SEDIMENT CHARACTERIZATION
BLAIR WATERWAY BERTH MAINTENANCE DREDGING
HUSKY, WASHINGTON UNITED, AND PIERCE COUNTY TERMINALS, TACOMA, WASHINGTON

DATA REPORT
FINAL

MARCH 31, 2021

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TABLE OF CONTENTS

Appendices

List of Tables

List of Figures

ACRONYMS AND ABBREVIATIONS

ARI	Analytical Resources, Inc.
cy	cubic yard
BT	bioaccumulation trigger
CAB	cellulose acetate butyrate
COC	chemical of concern
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DDX	collective reference for DDT, DDE, and DDD
DGPS	differential global positioning system
DL	detection limit
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Program
DMMU	dredged material management unit
EDD	electronic data deliverable
EIM	Environmental Information Management
EMPC	estimated maximum possible concentration
EPA	U.S. Environmental Protection Agency
GIS	geographic information system
GPS	global positioning system
HPAH	high molecular weight polycyclic aromatic hydrocarbon
LPAH	low molecular weight polycyclic aromatic hydrocarbon
MDL	method detection limit
ML	maximum level
MLLW	Mean Lower Low Water
MRL	method reporting limit
ND	non-detected
NOAA	National Oceanic and Atmospheric Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCT	Pierce County Terminal
Q	lab qualifier
QC	quality control
RL	reporting limit
RPD	relative percent difference
R/V	research vessel
SAP	Sampling and Analysis Plan
SL	screening level
SVOC	semi-volatile organic compound
TEF	toxic equivalency factor
TEQ	toxic equivalent

TOC	total organic carbon
TVS	total volatile solid
VQ	validation qualifier
WGS84	World Geodetic System
WUT	Washington United Terminal

1.0 INTRODUCTION

The Port of Tacoma (Port) is evaluating maintenance dredging of berthing areas of Husky Terminal (Husky), Washington United Terminal (WUT), and Pierce County Terminal (PCT) in the Blair Waterway, Tacoma, Washington (Figure 1) to restore the berths to their authorized depth of -51 ft Mean Lower Low Water (MLLW). The Port applied for Corps permits for this work on October 22, 2020 under Corps reference number NWS-2020-1017-WRD.

This document provides the results of the Dredged Material Management Program (DMMP) sediment characterization performed by the Port in October 2020. This characterization study was conducted following the Blair Berth Dredging Sediment Characterization, Husky, Washington United, and Pierce County Terminals, Washington, Sampling and Analysis Plan (SAP) (Appendix A, NewFields and Leon Environmental 2020). The SAP described the overall study design including the dredged material management unit (DMMU) designations and proposed sampling locations, sediment collection methods, chemical analysis, and data reporting requirements.

The following sections provide an overview of the project, a brief description of the sample collection methods, modifications or deviations to the sampling plan, a summary of the actual sampling locations and depths, the results of the chemical analysis, a comparison of the data results to DMMP guidelines, and a summary of quality control data for conventional and chemistry testing, including validation results. Biological testing was not proposed or conducted for this characterization. The full list of appendices includes: the final DMMP-approved SAP (Appendix A); the field logbooks, sediment and container logs, and core photos (Appendix B, electronic copy only); the analytical laboratory reports and chain-of-custody forms (Appendix C, electronic copy only); data validation reports (Appendix D); the results of chemical analyses reported in Environmental Information Management (EIM) format (Appendix E, electronic copy only); and the forensic analysis of the dioxin/furan congener results (Appendix F).

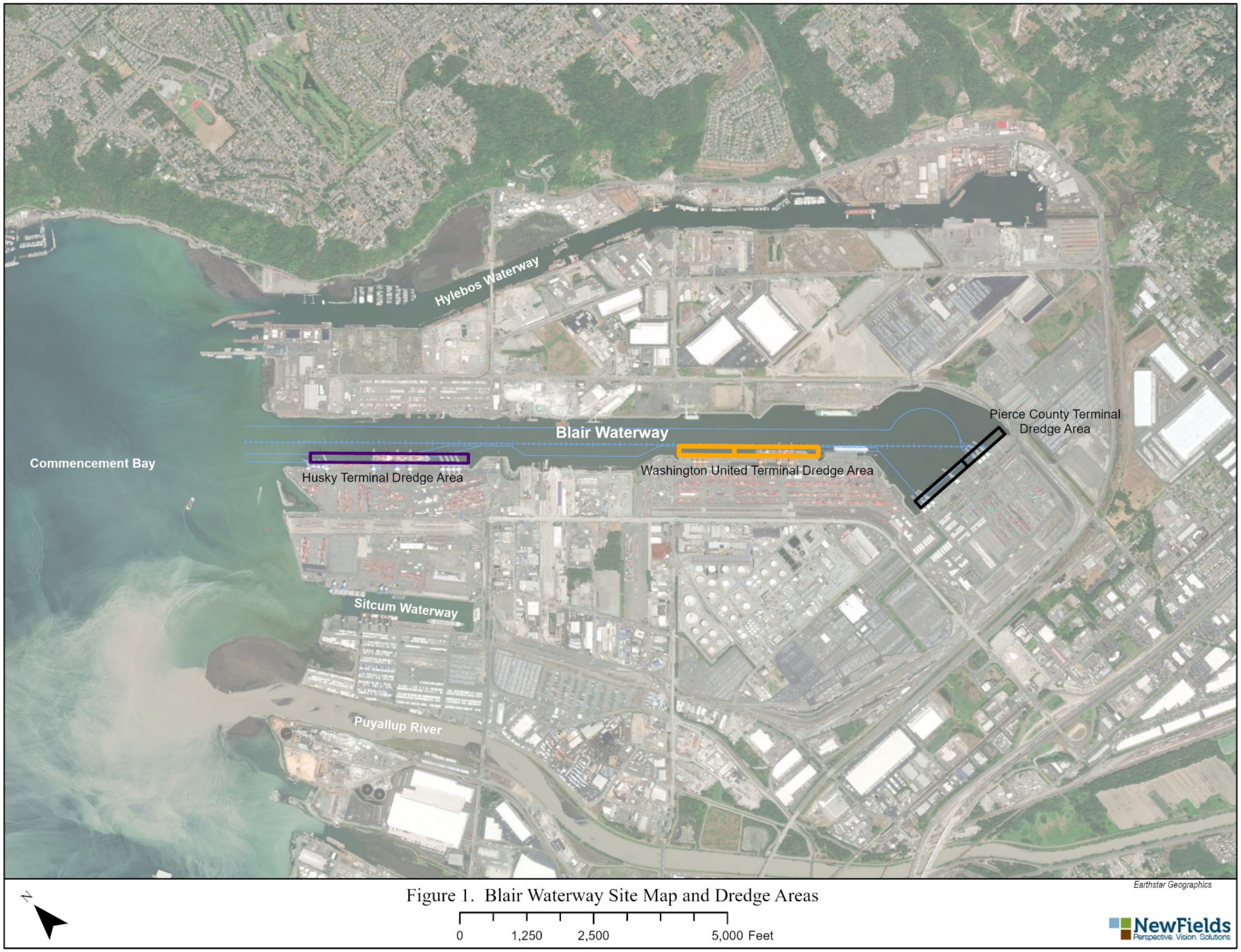

Figure 1. Blair Waterway Site Map and Dredge Areas

1.1 Project Overview

The total dredged material volume in the three berthing areas to restore the bottom elevation to −51 ft. Mean Lower Low Water (MLLW) plus 1 foot of overdepth was originally estimated at 38,152 cubic yards (cy) (Table 1), based on a simple Geographic Information System (GIS) geometric estimate. The Port updated these volume estimates based on engineered dredging prisms that were prepared after sampling. In contrast to the engineered dredging prism volume estimates provided in this data report, the simple geometric calculation used to prepare the SAP volume estimates does not consider the sloughing that will occur until side slopes reach a stable angle of repose; therefore, the engineered dredging volume estimate exceeds the initial geometric estimate. Because the dredging prism at Husky is long and narrow, sloughing will represent a much larger component of total dredging volume than at WUT. The Port also decided against dredging the berthing areas at PCT. The total dredged material volume in the two remaining berthing areas (Husky and WUT) based on engineering calculations was 26,890 cy (Table 1). Due to the conservative sample collection framework implemented, sufficient samples were collected to meet DMMP sampling guidelines for the updated volumes.

The DMMP project-specific ranking for dredging projects in Blair Waterway, excluding the federal navigation channel, is classified as variable (based on location and project) (DMMP 2018). For the recent advisory evaluation of the Tacoma Harbor Feasibility Study in the Blair Waterway (DMMP 2019), the DMMP ranked the channel as low-moderate and the side slopes as moderate. The sampling design for this study used a moderate project ranking, which required a minimum of one sample for every 4,000 cy of material and a surface DMMU size of up to 16,000 cy of material for heterogeneous sediment conditions (DMMP 2018). Only surface DMMUs were required.

This sediment characterization study was designed as a chemistry-only evaluation for suitability determination. Material found suitable for open-water disposal will be taken to the Commencement Bay DMMP disposal site.

Table 1. Project Dredged Material Volumes

Terminal	Berthing Depth (ft. MLLW)	Dredge Volume to Berthing Depth (cy)	Dredge Volume 1-foot Overdepth (cy)	Total Volume (cy)
Initial Volume Estimates				
Husky	−51	2,530	2,250	4,780
WUT	−51	11,440	6,381	17,821
PCT	−51	~~8,970~~ N/A	~~6,581~~ N/A	~~15,551~~ N/A
Total Volume (cy)		~~22,940~~ 13,970	~~15,212~~ 8,631	**~~38,152~~ 22,601**
Final Engineered Volume Calculations				
Husky	−51	5,830	2,250	8,080
WUT	−51	12,440	6,370	18,810
PCT	−51	Berthing area will not be dredged at this time		
Total Volume (cy)		18,270	8,620	**26,890**

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2.0 Data Collection and Analysis Methods

This section briefly describes the methods for positioning, sample collection, processing, and laboratory analysis for the Blair berth dredging sediment characterization. The study design and detailed methods are provided in the SAP (Appendix A). Deviations from the SAP are summarized in Section 2.6.

2.1 Sediment Sampling Overview

Sediment sampling activities were conducted in the Blair berthing areas from October 5 through 8, 2020. The research vessel (R/V) *Ingalls*, a 36-foot aluminum landing craft owned and operated by Gravity Marine Services (Gravity), was the platform used for the sediment core collection. Sediment cores were collected using vibracore samplers (VIC 5500 and RIC 5500 units) also provided by Gravity.

Vibracores were transferred to a shore-based team at the Port of Tacoma Administration Building parking lot for processing, compositing, and sample collection. Personnel from NewFields were responsible for evaluating, compositing, and transferring sediment samples to appropriate containers on shore, while personnel from Gravity and Leon Environmental operated the vibracorer and measured water depth and core penetration under the direction of the NewFields field lead.

2.2 Navigation and Positioning

Geographic station positioning was accomplished using an onboard Differential Global Positioning System (DGPS) with the antenna for the onboard GPS receiver located on the sampler deployment A-frame. The mudline elevation at each sampling location was determined using a lead line. Real-time tidal corrections were applied using water level measurements from the National Oceanic and Atmospheric Administration (NOAA) Tacoma, WA tide station (Station ID: 9446484). Details regarding navigation and positioning methods are provided in the SAP (Appendix A).

The actual sampling coordinates, DMMU compositing scheme, water depth (with tidal stage), and mudline elevations are provided in Table 2. Figures 2 through 4 display the DMMU configurations and actual sampling locations for Husky, WUT, and PCT, respectively.

