



**EAST WATERWAY OPERABLE UNIT
SUPPLEMENTAL REMEDIAL INVESTIGATION/
FEASIBILITY STUDY**

**DATA REPORT:
CLAM SURVEY, GEODUCK SURVEY, FISH AND
SHELLFISH TISSUE COLLECTION PCB CONGENER
AND DIOXIN/FURAN RESULTS**

FINAL

For submittal to

**The US Environmental Protection Agency
Region 10
Seattle, WA**

July 2010

Prepared by:



200 West Mercer Street • Suite 401
Seattle, Washington • 98119

Table of Contents

Tables	ii
Acronyms	iii
1 Introduction	1
2 Sample Selection and Laboratory Analyses	1
3 Results of Chemical Analyses	3
3.1 PCB CONGENER RESULTS	3
3.1.1 Fish tissue PCB congener results	3
3.1.2 Crab tissue PCB congener results	7
3.1.3 Clam and geoduck tissue PCB congener results	9
3.2 DIOXIN AND FURAN RESULTS	12
3.2.1 Fish tissue dioxin and furan results	12
3.2.2 Crab tissue dioxin and furan results	13
3.2.3 Clam and geoduck tissue dioxin and furan results	15
3.2.4 Assessment of reporting limit influences on the calculation of PCB and Dioxin/Furan TEQs	16
3.3 PCB AROCLORS, LIPIDS AND TOTAL SOLIDS RESULTS	19
3.3.1 EW fish tissue super-composite sample results	19
3.3.1 EW fish crab super-composite sample results	22
3.4 DATA VALIDATION RESULTS	24
4 References	25
Appendix A PCB Congener and Dioxin and Furan Data Tables	
Appendix B Data Management	
Appendix C Data Validation Report	
Appendix D Laboratory Form 1s	
Appendix E Sample Selection Memorandum	
Appendix F Graphical comparison of total PCBs (sum of Aroclors) and total PCBs (sum of congeners)	

Tables

Table 2-1.	<i>Numbers of samples selected for PCB congener and dioxin/furan analysis</i>	2
Table 3-1.	<i>Detection frequencies and concentration summaries of coplanar PCB congeners in EW fish fillet and whole-body tissue samples</i>	4
Table 3-2.	<i>Coplanar PCB congener, total PCB congener, and PCB TEQ concentrations in fish tissue samples</i>	6
Table 3-3.	<i>Detection frequencies and concentration summaries of coplanar PCB congeners in EW crab hepatopancreas and edible meat tissue samples</i>	7
Table 3-4.	<i>Coplanar PCB congener, total PCB congener, and PCB TEQ concentrations in crab tissue samples</i>	8
Table 3-5.	<i>Detection frequencies and concentration summaries of coplanar PCB congeners in EW clam and geoduck tissue samples</i>	9
Table 3-6.	<i>Coplanar PCB congener, total PCB congener, and PCB TEQ concentrations in clam and geoduck tissue samples (ng/kg ww)</i>	11
Table 3-7.	<i>EW fish tissue summary for dioxin/furans</i>	12
Table 3-8.	<i>EW fish tissue results for dioxin/furan TEQs</i>	13
Table 3-9.	<i>EW crab tissue summary for dioxins/furans</i>	14
Table 3-10.	<i>EW crab tissue results for dioxin/furan TEQs</i>	15
Table 3-11.	<i>Summary of clam and geoduck tissue results for dioxins/furans</i>	15
Table 3-12.	<i>EW clam and geoduck tissue results for dioxin/furan TEQs</i>	16
Table 3-13.	<i>PCB congener TEQ calculated with RL as zero, half RL and full RL</i>	17
Table 3-14.	<i>Dioxin/furan TEQ (ng/kg ww) calculated with RL as zero, half RL and full RL</i>	18
Table 3-15.	<i>EW Fish tissue super-composite sample results for PCB Aroclors, percent lipids and total solids</i>	19
Table 3-16.	<i>EW fish tissue super-composite sample results for PCB Aroclors, total lipids, and total solids</i>	21
Table 3-17 –	<i>EW Crab tissue super-composite sample results for PCB Aroclors, percent lipids and total solids</i>	22
Table 3-18.	<i>EW crab tissue super-composite sample results for PCB Aroclors, total lipids, and total solids</i>	23
Table 3-19.	<i>Data validation performed for each SDG</i>	24

Acronyms

Acronym	Definition
ACG	analytical concentration goal
Ecology	Washington Department of Ecology
EPA	US Environmental Protection Agency
GC/ECD	gas chromatography/electron capture detection
GC/MS	gas chromatography/mass spectrometry
LCS	laboratory control sample
LDW	Lower Duwamish Waterway
MS/MSD	matrix spike/matrix spike duplicate
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RI	remedial investigation
RL	reporting limit
SDG	sample delivery group
SVOC	semivolatile organic compound
TEF	toxic equivalence factor
TEQ	toxic equivalent
Windward	Windward Environmental LLC
WHO	World Health Organization
ww	wet weight

1 Introduction

This data report provides the results of the analysis of clam, geoduck, fish, and crab tissue samples for individual polychlorinated biphenyl (PCB) congeners and dioxins and furans as specified in the Clam tissue QAPP (Windward 2008) and the Fish and Shellfish tissue collection QAPP (Windward 2008).

This report is organized into sections addressing sample selection and laboratory analyses, chemical analysis results, and references. The text is supported by the following appendices:

- ◆ Appendix A - PCB Congener and Dioxin and Furan Data Tables
- ◆ Appendix B - Data Management
- ◆ Appendix C - Data Validation Report
- ◆ Appendix D - Laboratory Form 1s
- ◆ Appendix E - Sample Selection Memorandum
- ◆ Appendix F - Graphical comparison of total PCBs (sum of Aroclors) and total PCBs (sum of congeners)

2 Sample Selection and Laboratory Analyses

The following sections present a summary of the sample selection and laboratory analyses for the PCB congener and dioxin and furan analyses. The selection of samples for analysis was approved by EPA prior to analysis (see Appendix E).

Two approaches were followed for the analysis of PCB congeners and dioxins and furans. For species that have home ranges that are greater than the EW (i.e. crab, shiner surfperch, English sole), “super composites” were created. These composites contain tissue from all available tissue composite samples. For example, there were 11 composite samples of English sole fillets and the super composite was created using an equal amount of tissue from all 11 composite samples, creating one sample with contributions from 55 individual English sole fillets (11 composite samples each containing 5 fillets). The “super” composite sample includes contributions from all collected organisms/composite samples. This provides an estimate of the population mean TEQ concentration using tissue from all collected organisms.

Each super composite was created from a aliquot of tissue collected from all available tissue composite samples. These composites were analyzed in triplicate. The triplicates were created from additional aliquots of tissue collected from each composite sample following additional homogenization. The variability among the triplicate samples

reflects the variability within the tissue homogenates as well as analytical variability associated with the analytical method.

For species with home ranges smaller than the EW (brown rockfish, clams, geoducks) the existing tissue samples were selected for analysis. While all of the brown rockfish individual whole body samples were analyzed, a subset of both the clam samples and geoduck whole body and gutball samples were selected for analysis. Table 2-1 lists the types and numbers of samples selected for analysis. A detailed discussion of the selection of samples for analysis of PCB congeners and dioxins and furans is presented in the Final Sample Selection Memorandum (Appendix E).

