Spatial Extent of Dioxin/Furan Contaminated Sediments in Dillenbaugh Creek

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Spatial Extent of Dioxin/Furan Contaminated Sediments in Dillenbaugh Creek

by
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Abstract

Sediment samples from Dillenbaugh Creek, located in Chehalis, Washington, were analyzed for polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/PCDFs) in April 2004 by the Washington State Department of Ecology. The study was conducted after a 1998 screening-level investigation found that residual PCDD/PCDFs exist in the vicinity of the American Crossarm and Conduit Company (ACC) Superfund site, cleaned up in the late 1980s.

PCDD/PCDF contamination was found in sediment samples in a half-mile segment of Dillenbaugh Creek downstream of the former ACC stormwater lagoon. Concentrations were comparable to those found in the 1998 screening-level investigation. Although Washington State does not have a numerical freshwater sediment quality limit for PCDD/PCDF concentrations, some concentrations from this segment of Dillenbaugh Creek were over 100 times the dioxin level for the cleanup of soils to protect human health.

Upstream from where the ACC stormwater lagoon empties into Dillenbaugh Creek, PCDD/PCDF concentrations are less elevated, suggesting that the contamination may have entered the creek from the lagoon. At some locations in the upstream segment, PCDD/PCDF concentrations were still above the soil cleanup level for dioxin.

Acknowledgements

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Introduction

The American Crossarm and Conduit Company (ACC) operated a wood-treating facility adjacent to Dillenbaugh Creek in Chehalis, Washington from the 1930s to 1983. This site was contaminated with polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/PCDFs), polycyclic aromatic hydrocarbons (PAHs), and pentachlorophenol (PCP) through the discharge of process liquids and wastewaters. In 1986, contamination was dispersed throughout the property when the Chehalis River flooded and spread about 10,000 gallons of PCP mixed with diesel oil to neighboring residences (Figure 1).

In the early 1990s, Roy F. Weston, Inc., under contract with the U.S. Environmental Protection Agency (EPA), investigated the nature and extent of residual contamination at the site. The investigation was conducted following remedial actions begun after the 1986 flood. Weston found up to 0.8 ng/L of PCDD/PCDFs in surface waters of Dillenbaugh Creek and 0.6 ng/L from the nearby stormwater lagoon and in the Chehalis River (Weston, 1992).

In 1998, the Washington State Department of Ecology (Ecology) conducted a follow-up investigation to evaluate contaminant levels in Dillenbaugh Creek fish and sediment (Era-Miller et al., 2002). The results of this study showed that Dillenbaugh Creek sediments within the ACC area of contamination were higher than background stations and sediments in the Chehalis River. However, sediments were sampled at only four locations in the creek (Figure 1), and more data are needed for cleanup decisions.

Study Goals and Objectives

The primary goal of this study was to assist Ecology's Toxics Cleanup Program in making cleanup decisions for Dillenbaugh Creek by extensive sampling of the sediments for PCDD/PCDFs. A secondary goal was to evaluate whether ongoing discharge of PCDD/PCDFs was occurring in the creek.

Primary objectives of the study were to:

- Evaluate the significance of PCDD/PCDF concentrations.
- Develop a longitudinal profile of PCDD/PCDF sediment concentrations in Dillenbaugh Creek downstream of the former ACC wood-treating facility.
- Characterize the vertical concentration profile of PCDD/PCDF in sediments from sampling at some locations in Dillenbaugh Creek.

All samples were analyzed for PCDD/PCDFs using EPA Method 4025, an immunoassay technique. To check the results for accuracy, a selection of the samples was also analyzed using high-resolution gas chromatography/high-resolution mass spectrometry analysis, EPA Method 1613b.

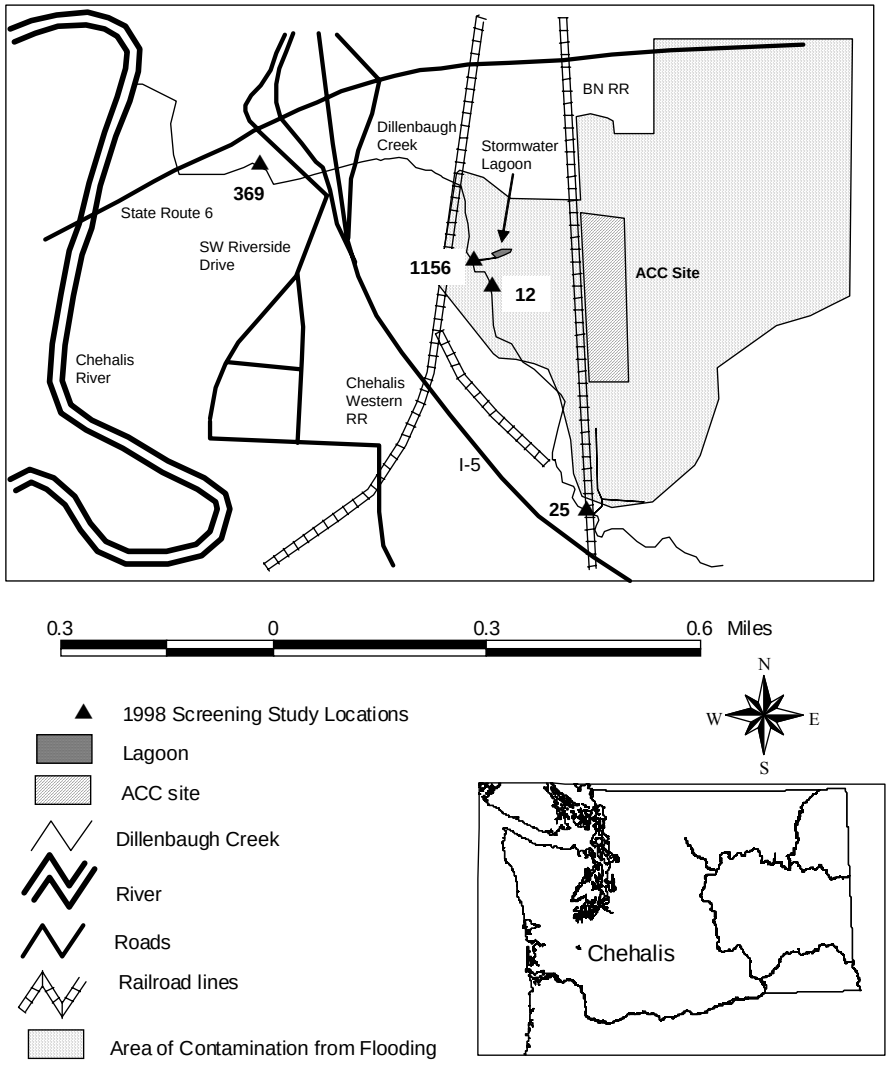

Figure 1. Study Area Showing Sampling Locations and PCDD/PCDF Concentrations (pg/g TEQ) from 1998 Ecology Screening-level Study.

Methods

Station Selection

The sampling design for this project required 22 sampling locations spaced at approximately 250-ft intervals along a transect running from the BNSF Railroad Bridge to the Chehalis River (Jack, 2004). Actual sampling locations deviated from this plan primarily because some sections of the transect were inaccessible or because the grab sampler could not penetrate the streambed. The grab sampler was ineffective at locations where hard clay or woody debris lined the streambed, and the sampling location was relocated progressively further downstream until a sediment sample was retrieved successfully.

Four locations for core sampling were spaced somewhat evenly along the transect. However, a sample was obtained successfully at only one of these locations.

Sampling locations are shown in Figure 2. Location descriptions and positions are provided in Appendix A, Table A-1.

Sample Collection and Preparation

All of the stainless steel sampling and compositing implements were cleaned prior to sampling by scrubbing with Liquinox® detergent, followed by sequential rinses with hot tap water, deionized water, pesticide-grade acetone, and pesticide-grade hexane. This equipment was covered with aluminum foil to maintain cleanliness before field use.

At each station, a petite Ponar ($0.02m^2$) was used to collect three sediment grabs within a radius of about two meters. The sediment from the top five cm of these grabs was composited in a stainless steel mixing bowl, mixed thoroughly with a stainless steel spoon, and placed into precleaned glass jars.

Sediment cores were collected using a JMC Environmentalist's Sub-Soil Probe (Clements Associates Inc. http://www.jmcsoil.com/). The probe has a 108-cm metal sampling tube which holds a 91-cm PETG copolyester liner with a 2.2-cm internal diameter. Liners were precleaned with Liquinox® detergent, followed by sequential rinses with hot tap water and deionized water. Each end of the liner was then sealed with Parafilm until needed for sampling.

Repeated attempts to collect sediment cores with the sub-soil probe were largely unsuccessful, for various reasons. For example, saturated fine-grained sediments flowed out of the liner tube when it was raised, even when the top end of the tube was sealed to prevent core loss.

Cores were only obtained at one location, where the probe was driven into clay lining the streambed. Two cores, within a two-meter radius, were obtained at this location. In both cases, depth of penetration was approximately equivalent to the liner tube length (91 cm). The shallow

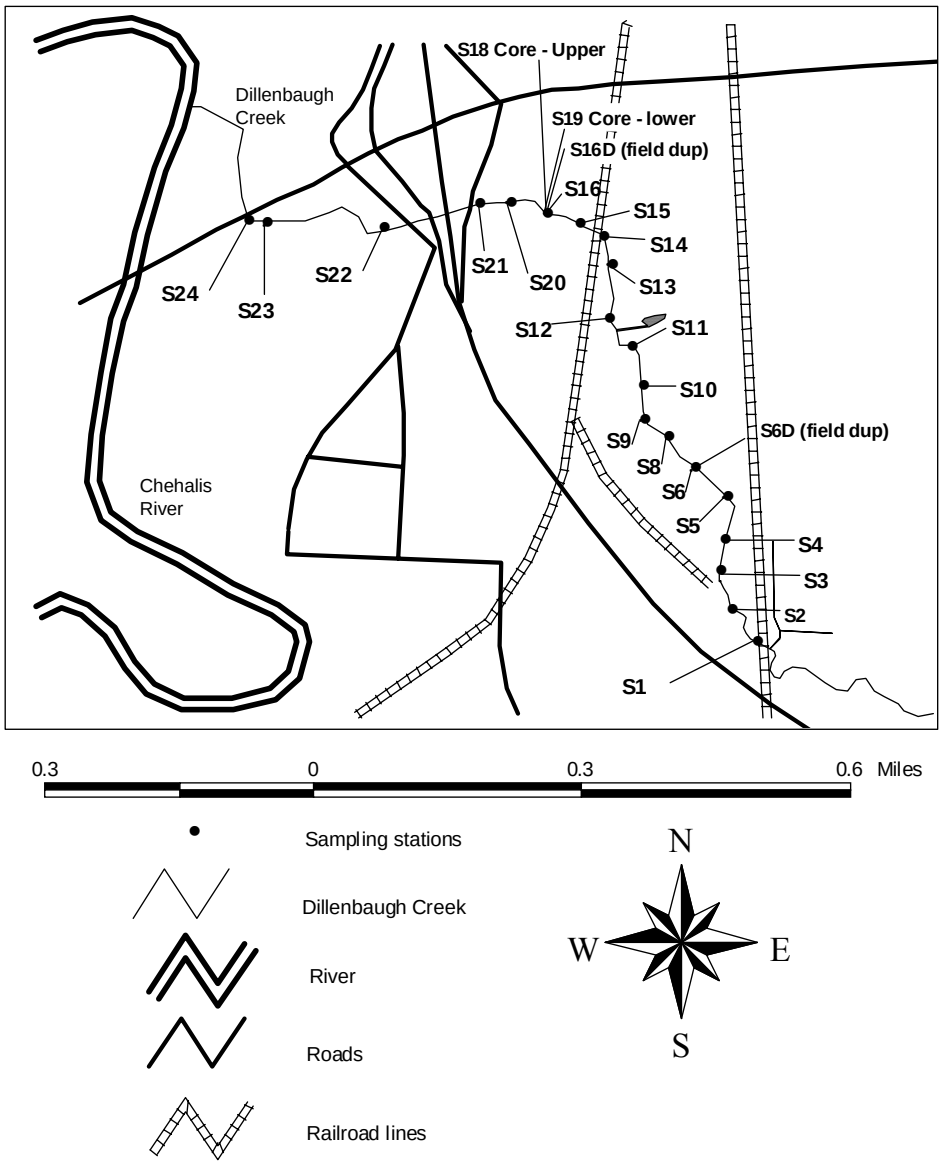

Figure 2. Ponar Grab Sediment Sampling Station Locations. Two sediment cores were also taken near S16 and sectioned. The upper section from each was combined and designated S18, and the lower sections were treated similarly (S19).