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Table 2. DMMUs, Sample Locations, Actual Sampling Coordinates, Mudline, and Sample Elevations

Surface DMMU	Estimated Volume (cy)	Sample Location	Core Processed[a]	Date (mm/dd/yyyy)	Time (hh:mm)	State Plane WA-S, WGS84		Latitude (N) WGS84	Longitude (W) WGS84	Core Penetration (ft.)	Core Recovery (ft.)	Recovery (percent)	Measured Water Depth (ft.)	Tidal Height (ft.)	Mudline (ft. MLLW)	Surface DMMU (ft. MLLW)		"Pseudo" Z-sample (ft. MLLW)		Z-sample (ft. MLLW)		Z2-sample (ft. MLLW)	
						Northing	Easting									Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom
Husky Terminal																							
HSK-1	8,080	H1	Core 2 of 2	10/05/2020	10:32	1165738.67	714282.24	47.27621350	122.41239906	3.4	3.2	94	-59.8	9.4	-50.4	-50.4	-52.0			-52.0	-53.6		
		H2	Core 1 of 3	10/05/2020	11:22	1166112.82	713911.60	47.27522249	122.41085609	2.5	2.2	88	-57.6	8.0	-49.6	-49.6	-51.8	-50.8	-51.8				
		H3	Core 1 of 1	10/05/2020	14:05	1166573.90	713486.19	47.27408712	122.40895777	3.2	3.0	94	-55.6	5.0	-50.6	-50.6	-52.0			-52.0	-53.6		
		H4	Core 3 of 3	10/05/2020	16:15	1166972.61	713099.61	47.27305401	122.40731447	2.6	2.0	77	-57.1	6.7	-50.4	-50.4	-52.0			-52.0	-52.4		
Washington United Terminal																							
WUT-1	9,233	W1	Core 3 of 3	10/07/2020	15:40	1170667.06	709747.58	47.26411054	122.39211288	5.0	8.5	>100	-56.1	6.8	-49.3	-49.3	-52.0			-52.0	-54.0	-54.0	-57.8
		W2	Core 2 of 2	10/08/2020	09:00	1170779.98	709641.49	47.26382719	122.39164798	3.8	3.1	82	-60.0	9.6	-50.4	-50.4	-52.0			-52.0	-53.5		
		W3	Core 2 of 3	10/08/2020	10:15	1171156.28	709435.24	47.26328661	122.39011296	4.5	7.3	>100	-60.1	10.6	-49.5	-49.5	-52.0			-52.0	-54.0	-54.0	-56.8
WUT-2	9,577	W4	Core 3 of 3	10/06/2020	09:30	1171537.03	708882.61	47.26179693	122.38852665	4.5	3.7	82	-59.7	10.5	-49.2	-49.2	-52.0	-51.0	-52.0	-52.0	-52.9		
		W5	Core 3 of 4	10/06/2020	11:30	1171763.39	708809.83	47.26161231	122.38760827	4.5	3.4	75	-56.1	8.6	-47.5	-47.5	-50.9	-49.9	-50.9				
		W6	Core 3 of 3	10/06/2020	14:20	1171891.73	708723.03	47.26138282	122.38708319	6.0	5.0	83	-53.7	6.0	-47.7	-47.7	-52.0	-51.0	-52.0	-52.0	-52.7		
Pierce County Terminal																							
PCT-1	7,139	P1	Core 1 of 3	10/07/2020	08:35	1173073.54	706084.71	47.25422893	122.38207150	5.5	8.0	>100	-59.4	10.1	-49.3	-49.3	-52.0			-52.0	-54.0	-54.0	57.3
		P2	Core 2 of 2	10/07/2020	10:30	1173280.74	706171.16	47.25447943	122.38124569	4.5	4.3	96	-60.0	10.4	-49.6	-49.6	-52.0			-52.0	-53.9		
		P3	Core 3 of 3	10/06/2020	17:15	1173843.31	706119.44	47.25437444	122.37897601	4.2	3.7	88	-58.0	8.2	-49.8	-49.8	-52.0			-52.0	-53.5		
PCT-2	8,412	P4	Core 1 of 1	10/07/2020	12:20	1174421.91	706059.28	47.25424731	122.37664099	8.0	8.2	>100	-55.9	8.8	-47.1	-47.1	-52.1			-52.1	-54.1	-54.1	-55.3
		P5	Core 1 of 1	10/07/2020	13:05	1174861.40	706106.05	47.25440415	122.37487624	5.0	7.7	>100	-57.2	8.0	-49.2	-49.2	-52.0			-52.0	-54.0	-54.0	-56.9
		P6	Core 1 of 1	10/07/2020	13:50	1175118.80	705997.73	47.25412402	122.37382967	7.0	9.5	>100	-54.5	7.4	-47.1	-47.1	-52.0			-52.0	-54.0	-54.0	-56.5

a. Core that was processed and the number of coring attempts.

