APPENDIX E

Data Validation Reports

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DATA VALIDATION REPORT

Lower Duwamish Waterway– Enhanced Natural Recovery/Activated Carbon Pilot Study, Calibration Study and Baseline Samples, July, 2016 – January 2017

Prepared for:
AMEC Foster Wheeler
3500 188th Street SW, Ste 601
Lynnwood, WA 98037-4763

March 17, 2017

1.0 Introduction

Data validation was performed on the following samples:

Sample ID	Sample Date/Time	Lab ID(s)	Matrix	Analyses
LDW-CS-C1-S010-PW-TB	06/29/2016 16:00	09967-001-0001-SA	Solvent	PCB
LDW-CS-C2-S010-PW-TB	06/29/2016 16:00	09967-002-0001-SA	Solvent	PCB
LDW-CS-C3-S010-PW-TB	06/29/2016 16:00	09967-003-0001-SA	Solvent	PCB
LDW-CS-1-S00.2-KPDMS	07/11/2016 14:30	09987-001-0001-SA	Solvent	PCB
LDW-CS-2-S00.2-KPDMS	07/11/2016 14:40	09987-002-0001-SA	Solvent	PCB
LDW-CS-3-S00.2-KPDMS	07/11/2016 14:50	09987-003-0001-SA	Solvent	PCB
LDW-CS-C6-S010-PW-SED	07/11/2016 15:00	09987-004-0001-SA	Solvent	PCB
LDW-BA-SC-S010-PW-TB	07/28/2016 11:48	10071-001-0001-SA	Solvent	PCB
LDW-BA-SU-S010-PW-TB	07/28/2016 11:58	10071-002-0001-SA	Solvent	PCB
LDW-BA-IN-S010-PW-TB	07/28/2016 12:12	10071-003-0001-SA	Solvent	PCB
LDW-BA-SC-ENR+AC-CB-CORE	09/09/2016 09:45	10147-002-0001-SA, L1629119-07	Sediment	PCB, BC, GS, TOC
LDW-BA-SC-ENR+AC-CA-CORE	09/09/2016 10:08	10147-001-0001-SA. L1629119-06	Sediment	PCB, BC, GS, TOC
LDW-BA-SC-ENR+AC-CC-CORE	09/09/2016 16:00	10147-003-0001-SA, L1629119-08	Sediment	PCB, BC, GS, TOC
LDW-BA-SC-ENR-CA-S010	09/10/2016 09:00	10146-004-0001-SA	Solvent	PCB
LDW-BA-SC-ENR-CB-S010	09/10/2016 09:15	10146-005-0001-SA	Solvent	PCB
LDW-BA-SC-ENR-CC-S010	09/10/2016 09:36	10146-006-0001-SA	Solvent	PCB
LDW-BA-SC-ENR+AC-CA-S010	09/10/2016 10:20	10146-001-0001-SA	Solvent	PCB
LDW-BA-SC-ENR+AC-CB-S010	09/10/2016 10:30	10146-002-0001-SA	Solvent	PCB
LDW-BA-SC-ENR+AC-CC-S010	09/10/2016 10:42	10146-003-0001-SA	Solvent	PCB
LDW-BA-IN-ENR+AC-CA-S010	09/10/2016 11:23	10146-007-0001-SA	Solvent	PCB
LDW-BA-IN-ENR+AC-CB-S010	09/10/2016 11:31	10146-008-0001-SA	Solvent	PCB
LDW-BA-IN-ENR+AC-CC-S010	09/10/2016 11:39	10146-009-0001-SA	Solvent	PCB
LDW-BA-SC-ENR-CB-CORE	09/10/2016 12:10	10147-007-0001-SA, L1629119-02	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR-CA-S010	09/10/2016 12:14	10146-010-0001-SA	Solvent	PCB
LDW-BA-IN-ENR-CB-S010	09/10/2016 12:23	10146-011-0001-SA	Solvent	PCB
LDW-BA-SC-ENR-CC-CORE	09/10/2016 12:25	10147-008-0001-SA, L1629119-03	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR-CC-S010	09/10/2016 12:32	10146-012-0001-SA	Solvent	PCB

Sample ID	Sample Date/Time	Lab ID(s)	Matrix	Analyses
LDW-BA-SC-ENR-CA-CORE	09/10/2016 13:05	10147-006-0001-SA, L1629119-01	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR+AC-CC-CORE	09/14/2016 09:57	10147-013-0001-SA, L1629119-16	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR+AC-CA-CORE	09/14/2016 10:20	10147-011-0001-SA, L1629119-14	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR-CB-CORE	09/14/2016 10:40	10147-016-0001-SA, L1629119-12	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR+AC-CB-CORE	09/14/2016 10:55	10147-012-0001-SA, L1629119-15	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR-CA-CORE	09/14/2016 11:30	10147-015-0001-SA, L1629119-11	Sediment	PCB, BC, GS, TOC
LDW-BA-IN-ENR-CC-CORE	09/14/2016 11:42	10147-017-0001-SA, L1629119-13	Sediment	PCB, BC, GS, TOC
LDW-BA-SU-ENR+AC-CB-CORE	11/26/2016 14:20	10311-002-0001-SA L1638960-05	Sediment	PCB, BC, GS, TOC
LDW-BA-SU-ENR+AC-CC-CORE	11/26/2016 14:35	10311-003-0001-SA L1638960-06	Sediment	PCB, BC, GS, TOC
LDW-BA-SU-ENR+AC-CA-CORE	11/26/2016 15:15	10311-001-0001-SA L1638960-04	Sediment	PCB, BC, GS, TOC
LDW-BA-SU-ENR-CC-CORE	11/26/2016 15:35	10311-006-0001-SA L1638960-03	Sediment	PCB, BC, GS, TOC
LDW-BA-SU-ENR-CA-CORE	11/26/2016 17:15	10311-004-0001-SA L1638960-01	Sediment	PCB, BC, GS, TOC
LDW-BA-SU-ENR-CB-CORE	11/26/2016 17:30	10311-005-0001-SA L1638960-02	Sediment	PCB, BC, GS, TOC
LDW-BA-SU-S010-TB-EXSITU1	12/06/2016 15:15	10322-001-0001-SA	Solvent	PCB
LDW-BA-SU-S010-TB-EXSITU2	12/06/2016 15:28	10322-002-0001-SA	Solvent	PCB
LDW-BA-SU-S010-TB-EXSITU3	12/06/2016 15:52	10322-003-0001-SA	Solvent	PCB
LDW-BA-SU-ENR+AC-CA-S010	01/18/2017 08:28	10398-001-0001-SA	Solvent	PCB
LDW-BA-SU-ENR+AC-CB-S010	01/18/2017 08:46	10398-002-0001-SA	Solvent	PCB
LDW-BA-SU-ENR+AC-CC-S010	01/18/2017 09:10	10398-003-0001-SA	Solvent	PCB
LDW-BA-SU-ENR-CA-S010	01/18/2017 10:58	10398-004-0001-SA	Solvent	PCB
LDW-BA-SU-ENR-CB-S010	01/18/2017 11:17	10398-005-0001-SA	Solvent	PCB
LDW-BA-SU-ENR-CC-S010	01/18/2017 11:36	10398-006-0001-SA	Solvent	PCB
LDW-BA-SU-S010-LCB-EXSITU	01/18/2017 12:26	10398-007-0001-SA	Solvent	PCB

PCB analyses were performed by Frontier Analytical Laboratory, in El Dorado Hills, California. Remaining analyses were performed by Alpha Analytical in Mansfield, Massachusetts.

Validation: A full validation was performed on the Baseline PCB data, including laboratory sample delivery groups (SDGs) 10071, 10146, 10147, 10311, 10322, and 10398. A summary validation was performed on the Calibration Study PCB Data (SDGs 09967 and 09987) and the remaining analyses. Validation was performed by Cari Sayler. Data qualifiers are summarized in section 5.0 of this report.

Analytical methods: Table 3.3 of the QAPP specifies the following analytical methods:

Analysis	Method
Polychlorinated Biphenyl Congeners (PCB)	EPA 1668C
Total Organic Carbon (TOC)	EPA 9060
Black Carbon (BC)	Gustafsson
Grain size (GS)	ASTM D422

These methods were used with the following exception: The most recent version of the methods for TOC (9060A) was used. This is considered an acceptable substitution.

Sample Receipt: Sample chain-of-custodies and sample log-in documentation were reviewed. All requested analyses were performed with the following exception: Samples within batches 09987, 10147, and L1629119 which were not analyzed were noted in their respective narratives as having been placed on hold.

Sample number transcription: Sample IDs in the electronic data deliverable (EDD) were compared to the chain-of-custody for each sample. Sample IDs matched the chain of custody.

2.0 Polychlorinated Biphenyl Congener Analyses

Quality control analysis frequencies: The method specifies that method blank and ongoing precision and recovery (OPR) samples must be analyzed with each batch. In addition, injection standards, isotope dilution standards and cleanup standards must be measured in each field and quality control sample. These frequencies were met.

Analysis holding times: Method 1668C specifies a one year holding time between extraction and analysis, and a one year holding time from sampling to extraction for both water and Sediment samples. These holding times were met.

Sample receipt temperatures were 8°C, slightly above the recommended 2-6°C in batch 09967. However, polychlorinated biphenyl compounds are stable and no qualifiers are assigned.

System performance checks: System performance criteria include: 1) The tune must demonstrate a resolving power $\geq$10,000 at m/z 330.9792 and $\geq$8,000 throughout the range. 2) The monitored m/z must be <5 ppm from theoretical for the following theoretical m/z's: 218.9856, 242.9856, 280.9825, 330.9792, 354.9797, 354.9792, and 454.9728. 3) The retention time of congener 209 must exceed 55 minutes on the SPB-Octyl column. 4) The isomer specificity check must demonstrate resolution of congeners with valleys of $\leq$40% for congeners PCB-034 from PCB-023 and PCB-187 from PCB-182 on the SPB-Octyl Column. 5) The isomer specificity check must demonstrate elution of PCB 156 and PCB 157 within 2 seconds for the SPB-Octyl Column.

These criteria were evaluated for the full validation data packages only.

The laboratory utilized a DB1 column and provided the following column-specific performance critieria: Resolution of congeners with valleys of $\leq$40% for congeners PCB-156 and 157 and PCB 209 RT$\geq$50 minutes. Additionally, congeners 106 and 118 were evaluated for coelution within 2 seconds. These criteria were met with the following exceptions:

No isomer specificity check analysis was provided with the initial calibration or at the end of each the 12-hour sequence. Because the initial and next day's isomer specificity check standard met criteria with very little retention time drift, no qualifiers were assigned.

Instrument calibration: Initial calibration criteria include 1) maximum percent relative standard deviations (%RSD) of $\leq$20% for target compounds and $\leq$35% for labeled compounds, 2) Ion abundance ratios must be within $\pm$15% of theoretical, and 3) signal to noise ratios must be at or above 10. Continuing calibration criteria include 1) percent recoveries within 75-125% for target compounds, 65-135% for 13C-PCB-028 and 75-125% for 13C-PCB-111 and 13C-PCB-178, and 50-145% for the remaining labeled compounds. 2) Ion abundance ratios must be within $\pm$ 15% of theoretical, and 3) signal to noise ratios must be at or above 10. 4) Absolute retention times for injection internal standards must be within $\pm$ 15 seconds of the initial calibration and 5) Relative retention times (RRT) must meet method or column-specific criteria.

These criteria were evaluated for the full validation data packages only.

RRTs were not summarized in the first five SDGs (10071, 10146, 10147, 10311, or 10322). SICP chromatograms in these reports were reviewed for expected retention time and no discrepancies were noted. RRT criteria were met for continuing calibration standards in SDG 10398. All remaining calibration criteria were met.

Laboratory blank results: Laboratory performance criteria in method 1668C states that the method blank must not contain any target compound at a concentration greater than either the minimum level or one-third the regulatory compliance level, whichever is greater. Additionally, the method blank must not contain any potentially interfering compound at a concentration greater than either the minimum level or one-third the regulatory compliance level, whichever is greater. This criterion was met.

Isotope dilution standard recoveries: Method criteria are 5-145% for labeled congeners between C13-PCB-001 and C13-PCB-045 and 10-145% for labeled congeners between C13-PCB-077 and C13-PCB-209. Isotope dilution standard recoveries were within these limits.

Cleanup standard recoveries: Method criteria are 5-145% for C13-PCB-028 and 10-145% for C13-PCB-111 and C13-PCB-178. Cleanup standard recoveries were within laboratory control limits with 2 exceptions:

Sample ID	Surrogate	% Recovery	Lab Control Limit
LDW-BA-IN-ENR-CA-CORE	13C-PCB-028	149	5 – 145
LDW-BA-IN-ENR-CB-CORE	13C-PCB-028	148	5 – 145
LDW-BA-SU-ENR-CB-CORE	13C-PCB-028	159	5 – 145

No qualifiers are required on the basis of high cleanup standard recoveries.

OPR recoveries: Method criteria for OPR recoveries are 60-135% for 27 representative target compounds. OPR recoveries were within these limits.

Compound Identification: Method criteria for compound identification include: 1) The signals of the characteristic ions must maximize within the same 2 scans. 2) The signal to noise ratio must be greater than 2.5. 3) Ion abundance ratios must be within ± 15% of theoretical, or within ±15% of the calibration verification standard. 4) Relative retention times must meet method or column-specific criteria.

