Hatfield
CONSULTANTS

Howe Sound Pulp and Paper Environmental Effects Monitoring Cycle Six

Final

March 2013

Prepared for:

Howe Sound Pulp and Paper Limited Partnership
Port Mellon, British Columbia

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HOWE SOUND PULP AND PAPER ENVIRONMENTAL EFFECTS MONITORING CYCLE SIX

FINAL

Prepared for:

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Primary investigators for the Environmental Effects Monitoring (EEM) Cycle Six program for Howe Sound Pulp and Paper (HSPP), from Hatfield Consultants include Ms. Heather Keith, Mr. Wade Gibbons, and Ms. Felicia Juelfs. Ms. Susan Stanley assisted with graphics and Mr. Devon Wells and Ms. Annika Rieley assisted with report production.

Field sampling for the benthic survey and the dioxin and furan program was undertaken by Hatfield personnel with help from the captain and crew of the MV Rileda vessel. Subcontractors involved in the project included ALS Environmental (Vancouver, BC) Biologica Environmental Services (Victoria, BC), Nautilus Environmental (Vancouver, BC), and AXYS Analytical Services Ltd. (Sidney, BC).

The HSPP EEM Local Monitoring Committee (LMC) meeting for Howe Sound Pulp and Paper Corporation provide a valuable forum for reviewing results of previous cycles, and the draft Cycle Six design. The LMC for Howe Sound EEM program consists of representatives from the federal and provincial governments, non-governmental organizations, HSPP and Hatfield Consultants (Hatfield). Hatfield would like to acknowledge the following members of the HSPP LMC for their assistance:

- Ms. Janice Boyd, Environment Canada;
- Ms. Liz Freyman, BC Ministry of Environment;
- Mr. Paul van Poppelen, Reach for Unbleached; and
- Mr. Khalid Jasim, Howe Sound Pulp and Paper Corporation.

EXECUTIVE SUMMARY

The Environmental Effects Monitoring (EEM) Cycle Six program for Howe Sound Pulp and Paper (HSPP) ran between April 2010 and April 2013, and included sublethal toxicological testing of mill effluent, benthic invertebrate community survey with a supporting sediment quality assessment, and a dioxin/furan monitoring survey of sediment, crab and finfish in support of the EEM fish tissue survey.

Sublethal toxicity testing was undertaken six times from 2010 to 2012 at the Howe Sound pulpmill. There were observed effects of mill effluent on echinoderm fertilization at a mean effluent concentration of 12.3% (IC25) and effects on *Champia parvula* reproduction at a mean effluent concentration of 1.0% (IC25). Based on a 1% effluent concentration zone of 2,000 m from the diffuser, maximum potential zones of sublethal effect from the effluent discharge point were 162 m for invertebrate fertilization, and 1,995 m for algal reproduction.

In March 2012, sediments, crabs, and finfish (spiny dogfish) were collected from various historical sites in Howe Sound for organochlorine analyses. Concentrations of dioxins and furans in sediments near the mill were within the lower end of the historical range. Concentrations of dioxins and furans in hepatopancreas tissue of Dungeness crab collected from three (C14, C19a, and C28, throughout Howe Sound) of the eight sampling sites exceeded the Health Canada consumption criteria (24.4 pg/g), while levels at the remaining five sites were below the criteria. The total TEQ concentration in dogfish liver was 11.5 times greater than the Health Canada criteria (30.0 pg/g liver). An exceedance was not observed in dogfish muscle tissue. Based on data collected in Cycle Six and similar to previous years, concentrations of dioxins and furans appear to be exhibiting a decreasing trend in sediment near the diffuser, and in Dungeness crab and dogfish captured in Howe Sound.

The benthic invertebrate survey, conducted in March 2012, used a gradient design including twelve stations located in Howe Sound. Absolute distance from the diffuser and carbon/nitrogen (C/N) ratio in sediment were used as exposure gradients to compare benthic community metrics and sediment quality among stations.

Benthic invertebrate community densities and the Bray-Curtis dissimilarity index exhibited clear spatial trends along the distance exposure gradient. Density generally decreased with increasing distance from the diffuser and exposed communities located further from the diffuser were more similar to reference communities. However, only the difference in the Bray-Curtis index exceeded the critical effects criteria. Taxa richness, evenness, and diversity did not show any significant spatial trends with the exposure gradient.

Sediments to the south of the diffuser exhibited some organic enrichment but an improvement in oxygen conditions compared to Cycle Three. Sediment at stations to the north of the diffuser exhibited a decrease in organic content, with exception of station HSB8A, and exhibited a better oxidative state compared to Cycle Three. Possible sources of nutrient enrichment included log booming activities, particularly to the south of the diffuser, and the degrading historical fibre mat near the pulpmill, which is still present in some areas, particularly to the north of the diffuser.

Based on trends across EEM cycles, it is evident that conditions in Howe Sound with respect to sediment quality and benthic invertebrate communities continue to improve. Sources of nutrient enrichment, which likely contributed to the higher densities and TOC and TN concentrations at near-field stations included the degrading historical fibre mat to the north of the pulpmill and log booming activities to the south, rather than current effluent conditions.

DISTRIBUTION LIST

The following individuals/firms have received this document:

Name	Firm	Hardcopy	CD
Ms. Janice Boyd	Environment Canada	1	1
Mr. Khalid Jasim	Howe Sound Pulp and Paper	1	1
Mr. Paul van Poppelen	Reach for Unbleached	1	2
Ms. Liz Freyman	B.C. Ministry of Environment	1	1

1.0 INTRODUCTION

Under the federal *Pulp and Paper Effluent Regulations* (PPER; originally released in 1992, revised in May 2004 [Government of Canada 2004], and updated in 2008) pulpmills are required to monitor the chemistry and toxicity of mill effluent and its potential effects on the receiving environment. Effluent chemistry (limited to total suspended solids and biological oxygen demand) and lethal toxicity are measured to evaluate effluent quality and its potential effects on aquatic biota. However, because there are many factors that can alter the chemistry and toxicity of effluent in the receiving environment, Environmental Effects Monitoring (EEM) studies are also conducted to directly assess the effects of mill effluent on fish, fish habitat, and use of fisheries resources in the vicinity of the effluent discharge (Environment Canada 2010). EEM studies can include:

- A fish population survey to assess fish health;
- A fish tissue survey to assess concentrations of dioxins and furans (only required for mills where dioxins and furans are present in mill effluent);
- A benthic invertebrate community survey to assess the condition of fish habitat;
- Supporting water and sediment quality data to help interpret findings from fish and benthic invertebrate surveys; and
- Sublethal toxicity testing to assess effects of effluent on growth and reproduction of representative aquatic organisms.

EEM programs typically are conducted in three year cycles, which begin with the development of a study design, followed by study implementation, data analysis, and reporting. The following cycles have been completed for the HSPP pulpmill since the onset of the EEM monitoring program:

- Cycle One: 1993 to 1996;
- Cycle Two: 1997 to 2000;
- Cycle Three: 2000 to 2004;
- Cycle Four: 2004 to 2007; and
- Cycle Five: 2007 to 2010.

The current program, Cycle Six, was conducted between April 2010 and April 2013. In 2010, the *Pulp and Paper Technical Guidance for Environmental Effects Monitoring* (Environment Canada 2010) was revised and replaced the 2005 version. The revisions were made in response to the 2008 amendments to the PPER, outcomes from the Smart Regulation Initiatives on improving the effectiveness and efficiency of the EEM program, and ongoing efforts to streamline the guidance document (i.e., Environment Canada 2010). Accordingly, the current design for HSPP incorporates relevant changes and recommendations outlined in the revised guidance document.

This report presents results from the EEM Cycle Six program for HSPP. The HSPP mill is located in Thornbrough Channel of Howe Sound near Port Mellon, British Columbia, Canada (Figure 1.1). The mill is located on the mainland directly across from the western side of Gambier Island.

The Cycle Six program, previously described in the study design (Hatfield Consultants 2012), included a fish tissue study (crabs, finfish, and sediments), benthic invertebrate survey, and sublethal toxicity testing of mill effluent. Information on changes to mill processes, effluent treatment, and/or the receiving environment that occurred during Cycle Six also is presented. Sections in this report include:

- Section 2 – Mill Study Area and Cycle Six Design Update;
- Section 3 – Sublethal Toxicity Testing of Mill Effluent;
- Section 4 – Fish Population Survey;
- Section 5 – Fish Tissue Survey;
- Section 6 – Benthic Invertebrate Survey;
- Section 7 – Cycle Six Conclusions;
- Section 8 – Closure;
- Section 9 – References;
- Section 10 – Glossary; and
- Appendices.

Figure 1.1 Location of Howe Sound Pulp and Paper Corporation on Thornbrough Channel, Howe Sound, British Columbia.

Legend

- Waterbody
- Watercourse
- Mill

0 5 10 20 km

Scale: 1:800,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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2.0 MILL STUDY AREA AND CYCLE SIX DESIGN UPDATE

2.1 MILL OPERATIONS

2.1.1 Process Description and Update

The HSPP mill was originally established in 1908 with a production rate of 20 ADt/d of soda pulp. Multiple changes and upgrades over the years have increased production to approximately 1,000 ADt/d of bleached Kraft pulp and 600 ADt/d of newsprint. Kraft pulp is produced from Kraft processing and newsprint pulp is produced from thermomechanical processing. Newsprint and Kraft production increased from the mid-1990s relative to previous years; in 2006 the mill established new production records when it produced 215,742 ADt of newsprint and 378,421 ADt of bleached Kraft pulp. In 2012, total production increased to 575,115 ADt/year, with an average production of 1,715 ADt/day. Average effluent flow was 71,600 (m^3/d) (Table 2.1, Figure 2.1).

Chlorine dioxide bleaching was brought online at the mill in 1989, when elemental chlorine was increased to a minimum of 50%. Since June 1997, Kraft pulp has been bleached exclusively with chlorine dioxide (100% substitution); newsprint pulp is semi-bleached without the use of any chlorine-containing chemicals. The bleaching of Kraft pulp is conducted in four stages following oxygen delignification, where the sequence is $DE_{OP}D_ND$. The first stage uses chlorine dioxide [D]. The second stage uses caustic extraction [E], oxygen [O] and peroxide [P], and the third and fourth stages use chlorine dioxide, with caustic neutralization [N] between stages. Newsprint pulp bleaching uses hydrogen peroxide and sodium hydrosulphide.

Wood furnish varies according to the pulp grade. In general, blends of hemlock, fir, cedar, and SPF (spruce, pine, fir) are used. Various sawmills from the surrounding area and the Lower Mainland supply woodchips.

The UNOX secondary effluent treatment system was installed in 1990. No major changes have been implemented since that time (Hatfield 1996) and effluent quality variables have continued to remain below permitted and regulated load limits. Since 1982, process effluent at HSPP has been discharged via six ports along a deep-sea diffuser ranging from 30 m to 115 m in depth. The diffuser pipe extends approximately 277 m into Thornbrough Channel. The mean effluent flow for 2010, 2011 and 2012 was 75,342 m^3/d, 72,500 m^3/d, and 71,600 m^3/d, respectively (Table 2.1).

Table 2.1 Annual mean values for process effluent quality variables, Howe Sound Pulp and Paper, 2007 to 2012.

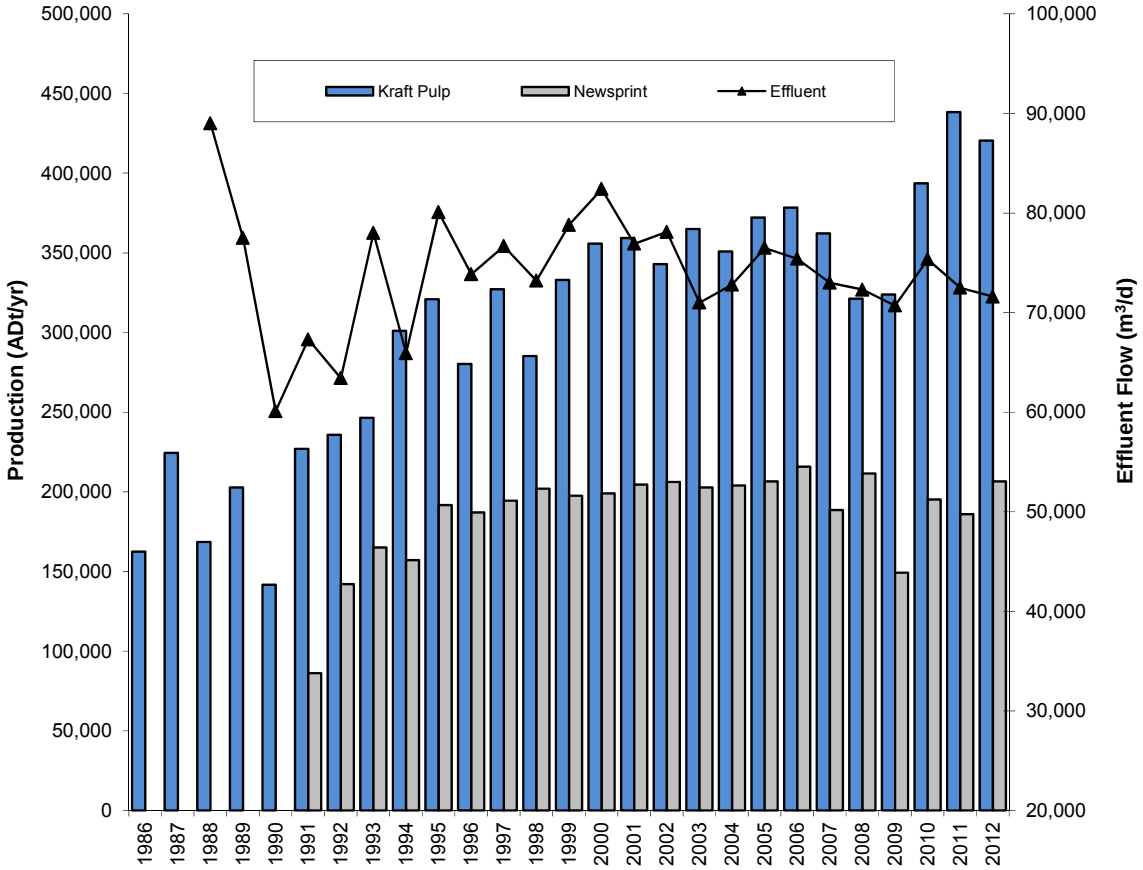
Variable	2007	2008	2009	2010	2011	2012
Production						
Total production (ADt/day)	1,588	1,568	1,515	1,627	1,698	1,715
Total Production (ADt/yr)	550,708	532,669	473,018	559,668	576,905	575,115
Kraft Pulp (ADt/yr)	362,151	321,220	323,787	393,673	438,365	420,484
Newsprint (ADt/yr)	188,557	211,449	149,231	195,100	185,896	206,479
Treated Effluent Quality						
Effluent flow (m^3/d)	73,000	72,300	70,700	75,342	72,500	71,600
pH	6.4	6.4	6.4	6.3	6.4	6.4
Temperature (°C)	33	33.3	32	33	32.2	32.8
TSS (kg/d) [kg/ADt]	1,916	2,273	1,784	2,356	2,920	3,496
BOD(kg/d) [kg/ADt]	896	981	634	560	548	780
AOX (kg/ADt)	0.21	0.29	0.24	0.21	0.2	0.2
2,3,7,8-TCDD (pg/L)	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDF (pg/L)	ND	ND	ND	ND	ND	ND
Rainbow trout 96-hr LC50 (% effluent)	14 of 15 >93%	100%	100%	100%	15 of 16 >93%	17 of 19 >89%
Daphnia magna 48-hr LC50 (% effluent)	50 of 50 >100%	96%	100%	100%	49 of 52 >94%	51 of 56 >91%

ND = Not Detected.

ADt = air dried metric tonnes.

ppq = parts per quadrillion (pg/L).

Figure 2.1 Annual pulp production and effluent flow from 1986 to 2012, Howe Sound Pulp and Paper.



2.1.2 Effluent Quality

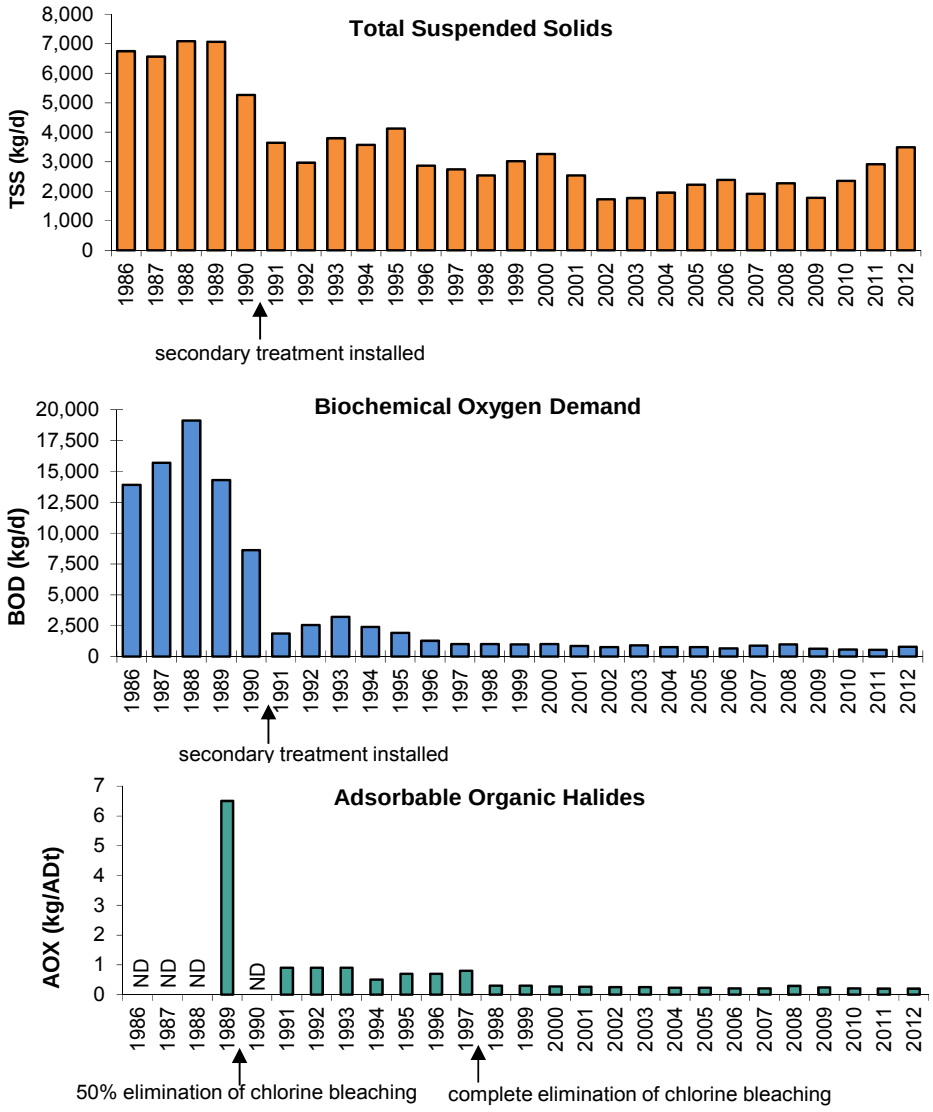
Effluent quality variables are routinely measured following provincial and federal requirements; annual results are presented in Figure 2.2. Mean annual pulp production levels at the mill steadily increased from 1991 to 1997, and then began to decline until 2007, due to significant mill downtime. With the exception of TSS, effluent quality variables have remained low since 2000 (Figure 2.2).

Total suspended solids (TSS), biological oxygen demand (BOD), and concentrations of adsorbable organic halides (AOX) in effluent declined initially following the introduction of chlorine dioxide in 1989, and again after the installation of secondary effluent treatment in 1990 (Figure 2.2). Concentrations of AOX declined again following the complete elimination of elemental chlorine bleaching in 1997. In recent years, concentrations of all three variables have remained relatively consistent. In 2012, TSS was 3,496 kg/day, BOD was 780 kg/day, and AOX was 0.20 kg/ADt (Table 2.1).

Concentrations of tetra-chlorinated dioxins (i.e., 2,3,7,8-T_4CDD) and furans (i.e., 2,3,7,8-T_4CDF) were not detected in HSPP effluent at any time in Cycle Six (Table 2.1).

In order to remain in compliance with the federal *Pulp and Paper Effluent Regulations* (PPER), mills are required to sustain no acute toxicity of effluent to rainbow trout (i.e., all LC50s – effluent concentrations that kill 50% of trout – must be greater than 100% v/v effluent). In 2010, acute toxicity (96-hour LC50) endpoints for rainbow trout passed (LC50 > 100%) 100% of the time; whereas in 2011 and 2012 both tests passed 93% and 89% of the time, respectively (Table 2.1). *Daphnia magna* 48-hr acute toxicity tests passed 100% of the time in 2010, 94% of the time in 2011, and 91% of the time in 2012.

Figure 2.2 Mean daily total suspended solids (TSS), biochemical oxygen demand (BOD), and adsorbable organic halides (AOX) in effluent, Howe Sound Pulp and Paper, 1986 to 2012.



ND= no data

2.1.3 Spills to the Receiving Environment

No spills were reported in Cycle Six.

2.1.4 Study Area Updates

During Cycle Six there were no major anthropogenic influences or significant natural ecological variations in the HSPP EEM study area.

2.2 CYCLE SIX STUDY DESIGN UPDATE

No major changes were made to the Cycle Six study design during the field surveys.

3.0 SUBLETHAL TOXICITY TESTING OF MILL EFFLUENT

Summary of Sublethal Toxicity Testing (February 2010 through October 2012) for Howe Sound Pulp and Paper Corporation (HSPP):

- Echinoderm fertilization was affected at a mean effluent concentration of 12.3% (IC25);
- *Champia* reproduction was affected at a mean effluent concentration of 1.0% (IC25); and
- Based on a 1% effluent concentration zone of 2,000 m from the HSPP diffuser, maximum potential zones of sublethal effect from the effluent discharge point were 162 m for invertebrate fertilization, and 1,995 m for algal reproduction.

Federal and provincial government regulations require pulp and paper mills to undertake toxicity testing as part of their EEM programs to determine any lethality or inhibitory effects that their effluent may have on fish populations and fish habitat. Sublethal and acute lethality tests may indicate whether fisheries resources are being protected or impacted in areas adjacent to their effluent discharges. Current EEM regulations require the use of sublethal toxicity tests to help meet the following objectives:

- Contribute to the field program as part of a weight-of-evidence approach;
- Compare process effluent quality between mill types and measure changes in effluent quality as a result of effluent treatment and process changes; and
- Contribute to the understanding of relative contributions of the mill to multiple discharge situations (Environment Canada 2010).

For HSPP and other pulpmills that discharge to a marine receiving environment, sublethal toxicity testing in Cycle Six included the following tests (Environment Canada 2010):

- Invertebrate fertilization toxicity test using an echinoderm (either the sand dollar *Dendraster excentricus*, or purple sea urchin *Strongylocentrotus purpuratus*); and
- Plant reproduction toxicity test using a red marine alga (*Champia parvula*).

Sublethal toxicity testing of echinoderms was undertaken by Cantest Inc. (Vancouver, BC; February 2010), Maxxam Analytics (formerly Cantest Inc., Burnaby, BC; October 2010 and April 2011), and Nautilus Environmental (Burnaby, BC; September 2011 to April 2012). *Champia* tests were conducted by the Saskatchewan Research Council (Saskatoon, SK; February 2010) or by AquaTox Testing & Consulting Inc. (Guelph, ON; October 2010 through October 2012). A summary of reported endpoints is included with this Cycle Six interpretive report.

3.1 METHODS

3.1.1 General Methods and Definitions

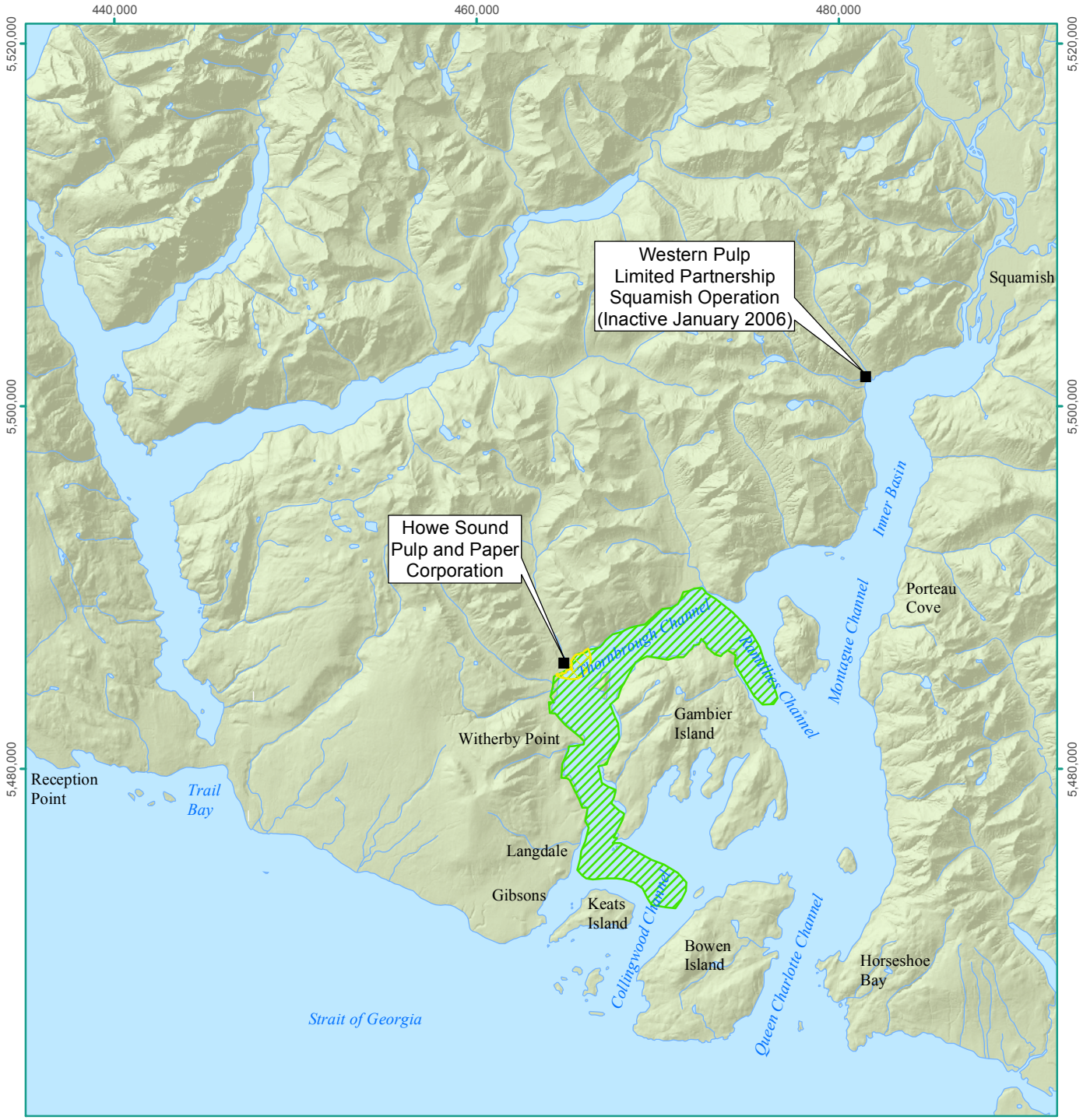
Sublethal toxicity testing of process effluent must be conducted twice a year, at least six months apart, for a total of six test periods per three-year EEM cycle (Hatfield 2005). Testing for Cycle Six was initiated in February 2010 and continued until October 2012 for HSPP.

Mill personnel collected a grab sample of effluent on each test date according to the methodology described in the *Technical Guidance Document* (Environment Canada 2010). Sublethal toxicity tests involve exposure of organisms to a series of effluent dilutions. All sublethal toxicity tests were conducted with controls in order to assess the "background response" of test organisms and determine the acceptability of the test using predefined criteria. For test endpoints reported for EEM Cycle Six, controls must meet or exceed test protocol requirements. In addition, in-house cultures are tested with a reference toxicant to monitor the health and sensitivity of the culture.

Algal reproduction and invertebrate fertilization tests provide an IC25 result, which is an estimate of the concentration of effluent that causes 25% inhibition of a quantitative biological function, such as reproduction or growth. Confidence limits were given for each endpoint where possible.

A zone of effluent mixing was determined by a plume delineation study undertaken during the Cycle One pre-design study (Hatfield 1994). That study estimated the maximum extent of effluent concentration that was ≥1% (i.e., 100:1 dilution) in the receiving water environment. This 1% effluent zone originally was used to define near-field and far-field areas to aid in selecting sites to conduct required environmental sampling. The 1% effluent zone represents conditions of minimum dilution, maximum extent, and long-term average conditions (i.e., long-term effect of effluent discharge) (Environment Canada 2010) and; therefore, represents worst-case effluent dilution conditions. For the HSPP, the maximum extent of 1% effluent was defined as a radial distance of approximately 2 km (2,000 m) from the pulpmill diffusers (Hatfield 1994).

Figure 3.1 Estimated zones of effluent dispersion near Howe Sound Pulp and Paper, 2012.



Legend

- Waterbody
- Watercourse
- Mill
- 1% Effluent Concentration Zone
- Far-field Dispersion of Effluent

0 2.5 5 10 km

Scale: 1:325,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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A maximum potential zone of sublethal effect was calculated for each test species from the geometric mean of the IC25 endpoints and the extent of the 1% effluent concentration zone, as per Environment Canada (2010). This potential zone of sublethal effect describes the downstream area where the effluent concentrations exceed the geometric mean of the IC25 endpoint, and is the maximum distance from the effluent discharge where a specified effect may be expressed for a test species. This maximum zone of potential sublethal effect was calculated as follows:

$$\text{Zone (m)} = \frac{\text{Extent of 1\% effluent zone (m)}}{\text{Geometric mean of IC25 endpoints}}$$

As discussed in Section 3.2.3, this model may not be realistic for the Howe Sound mill, given that effluent is discharged through multi-port diffusers that rapidly dilute effluent upon release.

3.1.2 Sublethal Toxicity Test Methods

General procedures for the echinoderm fertilization test are based on the methodology document *Biological Test Method: Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars)*, Report EPS 1/RM/27, December 1992, November 1997 amendments (Environment Canada 1997b). The test assesses the fertilization success of an echinoderm using the sand dollar *Dendraster excentricus* or the sea urchin *Strongylocentrotus purpuratus*. Male and female gametes are exposed to the test material for 20 minutes; the percentage of eggs fertilized is compared between the controls and the effluent sample concentrations to determine if any significant inhibition of fertilization is observed. The IC25 endpoint is the percent effluent concentration where fertilization is reduced by 25% from control fertilization rates.

Procedures for conducting the marine algae (*Champia parvula*) test are based on *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to Marine and Estuarine Organisms*, Third Edition, EPA821/R/02-014, October 2002 (US EPA 2002). The *Champia* test is a static, non-renewal, marine algal reproduction test where male and female plants are exposed to a test sample for a 48-hour period, followed by a 6- to 8-day recovery period. The inhibition of cystocarp reproduction by 25% by the end of the recovery period is the effluent concentration endpoint (reproduction IC25) used to assess toxicity.

3.2 RESULTS AND DISCUSSION

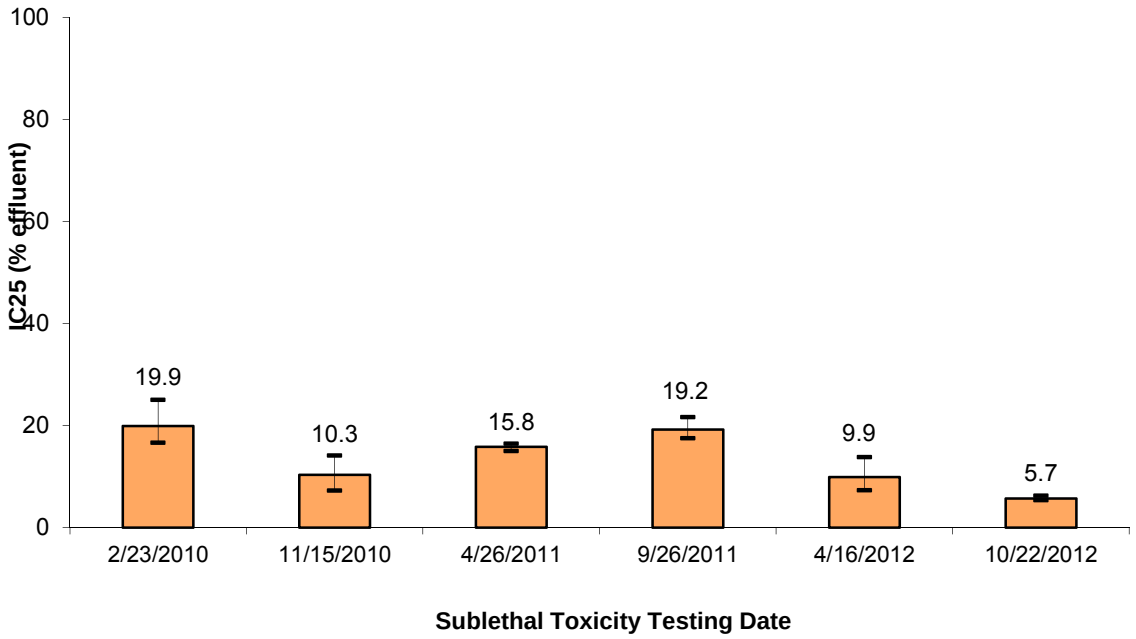
HSPP conducted six sublethal toxicity tests from February 2010 to October 2012 for Cycle Six. The September 2011 and April 2012 echinoderm tests were repeated due to poor control performance in the original tests. During the September 2011 test event, available sand dollars were at the end of their spawning season, and egg and sperm quality was poor, while in April 2012, inclement weather conditions prevented the collection of sea urchins for the initial sample date, so sand dollars were instead used for the testing. In both cases, echinoderm fertilization tests did not meet the acceptability criteria of 50%

fertilization in the control treatment. All subsequent testing using sea urchins met control treatment criteria. Appendix A1 provides a summary of HSPP Cycle Six sublethal toxicity test results, including dose-response plots for all tests conducted.

3.2.1 Echinoderm Fertilization Test

The IC25 values for echinoderm (sand dollars and sea urchins) fertilization ranged from 5.7% to 19.9% effluent in Cycle Six, with a geometric mean of 12.3%. Results were variable across test periods, and were lower (i.e., higher toxicity) than observed in Cycle Five, but were generally lower or consistent to results reported in Cycle Four. Dose response curves were relatively consistent among testing periods (Appendix A1). In general, the IC25 for echinoderm fertilization showed a decreasing trend (i.e., higher toxicity) throughout most of Cycle Six, likely related to increased production at the mill (K. Jasim, pers. comm. 2012) (Figure 3.2).

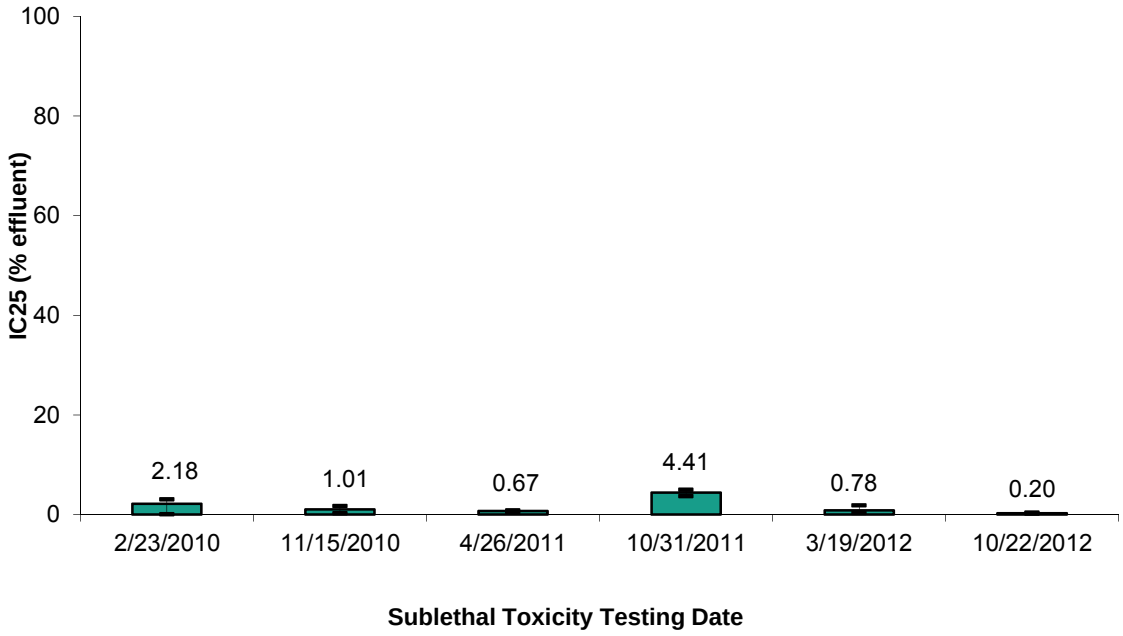
Figure 3.2 IC25 values and 95% confidence limits for echinoderm fertilization while exposed to effluent from HSPP, EEM Cycle Six.



3.2.2 *Champia* Reproduction Test

The IC25 values for *Champia* reproduction ranged from 0.20% to 4.41% with a geometric mean of 1.0%. Although higher individual results were observed in Cycle Six (i.e., IC25 for February 2010 [2.18%] and September 2011[4.41%]) than results from the second half of Cycle Five, average results in Cycle Six indicated an increased effect of effluent on *Champia* reproduction. IC25 endpoints were variable during Cycle Six, with no apparent trends. The October 2012 effluent sample resulted in the greatest effects while the April 2011 test period effluent sample resulted in the smallest effect (Figure 3.3). Overall, IC25 endpoints and dose-response plots were relatively consistent (Appendix A1) across Cycle Six.

Figure 3.3 IC25 values and 95% confidence limits *for Champia* reproduction while exposed to effluent from HSPP, EEM Cycle Six.



3.2.3 Potential Zone of Sublethal Effect

The 1% zone of effluent concentration for HSPP extends approximately 2,000 m in radius from the effluent diffuser (Hatfield Consultants Ltd. 1994). Table 3.1 presents the geometric means of IC25 endpoints for each test species for all six cycles, and the resulting Potential Zone of Sublethal Effect calculated using the 2,000 m 1% effluent zone. Calculations of geometric means and potential zones of sublethal effects can be found in Appendix A1.

The zone of sublethal effect increased for echinoderms from 61 m in Cycle Five to 162 m in Cycle Six. The *Champia* zone of sublethal effect is the largest; this value has increased since Cycle One (from 114 m to 1,995 m in Cycle Six) indicating an increase in toxicity over time (Table 3.1).

Table 3.1 Potential Zone of Sublethal Effect for HSPP, EEM Cycles One through Six.

	IC25 Geometric Mean (% v/v)					
	Cycle One	Cycle Two	Cycle Three	Cycle Four	Cycle Five	Cycle Six
Sublethal Toxicity Test Species						
Echinoderm Fertilization	11.12%	15.97%	25.01%	18.30%	32.82%	12.30%
Algal Reproduction	17.52%	19.06%	19.19%	10.20%	2.69%	1.00%
Potential Zone of Sublethal Effect (m)						
Echinoderm Fertilization	180	125	80	109	61	162
Algal Reproduction	114	105	104	196	743	1,995

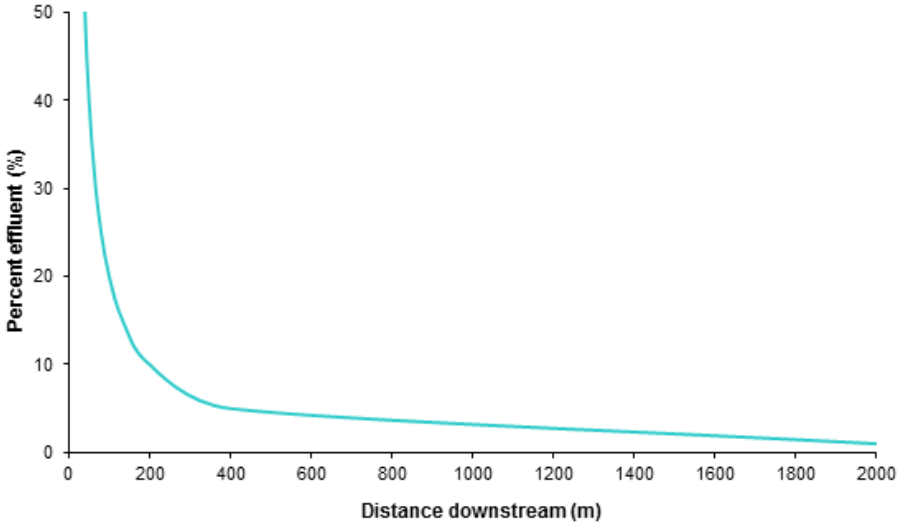
In Cycle Six, the geometric mean of the IC25 endpoint for *Champia parvula* reproduction was equal to 1.0%. This is slightly below the 2.3% concentration value observed during an effluent dispersion study conducted in 1989 (Hodgins and Knoll 1990a). All IC25 endpoint values calculated in Cycle Six were lower than the observed value of 2.3% with the exception of the September 2011 test period (4.41%). No other major industrial or municipal discharges occur within the study area for HSPP that could confound toxicity impacts in the near-field receiving environment. However, the presence of log booms likely has some ecological implications to the HSPP near-field receiving environment.

Figure 3.4 presents the rate of effluent dilution for HSPP implied by the Environment Canada (2010) zone-of-effect model. Using a conservative maximum extent of 1% effluent of 2,000 m, this model assumes that effluent would be diluted to 50% of release concentration 40 m from the diffuser, to 20% of release at 100 m, and to 5% of release at 400 m from the diffuser. However, actual dilution of HSPP effluent occurs much more rapidly than this, mainly due to its discharge through a multi-port diffuser, which was designed to maximize initial dilution and dispersion of effluent in the marine receiving environment.

3.3 CONCLUSIONS

The toxicity testing results contribute to the overall weight-of-evidence used to assess potential environmental effects of effluent discharges. When interpreting sublethal toxicity data it is important to keep in mind that laboratory toxicity test results may not accurately predict toxicity in receiving environments. Laboratory tests involve single species that may or may not be found in the study area, and there is an assumption that there is no background toxicity in the area. Furthermore, effluent plume dispersion and dilution vary due to tides and currents, and receiving waters and effluent quality characteristics vary seasonally or in other ways that could affect toxicity levels.

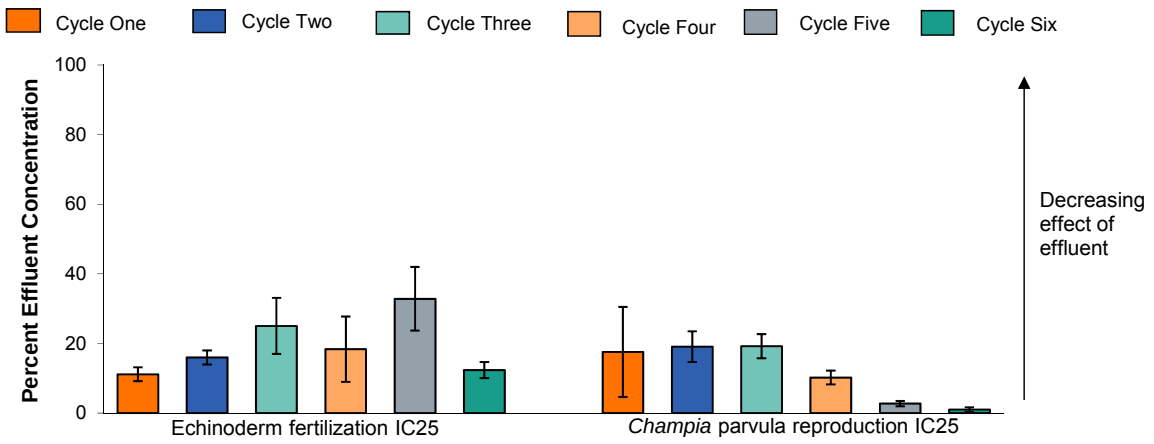
Figure 3.4 Dilution of HSPP effluent in the marine receiving environment assumed by the Environment Canada (2010) maximum-zone-of-effect model.



Sublethal effects of Howe Sound effluent on echinoderms were observed at average concentrations greater than 12.3%. Such concentrations have not been observed in Port Mellon and would not be expected to occur beyond the initial dilution zone surrounding the diffuser. Sublethal effects on *Champia parvula* reproduction; however, were observed at average concentrations of 1.0%. Concentrations that are slightly higher (2.3%) were observed during an effluent dispersion study conducted by Hodgins and Knoll in 1989. This is a concern because toxicity of effluent on *Champia* reproduction has generally showed an increasing trend since Cycle One.

Relative to previous EEM cycles, results of sublethal testing indicated reduced effluent quality for both echinoderm fertilization and algae reproduction in Cycle Six (Figure 3.5, Table 3.1).

Figure 3.5 Geometric mean IC25 values for test organisms exposed to effluent from HSPP, EEM Cycle One through Cycle Six.



4.0 FISH POPULATION SURVEY

The fish survey for EEM is designed to provide an assessment of whether differences exist in fish characteristics between exposed and reference areas. The study design should be based on the ability to detect a difference in reproduction endpoints (relative gonad size) and fish health (liver size or condition) between reference and exposed areas (Environment Canada 2010). Standard fish surveys have been difficult to conduct at HSPP due to several confounding factors in the marine environment in Howe Sound, including:

- The absence of barriers to restrict finfish movement;
- Patchy distribution of non-fin fish species (e.g., wild mussels);
- A paucity of life history data available for most marine species. For instance, the use of Dungeness crab was not recommended in Cycle Two due difficulties in age determination and limited knowledge on pulpmill effects on this species' life history and movement; and
- Effluent trapped at varying depths based on temperature, season, and currents, which makes it difficult to assess exposure.

Several fish population surveys and alternatives were evaluated and considered for previous EEM cycles, including standard adult finfish surveys, invertebrate shellfish surveys, and alternatives to fish surveys.

The Cycle One fish survey proved it difficult to find suitable adult sentinel finfish species; difficulties were attributed to poor catch success, fish mobility, and uncertainty regarding exposure of fish related to depth and dispersion of effluent. Therefore, finfish were not considered for the fish population survey since Cycle Two when the mill began to explore alternatives to the fish survey.

Dungeness crab (*Cancer magister*) and blue mussels (*Mytilus trossulus* or *M. gallo-provincialus*) were collected during Cycle One to evaluate potential effects of mill effluent on fish. Neither species was considered suitable for evaluating the effects of effluent exposure given uncertainties regarding their exposure related to depth and dispersion of effluent, confounding environmental factors, and limited information on crab age and mobility.

During Cycle Two, BC Environment conducted two caged bivalve surveys at HSPP to assess suitability of using caged mussels as an alternative to the traditional EEM fish survey. Results from these surveys were generally inconclusive due to the limited recovery of cages from sites, the high number of dead organisms found upon retrieval, and uncertainty regarding effluent exposure given organisms were suspended near the surface of the water column several meters above the trapped effluent plume.

A mesocosm study was also considered unsuitable for Howe Sound because of difficulties obtaining marine control/dilution water unaffected by mill effluent and problems identifying/collecting appropriate marine fish species to be used as a test species.

In Cycle Three, an extended sublethal toxicity test (28-day topsmelt larvae growth and survival test) was conducted as an alternative to the standard fish population survey. The objective of the test was to provide supplementary information about the potential effects of mill effluent on marine fishes and assess the potential of this alternative approach for future EEM programs. The results of the study indicated that effects on growth were only observed at higher effluent concentrations and; therefore, given the low effluent concentrations encountered in the receiving environment, effects would be unlikely to occur.

In Cycle Five, the extended topsmelt sublethal toxicity test was repeated to verify the results of Cycle Three. The test was similar to Cycle Three but with improved quality control measures. The test was terminated due to high mortality rates in the control treatment by day 13. In addition, high mortality rates and inconsistent dose responses were also observed with the majority of effluent test concentrations. No alternatives to the extended topsmelt test were identified for Cycle Five.

Based on the results of the extended sublethal toxicity test in cycles Three and Five, it was determined that "interpretable no effects" were found; therefore, a fish population survey was not required in Cycle Six.

5.0 FISH TISSUE SURVEY

Summary of sediment, crab and finish surveys for Howe Sound Pulp and Paper (HSPP):

- Sediment at site S14, located near the diffuser, was primarily comprised of sand substrate with some silt. Concentrations of dioxins and furans in sediment at site S14 were lower than previous years, exhibiting a decreasing trend;
- Concentrations of dioxin and furans in hepatopancreas samples of Dungeness crabs at three sites, C14, C19a, and C28, exceeded the Health Canada guideline (24.4 pg/g) by 1.5, 6.2, and 2.7 times, respectively. Concentrations of dioxins and furans in liver samples of spiny dogfish exceeded the Health Canada advisory guideline (30.0 pg/g) by 9.4 times; concentrations of dioxins and furans in muscle tissue of spiny dogfish did not exceed the Health Canada advisory guideline; and
- Based on data collected in EEM Cycle Six and similar to previous years, concentrations of dioxin and furans appear to be exhibiting a decreasing trend in sediment near the diffuser, and in Dungeness crabs and dogfish captured in Howe Sound.

5.1 INTRODUCTION

Since 1989, HSPP has monitored organochlorines in sediments and biota within Howe Sound, following directives from the Department of Fisheries and Oceans (DFO), Health Canada and Environment Canada (EC). These studies were initiated following the discovery of high concentrations of polychlorinated dibenzodioxins (dioxins) and dibenzofurans (furans) in marine sediments and shellfish near HSPP, which resulted in the closure of commercial and recreational fisheries (Nassichuck 1992).

The Howe Sound organochlorine monitoring program has historically involved collection and analysis of sediments, Dungeness crabs (*Cancer magister*), spiny dogfish (*Squalus acanthias*), and bottomfish, with special emphasis on tetrachlorinated dioxins (T_4CDD) and furans (T_4CDF), and toxic equivalency (TEQ) concentrations. The sampling program was performed annually at the Howe Sound mill between 1989 and 2005. Subsequent to this, the frequency of the program was reduced to a three-year cycle to synchronize with the federal Environmental Effects Monitoring (EEM) program at the mill (R. More, Environment Canada, pers. comm. 2005), with the last survey conducted in 2009 (Hatfield 2009).

Concentrations of dioxins and furans in fish and shellfish have declined near HSPP since 1989 (Hatfield 2009). In 2009, total TEQ concentrations in crab hepatopancreas at three of the seven sits were above Health Canada's consumption criteria (24.4 pg/g). As a result, several areas near Howe Sound remain closed to commercial fisheries and health advisories continue to be issued for the recreational consumption of crab hepatopancreas (DFO 2012).

In recent years, rates of decline in dioxin/furan concentrations in crab near Howe Sound have slowed, a phenomenon that has also been observed at other coastal mills in BC (Yunker et al. 2002). The goal of the current Howe Sound dioxin/furan trend monitoring program is to continue to document organochlorine concentrations in sediment, Dungeness crab tissue, and spiny dogfish.

Under the federal EEM guidelines (Environment Canada 2010) mills that have used chlorine bleaching may be required to conduct analysis of tissue levels of chlorinated dioxin and furan congeners on edible portions of fish if dioxins and furans are an issue for the receiving environment. Mills are required to perform fish tissue analysis for dioxins and furans in two instances:

- Where mill effluent has contained measurable concentrations of 2,3,7,8-T_4CDD or 2,3,7,8-T_4CDF since the submission of the most recent interpretive report. The definition of measurable is provided in the *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulation* (SOR/2000-102, s. 8) and *Reference Method for the Determination of PCDDs and PCDFs in Pulp and Paper Mill Effluents* (EPS 1/RM/19); and

- Where an effect on fish tissue was reported in the most recent interpretive report; an effect is defined as a concentration which exceeds 15 pg/g wet weight in muscle, 30 pg/g wet weight in finfish liver, and 24.4 pg/g wet weight in crab hepatopancreas.

Based on ongoing recreational consumption advisories in Howe Sound (Figure 5.1), the HSPP mill was required to monitor dioxins and furans in crab and finfish during the Cycle Six EEM program, as per direction from Environment Canada. This report presents results for the dioxin and furan monitoring program conducted in March 2012. As in previous years, dioxins, furans and other select organochlorines were measured in sediments, Dungeness crab (*Cancer magister*) and spiny dogfish (*Squalus acanthias)* collected from Howe Sound.

5.2 METHODS

Methods used for the 2012 Howe Sound dioxin and furan trend monitoring program were consistent with requirements and methods used in previous surveys at the mill, from 1989 to 2009 (Hatfield 2009).

5.2.1 Field Sampling

Field personnel consisted of Hatfield biologists and technicians with previous experience in ultra-trace contaminant studies. A 25 m fishing vessel was used for traveling to monitoring sites to collect samples of crab, dogfish, and sediment. Sites were carefully located using GPS technology to ensure consistency with sites sampled in previous years. At each site, the precise GPS coordinate, depth, and sampling details were recorded on project-specific field datasheets.

A summary of the samples collected and sites locations for the 2012 monitoring program is provided in Table 5.1.

Table 5.1 Summary of sediment, crab and finfish sampling sites for the Howe Sound dioxin/furan trend monitoring program, 2012.

Survey Component	Site	Location	Collection Date	Latitude	Longitude	Samples Collected
Sediment	S14	HSPP diffuser	16-Mar-2012	49°31.138	123°28.736	3 replicate grabs
Crab	C9	McNab Point	06-Mar-2012 to 09-Mar-2012	49°33.554	123°23.189	8 male crab
	C10	HSPP diffuser	06-Mar-2012 to 13-Mar-2012	49°30.613	123°29.357	8 male crab
	C14	West Keats Island	06-Mar-2012 to 11-Mar-2012	49°24.075	123°28.557	9 male crab
	C16a	Port Graves	06-Mar-2012 to 09-Mar-2012	49°28.101	123°21.502	10 male crab
	C19a	Cates Bay	06-Mar-2012 to 09-Mar-2012	49°24.817	123°18.707	10 male crab
	C21	S. Gower Pt.	07-Mar-2012 to 19-Mar-2012	49°22.932	123°31.498	10 male crab
	C27	Douglas Bay	06-Mar-2012 to 13-Mar-2012	49°31.242	123°21.248	1 male crab
	C28	Brigade Bay	06-Mar-2012 to 13-Mar-2012	49°29.300	123°20.049	5 male crab
Finfish	T9	Queen Charlotte Channel	10-Mar-2012	49°30.019	123°20.122	8 dogfish

Sediment Sampling

Sediment samples were collected on March 16, 2012 from site S14 located near the HSPP diffuser (Table 5.1). Figure 5.1 provides the location of this site relative to the HSPP mill, as well as historical sites sampled during previous Dx/Fn monitoring programs. As in past surveys, a stainless steel Smith-McIntyre sediment grab (31 x 31 cm) was used to collect the sediment samples. The grab was raised using line wound on a hydraulically powered drum. Prior to sampling, the grab and other stainless-steel sampling equipment (i.e., pans and spoons for mixing of samples) were cleaned by scrubbing and rinsing with seawater, then hexane, acetone, and seawater again. Three replicate grabs were then collected to obtain a composite sample. Only those grabs that met the following criteria were used:

- Grabs did not contain large or foreign objects;
- Grabs obtained an adequate penetration depth;
- Grab doors and jaws were firmly closed; and
- Grabs were not overfilled or leaking.

Samples were photographed, and sub-samples from the top 2 cm of each replicate grab were removed, combined in a stainless steel pan, and stirred into a homogenous mixture. From the mixture, three sample jars were filled: one for dioxin and furan analysis, a second for supporting variables (particle size, loss on ignition, moisture content), and a third to provide additional material in the

event of breakage or other issues that may have compromised the sample. All sediment samples were placed in pre-labelled, 250 mL heat-treated, wide-mouth amber glass jars and sealed with Teflon-lined lids. Duplicate sample identification labels were applied to the field sheet.

Samples were frozen at the end of the field day, and at the conclusion of the program, delivered to AXYS Analytical Services Ltd. (AXYS) in Sidney, BC, for dioxin/furan analysis and ALS Environmental (ALS) in Vancouver, BC, for supporting chemical analyses (LOI, % moisture, and particle size). Methodologies and QA/QC protocols used by the laboratories to perform these analyses are presented in Appendix A2.

Crab Sampling

Dungeness crab were collected from a total of eight sites in Howe Sound from March 5 to 8, 2012 (Table 5.1). The location of each site was consistent with the 2009 dioxin and furan survey (Hatfield 2009). Figure 5.2 shows the location of these sites relative to the HSPP mill, as well as historical sites from previous dioxin/furan monitoring programs. Appendix A3 summarizes historical crab sampling sites and fishing effort since 1989.

Standard commercial crab traps were set using the fishing vessel at designated sites. Each trap (or string of traps) was baited with fish parts and/or fish food pellets, set overnight, and, weather permitting, retrieved the following day. Crabs were removed from the traps and handled by personnel wearing clean latex gloves, which were changed between sites. Only commercially-sized adult male Dungeness crabs (carapace width ≥165 mm) were retained for analysis. The daily catch from each site was placed in a clean, labeled polyethylene bag and stored in a secure deep-freezer at the end of each field day. Care was taken to ensure that crab legs did not puncture the bags. Traps were then reset at the same location, until sufficient crabs were collected (i.e., target of 7 crabs/site). If crabbing at a particular site position yielded poor catch results after several attempts, traps were reset at a slightly different position nearby, within the same general site location.

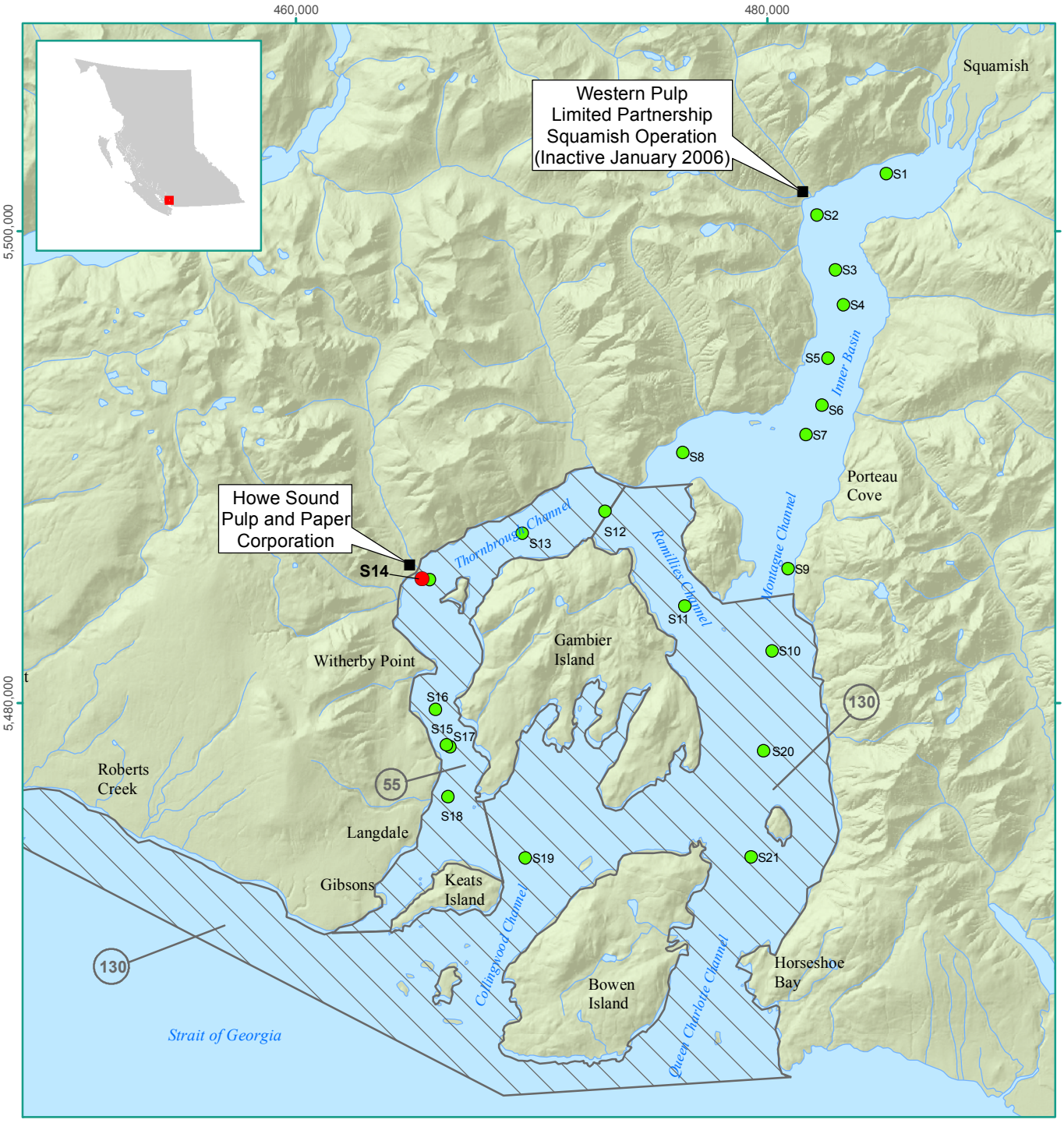
Frozen crabs were transported to a Hatfield storage facility for subsequent dissection and analyses. Table 5.1 outlines sampling efforts and compositing information for each site.

Finfish Sampling

The species targeted for the finfish component was the spiny dogfish (*Squalus acanthias).* Fish were collected at site T9 in Queen Charlotte Channel (Figure 5.2), between March 5 and 17, 2012. Longlines were used to capture fish at depths ranging from 25 to 96 m.

Once fishing was completed, the catch was brought on board and enumerated. All by-catch was immediately released and spiny dogfish were handled by crew members wearing clean latex gloves to prevent contamination. The spiny dogfish were then placed in labeled polyethylene bags, stored in the onboard freezer and transferred to storage freezers at the end of the sampling day.

Figure 5.1 Sediment sampling locations for the HSPP dioxin/furan trend monitoring program, 1989 to 2012.



Legend

- Mill
- Closed to commercial crab fishing with a health advisory on non-commercial crab fisheries on the consumption of crab hepatopancreas
- (#) Crab hepatopancreas consumption limit (grams/week)
- 2012 Sediment Site
- Historical Sediment Site

0 2 4 8 km

Scale: 1:250,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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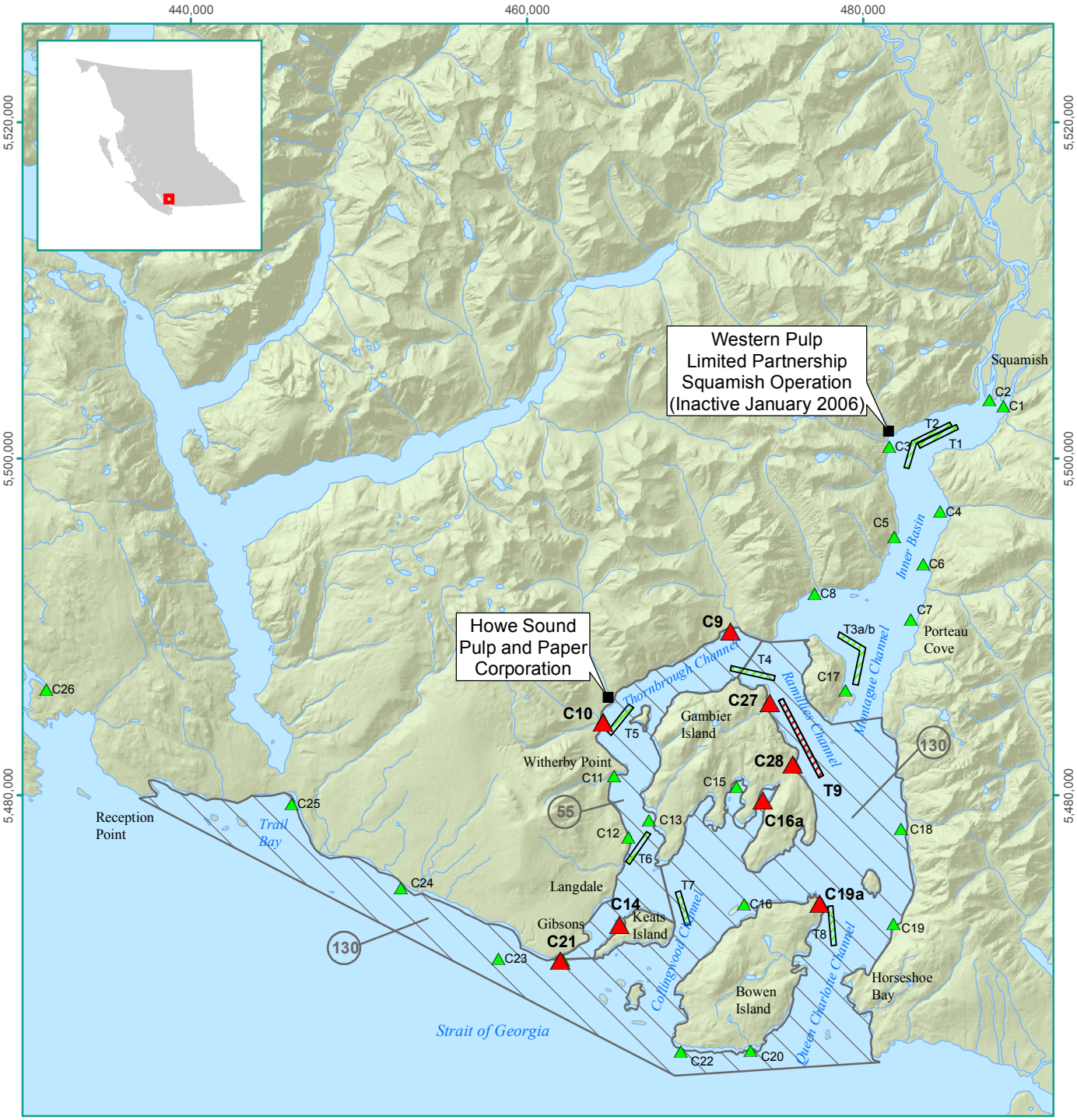
Figure 5.2 Dungeness crab and spiny dogfish sampling locations for the HSPP dioxin/furan trend monitoring program, 1989 to 2012.



Legend

- Mill
- Closed to commercial crab fishing with a health advisory on non-commercial crab fisheries on the consumption of crab hepatopancreas
- (#) Crab hepatopancreas consumption limit (grams/week)
- 2012 Crab Site
- Historical Crab Site
- 2012 Fish Area
- Historical Fish Area

0 2.5 5 10 km

Scale: 1:350,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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5.2.2 Crab and Finfish Sample Preparation

Tissue dissections were performed at a Hatfield facility in North Vancouver. As in previous dioxin/furan monitoring programs conducted for HSPP by Hatfield, ultra-clean techniques were used in the dissection and preparation of samples for analysis.

5.2.2.1 Special Precautions in Handling of Biological Tissues

Special precautions were exercised during all handling and dissection procedures in order to prevent contamination of crab and finfish samples; these included:

- Use of disposable latex gloves for handling all specimens (gloves were changed between each composite);
- Rinsing of stainless steel dissection trays and tools (scalpels, forceps, calipers, etc.) using Liquinox metals-free soap, followed by hexane and acetone rinses between composites; and
- Tools and gloved fingertips which touched the external parts of a specimen were not allowed to touch internal tissues; any tissue suspected of being contaminated in this manner was discarded.

5.2.2.2 Crab Dissections

Dungeness crab hepatopancreas analyses for the 2012 Howe Sound program included multi-crab composites from each site.

Crabs were dissected in April 2012 by Hatfield personnel at Hatfield's facilities in North Vancouver. Specimens were taken out of the Hatfield freezer facility the evening before, and thawed overnight. Crabs were measured using calipers to record the carapace width (± 0.5 mm). Crabs were weighed using a Kilotech Scale (up to 5,000 g with ±0.1 g accuracy). Carapace and leg colour and hardness, presence of lesions or barnacles, and any missing legs were noted.