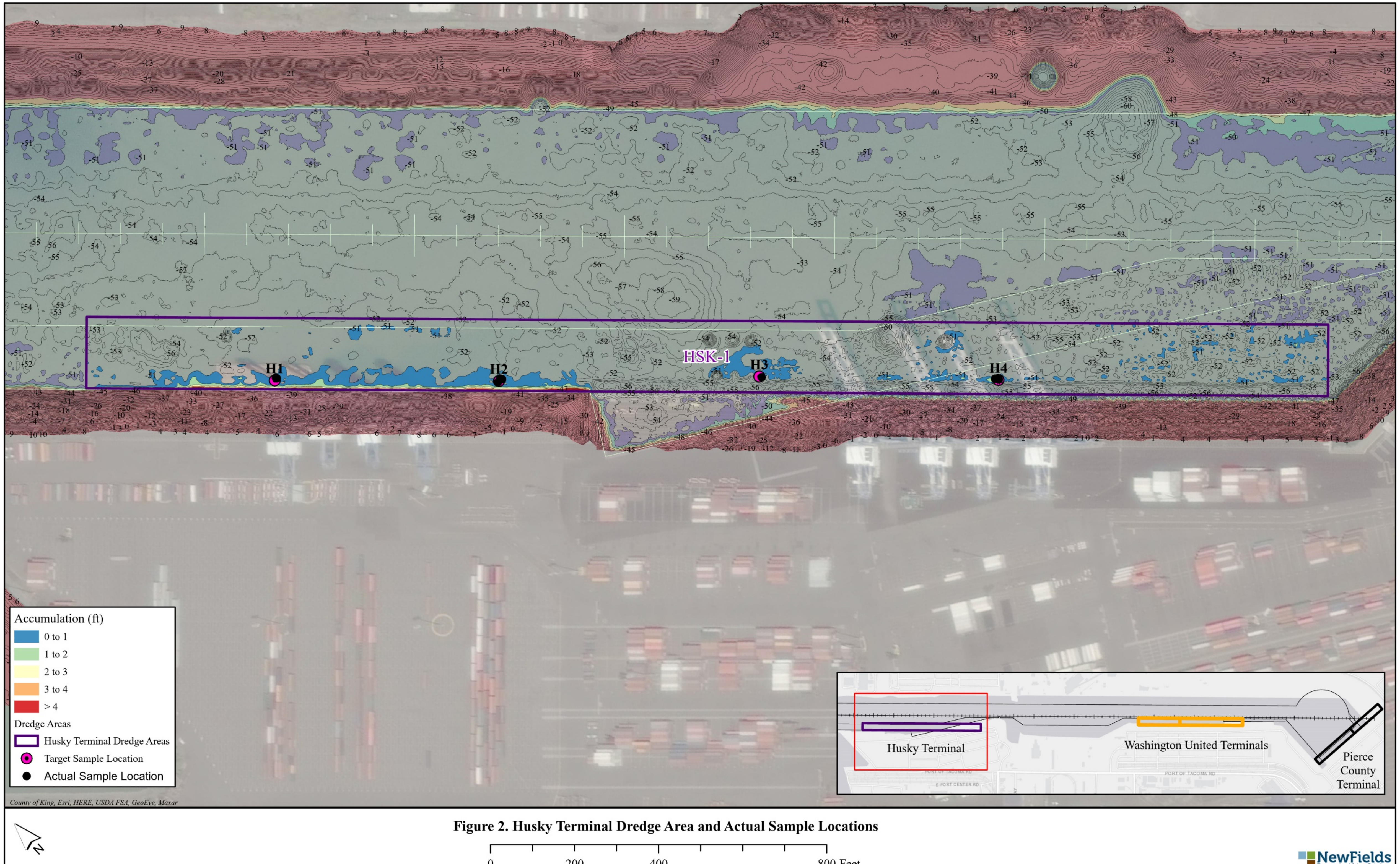

Figure 2. Husky Terminal Dredge Area and Actual Sample Locations

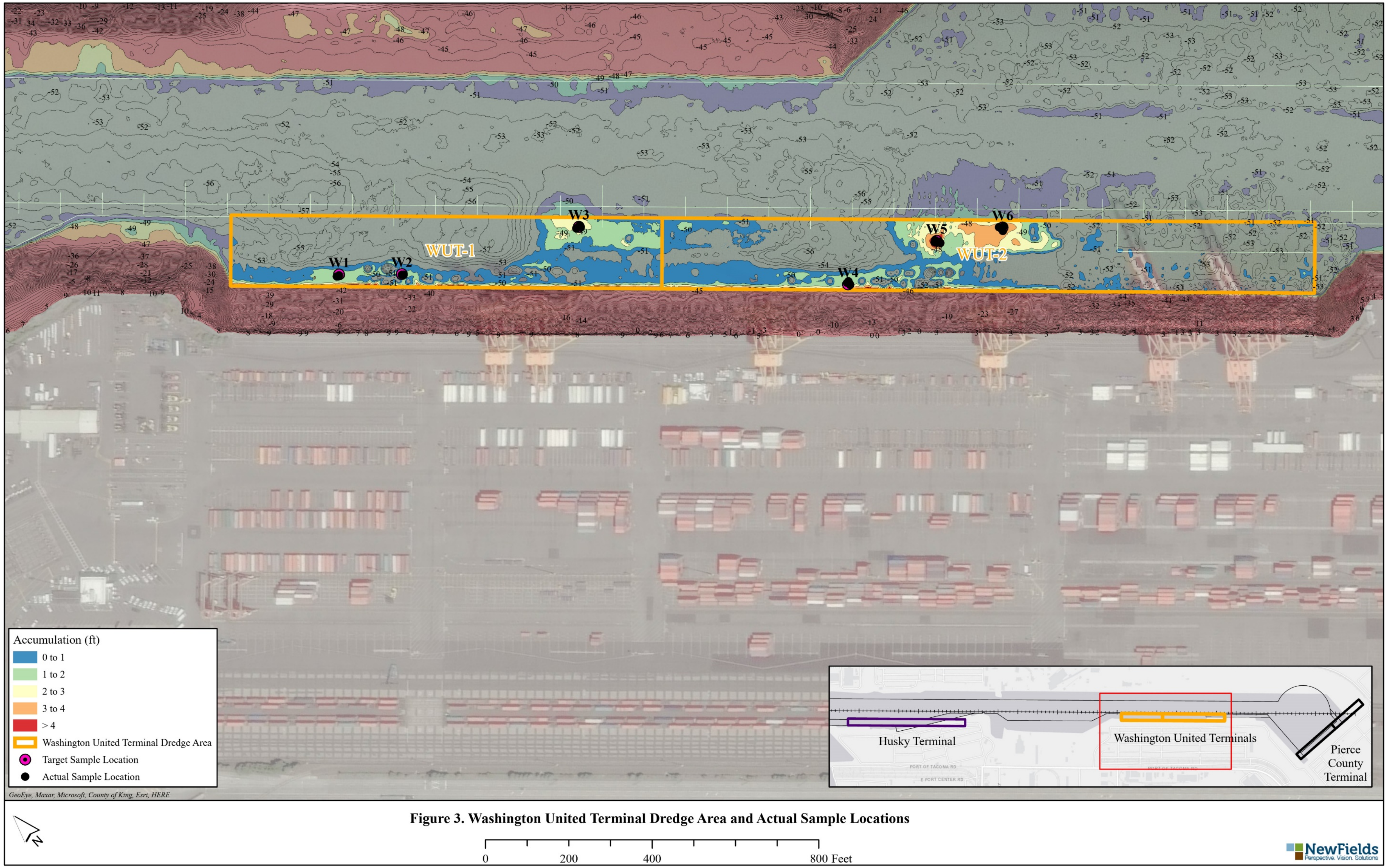

Figure 3. Washington United Terminal Dredge Area and Actual Sample Locations

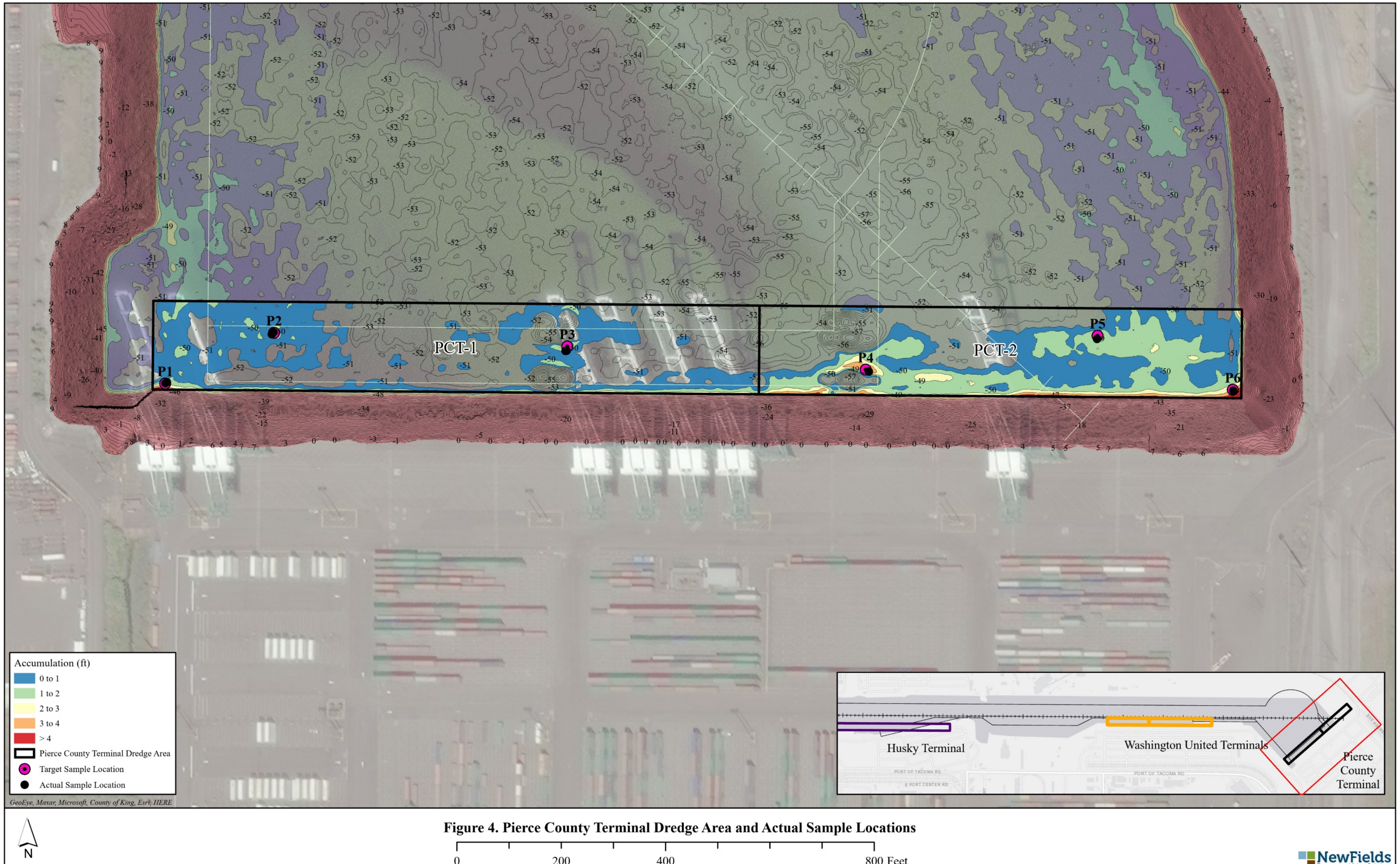

Figure 4. Pierce County Terminal Dredge Area and Actual Sample Locations

2.3 DMMUs and Sampling Locations

The project sediment characterization areas were ranked moderate based on DMMP guidelines (DMMP 2018, 2019). The minimum number of DMMUs and samples under a moderate ranking includes one field sample for every 4,000 cy, one DMMU for every 16,000 cy of surface sediment. Subsurface DMMUs were not required for this characterization study. Figures 2 through 4 display the actual sampling locations for Husky, WUT, and PCT, respectively. The dredged material characterization consisted of one DMMU for Husky, two DMMUs for WUT, and two DMMUs for PCT.

The updated volume calculations at Husky and WUT did not affect the number of DMMUs required for this characterization. Similarly, increasing the total volume to be dredged at WUT from 17,821 cy to 18,810 cy did not affect the number of field samples required; however, increasing the total volume to be dredged at Husky from 4,780 cy to 8,080 cy increased the number of required field samples from two field samples to three field samples. Because the Port collected more samples than the minimum required under typical DMMP guidelines, sufficient field samples were collected to fully characterize the updated volumes at all DMMUs. This information is summarized in Table 3.

Table 3. DMMU and Field Sample Requirements by Volume

Terminal	Initial Vol. Estimate			Final Engineered Vol. Calculation			Field Samples Collected
	Initial Volume Estimate	DMMUs	Field Samples Required	Final Volume Calculation	DMMUs	Field Samples Required	
Husky	4,780	1	2	8,080	1	3	4
WUT	17,821	2	5	18,810	2	5	6
PCT	15,551	2	4	N/A	N/A	N/A	6

All retained vibracores were collected within 10 feet (3 meters) of target sampling locations. Geographic coordinates for the actual sampling locations are provided in Table 2.

The sediment characterization in all berthing areas was to −52 ft. MLLW, which includes the maintained depth (−51 ft. MLLW) plus 1 foot of overdepth (see Table 2). Four vibracore locations were occupied within the Husky project area (Figure 2) and six vibracores each were occupied within the WUT and PCT project areas (Figures 3 and 4). Due to refusal, some vibracores could not be advanced to −54 ft. MLLW to obtain 2-foot Z-samples, as noted in Section 2.6.

2.4 Sample Collection Methods

A summary of the sample collection methods is provided in this section. The detailed methods are described in the SAP (Appendix A).

2.4.1 Vibracore Samples

Core samples were collected using Gravity's VIC 5500 vibracorer or RIC 5500 vibracorer. The units were equipped with pre-cleaned cellulose acetate butyrate (CAB) core barrels lined with a soft polyethylene plastic liner. The core tubes were 4 inches in diameter.

The vibracore was mechanically lowered into position on the seafloor, activated, and allowed to penetrate to the target sampling depth or refusal. A measurement tape was attached to the corer head to monitor real-time depth penetration. Measurements at the water line were noted at the start and end of sampling to determine the depth of core penetration. Once sampling was complete, the vibracore was retrieved and the core tube removed from the vibracore head. The condition and quantity of material within the core was then inspected to determine acceptability. If a core was deemed acceptable, the core tube was capped on both ends, secured with duct tape, and labeled with the station and replicate number. A sediment recovery of at least 75 percent of the penetration depth was achieved for each retained core.

Core samples were transported to a shore-side location for processing. Overlying water was decanted, the core catcher removed, the top and bottom of the polyethylene liner were sealed closed with zip ties, and the core sample (liner with retained sediment) was removed from the CAB core tube and placed on a processing tray. The polyethylene liner was opened using a utility knife and the sediment core was then split lengthwise using a pre-cleaned stainless-steel spatula. Once opened, the sediment was inspected, measured, described in a core log, and photographed. Core logs and photographs are provided in Appendix B.

Cross-sectional cuts were made along the core at the appropriate depths for the DMMUs and Z-samples. Depth-proportional volumes of sediment were removed from each core interval comprising a DMMU composite. In other words, approximately equal volumes of sediment were removed from each foot of core. Sediment was collected from throughout the entire acceptable sample, except for sediment coming in direct contact with the polyethylene liner.

If all core intervals for a DMMU composite were not collected in one day, the sediment from each core interval sample was placed in a polyethylene bag, labeled with the core sample number, sealed with limited headspace, and stored overnight on ice in coolers while in the field.

Once the sediment from all core intervals comprising a DMMU was collected, the sample was homogenized in a pre-cleaned stainless-steel bowl with a pre-cleaned stainless-steel spoon until a consistent sediment color and texture was achieved. Aliquots of the homogenized sediment were placed in the appropriate pre-cleaned containers for chemical and conventional testing. Archive samples (8-oz. jar) were also collected from each individual core interval used in each DMMU and Z-samples.

Excess sediments from core processing at the shore-side location were retained in a 55-gallon drum and were properly disposed by the Port of Tacoma following receipt of the analytical laboratory results.

2.5 Chemical Analytical Methods

The specific conventional and chemical analyses that were measured, sample preparation methods, analytical methods, target reporting limits (RLs) are discussed in detail in the SAP (Appendix A). All samples were analyzed by Analytical Resources, Inc. (ARI), located in Tukwila, Washington, with the exception of high-resolution organochlorine pesticides (Method 1699), which were analyzed by Vista Analytical Laboratory in El Dorado Hills, California. A list of samples collected and analyzed for the DMMP chemicals of concern (COCs), including tributyltin and dioxins/furans is provided in Table 4.

2.6 Summary of Data Collection Activities and Deviations from SAP

This section provides a summary of the daily sampling and processing activities, as well as any deviations or additions to the field sampling or laboratory testing, relative to those proposed in the SAP (Appendix A).

2.6.1 Summary of Daily Collection Activities

Day 1 (10/5/2020): The shore-side processing area was setup at the Port of Tacoma Administration Building parking lot, and core sampling activities were initiated in proposed dredging areas in the Blair Waterway. Weather conditions were calm with overcast skies. Four sediment cores required for Husky were collected and processed, and DMMU composite HSK-1 was completed.

- Three coring attempts were made at station H2, but refusal was encountered before penetrating the Z-layer. Coarse-grained sediments (sands and large gravels) were present at the base of the core samples. The issue was discussed with the Dredged Material Management Office (DMMO) representative and it was decided to retain sediment from the lower 1 foot of core as a "pseudo" Z-layer archive[1]. The core with the greatest penetration (Replicate 1) was retained for processing.
- Three coring attempts were also made at station H4, but refusal was encountered before meaningful penetration into the Z-layer due to the presence of coarse sand and gravels. The DMMO representative was notified and the core with the greatest penetration (Replicate 3) was retained for processing, and an incomplete Z-layer archive was retained (–52.0 to –52.4 ft. MLLW). H1 and H3 also had incomplete Z-samples (see Table 2).

Day 2 (10/6/2020): Weather conditions were calm with a slight haze and overcast skies. Cores from WUT stations W4, W5, and W6 were collected and DMMU composite WUT-2 was completed. A core from PCT station P3 was collected, processed, placed in a polyethylene bag, and stored overnight on ice in a cooler.

- Three coring attempts each were made at stations W4 and W6. The cores with the greatest penetration at each station were retained for processing. In both cases, the cores penetrated approximately 1 foot into the Z-layer before reaching refusal. The incomplete Z-samples were collected, and 1-foot "pseudo" Z-layer archives were also retained.
- Four coring attempts were made at station W5, but refusal was encountered before penetrating the Z-layer. The core with the greatest penetration (Replicate 3) was retained for processing, and a "pseudo" Z-layer archive was retained.

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[1] If the overlying DMMU is determined to be unsuitable for open-water disposal, the Z-sample is analyzed to characterize the surface exposed after dredging (DMMP 2018). If a Z-layer sample is not available, the "pseudo" Z-layer sample (bottom 1-foot of the DMMU) might be considered for analysis to determine whether the 1-foot of material overlying the exposed surface is considered suitable. This substitution would require DMMP agency approval.

- Three coring attempts were made at station P3, but refusal was encountered before full penetration into the Z-layer. The core with the greatest penetration (Replicate 3) was retained for processing, and an incomplete Z-sample was retained.
- At the end of the day, Gravity delivered an alternate vibracore unit (RIC 5500) that provided a higher impact force than the VIC 5500 vibracore[2]. It was anticipated that the RIC 5500 unit would improve the penetration of the vibracore into the sandy and compact Z-layer sediments.

Day 3 (10/7/2020): Weather conditions were calm with overcast skies. Vibracore unit RIC 5500 was used and cores were collected from PCT stations P1, P2, P4, P5, and P6, and DMMU composites PCT-1 and PCT-2 were completed. A core from WUT station W1 was collected, processed, placed in a polyethylene bag, and stored overnight on ice in a cooler.

- The RIC 5500 vibracore improved core penetration and resulted in >100 percent sample recovery at stations P1, P4, P5, P6, and W1. During core processing, sedimentary layering was visible and remained intact, with slight layer deformation observed in some cores. Sediment core material from below the Z-layer (−52 to −54 ft. MLLW) was retained at these stations as a second Z-layer ("Z2-sample"; material below −54 ft. MLLW).
- Performance of the RIC 5500 vibracore was discussed with Gravity. For the cores with significantly greater than 100 percent recovery, the rate of core penetration generally slowed when reaching the sediments in or near the Z-layer. The locations where this occurred (cores W1, W3, P1, P5, and P6 collected on Days 3 and 4) showed the presence of fine to medium sands at the base of the cores. Although "over recovery" of sediment is not common, Gravity indicated that this could occur in areas of dense sand using a high frequency vibracore head. The high frequency vibration causes the dense sand to expand in volume or 'dilate'. Water fills the pore spaces between the sand grains causing expansion at the head of the corer and forcing sample up the core tube. The intact lithology observed in the cores (see Appendix B) suggested that the sediment collected for the surface DMMU and primary Z-sample for each core was representative of sediment conditions.
- The core sample collected at P2 penetrated slightly less than the target depth of −54.0 ft. MLLW. An incomplete Z-sample (−52.0 to −53.9 ft. MLLW) was retained.

Day 4 (10/8/2020): Weather conditions were calm with overcast skies. Cores from WUT stations W2 and W3 were collected and DMMU composite WUT-1 was completed. The shore-side processing area was demobilized.

- Core recovery at W3 was >100 percent. Sediment core material present below the Z-layer (−52 to −54 ft. MLLW) was retained as a second Z-layer or Z2-sample (material below −54 ft. MLLW). At station W2 an incomplete Z-sample was achieved.

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[2] The Gravity VIC 5550 vibracore has a higher 3500 vibrations per minute, 5500 lbs. of force, and an impact of 30 lbs. per revolution. The Gravity RIC 5500 vibracore has a lower 1500 vibrations per minute, 5500 lbs. of force, but an impact of 60 lbs. per revolution.

