there was no exceedance of the turbidity criterion. Turbidity levels were within 0.1 NTUs of the corresponding ambient readings. Work was resumed. The construction management team informed the water quality field crew that material placement would only be conducted for another 30 to 40 minutes; therefore additional rounds of water quality monitoring were not conducted.

The field forms follow.

WQ Monitoring Field Form

Sheet: 2 of 2

Job #: LY15160310

Date: 12-5-16 **Round:** 1 **Crew:** RG GSM

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	150 up		75 up						Ambient
Start Time:	1108		1112						1039
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	7.8		8.2						7.4
4	7.9		8.0						7.6
6									7.6
8									7.7
10									7.8
12									4.6
14									34
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments:

WQ Monitoring Field Form

Job #: LY15160310

Date: 12-5-16 **Round:** 1

Sheet: 1 of 2

Crew: RG GSM

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 D		150 D		300 D		\		Ambient
Start Time:	1024		1031		1051		\		1039
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	8 @34		16.3	X	9.9				7.4
4			[illegible]		9.1				7.6
6					8.5				7.6
8					8.8				7.7
10					8.8				7.8
12									4.6
14									3.4
16									
18									
20									
22									
24									
26									
28									
30	6.5 ft		8 ft						
32	total		total						
34	water		depth						
36	depth								
38									
40									

Barometric compensation for depth reading ☒

Comments: material placement at 08:21

ambient upstream + across river

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310 **Date:** 12-5-16 **Round:** 2 **Crew:** RG GSM

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 D		150 D		150 up		75 up		Ambient
Start Time:	1223		1226		1234		1237		1241
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	8.7		9.8		7.8		8.2		8.4
4					7.9@3ft		8.4@3ft		8.7
6									9.4
8									9.0
10									8.8
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32			5 ft		6 ft		6 ft		
34			water		water		water		
36			depth		depth		depth		
38									
40									

Barometric compensation for depth reading X

Comments: ambient - upstream & across river

WQ Monitoring Field Form

Job #: LY15160310

Date: 12-5-16 **Round:** 3

Sheet: 1 of 1

Crew: RG GSM

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 Down		150 Down		300 Down		150 Down		Ambient
Start Time:	1422		1426		1438		1450		1432
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	13.0		16.3	X	12.1		9.9		10.0
4	30 @ 3.5	X	20.5	X	15.1		10.1		10.2
6					19.5	X			11.4
8									11.0
10									
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading X

Comments: ambient upstream + across river

Dan Pickering (DOF) informed @ 1440 of exceedance @ 300+4.

Work resumed @ 1505

Crew will work another 40min then secure

Date: December 6, 2016

Test Area: Intertidal

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

Material placement of Sand/Gravel +AC was started at 08:22. First round of monitoring was started at 09:57. Tide was approaching high slack (11.6 feet MLLW at 10:11). The maximum turbidity at the 75 foot downstream station was found at 8 feet below the surface (22.3 NTUs vs 6.9 NTUs at the ambient). Turbidities at 2 foot, 4 foot, and 6 foot below the surface at 75 feet downstream of material placement were 7, 6.4, and 7.6 NTUs, respectively). The maximum turbidity at 150 feet downstream of the material placement was 7.6 NTUs at 4 feet below the surface (6.2 NTUs for the corresponding ambient reading). The maximum turbidity recorded during monitoring at the 75 foot and 150 foot upstream stations was 6.1 NTUs (2 feet below the surface at the 150 foot upstream station). The corresponding ambient reading was 6.4 NTUs. There were no exceedances of the turbidity criterion.

The second round of monitoring was started at 12:00 on the ebb tide. The maximum turbidity was 9.6 NTUs at 4 feet below the surface at 150 feet downstream of the material placement. The corresponding ambient value was 5.6 NTUs. The turbidities at the 75 foot and 150 foot upstream stations were similar to the corresponding ambient stations (5.3 to 5.5 NTUs vs 5.4 to 5.6 NTUs at the ambient. There were no turbidity exceedances during the second round of monitoring. Monitoring was suspended for rest of the day and material placement continued.

The field forms follow.

WQ Monitoring Field Form

Job #: LY15160310

Date: 12/6 **Round:** 1

Sheet: 1 of 1

Crew: RG & GSM

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 down		150 Down		150 up		75 up	Ambient
Start Time:	0957		1002		1014		1018	1008
Tide Cycle:	HS Ebb LS [✓ Flood]		[✓ HS] Ebb LS Flood		[✓ HS] Ebb LS Flood		[✓ HS] Ebb LS Flood	[✓ HS] Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	7.0		7.2		6.1		5.9		6.4
4	6.4		7.6		6.0		6.0		6.2
6	7.6		7.3		5.8		6.0		6.4
8	22.3	×	7.0						6.9
10									7.2
12									3.4
14									3.5
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments: Material placement started @ approximately ~~0845~~ 0822

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310

Date: 12-6-16 **Round:** 2

Crew: RG GSM

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 down		150 down		150 up		75 up		Ambient
Start Time:	1200		1205		1217		1220		1210
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	6.3		7.6		5.4		5.3		5.4
4	6.0		9.6		5.4		5.4		5.6
6	7.9		8.9				5.4		5.4
8							5.5		5.5
10									5.8
12									2.9
14									2.8
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments: Material Placement continues

Date: December 8, 2016

Test Area: Intertidal

Plot: Sand/Gravel ENR

Summary of Monitoring Results:

Material placement of the Sand/Gravel +AC was started at 10:01. Work was suspended shortly about 30 minutes later to swap the materials barge and to move to the Intertidal ENR plot.

Work resumed at 12:35 with placement of ENR material at the intertidal plot. No exceedances occurred during the two rounds of sampling that were done on Thursday Dec. 8 during ENR material placement at the intertidal plot.

During the first round of monitoring elevated readings occurred at the 75 foot downstream early warning location with a 32.2 NTU vs 3.0 NTU ambient reading occurring at the 6 ft. depth. No exceedances occurred at the 150 foot station with the highest reading at the downstream 150 foot station being 3.9 NTU vs 3.0 NTU ambient at the 6 ft. depth.

The second round of sampling was started slightly early at 14:57 due to limited daylight hours to assure that the second round could be completed before dark. During the second round of monitoring elevated readings again occurred at the 75 foot downstream early warning location with a 15.0 NTU vs 3.0 NTU ambient reading occurring at the 4 foot depth. No exceedances occurred at the 150 foot station with the highest reading at the downstream station being 7.2 NTU vs 2.9 NTU ambient at the 2 foot depth.

The field forms follow.

WQ Monitoring Field Form

Job #: LY15160310

Date: 12-8-16 **Round:** 1

Sheet: 1 of 1

Crew: Gsh TS

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 down		150 down		150 up		75 up		Ambient
Start Time:	1335		1338		1353		1358		1349
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.0		3.2		3.0		3.0		2.2
4	3.3		3.2		3.1		2.9		3.0
6	32.2		3.9		3.0		2.9		3.0
8									3.2
10									2.9
12									
14									
16									
18									
20									
22									salt wedge
24									~ 8.5 ft
26									
28									
30	total depth		total depth		T. depth		T.D.		
32	8.5		8.5		9.0		9.5		
34									
36									
38									
40									

Barometric compensation for depth reading X

Comments: placement started at 1001 work paused ~1030 to swap barges of sand

work resumed at 1235

ambient upriver & cross channel

WQ Monitoring Field Form

Job #: LY15160310
Date: 12-8-16 **Round:** 2
Sheet: 1 of 1
Crew: Gsm TS

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]
Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 down		150 down		150 up		75 up		Ambient
Start Time:	1457		1505		1515		1519		1509
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	5.5		7.2		2.9		2.7		2.9
4	15.0		6.9		3.0		2.9		3.0
6	11.0		6.9				3.0		3.2
8									3.2
10									3.4
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32	T.D. 8'		T.D. 9'		T.D. 7 ft		T.D. 8'		
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments: T.D. = total depth

Date: December 9, 2016

Test Area: Intertidal

Plot: Sand/Gravel ENR

Summary of Monitoring Results:

Placement of the ENR material at the intertidal plot was started at 08:21. The first round of monitoring was conducted starting at 10:36. Tide was flooding. Turbidity at 2 feet below the surface at the 75 foot downstream station was 14.2 NTUs. The highest turbidity at 150 feet downstream of material placement was at 2 feet below the surface. Turbidity was 7.7 NTUs (2.7 NTUs at the ambient). The 5 NTU turbidity difference was an exceedance of the turbidity criterion. The excavator had stopped placement of material as the monitoring at 150 feet downstream was being conducted.

Placement of material was resumed about 20 minutes later. Upstream monitoring was conducted approximately 25 minutes after resumption of work. There were no exceedances at the upstream monitoring stations. The 150 foot downstream monitoring station was reoccupied and a second profile was conducted after material placement had been in progress for 45 minutes (11:39). Turbidity at 6 feet below the surface was 26 NTUs vs 2.7 NTUs at the ambient. At 300 feet downstream from the site of material placement the highest turbidity was again 26 NTUs at 6 feet below the surface (at 11:43; ambient 2.7 NTUs). The project engineer was informed and work was stopped at 11:52. Turbidity was measured at 450 feet downstream after the work stoppage. The highest turbidity was 6.2 NTUs at 6 feet below the surface.

Following a telephone conversation with Erika Hoffman of EPA, additional monitoring was conducted at the 300 foot downstream station until the maximum turbidity dropped below the 5 NTUs over ambient value (approximately 8 NTUs). The maximum turbidity at 300 feet dropped to 7.1 NTUs by 12:27 (ambient was 2.7 NTUs at 8 feet below the surface). During this work stoppage the contractor was conducting a bathymetric survey during the high tide (high of 11.8 feet MLLW was at 12:26). The barges had been moved off the placement area and material placement was suspended until 13:50.

A second round of monitoring was conducted at 15:07 on an ebb tide. The highest turbidity was 3.6 NTUs at 6 feet below the surface at 150 feet downstream of the material placement. The ambient turbidity at 6 feet below the surface was 3 NTUs. Because the tide was ebbing upstream monitoring was not conducted based on discussions with EPA. Monitoring was suspended due to the approaching dusk.

The field sheets follow.

WQ Monitoring Field Form

Job #: LY15160310

Date: 12/ 9

Round: 1

Sheet: 1 of 3

Crew: RG + SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ~~ENR+AC~~ [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstream		150ft downstream		75ft upstream		150ft upstream		Ambient
Start Time:	10:36		10:38				11:21		10:44
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	14.2		7.7		2.8		2.8		2.7
4	4.6		5.4		4.8		2.8		2.6
6	4.3		3.6		5.6		3.4		2.9
8			3.4						2.0
10									2.0
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading

Comments: Starting placing material 9:21
10:35 - Ore nested barge, stop work
10:54 - begun placing materials

WQ Monitoring Field Form

Sheet: 2 of 2

Job #: LY15160310

Date: 12/09/11 **Round:** 1 **Crew:** RG + SU

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	150ft downstream		300ft downstream		450ft downstream		~~300~~ ft downstream		Ambient
Start Time:	11:34		11:43		11:58		12:27		12:35
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		[✓ HS] Ebb LS Flood		[✓ HS] Ebb LS Flood		[✓ HS] Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	6.1		7.1		5.8		3.2		2.7
4	9.2		4.6		3.5		3.8		2.7
6	26.0		26.0		6.2		5.7		2.7
8			7.0		5.6		7.1		2.7
10									2.8
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading

Comments: 6-8ft Halocline

11:52 - Stop work

Per CSW instructions monitoring conducted

@ 300ft downstream for compliance after

work stoppage

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310 **Date:** 12/09/16 **Round:** 3 **Crew:** RGL SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	95 ft downstream		150ft downstream						Ambient
Start Time:	1513		15:07						16:18
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.1		3.1						3.3
4	3.1		3.1						3.3
6			3.6						3.0
8									3.2
10									3.3
12									3.4
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading

Comments: o Water velocity increased downstream

Material placement resumed @ 1350

Date: December 12, 2016

Test Area: Intertidal

Plot: Sand/ Gravel ENR

Summary of Monitoring Results:

ENR placement was halted due to an equipment malfunction. One round of water quality monitoring was conducted just after placement stopped. There is no estimated time for repair of the equipment; therefore, water quality monitoring will be suspended for the remainder of the day. Based on a discussion with Erika Hoffman, water quality monitoring of ENR material placement at the intertidal plot will be conducted tomorrow (12-13-16).

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310 **Date:** 12-12-16 **Round:** 1 **Crew:** GSM TS

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 down		150 down		150 up		75 up		Ambient
Start Time:	1158		1204		1217		1221		1210
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.2		3.0		2.4		2.3		2.6
4	4.0		3.7		2.5		2.5		2.6
6	4.9		3.8		3.0		3.4		2.5
8	5.8		3.6		4.4		4.4		2.9
10	3.7		3.3		3.6				3.2
12	3.6		3.2						3.2
14			5.2						4.4
16									
18									
20									
22									
24									
26									
28									
30									
32	T.D 13.5		TD 15.5		TD 12		T.D. 10.5		
34									
36									
38									
40									

Barometric compensation for depth reading

Comments: 1021 first bucket placed TD = total depth
1158 arrived on site - work just stopped due to electrical problem
ambient in the cross river
1400 excavator under repairs - ETA to resume work unknown
and WQ monitoring with EPA permission

Date: December 13, 2016

Test Area: Intertidal

Plot: Sand/Gravel ENR

Summary of Monitoring Results:

Material placement began at 08:33 on 12/13/2016. The low tide (6.2 feet MLLW) was at 10:11. The first round of monitoring was conducted at 10:02. The highest turbidity at the 75 foot downstream monitoring station was 21.7 NTUs at 2 feet below the surface (vs ambient at 2 feet of 2.8 NTUs). At 150 feet downstream of ENR material placement the highest turbidity was 3.8 NTUs at 4 feet below the surface (vs ambient at 4 feet of 2.8 NTUs). Monitoring at the 75 foot upstream station was not conducted due to due to barge movements. The turbidity at the 150 foot upstream station was 2.7 NTUs (vs 2.8 NTUs at the ambient). There were no turbidity exceedances during the first round of monitoring.

The second round of monitoring was conducted about 2 hours later (started at 12:14) on a flood tide. The highest turbidity at the 75 foot downstream station was 3.5 NTUs (vs 2.6 NTUs at 4 feet below the surface). At 150 foot downstream station the highest turbidity was 14.4 NTUs at 4 feet below the surface (vs 2.6 NTUs at the ambient). This was an exceedance of the turbidity criterion. Monitoring was conducted at 300 feet downstream of the material placement. The highest turbidity was 3.6 NTUs at 6 feet below the surface (vs 2.6 NTUs at the ambient). The project engineer and the project manager were informed of the exceedance. Material placement continued. Monitoring was conducted at the 150 foot upstream monitoring station. The highest turbidity was 4.5 NTUs at 4 feet below the surface (vs 2.6 NTUs at the ambient station). Monitoring was not conducted at the 75 foot upstream station due to safety considerations.