Table 2-1. Numbers of samples selected for PCB congener and dioxin/furan analysis

	Super-Composite Samples	Composite Samples	Individual Whole-Body Samples
Brown rockfish	–	–	6
Crab hepatopancreas	3	–	–
Crab edible meat	3	–	–
English sole whole body	3	-	–
English sole fillet	3	-	-
Shiner surfperch	3	-	–
Butter clam	–	2	–
Cockle	–	1	–
Geoduck whole-body	–	–	3
Geoduck gutball	–	2	–
Total	15	5	9

All selected tissue samples were analyzed for PCB congeners and dioxins and furans. The super-composite samples were also analyzed for PCB Aroclors as well as percent lipids and total solids. These analyses were conducted in order to generate PCB datasets for supercomposites that were comparable to the datasets for other tissue samples. The analyses were conducted by Analytical Resources Inc. following methods provided in the Fish and Shellfish QAPP (Windward 2009).

3 Results of Chemical Analyses

This section presents a summary of the results of the PCB congener analyses (Section 3.1) and dioxins and furans analyses (Section 3.2). In addition, the results for the PCB Aroclor analyses and lipids and total solids for the super-composite samples are presented (Section 3.3).

3.1 PCB CONGENER RESULTS

This section presents the results for total PCBs, based on the sum of detected PCB congeners, and results for individual coplanar PCB congeners for fish (Section 3.1.1), crab (Section 3.1.2) and clams and geoducks (Section 3.1.3) tissue samples. The results for all 209 PCB congeners analyzed in tissue samples are presented in Appendix A. The coplanar PCB congeners are those congeners for which World Health Organization (WHO) toxic equivalence factors (TEFs) are available (Van den Berg et al. 2006). Coplanar PCB congeners include PCB-077, PCB-081, PCB-105, PCB-114, PCB-118, PCB-123, PCB-126, PCB-156, PCB-157, PCB-167, PCB-169, and PCB-189. In addition, the toxic equivalent quotient (TEQ) based on the coplanar PCB congener results for each sample are presented.

In many samples, two or more PCB congeners cannot be separated analytically. In these samples, the congeners coelute and the concentration of the combined congeners is reported as one value. When coelutions have occurred the convention of assigning the concentration of the coeluting congener to the congener with the lowest IUPAC number has been used. For example, PCB-156 and PCB-157 coelute and the concentration is reported as PCB-156. PCB-157 is reported as C156 to indicate that it is a component of a coelution. This convention has been followed in presenting congener data throughout this data report.

TEQs were calculated using the WHO mammalian TEFs (Van den Berg et al. 2006). For each sample, TEQs were calculated using half the reporting limit (RL) as the selected value for undetected PCB congeners. The coelution between PCB-156 and PCB-157 does not affect the TEQ calculation because both congeners have a TEF of 0.0005.

3.1.1 Fish tissue PCB congener results

Most coplanar PCB congeners were detected in all of the fish tissue samples. Detection frequencies, the range of detected values and reporting limits are summarized for coplanar PCB congeners and total PCBs are provided in Table 3-1.

Table 3-1. Detection frequencies and concentration summaries of coplanar PCB congeners in EW fish fillet and whole-body tissue samples

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limit ^a
		Minimum	Minimum	
PCB-077	15 / 15	103	671	na
PCB-081	3 / 15	35.9	51.0	8.13 - 48.5
PCB-105	15 / 15	5,610	112,000 J	na
PCB-114	15 / 15	487	5,590	na
PCB-118	15 / 15	22,200	316,000 J	na
PCB-123	15 / 15	258	3,670	na
PCB-126	14 / 15	34.2	426	8.33
PCB-156	15 / 15	5,040 C	63,400 C	na
PCB-157	15 / 15	C156	C156	na
PCB-167	15 / 15	2,380	31,200	na
PCB-169	9 / 15	191	751	9.43 - 48.5
PCB-189	15 / 15	604	5,900	na
Total PCB Congeners	15 / 15	618,000	5,970,000 J	na
PCB TEQ	15 / 15	5.05	59.5 J	na

^a Reporting limit range for non-detect samples only

na – not applicable C156 - PCB-156 and PCB-157 co-elute; the combined concentration is presented as the concentration of PCB-156

Data qualifiers: C–concentration represents coelution; J - estimated concentration

The concentrations of the individual coplanar PCB congener and total PCB concentrations (i.e., the sum of the detected concentrations of all 209 PCB congeners) for all fish tissue samples are presented in Table 3-2. Total PCB concentrations ranged from 1,007 to 1,243 µg/kg ww in English sole fillet super-composite samples. Total PCB concentrations ranged from 2,010 to 2,365 µg/kg ww in the English sole whole-body super-composite samples. Total PCB concentrations ranged from 644 to 762 µg/kg ww in shiner surfperch whole-body super-composite samples. The two highest total PCB tissue concentrations were reported for whole-body samples of brown rockfish from Sampling Area 8 (5,970 µg/kg ww) and Sampling Area 11 (2,438 µg/kg ww) (Table 3-2). Fish tissue plots of total PCB concentrations as the sum of the detected congeners versus the total PCB concentrations as the sum of the detected Aroclors are presented in Appendix F.

The individual PCB congener concentrations, the total PCBs (sum of congeners) and the TEQ values the replicate super-composites samples were very consistent for each of the tissue types analyzed as super-composites.

All of the coplanar PCB congeners were detected in all of the fish composite tissue samples, except PCB-081, which was not detected in the brown rockfish, English sole fillet and English sole whole-body tissue samples and PCB-169 which was not detected in the six brown rockfish samples (Table 3-2). Overall, mammalian TEQs (half RL) ranged from 5.05 to 37.4 ng/kg ww. All RLs for PCB-081 and PCB-169 were above the analytical concentration goal (ACG) of 2.4 ng/kg ww established for fish tissue samples (Appendix D of the QAPP). RLs for PCB-081 ranged from 8.13 to 48.5 ng/kg ww and RLs for PCB-169 ranged from 9.43 to 48.5 ng/kg ww. Dioxin-like PCB congeners, such as PCB-081, will be evaluated as toxic equivalents (TEQs) in the risk assessments, rather than as individual congeners. However, because TEQs are calculated, rather than measured by the laboratory, ACGs for individual congeners are presented to facilitate comparison with RLs for those congeners. In the risk assessment, since risks will be assessed based on sums of these congeners (normalized per their relative toxicity to TCDD), comparison to RLs on a congener-specific basis is somewhat uncertain.