A stainless-steel spoon was then slid under the carapace to pry the shell open and expose the internal organs in order to perform a general health assessment. Using stainless-steel forceps, hepatopancreas tissue was removed from the anterior corners of the carapace and from discrete pockets in the main body cavity, with caution being exercised to avoid the gill area. Hepatopancreas tissue was placed into the appropriate pre-labeled, heat-treated glass jar, and weighed using a tared electronic balance (± 0.01 g). Tissue from all crabs at a site were placed into a single jar to achieve a target weight of 10 g of tissue per crab for each site composite, as per Government of Canada requirements (More R, Environment Canada, pers. comm. 2009). One chela and leg (i.e., muscle tissue) was removed from the body of each crab and archived at Hatfield's freezer facilities, while the remaining carcass was discarded. Site composite jars were sealed with a Teflon-lined lid, immediately frozen, and transported to AXYS Analytical Services Ltd. (AXYS) in Sidney, BC, for analyses.

5.2.2.3 Finfish Dissections

Spiny dogfish collected from Howe Sound were dissected in April 2012. Each fish was measured for fork length and total length (± 1 mm), and weighed using an electronic balance (± 0.1 g). The external condition of each fish was evaluated, including the condition of the skin, fins and eyes.

Each fish was opened using stainless steel scissors, and positioned with the dorsal side down facing upward. From each dogfish, a piece of the right lobe of the liver was removed and transferred to a heat-treated, labeled, amber glass jar and weighed using an electronic balance (± 0.1 g). Liver tissue from the spiny dogfish that were collected was placed into a single jar; a target weight of 10 g of tissue per fish was used for each site composite.

A piece of muscle tissue from all spiny dogfish was removed from the region posterior to the dorsal fin and above the lateral line. The skin was carefully removed from the muscle tissue, and the sample was transferred to an amber glass jar and weighed.

An internal assessment was then performed on each fish in order to determine sex, as well as the appearance of the spleen, liver, kidney, gall bladder, hindgut, and to estimate overall fat content and parasitic presence.

Composites of the spiny dogfish liver and muscle tissue were immediately frozen following dissection, and transported to AXYS Analytical Services Ltd. (AXYS) in Sidney, BC for analyses.

5.3 SAMPLE ANALYSIS

A list of samples submitted for analyses is provided in Table 5.2.

5.3.1 Sediment

Sediment samples were analyzed by AXYS for dioxins and furans (pg/g dry weight), and by ALS for particle size, percent loss on ignition (LOI), and percent moisture content. As in previous programs, sediments were fractionated into the following four categories for size analysis: clay (<4 μm), silt (4 μm to 0.063 mm), sand (0.063 mm to 2 mm), and gravel (> 2 mm). LOI was measured to give an indication of the amount of organic matter in the sediments.

5.3.2 Crab and Finfish Tissues

Crab and spiny dogfish tissues were analyzed by AXYS for percent lipid, moisture content, and dioxin and furans (Appendix A2).

Table 5.2 Summary of sediment, crab, and finfish sample submissions for the Howe Sound dioxin/furan trend monitoring program, 2012.

Survey Component	Site	Samples Submitted for Analyses
Sediment	S14 (HSPP diffuser)	1 composite sample to ALS for particle size, LOI%, moisture% 1 composite sample to AXYS for dioxin and furan analyses
Crab	C9 (McNab Point)	1 composite of 8 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
	C10 (HSPP diffuser)	1 composite of 8 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
	C14 (West Keats Island)	1 composite of 9 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
	C16a (Port Graves)	1 composite of 10 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
	C19a (Cates Bay)	1 composite of 10 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
	C21 (S. Gower Pt.)	1 composite of 10 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
	C27 (Douglas Bay)	1 composite of 1 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
	C28 (Brigade Bay)	1 composite of 5 male Dungeness crab hepatopancreas to AXYS for lipid%, moisture%, dioxin and furan analyses
Finfish	T9 (Queen Charlotte Channel)	1 composite of 8 dogfish liver tissues to AXYS for lipid%, moisture%, dioxin and furan analyses 1 composite of 8 dogfish muscle tissues to AXYS for lipid%, moisture%, dioxin and furan analyses

5.4 DATA PRESENTATION

The following sections summarize definitions and criteria used throughout the report.

5.4.1 Terminology and Abbreviations

For the purpose of this report, the term "crab" refers to Dungeness crab. Unless otherwise stated, "dioxin" and "furan" refer to 2,3,7,8-tetrachlorodibenzodioxin (2,3,7,8-T_4CDD, T_4CDD, or TCDD) and 2,3,7,8-tetrachlorodibenzofuran (2,3,7,8-T_4CDF, T_4CDF, or TCDF), respectively. Unless otherwise specified, "Total-TEQ" or "TEQ" refers to Environment Canada Total-2,3,7,8-T_4CDD Equivalents; "Norm. TEQ" refers to either the carbon-normalized TEQ (sediments) or the lipid-normalized TEQ.

Several abbreviations are used in the text, figures, and appendices to present data; these include:

- ND (not detected);
- NDR (peak detected in analysis, but did not meet laboratory quantification criteria);

- NC (not collected; Hatfield staff were not instructed to collect crabs from this site);
- NCAP (not captured; Hatfield staff were instructed to collect crab from this site, but despite every reasonable attempt, specimens could not be collected); and
- NT (not tested; samples were collected, but were archived and not analyzed by any laboratory).

5.4.2 Data Format

Analytical data in this report are presented in the format provided by the analytical laboratories. For dioxin and furan analyses, concentration units are reported in picograms per gram (pg/g), equivalent to parts per trillion (ppt). Dioxin and furan data are presented by dry weight for sediments, and wet weight for tissues.

5.4.3 Detection Limits

Detection limits vary according to variable, matrix (i.e., sediment or tissue), and sample. Internal laboratory QA/QC procedures define detection limits, which are reported along with sample data. Concentrations closer to the detection limit are subject to higher coefficients of variability. In this report, concentrations of all variables that are less than five times the detection limit are considered trace. The US EPA (1982) defines the Method Detection Limit (MDL) as "*The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.*"

5.4.4 Levels of Quantification

The level of quantification refers to the minimal concentration that can be certified with sufficient confidence for legal purposes. The US EPA (1982) defines estimated quantification limits (EQL) as *"The* lowest *concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally five to ten times the method detection limit. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes the EQL concentration is selected as the lowest non-zero standard in the calibration curve. Sample EQLs are highly matrix dependent."* These levels are partially based on inter-laboratory comparisons and have only been developed for 2,3,7,8-T_4CDD/F concentrations in mill effluent. These values have been set at 15 pg/kg for 2,3,7,8-T_4CDD and 50 pg/kg for 2,3,7,8-T_4CDF, resulting in a 2,3,7,8-T_4CDD/F TEQ of 20 pg/kg (Government of Canada 1992).

5.4.5 Non-Detectable Values

In the case where an "ND" or "NDR" value was used in calculations of mean concentrations of an analyte/congener, the detection limit for the analyte/congener was used in the calculation.

5.4.6 Lab Duplicates

Duplicate analyses were performed as part of the QA/QC program by the laboratory; unless noted otherwise, data used in the report and in tables and figures are the mean values from the original analyses. Results of all duplicate analyses are provided in Appendix A2.

5.4.7 TEQ Values

Total-TEQ values represent the sum of all dioxin and furan congener TEQ values for a sample and provide a measure of the total toxicity of a sample. TEQs are calculated by multiplying the concentration of each congener with its respective Toxic Equivalency Factor (TEF) to normalize the concentration to the level that would be produced by an equivalent amount of 2,3,7,8-T_4CDD or P_5CDD (the most toxic congeners).

The World Health Organization (WHO) has established and regularly re-evaluates TEFs (WHO-TEFs) for dioxins based on expert consultations and the most recent, up-to-date peer-reviewed scientific literature.

Two methods can be used to include non-detectable concentrations of dioxin and furan congeners in TEQ calculations:

- Use half the detection limit of the congener in the TEQ calculation (i.e., ND= ½ DL); or
- Assign a value of 0 to the congener in the TEQ calculation (i.e., ND=0 pg/g).

Unless otherwise stated, the latter TEQ calculation was used for non-detectable concentrations throughout this report. Major differences between TEQ values calculated using the two methods will only occur if a large number of congeners are below detection; this was not the case in this report.

Dioxin and furan congener contributions to the Total-TEQ were calculated for sediment and tissues. All congeners from collected samples were multiplied by the WHO-TEFs, summed, and then divided by the Total-TEQs to determine relative congener contributions out of 100%. These profiles can be useful to identify potential sources of dioxins and furans (Luthe and Prahacs 1993, Luthe et al. 1995).

5.4.8 Normalized TEQ Values

Dioxins and furans are lipophillic and hydrophobic organic chemicals that will be preferentially absorbed in carbon of sediments and lipid (i.e., fat) of aquatic biota. Consequently, normalizing dioxin and furan concentrations with concentrations of carbon in sediment or lipid in biota will provide a more meaningful basis for making comparisons in relative concentrations among years or sites. Carbon-normalized TEQs were estimated by dividing the sediment TEQ by percent loss on ignition, and multiplying the result by 100. Lipid normalized TEQs ("Norm. TEQs") were calculated by dividing the tissue TEQ by percent lipid, and multiplying the result by 100.

5.4.9 Health Hazard Assessment Levels

Health Canada has developed criteria for establishing consumption advisories/fisheries closures based on tissue concentrations of 2,3,7,8-T_4CDD/F (expressed as Total-TEQ). Historically, dioxin/furan trend monitoring criteria have been set at 15 pg/g TEQ for muscle tissue and 30 pg/g TEQ for liver and hepatopancreas tissue. For crab, these criteria were established using a tolerable daily intake (TDI) of 10 pg TEQ/kg body weight, a mean body weight of 60 kg, and an adult daily intake of 20 g/day of crab hepatopancreas.

In July 2006, Health Canada re-evaluated the human health risk associated with the consumption of crab hepatopancreas using dioxin data from 2003 onward. The new assessment was based on a revised tolerable daily intake (TDI) of 2.3 TEQ/kg body weight, a mean body weight of 65 kg, and an adult daily intake of 6.2 g/day of crab hepatopancreas. A new consumption threshold of 24.4 pg/g total TEQ (wet weight) for crab hepatopancreas tissue was established as a result of these changes (Hatfield 2009). Consumption thresholds of 15.0 pg/g total TEQ (wet weight) for crab and finfish muscle tissue, and 30 pg/g total TEQ (wet weight) for finfish liver tissue remain the same (R. More, Environment Canada, pers. comm. 2009).

5.5 DATA ANALYSIS

5.5.1 Descriptive Graphs

Graphical methods were used to display results visually in order to aid with data assessment and interpretation of temporal and spatial trends.

5.6 RESULTS

5.6.1 Sediment

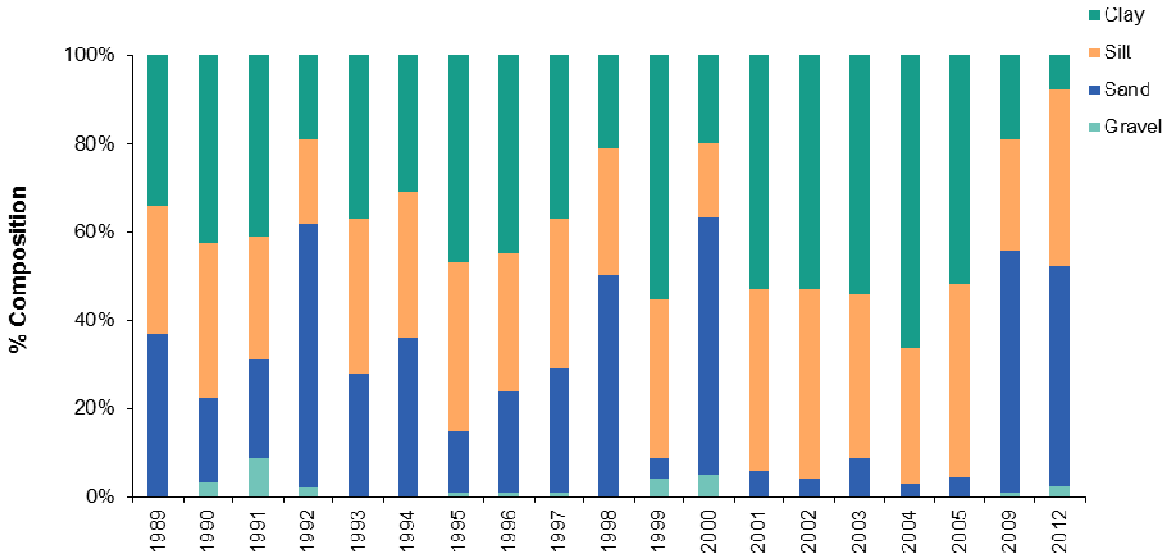
Raw sediment data for site S14 in 2012 are presented in Appendix A2. This site has been sampled regularly since the Howe Sound dioxin/furan trend monitoring program began in 1989, and has been the sole sediment monitoring site since 1997.

5.6.1.1 Physical Characteristics of Sediment

Particle Size Distribution

In 2012, sediments at site S14 consisted primarily of sand (50%) and silt (40%), with a relatively smaller amount of gravel (2.3%) and clay (7.9%) (Figure 5.3). Since sediment monitoring began in 1989, sediments at site S14 have exhibited varying degrees of sand versus the finer silt/clay fractions, suggesting the patchy nature of sediments present in the vicinity of the sampling site.

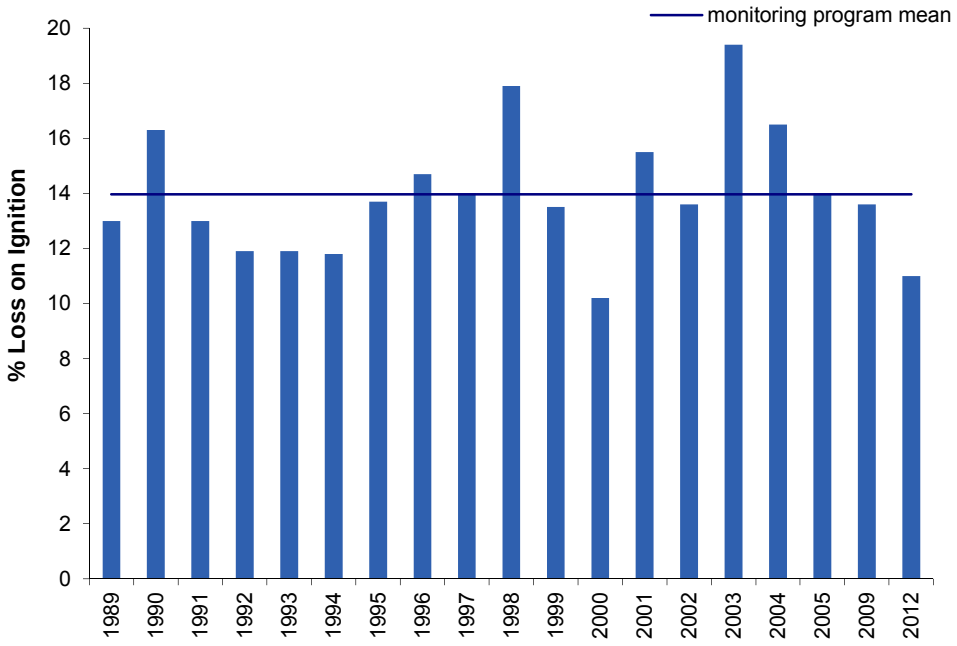
Figure 5.3 Particle size distribution profile (% composition) of sediments collected at site S14, Howe Sound, 1989 to 2012.



5.6.1.2 Volatile Residue

Volatile residues in sediments from site S14 measured during 2012 were 11% (measured as % loss on ignition; Figure 5.4). The concentration observed in 2012 was lower than historical years, with the exception of 2000 (10.2%), and below the mean concentration across the entire monitoring program (13.97%).

Figure 5.4 Volatile residues (% loss on ignition) in sediments collected at site S14, Howe Sound, 1989 to 2012.

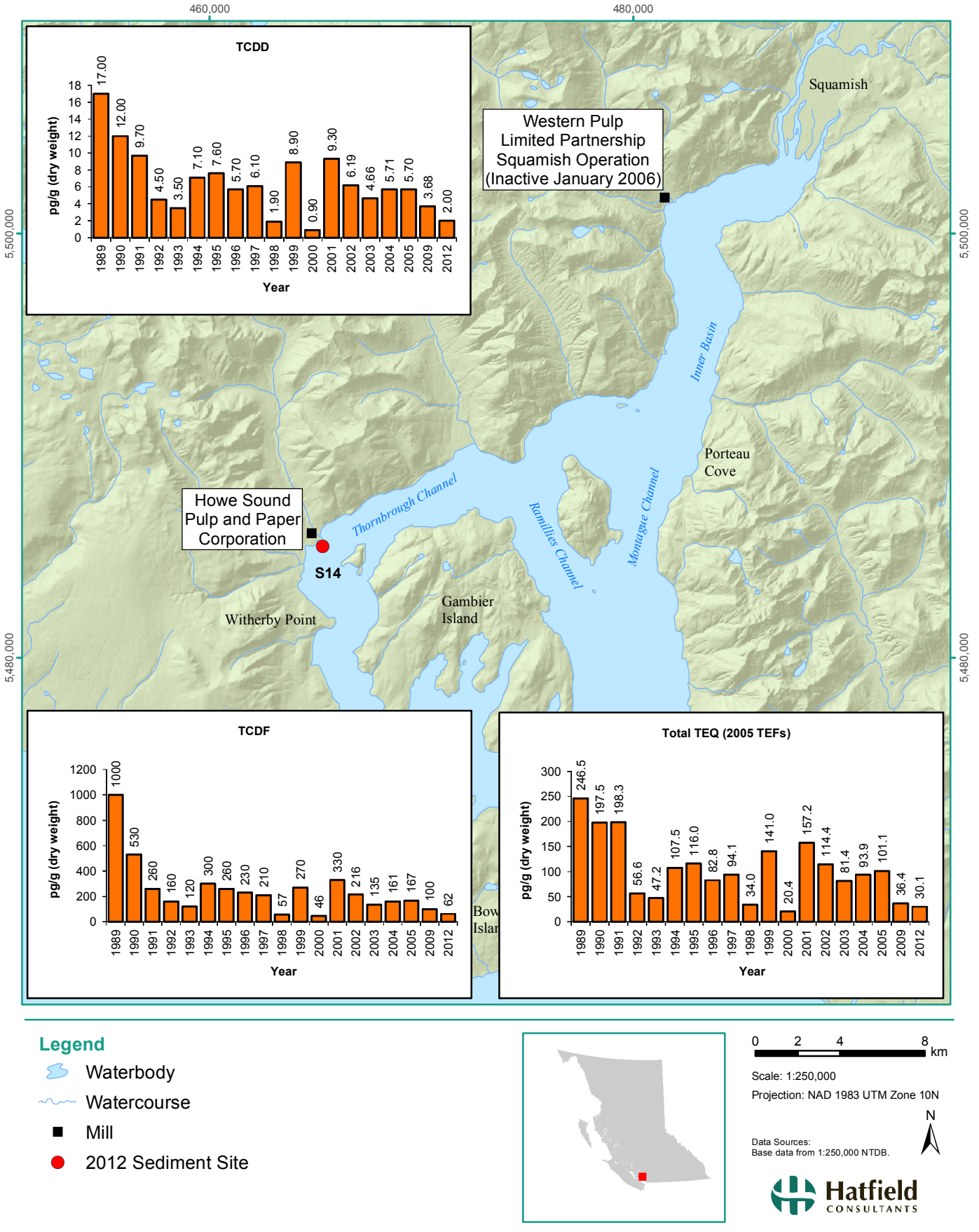


5.6.1.3 Dioxins

The concentration of 2,3,7,8-T_4CDD in sediments at site S14 in 2012 (2.0 pg/g) was at the lower end of the range of concentrations reported since 1992 (Figure 5.5). Prior to 1992, concentrations of 2,3,7,8-T_4CDD in sediments were higher and exhibited annual decreases in response to the progressive switch from elemental chlorine to chlorine dioxide in the bleaching process. Following 1992, concentrations were quite variable although still below concentrations observed prior to 1990.

Concentrations of total dioxin congeners measured in 2012 were within the lower end of the historical range (Figure 5.6). Historically, concentrations of H_6CDD ranged from 400 pg/g to 3,500 pg/g; H_6CDD in 2012 was 617 pg/g, and the lowest concentration observed since 2000. The other four dioxin congeners typically exhibited concentrations less than 700 pg/g. Total T_4CDD concentrations were consistently the lowest of the five congeners; in 2012, T_4CDD measured 27.2 pg/g.

Figure 5.5 Concentrations of 2,3,7,8-T_4CDD, 2,3,7,8-T_4CDF, and Total TEQ in sediments at site S14, Howe Sound, 1989 to 2012.



Legend

- Waterbody
- Watercourse
- Mill
- 2012 Sediment Site

0 2 4 8 km

Scale: 1:250,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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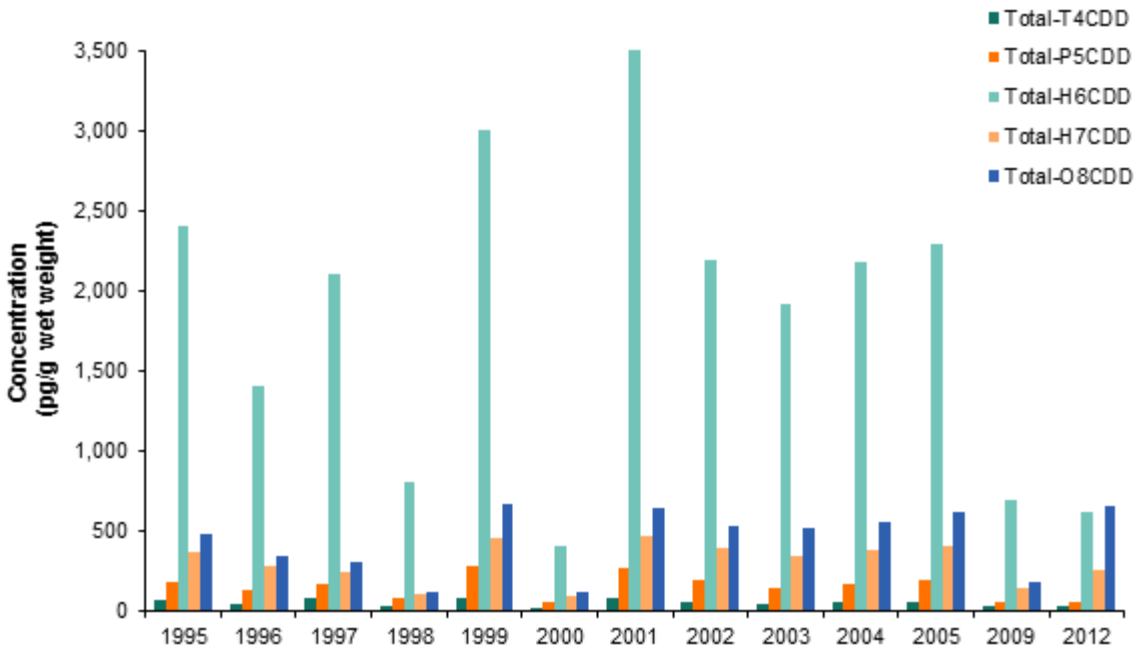
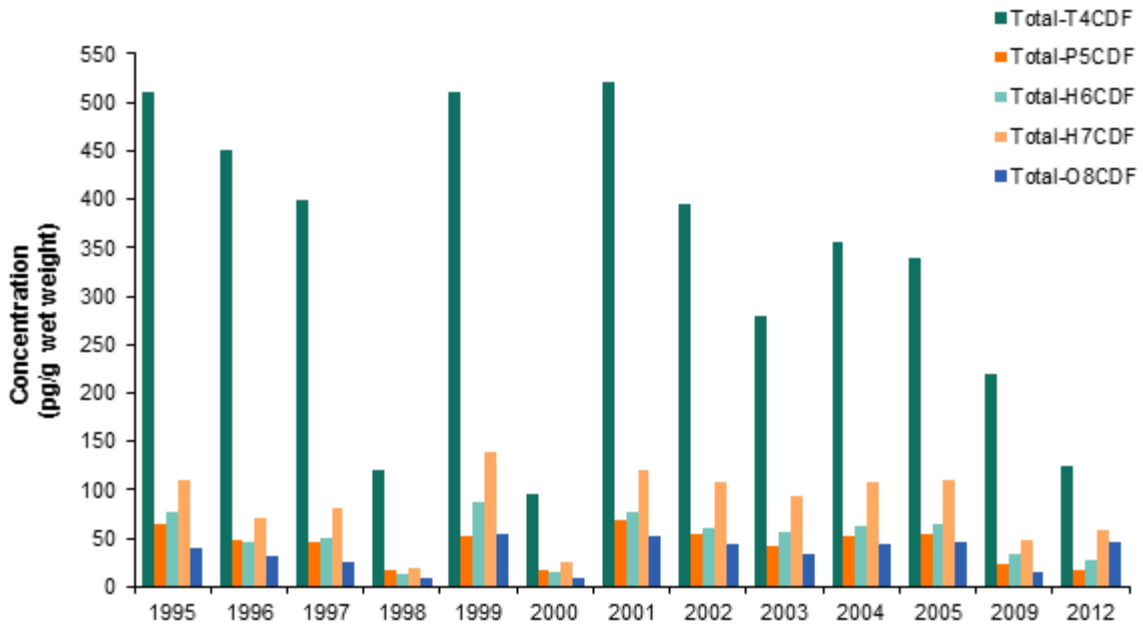
Figure 5.6 Concentrations of dioxin congeners in sediments collected at site S14, Howe Sound, 1995 to 2012.



5.6.1.4 Furans

Historically, T_4CDF concentrations ranged between 95 and 520 pg/g; the concentration T_4CDF was 125 pg/g in 2012, which was the lowest concentration observed since 2000 (Figure 5.7). The other four furan congeners typically exhibited concentrations less than 150 pg/g. Total O_8CDF concentrations were consistently the lowest of the five congeners; however, in 2012, O_8CDF was 46.3 pg/g, resulting in the highest concentration recorded since 1995 for this specific congener.

Figure 5.7 Concentrations of furan congeners in sediments collected at site S14, Howe Sound, 1995 to 2012.

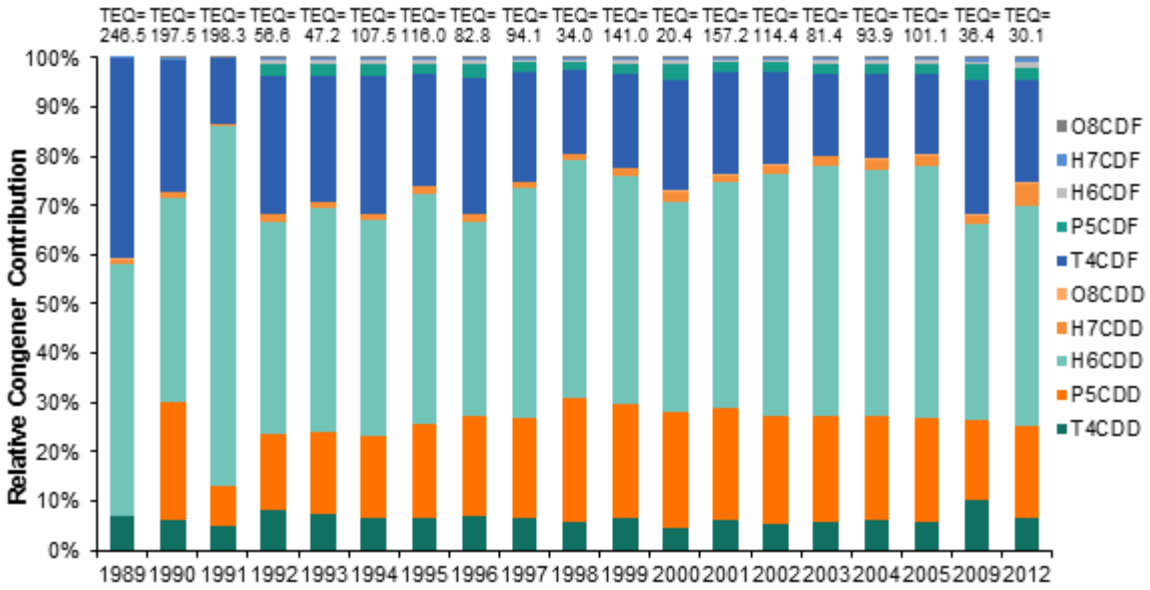


5.6.1.5 Total TEQs

In 2012, the total TEQ concentration measured in sediments at site S14 (30.1 pg/g) was comparable to the lowest historical concentration that was observed in 2000 (20.4 pg/g) (Figure 5.8). Historically, the concentrations of TEQs ranged from 246.5 pg/g in 1989 to 20.4 pg/g in 2000.

TEQ values in sediment at site S14 have been dominated by the following three congeners: H_6CDD, P_5CDD, and T_4CDF (Figure 5.8). Relative contributions of these congeners to the total TEQs have varied over time, but have remained as the dominant congeners.

Figure 5.8 Percent contribution of individual congeners to total TEQs in sediments collected at site S14, Howe Sound, 1990 to 2012.

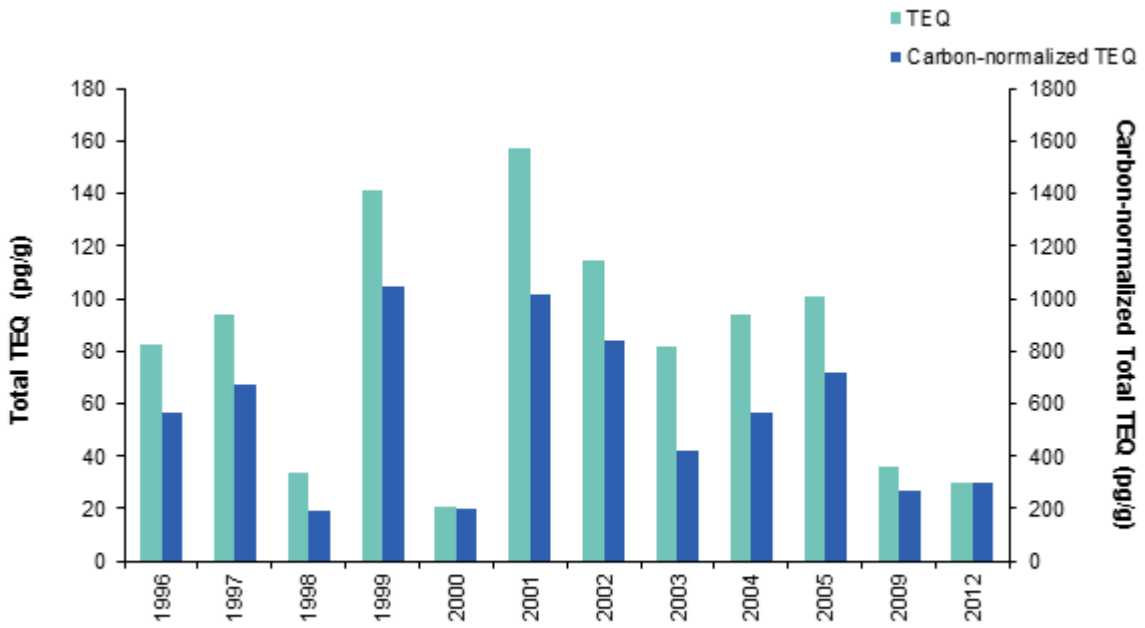


5.6.1.6 Carbon-normalized TEQs

In 2012, concentrations of carbon-normalized total TEQ in sediment at site S14 were 301 pg/g (Figure 5.9), which was lower than previous years with the exception of 2000 (200.4 pg/mg) and 2009 (267.4 pg/g). The organic content of sediments at site S14 in 2012 was lower than in previous years (10%).

Overall, the total TEQ at site S14 was within the lower historical range with and without organic content factored into the concentrations (Figure 5.9). With carbon variability removed, TEQ levels in 2012 were still near the lower end of the historical range of concentrations.

Figure 5.9 Carbon-normalized TEQ and Total TEQ in sediment collected at site S14, Howe Sound, 1996 to 2012.



5.6.2 Dungeness Crabs

5.6.2.1 Catch Results

Crabbing effort took place across seven days, between March 5 and 11, 2012, at a total of eight sites in Howe Sound. The required number of adult male crabs to be captured from each site was seven. At six of the eight sites (C9 to C21) between eight and ten crabs were captured and at sites C27 and C28, one and five crabs were captured, respectively.

5.6.2.2 Size and Condition

Carapace widths of crabs caught in 2012 ranged from 167 mm to 218 mm and body weight ranged from 548 g to 1256 g. The minimum size restriction for adult crabs (165 mm) was implemented in 2003; prior to 2003, smaller crabs have been collected for the Howe Sound dioxin/furan program.

In 2012, no obvious patterns were observed for external or internal abnormalities in crabs. Lesions were observed on the carapace, legs and chela of several crabs at all sites. Moderate to heavy gill fouling was also observed at several sites in Howe Sound due to particulate matter.

Length and weight data are presented in Appendix A3.

5.6.2.3 Tissue Chemistry

Dioxins

Results for dioxin concentrations in crab hepatopancreas measured during the 2012 monitoring program at Howe Sound are listed in Table 5.3. Detailed laboratory reports are provided in Appendix A2.

In 2012, concentrations of 2,3,7,8-T_4CDD in crab hepatopancreas ranged from 0.48 pg/g (C27) to 7.23 pg/g (C19a). Concentrations in 2012 of 2,3,7,8-T_4CDD in crabs, were lower than concentrations measured during previous sampling years (Figure 5.10).

A full range of total dioxin congeners was detected in crab hepatopancreas analyzed in 2012 (Table 5.3). Similar to 2009, site C27 exhibited the lowest overall concentrations of the five congeners, while site C19a exhibited the highest congener concentrations. Relative concentrations of dioxin congeners from largest to smallest were: H_6CDD > P_5CDD > H_7CDD > O_8CDD > T_4CDD. H_6CDD congeners were present in the highest concentrations ranging from 0.53 pg/g at site C27 to 4.24 pg/g at site C28. T_4CDD congeners exhibited the lowest concentrations ranging from 0.48 pg/g at site C27 to 7.23 pg/g at site C19a.

Furans

Results for furan concentrations in crab hepatopancreas measured during the 2012 monitoring program at Howe Sound are listed in Table 5.3.

In 2012, concentrations of 2,3,7,8-T_4CDF in crab hepatopancreas ranged from 5.34 pg/g (C27) to 381 pg/g (C19a). Concentrations of 2,3,7,8-T_4CDF in crabs at four of the eight sites (C14, C16a, C19a, C28) were higher in 2012 than concentrations measured during the previous sampling program conducted in 2009 (Figure 5.11).

A full range of total furan congeners were detected in crab hepatopancreas analyzed in 2012 (Table 5.3). Site C27 exhibited the lowest overall concentrations of the five congeners and site C19a exhibited the highest congener concentrations. Relative concentrations of furan congeners, in order from largest to smallest, were: T_4CDF > P_5CDF > H_6CDF > H_7CDF > O_8CDF. T_4CDF congeners were present in the highest concentrations ranging from 6.45 pg/g at site C27 to 329 pg/g at site C19a. Total O_8CDF congeners exhibited the lowest concentrations ranging from 0.442 pg/g at sites C16 and C19a to 1.33 pg/g at site C27.

Table 5.3 Concentrations (pg/g wet weight) of dioxin and furan congeners in crab hepatopancreas, 2012.

Site	2,3,7,8 T_4CDD	Total T_4CDD	Total P_5CDD	Total H_6CDD	Total H_7CDD	Total O_8CDD	1,2,3,7,8 P_5CDD	% Lipid
C9	1.49	6.29	26	110	4.63	1.11	6.31	10.6
C10	1.71	7.77	24.5	183	8.46	1.24	6.31	7.55
C14	2.51	11.7	43.1	134	6.26	1.66	13.1	7.71
C16a	2.14	11.9	38.1	93.4	15.4	3.49	9.75	12.2
C19a	7.23	36.7	262	892	25.6	5.26	54.7	9.44
C21	1.19	8.19	17	73	9.89	1.62	4.38	12.5
C27	0.48	1.83	1.97	5.69	<0.53	<1.33	0.93	1.39
C28	4.09	13.9	102	352	11.3	ND (2.52)	22.9	10.1

Site	2,3,7,8 T_4CDF	Total T_4CDF	Total P_5CDF	Total H_6CDF	Total H_7CDF	Total O_8CDF	Total TEQ[1]	Lipid-normalized TEQ[2]
C9	47.1	72.3	16.3	8.83	1.37	<0.49	17.67	166.70
C10	54.9	92.4	17.3	6.78	1.46	<0.50	20.25	268.21
C14	116	155	36.7	15.3	1.33	<0.45	36.06	467.70
C16a	53.1	92.8	31.3	15	2.26	<0.44	21.86	179.18
C19a	381	553	236	215	16.5	<0.44	151.49	1604.77
C21	25	49.8	23	16.6	2.89	<0.49	11.98	95.84
C27	5.34	10.1	0.34	<0.53	<0.53	<1.33	2.65	190.65
C28	188	254	85.4	68.1	6.4	<0.46	66.88	662.18

[1] WHO TEQ (2005).

[2] Lipid-normalized TEQ is calculated by dividing the WHO-TEQ (ND=O) by the % lipid and multiplying by 100.

ND (DL) = not detected (detection limit).

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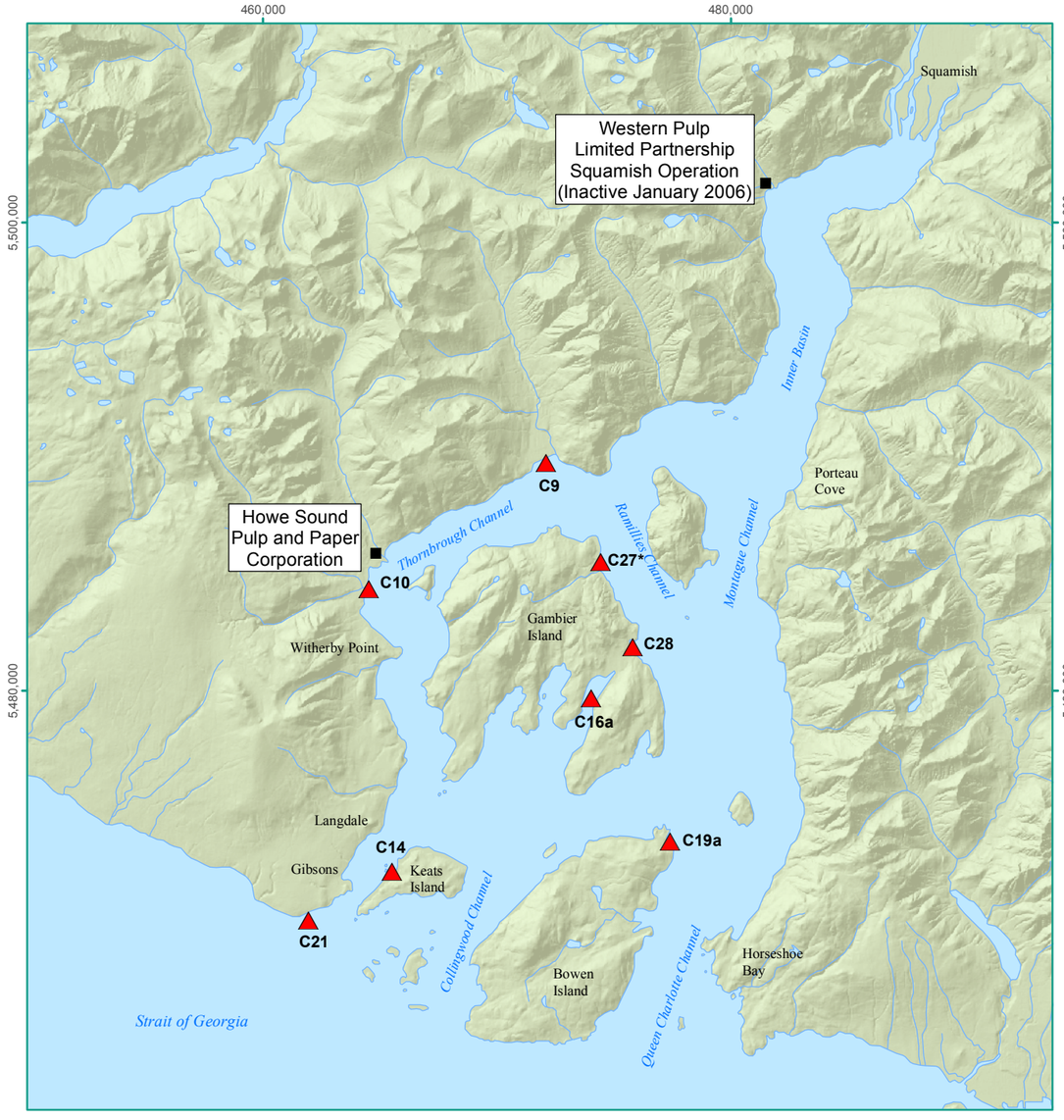
Figure 5.10 Concentrations of 2,3,7,8-T_4CDD in Dungeness crab hepatopancreas, Howe Sound, 1989 to 2012.



Legend

- Waterbody
- Watercourse
- Mill
- 2012 Crab Site

NC Not Collected
NCAP Not Captured
* Only one crab was captured at this location

0 1.5 3 6 km

Scale: 1:250,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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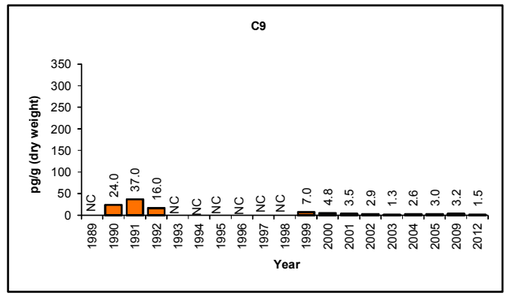
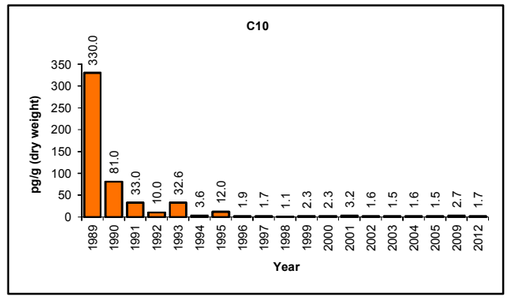
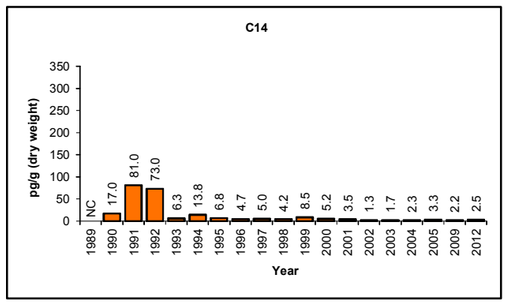
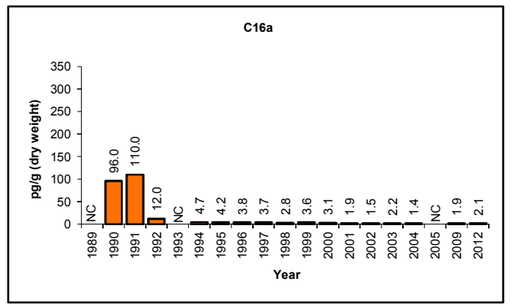
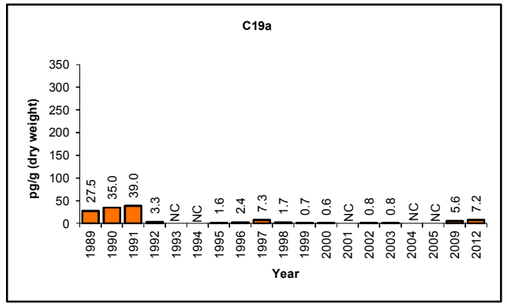
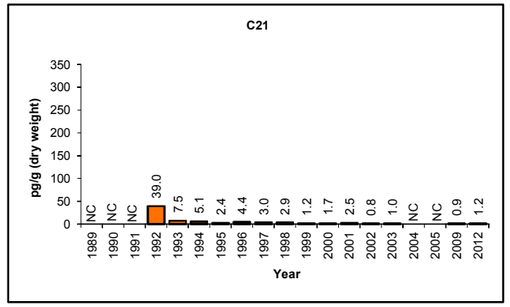


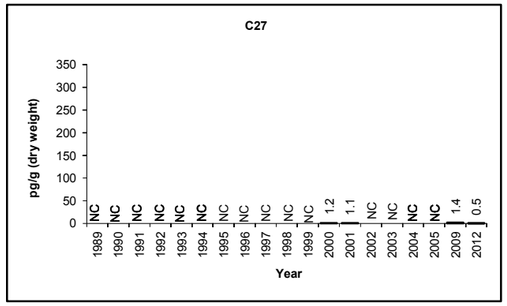












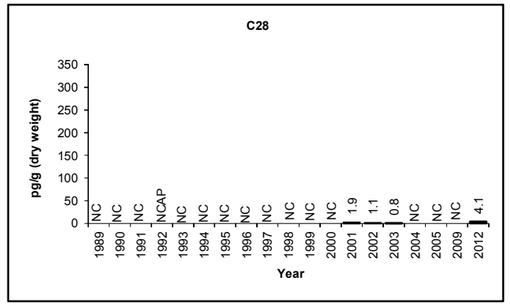
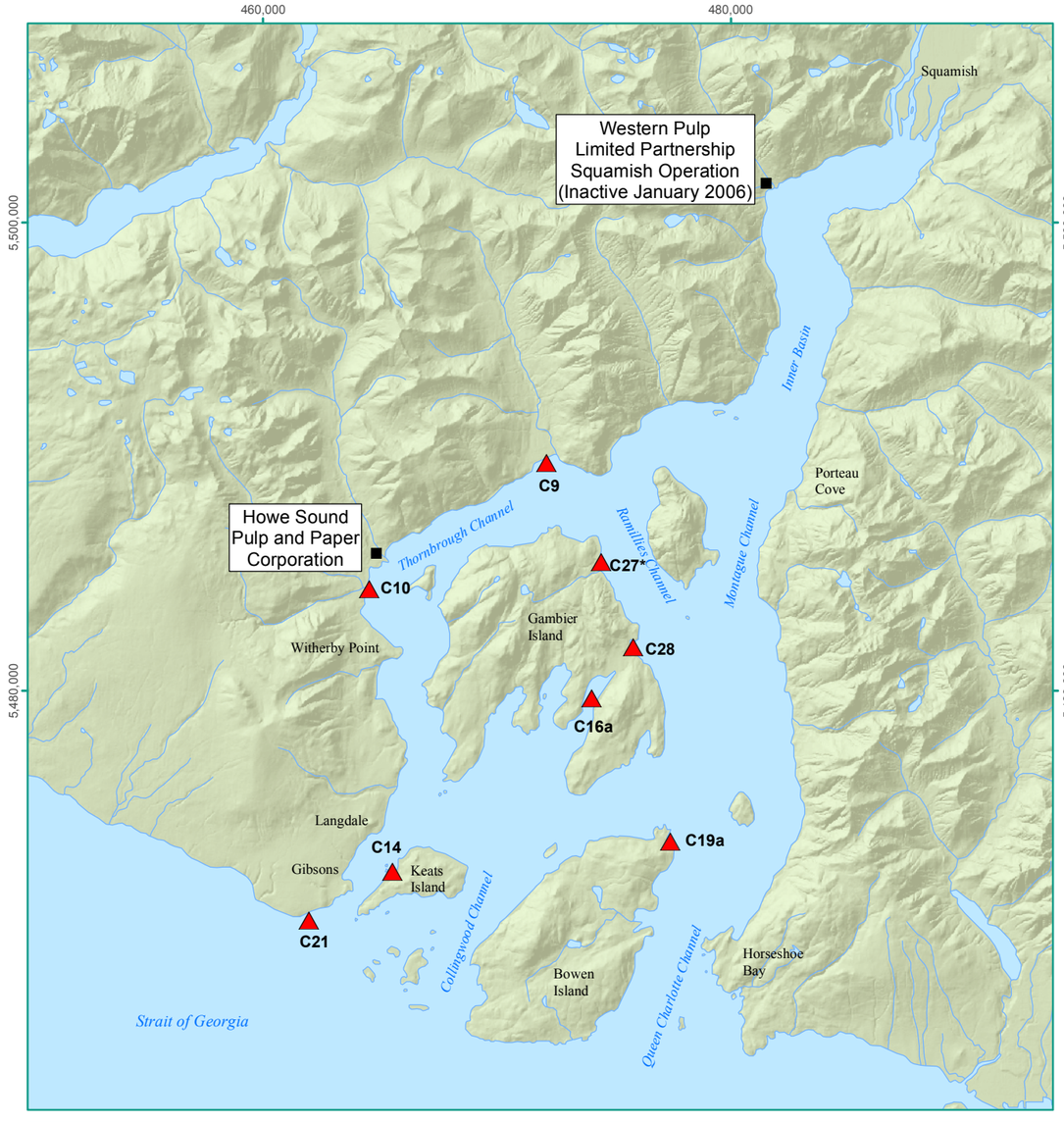


Figure 5.11 Concentrations of 2,3,7,8-T_4CDF in Dungeness crab hepatopancreas, Howe Sound, 1989 to 2012.



Legend

- Waterbody
- Watercourse
- Mill
- 2012 Crab Site
  - NC Not Collected
  - NCAP Not Captured
  - * Only one crab was captured at this location

0 1.5 3 6 km

Scale: 1:250,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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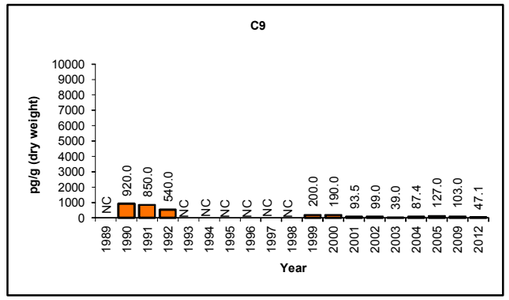

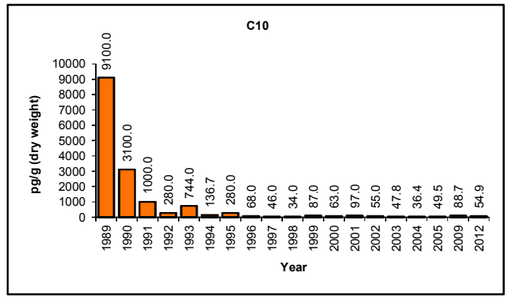

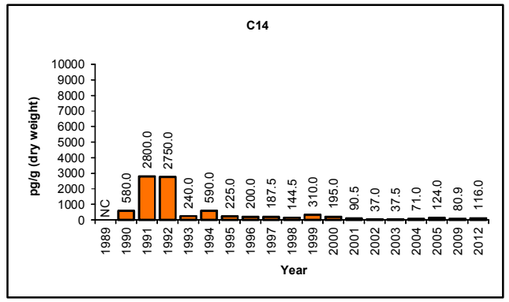

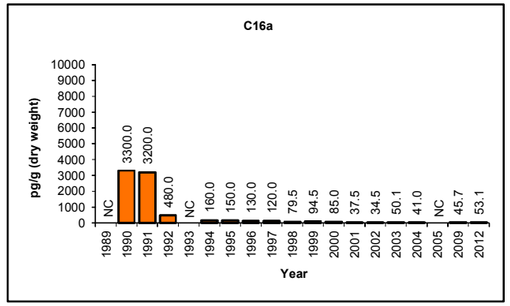

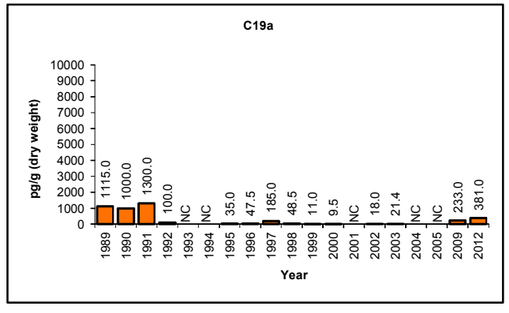

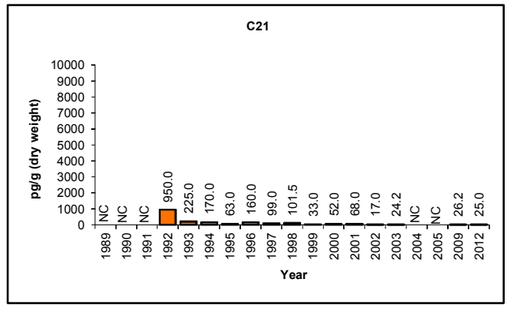

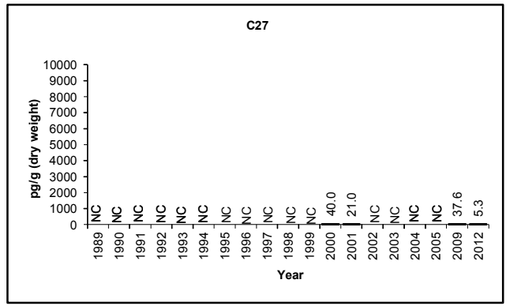

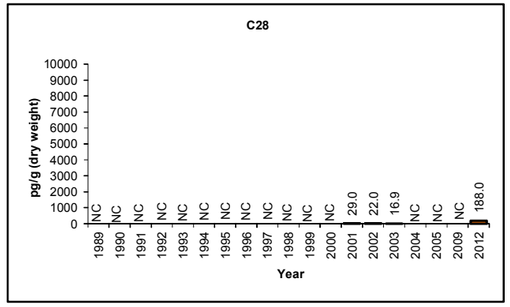

5.6.2.4 Toxicity Equivalent Values (TEQs)

Total TEQs

Crab total TEQs from largest to smallest were as follows: 151.5 pg/g at C19a, 66.9 pg/g at C28, 36.1 pg/g at C14, 21.9 pg/g at C16a, 20.3 pg/g at C10, 17.7 pg/g at C9, 12.0 pg/g at C21 and 2.7 pg/g at C27 (Table 5.3). Although levels at most sites continue to fluctuate, total TEQ values have decreased since the onset of organochlorine monitoring at the mill, pollution abatement changes at the mill in the early 1990s, and from ongoing mill updates and changes in production levels in the early 2000s (Figure 5.12). In 2012, three sites (C19a, C21 and C28) had higher TEQ levels in crabs than in previous years, while two sites (C14 and C16a) had the highest TEQs since 2001; the remaining three sites had generally lower TEQ values than previous sampling years.

Congener Contributions TEQs

In 2012, relative congener contributions to total TEQ were similar between sites (Figure 5.13), with the largest contributing factors to TEQ being P_5CDD, T_4CDF, and H_6CDD. At all sites, contributions of P_5CDD were greater than those of T_4CDF and H_6CDD.

Historical comparisons at all sites indicated that congener contributions to total TEQs in crab hepatopancreas have been consistent across sampling years from the late 1990s/early 2000s, with the exception of site C19a, C27 and C28 (Figure 5.14 to Figure 5.21). At all sites, contributions of T_4CDD and T_4CDF relative to all other congeners have declined over time as a result of the elimination of elemental chlorine bleaching at the mill.

Lipid-normalized TEQs

Lipid-normalizing TEQ values diminish the confounding effects of crab-to-crab variations in fatty tissues, which are known to accumulate contaminants. Normalized crab TEQ concentrations were higher at four of eight sites (C10, C14, C19a, and C27); however, with the exception of site C27, differences between total TEQ and lipid-normalized TEQ concentrations in 2012 were not substantial (Figure 5.22).

Screening Against Crab Consumption Criteria

TEQ concentrations in crab collected from three sites in Howe Sound exceeded the Health Canada consumption advisory criteria of 24.4 pg/g: C14 (1.5 times higher), C19a (6.2 times higher), and C28 (2.7 times higher). TEQ concentrations at all other sites were below the guideline. TEQ concentrations exceeded the guideline in crabs from site C19a in Cycle Five as well, by 3.5 times; however, two other sites (C10 and C9) had showed exceedances of TEQ concentrations in Cycle Five that were not observed in Cycle Six.

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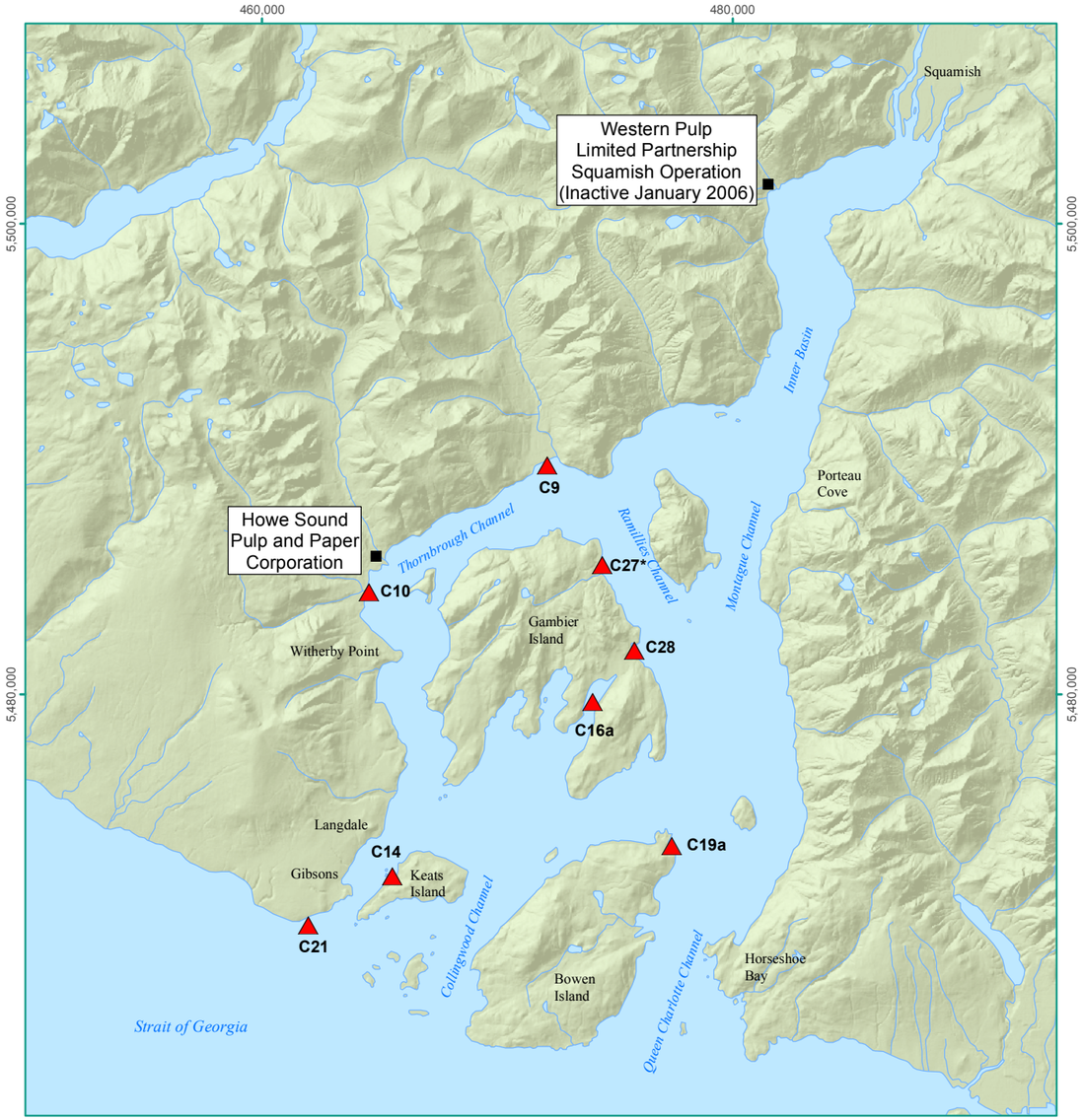
Figure 5.12 Concentrations of Total TEQ (based on WHO 2005 TEFs) in Dungeness crab hepatopancreas, Howe Sound, 1989 to 2012.



Legend

- Waterbody
- Watercourse
- Mill
- 2012 Crab Site
  - NC Not Collected
  - NCAP Not Captured
  - * Only one crab was captured at this location

0 1.5 3 6 km

Scale: 1:250,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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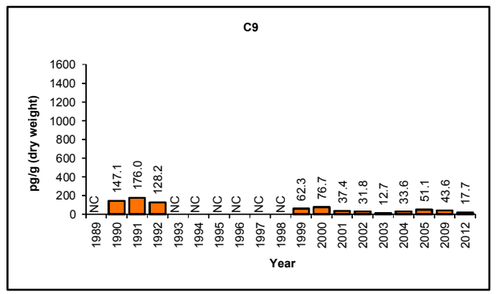
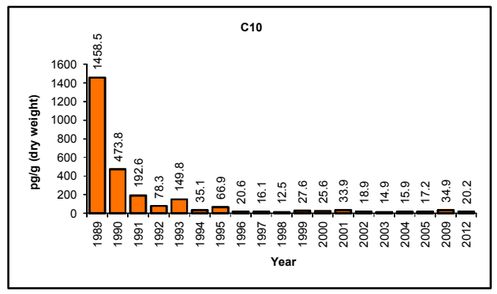
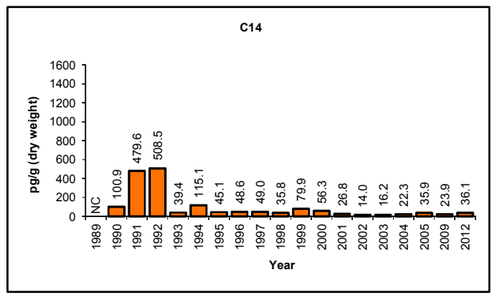
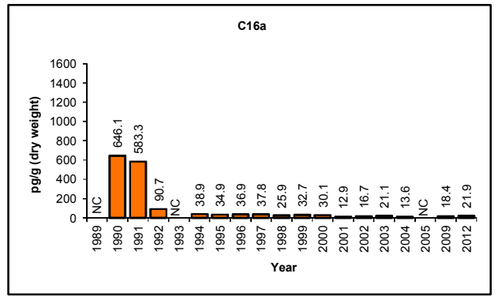
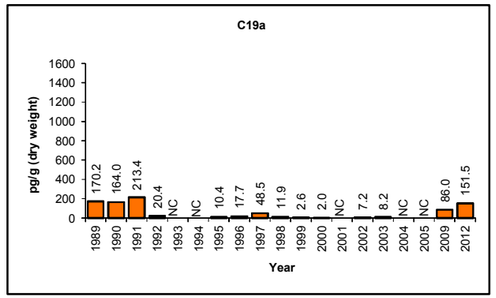
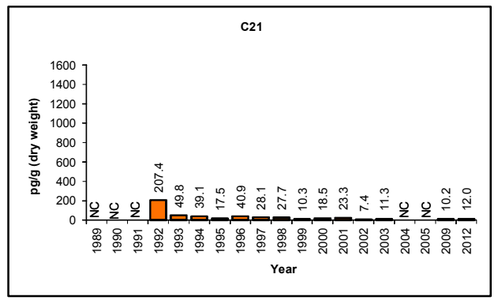


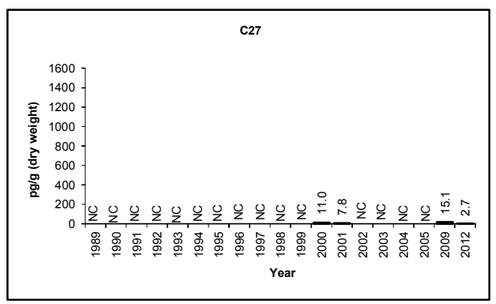












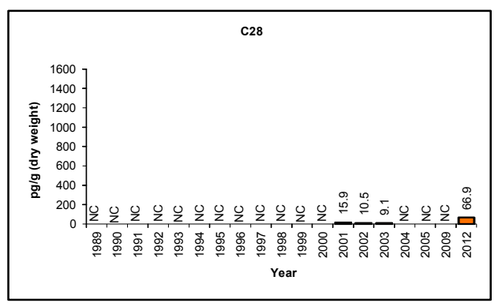


Figure 5.13 Percent contribution of individual congeners to total TEQs in crab hepatopancreas at all sites, 2012.

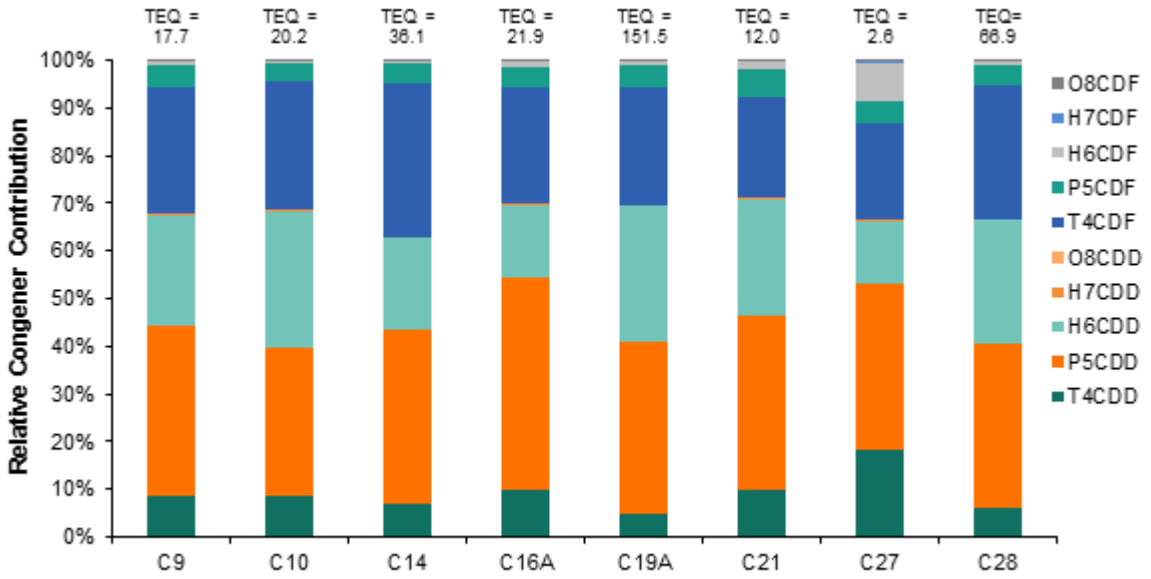


Figure 5.14 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C9, 1990 to 2012.

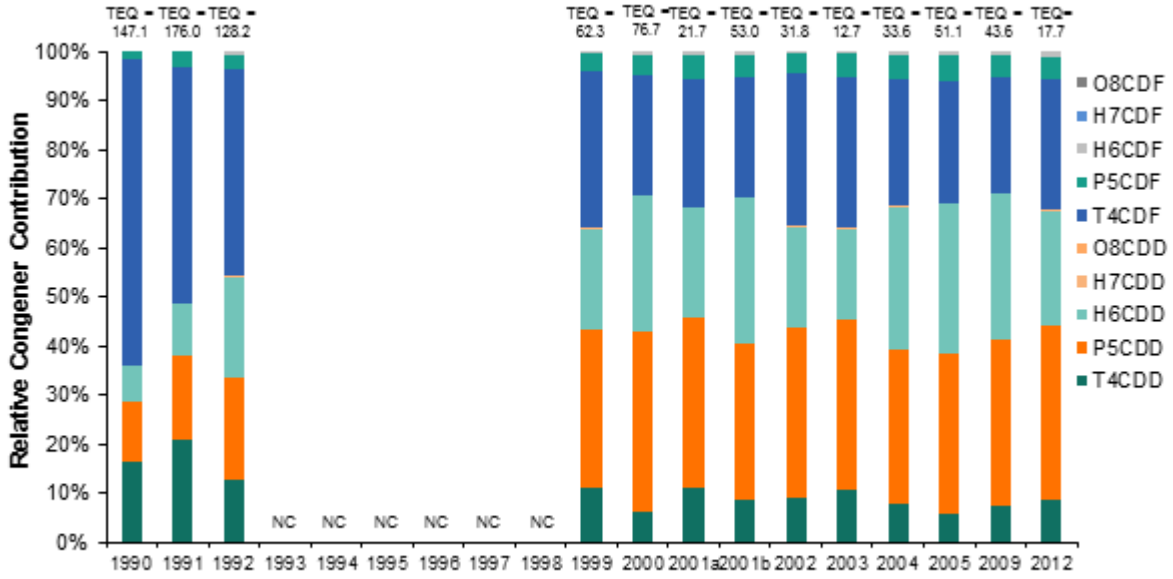


Figure 5.15 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C10, 1989 to 2012.