The third round of monitoring was conducted after approximately two hours. The highest turbidity was recorded at the 75 foot downstream station. The turbidity was 7.8 NTUs at 2 feet below the surface (vs 2.5 NTUs at the ambient). At the 150 foot downstream station the highest turbidity was 6.3 NTUs at 2 feet below the surface. Monitoring was conducted at the 75 foot and 150 foot upstream station. The highest turbidity was 2.8 NTUs at 2 feet and 6 feet below the surface at the 150 foot upstream station (vs 2.5 NTUs and 4.8 NTUs, for 2 feet and 6 feet below the surface, respectively, at the ambient station). There were no exceedances of the turbidity criterion during this round of sampling Monitoring was suspended for the day.

The field forms follow.

WQ Monitoring Field Form

Job #: LY15160310

Date: 12/13/14 **Round:** 1

Sheet: 1 of 1

Crew: RG + SL

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstream		150ft downstream				150 upstream		Ambient
Start Time:	1002		10:09				10:20		1014
Tide Cycle:	HS Ebb [✓ LS] ~~[✓ Flood]~~		HS Ebb [✓ LS] ~~[✓ Flood]~~		HS Ebb LS Flood		HS Ebb LS [✓ Flood]		HS Ebb [✓ LS] ~~[✓ Fld]~~
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	21.7	X	3.7				2.7		2.8
4	11.5		3.8				2.7		2.8
6									2.8
8									
10									
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments: Start placing material @ 0833
75ft upstream not monitored moving barge.

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310

Date: 12/13/16 **Round:** 2 **Crew:** RG & SW

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstream		150ft downstrm		300ft downstrm		150 upstrm		Ambient
Start Time:	1214		1018		12:34		12:52		12:39
Tide Cycle:	HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.2		4.7		3.4		4.0		2.6
4	3.5		14.4	X	3.3		4.5		2.6
6					3.6		3.3		2.6
8									3.7
10									3.7
12									3.4
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments: 75Ft upstream not done. due to safety considerations. inside swing radius

WQ Monitoring Field Form

Job #: LY15160310 **Date:** 12/13/16 **Round:** 3 **Sheet:** 1 of 1 **Crew:** RG&SL

Site (circle): Demonstration Scour Subtidal [✓ Intertidal]

Material (circle): ENR+AC [✓ ENR]

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstream		150ft downstream		75ft up		150ft up		Ambient
Start Time:	14:18		14:22		1439		14:35		1428
Tide Cycle:	[✓ HS] Ebb LS [✓ Flood]		[✓ HS] Ebb LS [✓ Flood]		[✓ HS] Ebb LS [✓ Flood]		[✓ HS] Ebb LS [✓ Flood]		[✓ HS] Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	7.8	X	6.3		2.6		2.8		2.5
4	6.7		5.0		2.5		2.6		2.5
6	6.2		4.6		2.6		2.8		4.8
8			5.4						3.3
10									3.0
12									
14									
16									
18									
20									
22									
24									
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading ☒

Comments:

WATER QUALITY MONITORING
DAILY SUMMARY AND FIELD NOTES—SCOUR PLOTS

Date: December 20, 2016

Test Area: Scour

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

Described below is a summary of the water quality monitoring conducted at the scour plot during ENR+AC placement on December 20, 2016.

Material placement of the Sand/Gravel + AC was started at 09:41 at the scour plot. The first round of monitoring was started at 11:49 approximately 2 hours after material placement began. The tide was ebbing. A total of two rounds of monitoring were performed and no exceedances of the turbidity were observed. The ambient station was located across the river channel and upriver of the project area.

The highest turbidity during the first round of monitoring occurred at 12 feet below the surface at the 75 foot downstream monitoring station with a reading of 4.2 NTUs vs 1.5 NTUs at the ambient at 12 feet below the surface.

The construction manager informed the monitoring team that material placement would probably end around 14:30 due to lack of hydrated activated carbon. The second round of monitoring was started at 13:30 approximately 1.5 hours after the first round of sampling so that the second round of monitoring could be completed prior to cessation of material placement.

The highest turbidity during the second round of monitoring occurred at 2 feet below the surface at the 150 foot downstream monitoring station with a reading of 3.4 NTUs vs 2.2 NTUs at the ambient station at 2 feet below the surface.

The field notes follow

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310

Date: 12-20-16 **Round:** 1 **Crew:** Gsn Sw

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 down		150 down		75 up		150 up		Ambient
Start Time:	1149		1159		1208		1227		1247
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.6		2.8		1.8		2.4		2.3
4	2.7		3.8		1.7		2.5		2.1
6	1.7		2.7		1.7		2.0		1.8
8	2.1		3.6		1.7		1.8		1.6
10	2.0		3.4		1.7		1.8		1.6
12	4.2		3.7		1.5		1.6		1.5
14	3.3		3.6		1.2		1.6		1.7
16			2.6		1.4		1.6		1.4
18			2.9		1.4		1.2		1.3
20			1.7		1.3		1.2		1.3
22					1.5		1.4		1.6
24					1.3		1.4		1.6
26					1.4		1.2		1.7
28	Bottom		Bottom		1.6		1.1		1.6
30	17.3		23		1.5		1.4		1.5
32					1.6		1.4		1.6
34					1.9		1.5		1.6
36							1.4		1.5
38					bottom		bottom		
40					374		394		

Barometric compensation for depth reading ☐

Comments: start placement at 0941

1220 - barge moving to new location

ambient on w side of river + upstream

WQ Monitoring Field Form

Sheet: 1 of 1

Job #: LY15160310 **Date:** 12-20-16 **Round:** 2 **Crew:** GSM SW

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 down		150 down		75 up		150 up		Ambient
Start Time:	1330		1336		1341		1351		1359
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.1		3.4		1.9		1.9		2.2
4	1.9		2.0		1.9		1.8		1.8
6	2.5		2.0		1.6		1.8		1.5
8			1.7		1.3		1.3		1.6
10			1.7		1.2		1.3		1.3
12					1.2		1.2		1.4
14					1.2		1.4		1.2
16					1.3		1.5		1.2
18					1.2		1.3		1.2
20					1.5		1.3		1.3
22					1.3		1.1		1.3
24					1.3		1.1		1.7
26					1.1		1.1		2.1
28					1.1		1.0		2.5
30					1.1		1.1		2.7
32					1.2		1.3		2.6
34					1.1		1.3		
36	Bottom		Bottom						
38	9ft		13ft		Bottom		Bottom		Bottom
40					36ft		36ft		34

Barometric compensation for depth reading

Comments: started 2nd round early due to work stopping around 230 (lack of wet carbon)
ambient on W side of river and up river

Date: December 21, 2016

Test Area: Scour

Plot: Sand/Gravel ENR + AC

Summary of Monitoring Results:

Material placement began at 7:54. The first round of monitoring was conducted at 9::40. The tide was flooding (high at 11:05). The highest turbidity was found at the 75 foot monitoring station at 24 feet below the surface. The measured turbidity was 27 NTUs (vs 1 NTU at ambient). At the 150 foot downstream station the highest turbidity was found at 26 feet below the surface. Turbidity was 6.8 NTUs (vs 1 NTU at ambient) and exceeded the turbidity criterion. The highest turbidity at the upstream stations was 4.6 NTUs. Monitoring was conducted at the 300 foot downstream station. The highest turbidity was 5.6 NTUs at 2 feet below the surface (vs 2.9 NTUs at the ambient).

The second round of monitoring was conducted at 12:14 during an ebb tide. The highest turbidity was found at the 75 foot monitoring station at 24 feet below the surface. The measured turbidity was 9.1 NTUs (vs 1 NTU at ambient). At the 150 foot downstream station the highest turbidity was found at 10 feet below the surface. Turbidity was 7.4 NTUs (vs 1.3 NTU at ambient) and exceeded the turbidity criterion. The highest turbidity at the upstream stations was 3.0 NTUs. Monitoring was conducted at the 300 foot downstream station. The highest turbidity was 6.8 NTUs at 2 feet below the surface (vs 3.2 NTUs at the ambient). After completion of the monitoring round the project engineer informed the boat crew that the material placement was being suspended. Water quality monitoring was suspended.

The field notes follow.

WQ Monitoring Field Form

Sheet: 1 of 4

Job #: LY15160310 **Date:** 12/21/16 **Round:** 1 **Crew:** RGCG

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstrem		150ft dwnstrem		75ft up strem		150ft upstrem		Ambient
Start Time:	9:40		9:49		10:01		10:11		10:23
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.8		2.5		3.0		2.1		2.9
4	2.8		4.7		2.7		2.9		2.6
6	5.2		3.8		2.4		2.3		1.9
8	2.0		1.7		1.8		1.6		1.6
10	4.6		1.2		1.7		1.4		1.2
12	2.9		1.2		2.0		1.2		1.2
14	1.5		1.2		2.6		2.2		1.1
16	1.8		1.2		2.4		2.1		1.0
18	3.9		1.1		2.6		2.1		1.1
20	3.8		2.0		3.0		2.3		1.0
22	2.8		4.0		3.1		3.6		1.0
24	27.0	X	5.6		4.4		3.2		1.0
26			6.8	X	4.6		3.2		1.0
28			5.9		3.2		2.9		1.0
30			4.2		3.0		2.0		0.9
32					1.8		1.7		0.9
34					1.6		1.5		0.9
36					1.7		2.8		0.9
38							1.4		0.9
40									

Barometric compensation for depth reading: 65

Comments:

WQ Monitoring Field Form

Sheet: 2 of 4

Job #: LY15160310

Date: 12/21/15

Round: 1

Crew: RG JA & SV

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	300ft downstream								Ambient
Start Time:	10:40								
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	5.6								
4	3.1								
6	3.6								
8	3.5								
10	5.3								
12	2.4								
14	3.7								
16	4.1								
18	2.8								
20	2.8								
22	2.2								
24	1.8								
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading 0.5

Comments:

WQ Monitoring Field Form

Sheet: 3 of 4

Job #: LY15160310 Date: 12/21/16 Round: 2 Crew: RC&SW

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft downstream		150ft dwnstm		75ft upstream		150ft up		Ambient
Start Time:	1214		1222		1229		1237		1247
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.2		3.0		2.9		3.0		3.2
4	8.4	X	2.1		2.8		2.8		2.9
6	8.1	X	1.7		2.4		2.3		2.1
8	4.6		1.4		1.7		1.7		1.5
10	2.0		7.4	X	1.3		1.4		1.3
12	3.4		2.3		1.1		0.8		1.2
14	1.9		1.6		0.9		0.8		0.9
16	1.8		3.6		1.0		0.9		0.9
18	1.5		3.1		1.1		1.0		1.0
20	1.6				1.1		1.1		1.0
22	2.0				1.0		1.2		1.1
24	9.1	X			1.0		1.2		1.0
26	4.6				1.1		1.1		1.1
28					1.4		1.0		0.9
30					1.3		1.0		0.9
32					1.5		0.9		1.2
34					1.1		1.2		1.0
36							0.9		0.8
38									1.0
40									1.0

Barometric compensation for depth reading 0.5

Comments:

WQ Monitoring Field Form

Sheet: 4 of 4

Job #: LY15160310

Date: 12/21/16 **Round:** 2

Crew: R/GaSh

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	300ft downstream								Ambient
Start Time:	1303								
Tide Cycle:	HS [✓ Ebb] LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	6.8								
4	4.4								
6	2.2								
8	1.3								
10	13								
12	1.1								
14	1.1								
16	1.1								
18	1.0								
20	11								
22	1.8								
24	1.7								
26									
28									
30									
32									
34									
36									
38									
40									

Barometric compensation for depth reading 0.5

Comments: Dan Pickering says they are done for the day No more ENR+AC material that has soaked available. @ 1318 Monitoring suspended.

Date: December 22, 2016

Test Area: Scour

Plot: Sand/ Gravel ENR + AC

Summary of Monitoring Results:

Material placement of the Sand/Gravel + AC was started at approximately 8:40 at the scour plot. The first round of monitoring was started at 9:57 approximately 1.25 hours after material placement began. The tide was flooding (high at 11:49). The highest turbidity during the first round of monitoring occurred at 28 feet below the surface at the 75 foot downstream monitoring station. The turbidity was 4.9 NTUs (vs 1 NTU at the ambient). The highest turbidity at either the 150 foot downstream or the 150 foot upstream stations was 3.9 NTUs.

The second round of monitoring was started at 12:28. Tide was ebbing. The highest turbidity during the second round of monitoring occurred at 4 feet below the surface at the 75 foot downstream monitoring station. The turbidity was 4 NTUs (vs 2.4 NTUs at the ambient). The highest turbidity at either the 150 foot downstream or the 150 foot upstream station was 2.9 NTUs.

The field notes are attached.

WQ Monitoring Field Form

Sheet: 1 of 2

Job #: LY15160310

Date: 12/22/16 **Round:** 1 **Crew:** RG & TS

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' ds		150' ds		75' us		150' us		Ambient
Start Time:	9:57		10:04		10:10		10:21		10:31
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.4		3.9		3.1		3.1		3.1
4	4.6		3.9		3.0		3.0		2.9
6	2.3		2.7		2.6		2.3		2.7
8	2.6		2.0		1.6		1.8		1.8
10	2.0		1.8		1.4		1.7		1.4
12	1.6		1.4		1.3		1.8		1.1
14	1.4		1.1		1.8		2.0		1.1
16	1.8		1.3		2.0		2.0		1.0
18	2.3		2.8		1.8		1.7		0.9
20	2.8				1.9		1.5		0.9
22	4.1				1.8		1.3		0.9
24	4.2				1.7		1.2		0.9
26	4.1				2.0		1.2		1.0
28	4.9				1.8		1.0		1.0
30					1.5		1.1		0.9
32					1.4		1.2		0.9
34					1.7		1.4		0.9
36					1.6				
38					1.7				
40									

Barometric compensation for depth reading

Comments: Material placement @ 0840

WQ Monitoring Field Form

Sheet: 2 of 2

Job #: LY15160310 **Date:** 12/22/16 **Round:** 2 **Crew:** RO & TS

Site (circle): Demonstration [✓ Scour] Subtidal Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	150' US		75' US		75' ds		150' ds		Ambient
Start Time:	12:28		12:42		12:51		12:57		13:04
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.7		3.0		2.2		2.8		2.7
4	2.4		2.8		4.0		2.9		2.4
6	2.2		2.4		2.6		1.8		2.0
8	2.0		2.3		2.0		1.5		1.6
10	1.5		1.4		1.6		1.4		1.5
12	1.3		1.1		1.3		1.4		1.1
14	1.2		0.9		1.2		1.2		1.1
16	1.0		1.0		1.1		1.2		1.0
18	1.0		1.0		1.0		1.2		1.0
20	1.1		1.1		1.2				1.0
22	1.1		1.3		1.2				1.0
24	1.1		1.2		1.3				0.8
26	1.1		1.0		1.2				0.9
28	1.1		1.2		1.6				1.1
30	1.1		1.4						1.0
32	1.1		1.4						1.0
34	1.4		1.4						
36			1.8						
38			2.4						
40									

Barometric compensation for depth reading ☒

Comments:

WATER QUALITY MONITORING
DAILY SUMMARY AND FIELD NOTES—SUBTIDAL PLOTS

Date: January 9, 2017

Test Area: Subtidal

Plot: Sand ENR + AC

Summary of Monitoring Results:

Material placement of the sand ENR material +AC was started at approximately 13:00 at the subtidal plot. The first round of monitoring was started at 14:20 approximately 1.25 hours after material placement began. The tide was ebbing (high at 13:27). A single round of monitoring was performed and no exceedances of the turbidity were observed. The ambient station was located across the river channel and upriver of the project area.