Table 3-2. Coplanar PCB congener, total PCB congener, and PCB TEQ concentrations in fish tissue samples

Species Tissue Type/ Sample ID	PCB-077	PCB-081	PCB-105	PCB-114	PCB-118	PCB-123	PCB-126	PCB-156	PCB-157	PCB-167	PCB-169	PCB-189	PCB TEQ	Total PCB Congeners ^a
	ng/kg ww													µg/kg ww
Brown rockfish														
EW-08-SB002-BR-02	671	48.5 U	27,800	1,580	73,500 J	1,090	140	13,600 C	C156	7,300	48.5 U	1,110	18.6 J	1,640 J
EW-08-SB006-BR-06	103	9.43 U	5,610	487	22,200	258	37.9	5,040 C	C156	2,380	9.43 U	827	5.05	618
EW-08-SB008-BR-08	540	46.7 U	112,000 J	5,590	316,000 J	3,670	426	63,400 C	C156	31,200	46.7 U	5,900	59.5 J	5,970 J
EW-08-SB009-BR-09	613	46.7 U	38,400 J	1,980	106,000 J	1,350	168	20,400 C	C156	11,000	46.7 U	2,090	23.0 J	2,320 J
EW-08-SB012-BR-10	186	48.1 U	19,700	1,080	54,100 J	636	113	10,800 C	C156	5,110	48.1 U	1,120	14.8 J	1,106 J
EW-08-SB011-BR-11	394	46.7 U	42,300 J	2,300	115,000 J	1,450	209	23,100 C	C156	11,800	46.7 U	2,390	27.6 J	2,438 J
English sole (fillet)														
EW08-ES-FL-SUPCOMP1	260	9.26 U	11,400	679	36,200	477	41.0	6,800 C	C156	3,430	316	789	15.4	1,243
EW08-ES-FL-SUPCOMP2	201	8.33 U	9,670	547	29,800	460	8.33 U	5,640 C	C156	2,910	271	688	10.1	1,007
EW08-ES-FL-SUPCOMP3	210	9.62 U	10,100	628	31,300	448	34.2	5,860 C	C156	2,970	273	697	13.2	1,072
English sole (whole-body)														
EW08-ES-WB-SUPCOMP1	508	9.90 U	21,900	1,410	70,900 J	1,080	114	14,200 C	C156	7,450	746	1,870	37.4 J	2,365 J
EW08-ES-WB-SUPCOMP2	430	8.13 U	19,000	1,220	61,900 J	946	88.6	12,300 C	C156	6,420	680	1,600	32.4 J	2,010 J
EW08-ES-WB-SUPCOMP3	483	8.26 U	20,400	1,350	66,600 J	1,080	92.0	13,500 C	C156	7,070	751	1,750	35.1 J	2,260 J
Shiner surfperch														
EW08-SS-WB-SUPCOMP1	475	39.0	8,280	544	25,600	404	42.9	5,530 C	C156	2,810	191	604	11.4	644.3
EW08-SS-WB-SUPCOMP2	513	51.0	9,340	578	28,800	498	56.7	6,300 C	C156	3,120	215	704	13.7	733
EW08-SS-WB-SUPCOMP3	518	35.9	9,700	605	29,700	517	58.5	6,740 C	C156	3,430	228	759	14.3	762

^a Total PCB concentration calculated as the sum of the detected concentrations of all 209 PCB congeners, following summation rules in Appendix B
 C156 - PCB-156 and PCB-157 co-elute; the combined concentration is presented as the concentration of PCB-156
 PCB – polychlorinated biphenyl
 TEQ – Toxic Equivalency Quotient
 Data qualifiers: C–concentration represents coelution; U - not detected at the given reporting limit; J - estimated concentration

3.1.2 Crab tissue PCB congener results

Most coplanar PCB congeners were detected in all of the crab tissue samples. Detection frequencies, the range of detected values and reporting limits are summarized for coplanar PCB congeners and total PCBs in Table 3-3.

Table 3-3. Detection frequencies and concentration summaries of coplanar PCB congeners in EW crab hepatopancreas and edible meat tissue samples

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limit ^a
		Minimum	Minimum	
PCB-077	6 / 6	75.8	345	na
PCB-081	1 / 6	22.2	22.2	8.26 - 9.71
PCB-105	6 / 6	1,590	8,410	na
PCB-114	6 / 6	127	568	na
PCB-118	6 / 6	2,380	15,800	na
PCB-123	6 / 6	65.3	373	na
PCB-126	3 / 6	5.38 J	41.1	8.26 - 30.8
PCB-156	6 / 6	987 C	6,100 C	na
PCB-157	6 / 6	C156	C156	na
PCB-167	6 / 6	333	2,470	na
PCB-169	6 / 6	31.1	197	na
PCB-189	6 / 6	101	798	na
Total PCB Congeners	6 / 6	95,600	597,000	na
PCB TEQ	6 / 6	1.53	11.0	na

^a Reporting limit range for non-detect samples

na – not applicable

C156 - PCB-156 and PCB-157 co-elute; the combined concentration is presented as the concentration of PCB-156

Data qualifiers: C–concentration represents coelution; J - estimated concentration

The concentrations of the individual coplanar PCB congeners and total PCB concentrations (i.e., the sum of the detected concentrations of all 209 congeners) for all crab tissue super-composite samples are presented in Table 3-4. Total PCB concentrations for the crab hepatopancreas super-composite samples ranged from 546 to 597 µg/kg ww. The total PCB concentrations for the crab edible meat super-composite samples ranged from 95.6 to 114.9 µg/kg ww (Table 3-4). Crab tissue plots of total PCB concentrations as the sum of the congeners versus the total PCB concentrations as the sum of the Aroclors are presented in Appendix F. Overall, TEQs (half RL) ranged from 1.53 to 11.0 ng/kg ww.

Table 3-4. Coplanar PCB congener, total PCB congener, and PCB TEQ concentrations in crab tissue samples

Species Tissue Type/ Sample ID	PCB-077	PCB-081	PCB-105	PCB-114	PCB-118	PCB-123	PCB-126	PCB-156	PCB-157	PCB-167	PCB-169	PCB-189	PCB TEQ	Total PCB Congeners ^a
	ng/kg ww													µg/kg ww
Crab edible meat														
EW08-RRDC-EM-SUPCOMP1	75.8	8.26 U	1,590	127	2,380	65.3	8.26 U	987 C	C156	333	31.3	101	1.53	95.60
EW08-RRDC-EM-SUPCOMP2	83.4	8.70 U	1,700	134	2,570	79.1	5.38 J	1,090 C	C156	361	31.1	111	1.66 J	104.50 J
EW08-RRDC-EM-SUPCOMP3	81.9	8.33 U	1,850	154	2,770	69.9	8.33 U	1,200 C	C156	426	36.1	123	1.71	114.90
Crab hepatopancreas														
EW08-RRDC-HP-SUPCOMP1	303	22.2	7,590	530	14,300	318	30.8 U	5,560 C	C156	2,220	185	720	8.06	546.00
EW08-RRDC-HP-SUPCOMP2	318	9.52 U	7,880	541	14,800	347	41.1	5,790 C	C156	2,310	187	755	10.7	566.50
EW08-RRDC-HP-SUPCOMP3	345	9.71 U	8,410	568	15,800	373	40.3	6,100 C	C156	2,470	197	798	11.0	597.00

^a Total PCB concentration calculated as the sum of the detected concentrations of all 209 PCB congeners, following summation rules in Appendix B

C156 - PCB-156 and PCB-157 co-elute; the combined concentration is presented as the concentration of PCB-156

PCB – polychlorinated biphenyl

TEQ – Toxic Equivalency Quotient

Data qualifiers: C—concentration represents coelution; U - not detected at the given reporting limit; J - estimated concentration

The individual PCB congener concentrations, the total PCBs (sum of congeners) and the TEQ values the replicate super-composites samples were very consistent for each of the tissue types analyzed as super-composites.

All of the coplanar PCB congeners were detected in all of the crab super-composite tissue samples except PCB-081 (Table 3-5). PCB-081 was detected in only one of the three hepatopancreas super-composite samples. The RLs for PCB-81 ranged from 8.26-9.71 ng/kg ww were above the ACG established for crab edible meat samples (2.4 ng/kg ww) (Appendix D of the QAPP). Dioxin-like PCB congeners, such as PCB-081, will be evaluated as toxic equivalents (TEQs) in the risk assessments, rather than as individual congeners. However, because TEQs are calculated, rather than measured by the laboratory, ACGs for individual congeners are presented to facilitate comparison with RLs for those congeners. In the risk assessment, since risks will be assessed based on sums of these congeners (normalized per their relative toxicity to TCDD), comparison to RLs on a congener-specific basis is somewhat uncertain.

