BLAIR DREDGING SUPPLEMENTAL SEDIMENT CHARACTERIZATION – BIOACCUMULATION TESTING PIERCE COUNTY TERMINAL, TACOMA, WASHINGTON

DATA REPORT
FINAL

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Acronyms and Abbreviations

ARI	Analytical Resources, Inc.
BT	bioaccumulation trigger
cy	cubic yards
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
dw	dry weight
EDD	electronic data deliverable
EDL	estimated detection limit
EIM	Environmental Information Management
EMPC	estimated maximum possible concentration
EPA	U.S. Environmental Protection Agency
GPS	global positioning system
Gravity	Gravity Environmental
HPAH	high molecular weight polycyclic aromatic hydrocarbon
Husky	Husky Terminal
ISRS	in-situ recovery system
L-E	Leon Environmental
LPAH	low molecular weight polycyclic aromatic hydrocarbon
MDL	method detection limit
mg/kg	milligrams per kilogram
ML	maximum level
MLLW	Mean Lower Low Water
MRL	method reporting limit
NAD83	North American Datum of 1983
ND	non-detected
ng/kg	nanograms per kilogram
NOAA	National Oceanic and Atmospheric Administration
OPR	ongoing precision and recoveries
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCT	Pierce County Terminal
Port	Port of Tacoma
PQL	practical quantitation limit
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
TTL	target tissue level
TVS	total volatile solid
VQ	validation qualifier
μg/kg	microgram per kilogram
WUT	Washington United Terminal
ww	wet weight

1.0 INTRODUCTION

In October 2020, the Port of Tacoma (Port) conducted a Dredged Material Management Program (DMMP) chemistry-only characterization of sediment mounds created by propeller-wash in the berthing area of Washington United Terminal (WUT), Husky Terminal (Husky), and Pierce County Terminal (PCT), Port of Tacoma, WA (NewFields and Leon Environmental [L-E] 2021). The mounds posed a navigation hazard to Port operations, requiring terminal operators to "light-load" vessels. The 2020 DMMP characterization determined that the proposed dredged material from WUT and Husky terminals was suitable for open-water disposal (DMMP 2021a). However, the dioxin/furan concentrations measured in the proposed dredged material at PCT triggered supplemental bioaccumulation testing to determine whether the material would be suitable for open-water disposal. Because bioaccumulation testing would have delayed the more urgently required dredging at WUT and Husky, the Port removed dredging of PCT from the 2020 maintenance action. In the summer of 2022, the Port initiated the follow-on DMMP bioaccumulation study of dioxins/furans at PCT to assess whether the dredged material would be suitable for open-water disposal.

This report summarizes the results of the DMMP bioaccumulation study at PCT that was completed in the fall of 2023, which followed the DMMP-approved Sampling and Analysis Plan (SAP) (Appendix A, NewFields and L-E 2022). The SAP described the overall study design including the dredged material management unit (DMMU) designations, proposed sampling locations, sediment collection methods, chemical and biological analysis methods, and data reporting requirements.

The following sections provide a summary of the chemistry-only DMMP characterization results for PCT, a brief description of the sample collection and analytical methods for the bioaccumulation study, modifications or deviations to the sampling plan, a summary of the actual sampling locations and depths, the results of the biological and chemical analyses, a summary of quality control data for the chemistry analysis, including validation results, and an evaluation of the bioaccumulation results following DMMP guidelines (DMMP 2021b). The full list of appendices includes: the final SAP (Appendix A); the field logbooks, sediment and container logs, core logs, and core photos (Appendix B); the analytical and biological 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); the dioxin/furan TEQ calculations (Appendix F); and the BioStat statistical comparison output (Appendix G).

1.1 Summary of 2020 Chemistry-Only DMMP Characterization at PCT

The Port conducted a DMMP characterization of sediment mounds created by propeller-wash in the berthing area of PCT in October 2020 (NewFields and L-E 2021). The project depth was −51 feet mean lower low water (MLLW) including one foot of allowable overdepth (−52 feet MLLW). The project followed a moderate ranking, which required a minimum of one sample for every 4,000 cubic yards (cy) of material and a surface DMMU size of up to 16,000 cy. Only surface DMMUs were required. The 2020 sediment characterization study was designed as a chemistry-only evaluation for suitability determination.

The dredged material volume estimate for PCT was 15,551 cy based on bathymetry data collected in May 2020. The sampling design chemically characterized the sediments as two DMMUs. Each DMMU included sediment cores from three locations each (Figure 1 and Table 1). The dioxin/furan concentrations measured in proposed dredged sediments at PCT triggered supplemental bioaccumulation testing to determine whether the material would be suitable for open-water disposal (Table 2). In addition, although total chlordane was undetected, the reporting limit slightly exceeded the screening level (SL) for one DMMU. To further evaluate the spatial distribution of dioxin/furan concentrations at PCT, samples from the individual cores that comprised each composite were also analyzed for dioxins/furans (Table 3). At that time, the Port decided against proceeding with proposed dredging at PCT as part of the 2020 maintenance action because of the timeframe required to complete the bioaccumulation testing.

Table 1. 2020 PCT Project Estimated Dredged Material Volumes Including 1-foot Overdepth

DMMU	Berthing Depth (ft MLLW)	Dredge Volume to Berthing Depth (cy)	Dredge Volume 1-foot Overdepth (cy)	Total Volume (cy)
PCT-1	−51	2,453	4,686	**7,139**
PCT-2	−51	6,517	1,895	**8,412**
Totals:		**8,970**	**6,581**	**15,551**

Abbreviations:
cy = cubic yards
MLLW = mean lower low water

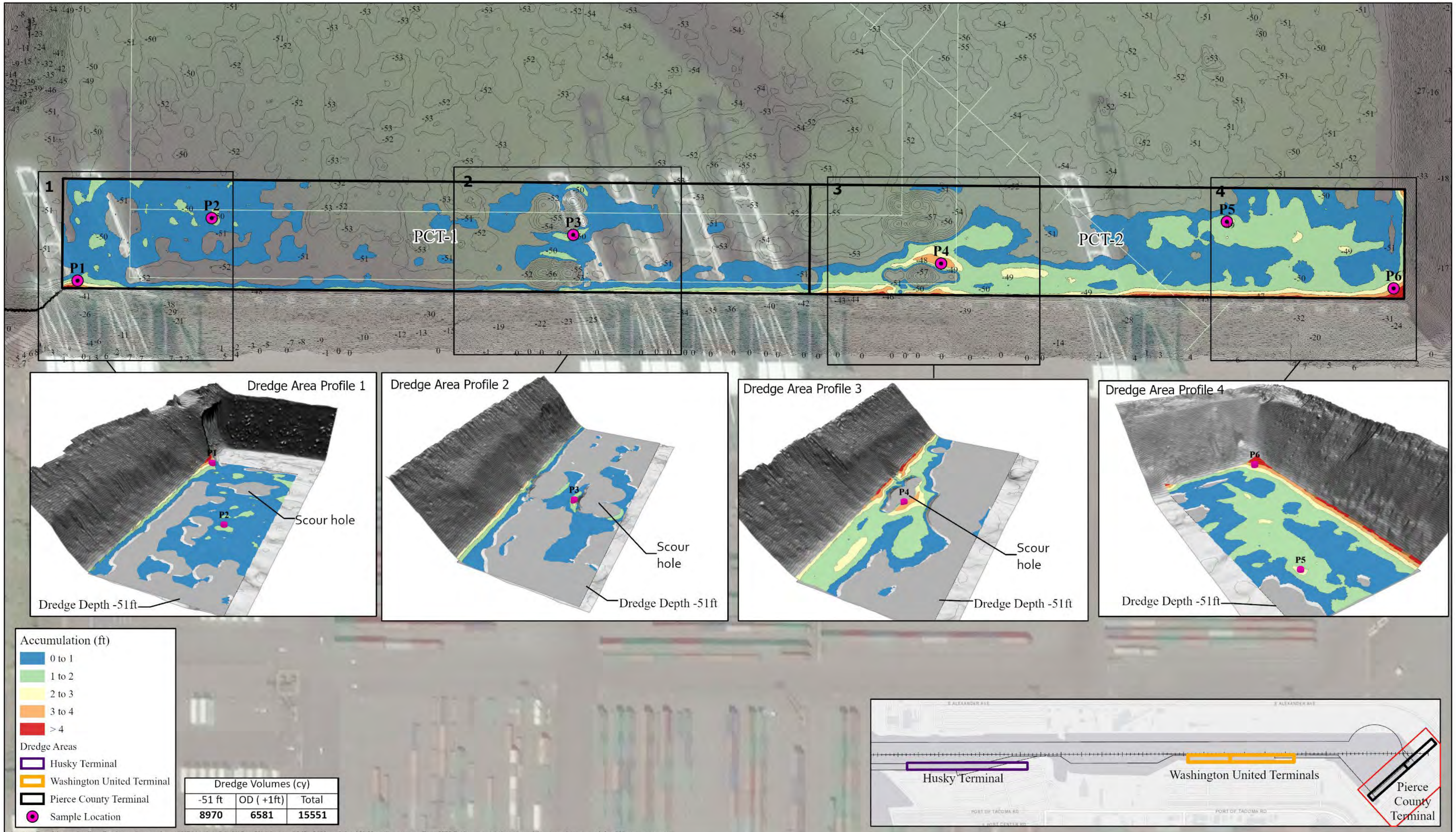

Figure 1. 2020 Pierce County Terminal Dredge Area and Sample Locations

N

0 150 300 600 Feet

NewFields

Table 2. 2020 PCT Sediment Chemistry Results

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
Conventionals								
Total Solids	%	---	---	---	75.48		69.02	
Total Volatile Solids	%	---	---	---	2.28		5.59	
Total Organic Carbon	%	---	---	---	0.41		0.75	
Total Sulfides	mg/kg	---	---	---	271		973	
Ammonia	mg/kg	---	---	---	11.2		27.2	
Gravel	%	---	---	---	0.6		2.1	
Sand	%	---	---	---	65.5		32.2	
Silt	%	---	---	---	25.2		53.2	
Clay	%	---	---	---	8.6		12.3	
Grain Size (Fines)	%	---	---	---	33.8		65.5	
Metals and Metalloids								
Antimony	mg/kg	150	---	200	0.26	UJ	0.13	J
Arsenic	mg/kg	57	507.1	700	4.86	J	10.7	J
Cadmium	mg/kg	5.1	---	14	0.05	J	0.08	J
Chromium	mg/kg	260	---	---	12		15.2	
Copper	mg/kg	390	---	1,300	24.2		32.1	
Lead	mg/kg	450	975	1,200	5.03	J	7.48	J
Mercury	mg/kg	0.41	1.5	2.3	0.0164	J	0.0293	
Selenium	mg/kg	---	3	---	0.76		0.78	
Silver	mg/kg	6.1	---	8.4	0.1	J	0.11	J
Zinc	mg/kg	410	---	3,800	34.7	J	44.1	J
Butyltins								
Tributyltin ion	µg/kg	---	73	---	11.9		3.84	U
Organics								
PAHs								
Naphthalene	µg/kg	2,100	---	2,400	6	J	6.2	J
Acenaphthylene	µg/kg	560	---	1,300	19.9	U	19.9	U
Acenaphthene	µg/kg	500	---	2,000	19.9	U	19.9	U
Fluorene	µg/kg	540	---	3,600	5.9	J	6.2	J
Phenanthrene	µg/kg	1,500	---	21,000	16.7	J	23.9	
Anthracene	µg/kg	960	---	13,000	6.4	J	8.1	J
2-Methylnaphthalene	µg/kg	670	---	1,900	6	J	7.4	J
Total LPAH	µg/kg	5,200	---	29,000	41	J	51.8	J
Fluoranthene	µg/kg	1,700	4,600	30,000	24.6		42.5	
Pyrene	µg/kg	2,600	11,980	16,000	59.8		98.4	
Benzo(a)anthracene	µg/kg	1,300	---	5,100	15.4	J	20.6	
Chrysene	µg/kg	1,400	---	21,000	22.2		48.8	
Benzofluoranthenes	µg/kg	3,200	---	9,900	75.2		98	
Benzo(a)pyrene	µg/kg	1,600	---	3,600	25.4		28.9	
Indeno(1,2,3-c,d)pyrene	µg/kg	600	---	4,400	22.9		27.6	

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
Dibenzo(a,h)anthracene	µg/kg	230	---	1,900	7.1	J	8.7	J
Benzo(g,h,i)perylene	µg/kg	670	---	3,200	29.1		39.2	
Total HPAH	µg/kg	12,000	---	69,000	281.7	J	412.7	J
Chlorinated Hydrocarbons								
1,4-Dichlorobenzene	µg/kg	110	---	120	1.7	J	1	J
1,2-Dichlorobenzene	µg/kg	35	---	110	1.1	J	5	U
1,2,4-Trichlorobenzene	µg/kg	31	---	64	19.9	U	19.9	U
Hexachlorobenzene	µg/kg	22	168	230	5	U	5	U
Phthalates								
Dimethyl phthalate	µg/kg	71	---	1,400	19.9	U	19.9	U
Diethyl phthalate	µg/kg	200	---	1,200	19.9	U	19.9	U
Di-n-butyl phthalate	µg/kg	1,400	---	5,100	19.9	U	19.9	U
Butyl benzyl phthalate	µg/kg	63	---	970	19.9	U	8.2	J
Bis(2-ethylhexyl)phthalate	µg/kg	1,300	---	8,300	34.6	J	67.5	
Di-n-octyl phthalate	µg/kg	6,200	---	6,200	19.9	U	19.9	U
Phenols								
Phenol	µg/kg	420	---	1,200	9.4	J	9.7	J
2-Methylphenol	µg/kg	63	---	77	19.9	U	19.9	U
4-Methylphenol	µg/kg	670	---	3,600	19.9	U	19.9	U
2,4-Dimethylphenol	µg/kg	29	---	210	19.9	U	2.2	J
Pentachlorophenol	µg/kg	400	504	690	99.6	U	99.7	U
Miscellaneous Extractables								
Benzyl alcohol	µg/kg	57	---	870	19.9	U	19.9	U
Benzoic acid	µg/kg	650	---	760	199	UJ	199	UJ
Dibenzofuran	µg/kg	540	---	1,700	19.9	U	4.6	J
Hexachlorobutadiene	µg/kg	11	---	270	0.8	J	5	U
N-Nitrosodiphenylamine	µg/kg	28	---	130	19.9	U	19.9	U
Pesticides and PCBs								
4,4'-DDD	µg/kg	16	---	---	0.98	U	0.99	U
4,4'-DDE	µg/kg	9	---	---	0.98	U	0.99	U
4,4'-DDT	µg/kg	12	---	---	0.98	U	0.99	U
Total 4,4'-DDX	µg/kg	---	50	69	0.98	U	0.99	U
Aldrin	µg/kg	9.5	---	---	0.49	U	1.98	U
Total Chlordane	µg/kg	2.8	37	---	1.97	U	2.98	U
Dieldrin	µg/kg	1.9	---	1,700	0.98	U	0.99	U
Heptachlor	µg/kg	1.5	---	270	0.49	U	0.5	U
Total PCBs	µg/kg	130	38*	3,100	8.0	J	13.6	J
Dioxins/Furans								
2,3,7,8-TCDF	ng/kg	---	---	---	3.73		32.5	
2,3,7,8-TCDD	ng/kg	---	---	---	0.114	U	0.148	U
1,2,3,7,8-PeCDF	ng/kg	---	---	---	8.27		35.8	
2,3,4,7,8-PeCDF	ng/kg	---	---	---	3.30		13.0	

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.977	J	1.29	
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	17.9	J	58.5	J
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	4.03		16.1	
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	1.77		4.91	
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	2.73		7.51	
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	1.04		1.30	U
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	4.45		6.97	
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	2.35		2.91	
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	19.9		41.8	
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	3.39		9.34	
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	115		124	
OCDF	ng/kg	---	---	---	45.5		92.1	
OCDD	ng/kg	---	---	---	1110		989	
Total TEQ (ND = 0)	ng/kg	4	10	---	7.74		21.28	
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	7.80		21.42	
Total TCDF	ng/kg	---	---	---	7.02		77.3	
Total TCDD	ng/kg	---	---	---	3.29		5.77	
Total PeCDF	ng/kg	---	---	---	25.4		94.3	
Total PeCDD	ng/kg	---	---	---	7.00		4.36	
Total HxCDF	ng/kg	---	---	---	50.7		133	
Total HxCDD	ng/kg	---	---	---	39.3		49.1	
Total HpCDF	ng/kg	---	---	---	58.3		109	
Total HpCDD	ng/kg	---	---	---	279		276	

Exceeds SL	Exceeds BT	Exceeds ML

Abbreviations:

BT = bioaccumulation trigger
DDD = dichlorodiphenyldichloroethane
DDE = dichlorodiphenyldichloroethylene
DDT = dichlorodiphenyltrichloroethane
DDX = sum of DDD, DDE, DDT
DL = detection limit
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH
ML = maximum level
ng/kg = nanograms per kilogram
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
SL = screening level
TEQ = toxic equivalent

Validation Qualifier (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 3. 2020 Dioxin/Furan Congener Results for Individual Core Samples

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-P1-S Results	BW20-P1-S VQ	BW20-P2-S Results	BW20-P2-S VQ	BW20-P3-S Results	BW20-P3-S VQ
Dioxins/Furans										
2,3,7,8-TCDF	ng/kg	---	---	---	3.21		9.94		2.06	
2,3,7,8-TCDD	ng/kg	---	---	---	0.129	U	0.302	UJ	0.092	U
1,2,3,7,8-PeCDF	ng/kg	---	---	---	7.61		15.4		3.72	
2,3,4,7,8-PeCDF	ng/kg	---	---	---	2.44		6.83		1.54	
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.952	J	1.63		0.663	UJ
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	18.9		31.3		6.75	
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	5.82		9.57		2.02	
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	1.90		3.50		0.928	J
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	2.48		5.21		1.16	
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	1.10	U	2.13		0.599	J
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	4.66		10.1		3.15	
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	2.42		4.94		1.60	
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	22.5		41.9		10.4	
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	4.10		7.46		1.92	
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	104		234		62.6	
OCDF	ng/kg	---	---	---	58.4		102		24.7	
OCDD	ng/kg	---	---	---	1070		2140		628	
Total TEQ (ND = 0)	ng/kg	4	10	---	7.50		15.32		3.35	
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	7.62		15.47		3.72	
Total TCDF	ng/kg	---	---	---	7.85		27.9		4.72	
Total TCDD	ng/kg	---	---	---	2.82		4.20		1.76	
Total PeCDF	ng/kg	---	---	---	18.0		53.6		11.9	
Total PeCDD	ng/kg	---	---	---	2.97		4.06		1.82	
Total HxCDF	ng/kg	---	---	---	50.3		96.0		19.9	
Total HxCDD	ng/kg	---	---	---	33.8		83.8		24.0	
Total HpCDF	ng/kg	---	---	---	67.6		122		31.3	
Total HpCDD	ng/kg	---	---	---	263		648		166	

Exceeds SL	Exceeds BT	Exceeds ML

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

Exceeds SL	Exceeds BT	Exceeds ML

Qualifiers (Q):

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 method reporting limit/method detection limit (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.

Notes:

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 included a Stage 4 data package if validation is required in the future (NewFields and L-E 2021).

1.2 Bioaccumulation Study Project Overview

In the summer of 2022, the Port conducted DMMP bioaccumulation testing and chemical analysis at PCT to assess whether the proposed dredged material was suitable for open-water disposal at the Commencement Bay DMMP site. Bioaccumulation testing was conducted due to dioxin/furan concentrations that exceeded the SL for DMMU PCT-1 and the bioaccumulation trigger (BT) for DMMU PCT-2 during the 2020 DMMP characterization (see Table 2). In addition, the test sediment from DMMU PCT-2 was re-analyzed for total chlordane using a high-resolution method (EPA method 1699) to ensure reporting limits were below the SL. All other DMMP chemical parameters were undetected or measured at concentrations below corresponding SLs during the 2020 DMMP characterization.

The berthing depth for PCT is −51 feet MLLW. The sediment characterization depth was the berthing depth including an additional 1 foot of allowable overdepth to −52 feet MLLW. During development of the SAP for the bioaccumulation testing, the Port had expressed an interest to increase the overdepth from 1 foot to 2 feet due to operational constraints created by the tight overdredge allowance during recent dredging at the WUT and Husky terminals. Dredging around the thin edges of the mounded areas and removal of displaced large riprap armoring along the toe of slope, while staying within the 1-foot overdepth, left some slightly high areas in the berthing areas in the range of 0.1–0.2 feet above the target of -51 feet MLLW, and a small amount of material along the fender face. These slightly higher areas and proximity to the fender face were problematic to re-dredge and stay above the 1-foot overdredge allowance.

The additional 1 foot of overdepth proposed by the Port would likely include “native” material, which could change the ratio of “native” versus overlying sediment that was originally characterized in 2020. Due to the dredging constraints described above, the DMMP agencies recommended that the bioaccumulation testing of the sediments to −52 feet MLLW, as originally characterized, would be more representative of the actual dredged material (DMMP 2022). Therefore, the Port conducted bioaccumulation testing of sediment to −52 feet MLLW to be consistent with the 2020 study. As part of the sampling effort, two-foot Z-sample composites were collected to allow for verification of the sediment quality of the “leave” surface (DMMP 2021b). Characterization of the Z-sample composites covered the additional 1 foot of overdepth that may be needed by the Port due to dredging constraints, as well as compliance with the antidegradation standards for the “leave” surface (DMMP 2022).

Core sampling locations were the same as targeted during the 2020 Blair Waterway maintenance dredging project, except for Station P3. Based on the review of the bathymetry collected by Seattle District in October 2021, the mound near P3 had shifted slightly to the northeast. Therefore, the sampling location was moved 25 meters to the northeast to target the mound in that region[1] (Figure 2). It was expected that the propeller-wash from vessels operating in the berthing area could slightly alter the geometry of the mounds over time. Propeller wash from container vessels have created scour holes that generally remain in the

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[1] This sampling modification relative to the 2020 study was outlined in the bioaccumulation SAP and approved by the DMMP agencies (NewFields and L-E 2022).

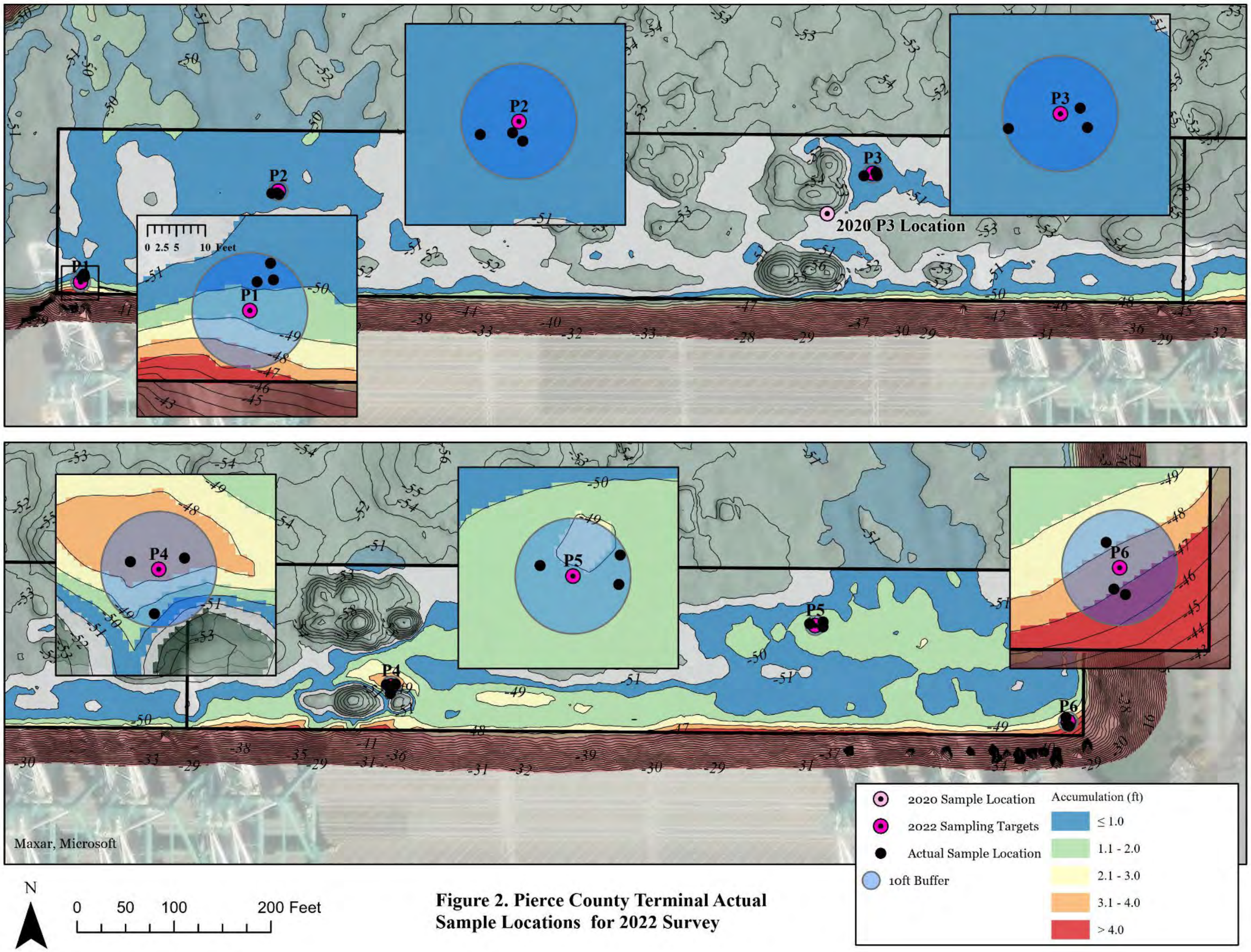

Figure 2. Pierce County Terminal Actual Sample Locations for 2022 Survey

same areas. The mounds near the scour holes tend to shift around more by propeller wash compared to distant areas (east and west) of the berth (see Figures 1 and 2).

The updated estimate of dredged material volume at PCT, based on 2021 Seattle District bathymetry, is summarized in Table 4. The engineered volume estimate included a 2-foot overdepth and the approximate slope slough volume to reflect the maximum dredged material volume that may be removed during dredging, as described above. Based on these updated volume estimates, DMMU PCT-1 would normally require four samples to comply with a moderate ranking (a minimum of one sample for every 4,000 cy of material and a surface DMMU size of up to 16,000 cy). However, the original sampling design was followed (three samples for DMMU PCT-1) to be consistent with the previous sampling and provide similar concentrations of dioxins/furans in the re-sampled DMMU (DMMP 2022).

A tiered testing program was conducted to allow for the analysis of dioxins/furans in the Z-layer samples prior to the initiation of bioaccumulation testing. The two surface DMMUs and the two corresponding Z-sample composites were initially analyzed for DMMP conventionals and dioxins/furans. In addition, DMMU sample PCT-2 was analyzed for total chlordane. The concentration of dioxins/furans in the Z-sample composites were used to determine whether bioaccumulation testing of the Z-sample composites was necessary to comply with state antidegradation standards. Upon receipt of the analytical results, the Dredged Material Management Office (DMMO) was consulted to confirm the need for bioaccumulation testing of the Z-sample composites.

A reference sediment from Carr Inlet was collected by the biological laboratory for the bioaccumulation testing. The reference sediment was analyzed for DMMP conventionals and dioxins/furans.

Table 4. 2022 PCT Project Maximum Expected Dredged Material Volumes Including 2-foot Overdepth (KPFF 2022)

DMMU	Berthing Depth (ft MLLW)	Dredge Volume to Berthing Depth (cy)	Dredge Volume 2-foot Overdepth (cy)	Approximate Slough (cy)	Total Volume (cy)
PCT-1	–51	6,883	7,597	1,489	**15,969**
PCT-2	-51	4,907	5,416	1,061	**11,384**
Totals:		**11,790**	**13,013**	**2,550**	**27,462**

Notes:
The table includes the volume for 2-foot overdepth to reflect the maximum possible dredged material volume that could be removed as part of this project (see Section 1.2).
The maximum expected total volume includes all dredge, 100% available overdepth, and 100% slough determined using the Seattle District bathymetry data collected in October 2021 (KPFF 2022).
Assumed instant slough slope of 1.5:2.

2.0 Data Collection and Analysis Methods

This section briefly describes the methods for positioning, sample collection, processing, and laboratory analysis for the PCT bioaccumulation study. The study design and detailed methods are provided in the SAP (Appendix A). Deviations from the SAP are summarized in Section 2.8.

2.1 Sediment Sampling Overview

Sediment sampling activities were conducted in the PCT berthing areas from June 21 through 24, 2022. The research vessel (R/V) *Ingalls*, a 36-foot aluminum landing craft owned and operated by Gravity Environmental (Gravity), was the platform used for the sediment core collection. Sediment cores were collected using a vibracore sampler 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 NewFields operated the vibracorer and measured water depth and core penetration under the direction of the NewFields field lead.

2.2 Navigation and Positioning

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 5. Figure 2 displays the DMMU configurations and actual sampling locations for the PCT bioaccumulation study.

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Table 5. DMMUs, Sample Locations, Actual Sampling Coordinates, Mudline, and Sample Elevations

Surface DMMU	Estimated Volume (cy)	Z-Layer Composite	Sample Location	Core Replicate Processed	Date (mm/dd/yyyy)	Time (hh:mm)	State Plane WA-S, NAD83 (ft)		Latitude (N) NAD83	Longitude (W) NAD83	Core Penetration (ft.)	Core Recovery (ft.)	Recovery (percent)	Measured Water Depth (ft.)	Tidal Height (ft.)	Mudline (ft. MLLW)	Surface DMMU (ft. MLLW)		Z-sample (ft. MLLW)		Z2-sample (ft. MLLW)	
							Northing	Easting									Top	Bottom	Top	Bottom	Top	Bottom
PCT-1-C	15,969	PCT-1-Z	P1	D	6/21/2022	13:45	1173077.41	706092.76	47.25425125	122.38205669	5.5	6.2	113	-56.8	+6.5	-50.3	-50.3	-52.0	-52.0	-54.0	-54.0	-56.2
				G	6/21/2022	15:37	1173074.97	706089.62	47.25424249	122.38206621	5.5	6.8	124	-54.2	+3.9	-50.3	-50.3	-52.0	-52.0	-54.0	-54.0	-56.4
				H	6/23/2022	8:10	1173077.81	706089.87	47.25424336	122.38205480	5.7	5.6	98	-51.5	+1.3	-49.8	-49.8	-52.0	-52.0	-54.0	-54.0	-55.4
			P2	C	6/22/2022	11:07	1173281.28	706167.74	47.25447008	122.38124319	6.0	4.5	75	-56.5	+6.5	-50.0	-50.0	-52.0	-52.0	-54.0		
				D	6/22/2022	11:40	1173273.96	706169.14	47.25447344	122.38127278	6.0	4.7	78	-57.4	+7.1	-50.3	-50.3	-52.0	-52.0	-54.0	-54.0	-54.5
				G	6/22/2022	13:17	1173279.57	706169.25	47.25447411	122.38125022	5.0	4.0	80	-58.3	+8.0	-50.3	-50.3	-52.0	-52.0	-54.0	-54.0	-54.3
			P3	D	6/24/2022	10:30	1173898.82	706165.16	47.25450336	122.37875694	5.0	4.0	80	-51.9	+1.2	-50.7	-50.7	-52.0	-52.0	-54.0	-54.0	-54.7
				E	6/24/2022	10:50	1173885.15	706165.46	47.25450331	122.37881197	5.0	4.6	92	-52.3	+1.4	-50.8	-50.8	-52.0	-52.0	-54.0	-54.0	-55.1
				F	6/24/2022	11:00	1173897.69	706168.56	47.25451261	122.37876181	5.0	5.0	100	-52.7	+2.0	-50.7	-50.7	-52.0	-52.0	-54.0	-54.0	-55.4
PCT-2-C	11,384	PCT-2-Z	P4	A	6/23/2022	09:10	1174417.04	706060.76	47.25425106	122.37666072	8.0	6.0	75	-49.0	+1.6	-47.4	-47.4	-52.0	-52.0	-53.4		
				B	6/23/2022	09:40	1174426.44	706061.06	47.25425247	122.37662294	8.0	7.9	98	-49.4	+2.1	-47.3	-47.3	-52.0	-52.0	-54.0	-54.0	-54.7
				E	6/23/2022	10:54	1174420.89	706051.62	47.25422625	122.37664436	6.0	5.3	88	-55.6	+5.6	-50.0	-50.0	-52.0	-52.0	-54.0	-54.0	-54.8
			P5	A	6/23/2022	14:00	1174855.77	706108.06	47.25440928	122.37489911	6.0	5.6	93	-57.9	+8.4	-49.5	-49.5	-52.0	-52.0	-54.0	-54.0	-54.8
				B	6/23/2022	14:30	1174869.69	706109.39	47.25441383	122.37484319	6.0	7.0	117	-58.0	+8.7	-49.3	-49.3	-52.0	-52.0	-54.0	-54.0	-56.0
				C	6/23/2022	14:55	1174869.28	706104.32	47.25439992	122.37484433	6.0	5.0	83	-58.0	+8.7	-49.3	-49.3	-52.0	-52.0	-54.0		
			P6	A	6/23/2022	15:35	1175119.64	705993.06	47.25411128	122.37382583	9.0	9.5	106	-55.2	+8.6	-46.6	-46.6	-52.0	-52.0	-54.0	-54.0	-56.0
				B	6/23/2022	15:55	1175117.68	705994.07	47.25411392	122.37383383	9.0	9.0	100	-55.1	+8.9	-46.7	-46.7	-52.0	-52.0	-54.0	-54.0	-55.4
				D	6/24/2022	09:35	1175116.62	706002.19	47.25413611	122.37383886	9.0	8.3	92	-48.3	+0.2	-48.1	-48.1	-52.0	-52.0	-54.0	-54.0	-56.0

Notes:
Z-layer composites were comprised of the Z-samples collected for each of the DMMUs. For example, PCT-1-Z is the Z-layer composite sample comprised of Z-samples collected from the cores collected at P1, P2, and P3.
Z2 sample archives not available for collection in cores P2 Rep C, P4 Rep A, and P5 Rep C
NAD83 = North American Datum of 1983

2.3 DMMUs and Sampling Locations

The DMMUs and target sampling locations for the 2022 PCT bioaccumulation study were the same as the 2020 Blair Waterway maintenance dredging project, except for sampling location P3. The sediment mound near P3 appeared to have shifted slightly based on the recent bathymetry collected by the Seattle District (October 2021). The target location for P3 was moved 25 meters to the northeast to sample the mound in that region (Figure 2).

Vibracores were collected within 10 feet (3 meters) of target sampling locations. Geographic coordinates for the actual core sample locations and depth intervals for collected samples are provided in Table 5. Six vibracore locations were occupied within the PCT project area and three cores were collected at each location to obtain adequate volume for chemical and bioaccumulation testing for both the DMMUs and Z-layer composite samples (Figure 2). Each vibracore was advanced to at least −54 ft MLLW to obtain 2-foot Z-samples.

2.4 Sample Collection Methods

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

2.4.1 Vibracore Samples

Core samples were collected using Gravity's vibracorer equipped with a pre-cleaned Lexan plastic core barrel and a polyethylene liner. The end of the sediment core barrel (4-inch diameter) included an "eggshell" core catcher to retain sediments that entered the barrel.

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 (see Table 5).

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 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.

If all core intervals for a DMMU 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 or Z-layer composite was collected, the sample was homogenized in a pre-cleaned stainless-steel pot using a pre-cleaned stainless-steel paint mixer powered by an electric drill. The sediment was homogenized until a consistent sediment color and texture was achieved. Aliquots of the homogenized sediment were placed in the appropriate pre-cleaned containers for conventionals, chlordane (PCT-2-C only), and dioxin/furan analyses.

Archive samples (8-oz. jar) were collected from each individual core interval used in each of the DMMU and Z-layer composites. Most core samples were driven deeper than the target depth, resulting in the collection of sediment below the Z-layer ("Z2-layer"). Therefore, archived samples were collected from the Z2-layer when captured in the core (see Table 5). Archive samples were also collected along the length of each core consisting of the top 1 foot, and 2-foot intervals thereafter, for potential future chemical analysis. A summary of all collected sediment samples for chemical analysis, archiving, and bioaccumulation testing is provided in Table 6.

All chemistry and archived sediment samples were stored on ice, in coolers, and under chain-of-custody until delivery to the chemical laboratory (Analytical Resources, Inc. [ARI], Tukwila, WA). Sediments for bioaccumulation testing were placed in polyethylene bags with no headspace and stored on ice, in coolers, and under chain-of-custody until delivery to the bioaccumulation testing laboratory (EcoAnalysts, Port Gamble, WA).

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.

2.4.2 Carr Inlet Reference Sample Collection

A reference sediment was collected from Carr Inlet for bioaccumulation testing with the PCT sediments. The reference sediment was collected by EcoAnalysts on June 30, 2022, using a stainless steel 0.6-m^2 Ponar grab sampler. Sample location coordinates for the Carr Inlet sample are provided in Table 7. The top 10 centimeters of sediment from 10 grabs were collected for a minimum of 26.5 liters of sediment needed for the bioaccumulation testing. The sediment was homogenized until a consistent sediment color and texture was achieved.

Based on the grain sizes for the PCT test sediments, a reference sediment with an approximate grain size of 47% fines (silt and clay) was targeted. Using the wet sieving method in the field, a Carr Inlet reference of approximately 40% fines was collected by EcoAnalysts. A subsample for conventionals and dioxin/furan analysis was delivered to ARI immediately following sample collection at Carr Inlet. Sediments collected for bioaccumulation testing remained in the custody of EcoAnalysts and were placed in cold storage at the Port Gamble, WA, laboratory until bioaccumulation testing was initiated (Table 6).

Table 6. PCT and Carr Inlet Sediment Samples Collected

Sample ID	Grain Size	Total Solids	Total Volatile Solids (TVS)	Total Organic Carbon (TOC)	Ammonia	Total Sulfides	Total Chlordane	Dioxins/Furans	Sediment Archive	Bioaccumulation
Pierce County Terminal										
BW22-PCT-1-C	X	X	X	X	X	X	-	X	A	X
BW22-PCT-1-Z	X	X	X	X	X	X	-	X	A	X
BW22-P1-S	-	-	-	-	-	-	-	-	A	-
BW22-P1-Z	-	-	-	-	-	-	-	-	A	-
BW22-P1-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P1-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P1-D-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P1-G-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P2-S	-	-	-	-	-	-	-	-	A	-
BW22-P2-Z	-	-	-	-	-	-	-	-	A	-
BW22-P2-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P2-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P2-D-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P2-G-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P3-S	-	-	-	-	-	-	-	-	A	-
BW22-P3-Z	-	-	-	-	-	-	-	-	A	-
BW22-P3-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P3-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P3-D-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P3-E-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P3-F-Z2	-	-	-	-	-	-	-	-	A	-
BW22-PCT-2-C	X	X	X	X	X	X	X	X	A	X
BW22-PCT-2-Z	X	X	X	X	X	X	-	X	A	X
BW22-P4-S	-	-	-	-	-	-	-	-	A	-
BW22-P4-Z	-	-	-	-	-	-	-	-	A	-
BW22-P4-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P4-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P4-3-5	-	-	-	-	-	-	-	-	A	-
BW22-P4-B-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P4-E-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P5-S	-	-	-	-	-	-	-	-	A	-
BW22-P5-Z	-	-	-	-	-	-	-	-	A	-
BW22-P5-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P5-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P5-A-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P5-B-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P6-S	-	-	-	-	-	-	-	-	A	-
BW22-P6-Z	-	-	-	-	-	-	-	-	A	-
BW22-P6-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P6-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P6-3-5	-	-	-	-	-	-	-	-	A	-
BW22-P6-A-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P6-B-Z2	-	-	-	-	-	-	-	-	A	-
BW22-P6-D-Z2	-	-	-	-	-	-	-	-	A	-

Sample ID	Grain Size	Total Solids	Total Volatile Solids (TVS)	Total Organic Carbon (TOC)	Ammonia	Total Sulfides	Total Chlordane	Dioxins/Furans	Sediment Archive	Bioaccumulation
Carr Inlet										
Carr Ref	X	X	X	X	X	X	-	X	A	X
Total Samples	5	5	5	5	5	5	1	5	45	5

Notes:
X: Sample analyzed
A: Sample archived

Table 7. Carr Inlet Reference Sample Location

Sample Location	Date (mm/dd/yyyy)	Time (hh:mm)	Latitude (N) NAD83	Longitude (W) NAD83	Sample Collection Depth (cm)	Notes:
Carr Ref	6/30/2022	12:45	47.33240	122.67673	10 cm	10 grabs collected

2.5 Bioaccumulation Testing Methods

Bioaccumulation testing by EcoAnalysts followed DMMP guidance (DMMP 2021b) as outlined in the SAP (Appendix A). Testing was conducted using the adult bivalve (*Macoma nasuta*) and adult polychaete (*Alitta virens*) using separate exposure tanks for a 45-day period. Five replicates for each species were generated for each DMMU and Z-layer composite, as well as three pre-test replicates for each species (Table 8).

The EcoAnalysts bioaccumulation laboratory report is provided in Appendix C. The bioaccumulation test was validated by 95 percent mean survival for *A. virens* and 96 percent for *M. nasuta* in the control treatment.

Survival in the test treatments ranged from 92.5 to 100 percent for *A. virens*. Recovered replicate tissue masses for *A. virens* ranged from 21.0 to 42.5 grams wet weight (ww), within the targeted test tissue mass of greater than 20 grams per replicate. Survival for the *M. nasuta* test treatments ranged from 74 to 90 percent. The recovered replicate tissue masses for *M. nasuta* ranged from 17.7 to 42.3 grams ww, with tissue recovery below the targeted mass in the control replicates. However, all test and reference treatment replicates were within the targeted wet tissue mass of greater than 20 grams per replicate.

Water quality parameters were within the target ranges for the duration of the 45-day bioaccumulation tests except for temperature, which exceeded the target range of 14 ±2 degrees Celsius (Tables 9 and 10). However, this deviation was within the tolerance range for both test organisms and did not appear to affect organism survival.

2.6 Chemical Analytical Methods

The specific conventional and chemical analyses that were measured, sample preparation methods, analytical methods, and target reporting limits (RLs) are discussed in detail in the SAP (Appendix A). All samples were analyzed by ARI except for grain size, which was analyzed by AmTest Inc., Redmond, WA, and total chlordane, which was analyzed by Vista Analytical Laboratory, El Dorado Hills, CA. Sample and laboratory identification numbers for the collected tissue and sediment samples as well as the chemical analysis parameters are listed in Tables 8 and 11.

2.7 Summary of Daily Sampling Activities

A summary of sampling activities and any issues encountered was provided to the DMMP agencies at the end of each sampling day. The daily summaries are provided below.

Day 1 (June 21, 2022): Core sampling activities were initiated in the PCT berthing areas in the Blair Waterway. Day 1 core sampling was limited to location P1.

- Seven vibracores were attempted at location P1. Core recoveries were greater than 100% for the cores, similar to what was observed for some of the core sampling conducted for the 2020 chemistry-only DMMP characterizations at the Husky, WUT, and PCT terminals (NewFields and L-E 2021).
- During the 4th coring attempt, the vibracore was advanced one foot at a time, stopping to get measurements of sediment recovery within the core using Gravity's in-situ recovery system (ISRS). Penetration and core recovery were consistent during the drive until the core penetrated approximately one foot into the Z-layer. At that point, the amount of sediment increased in the core barrel.

- It appeared that vibracoring in compact sands in the Z-layer using a Lexan core barrel fluidized the sand around the vibrating tip of the core, resulting in sand flowing into the core barrel faster than the core advanced into the sediment. The Lexan barrel is more flexible than a metal core barrel and can have a greater amplitude of movement, which can then fluidize a greater area/volume of sand (D. Browning, personal communication, July 26, 2022).
- Two of the P1 cores (replicates D and G) were retained and processed. Both cores had greater than 100% recovery (113% for core replicate D and 124% for replicate G). The core lithologies consisted of dark olive brown silts overlying damp medium to fine sands (presumed to be native sands). Core intervals deeper than the Z-layer (Z2 samples) were collected and archived.
- Collected samples were stored on ice in coolers. Sediment for the bioaccumulation composite PCT-1 was placed in polyethylene bags and stored on ice in a cooler.

Day 2 (June 22, 2022): Core sampling activities continued in the PCT berthing areas in the Blair Waterway. Core samples from locations P2 and P3 were collected during Day 2.

- Seven vibracores were attempted at location P2. Core recoveries were acceptable, ranging from 75% to 80%. Three P2 cores (replicates C, D, and G) were retained and processed. Core recoveries were 75% for replicate C, 78% for replicate D, and 80% for replicate G. Medium to fine sands were present at the base of the cores, which were presumed to be native sands.
- Three vibracores were attempted at location P3. Core recoveries were variable and exceeded 100% for replicates B and C. Approximately one foot of material was needed for the DMMU sample. Core recoveries were 89% for replicate A, 158% for replicate B, and 250% for replicate C. It was suspected that higher recoveries occurred because the amount of DMMU material was relatively thin before the vibracore penetrated the underlying native sands. The lithologies were similar for the three cores (0.5 feet or less of unconsolidated fine silt over medium to fine sands. However, per consultation with the DMMO representative, all three core samples were rejected due to concerns with sample integrity of the Z-samples. Cores at P3 were recollected on Day 4.
- Collected samples were stored on ice in coolers. Sediments for the bioaccumulation composite PCT-1 (cores from P2 and P3) were placed in polyethylene bags and stored on ice in coolers.

Day 3 (June 23, 2022): Core sampling activities continued in the PCT berthing areas in the Blair Waterway. Core samples from locations P1, P4, P5, and P6 were collected during Day 3.

- A third core from location P1 was collected and processed. Core sample recovery for replicate H was 98%.
- Three acceptable cores were collected and processed at location P4. Core recoveries were 75% for replicate A, 98% for replicate B, and 88% for replicate E. Fine sand (approximately one to two feet) was present on the surface of the cores, presumed to be material that had been deposited from propeller wash. Location P4 was near a scour hole. In consultation with the DMMO representative, this material was included as part of the surface DMMU samples.
- Three acceptable cores from location P5 were collected and processed. Core recoveries were 93% for replicate A, 117% for replicate B, and 83% for replicate C. Approximately

one foot of fine sand was present on the surface and presumed to be material deposited from propeller wash.

- Two acceptable cores from location P6 were collected and processed. Core recoveries were 106% for replicate A and 100% for replicate B.
- Collected samples were stored on ice in coolers. Sediments for the bioaccumulation composite PCT-1 (core from P1) and composite PCT-2 (cores from P4, P5, and P6) were placed in polyethylene bags and stored on ice in coolers.

Day 4 (June 24, 2022): Core sampling activities were completed in the PCT berthing areas in the Blair Waterway. Core samples from locations P3 and P6 were collected during Day 3. The shore-side processing area was demobilized following completion of core processing.

- The third core sample from location P6 was collected and processed. Core sample recovery for replicate D was 92%.
- Three cores were recollected and processed at location P3. Core recoveries were 80% for replicate D, 100% for replicate E, and 100% for replicate F.
- DMMU and Z-layer composite samples were prepared. Wet sieving was conducted on the composite samples:
    - PCT-1-C = 47% fines
    - PCT-1-Z = 24% fines
    - PCT-2-C = 40% fines
    - PCT-2-Z = 47% fines

2.8 Deviations from the SAP

This section describes any deviations or issues related to the field sampling or laboratory testing, relative to those proposed in the SAP (Appendix A).

- **Z2-layer Samples** – Most of the vibracores were advanced past the minimum target depth of -54 ft MLLW to ensure adequate core recoveries. In most cores, this resulted in the collection of sediment below the Z-layer, which was retained as an archive sample (Z2-layer samples). The list of Z2-layer samples archived at ARI is provided in Table 6.
- **Z-layer Sample for Location P4 Replicate A** – Although all vibracores were advanced to a minimum of -54 ft MLLW, the Z-sample collected from location P4 core replicate A was 1.4 feet in length instead of 2.0 feet. The vibracore for P4 replicate A penetrated 8 feet (advanced to -55.4 ft MLLW), but the core recovery was 75%. Cores were processed linearly and not adjusted for compaction per the SAP, so the Z-sample length was 1.4 feet. The remaining two cores collected from location P4, as well as the six cores collected from locations P5 and P6, were all 2.0 feet in length. Therefore, including the 1.4-foot core for P4 replicate A was not expected to affect the representativeness of the Z-layer composite for PCT-2.
- **Fluidization of Compact Sands** – As described in Section 2.7, it appeared that vibracoring in compact sands in the Z-layer using a Lexan plastic core barrel caused fluidization of the sand around the vibrating tip of the core, resulting in sand flowing into the core barrel faster than the core advanced into the sediment. The DMMP agencies were consulted in the field, and it was not believed that sand fluidization affected the integrity of the surface sections of the core samples. However, to ensure the integrity of the Z-layer samples, the processing of cores with recoveries much greater than 100% was avoided. For example, the first three core samples collected at Station P3 were rejected

due to possible concerns with sample integrity. Four cores were processed that had recoveries greater than 100% (P1 replicate D = 113%, P1 replicate G = 124%, P5 replicate B = 117%, and P6 replicate A = 106%). For future vibracore sampling projects in the Blair Waterway, a metal vibracore barrel will be available for sampling if Lexan core barrels cause fluidization in compact sands resulting in core recoveries greater than 100%.

- **Carr Inlet Reference Sediment** – EcoAnalysts collected the Carr Inlet reference sediment at 12:45 pm on June 30, 2022, and sediments were kept on ice in two coolers during transport to ARI. Upon arrival at ARI, EcoAnalysts created homogenized samples (which required opening the sample bags, mixing, and extracting subsamples) and filled sample jars for conventionals and dioxin/furan sample analyses. The sample jars were then taken into ARI sample receiving at 4:05 pm. ARI noted the log-in temperature of each reference sediment sample jar was 21.9 degrees Celsius. Since the jars were recently filled, the glass jar temperatures were warmer than the sediment placed inside. ARI put the samples into cold storage upon receipt. In consultation with the DMMO representative on July 5, 2022, it was determined that ARI could proceed with the analysis of conventionals and dioxins/furans given the sample transportation explanation and the short period of time that the sample was out of temperature compliance.
- **Grain Size for Carr Inlet Reference Sediment** – The wet sieve analysis of the reference sediment performed in the field by EcoAnalysts was 40 percent fines, which was within the range of percent fines that was requested for collection in consultation with the DMMO representative (40 to 47 percent fines). EcoAnalysts also performed a wet sieve upon receipt of the reference sample at the Port Gamble laboratory and measured 36 percent fines. However, grain size analysis by AmTest, Inc. determined a grain size of 24.5 percent fines for the reference sediment, which was lower than anticipated. The DMMO representative was consulted about the lower percent fines on August 4, 2022, and the Carr Inlet reference sediment was approved for use for the PCT bioaccumulation testing.

Table 8. Summary of Tissue Samples Submitted for Chemical Analysis

Work Order	Sample ID	Lab ID	Matrix	Analytes		
				Total Solids	Total Lipids	Dioxin/Furan[1]
22I0519	M.n. Pretest Rep 1	22I0519-01	Tissue	X	X	
		22I0519-01RE1				X
22I0519	M.n. Pretest Rep 2	22I0519-02	Tissue	X	X	
		22I0519-02RE1				X
22I0519	M.n. Pretest Rep 3	22I0519-03	Tissue	X	X	
		22I0519-03RE1				X
22I0519	M.n. Carr Ref Rep 1	22I0519-04	Tissue	X	X	
		22I0519-04RE1				X
22I0519	M.n. Carr Ref Rep 2	22I0519-05	Tissue	X	X	
		22I0519-05RE1				X
22I0519	M.n. Carr Ref Rep 3	22I0519-06	Tissue	X	X	
		22I0519-06RE1				X
22I0519	M.n. Carr Ref Rep 4	22I0519-07	Tissue	X	X	
		22I0519-07RE1				X
22I0519	M.n. Carr Ref Rep 5	22I0519-08	Tissue	X	X	
		22I0519-08RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 1	22I0519-09	Tissue	X	X	
		22I0519-09RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 2	22I0519-10	Tissue	X	X	
		22I0519-10RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 3	22I0519-11	Tissue	X	X	
		22I0519-11RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 4	22I0519-12	Tissue	X	X	
		22I0519-12RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 5	22I0519-13	Tissue	X	X	
		22I0519-13RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 1	22I0519-14	Tissue	X	X	
		22I0519-14RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 2	22I0519-15	Tissue	X	X	
		22I0519-15RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 3	22I0519-16	Tissue	X	X	
		22I0519-16RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 4	22I0519-17	Tissue	X	X	
		22I0519-17RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 5	22I0519-18	Tissue	X	X	
		22I0519-18RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 1	22I0519-19	Tissue	X	X	
		22I0519-19RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 2	22I0519-20	Tissue	X	X	
		22I0519-20RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 3	22I0519-21	Tissue	X	X	
		22I0519-21RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 4	22I0519-22	Tissue	X	X	
		22I0519-22RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 5	22I0519-23	Tissue	X	X	
		22I0519-23RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 1	22I0519-24	Tissue	X	X	
		22I0519-24RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 2	22I0519-25	Tissue	X	X	
		22I0519-25RE1				X

Work Order	Sample ID	Lab ID	Matrix	Analytes		
				Total Solids	Total Lipids	Dioxin/Furan[1]
22I0519	M.n. BW22-PCT-2-Z Rep 3	22I0519-26	Tissue	X	X	
		22I0519-26RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 4	22I0519-27	Tissue	X	X	
		22I0519-27RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 5	22I0519-28	Tissue	X	X	
		22I0519-28RE1				X
22I0519	A.v. Pretest Rep 1	22I0519-29	Tissue	X	X	
		22I0519-29 RE1				X
22I0519	A.v. Pretest Rep 2	22I0519-30	Tissue	X	X	
		22I0519-30RE1				X
22I0519	A.v. Pretest Rep 3	22I0519-31	Tissue	X	X	
		22I0519-31RE1				X
22I0519	A.v. Carr Ref Rep 1	22I0519-32	Tissue	X	X	
		22I0519-32RE1				X
22I0519	A.v. Carr Ref Rep 2	22I0519-33	Tissue	X	X	
		22I0519-33RE1				X
22I0519	A.v. Carr Ref Rep 3	22I0519-34	Tissue	X	X	
		22I0519-34RE1				X
22I0519	A.v. Carr Ref Rep 4	22I0519-35	Tissue	X	X	
		22I0519-35RE1				X
22I0519	A.v. Carr Ref Rep 5	22I0519-36	Tissue	X	X	
		22I0519-36RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 1	22I0519-37	Tissue	X	X	
		22I0519-37RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 2	22I0519-38	Tissue	X	X	
		22I0519-38RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 3	22I0519-39	Tissue	X	X	
		22I0519-39RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 4	22I0519-40	Tissue	X	X	
		22I0519-40RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 5	22I0519-41	Tissue	X	X	
		22I0519-41RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 1	22I0519-42	Tissue	X	X	
		22I0519-42RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 2	22I0519-43	Tissue	X	X	
		22I0519-43RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 3	22I0519-44	Tissue	X	X	
		22I0519-44RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 4	22I0519-45	Tissue	X	X	
		22I0519-45RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 5	22I0519-46	Tissue	X	X	
		22I0519-46RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 1	22I0519-47	Tissue	X	X	
		22I0519-47RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 2	22I0519-48	Tissue	X	X	
		22I0519-48RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 3	22I0519-49	Tissue	X	X	
		22I0519-49RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 4	22I0519-50	Tissue	X	X	
		22I0519-50RE1				X

Work Order	Sample ID	Lab ID	Matrix	Analytes		
				Total Solids	Total Lipids	Dioxin/Furan[1]
22I0519	A.v. BW22-PCT-2-C Rep 5	22I0519-51	Tissue	X	X	
		22I0519-51RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 1	22I0519-52	Tissue	X	X	
		22I0519-52RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 2	22I0519-53	Tissue	X	X	
		22I0519-53RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 3	22I0519-54	Tissue	X	X	
		22I0519-54RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 4	22I0519-55	Tissue	X	X	
		22I0519-55RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 5	22I0519-56	Tissue	X	X	
		22I0519-56RE1				X

Notes:
The tissue samples (frozen extract archives) were reanalyzed for dioxin/furan congeners in May and August 2023 and reported with an updated Lab ID (RE1 postscript added). See narrative in Section 5.1 regarding the reanalysis.
M.n. = *Macoma nasuta*
A.v. = *Alitta virens*

Table 9. Water Quality Summary for the *Alitta virens* Bioaccumulation Test

Sample ID	Dissolved Oxygen (mg/L) >5.1			Temperature (°C) 14 ± 2			Salinity (ppt) 30 ± 2			pH (pH units) 6 - 9		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Control	7.5	6.4	8.4	14.7	12.8	**17.4**	31	30	32	7.8	7.2	8.0
Carr Ref	7.6	6.6	8.3	14.7	12.8	**17.4**	31	30	32	7.8	7.3	8.0
BW22-PCT-1-C	7.6	6.2	8.4	14.7	12.6	**17.4**	31	30	32	7.8	7.3	8.0
BW22-PCT-1-Z	7.6	6.7	8.3	14.7	12.6	**17.5**	31	30	32	7.8	7.4	8.0
BW22-PCT-2-C	7.4	5.6	8.3	14.8	12.6	**17.4**	31	30	32	7.8	7.3	8.0
BW22-PCT-2-Z	7.5	6.4	8.4	14.7	12.7	**17.7**	31	30	32	7.8	7.4	8.0

Notes:
Bold values exceeded targeted water quality range   ppt = parts per thousand

Table 10. Water Quality Summary for the *Macoma nasuta* Bioaccumulation Test

Sample ID	Dissolved Oxygen (mg/L) >5.1			Temperature (°C) 14 ± 2			Salinity (ppt) 30 ± 2			pH (pH units) 6 - 9		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
Control	7.8	6.5	8.5	14.8	12.3	**17.3**	31	30	32	7.9	7.5	8.0
Carr Ref	7.7	5.3	8.4	14.8	12.4	**17.3**	31	30	32	7.8	7.6	8.0
BW22-PCT-1-C	7.7	6.5	8.4	15.1	12.6	**17.5**	31	30	32	7.8	7.1	8.0
BW22-PCT-1-Z	7.6	6.3	8.3	15.0	12.8	**17.4**	31	30	32	7.8	7.4	8.0
BW22-PCT-2-C	7.6	6.3	8.3	14.9	12.6	**17.4**	31	30	32	7.8	7.0	8.0
BW22-PCT-2-Z	7.7	5.7	8.4	15.0	12.6	**17.4**	31	30	32	7.8	7.3	8.0

Notes:
Bold values exceeded targeted water quality range   ppt = parts per thousand

Table 11. Summary of Sediment Samples Submitted for Chemical Analysis and Bioaccumulation Testing

Work Order	Sample ID	Lab ID	Sediment Conventionals					Organics		Sediment Archive	Bioaccumulation
			Grain Size	TS/TVS	TOC	Total Sulfides	Ammonia	Pesticides	Dioxin/Furan Congeners		
22F0428	BW22-PCT-1-C	22F0428-01		X	X	X	X		X	A	X
22-A01099		22-A010992	X								
22F0428	BW22-PCT-1-Z	22F0428-02		X	X	X	X		X	A	X
22-A01099		22-A010993	X								
22F0428	BW22-PCT-2-C	22F0428-03		X	X	X	X		X	A	X
22-A01099		22-A010994	X								
2207018		2207018-01						X			
22F0428	BW22-PCT-2-Z	22F0428-04		X	X	X	X		X	A	X
22-A01099		22-A010995	X								
22G0001	BW22-CAR-C	22G0001-01		X	X	X	X		X	A	X
22-A01115		22-A011154	X								

Notes:
TS/TVS = Total Solids/Total Volatile Solids
TOC = total organic carbon
A: Sample archived

3.0 Results

The validated analytical chemistry results for the PCT sediment and bioaccumulation testing for dioxins/furans are presented in this section. Chain of custody forms and laboratory reports are included in Appendix C. The data validation reports are provided in Appendix D and summarized in Section 4.0. Environmental Information Management (EIM) electronic data files of the validated data are provided as Appendix E.

3.1 Sediment Chemistry Results

This section summarizes the conventional and chemistry results for PCT sediment samples collected for the bioaccumulation testing program. Analytical results for surface DMMUs PCT-1-C and PCT-2-C, Z-layer composite samples PCT-1-Z and PCT-2-Z, and the Carr Inlet reference are presented in Table 12. Sediment concentrations that exceeded the DMMP SL, maximum level (ML), or BT are highlighted. Total toxic equivalency (TEQ) calculations for the sediment dioxin/furan congener results using non-detects equal to zero (ND=0*EDL) and using half the estimated detection limit (EDL) for non-detects (ND=1/2*EDL) are provided in Appendix F.

3.1.1 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 location P5.

3.1.2 Sediment Conventionals

The grain sizes of PCT sediments ranged from 28.3 percent fines for PCT-1-Z to 46.0 percent fines for PCT-2-Z. The Carr Inlet reference grain size was 24.5 percent fines. Total volatile solids, TOC, and ammonia were relatively low for all PCT samples. Total sulfides ranged from 501 mg/kg dry weight (dw) for PCT-1-Z to 1,300 mg/kg dw for PCT-2-C (Table 12).

3.1.3 Sediment Chemistry

Total chlordane for sample PCT-2-C and dioxin/furan congeners for all PCT samples and the Carr Inlet reference are listed in Table 12.

The reported concentration for total chlordane was 0.26 µg/kg for PCT-2-C, well below the DMMP SL. During the 2020 characterization, total chlordane was undetected in sample PCT-2-C, but the RL of 2.98 µg/kg just exceeded the DMMP SL of 2.8 µg/kg.

The dioxin/furan TEQ is calculated as a weighted sum that uses toxic equivalence factors (TEFs) to weight the individual dioxin/furan congener concentrations.[2] The influence of the individual congener results on the TEQ varies based on the TEF values, which range from 0.0003 to 1. The

[2] TEFs used for dioxin/furan TEQ calculations are presented in Table 8-5 of the DMMP User Manual (DMMP 2021) and consistent with Van den Berg et al. (2006).

dioxin/furan total TEQ (ND=1/2*EDL) for PCT-1-C was 8.88 ng/kg and for PCT-1-Z was 8.95 ng/kg. Both samples for PCT-1 exceeded the DMMP SL of 4.0 ng/kg TEQ. The dioxin/furan total TEQ for PCT-2-C was 12.82 ng/kg and for PCT-2-Z was 17.49 ng/kg. Both samples for PCT-2 exceeded the DMMP BT of 10 ng/kg TEQ. The dioxin/furan total TEQ for the Carr Inlet reference was very low at 0.490 ng/kg.

Bioaccumulation testing of dioxins/furans was run on all four composite samples (PCT-1-C, PCT-1-Z, PCT-2-C, and PCT-2-Z) to evaluate the potential for bioaccumulation by organisms from exposure to the proposed dredged material (DMMUs) as well as the leave layer (Z-layer composites).

3.2 Bioaccumulation Testing Tissue Chemistry Results

This section summarizes the PCT bioaccumulation testing tissue chemistry results, which included total solids, lipids, and total TEQs for the dioxin/furan congeners (Tables 13 and 14). Total TEQ calculations for the tissue dioxin/furan congener results are provided in Appendix F. Five replicates for each species (*M. nasuta* and *A. virens*) were analyzed for each DMMU, Z-layer composite, and Carr Inlet reference, as well as three pre-test replicates for each species.

The lipid content in *M. nasuta* tissues was relatively consistent for all samples, ranging from 0.61 to 0.72 percent for the pre-test tissues, 0.51 to 0.70 percent for the DMMU and Z-layer composite tissues, and 0.52 to 0.69 percent for the Carr Inlet reference tissues.

Dioxin/furan total TEQs (ND=1/2*EDL) for *M. nasuta* tissues were comparable for the pre-test and Carr Inlet reference tissues, ranging from 0.130 to 0.139 ng/kg ww for the pre-test tissues and 0.138 to 0.169 ng/kg ww for the Carr Inlet reference tissues. For the DMMUs, dioxin/furan TEQs for *M. nasuta* tissues ranged from 0.283 to 0.436 ng/kg ww for PCT-1-C and 0.266 to 0.470 ng/kg ww for PCT-2-C. For the Z-layer composites, *M. nasuta* tissues ranged from 0.400 to 0.574 ng/kg ww for PCT-1-Z and 0.479 to 0.698 ng/kg ww for PCT-2-Z (Figure 3).

The lipid content in *A. virens* tissues showed higher variability among samples, ranging from 0.78 to 0.92 percent for the pre-test tissues, 0.66 to 1.4 percent for the DMMU and Z-layer composite tissues, and 0.70 to 1.7 percent for the Carr Inlet reference tissues.

Dioxin/furan total TEQs (ND=1/2*EDL) for *A. virens* tissues ranged from 0.349 to 0.420 ng/kg ww for the pre-test tissues and 0.329 to 0.701 ng/kg ww for the Carr Inlet reference tissues. For the DMMUs, dioxin/furan TEQs for *A. virens* tissues ranged from 0.420 to 0.682 ng/kg ww for PCT-1-C and 0.454 to 0.795 ng/kg ww for PCT-2-C. For the Z-layer composites, *A. virens* tissues ranged from 0.587 to 0.925 ng/kg ww for PCT-1-Z and 0.636 to 0.874 ng/kg ww for PCT-2-Z (Figure 4).

Table 12. PCT DMMU, Z-Layer Composite, and Carr Inlet Sediment Chemistry Results

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW22-PCT-1-C	VQ	BW22-PCT-1-Z	VQ	BW22-PCT-2-C	VQ	BW22-PCT-2-Z	VQ	BW22-CAR-C	VQ
Conventionals														
Total Solids	%	-	-	-	67.02		75.08		68.1		71.17		70.86	
Total Solids, Sulfide	%	-	-	-	68.24		73.23		67.56		71.11		71.92	
Total Volatile Solids	%	-	-	-	2.75		1.84		3.1		2.34		1.47	
Total Organic Carbon	% dry	-	-	-	0.5		0.34		0.63		0.53		0.28	
Total Sulfides	mg/kg dry	-	-	-	527	J	501		1300		964		130	J
Ammonia	mg/kg dry	-	-	-	13.7		13.1		22.1		28.2		8.73	
Total Gravel	%	-	-	-	1.30		2.20		5.10		1.80		0.2	
Total Sand	%	-	-	-	55.10		69.50		60.80		52.30		75.2	
Total Silt	%	-	-	-	32.90		22.90		28.50		39.20		17.3	
Total Clay	%	-	-	-	10.80		5.40		5.70		6.80		7.2	
Total Fines (Silt + Clay)	%	-	-	-	43.70		28.30		34.20		46.00		24.50	
Pesticides														
Total Chlordane	µg/kg	2.8	37	-	-		-		0.26	J	-		-	
Dioxin/Furan Congeners														
2,3,7,8-TCDD	ng/kg dw	-	-	-	0.241	U	0.243	U	0.205	U	0.234	U	0.207	U
1,2,3,7,8-PeCDD	ng/kg dw	-	-	-	1.12		1.08		0.934	UJ	0.965	J	0.32	U
1,2,3,4,7,8-HxCDD	ng/kg dw	-	-	-	0.386	U	1.44		1.64		0.954	J	0.339	U
1,2,3,6,7,8-HxCDD	ng/kg dw	-	-	-	4.89		6.11		6.97		5.53		0.32	U
1,2,3,7,8,9-HxCDD	ng/kg dw	-	-	-	2.65		2.82		3.31		0.45	U	0.355	U
1,2,3,4,6,7,8-HpCDD	ng/kg dw	-	-	-	125		113		126		81.6		5.16	
OCDD	ng/kg dw	-	-	-	1200		1050		1120		667		37.5	
2,3,7,8-TCDF	ng/kg dw	-	-	-	5.76	J	5.18		8.3		15.6		0.209	U
1,2,3,7,8-PeCDF	ng/kg dw	-	-	-	10.3	J	12		20.7		29.9		0.258	U
2,3,4,7,8-PeCDF	ng/kg dw	-	-	-	3.78		4.42		7.59		10.6		0.243	U
1,2,3,4,7,8-HxCDF	ng/kg dw	-	-	-	19.4	J	17.7		31		56.2		0.25	U
1,2,3,6,7,8-HxCDF	ng/kg dw	-	-	-	5.2	J	4.9		8.94		17.3		0.243	U
1,2,3,7,8,9-HxCDF	ng/kg dw	-	-	-	2.62		3.08		4.74		7.7		0.344	U
2,3,4,6,7,8-HxCDF	ng/kg dw	-	-	-	2.12		2.29		3.91		4.97		0.249	U
1,2,3,4,6,7,8-HpCDF	ng/kg dw	-	-	-	23.7		21.4		33.5		35.2		1.23	U
1,2,3,4,7,8,9-HpCDF	ng/kg dw	-	-	-	4.45		3.3		5.67		9.86		0.336	U
OCDF	ng/kg dw	-	-	-	67.6		48		81.9		67.4		1.9	UJ

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW22-PCT-1-C	VQ	BW22-PCT-1-Z	VQ	BW22-PCT-2-C	VQ	BW22-PCT-2-Z	VQ	BW22-CAR-C	VQ
Total TEQ (ND = 0*EDL)	ng/kg dw	4	10	-	**8.74**		**8.82**		**12.73**		**17.35**		**0.063**	
Total TEQ (ND = 1/2*EDL)	ng/kg dw	4	10	-	**8.88**		**8.95**		**12.83**		**17.49**		**0.490**	
Total TCDF	ng/kg dw	-	-	-	11.5		12.1		22.7		37.9		0.999	U
Total TCDD	ng/kg dw	-	-	-	1.4		0.147	U	1.13		1.61		0.999	U
Total PeCDF	ng/kg dw	-	-	-	33.6		32		58.1		59.9		0.408	J
Total PeCDD	ng/kg dw	-	-	-	2.38		2.11		1.92		2.54		0.999	U
Total HxCDF	ng/kg dw	-	-	-	60.9		57		90.6		123		0.342	J
Total HxCDD	ng/kg dw	-	-	-	40.7		47		46.5		31.5		1.09	
Total HpCDF	ng/kg dw	-	-	-	78.6		61.8		93.2		84.1		1.75	
Total HpCDD	ng/kg dw	-	-	-	304		272		264		190		11.9	

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.