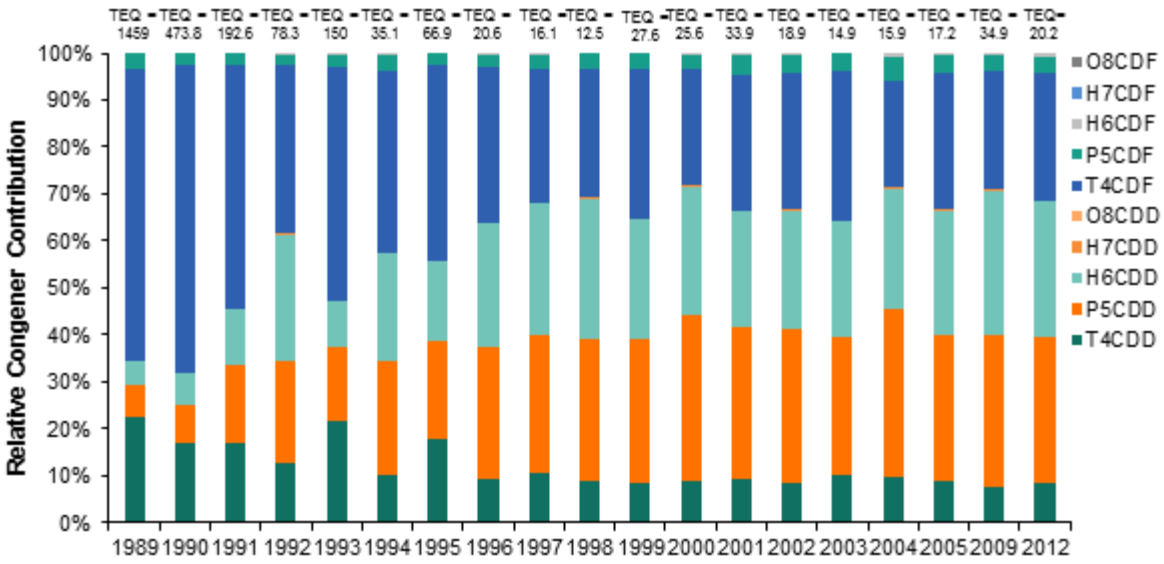


Figure 5.16 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C14, 1990 to 2012.

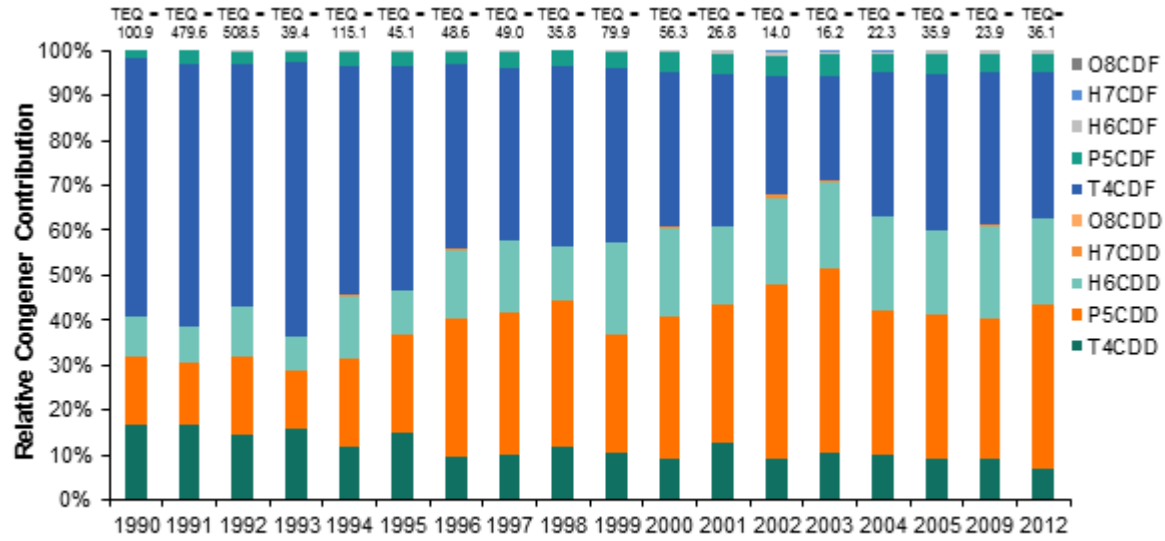


Figure 5.17 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C16a, 1990 to 2012.

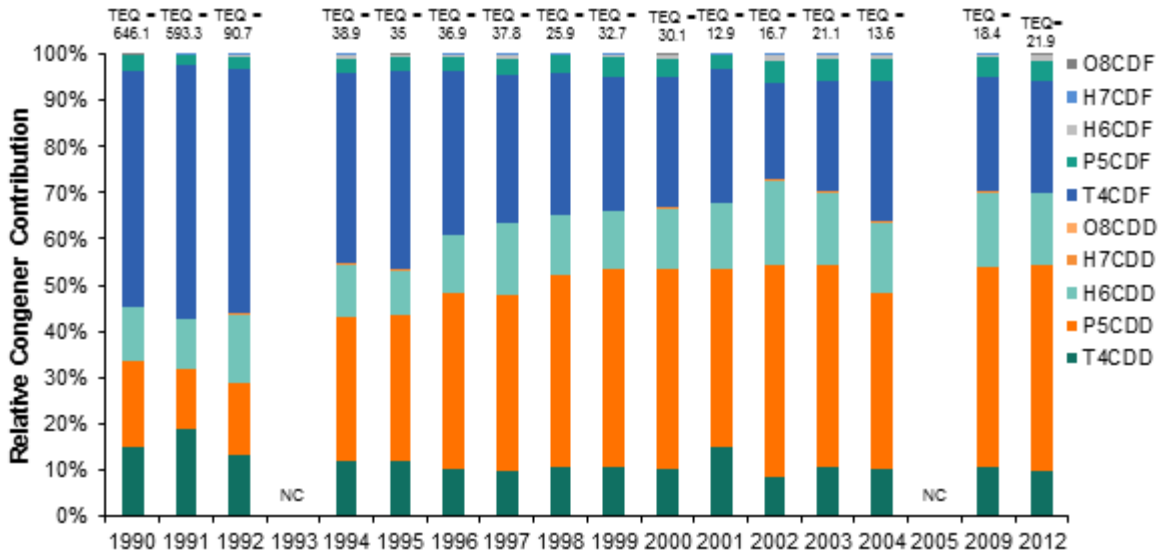


Figure 5.18 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C19a, 1989 to 2012.

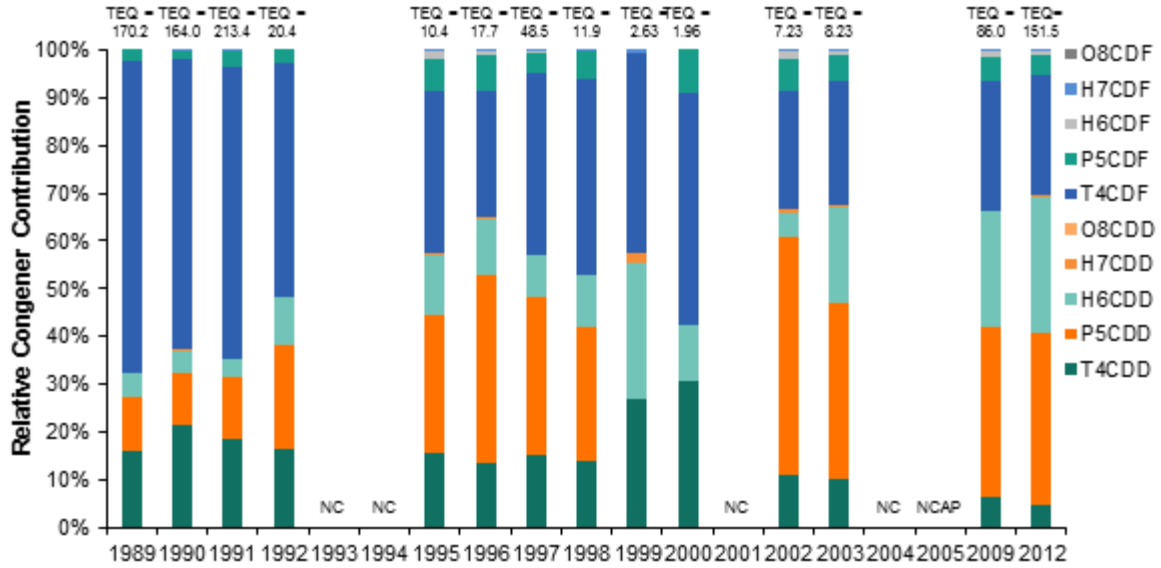


Figure 5.19 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C21, 1992 to 2012.

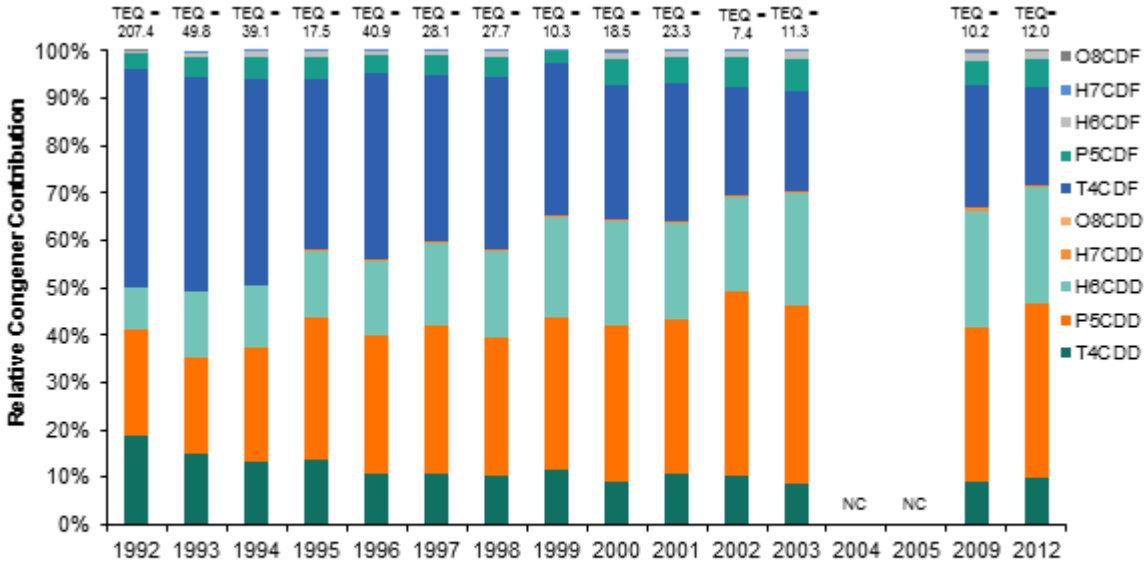


Figure 5.20 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C27, 2000 to 2012.

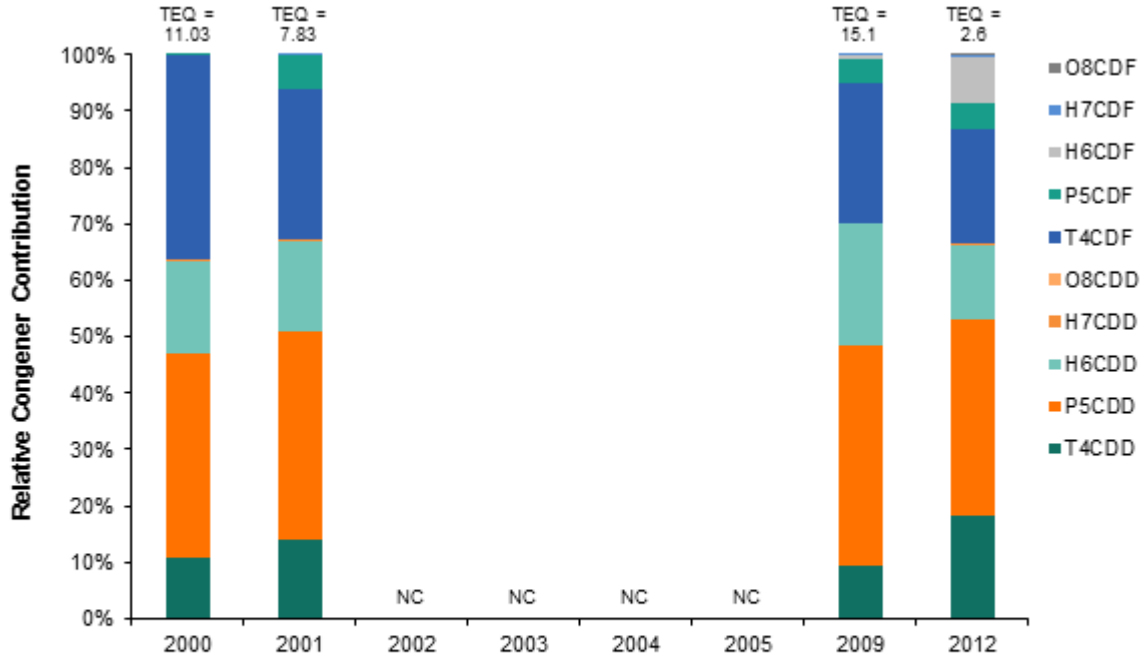


Figure 5.21 Percent contribution of individual congeners to total TEQs in crab hepatopancreas from site C28, 2000 to 2012.

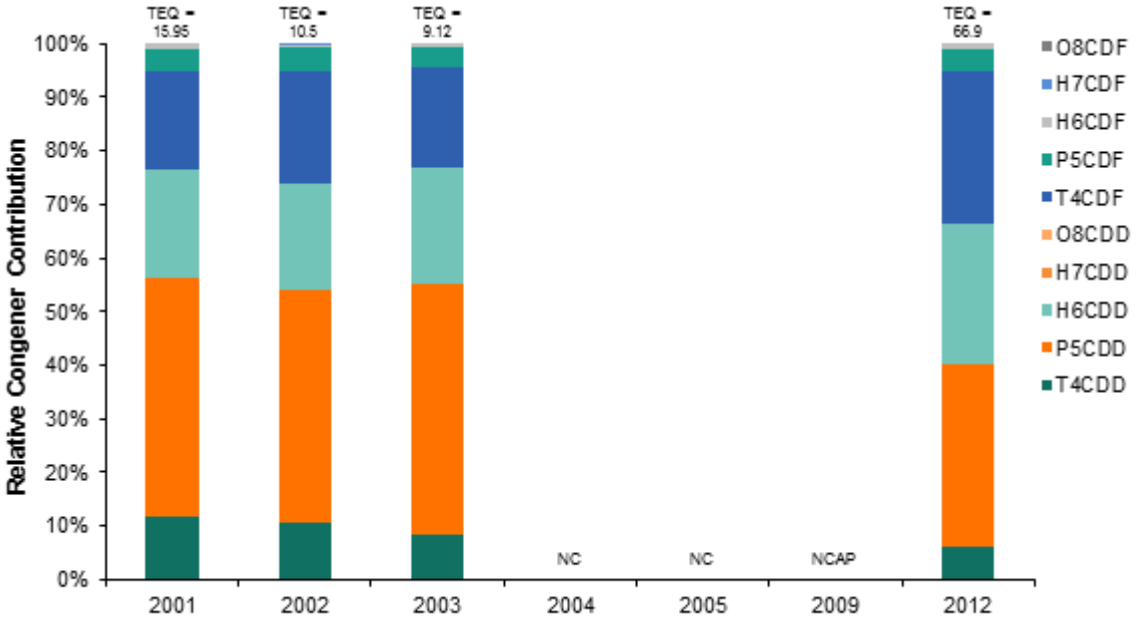
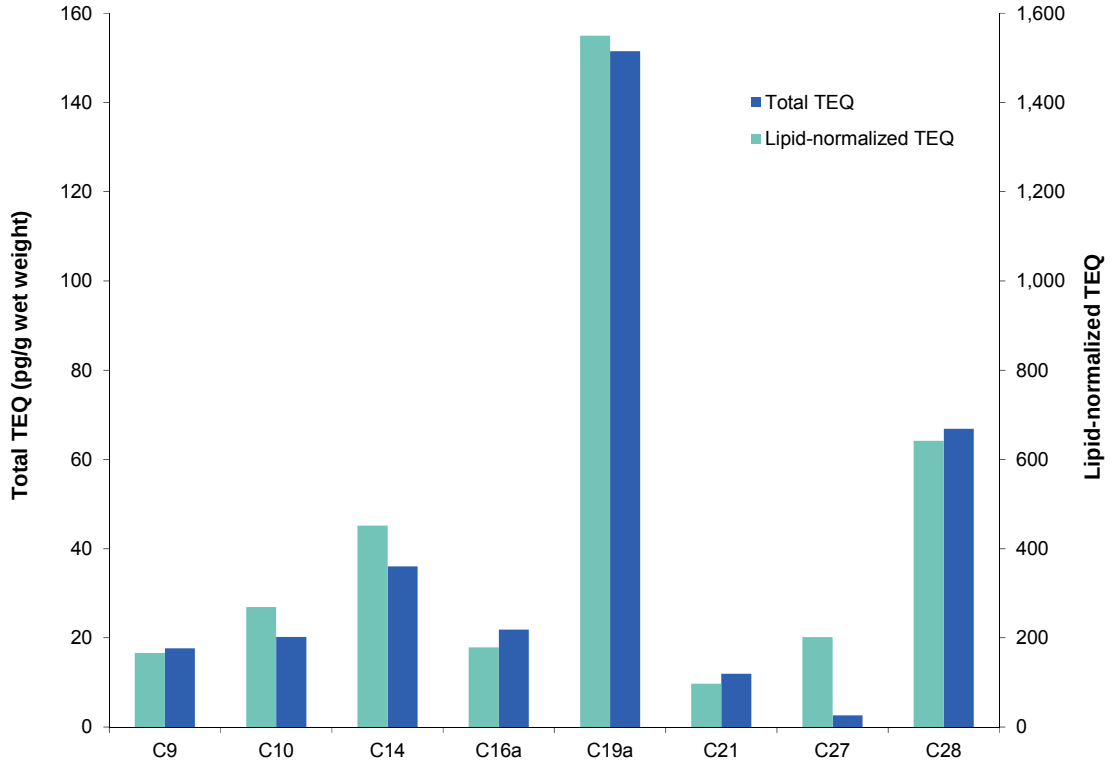


Figure 5.22 Total TEQs and lipid-normalized TEQs (pg/g wet weight) in Dungeness crab hepatopancreas collected at all sites, 2012.



5.6.3 Finfish

5.6.3.1 Catch Results

Fishing effort took place at site T9 in the Queen Charlotte Channel over two days, on March 10 and 11, 2012 (Table 5.4). The required number (n=7) of spiny dogfish, greater than 600 mm in length (n=7), were captured for the 2012 dioxin/furan monitoring program.

5.6.3.2 Size and Condition

The total length of spiny dogfish captured at site T9 in 2012 ranged from 677 mm to 813 mm, while the body weight ranged from 1,159 g to 2,518 g. Dogfish caught in 2012 were much smaller in weight than fish captured in 2009 (Appendix A3).

A health assessment of individual spiny dogfish did not show any obvious external or internal patterns of abnormalities; however, three dogfish had parasites in their gut and one dogfish had a granular kidney.

5.6.3.3 Tissue Chemistry

Dioxins

Results for dioxin concentrations in dogfish liver and muscle tissues measured during the 2012 dioxin/furan monitoring program at Howe Sound are presented in Table 5.4.

In 2012, concentrations of 2,3,7,8-T_4CDD was 45.3 pg/g in dogfish liver and 1.49 pg/g in dogfish muscle tissue. Higher concentrations of 2,3,7,8-T_4CDD in the liver were expected due to the detoxifying role of this organ. Generally, concentrations of T_4CDD in dogfish liver were lower than previous years, with the exception of 2004 (Figure 5.23).

Total dioxin congeners that were detected in dogfish liver and tissue samples in 2012 are presented in Table 5.4. Similarly to 2009, the relative concentrations of dioxin congeners from highest to lowest were: H_6CDD > P_5CDD > T_4CDD > H_7CDD > O_8CDD. H_6CDD was present in the highest concentrations in both the composite liver (155 pg/g) and tissue (76.3 pg/g) samples. Total O_8CDD exhibited the lowest concentrations, and below the detection limit in liver and 0.64 pg/g in muscle tissue.

Furans

Results for furan concentrations in dogfish liver and muscle tissues measured during the 2012 dioxin/furan monitoring program at Howe Sound are presented in Table 5.4.

In 2012, 2,3,7,8-T_4CDF in dogfish liver was 1,460 pg/g, which was 2.3 times lower than observed in 2009, and 49.9 pg/g in dogfish muscle tissue. Overall 2012 T_4CDF results for liver samples were lower than concentrations in previous years, with the exception of 2004 (Figure 5.23).

Table 5.4 Concentrations (pg/g wet weight) of dioxin and furan congeners in spiny dogfish, 2012.

Analyte	Dogfish Liver*	Dogfish Muscle
Dioxins		
2,3,7,8-TCDD	45.30	1.49
1,2,3,7,8-PeCDD	68.20	6.03
1,2,3,4,7,8-HxCDD	2.91	1.03
1,2,3,6,7,8-HxCDD	132	35.10
1,2,3,7,8,9-HxCDD	14.30	3.42
1,2,3,4,6,7,8-HpCDD	3.27	1.06
OCDD	ND (1.06)	0.64
Furans		
2,3,7,8-TCDF	1,460	51.90
1,2,3,7,8-PeCDF	6.82	0.28
2,3,4,7,8-PeCDF	25.70	2.35
1,2,3,4,7,8-HxCDF	1.02	0.61
1,2,3,6,7,8-HxCDF	1.01	< 0.20
1,2,3,7,8,9-HxCDF	< 0.19	< 0.20
2,3,4,6,7,8-HxCDF	1.29	0.71
1,2,3,4,6,7,8-HpCDF	0.73	1.19
1,2,3,4,7,8,9-HpCDF	< 0.19	< 0.20
OCDF	< 0.48	< 0.49
Total Dioxin Congeners		
Total Tetra-Dioxins	48	3.83
Total Penta-Dioxins	70	22
Total Hexa-Dioxins	155.0	76.3
Total Hepta-Dioxins	3.27	2.49
Total Furan Congeners		
Total Tetra-Furans	1,460	74
Total Penta-Furans	38.70	19.20
Total Hexa-Furans	6.39	13.10
Total Hepta-Furans	0.73	1.49
Total TEQ[1]	**282.7**	**17.3**
% Lipid	**67.9**	**14.1**
Lipid-normalized TEQ[2]	**509.57**	**122.70**

[1] WHO TEQ (2005).

[2] Lipid-normalized TEQ is calculated by dividing the WHO-TEQ (ND=O) by the % lipid and multiplying by 100.

ND (DL) = not detected (detection limit).

* Due to an interference inflating the 2,3,7,8-TCDF DB225 result, it was recommended by AXYS to use the DB-5 result which is the lower TCDF value (1460 pg/g) originally calculated. A new total TEQ was calculated using the DB-5 result and the 2005 TEF.

Dogfish liver samples from site T9 exhibited higher concentrations of the five congeners compared to the tissue samples. Similar to 2009, relative concentrations of furan congeners from highest to lowest were: T_4CDF > P_5CDF > H_6CDF > H_7CDF > O_8CDF. T_4CDF was present in the highest concentrations in composite liver (1,460 pg/g) and tissue (74 pg/g) samples. O_8CDF concentrations were below the detection limit for both liver and muscle tissue samples.

5.6.3.4 Toxicity Equivalent Values

Total TEQ

In 2012, the total TEQ concentration was higher in dogfish liver (282.7 pg/g) than dogfish tissue (17.3 pg/g) (Table 5.4). Overall, total TEQ concentrations in dogfish have decreased since monitoring began in the late 1990s; however, concentrations have increased again since 2004 when they reached a low of 2.8 pg/g (Figure 5.24).

Congener Contributions to TEQs

In 2012, relative congener contributions of TEQ were similar for dogfish liver. The most significant contributors to TEQ were T_4CDF, P_5CDD, and T_4CDD. Similarly to previous years, T_4CDF was a dominant contributor to TEQ in dogfish.

Congener contributions to total TEQs in dogfish have fluctuated historically at site T9. Contributions of T_4CDD and T_4CDF relative to all other congeners have not exhibited clear or consistent trends.

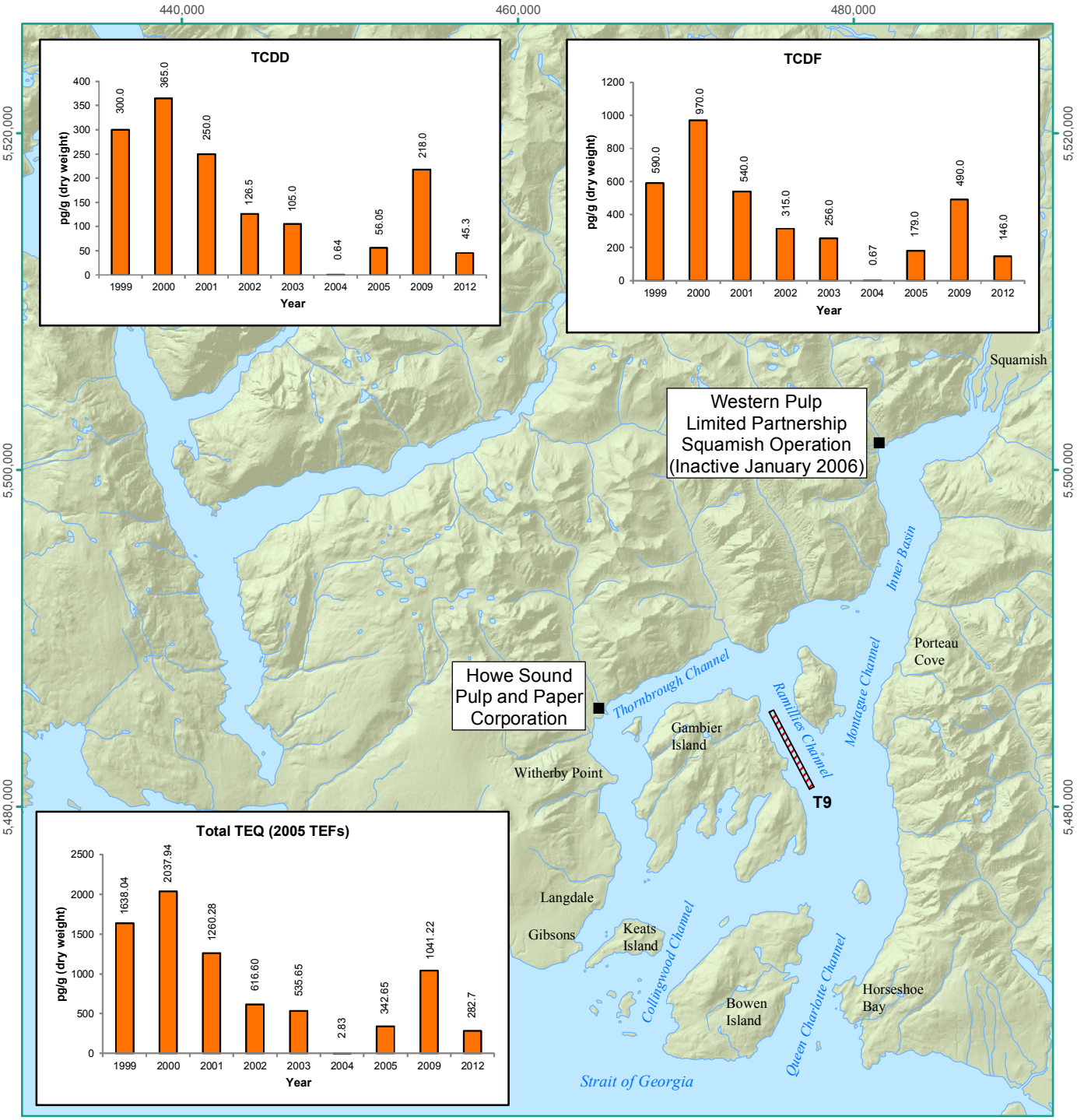
Lipid-normalized TEQs

In 2012, lipid-normalized TEQ concentrations relative to non-normalized TEQs were higher in both dogfish liver and muscle tissues (Table 5.4); these results are similar to TEQs in previous years (Hatfield 2009).

Screening Against Fish Consumption Criteria

Historically, TEQ concentrations in dogfish liver tissues collected from site T9 have exceeded the Health Canada consumption advisory criteria of 30.0 pg/g TEQ, with the exception of 2004 when TEQ levels dropped to 2.8 pg/g (Figure 5.23). In 2012, concentrations in dogfish liver (282.7 pg/g) were 9.4 times higher than the guideline.

Figure 5.23 Concentrations of 2,3,7,8-T_4CDD, 2,3,7,8-T_4CDF, and Total TEQ in dogfish liver at site T9, Howe Sound, 1999 to 2012.



Legend

- Waterbody
- Watercourse
- Mill
- 2012 Fish Area

0 2.5 5 10 km

Scale: 1:350,000

Projection: NAD 1983 UTM Zone 10N

N

Data Sources:
Base data from 1:250,000 NTDB.

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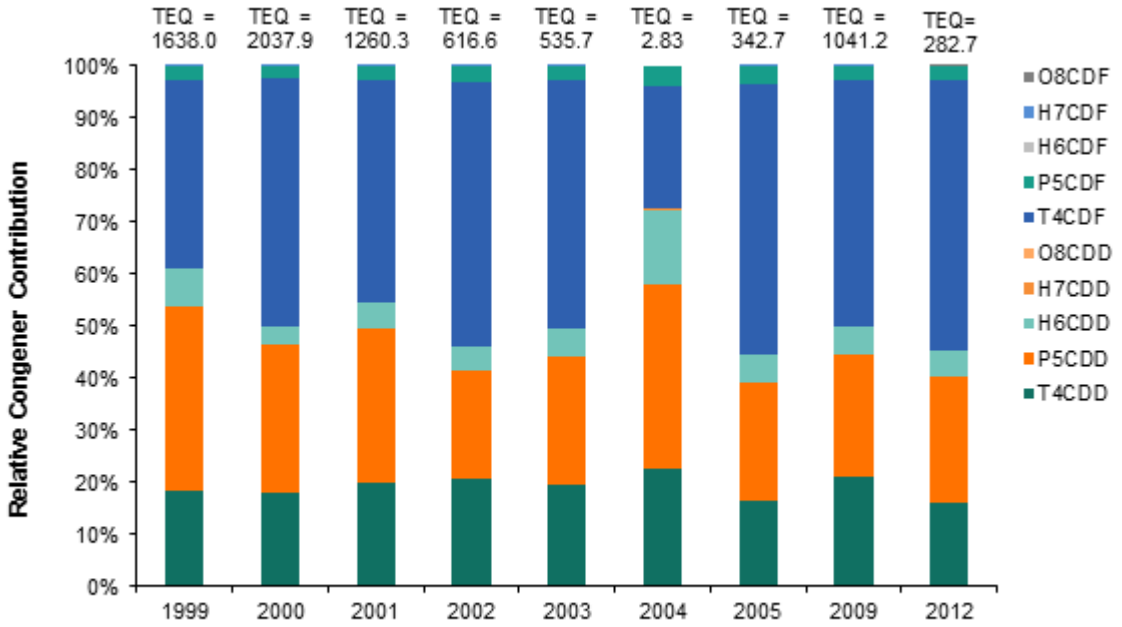
K:\Data\Project\HS1625_MXD\HS1625__I_FishTCDDFQ_20130304.mxd

Figure 5.24 Percent contribution of individual congeners to total TEQs in dogfish livers from site T9, 1999 to 2012.



5.7 DISCUSSION

In the late 1980s/early 1990s, while elemental chlorine was progressively being replaced by chlorine dioxide in the bleaching process, organochlorine concentrations in sediments near the HSPP diffuser began to decline each year. This result was consistent with what was observed at other Kraft mills where the presence of T_4CDD and T_4CDF congeners in aquatic environments was the direct result of elemental chlorine bleaching products in pulpmill effluents (Macdonald et al. 1998). However, given the persistent nature of organochlorine compounds, and despite the complete elimination of elemental chlorine bleaching in 1997 at HSPP, low concentrations of dioxins and furans have continued to persist in sediments near the HSPP diffuser, exhibiting no clear patterns over time. In 2012, this trend continued, although total TEQs in sediments were found be lower than has been observed since 2000, which could be related to the lower organic compounds content in sediments. Dioxin and furan tend to be more highly concentrated in sediments exhibiting greater levels of organic content (Isaacson and Frink 1984).

Similarly, concentrations of dioxins and furans in marine biota (i.e., Dungeness crab, spiny dogfish, bottomfish – historical studies) were also observed to decline markedly in the early 1990s, whereby they persisted and fluctuated at lower concentrations until present day.

Despite the overall decline in dioxin and furan concentrations in the hepatopancreas of crab, concentrations continue to fluctuate above and below the consumption guideline on an annual basis. For example, in 2012 total TEQ concentrations in crab hepatopancreas exceeded the Health Canada consumption

criteria (24.4 pg/g) at three of eight sampling sites, whereas crab from only one of these three sites (site C27) exceeded the criteria in 2009, along with crab from two different sites. Interestingly, there does not appear to be any consistent spatial trend in present day concentrations as crab from sites located closest to the HSPP diffuser (e.g., C9, C10) did not exceed the consumption criteria and site C19a, one of the more distant sites, has exhibited higher total TEQs in crabs over the past two surveys.

In the past decade, concentrations of dioxins and furans in dogfish have declined following the elimination of elemental chlorine bleaching. Recently, levels have fluctuated from below the consumption criteria in 2004 to greater than 30 times the guideline concentration in 2009. In 2012, concentrations in dogfish liver (282.7 pg/g) were 9.4 times higher than the Health Canada consumption advisory criteria of 30.0 pg/g, which was markedly lower than was found in 2009. It is interesting to note that although the dogfish captured in the 2009 and 2012 surveys were of similar length, the dogfish captured in 2009 were substantially heavier, which could relate to the much higher observed dioxin and furan concentrations in that year. In previous sampling years, no observable trend can be inferred; however, spiny dogfish in the Pacific region live to 40 years of age, with records of fish living 70 to 80 years in the Strait of Georgia (Saunders and McFarlane 1993). As stated in Hatfield Consultants (2009), maturing or matured dogfish that are captured during the dioxin/furan monitoring program in Howe Sound likely have been alive for several decades during the use of elemental chlorine bleaching at the mill, and it is likely historical exposure to high organochlorine concentrations resulted in bioaccumulation of these compounds in their tissues during that time.

The current goal for Howe Sound EEM program was to continue documenting organochlorine concentrations in sediment, Dungeness crab hepatopancreas, and dogfish muscle tissue and liver. Since 1989, concentrations of dioxin and furans in shellfish and finfish have been declining (Hatfield 2007 and 2009), which resulted in the removal of non-commercial crab fishery closures in select areas of Howe Sound. Despite this removal, consumption advisories for crab hepatopancreas are still in effect (55 g/week; DFO 2012). In 2012, toxic equivalency (TEQ) levels in crab hepatopancreas exceeded Health Canada's consumption guidelines (i.e., 24.4 pg/g) at three of the eight survey sites, although exceedances have been found to vary among sites and over time. In general, results from the analysis of sediment samples and crab tissue suggest that historical deposits of organochlorine compounds continue to persist at varying low concentrations and are available to biota in the receiving environment.

6.0 BENTHIC INVERTEBRATE SURVEY

Summary of the benthic invertebrate survey for HSPP EEM Cycle Six, March 2012:

- The benthic invertebrate survey used a gradient design with 12 stations extending from the mill in two directions. Station locations were consistent with those used in Cycle Three, with the addition of a reference station at the West Bay of Gambier Island;
- Density and the Bray-Curtis dissimilarity index exhibited clear spatial trends along the absolute distance exposure gradient. Density generally decreased with increasing distance from the diffuser and exposed communities located further from the diffuser were more similar to reference communities. Taxa richness, evenness and diversity showed no spatial trend with exposure gradient;
- Sediments within a 3.4 km radius of the pulpmill diffuser exhibited organic enrichment, with evidence of slight anoxic conditions;
- Concentrations of pulpmill-specific contaminants in sediment (i.e., chlorinated organic compounds) continue to decline in Howe Sound; and
- Based on trends across EEM cycles, it is evident that conditions in Howe Sound with regard to sediment quality and the benthic invertebrate communities continue to improve in the near-field area given that the evidence of nutrient enrichment from historical conditions continues to decline.

6.1 INTRODUCTION

Benthic invertebrate surveys for the EEM program are conducted to determine if effluent has an effect on fish habitat (Environment Canada 2010). The benthic invertebrate survey provides an assessment of whether differences exist in community structure between organisms from exposed versus reference areas.

Results from the first four cycles have demonstrated that benthic communities have improved or remained similar over time (Hatfield 1996, 2000, 2004, 2007). In Cycle Four, an Investigation of Cause (IOC) study was undertaken to evaluate the potential relationship between observed mild enrichment of subtidal benthic invertebrate communities, and the historically deposited fibre mat versus current effluent discharge. Results from this study strongly indicated that enrichment near the HSPP mill was largely related to the presence of a historical fibre mat, rather than current effluent conditions (Hatfield 2007). Results of the traditional benthic survey component also performed in Cycle Four indicated that there were no statistically significant differences in the benthic invertebrate community structure between the reference and exposed stations for density or richness. The Bray-Curtis index did show an effect, but did not exceed the critical effect size (+/-2 SD).

As the fibre mat continues to degrade, benthic communities in the near-field area likely will continue to become more similar to communities found in the reference areas. Furthermore, with regard to Investigation of Solutions (IOS) studies, which typically follow IOC studies in the EEM process, there were no mitigative actions that could be recommended to facilitate community recovery given that the effects are considered historical and not due to current effluent conditions. Accordingly, a benthic community survey was not required in Cycle Five, but a surveillance-level survey was required as part of the Cycle Six EEM program to confirm whether subtidal benthic invertebrate communities of the near-field zone of the HSPP mill are continuing to improve over time.

The following section provides results of the benthic invertebrate community survey conducted in March 2012 for Cycle Six. Comparisons with historical invertebrate surveys were made where possible. Information on changes in methodology, supporting variables, and QA/QC is also presented.

6.2 METHODS

6.2.1 Station Selection

Stations were selected along gradients of exposure from the diffuser to approximately 20 km away, within Howe Sound. Station locations were consistent with those used in Cycle Three specific to the HSPP mill to facilitate comparisons in benthic invertebrate community structure over time (Hatfield 2004) (Table 6.1, Figure 6.1). Stations were selected in consideration of known sediment transport patterns, particle size data, areas of contamination (e.g., log booming grounds, mine tailings, sanitary shellfish closures), and effluent dispersion patterns. An additional reference station was added in Cycle Six at the West Bay of Gambier Island (HSB21) as it was not directly influenced by flows from the Squamish River.

6.2.1.1 Modifications to the Benthic Invertebrate Sampling Design

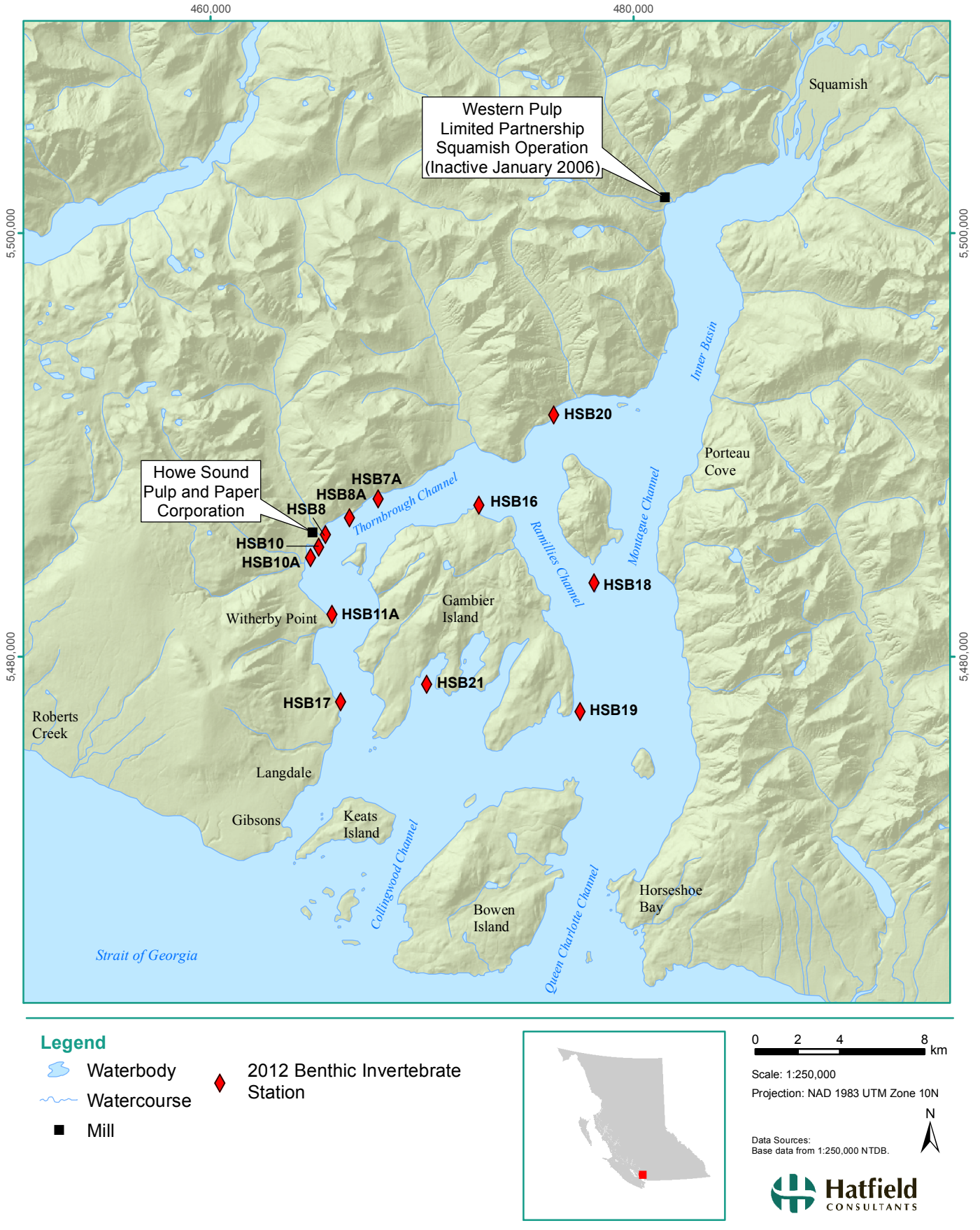
No major changes were made during field collections to station locations or methodology from that presented in the Howe Sound Cycle Six design document (Hatfield 2012). Problems in collecting sediment samples were encountered at some stations due to steep bathymetry; therefore, some samples were collected at greater depths than previous surveys.

Due to station depth and sampling platform drift, water quality measurements were not possible at full depth. Water measurements were taken approximately 20 m below the surface at all stations to provide consistency.

Table 6.1 Location, distance and depth of stations sampled during the benthic invertebrate survey, HSPP EEM Cycle Six, March 2012.

Station	Location	Distance from diffuser (m)	Date Sampled	Latitude	Longitude	Sample Depth
HSB17	Hutchinson Creek	7,200	13-Mar-12	-123°28.036	49°27.167	44.7
HSB11A	Witherby Point	3,400	15-Mar-12	-123°28.377	49°29.397	150.1
HSB10A	South of HSPP diffuser	1,200	15-Mar-12	-123°29.233	49°30.826	189.6
HSB10	HSPP Diffuser South	400	15-Mar-12	-123°28.932	49°31.087	200.5
HSB8	HSPP Diffuser North	400	15-Mar-12	-123°28.666	49°31.415	179.6
HSB8A	North of HSPP diffuser	2,600	13-Mar-12	-123°27.725	49°31.853	165.8
HSB7A	North of Bain Creek	4,400	13-Mar-12	-123°26.610	49°32.324	121.9
HSB16	Ekins Point	8,000	14-Mar-12	-123°22.648	49°32.189	157.3
HSB20	North of Anvil Island	13,000	14-Mar-12	-123°19.713	49°34.499	166.4
HSB18	South Anvil Island	14,000	14-Mar-12	-123°18.117	49°30.225	52.5
HSB21	West Bay, Gambier Island	15,300	21-Mar-12	-123°24.666	49°27.617	131.8
HSB19	Halkett Point	20,000	13-Mar-12	-123°18.634	49°26.950	104.8

Figure 6.1 Benthic invertebrate sampling stations, Howe Sound EEM Cycle Six, 2012.



6.2.2 Sampling Procedures

6.2.2.1 Sample Platform

Samples were collected from the *Rileda*, a 20-m commercial fishing vessel with capabilities to conduct marine sediment and marine habitat related work. The vessel was equipped with a hydraulic winch system, VHF radio, and all safety equipment required by Transport Canada. Station locations were determined using an on-board, differentially corrected Global Positioning System (GPS) integrated with digital nautical charts. Depth at sampling stations was recorded from the depth sounder.

6.2.2.2 Sample Collection

Three field subsamples were collected at each station for a total of 36 samples (12 stations x 3 sub-samples). As in past cycles, samples were collected from depths ranging from 50 to 100 m. This moderate depth range was targeted to assess invertebrate communities that lie close to the zone of trapped effluent (typically between 20 to 60 m in depth. Due to the steep-sided bathymetry of Howe Sound, shallower areas could not be sampled.

Sediment and benthos samples were collected using a stainless-steel, 30 cm Smith-McIntyre grab. The total surface area sampled by this grab was 0.0868 m^2. After retrieving the grab, hinged doors of the grab were lifted and sediment samples were taken. Photographs of each benthic sample also were collected. Samples of sediment to be analyzed for total organic carbon (1 – 125 mL clear glass jar), particle size distribution (1 – 125 mL clear glass jar), and chlorinated phenolic compounds, oxidation/reduction (redox) potential, total sulphides, and total nitrogen (1 – 125 mL clear glass jar) were removed by collecting three volumes of sediment measuring 2 cm deep by 5 cm wide by 5 cm long from each grab intended for benthic community analysis (n=3 sub-samples/station) and depositing them into the jars. Following removal of the three sediment samples from the grab, the grab was then opened and dumped into a large plastic tote. Each jar for the analyses mentioned above was comprised of sediment taken from each of the three sub-sample grabs to make composite samples for each station. The identification number for each subsample was added to the tote and recorded on the benthos data collection sheet.

To ensure that samples were not contaminated between stations, after sampling at each station, the grab and other stainless steel sampling equipment were cleaned by scrubbing and rinsing with ambient seawater.

6.2.2.3 Sample Sieving and Preservation

Benthic invertebrate samples were immediately sieved onshore at the HSPP mill by Biologica Environmental Services following collection of all subsamples from each station. The contents of each subsample were placed in a washtub with 0.5 mm stainless steel mesh screen on its bottom surface and sieved by holding the screened washtub in a larger bin filled with sea water and gently washing with running water to allow the <0.5 mm fraction to pass through the mesh

sieve. Following sieving, each subsample was placed in a 1-L plastic jar, appropriately labelled with the station and subsample number and preserved with 10% buffered formalin. Benthic samples were taken back to the Biologica's taxonomic laboratory for processing.

6.2.3 Taxonomic Analysis

Field-sieved benthos samples were taken to Biologica Environmental Services laboratory in Victoria, BC, for sorting and taxonomic identification (Appendix A4). Samples were sorted into 1-mm and 500-µm size fractions. Only debris retained by the 1-mm sieve was sorted for benthic invertebrate organisms. Organisms were identified to species or the lowest taxonomic level possible, as recommended in Table 4-3 of the *Technical Guidance Document* (Environment Canada 2010) for marine environments.

During the course of the EEM program, a reference collection of identified taxa has been developed from benthic invertebrate samples. New taxa identified during Cycle Six were verified by a qualified marine taxonomists (Sandy Lipovsky, Columbia Science) before they were included in the reference collection (Appendix A4).

The primary quality assurance/quality control functions relate to sample splitting and sorting efficiency. Re-sorts of debris were conducted on 10% (four samples) of the total number of samples. Biologica re-sorted these random samples following the initial spot checks that are conducted on all samples processed in the lab to meet efficiency requirements of >90%. For samples that were split (subsampled), precision and accuracy were verified using 10% of all samples to ensure 20% precision and accuracy was measured.

The subsampling method involved placing the fine material (1 to 3 mm) into a flat-bottomed pan. The material was gently shaken so that it was evenly distributed over the pan bottom. If any clumping of material was observed, the clump was carefully "teased" apart for even distribution. A grid with four (4) sections was placed into the pan and carefully worked through the sample material until the rubber on the bottom of the grid contacted the bottom of the pan. The grid was weighted down to secure a water-tight seal between sections. Each quarter of the sample was then siphoned into separate containers and appropriately labeled.

6.2.4 Supporting Environmental Variables

6.2.4.1 Water Quality

Mid-water column samples were collected at each station using a 4-L Van Dorn water sampler. The sampler was brought to the surface and instantaneous measurements of dissolved oxygen (±0.1 mg/L), temperature (±0.1°C), pH (±0.1 unit) and salinity (±0.1 ppt) were made at each station using a calibrated Hanna multi-meter (Model 9828).

6.2.4.2 Sediment Quality

Composite sediment samples from each benthos station were shipped on ice to ALS Environmental, Burnaby, British Columbia for the following analyses:

- Total organic carbon (TOC; ± 0.05%);
- Total nitrogen (± 0.1%);
- Total sulphides (± 10 µmol);
- Oxidation/reduction ("redox") potential (Eh) (± 1 mV);
- Particle size distribution and moisture content (± 0.1%); and
- Chlorinated phenolic compounds (± 0.001 mg/kg dry weight).

6.2.5 Analytical Approach

6.2.5.1 Data Handling

Data were entered into an electronic spreadsheet by the consulting taxonomist, who checked for transcription errors. Taxonomic records were organized by the taxonomist into adults (which included "adult" and "intermediate" classifications) and juveniles for Cycle Six. Juvenile taxa were reported for all samples and stations separately from adult taxa as required.

All count data were multiplied by the following density factor (DF) in order to estimate the density of each taxon in each sample on a per 1 m^2 basis, as required for electronic reporting for the national database (Appendix A4):

$$DF = \frac{1m^2}{(\text{grab sample area} - \text{area of subsamples taken for sediment chemistry})}$$

$$DF = \frac{1}{[0.0868m^2(\text{grab sample area}) - 0.000182m^2(\text{redox, TS, TOC/TN, PS, CP})]}$$

$$DF = 11.54$$

Individual densities were reported per sub-sample and station densities were calculated using the mean of all sub-samples.

Total adult taxonomic richness (i.e., to family level and to lowest possible taxonomic level) was also calculated for each sample.

6.2.5.2 Biotic Indices

Three biotic indices were calculated to describe benthic community composition for each area, and compared among stations. These indices were calculated using taxon density data for each station. Descriptions of each biotic index area are presented below and further described in the *Technical Guidance Document* (Environment Canada 2010).

Evenness can be quantified for each station as presented in Smith and Wilson (1996). The index takes into consideration the abundance of each taxon in proportion to total abundance, and the taxonomic richness at the station. Evenness is calculated as:

$$E = 1/\sum_{i=1}^{s}[pi]^2/S$$

where: E = Evenness;

p_i = proportion of i^{th} taxon at the station; and

S = number of taxa in the sample.

Simpson's Diversity Index

Simpson's diversity can be calculated for each station as presented in Krebs (1985). The index takes into account both the abundance patterns and the taxonomic richness of the community and determines for each taxonomic group at a station, the proportion of individuals that it contributes to the total in that station. Diversity is calculated as:

$$D = 1 - \sum_{i=1}^{s}[p_i]^2$$

where: D = Simpson's index of diversity;

S = the total number of taxa at the station; and

p_i = the proportion of the i^{th} taxon at the station.

Bray-Curtis Dissimilarity Coefficients

The Bray-Curtis dissimilarity coefficient is a distance measurement that reaches a maximum value of "1" for two stations that are entirely different and a minimum of "0" for two stations that possess identical descriptors (Bray and Curtis 1957). Bray-Curtis dissimilarity coefficients were calculated to compare the degree of similarity between individual stations and a reference median. Dissimilarity coefficients for the reference median and individual stations were calculated using SYSTAT 10 (SPSS Inc. 2000). The Bray-Curtis index is calculated as:

$$B-C = \frac{\sum_{i=1}^{n} \left| y_{i1} - y_{i2} \right|}{\sum_{i=1}^{n} \left(y_{i1} + y_{i2} \right)}$$

where: B-C = Bray-Curtis distance between stations 1 and 2;

y_{i1} = count for species i at station 1;

y_{i2} = count for species i at station 2; and

n = total number of species present at the two stations.

Four stations were selected as "reference" stations based on their location outside of the estimated far-field effluent dispersion zone: HSB18, HSB19, HSB20, and HSB21.

6.2.5.3 Statistical Analysis

Analyses were conducted using G*POWER (Faul and Erdfelder 1992), R Software (R Development Core Team 2011), and SYSTAT 10 (SPSS Inc. 2000).

Summary Statistics

Summary statistics, including means, medians, standard deviations (SD), and standard errors (SE) were calculated for all the biotic indices.

Regressions

Linear regression was used to determine if significant linear relationships existed among benthic community metrics and exposure gradients. In this study, the exposure gradient was defined in two ways: as absolute distance from the pulpmill diffuser; and a carbon/nitrogen (C/N) ratio, which provides an indication of the ratio of organic matter present in sediments that was derived from terrestrial sources (such as pulpmill solids) or marine sources (Macdonald and Crecelius 1994). Supporting environmental variables also were examined against these exposure gradients using regression analysis.

Residual plots from regressions were evaluated to ensure that assumptions of the regression model were met. If data met these assumptions, regressions were conducted using $\log_{10}$-transformed variables to determine if the fit of the model improved. If the fit had improved, results for $\log_{10}$-transformed variables were reported but if that fit did not improve, results from untransformed variables were reported. If $\log_{10}$-transformed data still failed to meet assumptions of model, regressions were conducted using ranked data.

All tests were conducted at a significance level of $\alpha = 0.10$.

Determination of Effects

Results of regression analyses were used to determine whether there were effects on benthic invertebrates along the exposure gradient, where an effect was defined as a statistically significant relationship between a metric and distance or a metric and effluent exposure (Environment Canada 2010).

The magnitude and direction of observed effects were calculated and compared to the EEM effect criterion for a biologically (rather than simply statistically) significant effect of ± 2 standard deviations (SD) from the reference mean for suitable "reference" stations (stations located outside the area where mill-related effects were observed).

In this gradient-based study, which used a regression-based rather than analysis-of-variance-based approach to assess effect, a relationship between a benthic invertebrate community metric and distance from the pulpmill diffuser with a correlation coefficient (r) of at least |0.707| was considered to be biologically significant (Cohen 1988), which was equivalent to ±2 times the standard deviation of the reference mean (Environment Canada 2010).

Correlations

Spearman's rank correlations were used to evaluate the relationships between benthic community metrics and supporting environmental variables. Correlations greater than r_s of |0.503| for n = 12 (number of stations) ($\alpha = 0.10$) were indicative of statistically significant relationships. Moderate correlations were defined as those ranging from |0.50| to |0.75|. Strong correlations were defined as those ranging from |0.75| to |1.00|.

Cluster Analysis

Cluster analysis is a multivariate procedure for detecting natural groupings in data. It is based on the relative abundance of taxa from each station; taxa that are abundant tend to influence the cluster analysis more than rare taxa. The cluster analysis was conducted on Bray-Curtis dissimilarity coefficients created from abundance data for individual taxa. These Bray-Curtis dissimilarity coefficients differ from those described in the preceding section in that they include pair-wise comparisons for all stations, rather than being restricted to comparisons to the reference median.

Power Analysis

Post-hoc power analysis was conducted to verify the ability of regression analyses to detect an effect, which was defined as a relationship with a correlation coefficient (r) of at least |0.707| (Environment Canada 2010, Cohen 1988). Regression analyses were considered to have sufficient power when P≥0.90. Analyses were only completed for insignificant relationships to verify that the design had sufficient statistical power.

Power analysis was conducted using G*POWER (Faul and Erdfelder 1992).

6.3 RESULTS

6.3.1 Benthic Invertebrate Communities

Raw benthic data are presented in Appendix A4. Summary tables and figures are presented below (Table 6.2, Table 6.4, Figure 6.2).

6.3.1.1 Density, Taxonomic Richness and Community Structure

Table 6.2 presents the adult mean per station (or total for taxa richness) for each biological index. A summary of juvenile density and taxa richness is presented in Table 6.3. Table 6.4 provides the summary statistics for the benthic invertebrate indices across stations.

Density was highest at the two near-field stations (HSB8 and HSB10) on either side of the diffuser (Figure 6.2). Generally density decreased with distance from the diffuser in north and south directions from the mill. Low densities were observed at a far-field station (HSB16) and the new reference station added near Gambier Island (HSB21). Mean adult density ranged from 809 organisms/m^2 at HSB16 to 5,290 organisms/m^2 at HSB8. Densities of juvenile organisms were variable across stations but generally higher at the stations closest to the mill and lowest at HSB16 and HSB21.

In 2012, taxa richness ranged from 31 (HSB8A) to 65 (HSB17) at the gradient stations and 25 (HSB21) to 51 (HSB19) at the reference stations (Figure 6.2). Taxa richness among stations in the near-field area was similar to what was observed for density, with the highest richness at station HSB8 (near the diffuser) relative to adjacent stations. Taxa richness was generally higher at the near-field stations compared to the reference stations in Cycle Six.

Table 6.5 presents the most abundant taxa for each station, with taxa listed in decreasing order of density. Similarly to Cycle Three, sedentary polychaete taxa dominated the species composition, followed by errant polychaetes.

The predominant polychaetes included *Mediomastus californiensis*, *Galathowenia oculata, Prionospio lighti*, and *Arcidea lopezi*, with highest densities at HSB10, HSB8, HSB11a, and HSB8A, respectively (Table 6.5). The errant polychaete group included *Lumbrineris cruzensis* with the highest density observed at HSB8A. Relative to the reference stations, the highest densities of all taxa were found at stations closest to the mill (HSB10, HSB8, and HSB8A). The majority of the dominant taxa were sedentary polychaetes and a few crustaceans. Non-motile, typically tube-dwelling worms in the sedentary polychaete family comprised 16 of the 20 most abundant taxa.

There were some taxa that were more abundant at the reference stations relative to the gradient stations, including *Scoletoma luti* and *Exogone lourei* (Table 6.5). There were no species that were present at the gradient stations relative to the reference stations, indicating that species composition was generally similar across stations.

Table 6.2 Benthic invertebrate community statistics for adult organisms, Howe Sound EEM Cycle Six, March 2012.

Station	Distance from Diffuser (m)	Total Density (organisms/m^2)	Taxa Richness (# families)	Simpson's Diversity	Evenness	Bray-Curtis
HSB17	7,200	2,520	64	0.930	0.222	0.478
HSB11A	3,400	1,782	32	0.818	0.172	0.673
HSB10A	1,200	2,081	29	0.818	0.190	0.601
HSB10	400	3,999	36	0.813	0.149	0.630
HSB8	400	5,290	50	0.842	0.126	0.701
HSB8A	2,600	3,261	31	0.914	0.376	0.590
HSB7A	4,400	1,439	37	0.887	0.240	0.410
HSB16	8,000	809	35	0.923	0.372	0.653
HSB20	13,000	1,029	39	0.900	0.259	0.424
HSB18	14,000	2,815	42	0.875	0.190	0.414
HSB21	15,300	933	25	0.820	0.222	0.494
HSB19	20,000	2,065	48	0.910	0.231	0.284

Table 6.3 Juvenile invertebrate density and taxa richness, Howe Sound EEM Cycle Six, March 2012.

Station	Distance from diffuser (m)	Total Density (#/m^2)	Taxa Richness (# families)
HSB17	7,200	669	23
HSB11A	3,400	42	6
HSB10A	1,200	35	3
HSB10	400	365	9
HSB8	400	531	15
HSB8A	2,600	73	4
HSB7A	4,400	354	8
HSB16	8,000	77	7
HSB20	13,000	42	9
HSB18	14,000	900	14
HSB21	15,300	19	4
HSB19	20,000	454	26

Table 6.4 Summary of benthic community measurement endpoints, Howe Sound EEM Cycle Six, March 2012.

Measurement Endpoint	N	Median	Minimum	Maximum	SD	SE
Total density (organisms/m^2)	12	2,073	809	5,290	1,344	388
Taxa richness (# families)	12	37	25	64	11	3
Simpson's Diversity	12	0.881	0.813	0.930	0.044	0.013
Evenness	12	0.222	0.126	0.376	0.078	0.022
Bray-Curtis	12	0.640	0.300	0.750	0.151	0.044

Figure 6.2 Mean density (organisms/m^2) and total taxa richness per station, Howe Sound EEM Cycle Six, March 2012.

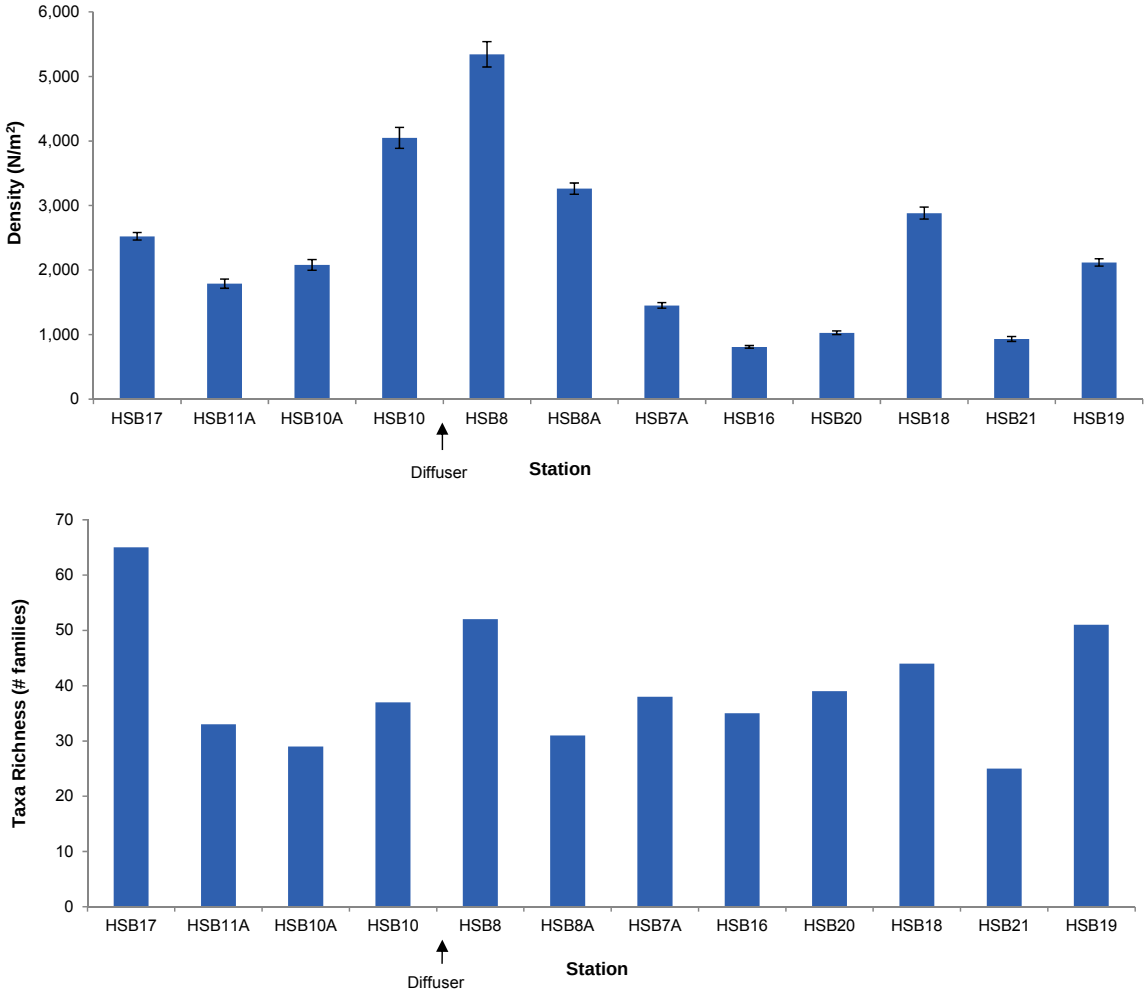


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Table 6.5 Most abundant taxa at each benthic station, Howe Sound EEM Cycle Six, March 2012.

Taxon	Taxonomic Group	Gradient Station								Reference Station			
		HSB17	HSB11A	HSB10A	HSB10	HSB8	HSB8A	HSB7A	HSB16	HSB20	HSB18	HSB21	HSB19
Mediomastus californiensis	Polychaeta (sedentaria)	88.47	11.54	180.79	1,400.19	473.14	126.94	169.25	3.85	15.39	573.15	0.00	388.51
Galathowenia oculata	Polychaeta (sedentaria)	180.79	19.23	3.85	219.26	473.14	146.17	300.04	0.00	26.93	315.43	0.00	46.16
Prionospio lighti	Polychaeta (sedentaria)	11.54	630.85	173.10	315.43	19.23	215.41	19.23	7.69	3.85	0.00	100.01	0.00
Aricidea lopezi	Polychaeta (sedentaria)	50.01	103.86	334.66	107.71	42.31	438.52	53.85	11.54	11.54	0.00	276.96	7.69
Lumbrineris cruzensis	Polychaeta (errantia)	73.09	57.70	19.23	161.56	180.79	296.19	111.55	42.31	130.79	50.01	42.31	7.69
Cossura modica	Polychaeta (sedentaria)	0.00	173.10	503.91	30.77	0.00	330.81	0.00	0.00	7.69	0.00	7.69	11.54
Eudorella pacifica	Crustacea (cumacea)	0.00	76.93	34.62	15.39	26.93	315.43	111.55	138.48	11.54	0.00	11.54	123.09
Heteromastus filobranchus	Polychaeta (sedentaria)	0.00	0.00	107.71	42.31	103.86	61.55	96.17	19.23	126.94	0.00	207.72	7.69
Decamastus nr. *gracilis*	Polychaeta (sedentaria)	276.96	0.00	0.00	92.32	0.00	46.16	0.00	0.00	0.00	230.80	0.00	26.93
Glycera nana	Polychaeta (errantia)	57.70	34.62	30.77	107.71	61.55	103.86	61.55	38.47	38.47	38.47	50.01	19.23
Heterophoxus ellisi	Crustacea (amphipoda)	0.00	0.00	30.77	115.40	161.56	126.94	38.47	0.00	0.00	57.70	0.00	23.08
Exogone lourei	Polychaeta (errantia)	134.63	0.00	0.00	46.16	0.00	0.00	0.00	0.00	7.69	119.25	0.00	215.41
Scoletoma luti	Polychaeta (errantia)	123.09	3.85	0.00	0.00	0.00	19.23	0.00	3.85	84.63	123.09	0.00	119.25
Cossura pygodactylata	Polychaeta (errantia)	0.00	126.94	161.56	15.39	0.00	76.93	3.85	15.39	0.00	23.08	23.08	7.69
Bipalponephtys cornuta	Polychaeta (errantia)	0.00	73.09	42.31	15.39	38.47	65.39	42.31	96.17	15.39	7.69	7.69	15.39
Protodorvillea gracilis	Polychaeta (errantia)	0.00	0.00	0.00	250.03	46.16	7.69	0.00	0.00	0.00	0.00	0.00	0.00
Brisaster latifrons	Echnioderm (echinoidea)	0.00	42.31	15.39	42.31	19.23	65.39	11.54	23.08	61.55	0.00	0.00	0.00
Prionospio jubata	Polychaeta (sedentaria)	88.47	7.69	7.69	0.00	30.77	50.01	30.77	7.69	0.00	7.69	15.39	0.00
Prionospio multibranchiata	Polychaeta (sedentaria)	38.47	0.00	0.00	15.39	76.93	0.00	0.00	0.00	0.00	19.23	0.00	84.63
	C/N Ratio	**7.2**	**3.4**	**1.2**	**0.4**	**0.4**	**2.6**	**4.4**	**8.0**	**13.0**	**14.0**	**15.3**	**20.0**
	Distance from Diffuser (km)	**25.00**	**23.48**	**26.79**	**26.70**	**23.72**	**28.61**	**21.07**	**11.60**	**10.00**	**10.69**	**14.04**	**9.09**

6.3.1.2 Biotic Community Indices

Evenness Index

Evenness ranged from 0.126 at station HSB8 to 0.376 at station HSB8A for stations along the gradient and from 0.190 (HSB18) to 0.259 (HSB20) across the reference stations (Table 6.2). Evenness was lowest at stations closest to the diffuser (Figure 6.3), which was consistent with results from Cycle Three. Although density and taxa richness was high at the stations closest to the mill, there were a low number of taxa contributing to the highest proportions of the total density (Table 6.5).