Criteria were reviewed for each Toxic WHO Congener in the full validation samples.

Neither the signal to noise ratio nor the individual signal (in height) and noise levels were included for in the raw data detected compounds in the first five SDGs (10071, 10146, 10147, 10311, or 10322). SICP chromatograms in these reports were reviewed for approximate signal to noise ratios and no further investigation was deemed necessary. Signal to noise ratio criteria were met for Toxic WHO congeners in SDG 10398.

No discrepancies were noted with the remaining identification criteria.

Compound Quantitation: Sample concentrations were recalculated to verify sample quantitations. Concentrations of two congeners in one sample differed between the recalculated value and the laboratory electronic data deliverable (EDD) value as follows:

Sample ID	Analyte	Report value (pg/g)	EDD value (pg/g)	Correct value (pg/g)
LDW-BA-SU-ENR+AC-CB-CORE	PCB-058	20.4	24	20.4
LDW-BA-SU-ENR+AC-CB-CORE	PCB-096	60.4	64	60.4

The laboratory EDD was corrected to match the report value, and no further action was necessary.

No other quantitation discrepancies were noted.

Second column confirmation: Second column confirmation was not required to separate congeners 156 and 157 due to the use of the DB1 Column.

Second column confirmation was not performed to separate congeners 106 and 118. Since congener 106 is not a component of any of the commercial Aroclor mixtures, no further action was deemed necessary.

Estimated detection limits: Estimated detection limits (EDLs) were recalculated for each Toxic WHO Congener in the full validation samples. No discrepancies were noted. All sediment EDLs met QAPP target reporting limits of 4 pg/g. Solvent EDLs ranged from 2 to 20 pg/sample.

Toxicity equivalent quantity (TEQ): TEQ calculations were not required for this project.

Laboratory narrative: No additional qualifiers are assigned based on the laboratory narrative.

Overall assessment: With minor exceptions and addendums, documentation was found to be clear and complete. No discrepancies were noted in analyte identification or result quantitation. Calibration data and system performance checks demonstrate acceptable instrument performance. Quality control results indicate acceptable accuracy.

Polychlorinated biphenyl data are acceptable for use as reported.

3.0 General Chemistry Analyses

Quality control analysis frequencies: For black carbon, a method blank, standard reference material (SRM), and matrix spike (MS) were analyzed in each batch. Four of the five batches included a laboratory duplicate, and three of the five batches included MS duplicate, meeting frequency requirements. For total organic carbon (TOC), a method blank, SRM, and MS were analyzed in each batch. Four of the five batches included a laboratory duplicate, and three of the five batches included MS duplicate, meeting frequency requirements.

Holding times: Both TOC and black carbon must be analyzed within 28 days. Samples should be shipped and maintained at temperatures between 2 and 6° Celsius. These criteria were met

Laboratory blank results: Criteria for method blanks are that analyte concentrations must be below the PQL, or below 10% of the lowest associated sample concentration. This criterion was met for all method blanks.

SRM results: Control limits were 75-125%. These criteria were met.

MS recoveries: Control limits were 75-125%. Widely varying recoveries were observed in the MS and MSDs as follows:

QC ID	Analyte	% Recovery	Lab Control Limit
LDW-BA-SC-ENR-CA-CORE SD	Total Organic Carbon (Rep2)	141	75 - 125
LDW-BA-SU-ENR-CA-CORE MS	Total Organic Carbon (Rep1)	127	75 - 125
LDW-BA-SU-ENR-CA-CORE SD	Total Organic Carbon (Rep1)	69	75 - 125
LDW-BA-SU-ENR-CA-CORE SD	Total Organic Carbon (Rep2)	468	75 - 125

It should be noted that the native concentration ranged from two to two and a half times the spike amount in these QC samples, and sample variability likely contributed to these recovery outliers. The second TOC replicate result in sample LDW-BA-SC-ENR-CA-CORE and both TOC replicate results in sample LDW-BA-SU-ENR-CA-CORE are qualified as estimated.

Sample replicate variability: The RPD between the first and second replicate analysis of each sample was below 25% with the following exception:

QC ID	Analyte	Rep 1 (%)	Rep 2 (%)	RPD
LDW-BA-SU-ENR-CA-CORE	% Soot	0.104	0.257	85%

This sample result is qualified as estimated.

Matrix spike duplicate variability: The laboratory reported RPDs were calculated based on the found values in the MS and MSD. However, because the spike added varied significantly between the MS and MSD, the difference in the found values does not accurately represent the variability in the analysis. RPDs were recalculated based on a modified recovery comprised of the MS or MSD concentration divided by the sum of the native concentration and the spike amount. Additionally, the relative standard deviation (RSD) of all four modified recoveries in each MS/MSD pair was evaluated.

Recalculated RPDs and RSDs were within 25% with the following exceptions:

QC ID	Analyte	RPD	RSD
LDW-BA-SU-ENR-CA-CORE MSD	Total Organic Carbon (Rep2)	71	45

Both TOC replicate results in sample LDW-BA-SU-ENR-CA-CORE are qualified as estimated.

Laboratory duplicate results: Control limit was 25% for both TOC and black carbon. Individual replicate RPDs and RSDs of all four replicates were within 25% with the following exceptions:

Sample ID	Analyte	RPD	RSD
LDW-BA-SU-ENR-CA-CORE LD	% Soot (Rep 2)	89	55
LDW-BA-SU-ENR-CA-CORE LD	Total Organic Carbon (Rep1)	37	15

Both % soot replicate results and the first TOC replicate result in sample LDW-BA-SU-ENR-CA-CORE are qualified as estimated.

Overall assessment: Documentation was found to be clear and complete. Method blank and SRM results demonstrate acceptable laboratory accuracy. Replicate measurements and MS, MSD, and laboratory duplicate results indicate some duplicate variability.

General chemistry results are acceptable for use as qualified.

4.0 Grain Size Analyses

Quality control analysis frequencies: Each batch included a laboratory triplicate, meeting frequency requirements.

Holding times: Sediment samples must be analyzed within 6 months of collection. Samples were analyzed within the holding time.

Laboratory triplicate RSDs: Samples LDW-BA-SC-ENR-CA-CORE and LDW-BA-SU-ENR-CB-CORE were analyzed in triplicate, but triplicate RSDs were not reported by the laboratory. Triplicate RSDs were calculated and exceeded 25% as follows:

Sample ID	Analyte	RSD	Control Limit
LDW-BA-SC-ENR-CA-CORE	% Clay Fine	28%	25
LDW-BA-SC-ENR-CA-CORE	% Coarse Sand	72%	25
LDW-BA-SC-ENR-CA-CORE	% Fine Gravel	69%	25
LDW-BA-SC-ENR-CA-CORE	% Medium Sand	86%	25
LDW-BA-SC-ENR-CA-CORE	% Total Gravel	69%	25
LDW-BA-SC-ENR-CA-CORE	% Total Sand	49%	25
LDW-BA-SU-ENR-CB-CORE	% Clay Fine	36%	25
LDW-BA-SU-ENR-CB-CORE	% Coarse Sand	69%	25
LDW-BA-SU-ENR-CB-CORE	% Fine Gravel	94%	25
LDW-BA-SU-ENR-CB-CORE	% Fine Sand	59%	25
LDW-BA-SU-ENR-CB-CORE	% Medium Sand	67%	25
LDW-BA-SU-ENR-CB-CORE	% Silt Fine	48%	25
LDW-BA-SU-ENR-CB-CORE	% Total Fines	47%	25
LDW-BA-SU-ENR-CB-CORE	% Total Gravel	94%	25
LDW-BA-SU-ENR-CB-CORE	% Total Sand	63%	25

The % fine gravel and % total gravel results in LDW-BA-SC-ENR-CA-CORE triplicate are below 5 times the reporting limit and the 25% control limit does not apply. Results for the remaining fractions are qualified as estimated in the associated samples.

Grain size data are acceptable for use as qualified.

5.0 Qualifier Summary Table

Client ID	Analyte(s)	Qualifier	Reason
General Chemistry Analysis			
LDW-BA-SU-ENR-CA-CORE	% Soot (Rep 1), % Soot (Rep 2)	J	Sample replicate variability
LDW-BA-SC-ENR-CA-CORE	Total Organic Carbon (Rep2)	J	High MSD recovery
LDW-BA-SU-ENR-CA-CORE	Total Organic Carbon (Rep1)	J	High MS recovery, Low MSD recovery, High MS/MSD RPD, High MS/MSD replicate RSD
LDW-BA-SU-ENR-CA-CORE	Total Organic Carbon (Rep2)	J	High MSD recovery, High MS/MSD RPD, High MS/MSD replicate RSD
Grain Size Analysis			
LDW-BA-IN-ENR+AC-CA-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD

Client ID	Analyte(s)	Qualifier	Reason
LDW-BA-IN-ENR+AC-CB-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-IN-ENR+AC-CC-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-IN-ENR-CA-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-IN-ENR-CB-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Sand	J	High triplicate RSD
LDW-BA-IN-ENR-CC-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SC-ENR+AC-CA-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SC-ENR+AC-CB-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SC-ENR+AC-CC-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Sand	J	High triplicate RSD
LDW-BA-SC-ENR-CA-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SC-ENR-CB-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Sand	J	High triplicate RSD
LDW-BA-SC-ENR-CC-CORE	% Clay Fine, % Coarse Sand, % Medium Sand, % Total Sand	J	High triplicate RSD
LDW-BA-SU-ENR+AC-CA-CORE	% Clay Fine, % Coarse Sand, % Fine Gravel, % Fine Sand, % Medium Sand, % Silt Fine, % Total Fines, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SU-ENR+AC-CB-CORE	% Clay Fine, % Coarse Sand, % Fine Gravel, % Fine Sand, % Medium Sand, % Silt Fine, % Total Fines, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SU-ENR+AC-CC-CORE	% Clay Fine, % Coarse Sand, % Fine Sand, % Medium Sand, % Silt Fine, % Total Fines, % Total Sand	J	High triplicate RSD
LDW-BA-SU-ENR-CA-CORE	% Clay Fine, % Coarse Sand, % Fine Gravel, % Fine Sand, % Medium Sand, % Silt Fine, % Total Fines, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SU-ENR-CB-CORE	% Clay Fine, % Coarse Sand, % Fine Sand, % Medium Sand, % Silt Fine, % Total Fines, % Total Gravel, % Total Sand	J	High triplicate RSD
LDW-BA-SU-ENR-CC-CORE	% Clay Fine, % Coarse Sand, % Fine Gravel, % Fine Sand, % Medium Sand, % Silt Fine, % Total Fines, % Total Gravel, % Total Sand	J	High triplicate RSD

6.0 Abbreviations and Def initions

DV Qualifier	Definition
U	The material was analyzed for, but was not detected above the level of the associated value.
UY	The reporting limit was elevated due to chromatographic overlap with related compounds. The material was analyzed for, but was not detected above the level of the associated value.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.

DV Qualifier	Definition
R	The sample result is rejected. The presence or absence of the analyte cannot be verified and data are not usable.
R1	This sample result has been rejected in favor of a more accurate, precise or conservative result. The other result should be used.
R2	This sample result has been rejected in favor of a more accurate, precise or conservative result from another analytical method. The other result should be used.

Abbreviation	Definition
DV	Data validation
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
EDL	Estimated detection limit
EMPC	Estimated maximum possible concentration
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not Applicable
OPR	Ongoing Precision and Recovery
RL	Reporting limit
RPD	Relative percent difference
RRM	Regional reference material
RSD	Relative standard deviations
SRM	Standard reference material

7.0 References

National Functional Guidelines For Inorganic Superfund Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, August 2014, USEPA-540-R-13-001.

National Functional Guidelines for High Resolution Superfund Methods Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, April 2016, EPA-542-B-16-001.

Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS, US Environmental Protection Agency, Office of Water Engineering and Analysis Division, April 2010.

Quality Assurance Project Plan Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Prepared by AMEC Foster Wheeler Environment & Infrastructure Inc., et al. Prepared for: USEPA Region 10 and WA-DOE Northwest Regional Office, February 22, 2016.

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CALCULATION REVIEW SUMMARY

Lower Duwamish Waterway– Enhanced Natural Recovery/Activated Carbon Pilot Study, Baseline Samples, July, 2016 – January 2017

Prepared for:
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March 30, 2017

1.0 Introduction

The objective of this review was to verify that the freely dissolved polychlorinated biphenyl (PCB) concentrations were accurately calculated. This review was performed by Cari Sayler.

Laboratory reported total mass per sample concentrations were converted to freely dissolved PCBs in sediment porewater by GeoSyntec Consultants of Huntington Beach, California, in two reports both dated March 22, 2017. Laboratory analysis results were validated separately.

