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MARINE SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT

Ladysmith Harbour
Ladysmith, BC

Submitted to:
Attention: Geoff Sinnett
Ministry of Forests, Lands and Natural Resource Operations
PO Box 9373, Stn. Prov. Govt.
Victoria, BC V8W 9M3

REPORT

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Executive Summary

Golder Associates Ltd. (Golder) was retained by the Crown Land Opportunities and Restoration Branch of the Ministry of Forests, Lands and Natural Resource Operations to conduct environmental and geotechnical investigations of the upland, foreshore and subtidal areas at Ladysmith Harbour in the Town of Ladysmith, on Vancouver Island, BC. This report presents the results of the Sediment Investigation for the subtidal zone of Ladysmith Harbour and nearby areas.

The overall objective of the sediment investigation was to inform refinement of remedial costs and options, including an assessment of whether ocean disposal or risk assessment might be a viable option (depending on project needs) for potential developers of Ladysmith Harbour. It characterized the degree of sediment contamination in the harbour, the degree to which sediment contamination is bioavailable to marine organisms, and possible causes of toxicity to marine organisms, and then integrated this information to assess the viability of sediment management options.

The feasibility of Disposal at Sea of dredged sediments and risk-based management of sediment contamination were evaluated as these are understood to be elements of a conceivable sediment management strategy for Ladysmith Harbour, depending on the specific project component needs of as yet to be developed concepts for the waterfront.

A Disposal at Sea application for dredged sediments from Ladysmith Harbour would require a program of sampling and analysis developed in consultation with Environment Canada, based on a specified development plan for the Harbour. A preliminary evaluation, based on existing data, was conducted to provide insight into the possible findings of studies carried out to support such an application; however, uncertainty remains because the results of future investigations cannot be predicted with confidence. The results of the evaluation for Disposal at Sea resulted in assignment of areas of the Harbour to one of four categories. The category assignments were as follows:

- **Category 1:** Small portions of the Harbour west of Slack Point and in the northwest corner of the Harbour could be categorized as having conditions favourable for Disposal at Sea, with low uncertainty.
- **Category 2:** More than half of the Harbour could be categorized as having conditions favourable for Disposal at Sea, but uncertainty was considered high due to data gaps regarding sediment toxicity.
- **Category 3:** Less than half of the Harbour was categorized as having conditions potentially unfavourable for Disposal at Sea. Over much of this area uncertainty was considered high due to data gaps regarding contaminant bioavailability and sediment toxicity.
- **Category 4:** In a small portion of the westernmost corner of the Harbour and an small area on the east side of Slack Point, conditions were considered unfavourable and uncertainty was low because observed toxicity to amphipod provides an indication that sediments are likely to fail Disposal at Sea approval guidelines.

The viability of a risk-based management approach was considered to be high for the entire Harbour. A sediment risk assessment for the Harbour could be based on integrating an assessment of benthic invertebrate communities with the chemistry, toxicity and bioavailability data reported herein. One of the main purposes of the sediment risk assessment option would be to reduce and better understand the influence of uncertainty on the assessment of potential effects to marine organisms in Ladysmith Harbour. It should be noted that while the methods used in this study were in many ways similar to a sediment risk assessment, additional lines of evidence that would normally be considered in a sediment risk assessment (*i.e.,* benthic community structure) have not been included. Thus, sediment risk assessment is considered a viable and appropriate next step to address this uncertainty.

These findings with respect to the viability of the Disposal at Sea and risk-based management options were supported by the results of the scientific studies of sediment chemistry, sediment contaminant bioavailability, sediment toxicity, and sediment porewater toxicity described herein. Key results included:

- Metals and PAH concentrations exceeded federal and provincial benchmarks, but the observed concentrations did not clearly indicate a high level of concern, especially given the uncertainty in the bioavailability of the observed concentrations. When considering, the magnitude of contamination of Harbour sediments, the sediment chemistry was in the range observed at sites where risk-based sediment management approaches have been successfully employed.
- Sediment conditions in many areas Ladysmith Harbour appear to be limiting the bioavailability of sediment contaminants. Specifically, over much of the Harbour, sulphides appear to be limiting the bioavailability of divalent metals. The bioavailability of PAHs is variable. In some portions of the Harbour where PAHs concentrations are elevated, the PAHs appear to be associated with coal particles, limiting their bioavailability.
- Sediment samples were not toxic (*i.e.,* there was no difference in the performance of test organisms between test sediments and controls) to the survival of polychaetes or to photoluminescent bacteria. A small number of samples elicited a 20 to 30% reduction in amphipod survival and polychaete growth relative to control or regional reference sediments. An evaluation of concentration-response relationships indicated that possible causes of the observed toxic responses to amphipods and polychaetes included bioavailable metals (in sediments where sulphides were not limiting bioavailability) and bioavailable PAHs where concentrations exceeded benchmarks and were not coal-associated.

Toxicity to echinoderm fertilization in the sediment porewater test was highly variable across the Harbour and did not exhibit any apparent correlations with sediment contaminant concentrations. A toxicity identification evaluation, combined with consideration of sediment and porewater chemistry, and toxicity thresholds of potential toxicants, indicated that the observed toxicity to the echinoderm fertilization test did not appear to be related to contaminants in Harbour sediments. Rather, it appeared to be related to elevated sulphide concentrations in sediment porewater which are due to natural decay and redox conditions in the sediments rather than a source of sulphur contamination. However, this hypothesis was not supported by all results, and uncertainty remains regarding the cause of observed echinoderm toxicity. To reduce uncertainty if needed to support future management or permit applications more detailed TIE procedures could be followed, in particular, methods with greater removal specificity for sulphide.

Study Limitations

This report was prepared for the exclusive use of the Crown Land Opportunities and Restoration Branch (CLORB) of the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) and the Town of Ladysmith and is intended to provide an assessment of environmental-related marine sediment conditions at the Site.

The report is based on data and information collected during investigations conducted by Golder Associates Ltd.'s personnel and the review of reports prepared by others as listed in this report. It is based solely on the conditions of the subject property at the time of the site investigations conducted between 2009 and 2011, as described in this report. The data presented in this report represents marine sediment conditions encountered at the sampling locations tested during this time period. Sediment conditions may vary with location, sediment depth, time, sampling methodology, analytical techniques and other factors. Golder Associates Ltd. makes no warranty, expressed or implied, and assumes no liability with respect to the use of the information contained in this report at the subject site, or any other site, for other than its intended purpose.

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If new information is discovered in the future, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this report and provide amendments as required prior to any reliance upon the information presented herein.

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by the Crown Land Opportunities and Restoration Branch (CLORB) of the Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) to conduct environmental and geotechnical investigations of the upland, foreshore and subtidal areas at Ladysmith Harbour in the Town of Ladysmith, on Vancouver Island, BC. Authorization was provided by Mr. Geoff Sinnett of MFLNRO. Collectively the upland, foreshore and subtidal areas of Ladysmith Harbour which are being investigated by Golder are referred to hereafter as "the Site".

This report presents the results of the Sediment Investigation for the subtidal zone of Ladysmith Harbour and nearby areas. Hereafter, the term "Harbour" is used to refer to the following waterlots and areas of Ladysmith Harbour:

- D.L. 650
- Block C – District Lot 016
- D.L. 651
- The area immediately east of upland lot D.L. 16G, Oyster District (hereafter referred to as "Slack Point").

Results of the other environmental and geotechnical investigations are presented under separate covers.

1.1 Background and Objectives

Ladysmith Harbour was an industrial harbour for the majority of the last century. The two main industries were a coal washing and load out facility, and forest industry activities (log sorting, dumping, storing and shipping). These industries both discharged waste to the harbour. It is understood that the CLORB and the Town of Ladysmith, desire to attract developers who would re-develop the Site for potential residential, park, and/or commercial land use; however, specific development plans and/or proponents are, as of the time of writing, unknown. The main objectives of the present investigation are to refine estimates of potential remedial costs and options for the Site by evaluating the level of contamination, the likelihood of environmental harm from that contamination and the probable causes of that contamination.

Some areas of the Site are currently undeveloped (for example Slack Point) and some portions of the Uplands are developed. Along the waterfront area, northeast of the Uplands, is an existing government wharf. A marina is located within Ladysmith Harbour to the northwest of Slack Point. Former activities in this area have included the dumping of waste coal to form Slack Point and off-loading logs from the railway into Ladysmith Harbour, where dumping, sorting, storing, and shipping took place. In addition, the Uplands area was formerly a rail yard, which at one time contained fuel tanks, a train station, a locomotive and railcar repair shop, a roundhouse, and underground maintenance pits.

While there are no detailed development plans available, there is the possibility that waterfront development could potentially require management and/or dredging of marine sediments to accommodate a waterfront development or construction-related activities such as geotechnical improvement. As part of the process of

evaluating potential development options and associated costs of development, CLORB of MFLNRO and the Town of Ladysmith, along with Town of Ladysmith wish to refine the current understanding of contamination in marine sediments so that sediment management options can be better estimated.

A previous assessment of financial liabilities related to contamination at the Site (Golder 2005) identified potential contamination in Harbour sediments and identified gaps in knowledge regarding this contamination. The 2005 assessment report concluded that further investigation to address the data gaps identified would serve to refine the remediation cost estimates for identified areas of sediment contamination.

This report describes the sediment investigation portion of follow-up work for the Harbour and is intended to provide an improved understanding of the implications of contamination in marine sediments. This understanding provides a basis for future sediment management decision-making; however, such decisions can only be made at such time as specific development project descriptions are available.

The objectives of the sediment investigation include:

- Characterize the magnitude and spatial extent of sediment contamination in the harbour;
- Assess the bioavailability and toxicity of sediment contamination, to inform the evaluation of potential sediment management options;
- Where relevant to sediment management options, identify contaminants of potential concern responsible for observed sediment or sediment porewater toxicity; and,
- Identify the implications of sediment contamination for selected sediment management options.

This sediment investigation was not intended to complete an application for Disposal at Sea of sediments that may be dredged as part of development plans, nor was it intended to complete a sediment ecological risk assessment, because the circumstances for each of these are not known. Rather, it provides a characterization of the degree of sediment contamination in the harbour, and the degree to which sediment contamination is bioavailable to marine organisms. This information is intended to inform high-level decision making for future Site development by providing a context for plausible outcomes to foreseeable sediment management options associated with development as well as indicating the uncertainty in the current understanding of contamination present in Harbour sediments.

1.2 Applicable Regulatory Frameworks

1.2.1 Federal and Provincial Sediment Quality Benchmarks

The sediment investigation described in this report makes reference to both federal and provincial sediment quality benchmarks and associated guidance. The applicable federal guidance specifies Interim Sediment Quality Guidelines (ISQGs), representing the concentration below which adverse effects rarely occur, and Probable Effects Levels (PEL), representing concentrations above which adverse biological effects frequently occur (CCME 2001). The BC Contaminated Sites Regulation (CSR; Government of British Columbia 2011) specifies Sediment Quality Criteria for typical contaminated sites ($SedQC_{TS}$), representing levels that provide

moderate protection to sediment-dwelling organisms, and Sediment Quality Criteria for sensitive contaminated sites ($SedQC_{SS}$), representing levels that provide a relatively high level of protection to sediment-dwelling organisms. Given the previous industrial state of Ladysmith Harbour and the likelihood that it will remain as a mixed use of industrial, residential and parkland, the $SedQC_{TS}$ were considered appropriate values for use in interpreting data collected in the sediment investigation.

The ISQG, PEL and $SedQC_{TS}$ were applied in the sediment investigation to provide interpretation of the sediment chemistry results, and to indicate where sediments might be considered contaminated according to federal or provincial processes. While the $SedQC_{TS}$ and the $SedQC_{SS}$ are part of the CSR, the ISQG and the PEL are sediment quality guidelines and do not have the force of law.

1.2.2 Disposal at Sea

In the event that future development scenarios require the dredging of sediments and disposal at sea, the Disposal at Sea Regulations of the *Canadian Environmental Protection Act, 1999* (Government of Canada, 2001) would apply to any proposal to dispose of those sediments. The National Action List of the Disposal at Sea Regulations specifies criteria for evaluating the suitability of sediments for disposal at sea.

The "Lower Level" numerical limits of the National Action List are based on the concentrations of specific substances, including:

- Cadmium and its compounds (0.6 mg/kg dry weight [dw]);
- Mercury and its compounds (0.75 mg/kg dw);
- Total PAHs (2.5 mg/kg dw); and,
- Total PCBs (0.1 mg/kg dw).

Where substances in sediments do not exceed the Lower Level numerical limits, the sediments are considered to be below the Lower Level of the National Action List and may be suitable for ocean disposal, subject to a permit being obtained.

The National Action List also includes an "Upper Level" which is based on the results of biological responses to sediments by three marine or estuarine biological (toxicity) tests. The specific tests and test evaluation criteria are specified in the *National Guidelines for Monitoring Dredged and Excavated Material at Ocean Disposal Sites* (Environment Canada, 1998), with updates and modifications on the current *Disposal at Sea Program* Website (Environment Canada 2011). The test and "failure" criteria include the following:

- **Amphipod 10-d Survival Test (acute lethality):** a statistically significant 20% (or greater) reduction in survival relative to a reference sediment, or (where there is no acceptable reference sediment) a statistically significant 30% (or greater) reduction in survival relative to the control sediment;
- **Photolumenescent Bacteria Solid-Phase Test (sublethal):** 10-minute IC_{50} (inhibition of light production) less than 1000 mg/L;

- **Echinoderm Fertilization Test (sublethal):** a statistically significant 25% (or greater) reduction in fertilization between the test sediment and control water.
- **Bioaccumulation Test:** a statistically significant increase in tissue concentrations of a toxicant between the organism exposed to the test sediment and the organisms exposed to the reference or control sediment.

Where none of the three marine/estuarine tests fail according to these criteria, the sediments are considered to be below the Lower Level of the National Action List. If either the acute lethality test or both of the sublethal/bioaccumulation tests fail according to these criteria, the sediments are considered to be above the Upper Level of the National Action List. If the acute lethality test and at least one of the sublethal or bioaccumulation tests pass according to these criteria, then the sediments are considered to fall between the Lower and Upper Levels of the National Action List.

According to Schedule 6 of *CEPA* (1999), the following decision criteria should be applied for Disposal at Sea with respect to the National Action List:

- **Below the Lower Level:** sediments are considered to be of little environmental concern in relation to disposal at sea;
- **Between the Lower and Upper Level:** sediments require more detailed assessment prior to determination of suitability for disposal at sea; and,
- **Above the Upper Level:** sediments shall not be disposed of at sea, unless made acceptable for disposal through the use of management techniques or processes (*e.g.,* sediment treatment).

The National Action List concentration criteria and biological response failure criteria were applied in the sediment investigation to assess the potential viability of a permit application for Disposal at Sea for sediment dredged as part of harbour development.

It is important to note that as part of a Disposal Permit application, Environment Canada typically requires submission of the sampling and analysis plan for approval prior to implementation (Environment Canada 2011). Further investigation of sediment quality, with pre-approval by Environment Canada, would likely be required prior to initiating a permit application for a specific dredging program. As this investigation was not intended to support a permit application for disposal at sea, the sampling and analysis plan was not submitted to Environment Canada and the conclusions of this study regarding the potential viability of a permit application for disposal at sea should be considered indicative but not conclusive.

1.2.3 Alternatives to Disposal at Sea

It is also acknowledged that alternatives to Disposal at Sea for dredged sediments, such as disposal at a permitted landfill, confined uplands disposal, confined aquatic disposal or beneficial re-use, might be preferred as part of re-development plans. It is important to note that each of these possible disposal options could have specifically regulatory requirements under the BC Environmental Management Act and Contaminated Sites Regulation, the BC Waste Management Act and Hazardous Waste Regulations, and other applicable Federal or Provincial legislation and regulations. Examination of these options and regulatory requirements was considered beyond the scope of this report.

1.2.4 Fisheries Act

The federal Fisheries Act is concerned with the management and protection of those fish stocks contributing to sport, commercial, and subsistence fisheries. Maintaining these stocks also requires the management of their habitat and protection of fish populations from pollution. Dredging can have both physical impacts on habitat and, particularly in areas of contaminated sediments, can result in the dispersion of harmful substances.

1.2.4.1 Conservation of Biophysical Elements of Fish Habitat

The biophysical aspects of fish habitat include spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes. Section 35 of the Fisheries Act prohibits harmful alteration, disruption, or destruction (HADD) of fish habitat, unless the destruction is authorized by Fisheries and Oceans (DFO), the agency that administers this section of the Act. The *National Policy for the Management of Fish Habitat* (DFO, 1986) outlines the objectives and procedures that are followed by Fisheries and Oceans in managing habitat. One of the major themes contained in this policy requires that there be No Net Loss (NNL) of fish habitat and a first preference in attaining this goal is the design of projects to avoid a HADD. Potential interactions of future work in the study area with Section 35 of the *Fisheries Act* involve the physical works associated with dredging or other shoreline work.

DFO decides whether a particular work or activity (such as dredging) would result in a HADD and whether or not a HADD is authorized under Subsection 35(2). To aid DFO in their assessment, a project proponent is usually required to provide information on the habitat characteristics, a description of the proposed project and associated work, an analysis of how the project work interacts with fish habitat and mitigation that will be applied. In the case of certain projects, this may require detailed biophysical surveys specific to the areas of habitat modification will be required to support the granting of an Authorization under the *Fisheries Act* and to identify the manner and extent of compensatory fish habitat if and as necessary. These aspects of the *Fisheries Act* would apply to the sediments and shoreline, regardless of whether or not the site is contaminated.

1.2.4.2 Protection Against Pollution

In addition to the biophysical aspects of fish habitat, the ongoing conservation of fish stocks also necessitates their protection from harmful (deleterious) substances. Section 36 of the *Fisheries Act* is concerned with the control of substances that are harmful to fish (deleterious substances).

The pollution prevention provisions of the *Fisheries Act* are administered separately from the administration of the biophysical habitat. Environment Canada is the lead federal agency for matters of pollution (which includes a mandate broader than water pollution or fish stock protection). However, the Minister of Fisheries and Oceans maintains accountability to Parliament for the *Fisheries Act* in its entirety (including Section 36) and DFO can (and does) exercise authority under Section 36. It is common for both DFO and Environment Canada to have a cooperative role in administering/enforcing Section 36, with Environment Canada taking the lead role and each department referring applications to one another. Over the past few years, DFO has removed itself from an active, operational role in water quality management (Section 36) issues, except in limited circumstances or when sediment-laden water (*e.g.*, dredging) is involved.

The *Fisheries Act* contains a general prohibition against depositing deleterious substances. While certain sector-specific regulations (*e.g.*, *Metal Mining Effluent Regulation*) define what a deleterious substance is for that sector, the properties defining a substance as being deleterious under the parent Act are left to interpretation by experts in aquatic toxicology and water quality. DFO may require that the specific controls applied to a dredging project include containment of areas that are contaminated and may require control of dredgeate dewatering effluent.

1.3 Summary of Historical Data

Historical sediment chemistry data for Ladysmith Harbour are available in the following reports:

- G3 Consulting Ltd. 2005. *Report on Ladysmith Harbour Foreshore Fill Sampling & Analysis*. Dated March 2005.
- Levelton Engineering Ltd. 2000. *Preliminary Site Investigation Stage I and Stage II Lot 4, Plan 45800, District Lot 8G, Lot 11G and Lot 1, Plan VIP64405, Oyster Land District*. Ladysmith, B.C. Dated October 25, 2000.
- Levelton Engineering Ltd. 2000. *Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District*. Ladysmith, B.C. Dated October 25, 2000.
- Phoenix Environmental Services Ltd. 1999. *Environmental Impact Assessment Report Proposed for Ladysmith Marina and Waterfront Development Project Ladysmith, B.C*. Dated December 1999.
- Phoenix Enviornmental Services Ltd. 2002. *Sediment Chemistry Investigation Report Ladysmith Harbour Proposed Waterfront Re-Development Ladysmith, B.C*. Dated September 2002.

The historical data available in these reports were compiled and reviewed to obtain a preliminary understanding of sediment contamination conditions in Ladymisth Harbour. This understanding was used to set the context and scope of the current investigation.

The compiled historical data were compared to the ISQG and PEL (CCME 2001), $SedQC_{TS}$ (BC CSR), and the Lower Level numerical limits (CEPA 1999) to evaluate the degree of contamination based on bulk sediment chemistry and to guide the selection of analytes for the sediment investigation. The historical sediment chemistry data are presented in Appendix I. A summary of analytes that were reported at concentrations greater than applicable benchmarks is presented in Table 1. The results of the compiled historical data for each group of analytes are discussed below.

Metals: Several metals were reported at concentrations greater than the ISQG, PEL and $SedQC_{TS}$ in one or more sediment samples collected from Ladysmith Harbour. One metal was also reported at concentrations greater than the Lower Level numerical limits. A summary of the comparison of historical data to benchmarks is as follows:

- Concentrations greater than the ISQG: arsenic, cadmium, copper, lead, mercury and zinc;
- Concentrations greater than the PEL: copper, lead, mercury and zinc;
- Concentrations greater than the $SedQC_{TS}$: copper, lead; and,
- Concentrations greater than the Lower Level numerical limit: cadmium.

Metal concentrations greater than applicable benchmarks were reported from sampling locations throughout the Harbour, with the highest concentrations typically identified in the vicinity of the DL 651 area, in the eastern portion of the Harbour, and adjacent to Slack Point.

Polycyclic aromatic hydrocarbons (PAHs): Several PAHs were reported at concentrations greater than the ISQG, PEL and $SedQC_{TS}$ in one or more sediment samples collected from Ladysmith Harbour. Total PAHs were also reported at concentrations greater than the Lower Level numerical limit. A summary of the comparison of historical data to benchmarks is as follows:

- Concentrations greater than the ISQG: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, naphthalene, phenanthrene and pyrene.
- Concentrations greater than the PEL: acenaphthylene, anthracene, benzo(a)anthracene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene and pyrene.
- Concentrations greater than the $SedQC_{TS}$: naphthalene, acenaphthylene, rluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene,
- Concentrations greater than the Lower Level numerical limit: Total PAHs

The spatial distribution of PAHs concentrations in Ladysmith Harbour did not appear to be restricted to any particular area, with concentrations greater than applicable benchmarks reported from most sampling locations throughout the harbour.

Table 1: Summary of Historical Sediment Data

Substance	Number of Sample Locations	Reported Concentrations		Benchmark (Number of Exceedances)			
		Min	Max	CCME ISQG[a]	CCME PEL[b]	BC SedQC$_{TS}$[c]	Lower Level Numerical Limit[d]
Arsenic	79	2.7	19	7.24 (36)	41.6 (0)	50 (0)	-
Cadmium	79	0.06	3.48	0.7 (37)	4.2 (0)	5 (0)	0.6 (39)
Copper	79	19	344	18.7 (79)	108 (4)	130 (2)	-
Lead	79	4.18	165	30.2 (20)	112 (2)	130 (2)	-
Mercury	79	0.047	0.749	0.13 (60)	0.7 (1)	0.84 (0)	0.75 (0)
Zinc	79	26.4	275	124 (29)	271 (1)	330 (0)	-
Naphthalene	17	0.07	3.26	0.0346 (17)	0.391 (7)	0.47 (5)	-
Acenaphthene	17	0.06	0.08	0.00671 (4)	0.0889 (0)	0.11 (0)	-
Acenaphthylene	17	0.05	0.52	0.00587 (14)	0.128 (4)	0.15 (4)	-
Fluorene	17	0.06	0.61	0.0212 (15)	0.144 (5)	0.17 (5)	-
Phenanthrene	17	0.15	8.09	0.0867 (17)	0.544 (15)	0.65 (14)	-
Anthracene	17	0.06	1.35	0.0469 (16)	0.245 (14)	0.29 (10)	-
Fluoranthene	17	0.07	2.56	0.113 (16)	1.494 (4)	1.8 (3)	-
Pyrene	17	0.06	2.46	0.153 (16)	1.398 (4)	1.7 (3)	-
Benz(a)anthracene	17	0.05	1.11	0.0748 (15)	0.683 (5)	0.83 (3)	-
Chrysene	17	0.05	1.16	0.108 (15)	0.846 (5)	1.0 (4)	-
Benzo(a)pyrene	17	0.06	0.49	0.0888 (15)	0.763 (0)	0.92 (0)	-
Indeno(1,2,3-c,d) pyrene	17	0.08	0.57	0.0202 (11)	0.201 (5)	-	-
Dibenz(a,h) anthracene	17	0.05	0.08	0.00622 (3)	0.135 (0)	0.16 (0)	-
Total PAHs	17	0.45	18.86	-	-	20 (0)	2.5 (15)

Concentrations expressed as mg/kg dry weight.
a - Federal interim sediment quality guideline (CCME2001)
b - Federal probable effects level (CCME 2001)
c - BC Contaminated Sites Regulation, Schedule 9 – Generic Numerical Sediment Criteria for typical sites (Government of British Columbia 2011)
d - Disposal at Sea Regulations (CEPA 1999)
- No applicable value

1.4 Study Approach

The overall objective of the sediment investigation is intended to provide an improved understanding of the implications of contamination in marine sediments in the harbour. This understanding provides a basis for future sediment management decision-making; however, such decisions can only be made at such time as specific development project descriptions are available.

Based on the review of the historical data and a consideration of identified data gaps, the following tasks were undertaken:

1) **Delineation of sediment contamination:** The current understanding of sediment contamination was refined by further delineating the magnitude and spatial extent of surface contamination in areas that have not been previously characterized. Confirmatory sampling was undertaken in areas that had been previously characterized.

2) **Investigation of the bioavailability of reported sediment contamination:** A bioavailability assessment was undertaken to provide information about the potential viability of risk-based approaches to managing sediment contamination (*e.g.*, a risk assessment to support *in situ* management), as well as information about the feasibility of ocean disposal options in the event that dredging is required.

3) **Investigation of the contaminants that are causing observed toxicity:** Toxicity Identification Evaluation (TIE) procedures were applied to evaluate the likely causes of toxicity.

4) **Evaluation of sediment quality in the context of selected management options:** The sediment quality was evaluated in the context of a project where sediments need to be dredged and disposed of at sea (typically the lower-cost option for disposal) or in the context of a situation where the desired option was to leave the sediments in place, supported by a risk assessment. .

Note that the understanding of available historical data was applied to develop the study approach and sampling design. However, given the potential temporal variability in an active harbour due to ongoing contaminant sources, and anthropogenic and natural contaminant redistribution process, it was expected that current sediment conditions could be different than observed historically. For this reason, the marine sediment investigation included both confirmation of historical sediment conditions as well as investigation of sediments that were previously investigated, and the evaluation of management options in Task 4 relied on the data from the 2009 and 2010 sediment investigations only.

The following sections provide an overview of each task.

1.4.1 Task 1: Spatial Delineation of Contamination

A review of previous work in the Harbour indicated that concentrations of contaminants are highly variable within the areas that were previously sampled, and that those areas with the highest concentrations of PAHs have not been adequately delineated. These observations indicated that it would be inappropriate to extrapolate sediment characterization across the whole of the study area based on the limited existing data set. Uncharacterized areas relevant to potential development of the Site include the central-seaward portion of the Harbour (approximately one-third of the Harbour) and off-site areas adjacent to the Harbour and southeast of Slack Point.

A study to further characterize sediment contamination was undertaken in October 2009 by the collection and analysis of surface sediment samples in at 40 locations, including 25 within the Harbour, ten in areas adjacent to the Harbour, and five from locations selected to represent regional reference conditions.

Supplemental analysis of sediments was also conducted in December 2010, including 6 surficial grab samples and 5 sediment cores selected to obtain a preliminary characterization of subsurface sediment chemistry. Three additional cores were collected to delineate a suspected subsurface plume of hydrocarbon from upland sources, but these cores were not submitted for chemical analysis.

Samples were analyzed for a suite of potential sediment contaminants (metals, PAHs, LEPH/HEPH, VOCs), ancillary parameters (grain size and total organic carbon) and petrographic analysis of coal content.

1.4.2 Task 2: Bioavailability Assessment

Sediment concentrations of PAHs greater than the $SedQC_{TS}$ were reported historically from locations throughout the harbour. In some locations, concentrations of individual PAHs exceeded the $SedQC_{TS}$ by more than a factor of ten. Based on these bulk sediment chemistry results alone, concentrations of this magnitude would ordinarily suggest that the sediment could be toxic to marine biota such as amphipods, and this could preclude *in-situ* management and ocean disposal. However, given the reported prevalence of coal in sediment in the Harbour, it was considered possible that a portion of the measured PAHs would be sequestered in a coal matrix and thus may present lower risks due to limited bioavailability. Additionally, the acid-volatile sulphide (AVS) that is typically present in marine sediments can sequester divalent metals such as copper, reducing their bioavailability and resulting toxicity. Sediment quality criteria do not normally consider processes that would limit the bioavailability of contaminants and, therefore, where bioavailability is limited, comparison of sediment chemistry to regulatory benchmark values can overestimate the risk to marine biota.

The bioavailability assessment combined sediment chemistry results with measures of contaminant availability and laboratory bioassay testing to determine the degree to which sediment contaminants were available and had the potential to cause adverse responses in representative benthic invertebrate species. Metals bioavailability was assessed by measurement of simultaneously extractable metals (SEM) and acid-volatile sulphide (AVS). The SEM/AVS ratio is a commonly employed measure of the bioavailability of divalent metals. PAH bioavailability was assessed using a sediment passive extraction method to assess the potential for PAHs present at the sampling locations to be accumulated by organisms. The technique employed was conceptually similar to the semi-permeable membrane devices routinely used to assess hydrocarbon bioavailability in water. A set of 20 surface sediment samples, selected to represent spatial heterogeneity in concentrations and potential sources of contamination, were tested with a 10-d marine amphipod survival test. A subset of nine of these samples (six inside the Harbour, two adjacent to the Harbour, and one from a regional reference station) were tested using three additional bioassay tests: a 21-d marine worm survival and growth test, an echinoderm fertilization assay on sediment porewater, and a solid phase test using photoluminescent bacteria.

Toxicity testing with amphipods was intended to provide a site-specific indication of the potential for the reported sediment contaminant concentrations to elicit adverse effects in marine biota. Toxicity testing with the battery of test species was intended to provide additional information (*i.e.,* sublethal endpoints, diversity of life histories and modes of exposure) at a subset of locations, as well as providing a more comprehensive assessment of the potential for adverse effects due to unmeasured substances.

1.4.3 Task 3: Sediment Toxicity Identification Evaluation

Testing of the nine sediment samples in 2009 with the battery of test species indicated adverse effects on echinoderm fertilization in samples collected from multiple stations. However, no clear correlation was observed between porewater toxicity and sediment contaminant concentrations, indicating that the cause of the observed toxicity was uncertain.

To examine the cause of echinoderm toxicity observed in 2009, porewater was extracted from the surface sediments collected in 2010 and subjected to a toxicity identification evaluation (TIE). Porewater was analyzed for dissolved metals and conventional toxicants such as ammonia and sulphides. Follow up testing was then conducted on a subset of porewater samples using the echinoderm fertilization test. Tested porewater samples were subjected to sample amendments to examine potential sulphide toxicity and potential cationic metals toxicity. Causes of the observed toxic responses were then confirmed by comparing measured toxicant concentrations to reported toxicity thresholds.