The highest turbidity during the round of monitoring occurred at 38 feet below the surface at the 150 foot downstream monitoring station. The turbidity was 5.8 NTUs (vs 3.6 NTU at the ambient). A patchy surface sheen of activated carbon was noted at the 75 foot downstream station.

A second round of monitoring was not conducted because material placement was shutting down (15:30) and dusk was approaching.

The field notes follow.

WQ Monitoring Field Form

Job #: LY15160310

Date: 1/9/17 **Round:** 1

Sheet: 1 of 1

Crew: TWS, SW

Site (circle): Demonstration Scour [✓ Subtidal] Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' ds		150' ds		75' us		150' us		Ambient
Start Time:	1420		1433		1450		1504		1515
Tide Cycle:	HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Flood		HS [✓ Ebb] LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.7		2.9		3.2		3.3		3.3
4	2.8		2.6		3.1		3.1		2.8
6	2.8		2.6		2.9		2.5		2.4
8	3.0		2.9		2.8		2.3		2.2
10	2.7		2.7		3.1		2.6		2.3
12	2.2		2.8		2.8		3.1		2.5
14	2.2		2.8		2.7		3.0		3.5
16	2.4		2.1		2.4		3.0		3.5
18	2.0		2.0		2.8		3.1		3.7
20	1.9		2.3		2.6		2.8		3.7
22	1.5		1.8		2.7		2.7		3.4
24	1.4		1.7		2.7		2.8		3.4
26	1.6		1.2		2.3		2.7		3.1
28	1.3		1.1		2.0		2.8		3.2
30	1.4		1.3		1.8		2.4		2.7
32	1.5		1.2		1.7		2.8		2.9
34	1.4		1.2		2.2		2.4		2.6
36	1.5		1.2		2.1		2.7		3.0
38	1.5		5.8		2.1		2.6		3.6
40	2.2		depth 42.5ft		2.2		depth 39'		depth 39'

Barometric compensation for depth reading ☒ depth 45'

tot'l depth 43'

Comments: surface sheen of AC noted at 75' ds. 75' us station was alongside materials barge - not directly upstream → - no room on other side of dredge barge. 150' us station was on opposite end of dredge barge →.

Date: January 10, 2017

Test Area: Subtidal

Plot: Sand ENR + AC

Summary of Monitoring Results:

Material placement of the Sand ENR +AC was started at 7:58 at the subtidal plot. The first round of monitoring was started at 10:30 approximately 2.5 hours after material placement began. A total of two rounds of monitoring were performed and no exceedances of the turbidity criterion were observed. The ambient station was located across the river channel and upriver of the project area.

The highest turbidity during the first round of monitoring conducted on a flood tide (high tide at 14:17) occurred at 4 feet below the surface at the 75 foot upstream monitoring station. The turbidity was 4.4 NTUs (vs 2.6 NTUs at the ambient). The highest turbidity at the 150 foot upstream stations was 4.3 NTUs (38 feet below the surface). The ambient had 1.4 NTUs at 36 feet below the surface (the deepest available).

The second round of monitoring was started at 13:51. Tide was high slack. The highest turbidity during the second round of monitoring occurred at 40 feet below the surface at the 150 foot upstream monitoring station. The turbidity was 5.2 NTUs (vs 5.8 NTUs at the ambient at 34 feet below the surface; deepest available). The highest turbidity at the 150 foot upstream station was 2.6 NTUs at 2 feet below the surface (vs 2.5 NTUs at the ambient).

The field notes follow.

WQ Monitoring Field Form

Job #: LY15160310

Date: 1/10/17 **Round:** 1

Sheet: 1 of 2

Crew: RS & SW

Site (circle): Demonstration Scour [✓ Subtidal] Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75 ft downstream		150 ft downstream		75 ft upstream		150 ft upstream		Ambient
Start Time:	10:36		1049		1107		1131		1143
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.2		2.0		3.6		3.0		3.2
4	2.5		2.4		4.4		2.6		2.6
6	2.2		2.2		2.2		2.3		1.7
8	1.6		1.7		2.0		1.9		1.7
10	1.7		1.4		1.6		1.8		1.7
12	1.4		1.3		1.3		1.8		1.9
14	1.3		1.3		1.3		1.8		1.9
16	1.3		1.4		1.2		1.8		1.7
18	1.3		1.4		1.2		2.1		1.6
20	1.3		1.4		1.4		1.9		1.5
22	1.3		1.4		1.9		2.3		1.6
24	1.3		1.3		1.5		2.3		1.4
26	1.4		1.5		1.4		2.1		1.6
28	1.3		1.4		1.3		2.2		1.7
30	1.3		1.4		1.3		2.5		1.7
32	1.4		1.6		1.5		2.8		1.5
34	1.3		1.6		1.5		2.9		1.4
36	1.4		1.3		2.3		4.1		1.4
38	1.4		1.3				4.3		
40			1.5						

Barometric compensation for depth reading ☒

Comments: Placement started @ 758

Barges moving between monitoring @ 75 ft upstream and 150 ft upstream

WQ Monitoring Field Form

Job #: LY15160310

Date: 1/10/17 Round: 2

Sheet: 2 of 2

Crew: RG & SW

Site (circle): Demonstration Scour [✓ Subtidal] Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75ft up stream		150ft up stream		75 DS		150 DS		Ambient
Start Time:	13:51		14:07		1437		1459		1423
Tide Cycle:	HS Ebb LS [✓ Flood]		[✓ HS] Ebb LS [✓ Flood]		[✓ HS] Ebb LS Flood		HS [✓ Ebb] LS Flood		HS Ebb LS Fld
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	2.0		2.3		2.6		26		2.5
4	22		22		2.6		24		2.1
6	2.1		2.1		3.8		2.1		2.2
8	2.0		1.9		1.8		1.9		21
10	1.8		1.8		1.7		1.8		21
12	1.8		1.8		1.9		1.7		2.5
14	1.8		1.9		2.2		1.8		3.2
16	1.8		1.8		2.0		1.6		3.5
18	1.7		1.4		2.2		1.9		3.8
20	1.7		1.4		2.9		2.8		3.5
22	1.6		1.4				2.2		22
24	1.5		1.3				2.4		2.8
26	1.5		1.4				2.2		2.6
28	1.5		1.6				1.6		2.8
30	2.4		2.2				1.2		2.9
32	2.8		3.4				1.7		4.7
34	2.9		3.6				1.7		5.8
36	2.0		4.4				1.7		
38	33		4.4						
40			5.2						

Barometric compensation for depth reading X

237yds

Comments: 75 ft Down stream stopped before full depth monitored due to safety considerations Tug and barge @ Cadman East side of river

Date: January 11, 2017

Test Area: Subtidal

Plot: Sand ENR + AC

Summary of Monitoring Results:

Material placement of the Sand ENR +AC was started at approximately 7:45 at the subtidal plot. The first round of monitoring was started at 10:20 approximately 2.5 hours after material placement began. The tide was beginning to flood (high low at 10:08 to a high at 15:08). A total of two rounds of monitoring were performed and no exceedances of the turbidity were observed. The ambient station was located across the river channel and upriver of the project area.

The highest turbidity during the first round of monitoring occurred at 6 feet below the surface at the 75 foot downstream monitoring station. The turbidity was 4.7 NTUs (vs 2.8 NTU at the ambient). The highest turbidity at the 150 foot downstream station was 3.3 NTUs (6 feet below the surface) and the highest turbidity at the 150 foot upstream station was 3.1 NTUs (4 feet below the surface). The turbidity at the ambient ranged from 3.1 to 1.5 NTUs.

The second round of monitoring was started at 12:31. Tide was flooding. The highest turbidity during the second round of monitoring occurred at 4 feet below the surface at the 75 foot downstream monitoring station. The turbidity was 3.5 NTUs (vs 3 NTUs at the ambient). The highest turbidity at the 150 foot downstream station was 2.8 NTUs (2 feet below the surface) and the highest turbidity at the 150 foot upstream station was 3.3 NTUs (2 feet below the surface). The turbidity at the ambient ranged from 3.2 to 1.0 NTUs.

The field notes follow.

WQ Monitoring Field Form

Sheet: 1 of 2

Job #: LY15160310 Date: 1/11/17 Round: 1 Crew: KK, TS

Site (circle): Demonstration Scour [✓ Subtidal] Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' DS (north)		150' DS		75' US (south)		150' US		Ambient
Start Time:	10:20		10:28		10:37		10:46		11:03
Tide Cycle:	HS Ebb [✓ LS] Flood		HS Ebb [✓ LS] Flood		HS Ebb [✓ LS] Flood		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.6		3.0		3.5		3.0		3.1
4	4.2		3.2		3.5		3.1		3.0
6	4.7		3.3		3.0		2.7		2.8
8	3.2		2.8		2.4		2.2		2.2
10	2.6		2.3		2.4		2.0		2.1
12	2.0		2.6		2.0		1.6		1.9
14	1.6		2.2		1.6		1.6		1.9
16	1.8		2.3		1.6		1.6		1.7
18	2.2		1.6		1.5		1.7		1.6
20	1.9		1.6		1.8		1.8		1.9
22	1.8		1.9		1.9		1.9		1.8
24	2.1		2.1		1.8		1.8		1.9
26	2.0		2.0		1.9		1.9		1.9
28	2.2		1.9		1.4		1.8		2.0
30	1.9		1.7		1.9		1.9		1.7
32	1.7		1.6		1.8		1.8		1.5
34	1.7		1.7		2.1		1.5		1.8
36	1.6		1.6				1.8		2.0
38							1.7		
40	depth 39.5'		depth 39.5		depth 38.5		depth 42'		depth 40'

Barometric compensation for depth reading 0.5

Comments: Placement started @ approximately 0745

WQ Monitoring Field Form

Sheet: 1 of 2

Job #: LY15160310

Date: 1/11/17 Round: 2 Crew: TWJ KK

Site (circle): Demonstration Scour [✓ Subtidal] Intertidal

Material (circle): [✓ ENR+AC] ENR

Note: Sta = Distance from construction (feet) / Dir = Direction (upstream, downstream, inshore, offshore)

Note: Tide Cycle: HS= High Slack, Ebb=Outgoing Tide, LS=Low Slack, Flood=Incoming Tide

Sta/Dir:	75' DS		150' DS		75' US		150' US		Ambient
Start Time:	1231		1238		1248		1304		1317
Tide Cycle:	HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Flood]		HS Ebb LS [✓ Fld]
Depth	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Turbidity (NTU)	Exceedance	Ambient Turbidity (NTU)
2	3.3		2.8		3.2		3.3		3.2
4	3.5		2.4		3.2		2.9		3.0
6	3.0		2.1		2.8		2.3		2.2
8	2.8		1.9		2.3		2.1		1.8
10	2.2		1.8		1.6		1.5		1.6
12	2.0		1.7		1.5		1.4		1.5
14	1.7		1.4		1.7		1.4		1.5
16	1.8		1.2		1.4		1.4		1.7
18	1.3		1.1		1.3		1.3		1.6
20	1.3		1.1		1.2		1.3		1.3
22	1.2		1.0		1.8		1.3		1.3
24	1.1		1.2		1.1		1.5		1.0
26	1.4		1.1		1.5		1.5		1.3
28	1.2		1.2		1.2		1.3		1.4
30	1.3		1.1		1.1		1.3		1.3
32	1.6		1.3		1.6		1.3		1.4
34	1.5		1.1		2.0		1.2		1.8
36	1.6		1.4		2.8		1.2		2.2
38	1.5		1.5		3.0		2.1		2.2
40	depth 42'		1.3		depth 42'		2.9		depth 39'
Barometric compensation for depth reading			depth 44'	0.5			3.6 @ 42 depth 46		

Comments:

CALIBRATION WORKSHEETS
FOR WATER QUALITY MONITORING

CALIBRATION WORK SHEET

Date of Calibration: 11/28/16
Technician: Rob Gilmour

YSI 6820
Sonde ID: 04J15529 AA

RP DO membrane changed? Y N
RP DO membrane o-ring changed? Y N

Note: Wait 3 to 6 hours before calibrating for unattended deployments; run in Discrete mode for 10 minutes to accelerate burn in. (Rapid Pulse DO Only)

Turbidity wiper changed? [✓ Y] N
ROX DO wiper changed? Y N
BGA-PC wiper changed? Y N
Chlorophyll wiper changed? Y N
BGA-PE wiper changed? Y N
Rhodamine wiper changed? Y N

Note: If parking problems occur with optical probes having a serial number 07L (Dec 07) or older, be sure the firmware is 3.06 or later. Parking issues with optical probes having a serial number prior to 07L may be related to a dirty wiper body or pad.

Record sonde battery voltage: ______________ (if applicable)

Record the following diagnostic numbers after calibration.

6560 Conductivity cell constant ____________ Range 5.0 ± .45
Integrated conductivity cell constant ________ Range 5.0 ± .70
pH mv Buffer 7 ____________ Range 0 ± 50 mv
pH mv Buffer 4 ____________ Range +180 ± 50 mv*
pH mv Buffer 10 ____________ Range -180 ± 50 mv *

***Note:** Millivolt span between pH 4 and 7 should be ≈ 165 to 180 mv

Millivolt span between pH 7 and 10 should be ≈ 165 to 180 mv

DO charge (RP only) ____________ Range 25 to 75
DO gain ____________ Range 0.7 to 1.4
ODO gain ____________ Range 0.85 to 1.15

Turbidity standard used in calibration YSI 6073G 126NTU
Manufacturer and part number YSI 607300

Barometric Pressure: ________________ mmHg
DO % Calculated – (BARO mmHg divided by 7.6) = % saturation
Example: 760 ÷ 7.6 = 100.0%

Record Calibration Values

	Standard	Pre Cal / Post Cal
Temperature		____Sonde
Conductivity		/
pH 7		/
pH 4		/
pH 10		/
ORP		/
Turbidity	0	0.5 / 0
Turbidity	126	110 / 126
Turbidity 0.5		/
Chlorophyll		/
Chlorophyll		/
DO RP		/
DO ROX		/
BGA PE/PC		/
BGA PE/PC		/
Rhodamine		/

Depth Calibration - If zero was entered, record barometric pressure at time of calibration ____________ mmHg
Depth Calibration - If offset depth was entered, record value ___________ meters/feet and pressure ___________ mmHg
Depth Calibration (Vented) – Acceptable calibration constant: 0.0 psig ± 0.15 ____________________

Notes:

CALIBRATION WORK SHEET

Date of Calibration: 1/3/2017

Technician: Rob Gilmour

Sonde ID: YSI 6820 04J15529 AA

RP DO membrane changed? Y N

RP DO membrane o-ring changed? Y N

Note: Wait 3 to 6 hours before calibrating for unattended deployments; run in Discrete mode for 10 minutes to accelerate burn in. (Rapid Pulse DO Only)

Turbidity wiper changed? Y [✓ N]

ROX DO wiper changed? Y N

BGA-PC wiper changed? Y N

Chlorophyll wiper changed? Y N

BGA-PE wiper changed? Y N

Rhodamine wiper changed? Y N

Note: If parking problems occur with optical probes having a serial number 07L (Dec 07) or older, be sure the firmware is 3.06 or later. Parking issues with optical probes having a serial number prior to 07L may be related to a dirty wiper body or pad.