2.6.2 Deviations from the SAP

- Vibracore samples were collected with a 4-inch diameter rigid CAB core barrel lined with a polyethylene liner, rather than a metal core tube equipped with a flexible CAB liner as specified in the SAP. Rigid CAB core barrels with polyethylene liners are commonly used for the collection of vibracores and were successfully used in the Blair Waterway for the 2019 Tacoma Harbor Feasibility Study. The rigid CAB core barrels are translucent and allowed rapid visual confirmation of sediment recovery during coring operations.
- Following receipt of the initial chemical analysis results for the DMMU samples, the Port determined that the dioxin/furan concentrations measured in DMMU samples WUT-1, PCT-1, and PCT-2 would benefit from analysis of the individual core samples that comprised the DMMU samples. Individual core sample archived for W1, W2, W3, P1, P2, P3, P4, P5, and P6 were analyzed for dioxins/furans.
- The Port conducted a forensic evaluation of the dioxin/furan congener profiles of the DMMUs and individual core samples (Appendix F).
- The reporting limit for total chlordane was slightly elevated using Method 8081 and non-detects exceeded the screening level (SL) for three DMMU samples. Two DMMU samples (HSK-1 and WUT-2) were reanalyzed for organochlorine pesticides using EPA Method 1699, which provided lower reporting limits than Method 8081. The Port determined that DMMU sample PCT-2 would not require reanalysis for organochlorine pesticides due to the concentrations of dioxins/furans measured in that sample.

Table 4. Summary of Samples Submitted for Chemical Analysis

Sample Delivery Group	Sample ID	Lab ID	Grain Size	Total Solids	Total Volatile Solids	Total Organic Carbon	NH3	Sulfides	Metals	PCB Aroclors	Pesticides (8081)	Pesticides (1699)[a]	Dioxins/ Furans[b]	SVOC	Archive
20J0095/ 20L0034	BW20-HSK-1-C	20J0095-01/ 20L0034-01	X	X	X	X	X	X	X	X	X	X	X	X	X
20J0095	BW20-H1-S	20J0095-03													X
20J0095	BW20-H1-Z	20J0095-04													X
20J0095	BW20-H2-S	20J0095-05													X
20J0095	BW20-H2-Z	20J0095-06													X
20J0095	BW20-H3-S	20J0095-07													X
20J0095	BW20-H3-Z	20J0095-08													X
20J0095	BW20-H4-S	20J0095-09													X
20J0095	BW20-H4-Z	20J0095-10													X
20J0148	BW20-WUT-1-C	20J0148-20	X	X	X	X	X	X	X	X	X		X	X	X
20J0148/ 20L0034	BW20-W1-S	20J0148-17/ 20L0034-09											X		X
20J0148	BW20-W1-Z	20J0148-18													X
20J0148	BW20-W1-Z2	20J0148-19													X
20J0148/ 20L0034	BW20-W2-S	20J0148-24/ 20L0034-11											X		X
20J0148	BW20-W2-Z	20J0148-25													X
20J0148/ 20L0034	BW20-W3-S	20J0148-21/ 20L0034-10											X		X
20J0148	BW20-W3-Z	20J0148-22													X
20J0148	BW20-W3-Z2	20J0148-23													X
20J0095/ 20L0034	BW20-WUT-2-C	20J0095-02/ 20L0034-02	X	X	X	X	X	X	X	X	X	X	X	X	X
20J0095	BW20-W4-S	20J0095-11													X
20J0095	BW20-W4-Z	20J0095-12													X
20J0095	BW20-W4-Z2	20J0095-13													X
20J0095	BW20-W5-S	20J0095-14													X
20J0095	BW20-W5-Z	20J0095-15													X
20J0095	BW20-W6-S	20J0095-16													X
20J0095	BW20-W6-Z	20J0095-17													X
20J0095	BW20-W6-Z2	20J0095-18													X

Sample Delivery Group	Sample ID	Lab ID	Grain Size	Total Solids	Total Volatile Solids	Total Organic Carbon	NH3	Sulfides	Metals	PCB Aroclors	Pesticides (8081)	Pesticides (1699)[a]	Dioxins/ Furans[b]	SVOC	Archive
20J0148	BW20-PCT-1-C	20J0148-01	X	X	X	X	X	X	X	X	X		X	X	X
20J0148/ 20L0034	BW20-P1-S	20J0148-02/ 20L0034-04											X		X
20J0148	BW20-P1-Z	20J0148-03													X
20J0148	BW20-P1-Z2	20J0148-04													X
20J0148/ 20L0034	BW20-P2-S	20J0148-05/ 20L0034-04											X		X
20J0148	BW20-P2-Z	20J0148-06													X
20J0095/ 20L0034	BW20-P3-S	20J0095-19/ 20L0034-03											X		X
20J0095	BW20-P3-Z	20J0095-20													X
20J0148	BW20-PCT-2-C	20J0148-07	X	X	X	X	X	X	X	X	X		X	X	X
20J0148/ 20L0034	BW20-P4-S	20J0148-11/ 20L0034-07											X		X
20J0148	BW20-P4-Z	20J0148-12													X
20J0148	BW20-P4-Z2	20J0148-13													X
20J0148/ 20L0034	BW20-P5-S	20J0148-08/ 20L0034-06											X		X
20J0148	BW20-P5-Z	20J0148-09													X
20J0148/ 20L0034	BW20-P6-S	20J0148-14/ 20L0034-08											X		X
20J0148	BW20-P6-Z	20J0148-15													X
20J0148	BW20-P6-Z2	20J0148-16													X

Notes:
NH3 = ammonia
PCB = polychlorinated biphenyls
SVOC = semivolatile organic compounds

a. Due to elevated RLs for total chlordane, high resolution analysis (EPA Method 1699) for organochorine pesticides was subsequently conducted for DMMU samples HSK-1 and WUT-2.
b. Upon receipt of dioxin/furan results for the DMMU composite samples, individual core samples from DMMUs WUT-1, PCT-1, and PCT-2 were subsequently analyzed for dioxins/furans (samples W1, W2, W3, P1, P2, P3, P4, P5, and P6).

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3.0 RESULTS

The validated analytical chemistry results for the sediment characterization are presented in this section. Table 5 summarizes the conventional and chemistry results for each DMMU. Table 6 summarizes the dioxin/furan congener results for the individual core samples. Table 7 provides the total toxic equivalent (TEQ) calculations for the dioxin/furan congener results. Chain of custody forms and laboratory reports are provided in Appendix C.

Several chemical groups are represented by a total concentration, including low molecular weight polycyclic aromatic hydrocarbons (LPAHs), high molecular weight polycyclic aromatic hydrocarbons (HPAHs), total dichlorodiphenyltrichloroethane (DDT), chlordane, and polychlorinated biphenyl (PCB) Aroclors. Total concentrations were calculated by summing detected results. If all results were undetected, then the maximum RL of any constituent was reported.

Table 5 highlights any concentrations that exceeded the DMMP screening level (SL), maximum level (ML), or bioaccumulation trigger (BT).

3.1 Husky Terminal

This section summarizes the sediment chemistry results for Husky Terminal. Analytical results for one surface DMMU (HSK-1) are provided in Table 5. All chemical results in Husky Terminal were below the DMMP SLs.

3.1.1 Sediment Description

Sediments characterized within the Husky Terminal consisted primarily of olive brown to dark gray silty fine sands. Sediments present in the Z-layer ranged from fine to medium sands at stations H1 and H3, to rocks and gravels at stations H2 and H4.

3.1.2 Sediment Conventionals

Sediments within Husky Terminal were relatively sandy, with DMMU composite sample HSK-1 having 62.5 percent sand. Total organic carbon (TOC) was relatively low, measured at 0.44 percent. Total sulfides were measured at 195 mg/kg. Ammonia was relatively low and was measured at 3.98 mg/kg.

3.1.3 Sediment Chemistry

All metals were detected at low concentrations in DMMU sample HSK-1, with estimated (J-qualified) concentrations for antimony, cadmium, mercury, and silver. Tributyltin also had an estimated concentration of 1.36 µg/kg. All metals and tributyltin concentrations were well below DMMP SLs and BTs.

The concentrations of SVOCs were also well below the DMMP SLs. The polycyclic aromatic hydrocarbons (PAHs) were undetected or detected at low concentrations. The remaining SVOCs were undetected except for estimated concentrations of 1,4-dichlorobenze, phenol, and dibenzofuran. Total PCBs had an estimated (J-qualified) concentration also below the DMMP SL.

Using EPA Method 8081, pesticides were undetected but the RL for total chlordane exceeded the DMMP SL. DMMU sample HSK-1 was subsequently reanalyzed using EPA Method 1699 and all estimated concentrations of the DMMP pesticides were measured below the DMMP SLs. The pesticide reanalysis results for HSK-1 are reported in Table 5.

The total TEQ for dioxins/furans was 1.49 ng/kg using zero for non-detected congeners (ND=0) and 1.62 ng/kg using half of the detection limit for non-detects (ND=1/2 DL). The total TEQs were below the DMMP SL of 4.0 ng/kg TEQ.

3.2 Washington United Terminal

Analytical results for two surface DMMUs (WUT-1 and WUT-2) are provided in Table 5. A summary of results is provided below.

3.2.1 Sediment Description

Surface sediments in WUT generally consisted of olive brown to very dark gray silty fine sand with scattered shell particles. Scattered fine wood or organic particles were also observed in sediments at stations W4 and W6. Sediments present in the Z-layer generally consisted of moderately consolidated medium to fine sands, except for station W6 where stiff brown clay (presumed to be native sediment) was present.

3.2.2 Sediment Conventionals

Sediments in WUT were comprised mostly of sand, with 78.1 percent sand measured in WUT-1 and 75.5 percent sand measured in WUT-2. TOC was low, measured at 0.24 percent in WUT-1 and 0.35 percent in WUT-2. Ammonia was also relatively low, measured at 2.66 mg/kg at WUT-1, and 4.81 mg/kg at WUT-2. Total sulfides were measured at 82.9 mg/kg at WUT-1 and 260 mg/kg at WUT-2.

3.2.3 Sediment Chemistry

All metals were undetected or detected at low concentrations in WUT-1 and WUT-2. Tributyltin had estimated concentrations of 3.67 µg/kg in WUT-1 and 3.35 µg/kg in WUT-2. All metals and tributyltin concentrations were well below DMMP SLs and BTs.

The concentrations of SVOCs were well below the DMMP SLs for both WUT samples. The PAHs were undetected or detected at low concentrations. The remaining SVOCs were undetected except for estimated concentrations of 1,4-dichlorobenze in both WUT samples, bis(2-ethylhexyl)phthalate in WUT-1, and dibenzofuran in WUT-2. Total PCBs had estimated concentrations well below the DMMP SL.

Using EPA Method 8081, pesticides were undetected but the RL for total chlordane exceeded the DMMP SL for WUT-2. DMMU sample WUT-2 was subsequently reanalyzed using EPA Method 1699 and all estimated concentrations of the DMMP pesticides were measured below the DMMP SLs. The pesticide reanalysis results for WUT-2 are reported in Table 5.

The total TEQ for dioxins/furans for WUT-1 was 6.71 ng/kg (ND=0) and 6.80 ng/kg (ND=1/2 DL), which exceed the DMMP SL of 4.0 ng/kg TEQ. The total TEQ for WUT-2 was 2.10 ng/kg (ND=0) and 2.59 ng/kg (ND=1/2 DL), which was below the DMMP SL. The individual core samples that comprise WUT-1 (W1, W2, and W3) were subsequently analyzed for dioxins/furans to the evaluate the spatial distribution of concentrations (Table 6). Core samples W1 and W2 had total TEQ values that were below the DMMP SL. Core sample W3 had total TEQs of 4.58 ng/kg (ND=0) and 4.97 ng/kg (ND=1/2 DL), which exceeded the DMMP SL.

3.3 Pierce County Terminal

This section summarizes the sediment chemistry results for PCT. Analytical results for surface DMMUs PCT-1 and PCT-2 are provided in Table 5.

3.3.1 Sediment Description

Surface sediments within PCT varied by location and consisted primarily of olive brown to dark grayish brown silt and fine sand in the southern portion of the terminal (PCT-1), and olive brown to grayish brown fine sandy silt in the northern portion of the terminal (PCT-2). Sediments present in the Z-layer consisted primarily of dark grayish brown fine sand across the site, with olive brown sandy silt observed in the Z-sample at station P5.

3.3.2 Sediment Conventionals

Sediments in PCT varied in grain size, with PCT-1 containing 65.5 percent sand and PCT-2 containing 32.2 percent sand. TOC and ammonia were relatively low for both PCT samples. However, total volatile solids (TVS) (5.59 percent) and sulfides (973 mg/kg) in PCT-2 were higher in comparison to PCT-1 (TVS of 2.28 percent and sulfides at 271 mg/kg).

3.3.3 Sediment Chemistry

All metals were undetected or detected at low concentrations in PCT-1 and PCT-2. Tributyltin was measured at 11.9 µg/kg in PCT-1 and was undetected in PCT-2. All metals and tributyltin concentrations were below DMMP SLs and BTs.

The SVOCs were undetected or detected at low or estimated concentrations that were below the DMMP SLs for both PCT samples. The PAHs were undetected or detected at low concentrations. The remaining SVOCs were undetected or detected at estimated concentrations with the exception of bis(2-ethylhexyl)phthalate, which was measured at 67.5 µg/kg in PCT-2. Total PCBs had estimated concentrations in both PCT samples below the DMMP SL.