1.4.4 Task 4: Evaluation of Management Options

The results of the bioavailability assessment and sediment TIE were integrated to evaluate the potential viability of risk-based approaches for sediment assessment, and to assess whether *in-situ* management may be a feasible sediment management option, subject to conducting a sediment risk assessment. In addition, bioassay testing components were designed to be consistent with testing (but not necessarily sampling) requirements of the Disposal at Sea Regulations, to inform the potential viability of ocean disposal as a sediment disposal option. Based on the integrated findings of the investigations described above, portions of the Harbour were assigned to one of four Categories indicating potential approval status with respect to Disposal at Sea and the degree of uncertainty in the understanding of sediment conditions for stations within a particular category.

1.5 Report Organization

This remainder of this report is organized into the following sections:

Section 2.0 – Methods: Describes the rationale and methods for sediment sampling and analyses.

Section 3.0 – Results: Describes the results for sediment analyses.

Section 4.0 – Integration of Findings: Integrates and provides an interpretation of the information from the sediment investigation.

Section 5.0 – Summary: Provides an overview of the findings.

2.0 METHODS

2.1 Sampling Locations

The first phase of sediment sampling was conducted in October, 2009. Sediment samples were collected from a total of 40 locations, including 25 locations within the harbour, ten locations adjacent to the harbour, and five locations outside the harbour (Figure 1). Follow-up sediment sampling was conducted in December 2010 via six surface grabs and eight core samples within the Harbour. Core samples were collected at 2010-03, 2010-04 and 2010-06 to investigate the potential presence of non-aqueous phase liquid (NAPL) hydrocarbon entering the subsurface subtidal zone from upland sources. Based on visual observations in the field which did not indicate NAPL presence, the decision was made not to submit these samples for chemical analysis (Section 2.2.1). Table 2 provides a summary of the analyses performed for each station.

For the discussion of results in Section 3.0, the surface sediment stations from 2009 and 2010 were grouped into three areas:

- **Inside the Harbour:** 1A to 25A, 2010-7 to 2010-11, and 2010-13 (a total of 31 stations). These samples were intended represent conditions within Ladysmith Harbour. Sediment core samples collected in 2010 were all from inside the Harbour.
- **Adjacent to the Harbour:** 26A to 35A (a total of ten stations). These samples were intended to represent conditions near Ladysmith Harbour, in locations that may have been influenced by current and historical activities within the Harbour.
- **Regional Reference:** 36R to 40R (a total of five stations). These samples were intended to represent the conditions that would be expected in areas near Ladysmith Harbour but not subject to the influence of current and historical activities within the harbour.

Table 2: Rationale for Sediment Sampling Locations and Sediment Analyses

Station	Rationale	Field Observations	Laboratory Analysis					
			Chemistry	Bioavailability Assessment	Amphipod Toxicity Test	Toxicity Test Battery	Benthic Sample	TIE
October 2009								
1A	Confirmatory/Delineation	✓	✓	✓	✓		✓	
2A	Confirmatory/Delineation	✓	✓	✓		✓	✓	
3A	Confirmatory/Delineation	✓	✓	✓	✓		✓	
4A	Confirmatory/Delineation	✓	✓	✓			✓	
5A	Confirmatory/Delineation	✓	✓	✓			✓	
6A	Data gap – Within Harbour	✓	✓	✓		✓	✓	
7A	Data gap – Within Harbour	✓	✓	✓			✓	
8A	Confirmatory/Delineation	✓	✓	✓			✓	
9A	Data gap – Within Harbour	✓	✓	✓			✓	
10A	Data gap – Within Harbour	✓	✓	✓	✓		✓	
11A	Data gap – Within Harbour	✓	✓	✓			✓	
12A	Data gap – Within Harbour	✓	✓	✓		✓	✓	
13A	Data gap – Within Harbour	✓	✓	✓			✓	
14A	Data gap – Within Harbour	✓	✓	✓			✓	
15A	Data gap – Within Harbour	✓	✓	✓		✓	✓	
16A	Data gap – Within Harbour	✓	✓	✓			✓	
17A	Data gap – Within Harbour	✓	✓	✓			✓	
18A	Data gap – Within Harbour	✓	✓	✓			✓	
19A	Confirmatory/Delineation	✓	✓	✓			✓	
20A	Data gap – Within Harbour	✓	✓	✓			✓	
21A	Data gap – Within Harbour	✓	✓	✓	✓		✓	

Station	Rationale	Field Observations	Laboratory Analysis					
			Chemistry	Bioavailability Assessment	Amphipod Toxicity Test	Toxicity Test Battery	Benthic Sample	TIE
22A	Data gap – Within Harbour	✓	✓	✓		✓	✓	
23A	Confirmatory/Delineation	✓	✓	✓	✓		✓	
24A	Confirmatory/Delineation	✓	✓	✓		✓	✓	
25A	Data gap – Within Harbour	✓	✓	✓			✓	
26A	Data Gap – Adjacent to Harbour	✓	✓	✓	✓		✓	
27A	Data Gap – Adjacent to Harbour	✓	✓	✓			✓	
28A	Data Gap – Adjacent to Harbour	✓	✓	✓		✓	✓	
29A	Data Gap – Adjacent to Harbour	✓	✓	✓			✓	
30A	Data Gap – Adjacent to Harbour	✓	✓	✓	✓		✓	
31A	Data Gap – Adjacent to Harbour	✓	✓	✓			✓	
32A	Data Gap – Adjacent to Harbour	✓	✓	✓			✓	
33A	Data Gap – Adjacent to Harbour	✓	✓	✓		✓	✓	
34A	Data Gap – Adjacent to Harbour	✓	✓	✓			✓	
35A	Data Gap – Adjacent to Harbour	✓	✓	✓	✓		✓	
36R	Regional Reference	✓	✓	✓			✓	
37R	Regional Reference	✓	✓	✓	✓		✓	
38R	Regional Reference	✓	✓	✓		✓	✓	
39R	Regional Reference	✓	✓	✓			✓	
40R	Regional Reference	✓	✓	✓			✓	
December 2010								
2010-10	Sediment TIE (Grab)	✓	✓		✓			✓
2010-11	Sediment TIE (Grab)	✓	✓		✓			✓
2010-12	Subsurface Delineation (Core)	✓	✓					

Station	Rationale	Field Observations	Laboratory Analysis					
			Chemistry	Bioavailability Assessment	Amphipod Toxicity Test	Toxicity Test Battery	Benthic Sample	TIE
2010-13	Sediment TIE and Subsurface Delineation (Grab + Core)	✓	✓		✓			✓
2010-09	Sediment TIE and Subsurface Delineation (Grab + Core)	✓	✓		✓			✓
2010-08	Sediment TIE and Subsurface Delineation (Grab + Core)	✓	✓		✓			✓
2010-07	Sediment TIE and Subsurface Delineation (Grab + Core)	✓	✓		✓			✓
2010-03	Subsurface Delineation (Core)	✓						
2010-04	Subsurface Delineation (Core)	✓						
2010-06	Subsurface Delineation (Core)	✓						

Notes:

Chemistry	Metals, PAHs, LEPH/HEPH, AVS/SEM, grain size, and petrographic analysis
Bioavailability	Coal content and bioavailability of PAHs
Amphipod Toxicity Test	*Eohaustorius* toxicity test only
Toxicity Test Battery	*Eohaustorius, Neanthes*, Echinoderm, and Microtox toxicity tests
Benthic Sample	Benthic invertebrate taxonomy (samples archived, not analyzed)
Confirmatory/Delineation	Sampling locations intended to confirm and delineate previously-identified contamination
Data gap	Sampling locations intended to characterize site conditions in areas not previously sampled within and adjacent to Harbour
Regional Reference	Sampling locations intended to provide regional-scale context for observed site conditions
TIE	Toxicity Identification Evaluation
Subsurface Delineation	Core samples intended to provide an indication of contamination a subsurface sediment depths.

2.2 Sample Collection Procedures

2.2.1 Surface Sediment Chemistry, Petrography and Bioavailability Samples

Surface sediment samples were collected using a boat-deployed Van Veen grab sampler. Once the boat was confirmed to be on station and the GPS coordinates had been recorded, the grab sampler was deployed. Only those grab samples that met the following acceptability criteria were retained:

- The sampler was closed and did not contain large rocks or other debris;
- There was adequate penetration depth (enough to retain the top 10-15 cm of the grab);
- The sample was not overfilled (*i.e.,* sample was not touching the top screen); the sediment surface was still intact and the sampler was not deployed on an angle (sediment surface did not touch the top of the sampler, and was relatively flat); and,
- The sampler was not leaking (there was overlying water present and no visible leaks out of the sampler jaws).

If the grab was classified as acceptable, then sample processing proceeded as described below. Upon acceptance, the overlying water in the grab was removed using a siphon and a description of the sediment with respect to colour, particle size, odour, and presence of non-sediment materials (*e.g.,* shells, debris, biota) was recorded. Sample processing is described for the two sampling dates, below.

Samples were collected in October 2009 from forty sample locations for chemistry, petrography and bioavailability analysis. Pre-cleaned bowls and utensils were used for subsampling of sediments. The top 10-15 cm of the Van Veen sampler's contents was spooned into a stainless steel bowl and homogenized until consistent in texture and colour. Four 125 mL and one 250 mL glass jars of sediment were collected for physical and chemical analysis from each homogenized sample. Jars were filled completely to the top, minimizing headspace. Duplicate samples were collected at four sample locations. All samples were kept cool until submitted to Cantest (Burnaby, BC) at the end of the sampling program. Photographs were taken as appropriate. The jars were retained for the following analyses:

- 3 x 125 ml – bulk sediment physical and chemical analyses
- 1 x 125 ml – sediment bioavailability analysis
- 1 x 250 ml – sediment petrography

Samples were collected in December 2010 from six locations as subsamples from the toxicity sediment sample buckets that were collected in support of the TIE. Sediments were subsampled by Maxxam (Burnaby, BC) during during sediment homogenization that was conducted in preparation for toxicity testing. Subsamples of homogenized sediment were retained for bulk sediment physical and chemical analyses.

2.2.2 Sediment Toxicity Samples

Samples for toxicity tests were collected using the methods and equipment described above for sediment sampling. The required volume of sediment collected varied between locations, based on the number of planned toxicity tests. The subsamples for toxicity testing were the same homogenized samples as the sediment subsamples.

Samples for toxicity testing were collected in October 2009 from a subset of 19 sample locations. Two 4-L pails of sediment were collected from nine locations assigned to the full batch of tests (*i.e., Eohaustorius* survival test, *Neanthes* survival and growth test, echinoderm fertilization test, and Microtox), and one 4-L pail of sediment was collected from an additional ten locations assigned to the *Eohaustorius* toxicity test only[1]. Pails were filled completely, minimizing headspace, with aliquots from the same homogenized sample, and lids were secured with duct tape. Photographs were taken as appropriate. All samples were kept cool until submitted to Cantest (Burnaby, BC; now Maxxam) at the completion of the sampling program.

Samples were collected in December 2010 from six of the 2010 sample locations for the TIE using echinoderm fertilization testing. At all locations multiple composited grabs were required to collect the required sample volume of 16 L. The top 10-15 cm of the Van Veen sampler's contents were transferred directly from the grab into four 4-L plastic pails. Pails were filled completely, minimizing headspace and lids were secured with duct tape. Grabs were not homogenized in the field as homogenization was conducted in the lab. All samples were kept cool until submitted to Maxxam (Burnaby, BC; formerly Cantest) at the end of the sampling program. Photographs were taken as appropriate. All samples were kept cool until submitted to Maxxam at completion of the sampling program.

2.2.3 Subsurface Sediment Chemistry Samples

During the December 2010 sampling event, eight subsurface samples were collected using a vibrocorer. Depth strata were sampled from each core, including (to the depth of penetration) surface, 0.5 m, 1 m, and 2 m strata. The maximum core depth achieved with the vibrocorer was approximately1.6 m, and therefore fewer than four depth strata were collected at most locations. Pre-cleaned bowls and utensils were used to subsample core strata. The contents of each core stratum sample were homogenized in a stainless steel bowl and spooned into four 125 mL glass jars. Two field duplicate sediment samples were collected at different strata to provide an indication of variability in the sediment chemistry. All samples were submitted for physical and chemical analysis with the exception of the three core samples in the area of the former log dump (stations 2010-03, 2010-04 and 2010-06). These were exploratory cores intended to rule out the potential presence of NAPL entering the subsurface subtidal zone. The cores were observed in the field to contain primarily woody material and debris, and there was no indication of NAPL in the subsurface. Based on these observations, analysis of strata from these cores was not considered necessary.

[1] Note sampling for toxicity testing using the full batch of tests was also conducted for Station 5A but the toxicity samples for this station were lost in shipping and, therefore, were not tested.

2.2.4 Benthic Community Samples

A benthic community sample was collected from each sample location using a Ponar grab sampler. Once the boat was confirmed to be on station and the GPS coordinates had been recorded, the grab sampler was deployed. Only those grab samples that met the following acceptability criteria were retained:

- The sampler was fully closed and did not contain large rocks or other debris;
- There was adequate penetration depth (*i.e.,* 10 cm);
- The sample was not overfilled or disturbed, and the sampler was not deployed on an angle; and,
- The sampler was not leaking (there was overlying water present and no visible leaks).

If the grab was classified as acceptable, then the contents of the grab were transferred to a 5L plastic tote. Sediments were field-sieved on board the boat with a 1-mm mesh sieve. Seawater was used to rinse the sediments during field sieving. The material remaining on the sieve was transferred into 1-L plastic containers using a stainless steel spoon and a minimal volume of seawater. Samples were preserved using a 10% solution of buffered formalin and container lids were secured with tape to prevent spills, and stored at the Golder Associates warehouse in Burnaby, BC.

2.2.5 Equipment Decontamination and Field QA/QC

Quality assurance and control (QA/QC) practices were followed as described below to promote and verify sample quality during collection and transport.

- All sampling equipment (grabs, totes, sieve, etc.) was decontaminated between sampling locations by scrubbing in site water with Liquinox^{TM} detergent, followed by rinsing in site water.
- Pre-cleaned and lab-certified glass jars and plastic pails were used for sample collection.
- Chain-of-custody procedures were initiated during sample collection and a chain-of-custody record accompanied each sample to its final destination.
- Samples were collected and processed by qualified, experienced personnel.
- Sample handling or contact with contaminating materials and surfaces was minimized.

Field homogenization duplicates were collected during October 2009 grab sampling and as part of core stratum subsampling in December 2010.

2.3 Sediment Analyses

2.3.1 Sediment Bulk Chemistry

Surface sediment subsamples collected in 2009 were submitted to Cantest Laboratory (Burnaby, BC) for analysis of the following parameters according to the laboratory's standard operating procedures (methods described in laboratory reports in Appendix II):

- Moisture content, sediment pH, particle size, total organic carbon (TOC);
- Metals;
- Acid volatile sulphide and simultaneously extractable metals (AVS/SEM);
- PAHs; and,
- CCME petroleum hydrocarbon fractions F2, F3 and F4.

Sediment subsamples collected in December 2010 from the toxicity pails, and core surface strata, were analyzed by Maxxam (Burnaby, BC) for the same parameters as the subsamples in October 2009 with the following exceptions:

- For the subsamples collected from the toxicity pails, BTEX and CCME petroleum hydrocarbon fraction F1 were also analyzed; and,
- For the core surface strata, particle size was not analyzed.

Core subsurface strata were analyzed for the same parameters as the subsamples in October 2009, with the exception of AVS/SEM which was not analyzed.

2.3.2 Sediment PAH Passive Sampler Analysis

Thin-film solid phase extraction was used to estimate the relative bioavailability of PAHs in sediment samples collected in October 2009. The basic principle of this method is to expose sediments to a passive sampling material (in this case the polymer ethylene vinyl acetate [EVA]), and to measure the concentration of chemical that diffuses from the sediment sample into the sampling material following a suitable equilibration period. Methods were based on those described in Meloche *et al.* (2009), and are described in more detail below.

Passive samplers were prepared at Cantest Laboratory (Burnaby, BC) on October 1st, 2009. Each sample vial was prepared by adding 0.15 mL of an EVA solution (6.2 mg/mL EVA dissolved in dichloromethane) into a 20 mL borosilicate glass scintillation vial. The uncapped vials were gently rotated to allow the dichloromethane to evaporate, leaving a thin film of EVA on the vial interior. Resulting EVA films were 1 µL in volume, with an approximate surface area-to -volume ratio of 37,000 m^{-1}. These sampler properties were selected to achieve a relatively fast equilibration (*i.e.,* high surface area to volume ratio) while preventing depletion of the sediment concentration (*i.e.,* ratio of EVA volume to sediment organic carbon was low). Vials were capped and stored in the laboratory until test initiation.

The test was initiated on November 19th, 2009 (Day 1). Sediments were press sieved (2 mm mesh sieve) to remove large particles or debris prior to addition into the sampler vials. Three passive sampler vials were filled for each sediment sample. In addition to the harbour samples, positive and negative controls were prepared to provide a relative measure of high and low bioavailable PAHs, as follows:

- **Positive control (spiked sample)**: A stock PAH solution (Certified reference material, Ultra Scientific, North Kingstown, RI) was added to Chesapeake Bay (CB) control sediment (TOC 3%, moisture content 60%, sand 4%, silt 51%, clay 45%). Sediment spiking was conducted directly in the passive sampler vials. Three vials were filled halfway with the control sediment, and 75 uL of the stock PAH solution was added to each vial. Vials were left uncapped for four hours to allow the carrier solution to evaporate, and were then filled to 20 mL with CB control sediment and mixed for 5 minutes. The resulting nominal total PAH concentration in the vials was 200 mg/kg dry weight.
- **Negative control (activated carbon)**: 5 grams of activated carbon (1-2 mm granules) was added to each of three vials containing 20 mL of CB control sediment. Vials were mixed to allow the activated carbon to distribute evenly throughout the sediment.

Once filled, all vials (test and control) were stored in a dark room at 15°C and were inverted once per day for the duration of the equilibration period to allow some mixing and renewal of the EVA-sediment contact layer. Three empty vials were also stored with the test vials as method blanks.

On Day 8, sediments were removed from the sampler vials and the EVA thin-films were extracted using hexane. Vials were shaken to fully remove the EVA from the sides, and the contents of the vials were emptied into a glass dish containing de-ionized water. The EVA films were recovered by floatation, rinsed with water to remove residual sediment debris, and stored in empty glass vials. Thin films from the three replicates per sample were composited into one glass vial. The films were then extracted with three consecutive rinses with 1 mL hexane each. The 3 mL hexane extracts were stored in clean 20 mL scintillation vials and shipped to Pacific Rim Laboratory (Surrey, BC) for high-resolution analysis of PAHs.

Hexane extracts were transferred to 15 mL test tubes and spiked with 50 ng each of 16 carbon-13 labelled internal standards. The sample volume was reduced to 0.5 mL under a gentle stream of nitrogen and then transferred to a 700 µL gas chromatography vial. Sample analysis was conducted on a Micromass Ultima High Resolution Mass Spectrometer coupled with a Hewlett-Packard 5890 gas chromatograph. An initial five-point calibration was conducted with concentrations ranging from 3 to 300 ng/mL. All analytes were quantified relative to their corresponding carbon-13 labelled analogue and the calibration was verified every twelve hours by injecting a mid-point standard.

One blank (0.5 mL hexane, spiked with 50 ng of internal standards) was analyzed. It contained detectable amounts of most of the analytes. All data were therefore corrected for blank contamination. Detection limits were calculated by analyzing three spiked blanks. The detection limits were set at three times the standard deviation of the blanks. No blank contamination was detected for indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene or dibenz(a,h)anthracene. The detection limit for these parameters was set at 1 ng per sample.

Analytical results were reported as ng of analyte per sample (Appendix II). To calculate the concentration of each analyte in EVA (*i.e.,* the passive sampler concentration), the mass in hexane was divided by the volume of EVA in the composited samples.

2.3.3 Bulk Sediment and Porewater Toxicity Testing

2.3.3.1 10-d Amphipod Survival Test

Sediments from 19 stations were tested with *Eohaustorius estuarius* using the 10-day Acute Survival and Reburial Test, as described by Environment Canada's Biological Test Methods (EPS 1/RM/35). Two 10-day *E. estuarius* tests were initiated, the first on November 13, 2009, and the second on November 20, 2009, with reburial commencing on test end dates, November 23, 2009 and November 30, 2009, respectively. The test involves exposure of the amphipod, *E. estuarius,* to marine sediments for a period of 10 days to assess effects on survival and reburial.

Test organisms and the negative control sediment for the test were field collected intertidally from Mackenzie Beach, Tofino, BC on November 9, 2009 and transported to the Cantest laboratory for use (further information on collection and handling is provided in the Cantest report in Appendix II). Amphipods were acclimatized in the laboratory for 2-10 days in negative control sediment under static conditions at 15 ± 2°C. Overlying water for the test was uncontaminated seawater obtained from the Vancouver Aquarium. Five replicate test containers were prepared for each treatment; test treatments included the test sediment and a negative control. The negative control, consisting of sediment from the amphipod collection site, also had five replicates. The test was conducted in 1-L glass jars, each containing a 2-cm layer of sediment, 800 mL of clean, overlying seawater, and 20 amphipods. The exposure period was 10 days at 15 ± 1°C under continuous light, with no food provided or renewal of overlying water. All replicates were gently aerated throughout the test. Water quality and amphipod sediment avoidance were monitored daily; final counts of surviving amphipods and reburial ability were made on Day 10. Surviving organisms were assessed for reburial in control sediment for up to one hour. At the end of the test, survival was compared with the controls. The test was considered valid if mean survival in the control was ≥ 90%, and the survival in individual control replicates was ≥ 80%.

Subsamples for ammonia (mg/L N) in overlying water were collected on Days 0 and 10. Sample-specific measurements of pH and salinity, together with the fixed test chamber temperature were also made to facilitate calculation of the unionized ammonia fraction.

2.3.3.2 20-d Polychaete Survival and Growth Test

Sediments from nine stations sampled in October 2009 were tested with *Neanthes arenaceodentata* 20-d Survival and Growth Test, as described in PSEP (1995). The test was initiated on November 20, 2009. The test involves exposure of the polychaete *N. arenaceodentata* to assess effects on survival, mean individual dry weigth, and mean growth.

Test organisms were laboratory-reared and provided by Don Reish at California State University, Long Beach CA. They were collected on November 16, 2009 and shipped overnight in whirlpack bags and arrived at Cantest in satisfactory condition on November 17, 2009. The control sediment used in the *N. arenaceodentata* test was provided by the organism supplier and was collected from Chesapeake Bay, NH. Preparation of the sediment for

use as a negative control included press-sieving the material through a 250 µm stainless steel screen, rinsing the sediment with control water, then freezing the sediment for a minimum of 72 h to eliminate indigenous organisms that might be present. Overlying water for the test was uncontaminated seawater obtained from the Vancouver Aquarium. Five replicate test containers were prepared for each treatment; test treatments included the test sediment and a negative control consisting of the control sediment also had five replicates. The test was conducted in 1-L glass jars, each containing 175 ml of homogenized sediment, 800 mL of clean, overlying seawater, and 20 amphipods. The exposure period was 20 days at 20 ± 1°C under continuous light, with feeding every second day (40 mg Tetramin/replicate) and 30% renewal of overlying water every third day. All replicates were gently aerated throughout the test. Water quality was monitored daily.

At test termination (Day 20), the organisms were collected from the sediments and final survival was recorded. Surviving organisms were dried and weighed to determine total dry weight, average individual dry weight, and average individual growth rate for each replicate. The test was valid if mean survival in the control was ≥ 90%, mean growth rate in the control was ≥ 0.38 mg/worm/day, and mean individual growth rate/mean individual growth rate in the control was ≥ 80%. Subsamples for overlying ammonia (mg/L N) were collected on Days 0 and 20. Sample-specific measurements of pH and salinity were also made to facilitate calculation of the unionized ammonia fraction.

2.3.3.3 Echinoderm Fertilization

Porewater centrifuged from sediments from nine stations sampled in October 2009 were tested with the Echinoderm Fertilization Test using *Strongylocentrotus purpuratus* as described by Environment Canada's Biological Test Methods (EPS 1/RM/27). The test was initiated on November 19, 2009. The test involves exposure of sperm and eggs of the sea urchin *S. purpuratus* to determine effects of pore water on fertilization.

Test organisms were field-collected and provided by Steve Lepage of Marine Research and Educational Products, in Carlsbad, CA. Collected sea urchins were held for at least 24 hours prior to shipping in Styrofoam coolers with ice packs and received at Cantest on November 19, 2009. Control water was uncontaminated seawater obtained from the Vancouver Aquarium. Four replicate test containers were prepared for each treatment; test treatments included the test porewater and a negative control consisting of clean seawater that also had four replicates. The test was conducted in 20 ml glass tubes, each containing 6 ml of sediment porewater or control water and an estimated 1,051 sea urchin eggs and 19,711 sea urchin sperm. The exposure period was 20 minutes (10 minutes sperm exposure only followed by 10 minutes sperm and egg exposure), with pre-aeration but no aeration during the test. Water quality was monitored in the 100% porewater and at test initiation. At exposure termination, a subset of 100-200 eggs was taken from each test vessel for microscopic examination to determine the fertilization state of each egg and estimate the overall rate of fertilization.

The test was valid if mean fertilization in the control was ≥ 50% but ≤ 100%. Subsamples of porewater were collected prior to test initiation for analysis for ammonia (mg/L N) and sulphide (mg/L). Sample-specific measurements of pH and salinity were also made to facilitate calculation of the unionized ammonia fraction.

2.3.3.4 Solid Phase Microtox

Sediment from nine stations sampled in October 2009 was tested with the Solid Phase Light Inhibition Microtox™ test using the bacteria *Vibrio fischeri* according to the *Environment Canada Biological Method for Determining the Toxicity of a Sediment Using Luminescent Bacteria* (EPS 1/RM/42). The tests were performed on November 26 and 27, 2009. The test measures light production in *V. fischeri* exposed to multiple dilutions of a sediment elutriate to determine the IC_{50} for inhibition in light production.

Test organisms were obtained from Strategic Diagnostics Inc. (Strain NRRL B-11177). Control and dilution water was a 3.5% NaCl solution. Three replicate test containers were prepared for each control with 1 test container for each dilution concentration. Exposure was conducted in 15 ml polycarbonate tubes, each containing up to 7 g homogenized sediment and 35 mL diluents (in a dilution series) and 20 µL of inoculum. The bacterial strain was incubated in each tube for a period of 20 minutes followed by filtration/stabilization of the contents for 10 minutes and subsequent measurement of light production in a photometer.

The test was valid if the coefficient of variation in light production in the control replicates was ≤ 12%. Temperature was measured at each stage of the test.

2.3.3.5 Toxicity Identification Evaluation

Porewater centrifuged from surface sediments from the six stations sampled in December 2010 was tested with the Echinoderm Fertilization Test by Maxxam (Burnaby, BC) using test methods similar to those described in the preceding Section. Two tiers of testing were conducted:

- **Tier 1:** The first round was used to confirm porewater toxicity to echinoderm fertilization for each of the six samples and support a preliminary assessment of possible causes of toxicity; and
- **Tier 2:** The second round involved testing of the porewater from a subset of three of the six stations (2010-7, 2010-9, 2010-11), with sample amendments to evaluate potential metal or sulphide toxicity.

This testing was also combined with porewater chemistry analyses for dissolved metals, total suspended solids, hardness, ammonia, and sulphide.

The sediment samples were received at Maxxam on December 17, 2010, where they were stored in the dark at 4 ± 2°C, prior to testing. The sediment samples were combined and homogenized, porewater was extracted via centrifugation and the Tier 1 testing on porewater was conducted on December 21, 2010. Test organisms for this tier of testing were field-collected and provided by Steve Lepage of Marine Research and Educational Products, in Carlsbad, CA. Collected sea urchins were held for at least 24 hours prior to shipping in Styrofoam coolers with ice packs and received at Cantest on December 21, 2010. Extracted porewater was subsampled, prior to testing, for chemistry analyses.

Tier 2 testing involved further testing of new porewater extracted from the three sediment samples that exhibited the highest toxicity in December 2010 testing. Sediment porewater was extracted via centrifugation from 2010-7, 2010-9, 2010-11 on February 22, 2011. Separate aliquots of each porewater sample were subjected to the following testing and amendments:

- Testing of the un-amended sample.
- Sulphide removal by allowing the samples to sit in open containers in a fume hood overnight (approximately 19 hours), facilitating volatilization of sulphides with minimal other alteration of the porewater sample. This was followed by testing of the sulphide-amended sample.
- Divalent metals chelation by addition of ethylenediaminetetraacetic acid (EDTA) at four concentrations: 0.8, 1.6, 2.4 and 3.2 g EDTA/L. This was followed by testing of each of the four treatments of the EDTA-amended sample.

Echinoderm fertilization tests were initiated on the un-amended and amended porewater samples on February 24, 2011. Test organisms for this tier of testing were field-collected and provided by Steve Lepage of Marine Research and Educational Products, in Carlsbad, CA. Collected sea urchins were held for at least 24 hours prior to shipping in Styrofoam coolers with ice packs and received at Cantest on February 22, 2011.

For Tier 2, extracted porewater was subsampled, prior to amendment and testing, for chemistry analyses listed above, excluding TSS. Following sulphide removal, the sulphide-amended samples were also subsampled for analyses of the same parameters.

2.3.4 Sediment Petrography

Petrographic analysis was used to determine the coal content of surface grab sediment samples collected during the 2009 sampling event. Sediment subsamples were submitted to JP Petroraphics (Calgary AB) for microscopic analysis using standard petrographic techniques developed for routine analysis of coal samples. The analysis involved classification of sediment materials into organic and inorganic matter. These classifications were further subdivided to identify various forms of coal, other organic materials and other inorganic materials. Further information on the method is provided in the laboratory report in Appendix II.

3.0 RESULTS

The results of the 2009 and 2010 sediment investigations are described in this Section. Historical sediment investigation data are summarized in Section 1.3.

3.1 Field Observations

Photos of typical sediment characteristics and field sediment grab and core sampling logs, a summary of observations, and are provided in Appendices II, III and IV.

3.2 Surface Sediment Chemistry

This section summarizes the surface sediment chemistry results for the 2009 and 2010 surface grab samples. Description of the surface sediment chemistry results is grouped by parameter and where appropriate, the results are subdivided by the areas described in Section 2.1 (*i.e.,* Inside the Harbour, Adjacent to the Harbour, and Regional Reference).

3.2.1 Ancillary Sediment Characteristics

Particle size data are presented in Appendix V. A summary of particle size observed in the 2009 and 2010 grab samples is as follows:

- Inside the Harbour: sand (> 0.053 mm particles) ranged from 16 to 96%, silt (0.002 to 0.053 mm particles) ranged from 2 to 68% and clay (< 0.002 mm particles) ranged from 2 to 28%.
- Adjacent to the Harbour: sand ranged from 57 to 95%, silt ranged from 3 to 29% and clay ranged from 2 to 13%.
- Regional Reference Stations: sand ranged from 26 to 95%, silt ranged from 3 to 51% and clay ranged from 2 to 23%.

Sediment total organic carbon (TOC) data are presented in Appendix V. Total organic carbon concentrations ranged from 1.1 to 43.3% at Inside the Harbour locations, 1.2 to 10.1% at Adjacent to the Harbour locations and 1.1 to 4.3% at Regional Reference locations.

3.2.2 Metals

Inside the Harbour

Metal concentrations observed inside the Harbour are compiled in Appendix V and summarized in Table 3.