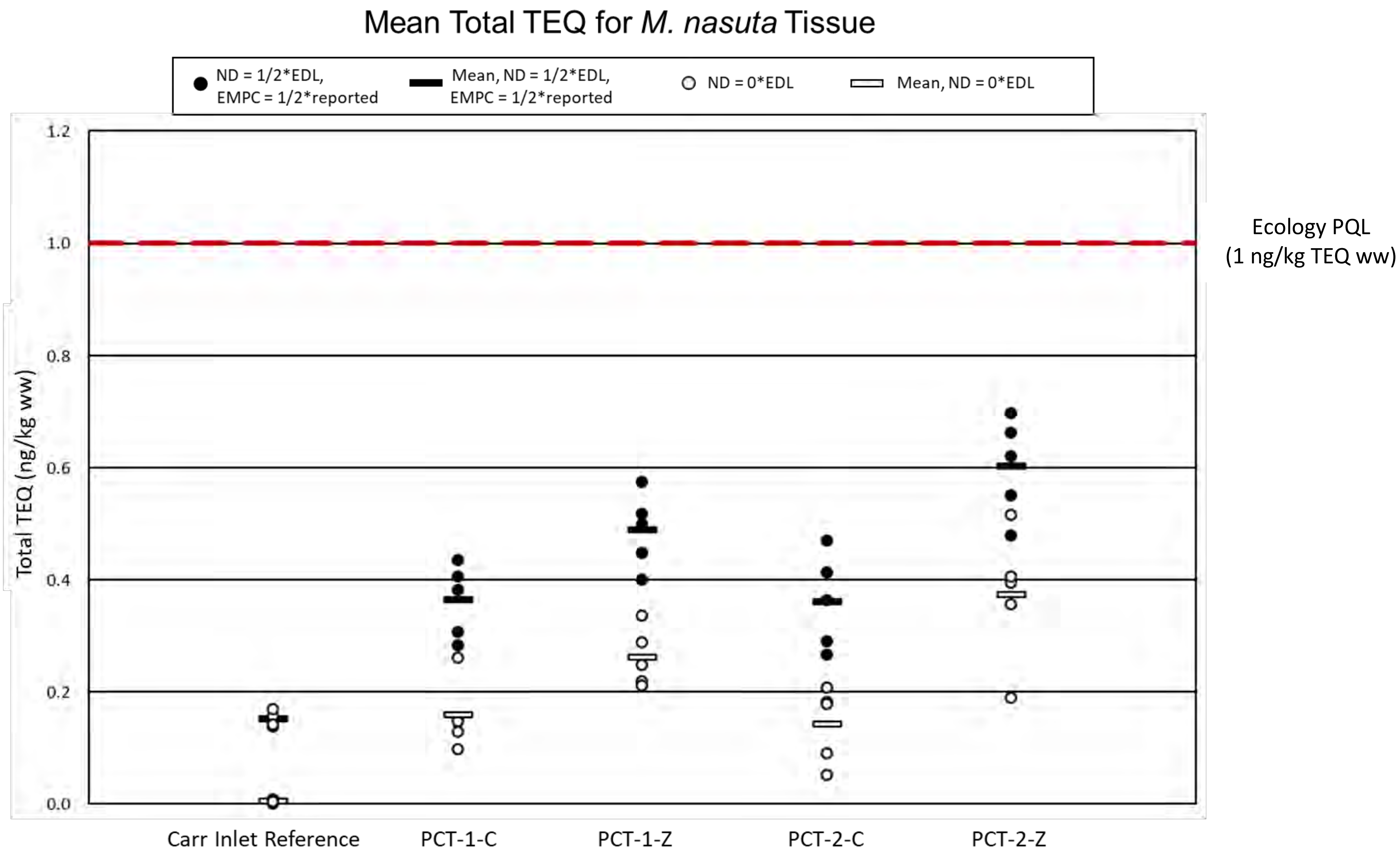
UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Table 13. PCT Bioaccumulation Testing – *M. nasuta* Tissue Chemistry Results

M. nasuta Tissue Sample	Total Solids (%)	Lipids (%)	Dioxin/Furan Total TEQ (ND = 0*EDL) ng/kg ww	Dioxin/Furan Total TEQ (ND = ½*EDL) ng/kg ww
PreTest-M1	15.02	0.61	0.000	0.139
PreTest-M2	15.66	0.76	0.000	0.130
PreTest-M3	19.36	0.72	0.000	0.139
BW22-PCT-1-C-M1	15.72	0.53	0.153	0.283
BW22-PCT-1-C-M2	15.34	0.67	0.129	0.307
BW22-PCT-1-C-M3	16.17	0.65	0.098	0.382
BW22-PCT-1-C-M4	15.96	0.65	0.261	0.436
BW22-PCT-1-C-M5	17.33	0.65	0.147	0.406
BW22-PCT-1-Z-M1	14.80	0.54	0.219	0.399
BW22-PCT-1-Z-M2	13.81	0.61	0.211	0.500
BW22-PCT-1-Z-M3	14.74	0.54	0.289	0.574
BW22-PCT-1-Z-M4	14.55	0.61	0.249	0.449
BW22-PCT-1-Z-M5	14.75	0.70	0.335	0.517
BW22-PCT-2-C-M1	14.71	0.52	0.183	0.413
BW22-PCT-2-C-M2	14.42	0.55	0.209	0.471
BW22-PCT-2-C-M3	14.20	0.51	0.052	0.291
BW22-PCT-2-C-M4	16.41	0.63	0.091	0.266
BW22-PCT-2-C-M5	14.70	0.62	0.179	0.363
BW22-PCT-2-Z-M1	14.85	0.69	0.357	0.550
BW22-PCT-2-Z-M2	14.06	0.62	0.190	0.479
BW22-PCT-2-Z-M3	15.20	0.58	0.395	0.620
BW22-PCT-2-Z-M4	14.20	0.68	0.515	0.663
BW22-PCT-2-Z-M5	15.37	0.61	0.406	0.698
BW22-CAR-M1	15.24	0.52	0.006	0.138
BW22-CAR-M2	14.53	0.57	0.009	0.157
BW22-CAR-M3	16.28	0.63	0.000	0.169
BW22-CAR-M4	16.01	0.69	0.007	0.142
BW22-CAR-M5	15.78	0.66	0.005	0.142

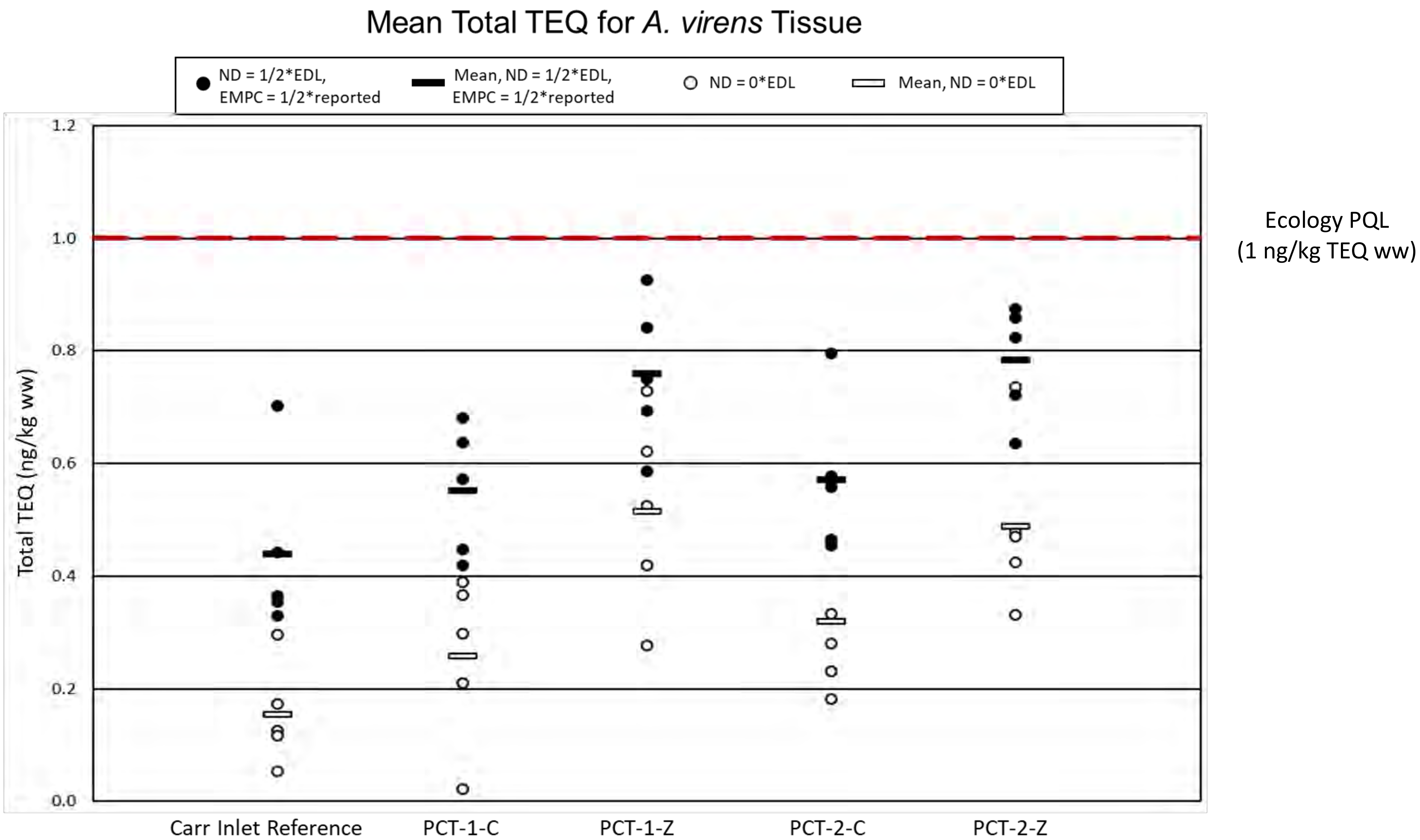
Table 14. PCT Bioaccumulation Testing – *A. virens* Tissue Chemistry Results

A. virens Tissue Sample	Total Solids (%)	Lipids (%)	Dioxin/Furan Total TEQ (ND = 0*EDL) ng/kg ww	Dioxin/Furan Total TEQ (ND = ½*EDL) ng/kg ww
PreTest-A1	13.38	0.88	0.016	0.349
PreTest-A2	12.87	0.92	0.169	0.420
PreTest-A3	12.61	0.78	0.141	0.403
BW22-PCT-1-C-A1	12.65	1.20	0.299	0.572
BW22-PCT-1-C-A2	11.99	0.91	0.209	0.448
BW22-PCT-1-C-A3	12.34	0.82	0.022	0.420
BW22-PCT-1-C-A4	12.59	0.81	0.366	0.637
BW22-PCT-1-C-A5	12.18	0.72	0.389	0.682
BW22-PCT-1-Z-A1	12.16	1.10	0.526	0.694
BW22-PCT-1-Z-A2	13.02	1.40	0.728	0.925
BW22-PCT-1-Z-A3	12.68	1.20	0.277	0.751
BW22-PCT-1-Z-A4	11.79	0.90	0.420	0.587
BW22-PCT-1-Z-A5	11.96	0.82	0.621	0.840
BW22-PCT-2-C-A1	12.32	0.81	0.231	0.465
BW22-PCT-2-C-A2	11.96	0.66	0.333	0.577
BW22-PCT-2-C-A3	12.99	1.20	0.568	0.795
BW22-PCT-2-C-A4	12.83	0.80	0.281	0.558
BW22-PCT-2-C-A5	11.43	1.00	0.183	0.454
BW22-PCT-2-Z-A1	11.68	0.80	0.425	0.823
BW22-PCT-2-Z-A2	12.97	0.77	0.480	0.859
BW22-PCT-2-Z-A3	11.90	0.94	0.469	0.722
BW22-PCT-2-Z-A4	12.74	1.00	0.735	0.874
BW22-PCT-2-Z-A5	12.48	0.86	0.331	0.636
BW22-CAR-A1	13.30	1.10	0.053	0.365
BW22-CAR-A2	12.79	1.70	0.297	0.701
BW22-CAR-A3	12.38	0.92	0.125	0.354
BW22-CAR-A4	12.35	0.70	0.118	0.329
BW22-CAR-A5	12.60	0.83	0.174	0.443



Notes:
EDL = estimated detection limit
PQL = practical quantitation limit
EMPC = estimated maximum possible concentration
TEQ = toxic equivalent
ND = not detected

Figure 3. Mean Total TEQ for *M. nasuta* Tissue Samples



Notes:
EDL = estimated detection limit
PQL = practical quantitation limit
EMPC = estimated maximum possible concentration
TEQ = toxic equivalent
ND = not detected

Figure 4. Mean Total TEQ for *A. virens* Tissue Samples

4.0 Data Interpretation

This section interprets the results of the PCT bioaccumulation study for dioxin/furan congeners following the data interpretation guidelines and other considerations in DMMP (2021b). A target tissue level (TTL) has not been established for dioxin/furan congeners, so the evaluation of the ecological effects of bioaccumulation is initially accomplished by statistical comparison of the test tissue concentrations to tissue residues resulting from exposure to reference sediment. If the results of the statistical comparison show that the test tissue concentrations are statistically higher than the reference sediment, the test tissue results are further evaluated to determine their potential risk. For this evaluation, the DMMP considers a weight-of-evidence approach as part of the suitability determination process. In addition to the statistical comparison to reference, factors considered in the weight-of-evidence approach (DMMP 2021b) are presented in this section and include the following:

- The magnitude of the bioaccumulation from PCT sediments compared to reference sediments (Section 4.2);
- Evaluation of the impact of non-detects on PCT tissue total TEQ values (Section 4.3);
- Evaluation of PCT tissue concentrations relative to Practical Quantitation Limits (PQLs) (Section 4.4); and
- Comparison of PCT tissue total TEQ values to those of comparable species found in the vicinity of the Commencement Bay DMMP disposal site (Section 4.5).

4.1 Statistical Comparison of Test Tissues to Reference Tissue Concentrations

For both bioaccumulation test species, the mean dioxin/furan total TEQs for the five replicate tissue samples for each DMMU, Z-layer composite, and Carr Inlet reference are listed in Tables 13 and 14 and displayed in Figures 3 and 4. The mean dioxin/furan total TEQs for each DMMU and Z-layer composite (Table 15) were compared with the mean dioxin/furan total TEQs from the Carr Inlet reference using a one-sided t-test and an alpha level of 0.1. The t-tests were conducted using BioStat (USACE 2007) and evaluated the null hypothesis that mean tissue dioxin/furan total TEQ for the test sediment was less than or equal to the mean tissue dioxin/furan total TEQ for the reference.

The Bonferroni’s correction was then run using R Studio 4.3.1 to confirm statistical significance. The Bonferroni’s correction is used to reduce the instance of a false positive and is designed to prevent data from incorrectly appearing to be statistically significant. A significance level of 0.1 was used for the Bonferroni's correction and one-tailed was specified.

The BioStat statistical comparison output is provided in Appendix G and the results of the t-tests and Bonferroni’s corrections are summarized in Table 16. The tissue concentrations for *A. virens* for sample PCT-1-C were not statistically different from the Carr Inlet reference for both ND=1/2*EDL and ND=0*EDL, which were confirmed using Bonferroni’s correction. An adjusted p-value of 1 by the Bonferroni correction indicated that the p-values remained greater than 0.1 and were not statistically significant. A Bonferroni-adjusted p-value of 1 was also indicated for the statistical comparison between the *A. virens* tissues for sample PCT-2-C and the Carr Inlet reference for ND=1/2*EDL (p-value = 0.09541). However, this was due to the conservative nature of the adjustments in Bonferroni's correction and the difference was still considered statistically significant.

With the exception of tissue concentrations for *A. virens* for PCT-1-C, the remaining *A. virens* and all *M. nasuta* tissue concentrations associated with the DMMUs and Z-layer composites were significantly greater than the Carr Inlet reference for both ND=1/2*EDL and ND=0*EDL. Because statistically significant differences between test tissues and reference were observed, several additional weight-of-evidence factors are necessary to determine whether PCT dredged material is suitable for open-water disposal (Sections 4.2 through 4.5) (DMMP 2017).

4.2 Magnitude of Bioaccumulation Compared to Reference

The statistical comparison presented in Section 4.1 identified significant differences between PCT and reference sediment bioaccumulation, but not the magnitude of these differences. Therefore, relative percent differences (RPDs) were calculated for the mean dioxin/furan TEQ tissue values (ND=1/2*EDL) for the DMMUs and Z-layer composites and compared to the mean dioxin/furan TEQ tissue values for Carr Inlet (Table 17). The RPDs for the *A. virens* samples ranged from 22.9% for PCT-1-C to 56.4% for PCT-2-Z relative to the Carr Inlet reference. The RPDs were greater for the *M. nasuta* samples due to the relatively low mean TEQ for the Carr Inlet tissues. The RPDs for the *M. nasuta* samples ranged from 82.7% for PCT-2-C to 120.4% for PCT-2-Z relative to the Carr Inlet reference. Expressed differently, the mean *A. virens* TEQ for each DMMU and Z-layer composite was between 1.26 and 1.79 times greater than the mean *A. virens* TEQ exposed to the Carr Inlet reference material. The mean TEQ among *M. nasuta* samples ranged between 2.41 and 4.02 times greater than the Carr Inlet reference material. By comparison, the sediment TEQ (ND=1/2*EDL) for PCT-2-C is 26.2 times greater than Carr Inlet sediment (Table 12), yet the magnitude of bioaccumulation is significantly less for each test species evaluated (2.41 times greater for *M. nasuta* and 1.30 times greater for *A. virens*).

4.3 Influence of Non-Detects on the Total TEQ for Test Tissues

The total TEQ is influenced by non-detected congeners and congeners that did not meet all of the analytical method criteria to meet a positive identification (EMPC qualified data). Averages of 35.5% to 49.4% of the congeners were not detected for both the *M. nasuta* and *A. virens* tissues (Table 18). The average EDL for each dioxin/furan congener is shown in Table 19. EDLs are sample- and analyte-specific detection limits that capture the minimum concentration that can be reliably quantified for each analyte by the instrument on a given day.

The influence of the non-detected dioxin/furan congener results on the TEQs were evaluated based on their TEF-weighted concentrations. The contribution of the TEF-weighted non-detected congener concentrations to the dioxin/furan total TEQs (ND=1/2*EDL) for each sample is summarized in Table 20 and displayed in Figures 5 and 6. Non-detected congeners contributed 20.8% to 39.1% of the total TEQ for *M. nasuta* when ND=1/2*EDL. On average, non-detected congeners contributed 30% of the total TEQ calculated for the *M. nasuta* tissues. Congeners reported and validated as estimated maximum possible concentrations (EMPCs) contributed between 17.4% and 26.1% of the total TEQ for *M. nasuta* when calculated as half of the reported concentration. EMPCs are detections of a congener that meet the signal-to-noise ratio criteria defined by the analytical method but do not meet the ion abundance ratio criteria necessary for positive identification. An EMPC represents a conservative maximum concentration that the congener could have. The DMMP User Manual notes that EMPCs should be qualified as non-detect ("U") and reported at the level the analyte was detected (i.e., the maximum possible concentration). The combined contribution of non-detected and EMPC congeners averaged 51% of the total TEQ for *M. nasuta* tissues when the EMPC fraction of the Total TEQ was calculated using one-half the reported EMPC result (TEQ_{EMPC} = ½*EMPC).

For *A. virens*, non-detected congeners contributed approximately 14.4% to 34.7% of the total TEQ when ND=1/2*EDL and EMPCs contributed between 18.2% and 21.5%. On average, non-detected congeners contributed 25% of the total TEQ calculated for the *A. virens* tissues. The combined contribution of non-detected and EMPC-designated congeners averaged 43% of the total TEQ when TEQ_{EMPC} = ½*EMPC.

Consideration of the substantial contributions of non-detected congeners to total TEQ of PCT test tissues is necessary to compare the PCT bioaccumulation results to other tissue datasets. Eliminating non-detects from the TEQ summation (ND=0*EDL) is an appropriate means of assessing the sensitivity of results to frequently non-detected congeners.

4.4 Evaluation of Tissue Concentrations Relative to PQLs

The PQL is the lowest concentration of an analyte that can be reliably measured within specified limits of precision and accuracy under routine laboratory operating conditions. Concentrations reported above the PQL can be considered with a high degree of confidence, while concentrations below the PQL are typically considered estimated values. Therefore, PQLs may be an important consideration for evaluating data when concentrations are low. The PQL for each dioxin/furan congener for this project was defined as the lowest method calibration standard used by ARI to calibrate its instruments (Table 21). A broad evaluation of the significance of laboratory-reported estimated dioxin/furan congener concentrations can be achieved by comparing tissue TEQs to the sum TEF-weighted PQLs. The sum of TEF-weighted PQLs for this project was 1.58 ng/kg ww TEQ (Table 21), greater than the sum PQL of 1 ng/kg ww TEQ defined by Ecology (Ecology 2021) as a target standard of acceptable quantification measurement by a laboratory. However, the specific analytical method used to generate the project data allows for the sample-specific quantification of EDLs for each congener. If the project PQLs were defined by average EDLs for each congener (Table 19), the sum of TEF-weighted PQLs would be 0.413 ng/kg ww TEQ, far lower than Ecology's target sum PQL. For both *M. nasuta* and *A. virens*, the mean total TEQ as well as the total TEQs for the five replicates analyzed for each sample were less than both the project-specific and Ecology PQLs (Figures 3 and 4). This finding indicates that even when detected, the general low concentrations of dioxins/furans present in PCT tissues necessitate the laboratory to estimate these concentrations, adding further uncertainty to tissue total TEQ values even when non-detects are excluded from TEQ calculations (ND=0*EDL).

4.5 Tissue Concentrations of Comparable Species in Commencement Bay

Comparing PCT tissue total TEQ values to those measured in comparable species at the Commencement Bay DMMP disposal site provides additional evidence to evaluate the potential for PCT material to cause unacceptable adverse ecological impacts at the site. In 2007, the DMMP conducted a special dioxin/furan study at the unconfined open water dredged material disposal sites in Puget Sound (SAIC 2008). Organisms were collected in the vicinity of the DMMP sites and analyzed for dioxin/furan congeners. At the Commencement Bay DMMP site, three genera of polychaetes (*Glyceridae*, *Maldanidae*, and *Travisia*) and one genera of bivalve (*Compsomyax*) were collected from six offsite stations in the vicinity of the disposal site boundary (perimeter and transect stations). The dioxin/furan total TEQs for the tissues collected at Commencement Bay perimeter and transect stations in 2007 are summarized in Table 22.

Figures 7 through 10 present comparisons of the PCT dioxin/furan tissue total TEQs to tissue total TEQs from species found in the vicinity of the Commencement Bay disposal site. Comparison of the *M. nasuta* bioaccumulation results to the *Compsomyax* tissue in Commencement Bay is not considered to be appropriate due to different feeding strategies by the clams. The *Compsomyax* clam has a relatively short siphon and is typically a filter feeder that lives exclusively in the subtidal (Lauzier 1997). Whereas, the *Macoma* clam has adapted to a broad range of depths and substrate types and is primarily a deposit feeder (Hylleberg and Gallucci 1975). The mean dioxin/furan total TEQ for the Commencement Bay *Compsomyax* tissues was 0.012 ng/kg ww (ND=1/2*EDL), which was a magnitude lower than the *M. nasuta* Carr Inlet reference tissues with a mean dioxin/furan total TEQ of 0.150 ng/kg ww (ND=1/2*EDL). Therefore, comparison of the *M. nasuta* bioaccumulation results to the Commencement Bay polychaete species was deemed a more appropriate comparison.

The *M. nasuta* and *A. virens* tissue concentrations were all below 1 ng/kg total TEQ ww and within the range of TEQs reported for the polychaete species present in the vicinity of the Commencement Bay disposal site. Figures 7 and 8 present the *A. virens* tissue total TEQ comparisons using ND=1/2*EDL and ND=0*EDL, respectively. Similarly, Figures 9 and 10 present the *M. nasuta* tissue total TEQ comparisons using ND=1/2*EDL and ND=0*EDL, respectively.

The mean dioxin/furan total TEQs (ND=1/2*EDL) for the *A. virens* tissues for the DMMUs and Z-layer composite samples ranged from 0.552 to 0.783 ng/kg ww, which were within the range of the mean total TEQs (ND=1/2*EDL) for the Commencement Bay polychaete species (*Glyceridae*, *Maldanidae*, and *Travisia*) (0.355 to 0.853 ng/kg ww). Similarly, the mean dioxin/furan total TEQs (ND=1/2*EDL) for the *M. nasuta* tissues for the DMMUs and Z-layer composite samples ranged from 0.361 to 0.602 ng/kg ww, which were within the range of the Commencement Bay polychaete species concentrations.

As discussed in Section 4.3, the non-detect congeners provided a notable contribution to the dioxin/furan total TEQs for the test tissues (on average, 30% of the total TEQ calculated for *M. nasuta*, and 25% of the total TEQ calculated for *A. virens*). For this reason, the dioxin/furan total TEQs using ND=0*EDL are plotted in Figures 8 and 10. The mean dioxin/furan total TEQs (ND=0*EDL) for the *A. virens* tissues for the DMMUs and Z-layer composite samples ranged from 0.257 to 0.514 ng/kg ww, which were within the range of, or below, the mean total TEQs (ND=0*EDL) for the Commencement Bay polychaete species (*Glyceridae*, *Maldanidae*, and *Travisia*) (0.297 to 0.812 ng/kg ww). Similarly, the mean dioxin/furan total TEQs (ND=0*EDL) for the *M. nasuta* tissues for the DMMUs and Z-layer composite samples ranged from 0.143 to 0.373

ng/kg ww, which were within the range of, or below, the Commencement Bay polychaete species concentrations.

These comparisons demonstrate that observed dioxin/furan TEQ values in PCT test organisms are within the range of what the DMMP observed in polychaete tissues collected from the vicinity of the Commencement Bay DMMP disposal site.

Table 15. Mean Dioxin/Furan TEQ Values in Tissues

Sample	Mean Dioxin/Furan TEQ ng/kg ww (ND=1/2*EDL)			
	M. nasuta		*A. virens*	
	Mean	Standard Deviation	Mean	Standard Deviation
Carr Inlet	0.150	0.013	0.438	0.153
PCT-1-C	0.363	0.065	0.552	0.115
PCT-1-Z	0.488	0.067	0.759	0.131
PCT-2-C	0.361	0.085	0.570	0.137
PCT-2-Z	0.602	0.088	0.783	0.101
Sample	**Mean Dioxin/Furan TEQ ng/kg ww (ND=0*EDL)**			
	M. nasuta		***A. virens***	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Carr Inlet	0.005	0.003	0.153	0.091
PCT-1-C	0.158	0.062	0.257	0.149
PCT-1-Z	0.261	0.052	0.514	0.175
PCT-2-C	0.143	0.067	0.319	0.150
PCT-2-Z	0.373	0.118	0.488	0.150

Table 16. Results of the T-Tests and Bonferroni Tests Comparing Mean Dioxin/Furan TEQs in Organisms Exposed to PCT Sediments with Organisms Exposed to the Carr Inlet Reference

Organism	Dioxin/Furan TEQ	P Value (one-sided)			
		PCT-1-C	PCT-1-Z	PCT-2-C	PCT-2-Z
M. nasuta	ND=1/2*EDL	0.0007	0.0001	0.0023	0.0001
	ND=0*EDL	0.0026	0.0002	0.0051	0.0011
A. virens	ND=1/2*EDL	0.1126	0.0037	0.0954	0.0015
	ND=0*EDL	0.1098	0.0017	0.0339	0.0014
Organism	**Dioxin/Furan TEQ**	**Bonferroni-Adjusted P Value (one-sided)**			
		PCT-1-C	**PCT-1-Z**	**PCT-2-C**	**PCT-2-Z**
M. nasuta	ND=1/2*EDL	0.0120	0.0019	0.0374	0.0022
	ND=0*EDL	0.0411	0.0030	0.0818	0.0177
A. virens	ND=1/2*EDL	1	0.0585	1	0.0241
	ND=0*EDL	1	0.0277	0.5416	0.0220

Notes:
P values < 0.10 indicate a value significantly greater than the Carr Inlet reference.
ND = not detected
EDL = estimated detection limit
TEQ = toxic equivalent

Table 17. Relative Percent Difference Between Mean Dioxin/Furan TEQs (ND=1/2*EDL) for the PCT and the Carr Inlet Reference Tissues

Organism	Mean Dioxin/Furan TEQ (ND=1/2*EDL)				
	Carr Inlet	PCT-1-C	PCT-1-Z	PCT-2-C	PCT-2-Z
M. nasuta	-	83.2%	106.1%	82.7%	120.4%
A. virens	-	22.9%	53.6%	26.1%	56.4%

Note:
Relative percent difference was calculated as the difference between the two means (e.g., mean TEQ for Carr Inlet and mean TEQ for PCT-1-C) divided by the average of the two means.

Table 18. Percent of Non-Detected Congeners for Each PCT Sample for Each Test Species

Sample	Minimum	Maximum	Mean	Standard Deviation
M. nasuta				
PCT-1-C	35.3%	47.0%	40.0%	4.9%
PCT-1-Z	23.5%	41.2%	34.1%	6.4%
PCT-2-C	35.3%	34.7%	43.5%	12.2%
PCT-2-Z	23.5%	47.0%	35.3%	9.3%
A. virens				
PCT-1-C	11.8%	58.8%	49.4%	21.4%
PCT-1-Z	35.3%	52.9%	43.5%	8.9%
PCT-2-C	35.3%	64.7%	45.9%	12.7%
PCT-2-Z	35.3%	47.1%	42.4%	4.9%

Table 19. Average Congener-Specific Estimated Detection Limits (EDLs) for Each Test Species

Congener	*M. nasuta*	*A. virens*
	Average EDL (ng/kg)	Average EDL (ng/kg)
2,3,7,8-TCDF	0.133	0.101
2,3,7,8-TCDD	0.083	0.072
1,2,3,7,8-PeCDF	0.150	0.129
2,3,4,7,8-PeCDF	0.137	0.154
1,2,3,7,8-PeCDD	0.144	0.221
1,2,3,4,7,8-HxCDF	0.079	0.159
1,2,3,6,7,8-HxCDF	0.078	0.152
2,3,4,6,7,8-HxCDF	0.082	0.141
1,2,3,7,8,9-HxCDF	0.092	0.146
1,2,3,4,7,8-HxCDD	0.107	0.201
1,2,3,6,7,8-HxCDD	0.102	0.145
1,2,3,7,8,9-HxCDD	0.114	0.182
1,2,3,4,6,7,8-HpCDF	0.107	0.108
1,2,3,4,7,8,9-HpCDF	0.152	0.128
1,2,3,4,6,7,8-HpCDD	0.149	0.133
OCDF	0.229	0.167
OCDD	0.238	0.203

Table 20. Percent Contribution of Non-Detected Congeners and EMPCs on the Total TEQ (ND = ½*EDL) Calculated for Each Test Species for Each PCT Sample

Sample	Non-Detected			EMPC		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
M. nasuta						
PCT-1-C	29.9%	47.1%	39.1%	10.2%	31.7%	17.4%
PCT-1-Z	16.9%	32.1%	24.8%	9.1%	32.3%	21.7%
PCT-2-C	16.1%	58.8%	35.9%	7.0%	39.7%	26.1%
PCT-2-Z	10.3%	31.3%	20.8%	6.1%	31.5%	18.4%
A. virens						
PCT-1-C	2.2%	52.3%	34.7%	6.5%	42.4%	21.5%
PCT-1-Z	5.7%	28.4%	14.4%	0.0%	57.4%	18.2%
PCT-2-C	19.0%	50.2%	29.5%	0.0%	33.3%	16.6%
PCT-2-Z	5.6%	28.0%	20.1%	10.3%	26.0%	18.2%

Table 21. Congener-Specific PQLs and TEF-weighted PQLs Compared to Ecology's Tissue PQL for Dioxins/Furans

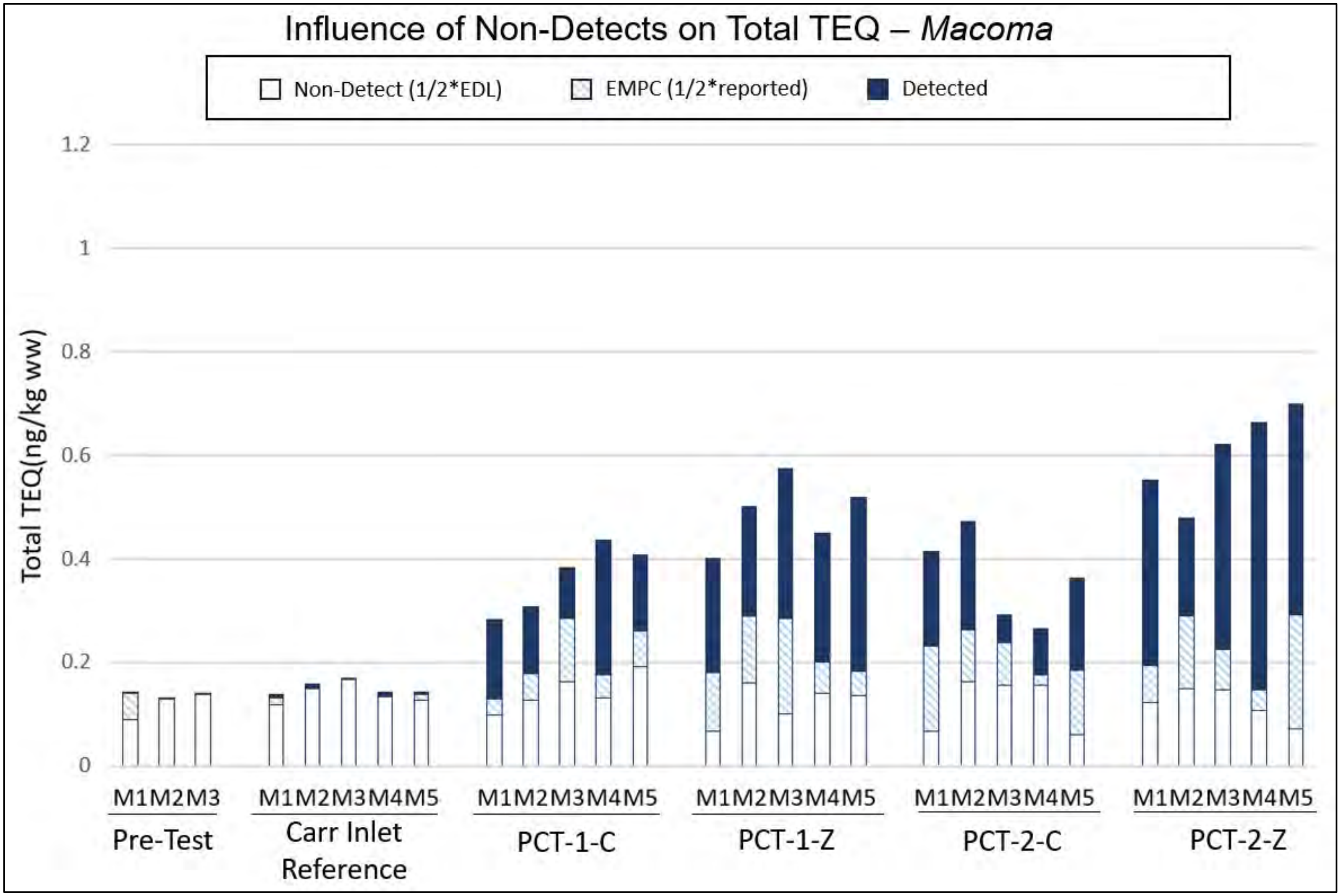
Congener	PQL (ng/kg ww)	TEF	TEF-weighted Concentration (ng/kg TEQ ww)
2,3,7,8-TCDF	0.5	0.1	0.05
2,3,7,8-TCDD	0.5	1	0.5
1,2,3,7,8-PeCDF	0.5	0.03	0.015
2,3,4,7,8-PeCDF	0.5	0.3	0.15
1,2,3,7,8-PeCDD	0.5	1	0.5
1,2,3,4,7,8-HxCDF	0.5	0.1	0.05
1,2,3,6,7,8-HxCDF	0.5	0.1	0.05
2,3,4,6,7,8-HxCDF	0.5	0.1	0.05
1,2,3,7,8,9-HxCDF	0.5	0.1	0.05
1,2,3,4,7,8-HxCDD	0.5	0.1	0.05
1,2,3,6,7,8-HxCDD	0.5	0.1	0.05
1,2,3,7,8,9-HxCDD	0.5	0.1	0.05
1,2,3,4,6,7,8-HpCDF	0.5	0.01	0.005
1,2,3,4,7,8,9-HpCDF	0.5	0.01	0.005
1,2,3,4,6,7,8-HpCDD	0.5	0.01	0.005
OCDF	1	0.0003	0.0003
OCDD	5	0.0003	0.0015
SUM of PQLs			**1.582**
Ecology Dioxin PQL (2021)			**1**

Notes:
PQL = practical quantitation limit
TEF = toxic equivalency factor
TEQ = toxic equivalent

Table 22. Summary of Dioxin/Furan Total TEQs for Commencement Bay DMMP Site Tissues

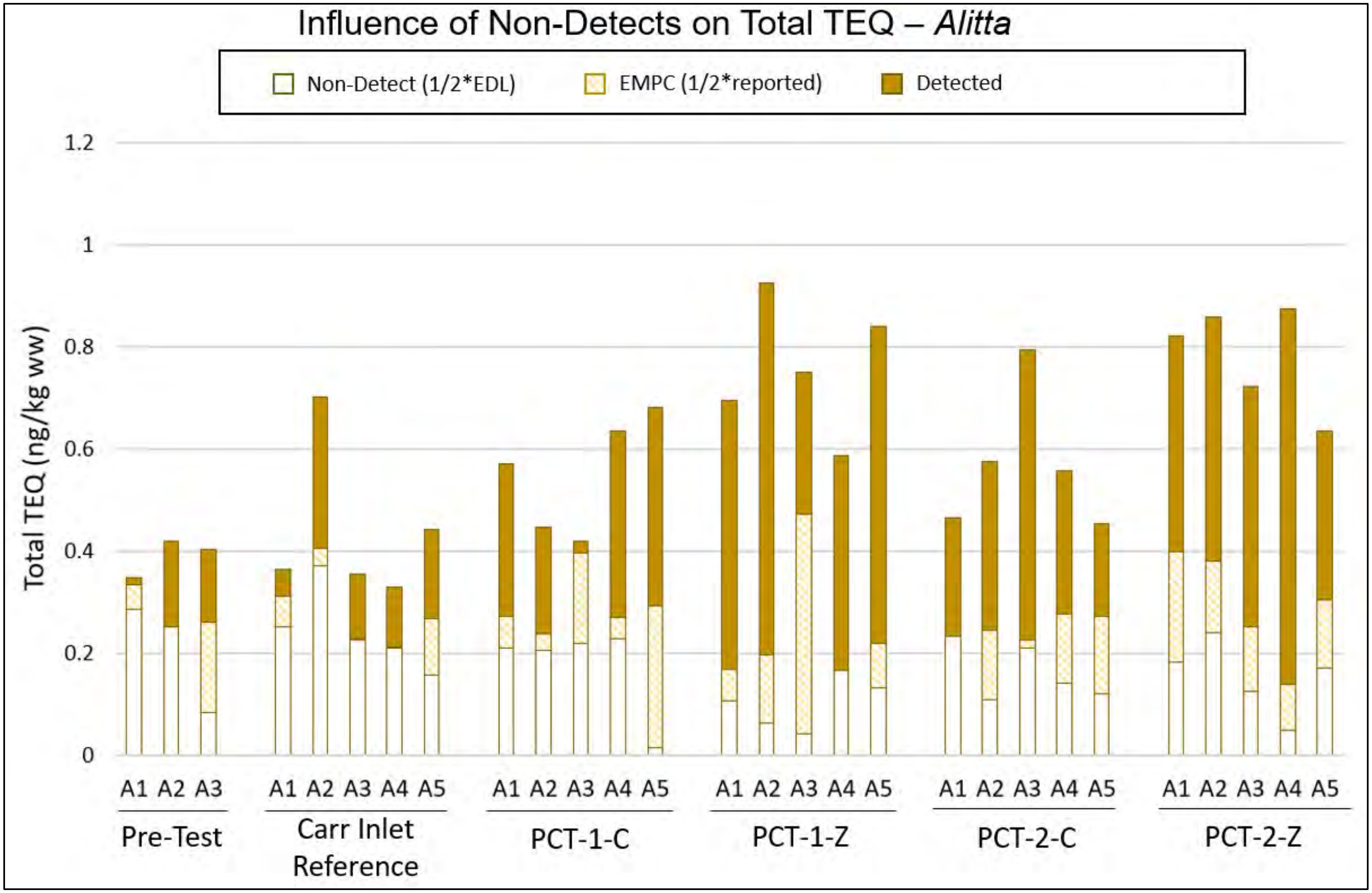
Location	Study Year	Organism	TEQ ng/kg ww (ND = 0*EDL)			TEQ ng/kg ww (ND = 1/2*EDL)			Lipids (%)		
			Min/Max	Mean	Standard Deviation	Min/Max	Mean	Standard Deviation	Min/Max	Mean	Standard Deviation
Commencement Bay Disposal Site (Transect and Perimeter)	2007	*Compsomyax*	0.002 0.023	0.012	0.011	0.062 0.089	0.076	0.013	0.20 0.25	0.23	0.03
		Travisia	0.530 1.062	0.812	0.202	0.661 1.074	0.853	0.166	0.35 0.54	0.46	0.07
		Glyceridae	0.213 0.511	0.370	0.102	0.263 0.570	0.403	0.105	1.00 1.46	1.23	0.18
		Maldanidae	0.143 0.371	0.297	0.091	0.229 0.426	0.355	0.076	0.86 1.45	1.08	0.23

Notes:
EDL = estimated detection limit TEQ = toxic equivalent



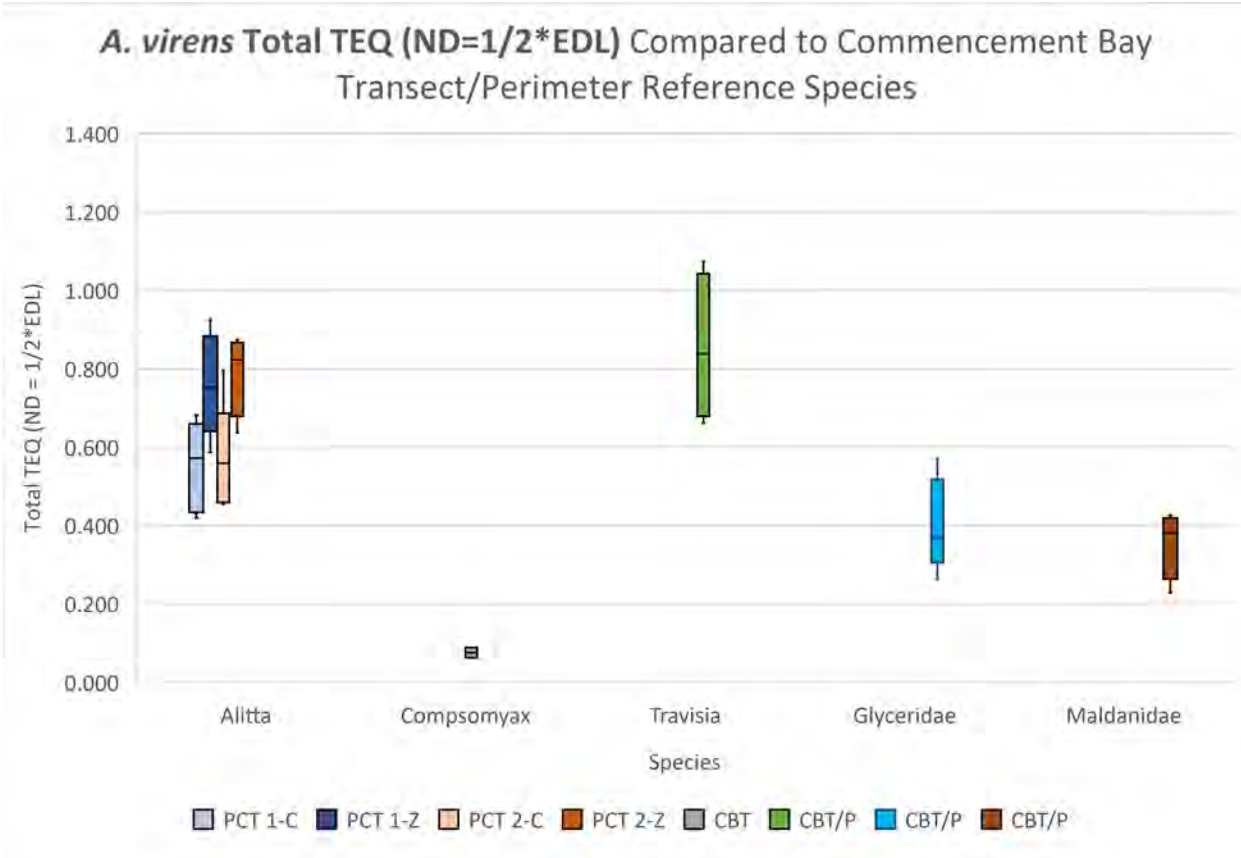
Notes:
EDL = estimated detection limit
EMPC = estimated maximum possible concentration
TEQ = toxic equivalent

Figure 5. Influence of Non-Detects on Total TEQ for *M. nasuta*



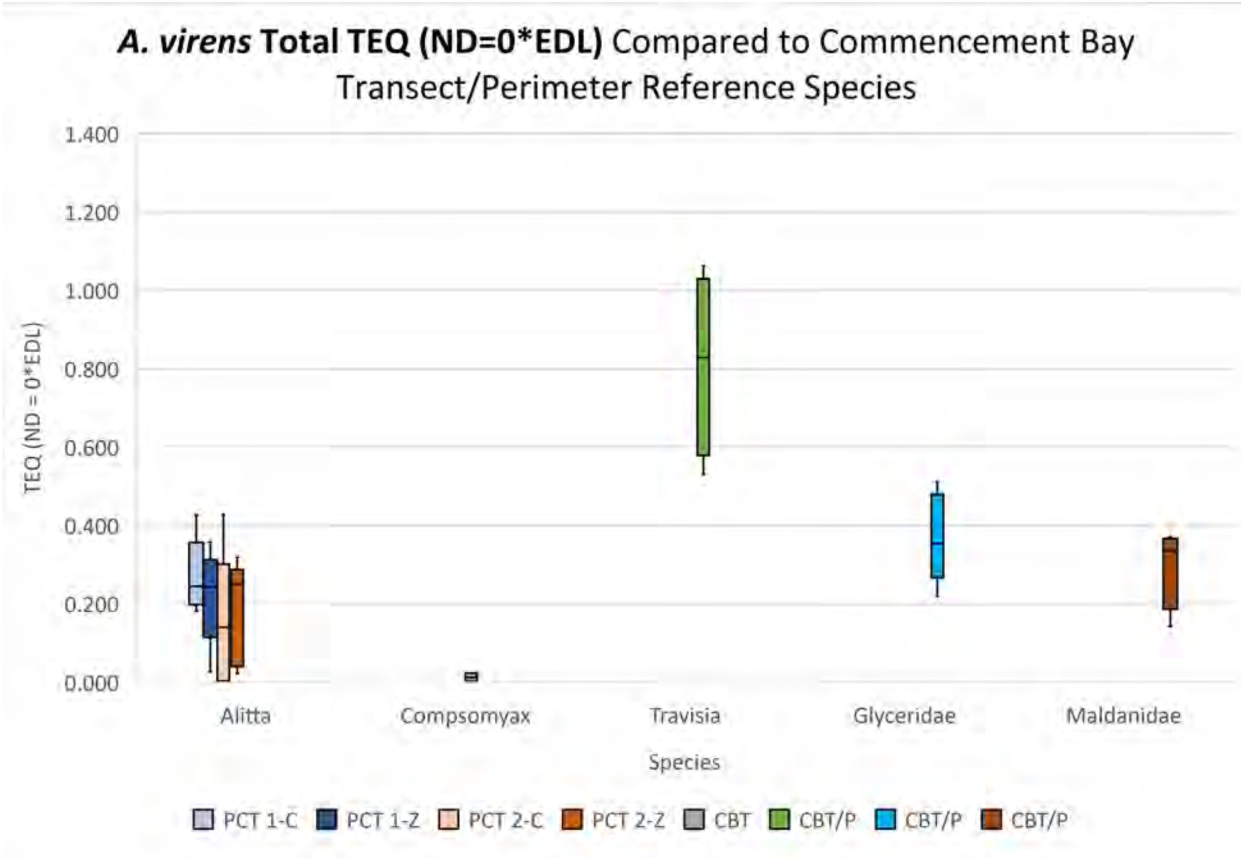
Notes:
EDL = estimated detection limit
EMPC = estimated maximum possible concentration
TEQ = toxic equivalent

Figure 6. Influence of Non-Detects on Total TEQ for *A. virens*



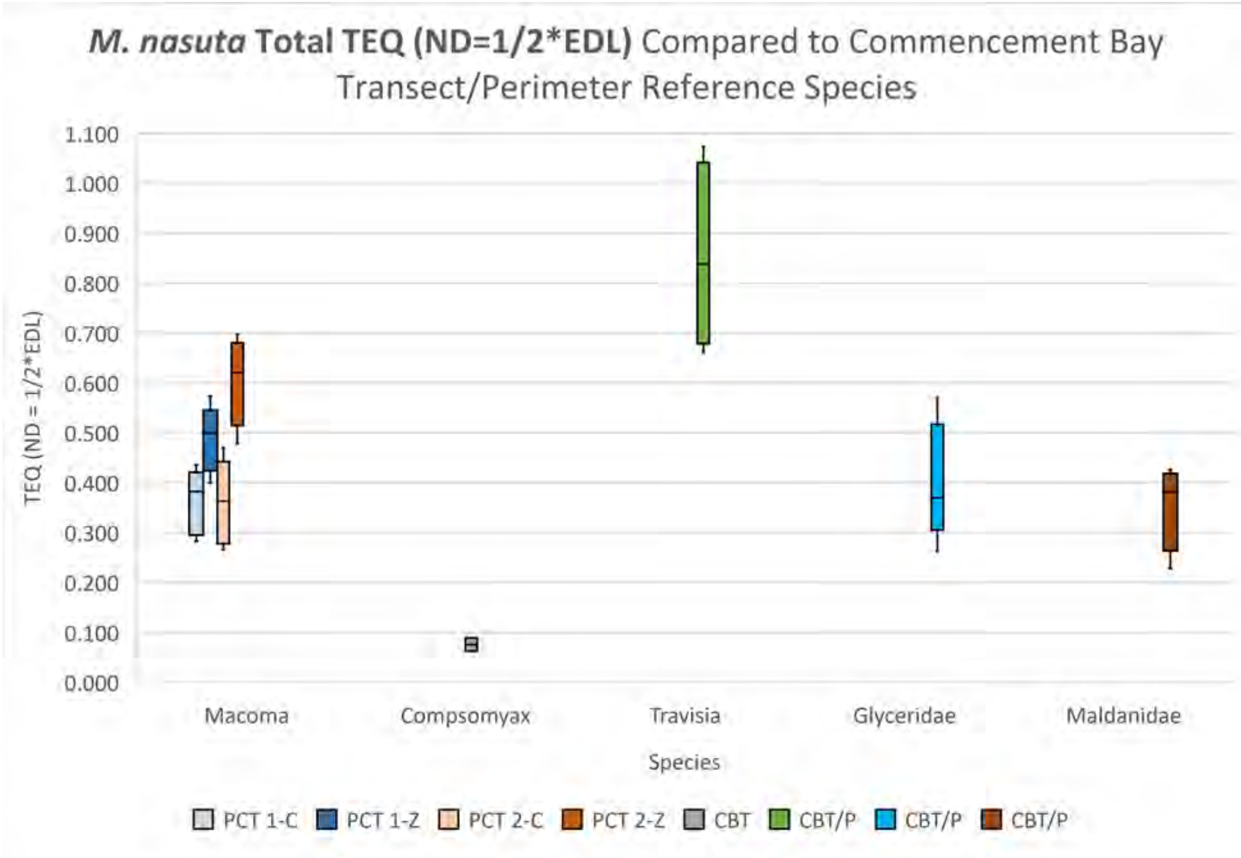
Notes:
EDL = estimated detection limit ND = not detected TEQ = toxic equivalent

Figure 7. *A. virens* Dioxin/Furan Total TEQ (ND=1/2*EDL) Compared to Commencement Bay DMMP Site Tissues



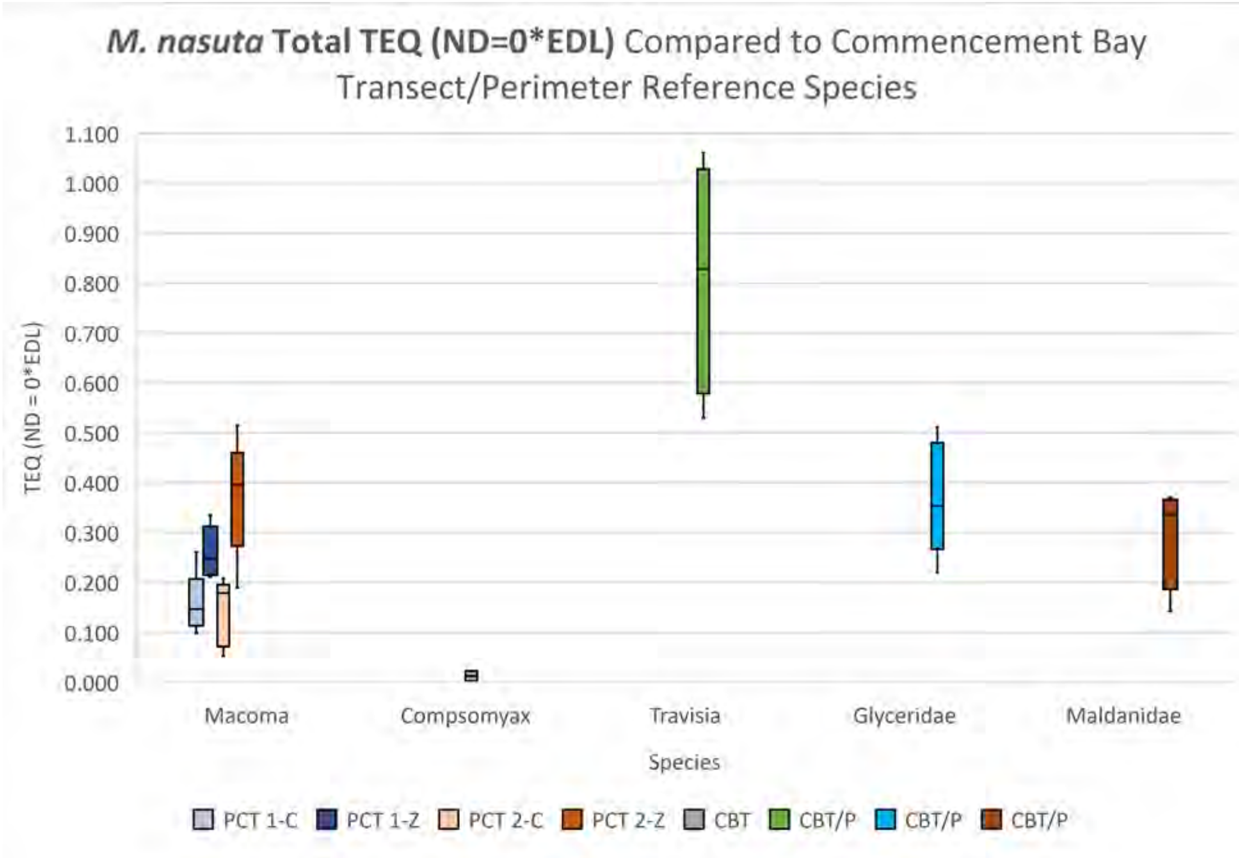
Notes:
EDL = estimated detection limit ND = not detected TEQ = toxic equivalent

Figure 8. ***A. virens*** **Dioxin/Furan Total TEQ (ND=0*EDL) Compared to Commencement Bay DMMP Site Tissues**



Notes:
EDL = estimated detection limit ND = not detected TEQ = toxic equivalent

Figure 9. ***M. nasuta*** **Dioxin/Furan Total TEQ (ND=1/2*EDL) Compared to Commencement Bay DMMP Site Tissues**



Notes:
EDL = estimated detection limit ND = not detected TEQ = toxic equivalent

Figure 10. ***M. nasuta*** **Dioxin/Furan Total TEQ (ND=0*EDL) Compared to Commencement Bay DMMP Site Tissues**

5.0 Quality Assurance and Quality Control

5.1 Elevated Detection Limits During Initial Tissue Dioxin/Furan Analysis

During review of the initial analysis of the bioaccumulation tissues for dioxin/furan congeners by ARI (Work Order 2210519 – dated December 19, 2022), the reported EDLs appeared elevated when compared to the EDLs reported for other ARI projects that analyzed tissues for dioxins/furans and were also elevated relative to the PQL for tissues of 1 ng/kg TEQ ww established by Ecology (2021). EcoChem, Inc., Seattle, WA, was contracted to perform an EPA Level 4 data validation of the tissue dioxin/furan results (Section 5.2). Some congener data were qualified as not detected based on method blank contamination or to indicate that EMPC values were effectively elevated EDLs (Appendix D). However, the validation does not evaluate the magnitude of the EDLs reported by the laboratory, only the validity of EDL calculations based on analytical instrument output.

ARI was requested to further review the PCT tissue analysis results. ARI indicated that all standard instrument Quality Control (QC) measures were within normal parameters, but it was discovered that two power outages that occurred during the analysis of the PCT tissues may have affected the analytical instrument performance. Following equipment maintenance, ARI re-analyzed archived extracts for the *M. nasuta* tissues as well as a subset of the *A. virens* tissues on May 17-18, 2023, which resulted in a decrease of EDLs by an average of 64% for the *M. nasuta* tissues and an improvement in sensitivity of the data (Figure 11). ARI then re-analyzed the remaining archived extracts for the *A. virens* tissues on August 2-3, 2023, within one year of initial tissue extraction consistent with the holding time recommended in EPA National Functional Guidelines (EPA 2020). Reanalysis resulted in an improvement in the EDLs for the *A. virens* tissues by an average of 69% (Figure 12). The reduction in EDLs across the dataset allowed more confident quantification of lower dioxin/furan congener concentrations and resulted in fewer congeners needing to be qualified as non-detected.

EDLs from the reanalyzed tissue extracts were within the range of tissue dioxin/furan method detection limits (method 1613B) reported in Ecology's laboratory survey as well as a reduction of non-detected congeners for each sample replicate. The tissue dioxin/furan reanalysis results as well as the original results are included in the ARI laboratory report (Work Order 2210519 – dated August 8, 2023) (Appendix C). ARI has since updated their instrument performance QC protocols to include the monitoring of EDLs as a result of this data quality investigation.

5.2 Data Validation

NewFields conducted EPA Level 2B review and validation of the sediment and tissue chemistry data, including the tissue reanalysis of dioxin/furan congeners (Appendix D). EcoChem, Inc., conducted EPA Level 4 review and validation of the initial report of the dioxin/furan congener tissue chemistry data. However, tissue reanalysis was required due to elevated EDLs as discussed in Section 5.1. EPA Level 4 validation was not conducted on the tissue reanalysis of dioxin/furan congeners. The laboratory report included a Level 4 data package if validation is required in the future. The EPA Level 4 validation report for the initial tissue analysis of dioxin/furan congeners is provided in Appendix D.

The Level 2B validation for sediment and tissue analyses included evaluations of sample holding times, quality control sample results, analytical methods, and calculation verification. Overall, sediment quality control results for conventional parameters, total chlordane, and dioxin/furan congeners were within the control limits prescribed by the analytical methods, DMMP requirements, or the laboratory. Due to duplicate or triplicate RPD outliers for the sediment analyses, two total sulfides results, the Nonachlor and cis-Nonachlor results for one sample, and four dioxin/furan congeners for one sample were estimated. Project samples with an EMPC flag for dioxin/furan congeners were qualified as not detected.

The tissue quality control results for total solids, lipids, and dioxin/furan congeners were generally within the control limits prescribed by the analytical methods, DMMP requirements, or the laboratory. For the dioxin/furan congener analysis, quality control outliers were noted for laboratory method blanks and compound identification due to diphenyl ether interference. With those exceptions, accuracy was acceptable as demonstrated by the labeled compound and on-going precision and recovery standard values. A summary of assigned Level 2B validation qualifiers is provided in Table 23.

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

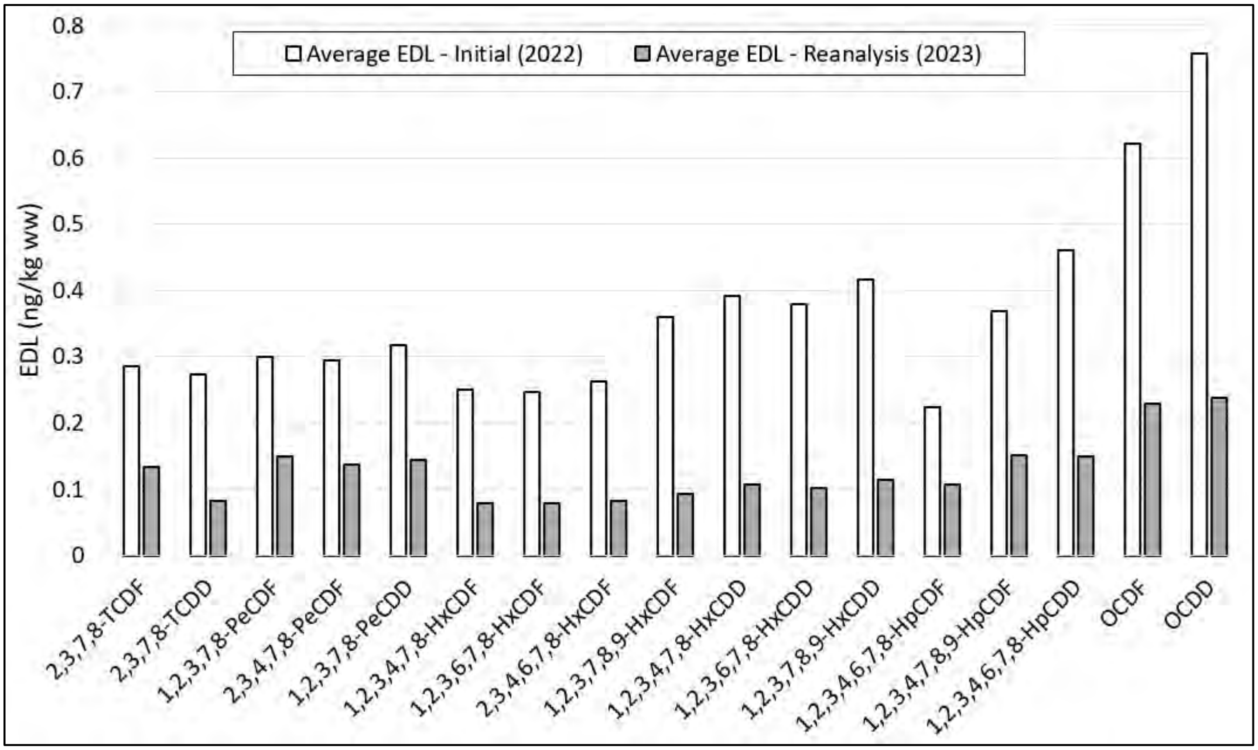


Figure 11. Comparison of Average Congener-specific EDLs for Dioxins/Furans between Initial Analysis (2022) and Reanalysis (2023) for *M. nasuta* tissues

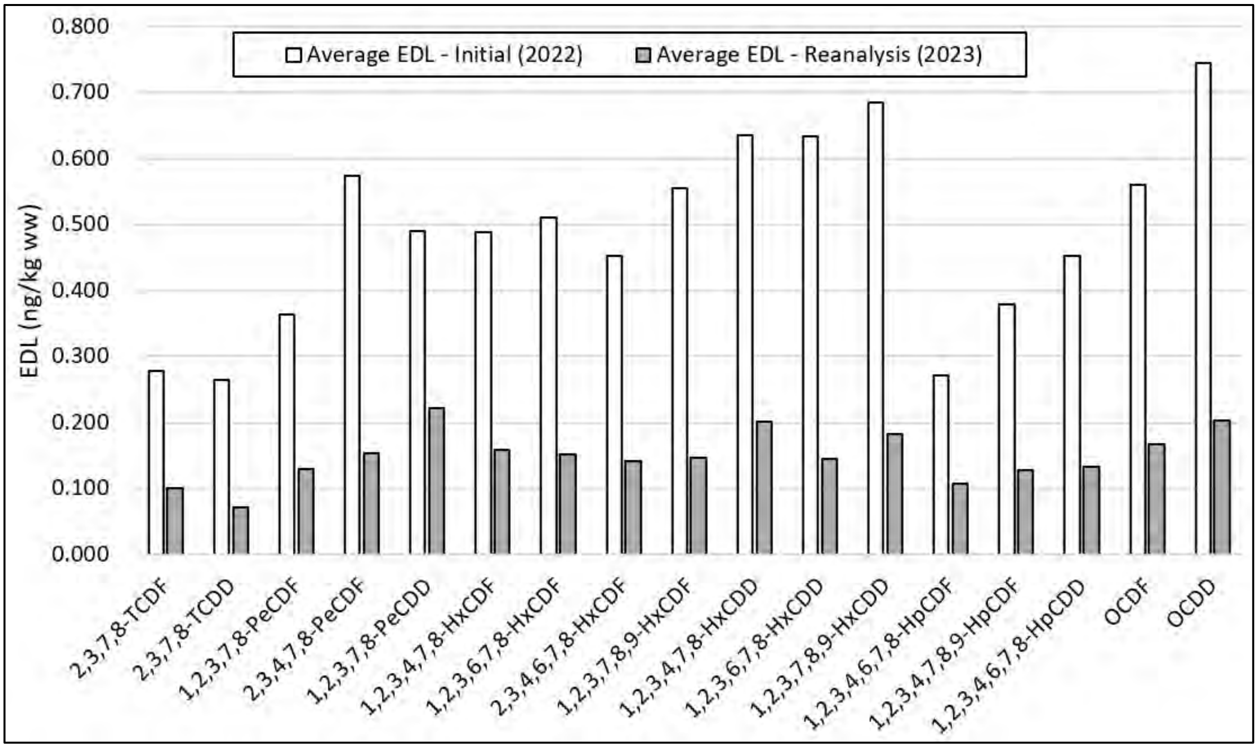


Figure 12. Comparison of Average Congener-specific EDLs for Dioxins/Furans between Initial Analysis (2022) and Reanalysis (2023) for *A. virens* tissues

Table 23. Tissue Data Qualified by EPA Level 2B Validation

Work ID	Sample ID	Analyte	Qualifier
Data Qualified due to Method Blank Detections			
22I0519	M.n. BW22-PCT-1-C Rep 1	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-C Rep 2	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-C Rep 3	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-C Rep 4	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-C Rep 5	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-Z Rep 1	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-Z Rep 2	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-Z Rep 3	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-Z Rep 4	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-1-Z Rep 5	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-2-C Rep 1	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-2-C Rep 2	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-2-C Rep 3	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-2-C Rep 4	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-2-C Rep 5	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-2-Z Rep 1	1,2,3,7,8-PeCDF	U
22I0519	M.n. BW22-PCT-2-Z Rep 2	1,2,3,7,8-PeCDF	U
22I0519	A.v. Pretest Rep 3	1,2,3,7,8-PeCDF	U
22I0519	A.v. Carr Ref Rep 5	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-C Rep 1	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-C Rep 2	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-C Rep 3	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-C Rep 4	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-C Rep 5	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-Z Rep 1	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-Z Rep 2	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-Z Rep 3	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-Z Rep 4	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-1-Z Rep 5	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-C Rep 1	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-C Rep 2	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-C Rep 3	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-C Rep 4	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-C Rep 5	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-Z Rep 2	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-Z Rep 3	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-Z Rep 4	1,2,3,7,8-PeCDF	U
22I0519	A.v. BW22-PCT-2-Z Rep 5	1,2,3,7,8-PeCDF	U
22I0519	M.n. Pretest Rep 1	OCDD	U
22I0519	M.n. Pretest Rep 2	OCDD	U
22I0519	M.n. Pretest Rep 3	OCDD	U
22I0519	M.n. Carr Ref Rep 1	OCDD	U

Work ID	Sample ID	Analyte	Qualifier
22I0519	M.n. Carr Ref Rep 3	OCDD	U
22I0519	M.n. Carr Ref Rep 5	OCDD	U
Data Qualified due to Surrogate Percent Recovery			
22I0519	A.v BW22-PCT-1-Z Rep 2	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 2	OCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 3	1,2,3,4,7.8,9-HpCDF	UJ
22I0519	A.v BW22-PCT-1-Z Rep 3	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 3	OCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 4	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 4	OCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 5	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 5	OCDD	J
22I0519	A.v BW22-PCT-2-C Rep 5	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-2-C Rep 5	OCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 4	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 4	OCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 5	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 5	OCDD	J

Validation Qualifiers:

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.

6.0 SUMMARY

Dioxin/furan concentrations measured in the proposed dredged material at PCT triggered supplemental DMMP bioaccumulation testing to evaluate the suitability for open-water disposal. In 2022, the Port conducted bioaccumulation testing of two DMMUs from PCT as well as two Z-layer composite samples. The results of the testing were as follows:

- **Statistical Comparison to Reference** – Dioxin/furan total TEQs for *A. virens* for sample PCT-1-C were not statistically different from the Carr Inlet reference for both ND=1/2*EDL and ND=0*EDL. The remaining *A. virens* and all *M. nasuta* tissue concentrations associated with the DMMUs and Z-layer composites were significantly greater than the Carr Inlet reference for both ND=1/2*EDL and ND=0*EDL. Due to statistically significant differences between PCT test tissues and reference, additional weight-of-evidence factors are required to evaluate whether PCT dredged material is suitable for open-water disposal.
- **Magnitude of Bioaccumulation Compared to Reference** – The RPDs for the *A. virens* samples ranged from 22.9% for PCT-1-C to 56.4% for PCT2-Z relative to the Carr Inlet reference. The RPDs were greater for the *M. nasuta* samples due to the relatively low mean TEQ for the Carr Inlet tissues. The RPDs for the *M. nasuta* samples ranged from 82.7% for PCT-2-C to 120.4% for PCT-2-Z relative to the Carr Inlet reference. While these results indicate a greater degree of bioaccumulation occurred in PCT test tissues compared to reference, further evaluation identified that much of the perceived PCT bioaccumulation was due to the contributions of non-detected dioxin/furan congeners to the total TEQs.
- **Influence of Non-Detects on Total TEQ for Test Tissues** – Non-detected congeners provided a substantial contribution to the dioxin/furan total TEQs for the PCT test tissues. Non-detected congeners contributed an average of 30% of the total TEQ for *M. nasuta* when ND=1/2*EDL. For *A. virens*, non-detected congeners contributed an average of 25% of the total TEQ when ND=1/2*EDL. These substantial contributions of non-detected congeners to total TEQ of PCT test tissues provide evidence necessary to compare the PCT bioaccumulation results to other tissues, such as those from the vicinity of the Commencement Bay disposal site.
- **Tissue Concentrations Relative to PQLs** – While concentrations above the PQL can be considered with a high degree of confidence, concentrations below the PQL are estimated values with less confidence. For both *M. nasuta* and *A. virens*, the mean TEQ as well as the TEQs for the five replicates analyzed for each sample were all less than the Ecology PQL of 1 ng/kg ww TEQ. Therefore, even when detected, the general low concentrations of dioxins/furans present in PCT tissues necessitate the laboratory to estimate these concentrations, adding further uncertainty to tissue total TEQ values even when non-detects are excluded from TEQ calculations (ND=0*EDL).
- **Tissue Concentrations of Comparable Species in Commencement Bay** – The *M. nasuta* and *A. virens* mean dioxin/furan total TEQs (ND=1/2*EDL) were all below 1 ng/kg total

TEQ ww and within the range of the TEQs reported for the polychaete species present in sediment adjacent to, but not within, the Commencement Bay disposal site. As noted previously, non-detected congeners provided a substantial contribution to the dioxin/furan total TEQs. If removed from the total TEQ calculation (ND=0*EDL), the *M. nasuta* and *A. virens* mean dioxin/furan total TEQs were within or below the range of mean total TEQs for the Commencement Bay polychaete species. Therefore, the concentrations of dioxins/furans present in PCT sediments result in a similar magnitude of tissue bioaccumulation as those in the region that are unimpacted by dredged material disposal. Open-water disposal of PCT sediments at the Commencement Bay DMMP site is unlikely to cause unacceptable adverse impacts at the site.

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APPENDIX A: SAMPLING AND ANALYSIS PLAN

APPENDIX B: FIELD LOGS, CORE LOGS, AND CORE PHOTOGRAPHS

APPENDIX C: LABORATORY DATA REPORTS AND CHAIN OF CUSTODY FORMS

(ELECTRONIC COPY ONLY)

APPENDIX D: DATA VALIDATION REPORTS

APPENDIX E: ENVIRONMENTAL INFORMATION MANAGEMENT DATABASE
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APPENDIX F: CALCULATIONS FOR DIOXIN/FURAN TEQS

APPENDIX G: BIOSTAT STATISTICAL COMPARISON OUTPUT

APPENDIX A: SAMPLING AND ANALYSIS PLAN

BLAIR DREDGING SUPPLEMENTAL SEDIMENT CHARACTERIZATION – BIOACCUMULATION TESTING PIERCE COUNTY TERMINAL, TACOMA, WASHINGTON

SAMPLING AND ANALYSIS PLAN FINAL

JUNE 17, 2022

Prepared for:

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In Partnership with:

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Approval signatures indicate that each member of the project team has reviewed this Sampling and Analysis Plan (SAP) and agrees to follow the methods and QA procedures contained herein. NewFields Sediment Management and Marine Sciences, LLC (NewFields), Edmonds, Washington, has prepared this SAP in partnership with Leon Environmental, LLC (L-E), on behalf of the Port of Tacoma.

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Acronyms and Abbreviations

ARI	Analytical Resources, Inc.
BT	bioaccumulation trigger
CAB	cellulose acetate butyrate
CFR	Code of Federal Regulations
COC	chemical of concern
CRM	certified reference material
cy	cubic yards
DDT	dichlorodiphenyltrichloroethane
DGPS	Differential Global Positioning System
DMMO	Dredged Material Management Office
DMMP	Dredged Material Management Program
DMMU	dredged material management unit
EDL	estimated detection limit
EIM	Environmental Information Management
EMPC	estimated maximum possible concentration
EPA	U.S. Environmental Protection Agency
FOA	frequency of analysis
GC/MS	gas chromatography/mass spectrometry
HRGC	high resolution gas chromatography
HRMS	high resolution mass spectrometry
HPAH	high molecular weight polycyclic aromatic hydrocarbon
ID	identification
LPAH	low molecular weight polycyclic aromatic hydrocarbon
MDL	method detection limit
ML	maximum level
MLLW	Mean Lower Low Water
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
NAD83	North American Datum of 1983
NOAA	National Oceanic and Atmospheric Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
Port	Port of Tacoma
PCT	Pierce County Terminal
PPE	personal protective equipment
PSEP	Puget Sound Estuary Program
PS-SRM	Puget Sound Sediment Reference Material
PQL	practical quantification limit
QA	quality assurance
QC	quality control
RL	reporting limit

RPD	relative percent difference
RSD	relative standard deviation
SAP	Sampling and Analysis Plan
SDG	sample delivery group
SL	screening level
SRM	standard reference material
TEC	toxic equivalent concentration
TEF	toxic equivalency factor
TEQ	toxicity equivalence
TOC	total organic carbon
TVS	total volatile solid
USACE	U.S. Army Corps of Engineers, Seattle District
VQ	validation qualifier
WUT	Washington United Terminal

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1.0 INTRODUCTION

In October 2020, the Port of Tacoma (Port) conducted a Dredged Material Management Program (DMMP) chemistry-only characterization of sediment mounds created by propeller-wash in the berthing area of Washington United Terminal (WUT), Husky Terminal (Husky), and Pierce County Terminal (PCT), Port of Tacoma, WA (NewFields and L-E 2021). The mounds posed a navigation hazard to Port operations, requiring terminal operators to "light-load" vessels. The 2020 DMMP characterization determined that the proposed dredged material from WUT and Husky terminals was suitable for open-water disposal (DMMP 2021a). However, the dioxin/furan concentrations measured in the proposed dredged material at PCT triggered supplemental bioaccumulation testing to determine whether the material is suitable for open-water disposal. Because bioaccumulation testing would have delayed the more urgently required dredging at WUT and Husky, the Port removed dredging of PCT from the 2020 maintenance action.

The Port proposes to conduct a follow-on DMMP bioaccumulation study at PCT to assess whether the dredged material would be suitable for open-water disposal. The purpose of this Sampling and Analysis Plan (SAP) is to describe the methodology for the dioxins/furans bioaccumulation study, including the overall study design, team responsibilities, dredged material management unit (DMMU) delineations and volumes, sediment collection methods, chemical and biological analysis methods, quality assurance methods, and data reporting requirements.

1.1 Past Sediment Characterizations

The following sections summarize past sediment characterization studies at PCT, including the preliminary results from the DMMP characterization that was conducted as part of the 2020 Blair Waterway berth maintenance dredging.

1.1.1 PCT Expansion in the Blair Waterway 2001–2003

The Port's PCT expansion project in 2001 required the DMMP characterization of approximately 2.1 million cubic yards (cy) of dredged material, with much of the material consisting of native sediment. The project depth was −51 feet mean lower low water (MLLW) including one foot of allowable overdepth (−52 feet MLLW). The project was ranked low to low-moderate, and native material present below fill only required confirmatory testing (10% of cores). The characterization occurred over three phases from 2000 through 2001. Phase I and II analyses showed patchy polychlorinated biphenyls (PCBs) and total dichlorodiphenyltrichloroethane (DDT) above the bioaccumulation trigger (BT) and screening level (SL), respectively, that appeared to be concentrated in a portion of the dredge prism. Phase III involved the analysis of archived discrete samples for pesticides and PCBs to clarify the horizontal and vertical extent. The DMMP agencies concluded that 2.0 million cy of dredged material were suitable for open-water disposal. A total of 69,593 cy of material was determined unsuitable (DMMP 2001).

In 2003, an additional 205,060 cy of dredged material from the PCT expansion project were characterized because of design adjustments and required additional cutback dredging (DMMP 2003). The DMMP characterization determined that the "fill" (DMMU C10) was predominantly free of chemicals of concern (COCs). However, the DMMU representing the top 6 feet "native" layer (C11) showed high molecular weight polycyclic aromatic hydrocarbons (HPAHs) that exceeded SLs. HPAHs and DDT were also found to exceed DMMP guidelines in three subunit DMMUs. The DMMP agencies concluded that 190,360 cy of dredged material were suitable for open-water disposal. A total of 14,700 cy of material were determined unsuitable (DMMP 2003).

1.1.2 Blair Waterway – 2019 Tacoma Harbor Feasibility Study

The U.S Army Corps of Engineers (USACE), Seattle District and the Port conducted a feasibility study to investigate potential deepening and widening alternatives for the Blair Waterway federal navigation channel (DMMP 2019). The waterway is currently authorized to a depth of −51 feet MLLW, and depths of up to −58 feet MLLW plus 2 feet of overdepth are being evaluated. The mudline elevations within the existing navigation channel have generally remained near −51 feet MLLW because of minimal accumulation of sediments. The last deepening of the federal waterway, which consisted of dredging to −51 feet MLLW including 2 feet of overdepth, occurred in 2000–2001.