(upper third) sections from the two cores were composited together, mixed in dedicated bowls with dedicated spoons, and placed into precleaned jars. The deep (lower third) sections from the two cores were processed similarly. The middle sections were discarded.

Labeled jars with composited material from grab and core sampling were placed in an ice cooler and later refrigerated at 4° C. They were then shipped in ice coolers to the laboratories for analysis. Samples intended for possible analysis by isotope dilution, high-resolution capillary column gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) analysis were stored frozen at -20° C before being shipped in ice coolers to the laboratory.

Laboratory Procedures

Table 1 summarizes the analytical methods and reporting limits. Total organic carbon (TOC) and percent solids analyses were performed by the Ecology/EPA Manchester Environmental Laboratory. Grain size and PCDD/PCDF analyses were performed by contract laboratories.

Table 1. Analytical Methods, Reporting Limits, and Laboratories.

Parameter	Reporting Limit	Method	Laboratory
Grain Size	0.1%	Sieve and Pipet – PSEP, 1986	Analytical Resources
TOC	0.1%	Combustion/CO2 – PSEP, 1986	Manchester
% Solids	0.1%	Standard Methods 2540G	Manchester
2,3,7,8-TCDD TEQ	5 pg/g, total TEQ	EPA Method 4025 – Immunoassay	Cape Technologies
2,3,7,8-PCDD/PCDFs	2×10^{-3} pg/g, total TEQ	EPA Method 1613b – HRGC/HRMS	Pace Analytical

All samples were analyzed for 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD) and toxicologically related PCDD/PCDF congeners using a screening-level immunoassay method. This Enzyme Linked Immunosorbent Assay (EIA) does not quantify the concentration of 2,3,7,8-TCDD or other PCDD/PCDF congeners. Rather, it provides an estimate of the 2,3,7,8-TCDD Toxic Equivalent (TEQ) concentration (Appendix B).

The use of dioxin TEQs is based on the observation that dioxins and dioxin-like PCBs have similar toxicological effects but to different degrees. Toxic Equivalency Factors (TEFs) are available (EPA, 1989) that allow concentrations of the less toxic compounds to be expressed as a concentration equivalent to the most toxic dioxin (2,3,7,8-TCDD). These toxicity-weighted concentrations are then summed to give a single value, which is expressed as a TEQ. The dioxin TEFs are listed in Appendix B.

From a set of stored, frozen samples taken at all stations, a subset was analyzed for PCDD/PCDF congeners by HRGC/HRMS. For this analysis, TEQs were then calculated from the PCDD/ PCDF congener concentrations using the TEFs described above.

Data Quality

All analyses conducted for this project passed Quality Assurance reviews conducted by Manchester Environmental Laboratory. Details of the reviews are summarized in Case Narratives provided in Appendix C.

Most analytical goals for this project were met. Appendix Table D-1 provides a summary evaluation with respect to goals established in the Quality Assurance Project Plan (Jack, 2004), with the exception of a goal established for the correlation between EIA and HRGC/HRMS data ($r \geq 0.89$, or $r^2 \geq 0.80$). The comparability of data from these two analyses is addressed in the *Discussion* section of this report.

A Standard Reference Material was included with samples analyzed by HRGC/HRMS (Appendix E). A comparison with the Certificate of Analysis data is discussed in the *Results* section.

Results

Conventional Sediment Analysis

Sediment samples were mostly silt and sand (Table 2). Samples from the most downstream locations (S23 and S24) were predominantly sand, with low TOC and high percent solids. On the other hand, although S15 and S14 had typical grain size, they had the highest TOC values and lowest percent solids.

Table 2. Sediment Sample Grain Size, Percent Solids, and TOC Content.

Station ID	Lab ID	% solids	TOC (%)	Grain Size (%)			
				Gravel	Sand	Silt	Clay
S1	4188108	27	4.6	12.2	28.3	39.3	20.2
S2	4188109	30	5.3	4.6	21.6	46.7	27.1
S3	4188110	50	2.6	4.8	28.9	37.1	29.3
S4	4188111	20	7.1	8.1	32.6	40.9	18.4
S5	4188112	36	5.0	12.9	26.9	38.4	21.6
S6	4188113	33*	3.6*	22.0	25.8	50.1	2.2
S6D	4188114	32	3.5	18.8	25.3	51.9	4.0
S8	4188115	36	3.8	14.8*	38.1*	46.4*	0.6*
S9	4188116	23	5.3	2.5	31.5	65.1	0.8
S10	4188117	38	3.1	10.3	44.2	41	4.4
S11	4188118	55	1.7	7.6	31.7	32.4	28.4
S12	4188119	55*	1.4*	10.3	37.7	33.2	18.6
S13	4188120	54	1.4	8.9	43.7	33.9	13.6
S14	4188107	15	7.4	10.8	49.3	34.2	5.7
S15	4188106	13	8.2	15.6	37.2	40.4	7.0
S16	4188102	23	5.4	15.9	53.5	21.4	9.3
S16D	4188103	25	5.2	18.1	49.7	23.5	8.8
S20	4188101	26	5.4	9.3	50.9	30.4	9.4
S21	4188100	60	1.2	16.8	20.1	32.6	30.5
S22	4188121	41	3.4	18.4	55.7	24.1	1.9
S23	4188122	61	0.8	4.8	84.6	7.7	2.9
S24	4188123	62	1.1	8.8	84.1	5.9	1.2

* Mean of three laboratory triplicates.

Measurements were not made for sediment core samples (S18 and S19) due to insufficient material available in these samples.

Enzyme Linked Immunosorbent Assay (EIA) Screening-level Evaluation

TEQ values from the Ponar grab samples ranged from 26 pg/g (parts per trillion) to 200 pg/g (Table 3). In the coring sample, the surface sediment concentration (81 pg/g) was similar to the grab sample concentrations. However, the deep sediment concentration (5 pg/g) was considerably lower than the surface concentrations.

Table 3. PCDD/PCDF Concentrations in Sediment (Enzyme Linked Immunosorbent Assay).

Station	Lab ID	TEQ (pg/g)		
		Sample	Laboratory duplicate	Mean
Ponar grab samples				
S1	188108	31		
S2	188109	38		
S3	188110	50	47	49
S4	188111	50		
S5	188112	33		
S6	188113	40		
S6D	188114	40		
S8	188115	37		
S9	188116	46		
S10	188117	26		
S11	188118	27	26	27
S12	188119	92		
S13	188120	103	80	92
S14	188107	60		
S15	188106	119		
S16	188102	156		
S16D	188103	119		
S20	188101	149		
S21	188100	100		
S22	188121	183	218	200
S23	188122	85		
S24	188123	50	72	61
Sediment core samples[a] near DC03				
S18 (Upper sections)	188104	100	62	81
S19 (Lower sections)	188105	5		

a S18 and S19 were composited from upper and lower sections of two cores.
First core: 58 cm long. Used upper 20 cm for S18 and lower 20 cm for S19
Second core: 38 cm long. Used upper 13 cm for S18 and lower 13 cm for S19
Samples are shorter than the probe sampling tube due to compression during coring.

High-Resolution GC/MS (HRGC/HRMS) Evaluation

Sample Selection

A subset of the stored samples from each of the transect locations was selected for analysis with HRGC/HRMS. The samples were selected to include: (1) Stations representing a wide range of TEQ values, based on results from the EIA analysis; (2) Stations of interest because of their location (e.g., immediately downstream of the confluence of the stormwater lagoon channel and the creek); and (3) Stations where field or laboratory duplicates were available and more than one EIA measurement was therefore available for the station.

PCDD/PCDF Concentrations

TEQ values were calculated from HRGC/HRMS data (Appendix Table E-1) and TEFs listed in Appendix Table B-1. For the Ponar grab samples, the calculated values ranged from 3.7 pg/g TEQ to 790.0 pg/g TEQ (Table 4). For the coring sample, the surface sediment concentration (63 pg/g) was considerably higher than the deep sediment location (1.0 pg/g). However, it was an order of magnitude lower than in the grab sample from the same station (S16).

Results for the Standard Reference Material (210 pg/g) were lower than the nominal value of 248 pg/g from the Certificate of Analysis (NIST, 1999). This suggests that any bias in the analyses may be towards underestimation. No similar evaluation can be made for the EIA method, because the Standard Reference Material was used for calibration in the EIA analyses.

Table 4. PCDD/PCDF TEQs in Sediments (determined by HRGC/HRMS).

Station	Lab ID	TEQ (pg/g)			
		Sample	Laboratory duplicate	Mean	EIA value
Ponar grab samples					
S03	188110	23			49*
S06	188113	11			40
S11	188118	3.7			27*
S12	188119	210			92
S13	188120	48	63	55.5	92*
S15	188106	780			119
S16	188102	630			156
S16D	188103	740			119
S22	188121	790			200*
S24	188123	91	64	77.5	61*
Sediment core samples[a]					
S18 (Upper sections)	188104	68			81*
S19 (Lower sections)	188105	1.0	1.4	1.2	5
Standard Reference Material (TEQ = 248 pg/g)		210			

a S18 and S19 were composited from upper and lower sections of two cores.
First core: 58 cm long. Used upper 20 cm for S18 and lower 20 cm for S19.
Second core: 38 cm long. Used upper 13 cm for S18 and lower 13 cm for S19.
Samples are shorter than the probe sampling tube due to compression during coring.

* Mean of two laboratory values.

Discussion

Comparison of EIA and HRGC/HRMS Results

Two issues regarding the EIA dataset are of particular interest: (1) How reliable are EIA data in predicting TEQ concentrations? (2) How useful is the EIA dataset as a semiquantitative screening tool? These issues are addressed below.

Quantitative Predictions from EIA

Dioxin TEQ values from the HRGC/HRMS analysis do not show a strong linear relationship to data from the EIA analysis, although a power function gives a better fit (Figure 3).

The power function analysis is equivalent to performing a linear regression on the log-transformed EIA and HRGC/HRMS values, which yields a correlation of 0.93 (r^2 =0.86). Thus, the Quality Assurance Project Plan (Jack, 2004) goal of $r^2 \geq 0.80$ was met for log-transformed data but not for the raw data (r^2 =0.73).

Despite the power function relationship, it is clear from Figure 3 that EIA data may underestimate dioxin TEQ values considerably at higher concentrations. For example, the values from EIA analyses of S17 and S15 samples were 119 pg/g TEQ in both cases, while the HRGC/HRMS values were 740 and 780 pg/g, respectively.

Overall, the data suggest that stations with ≈100 pg/g TEQ or higher from EIA analysis should be considered as possibly having considerably higher dioxin levels. This caveat applies only to S20, since this is the only affected station for which HRGC/HRMS data are unavailable.

Screening-level EIA Applications

Washington State does not have a regulatory numerical standard for dioxin in freshwater sediments. However, other standards suggest that the reliability of EIA in detecting concentrations of ≥ 5 pg/g TEQ is a reasonable performance measure. Examples of existing numerical criteria include:

- Washington State cleanup regulation (Chapter 173-340 WAC) Method B soil criterion for protection of human health (6.67 pg/g)
- Washington State cleanup regulation wildlife protection soil screening value (2 pg/g)
- Proposed freshwater sediment Apparent Effects Threshold for benthic fauna (8.8 pg/g) (Cubbage et al., 1997)
- EPA sediment quality guideline for wildlife protection (2.5 pg/g) (cited in Era-Miller et al., 2002)

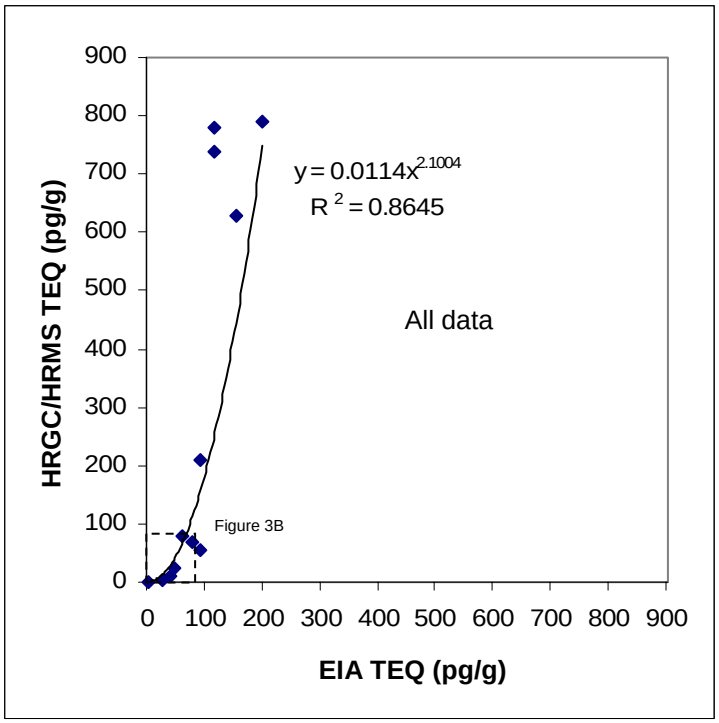

Figure 3A. Comparison of EIA and HRGC/HRMS Results. Data from Table 4.