Several metals exceeded the ISQG, PEL and $SedQC_{TS}$ in one or more of the sediment samples collected inside the Harbour. In addition, some metals exceeded the Lower Level numerical limit.

Applicable benchmarks, maximum and minimum concentrations, and number of exceedances are presented in Table 4. A summary of the metal exceedances are as follows:

- *Metals that exceeded the ISQG:* arsenic, cadmium, copper, lead, mercury and zinc.
- *Metals that exceeded the PEL:* copper.
- *Metals that exceeded the $SedQC_{TS}$:* copper.
- *Metals that exceeded the Disposal at Sea Lower Level numerical limit:* cadmium.

Metal concentrations exceeded benchmarks across the Harbour with the two exceedances of the $SedQC_{TS}$ located in the lot titled “Block C”. Based on air photo examination, Block C appears to correspond with a former/current marina facility. Contaminant distribution is examined further in Section 4.1.

Adjacent to Harbour

Metal concentrations observed adjacent to the Harbour are compiled in Appendix V and a summary is presented in Table 4.

Arsenic, cadmium, copper and mercury exceeded the ISQG in surface sediments adjacent to the Harbour. There were no exceedances of the PEL or $SedQC_{TS}$ for metals in surface sediments from this area.

Regional Reference

Metal concentrations observed at Regional Reference stations are compiled in Appendix V and a summary is presented in Table 5.

Arsenic, copper, cadmium and mercury exceeded the ISQG at one or more stations located in the Regional Reference areas. The PEL and $SedQC_{TS}$ were not exceeded in any of the surface sediment samples from these areas.

Table 3: Inside Harbour Sediment Data Screening

Substance	Number of Surface Stations	Concentration		Benchmark (Number of Exceedances)			
		Min	Max	CCME ISQG[a]	CCME PEL [b]	BC $SedQC_{TS}$ [c]	Lower Level Numerical Limit [d]
Arsenic	31	2.3	15.9	7.24 (24)	41.6 (0)	50 (0)	-
Cadmium	31	0.34	4.2	0.7 (24)	4.2 (0)	5 (0)	0.6 (24)
Copper	31	19	300	18.7 (31)	108 (2)	130 (2)	-
Lead	31	3.3	52.3	30.2 (4)	112 (0)	130 (0)	-
Mercury	31	0.03	0.51	0.13 (26)	0.7 (0)	0.84 (0)	0.75 (0)
Zinc	31	26	199	124 (16)	271 (0)	330 (0)	-
Acenaphthene	31	0.008	0.34	0.00671 (28)	0.0889 (13)	0.11 (9)	-
Acenaphthylene	31	0.028	0.082	0.00587 (5)	0.128 (0)	0.15 (0)	-
Anthracene	31	0.02	0.62	0.0469 (31)	0.245 (10)	0.29 (11)	-
Benzo(a)anthracene	31	0.03	0.87	0.0748 (24)	0.693 (1)	0.83 (1)	-
Benzo(a)pyrene	31	0.02	0.45	0.0888 (21)	0.763 (0)	0.92 (0)	-
Chrysene	31	0.03	0.74	0.108 (25)	0.846 (0)	1.0 (0)	-
Dibenz(a,h)anthracene	31	0.005	0.07	0.00622 (24)	0.135 (0)	0.16 (0)	-
Fluoranthene	31	0.06	2.6	0.113 (29)	1.494 (4)	1.8 (3)	-
Fluorene	31	0.02	0.56	0.0212 (27)	0.144 (13)	0.17 (9)	-
Methylnaphthalene (2-)	31	0.03	5	0.0202 (30)	0.201 (23	-	-
Naphthalene	31	0.02	1.9	0.0346 (31)	0.391 (9)	0.47 (9)	-
Phenanthrene	31	0.03	4.5	0.0867 (29)	0.544 (16)	0.65 (12)	-
Pyrene	31	0.04	1.8	0.153 (30)	1.398 (2)	1.7 (1)	-
Total PAHs	31	0.25	15.4	-	-	20 (0)	2.5 (22)

Notes:
Concentrations expressed as mg/kg dry weight.
a - Federal interim sediment quality guideline (ISQG). CCME, 2001.
b - Federal probable effects level (PEL). CCME, 2001.
c - Provincial sediment quality criteria for typical contaminated sites ($SedQC_{TS}$) (Government of British Columbia 2011)
d - Disposal at Sea Regulations of the Canadian Environmental Protection Act (CEPA), 1999.
- No Benchmark

Table 4: Adjacent to Harbour Sediment Data Screening

Substance	Number of Surface Stations	Concentration		Benchmark (Number of Exceedances)			
		Min	Max	CCME ISQG [a]	CCME PEL[b]	BC $SedQC_{TS}$[c]	Lower Level Numerical Limit[d]
Arsenic	10	2.1	10.3	7.24 (2)	41.6 (0)	50 (0)	-
Cadmium	10	0.2	1.9	0.7 (5)	4.2 (0)	5 (0)	0.6 (5)
Copper	10	18	61	18.7 (9)	108 (0)	130 (0)	-
Mercury	10	0.05	0.26	0.13 (5)	0.7 (0)	0.84 (0)	0.75 (0)
Acenaphthene	10	0.015	0.16	0.00671 (7)	0.0889 (2)	0.11 (1)	-
Acenaphthylene	10	0.012	0.13	0.00587 (4)	0.128 (1)	0.15 (0)	-
Anthracene	10	0.03	0.37	0.0469 (6)	0.245 (3)	0.29 (3)	-
Benzo(a)anthracene	10	0.03	0.49	0.0748 (6)	0.693 (0)	0.83 (0)	-
Benzo(a)pyrene	10	0.01	0.27	0.0888 (3)	0.763 (0)	0.92 (0)	-
Chrysene	10	0.04	0.53	0.108 (6)	0.846 (0)	1.0 (0)	-
Dibenz(a,h)anthracene	10	0.007	0.048	0.00622 (4)	0.135 (0)	0.16 (0)	-
Fluoranthene	10	0.02	1.3	0.113 (6)	1.494 (0)	1.8 (0)	-
Fluorene	10	0.03	0.37	0.0212 (6)	0.144 (3)	0.17 (3)	-
Methylnaphthalene (2-)	10	0.02	3.9	0.0202 (9)	0.201 (6)	-	-
Naphthalene	10	0.07	1.5	0.0346 (9)	0.391 (5)	0.47 (5)	-
Phenanthrene	10	0.02	2.8	0.0867 (9)	0.544 (6)	0.65 (6)	-
Pyrene	10	0.04	0.81	0.153 (6)	1.398 (0)	1.7 (0)	-
Total PAH's	10	0.1	11.2	-	-	20 (0)	2.5 (6)

Notes:
Concentrations expressed as mg/kg dry weight.
a - Federal interim sediment quality guideline (ISQG). CCME, 2001.
b - Federal probable effects level (PEL). CCME, 2001.
c - Provincial sediment quality criteria for typical contaminated sites ($SedQC_{TS}$) (Government of British Columbia 2011).
d - Disposal at Sea Regulations of the Canadian Environmental Protection Act (CEPA), 1999.
- No Benchmark

Table 5: Regional Reference Sediment Data Screening

Substance	Number of Surface Stations	Concentration (mg/kg dry weight)		Benchmark (Number of Exceedances)			
		Min	Max	CCME ISQG [a]	CCME PEL [b]	BC $SedQC_{TS}$ [c]	Lower Level Numerical Limit [d]
Arsenic	5	4.3	10.1	7.24 (2)	41.6 (0)	50 (0)	-
Cadmium	5	0.9	3.7	0.7 (5)	4.2 (0)	5 (0)	0.6 (5)
Copper	5	17	56	18.7 (4)	108 (0)	130 (0)	-
Mercury	5	0.04	0.22	0.13 (3)	0.7 (0)	0.84 (0)	0.75 (0)
Acenaphthene	5	0.012	0.026	0.00671 (3)	0.0889 (0)	0.11 (0)	-
Dibenz(a,h)anthracene	5	0.007	0.007	0.00622 (1)	0.135 (0)	0.16 (0)	-
Fluoranthene	5	0.03	0.12	0.113 (1)	1.494 (0)	1.8 (0)	-
Fluorene	5	0.02	0.03	0.0212 (2)	0.144 (0)	0.17 (0)	-
Methylnaphthalene (2-)	5	0.04	0.1	0.0202 (4)	0.201 (0)	-	-
Naphthalene	5	0.02	0.06	0.0346 (2)	0.391 (0)	0.47 (0)	-
Phenanthrene	5	0.04	0.12	0.0867 (2)	0.544 (0)	0.65 (0)	-

Notes:

Concentrations expressed as mg/kg dry weight.

a - Federal interim sediment quality guideline (ISQG). CCME, 2001.

b - Federal probable effects level (PEL). CCME, 2001.

c - Provincial sediment quality criteria for typical contaminated sites ($SedQC_{TS}$) (Government of British Columbia 2011).

d - Disposal at Sea Regulations of the Canadian Environmental Protection Act (CEPA), 1999.

- No Benchmark

3.2.3 PAHs

Inside the Harbour

PAH concentrations observed inside the harbour are compiled in Appendix V and a summary is presented in Table 3.

Several PAHs exceeded the ISQG, PEL and $SedQC_{TS}$ in one or more of the sediment samples collected inside the Harbour. In addition, total PAHs exeeded the Lower Level numerical limit at some locations. The applicable benchmarks, maximum and minimum concentrations and number of exceedances are presented in Table 3. A summary is provided below:

- *PAHs that exceeded the ISQG:* acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene.
- *PAHs that exceeded the PEL:* acenaphthene, anthracene, benzo(a)anthracene, fluoranthene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene.
- *PAHs that exceeded the $SedQC_{TS}$:* naphthalene, acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, benzo(a)anthracene,
- *PAHs that exceeded the Lower Level numerical limit:* Total PAHs

The spatial distributions of PAHs concentrations inside the Harbour were not focused in any particular region, with concentrations that exceeded the benchmarks distributed over the entire study area. Contaminant distribution is discussed further in Section 4.1.

Adjacent to Harbour

PAH concentrations observed adjacent to the harbour are compiled in Appendix V and a summary is presented in Table 4.

All the evaluated PAHs exceeded the ISQG, similar to the concentrations observed inside the Harbour. In addition, several PAHs exceeded the PEL and $SedQC_{TS}$ in samples adjacent to the Harbour, exhibiting similar concentrations ranges to those inside the harbour.

Regional Reference

PAH concentrations observed at Regional Reference stations are compiled in Appendix V and a summary is presented in Table 5.

Acenaphthene, dibenz(a,h)anthracene, fluoranthene, fluorine, 2-methylnaphthalene, naphthalene and phenanthrene exceeded the ISQG at one or more stations located in the Regional Reference areas. The PEL and $SedQC_{TS}$ were not excedeed in any of the surface sediment samples from these areas.

3.2.4 CCME Petroleum Hydrocarbon Fractions F1-F4

The concentrations of CCME petroleum hydrocarbon fractions F1 and F4 were less than analytical detection limits (DL) for the majority of the collected samples (Appendix V). Descriptions of detected fractions are as follows:

- **Inside the Harbour:** Detected concentrations of F2 ranged from 23 to 230 µg/g (detected in 14 of 31 samples) and of F3 ranged from 170 to 960 µg/g (detected in 28 of 31 samples). F4 was not detected in 2009 samples (< 500 µg/g) and ranged from 110 to 240 µg/g in 2010 samples (detected in all 6 samples). F1 concentrations were determined in 2010 samples only and were all below the method detection limits.
- **Adjacent to Harbour:** Detected concentrations of F2 ranged from 90 to 220 µg/g (five of 10 samples) and of F3 ranged from 120 to 540 µg/g (eight of 10 samples above DL). F4 was not detected in 2009 samples from this area (< 500 µg/g), and F1 was not analyzed in 2009 samples from this area.
- **Regional Reference:** Concentrations of F2 were all below DL and of F3 ranged from 140 to 230 µg/g (three of five samples were above DL). F4 was not detected in 2009 samples from this area (< 500 µg/g), and F1 was not analyzed in 2009 samples from this area.

3.2.5 Monoaromatic Hydrocarbons (BTEX)

BTEX was analyzed for the 2010 surface samples. Concentrations of BTEX were less than analytical detection limits for the majority of the collected samples (Appendix V). Descriptions of measurable hydrocarbons concentrations are as follows:

- Detected concentrations of toluene ranged from 0.05 to 0.19 µg/g (five of six samples contained detectable toluene). Benzene had a single detectable concentration of 0.04 µg/g.

3.2.6 Acid Volatile Sulphide and Simultaneously Extractable Metals

The SEM to AVS ratio is a surrogate for metal bioavailability (DiToro *et al.*, 1990; Ankley *et al.*, 1991; Chapman, 1996b; Casas and Crecelius, 1994). Samples with an excess of AVS (relative to SEM) are assumed to have relatively low metal bioavailability because divalent metal cations (*i.e.,* cadmium, copper, lead, mercury, nickel and zinc) are likely sequestered as insoluble metal-sulphide complexes and thus have low bioavailability. When the molar quantity of SEM approaches or exceeds AVS, the capacity of the available AVS to form metal-sulphide complexes is likely to be exceeded and a portion of the metals present are expected to be bioavailable.

The AVS and SEM results for sediment grab samples are presented in Appendix V. Only one station, 6A, had an SEM:AVS ratio exceeding one (*i.e.,* indicating bioavailable metals). This station is located inside the harbour. An additional four stations (1A, 24A, 33A and 2010-13) had SEM:AVS ratios that were between 0.5 and 1 indicating that the molar quantity of SEM was close to the quantity of AVS. One of these stations (33A) was located adjacent to the Harbour, and the remainder were located inside the Harbour.

Grab samples from the remaining stations all had SEM:AVS ratios below 0.5, indicating that the molar quantity of AVS was in excess of the SEM present.

3.2.7 Sediment PAH Passive Sampler Results

The PAH results for the passive sampler testing are summarized in Appendix V. The Pacific Rim Laboratory report for the extract analysis is provided in Appendix II. The total mass of PAHs in each sample extract was summed and then normalized to the amount of EVA used in each sampler to provide an index of the degree to which the PAHs in collected sediments were available for absorption into the EVA.

Total available PAHs (µg PAHs/g EVA) were markedly higher for station 26A (128 µg PAHs/g EVA) than for any other station sampled inside or outside the Harbour. Excluding this station, the ranges of total available PAHs were as follows:

- **Inside the Harbour:** total available PAHs ranged from 2.3 to 19.9 µg PAHs/g EVA.
- **Adjacent to Harbour:** total available PAHs ranged from 1.2 to 5.6 µg PAHs/g EVA.
- **Regional Reference:** total available PAHs ranged from 0.6 to 3.6 µg PAHs/g EVA.

The total available PAH concentrations in the negative control (activated carbon added to control sediment), positive control (control sediment spiked with PAHs) and blank were 1.4, 1423 and 0.9 µg PAHs/g EVA, respectively.

3.2.8 Petrography

The results of the sediment petrography analysis are summarized in Appendix V. The JP Petrographics laboratory report is provided in Appendix II. Percent coal for each sediment sample was estimated by summing the percentage of coal and shaley coal observed in each sample. The ranges of percent coal in sediment samples were as follows:

- **Inside the Harbour:** percent coal ranged from 3 to 78%.
- **Adjacent to Harbour:** percent coal ranged from 2 to 55%.
- **Regional Reference Stations:** percent coal ranged from zero to 21%.

3.2.9 QA/QC Results

Field duplicates were collected at a rate of 10% of the total number of primary samples. Each duplicate was collected as a split quantity of the same homogenized sediment sample (*i.e.,* after sample homogenization in the field). Field duplicates were collected during the October 2009 grab sampling at stations 15A, 21A and 22A,

To assess variability between field duplicates, the relative percent difference (RPD) was calculated as follows:

$$RPD = \left(\frac{sample - duplicate}{(sample + duplicate)/2}\right) \times 100$$

In accordance with the BC Technical Guidance 19 on Contaminated Sites (BC MOE 2005), an RPD value of ± 35% for values ≥ 5 times the method detection limit (MDL) was used to identify notable differences between original and duplicate samples. Values less than five times the MDL were not included in the RPD calculations because analytical variability near the MDL is much higher and does not provide a good measure of precision associated with the collection of field samples.

Appendix VI presents the RPD calculations and values for the field duplicate samples. Field duplicates exhibited concentrations similar (*i.e.,* within 35% for values >5 times the MDL) to the original sample for all metals analyses.

Although Technical Guidance 19, does not specify an RPD value for organics analyses, the 35% guideline was used as a general indication of duplicate similarity. RPDs for individual PAHs for station 21A ranged from 23% to 51% and for station 22A ranged from 24% to 68%. The RPDs for PAHs at these stations are considered anomalous given the RPDs for metals which were within the accepted ranges. The variability for PAHs may reflect the association of PAHs with coal particles or other debris.

An examination of the available RPDs indicates that samples were adequately homogenized. High RPDs of a few individual parameters are indicative of the presence of an analyte in particulate form, and are not an indication of poor homogenization or measurement error when other related compounds demonstrate relatively low RPDs. RPDs observed in this study are common for sediment sampling programs, especially for PAHs in sediments influenced by the presence of coal particles. Sediment heterogeneity may explain the variability between the field duplicate and original sample.

All laboratory QA/QC measures, including laboratory duplicates, method spikes, method blanks and analysis of certified reference material met internal laboratory QA/QC criteria.

3.3 Core Sediment Chemistry

The core sample data included 20 strata samples taken from five core sample locations from the December 2010 sampling event. All core samples were located inside the Harbour. Core strata were defined as follows:

- **Surface stratum** – 0 to 0.3 m;
- **Middle stratum** – 0.3 m to 0.7 m; and,
- **Deep stratum** – Greater than 0.7 m.

3.3.1 Metals

Sediment metals concentrations in core strata are compiled in Appendix V. The results of screening against the benchmarks for metals are presented in Tables 6, 7 and 8, and summarized as follows.

Surface (0 to 0.3m)

Several metals exceeded the ISQG and PEL in one or more of the surface sediment samples. However, there were no exceedances of the $SedQC_{TS}$ numerical criteria. Cadmium exceeded the Lower Level numerical limit. A summary of the metal exceedances is as follows:

- *Metals that exceeded the ISQG:* arsenic, cadmium, copper, mercury and zinc;
- *Metals that exceeded the PEL:* zinc; and,
- *Metals that exceeded the Lower Level numerical limit:* cadmium.

Middle (0.3m to 0.7m)

Several metals exceeded the ISQG, PEL and $SedQC_{TS}$ numerical criteria in one or more of the middle strata sediment samples. In addition, cadmium exceeded the Lower Level numerical limit. A summary of the metal exceedances are as follows:

- *Metals that exceeded the ISQG:* cadmium, copper, mercury and zinc;
- *Metals that exceeded the PEL:* zinc; and,
- *Metals that exceeded the Lower Level numerical limit:* cadmium.

Deep (> 0.7m)

Several metals exceeded the ISQG in one or more of the surface strata sediment samples. However, there were no exceedances of the PEL or $SedQC_{TS}$ numerical criteria. In addition, cadmium exceeded the Lower Level numerical limit. A summary of the metal exceedances are as follows:

- *Metals that exceeded the ISQG:* arsenic, cadmium, copper and mercury; and,
- *Metals that exceeded the Lower Level numerical limit:* cadmium.

Table 6: Surface Stratum Sediment Core Data Screening

Substance	Number of SurfaceStrata	Concentration		Benchmark (Number of Exceedances)			
		Min	Max	CCME ISQG[a]	CCME PEL [b]	BC $SedQC_{TS}$ [c]	Lower Level Numerical Limit [d]
Arsenic	5	3.1	16.2	7.24 (3)	41.6 (0)	50 (0)	-
Cadmium	5	0.3	3.63	0.7 (4)	4.2 (0)	5 (0)	0.6 (4)
Copper	5	31.4	82.3	18.7 (5)	108 (0)	130 (0)	-
Lead	5	13.1	25.7	30.2 (0)	112 (0)	130 (0)	-
Mercury	5	0.16	0.29	0.13 (5)	0.7 (0)	0.84 (0)	0.75 (0)
Zinc	5	61	4920	124 (3)	271 (1)	330 (1)	-
Acenaphthene	5	0.015	0.31	0.00671 (5)	0.0889 (4)	0.11 (3)	-
Acenaphthylene	5	0	0	0.00587 (0)	0.128 (0)	0.15 (0)	-
Anthracene	5	0.052	0.54	0.0469 (5)	0.245 (4)	0.29 (2)	-
Benzo(a)anthracene	5	0.1	0.62	0.0748 (5)	0.693 (0)	0.83 (0)	-
Benzo(a)pyrene	5	0.1	0.31	0.0888 (3)	0.763 (0)	0.92 (0)	-
Chrysene	5	0.11	0.57	0.108 (5)	0.846 (0)	1 (0)	-
Dibenz(a,h)anthracene	5	0.015	0.05	0.00622 (3)	0.135 (0)	0.16 (0)	-
Fluoranthene	5	0.25	1.4	0.113 (5)	1.494 (0)	1.8 (0)	-
Fluorene	5	0.037	0.71	0.0212 (5)	0.144 (4)	0.17 (3)	-
Methylnaphthalene (2-)	5	0.23	3.8	0.0202 (5)	0.201 (5)	-	-
Naphthalene	5	0.087	1.8	0.0346 (5)	0.391 (4)	0.47 (4)	-
Phenanthrene	5	0.22	3.1	0.0867 (5)	0.544 (4)	0.65 (4)	-
Pyrene	5	0.23	1.6	0.153 (5)	1.398 (1)	1.7 (0)	-
Total PAHs	5	1.8	15	-	-	20 (0)	2.5 (4)

Notes:

Concentrations expressed as mg/kg dry weight.

a - Federal interim sediment quality guideline (ISQG). CCME, 2001.

b - Federal probable effects level (PEL). CCME, 2001.

c - Provincial sediment quality criteria for typical contaminated sites ($SedQC_{TS}$) (Government of British Columbia 2011)

d - Disposal at Sea Regulations of the Canadian Environmental Protection Act (CEPA), 1999.

- No Benchmark

Table 7: Middle Stratum Sediment Core Data Screening

Substance	Number of Middle Strata	Concentration		Benchmark (Number of Exceedances)			
		Min	Max	CCME ISQG[a]	CCME PEL [b]	BC $SedQC_{TS}$ [c]	Lower Level Numerical Limit [d]
Arsenic	5	2.1	10.3	7.24 (2)	41.6 (0)	50 (0)	-
Cadmium	5	0.27	3.19	0.7 (4)	4.2 (0)	5 (0)	0.6 (4)
Copper	5	26	67.9	18.7 (5)	108 (0)	130 (0)	-
Lead	5	5.4	22.8	30.2 (0)	112 (0)	130 (0)	-
Mercury	5	0.11	0.31	0.13 (4)	0.7 (0)	0.84 (0)	0.75 (0)
Zinc	5	33	2970	124 (2)	271 (1)	330 (1)	-
Acenaphthene	5	0.008	0.57	0.00671 (5)	0.0889 (3)	0.11 (3)	-
Acenaphthylene	5	0	0	0.00587 (0)	0.128 (0)	0.15 (0)	-
Anthracene	5	0.029	1.1	0.0469 (4)	0.245 (3)	0.29 (2)	-
Benzo(a)anthracene	5	0.052	1.1	0.0748 (3)	0.693 (1)	0.83 (1)	-
Benzo(a)pyrene	5	0.038	0.36	0.0888 (1)	0.763 (0)	0.92 (0)	-
Chrysene	5	0.081	1.2	0.108 (3)	0.846 (1)	1 (1)	-
Dibenz(a,h)anthracene	5	0.008	0.06	0.00622 (3)	0.135 (0)	0.16 (0)	-
Fluoranthene	5	0.11	1.9	0.113 (4)	1.494 (2)	1.8 (1)	-
Fluorene	5	0.017	1.5	0.0212 (4)	0.144 (3)	0.17 (3)	-
Methylnaphthalene (2-)	5	0.063	9.6	0.0202 (5)	0.201 (4)	-	-
Naphthalene	5	0.04	4.6	0.0346 (5)	0.391 (3)	0.47 (3)	-
Phenanthrene	5	0.16	7.1	0.0867 (5)	0.544 (3)	0.65 (3)	-
Pyrene	5	0.1	2.6	0.153 (4)	1.398 (2)	1.7 (1)	-
Total PAHs	5	1.2	32	-	-	20 (1)	2.5 (3)

Notes:

Concentrations expressed as mg/kg dry weight.

a - Federal interim sediment quality guideline (ISQG). CCME, 2001.

b - Federal probable effects level (PEL). CCME, 2001.

c - Provincial sediment quality criteria for typical contaminated sites ($SedQC_{TS}$) (Government of British Columbia 2011)

d - Disposal at Sea Regulations of the Canadian Environmental Protection Act (CEPA), 1999.

- No Benchmark

Table 8: Deep Stratum Sediment Core Data Screening

Substance	Number of Deep Strata	Concentration		Benchmark (Number of Exceedances)			
		Min	Max	CCME ISQG[a]	CCME PEL [b]	BC $SedQC_{TS}$[c]	Lower Level Numerical Limit [d]
Arsenic	6	2.3	11.5	7.24 (1)	41.6 (0)	50 (0)	-
Cadmium	6	0.06	1.96	0.7 (4)	4.2 (0)	5 (0)	0.6 (4)
Copper	6	16.2	82.2	18.7 (4)	108 (0)	130 (0)	-
Lead	6	1	19.8	30.2 (0)	112 (0)	130 (0)	-
Mercury	6	0.07	0.28	0.13 (4)	0.7 (0)	0.84 (0)	0.75 (0)
Zinc	6	23	2880	124 (3)	271 (1)	330 (1)	-
Acenaphthene	6	0.008	0.33	0.00671 (5)	0.0889 (3)	0.11 (3)	-
Acenaphthylene	6	0	0	0.00587 (0)	0.128 (0)	0.15 (0)	-
Anthracene	6	0.011	0.65	0.0469 (4)	0.245 (3)	0.29 (3)	-
Benzo(a)anthracene	6	0.001	0.44	0.0748 (4)	0.693 (0)	0.83 (0)	-
Benzo(a)pyrene	6	0.008	0.24	0.0888 (2)	0.763 (0)	0.92 (0)	-
Chrysene	6	0.002	0.53	0.108 (4)	0.846 (0)	1 (0)	-
Dibenz(a,h)anthracene	6	0.04	0.04	0.00622 (2)	0.135 (0)	0.16 (0)	-
Fluoranthene	6	0.001	1.3	0.113 (4)	1.494 (0)	1.8 (0)	-
Fluorene	6	0.015	0.54	0.0212 (3)	0.144 (2)	0.17 (2)	-
Methylnaphthalene (2-)	6	0.005	4.4	0.0202 (5)	0.201 (4)	-	-
Naphthalene	6	0.003	2	0.0346 (5)	0.391 (3)	0.47 (3)	-
Phenanthrene	6	0.068	2.8	0.0867 (4)	0.544 (4)	0.65 (3)	-
Pyrene	6	0.002	0.93	0.153 (4)	1.398 (0)	1.7 (0)	-
Total PAHs	6	0.014	12	-	-	20 (0)	2.5 (4)

Notes:
Concentrations expressed as mg/kg dry weight.
a - Federal interim sediment quality guideline (ISQG). CCME, 2001.
b - Federal probable effects level (PEL). CCME, 2001.
c - Provincial sediment quality criteria for typical contaminated sites ($SedQC_{TS}$) (Government of British Columbia 2011)
d - Disposal at Sea Regulations of the Canadian Environmental Protection Act (CEPA), 1999.
- No Benchmark

3.3.2 PAHs

Sediment PAH concentrations for the core strata samples are compiled in Appendix V. The results of screening against the benchmarks for PAHs are presented in Tables 6, 7 and 8, and summarized as follows.

Surface (0 to 0.3m)

Several PAHs exceeded the ISQG, PEL and $SedQC_{TS}$ or Lower Level numerical limit in one or more of the surface strata sediment samples. A summary is provided below:

- *PAHs that exceeded the ISQG:* acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene; and,
- *PAHs that exceeded the PEL and/or $SedQC_{TS}$:* acenaphthene, anthracene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene.
- Total PAHs exeeded the Lower Level numerical limit in 4 of 5 surface core samples.

Middle (0.3m to 0.7m)

Several PAHs exceeded the ISQG, PEL and $SedQC_{TS}$ or Lower Level numerical limit in one or more of the middle strata sediment samples. A summary is provided below:

- *PAHs that exceeded the ISQG*: acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene; and,
- *PAHs that exceeded the PEL and/or $SedQC_{TS}$:* acenaphthene, anthracene, benzo(a)anthracene, chrysene, fluoranthene fluorene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene.
- Total PAHs exeeded the Lower Level numerical limit in 3 of 5 middle core samples.

Deep (> 0.7m)

Several PAHs exceeded the ISQG, PEL and $SedQC_{TS}$ or Lower Level numerical limit in one or more of the deep strata sediment samples. A summary is provided below:

- *PAHs that exceeded the ISQG:* acenaphthene, acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene and pyrene; and,
- *PAHs that exceeded the PEL and/or $SedQC_{TS}$:* acenaphthene, anthracene, fluorene, 2-methylnaphthalene, naphthalene and phenanthrene.
- Total PAHs exeeded the Lower Level numerical limit in 4 of 6 deep core samples.

3.3.3 CCME Petroleum Hydrocarbon Fractions F1-F4

Concentrations of CCME PHC fractions are compiled in Appendix V. Descriptions of measurable hydrocarbons concentrations are as follows:

Surface (0 to 0.3m)

Concentrations of F1 were all below DL. Detected concentrations of F2 ranged from 19 to 160 µg/g, F3 ranged from 140 to 680 µg/g, and F4 ranged from 110 to 200 µg/g.

Middle (0.3m to 0.7m)

Concentrations of F1 were all below DL. Detected concentrations of F2 ranged from 35 to 270 µg/g, F3 ranged from 15 to 810 µg/g and F4 ranged from 51 to 180 µg/g; and

Deep (> 0.7m)

F1 had a single detectable concentration of 16 µg/g. Detected concentrations of F2 ranged from 77 to 170 µg/g, F3 ranged from 20 to 870 µg/g and F4 ranged from 62 to 230 µg/g.

3.3.4 Monoaromatic Hydrocarbons (BTEX)

Concentrations of monoaromatic hydrocarbons (BTEX) were less than analytical detection limits for the majority of the collected samples (Appendix V). Descriptions of measurable BTEX concentrations are as follows:

Surface (0 to 0.3m)

Ethylbenzene had a single detectable concentration of 0.03 µg/g. Detected concentrations of toluene ranged from 0.08 to 0.11 µg/g. Total xylenes had a single detectable concentration of 0.14 µg/g.

Middle (0.3m to 0.7m)

Ethylbenzene had a single detectable concentration of 0.02 µg/g. Detected concentrations of toluene ranged from 0.07 to 0.1 µg/g. Total xylenes had a single detectable concentration of 0.12 µg/g.

Deep (> 0.7m)

Ethylbenzene had a single detectable concentration of 0.05 µg/g. Detected concentrations of toluene ranged from 0.07 to 0.1 µg/g. Total xylenes ranged from 0.05 to 0.35 µg/g. VH6-10 had a single detectable concentration of 16 µg/g.