3.1.3 Clam and geoduck tissue PCB congener results

Most coplanar PCB congeners were detected in all of the clam and geoduck tissue samples. Detection frequencies, the range of detected values and reporting limits are summarized for coplanar PCB congeners and total PCBs are provided in Table 3-5.

Table 3-5. Detection frequencies and concentration summaries of coplanar PCB congeners in EW clam and geoduck tissue samples

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limit ^a
		Minimum	Minimum	
PCB-077	8 / 8	6.86	99.8	na
PCB-081	7 / 8	0.651 J	6.43	2.14
PCB-105	8 / 8	73.8	731	na
PCB-114	8 / 8	16.9	50.9	na
PCB-118	8 / 8	259	1,750	na
PCB-123	8 / 8	9.87	41.1	na
PCB-126	8 / 8	0.627 J	6.10	na
PCB-156	8 / 8	26.4 C	459 C	na
PCB-157	8 / 8	C156	C156	na
PCB-167	8 / 8	31.1	221	na
PCB-169	0 / 8	nd	nd	0.983 - 0.997
PCB-189	8 / 8	0.917 J	62.2	na

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limit ^a
		Minimum	Minimum	
Total PCB Congeners	8 / 8	13,490 J	72,600	na
PCB TEQ	8 / 8	0.0910 J	0.734	na

^a Reporting limit range for non-detect samples

na – not applicable

C156 - PCB-156 and PCB-157 co-elute; the combined concentration is presented as the concentration of PCB-156

Data qualifiers: C–concentration represents coelution; J - estimated concentration

The concentrations of the individual coplanar PCB congeners and total PCB concentrations (i.e., the sum of the detected concentrations of all 209 congeners) for all clam and geoduck tissue samples are presented in Table 3-6. Total PCB concentrations for the butter clam and cockle tissue samples ranged from 28 to 72.6 µg/kg ww. The total PCB concentrations for the geoduck edible meat samples ranged from 13.49 to 25.90 µg/kg ww and geoduck gutball composite samples ranged from 52.92 to 71.67 µg/kg ww (Table 3-5). Clam and geoduck tissue plots of total PCB concentrations as the sum of the congeners versus the total PCB concentrations as the sum of the Aroclors are presented in Appendix F. Overall TEQs ranged from 0.0910 to 0.734 ng/kg ww.

All of the coplanar PCB congeners were detected in all of the clam and geoduck tissue samples tissue except PCB-081 and PCB-169 (Table 3-6). PCB-081 was not detected in one of the two geoduck gutball samples and PCB-169 was not detected in any of the clam and geoduck tissue samples. The RL for PCB-81 was 2.14 ng/kg ww and the RLs for PCB-169 ranged from 0.983-0.997 ng/kg ww which are all below the ACG established for tissue samples (2.4 ng/kg ww) (Appendix D of the QAPP). Dioxin-like PCB congeners, such as PCB-081 and PCB-169, will be evaluated as TEQs in the risk assessments, rather than as individual congeners. However, because TEQs are calculated, rather than quantitated by the laboratory, comparisons of ACGs for individual PCB congeners to RLs are somewhat uncertain.

Table 3-6. Coplanar PCB congener, total PCB congener, and PCB TEQ concentrations in clam and geoduck tissue samples (ng/kg ww)

Species Tissue Type/ Sample ID	PCB-077	PCB-081	PCB-105	PCB-114	PCB-118	PCB-123	PCB-126	PCB-156	PCB-157	PCB-167	PCB-169	PCB-189	PCB TEQ	Total PCB Congeners ^a
	ng/kg ww													µg/kg ww
Butter clam - whole body														
EW-B06-BC-01-comp1	99.8	6.43	731	50.9	1,750	41.1	6.10	459 C	C156	170	0.985 U	62.2	0.734	72.60
EW-B10-BC-01-comp1	33.4	2.21	279	17.6	614	18.7	2.16	187 C	C156	62.2	0.994 U	22.4	0.271	28.00
Cockle - whole body														
EW-B08-CN-02-comp1	41.5	1.84	328	16.9	828	15.4	1.49	169 C	C156	73.1	0.997 U	22.2	0.212	30.21
Geoduck – edible meat														
EW-S01-GD-02	6.86	0.651 J	73.8	19.5	259	9.87	0.627 J	26.4 C	C156	31.1	0.988 U	0.917 J	0.0910 J	13.49 J
EW-S01-GD-04	13.8	1.01	146	19.7	480	13.8	1.49	122 C	C156	85.4	0.987 U	8.45	0.192	25.90
EW-S01-GD-10	11.7	0.817 J	104	19.9	379	13.6	1.03	83.1 C	C156	63.9	0.991 U	7.32	0.140 J	24.58 J
Geoduck - gutball														
EW-S01-GD-GB-comp01	27.3	1.35	333	17.6	1,090	21.5	3.06	186 C	C156	149	0.983 U	13.2	0.378	52.92
EW-S01-GD-GB-comp02	41.0	2.14 U	522	27.8	1,610	36.9	4.44	273 C	C156	221	0.988 U	17.0	0.544	71.67

^a Total PCB concentration calculated as the sum of the detected concentrations of all 209 PCB congeners, following summation rules in Appendix B

C156 - PCB-156 and PCB-157 co-elute; the combined concentration is presented as the concentration of PCB-156

PCB – polychlorinated biphenyl

TEQ – toxic equivalent quotient

Data qualifiers: C–concentration represents coelution; U - not detected at the given reporting limit; J - estimated concentration

3.2 DIOXIN AND FURAN RESULTS

This section presents a summary of the dioxin and furan analyses results for fish (Section 3.2.1), crab (Section 3.2.2) and clam and geoduck (Section 3.2.3) tissue samples. This section also presents the dioxin/furan TEQ based on the seventeen congeners for which World Health Organization (WHO) toxic equivalence factors (TEFs) are available (Van den Berg et al. 2006). TEQs were calculated using the WHO mammalian TEFs (Van den Berg et al. 2006). For each sample, TEQ values were calculated using half the RL for nondetected congeners in accordance with the data management protocols (Appendix B). The results of each of the seventeen dioxin and furan TEQ congeners are presented in Appendix A.

3.2.1 Fish tissue dioxin and furan results

Most dioxin and furan congeners were detected in all of the fish tissue samples. Detection frequencies, the range of detected values and reporting limits are summarized for all the dioxin and furan TEQ congeners are provided in Table 3-7.