Record sonde battery voltage: __________ (if applicable)

Record the following diagnostic numbers after calibration.

6560 Conductivity cell constant ________ Range 5.0 ± .45

Integrated conductivity cell constant ________ Range 5.0 ± .70

pH mv Buffer 7 ________ Range 0 ± 50 mv

pH mv Buffer 4 ________ Range +180 ± 50 mv*

pH mv Buffer 10 ________ Range -180 ± 50 mv *

***Note:** Millivolt span between pH 4 and 7 should be ≈ 165 to 180 mv

Millivolt span between pH 7 and 10 should be ≈ 165 to 180 mv

DO charge (RP only) ________ Range 25 to 75

DO gain ________ Range 0.7 to 1.4

ODO gain ________ Range 0.85 to 1.15

Turbidity standard used in calibration YSI 6073 G

Manufacturer and part number YSI Incorp. 607300

Barometric Pressure: ________ mmHg

DO % Calculated – (BARO mmHg divided by 7.6) = % saturation

Example: 760 ÷ 7.6 = 100.0%

Record Calibration Values

	Standard	Pre Cal / Post Cal
Temperature		Sonde
Conductivity		/
pH 7		/
pH 4		/
pH 10		/
ORP		/
Turbidity	0 DT	0.0/0.0
Turbidity	126	127 / 126
Turbidity 0.5		/
Chlorophyll		/
Chlorophyll		/
DO RP		/
DO ROX		/
BGA PE/PC		/
BGA PE/PC		/
Rhodamine		/

Depth Calibration - If zero was entered, record barometric pressure at time of calibration ________ mmHg

Depth Calibration - If offset depth was entered, record value ________ meters/feet and pressure ________ mmHg

Depth Calibration (Vented) – Acceptable calibration constant: 0.0 psig ± 0.15 ________

Notes:

ATTACHMENT 8

Pre-Placement Subtidal Substrate Observations

SUBTRATE OBSERVATIONS

Page 1 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 / 178	SUBTIDAL / ENR	89

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY/COLD	RM	DD		45	FT		

VIS @ 8' - 10'
V H

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 10113
1- FINGER 2- LOCATION
3- LOCATION

STAKE: ☐ Deploy ☐ Monitor

Height: ______

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ______
☐ Piddock Clam
☐ ______
☐ ______

Debris: ☐ Logs ☒ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ______

Terrain: **Height:** **Spacing:**
☐ Flat
☐ Hummocks ______ ______
☒ Ripples ~4" 12" - 18" MULTIPLE DRAGS

Major Constituent (Circle major & underline modifying)
[✓ Fine] Medium Coarse Boulder Cobble Gravel Sand [✓ Silt] Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

NO STAKES PLACED IN SUBTIDAL PLOT - OBSERVATIONS
@ EACH MEASUREMENT LOCATION.

SILTY SAND
RIPPLES SE → NW ALONG

FIRST 3 PHOTOS IN 3 PHOTO BURSTS
LAST PHOTO IS DIVERS + FINGER "1"

SUBTRATE OBSERVATIONS

Page 2 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 / 1~~6~~ 7	SUBTIDAL / ~~69~~ ENR	69

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth: Depth	f	t	SPME Time
CLEAR/SUNNY/COLD	RM	DD		45	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 10:23
95-2 FINGERS

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________
☐ Piddock Clam
☒ SHINER PERCH 2"
☐ ____________

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____________

Terrain: **Height:** **Spacing:**
☐ Flat
☐ Hummocks ____________ ____________
☒ Ripples 3" 12-18"

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] Medium Coarse Boulder Cobble Gravel Sand [✓ Silt] Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

MORE DEFINATE RIPPLING, 1 CHAIN TRACK 4" WIDE BETWEEN 49 & 69

LOOSE SED INCREASING FIRMNESS, AT 8" HARD SED.

FURROWS EVIDENT IN AR~~R~~EA SIMILAR TO LAST LOCATION

SUBTRATE OBSERVATIONS

Page 3 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 / 1~~6~~ 7	SUBTIDAL / AC	70

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR SUN	RM	DD					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 10:30

97 - 3 FINGERS 98 - SEDIMENT, 99 - TYPICAL MOUND

STAKE: ☐ Deploy ☐ Monitor

Height: ________

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ________
- ☐ Piddock Clam
- ☒ SMALL CRABS
- ☒ SEA PEN (~1/4") HIGH

Debris:
- ☐ Logs ☒ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ ________

Terrain: **Height:** **Spacing:**
- ☐ Flat
- ☒ Hummocks 1.5' OR LESS 3' (IRREGULAR) MULTIPLE IN 10' RADIUS
- ☐ Ripples ________ ________

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

SUBTRATE OBSERVATIONS

Page 4 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 / 1 ~~6~~ 7	SUBTIDAL / AC	90

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR SUNNY	RM	DD					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 10:37

100-4 FINGERS, 101-SED, 102-DEBRIS & CRAB
SL CAM - 4 FINGERS, SED, DEBRIS & CRAB

STAKE: ☐ Deploy ☐ Monitor

Height: ______

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ______
☐ Piddock Clam
☒ HERMET CRAB
☐ ______

Debris: ☐ Logs ☒ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☒ WOOD / ORGANIC DEBRIS

Terrain: **Height:** **Spacing:**
☐ Flat
☒ Hummocks 1'-1.5' 18"
☒ Ripples ______ ______

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] Medium Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

MOUNDY FURROWING BETWEEN 70 & 90
BURROWS (WORM OR SHRIMP) BETWEEN 70 & 90
LOTS OF CRAB TRACKS @ 90
FIRM SED, MORE CLAY 3" UNDER SURFACE

SUBTRATE OBSERVATIONS

Page 5 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 4 /16	SUBTIDAL/+AC	88

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	DD		43	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 10:44

103 - 5 FINGERS, 104 SHELLS, LEAFY DEBRIS

5L - 5 FINGERS.

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☒ SHELLS

☐ CRAB TRACKS

Debris: ☐ Logs ☑ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ____________

Terrain:		**Height:**	**Spacing:**
☐	Flat		
☒	Hummocks	~1.5'	5'
☒	Ripples	SIMILAR TO PREVIOUS	

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

FURROWS BETWEEN 90 & 88 MORE ALONG CHANNEL DIRECTION

CLAYEY MATL 4" BELOW SURFACE OF ML

DID 1 VIDEO OF 5 FINGERS BY MISTAKE.

DIVER LEFT BOTTOM @ 1048

SUBTRATE OBSERVATIONS

Page 6 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 4 / 1 ~~6~~ 7	SUBTIDAL / ENR	87

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth: Depth	f	t	SPME Time
SUNNY / CLEAR	RM	DD		43	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 11:42 VIS ~ 4FT HORIZ

10 - 6 FINGER (SIDEWAYS 1)

3L - #6 FINGER ″, SED

STAKE: ☐ Deploy ☐ Monitor

Height: ____

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____ ☐ Piddock Clam ☐ CRAB TRACS ☐ WORM TUBES + SEA PEN (SMALL)

Debris: ☐ Logs ☒ Sticks ☐ Concrete ☐ Tire ☐ Riprap ☐ Lumber ☐ Metal ☐ Cable ☐ PLASTIC CONTAINER WOOD DEBRIS

Terrain: ☒ Flat ☐ Hummocks ☐ Ripples

Height: ____ **Spacing:** ____

Major Constituent **(Circle major & underline modifying)**

Fine Medium Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

CHANGED AIR TANK + SET NEW MARKERS. DIVER IN WATER @ 11:37

ON BOTTOM @ 11:39

FIRM MATL @ 3" BELOW SED SURFACE

SUBTRATE OBSERVATIONS

Page 7 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	/ /1 6	SUBTIDAL/ENR	85

<table>
<tr><th rowspan="2">Weather</th><th rowspan="2">Initials</th><th rowspan="2">Diver Initials</th><th rowspan="2">Buoy Deploy Time</th><th colspan="3">Water Depth</th><th rowspan="2">SPME Time</th></tr>
<tr><th>Depth</th><th>f</th><th>t</th></tr>
<tr><td>CLEAR/SUNNY</td><td>RM</td><td>DD</td><td></td><td>42</td><td></td><td></td><td></td></tr>
</table>

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 11:44

135- 7-FINGER, 136 SED

SL -1"7 " , SURF GRAV, LEAFY

STAKE: ☐ Deploy ☐ Monitor

Height: ___

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ___

☐ Piddock Clam

☐ NONE

☒ SHRIMP

Debris: ☐ Logs ☒ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ WOOD DEBRIS

Terrain: ☒ Flat **Height:** **Spacing:**

☐ Hummocks ___ ___

☐ Ripples ___ ___

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel [✓ Sand] <u>Silt</u> Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

FURROWS BETWEEN 87 & 85

1" SOFT SED CLAY BELOW SURF

SUBTRATE OBSERVATIONS

Page 8 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 4 /1~~6~~ 9	SUBTIDAL/ENR	67

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth			SPME Time
				Depth	f	t	
SUNNY/CLEAR	RM	DD		43'	F	T	

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 11:54

138 ~~147~~ - 5 FINGER, 139 - AREA

SL - 5 FINGER, AREA - SHELL & LEAF

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ CRAB TRACKS

☐ SHELLS

Debris: ☐ Logs ☒ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ LEAFY

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel Sand [✓ Silt] Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

THIN LAYER FINE SED THEN STIFF CLAY w/ WOOD

SUBTRATE OBSERVATIONS

Page 9 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 4 /1 ~~6~~ 7	SUBTIDAL / ENR	83

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
SUNNY / CLEAR	RM	DD		42FT			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1205

140 9 FINGER, 141 SURROUNDINGS

MICROLIFE 9 FINGER

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological:
☐ Algae % cover: ____________
☐ Piddock Clam
☒ WORM TUBES
☒ CRAB (CANCER)

Debris:
☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ORGANIC / WOOD / LEAVES

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____________ ____________
☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

DRAG LINES BETWEEN 67 & 83 W/ CHANNEL FURROWS 6" HIGH W 1.5' SPACING

2" SOFT SED OVER FIRM

SUBTRATE OBSERVATIONS

Page 10 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /14 /16	SUBTIDAL / AC	84

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	DD		41	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ ____ 171- 10 FINGER (FIST), 172- AREA MICRO LIFE - FIST ; CRAB AREA, DEBRIS

STAKE: ☐ Deploy ☐ Monitor

Height: ____

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☐ WORM TUBES
☐ CRAB TRACKS/CRAB

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain:	**Height:**	**Spacing:**
☐ Flat		
☒ Hummocks	4"	12"
☒ Ripples	6"	

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel ~~Sand~~ [✓ Silt] Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:
3' SOFT OVER CLAY (SOFT)

SUBTRATE OBSERVATIONS

Page 11 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 4 /1 ~~8~~ 7	SUBTIDAL / AC	68

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	DD	40'				

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ ____________

173 - 1 FINGER, 174 - AREA LEAF DEBRIS
54 - 1 FINGER, DEBRIS + FURROW

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ____________
- ☐ Piddock Clam
- ☐ TUBES
- ☐ V. LITTLE CRAB SIGNS

Debris:
- ☐ Logs ☐ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ ____________

Terrain:	**Height:**	**Spacing:**
☐ Flat		
☐ Hummocks	____________	____________
☒ Ripples	6"-12"	12"

FURROWS

Major Constituent **(Circle major & underline modifying)**

Fine Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

VERY HUMMOCKY w/ 4X12 BEAM ABOUT 4' AWAY FROM 54

FURROWS IN CHANNEL DIRECTION

1" SOFT OVER FIRM CLAY

SUBTRATE OBSERVATIONS

Page 12 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 4/1 ~~6~~ 7	SUBTIDAL / AC	86

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth: Depth	f	t	SPME Time
CLEAR/SUNNY	RM	DD		39	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1226

175 - 2 FINGER, 176 - SURROUNDINGS

SL - 2 FINGER, SURROUNDINGS, RIDGE TOP/FURROW

12 PHOTO'S

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ CRAB TRACKS

☐ ____________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ LEAFS/ORGANICS

Terrain:		**Height:**	**Spacing:**	
☐	Flat			
☐	Hummocks	____________	____________	
☒	Ripples	6"	~18"	FURROWS

Major Constituent (Circle major & underline modifying)

[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

STIFF SURFACE NO SOFT SED @ SURFACE

SET MORE BUOYS

LEFT BOTTOM @ 1229

500 PSI - PRESSURE

SUBTRATE OBSERVATIONS

Page 13 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 / 1~~6~~ 7	SUBTIDAL / ENR	41

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth: Depth	f	t	SPME Time
CLEAR / SUNNY	RM	VG		42	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1327

175 - FINGER

SL – FINGER, AREA

179 - AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ NONE

☐ ____________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ Leaf debris

Terrain: **Height:** **Spacing:** ~ NOTHING BIG

☒ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

VICTOR NEXT DIVER, IN WATER AT 13:17

LEFT SURFACE @ 1319

ON BOTTOM @1322

LOW VISABILITY

CURRENT ON BOTTOM ENOUGH TO STIR SED OFF BOTTOM. VISIBILITY ON BOTTOM REDUCED

SUBTRATE OBSERVATIONS

Page 14 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1/4/1~~8~~7	~~#~~SUBTIDAL/ENR	65

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	VG		42			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1341

180-2 FINGERS, AREA-181

0L FINGERS, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ____________
- ☐ Piddock Clam
- ☐ ~~NONE~~
- ☐ LITTLE BIT OF SHELLS

Debris:
- ☐ Logs ☒ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ ____________

Terrain: **Height:** **Spacing:**
- ☒ Flat
- ☐ Hummocks ____________ ____________
- ☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine [✓ Medium] Coarse Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

CURRENT KICKING UP TURBIDITY FROM BOTTOM SED.

POOR VISABILITY.

SUBTRATE OBSERVATIONS

Page 15 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 /1~~6~~ 7	SUBTIDAL/ENR AC	~~79~~ 80

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR SUNNY	RM	VG		40			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1356
184 3 FINGERS, LAST # 187

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________
☐ Piddock Clam
☐ SCATTERED SHELLS
☐ ____________

Debris: ☐ Logs ☒ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ PLANT DEBRIS (DEAD) + WOOD

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____________ ____________
☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

~~STEE~~
LOOKING FOR 79 + FOUND 80. TAKE OBSERVATIONS @ 80. SOME RIPPLES FROM CHAIN BETWEEN 80 + 79. VISABILITY IMPROVING TO 2'-3'.

SUBTRATE OBSERVATIONS

Page 16 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 4 /1 ~~6~~ 7	SUBTIDAL / ENR	79

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1422

155 - 4 FINGER, AREA PHOTOS - 191
52 - 4 FINGER, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ ____________________

☐ ~~NONE~~ LITTLE BIT OF SHELLS

Debris: ☐ Logs ☒ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ WOOD

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel Sand [✓ Silt] <u>Clay</u>

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

BROUGHT DIVER BACK TO BOAT, CHANGE TANK + GO TO 79.