3.3.5 QA/QC Results

Field duplicates were collected at a rate of 10% of the total number of primary samples. Each duplicate was collected as a split quantity of the same homogenized sediment sample (*i.e.,* after sample homogenization in the

field). Field duplicates were collected as part of core stratum subsampling in 2010 at stations 2010-12 and 2010-13. The methods used to assess variability between field duplicates was the same as described in Section 3.2.8.

Appendix VI presents the RPD calculations and values for the field duplicate samples. Field duplicates exhibited concentrations similar (*i.e.,* within 35% for values > 5 times the MDL) to the original sample with a few exceptions:

- RPDs were less than 20% for all metals, with the exception of barium (RPD = 52%) and cadmium (RPD = 39%) for station 2010-12.
- RPDs for individual PAHs in core 2010-12 ranged from 96% to 100%. The RPDs for PAHs at this station are considered anomalous given the RPDs for metals which were mostly within the accepted ranges. The variability for PAHs may reflect the association of PAHs with coal particles or other debris.

An examination of the available RPDs indicates that samples were adequately homogenized. High RPDs of a few individual parameters are indicative of the presence of an analyte in particulate form, and are not an indication of poor homogenization or measurement error when other related compounds demonstrate relatively low RPDs. RPDs observed in this study are common for sediment sampling programs, especially for PAHs in sediments influenced by the presence of coal particles. Sediment heterogeneity may explain the variability between the field duplicate and original sample.

All laboratory QA/QC measures, including laboratory duplicates, method spikes, method blanks and analysis of certified reference material met internal QA/QC criteria.

3.4 Sediment Toxicity

This section summarizes the results of laboratory toxicity testing of sediment samples collected in 2009 and 2010. The results of toxicity testing were were evaluated with respect to the following benchmark:

- A level representing a modest (20 to 30%) reduction in endpoint performance versus the negative control. Normally, a 20% effect level is considered to represent an ecologically-relevant effect on the class of organisms represented by the test species. However, this value was varied to be consistent with the Disposal at Sea Upper Level “Failure” criteria which include a 20% or 30% reduction in amphipod survival relative to a reference or control sediment, respectively, and, a 25% reduction in echinoderm fertilization between the test sediment and control water. There are no Disposal at Sea Upper Level “Failure” criteria for the polychaete test and a 20% threshold was applied for evaluating the results of this test.

These benchmarks were applied to determine when the result of a toxicity test with amphipods, polychaetes, or echinoderm fertilization indicated that the sample was “toxic” with respect to the given test species and endpoint, to support interpretation of these data within the context of the Disposal at Sea Regulation. Microtox test results were evaluated according to the guidelines provided by Buday (2000).

3.4.1 10-d Amphipod Survival

Two 10-day amphipod *Eohaustorius estuarius* tests were initiated on November 13 and 20, 2009.

November 13, 2009

Results for the 10-d *E. estuarius* toxicity test initiated on November 13, 2009 are summarized in Tables 9 and 10, and the Cantest laboratory report for 2009 toxicity testing is presented in Appendix II.

Survival Endpoint Performance: Mean survival in the negative control was 98%. Overall mean survival in the samples ranged from 69 to 99%. All stations, with the exception of one, exhibited survival within 20% of control responses. For station 1A, a statistically significant reduction of 30% relative to the control and 26% relative to the Regional Reference station (37R) was observed for survival. No stations exhibited reductions in survival by more than 50% relative to the mean control response or the Regional Reference response.

Ammonia: Total ammonia concentrations in overlying water ranged from 0.16 to 10.2 mg/L N (0.009 to 0.06 mg/L unionized ammonia) on Day 0, and from 0.22 to 11 mg/L N (0.029 to 0.26 mg/L unionized ammonia) on Day 10. Measured total ammonia concentrations were below the recommended limit of 60 mg/L N for this species (USEPA/USACE, 1998).

Sulphide: The reported interstitial water sulphide concentrations were below detection limits (0.05 mg/L) for all stations, with the exception of one. Station 21A had the only recorded (greater than detect) sulphide concentration observed in the toxicity tests at 24.4 mg/L.

November 20, 2009

Results for the 10-d *E. estuarius* toxicity test initiated on November 20, 2009 are summarized in Tables 11 and 12, and the Cantest laboratory report for 2009 toxicity testing is presented in Appendix II.

Survival Endpoint Performance: Mean survival in the negative control was 99%. Overall mean survival in the samples ranged from 73 to 99%. All stations, with the exception of one, exhibited survival within 20% of control responses. For station 33A, survival was reduced by 26% relative to both the control and the Regional Reference station (38R). No stations exhibited reductions in survival by more than 50% relative to the mean response in the control or the Regional Reference station.

Ammonia: Total ammonia concentrations in overlying water ranged from 0.1 to 2.51 mg/L N (0.007 to 0.03 mg/L unionized ammonia) on Day 0, and from 0.23 to 6.48 mg/L N (0.027 to 0.10 mg/L unionized ammonia) on Day 10. Measured total ammonia concentrations were below the recommended limit of 60 mg/L N for this species (USEPA/USACE, 1998).

Sulphide: The reported interstitial water sulphide concentrations were below detection limits (0.05 mg/L) for all stations tested.

Table 9: Results for the Mean Survival Comparisons in the 10-d Acute Amphipod (Eohaustorius) Test (Initiated November 13, 2009)

Station	Mean Survival ± SD (%)	Survival Relative to Control (%)	Survival Relative to Regional Reference (%)
Control	98.0 ± 4.5	-	-
1A	69.0 ± 15.6*	70%	74%
3A	91.0 ± 2.2*	93%	98%
8A	92.0 ± 2.7*	94%	99%
10A	92.0 ± 4.5*	94%	99%
21A	88.0 ± 5.7*	90%	95%
23A	91.0 ± 9.6	93%	98%
26A	96.0 ± 2.2	98%	103%
30A	95.0 ± 3.5	97%	102%
35A	91.0 ± 5.5*	93%	98%
37R	93.0 ± 5.7	95%	-

Asterisk and numerical notations indicate that there is a statistically significant effect in the sample mean as compared to the negative control (*).

Table 10: Summary of Un-ionized Ammonia and Sulphide in the 10-d Acute Amphipod (Eohaustorius) Test (initiated November 13, 2009)

Station ID	pH	Total Ammonia-Nitrogen (mg/L)		Un-ionized Ammonia (mg/L)		Sulphide (mg/L)
		Day 0	Day 10	Day 0	Day 10	
Control	7.65	0.16	0.22	0.0016	0.0021	< 0.05
1A	7.85	0.77	2.68	0.009	0.0397	< 0.05
3A	8.05	4.18	11	0.0613	0.258	< 0.05
8A	7.85	1.1	3.16	0.0137	0.0475	< 0.05
10A	7.85	0.82	1.92	0.0099	0.0287	< 0.05
21A	8.15	10.2	2.62	0.0119	0.0769	24.4
23A	7.85	0.95	2.32	0.0143	0.0344	< 0.05
26A	7.85	2.22	5.36	0.033	0.1011	< 0.05
30A	7.95	2.16	6.05	0.0256	0.1124	< 0.05
35A	7.85	0.97	3.81	0.0144	0.0703	< 0.05
37R	7.75	0.54	1.49	0.0067	0.0176	< 0.05

Table 11: Results for the Mean Survival Comparisons in the 10-d Acute Amphipod Test (initiated November 20, 2009)

Station	Mean Survival ± SD (%)	Survival Relative to Control (%)	Survival Relative to Regional Reference (%)
Control	99.0 ± 2.2	-	-
2A	95.0 ± 6.1	96%	96%
6A	93.0 ± 2.7*	94%	94%
12A	80.0 ± 44.7	81%	81%
15A	98.0 ± 2.7	99%	99%
22A	95.0 ± 3.5*	96%	96%
24A	96.0 ± 6.5	97%	97%
28A	98.0 ± 2.7	99%	99%
33A	73.0 ± 37.3	74%	74%
38R	99.0 ± 2.2	100%	100%

Asterisk and numerical notations indicate that there is a statistically significant effect in the sample mean as compared to the negative control (*).

Table 12: Summary of Un-ionized Ammonia in the 10 Day Acute Amphipod Test (initiated November 20, 2009)

Station ID	pH	Total Ammonia-Nitrogen (mg/L)		Un-ionized Ammonia[1] (mg/L)		Sulphide (mg/L)
		Day 0	Day 10	Day 0	Day 10	
Control	7.65	0.1	0.23	0.001	0.003	<0.05
2A	7.75	2.51	6.48	0.0299	0.1004	<0.05
6A	7.75	1.01	2.31	0.0123	0.0353	<0.05
12A	7.75	1.09	3.58	0.013	0.0547	<0.05
15A	7.75	1.3	3.47	0.0156	0.0526	<0.05
22A	7.75	0.62	1.41	0.0073	0.0268	<0.05
24A	7.85	0.93	2.38	0.0141	0.0459	<0.05
28A	7.85	1.52	3.48	0.0232	0.0666	<0.05
33A	7.85	1.28	4.07	0.0193	0.0774	<0.05
38R	7.85	0.69	1.8	0.0103	0.0342	<0.05

[1] Refer to the Cantest Laboratory Report in Appendix II for calculation of un-ionized ammonia concentrations.

3.4.2 20-d Polychaete Survival and Growth

The 20-d *Neanthes arenaceodentata* (polychaete) growth and survival tests were initiated on November 20, 2009. The test results are summarized in Tables 13 and 14, and the Cantest laboratory report for 2009 toxicity testing is presented in Appendix II.

Survival Endpoint Performance: Mean survival in the negative control was 100%. Overall mean survival in the samples ranged from 84 to 100%. All stations exhibited survival within 20% reduction of control responses.

Growth Endpoint Performance: Mean individual dry weight and growth rate in the negative control were 1.28 mg and 0.60 mg/day, respectively. Two stations exhibited an individual dry weight and growth rate reduction exceeding 20% relative to the control responses. For station 6A, individual dry weight was reduced by 22% and growth rate was reduced by 23% relative to control. For station 33A, individual dry weight was reduced by 30% and growth rate was reduced by 32% relative to control. No stations exhibited reductions in individual dry weight or growth rate by more than 50% relative to the mean control response. The > 20% decreases in weight and growth observed for 6A and 33A were not statistically significant at an alpha level of 0.05.

Ammonia: Total ammonia concentrations in overlying water ranged from 0.7 to 2.46 mg/L N (0.013 to 0.063 mg/L unionized ammonia) on Day 0, and from 7.94 to 11.3 mg/L N (0.025 to 0.20 mg/L unionized ammonia) on Day 20. Dillon *et al.* (1993) found that *Neanthes* survival and growth were unaffected at 10 mg/L N. Total ammonia concentrations exceeded this level on Day 20 for Stations 2A and 38R but survival, weight and growth were similar (within 20%) to control values for these samples.

Sulphide: The reported interstitial water sulphide concentrations were below detection limits (0.05 mg/L) for all stations tested.

Table 13: Results for the Mean Survival, Mean Individual Dry Weight, and Mean Growth Rate Comparisons for the 20-d Neanthes (Polychaete) Test

Station	Mean Survival ± SD (%)	Relative Survival	Mean Ind. Dry Weight ± SD (mg)	Relative Ind. Dry Weight	Mean Growth Rate ± SD (mg/day)	Relative Growth Rate
Control	100 ± 0.0	-	12.8 ± 3.5	-	0.60 ± 0.17	-
2A	96.0 ± 8.9	96%	12.7 ± 4.0	99%	0.59 ± 0.20	98%
6A	84.0 ± 26.1	84%	10.0 ± 3.0	78%	0.46 ± 0.15	77%
12A	100 ± 0.0	100%	13.3 ± 2.7	104%	0.62 ± 0.14	103%
15A	100 ± 0.0	100%	12.0 ± 2.9	94%	0.56 ± 0.14	93%
22A	100 ± 0.0	100%	12.5 ± 1.4	98%	0.58 ± 0.07	97%
24A	100 ± 0.0	100%	10.9 ± 3.5	85%	0.50 ± 0.17	83%
28A	100 ± 0.0	100%	11.5 ± 2.7	90%	0.53 ± 0.14	88%
33A	100 ± 0.0	100%	9.0 ± 3.9	70%	0.41 ± 0.19	68%
38R	100 ± 0.0	100%	10.4 ± 2.8	81%	0.48 ± 0.14	80%

Table 14: Summary of Un-ionized Ammonia in the 20-d Neanthes (Polychaete) Test

Station ID	pH	Total Ammonia-Nitrogen (mg/L)		Un-ionized Ammonia[1] (mg/L)		Sulphide (mg/L)
		Day 0	Day 20	Day 0	Day 20	
Control	7.85	2.46	8.53	0.0505	0.0777	<0.05
2A	7.95	2.45	11.3	0.0625	0.02549	<0.05
6A	7.95	0.84	9.8	0.0214	0.1736	<0.05
12A	7.85	1.17	8.84	0.0243	0.1591	<0.05
15A	7.85	1.14	8.62	0.0236	0.1552	<0.05
22A	7.85	0.66	8.3	0.0134	0.1181	<0.05
24A	7.95	0.85	7.94	0.0219	0.145	<0.05
28A	7.95	1.32	9.04	0.0337	0.199	<0.05
33A	7.95	1.28	9.1	0.0338	0.1648	<0.05
38R	7.95	0.7	10.5	0.0178	0.186	<0.05

[1] Refer to the Cantest Laboratory Report in Appendix II for calculation of un-ionized ammonia concentrations.

3.4.3 Echinoderm Fertilization

Echinoderm fertilization tests with centrifuged porewater were initiated on November 19, 2009. Results are summarized in Tables 15 and 16, and the Cantest laboratory report for 2009 toxicity testing is presented in Appendix II.

Percent Fertilization: Mean fertilization in the negative control was 94%. Overall fertilization success in the samples ranged from 1 to 95%. Three stations (2A, 24A and 33A) exhibited mean fertilization response within 25% of control responses. Reductions in mean fertilization exceeding 25% relative to the mean control response were found for stations 6A, 12A, 15A, 22A 28A and 38R, and for each of these stations except 6A, fertilization was reducted by 90% or higher relative to the control.

Ammonia: Ammonia concentrations in tested porewater water ranged from 1.8 to 32.8 mg/L N (0.006 to 0.41 mg/L unionized ammonia). Bailey *et al.* (1995) determined an ammonia no observed effect concentration (NOEC) and 25% inhibition concentration (IC_{25}) for *S. purpuratus* of 10 mg/L N (0.17 mg/L unionized ammonia) and > 100 mg/L N (> 1.69 mg/L unionized ammonia). The porewater ammonia concentrations (both total and un-ionized ammonia) ranged above the NOEC values, but were below the IC25 values; furthermore, there was no clear pattern of increasing ammonia concentrations leading to decreased fertilization success.

Sulphide: The reported porewater water sulphide concentrations were below detection limits (0.05 mg/L) for all stations tested.

Table 15: Results for Mean Fertilization Comparisons for the Echinoderm Fertilization Test

Station	Mean Fertilization ± SD (%)	Fertilization Relative to Control
Control	94.0 ± 5	-
2A	84.0 ± 4*	89%
6A	45.0 ± 14*	48%
12A	2.00 ± 2*	2%
15A	4.00 ± 4*	4%
22A	2.00 ± 1*	2%
24A	93.0 ± 7	99%
28A	1.00 ± 0*	1%
33A	95.0 ± 3	101%
38R	8.00 ± 4*	9%

Asterisk and numerical notations indicate that there is a statistically significant effect in the sample mean as compared to the negative control (*).

Table 16: Summary of Un-ionized Ammonia and Sulphide in the Echinoderm Fertilization Test

Station	pH	Total Ammonia-Nitrogen (mg/L)	Un-ionized Ammonia[1] (mg/L)	Sulphide (mg/L)
		Day 0	Day 0	
2A	7.55	32.8	0.269	< 0.05
6A	7.35	8.1	0.408	< 0.05
12A	7.45	12	0.0777	< 0.05
15A	7.15	1.8	0.0059	< 0.05
22A	7.15	4.97	0.0164	< 0.05
24A	7.45	9.3	0.0598	< 0.05
28A	7.35	14.2	0.0714	< 0.05
33A	7.55	10.1	0.0816	< 0.05
38R	7.15	6.79	0.021	< 0.05

[1] Refer to the Cantest Laboratory Report in Appendix II for calculation of un-ionized ammonia concentrations.

3.4.4 Solid Phase Microtox

The Solid Phase Microtox test using *Vibrio fischeri* was conducted on November 26, 2009. Test results were interpreted according to the guidelines provided by Buday (2000), summarized in Table 17. Test results are summarized in Table 18. The Cantest laboratory report for 2009 toxicity testing is presented in Appendix II.

Table 17: Interpretation of Solid Phase Microtox® Test Results (per Buday 2000)

IC50 (mg/L)	Level of Toxicity
>5,000	Practically non-toxic
1,000-5,000	Marginally toxic
<1000	Toxic

IC50 Endpoint Performance: The IC50 values for the tested sediment samples exceeded 5,000 mg/L in all cases and ranged from 16,616 mg/L to 251,659 mg/L (note that the lower 95% confidence intervals of the mean for each sample also exceeded 5,000 mg/L). These findings indicate that all samples were practically non-toxic to *Vibrio fischeri.*

Table 18: Thirty-minute IC50 Values for Ladysmith Harbour Marine Sediment (mg/L)

Station	Dry Weight IC50		
	Mean	Lower 95% CI	Upper 95% CI
2A	26,990	24,345	29,927
6A	196,478	54,405	709,550
12A	16,616	9,423	29,286
15A	33,143	30,028	36,598
22A	25,152	13,880	45,591
24A	224,972	73,367	689,717
28A	68,450	35,807	130,876
33A	104,340	74,447	146,390
38R	251,659	80,844	783,600

3.4.5 Echinoderm Toxicity Identification Evaluation

3.4.5.1 Tier One

Echinoderm fertilization tests were initiated on 6 sediment samples on December 21, 2010. The results are summarized in Table 19 and Table 20. The Maxxam laboratory report for the December 2010 testing is presented in Appendix II.

Echinoderm Test Results

Percent Fertilization: Mean fertilization in the negative control was 97%. Overall fertilization survival in the samples ranged from 1 to 97%. One station (2010-13) exhibited mean fertilization response within 20% reduction of control responses. The remaining five stations (2010-07, 2010-08, 2010-09, 2010-10 and 2010-11) exhibited considerable (63-99%) reductions in mean fertilization relative to the mean control.

Table 19: Results for Mean Fertilization Comparisons for the Echinoderm Fertilization Test

Station	Sample ID	Mean Fertilization ± SD (%)	Fertilization Relative to Control
Control	-	97 ± 2	-
2010-10	0086-01	16 ± 4*	16%
2010-11	0086-02	10 ± 5*	10%
2010-13	0086-03	97 ± 1	100%
2010-09	0086-04	1 ± 1*	1%
2010-08	0086-05	36 ± 5*	37%
2010-07	0086-06	1 ± 1*	1%

Asterisk and numerical notations indicate that there is a statistically significant effect in the sample mean as compared to the negative control (*).

Table 20: Summary of Un-ionized Ammonia and Sulphide in the Echinoderm Fertilization Test

Station	Laboratory Sample ID	pH	Total Ammonia-Nitrogen (mg/L)	Un-ionized Ammonia[1] (mg/L)	Sulphide (mg/L)	TSS (mg/L)
2010-10	0086-01	7.35	3	0.0140	2.9	86
2010-11	0086-02	7.25	2.7	0.0098	3.5	110
2010-13	0086-03	7.35	2.4	0.0113	0.015	120
2010-09	0086-04	7.25	4.4	0.0184	19.4	77
2010-08	0086-05	7.25	2.8	0.0107	1.11	92
2010-07	0086-06	7.35	5.4	0.0248	22.2	76

[1] Refer to the Maxxam Laboratory Report in Appendix II for calculation of un-ionized ammonia concentrations.

Porewater Chemistry

Ammonia: Total ammonia concentrations observed during Tier One testing are presented in Table 20. Ammonia concentrations in tested porewater ranged from 2.4 to 5.4 mg/L N (0.01 to 0.025 mg/L unionized ammonia). These values are below the NOEC (10 mg/L N; 0.17 mg/L unionized ammonia) determined by Bailey *et al.* (1995) suggesting that ammonia was not a confounding influence on the test results.

Sulphide: Sulphide concentrations observed during Tier One testing are presented in Table 20. Sulphide concentrations in tested porewater ranged from 0.015 mg/L to 22.2 mg/L. Knezovich *et al.* (1996) reported a EC_{50} of 0.19 mg/L sulphide for abnormal development of *S. purpuratus*. Although the endpoint is different (normal development versus fertilization success), this EC_{50} provides an approximation of the concentration at which porewater sulphide concentrations begin to become toxic to *S. purpuratus* embryos. Sulphide concentrations exceeded the EC_{50} for five of the six stations tested, and at these stations fertilization success was statistically significantly lower than the control response. The remaining station (2010-13) had a sulphide concentration less than the EC_{50} and fertilization success similar to that in the control. The potential influence of sulphide on the observed toxicity is discussed further in Section 4.3.

TSS: Total suspended sediment concentrations (TSS) observed during Tier One testing are presented in Table 20. The TSS concentrations in tested porewater ranged from 76 to 120 mg/L. Increased TSS did not appear to exert a negative influence on echinoderm responses, as the lowest fertilization success (*i.e.,* highest toxicity) was observed in the two samples with the lowest TSS concentrations. The possible influence of TSS on observed echinoderm responses is discussed further in Section 4.3.

Dissolved Metals: Dissolved metals concentrations observed during Tier One testing are presented in Appendix V. The possible influence of individual dissolved metal concentrations on observed echinoderm responses is discussed further in Section 4.3.

3.4.5.2 Tier Two

Follow-up echinoderm fertilization tests of sediment porewater from three of the six Tier 1 stations (2010-11, 2010-09 and 2010-07) were conducted on February 22, 2011. To yield information on the suspected toxicants, sulphide and EDTA amendments were performed on the samples prior to testing (Section 2.3.3.5). Un-amended samples were also tested. Test results are summarized in Table 21, Table 22, and Table 23. The Maxxam laboratory report for Tier 2 testing is presented in Appendix II.

Sulphide Amendment Echinoderm Test Results

Percent Fertilization: Mean fertilization success in the negative controls ranged from 66% to 96%. In the un-amended samples, mean fertilization success was higher in 2010-11 (93%) than in the corresponding control, but considerably lower in 2010-09 (2%) and 2010-07 (0%), relative to the corresponding controls. For the sulphide-amended samples, the amended sample for 2010-11 exhibited similar fertilization success (95%) to the un-amended sample. In contrast, the sulphide-amended samples for 2010-09 and 2010-07 exhibited no evidence of the toxicity that was present in un-amended samples, with fertilization success of 97% and 98%, respectively.

Table 21: Results for Mean Fertilization Comparisons for the Sulphide Amended Echinoderm Fertilization Test

Station	Laboratory Sample ID	Mean Fertilization ± SD (%)	Fertilization Relative to Control
Control	-	66 ± 2	-
2010-11	0086-02 (Un-amended)	93 ± 4	140%
	0086-02 (Sulphide-amended)	95 ± 2	144%
Control	-	90 ± 4	-
2010-09	0086-04 (Un-amended)	2 ± 2	2%
	0086-04 (Sulphide-amended)	97 ± 3	107%
Control	-	96 ± 2	-
2010-07	0086-06 (Un-amended)	0 ± 1	0%
	0086-06 (Sulphide-amended)	98 ± 1*	102%

Asterisk and numerical notations indicate that there is a statistically significant effect in the sample mean as compared to the negative control (*).

Table 22: Summary of Un-ionized Ammonia and Sulphide in the Sulphide Amended Echinoderm Fertilization Test

Station	Laboratory Sample ID	pH	Total Ammonia-Nitrogen (mg/L)	Un-ionized Ammonia[1] (mg/L)	Sulphide (mg/L)	TSS
2010-11	0086-02 (Un-amended)	7.35	11	0.0506	12.2	53
	0086-02 (Sulphide-amended)	7.55	8.9	0.0648	0.022	83
2010-09	0086-04 (Un-amended)	7.45	10	0.0579	34	88
	0086-04 (Sulphide-amended)	7.75	7.8	0.0904	0.028	87
2010-07	0086-06 (Un-amended)	7.35	9.1	0.0473	27	100
	0086-06 (Sulphide-amended)	7.65	6.6	0.0681	0.026	66

[1] Refer to the Maxxam Laboratory Report in Appendix II for calculation of un-ionized ammonia concentrations.

Table 23: Results for Mean Fertilization Comparisons for the EDTA Amended Echinoderm Fertilization Test

Station	Laboratory Sample ID	Mean Fertilization ± SD (%)	Fertilization Relative to Control
Control	-	66 ± 2	-
2010-11	0086-02 (Un-amended)[1]	93 ± 4	140%
	0086-02 EDTA 0.8 g/L	93 ± 3	140%
	0086-02 EDTA 1.6 g/L	4 ± 2*	60%
	0086-02 EDTA 2.4 g/L	0 ± 0*	0%
Control	-	90 ± 4	-
2010-09	0086-04 (Un-amended)[1]	2 ± 2	2%
	0086-04 EDTA 0.8 g/L	10 ± 2	11%
	0086-04 EDTA 1.6 g/L	1 ± 1*	1%
	0086-04 EDTA 2.4 g/L	0 ± 0*	0%
Control	-	96 ± 2	-
2010-07	0086-06 (Un-amended)[1]	0 ± 1	0%
	0086-06 EDTA 0.8 g/L	17 ± 2*	18%
	0086-06 EDTA 1.6 g/L	4 ± 1*	4%
	0086-06 EDTA 2.4 g/L	0 ± 0	0%

Asterisk and numerical notations indicate that there is a statistically significant effect in the sample mean as compared to the negative control (*).
1 – same sample as in Table 21.

EDTA Amendment Echinoderm Test Results

Percent Fertilization: Mean fertilization success in the negative controls and the un-amended samples was the same as reported for the sulphide amendment testing (the tests were run concurrently and only one set of controls and un-amended samples was run). For sample 2010-11, mean fertilization success at 0.8 g/L EDTA (93%) was similar to that in the unadjusted sample and higher than in the control. At higher EDTA treatment levels, a marked decrease in fertilization success was observed, with mean fertilization of 4% at 1.6 g/L EDTA and 0% at 2.4 g/L EDTA. For samples 2010-09 and 2010-07, mean fertilization success at 0.8 g/L EDTA was moderately higher (10% and 17%, respectively) than in the un-amended samples but still well below the mean control responses. At higher EDTA treatment levels, mean fertilization success was similar to that in the un-amended samples, and well below the mean control responses.

Porewater Chemistry

Ammonia: Total ammonia concentrations observed during Tier Two testing are presented in Table 22. Ammonia concentrations in the amended and un-amended samples ranged from 6.6 to 11 mg/L N (0.065 to 0.09 mg/L unionized ammonia). With one exception, these values are below the NOEC (10 mg/L N; 0.17 mg/L unionized ammonia) determined by Bailey *et al.* (1995) suggesting that ammonia was not a confounding influence on the test results. For the one sample with 11 mg/L N (2010-11, un-amended), fertilization success was similar to the control.

Sulphide: Sulphide concentrations observed during Tier Two testing are presented in Table 22. Sulphide concentrations in the un-amended samples ranged from 12.2 to 34 mg/L, and following sulphide amendment ranged from 0.022 mg/L to 0.028 mg/L, showing a marked decrease in sulphide concentrations in all samples as a result of the amendment procedure. Sulphide amendment reduced sulphide concentrations from well above the *S. purpuratus* EC_{50} to well below it. For two samples (2010-09 and 2010-07), this coincided with a large increase in fertilization success. The potential influence of sulphide on the observed toxicity is discussed further in Section 4.3.

Ammonia and Sulphide: No samples were taken from the EDTA adjusted samples for sulphide analysis. The ammonia and sulphide results for the un-amended samples were the same as reported for the sulphide amendment testing.

TSS: Total suspended sediment concentrations (TSS) observed during Tier Two testing are presented in Table 22. The TSS concentrations in tested porewater ranged from 53 to 100 mg/L. There did not appear to be any clear relationship of observed toxicity with TSS concentration. The possible influence of TSS on echinoderm responses is examined further in Section 4.3.

Dissolved Metals: Dissolved metals concentrations observed during Tier Two testing are presented in Appendix V. The possible influence of individual dissolved metal concentrations on echinoderm responses is examined further in Section 4.3.

3.4.6 QA/QC Results

Sediment samples used for November 2009 testing were received at Cantest in Burnaby in good condition on October 22, 2009. The samples used for December 2010 and February 2011 testing were received at Maxxam in Burnaby in good condition on December 17, 2010. All sediments were stored at 4°C and following sediment handling and use, any headspace in the jars and pails was replaced with nitrogen gas prior to re-sealing the pail.

The test results were evaluated based on the performance of negative controls, reference toxicant tests, and compliance with the specified testing conditions (*e.g.*, maintenance of water quality, no unusual observations during testing). Water quality measurements throughout tests (*e.g.*, dissolved oxygen, pH, salinity and temperature) were within acceptable ranges. All tests met their test acceptability criteria for negative control performance such that the tests are considered valid; and, testing conditions were also acceptable.

Reference toxicant results were acceptable with one exception. The echinoderm reference toxicant test conducted as part of the Tier 2 TIE testing was more toxic than expected based on past performance. However, this result did not invalidate that Tier 2 testing because control survival and test conditions for all Tier 2 testing met the validity criteria.

Following Tier 1 echinoderm testing in support of the TIE, it became apparent that the porewater sulphide measurements made as part of the November 2009 testing were considerably lower than those measured in porewater extracted for the Tier 1 testing. An inquiry was made with Maxxam as to possible issues with the 2009 sulphide analyses. Maxxam did not identify any issues with the preservation of the samples based on internal laboratory notes but did acknowledge that large number of non-detect results (all but one sulphide determination was below the detection limit of 0.05 mg/L) was unusual given that a sulphide odour was noticed in all of the porewater samples analyzed in 2009. Based on this observation, Maxxam acknowledged that the results were anomalous and recommended relying on the 2010 and 2011 results when evaluating potential sulphide toxicity in the echinoderm test (Jeremy Keating, Maxxam, *personal communication*).

For interpreting the TIE results in Section 4.3, we relied primarily on sulphide-toxicity relationships for the 2010 echinoderm TIE testing only.

4.0 INTEGRATION OF FINDINGS

In this section, the findings of the sediment chemistry and toxicity investigations are integrated to achieve the tasks listed in Section 1.4. The main topics covered include:

1) **Characterization of sediment contamination:** Sediment chemistry data from surface sampling and core sampling, are integrated to provide a summary of the spatial and vertical extent of sediment contamination and contaminant concentrations are compared to sediment benchmarks to provide an indication of the degree of contamination. The results of toxicity testing at specific stations are also presented spatially, as is the coal content of sediments. Contaminant co-occurrence with coal is examined to characterize the degree to which coal may be contributing contaminants to Harbour sediments.

2) **Bioavailability assessment:** The results of sediment and sediment porewater toxicity testing are combined with indicators of contaminant exposure including metals and PAH concentrations, PAH bioavailability (as indicated by the sediment passive sampler results, and associations with coal content), and metals bioavailability (as indicated by SEM/AVS ratios). The resulting relationships between exposure and toxicity provide indications of possible causes of toxicity to test organisms.