For the advisory evaluation of the Tacoma Harbor Feasibility Study, the DMMP ranked the channel as low-moderate and the side slopes as moderate (DMMP 2019). A total of 25 locations were sampled throughout the waterway, including five locations in the turning basin near PCT. Core samples were collected at each location and at least two samples (2-foot depth intervals) from each core were chemically analyzed. The analytical parameters included DMMP conventionals and chemicals of concern (COCs), i.e., metals, semi-volatiles, pesticides, PCB Aroclors, bulk tributyltin (TBT), and dioxins/furans. Samples from the locations near the PCT berthing area did not have COC concentrations that exceeded DMMP SLs.

An additional goal of this study was to determine the elevation of the native sediment horizon, which was expected to be around −53 feet MLLW due to the previous deepening to −51 feet MLLW including 2 feet of overdepth (DMMP 2019). The native horizon was identified based on evaluation of the core lithology by sampling personnel familiar with the characteristics of the native sediments in Tacoma Harbor. Based on review of uplands geotechnical boring and available sediment cores in the Blair Waterway, the native unit was expected to consist of moist, medium dense to dense, gray to grayish brown, fine to medium sand with various amounts of silt and trace shell hash and occasional interbeds of moist, medium stiff, light gray, clayey silt (DMMP 2019).

1.1.3 Blair Waterway Berth Maintenance Dredging 2020

The Port conducted a DMMP characterization of sediment mounds created by propeller-wash in the berthing areas of WUT, Husky Terminal, and PCT in October 2020 (NewFields and L-E 2021). The project depth was −51 feet MLLW including one foot of allowable overdepth (−52 feet MLLW). The project followed a moderate 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. Only surface DMMUs were required. The 2020 sediment characterization study was designed as a chemistry-only evaluation for suitability determination. The characterization determined that the proposed dredged material from WUT and Husky terminals was suitable for open-water disposal (DMMP 2021a).

The dredged material volume estimate for PCT was 15,551 cubic yards based on bathymetry data collected in May 2020. The sampling design chemically characterized the sediments as two DMMUs. Each DMMU included sediment cores from three locations each (Figure 1 and Table 1). The dioxin/furan concentrations measured in proposed dredged sediments at PCT triggered supplemental bioaccumulation testing to determine whether the material is suitable for open-water disposal (Table 2). In addition, although total chlordane was undetected, the reporting limit slightly exceeded the SL for one DMMU. To further evaluate the spatial distribution of dioxin/furan concentrations at PCT, samples from the individual cores that comprised each composite were also analyzed for dioxins/furans (Table 3). At that time, the Port decided against proceeding with proposed dredging at PCT as part of the 2020 maintenance action, because the bioaccumulation testing required to evaluate whether PCT dredged material was suitable for open-water disposal would have delayed time-critical dredging at WUT and Husky.

Table 1. 2020 PCT Project Estimated Dredged Material Volumes Including 1-foot Overdepth

DMMU	Berthing Depth (ft MLLW)	Dredge Volume to Berthing Depth (cy)	Dredge Volume 1-foot Overdepth (cy)	Total Volume (cy)
PCT-1	−51	2,453	4,686	**7,139**
PCT-2	−51	6,517	1,895	**8,412**
Totals:		**8,970**	**6,581**	**15,551**

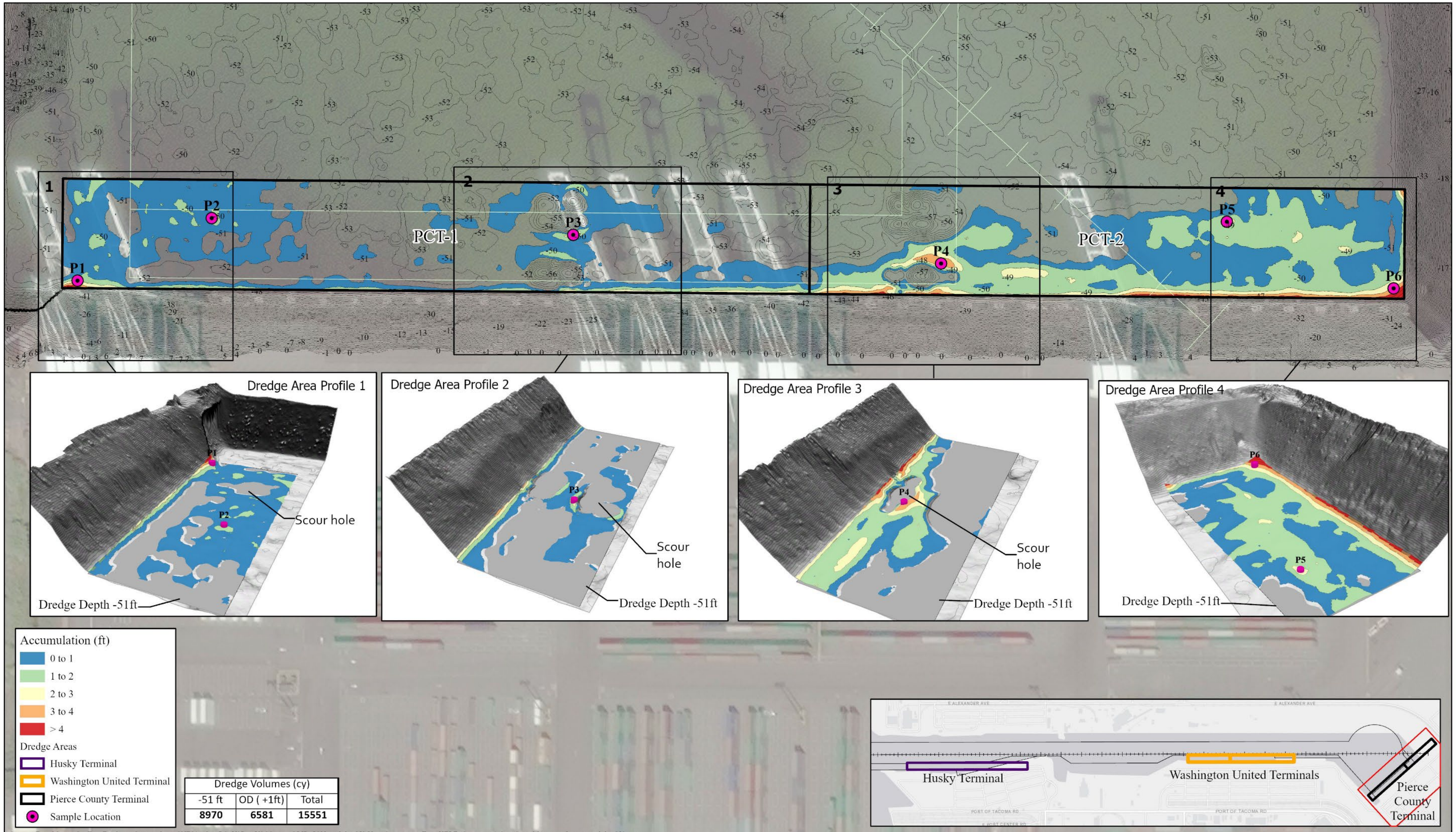

Figure 1. 2020 Pierce County Terminal Dredge Area and Sample Locations

N

0 150 300 600 Feet

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Table 2. 2020 PCT Sediment Chemistry Results

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
Conventionals								
Total Solids	%	---	---	---	75.48		69.02	
Total Volatile Solids	%	---	---	---	2.28		5.59	
Total Organic Carbon	%	---	---	---	0.41		0.75	
Total Sulfides	mg/kg	---	---	---	271		973	
Ammonia	mg/kg	---	---	---	11.2		27.2	
Gravel	%	---	---	---	0.6		2.1	
Sand	%	---	---	---	65.5		32.2	
Silt	%	---	---	---	25.2		53.2	
Clay	%	---	---	---	8.6		12.3	
Grain Size (Fines)	%	---	---	---	33.8		65.5	
Metals and Metalloid								
Antimony	mg/kg	150	---	200	0.26	UJ	0.13	J
Arsenic	mg/kg	57	507.1	700	4.86	J	10.7	J
Cadmium	mg/kg	5.1	---	14	0.05	J	0.08	J
Chromium	mg/kg	260	---	---	12		15.2	
Copper	mg/kg	390	---	1,300	24.2		32.1	
Lead	mg/kg	450	975	1,200	5.03	J	7.48	J
Mercury	mg/kg	0.41	1.5	2.3	0.0164	J	0.0293	
Selenium	mg/kg	---	3	---	0.76		0.78	
Silver	mg/kg	6.1	---	8.4	0.1	J	0.11	J
Zinc	mg/kg	410	---	3,800	34.7	J	44.1	J
Butyltins								
Tributyltin ion	ug/kg	---	73	---	11.9		3.84	U
Organics								
PAHs								
Naphthalene	ug/kg	2,100	---	2,400	6	J	6.2	J
Acenaphthylene	ug/kg	560	---	1,300	19.9	U	19.9	U
Acenaphthene	ug/kg	500	---	2,000	19.9	U	19.9	U
Fluorene	ug/kg	540	---	3,600	5.9	J	6.2	J
Phenanthrene	ug/kg	1,500	---	21,000	16.7	J	23.9	
Anthracene	ug/kg	960	---	13,000	6.4	J	8.1	J
2-Methylnaphthalene	ug/kg	670	---	1,900	6	J	7.4	J
Total LPAH	ug/kg	5,200	---	29,000	41	J	51.8	J
Fluoranthene	ug/kg	1,700	4,600	30,000	24.6		42.5	
Pyrene	ug/kg	2,600	11,980	16,000	59.8		98.4	
Benzo(a)anthracene	ug/kg	1,300	---	5,100	15.4	J	20.6	
Chrysene	ug/kg	1,400	---	21,000	22.2		48.8	
Benzofluoranthenes	ug/kg	3,200	---	9,900	75.2		98	
Benzo(a)pyrene	ug/kg	1,600	---	3,600	25.4		28.9	
Indeno(1,2,3-c,d)pyrene	ug/kg	600	---	4,400	22.9		27.6	

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
Dibenzo(a,h)anthracene	ug/kg	230	---	1,900	7.1	J	8.7	J
Benzo(g,h,i)perylene	ug/kg	670	---	3,200	29.1		39.2	
Total HPAH	ug/kg	12,000	---	69,000	281.7	J	412.7	J
Chlorinated Hydrocarbons								
1,4-Dichlorobenzene	ug/kg	110	---	120	1.7	J	1	J
1,2-Dichlorobenzene	ug/kg	35	---	110	1.1	J	5	U
1,2,4-Trichlorobenzene	ug/kg	31	---	64	19.9	U	19.9	U
Hexachlorobenzene	ug/kg	22	168	230	5	U	5	U
Phthalates								
Dimethyl phthalate	ug/kg	71	---	1,400	19.9	U	19.9	U
Diethyl phthalate	ug/kg	200	---	1,200	19.9	U	19.9	U
Di-n-butyl phthalate	ug/kg	1,400	---	5,100	19.9	U	19.9	U
Butyl benzyl phthalate	ug/kg	63	---	970	19.9	U	8.2	J
Bis(2-ethylhexyl)phthalate	ug/kg	1,300	---	8,300	34.6	J	67.5	
Di-n-octyl phthalate	ug/kg	6,200	---	6,200	19.9	U	19.9	U
Phenols								
Phenol	ug/kg	420	---	1,200	9.4	J	9.7	J
2-Methylphenol	ug/kg	63	---	77	19.9	U	19.9	U
4-Methylphenol	ug/kg	670	---	3,600	19.9	U	19.9	U
2,4-Dimethylphenol	ug/kg	29	---	210	19.9	U	2.2	J
Pentachlorophenol	ug/kg	400	504	690	99.6	U	99.7	U
Miscellaneous Extractables								
Benzyl alcohol	ug/kg	57	---	870	19.9	U	19.9	U
Benzoic acid	ug/kg	650	---	760	199	UJ	199	UJ
Dibenzofuran	ug/kg	540	---	1,700	19.9	U	4.6	J
Hexachlorobutadiene	ug/kg	11	---	270	0.8	J	5	U
N-Nitrosodiphenylamine	ug/kg	28	---	130	19.9	U	19.9	U
Pesticides and PCBs								
4,4'-DDD	ug/kg	16	---	---	0.98	U	0.99	U
4,4'-DDE	ug/kg	9	---	---	0.98	U	0.99	U
4,4'-DDT	ug/kg	12	---	---	0.98	U	0.99	U
Total 4,4'-DDX	ug/kg	---	50	69	0.98	U	0.99	U
Aldrin	ug/kg	9.5	---	---	0.49	U	1.98	U
Total Chlordane	ug/kg	2.8	37	---	1.97	U	2.98	U
Dieldrin	ug/kg	1.9	---	1,700	0.98	U	0.99	U
Heptachlor	ug/kg	1.5	---	270	0.49	U	0.5	U
Total PCBs	ug/kg	130	38*	3,100	8.0	J	13.6	J
Dioxins/Furans								
2,3,7,8-TCDF	ng/kg	---	---	---	3.73		32.5	
2,3,7,8-TCDD	ng/kg	---	---	---	0.114	U	0.148	U
1,2,3,7,8-PeCDF	ng/kg	---	---	---	8.27		35.8	
2,3,4,7,8-PeCDF	ng/kg	---	---	---	3.30		13.0	

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-PCT-1-C Results	BW20-PCT-1-C VQ	BW20-PCT-2-C Results	BW20-PCT-2-C VQ
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.977	J	1.29	
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	17.9	J	58.5	J
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	4.03		16.1	
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	1.77		4.91	
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	2.73		7.51	
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	1.04		1.30	U
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	4.45		6.97	
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	2.35		2.91	
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	19.9		41.8	
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	3.39		9.34	
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	115		124	
OCDF	ng/kg	---	---	---	45.5		92.1	
OCDD	ng/kg	---	---	---	1110		989	
Total TEQ (ND = 0)	ng/kg	4	10	---	7.74		21.28	
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	7.80		21.42	
Total TCDF	ng/kg	---	---	---	7.02		77.3	
Total TCDD	ng/kg	---	---	---	3.29		5.77	
Total PeCDF	ng/kg	---	---	---	25.4		94.3	
Total PeCDD	ng/kg	---	---	---	7.00		4.36	
Total HxCDF	ng/kg	---	---	---	50.7		133	
Total HxCDD	ng/kg	---	---	---	39.3		49.1	
Total HpCDF	ng/kg	---	---	---	58.3		109	
Total HpCDD	ng/kg	---	---	---	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 3. 2020 Dioxin/Furan Congener Results for Individual Core Samples

Compound	Units	DMMP SL	DMMP BT	DMMP ML	BW20-P1-S Results	Q	VQ	BW20-P2-S Results	Q	VQ	BW20-P3-S Results	Q	VQ
Dioxins/Furans													
2,3,7,8-TCDF	ng/kg	---	---	---	3.21			9.94			2.06		
2,3,7,8-TCDD	ng/kg	---	---	---	0.129	U		0.302	UJ		0.092	U	
1,2,3,7,8-PeCDF	ng/kg	---	---	---	7.61			15.4			3.72		
2,3,4,7,8-PeCDF	ng/kg	---	---	---	2.44			6.83			1.54		
1,2,3,7,8-PeCDD	ng/kg	---	---	---	0.952	J		1.63			0.663	UJ	
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	18.9			31.3			6.75		
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	5.82			9.57			2.02		
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	1.90			3.50			0.928	J	
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	2.48			5.21			1.16		
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	1.10	U		2.13			0.599	J	
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	4.66			10.1			3.15		
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	2.42			4.94			1.60		
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	22.5			41.9			10.4		
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	4.10			7.46			1.92		
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	104			234			62.6		
OCDF	ng/kg	---	---	---	58.4			102			24.7		
OCDD	ng/kg	---	---	---	1070			2140			628		
Total TEQ (ND = 0)	ng/kg	4	10	---	7.50			15.32			3.35		
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	7.62			15.47			3.72		
Total TCDF	ng/kg	---	---	---	7.85			27.9			4.72		
Total TCDD	ng/kg	---	---	---	2.82			4.20			1.76		
Total PeCDF	ng/kg	---	---	---	18.0			53.6			11.9		
Total PeCDD	ng/kg	---	---	---	2.97			4.06			1.82		
Total HxCDF	ng/kg	---	---	---	50.3			96.0			19.9		
Total HxCDD	ng/kg	---	---	---	33.8			83.8			24.0		
Total HpCDF	ng/kg	---	---	---	67.6			122			31.3		
Total HpCDD	ng/kg	---	---	---	263			648			166		

Exceeds SL	Exceeds BT	Exceeds ML

Compound	Units	DMMP SL	DMMP BT	DMMP ML	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	---	---	---	16.2			15.6			20.5		
2,3,7,8-TCDD	ng/kg	---	---	---	0.237	UJ		0.194	UJ		0.182	UJ	
1,2,3,7,8-PeCDF	ng/kg	---	---	---	24.3			24.2			39.6		
2,3,4,7,8-PeCDF	ng/kg	---	---	---	9.94			10.1			13.2		
1,2,3,7,8-PeCDD	ng/kg	---	---	---	2.41			0.735	J		0.727	J	
1,2,3,4,7,8-HxCDF	ng/kg	---	---	---	45.3			40.7			61.3		
1,2,3,6,7,8-HxCDF	ng/kg	---	---	---	12.7			11.8			16.9		
2,3,4,6,7,8-HxCDF	ng/kg	---	---	---	5.95			3.49			4.69		
1,2,3,7,8,9-HxCDF	ng/kg	---	---	---	7.33			6.13			8.15		
1,2,3,4,7,8-HxCDD	ng/kg	---	---	---	2.19			0.698	J		0.868	J	
1,2,3,6,7,8-HxCDD	ng/kg	---	---	---	17.5			3.57			3.44		
1,2,3,7,8,9-HxCDD	ng/kg	---	---	---	6.13			1.74			1.99		
1,2,3,4,6,7,8-HpCDF	ng/kg	---	---	---	54.2			30.0			35.0		
1,2,3,4,7,8,9-HpCDF	ng/kg	---	---	---	9.99			9.21			11.1		
1,2,3,4,6,7,8-HpCDD	ng/kg	---	---	---	211			79.9			68.7		
OCDF	ng/kg	---	---	---	100			81.5			86.4		
OCDD	ng/kg	---	---	---	1510			807			616		
Total TEQ (ND = 0)	ng/kg	4	10	---	20.69			14.32			19.02		
Total TEQ (ND = 1/2 DL)	ng/kg	4	10	---	20.80			14.42			19.11		
Total TCDF	ng/kg	---	---	---	46.0			40.2			48.1		
Total TCDD	ng/kg	---	---	---	4.09			2.09			0.431		
Total PeCDF	ng/kg	---	---	---	76.7			62.9			90.7		
Total PeCDD	ng/kg	---	---	---	7.65			3.87			1.81		
Total HxCDF	ng/kg	---	---	---	148			89.1			118		
Total HxCDD	ng/kg	---	---	---	98.6			24.6			24.7		
Total HpCDF	ng/kg	---	---	---	134			80.0			87.3		
Total HpCDD	ng/kg	---	---	---	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 method reporting limit/method detection limit (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.

1.2 Project Description

The Port proposes to conduct DMMP bioaccumulation testing and chemical analysis at PCT to assess whether the proposed dredged material is suitable for open-water disposal at the Commencement Bay DMMP site. The chemistry-only DMMP characterization of the PCT sediments conducted in October 2020 measured dioxin/furan concentrations that exceeded the SL for DMMU PCT-1 and the BT for DMMU PCT-2 (Table 2). Further evaluation of the spatial distribution of dioxin/furan concentrations at PCT was conducted by analyzing the six individual core samples that comprised the two composite samples. Dioxin/furan concentrations in one core sample was below the SL, one core sample exceeded the SL, and four core samples exceeded the BT (Table 3). In addition, total chlordane was undetected in both DMMUs, but the reporting limit slightly exceeded the SL for DMMU PCT-2. As part of this study, PCT-2 will be re-analyzed for chlordane using a high-resolution method (EPA Method 1699). All other DMMP chemical parameters were undetected or measured at concentrations below corresponding SLs.

Details of the project area are described below and summarized in Table 4. The berthing depth for PCT is −51 feet MLLW. The sediment characterization depth is the berthing depth including an additional 1 foot of allowable overdepth to −52 feet MLLW. The Port had expressed an interest to increase the overdepth from 1 foot to 2 foot due to operational constraints created by the tight overdredge allowance during recent dredging at the WUT and Husky terminals. Dredging around the thin edges of the mounded areas and removal of displaced large riprap armoring along the toe of slope, while staying within the 1-foot overdepth, left some slightly high areas in the berthing areas in the range of 0.1-0.2 feet above the target of -51 feet MLLW, and a small amount of material along the fender face. These slightly higher areas and proximity to the fender face were problematic to re-dredge and stay above the 1-foot overdredge allowance. These areas were thought to be sufficiently addressed. However, after review of the revised berth depths by the Puget Sound Pilots these areas caused the updated “Least Depth” determination to range from -49 feet to -50.8 feet MLLW at the four berthing locations.

The additional 1 foot of overdepth proposed by the Port would likely include “native” material, which could change the ratio of “native” versus overlying sediment that was originally characterized in 2020. Due to the dredging constraints described above, the DMMP agencies have commented that the bioaccumulation testing of the sediments to −52 feet MLLW, as originally characterized, would be more representative of the actual dredged material (DMMP 2022). Therefore, the Port will conduct bioaccumulation testing of sediment to −52 feet MLLW to be consistent with the 2020 study. As part of the proposed sampling effort, two-foot Z-sample composites will be collected to allow for verification of the sediment quality of the “leave” surface (DMMP 2021b). Characterization of the Z-sample composites will cover the additional 1 foot of overdepth that may be needed by the Port due to dredging constraints, as well as compliance with the antidegradation standards for the “leave” surface (DMMP 2022). Tiered testing of the Z-sample composites is described below.

Core sampling locations will be the same as targeted during the 2020 Blair Waterway maintenance dredging project, except for Station P3. Based on the review of recently collected bathymetry by the Seattle District (October 2021), the mound near P3 has shifted slightly to the northeast. The sampling location was moved 25 meters to the northeast to target the mound in that region (Figure 2). It was expected that the propeller-wash from vessels operating in the berthing area could slightly alter the geometry of the mounds over time. Propeller wash from container vessels have created scour holes that generally remain in the same areas. The mounds near the scour holes tend to shift around more by propeller wash compared to distant areas (east and west) of the berth (see Figures 1 and 2).

The updated estimate of dredged material volume at PCT, based on 2021 Seattle District bathymetry, is summarized in Table 5. The engineered volume estimate includes the 2-foot overdepth and the approximate slope slough volume to reflect the maximum dredged material volume that may be removed during this project, as described above. The existing sampling design for the project remains in compliance with the moderate ranking, which requires a minimum of one sample for every 4,000 cy of material and a surface DMMU size of up to 16,000 cy.

A tiered testing program is proposed to allow for the analysis of dioxins/furans in the Z-layer samples prior to the initiation of bioaccumulation testing. The two surface DMMUs and the two corresponding Z-sample composites will be initially analyzed for DMMP conventionals and dioxins/furans. In addition, DMMU sample PCT-2 will be analyzed for total chlordane. The concentration of dioxins/furans in the Z-sample composites will determine whether bioaccumulation testing of the Z-sample composites will be necessary to comply with state antidegradation standards. Upon receipt of the analytical results, the DMMO will be consulted to confirm whether bioaccumulation testing of one or both Z-sample composites is warranted.

A reference sediment from Carr Inlet will be collected by the biological laboratory for the bioaccumulation testing. The reference sediment will be analyzed for DMMP conventionals and dioxins/furans.

1.3 Project Objectives

This SAP details the sample collection and analysis procedures for this bioaccumulation study and is designed to ensure that collection, handling, and analysis of representative sediment samples from the proposed dredging area are conducted in accordance with protocols and quality assurance/quality control (QA/QC) requirements in the current DMMP User Manual (DMMP 2021b).

Table 4. PCT Surface DMMUs, Volumes, Sampling Locations, and Sediment Thickness

DMMU	Estimated Volume (cy)	Location ID	Expected Mudline (ft MLLW)	Length to –51 ft (ft)	1 ft Overdepth (ft)	2-ft Z-Layer[1] (ft)
Pierce County Terminal						
PCT-1	15,969	P1	–49.4	1.6	2.6	4.6
		P2	–50.4	0.6	1.6	3.6
		P3	–50.5	0.5	1.5	3.5
PCT-2	11,384	P4	–47.3	3.7	4.7	6.7
		P5	–49.1	1.9	2.9	4.9
		P6	–47.5	3.5	4.5	6.5

1. Composite samples will be collected from the 2-foot Z-layer (-52 to -54 feet MLLW) and may undergo bioaccumulation testing following a tiered testing approach to verify the sediment quality of the "leave" surface (see Section 1.2).

Table 5. 2022 PCT Project Maximum Expected Dredged Material Volumes Including 2-foot Overdepth (KPFF 2022)

DMMU	Berthing Depth (ft MLLW)	Dredge Volume to Berthing Depth (cy)	Dredge Volume 2-foot Overdepth (cy)	Approximate Slough (cy)	Total Volume (cy)
PCT-1	–51	6,883	7,597	1,489	**15,969**
PCT-2	-51	4,907	5,416	1,061	**11,384**
Totals:		**11,790**	**13,013**	**2,550**	**27,462**

Notes:
The table includes the volume for 2-foot overdepth to reflect the maximum possible dredged material volume that could be removed as part of this project (see Section 1.2).
The maximum expected total volume includes all dredge, 100% available overdredge, and 100% slough determined using the Seattle District bathymetry data collected in October 2021 (KPFF 2022).
Assumed instant slough slope of 1.5:2
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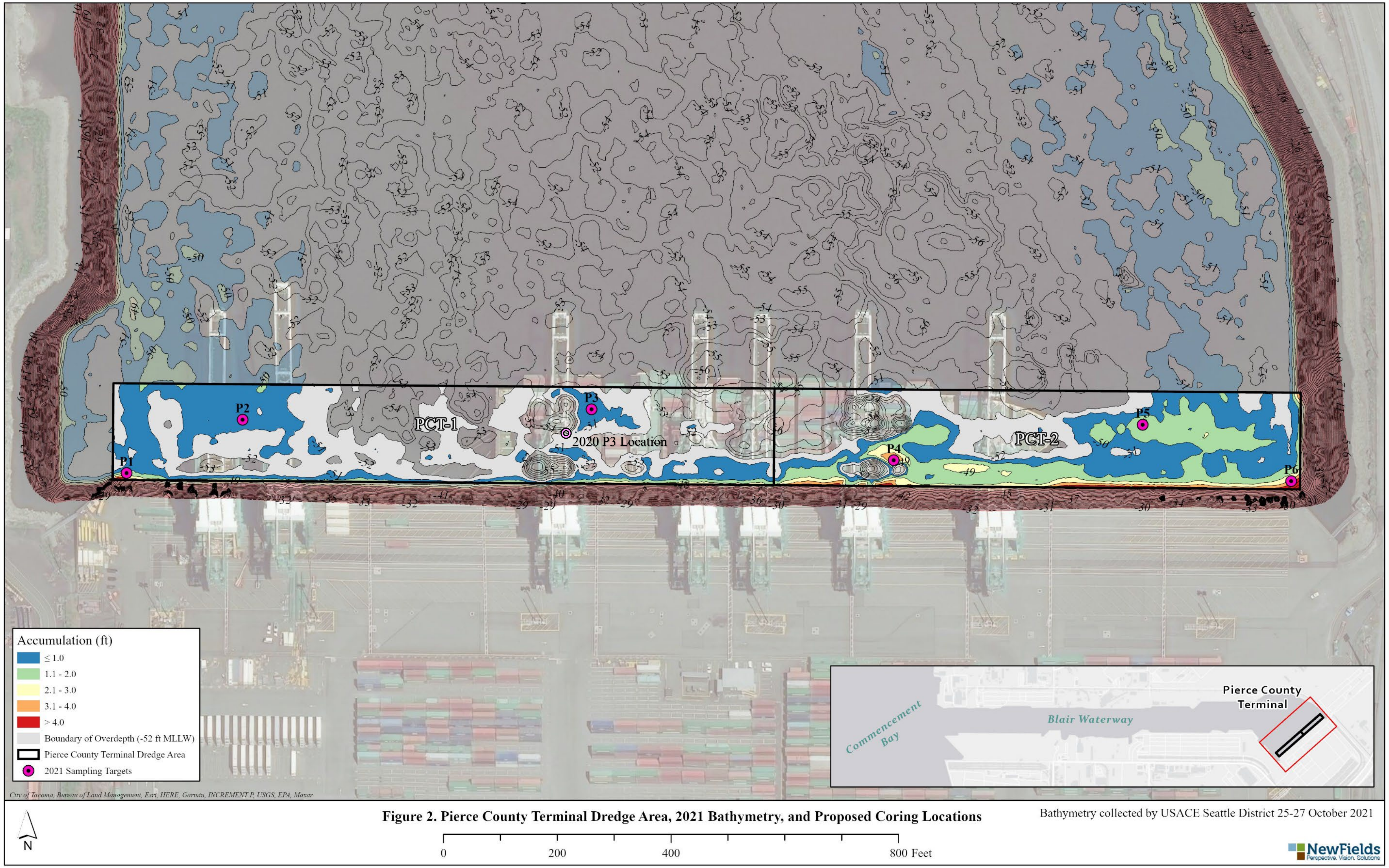

Figure 2. Pierce County Terminal Dredge Area, 2021 Bathymetry, and Proposed Coring Locations

1.4 Project Schedule

The preliminary project schedule for the bioaccumulation testing of sediment mounds in the berthing areas of PCT is provided in Table 6.

1.5 Project Team and Responsibilities

The bioaccumulation study will include (1) project planning and agency coordination, (2) field sample collection, (3) laboratory preparation and analysis, (4) data evaluation and QA/QC review, and (5) draft and final data reports. Staffing and responsibilities are outlined below.

1.5.1 Project Planning and Agency Coordination

The Port of Tacoma is the sponsor for this project. Stanley Sasser is the Environmental Project Manager for the Port of Tacoma. Leon Environmental, LLC (L-E), is the Port of Tacoma's consultant responsible for leading the project and providing environmental permitting services. Mr. Peter Leon is the Principal Scientist at L-E.

Port of Tacoma Project Manager
Mr. Stanley Sasser
Port of Tacoma
253-383-9439
ssasser@portoftacoma.com

L-E Contract & Project Manager
Mr. Peter Leon
Leon Environmental, LLC
206-948-5366
peter@leon-environmental.com

Ms. Joy Dunay of the Seattle District Dredged Material Management Office (DMMO) will be the primary contact for the DMMP agencies, assist in technical matters related to the SAP, and provide review comments to the contractor. NewFields will be responsible for SAP preparation, field sampling, and reporting. NewFields is under contract to L-E to lead the bioaccumulation study at PCT. Mr. John Nakayama of NewFields will serve as the Project Manager for supplemental sediment characterization and will be responsible for coordinating project activities with the DMMO representative in consultation with Peter Leon. Any significant deviation from the approved sampling plan will be coordinated with the DMMO.

DMMO Representative
Ms. Joy Dunay
U.S. Army Corps of Engineers
206-764-6083
joy.m.dunay@usace.army.mil

NewFields Project Manager
Mr. John Nakayama
NewFields
425-967-5285 x102
jnakayama@newfields.com

Table 6. Preliminary Project Schedule

Item	Date
Draft SAP Submittal to DMMP	May 14, 2022
DMMP Comments on Draft SAP	June 3, 2022
Final SAP to Port	June 9, 2022
Port Comments on Final SAP	June 13, 2022
Final SAP Submittal	June 15, 2022
Sampling and Core Processing at PCT	Week of June 20 or June 27, 2022
Carr Inlet Reference Sediment Collection	Week of June 20 or June 27, 2022
Initiate Laboratory Analyses	1 Day after Sampling
Laboratory Sediment Chemistry Results	July 29, 2022
Sediment Data Validation Completed	August 26, 2022
Bioaccumulation Testing Initiated	Week of August 8, 2022
Bioaccumulation Testing Completed	September 23, 2022
Initiate Tissue Analyses	September 26, 2022
Laboratory Tissue Chemistry Results	November 4, 2022
Tissue Data Validation Completed	November 28, 2022
Draft Data Report to Port	December 9, 2022
Port Comments on Draft Report	December 16, 2022
Draft Data Report to DMMP	December 23, 2022
DMMP Comments on Draft Data Report	January 20, 2023
Final Data Report to Port	January 27, 2023
Port Comments on Final Data Report	February 3, 2023
Final Data Report, EIM Submittal	February 10, 2023

Notes:

1) Schedule is dependent on weather, vessel availability, accessibility of berthing areas during Port operations, organism availability for bioaccumulation testing, and potential delays related to COVID-19.
2) Daily sampling/processing reports (events of the day, any problems encountered, schedule) will be submitted electronically at the end of each sampling day.
3) Preliminary chemistry data will be compiled and distributed as received.

1.5.2 Field Sample Collection

NewFields will conduct the field collection of sediment samples, coordinate vessel and equipment logistics, assure conformance to the sampling and handling requirements, maintain the field log, schedule sampling personnel, and coordinate with the analytical laboratories. Mr. Leon Delwiche of NewFields will serve as the Site Safety Officer (the Health and Safety Plan is provided as Appendix A) and participate in the field sampling program. Mr. Shawn Hinz, Gravity Environmental, will be responsible for vessel operation, accurate station positioning, deployment and retrieval of sampling equipment, recording sample locations, and measuring water depth.

Health and Safety Manager
Mr. Leon Delwiche
NewFields
206-412-6800
ldelwiche@newfields.com

Vessel Provider
Mr. Shawn Hinz
Gravity Environmental
425-281-1417
shawn@gravitymarine.com

NewFields personnel will oversee the collection and processing of the sediment samples; however, L-E personnel may also participate in sediment characterization activities. NewFields will be responsible for documenting sample preparation, sample descriptions, and chain-of-custody until the samples are shipped or delivered to the laboratories for analysis. NewFields will also ensure that all required handling and analytical protocols, including decontamination, compositing, record keeping, storage conditions, and holding times, are maintained in accordance with the SAP.

1.5.3 Laboratory Analyses

Ms. Sue Dunnihoo of Analytical Resources, Inc. (ARI), Tukwila, Washington, will serve as the analytical laboratory project manager, and will be responsible for the testing and reporting of all sediment conventional and chemical analytes. ARI will handle and analyze the submitted samples in accordance with DMMP protocols. The analytical laboratory report will be included as an appendix to the final data report.

Analytical Laboratory Project Manager
Ms. Sue Dunnihoo
206-695-6207
sue.dunnihoo@arilabs.com

Mr. Brian Hester of EcoAnalysts, Inc., Port Gamble, Washington, will serve as the biological laboratory project manager, and will be responsible for performing the 45-day bioaccumulation testing. EcoAnalysts will also be responsible for the collection of the Carr Inlet reference sediment. The bioaccumulation laboratory report will be included as an appendix to the final data report.

Biological Laboratory Project Manager
Mr. Brian Hester
360-461-5784
bhester@ecoanalysts.com

1.5.4 QA/QC Management

Mr. John Nakayama will be responsible for QA/QC management of the field sampling, sample processing, and reporting elements of the bioaccumulation study. Mr. Nakayama's contact information is provided in Section 1.5.1. The DMMO representative will be notified immediately of any activities that vary from the written SAP. Mr. Nakayama will serve as the Contractor Quality Control Supervisor for NewFields and will be responsible for overall quality control of all project activities. Ms. Sarah Benson will serve as the Data Quality Control Manager to provide laboratory coordination, QA/QC oversight of analytical laboratory procedures, data review and management coordination, and assurance that reported data are valid and usable to meet DMMP requirements. Ms. Benson will also serve as the Data Quality Reviewer to provide Stage 2B quality review and validation in accordance with the SAP procedures and DMMP protocols. Ms. Chris Ransom of EcoChem, Seattle, WA, will conduct Stage 4 data validation for dioxins/furans.

Data Quality Reviewer
Ms. Sarah Benson
NewFields
425-967-5285 ext. 103
sbenson@newfields.com

Stage 4 Data Quality Reviewer
Ms. Chris Ransom
EcoChem, Inc.
206-508-2109
cransom@ecochem.net

1.6 Draft and Final Data Reports

NewFields will prepare draft and final bioaccumulation study reports, which will include the following information:

- Field sampling methods, including a summary of sampling, compositing, chemical and biological testing, and QA/QC procedures
- Any deviations from the SAP
- Sample target and actual locations and depths (in both figure and table form)
- Sample compositing scheme (table)
- Sampling log sheets and photos with written observations regarding sediment characteristics
- Laboratory analyses conducted for each sample ID and DMMU
- Chemistry results with both laboratory and data validation qualifiers
- A summary of QA/QC data, including validation results
- Comprehensive laboratory data deliverables (electronic only)
- Interpretation of bioaccumulation testing results following DMMP guidelines:
    - Weight-of-evidence approach including consideration of practical quantitation limits (PQLs), the effect of non-detects on statistical comparisons, the magnitude of bioaccumulation, and a comparison to tissue concentrations in comparable species in the vicinity of the Commencement Bay disposal site (DMMP 2021b).

- Dioxin analytical and data validation results:
    - toxic equivalent factor (TEF) for each congener, the toxic equivalent concentration (TEC) for each sample/congener, and total toxicity equivalence (TEQ) using both U = 0 and U = ½ EDL (estimated detection limit)

The draft data report will be provided to the DMMP agency reviewers in electronic format (Microsoft Word and PDF). The final data report will be prepared following receipt of written comments from the DMMP agencies. Once all comments are received, any necessary text additions, revisions, and/or clarifications will be made to the data report. Responses to comments will be discussed with reviewers to assure their comments are adequately addressed in the revised data report. The final data report will be submitted electronically and will include full laboratory packages, validation reports, field notes, sample logs, and photographs. A more detailed listing of the contents of the data report can be found in Section 5 of this SAP.

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2.0 Data Collection and Sample Handling Methods

This section describes the methodology for data collection including the sampling vessel, positioning, sample collection, sample processing, sample identification, documentation, equipment decontamination, and waste handling for the bioaccumulation study.

2.1 Sampling Vessel

A suitable research vessel equipped with an A-frame and winch will be provided by Gravity Environmental for the collection of sediment cores.

2.2 Navigation and Positioning

Geographic station positioning will be accomplished using an onboard Differential Global Positioning System (DGPS). A satellite-based differential correction signal will be utilized to obtain a minimum accuracy of ± 1 meter. The antenna for the onboard DGPS receiver will be mounted to the vibracore sampler deployment boom to minimize separation between the sampler and the recorded position. Station coordinates will be recorded in latitude and longitude as decimal degrees with a minimum precision of six decimal places and shall be based on the North American Datum of 1983 (NAD83).

The mudline elevation at the sampling locations in PCT will be determined using a fathometer or lead line. The water level will be determined real-time using local tide gauge data corrected to an on-site tide board or real-time corrections from the nearby Tacoma, WA, National Oceanic and Atmospheric Administration (NOAA) tide station (#9446484). Vertical accuracy of less than 0.5 feet will be achieved.

2.3 DMMUs and Target Sampling Locations

The DMMUs and target sampling locations for the PCT bioaccumulation study will be the same as the 2020 Blair Waterway maintenance dredging project, except for sampling location P3. The sediment mound near P3 appears to have shifted slightly based on the recent bathymetry collected by the Seattle District (October 2021). The target location for P3 was moved 25 meters to the northeast to sample the mound in that region (Figure 2). It was expected that the propeller-wash from vessels operating in the berthing area could slightly alter the geometry of the mounds over time.

Vibracores will be collected within 10 feet (3 meters) of target sampling locations. Geographic coordinates for the sampling locations are provided in Table 7. Six vibracores locations will be occupied within the PCT project area and three cores will be collected at each location to obtain adequate volume for chemical and bioaccumulation testing. (Figure 2). Each vibracore will be advanced to −54 ft MLLW to obtain 2-foot Z-samples.

The sampling locations and depth intervals that will be composited to form the two DMMU samples are provided in Table 8.

Table 7. Target Sampling Locations

Station ID	Expected Mudline (ft MLLW)	State Plane CS - WA.S NAD83 (ft)		NAD83	
		X	Y	Latitude	Longitude
Pierce County Terminal					
P1	–49.4	1173073.54	706084.71	47.254229	–122.382072
P2	–50.4	1173280.74	706171.16	47.254479	–122.381246
P3	–50.5	1173894.23	706167.70	47.254510	–122.378776
P4	–47.3	1174421.91	706059.28	47.254247	–122.376641
P5	–49.1	1174861.40	706106.05	47.254404	–122.374876
P6	–47.5	1175118.80	705997.73	47.254124	–122.373830

MLLW = Mean Lower Low Water NAD83 = North American Datum 1983
Latitude and longitude in decimal degrees

Table 8. Sample Compositing Scheme

DMMU	Location ID	Elevation in Feet (MLLW)		Depth Below Mudline (ft)		
		Expected Mudline/Top of DMMU	DMMU Bottom	DMMU Top	DMMU Bottom	Z-Layer Bottom
Pierce County Terminal						
PCT-1	P1	–49.4	–52	0.0	2.6	4.6
	P2	–50.4	–52	0.0	1.6	3.6
	P3	–50.5	–52	0.0	1.5	3.5
PCT-2	P4	–47.3	–52	0.0	4.7	6.7
	P5	–49.1	–52	0.0	2.9	4.9
	P6	–47.5	–52	0.0	4.5	6.5

Note: Actual mudline elevations will be confirmed in the field, which will then be used for determining actual sampling elevations

2.4 Sample Collection Methods

Sediments at PCT will be collected using a vibracorer. Surface sediments at the Carr Inlet reference area will be collected using a 0.1 m^2 Van Veen grab sampler. The following sections discuss the sample collection and compositing methods.

2.4.1 Vibracore Samples

Core samples at PCT will be collected using Gravity Environmental's vibracorer equipped with pre-cleaned cellulose acetate butyrate (CAB) core barrel with a polyethylene liner. The rigid CAB core barrels are translucent and allow rapid visual confirmation of sediment recovery. The end of the sediment core barrel (4-inch diameter) is equipped with stainless steel "eggshell" core catcher to retain sediments that enter the barrel. A check-valve is used in the tube adapter clamp to prevent suction caused from pulling the core out of the mud and backflow of sample out of the vibracorer tube.

The vibracorer is mechanically lowered into position on the seafloor, activated, and allowed to penetrate to the target sampling depth or refusal. An integrated measurement line is used to monitor real-time depth penetration of the corer head. In addition, an in-situ recovery system (ISRS) will be used to provide a real time view of the core recovery depth while driving the vibracorer into the sediment. The ISRS consists of a sensor inside of the core barrel that is connected to a topside digital depth reader system (Appendix C).

Once sampling is complete, the vibracorer is retrieved and sediment recovery verified. The core barrel will then be removed and the condition and quantity of material within the core will then be inspected to determine acceptability.

To verify whether an acceptable core sample has been collected, the following criteria must be met:

- Target penetration depth was achieved or hit refusal due to presence of native sediment.
- Sample appears undisturbed and intact without any evidence of obstruction or blocking within the core tube or core catcher.
- Sediment recovery is at least 75 percent of the penetration depth. If this amount of recovery is not achieved during the first coring attempt, the field team may move the core location within 10 feet of the target sampling location to try up to two additional times. The location will target the sediment mounds observed in the bathymetry. The DMMO representative will be contacted if there is a need to move a sampling location more than 10 feet from any target location. Of the cores collected, the three with the greatest percent recovery will be used.
- Rip rap was not encountered previously. However, if encountered the moving of the sampling location (which could be greater than 10 feet) will be coordinated with the DMMO representative. The revised location will target the sediment mounds observed in the bathymetry.

The percent sediment recovery will be determined by dividing the length of material recovered by the depth of core penetration below the mudline. If the sample is deemed acceptable, overlying water will be carefully poured off by tipping the core barrel, and each end of the liner will be sealed closed with a zip tie. All cores will be labeled with the sampling location, core number, date and time of collection, depth, and direction arrows indicating the top end. The sampling location, core number, station coordinates, date and time of collection, field crew, and weather conditions will be recorded in the field log. The coring log will include penetration depth, length of core recovered, calculated recovery, measured water depth, tidal height at the time of sampling, and the calculated mudline elevation. The cores will be processed at a shore-based location adjacent to the project area.

2.4.2 Core processing

At the shore processing location, the core liner will be pulled from the core barrel and placed on a core processing tray. After removal of overlying water, the core liner will be cut along the axis using shears or a utility knife. The sediment will then be split along this axis using a pre-cleaned spatula. Once a core liner is opened, the sediment will be inspected, described, and photographed. Following visual classification, individual sediment samples will be collected as discussed in Section 2.4.3. As much as possible, sampling will proceed by completing the cores required for a DMMU composite before proceeding to collect samples for the next composite.

2.4.3 Core Sample Compositing and Subsampling

The following paragraphs describe the procedures for compositing sediments from multiple core interval samples and subsampling the composites for chemical and biological testing.

Once the core has been split, sampling depth intervals will be delineated in the sediment using a pre-cleaned stainless-steel spoon. The depth intervals will not be adjusted to account for compaction unless compaction is suspected and the DMMO Representative approves.

Only surface DMMUs will be collected, so each sediment core will be divided into a surface sample for the DMMU and a Z-sample. A pre-cleaned stainless-steel mixing container will be labeled with the DMMU number. The field manager will be responsible for ensuring the compositing container remain organized and that surface core samples are placed in the correct container.

Sediment will be removed from each core interval comprising a DMMU composite and placed in a decontaminated stainless-steel container. Sediment will be collected from the full length of the core interval to provide representative material for the dredge prism. Sediment will be collected from throughout the entire acceptable sample, except for sediment coming in direct contact with the sampling equipment. Each container will be covered with foil or a pre-cleaned stainless-steel lid. Once the required sediment has been collected for a composite, the sample will be homogenized with a pre-cleaned stainless-steel paint mixer and electric drill until a consistent color and texture is achieved.

Aliquots of the homogenized sediment will be placed in the appropriate pre-cleaned containers for conventional and chemical testing. Sediments for bioaccumulation testing will be placed in polyethylene bags and sealed with no head space. One 16-oz jar of sediment from each DMMU and Z-sample composite will be archived. An archive sample (8-oz) will be collected from each individual core interval and Z-layer.

Additional archive samples (8-oz) will be collected along the length of each core consisting of the top 1 foot, and 2-foot intervals thereafter, for potential future chemical analysis, if needed.

A minimum of 27 liters of sediment will be needed to provide adequate volume for all required testing for each sample. A minimum of nine core intervals will be collected from each DMMU (3 cores per location) and will provide adequate sample volume. Assuming a core diameter of 4 inches (10 cm) and the anticipated core lengths listed in Table 8, the sediment volumes are up to 40.9 liters for DMMU PCT-1, 86.9 liters for DMMU PCT-2, and 43.1 liters for each of the Z-sample composites.

2.4.4 Carr Inlet Reference Sediment Collection

A reference sediment from Carr Inlet will be collected with similar grain size characteristics as the PCT test sediments as well as concentrations of dioxins/furans equal to or below the disposal site management objective of 4.0 ng/kg TEQ. The reference sediment will be included with the bioaccumulation testing. In previous testing, DMMU PCT-1 has a grain size of 33.8% fines, and DMMU PCT-2 has a grain size of 65.5% fines. The PCT test sediments will be wet sieved in the field to determine the percent fines (procedure described below). The DMMO/DMMP will then be contacted to determine what grain size should be targeted for the reference sediment(s) in Carr Inlet.

EcoAnalysts will be responsible for the collection of the reference sediment. A stainless steel 0.1-m^2 Van Veen grab sampler or similar device will be used to collect reference sediment using methods described in PSEP (1997d). The surface 10 centimeters of sediment will be removed from the sampler and homogenized. The silt and clay (fines) content of the sample will be determined by the following wet-sieving procedure:

1) Measure and record the exact volume of a small (50 ml) flat-topped beaker. (Note: the 50 ml gradation is generally located slightly below the rim of the beaker; hence, the actual beaker volume is greater than 50 ml).
2) Completely fill the beaker to the rim with an aliquot of homogenized sediment. Lightly tap the beaker on a hard surface to remove any air bubbles, and level the surface.
3) Rinse the entire contents of the beaker through a 63-micron (#230, 4 phi) sieve. Aggregates of material should be gently broken to facilitate sieving. Continue sieving until clear rinse water passes through the sieve.
4) Carefully transfer and rinse the coarse-grained material from the sieve into a 100 ml graduated cylinder.
5) Divide the amount of material measured in the bottom of the graduated cylinder by the capacity of the beaker to determine the decimal percentage of coarse-grained material. Subtract the decimal percentage of coarse-grained material from 1 to determine the decimal percentage of fines (silt and clay).

Percentages of coarse- and fine-grained material will be recorded in the logbook. Reference sediments will be analyzed for total solids, total volatile solids, total organic carbon, bulk ammonia, total sulfides, grain size, and dioxins/furans.

2.4.5 *Sample Identification*

Samples will be identified following the same naming conventions used during the 2020 Blair Waterway characterization. Sample names are based on the project sampling event, DMMU or sampling location, and sample type (Table 9). All samples collected for the bioaccumulation study will be labeled clearly and legibly. Each sample will be labeled with a unique alphanumeric sample identification number that identifies characteristics of the sample as follows:

- Sampling Event: Four characters describing the sampling event (i.e., BW = Blair Waterway, 22 = 2022).
- DMMU or Sampling Location: Three characters (PCT = Pierce County Terminal, CAR = Carr Inlet) and number identifying the DMMU (e.g., PCT-1) or the designated sampling location (e.g., P1).
- Sample Type: One or two characters indicating the sample type:
  - C = sample composite
  - S = surface sample
  - Z = Z-sample
  - M1 = *M. nasuta* clam tissue – replicate 1
  - A2 = *A. virens* worm tissue – replicate 2
  - 0-1 = 0 to 1 foot interval (core sample archive)
  - 1-3 = 1 to 3 feet interval (core sample archive)
  - 3-5 = 3 to 5 feet interval (core sample archive)

Table 9. Sample Identification Scheme Examples

Sampling Event	DMMU or Sampling Location	Sample Type	Description
BW22	PCT-1	C	DMMU PCT-1 composite
BW22	PCT-1	Z	Z-sample composite below PCT-1
BW22	P1	0-1	Archive sample 0 to 1 foot from P1
BW22	P1	1-3	Archive sample 1 to 3 feet from P1
BW22	P1	S	Surface sample P1
BW22	P2	Z	Z sample for P2

Sample aliquots submitted to the analytical laboratories will be placed in pre-cleaned sample containers and preserved as identified in Table 10. The specific sediment samples to be collected are listed in Table 11, and anticipated bioaccumulation tissue samples are listed in Table 12. The procedure for sample storage and shipping is provided in Section 2.4.6.

Sample labels will be self-adhering, waterproof material. Indelible ink will be used to fill out each label. Each sample label will contain the project name (2022 PCT Bioaccumulation Study), sample identification, date and time of collection, analyses, preservative (as applicable), and the initials of the person preparing the sample. In addition, a unique, sequentially numbered jar tag label will be placed on each sample container for tracking purposes. Jar tag label numbers will be recorded in a Sample Container Logbook (Appendix B). Sample labels and jar tag labels will be protected by packaging tape wrapped around the entire jar to prevent loss or damage of the labels during handling and storage.

2.4.6 Sample Storage and Delivery

All sediment samples will be stored in insulated coolers and preserved by cooling with ice or frozen gel-packs to a temperature of 4±2°C. Tissue samples will be frozen at -18°C. Maximum sample holding and extraction times will be strictly adhered to by field personnel and the analytical laboratories. Preparation of jars for shipment will be performed in the following manner:

- Place individual sample containers in plastic bubble-pack bags or zip-lock and wrap in bubble pack and secure with packaging tape.
- Prepare an empty insulated cooler by placing three to four ice packs in a garbage bag at the bottom of the cooler. Place sample containers in a garbage bag and fill with the sample bottles. Add additional bags of ice as needed to surround the bag containing the samples.
- Include a temperature blank in the cooler.
- Seal the cooler with strapping tape and a custody seal.

Samples for chemical analyses will be hand-carried to the analytical laboratory accompanied by the chain-of-custody record, which identifies the shipment contents. The chain-of-custody form will be signed by the individual relinquishing samples to the laboratory. Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24. NewFields field personnel will be responsible for the following:

- Packaging the samples
- Ensuring the signed chain-of-custody forms are enclosed in a plastic bag and taped to the inside lid of the cooler
- Applying a shipping label, a waybill, a custody seal, and strapping tape to the cooler
- Shipping the samples in accordance with the maximum holding time allowed for the analyses to be performed.

Table 10. Sample Types, Containers, Holding Times, Preservatives, and Storage Requirements

Sample Type	Sample Size[1]	Preservation[2]	Holding Time	Container[3]
Sediment Conventionals				
Grain Size	100–200 g	4±2°C	6 months	16-oz glass or HDPE
Total Solids	125 g	4±2°C/–18±2°C	14 days/6 months	8-oz glass
Total Volatile Solids	125 g	4±2°C/–18±2°C	14 days/6 months	
Total Organic Carbon	125 g	4±2°C/–18±2°C	14 days/6 months	
Ammonia	25 g	4±2°C	7 days	
Total Sulfides	50 g	4±2°C, 2N zinc acetate	7 days	2-oz glass
Chemistry				
Pesticides	50 g	4±2°C/–18±2°C	14 days/1 year	4-oz glass
Dioxins/Furans	100 g	4±2°C/–18±2°C	14 days/1 year	8-oz amber glass
Bioaccumulation Testing				
45-day suspension/filter-feeding (*Macoma nasuta*)	26.5 L	4±2°C, nitrogen atmosphere[4]	8 weeks	Polyethylene bag
45-day deposit feeding (*Alitta virens*)		4±2°C, nitrogen atmosphere[4]	8 weeks	
Archival				
Sample Archive[5]	125 g	4±2°C/–18±2°C	14 days/6 months	16-oz or 8-oz glass

Notes:

1. Recommended minimum field sample sizes for one laboratory analysis. Actual volumes to be collected have been increased to provide a margin of error and allow for retests.
2. During transport to the lab, samples will be stored on ice. Chemistry archive samples will be frozen immediately upon receipt.
3. All sample containers will have Teflon-lined lids.
4. If headspace is present, purge with nitrogen at the laboratory.
5. One 16-oz container (each composite sample) and an 8-oz container (every individual core sample) will be archived for potential analysis/re-analysis. One 16-oz container will be archived for each Z-sample composite.

Table 11. PCT and Carr Inlet Sediment Samples to be Collected

Sample ID	Grain Size	Total Solids	Total Volatile Solids (TVS)	Total Organic Carbon (TOC)	Ammonia	Total Sulfides	Total Chlordane	Dioxins/Furans	Sediment Archive	Bioaccumulation
Pierce County Terminal										
BW22-PCT-1-C	X	X	X	X	X	X	-	X	A	X
BW22-PCT-1-Z	X	X	X	X	X	X	-	X	A	A[1]
BW22-P1-S	-	-	-	-	-	-	-	-	A	-
BW22-P1-Z	-	-	-	-	-	-	-	-	A	-
BW22-P1-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P1-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P2-S	-	-	-	-	-	-	-	-	A	-
BW22-P2-Z	-	-	-	-	-	-	-	-	A	-
BW22-P2-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P2-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P3-S	-	-	-	-	-	-	-	-	A	-
BW22-P3-Z	-	-	-	-	-	-	-	-	A	-
BW22-P3-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P3-1-3	-	-	-	-	-	-	-	-	A	-
BW22-PCT-2-C	X	X	X	X	X	X	X	X	A	X
BW22-PCT-2-Z	X	X	X	X	X	X	-	X	A	A[1]
BW22-P4-S	-	-	-	-	-	-	-	-	A	-
BW22-P4-Z	-	-	-	-	-	-	-	-	A	-
BW22-P4-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P4-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P4-3-5	-	-	-	-	-	-	-	-	A	-
BW22-P5-S	-	-	-	-	-	-	-	-	A	-
BW22-P5-Z	-	-	-	-	-	-	-	-	A	-
BW22-P5-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P5-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P5-3-5	-	-	-	-	-	-	-	-	A	-
BW22-P6-S	-	-	-	-	-	-	-	-	A	-

Sample ID	Grain Size	Total Solids	Total Volatile Solids (TVS)	Total Organic Carbon (TOC)	Ammonia	Total Sulfides	Total Chlordane	Dioxins/Furans	Sediment Archive	Bioaccumulation
BW22-P6-Z	-	-	-	-	-	-	-	-	A	-
BW22-P6-0-1	-	-	-	-	-	-	-	-	A	-
BW22-P6-1-3	-	-	-	-	-	-	-	-	A	-
BW22-P6-3-5	-	-	-	-	-	-	-	-	A	-
Carr Inlet										
BW22-CAR-C	X	X	X	X	X	X	-	X	A	X
SRM	-	-	-	-	-	-	-	-	-	-
Total Samples	5	5	5	5	5	5	1	5	34	5

Notes:

1. Z-sample bioaccumulation test sediments will be archived pending dioxin/furan results and consultation with the DMMO.

X: Sample collected to be analyzed

A: Sample to be archived

SRM: Standard reference material

Table 12. PCT and Carr Inlet Tissue Samples

Sample ID	Organism	Total Solids	Lipids	Dioxins/Furans
BW22-PCT-1-M1	*M. nasuta*	√	√	√
BW22-PCT-1-M2	*M. nasuta*	√	√	√
BW22-PCT-1-M3	*M. nasuta*	√	√	√
BW22-PCT-1-M4	*M. nasuta*	√	√	√
BW22-PCT-1-M5	*M. nasuta*	√	√	√
BW22-PCT-1-A1	*A. virens*	√	√	√
BW22-PCT-1-A2	*A. virens*	√	√	√
BW22-PCT-1-A3	*A. virens*	√	√	√
BW22-PCT-1-A4	*A. virens*	√	√	√
BW22-PCT-1-A5	*A. virens*	√	√	√
BW22-PCT-2-M1	*M. nasuta*	√	√	√
BW22-PCT-2-M2	*M. nasuta*	√	√	√
BW22-PCT-2-M3	*M. nasuta*	√	√	√
BW22-PCT-2-M4	*M. nasuta*	√	√	√
BW22-PCT-2-M5	*M. nasuta*	√	√	√
BW22-PCT-2-A1	*A. virens*	√	√	√
BW22-PCT-2-A2	*A. virens*	√	√	√
BW22-PCT-2-A3	*A. virens*	√	√	√
BW22-PCT-2-A4	*A. virens*	√	√	√
BW22-PCT-2-A5	*A. virens*	√	√	√
BW22-CAR-M1	*M. nasuta*	√	√	√
BW22-CAR-M2	*M. nasuta*	√	√	√
BW22-CAR-M3	*M. nasuta*	√	√	√
BW22-CAR-M4	*M. nasuta*	√	√	√
BW22-CAR-M5	*M. nasuta*	√	√	√
BW22-CAR-A1	*A. virens*	√	√	√
BW22-CAR-A2	*A. virens*	√	√	√
BW22-CAR-A3	*A. virens*	√	√	√
BW22-CAR-A4	*A. virens*	√	√	√
BW22-CAR-A5	*A. virens*	√	√	√
PreTest-M1	*M. nasuta*	√	√	√
PreTest-M2	*M. nasuta*	√	√	√
PreTest-M3	*M. nasuta*	√	√	√
PreTest-A1	*A. virens*	√	√	√
PreTest-A2	*A. virens*	√	√	√
PreTest-A3	*A. virens*	√	√	√

Notes:

Sample list does not include tissue samples generated for Z-sample bioaccumulation testing, if required.

The samples will remain in the custody of the field staff until completion of sample processing at the end of each day and transported to a secure storage facility. Efforts will be made to deliver samples in a single sample delivery group (SDG) to the analytical laboratory at the completion of sampling. Cooler temperatures will be monitored, and ice will be changed daily to ensure proper sample preservation.

2.4.7 *Field Documentation*

A complete record of field activities will be maintained. Documentation necessary to meet QA objectives for this project include field notes and field forms (Appendix B), sample container labels, and chain-of-custody forms. The field documentation will provide descriptions of all sampling activities, sampling personnel, and weather conditions, and it will record all modifications, decisions, and/or corrective actions to the study design and procedures. In addition, photographs of the cores will be included in the field documentation.

2.4.8 *Field Logbooks*

Field logbook(s) will be kept on site during field operations. Daily activities will be recorded in a bound field logbook of water-resistant paper. Separate logbooks, consisting of bound, paginated field forms, will be kept for sediment cores, the daily sample/processing report, and an inventory of sample containers (separate from chain-of-custody documentation). Examples of the field forms to be used are presented in Appendix B. All entries will be made legibly, in indelible ink, and will be signed and dated. Information recorded will include the following:

- Date, time, place, and location of sampling
- Onsite personnel and visitors
- Daily safety discussion and any safety issues
- Verification of horizontal and vertical positioning systems
- Quality control samples
- Field measurements and their units
- Observations about site, location, and samples (weather, current, odors, appearance, etc.)
- Equipment decontamination verification

Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occur during project field activities. Entries should be factual, detailed, and objective. Unless restricted by weather conditions, all original data recorded in field logbooks and on sample identification labels, chain-of-custody records, and field forms will be written in waterproof, indelible ink. If an error is made, the individual responsible may make corrections simply by crossing out the error and entering the correct information. The erroneous information should not be obliterated. All corrections must be initialed and dated. All documentation, including voided entries, must be maintained within project files.

2.4.9 *Chain-of-Custody Procedures*

Samples will be retained at all times in the field crew's custody until samples are delivered or shipped to the appropriate laboratory by NewFields personnel. All samples will be held and transported in coolers with ice or frozen gel-packs at approximately 4±2°C. Chain-of-custody forms will be initiated at the time of sample collection to ensure that all collected samples are properly documented and traceable through storage, transport, and analysis. Information tracked by the chain-of-custody records will include sample identification, date and time of sample collection and receipt, and analyses required. When all line items on the form are completed or when the samples are relinquished, the sample collection custodian will sign and date the form, list the time, and confirm the completeness of all descriptive information contained on the form. Each individual who subsequently assumes responsibility for the samples will sign and date the chain-of-custody form. The signed and dated chain-of-custody forms will be enclosed in a plastic bag and taped to the inside lid of the cooler prior to shipping. The field chain-of-custody terminates when the laboratory receives the samples. The field sample custodian should retain a copy of the completed, signed chain-of-custody form(s) for project files. Upon receipt of samples at the laboratories, the shipping container seal will be broken and the receiver will record the condition of the samples and the temperature of the temperature blank. The laboratories will maintain chain-of-custody internally to track handling and final disposition of all samples.

2.5 Equipment Decontamination Procedures

Sample processing equipment (i.e., spoons, bowls, and reusable containers from which samples are transferred to sample jars) will be washed with a phosphate-free, biodegradable, laboratory-grade detergent (e.g., Liquinox) and water solution and then rinsed with distilled water prior to field operations. Decontaminated equipment will be wrapped or covered with aluminum foil. Subsampling and processing equipment will be decontaminated before use at each location to prevent cross contamination of samples. Any deviations from these procedures will be documented in the field notebook.

Personal non-disposable field equipment (e.g., boots and waterproof gloves and garments) will be rinsed with water and brushed clean prior to leaving the immediate vicinity of the sample collection area. Special attention will be given to removing mud and sediments that may adhere to boot treads.

2.6 Waste Disposal

Two types of investigation-derived waste will be generated during the activities described in this work plan:

- Sediment not submitted to the laboratories
- Disposable protective clothing and supplies

Excess sediment from core sampling will be returned to the site at the time of collection. Excess sediment that remains following core processing will be retained in a 55-gallon drum at the Port of Tacoma. The Port is responsible for the disposal of excess sediment and the 55-gallon drum, and upon receipt of laboratory data results, the Port will determine the proper method of disposal.

Used personal protective equipment (PPE) such as disposable gloves and supplies (e.g., paper towels and packaging) will be placed in plastic storage bags and disposed of as municipal waste. Recyclable waste material (e.g., cardboard, aluminum) will be recycled as feasible.

3.0 Laboratory Methods

All of the chemical and biological testing procedures used in this program will be performed in accordance with the PSEP (1997a,b,c,d) and DMMP (2021b) guidelines. The laboratories participating in this program have internal QA/QC plans. Analyses will conform to accepted standard methods and internal QA/QC checks.

3.1 Analytical Methods

All samples will be submitted to ARI for chemical analysis. The specific analyses and conventional parameters to be measured, sample preparation methods, analytical methods, anticipated method detection limits (MDLs) and target reporting limits (RLs), and DMMP guidelines are presented in Table 13. Actual sample RLs may vary because of analytical dilutions, percent solids, sample volume used for analysis, and matrix interferences.

3.1.1 Detection Limits, Reporting Limits, and Sample Analysis Scenarios

The samples collected for characterization will be analyzed for the parameters listed in Table 13. Reporting limits for the COCs should be below DMMP SLs. All reasonable means, including additional cleanup steps and method modifications, should be used to achieve sample RLs at or below the associated SLs. An aliquot (8-oz or 16-oz) of each sediment sample will be archived frozen for additional analysis if needed.

3.1.2 Sediment Analyses

Sediment Conventionals

DMMP sediment conventional parameters will be analyzed:

- Total solids
- Total volatile solids (TVS)
- Total organic carbon (TOC)
- Total sulfides
- Ammonia
- Grain size

Analysis methods for the conventional parameters are listed in Table 13. The laboratory shall perform all method-required QC procedures outlined in Table 14. Grain size distribution for each composite sample will be determined in accordance with PSEP (1986). Nos. 10 and 230 sieves will be used. Hydrogen peroxide will not be used in this analysis, because it breaks down organic aggregates and causes an overestimation of the percent fines found in undisturbed sediment.

Table 13. DMMP Chemical Parameters

Parameter	Prep Method	Analysis Method	Sediment		DMMP[1]		
			MDL[1,3]	RL[1,3]	SL	BT	ML
Conventionals							
Total Solids (%)	---	PSEP	0.04	0.04	---	---	---
Total Volatile Solids (%)	---	PSEP	0.01	0.01	---	---	---
Total Organic Carbon (%)	---	9060(modified)	0.02	0.02	---	---	---
Total Sulfides (mg/kg)	---	PSEP	1.00	1.00	---	---	---
Ammonia (mg/kg)	---	Plumb (1981)[2]	0.04	0.5	---	---	---
Grain Size (%)	---	PSEP	0.1	0.1	---	---	---
***Pesticides*[3]**							
Total Chlordane[4]	3540/3550[5]	1699[6]	0.012-0.038	0.012-0.038	2.8	37	---
Dioxin/Furan Congeners (ng/kg)							
2,3,7,8-TCDD	---	1613B[3]	0.160	1.00	---	---	---
1,2,3,7,8-PeCDD	---	1613B[3]	0.180	5.00	---	---	---
1,2,3,4,7,8-HxCDD	---	1613B[3]	0.200	5.00	---	---	---
1,2,3,6,7,8-HxCDD	---	1613B[3]	0.320	5.00	---	---	---
1,2,3,7,8,9-HxCDD	---	1613B[3]	0.340	5.00	---	---	---
1,2,3,4,6,7,8-HpCDD	---	1613B[3]	0.270	5.00	---	---	---
OCDD	---	1613B[3]	3.40	10.0	---	---	---
2,3,7,8-TCDF	---	1613B[3]	0.0900	1.00	---	---	---
1,2,3,7,8-PeCDF	---	1613B[3]	0.280	5.00	---	---	---
2,3,4,7,8-PeCDF	---	1613B[3]	0.230	5.00	---	---	---
1,2,3,4,7,8-HxCDF	---	1613B[3]	0.120	5.00	---	---	---
1,2,3,6,7,8-HxCDF	---	1613B[3]	0.210	5.00	---	---	---
1,2,3,7,8,9-HxCDF	---	1613B[3]	0.140	5.00	---	---	---
2,3,4,6,7,8-HxCDF	---	1613B[3]	0.110	5.00	---	---	---
1,2,3,4,6,7,8-HpCDF	---	1613B[3]	0.350	5.00	---	---	---
1,2,3,4,7,8,9-HpCDF	---	1613B[3]	0.330	5.00	---	---	---
OCDF	---	1613B[3]	0.440	10.0	---	---	---
Total TEQ[7,8]	---	1613B[3]	---	---	4[9]	10	---

Notes:
EDL = estimated detection limit
MDL = method detection limit
RL = reporting limit
SL = screening level
BT = bioaccumulation trigger
ML = maximum level

1. MDLs, RLs, and DMMP screening levels are on a dry weight basis.
2. Procedures for Handling and Chemical Analysis of Sediment and Water Samples, Russell H. Plumb, Jr., EPA/Corps of Engineers, May 1981.
3. EPA HRMS methods report to EDLs and do not have fixed RLs. The listed MDLs represent a reasonable estimation of EDLs that are observed.
4. Chlordane includes sum of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane.
5. Soxhlet (method 3540) or ultrasonic extraction (3550) methods, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, EPA 1994 and updates.
6. EPA Method 1699: Pesticides in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS. December 2007. EPA-821-R-08-001.
7. Toxicity equivalences (TEQs) will be calculated by substituting the EDL for dioxin/furan congeners with both non-detected values (U) = ½ MDL and with U = 0.
8. Estimated maximum possible concentration (EMPC). For the purposes of TEQ summations, concentrations of EMPC qualifiers will be treated as non-detects and included in the TEQ summations at U = ½ EMPC and U = 0.
9. Project volume-weighted average for open-water disposal; exceedance does not trigger bioassays.

Table 14. Laboratory QA/QC Requirements

Analysis Type	Method Blanks[1]	Replicates[1]	Triplicates[1]	MS/MSD[1]	Surrogates[2]
Total Solids			X		
Total Volatile Solids			X		
Total Organic Carbon	X		X		
Total Sulfides	X		X		
Ammonia	X		X		
Grain Size			X		
Pesticides[3,4]	X[5]	X			X[6]
Dioxins/Furans	X[5]	X			X[6]

Notes:

MS/MSD = matrix spike/matrix spike duplicate

1. Frequency of analysis (FOA) = 5 percent or one per batch, whichever is more frequent.
2. Surrogate spikes required for every sample, including matrix spiked samples, blanks, and reference materials.
3. Initial calibrations required before any samples are analyzed, after each major disruption of equipment, and when ongoing calibration fails to meet criteria.
4. Ongoing calibration required at the beginning of each work shift, every 10 to 12 samples or every 12 hours (whichever is more frequent), and at the end of each shift.
5. FOA = one per extraction batch.
6. Stable-isotope-labeled compounds.

Pesticides

The pesticide total chlordane will be analyzed using Method 1699, which will provide lower a reporting limit than Method 8081. The laboratory shall perform all method-required QC procedures outlined in Table 14.

Dioxin/Furan Congeners

Dioxin/furan congeners will be analyzed using EPA Method 1613B for 2,3,7,8-substituted chlorinated dioxins and furans (DMMP 2021b). To identify analytical interferences, the laboratory and data reviewers shall review the chromatograms for carryover from higher concentration samples and false positives from the presence of chlorinated diphenyl ethers.

Seventeen individual dioxin and furan congeners will be reported on a dry-weight basis as well as the summation of each homolog group. Toxicity equivalence (TEQ) values will be calculated using World Health Organization mammalian toxic equivalent factors (TEF) reported by Van den Berg et al. (2006). Estimated Maximum Possible Concentrations (EMPCs) will be qualified as non-detected at the level the analyte was detected (EMPC concentrations) unless there is reason to believe the EMPC concentration is a positive detection. TEQ values will be reported both with non-detects equal to one-half the estimated detection limit (EDL) and as zero.

3.1.3 Bioaccumulation Testing

Bioaccumulation testing will be conducted following DMMP guidance (DMMP 2021b) with modifications as outlined below. Testing will be conducted using the adult bivalve (*Macoma nasuta*) and adult polychaete (*Alitta virens*) using separate exposure tanks for a 45-day period.

Five replicates for each species (approximately 20 grams/species/replicate) will be generated for each DMMU, as well as three pre-test replicates for each species.

The test chambers will be maintained under flow-through conditions and daily water quality measurements will be taken on each chamber. Water circulation will not exceed four exchanges per 24-hour period. The test chambers will be checked daily for the presence of dead organisms. If mortality of greater than 25% is observed prior to the completion of testing, the DMMP agencies will be notified to discuss options such as early termination, testing restart, or continuation of testing. On the 45th day of the test, the sediment will be sieved to remove the worms and clams. The surviving animals will be placed in clean flow-through aquaria to purge their gut contents for 24 hours, after which tissues will be placed into certified-clean glass sample jars, frozen, and sent to the chemistry laboratory for compositing and tissue analysis. If mortality exceeds 25% in any test replicate, the DMMO will be contacted to discuss reduced tissue volume for chemical analysis (which could result in the need for increased chemical detection limits and/or compositing of replicates).

Tissue Analyses

Tissues generated from the 45-day bioaccumulation testing will include the adult bivalve (*M. nasuta*) and adult polychaete (*A. virens*). Tissue samples for each replicate will be homogenized by the analytical laboratory and analyzed for total solids, total lipid content (Bligh and Dyer 1959), and dioxin/furan congeners. Analytical methods for dioxins/furans will be the same as those described for sediments (Section 3.1.2).

3.1.4 Holding Times

All samples for will be maintained at the laboratories at appropriate temperatures and will be analyzed prior to the expiration times specified in Table 10. Samples archived for potential future chemical analysis will be stored frozen at the analytical laboratory.

3.1.5 Quality Assurance/Quality Control

The chemistry QA/QC procedures summarized in Table 14 will be conducted to ensure data quality and usability for dredged material characterization and suitability determinations.

3.2 Analytical Laboratory Written Report

Preliminary analytical data will be provided to the DMMO representative as soon as possible upon receipt from the analytical laboratory. Any data qualifiers applied will include descriptions at the time the preliminary data are submitted. Missing information or data not yet reported by the lab will be identified as such. Reports from the chemistry analytical laboratories for this program will be accompanied by sufficient backup data and QC results to enable independent reviewers to evaluate the quality of the data results. Analytical data will be reported in the units specified by the RLs listed in Table 13.