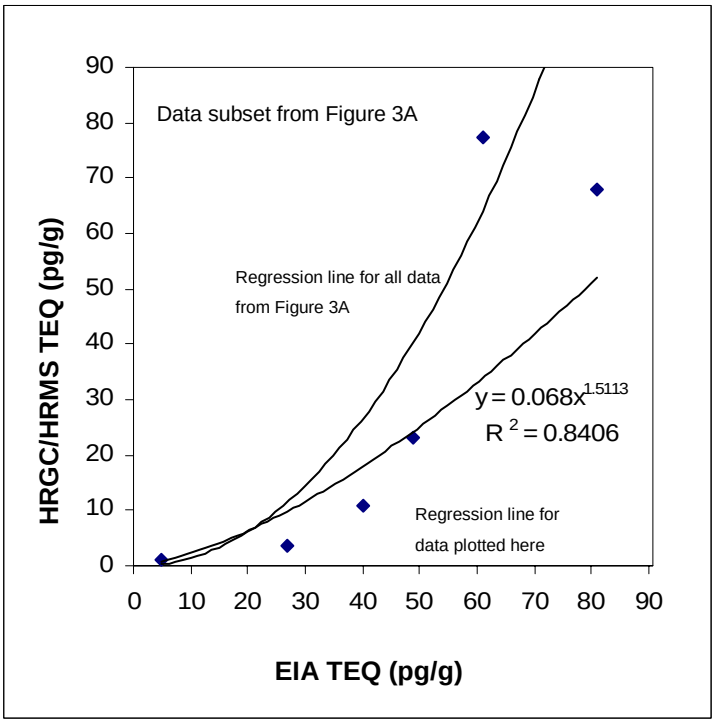

Figure 3B. Expanded View of Lower Values from Figure 3A

Of the samples analyzed with HRGC/HRMS, only two had concentrations less than 5 pg/g TEQ (Table 4). The EIA analysis result was ≥ 5 pg/g TEQ (i.e., a false positive). There were no false negatives; all samples with ≥ 5 pg/g TEQ by HRGC/HRMS also exceeded this value in the EIA analyses.

Based on these results and the small sample size, the data from this study provide insufficient evidence that the EIA method would be effective in screening out freshwater sediments with low-level dioxin contamination.

Higher screening values may be of interest for some applications (e.g., as remedial criteria) and would require reappraisal of the EIA method for false negative and false positive rates. Figure 4 shows the rates calculated from this data set for screening values up to 200 pg/g TEQ. Note that while the false positive rate was 0% at screening values of 100 pg/g or higher, the false negative rate rose to 33% at 160 pg/g. Thus, for action levels of 160 pg/g TEQ or higher, the EIA method may fail to detect too many exceedances to be considered reliable.

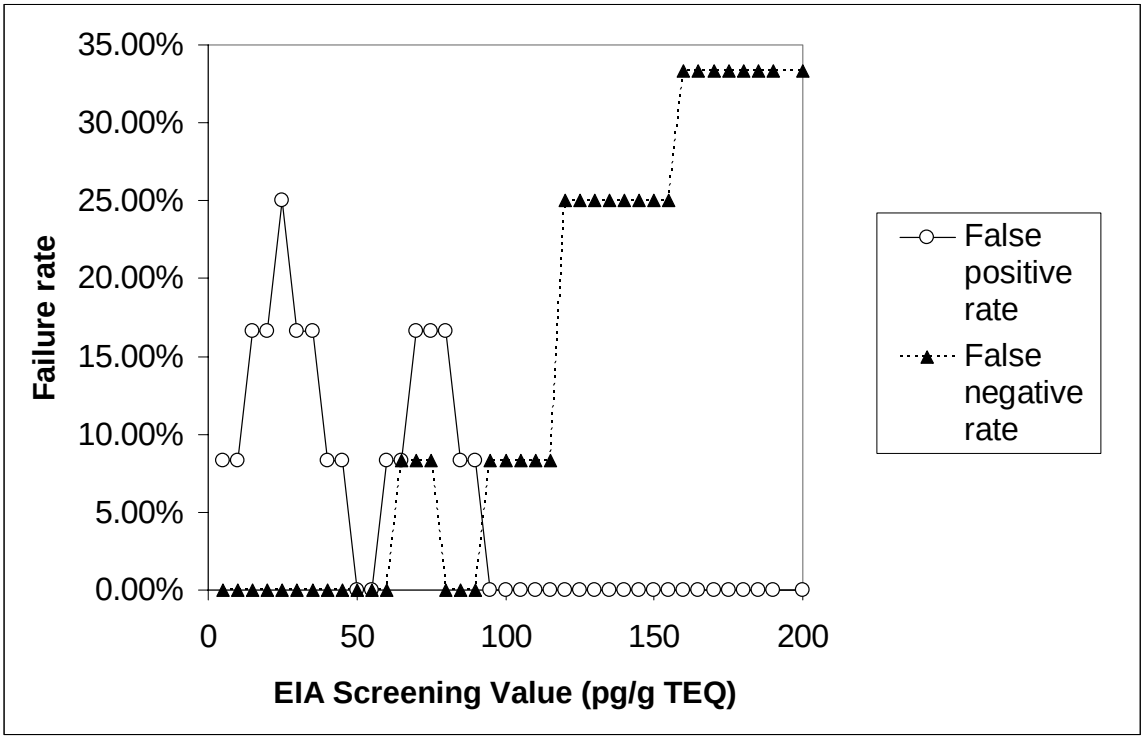

Figure 4. Evaluation of EIA for Identifying Field Concentrations below a Screening Value. False positive and false negative rates calculated from Table 4.

False positive: EIA measurement ≥ Screening Value, and HRGC/HRMS measurement < Screening Value.

False negative: EIA measurement < Screening Value, and HRGC/HRMS measurement ≥ Screening Value.

Spatial Extent of Dioxin Contamination

Within the study area, Dillenbaugh Creek can be broadly divided into two segments, based on results from the EIA analyses. The demarcation uses the confluence of the stormwater lagoon channel and the creek, between stations S11 and S12, to divide the creek into "downstream" and "upstream" segments (Figure 5).

Downstream Segment

The downstream segment is characterized by higher dioxin concentrations than found upstream, ranging from 60-200 pg/g TEQ by EIA analyses (48-790 pg/g by HRGC/HRMS).

There are two uncertainties regarding characterization of the downstream segment:

1. Contaminated sediment may have accumulated in ponded areas of the downstream segment that have not been adequately sampled. A large pond lies behind a beaver dam in wetlands downstream of S22 (Appendix Figure F-1). The pond may trap suspended solids being transported downstream but has only been sampled at one station, immediately behind the beaver dam (S24). Another, smaller ponded area is located downstream of the Chehalis Western Railroad Bridge (Appendix Figure F-2) and was sampled at one location (S15). Disturbance of the sediment at this location produced a sheen on the water and a petroleum odor similar to diesel oil; a sample from this station submitted for BNA analysis contained pentachlorophenol and PAHs (Appendix G).
2. The origin of sediments collected at many of the sampling stations is unclear, since much of the streambed has a scoured hard clay bottom. Pockets of sediment where samples were successfully retrieved with the Ponar grab may represent material that had been transported downstream and deposited in areas with low-velocity eddies. However, it is also possible that at least some sediment pockets recently originated as stream bank soil breaking loose and falling into the creek.

Upstream Segment

Data from both EIA and HRGC/HRMS methods are consistent in indicating lower dioxin concentrations in the transect segment upstream of the stormwater lagoon channel than the downstream segment. Upstream stations had dioxin concentrations ranging from 26-50 pg/g TEQ by EIA analyses (3.7-23 pg/g by HRGC/HRMS).

Despite the lower dioxin concentrations in the upstream segment, they may still be elevated relative to the surrounding area and risk-based levels. The highest of the three available HRGC/HRMS dioxin values in this segment (23 pg/g TEQ, at S3) exceeds concentrations reported by Era-Miller et al. (2002) from outside the area contaminated by the 1986 flood (0.8-8.2 pg/g TEQ), and also exceeds risk-based cleanup levels and guidelines (2-8.8 pg/g, Table 5).

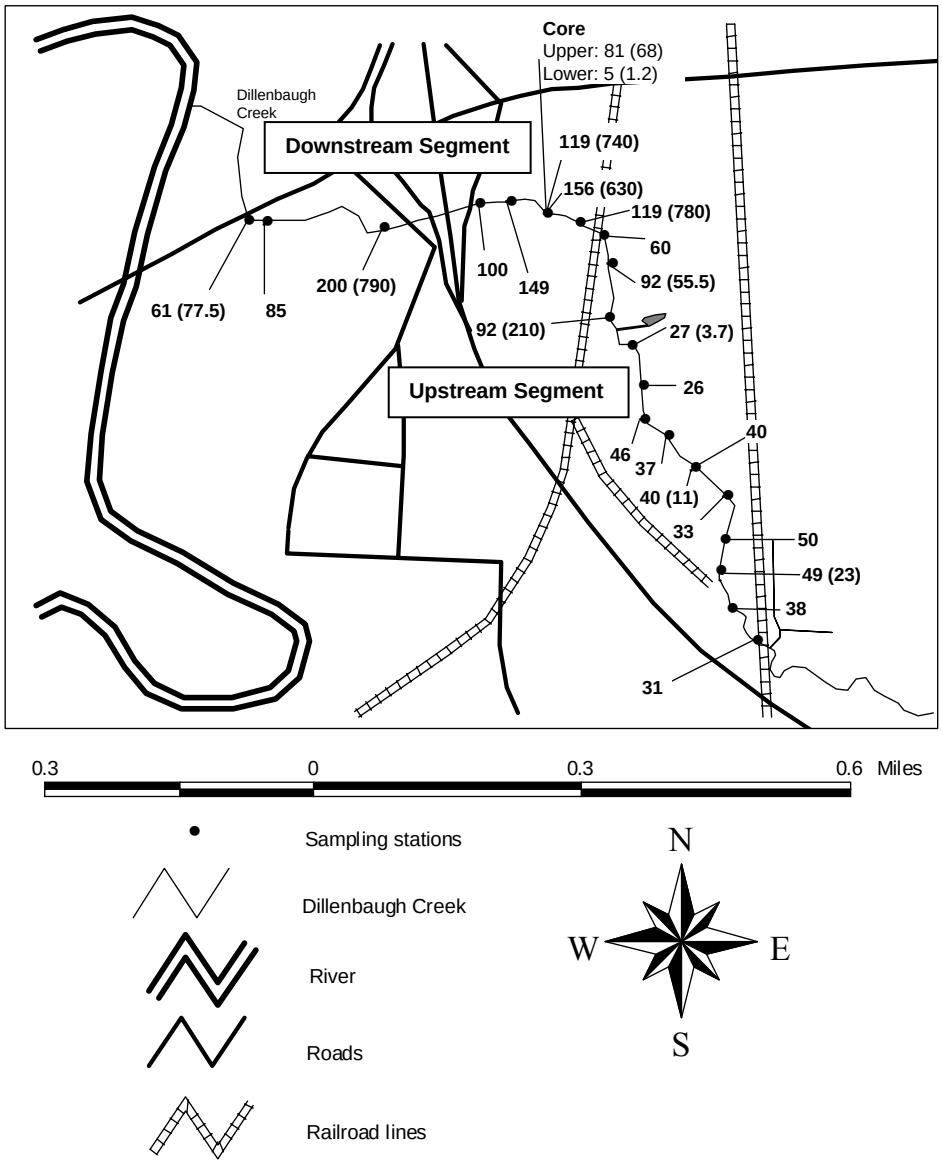

Figure 5. PCDD/PCDF TEQs (pg/g) in Dillenbaugh Creek Sediments from EIA Analysis. Values in Parentheses Show Results from HRGC/HRMS Analysis.