Table 3-7. EW fish tissue summary for dioxin/furans

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limit ^a
		Minimum	Maximum	
2,3,7,8-TCDD	11 / 15	0.212	0.946	0.197 - 0.628
1,2,3,7,8-PeCDD	8 / 15	0.276 J	0.958 J	0.240 - 0.701
1,2,3,4,7,8-HxCDD	4 / 15	0.0737 J	0.146 J	0.0734 - 0.180
1,2,3,6,7,8-HxCDD	13 / 15	0.238 J	3.99	0.212 - 0.273
1,2,3,7,8,9-HxCDD	3 / 15	0.117 J	0.522 J	0.0646 - 0.443
1,2,3,4,6,7,8-HpCDD	14 / 15	0.332 J	5.00	0.713
OCDD	14 / 15	0.776 J	15.5	1.04
2,3,7,8-TCDF	15 / 15	0.791	7.60	na
1,2,3,7,8-PeCDF	12 / 15	0.106 J	1.28 J	0.0821 - 0.219
2,3,4,7,8-PeCDF	13 / 15	0.519 J	1.42	0.369 - 0.581
1,2,3,4,7,8-HxCDF	5 / 15	0.316 J	0.607 J	0.0854 - 0.808
1,2,3,6,7,8-HxCDF	9 / 15	0.117 J	0.405 J	0.0640 - 0.377
1,2,3,7,8,9-HxCDF	0 / 15	nd	nd	0.0308 - 0.168
2,3,4,6,7,8-HxCDF	9 / 15	0.0873 J	0.429 J	0.0500 - 0.150
1,2,3,4,6,7,8-HpCDF	6 / 15	0.313 J	1.02 J	0.428 - 1.41
1,2,3,4,7,8,9-HpCDF	1 / 15	0.0443 J	0.0443 J	0.0370 - 0.171
OCDF	9 / 15	0.315 J	1.23 J	0.182 - 0.383
Dioxin/furan TEQ	15 / 15	0.658 J	3.00 J	na

^a Reporting limit range for non-detect samples

na – not applicable

J - estimated concentration

The calculated dioxin and furan TEQ for each fish tissue sample is provided in Table 3-8. Dioxin and furan TEQs ranged from 0.658 to 3.00 ng TEQ/kg ww. The highest TEQ values were calculated for individual whole-body brown rockfish samples (EW-08-SB002-BR-02 and EW-08-SB011-BR-11). The TEQ values calculated for the replicate super-composites samples were very consistent for each of the three tissue types analyzed as super-composites (English sole fillets, English sole whole-body and shiner surfperch whole body).

Table 3-8. EW fish tissue results for dioxin/furan TEQs

Sample Name	Unit	Dioxin/Furan TEQ
English Sole - fillet super-composites		
EW08-ES-FL-SUPCOMP1	ng/kg ww	0.728 J
EW08-ES-FL-SUPCOMP2	ng/kg ww	0.736 J
EW08-ES-FL-SUPCOMP3	ng/kg ww	0.793 J
English Sole - whole body super-composites		
EW08-ES-WB-SUPCOMP1	ng/kg ww	1.54 J
EW08-ES-WB-SUPCOMP2	ng/kg ww	1.89 J
EW08-ES-WB-SUPCOMP3	ng/kg ww	1.89 J
Shiner surfperch - whole-body super-composites		
EW08-SS-WB-SUPCOMP1	ng/kg ww	1.01 J
EW08-SS-WB-SUPCOMP2	ng/kg ww	1.35 J
EW08-SS-WB-SUPCOMP3	ng/kg ww	1.30 J
Brown rockfish – whole-body		
EW-08-SB002-BR-02	ng/kg ww	3.00 J
EW-08-SB006-BR-06	ng/kg ww	0.658 J
EW-08-SB008-BR-08	ng/kg ww	2.33 J
EW-08-SB009-BR-09	ng/kg ww	1.89 J
EW-08-SB011-BR-11	ng/kg ww	2.80 J
EW-08-SB012-BR-10	ng/kg ww	1.96 J

J – estimated concentration

ww – wet weight

3.2.2 Crab tissue dioxin and furan results

Most dioxin and furan congeners were detected in all of the crab tissue samples. Detection frequencies, the range of detected values and reporting limits are summarized for all the dioxin and furan TEQ congeners are provided in Table 3-9.

Table 3-9. EW crab tissue summary for dioxins/furans

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limit ^a
		Minimum	Maximum	
2,3,7,8-TCDD	5 / 6	0.0701 J	0.285	0.227
1,2,3,7,8-PeCDD	5 / 6	0.123 J	0.678 J	0.135
1,2,3,4,7,8-HxCDD	4 / 6	0.110 J	0.536 J	0.0756 - 0.128
1,2,3,6,7,8-HxCDD	6 / 6	0.256 J	1.92	na
1,2,3,7,8,9-HxCDD	4 / 6	0.0910 J	0.540 J	0.102 - 0.470
1,2,3,4,6,7,8-HpCDD	6 / 6	0.611 J	6.49	na
OCDD	6 / 6	1.46 J	10.9	na
2,3,7,8-TCDF	6 / 6	1.25	4.87	na
1,2,3,7,8-PeCDF	6 / 6	0.127 J	0.659 J	na
2,3,4,7,8-PeCDF	5 / 6	0.214 J	1.69	0.253
1,2,3,4,7,8-HxCDF	0 / 6	nd	nd	0.111 - 1.04
1,2,3,6,7,8-HxCDF	5 / 6	0.0643 J	0.337 J	0.0541
1,2,3,7,8,9-HxCDF	0 / 6	nd	nd	0.0251 - 0.0861
2,3,4,6,7,8-HxCDF	4 / 6	0.0333 J	0.238 J	0.0288 - 0.0604
1,2,3,4,6,7,8-HpCDF	0 / 6	nd	nd	0.227 - 1.90
1,2,3,4,7,8,9-HpCDF	1 / 6	0.0447 J	0.0447 J	0.0239 - 0.0544
OCDF	4 / 6	0.374 J	0.682 J	0.133 - 0.196
Dioxin/furan TEQ	6 / 6	0.451 J	2.35 J	na

^a Reporting limit range for non-detect samples

na – not applicable

J - estimated concentration

The calculated dioxin and furan TEQ for each crab tissue sample is provided in Table 3-10. Dioxin and furan TEQs ranged from 0.451 to 2.35 ng TEQ/kg ww. The highest TEQ values were calculated for crab hepatopancreas super-composite samples. The TEQ values calculated for the replicate super-composites samples were very consistent for both the crab edible meat super-composite samples and the crab hepatopancreas super-composite samples

Table 3-10. EW crab tissue results for dioxin/furan TEQs

Sample Name	Unit	Dioxin/Furan TEQ
Crab - edible meat super-composites		
EW08-RRDC-EM-SUPCOMP1	ng/kg ww	0.451 J
EW08-RRDC-EM-SUPCOMP2	ng/kg ww	0.488 J
EW08-RRDC-EM-SUPCOMP3	ng/kg ww	0.471 J
Crab - hepatopancreas super-composites		
EW08-RRDC-HP-SUPCOMP1	ng/kg ww	2.26 J
EW08-RRDC-HP-SUPCOMP2	ng/kg ww	2.22 J
EW08-RRDC-HP-SUPCOMP3	ng/kg ww	2.35 J

J – estimated concentration

ww – wet weight

3.2.3 Clam and geoduck tissue dioxin and furan results

Most dioxin and furan congeners were detected in all of the clam and geoduck tissue samples. Detection frequencies, the range of detected values and reporting limits are summarized for all the dioxin and furan TEQ congeners are provided in Table 3-11.