The analytical laboratory deliverables will include the following:

- Case narrative (including any problems encountered, protocol modifications, and/or corrective actions taken)
- Laboratory data qualifiers and a summary of qualifier definitions

- MDLs and RLs for each result
- EDLs for dioxin/furan congeners
- Sample analytical and QA/QC results with units
- Appropriate method references for all analytical, preparatory, and cleanup methods used during analyses
- Any protocol deviations from the approved sampling plan
- Surrogate recovery results and control limits
- MS/MSD results and control limits
- Laboratory duplicate/triplicate results and control limits
- Method blank and instrument blank results
- Initial calibration summary forms
- Continuing calibration summary forms
- Chromatograms for each gas chromatography sample analyses
- Mass spectra of detected target compounds for each sample and associated library spectra for gas chromatography/mass spectrometry analysis
- Raw data quantification reports for each sample
- Sample custody records (including original chain-of-custody forms)
- Analytical results in the Environmental Information Management (EIM) electronic data delivery format

3.3 Data Validation

All chemistry and conventionals data generated as part of this investigation will undergo a quality assurance review and data validation by NewFields and EcoChem, Inc. Validation shall include a minimum of Stage 2b validation for all chemical data. Given the focus of this investigation, ten percent of the dioxin/furan congener data will undergo an independent Stage 4 validation in addition to the Stage 2b validation. Validation will be conducted using most recent EPA (EPA 2005, 2008, 2009, 2010) guidelines. If data quality concerns are noted, the laboratory will be contacted, and the data will be reanalyzed, qualified, and/or discussed in a data validation report. The results of the data validation will be summarized in the data validation report, which will be included as an appendix to the data report.

The analytical laboratory will provide full-level, Stage 4 chemistry data packages that will allow for the examination of the complete analytical process from calculation of instrument and MDLs, RLs, final dilution volumes, sample sizes, and wet-to-dry ratios to quantification of calibration compounds and all analytes detected in blanks and environmental samples.

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4.0 Quality Assurance and Quality Control Methods

The purpose of the project QA/QC is to provide confidence in the project data results through a system of quality control performance checks with respect to data collection methods, laboratory analysis, data reporting, and appropriate corrective actions to achieve compliance with established performance and data quality criteria. This section presents the QA/QC procedures to ensure that the investigation's data results are defensible and usable for their intended purpose.

4.1 Measurements of Data Quality

The tolerable limits for the data reported by the laboratory will be measured through precision, accuracy, representativeness, completeness, and comparability. Acceptance criteria for dioxin/furan congeners and other COCs is presented in Table 15.

4.1.1 Precision

Precision is a measure of mutual agreement among individual measurements of the same property under prescribed conditions. Precision will be assessed by the analysis of lab replicates and/or MS/MSDs (for organics) performed on select project samples to determine the reproducibility of the measurements. The relative percent difference (RPD) will be compared to the precision objectives listed in Table 15. Conventional parameter determinations will be evaluated by the relative standard deviation (RSD) of triplicate analyses.

4.1.2 Accuracy

Accuracy is the degree of agreement of a measurement (or an average of multiple measurements) with an accepted reference or true value, usually expressed as the difference between the two values (measured-true), the difference as a percentage of the true value, or as a ratio. Accuracy is a measure of the bias in the system and is expressed as the percent recovery of spiked (matrix or surrogate spike) samples. Accuracy objectives for the percent recovery of matrix spike samples are listed in Table 15. Laboratory control samples will be analyzed with each batch of samples as a further assessment of analytical accuracy in the absence of matrix effects.

4.1.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an actual condition or characteristic at a sampling point. Representativeness is achieved by collecting samples representative of the matrix at the time of collection. Representativeness can be evaluated using replicate samples, additional sampling locations, and blanks.

Table 15. Recommended Measurement Performance Criteria (DMMP 2021b)

Analysis	Precision	Accuracy	Surrogate Limit	Completeness
Pesticides[1]	±35% RPD	50%-150% R	Lab Limits	95%
Ammonia	±20% RSD	75%-125% R	NA	95%
Total Sulfides	±20% RSD	75%-125% R	NA	95%
Total Organic Carbon	±20% RSD	75%-125% R	NA	95%
Total Solids	±20% RSD	NA	NA	95%
Total Volatile Solids	±20% RSD	NA	NA	95%
Grain Size	±20% RSD	NA	NA	95%
Dioxins/Furans	±30% RPD	Method Limits[1]	Method Limits[1]	95%

NA = not applicable

R = recovery

RPD = relative percent difference

RSD = relative standard deviation

1. Method 1613B

4.1.4 *Completeness*

Completeness refers to the number of valid (i.e., not rejected) data points achieved divided by the total number of data points expected. For this project, completeness objectives have been established at 95 percent (Table 15).

4.1.5 *Comparability*

Comparability is based on the use of established PSEP and EPA-approved methods for the analysis of the selected parameters. The quantification of the analytical parameters is based on published methods supplemented with well-documented procedures used in the laboratory to ensure reproducibility of the data.

4.2 QA/QC Samples for Chemical Analysis

Laboratory QA/QC samples will be used to evaluate the data precision, accuracy, representativeness, and comparability of the analytical results. Laboratory QA/QC samples will consist of method blanks, lab replicates, lab triplicates, MS/MSD pairs, and surrogate compounds. The results of these laboratory QA/QC samples will provide information on the accuracy and precision of the chemical analysis as well as to verify that the measured concentrations are acceptable. The specific laboratory QA/QC samples to be analyzed are provided in Table 14, which will be analyzed for every 20 sediment samples submitted or for each analytical batch of samples.

5.0 REPORTING

The analytical laboratory results and the QA/QC data reports will be e-mailed to the DMMO representative, both for review and distribution to the agencies. The analysis results will be tabulated and incorporated into the draft and final reports.

5.1 Draft and Final Report

NewFields will prepare a written report documenting all activities associated with collection, compositing, transportation, and chemical analysis of sediment samples. The laboratory report for chemical testing will be included as an appendix. At a minimum, the following will be included:

- Summary of sampling, compositing, chemical testing, QA/QC procedures, and any deviations from the approved sampling and analysis plan
- Table(s) with sampling location coordinates (latitude/longitude), mudline elevations, and compositing information, including date collected, measured water depths, tidal heights and mudline elevations (tide-corrected and referenced to MLLW)
- Figures showing target and actual sampling locations
- Table cross-referencing laboratory sample IDs with DMMU IDs and indicating the analyses done for each sample
- Table(s) with analytical results for chemical and conventional testing with both laboratory and validation qualifiers provided. Exceedances of SLs, BTs, and MLs will be highlighted:
    - Grain size data will be provided as percentages of the following categories: gravel, sand, silt, clay, and fines
    - Both total and constituent concentrations will be provided for chlordane
- A summary of QC data for conventional and chemical testing, including validation results
- Appendices to include the final sampling and analysis plan, daily sampling/processing reports, field notes, sample logs and photographs, chain-of-custody forms, and chemistry and data validation reports (the lab report is to include a case narrative from the laboratory)
- Results reported in EIM format
- Level III/IV data deliverables (electronic only)
- Tables with analytical results for the 2,3,7,8-substituted dioxin/furan congeners with laboratory and validation qualifiers provided. The tables will also include the TEF for each congener and the TEC for each sample/congener. Total TEQ will be provided for each sample, both with U = 0 and U = ½ EDL. EMPCs will be identified in the laboratory qualifiers and converted to U in the validation qualifiers. TEQs will be calculated using the validation qualifiers.
- Bioaccumulation reporting requirements will follow DMMP (2021b):

- Day 0 tissue concentrations
- Tissue concentrations resulting from exposure to test and reference sediment. Note: control tissues will be archived and may be analyzed as an investigative step – e.g., if needed to confirm potential input of contaminants from the biological laboratory testing system such as the water supply, plumbing, or tissue handling.
- Statistical comparison of test and reference tissue results.
- Evaluation of tissue concentrations relative to comparable species found in the vicinity of the Commencement Bay DMMP disposal site. Tissue data (*Compsomyax*, sp. bivalves, Glyceridae, Maldanidae, *Travisia* sp., and *Nephtys* sp. polychaetes) from the 2007 special dioxin study conducted at the Commencement Bay site will be used for comparison (SAIC 2008).
- Evaluation of tissue concentrations relative to PQLs.
- Evaluation of the role of non-detects on statistical comparisons.
- Bioaccumulation laboratory report.
- Evaluation of indicators of test organism health, including biomass and mortality
- Summary of water quality data.
- Discussion of any other factors that may have affected the bioaccumulation testing results.

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APPENDIX A: HEALTH AND SAFETY PLAN

Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing
Pierce County Terminal, Tacoma, Washington

Health and Safety Plan

April 19, 2022

Prepared for:

Port of Tacoma

One Sitcum Plaza
Tacoma, Washington 98421

Prepared by:

NewFields

Edmonds, Washington

In Partnership with:

LEON Environmental, LLC

Seattle, Washington

1.0 Introduction

This site-specific Health and Safety Plan (HASP) is for the Blair Dredging Supplemental Sediment Characterization Project of Pierce County Terminal in Tacoma, WA. This plan is intended to address sampling activities in support of sediment collection and must be re-evaluated should project conditions change.

The procedures and protocols in this plan have been established to ensure that a mechanism is in place to address project personnel in the event that hazards from field work or site contamination are encountered during the project. This plan addresses typical on-site activities such as collection of contaminated sediment samples and marine vessel use. This HASP is not designed to replace existing procedures or to address all health and safety procedures that could be required during typical emergency response activities.

This plan also includes guidance for best practices when conducting fieldwork during the coronavirus disease 2019 (COVID-19) pandemic. COVID-19 is a respiratory disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). These best practices are provided in Section 4.5 of this HASP, and the NewFields Best Practices (BP) guidance document for COVID-19 is provided as Attachment A-1.

Compliance with this HASP is required from all authorized NewFields project personnel, project support personnel, and visitors who enter the work areas of this project. No field work will be conducted without meeting the requirements of this HASP.

The content of this HASP may change or undergo revision based upon unexpected field conditions, modifications to the technical scope of work, or additional information made available to health and safety personnel. Any proposed changes must also be reviewed and approved by designated NewFields personnel.

1.1 Project Location

Project work will be conducted in the Blair Waterway in the Port of Tacoma at the Pierce County Terminal Area. In-water work will be conducted from a research vessel provided by Gravity Environmental.

1.2 Personnel and Emergency Contact Information

Table 1 lists relevant project personnel and local emergency contact information. Additional detailed emergency information is found in Section 6.0 along with written hospital directions and an accompanying map.

All project personnel, project support personnel, and visitors present during field work must sign in the space provided in Table 1 prior to initiating project work. A signature below indicates commitment to implement this plan and to ensure that project fieldwork is conducted safely. A signature below also indicates review and approval of the plan and agreement that the anticipated hazards are correct and that planned hazard controls are sufficient.

Table 1. Project Personnel and Local Emergency Contact Information

Project Personnel	
DMMO Technical Representative, Joy Dunay	(206) 764-6083
Project Manager and Principal Investigator, John Nakayama	(206) 276-0257
Field Manager and Health and Safety Officer, Leon Delwiche	(206) 412-6800
Emergency Contact Information	
Port of Tacoma Security Dispatch (this should be the first point of contact so that emergency services can be directed to you and respond quickly)	(253) 383-9472
Stanley Sasser, Port of Tacoma Project Manager	(253) 383-9439
Emergency Pierce County Sheriff Department	911 (253) 798-7530
Emergency Tacoma Fire Department	911 (253) 591-5737
Ambulance	911
Hospital: St. Joseph Medical Center 1717 S J St Tacoma, WA 98405 (253) 426-4101	(253) 426-4101
U.S. Coast Guard	(206) 217-6410
National Response Center (NRC) for Oil/Chemical Spills	(800) 424-8802
Poison Control Center	(800) 222-1222

Name	Signature	Date

2.0 Health and Safety Personnel

The following briefly describes the health and safety designations and general responsibilities for this project.

2.1 Project Manager – NewFields

The Project Manager or designee has overall executive responsibility for all activities and personnel on the site during all project activities described in this HASP.

2.2 On-Site Health and Safety Officer

The Health and Safety Officer (HSO) is responsible for the development of safety protocols and procedures, pursuant to all hazardous aspects of this project and implementation and enforcement of this HASP. The HSO has the authority to modify this HASP based on actual site working conditions and procedures. The HSO will also be responsible for the resolution of any outstanding health and safety issues which arise during the conduct of site work.

Health- and safety-related duties and responsibilities will be assigned only to qualified individuals by the HSO. The HSO has stop-work authorization, which will be executed upon determination of an imminent safety hazard, emergency situation, or other potentially dangerous situation, such as extreme weather conditions. An Authorization to Proceed with work will be issued by the HSO after such action. The HSO or designee will initiate and execute contact with support facilities and personnel when this action is appropriate. The HSO may periodically conduct QA/QC surveys of the health and safety procedures implemented onsite.

3.0 Site and Project Description

The Blair Waterway is an industrial waterway located in the Port of Tacoma of Washington State in Pierce County. Within the waterway, Pierce County Terminal is proposed to be dredged.

The Port of Tacoma (Port) requires Dredged Material Management Program (DMMP) characterization of sediment mounds created by propeller-wash in the berthing area of Pierce County Terminal in the Blair Waterway, Tacoma, WA. The mounds have created navigation hazards to Port operations in the berthing area, requiring terminal operators to "light-load" vessels. Dredging is required to restore terminal operations to full capacity.

3.1 Scope of Work

NewFields will conduct a field collection of sediment core samples for dredge material characterization. The purpose of the dredged material characterization is to collect chemical and bioaccumulation data to determine the suitable disposal of dredged material. NewFields will be responsible for transportation of core samples to the shore, sample processing, compositing, evaluation, and documentation on the vessel and on shore.

The sediment sampler will be deployed from the Gravity Environmental research vessel using a winch and boom. Two persons will guide the sampler over the stern of the vessel during deployment and recovery operations. Core samples will be collected via vibracore. Sediment processing of core samples will be processed on the shore. Analytical laboratories will conduct all analyses/testing. Specific details regarding proposed sampling activities are provided in the Sampling and Analysis Plan (NewFields 2022).

4.0 Hazard Assessment

This section summarizes hazards that may exist during project related tasks.

4.1 Task Specific Hazard Assessment

For the field sampling tasks described in Section 3, the overall hazard level is low. Hazards encountered during this sampling program are largely because of physical safety hazards associated with the field operations. Types of potential hazards associated with the field sampling effort are summarized in Table 2. Potential hazards while working at the site include, but are not limited to, the following:

- Physical hazards from use of sampling equipment and operations on a vessel
- Physical hazards from working conditions (e.g., slips/trips/falls, drowning, hypothermia)
- Physical hazards from operating a motor vehicle to transit to and from the work site.

As described below, protective equipment and safe working procedures will help prevent accidents caused by these hazards.

Table 2. Sediment Sampling – Types of Potential Hazards

Physical Hazards	Source	Exposure Level/Potential	Exposure Limit
Boating operations	boat deck	likely	n/a
Heat (ambient)	sun	likely	n/a
Cold weather operations	boat deck area	unlikely	n/a
Heavy manual lifting/moving	sampler, coolers	likely	n/a
Slips/trips/falls	boat deck area	likely	n/a
Inclement weather—snow, rain	boat deck area	possible	n/a
Material handling	sediment	likely	n/a
Vehicular travel	van shuttle	likely	n/a
Working over water	boat deck area	likely	n/a
Biological Hazards	**Source**	**Exposure Level/Potential**	**Exposure Limit**
Insect bites and stings	boat area	unlikely	n/a
Chemical Hazards	**Source**	**Exposure Level/Potential**	**Exposure Limit**
Chemicals of concern (COCs)	sediment	possible	n/a
Control Measures Used			
Engineering Controls:	Liberal use of seawater to keep the deck of the vessel clean.		
Level of PPE:	D		
PPE on boat deck, stream/intertidal:	Chemical-resistant steel-toed boots or waders, PVC bib-style overalls (and jacket with hood as necessary), splash-proof safety goggles, nitrile gloves, PFD Type III.		
Work Practices:	Watch for trip or slip hazards on boat deck. Keep hands and other appendages out of pinch points between vessel and sampling equipment. Wash hands with soap and water prior to eating.		

n/a = not applicable

4.2 *Physical Hazards*

The following is a general discussion of the hazards that may be encountered on site. Exposure to chemical contaminants is not expected during this project.

4.2.1 Sampling Vessel Operations

The physical hazards associated with the deployment and retrieval of sampling equipment result from their weight and the method of deployment. Only appropriate personnel whose presence is required will deploy and retrieve the sampling gear. Under circumstances of potentially dangerous waves or winds, the sampling leader will employ best professional judgment to ensure safe field operations.

To avoid injuries from slipping on wet surfaces, rubber boots or waders with appropriate tread will be worn when working on the work deck or loading/unloading heavy equipment from the vessel. No overhead gear will be deployed; however, hard hats will be worn if overhead hazards exist. Sampling equipment, containers, supplies, and deck lines not in immediate use will be kept clear of walkways and work areas until needed.

Life vests will be provided for and worn by all personnel working on the deck or as directed by the Site Safety Officer or vessel operator.

4.2.2 Man Overboard Operations

If someone falls overboard, maneuver the boat's stern away from the victim. Shift into neutral immediately (kill the motor if you do not have a gearshift) and throw a buoyant cushion or life jacket near the victim (try to get it close but do not aim directly at the victim). Make sure you are well clear of the person in the water before shifting into gear again. Circle around quickly, selecting a course that will allow you to approach the person with the boat headed into the wind. Approach slowly, taking care to come alongside and not over the victim. Stop the motor before attempting to get the victim aboard. When alongside, extend a paddle or boathook to them or one end of a line. With the motor stopped, lead them around to the stern, where the freeboard is the lowest, if there is enough space at the transom for them to get aboard without contacting the motor. If this is not feasible, help the victim aboard over the side as far aft as possible. To avoid a capsize while the victim is coming aboard, other passengers should shift their weight to the opposite side to maintain trim as much as possible. When helping a person aboard, hold them under the armpits and lift gently.

4.2.3 Motor Vehicle Operation

Motor vehicles will be used to transport field personnel, equipment, and supplies to the sampling sites or laboratories. Only sampling team personnel with valid driver's licenses and liability insurance (per local state laws) will operate motor vehicles required for work activities. All field staff will use best professional judgment at all times to ensure safe operation of motor vehicles, including the following:

- Operators are to practice defensive driving and drive in a courteous manner
- Be aware of pedestrians and give them the right-of-way
- All vehicles are to be operated in a safe manner and in compliance with statutory traffic regulations and ordinances
- Verify safety seat belts are in proper operating order

- Seat belts are to be worn by the driver and all passengers whenever the vehicle is in motion
- No persons are allowed to ride in the back of any vehicles unless equipped with seatbelts
- Vehicles are to be driven in conformance with local speed limits
- Avoid excessively long driving periods
- Personnel who are impaired by fatigue, illness, alcohol, illegal or prescription drugs, or who are otherwise physically unfit, are not allowed to drive
- Personnel are to avoid using cellular phones or engaging in other distractions while driving
- Motor vehicle accidents are to be reported to the responsible law enforcement agency, the NewFields manager, and the NewFields HSO.

4.2.4 Weather

If severe weather occurs that may affect the safety of site workers, the NewFields PM or their designee shall stop affected field operations. The PM or their designee will resume operations when weather conditions improve to acceptable levels.

4.2.5 Heat and Cold Stress

Depending on the time of year and weather conditions, cold or heat stress may be a potential problem. The PM will ensure that the heat and cold stress programs are implemented and that adequate rest breaks and liquid (e.g., water, Gatorade) consumption occur.

Proposed work/rest schedules will be dependent upon the weather conditions encountered and the level of personal protective equipment being utilized by on-site personnel. The PM or designee will establish work/rest schedules prior to the commencement of the project tasks and will adjust as needed.

Table 3. Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers

Adjusted Temperature	Normal Work Ensemble	Impermeable Ensemble
≥90° F (≥32.2°C)	After each 45 min of work	After each 15 min of work
87.5–90°F (30.8–32.2°C)	After each 60 min of work	After each 30 min of work
82.5–87.5°F (28.1–30.8°C)	After each 90 min of work	After each 60 min of work
77.5–82.5°F (25.3–28.1°C)	After each 120 min of work	After each 90 min of work

4.2.6 Illumination

Work is proposed during daylight hours. If work activities need to occur before sunrise and/or after sunset, lighting will be provided at each work area to meet the requirements of 29 CFR 1910.120(m). The standard states that while any work is in progress, the general site areas shall be lighted to not less than 5 foot-candles; excavation, waste areas, access ways, active storage areas, loading platforms, and field maintenance areas shall be lighted to not less than 3 foot-candles; and first aid stations not less than 30 foot-candles.

4.2.7 Slip, Trip, and Fall Hazards

As in any work area, it is expected that the ground may be uneven, the surface may be unreliable because of surface evenness, debris may be present, and/or wet or muddy areas may exist.

Therefore, the potential for slipping, tripping, and falling is present. Severe trip hazards will be identified prior to commencement of project activities and demarcated by flags or caution tape.

4.2.8 Manual Lifting

Manual Manual lifting of heavy objects such as coolers with samples may be required. Failure to follow proper lifting technique can result in back injuries and strains. Site workers will be instructed to use power equipment to lift heavy loads whenever possible and to evaluate loads before trying to lift them (i.e., they should be able to easily tip the load and then return it to its original position). For carrying heavy loads with a buddy and proper lifting techniques, 1) make sure footing is solid, 2) make back straight with no curving or slouching, 3) center body over feet, 4) grasp the object firmly and as close to your body as possible, 5) lift with legs, and 6) turn with your feet, do not twist. Back injuries are a serious concern as they are the most common workplace injury, often resulting in lost or restricted work time and long treatment and recovery periods. In addition, hand digging for pipes may present lifting/ergonomic hazards.

4.2.9 Other Physical Hazards

Incorporating the following basic safety procedures can prevent many of the most common causes of injury or accident during field sampling:

Implement good housekeeping practices, including immediate cleanup of spills and safe storage of all materials. All equipment or materials not in immediate use will be removed from the immediate work area.

Use proper lifting and moving techniques to prevent back or muscle strain or injury. Any heavy equipment, boxes, coolers, etc., should be tested before lifting, and if it is too heavy, the equipment should be broken into smaller components or lifted with assistance. Lifting should be done with the legs, not the back.

Use extra caution when handling sharp tools or sampling devices and, when possible, wear protective gloves.

4.3 Biological Hazards

The project location and timing of proposed field work is such that risks from typical biological hazards are low. Risks associated with COVID-19 are discussed in Section 4.5 and Attachment A-1.

4.4 Chemical Hazards

Potential exposure to COCs and chemicals used on site will be controlled by minimizing personnel contact, utilization of appropriate PPE, and training on the Safety Data Sheets (SDS) (see Section 7.0).

4.5 COVID-19 Health and Safety While Conducting Fieldwork

Considering current public health concerns regarding the exposure to and transmission of COVID-19, all personnel will comply with CDC, Washington State, and NewFields requirements when conducting essential field work. Best practices are outlined in Attachment A-1 and summarized below.

4.3.1 Standard COVID-19 Health and Safety Measures

All personnel shall abide by the following:

- Maintain at least six-foot social distancing from other individuals.
- Wash hands with soap and water for at least 20 seconds as frequently as possible.
- Use hand sanitizer when washing with soap and water is not possible.
- Cover coughs or sneezes with the sleeve or elbow (not hands).
- Regularly clean high-touch surfaces.
- Refrain from shaking hands.
- Wear a cloth face covering in public settings.
- Conduct temperature checks before work and throughout the day. An individual with a temperature exceeding 100.4°F shall not work and shall stay at or return to their residence.

4.3.2 Additional Measures: Travel, Food/Drink, Meetings

The following additional safety measures shall be followed:

- Field staff shall drive directly from their residences to the site (i.e., no carpooling permitted).
- Protective gloves should be worn when refueling vehicles.
- Personnel who must stay locally shall stay in a stand-alone unit with food preparation capabilities (e.g., a rental home).
- Food and beverages consumed at the site are prepared at each staff member's residence and not shared.
- Daily safety meetings shall be held outside.
- During each safety meeting, each person is asked if they have any COVID-19 symptoms themselves or if they have contact with individuals showing symptoms. If yes to either, they shall return to their residence.

4.3.2 General Information on COVID-19

Symptoms of COVID-19

- Fever
- Cough
- Difficulty breathing/shortness of breath
- Chills
- Repeated shaking with chills
- Muscle pain
- Headaches
- Sore throat
- Loss of smell/taste

When To Seek Medical Attention

Seek medical attention immediately if any of the following emergency warning signs occur:

- Trouble breathing
- Persistent pain or pressure in the chest
- New confusion or inability to arouse
- Bluish lips or face

Note that these lists are not all-inclusive. Please consult a medical provider for any other symptoms that are severe or concerning.

Call 911 if you have a medical emergency. Notify the operator that you have, or think you might have, COVID-19. If possible, put on a cloth face covering before medical help arrives.

5.0 Work Clothing and Levels of Personnel Protection

5.1 Work Clothing and Personal Protective Equipment

The PM or designee will recommend appropriate levels of protective clothing to be worn in the event that hazardous materials are encountered. In addition to the level of protection described below, personnel should wear a cloth face covering in public settings because of COVID-19 (see Section 4.5).

The field sampling activities described in this site-specific HASP will be performed in Level D or modified Level D PPE, as specified in Table 2. If site conditions include hazards that exceed the protection of Level D or modified Level D PPE, work will be halted and personnel will immediately exit the area while site conditions and PPE levels are re-evaluated by the Site Supervisor and HSO.

Definition of Relevant Levels of Protection:

Level D: Work coveralls
Gloves
Appropriate work boots
Hard hat (if overhead gear is present)
Safety glasses with side shields or splash goggles as needed
A respirator is not required

5.2 Donning and Doffing

Manufacturers' procedures for donning and doffing PPE ensembles will be followed in order to prevent damage to PPE as well as reduce and eliminate contaminant migration from the work area and the transfer of contaminants to the wearer's body or others.

5.3 Storage and Inspection

Protective equipment will be stored and maintained in the company vehicles on site or aboard the vessel. Employees are responsible for inspecting personal protective equipment prior to donning, during use, and at the end of the shift. Defective equipment shall be removed from service and reported to the PM. All reusable equipment will be maintained in a sanitary condition and in accordance with the manufacturer's recommendations.

Table 4. Level D Storage and Cleaning Procedures.

Level D Cleaning Procedures
If necessary, cleaning procedures for PPE require that hard hats, nitrile gloves, rain gear, boots, and personal floatation devices be brushed thoroughly with a solution of Liquinox and rinsed with tap water.

6.0 Emergency Plan

Emergency situations can be characterized as an accident or injury to the field personnel. Emergency phone numbers are listed in Section 1 of this Health and Safety Plan. In case of emergency, it is important that the following Incident Reporting Procedure be observed:

It is important to ensure the rapid and accurate transfer of information among appropriate personnel in the event of an emergency situation. To simplify the procedure, emergency situations can be reported by dialing 911. This includes incidents requiring police assistance, fire department, or medical emergencies.

Be sure to provide the following information to the dispatcher:

1. Caller full name
2. The nature of the incident (i.e., fire)
3. The location of the incident (i.e., street location and nearest intersection). The more specific the better.
4. What you need (i.e., Fire Department and first aid)
5. If you are able, where you will meet emergency responders (i.e., at end of West Street, near train tracks)
6. If applicable, a call back number or your cell phone number (e.g., "I'll be at the scene; my cell phone number is (555) 123-4567.")
7. Status of the situation (e.g., “I have the fire under control.”)

If anyone is injured or in need of emergency assistance (e.g., "A mechanic working on a pump was burned").

6.1 Site Emergency Coordinator

Site Emergency Coordinator: John Nakayama (Project Manager)

6.2 Personnel Injury

In the event of an emergency situation, the local emergency response group will be called. In case of a life-threatening situation, emergency first aid may be applied on-site as deemed necessary. The individual should be cleaned up and/or decontaminated and then transported to the nearest medical facility if needed.

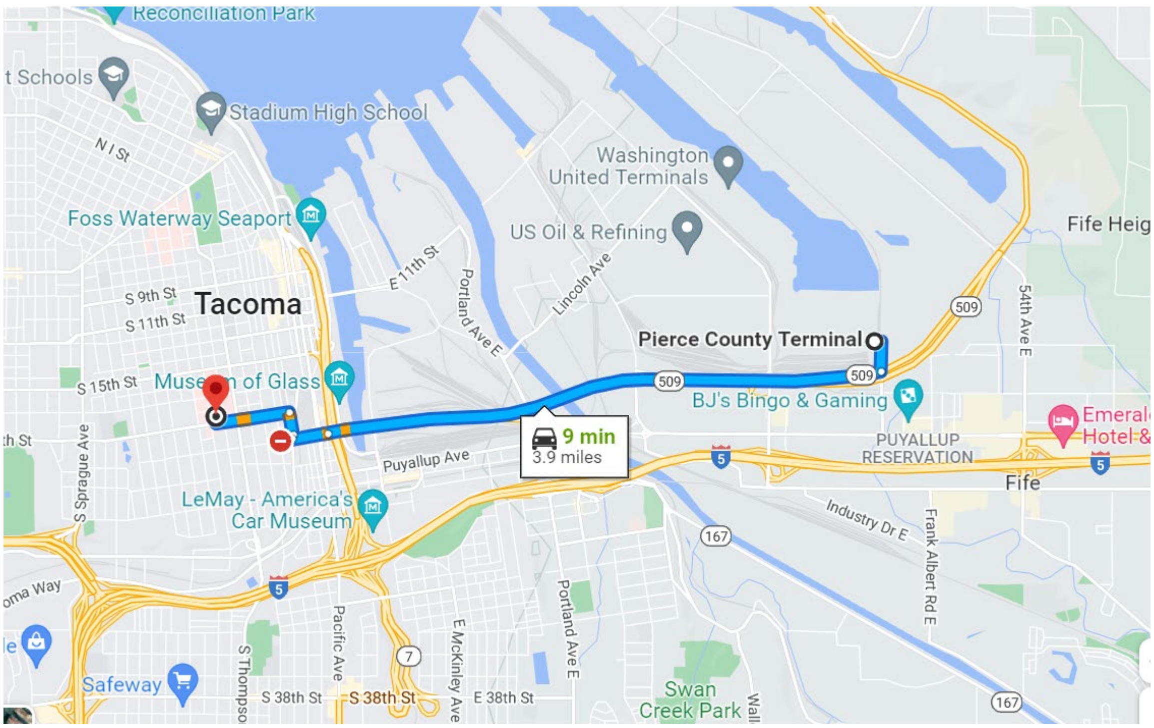
The local rescue squad shall be contacted for transport as necessary in an emergency. Since some situations may require transport of an injured party by other means, transportation by automobile may be required.

6.3 *Hospital*

St. Joseph Medical Center
1717 S J St
Tacoma, WA 98405
(253) 426-4101

Directions to St. Joseph Medical Center from Pierce County Terminal:

1) Head south on Alexander Ave E toward WA-509 S.
2) Turn right on WA-509 S, continue onto S 21st St.
3) Turn right onto Jefferson Ave, take a slight left onto Market St.
4) Turn left at the 1st cross street onto S 19th St..
5) Hospital entrance will be on the right



7.0 Safety Data Sheets

Liquinox: This liquid detergent is used with water to clean sampling equipment. It does not contain hazardous materials as defined by OSHA.

Safety Data Sheet

Effective date: 11 May 2020 **Revision** : 11 May 2020

Trade Name: Liquinox®

1 Identification of the substance/mixture and of the supplier

1.1 GHS Product identifier

Trade Name: Liquinox®
Product number: 1201, 1201-1, 1205, 1215, 1230, 1232, 1232-1, 1255

1.2 Application of the substance / the mixture: Cleaning material/Detergent

1.2.1 Recommended dilution ratio: 1 - 2% in water

1.3 Details of the supplier of the Safety Data Sheet

Manufacturer:

Alconox Inc.
30 Glenn St
White Plains, NY 10603
(914) 948-4040

Supplier:

Emergency telephone number:
ChemTel Inc
North America: 1-888-255-3924
International: +1 813-248-0573

2 Hazards identification

2.1 Classification of the substance or mixture:

In compliance with EC regulation No. 1272, 29CFR1910/1200 and GHS requirements.

Hazard-determining components of labeling:
Alcohol ethoxylate
Sodium alkylbenzene sulfonate
Sodium xylenesulphonate
Lauramine oxide

2.2 Label elements:

Eye damage, category 1.
Skin irritation, category 2.

Product at recommended dilution:

Eye irritation, category 2B

Hazard pictograms:

Signal word: Danger

Hazard statements:
H315 Causes skin irritation.
H318 Causes serious eye damage.

Precautionary statements:
P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.

P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P332+P313 If skin irritation occurs: Get medical advice/attention.
P501 Dispose of contents and container as instructed in Section 13.

Hazardous Elements at Use Dilution:

Hazard pictograms:

Signal word: Warning

Hazard statements:

H320 Causes eye irritation

Precautionary statements:

P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P501 Dispose of contents and container as instructed in Section 13

Additional information: None.

Hazard description

Hazards Not Otherwise Classified (HNOC): May cause surfaces to become slippery. Use caution in areas of foot traffic if on floors.

Information concerning particular hazards for humans and environment:

The product has to be labelled due to the calculation procedure of the "General Classification guideline for preparations of the EU" in the latest valid version.

Classification system:

The classification is according to EC regulation No. 1272, 29CFR1910/1200 and GHS, and extended by company and literature data. The classification is in accordance with the latest editions of international substances lists and is supplemented by information from technical literature and by information provided by the company.

3 Composition/information on ingredients

3.1 Chemical characterization: None

3.2 Description: None

3.3 Hazardous components (percentages by weight)

Identification	Chemical Name	Classification	Wt. %
CAS number: 68081-81-2 or 68411-30-3	Sodium Alkylbenzene Sulfonate	Acute Tox. 4; H303 Skin Irrit. 2 ; H315 Eye Dam. 1; H318	10-25
CAS number: 1300-72-7	Sodium Xylenesulphonate	Eye Irrit. 2; H319	2.5-10
CAS number: 84133-50-6	Alcohol Ethoxylate	Skin Irrit. 2 ; H315 Eye Dam. 1; H318	2.5-10
CAS number: 1643-20-5	Lauramine oxide	Skin Irrit. 2 ; H315 Eye Dam. 1; H318	1-2

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At use dilution:				
	CAS number: 68081-81-2 or 68411-30-3	Sodium Alkylbenzene Sulfonate	Eye Irr. 2B; H319	0.1-0.25

3.4 Additional Information: None.

4 First aid measures

4.1 Description of first aid measures

General information: None.

After inhalation:
Maintain an unobstructed airway.
Loosen clothing as necessary and position individual in a comfortable position.

After skin contact:
Wash affected area with soap and water.
Seek medical attention if symptoms develop or persist.

After eye contact:
Rinse/flush exposed eye(s) gently using water for 15-20 minutes.
Remove contact lens(es) if able to do so during rinsing.
Seek medical attention if irritation persists or if concerned.

After swallowing:
Rinse mouth thoroughly.
Seek medical attention if irritation, discomfort, or vomiting persists.

4.2 Most important symptoms and effects, both acute and delayed

None

4.3 Indication of any immediate medical attention and special treatment needed:

No additional information.

First aid measure at recommended dilution:

General information: None.

After inhalation:
Maintain an unobstructed airway.
Loosen clothing as necessary and position individual in a comfortable position.

After skin contact:
Wash affected area with soap and water.

After eye contact:
Rinse/flush exposed eye(s) gently using water for 15-20 minutes.
Remove contact lens(es) if able to do so during rinsing.

After swallowing:
Rinse mouth thoroughly. Seek medical attention if irritation, discomfort, or vomiting develops.

Safety Data Sheet

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5 Firefighting measures

5.1 Extinguishing media

Suitable extinguishing agents:

Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition.

For safety reasons unsuitable extinguishing agents: None

5.2 Special hazards arising from the substance or mixture:

Thermal decomposition can lead to release of irritating gases and vapors.

5.3 Advice for firefighters

Protective equipment:

Wear protective eye wear, gloves and clothing.
Refer to Section 8.

5.4 Additional information:

Avoid inhaling gases, fumes, dust, mist, vapor and aerosols.
Avoid contact with skin, eyes and clothing.

6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation.
Ensure air handling systems are operational.

6.2 Environmental precautions:

Should not be released into the environment.
Prevent from reaching drains, sewer or waterway.

6.3 Methods and material for containment and cleaning up:

Wear protective eye wear, gloves and clothing.

6.4 Reference to other sections: None

7 Handling and storage

7.1 Precautions for safe handling:

Avoid breathing mist or vapor.
Do not eat, drink, smoke or use personal products when handling chemical substances.

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, well-ventilated area.

7.3 Specific end use(s):

No additional information.

8 Exposure controls/personal protection

8.1 Control parameters :

25322-68-3, Poly(ethylene oxide), AIHA TWA 10 mg/m3 (<0.15% present in concentrate)

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8.2 Exposure controls

Appropriate engineering controls:
Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use or handling.

Respiratory protection:
Not needed under normal conditions.

Protection of skin:
Select glove material impermeable and resistant to the substance.

Eye protection:
Safety goggles or glasses, or appropriate eye protection.

General hygienic measures:
Wash hands before breaks and at the end of work.
Avoid contact with skin, eyes and clothing.

Exposure Control and Personal Protective Equipment at recommended dilution:

Under normal use and operational conditions, no special personal protective equipment or engineering controls will be necessary. Handle with care.

9 Physical and chemical properties

Appearance (physical state, color):	Pale yellow liquid	**Explosion limit lower**: **Explosion limit upper**:	Not determined or not available. Not determined or not available.
Odor:	Not determined or not available.	**Vapor pressure at 20°C**:	Not determined or not available.
Odor threshold:	Not determined or not available.	**Vapor density**:	Not determined or not available.
pH-value:	8.5 (as is)	**Relative density**:	Not determined or not available.
Melting/Freezing point:	Not determined or not available.	**Solubilities**:	Not determined or not available.
Boiling point/Boiling range:	Not determined or not available.	**Partition coefficient (n-octanol/water)**:	Not determined or not available.
Flash point (closed cup):	Not determined or not available.	**Auto/Self-ignition temperature**:	Not determined or not available.
Evaporation rate:	Not determined or not available.	**Decomposition temperature**:	Not determined or not available.
Flammability (solid, gaseous):	Not flammable	**Viscosity**:	a. Kinematic: Not determined or not available. b. Dynamic: Not determined or not available.
Density at 20°C:	1.08 g/mL		

Safety Data Sheet

Effective date: 11 May 2020 **Revision** : 11 May 2020

Trade Name: Liquinox®

10 Stability and reactivity

10.1 Reactivity: Not determined or not available.
10.2 Chemical stability: Not determined or not available.
10.3 Possibility hazardous reactions: Not determined or not available.
10.4 Conditions to avoid: Not determined or not available.
10.5 Incompatible materials: Not determined or not available.
10.6 Hazardous decomposition products: Not determined or not available.

11 Toxicological information

11.1 Information on toxicological effects:

Acute Toxicity:

Oral:

: LD50 >5000 mg per kg (Rat, Oral) - product.

Chronic Toxicity: No additional information.

Skin corrosion/irritation (raw materials):

Alcohol Ethoxylate: May cause mild to moderate skin irritation.

Sodium Alkylbenzene Sulfonate: Causes skin irritation.

Lauramine oxide: Causes skin irritation.

Serious eye damage/irritation (raw materials):

Sodium Alkylbenzene Sulfonate: Causes serious eye damage.

Alcohol Ethoxylate: Causes moderate to severe eye irritation and conjunctivitis.

Sodium xylenesulphonate: irritating to eyes.

Lauramine oxide: Causes serious eye damage.

Product information at recommended dilution:

Eye irritation may occur upon direct contact with eyes. No specific hazards for skin contact, inhalation, or chronic exposure are expected within normal use parameters.

Respiratory or skin sensitization: No additional information.

Carcinogenicity: No additional information.

IARC (International Agency for Research on Cancer): None of the ingredients are listed.

NTP (National Toxicology Program): None of the ingredients are listed.

Germ cell mutagenicity: No additional information.

Reproductive toxicity: No additional information.

STOT-single and repeated exposure: No additional information.

Additional toxicological information: No additional information.

12 Ecological information

12.1 Toxicity:

Sodium Alkylbenzene Sulfonate: Fish, LC50 1.67 mg/l, 96 hours.
Sodium Alkylbenzene Sulfonate: Aquatic invertebrates, EC50 Daphnia 2.9 mg/l, 48 hours. Sodium Alkylbenzene Sulfonate: Aquatic Plants, EC50 Algae 29 mg/l, 96 hours.
Lauramine oxide: Fish, LC50 24.3 mg/l, 96h [Killifish (Cyprinodontidae)]
Lauramine oxide: Aquatic invertebrates, (LC50): 3.6 mg/l 96 hours [Daphnia (Daphnia)].
Lauramine oxide: Aquatic plants, EC50 Algae 0.31 mg/l 72 hours [Algae]
Alcohol Ethoxylate: Aquatic invertebrates, (LC50): 4.01 mg/l 48 hours [Daphnia (daphnia)].

12.2 Persistence and degradability: No additional information.

12.3 Bioaccumulative potential: No additional information.

12.4 Mobility in soil: No additional information.

General notes: No additional information.

12.5 Results of PBT and vPvB assessment:

PBT: No additional information.

vPvB: No additional information.

12.6 Other adverse effects: No additional information.

13 Disposal considerations

13.1 Waste treatment methods (consult local, regional and national authorities for proper disposal)

Relevant Information:

It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities. (US 40CFR262.11).

14 Transport information

14.1 UN Number: ADR, ADN, DOT, IMDG, IATA	None
14.2 UN Proper shipping name: ADR, ADN, DOT, IMDG, IATA	None
14.3 Transport hazard classes: ADR, ADN, DOT, IMDG, IATA	**Class:** None **Label:** None **LTD. QTY:** None
US DOT **Limited Quantity Exception:**	None

Safety Data Sheet

Effective date: 11 May 2020 **Revision** : 11 May 2020

Trade Name: Liquinox®

Bulk: **RQ (if applicable):** None **Proper shipping Name:** None **Hazard Class:** None **Packing Group:** None **Marine Pollutant (if applicable):** No additional information. **Comments:** None	**Non Bulk:** **RQ (if applicable):** None **Proper shipping Name:** None **Hazard Class:** None **Packing Group:** None **Marine Pollutant (if applicable):** No additional information. **Comments:** None
14.4 Packing group: ADR, ADN, DOT, IMDG, IATA	None
14.5 Environmental hazards:	None
14.6 Special precautions for user:	None
Danger code (Kemler):	None
EMS number:	None
Segregation groups:	None
14.7 Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code: Not applicable.	
14.8 Transport/Additional information:	
Transport category:	None
Tunnel restriction code:	None
UN "Model Regulation":	None

15 Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture.

North American

SARA

Section 313 (specific toxic chemical listings): None of the ingredients are listed.
Section 302 (extremely hazardous substances): None of the ingredients are listed.

CERCLA (Comprehensive Environmental Response, Clean up and Liability Act)

Reportable Spill Quantity: None of the ingredients are listed.

TSCA (Toxic Substances Control Act):

Inventory: All ingredients are listed as active.
Rules and Orders: Not applicable.

Proposition 65 (California):

Chemicals known to cause cancer: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for females: None of the ingredients are listed.

Chemicals known to cause reproductive toxicity for males: None of the ingredients are listed.

Chemicals known to cause developmental toxicity: None of the ingredients are listed.

Canadian

Canadian Domestic Substances List (DSL):
All ingredients are listed.

Safety Data Sheet

Effective date: 11 May 2020 **Revision** : 11 May 2020

Trade Name: Liquinox®

Asia Pacific

Australia

Australian Inventory of Chemical Substances (AICS): All ingredients are listed.

China

Inventory of Existing Chemical Substances in China (IECSC): All ingredients are listed.

Japan

Inventory of Existing and New Chemical Substances (ENCS): All ingredients are listed.

Korea

Existing Chemicals List (ECL): All ingredients are listed.

New Zealand

New Zealand Inventory of Chemicals (NZOIC): All ingredients are listed.

Philippines

Philippine Inventory of Chemicals and Chemical Substances (PICCS): All ingredients are listed.

Taiwan

Taiwan Chemical Substance Inventory (TSCI): All ingredients are listed.

EU

REACH Article 57 (SVHC): None of the ingredients are listed.
Germany MAK: Not classified.

16 Other information

Abbreviations and Acronyms: None

Summary of Phrases

Hazard statements:

H315 Causes skin irritation.
H318 Causes serious eye damage.

Precautionary statements:

P264 Wash skin thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P302+P352 If on skin: Wash with soap and water.
P305+P351+P338 If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do. Continue rinsing.
P332+P313 If skin irritation occurs: Get medical advice/attention.
P501 Dispose of contents and container as instructed in Section 13.

Manufacturer Statement:

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

	At recommended dilution:
NFPA: 1-0-0	NFPA: 1-0-0
HMIS: 1-0-0	HMIS: 1-0-0

Attachment A-1

NewFields Health, Safety and Environmental Best Practices

NewFields Health, Safety and Environment Best Practice

BP 4 – Field Work and Infectious Disease

Last Update
18 January 2022

BP 4 – Field Work and Infectious Disease

The safety and well-being of NewFields staff and others working in the field during the COVID-19 virus pandemic is of paramount importance to NewFields. The Occupational Safety and Health Administration (OSHA) has prepared Guidance on Preparing Workplaces for COVID-19. In general, OSHA focuses on the need for employers to implement engineering, administrative and work practice controls and Personal Protective Equipment (PPE). In addition, OSHA's General Duty Clause, Section 5 (a)(1), requires employers to provide their employees with a workplace free from recognized hazards likely to cause death or serious physical harm. Site specific Health and Safety Plans (HASPs) prepared for projects or field work generally address potential physical, chemical and biological hazards. Biological hazards such as infectious diseases are not typically considered in a site-specific HASP. Consequently, NewFields has adopted this Best Practice (BP) guidance for field work conducted in geographic areas with the potential for the presence of infectious diseases, specifically COVID-19.

Coronavirus Disease 2019 (COVID-19) is a respiratory disease caused by the Severe Acute Respiratory Syndrome Coronavirus (SARS-Cov-2). First discovered in China, it has spread to most counties around the world including the United States. Infection with SARS-CoV-2, the virus that causes COVID-19, can cause illness ranging from mild to severe and, in some cases, can be fatal. Symptoms typically include fever, cough, and shortness of breath. Some people infected with the virus have reported experiencing other non-respiratory symptoms. Other people, referred to as "asymptomatic cases", have experienced no symptoms at all. According to the Centers for Disease Control and Prevention (CDC), symptoms of COVID-19 may appear in as few as two days or as long as 14 days after exposure.

Although the first human case of COVID-19 likely resulted from exposure to infected animals, infected people can spread SARS-CoV-2 to other people. The virus is thought to spread mainly from person to person transmission, including:

- Between people who are in close contact with one another (within about 6 feet), and
- Through respiratory droplets produced when an infected person coughs or sneezes. These droplets can land in the mouths or noses of people who are nearby or possibly be inhaled into the lungs.

It may be possible that a person can contract COVID-19 by touching a surface or object that has SARS-CoV-2 on it and then touching their own mouth, nose, or possibly their eyes, although this is not thought to be the main way the virus spreads.

According to a recent study,[1] the length of time SARS-Cov-2 virus remains on various surfaces depends on the surface. According to the study:

- **On plastic:** After eight hours only 10 percent of the virus was still there, but it didn't become undetectable until after 72 hours.
- **On stainless steel:** The numbers began plummeting after just four hours, becoming undetectable by about 48 hours.
- **On copper:** Undetectable by 8 hours.
- **On cardboard:** Undetectable by 48 hours.

[1] Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1, The New England Journal of Medicine. Available on-line at https://www.nejm.org/doi/full/10.1056/NEJMc2004973?query=featured_home

Mitigations to the Risk of Exposure

NewFields staff performing field work will take the following precautions to protect their health, the health of coworkers, our clients and their staff, as well at the community at large:

- Do not perform field work or report to a work site if you are not authorized to travel to or work in a location with a Shelter-in-Place or Stay-in-Place Order (below).
- Do not report to work or a job site if you are sick or exhibiting the symptoms of COVID-19, including fever, cough or shortness of breath.
- Do not report to work or a job site
    - if you have been confirmed or diagnosed as possibly having COVID-19 by a healthcare provider;
    - for 5 days if you have come into close contact[2] with an individual who has COVID, and (i) it has been longer than 6 months since you completed the Moderna or Pfizer vaccine regimen or longer than 2 months since you completed the Johnson & Johnson vaccine regimen, and (2) you have not received a booster dose.[3] You should test after day 5 if possible and wear a mask for an additional 5 days. If you develop symptoms during this time, take a test and stay home.
- You must inform NewFields Human Resources Department if you were in close contact with any NewFields employees, contractors, or business partners, or were present at a NewFields client site, in the 2 days prior to the date that you first exhibited symptoms or the 2 days prior to your first COVID positive test, if you exhibit no symptoms.
- Wash hands thoroughly and frequently with soap and water or alcohol-based hand sanitizer with 60-70 percent alcohol.
- Avoid touching your face, eyes, nose and mouth with unwashed hands.
- Cover your cough or sneeze with a tissue, then throw the tissue in the trash, and wash your hands immediately after.
- Avoid contact with people who appear sick or ill.
- Utilize social distancing work practices whenever possible. This includes maintaining a distance of 6 feet or more between site workers.

Individual States and municipalities may have also adopted local requirements in addition to the recommendations put forward by the CDC. For example, additional requirements on a job site may include COVID-19 specific warning or work practice signage all workers and visitors must comply with. These may include social distancing requirements, the use of masks. Local regulations may also require the use of gloves and other local area or site-specific performance requirements.

[2] Close contact means any of the following: (1) contact within 6 feet for a cumulative total of 15 minutes or more over a 24-hour period starting from two days prior to illness onset (or two days prior to test specimen collection for asymptomatic patients) until the time the patient is isolated; (2) having direct contact with infectious secretions such as being coughed or sneezed on; (3) providing care at home to someone who is sick with COVID; (4) having direct physical contact with a person who has COVID (i.e. hugging or kissing); or (5) sharing eating or drinking utensils with someone who has COVID.

[3] Individuals who completed both doses of the Moderna or Pfizer vaccines within the past 6 months, completed the Johnson & Johnson vaccine within the past 2 months, or who have received a booster dose of any of these vaccines need not quarantine after exposure, but should wear a mask for 10 days and test on day 5 if possible.

Workplace Cleaning and Disinfecting

NewFields staff performing field work will establish regular cleaning cycle of the work area and work place tools or equipment based on frequency of use and work area staffing levels. Disposable gloves will be worn by those cleaning the workplace. Cleaning with soap and water reduces the number of germs, dirt and impurities on the surface. Disinfecting surfaces after cleaning kills germs on surfaces.

In addition, CDC also recommends disinfecting frequently touched surfaces by using a EPA-registered household disinfectant. Follow the instructions on the product label to ensure safe and effective use of the product. Many products recommend keeping the surface wet for a period of time (see product label). Precautions such as wearing gloves and making sure there is good ventilation during product use. See NewFields HSE SOP 13 Hazard Communication for additional guidance on product use and storage.

OSHA requires employers to provide a workplace which is free from recognized hazards that are causing or likely to cause death or serious harm. The CDC also advises that steps be taken to mitigate possible spread of COVID when a COVID positive or presumed positive Team Member has been present at a NewFields office. These steps can range from a targeted deep cleaning to full office closure. It is difficult to set a rule regarding when deep cleaning or office closure is required, given the different levels of possible contamination. Office administrators should use best judgment in making these decisions, and should follow CDC guidance that can be found here: Cleaning and Disinfecting Your Facility (see chart on "Cleaning and disinfecting your building or facility if someone is sick.")

In summary, steps that should be taken to mitigate transmission of COVID if a COVID positive or presumed positive individual has been present at the office within seven (7) days[4] should include one or more of the following:

- Close off areas (i.e. personal offices) used by the person who was sick.
- Open doors and windows for increased ventilation, if possible.
- Wait 24 hours to clean or disinfect; then, clean and disinfect all areas used by the person who was sick, such as bathrooms common areas, shared electronics and equipment, etc. Wear gloves while cleaning and follow manufacturers recommendations on the proper use, compatibility and storage of cleaning products. EPA-registered disinfectants can be found here: Disinfectants for use against SARS-CoV-2.
- If vacuuming, use a vacuum with a HEPA filter, and do not vacuum while other people are present in the room.
- Temporarily turn off in-room, window or wall-mounted air conditioning or fans; do not deactivate central HVAC systems as they have filtration capabilities.

Shelter-in-Place / Stay-in-Place Orders

NewFields staff who intend to perform field work in a geographic location with an established Shelter-in-Place or Stay-in-Place Order must ensure they will be performing "Essential Work" activities and are authorized to mobilize and perform site work activities. A letter stating this authorization must accompany the employee during travel to and from the work site. A letter of authorization may be obtained from the worksite owner or their management team. An authorizing letter may also be obtained

[4] Current CDC guidance is that if more than 7 days have passed since the sick person visited or used the facility, additional cleaning and disinfection is not necessary.

by contacting NewFields Legal Department, B.B. Carlson or Jennifer Rosenberg.

Use of Face Masks

The CDC continues to study the spread and effects of the novel coronavirus across the United States. Studies indicate that a significant portion of individuals with coronavirus lack symptoms ("asymptomatic") and that even those who eventually develop symptoms ("pre-symptomatic") can transmit the virus to others before showing symptoms. This means that the virus can spread between people interacting in close proximity—for example, speaking, coughing, or sneezing—even if those people are not exhibiting symptoms. In light of this new evidence, the CDC now recommends wearing face coverings in public settings where other social distancing measures are difficult to maintain (e.g., grocery stores and pharmacies), **especially** in areas of significant community-based transmission. The CDC continues to maintain, however, that it is still critical to practice 6-feet social distancing to slow the spread of the virus.

Current CDC guidance regarding use of face coverings to prevent the spread of COVID -19 can be found here: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html. In sum, the CDC now recommends that individuals choose N-95 or KN95 masks over cloth masks, although "surgical N95s" are a specific type of respirator that should be reserved for healthcare settings. The use of N-95 or KN-95 respirators by any NewFields employee for this purpose is considered "Voluntary Use" and users must review and understand SOP 21 Respiratory Protection prior to using or wearing a respirator. Accordingly, NewFields staff and contractors who intend to perform field work are expected to abide by the CDC guidelines and wear face masks where required by state or local law or by our clients[3]. In addition, all project managers must ensure that this requirement is shared with all independent contractors and subcontractors.[5]

For this purpose, NewFields recommends the following when considering the use of face masks:

- Select a face mask type and size that will fit your face properly and cover both your nose and mouth while allowing you to breathe comfortably. The mask should not restrict breathing in any way.
- The mask must *at a minimum* meet CDC Guidelines found here: https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/diy-cloth-face- coverings.html.
- Wash your hands thoroughly before handling the face mask or touching your face.
- Be sure to secure the mask to your face properly.
- Avoid loose fitting masks or materials, if possible, as this may lead to the mask or covering slipping down your face.
- Resist the temptation to bring your hands to your face to adjust or reposition the mask or covering as this may bring your unwashed hands in contact with your eyes, nose or mouth.
- Wash your hands thoroughly before removing your mask.
- Wash and dry reusable masks frequently.
- Do not share your face mask with coworkers or others.
- Store the mask in a clean environment such as a resealable bag or baggie.
- Do not reuse the mask if it has become damaged, is wet or if breathing becomes difficult.

[5] "Public settings" include all places where you encounter others (even when those encounters occur outside).

- If you are provided a face mask by NewFields, you may choose to wear the one provided or one of your own choosing as long as it meets the guidelines listed above.

Temperature Checks

In an effort to proactively identify potential illness, prevent potential exposure to others and as required by some work locations, NewFields fieldwork staff and contractors must periodically conduct self-administered temperature checks. In addition, temperature checks may also be performed by client representatives prior to entry to a work site and periodically throughout the work shift. NewFields staff and contractors must follow these protocols with respect to temperature checks:

- On workdays, you must self-administer temperature checks before work each day and also at a minimum two to four times per shift.
- All temperature screenings may be performed using a non-invasive temperature scanning device or a standard thermometer. If a standard thermometer is to be used, it will be thoroughly disinfected with a solution containing at least 60-70 percent alcohol.
- If your reading is within the normal range (<100.4 F) and you are not experiencing symptoms of illness, continue as previously planned.
- If your temperature reading is high (>100.4 F), document the reading using the form at the end of this document and do not report to work or a field site. Remain or return home and contact your personal care physician by phone for guidance and instruction. Also inform your supervisor that you will not be reporting to work and contact the Human Resources Department. Your medical condition will remain confidential information.
- Use the form at the end of this document to log your temperature checks if the client whose project you are working on requires keeping such a log. If the client has another form that the client prefers, use that form.

If You Become Sick or Ill

If you become sick or exhibit any symptoms of COVID-19, do not report to an office or field work site. If you have travelled to a remote work site or location for work, return to your hotel or accommodation and contact your personal care physician or local medical center for advice and guidance. This guidance may include advice on resting and recovering in your hotel or accommodation or advice for travel to return to your home location.

In addition, contact the Human Resources Department if you have (i) been confirmed or diagnosed as possibly having COVID-19 by a healthcare provider or (ii) have come into close contact with such an individual in the last 14 days[6] **and** you were in close contact with any NewFields employees, contractors, or business partners, or were present at a NewFields client site in the 2 days prior to the date that you first exhibited symptoms or two days prior to the date on which you took your first COVID-positive test if you are asymptomatic.

Mitigations to Business Continuity

NewFields Partners and Project Managers should also consider alternative project staffing arrangements in the event project programmed staff become sick, ill or are required to self-isolate preventing work on a job site or an office location. These situations may occur as a result of the following:

- Employees need to self-isolate following travel (if required by applicable law) or if staff are

[6] Fully vaccinated employees do not need to notify HR if they have been in close contact with a COVID positive or presumed positive individual unless they experience symptoms of COVID.

notified of potential close contact with other individuals presumed or tested positive for COVID-19.

- Self-isolation resulting from contact with members of their household who are presumed or have tested positive for COVID-19.

- Self-isolation resulting from close contact with coworkers who are presumed or have tested positive for COVID-19.

Travel Concerns

Provided that you are not ill, subject to involuntary isolation for another reason, or have requested and been approved not to travel by HR[7], staff whose job includes fieldwork or visiting client sites, will continue to be expected to perform those functions of their job. If you are ever concerned, however, that COVID-19 safety protocols (or any other safety protocols) are not being followed at a worksite, please contact your supervisor, Richard Leferink, or HR immediately.

Even where safety protocols are being followed, NewFields understands that travel during the pandemic can cause concern. If, despite taking the precautions required by this policy[8] you are concerned about the risks of travel presented to your own health and safety or that of your family or household members (when you return home), we encourage you to discuss those concerns with your supervisor. Supervisors are encouraged, where possible, to schedule assignments in ways that allow staff to have breaks between travel such that the staff member will have some time to assess whether s/he is experiencing any COVID-19 symptoms before his/her next trip. If you have concerns that you feel are not adequately resolved after you have worked with your supervisor, please contact HR.

If you are concerned about returning home to vulnerable family members or household members after an assignment involving travel, you may choose to self-isolate for 14 days during which time you may have the opportunity to assess whether you are experiencing any COVID-19 symptoms. If you cannot work from home during this time or if voluntary self-isolation prevents you from performing the fieldwork to which you are assigned[9], you may use any paid leave available[10] to you or you may take unpaid leave.

If at any time you experience COVID-19 symptoms, follow the instructions in this policy. If you wish to be tested, either because you are experiencing symptoms of COVID-19 or believe you have been exposed to COVID-19, the cost of your test should be covered by your health plan. The U.S. government has arranged for each household to receive up to 4 free at-home COVID tests, which can be ordered https://special.usps.com/testkits. In addition, members of NewFields Companies Health Benefits Plan may be eligible to receive a self-performed COVID test kit at no cost; see NewFields COVID Testing Policy for more information about these test kits.

Please note that self-isolation after travel is not required by NewFields policy. However, if state law or client site rules require self-isolation, you will be expected to comply.

Please research all rules and regulations related to testing requirements before you make any travel plans. Countries, states and/or airlines may restrict travel to those who are able to show evidence of a

---

[7] See below.

[8] Also note further precautions discussed on the CDC website regarding travel: https://www.cdc.gov/coronavirus/2019-ncov/travelers/travel-in-the-us.html. You can also contact Richard Leferink or HR for assistance in travel planning. They can help research, for example, which airlines are keeping middle seats unoccupied.

[9] You may still be assigned to fieldwork during voluntary self-isolation. Voluntary self-isolation is isolation that occurs when an employee is not required by applicable law, NewFields policy, or a client requirement to isolate, but the employee chooses to isolate anyway for some other reason.

[10] Contractors and subcontractors are not eligible for any NewFields benefits, including paid leave or reimbursement for hotel stays or COVID tests, as referenced in this section.

negative COVID test result within a certain time period. You may wish to schedule testing in advance, both prior to your departure and prior to your return. Particularly note that Effective December 17, 2021, the CDC had implemented a rule requiring all travelers entering the U.S. via air to show evidence of a negative COVID test result from a test taken no more than one day prior to departure before boarding the flight[11]. This applies to U.S. and non-U.S. citizens. We encourage you to locate an appropriate testing facility at your destination (and make an appointment if possible) before leaving the U.S. in order to minimize any risk of being finding yourself unable to return home.

Requesting Not to Travel

NewFields understands that some people who have underlying conditions may have concerns about travelling for work. While the Americans with Disabilities Act (ADA) requires companies to provide reasonable accommodation to anyone whose disability affects their ability to perform their job, many people who are considered to be a part of the "vulnerable population" by the CDC with respect to COVID-19 would not be considered "disabled" under the ADA. However, even though the ADA may not require NewFields to provide accommodation to those who fall within the CDC definition of "vulnerable population", NewFields would like to discuss your concerns with you in order to determine if there is a way to alleviate those concerns- such as perhaps allowing you not to travel or limiting your travel during this pandemic.

The CDC defines the COVID-19 "vulnerable population" as:

- adults age 65 or older
- people who have underlying medical conditions including:
    - chronic lung disease,
    - cancer
    - moderate to severe asthma,
    - heart conditions,
    - diabetes (type 1 or type 2),
    - chronic kidney disease,
    - severe obesity, and
    - chronic liver disease,
    - dementia or other neurological conditions
    - Down syndrome
    - HIV infection
    - Mental health conditions, including depression or schizophrenia spectrum disorders

[11] Individuals who recently recovered from COVID-19 may instead travel with documentation of such recovery in lieu of a negative COVID test result. Such travelers will be required to show a positive COVID-19 viral test result on a sample taken no more than 90 days before the flight's departure from a foreign country **and** a letter from a licensed healthcare provider or public health official stating that the individual was cleared to travel.

- Sickle cell disease or thalassemia
- Current or former smokers
- Stroke or cerebrovascular disease
- Substance use disorder
- Tuberculosis

- Solid organ or blood stem cell transplant recipients
- individuals who otherwise are immunocompromised
- Individuals who are pregnant or have been pregnant in the past 42 days

If you fall within one of these categories, it is <u>your</u> responsibility to voice your concerns to HR. We want to take proactive steps to continue to protect your health but cannot do so without employee cooperation. If you fall within the definition of “vulnerable population” and reach out to HR, NewFields will consider your request without asking for extensive details regarding your personal health situation, although we may ask for some verification of the underlying condition**. If you do not reach out to HR, NewFields will assume you do not have concerns about travelling for work**.

Temperature Check Log

Employee Name:	
Home Office Location:	
Field Work Location:	

Date	**Time**	**Temperature**	**Testing Device**	**Administered by**	**COVID-19 Symptoms**	
					No	**Yes**

APPENDIX B: FIELD FORMS

SEDIMENT CORING LOG

NewFields
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Location/Core Number ____________________

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	
		CORE RECOVERY:	
DATE SAMPLED:		% RECOVERY:	
TIME:		Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):		PCT-1, PCT-2	-52 / -54
NOS WATER LEVEL (TIDE):			
WATER DEPTH MLLW:			
SAMPLED BY:			

DEPTH		SAMPLE ID	SEDIMENT DESCRIPTION	COMMENTS
In-Situ Core Length (feet below mudline)	Actual Recovered Core Length (feet below mudline)			
1				
2				
3				
4				
5				
6				
7				
8				

REVIEWED BY: ____________________ PAGE ______ OF ______

Client: Port of Tacoma	**Location ID:**
Project: 2022 PCT Bioaccumulation Study	**Time/Date Collected:**
Crew:	**Time/Date Processed:**
Comments:	

Sample Container Tag Number	Sample ID	Analysis	Laboratory

Notes:

NewFields
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Completed by:________________________

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115 2nd Ave N, Suite 100
Edmonds, WA 98020
TEL: 425.967.5285

CHAIN OF CUSTODY

Page ______ of ______

Project Name:	2022 PCT Bioaccumulation STudy
Project Location:	Port of Tacoma, WA
Client/Point of Contact:	Port of Tacoma / Stanley Sasser
Destination Lab:	
Destination Contact:	
Turn around Time:	
Sample Originator:	NewFields
Project Manager:	John Nakayama
Originator Phone/Email:	(425) 967-5285 ext. 102 / jnakayama@newfields.com
Sample Collectors:	NewFields, Leon Environmental, Gravity Environmental

Analyses / Tests

Number of Shipping Containers:

Invoice to:

Address:

Project Number:

Sample ID	Matrix	Date	Time	No. and Type of Containers													Comments

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Signature:	Signature:	Signature:	Signature:
Date/Time:	Date/Time:	Date/Time:	Date/Time:
Affiliation:	Affiliation:	Affiliation:	Affiliation:

• Sample originator and destination laboratory each sign and retain one copy.

APPENDIX C: GRAVITY SOP SW-19 VIBRACORE STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE (SOP) SW-19

VIBRACORE STANDARD OPERATING PROCEDURES

SCOPE AND APPLICATION

Sediment cores will be collected at each location identified using a vibracorer rig mounted aboard Gravity's Research Vessel. Gravity's RIC 5500 vibracore operates at 1800 vibrations per minute with a force of 5000 ft/lbs and 59 lbs of impact per rotation . The frequency of the unit can be adjusted in the field to minimize disturbance of the sediment substrates for optimum collection of representative layers. The vibracorer uses either polycarbonate or aluminum barrels that are 4 inches in diameter. Tube liners are either soft liner for Polycarbonate barrels or 1/16th wall lexan tubes for aluminum barrels. The tubes have an internal lexan finger system to retain substrate at the tip as well as a custom check-valve inside the tube designed help retain core and minimize loss. Dependent on slope and water depth, the vibracore can be affixed to a drive frame for collecting samples. The vibracorer can also be provided with a penetrometer for measuring drive depth and an in-situ system for measuring core recovery during the drive.

Station Access

Prior to entering select areas such as private beaches, embayment's, or proximity to docks, it may be necessary to acquire permission from the landowner to access the property. Access permission must be acquired in advance of the sampling program and may require a written agreement. This access assessment should be followed up with a desktop study by the client to confirm no buried objects that are hazardous to operations such as cables, pipelines or unexploded ordinance are present.

Station Location

Samples will be collected at specific transects or sample locations as identified in project QAPP.

Positioning & Coordinates

Horizontal positioning will be determined by the onboard differential global positioning system (DGPS) based on target coordinates. Measured station positions will be converted to latitude and longitude (North American Datum [NAD] 83) to the nearest 0.1 second. The accuracy of measured and recorded horizontal coordinates will be within 2 meters. Vertical elevation of each boring station will be measured using a fathometer or lead line and converted to the applicable local elevation datum. The vessel navigation system can be upgraded to RTK GPS for additional costs to provide 10 cm vertical and 30 cm horizontal accuracy. In addition Gravity can provide an in-situ tide gauge for longer-term projects where higher vertical accuracy is needed.

Safety and Hazardous Materials Management

General Lab Safety- All general laboratory safety practices should be complied with, including wearing a lab coat, safety glasses, and gloves. Samples should be treated with regard to possible toxicity and microbiological potential.

From a Vessel - Sampling personnel will follow standard safety procedures while on board the sampling vessel. The vessel skipper has ultimate responsibility for safety while the vessel is underway. During deployment of equipment, the operator and the skipper must communicate with one another to avoid potential loss of the instrument due to propeller interface with the underwater field cable.

Streams/Rivers – Sampling personnel will always enter streams/rivers cautiously and follow standard safety procedures when entering these flowing bodies of water. There are many hazards associated with streams and rivers sampling. Some of these hazards include traffic, fast moving or deep water, steep slopes to sampling sites, and hostile dogs or people. Use extreme caution when exiting sampling vehicles, walking along busy highways or sampling on bridges. Fast moving water can cause the sampling personnel to lose balance and fall into the water. This can result in injury or drowning. Be aware of your surroundings and potential presence of other people, especially under bridges or in culverts.

SUMMARY OF METHOD

Samples will be collected from a vessel at predefined sampling locations. The vessel should be equipped with the necessary equipment to safely operate and navigate and complete the required sampling tasks. Additionally, the proper vessel should be selected for stations in shallow areas which may preclude larger vessels due to draft limitations.

Sample Collection

The vibracorer will be lowered to the bottom, where the unit will then be energized and allowed to penetrate. The core will be driven to its maximum length or to refusal. Acceptance criteria for a sediment core sample are as follows:

- The core penetrated to, and retained material to, project depth or refusal
- Recovery was at least 75 percent of the length of core penetration or per client QAPP
- Cored material did not extend out the top of the core tube or contact any part of the sampling apparatus at the top of the core tube

- There are no obstructions in the cored material that might have blocked the subsequent entry of sediment into the core tube and resulted in incomplete core collection.

If core rejections require the core station to be relocated, two additional attempts will be made within a radius of 25 feet of the target or per the client QAPP. If penetration or retention continue to be an issue consistently across the site, Gravity provides the following options

- For recovery, an internal piston or vacuum system can be used to remove backpressure and actively pull material into the tube.
- For recovery, a lexan tip with a flexible nitrile liner can help keep soft muds retained.
- For penetration, a waterjet can be used to penetrate areas unsuccessful by other methods and a sample collected below problem areas.
- For penetration, a smaller diameter tube can be used to drive deeper such as 3" barrels.

The core tube caps will be removed immediately prior to placement into the coring device. Care will be taken during sampling to avoid contact of the sample tube with potentially contaminated surfaces. Extra sample tubes will be available during sampling operations for uninterrupted sampling in the event of a potential core tube breakage or contamination. Core tubes suspected to have been accidentally contaminated will not be used. Logs and field notes of all core samples will be maintained as samples are collected and correlated to the sampling location map.

A1. Alternative sample collection using Core Penetrometer

The Gravity Penetrometer logs speed of drive and depth of vibracorer during coring activities. The Penetrometer consists of a depth sensor connected to the RIC head and a topside digital reader system. The topside screen provides real-time viewing of the depth while driving as well as functions for saving and calibrating the system. Data can be recorded in the field about the speed of drive and the final depth penetration

A2. Alternative sample collection using in-situ recovery system

The Gravity in situ recovery system (ISRS) can be used to provide a real time view of the core recovery depth while driving the vibracorer into the sediment. The ISRS consists of a sensor inside of the core barrel that is connected to a topside digital depth reader system. The sensor rides at the surface of the sediment and logs depth of the sensor throughout the drive. The topside screen provides real-time viewing of the recovery depth while driving as well as functions for saving and calibrating the system. Measurements of the sensor are normally done in 30 second periods or if the corer is penetrating quickly in 1' increments. In some sediments it may take up to 5 minutes for the in-situ sensor to settle before accurate readings can be provided. Data can be recorded in the field about the recovery throughout the drive and is often combined with the Gravity Pentrometer for a full picture of the drive progress. The

Penetrometer and the ISRS provide depth of the corer both at the head to read penetration and depth of the internal sensor which rides on the surface of the recovered sample. For example if water depth is 100 feet and a 10′ vibracorer barrel is just touching the sediment surface the Penetrometer will read 90′ and the ISRS sensor will read 100′. After driving 1 foot the Penetrometer will read 91′ and if only 50% of the core was collected the ISRS sensor will read 100.5′.

Please note that the ISRS may not accurately represent recovery in soft sediments as the fathometer has a tendency to be saturated and/or sink through these layers. Due to plugging in soft sediments Gravity also provides a pneumofathometer version of the sensor that uses air pressure to keep the ports clean from sediment.

Sample Handling

Sediment processing will be conducted aboard the sampling vessel. Filled sample containers will be stored in coolers containing ice to maintain the samples at 4°± 2°C until delivery or shipping to the analytical laboratories.

All working surfaces and instruments will be thoroughly cleaned, decontaminated, and covered with aluminum foil to minimize outside contamination between sampling events. Disposable gloves will be discarded after processing each station and replaced prior to handling decontaminated instruments or work surfaces.

Sample containers will be kept in packaging as received from the analytical lab until use; a sample container will be withdrawn only when a sample is to be collected and will be
The steps for processing the samples are provided below.

1. Extrude sample material from sample core tube onto a stainless steel tray using a vibrating core-extruder. Alternatively, the core may be cut longitudinally using a circular saw, taking care not to penetrate the sediment while cutting.
2. Fill container with sample as full as possible to eliminate air space in sample jar (it may be necessary to slightly overfill jar to reach a convex meniscus and slide the the cap liner, with PTFE side down, expelling the additional sample).
3. Screw cap on the container and tighten.
4. Repeat steps 2 through 4 for the second 2-ounce glass container.
5. Record the description of the core sample on the core log form for the following parameters as appropriate and present:
   - Sample recovery (depth in feet of penetration and sample compaction)
   - Physical soil description in accordance with the Unified Soil Classification System (includes soil type, density/consistency of soil, and color)
   - Odor (e.g., hydrogen sulfide, petroleum, etc.)
   - Vegetation

- Debris
- Biological activity (e.g., detritus, shells, tubes, bioturbation, and live or dead organisms)
- Presence and depth (in feet) of the redox potential discontinuity layer
- Presence of oil sheen
- Any other distinguishing characteristics or features

6. Using a clean spoon, place sample material from the core into a cleaned stainless steel bowl or HDPE bucket, homogenize using a stainless steel paddle and variable speed drill,
7. Collect and process grain size analysis with Field Sieve Kit using the PSDDA volumeteric method.
8. Collect and process Shear Stress using a Humboldt Mini Torvane test kit (H4212 MH)
9. Thoroughly check all sample containers for proper identification, analysis type, and lid tightness.
10. Pack each container carefully to prevent breakage and place upright inside a cooler with ice for storage at the proper temperature (4°± 2°C for all samples).

RECORDING

The following information will be included in this log:

- Elevation of each station sampled as measured from MLLW
- Location of each station as determined by DGPS
- Date and time of collection of each sediment core sample
- Names of field supervisor and person(s) collecting and handling the sample
- Observations made during sample collection including: weather conditions, complications, ship traffic, and other details associated with the sampling effort
- The sample station identification
- Length and depth intervals of each core and estimated recovery for each sediment sample as measured from MLLW
- Qualitative notation of apparent resistance of sediment column to coring
- Any deviation from the approved SAP

Note on Environmental impacts of vibracoring activities

Gravity has extensive experience operating vibracorer's in sensitive habitat areas and has conducted a significant amount of field monitoring to assure minimal impact of the vibracore system. Below are some key environmental considerations.