Using EPA Method 8081, pesticides were undetected but the RL for total chlordane exceeded the DMMP SL for PCT-2. Given the concentrations of dioxins/furans in PCT-2 (see below), it was decided not to reanalyze the pesticides using EPA Method 1699.

The total TEQ for dioxins/furans for PCT-1 was 7.74 ng/kg (ND=0) and 7.80 ng/kg (ND=1/2 DL), which exceed the DMMP SL of 4.0 ng/kg TEQ. The total TEQ for PCT-2 was 21.28 ng/kg (ND=0) and 21.42 ng/kg (ND=1/2 DL), which exceeded the DMMP BT of 10 ng/kg TEQ. The individual core samples that comprised PCT-1 (P1, P2, and P3) and PCT-2 (P3, P4, and P5) were subsequently analyzed for dioxins/furans to evaluate the spatial distribution of concentrations (Table 6).

The total TEQ for sample P1 was 4.58 ng/kg (ND=0) and 4.97 ng/kg (ND=1/2 DL), which exceeded the DMMP SL of 4.0 ng/kg TEQ. The total TEQ for P2 was 15.32 ng/kg (ND=0) and

15.47 ng/kg (ND=1/2 DL), which exceeded the DMMP BT of 10 ng/kg TEQ. However, the total TEQ for P3 was 3.35 ng/kg (ND=0) and 3.72 ng/kg (ND=1/2 DL), which was below the DMMP SL. Core samples P2, P3, and P4 all had total TEQ values that exceeded the DMMP BT of 10 ng/kg TEQ.

3.4 Volume-Weighted Average Concentration for Dioxins/Furans

For non-dispersive disposal sites, DMMUs with dioxin/furan concentrations below 10 ng/kg TEQ are allowed for open water disposal if the volume-weighted average concentration of dioxins/furans in material from the entire dredging project does not exceed the Disposal Site Management Objective of 4 ng/kg TEQ (DMMP 2018).

Dioxin/furan concentrations at PCT suggested that DMMUs PCT-1 and PCT-2 were both unsuitable for open-water, based on the existing data. The Port decided against dredging PCT as part of the current maintenance action. Therefore, the volume-weighted average concentration of dioxins/furans for the dredging project consisting of Husky and WUT was evaluated.

The dioxin/furan volume-weighted average concentration for DMMUs HSK-1, WUT-1, and WUT-2, with a combined volume of 26,890 cy was 3.50 ng/kg (ND=0) and 3.74 ng/kg (ND=1/2 DL), which were both below the Disposal Site Management Objective of 4.0 ng/kg TEQ (Figure 5). Since the Port chose to analyze individual cores for dioxin/furan, the volume-weighted average concentration is calculated for the individual cores to demonstrate that the 4.0 ng/kg TEQ objective is still met. For the individual core samples (W1, W2, and W3) which comprise WUT-1, the total TEQ was 3.25 ng/kg (ND=0) and 3.63 ng/kg (ND=1/2 DL) for the combined volume of 9,233 cy (Figure 5). Replacing WUT-1 with the individual core samples, the volume-weighted average concentration for Husky and WUT was 2.31 ng/kg (ND=0) and 2.65 ng/kg (ND=1/2 DL), which also met the Disposal Site Management Objective (Figure 5).

Overall, the dioxin/furan volume-weighted average concentrations calculated for the dredging project suggested that the proposed dredged material from WUT was suitable for open-water disposal when the volume was combined with the material from Husky.

3.5 Puget Sound Sediment Reference Material Results

The laboratory extracted and analyzed the Puget Sound Sediment Reference Material (PS-SRM) as part of each analytical batch (Tables 8 and 9). The guidance limit for dioxin/furan congeners was 50%-150% and the acceptance range for Aroclor 1260 was 41-180 µg/kg (DMMP 2018).

The EPA Level 4 validation noted the following outliers for analytical batch 20J0095:

- The recovery for 1,2,3,7,8,9-HxCDF was greater than the upper control limit. Sample results for this compound were estimated (J) to indicate a potential high bias.
- In addition, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF, and 2,3,4,7,8-PeCDF were reported as not-detected. The reference values for these compounds were less than the RL. However, because the compounds were not detected, results in the associated samples were estimated (J/UJ) to indicate a potential low bias (see Section 4.0).

Table 5. Sediment Characterization DMMU Chemistry Results

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-HSK-1-C Results	BW20-HSK-1-C VQ	BW20-WUT-1-C Results	BW20-WUT-1-C VQ	BW20-WUT-2-C Results	BW20-WUT-2-C VQ	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
Conventionals														
Total Solids	%	---	---	---	76.47		76.66		77.29		75.48		69.02	
Total Volatile Solids	%	---	---	---	1.92		1.64		2.29		2.28		5.59	
Total Organic Carbon	%	---	---	---	0.44		0.24		0.35		0.41		0.75	
Total Sulfides	mg/kg	---	---	---	195		82.9		260		271		973	
Ammonia	mg/Kg	---	---	---	3.98		2.66		4.81		11.2		27.2	
Gravel	%	---	---	---	1.0		2.9		2.4		0.6		2.1	
Sand	%	---	---	---	62.5		78.1		75.5		65.5		32.2	
Silt	%	---	---	---	27.1		13.8		16.1		25.2		53.2	
Clay	%	---	---	---	9.4		5.1		6.0		8.6		12.3	
Grain Size (Fines)	%	---	---	---	36.5		18.9		22.1		33.8		65.5	
Metals and Metalloid														
Antimony	mg/kg	150	---	200	0.08	J	0.24	UJ	0.24	UJ	0.26	UJ	0.13	J
Arsenic	mg/kg	57	507.1	700	4.59	J	4.93	J	4.56	J	4.86	J	10.7	J
Cadmium	mg/kg	5.1	---	14	0.04	J	0.12	U	0.05	J	0.05	J	0.08	J
Chromium	mg/kg	260	---	---	10.4		10.3		10.5		12		15.2	
Copper	mg/kg	390	---	1,300	22.5		17.6		18.6		24.2		32.1	
Lead	mg/kg	450	975	1,200	7.84	J	3.86	J	3.51	J	5.03	J	7.48	J
Mercury	mg/kg	0.41	1.5	2.3	0.0248	J	0.0097	J	0.0118	J	0.0164	J	0.0293	
Selenium	mg/kg	---	3	---	0.7		0.68		0.74		0.76		0.78	
Silver	mg/kg	6.1	---	8.4	0.09	J	0.07	J	0.07	J	0.1	J	0.11	J
Zinc	mg/kg	410	---	3,800	48.0	J	28.0	J	59.3	J	34.7	J	44.1	J
Butyltins														
Tributyltin ion	ug/kg	---	73	---	1.36	J	3.67	J	3.35	J	11.9		3.84	U
Organics														
PAHs														
Naphthalene	ug/kg	2,100	---	2,400	10.3	J	6.3	J	7.5	J	6	J	6.2	J
Acenaphthylene	ug/kg	560	---	1,300	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Acenaphthene	ug/kg	500	---	2,000	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Fluorene	ug/kg	540	---	3,600	9.4	J	19.9	U	7.4	J	5.9	J	6.2	J
Phenanthrene	ug/kg	1,500	---	21,000	24.4		15.6	J	24.1		16.7	J	23.9	
Anthracene	ug/kg	960	---	13,000	10.7	J	19.9	U	8.6	J	6.4	J	8.1	J

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-HSK-1-C Results	BW20-HSK-1-C VQ	BW20-WUT-1-C Results	BW20-WUT-1-C VQ	BW20-WUT-2-C Results	BW20-WUT-2-C VQ	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
2-Methylnaphthalene	ug/kg	670	---	1,900	12.1	J	6.3	J	24.4		6	J	7.4	J
Total LPAH	ug/kg	5,200	---	29,000	66.9	J	28.2	J	72	J	41	J	51.8	J
Fluoranthene	ug/kg	1,700	4,600	30,000	33.4		17	J	18.7	J	24.6		42.5	
Pyrene	ug/kg	2,600	11,980	16,000	57.7		32.8		32.5		59.8		98.4	
Benzo(a)anthracene	ug/kg	1,300	---	5,100	24.9		9.9	J	13.5	J	15.4	J	20.6	
Chrysene	ug/kg	1,400	---	21,000	30.1		14.9	J	22.4		22.2		48.8	
Benzofluoranthenes	ug/kg	3,200	---	9,900	66		39.6	J	36	J	75.2		98	
Benzo(a)pyrene	ug/kg	1,600	---	3,600	27.3		13.8	J	13.8	J	25.4		28.9	
Indeno(1,2,3-c,d)pyrene	ug/kg	600	---	4,400	17.2	J	11.5	J	11	J	22.9		27.6	
Dibenzo(a,h)anthracene	ug/kg	230	---	1,900	19.9	U	19.9	U	19.9	U	7.1	J	8.7	J
Benzo(g,h,i)perylene	ug/kg	670	---	3,200	19	J	13.8	J	13.7	J	29.1		39.2	
Total HPAH	ug/kg	12,000	---	69,000	275.6	J	153.3	J	161.6	J	281.7	J	412.7	J
Chlorinated Hydrocarbons														
1,4-Dichlorobenzene	ug/kg	110	---	120	0.9	J	1	J	0.7	J	1.7	J	1	J
1,2-Dichlorobenzene	ug/kg	35	---	110	5	U	5	U	5	U	1.1	J	5	U
1,2,4-Trichlorobenzene	ug/kg	31	---	64	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Hexachlorobenzene	ug/kg	22	168	230	5	U	5	U	5	U	5	U	5	U
Phthalates														
Dimethyl phthalate	ug/kg	71	---	1,400	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Diethyl phthalate	ug/kg	200	---	1,200	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Di-n-butyl phthalate	ug/kg	1,400	---	5,100	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Butyl benzyl phthalate	ug/kg	63	---	970	19.9	U	19.9	U	19.9	U	19.9	U	8.2	J
Bis(2-ethylhexyl)phthalate	ug/kg	1,300	---	8,300	49.8	U	36.7	J	49.8	U	34.6	J	67.5	
Di-n-octyl phthalate	ug/kg	6,200	---	6,200	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Phenols														
Phenol	ug/kg	420	---	1,200	10.2	J	19.9	U	19.9	U	9.4	J	9.7	J
2-Methylphenol	ug/kg	63	---	77	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
4-Methylphenol	ug/kg	670	---	3,600	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
2,4-Dimethylphenol	ug/kg	29	---	210	19.9	U	19.9	U	19.9	U	19.9	U	2.2	J
Pentachlorophenol	ug/kg	400	504	690	99.6	U	99.5	U	99.7	U	99.6	U	99.7	U
Miscellaneous Extractables														
Benzyl alcohol	ug/kg	57	---	870	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Benzoic acid	ug/kg	650	---	760	199	UJ	199	UJ	199	UJ	199	UJ	199	UJ

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-HSK-1-C Results	BW20-HSK-1-C VQ	BW20-WUT-1-C Results	BW20-WUT-1-C VQ	BW20-WUT-2-C Results	BW20-WUT-2-C VQ	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
Dibenzofuran	ug/kg	540	---	1,700	7.2	J	19.9	U	9.3	J	19.9	U	4.6	J
Hexachlorobutadiene	ug/kg	11	---	270	5	U	5	U	5	U	0.8	J	5	U
N-Nitrosodiphenylamine	ug/kg	28	---	130	19.9	U	19.9	U	19.9	U	19.9	U	19.9	U
Pesticides and PCBs					*Method 1699*				*Method 1699*					
4,4'-DDD	ug/kg	16	---	---	0.0774		0.97	U	0.0668		0.98	U	0.99	U
4,4'-DDE	ug/kg	9	---	---	0.0748		0.97	U	0.0685		0.98	U	0.99	U
4,4'-DDT	ug/kg	12	---	---	0.0215	U	0.97	U	0.169		0.98	U	0.99	U
Total 4,4'-DDX	ug/kg	---	50	69	0.1522		0.97	U	0.3043	U	0.98	U	0.99	U
Aldrin	ug/kg	9.5	---	---	0.110	UJ	0.49	U	0.104		0.49	U	1.98	U
Total Chlordane	ug/kg	2.8	37	---	0.0242	J	0.97	U	0.0166	J	1.97	U	2.98	U
Dieldrin	ug/kg	1.9	---	1,700	0.0144	UJ	0.97	U	0.0145	UJ	0.98	U	0.99	U
Heptachlor	ug/kg	1.5	---	270	0.0022	U	0.49	U	0.0033	U	0.49	U	0.5	U
Total PCBs	ug/kg	130	38*	3,100	1.9	J	6.7	J	3.5	J	8.0	J	13.6	J
Dioxins/Furans														
2,3,7,8-TCDF	ng/kg	---	---	---	0.127	UJ	12.1		1.07	UJ	3.73		32.5	
2,3,7,8-TCDD	ng/kg	---	---	---	0.110	U	0.096	U	0.086	U	0.114	U	0.148	U
1,2,3,7,8-PeCDF	ng/kg	---	---	---	0.585	UJ	13.0		1.37	UJ	8.27		35.8	
2,3,4,7,8-PeCDF	ng/kg	---	---	---	0.398	J	6.94		0.748	UJ	3.30		13.0	
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.393	J	0.412	J	0.511	U	0.977	J	1.29	
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	1.19	J	8.59	J	2.97	J	17.9	J	58.5	J
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	0.433	J	2.25	J	1.00		4.03		16.1	
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	0.487	U	1.31		0.492	J	1.77		4.91	
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	0.378	U	2.07	J	0.749	J	2.73		7.51	
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	0.381	U	0.408	U	0.628	J	1.04		1.30	U
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	1.34		1.89		2.69		4.45		6.97	
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	0.843	J	1.08		1.20		2.35		2.91	
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	7.16		10.8		11.3		19.9		41.8	
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	0.521	U	1.06		1.21		3.39		9.34	
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	40.3		53.1		74.0		115		124	
OCDF	ng/kg	---	---	---	28.5		31.5		39.2		45.5		92.1	
OCDD	ng/kg	---	---	---	369		786		840		1110		989	
Total TEQ (ND = 0)	ng/kg	4	10	---	1.49		6.71		2.10		7.74		21.28	
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	1.62		6.80		2.59		7.80		21.42	