Data included the following samples and trip blanks:

Sample ID	Sample Date/Time	Lab ID(s)	GeoSyntec Report Date
LDW-BA-SC-S010-PW-TB	07/28/2016 11:48	10071-001-0001-SA	12/06/2016
LDW-BA-SU-S010-PW-TB	07/28/2016 11:58	10071-002-0001-SA	12/06/2016
LDW-BA-IN-S010-PW-TB	07/28/2016 12:12	10071-003-0001-SA	12/06/2016
LDW-BA-SC-ENR-CA-S010	09/10/2016 09:00	10146-004-0001-SA	12/06/2016
LDW-BA-SC-ENR-CB-S010	09/10/2016 09:15	10146-005-0001-SA	12/06/2016
LDW-BA-SC-ENR-CC-S010	09/10/2016 09:36	10146-006-0001-SA	12/06/2016
LDW-BA-SC-ENR+AC-CA-S010	09/10/2016 10:20	10146-001-0001-SA	12/06/2016
LDW-BA-SC-ENR+AC-CB-S010	09/10/2016 10:30	10146-002-0001-SA	12/06/2016
LDW-BA-SC-ENR+AC-CC-S010	09/10/2016 10:42	10146-003-0001-SA	12/06/2016
LDW-BA-IN-ENR+AC-CA-S010	09/10/2016 11:23	10146-007-0001-SA	12/06/2016
LDW-BA-IN-ENR+AC-CB-S010	09/10/2016 11:31	10146-008-0001-SA	12/06/2016
LDW-BA-IN-ENR+AC-CC-S010	09/10/2016 11:39	10146-009-0001-SA	12/06/2016
LDW-BA-IN-ENR-CA-S010	09/10/2016 12:14	10146-010-0001-SA	12/06/2016
LDW-BA-IN-ENR-CB-S010	09/10/2016 12:23	10146-011-0001-SA	12/06/2016
LDW-BA-IN-ENR-CC-S010	09/10/2016 12:32	10146-012-0001-SA	03/17/2016
LDW-BA-SU-S010-TB-EXSITU1	12/06/2016 15:15	10322-001-0001-SA	03/17/2016
LDW-BA-SU-S010-TB-EXSITU2	12/06/2016 15:28	10322-002-0001-SA	03/17/2016
LDW-BA-SU-S010-TB-EXSITU3	12/06/2016 15:52	10322-003-0001-SA	03/17/2016
LDW-BA-SU-ENR+AC-CA-S010	01/18/2017 08:28	10398-001-0001-SA	03/17/2016
LDW-BA-SU-ENR+AC-CB-S010	01/18/2017 08:46	10398-002-0001-SA	03/17/2016
LDW-BA-SU-ENR+AC-CC-S010	01/18/2017 09:10	10398-003-0001-SA	03/17/2016
LDW-BA-SU-ENR-CA-S010	01/18/2017 10:58	10398-004-0001-SA	03/17/2016
LDW-BA-SU-ENR-CB-S010	01/18/2017 11:17	10398-005-0001-SA	03/17/2016
LDW-BA-SU-ENR-CC-S010	01/18/2017 11:36	10398-006-0001-SA	03/17/2016
LDW-BA-SU-S010-LCB-EXSITU	01/18/2017 12:26	10398-007-0001-SA	03/17/2016

2.0 Data Sources

Data were loaded from various sources in order to independently calculate each PCB Cfree concentration and detection limit. Spot checking and limited recalculation was done to verify the data sources as described below:

Laboratory reported concentrations: Laboratory reported mass concentrations were obtained from the validated laboratory electronic data deliverable (EDD). Sporadic comparisons were made to the data in table A3 of the report, and no discrepancies were noted for the PCB mass concentrations. However, the PCB mass MDLs require further clarification:

Data reported in table A3 as "PCB Mass MDL" was a mix of values. For the non-detect compounds, this column was populated with the estimated detection limit (EDL) which was found in the laboratory report under column heading of "DL" and in the EDD in the "Result" field. For detected results, this column was populated with the minimum level of quantitation (ML) which was not present on the laboratory report, but was present in the laboratory EDD in the "ML" field. The method detection limit (MDL), is also not present in the laboratory report, but was present in the laboratory EDD in the field "MDL".

While the title of this field in the Geosyntec reports is misleading, no discrepancies were noted between the values listed in the column and the laboratory EDLs and MLs.

SPME sampling details: SPME fiber details were obtained from the Table A1 of the report. Data for mass of fiber, length of fiber, % recovery, volume of PDMS, mass of PDMS were recalculated from the remaining data. No discrepancies were noted.

Reference values: Log K_{PDMS} values for each PCB were obtained from table A5, and spot checked against reference documentation (Smedes 2009). No discrepancies were noted.

Reported PCB Cfree concentrations: Reported PCB Cfree concentrations were obtained from an electronic an excel spreadsheet of table A6 results. This spreadsheet was used for the basis of comparison to recalculated values. Sporadic comparisons were made to the data in table 1 of the Geosyntec report and no discrepancies in PCB Cfree result values were noted.

However, PCB Cfree MDL values in table 1 contained the same mix of values that table A3 did. For the non-detect compounds, PCB Cfree EDL were listed. For detected compounds, PCB Cfree MLs were listed.

While the title of these columns in the Geosyntec reports is misleading, no discrepancies were noted between the values listed in the report tables and the excel spreadsheet.

3.0 Calculations

Formulas present in Attachment A were used to recalculate PCB free concentrations.

It should be noted that the formula for the expected concentration of trace PCBs remaining in the sample at the end of deployment (Step 3) contained an extra negative sign in a prior version of the subtidal report. This formula was correct in the March 22, 2017 version of the reports.

Data calculations were performed in a Microsoft Access database. An Access Visual Basic for Applications (VBA) subroutine to calculate regression statistics was obtained from the internet, and verified in excel. Additional VBA routines were written to calculate the PCB free concentrations, EDLs, MLs and MDLs, and to compare the recalculated results to the reported results. These additional VBA routines were verified manually, and by agreement with the reported data.

4.0 Conclusions

Concentrations: Cfree concentrations of each detected PCB was recalculated and compared to the reported values. Concentrations agreed within a reasonable variation for rounding differences. Calculated relative percent differences (RPDs) were between 0 and 5.

Reporting limits: Cfree EDLs or MLs of each PCB was recalculated and compared to the reported values. Values agreed within a reasonable variation for rounding differences. Calculated RPDs were between 0 and 5.

Additionally, independently calculated MDLs for both detections and non-detects and independently calculated MLs for non-detects have been provided in an electronic data deliverable to complete the data provided in table 1 and table A6.

PRC Linearity: Poor linearity was observed in the performance recovery compounds (PRC) of several samples. The coefficient of determination (R^2) for each sample is shown below:

Sample ID	R^2
LDW-BA-IN-ENR+AC-CA-S010	0.834
LDW-BA-IN-ENR+AC-CB-S010	0.694
LDW-BA-IN-ENR+AC-CC-S010	0.712
LDW-BA-IN-ENR-CA-S010	0.636
LDW-BA-IN-ENR-CB-S010	0.149
LDW-BA-IN-ENR-CC-S010	0.688
LDW-BA-SC-ENR+AC-CA-S010	0.738
LDW-BA-SC-ENR+AC-CB-S010	0.810
LDW-BA-SC-ENR+AC-CC-S010	0.195
LDW-BA-SC-ENR-CA-S010	0.753
LDW-BA-SC-ENR-CB-S010	0.854
LDW-BA-SC-ENR-CC-S010	0.937
LDW-BA-SU-ENR+AC-CA-S010	0.001
LDW-BA-SU-ENR+AC-CB-S010	0.078
LDW-BA-SU-ENR+AC-CC-S010	0.008
LDW-BA-SU-ENR-CA-S010	0.014
LDW-BA-SU-ENR-CB-S010	0.022
LDW-BA-SU-ENR-CC-S010	0.333
LDW-BA-SU-S010-LCB-EXSITU	0.351
LDW-CS-C6-S010-PW-SED	0.832

It was decided to add an uncertainty analysis rather than assigning data qualifiers to demonstrate the potential variability in the results, and this analysis was included in the 3/22 version of the reports.

It should be noted that this upper and lower confidence limits reflects variation due to PRC linearity, but not necessarily variation due to other factors such as analytical reproducibility or matrix inhomogeneity.

Qualifiers: Assigned qualifiers were reviewed with the following observations:

1) In five samples, the background concentration exceeded the detected concentration and no PCB free concentration was reported in table 1:

Sample ID	Analyte	PCB free no background subtraction (pg/L)	MDL free (pg/L)	ML free (pg/L)
LDW-BA-SU-ENR+AC-CA-S010	PCB-207	0.059	0.0015	0.031
LDW-BA-SU-ENR+AC-CC-S010	PCB-207	0.052	0.0013	0.035
LDW-BA-SU-ENR-CA-S010	PCB-207	0.035	0.0010	0.024
LDW-BA-SU-ENR-CC-S010	PCB-207	0.059	0.0016	0.036
LDW-BA-SU-S010-LCB-EXSITU	PCB-172	0.96	0.044	0.70

These results should be considered not detected at the lowest available detection limit, the MDL, and are qualified “UB”.

2) In a prior version of the report, there were differences in the reported L qualifiers and the recalculated % of steady state values. Geosyntec was contacted and qualifiers were updated on March 22, 2017. The updated report qualifiers agree with the recalculated % of steady state values.

Total detected PCBs: Total detected PCBs were recalculated based on the reported individual PCB Cfree concentrations. Recalculated values matched exactly to the reported values.

Confidence levels: The uncertainty upper and lower confidence levels summarized in Table A6 are beyond the scope of this review and have not been recalculated.

5.0 Abbreviations and Definitions

Abbreviation	Definition
EDL	Estimated detection limit
MDL	Method detection limit
ML	Minimum level of quantitation
PDMS	Polydimethylsiloxane
PRC	Performance Reference Compound
RPD	Relative percent difference
SPME	Solid phase microextraction

6.0 References

Certificate of Analysis Concentrations of Freely-dissolved Polychlorinated Biphenyls (PDBs) Measured via SP3ME Passive Samplers. Prepared for Lower Duwamish Waterway Group, Prepared by Geosyntec Consultants, March 22, 2017. This report contains data for samples collected July to September 2016.

Certificate of Analysis Concentrations of Freely-dissolved Polychlorinated Biphenyls (PDBs) Measured via SP3ME Passive Samplers. Prepared for Lower Duwamish Waterway Group, Prepared by Geosyntec Consultants, March 22, 2017. This report contains data for samples collected November 2016 to January 2017.

Polymer-water partition coefficients of hydrophobic compounds for passive sampling: Application of cosolvent models for validation. Environ. Sci. Technol. 43:7047-7054. Smedes, et al. 2009.

Quality Assurance Project Plan Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Prepared by AMEC Foster Wheeler Environment & Infrastructure Inc., et al. Prepared for: USEPA Region 10 and WA-DOE Northwest Regional Office, February 22, 2016.

YEAR 0

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DATA VALIDATION REPORT

Lower Duwamish Waterway– Enhanced Natural Recovery/Activated Carbon Pilot Study, Year 0 Samples, April 2017

Prepared for:
AMEC Foster Wheeler
3500 188th Street SW, Ste 601
Lynnwood, WA 98037-4763

June 30, 2017

1.0 Introduction

Data validation was performed on the following samples:

Sample ID	Sample Date/Time	LabID(s)	Analyses
LDW-Y0-IN-ENR-CA-CORE	04/13/2017 13:40	L1712518-01, L1712518-02, L1712518-03	TVS, GS
LDW-Y0-IN-ENR-CA-CORE-#50	04/13/2017 13:40	L1712518-04, L1712518-05, L1712518-06	TVS
LDW-Y0-IN-ENR-CB-CORE	04/13/2017 13:50	L1712518-07, L1712518-08, L1712518-09	TVS, GS
LDW-Y0-IN-ENR-CB-CORE-#50	04/13/2017 13:50	L1712518-10, L1712518-11, L1712518-12	TVS
LDW-Y0-IN-ENR-CC-CORE	04/13/2017 13:55	L1712518-13, L1712518-14, L1712518-15	TVS, GS
LDW-Y0-IN-ENR-CC-CORE-#50	04/13/2017 13:55	L1712518-16, L1712518-17, L1712518-18	TVS
LDW-Y0-IN-ENR+AC-CA-CORE	04/13/2017 14:15	L1712518-19, L1712518-20, L1712518-21	TVS, GS
LDW-Y0-IN-ENR+AC-CA-CORE-#50	04/13/2017 14:15	L1712518-22, L1712518-23, L1712518-24	TVS
LDW-Y0-IN-ENR+AC-CB-CORE	04/13/2017 14:30	L1712518-25, L1712518-26, L1712518-27	TVS, GS
LDW-Y0-IN-ENR+AC-CB-CORE-#50	04/13/2017 14:30	L1712518-28, L1712518-29, L1712518-30	TVS
LDW-Y0-IN-ENR+AC-CC-CORE	04/13/2017 14:40	L1712518-31, L1712518-32, L1712518-33	TVS, GS
LDW-Y0-IN-ENR+AC-CC-CORE-#50	04/13/2017 14:40	L1712518-34, L1712518-35, L1712518-36	TVS
LDW-Y0-IN-ENR+AC-1-A-COR	04/13/2017 14:05	L1712518-37, L1712518-38, L1712518-39	TVS
LDW-Y0-IN-ENR+AC-1-B-COR	04/13/2017 14:20	L1712518-40, L1712518-41, L1712518-42	TVS
LDW-Y0-IN-ENR+AC-1-C-COR	04/13/2017 14:30	L1712518-43, L1712518-44, L1712518-45	TVS
LDW-Y0-IN-ENR+AC-2-A-COR	04/13/2017 14:06	L1712518-46, L1712518-47, L1712518-48	TVS
LDW-Y0-IN-ENR+AC-2-B-COR	04/13/2017 14:21	L1712518-49, L1712518-50, L1712518-51	TVS
LDW-Y0-IN-ENR+AC-2-C-COR	04/13/2017 14:31	L1712518-52, L1712518-53, L1712518-54	TVS
LDW-Y0-IN-ENR+AC-3-A-COR	04/13/2017 14:07	L1712518-55, L1712518-56, L1712518-57	TVS
LDW-Y0-IN-ENR+AC-3-B-COR	04/13/2017 14:22	L1712518-58, L1712518-59, L1712518-60	TVS
LDW-Y0-IN-ENR+AC-3-C-COR	04/13/2017 14:32	L1712518-61, L1712518-62, L1712518-63	TVS
LDW-Y0-IN-ENR+AC-4-A-COR	04/13/2017 14:08	L1712518-64, L1712518-65, L1712518-66	TVS
LDW-Y0-IN-ENR+AC-4-B-COR	04/13/2017 14:23	L1712518-67, L1712518-68, L1712518-69	TVS
LDW-Y0-IN-ENR+AC-4-C-COR	04/13/2017 14:33	L1712518-70, L1712518-71, L1712518-72	TVS
LDW-Y0-IN-ENR+AC-5-A-COR	04/13/2017 14:09	L1712518-73, L1712518-74, L1712518-75	TVS
LDW-Y0-IN-ENR+AC-5-B-COR	04/13/2017 14:24	L1712518-76, L1712518-77, L1712518-78	TVS
LDW-Y0-IN-ENR+AC-5-C-COR	04/13/2017 14:34	L1712518-79, L1712518-80, L1712518-81	TVS
LDW-Y0-IN-ENR+AC-6-A-COR	04/13/2017 14:10	L1712518-82, L1712518-83, L1712518-84	TVS
LDW-Y0-IN-ENR+AC-6-B-COR	04/13/2017 14:25	L1712518-85, L1712518-86, L1712518-87	TVS
LDW-Y0-IN-ENR+AC-6-C-COR	04/13/2017 14:35	L1712518-88, L1712518-89, L1712518-90	TVS
LDW-Y0-SU-ENR-CA-CORE	04/13/2017 08:45	L1712837-01, L1712837-02, L1712837-03	TVS, GS
LDW-Y0-SU-ENR-CA-CORE-#50	04/13/2017 08:45	L1712837-04, L1712837-05, L1712837-06	TVS