Suspended sediments – the vibracorer produces minimal impact to surface waters. Vibration typically settles particles and because most the energy from the coring is located at the subsurface driving tip, surface sediments are often not disturbed. In-water turbidity monitoring has been conducted during coring at a variety of sites with different sediment substrates. Project NTU has not been observed above 2 NTU over background.

Noise – the vibracorer does not cause mechanical impact, but centrifugal impact, and therefore is not comparative to typical pile driving operations. Gravity has monitored with hydrophones near vibracoring sites and we have not observed decibel readings of 20.

APPENDIX B: FIELD LOGS, CORE LOGS, AND CORE PHOTOGRAPHS

B1: FIELD LOGS

PCT Bioaccumulation Sampling 1

6/21/22

08:00 Arrive Sinclair Inlet
08:30 vessel arrived
10:35 depart dock for Blair waterway

Sunny - weather calm
slight breeze

L. Delwiche T. Whorley S.
M. Duffield, S~~hawn~~ Sean Marsh

11:32 - In water @ Stn P1

~~47 15.~~ 47 15.2583N
122 29.9249W

1173073 E
706086 N

Showing ~~6.4~~ 10.0' pen on readout

7.5' IC = 73%

Scale: 1 square = ________

Rite in the Rain

12:10 – core B
~~46~~ 44.8' start on readout

47 15.2581 N
122 22.9256 W

1173071 E
706084 N

hit refusal @ 3.0' pen
show 3.5' on ~~tube rea~~
real time readout
recover ~~6.5~~ 8'9"
after 8'

12:50 – core C P1

44.1' start

47 15.2575 N
122 22.9244 E

1173074 E
706081 N

hit refusal @ 4.7' pen

LD

Scale: 1 square = ______

tube is full of sediment with
shell hash at to top
suspect core tiped over before
going in → rejected

reposition for next core
13:45
In water for core D

47 15.2594 N
122 22.9243 W

1173077 E
706093 N

start depth of read 44.8'
Real time = 4.3'
core ~~pend~~ depth = 50.3'
5.5'

in tube reading = 4.7' pen

LD

Scale: 1 square = ______

14:19 ~ core E @ P1
in tube
44.2 Start 12.3
45.3 → erroneous
↳ think the
liner is
confusing
measurement

49.7' → 5.5' pen

core is full of sediment
→ reject
reposition for another core

14:50 core F @ P1
need core of 5.2'

		tube	
Start	43'	11.6	→ + core catcher
	44'	–	
	45'	10.0'	
	46'	8.9'	
	47.1'	1.7'	4' pen
			3.7' recovery

15:37 core F @ P1

Start 42.5 Stop: 48.0
→ 5.5' pen
over 9' of material in tube
return to pier with 4
cores

17:00 secure from boat
sampling

6-22-22 PCT Bioaccumulation
Sediment Sampling
Day 2

09:00 Underway from The Port
Admin Bldg.

Overcast skies, slight breeze
Leon Delwiche
Sarah Benson
Mike Duffield
Sean Marsh

09:50 Station P2-A

start	tube
42.6	11.5
43.6	10.4
44.6	— 11.6?
45.6	10.9?
46.6	9.8
47.6	8.9
48.6	8.1 → 6' pen

3' sediment in core tube → reject

LD

P2-B
55.8' depth
5.37' tide 1173275 E
50.23' MLLW 706167 N

10:28

Start	43.8	11.6	47 15.2785 N
	44.8	9.1	122 22.8764 W
	45.8	8.8	
	46.8	8.5	
	47.8	8.6	
	48.8	9.8 ?	
	49.8	9.6 ?	→ 6' pen

Wood plug in tube @ 2' → reject core

(See image on next page)

P2-C

56.5' depth
6.5' tide
50.0' MLLW

1173281 E
706167 N

47 15.2724 N
122 22.8760 W

11:07

Start	44.5	12.3
	45.5	10.5
	46.5	9.8
	47.5	9.6
	48.5	8.8
	49.5	8.0
	50.5	7.0 → 6' pen

recovered 4.6' → keep

P2-D

57.4' depth
7.07' tide
50.33' MLLW

1173276 E
706167 N

47 15.2727 N
122 22.8778 E

11:40

Start	45.4	11.5
	46.4	11.5
	47.4	10.7
	48.5	9.3
	49.5	9.2
	50.4	9.0
	51.4	8.0

4'6" recovery – core is good

P2-E

57.8' depth
7.64' tide
50.16' MLLW

1173284.4
706168.9

47 15.2727N
122 22.8751E

12:20

Start	45.8	11.5
	46.8	11.5
	47.8	10.7
	48.8	7.5
	49.8	8.3
	50.3	8.4

Pen → 4.5'

3' recovery - reject
~~wody~~ woody debris in bottom
of core tube

P2-F

57.9' Depth
7.94' tide
50.04' MLLW

12:56

Start 45.9	12.5	
46.9	11.3	
47.9	11.5	→ no material entering the core

recover core → tube empty

redeploy after moving boat

P2-G

58.3' depth 1173281.9 E
7.98' tide 706169.5 N
50.32' MLLW

47 15.2728 N
122 22.8759 W

13:17

46.8	11.6
47.8	10.0
48.8	9.3
49.8	9.0
50.8	8.5
51.8	8.0 → 5' pen

recover core → 4' of seds
retain core

take core for processing

P3 -A

1173884 E
58.1' depth 706146 N
7.21
50.89 47 15.2713 N
122 22.7296 W

Start	46.3	11.5
	47.3	–
	48.2	11.7

↓
drive to 4'
no material in core
redeploy same location

~~58~~ 1173882
706146

bring core on deck
outside target
zone

WD

P3-A

57' depth 1173890.3
6.34 tide 706168.3
50.66 MLLW
need 3.34' core
→ 4'

not showing penetration
recovering core → no ~~[illegible]~~ seds
no redeploy

56.8' depth 1173890.1
5.95 tide 706168.0
50.85 MLLW
need 4' core

16:06
Pen → 4.0' needed
3' pen

8' recovered

16:30 Secure from Sampling
bring cores to processing

WD

Scale: 1 square = ______

P3-B

56.5' Depth 1173889.4
5.57 tide 706168.7
50.93 MLLW
45° 15.2751'N
16:27 122° 22.7274'W
need 4.0'
pen 4.0'
recovered 6.5'

P3-C

56.2' Depth 1173890.3
5.21 tide 706169.3
51.0' MLLW
4.0' core 45 15.2752 N
122 22.7274 W
16:40

pen = 3.0'

Secure from Sampling
17:00 → transit to Sinclair

WD

Scale: 1 square = ______

6/23/22 PCT Sampling Day 3

07:35 underway from
Sinclair Inlet and away
to P1

Sunny, calm

~~LD~~ Leon Delwiche
Adam Crispin
Mike Duffield
Sean Marsh

07:54 setting up on P1

P1-G - 08:10

1173082.2
51.1 depth 706088.3
1.26 tide
49.84 MLLW
need 5.5' core

Start ~~12.1~~
39.2 12.1 hit
44.9 6.2 → 5.7' refusal

Scale: 1 square = ______ 5.6 recover → keep

09:00 on Station P4

A 49' depth 1174420.4 E
1.57' tide 706058.3 N
47.43 MLLW

09:10
Start 37.0' 12.0
45.0' 6.0

8.0' of pen 6.0' recovery

P4-B

49.4' depth 1174423.5 E
2.07' tide 706061.0 N
47.33 MLLW
need 8' core

Start 09:40
37.7 12.0
45.8 4.4
~~7.6'~~
8.0' pen
7.7' recovery → good core

PY-C

50.1' depth 1174420.7 E
2.51 tide 706061.9 N
47.59 MLLW
= 7.41
→ 8.0' core

10:00

Start 38.4 12.0'
45.4 8.0'
8.0' penetration
< 4.0' recovery
hard dry clay plug in core
tube
reset for another attempt

(see image on next page)

PY-D

50.6' depth 1174422.8
3.02 tide 706063.5
47.58 MLLW
7.42'
need 8.0' core

10:25 Start

39.1' 11.6'
47.1 6.6

8.0' pen.
5.3' rec
low recovery discard
move for another attempt

P4-E

55.6 depth 1174422.0 E
5.65 tide 706051.4 N
49.95 MLLW
5.05
get 6.0' core

10:54 start

43.6 11.6
49.6 7.3
6.0' core
5.33' recovery

11:50 dropping cores @ dock
for processing

13:33
Depart dock to Station P5

P5-A

57.9 depth 1174856.0
8.35 tide 706106.7
49.55 MLLW
5.45 length
→ get 6.0' core

14:00 Start

46.0' 12.0
52.1 6.1

6.0' pen

PS-B

57.9' depth 1174869.0

8.38' tide 706108.9

49.32

5.68' length

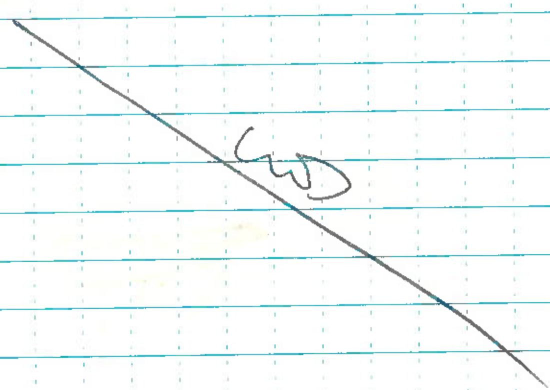
get 6.0' core

14:30 Start

46.0' 12.0

52.0' 4.8'

6.0' penetration



PS-C

~~depth 58~~ 1174867.1

58.0' depth 706104.3

8.65 tide

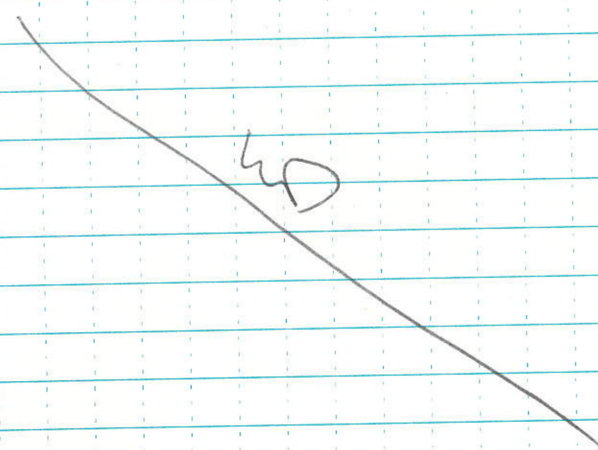
49.35 MLLW

14:55 Start

46.2 11.5

52.0 6.5

6.0' pen



P6 - A

55.2 depth 1175114.1
8.56 tide 705991.5
46.64 MLLW
8.36'
need 9.0' core

15:35 start
43.9
52.8
9.0' drive → good core

P6 - B

55.1 depth 1175117.8
8.41 tide 705995.8
46.69 MLLW
8.31' core
get 9.0' core
start 15:55
43.2 11.5
52.2 3.3
9.0' pen
Finish sampling for the day

Scale: 1 square = ______

6/24/22
08:34 underway from pier
Day 4
Sunny slight breeze
Leon Delwiche
Sarah Benson
Mike Duffield
Sean Marsh

09:00 on Station P6-C

46.8' depth 1175118.2 E
0.07' tide 705994.3 N
46.73' MLLW
8.27' length
→ 9.0' core

Start 09:05

34.7 11.5
43.8 -
9.0' pen
full take need to allow for material to settle before measuring move to Stn P3
measure from top → 6"
Scale: 1 square = ______ take another core

P6-D

48.3 depth 1175117.8 E
0.17 tide 706000.1 N
48.13 MLLW
6.87' length
→ 7.0' core

09:35 Start

36.3 11.5
~~97~~.3 -
9.0' drive
measure 6.8' recovery
good core

Move to Station P3

P3-D

81.9 depth 1173901.4 E
1.17 tide 706165.0 N
50.73 MLLW
50.73
-4.27' length
5.0' core
→ 5.0' penetration

39.9 Start → 10:30
43.1
4'7" penetration good core

P3-E

52.2' depth 1173884.5 E
1.42' tide 706165.4 N
50.78' MLLW
4.22' length
5.0' core

40.0 10:40 Start
45.1
5.1' penetration

PB-F

52.7' depth 1173900.3
1.99' tide 706168.9
50.71' MLLW
4.29' length
5.0' core
5.0' penetration

11:00 start
5.0' pen

11:20 - Secure from sampling
return to dock to deliver
cores.
completed sampling aboard
vessle

EJD

Scale: 1 square = ______

PCT Bioaccum Sampling 6/21/22

0800 - 0830 Arrive at Port Admin bldg.

0830 Gravity Vessel arrived at dock
Prep for coring ops.
Gravity needs power cord, will need to go to Hardware store to pick up.

0900 Conduct safety briefing with team.

Mike Duffield	Gravity
Jean Marsh	↓
Leon Delwiche	NF
Theresa Whorley	
Sarah Benson	
John Nakayama	↓

Weather: Partly sunny, light winds 65°F

1030 Power cord obtained, depart to do coring ops.

Crew checked in, having cores with ≥100% recovery.

Core F - Tried coring, stopping every foot to measure recovery. At about 1 ft into Z-layer, sediment in tube was exceeding penetration rate.

Spoke with EPA: Ecology to discuss core recovery observations. It appears based on rep D that sand heave is occurring when core gets into 1 foot of Z layer.

1630 Coring team returned to dock with 4 cores.
Rejected reps B and F, process reps D and G. Will need to collect one more at P1

Based on core lithology, we are getting into the ambient sands at depth. When core gets about a foot into Z-layer we have some sand heaving + resuspension of surface fines - which makes recovery look very high, >100%. Once core fines settled, recovery is still >100% but not as extreme. Core lithology looks intact.

1845 Processing completed ~~and~~ processing area picked up.
Depart PoT.

Notes: Tried 7 core attempts, retained 2 for processing at P1.

For Z2 samples retaining 8-oz amber for each core sample.

e.g. labeled BW22-P1-D-Z2

6/22/22
PCT Bioaccum Sampling

1030 Arrive @ Port Admin Bldg, set up processing area. J. Nakayama, T. Whorley

Weather: overcast, light winds, 60°F.
T. Whorley, J. Nakayama @ processing
L. Dehring, S. Benson on Gravity Boat.

Coring team starting at P2.

1300 Reported back that they are hitting woody debris and pile driving. Have 2 cores after 6 attempts.

1345 Core sampling team on way to dock with 3 cores.
Recovery has been 75% or a little less.
Notified EPA about situation

1400-1540 Process cores at P2
Recoveries were 75, 78, and 80%
Reps C, D, and G.
Could only get <0.5' Z2 Samples at D & G

1715 Core team returned with 3 cores from P3. % recoveries varied from 89% to 256%.
Field team was out of core setups for the day due to multiple extra core attempts needed to obtain cores, so could not take any more redos at P3.

1730-1900 Cores processed.

DMMU sample needed was 1-1.1 ft.
Cores were penetrated 4' for Reps A & B
Rep C was penetrated 3' but had high sand heave.

1900 Processing center taken down, depart Admin Bldg.

PCT Biozccum Sampling 6/23/22

1030 Arrive @ processing site, setup station J. Nakayama, S Benson
Weather: partly sunny, warm 60°F

L. Delwiche: Adam Crispin on Gravity Boat. Collected last P1 core, collected P4 cores.

DMMP agency reps contacted us and indicated that the core with 250% recovery from P3 is of concern. Preference from DMMP is to not include ∴ P3 cores will be recollected Fri.

1200 Gravity boat returned with 4 cores.
Process P1-H, P4-A, B & E.

Coring crew collected P5 cores and 2 of the P6 cores.

1630 Gravity boat returned with 5 cores. P5-A, B, C, P6-A, B

All cores process, all with acceptable recovery

1900 Processing completed and site pack up. End of day.

Cores remaining: 1 @ P6
3 @ P3

6/24/22 PCT Biassay Sampling

1000 Arrive @ Port Admin Bldg setup processing area. J. Nakayama

Weather: Sunny, light winds 60-65°F

T. Whorley to arrive @ 1pm if needed for processing.

L. Delwiche & S. Benson on Gravity Vessel to collect last PB core, recollect 3 cores.

1130 Cores arrived

1145 Begin processing PB-D

~1330 Core processing complete, begin PCT compositing.

1400 PCT-1-C Complete 47% fines - wet sieve

PCT-1-Z 24% fines

PCT-2-C 40% fines

PCT-2-Z 47% fines

1600 Processing complete & processing area broken down.

B2: CORE LOGS

SEDIMENT CORING LOG

NewFields
Perspective. Vision. Solutions.

Location/Core Number: P1-D

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	5.5'
		CORE RECOVERY:	6.2'
DATE SAMPLED:	6-21-2022	% RECOVERY:	113%
TIME:	13:45	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-56.8'	PCT-1	-52 / -54
NOS WATER LEVEL (TIDE):	+6.5'		
WATER DEPTH MLLW:	-50.3'		
SAMPLED BY:	LD, TW, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
1		BW22-P1-S	BW22-P1-0-1	0-0.5' soft, very wet, loose, olive gray to olive brown silt 0.5-3.5' soft, wet, dark olive brown silt	
	1.7'		BW22-P1-1-3		
2, 3	3.7'	BW22-P1-Z			
4, 5	5.9'	BW22-P1-D-Z2		3.5-6.2' loose, damp, dark olive gray to black, M-F sand with scattered gravels	
6	6.2'	Core nose empty			
7, 8				Bottom of core (6.2')	

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

NewFields — Perspective. Vision. Solutions.

Location/Core Number: P1-G

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	5.5'
DATE SAMPLED:	6-21-2022	CORE RECOVERY:	6.8'
TIME:	15:37	% RECOVERY:	124%
UNCORRECTED DEPTH (-FT):	-54.2'	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
NOS WATER LEVEL (TIDE):	+3.9'	PCT-1	-52 / -54
WATER DEPTH MLLW:	-50.3'		
SAMPLED BY:	LD, TW, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
1		BW22-P1-S	BW22-P1-0-1	0-0.7' soft, very wet, loose, dark olive brown silt	
			BW22-P1-1-3	0.7-4.2' soft, wet, dark olive brown to black silt, grading to sandy silt with depth. 1.2-2.0' shell particles	
2, 3	1.7'	BW22-P1-Z			
4, 5, 6	3.7'	BW22-P1-G-Z2		4.2-5.0' construction gravels present 4.2-6.4' loose to moderately loose, dark olive brown F sand, grading to M-F sand with scattered small gravels.	
	6.4'	Core nose empty		Core nose in 6.4' to 6.8' interval	
7, 8	6.8'			Bottom of core (6.8')	

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

NewFields
Perspective. Vision. Solutions.

Location/Core Number: P1-H

PROJECT NAME:	2022 PCT Bioaccumulation Study	CORE PENETRATION:	5.7'
DATE SAMPLED:	6-23-2022	CORE RECOVERY:	5.6'
TIME:	08:10	% RECOVERY:	98%
UNCORRECTED DEPTH (-FT):	-51.1'		
NOS WATER LEVEL (TIDE):	+1.3'		
WATER DEPTH MLLW:	-49.8'		
SAMPLED BY:	LD, AC, MD, SM		

Dredging Unit	Characterization Depth (ft)	Z-Layer (ft)
PCT-1	-52	-54

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
		BW22-P1-S	BW22-P1-0-1	0-2.4' soft, wet to moist, very dark grayish brown organic silt, scattered shells down to 1.6'	small woody debris at 0.6'
1			BW22-P1-1-3		2" wood chunk from 1.6-1.8'
2	2.2'				
3		BW22-P1-Z		2.4-5.6' loose, damp, very dark grayish brown to black M-F sand	
4	4.2'				
5	5.3'	BW22-P1-G-Z2			
	5.6'	Core nose empty			
6				Bottom of core (5.6')	
7					
8					

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

NewFields
Perspective. Vision. Solutions.

Location/Core Number: P2-C

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	6.0'
		CORE RECOVERY:	4.5'
DATE SAMPLED:	6-22-2022	% RECOVERY:	75%
TIME:	11:07	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-56.5'	PCT-1	-52 / -54
NOS WATER LEVEL (TIDE):	+6.5'		
WATER DEPTH MLLW:	-50.0'		
SAMPLED BY:	LD, SB, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
0–1		BW22-P1-S	BW22-P1-0-1	0-0.6' soft, wet, olive brown silt 0.6-2.0' soft, wet, very dark gray to black clayey silt, trace F. sand	
1–2	2.0'		BW22-P1-1-3		
2–4	4.0'	BW22-P1-Z		2.0-4.0' moderately loose, damp, very dark grayish brown F. sand grading to M. sand with depth, scattered brick colored grains 3.6' mud clast present	
4–4.5	4.5'	No Z2, core nose empty			
4.5–8				Bottom of core (4.5')	Note: No apparent wood debris

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

NewFields
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Location/Core Number: P2-D

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	6.0'
		CORE RECOVERY:	4.7'
DATE SAMPLED:	6-22-2022	% RECOVERY:	78%
TIME:	11:40	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-57.4'	PCT-1	-52 / -54
NOS WATER LEVEL (TIDE):	+7.1'		
WATER DEPTH MLLW:	-50.3'		
SAMPLED BY:	LD, SB, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
0–1		BW22-P2-S	BW22-P2-0-1	0-3.0' very soft to soft, wet, very dark brown and dark grayish brown silt with trace F. sand	
1–2	1.7'		BW22-P2-1-3		
2–3		BW22-P2-Z		3.0-4.2' damp, moderately loose, black grading to very dark grayish brown F-M. sand.	
3				3.3' olive brown mud clast	Mud clasts approx 0.1' in width
				3.5' and 3.8' black mud clasts	
4	3.7'	BW22-P2-D-Z2			
	4.2'			(Empty core nose)	
5	4.7'			Bottom of core (4.7')	Note: No wood debris
6					
7					
8					

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

Location/Core Number: P2-G

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	5.0'
		CORE RECOVERY:	4.0'
DATE SAMPLED:	6-22-2022	% RECOVERY:	80%
TIME:	13:17	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-58.3'	PCT-1	-52 / -54
NOS WATER LEVEL (TIDE):	+8.0'		
WATER DEPTH MLLW:	-50.3'		
SAMPLED BY:	LD, SB, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
		BW22-P2-S	BW22-P2-0-1	0-1.0' loose, wet, olive brown unconsolidated silt	
1	1.7'		BW22-P2-1-3	1.0-2.6' soft, moist, very dark grayish brown to black clayey silt with trace F. sand	2 pieces (1"-2") of woody debris at 1.2'
2		BW22-P2-Z			
3	3.7'			2.6-4.0' moderately loose, damp, very dark grayish brown silty F. sand grading to M. sand.	
		BW22-P2-D-Z2		3.4' light olive brown 0.1" mud clast	
4	4.0'			Bottom of core (4.0')	
5					
6					
7					
8					

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

NewFields
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Location/Core Number: P3-D

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	5.0'
		CORE RECOVERY:	4.0'
DATE SAMPLED:	6-24-2022	% RECOVERY:	80%
TIME:	10:30	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-51.9'	PCT-1	-52 / -54
NOS WATER LEVEL (TIDE):	+1.2'		
WATER DEPTH MLLW:	-50.7'		
SAMPLED BY:	LD, SB, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
0–1		BW22-P3-S	BW22-P3-0-1	0-0.4' very loose, wet, olive brown silt 0.4-1.5' loose, wet, very dark grayish brown F. sand	
1	1.3'		BW22-P3-1-3	1.5-2.0' soft, wet, mottled black with very dark grayish brown silt	
2		BW22-P3-Z		2.0-2.4' slightly hard, damp, very dark grayish brown silty F. sand	
3	3.3'	BW22-P3-D-Z2		2.4-4.0' loose, damp, very dark grayish brown F. sand grading to M-F. sand with depth. Scattered coarse sand with depth	2cm gravel/rock at 3.4'
4	4.0'			Bottom of core (4.0')	
5					
6					
7					
8					

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

NewFields
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Location/Core Number: P3-E

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	5.0'
		CORE RECOVERY:	4.6'
DATE SAMPLED:	6-24-2022	% RECOVERY:	92%
TIME:	10:50		
UNCORRECTED DEPTH (-FT):	-52.3'		
NOS WATER LEVEL (TIDE):	+1.4'		
WATER DEPTH MLLW:	-50.8'		
SAMPLED BY:	LD, SB, MD, SM		

Dredging Unit	Characterization Depth (ft)	Z-Layer (ft)
PCT-1	-52	-54

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
1		BW22-P3-S	BW22-P3-0-1	0-0.2' unconsolidated wet silt 0.2-3.0' loose, wet to moist, very dark grayish brown F. sand, pockets of silt at 1.4'	
	1.2'		BW22-P3-1-3		
2		BW22-P3-Z			
3	3.2'			2.9-3.0' wet, silty sand 3.0-4.3' loose, wet and moist, very dark grayish brown M-F. sand	
4	4.3'	BW22-P3-E-Z2			
	4.6'	Core nose empty		Bottom of core (4.6')	
5					
6					
7					
8					

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

NewFields
Perspective. Vision. Solutions.

Location/Core Number: P3-F

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	5.0'
		CORE RECOVERY:	5.0'
DATE SAMPLED:	6-24-2022	% RECOVERY:	100%
TIME:	11:00	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-52.7'	PCT-1, PCT-2	-52 / -54
NOS WATER LEVEL (TIDE):	+2.0'		
WATER DEPTH MLLW:	-50.7'		
SAMPLED BY:	LD, SB, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
1	1.2'	BW22-P3-S	BW22-P3-0-1	0-0.5' very loose, wet, olive brown silt	
			BW22-P3-1-3	0.5-3.3' loose, wet to moist, very dark grayish brown F. sand, scattered M. sands	
2, 3	3.3'	BW22-P3-Z			
4	4.7'	BW22-P3-F-Z2		3.3-3.8' soft, moist, black mottled with very dark grayish brown, slightly sandy silt 3.8-4.7' loose, wet to moist, very dark grayish brown silty F. sand grading to M-F sand	
5	5.0'	Core nose empty			
				Bottom of core (5.0')	
6					
7					
8					

REVIEWED BY: J. Nakayama

SEDIMENT CORING LOG

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Location/Core Number: P4-A

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	8.0'
		CORE RECOVERY:	6.0'
DATE SAMPLED:	6-23-2022	% RECOVERY:	75%
TIME:	09:10	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-49.0'	PCT-2	-52 / -54
NOS WATER LEVEL (TIDE):	+1.6'		
WATER DEPTH MLLW:	-47.4'		
SAMPLED BY:	LD, AC, MD, SM		

DEPTH		SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
In-Situ Core Length (feet below mudline)	Actual Recovered Core Length (feet below mudline)				
0–1		BW22-P4-S	BW22-P4-0-1	0-1.9' wet to damp, loose, very dark grayish brown F. sand	
1–3			BW22-P4-1-3	1.9-4.5' soft, moist, olive brown, grading to black, silt, with inter-beds of fine sand with F. wood debris at 3.4' and 3.8-4.5'	
3–5	4.6'		BW22-P4-3-5		
5–6	6.0'	BW22-P4-Z		4.5-6.0' slightly hard, damp, very dark gray, VF. sand with silt, gravels scattered at 5.2', and wood particles 5.3-5.5'	
6–8		No Z2 sample		Bottom of core (6.0')	

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SEDIMENT CORING LOG

Location/Core Number: P4-B

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	8.0'
		CORE RECOVERY:	7.9'
DATE SAMPLED:	6-23-2022	% RECOVERY:	98%
TIME:	09:40	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-49.4'	PCT-2	-52 / -54
NOS WATER LEVEL (TIDE):	+2.1'		
WATER DEPTH MLLW:	-47.3'		
SAMPLED BY:	LD, AC, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
0–1		BW22-P4-S	BW22-P4-0-1	0-2.7' loose, wet to damp, very dark grayish brown F. sand	
1–3		BW22-P4-S	BW22-P4-1-3		
3–4.6	4.6'	BW22-P4-S	BW22-P4-3-5	2.7-4.3' soft, moist, very dark grayish brown silt. Increased organics with depth. 4.3-6.0' soft, wet to moist, very dark grayish brown to black, F. sandy silt with ambient fine organic debris	
4.6–6.7	6.7'	BW22-P4-Z		6.0-7.4' moderately soft, dark gray to light olive brown clay and F-VF. sand.	
6.7–7.4	7.4'	BW22-P4-B-Z2			
7.4–8		(empty core nose)		Bottom of core (7.9')	

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SEDIMENT CORING LOG

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Location/Core Number: P4-E

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	6.0'
		CORE RECOVERY:	5.3'
DATE SAMPLED:	6-23-2022	% RECOVERY:	88%
TIME:	10:54	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-55.6'	PCT-2	-52 / -54
NOS WATER LEVEL (TIDE):	+5.6'		
WATER DEPTH MLLW:	-50.0'		
SAMPLED BY:	LD, AC, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
0–1		BW22-P4-S	BW22-P4-0-1	0-0.5' soft, wet, unconsolidated silt/clay, trace organics	
1–2			BW22-P4-1-3	0.5-2.6' loose, wet to moist, very dark grayish brown F sand, scattered shell particles 1.5-2.6'	
2	2.0'				2.0, 2.6, 2.9' large shells present
3		BW22-P4-Z		2.6-5.3' loose, damp, very dark grayish brown to black M-F sand, trace fine shell particles	
4	4.0'	BW22-P4-E-Z2			
5	4.8'	(empty core nose)			
6				Bottom of core (5.3')	
7					
8				Bottom of core (7.9')	

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SEDIMENT CORING LOG

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Location/Core Number: P5-A

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	6.0'
DATE SAMPLED:	6-23-2022	CORE RECOVERY:	5.6'
TIME:	14:00	% RECOVERY:	93%
UNCORRECTED DEPTH (-FT):	-57.9'		
NOS WATER LEVEL (TIDE):	+8.4'		
WATER DEPTH MLLW:	-49.5'		
SAMPLED BY:	LD, AC, MD, SM		

Dredging Unit	Characterization Depth (ft)	Z-Layer (ft)
PCT-2	-52	-54

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
		BW22-P5-S	BW22-P5-0-1	0-0.2' very soft, wet, very dark grayish brown unconsolidated silt.	Ghost shrimp present at 0.1'
1		BW22-P5-S	BW22-P5-1-3	0.2-1.2' loose, moist, very dark grayish brown F. sand	
2		BW22-P5-S	BW22-P5-1-3	1.2-2.5' soft, wet to moist, very dark grayish brown silt with trace F. sand	Shell piece at 2.4'
3	2.5'	BW22-P5-Z		2.5-4.0' very soft, wet, very dark gray, slightly sandy silt.	
4		BW22-P5-Z			
5	4.5'	BW22-P5-A-Z2		4.5-5.6' slightly hard, very dark grayish brown F. sand with inter-bedded layers of olive brown clay from 4.7-4.9'.	
	5.3'	Empty core nose			
6	5.6'			Bottom of core (5.6')	
7					
8					

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SEDIMENT CORING LOG

Location/Core Number: P5-B

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	6.0'
DATE SAMPLED:	6-23-2022	CORE RECOVERY:	7.0'
TIME:	14:30	% RECOVERY:	117%
UNCORRECTED DEPTH (-FT):	-58.0'		
NOS WATER LEVEL (TIDE):	+8.7'		
WATER DEPTH MLLW:	-49.3'		
SAMPLED BY:	LD, AC, MD, SM		

Dredging Unit	Characterization Depth (ft)	Z-Layer (ft)
PCT-2	-52	-54

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
		BW22-P5-S	BW22-P5-0-1	0-0.3' very soft, wet, olive brown unconsolidated silt	Slight sulfide odor
				0.3-1.2' soft, wet, dark grayish brown silty F. sand	Small polychaete at 0.3'
1			BW22-P5-1-3	1.2-3.5' soft, wet, very dark grayish brown silt, trace F. sand	
2					Live clam at 2.5'
	2.7'	BW22-P5-Z			
3					
4				3.5-5.6' very soft, wet, very dark grayish brown silt with trace F. sand	
	4.7'	BW22-P5-B-Z2			
5					
6				5.6-6.7' loose, damp, silty F. sand grading to F. sand with depth.	
	6.7'	Empty core nose			
7	7.0'			Bottom of core (7.0')	
8					

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SEDIMENT CORING LOG

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Location/Core Number: P5-C

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	6.0'
		CORE RECOVERY:	5.0'
DATE SAMPLED:	6-23-2022	% RECOVERY:	83%
TIME:	14:55		
UNCORRECTED DEPTH (-FT):	-58.0'		
NOS WATER LEVEL (TIDE):	+8.7'		
WATER DEPTH MLLW:	-49.3'		
SAMPLED BY:	LD, AC, MD, SM		

Dredging Unit	Characterization Depth (ft)	Z-Layer (ft)
PCT-1, PCT-2	-52	-54

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
		BW22-P5-S	BW22-P5-0-1	0-0.3' very soft, wet, olive brown silt	
1				0.3-0.9' loose, wet, very dark olive brown silty sand	Shell piece at 0.9'
			BW22-P5-1-3	0.9-2.3' soft, wet to moist, very dark grayish brown silt with trace sand	
2					
	2.7'			2.3-4.0' very soft, wet, unconsolidated dark brown silt with trace F. sand	
3		BW22-P5-Z			
4				4.0-4.7' loose to slightly hard, very dark grayish brown to dark olive brown F. sand with scattered gravels	
	4.7'	Empty core nose			
5	5.0'	No Z2 sample		Bottom of core (5.0')	
6					
7					
8					

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SEDIMENT CORING LOG

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Location/Core Number: P6-A

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	9.0'
		CORE RECOVERY:	9.5'
DATE SAMPLED:	6-23-2022	% RECOVERY:	106%
TIME:	15:35	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-55.2'	PCT-2	-52 / -54
NOS WATER LEVEL (TIDE):	+8.6'		
WATER DEPTH MLLW:	-46.6'		
SAMPLED BY:	LD, AC, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
0–1		BW22-P6-S	BW22-P6-0-1	0-1.1' very soft, wet, very dark grayish brown to black silt, scattered organics and shells	Slightly sulfide odor
1–3			BW22-P6-1-3	1.1-4.7' soft, wet, black, slightly sandy silt with abundant shell debris, scattered organic fibers/ particles and layers	
3–5			BW22-P6-3-5		
5–7	5.4'	BW22-P6-Z		4.7-7.6' soft, wet to moist, very dark gray silt, scattered gravels	
7–8	7.4'	BW22-P6-A-Z2		7.6-9.4' loose, damp, very dark gray F. sand	

9.4' Bottom of core

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PAGE 1 OF 1

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SEDIMENT CORING LOG

Location/Core Number: P6-B

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	9.0'
		CORE RECOVERY:	9.0'
DATE SAMPLED:	6-23-2022	% RECOVERY:	100%
TIME:	15:55	Dredging Unit	Characterization Depth (ft) / Z-Layer (ft)
UNCORRECTED DEPTH (-FT):	-55.1'	PCT-2	-52 / -54
NOS WATER LEVEL (TIDE):	+8.9'		
WATER DEPTH MLLW:	-46.7'		
SAMPLED BY:	LD, AC, MD, SM		

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
0–1		BW22-P6-S	BW22-P6-0-1	0-3.8' soft, wet, olive brown quickly grading to very dark grayish brown silt with trace sand and abundant shell and small wood debris	Slightly sulfide odor
1–3			BW22-P6-1-3		
3–5.3			BW22-P6-3-5	3.8-6.6' soft, wet, very dark gray silt with trace F. sand, abundant gravel layer from 5.4-5.9'	
5.3–7.3	5.3'	BW22-P6-Z		6.6-9.0' loose, damp, very dark grayish brown F. sand with trace small gravels	
7.3–8	7.3'	BW22-P6-B-Z2			

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PAGE 1 OF 1

Z2 sample to 8.7' Bottom of core (9.0') Empty core nose (8.7-9.0')

SEDIMENT CORING LOG

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Location/Core Number: P6-D

PROJECT NAME:	**2022 PCT Bioaccumulation Study**	CORE PENETRATION:	9.0'
DATE SAMPLED:	6-24-2022	CORE RECOVERY:	8.3'
TIME:	09:35	% RECOVERY:	92%
UNCORRECTED DEPTH (-FT):	-48.3'		
NOS WATER LEVEL (TIDE):	+0.2'		
WATER DEPTH MLLW:	-48.1'		
SAMPLED BY:	LD, SB, MD, SM		

Dredging Unit	Characterization Depth (ft)	Z-Layer (ft)
PCT-2	-52	-54

DEPTH: In-Situ Core Length (feet below mudline)	DEPTH: Actual Recovered Core Length (feet below mudline)	SAMPLE ID		SEDIMENT DESCRIPTION	COMMENTS
		BW22-P6-S	BW22-P6-0-1	0-0.8' very soft/loose, wet, black silt with trace sand	
1			BW22-P6-1-3	0.8-3.2' soft, wet to moist, slightly sandy silt with moderate shell debris and wood particles, very dark gray to black, organic rich 1.3-1.8' layer of F. sand with silt	
2					
3			BW22-P6-3-5	3.2-5.5' soft, wet, olive brown silt with trace F. sand	
4	3.9'	BW22-P6-Z			
5					
6	5.9'	BW22-P6-D-Z2		5.5-7.9' loose, damp, very dark grayish brown slightly silty F. sand grading to F-M sand with depth. 6.8' gravels	
7					
8	7.9'				

7.9-8.3' Core Nose   Bottom of core (8.3')

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B3: Core Photographs


6/21/2022
@ 13:45
P1-D-S
HERKULE
FROM GRUNDE
Sparco


6/21/2022
@ 13:45
P1-D-Z
HERKULES
FROM GRUNDENS
19 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48


6/21/2022
@ 13:45
P1-D-Z2
HERKULES


6/21/2022
@14:50
P1-F-S


6/21/2022
@14:50
P1-F-Z
SED-43 #1
MUNSELL SOIL COLOR NAME DIAGRAM
MUNSELL SOIL COLOR CHART
HUE 2.5Y


6/21/2022
@ 14:50
P1-F-Z2
41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67


6/21/2022
@ 15:37
P1-G-S

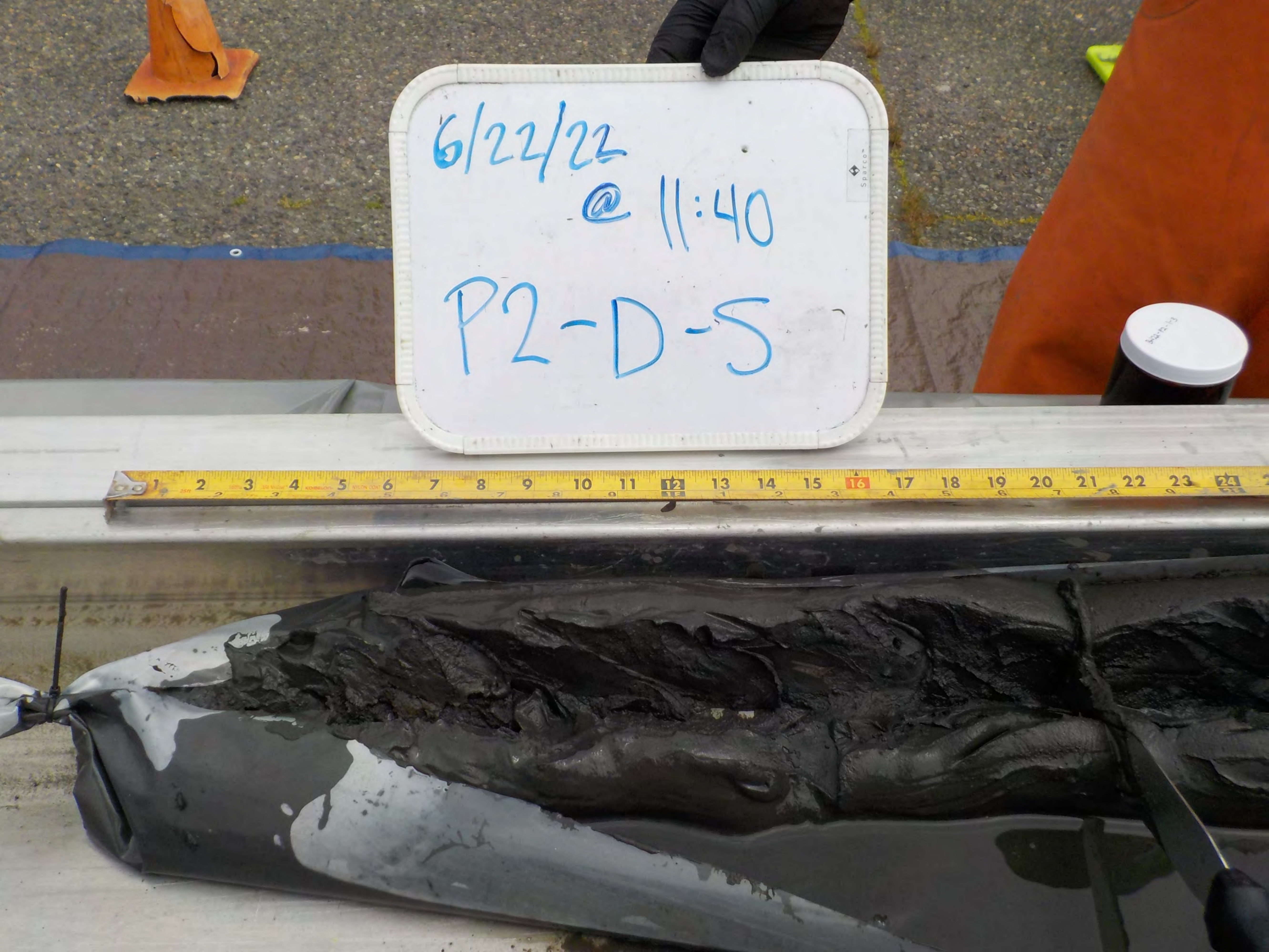

6/21/2022
@ 15:37
P1-G-Z


6/21/2022
@ 15:37
P1-G-Z2


6/23/22
@0810
PI-H-S

6/23/22
@0810
P1-H-Z


6/23/22
@0810
PI-H-Z2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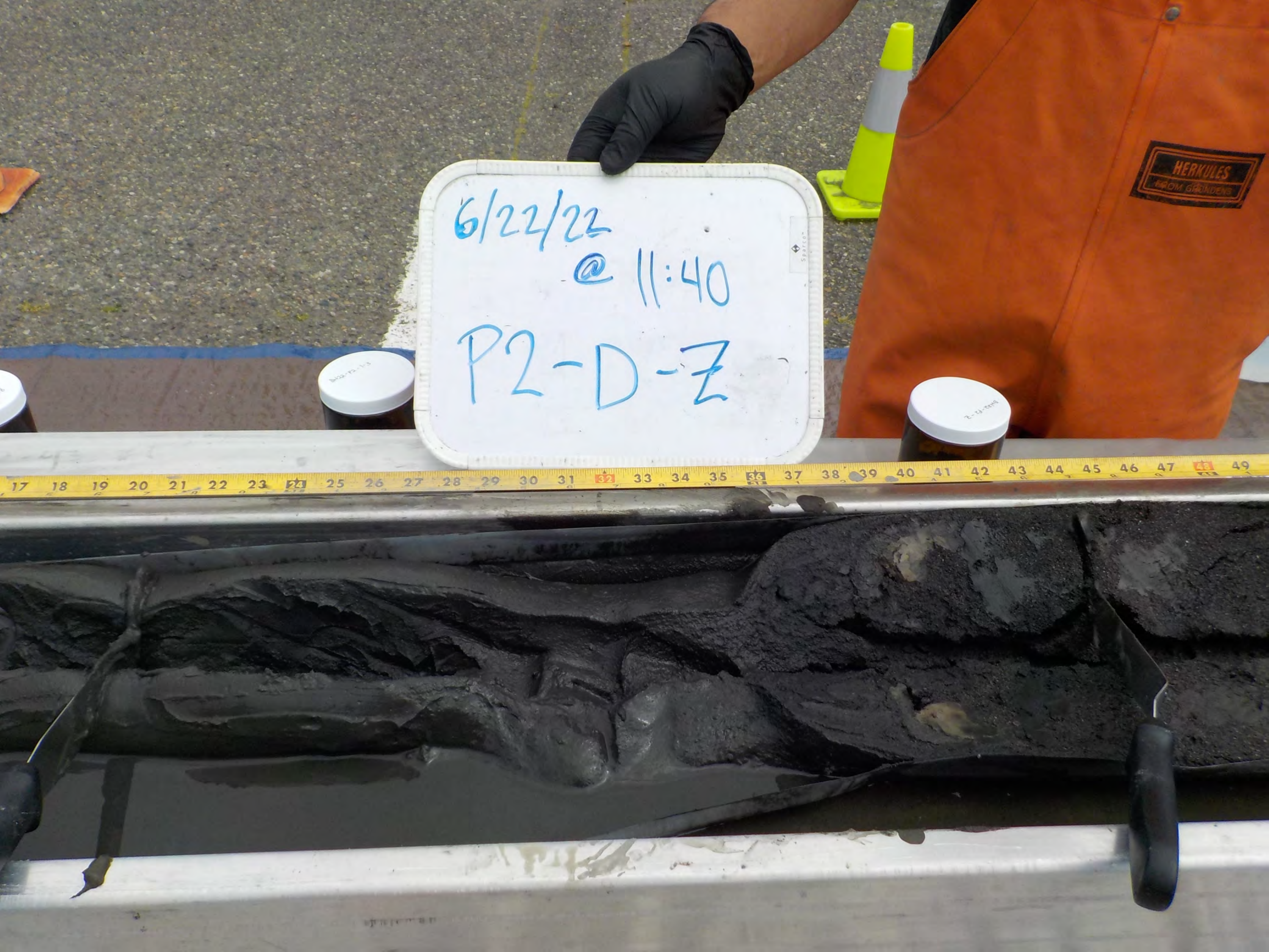
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HERKULES
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6/22/22
@ 11:40
P2-D-Z2
HERKULES
FROM GRUNDENS
36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56


6/22/22
@ 13:17
P2-G-5


6/22/22
@ 13:17
P2-G-Z


6/22/22
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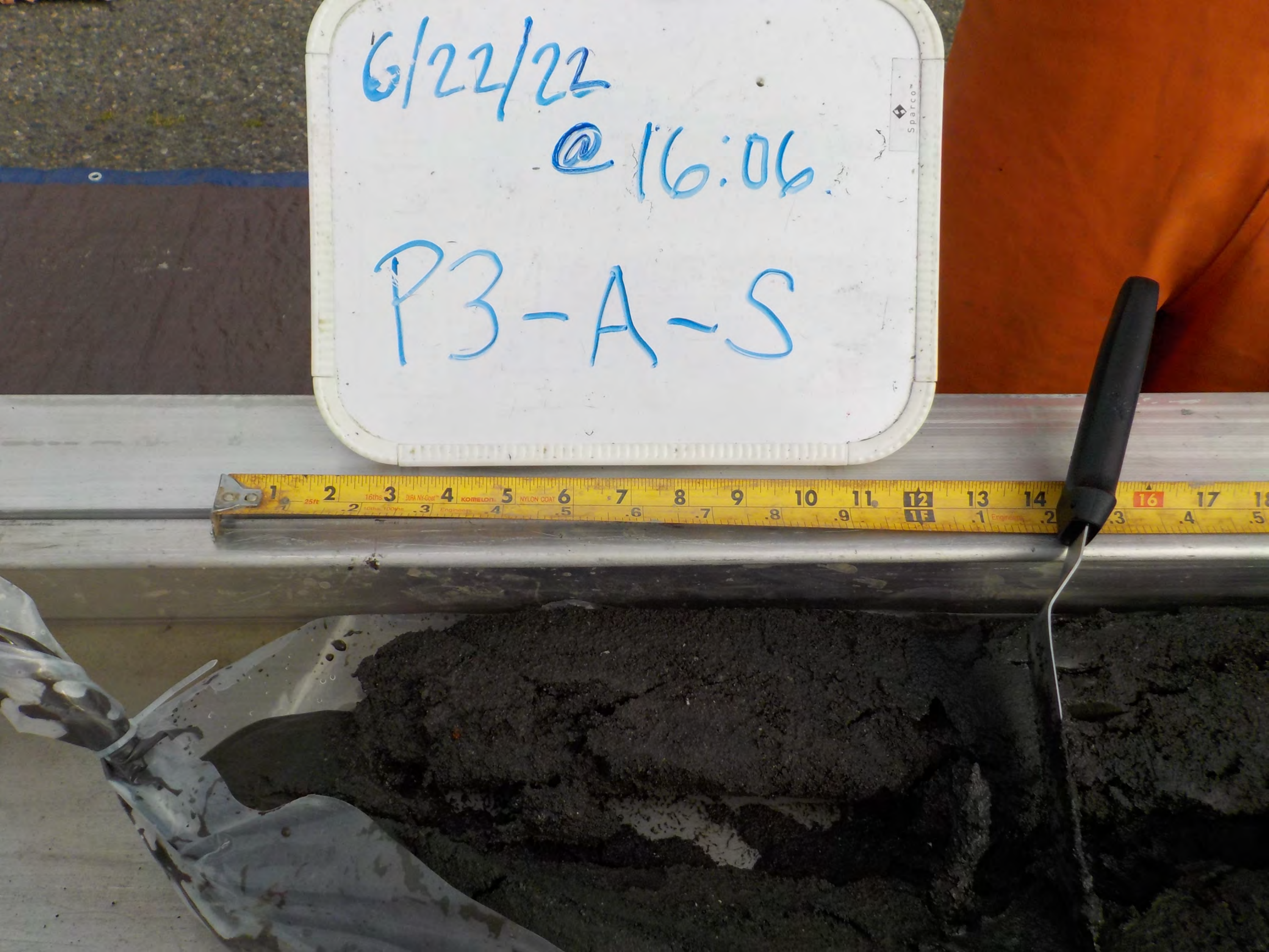
P2-G-Z2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6/22/22
@ 16:06
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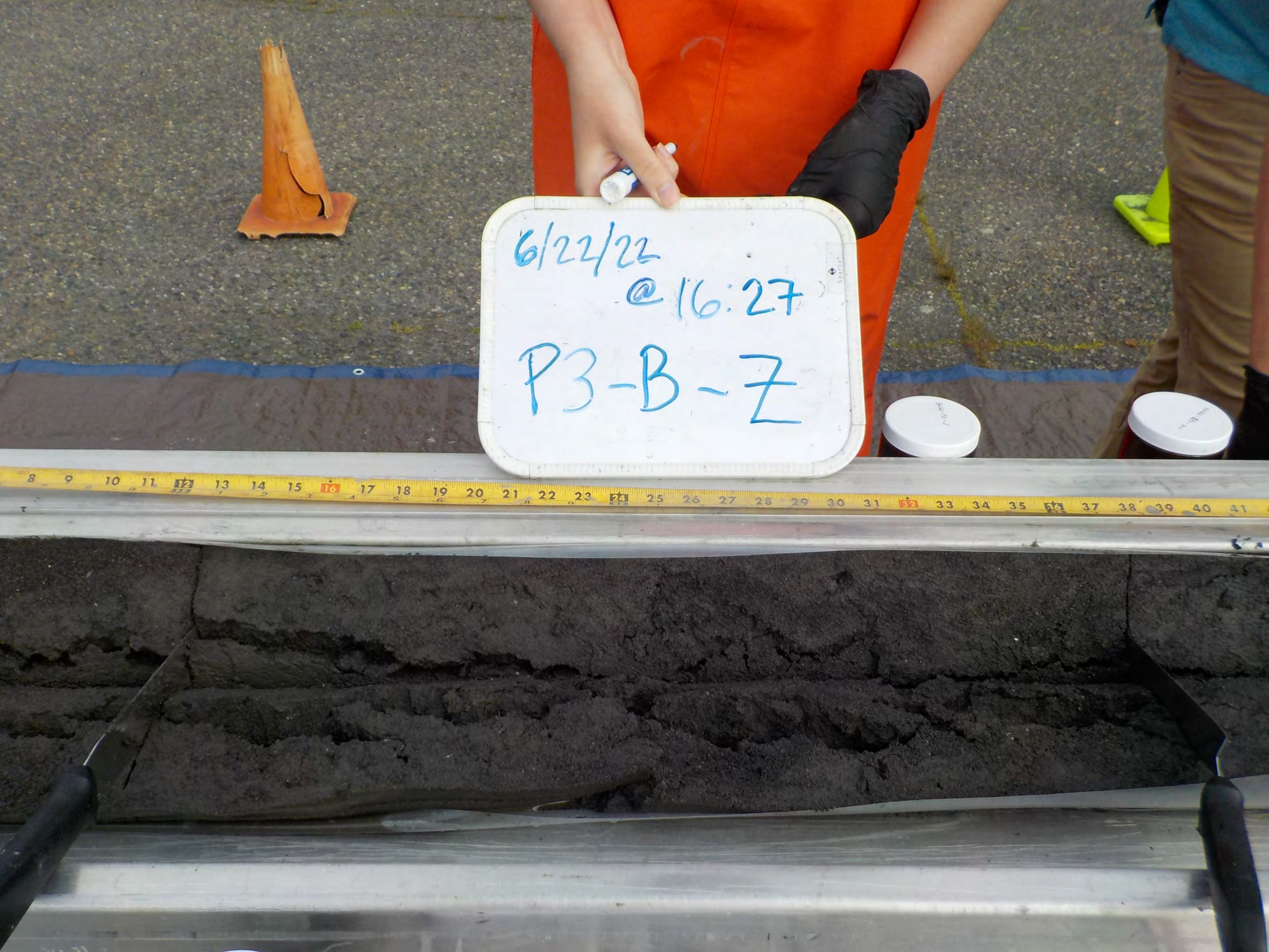
FROM GRUNDENS


6/22/22
@ 16:27
P3-B-S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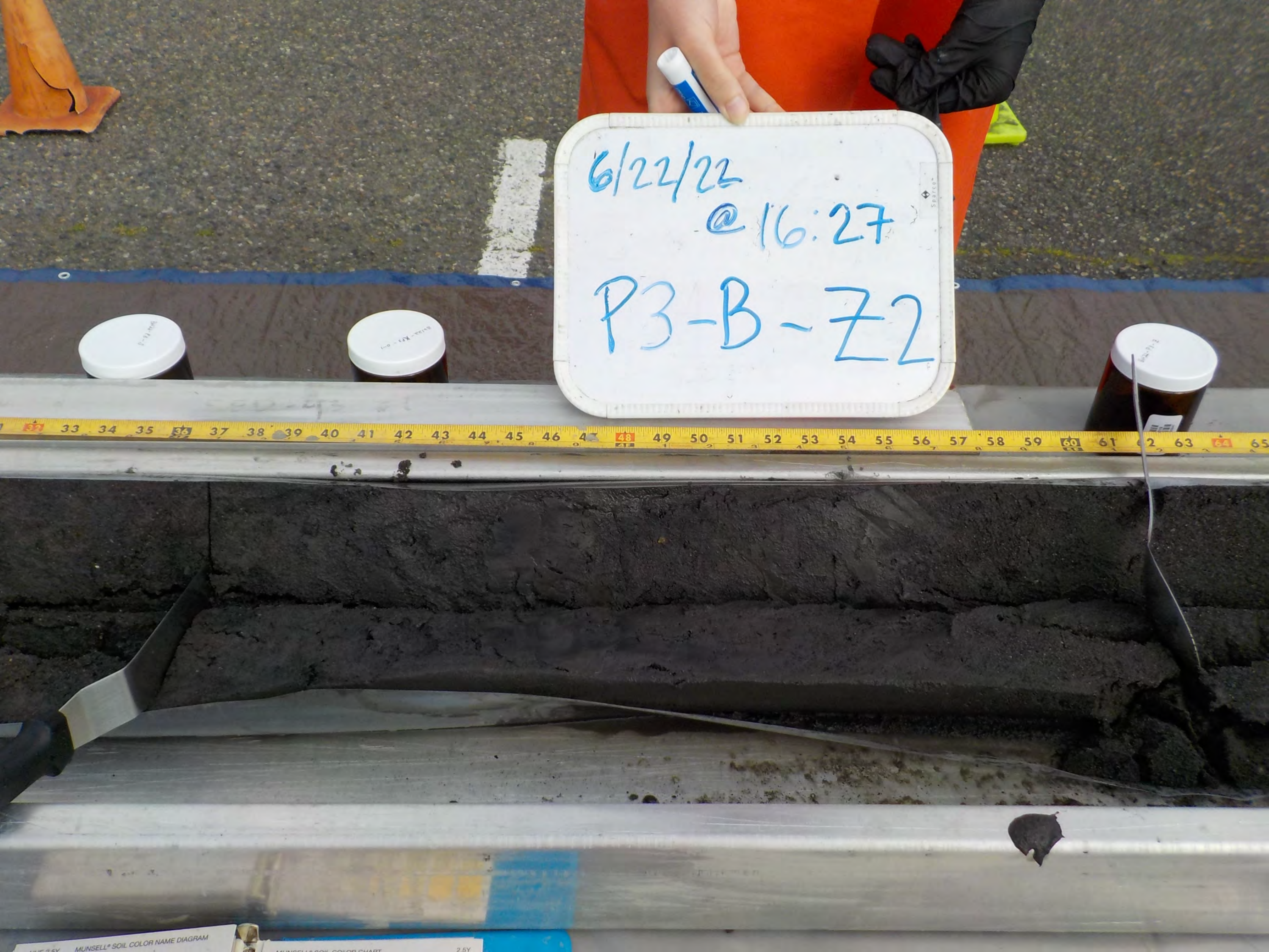
6/22/22
@16:27
P3-B-Z2


6/22/22
@ 16:40
P3-C-S

6/22/22
@ 16:40
P3-C-Z
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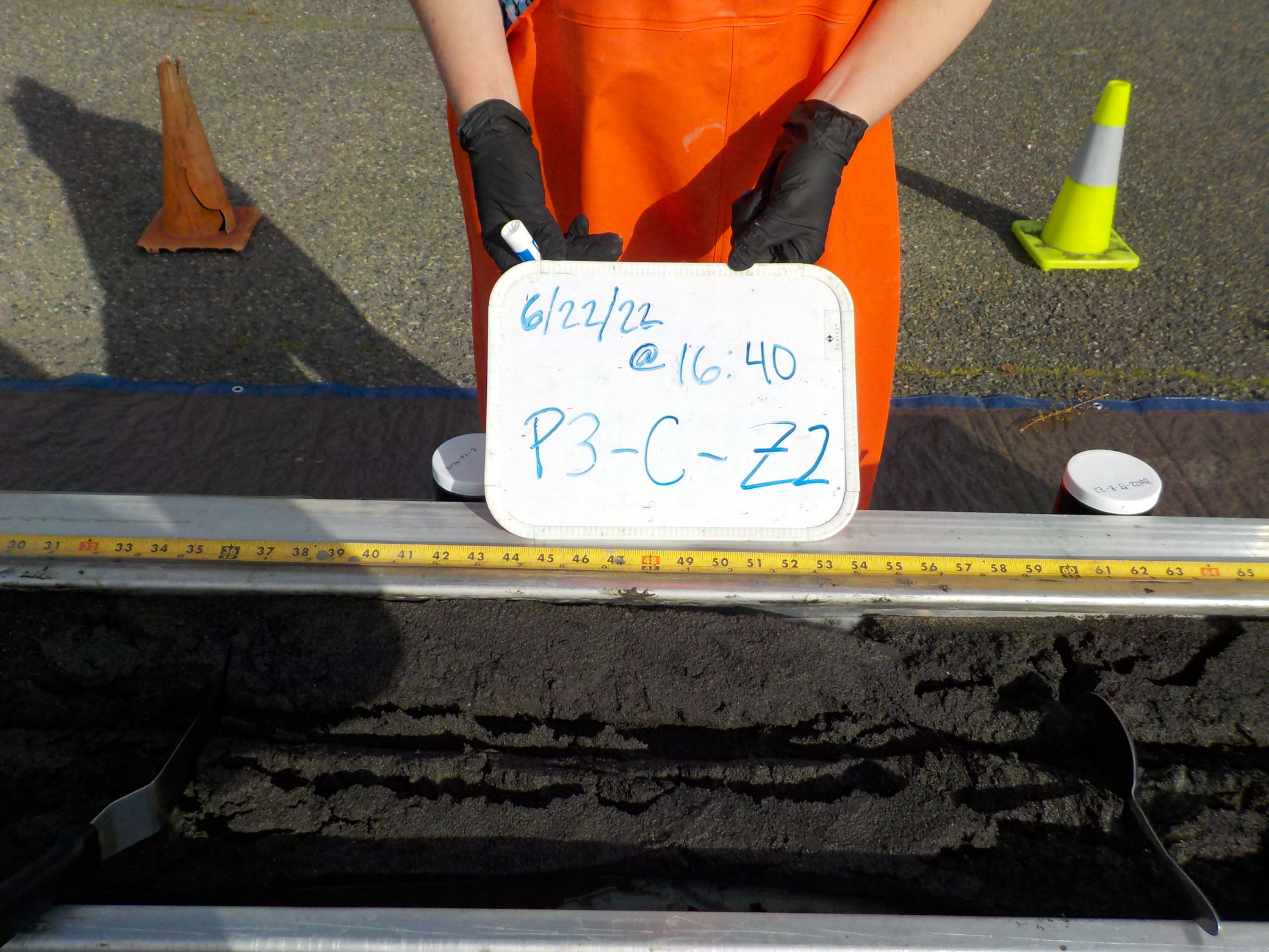
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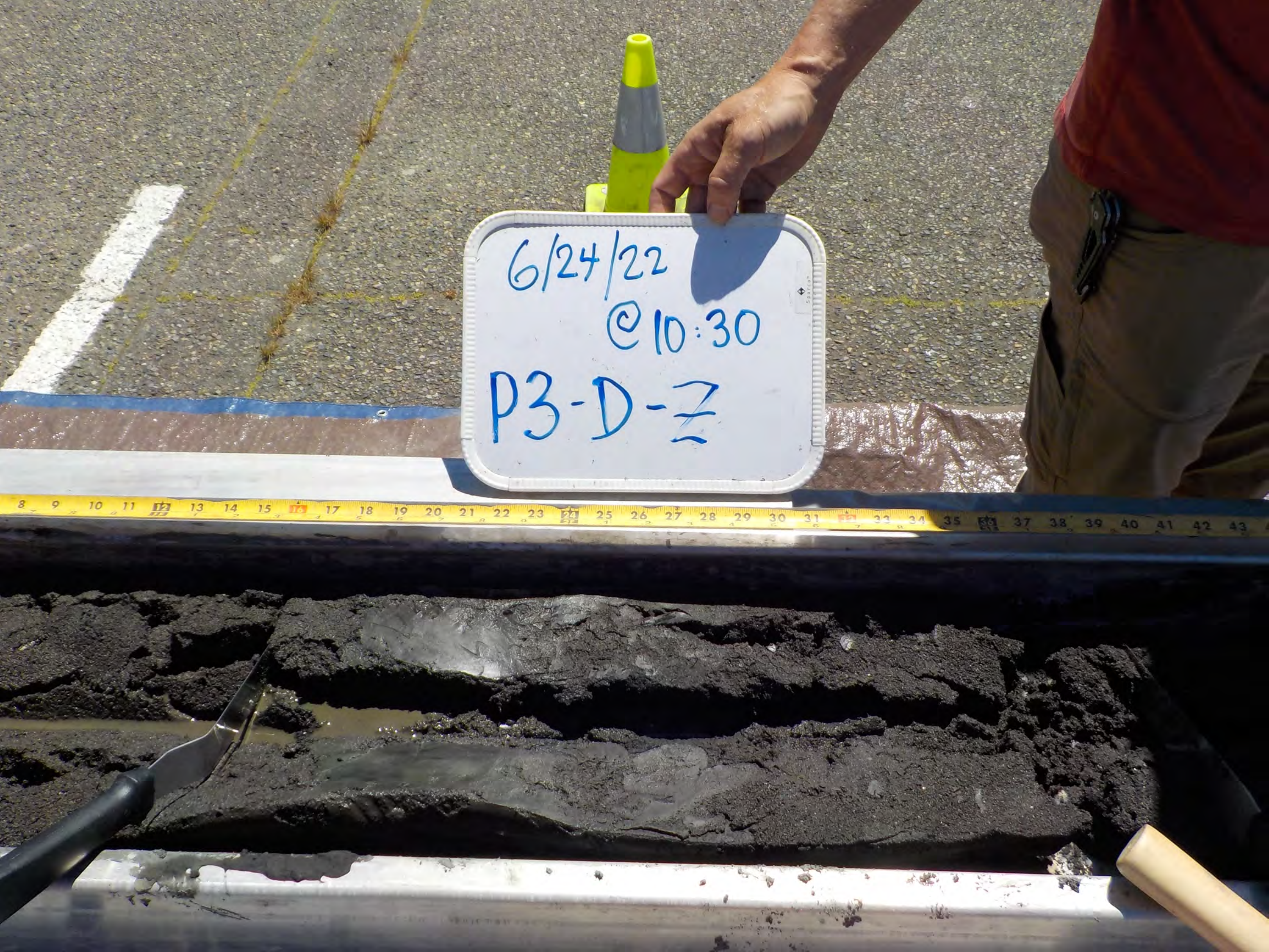
6/24/22
@10:30
P3-D-S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6/24/22
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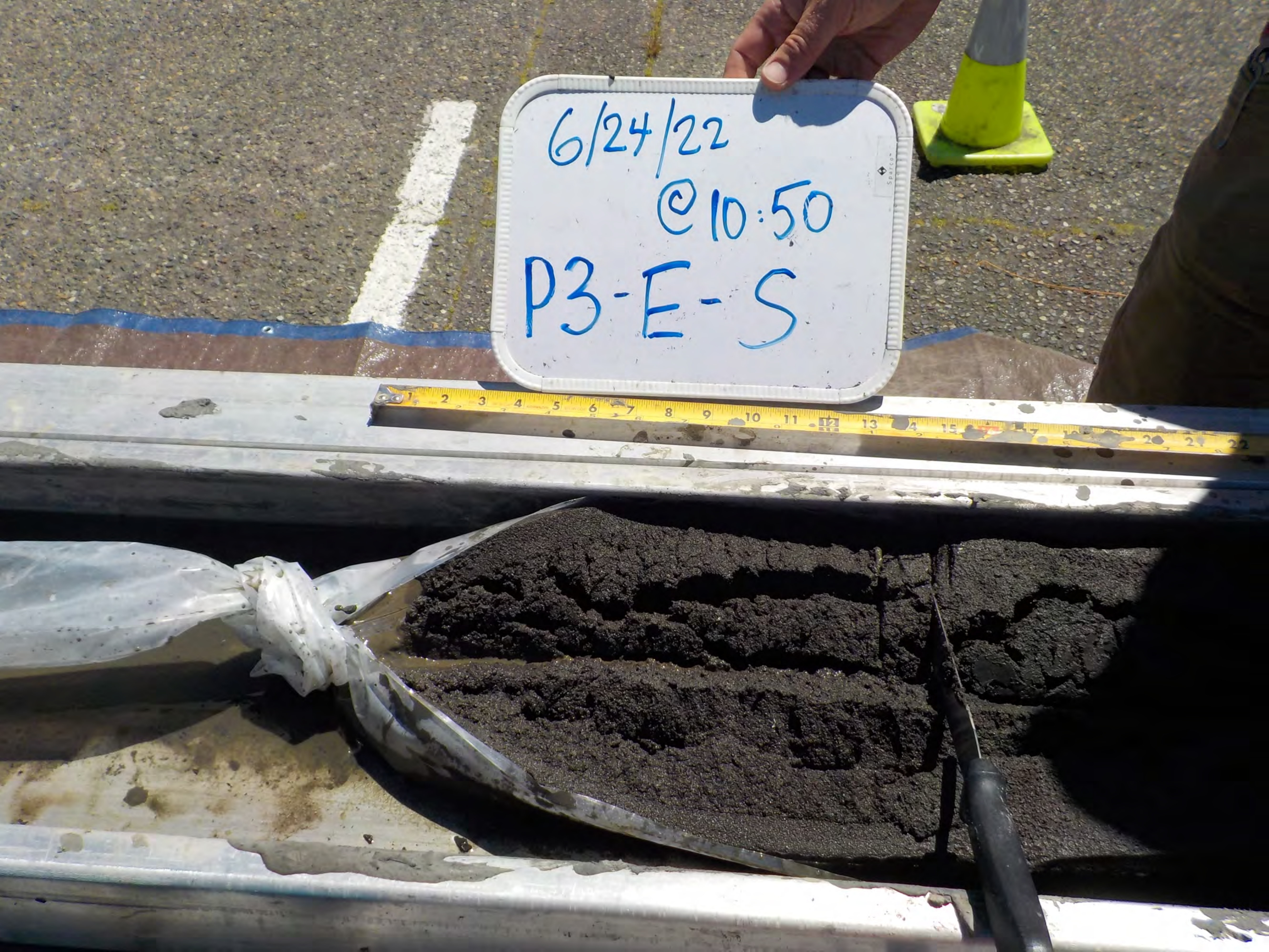
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P3-E-S


6/24/22
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P3-E-Z


6/24/22
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6/24/22
@11:00
P3-F-S


6/24/22
@11:00
P3-F-Z


6/24/22
@11:00
P3-F-Z2


6/23/22
@0910
P4-A-S

6/23/22
@0910
P4-A-S
SEDIMENT CORING LOG
NewFields


6/23/22
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P4-A-Z
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6/23/22
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BW22-P4-0-1
BW22-P4-S
BW22-P4-1-3


6/23/22
@0940
P4-B-S
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33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66

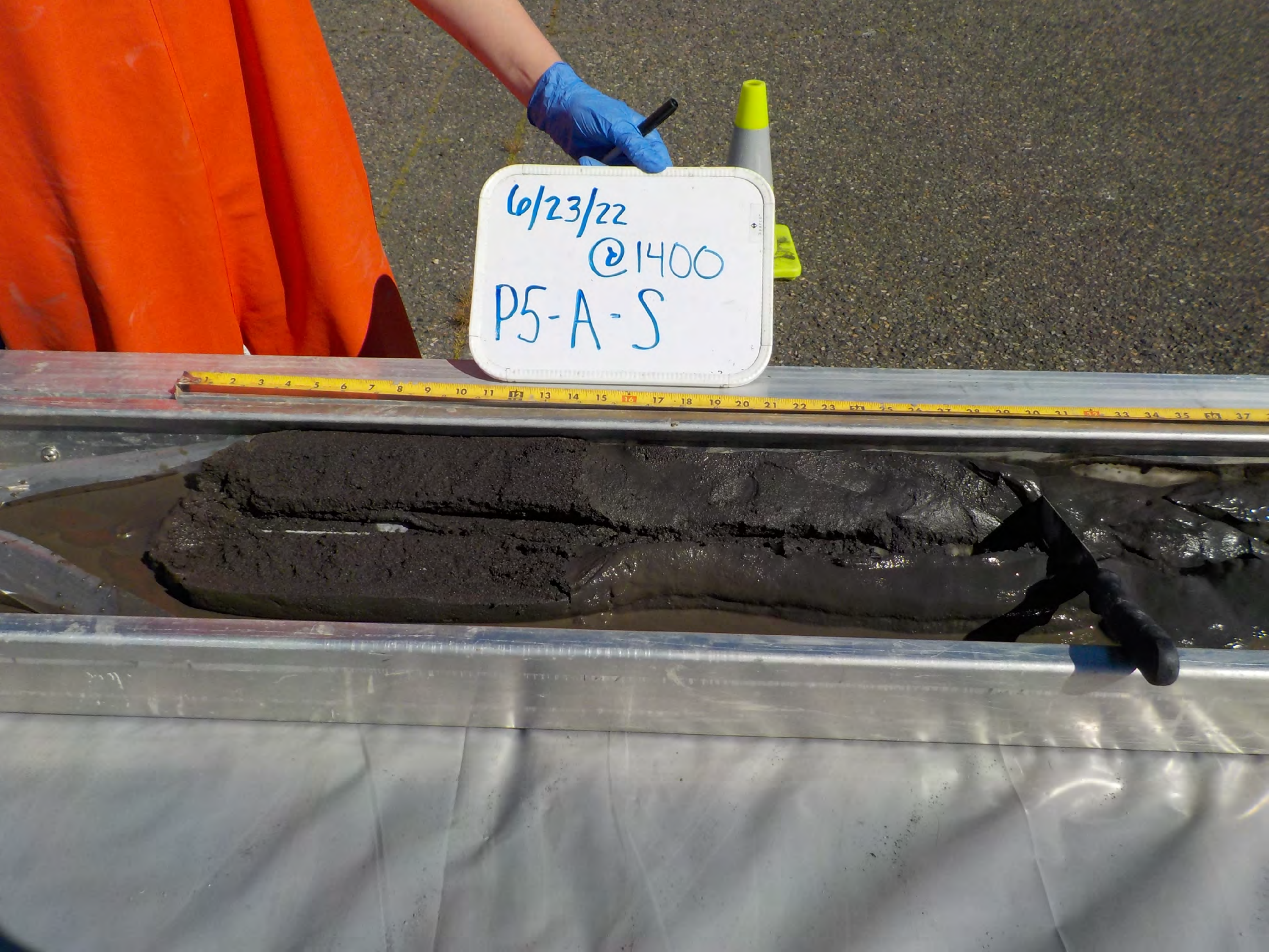

6/23/22
@0940
P4-B-Z


6/23/22
@0940
P4-B-Z2
71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90

6/23/22
@1054
P4-E-S


6/23/22
@1054
P4-E-Z


6/23/22
@1054
P4-E-Z2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@1400
P5-A-S