Simpson's Diversity

Simpson's diversity index ranged from 0.813 at station HSB10 to 0.930 at station HSB17 (Figure 6.3). All stations were generally similar in diversity with little variability among stations.

Bray-Curtis Index

Using the four reference stations as a reference median, dissimilarity was highest at station HSB8 (0.701), located closest to the diffuser, and lowest at station HSB7A, located to the north of the diffuser. The Bray-Curtis index ranged from 0.410 (HSB7A) to 0.701 (HSB8) for stations along the gradient and from 0.284 (HSB19) to 0.494 (HSB21) at the reference stations (Figure 6.4, Table 6.2).

Cluster Analysis

Results from the cluster analysis of Bray-Curtis dissimilarity indices are presented in (Figure 6.4). There were three major clusters with no clear distinction between reference and gradient stations, with the exception the two stations closest to the diffuser (HSB8, HSB10), which were clustered into a group and two reference stations (HSB16 and HSB20), which were clustered together. The new reference station HSB21 clustered with stations close to the diffuser (HSB10A, HSB8A, and HSB11A) than with the other reference stations.

Figure 6.3 Evenness and Simpson's Diversity of benthic invertebrate communities, Howe Sound EEM Cycle Six, March 2012.

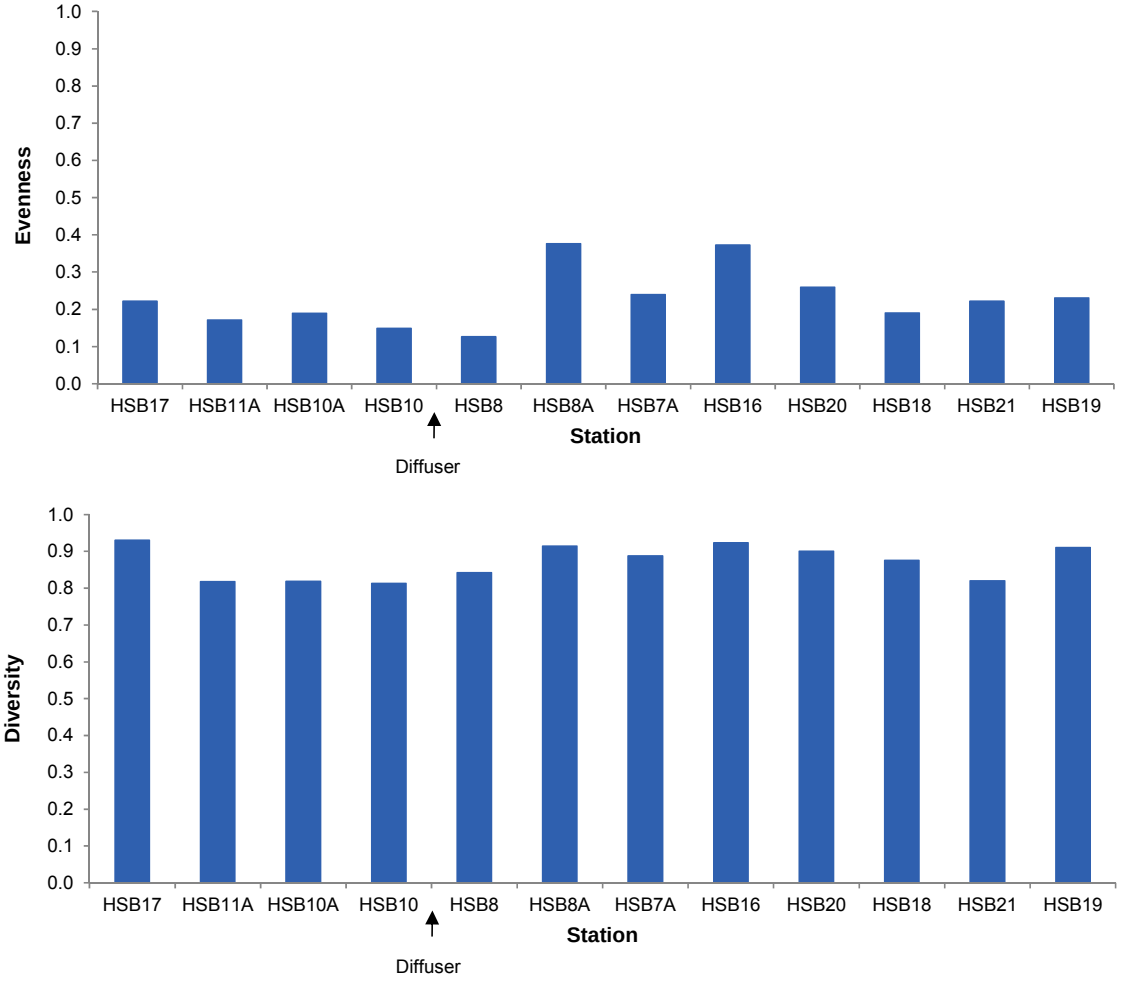


Figure 6.4 Bray-Curtis dissimilarity index for benthic invertebrate communities in Howe Sound EEM Cycle Six, March 2012.

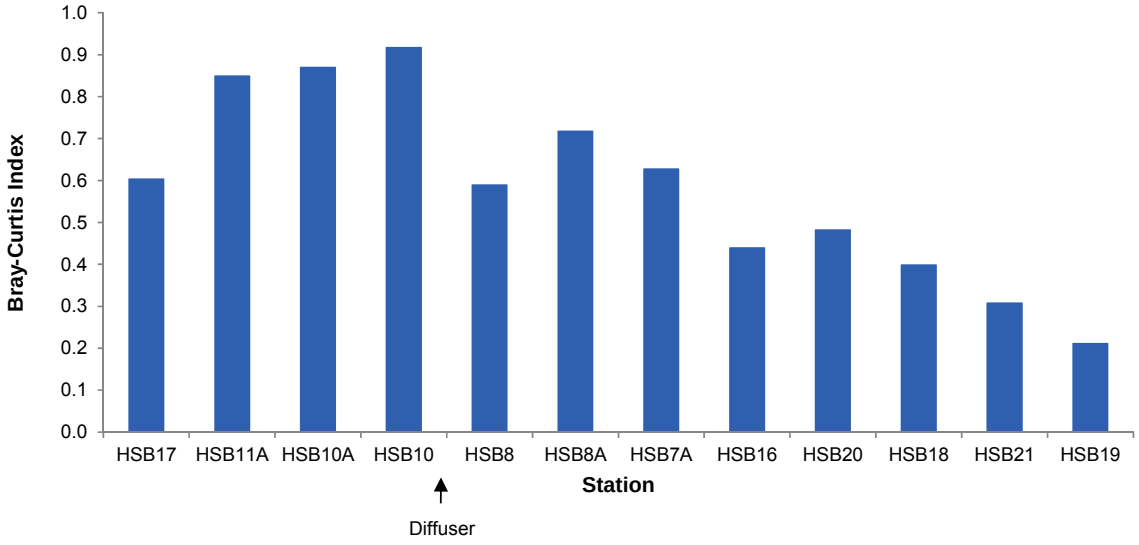
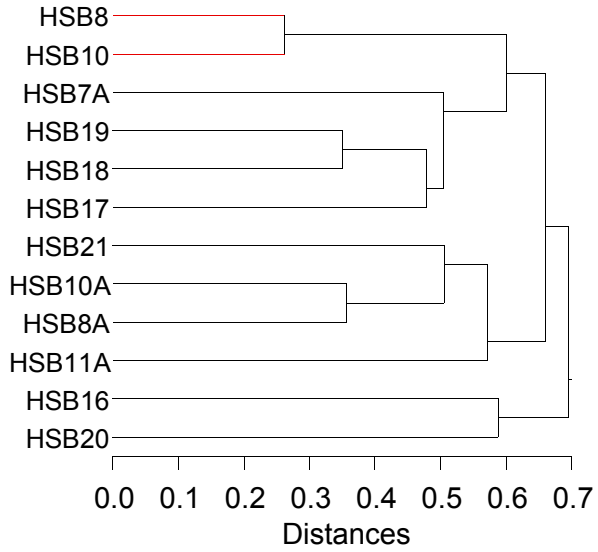


Figure 6.5 Dendrogram describing cluster analysis using Bray-Curtis dissimilarity index for benthic invertebrate density, Howe Sound EEM Cycle Six, March 2012.



6.3.1.3 Statistical Analyses

Regression Analyses

No significant relationship was found between absolute distance from the diffuser and taxa richness, evenness, and diversity (Table 6.6). Significant negative relationships were observed between absolute distance and density ($p=0.034$) and between absolute distance and the Bray-Curtis index ($p=0.002$).

When the pulpmill exposure gradient was defined using the C/N ratio, an indicator of terrestrial organic inputs and related to distance itself, there was a significant positive relationship with density and the Bray-Curtis index, and a negative relationship with diversity (Table 6.7).

The EEM effects criterion was defined as a biologically significant relationship with a correlation coefficient (r) of at least |0.707|, which is equivalent to ±2SD of the reference mean (Environment Canada 2010). Based on this criterion, the Bray-Curtis index was the only metric that showed a gradient effect with increasing distance (negative relationship) from the diffuser (Table 6.6).

Table 6.6 Relationship between benthic invertebrate metrics and absolute distance from the pulpmill diffuser, Howe Sound EEM Cycle Six, March 2012.

Effect Endpoint	p-value for F-test[2]	Regression Equation[1]	r	r^2	Effect (statistically significant)[2]	Effect (> CES)[4]
Density[3]	**0.034**	RankDENS = 10.49 - 0.61RankDIST	-0.613	0.376	**Yes**	No
Taxa Richness	0.711	RICH = 37.54 + 0.19DIST	0.120	0.014	No	No
Evenness[3]	0.134	RankEVEN = 3.51 + 0.46RankDIST	0.459	0.211	No	No
Simpson's Diversity[3]	0.182	RankDIV = 3.81 + 0.41RankDIST	0.413	0.171	No	No
Bray-Curtis	**0.002**	B-C = 0.65 - 0.01DIST	**-0.790**	0.625	**Yes**	**Yes**

[1] DENS = density; RICH = taxa richness; EVEN = evenness; DIV = diversity; B-C = Bray-Curtis index.

[2] Significant result ($p \leq 0.10$); significant values are in bold and determine whether there is a statistically significant effect.

[3] Data was ranked.

r = Pearson's correlation coefficient (parametric correlations).

r^2 = coefficient of determination.

[4] Biologically significant effect defined by an exceedances of the critical effects size (r>|0.707|).

Table 6.7 Relationships between benthic invertebrate metrics and C/N ratio, Howe Sound EEM Cycle Six, March 2012.

Effect Endpoint	p-value for F-test[2]	Regression Equation[1]	r	r^2	Effect (statistically significant)[2]	Effect (> CES)[4]
Density[3]	**0.049**	LnDENS = 6.75 + 0.04CN	0.577	0.333	**Yes**	No
Taxa Richness	0.911	RICH = 39.99 - 0.05CN	-0.036	0.001	No	No
Evenness	0.430	RankEVEN = 8.13 - 0.25RankCN	-0.252	0.063	No	No
Simpson's Diversity	**0.067**	DIV = 0.91 - 0.001CN	-0.331	0.110	**Yes**	No
Bray-Curtis	**0.038**	B-C = 0.33 + 0.01CN	0.603	0.364	**Yes**	No

[1] DENS = density; RICH = taxa richness; EVEN = evenness; DIV = diversity; B-C = Bray-Curtis index.

[2] Significant result ($p \leq 0.10$); significant values are in bold and determine whether there is a statistically significant effect.

[3] Data was log-transformed.

r = Pearson's correlation coefficient (parametric correlations).

r^2 = coefficient of determination.

[4] Biologically significant effect defined by an exceedances of the critical effects size (r>|0.707|).

Power Analyses

The statistical power of the gradient regressions was 0.94, above the recommended level of power of P=0.90, indicating sufficient power to detect the target effect size for this survey.

6.3.1.4 QA/QC and Verifications

All QA/QC reports are presented in Appendix A4. Sorting efficiency ranged from 91.2% to 97.4% for four sets of samples (four stations), with an average sorting efficiency of 95.4%, which passed the required >90% efficiency benchmark.

QA/QC results for the accuracy of the splitting technique showed a sub-sampling error range from 0.0% to 19.4% for six sets of samples (two stations), with an average sub-sampling error of 13.6%, which was within the 20% error allowed.

Verifications of the reference collection, conducted by Columbia Science, are presented in Appendix A4. Out of a total of fifty-two taxa that were included in the reference collection and verified Howe Sound EEM Cycle Six, forty-seven organisms were in agreement with the initial identification by Biologica and four organisms were confirmed to the family level.

6.3.2 Supporting Environmental Variables

6.3.2.1 Water Quality

Water quality measurements for each station are summarized in Table 6.8. Water quality was sampled from shallower depths than benthic invertebrate communities and sediment and was generally similar across stations (Table 6.8). Dissolved oxygen ranged from 7.03 to 9.85 mg/L; temperature ranged from 5.5 to 10.1°C; pH ranged from 7.1 to 8.1; and salinity ranged from 25.5 to 28.9‰. The new reference station had the highest water temperature and salinity and the lowest pH and DO, which likely reflected the protected nature (i.e., reduced current) of the small inlet where the station was located.

Table 6.8 Mid-water column water quality for the benthic invertebrate survey, Howe Sound EEM Cycle Six, March 2012.

Station	Sample Depth (m)	DO (mg/L)	Temp (˚C)	pH	Salinity (‰)
HSB17	19.07	7.73	6.5	7.7	25.5
HSB11A	19.07	7.52	7.0	8.1	26.1
HSB10A	19.07	7.60	7.0	8.0	26.4
HSB10	19.07	7.63	6.7	8.3	26.8
HSB8*	19.07		No data collected		
HSB8A	19.07	8.70	6.6	7.8	25.5
HSB7A	19.07	8.97	5.5	8.1	27.0
HSB16	19.07	7.55	6.3	8.0	27.0
HSB20	19.07	8.13	6.4	8.0	26.5
HSB18	19.07	7.60	6.4	7.3	26.6
HSB21	19.07	7.03	10.1	7.1	28.9
HSB19	Surface	9.85	6.3	7.9	26.8

* Water quality data not collected due to Van Dorn malfunction.

6.3.2.2 Sediment Quality

Particle Size and Moisture Content

Particle size distribution of composited sediments at all stations in Howe Sound was dominated by silt followed by clay, with very low proportions of gravel (Table 6.9 and Figure 6.6). Sediments in the vicinity of HSPP contained higher portions of silt, with the exception of HSB8, which had a higher portion of sand (Figure 6.6). Sediments at the reference stations were comprised primarily of silt and clay. The new reference station (HSB21) was similar in substrate to most other stations, with silt as the dominant substrate.

Moisture content varied slightly among most stations in Howe Sound, with the exception of site HSB17, where the moisture content was markedly lower (33.7%), but also exhibited the largest proportion of sand and lowest proportions of silt and clay.

Figure 6.6 Particle size of sediments at benthic invertebrate stations, Howe Sound EEM Cycle Six, March 2012.

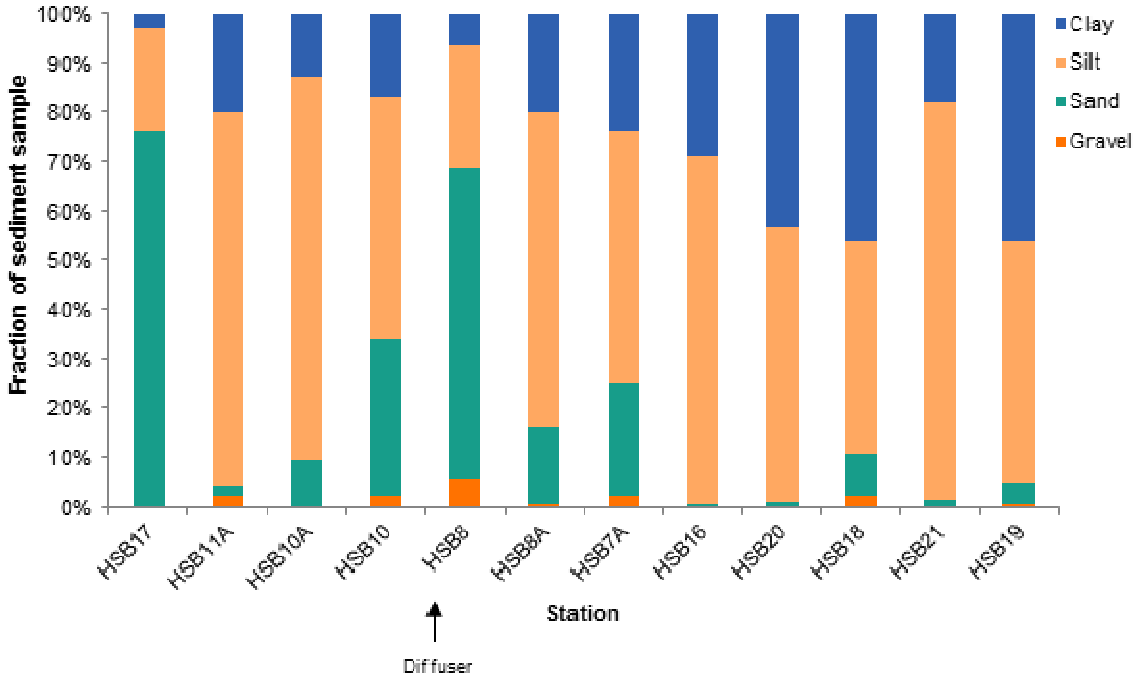


Table 6.9 Physical characteristics of sediments collected for Howe Sound EEM Cycle Six, March 2012.

Station	Diffuser Distance (m)	Depth (m)	Particle Size[1] (%)				Moisture (%)	Total Organic Carbon (%)	Total Nitrogen (%)	C/N Ratio	Redox Potential (mV)	Total Sulphides (mg/kg)
			Gravel	Sand	Silt	Clay						
HSB17	7,200	44.7	0.30	75.90	21.10	2.64	33.70	1.10	0.04	25.00	-73.00	1.02
HSB11A	3,400	150.1	1.86	2.21	76.00	19.90	75.60	8.29	0.35	23.48	-136.00	6.10
HSB10A	12,000	189.6	<0.10	9.66	77.50	12.80	66.90	6.75	0.25	26.79	-159.00	2.30
HSB10	4,000	200.5	2.07	32.00	49.20	16.80	65.70	5.74	0.22	26.70	-102.00	1.67
HSB8	4,000	179.6	5.72	63.10	24.90	6.28	63.80	2.87	0.12	23.92	-56.00	1.61
HSB8A	2,600	165.8	0.77	15.63	63.70	20.00	68.80	7.01	0.25	28.61	-73.00	1.90
HSB7A	4,400	121.9	1.87	23.45	51.10	23.70	61.30	3.56	0.17	21.07	-18.00	1.16
HSB16	8,000	157.3	<0.10	0.69	70.50	28.80	69.30	1.89	0.16	11.60	-116.00	2.60
HSB20	13,000	166.4	<0.10	1.30	55.50	43.20	68.10	1.77	0.18	10.00	-58.00	1.25
HSB18	14,000	52.5	2.11	8.68	43.20	46.10	60.30	1.09	0.10	10.69	-225.00	<0.37
HSB21	15,300	131.9	<0.10	1.69	80.10	18.20	71.50	3.89	0.28	14.04	-90.00	5.00
HSB19	20,000	104.7	0.75	3.88	49.50	45.90	68.50	1.40	0.15	9.09	-19.00	<0.55

[1] gravel = >2 mm; sand = 0.063 to 2 mm; silt = 0.004 to 0.063 mm; clay = <0.004 mm.

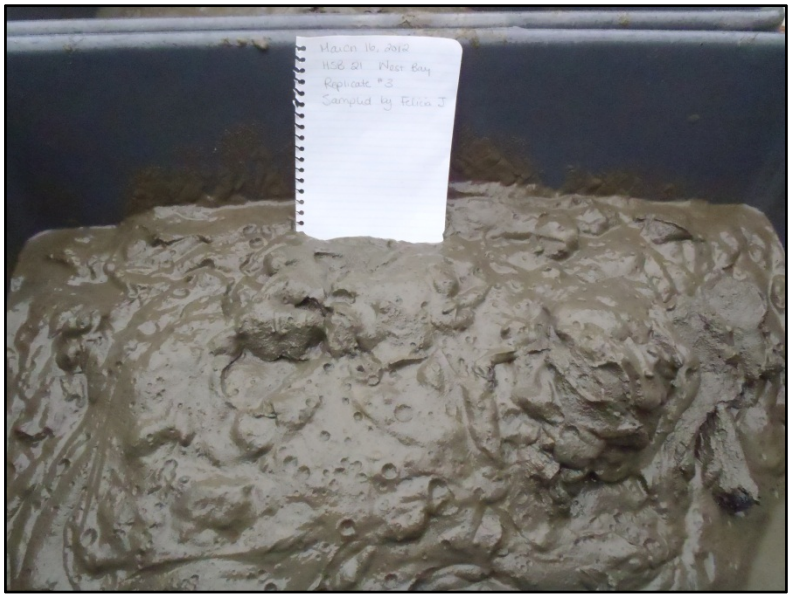
Sediment grabs were photographed at sample collection prior to sieving for benthic invertebrate samples. Four photographs are included here to illustrate the range of conditions found at various stations, including the new reference station. Visual observations of sediment debris undertaken while sorting samples for benthic invertebrates described wood fragments at stations close to the mill (e.g., HSB8) (Figure 6.7). Most samples also contained worms that were in high abundance at most stations in 2012 (Figure 6.8).

Figure 6.7 Substrate at HSB8, north of diffuser, dominated by sand and wood fragments, Howe Sound benthic invertebrate survey, March 2012.

Figure 6.8 Substrate at HSB16, Ekins Point, dominated by silt and the presence of worms, Howe Sound benthic invertebrate survey, March 2012.

Figure 6.9 Substrate at HSB20, reference station, dominated by silt and clay, Howe Sound benthic invertebrate survey, March 2012.

Figure 6.10 Substrate at HSB21, new reference station, dominated by silt, Howe Sound benthic invertebrate survey, March 2012.



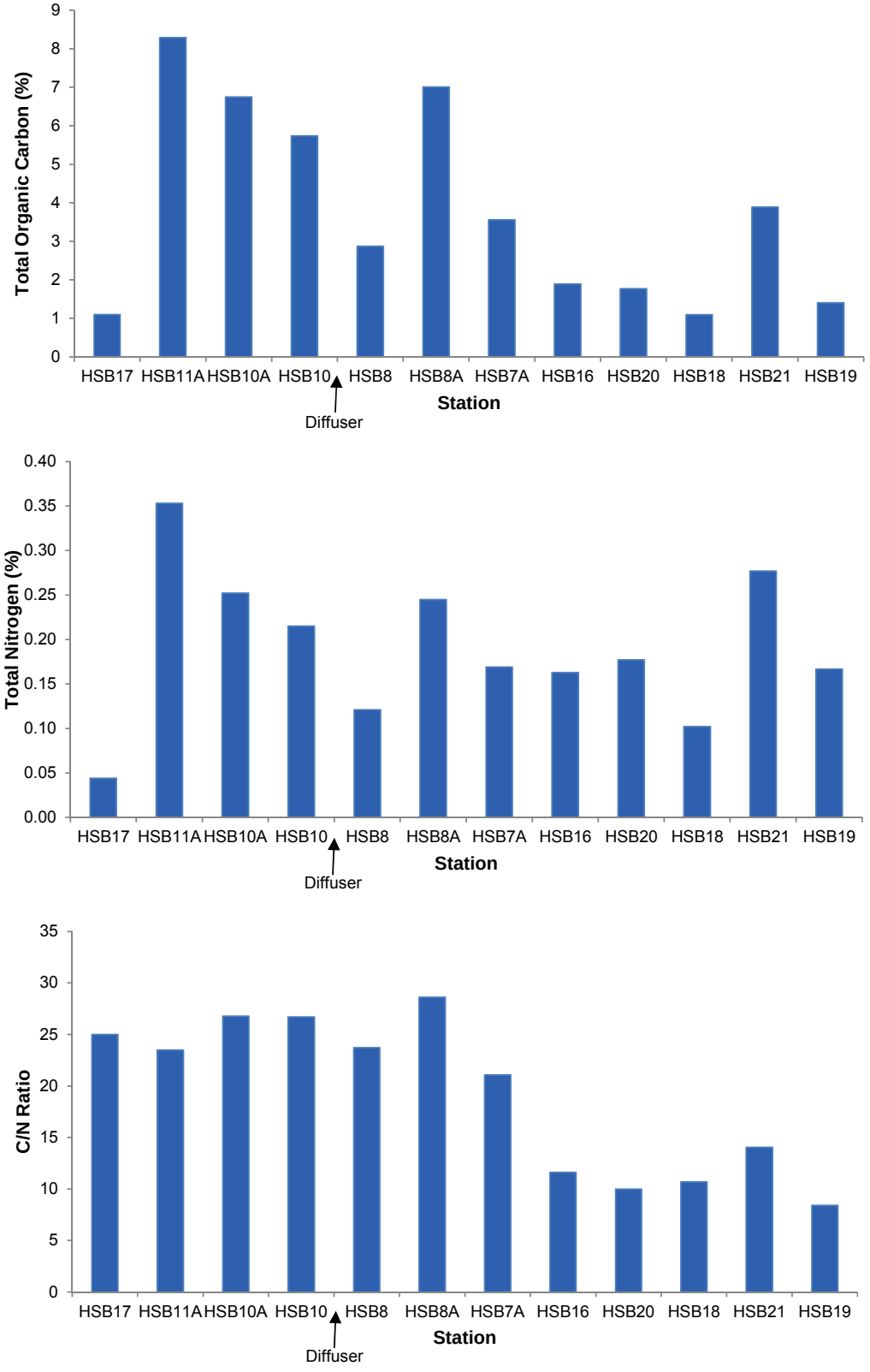
Total Organic Carbon, Total Nitrogen and C:N Ratio

Total organic carbon (TOC), total nitrogen (TN), and carbon/nitrogen ratios at each station are presented in Table 6.9 and Figure 6.11. To the south of the diffuser, TOC increased with distance until a maximum was observed at HSB11A. With the exception of HSB8A, TOC decreased to the north of the diffuser with increasing distance. TOC among reference stations was highest at HSB21, located in the protected inlet of Gambier Island.

Total nitrogen followed a very similar pattern to what was observed with TOC. TN ranged from 0.04 to 0.35% along the gradient stations and from 0.10 to 0.28% across the reference stations (Figure 6.11).

Carbon/nitrogen ratios along the gradient stations ranged from 11.6 (HSB16) to 28.6 (HSB8A), and from 8.4 (HSB19) to 14.0 (HSB21) for the reference stations (Figure 6.11). All stations exhibited a C/N ratio greater than 10, suggesting terrestrial carbon sources in sediments, specifically for those stations closer to the diffuser or near historical and current log booming grounds south of the diffuser. The reference stations exhibited the lowest C/N ratios, with the exception of HSB21. Station HSB21 is located in an inlet of Gambier Island, where the current is lower and logs and debris can accumulate.

Figure 6.11 Total organic carbon (TOC), total nitrogen (TN), and C/N ratios in sediments, Howe Sound EEM Cycle Six, March 2012.

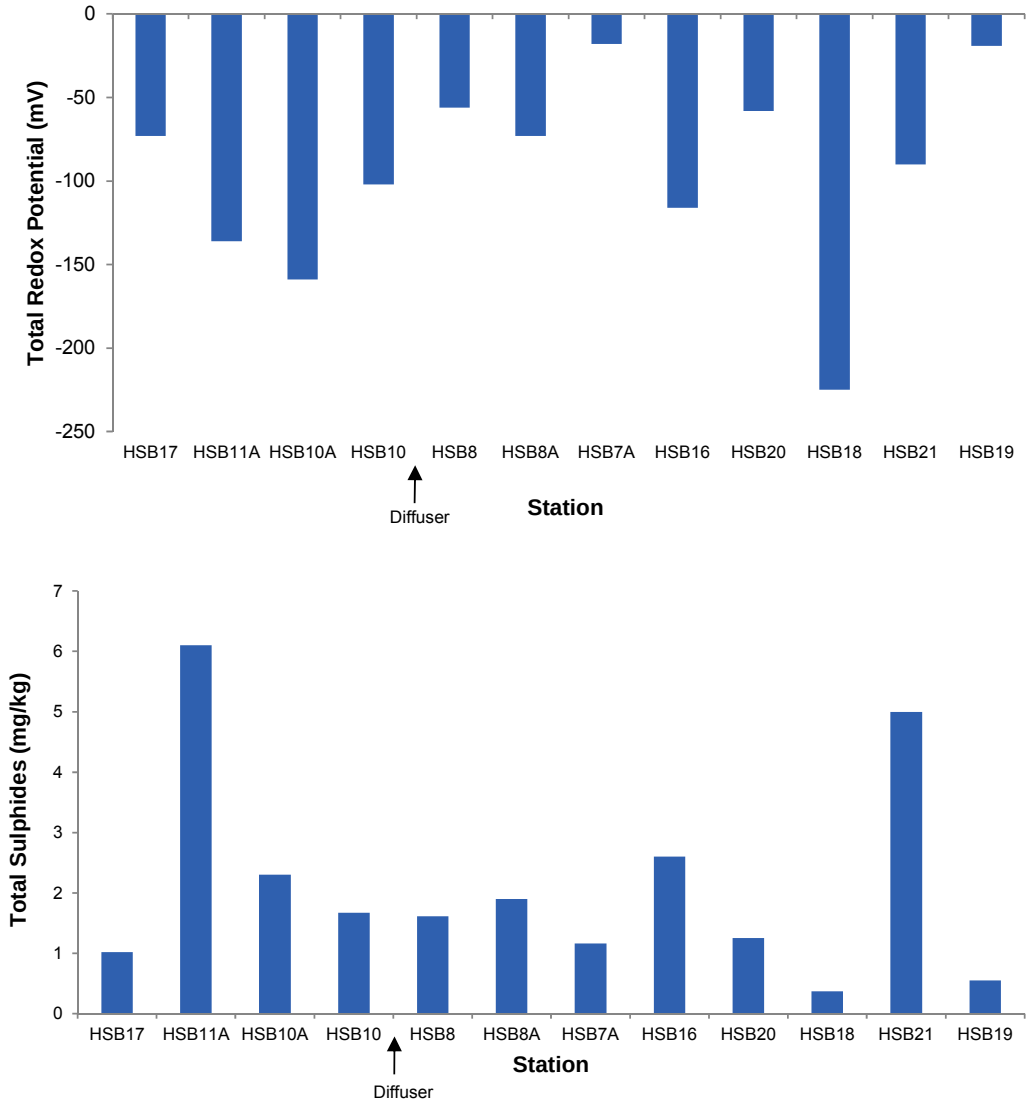


Oxidative State

The oxidative state of sediments was assessed through analysis of two measures: oxidation/reduction (redox) potential and concentration of total sulphides (Table 6.9). Redox potential indicates the oxygen condition of sediments; whereas sulphide concentrations are indicative of anaerobic metabolism.

Redox potential was negative (i.e., indicative of reducing conditions) at all stations in Cycle Six (Figure 6.12). Redox potential ranged from -225 mV (HSB18) to -18 mV (HSB7A), with declining redox (more negative) at stations immediately to the south and north of the diffuser. Redox among reference stations was quite variable with HSB18 exhibiting the lowest value measured in Cycle Six. Total sulphide values ranged from 1.02 mg/kg (HSB17) to 6.1 mg/kg (HSB11A) for gradient stations and from 0.37 mg/kg (HSB18) to 5.0 mg/kg (HSB21) for the reference stations (Figure 6.12).

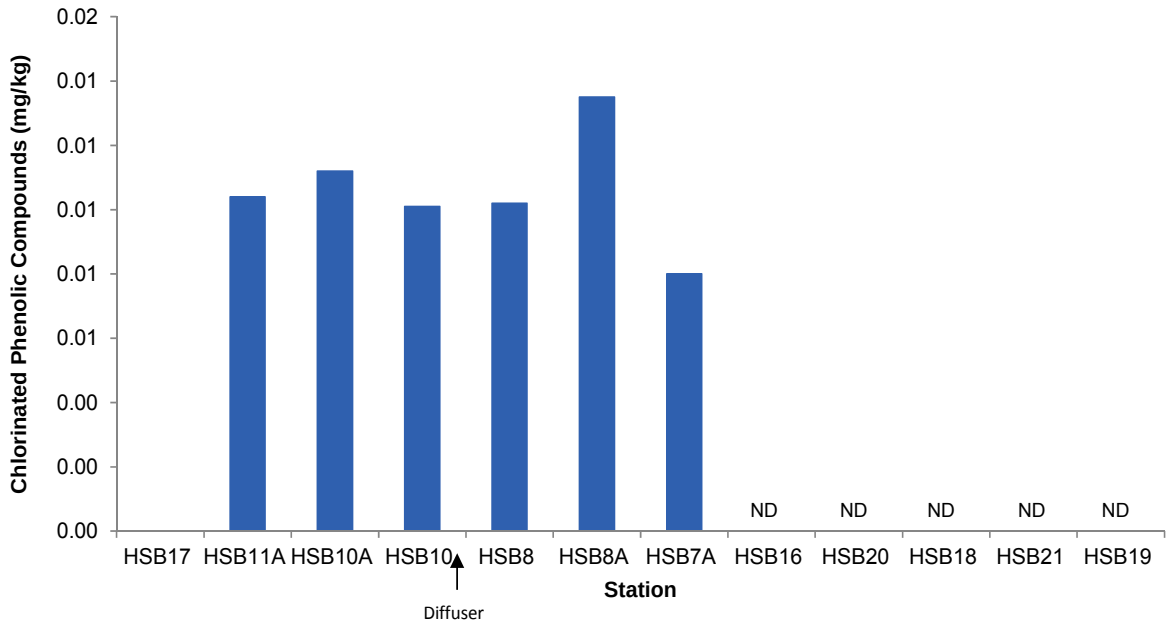
Figure 6.12 Redox potential and total sulphides in sediment, Howe Sound EEM Cycle Six, March 2012.



Chlorinated Phenolic Compounds

Concentrations of total chlorinated phenolics are provided in Figure 6.13. Table 6.9 provides concentrations of specific chlorinated phenolic compounds in composited sediments collected at each benthic invertebrate station in the vicinity of HSPP. The concentration of total chlorinated phenolics ranged from 0.008 mg/kg (HSB7A) to 0.0135 mg/kg (HSB10A). Generally, the concentration of total chlorinated phenolics was higher at near-field stations compared to reference stations, where concentrations of chlorinated phenolic compounds were below detection limits.

Figure 6.13 Summary of total chlorinated phenolic compounds in sediments, Howe Sound EEM Cycle Six, March 2012.



Note: Total chlorinated phenolic compounds were equal to the tetrachlorocatechol compound at all stations where a concentration was detected. No other compounds had concentrations that were detectable.

Table 6.10 Chlorinated phenolic compounds in sediments (mg/kg dry weight), Howe Sound EEM Cycle Six, March 2012[1].

Variable	HSB17 Hutchinson Creek	HSB11A Witherby Point	HSB 10A South of HSPP diffuser	HSB10 HSPP Diffuser South	HSB8 HSPP Diffuser North	HSB8A North of HSPP diffuser	HSB7A North of Bain Creek	HSB16 Ekins Point	HSB20 North of Anvil Island	HSB18 South Anvil Island	HSB21 West Bay, Gambier Island	HSB19 Halkett Point
3,4,5-Trichlorocatechol	<0.0050	<0.0090	<0.0080	<0.0090	<0.0050	<0.0080	<0.0050	<0.0050	<0.0050	<0.0050	<0.015	<0.0050
Tetrachlorocatechol	<0.0050	**0.0104**	**0.0112**	**0.010**	**0.0102**	**0.0135**	**0.008**	<0.0060	<0.0060	<0.0050	<0.015	<0.0050
3,4,5-Trichloroguaiacol	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tetrachloroguaiacol	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0090	<0.0050
2,3,4-Trichlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
2,3,5-Trichlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
2,3,6-Trichlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
2,4,5-Trichlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
2,4,6-Trichlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
2,3,4,5-Tetrachlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
2,3,4,6-Tetrachlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
2,3,5,6-Tetrachlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Pentachlorophenol	<0.0020	<0.0020	<0.0020	<0.0020	<0.0030	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0030	<0.0020
Cycle Six Station Total[2]	0.0000	0.0104	0.0112	0.0101	0.0102	0.0135	0.0080	0.0000	0.0000	0.0000	0.0000	0.0000

[1] Values greater than the detection limit appear in **bold.** Non-detect values considered as zero in total summations.

[2] Only detected levels included in totals.

6.3.2.3 Statistical Analyses

Regression Analyses

Results from regression analyses of chemical and physical variables against distance from the pulpmill diffuser are summarized in Table 6.11. Total organic carbon, carbon/nitrogen ratio, chlorinated phenolics, percent clay, and percent sand exhibited significant correlations with distance from the diffuser (p=0.043, <0.001, 0.001, 0.022, 0.043, respectively). Generally, a decreasing trend was observed in the concentration of each environmental variable with distance from the diffuser.

Table 6.11 Relationships between supporting environmental variables and absolute distance from the pulpmill diffuser, Howe Sound EEM Cycle Six, March 2012.

Effect Endpoint	p-value for F-test	Regression Equation[1]	r	r^2
TOC[2]	**0.043**	**Rank TOC = 10.35 - 0.59DIST**	**-0.592**	**0.350**
Total nitrogen[2]	0.562	TN = 0.21 - 0.002DIST	-0.186	0.035
C/N[2]	**<0.001**	**C/N = 26.80 - 1.02DIST**	**-0.885**	**0.782**
Total sulphides	0.323	RankTS = 8.53 - 0.31DIST	-0.312	0.098
Redox potential	0.814	REDOX= -98.86 + 0.68DIST	0.076	0.006
Chlorinated phenolics	**0.001**	**RankCP = 11.47 - 0.76DIST**	**-0.815**	**0.664**
% clay	**0.022**	**RankCLAY = 2.2579 + 0.65RankDIST**	**0.651**	**0.424**
% silt	0.883	SILT = 54.14 + 0.14DIST	0.048	0.002
% sand	**0.043**	**LnSAND = 3.03 - Ln 0.68DIST**	**-0.590**	**0.348**
% gravel	0.182	GRAV = 2.06 - 0.10DIST	-0.413	0.170

[1] Note that in these equations, Ln refers to the Natural Log; Significant results ($p \leq 0.10$) in **bold**.

[2] Data were log-transformed; DIST = distance.

r = Pearson's correlation coefficient (parametric); r^2 = coefficient of determination.

Correlations between Benthic Metrics and Sediment Variables

Rank correlations between benthic community metrics and chemical and physical variables are presented in Table 6.12. Results from these analyses demonstrate that a number of benthic community metrics were moderately or strongly correlated with physical and chemical variables. Mean adult density was positively correlated with the C/N ratio, and gravel and sand substrate but negatively correlated with silt substrate and distance from the diffuser. Taxa richness negatively correlated with TOC, TN, total sulphides, and silt substrate but positively correlated with dissolved oxygen in the water. Evenness was negatively correlated with TOC, TN, and water temperature. Simpson's diversity was positively correlated with clay substrate and negatively correlated with water temperature. The Bray-Curtis dissimilarity index was positively correlated with TOC, C/N ratio, total sulphides, chlorinated phenolics, and water temperature, indicating that these are potential drivers contributing to dissimilarities between stations.

Table 6.12 Spearman's rank correlations (r_s) between benthic community metrics and supporting environmental variables, Howe Sound EEM Cycle Six, March 2012.

Variable	Density	Richness	Evenness	Simpson's Diversity	Bray-Curtis
TOC	0.056	**-0.762**	**-0.552**	-0.182	**0.552**
TN	-0.238	**-0.832**	**-0.580**	-0.098	0.259
C/N ratio	**0.559**	-0.315	-0.231	-0.252	**0.510**
% Gravel	**0.715**	0.427	-0.306	-0.502	0.114
% Sand	**0.790**	0.441	-0.042	-0.392	0.056
% Silt	**-0.622**	**-0.916**	-0.280	0.210	0.196
% Clay	-0.385	0.042	0.252	**0.510**	**-0.559**
Redox potential	-0.014	0.438	0.378	0.305	-0.371
Total sulphides	-0.319	**-0.809**	-0.410	-0.116	**0.722**
Chlorinated phenolics	0.489	-0.414	-0.425	-0.272	**0.526**
DO	0.301	**0.560**	0.419	0.460	**-0.670**
Water temperature	0.146	**-0.683**	**-0.551**	**-0.542**	**0.615**
Salinity	-0.500	-0.191	-0.236	0.009	-0.173
Distance	**-0.613**	0.109	0.413	0.459	**-0.683**

Bolded values represent significant correlations where $r_s \geq |0.503|$ for n=12.

Moderate Correlations: $|0.5|<r_s<|0.75|$; Strong Correlations: $r_s>|0.75|$.

6.4 DISCUSSION

Results from the Cycle Six benthic invertebrate survey indicated that only density and the Bray-Curtis dissimilarity index exhibited statistically significant spatial trends with distance from the diffuser. Density was highest at stations closest to the mill, particularly at stations on either side of the diffuser (i.e., HSB10 and HSB8) and decreased with increasing distance from the mill. However, this relationship was not found to exceed the critical effect size (Table 6.13). Similarly, there was a significant relationship between the Bray Curtis index and distance from the diffuser, where exposed communities located further from the diffuser were more similar to reference communities than near-field communities. This relationship was stronger and exceeded the effects criterion (Table 6.13). However, despite the difference between exposed and reference communities described by the Bray-Curtis Index, taxa richness, evenness, and diversity did not exhibit any significant trends along the exposure gradient, suggesting that there were no marked differences in the composition of the benthic invertebrate communities among near-field and far-field stations.

Sediment quality with respect to TOC, C/N ratio, and chlorinated phenolics, showed significant decreasing trends with increasing distance from the mill; however, TOC and TN were generally higher at stations south of the mill (i.e., HSB10, HSB10A, and HSB11A). Log booming activities occur in areas near these stations and can provide increased nutrients to marine sediments from terrestrial sources. TOC and TN were also high at the new reference station

(HSB21), located in an inlet of Gambier Island, where debris and logs become trapped due to tidal currents. Density was significantly and positively correlated with sand substrate, which also significantly decreased with increasing distance from the diffuser and negatively correlated with silt which increased with increasing distance from the diffuser, indicating that substrate composition was likely a factor driving density of benthic invertebrates. The Bray-Curtis index was positively correlated with TOC, C/N ratio, and chlorinated phenolics, all of which significantly decreased with distance from mill. Taxa richness was significantly and negatively correlated with TOC and TN, which was evident at stations HSB10A and HSB11A, where concentrations of TOC and TN were high but taxa richness was low compared to other stations.

Table 6.13 Summary of benthic invertebrate endpoint analyses, Howe Sound EEM Cycle Six.

Effect Endpoint	Effect (Statistical Difference)	Effect (>CES)	Direction	Sufficient Power
Density	Yes	No	-	Yes (0.942)
Taxa Richness	No	No	-	Yes (0.942)
Biomass	No	No	-	Yes (0.942)
Evenness	No	No	-	Yes (0.942)
Bray-Curtis	Yes	Yes	Decrease with distance (i.e., increasing similarity)	-

6.4.1 Comparisons with Previous Cycles

Results from the Cycle Six benthic invertebrate survey were compared to results obtained in previous cycles at Howe Sound. The Cycle Six gradient survey was similar to the design in cycles Two to Four, consisting of near-field stations, with stations extending in either direction from the mill diffuser. Reference stations were chosen from those areas furthest from the mill and unaffected by the mill operations. An additional reference station (HSB21) was sampled in Cycle Six because it was not influenced by the flow from Squamish River, as were other reference stations.

In cycles Two and Three, density and richness were significantly higher at near-field stations and exceeded the critical effects size in Cycle Three; the higher densities and richness were attributed to a nutrient enrichment effect in the near-field area. Higher densities were also observed at near-field stations in Cycle Four and Cycle Six, indicating that a source of nutrient enrichment likely continues to be evident at these stations. Sources of nutrient enrichment included log booming activities, particularly to the south of the diffuser, and the degrading historical fibre mat near the pulpmill, which is still present in some areas, particularly to the north of the diffuser (Hatfield 2006). Nutrient enrichment observed at near-field stations was likely from terrestrial sources but not pulpmill related, based on different isotope signatures between the benthic community and the effluent from the pulpmill that was determined during Cycle Four (Hatfield 2006).

Taxa richness in Cycle Six was fairly consistent to results observed in Cycle Four, but much lower compared to cycles Two and Three. The decrease in taxa richness across cycles, particularly at the near-field stations could indicate a decrease in nutrient enrichment effects given that the near-field stations are becoming more consistent with the reference stations with respect to community composition. This is also further supported by the similarities in dominant taxa observed across stations in Cycle Six. The lower taxa richness observed in more recent cycles may also be attributed to an increase in silt substrate at all stations, which was negatively correlated with richness.

Across cycles, the Bray-Curtis index has exhibited the same significant spatial pattern and has exceeded the critical effects size in cycles Three and Six. Evenness and diversity, although slightly lower at the near-field stations have been generally consistent across stations with no clear trends across all four cycles.

Table 6.14 Mean density and richness of benthic invertebrate communities in Howe Sound, EEM cycles Two (1999), Three (2003), Four (2005), and Six (2012).

Station	Location	Mean Density (#/m^2)				Taxa Richness (# families)			
		Cycle Two	Cycle Three	Cycle Four	Cycle Six	Cycle Two	Cycle Three	Cycle Four	Cycle Six
HSB17	Hutchinson Creek	1,104	3,357	ns	5,524	80	83	ns	65
HSB11A	Witherby Point	1,096	3,225	ns	1,790	90	99	ns	33
HSB10A	South of HSPP	2,109	4,226	2,970	2,081	94	92	31	29
HSB10	HSPP diffuser South	1,308	8,846	1,455	4,046	88	84	26	37
HSB8	HSPP diffuser North	407	3,859	3,500	5,342	73	86	45	52
HSB8A	North of HSPP diffuser	1,391	5,454	1,894	3,261	83	115	33	31
HSB7A	North of Bain Creek	590	2,759	2,823	1,451	84	100	45	38
HSB16	Ekins Point	187	1,762	730	809	53	72	27	35
HSB20	North of Anvil Island	ns	5	1,148	1,029	ns	72	30	39
HSB18	South Anvil Island	781	2,803	2,567	2,882	82	80	46	44
HSB21*	West Bay, Gambier Island	ns	ns	ns	933	ns	ns	ns	25
HSB19	Halkett Point	602	1,344	1,563	2,117	74	61	40	51

* Reference station HSB21 was added in Cycle Six.

ns = not sampled.

6.4.2 Sediment Quality and Benthic Community Characteristics

The EEM Technical Guidance Document (Environment Canada 2010) provides the following guidance for examining critical effects or impacts of sediment chemistry on marine benthic invertebrates, based on studies undertaken in the vicinity of salmon aquaculture farms on the east coast of Canada (Environment Canada 2010) (Table 6.15).

Table 6.15 Sediment quality criteria for grading impacts on marine sediments (Environment Canada 2010).

Degree of Impact	% TOC	Redox Potential (mV)	Total Sulphides (µmol)
Normal	Normal (0 to 0.5%)	> 100	< 300
Low impact or enrichment	Slight increase (0.5 to 5%)	0 to 100	300 to 1,300
Moderate to high impact	Moderate increase (5 to 20%)	-100 to 0	1,300 to 6,000
Gross impact	High TOC (>20%)	< -100	> 6,000

Based on these criteria, Table 6.16 summarizes the estimated level of "impact" of each station sampled during cycles Three and Six. In Cycle Six, TOC levels were low to moderate at all stations, which shows an improvement compared to Cycle Three. Station HSB10, near the diffuser, was rated as "high", with respect to TOC levels in Cycle Three and had a "moderate" rating in Cycle Six. TOC was correlated with distance from the mill, which was evident in the impacts rating given that the near-field stations were primarily rated as "moderate" and the far-field and reference stations were rated as "low" (Table 6.16).

The EEM Technical Guidance Document (Environment Canada 2010) provides guidance for interpreting "normal" concentrations of TOC in sediments. Normal concentrations are 0.5% for sediments composed of 0 to 20% silt/clay, 1.7% for sediments composed of 20 to 50% silt/clay, 3.2% for 50 to 80% silt/clay, and 2.6% for >80% silt clay. TOC at all near-field stations exceeded these criteria in Cycle Three and Cycle Six.

Based on the redox potential criteria, most stations were categorized as moderately impacted; and two of the near-field stations (HSB10 and HSB10A) and one reference station (HSB18) exhibited "gross" impacts (Table 6.16). Station HSB10, near the diffuser; however, exhibited an increase in redox potential, indicating improving oxygen conditions at this station since Cycle Three. Stations HSB8 and HSB16 went from positive to negative redox potential from Cycle Three to Cycle Six, indicating a decrease in oxygen in sediments. It is worth noting that the reference stations exhibited lower redox potential compared to results from Cycle Three, with the exception of HSB19.

The level of impact from concentrations of total sulphides could not be assessed for Cycle Six given that the laboratory method that was used did not provide results in the unit of measurement (i.e., µmol) used to develop the impact criteria.

Concentrations of chlorinated phenolics are a direct result of pulpmill operations. Since initial testing in Cycle One, concentrations have steadily decreased with the exception of Cycle Three when concentrations peaked at some stations. In Cycle Six; however, concentrations of chlorinated phenolics were the lowest observed across all cycles, with many phenolic compounds being undetected.

Table 6.16 Evaluation of sediment variables and benthos metrics per station based on "impact grades" provided in the EEM Technical Guidance Document[1]; Howe Sound EEM Cycle Six, March 2012.

Station	Cycle Three					Cycle Six				
	TOC Level	Redox Potential	Total Sulphides	Benthos Density[2]	Benthos Taxa[2]	TOC Level	Redox Potential	Total Sulphides	Benthos Density[2]	Benthos Taxa[2]
HSB17 – Hutchinson Creek	Low	Gross	Normal	Normal	> Normal	Low	Moderate	-	Normal	Low
HSB11A – Witherby Point	Moderate	Gross	Low	Normal	> Normal	Moderate	Gross	-	Normal	Normal
HSB10A – South of HSPP	Moderate	Gross	Moderate	Normal	> Normal	Moderate	Gross	-	Low	Normal
HSB10 – HSPP diffuser south	High	Gross	Low	> Normal	> Normal	Moderate	Gross	-	Normal	Normal
HSB8 – HSPP diffuser north	Moderate	Moderate	Moderate	Normal	> Normal	Low	Moderate	-	Low	Normal
HSB8A – North of HSPP	Moderate	Gross	Low	> Normal	> Normal	Moderate	Moderate	-	Normal	Normal
HSB7A – North of Basin Ck.	Moderate	Gross	Low	Normal	> Normal	Low	Moderate	-	Normal	Normal
HSB16 – Ekins Point	Low	Moderate	Normal	Normal	Normal	Low	Gross	-	Normal	Normal
HSB20 – North of Anvil Is.	Moderate	Gross	Low	na	na	Low	Moderate	-	na	na
HSB18 – South of Anvil Is.	Low	Moderate	Normal	na	na	Low	Gross	-	na	na
HSB21 – Gambier Island	ns	ns	ns	ns	ns	Low	Moderate	-	na	na
HSB19 – Halkett Point	Low	Gross	Normal	na	na	Low	Moderate	-	na	na

[1] Environment Canada 2010.

[2] Data from stations HSB18, HSB19, HSB20, and HSB21 (in Cycle Six only) were used to determine mean and range of "normal" benthic invertebrate values. Impacts: no macrofauna = gross; density and biomass <50% reference, <10 taxa = moderate; density, biomass, taxa >50% reference = low; within reference range = normal.

[3] TOC (total organic carbon) impacts: <0.5%=normal, 0.5 to 2%=low, 2 to 10%=moderate, 10 to 20%=high, >20%=gross.

[4] Redox potential (mV) impacts: >100=normal, 0 to 100=low, -100 to 0=moderate, <-100=gross.

[5] An impact assessment of total sulphides could not be conducted in Cycle Six given that the laboratory methods that were conducted provided the results in different units than what was established for the impact criteria (i.e., impacts: <300=normal, 300 to 1,300=low, 1,300 to 6,000=moderate, >6,000=gross).

ns=not sampled.

6.5 CONCLUSIONS

Based on the results of the HSPP Cycle Six EEM benthic invertebrate survey and supporting sediment quality survey, the following conclusions are made:

- Benthic invertebrate community densities and the Bray-Curtis dissimilarity index exhibited significant spatial trends with distance to the south and north of the diffuser. Density generally decreased with increasing distance from the diffuser and exposed communities located further from the diffuser were more similar to reference communities. Only the Bray-Curtis index exceeded the critical effects size. Taxa richness, evenness, and diversity showed no significant spatial trends along the exposure gradient or any exceedance of the critical effects size;

- Sediments to the south of the diffuser exhibited some organic enrichment but an improvement in oxygen conditions compared to Cycle Three. Sediment at stations to the north of the diffuser exhibited a decrease in organic content, with the exception of station HSB8A, and exhibited a better oxidative state compared to Cycle Three. Possible sources of nutrient enrichment included log booming activities, particularly to the south of the diffuser, and the degrading historical fibre mat near the pulpmill, which is still present in some areas, particularly to the north of the diffuser;

- Concentrations of pulpmill-specific contaminants in sediment (i.e., chlorinated organic compounds) continue to decline in Howe Sound; and

- Based on trends across EEM cycles, it is evident that conditions in Howe Sound with respect to sediment quality and benthic invertebrate communities continue to improve. Sources of nutrient enrichment, which likely contributed to the higher densities and TOC and TN concentrations at near-field stations included the degrading historical fibre mat to the north of the pulpmill and log booming activities to the south, rather than current effluent conditions.

7.0 CYCLE SIX CONCLUSIONS

Considering all components of the Howe Sound EEM Cycle Six program, results of this study indicated that current effluent discharges from HSPP contribute to Howe Sound as follows:

- Sublethal effects of Howe Sound effluent on echinoderms were observed at a mean concentration greater than the 12.3%, which was lower than Cycle Five, but consistent with results reported in Cycle Four. Mean results in Cycle Six indicated an increased effect of effluent on *Champia* reproduction;

- Based on a 1% effluent concentration zone of 2,000 m from the HSPP diffuser, maximum potential zones of sublethal effect were 162 m for invertebrate fertilization, and 1,995 m for algal reproduction;

- Concentrations of dioxins and furans at site S14, located near the HSPP diffuser, were lower than previous years exhibiting a decreasing trend over time. Sediment at site S14 have shifted over time to consist primarily of sand substrate, with some silt;

- Concentrations of dioxins and furans continue to decrease in tissues of Dungeness crab and spiny dogfish collected from Howe Sound. Concentrations of dioxins and furans exceeded the Health Canada's advisory criteria (24.4 pg/g) in crab from sites C14, 19a, and C28 by 1.5, 6.2, and 2.7 times, respectively. Concentrations of dioxins and furans in spiny dogfish liver exceeded the Health Canada's advisory guideline (30.0 pg/g) by 9.4 times; an exceedance was not observed in spiny dogfish muscle tissue;

- Benthic invertebrate community densities and the Bray-Curtis dissimilarity index exhibited clear spatial trends with distance to the south and north of the diffuser. Density generally decreased with increasing distance from the diffuser and exposed communities located further from the diffuser were more similar to reference communities. Only the Bray-Curtis index exceeded the critical effects criteria. Taxa richness, evenness, and diversity showed no significant spatial trends along the exposure gradient or any exceedance of the effects criteria;

- Sediments to the south of the diffuser exhibited some organic enrichment but an improvement in oxygen conditions compared to Cycle Three. Sediment at stations to the north of the diffuser exhibited a decrease in organic content, with exception of station HSB8A, and exhibited a better oxidative state compared to Cycle Three. Possible sources of nutrient enrichment included log booming activities, particularly to the south of the diffuser, and the degrading historical fibre mat near the pulpmill, which is still present in some areas, particularly to the north of the diffuser;

- Concentrations of pulpmill-specific contaminants in sediment (i.e., chlorinated organic compounds) continue to decline in Howe Sound; and

- Based on trends across EEM cycles, it is evident that conditions in Howe Sound with regards to dioxin and furan concentrations continue to improve. Similarly, sediment conditions and benthic invertebrate communities, although variable across stations, continue to show improvement in the near-field area.

8.0 CLOSURE

We trust the above information meets your requirements. If you have any questions or comments, please contact the undersigned.

HATFIELD CONSULTANTS:

Approved by: _____ March 18, 2013

Heather Keith
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Date

Approved by: _____ March 18, 2013

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9.0 REFERENCES

Cohen J. 1988. Statistical Power Analysis for the Behavioral Sciences. Second Edition. Lawrence Erlbaum Associates. Hillsdale, New Jersey.

[DFO] Fisheries and Oceans Canada. 2012. Recreational Fishing, Tidal Area Regulations, Area 28 (Howe Sound). Available from: http://www.pac.dfo-mpo.gc.ca/fm-gp/rec/tidal-maree/a-s28-eng.htm#Shellfish

Environment Canada. 1992. Biological test method: fertilization assay with echinoids (sea urchins and sand dollars). Ottawa (ON): Environmental Technology Centre. Report EPS 1/RM/27, December 1992. Amended in November 1997.

Environment Canada. 1998. Pulp and paper technical guidance for aquatic environmental effects monitoring. EEM/1998/1. Environment Canada, April 1998.

Environment Canada. 2010. Pulp and paper technical guidance for aquatic environmental effects monitoring. Environment Canada, 2010.

Faul F, Erdfelder E. 1992. GPOWER. A priori, post-hoc and compromise power analyses (Computer program). Bonn, Germany. Bonn University, Dept. of Psychology.

Hatfield. 1994. Howe Sound environmental effects monitoring (EEM) pre-design reference document. Prepared for Western Pulp Limited Partnership, Squamish Operation, and Howe Sound Pulp and Paper Limited by Hatfield Consultants, Ltd., March 1994.

Hatfield. 1996. Howe Sound environmental effects monitoring (EEM) Cycle One interpretive report. Prepared for Western Pulp Limited Partnership, Squamish Operation, and Howe Sound Pulp and Paper Limited by Hatfield, November 1996.

Hatfield. 1998. Howe Sound environmental effects monitoring (EEM) Cycle One interpretive report. Prepared for Western Pulp Limited Partnership, Squamish Operation, and Howe Sound Pulp and Paper Limited by Hatfield Consultants Ltd., December 1998.

Hatfield. 2004. Howe Sound environmental effects monitoring (EEM) Cycle Three interpretive report. Prepared for Western Pulp Limited Partnership – Squamish Operation. Hatfield Consultants Ltd., West Vancouver, BC.

Hatfield. 2007. Howe Sound environmental effects monitoring (EEM) Cycle Four interpretive report. Prepared for Western Pulp Limited Partnership – Squamish Operation. Hatfield Consultants Ltd., West Vancouver, BC.

Hatfield. 2009. Howe Sound dioxin/furan trend monitoring program. Prepared for Howe Sound Pulp and Paper Limited Partnership. Hatfield Consultants Ltd., North Vancouver, BC.

Hatfield. 2012. Howe Sound environmental effects monitoring (EEM) Cycle Six design document. Prepared for Howe Sound Pulp and Paper Corporation. Hatfield Consultants Partnership. North Vancouver, BC.

Isaacson PJ, Frink CR. 1984. Nonreversible Sorption of Phenolic Compounds by Sediment Fractions: The Role of Sediment Organic Matter. Environmental Science and Technology. 7904(18): 43-48.

Luthe CE, Prahacs S. 1993. Dioxins from pulp mill combustion processes: implications and control. Pulp and Paper Canada. 94(8): T227-236.

Luthe CE, Voss RH, Berry RM. 1995. Tracking dioxins: from chips to finished product. Chemosphere. 30(4): 661-670.

Macdonald RW, Crecelius EA. 1994. Marine sediments in the Strait of Georgia, Juan de Fuca and Puget Sound: what can they tell us about contamination? [In] Wilson RCH, Beamish RJ, Aikens F, Bell J, editors. Review of the marine environment and biota of the Strait of Georgia, Puget Sound and Juan de Fuca Strait. Can. Tech. Rpt. Fish. Aquat. Sci. 1948:101-129.

Macdonald RW, Cretney WJ, Crewe N, Paton D. 1992. A History of Octachlorodibenzo-p-dioxin, 2,3,7,8-Tetrachlorodibenzofuran, and 3,3',4,4'-Tetrachlorobiphenyl Contamination in Howe Sound, British Columbia. Environmental Science and Technology. 26(8): 1544-1550.

Macdonald RW, Ikonomou MG, Paton DW. 1998. Historical inputs of PCDDs, PCDFs, and PCBs to a British Columbia interior lake: the effect of environmental controls on pulp mill emissions. Environmental Science and Technology. 32: 331-337.

R Development Core Team. 2011. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0. URL http://www.R-project.org/.

Saunders MW, McFarlane GA. 1993. Age and length at maturity of the female spiny dogfish, Squalus acanthias, in the Strait of Georgia, British Columbia, Canada. Environmental Biology of Fishes. 38(1-3): 49-57.

SPSS Inc. 2000. SYSTAT 10. Statistics I. SPSS Inc. United States of America. p.663.

Uloth V, Wenli D, Leclerc D, Karidio I, Kish J, Singbeil D. 2005, Investigations into the variability and control of dioxins formation and emissions from coastal power boilers. Technical Association of the Pulp and Paper Industry – Engineering, Pulping, and Environmental Conference 2005.

[US EPA] US Environmental Protection Agency. 1982. Methods for chemical analysis of municipal and industrial wastewater. EPA-600/4-82-057, July 1982. EMSL, Cincinnati, OH 45268.

US EPA. 2002. Short-term methods for estimating the toxicity of effluents and receiving water to West Coast organisms. First edition. Cincinnati (OH): Environmental Monitoring Systems laboratory, U.S. Environmental Protection Agency. EPA/821/R-02/014, October 2002.

[WHO] World Health Organization. 2005. Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds.

10.0 GLOSSARY

Acute	With reference to toxicity tests with fish, usually means an effect that happens within four to seven days, or an exposure of that duration. An acute effect could be mild or sublethal, if it were rapid.
ANCOVA	Analysis of covariance. ANCOVA compares regression lines, testing for differences in either slopes or intercepts (adjusted means).
ANOVA	Analysis of variance. An ANOVA tests for differences among levels of one or more factors. For example, individual sites are levels of the factor site. Two or more factors can be included in an ANOVA (e.g., site and year).
Benthos	Organisms that inhabit the bottom substrates (sediments, debris, logs, macrophytes) of aquatic habitats for at least part of their life cycle. The term benthic is used as an adjective, as in benthic invertebrates.
BOD	Biochemical oxygen demand. The test measures the oxygen utilized during a specified incubation period for the biochemical degradation of organic material and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. Usually conducted as a 5-day test (i.e., BOD5).
Chronic	Long-lasting or continued. Can refer to the effect or the duration of exposure. In mammalian toxicology, it usually signifies exposures lasting at least one-tenth of a lifetime. In aquatic toxicology, it sometimes is used to mean a full life-cycle test.
CL	Confidence limits. A set of possible values within which the true value will lie with a specified level of probability.
Colour	True colour of water is the colour of a filtered water sample (and thus with turbidity removed), and results from materials which are dissolved in the water. These materials include natural mineral components such as iron and calcium carbonate, as well as dissolved organic matter such as humic acids, tannin, and lignin. Organic and inorganic compounds from industrial or agricultural uses may also add colour to water. As with turbidity, colour hinders the transmission of light through water, and thus "regulates" biological processes within the body of water.
Community	A set of taxa coexisting at a specified spatial or temporal scale.

Concentration

Units Table

Concentration Units	Abbreviation	Units
Parts per million	ppm	mg/kg or μg/g or mg/L
Parts per billion	ppb	μg/kg or ng/g or μg/L
Parts per trillion	ppt	ng/kg or pg/g or ng/L
Parts per quadrillion	ppq	pg/kg or fg/g or pg/L

Condition Factor — A measure of the plumpness or fatness of aquatic organisms. For oysters and mussels, values are based on the ratio of the soft tissue dry weight to the volume of the shell cavity. For fish, the condition factor is based on length-weight relationships.

Conductivity — A numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence and relative concentrations, and on the temperature of measurement.

Covariate — An independent variable; a measurement taken on each experimental unit that predicts to some degree the final response to the treatment, but which is unrelated to the treatment (e.g., body size [covariate] included in the analysis to compare gonad weights of fish collected from reference and exposed areas).

Dioxins/Furans — Polychlorinated dibenzo-para-dioxins (PCDDs) and dibenzofurans (PCDFs) are often simply called dioxins, although they are two separate groups of substances with similar effects. There are 210 different compounds, of which 17 are the most toxic.

DO — Dissolved oxygen, the gaseous oxygen in solution with water. At low concentrations it may become a limiting factor for the maintenance of aquatic life. It is normally measured in milligrams/litre, and is widely used as a criterion of receiving water quality. The level of dissolved oxygen which can exist in water before the saturation point is reached is primarily controlled by temperature, with lower temperatures allowing for more oxygen to exist in solution. Photosynthetic activity may cause the dissolved oxygen to exist at a level which is higher than this saturation point, whereas respiration may cause it to exist at a level which is lower than this saturation point. At high saturation, fish may contract gas bubble disease, which produces lesions in blood vessels and other tissues and subsequent physiological dysfunctions.

ECp — A point estimate of the concentration of test material that causes a specified percentage effective toxicity (sublethal or lethal). In most instances, the ECp is statistically derived by analysis of an observed biological response (e.g., incidence of nonviable embryos or reduced hatching success) for various test concentrations after a fixed period of exposure. EC25 is used for the rainbow trout sublethal toxicity test.