Sample ID	Sample Date/Time	LabID(s)	Analyses
LDW-Y0-SU-ENR-CB-CORE	04/13/2017 09:03	L1712837-07, L1712837-08, L1712837-09	TVS, GS
LDW-Y0-SU-ENR-CB-CORE-#50	04/13/2017 09:03	L1712837-10, L1712837-11, L1712837-12	TVS
LDW-Y0-SU-ENR-CC-CORE	04/13/2017 09:20	L1712837-13, L1712837-14, L1712837-15	TVS, GS
LDW-Y0-SU-ENR-CC-CORE-#50	04/13/2017 09:20	L1712837-16, L1712837-17, L1712837-18	TVS
LDW-Y0-SU-ENR+AC-CA-CORE	04/13/2017 09:40	L1712837-19, L1712837-20, L1712837-21	TVS, GS
LDW-Y0-SU-ENR+AC-CA-CORE-#50	04/13/2017 09:40	L1712837-22, L1712837-23, L1712837-24	TVS
LDW-Y0-SU-ENR+AC-CB-CORE	04/13/2017 10:10	L1712837-25, L1712837-26, L1712837-27	TVS, GS
LDW-Y0-SU-ENR+AC-CB-CORE-#50	04/13/2017 10:10	L1712837-28, L1712837-29, L1712837-30	TVS
LDW-Y0-SU-ENR+AC-CC-CORE	04/13/2017 10:25	L1712837-31, L1712837-32, L1712837-33	TVS, GS
LDW-Y0-SU-ENR+AC-CC-CORE-#50	04/13/2017 10:25	L1712837-34, L1712837-35, L1712837-36	TVS
LDW-Y0-SU-ENR+AC-1-A-COR	04/13/2017 09:30	L1712837-37, L1712837-38, L1712837-39	TVS
LDW-Y0-SU-ENR+AC-1-B-COR	04/13/2017 10:00	L1712837-40, L1712837-41, L1712837-42	TVS
LDW-Y0-SU-ENR+AC-1-C-COR	04/13/2017 10:25	L1712837-43, L1712837-44, L1712837-45	TVS
LDW-Y0-SU-ENR+AC-2-A-COR	04/13/2017 09:31	L1712837-46, L1712837-47, L1712837-48	TVS
LDW-Y0-SU-ENR+AC-2-B-COR	04/13/2017 10:01	L1721003-01, L1721003-02, L1721003-03	TVS
LDW-Y0-SU-ENR+AC-2-C-COR	04/13/2017 10:20	L1721003-07, L1721003-08, L1721003-09	TVS
LDW-Y0-SU-ENR+AC-3-A-COR	04/13/2017 09:32	L1721003-13, L1721003-14, L1721003-15	TVS
LDW-Y0-SU-ENR+AC-3-B-COR	04/13/2017 10:02	L1721003-19, L1721003-20, L1721003-21	TVS
LDW-Y0-SU-ENR+AC-3-C-COR	04/13/2017 10:27	L1721003-25, L1721003-26, L1721003-27	TVS
LDW-Y0-SU-ENR+AC-4-A-COR	04/13/2017 09:33	L1721003-31, L1721003-32, L1721003-33	TVS
LDW-Y0-SU-ENR+AC-4-B-COR	04/13/2017 10:03	L1721003-37, L1721003-38, L1721003-39	TVS
LDW-Y0-SU-ENR+AC-4-C-COR	04/13/2017 10:28	L1721003-43, L1721003-44, L1721003-45	TVS
LDW-Y0-SU-ENR+AC-5-A-COR	04/13/2017 09:34	L1721003-49, L1721003-50, L1721003-51	TVS
LDW-Y0-SU-ENR+AC-5-B-COR	04/13/2017 10:04	L1721003-55, L1721003-56, L1721003-57	TVS
LDW-Y0-SU-ENR+AC-5-C-COR	04/13/2017 10:29	L1712837-69, L1712837-70, L1712837-71	TVS
LDW-Y0-SU-ENR+AC-6-A-COR	04/13/2017 09:35	L1712837-72, L1712837-73, L1712837-74	TVS
LDW-Y0-SU-ENR+AC-6-B-COR	04/13/2017 10:05	L1712837-75, L1712837-76, L1712837-77	TVS
LDW-Y0-SU-ENR+AC-6-C-COR	04/13/2017 10:30	L1712837-78, L1712837-79, L1712837-80	TVS
LDW-Y0-SC-ENR-CA-CORE	04/13/2017 11:00	L1713139-01, L1713139-02, L1713139-03	TVS, GS
LDW-Y0-SC-ENR-CA-CORE-#50	04/13/2017 11:00	L1713139-04, L1713139-05, L1713139-06	TVS
LDW-Y0-SC-ENR-CB-CORE	04/13/2017 11:10	L1713139-07, L1713139-08, L1713139-09	TVS, GS
LDW-Y0-SC-ENR-CB-CORE-#50	04/13/2017 11:10	L1713139-10, L1713139-11, L1713139-12	TVS
LDW-Y0-SC-ENR-CC-CORE	04/13/2017 11:20	L1713139-13, L1713139-14, L1713139-15	TVS, GS
LDW-Y0-SC-ENR-CC-CORE-#50	04/13/2017 11:20	L1713139-16, L1713139-17, L1713139-18	TVS
LDW-Y0-SC-ENR+AC-CA-CORE	04/13/2017 12:55	L1713139-19, L1713139-20, L1713139-21	TVS, GS
LDW-Y0-SC-ENR+AC-CA-CORE-#50	04/13/2017 12:55	L1713139-22, L1713139-23, L1713139-24	TVS
LDW-Y0-SC-ENR+AC-CB-CORE	04/13/2017 13:05	L1713139-25, L1713139-26, L1713139-27	TVS, GS
LDW-Y0-SC-ENR+AC-CB-CORE-#50	04/13/2017 13:05	L1713139-28, L1713139-29, L1713139-30	TVS
LDW-Y0-SC-ENR+AC-CC-CORE	04/13/2017 13:20	L1713139-31, L1713139-32, L1713139-33	TVS, GS
LDW-Y0-SC-ENR+AC-CC-CORE-#50	04/13/2017 13:20	L1713139-34, L1713139-35, L1713139-36	TVS
LDW-Y0-SC-ENR+AC-1-A-COR	04/13/2017 12:45	L1713139-37, L1713139-38, L1713139-39	TVS
LDW-Y0-SC-ENR+AC-1-B-COR	04/13/2017 13:00	L1713139-40, L1713139-41, L1713139-42	TVS
LDW-Y0-SC-ENR+AC-1-C-COR	04/13/2017 13:14	L1713139-43, L1713139-44, L1713139-45	TVS
LDW-Y0-SC-ENR+AC-2-A-COR	04/13/2017 12:46	L1713139-46, L1713139-47, L1713139-48	TVS
LDW-Y0-SC-ENR+AC-2-B-COR	04/13/2017 13:01	L1713139-49, L1713139-50, L1713139-51	TVS
LDW-Y0-SC-ENR+AC-2-C-COR	04/13/2017 13:15	L1713139-52, L1713139-53, L1713139-54	TVS
LDW-Y0-SC-ENR+AC-3-A-COR	04/13/2017 12:47	L1713139-55, L1713139-56, L1713139-57	TVS
LDW-Y0-SC-ENR+AC-3-B-COR	04/13/2017 13:02	L1713139-58, L1713139-59, L1713139-60	TVS
LDW-Y0-SC-ENR+AC-3-C-COR	04/13/2017 13:16	L1713139-61, L1713139-62, L1713139-63	TVS
LDW-Y0-SC-ENR+AC-4-A-COR	04/13/2017 12:48	L1713139-64, L1713139-65, L1713139-66	TVS
LDW-Y0-SC-ENR+AC-4-B-COR	04/13/2017 13:03	L1713139-67, L1713139-68, L1713139-69	TVS
LDW-Y0-SC-ENR+AC-4-C-COR	04/13/2017 13:17	L1713139-70, L1713139-71, L1713139-72	TVS
LDW-Y0-SC-ENR+AC-5-A-COR	04/13/2017 12:49	L1713139-73, L1713139-74, L1713139-75	TVS
LDW-Y0-SC-ENR+AC-5-B-COR	04/13/2017 13:04	L1713139-76, L1713139-77, L1713139-78	TVS
LDW-Y0-SC-ENR+AC-5-C-COR	04/13/2017 13:18	L1713139-79, L1713139-80, L1713139-81	TVS
LDW-Y0-SC-ENR+AC-6-A-COR	04/13/2017 12:50	L1713139-82, L1713139-83, L1713139-84	TVS
LDW-Y0-SC-ENR+AC-6-B-COR	04/13/2017 13:05	L1713139-85, L1713139-86, L1713139-87	TVS
LDW-Y0-SC-ENR+AC-6-C-COR	04/13/2017 13:19	L1713139-88, L1713139-89, L1713139-90	TVS

Total volatile solids analyses were performed by Alpha Analytical Laboratory, in Westborough, Massachusetts. Grain size analyses were performed by Alpha Analytical in Mansfield, Massachusetts.

Validation: A summary validation was performed on the total volatile solids and grain size data. Validation of the black carbon results in SDG L1712837 and the total volatile solids results in SDG L1719382 were not required and were excluded from this review. Validation was performed by Cari Sayler. Data qualifiers are summarized in section 4.0 of this report.

Analytical methods: Table 3.3 of the QAPP specifies the following analytical methods:

Analysis	Method
Total Volatile Solids (TVS)	Not specified
Grain size (GS)	ASTM D422

TVS was analyzed by method SM2540E and grainsize was analyzed by ASTM D422. Methods were considered appropriate.

Sample Receipt: Sample chain-of-custodies and sample log-in documentation were reviewed. All requested analyses were performed.

Sample number transcription: Sample IDs in the electronic data deliverable (EDD) were compared to the chain-of-custody for each sample. The reported Sample IDs included a -#50 suffix to indicate the #50 sieve fraction was analyzed. Additionally, the total volatile solids samples were analyzed in triplicate, and a -1,-2, or -3 suffix was added to indicate the replicate number. The replicate suffixes were removed from the sample IDs throughout this report. Other than the suffixes described above, the sampleIDs matched the chain of custody.

2.0 Total Volatile Solids

Quality control analysis frequencies: Samples were analyzed in twenty-three batches. A method blank was analyzed in each batch. Eighteen of the twenty-three batches contained a project-specific laboratory duplicate. Additionally, samples were analyzed in triplicate. QA/QC samples were sufficient to evaluate precision as appropriate for the method.

Holding times: The method specifies that soil samples must be analyzed within 7 days. The sample matrix consisted of Activated Carbon added to sand and/or sandy gravel and therefore the soil holding times do not apply.

Activated carbon is routinely stored for months at room temperature prior to use according to the manufacturer (Calgon). Samples were analyzed between 20 and 72 days after sampling and no qualifiers are assigned. However, since the purpose of the analysis was to confirm the activated carbon content in the samples, the analyte name has been changed to Activated Carbon by TVS.