3) **Echinoderm fertilization TIE:** The findings of the echinoderm fertilization TIE are examined to determine the potential toxicant to echinoderm fertilization in sediment porewater. Key uncertainties in the TIE findings, and implications for decision making are also discussed.

4) **Evaluation of sediment management options:** Study findings are summarized and integrated to draw conclusions regarding the potential viability of two sediment management options: (i) Disposal at Sea in the event that sediments need to be dredged and disposed of; and (ii), sediment risk assessment, where the desired option was to leave sediments in place.

Note that the integration of findings relied on the results of the 2009 and 2010 sediment investigations only. Given the potential temporal variability in an active harbour due to ongoing contaminant sources, and anthropogenic and natural contaminant redistribution process, it was expected that current sediment conditions could be different than those observed historically. The historical data were used to guide design of the 2009 and 2010 investigations.

4.1 Characterization of Sediment Contamination

4.1.1 Spatial Extent of Contamination

Exceedances of applicable benchmarks for metals and PAHs were observed at sampling locations throughout Ladysmith Harbour. Sediment chemistry results were compared to the ISQG, PEL and $SedQC_{TS}$ to indicate areas of potential contamination according to federal or provincial regulatory frameworks. The Lower Level numerical limits of the *Disposal at Sea Regulation* were also considered relevant for future sediment management decisions. The spatial distribution of exceedances of these benchmarks is discussed in the following sections.

4.1.1.1 Metals

Figure 2 illustrates the distribution of surface stations at which sediment metals concentrations exceeded applicable benchmarks. The colour of the symbols indicates if there was an exceedance of either the Lower Level numerical limit (Blue) or $SedQC_{TS}$ (Red).

Exceedance of the Lower Level numerical limit for cadmium was widespread throughout the harbour. Further spatial characterization of cadmium concentrations (Figure 3) indicates that the zone of highest concentration (3.0 to 4.2 mg/kg) centers between the waterlots that make up the Harbour, with the majority of this zone located in D.L. 651. Although the PEL and $SedQC_{TS}$ for cadmium are not exceeded at any stations, the ISQG and Lower Level numerical limit are exceeded over most of the harbour. Although identification of cadmium sources was not pursued as part of this study, it is well known that cadmium can be elevated in marine sediments in many places in British Columbia. It is believed that such cadmium reflects geological background.

There were two exceedances of the $SedQC_{TS}$ for copper in the lot titled "Block C" (Figure 2). Examination of the air photos underlying Figure 2 suggests that this area corresponds with a former/current marina facility. Further spatial characterization of copper concentrations (Figure 4) confirms the "Block C" hotspots where the PEL and the $SedQC_{TS}$ are exceeded. Outside of these areas, copper concentrations were also elevated above the ISQG over most of the harbour.

Several other metals (arsenic, cadmium, copper, lead, mercury and zinc) also exceeded the ISQG, but not the PEL or $SedQC_{TS}$ at multiple stations. These exceedances were considered consistent with a low level of contamination expected in an operating harbour and spatial analysis was not conducted for these metals.

4.1.1.2 PAHs

Concentrations of PAHs exceeding the ISQG, PEL and $SedQC_{TS}$ were observed for one or more PAHs at each of the sediment samples collected from the study area. Total PAH concentrations exceeded the Lower Level numerical limit (but not the $SedQC_{TS}$) at multiple stations. Figure 5 presents the stations for which total PAH exceeded the Lower Level numerical limit (blue dots) and for which both total PAH exceeded the Lower Level numerical limit and individual PAH exceeded the $SedQC_{TS.}$ (red dots). Figure 6 presents contours of total PAH concentrations across the harbour.

Total PAH concentrations were highest in the vicinity of Slack Point, exceeding the Lower Level numerical limit at all stations in this area. At each of these stations at least one individual PAH also exceeded the $SedQC_{TS.}$ PAH concentrations were generally lower in areas distal to Slack Point with fewer stations having exceedances of the $SedQC_{TS}$ for individual PAHs and exceedances of the Lower Level numerical limit for total PAHs scattered across the waterlots. Outside the waterlots (Stations 27A to 30A), total PAH concentrations were below the Lower Level numerical limit and individual PAH concentrations did not exceed the $SedQC_{TS.}$

Comparison to the $SedQC_{TS}$ was used to indicate the level of contamination for individual PAHs. Acenaphthene, anthracene and phenanthrene were the PAH congeners that exceeded the $SedQC_{TS.}$ by the greatest amount. Of these, phenanthrene concentrations were the highest relative to the $SedQC_{TS}$ for most stations, with a measured concentration 6.9-fold higher than the $SedQC_{TS}$ at Station 19A.

4.1.1.3 Coal Content

Petrographic analysis was used to determine the percentage coal content of surface grab sediment samples collected during the 2009 sampling event. The spatial distribution of coal material indicates that the percentage of coal increases toward the area of Slack Point inside D.L. 651 (Figure 7). Near Slack Point, percent coal typically ranged from 30 to 50% with a "hotspot" at Station 23A, where coal accounted for 77.8% of the sediment sample. The elevated coal content coincided with the zone of higher total PAH concentrations and greater numbers of benchmark exceedances for individual PAHs around Slack Point (Figure 5 and Figure 6).

4.1.1.4 Summary of Sediment Contamination Levels

Based on the comparison of surface sediment contaminant concentrations to the applicable sediment benchmarks, and observations described above regarding the spatial distribution of contamination, it is possible to make the following general statements regarding the level of sediment contamination observed in Ladysmith Harbour:

- **Metals:** The ISQG was exceeded for multiple metals at stations within the Harbour, but this guideline is intended to be a conservative threshold below which adverse effects are unlikely to occur rather than an indication of a problem. The Lower Level numerical limit for cadmium was also exceeded at multiple stations, but this level is lower than the ISQG for cadmium, indicating that it is also a conservative benchmark; nevertheless, this bench mark does have legal standing where a proponent wishes to manage materials through disposal at sea. The PEL and $SedQC_{TS}$, which are consistent with a moderate level of protection to marine organisms, were only exceeded for copper at two stations. In general, the level of metals contamination in Harbour sediments, although above conservative benchmarks, was below levels that would be expected to cause concern regarding risk to benthic biota. The exception to this statement is the two locations where elevated concentrations of copper were found. The concentrations of sediment metals in stations adjacent to the Harbour were lower than those within the Harbour, with concentrations exceeding the ISQG and Lower Level numerical limit, but not the PEL or $SedQC_{TS}$. The bioavailability of sediment metals was examined through measurement of SEM/AVS ratios and toxicity testing; metals bioavailability information is discussed in Section 4.2.

- **PAHs:** All of the PAHs measured at stations within the Harbour exceeded the ISQG at multiple stations. The concentrations of acenaphthene, anthracene, fluorene, 2-methylnaphthalene, naphthalene, and phenanthrene also exceed the PEL and/or $SedQC_{TS}$ at multiple stations, primarily in the vicinity of Slack Point. The highest PAH exceedance relative to the $SedQC_{TS}$ was for phenanthrene, which exceeded its criterion by a factor of up to 6.9 near Slack Point. The Lower Level numerical limit for total PAHs was also exceeded at most stations located within the Harbour. Although the exceedance of the PEL and $SedQC_{TS}$ by individual PAH compounds suggests an elevated level of contamination by individual PAHs, the $SedQC_{TS}$ for total PAHs, an additional indicator of aggregate contamination by PAHs, was not exceeded. In general, the level of PAH contamination in Harbour sediments was above benchmarks and potentially at levels that would cause concern regarding risk to benthic biota, especially in areas with high sediment coal content. The concentrations of sediment PAHs in stations adjacent to the Harbour were lower than within the Harbour, with fewer individual PAHs exceeding the PEL or $SedQC_{TS}$ and total PAH concentrations below the Lower Level numerical limit The bioavailability of sediment PAHs was examined through passive sampler analysis and toxicity testing; PAH bioavailability information is discussed in Section 4.2.

When considering, the magnitude of contamination of Harbour sediments, the sediment chemistry was in the range observed at sites where risk-based sediment management approaches have been successfully employed. However, it is important to appreciate that risk assessments are site-specific. Findings of insignificant risk at one particular site cannot be extrapolated to other sites. Site specific risk assessment is needed. Metals and PAH concentrations exceeded federal and provincial benchmarks, but the observed concentrations did not clearly indicate a high level of concern, especially given the uncertainty in the bioavailability of the observed concentrations. Thus, examination of bioavailability and field-level effects measures would be appropriate to evaluate actual risks to marine organisms and the feasibility of disposal at sea of dredged sediments.

4.1.2 Vertical Extent of Contamination

As presented in Section 3.3, the core stratum data indicate that metals and PAHs exceeded the ISQG, PEL, $SedQC_{TS}$ and the Lower Level numerical limit throughout the analyzed core samples. Although the metals and PAHs that exhibited exceedances of benchmarks were generally consistent in concentration across strata, concentrations were typically higher in the surface strata than in deeper strata (Table V-2 of Appendix V). Overall, the contamination appears to be highest at the surface. One exception was that total PAH exceeded the $SedQC_{TS}$ in the middle stratum of location 2010-07 (near Slack Point), and this was the highest total PAH concentration observed in surface or subsurface sediments in the Harbour.

4.1.3 Contaminant Co-Occurrence with Coal

Comparison of Figure 7 with Figure 6 indicated a spatial co-occurrence of elevated PAH concentrations with higher observed coal content in sediments. This is consistent with reports that coal is comprised of and a source of PAHs in the environment (*e.g.*, Wang *et al.* 2010). However, although coal particles can result in a significant presence of PAHs in the environment, the bioavailability of PAHs in coal particles is often lower than would be expected for PAHs from other sources. For example, Deepthike *et al.* (2009) demonstrated low bioavailability of PAHs in Gulf of Alaska coal relative to PAHs in crude oil from the Exxon Valdez oil spill. The bioavailability of metals in coal is less well understood.

To examine the degree to which concentrations of substances exceeding sediment benchmarks and which might be related to the presence of coal particles, the spatial correspondence of metal and PAH concentrations with coal content was examined through a combination of graphical and correlation analysis.

Figure 8 presents scatterplots of concentration as a function of coal content for cadmium, mercury and total PAHs. The Lower Level numerical limits are also shown on Figure 8 for comparison. Rank order correlations (Spearman's R) between sediment contaminant concentrations and coal content are presented in Table 24. Mercury and total PAHs exhibited an apparent pattern of increasing concentration with increasing sediment coal content, and this pattern was supported by statistically significant positive correlations ($p < 0.05$). No pattern was apparent for cadmium.

Table 24: Rank Order Correlations (Spearman's R) Between Sediment Contaminants and Sediment Coal Content

Parameter	n	R	Parameter	n	R
Acenaphthene	39	**0.302**	Aluminum	39	0.092
Acenaphthylene	39	-0.132	Arsenic	39	0.122
Anthracene	39	**0.558**	Barium	39	**0.776**
Benzo[a]anthracene	39	**0.483**	Boron	39	0.257
Benzo[a]pyrene	39	**0.393**	Cadmium	39	0.014
Benzo[b]fluoranthene	39	**0.402**	Chromium	39	**0.618**
Benzo[ghi]perylene	39	**0.558**	Cobalt	39	0.208
Benzo[k]fluoranthene	39	**0.312**	Copper	39	**0.41**
Chrysene	39	**0.46**	Iron	39	-0.012
Dibenz[ah]anthracene	39	0.145	Mercury	39	**0.668**
Fluoranthene	39	**0.295**	Lead	39	**0.326**
Fluorene	39	**0.361**	Manganese	39	-0.071
Indeno[123-cd]pyrene	39	0.239	Molybdenum	39	0.068
Methylnaphthalene	39	**0.777**	Nickel	39	**0.77**
Naphthalene	39	**0.768**	Selenium	39	**0.31**
Phenanthrene	39	**0.682**	Strontium	39	**0.57**
Pyrene	39	**0.323**	Thallium	39	-0.499
Total HMW PAHs	39	**0.352**	Titanium	39	-0.72
Total LMW PAHs	38	**0.67**	Vanadium	39	0.237
Total PAHs	39	**0.612**	Zinc	39	0.197
Total PAH-EVA	39	-0.467	Zirconium	39	**0.822**

Bold-Underlined: significant positive correlation ($p < 0.05$, 1-tailed)

For total PAHs, the pattern and correlation confirm the expectation that PAHs are expected to co-occur with coal. Significant correlations between concentration and coal content were also observed for multiple individual PAHs and the sum of low molecular weight (LMW) PAHs. The significant correlation for LMW PAHs, but not for high molecular weight (HMW) PAHs, may be related to coal quality; Wang *et al.* (2010) recently demonstrated that HMW PAHs were predominant in low-rank coals while LMW PAHs were predominant in high-rank coals. In contrast to PAH concentrations determined in sediment, bioavailable PAHs (Total PAH-EVA) as determined using the passive sampler analysis (Section 2.3.2) did not show significant positive correlation with coal content. The interaction between PAH concentrations, coal content and bioavailability of PAHs in sediments is examined further in Section 4.2.

The correlation of mercury with coal content was also expected because, based on evidence from coal combustion facilities, coal is expected to be a source of mercury compounds to the environment. In contrast, there was no apparent pattern or statistically significant correlation of increasing cadmium with increasing sediment coal content, indicating that cadmium in Harbour sediments is unlikely to be related to the presence of coal particles.

Figure 9 presents scatterplots of concentration versus coal content for arsenic, copper, lead and zinc. Rank order correlations with coal content for these metals are presented in Table 24. The scatterplots for these metals did not indicate any clear increasing pattern of concentration with increasing sediment coal content. However, rank order correlations were significant ($p < 0.05$) for copper and for lead. For copper, the two "hotspots" where concentrations exceed the PEL were located in areas far from Slack Point with relatively low coal content (< 20%) suggesting that copper concentrations in excess of the PEL were not solely related to coal presence in sediments. Similarly, for lead, sediment concentrations in excess of the ISQG occured only in sediments with relatively low coal content (< 20%), suggesting that lead concentrations that exceed this guideline are not related to coal content. For arsenic and zinc, neither the scatterplots nor the rank order correlations indicate an association with sediment coal content.

4.1.4 Spatial Distribution of Toxicity Findings

Figure 10 presents the spatial distribution of toxicity for amphipod survival, polychaete growth and weight and echinoderm fertilization. There was no response observed for Microtox at any of the stations tested. Polychaete survival was 100% for all stations tested. The organism responses were categorized according to the benchmarks discussed in Section 3.4 to identify stations where sediment or sediment porewater was considered toxic to the test species and endpoint.

Surface sediments were not toxic to amphipod survival over most of the harbour, with two exceptions. Amphipod survival was reduced relative to the Regional Reference at Station 1A (in the western corner of Block C) and Station 33A (east of Slack Point). No other toxicity testing was conducted at Station 1A, and the potential for sublethal effects to polychaetes or echinoderms is therefore uncertain. At Station 33A, sediments were also toxic to polychaete growth and weight. Toxicity to polychaete growth was also observed at Station 6A, which is located in the area of the current dock and marina facility. The potential influence of contaminant bioavailability on toxicity is discussed further in Section 4.2.

Stations where sediment porewater was toxic to echinoderm fertilization were spread throughout the Harbour. There was no clear pattern of echinoderm response with Harbour location or sediment contaminant profiles. The possible toxicant responsible for effects to echinoderm fertilization was examined further in the TIE (Section 4.3).

4.2 Bioavailability Assessment

4.2.1 Bioavailability of PAHs

Passive sampler analysis was used to estimate the relative bioavailability of PAHs in sediment samples collected within and adjacent to the Harbour and at Regional Reference stations. This method measures the relative amount of a chemical that is available to diffuse from sediment into the aqueous phase (Meloche *et al.* 2009).

Diffusion into the aqueous phase is typically considered a limiting factor in the bioavailability of sediment-associated organic contaminants.

As described in Section 4.1.3, total PAH concentrations in the Harbour correlate with sediment coal content, but bioavailable PAHs in sediment do not correlate with coal content. Although coal contains PAHs, coal-associated PAHs are expected to have lower bioavailability than PAHs from sources such as oils (Deepthike *et al.* 2009). Relationships between PAH bioavailability, total PAH concentrations, and coal content of sediments was examined through scatterplot analysis (Figure 11). Station groupings were identified in this analysis, as follows:

- **Regional Reference Stations (36R to 40R)** – At the regional stations, which provide an indication of typical reference PAH levels in marine sediments near Ladysmith, total PAHs were below 1 mg/kg, bioavailable PAHs were below 3 µg/g EVA and coal content was typically < 20%. PAHs in these sediments would likely be from a combination of non-point pyrogenic and petrogenic sources, as well as from coal particles that occur naturally or were transported to these areas.
- **Stations Adjacent to the Harbour (26A to 30A)** - With the exception of Station 26, these stations have total PAH concentrations similar to the regional stations (< 1 mg/kg) and similarly low coal content (< 20%) but somewhat higher bioavailable PAHs (3.8 to 5.6 µg/g EVA). This may indicate that these stations are more influenced by sources of non-coal petrogenic PAHs (*e.g.*, oils and/or fuels), possibly as a result of marine and harbour activities. Station 26 had an anomalously high and unexplained concentration of bioavailable PAHs (128.5 µg/g EVA) relative to total PAH concentration and coal content observed there.
- **Stations Adjacent to Slack Point (19A, 22-25A, 31-35A) -** High coal content (20 to 80%) was observed at these stations and most had relatively low bioavailable PAHs (< 3 µg/g EVA) compared to other stations with lower coal content but elevated total PAH concentrations (> 4 mg/kg). The lower relative bioavailability of PAHs in these areas with elevated coal content supports the hypothesis that a substantial portion of the PAHs are coal-associated. Despite the elevated total PAH levels, the concentration of bioavailable PAHs in this area appeared similar to that at the Regional Reference stations.
- **Remaining Stations Inside the Harbour** – The stations not adjacent to Slack Point appeared to be more influenced by harbour-related sources of non-coal PAHs (*e.g.*, oils and fuels). This was confirmed by the relatively low coal content (typically < 20%) and concordance between total PAH concentrations and bioavailable PAH concentrations. Total PAH concentrations ranged from < 1 mg/kg to ~10 mg/kg, and bioavailable PAHs were in some cases greater than 10 µg/g EVA. Based on these results, PAH bioavailability is likely higher in these areas than near Slack Point or in areas outside the Harbour.

4.2.2 Concentration-Response Relationships

4.2.2.1 Representativeness of Testing

The toxicity testing component of this sediment investigation focussed on a set of 20 surface sediment samples, selected to represent spatial heterogeneity in concentrations and potential sources of contamination. All 20 stations were tested with an amphipod survival test, and a subset of nine of these stations were also tested with a toxicity test battery, including the marine polychaete survival and growth test, the echinoderm fertilization tests on sediment porewater, and the solid phase test using Microtox.

Results from the tested stations were extrapolated to draw general conclusions regarding the distribution of contaminant bioavailability and toxicity in Harbour sediments. To support this extrapolation, the range of contaminant concentrations at the toxicity testing stations was compared to the range of contaminant concentrations overall, in and near the Harbour. This was conducted for four integrated contaminant exposure indicators:

- **PAHs:** total PAHs and total bioavailable PAHs (the passive sampler results); and,
- **Metals:** metals hazard index and the SEM/AVS ratio.

The metals hazard index was calculated for metals for which there is a BC $SedQC_{TS}$. For each station, the concentration of each metal was divided by its $SedQC_{TS}$ and the quotients were then summed to provide the metals hazard index for the station. This index was used to indicate the overall degree of metals contamination, and was considered a more informative index of contamination level (*i.e.,* indicative of concentrations relative to benchmark values) than simply summing metals concentrations. AVS/SEM and total bioavailable PAHs provide an indication of potential contaminant bioavailability.

Figure 12 and Figure 13 present scatterplots of the contaminant exposure indicators at the stations for which toxicity testing was conducted. For PAH indicators, the samples tested with only the amphipod test covered the full range of both total PAHs and bioavailable PAHs observed in sediments. The full battery of tests covered the range of total PAHs observed and, with the exception of station 26, was near the upper end of the range of bioavailable PAHs. The stations tested with the amphipod test or the full battery of tests also encompassed most of the range of sediment coal content observed in and near the harbour.

For sediment metals, the two stations with the highest metals hazard index were not included in the toxicity testing program. However, multiple stations at the upper end of the range of SEM/AVS ratios were tested with the full battery of tests. Figure 13 indicates that SEM/AVS ratios greater than 0.5 are associated with samples that exhibited toxicity to polychaetes or amphipods (discussed further in Section 4.2.2.2), and the stations tested included most of those with SEM/AVS greater than 0.5.

Overall, Figure 12 and Figure 13 indicate that the range of sediment contamination encompassed in the toxicity testing program was representative of the range of contamination present in the Harbour and adjacent areas.

4.2.2.2 Relationships Between Exposure and Toxicity

Relationships between contaminant exposure and toxicity were analyzed to evaluate which toxicants might be responsible for observed toxicity in test organisms. This analysis included a combination of graphical and correlation analysis. Figure 12 and Figure 13 combine the toxicity findings with key indicators of contaminant exposure and bioavailability. Rank order correlations of toxicity relative to metals and PAH concentrations and bioavailability indicators are presented in Table 25.

For the echinoderm fertilization test, there was no apparent pattern of response with indicators of exposure and bioavailability of metals and PAHs. This test was conducted on sediment porewater rather than bulk sediment and there is uncertainty as to how well bulk sediment contaminant concentrations would relate to porewater

concentrations. For metals, toxicity to echinoderm fertilization (*i.e.,* a 25% or greater reduction relative to the control) was observed across the range of metals hazard index values, but was not observed at the two tested stations with the highest SEM/AVS ratios. This suggests a lack of clear correspondence with sediment metals concentrations and increased metals bioavailability. Similarly, there was no apparent relationship between PAH exposure and effects to echinoderm fertilization. The cause of toxicity to the echinoderm test was examined further as part of the TIE, which indicated that porewater sulphide was the primary toxicant (Section 3.4.5). Therefore, concentration-response relationships with sediment were not examined further for this test.

Toxicity was not observed in the Microtox test on any samples, and therefore, this test was also excluded from concentration-response assessment.

Amphipod survival and polychaete weight and growth exhibited toxic responses at only a few stations, limiting the ability of a correlation analysis to attribute effects to a particular toxicant. However, the data suggest bioavailable metals or possibly PAHs may be responsible for the observed test responses.

The hypothesis that metals may have elicited toxic effects at some stations was supported by the observation that these responses occurred at stations with relatively high SEM/AVS ratios. In anoxic sediments, sulphide is known to bind to divalent metals such as copper, lead, and zinc (substances that exceeded $SedQC_{TS}$), limiting their bioavailability (DiToro *et al.*, 1990; Ankley *et al.*, 1991; Chapman, 1996b; Casas and Crecelius, 1994). Normally, it is expected that divalent metals will become more bioavailable when SEM/AVS exceeds 1, indicating that there is an excess of metals relative to sulphide. However, given the uncertainty the SEM and AVS measurements, natural sediment variability, and complexity of sediment geochemistry, a SEM/AVS ratio below but near 1 may indicate potential increasing metals bioavailability as the binding capacity of sulphides nears saturation, particularly in the aerated environment of a sediment toxicity test. Furthermore, AVS values in some samples in the Harbour were below the detection limit meaning that the AVS concentrations are limit values (*i.e.,* the “true” concentration could range from well-below, up to the detection limit). Thus, the calculated SEM/AVS ratio may be an underestimate of the true ratio, especially if the “true” concentration of AVS is well below the detection limit.

From Figure 12, it is apparent that toxic responses to amphipods and polychaetes only occurred at stations with an SEM/AVS ratio exceeding 0.5, suggesting that bioavailable metals contributed to the observed toxicity. However, toxic responses in these tests were not observed for all stations with SEM/AVS exceeding 0.5, and, with the exception of lead, correlation analysis did not indicate a strong correspondence between toxicity test endpoints and metals concentrations, metals hazard index, or SEM/AVS (Table 25).

Table 25: Rank Order Correlations (Spearman R) Between Sediment Chemistry and Sediment Toxicity (2009 testing)

Parameter	Amphipod Survival		Polychaete Growth		Toxic to Amphipod Survival and/or Polychaete Growth	
	n	Spearman R	n	Spearman R	n	Spearman R
%Sand	19	0.073	9	-0.267	19	-0.158
%Silt	19	-0.121	9	0.283	19	0.158
%Clay	19	0.048	9	0.4	19	0.211
%Fines	19	-0.073	9	0.267	19	0.158
TOC	19	-0.166	9	0.1	19	0.092
pH	19	-0.134	9	-0.521	19	-0.079
Aluminum	19	0.221	9	0.151	19	0.145
Antimony	19	-0.065	9	.	19	0.102
Arsenic	19	0.18	9	0.483	19	0.29
Barium	19	-0.069	9	-0.477	19	-0.079
Boron	19	-0.142	9	0.233	19	0.092
Cadmium	19	0.211	9	0.17	19	0.213
Chromium	19	-0.071	9	-0.218	19	-0.027
Cobalt	19	0.047	9	-0.02	19	0.046
Copper	19	-0.37	9	0.226	19	-0.026
Iron	19	0.103	9	0.417	19	0.145
Lead	19	**-0.512**	9	0.317	19	-0.211
Manganese	19	0.276	9	0.117	19	0.158
Mercury	19	-0.216	9	-0.092	19	0.013
Molybdenum	19	0.031	9	0.5	19	0.158
Nickel	19	-0.151	9	-0.333	19	0
Phosphorus	19	0.244	9	-0.05	19	0.237
Selenium	19	-0.016	9	0.133	19	0.093
Silver	19	-0.081	9	0.24	19	0.042
Sodium	19	-0.018	9	0.517	19	0.211
Strontium	19	-0.368	9	-0.083	19	0.119
Thallium	19	0.594	9	0.239	19	0.367
Tin	19	.	9	.	19	.
Titanium	19	0.175	9	0.233	19	-0.026
Vanadium	19	-0.075	9	0.444	19	0.186
Zinc	19	-0.085	9	0.417	19	0.053
Zirconium	19	-0.242	9	-0.381	19	-0.094
SEM/AVS	19	-0.199	9	-0.533	19	**-0.606**
Metals Hazard Index	19	-0.159	9	-0.05	19	0.026
Acenaphthene	19	**-0.571**	9	0.332	19	-0.211
Acenaphthylene	19	-0.157	9	0.017	19	-0.157
Anthracene	19	**-0.615**	9	0.092	19	-0.251
Benzo[a]anthracene	19	**-0.701**	9	0.143	19	-0.238
Benzo[a]pyrene	19	**-0.618**	9	0.176	19	-0.198
Benzo[b]fluoranthene	19	**-0.625**	9	0.25	19	-0.145
Benzo[ghi]perylene	19	**-0.569**	9	0.119	19	-0.2
Benzo[k]fluoranthene	19	**-0.531**	9	0.373	19	-0.119
Chrysene	19	**-0.524**	9	0.1	19	-0.184
Dibenz[ah]anthracene	19	**-0.535**	9	0.068	19	-0.338

Parameter	Amphipod Survival		Polychaete Growth		Toxic to Amphipod Survival and/or Polychaete Growth	
	n	Spearman R	n	Spearman R	n	Spearman R
Fluoranthene	19	**-0.513**	9	0.333	19	-0.105
Fluorene	19	**-0.678**	9	0.153	19	-0.304
Indeno[123-cd]pyrene	19	**-0.468**	9	0.275	19	-0.22
Methylnaphthalene	19	**-0.396**	9	-0.209	19	-0.198
Naphthalene	19	**-0.48**	9	-0.151	19	-0.238
Phenanthrene	19	**-0.485**	9	-0.109	19	-0.211
Pyrene	19	**-0.605**	9	0.2	19	-0.132
TotalPAHS	19	**-0.549**	9	0.067	19	-0.185
Total PAHEVA	19	-0.235	9	0.583	19	0.026

Notes:
Correlations for polychaete survival and Microtox are not included in table. No toxicity was observed in these tests.
Bold-Underlined: significant negative correlation (p≤0.05, 1-tailed

An alternative explanation for the observed toxicity to amphipod survival and polychaete weight/growth is sediment PAHs. From Figure 13 is apparent that toxicity to these species occurred at total PAH concentrations exceeding approximately 2.5 mg/kg, and there were multiple significant negative correlations ($p < 0.05$) between PAH concentrations (individual and total) and toxicity to amphipods. However, toxicity to amphipods and polychaetes occurred across a range of total bioavailable PAH concentrations which overlapped with the range where toxicity was not observed. Also, stations with higher total bioavailable PAH concentrations did not exhibit toxicity to amphipods or polychaetes. Figure 13 illustrates the influence of coal on PAH concentration and bioavailability and suggests that while toxicity occurred with higher frequency at higher total PAH concentrations, the most toxic sample (toxic to both amphipod survival and polychaete growth) was in the lower range of total bioavailable PAH concentrations and was influenced by relatively high coal content.

These findings indicate that either bioavailable metals or PAHs could be the cause of observed toxic responses in amphipods and polychaetes. The evidence for an increased incidence of toxicity above an SEM/AVS ratio of 0.5 appears reasonably clear based on the visual relationship in Figure 12. The observation of increased incidence of toxicity above a total PAH concentration of 2.5 mg/kg is less consistent (Figure 13). Also, total PAH concentrations were confounded by coal content in sediments, and no correspondence was observed between toxicity and bioavailable PAH concentrations. However, given the multiple negative correlations between amphipod survival and PAH concentrations, a potential for toxicity above 2.5 mg/kg (which is coincident with the Lower Level numerical limit) cannot be ruled out.

4.3 Echinoderm Fertilization TIE

In 2009 echinoderm fertilization testing, there was no apparent correspondence between toxicity test response and indicators of exposure to sediment metals and PAHs (*i.e.,* based on measured concentrations and indicators of bioavailability). Follow-up sediment collection and testing of sediment porewater with the echinoderm fertilization test was conducted in 2010 and 2011 using a TIE approach (Section 3.4.5). The results of Tier 1 testing of porewater from newly-collected sediments, along with determination of porewater metals, TSS, ammonia and sulphide concentrations, indicated that toxicity might be attributable to porewater metals or

sulphide. Tier 2 testing, employing amendments to remove sulphide and metals toxicity, further supported the attribution of toxicity to porewater sulphide.

Examination of possible causative toxicants for the observed echinoderm toxicity considered the following lines of evidence, with refinement of the TIE conclusion at each step. These considerations support a conclusion that porewater sulphide was the likely toxicant for echinoderm fertilization in the samples tested. Further discussion is provided below.

1) Sediment/toxicity correlations (2009 and TIE data combined);

2) Porewater/toxicity correlations (with TIE data, and where available 2009 data);

3) The influence of specific amendments on toxicity; and,

4) Comparison of correlated substances in porewater with known toxicity thresholds.

4.3.1 Sediment Correlation Results

Table 26 presents rank order correlations between echinoderm toxicity, indicators of sediment contaminant exposure and sediment characteristics for the combined 2009 and TIE data. Significant negative rank order correlations ($p < 0.05$) were observed for grain size parameters (clay, silt and percent fines), sediment metals (arsenic, cadmium, selenium, silver, and thallium), and acenaphthene.

The significant negative correlations of echinoderm fertilization with clay, silt and percent fines suggested that fines suspended in sediment porewater could be causing the observed responses. Total suspended solids (TSS) were determined in the sediment porewater used for the TIE and possible correlations with toxicity are examined in the next section.