Table 3-11. Summary of clam and geoduck tissue results for dioxins/furans

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limits
		Minimum	Maximum	
2,3,7,8-TCDD	0 / 8	nd	nd	0.0926 - 0.177
1,2,3,7,8-PeCDD	0 / 8	nd	nd	0.0941 - 0.246
1,2,3,4,7,8-HxCDD	2 / 8	0.128 J	0.243 J	0.125 - 0.259
1,2,3,6,7,8-HxCDD	2 / 8	0.250 J	0.422 J	0.147 - 0.292
1,2,3,7,8,9-HxCDD	2 / 8	0.122 J	0.213 J	0.145 - 0.289
1,2,3,4,6,7,8-HpCDD	5 / 8	2.13 J	4.80	0.150 - 0.424
OCDD	8 / 8	0.807 J	47.3	na
2,3,7,8-TCDF	4 / 8	0.173 J	0.495	0.0837 - 0.259
1,2,3,7,8-PeCDF	0 / 8	nd	nd	0.0609 - 0.212
2,3,4,7,8-PeCDF	2 / 8	0.177 J	0.379 J	0.112 - 0.240
1,2,3,4,7,8-HxCDF	2 / 8	0.199 J	0.246 J	0.0615 - 0.191
1,2,3,6,7,8-HxCDF	0 / 8	nd	nd	0.0547 - 0.111
1,2,3,7,8,9-HxCDF	0 / 8	nd	nd	0.0777 - 0.169
2,3,4,6,7,8-HxCDF	0 / 8	nd	nd	0.0601 - 0.133
1,2,3,4,6,7,8-HpCDF	6 / 8	0.0879 J	1.01 J	0.0769 - 0.377
1,2,3,4,7,8,9-HpCDF	0 / 8	nd	nd	0.0958 - 0.156

Chemical	Detection Frequency	Detected Concentration (ng/kg ww)		Reporting Limits
		Minimum	Maximum	
OCDF	5 / 8	0.829 J	2.11 J	0.226 - 0.588
Dioxin/furan TEQ	8 / 8	0.218 J	0.536 J	na

J – estimated concentration

na – not applicable

ww – wet weight

The calculated dioxin and furan TEQ for each clam and geoduck tissue sample is provided in Table 3-12. Dioxin and furan TEQs ranged from 0.218 to 0.536 ng TEQ/kg ww. The highest TEQ value was calculated for a geoduck gutball sample (EW-S01-GD-GB-comp02).

Table 3-12. EW clam and geoduck tissue results for dioxin/furan TEQs

Sample Name	Unit	Dioxin/Furan TEQ
Butter clam - Whole body		
EW-B06-BC-01-comp1	ng/kg ww	0.379 J
EW-B10-BC-01-comp1	ng/kg ww	0.237 J
Cockle - Whole body		
EW-B08-CN-02-comp1	ng/kg ww	0.234 J
Geoduck – edible meat		
EW-S01-GD-02	ng/kg ww	0.246 J
EW-S01-GD-04	ng/kg ww	0.239 J
EW-S01-GD-10	ng/kg ww	0.218 J
Geoduck - Gutball		
EW-S01-GD-GB-comp01	ng/kg ww	0.303 J
EW-S01-GD-GB-comp02	ng/kg ww	0.536 J

J – estimated concentration

ww – wet weight

3.2.4 Assessment of reporting limit influences on the calculation of PCB and Dioxin/Furan TEQs

PCB congener TEQs and dioxin/furan TEQs were calculated with nondetected results treated as half the RL as described in Appendix B. In order to determine the extent to which the calculated TEQs were influenced by the RL values, TEQs were calculated with the RL incorporated as zero, half the RL or full RL for PCB congener TEQs (Table 3-13) and dioxin/furan TEQs (Table 3-14). The largest differences were observed for dioxin/furan TEQs calculated for geoduck edible meat samples due to the fact that

very few dioxin and furan congeners were detected in these samples. In general, the non-detected values do not substantially influence the calculated TEQ values.

Table 3-13. PCB congener TEQ calculated with RL as zero, half RL and full RL

Species Tissue Type/Sample ID	Unit	PCB TEQ - mammal (zero RL)	PCB TEQ - mammal (half RL)	PCB TEQ - mammal (full RL)
Brown rockfish				
EW-08-SB002-BR-02	ng/kg ww	17.8 J	18.6 J	19.4 J
EW-08-SB006-BR-06	ng/kg ww	4.90	5.05	5.19
EW-08-SB008-BR-08	ng/kg ww	58.8 J	59.5 J	60.2 J
EW-08-SB009-BR-09	ng/kg ww	22.3 J	23.0 J	23.7 J
EW-08-SB012-BR-10	ng/kg ww	14.1 J	14.8 J	15.5 J
EW-08-SB011-BR-11	ng/kg ww	26.9 J	27.6 J	28.3 J
English sole - fillet super-composites				
EW08-ES-FL-SUPCOMP1	ng/kg ww	15.4	15.4	15.4
EW08-ES-FL-SUPCOMP2	ng/kg ww	9.65	10.1	10.5
EW08-ES-FL-SUPCOMP3	ng/kg ww	13.2	13.2	13.2
English sole - whole body super-composites				
EW08-ES-WB-SUPCOMP1	ng/kg ww	37.4 J	37.4 J	37.4 J
EW08-ES-WB-SUPCOMP2	ng/kg ww	32.4 J	32.4 J	32.4 J
EW08-ES-WB-SUPCOMP3	ng/kg ww	35.1 J	35.1 J	35.1 J
Shiner surfperch - whole-body super-composites				
EW08-SS-WB-SUPCOMP1	ng/kg ww	11.4	11.4	11.4
EW08-SS-WB-SUPCOMP2	ng/kg ww	13.7	13.7	13.7
EW08-SS-WB-SUPCOMP3	ng/kg ww	14.3	14.3	14.3
Crab - edible meat super-composites				
EW08-RRDC-EM-SUPCOMP1	ng/kg ww	1.11	1.53	1.94
EW08-RRDC-EM-SUPCOMP2	ng/kg ww	1.66 J	1.66 J	1.66 J
EW08-RRDC-EM-SUPCOMP3	ng/kg ww	1.28	1.71	2.13
Crab - hepatopancreas super-composites				
EW08-RRDC-HP-SUPCOMP1	ng/kg ww	6.52	8.06	9.60
EW08-RRDC-HP-SUPCOMP2	ng/kg ww	10.7	10.7	10.7
EW08-RRDC-HP-SUPCOMP3	ng/kg ww	11.0	11.0	11.0
Butter clam - whole body				
EW-B06-BC-01-comp1	ng/kg ww	0.719	0.734	0.749
EW-B10-BC-01-comp1	ng/kg ww	0.256	0.271	0.286
Cockle - whole body				
EW-B08-CN-02-comp1	ng/kg ww	0.197	0.212	0.227
Geoduck – edible meat				
EW-S01-GD-02	ng/kg ww	0.0760 J	0.0910 J	0.106 J
EW-S01-GD-04	ng/kg ww	0.177	0.192	0.207
EW-S01-GD-10	ng/kg ww	0.125 J	0.140 J	0.154 J

Species Tissue Type/Sample ID	Unit	PCB TEQ - mammal (zero RL)	PCB TEQ - mammal (half RL)	PCB TEQ - mammal (full RL)
Geoduck - gutball				
EW-S01-GD-GB-comp01	ng/kg ww	0.364	0.378	0.393
EW-S01-GD-GB-comp02	ng/kg ww	0.529	0.544	0.559

J – estimated concentration

RL – reporting limit

Table 3-14. Dioxin/furan TEQ (ng/kg ww) calculated with RL as zero, half RL and full RL