Laboratory blank results: Criteria for method blanks are that analyte concentrations must be below the PQL, or below 10% of the lowest associated sample concentration. This criterion was met for all method blanks.

Sample replicate variability: The RSD between the three replicate analyses of each sample was below 20% with the following exceptions:

Sample ID	Analyte	Rep 1 (%)	Rep 2 (%)	Rep 3 (%)	RSD
LDW-Y0-IN-ENR+AC-4-C-COR	Activated carbon by TVS	2.9	4.8	3.2	28.11
LDW-Y0-SC-ENR-CA-CORE	Activated carbon by TVS	1.3	0.9	0.9	22.35
LDW-Y0-SC-ENR+AC-CB-CORE	Activated carbon by TVS	1.6	3.1	3.9	40.73
LDW-Y0-SC-ENR+AC-4-A-COR	Activated carbon by TVS	4.5	4.3	2.9	22.35
LDW-Y0-SC-ENR+AC-4-B-COR	Activated carbon by TVS	4.5	3.2	3.2	20.66
LDW-Y0-SC-ENR+AC-6-C-COR	Activated carbon by TVS	1.2	3.3	3.3	46.63
LDW-Y0-SU-ENR+AC-CA-CORE-#50	Activated carbon by TVS	2.8	2.9	1.3	38.41
LDW-Y0-SU-ENR+AC-2-C-COR	Activated Carbon by TVS	0.1 U	3.1	3.1	82.48

These sample results are qualified as estimated.

Laboratory duplicate results: Laboratory duplicate RPDs were within the laboratory control limit with the following exceptions:

QC ID	Analyte	RPD	Lab Control Limit
LDW-Y0-IN-ENR+AC-1-B-COR-1 LD	Activated carbon by TVS	12	11
LDW-Y0-IN-ENR+AC-5-C-COR-1 LD	Activated carbon by TVS	19	11
LDW-Y0-IN-ENR+AC-5-C-COR-3 LD	Activated carbon by TVS	24	11
LDW-Y0-SC-ENR+AC-4-B-COR-3 LD	Activated carbon by TVS	91	11
LDW-Y0-SC-ENR-CC-CORE-1 LD	Activated carbon by TVS	12	11

Total volatile solids results in the parent samples are qualified as estimated. Due to the availability of sample replicate results, qualifiers for laboratory duplicates are limited to the parent sample only.

Total volatile solids results are acceptable for limited use as qualified and discussed.

3.0 Grain Size Analyses

Quality control analysis frequencies: Each batch included a laboratory duplicate, meeting frequency requirements. Additionally, one sample was analyzed in triplicate.

Holding times: Sediment samples must be analyzed within 6 months of collection. Samples were analyzed within the holding time.

Sample replicate variability: The RSD between the three replicate analyses was below 20% with the following exceptions:

Sample ID	Analyte	Rep 1	Rep 2	Rep 3	RSD
LDW-Y0-SC-ENR-CA-CORE	% Fine Sand	13.5	8.2	8.8	28.55

The % fine sand result in this sample is qualified as estimated.

Laboratory duplicate RPDs: Laboratory duplicate RPDs were within 20% with the following exceptions:

QC ID	Analyte	RPD	Lab Control Limit
LDW-Y0-IN-ENR-CA-CORE-1 LD	% Fine Gravel	43	20
LDW-Y0-IN-ENR-CA-CORE-1 LD	% Total Gravel	43	20
LDW-Y0-SU-ENR-CA-CORE-1 LD	% Total Fines	38	20

QC ID	Analyte	RPD	Lab Control Limit
LDW-Y0-SC-ENR+AC-CB-CORE-1 LD	% Total Fines	33	20

The % total fines result in LDW-Y0-SC-ENR+AC-CB-CORE-1 duplicate are below 5 times the reporting limit and the control limit does not apply. Results for the remaining fractions are qualified as estimated in the associated samples.

Grain size data are acceptable for use as qualified.

4.0 Qualifier Summary Table

Client ID	Analyte(s)	Qualifier	Reason
Total Volatile Solids			
LDW-Y0-IN-ENR+AC-1-B-COR	Activated Carbon by TVS	J	High duplicate RPD
LDW-Y0-IN-ENR+AC-4-C-COR	Activated Carbon by TVS	J	High replicate RSD
LDW-Y0-IN-ENR+AC-5-C-COR	Activated Carbon by TVS	J	High duplicate RPD
LDW-Y0-SC-ENR+AC-4-A-COR	Activated Carbon by TVS	J	High replicate RSD
LDW-Y0-SC-ENR+AC-4-B-COR	Activated Carbon by TVS	J	High duplicate RPD, High replicate RSD
LDW-Y0-SC-ENR+AC-6-C-COR	Activated Carbon by TVS	J	High duplicate RPD, High replicate RSD
LDW-Y0-SC-ENR+AC-CB-CORE	Activated Carbon by TVS	J	High duplicate RPD, High replicate RSD
LDW-Y0-SC-ENR-CA-CORE	Activated Carbon by TVS	J	High duplicate RPD, High replicate RSD
LDW-Y0-SC-ENR-CC-CORE	Activated Carbon by TVS	J	High duplicate RPD
LDW-Y0-SU-ENR+AC-CA-CORE-#50	Activated Carbon by TVS	J	High duplicate RPD, High replicate RSD
LDW-Y0-SU-ENR+AC-2-C-COR	Activated Carbon by TVS	J	High replicate RSD
Grain Size			
LDW-Y0-IN-ENR+AC-CA-CORE	% Fine Gravel, % Total Gravel	J	High duplicate RPD
LDW-Y0-IN-ENR+AC-CB-CORE	% Fine Gravel, % Total Gravel	J	High duplicate RPD
LDW-Y0-IN-ENR+AC-CC-CORE	% Fine Gravel, % Total Gravel	J	High duplicate RPD
LDW-Y0-IN-ENR-CA-CORE	% Fine Gravel, % Total Gravel	J	High duplicate RPD
LDW-Y0-IN-ENR-CB-CORE	% Fine Gravel, % Total Gravel	J	High duplicate RPD
LDW-Y0-IN-ENR-CC-CORE	% Fine Gravel, % Total Gravel	J	High duplicate RPD
LDW-Y0-SC-ENR-CA-CORE	% Fine Sand	J	High replicate RSD
LDW-Y0-SU-ENR+AC-CA-CORE	% Total Fines	J	High duplicate RPD
LDW-Y0-SU-ENR+AC-CB-CORE	% Total Fines	J	High duplicate RPD
LDW-Y0-SU-ENR+AC-CC-CORE	% Total Fines	J	High duplicate RPD
LDW-Y0-SU-ENR-CA-CORE	% Total Fines	J	High duplicate RPD
LDW-Y0-SU-ENR-CB-CORE	% Total Fines	J	High duplicate RPD
LDW-Y0-SU-ENR-CC-CORE	% Total Fines	J	High duplicate RPD

5.0 Abbreviations and Definitions

DV Qualifier	Definition
U	The material was analyzed for, but was not detected above the level of the associated value.
UY	The reporting limit was elevated due to chromatographic overlap with related compounds. The material was analyzed for, but was not detected above the level of the associated value.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R	The sample result is rejected. The presence or absence of the analyte cannot be verified and data are not usable.

DV Qualifier	Definition
R1	This sample result has been rejected in favor of a more accurate, precise or conservative result. The other result should be used.
R2	This sample result has been rejected in favor of a more accurate, precise or conservative result from another analytical method. The other result should be used.

Abbreviation	Definition
DV	Data validation
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
LD	Laboratory duplicate
EDL	Estimated detection limit
EMPC	Estimated maximum possible concentration
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not Applicable
OPR	Ongoing Precision and Recovery
RL	Reporting limit
RPD	Relative percent difference
RRM	Regional reference material
RSD	Relative standard deviations
SRM	Standard reference material

6.0 References

National Functional Guidelines For Inorganic Superfund Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, August 2014, USEPA-540-R-13-001.

National Functional Guidelines for High Resolution Superfund Methods Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, April 2016, EPA-542-B-16-001.

Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS, US Environmental Protection Agency, Office of Water Engineering and Analysis Division, April 2010.

Quality Assurance Project Plan Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Prepared by AMEC Foster Wheeler Environment & Infrastructure Inc., et al. Prepared for: USEPA Region 10 and WA-DOE Northwest Regional Office, February 22, 2016.

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DATA VALIDATION REPORT

Lower Duwamish Waterway– Enhanced Natural Recovery/Activated Carbon Pilot Study, Year 0 Samples, April 2017, Total Organic Carbon Analysis

Prepared for:
AMEC Foster Wheeler
3500 188th Street SW, Ste 601
Lynnwood, WA 98037-4763

December 5, 2017

1.0 Introduction

Data validation was performed on the following samples:

Sample ID	Sample Date/Time	Lab ID	Analyses
LDW-Y0-IN-ENR-CA-CORE	04/13/2017 13:40	K1709634-001	TOC
LDW-Y0-IN-ENR-CB-CORE	04/13/2017 13:50	K1709634-002	TOC
LDW-Y0-IN-ENR-CC-CORE	04/13/2017 13:55	K1709634-003	TOC
LDW-Y0-IN-ENR+AC-CA-CORE (-50 mesh)	04/13/2017 13:40	K1709634-004	TOC
LDW-Y0-IN-ENR+AC-CB-CORE (-50 mesh)	04/13/2017 13:50	K1709634-005	TOC
LDW-Y0-IN-ENR+AC-CC-CORE (-50 mesh)	04/13/2017 13:55	K1709634-006	TOC
LDW-Y0-IN-ENR+AC-1-A-COR	04/13/2017 14:05	K1709634-007	TOC
LDW-Y0-IN-ENR+AC-1-B-COR	04/13/2017 14:20	K1709634-008	TOC
LDW-Y0-IN-ENR+AC-1-C-COR	04/13/2017 14:30	K1709634-009	TOC
LDW-Y0-IN-ENR+AC-2-A-COR	04/13/2017 14:06	K1709634-010	TOC
LDW-Y0-IN-ENR+AC-2-B-COR	04/13/2017 14:21	K1709634-011	TOC
LDW-Y0-IN-ENR+AC-2-C-COR	04/13/2017 14:31	K1709634-012	TOC
LDW-Y0-IN-ENR+AC-3-A-COR	04/13/2017 14:07	K1709634-013	TOC
LDW-Y0-IN-ENR+AC-3-B-COR	04/13/2017 14:22	K1709634-014	TOC
LDW-Y0-IN-ENR+AC-3-C-COR	04/13/2017 14:32	K1709634-015	TOC
LDW-Y0-IN-ENR+AC-4-A-COR	04/13/2017 14:08	K1709634-016	TOC
LDW-Y0-IN-ENR+AC-4-B-COR	04/13/2017 14:23	K1709634-017	TOC
LDW-Y0-IN-ENR+AC-4-C-COR	04/13/2017 14:33	K1709634-018	TOC
LDW-Y0-IN-ENR+AC-5-A-COR	04/13/2017 14:09	K1709634-019	TOC
LDW-Y0-IN-ENR+AC-5-B-COR	04/13/2017 14:24	K1709634-020	TOC
LDW-Y0-IN-ENR+AC-5-C-COR	04/13/2017 14:34	K1709634-021	TOC
LDW-Y0-IN-ENR+AC-6-A-COR	04/13/2017 14:10	K1709634-022	TOC
LDW-Y0-IN-ENR+AC-6-B-COR	04/13/2017 14:25	K1709634-023	TOC
LDW-Y0-IN-ENR+AC-6-C-COR	04/13/2017 14:35	K1709634-024	TOC
LDW-Y0-IN-ENR+AC-CA-CORE	04/13/2017 14:15	K1709634-025	TOC
LDW-Y0-IN-ENR+AC-CB-CORE	04/13/2017 14:30	K1709634-026	TOC
LDW-Y0-IN-ENR+AC-CC-CORE	04/13/2017 14:40	K1709634-027	TOC
LDW-Y0-SU-ENR-CA-CORE	04/13/2017 08:45	K1709635-001	TOC
LDW-Y0-SU-ENR-CB-CORE	04/13/2017 09:03	K1709635-002	TOC
LDW-Y0-SU-ENR-CC-CORE	04/13/2017 09:20	K1709635-003	TOC