Vertical Extent of Dioxin Contamination

The streambed at S16 has only minor levels of PCDD/PCDF (1 pg/g TEQ) at a depth of 60-90 cm (24-35 in), based on data from core samples (Table 4). In the upper 0-30 cm (0-12 in), the concentration was 68 pg/g by HRGC/HRMS.

The concentration in the upper 0-30 cm is about an order of magnitude lower than found in Ponar grab samples from S16 (Table 4). This suggests that the vertical concentration profile attenuates within this depth range, so that the higher surface concentration is diluted by cleaner underlying material within this horizon.

Another possible factor may be differences in the material sampled with the two types of equipment. The coring samples were taken from firmer, clay substrate that may adsorb less PCDD/PCDFs than unconsolidated soft sediments that can be penetrated with the Ponar grab sampler.

Comparisons with Concentrations from Previous Studies and with Numerical Criteria

PCDD/PCDF concentrations from sampling stations in this study are comparable to data from previous investigations from the same vicinity in Dillenbaugh Creek (Table 5). The PCDD/PCDF levels reported in these studies have not been found in the Chehalis River downstream of the confluence with Dillenbaugh Creek, or from stations chosen as background locations in previous studies. These locations are in Dillenbaugh Creek over 0.5 mile upstream of the ACC site, and in the Chehalis River upstream of its confluence with Dillenbaugh Creek.

Although information on PCDD/PCDF levels from freshwater sediments in Washington State are not available, "typical" concentrations for soils are available (Yake et al., 2000). The PCDD/PCDF concentrations from this study are elevated relative to these soil concentrations and also relative to the risk-based numerical values (Table 5).

Table 5. Comparison of Sediment PCDD/PCDF Concentrations with Data from Previous Studies of Dillenbaugh Creek and Surrounding Area, Data for Washington State Soils, and Risk-based Numerical Criteria.

	TEQ (pg/g)		Reference
	Range	Mean	
Dillenbaugh Creek Sediments			
This study (HRGC/HRMS data only)	3.7-790	308	
1998 Study	11.8-1156	390.6	Era-Miller et al., 2002
1991 Remedial Investigation	1.1-319	80.1	Weston, 1992
1986 Study	593	--	Yake, 1987
Dillenbaugh Creek Vicinity Sediments			
Chehalis River below Dillenbaugh Creek confluence:			
1998 Study	2.1-6.9	4.5	Era-Miller et al., 2002
Upstream Dillenbaugh Creek "background" stations:			
1998 Study	8.2	--	Era-Miller et al., 2002
1991 Investigation	<0.1-1.7	--	Weston, 1992
Chehalis River "background" stations:			
1998 Study	0.8	--	Era-Miller et al., 2002

	TEQ (pg/g)		Reference
	Range	Mean	
Washington State Soils (by land use)			
Urban	0.13-19	4.1	Yake et al., 2000
Forest	0.033-5.2	2.3	Yake et al., 2000
Open	0.040-4.6	1.0	Yake et al., 2000
Agriculture	0.0078-1.2	0.14	Yake et al., 2000

	TEQ (pg/g)	Reference
Numerical criteria		
Method B soil cleanup standard	6.67	Chapter 173-340 WAC
Wildlife protection soil screening value	2	Chapter 173-340 WAC
Proposed freshwater sediment AET	8.8	Cubbage et al., 1997
EPA sediment quality guideline for mammalian wildlife protection	2.5	Cook et al., 1993

Conclusions

Results of this study show that sediments in Dillenbaugh Creek are contaminated with PCDD/PCDF concentrations up to 790 pg/g TEQ for at least 0.5 mile downstream of the former ACC stormwater lagoon. These findings confirm and extend results from a screening-level study conducted in 1998, which showed concentrations up to 1,156 ug/g TEQ in this same segment of the creek (Era-Miller et al., 2002).

Within this stream segment, ponded areas may serve as sinks for contaminated sediments being transported downstream. However, additional sediment sampling is needed to evaluate sediment contamination in these areas.

This study did not attempt to identify the source of PCDD/PCDF contaminated sediments in this segment. Sediments in the stormwater lagoon and the channel from the lagoon to Dillenbaugh Creek are potential sources. However, it is also possible that residual contamination in eroding streambanks and in riparian soils along the creek may be a source.

In the creek segment upstream of the stormwater lagoon, PCDD/PCDF concentrations in sediments are lower, consistent with findings from the 1998 screening study (Era-Miller et al., 2002). However, in some locations they exceed concentrations in sediments from the surrounding area as well as risk-based concentrations.

The EIA method used to analyze sediments in this study was effective in identifying spatial patterns of PCDD/PCDF contamination. This method may also be appropriate as a semiquantitative screening tool where order of magnitude differences in PCDD/PCDF concentrations are of interest.

Recommendations

Additional soil and sediment sampling in the following areas would provide a better understanding of PCDD/PCDF contamination in the creek segment downstream of the stormwater lagoon:

- Ponded sections of the creek, particularly the area illustrated in Appendix F, Figure F-1, east of State Highway 6. Further investigation of these areas would help clarify the extent of contamination.
- Potential sources of contaminated creek sediments. These include bank and riparian soils along the creek segment, the former American Crossarm and Conduit Company stormwater lagoon, and the connecting channel to Dillenbaugh Creek.

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Appendices

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Appendix A. Sampling Station Location Information

Table A-1. Sampling Station Location Information.

Station ID	Station Name	Lab ID	Sediment Sample Location Description	Decimal Degrees	
				Latitude	Longitude
S1	DC-09	4188108	At BNSF RR bridge	46.65240	122.96920
S2	DC-10	4188109	250 ft downstream of DC-09	46.65292	122.96982
S3	DC-11	4188110	250 ft downstream of DC-10	46.65352	122.97012
S4	DC-12	4188111	250 ft downstream of DC-11	46.65402	122.97003
S5	DC-13	4188112	250 ft downstream of DC-12	46.65473	122.97000
S6	DC-14	4188113	250 ft downstream of DC-13	46.65517	122.97078
S6D	DC-15	4188114	Field duplicate of DC-14		
S8	DC-16	4188115	220 ft downstream of DC-14	46.65567	122.97142
S9	DC-17	4188116	200 ft downstream of DC-16	46.65592	122.97202
S10	DC-18	4188117	200 ft downstream of DC-17	46.65647	122.97207
S11	DC-19	4188118	200 ft downstream of DC-18	46.65710	122.97237
S12	DC-20	4188119	250 ft downstream of DC-19	46.65755	122.97292
S13	DC-21	4188120	270 ft downstream of DC-20	46.65842	122.97287
S14	DC-08	4188107	54 ft upstream of old Western Chehalis RR bridge	46.65887	122.97310
S15	DC-07	4188106	96 ft downstream of old Western Chehalis RR bridge	46.65905	122.97367
S16	DC-03	4188102	200 ft upstream of DC-02	46.65920	122.97445
S16D	DC-04	4188103	Field duplicate of DC-03		
S18	DC-05	4188104	Upper sections of core samples at DC-03		
S19	DC-06	4188105	Lower sections of core samples at DC-03		
S20	DC-02	4188101	200 ft upstream of DC-01	46.65937	122.97530
S21	DC-01	4188100	Northbound I-5 Exit 77 offramp bridge	46.65932	122.97605
S22	DC-22	4188121	SW Riverside bridge	46.65890	122.97827
S23	DC-23	4188122	Highway 6 bridge	46.65893	122.98145
S24	DC-24	4188123	Upstream side of beaver dam between Highway 6 bridge and SW Riverside bridge	46.65893	122.98103

Horizontal Reference Datum: NAD27

Appendix B. Enzyme Linked Immunosorbent Assay (EIA) Method

EIA is an EPA-approved method (EPA Method 4025) based on the use of polyclonal antibodies to 2,3,7,8-tetrachloro-dibenzo-p-dioxin and other PCDD/PCDF congeners. The method is described schematically in Figure B-1.

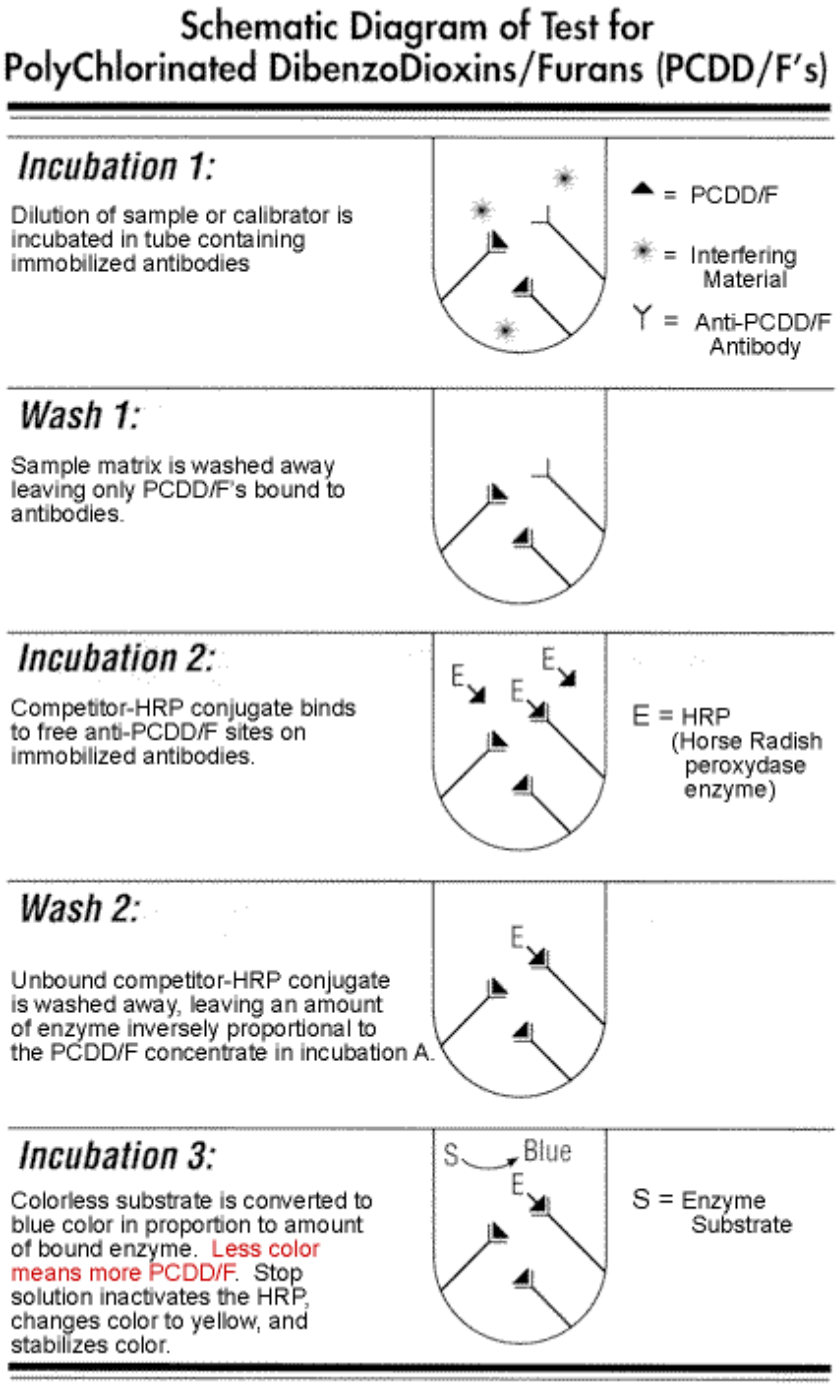
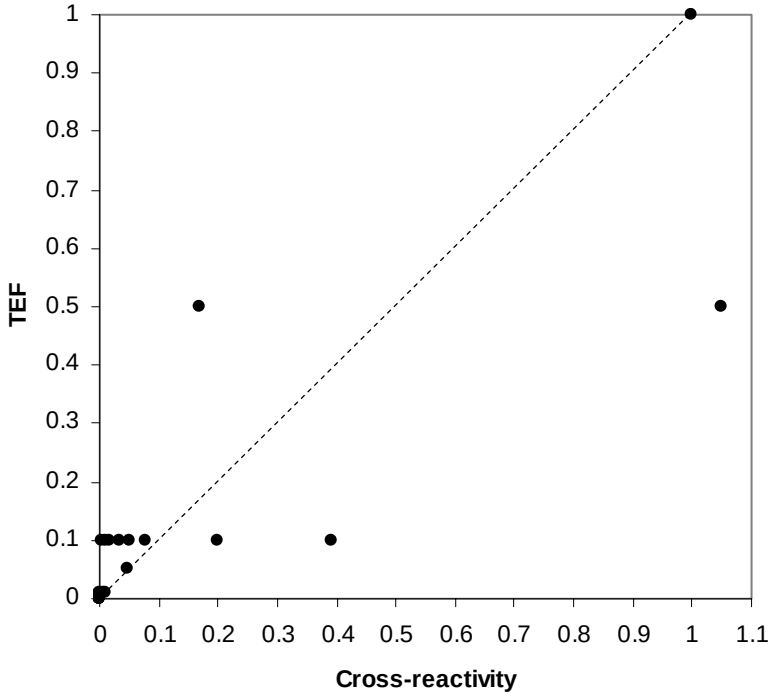


Figure B-1. Enzyme Linked Immunosorbent Assay Method (CAPE Technologies, 2005)

As a method for measuring dioxin TEQs, the antibody cross-reactivity for PCDD/PCDF congeners should be directly proportional to the congener TEF. This is approximately the case although for some congeners there is a marked discrepancy (Figure B-2).