6/23/22
@1400
P5-A-Z


6/23/22
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Milwaukee

6/23/22
@1430
P5-B-S

6/23/22
@1430
P5-B-Z
27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63


6/23/22
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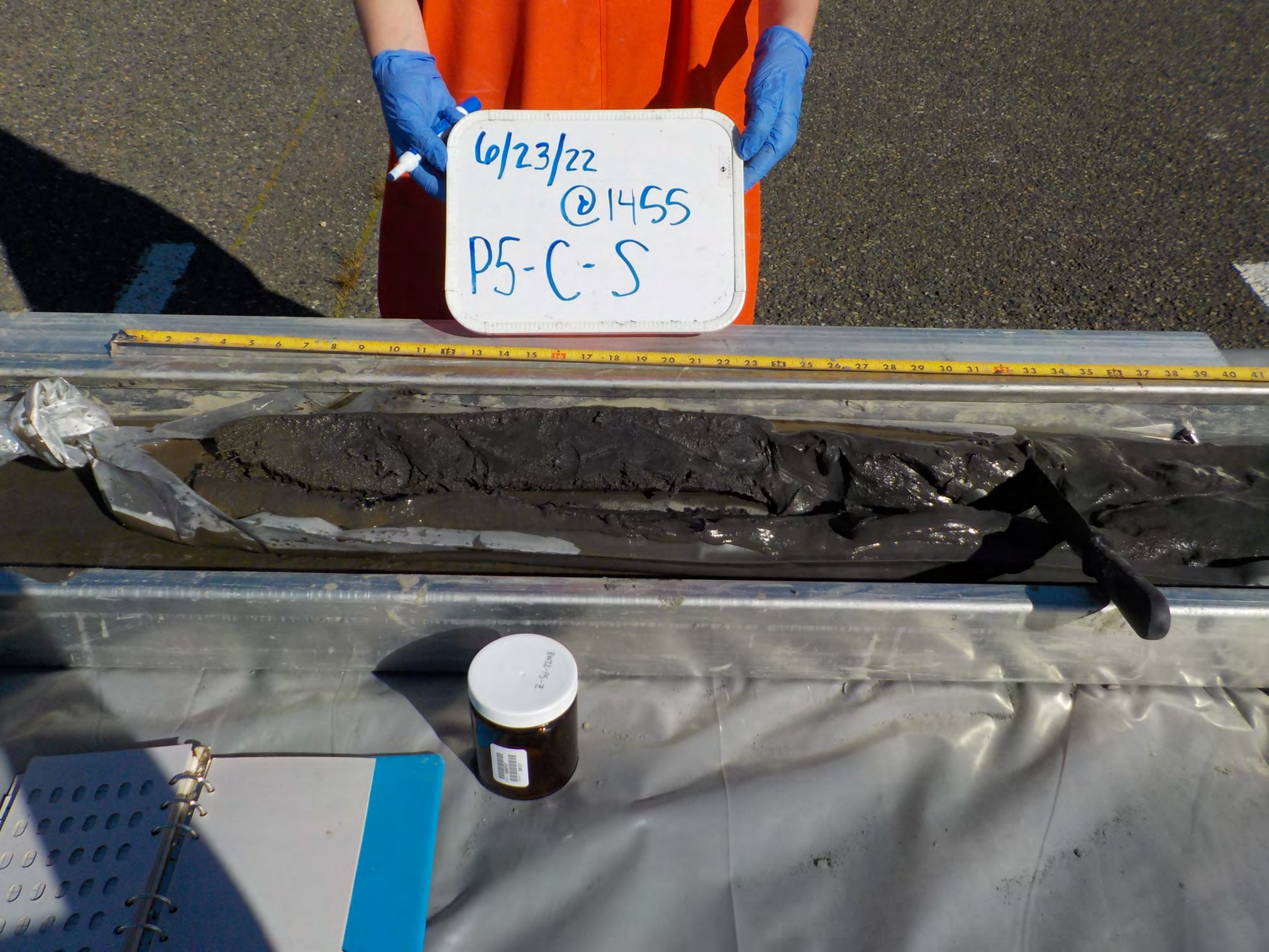
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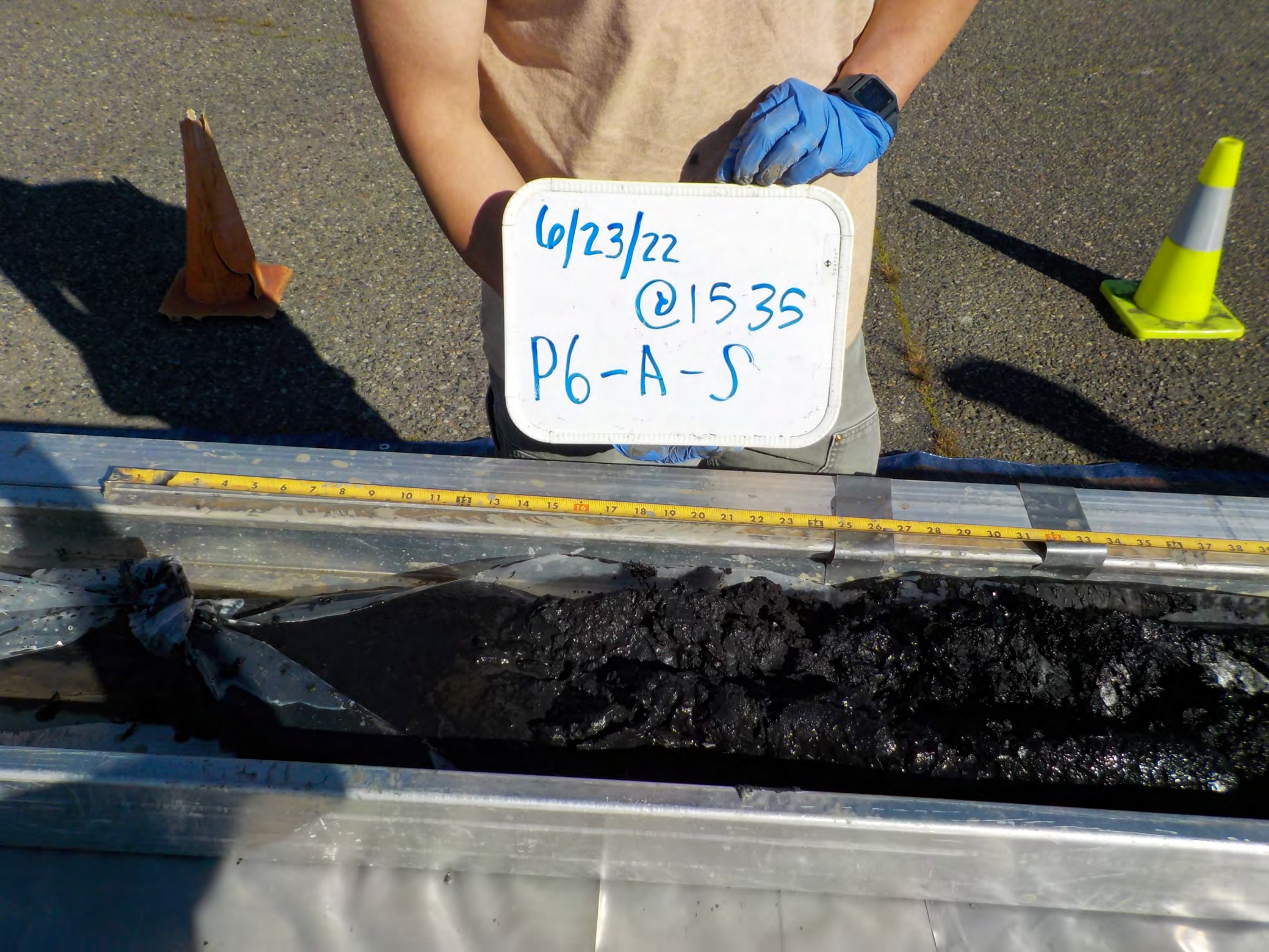
@1455
P5-C-S


6/23/22
@1455
P5-C-Z


6/24/22
@0935
P6-D-S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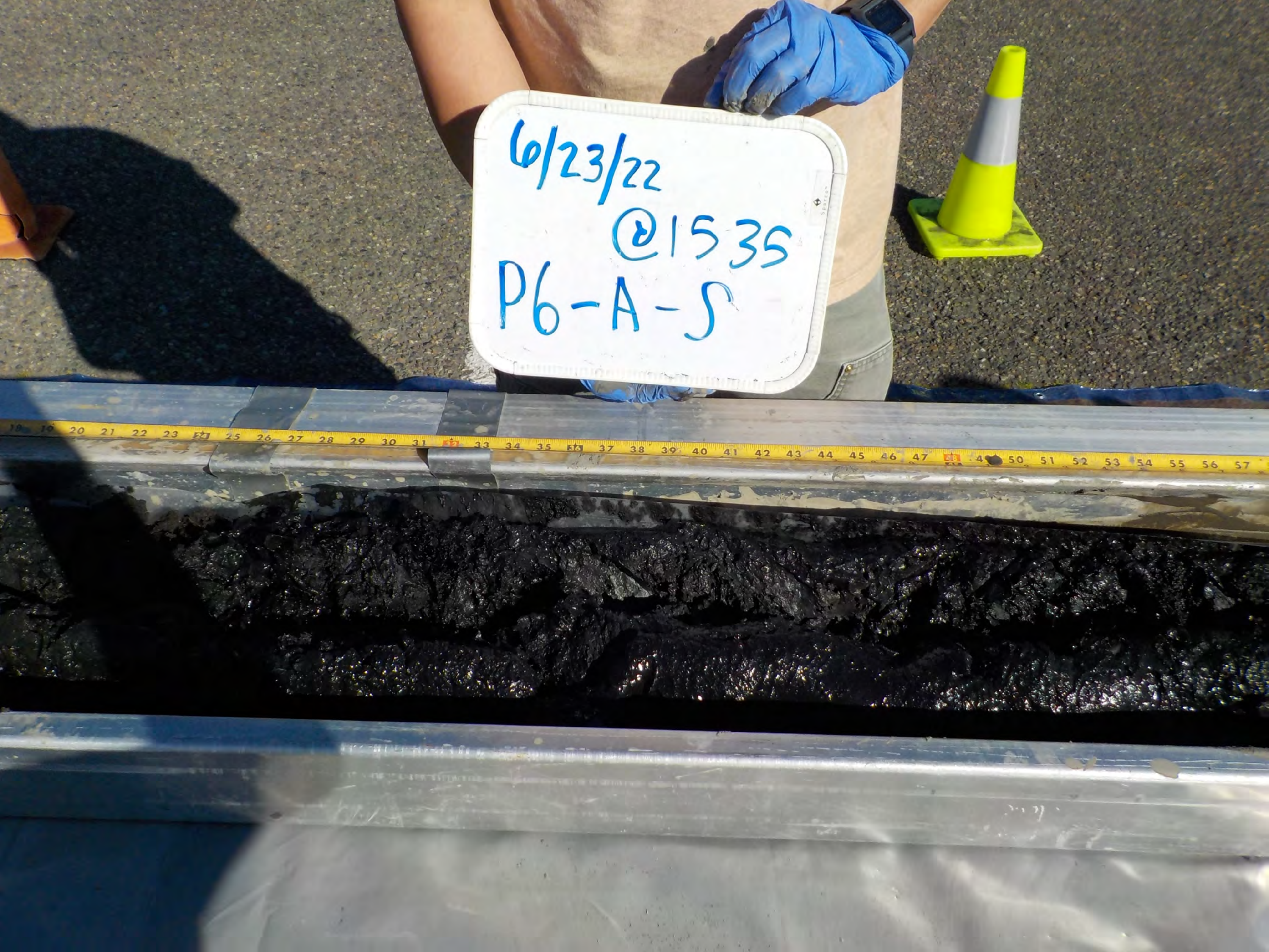

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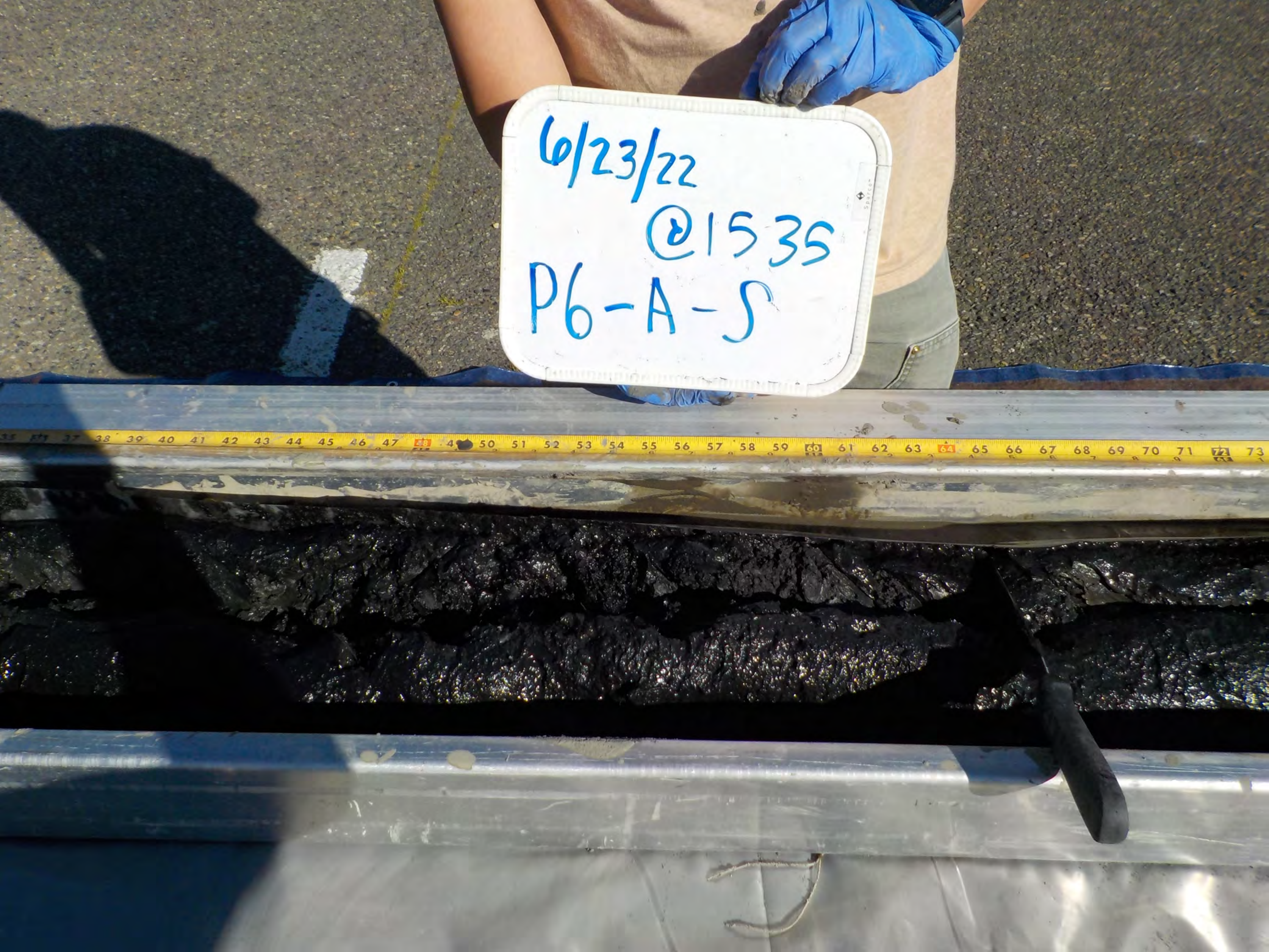
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P6-A-S
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6/23/22
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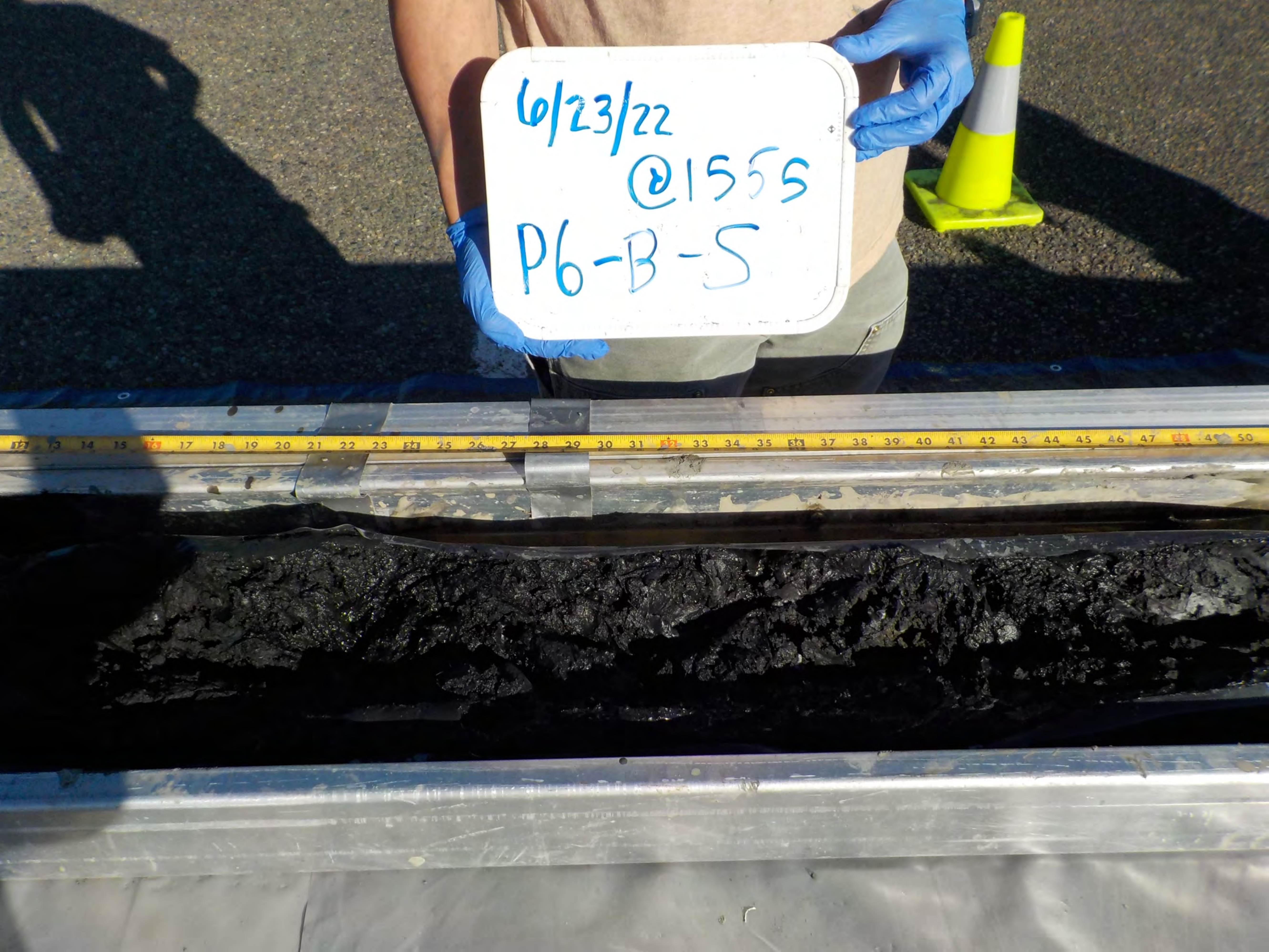
P6-A-Z


6/23/22
@1535
P6-A-Z2


6/23/22
@1555
P6-B-S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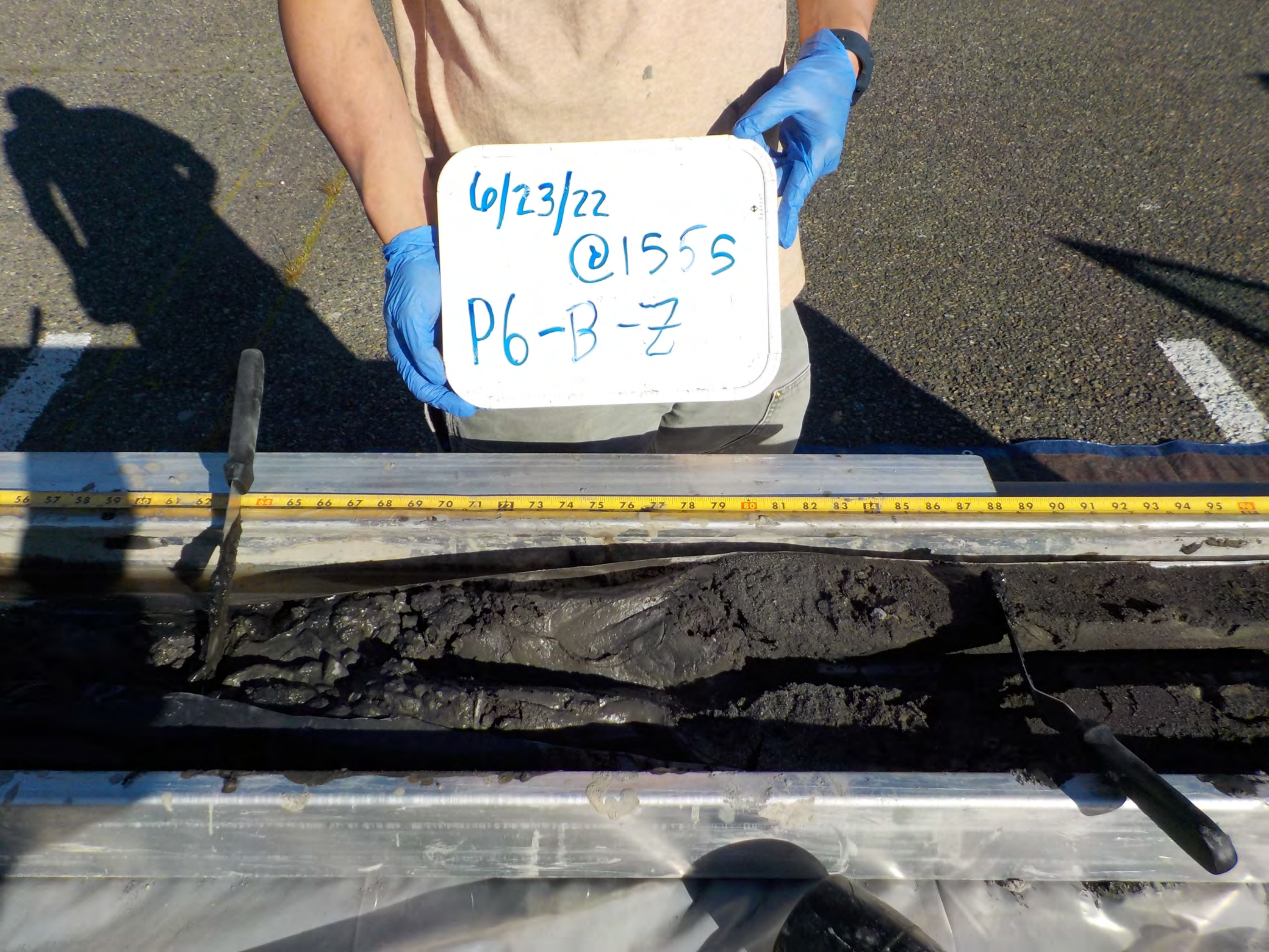
P6-B-5


6/23/22
@1555
P6-B-5
BW22-P6-3-5
BW22-P6-Z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P6-B-Z
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6/23/22
@1555
P6-B-Z2


6/24/22
@0935
P6-D-S


6/24/22
@0935
P6-D-S

6/24/22
@0935
P6-D-Z


6/24/22
@0935
P6-D-Z2

APPENDIX D: DATA VALIDATION REPORTS

D1: EPA Stage 2B Validation Report - Sediments

EPA Stage 2B Data Validation Report
Sediments

Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing
Pierce County Terminal, Tacoma, Washington

January 2023

Prepared for:

Port of Tacoma

One Sitcum Plaza
Tacoma, Washington 98421

Prepared by:

NewFields

Edmonds, Washington

In Partnership with:

LEON Environmental, LLC

Seattle, Washington

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Acronyms and Abbreviations

ARI	Analytical Resources, LLC
DL	detection limit
DMMO	Dredge Material Management Office
dw	dry weight
EMPC	Estimated Maximum Possible Concentration
GS	grain size
LCS	laboratory control samples
MB	method blanks
MQO	method quality objective
MS/MSD	matrix spike/matrix spike duplicate
PCT	Pierce County Terminal
QC	quality control
RL	reporting limit
RPD	relative percent difference
SAP	Sampling and Analysis Plan
TOC	total organic carbon
TS	total solids
TVS	total volatile solids
USEPA	U. S. Environmental Protection Agency
Vista	Vista Analytical Laboratory

1. Project Narrative

This document describes the results of a U. S. Environmental Protection Agency (USEPA) Stage 2B data validation performed on sediment and quality control sample data for the Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing for Pierce County Terminal (PCT), Tacoma, Washington. Validation was performed on all analytes and samples. A complete list of samples is provided in Table 1-1.

Sediment samples were collected at six locations and divided into intervals (Table 1-1). Surface samples were divided and composited into two samples; Z-samples were divided and composited into two samples. Remaining sediment intervals were archived. Additional sediment was collected in Carr Inlet to serve as a reference. Sediment samples were analyzed for conventional parameters (grain size [GS], total solids [TS], total volatile solids [TVS], total organic carbon [TOC], total sulfides, and ammonia), pesticides (total chlordane), and dioxin/furan congeners (Table 1-2). All parameters, besides grain size and pesticides, were analyzed by Analytical Resources, LLC (ARI) in Tukwila, Washington. ARI subcontracted AmTest Laboratories in Kirkland, Washington for grain size analysis and Vista Analytical Laboratory (Vista) in El Dorado Hills, California for pesticides. The analytical methods are provided in Table 1-3.

Table 1-1: Samples Collected

Sample ID	Sediment Conventionals					Organics		Sediment Archive	Bioaccumulation
	Grain Size	TS/TVS	TOC	Total Sulfides	Ammonia	Pesticides	Dioxin/Furan Congeners		
BW22-PCT-1-C	X	X	X	X	X	-	X	A	X
BW22-PCT-1-Z	X	X	X	X	X	-	X	A	A[1]
BW22-P1-S	-	-	-	-	-	-	-	A	-
BW22-P1-Z	-	-	-	-	-	-	-	A	-
BW22-P1-0-1	-	-	-	-	-	-	-	A	-
BW22-P1-1-3	-	-	-	-	-	-	-	A	-
BW22-P2-S	-	-	-	-	-	-	-	A	-
BW22-P2-Z	-	-	-	-	-	-	-	A	-
BW22-P2-0-1	-	-	-	-	-	-	-	A	-
BW22-P2-1-3	-	-	-	-	-	-	-	A	-
BW22-P3-S	-	-	-	-	-	-	-	A	-
BW22-P3-Z	-	-	-	-	-	-	-	A	-
BW22-P3-0-1	-	-	-	-	-	-	-	A	-
BW22-P3-1-3	-	-	-	-	-	-	-	A	-
BW22-PCT-2-C	X	X	X	X	X	X	X	A	X
BW22-PCT-2-Z	X	X	X	X	X	-	X	A	A[1]
BW22-P4-S	-	-	-	-	-	-	-	A	-
BW22-P4-Z	-	-	-	-	-	-	-	A	-
BW22-P4-0-1	-	-	-	-	-	-	-	A	-
BW22-P4-1-3	-	-	-	-	-	-	-	A	-
BW22-P4-3-5	-	-	-	-	-	-	-	A	-
BW22-P5-S	-	-	-	-	-	-	-	A	-
BW22-P5-Z	-	-	-	-	-	-	-	A	-
BW22-P5-0-1	-	-	-	-	-	-	-	A	-
BW22-P5-1-3	-	-	-	-	-	-	-	A	-
BW22-P5-3-5	-	-	-	-	-	-	-	A	-
BW22-P6-S	-	-	-	-	-	-	-	A	-

Sample ID	Sediment Conventionals					Organics		Sediment Archive	Bioaccumulation
	Grain Size	TS/TVS	TOC	Total Sulfides	Ammonia	Pesticides	Dioxin/Furan Congeners		
BW22-P6-Z	-	-	-	-	-	-	-	A	-
BW22-P6-0-1	-	-	-	-	-	-	-	A	-
BW22-P6-1-3	-	-	-	-	-	-	-	A	-
BW22-P6-3-5	-	-	-	-	-	-	-	A	-
BW22-CAR-C	X	X	X	X	X	-	X	A	X

Notes:
TS/TVS = Total Solids/Total Volatile Solids, TOC = total organic carbon
1: Z-Sample bioaccumulation test sediments will be archived pending dioxin/furan results and consultation with the DMMO.
X: Sample to be analyzed
A: Sample to be archived

Table 1-2: Sample Analysis

Work Order	Sample ID	Lab ID	Sediment Conventionals					Organics		Sediment Archive	Bioaccumulation
			Grain Size	TS/TVS	TOC	Total Sulfides	Ammonia	Pesticides	Dioxin/Furan Congeners		
22F0428	BW22-PCT-1-C	22F0428-01		X	X	X	X		X	A	X
22-A01099		22-A010992	X								
22F0428	BW22-PCT-1-Z	22F0428-02		X	X	X	X		X	A	A[1]
22-A01099		22-A010993	X								
22F0428	BW22-PCT-2-C	22F0428-03		X	X	X	X		X	A	X
22-A01099		22-A010994	X								
2207018		2207018-01						X			
22F0428	BW22-PCT-2-Z	22F0428-04		X	X	X	X		X	A	A[1]
22-A01099		22-A010995	X								
22G0001	BW22-CAR-C	22G0001-01		X	X	X	X		X	A	X
22-A01115		22-A011154	X								

Notes:
TS/TVS = Total Solids/Total Volatile Solids, TOC = total organic carbon
1: Z-Sample bioaccumulation test sediments will be archived pending dioxin/furan results and consultation with the DMMO.
X: Sample to be analyzed
A: Sample to be archived

Table 1-3: Analyses Performed

Analysis	SAP Method	Laboratory Method
Conventionals		
Grain Size (%)	PSEP	PSEP 1986
Total Solids (%)	PSEP	SM 2540 G-97
Total Volatile Solids (%)	PSEP	PSEP 1986
Total Organic Carbon (%)	EPA 9060 (modified)	EPA 9060A m
Total Sulfides (mg/kg dw)	PSEP	SM 4500-S2 D-00
Ammonia (mg/kg dw)	Plumb 1981	SM 4500-NH3 H-97
Organics		
Pesticides (µg/kg dw)	EPA 1699	EPA 1699
Dioxin/furan congeners (ng/kg dw)	EPA 1613B	EPA 1613B

The data were reviewed using guidance and quality control criteria documented in the analytical methods and the Bioaccumulation Testing Sampling and Analysis Plan (SAP) (NewFields, 2022). All data, as qualified, were determined to be acceptable for use.

2. Conventional Analyses

This section documents the review of conventional parameter data from the analysis of sediment samples and the associated laboratory quality control (QC) samples. ARI and AmTest analyzed the samples shown below. Refer to Table 1-2 for a list of samples reviewed.

Work Order: 22F0428; 22-A01099; 22G0001
Number of Samples Validated: 5
Validation Level: EPA Stage 2B

The conventional analytical tests that were performed are summarized below.

Parameter	Laboratory Method
Grain Size (%)	PSEP 1986
Total Solids (%)	SM 2540 G-97
Total Volatile Solids (%)	PSEP 1986
Total Organic Carbon (%)	EPA 9060A m
Total Sulfides (mg/kg dw)	SM 4500-S2 D-00
Ammonia (mg/kg dw)	SM 4500-NH3 H-97

2.1 Data Package Completeness

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and anomalies were included in the case narrative.

2.2 Technical Data Validation

The QC requirements for review are listed in Table 2-1.

Table 2-1: Conventional QC Requirements

X	Sample Receipt, Preservation, and Holding Times
X	Method Blanks (MB)
X	Laboratory Control Sample (LCS)
2	Laboratory Duplicates/Triplicates
X	Detection Limit/Reporting Limit (DL/RL)
X	Reporting Results
X	Calibration Summary

X: Stated method quality objectives (MQOs) and quality criteria have been met. No outliers are noted or discussed.
1. QC results discussed further; no data qualified.
2. QC outlier result that impact reported data, data qualified and discussed below.

2.2.1 Laboratory Duplicates/Triplicates

The laboratory conducted a duplicate analysis for conventionals on sample BW22-CAR-C and triplicate on BW22-PCT-1-C. The Relative Percent Difference (RPD) of total sulfides (48.7%) was outside of control limits (≤20%) for BW22-CAR-C. For BW22-PCT-1-C triplicate, the RPDs of total sulfides (29.9% and 24.8%) were outside of the control limits (≤20%). Project sample qualified as estimated are presented in Table 2-2.

Table 2-2: Data Qualified due to RPD Exceedances

Work ID	Sample ID	Analyte	Qualifier
22G0001	BW22-CAR-C	Total Sulfides	J
22G0001	BW22-PCT-1-C	Total Sulfides	J

2.3 Overall Assessment

As determined by this evaluation, the laboratory followed the specified analytical methods. With exceptions noted, accuracy and precision were acceptable.

All data, as qualified, are acceptable for use.

3. Pesticides Analyses

This section documents the review of pesticides data from the analysis of sediment samples and the associated laboratory quality control (QC) samples. Vista Analytical analyzed the samples shown below. Refer to Table 1-2 for a list of samples reviewed.

Work Order: 2207018
Number of Samples Validated: 1
Validation Level: EPA Stage 2B

The pesticides analytical test that was performed is summarized below.

Parameter	Laboratory Method
Pesticides	EPA 1699

3.1 Data Package Completeness

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and anomalies were included in the case narrative.

3.2 Technical Data Validation

The QC requirements for review are listed in Table 3-1 and discussed in the following sections.

Table 3-1: Pesticides QC Requirements

X	Sample Receipt, Preservation, and Holding Times
X	Method Blanks
X	Surrogates
2	Laboratory Duplicates
X	Detection Limit/Reporting Limit
1	Reporting Results
X	Calibration Summary

X: Stated method quality objectives (MQOs) and quality criteria have been met. No outliers are noted or discussed.
1. QC results discussed further; no data qualified.
2. QC outlier result that impact reported data, data qualified and discussed below.

3.2.1 Laboratory Duplicates

The laboratory conducted a duplicate analysis for pesticides on sample BW22-PCT-2-C. The RPD of trans-Nonachlor and cis-Nonachlor (31.1% and 25.1%, respectively) were outside of control limits (≤25%). Project samples qualified as estimated are presented in Table 3-2.

Table 3-2: Data Qualified due to RPD Exceedances

Work ID	Sample ID	Analyte	Qualifier
2207018	BW22-PCT-2-C	trans-Nonachlor	J
2207018	BW22-PCT-2-C	cis-Nonachlor	J

3.2.2 Reporting Results

The laboratory assigned J-flags to analytes that were positively identified but is an estimated concentration and U-flags to results that were not detected above the RL.

3.3 Overall Assessment

As determined by this evaluation, the laboratory followed the specified analytical methods. With exceptions noted, accuracy and precision were acceptable as demonstrated by the ongoing precision recoveries.

All data, as qualified, are acceptable for use.

4. Dioxin/Furan Congeners Analyses

This section documents the review of dioxin/furan congeners data from the analysis of sediment samples and the associated laboratory quality control (QC) samples. ARI analyzed the samples shown below. Refer to Table 1-2 for a list of samples reviewed.

Work Order: 22F0428; 22G0001
Number of Samples Validated: 5
Validation Level: EPA Stage 2B

The dioxin/furan congeners analytical test that was performed is summarized below.

Parameter	Laboratory Method
Dioxin/Furan	EPA 1613

4.1 Data Package Completeness

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and anomalies were included in the case narrative.

4.2 Technical Data Validation

The QC requirements for review are listed in Table 4-1 and discussed in the following sections.

Table 4-1: Dioxin/Furan QC Requirements

X	Sample Receipt, Preservation, and Holding Times
X	Method Blanks (MB)
X	Surrogates
X	Laboratory Control Samples (LCS)
2	Laboratory Duplicates
X	[Estimated] Detection Limit/Reporting Limit ([E]DL/RL)
1	Reporting Results
X	Calibration Summary

X: Stated method quality objectives (MQOs) and quality criteria have been met. No outliers are noted or discussed.
1. QC results discussed further; no data qualified.
2. QC outlier result that impact reported data, data qualified and discussed below.

4.2.1 Laboratory Duplicates

Laboratory duplicates were conducted for dioxin/furan congeners on BW22-PCT-1-C. The RPD for multiple analytes were outside of control limits (≤ 25%). Project samples qualified as estimated are presented in Table 4-2.

Table 4-2: Data Qualified due to RPD Exceedances

Work ID	Sample ID	Analyte	RPD (%)	Qualifier
22F0428	BW22-PCT-1-C	2,3,7,8-TCDF	34.8	J
22F0428	BW22-PCT-1-C	1,2,3,7,8-PeCDF	42.3	J
22F0428	BW22-PCT-1-C	1,2,3,4,7,8-HxCDF	42.8	J
22F0428	BW22-PCT-1-C	1,2,3,6,7,8-HxCDF	27.9	J

4.2.2 Reporting Results

The laboratory assigned J-flags to analytes that were positively identified but is an estimated concentration and U-flags to results that were not detected above the RL. Multiple results were flagged Estimated Maximum Potential Concentration (EMPC) when the ion ratio was outside of the ratio limits. Project samples with an EMPC flag are qualified as not detected and presented in Table 4-3.

Table 4-3: Data Qualified due to EMPC Flag

Work ID	Sample ID	Analyte	Qualifier
22F0428	BW22-PCT-1-C	1,2,3,4,7,8-HxCDD	U
22F0428	BW22-PCT-2-C	1,2,3,7,8-PeCDD	UJ*
22F0428	BW22-PCT-2-Z	1,2,3,7,8,9-HxCDD	U
22G0001	BW22-CAR-C	1,2,3,4,6,7,8-HpCDF	U
22G0001	BW22-CAR-C	OCDF	UJ*

Notes: * Sample flagged EMPC, J by lab. Qualified through validation as UJ.

4.3 Overall Assessment

As determined by this evaluation, the laboratory followed the specified analytical methods. With exceptions noted, accuracy was acceptable, as demonstrated by the surrogates and LCS recoveries. Precision was also acceptable as indicated by the LCS relative percent difference.

All data, as qualified, are acceptable for use.

5. Data Qualifier Codes

Below briefly describes data qualifying codes that are assigned to results during data review:

J	The analyte was positively identified, estimated concentration value.
U	The analyte was not detected above the reporting limit (RL).
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 measure the analyte accurately and precisely in the sample.

6. References

NewFields and L-E. 2022. Sampling and Analysis Plan, Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing, Pierce County Terminal, Tacoma, Washington. Final. June 17, 2022. Prepared for Port of Tacoma. Prepared by NewFields, Edmonds, Washington in partnership with LEON Environmental, Seattle, Washington.

D2: EPA Stage 2B Validation Report - Tissues

EPA Stage 2B Data Validation Report

Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing
Pierce County Terminal, Tacoma, Washington

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Acronyms and Abbreviations

ARI	Analytical Resources, LLC
CDPE	Chlorinated Diphenyl Ether
DL	detection limit
DMMP	Dredged Material Management Program
dw	dry weight
EDD	electronic data deliverable
EDL	estimated detection limit
EMPC	Estimated Maximum Possible Concentration
LCS	laboratory control samples
MQO	method quality objective
PCT	Pierce County Terminal
QC	quality control
RL	reporting limit
RPD	relative percent difference
SAP	Sampling and Analysis Plan
USEPA	U. S. Environmental Protection Agency

1. Project Narrative

This document describes the results of a U. S. Environmental Protection Agency (USEPA) Stage 2B data validation performed on bioaccumulation tissue and quality control (QC) sample data for the Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing for Pierce County Terminal (PCT), Tacoma, Washington. Validation was performed on all samples. A complete list of samples is provided in Table 1-1.

Sediment samples were collected and composited into two surface samples and two Z-layer samples. Additional sediment was collected in Carr Inlet to serve as a reference. Bioaccumulation testing was conducted with these sediment samples following Dredged Material Management Program (DMMP) guidance (DMMP 2021b) with modifications noted in the Bioaccumulation Testing Sampling and Analysis Plan (SAP) (NewFields 2022). Tissue samples were analyzed for total solids, total lipid content, and dioxin/furan congeners[1] (Table 1-1). All parameters were analyzed by Analytical Resources, LLC (ARI) in Tukwila, Washington. The analytical methods are provided in Table 1-2.

Table 1-1: Samples Submitted for Analysis

Work Order	Sample ID	Lab ID	Matrix	Analytes		
				Total Solids	Total Lipids	Dioxin/Furan●
22I0519	M.n. Pretest Rep 1	22I0519-01	Tissue	X	X	
		22I0519-01RE1				X
22I0519	M.n. Pretest Rep 2	22I0519-02	Tissue	X	X	
		22I0519-02RE1				X
22I0519	M.n. Pretest Rep 3	22I0519-03	Tissue	X	X	
		22I0519-03RE1				X
22I0519	M.n. Carr Ref Rep 1	22I0519-04	Tissue	X	X	
		22I0519-04RE1				X
22I0519	M.n. Carr Ref Rep 2	22I0519-05	Tissue	X	X	
		22I0519-05RE1				X
22I0519	M.n. Carr Ref Rep 3	22I0519-06	Tissue	X	X	
		22I0519-06RE1				X
22I0519	M.n. Carr Ref Rep 4	22I0519-07	Tissue	X	X	
		22I0519-07RE1				X
22I0519	M.n. Carr Ref Rep 5	22I0519-08	Tissue	X	X	
		22I0519-08RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 1	22I0519-09	Tissue	X	X	
		22I0519-09RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 2	22I0519-10	Tissue	X	X	
		22I0519-10RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 3	22I0519-11	Tissue	X	X	
		22I0519-11RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 4	22I0519-12	Tissue	X	X	
		22I0519-12RE1				X
22I0519	M.n. BW22-PCT-1-C Rep 5	22I0519-13	Tissue	X	X	
		22I0519-13RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 1	22I0519-14	Tissue	X	X	
		22I0519-14RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 2	22I0519-15	Tissue	X	X	
		22I0519-15RE1				X

[1] Samples were analyzed in October 2022. Due to high EDLs, samples were reanalyzed for dioxin/furan congeners after instrument maintenance.

Work Order	Sample ID	Lab ID	Matrix	Analytes		
				Total Solids	Total Lipids	Dioxin/Furan●
22I0519	M.n. BW22-PCT-1-Z Rep 3	22I0519-16	Tissue	X	X	
		22I0519-16RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 4	22I0519-17	Tissue	X	X	
		22I0519-17RE1				X
22I0519	M.n. BW22-PCT-1-Z Rep 5	22I0519-18	Tissue	X	X	
		22I0519-18RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 1	22I0519-19	Tissue	X	X	
		22I0519-19RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 2	22I0519-20	Tissue	X	X	
		22I0519-20RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 3	22I0519-21	Tissue	X	X	
		22I0519-21RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 4	22I0519-22	Tissue	X	X	
		22I0519-22RE1				X
22I0519	M.n. BW22-PCT-2-C Rep 5	22I0519-23	Tissue	X	X	
		22I0519-23RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 1	22I0519-24	Tissue	X	X	
		22I0519-24RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 2	22I0519-25	Tissue	X	X	
		22I0519-25RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 3	22I0519-26	Tissue	X	X	
		22I0519-26RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 4	22I0519-27	Tissue	X	X	
		22I0519-27RE1				X
22I0519	M.n. BW22-PCT-2-Z Rep 5	22I0519-28	Tissue	X	X	
		22I0519-28RE1				X
22I0519	A.v. Pretest Rep 1	22I0519-29	Tissue	X	X	
		22I0519-29 RE1				X
22I0519	A.v. Pretest Rep 2	22I0519-30	Tissue	X	X	
		22I0519-30RE1				X
22I0519	A.v. Pretest Rep 3	22I0519-31	Tissue	X	X	
		22I0519-31RE1				X
22I0519	A.v. Carr Ref Rep 1	22I0519-32	Tissue	X	X	
		22I0519-32RE1				X
22I0519	A.v. Carr Ref Rep 2	22I0519-33	Tissue	X	X	
		22I0519-33RE1				X
22I0519	A.v. Carr Ref Rep 3	22I0519-34	Tissue	X	X	
		22I0519-34RE1				X
22I0519	A.v. Carr Ref Rep 4	22I0519-35	Tissue	X	X	
		22I0519-35RE1				X
22I0519	A.v. Carr Ref Rep 5	22I0519-36	Tissue	X	X	
		22I0519-36RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 1	22I0519-37	Tissue	X	X	
		22I0519-37RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 2	22I0519-38	Tissue	X	X	
		22I0519-38RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 3	22I0519-39	Tissue	X	X	
		22I0519-39RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 4	22I0519-40	Tissue	X	X	
		22I0519-40RE1				X
22I0519	A.v. BW22-PCT-1-C Rep 5	22I0519-41	Tissue	X	X	
		22I0519-41RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 1	22I0519-42	Tissue	X	X	
		22I0519-42RE1				X

Work Order	Sample ID	Lab ID	Matrix	Analytes		
				Total Solids	Total Lipids	Dioxin/Furan●
22I0519	A.v. BW22-PCT-1-Z Rep 2	22I0519-43	Tissue	X	X	
		22I0519-43RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 3	22I0519-44	Tissue	X	X	
		22I0519-44RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 4	22I0519-45	Tissue	X	X	
		22I0519-45RE1				X
22I0519	A.v. BW22-PCT-1-Z Rep 5	22I0519-46	Tissue	X	X	
		22I0519-46RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 1	22I0519-47	Tissue	X	X	
		22I0519-47RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 2	22I0519-48	Tissue	X	X	
		22I0519-48RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 3	22I0519-49	Tissue	X	X	
		22I0519-49RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 4	22I0519-50	Tissue	X	X	
		22I0519-50RE1				X
22I0519	A.v. BW22-PCT-2-C Rep 5	22I0519-51	Tissue	X	X	
		22I0519-51RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 1	22I0519-52	Tissue	X	X	
		22I0519-52RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 2	22I0519-53	Tissue	X	X	
		22I0519-53RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 3	22I0519-54	Tissue	X	X	
		22I0519-54RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 4	22I0519-55	Tissue	X	X	
		22I0519-55RE1				X
22I0519	A.v. BW22-PCT-2-Z Rep 5	22I0519-56	Tissue	X	X	
		22I0519-56RE1				X

Notes:

●Dioxin/Furan congener samples were reanalyzed in May 2023 with the updated Lab ID.

Table 1-2: Analyses Performed

Analysis	SAP Method	Laboratory Method
Total Solids (%)	EPA 1613B	EPA 1613B
Total Lipids (%)	Bligh & Dyer 1959	Bligh & Dyer (Mod)
Dioxin/furan congeners (ng/kg dw)	EPA 1613B	EPA 1613B

The data were reviewed using guidance and quality control criteria documented in the analytical methods and the Bioaccumulation Testing SAP (NewFields, 2022). All data, as qualified, were determined to be acceptable for use.

2. Conventional Analysis

This section documents the review of conventional parameter data from the analysis of tissue samples and the associated laboratory QC samples. ARI analyzed the samples shown below. Refer to Table 1-1 for a list of samples reviewed.

Work Order: 22I0519
Number of Samples Validated: 56
Validation Level: EPA Stage 2B

The conventional analytical test performed is summarized below.

Parameter	Laboratory Method
Total Solids (%)	SM 2540 G-97

2.1 Data Package Completeness

The laboratory submitted all required deliverables.

2.2 Technical Data Validation

The QC requirements for review are listed in Table 2-1.

Table 2-1: Conventional QC Requirements

X	Sample Receipt, Preservation, and Holding Times
X	Method Blanks
X	Laboratory Control Sample
X	Laboratory Duplicates/Triplicates
X	Detection Limit/Reporting Limit
X	Reporting Results
X	Calibration Summary

X: Stated method quality objectives (MQOs) and quality criteria have been met. No outliers are noted or discussed.

2.3 Overall Assessment

As determined by this evaluation, the laboratory followed the specified analytical methods, and accuracy and precision were acceptable.

All data, as qualified, are acceptable for use.

3. Total Lipids Analysis

This section documents the review of total lipids data from the analysis of tissue samples and the associated laboratory QC samples. ARI analyzed the samples shown below. Refer to Table 1-1 for a list of samples reviewed.

Work Order: 22I0519
Number of Samples Validated: 56
Validation Level: EPA Stage 2B

The analytical test performed is summarized below.

Parameter	Laboratory Method
Total Lipids (%)	Bligh & Dyer (Mod)

3.1 Data Package Completeness

The laboratory submitted all required deliverables.

3.2 Technical Data Validation

The QC requirements for review are listed in Table 3-1 and discussed in the following sections.

Table 3-1: Total Lipids QC Requirements

X	Sample Receipt, Preservation, and Holding Times
X	Method Blanks
X	Surrogates
X	Laboratory Duplicates
X	Detection Limit/Reporting Limit
X	Reporting Results

X: Stated MQOs and quality criteria have been met. No outliers are noted or discussed.

3.3 Overall Assessment

As determined by this evaluation, the laboratory followed the specified analytical methods, and accuracy and precision were acceptable.

All data, as qualified, are acceptable for use.

4. Dioxin/Furan Congeners Analysis

This section documents the review of dioxin/furan congeners data from the analysis of tissue samples and the associated laboratory QC samples. ARI analyzed the samples shown below. Refer to Table 1-1 for a list of samples reviewed.

Work Order: 22I0519
Number of Samples Validated: 56
Validation Level: EPA Stage 2B

The dioxin/furan congeners analytical test that was performed is summarized below.

Parameter	Laboratory Method
Dioxin/Furan	EPA 1613

4.1 Data Package Completeness

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and anomalies were included in the case narrative.

4.2 Technical Data Validation

The QC requirements for review are listed in Table 4-1 and discussed in the following sections.

Table 4-1: Dioxin/Furan QC Requirements

X	Sample Receipt, Preservation, and Holding Times
2	Method Blanks
2	Labeled Compounds
X	Laboratory Control Samples (LCS)
2	Laboratory Duplicates
X	[Estimated] Detection Limit/Reporting Limit ([E]DL/RL)
2	Reporting Results
X	Calibration Summary

X: Stated MQOs and quality criteria have been met. No outliers are noted or discussed.

1. QC results discussed further; no data qualified.
2. QC outlier result that impact reported data, data qualified and discussed below.

4.2.1 Method Blanks

Method blanks were conducted for dioxin/furan congeners. At EDLs, method blanks were clean. Compounds 1,2,3,7,8-PeCDF and OCDD were detected above EDL and assigned a J-flag by the laboratory. An action level of five times (5x) the concentration was established to determine the impact of any blank contaminant. If a contaminant was reported in an associated field sample and the concentration was less than the action level, the result is qualified as not detected (U). Project samples that were qualified as undetected are presented in Appendix A (Table A-1).

4.2.2 Labeled Compounds

Stable isotope labeled compounds were included for dioxin/furan analysis. Percent recovery for multiple compounds was outside of control limits. Project samples with a percent recovery greater than 150% were qualified as estimated (J-flag) are presented in Appendix A (Table A-2).

4.2.3 Laboratory Duplicates

Laboratory duplicates were conducted for dioxin/furan congeners. The relative percent differences (RPD) for multiple compounds were greater than advisory control limits (≤ 20%). No data were qualified because the percent recoveries in the laboratory control samples (LCS) met control limits and verified the laboratory can perform an analysis in a clean matrix.

4.2.4 Reporting Results

The laboratory assigned J-flags to analytes that were positively identified but is an estimated concentration and U-flags to results that were not detected above the RL. Multiple results were flagged Estimated Maximum Potential Concentration (EMPC) when the ion ratio was outside of the ratio limits. Project samples with an EMPC flag are qualified as not detected and presented in Appendix A (Table A-3).

The laboratory report assigned X-flags to several of the reported values for analyte 2,3,7,8-TCDF to indicate possible CDPE matrix interference. The EDD provided by the laboratory had the X-flags replaced with J-flags. A review of the laboratory's assignment of J-flags to the X-flagged 2,3,7,8-TCDF results was conducted and verified the proper assignment of J-flags for these results. No additional data were qualified due to the laboratory qualifying the reported results as positively identified but is an estimated concentration (J-flag).

4.3 Overall Assessment

As determined by this evaluation, the laboratory followed the specified analytical methods. With exceptions noted, accuracy was acceptable, as demonstrated by the LCS recoveries. Precision was also acceptable as indicated by the LCS and duplicate relative percent difference.

All data, as qualified, are acceptable for use.

5. Data Qualifier Codes

Below briefly describes data qualifying codes that are assigned to results during data review:

J	The analyte was positively identified, estimated concentration value.
U	The analyte was not detected above the reporting limit (RL).
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 measure the analyte accurately and precisely in the sample.

6. References

DMMP. 2021b. Dredged Material Evaluation and Disposal Procedures User Manual. Dredged Material Management Program. Prepared by the Dredged Material Management Office, U.S. Army Corps of Engineers, Seattle District. July 2021.

NewFields. 2022. Sampling and Analysis Plan, Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing, Pierce County Terminal, Tacoma, Washington. Final. June 17, 2022. Prepared for Port of Tacoma. Prepared by NewFields, Edmonds, Washington in partnership with LEON Environmental, Seattle, Washington.

Appendix A

Qualified Data

Table A-1: Data Qualified due to Dioxin/Furan Congener Method Blank Detections

Work ID	Sample ID	Analyte	Qualifier
2210519	M.n. BW22-PCT-1-C Rep 1	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-C Rep 2	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-C Rep 3	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-C Rep 4	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-C Rep 5	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-Z Rep 1	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-Z Rep 2	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-Z Rep 3	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-Z Rep 4	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-1-Z Rep 5	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-2-C Rep 1	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-2-C Rep 2	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-2-C Rep 3	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-2-C Rep 4	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-2-C Rep 5	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-2-Z Rep 1	1,2,3,7,8-PeCDF	U
2210519	M.n. BW22-PCT-2-Z Rep 2	1,2,3,7,8-PeCDF	U
2210519	A.v. Pretest Rep 3	1,2,3,7,8-PeCDF	U
2210519	A.v. Carr Ref Rep 5	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-C Rep 1	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-C Rep 2	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-C Rep 3	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-C Rep 4	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-C Rep 5	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-Z Rep 1	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-Z Rep 2	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-Z Rep 3	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-Z Rep 4	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-1-Z Rep 5	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-C Rep 1	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-C Rep 2	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-C Rep 3	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-C Rep 4	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-C Rep 5	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-Z Rep 2	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-Z Rep 3	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-Z Rep 4	1,2,3,7,8-PeCDF	U
2210519	A.v. BW22-PCT-2-Z Rep 5	1,2,3,7,8-PeCDF	U
2210519	M.n. Pretest Rep 1	OCDD	U
2210519	M.n. Pretest Rep 2	OCDD	U
2210519	M.n. Pretest Rep 3	OCDD	U
2210519	M.n. Carr Ref Rep 1	OCDD	U
2210519	M.n. Carr Ref Rep 3	OCDD	U
2210519	M.n. Carr Ref Rep 5	OCDD	U

Table A-2: Dioxin/Furan Congener Data Qualified due to Surrogate Percent Recovery

Work ID	Sample ID	Analyte	Qualifier*
22I0519	A.v BW22-PCT-1-Z Rep 2	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 2	OCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 3	1,2,3,4,7.8,9-HpCDF	UJ
22I0519	A.v BW22-PCT-1-Z Rep 3	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 3	OCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 4	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 4	OCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 5	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-1-Z Rep 5	OCDD	J
22I0519	A.v BW22-PCT-2-C Rep 5	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-2-C Rep 5	OCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 4	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 4	OCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 5	1,2,3,4,6,7,8-HpCDD	J
22I0519	A.v BW22-PCT-2-Z Rep 5	OCDD	J

Notes: *Sample flagged “U” by lab. Qualified through validation as “UJ”.

Table A-2: Dioxin/Furan Congener Data Qualified due to EMPC Flag

Work ID	Sample ID	Analyte	Qualifier*
22I0519	M.n. Pretest Rep 1	1,2,3,7,8-PeCDD	UJ
22I0519	M.n. Pretest Rep 1	1,2,3,4,6,7,8-HpCDD	UJ
22I0519	M.n. Pretest Rep 2	1,2,3,4,6,7,8-HpCDD	UJ
22I0519	M.n. Pretest Rep 3	1,2,3,4,6,7,8-HpCDD	UJ
22I0519	M.n. Carr Ref Rep 1	2,3,7,8-TCDF	UJ
22I0519	M.n. Carr Ref Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. Carr Ref Rep 3	1,2,3,4,6,7,8-HpCDD	UJ
22I0519	M.n. Carr Ref Rep 4	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. Carr Ref Rep 4	OCDF	UJ
22I0519	M.n. Carr Ref Rep 5	2,3,7,8-TCDF	UJ
22I0519	M.n. Carr Ref Rep 5	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. Carr Ref Rep 5	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. Carr Ref Rep 5	OCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 1	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 1	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 1	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-C Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 2	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 2	1,2,3,4,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 2	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-C Rep 2	1,2,3,4,7,8,9-HpCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 3	2,3,7,8-TCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 3	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 3	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 3	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-C Rep 3	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-C Rep 3	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 3	1,2,3,4,7,8,9-HpCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 4	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 4	OCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 5	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 5	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-C Rep 5	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-C Rep 5	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 1	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 1	1,2,3,7,8-PeCDD	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 1	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 2	2,3,7,8-TCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 2	1,2,3,4,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 2	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 2	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 3	2,3,7,8-TCDD	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 3	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 3	2,3,4,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 3	1,2,3,4,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 3	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 4	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 4	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 4	1,2,3,4,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 4	OCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 5	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-1-Z Rep 5	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 1	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 1	1,2,3,7,8-PeCDD	UJ
22I0519	M.n. BW22-PCT-2-C Rep 1	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 1	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-C Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 2	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 2	1,2,3,4,7,8-HxCDF	UJ

Work ID	Sample ID	Analyte	Qualifier*
22I0519	M.n. BW22-PCT-2-C Rep 2	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 2	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-C Rep 3	2,3,7,8-TCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 3	1,2,3,4,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 3	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 3	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-C Rep 3	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 3	1,2,3,4,7,8,9-HpCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 4	1,2,3,4,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 4	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-C Rep 5	2,3,7,8-TCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 5	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 5	1,2,3,4,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-C Rep 5	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-C Rep 5	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 1	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 1	1,2,3,7,8,9-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 1	OCDD	U
22I0519	M.n. BW22-PCT-2-Z Rep 2	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 2	1,2,3,4,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 2	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 2	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 3	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 3	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 3	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 4	1,2,3,6,7,8-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 4	1,2,3,7,8,9-HxCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 4	1,2,3,6,7,8-HxCDD	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 5	1,2,3,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 5	2,3,4,7,8-PeCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 5	1,2,3,7,8-PeCDD	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 5	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	M.n. BW22-PCT-2-Z Rep 5	1,2,3,4,6,7,8-HpCDD	UJ
22I0519	A.v. Pretest Rep 1	2,3,7,8-TCDF	UJ
22I0519	A.v. Pretest Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. Pretest Rep 1	OCDF	UJ
22I0519	A.v. Pretest Rep 2	OCDF	UJ
22I0519	A.v. Pretest Rep 3	2,3,7,8-TCDD	UJ
22I0519	A.v. Pretest Rep 3	1,2,3,7,8-PeCDD	UJ
22I0519	A.v. Pretest Rep 3	1,2,3,7,8,9-HxCDD	UJ
22I0519	A.v. Pretest Rep 3	1,2,3,4,6,7,8-HpCDD	UJ
22I0519	A.v. Carr Ref Rep 1	2,3,7,8-TCDF	UJ
22I0519	A.v. Carr Ref Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. Carr Ref Rep 2	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. Carr Ref Rep 3	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. Carr Ref Rep 4	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. Carr Ref Rep 4	OCDF	UJ
22I0519	A.v. Carr Ref Rep 5	2,3,7,8-TCDD	UJ
22I0519	A.v. Carr Ref Rep 5	OCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 1	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 1	OCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 2	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 2	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 3	2,3,7,8-TCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 3	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 3	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 3	1,2,3,6,7,8-HxCDD	UJ
22I0519	A.v. BW22-PCT-1-C Rep 3	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 3	OCDF	UJ

Work ID	Sample ID	Analyte	Qualifier*
22I0519	A.v. BW22-PCT-1-C Rep 4	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 4	OCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 5	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-1-C Rep 5	1,2,3,7,8-PeCDD	UJ
22I0519	A.v. BW22-PCT-1-C Rep 5	1,2,3,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 5	2,3,4,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 5	1,2,3,7,8,9-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 5	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. BW22-PCT-1-C Rep 5	1,2,3,4,7,8,9-HpCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 1	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 1	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 1	OCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 2	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 2	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 2	1,2,3,6,7,8-HxCDD	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 2	1,2,3,4,7,8,9-HpCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 2	OCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 3	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 3	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 3	1,2,3,7,8-PeCDD	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 3	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 3	1,2,3,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 4	OCDF	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 5	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-1-Z Rep 5	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 2	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-2-C Rep 2	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 2	1,2,3,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 2	1,2,3,6,7,8-HxCDD	UJ
22I0519	A.v. BW22-PCT-2-C Rep 2	OCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 3	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 3	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 3	OCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 4	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-2-C Rep 4	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 4	1,2,3,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 4	1,2,3,6,7,8-HxCDD	UJ
22I0519	A.v. BW22-PCT-2-C Rep 4	1,2,3,4,6,7,8-HpCDD	UJ
22I0519	A.v. BW22-PCT-2-C Rep 5	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-2-C Rep 5	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 5	1,2,3,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 5	2,3,4,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-C Rep 5	1,2,3,4,7,8,9-HpCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 1	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 1	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 1	1,2,3,6,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 2	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 2	1,2,3,6,7,8-HxCDD	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 2	1,2,3,4,6,7,8-HpCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 3	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 3	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 3	OCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 4	2,3,7,8-TCDD	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 5	2,3,4,7,8-PeCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 5	1,2,3,4,7,8-HxCDF	UJ
22I0519	A.v. BW22-PCT-2-Z Rep 5	1,2,3,6,7,8-HxCDF	UJ

Notes: *Sample flagged “EMPC, J” by lab. Qualified through validation as “UJ”.

D3: EPA Stage 4 Validation Report - Initial Dioxin/Furan Tissue Analysis

ECOCHEM
Data Quality

DATA VALIDATION REPORT

PORT OF TACOMA
BLAIR DREDGING SUPPLEMENTAL SEDIMENT CHARACTERIZATION
BIOACCUMULATION TESTING

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PROJECT NARRATIVE

Basis for Data Validation

This report summarizes the results of full validation (EPA Stage 4) performed on tissue and quality control (QC) sample data for the Port of Tacoma Blair Bioaccumulation Study project. A list of all samples is provided in the Sample Index.

Samples were analyzed by Analytical Resources, Inc., Tukwila, Washington. The analytical method and EcoChem project chemists are noted below.

ANALYSIS	METHOD OF ANALYSIS	PRIMARY REVIEW	SECONDARY REVIEW
Dioxin/Furan	1613B	E. Clayton	C. Ransom

The data were reviewed using guidance and quality control criteria documented in the analytical method; the *Blair Dredging Supplemental Sediment Characterization – Bioaccumulation Testing Sampling and Analysis Plan* (NewFields and Leon Environmental, June 17, 2022); and *USEPA National Functional Guidelines for High Resolution Superfund Methods Data Review* (USEPA, April 2016).

EcoChem's goal in assigning data assessment qualifiers is to assist in proper data interpretation. If values are estimated (J or UJ), data may be used for site evaluation and risk assessment purposes but reasons for data qualification should be taken into consideration when interpreting sample concentrations. If values are assigned an R, the data are to be rejected and should not be used for any site evaluation purposes. If values have no data qualifier assigned, then the data meet the data quality objectives as stated in the documents and methods referenced above.

Data qualifier definitions, reason codes, and validation criteria are included as Appendix A. The qualified data summary table is included as Appendix B. Data Validation Worksheets and the associated communication records will be kept on file at EcoChem, Inc. A qualified laboratory electronic data deliverable (EDD) was also submitted with this report.

Sample Index

Port of Tacoma Blair Bioaccumulation Study

SDG	SAMPLE ID	LAB ID	Matrix	Dioxin/Furan
22I0519	M.n. Pretest Rep 1	22I0519-01	Tissue	✓
22I0519	M.n. Pretest Rep 2	22I0519-02	Tissue	✓
22I0519	M.n. Pretest Rep 3	22I0519-03	Tissue	✓
22I0519	M.n. Carr Ref Rep 1	22I0519-04	Tissue	✓
22I0519	M.n. Carr Ref Rep 2	22I0519-05	Tissue	✓
22I0519	M.n. Carr Ref Rep 3	22I0519-06	Tissue	✓
22I0519	M.n. Carr Ref Rep 4	22I0519-07	Tissue	✓
22I0519	M.n. Carr Ref Rep 5	22I0519-08	Tissue	✓
22I0519	M.n. BW22-PCT-1-C Rep 1	22I0519-09	Tissue	✓
22I0519	M.n. BW22-PCT-1-C Rep 2	22I0519-10	Tissue	✓
22I0519	M.n. BW22-PCT-1-C Rep 3	22I0519-11	Tissue	✓
22I0519	M.n. BW22-PCT-1-C Rep 4	22I0519-12	Tissue	✓
22I0519	M.n. BW22-PCT-1-C Rep 5	22I0519-13	Tissue	✓
22I0519	M.n. BW22-PCT-1-Z Rep 1	22I0519-14	Tissue	✓
22I0519	M.n. BW22-PCT-1-Z Rep 2	22I0519-15	Tissue	✓
22I0519	M.n. BW22-PCT-1-Z Rep 3	22I0519-16	Tissue	✓
22I0519	M.n. BW22-PCT-1-Z Rep 4	22I0519-17	Tissue	✓
22I0519	M.n. BW22-PCT-1-Z Rep 5	22I0519-18	Tissue	✓
22I0519	M.n. BW22-PCT-2-C Rep 1	22I0519-19	Tissue	✓
22I0519	M.n. BW22-PCT-2-C Rep 2	22I0519-20	Tissue	✓
22I0519	M.n. BW22-PCT-2-C Rep 3	22I0519-21	Tissue	✓
22I0519	M.n. BW22-PCT-2-C Rep 4	22I0519-22	Tissue	✓
22I0519	M.n. BW22-PCT-2-C Rep 5	22I0519-23	Tissue	✓
22I0519	M.n. BW22-PCT-2-Z Rep 1	22I0519-24	Tissue	✓
22I0519	M.n. BW22-PCT-2-Z Rep 2	22I0519-25	Tissue	✓
22I0519	M.n. BW22-PCT-2-Z Rep 3	22I0519-26	Tissue	✓
22I0519	M.n. BW22-PCT-2-Z Rep 4	22I0519-27	Tissue	✓
22I0519	M.n. BW22-PCT-2-Z Rep 5	22I0519-28	Tissue	✓
22I0519	A.v. Pretest Rep 1	22I0519-29	Tissue	✓
22I0519	A.v. Pretest Rep 2	22I0519-30	Tissue	✓
22I0519	A.v. Pretest Rep 3	22I0519-31	Tissue	✓
22I0519	A.v. Carr Ref Rep 1	22I0519-32	Tissue	✓
22I0519	A.v. Carr Ref Rep 2	22I0519-33	Tissue	✓
22I0519	A.v. Carr Ref Rep 3	22I0519-34	Tissue	✓
22I0519	A.v. Carr Ref Rep 4	22I0519-35	Tissue	✓
22I0519	A.v. Carr Ref Rep 5	22I0519-36	Tissue	✓
22I0519	A.v. BW22-PCT-1-C Rep 1	22I0519-37	Tissue	✓
22I0519	A.v. BW22-PCT-1-C Rep 2	22I0519-38	Tissue	✓
22I0519	A.v. BW22-PCT-1-C Rep 3	22I0519-39	Tissue	✓
22I0519	A.v. BW22-PCT-1-C Rep 4	22I0519-40	Tissue	✓
22I0519	A.v. BW22-PCT-1-C Rep 5	22I0519-41	Tissue	✓
22I0519	A.v. BW22-PCT-1-Z Rep 1	22I0519-42	Tissue	✓
22I0519	A.v. BW22-PCT-1-Z Rep 2	22I0519-43	Tissue	✓

Sample Index
Port of Tacoma Blair Bioaccumulation Study

SDG	SAMPLE ID	LAB ID	Matrix	Dioxin/Furan
22I0519	A.v. BW22-PCT-1-Z Rep 3	22I0519-44	Tissue	✓
22I0519	A.v. BW22-PCT-1-Z Rep 4	22I0519-45	Tissue	✓
22I0519	A.v. BW22-PCT-1-Z Rep 5	22I0519-46	Tissue	✓
22I0519	A.v. BW22-PCT-2-C Rep 1	22I0519-47	Tissue	✓
22I0519	A.v. BW22-PCT-2-C Rep 2	22I0519-48	Tissue	✓
22I0519	A.v. BW22-PCT-2-C Rep 3	22I0519-49	Tissue	✓
22I0519	A.v. BW22-PCT-2-C Rep 4	22I0519-50	Tissue	✓
22I0519	A.v. BW22-PCT-2-C Rep 5	22I0519-51	Tissue	✓
22I0519	A.v. BW22-PCT-2-Z Rep 1	22I0519-52	Tissue	✓
22I0519	A.v. BW22-PCT-2-Z Rep 2	22I0519-53	Tissue	✓
22I0519	A.v. BW22-PCT-2-Z Rep 3	22I0519-54	Tissue	✓
22I0519	A.v. BW22-PCT-2-Z Rep 4	22I0519-55	Tissue	✓
22I0519	A.v. BW22-PCT-2-Z Rep 5	22I0519-56	Tissue	✓

DATA VALIDATION REPORT
Port of Tacoma Blair – Bioaccumulation Study
Dioxin/Furan Compounds by EPA 1613B

This report documents the review of analytical data from the analysis of tissue samples and the associated laboratory quality control (QC) samples. Analytical Resources, Inc., Tukwila, Washington, analyzed the samples. Refer to the Sample Index for a complete list of samples.

SDG	Number of Samples	Validation Level
22I0519	56 Tissue	EPA Stage 4

DATA PACKAGE COMPLETENESS

The laboratory submitted all required deliverables. The laboratory followed adequate corrective action processes and all anomalies were discussed in the case narrative.

EDD TO LABORATORY REPORT PACKAGE VERIFICATION

A complete (100%) verification of the electronic data deliverable (EDD) results was performed by comparison to the laboratory data package. Laboratory QC results were also verified (10%).

For non-detected results, the Result_Value field was populated with the reporting limit. For dioxins, results are not-detected at the estimated detection limit (EDL). For results with a lab flag of "U", the Result_Value field was changed to the EDL. No further action was taken.

For Samples A.v. Pretest Rep 1, A.v. Pretest Rep 2, and A.v. Pretest Rep 3, the collection times in the EDD and hardcopy data package did not match the chain-of-custody. The EDD was revised; no further action was taken.

TECHNICAL DATA VALIDATION

The quality control (QC) requirements that were reviewed are listed in the following table.

1	Sample Receipt, Preservation, and Holding Times	1	Field Duplicates
✓	System Performance and Resolution Checks	1	Replicate Analyses
✓	Initial Calibration (ICAL)	✓	Target Analyte List
✓	Calibration Verification (CCV)	✓	Reporting Limits
2	Laboratory Blanks	2	Compound Identification
1	Field Blanks	✓	Compound Quantitation
2	Labeled Compound Recovery	✓	Reported Results
✓	Ongoing Precision and Recovery (OPR)	1	Calculation Verification
✓	Laboratory Duplicates		

✓Method quality objectives (MQO) and QC criteria have been met. No outliers are noted or discussed.
1 Quality control results are discussed below, but no data were qualified.
2 Quality control outliers that impact the reported data were noted. Data qualifiers were issued as discussed below.

Sample Receipt, Preservation, and Holding Times

The validation guidance documents state that sample shipping coolers should arrive at the laboratory within the advisory temperature range of 2-6°C. The laboratory received the sample cooler with a temperature less than the acceptance criteria at -0.5°C. This outlier did not impact data quality; no qualifiers were assigned.

Samples were stored frozen prior to extraction. All samples were extracted within the one year holding time.

Laboratory Blanks

To assess the impact of any blank contaminant on the reported sample results, an action level was established at five times (5x) the concentration reported in the blank. If a contaminant was reported in an associated field sample and the concentration was less than the action level, the result was qualified as not detected (U-7). The laboratory assigned EMPC-flags to values when a peak was detected but did not meet identification criteria. These values cannot be considered as positive identifications, but are "estimated maximum possible concentrations". When these occurred in the method blank, the results were considered as false positives. No action levels were established for these analytes. Blank qualifiers are not assigned for total homolog groups.

The target analyte OCDD was detected in the method blank for Batch BKJ0352. All associated results less than the 5x action level were qualified as not detected (U-7).

Field Blanks

No field blank samples were submitted.

Replicate Analyses

The pretest and reference sample tests were performed in triplicate. All bioaccumulation exposures were performed in quintuplicate. The percent relative standard deviation (%RSD) values were evaluated for the replicate analyses. Where results were greater than 5x the reporting limit (RL), a percent relative standard deviation (%RSD) value of 50% was used to evaluate the sample results. Where results were less than 5x the RL, a criterion of 2x the RL was used to evaluate the standard deviation. When precision criteria were not met, results for all replicates were estimated (J-9). The following outliers were noted:

Sample ID	Analyte	Outlier	Qualifier
A.v. BW22-PCT-1-C	Total HpCDD	Std Dev > 2x RL	J-9
M.n. BW22-PCT-1-Z	Total HpCDD	Std Dev > 2x RL	J-9
M.n. BW22-PCT-2-C	Total HpCDD	Std Dev > 2x RL	J/UJ-9

Labeled Compound Recovery

Isotope-stable labeled compounds were added to each field and QC sample. For recoveries greater than the upper control limit, associated detected results are estimated (J-13H). All outliers were greater than the upper control limits; however only results associated with the following outliers required qualification.

CLIENT ID	LABELED COMPOUND	QUALIFIER
A.v. BW22-PCT-1-C Rep 5	13C12-1,2,3,4,6,7,8-HpCDD	J-13H
A.v. BW22-PCT-1-Z Rep 1	13C12-OCDD	J-13H
A.v. BW22-PCT-1-Z Rep 3	13C12-1,2,3,4,6,7,8-HpCDD	J-13H
	13C12-OCDD	J-13H
A.v. BW22-PCT-1-Z Rep 4	13C12-1,2,3,4,6,7,8-HpCDD	J-13H
	13C12-OCDD	J-13H
A.v. BW22-PCT-1-Z Rep 5	13C12-1,2,3,4,6,7,8-HpCDD	J-13H
	13C12-OCDD	J-13H
A.v. BW22-PCT-2-C Rep 1	13C12-OCDD	J-13H
A.v. BW22-PCT-2-C Rep 5	13C12-OCDD	J-13H
A.v. BW22-PCT-2-Z Rep 4	13C12-1,2,3,4,6,7,8-HpCDF	J-13H
	13C12-1,2,3,4,6,7,8-HpCDD	J-13H
	13C12-OCDD	J-13H
A.v. BW22-PCT-2-Z Rep 5	13C12-OCDD	J-13H

Field Duplicates

No field duplicates were submitted.

Compound Identification

The method requires the confirmation of 2,3,7,8-TCDF detects using an alternate GC column. The DB5 column that is typically used cannot fully separate 2,3,7,8-TCDF from closely eluting non-target TCDF isomers. The laboratory did not perform a second column confirmation; however, the laboratory uses a RTX-Dioxin2 column. This modified column has been proven to adequately resolve the TCDF isomers.

The laboratory reported EMPC or "estimated maximum possible concentrations" values when a peak was detected but did not meet identification criteria as required by the method. The QAPP specified that these results are not to be considered as positive identifications for the analyte. To indicate that the reported result for an individual analyte is in effect an elevated detection limit, the EMPC values were qualified as not-detected (U-25) at the reported values.

The laboratory assigned “X” flags to several of the reported results to indicate that diphenyl ether interference was present, which may result in a high bias to the reported result. All results that were “X” flagged by the laboratory were estimated (J-23H).

Calculation Verification

Several results were verified by recalculation from the raw data. No calculation or transcription errors were found.

OVERALL ASSESSMENT

As determined by this evaluation, the laboratory followed the specified analytical method. With the exceptions noted above, accuracy was acceptable as demonstrated by the labeled compound and on-going precision and recovery standard values. Precision was acceptable as indicated by the laboratory duplicate RPD values.