The correlations between echinoderm toxicity and concentrations of some sediment metals suggested that metals might be the cause of observed echinoderm toxicity. However, the correlations between SEM/AVS ratios, an indicator of metals bioavailability, were not significant. Metals bioavailability in porewater was investigated further through the measurement of dissolved metals concentrations in the porewater used for 2010 testing. Porewater metals/toxicity correlations are examined in the next section.

Despite the significant correlation of toxicity with acenapthene, the lack of negative correlation of echinoderm fertilization with total PAHs or total bioavailable PAHs (from the passive samples testing) suggests that PAHs were not the primary cause of toxicity to echinoderm fertilization.

Table 26: Rank Order Correlations (Spearman R) Between Sediment Chemistry and Echinoderm Fertilization Success (2009 and 2010 testing)

Parameter	n	Spearman R	Parameter	n	Spearman R
%Sand	15	0.54	Vanadium	15	-0.415
%Silt	15	**-0.522**	Zinc	15	-0.317
%Clay	15	**-0.63**	Zirconium	15	0.131
pH	15	0.654	Acenaphthene	15	**-0.511**
SEM/AVS	15	0.619	Acenaphthylene	15	-0.222
Aluminum	15	-0.165	Anthracene	15	-0.205
Antimony	15	-0.161	Benzo[a]anthracene	15	-0.106
Arsenic	15	**-0.692**	Benzo[a]pyrene	15	-0.174
Barium	15	0.113	Benzo[b]fluoranthene	15	-0.241
Beryllium	15	-0.093	Benzo[ghi]perylene	15	-0.085
Cadmium	15	**-0.592**	Benzo[k]fluoranthene	15	-0.22
Chromium	15	-0.283	Chrysene	15	-0.081
Cobalt	15	-0.194	Dibenz[ah]anthracene	15	-0.139
Copper	15	-0.352	Fluoranthene	15	-0.34
Iron	15	-0.429	Fluorene	15	-0.395
Lead	15	-0.045	Indeno[123-cd]pyrene	15	-0.167
Manganese	15	0.122	Methylnaphthalene	15	-0.028
Mercury	15	-0.194	Naphthalene	15	-0.049
Molybdenum	15	-0.425	Phenanthrene	15	-0.034
Nickel	15	-0.043	Pyrene	15	-0.187
Selenium	15	**-0.613**	TotalHMWPAH	15	-0.303
Silver	15	**-0.562**	TotalLMWPAH	15	0.126
Strontium	15	0.065	TotalPAHS	15	-0.133
Thallium	15	**-0.583**	TotalPAHEVA	9*	-0.444
Tin	15	0.134	%Fines	15	**-0.54**
Titanium	15	-0.145			

*Only determined for 2009 sediment samples.
Bold-Underlined: significant negative correlation (p≤0.05, 1-tailed)

4.3.2 Porewater Chemistry-Toxicity Correlations.

Rank order correlation analysis was used to examine relationships between porewater chemistry and toxicity to the echinoderm fertilization test (refer to Table 27). The suspect porewater sulphide concentrations reported in 2009 (Section 3.4.6) were excluded from this analysis. Significant negative correlations ($p < 0.05$) were observed with porewater sulphide and dissolved aluminum concentrations, and scatterplots (Figure 14) indicated a pattern of decreased fertilization success with increased concentrations of these substances. Correlations of echinoderm toxicity with TSS and other metals concentrations in porewater were not significant, and there was no apparent pattern in the concentration-toxicity scatterplots (Appendix VII) suggesting that toxicity was unlikely to be related to these parameters.

The significant correlations and scatterplots suggested that sulphide and/or dissolved aluminum could be the potential toxicant in sediment porewater. The attribution of observed toxicity to sulphide and dissolved aluminum was investigated further via sample amendments (Section 4.3.3) and by consideration of published toxicity data for these substances (Section 4.3.4).

4.3.3 Influence of Sample Amendments on Toxicity

The amendments that were applied to the porewater samples were sulphide removal and metals chelation using EDTA. The results of toxicity testing on porewater samples following each amendment were as follows:

- **Sulphide Amendment** – The sulphide amendment involved removal of sulphide via volatilization. Sulphide removal reduced toxicity that was apparent in two of the three test samples (2010-07 and 2010-09). Sulphide removal in these two samples resulted in echinoderm fertilization success that was similar to that observed in the control. The remaining sample (2010-11) was not toxic prior to amendment. This finding was unexpected, because the porewater extracted from 2010-11 sediments was toxic to echinoderm in Tier 1 testing, with a reported sulphide concentration of 3.5 mg/L. In Tier 2 testing, 2010-11 porewater was not toxic at reported sulphide concentrations of 12.2 mg/L (un-amended sample) or 0.022 mg/L (amended sample). The lack of toxicity to the un-amended sample could not be explained, especially given that the sulphide concentration in the sample exceeded the reported EC_{50} for toxicity to echinoderm fertilization (Section 4.3.4). Thus, two of the samples subjected to this amendment supported the hypothesis that sulphide caused the toxicity to echinoderm observed in porewater, whereas the third sample, which was considered unusual given the sulphide concentration and known toxicity threshold for sulphide, did not support this hypothesis. Thus, based on this finding alone the strength of this hypothesis is uncertain and additional evidence was considered for further interpretation of TIE results.

Table 27: Rank Order Correlations (Spearman R) Between Porewater Chemistry and Echinoderm Fertilization Success (2009 and 2010 testing)

Parameter	2010 and 2011 TIE Testing	
	n	Spearman R
Ammonia	13	-0.235
Sulphide	13	**-0.871**
Unionized Ammonia	12	0.351
TSS	13	-0.169
Aluminum	13	**-0.72**
Antimony	13	0.06
Arsenic	13	-0.053
Barium	13	-0.459
Bismuth	13	-0.166
Boron	13	-0.21
Cadmium	13	0.08
Chromium	13	0.151
Cobalt	13	-0.264
Copper	13	0.318
Iron	13	-0.3
Lead	13	0.591
Lithium	13	-0.028
Manganese	13	0.12
Molybdenum	13	0.288
Nickel	13	-0.312
Selenium	13	-0.062
Silicon	13	-0.183
Silver	13	-0.166
Strontium	13	-0.174
Thallium	13	-0.166
Tin	13	-0.166
Titanium	13	-0.166
Uranium	13	0.371
Vanadium	13	-0.166
Zinc	13	-0.106
Calcium	13	-0.329
Magnesium	13	-0.346
Potassium	13	-0.376
Sodium	13	-0.258
Sulphur	13	-0.337

Bold-Underlined: significant negative correlation (p≤0.05, 1-tailed)

- **EDTA Amendment** – EDTA chelates cationic metals, limiting their bioavailability in solution (U.S. EPA 2007). A concomitant reduction in toxicity is therefore evidence that cationic metals are a primary toxicant. EDTA can also be toxic to marine organisms, but when cationic metals are present in solution (*i.e.,* available for chelation), the EDTA-metal complexes are not toxic. Therefore, when cationic metals are a primary toxicant, a reduction in toxicity should be observed with EDTA treatment, but the toxicity reduction will be sensitive to the amount of EDTA added because once all available metals have been chelated, then the residual EDTA may become toxic to test organism. EDTA amendment at the lowest EDTA treatment level reduced toxicity slightly in two of the three samples (2010-07 and 2010-09), but echinoderm fertilization in these amended samples was still reduced relative to control values. As discussed in the Maxxam report, it is possible that the toxicity reduction following EDTA amendment was due to loss of sulphide during sample processing. Fertilization success was still significantly impaired with the EDTA treatment, indicating that metals are unlikely to have been the only toxicant. At higher dosing levels of EDTA, an increase in toxicity was observed suggesting that residual EDTA was a possible cause.

The sample amendment findings provided evidence that aluminum was unlikely to be the primary toxicant responsible for the reduction in echinoderm fertilization success.

The evidence relating observed toxicity to sulphide was inconsistent. Two of the amended samples supported the hypothesis of sulphide toxicity, but the third sample did not. These inconsistent results could indicate the toxicant was not sulphide, but rather some other, unmeasured substance that was also detoxified by exposure to air. An alternative explanation is that the results for sample 2010-11 were anomalous, potentially due to an artefact of sample handling or analysis. The consideration of published toxicity data presented below supports this alternative explanation, in that the reported porewater sulphide concentration in sample 2010-11 was almost six-fold higher than a published EC50 for sulphide toxicity to echinoderm embryo development (refer to the next section), and was therefore inconsistent with the reported lack of toxicity in this sample.

4.3.4 Toxicity Thresholds

The final line of evidence of the TIE involved consideration of thresholds for toxicity of sulphide and aluminum to echinoderm fertilization. These included:

- **Sulphide:** In a study of the sulphide tolerance of four standard marine test species, Knezovich *et al.* (1996) tested the effect of porewater sulphide on embryo development in *Strongylocentrotus purpuratus* (the same species used echinoderm testing here). The sulphide EC_{50} for normal embryo development in *S. purpuratus* was 0.19 mg/L. Although the endpoint used by Knezovich *et al.* (1996) was different than used in this study (normal embryo development versus fertilization success), the results of Knezovich *et al.* (1996) are the closest available in terms of life stage for the concentration at which adverse effects to sea urchin would be expected.
- **Aluminum:** Pagano *et al.* (1996) examined the effect of exposure to aluminum sulphate on the fertilization success of the sea urchin, *Sphaerechinus granularis*. At an exposure concentration of 10^{-4} mol/L $Al_2(SO_4)_3$ (5.4 mg/L Al), a statistically significant reduction in fertilization success of approximately 50%, relative to the control, was observed ($p < 0.05$). At lower test concentrations ranging from 0.00054 to 0.54 mg/L Al, fertilization success ranged from 71 to 96% of but was not significantly different than the control ($p > 0.05$). Although the species tested by Pagano *et al.* was different than used in this study, the life stage, endpoint and organism class was similar and the results were considered indicative of the concentration near which adverse effects to sea urchin would be expected.

Figure 15 provides a comparison of the TIE echinoderm toxicity results to dissolved aluminum and sulphide concentrations and their respective toxicity thresholds. The 2009 echinoderm testing data were not included because of uncertainty associated with the sulphide determination in the 2009 samples (Section 3.4.6).

This comparison provides additional support to the hypothesis that sulphide was the toxicant responsible for effects to echinoderm fertilization. Seven of the eight samples for which the sulphide concentration exceeded the EC_{50} of 0.19 mg/L were toxic to echinoderm fertilization, with some indication of a dose-response relationship between toxicity and sulphide concentration.

None of the samples in which echinoderm toxicity was observed had dissolved aluminum concentrations near or above the estimated EC_{50} for aluminum (5.4 mg/L).

4.3.5 TIE Conclusion

The findings of the TIE are subject to residual uncertainty, but are suggestive that sulphides are the toxicant to echinoderm fertilization in sediment porewater. The evidence contributing to this conclusion includes:

- With the exception of dissolved aluminum, correlations with other parameters, including ammonia, TSS, and other dissolved metals were lacking;
- The available evidence suggested that dissolved aluminum was unlikely to be the primary toxicant because the EDTA amendment caused only a minor reduction in toxicity and dissolved aluminum concentrations were well below the approximate EC50 for echinoderm fertilization;
- The amendment to remove sulphides from the porewater, while non-specific, removed toxicity, when it was present; and,
- With the exception of the lack of toxicity for unamended sample 2010-11, there was a clear dose-response relationship between increasing sulphide and decreasing echinoderm fertilization that was consistent with the EC50 for echinoderm larval development, the closest life-stage/endpoint for which sulphide toxicity information was available.

Conversely, the lack of toxicity observed for unamended sample 2010-11, does not appear to support this hypothesis. While the results from this sample may be anomalous, they may also indicate that sulphide was not the toxicant.

Thus, notwithstanding the evidence presented in the bullets above, the TIE should not be considered conclusive, but rather suggestive that sulphide is potentially the toxicant causing reduced echinoderm fertilization. The present level of TIE analysis, while appropriate for an initial evaluation, relies on methods that are non-specific to removal of the substance of interest (sulphide). Oxidation processes could also remove toxicity of other substances such as, for example, oxidation of Fe^{2+} (toxic) to Fe^{3+} (non-toxic, but could have physical effects from particulate material). However, in the case that an alternate toxicant is causing the observed toxicity, it appears that it would be removed and/or detoxified by exposure to air, and therefore, processes that mitigate sulphide toxicity may also mitigate the toxicity of the unidentified toxicant, if present.

4.4 Evaluation of Sediment Management Options

The following sections evaluate the feasibility of disposal at sea of dredged sediments and risk-based management of sediment contamination, as these are understood to be elements of a conceivable sediment management strategy for Ladysmith Harbour, depending on the specific project component needs of as yet to be developed concepts for the waterfront. The disposal at sea option is evaluated in Section 4.4.1. The risk assessment option is evaluated in Section 4.4.2.

4.4.1 Disposal at Sea Option

A Disposal at Sea application for dredged sediments from Ladysmith Harbour would require a program of sampling and analysis developed in consultation with Environment Canada, based on a specified development plan for the Harbour. The following evaluation of the Disposal at Sea option is based on data collected in a manner consistent with methods specified in the Disposal at Sea Regulations, and from locations in portions of the Harbour that might be considered for dredging. However, the intensity of sampling needed by Environment Canada may differ. The results of the following evaluation are therefore intended to provide insight into the possible findings of studies carried out to support such an application; however, the results of future investigations cannot be predicted with confidence, and this evaluation should not be considered conclusive.

The following evaluation is based on the results of the sediment chemistry, contaminant bioavailability, and toxicity testing investigations presented above. The evaluation was conducted on a station-by-station basis, because it was expected that dredging would be considered for only some as yet unknown portions of the Harbour, and that Disposal at Sea might be feasible for some locations but not others. In general Environment Canada does not favour excising portions of sediments in waterlots based on kriging between sample points, although in specific circumstances, they have supported such approaches to sediment management. Because not all lines of evidence were collected at every station (*e.g.*, toxicity testing was conducted on a subset of stations), the evaluation at some stations was based on the available lines of evidence and a consideration of possible outcomes of additional testing.

Key findings relevant to the feasibility of the Disposal at Sea option are as follows:

1) **Sediment Concentrations of Cadmium, Mercury, and Total PAHs**. Concentrations of cadmium and total PAHs exceeded the Lower Level numerical limits at most stations. Exceedance of the Lower Level numerical limits was considered to reduce the probability of a successful Disposal at Sea application, unless other lines of evidence were available to demonstrate that the contamination was not bioavailable. Mercury did not exceed the Lower Level numerical limit at any station, and was not considered further.

2) **Toxicity Testing Results**. Test results were considered as follows:

a) Results of the amphipod survival test were compared to the Disposal at Sea interpretation guidelines. Results that indicated a 20% reduction in survival relative to the regional reference station or a 30% reduction in survival relative to the control (refer to Section 3.4) were classified as "Toxic" and considered to reduce the probability of a successful Disposal at Sea application. This was the case for Stations 1A and 33A.

b) Results of the polychaete test were considered as an additional line of evidence regarding the potential bioavailability of sediment contamination. Results that indicated a 20% reduction in weight and growth relative to the control (refer to Section 3.4) were classified as "Toxic" and considered to reduce the probability of a successful Disposal at Sea application. None of the tested sediment samples were toxic to polychaete survival.

c) Toxicity to echinoderm fertilization was observed at stations throughout the harbour and this finding would need to be addressed in order to advance a successful application for disposal at sea. An initial TIE, supported by numeric relationships between contaminant concentrations and biological test responses was suggestive of the test response being the result of porewater sulphides, rather than metals or PAHs. The physical disturbance associated with dredging and dumping of sediment would be expected to result in a loss of porewater sulphides, through oxidation and advection and, in the physical process of removal and disposal at sea, the sediments would be rendered acceptable for disposal. Based on these considerations, a scientific rationale could be advanced to omit the echinoderm fertilization test results from a Disposal at Sea permit application and replace these results with Microtox testing. However, we note that the present level of TIE analysis, while appropriate for an initial evaluation relies on methods that are non-specific to removal of the substance of interest (sulphide). Oxidation processes could also remove toxicity of other substances such as, for example, oxidation of Fe^{2+} (toxic) to Fe^{3+} (non-toxic, but could have physical effects from particulate material). Thus, uncertainty still remains, regarding the cause of echinoderm toxicity, for which Environment Canada could request further investigation. To address this uncertainty, we recommend that more detailed TIE procedures be undertaken, in particular, methods with greater removal specificity for sulphide to ideally determine, with more certainty, whether sulphide toxicity explains the observed impairment of echinoderm fertilization. An increased scope of testing (number of samples and stages in the TIE evaluation) might be required to support this rationale to the satisfaction of Environment Canada. Needless to say, there is uncertainty in both the results of such testing and in Environment Canada's response to the proposed change. Nevertheless, the results presented here suggest (but do not conclude) that observed toxicity in the echinoderm fertilization test need not preclude a successful Disposal at Sea application. Test results indicating no toxicity to the echinoderm fertilization test were considered to increase the probability of a successful Disposal at Sea application.

d) None of the tested sediments were toxic in the Microtox test.

3) **Relative Bioavailability.** Relative bioavailability of sediment contaminants was indicated by SEM/AVS ratios for metals and by sediment concentration and coal association for PAHs:

   a) **SEM/AVS Ratios.** Toxicity to the amphipod or polychaete tests was more frequently observed in sediments with a molar SEM/AVS ratio greater than 0.5. Observed SEM/AVS greater than 0.5 was considered to indicate a greater potential for sediment metals to be bioavailable, and a greater potential for sediment toxicity (at stations where toxicity testing has not been conducted). Conversely, for stations where SEM/AVS did not exceed 0.5, toxicity to test organisms was considered unlikely. Where SEM/AVS exceeded 0.5 metals relative bioavailability was classified as "High"; this was the case for Stations 1A, 5A, 6A, 7A, 11A, 12A, 13A, 15A and 24A. For the remaining stations metals relative bioavailability was classified as "Low".

   b) **PAH Concentrations and Coal Association**. Evidence for toxicity as a result of sediment PAH was weak, but toxicity was more frequently observed at total PAH concentrations above 2.5 mg/kg and a possible causal relationship could not be ruled out (the possibility of PAH toxicity was not part of the TIE testing). The potential for sediment PAHs to elicit toxicity was considered to be relatively low when there was evidence that the PAHs had low bioavailability or were associated with coal (Section 4.2). For these stations, relative bioavailability of PAHs was classified as "Low". Where PAHs occurred in the absence of factors that indicate reduced bioavailability (*i.e.,* coal particles), relative bioavailability was classified as "High". High relative bioavailability co-occurring with total PAH concentrations exceeding 2.5 mg/kg, was considered to reduce the probability of a successful Disposal at Sea application, without additional evidence (*e.g.,* toxicity findings) to demonstrate that they are not responsible for toxicity.

Table 28 integrates these three lines of evidence to provide an overall evaluation of the anticipated outcome of a Disposal at Sea application.

After integrating the available chemistry, bioavailability and toxicity data, stations were classified as follows:

- **Category 1:** For these stations, sediment contaminant concentrations and toxicity are known, reducing uncertainty, and the observed conditions appear favourable for a Disposal at Sea Application. The available data for these stations indicated sediment conditions that, assuming conditions as encountered here would be encountered in subsequent application-specific testing, would likely be approved for Disposal at Sea, either because they meet the numerical limits or because toxicity data indicate they are below the Lower Level of the National Action List. Sediment conditions included in this category were:
  - Cadmium, mercury and total PAH concentrations were all below the Lower Level numerical limits (Stations 2A and 3A).
  - Total PAH concentrations exceeded the Lower Level numerical limits, but there was evidence of low PAH bioavailability and a lack of toxicity to any test species (Station 24A).

Table 28: Summary of Findings Relevant to a Disposal at Sea Application

Station	Comparison to Lower Level Numerical Limit		Relative Bioavailability		Toxicity Classification				Anticipated Approval Status[1]
	Cd	Total PAHs	Metals	PAHs	Amphipod	Polychaete	Microtox	Echinoderm	
2A	Below	Below	Low	High	Non-toxic	Non-toxic	Non-toxic	Non-toxic	
3A	Below	Below	Low	High	Non-toxic	-	-	-	Category 1
24A	Below	Above	High	Low	Non-toxic	Non-toxic	Non-toxic	Non-toxic	
19A	Above	Above	Low	Low	-	-	-	-	
25A	Above	Above	Low	Low	-	-	-	-	
31A	Below	Above	Low	Low	-	-	-	-	
32A	Below	Above	Low	Low	-	-	-	-	
34A	Above	Above	Low	Low	-	-	-	-	
8A	Above	Above	Low	High	Non-toxic	-	-	-	
10A	Above	Above	Low	High	Non-toxic	-	-	-	
21A	Above	Above	Low	High	Non-toxic	-	-	-	
26A	Below	Above	Low	High	Non-toxic	-	-	-	
28A	Above	Below	Low	High	Non-toxic	Non-toxic	Non-toxic	Toxic	
14A	Above	Below	Low	High	-	-	-	-	Category 2
16A	Above	Below	Low	High	-	-	-	-	
17A	Above	Below	Low	High	-	-	-	-	
20A	Above	Below	Low	High	-	-	-	-	
27A	Above	Below	Low	High	-	-	-	-	
4A	Above	Below	Low	High	-	-	-	-	
9A	Above	Below	Low	High	-	-	-	-	
18A	Above	Below	Low	High	-	-	-	-	
29A	Above	Below	Low	High	-	-	-	-	
30A	Above	Below	Low	High	Non-toxic	-	-	-	
22A	Above	Above	Low	Low	Non-toxic	Non-toxic	Non-toxic	Toxic	

Station	Comparison to Lower Level Numerical Limit		Relative Bioavailability		Toxicity Classification				Anticipated Approval Status[1]
	Cd	Total PAHs	Metals	PAHs	Amphipod	Polychaete	Microtox	Echinoderm	
23A	Below	Above	Low	Low	Non-toxic	-	-	-	
35A	Below	Above	Low	Low	Non-toxic	-	-	-	
12A	Above	Above	Low	High	Non-toxic	Non-toxic	Non-toxic	Toxic	
15A	Above	Above	Low	High	Non-toxic	Non-toxic	Non-toxic	Toxic	
6A	Above	Above	High	High	Non-toxic	Toxic	Non-toxic	Toxic	Category 3
5A	Below	Above	Low	High	-	-	-	-	
7A	Above	Above	Low	High	-	-	-	-	
11A	Above	Above	Low	High	-	-	-	-	
13A	Above	Above	Low	High	-	-	-	-	
2010-10	Above	Above	Low	-	-	-	-	Toxic	
2010-11	Above	Above	Low	-	-	-	-	Toxic	
2010-13	Below	Above	High	-	-	-	-	Non-toxic	
2010-09	Above	Above	Low	-	-	-	-	Toxic	
2010-08	Above	Above	Low	-	-	-	-	Toxic	
2010-07	Above	Above	Low	-	-	-	-	Toxic	
33A	Below	Above	High	Low	Toxic	Toxic	Non-toxic	Non-toxic	Category 4
1A	Below	Above	High	High	Toxic	-	-	-	

Notes:
[1]Categories are defined in text.
- Indicates information is lacking.

- **Category 2:** For these stations, gaps in knowledge and understanding with respect to contaminant bioavailability and toxicity create uncertainty but the available information is suggestive of favourable conditions for a Disposal at Sea Application. Data for stations in this category indicated that, despite exceedances of the Lower Level numerical limits, bioavailability of metals and PAHs was likely low. Sediment conditions included in this category were:
  - Cadmium and/or total PAH concentrations were above the Lower Level numerical limits, but the bioavailability assessment indicated low bioavailability (Stations 19A, 25A, 31A, 32A and 34A). No toxicity data were available for these stations to support a more definitive classification, as would be needed to support an Application for Disposal at Sea.
  - Cadmium exceeded the Lower Level numerical limit, but there was evidence of low metals bioavailability (Stations 4A, 9A, 14A, 16A, 17A, 18A, 20A, 27A, 28A, 29A and 30A). At stations 28A and 30A, this conclusion was supported by a lack of toxicity to the amphipod test. Toxicity to echinoderm fertilization was observed at stations 28A, but the TIE indicated that this was attributable to porewater sulphides rather than sediment contamination. Cadmium is known to be elevated in certain BC Coastal Sediments as a result of natural geological conditions.
  - Total PAHs exceeded the Lower Level numerical limit, but there was no toxicity observed in the amphipod test (Stations 23A, 26A and 35A). At stations 23A and 35A this conclusion was further supported by the bioavailability assessment. No other toxicity data were available for these stations.
  - Both total PAHs and cadmium exceeded the Lower Level numerical limits, but there was no toxicity observed in the amphipod test (Stations 8A, 10A, 12A, 15A, 21A and 22A). At stations 12A, 15A and 22A this conclusion was further supported by a lack of toxicity to the polychaete and Microtox tests. The bioavailability assessment indicated low metals bioavailability at all stations in this category, and low PAH bioavailability at station 22A. Toxicity to echinoderm fertilization was observed at stations 12A, 15A and 22A; however, initial TIE and chemical-toxicological relationships suggest porewater sulphides rather than contaminants. Sulphides could occur at higher concentrations when organics such as wood debris result in the reductive transformation of sulphate to sulphide. Sulphate is abundant in seawater, comprising roughly 7.7% of major ions (Thurman, 1978).
- **Category 3:** For these stations, gaps in knowledge and understanding with respect to contaminant bioavailability and toxicity create uncertainty and the available information suggests possible unfavourable conditions for a Disposal at Sea Application. Stations in this category exhibited cadmium and/or total PAH concentrations exceeding the Lower Level numerical limits, with no indication of low bioavailability of metals or PAHs. However, these stations either were not included in the toxicity testing program, or were included but exhibited inconclusive results. There is therefore uncertainty regarding what would be the outcome of an assessment of these locations following toxicity testing. Sediment conditions included in this category were:
  - Total PAHs exceeded the Lower Level numerical limit, with no indication of low PAH bioavailability (Stations 5A and 2010-13). Porewater from station 2010-13 exhibited no toxicity to the echinoderm fertilization test.

- Total PAHs and cadmium exceeded the Lower Level numerical limits, with evidence of low metals bioavailability but no evidence of low PAH bioavailability (Stations 7A, 11A, 13A, 2010-7, 2010-8, 2010-9, 2010-10, and 2010-11). None of these stations were tested with the amphipod, polychaete or Microtox tests. Toxicity to echinoderm fertilization was observed at stations 2010-7, 2010-8, 2010-9, 2010-10, and 2010-11, but the TIE indicated that this was attributable to porewater sulphides rather than sediment contamination.
- Total PAHs and cadmium exceeded the Lower Level numerical limits, with evidence that bioavailability of both metals and PAHs was potentially high, and observed toxicity to polychaetes and echinoderm fertilization (Station 6A). However, the amphipod and Microtox tests showed no toxicity at this station. The polychaete test is not required for a Disposal at Sea application, and the TIE indicated that toxicity to echinoderm fertilization was attributable to porewater sulphides rather than sediment contamination. Therefore, there is uncertainty regarding what would be the outcome of an assessment of this location following a full suite of toxicity testing.

- **Category 4:** For these stations, sediment contaminant concentrations and toxicity are known, reducing uncertainty, but the observed conditions do not appear favourable for a Disposal at Sea Application. Stations in this category exhibited total PAH concentrations exceeding the Lower Level numerical limit, with evidence of toxicity to amphipods sufficient to classify these sediments as “above the Upper Level”. Sediment conditions included in this category were:
  - Total PAHs exceeded the Lower Level numerical limit, with no indication of low PAH bioavailability and with evidence of toxicity to amphipods (Station 1A).
  - Total PAHs exceeded the Lower Level numerical limit, with an indication of low PAH bioavailability but evidence of toxicity to amphipods and polychaetes (Station 33A).

Figure 16 shows the expected approval status of a Disposal at Sea application, based on the classification provided above, for different portions of Ladysmith Harbour. The majority of the Harbour was classified as Category 2 with gaps in knowledge and understanding causing uncertainty, but indications of conditions favourable for Disposal at Sea. The available information indicated that these locations have cadmium and/or total PAH concentrations exceeding the Lower Level numerical limits, but are characterized by low contaminant bioavailability, likely to result in a lack of toxicity in test species relevant to the Disposal at Sea Regulation.

Small portions of the Harbour west of Slack Point (around Station 24A) and in the northwest corner of the Harbour (near Stations 2A and 3A) exhibited no exceedances of the Lower Level numerical limits or were not toxic to test species, and thus were categorized as Category 1. The evaluation of these portions of the Harbour would need to be confirmed through additional sediment investigation in consultation with Environment Canada, but the available data indicate that pursuing an application for Disposal at Sea for these areas and based on conditions encountered in this study would have merit.

Small portions of the Harbour were also categorized as Category 4, with conditions that appear to preclude Disposal at Sea based on existing data. Locations categorized as Category 4 included the westernmost corner of the Harbour around Stations 1A, and the east side of Slack Point around Station 33A, where toxicity to amphipod survival was observed.

Locations categorized as Category 3 included a zone extending from Station 1A into the central portion of the Harbour, isolated patches around Stations 2010-09, 2010-08 and 2010-07, and the area surrounding Station 33A east of Slack Point. The observed toxicity to test organisms in these areas indicates that a successful Disposal at Sea application for these sediments may not approved. Some areas were included in this category based on sediment chemistry and a lack of data to mitigate exceedances of Lower Level numerical limits (*e.g.*, 2010-07, 2010-08, 2010-09 and 2010-10). The classification of these locations has relatively high uncertainty, and could change with collection of further data.

4.4.2 Risk Assessment Option

A risk assessment option might be desired for development scenarios that do not require dredging of harbour sediments and where there is desire to manage sediments *in situ* (*i.e.,* leave in place, possibly with specified restrictions on future activities). Risk assessment is accepted in provincial law as a form of "remediation" such that the sediments are considered to be "clean". Although the concentrations of some metals and PAHs exceeded federal and provincial sediment benchmarks, several considerations indicate that there may be a relatively low ecological risk to marine biota in at least some portions of the Harbour and that risk assessment could be a viable approach to managing sediments where their removal is not needed. These considerations include:

- With the exception of copper at two stations, metals concentrations were below both the PEL and the $SedQC_{TS}$. Thus, the available sediment chemistry data indicate a potential for adverse effects, but not necessarily a likelihood of those effects occurring.
- Over much of the Harbour, acid-volatile sulphides were measured to be at concentrations sufficient to reduce the bioavailability of divalent metals.
- Although individual PAHs exceeded the PEL or the $SedQC_{TS}$, the $SedQC_{TS}$ for total PAHs, an indicator of more widespread contamination by PAHs, was not exceeded at any surface station.
- The bioavailability of PAHs is uncertain due to the presence of high coal content in many areas, including the location west of Slack Point where PAHs concentrations were highest. The bioavailability assessment supported the hypothesis that coal-associated PAHs in Harbour sediments have limited bioavailability.
- Toxicity to echinoderm fertilization did not appear to be related to sediment contamination, but to elevated porewater sulphide concentrations, based on preliminary toxicity identification evaluation procedures. Porewater sulphides are expected to result from natural biogeochemical processes in sediment, and would not ordinarily be considered to warrant remediation.
- Toxicity to amphipods and polychaetes was observed at only a few stations across the Harbour. While bioavailable metals and/or PAHs were identified as possible causes of toxicity to these test species, this attribution is uncertain given that toxicity did not occur everywhere that metals and PAHs were elevated and potentially bioavailable.
- Uncertainty exists in the extrapolation of toxicity observed in laboratory test organisms to those in natural environments. The test organisms used for testing of Ladysmith Harbour sediments were field-collected from relatively pristine areas and therefore could be more sensitive than the benthic invertebrate community in Ladysmith Harbour.