Sample ID	Sample Date/Time	Lab ID	Analyses
LDW-Y0-SU-ENR+AC-CA-CORE (-50 mesh)	04/13/2017 08:45	K1709635-004	TOC
LDW-Y0-SU-ENR+AC-CB-CORE (-50 mesh)	04/13/2017 09:03	K1709635-005	TOC
LDW-Y0-SU-ENR+AC-CC-CORE (-50 mesh)	04/13/2017 09:20	K1709635-006	TOC
LDW-Y0-SU-ENR+AC-1-A-COR	04/13/2017 09:30	K1709635-007	TOC
LDW-Y0-SU-ENR+AC-1-B-COR	04/13/2017 10:00	K1709635-008	TOC
LDW-Y0-SU-ENR+AC-1-C-COR	04/13/2017 10:25	K1709635-009	TOC
LDW-Y0-SU-ENR+AC-2-A-COR	04/13/2017 09:31	K1709635-010	TOC
LDW-Y0-SU-ENR+AC-2-B-COR	04/13/2017 10:01	K1709635-011	TOC
LDW-Y0-SU-ENR+AC-2-C-COR	04/13/2017 10:20	K1709635-012	TOC
LDW-Y0-SU-ENR+AC-3-A-COR	04/13/2017 09:32	K1709635-013	TOC
LDW-Y0-SU-ENR+AC-3-B-COR	04/13/2017 10:02	K1709635-014	TOC
LDW-Y0-SU-ENR+AC-3-C-COR	04/13/2017 10:27	K1709635-015	TOC
LDW-Y0-SU-ENR+AC-4-A-COR	04/13/2017 09:33	K1709635-016	TOC
LDW-Y0-SU-ENR+AC-4-B-COR	04/13/2017 10:03	K1709635-017	TOC
LDW-Y0-SU-ENR+AC-4-C-COR	04/13/2017 10:28	K1709635-018	TOC
LDW-Y0-SU-ENR+AC-5-A-COR	04/13/2017 09:34	K1709635-019	TOC
LDW-Y0-SU-ENR+AC-5-B-COR	04/13/2017 10:04	K1709635-020	TOC
LDW-Y0-SU-ENR+AC-5-C-COR	04/13/2017 10:29	K1709635-021	TOC
LDW-Y0-SU-ENR+AC-6-A-COR	04/13/2017 09:35	K1709635-022	TOC
LDW-Y0-SU-ENR+AC-6-B-COR	04/13/2017 10:05	K1709635-023	TOC
LDW-Y0-SU-ENR+AC-6-C-COR	04/13/2017 10:30	K1709635-024	TOC
LDW-Y0-SU-ENR+AC-CA-CORE	04/13/2017 09:40	K1709635-025	TOC
LDW-Y0-SU-ENR+AC-CB-CORE	04/13/2017 10:10	K1709635-026	TOC
LDW-Y0-SU-ENR+AC-CC-CORE	04/13/2017 10:25	K1709635-027	TOC
LDW-Y0-SC-ENR-CA-CORE	04/13/2017 11:00	K1709636-001	TOC
LDW-Y0-SC-ENR-CB-CORE	04/13/2017 11:10	K1709636-002	TOC
LDW-Y0-SC-ENR+AC-CA-CORE (-50 mesh)	04/13/2017 11:00	K1709636-004	TOC
LDW-Y0-SC-ENR+AC-CB-CORE (-50 mesh)	04/13/2017 11:10	K1709636-005	TOC
LDW-Y0-SC-ENR+AC-CC-CORE (-50 mesh)	04/13/2017 11:20	K1709636-006	TOC
LDW-Y0-SC-ENR+AC-1-A-COR	04/13/2017 12:45	K1709636-007	TOC
LDW-Y0-SC-ENR+AC-1-B-COR	04/13/2017 13:00	K1709636-008	TOC
LDW-Y0-SC-ENR+AC-1-C-COR	04/13/2017 13:14	K1709636-009	TOC
LDW-Y0-SC-ENR+AC-2-A-COR	04/13/2017 12:46	K1709636-010	TOC
LDW-Y0-SC-ENR+AC-2-B-COR	04/13/2017 13:01	K1709636-011	TOC
LDW-Y0-SC-ENR+AC-2-C-COR	04/13/2017 13:15	K1709636-012	TOC
LDW-Y0-SC-ENR+AC-3-A-COR	04/13/2017 12:47	K1709636-013	TOC
LDW-Y0-SC-ENR+AC-3-B-COR	04/13/2017 13:02	K1709636-014	TOC
LDW-Y0-SC-ENR+AC-3-C-COR	04/13/2017 13:16	K1709636-015	TOC
LDW-Y0-SC-ENR+AC-4-A-COR	04/13/2017 12:48	K1709636-016	TOC
LDW-Y0-SC-ENR+AC-4-B-COR	04/13/2017 13:03	K1709636-017	TOC
LDW-Y0-SC-ENR+AC-4-C-COR	04/13/2017 13:17	K1709636-018	TOC
LDW-Y0-SC-ENR+AC-5-A-COR	04/13/2017 12:49	K1709636-019	TOC
LDW-Y0-SC-ENR+AC-5-B-COR	04/13/2017 13:04	K1709636-020	TOC
LDW-Y0-SC-ENR+AC-5-C-COR	04/13/2017 13:18	K1709636-021	TOC
LDW-Y0-SC-ENR+AC-6-A-COR	04/13/2017 12:50	K1709636-022	TOC
LDW-Y0-SC-ENR+AC-6-B-COR	04/13/2017 13:05	K1709636-023	TOC
LDW-Y0-SC-ENR+AC-6-C-COR	04/13/2017 13:19	K1709636-024	TOC
LDW-Y0-SC-ENR+AC-CA-CORE	04/13/2017 12:55	K1709636-025	TOC
LDW-Y0-SC-ENR+AC-CB-CORE	04/13/2017 13:05	K1709636-026	TOC
LDW-Y0-SC-ENR+AC-CC-CORE	04/13/2017 13:20	K1709636-027	TOC

Analyses were performed by ALS Environmental in Kelso, Washington.

Validation: A summary validation was performed on the reported results. Validation was performed by Cari Sayler. No qualifiers are assigned as a result of this review.

Analytical methods: The analysis method matched the QAPP specified method as follows:

Analysis	QAPP Method	Analysis Method
Total Organic Carbon Analysis (TOC)	EPA 9060	EPA 9060

Sample Receipt: Sample chain-of-custodies and sample log-in documentation were reviewed. Sample LDW-Y0-SC-ENR-CC-CORE (K1709636-003) was put on hold and not analyzed. All other samples listed on the chain of custody were analyzed as requested.

Sample number transcription: Sample IDs in the electronic data deliverable (EDD) were compared to the chain-of-custody for each sample. The reported Sample IDs included a (-50 mesh) suffix to indicate the #50 sieve fraction was analyzed. Other than the suffix described above, the sampleIDs matched the chain of custody.

2.0 Total Organic Carbon

Quality control analysis frequencies: Samples were analyzed in six batches. Each batch contained a method blank, lab control sample, matrix spike and matrix spike duplicate. Additionally, each sample was analyzed in duplicate. QA/QC samples were sufficient to evaluate precision as appropriate for the method.

Holding times: Total Organic Carbon in sediment typically must be analyzed within 28 days. The sample matrix consisted of Activated Carbon added to sand and/or sandy gravel and therefore the soil holding times do not apply.

Activated carbon is routinely stored for months at room temperature prior to use according to the manufacturer (Calgon). Samples were analyzed between 209 and 216 days after sampling and no qualifiers are assigned. However, since the purpose of the analysis was to confirm the activated carbon content in the samples, the analyte name has been changed to Activated Carbon by TOC.

Laboratory blank results: Criteria for method blanks are that analyte concentrations must be below the PQL, or below 10% of the lowest associated sample concentration. This criterion was met for all method blanks.

LCS recoveries: QAPP control limits were 75-125%. Laboratory control limits were 70-122%. LCS recoveries were within QAPP and laboratory control limits.

MS recoveries: QAPP control limits were 75-125%. Laboratory control limits were 70-122%. Recoveries were within QAPP and laboratory control.

MS/MSD RPDs: QAPP control limit was 25%. Laboratory control limit was 20%. RPDs were within QAPP and laboratory control limits.

Sample duplicate variability: The RPD between the two duplicate analyses of each sample was below 20%.

Total organic carbon results are acceptable for use to confirm the activated carbon content in the samples limited as discussed.

3.0 Abbreviations and Definitions

DV Qualifier	Definition
U	The material was analyzed for, but was not detected above the level of the associated value.
UY	The reporting limit was elevated due to chromatographic overlap with related compounds. The material was analyzed for, but was not detected above the level of the associated value.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R	The sample result is rejected. The presence or absence of the analyte cannot be verified and data are not usable.
R1	This sample result has been rejected in favor of a more accurate, precise or conservative result. The other result should be used.
R2	This sample result has been rejected in favor of a more accurate, precise or conservative result from another analytical method. The other result should be used.

Abbreviation	Definition
DV	Data validation
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not Applicable
RL	Reporting limit
RPD	Relative percent difference
RRM	Regional reference material
RSD	Relative standard deviations
SRM	Standard reference material

4.0 References

National Functional Guidelines For Inorganic Superfund Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, August 2014, USEPA-540-R-13-001.

Quality Assurance Project Plan Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Prepared by AMEC Foster Wheeler Environment & Infrastructure Inc., et al. Prepared for: USEPA Region 10 and WA-DOE Northwest Regional Office, February 22, 2016.

YEAR 1

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DATA VALIDATION REPORT

Lower Duwamish Waterway– Enhanced Natural Recovery/Activated Carbon Pilot Year One Samples, May 2018 – July 2018

Prepared for:
Wood Environment and Infrastructure Solutions
3500 188th Street SW, Ste 601
Lynnwood, WA 98037-4763

September 5, 2018

1.0 Introduction

Data validation was performed on the following samples:

Sample ID	Sample Date/Time	Lab ID	Analyses	Matrix
LDW-Y1-SC-ENR+AC-CA-S010	06/30/2018 14:30	11703-001-0001-SA	PCB	Solvent
LDW-Y1-SC-ENR+AC-CB-S010	06/30/2018 14:38	11703-002-0001-SA	PCB	Solvent
LDW-Y1-SC-ENR+AC-CC-S010	06/30/2018 14:45	11703-003-0001-SA	PCB	Solvent
LDW-Y1-SC-ENR-CA-S010	06/30/2018 15:29	11703-006-0001-SA	PCB	Solvent
LDW-Y1-SC-ENR-CB-S010	06/30/2018 15:36	11703-007-0001-SA	PCB	Solvent
LDW-Y1-SC-ENR-CC-S010	06/30/2018 15:43	11703-008-0001-SA	PCB	Solvent
LDW-Y1-SU-ENR+AC-CA-S010	06/30/2018 11:45	11703-011-0001-SA	PCB	Solvent
LDW-Y1-SU-ENR+AC-CB-S010	06/30/2018 11:54	11703-012-0001-SA	PCB	Solvent
LDW-Y1-SU-ENR+AC-CC-S010	06/30/2018 12:03	11703-013-0001-SA	PCB	Solvent
LDW-Y1-SU-ENR-CA-S010	06/30/2018 13:35	11704-002-0001-SA	PCB	Solvent
LDW-Y1-SU-ENR-CB-S010	06/30/2018 13:41	11704-003-0001-SA	PCB	Solvent
LDW-Y1-SU-ENR-CC-S010	06/30/2018 13:50	11704-004-0001-SA	PCB	Solvent
LDW-Y1-SU-S010-LCB	06/30/2018 14:13	11704-007-0001-SA	PCB	Solvent
LDW-Y1-IN-ENR+AC-CA-S010	06/30/2018 16:17	11704-008-0001-SA	PCB	Solvent
LDW-Y1-IN-ENR+AC-CB-S010	06/30/2018 16:23	11704-009-0001-SA	PCB	Solvent
LDW-Y1-IN-ENR+AC-CC-S010	06/30/2018 16:30	11704-010-0001-SA	PCB	Solvent
LDW-Y1-IN-ENR-CA-S010	06/30/2018 16:59	11704-013-0001-SA	PCB	Solvent
LDW-Y1-IN-ENR-CB-S010	06/30/2018 17:07	11704-014-0001-SA	PCB	Solvent
LDW-Y1-IN-ENR-CC-S010	06/30/2018 17:13	11704-015-0001-SA	PCB	Solvent
LDW-Y1-SC-S010-TB	06/30/2018 16:04	11704-018-0001-SA	PCB	Solvent
LDW-Y1-SU-S010-TB	06/30/2018 15:22	11704-019-0001-SA	PCB	Solvent
LDW-Y1-IN-S010-TB	06/30/2018 15:38	11704-020-0001-SA	PCB	Solvent
LDW-Y1-IN-ENR-CA-CORE	07/06/2018 13:45	11719-001-0001-SA, K1806435-001	PCB, TOC, GS	Sediment

Sample ID	Sample Date/Time	Lab ID	Analyses	Matrix
LDW-Y1-IN-ENR-CB-CORE	07/06/2018 14:00	11719-002-0001-SA, K1806435-002	PCB, TOC, GS	Sediment
LDW-Y1-IN-ENR-CC-CORE	07/06/2018 14:20	11719-003-0001-SA, K1806435-003	PCB, TOC, GS	Sediment
LDW-Y1-IN-ENR+AC-CA-CORE	07/06/2018 15:00	11719-004-0001-SA, K1806435-004	PCB, TOC, GS	Sediment
LDW-Y1-IN-ENR+AC-CB-CORE	07/06/2018 15:10	11719-005-0001-SA, K1806435-005	PCB, TOC, GS	Sediment
LDW-Y1-IN-ENR+AC-CC-CORE	07/06/2018 15:20	11719-006-0001-SA, K1806435-006	PCB, TOC, GS	Sediment
LDW-Y1-SC-ENR-CA-CORE	07/06/2018 10:45	11719-007-0001-SA, K1806431-001	PCB, TOC, GS	Sediment
LDW-Y1-SC-ENR-CB-CORE	07/06/2018 11:00	11719-008-0001-SA, K1806431-002	PCB, TOC, GS	Sediment
LDW-Y1-SC-ENR-CC-CORE	07/06/2018 11:20	11719-009-0001-SA; K1806431-003	PCB, TOC, GS	Sediment
LDW-Y1-SC-ENR+AC-CA-CORE	07/06/2018 12:05	11719-010-0001-SA, K1806431-004	PCB, TOC, GS	Sediment
LDW-Y1-SC-ENR+AC-CB-CORE	07/06/2018 12:45	11719-011-0001-SA, K1806431-005	PCB, TOC, GS	Sediment
LDW-Y1-SC-ENR+AC-CC-CORE	07/06/2018 13:00	11719-012-0001-SA, K1806431-006	PCB, TOC, GS	Sediment
LDW-Y1-SU-ENR-CA-CORE	05/03/2018 09:50	11719-013-0001-SA, K1804260-001	PCB, TOC, GS	Sediment
LDW-Y1-SU-ENR-CB-CORE	05/03/2018 10:10	11719-014-0001-SA, K1804260-002	PCB, TOC, GS	Sediment
LDW-Y1-SU-ENR-CC-CORE	05/03/2018 10:25	11719-015-0001-SA, K1804260-003	PCB, TOC, GS	Sediment
LDW-Y1-SU-ENR+AC-CA-CORE	05/03/2018 12:00	11719-016-0001-SA, K1804260-004	PCB, TOC, GS	Sediment
LDW-Y1-SU-ENR+AC-CB-CORE	05/03/2018 12:15	11719-017-0001-SA, K1804260-005	PCB, TOC, GS	Sediment
LDW-Y1-SU-ENR+AC-CC-CORE	05/03/2018 12:25	11719-018-0001-SA, K1804260-006	PCB, TOC, GS	Sediment

PCB analyses were performed by Frontier Analytical Laboratory (Frontier), in El Dorado Hills, California. TOC analyses were performed by ALS Environmental (ALS) in Kelso, Washington. Grain size analyses were performed by Materials Testing & Consulting, Inc (MTC) in Burlington Washington.