SOFT MUCK ON BOTTOM - NO ~~FIM~~ FIRM LAYER UNDER SURFACE SED FELT.

SUBTRATE OBSERVATIONS

Page 17 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 / 1~~6~~ 7	SUBTIDAL / AC	06

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR / SUNNY	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1440

192 5 FINGER, AREA PHOTOS → 194

9L 5 FINGER, AREA PHOTO'S

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ____________
- ☐ Piddock Clam
- ☒ NONE OBSERVED
- ☐ ____________

Debris:
- ☐ Logs ☐ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ NONE OBSERVED

Terrain: **Height:** **Spacing:**
- ☒ Flat
- ☐ Hummocks ____________ ____________
- ☐ Ripples 3-4" HIGH 5"-6' WIDE JUST 1 TRENCH

Major Constituent **(Circle major & underline modifying)**

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Minor Constituent with trace

Fine [✓ Medium] Coarse Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

SUBTRATE OBSERVATIONS

Page 18 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 14 /1 ~~6~~ 7	SUBTIDAL / AC	S2

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1449
195-6 FINGER, AREA PHOTO 197 L
5L-6 FINGER AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________
☐ Piddock Clam
☐ CRAB
☐ ____________

Debris: ☐ Logs ☒ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ WOOD DEBRIS

Terrain: **Height:** **Spacing:**
☐ Flat
☐ Hummocks ____________ ____________
☐ Ripples 2-3" x 1.5' WIDE 1 FURROWS

Major Constituent (Circle major & underline modifying)
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Minor Constituent with trace
Fine Medium [✓ Coarse] Boulder ~~Cobble~~ ~~Gravel~~ Sand Silt Clay
SPALLS SIZE SMALL MELLON ANGULAR

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

FURROWS ORIENTED UP/DOWN STREAM

SUBTRATE OBSERVATIONS

Page 19 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 14 / 1~~6~~7	SUBTIDAL/ENR	77

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f t	SPME Time
CLEAR/SUNNY	RM	DD		37	FT	

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1524
197-1 FINGER, 227, 1 FINGER
228 SURROUNDING AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ___________

Surficial sediment characteristics:
SL-1 FINGER, SHELLS

Biological: ☐ Algae % cover: ___________
☐ Piddock Clam
☐ WORMS, CRAB
☐ SHELLS, MUSCLE

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ WOOD, METAL DUCTWORK
5" DIA PIPE
A LOT OF WOOD w/ ORGANIC

Terrain: ☒ Flat
☐ Hummocks
☐ Ripples

Height: 3" HIGH

Spacing: ~18"

Major Constituent **(Circle major & underline modifying)**
Fine Medium Coarse Boulder Cobble Gravel Sand [✓ Silt] Clay

Minor Constituent ~~with trace~~
Fine [✓ Medium] Coarse Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:
CHANGE DIVERS: DALE BACK IN WATER @1522
ON BOTTOM @ 1523

3" SOFT SILT SAND → STIFFER CLAY
5" STIFFER YET.

SUBTRATE OBSERVATIONS

Page 20 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / ~~4~~ 5 / 1 ~~6~~ 7	SUBTIDAL/ENR	63

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
SUNNY/CLEAR	RM	~~DD~~ VG		46	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 10133

GOPRO WONT TURN ON

SL - NUMBER, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ ~~BANA~~ BARNICLES ON ROCKS

☐ ____________

Debris: ☐ Logs ☒ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ LEAVES

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

Fine Medium Coarse Boulder Cobble Gravel [✓ Sand] [✓ Silt] Clay

Minor Constituent with trace

Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

WILL CONTINUE AT 63 TOMORROW 1/5/17. BARGE COMING OUT OF ALASKA MARINE LINES.

1/5/17 - BARGE BEING BROUGHT TO + NEW BARGE BEING BROUGHT OUT. STANDBY FOR BARGE TRAFFIC.

DIVER IN WATER @ 10:25. ON BOTTOM @ 10133

ROCKS SCATERED AROUND LOCATION &

CANNON BALL HAD STICKY CLAY ON IT WHEN RECOVERED.

SUBTRATE OBSERVATIONS

Page ~~20~~ 21 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 5 /1 ~~6~~ 7	SUBTIDAL/AC	64

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY/COLD	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1040

NO GOPRO

SL-LABEL, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____

☐ Piddock Clam

☐ CRAB

☐ ____

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ SMALL ROCKS

SCATTERED

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____ ____

☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**

Fine Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

~~WAIT FOR BARGE TRAFFIC PRIOR TO STARTING. WESTERN "TUG" BRINGING BARGE TO ALASKA BARGE + LEAVING W/ BARGE.~~ NOTES TRANSFERED TO STA, 63.

ROCK IS ANGULAR

CANNON BALL HAD STICKY CLAY ON IT.

SUBTRATE OBSERVATIONS

Page 22 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /15 /1~~8~~9	SUBTIDAL / AC	78

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY/COLD	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1051
SL - TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ___________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ___________
☐ Piddock Clam
☐ ~~NONE OBSERVED~~
☐ SHELLS

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ SMALL ROCKS/SHELL

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ___________ ___________
☐ Ripples ___________ ___________

Major Constituent **(Circle major & underline modifying)**
Fine Medium Coarse Boulder Cobble Gravel Sand [✓ Silt] Clay

Minor Constituent with trace
Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:
GO PRO CAMERA NOT WORKING, USING SEALIFE CAMERA.

SUBTRATE OBSERVATIONS

Page 23 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 5 / 1 ~~6~~ 7	SUBTIDAL / AC	62

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 11:00 TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ SHRIMP (LOTS)

☐ ____________

Debris: ☐ Logs ☒ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ WOOD, ROCKS, PLANT(DEAD)

Terrain: **Height:** **Spacing:**

☐ Flat

☐ Hummocks ____________ ____________

☒ Ripples 3" ____________

Major Constituent **(Circle major & underline modifying)**

Fine Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

SMALL TRENCH - PROBABLY FROM TOW BRIDAL

SUBTRATE OBSERVATIONS

Page 24 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 15 / 1 ~~6~~ 7	SUBTIDAL / AC	76

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY	RM	YG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 11:06
SL; TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological:
☐ Algae % cover: ____________
☐ Piddock Clam
☒ SHRIMP
☒ BURROW HOLES

Debris:
☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☒ SMALL WOOD + PLANT

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____________ ____________
☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace
Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:
1ST PHOTO AT EACH STATION IS THE TAG #.

SUBTRATE OBSERVATIONS

Page 25 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /15 /1 6	SUBTIDAL / ENR	75

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY/COLD	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 11:11
SL TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ___________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ___________
☐ Piddock Clam
☐ ___________
☐ ___________

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ GRAVEL, DEAD PLANT DEBRIS

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ___________ ___________
☐ Ripples ___________ ___________

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace
Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

AIR TEMP HIGH 20's TO LOW 30's
AIR PRESSURE @ 500 psi
BRING DIVER TO SURFACE TO SWITCH TANKS AT 11:12,
LEFT BOTTOM @ 11:13

SUBTRATE OBSERVATIONS

Page 26 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 15 /19	SUBTIDAL / ENR	61

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY/COLD	R			45	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1153

61 - TAG, AREA
5L - TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ___

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ___

☐ Piddock Clam

☐ ___

☐ SHELLS

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ PLANT/SHELL DEBRIS

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ___ ___

☐ Ripples ___ ___

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium <u>Coarse</u> Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

DIVER IN WATER ~ 11:50

3000 BACKUP } DIVER AIR
2600 PRIMARY }

BOTTOM SED FIRMER AT SURFACE THAN PREVIOUS LOCATIONS THIS MORNING

SUBTRATE OBSERVATIONS

Page 27 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 5 /1 ~~6~~ 7	SUBTIDAL / ENR	73

<table>
<tr><th rowspan="2">Weather</th><th rowspan="2">Initials</th><th rowspan="2">Diver Initials</th><th rowspan="2">Buoy Deploy Time</th><th colspan="3">Water Depth</th><th rowspan="2">SPME Time</th></tr>
<tr><th>Depth</th><th>f</th><th>t</th></tr>
<tr><td>CLEAR/SUNNY</td><td>PM</td><td>VG</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ ____

PICTURES - TAG, AREA

OL TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____

☐ Piddock Clam

☐ CRAB CARAPICE, SHELLS

☐ ____

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ PLANT/GRAVEL

Terrain:	**Height:**	**Spacing:**
☒ Flat		
☐ Hummocks	____	____
☐ Ripples	____	____

Major Constituent **(Circle major & underline modifying)**

Fine Medium Coarse Boulder Cobble Gravel [✓ Sand] [✓ Silt] Clay

Minor Constituent with trace

Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

HARD COMPACT SEDIMENT

MORE ROCK THAN PREVIOUS LOCATIONS TODAY.

SUBTRATE OBSERVATIONS

Page 28 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /5 /1 ~~6~~ 7	SUBTIDAL/ENR	71

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
COLD/SUNNY/CLEAR	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1210

GOPRO - TAG, AREA

SL - TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ____________

Surficial sediment characteristics:

Biological:

☐ Algae % cover: ____________

☐ Piddock Clam

☐ NOTHING OBSERVED

☐ ____________

Debris:

☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ PLANT DEBRIS & ROCKS

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] Medium Coarse Boulder Cobble Gravel <u>Sand</u> [✓ Silt] Clay

Minor Constituent with trace

Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

SOFTER SED THAN 73

SUBTRATE OBSERVATIONS

Page 29 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /5 /1 ~~8~~ 9	SUBTIDAL / AC	72

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth: Depth	f	t	SPME Time
CLEAR/SUNNY/COLD	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ __________

GOPRO - TAG, AREA
SL - TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: __________

Surficial sediment characteristics:

Biological: ☐ Algae % cover: __________
☐ Piddock Clam
☐ __________
☐ SHELL

Debris: ☐ Logs ☒ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ PLANT DEBRIS/ ROCKS
WOOD

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks __________ __________
☐ Ripples __________ __________

Major Constituent **(Circle major & underline modifying)**
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Minor Constituent with trace
Fine Medium [✓ Coarse] Boulder <u>Cobble</u> [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

VISIBILITY ~~GOIN~~ REDUCING
GROUPINGS OF ROCKS - ROUNDED, 1-2" GRAVEL TO
5" COBLES. PREVIOUS ROCK HAS BEEN ANGULAR.

SUBTRATE OBSERVATIONS

Page 30 of 30

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 5 / 1~~6~~7	SUBTIDAL AC	74

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
SUNNY/CLEAR	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ ________

GOPRO; TAG, AREA
OL; TAG, AREA

STAKE: ☐ Deploy ☐ Monitor

Height: ________

Surficial sediment characteristics:

Biological:
☐ Algae % cover: ________
☐ Piddock Clam
☐ NONE OBSERVED
☐ ________

Debris:
☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ PLANT DEBRIS
ROPE

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ________ ________
☐ Ripples ________ ________

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] Medium Coarse Boulder Cobble Gravel Sand [✓ Silt] Clay

Minor Constituent with trace
Fine Medium [✓ Coarse] Boulder Cobble [✓ Gravel] Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:

SOFT SEDIMENT AT BOTTOM
ROUND ROCK - Gravel & Cobbles

ATTACHMENT 9

Post-Placement Subtidal Substrate Observations

SUBTRATE OBSERVATIONS

Page 1 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30 /1 7	SUBTIDAL/ENR+AC	90

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	VG		38	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☑ DIDNT GET TIME

STAKE: ☐ Deploy ☐ Monitor

Height: 13" (PROBE)

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ NONE

☐ ____________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ____________

Terrain: **Height:** **Spacing:**

☑ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

~~Fine~~ [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

ON BOTTOM @ 1139, 38'

FINE SAND

DIVER HAD SOME DIFFICULTY W/ DETERMINING CHANGE IN RESISTANCE ~~FOR~~ WHEN PROBING

RELATIVELY FLAT W/ NO HUMMOCKS OR DRAG MARKS

SUBTRATE OBSERVATIONS

Page 2 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1/30/17	SUBTIDAL/ENR+AC	7088

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST / 40s	RM	VG		39			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1150
PIC OF TAG & BOTTOM

STAKE: ☐ Deploy ☐ Monitor

Height: 14" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☐ NONE
☐ ____

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____ ____
☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:
MORE DISTINCTIVE DIFF. BETWEE SAND & NATIVE
WHEN PROBING

SUBTRATE OBSERVATIONS

Page 3 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 / 1 7	SUBTIDAL ENR	87

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 12:09
PHOTO OF TAG 121

STAKE: ☐ Deploy ☐ Monitor

Height: 14"-15" PROBE

Surficial sediment characteristics:

Biological:
☐ Algae % cover: ____________
☐ Piddock Clam
☒ NONE
☐ ____________

Debris:
☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____________

Terrain: **Height:** **Spacing:**
☑ Flat
☐ Hummocks ____________ ____________
☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**
~~Fine~~ [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☑ No

Sediment Sample: ☐ Yes ☒ No

Comments:

FINE SAND - DIVER DESCRIPTION.

DIVER DID 2 PROBES @ 15" & 14"

SUBTRATE OBSERVATIONS

Page 4 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30/17	SUBTIDAL/ ENR	89

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 12:16

STAKE: ☐ Deploy ☐ Monitor

Height: 12" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ______
☐ Piddock Clam
☐ NONE
☐ ______

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ______

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ______ ______
☐ Ripples ______ ______

Major Constituent **(Circle major & underline modifying)**
[✓ Fine] [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

BETWEEN 87 + 89; ONE HUMMOCK

AIR - 900

SUBTRATE OBSERVATIONS

Page 5 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 / 1 7	SUBTIDAL / ENR	64

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST / 40s	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 12:22

STAKE: ☐ Deploy ☐ Monitor

Height: 16" PROBE

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ____
- ☐ Piddock Clam
- ☐ NONE
- ☐ ____

Debris:
- ☐ Logs ☐ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ ____

Terrain:	**Height:**	**Spacing:**
☒ Flat		
☐ Hummocks	____	____
☐ Ripples	____	____

Major Constituent **(Circle major & underline modifying)**

[✓ Fine] [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

BRING DIVER TO SURFACE TO CHANGE TANK,

52 MIN

SUBTRATE OBSERVATIONS

Page 6 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 / 17	SUBTIDAL/ENR+AC	70

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40S	RM	VG		38			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☑ 1229

STAKE: ☐ Deploy ☐ Monitor

Height: 15" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☒ CRAB TRACKS

☐ ____________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ____________

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

PRIMARY 2400

DIVER DESCRIBING MED SAND BUT CALLING IT FINE SAND.