Based on these considerations, follow-up investigation to complete a sediment ecological risk assessment appears to be appropriate viable approach for sediments that would not be dredged as part of a development plan.

Provincial guidance has been developed in BC regarding the design and implementation of sediment quality assessments (BCMOE 2005). The *Draft Guidance for Detailed Ecological Risk Assessments (DERA) in British Columbia* (Golder 2006) provides additional considerations and guidance for conducting site-specific sediment ecological risk assessments. The approach typically involves the development of a weight of evidence assessment based on the Sediment Quality Triad (Chapman 1990, 1996; Chapman *et al.* 1997). The Sediment Quality Triad involves collection and integration of information regarding:

- Sediment and/or porewater chemistry. The presence of contaminants at concentrations exceeding regulatory benchmarks is considered to indicate a potential for contaminant-related adverse effects. Measures of sediment chemistry are generally considered to have uncertain ecological relevance, given the potential for large differences in bioavailability between sites. Measures of bioavailability (*e.g.*, AVS/SEM) are considered during the interpretation of contaminant concentrations.
- Sediment and/or porewater toxicity. Observed effects to laboratory organisms are considered to support the hypothesis that measured contaminant concentrations are resulting in adverse effects to resident biota. Toxicity test results have uncertain ecological relevance, given differences between laboratory and field conditions, and the potential for test organism responses to reflect non-contaminant factors. Other sediment characteristics that can elicit responses in laboratory tests (*e.g.*, porewater sulphide) are considered during the interpretation of toxicity data.
- Benthic community structure. An observed perturbation of benthic community structure relative to reference areas is considered to provide the most relevant support for the hypothesis of contaminant-related effects (Chapman 1990, 1996; Chapman *et al.* 1997). Benthic community data are typically highly variable, however, and can reflect the influence of many non-contaminant habitat characteristics. Several habitat characteristics that can affect biological communities (*e.g.*, grain size, depth) are considered during the interpretation of benthic community data.
- At sites where bioaccumulative contaminants have been identified, an assessment of contaminant bioaccumulation is also considered to be necessary. However, the findings of the PSI, DSI, and this sediment investigation have not identified elevated concentrations of bioaccumulative contaminants in Harbour sediments.

The sediment investigation presented in the previous sections integrated the findings of sediment chemistry, bioavailability, and toxicity information for stations throughout the Harbour. The interpretation of these data to evaluate the risk of contaminant-related effects to biota would be enhanced by the inclusion of benthic community data. The integration of these three lines of evidence in a logical and transparent framework like the Sediment Quality Triad would support a risk assessment-based approach, that, based on the data provided here, has a reasonable likelihood of identifying low risks. Nevertheless, as with any risk assessment, certainty of outcome cannot be provided. .

4.5 Key Uncertainties

The approach applied for this investigation was designed to reduce uncertainty arising from sediment data compiled in previous reports, with respect to options available for future development of the Ladysmith Harbour waterfront. Several complementary lines of evidence, including chemistry, bioavailability, sediment and porewater toxicity and a toxicity identification evaluation were collected in this study and were used to assemble a profile of sediment contamination in the harbour that would provide indication, in broad terms, of the potential success of sediment management options that could be part of an as yet undefined development scenario. In addition, a concentration-response analysis was applied to infer observed responses at stations where toxicity testing was conducted, to stations where this information was lacking. A key uncertainty in the work carried out was the absence of a defined development project description. The sediment study was therefore extensive through the water lot, rather than intensively focused on development project-specific study questions. The implications of this uncertainty are that more detailed study may be needed to advance certain development proposals that are dependent on sediment management solutions.

Other uncertainties in each study component are discussed below:

- **Chemistry:** The chemistry results have relatively low uncertainty with respect to the numerical concentrations of analytes. Samples were collected and analyzed using established procedures. With the exception of porewater sulphide concentrations reported in 2009, no significant QA/QC issues were identified that suggested that the sediment chemistry data were unreliable. Although the sample stations were distributed throughout the Harbour, we cannot rule out the possibility, even with additional testing, that localized areas or depths of elevated contamination have not been sampled. A common uncertainty with respect to sediment chemistry as a proxy for environmental impact is the extrapolation from environmental concentration to biological responses. Generic sediment quality benchmarks are generic predictors of potential effects, they do not reflect site-specific conditions, and, similar to many other sediment studies, were found to be generally poor predictors of sediment toxicity in this study.

- **Bioavailability and Concentration-Response Assessment:** The bioavailability results for metals (SEM/AVS) have relatively low uncertainty with respect to the numerical values of the indicators. Samples were collected, processed and analyzed using established procedures. No significant QA/QC items were identified that suggested that the bioavailability data were unreliable. The numerical values for the PAH passive sampler results have similarly low uncertainty but the technique is less established and tested than than the SEM/AVS approach for metals. The PAH passive sampler technique has been shown to estimate the bioavailable fractions of PAHs in marine sediment (Meloche et al. 2009), but to our knowledge this technique has not been extensively tested and validated. It is possible that site-specific factors could limit the utility of the method, and this uncertainty has not been quantified. An additional area of uncertainty is the degree to which the bioavailability indicators are representative of the Harbour as a whole. Although the sample stations were distributed throughout Ladysmith Harbour, we cannot rule out the possibility, even with additional testing, that additional localized areas with high bioavailability of metals or PAHs have not been sampled. This is particularly true in a harbour where creosoted timber, in contact with the sediment, will have been used for building harbour infrastructure.

- **Toxicity:** The toxicity testing program was based on a battery of toxicity test endpoints including those relevant to Disposal at Sea (amphipod, echinoderm and Microtox), and a polychaete test with both sublethal and lethal endpoints. The inclusion of multiple endpoints and taxa in the toxicity program increases the sensitivity of the test program to detect potential effects. Comparisons were made to both laboratory controls and regional reference stations to also consider the local ecological relevance of testing program findings. However, in some cases toxicity tests are subject to uncertainty related to the interpretation of test outcomes. Although toxicity test protocols are designed to reduce confounding environmental factors, these tests are nevertheless subject to non-contaminant influences or influences that are the result of sample handling (*e.g.,* shift in redox and oxidation of sediment contaminants (iron) or their complexes (metal sulphides)) that can affect study results. Test organism responses are inherently variable, and they may respond to particle size distributions, physical influences, handling stress, and other factors. In this study, this uncertainty was reduced through the quantification of confounding variables, wherever possible and where appropriate (i.e. for echinoderm toxicity), more in depth analysis to examine the cause of toxicity. The apparent effects for amphipod survival and polychaete weight and growth were observed at the threshold for whether the effects indicated toxicity to these endpoints. These findings were conservatively assumed to represent contaminant-related toxicity as opposed to natural variability or the influence of a confounding factor – doing so is a judgment rather than a finding of fact. Furthermore, as discussed in the preceding section, uncertainty exists in the extrapolation of toxicity observed in laboratory test organisms to those in natural environments and it is uncertain whether adverse effects would be occurring to organisms in Ladysmith Harbour.
- **Toxicity Identification Evaluation:** The TIE for echinoderm fertilization was based on results observed over two sampling events and multiple porewater extractions for the sediments collected in 2010. The approach used for TIE was essentially a process of elimination to identify potential toxicants, combined with confirmation of likely toxicity thresholds for likely toxicants. There was significant uncertainty in the porewater sulphide results observed during 2009 toxicity testing. In the initial TIE, which was scaled back from a full TIE, only a limited number of samples were tested. One of these samples produced results that were in apparent contradiction to the hypothesis of sulphide being the cause of toxicity; however, this sample is believed to be an anomalous outlier as it also did not conform to previously established toxicity levels and the relationship between concentration and effect was markedly different from other samples, which fit an expected dose-response curve based well, based on the hypothesis that sulphide was the cause of toxicity (Figure 14). Based on a weight of evidence including the TIE study and other data collected, we believe that porewater sulphide was a significant determinant of sediment toxicity..
- **Options Assessment:** The assessment of sediment management options made assumptions regarding possible management needs as part of Harbour re-development. However a key uncertainty in the work carried out was the absence of a defined development project description meaning that our study made generalizations regarding general conditions in the Harbour as a whole, as opposed to answering specific questions regarding potential risks and Disposal at Sea feasibility for defined areas of the Harbour with defined development or management objectives. For Disposal at Sea, the current study provides context, specifically that although some toxicity was observed in sediment and sediment porewater, our results suggest that a scientific rationale could be developed in support of Disposal at Sea. This finding, notwithstanding, the study was not designed to satisfy Disposal at Sea application requirements and therefore, follow up investigation in support of an application, with pre-approval by Environment Canada, would be required. O ne of the main purposes of the sediment risk assessment option would be to reduce

and better understand the influence of this uncertainty on the assessment of potential effects to marine organisms in Ladysmith Harbour. It should be noted that while the methods used are in many ways similar to a sediment risk assessment there is uncertainty because additional lines of evidence that would normally be considered in a sediment risk assessment (*i.e.,* benthic community structure) have not been included. Thus, sediment risk assessment is considered a viable and appropriate next step to address this uncertainty.

5.0 SUMMARY

This report presents the results of the Sediment Investigation for the subtidal zone of Ladysmith Harbour and nearby areas. The overall objective of the sediment investigation was to inform refinement of remedial costs and options, including an assessment of whether ocean disposal or risk assessment might be a viable option (depending on project needs) for potential developers of Ladysmith Harbour. It characterized the degree of sediment contamination in the harbour, the degree to which sediment contamination is bioavailable to marine organisms, and possible causes of toxicity to marine organisms, and then integrated this information to assess the viability of sediment management options.

The feasibility of Disposal at Sea of dredged sediments and risk-based management of sediment contamination were evaluated as these are understood to be elements of a conceivable sediment management strategy for Ladysmith Harbour, depending on the specific project component needs of as yet to be developed concepts for the waterfront.

A Disposal at Sea application for dredged sediments from Ladysmith Harbour would require a program of sampling and analysis developed in consultation with Environment Canada, based on a specified development plan for the Harbour. A preliminary evaluation, based on existing data, was conducted to provide insight into the possible findings of studies carried out to support such an application; however, uncertainty remains because the results of future investigations cannot be predicted with confidence. The results of the evaluation for Disposal at Sea resulted in assignment of areas of the Harbour to one of four categories. The category assignments were as follows:

- **Category 1:** Small portions of the Harbour west of Slack Point and in the northwest corner of the Harbour could be categorized as having conditions favourable for Disposal at Sea, with low uncertainty.
- **Category 2:** More than half of the Harbour could be categorized as having conditions favourable for Disposal at Sea, but uncertainty was considered high due to data gaps regarding sediment toxicity.
- **Category 3:** Less than half of the Harbour was categorized as having conditions potentially unfavourable for Disposal at Sea. Over much of this area uncertainty was considered high due to data gaps regarding contaminant bioavailability and sediment toxicity.
- **Category 4:** In the westernmost corner of the Harbour and an area on the east side of Slack Point, conditions were considered unfavourable and uncertainty was low because observed toxicity to amphipod provides an indication that sediments are likely to fail Disposal at Sea approval guidelines.

The viability of a risk-based management approach was considered to be high for the entire Harbour. A sediment risk assessment for the Harbour could be based on integrating an assessment of benthic invertebrate communities with the chemistry, toxicity and bioavailability data reported herein. One of the main purposes of the sediment risk assessment option would be to reduce and better understand the influence of uncertainty on the assessment of potential effects to marine organisms in Ladysmith Harbour. It should be noted that while the methods used in this study were in many ways similar to a sediment risk assessment, additional lines of evidence that would normally be considered in a sediment risk assessment (*i.e.,* benthic community structure) have not been included. Thus, sediment risk assessment is considered a viable and appropriate next step to address this uncertainty.

6.0 CLOSURE

We trust the information contained in this report is sufficient for your present needs. Should you have any additional questions regarding the project, please do not hesitate to contact the undersigned at 604-296-4200.

GOLDER ASSOCIATES LTD.

ORIGINAL SIGNED

Ryan Stevenson, M.R.M., R.P.Bio.
Environmental Scientist

ORIGINAL SIGNED

Adrian De Bruyn, Ph.D., R.P.Bio
Senior Environmental Scientist

Reviewed by:

ORIGINAL SIGNED

Lee Nikl, M.Sc., R.P.Bio.
Principal

RWS/ADB/LKN/jcc

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440000 440200 440400 440600 440800 441000 441200

5427800 5427600 5427400 5427200 5427000 5426800

N

LEGEND

- Surface Sediment Sample Location (2009 - 2010)
- Surface and Core Sediment Sample Location (2010)
- Core Sediment Sample Location (2010)
- Water Lot Boundary



REFERENCE

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Projection: UTM Zone 10 Datum: NAD 83

125 0 125
SCALE 1:5,000 METRES

PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
2009 - 2010 SEDIMENT SAMPLING LOCATIONS

Golder Associates
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PROJECT No. 09-1436-5008			PHASE No. 5000	
DESIGN	VM	11 May. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011		
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FIGURE 1

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440000 440200 440400 440600 440800 441000 441200

5427800 5427600 5427400 5427200 5427000 5426800

N

LEGEND

Sample Location (2009 - 2010)

- No Exceedances
- Cadmium exceeds Disposal at Sea Lower Level
- One or more metals exceeds PEL or $SedQC_{TS}$
- Water Lot Boundary

NOTE

Metals which exceed the PEL and $SedQC_{TS}$

Site 7A	Site 9A
Copper = 300 ug/g $SedQC_{TS}$ = 130 ug/g PEL = 108 ug/g	Copper = 132 ug/g $SedQC_{TS}$ = 130 ug/g PEL = 108 ug/g

REFERENCE

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PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
INDICATION OF GUIDELINE EXCEEDANCES FOR METALS IN SURFACE SEDIMENTS

Golder Associates
Greater Vancouver Office, B.C.

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DESIGN	VM	11 May. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011		
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FIGURE 2

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440000 440200 440400 440600 440800 441000 441200

5427800 5427600 5427400 5427200 5427000 5426800

N

Ladysmith Harbour

D.L. 650

Block C D.L. 132

D.L. 650

Block A

Block B

Block C

District Lot 2[illegible]

Cowichan

Lot 16G

Rem. Lot 4

Oyster

Plan

District

45800

Ladysmith

Harbour

D. L. 651

Lot 5

Rem. Lot A

Rem. D.L. 138

Park

park

D.L. 6G

Plan VIP71943

Road

Trans Canada Highway

Railway

Statutory Right of Way Plan 45801

Plan 17025

Plan 423RW

Plan VIP72131

Plan 45800

Plan VIP65252

Plan VIP65289

Plan VIP64405

Plan 45801

Plan 45800

Plan VIP66352

1A 2A 3A 4A 5A 6A 7A 8A 9A 10A 11A 12A 13A 14A 15A 16A 17A 18A 19A 20A 21A 22A 23A 24A 25A 26A 27A 28A 29A 30A 31A 32A 33A 34A 35A

2010-07 2010-08 2010-09 2010-10 2010-11 2010-12 2010-13

LEGEND

- Surface Sediment Sample Location (2009 - 2010) *
- Cadmium Contour
- Water Lot Boundary

Distribution of Cadmium

- <0.6 mg/kg (< Lower Level)
- 0.6 - 1.8 mg/kg (> Lower Level and ISQG)
- 1.8 - 3.0 mg/kg
- 3.0 - 4.2 mg/kg
- >4.2 mg/kg (>PEL < SEDQC)

TS

* The surface sediment sample locations include the upper core stratum at 2010-12.

REFERENCE

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Projection: UTM Zone 10 Datum: NAD 83

125 0 125

SCALE 1:5,000 METRES

PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
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TITLE
DISTRIBUTION OF CADMIUM IN SURFACE SEDIMENTS

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Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 5000	
DESIGN	VM	11 May. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011		
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FIGURE 3

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LEGEND

- Surface Sediment Sample Location (2009 - 2010) *
- Copper Contour
- Water Lot Boundary

Distribution of Copper

- <18.7 mg/kg (<ISQG)
- 18.7 - 54 mg/kg
- 54 - 108 mg/kg
- 108 - 130 mg/kg (>PEL)
- >130 mg/kg (>SedQC$_{TS}$)

* The surface sediment sample locations include the upper core stratum at 2010-12.

REFERENCE

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SCALE 1:5,000 METRES

PROJECT
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SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
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TITLE
DISTRIBUTION OF COPPER IN SURFACE SEDIMENTS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 5000	
DESIGN	VM	11 May. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011		
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FIGURE 4

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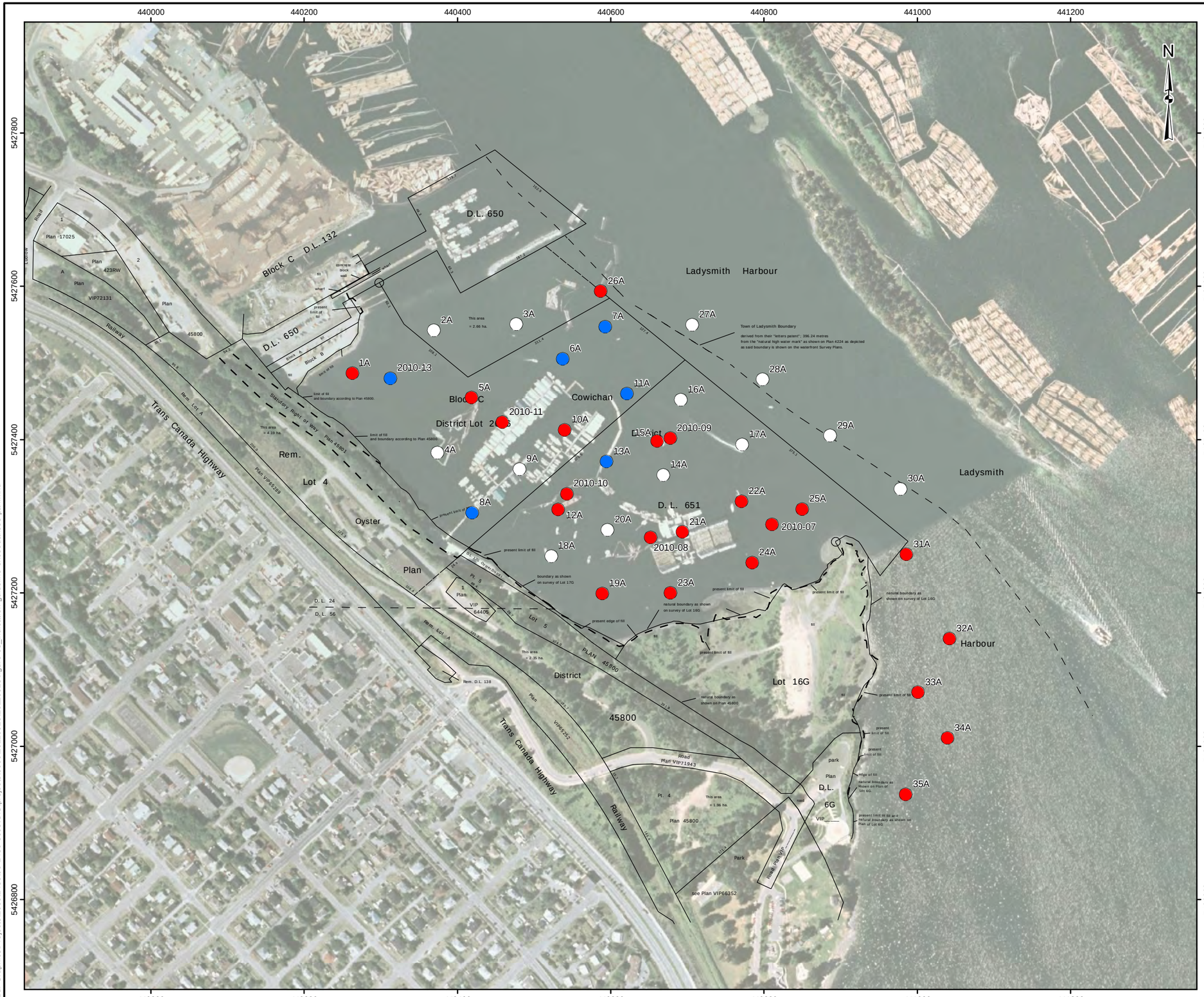

LEGEND

- Water Lot Boundary

Sample Location (2009 - 2010)

- No Exceedances
- Total PAHs exceed the Disposal at Sea Lower Action Level (2.5 mg/Kg)
- Total PAHs exceed the Disposal at Sea Lower Action Level (2.5 mg/Kg) and at least one individual PAH exceeds the $SedQC_{TS}$

Site	PAH with the Maximum Exceedance Factor	$SedQC_{TCS}$ Exceedance Factor
1A	Phenanthrene	3.1
5A	Acenaphthene	2.5
10A	Phenanthrene	1.0
12A	Anthracene	1.8
19A	Phenanthrene	6.9
21A	Acenaphthene	1.8
22A	Phenanthrene	1.8
23A	Phenanthrene	4.9
24A	Phenanthrene	4.0
25A	Phenanthrene	1.5
26A	Phenanthrene	1.2
31A	Phenanthrene	4.3
32A	Phenanthrene	4.3
33A	Phenanthrene	3.2
34A	Phenanthrene	1.5
35A	Phenanthrene	3.7
2010-10	Phenanthrene	1.3
2010-11	Phenanthrene	1.1
2010-09	Phenanthrene	1.8
2010-08	Acenaphthene	2.6
2010-07	Phenanthrene	3.7

* The surface sediment sample locations include the upper core stratum at 2010-12.

REFERENCE

Background image copyright GoogleEarth. Samples and contours created by Golder.
Projection: UTM Zone 10 Datum: NAD 83

125 0 125
SCALE 1:5,000 METRES

PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
INDICATION OF GUIDELINE EXCEEDANCES FOR PAH IN SURFACE SEDIMENTS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 5000	
DESIGN	RS	22 Sep. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011		
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REVIEW				

FIGURE 5

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LEGEND

- Surface Sediment Sample Location (2009 - 2010) *
- Total PAH Contour
- Water Lot Boundary

Distribution of Total PAH

- <2.5 mg/kg (<Lower Level)
- 2.5 - 6.0 mg/kg (>Lower Level)
- 6.0 - 13.0 mg/kg
- 13.0 - 20.0 mg/kg
- >20.0 mg/kg (>SedQCTS)

* The surface sediment sample locations include the upper core stratum at 2010-12.

REFERENCE

Background image copyright GoogleEarth. Samples and contours created by Golder.

Projection: UTM Zone 10 Datum: NAD 83

125 0 125

SCALE 1:5,000 METRES

PROJECT

MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE

DISTRIBUTION OF TOTAL PAHS IN SURFACE SEDIMENTS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 5000	
DESIGN	VM	11 May. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011		
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REVIEW				

FIGURE 6

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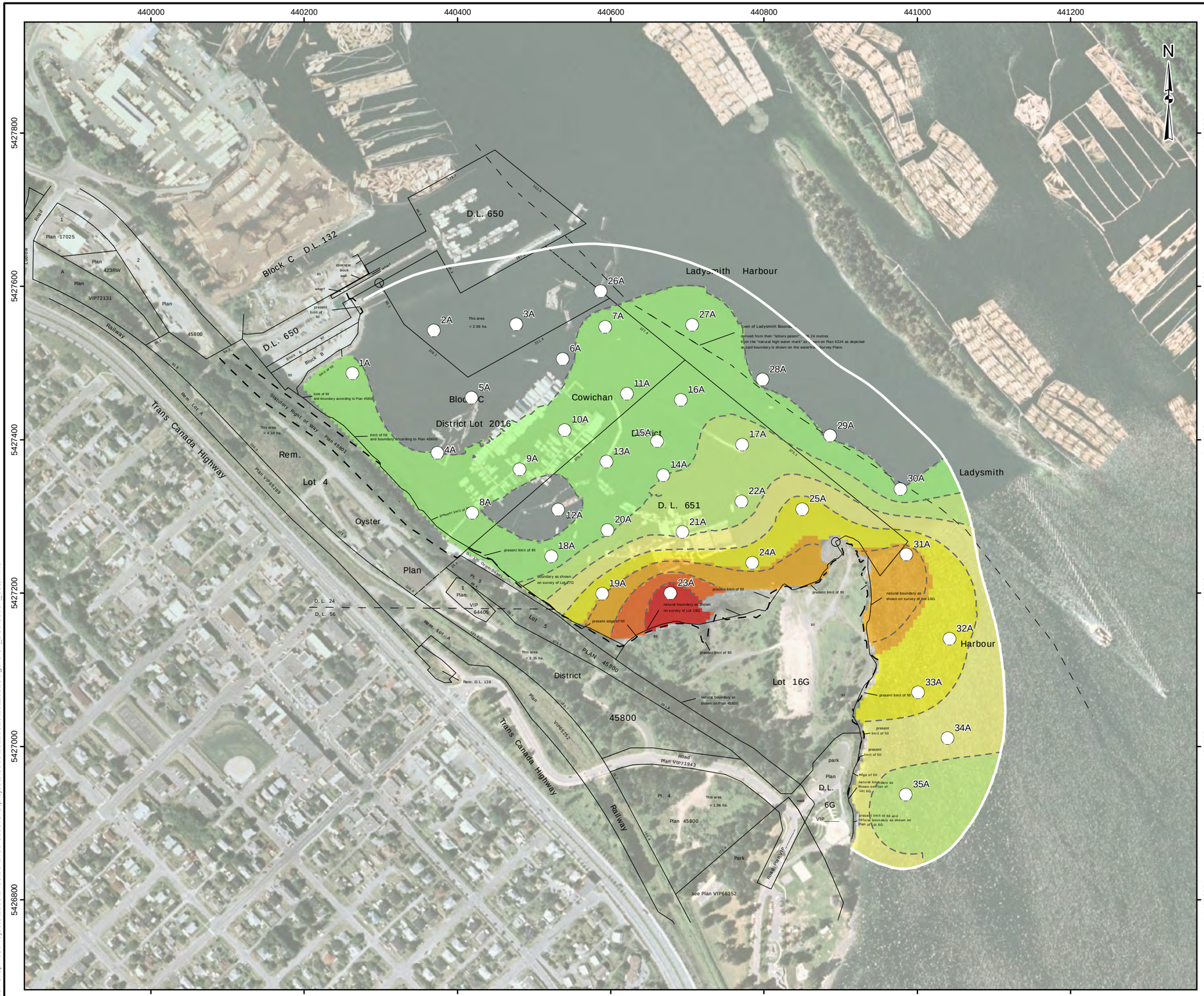

LEGEND

- Surface Sediment Sample Location (2009 - 2010)
- Total PAH Contour
- Water Lot Boundary

Distribution of Coal

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50- 60
- 60 - 70
- 70 - 80

REFERENCE

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Projection: UTM Zone 10 Datum: NAD 83

125 0 125
SCALE 1:5,000 METRES

PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
DISTRIBUTION OF COAL IN SURFACE SEDIMENTS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 5000	
DESIGN	VM	11 May. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011	FIGURE 7	
CHECK				
REVIEW				

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Figure 8: Scatterplots of sediment cadmium, mercury and total PAH concentrations versus sediment coal content

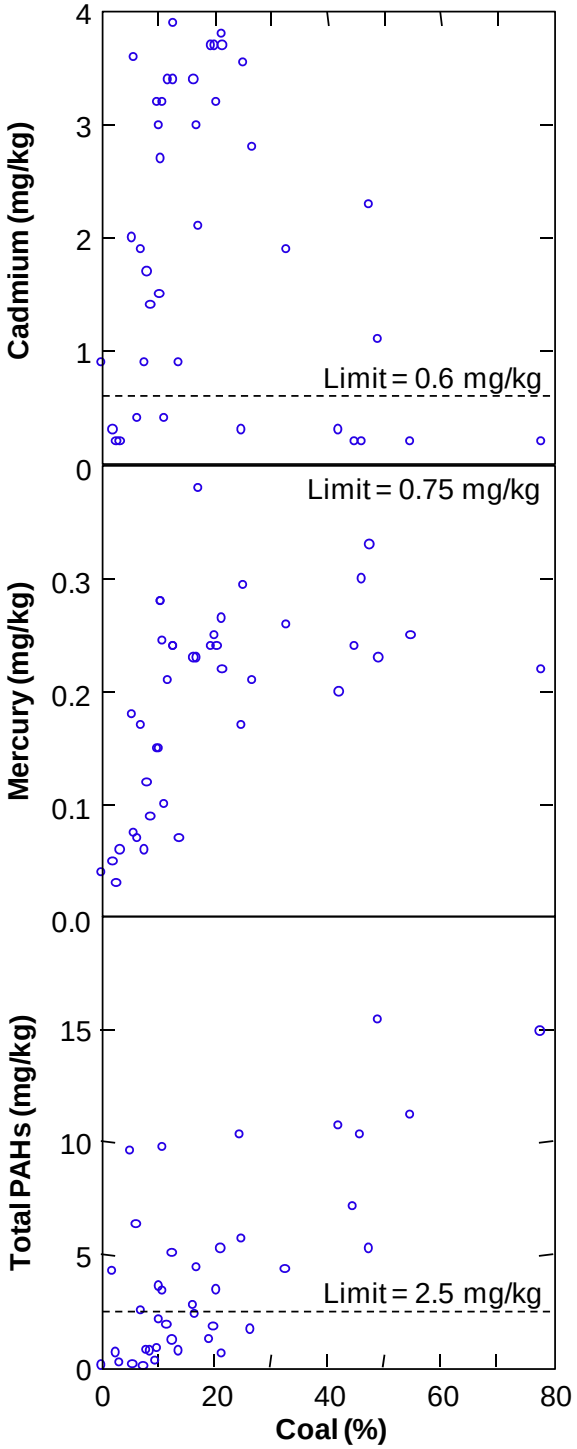
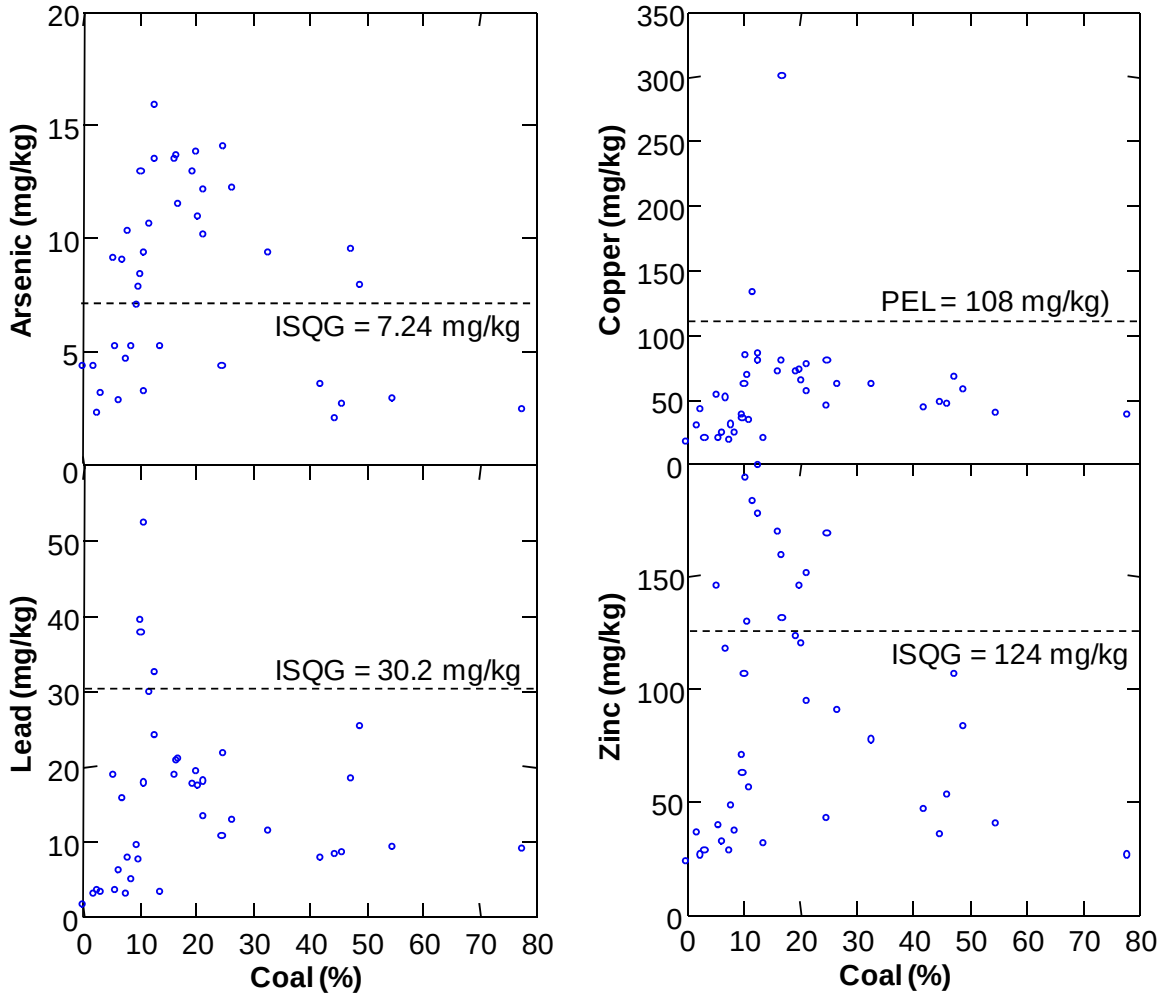


Figure 9: Scatterplots of sediment arsenic, copper, lead and zince concentrations versus sediment coal content



440000 440200 440400 440600 440800 441000 441200

5427800 5427600 5427400 5427200 5427000 5426800

N

Ladysmith Harbour

D.L. 650

Block C D.L. 132

D.L. 650

Block A

Block B

Block C

Cowichan District Lot 2

Rem. Lot 4

Oyster District

Plan 45800

Lot 5

Lot 16G

D. L. 651

Ladysmith Harbour

Plan 45800

Plan VIP71943

Plan VIP66352

Plan VIP52562

Plan VIP52269

Plan 17025

Plan 423RW

Plan VIP72131

Rem. D.L. 138

D. L. 24

D. L. 56

Plan VIP64405

Plan VIP66352

Trans Canada Highway

Railway

Statutory Right of Way Plan 45801

Rem. Lot A

Road Plan VIP71943

Road Plan VIP

Park

Town of Ladysmith Boundary

derived from their "letters patent"; 396.24 metres from the "natural high water mark" as shown on Plan 4224 as depicted as said boundary is shown on the waterfront Survey Plans.