Fecundity	The number of eggs or offspring produced by a female.
Gonad	A male or female organ producing reproductive cells or gametes (i.e., female ovum, male sperm). The male gonad is the testis, the female gonad is the ovary.
GSI	Gonadosomatic Index. Calculated by expressing gonad weight as a percentage of whole body weight.
Hardness	Total hardness is defined as the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in milligrams per litre.
ICp	A point estimate of the concentration of test material that causes a specified percentage impairment in a quantitative biological test which measures a change in rate, such as reproduction, growth, or respiration.
LC50	Median lethal concentration. The concentration of a substance that is estimated to kill half of a group of organisms. The duration of exposure must be specified (e.g., 96-hour LC50).
LSI	Liver Somatic Index. Calculated by expressing liver weight as a percent of whole body weight.
Macroinvertebrates	Those invertebrate (without backbone) animals that are visible to the eye and retained by a sieve with 500 μm mesh openings for freshwater, or 1,000 μm mesh openings for marine surveys (EEM methods).
Negative Control	Material (e.g., water) that is essentially free of contaminants and of any other characteristics that could adversely affect the test organism. It is used to assess the "background response" of the test organism to determine the acceptability of the test using predefined criteria.
Organochlorine	Chlorine that is attached to an organic molecule. The amount present is expressed as the weight of the chlorine. There are thousands of such substances, including some that are manufactured specifically as pesticides because of their toxicity.
pH	A measure of the acid or alkaline nature of water or some other medium. Specifically, pH is the negative logarithm of the hydronium ion (H30+) concentration (or more precisely, activity). Practically, pH 7 represents a neutral condition in which the acid hydrogen ions balance the alkaline hydroxide ions. The pH of the water can have an important influence on the toxicity and mobility of chemicals in pulpmill effluents.
Plume	The main pathway for dispersal of effluent within the receiving waters, prior to its complete mixing.

Population	A group of organisms belonging to a particular species or taxon, found within a particular region, territory or sampling unit. A collection of organisms that interbreed and share a bounded segment of space.
ppt	Parts per thousand.
Quality Assurance (QA)	Refers to the externally imposed technical and management practices which ensure the generation of quality and defensible data commensurate with the intended use of the data; a set of operating principles that, if strictly followed, will produce data of known defensible quality.
Quality Control (QC)	Specific aspect of quality assurance which refers to the internal techniques used to measure and assess data quality and the remedial actions to be taken when data quality objectives are not realized.
Redox Potential (Eh)	In marine sediments, the measurement of reduction and oxidation by testing electron movement and, consequently, available oxygen.
Reference Toxicant	A chemical of quantified toxicity to test organisms, used to gauge the fitness, health, and sensitivity of a batch of test organisms.
Resin Acids	Any of a class of vegetable substances, composed chiefly of esters and ethers of organic acids, that occur as a sticky yellow or brown substance exuded on the bark of various plants and trees, such as the pine and fir.
Salinity	A measure of the quantity of dissolved salts in seawater - in parts per thousand (ppt) by weight.
SD	Standard deviation.
SE	Standard error.
Secondary Treatment	A stage of purification of a liquid waste in which micro-organisms decompose organic substances in the waste. In the process, the micro-organisms use oxygen. Oxygen usually is supplied by mechanical aeration and/or large surface area of treatment ponds (lagoons). Most secondary treatment also reduces toxicity.
Sentinel Species	A monitoring species selected to be representative of the local receiving environment.
Stressor	An environmental factor or group of factors eliciting a response by a community.

Sublethal	A concentration or level that would not cause death. An effect that is not directly lethal.
T4CDD	2,3,7,8-tetrachlorodibenzo-para-dioxin, the most toxic dioxin.
TEQ	Toxic Equivalents.
TN	Total nitrogen.
TOC	Total organic carbon (TOC).
Total-TEQs	TEQs are calculated by multiplying the concentration of each congener with its respective International Toxicity Equivalency Factor (ITEF), to normalize concentrations to the level that would be produced by an equivalent amount of 2,3,7,8-T4CDD, then summing all the concentrations.
TS	Total sulphides.
TSS	Total suspended solids (TSS) is a measurement of the oven dry weight of particles of matter suspended in the water which can be filtered through a standard filter paper with pore size of 0.45 micrometres.
Turbidity	Turbidity in water is caused by the presence of matter such as clay, silt, organic matter, plankton, and other microscopic organisms that are held in suspension.
v/v	volume/volume - used to define dilution ratios for two liquids.

APPENDICES

Appendix A1

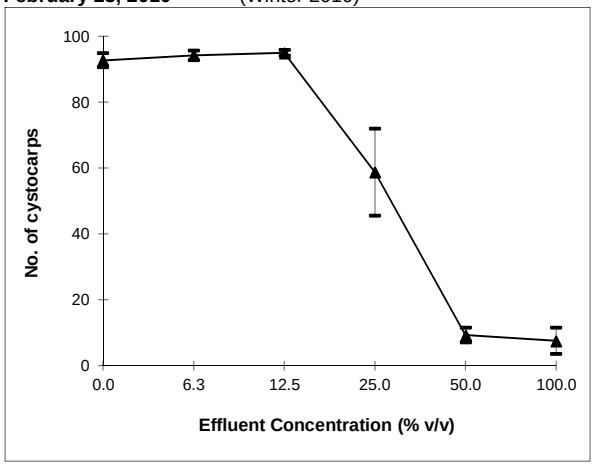
Sublethal Toxicity Data and Calculations

Table A1.1 Howe Sound Pulp and Paper calculation of geomeans and potential zones of sublethal effect.

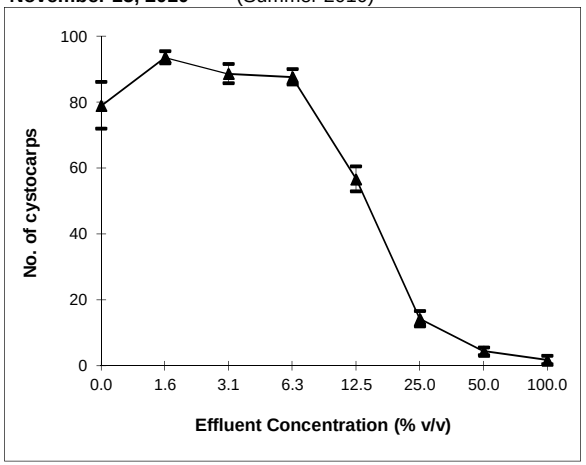
	Invertebrate Fertilization						Algae Reproduction					
	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Cycle 6
	IC25	IC25	IC25	IC25	IC25	IC25	IC25	IC25	IC25	IC25	IC25	IC25
		23.01	5.74	10.94	80.10	19.90	17.60	28.21	7.49	11.17	5.77	2.18
		17.92	9.89	37.65	39.90	10.30	6.40	18.40	11.29	5.29	4.31	1.01
	13.30	11.39	22.02	3.87	30.62	15.80	13.20	32.76	25.56	6.57	4.52	0.67
	9.30	16.82	49.70	67.00	25.40	19.20	63.40	7.12	22.65	10.45	1.31	4.41
		13.17	35.37	22.60	16.60	9.90		20.80	28.49	16.84	1.80	0.78
			62.37	15.80	30.30	5.70			19.35	16.47	1.44	0.20
			17.96						38.23			
			62.22						17.84			
Geomean	11.12	15.97	25.01	18.35	32.82	12.33	17.52	19.06	19.19	10.20	2.69	1.00
SE	2.00	2.02	8.05	9.40	9.13	2.33	12.96	4.41	3.45	1.97	0.78	0.63
1% effluent zone (m)												
6000	539.49	375.59	239.89	327.04	182.80	486.73	342.42	314.72	312.63	588.32	2227.76	5985.25
2000	179.83	125.20	79.96	109.01	60.93	162.24	114.14	104.91	104.21	196.11	742.59	1995.08

Figure A1.1 **Mean (± SD) number of echinoderm eggs fertilized when exposed to final effluent and control water, Howe Sound Pulp and Paper, EEM Cycle Six.**

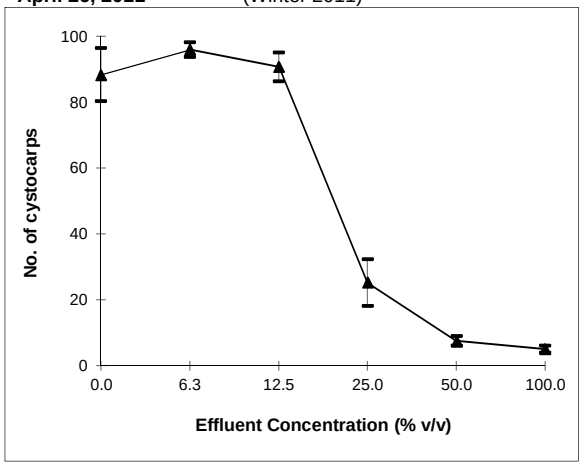
February 23, 2010 (Winter 2010)



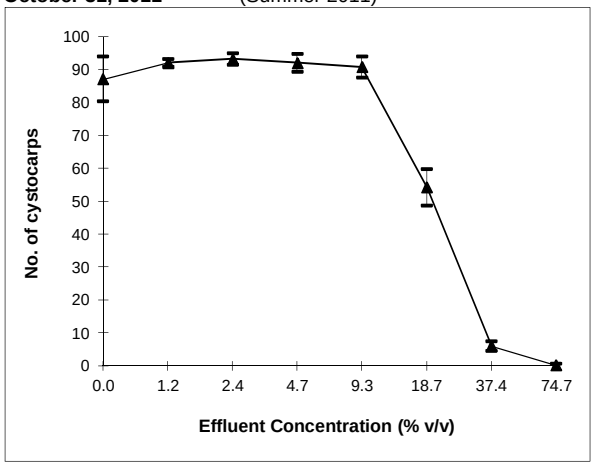
November 15, 2010 (Summer 2010)



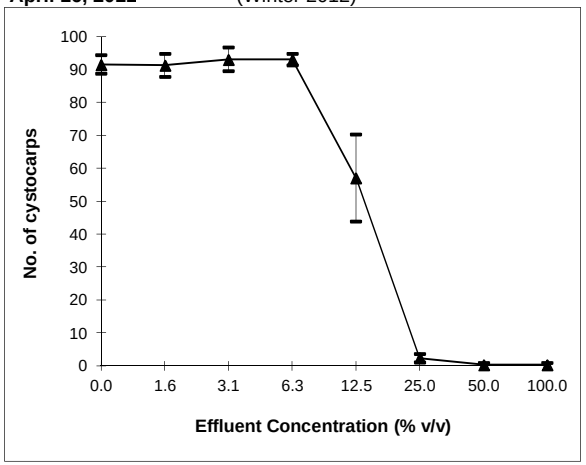
April 26, 2011 (Winter 2011)



October 31, 2011 (Summer 2011)



April 16, 2012 (Winter 2012)



October 22, 2012 (Summer 2012)

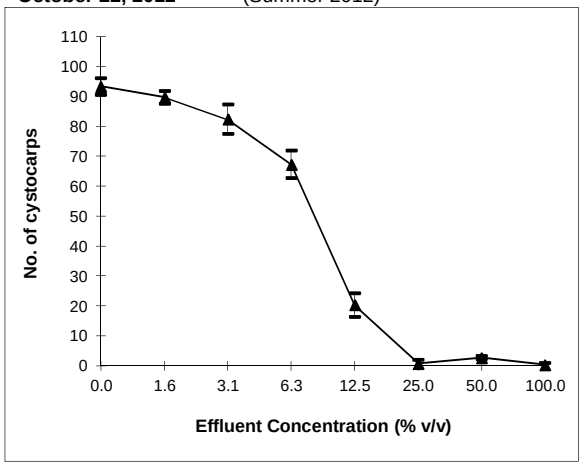
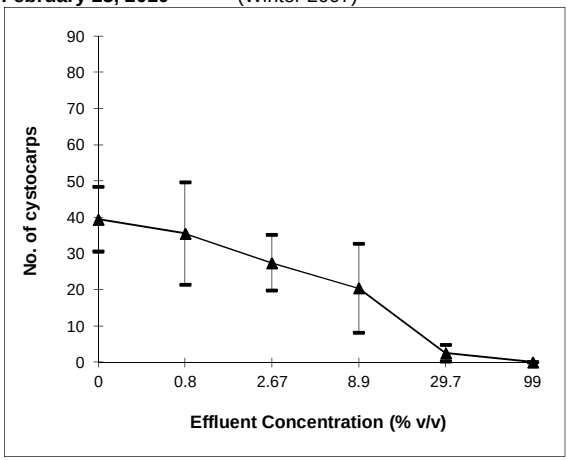
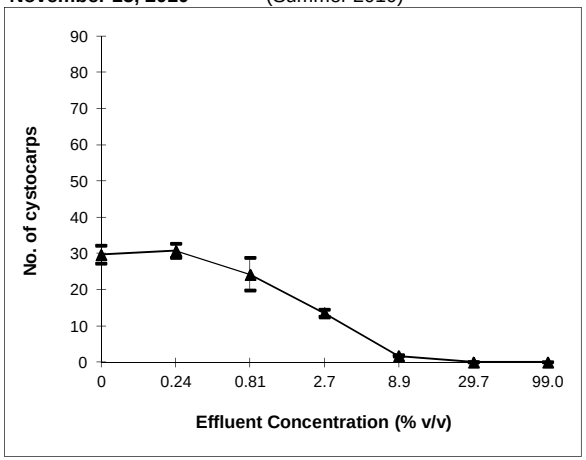


Figure A1.2 **Mean (± SD) number of cystocarps produced by an alga (Champia parvula) exposed to final effluent and control water, Howe Sound Pulp and Paper, EEM Cycle Six.**

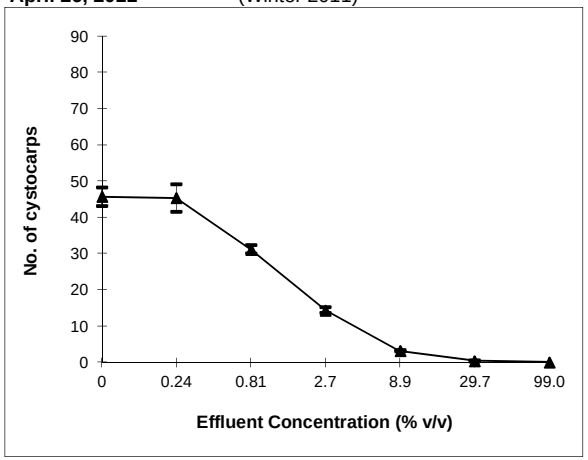
February 23, 2010 (Winter 2007)



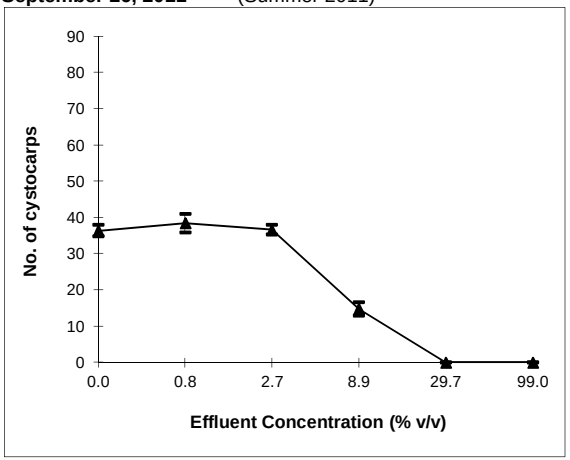
November 15, 2010 (Summer 2010)



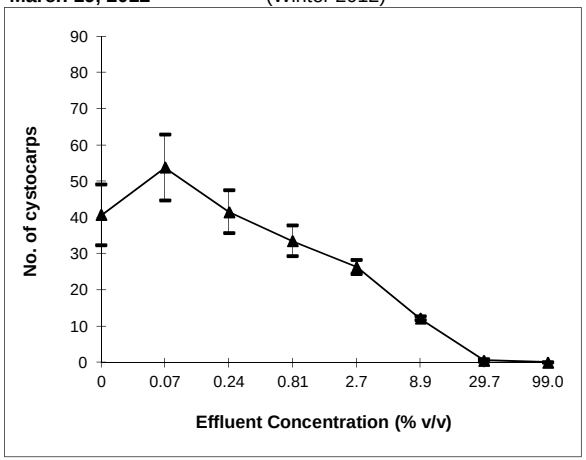
April 26, 2011 (Winter 2011)



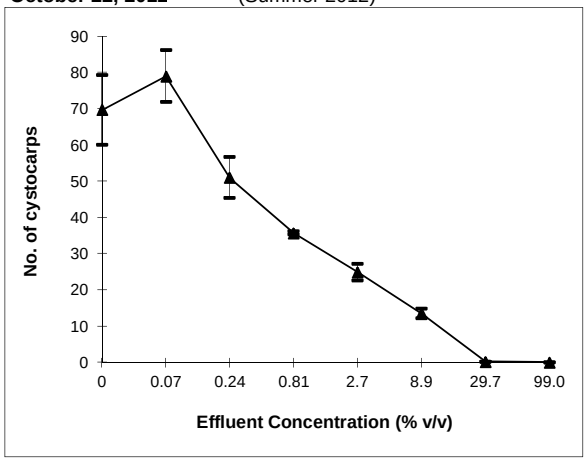
September 26, 2011 (Summer 2011)



March 19, 2012 (Winter 2012)



October 22, 2012 (Summer 2012)



Appendix A2

Laboratory Reports

HATFIELD CONSULTANTS
ATTN: Heather Keith
200 - 850 Harbourside Drive
North Vancouver BC V7P 0A3

Date Received: 16-MAR-12
Report Date: 30-APR-12 14:09 (MT)
Version: FINAL

Client Phone: 604-926-3261

Certificate of Analysis

Lab Work Order #: L1125084

Project P.O. #:	NOT SUBMITTED
Job Reference:	HS1625
C of C Numbers:	2, 3, HS1625-1
Legal Site Desc:	HOWE SOUND PULP AND PAPER

Comments: Please note that low surrogate recoveries were noted for samples -3 to -6 and -12. Samples were re-extracted with the same results. Therefore the values reported for Tetrachlorocatechol may be biased slightly low.

Brent Mack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1125084-1	L1125084-2	L1125084-3	L1125084-4	L1125084-5
	Description	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT	SEDIMENT
	Sampled Date	13-MAR-12	15-MAR-12	13-MAR-12	15-MAR-12	15-MAR-12
	Sampled Time	12:00	11:00	14:00	14:00	12:00
	Client ID	HSB7A NORTH OF BAIN CREEK	HSB8 HSPP OUTFALL NORTH	HSB8A NORTH OF HSPP DIFFUSER	HSB10 HSPP OUFALL SOUTH	HSB10A SOUTH OF HSPP
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss on Ignition @ 550 C (%)	10	8	16	14	15
	Moisture (%)	61.3	63.8	68.8	65.7	66.9
Particle Size	% Gravel (>2mm) (%)	1.87	5.72	0.77	2.07	<0.10
	% Course Sand (2.0mm - 0.2mm) (%)	13.5	47.4	2.33	16.4	0.86
	% Fine Sand (0.2mm - 0.063mm) (%)	9.95	15.7	13.3	15.6	8.80
	% Silt (0.063mm - 4um) (%)	51.1	24.9	63.7	49.2	77.5
	% Clay (<4um) (%)	23.7	6.28	20.0	16.8	12.8
	Texture	Silt loam	Sandy loam	Silt loam	Silt loam	Silt loam / Silt
Leachable Anions & Nutrients	Sulphide as S (mg/kg)	1.16	1.61	1.9	1.67	2.3
Anions and Nutrients	Total Nitrogen by LECO (%)	0.169	0.121	0.245	0.215	0.252
Organic / Inorganic Carbon	Total Organic Carbon (%)	3.56	2.87	7.01	5.74	6.75
Saturated Paste Extractables	Oxidation-Reduction Potential (ORP) (mV)	-18	-56	-73	-102	-159
Phenolics	Pentachlorophenol (mg/kg)	<0.0020	<0.0030 DLM	<0.0020	<0.0020	<0.0020
	Tetrachlorocatechol (mg/kg)	0.0080	0.0102	0.0135	0.0101	0.0112
	Tetrachloroguaiacol (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	2,3,4,5-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,4,6-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,5,6-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	3,4,5-Trichlorocatechol (mg/kg)	<0.0050	<0.0050	<0.0080 DLM	<0.0090 DLM	<0.0080 DLM
	3,4,5-Trichloroguaiacol (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	2,3,4-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,5-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,6-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,4,5-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,4,6-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1125084-6 SEDIMENT 15-MAR-12 08:30 HSB11A WITHERBY POINT	L1125084-7 SEDIMENT 14-MAR-12 14:00 HSB16 EKINS POINT	L1125084-8 SEDIMENT 13-MAR-12 15:00 HSB17 HUTCHINSON CREEK	L1125084-9 SEDIMENT 14-MAR-12 08:30 HSB18 SOUTH OF ANVIL ISLAND	L1125084-10 SEDIMENT 13-MAR-12 08:00 HSB19 HALKETT POINT
SOIL						
Physical Tests	Loss on Ignition @ 550 C (%)	20	9	3	6	7
	Moisture (%)	75.6	69.3	33.7	60.3	68.5
Particle Size	% Gravel (>2mm) (%)	1.86	<0.10	0.30	2.11	0.75
	% Course Sand (2.0mm - 0.2mm) (%)	0.49	0.23	13.4	5.29	1.82
	% Fine Sand (0.2mm - 0.063mm) (%)	1.72	0.46	62.5	3.39	2.06
	% Silt (0.063mm - 4um) (%)	76.0	70.5	21.1	43.2	49.5
	% Clay (<4um) (%)	19.9	28.8	2.64	46.1	45.9
	Texture	Silt loam	Silt loam	Sand / Loamy sand	Silty clay	Silt Clay loam / Silty clay
Leachable Anions & Nutrients	Sulphide as S (mg/kg)	6.1	2.6	1.02	<0.37	<0.55
Anions and Nutrients	Total Nitrogen by LECO (%)	0.353	0.163	0.044	0.102	0.154
Organic / Inorganic Carbon	Total Organic Carbon (%)	8.29	1.89	1.10	1.09	1.40
Saturated Paste Extractables	Oxidation-Reduction Potential (ORP) (mV)	-136	-116	-73	-225	-19
Phenolics	Pentachlorophenol (mg/kg)	<0.0020	<0.0020	<0.020 DLM	<0.0020	<0.0020
	Tetrachlorocatechol (mg/kg)	0.0104	<0.0060 DLB	<0.0050	<0.0050	<0.0050
	Tetrachloroguaiacol (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	2,3,4,5-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,4,6-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,5,6-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	3,4,5-Trichlorocatechol (mg/kg)	<0.0090 DLM	<0.0050	<0.0050	<0.0050	<0.0050
	3,4,5-Trichloroguaiacol (mg/kg)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	2,3,4-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,5-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,3,6-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,4,5-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
	2,4,6-Trichlorophenol (mg/kg)	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1125084-11	L1125084-12			
	Description	SEDIMENT	SEDIMENT			
	Sampled Date	14-MAR-12	15-MAR-12			
	Sampled Time	13:00	12:30			
	Client ID	HS20 NORTH OF ANVIL ISLAND	HSB00(DUP)			
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss on Ignition @ 550 C (%)	8	13			
	Moisture (%)	68.1	66.2			
Particle Size	% Gravel (>2mm) (%)	<0.10	0.17			
	% Course Sand (2.0mm - 0.2mm) (%)	0.22	1.10			
	% Fine Sand (0.2mm - 0.063mm) (%)	1.08	8.19			
	% Silt (0.063mm - 4um) (%)	55.5	66.8			
	% Clay (<4um) (%)	43.2	23.8			
	Texture	Silty clay loam	Silt loam			
Leachable Anions & Nutrients	Sulphide as S (mg/kg)	1.25	1.27			
Anions and Nutrients	Total Nitrogen by LECO (%)	0.177	0.233			
Organic / Inorganic Carbon	Total Organic Carbon (%)	1.77	5.50			
Saturated Paste Extractables	Oxidation-Reduction Potential (ORP) (mV)	-58	-132			
Phenolics	Pentachlorophenol (mg/kg)	<0.0020	<0.0020			
	Tetrachlorocatechol (mg/kg)	<0.0060 DLB	0.0131			
	Tetrachloroguaiacol (mg/kg)	<0.0050	<0.0050			
	2,3,4,5-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020			
	2,3,4,6-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020			
	2,3,5,6-Tetrachlorophenol (mg/kg)	<0.0020	<0.0020			
	3,4,5-Trichlorocatechol (mg/kg)	<0.0050	<0.010 DLM			
	3,4,5-Trichloroguaiacol (mg/kg)	<0.0050	<0.0050			
	2,3,4-Trichlorophenol (mg/kg)	<0.0020	<0.0020			
	2,3,5-Trichlorophenol (mg/kg)	<0.0020	<0.0020			
	2,3,6-Trichlorophenol (mg/kg)	<0.0020	<0.0020			
	2,4,5-Trichlorophenol (mg/kg)	<0.0020	<0.0020			
	2,4,6-Trichlorophenol (mg/kg)	<0.0020	<0.0020			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection limit was raised due to detection of analyte at comparable level in Method Blank.
DLM	Detection Limit Adjusted For Sample Matrix Effects

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

CP-LL-P&P-SE-MS-VA	Soil	CP-P&P-SE-MS-VA	EPA METHODS 3500B, 8041 & 8270C

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3500B, 8041 & 8270C, published by the United States Environmental Protection Agency (EPA). A sediment/soil sub-sample is extracted with basic methanol or acidified acetone. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS) and/or electron capture detection (GC/ECD).

LOI-550-SK	Soil	Loss on Ignition @ 550 C	CSSS (1993) p.461-462

The sample is air dried at 40C overnight, then ground to < 2mm in particle size using a flail grinder. A portion of the dried and ground sample is dried at 105C overnight, then ignited at 550C for 16-20 hours. Loss on ignition at 550C is reported on a dry sample basis.

Carter, Martin. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1993) method 44.3.3

MOISTURE-VA	Soil	Moisture content	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where nitrogen in the reduced nitrous oxide gas is determined using a thermal conductivity detector.

ORP-PASTE-VA	Soil	Oxidation reduction potential of Soil	SOIL SAMPLING AND METHODS OF ANALYSIS

This analysis is carried out using procedures adapted from ASTM G57-95a (2001) "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method". In summary, 200 to 500 grams of sample is mixed with deionized water as required to create a saturated paste. The sample is then measured as is (i.e. the paste) for Oxidation Reduction Potential.

PSA-1-SIEVE-SK	Soil	Particle Size - Pipette & Sieve Method	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

S2-NAOH-VA	Soil	Sediment Sulphide (NaOH leach) by Colour	ALSEV IN-HOUSE METHOD

This analysis is carried out on a leachable basis. The procedure involves shaking a subsample for 20 minutes with a sodium hydroxide solution in a one to seven ratio. The leachate is filtered and Zinc acetate is added to an aliquot of filtrate and analyzed colorimetrically using methylene blue.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA

Reference Information

SK ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

2 3 HS1625-1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

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COC # HS1625-1

Page 3 of 3

Report To		Report Format / Distribution	
Company:	HATFIELD CONSULTANTS	☐ Standard ☐ Other	
Contact:	Heather Keith	☑ PDF ☑ Excel ☐ Digi	
Address:	Suite 200 - 850 Harboutside Drive	Email 1:	hkeith@hatfieldgroup.com
	North Vancouver, BC, V7P OA3	Email 2:	
Phone:	604-926-3261 Fax: 604-926-5389	Email 3:	
Invoice To	Same as Report ? ☑ Yes ☐ No	**Client / Project Information**	
Hardcopy of Invoice with Report?	☐ Yes ☑ No	Job #:	HS1625
Company:		PO / AFE:	
Contact:		LSD:	Howe Sound Pulp and Paper
Address:			
Phone:	Fax:	Quote #:	Q32504
[redacted] Lab Work Order # (lab use only)	[redacted]	**ALS Contact:**	Brent Mack **Sampler:** Tim Poulton

ie analysis subject to availability)
- ◉ Regular (Standard T
- ○ Priority (2-4 Busines
- ○ Emergency (1-2 Bus
- ○ Same Day or Weeke

Analysis Request

Please Indicate below Filtered, Preserved or both (F, P, F/P)

[redacted] Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Organic Carbon	Loss of Ignition @ 550 C	Moisture Content	Total Nitrogen	Oxidation reduction potential	Pulp and Paper Chlorophenol	Particle Size	Sediment Sulphide					Number of Containers
[redacted]	HSB18 South of Anvil Island	14-Mar-12	8:30	Sediment	X												1
[redacted]	HSB18 South of Anvil Island	14-Mar-12	8:30	Sediment						X							1
[redacted]	HSB18 South of Anvil Island	14-Mar-12	8:30	Sediment		X	X	X	X		X	X					1
[redacted]	HSB19 Halkett Point	13-Mar-12	8:00	Sediment	X												1
[redacted]	HSB19 Halkett Point	13-Mar-12	8:00	Sediment						X							1
[redacted]	HSB19 Halkett Point	13-Mar-12	8:00	Sediment		X	X	X	X		X	X					1
[redacted]	HSB20 North of Anvil Island	14-Mar-12	13:00	Sediment	X												1
[redacted]	HSB20 North of Anvil Island	14-Mar-12	13:00	Sediment						X							1
[redacted]	HSB20 North of Anvil Island	14-Mar-12	13:00	Sediment		X	X	X	X		X	X					1
[redacted]																	
[redacted]																	
[redacted]																	

[redacted] Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

[redacted] SHIPMENT RELEASE (client use)			[redacted] SHIPMENT RECEPTION (lab use only)			[redacted] SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Tim Poulton	16-Mar-12		[signature]	16-Mar-12	1520	10.6 °C				

GENF 18.01 Front

ALS Environmental

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Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC # HS1625-1

Page 2 of 3

Report To		**Report Format / Distribution**	**Service Requested** (Rush for routine analysis subject to availability)
Company:	HATFIELD CONSULTANTS	☐ Standard ☐ Other	◉ Regular (Standard T
Contact:	Heather Keith	☑ PDF ☑ Excel ☐ Digital	○ Priority (2-4 Busines
Address:	Suite 200 - 850 Harboutside Drive	Email 1: hkeith@hatfieldgroup.com	○ Emergency (1-2 Bus
	North Vancouver, BC, V7P OA3	Email 2:	○ Same Day or Weeke
Phone:	604-926-3261 Fax: 604-926-5389	Email 3:	st
Invoice To	Same as Report ? ☑ Yes ☐ No	**Client / Project Information**	d or both (F, P, F/P)
Hardcopy of Invoice with Report?	☐ Yes ☑ No	Job #: HS1625	
Company:		PO / AFE:	
Contact:		LSD: Howe Sound Pulp and Paper	
Address:			
Phone:	Fax:	Quote #: Q32504	
Lab Work Order # (lab use only)	[redacted]	**ALS Contact:** Brent Mack	**Sampler:** Tim Poulton

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Organic Carbon	Loss of Ignition @ 550 C	Moisture Content	Total Nitrogen	Oxidation reduction potential	Pulp and Paper Chlorophenol	Particle Size	Sediment Sulphide					Number of Containers
[redacted]	HSB10A South of HSPP	15-Mar-12	12:00	Sediment	X												1
[redacted]	HSB10A South of HSPP	15-Mar-12	12:00	Sediment						X							1
[redacted]	HSB10A South of HSPP	15-Mar-12	12:00	Sediment		X	X	X	X		X	X					1
[redacted]	HSB11A Witherby Point	15-Mar-12	8:30	Sediment	X												1
[redacted]	HSB11A Witherby Point	15-Mar-12	8:30	Sediment						X							1
[redacted]	HSB11A Witherby Point	15-Mar-12	8:30	Sediment		X	X	X	X		X	X					1
[redacted]	HSB16 Ekins Point	14-Mar-12	14:00	Sediment	X												1
[redacted]	HSB16 Ekins Point	14-Mar-12	14:00	Sediment						X							1
[redacted]	HSB16 Ekins Point	14-Mar-12	14:00	Sediment		X	X	X	X		X	X					1
[redacted]	HSB17 Hutchinson Creek	13-Mar-12	15:00	Sediment	X												1
[redacted]	HSB17 Hutchinson Creek	13-Mar-12	15:00	Sediment						X							1
[redacted]	HSB17 Hutchinson Creek	13-Mar-12	15:00	Sediment		X	X	X	X		X	X					1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Tim Poulton	16-Mar-12				1520	10.6 °C				

GENF 18.01 Front

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www.alsglobal.com

COC # HS1625-1

Page 1 of 3

Report To		Report Format / Distribution		analysis subject to availability)
Company:	HATFIELD CONSULTANTS	☐ Standard ☐ Other		◉ Regular (Standard T
Contact:	Heather Keith	☑ PDF ☑ Excel ☐ Digita		○ Priority (2-4 Busines
Address:	Suite 200 - 850 Harboutside Drive	Email 1: hkeith@hatfieldgroup.com		○ Emergency (1-2 Bus
	North Vancouver, BC, V7P OA3	Email 2:		○ Same Day or Weeke
Phone:	604-926-3261 Fax: 604-926-5389	Email 3:		
Invoice To	Same as Report ? ☑ Yes ☐ No	**Client / Project Information**		Analysis Request
Hardcopy of Invoice with Report?	☐ Yes ☑ No	Job #: HS1625		Please indicate below Filtered, Preserved or both (F, P, F/P)
Company:		PO / AFE:		
Contact:		LSD: Howe Sound Pulp and Paper		
Address:				
Phone:	Fax:	Quote #: Q32504		
[redacted] Lab Work Order # (lab use only)	[redacted]	**ALS Contact:** Brent Mack	**Sampler:** Tim Poulton	

[redacted] Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Organic Carbon	Loss of Ignition @ 550 C	Moisture Content	Total Nitrogen	Oxidation reduction potential	Pulp and Paper Chlorophenol	Particle Size	Sediment Sulphide					Number of Containers
[redacted]	HSB7A North of Bain Creek	13-Mar-12	12:00	Sediment	X												1
[redacted]	HSB7A North of Bain Creek	13-Mar-12	12:00	Sediment						X							1
[redacted]	HSB7A North of Bain Creek	13-Mar-12	12:00	Sediment		X	X	X	X		X	X					1
[redacted]	HSB8 HSPP Outfall North	15-Mar-12	11:00	Sediment	X												1
[redacted]	HSB8 HSPP Outfall North	15-Mar-12	11:00	Sediment						X							1
[redacted]	HSB8 HSPP Outfall North	15-Mar-12	11:00	Sediment		X	X	X	X		X	X					1
[redacted]	HSB8A North of HSPP Diffuser	13-Mar-12	14:00	Sediment	X												1
[redacted]	HSB8A North of HSPP Diffuser	13-Mar-12	14:00	Sediment						X							1
[redacted]	HSB8A North of HSPP Diffuser	13-Mar-12	14:00	Sediment		X	X	X	X		X	X					1
[redacted]	HSB10 HSPP Outfall South	15-Mar-12	14:00	Sediment	X												1
[redacted]	HSB10 HSPP Outfall South	15-Mar-12	14:00	Sediment						X							1
[redacted]	HSB10 HSPP Outfall South	15-Mar-12	14:00	Sediment		X	X	X	X		X	X					1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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[redacted] SHIPMENT RELEASE (client use) [redacted]			[redacted] SHIPMENT RECEPTION (lab use only) [redacted]				[redacted] SHIPMENT VERIFICATION (lab use only) [redacted]			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Tim Poulton	16-Mar-12			16/Mar/12	15:20	10.6 °C				

GENF 18.01 Front

HATFIELD CONSULTANTS
ATTN: Heather Keith
200 - 850 Harbourside Drive
North Vancouver BC V7P 0A3

Date Received: 19-MAR-12
Report Date: 26-APR-12 18:45 (MT)
Version: FINAL

Client Phone: 604-926-3261

Certificate of Analysis

Lab Work Order #: L1125475

Project P.O. #:	NOT SUBMITTED
Job Reference:	HS1625
C of C Numbers:	HS1625-1
Legal Site Desc:	HOWE SOUND PULP AND PAPER

Brent Mack
Account Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1125475-1	L1125475-2			
	Description	SEDIMENT	SEDIMENT			
	Sampled Date	16-MAR-12	16-MAR-12			
	Sampled Time	08:47	10:31			
	Client ID	HSB21 WEST BAY	HSDX09-SI-14			
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss on Ignition @ 550 C (%)		10			
	Moisture (%)	71.5				
Particle Size	% Gravel (>2mm) (%)	<0.10	2.33			
	% Course Sand (2.0mm - 0.2mm) (%)	0.71	20.7			
	% Fine Sand (0.2mm - 0.063mm) (%)	0.98	29.2			
	% Silt (0.063mm - 4um) (%)	80.1	40.0			
	% Clay (<4um) (%)	18.2	7.85			
	Texture	Silt loam	Sandy loam			
Leachable Anions & Nutrients	Sulphide as S (mg/kg)	5.0				
Anions and Nutrients	Total Nitrogen by LECO (%)	0.277				
Organic / Inorganic Carbon	Total Organic Carbon (%)	3.89				
Saturated Paste Extractables	Oxidation-Reduction Potential (ORP) (mV)	-90				
Phenolics	Pentachlorophenol (mg/kg)	<0.0030 DLB				
	Tetrachlorocatechol (mg/kg)	<0.015 DLB				
	Tetrachloroguaiacol (mg/kg)	<0.0090 DLB				
	2,3,4,5-Tetrachlorophenol (mg/kg)	<0.0020				
	2,3,4,6-Tetrachlorophenol (mg/kg)	<0.0020				
	2,3,5,6-Tetrachlorophenol (mg/kg)	<0.0020				
	3,4,5-Trichlorocatechol (mg/kg)	<0.015 DLM				
	3,4,5-Trichloroguaiacol (mg/kg)	<0.0050				
	2,3,4-Trichlorophenol (mg/kg)	<0.0020				
	2,3,5-Trichlorophenol (mg/kg)	<0.0020				
	2,3,6-Trichlorophenol (mg/kg)	<0.0020				
	2,4,5-Trichlorophenol (mg/kg)	<0.0020				
	2,4,6-Trichlorophenol (mg/kg)	<0.0020				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Pentachlorophenol	MB-LOR	L1125475-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection limit was raised due to detection of analyte at comparable level in Method Blank.
DLM	Detection Limit Adjusted For Sample Matrix Effects
MB-LOR	Method Blank exceeds ALS DQO. LORs adjusted for samples with positive hits below 5 times blank level. Please contact ALS if re-analysis is required.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TOT-ORG-LECO-SK	Soil	Organic Carbon by combustion method	SSSA (1996) p. 973

Total Organic Carbon (C-TOT-ORG-LECO-SK, C-TOT-ORG-SK)

Total C and inorganic C are determined on separate samples. The total C is determined by combustion and thermal conductivity detection, while inorganic C is determined by weight lass after addition of hydrochloric acid. Organic C is calculated by the difference between these two determinations.

Reference for Total C:
Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, organic carbon and organic matter. P. 961-1010 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

Reference for Inorganic C:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

CP-LL-P&P-SE-MS-VA	Soil	CP-P&P-SE-MS-VA	EPA METHODS 3500B, 8041 & 8270C

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3500B, 8041 & 8270C, published by the United States Environmental Protection Agency (EPA). A sediment/soil sub-sample is extracted with basic methanol or acidified acetone. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS) and/or electron capture detection (GC/ECD).

LOI-550-SK	Soil	Loss on Ignition @ 550 C	CSSS (1993) p.461-462

The sample is air dried at 40C overnight, then ground to < 2mm in particle size using a flail grinder. A portion of the dried and ground sample is dried at 105C overnight, then ignited at 550C for 16-20 hours. Loss on ignition at 550C is reported on a dry sample basis.

Carter, Martin. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1993) method 44.3.3

MOISTURE-VA	Soil	Moisture content	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where nitrogen in the reduced nitrous oxide gas is determined using a thermal conductivity detector.

ORP-PASTE-VA	Soil	Oxidation reduction potential of Soil	SOIL SAMPLING AND METHODS OF ANALYSIS

This analysis is carried out using procedures adapted from ASTM G57-95a (2001) "Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method". In summary, 200 to 500 grams of sample is mixed with deionized water as required to create a saturated paste. The sample is then measured as is (i.e. the paste) for Oxidation Reduction Potential.

PSA-1-SIEVE-SK	Soil	Particle Size - Pipette & Sieve Method	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

S2-NAOH-VA	Soil	Sediment Sulphide (NaOH leach) by Colour	ALSEV IN-HOUSE METHOD

This analysis is carried out on a leachable basis. The procedure involves shaking a subsample for 20 minutes with a sodium hydroxide solution in a one to seven ratio. The leachate is filtered and Zinc acetate is added to an aliquot of filtrate and analyzed colorimetrically using methylene blue.

Reference Information

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BC, CANADA
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

HS1625-1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
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HS1625-1

Report To		Report Format / Distribution	
Company:	HATFIELD CONSULTANTS	☐ Standard ☐ Other	
Contact:	Heather Keith	☑ PDF ☑ Excel ☐ Digital ☐ Fax	
Address:	Suite 200 - 850 Harboutside Drive	Email 1:	hkeith@hatfieldgroup.com
	North Vancouver, BC, V7P OA3	Email 2:	
Phone:	604-926-3261 Fax: 604-926-5389	Email 3:	
Invoice To	Same as Report ? ☑ Yes ☐ No	**Client / Project Information**	
Hardcopy of Invoice with Report?	☐ Yes ☑ No	Job #:	HS1625
Company:		PO / AFE:	
Contact:		LSD:	Howe Sound Pulp and Paper
Address:			
Phone:	Fax:	Quote #:	Q32504
Lab Work Order # (lab use only)	L1125405	**ALS Contact:**	Brent Mack **Sampler:** Felicia Juelfs

is subject to availability)
- ◉ Regular (Standard T
- ○ Priority (2-4 Busines
- ○ Emergency (1-2 Bus
- ○ Same Day or Weeke

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Organic Carbon	Loss of Ignition @ 550 C	Moisture Content	Total Nitrogen	Oxidation reduction potential	Pulp and Paper Chlorophenol	Particle Size	Sediment Sulphide					Number of Containers
	HSB21 West Bay	16-Mar-12	8:47	Sediment	X												1
	HSB21 West Bay	16-Mar-12	8:47	Sediment						X							1
	HSB21 West Bay	16-Mar-12	8:47	Sediment			X	X	X		X	X					1
	HSDX09-SI-14	16-Mar-12	10:31	Sediment							X						1
	HSDX09-SI-14	16-Mar-12	10:31	Sediment		X											1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

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SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Felicia Juelfs	19-Mar-12	12:00		Mar.19/12	16:35	3 °C				

AXYS | Axys Analytical Services Ltd
2045 Mills Road West
SIDNEY, BRITISH COLUMBIA, CANADA V8L 5X2
TEL 250-655-5800 FAX 250-655-5811
www.axysanalytical.com

AXYS Client No.: 2544

Client Address: Hatfield Consultants
suite 200 - 850 Harbourside Drive
North Vancouver, BC, CA, V7P 0A3

The AXYS contact for these data is Georgina Brooks.

BATCH SUMMARY

Batch ID: WG39570	***Date:*** 25-Apr-2012
Analysis Type: Dioxin/Furan	***Matrix Type:*** Solid

BATCH MAKEUP

Contract: 2544

Samples:

L17730-1 HSDX09-S1-14

Blank: WG39570-101

Reference or Spike: WG39570-102

Duplicate:

Comments:

1- Data are not blank corrected
2- The laboratory analyst noted that a ¼ of the laboratory blank extract was inadvertently lost before the microvialling procedure. Consequently, the percent surrogate recoveries were below method specifications. Given that the loss occurred after the addition of labeled surrogate compounds, the isotope dilution quantification procedure adjusts for losses. In AXYS experience the surrogates would accurately track any background contrubution, but if additional blank support is required, we can supply a summary of similar blanks processed over the last several months.

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February 1993

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

CLIENT SAMPLE I.D.:	HSDX09-S1-14	**AXYS FILE:**	L17730-1
SAMPLE COLLECTION:	16-Mar-2012		
CLIENT NO.:	2544	**REPORT DATE:**	25-Apr-2012
PROJECT NO.:	HS1625	**METHOD NO.:**	AXYS METHOD MLA-017 Rev 20
SAMPLE TYPE:	SOLID	**EXTRACTION DATE:**	30-Mar-2012
SAMPLE SIZE:	9.99 g (dry)	**INSTRUMENT:**	HR GC/MS
		ANALYSIS DATE:	11-Apr-2012
% Moisture:	58.1	**CONCENTRATION IN:**	pg/g (dry weight basis)

COMPOUND	Concentration	(RL)
2,3,7,8-TCDD	2.00	0.10
1,2,3,7,8-PECDD	5.58	0.10
1,2,3,4,7,8-HXCDD	2.16	0.20
1,2,3,6,7,8-HXCDD	89.8	0.20
1,2,3,7,8,9-HXCDD	42.9	0.20
1,2,3,4,6,7,8-HPCDD	128	0.20
OCDD	655	0.50
2,3,7,8-TCDF *	62.2	0.10
1,2,3,7,8-PECDF	1.34	0.10
2,3,4,7,8-PECDF	2.16	0.10
1,2,3,4,7,8-HXCDF	1.46	0.20
1,2,3,6,7,8-HXCDF	1.14	0.20
2,3,4,6,7,8-HXCDF	1.23	0.20
1,2,3,7,8,9-HXCDF	ND	0.20
1,2,3,4,6,7,8-HPCDF	24.3	0.20
1,2,3,4,7,8,9-HPCDF	1.36	0.20
OCDF	46.3	0.50
TOTAL TETRA-DIOXINS	27.2	0.10
TOTAL PENTA-DIOXINS	51.3	0.10
TOTAL HEXA-DIOXINS	617	0.20
TOTAL HEPTA-DIOXINS	247	0.20
TOTAL TETRA-FURANS	125	0.10
TOTAL PENTA-FURANS	17.3	0.10
TOTAL HEXA-FURANS	27.0	0.20
TOTAL HEPTA-FURANS	59.0	0.20

2,3,7,8-TCDD TEQs (Using WHO 2005 TEFs)

2,3,7,8-TCDD TEQs (ND=0) =	30.1
2,3,7,8-TCDD TEQs (ND=1/2 RL) =	30.1

Surrogate Standards	% Recovery
13C-2,3,7,8-TCDD	64.4
13C-1,2,3,7,8-PECDD	72.5
13C-1,2,3,6,7,8-HXCDD	70.4
13C-1,2,3,4,6,7,8-HPCDD	69.7
13C-OCDD	62.8
13C-2,3,7,8-TCDF	65.6
13C-1,2,3,7,8-PECDF	70.5
13C-1,2,3,4,7,8-HXCDF	69.8
13C-1,2,3,4,6,7,8-HPCDF	66.8

1. RL = Reporting Limit
2. ND = Not detected
3. NDR = peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration
4. Concentrations are recovery corrected
5. * = Concentration confirmed by analysis with DB-225 column

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Celine Vaillant_____

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Report Filename: AXYS_DIOXINS_AXYSDB5_L17730-1_SJ1448583.html; Workgroup: WG39570; Design ID: 83]

ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

CLIENT SAMPLE I.D.:	Lab Blank	**AXYS FILE:**	WG39570-101
SAMPLE COLLECTION:	N/A		
CLIENT NO.:	2544	**REPORT DATE:**	25-Apr-2012
PROJECT NO.:	N/A	**METHOD NO.:**	AXYS METHOD MLA-017 Rev 20
SAMPLE TYPE:	SOLID	**EXTRACTION DATE:**	30-Mar-2012
SAMPLE SIZE:	10.0 g	**INSTRUMENT:**	HR GC/MS
		ANALYSIS DATE:	11-Apr-2012
		CONCENTRATION IN:	pg/g

COMPOUND	Concentration	(RL)
2,3,7,8-TCDD	ND	0.10
1,2,3,7,8-PECDD	ND	0.10
1,2,3,4,7,8-HXCDD	ND	0.20
1,2,3,6,7,8-HXCDD	ND	0.20
1,2,3,7,8,9-HXCDD	ND	0.20
1,2,3,4,6,7,8-HPCDD	ND	0.20
OCDD	ND	0.50
2,3,7,8-TCDF	ND	0.10
1,2,3,7,8-PECDF	ND	0.10
2,3,4,7,8-PECDF	ND	0.10
1,2,3,4,7,8-HXCDF	ND	0.20
1,2,3,6,7,8-HXCDF	ND	0.20
2,3,4,6,7,8-HXCDF	ND	0.20
1,2,3,7,8,9-HXCDF	ND	0.20
1,2,3,4,6,7,8-HPCDF	ND	0.20
1,2,3,4,7,8,9-HPCDF	ND	0.20
OCDF	ND	0.50
TOTAL TETRA-DIOXINS	ND	0.10
TOTAL PENTA-DIOXINS	ND	0.10
TOTAL HEXA-DIOXINS	ND	0.20
TOTAL HEPTA-DIOXINS	ND	0.20
TOTAL TETRA-FURANS	ND	0.10
TOTAL PENTA-FURANS	ND	0.10
TOTAL HEXA-FURANS	ND	0.20
TOTAL HEPTA-FURANS	ND	0.20

2,3,7,8-TCDD TEQs (Using WHO 2005 TEFs)

2,3,7,8-TCDD TEQs (ND=0) =	0
2,3,7,8-TCDD TEQs (ND=1/2 RL) =	0.19

Surrogate Standards	% Recovery
13C-2,3,7,8-TCDD	14.0
13C-1,2,3,7,8-PECDD	17.1
13C-1,2,3,6,7,8-HXCDD	17.5
13C-1,2,3,4,6,7,8-HPCDD	16.8
13C-OCDD	14.4
13C-2,3,7,8-TCDF	14.0
13C-1,2,3,7,8-PECDF	15.8
13C-1,2,3,4,7,8-HXCDF	18.0
13C-1,2,3,4,6,7,8-HPCDF	16.4

1. RL = Reporting Limit
2. ND = Not detected
3. NDR = peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration
4. Concentrations are recovery corrected
5. * = Concentration confirmed by analysis with DB-225 column

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Celine Vaillant_____

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ANALYSIS REPORT
POLYCHLORINATED DIBENZODIOXINS AND DIBENZOFURANS

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

CLIENT SAMPLE I.D.:	Spiked Matrix	**AXYS FILE:**	WG39570-102 i3
CLIENT NO.:	2544	**REPORT DATE:**	25-Apr-2012
SAMPLE TYPE:	SOLID	**METHOD NO.:**	AXYS METHOD MLA-017 Rev 20
SAMPLE SIZE:	10.0 g	**INSTRUMENT:**	HR GC/MS
		CONCENTRATION IN:	pg/g

COMPOUND	Determined	Expected	% Recovery
2,3,7,8-TCDD	10.1	10.0	101
1,2,3,7,8-PECDD	54.6	52.0	105
1,2,3,4,7,8-HXCDD	57.3	56.5	101
1,2,3,6,7,8-HXCDD	55.2	55.5	99.4
1,2,3,7,8,9-HXCDD	56.9	54.0	105
1,2,3,4,6,7,8-HPCDD	47.8	47.5	101
OCDD	99.8	100	99.8
2,3,7,8-TCDF	10.5	10.7	97.9
1,2,3,7,8-PECDF	43.1	46.0	93.6
2,3,4,7,8-PECDF	44.5	47.0	94.8
1,2,3,4,7,8-HXCDF	47.9	50.0	95.8
1,2,3,6,7,8-HXCDF	49.3	47.5	104
2,3,4,6,7,8-HXCDF	50.5	53.0	95.3
1,2,3,7,8,9-HXCDF	51.7	52.5	98.5
1,2,3,4,6,7,8-HPCDF	58.5	50.0	117
1,2,3,4,7,8,9-HPCDF	50.1	50.0	100
OCDF	92.9	104	89.3

Surrogate Standards	% Recovery
13C-2,3,7,8-TCDD	52.1
13C-1,2,3,7,8-PECDD	63.4
13C-1,2,3,6,7,8-HXCDD	60.2
13C-1,2,3,4,6,7,8-HPCDD	67.7
13C-OCDD	71.5
13C-2,3,7,8-TCDF	50.3
13C-1,2,3,7,8-PECDF	59.8
13C-1,2,3,4,7,8-HXCDF	63.1
13C-1,2,3,4,6,7,8-HPCDF	62.6

1. Concentrations are recovery corrected

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Celine Vaillant_____

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AXYS Analytical Services Ltd.

Table 1a
NELAP Accreditation Held by AXYS Analytical Services Ltd.
for Chlorinated Dioxins/Furans, Chlorinated Pesticides, PCBs and PAHs

Matrix Codes for Table 1a

NPW = Non-Potable Water
DrW = Drinking Water
S = Solid
T = Tissue

Accreditation Method Codes and Explanation for Table 1

Code No.	Accreditation Certificate Method Reference	Applicable AXYS Method and Description
1	EPA 1613B	MLA-017, performance based implementation of EPA1613B (GC/HRMS)
2	EPA 8290	MLA-017, performance based implementation of EPA 8290 (GC/HRMS)
3	AXYS MLA-017	MLA-017, performance based implementation of EPA 1613B, 8290 (GC/HRMS)
4	EPA 608	MLA-007, performance based implementation of EPA 608 (GC/ECD)
5	EPA 8270C or 8270D	MLA-007, performance based **modification** of 8270C/D (GC/LRMS)
6	EPA 8081A or 8081B	MLA-007, performance based implementation of EPA 8081A/B (GC/ECD)
7	EPA 1668A	MLA-010, performance based implementation of EPA 1668A (GC/HRMS)
8	SM 6630B	MLA-007, performance based implementation of SM 18-20 6630B (GC/ECD)
9	EPA 1625B	MLA-021, performance based **modification** of EPA 1625B (GC/LRMS)
11	EPA 625	MLA-007, performance based **modification** of EPA 625 (GC/LRMS)
20	EPA 8270C or 8270D	MLA-021, performance based **modification** of EPA 8270C/D (GC/LRMS)

TABLE 1	**New York State Department of Health**		**California Department of Public Health**		**State of Florida Department of Health**				**State of New Jersey Department of Environmental Protection**			
	Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary			
	NPW	**S**	**NPW**	**S**	**Dr. W**	**NPW**	**S**	**T**	**Dr. W**	**NPW**	**S**	**T**
PCDD/F - Polychlorinated Dioxins and Furans												
Dioxins			1									
Dioxins and Dibenzofurans				2								
1,2,3,4,6,7,8-HpCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,4,6,7,8-HpCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,4,7,8,9-HpCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,4,7,8-HxCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,4,7,8-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,6,7,8-HxCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2

AXYS Analytical Services Ltd.

TABLE 1	New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection			
	Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary			
	NP W	S	NP W	S	Dr. W	NP W	S	T	Dr. W	NP W	S	T
1,2,3,6,7,8-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,7,8,9-HxCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,7,8,9-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,7,8-PeCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2
1,2,3,7,8-PeCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
2,3,4,6,7,8-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
2,3,4,7,8-PeCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
2,3,7,8-TCDD	1		1	2		1, 2, 3	2, 3	2, 3		1	2	2
2,3,7,8-TCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
OCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2
OCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2
Total TCDD			1			1, 2, 3	2, 3	2, 3			2	2
Total TCDF			1			1, 2, 3	2, 3	2, 3			2	2
Total PeCDD			1			1, 2, 3	2, 3	2, 3			2	2
Total PeCDF			1			1, 2, 3	2, 3	2, 3			2	2
Total HxCDD			1			1, 2, 3	2, 3	2, 3			2	2
Total HxCDF			1			1, 2, 3	2, 3	2, 3			2	2
Total HpCDD			1			1, 2, 3	2, 3	2, 3			2	2
Total HpCDF			1			1, 2, 3	2, 3	2, 3			2	2
PCBs – Polychlorinated biphenyls												
PCB 1 2-Chlorobiphenyl	7	7								7	7	
PCB 3 4-Chlorobiphenyl	7	7								7	7	
PCB 4 2,2'-Dichlorobiphenyl	7	7								7	7	
PCB 5 2,3-Dichlorobiphenyl	7	7								7	7	
PCB 15 4,4'-Dichlorobiphenyl	7	7								7	7	
PCB 18 2,2',5-Trichlorobiphenyl	7	7								7	7	
PCB 19 2,2',6-Trichlorobiphenyl	7	7								7	7	
PCB 31 2,4',5-Trichlorobiphenyl	7	7								7	7	
PCB 37 3,4,4'-Trichlorobiphenyl	7	7								7	7	
PCB 44 2,2',3,5'-Tetrachlorobiphenyl	7	7								7	7	
PCB 52 2,2',5,5'-Tetrachlorobiphenyl	7	7								7	7	
PCB 54 2,2',6,6'-Tetrachlorobiphenyl	7	7								7	7	
PCB 66 2,3',4,4'-Tetrachlorobiphenyl	7	7								7	7	
PCB 77 3,3',4,4'-Tetrachlorobiphenyl	7	7								7	7	
PCB 81 3,4,4',5-Tetrachlorobiphenyl	7	7								7	7	
PCB 87 2,2',3,4,5'-Pentachlorobiphenyl	7	7								7	7	

AXYS Analytical Services Ltd.

TABLE 1		New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection			
		Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary			
		NPW	S	NPW	S	Dr. W	NPW	S	T	Dr. W	NPW	S	T
PCB 101	2,2',4,5,5'-Pentachlorobiphenyl	7	7								7	7	
PCB 104	2,2',4,6,6'-Pentachlorobiphenyl	7	7								7	7	
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	7	7								7	7	
PCB 109	2,3,3',4,6-Pentachlorobiphenyl	7	7								7	7	
PCB 114	2,3,4,4',5-Pentachlorobiphenyl	7	7								7	7	
PCB 118	2,3',4,4',5-Pentachlorobiphenyl	7	7								7	7	
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl	7	7								7	7	
PCB 124	2,3',4',5,5'-Pentachlorobiphenyl										7	7	
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	7	7								7	7	
PCB 138	2,2',3,4,4',5'-Hexachlorobiphenyl	7	7								7	7	
PCB 141	2,2',3,4,5,5'-Hexachlorobiphenyl	7	7								7	7	
PCB 151	2,2',3,5,5',6-Hexachlorobiphenyl	7	7								7	7	
PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl	7	7								7	7	
PCB 155	2,2',4,4',6,6'-Hexachlorobiphenyl	7	7								7	7	
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl		7								7		
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl	7	7								7	7	
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	7	7								7	7	
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl	7	7								7	7	
PCB 170	2,2',3,3',4,4',5-Heptachlorobiphenyl	7	7								7	7	
PCB 180	2,2',3,4,4',5,5'-Heptachlorobiphenyl	7	7								7	7	
PCB 183	2,2',3,4,4',5',6-Heptachlorobiphenyl	7	7								7	7	
PCB 187	2,2',3,4',5,5',6-Heptachlorobiphenyl	7	7								7	7	
PCB 188	2,2',3,4',5,6,6'-Heptachlorobiphenyl	7	7								7	7	
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	7	7								7	7	
PCB 202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	7	7								7	7	
PCB 205	2,3,3',4,4',5,5',6-Octachlorobiphenyl	7	7								7		
PCB 206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	7	7								7	7	
PCB 208	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	7	7								7	7	
PCB 209	Decachlorobiphenyl	7	7								7	7	
Aroclor 1260		7, 11	5, 7	11	5								
Aroclor 1254		7, 11	5, 7	11	5								
Aroclor 1221		7, 11	5, 7	11	5								
Aroclor 1232		7, 11	5, 7	11	5								
Aroclor 1248		7, 11	5, 7	11	5								
Aroclor 1016		7, 11	5, 7	11	5								
Aroclor 1242		7, 11	5, 7	11	5								

AXYS Analytical Services Ltd.

TABLE 1	New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection			
	Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary			
	NPW	S	NPW	S	Dr. W	NPW	S	T	Dr. W	NPW	S	T
Pesticides												
4,4'-DDD	11	5	11	5								
4,4'-DDE	11	5	11	5								
4,4'-DDT	11	5	11	5								
Aldrin	11	5	11	5								
Alpha-HCH	11	5	11	5								
Beta-HCH	11	5	11	5								
cis-Chlordane (alpha-Chlordane)	5	5										
Chlordane, technical	5, 11	5	11	5								
Delta-HCH	11	5	11	5								
Dieldrin	4	6	4	6								
Endosulphan I	4	6	4	6								
Endosulphan II	4	6	4	6								
Endosulphan sulphate	4	6	4	6								
Endrin	4	6	4	6								
Endrin aldehyde	4	6	4	6								
trans-Chlordane (gamma-Chlordane)	5	5										
Gamma-HCH (Lindane)	11	5	11	5								
Heptachlor	11	5	11	5								
Heptachlor epoxide	4	6	4	6								
Hexachlorobenzene	9	5	9	5								
Methoxychlor	4,8	6	8	6								
Mirex	5											
PAH												
Anthracene	9	20	9	20								
Pyrene	9	20	9	20								
Benzo[ghi]perylene	9	20	9	20								
Indeno[1,2,3-cd]pyrene	9	20	9	20								
Benzo[b]fluoranthene	9	20	9	20								
Fluoranthene	9	20	9	20								
Benzo[k]fluoranthene	9	20	9	20								
Acenaphthylene	9	20	9	20								
Chrysene	9	20	9	20								
Benzo[a]pyrene	9	20	9	20								
Dibenz[ah]anthracene	9	20	9	20								
Benz[a]anthracene	9	20	9	20								

AXYS Analytical Services Ltd.

TABLE 1	New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection			
	Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary			
	NPW	S	NPW	S	Dr. W	NPW	S	T	Dr. W	NPW	S	T
Acenaphthene	9	20	9	20								
Phenanthrene	9	20	9	20								
Fluorene	9	20	9	20								
Naphthalene	9	20	9	20								

AXYS Analytical Services Ltd.

Table 1b
NELAP Accreditation Held by AXYS Analytical Services Ltd.
for Perfluorinated Organic Compounds

Matrix Codes for Table 1b

NPW = Non-Potable Water
DrW = Drinking Water
S = Solid
T = Tissue

Accreditation Method Codes and Explanation for Table 1b

Code No.	Accreditation Certificate Method Reference	Applicable AXYS Method and Description
12	AXYS MLA-041	MLA-041, laboratory performance based method (LC/MS-MS)
13	AXYS MLA-043	MLA-043, laboratory performance based method (LC/MS-MS)
14	AXYS MLA-060	MLA-060, laboratory performance based method (LC/MS-MS)

TABLE 1	State of Florida Department of Health				Minnesota Department of Health				State of New Jersey Department of Environmental Protection			
	Lab ID E871007 NELAP Primary				Lab ID 232-999-430 NELAP Primary				Lab ID CANA005 NELAP Secondary			
	Dr. W	NP W	S	T	Dr. W	NP W	S	T	Dr. W	NP W	S	T
PFC – Perfluorinated Organic Compounds												
Perfluorobutanoate (PFBA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluoropentanoate (PFPeA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorohexanoate (PFHxA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluoroheptanoate (PFHpA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorooctanoate (PFOA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorononanoate (PFNA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorodecanoate (PFDA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluoroundecanoate (PFUnA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorododecanoate (PFDoA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorobutanesulfonate (PFBS)	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorohexanesulfonate (PFHxS)	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorooctanesulfonate (PFOS)	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorooctane sulfonamide (PFOSA)	14	14	12	13	14	14	12	13				

Note: Accreditations by Minnesota Department of Health and New Jersey Department of Environmental Protection are against the corresponding acid form of the anion shown.

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Table 2:
Canadian and US State Specific Accreditation Held by AXYS Analytical Services Ltd.