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-HSK-1-C Results	BW20-HSK-1-C VQ	BW20-WUT-1-C Results	BW20-WUT-1-C VQ	BW20-WUT-2-C Results	BW20-WUT-2-C VQ	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
Total TCDF	ng/kg	---	---	---	2.80		24.8		0.947		7.02		77.3	
Total TCDD	ng/kg	---	---	---	1.88		0.311		6.62		3.29		5.77	
Total PeCDF	ng/kg	---	---	---	3.62		39.0		7.03		25.4		94.3	
Total PeCDD	ng/kg	---	---	---	3.12		1.51		2.01		7.00		4.36	
Total HxCDF	ng/kg	---	---	---	8.92		27.4		19.9		50.7		133	
Total HxCDD	ng/kg	---	---	---	9.00		13.0		21.7		39.3		49.1	
Total HpCDF	ng/kg	---	---	---	7.26		35.1		40.1		58.3		109	
Total HpCDD	ng/kg	---	---	---	101		112		158		279		276	

Exceeds SL	Exceeds BT	Exceeds ML

Validation Qualifiers (VQ):

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample

U The analyte was analyzed for but was not detected above the reported sample quantitation limit.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Table 6. Dioxin/Furan Congener Results for Individual Core Samples

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-W1-S Results	Q	VQ	BW20-W2-S Results	Q	VQ	BW20-W3-S Results	Q	VQ	BW20-P1-S Results	Q	VQ	BW20-P2-S Results	Q	VQ
Dioxins/Furans																			
2,3,7,8-TCDF	ng/kg	---	---	---	0.403	J		0.457	UJ		0.889	J		3.21			9.94		
2,3,7,8-TCDD	ng/kg	---	---	---	0.078	U		0.102	U		0.193	UJ		0.129	U		0.302	UJ	
1,2,3,7,8-PeCDF	ng/kg	---	---	---	0.542	UJ		0.572	UJ		1.04			7.61			15.4		
2,3,4,7,8-PeCDF	ng/kg	---	---	---	0.340	UJ		0.223	U		0.689	UJ		2.44			6.83		
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.363	J		0.422	UJ		0.718	J		0.952	J		1.63		
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	1.31	U		0.984	J		4.97			18.9			31.3		
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	0.447	UJ		0.338	UJ		1.54	U		5.82			9.57		
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	0.630	UJ		0.380	UJ		1.42	U		1.90			3.50		
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	0.297	J		0.359	J		1.85			2.48			5.21		
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	0.411	UJ		0.366	UJ		0.742	UJ		1.10	U		2.13		
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	1.82			1.54			5.94			4.66			10.1		
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	1.08	U		0.767	UJ		2.06			2.42			4.94		
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	7.87			7.56			28.3			22.5			41.9		
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	0.596	UJ		0.691	J		2.62			4.10			7.46		
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	45.6			40.8			152			104			234		
OCDF	ng/kg	---	---	---	26.4			21.8			39.4			58.4			102		
OCDD	ng/kg	---	---	---	540			422			1410			1070			2140		
Total TEQ (ND = 0)	ng/kg	4	10	---	1.32			0.91			4.58			7.50			15.32		
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	1.61			1.33			4.97			7.62			15.47		
Total TCDF	ng/kg	---	---	---	0.785			0.160			4.12			7.85			27.9		
Total TCDD	ng/kg	---	---	---	0.374			1.27			2.97			2.82			4.20		
Total PeCDF	ng/kg	---	---	---	1.70			3.01			5.52			18.0			53.6		
Total PeCDD	ng/kg	---	---	---	0.814			1.18			3.31			2.97			4.06		
Total HxCDF	ng/kg	---	---	---	10.3			9.46			53.5			50.3			96.0		
Total HxCDD	ng/kg	---	---	---	9.95			11.8			30.4			33.8			83.8		
Total HpCDF	ng/kg	---	---	---	29.8			25.8			105			67.6			122		
Total HpCDD	ng/kg	---	---	---	97.9			91.6			295			263			648		

Exceeds SL	Exceeds BT	Exceeds ML

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-P3-S Results	Q	VQ	BW20-P4-S Results	Q	VQ	BW20-P5-S Results	Q	VQ	BW20-P6-S Results	Q	VQ
Dioxins/Furans																
2,3,7,8-TCDF	ng/kg	---	---	---	2.06			16.2			15.6			20.5		
2,3,7,8-TCDD	ng/kg	---	---	---	0.092	U		0.237	UJ		0.194	UJ		0.182	UJ	
1,2,3,7,8-PeCDF	ng/kg	---	---	---	3.72			24.3			24.2			39.6		
2,3,4,7,8-PeCDF	ng/kg	---	---	---	1.54			9.94			10.1			13.2		
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.663	UJ		2.41			0.735	J		0.727	J	
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	6.75			45.3			40.7			61.3		
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	2.02			12.7			11.8			16.9		
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	0.928	J		5.95			3.49			4.69		
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	1.16			7.33			6.13			8.15		
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	0.599	J		2.19			0.698	J		0.868	J	
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	3.15			17.5			3.57			3.44		
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	1.60			6.13			1.74			1.99		
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	10.4			54.2			30.0			35.0		
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	1.92			9.99			9.21			11.1		
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	62.6			211			79.9			68.7		
OCDF	ng/kg	---	---	---	24.7			100			81.5			86.4		
OCDD	ng/kg	---	---	---	628			1510			807			616		
Total TEQ (ND = 0)	ng/kg	4	10	---	3.35			20.69			14.32			19.02		
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	3.72			20.80			14.42			19.11		
Total TCDF	ng/kg	---	---	---	4.72			46.0			40.2			48.1		
Total TCDD	ng/kg	---	---	---	1.76			4.09			2.09			0.431		
Total PeCDF	ng/kg	---	---	---	11.9			76.7			62.9			90.7		
Total PeCDD	ng/kg	---	---	---	1.82			7.65			3.87			1.81		
Total HxCDF	ng/kg	---	---	---	19.9			148			89.1			118		
Total HxCDD	ng/kg	---	---	---	24.0			98.6			24.6			24.7		
Total HpCDF	ng/kg	---	---	---	31.3			134			80.0			87.3		
Total HpCDD	ng/kg	---	---	---	166			443			194			140		

Exceeds SL	Exceeds BT	Exceeds ML

Qualifiers: J = Estimated concentration value detected below the reporting limit U = The analyte was analyzed for, but was not detected ("non-detect") at or above the MRL/MDL
UJ = Analyte not detected above the MRL; however the limit is approximate and may not represent the actual limit to accurately and precisely measure the analyte.

Table 7. Dioxin/Furan Congener Total TEQ Calculations

			BW20-HSK-1-C		BW20-WUT-1-C		BW20-WUT-2-C		BW20-PCT-1-C		BW20-PCT-2-C	
Dioxins/Furans	Units	TEFs	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL
2,3,7,8-TCDF	ng/kg	0.1		0.00635	1.21	1.21		0.0535	0.373	0.373	3.25	3.25
2,3,7,8-TCDD	ng/kg	1		0.055		0.048		0.043		0.057		0.074
1,2,3,7,8-PeCDF	ng/kg	0.03		0.008775	0.39	0.39		0.02055	0.2481	0.2481	1.074	1.074
2,3,4,7,8-PeCDF	ng/kg	0.3	0.1194	0.1194	2.082	2.082		0.1122	0.99	0.99	3.9	3.9
1,2,3,7,8-PeCDD	ng/kg	1	0.393	0.393	0.412	0.412		0.2555	0.977	0.977	1.29	1.29
1,2,3,4,7,8-HxCDF	ng/kg	0.1	0.119	0.119	0.859	0.859	0.297	0.297	1.79	1.79	5.85	5.85
1,2,3,6,7,8-HxCDF	ng/kg	0.1	0.0433	0.0433	0.225	0.225	0.1	0.1	0.403	0.403	1.61	1.61
2,3,4,6,7,8-HxCDF	ng/kg	0.1		0.02435	0.131	0.131	0.0492	0.0492	0.177	0.177	0.491	0.491
1,2,3,7,8,9-HxCDF	ng/kg	0.1		0.0189	0.207	0.207	0.0749	0.0749	0.273	0.273	0.751	0.751
1,2,3,4,7,8-HxCDD	ng/kg	0.1		0.01905		0.0408	0.0628	0.0628	0.104	0.104		0.065
1,2,3,6,7,8-HxCDD	ng/kg	0.1	0.134	0.134	0.189	0.189	0.269	0.269	0.445	0.445	0.697	0.697
1,2,3,7,8,9-HxCDD	ng/kg	0.1	0.0843	0.0843	0.108	0.108	0.12	0.12	0.235	0.235	0.291	0.291
1,2,3,4,6,7,8-HpCDF	ng/kg	0.01	0.0716	0.0716	0.108	0.108	0.113	0.113	0.199	0.199	0.418	0.418
1,2,3,4,7,8,9-HpCDF	ng/kg	0.01		0.002605	0.0106	0.0106	0.0121	0.0121	0.0339	0.0339	0.0934	0.0934
1,2,3,4,6,7,8-HpCDD	ng/kg	0.01	0.403	0.403	0.531	0.531	0.74	0.74	1.15	1.15	1.24	1.24
OCDF	ng/kg	0.0003	0.00855	0.00855	0.00945	0.00945	0.01176	0.01176	0.01365	0.01365	0.02763	0.02763
OCDD	ng/kg	0.0003	0.1107	0.1107	0.2358	0.2358	0.252	0.252	0.333	0.333	0.2967	0.2967
Total TEQ (ND = 0)	ng/kg		1.49		6.71		2.10		7.74		21.28	
Total TEQ (ND = 1/2 DL)	ng/kg			1.62		6.80		2.59		7.80		21.42
		Exceeds SL	Exceeds BT	Exceeds ML								

			BW20-W1-S		BW20-W2-S		BW20-W3-S		BW20-P1-S		BW20-P2-S	
Dioxins/Furans	Units	TEFs	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL	ND=0	ND=1/2DL
2,3,7,8-TCDF	ng/kg	0.1	0.0403	0.0403		0.02285	0.0889	0.0889	0.321	0.321	0.994	0.994
2,3,7,8-TCDD	ng/kg	1		0.039		0.051		0.0965		0.0645		0.151
1,2,3,7,8-PeCDF	ng/kg	0.03		0.00813		0.00858	0.0312	0.0312	0.2283	0.2283	0.462	0.462
2,3,4,7,8-PeCDF	ng/kg	0.3		0.051		0.03345		0.10335	0.732	0.732	2.049	2.049
1,2,3,7,8-PeCDD	ng/kg	1	0.363	0.363		0.211	0.718	0.718	0.952	0.952	1.63	1.63
1,2,3,4,7,8-HxCDF	ng/kg	0.1		0.0655	0.0984	0.0984	0.497	0.497	1.89	1.89	3.13	3.13
1,2,3,6,7,8-HxCDF	ng/kg	0.1		0.02235		0.0169		0.077	0.582	0.582	0.957	0.957
2,3,4,6,7,8-HxCDF	ng/kg	0.1		0.0315		0.019		0.071	0.19	0.19	0.35	0.35
1,2,3,7,8,9-HxCDF	ng/kg	0.1	0.0297	0.0297	0.0359	0.0359	0.185	0.185	0.248	0.248	0.521	0.521
1,2,3,4,7,8-HxCDD	ng/kg	0.1		0.02055		0.0183		0.0371		0.055	0.213	0.213
1,2,3,6,7,8-HxCDD	ng/kg	0.1	0.182	0.182	0.154	0.154	0.594	0.594	0.466	0.466	1.01	1.01
1,2,3,7,8,9-HxCDD	ng/kg	0.1		0.054		0.03835	0.206	0.206	0.242	0.242	0.494	0.494
1,2,3,4,6,7,8-HpCDF	ng/kg	0.01	0.0787	0.0787	0.0756	0.0756	0.283	0.283	0.225	0.225	0.419	0.419
1,2,3,4,7,8,9-HpCDF	ng/kg	0.01		0.00298	0.00691	0.00691	0.0262	0.0262	0.041	0.041	0.0746	0.0746
1,2,3,4,6,7,8-HpCDD	ng/kg	0.01	0.456	0.456	0.408	0.408	1.52	1.52	1.04	1.04	2.34	2.34
OCDF	ng/kg	0.0003	0.00792	0.00792	0.00654	0.00654	0.01182	0.01182	0.01752	0.01752	0.0306	0.0306
OCDD	ng/kg	0.0003	0.162	0.162	0.1266	0.1266	0.423	0.423	0.321	0.321	0.642	0.642
Total TEQ (ND = 0)	ng/kg		1.32		0.91		4.58		7.50		15.32	
Total TEQ (ND = 1/2 DL)	ng/kg			1.61		1.33		4.97		7.62		15.47
		Exceeds SL	Exceeds BT	Exceeds ML								