Species Tissue Type/Sample ID	Unit	Dioxin/furan TEQ - mammal (zero RL)	Dioxin/furan TEQ - mammal (half RL)	Dioxin/furan TEQ - mammal (full RL)
Brown rockfish				
EW-08-SB002-BR-02	ng/kg ww	2.95 J	3.00 J	3.05 J
EW-08-SB006-BR-06	ng/kg ww	0.339 J	0.658 J	0.978 J
EW-08-SB008-BR-08	ng/kg ww	1.87 J	2.33 J	2.78 J
EW-08-SB009-BR-09	ng/kg ww	1.19 J	1.89 J	2.58 J
EW-08-SB012-BR-10	ng/kg ww	1.73 J	1.96 J	2.18 J
EW-08-SB011-BR-11	ng/kg ww	2.77 J	2.80 J	2.83 J
English sole - fillet super-composites				
EW08-ES-FL-SUPCOMP1	ng/kg ww	0.576 J	0.728 J	0.880 J
EW08-ES-FL-SUPCOMP2	ng/kg ww	0.559 J	0.736 J	0.912 J
EW08-ES-FL-SUPCOMP3	ng/kg ww	0.757 J	0.793 J	0.828 J
English sole - whole body super-composites				
EW08-ES-WB-SUPCOMP1	ng/kg ww	1.23 J	1.54 J	1.85 J
EW08-ES-WB-SUPCOMP2	ng/kg ww	1.86 J	1.89 J	1.92 J
EW08-ES-WB-SUPCOMP3	ng/kg ww	1.84 J	1.89 J	1.93 J
Shiner surfperch - whole-body super-composites				
EW08-SS-WB-SUPCOMP1	ng/kg ww	0.628 J	1.01 J	1.39 J
EW08-SS-WB-SUPCOMP2	ng/kg ww	1.31 J	1.35 J	1.38 J
EW08-SS-WB-SUPCOMP3	ng/kg ww	1.26 J	1.30 J	1.34 J
Crab - edible meat super-composites				
EW08-RRDC-EM-SUPCOMP1	ng/kg ww	0.392 J	0.451 J	0.510 J
EW08-RRDC-EM-SUPCOMP2	ng/kg ww	0.393 J	0.488 J	0.583 J
EW08-RRDC-EM-SUPCOMP3	ng/kg ww	0.457 J	0.471 J	0.486 J
Crab - hepatopancreas super-composites				
EW08-RRDC-HP-SUPCOMP1	ng/kg ww	2.22 J	2.26 J	2.29 J
EW08-RRDC-HP-SUPCOMP2	ng/kg ww	2.07 J	2.22 J	2.38 J
EW08-RRDC-HP-SUPCOMP3	ng/kg ww	2.26 J	2.35 J	2.44 J

Species Tissue Type/Sample ID	Unit	Dioxin/furan TEQ - mammal (zero RL)	Dioxin/furan TEQ - mammal (half RL)	Dioxin/furan TEQ - mammal (full RL)
Butter clam - whole body				
EW-B06-BC-01-comp1	ng/kg ww	0.102 J	0.379 J	0.656 J
EW-B10-BC-01-comp1	ng/kg ww	0.0310 J	0.237 J	0.443 J
Cockle - whole body				
EW-B08-CN-02-comp1	ng/kg ww	0.0790 J	0.234 J	0.389 J
Geoduck – edible meat				
EW-S01-GD-02	ng/kg ww	0.000242 J	0.246 J	0.492 J
EW-S01-GD-04	ng/kg ww	0.0190 J	0.239 J	0.459 J
EW-S01-GD-10	ng/kg ww	0.0240 J	0.218 J	0.411 J
Geoduck - gutball				
EW-S01-GD-GB-comp01	ng/kg ww	0.106 J	0.303 J	0.500 J
EW-S01-GD-GB-comp02	ng/kg ww	0.324 J	0.536 J	0.749 J

J – estimated concentration

RL – reporting limit

3.3 PCB AROCLORS, LIPIDS AND TOTAL SOLIDS RESULTS

The results for the super-composite samples analyzed for PCB Aroclors, lipids and total solids are presented below.

3.3.1 EW fish tissue super-composite sample results

The results for the fish tissue super-composite samples are summarized in Table 3-15. Two Aroclors (Aroclor 1254 and Aroclor 1260) were detected in all the fish tissue super-composite samples.

Table 3-15. EW Fish tissue super-composite sample results for PCB Aroclors, percent lipids and total solids

Chemical	Detection Frequency	Unit	Detected Concentration		Reporting Limits
			Minimum	Maximum	
PCBs					
Aroclor-1016	0 / 9	µg/kg ww	nd	nd	9.9 - 50
Aroclor-1221	0 / 9	µg/kg ww	nd	nd	20 - 100
Aroclor-1232	0 / 9	µg/kg ww	nd	nd	9.9 - 50
Aroclor-1242	0 / 9	µg/kg ww	nd	nd	9.9 - 50
Aroclor-1248	0 / 9	µg/kg ww	nd	nd	9.9 - 50
Aroclor-1254	9 / 9	µg/kg ww	370	1,300	na
Aroclor-1260	9 / 9	µg/kg ww	320	1,400	na
Total PCBs	9 / 9	µg/kg ww	720	2,700	na

Chemical	Detection Frequency	Unit	Detected Concentration		Reporting Limits
			Minimum	Maximum	
Conventionals					
Lipid	9 / 9	% ww	1.40	5.50	na
Total solids	9 / 9	% ww	20.32	28.78	na

The results for each super-composite sample are provided in Table 3-16. The highest Aroclor concentrations were measured in the English sole whole-body super-composites. The PCB Aroclor, lipid and total solid results for replicate super-composites for each tissue type were consistent.

Table 3-16. EW fish tissue super-composite sample results for PCB Aroclors, total lipids, and total solids

Species Tissue Type/ Sample ID	PCB Aroclor Concentrations (µg/kg ww)								Lipids (%)	Total Solids (%)
	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260	Total PCBs		
English sole - fillet super-composites										
EW08-ES-FL-SUPCOMP1	9.9 U	20 U	9.9 U	9.9 U	9.9 U	400	320	720	1.53	20.32
EW08-ES-FL-SUPCOMP2	50 U	100 U	50 U	50 U	50 U	610	640	1,250	1.40	22.62
EW08-ES-FL-SUPCOMP3	50 U	100 U	50 U	50 U	50 U	790	850	1,640	1.61	20.44
English sole - whole body super-composites										
EW08-ES-WB-SUPCOMP1	50 U	99 U	50 U	50 U	50 U	1,100	1,200	2,300	3.08	21.90
EW08-ES-WB-SUPCOMP2	50 U	99 U	50 U	50 U	50 U	1,200	1,300	2,500	2.88	22.06
EW08-ES-WB-SUPCOMP3	50 U	100 U	50 U	50 U	50 U	1,300	1,400	2,700	2.93	22.31
Shiner surfperch - whole-body super-composites										
EW08-SS-WB-SUPCOMP1	50 U	100 U	50 U	50 U	50 U	440	700	1,140	5.50	27.72
EW08-SS-WB-SUPCOMP2	9.9 U	20 U	9.9 U	9.9 U	9.9 U	370	570	940	5.34	28.78
EW08-SS-WB-SUPCOMP3	10 U	20 U	10 U	10 U	10 U	370	560	930	5.37	28.36

J – estimated concentration

U – not detected at the given reporting limit

ww – wet weight

3.3.1 EW fish crab super-composite sample results

The results for the crab tissue super-composite samples are summarized in Table 3-17. Two Aroclors (Aroclor 1254 and Aroclor 1260) were detected in all the crab tissue super-composite samples.