RESET ANCHORS/BOUYS + BRING IN DIVER

SUBTRATE OBSERVATIONS

Page 1 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 / 17	SUBTIDAL/ ENR	67

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth: Depth	f t	SPME Time
OVERCAST/40s	RM	NB		38	FT	

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1329
TAG w/ LABLE

STAKE: ☐ Deploy ☐ Monitor

Height: SEE NOTE* (PROBE)

Surficial sediment characteristics:

Biological:
☐ Algae % cover: ____________
☐ Piddock Clam
☒ NONE
☐ ____________

Debris:
☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____________

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____________ ____________
☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] + SILT Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

Comments:
DRAG MARKS ~ 1" -
MED-COARSE SAND - V. CLEAN
*PROBE WENT IN EASILY + COULDN'T FIND INTERFACE
TOLD NOT TO DIG INTO CAP MATL FOR THICKNESS

SUBTRATE OBSERVATIONS

Page 8 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30/1 7	SUBTIDAL/ENR	83

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f | t	SPME Time
OVERCAST/40s	RM	NB		38	FT	

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1335

STAKE: ☐ Deploy ☐ Monitor

Height: 19" & 14" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________
☐ Piddock Clam
☒ NONE
☐ ____________

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____________

Terrain: **Height:** **Spacing:**
☑ Flat
☐ Hummocks ____________ ____________
☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] ~~Coarse~~ Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

V. CLEAN

DRAG MARKS <1" 1'-2' FROM STATION

2 PROBES 19" & 14"

SUBTRATE OBSERVATIONS

Page 9 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30/1 7	SUBTIDAL/ENR+AC	84

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	NB		33 38	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ ________

STAKE: ☐ Deploy ☐ Monitor

Height: 21" & 14" PROBE

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ________
- ☐ Piddock Clam
- ☒ NONE
- ☐ ________

Debris:
- ☐ Logs ☐ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ ________

Terrain: **Height:** **Spacing:**
- ☒ Flat
- ☐ Hummocks ________ ________
- ☐ Ripples ________ ________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

NO DRAG MARKS

BLACK "SEDIMENT" - CARBON DESCRIBED BY DIVER ON SURFACE OF SAND

2 PROBES 21" & 14"

SUBTRATE OBSERVATIONS

Page 10 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 17	SUBTIDAL / ENR+AC	68

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST / 40s	RM	NB		36			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1353

STAKE: ☐ Deploy ☐ Monitor

Height: 13" PROBE

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ____
- ☐ Piddock Clam
- ☒ NONE
- ☐ ____

Debris:
- ☐ Logs ☐ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ ____

Terrain: **Height:** **Spacing:**
- ☒ Flat
- ☐ Hummocks ____ ____
- ☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

NO DRAG-MARKS

SUBTRATE OBSERVATIONS

Page 11 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30 /1 7	SUBTIDAL	S6

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/	RM	NB		36	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1358

STAKE: ☐ Deploy ☐ Monitor

Height: 15" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☐ JUST LOG W/ BARINACLES
☐ ____

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____ ____
☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

LOG 1' DIA X 4' LONG W/BARICLES LAYING ON SURFACE W/ NO SAND ON TOP OF IT, LOG IS AT STATION ± 2' & WASN'T THERE DURING PRE-INSPECTION,

SUBTRATE OBSERVATIONS

Page 12 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 1 7	SUBTIDAL / ENR	85

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST / 40s	RM	NB					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1405

STAKE: ☐ Deploy ☐ Monitor

Height: 16" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☐ NONE
☐ ____

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____ ____
☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:
DUSTING OF BROWN (FINE) SEDIMENT OVER SAND.

SUBTRATE OBSERVATIONS

Page 13 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30/1 7	SUBTIDAL / ENR+AC	82

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth			SPME Time
				Depth	f	t	
OVERCAST / 40S	Rm	~~AB~~ VG		39			

SPME: ☐ Deploy

☐ Recover

PHOTO: ☑ 1451

STAKE: ☐ Deploy

☐ Monitor

Height: 14" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☐ NONE

☐ ____________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ____________

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____________ ____________

☐ Ripples ____________ ____________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

AFTER NEW BOUYS SET, SWITCH DIVERS.

SOME TRASH ON BOTTOM

SUBTRATE OBSERVATIONS

Page 14 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 / 17	SUBTIDAL/ENR+AC	66

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	VG		40	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1500

STAKE: ☐ Deploy ☐ Monitor

Height: 14" + 13" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☒ NONE
☐ ____

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____ ____
☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:
HUMMOCKS BETWEEN 82 + 66
2 PROBES; 14" + 13"

SUBTRATE OBSERVATIONS

Page 15 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 / 17	SUBTIDAL/ENR+AC	80

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1505

STAKE: ☐ Deploy ☐ Monitor

Height: 11' PROBE

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ____________
- ☐ Piddock Clam
- ☒ NONE
- ☐ ____________

Debris:
- ☐ Logs ☐ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☐ ____________

Terrain:		**Height:**	**Spacing:**
☒	Flat		
☐	Hummocks	____________	____________
☐	Ripples	____________	____________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

SUBTRATE OBSERVATIONS

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Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30/1 7	SUBTIDAL/ENR	79

<table>
<tr><th rowspan="2">Weather</th><th rowspan="2">Initials</th><th rowspan="2">Diver Initials</th><th rowspan="2">Buoy Deploy Time</th><th colspan="3">Water Depth</th><th rowspan="2">SPME Time</th></tr>
<tr><th>Depth</th><th>f</th><th>t</th></tr>
<tr><td>OVERCAST/40s</td><td>Rm</td><td>VG</td><td></td><td>~~3F~~40</td><td colspan="2">FT</td><td></td></tr>
</table>

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1511

STAKE: ☐ Deploy ☐ Monitor

Height: 14" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☒ NONE
☐ ____

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____ ____
☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

SUBTRATE OBSERVATIONS

Page 17 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /30 /1 7	SUBTIDAL/ ENR	6.5

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	VG		42			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ ________

STAKE: ☐ Deploy ☐ Monitor

Height: 14" & 15' PROBE

Surficial sediment characteristics:

Biological:
- ☐ Algae % cover: ________
- ☐ Piddock Clam
- ☒ NONE
- ☐ ________

Debris:
- ☐ Logs ☐ Sticks
- ☐ Concrete ☐ Tire ☐ Riprap
- ☐ Lumber ☐ Metal ☐ Cable
- ☒ WOOD; TWIGS

Terrain:	**Height:**	**Spacing:**
☒ Flat		
☐ Hummocks	________	________
☐ Ripples	________	________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

SMALL TWIGS @ 6.5 ON SURFACE

DID SEVERAL PROBES & GOT 14" & 15"

SUBTRATE OBSERVATIONS

Page 18 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 30 / 17	SUBTIDAL / ENR	81

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
OVERCAST/40s	RM	VG		42	FT		

SPME: ☐ Deploy

☐ Recover

PHOTO: ☐ ________

STAKE: ☐ Deploy

☐ Monitor

Height: 14" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ________

☐ Piddock Clam

☒ 2 FISH BETWEEN 65 & 81 BUT DARTED OFF

☐ ________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ________

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ________ ________

☐ Ripples ________ ________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

Two

SUBTRATE OBSERVATIONS

Page 19 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 31 / 1 7	SUBTIDAL/ENR+AC	76

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth			SPME Time
				Depth	f	t	
PART. CLOUDS/40s	RM	NB		45			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 9200929
PHOTO W/ TAG "76"

STAKE: ☐ Deploy ☐ Monitor

Height: 13"
PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ________
☐ Piddock Clam
☒ NONE
☐ ________

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ________

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ________ ________
☐ Ripples ________ ________

Major Constituent (Circle major & underline modifying)
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:
NATHAN B. FIRST DIVER.
917 LEFT SURFACE
918 ON BOTTOM
POOR VISABILITY <1'
STARTED TO TAKE PICTURES @ 920 BUT HAD TO
CHANGE BATTERY TO CAMERA.

SUBTRATE OBSERVATIONS

Page 20 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /31 /17	SUBTIDAL/ENR+AC	6~~2~~4

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
PART. CLOUDS/40s	RM	NB		43			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 941

STAKE: ☐ Deploy ☐ Monitor

~~Height~~: PROBE 18" & 15"

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____

☐ Piddock Clam

☒ NONE

☐ ____

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ____

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____ ____

☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

DIVER MOVING TO 62 BUT CAME ACROSS 64, GET
DATA AT 64.
VISABILITY IMPROVING A LITTLE
SEVERAL PROBES 18" & 15"

SUBTRATE OBSERVATIONS

Page 21 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /31 /17	SUBTIDAL/ENR+AC	78

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f t	SPME Time
P. CLOUDS/40s	RM	NB		43	FT	

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 0949

STAKE: ☐ Deploy ☐ Monitor

~~Height~~ PROBE: 14"

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ______
☐ Piddock Clam
☐ ______
☐ ______

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ______

Terrain: **Height:** **Spacing:**
☐ Flat
☐ Hummocks ______ ______
☐ Ripples ______ ______

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:
LIGHT (DUSTING) OF FINE GRAINED (BROWN) SED
RIVER (ROUND) ROCK ON TOP OF CAP SAND,
HAD DIVER ~~SQUEEZ~~ SQUEEZE ROUND ROCK TO
CONFIRM IT IS ROCK.
BARGES AT LAFARGE HAVE ROCK OUTSIDE OF
BIN WALLS (PHOTO @ ~ 952)

SUBTRATE OBSERVATIONS

Page 22 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 31 / 1 7	SUBTIDAL/ENR+AC	62

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
P. CLOUDS / 40s	RM	NB		4.5	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 10 02

STAKE: ☐ Deploy ☐ Monitor

~~Height:~~ PROBE 1"

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____ ☐ Piddock Clam ☒ NONE ☐ ____

Debris: ☐ Logs ☐ Sticks ☐ Concrete ☐ Tire ☐ Riprap ☐ Lumber ☐ Metal ☐ Cable ☐ ____

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____ ____

☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

THICKER LAYER OF SED (BROWN <1" OVER CAP SAND)

BRING DIVER TO BOAT TO CHANGE AIR TANKS.

SUBTRATE OBSERVATIONS

Page 23 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /31 /17	SUBTIDAL / ENR	63

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth			SPME Time
				Depth	f	t	
CLOUDS / 40s	RM	NB		42	FT		

SPME: ☐ Deploy

☐ Recover

PHOTO: ☒ 1029

STAKE: ☐ Deploy

☐ Monitor

~~Height:~~ PROBE 10"

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____________

☐ Piddock Clam

☒ NONE

☐ ____________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ____________

Terrain:		**Height:**	**Spacing:**
☒	Flat		
☐	Hummocks	________	________
☐	Ripples	________	________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

SUBTRATE OBSERVATIONS

Page 24 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /31 /17	SUBTIDAL / ENR	77

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f t	SPME Time
CLOUDY / 40S	KM	NB		42	FT	

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1042

STAKE: ☐ Deploy ☐ Monitor

Height: 13" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☒ NONE
☐ ____

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain: **Height:** **Spacing:**
☒ Flat
☐ Hummocks ____ ____
☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

~~CAP SAND W/ <1" OF "RIVER SAND"~~
~~ON TOP OF CAP SAND~~

FINER GRAINED SAND (<1") OVER COARSER SAND.
BOTH LOOK LIKE SAND USED FOR CAP BUT AT
THIS LOCATION IT LOOKS LIKE SAND @ SURFACE
IS FINER.

SUBTRATE OBSERVATIONS

Page 25 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 31 / 17	SUBTIDAL/ENR+AC	74

<table>
<tr><th rowspan="2">Weather</th><th rowspan="2">Initials</th><th rowspan="2">Diver Initials</th><th rowspan="2">Buoy Deploy Time</th><th colspan="3">Water Depth</th><th rowspan="2">SPME Time</th></tr>
<tr><th>Depth</th><th>f</th><th>t</th></tr>
<tr><td>CLOUDY / 40s / WINDY</td><td>RM</td><td>VG</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1141

STAKE: ☐ Deploy ☐ Monitor

Height: 16" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ________
☐ Piddock Clam
☒ NONE
☐ ________

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ________

Terrain: **Height:** **Spacing:**
☐ Flat
☐ Hummocks ________ ________
☐ Ripples ________ ________

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

~~MOVE~~ PLACE NEW SET OF BOUYS. VICTOR NEXT DIVER.

VISABILITY LOW 1'-2' DIFFICULTY GETTING PHOTO W/ TURBIDITY CAUSED BY CURRENT.

* DIVER CANT SEE IF ANY HUMMOCKS OR RIPPLES DUE TO LOW VISABILITY.

SUBTRATE OBSERVATIONS

Page 26 of ___

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 /31 /17	SUBTIDAL/ENR+AC	72

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLOUDY/40s/WINDY	RM	VG		43	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1154

STAKE: ☐ Deploy ☐ Monitor

Height: 14" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ______
☐ Piddock Clam
☐ ______
☐ ______

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ______

Terrain: **Height:** **Spacing:**
☐ Flat
☐ Hummocks ______ ______
☐ Ripples ______ ______

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

VISABILITY 1' W/ LIGHT
DIVER CAN'T TELL IF HUMMOCKS OR RIPPLES ARE
PRESENT DUE TO VISABILITY. NONE ENCOUNTERED
@ STA 72.

SUBTRATE OBSERVATIONS

Page 27 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1/31/17	SUBTIDAL/ENR	71

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
PARTIAL CLOUDS/40s	RM	VG		42	FT		

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ ________

STAKE: ☐ Deploy ☐ Monitor

Height: 14" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ________
☐ Piddock Clam
☐ ________
☐ ________

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ________

Terrain: **Height:** **Spacing:**
☐ Flat
☐ Hummocks ________ ________
☐ Ripples ________ ________

Major Constituent **(Circle major & underline modifying)**
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

LOW VIS ≈ 1'
DIVER CAN'T SEE IF ~~HS~~ HUMMOCKS / RIPPLES OR
BIOLOGICAL

SUBTRATE OBSERVATIONS

Page 28 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 31 / 1 7	SUBTIDAL/ENR	7.3

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
PARTIAL CLOUDS/SUN-BREAKS	RM	VG		34			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 121~~8~~ 7

STAKE: ☐ Deploy ☐ Monitor

Height: 8" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____
☐ Piddock Clam
☐ CAN'T SEE ANY MARINE LIFE OR VEG.
☐ ____

Debris: ☐ Logs ☐ Sticks
☐ Concrete ☐ Tire ☐ Riprap
☐ Lumber ☐ Metal ☐ Cable
☐ ____

Terrain: **Height:** **Spacing:**
☑ Flat
☐ Hummocks ____ ____
☐ Ripples ____ ____

Major Constituent (Circle major & underline modifying)
Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace
Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

STILL POOR VISABILITY

HARD/COMPACT SEDIMENT REPORTED DURING PRE-PLACEMENT INSPECTION.

SUBTRATE OBSERVATIONS

Page 29 of ____

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 31 / 17	SUBTIDAL/ENR	61

<table>
<tr><th rowspan="2">Weather</th><th rowspan="2">Initials</th><th rowspan="2">Diver Initials</th><th rowspan="2">Buoy Deploy Time</th><th colspan="3">Water Depth</th><th rowspan="2">SPME Time</th></tr>
<tr><th>Depth</th><th>f</th><th>t</th></tr>
<tr><td>PARTIAL CLOUDS/ SUNNY/ 40's</td><td>RM</td><td>VG</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1221

STAKE: ☐ Deploy ☐ Monitor

Height: 9" & 10" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ________

☐ Piddock Clam

☐ ________

☐ ________

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ________

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ________ ________

☐ Ripples ________ ________

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☑ No

Sediment Sample: ☐ Yes ☒ No

Comments:

COUPLE PROBES 9" & 10"

POOR VIS.