Data were qualified as not detected based on method blank contamination and to indicate that EMPC values represent elevated detection limits. Results were estimated due to labeled compound recovery outliers, replicate analysis precision outliers, and diphenyl ether interferences.

All data, as qualified, are acceptable for use.

ECOCHEM
Data Quality

APPENDIX A

DATA QUALIFIER DEFINITIONS
REASON CODES
AND CRITERIA TABLES

DATA VALIDATION QUALIFIER CODES
Based on National Functional Guidelines

The following definitions provide brief explanations of the qualifiers assigned to results in the data review process.

U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents the approximate concentration.
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.
R	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

The following is an EcoChem qualifier that may also be assigned during the data review process:

DNR	Do not report; a more appropriate result is reported from another analysis or dilution.

DATA QUALIFIER REASON CODES

Group	Code	Reason for Qualification
Sample Handling	1	Improper Sample Handling or Sample Preservation (i.e., headspace, cooler temperature, pH, summa canister pressure); Exceeded Holding Times
Instrument Performance	24	Instrument Performance (i.e., tune, resolution, retention time window, endrin breakdown, lock-mass)
	5A	Initial Calibration (RF, %RSD, r^2)
	5B	Calibration Verification (CCV, CCAL; RF, %D, %R) Use bias flags (H,L)[1] where appropriate
	5C	Initial Calibration Verification (ICV %D, %R) Use bias flags (H,L)[1] where appropriate
Blank Contamination	6	Field Blank Contamination (Equipment Rinsate, Trip Blank, etc.)
	7	Lab Blank Contamination (i.e., method blank, instrument blank, etc.) Use low bias flag (L)[1] for negative instrument blanks
Precision and Accuracy	8	Matrix Spike (MS and/or MSD) Recoveries Use bias flags (H,L)[1] where appropriate
	9	Precision (all replicates: LCS/LCSD, MS/MSD, Lab Replicate, Field Replicate)
	10	Laboratory Control Sample Recoveries (a.k.a. Blank Spikes) Use bias flags (H,L)[1] where appropriate
	12	Reference Material Use bias flags (H,L)[1] where appropriate
	13	Surrogate Spike Recoveries (a.k.a. labeled compounds, recovery standards) Use bias flags (H,L)[1] where appropriate
Interferences	16	ICP/ICP-MS Serial Dilution Percent Difference
	17	ICP/ICP-MS Interference Check Standard Recovery Use bias flags (H,L)[1] where appropriate
	19	Internal Standard Performance (i.e., area, retention time, recovery)
	22	Elevated Detection Limit due to Interference (i.e., chemical and/or matrix)
	23	Bias from Matrix Interference (i.e. diphenyl ether, PCB/pesticides)
Identification and Quantitation	2	Chromatographic pattern in sample does not match pattern of calibration standard
	3	2nd column confirmation (RPD or %D)
	4	Tentatively Identified Compound (TIC) (associated with NJ only)
	20	Calibration Range or Linear Range Exceeded
	25	Compound Identification (i.e., ion ratio, retention time, relative abundance, etc.)
Miscellaneous	11	A more appropriate result is reported (multiple reported analyses i.e., dilutions, re-extractions, etc. Associated with “R” and “DNR” only)
	14	Other (See DV report for details)
	26	Method QC information not provided

[1] H = high bias indicated
L = low bias indicated

DATA QUALIFIER REASON CODES

Group	Code	Reason for Qualification
Sample Handling	1	Improper Sample Handling or Sample Preservation (i.e., headspace, cooler temperature, pH, summa canister pressure); Exceeded Holding Times
Instrument Performance	24	Instrument Performance (i.e., tune, resolution, retention time window, endrin breakdown, lock-mass)
	5A	Initial Calibration (RF, %RSD, r^2)
	5B	Calibration Verification (CCV, CCAL; RF, %D, %R) Use bias flags (H,L)[1] where appropriate
	5C	Initial Calibration Verification (ICV %D, %R) Use bias flags (H,L)[1] where appropriate
Blank Contamination	6	Field Blank Contamination (Equipment Rinsate, Trip Blank, etc.)
	7	Lab Blank Contamination (i.e., method blank, instrument blank, etc.) Use low bias flag (L)[1] for negative instrument blanks
Precision and Accuracy	8	Matrix Spike (MS and/or MSD) Recoveries Use bias flags (H,L)[1] where appropriate
	9	Precision (all replicates: LCS/LCSD, MS/MSD, Lab Replicate, Field Replicate)
	10	Laboratory Control Sample Recoveries (a.k.a. Blank Spikes) Use bias flags (H,L)[1] where appropriate
	12	Reference Material Use bias flags (H,L)[1] where appropriate
	13	Surrogate Spike Recoveries (a.k.a. labeled compounds, recovery standards) Use bias flags (H,L)[1] where appropriate
Interferences	16	ICP/ICP-MS Serial Dilution Percent Difference
	17	ICP/ICP-MS Interference Check Standard Recovery Use bias flags (H,L)[1] where appropriate
	19	Internal Standard Performance (i.e., area, retention time, recovery)
	22	Elevated Detection Limit due to Interference (i.e., chemical and/or matrix)
	23	Bias from Matrix Interference (i.e. diphenyl ether, PCB/pesticides)
Identification and Quantitation	2	Chromatographic pattern in sample does not match pattern of calibration standard
	3	2nd column confirmation (RPD or %D)
	4	Tentatively Identified Compound (TIC) (associated with NJ only)
	20	Calibration Range or Linear Range Exceeded
	25	Compound Identification (i.e., ion ratio, retention time, relative abundance, etc.)
Miscellaneous	11	A more appropriate result is reported (multiple reported analyses i.e., dilutions, re-extractions, etc. Associated with “R” and “DNR” only)
	14	Other (See DV report for details)
	26	Method QC information not provided

[1] H = high bias indicated
L = low bias indicated

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Sample Handling					
Cooler/Storage Temperature Preservation	Waters/Solids ≤ 6°C & in the dark Tissues <-10°C & in the dark **Preservation Aqueous:** If Cl_2 is present Thiosulfate must be added and if pH > 9 it must be adjusted to 7 - 9	NFG (1) Method(2)	J(pos)/R(ND) if thiosulfate not added if Cl_2 present; J(pos)/UJ(ND) if pH not adjusted J(pos)/UJ(ND) if temp > 20°C	1	**EcoChem PJ, see TM-05**
Holding Time	**If properly stored, 1 year or:** **Extraction (all matrices):** 30 days from collection **Analysis (all matrices)**: 45 days from extraction	NFG (1) Method(2)	If not properly stored or HT exceedance: J(pos)/UJ(ND)	1	**EcoChem PJ, see TM-05** Gross exceedance = > 1 year 2011 NFG **Note:** Under CWA, SDWA, and RCRA the HT for H2O is 7 days.
Instrument Performance					
Mass Resolution (Tuning)	PFK (Perfluorokerosene) ≥10,000 resolving power at m/z 304.9824. Exact mass of m/z 380.9760 w/in 5 ppm of theoretical value (380.97410 to 380.97790) . Analyzed prior to ICAL and at the start and end of each 12 hr. shift.	NFG (1) Method (2)	R(pos/ND) all analytes in all samples associated with the tune	24	Notify PM
Windows Defining Mix	Peaks for first and last eluters must be within established retention time windows for each selector group (chlorination level)	NFG (1) Method (2)	If peaks are not completely within windows (clipped): If natives are ok, J(pos)/UJ(ND) homologs (Totals) If natives are affected, R all results for that selector group	24	Notify PM
Column Performance Mix	Both mixes must be analyzed before ICAL and CCAL Valley < 25% (valley = (x/y)*100%) where x = ht. of TCDD (or TCDF) & y = baseline to bottom of valley For all isomers eluting near the 2378-TCDD (TCDF) peak (TCDD only for 8290)	NFG (1) Method (2)	J(pos) if valley > 25%	24	**EcoChem PJ, see TM-05, Rev. 2**; Note: TCDF is evaluated only if second column confirmation is performed
Initial Calibration **Sensitivity**	S/N ratio > 10 for all native and labeled compounds in CS1 std.	NFG (1) Method (2)	If <10, elevate Det. Limit or R(ND)	5A	
Initial Calibration **Selectivity**	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	NFG (1) Method (2)	If 2 or more ion ratios are out for one compound in ICAL, J(pos)	5A	**EcoChem PJ, see TM-05, Rev. 2**

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Instrument Performance (continued)					
Initial Calibration (Minimum 5 stds.) **Stability**	%RSD < 20% for native compounds %RSD <30% for labeled compounds (%RSD < 35% for labeled compounds under 1613b)	NFG (1) Method (2)	J(pos) natives if %RSD > 20%	5A	
	Absolute RT of $^{13}C_{12}$-1234-TCDD >25 min on DB5 & >15 min on DB-225	NFG (1) Method (2)	Narrate, no action		**EcoChem PJ, see TM-05, Rev. 2**
Continuing Calibration (Prior to each 12 hr. shift) **Sensitivity**	S/N ratio for CS3 standard > 10	NFG (1) Method (2)	If <10, elevate Det. Limit or R(ND)	5B	
Continuing Calibration (Prior to each 12 hr. shift) **Selectivity**	Ion Abundance ratios within QC limits (Table 8 of method 8290) (Table 9 of method 1613B)	NFG (1) Method (2)	For congener with ion ratio outlier, J(pos) natives in all samples associated with CCAL. No action for labeled congener ion ratio outliers.	25	**EcoChem PJ, see TM-05**
Continuing Calibration (Prior to each 12 hr. shift) **Stability**	%D+/-20% for native compounds %D +/-30% for labeled compounds **(Must meet limits in Table 6, Method 1613B)** If %D in the closing CCAL are within 25%/35%, the mean RF from the two CCAL may be used to calculate samples **(Section 8.3.2.4 of 8290**).	NFG (1) Method (2)	**Labeled compounds:** Narrate, no action. **Native compounds:** 1613: J(pos)/UJ(ND)if %D is outside Table 6 limits J(pos)/R(ND) if %D is +/-75% of Table 6 limits 8290: J(pos)/UJ(ND) if %D = 20% - 75% J(pos)/R(ND) if %D > 75%	5B (H,L)[3]	
	Absolute RT of $^{13}C_{12}$-1234-TCDD and $^{13}C_{12}$-123789-HxCDD should be ± 15 seconds of ICAL RRT for all other compounds must meet criteria listed in Table 2 Method 1316.	NFG (1) Method (2)	Narrate, no action	5B	**EcoChem PJ, see TM-05**
Blank Contamination					
Method Blank (MB)	MB: One per matrix per batch of (of ≤ 20 samples) No detected compounds > RL	NFG (1) Method (2)	U(pos) if result is < 5X action level.	7	**Hierarchy of blank review:** **#1 - Review MB, qualify as needed** **#2 - Review FB , qualify as needed**
Field Blank (FB)	FB: frequency as per QAPP No detected compounds > RL		U(pos) if result is < 5X action level.	6	

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Precision and Accuracy					
MS/MSD (recovery)	**MS/MSD not typically required for HRMS analyses.** If lab analyzes MS/MSD then one set per matrix per batch (of ≤ 20 samples) Use most current laboratory control limits	EcoChem standard policy	J(pos) if both %R > UCL - high bias J(pos)/UJ(ND) if both %R < LCL - low bias J(pos)/R(ND) if both %R < 10% - very low bias J(pos)/UJ(ND) if one > UCL & one < LCL, with no bias **PJ if only one %R outlier**	8 (H,L)[3]	No action if only one spike %R is outside criteria. No action if parent concentration is >4x the amount spiked. Qualify parent sample only unless other QC indicates systematic problems.
MS/MSD (RPD)	**MS/MSD not typically required for HRMS analyses.** If lab analyzes MS/MSD then one set per matrix per batch (of ≤ 20 samples) Use most current laboratory control limits	EcoChem standard policy	J(pos) in parent sample if RPD > CL	9	Qualify parent sample only.
LCS (or OPR)	One per lab batch (of ≤ 20 samples) Use most current laboratory control limits **or** Limits from Table 6 of 1613B	NFG (1) Method (2)	J(pos) if %R > UCL - high bias J(pos)/UJ(ND) if %R < LCL - low bias J(pos)/R(ND) if %R < 10% - very low bias	10 (H,L)[3]	No action if only one spike %R is outside criteria, when LCSD is analyzed. Qualify all associated samples.
LCS/LCSD (RPD)	**LCSD not typically required for HRMS analyses.** One set per matrix and batch of 20 samples RPD < 35%	Method (2) Ecochem standard policy	J(pos) assoc. compound in all samples if RPD > CL	9	Qualify all associated samples.
Lab Duplicate (RPD)	**Lab Dup not typically required for HRMS analyses.** One per lab batch (of ≤ 20 samples) Use most current laboratory control limits	EcoChem standard policy	J(pos)/UJ(ND) if RPD > CL	9	
Labeled Compounds (Internal Standards)	Added to all samples %R = 40% - 135% in all samples 8290 %R must meet limits in Table 7 Method 1613B	NFG (1) Method (2)	J(pos) if %R > UCL - high bias J(pos)/UJ(ND) if %R < LCL - low bias J(pos)/R(ND) if %R < 10% - very low bias	13 (H,L)[3]	
Field Duplicates	Solids: RPD <50% OR difference < 2X RL (for results < 5X RL) Aqueous: RPD <35% OR difference < 1X RL (for results < 5X RL)	EcoChem standard policy	Narrate and qualify if required by project	9	**Use professional judgment**

Dioxin/Furan Analysis by HRMS
(Based on Dioxin NFG 2011 and Methods EPA 1613B and SW-846 8290)

QC Element	Acceptance Criteria	Source of Criteria	Action for Non-Conformance	Reason Code	Discussion and Comments
Compound ID and Calculation					
Quantitation/ Identification	All ions for each isomer must maximize within ± 2 seconds. S/N ratio >2.5 Ion ratios must meet criteria listed in Table 8 Method 8290, or Table 9 of 1613B; RRTs w/in limits in Table 2 of 1613B	NFG (1) Method (2)	Narrate in report; qualify if necessary NJ(pos) for retention time outliers. U(pos) for ion ratio outliers.	25	**EcoChem PJ, see TM-05**
EMPC (estimated maximum possible concentration)	If quantitation identification criteria are not met, laboratory should report an EMPC value.	NFG (1) Method (2)	If laboratory correctly reported an EMPC value, qualify the native compound U(pos) to indicate that the value is a detection limit and qualify total homolog groups J (pos)	25	**Use professional judgment See TM-18**
Interferences	Interferences from chlorodiphenyl ether compounds	NFG (1) Method (2)	J(pos)/UJ(ND) if present	23	**See TM-16**
	Lock masses must not deviate ± 20% from values in Table 8 of 1613B	Method (2)	J(pos)/UJ(ND) if present	24	**See TM-17**
Second Column Confirmation	All 2,3,7,8-TCDF hits must be confirmed on a DB-225 (or equiv) column. All QC criteria must also be met for the confirmation analysis.	NFG (1) Method (2)	Report the DB-225 value. If not performed use PJ.	3	DNR-11 DB5 result if both results from both columns are reported. **EcoChem PJ, see TM-05**
Calculation Check	Check 10% of field & QC sample results	EcoChem standard policy	Contact laboratory for resolution and/or corrective action	na	Full data validation only.
Electronic Data Deliverable (EDD)					
Verification of EDD to hardcopy data	EcoChem verify @ 10% unless problems noted; then increase level up to 100% for next several packages.		Depending on scope of problem, correct at EcoChem (minor issues) to resubmittal by laboratory (major issues).	na	EcoChem Project Manager and/or Database Administrator will work with lab to provide long-term corrective action.
Dilutions, Re-extractions and/or Reanalyses	Report only one result per analyte	Standard reporting policy	Use "DNR" to flag results that will not be reported.	11	

(pos) - positive (detected) results; (ND) - not detected results

1 National Functional Guidelines for Chlorinated Dibenzo-p-Dioxins (CDDs) & Chlorinated Dibenzofurans (CDFs) Data Review, September 2011

2 Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by High-Resolution Gas Chromatography/High-Resolution Mass Spectrometry (HRGC/HRMS), USEPA SW-846, Method 8290

2 EPA Method 1613, Rev.B, Tetra-through Octa-Chlorinated Dioxins and Furans by Isotope Dilution HRGS/HRMS, October 1994

3 NFG 2013 suggests using "+ / -" to indicate bias; EcoChem has chosen "H" = high bias indicated; "L" = low bias indicated.

APPENDIX B

QUALIFIED DATA SUMMARY TABLE

Qualified Data Summary Table
Port of Tacoma Blair Bioaccumulation Study

SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
M.n. Pretest Rep 1	22I0519-01	EPA1613B	1,2,3,4,6,7,8-HpCDD	0.294	ng/Kg	NUJ,J	U	25
M.n. Pretest Rep 1	22I0519-01	EPA1613B	OCDD	2.26	ng/Kg	NUJ,J,B	U	25
M.n. Pretest Rep 2	22I0519-02	EPA1613B	OCDD	0.975	ng/Kg	J,B	U	7
M.n. Pretest Rep 3	22I0519-03	EPA1613B	OCDD	0.703	ng/Kg	J,B	U	7
M.n. Carr Ref Rep 1	22I0519-04	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.158	ng/Kg	NUJ,J	U	25
M.n. Carr Ref Rep 1	22I0519-04	EPA1613B	1,2,3,4,6,7,8-HpCDD	0.523	ng/Kg	NUJ,J	U	25
M.n. Carr Ref Rep 1	22I0519-04	EPA1613B	OCDD	2.92	ng/Kg	NUJ,J,B	U	25
M.n. Carr Ref Rep 2	22I0519-05	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.156	ng/Kg	NUJ,J	U	25
M.n. Carr Ref Rep 2	22I0519-05	EPA1613B	1,2,3,4,6,7,8-HpCDD	0.471	ng/Kg	NUJ,J	U	25
M.n. Carr Ref Rep 2	22I0519-05	EPA1613B	OCDD	2.88	ng/Kg	J,B	U	7
M.n. Carr Ref Rep 3	22I0519-06	EPA1613B	OCDD	2.65	ng/Kg	NUJ,J,B	U	25
M.n. Carr Ref Rep 4	22I0519-07	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.16	ng/Kg	NUJ,J	U	25
M.n. Carr Ref Rep 4	22I0519-07	EPA1613B	1,2,3,4,6,7,8-HpCDD	0.389	ng/Kg	NUJ,J	U	25
M.n. Carr Ref Rep 4	22I0519-07	EPA1613B	OCDD	3.11	ng/Kg	J,B	U	7
M.n. Carr Ref Rep 5	22I0519-08	EPA1613B	OCDD	2.2	ng/Kg	J,B	U	7
M.n. BW22-PCT-1-C Rep 1	22I0519-09	EPA1613B	2,3,7,8-TCDF	0.447	ng/Kg	J	J	23H
M.n. BW22-PCT-1-C Rep 1	22I0519-09	EPA1613B	1,2,3,7,8-PeCDF	0.274	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 1	22I0519-09	EPA1613B	1,2,3,4,7,8-HxCDF	0.359	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 1	22I0519-09	EPA1613B	OCDF	1.22	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 2	22I0519-10	EPA1613B	2,3,7,8-TCDF	0.393	ng/Kg	J	J	23H
M.n. BW22-PCT-1-C Rep 2	22I0519-10	EPA1613B	1,2,3,7,8-PeCDF	0.363	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 2	22I0519-10	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.449	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 2	22I0519-10	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.98	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 2	22I0519-10	EPA1613B	OCDF	0.744	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 3	22I0519-11	EPA1613B	2,3,7,8-TCDF	0.555	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 3	22I0519-11	EPA1613B	1,2,3,7,8-PeCDF	0.42	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 3	22I0519-11	EPA1613B	1,2,3,6,7,8-HxCDD	0.326	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 4	22I0519-12	EPA1613B	2,3,7,8-TCDF	0.423	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 5	22I0519-13	EPA1613B	2,3,7,8-TCDF	0.579	ng/Kg	NUJ,J	U	25

Qualified Data Summary Table
Port of Tacoma Blair Bioaccumulation Study

SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
M.n. BW22-PCT-1-C Rep 5	22I0519-13	EPA1613B	1,2,3,4,7,8-HxCDF	0.42	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-C Rep 5	22I0519-13	EPA1613B	OCDF	1.16	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 1	22I0519-14	EPA1613B	2,3,7,8-TCDF	0.796	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 1	22I0519-14	EPA1613B	1,2,3,4,7,8-HxCDF	0.682	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 1	22I0519-14	EPA1613B	1,2,3,6,7,8-HxCDF	0.142	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 1	22I0519-14	EPA1613B	1,2,3,6,7,8-HxCDD	0.45	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 1	22I0519-14	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.665	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 1	22I0519-14	EPA1613B	1,2,3,4,6,7,8-HpCDD	4.48	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 1	22I0519-14	EPA1613B	Total HpCDD	1.46	ng/Kg		J	9
M.n. BW22-PCT-1-Z Rep 2	22I0519-15	EPA1613B	1,2,3,7,8-PeCDF	0.682	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 2	22I0519-15	EPA1613B	2,3,4,7,8-PeCDF	0.268	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 2	22I0519-15	EPA1613B	1,2,3,6,7,8-HxCDD	0.723	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 2	22I0519-15	EPA1613B	1,2,3,4,6,7,8-HpCDF	1.11	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 2	22I0519-15	EPA1613B	Total HpCDD	14.6	ng/Kg		J	9
M.n. BW22-PCT-1-Z Rep 3	22I0519-16	EPA1613B	2,3,7,8-TCDF	0.734	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 3	22I0519-16	EPA1613B	1,2,3,7,8-PeCDF	0.626	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 3	22I0519-16	EPA1613B	1,2,3,6,7,8-HxCDD	0.59	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 3	22I0519-16	EPA1613B	OCDF	1.17	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 3	22I0519-16	EPA1613B	Total HpCDD	13	ng/Kg		J	9
M.n. BW22-PCT-1-Z Rep 4	22I0519-17	EPA1613B	2,3,7,8-TCDF	0.825	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 4	22I0519-17	EPA1613B	1,2,3,4,7,8-HxCDF	0.454	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 4	22I0519-17	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.707	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 4	22I0519-17	EPA1613B	Total HpCDD	10.9	ng/Kg		J	9
M.n. BW22-PCT-1-Z Rep 5	22I0519-18	EPA1613B	2,3,7,8-TCDF	0.655	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 5	22I0519-18	EPA1613B	1,2,3,7,8-PeCDF	0.815	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 5	22I0519-18	EPA1613B	1,2,3,4,7,8-HxCDF	1.53	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 5	22I0519-18	EPA1613B	1,2,3,6,7,8-HxCDF	0.489	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 5	22I0519-18	EPA1613B	1,2,3,6,7,8-HxCDD	0.543	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-1-Z Rep 5	22I0519-18	EPA1613B	OCDF	0.952	ng/Kg	NUJ,J	U	25

Qualified Data Summary Table
Port of Tacoma Blair Bioaccumulation Study

SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
M.n. BW22-PCT-1-Z Rep 5	22I0519-18	EPA1613B	Total HpCDD	5.1	ng/Kg		J	9
M.n. BW22-PCT-2-C Rep 1	22I0519-19	EPA1613B	2,3,7,8-TCDF	1.02	ng/Kg	NUJ	U	25
M.n. BW22-PCT-2-C Rep 1	22I0519-19	EPA1613B	1,2,3,7,8-PeCDF	0.674	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 1	22I0519-19	EPA1613B	1,2,3,4,7,8-HxCDF	0.534	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 1	22I0519-19	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.72	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 1	22I0519-19	EPA1613B	Total HpCDD	0.996	ng/Kg	U	UJ	9
M.n. BW22-PCT-2-C Rep 2	22I0519-20	EPA1613B	2,3,7,8-TCDF	0.948	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 2	22I0519-20	EPA1613B	1,2,3,7,8-PeCDF	0.744	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 2	22I0519-20	EPA1613B	1,2,3,4,7,8-HxCDF	0.697	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 2	22I0519-20	EPA1613B	OCDF	1.71	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 2	22I0519-20	EPA1613B	Total HpCDD	7.26	ng/Kg		J	9
M.n. BW22-PCT-2-C Rep 3	22I0519-21	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.45	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 3	22I0519-21	EPA1613B	Total HpCDD	3.2	ng/Kg		J	9
M.n. BW22-PCT-2-C Rep 4	22I0519-22	EPA1613B	1,2,3,4,7,8-HxCDF	0.404	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 4	22I0519-22	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.54	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 4	22I0519-22	EPA1613B	OCDD	5.92	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 4	22I0519-22	EPA1613B	Total HpCDD	0.997	ng/Kg	U	UJ	9
M.n. BW22-PCT-2-C Rep 5	22I0519-23	EPA1613B	2,3,7,8-TCDF	1.2	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 5	22I0519-23	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.458	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-C Rep 5	22I0519-23	EPA1613B	Total HpCDD	2.97	ng/Kg		J	9
M.n. BW22-PCT-2-Z Rep 1	22I0519-24	EPA1613B	2,3,7,8-TCDF	1.29	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 1	22I0519-24	EPA1613B	1,2,3,7,8-PeCDF	1.3	ng/Kg	NUJ,J,B	U	25
M.n. BW22-PCT-2-Z Rep 1	22I0519-24	EPA1613B	OCDF	1.06	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 1	22I0519-24	EPA1613B	OCDD	10.9	ng/Kg	NUJ	U	25
M.n. BW22-PCT-2-Z Rep 2	22I0519-25	EPA1613B	2,3,7,8-TCDF	1.37	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 2	22I0519-25	EPA1613B	2,3,4,7,8-PeCDF	0.652	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 2	22I0519-25	EPA1613B	1,2,3,4,7,8-HxCDF	1.27	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 2	22I0519-25	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.798	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 3	22I0519-26	EPA1613B	2,3,7,8-TCDF	1.8	ng/Kg	NUJ	U	25

Qualified Data Summary Table
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SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
M.n. BW22-PCT-2-Z Rep 3	22I0519-26	EPA1613B	1,2,3,4,7,8-HxCDF	0.84	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 3	22I0519-26	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.7	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 3	22I0519-26	EPA1613B	OCDF	1.94	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 4	22I0519-27	EPA1613B	2,3,7,8-TCDF	1.57	ng/Kg	J	J	23H
M.n. BW22-PCT-2-Z Rep 4	22I0519-27	EPA1613B	1,2,3,4,7,8-HxCDF	0.912	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 4	22I0519-27	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.631	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 4	22I0519-27	EPA1613B	OCDF	1.02	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 5	22I0519-28	EPA1613B	2,3,7,8-TCDF	1.54	ng/Kg	NUJ	U	25
M.n. BW22-PCT-2-Z Rep 5	22I0519-28	EPA1613B	2,3,4,7,8-PeCDF	0.645	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 5	22I0519-28	EPA1613B	1,2,3,4,7,8-HxCDF	1.39	ng/Kg	NUJ,J	U	25
M.n. BW22-PCT-2-Z Rep 5	22I0519-28	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.779	ng/Kg	NUJ,J	U	25
A.v. Pretest Rep 2	22I0519-30	EPA1613B	2,3,7,8-TCDF	1.21	ng/Kg	NUJ,J	U	25
A.v. Pretest Rep 2	22I0519-30	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.62	ng/Kg	NUJ,J	U	25
A.v. Pretest Rep 2	22I0519-30	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.5	ng/Kg	NUJ,J	U	25
A.v. Pretest Rep 3	22I0519-31	EPA1613B	2,3,7,8-TCDF	1.5	ng/Kg	NUJ,J	U	25
A.v. Pretest Rep 3	22I0519-31	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.485	ng/Kg	NUJ,J	U	25
A.v. Pretest Rep 3	22I0519-31	EPA1613B	1,2,3,4,6,7,8-HpCDD	0.983	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 1	22I0519-32	EPA1613B	2,3,7,8-TCDF	1.37	ng/Kg	J	J	23H
A.v. Carr Ref Rep 2	22I0519-33	EPA1613B	2,3,7,8-TCDF	2.72	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 2	22I0519-33	EPA1613B	OCDD	3.92	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 3	22I0519-34	EPA1613B	2,3,7,8-TCDF	1.17	ng/Kg	J	J	23H
A.v. Carr Ref Rep 3	22I0519-34	EPA1613B	OCDD	2.83	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 4	22I0519-35	EPA1613B	1,2,3,4,6,7,8-HpCDD	0.657	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 5	22I0519-36	EPA1613B	2,3,7,8-TCDF	1.39	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 5	22I0519-36	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.288	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 5	22I0519-36	EPA1613B	1,2,3,4,6,7,8-HpCDD	0.701	ng/Kg	NUJ,J	U	25
A.v. Carr Ref Rep 5	22I0519-36	EPA1613B	OCDD	2.77	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 1	22I0519-37	EPA1613B	2,3,7,8-TCDF	2.76	ng/Kg	J	J	23H
A.v. BW22-PCT-1-C Rep 1	22I0519-37	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.61	ng/Kg	NUJ,J	U	25

Qualified Data Summary Table
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SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
A.v. BW22-PCT-1-C Rep 1	22I0519-37	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.68	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 1	22I0519-37	EPA1613B	Total HpCDD	1.7	ng/Kg		J	9
A.v. BW22-PCT-1-C Rep 2	22I0519-38	EPA1613B	2,3,7,8-TCDF	2.01	ng/Kg	J	J	23H
A.v. BW22-PCT-1-C Rep 2	22I0519-38	EPA1613B	Total HpCDD	1.18	ng/Kg		J	9
A.v. BW22-PCT-1-C Rep 3	22I0519-39	EPA1613B	2,3,7,8-TCDF	2.42	ng/Kg	J	J	23H
A.v. BW22-PCT-1-C Rep 3	22I0519-39	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.49	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 3	22I0519-39	EPA1613B	Total HpCDD	0.616	ng/Kg	J	J	9
A.v. BW22-PCT-1-C Rep 4	22I0519-40	EPA1613B	2,3,7,8-TCDF	4.18	ng/Kg	J	J	23H
A.v. BW22-PCT-1-C Rep 4	22I0519-40	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.04	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 4	22I0519-40	EPA1613B	OCDF	1.05	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 4	22I0519-40	EPA1613B	Total HpCDD	3.58	ng/Kg		J	9
A.v. BW22-PCT-1-C Rep 5	22I0519-41	EPA1613B	2,3,7,8-TCDF	1.38	ng/Kg	J	J	23H
A.v. BW22-PCT-1-C Rep 5	22I0519-41	EPA1613B	1,2,3,7,8-PeCDF	0.554	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 5	22I0519-41	EPA1613B	1,2,3,7,8-PeCDD	0.449	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 5	22I0519-41	EPA1613B	1,2,3,4,6,7,8-HpCDD	3.04	ng/Kg	J	J	13H
A.v. BW22-PCT-1-C Rep 5	22I0519-41	EPA1613B	OCDF	1.76	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-C Rep 5	22I0519-41	EPA1613B	Total HpCDD	3.87	ng/Kg		J	9
A.v. BW22-PCT-1-Z Rep 1	22I0519-42	EPA1613B	2,3,7,8-TCDF	1.86	ng/Kg	J	J	23H
A.v. BW22-PCT-1-Z Rep 1	22I0519-42	EPA1613B	1,2,3,7,8-PeCDD	0.468	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 1	22I0519-42	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.677	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 1	22I0519-42	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.18	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 1	22I0519-42	EPA1613B	OCDF	0.628	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 1	22I0519-42	EPA1613B	OCDD	8.41	ng/Kg	J	J	13H
A.v. BW22-PCT-1-Z Rep 2	22I0519-43	EPA1613B	2,3,7,8-TCDF	3.55	ng/Kg	J	J	23H
A.v. BW22-PCT-1-Z Rep 2	22I0519-43	EPA1613B	1,2,3,6,7,8-HxCDD	0.662	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 2	22I0519-43	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.553	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 2	22I0519-43	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.97	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 2	22I0519-43	EPA1613B	OCDF	0.613	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 3	22I0519-44	EPA1613B	2,3,7,8-TCDF	2.15	ng/Kg	J	J	23H

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SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
A.v. BW22-PCT-1-Z Rep 3	22I0519-44	EPA1613B	1,2,3,7,8-PeCDF	0.59	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 3	22I0519-44	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.569	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 3	22I0519-44	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.6	ng/Kg	J	J	13H
A.v. BW22-PCT-1-Z Rep 3	22I0519-44	EPA1613B	OCDF	0.506	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 3	22I0519-44	EPA1613B	OCDD	8.97	ng/Kg	J	J	13H
A.v. BW22-PCT-1-Z Rep 4	22I0519-45	EPA1613B	2,3,7,8-TCDF	2.41	ng/Kg	J	J	23H
A.v. BW22-PCT-1-Z Rep 4	22I0519-45	EPA1613B	1,2,3,7,8-PeCDF	0.313	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 4	22I0519-45	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.435	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 4	22I0519-45	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.34	ng/Kg	J	J	13H
A.v. BW22-PCT-1-Z Rep 4	22I0519-45	EPA1613B	OCDD	11.9	ng/Kg		J	13H
A.v. BW22-PCT-1-Z Rep 5	22I0519-46	EPA1613B	2,3,7,8-TCDF	4.98	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 5	22I0519-46	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.762	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 5	22I0519-46	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.41	ng/Kg	J	J	13H
A.v. BW22-PCT-1-Z Rep 5	22I0519-46	EPA1613B	OCDF	0.511	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-1-Z Rep 5	22I0519-46	EPA1613B	OCDD	11.1	ng/Kg		J	13H
A.v. BW22-PCT-2-C Rep 1	22I0519-47	EPA1613B	2,3,7,8-TCDF	1.59	ng/Kg	J	J	23H
A.v. BW22-PCT-2-C Rep 1	22I0519-47	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.44	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 1	22I0519-47	EPA1613B	OCDF	0.282	ng/Kg	J	J	13H
A.v. BW22-PCT-2-C Rep 1	22I0519-47	EPA1613B	OCDD	6.64	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 2	22I0519-48	EPA1613B	2,3,7,8-TCDF	2.25	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 2	22I0519-48	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.604	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 2	22I0519-48	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.24	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 2	22I0519-48	EPA1613B	OCDF	1.17	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 3	22I0519-49	EPA1613B	2,3,7,8-TCDF	4.06	ng/Kg	J	J	23H
A.v. BW22-PCT-2-C Rep 3	22I0519-49	EPA1613B	1,2,3,7,8-PeCDF	0.727	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 3	22I0519-49	EPA1613B	OCDD	7.95	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 4	22I0519-50	EPA1613B	2,3,7,8-TCDF	1.2	ng/Kg	J	J	23H
A.v. BW22-PCT-2-C Rep 4	22I0519-50	EPA1613B	1,2,3,7,8-PeCDF	0.249	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 4	22I0519-50	EPA1613B	OCDF	0.575	ng/Kg	NUJ,J	U	25

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SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
A.v. BW22-PCT-2-C Rep 5	22I0519-51	EPA1613B	2,3,7,8-TCDF	1.27	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 5	22I0519-51	EPA1613B	1,2,3,7,8-PeCDF	0.48	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 5	22I0519-51	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.322	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 5	22I0519-51	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.28	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-C Rep 5	22I0519-51	EPA1613B	OCDD	7.56	ng/Kg	J	J	13H
A.v. BW22-PCT-2-Z Rep 1	22I0519-52	EPA1613B	2,3,7,8-TCDF	2.62	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 2	22I0519-53	EPA1613B	2,3,7,8-TCDF	2.51	ng/Kg	J	J	23H
A.v. BW22-PCT-2-Z Rep 2	22I0519-53	EPA1613B	1,2,3,7,8-PeCDF	0.809	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 2	22I0519-53	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.629	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 2	22I0519-53	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.02	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 2	22I0519-53	EPA1613B	OCDD	8.2	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 3	22I0519-54	EPA1613B	2,3,7,8-TCDF	3.48	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 3	22I0519-54	EPA1613B	2,3,4,7,8-PeCDF	0.464	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 3	22I0519-54	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.504	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 3	22I0519-54	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.28	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 3	22I0519-54	EPA1613B	OCDD	5.8	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 4	22I0519-55	EPA1613B	2,3,7,8-TCDF	2.32	ng/Kg	J	J	23H
A.v. BW22-PCT-2-Z Rep 4	22I0519-55	EPA1613B	1,2,3,7,8-PeCDF	0.808	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 4	22I0519-55	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.447	ng/Kg	J	J	13H
A.v. BW22-PCT-2-Z Rep 4	22I0519-55	EPA1613B	1,2,3,4,6,7,8-HpCDD	1.56	ng/Kg	J	J	13H
A.v. BW22-PCT-2-Z Rep 4	22I0519-55	EPA1613B	OCDF	0.467	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 4	22I0519-55	EPA1613B	OCDD	7.73	ng/Kg	J	J	13H
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	2,3,7,8-TCDF	2.76	ng/Kg	J	J	23H
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	2,3,7,8-TCDD	0.34	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	1,2,3,7,8-PeCDF	1.08	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	1,2,3,7,8-PeCDD	0.401	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	1,2,3,4,6,7,8-HpCDF	0.777	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	1,2,3,4,7,8,9-HpCDF	0.222	ng/Kg	NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	1,2,3,4,6,7,8-HpCDD	2.25	ng/Kg	NUJ,J	U	25

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SAMPLE ID	LAB ID	METHOD	ANALYTE	RESULT	UNITS	LAB FLAG	DV QUAL	DV CODE
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	OCDF	0.929		NUJ,J	U	25
A.v. BW22-PCT-2-Z Rep 5	22I0519-56	EPA1613B	OCDD	8.62		J	J	13H

Appendix F: Calculations for Dioxin/Furan TEQs

F1: SEDIMENT DIOXIN/FURAN TEQ CALCULATIONS
F2: *M. NASUTA* DIOXIN/FURAN TEQ CALCULATIONS
F3: *A. VIRENS* DIOXIN/FURAN TEQ CALCULATIONS
F4: *M. NASUTA* DIOXIN/FURAN CONGENER DATA
F5: *A. VIRENS* DIOXIN/FURAN CONGENER DATA

Table F1: 2022 PCT Bioaccumulation Study – Dioxin/Furan Total TEQ Calculations for Sediment Samples

			BW22-PCT-1-C		BW22-PCT-1-Z		BW22-PCT-2-C		BW22-PCT-2-Z		REF-CARR INLET	
Dioxins/Furans	Units	TEFs	ND=0*EDL	ND=1/2*EDL	ND=0*EDL	ND=1/2*EDL	ND=0*EDL	ND=1/2*EDL	ND=0*EDL	ND=1/2*EDL	ND=0*EDL	ND=1/2*EDL
2,3,7,8-TCDD	ng/kg	1	0	0.1205	0	0.1215	0	0.1025	0	0.117	0	0.1035
1,2,3,7,8-PeCDD	ng/kg	1	1.12	1.12	1.08	1.08	0	0.467	0.965	0.965	0	0.16
1,2,3,4,7,8-HxCDD	ng/kg	0.1	0	0.0575	0.144	0.144	0.164	0.164	0.0954	0.0954	0	0.01695
1,2,3,6,7,8-HxCDD	ng/kg	0.1	0.489	0.489	0.611	0.611	0.697	0.697	0.553	0.553	0	0.016
1,2,3,7,8,9-HxCDD	ng/kg	0.1	0.265	0.265	0.282	0.282	0.331	0.331	0	0.108	0	0.01775
1,2,3,4,6,7,8-HpCDD	ng/kg	0.01	1.25	1.25	1.13	1.13	1.26	1.26	0.816	0.816	0.0516	0.0516
OCDD	ng/kg	0.0003	0.36	0.36	0.315	0.315	0.336	0.336	0.2001	0.2001	0.01125	0.01125
2,3,7,8-TCDF	ng/kg	0.1	0.576	0.576	0.518	0.518	0.83	0.83	1.56	1.56	0	0.01045
1,2,3,7,8-PeCDF	ng/kg	0.03	0.309	0.309	0.36	0.36	0.621	0.621	0.897	0.897	0	0.00387
2,3,4,7,8-PeCDF	ng/kg	0.3	1.134	1.134	1.326	1.326	2.277	2.277	3.18	3.18	0	0.03645
1,2,3,4,7,8-HxCDF	ng/kg	0.1	1.94	1.94	1.77	1.77	3.1	3.1	5.62	5.62	0	0.0125
1,2,3,6,7,8-HxCDF	ng/kg	0.1	0.52	0.52	0.49	0.49	0.894	0.894	1.73	1.73	0	0.01215
1,2,3,7,8,9-HxCDF	ng/kg	0.1	0.262	0.262	0.308	0.308	0.474	0.474	0.77	0.77	0	0.0172
2,3,4,6,7,8-HxCDF	ng/kg	0.1	0.212	0.212	0.229	0.229	0.391	0.391	0.497	0.497	0	0.01245
1,2,3,4,6,7,8-HpCDF	ng/kg	0.01	0.237	0.237	0.214	0.214	0.335	0.335	0.352	0.352	0	0.00615
1,2,3,4,7,8,9-HpCDF	ng/kg	0.01	0.0445	0.0445	0.033	0.033	0.0567	0.0567	0.0986	0.0986	0	0.00168
OCDF	ng/kg	0.0003	0.02028	0.02028	0.0144	0.0144	0.02457	0.02457	0.02022	0.02022	0	0.000285
Total TEQ (ND=0*EDL)	ng/kg		8.74		8.82		11.79		17.35		0.063	
Total TEQ (ND=½*EDL)	ng/kg			8.92		8.95		12.36		17.58		0.490

Exceeds SL	Exceeds BT	Exceeds ML

Table F2. 2022 PCT Bioaccumulation Study - *M. Nasuta* Dioxin/Furan Total TEQ Calculations

Macoma nasuta	TEFs	M.n. PreTest Rep 1 0*EDL	Q	M.n. PreTest Rep 2 0*EDL	Q	M.n. PreTest Rep 3 0*EDL	Q	M.n. BW22-PCT-1-C Rep 1 0*EDL	Q	M.n. BW22-PCT-1-C Rep 2 0*EDL	Q	M.n. BW22-PCT-1-C Rep 3 0*EDL	Q
2,3,7,8-TCDF	0.1	0	U	0	U	0	U	0.0597	J	0.0606	J	0	UJ
2,3,7,8-TCDD	1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0	U	0	U	0	U	0	UJ	0	UJ	0	UJ
1,2,3,7,8-PeCDD	1	0	UJ	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0	U	0	U	0	U	0.0342	J	0	UJ	0.0529	J
1,2,3,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	UJ	0.0108	J	0	UJ
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0	U	0	U	0	U	0.0259	J	0.0245	J	0	UJ
1,2,3,7,8,9-HxCDD	0.1	0	U	0	U	0	U	0	UJ	0	UJ	0	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0	U	0	U	0	U	0	UJ	0.00621	J	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	U	0	U	0	U	0	UJ	0	UJ
1,2,3,4,6,7,8-HpCDD	0.01	0	UJ	0	UJ	0	UJ	0.0276	J	0.0219	J	0.0372	J
OCDF	0.0003	0.0000624	J	0	U	0	U	0.000342	J	0.0002466	J	0.000408	J
OCDD	0.0003	0	U	0	U	0	U	0.00522		0.00447		0.00798	
Total TEQ (ND = 0*EDL)[1]		**0.0000624**		**0**		**0**		**0.152962**		**0.1287266**		**0.098488**	

1. ND, EMPC = 0 when Q = U, UJ

Macoma nasuta	TEFs	M.n. PreTest Rep 1 1/2*EDL	Q	M.n. PreTest Rep 2 1/2*EDL	Q	M.n. PreTest Rep 3 1/2*EDL	Q	M.n. BW22-PCT-1-C Rep 1 1/2*EDL	Q	M.n. BW22-PCT-1-C Rep 2 1/2*EDL	Q	M.n. BW22-PCT-1-C Rep 3 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.00515	U	0.00395	U	0.0044	U	0.0597	J	0.0606	J	0.04375	UJ
2,3,7,8-TCDD	1	0.0375	U	0.032	U	0.0375	U	0.0295	U	0.04	U	0.0415	U
1,2,3,7,8-PeCDF	0.03	0.00213	U	0.00168	U	0.00174	U	0.00207	U	0.001515	U	0.00243	U
2,3,4,7,8-PeCDF	0.3	0.01815	U	0.0159	U	0.01605	U	0.01755	UJ	0.0252	UJ	0.03225	UJ
1,2,3,7,8-PeCDD	1	0.0475	UJ	0.05	U	0.053	U	0.0555	U	0.073	U	0.103	U
1,2,3,4,7,8-HxCDF	0.1	0.00315	U	0.0031	U	0.0032	U	0.0342	J	0.01635	UJ	0.0529	J
1,2,3,6,7,8-HxCDF	0.1	0.0029	U	0.00315	U	0.00285	U	0.0064	UJ	0.0108	J	0.00935	UJ
2,3,4,6,7,8-HxCDF	0.1	0.0033	U	0.0032	U	0.00315	U	0.00275	U	0.0041	U	0.00455	U
1,2,3,7,8,9-HxCDF	0.1	0.0036	U	0.0038	U	0.00355	U	0.0031	U	0.0047	U	0.00525	U
1,2,3,4,7,8-HxCDD	0.1	0.0043	U	0.0039	U	0.00375	U	0.0037	U	0.0038	U	0.0057	U
1,2,3,6,7,8-HxCDD	0.1	0.004	U	0.0035	U	0.0037	U	0.0259	J	0.0245	J	0.0172	UJ
1,2,3,7,8,9-HxCDD	0.1	0.00455	U	0.00405	U	0.0041	U	0.00535	UJ	0.00845	UJ	0.01315	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0.000495	U	0.000395	U	0.00045	U	0.003355	UJ	0.00621	J	0.004325	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.0007	U	0.00053	U	0.000665	U	0.000585	U	0.001045	UJ	0.001325	UJ
1,2,3,4,6,7,8-HpCDD	0.01	0.001635	UJ	0.00128	UJ	0.001205	UJ	0.0276	J	0.0219	J	0.0372	J
OCDF	0.0003	0.0000624	J	0.00002775	U	0.00002655	U	0.000342	J	0.0002466	J	0.000408	J
OCDD	0.0003	0.00002355	U	0.00001965	U	0.0000219	U	0.00522		0.00447		0.00798	
Total TEQ (ND = 1/2*EDL)[2]		**0.13914595**		**0.1304824**		**0.13935845**		**0.282822**		**0.3068866**		**0.382268**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F2. 2022 PCT Bioaccumulation Study - *M. Nasuta* Dioxin/Furan Total TEQ Calculations

Macoma nasuta	TEFs	M.n. BW22-PCT-1-C Rep 4 0*EDL	Q	M.n. BW22-PCT-1-C Rep 5 0*EDL	Q	M.n. BW22-PCT-1-Z Rep 1 0*EDL	Q	M.n. BW22-PCT-1-Z Rep 2 0*EDL	Q	M.n. BW22-PCT-1-Z Rep 3 0*EDL	Q
2,3,7,8-TCDF	0.1	0.0684	J	0.0631	J	0.0765	J	0	UJ	0.0773	J
2,3,7,8-TCDD	1	0	U	0	U	0	U	0	U	0	UJ
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0	UJ	0	UJ	0	UJ	0.1068	J	0	UJ
1,2,3,7,8-PeCDD	1	0	U	0	U	0	UJ	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0.0646	J	0.0424	J	0.0603	J	0	UJ	0.0647	J
1,2,3,6,7,8-HxCDF	0.1	0.0235	J	0	UJ	0.0178	J	0	UJ	0.0211	J
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0.0171	J	0.0166	J	0	UJ
1,2,3,7,8,9-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	UJ
1,2,3,6,7,8-HxCDD	0.1	0.037	J	0	UJ	0	UJ	0	UJ	0.0589	J
1,2,3,7,8,9-HxCDD	0.1	0.0161	J	0	U	0	U	0.0166	J	0	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0.00739	J	0	UJ	0	UJ	0.011	J	0.0105	J
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0365	J	0.0328	J	0.0395	J	0.0498	J	0.0475	J
OCDF	0.0003	0	UJ	0.000474	J	0.000351	J	0.000531	J	0.000576	J
OCDD	0.0003	0.00735		0.00831		0.00738		0.00954		0.00843	
Total TEQ (ND = 0*EDL)[1]		**0.26084**		**0.147084**		**0.218931**		**0.210871**		**0.289006**	

1. ND, EMPC = 0 when Q = U, UJ

Macoma nasuta	TEFs	M.n. BW22-PCT-1-C Rep 4 1/2*EDL	Q	M.n. BW22-PCT-1-C Rep 5 1/2*EDL	Q	M.n. BW22-PCT-1-Z Rep 1 1/2*EDL	Q	M.n. BW22-PCT-1-Z Rep 2 1/2*EDL	Q	M.n. BW22-PCT-1-Z Rep 3 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.0684	J	0.0631	J	0.0765	J	0.051	UJ	0.0773	J
2,3,7,8-TCDD	1	0.043	U	0.0595	U	0.044	U	0.0495	U	0.107	UJ
1,2,3,7,8-PeCDF	0.03	0.002235	U	0.00285	U	0.002625	U	0.003435	U	0.00258	U
2,3,4,7,8-PeCDF	0.3	0.04425	UJ	0.03855	UJ	0.0429	UJ	0.1068	J	0.04455	UJ
1,2,3,7,8-PeCDD	1	0.069	U	0.1045	U	0.045	UJ	0.091	U	0.0915	U
1,2,3,4,7,8-HxCDF	0.1	0.0646	J	0.0424	J	0.0603	J	0.0365	UJ	0.0647	J
1,2,3,6,7,8-HxCDF	0.1	0.0235	J	0.0084	UJ	0.0178	J	0.0116	UJ	0.0211	J
2,3,4,6,7,8-HxCDF	0.1	0.0043	U	0.00495	U	0.0171	J	0.0166	J	0.00925	UJ
1,2,3,7,8,9-HxCDF	0.1	0.00475	U	0.0055	U	0.0052	U	0.0056	U	0.00485	U
1,2,3,4,7,8-HxCDD	0.1	0.00595	U	0.0063	U	0.0071	U	0.01025	U	0.0109	UJ
1,2,3,6,7,8-HxCDD	0.1	0.037	J	0.01695	UJ	0.02115	UJ	0.0294	UJ	0.0589	J
1,2,3,7,8,9-HxCDD	0.1	0.0161	J	0.0069	U	0.00775	U	0.0166	J	0.0134	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0.00739	J	0.00375	UJ	0.00387	UJ	0.011	J	0.0105	J
1,2,3,4,7,8,9-HpCDF	0.01	0.00107	U	0.001	U	0.000935	U	0.000845	U	0.000805	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0365	J	0.0328	J	0.0395	J	0.0498	J	0.0475	J
OCDF	0.0003	0.000267	UJ	0.000474	J	0.000351	J	0.000531	J	0.000576	J
OCDD	0.0003	0.00735		0.00831		0.00738		0.00954		0.00843	
Total TEQ (ND = 1/2*EDL)[2]		**0.435662**		**0.406234**		**0.399461**		**0.500001**		**0.573841**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F2. 2022 PCT Bioaccumulation Study - *M. Nasuta* Dioxin/Furan Total TEQ Calculations

Macoma nasuta	TEFs	M.n. BW22-PCT-1-Z Rep 4 0*EDL	Q	M.n. BW22-PCT-1-Z Rep 5 0*EDL	Q	M.n. BW22-PCT-2-C Rep 1 0*EDL	Q	M.n. BW22-PCT-2-C Rep 2 0*EDL	Q	M.n. BW22-PCT-2-C Rep 3 0*EDL	Q
2,3,7,8-TCDF	0.1	0.0773	J	0.0758	J	0.104	J	0.143	J	0	UJ
2,3,7,8-TCDD	1	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0	UJ	0	UJ	0	UJ	0	UJ	0	U
1,2,3,7,8-PeCDD	1	0	U	0	U	0	UJ	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0.0529	J	0.128	J	0.0494	J	0	UJ	0	UJ
1,2,3,6,7,8-HxCDF	0.1	0	UJ	0	UJ	0	UJ	0	UJ	0	UJ
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0.0175	J	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	UJ	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0.0511	J	0.0391	J	0	UJ	0	UJ	0.0274	J
1,2,3,7,8,9-HxCDD	0.1	0	U	0.0162	J	0	U	0.0135	J	0	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0.00872	J	0.0115	J	0	UJ	0.00921	J	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	U	0	U	0.00268	J	0	UJ
1,2,3,4,6,7,8-HpCDD	0.01	0.0492	J	0.0394	J	0.0236	J	0.0325	J	0.0205	J
OCDF	0.0003	0	UJ	0.000366	J	0.000522	J	0.00063	J	0.00051	J
OCDD	0.0003	0.00939		0.00738		0.00519		0.00711		0.00399	
Total TEQ (ND = 0*EDL)[1]		**0.24861**		**0.335246**		**0.182712**		**0.20863**		**0.0524**	

1. ND, EMPC = 0 when Q = U, UJ

Macoma nasuta	TEFs	M.n. BW22-PCT-1-Z Rep 4 1/2*EDL	Q	M.n. BW22-PCT-1-Z Rep 5 1/2*EDL	Q	M.n. BW22-PCT-2-C Rep 1 1/2*EDL	Q	M.n. BW22-PCT-2-C Rep 2 1/2*EDL	Q	M.n. BW22-PCT-2-C Rep 3 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.0773	J	0.0758	J	0.104	J	0.143	J	0.033	UJ
2,3,7,8-TCDD	1	0.0415	U	0.0425	U	0.042	U	0.054	U	0.0455	U
1,2,3,7,8-PeCDF	0.03	0.002385	U	0.001995	U	0.003135	U	0.002715	U	0.00288	U
2,3,4,7,8-PeCDF	0.3	0.04665	UJ	0.0294	UJ	0.03825	UJ	0.0399	UJ	0.0261	U
1,2,3,7,8-PeCDD	1	0.0805	U	0.0805	U	0.0975	UJ	0.0875	U	0.0645	U
1,2,3,4,7,8-HxCDF	0.1	0.0529	J	0.128	J	0.0494	J	0.0305	UJ	0.0192	UJ
1,2,3,6,7,8-HxCDF	0.1	0.00655	UJ	0.0179	UJ	0.01025	UJ	0.01325	UJ	0.0112	UJ
2,3,4,6,7,8-HxCDF	0.1	0.0043	U	0.0045	U	0.00445	U	0.0051	U	0.0047	U
1,2,3,7,8,9-HxCDF	0.1	0.0048	U	0.0175	J	0.00505	U	0.00555	U	0.0052	U
1,2,3,4,7,8-HxCDD	0.1	0.00545	UJ	0.00445	U	0.0052	U	0.0065	U	0.00705	U
1,2,3,6,7,8-HxCDD	0.1	0.0511	J	0.0391	J	0.0147	UJ	0.01695	UJ	0.0274	J
1,2,3,7,8,9-HxCDD	0.1	0.0069	U	0.0162	J	0.00565	U	0.0135	J	0.014	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0.00872	J	0.0115	J	0.00354	UJ	0.00921	J	0.003425	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.000745	U	0.000685	U	0.0009	U	0.00268	J	0.001345	UJ
1,2,3,4,6,7,8-HpCDD	0.01	0.0492	J	0.0394	J	0.0236	J	0.0325	J	0.0205	J
OCDF	0.0003	0.0002055	UJ	0.000366	J	0.000522	J	0.00063	J	0.00051	J
OCDD	0.0003	0.00939		0.00738		0.00519		0.00711		0.00399	
Total TEQ (ND = 1/2*EDL)[2]		**0.4485955**		**0.517176**		**0.413337**		**0.470595**		**0.2905**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F2. 2022 PCT Bioaccumulation Study - *M. Nasuta* Dioxin/Furan Total TEQ Calculations

Macoma nasuta	TEFs	M.n. BW22-PCT-2-C Rep 4 0*EDL	Q	M.n. BW22-PCT-2-C Rep 5 0*EDL	Q	M.n. BW22-PCT-2-Z Rep 1 0*EDL	Q	M.n. BW22-PCT-2-Z Rep 2 0*EDL	Q	M.n. BW22-PCT-2-Z Rep 3 0*EDL	Q
2,3,7,8-TCDF	0.1	0.0709	J	0	UJ	0.154	J	0.154		0.191	J
2,3,7,8-TCDD	1	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0.0381	J
2,3,4,7,8-PeCDF	0.3	0	U	0	UJ	0	UJ	0	UJ	0	UJ
1,2,3,7,8-PeCDD	1	0	U	0.123	J	0	U	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0	UJ	0	UJ	0.114	J	0	UJ	0.0951	J
1,2,3,6,7,8-HxCDF	0.1	0	U	0.0179	J	0.0269	J	0	UJ	0	UJ
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0	UJ	0	UJ	0.0293	J	0	UJ	0.0369	J
1,2,3,7,8,9-HxCDD	0.1	0	U	0	UJ	0	UJ	0	U	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00478	J	0.00748	J	0.00903	J	0.00877	J	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	U	0.00286	J	0	U	0.00326	J
1,2,3,4,6,7,8-HpCDD	0.01	0.0127	J	0.025	J	0.0205	J	0.0227	J	0.0262	J
OCDF	0.0003	0	U	0.000465	J	0.000378	J	0.000399	J	0.00051	J
OCDD	0.0003	0.002475	J	0.00489		0	U	0.00423		0.00432	
Total TEQ (ND = 0*EDL)[1]		**0.090855**		**0.178735**		**0.356968**		**0.190099**		**0.39539**	

1. ND, EMPC = 0 when Q = U, UJ

Macoma nasuta	TEFs	M.n. BW22-PCT-2-C Rep 4 1/2*EDL	Q	M.n. BW22-PCT-2-C Rep 5 1/2*EDL	Q	M.n. BW22-PCT-2-Z Rep 1 1/2*EDL	Q	M.n. BW22-PCT-2-Z Rep 2 1/2*EDL	Q	M.n. BW22-PCT-2-Z Rep 3 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.0709	J	0.049	UJ	0.154	J	0.154		0.191	J
2,3,7,8-TCDD	1	0.0445	U	0.041	U	0.037	U	0.0455	U	0.045	U
1,2,3,7,8-PeCDF	0.03	0.002175	U	0.002085	U	0.00246	U	0.002565	U	0.0381	J
2,3,4,7,8-PeCDF	0.3	0.01935	U	0.03285	UJ	0.0636	UJ	0.06645	UJ	0.05985	UJ
1,2,3,7,8-PeCDD	1	0.064	U	0.123	J	0.068	U	0.0795	U	0.0835	U
1,2,3,4,7,8-HxCDF	0.1	0.0117	UJ	0.0228	UJ	0.114	J	0.0424	UJ	0.0951	J
1,2,3,6,7,8-HxCDF	0.1	0.0044	U	0.0179	J	0.0269	J	0.01495	UJ	0.01375	UJ
2,3,4,6,7,8-HxCDF	0.1	0.0045	U	0.00505	U	0.00365	U	0.00475	U	0.0037	U
1,2,3,7,8,9-HxCDF	0.1	0.00525	U	0.00585	U	0.0042	U	0.00535	U	0.0041	U
1,2,3,4,7,8-HxCDD	0.1	0.00525	U	0.00525	U	0.0059	U	0.0055	U	0.0051	U
1,2,3,6,7,8-HxCDD	0.1	0.00695	UJ	0.0124	UJ	0.0293	J	0.0149	UJ	0.0369	J
1,2,3,7,8,9-HxCDD	0.1	0.0057	U	0.00715	UJ	0.0071	UJ	0.0058	U	0.0056	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00478	J	0.00748	J	0.00903	J	0.00877	J	0.0045	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.00091	U	0.000795	U	0.00286	J	0.000945	U	0.00326	J
1,2,3,4,6,7,8-HpCDD	0.01	0.0127	J	0.025	J	0.0205	J	0.0227	J	0.0262	J
OCDF	0.0003	0.0000357	U	0.000465	J	0.000378	J	0.000399	J	0.00051	J
OCDD	0.0003	0.002475	J	0.00489		0.00162	U	0.00423		0.00432	
Total TEQ (ND = 1/2*EDL)[2]		**0.2655757**		**0.362965**		**0.550498**		**0.478709**		**0.62049**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F2. 2022 PCT Bioaccumulation Study - *M. Nasuta* Dioxin/Furan Total TEQ Calculations

Macoma nasuta		M.n. BW22-PCT-2-Z Rep 4		M.n. BW22-PCT-2-Z Rep 5		M.n. Carr Ref Rep 1		M.n. Carr Ref Rep 2		M.n. Carr Ref Rep 3		M.n. Carr Ref Rep 4	
	TEFs	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q
2,3,7,8-TCDF	0.1	0.158		0.195		0	UJ	0	U	0	U	0	U
2,3,7,8-TCDD	1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8-PeCDF	0.03	0.0369	J	0	UJ	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0.1635	J	0	UJ	0	U	0	U	0	U	0	U
1,2,3,7,8-PeCDD	1	0	U	0	UJ	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0.103	J	0.12	J	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDF	0.1	0	UJ	0.0378	J	0	U	0	U	0	U	0	U
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	UJ	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0	UJ	0.0449	J	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDD	0.1	0.0136	J	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00879	J	0	UJ	0	UJ	0	U	0	U	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.00262	J	0.00263	J	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0245	J	0	UJ	0.00564	J	0.00774	J	0	UJ	0.00608	J
OCDF	0.0003	0.000429	J	0.000498	J	0	U	0	U	0	U	0	UJ
OCDD	0.0003	0.00375		0.00492		0	U	0.001122	J	0	U	0.001164	J
Total TEQ (ND = 0*EDL)[1]		**0.515089**		**0.405748**		**0.00564**		**0.008862**		**0**		**0.007244**	

1. ND, EMPC = 0 when Q = U, UJ

Macoma nasuta		M.n. BW22-PCT-2-Z Rep 4		M.n. BW22-PCT-2-Z Rep 5		M.n. Carr Ref Rep 1		M.n. Carr Ref Rep 2		M.n. Carr Ref Rep 3		M.n. Carr Ref Rep 4	
	TEFs	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.158		0.195		0.0134	UJ	0.00465	U	0.00655	U	0.00395	U
2,3,7,8-TCDD	1	0.037	U	0.048	U	0.0255	U	0.037	U	0.05	U	0.0335	U
1,2,3,7,8-PeCDF	0.03	0.0369	J	0.02655	UJ	0.00153	U	0.00186	U	0.002145	U	0.001605	U
2,3,4,7,8-PeCDF	0.3	0.1635	J	0.078	UJ	0.0162	U	0.01635	U	0.01905	U	0.01635	U
1,2,3,7,8-PeCDD	1	0.0625	U	0.0975	UJ	0.051	U	0.0585	U	0.0585	U	0.0555	U
1,2,3,4,7,8-HxCDF	0.1	0.103	J	0.12	J	0.00255	U	0.00365	U	0.00365	U	0.00265	U
1,2,3,6,7,8-HxCDF	0.1	0.01275	UJ	0.0378	J	0.0026	U	0.00345	U	0.0035	U	0.00265	U
2,3,4,6,7,8-HxCDF	0.1	0.0035	U	0.0061	U	0.0027	U	0.0038	U	0.00365	U	0.00265	U
1,2,3,7,8,9-HxCDF	0.1	0.0108	UJ	0.0067	U	0.0029	U	0.0042	U	0.00415	U	0.0029	U
1,2,3,4,7,8-HxCDD	0.1	0.0045	U	0.00545	U	0.00425	U	0.00465	U	0.00495	U	0.00395	U
1,2,3,6,7,8-HxCDD	0.1	0.01655	UJ	0.0449	J	0.0039	U	0.00435	U	0.00465	U	0.00345	U
1,2,3,7,8,9-HxCDD	0.1	0.0136	J	0.0059	U	0.00445	U	0.00495	U	0.00525	U	0.00405	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00879	J	0.00435	UJ	0.000595	UJ	0.00042	U	0.000495	U	0.000865	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.00262	J	0.00263	J	0.00049	U	0.000575	U	0.000745	U	0.000555	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0245	J	0.0136	UJ	0.00564	J	0.00774	J	0.001975	UJ	0.00608	J
OCDF	0.0003	0.000429	J	0.000498	J	0.0000231	U	0.0000315	U	0.00003135	U	0.00002325	UJ
OCDD	0.0003	0.00375		0.00492		0.00001965	U	0.001122	J	0.0000267	U	0.001164	J
Total TEQ (ND = 1/2*EDL)[2]		**0.662689**		**0.697898**		**0.13774775**		**0.1572985**		**0.16931805**		**0.14189225**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F2. 2022 PCT Bioaccumulation Study - *M. Nasuta* Dioxin/Furan Total TEQ Calculations

Macoma nasuta		M.n. Carr Ref Rep 5	
	TEFs	0*EDL	Q
2,3,7,8-TCDF	0.1	0	UJ
2,3,7,8-TCDD	1	0	U
1,2,3,7,8-PeCDF	0.03	0	U
2,3,4,7,8-PeCDF	0.3	0	U
1,2,3,7,8-PeCDD	1	0	U
1,2,3,4,7,8-HxCDF	0.1	0	U
1,2,3,6,7,8-HxCDF	0.1	0	U
2,3,4,6,7,8-HxCDF	0.1	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U
1,2,3,6,7,8-HxCDD	0.1	0	U
1,2,3,7,8,9-HxCDD	0.1	0	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0.00511	J
OCDF	0.0003	0	UJ
OCDD	0.0003	0	U
Total TEQ (ND = 0*EDL)[1]		**0.00511**	

1. ND, EMPC = 0 when Q = U, UJ

Macoma nasuta		M.n. Carr Ref Rep 5	
	TEFs	1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.0053	UJ
2,3,7,8-TCDD	1	0.0265	U
1,2,3,7,8-PeCDF	0.03	0.00138	U
2,3,4,7,8-PeCDF	0.3	0.01305	U
1,2,3,7,8-PeCDD	1	0.0655	U
1,2,3,4,7,8-HxCDF	0.1	0.0032	U
1,2,3,6,7,8-HxCDF	0.1	0.0033	U
2,3,4,6,7,8-HxCDF	0.1	0.0032	U
1,2,3,7,8,9-HxCDF	0.1	0.0036	U
1,2,3,4,7,8-HxCDD	0.1	0.0033	U
1,2,3,6,7,8-HxCDD	0.1	0.0031	U
1,2,3,7,8,9-HxCDD	0.1	0.0044	UJ
1,2,3,4,6,7,8-HpCDF	0.01	0.00072	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.00057	U
1,2,3,4,6,7,8-HpCDD	0.01	0.00511	J
OCDF	0.0003	0.000033	UJ
OCDD	0.0003	0.0000225	U
Total TEQ (ND = 1/2*EDL)[2]		**0.1422855**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Qualifiers

U: this analyte is not detected above the reporting limit (RL)
or if noted, not detected above the limit of detection (LOD)
J: concentration less than limit of quantification
UJ: identified a compound that was not detected

Table F3. 2022 PCT Bioaccumulation Study - *A. virens* Dioxin/Furan Total TEQ Calculations

Alitta virens		A.v. PreTest Rep 1		A.v. PreTest Rep 2		A.v. PreTest Rep 3		A.v. BW22-PCT-1-C Rep 1		A.v. BW22-PCT-1-C Rep 2		A.v. BW22-PCT-1-C Rep 3	
	TEF	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q
2,3,7,8-TCDF	0.1	0	UJ	0.13	J	0.131	J	0.266	J	0.182	J	0	UJ
2,3,7,8-TCDD	1	0	U	0	U	0	UJ	0	U	0	U	0	U
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0	U	0	U	0	U	0	UJ	0	UJ	0	UJ
1,2,3,7,8-PeCDD	1	0	U	0	U	0	UJ	0	U	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	UJ	0	UJ
1,2,3,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0	U	0.0177	J	0	U	0.0146	J	0	U	0	UJ
1,2,3,7,8,9-HxCDD	0.1	0	U	0	U	0	UJ	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0	UJ	0.00637	J	0.00761	J	0	UJ	0.00528	J	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0132	J	0.0126	J	0	UJ	0.0158	J	0.018	J	0.0186	J
OCDF	0.0003	0	UJ	0	UJ	0.0001857	J	0	UJ	0.0002184	J	0	UJ
OCDD	0.0003	0.002661	J	0.002397	J	0.002211	J	0.002304	J	0.00366		0.00381	
Total TEQ (ND = 0*EDL)[1]		**0.015861**		**0.169067**		**0.1410067**		**0.298704**		**0.2091584**		**0.02241**	

1. ND, EMPC = 0 when Q = U, UJ

Alitta virens		A.v. PreTest Rep 1		A.v. PreTest Rep 2		A.v. PreTest Rep 3		A.v. BW22-PCT-1-C Rep 1		A.v. BW22-PCT-1-C Rep 2		A.v. BW22-PCT-1-C Rep 3	
	TEF	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.04445	UJ	0.13	J	0.131	J	0.266	J	0.182	J	0.101	UJ
2,3,7,8-TCDD	1	0.057	U	0.0495	U	0.0795	UJ	0.042	U	0.0505	U	0.039	U
1,2,3,7,8-PeCDF	0.03	0.003705	U	0.00282	U	0.00228	U	0.00252	U	0.004065	U	0.008055	U
2,3,4,7,8-PeCDF	0.3	0.04125	U	0.03585	U	0.03465	U	0.0597	UJ	0.01875	UJ	0.0489	UJ
1,2,3,7,8-PeCDD	1	0.1295	U	0.117	U	0.083	UJ	0.103	U	0.1025	U	0.129	U
1,2,3,4,7,8-HxCDF	0.1	0.0067	U	0.0067	U	0.0078	U	0.00975	U	0.0131	UJ	0.01025	UJ
1,2,3,6,7,8-HxCDF	0.1	0.0069	U	0.0069	U	0.00785	U	0.0106	U	0.00515	U	0.0071	U
2,3,4,6,7,8-HxCDF	0.1	0.0066	U	0.0066	U	0.0081	U	0.0106	U	0.00505	U	0.0068	U
1,2,3,7,8,9-HxCDF	0.1	0.0064	U	0.0064	U	0.00735	U	0.00885	U	0.0061	U	0.00805	U
1,2,3,4,7,8-HxCDD	0.1	0.0093	U	0.0093	U	0.0099	U	0.0112	U	0.01155	U	0.01075	U
1,2,3,6,7,8-HxCDD	0.1	0.00795	U	0.0177	J	0.0075	U	0.0146	J	0.0099	U	0.01525	UJ
1,2,3,7,8,9-HxCDD	0.1	0.0094	U	0.0094	U	0.00615	UJ	0.01095	U	0.0114	U	0.0099	U
1,2,3,4,6,7,8-HpCDF	0.01	0.003325	UJ	0.00637	J	0.00761	J	0.00308	UJ	0.00528	J	0.002475	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.00107	U	0.00078	U	0.000825	U	0.001005	U	0.000765	U	0.000625	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0132	J	0.0126	J	0.0072	UJ	0.0158	J	0.018	J	0.0186	J
OCDF	0.0003	0.00005475	UJ	0.0000447	UJ	0.0001857	J	0.0000942	UJ	0.0002184	J	0.00009195	UJ
OCDD	0.0003	0.002661	J	0.002397	J	0.002211	J	0.002304	J	0.00366		0.00381	
Total TEQ (ND = 1/2*EDL)[2]		**0.34946575**		**0.4203617**		**0.4031117**		**0.5720532**		**0.4479884**		**0.41965695**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F3. 2022 PCT Bioaccumulation Study - *A. virens* Dioxin/Furan Total TEQ Calculations

Alitta virens	TEF	A.v. BW22-PCT-1-C Rep 4 0*EDL	Q	A.v. BW22-PCT-1-C Rep 5 0*EDL	Q	A.v. BW22-PCT-1-Z Rep 1 0*EDL	Q	A.v. BW22-PCT-1-Z Rep 2 0*EDL	Q	A.v. BW22-PCT-1-Z Rep 3 0*EDL	Q
2,3,7,8-TCDF	0.1	0.331	J	0.109	J	0.149	J	0.281	J	0.199	J
2,3,7,8-TCDD	1	0	U	0	UJ	0	U	0	UJ	0	UJ
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0	UJ	0.1167	J	0	UJ	0.1287	J	0	UJ
1,2,3,7,8-PeCDD	1	0	U	0	UJ	0.29	J	0.284	J	0	UJ
1,2,3,4,7,8-HxCDF	0.1	0	U	0.0362	J	0	U	0	UJ	0	UJ
1,2,3,6,7,8-HxCDF	0.1	0	U	0	UJ	0	U	0	U	0	UJ
2,3,4,6,7,8-HxCDF	0.1	0	U	0	UJ	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0	UJ	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0.0339	J	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0	U	0.0559	J	0.0621	J	0	UJ	0.0409	J
1,2,3,7,8,9-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00634	J	0	UJ	0	UJ	0.00597	J	0.00704	J
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	UJ	0	U	0	UJ	0	UJ
1,2,3,4,6,7,8-HpCDD	0.01	0.0237	J	0.031	J	0.0216	J	0.0246	J	0.0261	J
OCDF	0.0003	0	UJ	0.00045	J	0	UJ	0	UJ	0.0001875	J
OCDD	0.0003	0.0048		0.00621		0.002883	J	0.00378	J	0.00378	J
Total TEQ (ND = 0*EDL)[1]		**0.36584**		**0.38936**		**0.525583**		**0.72805**		**0.2770075**	

1. ND, EMPC = 0 when Q = U, UJ

Alitta virens	TEF	A.v. BW22-PCT-1-C Rep 4 1/2*EDL	Q	A.v. BW22-PCT-1-C Rep 5 1/2*EDL	Q	A.v. BW22-PCT-1-Z Rep 1 1/2*EDL	Q	A.v. BW22-PCT-1-Z Rep 2 1/2*EDL	Q	A.v. BW22-PCT-1-Z Rep 3 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.331	J	0.109	J	0.149	J	0.281	J	0.199	J
2,3,7,8-TCDD	1	0.0445	U	0.1025	UJ	0.024	U	0.0925	UJ	0.1075	UJ
1,2,3,7,8-PeCDF	0.03	0.00567	U	0.00762	U	0.00921	U	0.0075	U	0.008955	U
2,3,4,7,8-PeCDF	0.3	0.0411	UJ	0.1167	J	0.05895	UJ	0.1287	J	0.0765	UJ
1,2,3,7,8-PeCDD	1	0.1205	U	0.123	UJ	0.29	J	0.284	J	0.2065	UJ
1,2,3,4,7,8-HxCDF	0.1	0.00765	U	0.0362	J	0.01245	U	0.0182	UJ	0.0263	UJ
1,2,3,6,7,8-HxCDF	0.1	0.0072	U	0.01435	UJ	0.01545	U	0.01155	U	0.01405	UJ
2,3,4,6,7,8-HxCDF	0.1	0.00715	U	0.014	UJ	0.0121	U	0.01065	U	0.00635	U
1,2,3,7,8,9-HxCDF	0.1	0.00865	U	0.01665	UJ	0.00895	U	0.0105	U	0.0062	U
1,2,3,4,7,8-HxCDD	0.1	0.0098	U	0.0339	J	0.0125	U	0.01285	U	0.01125	U
1,2,3,6,7,8-HxCDD	0.1	0.0082	U	0.0559	J	0.0621	J	0.02175	UJ	0.0409	J
1,2,3,7,8,9-HxCDD	0.1	0.00955	U	0.00755	U	0.01195	U	0.01095	U	0.00935	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00634	J	0.004785	UJ	0.00254	UJ	0.00597	J	0.00704	J
1,2,3,4,7,8,9-HpCDF	0.01	0.00072	U	0.002	UJ	0.000615	U	0.00059	UJ	0.000545	UJ
1,2,3,4,6,7,8-HpCDD	0.01	0.0237	J	0.031	J	0.0216	J	0.0246	J	0.0261	J
OCDF	0.0003	0.00009195	UJ	0.00045	J	0.0001074	UJ	0.0000861	UJ	0.0001875	J
OCDD	0.0003	0.0048		0.00621		0.002883	J	0.00378	J	0.00378	J
Total TEQ (ND = 1/2*EDL)[2]		**0.63662195**		**0.681815**		**0.6944054**		**0.9251761**		**0.7505075**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F3. 2022 PCT Bioaccumulation Study - *A. virens* Dioxin/Furan Total TEQ Calculations