Because cross-reactivities and TEFs do not match exactly, the TEQ measured for a dioxin-contaminated sample with this method can be biased high or low, depending on the congener composition. For example, the measured TEQ would be an overestimate for a sample of pure 1,2,3,7,8-PeCDD because its cross-reactivity is even higher than for 2,3,7,8-TCDD although the TEF is 0.5. For a pure sample of 2,3,4,7,8-PeCDF, the measured TEQ would be an underestimate. There is no bias for 2,3,7,8-TCDD, where the cross-reactivity and TEF are both defined as 1.0.

Congener	Cross-reactivity[a]	TEF[b]
2,3,7,8-TCDD	1	1
1,2,3,7,8-PeCDD	1.05	0.5
1,2,3,4,7,8-HxCDD	0.016	0.1
1,2,3,6,7,8-HxCDD	0.079	0.1
1,2,3,7,8,9-HxCDD	0.39	0.1
1,2,3,4,6,7,8-HpCDD	0.007	0.01
OCDD	0.00001	0.001
2,3,7,8-TCDF	0.2	0.1
1,2,3,7,8-PeCDF	0.046	0.05
2,3,4,7,8-PeCDF	0.17	0.5
1,2,3,4,7,8-HxCDF	0.004	0.1
1,2,3,6,7,8-HxCDF	0.01	0.1
1,2,3,7,8,9-HxCDF	0.033	0.1
2,3,4,6,7,8-HxCDF	0.049	0.1
1,2,3,4,6,7,8-HpCDF	0.0002	0.01
1,2,3,4,7,8,9-HpCDF	0.009	0.01
OCDF	0.00001	0.001
1,2,3,4-TCDD	0.00001	0
1,2,3,4-TCDF	0.00001	0
1,3,6,8-TCDD	0.0005	0
1,3,6,8-TCDF	0.00007	0



[a] Affinity of the EIA antibody for PCDD/F congeners. Normalized to 1.00 for 2378-TCDD. Source: CAPE Technologies (2003).

[b] NATO/CCMS I-TEF/88 values. Normalized to 1.00 for 2378-TCDD. Source: EPA (1989).

Figure B-2. Tabled and graphical comparisons of EIA antibody cross-reactivity and Toxic Equivalency Factors (TEFs) for PCDD/PCDF congeners. In an ideal EIA system for measuring TEQ concentrations, cross-reactivity and TEFs would be numerically equal (indicated by the dashed line). Only those congeners for which cross-reactivities have been reported are shown in Figure B-2. A complete list of TEFs and congener abbreviations are provided in Table B-1.

Table B-1. Abbreviations and 2,3,7,8-TCDD Toxic Equivalency Factors (TEFs) for the Polychlorinated Dibenzo-p-dioxins and Dibenzofurans.

Compound	Abbreviation	TEF*
Dibenzofuran, 1,2,3,4,6,7,8-heptachloro-	1234678-HpCDF	0.01
Dibenzofuran, 1,2,3,4,7,8,9-heptachloro-	1234789-HpCDF	0.01
Dibenzofuran, 1,2,3,4,7,8-hexachloro-	123478-HxCDF	0.1
Dibenzofuran, 1,2,3,6,7,8-hexachloro-	123678-HxCDF	0.1
Dibenzofuran, 1,2,3,7,8,9-hexachloro-	123789-HxCDF	0.1
Dibenzofuran, 1,2,3,7,8-pentachloro-	12378-PeCDF	0.05
Dibenzofuran, 2,3,4,6,7,8-hexachloro-	234678-HxCDF	0.1
Dibenzofuran, 2,3,4,7,8-pentachloro-	23478-PeCDF	0.5
Dibenzofuran, 2,3,7,8-tetrachloro-	2378-TCDF	0.1
Dibenzofuran, heptachloro-, total	TOTAL HpCDF	0.0
Dibenzofuran, hexachloro-, total	TOTAL HxCDF	0.0
Dibenzofuran, octachloro-	OCDF	0.001
Dibenzofuran, pentachloro-, total	TOTAL PeCDF	0.0
Dibenzofuran, tetrachloro-, total	TOTAL TCDF	0.0
Dibenzo-p-dioxin, 1,2,3,4,6,7,8-heptachloro-	1234678-HpCDD	0.01
Dibenzo-p-dioxin, 1,2,3,4,7,8-hexachloro-	123478-HxCDD	0.1
Dibenzo-p-dioxin, 1,2,3,6,7,8-hexachloro-	123678-HxCDD	0.1
Dibenzo-p-dioxin, 1,2,3,7,8,9-hexachloro-	123789-HxCDD	0.1
Dibenzo-p-dioxin, 1,2,3,7,8-pentachloro-	12378-PeCDD	0.5
Dibenzo-p-dioxin, 2,3,7,8-tetrachloro-	2378-TCDD	1
Dibenzo-p-dioxin, heptachloro-, total	TOTAL HpCDD	0.0
Dibenzo-p-dioxin, hexachloro-, total	TOTAL HxCDD	0.0
Dibenzo-p-dioxin, octachloro-	OCDD	0.001
Dibenzo-p-dioxin, tetrachloro-, total	TOTAL TCDD	0.0
Dibenzo-p-dioxin, pentachloro-, total	TOTAL PeCDD	0.0

*NATO/CCMS I-TEF/88 values (EPA, 1989).

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Appendix C. Case Narratives

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard, Washington 98366

June 8, 2004

Project: Dillenbaugh Creek

Samples: 18-8100-03, 8106-23

Laboratory: Analytical Resources, Inc.

By: Pam Covey

Case Summary

These twenty-two sediment samples required Grain Size analyses using Puget Sound Estuary Protocol (PSEP) method. The samples were received at the Manchester Environmental Laboratory and shipped to the contract lab on May 5, 2004 for Grain Size analyses.

The samples were analyzed in two batches. Batch one did not use a sample from the project for the triplicate analysis, but one was used in batch two. Both sets of triplicate analysis compared favorably. See memo from ARI for anomalies that were encountered during analysis.

The analyses were reviewed for qualitative and quantitative accuracy, validity and usefulness.

The results are acceptable for use as reported.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard, Washington 98366

May 12, 2004

Subject: General Chemistry Dillenbaugh Creek - 18

Project No: 132404

Officer: Nigel Blakely

By: Dean Momohara

Summary

The data generated by the analysis of these samples can be used without qualification. The samples were analyzed by the following methods: Standard Methods 2540G for % solids and PSEP-TOC for total organic carbon (TOC).

All analyses requested were evaluated by established regulatory quality assurance guidelines.

Sample Information

Samples were received by Manchester Environmental Laboratory on 4/30/04. All coolers were received within the proper temperature range of 0°C - 6°C. All samples were received in good condition. Twenty two (22) samples were received and assigned laboratory identification numbers 188000 – 188003 and 18806 - 188023.

Holding Times

All analyses were performed within established EPA holding times.

Calibration

Instrument calibrations and calibration checks were performed in accordance with the appropriate method. All initial and continuing calibration checks were within control limits. The calibration correlation coefficient was within the acceptance range of 1.000 - 0.995. Balances are professionally calibrated yearly and calibrated in-house daily.
Oven and temperatures were recorded before and after each analysis batch and were within acceptable limits.

Method Blanks

No analytically significant levels of analyte were detected in the method blanks associated with these samples.

Matrix Spikes

NA

Replicates

All duplicate relative percent differences were within the acceptance range of 0% - 20%.

Laboratory Control Samples

All laboratory control sample recoveries were within the acceptance limits of 80% - 120%.

Other Quality Assurance Measures and Issues

U - The analyte was not detected at or above the reported result.

bold - The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Please call Dean Momohara at (360) 871-8808 to further discuss this project.

cc: Project File

Data Qualifier Codes

U	-	The analyte was not detected at or above the reported result.
J	-	The analyte was positively identified. The associated numerical result is an estimate.
UJ	-	The analyte was not detected at or above the reported estimated result.
REJ	-	The data are unusable for all purposes.
NAF	-	Not analyzed for.
N	-	For organic analytes there is evidence the analyte is present in this sample.
NJ	-	There is evidence that the analyte is present. The associated numerical result is an estimate.
NC	-	Not Calculated
E	-	The concentration exceeds the known calibration range.
bold	-	The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard, Washington 98366

June 22, 2004

Subject:	Dillenbaugh
Samples:	04-188100 through 188123
Project ID:	1324-04
Laboratory:	Cape Technologies
Project Officer:	Nigel Blakley
By:	Karin Feddersen

Dioxin by Immunoassay

Summary

The amount of analyte in each tube is calculated based on its EIA response. The amount of extract used and the concentration of sample in the extract (g soil equivalent [SE]) are then factored in to convert from pg/tube to pg/g (pg/tube ÷ g SE/tube = pg/g). This concentration has then been multiplied by a calibration adjustment factor ("CAF") to give a theoretical concentration based on the recoveries of the NIST SRM 1944. The CAF is the multiplier determined to adjust the mean (n=6) pg/g value for SRM 1944 to the NIST stated value of 248 pg/g TEQ. Both values are provided for each sample on the final "data summary" sheet.

Analytical Methods

These samples were analyzed using EPA Method 4025. Routine QA/QC procedures were performed.

Blanks

The method blanks have demonstrated that the analytical system is free of contamination.

Holding Times

All samples were analyzed within 28 days from collection.

Duplicate Samples

Duplicate analyses were performed on samples # 5 (188104), 11 (188110), 19 (188118), 21 (188120), 22 (188121), and 24 (188123). The Relative Percent Differences (RPD) between the corresponding results are, respectively, 47%, 7.2%, 3.7%, 7.6%, 2.9%, and 9.7%.

Matrix Spikes

Matrix spikes were performed on aliquots of the samples: #1, 5% (25%); 5, 10% (53%); 11, 3% (13%); 19, 6% (28%); 21, 6% (32%); and 24, 13% (65%). (Values in parentheses are based on the corrected results.)

Laboratory Control Sample

A blank fortified with several of the compounds of interest was analyzed as an LCS. Recoveries were 8% for batch 1, 12% for batch 2, and 9% for batch 3. (Results corrected for the SRM gave recoveries of 38%, 61%, and 46%, respectively.)

Data Qualifier Codes

U	-	The analyte was not detected at or above the reporting limit.
J	-	The analyte was positively identified. The associated numerical result is an estimate.
UJ	-	The analyte was not detected at or above the reported estimated reporting limit.
REJ	-	The data are unusable for all purposes.
NAF	-	Not analyzed for.
N	-	For organic analytes there is evidence the analyte is present in this sample.
NJ	-	There is evidence that the analyte is present. The associated numerical result is an estimate.
NC	-	Not Calculated
E	-	This qualifier is used when the concentration of the associated value exceeds the known calibration range.
bold	-	The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard, Washington 98366

August 23, 2004

Subject:	Dillenbaugh
Samples:	04-188102 through 188106, 188110, 188113, 188118 through 188121, 188123
Project ID:	1324-04
Laboratory:	Pace Analytical
Project Officer:	Nigel Blakley
By:	Karin Feddersen

Data Review for Polychlorodibenzo-p-dioxin and furan

(2,3,7,8 substituted tetra through octa PCDD/PCDF)

Samples were prepared and analyzed according to EPA method 1613. Data from these analyses were qualitatively and quantitatively reviewed and evaluated for precision and bias following the National Functional Guidelines for Organic Data Review adapted for high-resolution dioxin analysis and using the EPA Region 10 SOP for the Validation of PCDD/PCDF.