Dioxins/Furans	Units	TEFs	BW20-P3-S ND=0	BW20-P3-S ND=1/2DL	BW20-P4-S ND=0	BW20-P4-S ND=1/2DL	BW20-P5-S ND=0	BW20-P5-S ND=1/2DL	BW20-P6-S ND=0	BW20-P6-S ND=1/2DL
2,3,7,8-TCDF	ng/kg	0.1	0.206	0.206	1.62	1.62	1.56	1.56	2.05	2.05
2,3,7,8-TCDD	ng/kg	1		0.046		0.1185		0.097		0.091
1,2,3,7,8-PeCDF	ng/kg	0.03	0.1116	0.1116	0.729	0.729	0.726	0.726	1.188	1.188
2,3,4,7,8-PeCDF	ng/kg	0.3	0.462	0.462	2.982	2.982	3.03	3.03	3.96	3.96
1,2,3,7,8-PeCDD	ng/kg	1		0.3315	2.41	2.41	0.735	0.735	0.727	0.727
1,2,3,4,7,8-HxCDF	ng/kg	0.1	0.675	0.675	4.53	4.53	4.07	4.07	6.13	6.13
1,2,3,6,7,8-HxCDF	ng/kg	0.1	0.202	0.202	1.27	1.27	1.18	1.18	1.69	1.69
2,3,4,6,7,8-HxCDF	ng/kg	0.1	0.0928	0.0928	0.595	0.595	0.349	0.349	0.469	0.469
1,2,3,7,8,9-HxCDF	ng/kg	0.1	0.116	0.116	0.733	0.733	0.613	0.613	0.815	0.815
1,2,3,4,7,8-HxCDD	ng/kg	0.1	0.0599	0.0599	0.219	0.219	0.0698	0.0698	0.0868	0.0868
1,2,3,6,7,8-HxCDD	ng/kg	0.1	0.315	0.315	1.75	1.75	0.357	0.357	0.344	0.344
1,2,3,7,8,9-HxCDD	ng/kg	0.1	0.16	0.16	0.613	0.613	0.174	0.174	0.199	0.199
1,2,3,4,6,7,8-HpCDF	ng/kg	0.01	0.104	0.104	0.542	0.542	0.3	0.3	0.35	0.35
1,2,3,4,7,8,9-HpCDF	ng/kg	0.01	0.0192	0.0192	0.0999	0.0999	0.0921	0.0921	0.111	0.111
1,2,3,4,6,7,8-HpCDD	ng/kg	0.01	0.626	0.626	2.11	2.11	0.799	0.799	0.687	0.687
OCDF	ng/kg	0.0003	0.00741	0.00741	0.03	0.03	0.02445	0.02445	0.02592	0.02592
OCDD	ng/kg	0.0003	0.1884	0.1884	0.453	0.453	0.2421	0.2421	0.1848	0.1848
Total TEQ (ND = 0)	ng/kg		3.35		20.69		14.32		19.02	
Total TEQ (ND = 1/2 DL)	ng/kg			3.72		20.80		14.42		19.11
		Exceeds SL	Exceeds BT	Exceeds ML						

Table 8. Puget Sound Sediment Reference Material (Analytical Batch 20J0095)

Analyte	TRUE (ng/kg wet)	FOUND (ng/kg wet)	MDL	MRL	Q	PS-SRM % REC.	QC LIMITS % REC.
***Dioxins/Furans* (PSRM0045)**							
2,3,7,8-TCDF	1.1100	ND	0.126	2.00	*, U		50 - 150
2,3,7,8-TCDD	1.0500	1.00	0.280	2.00	J	95.6	50 - 150
1,2,3,7,8-PeCDF	1.2300	ND	0.300	2.00	*, U		50 - 150
2,3,4,7,8-PeCDF	1.0700	ND	0.300	2.00	*, U		50 - 150
1,2,3,7,8-PeCDD	1.0800	1.10	0.360	2.00	E, J	102	50 - 150
1,2,3,4,7,8-HxCDF	3.0200	2.62	0.280	2.00		86.7	50 - 150
1,2,3,6,7,8-HxCDF	1.0900	0.986	0.360	2.00	E, J	90.4	50 - 150
2,3,4,6,7,8-HxCDF	1.8300	1.51	0.220	2.00	J	82.6	50 - 150
1,2,3,7,8,9-HxCDF	0.51100	1.02	0.420	2.00	*, J	199 *	50 - 150
1,2,3,4,7,8-HxCDD	1.5900	1.39	0.360	2.00	J	87.7	50 - 150
1,2,3,6,7,8-HxCDD	3.8800	2.52	0.300	2.00		64.9	50 - 150
1,2,3,7,8,9-HxCDD	3.0400	2.57	0.440	2.00		84.6	50 - 150
1,2,3,4,6,7,8-HpCDF	18.700	21.3	0.420	2.00	E, B	114	50 - 150
1,2,3,4,7,8,9-HpCDF	1.6300	1.38	0.320	2.00	E, J	84.8	50 - 150
1,2,3,4,6,7,8-HpCDD	90.600	106	1.12	5.00	B	117	50 - 150
OCDF	58.400	76.2	2.20	5.00	B	131	50 - 150
OCDD	811.00	954	8.60	20.0	B	118	50 - 150
***PCB Aroclor* (PSRM0018)**							
Aroclor 1260	108.00	143	2.9	20.0		132	38 - 167
Aroclor 1260 [2C]	108.00	120	2.9	20.0		111	38 - 167

* Value outside of QC limits

Lab Qualifiers (Q):

B This analyte was detected in the method blank

E Estimated Maximum Possible Concentration qualifier for HRGCMS Dioxin

J The result is an estimated value below the reporting limit

U The analyte was analyzed for, but was not detected ("non-detect") at or above the MRL/MDL

Table 9. Puget Sound Sediment Reference Material (Analytical Batch 20J0148)

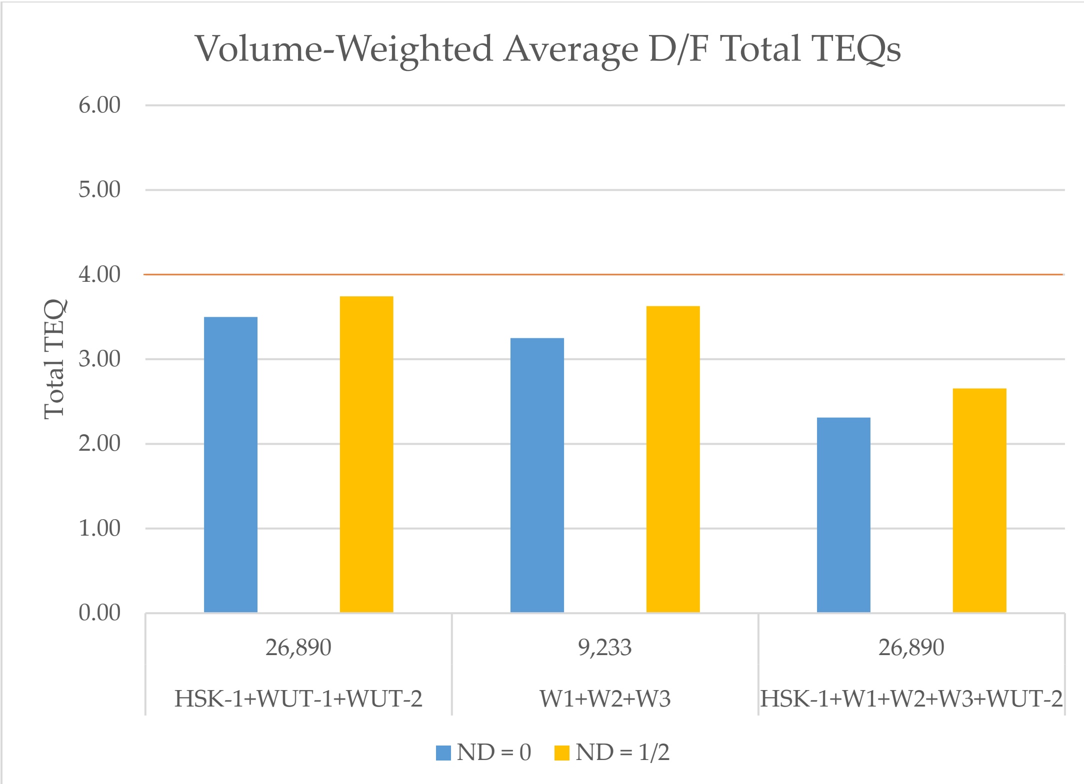
Analyte	TRUE (ng/kg wet)	FOUND (ng/kg wet)	MDL	MRL	Q	PS-SRM % REC.	QC LIMITS % REC.
***Dioxins/Furans* (PSRM0018)**							
2,3,7,8-TCDF	1.1100	0.880	0.063	1.00	J	79.3	50 - 150
2,3,7,8-TCDD	1.0500	1.03	0.140	1.00		98.1	50 - 150
1,2,3,7,8-PeCDF	1.2300	1.43	0.150	1.00		116	50 - 150
2,3,4,7,8-PeCDF	1.0700	1.05	0.150	1.00		98.1	50 - 150
1,2,3,7,8-PeCDD	1.0800	1.13	0.180	1.00		105	50 - 150
1,2,3,4,7,8-HxCDF	3.0200	2.70	0.140	1.00		89.5	50 - 150
1,2,3,6,7,8-HxCDF	1.0900	0.881	0.180	1.00	J	80.8	50 - 150
2,3,4,6,7,8-HxCDF	1.8300	1.75	0.110	1.00		95.6	50 - 150
1,2,3,7,8,9-HxCDF	0.51100	0.554	0.210	1.00	J	108	50 - 150
1,2,3,4,7,8-HxCDD	1.5900	1.32	0.180	1.00		83.0	50 - 150
1,2,3,6,7,8-HxCDD	3.8800	3.00	0.150	1.00		77.4	50 - 150
1,2,3,7,8,9-HxCDD	3.0400	2.46	0.220	1.00		81.0	50 - 150
1,2,3,4,6,7,8-HpCDF	18.700	19.2	0.210	1.00	B	103	50 - 150
1,2,3,4,7,8,9-HpCDF	1.6300	1.25	0.160	1.00		76.6	50 - 150
1,2,3,4,6,7,8-HpCDD	90.600	102	0.560	2.50	B	113	50 - 150
OCDF	58.400	57.5	1.10	2.50	B	98.4	50 - 150
OCDD	811.00	926	4.30	10.0	B	114	50 - 150
***PCB Aroclor* (PSRM0018)**							
Aroclor 1260	108.00	143	2.9	20.0		132	38 - 167
Aroclor 1260 [2C]	108.00	120	2.9	20.0		111	38 - 167

* Value outside of QC limits

Lab Qualifiers (Q):

B This analyte was detected in the method blank

J The result is an estimated value below the reporting limit



a) DMMU	cy	ND = 0 TEQ (ng/kg)	cy*TEQ	ND = 1/2 TEQ (ng/kg)	cy*TEQ
HSK-1	8,080	1.49	12039.2	1.62	13089.6
WUT-1	9,233	6.71	61953.43	6.8	62784.4
WUT-2	9,577	2.1	20111.7	2.59	24804.43

b) WUT-1 Cores	cy	ND = 0 TEQ (ng/kg)	cy*TEQ	ND = 1/2 TEQ (ng/kg)	cy*TEQ
W1	1,771	1.32	2337.72	1.61	2851.31
W2	1,771	0.91	1611.61	1.33	2355.43
W3	5,691	4.58	26064.78	4.97	28284.27

c) Volume Weighted Average	cy	ND = 0 TEQ (ng/kg)	cy*TEQ	ND = 1/2 TEQ (ng/kg)	cy*TEQ
HSK-1+WUT-1+WUT-2	26,890	3.50	94104.33	3.74	100678.4
W1+W2+W3	9,233	3.25	30014.11	3.63	33491.01
HSK-1+W1+W2+W3+WUT-2	26,890	2.31	62165.01	2.65	71385.04

TEQ ≤ 4

Note: Steps for calculating Volume Weighted Averages -

1. Dredged material volume (cy) is multiplied by the TEQ (cy*TEQ) for a) DMMUs or b) WUT-1 cores.
2. These numbers are added for the different combined areas and divided by the total dredged volume (cy) to compute the TEQ for c) Volume Weighted Average.