Matrix Codes for Table 2

NP W = Non-Potable Water
Dr. W = Drinking Water
W = Aqueous
S = Solid
T = Tissue

Accreditation Method Codes and Explanation for Table 2

Code No.	Accreditation Certificate Method Reference	Applicable AXYS Method and Description
1	EPA 1613	MLA-017 Performance based implementation of EPA 1613B (GC/HRMS)
3	AXYS MLA-017	MLA-017 Performance based implementation of EPA 1613B (GC/HRMS)
7	EPA 1668A	MLA-010 Performance based implementation of EPA 1668A (GC/HRMS)
10	AXYS MLA-007	MLA-007, Performance based **modification** of EPA 8270C/D, 8081A/B (GC/LRMS and GC/ECD)
12	AXYS MLA-041	MLA-041 Laboratory performance based method (LC/MS-MS)
13	AXYS MLA-043	MLA-043 Laboratory performance based method (LC/MS-MS)
14	AXYS MLA-060	MLA-060 Laboratory performance based method (LC/MS-MS)
15	AXYS MLA-010	MLA-010 Performance based implementation of EPA 1668A (GC/HRMS)
16	AXYS MLA-028	MLA-028 Laboratory performance based method (GC/HRMS)
17	AXYS MLA-033	MLA-033 Performance based implementation of EPA 1614 (GC/HRMS)
18	AXYS MLA-021	MLA-021 Performance based **modification** of EPA 8270C/D (GC/LRMS)
19	AXYS MLA-075	MLA-075 Performance based implementation of EPA 1694 (LC/MS-MS)

TABLE 2	**Canadian Association for Laboratory Accreditation (CALA)**				**Washington State Department of Ecology**	
	Accreditation No.: A 2637				Lab. ID: C404	
	W	**S**	**Pulp**	**T**	**NP W**	**S**
PCDD/F - Polychlorinated Dioxins and Furans						
1,2,3,4,6,7,8-HpCDD	3	3	3	3	1	1
1,2,3,4,6,7,8-HpCDF	3	3	3	3	1	1
1,2,3,4,7,8,9-HpCDF	3	3	3	3	1	1
1,2,3,4,7,8-HxCDD	3	3	3	3	1	1
1,2,3,4,7,8-HxCDF	3	3	3	3	1	1
1,2,3,6,7,8-HxCDD	3	3	3	3	1	1
1,2,3,6,7,8-HxCDF	3	3	3	3	1	1
1,2,3,7,8,9-HxCDD	3	3	3	3	1	1
1,2,3,7,8,9-HxCDF	3	3	3	3	1	1
1,2,3,7,8-PeCDD	3	3	3	3	1	1
1,2,3,7,8-PeCDF	3	3	3	3	1	1
2,3,4,6,7,8-HxCDF	3	3	3	3	1	1
2,3,4,7,8-PeCDF	3	3	3	3	1	1
2,3,7,8-TCDD	3	3	3	3	1	1
2,3,7,8-TCDF	3	3	3	3	1	1
OCDD	3	3	3	3	1	1
OCDF	3	3	3	3	1	1
Total TCDD					1	1
Total TCDF					1	1
Total PeCDD					1	1
Total PeCDF					1	1
Total HxCDD					1	1

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
		Accreditation No.: A 2637				Lab. ID: C404	
		W	S	Pulp	T	NP W	S
Total HxCDF						1	1
Total HpCDD						1	1
Total HpCDF						1	1
Total PCDD						1	1
Total PCDF						1	1
Total PCDD + PCDF						1	1
PCBs – Polychlorinated biphenyls							
PCB 1	2-Chlorobiphenyl	15	15		15	7	7
PCB 2	3-Chlorobiphenyl	15	15		15	7	7
PCB 3	4-Chlorobiphenyl	15	15		15	7	7
PCB 4	2,2'-Dichlorobiphenyl	15	15		15	7	7
PCB 5	2,3-Dichlorobiphenyl	15	15		15	7	7
PCB 6	2,3'-Dichlorobiphenyl	15	15		15	7	7
PCB 7	2,4-Dichlorobiphenyl	15	15		15	7	7
PCB 8	2,4'-Dichlorobiphenyl	15	15		15	7	7
PCB 8/5		10	10		10		
PCB 9	2,5-Dichlorobiphenyl	15	15		15	7	7
PCB 10	2,6-Dichlorobiphenyl	15	15		15	7	7
PCB 11	3,3'-Dichlorobiphenyl	15	15		15	7	7
PCB 12	3,4-Dichlorobiphenyl	15	15		15	7	7
PCB 13	3,4'-Dichlorobiphenyl	15	15		15	7	7
PCB 14	3,5-Dichlorobiphenyl	15	15		15	7	7
PCB 15	4,4'-Dichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 16	2,2',3-Trichlorobiphenyl	15	15		15	7	7
PCB 16/32		10	10		10		
PCB 17	2,2',4-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 18	2,2',5-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 19	2,2',6-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 20	2,3,3'-Trichlorobiphenyl	15	15		15	7	7
PCB 21	2,3,4-Trichlorobiphenyl	15	15		15	7	7
PCB 22	2,3,4'-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 23	2,3,5-Trichlorobiphenyl	15	15		15	7	7
PCB 24	2,3,6-Trichlorobiphenyl	15	15		15	7	7
PCB 24/27		10	10		10		
PCB 25	2,3',4-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 26	2,3',5-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 27	2,3',6-Trichlorobiphenyl	15	15		15	7	7
PCB 28	2,4,4'-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 29	2,4,5-Trichlorobiphenyl	15	15		15	7	7
PCB 30	2,4,6-Trichlorobiphenyl	15	15		15	7	7
PCB 31	2,4',5-Trichlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 32	2,4',6-Trichlorobiphenyl	15	15		15	7	7
PCB 33	2,3',4'-Trichlorobiphenyl	15	15		15	7	7
PCB 33/20/21		18	10		10		
PCB 34	2,3',5'-Trichlorobiphenyl	15	15		15	7	7
PCB 35	3,3',4-Trichlorobiphenyl	15	15		15	7	7
PCB 36	3,3',5-Trichlorobiphenyl	15	15		15	7	7
PCB 37	3,4,4'-Trichlorobiphenyl	15	15		15	7	7
PCB 38	3,4,5-Trichlorobiphenyl	15	15		15	7	7
PCB 39	3,4',5-Trichlorobiphenyl	15	15		15	7	7
PCB 40	2,2',3,3'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 41	2,2',3,4-Tetrachlorobiphenyl	15	15		15	7	7
PCB 41/71/64/68		10	10		10		

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
		Accreditation No.: A 2637				Lab. ID: C404	
		W	S	Pulp	T	NP W	S
PCB 42	2,2',3,4'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 42/59		10	10		10		
PCB 43	2,2',3,5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 44	2,2',3,5'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 45	2,2',3,6-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 46	2,2',3,6'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 47	2,2',4,4'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 47/48/75		10	10		10		
PCB 48	2,2',4,5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 49	2,2',4,5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 49/43		10	10		10		
PCB 50	2,2',4,6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 51	2,2',4,6'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 52	2,2',5,5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 52/73		10	10		10		
PCB 53	2,2',5,6'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 54	2,2',6,6'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 55	2,3,3',4-Tetrachlorobiphenyl	15	15		15	7	7
PCB 56	2,3,3',4'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 56/60		10	10		10		
PCB 57	2,3,3',5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 58	2,3,3',5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 59	2,3,3',6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 60	2,3,4,4'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 61	2,3,4,5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 62	2,3,4,6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 63	2,3,4',5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 64	2,3,4',6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 65	2,3,5,6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 66	2,3',4,4'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 66/80		10	10		10		
PCB 67	2,3',4,5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 68	2,3',4,5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 69	2,3',4,6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 70	2,3',4',5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 70/76		10	10		10		
PCB 71	2,3',4',6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 72	2,3',5,5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 73	2,3',5',6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 74	2,4,4',5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 74/61		10	10		10		
PCB 75	2,4,4',6-Tetrachlorobiphenyl	15	15		15	7	7
PCB 76	2,3',4',5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 78	3,3',4,5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 79	3,3',4,5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 80	3,3',5,5'-Tetrachlorobiphenyl	15	15		15	7	7
PCB 81	3,4,4',5-Tetrachlorobiphenyl	15	15		15	7	7
PCB 82	2,2',3,3',4-Pentachlorobiphenyl	15	15		15	7	7
PCB 83	2,2',3,3',5-Pentachlorobiphenyl	15	15		15	7	7
PCB 83/108		10	10		10		
PCB 84	2,2',3,3',6-Pentachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 85	2,2',3,4,4'-Pentachlorobiphenyl	15	15		15	7	7
PCB 85/120		10	10		10		

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
		Accreditation No.: A 2637				Lab. ID: C404	
		W	S	Pulp	T	NP W	S
PCB 86	2,2',3,4,5-Pentachlorobiphenyl	15	15		15	7	7
PCB 87	2,2',3,4,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 87/115/116		10	10		10		
PCB 88	2,2',3,4,6-Pentachlorobiphenyl	15	15		15	7	7
PCB 89	2,2',3,4,6'-Pentachlorobiphenyl	15	15		15	7	7
PCB 90	2,2',3,4',5-Pentachlorobiphenyl	15	15		15	7	7
PCB 91	2,2',3,4',6-Pentachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 92	2,2',3,5,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 93	2,2',3,5,6-Pentachlorobiphenyl	15	15		15	7	7
PCB 94	2,2',3,5,6'-Pentachlorobiphenyl	15	15		15	7	7
PCB 95	2,2',3,5',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 95/93		10	10		10		
PCB 96	2,2',3,6,6'-Pentachlorobiphenyl	15	15		15	7	7
PCB 97	2,2',3,4',5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 97/86		10	10		10		
PCB 98	2,2',3,4',6'-Pentachlorobiphenyl	15	15		15	7	7
PCB 99	2,2',4,4',5-Pentachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 100	2,2',4,4',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 101	2,2',4,5,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 101/90/89		10	10		10		
PCB 102	2,2',4,5,6'-Pentachlorobiphenyl	15	15		15	7	7
PCB 103	2,2',4,5',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 104	2,2',4,6,6'-Pentachlorobiphenyl	15	15		15	7	7
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	15	15		15	7	7
PCB 105/127		10	10		10		
PCB 106	2,3,3',4,5-Pentachlorobiphenyl	15	15		15	7	7
PCB 107	2,3,3',4',5-Pentachlorobiphenyl	15	15		15	7	7
PCB 107/109		10	10		10		
PCB 108	2,3,3',4,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 109	2,3,3',4,6-Pentachlorobiphenyl	15	15		15	7	7
PCB 110	2,3,3',4',6-Pentachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 111	2,3,3',5,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 112	2,3,3',5,6-Pentachlorobiphenyl	15	15		15	7	7
PCB 113	2,3,3',5',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 114	2,3,4,4',5-Pentachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 115	2,3,4,4',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 116	2,3,4,5,6-Pentachlorobiphenyl	15	15		15	7	7
PCB 117	2,3,4',5,6-Pentachlorobiphenyl	15	15		15	7	7
PCB 118	2,3',4,4',5-Pentachlorobiphenyl	15	15		15	7	7
PCB 118/116		10	10		10		
PCB 119	2,3',4,4',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 120	2,3',4,5,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 121	2,3',4,5',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 122	2,3,3',4',5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 124	2,3',4',5,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 125	2,3',4',5',6-Pentachlorobiphenyl	15	15		15	7	7
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 127	3,3',4,5,5'-Pentachlorobiphenyl	15	15		15	7	7
PCB 128	2,2',3,3',4,4'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 129	2,2',3,3',4,5-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 130	2,2',3,3',4,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 131	2,2',3,3',4,6-Hexachlorobiphenyl	15	15		15	7	7
PCB 131/142		10	10		10		

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
		Accreditation No.: A 2637				Lab. ID: C404	
		W	S	Pulp	T	NP W	S
PCB 132	2,2',3,3',4,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 133	2,2',3,3',5,5'-Hexachlorobiphenyl	15	15		15	7	7
PCB 134	2,2',3,3',5,6-Hexachlorobiphenyl	15	15		15	7	7
PCB 134/143		10	10		10		
PCB 135	2,2',3,3',5,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 136	2,2',3,3',6,6'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 137	2,2',3,4,4',5-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 138	2,2',3,4,4',5'-Hexachlorobiphenyl	15	15		15	7	7
PCB 138/163/164		10	10		10		
PCB 139	2,2',3,4,4',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 140	2,2',3,4,4',6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 141	2,2',3,4,5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 142	2,2',3,4,5,6-Hexachlorobiphenyl	15	15		15	7	7
PCB 143	2,2',3,4,5,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 144	2,2',3,4,5',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 144/135		10	10		10		
PCB 145	2,2',3,4,6,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 146	2,2',3,4',5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 147	2,2',3,4',5,6-Hexachlorobiphenyl	15	15		15	7	7
PCB 148	2,2',3,4',5,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 149	2,2',3,4',5',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 149/139		10	10		10		
PCB 150	2,2',3,4',6,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 151	2,2',3,5,5',6-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 152	2,2',3,5,6,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 154	2,2',4,4',5,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 155	2,2',4,4',6,6'-Hexachlorobiphenyl	15	15		15	7	7
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 158	2,3,3',4,4',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 158/160		10	10		10		
PCB 159	2,3,3',4,5,5'-Hexachlorobiphenyl	15	15		15	7	7
PCB 160	2,3,3',4,5,6-Hexachlorobiphenyl	15	15		15	7	7
PCB 161	2,3,3',4,5',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 162	2,3,3',4',5,5'-Hexachlorobiphenyl	15	15		15	7	7
PCB 163	2,3,3',4',5,6-Hexachlorobiphenyl	15	15		15	7	7
PCB 164	2,3,3',4',5',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 165	2,3,3',5,5',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 166	2,3,4,4',5,6-Hexachlorobiphenyl	15	15		15	7	7
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	15	15		15	7	7
PCB 168	2,3',4,4',5',6-Hexachlorobiphenyl	15	15		15	7	7
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 170	2,2',3,3',4,4',5-Heptachlorobiphenyl	15	15		15	7	7
PCB 170/190		10	10		10		
PCB 171	2,2',3,3',4,4',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 172	2,2',3,3',4,5,5'-Heptachlorobiphenyl	15	15		15	7	7
PCB 172/192		10	10		10		
PCB 173	2,2',3,3',4,5,6-Heptachlorobiphenyl	15	15		15	7	7
PCB 174	2,2',3,3',4,5,6'-Heptachlorobiphenyl	15	15		15	7	7
PCB 174/181		10	10		10		
PCB 175	2,2',3,3',4,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 176	2,2',3,3',4,6,6'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 177	2,2',3,3',4,5',6'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
		Accreditation No.: A 2637				Lab. ID: C404	
		W	S	Pulp	T	NP W	S
PCB 178	2,2',3,3',5,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 179	2,2',3,3',5,6,6'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 180	2,2',3,4,4',5,5'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 181	2,2',3,4,4',5,6-Heptachlorobiphenyl	15	15		15	7	7
PCB 182	2,2',3,4,4',5,6'-Heptachlorobiphenyl	15	15		15	7	7
PCB 183	2,2',3,4,4',5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 184	2,2',3,4,4',6,6'-Heptachlorobiphenyl	15	15		15	7	7
PCB 185	2,2',3,4,5,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 186	2,2',3,4,5,6,6'-Heptachlorobiphenyl	15	15		15	7	7
PCB 187	2,2',3,4',5,5',6-Heptachlorobiphenyl	15	15		15	7	7
PCB 187/182		10	10		10		
PCB 188	2,2',3,4',5,6,6'-Heptachlorobiphenyl	15	15		15	7	7
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 190	2,3,3',4,4',5,6-Heptachlorobiphenyl	15	15		15	7	7
PCB 191	2,3,3',4,4',5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 192	2,3,3',4,5,5',6-Heptachlorobiphenyl	15	15		15	7	7
PCB 193	2,3,3',4',5,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 194	2,2',3,3',4,4',5,5'-Octachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 195	2,2',3,3',4,4',5,6-Octachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 196	2,2',3,3',4,4',5,6'-Octachlorobiphenyl	15	15		15	7	7
PCB 196/203		10	10		10		
PCB 197	2,2',3,3',4,4',6,6'-Octachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 198	2,2',3,3',4,5,5',6-Octachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 199	2,2',3,3',4,5,5',6'-Octachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 200	2,2',3,3',4,5,6,6'-Octachlorobiphenyl	15	15		15	7	7
PCB 201	2,2',3,3',4,5',6,6'-Octachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	15	15		15	7	7
PCB 203	2,2',3,4,4',5,5',6-Octachlorobiphenyl	15	15		15	7	7
PCB 204	2,2',3,4,4',5,6,6'-Octachlorobiphenyl	15	15		15	7	7
PCB 205	2,3,3',4,4',5,5',6-Octachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 207	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 208	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	10, 15	10, 15		10, 15	7	7
PCB 209	Decachlorobiphenyl	10, 15	10, 15		10, 15	7	7
Total Monochlorobiphenyls		15	15		15		
Total Dichlorobiphenyls		10, 15	10, 15		10, 15		
Total Trichlorobiphenyls		10, 15	10, 15		10, 15		
Total Tetrachlorobiphenyls		10, 15	10, 15		10, 15		
Total Pentachlorobiphenyls		10, 15	10, 15		10, 15		
Total Hexachlorobiphenyls		10, 15	10, 15		10, 15		
Total Heptachlorobiphenyls		10, 15	10, 15		10, 15		
Total Octachlorobiphenyls		10, 15	10, 15		10, 15		
Total Nonachlorobiphenyls		10, 15	10, 15		10, 15		
Total Decachlorobiphenyls		10	10		10		
Total Polychlorinated biphenyls		10	10		10		7
Aroclors							
Aroclor 1260		10	10		10	7	7
Aroclor 1254		10	10		10	7	7
Aroclor 1268		10	10		10		
Aroclor 1221		10	10		10	7	7
Aroclor 1232		10	10		10	7	7
Aroclor 1248		10	10		10	7	7
Aroclor 1016						7	7

AXYS Analytical Services Ltd.

TABLE 2	Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
	Accreditation No.: A 2637				Lab. ID: C404	
	W	S	Pulp	T	NP W	S
Aroclor 1242					7	7
Aroclor 1242/1016	10	10		10		
Pesticides						
2,4'-DDD	10, 16	10, 16		10, 16	16	
2,4'-DDE	10, 16	10, 16		10, 16	16	
2,4'-DDT	10, 16	10, 16		10, 16	16	
4,4'-DDD	10, 16	10, 16		10, 16	16	
4,4'-DDE	10, 16	10, 16		10, 16	16	
4,4'-DDT	10, 16	10, 16		10, 16	16	
Aldrin	10, 16	10, 16		10, 16	16	
Alpha-HCH	10, 16	10, 16		10, 16	16	
Beta-HCH	10, 16	10, 16		10, 16	16	
cis-Chlordane (alpha-Chlordane)	10, 16	10, 16		10, 16	16	
cis-Nonachlor	10, 16	10, 16		10, 16	16	
Delta-HCH	10, 16	10, 16		10, 16	16	
Dieldrin	10, 16	10, 16		10, 16	16	
Endosulphan I	10, 16	10, 16		10, 16	16	
Endosulphan II	10, 16	10, 16		10, 16	16	
Endosulphan sulphate	10, 16	10, 16		10, 16	16	
Endrin	10, 16	10, 16		10, 16	16	
Endrin aldehyde	10, 16	10, 16		16	16	
Endrin ketone	10, 16	10, 16		10, 16	16	
Gamma-HCH (Lindane)	10, 16	10, 16		10, 16	16	
Heptachlor	10, 16	10, 16		10, 16	16	
Heptachlor epoxide	10, 16	10, 16		10, 16	16	
Hexachlorobenzene	10, 16	10, 16		10, 16	16	
Hexachlorobutadiene		16		16		
Methoxychlor	10, 16	10, 16		10, 16	16	
Mirex	10, 16	10, 16		10, 16	16	
Oxychlordane	10, 16	10, 16		10, 16	16	
Toxaphene	10	10		10		
trans-Chlordane (gamma-Chlordane)	10, 16	10, 16		10, 16	16	
trans-Nonachlor	16	10, 16		10, 16	16	
BDE - Brominated Diphenylethers						
BDE 7 2,4-dibromodiphenylether	17	17		17		
BDE 8 2,4'-dibromodiphenylether	17	17		17		
BDE 10 2,6-dibromodiphenylether	17	17		17		
BDE 11 3,3'-dibromodiphenylether	17	17		17		
BDE 12 3,4-dibromodiphenylether	17	17		17		
BDE 13 3,4'-dibromodiphenylether	17	17		17		
BDE 15 4,4'-dibromodiphenylether	17	17		17		
BDE 17 2,2',4-tribromodiphenylether	17	17		17		
BDE 25 2,3',4-tribromodiphenylether	17	17		17		
BDE 28 2,4,4'-tribromodiphenylether	17	17		17		
BDE 30 2,4,6-tribromodiphenylether	17	17		17		
BDE-33 2',3,4-tribromodiphenylether	17	17		17		
BDE 35 3,3',4-tribromodiphenylether	17	17		17		
BDE 37 3,4,4'-tribromodiphenylether	17	17		17		
BDE 47 2,2',4,4'-tetrabromodiphenylether	17	17		17		
BDE 49 2,2',4,5'-tetrabromodiphenylether	17	17		17		
BDE 66 2,3',4,4'-tetrabromodiphenylether	17	17		17		
BDE 75 2,4,4',6-tetrabromodiphenylether	17	17		17		

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
		Accreditation No.: A 2637				Lab. ID: C404	
		W	S	Pulp	T	NP W	S
BDE 77	3,3',4,4'-tetrabromodiphenylether	17	17		17		
BDE 85	2,2',3,4,4'-pentabromodiphenylether	17	17		17		
BDE 99	2,2',4,4',5-pentabromodiphenylether	17	17		17		
BDE 100	2,2',4,4',6-pentabromodiphenylether	17	17		17		
BDE 105	2,3,3',4,4'-pentabromodiphenylether	17	17		17		
BDE 116	2,3,4,5,6-pentabromodiphenylether	17	17		17		
BDE 119	2,3',4,4',6-pentabromodiphenylether	17	17		17		
BDE 126	3,3',4,4',5-pentabromodiphenylether	17	17		17		
BDE 140	2,2',3,4,4',6'-hexabromodiphenylether	17	17		17		
BDE 153	2,2',4,4',5,5'-hexabromodiphenylether	17	17		17		
BDE 154	2,2',4,4',5',6-hexabromodiphenylether	17	17		17		
BDE 155	2,2',4,4',6,6'-hexabromodiphenylether	17	17		17		
BDE 166	2,3,4,4',5,6-hexabromodiphenylether	17	17		17		
BDE 181	2,2',3,4,4',5,6-heptabromodiphenylether	17	17		17		
BDE-183	2,2',3,4,4',5',6-heptabromodiphenylether	17	17		17		
BDE 190	2,3,3',4,4',5,6-heptabromodiphenylether	17	17		17		
BDE 206	2,2',3,3',4,4',5,5',6-nonabromodiphenylether	17	17		17		
BDE 207	2,2',3,3',4,4',5,6,6'-nonabromodiphenylether	17	17		17		
BDE 208	2,2',3,3',4,5,5',6,6'-nonabromodiphenylether	17	17		17		
BDE 209	Decabromodiphenylether	17	17		17		
PFC – Perfluorinated Organic Compounds							
Perfluorobutanoate (PFBA)		14	12		13		
Perfluoropentanoate (PFPeA)		14	12		13		
Perfluorohexanoate (PFHxA)		14	12		13		
Perfluoroheptanoate (PFHpA)		14	12		13		
Perfluorooctanoate (PFOA)		14	12		13		
Perfluorononanoate (PFNA)		14	12		13		
Perfluorodecanoate (PFDA)		14	12		13		
Perfluoroundecanoate (PFUnA)		14	12		13		
Perfluorododecanoate (PFDoA)		14	12		13		
Perfluorobutanesulfonate (PFBS)		14	12		13		
Perfluorohexanesulfonate (PFHxS)		14	12		13		
Perfluorooctanesulfonate (PFOS)		14	12		13		
Perfluorooctane sulfonamide (PFOSA)		14	12		13		
PAH							
Anthracene			18		18		
Pyrene			18		18		
Benzo[ghi]perylene			18		18		
Benzo[e]pyrene			18		18		
Indeno[1,2,3-cd]pyrene			18		18		
Perylene			18		18		
Benzo[b]fluoranthene			18		18		
Fluoranthene			18		18		
Benzo[k]fluoranthene					18		
Acenaphthylene			18		18		
Chrysene			18		18		
Benzo[a]pyrene			18		18		
Dibenz[ah]anthracene			18		18		
Benz[a]anthracene			18		18		
Acenaphthene			18		18		
Phenanthrene			18		18		
Fluorene			18		18		

AXYS Analytical Services Ltd.

TABLE 2	Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
	Accreditation No.: A 2637				Lab. ID: C404	
	W	S	Pulp	T	NP W	S
Naphthalene		18		18		
PPCP (Pharmaceutical and Personal Care Products)						
Acetaminophen	19	19				
Azithromycin	19	19				
Caffeine	19	19				
Carbadox	19	19				
Carbamazepine	19	19				
Cefotaxime	19	19				
Ciprofloxacin	19	19				
Clarithromycin	19	19				
Clinafloxacin	19	19				
Cloxacillin	19	19				
Dehydronifedipine	19	19				
Digoxigenin	19	19				
Digoxin	19	19				
Diltiazem	19	19				
1,7-Dimethylxanthine	19	19				
Diphenhydramine	19	19				
Enrofloxacin	19	19				
Erythromycin	19	19				
Flumequine	19	19				
Fluoxetine	19	19				
Lincomycin	19	19				
Lomefloxacin	19	19				
Miconazole	19	19				
Norfloxacin	19	19				
Norgestimate	19	19				
Ofloxacin	19	19				
Ormetoprim	19	19				
Oxacillin	19	19				
Oxolinic acid	19	19				
Penicillin G	19	19				
Penicillin V	19	19				
Roxithromycin	19	19				
Sarafloxacin	19	19				
Sulfachloropyridazine	19	19				
Sulfadiazine	19	19				
Sulfadimethoxine	19	19				
Sulfamerazine	19	19				
Sulfamethazine	19	19				
Sulfamethizole	19	19				
Sulfamethoxazole	19	19				
Sulfanilamide	19	19				
Sulfathiazole	19	19				
Thiabendazole	19	19				
Trimethoprim	19	19				
Tylosin	19	19				
Virginiamycin	19	19				
Anhydrochlortetracycline (ACTC)	19	19				
Anhydrotetracycline (ATC)	19	19				
Chlortetracycline (CTC)	19	19				
Demeclocycline	19	19				

AXYS Analytical Services Ltd.

TABLE 2	Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
	Accreditation No.: A 2637				Lab. ID: C404	
	W	S	Pulp	T	NP W	S
Doxycycline	19	19				
4-Epianhydrochlortetracycline (EACTC)	19	19				
4-Epianhydrotetracycline (EATC)	19	19				
4-Epichlortetracycline (ECTC)	19	19				
4-Epioxytetracycline (EOTC)	19	19				
4-Epitetracycline (ETC)	19	19				
Isochlortetracycline (ICTC)	19	19				
Minocycline	19	19				
Oxytetracycline (OTC)	19	19				
Tetracycline (TC)	19	19				
Bisphenol A	19	19				
Furosemide	19	19				
Gemfibrozil	19	19				
Glipizide	19	19				
Glyburide	19	19				
Hydrochlorothiazide	19	19				
2-hydroxy-ibuprofen	19	19				
Ibuprofen	19	19				
Naproxen	19	19				
Triclocarban	19	19				
Triclosan	19	19				
Warfarin	19	19				
Albuterol	19	19				
Amphetamine	19	19				
Atenolol	19	19				
Atorvastatin	19	19				
Cimetidine	19	19				
Clonidine	19	19				
Codeine	19	19				
Cotinine	19	19				
Enalapril	19	19				
Hydrocodone	19	19				
Metformin	19	19				
Oxycodone	19	19				
Ranitidine	19	19				
Triamterene	19	19				
Alprazolam	19	19				
Amitriptyline	19	19				
Amlodipine	19	19				
Benzoylecgonine	19	19				
Benztropine	19	19				
Betamethasone	19	19				
Cocaine	19	19				
DEET (N,N-diethyl-m-toluamide)	19	19				
Desmethyldiltiazem	19	19				
Diazepam	19	19				
Fluocinonide	19	19				
Fluticasone propionate	19	19				
Hydrocortisone	19	19				
10-hydroxy-amitriptyline	19	19				
Meprobamate	19	19				

TABLE 2	Canadian Association for Laboratory Accreditation (CALA)				Washington State Department of Ecology	
	Accreditation No.: A 2637				Lab. ID: C404	
	W	S	Pulp	T	NP W	S
Methylprednisolone	19	19				
Metoprolol	19	19				
Norfluoxetine	19	19				
Norverapamil	19	19				
Paroxetine	19	19				
Prednisolone	19	19				
Prednisone	19	19				
Promethazine	19	19				
Propoxyphene	19	19				
Propranolol	19	19				
Sertraline	19	19				
Simvastatin	19	19				
Theophylline	19	19				
Trenbolone	19	19				
Trenbolone acetate	19	19				
Valsartan	19	19				
Verapamil	19	19				

Table 1 and Table 2 - Explanation of Terms Used:

- NELAP = National Environmental Laboratory Accreditation Program
- Non-potable water = water not fit for consumption without treatment as it may contain pollutants, contaminants, minerals or infective agents. Surface water, ground water, rainwater, effluents as well as any other non-drinking water sources are included in this category.
- Solid = environmental solid sample. Soil, sediment, biosolids, hazardous waste, mixed phase samples with significant solids content are included in this category.
- Performance based implementation = methodology follows that of the method reference but modifications deemed by AXYS as minor [1] may apply, results meet method reference data quality standard.
- Performance based modification = modifications deemed by AXYS as significant[2] have been made to method reference protocol, results meet method reference accuracy standard. The suitability of the methodology for any method prescriptive applications should be assessed based on the modifications made and the specific work requirements.
- Performance based method = an in-house AXYS method, published method reference not applicable.
- GC/LRMS = gas chromatography, low resolution mass spectrometry detection.
- GC/HRMS = gas chromatography, high resolution mass spectrometry detection.
- GC/ECD = gas chromatography, electron capture detection.
- LC/MS-MS = liquid chromatography, mass spectrometry-mass spectrometry detection.

Note 1:

Performance Based Implementation - Examples of Minor Modifications

- use of additional isotopically labeled references
- adjustment of calibration range
- adjustment of clean-up technique
- use of a different extraction of same general type (example soxhlet vs soxhlet Dean Stark)
- addition of matrix type using same principles (example addition of tissue matrix using same detection principle and similar extraction type)

Note 2:

Performance Based Modification - Examples of Significant Modifications

- different acquisition conditions using same detection principle (example MS SIM vs. full scan)
- different internal control limits while meeting method reference accuracy standard

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AXYS Client No.: 2544

Client Address: Hatfield Consultants
Suite 200- 850 Harbourside Drive
North Vancouver, BC, Canada, V7P 0A3

The AXYS contact for these data is Georgina Brooks.

BATCH SUMMARY

Batch ID: WG39854	***Date:*** 31-May-2012
Analysis Type: Dioxin/Furan	***Matrix Type:*** Tissue

BATCH MAKEUP

Contract: 2544

Samples:

L17883-1	HS1625-C9
L17883-2	HS1625-C10
L17883-3	HS1625-C14
L17883-4	HS1625-C16a
L17883-5	HS1625-C19a
L17883-6	HS1625-C21
L17883-7	HS1625-C27
L17883-8	HS1625-C28
L17883-9	HS1625-T9-DF Tissue
L17883-10	HS1625-T9-DF Liver

Blank: WG39854-101

Reference or Spike: WG39854-102

Duplicate: WG39854-103

Comments:

1. Data are not blank corrected.

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February 1993

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C9
Sample Collection:
24-Apr-2012 14:13

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-1 (A)
Matrix:	TISSUE	**Sample Size:**	10.2 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 01:03:08	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_079 S: 17**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	81.8 10.6

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		1.49	0.10 (S)	0.80	1.001
1,2,3,7,8-PECDD [4]		6.31	0.10 (Q)	0.61	1.001
1,2,3,4,7,8-HXCDD		1.21	0.20 (S)	1.40	1.000
1,2,3,6,7,8-HXCDD		33.5	0.20 (S)	1.17	1.000
1,2,3,7,8,9-HXCDD		6.63	0.20 (S)	1.19	1.000
1,2,3,4,6,7,8-HPCDD		2.37	0.20 (Q)	0.95	1.000
OCDD		1.11	0.49 (Q)	0.99	1.000
2,3,7,8-TCDF		46.3	0.10 (Q)	0.76	1.001
1,2,3,7,8-PECDF		0.64	0.10 (Q)	1.34	1.000
2,3,4,7,8-PECDF		2.64	0.10 (Q)	1.49	1.000
1,2,3,4,7,8-HXCDF		0.68	0.20 (Q)	1.30	1.000
1,2,3,6,7,8-HXCDF		0.32	0.20 (Q)	1.07	1.000
1,2,3,7,8,9-HXCDF	ND		0.20 (Q)		
2,3,4,6,7,8-HXCDF		0.58	0.20 (Q)	1.17	1.001
1,2,3,4,6,7,8-HPCDF		1.15	0.20 (Q)	0.90	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.20 (Q)		
OCDF	ND		0.49 (Q)		
TOTAL TETRA-DIOXINS		6.29	0.10 (S)		
TOTAL PENTA-DIOXINS		26.0	0.10 (Q)		
TOTAL HEXA-DIOXINS		110	0.20 (S)		
TOTAL HEPTA-DIOXINS		4.63	0.20 (Q)		
TOTAL TETRA-FURANS		72.3	0.10 (Q)		
TOTAL PENTA-FURANS		16.3	0.10 (Q)		
TOTAL HEXA-FURANS		8.83	0.20 (Q)		
TOTAL HEPTA-FURANS		1.37	0.20 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-1_Form1A_DX2M_079S17_SJ1463871.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C9
Sample Collection:
24-Apr-2012 14:13

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-1 (A)
Matrix:	TISSUE	**Sample Size:**	10.2 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 01:03:08	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_079 S: 17**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
Concentration Units:	pg absolute	**% Moisture:**	81.8
		% Lipid:	10.6

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1020	51.1	0.77	1.012
13C-1,2,3,7,8-PECDD [4]		2000	1130	56.7	0.61	1.382
13C-1,2,3,4,7,8-HXCDD		2000	1030	51.3	1.26	0.987
13C-1,2,3,6,7,8-HXCDD		2000	934	46.7	1.21	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1010	50.5	1.02	1.093
13C-OCDD		4000	1800	45.0	0.88	1.176
13C-2,3,7,8-TCDF		2000	970	48.5	0.76	0.965
13C-1,2,3,7,8-PECDF		2000	890	44.5	1.55	1.285
13C-2,3,4,7,8-PECDF		2000	858	42.9	1.57	1.352
13C-1,2,3,4,7,8-HXCDF		2000	959	47.9	0.51	0.955
13C-1,2,3,6,7,8-HXCDF		2000	863	43.1	0.51	0.958
13C-1,2,3,7,8,9-HXCDF		2000	955	47.8	0.51	1.005
13C-2,3,4,6,7,8-HXCDF		2000	899	45.0	0.51	0.980
13C-1,2,3,4,6,7,8-HPCDF		2000	765	38.3	0.41	1.061
13C-1,2,3,4,7,8,9-HPCDF		2000	795	39.8	0.40	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	98.5	49.2		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-1_Form2_DX2M_079S17_SJ1463871.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C10
Sample Collection:
24-Apr-2012 15:43

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-2
Matrix:	TISSUE	**Sample Size:**	10.1 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 02:53:35	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_079 S: 19**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	83.5 7.55

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		1.71	0.10 (Q)	0.77	1.001
1,2,3,7,8-PECDD [4]		6.31	0.10 (Q)	0.59	1.001
1,2,3,4,7,8-HXCDD		1.05	0.20 (S)	1.33	1.000
1,2,3,6,7,8-HXCDD		45.9	0.20 (S)	1.22	1.000
1,2,3,7,8,9-HXCDD		11.5	0.20 (S)	1.29	1.001
1,2,3,4,6,7,8-HPCDD		4.44	0.20 (Q)	0.98	1.000
OCDD		1.24	0.50 (Q)	0.81	1.000
2,3,7,8-TCDF		55.5	0.10 (Q)	0.75	1.001
1,2,3,7,8-PECDF		0.72	0.10 (Q)	1.58	1.001
2,3,4,7,8-PECDF		2.24	0.10 (Q)	1.41	1.001
1,2,3,4,7,8-HXCDF		0.44	0.20 (Q)	1.34	1.000
1,2,3,6,7,8-HXCDF	NDR	0.32	0.20 (Q)	0.90	1.000
1,2,3,7,8,9-HXCDF	ND		0.20 (Q)		
2,3,4,6,7,8-HXCDF		0.40	0.20 (Q)	1.29	1.000
1,2,3,4,6,7,8-HPCDF		1.46	0.20 (Q)	1.05	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.20 (Q)		
OCDF	ND		0.50 (Q)		
TOTAL TETRA-DIOXINS		7.77	0.10 (Q)		
TOTAL PENTA-DIOXINS		24.5	0.10 (Q)		
TOTAL HEXA-DIOXINS		183	0.20 (S)		
TOTAL HEPTA-DIOXINS		8.46	0.20 (Q)		
TOTAL TETRA-FURANS		92.4	0.10 (Q)		
TOTAL PENTA-FURANS		17.3	0.10 (Q)		
TOTAL HEXA-FURANS		6.78	0.20 (Q)		
TOTAL HEPTA-FURANS		1.46	0.20 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL; NDR = peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-2_Form1A_DX2M_079S19_SJ1463872.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C10
Sample Collection:
24-Apr-2012 15:43

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-2
Sample Receipt Date:	01-May-2012	**Sample Size:**	10.1 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 02:53:35	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_079 S: 19**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg absolute	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
		% Moisture:	83.5
		% Lipid:	7.55

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1410	70.7	0.79	1.013
13C-1,2,3,7,8-PECDD [4]		2000	1540	76.9	0.61	1.383
13C-1,2,3,4,7,8-HXCDD		2000	1440	71.9	1.23	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1300	64.9	1.22	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1410	70.4	1.01	1.094
13C-OCDD		4000	2390	59.7	0.88	1.176
13C-2,3,7,8-TCDF		2000	1230	61.6	0.80	0.966
13C-1,2,3,7,8-PECDF		2000	1250	62.4	1.55	1.285
13C-2,3,4,7,8-PECDF		2000	1210	60.6	1.57	1.352
13C-1,2,3,4,7,8-HXCDF		2000	1350	67.6	0.50	0.955
13C-1,2,3,6,7,8-HXCDF		2000	1220	61.2	0.52	0.959
13C-1,2,3,7,8,9-HXCDF		2000	1250	62.5	0.51	1.005
13C-2,3,4,6,7,8-HXCDF		2000	1250	62.6	0.51	0.981
13C-1,2,3,4,6,7,8-HPCDF		2000	1110	55.5	0.40	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	1140	57.0	0.39	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	138	68.9		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-2_Form2_DX2M_079S19_SJ1463872.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C14
Sample Collection:
24-Apr-2012 15:25

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-3
Sample Receipt Date:	01-May-2012	**Sample Size:**	11.1 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 03:48:48	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_079 S: 20**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg/g (wet weight basis)	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
		% Moisture:	82.2
		% Lipid:	7.71

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		2.51	0.09 (Q)	0.79	1.001
1,2,3,7,8-PECDD [4]		13.1	0.09 (Q)	0.59	1.000
1,2,3,4,7,8-HXCDD		2.14	0.18 (S)	1.26	1.000
1,2,3,6,7,8-HXCDD		60.7	0.18 (S)	1.21	1.000
1,2,3,7,8,9-HXCDD		7.49	0.18 (S)	1.21	1.000
1,2,3,4,6,7,8-HPCDD		3.01	0.18 (Q)	1.02	1.000
OCDD		1.66	0.45 (Q)	0.89	1.000
2,3,7,8-TCDF		103	0.09 (Q)	0.75	1.001
1,2,3,7,8-PECDF		0.77	0.09 (Q)	1.62	1.001
2,3,4,7,8-PECDF		5.10	0.09 (Q)	1.50	1.001
1,2,3,4,7,8-HXCDF		0.96	0.18 (Q)	1.12	1.000
1,2,3,6,7,8-HXCDF		0.28	0.18 (Q)	1.15	1.001
1,2,3,7,8,9-HXCDF	ND		0.18 (Q)		
2,3,4,6,7,8-HXCDF		0.82	0.18 (Q)	1.15	1.000
1,2,3,4,6,7,8-HPCDF		1.03	0.18 (Q)	0.95	1.001
1,2,3,4,7,8,9-HPCDF	ND		0.18 (Q)		
OCDF	ND		0.45 (Q)		
TOTAL TETRA-DIOXINS		11.7	0.09 (Q)		
TOTAL PENTA-DIOXINS		43.1	0.09 (Q)		
TOTAL HEXA-DIOXINS		134	0.18 (S)		
TOTAL HEPTA-DIOXINS		6.26	0.18 (Q)		
TOTAL TETRA-FURANS		155	0.09 (Q)		
TOTAL PENTA-FURANS		36.7	0.09 (Q)		
TOTAL HEXA-FURANS		15.3	0.18 (Q)		
TOTAL HEPTA-FURANS		1.33	0.18 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-3_Form1A_DX2M_079S20_SJ1463873.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C14
Sample Collection:
24-Apr-2012 15:25

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-3
Sample Receipt Date:	01-May-2012	**Sample Size:**	11.1 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 03:48:48	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_079 S: 20**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg absolute	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
		% Moisture:	82.2
		% Lipid:	7.71

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1290	64.3	0.75	1.013
13C-1,2,3,7,8-PECDD [4]		2000	1440	71.9	0.62	1.383
13C-1,2,3,4,7,8-HXCDD		2000	1260	63.1	1.22	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1190	59.4	1.22	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1330	66.3	1.07	1.093
13C-OCDD		4000	2290	57.3	0.88	1.176
13C-2,3,7,8-TCDF		2000	1120	56.2	0.79	0.965
13C-1,2,3,7,8-PECDF		2000	1160	58.1	1.53	1.285
13C-2,3,4,7,8-PECDF		2000	1120	56.2	1.53	1.352
13C-1,2,3,4,7,8-HXCDF		2000	1190	59.7	0.51	0.955
13C-1,2,3,6,7,8-HXCDF		2000	1090	54.7	0.51	0.958
13C-1,2,3,7,8,9-HXCDF		2000	1120	56.1	0.50	1.005
13C-2,3,4,6,7,8-HXCDF		2000	1110	55.3	0.50	0.981
13C-1,2,3,4,6,7,8-HPCDF		2000	1070	53.7	0.42	1.061
13C-1,2,3,4,7,8,9-HPCDF		2000	1030	51.6	0.42	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	138	69.2		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-3_Form2_DX2M_079S20_SJ1463873.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C16a
Sample Collection:
24-Apr-2012 11:07

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-4 i
Sample Receipt Date:	01-May-2012	**Sample Size:**	11.3 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 13:51:21	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_080 S: 4**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg/g (wet weight basis)	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
		% Moisture:	77.2
		% Lipid:	12.2

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		2.14	0.09 (Q)	0.76	1.001
1,2,3,7,8-PECDD [4]		9.75	0.09 (Q)	0.61	1.001
1,2,3,4,7,8-HXCDD		1.70	0.18 (S)	1.20	1.000
1,2,3,6,7,8-HXCDD		25.1	0.18 (S)	1.20	1.000
1,2,3,7,8,9-HXCDD		6.68	0.18 (S)	1.22	1.000
1,2,3,4,6,7,8-HPCDD		6.82	0.18 (Q)	1.09	1.000
OCDD		3.49	0.44 (Q)	0.91	1.000
2,3,7,8-TCDF		52.8	0.09 (Q)	0.76	1.001
1,2,3,7,8-PECDF		1.35	0.09 (Q)	1.45	1.001
2,3,4,7,8-PECDF		3.05	0.09 (Q)	1.43	1.001
1,2,3,4,7,8-HXCDF		0.96	0.18 (Q)	1.15	1.000
1,2,3,6,7,8-HXCDF		0.76	0.18 (Q)	1.16	1.001
1,2,3,7,8,9-HXCDF	ND		0.18 (Q)		
2,3,4,6,7,8-HXCDF		0.72	0.18 (Q)	1.13	1.000
1,2,3,4,6,7,8-HPCDF		1.86	0.18 (Q)	0.97	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.18 (Q)		
OCDF	ND		0.44 (Q)		
TOTAL TETRA-DIOXINS		11.9	0.09 (Q)		
TOTAL PENTA-DIOXINS		38.1	0.09 (Q)		
TOTAL HEXA-DIOXINS		93.4	0.18 (S)		
TOTAL HEPTA-DIOXINS		15.4	0.18 (Q)		
TOTAL TETRA-FURANS		92.8	0.09 (Q)		
TOTAL PENTA-FURANS		31.3	0.09 (Q)		
TOTAL HEXA-FURANS		15.0	0.18 (Q)		
TOTAL HEPTA-FURANS		2.26	0.18 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-4_Form1A_DX2M_080S4_SJ1463859.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C16a
Sample Collection:
24-Apr-2012 11:07

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-4 i
Sample Receipt Date:	01-May-2012	**Sample Size:**	11.3 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 13:51:21	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_080 S: 4**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg absolute	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
		% Moisture:	77.2
		% Lipid:	12.2

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1170	58.6	0.77	1.013
13C-1,2,3,7,8-PECDD [4]		2000	1170	58.6	0.61	1.383
13C-1,2,3,4,7,8-HXCDD		2000	1160	57.8	1.25	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1030	51.5	1.22	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1180	58.8	1.05	1.094
13C-OCDD		4000	2030	50.7	0.86	1.177
13C-2,3,7,8-TCDF		2000	1120	55.9	0.79	0.966
13C-1,2,3,7,8-PECDF		2000	1030	51.7	1.54	1.285
13C-2,3,4,7,8-PECDF		2000	980	49.0	1.56	1.351
13C-1,2,3,4,7,8-HXCDF		2000	1080	53.8	0.50	0.954
13C-1,2,3,6,7,8-HXCDF		2000	984	49.2	0.50	0.958
13C-1,2,3,7,8,9-HXCDF		2000	1020	51.2	0.49	1.005
13C-2,3,4,6,7,8-HXCDF		2000	994	49.7	0.50	0.980
13C-1,2,3,4,6,7,8-HPCDF		2000	929	46.5	0.44	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	953	47.7	0.44	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	125	62.7		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-4_Form2_DX2M_080S4_SJ1463859.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C19a
Sample Collection:
24-Apr-2012 15:04

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-5
Sample Receipt Date:	01-May-2012	**Sample Size:**	11.3 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 14:46:33	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_080 S: 5**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg/g (wet weight basis)	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
		% Moisture:	82.0
		% Lipid:	9.44

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		7.23	0.09 (Q)	0.78	1.001
1,2,3,7,8-PECDD [4]		54.7	0.09 (Q)	0.61	1.001
1,2,3,4,7,8-HXCDD		11.4	0.18 (S)	1.22	1.001
1,2,3,6,7,8-HXCDD		387	0.18 (S)	1.21	1.000
1,2,3,7,8,9-HXCDD		32.8	0.18 (S)	1.19	1.000
1,2,3,4,6,7,8-HPCDD		9.40	0.18 (Q)	1.00	1.000
OCDD		5.26	0.44 (Q)	1.00	1.000
2,3,7,8-TCDF		329	0.09 (S)	0.75	1.001
1,2,3,7,8-PECDF		1.43	0.09 (S)	1.44	1.001
2,3,4,7,8-PECDF		21.4	0.09 (S)	1.52	1.001
1,2,3,4,7,8-HXCDF		7.13	0.18 (S)	1.15	1.000
1,2,3,6,7,8-HXCDF		0.61	0.18 (S)	1.08	1.000
1,2,3,7,8,9-HXCDF	ND		0.18 (S)		
2,3,4,6,7,8-HXCDF		8.52	0.18 (S)	1.25	1.000
1,2,3,4,6,7,8-HPCDF		13.6	0.18 (S)	1.00	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.18 (S)		
OCDF	ND		0.44 (Q)		
TOTAL TETRA-DIOXINS		36.7	0.09 (Q)		
TOTAL PENTA-DIOXINS		262	0.09 (Q)		
TOTAL HEXA-DIOXINS		892	0.18 (S)		
TOTAL HEPTA-DIOXINS		25.6	0.18 (Q)		
TOTAL TETRA-FURANS		553	0.09 (S)		
TOTAL PENTA-FURANS		236	0.09 (S)		
TOTAL HEXA-FURANS		215	0.18 (S)		
TOTAL HEPTA-FURANS		16.5	0.18 (S)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-5_Form1A_DX2M_080S5_SJ1463860.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C19a
Sample Collection:
24-Apr-2012 15:04

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-5
Sample Receipt Date:	01-May-2012	**Sample Size:**	11.3 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 14:46:33	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_080 S: 5**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg absolute	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
		% Moisture:	82.0
		% Lipid:	9.44

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1150	57.3	0.75	1.013
13C-1,2,3,7,8-PECDD [4]		2000	1210	60.6	0.62	1.383
13C-1,2,3,4,7,8-HXCDD		2000	1210	60.6	1.23	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1110	55.6	1.23	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1240	61.9	0.99	1.094
13C-OCDD		4000	2170	54.2	0.87	1.177
13C-2,3,7,8-TCDF		2000	1170	58.7	0.79	0.966
13C-1,2,3,7,8-PECDF		2000	1080	54.0	1.52	1.285
13C-2,3,4,7,8-PECDF		2000	1040	52.0	1.54	1.351
13C-1,2,3,4,7,8-HXCDF		2000	1110	55.4	0.49	0.955
13C-1,2,3,6,7,8-HXCDF		2000	1010	50.7	0.51	0.958
13C-1,2,3,7,8,9-HXCDF		2000	1030	51.3	0.49	1.005
13C-2,3,4,6,7,8-HXCDF		2000	1050	52.6	0.49	0.981
13C-1,2,3,4,6,7,8-HPCDF		2000	975	48.8	0.42	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	1020	50.8	0.44	1.104
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	120	59.8		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-5_Form2_DX2M_080S5_SJ1463860.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C21
Sample Collection:
24-Apr-2012 13:32

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-6
Matrix:	TISSUE	**Sample Size:**	10.1 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 15:41:48	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 6**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg/g (wet weight basis)	**% Moisture:**	77.4
		% Lipid:	12.5

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		1.19	0.10 (Q)	0.67	1.001
1,2,3,7,8-PECDD [4]		4.38	0.10 (Q)	0.59	1.001
1,2,3,4,7,8-HXCDD		1.27	0.20 (S)	1.08	1.000
1,2,3,6,7,8-HXCDD		23.8	0.20 (S)	1.23	1.000
1,2,3,7,8,9-HXCDD		4.31	0.20 (S)	1.25	1.000
1,2,3,4,6,7,8-HPCDD		5.13	0.20 (S)	1.07	1.000
OCDD		1.62	0.49 (Q)	0.88	1.000
2,3,7,8-TCDF		26.7	0.10 (Q)	0.75	1.001
1,2,3,7,8-PECDF		0.58	0.10 (S)	1.51	1.001
2,3,4,7,8-PECDF		2.24	0.10 (S)	1.50	1.001
1,2,3,4,7,8-HXCDF		0.78	0.20 (Q)	1.06	1.000
1,2,3,6,7,8-HXCDF		0.44	0.20 (Q)	1.36	1.001
1,2,3,7,8,9-HXCDF	ND		0.20 (Q)		
2,3,4,6,7,8-HXCDF	NDR	0.64	0.20 (Q)	0.95	1.000
1,2,3,4,6,7,8-HPCDF		2.48	0.20 (Q)	1.07	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.20 (Q)		
OCDF	ND		0.49 (Q)		
TOTAL TETRA-DIOXINS		8.19	0.10 (Q)		
TOTAL PENTA-DIOXINS		17.0	0.10 (Q)		
TOTAL HEXA-DIOXINS		73.0	0.20 (S)		
TOTAL HEPTA-DIOXINS		9.89	0.20 (S)		
TOTAL TETRA-FURANS		49.8	0.10 (Q)		
TOTAL PENTA-FURANS		23.0	0.10 (S)		
TOTAL HEXA-FURANS		16.6	0.20 (Q)		
TOTAL HEPTA-FURANS		2.89	0.20 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL; NDR = peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-6_Form1A_DX2M_080S6_SJ1463861.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C21
Sample Collection:
24-Apr-2012 13:32

Form 2

PCDD/PCDF ANALYSIS REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-6
Matrix:	TISSUE	**Sample Size:**	10.1 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 15:41:48	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 6**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg absolute	**% Moisture:**	77.4
		% Lipid:	12.5

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	899	44.9	0.77	1.013
13C-1,2,3,7,8-PECDD [4]		2000	942	47.1	0.60	1.383
13C-1,2,3,4,7,8-HXCDD		2000	1030	51.3	1.23	0.987
13C-1,2,3,6,7,8-HXCDD		2000	919	45.9	1.25	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1040	51.9	1.02	1.094
13C-OCDD		4000	1780	44.6	0.86	1.177
13C-2,3,7,8-TCDF		2000	852	42.6	0.75	0.966
13C-1,2,3,7,8-PECDF		2000	842	42.1	1.54	1.285
13C-2,3,4,7,8-PECDF		2000	795	39.7	1.54	1.351
13C-1,2,3,4,7,8-HXCDF		2000	935	46.8	0.50	0.955
13C-1,2,3,6,7,8-HXCDF		2000	863	43.1	0.49	0.958
13C-1,2,3,7,8,9-HXCDF		2000	892	44.6	0.48	1.005
13C-2,3,4,6,7,8-HXCDF		2000	884	44.2	0.50	0.981
13C-1,2,3,4,6,7,8-HPCDF		2000	789	39.4	0.43	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	873	43.7	0.44	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	102	50.8		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-6_Form2_DX2M_080S6_SJ1463861.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C27
Sample Collection:
27-Apr-2012 15:37

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-7
Matrix:	TISSUE	**Sample Size:**	3.77 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 16:37:01	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 7**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg/g (wet weight basis)	**% Moisture:**	88.5
		% Lipid:	1.39

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		0.48	0.27 (Q)	0.67	1.001
1,2,3,7,8-PECDD [4]		0.93	0.27 (Q)	0.55	1.001
1,2,3,4,7,8-HXCDD	ND		0.53 (Q)		
1,2,3,6,7,8-HXCDD		2.38	0.53 (Q)	1.15	1.000
1,2,3,7,8,9-HXCDD		0.54	0.53 (Q)	1.07	1.000
1,2,3,4,6,7,8-HPCDD	ND		0.53 (Q)		
OCDD	ND		1.33 (Q)		
2,3,7,8-TCDF		6.45	0.27 (Q)	0.75	1.001
1,2,3,7,8-PECDF	ND		0.27 (Q)		
2,3,4,7,8-PECDF	NDR	0.41	0.27 (Q)	0.95	1.001
1,2,3,4,7,8-HXCDF	ND		0.53 (Q)		
1,2,3,6,7,8-HXCDF	ND		0.53 (Q)		
1,2,3,7,8,9-HXCDF	ND		0.53 (Q)		
2,3,4,6,7,8-HXCDF	ND		0.53 (Q)		
1,2,3,4,6,7,8-HPCDF	ND		0.53 (Q)		
1,2,3,4,7,8,9-HPCDF	ND		0.53 (Q)		
OCDF	ND		1.33 (Q)		
TOTAL TETRA-DIOXINS		1.83	0.27 (Q)		
TOTAL PENTA-DIOXINS		1.97	0.27 (Q)		
TOTAL HEXA-DIOXINS		5.69	0.53 (Q)		
TOTAL HEPTA-DIOXINS	ND		0.53 (Q)		
TOTAL TETRA-FURANS		10.1	0.27 (Q)		
TOTAL PENTA-FURANS		0.34	0.27 (Q)		
TOTAL HEXA-FURANS	ND		0.53 (Q)		
TOTAL HEPTA-FURANS	ND		0.53 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL; NDR = peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-7_Form1A_DX2M_080S7_SJ1463862.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C27
Sample Collection:
27-Apr-2012 15:37

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-7
Matrix:	TISSUE	**Sample Size:**	3.77 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 16:37:01	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 7**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg absolute	**% Moisture:**	88.5
		% Lipid:	1.39

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Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	954	47.7	0.76	1.013
13C-1,2,3,7,8-PECDD [4]		2000	1030	51.7	0.62	1.383
13C-1,2,3,4,7,8-HXCDD		2000	1230	61.5	1.23	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1130	56.7	1.23	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1250	62.7	1.03	1.094
13C-OCDD		4000	2340	58.4	0.86	1.177
13C-2,3,7,8-TCDF		2000	882	44.1	0.78	0.966
13C-1,2,3,7,8-PECDF		2000	973	48.6	1.55	1.285
13C-2,3,4,7,8-PECDF		2000	895	44.7	1.58	1.352
13C-1,2,3,4,7,8-HXCDF		2000	1130	56.4	0.50	0.954
13C-1,2,3,6,7,8-HXCDF		2000	1050	52.3	0.51	0.958
13C-1,2,3,7,8,9-HXCDF		2000	1100	54.8	0.52	1.005
13C-2,3,4,6,7,8-HXCDF		2000	1090	54.4	0.50	0.981
13C-1,2,3,4,6,7,8-HPCDF		2000	1020	50.8	0.44	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	998	49.9	0.40	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	112	56.2		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-7_Form2_DX2M_080S7_SJ1463862.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C28
Sample Collection:
24-Apr-2012 16:28

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-8
Sample Receipt Date:	01-May-2012	**Sample Size:**	10.8 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 17:32:15	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_080 S: 8**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg/g (wet weight basis)	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
		% Moisture:	82.3
		% Lipid:	10.1

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		4.09	0.09 (S)	0.78	1.001
1,2,3,7,8-PECDD [4]		22.9	0.09 (S)	0.61	1.001
1,2,3,4,7,8-HXCDD		4.24	0.19 (S)	1.39	1.000
1,2,3,6,7,8-HXCDD		156	0.19 (S)	1.22	1.001
1,2,3,7,8,9-HXCDD		14.4	0.19 (S)	1.30	1.000
1,2,3,4,6,7,8-HPCDD		4.33	0.19 (Q)	1.04	1.000
OCDD	NDR	2.52	0.46 (Q)	1.06	1.000
2,3,7,8-TCDF		167	0.09 (S)	0.74	1.001
1,2,3,7,8-PECDF		0.98	0.09 (S)	1.37	1.001
2,3,4,7,8-PECDF		9.58	0.09 (S)	1.48	1.001
1,2,3,4,7,8-HXCDF		2.62	0.19 (S)	1.17	1.000
1,2,3,6,7,8-HXCDF	NDR	0.27	0.19 (S)	0.89	1.000
1,2,3,7,8,9-HXCDF	ND		0.19 (S)		
2,3,4,6,7,8-HXCDF		3.17	0.19 (S)	1.23	1.000
1,2,3,4,6,7,8-HPCDF		5.22	0.19 (S)	1.12	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.19 (S)		
OCDF	ND		0.46 (Q)		
TOTAL TETRA-DIOXINS		13.9	0.09 (S)		
TOTAL PENTA-DIOXINS		102	0.09 (S)		
TOTAL HEXA-DIOXINS		352	0.19 (S)		
TOTAL HEPTA-DIOXINS		11.3	0.19 (Q)		
TOTAL TETRA-FURANS		254	0.09 (S)		
TOTAL PENTA-FURANS		85.4	0.09 (S)		
TOTAL HEXA-FURANS		68.1	0.19 (S)		
TOTAL HEPTA-FURANS		6.40	0.19 (S)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL; NDR = peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-8_Form1A_DX2M_080S8_SJ1463863.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C28
Sample Collection:
24-Apr-2012 16:28

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-8
Matrix:	TISSUE	**Sample Size:**	10.8 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 17:32:15	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 8**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg absolute	**% Moisture:**	82.3
		% Lipid:	10.1

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LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	712	35.6	0.79	1.013
13C-1,2,3,7,8-PECDD [4]		2000	647	32.4	0.61	1.383
13C-1,2,3,4,7,8-HXCDD		2000	710	35.5	1.28	0.987
13C-1,2,3,6,7,8-HXCDD		2000	669	33.5	1.28	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	728	36.4	1.09	1.094
13C-OCDD		4000	1230	30.8	0.85	1.177
13C-2,3,7,8-TCDF		2000	655	32.7	0.77	0.966
13C-1,2,3,7,8-PECDF		2000	598	29.9	1.52	1.284
13C-2,3,4,7,8-PECDF		2000	564	28.2	1.53	1.351
13C-1,2,3,4,7,8-HXCDF		2000	686	34.3	0.49	0.955
13C-1,2,3,6,7,8-HXCDF		2000	627	31.4	0.50	0.958
13C-1,2,3,7,8,9-HXCDF		2000	627	31.4	0.54	1.005
13C-2,3,4,6,7,8-HXCDF		2000	615	30.7	0.52	0.981
13C-1,2,3,4,6,7,8-HPCDF		2000	590	29.5	0.43	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	592	29.6	0.41	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	72.0	36.0		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-8_Form2_DX2M_080S8_SJ1463863.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-T9-DF Tissue
Sample Collection:
27-Apr-2012 09:54

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-9
Matrix:	TISSUE	**Sample Size:**	10.2 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 18:27:27	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 9**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg/g (wet weight basis)	**% Moisture:**	68.7
		% Lipid:	14.1

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		1.49	0.10 (Q)	0.80	1.001
1,2,3,7,8-PECDD [4]		6.03	0.10 (S)	0.63	1.001
1,2,3,4,7,8-HXCDD		1.03	0.20 (Q)	1.13	1.000
1,2,3,6,7,8-HXCDD		35.1	0.20 (Q)	1.19	1.000
1,2,3,7,8,9-HXCDD		3.42	0.20 (Q)	1.21	1.000
1,2,3,4,6,7,8-HPCDD		1.06	0.20 (Q)	1.14	1.000
OCDD		0.64	0.49 (Q)	0.87	1.000
2,3,7,8-TCDF		51.9	0.10 (Q)	0.75	1.001
1,2,3,7,8-PECDF		0.28	0.10 (S)	1.41	1.001
2,3,4,7,8-PECDF		2.35	0.10 (S)	1.72	1.001
1,2,3,4,7,8-HXCDF		0.61	0.20 (S)	1.09	1.000
1,2,3,6,7,8-HXCDF	ND		0.20 (S)		
1,2,3,7,8,9-HXCDF	ND		0.20 (S)		
2,3,4,6,7,8-HXCDF		0.71	0.20 (S)	1.15	1.000
1,2,3,4,6,7,8-HPCDF		1.19	0.20 (Q)	0.93	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.20 (Q)		
OCDF	ND		0.49 (Q)		
TOTAL TETRA-DIOXINS		3.83	0.10 (Q)		
TOTAL PENTA-DIOXINS		22.0	0.10 (S)		
TOTAL HEXA-DIOXINS		76.3	0.20 (Q)		
TOTAL HEPTA-DIOXINS		2.49	0.20 (Q)		
TOTAL TETRA-FURANS		74.0	0.10 (Q)		
TOTAL PENTA-FURANS		19.2	0.10 (S)		
TOTAL HEXA-FURANS		13.1	0.20 (S)		
TOTAL HEPTA-FURANS		1.49	0.20 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-9_Form1A_DX2M_080S9_SJ1463864.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-T9-DF Tissue
Sample Collection:
27-Apr-2012 09:54

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	L17883-9
Sample Receipt Date:	01-May-2012	**Sample Size:**	10.2 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	26-Mar-2012
Analysis Date:	17-May-2012 **Time:** 18:27:27	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB5
Injection Volume (uL):	1.0	**Sample Data Filename:**	**DX2M_080 S: 9**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg absolute	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
		% Moisture:	68.7
		% Lipid:	14.1

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1010	50.6	0.74	1.012
13C-1,2,3,7,8-PECDD [4]		2000	1180	58.8	0.62	1.382
13C-1,2,3,4,7,8-HXCDD		2000	1270	63.6	1.25	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1200	59.9	1.26	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1310	65.5	1.01	1.094
13C-OCDD		4000	2400	60.1	0.89	1.177
13C-2,3,7,8-TCDF		2000	923	46.1	0.79	0.965
13C-1,2,3,7,8-PECDF		2000	1050	52.5	1.50	1.284
13C-2,3,4,7,8-PECDF		2000	989	49.4	1.55	1.351
13C-1,2,3,4,7,8-HXCDF		2000	1200	60.1	0.50	0.955
13C-1,2,3,6,7,8-HXCDF		2000	1130	56.3	0.52	0.958
13C-1,2,3,7,8,9-HXCDF		2000	1120	56.2	0.48	1.005
13C-2,3,4,6,7,8-HXCDF		2000	1120	56.2	0.49	0.981
13C-1,2,3,4,6,7,8-HPCDF		2000	1050	52.3	0.43	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	1010	50.5	0.43	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	114	57.2		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-9_Form2_DX2M_080S9_SJ1463864.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-T9-DF Liver
Sample Collection:
27-Apr-2012 09:54

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-10
Matrix:	TISSUE	**Sample Size:**	10.4 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 19:22:41	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 10**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg/g (wet weight basis)	**% Moisture:**	27.3
		% Lipid:	67.9

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		45.3	0.10 (Q)	0.75	1.001
1,2,3,7,8-PECDD [4]		68.2	0.10 (Q)	0.61	1.001
1,2,3,4,7,8-HXCDD		2.91	0.19 (S)	1.24	1.000
1,2,3,6,7,8-HXCDD		132	0.19 (S)	1.24	1.000
1,2,3,7,8,9-HXCDD		14.3	0.19 (S)	1.23	1.000
1,2,3,4,6,7,8-HPCDD		3.27	0.19 (Q)	1.03	1.000
OCDD	NDR	1.06	0.48 (Q)	1.19	1.000
2,3,7,8-TCDF		1460	0.13 (S)	0.77	1.001
1,2,3,7,8-PECDF		6.82	0.10 (S)	1.35	1.001
2,3,4,7,8-PECDF		25.7	0.10 (S)	1.50	1.001
1,2,3,4,7,8-HXCDF		1.02	0.19 (Q)	1.08	1.001
1,2,3,6,7,8-HXCDF		1.01	0.19 (Q)	1.27	1.000
1,2,3,7,8,9-HXCDF	ND		0.19 (Q)		
2,3,4,6,7,8-HXCDF		1.29	0.19 (Q)	1.06	1.001
1,2,3,4,6,7,8-HPCDF		0.73	0.19 (Q)	1.00	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.19 (Q)		
OCDF	ND		0.48 (Q)		
TOTAL TETRA-DIOXINS		48.0	0.10 (Q)		
TOTAL PENTA-DIOXINS		70.0	0.10 (Q)		
TOTAL HEXA-DIOXINS		155	0.19 (S)		
TOTAL HEPTA-DIOXINS		3.27	0.19 (Q)		
TOTAL TETRA-FURANS		1460	0.13 (S)		
TOTAL PENTA-FURANS		38.7	0.10 (S)		
TOTAL HEXA-FURANS		6.39	0.19 (Q)		
TOTAL HEPTA-FURANS		0.73	0.19 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL; NDR = peak detected but did not meet quantification criteria, result reported represents the estimated maximum possible concentration.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-10_Form1A_DX2M_080S10_SJ1463854.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-T9-DF Liver
Sample Collection:
27-Apr-2012 09:54

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-10
Matrix:	TISSUE	**Sample Size:**	10.4 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 19:22:41	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_080 S: 10**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_080 S: 1
Concentration Units:	pg absolute	**% Moisture:**	27.3
		% Lipid:	67.9

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	882	44.1	0.78	1.012
13C-1,2,3,7,8-PECDD [4]		2000	860	43.0	0.61	1.382
13C-1,2,3,4,7,8-HXCDD		2000	905	45.3	1.25	0.987
13C-1,2,3,6,7,8-HXCDD		2000	839	42.0	1.21	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	930	46.5	1.03	1.094
13C-OCDD		4000	1820	45.4	0.89	1.177
13C-2,3,7,8-TCDF		2000	832	41.6	0.77	0.965
13C-1,2,3,7,8-PECDF		2000	772	38.6	1.60	1.284
13C-2,3,4,7,8-PECDF		2000	697	34.9	1.55	1.351
13C-1,2,3,4,7,8-HXCDF		2000	846	42.3	0.50	0.954
13C-1,2,3,6,7,8-HXCDF		2000	777	38.9	0.51	0.958
13C-1,2,3,7,8,9-HXCDF		2000	822	41.1	0.51	1.005
13C-2,3,4,6,7,8-HXCDF		2000	746	37.3	0.52	0.980
13C-1,2,3,4,6,7,8-HPCDF		2000	726	36.3	0.43	1.062
13C-1,2,3,4,7,8,9-HPCDF		2000	723	36.1	0.41	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	92.8	46.4		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_L17883-10_Form2_DX2M_080S10_SJ1463854.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
Lab Blank
Sample Collection:
N/A

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	N/A		
Contract No.:	2544	**Lab Sample I.D.:**	WG39854-101
Matrix:	TISSUE	**Sample Size:**	10.0 g
Sample Receipt Date:	N/A	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	16-May-2012 **Time:** 13:18:42	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_079 S: 5**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_079 S: 1
Concentration Units:	pg/g		

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD	ND		0.10 (Q)		
1,2,3,7,8-PECDD [4]		0.10	0.10 (Q)	0.63	1.001
1,2,3,4,7,8-HXCDD	ND		0.20 (Q)		
1,2,3,6,7,8-HXCDD	ND		0.20 (Q)		
1,2,3,7,8,9-HXCDD	ND		0.20 (Q)		
1,2,3,4,6,7,8-HPCDD	ND		0.20 (Q)		
OCDD	ND		0.50 (Q)		
2,3,7,8-TCDF	ND		0.10 (Q)		
1,2,3,7,8-PECDF	ND		0.10 (Q)		
2,3,4,7,8-PECDF	ND		0.10 (Q)		
1,2,3,4,7,8-HXCDF	ND		0.20 (Q)		
1,2,3,6,7,8-HXCDF	ND		0.20 (Q)		
1,2,3,7,8,9-HXCDF	ND		0.20 (Q)		
2,3,4,6,7,8-HXCDF	ND		0.20 (Q)		
1,2,3,4,6,7,8-HPCDF	ND		0.20 (Q)		
1,2,3,4,7,8,9-HPCDF	ND		0.20 (Q)		
OCDF	ND		0.50 (Q)		
TOTAL TETRA-DIOXINS	ND		0.10 (Q)		
TOTAL PENTA-DIOXINS		0.10	0.10 (Q)		
TOTAL HEXA-DIOXINS	ND		0.20 (Q)		
TOTAL HEPTA-DIOXINS	ND		0.20 (Q)		
TOTAL TETRA-FURANS	ND		0.10 (Q)		
TOTAL PENTA-FURANS	ND		0.10 (Q)		
TOTAL HEXA-FURANS	ND		0.20 (Q)		
TOTAL HEPTA-FURANS	ND		0.20 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_WG39854-101_Form1A_DX2M_079S5_SJ1464348.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
Lab Blank
Sample Collection:
N/A

Form 2

PCDD/PCDF ANALYSIS REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	N/A		
Contract No.:	2544	**Lab Sample I.D.:**	WG39854-101
Matrix:	TISSUE	**Sample Size:**	10.0 g
Sample Receipt Date:	N/A	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	16-May-2012 **Time:** 13:18:42	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_079 S: 5**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_079 S: 1
Concentration Units:	pg absolute		

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1300	65.1	0.77	1.012
13C-1,2,3,7,8-PECDD [4]		2000	1600	79.9	0.63	1.382
13C-1,2,3,4,7,8-HXCDD		2000	1630	81.3	1.23	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1490	74.5	1.22	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1680	83.8	1.03	1.094
13C-OCDD		4000	3030	75.8	0.90	1.176
13C-2,3,7,8-TCDF		2000	1250	62.3	0.77	0.965
13C-1,2,3,7,8-PECDF		2000	1360	67.8	1.55	1.284
13C-2,3,4,7,8-PECDF		2000	1220	61.1	1.59	1.352
13C-1,2,3,4,7,8-HXCDF		2000	1490	74.5	0.50	0.954
13C-1,2,3,6,7,8-HXCDF		2000	1410	70.4	0.50	0.958
13C-1,2,3,7,8,9-HXCDF		2000	1350	67.4	0.52	1.005
13C-2,3,4,6,7,8-HXCDF		2000	1390	69.7	0.51	0.980
13C-1,2,3,4,6,7,8-HPCDF		2000	1350	67.6	0.44	1.061
13C-1,2,3,4,7,8,9-HPCDF		2000	1350	67.3	0.43	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	136	68.2		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_WG39854-101_Form2_DX2M_079S5_SJ1464348.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 8A

PCDD/PCDF ONGOING PRECISION AND RECOVERY (OPR)

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**OPR Data Filename:**	**DX2M_079 S: 2**
Matrix:	TISSUE	**Lab Sample I.D.:**	WG39854-102
Extraction Date:	03-May-2012	**Analysis Date:**	16-May-2012 **Time:** 10:34:52

ALL CONCENTRATIONS REPORTED ON THIS FORM ARE CONCENTRATIONS IN EXTRACT, BASED ON A 20 uL EXTRACT VOLUME.