Results have been reported in nanograms per Kilogram (ng/Kg); parts per trillion dry weight.

There is a number reported for each analyte that appears in one or two columns. If the number appears in the column labeled "Conc" or "EMPC"; then this analyte has been detected at the reported concentration. Results found in the EMPC column have been tentatively identified and quantified.

The number in the column labeled "LOD" is the estimated detection limit and is based on the signal-to-noise ratio in each sample. Three short dashes appear in the "Conc" column whenever an analyte is not detected. In order to be consistent with Manchester Environmental Laboratory's reporting convention, a result reported as not detected with an associated number in LOD column, e.g.: 3.9, should be considered synonymous with 3.9 U, where "U" is a qualifier.

A number of congeners were qualified with a "J" because the concentration detected was below the lowest calibration standard; results derived from responses outside the calibration range are considered estimates.

Holding times

EPA method 1613 states: "if stored in the dark at <-10°C, solid, semi-solid, multi-phase, and tissue samples may be stored for up to one year." Samples were frozen and extracted and analyzed within the one-year holding time.

Method Blank

A few target analytes were detected in the method blank. Where these analytes were also detected in the samples at a concentration less than 10 times that in the blank, a "B" flag has been recorded on the report. Five times the blank contamination in the sample is EPA's standard convention for determining whether contaminants detected in the blank are native to the sample. (Pace states they are being conservative by using ten times.)

To be consistent with Manchester's reporting protocols; where the sample concentration was less than five times the blank concentration, the B has been replaced with a "UJ". The "B" flag has been removed from sample results that are greater than five times the blank concentration.

Calibration

The calibration standards were within 20% relative standard deviations (RSD) for all target analytes and 30% for all the labeled reference compounds (Internal Standards), with a few exceptions. Since the corresponding sample internal standards and LCS were within limits, the outliers were deemed to not affect the results.

All the ion abundance ratios were within +/- 15% of the theoretical value.

Internal Standard Recoveries

Internal standard recoveries for each congener in these samples were within Pace's in-house control limits of 20%–135% with several exceptions.

Ion Abundance Ratios

Each dioxin and furan isomer reported as detected met the isotopic abundance ratio and retention time criteria for positive identification with several exceptions, which have been qualified "N"; or "NJ", if they were in the EMPC column.

Laboratory Control Sample (LCS)

Recoveries for all target analytes in the laboratory control samples were within quality control limits.

Duplicate Samples

Duplicate analyses were performed on samples 188105, 188120, and 188123.

Data Qualifier Codes

U- The analyte was not detected at or above the reporting limit.
J- The analyte was positively identified. The associated numerical result is an estimate.
UJ- The analyte was not detected at or above the reported estimated reporting limit.
NJ- There is evidence that the analyte is present. The associated numerical result is an estimate.

Manchester Environmental Laboratory

7411 Beach Dr E, Port Orchard, Washington 98366

July 6, 2004

Subject: Dillenbaugh Creek- 18

Sample(s): 04- 188106

Officer(s): Nigel Blakely

By: Dickey Huntamer

Semivolatiles

Analytical Method(s)

These samples were analyzed by SW846 Method 8270 using capillary GC and a mass spectrometer detector. Soils were prepared by Soxhlet extraction with acetone.

Holding Times

All samples extracts were analyzed within the method holding times.

Instrument Tuning

Calibration against DFTPP is acceptable for the initial calibration, continuing calibration and all associated sample analyses.

Calibration

The average relative response factors for target analytes were above the minimums and % Relative Standard Deviations were within the maximum of 20% except for benzoic acid 2,4 dinitrophenol and benzo(k)fluoranthene in the initial calibration. All results for these compounds were "J "qualified. No continuing calibration was run since these samples were analyzed the same day as the initial calibration.

Blanks

Low levels of phenol, benzoic acid, diethylphthalate, phenanthrene and di-n-butylphthalate were detected in at least one of the laboratory blanks. Four of these compounds, di-n-butylphthalate, diethylphthalate, phenol and benzoic acid were above the reporting limits. Any compound detected in the sample and in the blank was considered native to the sample if the area counts in the sample are greater than or equal to five times the area counts in the associated method blank.

Surrogates

The surrogate recoveries were reasonable, acceptable, and within QC limits of 25% to 121% for 2-fluorophenol, 245 to 113% for d5-phenol, 20% to 130% for d4-2-chlorophenol, 20% to 130% for d4-1,2-dichlorobenzene, 23% to 120% for d5-nitrobenzne, 30% to 115% for 2-fluorobiphenyl, 30% to 150% for d10-pyrene and 18% to 137% for d14-terpheny.

Matrix Spikes

No matrix spikes were analyzed with this sample.

Replicates

Not applicable

Laboratory Control Samples

One laboratory fortified blank (LFB) OCS4146A1 was analyzed with the sample. Three compounds 2, 4-dimethylphenol, 4-chloroaniline and benzidine had low recoveries, less than 50%. Since LFB recoveries are not necessarily indicative of behavior in the sample itself no additional qualifiers were added to the results.

Comments

The data are useable as qualified.

Data Qualifier Codes

U	-	The analyte was not detected at or above the reported result.
J	-	The analyte was positively identified. The associated numerical result is an estimate.
UJ	-	The analyte was not detected at or above the reported estimated result.
REJ	-	The data are unusable for all purposes.
NAF	-	Not analyzed for.
N	-	For organic analytes there is evidence the analyte is present in this sample.
NJ	-	There is evidence that the analyte is present. The associated numerical result is an estimate.
NC	-	Not Calculated
E	-	The concentration exceeds the known calibration range.
bold	-	The analyte was present in the sample. (Visual Aid to locate detected compounds on report sheet.)

Appendix D. Quality Assurance Analyses

Table D-1. Data Quality Assessment based on Analytical Goals from the Quality Assurance Project Plan.

Percent Solids Analyses.

Surrogate or Control Sample Recovery Limits Goal: 90-110%

Assessment: No data available for assessment.

Precision (RPD) Goal: 25%

Assessment: Data meet precision goal. Estimates of precision are available from field duplicates and laboratory triplicates. For the latter, RPD values were calculated for all possible pairwise combinations. The largest RPD value obtained was then compared with the goal value. RPD values from field duplicates and laboratory triplicates were less than 25% (Table D-2).

Required Reporting Limit: 1%

Assessment: Data values were reported to 0.1%

Total Organic Carbon Analyses.

Surrogate or Control Sample Recovery Limits Goal: 90-110%

Assessment: Case Narrative states, "All laboratory control sample recoveries were within the acceptance limits 80% - 120%" (Appendix C)

Precision (RPD) Goal: 10%

Assessment: Data meet precision goal. Estimates of precision are available from field duplicates and laboratory triplicates. For the latter, RPD values were calculated for all possible pairwise combinations. The largest RPD value obtained was then compared with the goal value. RPD values from field duplicates and laboratory triplicates were less than 10% (Table D-2).

Required Reporting Limit: 0.5%

Assessment: Data values were reported to 0.1%

Grain Size Analyses.

Surrogate or Control Sample Recovery Limits Goal: Not applicable

Precision (RPD) Goal: 20%

Assessment: In general, data meet precision goal. Estimates of precision are available from field duplicates and laboratory triplicates. For the latter, RPD values were calculated for all possible pairwise combinations. The largest RPD value obtained was then compared with the goal value. RPD values from field duplicates were less than 20% for all size fractions except clay, where the RPD was 58% in one pair of duplicates (Table D-2). RPD values for one set of laboratory triplicates exceed 20% for three of the four size classes. The Case Narrative attributes high relative percent standard deviations for this set to the low quantity of fines (Appendix C). There were no exceedances for the other set.

Required Reporting Limit: ±1% per size fraction

Assessment: Data values were reported to 0.1% for each size fraction.

EIA Analyses.

Surrogate or Control Sample Recovery Limits Goal: Not applicable

Precision (RPD) Goal: 40%

Assessment: The Case Narrative indicates that RPD values from analyses of laboratory duplicates met this goal with one exception. The values from analyses of six sets of duplicates are 47%, 7.2%, 3.7%, 7.6%, 2.9% and 9.7% (Appendix C). For field duplicates, RPD values were 27% (Station DC03) and 0% (Station DC14).

Required Reporting Limit: 10 pg/g, total TEQ

Assessment: The lowest reported value was 5 pg/g.

HRGC/HRMS Analyses.

Surrogate or Control Sample Recovery Limits Goal: Per Table 7, Method 1613b

Assessment: "The recoveries of the isotopically-labeled PCDD/PCDF internal standards in the sample extracts ranged from 23-113%. With the exception of one low internal standard value in sample 188123 (Duplicate), which was flagged "P" on the results table, the labeled standard recoveries obtained for the samples were within the target ranges specified in Method 1613B." (Analytical laboratory report.)

Precision (RPD) Goal: 30%

Assessment: RPD values are available from laboratory duplicates for three samples. For individual congeners, or classes of congeners, many of the RPD values exceeded 40% (Table D-3). However, since the focus of this study is on toxicity-weighted concentrations, it is more relevant to evaluate RPD values for TEQs (35%, 35% and 27%). Since 2/3 of these estimates exceeded 30%, the goal for precision was not met.

Required Reporting Limit: 1 pg/g, total TEQ

Assessment: Not evaluated, although the limit of detection for 2,3,7,8-TCDD was less than 1 pg/g.

Table D-2. Precision Estimates for Conventionals from Laboratory and Field Replicate Data.

Analyte	Laboratory triplicates				Field duplicates		
	Lab ID	%	RSD	Max. RPD*	Lab ID	%	RPD
Percent solids	4188113	31.1			4188102	23.2	
		32.5			4188103	24.7	6.3
		34.3	4.9	9.8			
	4188119	54.9					
		54.8					
		54.9	0.1	0.2			
TOC	4188113	3.49			4188102	5.40	
		3.56			4188103	5.17	4.4
		3.64	2.1	4.2			
	4188119	1.38					
		1.42					
		1.43	1.9	3.6			
Grain size	Lab standard†				4188102, 4188103		
	Gravel	0			Gravel	15.9	
		0				18.1	12.9
		0	0	0	Sand	53.5	
	Sand	50.8				49.7	7.4
		49.3			Silt	21.4	
		48.8	2.1	4.0		23.5	9.4
	Silt	44.7			Clay	9.3	
		45.7				8.8	5.5
		46.2	1.7	3.3			
	Clay	4.6					
		5.1					
		5.1	5.9	10.3			
	4188115				4188113, 4188114		
	Gravel	12.6			Gravel	22.0	
		14.1				18.8	15.7
		17.6	17.4	33.1	Sand	25.8	
	Sand	45.0				25.3	2.0
		34.5			Silt	50.1	
		34.9	15.6	26.4		51.9	3.5
	Silt	42.3			Clay	2.2	
		49.5				4.0	58.1
		47.5	8.0	15.7			
	Clay	0					
		1.8					
		0	173.2	200.0			

* Largest of the RPD values calculated for all possible pairwise combinations.
† An unidentified laboratory sample was analyzed in triplicate.
RSD Relative Standard Deviation = 100(standard deviation/mean)
RPD Relative Percent Difference = The difference between two values divided by their mean and multiplied by 100.

Table D-3. HRGC/HRMS Precision Estimates from Laboratory Duplicates.