Figure 5. Volume-Weighted Average Concentration for Dioxin/Furan Total TEQs

4.0 Quality Assurance and Quality Control

EcoChem, Inc., conducted EPA Level 4 review and validation of the dioxin/furan congener results for the DMMU samples[3] and NewFields conducted EPA Level 2B review and validation for all DMMU chemistry data (Appendix D).

EPA Level 4 full validation was performed on dioxin/furan congener results for sediment and quality control (QC) sample data. The validation included a review of data package completeness, electronic data deliverable (EDD) verification, and technical data validation. Overall, accuracy was acceptable as demonstrated by the labeled compound, reference material, and ongoing precision and recoveries (OPR). Precision was acceptable as indicated by the laboratory duplicate relative percent difference (RPD) values. Data were qualified as non-detected to indicate that estimated maximum possible concentration (EMPC) values represented elevated detection limits. Results were estimated due to calibration verification and reference material outliers. A summary of assigned Level 4 validation qualifiers is provided in Table 10.

The Level 2B validation included evaluations of sample holding times, quality control sample results, analytical methods, and calculation verification. In general, sediment quality control results for conventional parameters, metals, butyltins, and organics (PCBs, organochlorine pesticides, and SVOCs) were within the control limits prescribed either by the SAP, analytical methods, DMMP requirements, or by the laboratory. Four metals and fluorene were estimated due to low QC recovery or duplicate RPD outliers. Benzoic acid was estimated due to calibration verification outliers. Dieldrin was qualified as undetected due to presence in the method blank. A summary of assigned Level 2B validation qualifiers is provided in Table 10.

All samples submitted to the laboratory were analyzed, and one hundred percent completeness was achieved for DMMP characterization of all parameters. All data, as qualified, are considered usable for the purposes of this characterization.

[3] Note that EPA Stage 4 validation was not conducted for the individual core samples that were subsequently analyzed for dioxin/furan congeners, as the analyses were conducted by the Port for confirmation purposes. However, the laboratory report includes a Stage 4 data package if validation is required in the future (Appendix C).

Table 10. Data Qualified by EPA Level 2B and Level 4 Validation

Sample ID	Lab ID	Method	Analyte	Result	Units	Q	VQ
BW20-HSK-1-C	20J0095-01	EPA6020A	Antimony	0.08	mg/kg	J	J
BW20-WUT-1-C	20J0148-20	EPA6020A	Antimony	0.24	mg/kg	U	UJ
BW20-WUT-2-C	20J0095-02	EPA6020A	Antimony	0.24	mg/kg	U	UJ
BW20-PCT-1-C	20J0148-01	EPA6020A	Antimony	0.26	mg/kg	U	UJ
BW20-PCT-2-C	20J0148-07	EPA6020A	Antimony	0.13	mg/kg	J	J
BW20-HSK-1-C	20J0095-01	EPA6020A	Arsenic	4.59	mg/kg		J
BW20-WUT-1-C	20J0148-20	EPA6020A	Arsenic	4.93	mg/kg		J
BW20-WUT-2-C	20J0095-02	EPA6020A	Arsenic	4.56	mg/kg		J
BW20-PCT-1-C	20J0148-01	EPA6020A	Arsenic	4.86	mg/kg		J
BW20-PCT-2-C	20J0148-07	EPA6020A	Arsenic	10.7	mg/kg		J
BW20-HSK-1-C	20J0095-01	EPA6020A	Lead	7.84	mg/kg		J
BW20-WUT-1-C	20J0148-20	EPA6020A	Lead	3.86	mg/kg		J
BW20-WUT-2-C	20J0095-02	EPA6020A	Lead	3.51	mg/kg		J
BW20-PCT-1-C	20J0148-01	EPA6020A	Lead	5.03	mg/kg		J
BW20-PCT-2-C	20J0148-07	EPA6020A	Lead	7.48	mg/kg		J
BW20-HSK-1-C	20J0095-01	EPA6020A	Zinc	48.0	mg/kg		J
BW20-WUT-1-C	20J0148-20	EPA6020A	Zinc	28.0	mg/kg		J
BW20-WUT-2-C	20J0095-02	EPA6020A	Zinc	59.3	mg/kg		J
BW20-PCT-1-C	20J0148-01	EPA6020A	Zinc	34.7	mg/kg		J
BW20-PCT-2-C	20J0148-07	EPA6020A	Zinc	44.1	mg/kg		J
BW20-HSK-1-C	20J0095-01	EPA8270E	Fluorene	9.4	µg/kg	J	J
BW20-WUT-2-C	20J0095-02	EPA8270E	Fluorene	7.4	µg/kg	J	J
BW20-PCT-1-C	20J0148-01	EPA8270E	Fluorene	5.9	µg/kg	J	J
BW20-PCT-2-C	20J0148-07	EPA8270E	Fluorene	6.2	µg/kg	J	J
BW20-HSK-1-C	20J0095-01	EPA8270E	Benzoic acid	199	µg/kg	U	UJ
BW20-WUT-1-C	20J0148-20	EPA8270E	Benzoic acid	199	µg/kg	U	UJ
BW20-WUT-2-C	20J0095-02	EPA8270E	Benzoic acid	199	µg/kg	U	UJ
BW20-PCT-1-C	20J0148-01	EPA8270E	Benzoic acid	199	µg/kg	U	UJ
BW20-PCT-2-C	20J0148-07	EPA8270E	Benzoic acid	199	µg/kg	U	UJ
BW20-HSK-1-C	20L0034-01	EPA1699	Dieldrin	0.0144	µg/kg	JB	U
BW20-WUT-2-C	20L0034-02	EPA1699	Dieldrin	0.0145	µg/kg	JB	U
BW20-HSK-1-C	20J0095-01	EPA1613B	2,3,7,8-TCDF	0.127	ng/kg	U	UJ
BW20-HSK-1-C	20J0095-01	EPA1613B	1,2,3,7,8-PeCDF	0.585	ng/kg	E,J	UJ
BW20-HSK-1-C	20J0095-01	EPA1613B	2,3,4,7,8-PeCDF	0.398	ng/kg	J	J
BW20-HSK-1-C	20J0095-01	EPA1613B	1,2,3,4,7,8-HxCDF	1.19	ng/kg		J
BW20-HSK-1-C	20J0095-01	EPA1613B	2,3,4,6,7,8-HxCDF	0.487	ng/kg	E,J	U
BW20-HSK-1-C	20J0095-01	EPA1613B	1,2,3,7,8,9-HxCDF	0.378	ng/kg	E,J	U
BW20-HSK-1-C	20J0095-01	EPA1613B	1,2,3,4,7,8-HxCDD	0.381	ng/kg	E,J	U
BW20-HSK-1-C	20J0095-01	EPA1613B	1,2,3,4,7,8,9-HpCDF	0.521	ng/kg	E,J	U
BW20-WUT-2-C	20J0095-02	EPA1613B	2,3,7,8-TCDF	1.07	ng/kg	E,J	UJ
BW20-WUT-2-C	20J0095-02	EPA1613B	1,2,3,7,8-PeCDF	1.37	ng/kg	E,J	UJ
BW20-WUT-2-C	20J0095-02	EPA1613B	2,3,4,7,8-PeCDF	0.748	ng/kg	E,J	UJ

Sample ID	Lab ID	Method	Analyte	Result	Units	Q	VQ
BW20-WUT-2-C	20J0095-02	EPA1613B	1,2,3,7,8-PeCDD	0.511	ng/kg	E,J	U
BW20-WUT-2-C	20J0095-02	EPA1613B	1,2,3,4,7,8-HxCDF	2.97	ng/kg		J
BW20-WUT-2-C	20J0095-02	EPA1613B	1,2,3,7,8,9-HxCDF	0.749	ng/kg	J	J
BW20-PCT-1-C	20J0148-01	EPA1613B	1,2,3,4,7,8-HxCDF	17.9	ng/kg		J
BW20-PCT-2-C	20J0148-07	EPA1613B	1,2,3,4,7,8-HxCDF	58.5	ng/kg		J
BW20-PCT-2-C	20J0148-07	EPA1613B	1,2,3,4,7,8-HxCDD	1.3	ng/kg	E,J	U
BW20-WUT-1-C	20J0148-20	EPA1613B	1,2,3,4,7,8-HxCDF	8.59	ng/kg		J
BW20-WUT-1-C	20J0148-20	EPA1613B	1,2,3,6,7,8-HxCDF	2.25	ng/kg		J
BW20-WUT-1-C	20J0148-20	EPA1613B	1,2,3,7,8,9-HxCDF	2.07	ng/kg		J
BW20-WUT-1-C	20J0148-20	EPA1613B	1,2,3,4,7,8-HxCDD	0.408	ng/kg	E,J	U

Lab Qualifiers (Q):

B This analyte was detected in the method blank

E Estimated Maximum Possible Concentration qualifier for HRGCMS Dioxin

J Estimated concentration value detected below the reporting limit

U The analyte was analyzed for, but was not detected ("non-detect") at or above the MRL/MDL

Validation Qualifiers (VQ):

J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U The analyte was analyzed for but was not detected above the reported sample quantitation limit.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

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5.0 SUMMARY

Five DMMUs from the sediment characterization project were analyzed for the full suite of DMMP chemical testing, including tributyltin and dioxins/furans. The characterization consisted of one surface DMMU from Husky, two surface DMMUs from WUT, and two surface DMMUS from PCT. The project depth for Husky, WUT, and PCT was −52 feet MLLW, which included the authorized depth of −51 feet MLLW plus 1 foot of overdepth.

Two DMMUs were reanalyzed for organochlorine pesticides using EPA Method 1699 to achieve lower reporting limits. All data were considered complete and usable. In addition, nine individual core samples from three DMMUs were analyzed for dioxins/furans to evaluate the spatial distribution of concentrations.

5.1 Husky Terminal

Chemistry results from Husky DMMU HSK-1 were below the DMMP SLs and suggested that the proposed dredged material was suitable for open-water disposal.

5.2 Washington United Terminal

Chemistry results from WUT were below the DMMP SLs, with the exception of dioxins/furans in DMMU WUT-1, which had a total TEQ of 6.71 ng/kg (ND=0) and 6.80 ng/kg (ND=1/2 DL), which exceed the DMMP SL of 4.0 ng/kg TEQ.

The dioxin/furan volume-weighted average concentration for the combined volume for DMMUs HSK-1, WUT-1, and WUT-2, was 3.50 ng/kg (ND=0) and 3.74 ng/kg (ND=1/2 DL), which were below the Disposal Site Management Objective of 4.0 ng/kg TEQ. In addition, the volume-weighted average concentration for the individual core samples (W1, W2, and W3) which comprise WUT-1 met the Disposal Site Management Objective. The volume-weighted average concentration for the individual core samples combined with HSK-1 and WUT-2 also met the Disposal Site Management Objective.

Overall, the dioxin/furan volume-weighted average concentrations calculated for the dredging project suggested that the proposed dredged material from WUT was suitable for open-water disposal when combined with Husky. Based on the results, both WUT and Husky will be dredged during the same dredging event. In addition, the Port will require the contractor to prioritize dredging WUT-1, and specifically the W3 sample location area (southern third) of WUT-1 as feasible (when the area is available), and specifically require that this area not be the last area dredged.

5.3 Pierce County Terminal

The dioxins/furans measured at PCT suggested that DMMUs PCT-1 and PCT-2 were both unsuitable for open-water disposal, based on the existing data. The Port decided against dredging PCT as part of the current maintenance action.

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6.0 References

DMMP. 2018. Dredged Material Evaluation and Disposal Procedures (User's Manual). Prepared by the Dredged Material Management Office, U.S. Army Corps of Engineers, Seattle District. December 2018.

DMMP. 2019. DMMP Advisory Determination Regarding the Potential Suitability of Proposed Dredged Material from the Blair Waterway in Tacoma Harbor for Unconfined Open-Water Disposal at the Commencement Bay Disposal Site or for Beneficial Use. Prepared by the Seattle District Dredged Material Management Office for the Dredged Material Management Program, June 25, 2019.

NewFields and Leon Environmental. 2020. Blair Dredging Sediment Characterization. Husky, Washington United, and Pierce County Terminals, Tacoma, Washington. Sampling and Analysis Plan. Final. October 1, 2020. Prepared for Port of Tacoma. Prepared by NewFields, Edmonds, WA, in partnership with Leon Environmental, Seattle, WA.

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APPENDIX A: SAMPLING AND ANALYSIS PLAN

APPENDIX B: FIELD LOGS AND PHOTOGRAPHS

(ELECTRONIC COPY ONLY)

APPENDIX C: LABORATORY DATA REPORTS AND CHAIN OF CUSTODY FORMS

(ELECTRONIC COPY ONLY)

APPENDIX D: EPA LEVEL 4 AND LEVEL 2B DATA VALIDATION

APPENDIX E: ENVIRONMENTAL INFORMATION MANAGEMENT DATABASE
(ELECTRONIC COPY ONLY)

APPENDIX F: DIOXIN/FURAN FORENSIC ANALYSIS