Substrate Observation Form.xlsx

SUBTRATE OBSERVATIONS

Page 30 of 31

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 31 / 17	SUBTIDAL / ENR	75

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth			SPME Time
				Depth	f	t	
PARTIAL CLOUDS / SUNNY	KM	VG					

SPME: ☐ Deploy ☐ Recover

PHOTO: ☒ 1239

STAKE: ☐ Deploy ☐ Monitor

Height: 16" PROBE

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____

☐ Piddock Clam

☐ NONE OBSERVED

☐ ____

Debris: ☐ Logs ☐ Sticks

☐ Concrete ☐ Tire ☐ Riprap

☐ Lumber ☐ Metal ☐ Cable

☐ ____

Terrain: **Height:** **Spacing:**

☒ Flat

☐ Hummocks ____ ____

☐ Ripples ____ ____

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☒ No

Sediment Sample: ☐ Yes ☒ No

Comments:

* POOR VIS.

SUBTRATE OBSERVATIONS

Page 31 of 31

Project Name	Date (mm/dd/yy)	Subplot Area	Station Identification Number
Lower Duwamish ENR/ENR+AC Pilot Study	1 / 31 / 17	SUBTIDAL/ENR	67

Weather	Initials	Diver Initials	Buoy Deploy Time	Water Depth Depth	f	t	SPME Time
CLEAR/SUNNY/ WINDY/ 40s	RM	N.B		38			

SPME: ☐ Deploy ☐ Recover

PHOTO: ☐ 1321

STAKE: ☐ Deploy ☐ Monitor

Height: 6"

Surficial sediment characteristics:

Biological: ☐ Algae % cover: ____ ☐ Piddock Clam ☐ ____ ☐ ____

Debris: ☐ Logs ☐ Sticks ☐ Concrete ☐ Tire ☐ Riprap ☐ Lumber ☐ Metal ☐ Cable ☐ ____

Terrain: ☐ Flat ☐ Hummocks ☐ Ripples

Height:

Spacing:

Major Constituent **(Circle major & underline modifying)**

Fine [✓ Medium] Coarse Boulder Cobble Gravel [✓ Sand] Silt Clay

Minor Constituent with trace

Fine Medium Coarse Boulder Cobble Gravel Sand Silt Clay

Total SPME(s): ☐

Pore Water Sample: ☐ Yes ☐ No

Sediment Sample: ☐ Yes ☐ No

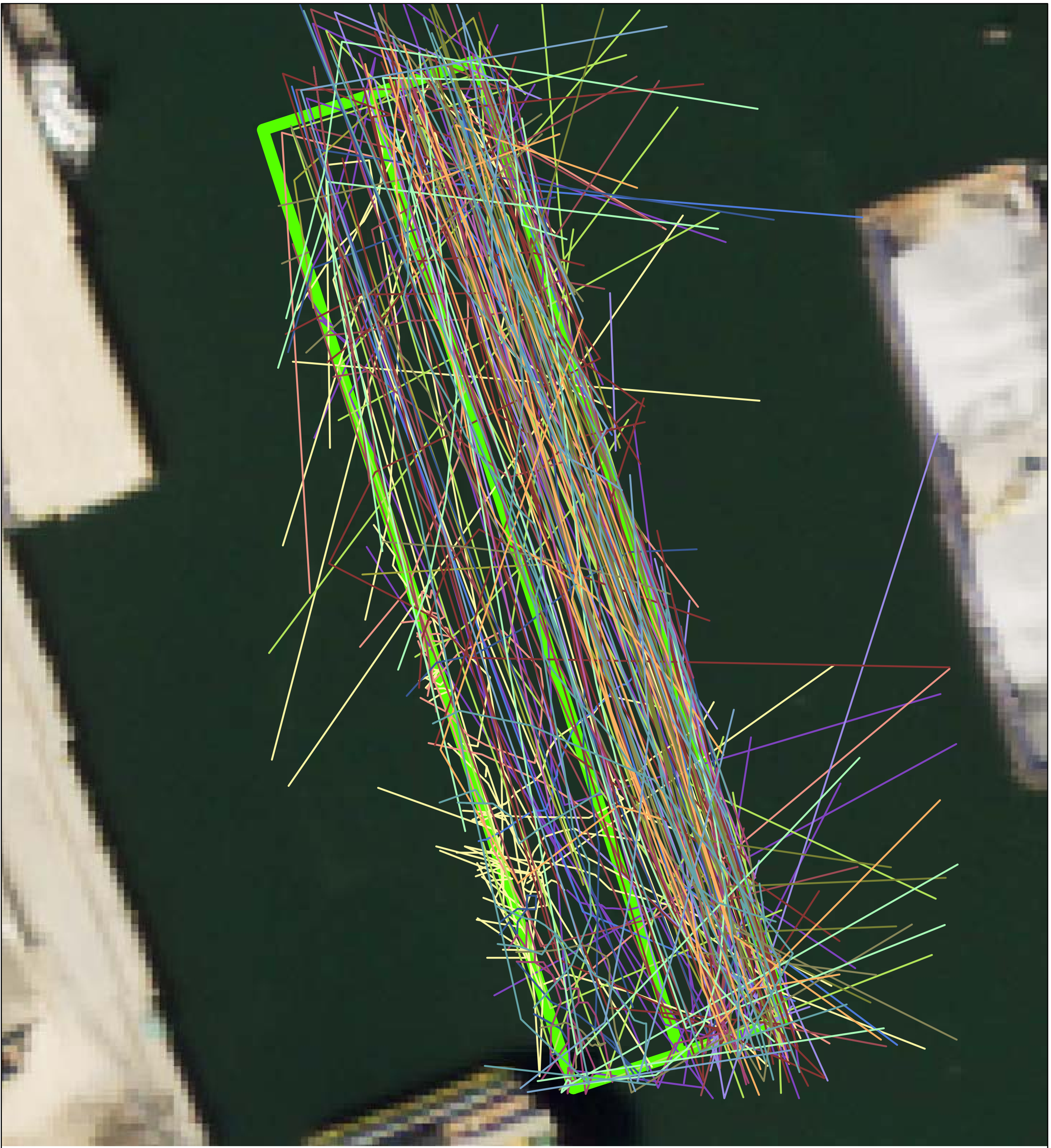
Comments:

COLLECTED OBSERVATIONS ON 1/30/17. DIVER COULDNT FEEL CHANGE WHEN PROBING & DIDN'T GET PROBE DEPTH. USE UNIVERSAL CORE HEAD TO GET ~~VISABLE~~ VISUAL OF CAP THICKNESS @ STA 67.

ONE CORE w/ RECOVERY. TOOK PHOTOS ON SURFACE & w/ DIVER.

ATTACHMENT 10

Vessel Traffic Over Subtidal Plot



King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 9 - 26, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
1

March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_AllTracks_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan09_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

▬ Subtidal Plot   ▬ Vessel Track Lines

Note: Nine vessels crossed the
Subtidal Plot on January 9.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 9, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
2
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

Note: Four vessels crossed the
Subtidal Plot on January 10.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 10, 2017

DALTON OLMSTED FUGLEVAND

FIGURE
3
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan10_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan11_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

Subtidal Plot

Vessel Track Lines

Note: Six vessels crossed the
Subtidal Plot on January 11.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

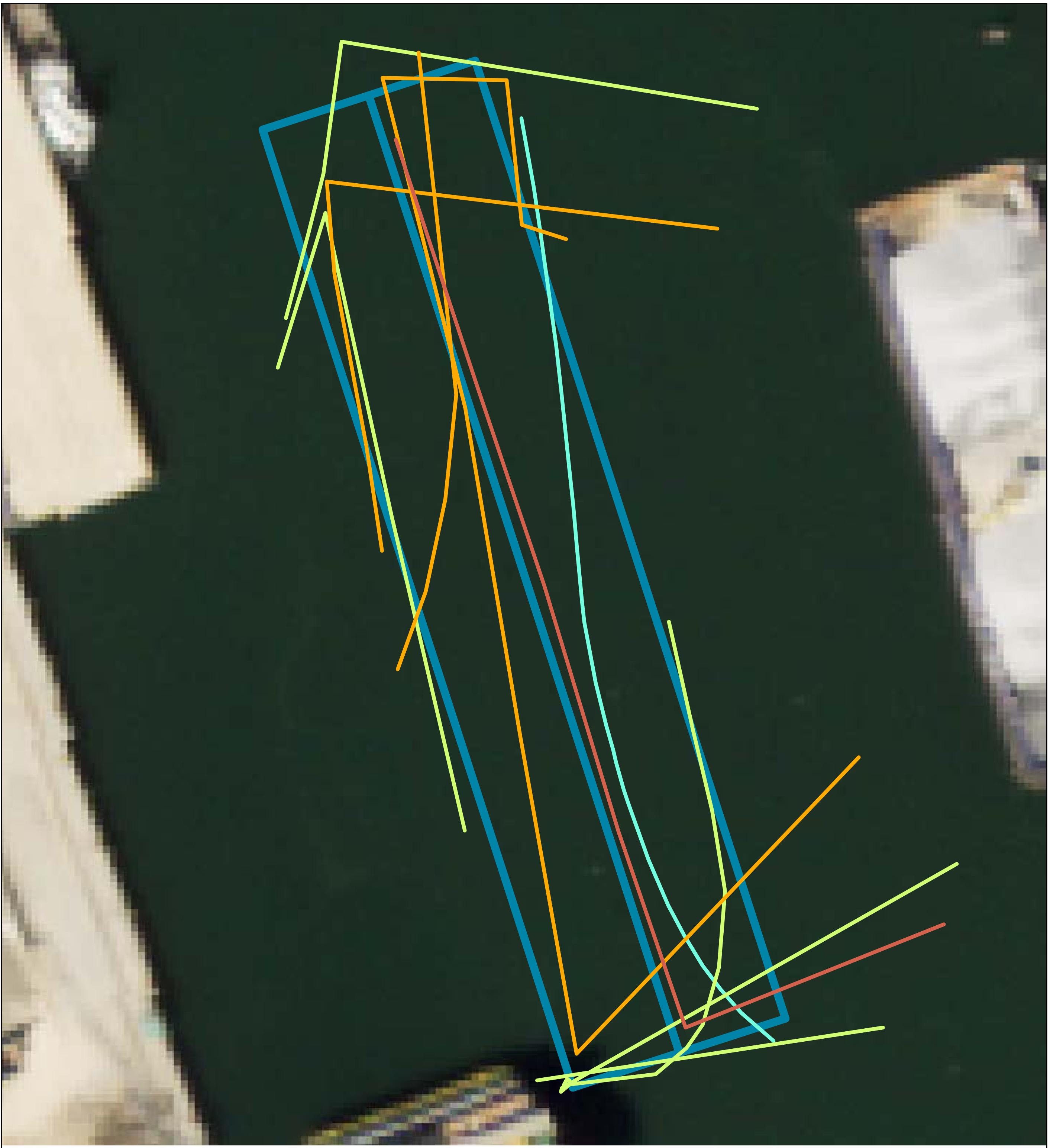
Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 11, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
4
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System



Legend

Subtidal Plot

Vessel Track Lines

Note: Four vessels crossed the Subtidal Plot on January 12. Destinctions were not made for vessels that may have crossed the Subtidal Plot multiple times on the same day.

N

0 100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 12, 2017

DALTON
OLMSTED
FUGLEVAND

FIGURE
5
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan12_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

▬ Subtidal Plot

▬ Vessel Track Lines

Note: Six vessels crossed the
Subtidal Plot on January 13.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 13, 2017

DALTON OLMSTED FUGLEVAND

FIGURE
6
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan13_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan14_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

Subtidal Plot   Vessel Track Lines

Note: Four vessels crossed the
Subtidal Plot on January 14.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0   100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

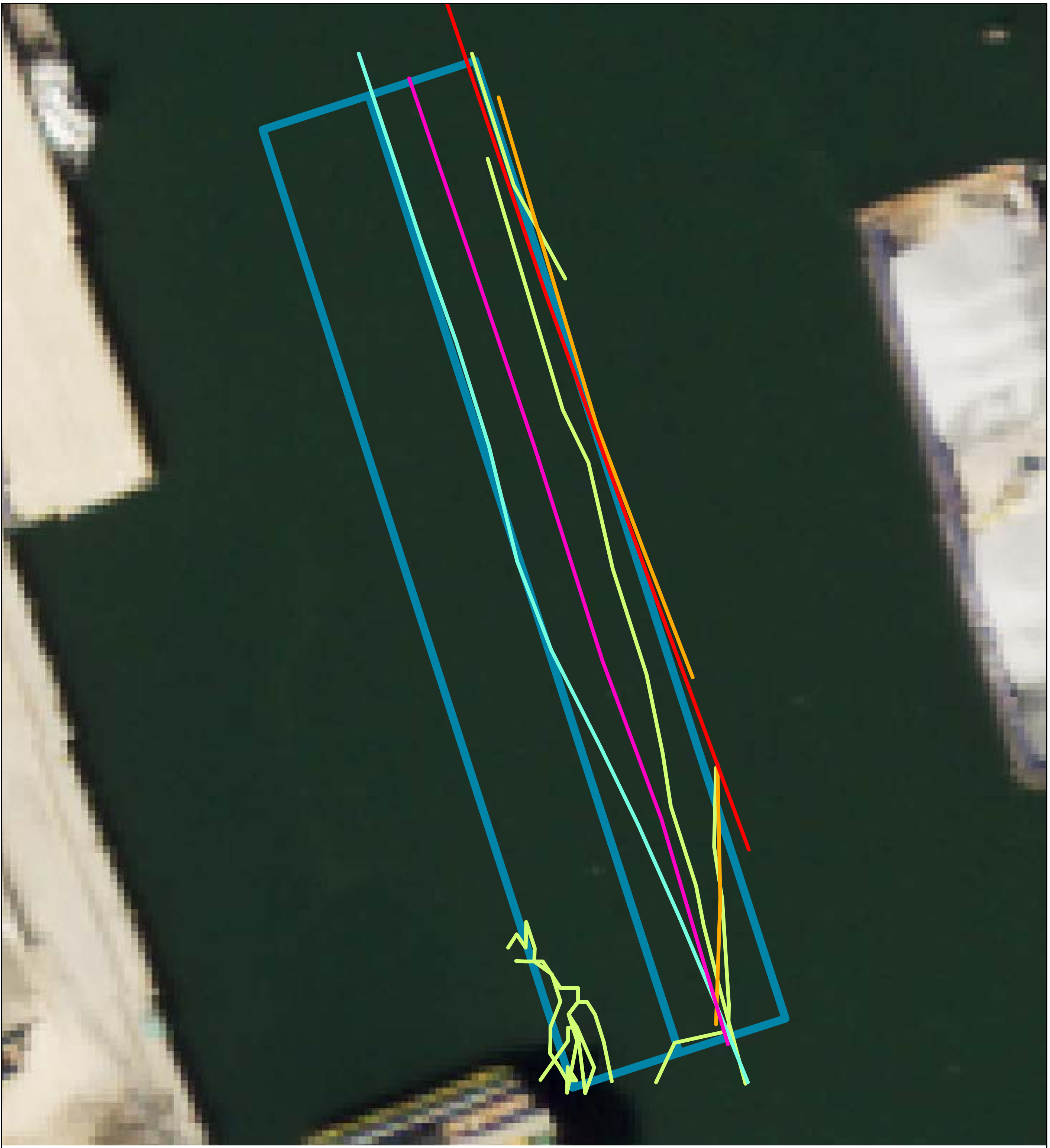
Vessel Traffic Over Subtidal Plot
January 14, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
7
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan15_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet



Legend

Subtidal Plot

Vessel Track Lines

Note: Five vessels crossed the Subtidal Plot on January 15. Destinctions were not made for vessels that may have crossed the Subtidal Plot multiple times on the same day.