Compound	Laboratory Sample ID 188105			Laboratory Sample ID 188120			Laboratory Sample ID 188123		
	Sample concentration (pg/g)		RPD (%)	Sample concentration (pg/g)		RPD (%)	Sample concentration (pg/g)		RPD (%)
2378-TCDF	0.110	ND	NA	1.20	0.66	58.1	0.83	1.00	18.6
TOTAL TCDF	0.480	0.90	60.9	7.60	4.40	53.3	12.00	11.00	8.7
2378-TCDD	ND	ND	NA	0.24	ND	NA	0.44	0.55	22.2
TOTAL TCDD	ND	0.25	NA	4.70	3.00	44.2	9.60	14.00	37.3
12378-PeCDF	0.089	ND	NA	5.70	ND	NA	2.20	ND	NA
23478-PeCDF	0.260	ND	NA	7.90	6.30	22.5	6.30	5.80	8.3
TOTAL PeCDF	2.100	0.76	93.7	94.00	64.00	38.0	93.00	130.00	33.2
12378-PeCDD	0.210	ND	NA	5.90	4.40	29.1	4.20	6.40	41.5
TOTAL PeCDD	0.570	ND	NA	23.00	18.00	24.4	35.00	54.00	42.7
123478-HxCDF	0.500	0.63	23.0	23.00	16.00	35.9	23.00	30.00	26.4
123678-HxCDF	0.220	ND	NA	10.00	6.10	48.4	8.60	11.00	24.5
234678-HxCDF	0.240	0.29	18.9	5.40	7.80	36.4	ND	17.00	NA
123789-HxCDF	0.250	ND	NA	11.00	8.50	25.6	7.70	13.00	51.2
TOTAL HxCDF	10.000	15.00	40.0	340.00	480.00	34.1	440.00	1100.00	85.7
123478-HxCDD	0.310	ND	NA	16.00	24.00	40.0	15.00	24.00	46.2
123678-HxCDD	1.900	1.40	30.3	110.00	78.00	34.0	92.00	140.00	41.4
123789-HxCDD	0.840	0.49	52.6	32.00	23.00	32.7	26.00	36.00	32.3
TOTAL HxCDD	8.100	5.00	47.3	340.00	240.00	34.5	340.00	440.00	25.6
1234678-HpCDF	5.600	9.40	50.7	250.00	170.00	38.1	400.00	470.00	16.1
1234789-HpCDF	0.460	0.84	58.5	20.00	14.00	35.3	28.00	36.00	25.0
TOTAL HpCDF	24.000	62.00	88.4	780.00	640.00	19.7	1800.00	2500.00	32.6
1234678-HpCDD	37.000	33.00	11.4	2000.00	1500.00	28.6	2100.00	2900.00	32.0
TOTAL HpCDD	62.000	51.00	19.5	3200.00	1800.0	56.0	3300.00	3900.00	16.7
OCDF	21.000	56.00	90.9	560.00	330.00	51.7	2100.00	2100.00	0.0
OCDD	230.00	210.00	9.1	12000.00	8500.00	34.1	14000.00	21000.00	40.0
TEQ	1.4	0.98	35	63	48	27	64	91	35

See Appendix Table B-1 for abbreviations.

Appendix E. HRGC/HRMS Results

Table E-1. PCDD/PCDF Congener Concentrations (pg/g) from HRGC/HRMS Analysis of Sediment Samples.

Congener*	Laboratory ID													
	188102		188103		188104	188105		188105 Dup		188106	188110		188113	
2378-TCDF	9.5		13		1	0.11	UJ	0.19	U	11	7.5		2.1	
TOTAL TCDF	68		84		10	0.48	UJ	0.9		85	29		14	
2378-TCDD	2.6		3.3		0.33	0.077	U	0.2	U	2.5	0.75		0.39	
TOTAL TCDD	26		33		4	0.077	U	0.25		29	4.9		3.3	
12378-PeCDF	280	NJ	210	NJ	2.6	0.089		0.4	U	25	3.1		4.6	NJ
23478-PeCDF	58		63		8.2	0.26	UJ	0.13	U	94	4.5		1.1	
TOTAL PeCDF	720		870		91	2.1		0.76		710	44		24	
12378-PeCDD	51		62		4.8	0.21		0.21	U	42	2		1.2	
TOTAL PeCDD	200		250		21	0.57		0.21	U	190	11		9.2	
123478-HxCDF	240		290		23	0.5		0.63		270	4		2.3	
123678-HxCDF	84		100		9.4	0.22		0.22	U	99	2.3		1.5	
234678-HxCDF	90		110		5.4	0.24		0.29		77	2.2		1.2	
123789-HxCDF	120	NJ	89	NJ	10	0.25		0.28	U	89	2	NJ	1	
TOTAL HxCDF	5300		1900		600	10		15		1900	100		33	
123478-HxCDD	170		180		14	0.31		0.2	U	150	3.4		2.6	
123678-HxCDD	1000		1200		100	1.9		1.4		1100	17		9.1	
123789-HxCDD	280		350		29	0.84		0.49		280	6.7		5.1	
TOTAL HxCDD	3400		4100		340	8.1		5		3800	230		94	
1234678-HpCDF	3200		4000		350	5.6		9.4		5100	57		39	
1234789-HpCDF	250		280		25	0.46		0.84		420	4.1		2.5	
TOTAL HpCDF	14000		15000		1700	24		62		23000	230		140	
1234678-HpCDD	21000		25000		2200	37		33		24000	730		320	
TOTAL HpCDD	34000		39000		3500	62		51		41000	3100		1200	
OCDF	12000		13000		1700	21		56		24000	230		140	
OCDD	130000		150000		14000	230		210		170000	6600		3300	

Table E-1 (cont.)

Congener*	Laboratory ID											
	188118		188119	188120	188120 Dup		188121	188123		188123 Dup		
2378-TCDF	0.68	UJ	4.4	1.2	0.66		11	0.83	UJ	1		
TOTAL TCDF	5.2		26	7.6	4.4		66	12		11		
2378-TCDD	0.17		0.71	0.24	0.2	U	3	0.44		0.55		
TOTAL TCDD	1.1		10	4.7	3		34	9.6		14		
12378-PeCDF	0.31		17	5.7	0.61	U	61	2.2		1.1	U	
23478-PeCDF	0.72		32	7.9	6.3		54	6.3		5.8		
TOTAL PeCDF	7.9		350	94	64		820	93		130		
12378-PeCDD	0.52		18	5.9	4.4		60	4.2		6.4		
TOTAL PeCDD	2.8		72	23	18		240	35		54		
123478-HxCDF	0.98		42	23	16		300	23		30		
123678-HxCDF	0.54		34	10	6.1		100	8.6		11		
234678-HxCDF	0.61		44	5.4	7.8		130	8.8	NJ	17		
123789-HxCDF	0.4		46	11	8.5		70	7.7		13		
TOTAL HxCDF	17		1900	340	480		6600	440		1100		
123478-HxCDD	0.89		61	16	24		170	15		24		
123678-HxCDD	3.8		430	110	78		1300	92		140		
123789-HxCDD	2.1		95	32	23		350	26		36		
TOTAL HxCDD	24		1300	340	240		4300	340		440		
1234678-HpCDF	13		680	250	170		4200	400		470		
1234789-HpCDF	0.87		56	20	14		310	28		36		
TOTAL HpCDF	36		2700	780	640		17000	1800		2500		
1234678-HpCDD	95		6900	2000	1500		27000	2100		2900		
TOTAL HpCDD	210		11000	3200	1800		42000	3300		3900		
OCDF	41		1100	560	330		14000	2100		2100		
OCDD	740		34000	12000	8500		160000	14000		21000		

Table E-1 (cont.)

Congener*	Standard Reference Material†		
	SRM 1944 (Measured)		SRM 1944 (Certificate)
2378-TCDF	31		39
TOTAL TCDF	640		700
2378-TCDD	100		133
TOTAL TCDD	230		250
12378-PeCDF	83	NJ	45
23478-PeCDF	51		45
TOTAL PeCDF	530		740
12378-PeCDD	21		19
TOTAL PeCDD	210		190
123478-HxCDF	140		220
123678-HxCDF	85		90
234678-HxCDF	41		54
123789-HxCDF	15		19
TOTAL HxCDF	970		1000
123478-HxCDD	23		26
123678-HxCDD	50		56
123789-HxCDD	34		53
TOTAL HxCDD	560		630
1234678-HpCDF	940		1000
1234789-HpCDF	36	NJ	40
TOTAL HpCDF	1200		1500
1234678-HpCDD	710		800
TOTAL HpCDD	1600		1800
OCDF	1300		1000
OCDD	5800		5800

* See Appendix Table B-1 for abbreviations

† National Institute of Standards and Technology Standard Reference Material 1944.
Certified analysis available at https://srmors.nist.gov/view_cert.cfm?srm=1944

Data Qualifier Codes:

U The analyte was not detected at or above the reporting limit.
J The analyte was positively identified. The associated numerical result is an estimate.
UJ The analyte was not detected at or above the reported estimated reporting limit.
N There is evidence that the analyte is present in this sample.
NJ There is evidence that the analyte is present. The associated numerical result is an estimate.

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Appendix F. Ponded Sections of Dillenbaugh Creek

Figure F-1. Dillenbaugh Creek between Stations S24 and S22. View from above a large beaver dam, looking upstream. Note area of open water upstream (arrow).

Figure F-2. Dillenbaugh Creek downstream of the Western Chehalis Railroad Bridge. Approximate location of Station S15 is indicated with an arrow.

Appendix G. BNA Analysis Results for Station S15

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Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID: 1324-04**

Sample: 04188106 **Date Collected:** 04/23/04 **Method:** SW8270
Field ID: DC07 **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil
Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** ug/Kg dw

Analyte	Result	Qualifier	Analyte	Result	Qualifier
N-Nitrosodimethylamine	130	U	2,4-Dinitrophenol	5050	UJ
Pyridine	630	U	4-Nitrophenol	630	U
Aniline	130	U	Dibenzofuran	63	U
Phenol	320	UJ	2,4-Dinitrotoluene	130	U
Bis(2-Chloroethyl)Ether	63	U	Diethylphthalate	130	U
2-Chlorophenol	63	U	**Fluorene**	**220**	
1,3-Dichlorobenzene	63	U	4-Chlorophenyl-Phenylether	63	U
1,4-Dichlorobenzene	63	U	4-Nitroaniline	630	U
1,2-Dichlorobenzene	63	U	4,6-Dinitro-2-Methylphenol	2520	U
Benzyl Alcohol	63	U	N-Nitrosodiphenylamine	130	U
2-Methylphenol	**35**	**J**	1,2-Diphenylhydrazine	130	U
2,2'-Oxybis[1-chloropropane]	63	U	4-Bromophenyl-Phenylether	63	U
N-Nitroso-Di-N-Propylamine	63	U	Hexachlorobenzene	63	U
4-Methylphenol	120	U	**Pentachlorophenol**	**1300**	
Hexachloroethane	130	U	**Phenanthrene**	**980**	
Nitrobenzene	63	U	**Anthracene**	**89**	
Isophorone	63	U	Caffeine	130	U
2-Nitrophenol	250	U	Carbazole	63	U
2,4-Dimethylphenol	130	U	Di-N-Butylphthalate	63	U
Bis(2-Chloroethoxy)Methane	63	U	**Fluoranthene**	**180**	
Benzoic Acid	**4780**	**J**	Benzidine	250	U
2,4-Dichlorophenol	130	U	**Pyrene**	**450**	
1,2,4-Trichlorobenzene	63	U	**Retene**	**290**	
Naphthalene	**56**	**J**	**Butylbenzylphthalate**	**87**	**NJ**
4-Chloroaniline	130	U	**Benzo(a)anthracene**	**100**	
Hexachlorobutadiene	63	U	3,3'-Dichlorobenzidine	630	U
4-Chloro-3-Methylphenol	130	U	**Chrysene**	**220**	
2-Methylnaphthalene	**820**		**Bis(2-Ethylhexyl) Phthalate**	**1260**	
1-Methylnaphthalene	**650**		Di-N-Octyl Phthalate	130	U
Hexachlorocyclopentadiene	630	U	**Benzo(b)fluoranthene**	**140**	**J**
2,4,6-Trichlorophenol	130	U	**Benzo(k)fluoranthene**	**140**	**J**
2,4,5-Trichlorophenol	130	U	**Benzo(a)pyrene**	**62**	**J**
2-Chloronaphthalene	63	U	**3B-Coprostanol**	**4950**	
2-Nitroaniline	130	U	Indeno(1,2,3-cd)pyrene	130	U
Dimethylphthalate	130	U	Dibenzo(a,h)anthracene	130	U
2,6-Dinitrotoluene	130	U	**Benzo(ghi)perylene**	**120**	**J**
Acenaphthylene	63	U			
3-Nitroaniline	130	U			
Acenaphthene	**150**				

Authorized By: _____ Release Date: _____

Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID:** 1324-04

Sample: 04188106 **Date Collected:** 04/23/04 **Method:** SW8270
Field ID: DC07 **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil
Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** ug/Kg dw