Validation: A full validation was performed on the PCB data. A summary validation was performed on the TOC data. Validation was performed by Cari Sayler. Data qualifiers are summarized in section 5.0 of this report.

Analytical methods: Table 3.3 of the QAPP specifies the following analytical methods:

Analysis	Method
Polychlorinated Biphenyl Congeners (PCB)	EPA 1668C

Analysis	Method
Total Organic Carbon (TOC)	EPA 9060
Grain size (GS)	ASTM D422

These methods were used with the following exception: MTC utilized the Puget Sound Estuary Protocol (PSEP) method. This is considered an acceptable substitution.

Requested analyses: Sample chain-of-custodies and sample log-in documentation were reviewed. All requested analyses were performed..

Sample number transcription: Sample IDs in the electronic data deliverable (EDD) were compared to the chain-of-custody for each sample. Sample IDs matched the chain of custody.

2.0 Polychlorinated Biphenyl Congener Analyses

Quality control analysis frequencies: The method specifies that method blank and ongoing precision and recovery (OPR) samples must be analyzed with each batch. In addition, injection standards, isotope dilution standards and cleanup standards must be measured in each field and quality control sample. These frequencies were met.

Analysis holding times: Method 1668C specifies a one year holding time between extraction and analysis, and a one year holding time from sampling to extraction for both water and Sediment samples. These holding times were met.

System performance checks: System performance criteria include: 1) The tune must demonstrate a resolving power $\geq$10,000 at m/z 330.9792 and $\geq$8,000 throughout the range. 2) The monitored m/z must be <5 ppm from theoretical for the following theoretical m/z's: 218.9856, 242.9856, 280.9825, 330.9792, 354.9797, 354.9792, and 454.9728. 3) The retention time of congener 209 must exceed 55 minutes on the SPB-Octyl column. 4) The isomer specificity check must demonstrate resolution of congeners with valleys of $\leq$40% for congeners PCB-034 from PCB-023 and PCB-187 from PCB-182 on the SPB-Octyl Column. 5) The isomer specificity check must demonstrate elution of PCB 156 and PCB 157 within 2 seconds for the SPB-Octyl Column.

The laboratory utilized a DB1 column and provided the following column-specific performance critieria: Resolution of congeners with valleys of $\leq$40% for congeners PCB-156 and 157 and PCB 209 RT$\geq$50 minutes. Additionally, congeners 106 and 118 were evaluated for coelution within 2 seconds. These criteria were met.

No isomer specificity check analysis was provided with the initial calibration or at the end of each the 12-hour sequence. Because the initial and next day's isomer specificity check standard met criteria with very little retention time drift, no qualifiers were assigned.

Instrument calibration: Initial calibration criteria include 1) maximum percent relative standard deviations (%RSD) of $\leq$20% for target compounds and $\leq$35% for labeled compounds, 2) Ion abundance ratios must be within $\pm$15% of theoretical, and 3) signal to noise ratios must be at or above 10. Continuing calibration criteria include 1) percent recoveries within 75-125% for target compounds, 65-135% for 13C-PCB-028 and 75-125% for 13C-PCB-111 and 13C-PCB-178, and 50-145% for the remaining labeled compounds. 2) Ion abundance ratios must be within $\pm$ 15% of theoretical, and 3) signal to noise ratios must be at or above 10. 4) Absolute retention times for injection internal standards must be within $\pm$ 15 seconds of the initial calibration and 5) Relative retention times (RRT) must meet method or column-specific criteria.

Signal to noise ratios and RRTs were not summarized in the raw data. SICP chromatograms were reviewed for expected retention time and noise levels. No discrepancies were noted. All remaining calibration criteria were met.

Laboratory blank results: Laboratory performance criteria in method 1668C states that the method blank must not contain any target compound at a concentration greater than either the minimum level or one-third the regulatory compliance level, whichever is greater. Additionally, the method blank must not contain any potentially interfering compound at a concentration greater than either the minimum level or one-third the regulatory compliance level, whichever is greater. This criterion was met.

Isotope dilution standard recoveries: Method criteria are 5-145% for labeled congeners between C13-PCB-001 and C13-PCB-045 and 10-145% for labeled congeners between C13-PCB-077 and C13-PCB-209. Isotope dilution standard recoveries were within these limits with the following exception:

Sample ID	Surrogate	% Recovery	Lab Control Limit
LDW-Y1-SC-ENR-CA-CORE	13C-PCB-202	224	10 - 145

Detected concentrations of the associated analytes (PCB-196, PCB-197, PCB-198, PCB-199, PCB-200, PCB-201, PCB-202, and PCB-204) were qualified as estimated in this sample.

Cleanup standard recoveries: Method criteria are 5-145% for C13-PCB-028 and 10-145% for C13-PCB-111 and C13-PCB-178. Cleanup standard recoveries were within laboratory control limits.

OPR recoveries: Method criteria for OPR recoveries are 60-135% for 27 representative target compounds. OPR recoveries were within these limits.

Compound Identification: Method criteria for compound identification include: 1) The signals of the characteristic ions must maximize within the same 2 scans. 2) The signal to noise ratio must be greater than 2.5. 3) Ion abundance ratios must be within $\pm$ 15% of theoretical, or within $\pm$15% of the calibration verification standard. 4) Relative retention times must meet method or column-specific criteria.

Criteria were reviewed for each Toxic WHO Congener. Neither the signal to noise ratio nor the individual signal in height and noise levels were included in the raw data for detected compounds. SICP chromatograms in these reports were reviewed for approximate signal to noise ratios and no further investigation was deemed necessary.

No discrepancies were noted with the remaining identification criteria.

Compound Quantitation: Sample concentrations were recalculated to verify sample quantitations. No quantitation discrepancies were noted.

Second column confirmation: Second column confirmation was not required to separate congeners 156 and 157 due to the use of the DB1 Column.

Second column confirmation was not performed to separate congeners 106 and 118. Since congener 106 is not a component of any of the commercial Aroclor mixtures, no further action was deemed necessary.

Estimated detection limits: Peak heights for isotope dilution standards were not present in the original data package. Additionally, it was noted that the estimated detection limit for PCB045 was missing for sample LDW-Y1-SU-S010-LCB. Resubmissions were requested, and received.

Estimated detection limits (EDLs) were recalculated for each Toxic WHO Congener in all samples. No discrepancies were noted. All sediment EDLs met QAPP target reporting limits of 4 pg/g. Solvent EDLs ranged from 0.95 to 11 pg/sample.

Toxicity equivalent quantity (TEQ): TEQ calculations were not required for this project.

Laboratory narrative: No additional qualifiers are assigned based on the laboratory narrative.

Overall assessment: With minor exceptions, resubmitted documentation was found to be clear and complete. No discrepancies were noted in analyte identification or result quantitation. Calibration data and system performance checks demonstrate acceptable instrument performance. With minor exceptions, quality control results indicate acceptable accuracy.

Polychlorinated biphenyl data are acceptable for use as qualified.

3.0 Total Organic Carbon (TOC) Analyses

Quality control analysis frequencies: Each sample was analyzed in duplicate. A method blank, and LCS was analyzed in each batch. Two of the three batches included a included matrix spike and matrix spike duplicate, meeting frequency requirements.

Holding times: TOC must be analyzed within 28 days. Samples should be shipped and maintained at temperatures between 0 and 6° Celsius. These criteria were met

Laboratory blank results: Criteria for method blanks are that analyte concentrations must be below the PQL, or below 10% of the lowest associated sample concentration. This criterion was met for all method blanks.

LCS results: The LCS recovery control limit was 72-122%. This criterion was met.

MS recoveries: The MS and MSD recovery control limit was 70-122%. This criterion was met.

Sample replicate variability: The RPD between the first and second replicate analysis of each sample was below 25%.

Matrix spike duplicate variability: The MS/MSD control limit for RPDs was <20%. This criterion was met.

Total organic carbon results are acceptable for use as reported.

4.0 Grain Size Analyses

Quality control analysis frequencies: This batch included a laboratory triplicate, meeting frequency requirements.

Holding times: Sediment samples must be analyzed within 6 months of collection. Samples were analyzed within the holding time.

Laboratory triplicate RSDs: Triplicate RSDs were below 25%.

Grain size data are acceptable for use as reported.

5.0 Qualifier Summary Table

Sample ID	Analyte	Qualifier	Reason
LDW-Y1-SC-ENR-CA-CORE	PCB-196, PCB-197, PCB-198, PCB-199, PCB-200, PCB-201, PCB-202	J	High IDS recovery

6.0 Abbreviations and Definitions

DV Qualifier	Definition
U	The material was analyzed for, but was not detected above the level of the associated value.
UY	The reporting limit was elevated due to chromatographic overlap with related compounds. The material was analyzed for, but was not detected above the level of the associated value.
J	The analyte was positively identified. The associated numerical value is the approximate concentration of the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a tentative identification.
UJ	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
R	The sample result is rejected. The presence or absence of the analyte cannot be verified and data are not usable.
R1	This sample result has been rejected in favor of a more accurate, precise or conservative result. The other result should be used.
R2	This sample result has been rejected in favor of a more accurate, precise or conservative result from another analytical method. The other result should be used.

Abbreviation	Definition
DV	Data validation
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
EDL	Estimated detection limit
EMPC	Estimated maximum possible concentration
IDS	Isotope dilution standard
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not Applicable
OPR	Ongoing Precision and Recovery
RL	Reporting limit
RPD	Relative percent difference
RRM	Regional reference material
RSD	Relative standard deviations
SRM	Standard reference material

7.0 References

National Functional Guidelines For Inorganic Superfund Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, August 2014, USEPA-540-R-13-001.

National Functional Guidelines for High Resolution Superfund Methods Data Review, Office of Superfund Remediation and Technology Innovation, U.S. Environmental Protection Agency, April 2016, EPA-542-B-16-001.

Method 1668C: Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS, US Environmental Protection Agency, Office of Water Engineering and Analysis Division, April 2010.

Quality Assurance Project Plan Enhanced Natural Recovery/Activated Carbon Pilot Study, Lower Duwamish Waterway. Prepared by AMEC Foster Wheeler Environment & Infrastructure Inc., et al. Prepared for: USEPA Region 10 and WA-DOE Northwest Regional Office, February 22, 2016.

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CALCULATION REVIEW SUMMARY

Lower Duwamish Waterway– Enhanced Natural Recovery/Activated Carbon Pilot Year One Samples, May 2018 – July 2018

Prepared for:
Wood Environment and Infrastructure Solutions
3500 188th Street SW, Ste 601
Lynnwood, WA 98037-4763

September 8, 2018

1.0 Introduction

The objective of this review was to verify that the freely dissolved polychlorinated biphenyl (PCB) concentrations were accurately calculated. This review was performed by Cari Sayler.

Laboratory reported total mass per sample concentrations were converted to freely dissolved PCBs in sediment porewater by GeoSyntec Consultants of Huntington Beach, California. Data were provided in an excel® spreadsheet named "LDWG Year1 Cfree Tables values only (090618).xlsx" and dated 9/7/2018.