Table 3-17 – EW Crab tissue super-composite sample results for PCB Aroclors, percent lipids and total solids

CHEMICAL	DETECTION FREQUENCY	UNITS	DETECTED CONCENTRATION		REPORTING LIMITS
			MINIMUM	MAXIMUM	
PCBs					
Aroclor-1016	0 / 6	µg/kg ww	nd	nd	9.8 - 10
Aroclor-1221	0 / 6	µg/kg ww	nd	nd	20
Aroclor-1232	0 / 6	µg/kg ww	nd	nd	9.8 - 10
Aroclor-1242	0 / 6	µg/kg ww	nd	nd	9.8 - 10
Aroclor-1248	0 / 6	µg/kg ww	nd	nd	9.8 - 10
Aroclor-1254	6 / 6	µg/kg ww	17 J	350 J	na
Aroclor-1260	6 / 6	µg/kg ww	34	580	na
Total PCBs	6 / 6	µg/kg ww	51 J	930 J	na
Conventionals					
Lipid	6 / 6	% ww	0.151	2.25	na
Total solids	6 / 6	% ww	14.47	19.11	na

The results for each super-composite sample are provided in Table 3-18. The highest Aroclor concentrations were measured in the crab hepatopancreas super-composites. The PCB Aroclor results for individual Aroclors as well as the total PCBs (sum of Aroclors) and , lipid and total solid results for replicate super-composites for each tissue type were consistent.

Table 3-18. EW crab tissue super-composite sample results for PCB Aroclors, total lipids, and total solids

Species Tissue Type/ Sample ID	PCB Aroclor Concentrations (µg/kg ww)								Lipids (%)	Total Solids (%)
	Aroclor- 1016	Aroclor- 1221	Aroclor- 1232	Aroclor- 1242	Aroclor- 1248	Aroclor- 1254	Aroclor- 1260	Total PCBs		
Crab - edible meat super-composites										
EW08-RRDC-EM-SUPCOMP1	10 U	20 U	10 U	10 U	10 U	33	60	93	0.151	18.85
EW08-RRDC-EM-SUPCOMP2	9.8 U	20 U	9.8 U	9.8 U	9.8 U	24 J	46	70 J	0.159	19.11
EW08-RRDC-EM-SUPCOMP3	10 U	20 U	10 U	10 U	10 U	17 J	34	51 J	0.151	18.58
Crab - hepatopancreas super-composites										
EW08-RRDC-HP-SUPCOMP1	10 U	20 U	10 U	10 U	10 U	310 J	510	820 J	2.13	14.47
EW08-RRDC-HP-SUPCOMP2	9.9 U	20 U	9.9 U	9.9 U	9.9 U	350 J	580	930 J	2.18	15.26
EW08-RRDC-HP-SUPCOMP3	9.8 U	20 U	9.8 U	9.8 U	9.8 U	340 J	570	910 J	2.25	15.43

J – estimated concentration

U – not detected at the given reporting limit

ww – wet weight

3.4 DATA VALIDATION RESULTS

Independent data validation was performed by EcoChem on all results in accordance with the QA/QC requirements and technical specifications of the methods and the national functional guidelines (EPA 1999, 2002, 2004, 2005). EcoChem conducted full-level data validation on all PCB congener and dioxin/furan results. Summary-level data validation was performed on the PCB Aroclor, lipids, and total solids results. The percent of samples submitted for full validation for each analysis is consistent with QAPP requirements for the entire EW fish and shellfish tissue dataset. The majority of the Aroclor and lipid data were presented in a separate data report (Windward 2010). Table 3-19 provides a summary of the number of samples in each sample delivery group (SDG) and the level of data validation.

Table 3-19. Data validation performed for each SDG

Laboratory	SDG	Validation Level	Number of Samples	Analyses
Analytical Perspectives	P1389	full	15	PCB congeners and dioxins/furans
Analytical Perspectives	P1395	full	14	PCB congeners and dioxins/furans
ARI	PA65	summary	15	lipids, total solids
CAS	K0905254	summary	15	PCB Aroclors

ARI – Analytical Resources, Inc.

CAS – Columbia Analytical Services, Inc.

PCB – polychlorinated biphenyl

SDG – sample delivery group

The data validation involved a review of all QC summary forms, including initial calibration, continuing calibration verification (CCV), internal standard, surrogate, laboratory control sample (LCS), laboratory control sample duplicate (LCSD), matrix spike (MS), and matrix spike duplicate (MSD)¹. The majority of the data did not require qualification or were qualified with a J, indicating that the concentration was an estimated value. No results were rejected as a consequence of data validation. Based on the information reviewed, the overall data quality was considered acceptable for all uses, as qualified. Issues that resulted in the qualification of data are summarized below. Detailed information regarding every qualified sample is presented in Appendix C.

- ◆ Eleven results for two PCB congeners (i.e., 8 results for PCB-118 and 3 results for PCB-105) were J-qualified because they exceeded the calibrated range of the instrument. All results were within the operating range of the instrument.

¹ QA sample analyzed for Aroclor analysis only.

- ◆ Sixty results were re-qualified as non-detect at elevated reporting limits because of method blank contamination. Results that were re-qualified as non-detect include 21 results for PCB-11, 15 results each for 1,2,3,4,6,7,8-HpCDF and 1,2,3,4,7,8-HxCDF, and 8 results for PCB-8.
- ◆ The results for PCB-1 and PCB-2 in sample EW08-RRDC-EM-SUPCOMP2 were J-qualified because the recovery of the associated spiked labeled standard was outside of QC limits.
- ◆ The RPDs between the results of dual-column analyses for Aroclor 1254 in 5 samples were greater than the control limit of $\pm 40\%$. These results were J-qualified to indicate estimated concentrations. The reported result was selected from the analytical column with the higher of the two values. Samples were not reanalyzed for elevated dual-column RPDs if all other QC criteria were met, but results were flagged as estimated.

4 References

- EPA. 1999. USEPA contract laboratory program national functional guidelines for organic data review. EPA-540/R-99/008. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.
- EPA. 2002. USEPA contract laboratory program national functional guidelines for inorganic data review. EPA 540-R-01-008. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.
- EPA. 2004. USEPA contract laboratory program national functional guidelines for inorganic data review. EPA 540-R-04-004. Office of Emergency and Remedial Response, US Environmental Protection Agency, Washington, DC.
- EPA. 2005. National functional guidelines for chlorinated dibenzo-p-dioxins (CDDs) and chlorinated dibenzofurans (CDFs) data review. OSWER 9240.1-51. EPA 540-R-05-001. Office of Superfund Remediation and Technology Innovation, US Environmental Protection Agency, Washington, DC.
- Van den Berg M, Birnbaum LS, Denison M, De Vito M, Farland W, Feeley M, Fiedler H, Hakansson H, Hanberg A, Haws L, Rose M, Safe S, Schrenk D, Tohyama C, Tritscher A, Tuomisto J, Tysklind M, Walker N, Peterson RE. 2006. The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. *Tox Sci* 93(2):223-241.
- Windward. 2008. Quality assurance project plan: clam studies. East Waterway Operable Unit supplemental remedial investigation/feasibility study. Windward Environmental LLC, Seattle, WA.

Windward. 2010. Data report: fish and shellfish tissue collection. Final. East Waterway Operable Unit supplemental remedial investigation/ feasibility study. Windward Environmental LLC, Seattle, WA.