N

0 100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 15, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
8
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan16_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

▬ Subtidal Plot ▬ Vessel Track Lines

Note: Three vessels crossed the
Subtidal Plot on January 16.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 16, 2017

DALTON
OLMSTED
FUGLEVAND

FIGURE
9
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

Legend

Subtidal Plot

Vessel Track Lines

Note: Nine vessels crossed the
Subtidal Plot on January 17.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0
100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

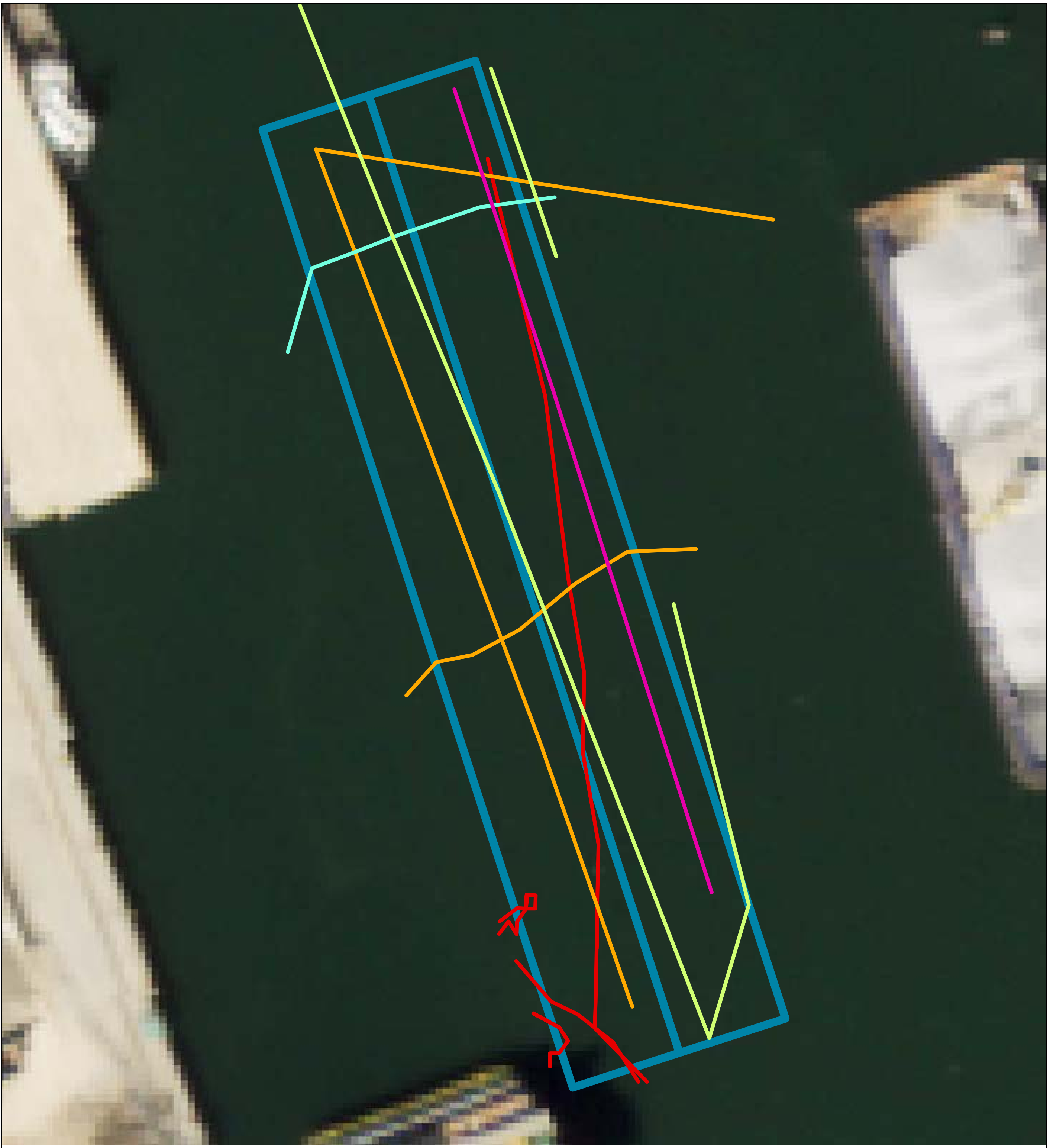
Vessel Traffic Over Subtidal Plot
January 17, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
10
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan17_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet



Legend

▬ Subtidal Plot

▬ Vessel Track Lines

Note: Five vessels crossed the
Subtidal Plot on January 18.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 18, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
11

March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan18_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan19_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

▬ Subtidal Plot

▬ Vessel Track Lines

Note: Four vessels crossed the
Subtidal Plot on January 19.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

DOF DALTON OLMSTED FUGLEVAND

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 19, 2017

FIGURE
12
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan20_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

━ Subtidal Plot ━ Vessel Track Lines

Note: Three vessels crossed the
Subtidal Plot on January 20.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

DOF DALTON OLMSTED FUGLEVAND

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 20, 2017

FIGURE
13
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

Legend

▬ Subtidal Plot

▬ Vessel Track Lines

Note: Five vessels crossed the Subtidal Plot on January 21. Destinctions were not made for vessels that may have crossed the Subtidal Plot multiple times on the same day.

N

0 100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 21, 2017

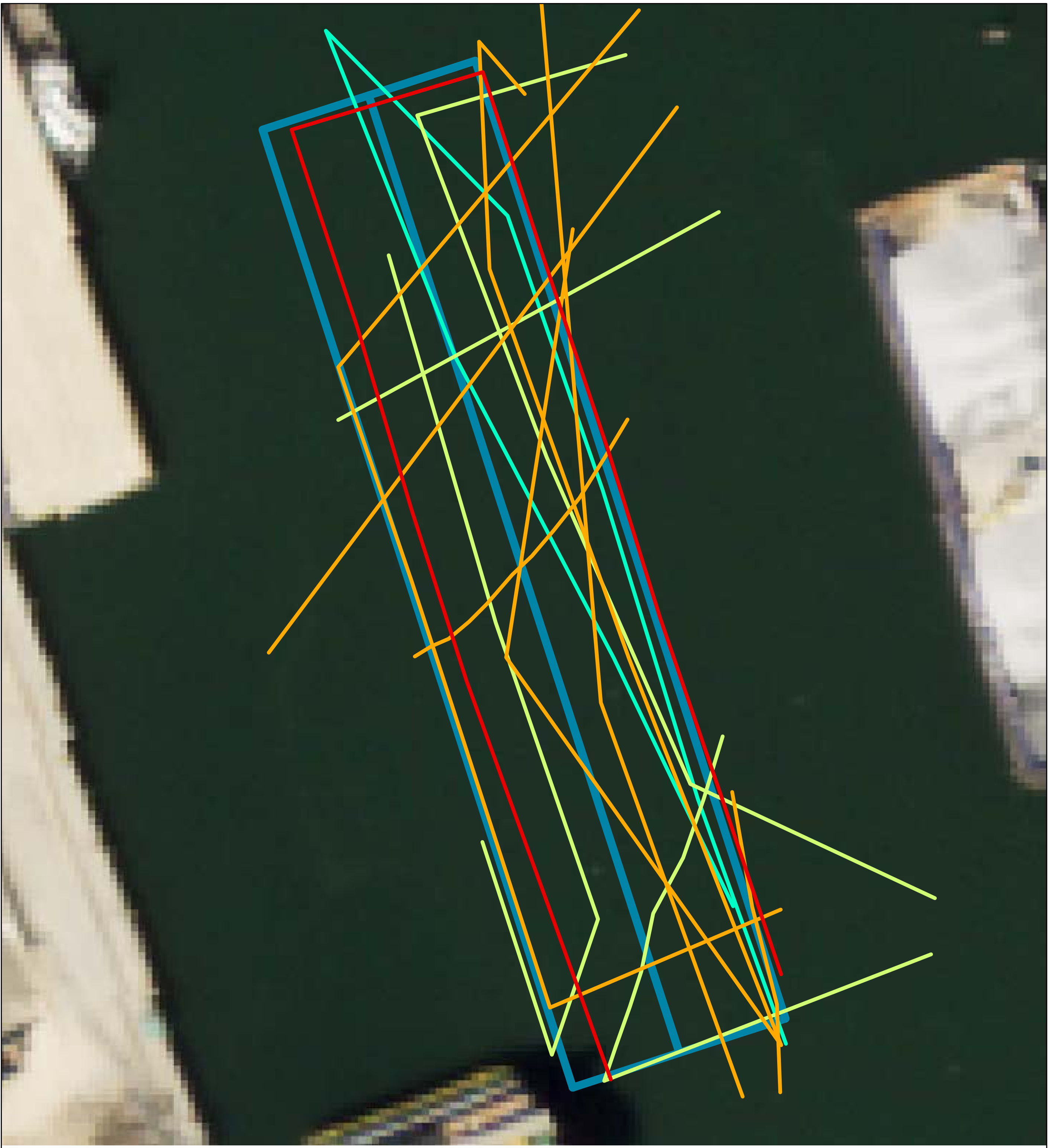
DALTON OLMSTED FUGLEVAND

FIGURE
14
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan21_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan22_20180308.mxd   Orthoimagery courtesy of the USGS; August 7, 2015   Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet



Legend

▬ Subtidal Plot ☰ Vessel Track Lines

Note: Four vessels crossed the
Subtidal Plot on January 22.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 22, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
15
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan23_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

- Subtidal Plot
- Vessel Track Lines

Note: Four vessels crossed the
Subtidal Plot on January 23.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 23, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
16
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan24_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

Subtidal Plot

Vessel Track Lines

Note: Four vessels crossed the
Subtidal Plot on January 24.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 24, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
17
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan25_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Legend

Subtidal Plot

Vessel Track Lines

Note: Six vessels crossed the
Subtidal Plot on January 25.
Destinctions were not made
for vessels that may have crossed
the Subtidal Plot multiple times
on the same day.

N

0 100
Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

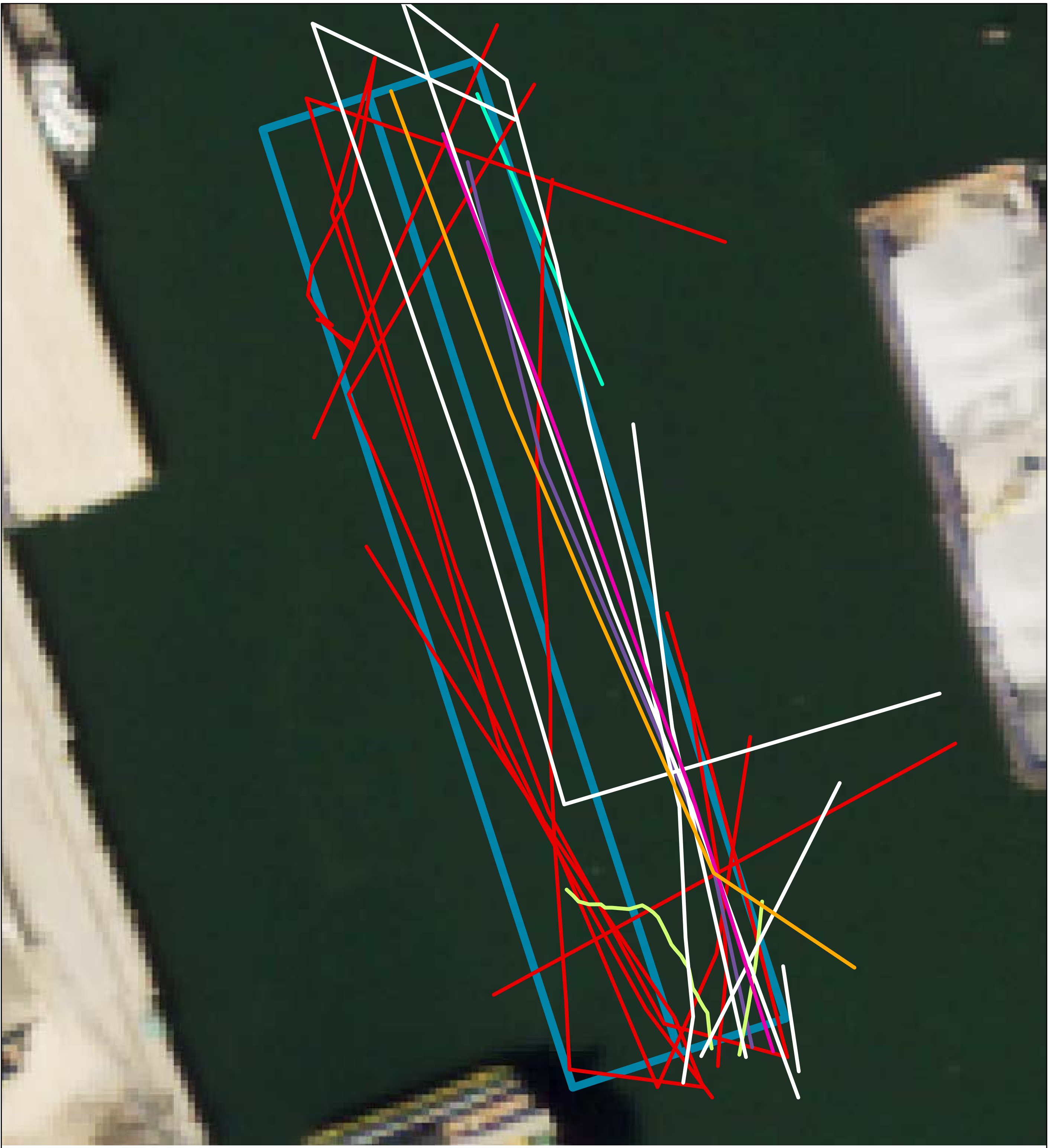
Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 25, 2017

DOF DALTON OLMSTED FUGLEVAND

FIGURE
18
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System



Legend

Subtidal Plot

Vessel Track Lines

Note: Six vessels crossed the Subtidal Plot on January 26. Destinctions were not made for vessels that may have crossed the Subtidal Plot multiple times on the same day.

N

0 100

Scale in Feet

King County Department of Natural Resources & Parks
Wastewater Treatment Division

Enhanced Natural Recovery-Active Carbon Study

Vessel Traffic Over Subtidal Plot
January 26, 2017

DALTON OLMSTED FUGLEVAND

FIGURE
19
March 8, 2018

Vessel data courtesy of the U.S. Coast Guard Navigation Center Automated Identification System

P:\King Cnty ENR\AIS\AIS data package\WorkOrder5224884\GIS\MXD\KingCounty_ENR_Jan26_20180308.mxd Orthoimagery courtesy of the USGS; August 7, 2015 Coordinate System: NAD 1983 StatePlane Washington North FIPS 4601 Feet