Alitta virens	TEF	A.v. BW22-PCT-1-Z Rep 4 0*EDL	Q	A.v. BW22-PCT-1-Z Rep 5 0*EDL	Q	A.v. BW22-PCT-2-C Rep 1 0*EDL	Q	A.v. BW22-PCT-2-C Rep 2 0*EDL	Q	A.v. BW22-PCT-2-C Rep 3 0*EDL	Q
2,3,7,8-TCDF	0.1	0.181	J	0.408	J	0.176	J	0.186	J	0.352	J
2,3,7,8-TCDD	1	0	U	0	UJ	0	U	0	UJ	0	U
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0.1233	J	0.129	J	0	U	0.1029	J	0.1662	J
1,2,3,7,8-PeCDD	1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0.0328	J	0	UJ	0	U	0	UJ	0	UJ
1,2,3,6,7,8-HxCDF	0.1	0	U	0.0171	J	0	U	0	UJ	0	U
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0.014	J	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0.0372	J	0.0296	J	0.0306	J	0	UJ	0.026	J
1,2,3,7,8,9-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00711	J	0.00612	J	0.00541	J	0.00551	J	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0307	J	0.0257	J	0.0165	J	0.0195	J	0.0203	J
OCDF	0.0003	0	UJ	0.0002073	J	0.0002493	J	0	UJ	0	UJ
OCDD	0.0003	0.00783	J	0.00495	J	0.00255	J	0.00459		0.00381	
Total TEQ (ND = 0*EDL)[1]		**0.41994**		**0.6206773**		**0.2313093**		**0.3325**		**0.56831**	

1. ND, EMPC = 0 when Q = U, UJ

Alitta virens	TEF	A.v. BW22-PCT-1-Z Rep 4 1/2*EDL	Q	A.v. BW22-PCT-1-Z Rep 5 1/2*EDL	Q	A.v. BW22-PCT-2-C Rep 1 1/2*EDL	Q	A.v. BW22-PCT-2-C Rep 2 1/2*EDL	Q	A.v. BW22-PCT-2-C Rep 3 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.181	J	0.408	J	0.176	J	0.186	J	0.352	J
2,3,7,8-TCDD	1	0.0215	U	0.071	UJ	0.0295	U	0.104	UJ	0.0255	U
1,2,3,7,8-PeCDF	0.03	0.007395	U	0.008235	U	0.008655	U	0.00816	U	0.010425	U
2,3,4,7,8-PeCDF	0.3	0.1233	J	0.129	J	0.036	U	0.1029	J	0.1662	J
1,2,3,7,8-PeCDD	1	0.101	U	0.1005	U	0.095	U	0.0825	U	0.132	U
1,2,3,4,7,8-HxCDF	0.1	0.0328	J	0.01615	UJ	0.0093	U	0.01335	UJ	0.01365	UJ
1,2,3,6,7,8-HxCDF	0.1	0.00665	U	0.0171	J	0.01135	U	0.0051	UJ	0.00755	U
2,3,4,6,7,8-HxCDF	0.1	0.00595	U	0.0043	U	0.0103	U	0.014	J	0.0068	U
1,2,3,7,8,9-HxCDF	0.1	0.00605	U	0.0046	U	0.0077	U	0.0052	U	0.0073	U
1,2,3,4,7,8-HxCDD	0.1	0.00965	U	0.00795	U	0.013	U	0.00715	U	0.0108	U
1,2,3,6,7,8-HxCDD	0.1	0.0372	J	0.0296	J	0.0306	J	0.0122	UJ	0.026	J
1,2,3,7,8,9-HxCDD	0.1	0.0079	U	0.00675	U	0.0119	U	0.00645	U	0.00925	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00711	J	0.00612	J	0.00541	J	0.00551	J	0.002945	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.000445	U	0.00033	U	0.000655	U	0.00035	U	0.000575	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0307	J	0.0257	J	0.0165	J	0.0195	J	0.0203	J
OCDF	0.0003	0.00012705	UJ	0.0002073	J	0.0002493	J	0.00011655	UJ	0.0001086	UJ
OCDD	0.0003	0.00783	J	0.00495	J	0.00255	J	0.00459		0.00381	
Total TEQ (ND = 1/2*EDL)[2]		**0.58660705**		**0.8404923**		**0.4646693**		**0.57707655**		**0.7952136**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F3. 2022 PCT Bioaccumulation Study - *A. virens* Dioxin/Furan Total TEQ Calculations

Alitta virens	TEF	A.v. BW22-PCT-2-C Rep 4 0*EDL	Q	A.v. BW22-PCT-2-C Rep 5 0*EDL	Q	A.v. BW22-PCT-2-Z Rep 1 0*EDL	Q	A.v. BW22-PCT-2-Z Rep 2 0*EDL	Q	A.v. BW22-PCT-2-Z Rep 3 0*EDL	Q
2,3,7,8-TCDF	0.1	0.152	J	0.125	J	0.25	J	0.229	J	0.266	J
2,3,7,8-TCDD	1	0	UJ	0	UJ	0	UJ	0	UJ	0	UJ
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0.0393	J	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0.1191	J	0	UJ	0	UJ	0.1716	J	0.1515	J
1,2,3,7,8-PeCDD	1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0	UJ	0	U	0.0714	J	0.0558	J	0	UJ
1,2,3,6,7,8-HxCDF	0.1	0	UJ	0	UJ	0	UJ	0	U	0	U
2,3,4,6,7,8-HxCDF	0.1	0	U	0	UJ	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0	UJ	0.0277	J	0.0341	J	0	UJ	0.0301	J
1,2,3,7,8,9-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00524	J	0.00588	J	0.00725	J	0	UJ	0.00452	J
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0	UJ	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0	UJ	0.0199	J	0.0195	J	0.019	J	0.0142	J
OCDF	0.0003	0.000204	J	0.0002568	J	0.0002823	J	0.0002409	J	0	UJ
OCDD	0.0003	0.00396		0.00378	J	0.002925	J	0.00387		0.00303	
Total TEQ (ND = 0*EDL)[1]		**0.280504**		**0.1825168**		**0.4247573**		**0.4795109**		**0.46935**	

1. ND, EMPC = 0 when Q = U, UJ

Alitta virens	TEF	A.v. BW22-PCT-2-C Rep 4 1/2*EDL	Q	A.v. BW22-PCT-2-C Rep 5 1/2*EDL	Q	A.v. BW22-PCT-2-Z Rep 1 1/2*EDL	Q	A.v. BW22-PCT-2-Z Rep 2 1/2*EDL	Q	A.v. BW22-PCT-2-Z Rep 3 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.152	J	0.125	J	0.25	J	0.229	J	0.266	J
2,3,7,8-TCDD	1	0.091	UJ	0.093	UJ	0.094	UJ	0.114	UJ	0.097	UJ
1,2,3,7,8-PeCDF	0.03	0.0081	U	0.006675	U	0.0393	J	0.01404	U	0.013665	U
2,3,4,7,8-PeCDF	0.3	0.1191	J	0.0477	UJ	0.10275	UJ	0.1716	J	0.1515	J
1,2,3,7,8-PeCDD	1	0.1005	U	0.087	U	0.15	U	0.1815	U	0.0785	U
1,2,3,4,7,8-HxCDF	0.1	0.01355	UJ	0.0058	U	0.0714	J	0.0558	J	0.0296	UJ
1,2,3,6,7,8-HxCDF	0.1	0.006	UJ	0.0063	UJ	0.01755	UJ	0.0088	U	0.00615	U
2,3,4,6,7,8-HxCDF	0.1	0.0051	U	0.00385	UJ	0.0091	U	0.0075	U	0.00575	U
1,2,3,7,8,9-HxCDF	0.1	0.00555	U	0.00485	U	0.008	U	0.00805	U	0.00635	U
1,2,3,4,7,8-HxCDD	0.1	0.01185	U	0.00865	U	0.0081	U	0.01085	U	0.00815	U
1,2,3,6,7,8-HxCDD	0.1	0.01585	UJ	0.0277	J	0.0341	J	0.0226	UJ	0.0301	J
1,2,3,7,8,9-HxCDD	0.1	0.01005	U	0.0072	U	0.0079	U	0.00905	U	0.00715	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00524	J	0.00588	J	0.00725	J	0.002965	UJ	0.00452	J
1,2,3,4,7,8,9-HpCDF	0.01	0.00047	U	0.000445	UJ	0.000685	U	0.00054	U	0.000555	U
1,2,3,4,6,7,8-HpCDD	0.01	0.00985	UJ	0.0199	J	0.0195	J	0.019	J	0.0142	J
OCDF	0.0003	0.000204	J	0.0002568	J	0.0002823	J	0.0002409	J	0.00009075	UJ
OCDD	0.0003	0.00396		0.00378	J	0.002925	J	0.00387		0.00303	
Total TEQ (ND = 1/2*EDL)[2]		**0.558374**		**0.4539868**		**0.8228423**		**0.8594059**		**0.72231075**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F3. 2022 PCT Bioaccumulation Study - *A. virens* Dioxin/Furan Total TEQ Calculations

Alitta virens		A.v. BW22-PCT-2-Z Rep 4		A.v. BW22-PCT-2-Z Rep 5		A.v. Carr Ref Rep 1		A.v. Carr Ref Rep 2		A.v. Carr Ref Rep 3		A.v. Carr Ref Rep 4	
	TEF	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q	0*EDL	Q
2,3,7,8-TCDF	0.1	0.227	J	0.269	J	0	UJ	0.272	J	0.114	J	0.106	J
2,3,7,8-TCDD	1	0	UJ	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8-PeCDF	0.03	0	U	0	U	0	U	0	U	0	U	0	U
2,3,4,7,8-PeCDF	0.3	0.1764	J	0	UJ	0.0426	J	0	UJ	0	U	0	U
1,2,3,7,8-PeCDD	1	0.204	J	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDF	0.1	0.0469	J	0	UJ	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDF	0.1	0	U	0	UJ	0	U	0	U	0	U	0	U
2,3,4,6,7,8-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,6,7,8-HxCDD	0.1	0.0332	J	0.0316	J	0	U	0	U	0	U	0	U
1,2,3,7,8,9-HxCDD	0.1	0	U	0	U	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00732	J	0.00636	J	0	UJ	0.00481	J	0	UJ	0	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0	U	0.00125	J	0	U	0	U	0	U	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0287	J	0.019	J	0.00897	J	0.016	J	0.00918	J	0.00891	J
OCDF	0.0003	0.000426	J	0.00021	J	0	U	0	U	0.0000837	J	0	UJ
OCDD	0.0003	0.01128	J	0.00351	J	0.001614	J	0.00396		0.001785	J	0.002661	J
Total TEQ (ND = 0*EDL)[1]		**0.735226**		**0.33093**		**0.053184**		**0.29677**		**0.1250487**		**0.117571**	

1. ND, EMPC = 0 when Q = U, UJ

Alitta virens		A.v. BW22-PCT-2-Z Rep 4		A.v. BW22-PCT-2-Z Rep 5		A.v. Carr Ref Rep 1		A.v. Carr Ref Rep 2		A.v. Carr Ref Rep 3		A.v. Carr Ref Rep 4	
	TEF	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q	1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.227	J	0.269	J	0.059	UJ	0.272	J	0.114	J	0.106	J
2,3,7,8-TCDD	1	0.09	UJ	0.0195	U	0.058	U	0.1045	U	0.0415	U	0.043	U
1,2,3,7,8-PeCDF	0.03	0.01311	U	0.01635	U	0.00252	U	0.004065	U	0.001935	U	0.00177	U
2,3,4,7,8-PeCDF	0.3	0.1764	J	0.08475	UJ	0.0426	J	0.03345	UJ	0.02055	U	0.01725	U
1,2,3,7,8-PeCDD	1	0.204	J	0.1095	U	0.126	U	0.1765	U	0.1125	U	0.0955	U
1,2,3,4,7,8-HxCDF	0.1	0.0469	J	0.0335	UJ	0.00845	U	0.0114	U	0.0078	U	0.0072	U
1,2,3,6,7,8-HxCDF	0.1	0.0068	U	0.01515	UJ	0.0074	U	0.01035	U	0.0066	U	0.0065	U
2,3,4,6,7,8-HxCDF	0.1	0.0059	U	0.0054	U	0.00745	U	0.0106	U	0.0062	U	0.00645	U
1,2,3,7,8,9-HxCDF	0.1	0.0061	U	0.0057	U	0.00895	U	0.0135	U	0.00715	U	0.0078	U
1,2,3,4,7,8-HxCDD	0.1	0.009	U	0.00835	U	0.01185	U	0.0141	U	0.00895	U	0.00885	U
1,2,3,6,7,8-HxCDD	0.1	0.0332	J	0.0316	J	0.00875	U	0.0115	U	0.00605	U	0.00695	U
1,2,3,7,8,9-HxCDD	0.1	0.0076	U	0.0068	U	0.01075	U	0.01355	U	0.00775	U	0.0083	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00732	J	0.00636	J	0.00132	UJ	0.00481	J	0.001495	UJ	0.001475	UJ
1,2,3,4,7,8,9-HpCDF	0.01	0.000535	U	0.00125	J	0.000895	U	0.00115	U	0.000615	U	0.00069	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0287	J	0.019	J	0.00897	J	0.016	J	0.00918	J	0.00891	J
OCDF	0.0003	0.000426	J	0.00021	J	0.0000315	U	0.0000522	U	0.0000837	J	0.0000516	UJ
OCDD	0.0003	0.01128	J	0.00351	J	0.001614	J	0.00396		0.001785	J	0.002661	J
Total TEQ (ND = 1/2*EDL)[2]		**0.874271**		**0.63593**		**0.3645505**		**0.7014872**		**0.3541437**		**0.3293576**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F3. 2022 PCT Bioaccumulation Study - *A. virens* Dioxin/Furan Total TEQ Calculations

Alitta virens	TEF	A.v. Carr Ref Rep 5 0*EDL	Q
2,3,7,8-TCDF	0.1	0.115	J
2,3,7,8-TCDD	1	0	UJ
1,2,3,7,8-PeCDF	0.03	0	U
2,3,4,7,8-PeCDF	0.3	0.0399	J
1,2,3,7,8-PeCDD	1	0	U
1,2,3,4,7,8-HxCDF	0.1	0	U
1,2,3,6,7,8-HxCDF	0.1	0	U
2,3,4,6,7,8-HxCDF	0.1	0	U
1,2,3,7,8,9-HxCDF	0.1	0	U
1,2,3,4,7,8-HxCDD	0.1	0	U
1,2,3,6,7,8-HxCDD	0.1	0	U
1,2,3,7,8,9-HxCDD	0.1	0	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00306	J
1,2,3,4,7,8,9-HpCDF	0.01	0	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0121	J
OCDF	0.0003	0	UJ
OCDD	0.0003	0.00372	
Total TEQ (ND = 0*EDL)[1]		**0.17378**	

1. ND, EMPC = 0 when Q = U, UJ

Alitta virens	TEF	A.v. Carr Ref Rep 5 1/2*EDL	Q
2,3,7,8-TCDF	0.1	0.115	J
2,3,7,8-TCDD	1	0.1115	UJ
1,2,3,7,8-PeCDF	0.03	0.002415	U
2,3,4,7,8-PeCDF	0.3	0.0399	J
1,2,3,7,8-PeCDD	1	0.1045	U
1,2,3,4,7,8-HxCDF	0.1	0.0075	U
1,2,3,6,7,8-HxCDF	0.1	0.0067	U
2,3,4,6,7,8-HxCDF	0.1	0.0066	U
1,2,3,7,8,9-HxCDF	0.1	0.0081	U
1,2,3,4,7,8-HxCDD	0.1	0.0073	U
1,2,3,6,7,8-HxCDD	0.1	0.0062	U
1,2,3,7,8,9-HxCDD	0.1	0.00715	U
1,2,3,4,6,7,8-HpCDF	0.01	0.00306	J
1,2,3,4,7,8,9-HpCDF	0.01	0.00084	U
1,2,3,4,6,7,8-HpCDD	0.01	0.0121	J
OCDF	0.0003	0.00006675	UJ
OCDD	0.0003	0.00372	
Total TEQ (ND = 1/2*EDL)[2]		**0.44265175**	

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Qualifiers

U: this analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD)

J: concentration less than limit of quantification

UJ: identified a compound that was not detected

Table F4. 2022 Bioaccumulation Study - *M. nasuta* Dioxin/Furan Congener Data

Macoma nasuta Compound	Units Wet Weight	M.n. PreTest Rep 1 Results	Q	M.n. PreTest Rep 2 Results	Q	M.n. PreTest Rep 3 Results	Q	M.n. BW22-PCT-1-C Rep 1 Results	Q	M.n. BW22-PCT-1-C Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	0.103	U	0.079	U	0.088	U	0.597	J	0.606	J
2,3,7,8-TCDD	ng/kg	0.075	U	0.064	U	0.075	U	0.059	U	0.08	U
1,2,3,7,8-PeCDF	ng/kg	0.142	U	0.112	U	0.116	U	0.138	U	0.101	U
2,3,4,7,8-PeCDF	ng/kg	0.121	U	0.106	U	0.107	U	0.117	UJ	0.168	UJ
1,2,3,7,8-PeCDD	ng/kg	0.095	UJ	0.1	U	0.106	U	0.111	U	0.146	U
1,2,3,4,7,8-HxCDF	ng/kg	0.063	U	0.062	U	0.064	U	0.342	J	0.327	UJ
1,2,3,6,7,8-HxCDF	ng/kg	0.058	U	0.063	U	0.057	U	0.128	UJ	0.108	J
2,3,4,6,7,8-HxCDF	ng/kg	0.066	U	0.064	U	0.063	U	0.055	U	0.082	U
1,2,3,7,8,9-HxCDF	ng/kg	0.072	U	0.076	U	0.071	U	0.062	U	0.094	U
1,2,3,4,7,8-HxCDD	ng/kg	0.086	U	0.078	U	0.075	U	0.074	U	0.076	U
1,2,3,6,7,8-HxCDD	ng/kg	0.08	U	0.07	U	0.074	U	0.259	J	0.245	J
1,2,3,7,8,9-HxCDD	ng/kg	0.091	U	0.081	U	0.082	U	0.107	UJ	0.169	UJ
1,2,3,4,6,7,8-HpCDF	ng/kg	0.099	U	0.079	U	0.09	U	0.671	UJ	0.621	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.14	U	0.106	U	0.133	U	0.117	U	0.209	UJ
1,2,3,4,6,7,8-HpCDD	ng/kg	0.327	UJ	0.256	UJ	0.241	UJ	2.76	J	2.19	J
OCDF	ng/kg	0.208	J	0.185	U	0.177	U	1.14	J	0.822	J
OCDD	ng/kg	0.157	U	0.131	U	0.146	U	17.4		14.9	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.000**		**0.000**		**0.000**		**0.153**		**0.129**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.139**		**0.130**		**0.139**		**0.283**		**0.307**	
Total TCDF	ng/kg	0.042	U	0.046	U	0.052	U	1.13		0.755	J
Total TCDD	ng/kg	0.091	U	0.071	U	0.096	U	0.073	U	0.061	U
Total PeCDF	ng/kg	1	U	1	U	1	U	0.745	J	1	U
Total PeCDD	ng/kg	0.237		0.081	U	0.075	U	0.056	U	0.071	U
Total HxCDF	ng/kg	0.083	U	0.093	U	0.086	U	1.4		0.368	J
Total HxCDD	ng/kg	0.093	U	0.091	U	0.087	U	0.121	U	0.249	J
Total HpCDF	ng/kg	0.108	U	0.115	U	0.085	U	1.64		0.071	U
Total HpCDD	ng/kg	0.127	U	0.562	J	0.117	U	6.97		2.88	

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F4. 2022 Bioaccumulation Study - *M. nasuta* Dioxin/Furan Congener Data

Macoma nasuta Compound	Units Wet Weight	M.n. BW22-PCT-1-C Rep 3 Results	Q	M.n. BW22-PCT-1-C Rep 4 Results	Q	M.n. BW22-PCT-1-C Rep 5 Results	Q	M.n. BW22-PCT-1-Z Rep 1 Results	Q	M.n. BW22-PCT-1-Z Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	0.875	UJ	0.684	J	0.631	J	0.765	J	1.02	UJ
2,3,7,8-TCDD	ng/kg	0.083	U	0.086	U	0.119	U	0.088	U	0.099	U
1,2,3,7,8-PeCDF	ng/kg	0.162	U	0.149	U	0.19	U	0.175	U	0.229	U
2,3,4,7,8-PeCDF	ng/kg	0.215	UJ	0.295	UJ	0.257	UJ	0.286	UJ	0.356	J
1,2,3,7,8-PeCDD	ng/kg	0.206	U	0.138	U	0.209	U	0.09	UJ	0.182	U
1,2,3,4,7,8-HxCDF	ng/kg	0.529	J	0.646	J	0.424	J	0.603	J	0.73	UJ
1,2,3,6,7,8-HxCDF	ng/kg	0.187	UJ	0.235	J	0.168	UJ	0.178	J	0.232	UJ
2,3,4,6,7,8-HxCDF	ng/kg	0.091	U	0.086	U	0.099	U	0.171	J	0.166	J
1,2,3,7,8,9-HxCDF	ng/kg	0.105	U	0.095	U	0.11	U	0.104	U	0.112	U
1,2,3,4,7,8-HxCDD	ng/kg	0.114	U	0.119	U	0.126	U	0.142	U	0.205	U
1,2,3,6,7,8-HxCDD	ng/kg	0.344	UJ	0.37	J	0.339	UJ	0.423	UJ	0.588	UJ
1,2,3,7,8,9-HxCDD	ng/kg	0.263	UJ	0.161	J	0.138	U	0.155	U	0.166	J
1,2,3,4,6,7,8-HpCDF	ng/kg	0.865	UJ	0.739	J	0.75	UJ	0.774	UJ	1.1	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.265	UJ	0.214	U	0.2	U	0.187	U	0.169	U
1,2,3,4,6,7,8-HpCDD	ng/kg	3.72	J	3.65	J	3.28	J	3.95	J	4.98	J
OCDF	ng/kg	1.36	J	1.78	UJ	1.58	J	1.17	J	1.77	J
OCDD	ng/kg	26.6		24.5		27.7		24.6		31.8	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.098**		**0.261**		**0.147**		**0.219**		**0.211**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.382**		**0.436**		**0.406**		**0.399**		**0.500**	
Total TCDF	ng/kg	0.765	J	0.05	U	0.335	J	0.239	J	1.65	
Total TCDD	ng/kg	0.085	U	0.078	U	0.082	U	0.097	U	0.111	U
Total PeCDF	ng/kg	0.6	J	0.877	J	1.45		2.18		1.26	
Total PeCDD	ng/kg	0.074	U	0.068	U	0.071	U	0.073	U	0.354	
Total HxCDF	ng/kg	1.32		2.01		1.68		1.02		3.05	
Total HxCDD	ng/kg	0.835	J	0.108	U	0.603	J	0.115	U	1.31	
Total HpCDF	ng/kg	0.925	J	0.755	J	2.42		0.887	J	1.74	
Total HpCDD	ng/kg	12.8		8.41		10.7		1.46	J	14.6	J

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F4. 2022 Bioaccumulation Study - *M. nasuta* Dioxin/Furan Congener Data

Macoma nasuta Compound	Units Wet Weight	M.n. BW22-PCT-1-Z Rep 3 Results	Q	M.n. BW22-PCT-1-Z Rep 4 Results	Q	M.n. BW22-PCT-1-Z Rep 5 Results	Q	M.n. BW22-PCT-2-C Rep 1 Results	Q	M.n. BW22-PCT-2-C Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	0.773	J	0.773	J	0.758	J	1.04	J	1.43	J
2,3,7,8-TCDD	ng/kg	0.214	UJ	0.083	U	0.085	U	0.084	U	0.108	U
1,2,3,7,8-PeCDF	ng/kg	0.172	U	0.159	U	0.133	U	0.209	U	0.181	U
2,3,4,7,8-PeCDF	ng/kg	0.297	UJ	0.311	UJ	0.196	UJ	0.255	UJ	0.266	UJ
1,2,3,7,8-PeCDD	ng/kg	0.183	U	0.161	U	0.161	U	0.195	UJ	0.175	U
1,2,3,4,7,8-HxCDF	ng/kg	0.647	J	0.529	J	1.28	J	0.494	J	0.61	UJ
1,2,3,6,7,8-HxCDF	ng/kg	0.211	J	0.131	UJ	0.358	UJ	0.205	UJ	0.265	UJ
2,3,4,6,7,8-HxCDF	ng/kg	0.185	UJ	0.086	U	0.09	U	0.089	U	0.102	U
1,2,3,7,8,9-HxCDF	ng/kg	0.097	U	0.096	U	0.175	J	0.101	U	0.111	U
1,2,3,4,7,8-HxCDD	ng/kg	0.218	UJ	0.109	UJ	0.089	U	0.104	U	0.13	U
1,2,3,6,7,8-HxCDD	ng/kg	0.589	J	0.511	J	0.391	J	0.294	UJ	0.339	UJ
1,2,3,7,8,9-HxCDD	ng/kg	0.268	UJ	0.138	U	0.162	J	0.113	U	0.135	J
1,2,3,4,6,7,8-HpCDF	ng/kg	1.05	J	0.872	J	1.15	J	0.708	UJ	0.921	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.161	U	0.149	U	0.137	U	0.18	U	0.268	J
1,2,3,4,6,7,8-HpCDD	ng/kg	4.75	J	4.92	J	3.94	J	2.36	J	3.25	J
OCDF	ng/kg	1.92	J	1.37	UJ	1.22	J	1.74	J	2.1	J
OCDD	ng/kg	28.1		31.3		24.6		17.3		23.7	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.289**		**0.249**		**0.335**		**0.183**		**0.209**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.574**		**0.449**		**0.517**		**0.413**		**0.471**	
Total TCDF	ng/kg	0.74	J	0.749	J	0.091	U	0.681	J	0.719	J
Total TCDD	ng/kg	0.35	J	0.21	U	0.2	U	0.249	U	0.266	U
Total PeCDF	ng/kg	1	U	2.08		1.67		0.746	J	1	U
Total PeCDD	ng/kg	0.153		0.136	U	0.146	U	0.14	U	0.183	U
Total HxCDF	ng/kg	2.94		1.4		0.962	J	0.153	U	1.06	
Total HxCDD	ng/kg	0.199	U	2.76		0.81	J	0.3	J	0.551	J
Total HpCDF	ng/kg	1.16		1.47		0.746	J	0.68	J	0.551	J
Total HpCDD	ng/kg	13	J	10.9	J	5.1	J	0.318	UJ	7.26	J

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F4. 2022 Bioaccumulation Study - *M. nasuta* Dioxin/Furan Congener Data

Macoma nasuta Compound	Units Wet Weight	M.n. BW22-PCT-2-C Rep 3 Results	Q	M.n. BW22-PCT-2-C Rep 4 Results	Q	M.n. BW22-PCT-2-C Rep 5 Results	Q	M.n. BW22-PCT-2-Z Rep 1 Results	Q	M.n. BW22-PCT-2-Z Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	0.66	UJ	0.709	J	0.98	UJ	1.54	J	1.54	
2,3,7,8-TCDD	ng/kg	0.091	U	0.089	U	0.082	U	0.074	U	0.091	U
1,2,3,7,8-PeCDF	ng/kg	0.192	U	0.145	U	0.139	U	0.164	U	0.171	U
2,3,4,7,8-PeCDF	ng/kg	0.174	U	0.129	U	0.219	UJ	0.424	UJ	0.443	UJ
1,2,3,7,8-PeCDD	ng/kg	0.129	U	0.128	U	0.123	J	0.136	U	0.159	U
1,2,3,4,7,8-HxCDF	ng/kg	0.384	UJ	0.234	UJ	0.456	UJ	1.14	J	0.848	UJ
1,2,3,6,7,8-HxCDF	ng/kg	0.224	UJ	0.088	U	0.179	J	0.269	J	0.299	UJ
2,3,4,6,7,8-HxCDF	ng/kg	0.094	U	0.09	U	0.101	U	0.073	U	0.095	U
1,2,3,7,8,9-HxCDF	ng/kg	0.104	U	0.105	U	0.117	U	0.084	U	0.107	U
1,2,3,4,7,8-HxCDD	ng/kg	0.141	U	0.105	U	0.105	U	0.118	U	0.11	U
1,2,3,6,7,8-HxCDD	ng/kg	0.274	J	0.139	UJ	0.248	UJ	0.293	J	0.298	UJ
1,2,3,7,8,9-HxCDD	ng/kg	0.28	UJ	0.114	U	0.143	UJ	0.142	UJ	0.116	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.685	UJ	0.478	J	0.748	J	0.903	J	0.877	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.269	UJ	0.182	U	0.159	U	0.286	J	0.189	U
1,2,3,4,6,7,8-HpCDD	ng/kg	2.05	J	1.27	J	2.5	J	2.05	J	2.27	J
OCDF	ng/kg	1.7	J	0.238	U	1.55	J	1.26	J	1.33	J
OCDD	ng/kg	13.3		8.25	J	16.3		10.8	U	14.1	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.052**		**0.091**		**0.179**		**0.357**		**0.190**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.291**		**0.266**		**0.363**		**0.550**		**0.479**	
Total TCDF	ng/kg	0.17	U	0.161	U	0.717	J	1.35		0.154	U
Total TCDD	ng/kg	0.431	U	0.333	U	0.361	U	0.258	U	0.389	U
Total PeCDF	ng/kg	0.769	J	1	U	1	U	1.31		0.892	J
Total PeCDD	ng/kg	0.256	U	0.237	U	0.217	U	0.2	U	0.23	U
Total HxCDF	ng/kg	0.342	U	0.2	U	0.203	U	1.21		1.03	
Total HxCDD	ng/kg	0.297	U	0.28	U	0.326	U	0.262	U	0.351	U
Total HpCDF	ng/kg	0.31	U	0.833	J	0.261	U	0.618	J	1.27	
Total HpCDD	ng/kg	3.2	J	0.368	UJ	2.97	J	5.16		4.4	

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F4. 2022 Bioaccumulation Study - *M. nasuta* Dioxin/Furan Congener Data

Macoma nasuta Compound	Units Wet Weight	M.n. BW22-PCT-2-Z Rep 3 Results	Q	M.n. BW22-PCT-2-Z Rep 4 Results	Q	M.n. BW22-PCT-2-Z Rep 5 Results	Q	M.n. Carr Ref Rep 1 Results	Q	M.n. Carr Ref Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	1.91	J	1.58		1.95		0.268	UJ	0.093	U
2,3,7,8-TCDD	ng/kg	0.09	U	0.074	U	0.096	U	0.051	U	0.074	U
1,2,3,7,8-PeCDF	ng/kg	1.27	J	1.23	J	1.77	UJ	0.102	U	0.124	U
2,3,4,7,8-PeCDF	ng/kg	0.399	UJ	0.545	J	0.52	UJ	0.108	U	0.109	U
1,2,3,7,8-PeCDD	ng/kg	0.167	U	0.125	U	0.195	UJ	0.102	U	0.117	U
1,2,3,4,7,8-HxCDF	ng/kg	0.951	J	1.03	J	1.2	J	0.051	U	0.073	U
1,2,3,6,7,8-HxCDF	ng/kg	0.275	UJ	0.255	UJ	0.378	J	0.052	U	0.069	U
2,3,4,6,7,8-HxCDF	ng/kg	0.074	U	0.07	U	0.122	U	0.054	U	0.076	U
1,2,3,7,8,9-HxCDF	ng/kg	0.082	U	0.216	UJ	0.134	U	0.058	U	0.084	U
1,2,3,4,7,8-HxCDD	ng/kg	0.102	U	0.09	U	0.109	U	0.085	U	0.093	U
1,2,3,6,7,8-HxCDD	ng/kg	0.369	J	0.331	UJ	0.449	J	0.078	U	0.087	U
1,2,3,7,8,9-HxCDD	ng/kg	0.112	U	0.136	J	0.118	U	0.089	U	0.099	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.9	UJ	0.879	J	0.87	UJ	0.119	UJ	0.084	U
1,2,3,4,7,8,9-HpCDF	ng/kg	0.326	J	0.262	J	0.263	J	0.098	U	0.115	U
1,2,3,4,6,7,8-HpCDD	ng/kg	2.62	J	2.45	J	2.72	UJ	0.564	J	0.774	J
OCDF	ng/kg	1.7	J	1.43	J	1.66	J	0.154	U	0.21	U
OCDD	ng/kg	14.4		12.5		16.4		0.131	U	3.74	J
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.395**		**0.515**		**0.406**		**0.006**		**0.009**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.620**		**0.663**		**0.698**		**0.138**		**0.157**	
Total TCDF	ng/kg	2.19		3.02		1.49		0.032	U	0.047	U
Total TCDD	ng/kg	0.286	U	0.311	U	0.264	U	0.1	U	0.086	U
Total PeCDF	ng/kg	0.776	J	1.3		2.69		1	U	1	U
Total PeCDD	ng/kg	0.211	U	0.196	U	0.197	U	0.086	U	0.071	U
Total HxCDF	ng/kg	0.743	J	0.197	U	0.215	U	0.092	U	0.082	U
Total HxCDD	ng/kg	0.385	J	0.313	J	0.368	U	0.119	U	0.142	U
Total HpCDF	ng/kg	1.39		0.198	U	0.201	U	0.085	U	0.095	U
Total HpCDD	ng/kg	4.82		1.87		6.03		0.817	J	0.169	U

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F4. 2022 Bioaccumulation Study - *M. nasuta* Dioxin/Furan Congener Data

Macoma nasuta Compound	Units Wet Weight	M.n. Carr Ref Rep 3 Results	Q	M.n. Carr Ref Rep 4 Results	Q	M.n. Carr Ref Rep 5 Results	Q
Dioxins/Furans							
2,3,7,8-TCDF	ng/kg	0.131	U	0.079	U	0.106	UJ
2,3,7,8-TCDD	ng/kg	0.1	U	0.067	U	0.053	U
1,2,3,7,8-PeCDF	ng/kg	0.143	U	0.107	U	0.092	U
2,3,4,7,8-PeCDF	ng/kg	0.127	U	0.109	U	0.087	U
1,2,3,7,8-PeCDD	ng/kg	0.117	U	0.111	U	0.131	U
1,2,3,4,7,8-HxCDF	ng/kg	0.073	U	0.053	U	0.064	U
1,2,3,6,7,8-HxCDF	ng/kg	0.07	U	0.053	U	0.066	U
2,3,4,6,7,8-HxCDF	ng/kg	0.073	U	0.053	U	0.064	U
1,2,3,7,8,9-HxCDF	ng/kg	0.083	U	0.058	U	0.072	U
1,2,3,4,7,8-HxCDD	ng/kg	0.099	U	0.079	U	0.066	U
1,2,3,6,7,8-HxCDD	ng/kg	0.093	U	0.069	U	0.062	U
1,2,3,7,8,9-HxCDD	ng/kg	0.105	U	0.081	U	0.088	UJ
1,2,3,4,6,7,8-HpCDF	ng/kg	0.099	U	0.173	UJ	0.144	UJ
1,2,3,4,7,8,9-HpCDF	ng/kg	0.149	U	0.111	U	0.114	U
1,2,3,4,6,7,8-HpCDD	ng/kg	0.395	UJ	0.608	J	0.511	J
OCDF	ng/kg	0.209	U	0.155	UJ	0.22	UJ
OCDD	ng/kg	0.178	U	3.88	J	0.15	U
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.000**		**0.007**		**0.005**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.169**		**0.142**		**0.142**	
Total TCDF	ng/kg	0.041	U	0.04	U	0.035	U
Total TCDD	ng/kg	0.081	U	0.078	U	0.082	U
Total PeCDF	ng/kg	1	U	1	U	1	U
Total PeCDD	ng/kg	0.063	U	0.071	U	0.058	U
Total HxCDF	ng/kg	0.073	U	0.083	U	0.081	U
Total HxCDD	ng/kg	0.112	U	0.115	U	0.353	J
Total HpCDF	ng/kg	0.092	U	0.071	U	0.231	J
Total HpCDD	ng/kg	1.13		0.614	J	0.851	J

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Qualifiers

U: this analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD)

J: concentration less than limit of quantification

UJ: identified a compound that was not detected

Table F4. 2022 Bioaccumulation Study - *M. nasuta* Dioxin/Furan Congener Data

Macoma nasuta Compound	Units Wet Weight
Dioxins/Furans	
2,3,7,8-TCDF	ng/kg
2,3,7,8-TCDD	ng/kg
1,2,3,7,8-PeCDF	ng/kg
2,3,4,7,8-PeCDF	ng/kg
1,2,3,7,8-PeCDD	ng/kg
1,2,3,4,7,8-HxCDF	ng/kg
1,2,3,6,7,8-HxCDF	ng/kg
2,3,4,6,7,8-HxCDF	ng/kg
1,2,3,7,8,9-HxCDF	ng/kg
1,2,3,4,7,8-HxCDD	ng/kg
1,2,3,6,7,8-HxCDD	ng/kg
1,2,3,7,8,9-HxCDD	ng/kg
1,2,3,4,6,7,8-HpCDF	ng/kg
1,2,3,4,7,8,9-HpCDF	ng/kg
1,2,3,4,6,7,8-HpCDD	ng/kg
OCDF	ng/kg
OCDD	ng/kg
Total TEQ (ND = 0*EDL)[1]	**ng/kg**
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**
Total TCDF	ng/kg
Total TCDD	ng/kg
Total PeCDF	ng/kg
Total PeCDD	ng/kg
Total HxCDF	ng/kg
Total HxCDD	ng/kg
Total HpCDF	ng/kg
Total HpCDD	ng/kg

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F5. 2022 Bioaccumulation Study - *A. virens* Dioxin/Furan Congener Data

Alitta virens Compound	Units Wet Weight	A.v. PreTest Rep 1 Results	Q	A.v. PreTest Rep 2 Results	Q	A.v. PreTest Rep 3 Results	Q	A.v. BW22-PCT-1-C Rep 1 Results	Q	A.v. BW22-PCT-1-C Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	0.889	UJ	1.3	J	1.31	J	2.66	J	1.82	J
2,3,7,8-TCDD	ng/kg	0.114	U	0.099	U	0.159	UJ	0.084	U	0.101	U
1,2,3,7,8-PeCDF	ng/kg	0.247	U	0.188	U	0.152	U	0.168	U	0.271	U
2,3,4,7,8-PeCDF	ng/kg	0.275	U	0.239	U	0.231	U	0.398	UJ	0.125	UJ
1,2,3,7,8-PeCDD	ng/kg	0.259	U	0.234	U	0.166	UJ	0.206	U	0.205	U
1,2,3,4,7,8-HxCDF	ng/kg	0.134	U	0.134	U	0.156	U	0.195	U	0.262	UJ
1,2,3,6,7,8-HxCDF	ng/kg	0.138	U	0.138	U	0.157	U	0.212	U	0.103	U
2,3,4,6,7,8-HxCDF	ng/kg	0.132	U	0.132	U	0.162	U	0.212	U	0.101	U
1,2,3,7,8,9-HxCDF	ng/kg	0.128	U	0.128	U	0.147	U	0.177	U	0.122	U
1,2,3,4,7,8-HxCDD	ng/kg	0.186	U	0.186	U	0.198	U	0.224	U	0.231	U
1,2,3,6,7,8-HxCDD	ng/kg	0.159	U	0.177	J	0.15	U	0.146	J	0.198	U
1,2,3,7,8,9-HxCDD	ng/kg	0.188	U	0.188	U	0.123	UJ	0.219	U	0.228	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.665	UJ	0.637	J	0.761	J	0.616	UJ	0.528	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.214	U	0.156	U	0.165	U	0.201	U	0.153	U
1,2,3,4,6,7,8-HpCDD	ng/kg	1.32	J	1.26	J	1.44	UJ	1.58	J	1.8	J
OCDF	ng/kg	0.365	UJ	0.298	UJ	0.619	J	0.628	UJ	0.728	J
OCDD	ng/kg	8.87	J	7.99	J	7.37	J	7.68	J	12.2	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.016**		**0.169**		**0.141**		**0.299**		**0.209**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.349**		**0.420**		**0.403**		**0.572**		**0.448**	
Total TCDF	ng/kg	0.285	J	1.41		1.67		3.17		2.78	
Total TCDD	ng/kg	0.998	U	0.998	U	0.267	J	0.997	U	0.998	U
Total PeCDF	ng/kg	1.24		1.14		0.807	J	3.44		1.16	
Total PeCDD	ng/kg	0.998	U	0.998	U	0.999	U	0.997	U	0.998	U
Total HxCDF	ng/kg	0.998	U	0.998	U	0.939	J	0.688	J	0.618	J
Total HxCDD	ng/kg	0.523	J	0.539	J	0.999	U	0.558	J	0.998	U
Total HpCDF	ng/kg	0.349	J	0.637	J	0.761	J	0.523	J	0.998	U
Total HpCDD	ng/kg	2.96		2.7		1.58		3.79		1.18	J

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F5. 2022 Bioaccumulation Study - *A. virens* Dioxin/Furan Congener Data

Alitta virens Compound	Units Wet Weight	A.v. BW22-PCT-1-C Rep 3 Results	Q	A.v. BW22-PCT-1-C Rep 4 Results	Q	A.v. BW22-PCT-1-C Rep 5 Results	Q	A.v. BW22-PCT-1-Z Rep 1 Results	Q	A.v. BW22-PCT-1-Z Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	2.02	UJ	3.31	J	1.09	J	1.49	J	2.81	J
2,3,7,8-TCDD	ng/kg	0.078	U	0.089	U	0.205	UJ	0.048	U	0.185	UJ
1,2,3,7,8-PeCDF	ng/kg	0.537	U	0.378	U	0.508	U	0.614	U	0.5	U
2,3,4,7,8-PeCDF	ng/kg	0.326	UJ	0.274	UJ	0.389	J	0.393	UJ	0.429	J
1,2,3,7,8-PeCDD	ng/kg	0.258	U	0.241	U	0.246	UJ	0.29	J	0.284	J
1,2,3,4,7,8-HxCDF	ng/kg	0.205	UJ	0.153	U	0.362	J	0.249	U	0.364	UJ
1,2,3,6,7,8-HxCDF	ng/kg	0.142	U	0.144	U	0.287	UJ	0.309	U	0.231	U
2,3,4,6,7,8-HxCDF	ng/kg	0.136	U	0.143	U	0.28	UJ	0.242	U	0.213	U
1,2,3,7,8,9-HxCDF	ng/kg	0.161	U	0.173	U	0.333	UJ	0.179	U	0.21	U
1,2,3,4,7,8-HxCDD	ng/kg	0.215	U	0.196	U	0.339	J	0.25	U	0.257	U
1,2,3,6,7,8-HxCDD	ng/kg	0.305	UJ	0.164	U	0.559	J	0.621	J	0.435	UJ
1,2,3,7,8,9-HxCDD	ng/kg	0.198	U	0.191	U	0.151	U	0.239	U	0.219	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.495	UJ	0.634	J	0.957	UJ	0.508	UJ	0.597	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.125	U	0.144	U	0.4	UJ	0.123	U	0.118	UJ
1,2,3,4,6,7,8-HpCDD	ng/kg	1.86	J	2.37	J	3.1	J	2.16	J	2.46	J
OCDF	ng/kg	0.613	UJ	0.613	UJ	1.5	J	0.716	UJ	0.574	UJ
OCDD	ng/kg	12.7		16		20.7		9.61	J	12.6	J
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.022**		**0.366**		**0.389**		**0.526**		**0.728**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.420**		**0.637**		**0.682**		**0.694**		**0.925**	
Total TCDF	ng/kg	3.27		6.64		1.38		1.7		4.78	
Total TCDD	ng/kg	0.163	U	0.996	U	1	U	0.206		0.998	U
Total PeCDF	ng/kg	1.5		2.57		1.5		2.75		1.2	
Total PeCDD	ng/kg	0.202	U	0.996	U	1	U	0.432	J	0.998	U
Total HxCDF	ng/kg	0.248	U	0.779	J	1	U	0.999	U	0.998	U
Total HxCDD	ng/kg	0.238	U	0.996	U	0.598	J	1.33		1.09	
Total HpCDF	ng/kg	0.137	U	1.05		1.06		0.999	U	0.323	J
Total HpCDD	ng/kg	0.616	J	3.58	J	3.87	J	4.99		1.49	

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F5. 2022 Bioaccumulation Study - *A. virens* Dioxin/Furan Congener Data

Alitta virens Compound	Units Wet Weight	A.v. BW22-PCT-1-Z Rep 3 Results	Q	A.v. BW22-PCT-1-Z Rep 4 Results	Q	A.v. BW22-PCT-1-Z Rep 5 Results	Q	A.v. BW22-PCT-2-C Rep 1 Results	Q	A.v. BW22-PCT-2-C Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	1.99	J	1.81	J	4.08	J	1.76	J	1.86	J
2,3,7,8-TCDD	ng/kg	0.215	UJ	0.043	U	0.142	UJ	0.059	U	0.208	UJ
1,2,3,7,8-PeCDF	ng/kg	0.597	U	0.493	U	0.549	U	0.577	U	0.544	U
2,3,4,7,8-PeCDF	ng/kg	0.51	UJ	0.411	J	0.43	J	0.24	U	0.343	J
1,2,3,7,8-PeCDD	ng/kg	0.413	UJ	0.202	U	0.201	U	0.19	U	0.165	U
1,2,3,4,7,8-HxCDF	ng/kg	0.526	UJ	0.328	J	0.323	UJ	0.186	U	0.267	UJ
1,2,3,6,7,8-HxCDF	ng/kg	0.281	UJ	0.133	U	0.171	J	0.227	U	0.102	UJ
2,3,4,6,7,8-HxCDF	ng/kg	0.127	U	0.119	U	0.086	U	0.206	U	0.14	J
1,2,3,7,8,9-HxCDF	ng/kg	0.124	U	0.121	U	0.092	U	0.154	U	0.104	U
1,2,3,4,7,8-HxCDD	ng/kg	0.225	U	0.193	U	0.159	U	0.26	U	0.143	U
1,2,3,6,7,8-HxCDD	ng/kg	0.409	J	0.372	J	0.296	J	0.306	J	0.244	UJ
1,2,3,7,8,9-HxCDD	ng/kg	0.187	U	0.158	U	0.135	U	0.238	U	0.129	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.704	J	0.711	J	0.612	J	0.541	J	0.551	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.109	UJ	0.089	U	0.066	U	0.131	U	0.07	U
1,2,3,4,6,7,8-HpCDD	ng/kg	2.61	J	3.07	J	2.57	J	1.65	J	1.95	J
OCDF	ng/kg	0.625	J	0.847	UJ	0.691	J	0.831	J	0.777	UJ
OCDD	ng/kg	12.6	J	26.1	J	16.5	J	8.5	J	15.3	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.277**		**0.420**		**0.621**		**0.231**		**0.333**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.751**		**0.587**		**0.840**		**0.465**		**0.577**	
Total TCDF	ng/kg	3.8		3.7		3.53		2.98		0.57	J
Total TCDD	ng/kg	0.998	U	0.999	U	0.998	U	1	U	0.283	
Total PeCDF	ng/kg	0.998	U	1.2		5.11		3.81		0.413	J
Total PeCDD	ng/kg	0.24	J	0.999	U	0.998	U	1	U	1	U
Total HxCDF	ng/kg	0.998	U	0.889	J	1.44		1	U	1	U
Total HxCDD	ng/kg	0.471	J	0.999	U	0.998	U	0.641	J	1	U
Total HpCDF	ng/kg	0.622	J	0.594	J	0.998	U	0.541	J	1	U
Total HpCDD	ng/kg	3.39		3.53		5.64		3.93		2.93	

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F5. 2022 Bioaccumulation Study - *A. virens* Dioxin/Furan Congener Data

Alitta virens Compound	Units Wet Weight	A.v. BW22-PCT-2-C Rep 3 Results	Q	A.v. BW22-PCT-2-C Rep 4 Results	Q	A.v. BW22-PCT-2-C Rep 5 Results	Q	A.v. BW22-PCT-2-Z Rep 1 Results	Q	A.v. BW22-PCT-2-Z Rep 2 Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	3.52	J	1.52	J	1.25	J	2.5	J	2.29	J
2,3,7,8-TCDD	ng/kg	0.051	U	0.182	UJ	0.186	UJ	0.188	UJ	0.228	UJ
1,2,3,7,8-PeCDF	ng/kg	0.695	U	0.54	U	0.445	U	1.31	J	0.936	U
2,3,4,7,8-PeCDF	ng/kg	0.554	J	0.397	J	0.318	UJ	0.685	UJ	0.572	J
1,2,3,7,8-PeCDD	ng/kg	0.264	U	0.201	U	0.174	U	0.3	U	0.363	U
1,2,3,4,7,8-HxCDF	ng/kg	0.273	UJ	0.271	UJ	0.116	U	0.714	J	0.558	J
1,2,3,6,7,8-HxCDF	ng/kg	0.151	U	0.12	UJ	0.126	UJ	0.351	UJ	0.176	U
2,3,4,6,7,8-HxCDF	ng/kg	0.136	U	0.102	U	0.077	UJ	0.182	U	0.15	U
1,2,3,7,8,9-HxCDF	ng/kg	0.146	U	0.111	U	0.097	U	0.16	U	0.161	U
1,2,3,4,7,8-HxCDD	ng/kg	0.216	U	0.237	U	0.173	U	0.162	U	0.217	U
1,2,3,6,7,8-HxCDD	ng/kg	0.26	J	0.317	UJ	0.277	J	0.341	J	0.452	UJ
1,2,3,7,8,9-HxCDD	ng/kg	0.185	U	0.201	U	0.144	U	0.158	U	0.181	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.589	UJ	0.524	J	0.588	J	0.725	J	0.593	UJ
1,2,3,4,7,8,9-HpCDF	ng/kg	0.115	U	0.094	U	0.089	UJ	0.137	U	0.108	U
1,2,3,4,6,7,8-HpCDD	ng/kg	2.03	J	1.97	UJ	1.99	J	1.95	J	1.9	J
OCDF	ng/kg	0.724	UJ	0.68	J	0.856	J	0.941	J	0.803	J
OCDD	ng/kg	12.7		13.2		12.6	J	9.75	J	12.9	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.568**		**0.281**		**0.183**		**0.425**		**0.480**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.795**		**0.558**		**0.454**		**0.823**		**0.859**	
Total TCDF	ng/kg	6.25		1.58		0.999	U	4.38		3.7	
Total TCDD	ng/kg	1	U	0.999	U	0.999	U	0.999	U	0.997	U
Total PeCDF	ng/kg	3.47		0.999	U	1.18		4.46		2.85	
Total PeCDD	ng/kg	1	U	0.999	U	0.999	U	0.999	U	0.997	U
Total HxCDF	ng/kg	0.765	J	0.34	J	0.999	U	0.714	J	0.997	U
Total HxCDD	ng/kg	1	U	0.999	U	0.999	U	0.984	J	0.997	U
Total HpCDF	ng/kg	0.382	J	0.999	U	0.999	U	1.56		0.997	U
Total HpCDD	ng/kg	1.77		1.8		0.999	U	4.92		1.85	

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F5. 2022 Bioaccumulation Study - *A. virens* Dioxin/Furan Congener Data

Alitta virens	Units	A.v. BW22-PCT-2-Z Rep 3		A.v. BW22-PCT-2-Z Rep 4		A.v. BW22-PCT-2-Z Rep 5		A.v. Carr Ref Rep 1		A.v. Carr Ref Rep 2	
Compound	Wet Weight	Results	Q	Results	Q	Results	Q	Results	Q	Results	Q
Dioxins/Furans											
2,3,7,8-TCDF	ng/kg	2.66	J	2.27	J	2.69	J	1.18	UJ	2.72	J
2,3,7,8-TCDD	ng/kg	0.194	UJ	0.18	UJ	0.039	U	0.116	U	0.209	U
1,2,3,7,8-PeCDF	ng/kg	0.911	U	0.874	U	1.09	U	0.168	U	0.271	U
2,3,4,7,8-PeCDF	ng/kg	0.505	J	0.588	J	0.565	UJ	0.142	J	0.223	UJ
1,2,3,7,8-PeCDD	ng/kg	0.157	U	0.204	J	0.219	U	0.252	U	0.353	U
1,2,3,4,7,8-HxCDF	ng/kg	0.592	UJ	0.469	J	0.67	UJ	0.169	U	0.228	U
1,2,3,6,7,8-HxCDF	ng/kg	0.123	U	0.136	U	0.303	UJ	0.148	U	0.207	U
2,3,4,6,7,8-HxCDF	ng/kg	0.115	U	0.118	U	0.108	U	0.149	U	0.212	U
1,2,3,7,8,9-HxCDF	ng/kg	0.127	U	0.122	U	0.114	U	0.179	U	0.27	U
1,2,3,4,7,8-HxCDD	ng/kg	0.163	U	0.18	U	0.167	U	0.237	U	0.282	U
1,2,3,6,7,8-HxCDD	ng/kg	0.301	J	0.332	J	0.316	J	0.175	U	0.23	U
1,2,3,7,8,9-HxCDD	ng/kg	0.143	U	0.152	U	0.136	U	0.215	U	0.271	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.452	J	0.732	J	0.636	J	0.264	UJ	0.481	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.111	U	0.107	U	0.125	J	0.179	U	0.23	U
1,2,3,4,6,7,8-HpCDD	ng/kg	1.42	J	2.87	J	1.9	J	0.897	J	1.6	J
OCDF	ng/kg	0.605	UJ	1.42	J	0.7	J	0.21	U	0.348	U
OCDD	ng/kg	10.1		37.6	J	11.7	J	5.38	J	13.2	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.469**		**0.735**		**0.331**		**0.053**		**0.297**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.722**		**0.874**		**0.636**		**0.365**		**0.701**	
Total TCDF	ng/kg	0.993	J	4.27		5.26		1.37		0.999	U
Total TCDD	ng/kg	0.998	U	0.998	U	0.998	U	0.996	U	0.999	U
Total PeCDF	ng/kg	2.05		0.5	J	2.1		0.772	J	1.33	
Total PeCDD	ng/kg	0.998	U	0.998	U	0.998	U	0.996	U	0.999	U
Total HxCDF	ng/kg	0.998	U	0.998	U	0.409	J	0.996	U	0.999	U
Total HxCDD	ng/kg	0.998	U	0.998	U	0.998	U	0.996	U	0.999	U
Total HpCDF	ng/kg	0.998	U	0.957	J	0.998	U	0.996	U	0.999	U
Total HpCDD	ng/kg	2.8		3.12		2.04		0.996	U	0.999	U

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Table F5. 2022 Bioaccumulation Study - *A. virens* Dioxin/Furan Congener Data

Alitta virens Compound	Units Wet Weight	A.v. Carr Ref Rep 3 Results	Q	A.v. Carr Ref Rep 4 Results	Q	A.v. Carr Ref Rep 5 Results	Q
Dioxins/Furans							
2,3,7,8-TCDF	ng/kg	1.14	J	1.06	J	1.15	J
2,3,7,8-TCDD	ng/kg	0.083	U	0.086	U	0.223	UJ
1,2,3,7,8-PeCDF	ng/kg	0.129	U	0.118	U	0.161	U
2,3,4,7,8-PeCDF	ng/kg	0.137	U	0.115	U	0.133	J
1,2,3,7,8-PeCDD	ng/kg	0.225	U	0.191	U	0.209	U
1,2,3,4,7,8-HxCDF	ng/kg	0.156	U	0.144	U	0.15	U
1,2,3,6,7,8-HxCDF	ng/kg	0.132	U	0.13	U	0.134	U
2,3,4,6,7,8-HxCDF	ng/kg	0.124	U	0.129	U	0.132	U
1,2,3,7,8,9-HxCDF	ng/kg	0.143	U	0.156	U	0.162	U
1,2,3,4,7,8-HxCDD	ng/kg	0.179	U	0.177	U	0.146	U
1,2,3,6,7,8-HxCDD	ng/kg	0.121	U	0.139	U	0.124	U
1,2,3,7,8,9-HxCDD	ng/kg	0.155	U	0.166	U	0.143	U
1,2,3,4,6,7,8-HpCDF	ng/kg	0.299	UJ	0.295	UJ	0.306	J
1,2,3,4,7,8,9-HpCDF	ng/kg	0.123	U	0.138	U	0.168	U
1,2,3,4,6,7,8-HpCDD	ng/kg	0.918	J	0.891	J	1.21	J
OCDF	ng/kg	0.279	J	0.344	UJ	0.445	UJ
OCDD	ng/kg	5.95	J	8.87	J	12.4	
Total TEQ (ND = 0*EDL)[1]	**ng/kg**	**0.125**		**0.118**		**0.174**	
Total TEQ (ND = 1/2*EDL)[2]	**ng/kg**	**0.354**		**0.329**		**0.443**	
Total TCDF	ng/kg	1.71		0.999	U	0.996	U
Total TCDD	ng/kg	0.996	U	0.999	U	0.996	U
Total PeCDF	ng/kg	0.996	U	0.999	U	0.502	J
Total PeCDD	ng/kg	0.996	U	0.999	U	0.996	U
Total HxCDF	ng/kg	0.996	U	0.999	U	0.996	U
Total HxCDD	ng/kg	0.996	U	0.999	U	0.996	U
Total HpCDF	ng/kg	0.996	U	0.999	U	0.996	U
Total HpCDD	ng/kg	0.996	U	0.826	J	0.35	J

Notes:

Q: data qualifier

1. ND, EMPC = 0 when Q = U, UJ

2. ND = 1/2*EDL; EMPC = 1/2*Reported when Q = UJ

Qualifiers

U: this analyte is not detected above the reporting limit (RL) or if noted, not detected above the limit of detection (LOD)

J: concentration less than limit of quantification

UJ: identified a compound that was not detected

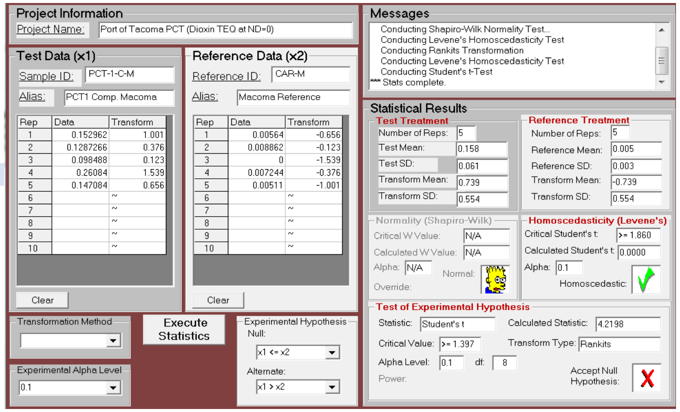
APPENDIX G: BIOSTAT STATISTICAL COMPARISON OUTPUT

Results Macoma

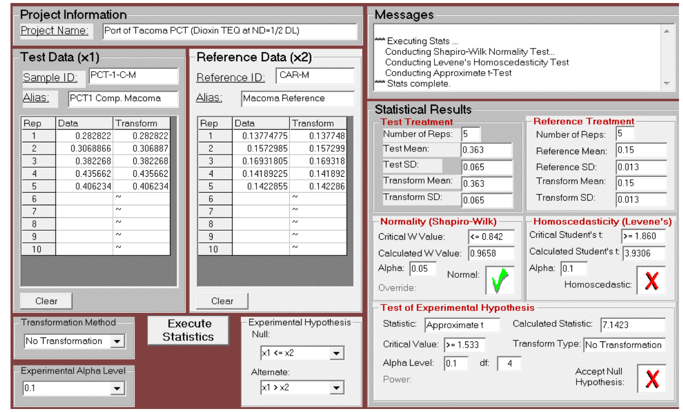
Non Detects = 0*EDL

Non Detects = 1/2*EDL

PCT-1-C-M

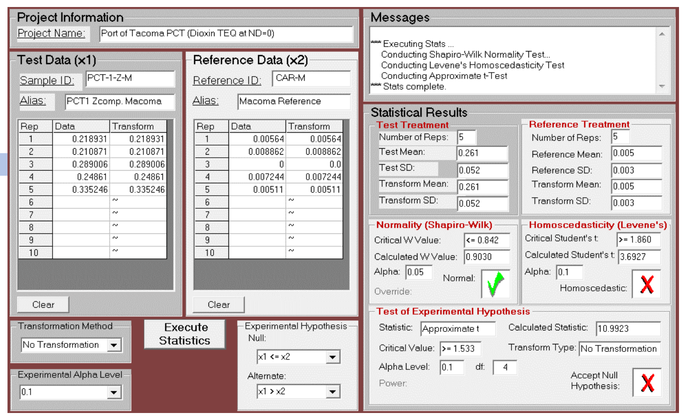


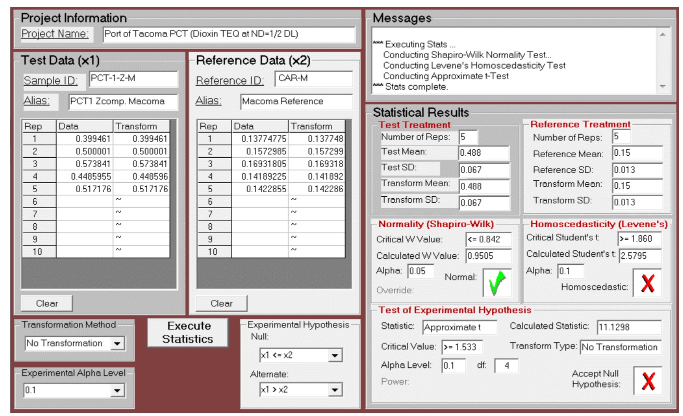
Data neither normal nor homoscedastic rankit transformation applied - Students t-test used



Data normal but not homoscedastic. No transformation - Approximate t-test used

PCT-1-Z-M





Data normal but not homoscedastic. No transformation - Approximate t-test used

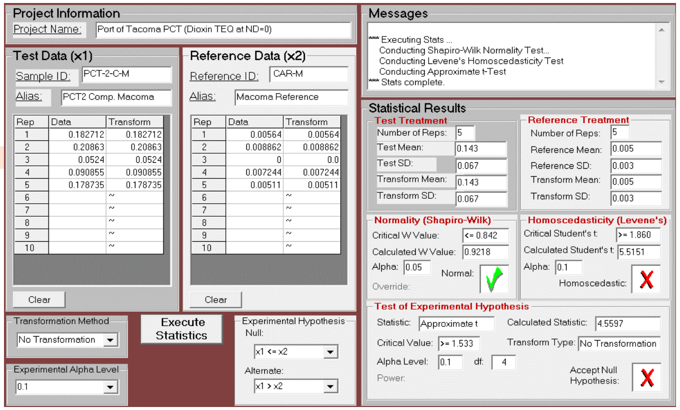
Data normal but not homoscedastic. No transformation - Approximate t-test used

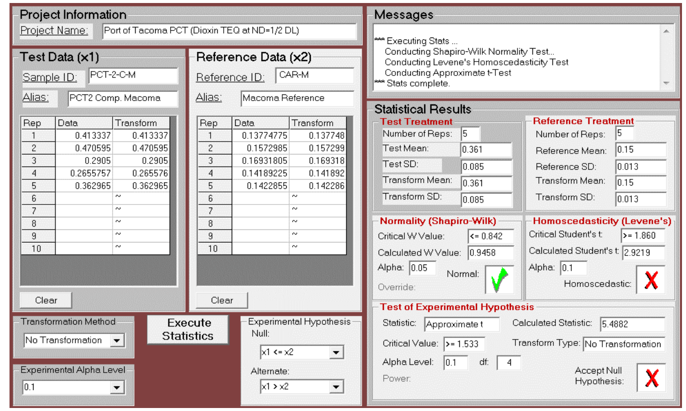
Results Macoma

Non Detects = 0*EDL

Non Detects = 1/2*EDL

PCT-2-C-M

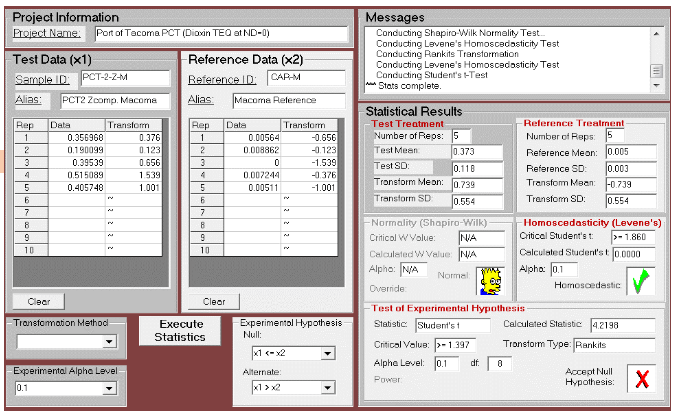


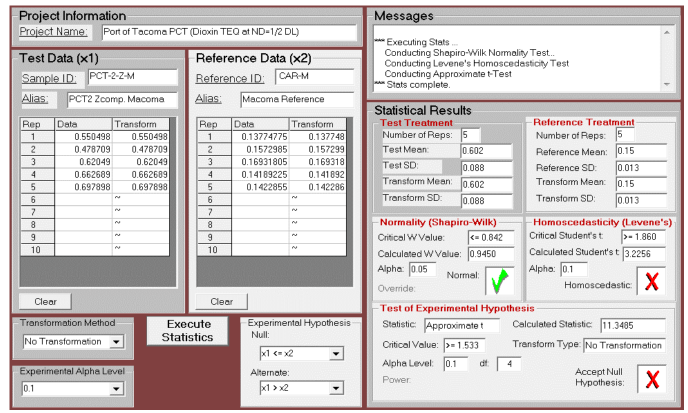


Data normal but not homoscedastic. No transformation - Approximate t-test used

Data normal but not homoscedastic. No transformation - Approximate t-test used

PCT-2-Z-M





Data neither normal nor homoscedastic rankit transformation applied - Students t-test used

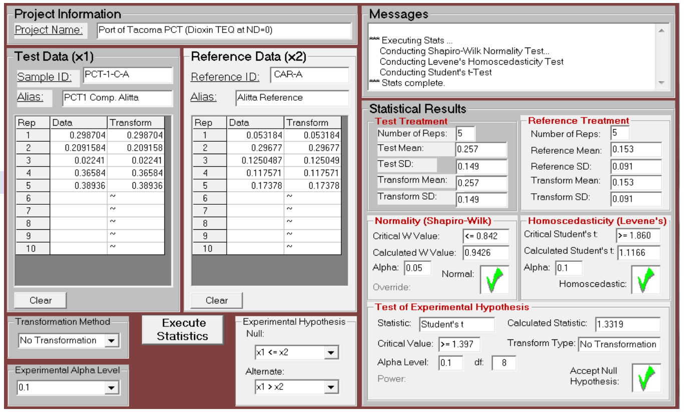
Data normal but not homoscedastic. No transformation - Approximate t-test used

Results Alitta

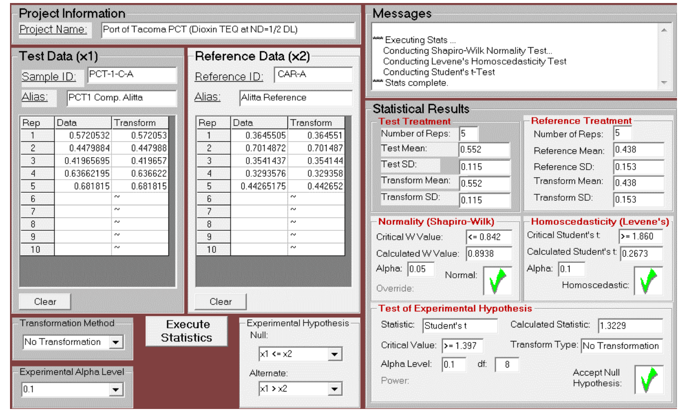
Non Detects = 0*EDL

Non Detects = 1/2*EDL

PCT-1-C-A

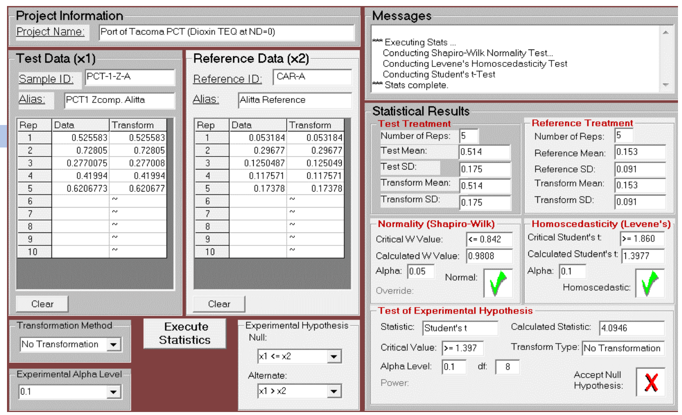


Data normal and homoscedastic. No transformation - Student's t-test used

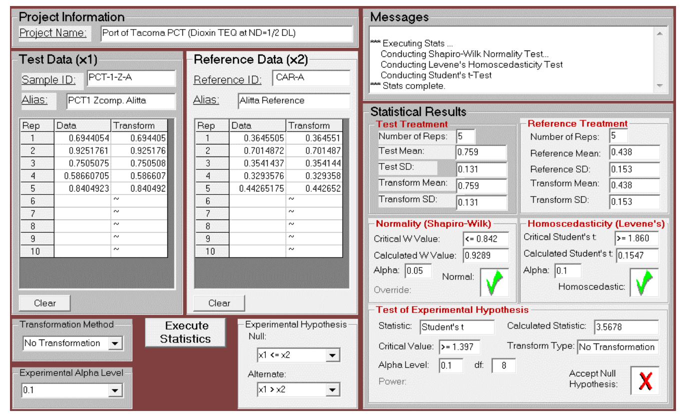


Data normal and homoscedastic. No transformation - Student's t-test used

PCT-1-Z-A



Data normal and homoscedastic. No transformation - Student's t-test used



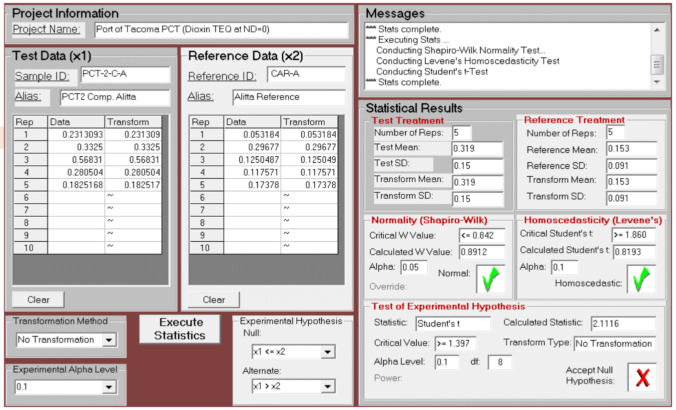
Data normal and homoscedastic. No transformation - Student's t-test used

Results Alitta

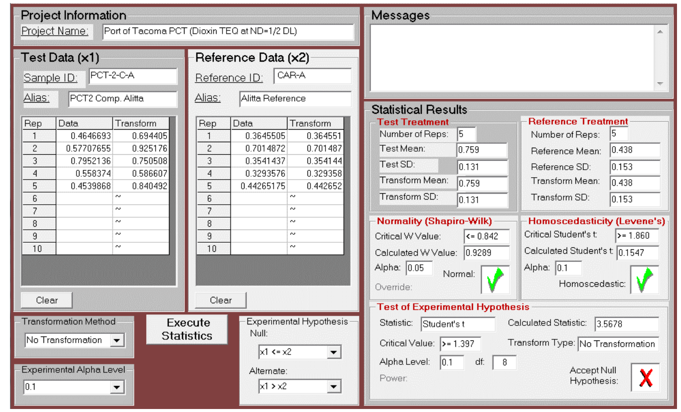
Non Detects = 0*EDL

Non Detects = 1/2*EDL

PCT-2-C-A

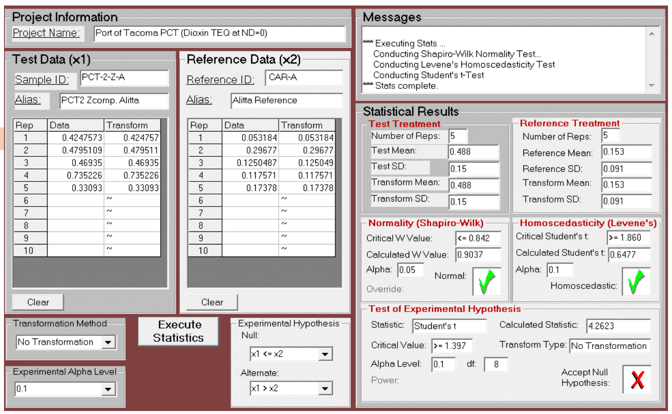


Data normal and homoscedastic. No transformation - Student's t-test used

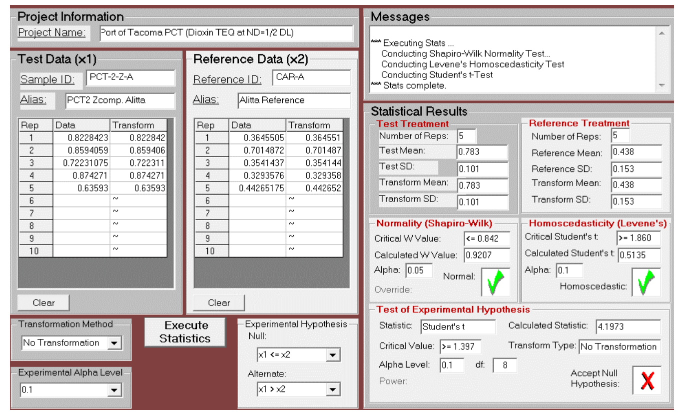


Data normal and homoscedastic. No transformation - Student's t-test used

PCT-2-Z-A



Data normal and homoscedastic. No transformation - Student's t-test used



Data normal and homoscedastic. No transformation - Student's t-test used