COMPOUND	LAB FLAG [1]	ION ABUND. RATIO [2]	SPIKE CONC. (ng/mL)	CONC. FOUND (ng/mL)	OPR CONC. LIMITS [3] (ng/mL)	% RECOVERY
2,3,7,8-TCDD		0.77	10.0	10.8	6.70 - 15.8	108
1,2,3,7,8-PECDD [4]		0.59	52.0	57.8	36.4 - 73.8	111
1,2,3,4,7,8-HXCDD		1.20	56.5	56.6	39.6 - 92.7	100
1,2,3,6,7,8-HXCDD		1.21	55.5	57.4	42.2 - 74.4	103
1,2,3,7,8,9-HXCDD		1.20	54.0	62.8	34.6 - 87.5	116
1,2,3,4,6,7,8-HPCDD		1.04	47.5	46.5	33.3 - 66.5	97.8
OCDD		0.88	100	100	78.0 - 144	100
2,3,7,8-TCDF		0.75	10.7	10.9	8.03 - 16.9	102
1,2,3,7,8-PECDF		1.50	46.0	46.6	36.8 - 61.6	101
2,3,4,7,8-PECDF		1.48	47.0	46.6	32.0 - 75.2	99.1
1,2,3,4,7,8-HXCDF		1.21	50.0	50.3	36.0 - 67.0	101
1,2,3,6,7,8-HXCDF		1.21	47.5	48.9	39.9 - 61.8	103
1,2,3,7,8,9-HXCDF		1.21	52.5	53.8	41.0 - 68.3	102
2,3,4,6,7,8-HXCDF		1.22	53.0	53.5	37.1 - 82.7	101
1,2,3,4,6,7,8-HPCDF		1.01	50.0	52.9	41.0 - 61.0	106
1,2,3,4,7,8,9-HPCDF		1.04	50.0	51.7	39.0 - 69.0	103
OCDF		0.88	104	91.6	65.5 - 177	88.1

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required Ion Abundance Ratios are specified in Table 9, Method 1613.
(3) Contract-required concentration range as determined from the percent of the test concentration in Table 6, Method 1613, under OPR.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

For Axys Internal Use Only [XSL Template: Form8A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_WG39854-102_Form8A_SJ1464346.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 8B
PCDD/PCDF ONGOING PRECISION AND RECOVERY (OPR)

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.: 2544 **OPR Data Filename:** **DX2M_079 S: 2**

Matrix: TISSUE **Lab Sample I.D.:** WG39854-102

Extraction Date: 03-May-2012 **Analysis Date:** 16-May-2012 **Time:** 10:34:52

ALL CONCENTRATIONS REPORTED ON THIS FORM ARE CONCENTRATIONS IN EXTRACT, BASED ON A 20 uL EXTRACT VOLUME.

LABELED COMPOUND	LAB FLAG [1]	ION ABUND. RATIO [2]	SPIKE CONC. (ng/mL)	CONC. FOUND (ng/mL)	OPR CONC. LIMITS [3] (ng/mL)	% RECOVERY
13C-2,3,7,8-TCDD		0.77	100	47.9	20.0-175	47.9
13C-1,2,3,7,8-PECDD [4]		0.61	100	54.6	21.0-227	54.6
13C-1,2,3,4,7,8-HXCDD		1.25	100	49.9	21.0-193	49.9
13C-1,2,3,6,7,8-HXCDD		1.25	100	44.3	25.0-163	44.3
13C-1,2,3,4,6,7,8-HPCDD		1.05	100	54.5	26.0-166	54.5
13C-OCDD		0.88	200	99.7	26.0-397	49.9
13C-2,3,7,8-TCDF		0.77	100	45.2	22.0-152	45.2
13C-1,2,3,7,8-PECDF		1.61	100	42.3	21.0-192	42.3
13C-2,3,4,7,8-PECDF		1.54	100	41.1	13.0-328	41.1
13C-1,2,3,4,7,8-HXCDF		0.51	100	45.4	19.0-202	45.4
13C-1,2,3,6,7,8-HXCDF		0.50	100	41.6	21.0-159	41.6
13C-1,2,3,7,8,9-HXCDF		0.50	100	44.4	17.0-205	44.4
13C-2,3,4,6,7,8-HXCDF		0.50	100	43.9	22.0-176	43.9
13C-1,2,3,4,6,7,8-HPCDF		0.44	100	42.7	21.0-158	42.7
13C-1,2,3,4,7,8,9-HPCDF		0.43	100	45.5	20.0-186	45.5
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD			10.0	6.39	3.10-19.1	63.9

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required Ion Abundance Ratios are specified in Table 9, Method 1613.
(3) Contract-required concentration limits for OPR as specified in Table 6, Method 1613. Labeled compound concentrations limits are based on required percent recovery (Section 15.5, Method 1613).
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

For Axys Internal Use Only [XSL Template: Form8B.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_WG39854-102_Form8B_SJ1464346.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C9 (Duplicate)
Sample Collection:
24-Apr-2012 14:13

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	WG39854-103 (DUP L17883-1)
Matrix:	TISSUE	**Sample Size:**	10.0 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 01:58:22	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_079 S: 18**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	83.4 10.5

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDD		1.51	0.10 (Q)	0.75	1.001
1,2,3,7,8-PECDD [4]		5.89	0.10 (Q)	0.64	1.001
1,2,3,4,7,8-HXCDD		1.07	0.20 (S)	1.14	1.000
1,2,3,6,7,8-HXCDD		33.0	0.20 (S)	1.22	1.000
1,2,3,7,8,9-HXCDD		6.02	0.20 (S)	1.20	1.000
1,2,3,4,6,7,8-HPCDD		2.18	0.20 (Q)	0.95	1.000
OCDD		1.02	0.50 (Q)	0.80	1.000
2,3,7,8-TCDF		46.1	0.10 (Q)	0.74	1.001
1,2,3,7,8-PECDF		0.54	0.10 (Q)	1.40	1.000
2,3,4,7,8-PECDF		2.31	0.10 (Q)	1.51	1.001
1,2,3,4,7,8-HXCDF		0.59	0.20 (Q)	1.10	1.001
1,2,3,6,7,8-HXCDF		0.25	0.20 (Q)	1.42	1.000
1,2,3,7,8,9-HXCDF	ND		0.20 (Q)		
2,3,4,6,7,8-HXCDF		0.65	0.20 (Q)	1.10	1.000
1,2,3,4,6,7,8-HPCDF		1.16	0.20 (Q)	0.98	1.000
1,2,3,4,7,8,9-HPCDF	ND		0.20 (Q)		
OCDF	ND		0.50 (Q)		
TOTAL TETRA-DIOXINS		5.79	0.10 (Q)		
TOTAL PENTA-DIOXINS		24.3	0.10 (Q)		
TOTAL HEXA-DIOXINS		106	0.20 (S)		
TOTAL HEPTA-DIOXINS		4.44	0.20 (Q)		
TOTAL TETRA-FURANS		71.9	0.10 (Q)		
TOTAL PENTA-FURANS		16.0	0.10 (Q)		
TOTAL HEXA-FURANS		8.47	0.20 (Q)		
TOTAL HEPTA-FURANS		1.16	0.20 (Q)		

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_WG39854-103_Form1A_DX2M_079S18_SJ1464345.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 2

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C9 (Duplicate)
Sample Collection:
24-Apr-2012 14:13

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	WG39854-103 (DUP L17883-1)
Matrix:	TISSUE	**Sample Size:**	10.0 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	26-Mar-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	17-May-2012 **Time:** 01:58:22	**GC Column ID:**	DB5
Extract Volume (uL):	20	**Sample Data Filename:**	**DX2M_079 S: 18**
Injection Volume (uL):	1.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DX2M_079 S: 11
Concentration Units:	pg absolute	**% Moisture:** **% Lipid:**	83.4 10.5

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

LABELED COMPOUND	LAB FLAG [1]	SPIKE CONC.	CONC. FOUND	R(%) [2]	ION ABUND. RATIO [3]	RRT [3]
13C-2,3,7,8-TCDD		2000	1260	63.0	0.75	1.012
13C-1,2,3,7,8-PECDD [4]		2000	1600	79.8	0.61	1.382
13C-1,2,3,4,7,8-HXCDD		2000	1450	72.5	1.26	0.987
13C-1,2,3,6,7,8-HXCDD		2000	1320	66.2	1.24	0.990
13C-1,2,3,4,6,7,8-HPCDD		2000	1410	70.4	1.06	1.094
13C-OCDD		4000	2700	67.6	0.86	1.177
13C-2,3,7,8-TCDF		2000	1220	60.8	0.78	0.965
13C-1,2,3,7,8-PECDF		2000	1270	63.6	1.58	1.285
13C-2,3,4,7,8-PECDF		2000	1140	57.0	1.55	1.351
13C-1,2,3,4,7,8-HXCDF		2000	1340	67.1	0.51	0.955
13C-1,2,3,6,7,8-HXCDF		2000	1240	61.8	0.51	0.959
13C-1,2,3,7,8,9-HXCDF		2000	1290	64.5	0.52	1.005
13C-2,3,4,6,7,8-HXCDF		2000	1260	62.9	0.48	0.980
13C-1,2,3,4,6,7,8-HPCDF		2000	1170	58.5	0.43	1.061
13C-1,2,3,4,7,8,9-HPCDF		2000	1130	56.7	0.42	1.103
CLEANUP STANDARD						
37CL-2,3,7,8-TCDD		200	128	64.0		1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Contract-required limits for percent recovery (R) are specified in Section 9.3.3, Method 1613.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613. NOTE: There is no ion abundance ratio for 37Cl4-2,3,7,8-TCDD
(4) Alternate confirmation and quantitation ions used for native and labeled PECDD.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form2.xsl; Created: 31-May-2012 14:00:44; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB5_WG39854-103_Form2_DX2M_079S18_SJ1464345.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C9
Sample Collection:
24-Apr-2012 14:13

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-1 (A)
Matrix:	TISSUE	**Sample Size:**	10.2 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 01:37:23	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 7**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	81.8 10.6

This page is part of a total report that contains information necessary for accreditation compliance.
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COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		47.1	0.10 (Q)	0.77	1.002

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613DB225_L17883-1_Form1A_DB23_061S7_SJ1463842.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C10
Sample Collection:
24-Apr-2012 15:43

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-2
Matrix:	TISSUE	**Sample Size:**	10.1 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 02:51:03	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 9**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	83.5 7.55

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		54.9	0.10 (Q)	0.77	1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_L17883-2_Form1A_DB23_061S9_SJ1463843.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C14
Sample Collection:
24-Apr-2012 15:25

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-3
Matrix:	TISSUE	**Sample Size:**	11.1 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 03:27:53	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 10**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	82.2 7.71

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		116	0.09 (Q)	0.78	1.002

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613DB225_L17883-3_Form1A_DB23_061S10_SJ1463844.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C16a
Sample Collection:
24-Apr-2012 11:07

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-4
Matrix:	TISSUE	**Sample Size:**	11.3 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 04:04:43	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 11**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	77.2 12.2

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		53.1	0.09 (Q)	0.79	1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_L17883-4_Form1A_DB23_061S11_SJ1463845.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C19a
Sample Collection:
24-Apr-2012 15:04

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-5
Matrix:	TISSUE	**Sample Size:**	11.3 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 04:41:33	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 12**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	82.0 9.44

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		381	0.09 (Q)	0.79	1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_L17883-5_Form1A_DB23_061S12_SJ1463846.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C21
Sample Collection:
24-Apr-2012 13:32

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-6
Matrix:	TISSUE	**Sample Size:**	10.1 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 05:18:24	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 13**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	77.4 12.5

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		25.0	0.11 (S)	0.81	1.002

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_L17883-6_Form1A_DB23_061S13_SJ1463847.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C27
Sample Collection:
27-Apr-2012 15:37

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-7
Matrix:	TISSUE	**Sample Size:**	3.77 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 05:55:13	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 14**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	88.5 1.39

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		5.34	0.27 (Q)	0.81	1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_L17883-7_Form1A_DB23_061S14_SJ1463848.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C28
Sample Collection:
24-Apr-2012 16:28

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-8
Matrix:	TISSUE	**Sample Size:**	10.8 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 06:32:07	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 15**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	82.3 10.1

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		188	0.10 (S)	0.78	1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_L17883-8_Form1A_DB23_061S15_SJ1463849.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-T9-DF Tissue
Sample Collection:
27-Apr-2012 09:54

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-9
Matrix:	TISSUE	**Sample Size:**	10.2 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 07:09:02	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 16**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	68.7 14.1

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		49.9	0.10 (Q)	0.79	1.002

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613DB225_L17883-9_Form1A_DB23_061S16_SJ1463850.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-T9-DF Liver
Sample Collection:
27-Apr-2012 09:54

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No.	HS1625		
Contract No.:	2544	**Lab Sample I.D.:**	L17883-10
Matrix:	TISSUE	**Sample Size:**	10.4 g (wet)
Sample Receipt Date:	01-May-2012	**Initial Calibration Date:**	09-May-2012
Extraction Date:	03-May-2012	**Instrument ID:**	HR GC/MS
Analysis Date:	18-May-2012 **Time:** 07:45:55	**GC Column ID:**	DB225
Extract Volume (uL):	20	**Sample Data Filename:**	**DB23_061 S: 17**
Injection Volume (uL):	2.0	**Blank Data Filename:**	DX2M_079 S: 5
Dilution Factor:	N/A	**Cal. Ver. Data Filename:**	DB23_061 S: 2
Concentration Units:	pg/g (wet weight basis)	**% Moisture:** **% Lipid:**	27.3 67.9

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Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		2090	0.10 (Q)	0.80	1.001

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_L17883-10_Form1A_DB23_061S17_SJ1463851.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

Form 1A

PCDD/PCDF ANALYSIS REPORT

CLIENT SAMPLE NO.
HS1625-C9 (Duplicate)
Sample Collection:
24-Apr-2012 14:13

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Project No.**	HS1625
Matrix:	TISSUE	**Lab Sample I.D.:**	WG39854-103 (DUP L17883-1)
Sample Receipt Date:	01-May-2012	**Sample Size:**	10.0 g (wet)
Extraction Date:	03-May-2012	**Initial Calibration Date:**	09-May-2012
Analysis Date:	18-May-2012 **Time:** 02:14:13	**Instrument ID:**	HR GC/MS
Extract Volume (uL):	20	**GC Column ID:**	DB225
Injection Volume (uL):	2.0	**Sample Data Filename:**	**DB23_061 S: 8**
Dilution Factor:	N/A	**Blank Data Filename:**	DX2M_079 S: 5
Concentration Units:	pg/g (wet weight basis)	**Cal. Ver. Data Filename:**	DB23_061 S: 2
		% Moisture:	83.4
		% Lipid:	10.5

This page is part of a total report that contains information necessary for accreditation compliance.
Results are compliant with CALA accreditation described in the total report. Sample results relate only to the sample tested.

COMPOUND	LAB FLAG [1]	CONCENTRATION FOUND	REPORTING LIMIT (RL)[2]	ION ABUND. RATIO [3]	RRT [3]
2,3,7,8-TCDF		45.9	0.10 (Q)	0.79	1.002

(1) Where applicable, custom lab flags have been used on this report.
(2) Reporting Limit (Code): S = sample detection limit; M = method detection limit; L = lowest calibration level equivalent; Q = contract defined limit.
(3) Contract-required limits for RRTs and ion abundance ratios are specified in Tables 2 and 9, respectively, Method 1613.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

For Axys Internal Use Only [XSL Template: Form1A.xsl; Created: 31-May-2012 14:01:14; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613DB225_WG39854-103_Form1A_DB23_061S8_SJ1464350.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C9

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	24-Apr-2012 14:13
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	10.2 g (wet)	**Lab Sample I.D.:**	L17883-1 (A)
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 7** **DX2M_079 S: 17**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		1.49	0.10	1	1.49e+00	1.49e+00	
1,2,3,7,8-PECDD		6.31	0.10	1	6.31e+00	6.31e+00	
1,2,3,4,7,8-HXCDD		1.21	0.20	0.1	1.21e-01	1.21e-01	
1,2,3,6,7,8-HXCDD		33.5	0.20	0.1	3.35e+00	3.35e+00	
1,2,3,7,8,9-HXCDD		6.63	0.20	0.1	6.63e-01	6.63e-01	
1,2,3,4,6,7,8-HPCDD		2.37	0.20	0.01	2.37e-02	2.37e-02	
OCDD		1.11	0.49	0.0003	3.33e-04	3.33e-04	
2,3,7,8-TCDF		47.1	0.10	0.1	4.71e+00	4.71e+00	
1,2,3,7,8-PECDF		0.64	0.10	0.03	1.92e-02	1.92e-02	
2,3,4,7,8-PECDF		2.64	0.10	0.3	7.92e-01	7.92e-01	
1,2,3,4,7,8-HXCDF		0.68	0.20	0.1	6.80e-02	6.80e-02	
1,2,3,6,7,8-HXCDF		0.32	0.20	0.1	3.20e-02	3.20e-02	
1,2,3,7,8,9-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
2,3,4,6,7,8-HXCDF		0.58	0.20	0.1	5.80e-02	5.80e-02	
1,2,3,4,6,7,8-HPCDF		1.15	0.20	0.01	1.15e-02	1.15e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.20	0.01	0.00e+00	1.00e-03	
OCDF	ND		0.49	0.0003	0.00e+00	7.35e-05	
			TOTAL TEQ		17.6	17.7	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

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Report Filename: 1613_DIOXINS_1613-TEQ_L17883-1_TEQ_SJ1463871.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C10

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Sample Collection: 24-Apr-2012 15:43

Contract No.: 2544

Project No. HS1625

Matrix: TISSUE

Lab Sample I.D.: L17883-2

Sample Size: 10.1 g (wet)

GC Column ID(s): DB225
DB5

Concentration Units: pg/g (wet weight basis)

Sample Data Filenames: **DB23_061 S: 9**
DX2M_079 S: 19

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		1.71	0.10	1	1.71e+00	1.71e+00	
1,2,3,7,8-PECDD		6.31	0.10	1	6.31e+00	6.31e+00	
1,2,3,4,7,8-HXCDD		1.05	0.20	0.1	1.05e-01	1.05e-01	
1,2,3,6,7,8-HXCDD		45.9	0.20	0.1	4.59e+00	4.59e+00	
1,2,3,7,8,9-HXCDD		11.5	0.20	0.1	1.15e+00	1.15e+00	
1,2,3,4,6,7,8-HPCDD		4.44	0.20	0.01	4.44e-02	4.44e-02	
OCDD		1.24	0.50	0.0003	3.72e-04	3.72e-04	
2,3,7,8-TCDF		54.9	0.10	0.1	5.49e+00	5.49e+00	
1,2,3,7,8-PECDF		0.72	0.10	0.03	2.16e-02	2.16e-02	
2,3,4,7,8-PECDF		2.24	0.10	0.3	6.72e-01	6.72e-01	
1,2,3,4,7,8-HXCDF		0.44	0.20	0.1	4.40e-02	4.40e-02	
1,2,3,6,7,8-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,7,8,9-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
2,3,4,6,7,8-HXCDF		0.40	0.20	0.1	4.00e-02	4.00e-02	
1,2,3,4,6,7,8-HPCDF		1.46	0.20	0.01	1.46e-02	1.46e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.20	0.01	0.00e+00	1.00e-03	
OCDF	ND		0.50	0.0003	0.00e+00	7.50e-05	
			TOTAL TEQ		20.2	20.2	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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For Axys Internal Use Only [XSL Template: TEQ.xsl; Created: 31-May-2012 14:01:35; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613-TEQ_L17883-2_TEQ_SJ1463872.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C14

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	24-Apr-2012 15:25
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	11.1 g (wet)	**Lab Sample I.D.:**	L17883-3
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 10** **DX2M_079 S: 20**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		2.51	0.09	1	2.51e+00	2.51e+00	
1,2,3,7,8-PECDD		13.1	0.09	1	1.31e+01	1.31e+01	
1,2,3,4,7,8-HXCDD		2.14	0.18	0.1	2.14e-01	2.14e-01	
1,2,3,6,7,8-HXCDD		60.7	0.18	0.1	6.07e+00	6.07e+00	
1,2,3,7,8,9-HXCDD		7.49	0.18	0.1	7.49e-01	7.49e-01	
1,2,3,4,6,7,8-HPCDD		3.01	0.18	0.01	3.01e-02	3.01e-02	
OCDD		1.66	0.45	0.0003	4.98e-04	4.98e-04	
2,3,7,8-TCDF		116	0.09	0.1	1.16e+01	1.16e+01	
1,2,3,7,8-PECDF		0.77	0.09	0.03	2.31e-02	2.31e-02	
2,3,4,7,8-PECDF		5.10	0.09	0.3	1.53e+00	1.53e+00	
1,2,3,4,7,8-HXCDF		0.96	0.18	0.1	9.60e-02	9.60e-02	
1,2,3,6,7,8-HXCDF		0.28	0.18	0.1	2.80e-02	2.80e-02	
1,2,3,7,8,9-HXCDF	ND		0.18	0.1	0.00e+00	9.00e-03	
2,3,4,6,7,8-HXCDF		0.82	0.18	0.1	8.20e-02	8.20e-02	
1,2,3,4,6,7,8-HPCDF		1.03	0.18	0.01	1.03e-02	1.03e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.18	0.01	0.00e+00	9.00e-04	
OCDF	ND		0.45	0.0003	0.00e+00	6.75e-05	
			TOTAL TEQ		36.0	36.1	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

For Axys Internal Use Only [XSL Template: TEQ.xsl; Created: 31-May-2012 14:01:35; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613-TEQ_L17883-3_TEQ_SJ1463873.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C16a

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	24-Apr-2012 11:07
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	11.3 g (wet)	**Lab Sample I.D.:**	L17883-4 i
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 11** **DX2M_080 S: 4**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		2.14	0.09	1	2.14e+00	2.14e+00	
1,2,3,7,8-PECDD		9.75	0.09	1	9.75e+00	9.75e+00	
1,2,3,4,7,8-HXCDD		1.70	0.18	0.1	1.70e-01	1.70e-01	
1,2,3,6,7,8-HXCDD		25.1	0.18	0.1	2.51e+00	2.51e+00	
1,2,3,7,8,9-HXCDD		6.68	0.18	0.1	6.68e-01	6.68e-01	
1,2,3,4,6,7,8-HPCDD		6.82	0.18	0.01	6.82e-02	6.82e-02	
OCDD		3.49	0.44	0.0003	1.05e-03	1.05e-03	
2,3,7,8-TCDF		53.1	0.09	0.1	5.31e+00	5.31e+00	
1,2,3,7,8-PECDF		1.35	0.09	0.03	4.05e-02	4.05e-02	
2,3,4,7,8-PECDF		3.05	0.09	0.3	9.15e-01	9.15e-01	
1,2,3,4,7,8-HXCDF		0.96	0.18	0.1	9.60e-02	9.60e-02	
1,2,3,6,7,8-HXCDF		0.76	0.18	0.1	7.60e-02	7.60e-02	
1,2,3,7,8,9-HXCDF	ND		0.18	0.1	0.00e+00	9.00e-03	
2,3,4,6,7,8-HXCDF		0.72	0.18	0.1	7.20e-02	7.20e-02	
1,2,3,4,6,7,8-HPCDF		1.86	0.18	0.01	1.86e-02	1.86e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.18	0.01	0.00e+00	9.00e-04	
OCDF	ND		0.44	0.0003	0.00e+00	6.60e-05	
			TOTAL TEQ		21.8	21.8	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

For Axys Internal Use Only [XSL Template: TEQ.xsl; Created: 31-May-2012 14:01:35; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613-TEQ_L17883-4_TEQ_SJ1463859.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C19a

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	24-Apr-2012 15:04
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	11.3 g (wet)	**Lab Sample I.D.:**	L17883-5
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 12** **DX2M_080 S: 5**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		7.23	0.09	1	7.23e+00	7.23e+00	
1,2,3,7,8-PECDD		54.7	0.09	1	5.47e+01	5.47e+01	
1,2,3,4,7,8-HXCDD		11.4	0.18	0.1	1.14e+00	1.14e+00	
1,2,3,6,7,8-HXCDD		387	0.18	0.1	3.87e+01	3.87e+01	
1,2,3,7,8,9-HXCDD		32.8	0.18	0.1	3.28e+00	3.28e+00	
1,2,3,4,6,7,8-HPCDD		9.40	0.18	0.01	9.40e-02	9.40e-02	
OCDD		5.26	0.44	0.0003	1.58e-03	1.58e-03	
2,3,7,8-TCDF		381	0.09	0.1	3.81e+01	3.81e+01	
1,2,3,7,8-PECDF		1.43	0.09	0.03	4.29e-02	4.29e-02	
2,3,4,7,8-PECDF		21.4	0.09	0.3	6.42e+00	6.42e+00	
1,2,3,4,7,8-HXCDF		7.13	0.18	0.1	7.13e-01	7.13e-01	
1,2,3,6,7,8-HXCDF		0.61	0.18	0.1	6.10e-02	6.10e-02	
1,2,3,7,8,9-HXCDF	ND		0.18	0.1	0.00e+00	9.00e-03	
2,3,4,6,7,8-HXCDF		8.52	0.18	0.1	8.52e-01	8.52e-01	
1,2,3,4,6,7,8-HPCDF		13.6	0.18	0.01	1.36e-01	1.36e-01	
1,2,3,4,7,8,9-HPCDF	ND		0.18	0.01	0.00e+00	9.00e-04	
OCDF	ND		0.44	0.0003	0.00e+00	6.60e-05	
			TOTAL TEQ		151	151	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

For Axys Internal Use Only [XSL Template: TEQ.xsl; Created: 31-May-2012 14:01:35; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613-TEQ_L17883-5_TEQ_SJ1463860.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C21

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	24-Apr-2012 13:32
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	10.1 g (wet)	**Lab Sample I.D.:**	L17883-6
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 13** **DX2M_080 S: 6**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		1.19	0.10	1	1.19e+00	1.19e+00	
1,2,3,7,8-PECDD		4.38	0.10	1	4.38e+00	4.38e+00	
1,2,3,4,7,8-HXCDD		1.27	0.20	0.1	1.27e-01	1.27e-01	
1,2,3,6,7,8-HXCDD		23.8	0.20	0.1	2.38e+00	2.38e+00	
1,2,3,7,8,9-HXCDD		4.31	0.20	0.1	4.31e-01	4.31e-01	
1,2,3,4,6,7,8-HPCDD		5.13	0.20	0.01	5.13e-02	5.13e-02	
OCDD		1.62	0.49	0.0003	4.86e-04	4.86e-04	
2,3,7,8-TCDF		25.0	0.11	0.1	2.50e+00	2.50e+00	
1,2,3,7,8-PECDF		0.58	0.10	0.03	1.74e-02	1.74e-02	
2,3,4,7,8-PECDF		2.24	0.10	0.3	6.72e-01	6.72e-01	
1,2,3,4,7,8-HXCDF		0.78	0.20	0.1	7.80e-02	7.80e-02	
1,2,3,6,7,8-HXCDF		0.44	0.20	0.1	4.40e-02	4.40e-02	
1,2,3,7,8,9-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
2,3,4,6,7,8-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,4,6,7,8-HPCDF		2.48	0.20	0.01	2.48e-02	2.48e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.20	0.01	0.00e+00	1.00e-03	
OCDF	ND		0.49	0.0003	0.00e+00	7.35e-05	
			TOTAL TEQ		11.9	11.9	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613-TEQ_L17883-6_TEQ_SJ1463861.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C27

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	27-Apr-2012 15:37
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	3.77 g (wet)	**Lab Sample I.D.:**	L17883-7
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 14** **DX2M_080 S: 7**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		0.48	0.27	1	4.80e-01	4.80e-01	
1,2,3,7,8-PECDD		0.93	0.27	1	9.30e-01	9.30e-01	
1,2,3,4,7,8-HXCDD	ND		0.53	0.1	0.00e+00	2.65e-02	
1,2,3,6,7,8-HXCDD		2.38	0.53	0.1	2.38e-01	2.38e-01	
1,2,3,7,8,9-HXCDD		0.54	0.53	0.1	5.40e-02	5.40e-02	
1,2,3,4,6,7,8-HPCDD	ND		0.53	0.01	0.00e+00	2.65e-03	
OCDD	ND		1.33	0.0003	0.00e+00	2.00e-04	
2,3,7,8-TCDF		5.34	0.27	0.1	5.34e-01	5.34e-01	
1,2,3,7,8-PECDF	ND		0.27	0.03	0.00e+00	4.05e-03	
2,3,4,7,8-PECDF	ND		0.27	0.3	0.00e+00	4.05e-02	
1,2,3,4,7,8-HXCDF	ND		0.53	0.1	0.00e+00	2.65e-02	
1,2,3,6,7,8-HXCDF	ND		0.53	0.1	0.00e+00	2.65e-02	
1,2,3,7,8,9-HXCDF	ND		0.53	0.1	0.00e+00	2.65e-02	
2,3,4,6,7,8-HXCDF	ND		0.53	0.1	0.00e+00	2.65e-02	
1,2,3,4,6,7,8-HPCDF	ND		0.53	0.01	0.00e+00	2.65e-03	
1,2,3,4,7,8,9-HPCDF	ND		0.53	0.01	0.00e+00	2.65e-03	
OCDF	ND		1.33	0.0003	0.00e+00	2.00e-04	
			TOTAL TEQ		2.24	2.42	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

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Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613-TEQ_L17883-7_TEQ_SJ1463862.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C28

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	24-Apr-2012 16:28
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	10.8 g (wet)	**Lab Sample I.D.:**	L17883-8
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 15** **DX2M_080 S: 8**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		4.09	0.09	1	4.09e+00	4.09e+00	
1,2,3,7,8-PECDD		22.9	0.09	1	2.29e+01	2.29e+01	
1,2,3,4,7,8-HXCDD		4.24	0.19	0.1	4.24e-01	4.24e-01	
1,2,3,6,7,8-HXCDD		156	0.19	0.1	1.56e+01	1.56e+01	
1,2,3,7,8,9-HXCDD		14.4	0.19	0.1	1.44e+00	1.44e+00	
1,2,3,4,6,7,8-HPCDD		4.33	0.19	0.01	4.33e-02	4.33e-02	
OCDD	ND		0.46	0.0003	0.00e+00	6.90e-05	
2,3,7,8-TCDF		188	0.10	0.1	1.88e+01	1.88e+01	
1,2,3,7,8-PECDF		0.98	0.09	0.03	2.94e-02	2.94e-02	
2,3,4,7,8-PECDF		9.58	0.09	0.3	2.87e+00	2.87e+00	
1,2,3,4,7,8-HXCDF		2.62	0.19	0.1	2.62e-01	2.62e-01	
1,2,3,6,7,8-HXCDF	ND		0.19	0.1	0.00e+00	9.50e-03	
1,2,3,7,8,9-HXCDF	ND		0.19	0.1	0.00e+00	9.50e-03	
2,3,4,6,7,8-HXCDF		3.17	0.19	0.1	3.17e-01	3.17e-01	
1,2,3,4,6,7,8-HPCDF		5.22	0.19	0.01	5.22e-02	5.22e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.19	0.01	0.00e+00	9.50e-04	
OCDF	ND		0.46	0.0003	0.00e+00	6.90e-05	
			TOTAL TEQ		66.8	66.9	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613-TEQ_L17883-8_TEQ_SJ1463863.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-T9-DF Tissue

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	27-Apr-2012 09:54
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	10.2 g (wet)	**Lab Sample I.D.:**	L17883-9
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 16** **DX2M_080 S: 9**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		1.49	0.10	1	1.49e+00	1.49e+00	
1,2,3,7,8-PECDD		6.03	0.10	1	6.03e+00	6.03e+00	
1,2,3,4,7,8-HXCDD		1.03	0.20	0.1	1.03e-01	1.03e-01	
1,2,3,6,7,8-HXCDD		35.1	0.20	0.1	3.51e+00	3.51e+00	
1,2,3,7,8,9-HXCDD		3.42	0.20	0.1	3.42e-01	3.42e-01	
1,2,3,4,6,7,8-HPCDD		1.06	0.20	0.01	1.06e-02	1.06e-02	
OCDD		0.64	0.49	0.0003	1.92e-04	1.92e-04	
2,3,7,8-TCDF		49.9	0.10	0.1	4.99e+00	4.99e+00	
1,2,3,7,8-PECDF		0.28	0.10	0.03	8.40e-03	8.40e-03	
2,3,4,7,8-PECDF		2.35	0.10	0.3	7.05e-01	7.05e-01	
1,2,3,4,7,8-HXCDF		0.61	0.20	0.1	6.10e-02	6.10e-02	
1,2,3,6,7,8-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,7,8,9-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
2,3,4,6,7,8-HXCDF		0.71	0.20	0.1	7.10e-02	7.10e-02	
1,2,3,4,6,7,8-HPCDF		1.19	0.20	0.01	1.19e-02	1.19e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.20	0.01	0.00e+00	1.00e-03	
OCDF	ND		0.49	0.0003	0.00e+00	7.35e-05	
			TOTAL TEQ		17.3	17.4	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613-TEQ_L17883-9_TEQ_SJ1463864.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-T9-DF Liver

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	27-Apr-2012 09:54
Matrix:	TISSUE	**Project No.**	HS1625
Sample Size:	10.4 g (wet)	**Lab Sample I.D.:**	L17883-10
Concentration Units:	pg/g (wet weight basis)	**GC Column ID(s):**	DB225 DB5
		Sample Data Filenames:	**DB23_061 S: 17** **DX2M_080 S: 10**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		45.3	0.10	1	4.53e+01	4.53e+01	
1,2,3,7,8-PECDD		68.2	0.10	1	6.82e+01	6.82e+01	
1,2,3,4,7,8-HXCDD		2.91	0.19	0.1	2.91e-01	2.91e-01	
1,2,3,6,7,8-HXCDD		132	0.19	0.1	1.32e+01	1.32e+01	
1,2,3,7,8,9-HXCDD		14.3	0.19	0.1	1.43e+00	1.43e+00	
1,2,3,4,6,7,8-HPCDD		3.27	0.19	0.01	3.27e-02	3.27e-02	
OCDD	ND		0.48	0.0003	0.00e+00	7.20e-05	
2,3,7,8-TCDF		2090	0.10	0.1	2.09e+02	2.09e+02	
1,2,3,7,8-PECDF		6.82	0.10	0.03	2.05e-01	2.05e-01	
2,3,4,7,8-PECDF		25.7	0.10	0.3	7.71e+00	7.71e+00	
1,2,3,4,7,8-HXCDF		1.02	0.19	0.1	1.02e-01	1.02e-01	
1,2,3,6,7,8-HXCDF		1.01	0.19	0.1	1.01e-01	1.01e-01	
1,2,3,7,8,9-HXCDF	ND		0.19	0.1	0.00e+00	9.50e-03	
2,3,4,6,7,8-HXCDF		1.29	0.19	0.1	1.29e-01	1.29e-01	
1,2,3,4,6,7,8-HPCDF		0.73	0.19	0.01	7.30e-03	7.30e-03	
1,2,3,4,7,8,9-HPCDF	ND		0.19	0.01	0.00e+00	9.50e-04	
OCDF	ND		0.48	0.0003	0.00e+00	7.20e-05	
			TOTAL TEQ		346	346	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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Report Filename: 1613_DIOXINS_1613-TEQ_L17883-10_TEQ_SJ1463854.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
Lab Blank

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Contract No.:	2544	**Sample Collection:**	N/A
Matrix:	TISSUE	**Project No.**	N/A
Sample Size:	10.0 g	**Lab Sample I.D.:**	WG39854-101
Concentration Units:	pg/g	**GC Column ID:**	DB5
		Sample Data Filename:	**DX2M_079 S: 5**

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD	ND		0.10	1	0.00e+00	5.00e-02	
1,2,3,7,8-PECDD		0.10	0.10	1	1.00e-01	1.00e-01	
1,2,3,4,7,8-HXCDD	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,6,7,8-HXCDD	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,7,8,9-HXCDD	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,4,6,7,8-HPCDD	ND		0.20	0.01	0.00e+00	1.00e-03	
OCDD	ND		0.50	0.0003	0.00e+00	7.50e-05	
2,3,7,8-TCDF	ND		0.10	0.1	0.00e+00	5.00e-03	
1,2,3,7,8-PECDF	ND		0.10	0.03	0.00e+00	1.50e-03	
2,3,4,7,8-PECDF	ND		0.10	0.3	0.00e+00	1.50e-02	
1,2,3,4,7,8-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,6,7,8-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,7,8,9-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
2,3,4,6,7,8-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
1,2,3,4,6,7,8-HPCDF	ND		0.20	0.01	0.00e+00	1.00e-03	
1,2,3,4,7,8,9-HPCDF	ND		0.20	0.01	0.00e+00	1.00e-03	
OCDF	ND		0.50	0.0003	0.00e+00	7.50e-05	
			TOTAL TEQ		0.100	0.245	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

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Report Filename: 1613_DIOXINS_1613-TEQ_WG39854-101_TEQ_SJ1464348.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

CLIENT SAMPLE NO.
HS1625-C9 (Duplicate)

PCDD/PCDF ANALYSIS TEQ DATA REPORT

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Sample Collection: 24-Apr-2012 14:13

Contract No.: 2544

Project No. HS1625

Matrix: TISSUE

Lab Sample I.D.: WG39854-103 (DUP L17883-1)

Sample Size: 10.0 g (wet)

GC Column ID(s): DB225
DB5

Concentration Units: pg/g (wet weight basis)

Sample Data Filenames: **DB23_061 S: 8**
DX2M_079 S: 18

COMPOUND	LAB FLAG [1]	CONC. FOUND	REPORTING LIMIT (RL)	WHO 2005 TEF	TEQ ND=0	TEQ ND=1/2 RL	TEQ ND=RL
2,3,7,8-TCDD		1.51	0.10	1	1.51e+00	1.51e+00	
1,2,3,7,8-PECDD		5.89	0.10	1	5.89e+00	5.89e+00	
1,2,3,4,7,8-HXCDD		1.07	0.20	0.1	1.07e-01	1.07e-01	
1,2,3,6,7,8-HXCDD		33.0	0.20	0.1	3.30e+00	3.30e+00	
1,2,3,7,8,9-HXCDD		6.02	0.20	0.1	6.02e-01	6.02e-01	
1,2,3,4,6,7,8-HPCDD		2.18	0.20	0.01	2.18e-02	2.18e-02	
OCDD		1.02	0.50	0.0003	3.06e-04	3.06e-04	
2,3,7,8-TCDF		45.9	0.10	0.1	4.59e+00	4.59e+00	
1,2,3,7,8-PECDF		0.54	0.10	0.03	1.62e-02	1.62e-02	
2,3,4,7,8-PECDF		2.31	0.10	0.3	6.93e-01	6.93e-01	
1,2,3,4,7,8-HXCDF		0.59	0.20	0.1	5.90e-02	5.90e-02	
1,2,3,6,7,8-HXCDF		0.25	0.20	0.1	2.50e-02	2.50e-02	
1,2,3,7,8,9-HXCDF	ND		0.20	0.1	0.00e+00	1.00e-02	
2,3,4,6,7,8-HXCDF		0.65	0.20	0.1	6.50e-02	6.50e-02	
1,2,3,4,6,7,8-HPCDF		1.16	0.20	0.01	1.16e-02	1.16e-02	
1,2,3,4,7,8,9-HPCDF	ND		0.20	0.01	0.00e+00	1.00e-03	
OCDF	ND		0.50	0.0003	0.00e+00	7.50e-05	
			TOTAL TEQ		16.9	16.9	

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.
(2) Concentrations that do not meet quantification criteria are not included in the TEQ calculations.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

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For Axys Internal Use Only [XSL Template: TEQ.xsl; Created: 31-May-2012 14:01:35; Application: XMLTransformer-1.12.14;
Report Filename: 1613_DIOXINS_1613-TEQ_WG39854-103_TEQ_SJ1464345.html; Workgroup: WG39854; Design ID: 1798]

AXYS METHOD MLA-017 Rev 20

PCDD/PCDF ANALYSIS REPORT
RELATIVE PERCENT DIFFERENCE

AXYS ANALYTICAL SERVICES
2045 MILLS RD., SIDNEY, B.C., CANADA
V8L 5X2 TEL (250) 655-5800 FAX (250) 655-5811

Project No. HS1625

Contract No.: 2544

Client ID: HS1625-C9

Concentration Units: pg/g (wet weight basis)

COMPOUND	L17883-1 (A)		WG39854-103		MEAN	RELATIVE PERCENT DIFFERENCE
	LAB FLAG [1]	CONC. FOUND	LAB FLAG [1]	CONC. FOUND		
2,3,7,8-TCDD		1.49		1.51	1.50	1.23
1,2,3,7,8-PECDD		6.31		5.89	6.10	6.83
1,2,3,4,7,8-HXCDD		1.21		1.07	1.14	11.9
1,2,3,6,7,8-HXCDD		33.5		33.0	33.2	1.38
1,2,3,7,8,9-HXCDD		6.63		6.02	6.32	9.65
1,2,3,4,6,7,8-HPCDD		2.37		2.18	2.28	8.32
OCDD		1.11		1.02	1.06	8.64
2,3,7,8-TCDF		47.1		45.9	46.5	2.69
1,2,3,7,8-PECDF		0.64		0.54	0.59	17.8
2,3,4,7,8-PECDF		2.64		2.31	2.48	13.0
1,2,3,4,7,8-HXCDF		0.68		0.59	0.64	14.9
1,2,3,6,7,8-HXCDF		0.32		0.25	0.28	24.3
1,2,3,7,8,9-HXCDF	ND		ND			
2,3,4,6,7,8-HXCDF		0.58		0.65	0.62	11.2
1,2,3,4,6,7,8-HPCDF		1.15		1.16	1.16	0.52
1,2,3,4,7,8,9-HPCDF	ND		ND			
OCDF	ND		ND			

(1) Where applicable, custom lab flags have been used on this report; ND = not detected at RL.

These data are validated and reported as accurate and in accord with AXYS Analytical Services Ltd. ISO17025 compliant quality assurance processes.
Signed: _____Shelley Facchin_____

These pages are part of a larger report that may contain information necessary for full data evaluation. Results reported relate only to the sample tested.

For Axys Internal Use Only [XSL Template: RPD.xsl; Created: 31-May-2012 14:02:03; Application: XMLTransformer-1.12.14;
Report Filename: RPD_DIOXINS_1613-RPD_WG39854-103_L17883-1_.html; Workgroup: WG39854; Design ID: 1798]

AXYS Analytical Services Ltd.

Table 1a
NELAP Accreditation Held by AXYS Analytical Services Ltd.
for Chlorinated Dioxins/Furans, Chlorinated Pesticides, PCBs and PAHs

Matrix Codes for Table 1a

NPW = Non-Potable Water
DrW = Drinking Water
S = Solid
T = Tissue

Accreditation Method Codes and Explanation for Table 1

Code No.	Accreditation Certificate Method Reference	Applicable AXYS Method and Description
1	EPA 1613B	MLA-017, performance based implementation of EPA1613B (GC/HRMS)
2	EPA 8290	MLA-017, performance based implementation of EPA 8290 (GC/HRMS)
3	AXYS MLA-017	MLA-017, performance based implementation of EPA 1613B, 8290 (GC/HRMS)
4	EPA 608	MLA-007, performance based implementation of EPA 608 (GC/ECD)
5	EPA 8270C or 8270D	MLA-007, performance based **modification** of 8270C/D (GC/LRMS)
6	EPA 8081A or 8081B	MLA-007, performance based implementation of EPA 8081A/B (GC/ECD)
7	EPA 1668A	MLA-010, performance based implementation of EPA 1668A (GC/HRMS)
8	SM 6630B	MLA-007, performance based implementation of SM 18-20 6630B (GC/ECD)
9	EPA 1625B	MLA-021, performance based **modification** of EPA 1625B (GC/LRMS)
11	EPA 625	MLA-007, performance based **modification** of EPA 625 (GC/LRMS)
20	EPA 8270C or 8270D	MLA-021, performance based **modification** of EPA 8270C/D (GC/LRMS)
21	EPA 1625B	MLA-007, performance based **modification** of EPA 1625B (GC/LRMS)

AXYS Analytical Services Ltd.

TABLE 1a	New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection				Virginia Division of Consolidated Laboratory Services		
	Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary				Lab ID 460224 NELAP Secondary		
	NP W	S	NP W	S	Dr. W	NP W	S	T	Dr. W	NP W	S	T	NP W	S	T
PCDD/F - Polychlorinated Dioxins and Furans															
Dioxins			1												
Dioxins and Dibenzofurans				2											
1,2,3,4,6,7,8-HpCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,4,6,7,8-HpCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,4,7,8,9-HpCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,4,7,8-HxCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,4,7,8-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,6,7,8-HxCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,6,7,8-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,7,8,9-HxCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,7,8,9-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,7,8-PeCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
1,2,3,7,8-PeCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
2,3,4,6,7,8-HxCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
2,3,4,7,8-PeCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
2,3,7,8-TCDD	1		1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
2,3,7,8-TCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
OCDD			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
OCDF			1	2		1, 2, 3	2, 3	2, 3		1	2	2	1, 2	2	2
Total TCDD			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
Total TCDF			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
Total PeCDD			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
Total PeCDF			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
Total HxCDD			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
Total HxCDF			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
Total HpCDD			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
Total HpCDF			1			1, 2, 3	2, 3	2, 3			2	2	2	2	2
PCBs – Polychlorinated biphenyls															
PCB 1 2-Chlorobiphenyl	7	7								7	7		7	7	
PCB 3 4-Chlorobiphenyl	7	7								7	7		7	7	
PCB 4 2,2'-Dichlorobiphenyl	7	7								7	7		7	7	
PCB 5 2,3-Dichlorobiphenyl	7	7								7	7		7	7	
PCB 15 4,4'-Dichlorobiphenyl	7	7								7	7		7	7	

AXYS Analytical Services Ltd.

TABLE 1a		New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection				Virginia Division of Consolidated Laboratory Services		
		Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary				Lab ID 460224 NELAP Secondary		
		NP W	S	NP W	S	Dr. W	NP W	S	T	Dr. W	NP W	S	T	NP W	S	T
PCB 18	2,2',5-Trichlorobiphenyl	7	7								7	7		7	7	
PCB 19	2,2',6-Trichlorobiphenyl	7	7								7	7		7	7	
PCB 31	2,4',5-Trichlorobiphenyl	7	7								7	7		7	7	
PCB 37	3,4,4'-Trichlorobiphenyl	7	7								7	7		7	7	
PCB 44	2,2',3,5'-Tetrachlorobiphenyl	7	7								7	7		7	7	
PCB 52	2,2',5,5'-Tetrachlorobiphenyl	7	7								7	7		7	7	
PCB 54	2,2',6,6'-Tetrachlorobiphenyl	7	7								7	7		7	7	
PCB 66	2,3',4,4'-Tetrachlorobiphenyl	7	7								7	7		7	7	
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	7	7								7	7		7	7	
PCB 81	3,4,4',5-Tetrachlorobiphenyl	7	7								7	7		7	7	
PCB 87	2,2',3,4,5'-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 101	2,2',4,5,5'-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 104	2,2',4,6,6'-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 109	2,3,3',4,6-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 114	2,3,4,4',5-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 118	2,3',4,4',5-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 124	2,3',4',5,5'-Pentachlorobiphenyl										7	7				
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	7	7								7	7		7	7	
PCB 138	2,2',3,4,4',5'-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 141	2,2',3,4,5,5'-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 151	2,2',3,5,5',6-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 155	2,2',4,4',6,6'-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl		7								7				7	
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl	7	7								7	7		7	7	
PCB 170	2,2',3,3',4,4',5-Heptachlorobiphenyl	7	7								7	7		7	7	
PCB 180	2,2',3,4,4',5,5'-Heptachlorobiphenyl	7	7								7	7		7	7	
PCB 183	2,2',3,4,4',5',6-Heptachlorobiphenyl	7	7								7	7		7	7	
PCB 187	2,2',3,4',5,5',6-Heptachlorobiphenyl	7	7								7	7		7	7	
PCB 188	2,2',3,4',5,6,6'-Heptachlorobiphenyl	7	7								7	7		7	7	
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	7	7								7	7		7	7	
PCB 202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	7	7								7	7		7	7	

AXYS Analytical Services Ltd.

TABLE 1a		New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection				Virginia Division of Consolidated Laboratory Services		
		Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary				Lab ID 460224 NELAP Secondary		
		NPW	S	NPW	S	Dr. W	NPW	S	T	Dr. W	NPW	S	T	NPW	S	T
PCB 205	2,3,3',4,4',5,5',6-Octachlorobiphenyl	7	7								7			7	7	
PCB 206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	7	7								7	7		7	7	
PCB 208	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	7	7								7	7		7	7	
PCB 209	Decachlorobiphenyl	7	7								7	7		7	7	
Aroclor 1260		7, 11	5, 7	11	5									11	5	
Aroclor 1254		7, 11	5, 7	11	5									11	5	
Aroclor 1221		7, 11	5, 7	11	5									11	5	
Aroclor 1232		7, 11	5, 7	11	5									11	5	
Aroclor 1248		7, 11	5, 7	11	5									11	5	
Aroclor 1016		7, 11	5, 7	11	5									11	5	
Aroclor 1242		7, 11	5, 7	11	5									11	5	
Pesticides																
4,4'-DDD		11	5	11	5									11	5	
4,4'-DDE		11	5	11	5									11	5	
4,4'-DDT		11	5	11	5									11	5	
Aldrin		11	5	11	5									11	5	
Alpha-HCH		11	5	11	5									11	5	
Beta-HCH		11	5	11	5									11	5	
cis-Chlordane (alpha-Chlordane)		5	5													
Chlordane, technical		5, 11	5	11	5									5, 11	5	
Delta-HCH		11	5	11	5									11	5	
Dieldrin		4	6	4	6									4	6	
Endosulphan I		4	6	4	6									4	6	
Endosulphan II		4	6	4	6									4	6	
Endosulphan sulphate		4	6	4	6									4	6	
Endrin		4	6	4	6									4	6	
Endrin aldehyde		4	6	4	6									4	6	
trans-Chlordane (gamma-Chlordane)		5	5													
Gamma-HCH (Lindane)		11	5	11	5									11	5	
Heptachlor		11	5	11	5									11	5	
Heptachlor epoxide		4	6	4	6									4	6	
Hexachlorobenzene		21	5	9	5										5	
Methoxychlor		4, 8	6	8	6									4	6	
Mirex		5												5		

AXYS Analytical Services Ltd.

TABLE 1a	New York State Department of Health		California Department of Public Health		State of Florida Department of Health				State of New Jersey Department of Environmental Protection				Virginia Division of Consolidated Laboratory Services		
	Lab ID 11674 NELAP Primary		Lab ID 01138CA NELAP Secondary		Lab ID E871007 NELAP Primary				Lab ID CANA005 NELAP Secondary				Lab ID 460224 NELAP Secondary		
	NP W	S	NP W	S	Dr. W	NP W	S	T	Dr. W	NP W	S	T	NP W	S	T
PAH															
Anthracene	9	20	9	20									9	20	
Pyrene	9	20	9	20									9	20	
Benzo[ghi]perylene	9	20	9	20									9	20	
Indeno[1,2,3-cd]pyrene	9	20	9	20									9	20	
Benzo[b]fluoranthene	9	20	9	20									9	20	
Fluoranthene	9	20	9	20									9	20	
Benzo[k]fluoranthene	9		9										9		
Acenaphthylene	9	20	9	20									9	20	
Chrysene	9	20	9	20									9	20	
Benzo[a]pyrene	9	20	9	20									9	20	
Dibenz[ah]anthracene	9	20	9	20									9	20	
Benz[a]anthracene	9	20	9	20									9	20	
Acenaphthene	9	20	9	20									9	20	
Phenanthrene	9	20	9	20									9	20	
Fluorene	9	20	9	20									9	20	
Naphthalene	9	20	9	20									9	20	

AXYS Analytical Services Ltd.

Table 1b
NELAP Accreditation Held by AXYS Analytical Services Ltd.
for Perfluorinated Organic Compounds

Matrix Codes for Table 1b

NPW = Non-Potable Water
DrW = Drinking Water
S = Solid
T = Tissue

Accreditation Method Codes and Explanation for Table 1b

Code No.	Accreditation Certificate Method Reference	Applicable AXYS Method and Description
12	AXYS MLA-041	MLA-041, laboratory performance based method (LC/MS-MS)
13	AXYS MLA-043	MLA-043, laboratory performance based method (LC/MS-MS)
14	AXYS MLA-060	MLA-060, laboratory performance based method (LC/MS-MS)

TABLE 1b	State of Florida Department of Health				Minnesota Department of Health				State of New Jersey Department of Environmental Protection			
	Lab ID E871007 NELAP Primary				Lab ID 232-999-430 NELAP Primary				Lab ID CANA005 NELAP Secondary			
	Dr. W	NP W	S	T	Dr. W	NP W	S	T	Dr. W	NP W	S	T
PFC – Perfluorinated Organic Compounds												
Perfluorobutanoate (PFBA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluoropentanoate (PFPeA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorohexanoate (PFHxA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluoroheptanoate (PFHpA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorooctanoate (PFOA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorononanoate (PFNA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorodecanoate (PFDA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluoroundecanoate (PFUnA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorododecanoate (PFDoA) Note	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorobutanesulfonate (PFBS)	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorohexanesulfonate (PFHxS)	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorooctanesulfonate (PFOS)	14	14	12	13	14	14	12	13	14	14	12	13
Perfluorooctane sulfonamide (PFOSA)	14	14	12	13	14	14	12	13				

Note: Accreditations by Minnesota Department of Health and New Jersey Department of Environmental Protection are against the corresponding acid form of the anion shown.

AXYS Analytical Services Ltd.

Table 2:
Canadian and US State Specific Accreditation Held by AXYS Analytical Services Ltd.

Matrix Codes for Table 2

NP W = Non-Potable Water
Dr. W = Drinking Water
W = Aqueous
S = Solid
T = Tissue
Ser = Serum/Plasma
U = Urine

Accreditation Method Codes and Explanation for Table 2

Code No.	Accreditation Certificate Method Reference	Applicable AXYS Method and Description
1	EPA 1613	MLA-017 Performance based implementation of EPA 1613B (GC/HRMS)
3	AXYS MLA-017	MLA-017 Performance based implementation of EPA 1613B (GC/HRMS)
7	EPA 1668A	MLA-010 Performance based implementation of EPA 1668A (GC/HRMS)
10	AXYS MLA-007	MLA-007, Performance based **modification** of EPA 8270C/D, 8081A/B (GC/LRMS and GC/ECD)
12	AXYS MLA-041	MLA-041 Laboratory performance based method (LC/MS-MS)
13	AXYS MLA-043	MLA-043 Laboratory performance based method (LC/MS-MS)
14	AXYS MLA-060	MLA-060 Laboratory performance based method (LC/MS-MS)
15	AXYS MLA-010	MLA-010 Performance based implementation of EPA 1668A (GC/HRMS)
16	AXYS MLA-028	MLA-028 Laboratory performance based method (GC/HRMS)
17	AXYS MLA-033	MLA-033 Performance based implementation of EPA 1614 (GC/HRMS)
18	AXYS MLA-021	MLA-021 Performance based **modification** of EPA 8270C/D (GC/LRMS)
19	AXYS MLA-075	MLA-075 Performance based implementation of EPA 1694 (LC/MS-MS)
22	AXYS MLA-901	MLA-901 Laboratory performance based method (GC/LRMS)
23	AXYS MLA-042	MLA-042 Laboratory performance based method (LC/MS-MS)
24	AXYS MLA-070	MLA-070 Laboratory performance based method (LC/MS-MS)
25	AXYS MLA-079	MLA-079 Laboratory performance based method (LC/MS-MS)
26	AXYS MLA-059	MLA-059 Laboratory performance based method (LC/MS-MS)
27	AXYS MLA-064	MLA-064 Laboratory performance based method (LC/MS-MS)
28	EPA 1668C	MLA-010 Performance based implementation of EPA 1668C (GC/HRMS)

AXYS Analytical Services Ltd.

TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
PCDD/F - Polychlorinated Dioxins and Furans								
1,2,3,4,6,7,8-HpCDD	3	3	3	3	3		1	1
1,2,3,4,6,7,8-HpCDF	3	3	3	3	3		1	1
1,2,3,4,7,8,9-HpCDF	3	3	3	3	3		1	1
1,2,3,4,7,8-HxCDD	3	3	3	3	3		1	1
1,2,3,4,7,8-HxCDF	3	3	3	3	3		1	1
1,2,3,6,7,8-HxCDD	3	3	3	3	3		1	1
1,2,3,6,7,8-HxCDF	3	3	3	3	3		1	1
1,2,3,7,8,9-HxCDD	3	3	3	3	3		1	1
1,2,3,7,8,9-HxCDF	3	3	3	3	3		1	1
1,2,3,7,8-PeCDD	3	3	3	3	3		1	1
1,2,3,7,8-PeCDF	3	3	3	3	3		1	1
2,3,4,6,7,8-HxCDF	3	3	3	3	3		1	1
2,3,4,7,8-PeCDF	3	3	3	3	3		1	1
2,3,7,8-TCDD	3	3	3	3	3		1	1
2,3,7,8-TCDF	3	3	3	3	3		1	1
OCDD	3	3	3	3	3		1	1
OCDF	3	3	3	3	3		1	1
PCBs – Polychlorinated biphenyls								
PCB 1 2-Chlorobiphenyl	15	15		15	15		28	28
PCB 2 3-Chlorobiphenyl	15	15		15	15		28	28
PCB 3 4-Chlorobiphenyl	15	15		15	15		28	28
PCB 4 2,2'-Dichlorobiphenyl	15	15		15	15		28	28
PCB 5 2,3-Dichlorobiphenyl	15	15		15	15		28	28
PCB 6 2,3'-Dichlorobiphenyl	15	15		15	15		28	28
PCB 7 2,4-Dichlorobiphenyl	15	15		15	15		28	28
PCB 8 2,4'-Dichlorobiphenyl	15	15		15	15		28	28
PCB 8/5	10	10		10				
PCB 9 2,5-Dichlorobiphenyl	15	15		15	15		28	28
PCB 10 2,6-Dichlorobiphenyl	15	15		15	15		28	28
PCB 11 3,3'-Dichlorobiphenyl	15	15		15	15		28	28
PCB 12 3,4-Dichlorobiphenyl	15	15		15	15		28	28
PCB 13 3,4'-Dichlorobiphenyl	15	15		15	15		28	28
PCB 14 3,5-Dichlorobiphenyl	15	15		15	15		28	28

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
PCB 15	4,4'-Dichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 16	2,2',3-Trichlorobiphenyl	15	15		15	15		28	28
PCB 16/32		10	10		10				
PCB 17	2,2',4-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 18	2,2',5-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 19	2,2',6-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 20	2,3,3'-Trichlorobiphenyl	15	15		15	15		28	28
PCB 21	2,3,4-Trichlorobiphenyl	15	15		15	15		28	28
PCB 22	2,3,4'-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 23	2,3,5-Trichlorobiphenyl	15	15		15	15		28	28
PCB 24	2,3,6-Trichlorobiphenyl	15	15		15	15		28	28
PCB 24/27		10	10		10				
PCB 25	2,3',4-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 26	2,3',5-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 27	2,3',6-Trichlorobiphenyl	15	15		15	15		28	28
PCB 28	2,4,4'-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 29	2,4,5-Trichlorobiphenyl	15	15		15	15		28	28
PCB 30	2,4,6-Trichlorobiphenyl	15	15		15	15		28	28
PCB 31	2,4',5-Trichlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 32	2,4',6-Trichlorobiphenyl	15	15		15	15		28	28
PCB 33	2,3',4'-Trichlorobiphenyl	15	15		15	15		28	28
PCB 33/20/21		18	10		10				
PCB 34	2,3',5'-Trichlorobiphenyl	15	15		15	15		28	28
PCB 35	3,3',4-Trichlorobiphenyl	15	15		15	15		28	28
PCB 36	3,3',5-Trichlorobiphenyl	15	15		15	15		28	28
PCB 37	3,4,4'-Trichlorobiphenyl	15	15		15	15		28	28
PCB 38	3,4,5-Trichlorobiphenyl	15	15		15	15		28	28
PCB 39	3,4',5-Trichlorobiphenyl	15	15		15	15		28	28
PCB 40	2,2',3,3'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 41	2,2',3,4-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 41/71/64/68		10	10		10				
PCB 42	2,2',3,4'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 42/59		10	10		10				
PCB 43	2,2',3,5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 44	2,2',3,5'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
PCB 45	2,2',3,6-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 46	2,2',3,6'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 47	2,2',4,4'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 47/48/75		10	10		10				
PCB 48	2,2',4,5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 49	2,2',4,5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 49/43		10	10		10				
PCB 50	2,2',4,6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 51	2,2',4,6'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 52	2,2',5,5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 52/73		10	10		10				
PCB 53	2,2',5,6'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 54	2,2',6,6'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 55	2,3,3',4-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 56	2,3,3',4'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 56/60		10	10		10				
PCB 57	2,3,3',5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 58	2,3,3',5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 59	2,3,3',6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 60	2,3,4,4'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 61	2,3,4,5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 62	2,3,4,6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 63	2,3,4',5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 64	2,3,4',6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 65	2,3,5,6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 66	2,3',4,4'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 66/80		10	10		10				
PCB 67	2,3',4,5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 68	2,3',4,5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 69	2,3',4,6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 70	2,3',4',5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 70/76		10	10		10				
PCB 71	2,3',4',6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 72	2,3',5,5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 73	2,3',5',6-Tetrachlorobiphenyl	15	15		15	15		28	28

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
PCB 74	2,4,4',5-Tetrachlorobiphenyl	15	15		15	15, 22		28	28
PCB 74/61		10	10		10				
PCB 75	2,4,4',6-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 76	2,3',4',5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 77	3,3',4,4'-Tetrachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 78	3,3',4,5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 79	3,3',4,5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 80	3,3',5,5'-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 81	3,4,4',5-Tetrachlorobiphenyl	15	15		15	15		28	28
PCB 82	2,2',3,3',4-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 83	2,2',3,3',5-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 83/108		10	10		10				
PCB 84	2,2',3,3',6-Pentachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 85	2,2',3,4,4'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 85/120		10	10		10				
PCB 86	2,2',3,4,5-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 87	2,2',3,4,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 87/115/116		10	10		10				
PCB 88	2,2',3,4,6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 89	2,2',3,4,6'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 90	2,2',3,4',5-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 91	2,2',3,4',6-Pentachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 92	2,2',3,5,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 93	2,2',3,5,6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 94	2,2',3,5,6'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 95	2,2',3,5',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 95/93		10	10		10				
PCB 96	2,2',3,6,6'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 97	2,2',3,4',5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 97/86		10	10		10				
PCB 98	2,2',3,4',6'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 99	2,2',4,4',5-Pentachlorobiphenyl	10, 15	10, 15		10, 15	15, 22		28	28
PCB 100	2,2',4,4',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 101	2,2',4,5,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 101/90/89		10	10		10				

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
PCB 102	2,2',4,5,6'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 103	2,2',4,5',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 104	2,2',4,6,6'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 105	2,3,3',4,4'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 105/127		10	10		10				
PCB 106	2,3,3',4,5-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 107	2,3,3',4',5-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 107/109		10	10		10				
PCB 108	2,3,3',4,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 109	2,3,3',4,6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 110	2,3,3',4',6-Pentachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 111	2,3,3',5,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 112	2,3,3',5,6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 113	2,3,3',5',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 114	2,3,4,4',5-Pentachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 115	2,3,4,4',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 116	2,3,4,5,6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 117	2,3,4',5,6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 118	2,3',4,4',5-Pentachlorobiphenyl	15	15		15	15, 22		28	28
PCB 118/116		10	10		10				
PCB 119	2,3',4,4',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 120	2,3',4,5,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 121	2,3',4,5',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 122	2,3,3',4',5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 123	2,3',4,4',5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 124	2,3',4',5,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 125	2,3',4',5',6-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 126	3,3',4,4',5-Pentachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 127	3,3',4,5,5'-Pentachlorobiphenyl	15	15		15	15		28	28
PCB 128	2,2',3,3',4,4'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 129	2,2',3,3',4,5-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 130	2,2',3,3',4,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 131	2,2',3,3',4,6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 131/142		10	10		10				
PCB 132	2,2',3,3',4,6'-Hexachlorobiphenyl	15	15		15	15		28	28

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
PCB 133	2,2',3,3',5,5'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 134	2,2',3,3',5,6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 134/143		10	10		10				
PCB 135	2,2',3,3',5,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 136	2,2',3,3',6,6'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 137	2,2',3,4,4',5-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 138	2,2',3,4,4',5'-Hexachlorobiphenyl	15	15		15	15, 22		28	28
PCB 138/163/164		10	10		10				
PCB 139	2,2',3,4,4',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 140	2,2',3,4,4',6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 141	2,2',3,4,5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 142	2,2',3,4,5,6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 143	2,2',3,4,5,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 144	2,2',3,4,5',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 144/135		10	10		10				
PCB 145	2,2',3,4,6,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 146	2,2',3,4',5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15, 22		28	28
PCB 147	2,2',3,4',5,6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 148	2,2',3,4',5,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 149	2,2',3,4',5',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 149/139		10	10		10				
PCB 150	2,2',3,4',6,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 151	2,2',3,5,5',6-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 152	2,2',3,5,6,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 153	2,2',4,4',5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15, 22		28	28
PCB 154	2,2',4,4',5,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 155	2,2',4,4',6,6'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 156	2,3,3',4,4',5-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15, 22		28	28
PCB 157	2,3,3',4,4',5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 158	2,3,3',4,4',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 158/160		10	10		10				
PCB 159	2,3,3',4,5,5'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 160	2,3,3',4,5,6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 161	2,3,3',4,5',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 162	2,3,3',4',5,5'-Hexachlorobiphenyl	15	15		15	15		28	28

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
PCB 163	2,3,3',4',5,6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 164	2,3,3',4',5',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 165	2,3,3',5,5',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 166	2,3,4,4',5,6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 167	2,3',4,4',5,5'-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 168	2,3',4,4',5',6-Hexachlorobiphenyl	15	15		15	15		28	28
PCB 169	3,3',4,4',5,5'-Hexachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 170	2,2',3,3',4,4',5-Heptachlorobiphenyl	15	15		15	15, 22		28	28
PCB 170/190		10	10		10				
PCB 171	2,2',3,3',4,4',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 172	2,2',3,3',4,5,5'-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 172/192		10	10		10				
PCB 173	2,2',3,3',4,5,6-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 174	2,2',3,3',4,5,6'-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 174/181		10	10		10				
PCB 175	2,2',3,3',4,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 176	2,2',3,3',4,6,6'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 177	2,2',3,3',4,5',6'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 178	2,2',3,3',5,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 179	2,2',3,3',5,6,6'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 180	2,2',3,4,4',5,5'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15, 22		28	28
PCB 181	2,2',3,4,4',5,6-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 182	2,2',3,4,4',5,6'-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 183	2,2',3,4,4',5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 184	2,2',3,4,4',6,6'-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 185	2,2',3,4,5,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 186	2,2',3,4,5,6,6'-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 187	2,2',3,4',5,5',6-Heptachlorobiphenyl	15	15		15	15, 22		28	28
PCB 187/182		10	10		10				
PCB 188	2,2',3,4',5,6,6'-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 189	2,3,3',4,4',5,5'-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 190	2,3,3',4,4',5,6-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 191	2,3,3',4,4',5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 192	2,3,3',4,5,5',6-Heptachlorobiphenyl	15	15		15	15		28	28
PCB 193	2,3,3',4',5,5',6-Heptachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28

AXYS Analytical Services Ltd.

TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
PCB 194	2,2',3,3',4,4',5,5'-Octachlorobiphenyl	10, 15	10, 15		10, 15	15, 22		28	28
PCB 195	2,2',3,3',4,4',5,6-Octachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 196	2,2',3,3',4,4',5,6'-Octachlorobiphenyl	15	15		15	15		28	28
PCB 196/203		10	10		10				
PCB 197	2,2',3,3',4,4',6,6'-Octachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 198	2,2',3,3',4,5,5',6-Octachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 199	2,2',3,3',4,5,5',6'-Octachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 200	2,2',3,3',4,5,6,6'-Octachlorobiphenyl	15	15		15	15		28	28
PCB 201	2,2',3,3',4,5',6,6'-Octachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 202	2,2',3,3',5,5',6,6'-Octachlorobiphenyl	15	15		15	15		28	28
PCB 203	2,2',3,4,4',5,5',6-Octachlorobiphenyl	15	15		15	15		28	28
PCB 204	2,2',3,4,4',5,6,6'-Octachlorobiphenyl	15	15		15	15		28	28
PCB 205	2,3,3',4,4',5,5',6-Octachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 206	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 207	2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 208	2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
PCB 209	Decachlorobiphenyl	10, 15	10, 15		10, 15	15		28	28
Total Monochlorobiphenyls		15	15		15	15		28	28
Total Dichlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Trichlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Tetrachlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Pentachlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Hexachlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Heptachlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Octachlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Nonachlorobiphenyls		10, 15	10, 15		10, 15	15		28	28
Total Decachlorobiphenyls		10	10		10				
Total Polychlorinated biphenyls		10	10		10				
Aroclors									
Aroclor 1260		10	10		10				
Aroclor 1254		10	10		10				
Aroclor 1268		10	10		10				
Aroclor 1221		10	10		10				
Aroclor 1232		10	10		10				

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TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
Aroclor 1248	10	10		10				
Aroclor 1016								
Aroclor 1242								
Aroclor 1242/1016	10	10		10				
Pesticides								
2,4'-DDD	10, 16	10, 16		10, 16	10, 16		16	
2,4'-DDE	10, 16	10, 16		10, 16	10, 16		16	
2,4'-DDT	10, 16	10, 16		10, 16	10, 16		16	
4,4'-DDD	10, 16	10, 16		10, 16	10, 16		16	
4,4'-DDE	10, 16	10, 16		10, 16	10, 16		16	
4,4'-DDT	10, 16	10, 16		10, 16	10, 16		16	
Aldrin	10, 16	10, 16		10, 16	10, 16		16	
Alpha-HCH	10, 16	10, 16		10, 16	10, 16		16	
Beta-HCH	10, 16	10, 16		10, 16	10, 16		16	
cis-Chlordane (alpha-Chlordane)	10, 16	10, 16		10, 16	10, 16		16	
cis-Nonachlor	10, 16	10, 16		10, 16	10, 16		16	
Delta-HCH	10, 16	10, 16		10, 16	10, 16		16	
Dieldrin	10, 16	10, 16		10, 16	10, 16		16	
Endosulphan I	10, 16	10, 16		10, 16	10, 16		16	
Endosulphan II	10, 16	10, 16		10, 16	10, 16		16	
Endosulphan sulphate	10, 16	10, 16		10, 16	10, 16		16	
Endrin	10, 16	10, 16		10, 16	10, 16		16	
Endrin aldehyde	10, 16	10, 16		16	16		16	
Endrin ketone	10, 16	10, 16		10, 16	10, 16		16	
Gamma-HCH (Lindane)	10, 16	10, 16		10, 16	10, 16		16	
Heptachlor	10, 16	10, 16		10, 16	10, 16		16	
Heptachlor epoxide	10, 16	10, 16		10, 16	10, 16		16	
Hexachlorobenzene	10, 16	10, 16		10, 16	10, 16		16	
Hexachlorobutadiene		16		16				
Methoxychlor	10, 16	10, 16		10, 16	10, 16		16	
Mirex	10, 16	10, 16		10, 16	10, 16		16	
Oxychlordane	10, 16	10, 16		10, 16	10, 16		16	
Toxaphene	10	10		10				
trans-Chlordane (gamma-Chlordane)	10, 16	10, 16		10, 16	10, 16		16	

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TABLE 2		Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
		Accreditation no.: A 2637						Lab. ID: C404	
		W	S	Pulp	T	Ser	U	NP W	S
trans-Nonachlor		16	10, 16		10, 16	10, 16		16	
BDE - Brominated Diphenylethers									
BDE 7	2,4-dibromodiphenylether	17	17		17	17			
BDE 8	2,4'-dibromodiphenylether	17	17		17	17			
BDE 10	2,6-dibromodiphenylether	17	17		17	17			
BDE 11	3,3'-dibromodiphenylether	17	17		17	17			
BDE 12	3,4-dibromodiphenylether	17	17		17	17			
BDE 13	3,4'-dibromodiphenylether	17	17		17	17			
BDE 15	4,4'-dibromodiphenylether	17	17		17	17			
BDE 17	2,2',4-tribromodiphenylether	17	17		17	17			
BDE 25	2,3',4-tribromodiphenylether	17	17		17	17			
BDE 28	2,4,4'-tribromodiphenylether	17	17		17	17			
BDE 30	2,4,6-tribromodiphenylether	17	17		17	17			
BDE-33	2',3,4-tribromodiphenylether	17	17		17	17			
BDE 35	3,3',4-tribromodiphenylether	17	17		17	17			
BDE 37	3,4,4'-tribromodiphenylether	17	17		17	17			
BDE 47	2,2',4,4'-tetrabromodiphenylether	17	17		17	17			
BDE 49	2,2',4,5'-tetrabromodiphenylether	17	17		17	17			
BDE 66	2,3',4,4'-tetrabromodiphenylether	17	17		17	17			
BDE 75	2,4,4',6-tetrabromodiphenylether	17	17		17	17			
BDE 77	3,3',4,4'-tetrabromodiphenylether	17	17		17	17			
BDE 85	2,2',3,4,4'-pentabromodiphenylether	17	17		17	17			
BDE 99	2,2',4,4',5-pentabromodiphenylether	17	17		17	17			
BDE 100	2,2',4,4',6-pentabromodiphenylether	17	17		17	17			
BDE 105	2,3,3',4,4'-pentabromodiphenylether	17	17		17	17			
BDE 116	2,3,4,5,6-pentabromodiphenylether	17	17		17	17			
BDE 119	2,3',4,4',6-pentabromodiphenylether	17	17		17	17			
BDE 126	3,3',4,4',5-pentabromodiphenylether	17	17		17	17			
BDE 140	2,2',3,4,4',6'-hexabromodiphenylether	17	17		17	17			
BDE 153	2,2',4,4',5,5'-hexabromodiphenylether	17	17		17	17			
BDE 154	2,2',4,4',5',6-hexabromodiphenylether	17	17		17	17			
BDE 155	2,2',4,4',6,6'-hexabromodiphenylether	17	17		17	17			
BDE 166	2,3,4,4',5,6-hexabromodiphenylether	17	17		17	17			
BDE 181	2,2',3,4,4',5,6-heptabromodiphenylether	17	17		17	17			

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TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
BDE-183 2,2',3,4,4',5',6-heptabromodiphenylether	17	17		17	17			
BDE 190 2,3,3',4,4',5,6-heptabromodiphenylether	17	17		17	17			
BDE 206 2,2',3,3',4,4',5,5',6-nonabromodiphenylether	17	17		17	17			
BDE 207 2,2',3,3',4,4',5,6,6'-nonabromodiphenylether	17	17		17	17			
BDE 208 2,2',3,3',4,5,5',6,6'-nonabromodiphenylether	17	17		17	17			
BDE 209 Decabromodiphenylether	17	17		17	17			
PFC – Perfluorinated Organic Compounds								
Perfluorobutanoate (PFBA)	14	12		13	23			
Perfluoropentanoate (PFPeA)	14	12		13	23			
Perfluorohexanoate (PFHxA)	14	12		13	23			
Perfluoroheptanoate (PFHpA)	14	12		13	23			
Perfluorooctanoate (PFOA)	14	12		13	23			
Perfluorononanoate (PFNA)	14	12		13	23			
Perfluorodecanoate (PFDA)	14	12		13	23			
Perfluoroundecanoate (PFUnA)	14	12		13	23			
Perfluorododecanoate (PFDoA)	14	12		13	23			
Perfluorobutanesulfonate (PFBS)	14	12		13	23			
Perfluorohexanesulfonate (PFHxS)	14	12		13	23			
Perfluorooctanesulfonate (PFOS)	14	12		13	23			
Perfluorooctane sulfonamide (PFOSA)	14	12		13	23			
PAH								
Anthracene		18		18				
Pyrene		18		18				
Benzo[ghi]perylene		18		18				
Benzo[e]pyrene		18		18				
Indeno[1,2,3-cd]pyrene		18		18				
Perylene		18		18				
Benzo[b]fluoranthene		18		18				
Fluoranthene		18		18				
Benzo[k]fluoranthene				18				
Acenaphthylene		18		18				
Chrysene		18		18				
Benzo[a]pyrene		18		18				

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TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
Dibenz[ah]anthracene		18		18				
Benz[a]anthracene		18		18				
Acenaphthene		18		18				
Phenanthrene		18		18				
Fluorene		18		18				
Naphthalene		18		18				
PPCP (Pharmaceutical and Personal Care Products)								
Acetaminophen	19	19						
Azithromycin	19	19						
Caffeine	19	19						
Carbadox	19	19						
Carbamazepine	19	19						
Cefotaxime	19	19						
Ciprofloxacin	19	19						
Clarithromycin	19	19						
Clinafloxacin	19	19						
Cloxacillin	19	19						
Dehydronifedipine	19	19						
Digoxigenin	19	19						
Digoxin	19	19						
Diltiazem	19	19						
1,7-Dimethylxanthine	19	19						
Diphenhydramine	19	19						
Enrofloxacin	19	19						
Erythromycin	19	19						
Flumequine	19	19						
Fluoxetine	19	19						
Lincomycin	19	19						
Lomefloxacin	19	19						
Miconazole	19	19						
Norfloxacin	19	19						
Norgestimate	19	19						
Ofloxacin	19	19						
Ormetoprim	19	19						

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TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
Oxacillin	19	19						
Oxolinic acid	19	19						
Penicillin G	19	19						
Penicillin V	19	19						
Roxithromycin	19	19						
Sarafloxacin	19	19						
Sulfachloropyridazine	19	19						
Sulfadiazine	19	19						
Sulfadimethoxine	19	19						
Sulfamerazine	19	19						
Sulfamethazine	19	19						
Sulfamethizole	19	19						
Sulfamethoxazole	19	19						
Sulfanilamide	19	19						
Sulfathiazole	19	19						
Thiabendazole	19	19						
Trimethoprim	19	19						
Tylosin	19	19						
Virginiamycin	19	19						
Anhydrochlortetracycline (ACTC)	19	19						
Anhydrotetracycline (ATC)	19	19						
Chlortetracycline (CTC)	19	19						
Demeclocycline	19	19						
Doxycycline	19	19						
4-Epianhydrochlortetracycline (EACTC)	19	19						
4-Epianhydrotetracycline (EATC)	19	19						
4-Epichlortetracycline (ECTC)	19	19						
4-Epioxytetracycline (EOTC)	19	19						
4-Epitetracycline (ETC)	19	19						
Isochlortetracycline (ICTC)	19	19						
Minocycline	19	19						
Oxytetracycline (OTC)	19	19						
Tetracycline (TC)	19	19						

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TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
Bisphenol A	19	19						
Furosemide	19	19						
Gemfibrozil	19	19						
Glipizide	19	19						
Glyburide	19	19						
Hydrochlorothiazide	19	19						
2-hydroxy-ibuprofen	19	19						
Ibuprofen	19	19						
Naproxen	19	19						
Triclocarban	19	19						
Triclosan	19	19						
Warfarin	19	19						
Albuterol	19	19						
Amphetamine	19	19						
Atenolol	19	19						
Atorvastatin	19	19						
Cimetidine	19	19						
Clonidine	19	19						
Codeine	19	19						
Cotinine	19	19						
Enalapril	19	19						
Hydrocodone	19	19						
Metformin	19	19						
Oxycodone	19	19						
Ranitidine	19	19						
Triamterene	19	19						
Alprazolam	19	19						
Amitriptyline	19	19						
Amlodipine	19	19						
Benzoylecgonine	19	19						
Benztropine	19	19						
Betamethasone	19	19						
Cocaine	19	19						

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TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
DEET (N,N-diethyl-m-toluamide)	19	19						
Desmethyldiltiazem	19	19						
Diazepam	19	19						
Fluocinonide	19	19						
Fluticasone propionate	19	19						
Hydrocortisone	19	19						
10-hydroxy-amitriptyline	19	19						
Meprobamate	19	19						
Methylprednisolone	19	19						
Metoprolol	19	19						
Norfluoxetine	19	19						
Norverapamil	19	19						
Paroxetine	19	19						
Prednisolone	19	19						
Prednisone	19	19						
Promethazine	19	19						
Propoxyphene	19	19						
Propranolol	19	19						
Sertraline	19	19						
Simvastatin	19	19						
Theophylline	19	19						
Trenbolone	19	19						
Trenbolone acetate	19	19						
Valsartan	19	19						
Verapamil	19	19						
HBCDD								
alpha-hexabromocyclododecane (a-HBCDD)					24			
beta-hexabromocyclododecane (b-HBCDD)					24			
gamma-hexabromocyclododecane (g-HBCDD)					24			
TBBPA								
Tetrabromobisphenol A					25			

TABLE 2	Canadian Association for Laboratory Accreditation (CALA)						Washington State Department of Ecology	
	Accreditation no.: A 2637						Lab. ID: C404	
	W	S	Pulp	T	Ser	U	NP W	S
BPA and MPE								
4,4'-dihydroxy-2,2-diphenylpropane (Bisphenol A) (BPA)						26		
Mono-(2-ethyl-5-hydroxyhexyl) phthalate (MEHHP)						26		
Mono-(2-ethyl-5-oxohexyl) phthalate (MEOHP)						26		
Mono-(3-carboxypropyl) phthalate (MCPP)						26		
Mono-2-ethylhexyl phthalate (MEHP)						26		
Mono-benzyl phthalate (MBzP)						26		
Mono-butyl phthalate (MBP) (n + iso)						26		
Mono-cyclohexyl phthalate (MCHP)						26		
Mono-ethyl phthalate (MEP)						26		
Mono-iso-nonyl phthalate (MiNP)						26		
Mono-methyl phthalate (MMP)						26		
Parabens								
Benzylparaben (Benzyl 4-hydroxybenzoate)						27		
Butylparaben (n-Butyl 4-hydroxybenzoate and isobutyl 4-hydroxybenzoate)						27		
Ethylparaben (Ethyl 4-hydroxybenzoate)						27		
Isopropylparaben (Isopropyl 4-hydroxybenzoate)						27		
Methylparaben (Methyl 4-hydroxybenzoate)						27		
n-Propylparaben (Propyl 4-hydroxybenzoate)						27		

Table 1 and Table 2 - Explanation of Terms Used:

- NELAP = National Environmental Laboratory Accreditation Program
- Non-potable water = water not fit for consumption without treatment as it may contain pollutants, contaminants, minerals or infective agents. Surface water, ground water, rainwater, effluents as well as any other non-drinking water sources are included in this category.
- Solid = environmental solid sample. Soil, sediment, biosolids, hazardous waste, mixed phase samples with significant solids content are included in this category.
- Performance based implementation = methodology follows that of the method reference but modifications deemed by AXYS as minor [1] may apply, results meet method reference data quality standard.

- Performance based modification = modifications deemed by AXYS as significant[2] have been made to method reference protocol, results meet method reference accuracy standard. The suitability of the methodology for any method prescriptive applications should be assessed based on the modifications made and the specific work requirements.
- Performance based method = an in-house AXYS method, published method reference not applicable.
- GC/LRMS = gas chromatography, low resolution mass spectrometry detection.
- GC/HRMS = gas chromatography, high resolution mass spectrometry detection.
- GC/ECD = gas chromatography, electron capture detection.
- LC/MS-MS = liquid chromatography, mass spectrometry-mass spectrometry detection.

Note 1:

Performance Based Implementation - Examples of Minor Modifications

- use of additional isotopically labeled references
- adjustment of calibration range
- adjustment of clean-up technique
- use of a different extraction of same general type (example soxhlet vs soxhlet Dean Stark)
- addition of matrix type using same principles (example addition of tissue matrix using same detection principle and similar extraction type)

Note 2:

Performance Based Modification - Examples of Significant Modifications

- different acquisition conditions using same detection principle (example MS SIM vs. full scan)
- different internal control limits while meeting method reference accuracy standard

Appendix A3

Crab and Fish Data

Table A3.1 **Data collected during fish dissections, Howe Sound EEM Cycle Six, June 2012.**

Howe Sound Dioxin/Furan Dissection Data 2012 (HS1625)

Station	Composite #	Crab ID #	Dissection Date (dd/mm/yy)	Dissection Time	Carapace Width (mm)	Total weight (g)	Sex	Sampled Hepatopancreas Weight (g)*	Muscle Tissue Archived	Health Assessment Information														
										Carapace					Chelae				Legs				Internal	
										State	exterior	Lesions	Barnacles	Colour	exterior	Lesions	Barnacles	Colour	exterior	Lesions	Barnacles	Colour	Gill fouling	Hepato colour
C9	HS1625 C9	C9-1	24-04-2012	14:13	192	728.2	M	23.1	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	light	hard	0	0	light	black	brown/black
C9	HS1625 C9	C9-2	24-04-2012	14:20	173	548.6	M	16.5	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	light	hard	0	0	light	light	brown/black
C9	HS1625 C9	C9-3	24-04-2012	14:25	185	675.6	M	22.3	Chelae	Previously fro:	hard	0	0	light	hard	0	0	medium	hard	0	0	medium	medium	green
C9	HS1625 C9	C9-4	24-04-2012	14:30	203	930	M	20.3	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	light	hard	0	0	light	light	tan
C9	HS1625 C9	C9-5	24-04-2012	14:34	191	729.6	M	16.7	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	light	hard	0	0	light	light	white/cream
C9	HS1625 C9	C9-6	24-04-2012	14:41	197	872.6	M	18	Chelae	Previously fro:	hard	0	0	light	hard	0	0	light	hard	0	0	light	light	yellow
C9	HS1625 C9	C9-7	24-04-2012	14:47	179	644.8	M	14.5	Chelae	Previously fro:	hard	0	0	light	hard	<5	0	medium	hard	<5	0	medium	medium	orange/red
C9	HS1625 C9	C9-8	24-04-2012	14:54	191	809.2	M	15.8	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	medium	hard	<5	0	medium	heavy	green
C10	HS1625 C10	C10-1	24-04-2012	15:43	167	577.8	M	10.6	Chelae	Previously fro:	hard	0	0	medium	hard	<5	<5	medium	hard	<5	0	medium	heavy	orange/red
C10	HS1625 C10	C10-2	24-04-2012	15:47	194	755.9	M	17.7	Chelae	Previously fro:	hard	<5	<5	light	hard	<5	0	dark	hard	>10	0	dark	black	orange/red
C10	HS1625 C10	C10-3	24-04-2012	15:52	184	670.3	M	14.4	Chelae	Previously fro:	hard	0	0	medium	hard	<5	0	dark	hard	>10	0	dark	black	orange/red
C10	HS1625 C10	C10-4	24-04-2012	15:56	190	779.1	M	35.9	Chelae	Previously fro:	hard	<5	0	dark	hard	0	0	medium	hard	5-10	0	medium	medium	yellow
C10	HS1625 C10	C10-5	24-04-2012	16:01	180	609.8	M	21.1	Chelae	Previously fro:	hard	0	0	light	hard	0	0	light	hard	<5	0	light	light	brown/black
C10	HS1625 C10	C10-6	24-04-2012	16:05	192	880.3	M	16.7	Chelae	Previously fro:	hard	0	0	medium	hard	5-10	0	dark	hard	>10	0	dark	black	yellow
C10	HS1625 C10	C10-7	27-04-2012	nd	192	791.9	M	22	Chelae	Previously fro:	hard	<5	0	medium	hard	<5	0	medium	hard	>10	0	medium	black	orange/red
C10	HS1625 C10	C10-8	27-04-2012	15:25	180	664	M	19.8	Chelae	Previously fro:	hard	<5	0	medium	hard	<5	nd	medium	soft	>10	0	dark	black	orange/red
C14	HS1625 C14	C14-1	24-04-2012	15:25	186	751.6	M	21.3	Chelae	Previously fro:	hard	<5	0	light	hard	<5	0	medium	hard	>10	0	medium	heavy	brown/black
C14	HS1625 C14	C14-2	24-04-2012	15:31	180	619.9	M	15.6	Chelae	Previously fro:	hard	0	<5	medium	hard	0	<5	light	hard	<5	0	light	medium	orange/red
C14	HS1625 C14	C14-3	24-04-2012	15:35	175	642.1	M	8.3	Chelae	Previously fro:	hard	0	<5	light	hard	5-10	0	medium	hard	>10	0	medium	black	orange/red
C14	HS1625 C14	C14-4	27-04-2012	14:20	185	765.6	M	22	Chelae	Previously fro:	hard	<5	0	light	hard	<5	0	medium	hard	>10	0	light	heavy	yellow
C14	HS1625 C14	C14-5	27-04-2012	14:30	183	725.2	M	24.5	Chelae	Previously fro:	hard	0	0	dark	hard	<5	0	light	hard	<5	0	light	heavy	brown/black
C14	HS1625 C14	C14-6	27-04-2012	14:37	188	721	M	25	Chelae	Previously fro:	hard	0	0	dark	hard	0	0	medium	hard	<5	0	light	light	brown/black
C14	HS1625 C14	C14-7	27-04-2012	14:45	178	691.7	M	20.8	Chelae	Previously fro:	hard	<5	<5	medium	hard	<5	0	light	hard	<5	0	light	heavy	yellow
C14	HS1625 C14	C14-8	27-04-2012	14:51	201	924	M	17.2	Chelae	Previously fro:	hard	0	0	light	hard	0	0	medium	hard	0	0	light	light	brown/black
C14	HS1625 C14	C14-9	27-04-2012	15:00	175	679.3	M	21.3	Chelae	Previously fro:	hard	0	<5	dark	hard	<5	0	medium	hard	<5	0	medium	heavy	brown/black
C16a	HS1625 C16a	C16a-1	24-04-2012	11:07	172	610.3	M	26.9	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	light	hard	0	0	light	heavy	orange/red
C16a	HS1625 C16a	C16a-2	24-04-2012	11:12	187	688.4	M	19.4	Chelae	Previously fro:	hard	0	0	light	hard	0	0	light	hard	0	0	light	clean	tan
C16a	HS1625 C16a	C16a-3	24-04-2012	11:17	172	621	M	18.5	Chelae	Previously fro:	hard	0	<5	light	hard	<5	0	medium	hard	5-10	0	medium	heavy	tan
C16a	HS1625 C16a	C16a-4	24-04-2012	11:22	180	666.4	M	14	Chelae	Previously fro:	hard	0	<5	light	hard	<5	<5	medium	hard	>10	0	medium	medium	orange/red
C16a	HS1625 C16a	C16a-5	24-04-2012	11:27	181	645.9	M	14.7	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	medium	hard	5-10	0	medium	medium	brown/black
C16a	HS1625 C16a	C16a-6	24-04-2012	11:31	194	744.3	M	17.1	Chelae	Previously fro:	hard	<5	<5	medium	hard	<5	<5	dark	hard	>10	<5	dark	black	orange/red
C16a	HS1625 C16a	C16a-7	24-04-2012	11:36	183	683.3	M	18.8	Chelae	Previously fro:	hard	0	0	light	hard	0	<5	medium	hard	<5	0	medium	medium	orange/red
C16a	HS1625 C16a	C16a-8	24-04-2012	11:41	197	814	M	19.9	Chelae	Previously fro:	hard	0	<5	medium	hard	<5	0	dark	hard	>10	0	dark	medium	orange/red
C16a	HS1625 C16a	C16a-9	24-04-2012	11:44	193	801	M	16.7	Chelae	Previously fro:	hard	0	0	medium	hard	<5	0	medium	hard	>10	0	medium	medium	orange/red
C16a	HS1625 C16a	C16a-10	24-04-2012	11:47	188	760.5	M	23.8	Chelae	Previously fro:	hard	0	0	light	hard	<5	<5	dark	hard	5-10	0	dark	medium	orange/red

Table A3.1 (Cont'd.)

Howe Sound Dioxin/Furan Dissection Data 2012 (HS1625)

										Health Assessment Information													
										Carapace					Chelae				Legs				Internal	
Station	Composite #	Crab ID #	Dissection Date (dd/mm/yy)	Dissection Time	Carapace Width (mm)	Total weight (g)	Sex	Sampled Hepatopancreas Weight (g)*	Muscle Tissue Archived	State	exterior	Lesions	Barnacles	Colour	exterior	Lesions	Barnacles	Colour	exterior	Lesions	Barnacles	Colour	Gill fouling	Hepato colour
C19a	HS1625 C19a	C19a-1	24-04-2012	15:04	203	918.1	M	14.7	Chelae	Previously fro:	hard	0	<5	medium	hard	<5	0	medium	hard	>10	0	medium	heavy	tan
C19a	HS1625 C19a	C19a-2	24-04-2012	15:09	176	659.6	M	12.4	Chelae	Previously fro:	hard	0	0	light	hard	<5	0	dark	hard	5-10	0	dark	black	tan
C19a	HS1625 C19a	C19a-3	24-04-2012	15:13	189	657.3	M	8	Chelae	Previously fro:	hard	0	0	medium	hard	5-10	0	medium	hard	>10	0	medium	heavy	orange/red
C19a	HS1625 C19a	C19a-4	24-04-2012	15:17	183	704.9	M	12.5	Chelae	Previously fro:	hard	0	<5	medium	hard	<5	<5	medium	hard	5-10	0	medium	heavy	tan
C19a	HS1625 C19a	C19a-5	27-04-2012	13:05	198	871.4	M	10.4	Chelae	Previously fro:	hard	0	<5	light	hard	<5	0	medium	hard	<5	0	light	medium	tan
C19a	HS1625 C19a	C19a-6	27-04-2012	13:20	190	825.5	M	20	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	light	hard	5-10	0	light	light	white/cream
C19a	HS1625 C19a	C19a-7	27-04-2012	13:27	185	635.1	M	9.5	Chelae	Previously fro:	hard	0	0	medium	hard	<5	0	light	hard	5-10	0	light	medium	tan
C19a	HS1625 C19a	C19a-8	27-04-2012	13:44	190	870.9	M	20	Chelae	Previously fro:	hard	0	0	medium	hard	<5	0	medium	hard	<5	0	medium	heavy	yellow
C19a	HS1625 C19a	C19a-9	27-04-2012	13:53	206	974.4	M	28.3	Chelae	Previously fro:	hard	0	0	light	hard	0	0	light	hard	5-10	0	light	light	orange/red
C19a	HS1625 C19a	C19a-10	27-04-2012	14:05	181	694.1	M	18.7	Chelae	Previously fro:	hard	0	0	medium	hard	<5	0	medium	hard	<5	0	light	heavy	orange/red
C21	HS1625 C21	C21-1	24-04-2012	13:32	218	1256.5	M	32.2	Chelae	Previously fro:	hard	nd	0	light	hard	<5	0	light	hard	5-10	0	light	heavy	yellow
C21	HS1625 C21	C21-2	24-04-2012	13:46	185	638.7	M	20.7	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	light	hard	0	0	light	clean	yellow
C21	HS1625 C21	C21-3	24-04-2012	13:53	184	736.4	M	24.3	Chelae	Previously fro:	hard	nd	<5	dark	hard	<5	<5	medium	hard	5-10	0	medium	medium	green
C21	HS1625 C21	C21-4	24-04-2012	14:00	217	1102.6	M	28.8	Chelae	Previously fro:	hard	0	0	medium	hard	<5	0	light	hard	5-10	0	light	light	yellow
C21	HS1625 C21	C21-5	27-04-2012	8:00	180	709.6	M	18.5	Chelae	Previously fro:	hard	0	5-10	light	hard	0	<5	light	hard	<5	<5	light	black	tan
C21	HS1625 C21	C21-6	27-04-2012	8:25	185	709.3	M	17.2	Chelae	Previously fro:	hard	0	<5	medium	hard	0	<5	light	hard	<5	0	light	medium	orange/red
C21	HS1625 C21	C21-7	27-04-2012	8:40	207	974	M	21.9	Chelae	Previously fro:	hard	0	0	light	hard	<5	0	light	hard	<5	0	light	medium	tan
C21	HS1625 C21	C21-8	27-04-2012	9:00	181	646.6	M	24	Chelae	Previously fro:	hard	0	0	light	hard	0	0	light	hard	0	0	light	light	brown/black
C21	HS1625 C21	C21-9	27-04-2012	9:15	195	778.7	M	10.5	Chelae	Previously fro:	hard	<5	0	medium	hard	<5	0	medium	hard	<5	0	light	medium	orange/red
C21	HS1625 C21	C21-10	27-04-2012	9:30	190	802.9	M	20	Chelae	Previously fro:	hard	0	<5	medium	hard	0	5-10	light	hard	<5	0	light	medium	orange/red
C27	HS1625 C27	C27-1	27-04-2012	15:37	175	625.9	M	10.7	Chelae	Previously fro:	hard	<5	0	medium	hard	0	0	medium	hard	<5	0	medium	heavy	tan
C28	HS1625 C28	C28-1	24-04-2012	16:28	187	720.3	M	13.8	Chelae	Previously fro:	hard	0	0	light	hard	0	0	light	hard	5-10	0	light	heavy	yellow
C28	HS1625 C28	C28-2	24-04-2012	16:33	178	614.5	M	14.1	Chelae	Previously fro:	hard	0	0	light	hard	<5	0	medium	hard	<5	0	medium	medium	orange/red
C28	HS1625 C28	C28-3	24-04-2012	16:38	194	869.6	M	20.8	Chelae	Previously fro:	hard	0	0	medium	hard	<5	0	medium	hard	5-10	0	medium	heavy	orange/red
C28	HS1625 C28	C28-4	24-04-2012	16:45	180	605.8	M	23.5	Chelae	Previously fro:	hard	0	0	light	hard	<5	0	light	hard	0	0	light	light	tan
C28	HS1625 C28	C28-5	24-04-2012	16:49	182	793.7	M	23.6	Chelae	Previously fro:	hard	0	0	medium	hard	0	0	medium	hard	<5	0	medium	light	yellow

Table A3.2 Data collected during Dungeness crab dissections, Howe Sound EEM Cycle Six, June 2012.

Howe Sound Dioxin/Furan Finfish Dissection Data 2012 (HS1625)

Station	Location	Species	Fish ID #	Liver Tissue Sample ID #	Muscle Tissue Sample ID #	Dissection Date (dd/mm/yy)	Dissection Time	Total Length (mm)	Total weight (g)	Clasper	Sex	Sampled Liver Weight (g)	Sampled Muscle Weight (g)
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-1	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	9:54	730	1352.6	y	m	12.7	11.0
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-2	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	10:52	746	1674.1	y	m	13.8	10.2
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-3	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	11:10	792	1811.2	y	m	13.6	12.8
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-4	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	11:23	807	2518.0	n	m	10.9	11.1
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-5	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	11:42	812	2509.9	n	f	11.6	12.7
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-6	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	11:58	704	1235.4	y	m	10.2	10.4
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-7	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	12:11	760	1733.5	y	m	12.1	10.3
T9	Queen Charlotte Ch.	Spiny Dogfish	T9-8	HS1625-T9-DF-Liver	HS1625-T9-DF-Tissue	27-04-2012	12:23	677	1159.0	y	m	10.2	10.6

Table A3.2 (Cont'd.)

Archived	State	External HAI			Internal HAI						
		Fins	Skin	Eyes	Fat	Parasites	Liver	Gall	Spleen	Kidney	Hindgut
spines	Previously frozen	no eros.	mild abber.	normal/clear	no fat	none	normal	half, blue green	dk red	normal	normal
spines	Previously frozen	no eros.	normal	normal/clear	no fat	none	normal	empty, grass green	dk red	normal	normal
spines	Previously frozen	lt eros.	normal	opaque	no fat	numerous, gut	normal	full, blue green	dk red	normal	normal
spines	Previously frozen	lt eros.	normal	normal/clear	no fat	moderate	normal	empty, blue	dk red	granular	normal
spines	Previously frozen	no eros.	normal	normal/clear	<50	none	normal	empty, yellow	dk red	other	normal
spines	Previously frozen	no eros.	normal	normal/clear	no fat	few, gut	normal	full, blue green	dk red	normal	normal
spines	Previously frozen	lt eros.	normal	normal/clear	no fat	none	normal	full, blue green	dk red	normal	normal
spines	Previously frozen	no eros.	normal	normal/clear	no fat	none	normal	full, yellow	dk red	normal	normal

Appendix A4

Benthic Invertebrate Data and QA/QC Reports

Table A4.1 **Grab locations for benthic and sediment samples with corresponding *in situ* water quality, Howe Sound EEM Cycle Six, March 2012.**

Site	Date	Coordinates		Grab #	Grab depth (m)	WQ Depth (m)	D.O. mg/L	D.O. %	Temp (°C)	pH	Salinity
		Latitude	Longitude								
HSB21	3/16/2012	49 27 230	123 24 881	1	130.4	19.07	7.03	74.3	10.06	7.07	28.94
HSB21	3/16/2012	49 27 181	123 24 843	2	133.5						
HSB21	3/16/2012	49 27 215	123 24 863	3	131.7						
HSB19	3/13/2012	49 26 636	123 18 503	1	128	Surface	9.85	84	6.25	7.9	26.79
HSB19	3/13/2012	49 26 604	123 18 504	2	76.5						
HSB19	3/13/2012	49 26 576	123 18 442	3	109.7						
HSB7A	3/13/2012	49 32 33.9	123 26 491	1	117	19.07	8.97	76.2	5.48	8.06	27
HSB7A	3/13/2012	49 32 33.2	123 26 475	2	133.5						
HSB7A	3/13/2012	49 32 33.9	123 26 587	3	115.2						
HSB17	3/13/2012	49 27 086	123 27 933	1	54.9	19.07	7.73	71.9	6.52	7.71	25.45
HSB17	3/13/2012	49 27 095	123 27 983	2	42.6						
HSB17	3/13/2012	49 27 078	123 27 994	3	36.6						
HSB8A	3/13/2012	49 31 807	123 27 830	1	142.6	19.07	8.7	77	6.57	7.8	25.52
HSB8A	3/13/2012	49 31 769	123 27 814	2	173.7						
HSB8A	3/13/2012	49 31 751	123 27 831	3	181						
HSB18	3/14/2012	49 30 172	123 18 152	1	59.6	19.07	7.6	75.3	6.38	7.3	26.58
HSB18	3/14/2012	49 30 151	123 18 048	2	60						
HSB18	3/14/2012	49 30 169	123 18 108	3	38						
HSB20	3/14/2012	49 34 288	123 19 480	1	168.2	19.07	8.13	80.7	6.39	7.99	26.45
HSB20	3/14/2012	49 34 338	123 19 436	2	164.6						
HSB20	3/14/2012	49 34 304	123 19 509	3	166.4						
HSB16	3/14/2012	49 32 092	123 22 488	1	158.2	19.07	7.55	75.9	6.28	8.01	26.96
HSB16	3/14/2012	49 32 092	123 22 488	2	170.8						
HSB16	3/14/2012	49 32 092	123 22 488	3	142.8						
HSB11A	3/15/2012	49 29 256	123 28 150	1	77.2	19.07	7.52	78.1	7.00	8.05	26.13
HSB11A	3/15/2012	49 29 256	123 28 150	2	184.7						
HSB11A	3/15/2012	49 29 256	123 28 150	3	188.4						
HSB10A	3/15/2012	49 30 440	123 29 148	1	190.2	19.07	7.6	73.4	7.00	8.00	26.39
HSB10A	3/15/2012	49 30 440	123 29 148	2	190.2						
HSB10A	3/15/2012	49 30 440	123 29 148	3	188.4						
HSB10	3/15/2012	49 31 021	123 28 544	1	204.8	19.07	7.63	76.5	6.67	8.25	26.8
HSB10	3/15/2012	49 31 068	123 28 542	2	193.8						
HSB10	3/15/2012	49 31 031	123 28 543	3	203.0						

Table A4.2 **Benthic invertebrate densities (#N/m^2) from each replicate at each site; Howe Sound EEM Cycle Six, June 2012.**

	HSB7A						HSB8						HSB8A						HSB10					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Family	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Ampeliscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0	0	0
Ampharetidae	23.08	23.08	11.54	11.54	57.7	0	80.78	0	0	0	92.32	0	138.48	0	0	0	34.62	0	0	0	46.16	0	46.16	0
Amphiuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anarthruridae	0	0	0	0	23.08	0	46.16	0	0	0	0	0	0	0	46.16	0	46.16	0	0	0	0	0	0	0
Aoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barentsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bodotriidae	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bougainvilliidae	0	0	0	0	0	0	0	0	46.16	0	23.08	0	0	0	0	0	0	0	11.54	0	92.32	0	11.54	0
Bugulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calloporidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanulariidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	46.16	0
Cancellothyrididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Candidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capitellidae	46.16	0	276.96	0	473.14	0	980.9	0	3058.1	0	1027.06	11.54	138.48	0	346.2	0	288.5	0	2134.9	0	1373.26	46.16	1165.54	150.02
Cardiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0	11.54	0
Chirodotidae	0	0	0	0	11.54	0	0	0	34.62	92.32	23.08	138.48	0	0	0	0	0	0	57.7	46.16	80.78	0	115.4	0
Cirratulidae	23.08	0	46.16	0	23.08	0	46.16	0	796.26	727.02	161.56	23.08	0	0	138.48	46.16	138.48	0	196.18	0	57.7	219.26	0	184.64
Columbellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conidae	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cossuridae	11.54	0	0	0	0	0	0	0	0	0	0	0	334.66	0	600.08	0	288.5	0	138.48	0	0	0	0	0
Cuspidariidae	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cylichnidae	11.54	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cylindroleberididae	0	0	0	0	23.08	0	46.16	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	0	0	0	0	0	0	138.48	0	934.74	69.24	207.72	0	0	0	0	0	23.08	0	507.76	0	57.7	0	230.8	0
Edwardsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emplectonematidae	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eusiridae	0	0	0	0	0	0	0	0	0	0	34.62	0	0	0	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	0	0	0	0	0	0	0	0	46.16	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Gadilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0
Galatheidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glyceridae	23.08	11.54	115.4	0	46.16	0	23.08	0	126.94	34.62	115.4	0	23.08	0	207.72	0	80.78	0	196.18	0	0	0	126.94	0
Gnathiidae	0	0	0	0	0	0	0	0	0	103.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Golfingiidae	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0
Goniadidae	23.08	0	0	0	0	0	57.7	0	11.54	0	0	0	34.62	0	92.32	0	0	0	57.7	0	23.08	0	80.78	0
Halacaridae	0	0	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haminoeidae	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hesionidae	0	11.54	11.54	0	0	0	0	0	0	11.54	23.08	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Hiatellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hippothoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoplonemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lasaeidae	0	0	0	0	0	0	0	0	46.16	0	69.24	0	0	0	0	0	0	0	0	23.08	92.32	46.16	46.16	115.4
Leptoplanidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leuconidae	253.88	0	34.62	0	46.16	0	0	0	0	0	0	0	623.16	0	276.96	0	46.16	0	0	0	0	0	46.16	0
Limidae	0	0	11.54	0	57.7	23.08	11.54	0	46.16	0	11.54	0	69.24	0	92.32	0	11.54	0	57.7	0	46.16	0	103.86	0
Limnoriidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	46.16	0	0	0
Lineidae	0	0	34.62	0	0	0	11.54	0	34.62	11.54	23.08	23.08	23.08	0	0	0	0	0	0	0	23.08	0	0	0
Lucinidae	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0
Lumbrineridae	115.4	0	34.62	0	184.64	23.08	323.12	0	57.7	0	69.24	0	323.12	0	461.6	0	161.56	0	242.34	0	80.78	0	161.56	0
Lyonsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysianassidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magelonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maldanidae	11.54	0	0	0	0	0	57.7	0	11.54	0	69.24	0	46.16	0	0	0	126.94	0	0	0	0	0	0	0
Melitidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molpadiidae	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Mytilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nannastacidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	46.16	0	0	0	0
Nephtyidae	11.54	0	69.24	0	46.16	0	0	0	23.08	0	0	0	69.24	0	92.32	0	34.62	0	46.16	0	0	0	0	0

Table A4.2 (Cont'd.)

	HSB7A						HSB8						HSB8A						HSB10					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Family	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Nereididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nototanaidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuculidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nymphonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oedicerotidae	0	0	11.54	0	0	0	0	0	0	0	46.16	0	46.16	0	0	0	0	0	92.32	0	0	0	57.7	0
Oenonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olindiasidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Onuphidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	11.54	0	46.16	0	0	0
Opheliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orbiniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oweniidae	727.02	773.18	34.62	0	138.48	92.32	1246.32	138.48	0	0	0	0	173.1	0	150.02	0	115.4	0	230.8	0	323.12	0	103.86	0
Paleonemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraonidae	57.7	0	103.86	0	23.08	0	0	0	115.4	0	34.62	0	265.42	0	969.36	0	242.34	0	184.64	0	46.16	0	92.32	0
Paratanaidae	0	0	0	0	0	0	0	0	276.96	0	0	0	0	0	0	0	0	0	0	0	92.32	0	196.18	0
Pardaliscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pectinariidae	0	0	0	0	23.08	0	57.7	0	23.08	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0
Pectinidae	0	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philomedidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pholadidae	0	0	0	0	0	0	0	0	34.62	0	0	0	0	0	0	0	0	0	0	0	46.16	0	46.16	0
Pholoidae	0	0	0	0	0	0	0	0	138.48	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0
Phoronidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phoxocephalidae	34.62	0	0	0	346.2	0	392.36	0	0	11.54	138.48	0	219.26	0	230.8	0	138.48	0	46.16	0	380.82	0	57.7	80.78
Phyllodocidae	0	0	0	0	23.08	0	0	0	57.7	0	23.08	0	0	0	0	0	0	0	46.16	0	0	0	92.32	0
Phyllophoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0
Pilargidae	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0
Polynoidae	0	0	0	0	0	0	11.54	0	69.24	0	23.08	0	0	0	0	0	0	0	0	0	0	0	11.54	0
Prosorhochmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulsellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyramidellidae	0	0	11.54	0	0	0	46.16	0	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0	0	0
Rhabdidae	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0
Rissoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sabellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scalibregmatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schizasteridae	0	0	23.08	0	11.54	0	23.08	0	0	0	11.54	23.08	0	0	57.7	0	138.48	0	80.78	0	23.08	0	23.08	0
Sigalionidae	0	0	0	0	0	0	0	0	46.16	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0
Solemyidae	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spionidae	0	0	103.86	0	46.16	0	230.8	46.16	1938.72	57.7	346.2	0	138.48	0	473.14	0	184.64	0	461.6	0	253.88	0	276.96	0
Sternaspidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Syllidae	0	0	0	0	0	0	0	0	69.24	0	23.08	0	0	0	0	0	0	0	0	0	92.32	0	57.7	0
Synopiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellinidae	0	0	23.08	23.08	0	23.08	0	0	46.16	0	23.08	0	0	0	0	0	0	0	0	0	0	46.16	0	0
Terebellidae	0	0	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0	0	0	0	0	92.32	46.16	0	0
Tetrastemmatidae	0	0	0	0	0	0	0	0	57.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thyasirisae	11.54	0	0	0	0	0	46.16	0	0	0	0	0	92.32	0	0	0	0	0	0	0	0	0	0	0
Trichobranchidae	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triticellidae	0	0	0	0	0	0	46.16	0	300.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trochochaetidae	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubulanidae	11.54	0	11.54	0	46.16	46.16	46.16	0	11.54	11.54	0	0	34.62	0	92.32	92.32	11.54	34.62	46.16	46.16	46.16	0	0	0
Veneridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vesicularíidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yoldiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jasmineira pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phyllochaetopterus pottsi	34.62	0	0	0	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0	92.32	0	46.16	0	0	0
Tubificoid Naididae indet.	0	0	0	0	0	0	0	0	57.7	0	46.16	23.08	0	0	0	0	0	0	0	0	0	0	0	0
Sipuncula indet.	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia indet.	0	0	0	0	0	0	0	0	0	69.24	0	0	0	0	0	0	0	0	0	11.54	0	23.08	0	0
Ostracoda indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryozoa indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ophiuroidea indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Density	**1523.28**	**819.34**	**1003.98**	**34.62**	**1673.3**	**207.72**	**4027.46**	**230.8**	**8678.08**	**1223.24**	**2758.06**	**242.34**	**2838.84**	**46.16**	**4442.9**	**138.48**	**2157.98**	**34.62**	**4985.28**	**173.1**	**3508.16**	**426.98**	**3219.66**	**530.84**
Taxa Richness	**22**	**4**	**21**	**2**	**20**	**5**	**24**	**3**	**36**	**13**	**27**	**6**	**20**	**2**	**19**	**2**	**21**	**1**	**24**	**5**	**24**	**6**	**25**	**4**

Table A4.2 (Cont'd.)

	HSB10A						HSB11A						HSB16						HSB17						HSB18					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Family	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Ampeliscidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	34.62	0	11.54	0	11.54	0	23.08	0	57.7	0
Ampharetidae	46.16	0	0	0	11.54	0	0	0	0	0	0	0	23.08	0	57.7	11.54	0	0	11.54	0	0	0	0	0	11.54	0	0	11.54	0	46.16
Amphiuridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anarthruridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	11.54	0	0	0
Aoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Barentsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Bodotriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0
Bougainvilliidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bugulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Calloporidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46.16	0	11.54	0	0	0	0	0	23.08	0	0	0
Campanulariidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Cancellothyrididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Candidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capitellidae	692.4	23.08	57.7	0	115.4	0	0	0	23.08	0	46.16	0	0	0	23.08	0	46.16	0	600.08	184.64	288.5	0	300.04	126.94	461.6	34.62	473.14	11.54	1534.82	184.64
Cardiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	34.62	0	0	11.54	0	46.16	0
Chaetopteridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chirodotidae	0	0	0	0	0	0	11.54	0	46.16	0	46.16	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirratulidae	0	0	0	0	11.54	0	46.16	0	11.54	0	80.78	0	0	0	11.54	0	0	0	11.54	0	46.16	0	11.54	0	23.08	11.54	46.16	0	196.18	23.08
Columbellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46.16	0	0	0	23.08	0	0	0	23.08	0	0	0
Conidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	11.54	0	46.16	0
Cossuridae	1477.12	0	276.96	0	242.34	0	380.82	0	184.64	0	334.66	0	0	0	46.16	0	0	0	0	0	0	0	0	0	0	0	11.54	0	57.7	0
Cuspidariidae	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Cylichnidae	0	0	0	0	0	0	0	0	0	0	0	0	103.86	0	46.16	0	23.08	0	23.08	0	0	0	0	23.08	0	0	0	0	0	0
Cylindroleberididae	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	23.08	0	0	0	11.54	0	0	0	11.54	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	11.54	0	0	0	0	0	0
Edwardsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emplectonematidae	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eusiridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	23.08	0	0	0	23.08	0	0	0	0	0	0	0	0	0	11.54	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Gadilidae	0	0	0	0	0	0	0	0	11.54	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galatheidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0
Glyceridae	34.62	0	11.54	0	46.16	0	11.54	0	57.7	0	34.62	0	46.16	0	57.7	0	11.54	0	57.7	0	34.62	0	80.78	11.54	57.7	0	46.16	0	11.54	0
Gnathiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	46.16	0	0	0
Golfingiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	11.54	0	0	115.4	34.62	92.32	57.7	207.72	92.32
Goniadidae	11.54	0	11.54	0	0	0	0	0	0	0	0	0	11.54	0	23.08	0	0	0	11.54	0	0	0	80.78	11.54	0	0	11.54	0	0	0
Halacaridae	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haminoeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0
Hesionidae	0	0	0	0	23.08	0	0	0	11.54	0	34.62	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hiatellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0
Hippothoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34.62	0	0	0	0	0	0	0	0	0
Hoplonemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lasaeidae	0	0	0	0	0	0	0	0	34.62	0	11.54	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoplanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leuconidae	23.08	0	0	0	80.78	0	11.54	0	126.94	0	92.32	0	207.72	0	103.86	0	103.86	0	0	0	0	0	0	0	80.78	0	115.4	0	0	0
Limidae	34.62	0	57.7	0	46.16	0	0	11.54	23.08	0	34.62	23.08	69.24	0	46.16	34.62	46.16	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Limnoriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lineidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	23.08	0	11.54	46.16	23.08	57.7	0	0	0	0	0	80.78
Lucinidae	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	69.24	0	46.16	0	23.08	0	0	0	0	0	0	0
Lumbrineridae	11.54	0	0	0	46.16	0	0	0	69.24	0	115.4	0	11.54	0	103.86	0	23.08	0	150.02	115.4	219.26	11.54	380.82	34.62	126.94	23.08	265.42	11.54	196.18	138.48
Lyonsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Lysianassidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57.7	0	0	0	0	0	0	0
Magelonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	11.54	0	0	0	0	0	0
Maldanidae	0	0	0	0	0	0	0	0	34.62	0	69.24	0	0	0	57.7	0	0	0	196.18	115.4	80.78	23.08	34.62	57.7	34.62	0	57.7	23.08	69.24	0
Melitidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	11.54	0	0	0	0	0	0
Molpadiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mytilidae	0	0	0	0	0	0	0	11.54	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	46.16	0	0	0	0	0	0	0
Nannastacidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Nemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Nephtyidae	115.4	0	0	0	11.54	0	57.7	0	69.24	0	92.32	0	57.7	0	219.26	0	11.54	0	0	0	0	0	0	0	23.08	0	11.54	0	23.08	0

Table A4.2 (Cont'd.)

	HSB10A						HSB11A						HSB16						HSB17						HSB18			
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Family	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**	**Adult**	**Juvenile**
Nereididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	46.16
Nototanaidae	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nuculidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46.16	46.16	69.24	34.62	34.62	103.86	23.08	0	0	0	0	0
Nymphonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Oedicerotidae	46.16	0	0	0	0	0	11.54	0	0	0	0	0	0	0	11.54	0	0	0	11.54	0	0	0	0	0	0	0	23.08	0	0	0
Oenonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46.16	0	0	0
Olindiasidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34.62	0	0	0	0	0	0	0
Onuphidae	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	23.08	0	0	0	11.54	11.54	23.08	0	23.08	0	0	0
Opheliidae	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	11.54	0	0	0	11.54	0	0	0	0	0	0	0
Orbiniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	138.48	0	288.5	0	276.96	0	0	0	0	0	0	0
Oweniidae	0	0	0	0	11.54	0	23.08	0	34.62	11.54	0	0	0	0	0	0	0	0	161.56	11.54	173.1	0	219.26	23.08	161.56	219.26	692.4	830.88	92.32	253.88
Paleonemertea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraonidae	761.64	0	138.48	0	253.88	0	80.78	0	80.78	0	184.64	0	23.08	0	11.54	0	0	0	161.56	0	34.62	0	69.24	0	57.7	0	103.86	0	0	0
Paratanaidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Pardaliscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Pectinariidae	0	0	0	0	11.54	0	11.54	0	11.54	0	11.54	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0
Pectinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	34.62	0	0	0	0	0	0
Philomedidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	11.54	0	23.08	0	80.78	0	138.48	0	300.04	0	46.16	0
Pholadidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pholoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80.78	0	46.16	0
Phoronidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	11.54	46.16	0	0	0	0	0	0	0
Phoxocephalidae	184.64	23.08	138.48	46.16	80.78	0	0	0	57.7	0	23.08	0	57.7	0	115.4	0	11.54	0	0	0	0	0	11.54	0	80.78	0	57.7	0	126.94	0
Phyllodocidae	46.16	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	11.54	0	23.08	0	23.08	0	0	0	11.54	0	23.08	0
Phyllophoridae	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pilargidae	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Polynoidae	0	0	0	0	0	0	11.54	0	23.08	0	34.62	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prosorhochmidae	0	0	0	0	0	0	103.86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulsellidae	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	46.16	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Pyramidellidae	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	23.08	0	11.54	0	11.54	0	11.54	0	0	0	11.54	0	0	0
Rhabdidae	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	46.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rissoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	69.24	0	34.62	0	46.16	0	0	0
Sabellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	11.54	0	0	0	0	0	0	0	0	46.16	46.16
Scalibregmatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Schizasteridae	34.62	0	0	0	11.54	0	34.62	0	69.24	11.54	23.08	23.08	34.62	34.62	23.08	57.7	11.54	46.16	0	0	0	0	0	0	0	0	0	0	0	0
Sigalionidae	23.08	0	0	0	11.54	0	0	0	0	0	46.16	0	0	0	11.54	0	0	0	46.16	0	23.08	0	23.08	0	0	0	0	0	0	0
Solemyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0
Spionidae	369.28	0	46.16	0	126.94	0	1523.28	0	115.4	0	276.96	0	11.54	0	34.62	11.54	11.54	0	115.4	0	92.32	0	242.34	0	34.62	0	23.08	0	57.7	0
Sternaspidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	11.54	0
Syllidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	184.64	0	57.7	0	230.8	0	150.02	0	103.86	0	138.48	0
Synopiidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tellinidae	0	0	0	0	34.62	0	0	0	0	0	0	0	0	0	11.54	0	0	0	46.16	161.56	11.54	184.64	23.08	369.28	34.62	57.7	57.7	196.18	0	92.32
Terebellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34.62	0	0	11.54	0	0	23.08	0	46.16	0
Tetrastemmatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thyasirisae	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	103.86	0	161.56	0	196.18	0	0	0	115.4	0	0	0
Trichobranchidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	11.54	0	57.7	23.08	57.7	34.62	115.4	0
Triticellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trochochaetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	57.7	0	0	0
Tubulanidae	23.08	0	0	0	11.54	0	11.54	0	23.08	0	0	0	23.08	11.54	46.16	0	0	0	0	0	0	0	23.08	0	0	11.54	0	11.54	0	69.24
Veneridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	11.54	11.54	0	0	0	0	0	0	0
Vesiculariidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	23.08	0	11.54	0	0	0	0	0	0	0
Yoldiidae	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	11.54	11.54	0	11.54	0	0	0
Jasmineira pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phyllochaetopterus pottsi	0	0	0	0	0	0	11.54	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	34.62	0	92.32	0
Tubificoid Naididae indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sipuncula indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	11.54	46.16	0
Ostracoda indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryozoa indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Ophiuroidea indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0	0	0	0
Total Density	**4039**	**46.16**	**738.56**	**46.16**	**1246.32**	**11.54**	**2342.62**	**23.08**	**1211.7**	**34.62**	**1627.14**	**69.24**	**773.18**	**46.16**	**1211.7**	**138.48**	**357.74**	**46.16**	**2561.88**	**727.02**	**1904.1**	**334.66**	**2838.84**	**980.9**	**1811.78**	**415.44**	**3196.58**	**1223.24**	**3335.06**	**1073.22**
Taxa Richness	**22**	**2**	**8**	**1**	**23**	**1**	**16**	**2**	**27**	**3**	**21**	**4**	**19**	**2**	**27**	**6**	**14**	**1**	**43**	**12**	**29**	**8**	**40**	**20**	**24**	**8**	**39**	**12**	**23**	**11**

Table A4.2 (Cont'd.)

	HSB19						HSB20						HSB21-R1					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Family	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Ampeliscidae	11.54	0	23.08	11.54	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Ampharetidae	11.54	0	11.54	0	11.54	0	11.54	0	23.08	0	11.54	0	0	23.08	23.08	0	23.08	0
Amphiuridae	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0
Anarthruridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aoridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Barentsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bodotriidae	0	0	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bougainvilliidae	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Bugulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calloporidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Campanulariidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cancellothyrididae	11.54	0	23.08	34.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Candidae	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capitellidae	727.02	57.7	542.38	0	23.08	11.54	138.48	0	150.02	0	219.26	0	242.34	0	161.56	0	242.34	0
Cardiidae	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaetopteridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chirodotidae	0	0	0	0	0	0	92.32	0	46.16	0	80.78	0	0	0	0	0	0	0
Cirratulidae	126.94	11.54	11.54	34.62	57.7	11.54	23.08	0	34.62	23.08	34.62	0	0	11.54	0	0	0	0
Columbellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conidae	23.08	0	0	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0
Cossuridae	23.08	0	0	0	34.62	0	11.54	0	11.54	0	0	0	34.62	0	0	0	57.7	0
Cuspidariidae	11.54	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Cylichnidae	0	0	0	0	0	0	57.7	0	92.32	0	80.78	0	11.54	0	11.54	0	0	0
Cylindroleberididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dorvilleidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Edwardsiidae	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Emplectonematidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eusiridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Flabelligeridae	34.62	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gadilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galatheidae	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glyceridae	23.08	46.16	23.08	0	11.54	0	46.16	0	23.08	0	46.16	0	46.16	0	57.7	0	46.16	0
Gnathiidae	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Golfingiidae	46.16	92.32	300.04	80.78	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Goniadidae	11.54	0	0	0	0	0	0	0	0	0	11.54	0	23.08	0	23.08	0	11.54	0
Halacaridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haminoeidae	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hesionidae	0	0	0	0	0	0	0	0	11.54	0	11.54	0	11.54	0	0	0	0	0
Hiatellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hippothoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hoplonemertea	0	0	0	0	0	0	0	0	0	0	34.62	0	0	0	0	0	0	0
Lasaeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leptoplanidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leuconidae	11.54	0	11.54	0	369.28	0	23.08	0	23.08	0	0	0	34.62	0	0	0	0	0
Limidae	0	0	0	0	23.08	0	11.54	0	23.08	0	0	11.54	11.54	0	0	0	0	0
Limnoriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lineidae	11.54	46.16	23.08	0	0	11.54	0	0	0	0	23.08	0	0	0	0	0	11.54	0
Lucinidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0
Lumbrineridae	103.86	0	161.56	34.62	150.02	0	69.24	0	288.5	0	288.5	11.54	23.08	0	23.08	0	80.78	11.54
Lyonsiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lysianassidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magelonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Maldanidae	80.78	300.04	69.24	11.54	11.54	0	0	0	34.62	0	46.16	11.54	0	0	0	0	0	0
Melitidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Molpadiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0
Mytilidae	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0
Nannastacidae	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertea	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nephtyidae	23.08	0	34.62	0	23.08	11.54	0	0	11.54	0	34.62	0	11.54	0	0	0	11.54	0

Table A4.2 (Cont'd.)

	HSB19						HSB20						HSB21-R1					
	Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3		Rep 1		Rep 2		Rep 3	
Family	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile	Adult	Juvenile
Nereididae	0	46.16	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nototanaidae	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Nuculidae	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Nymphonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oedicerotidae	0	0	0	0	0	0	0	0	23.08	0	0	0	11.54	0	0	0	0	0
Oenonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olindiasidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Onuphidae	0	11.54	0	0	0	0	0	11.54	11.54	0	0	0	0	0	0	0	0	0
Opheliidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orbiniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oweniidae	34.62	0	103.86	11.54	0	11.54	23.08	0	23.08	0	34.62	0	0	0	0	0	0	0
Paleonemertea	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraonidae	0	0	34.62	0	115.4	11.54	34.62	0	23.08	0	23.08	0	184.64	0	242.34	0	415.44	11.54
Paratanaidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pardaliscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pectinariidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	11.54	0	0	0
Pectinidae	0	23.08	0	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Philomedidae	150.02	0	57.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pholadidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pholoidae	80.78	23.08	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phoronidae	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phoxocephalidae	69.24	0	126.94	0	57.7	0	0	0	0	0	57.7	0	46.16	0	23.08	0	23.08	0
Phyllodocidae	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phyllophoridae	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0
Pilargidae	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0
Polynoidae	0	0	23.08	0	0	0	46.16	0	11.54	0	11.54	0	0	0	0	0	0	0
Prosorhochmidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pulsellidae	0	0	0	0	0	0	0	0	11.54	0	23.08	0	0	0	0	0	0	0
Pyramidellidae	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0
Rhabdidae	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0	11.54	0	11.54	0
Rissoidae	57.7	0	23.08	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Sabellidae	103.86	92.32	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Scalibregmatidae	11.54	23.08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schizasteridae	0	0	0	0	0	0	80.78	0	46.16	0	57.7	0	0	0	0	0	0	0
Sigalionidae	0	0	0	0	11.54	0	11.54	0	11.54	0	11.54	0	23.08	0	0	0	11.54	0
Solemyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spionidae	219.26	34.62	34.62	0	23.08	0	11.54	0	0	0	11.54	0	242.34	0	0	0	103.86	0
Sternaspidae	0	0	11.54	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Syllidae	680.86	0	173.1	0	0	0	0	0	0	0	23.08	0	0	0	0	0	0	0
Synopiidae	0	0	0	0	0	0	0	0	0	0	11.54	0	0	0	0	0	0	0
Tellinidae	0	11.54	0	11.54	0	0	0	11.54	0	11.54	0	0	11.54	0	0	0	0	0
Terebellidae	126.94	80.78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tetrastemmatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thyasirisae	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	11.54	0	0	0
Trichobranchidae	46.16	46.16	80.78	23.08	0	0	34.62	0	0	0	0	0	0	0	0	0	0	0
Triticellidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trochochaetidae	0	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubulanidae	11.54	0	11.54	23.08	0	11.54	0	0	11.54	0	0	11.54	34.62	0	0	0	11.54	0
Veneridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vesiculariidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yoldiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jasmineira pacifica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phyllochaetopterus pottsi	0	11.54	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificoid Naididae indet.	69.24	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sipuncula indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia indet.	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ostracoda indet.	69.24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bryozoa indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ophiuroidea indet.	0	0	0	11.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Density	**3092.72**	**992.44**	**2031.04**	**323.12**	**1003.98**	**92.32**	**738.56**	**23.08**	**969.36**	**46.16**	**1269.4**	**57.7**	**1003.98**	**34.62**	**623.16**	**0**	**1073.22**	**23.08**
Taxa Richness	**35**	**20**	**30**	**12**	**20**	**8**	**18**	**2**	**24**	**3**	**29**	**5**	**17**	**2**	**13**	**0**	**15**	**2**

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Sub-Sampling Accuracy Report- Marine Benthos, EEM 2012

Prepared for Hatfield Consultants, Inc.

Powell River 2012

Sub-sample #	Number Inverts [counted]	Predicted #	Predicted - Actual	% Difference from Actual	Absolute Difference
PRB5-R2					
1	560	1120	-16	-1.4	1.4
2	576	1152	16	1.4	1.4
Total remaining	0				
Total in sample	**1136**		**Mean Absolute sub-sampling error (%)**		**1.4**
(actual total count)				**Min % error**	**1.4**
				Max % error	**1.4**
Correction Factor: 2					

Sub-sample #	Number Inverts [counted]	Predicted #	Predicted - Actual	% Difference from Actual	Absolute Difference
PRB5A-R2					
1	340	1360	146	12.0	12
2	290	1160	-54	-4.4	4.4
3	273	1092	-122	-10.0	10
4	311	1244	30	2.5	2.5
Total remaining	0				
Total in sample	**1214**		**Mean Absolute sub-sampling error (%)**		**7.2**
(actual total count)				**Min % error**	**2.5**
				Max % error	**12**
Correction Factor: 4					

Average subsampling error (%) for Powell River (n=2 samples): 4.3
Universal average subsampling error (%) for all mills (n=6 samples): 9.0

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Sub-sample #	Number Inverts [counted]	Predicted #	Predicted - Actual	% Difference from Actual	Absolute Difference
HSB8-R3					
1	60	240	-44	-15.5	15.5
2	71	284	0	0.0	0
3	74	296	12	4.2	4.2
4	79	316	32	11.3	11.3
Total remaining	0				
Total in sample	**284**		**Mean Absolute sub-sampling error (%)**		**7.8**
(actual total count)				**Min % error**	**0**
				Max % error	**15.5**
Correction Factor: 4					

Sub-sample #	Number Inverts [counted]	Predicted #	Predicted - Actual	% Difference from Actual	Absolute Difference
HSB10A-R1					
1	163	326	53	19.4	19.4
2	110	220	-53	-19.4	19.4
Total remaining	0				
Total in sample	**273**		**Mean Absolute sub-sampling error (%)**		**19.4**
(actual total count)				**Min % error**	**19.4**
				Max % error	**19.4**
Correction Factor: 2					

Average subsampling error (%) for Howe Sound (n=2 samples) : 13.6

Average subsampling error (%) for all mills (n=6 samples): 9.0

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Port Alice 2012

Sub-sample #	Number Inverts [counted]	Predicted #	Predicted - Actual	% Difference from Actual	Absolute Difference
N1B1A-1					
1	257	514	58	12.7	12.7
2	199	398	-58	-12.7	12.7
Total remaining	0				
Total in sample	**456**		**Mean absolute sub-sampling error (%)**		**12.7**
(actual total count)				**Min % error**	**12.7**
				Max % error	**12.7**
Correction Factor: 2					

Sub-sample #	Number Inverts [counted]	Predicted #	Predicted - Actual	% Difference from Actual	Absolute Difference
N1B3A-3					
1	149	596	42	7.6	7.6
2	134	536	-18	-3.2	3.2
3	128	512	-42	-7.6	7.6
4	143	572	18	3.2	3.2
Total remaining	0				
Total in sample	**554**		**Mean absolute sub-sampling error (%)**		**5.4**
(actual total count)				**Min % error**	**3.2**
				Max % error	**7.6**
Correction Factor: 4					

Average subsampling error (%) for Port Alice (n=2 samples): 9.1

Average subsampling error (%) for all mills (n=6 samples): 9.0

Table A4.3 Output from power analyses of regressions to detect an "effect" (r=|0.707|) on benthic invertebrates using n=12 stations along the effluent exposure gradient; Howe Sound Cycle Six.

t tests	Correlation	
Analysis	Post hoc: Compute achieved power	
Input	Tail(s)	= Two
	Effect size |ρ	= 0.707
	α err prob	= 0.1
	Total sample size	= 12
Output	Noncentrality parameter δ	= 3.4631
	Critical t	= 1.8125
	Df	= 11
	Power (1-β err prob)	= 0.9419

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Environmental Services Ltd.
Marine & Freshwater Taxonomy

Howe Sound EEM 2012 Sorting Efficiency QA/QC Report

Prepared for Hatfield Consultants

Sorting efficiency calculated only for re-sorted samples.
Calculation for % efficiency: [(total count – spot check and re-sort) / total count] x 100%

Quality Control
21 of 36 samples were spotchecked.
Samples for QC re-sorts were selected non-randomly based on results of spot checks.

Re-sorted 5 of 36 samples for a re-sort rate of 13.9%
Estimated sorting efficiency from QC re-sorts: 95.0%

Quality Assurance
QA samples were randomly selected from all 36 samples.

Re-sorted 4 of 36 samples for a re-sort rate of 11.1%
Estimated sorting effiecincy from QA re-sorts: 95.4% (See table below)

This table is generated using preliminary count data (total number of organisms before identification).

Sample	Fraction	Initial Count	# Recovered on spot check	# Recovered QA Resort	Total Count	% Efficiency after QA
HSB7A-R1	Whole	190	3	2	195	97.44%
HSB10-R1	Whole	24	1		25	96.00%
	1/4a	109	3	1	113	96.46%
HSB10A-R1	Whole	20		1	21	95.24%
	1/4a	153		6	159	96.23%
HSB21-R3	Whole	93	1	8	102	91.18%
					Average	**95.4%**

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