Analyte	Result	Qualifier
Surrogate Recoveries		
2-Fluorophenol	**100**	**%**
D5-Phenol	**101**	**%**
Terphenyl-D14	**101**	**%**
D4-2-Chlorophenol	**102**	**%**
Pyrene-D10	**103**	**%**
1,2-Dichlorobenzene-D4	**69**	**%**
D5-Nitrobenzene	**82**	**%**
2-Fluorobiphenyl	**96**	**%**

Authorized By: _____ Release Date: _____

Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID:** 1324-04

Lab ID: OBS4146A1 **Method:** SW8270

QC Type: BLNK **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil

Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** ug/Kg dw

Analyte	Result	Qualifier	Analyte	Result	Qualifier
N-Nitrosodimethylamine	130	U	2,4-Dinitrophenol	5050	UJ
Pyridine	630	U	4-Nitrophenol	630	U
Aniline	130	U	Dibenzofuran	63	U
Phenol	**120**		2,4-Dinitrotoluene	130	U
Bis(2-Chloroethyl)Ether	63	U	**Diethylphthalate**	**120**	**J**
2-Chlorophenol	63	U	Fluorene	63	U
1,3-Dichlorobenzene	63	U	4-Chlorophenyl-Phenylether	63	U
1,4-Dichlorobenzene	63	U	4-Nitroaniline	630	U
1,2-Dichlorobenzene	63	U	4,6-Dinitro-2-Methylphenol	2520	U
Benzyl Alcohol	63	U	N-Nitrosodiphenylamine	130	U
2-Methylphenol	63	U	1,2-Diphenylhydrazine	130	U
2,2'-Oxybis[1-chloropropane]	63	U	4-Bromophenyl-Phenylether	63	U
N-Nitroso-Di-N-Propylamine	63	U	Hexachlorobenzene	63	U
4-Methylphenol	63	U	Pentachlorophenol	630	U
Hexachloroethane	130	U	**Phenanthrene**	**10**	**J**
Nitrobenzene	63	U	Anthracene	63	U
Isophorone	63	U	Caffeine	130	U
2-Nitrophenol	250	U	Carbazole	63	U
2,4-Dimethylphenol	130	U	**Di-N-Butylphthalate**	**98**	
Bis(2-Chloroethoxy)Methane	63	U	Fluoranthene	63	U
Benzoic Acid	**3740**	**J**	Benzidine	250	U
2,4-Dichlorophenol	130	U	Pyrene	63	U
1,2,4-Trichlorobenzene	63	U	Retene	130	U
Naphthalene	63	U	Butylbenzylphthalate	63	U
4-Chloroaniline	130	U	Benzo(a)anthracene	63	U
Hexachlorobutadiene	63	U	3,3'-Dichlorobenzidine	630	U
4-Chloro-3-Methylphenol	130	U	Chrysene	63	U
2-Methylnaphthalene	63	U	Bis(2-Ethylhexyl) Phthalate	63	U
1-Methylnaphthalene	63	U	Di-N-Octyl Phthalate	130	U
Hexachlorocyclopentadiene	630	U	Benzo(b)fluoranthene	130	U
2,4,6-Trichlorophenol	130	U	Benzo(k)fluoranthene	130	UJ
2,4,5-Trichlorophenol	130	U	Benzo(a)pyrene	63	U
2-Chloronaphthalene	63	U	3B-Coprostanol	1260	U
2-Nitroaniline	130	U	Indeno(1,2,3-cd)pyrene	130	U
Dimethylphthalate	130	U	Dibenzo(a,h)anthracene	130	U
2,6-Dinitrotoluene	130	U	Benzo(ghi)perylene	130	U
Acenaphthylene	63	U			
3-Nitroaniline	130	U			
Acenaphthene	63	U			

Authorized By: _____ Release Date: _____

Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID:** 1324-04

Lab ID: OBS4146A1 **Method:** SW8270

QC Type: BLNK **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil

Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** ug/Kg dw

Analyte	Result	Qualifier

Surrogate Recoveries

2-Fluorophenol	**83**	**%**
D5-Phenol	**82**	**%**
D4-2-Chlorophenol	**86**	**%**
1,2-Dichlorobenzene-D4	**93**	**%**
D5-Nitrobenzene	**99**	**%**
2-Fluorobiphenyl	**96**	**%**
Pyrene-D10	**95**	**%**
Terphenyl-D14	**96**	**%**

Authorized By: _____ Release Date: _____

Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID:** 1324-04

Lab ID: OBS4146A2 **Method:** SW8270

QC Type: BLNK **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil

Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** ug/Kg dw

Analyte	Result	Qualifier	Analyte	Result	Qualifier
N-Nitrosodimethylamine	130	U	2,4-Dinitrophenol	5050	UJ
Pyridine	630	U	4-Nitrophenol	630	U
Aniline	130	U	Dibenzofuran	63	U
Phenol	**110**		2,4-Dinitrotoluene	130	U
Bis(2-Chloroethyl)Ether	63	U	Diethylphthalate	130	U
2-Chlorophenol	63	U	Fluorene	63	U
1,3-Dichlorobenzene	63	U	4-Chlorophenyl-Phenylether	63	U
1,4-Dichlorobenzene	63	U	4-Nitroaniline	630	U
1,2-Dichlorobenzene	63	U	4,6-Dinitro-2-Methylphenol	2520	U
Benzyl Alcohol	63	U	N-Nitrosodiphenylamine	130	U
2-Methylphenol	63	U	1,2-Diphenylhydrazine	130	U
2,2'-Oxybis[1-chloropropane]	63	U	4-Bromophenyl-Phenylether	63	U
N-Nitroso-Di-N-Propylamine	63	U	Hexachlorobenzene	63	U
4-Methylphenol	63	U	Pentachlorophenol	630	U
Hexachloroethane	130	U	Phenanthrene	11	U
Nitrobenzene	63	U	Anthracene	63	U
Isophorone	63	U	Caffeine	130	U
2-Nitrophenol	250	U	Carbazole	63	U
2,4-Dimethylphenol	130	U	**Di-N-Butylphthalate**	**160**	
Bis(2-Chloroethoxy)Methane	63	U	Fluoranthene	63	U
Benzoic Acid	5050	UJ	Benzidine	250	U
2,4-Dichlorophenol	130	U	Pyrene	63	U
1,2,4-Trichlorobenzene	63	U	Retene	130	U
Naphthalene	63	U	Butylbenzylphthalate	63	U
4-Chloroaniline	130	U	Benzo(a)anthracene	63	U
Hexachlorobutadiene	63	U	3,3'-Dichlorobenzidine	630	U
4-Chloro-3-Methylphenol	130	U	Chrysene	63	U
2-Methylnaphthalene	63	U	Bis(2-Ethylhexyl) Phthalate	63	U
1-Methylnaphthalene	63	U	Di-N-Octyl Phthalate	130	U
Hexachlorocyclopentadiene	630	U	Benzo(b)fluoranthene	130	U
2,4,6-Trichlorophenol	130	U	Benzo(k)fluoranthene	130	UJ
2,4,5-Trichlorophenol	130	U	Benzo(a)pyrene	63	U
2-Chloronaphthalene	63	U	3B-Coprostanol	1260	U
2-Nitroaniline	130	U	Indeno(1,2,3-cd)pyrene	130	U
Dimethylphthalate	130	U	Dibenzo(a,h)anthracene	130	U
2,6-Dinitrotoluene	130	U	Benzo(ghi)perylene	130	U
Acenaphthylene	63	U			
3-Nitroaniline	130	U			
Acenaphthene	63	U			

Authorized By: _____ Release Date: _____

Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID:** 1324-04

Lab ID: OBS4146A2 **Method:** SW8270

QC Type: BLNK **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil

Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** ug/Kg dw

Analyte	Result	Qualifier

Surrogate Recoveries

2-Fluorophenol	**88**	**%**
D5-Phenol	**80**	**%**
D4-2-Chlorophenol	**86**	**%**
1,2-Dichlorobenzene-D4	**94**	**%**
D5-Nitrobenzene	**99**	**%**
2-Fluorobiphenyl	**95**	**%**
Pyrene-D10	**93**	**%**
Terphenyl-D14	**94**	**%**

Authorized By: _____ Release Date: _____

Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID:** 1324-04

Lab ID: OCS4146A1 **Method:** SW8270

QC Type: LCS- **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil

Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** %

Analyte	Result	Qualifier	Analyte	Result	Qualifier
N-Nitrosodimethylamine	**72**		**2,4-Dinitrophenol**	**99**	
Pyridine		NAF	**4-Nitrophenol**	**83**	
Aniline	**82**		**Dibenzofuran**	**85**	
Phenol	**74**		**2,4-Dinitrotoluene**	**101**	
Bis(2-Chloroethyl)Ether	**72**		**Diethylphthalate**	**104**	
2-Chlorophenol	**82**		**Fluorene**	**91**	
1,3-Dichlorobenzene	**77**		**4-Chlorophenyl-Phenylether**	**89**	
1,4-Dichlorobenzene	**76**		**4-Nitroaniline**	**80**	
1,2-Dichlorobenzene	**79**		**4,6-Dinitro-2-Methylphenol**	**98**	
Benzyl Alcohol	**87**		**N-Nitrosodiphenylamine**	**75**	
2-Methylphenol	**66**		**1,2-Diphenylhydrazine**	**94**	
2,2'-Oxybis[1-chloropropane]	**78**		**4-Bromophenyl-Phenylether**	**91**	
N-Nitroso-Di-N-Propylamine	**86**		**Hexachlorobenzene**	**88**	
4-Methylphenol	**71**		**Pentachlorophenol**	**78**	
Hexachloroethane	**79**		**Phenanthrene**	**86**	
Nitrobenzene	**90**		**Anthracene**	**73**	
Isophorone	**74**		Caffeine		NAF
2-Nitrophenol	**78**		**Carbazole**	**84**	
2,4-Dimethylphenol	**22**		**Di-N-Butylphthalate**	**88**	
Bis(2-Chloroethoxy)Methane	**85**		**Fluoranthene**	**94**	
Benzoic Acid	**137**		**Benzidine**	**6.8**	
2,4-Dichlorophenol	**81**		**Pyrene**	**91**	
1,2,4-Trichlorobenzene	**82**		Retene		NAF
Naphthalene	**78**		**Butylbenzylphthalate**	**95**	
4-Chloroaniline	**25**		**Benzo(a)anthracene**	**90**	
Hexachlorobutadiene	**82**		**3,3'-Dichlorobenzidine**	**83**	
4-Chloro-3-Methylphenol	**86**		**Chrysene**	**84**	
2-Methylnaphthalene	**85**		**Bis(2-Ethylhexyl) Phthalate**	**98**	
1-Methylnaphthalene		NAF	**Di-N-Octyl Phthalate**	**98**	
Hexachlorocyclopentadiene	**56**		**Benzo(b)fluoranthene**	**84**	
2,4,6-Trichlorophenol	**83**		**Benzo(k)fluoranthene**	**87**	
2,4,5-Trichlorophenol	**93**		**Benzo(a)pyrene**	**81**	
2-Chloronaphthalene	**88**		3B-Coprostanol		NAF
2-Nitroaniline	**88**		**Indeno(1,2,3-cd)pyrene**	**99**	
Dimethylphthalate	**95**		**Dibenzo(a,h)anthracene**	**101**	
2,6-Dinitrotoluene	**102**		**Benzo(ghi)perylene**	**988**	
Acenaphthylene	**76**				
3-Nitroaniline	**87**				
Acenaphthene	**81**				

Authorized By: _____ Release Date: _____

Washington State Department of Ecology
Manchester Environmental Laboratory
Analysis Report for
Base/Neutral/Acids

Project Name: Dillenbaugh Creek - 18 **LIMS Project ID:** 1324-04

Lab ID: OCS4146A1 **Method:** SW8270

QC Type: LCS- **Date Prepared:** 05/25/04 **Matrix:** Frozen Sediment/soil

Project Officer: Nigel Blakely **Date Analyzed:** 06/14/04 **Units:** %

Analyte	Result	Qualifier

Surrogate Recoveries

2-Fluorophenol	**92**	**%**
D5-Phenol	**93**	**%**
D4-2-Chlorophenol	**95**	**%**
1,2-Dichlorobenzene-D4	**84**	**%**
D5-Nitrobenzene	**99**	**%**
2-Fluorobiphenyl	**93**	**%**
Pyrene-D10	**102**	**%**
Terphenyl-D14	**102**	**%**