Data included the following samples and trip blanks:

Sample ID	Sample Date/Time	Lab ID
LDW-Y1-SC-ENR+AC-CA-S010	06/30/2018 14:30	11703-001-0001-SA
LDW-Y1-SC-ENR+AC-CB-S010	06/30/2018 14:38	11703-002-0001-SA
LDW-Y1-SC-ENR+AC-CC-S010	06/30/2018 14:45	11703-003-0001-SA
LDW-Y1-SC-ENR-CA-S010	06/30/2018 15:29	11703-006-0001-SA
LDW-Y1-SC-ENR-CB-S010	06/30/2018 15:36	11703-007-0001-SA
LDW-Y1-SC-ENR-CC-S010	06/30/2018 15:43	11703-008-0001-SA
LDW-Y1-SU-ENR+AC-CA-S010	06/30/2018 11:45	11703-011-0001-SA
LDW-Y1-SU-ENR+AC-CB-S010	06/30/2018 11:54	11703-012-0001-SA
LDW-Y1-SU-ENR+AC-CC-S010	06/30/2018 12:03	11703-013-0001-SA
LDW-Y1-SU-ENR-CA-S010	06/30/2018 13:35	11704-002-0001-SA
LDW-Y1-SU-ENR-CB-S010	06/30/2018 13:41	11704-003-0001-SA
LDW-Y1-SU-ENR-CC-S010	06/30/2018 13:50	11704-004-0001-SA
LDW-Y1-SU-S010-LCB	06/30/2018 14:13	11704-007-0001-SA
LDW-Y1-IN-ENR+AC-CA-S010	06/30/2018 16:17	11704-008-0001-SA
LDW-Y1-IN-ENR+AC-CB-S010	06/30/2018 16:23	11704-009-0001-SA
LDW-Y1-IN-ENR+AC-CC-S010	06/30/2018 16:30	11704-010-0001-SA
LDW-Y1-IN-ENR-CA-S010	06/30/2018 16:59	11704-013-0001-SA
LDW-Y1-IN-ENR-CB-S010	06/30/2018 17:07	11704-014-0001-SA
LDW-Y1-IN-ENR-CC-S010	06/30/2018 17:13	11704-015-0001-SA
LDW-Y1-SC-S010-TB	06/30/2018 16:04	11704-018-0001-SA
LDW-Y1-SU-S010-TB	06/30/2018 15:22	11704-019-0001-SA
LDW-Y1-IN-S010-TB	06/30/2018 15:38	11704-020-0001-SA

2.0 Data Sources

Data were loaded from various sources in order to independently calculate each PCB Cfree concentration and detection limit. Spot checking and limited recalculation was done to verify the data sources as described below:

Laboratory reported concentrations: Laboratory reported mass concentrations were obtained from the validated laboratory electronic data deliverable (EDD). Sporadic comparisons were made to the data in spreadsheet tab "TA3_Mass of PCBs", and no discrepancies were noted for the PCB mass concentrations. However, the PCB mass DLs require further clarification:

Data reported in the "PCB Mass DL" columns was a mix of values. For the non-detect compounds, this column was populated with the estimated detection limit (EDL) which was found in the laboratory report under column heading of "DL" and in the EDD in the "Result" field. For detected results, this column was populated with the minimum level of quantitation (ML) which was not present on the laboratory report, but was present in the laboratory EDD in the "ML" field. It should be noted that the ML is a quantitation limit rather than a detection limit.

No discrepancies were noted between the values listed in the column and the laboratory EDLs and MLs.

SPME sampling details: SPME fiber details were obtained from the data in spreadsheet tab "TA1_Fiber details". Data for mass of fiber, length of fiber, % recovery, volume of PDMS, mass of PDMS were recalculated from the remaining data. No discrepancies were noted.

Reference values: Log K_{PDMS} values for each PCB were retained from the calibration study/baseline sample calculation review. These values were spot checked against reference the data in spreadhsheet tab "TA5_KPDMS". No discrepancies were noted.

Reported PCB Cfree concentrations: Reported PCB Cfree concentrations were obtained from the data in spreadsheet tab "TA1_Cfree Final". This data was used for the basis of comparison to recalculated values. However, the PCB Cfree DL values contained the same mix of values that the spreadsheet tab "TA3_Mass of PCBs", did. For the non-detect compounds, PCB Cfree EDL were listed. For detected compounds, PCB Cfree MLs were listed.

3.0 Calculations

Formulas retained from the calibration study/baseline sample calculation review were used to recalculate PCB free concentrations.

Data calculations were performed in a Microsoft Access database. The Access Visual Basic for Applications (VBA) subroutine developed for the calibration study/baseline sample calculation review were again used to calculate the PCB free concentrations, EDLs, MLs and MDLs, and to compare the recalculated results to the reported results.

4.0 Conclusions

Concentrations: Cfree concentrations of each detected PCB was recalculated and compared to the reported values. Concentrations agreed within a reasonable variation for rounding differences. Calculated relative percent differences (RPDs) were between 0 and 5.

Reporting limits: Cfree EDLs or MLs of each PCB was recalculated and compared to the reported values. Values agreed within a reasonable variation for rounding differences. Calculated RPDs were between 0 and 5.

PRC Model: PRC Calculations were shown in tab "TA4_Ke" and values for slope, y-intercept were recalculated with good agreement.

The PRC coefficient of determination (R2) ranged from 0.50 to 0.99 indicating poor linearity in some samples. The upper and lower confidence limits were calculated to demonstrate the potential variability in the results, and this analysis was included on the "TA6_Uncertainty Cfree" tab. It should be noted that these upper and lower confidence limits reflects variation due to PRC linearity, but not necessarily variation due to other factors such as analytical reproducibility or matrix inhomogeneity, or the number of PRC compounds included in the PRC regression.

Sample LDW-Y1-SU-ENR-CB-S010 has a p-value of 0.08 that exceeds the 0.05 criteria for statistical significance, with only four of the ten PRC compounds were included in the regression. The variability in results for this sample may exceed the upper and lower confidence limits shown in tab "TA6_Uncertainty Cfree".

Qualifiers: Assigned qualifiers were reviewed with the following observations:

The background concentration exceeded the detected concentration and no PCB free concentration was reported in tab 'T1_Cfree FINAL for the following samples and analytes:

Sample ID	Analyte	PCB free no background subtraction (pg/L)	Qualifier	MDL free (pg/L)	ML free (pg/L)
LDW-Y1-SC-ENR+AC-CA-S010	PCB-011	7.64	UB J	0.958	7.76
LDW-Y1-SC-ENR+AC-CA-S010	PCB-172	1.55	UB L	0.0452	0.428
LDW-Y1-SC-ENR+AC-CA-S010	PCB-207	0.109	UB J L	0.00419	0.119
LDW-Y1-SC-ENR+AC-CA-S010	PCB-209	0.0725	UB L	0.00276	0.0653
LDW-Y1-SC-ENR+AC-CB-S010	PCB-011	11.9	UB	0.752	6.09
LDW-Y1-SC-ENR+AC-CB-S010	PCB-207	0.43	UB L	0.012	0.341
LDW-Y1-SC-ENR+AC-CB-S010	PCB-209	0.362	UB L	0.00975	0.23
LDW-Y1-SC-ENR+AC-CC-S010	PCB-011	21.9	UB	1.29	10.4
LDW-Y1-SC-ENR+AC-CC-S010	PCB-172	3.74	UB L	0.113	1.07
LDW-Y1-SC-ENR+AC-CC-S010	PCB-197	0.847	UB L	0.0549	0.634
LDW-Y1-SC-ENR+AC-CC-S010	PCB-207	0.36	UB J L	0.0139	0.396
LDW-Y1-SC-ENR-CA-S010	PCB-011	13.8	UB	0.697	5.65
LDW-Y1-SC-ENR-CA-S010	PCB-197	0.229	UB L	0.0115	0.133
LDW-Y1-SC-ENR-CA-S010	PCB-207	0.087	UB L	0.00245	0.0696
LDW-Y1-SC-ENR-CA-S010	PCB-209	0.0518	UB L	0.00155	0.0367
LDW-Y1-SC-ENR-CB-S010	PCB-172	27.7	UB L	0.495	4.69
LDW-Y1-SC-ENR-CB-S010	PCB-197	12.3	UB L	0.457	5.28
LDW-Y1-SC-ENR-CB-S010	PCB-207	8.76	UB L	0.208	5.9
LDW-Y1-SC-ENR-CC-S010	PCB-197	0.375	UB L	0.0136	0.158
LDW-Y1-SC-ENR-CC-S010	PCB-209	0.0948	UB L	0.00229	0.0542
LDW-Y1-SU-ENR+AC-CA-S010	PCB-011	7.57	UB	0.476	3.85
LDW-Y1-SU-ENR+AC-CB-S010	PCB-011	12.5	UB	0.594	4.81
LDW-Y1-SU-ENR+AC-CB-S010	PCB-197	1.46	UB L	0.0437	0.505
LDW-Y1-SU-ENR+AC-CC-S010	PCB-011	13.1	UB	0.549	4.44
LDW-Y1-SU-ENR+AC-CC-S010	PCB-197	0.508	UB L	0.0157	0.181

Sample ID	Analyte	PCB free no background subtraction (pg/L)	Qualifier	MDL free (pg/L)	ML free (pg/L)
LDW-Y1-SU-ENR-CA-S010	PCB-011	14.7	UB	0.596	4.83
LDW-Y1-SU-ENR-CB-S010	PCB-011	34.2	UB	0.877	7.1
LDW-Y1-SU-ENR-CC-S010	PCB-011	17.8	UB	0.57	4.61
LDW-Y1-SU-S010-LCB	PCB-011	21.7	UB	0.709	5.74
LDW-Y1-SU-S010-LCB	PCB-074	0.75	UB J L	0.25	4.06
LDW-Y1-SU-S010-LCB	PCB-080	0.982	UB J L	0.216	3.92
LDW-Y1-SU-S010-LCB	PCB-153	10.4	UB L	0.363	3.63
LDW-Y1-SU-S010-LCB	PCB-197	7.39	UB L	0.299	3.45
LDW-Y1-IN-ENR+AC-CA-S010	PCB-080	0.25	UB J	0.0774	1.41
LDW-Y1-IN-ENR+AC-CA-S010	PCB-197	3.78	UB L	0.112	1.29
LDW-Y1-IN-ENR+AC-CB-S010	PCB-011	4.25	UB	0.395	3.2
LDW-Y1-IN-ENR+AC-CB-S010	PCB-080	0.337	UB J	0.0843	1.53
LDW-Y1-IN-ENR+AC-CB-S010	PCB-172	9.89	UB L	0.146	1.38
LDW-Y1-IN-ENR+AC-CB-S010	PCB-197	3.82	UB L	0.121	1.4
LDW-Y1-IN-ENR+AC-CC-S010	PCB-011	4.04	UB	0.428	3.46
LDW-Y1-IN-ENR+AC-CC-S010	PCB-080	0.165	UB J	0.049	0.891
LDW-Y1-IN-ENR+AC-CC-S010	PCB-172	1.38	UB L	0.0232	0.22
LDW-Y1-IN-ENR+AC-CC-S010	PCB-197	0.273	UB L	0.0107	0.123
LDW-Y1-IN-ENR+AC-CC-S010	PCB-207	0.112	UB L	0.00259	0.0735
LDW-Y1-IN-ENR+AC-CC-S010	PCB-209	0.0799	UB L	0.00187	0.0443
LDW-Y1-IN-ENR-CA-S010	PCB-011	16.1	UB	0.892	7.22
LDW-Y1-IN-ENR-CA-S010	PCB-197	1.76	UB L	0.0851	0.983
LDW-Y1-IN-ENR-CB-S010	PCB-011	8.81	UB	0.507	4.11
LDW-Y1-IN-ENR-CB-S010	PCB-172	2.97	UB L	0.0472	0.447
LDW-Y1-IN-ENR-CB-S010	PCB-197	0.635	UB L	0.0244	0.282
LDW-Y1-IN-ENR-CB-S010	PCB-207	0.3	UB L	0.00655	0.186
LDW-Y1-IN-ENR-CC-S010	PCB-011	11.8	UB	0.764	6.18
LDW-Y1-IN-ENR-CC-S010	PCB-207	0.323	UB L	0.00898	0.255
LDW-Y1-IN-ENR-CC-S010	PCB-209	0.271	UB L	0.00689	0.163

These results are qualified “UB” and should be considered not detected at the lowest available detection limit, the MDL.

Total detected PCBs: Total detected PCBs were recalculated based on the reported individual PCB Cfree concentrations, excluding spiked PRC compounds. Recalculated values matched exactly to the reported values.

Confidence levels: The uncertainty upper and lower confidence levels summarized in the spreadsheet tab “TA6_Uncertainty Cfree” are beyond the scope of this review and have not been recalculated.

5.0 Abbreviations and Definitions

Abbreviation	Definition
EDL	Estimated detection limit
MDL	Method detection limit
ML	Minimum level of quantitation
PDMS	Polydimethylsiloxane
PRC	Performance Reference Compound

Abbreviation	Definition
RPD	Relative percent difference
SPME	Solid phase microextraction

6.0 References

Certificate of Analysis Concentrations of Freely-dissolved Polychlorinated Biphenyls (PDBs) Measured via SP3ME Passive Samplers. Prepared for Lower Duwamish Waterway Group, Prepared by Geosyntec Consultants, March 22, 2017. This report contains data for samples collected July to September 2016.

Certificate of Analysis Concentrations of Freely-dissolved Polychlorinated Biphenyls (PDBs) Measured via SP3ME Passive Samplers. Prepared for Lower Duwamish Waterway Group, Prepared by Geosyntec Consultants, March 22, 2017. This report contains data for samples collected November 2016 to January 2017.

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