This area = 2.66 ha.

This area = 4.39 ha.

This area = 2.35 ha.

This area = 1.96 ha.

limit of fill and boundary according to Plan 45800.

present limit of fill

present edge of fill

natural boundary as shown on survey of Lot 16G

natural boundary as shown on Plan 45800

natural boundary as shown on Plan of Lot 6G.

present limit of fill and natural boundary as shown on Plan of Lot 6G

concrete block wall

wharf

see Plan VIP66352

1A 2A 3A 4A 5A 6A 7A 8A 9A 10A 11A 12A 13A 14A 15A 16A 17A 18A 19A 20A 21A 22A 23A 24A 25A 26A 27A 28A 29A 30A 31A 32A 33A 34A 35A

2010-07 2010-08 2010-09 2010-10 2010-11 2010-13

LEGEND

Water Lot Boundary

Surface Sediment Location (2009-2010)

Spatial Bioavailability/Sediment Toxicity Findings

Amphipod

Polychaete Echinoderm

Amphipod (Survival)

- Within 20% of Control
- Less than 80% of Control
- Less than 50% of Control
- No Data

Polychaete (Growth and Weight)

- Growth/weight within 20% of control
- Growth/weight less than 80% of control
- Growth/weight less than 50% of control
- No Data

Echinoderm (Fertilization)

- Fertilization within 25% of control
- Fertilization less than 50% of control
- Fertilization less than 75% of control
- No Data

REFERENCE

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Projection: UTM Zone 10 Datum: NAD 83

125 0 125

SCALE 1:5,000 METRES

PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
SPATIAL BIOAVAILABILITY/SEDIMENT TOXICITY FINDINGS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 5000		
DESIGN	VM	19 Aug. 2011	SCALE AS SHOWN		REV. 0
GIS	JP	19 Dec. 2011	FIGURE 10		
CHECK					
REVIEW					

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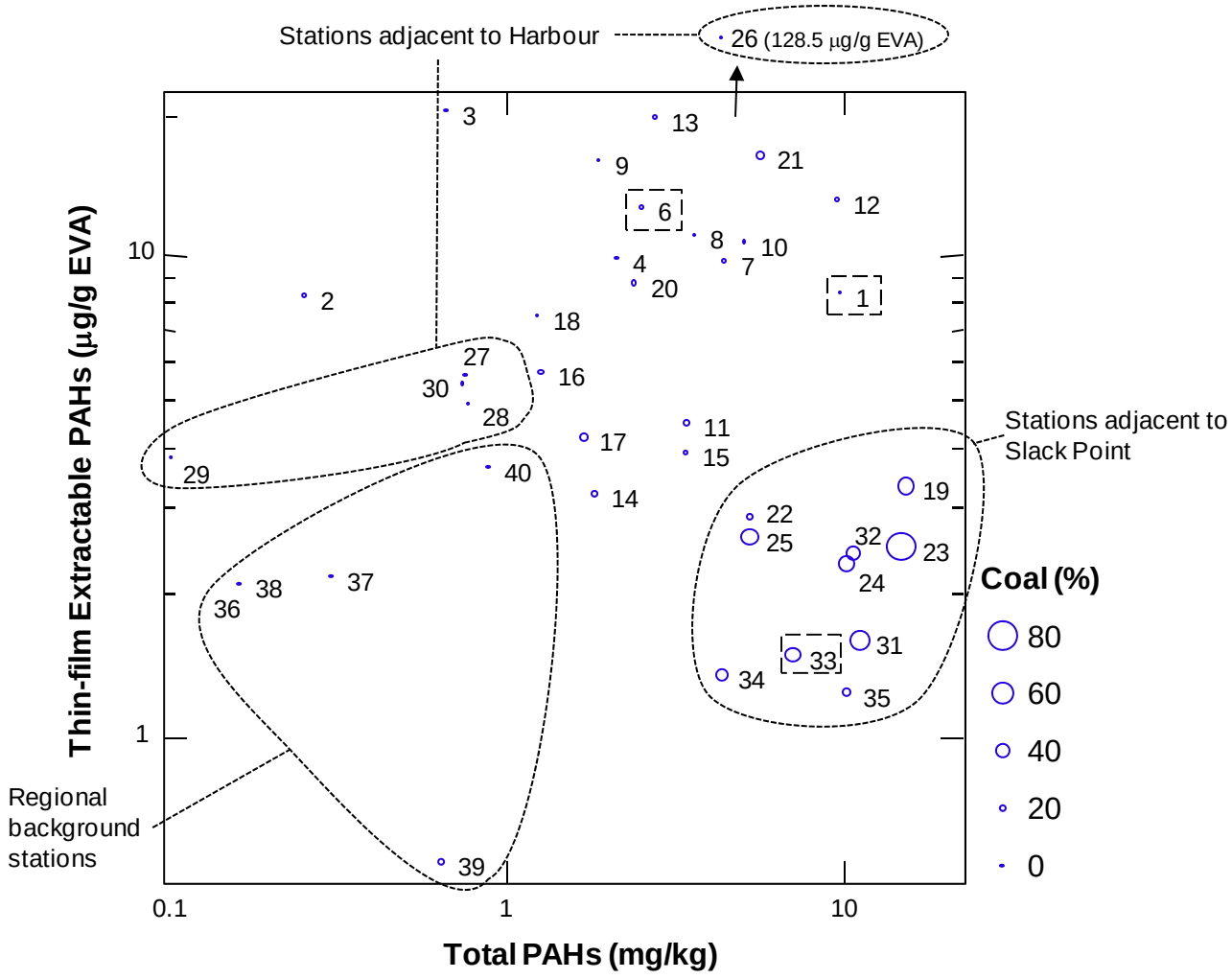
Figure 11: Scatterplots of Total PAHs versus PAH bioavailability versus coal content



Notes:

Dashed box indicates station where toxicity to ampipod or polychaete was observed.

For simplicity, the "A" and "R" suffixes of the Station identifiers has been omitted.

Figure 12: Scatterplots of Key Exposure Indicators for Metals and PAHs, Superimposed with Toxicity Results

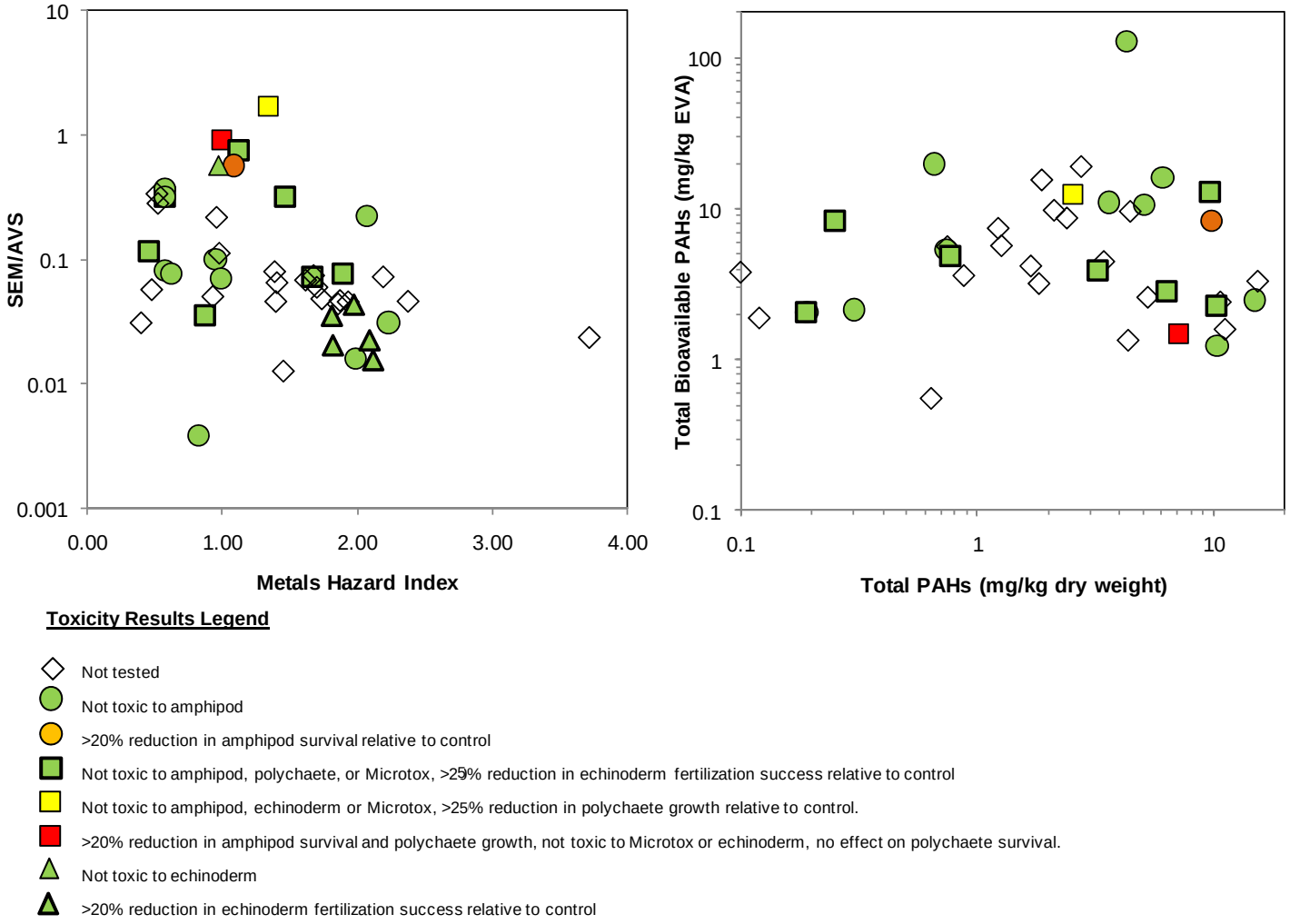
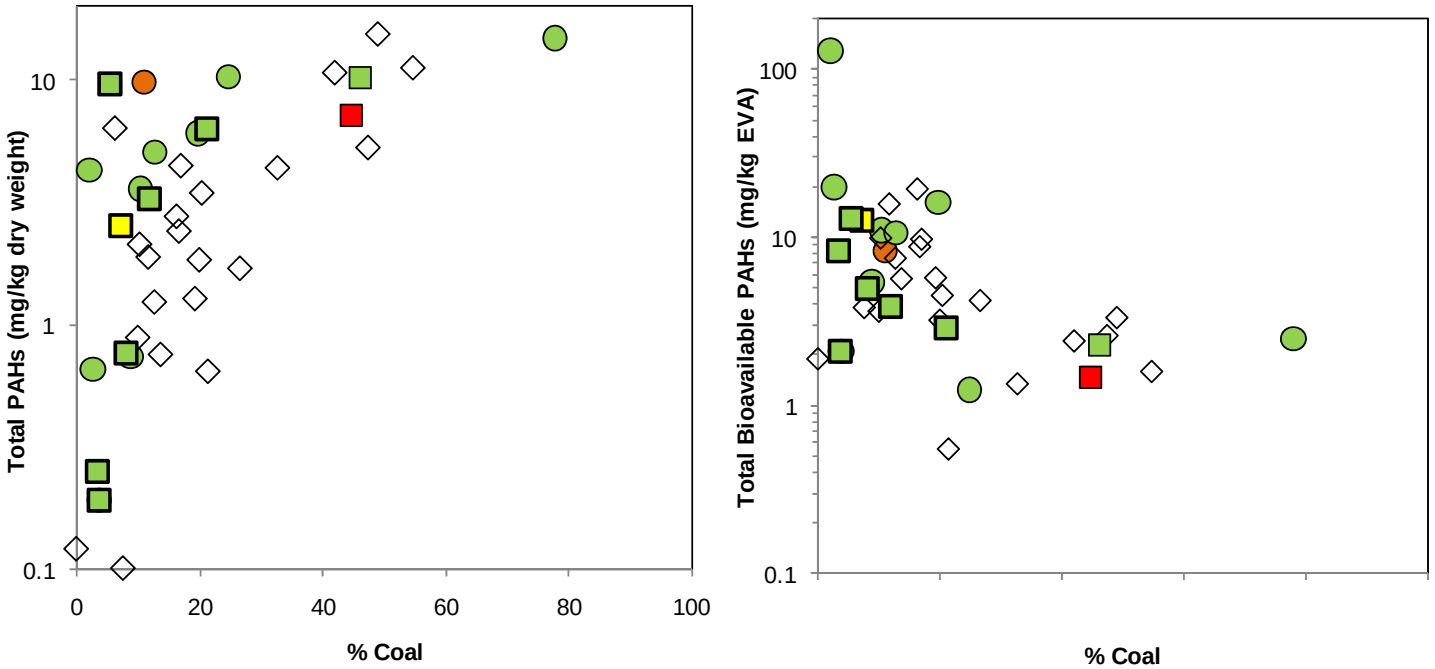


Figure 13: Scatterplots of Key PAH Exposure Indicators with Coal, Superimposed with Toxicity Results



Toxicity Results Legend

- Not tested
- Not toxic to amphipod
- >20% reduction in amphipod survival relative to control
- Not toxic to amphipod, polychaete, or Microtox, >25% reduction in echinoderm fertilization success relative to control
- Not toxic to amphipod, echinoderm or Microtox, >25% reduction in polychaete growth relative to control.
- >20% reduction in amphipod survival and polychaete growth, not toxic to Microtox or echinoderm, no effect on polychaete survival.
- Not toxic to echinoderm
- >20% reduction in echinoderm fertilization success relative to control

Figure 14: Relationships Between Exposure Concentrations of Sulphide and Dissolved Aluminum in Sediment Porewater and Echinoderm Fertilization Success

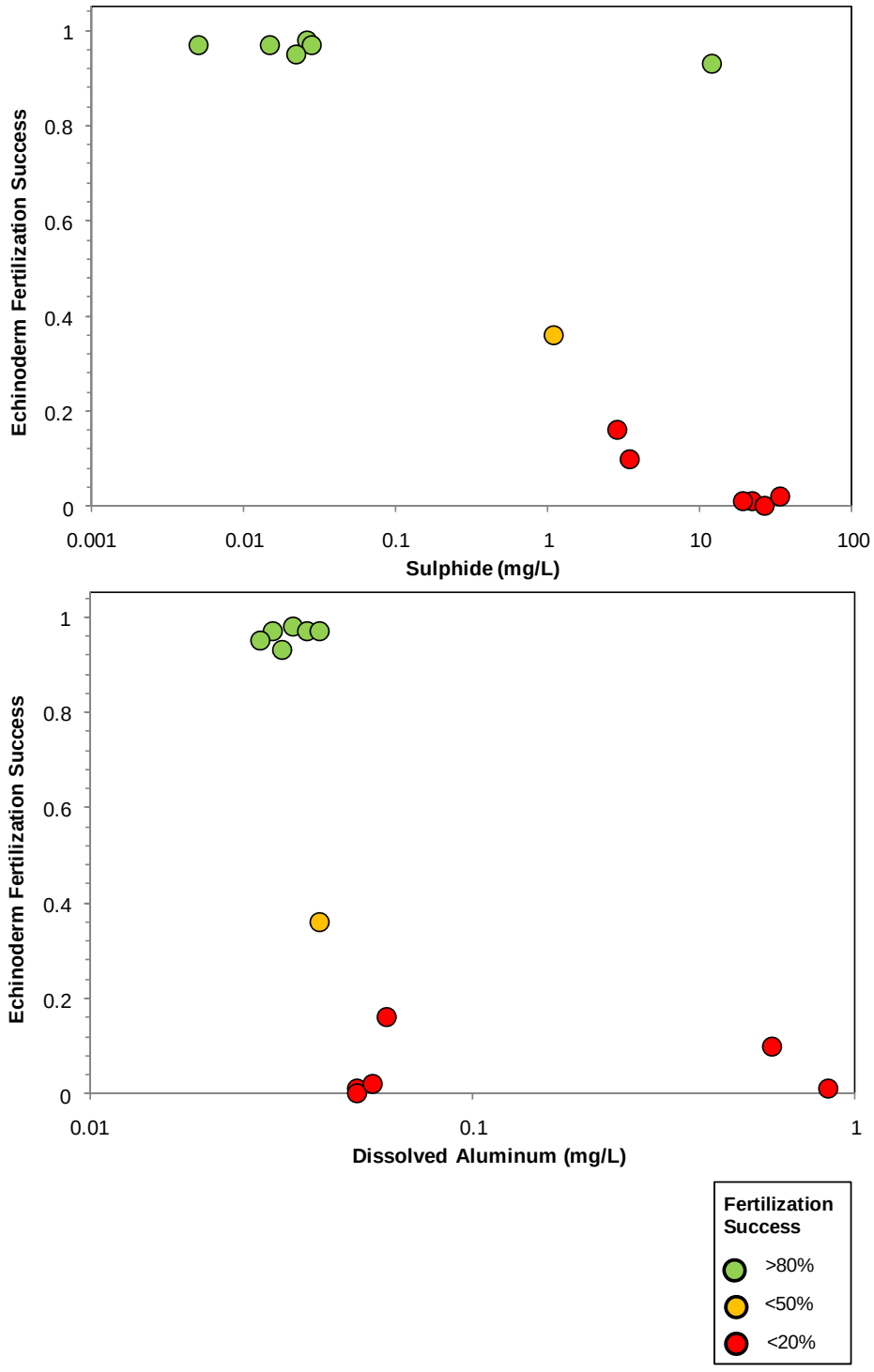
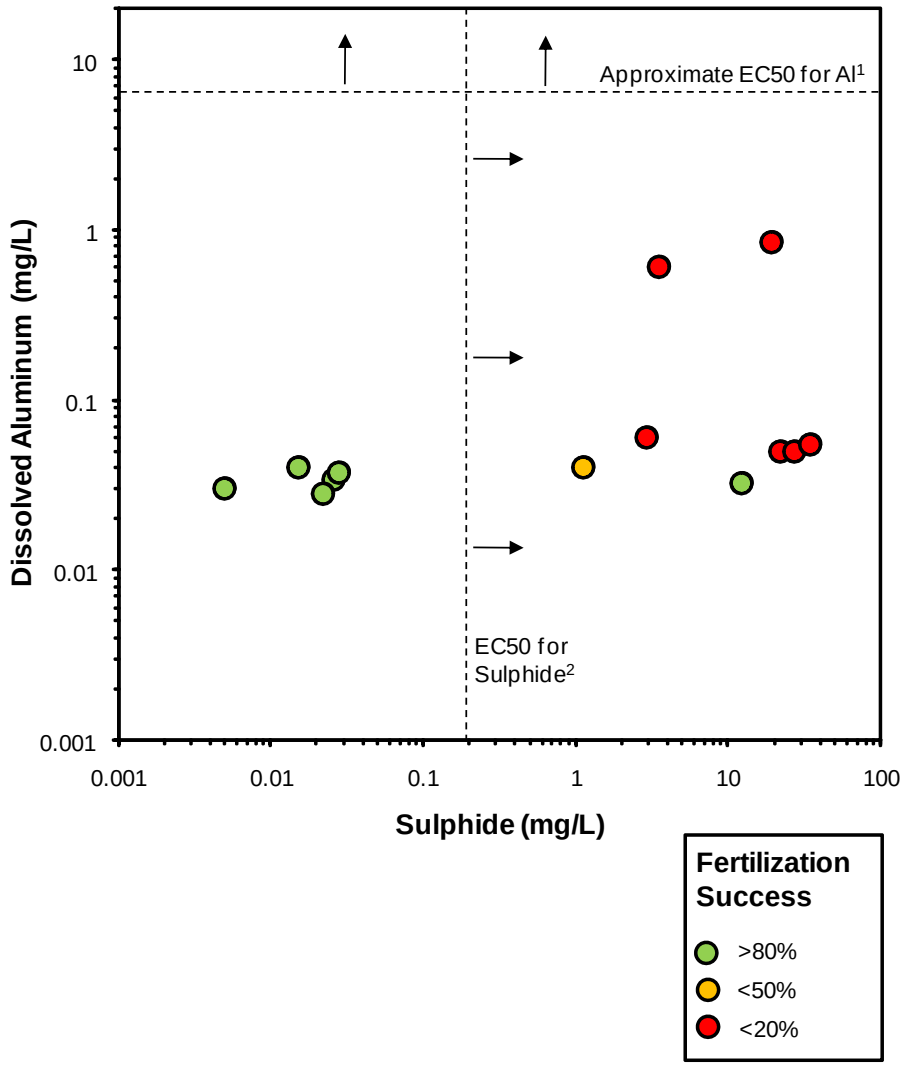


Figure 15: Comparison of Sulphide and Dissolved Aluminum in Sediment Porewater to Echinoderm Toxicity Values and Echinoderm Toxicity Test Results



Notes:

- - - - - Dashed lines indicate toxicity values for porewater aluminum and sulphide

→ Arrows indicate direction above which an increase in toxicity would be expected

[1] Approximate aluminum EC_{50} for *Sphaerechinus granularis* (Pagano *et al.* 1996)

[2] Sulphide EC_{50} for *Strongylocentrotus purpuratus* (Knezovich *et al.* 1996)

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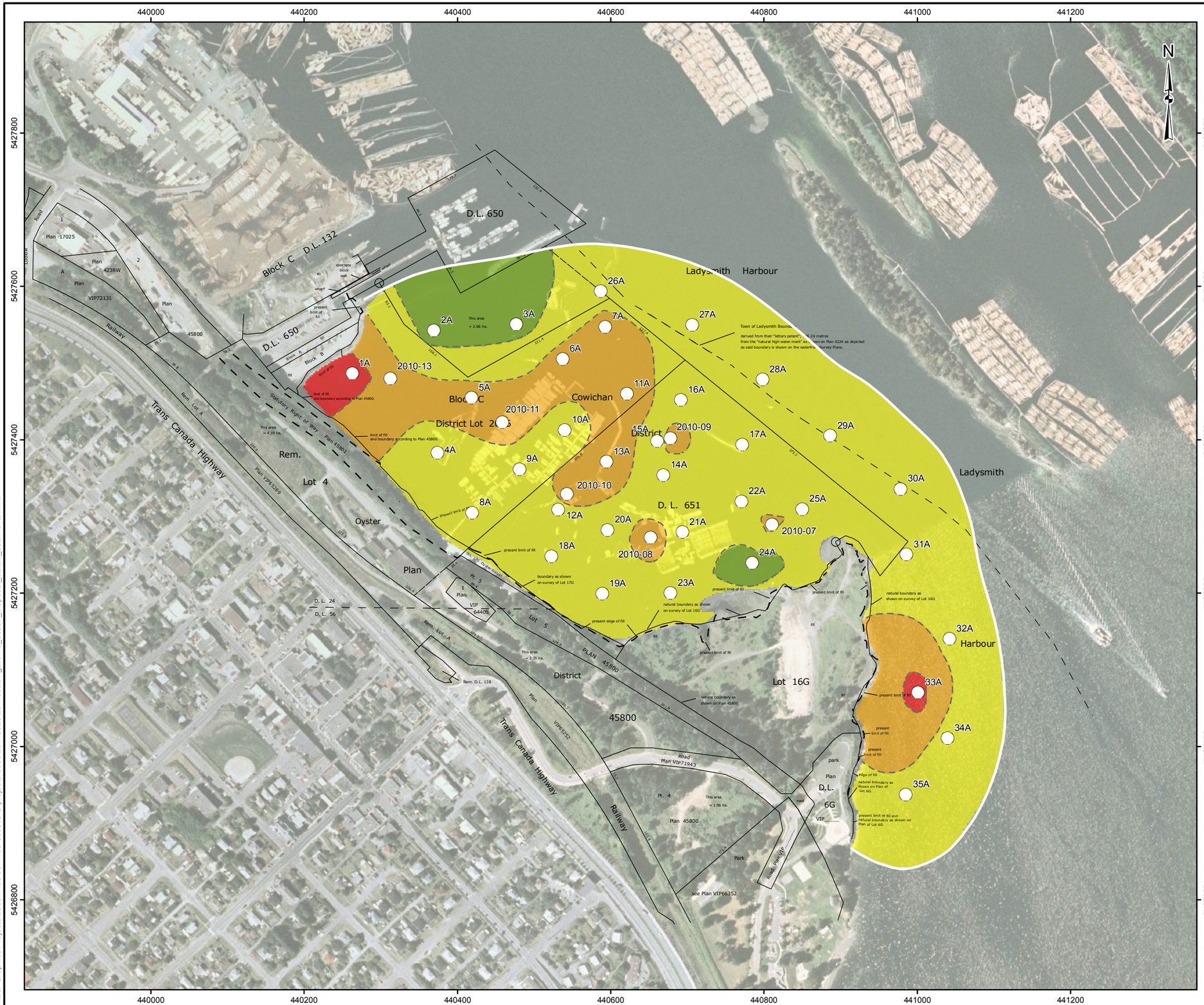

LEGEND

- Water Lot Boundary
- Surface Sediment Location (2009-2010)
- Anticipated Approval Status Contour

Anticipated Approval Status

- Category 4
- Category 3
- Category 2
- Category 1

REFERENCE

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Projection: UTM Zone 10 Datum: NAD 83

125 0 125
SCALE 1:5,000 METRES

PROJECT
MINISTRY OF FORESTS, LANDS AND NATURAL RESOURCE OPERATIONS
SEDIMENT INVESTIGATION AND MANAGEMENT OPTIONS ASSESSMENT
LADYSMITH HARBOUR, LADYSMITH, B.C.

TITLE
LADYSMITH HARBOUR - ANTICIPATED DISPOSAL AT SEA STATUS FOR SURFACE SEDIMENTS

Golder Associates
Greater Vancouver Office, B.C.

PROJECT No. 09-1436-5008			PHASE No. 5000	
DESIGN	VM	19 Aug. 2011	SCALE AS SHOWN	REV. 0
GIS	JP	19 Dec. 2011		
CHECK				
REVIEW				

FIGURE 16

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APPENDIX I

Historical Data

APPENDIX I
Table I-1: Summary of Ladysmith Harbour's Historical Bulk Sediment Chemistry Data
1999-2005

Location Depth (m) Soil Type Date Sampled QA/QC Data Source	Units	CCME Marine Sediment Guideline ISQG [a]	CCME Marine Sediment Guideline PEL [b]	BC CSR Marine Sediment Criteria [c]	Ocean Disposal Lower Action Limits [d]	A3 0-0.15 Grab 8/6/2002 Phoenix[e]	B3 0-0.15 Grab 8/6/2002 Phoenix[e]	B4 0-0.15 Grab 8/6/2002 FDA Phoenix[e]	B4 0-0.15 Grab 8/6/2002 FD Phoenix[e]	C3 0-0.15 Grab 8/6/2002 FDA Phoenix[e]	C3 0-0.15 Grab 8/6/2002 FD Phoenix[e]	C4 0-0.15 Grab 8/6/2002 Phoenix[e]	C5 0-0.15 Grab 8/6/2002 Phoenix[e]	C6 0-0.15 Grab 8/6/2002 Phoenix[e]	D2 0-0.15 Grab 8/6/2002 Phoenix[e]	D3 0-0.15 Grab 8/6/2002 Phoenix[e]	D4 0-0.15 Grab 8/6/2002 Phoenix[e]	D5 0-0.15 Grab 8/6/2002 FDA Phoenix[e]	D5 0-0.15 Grab 8/6/2002 FD Phoenix[e]	D6 0-0.15 Grab 8/6/2002 Phoenix[e]	D7 0-0.15 Grab 8/6/2002 Phoenix[e]	E2 0-0.15 Grab 8/6/2002 Phoenix[e]	E6 0-0.15 Grab 8/6/2002 Phoenix[e]	F1 0-0.15 Grab 8/6/2002 Phoenix[e]	F3 0-0.15 Grab 8/6/2002 FDA Phoenix[e]	F4 0-0.15 Grab 8/6/2002 Phoenix[e]	F5 0-0.15 Grab 8/6/2002 Phoenix[e]	G0 0-0.15 Grab 8/6/2002 FDA Phoenix[e]	G0 0-0.15 Grab 8/6/2002 FD Phoenix[e]	G1 0-0.15 Grab 8/6/2002 Phoenix[e]
TOC (%)	%					4.04	4.43	1.9	2.42	1.65	2.9	7.5	4.38	6.14	0.88	2.39	5.13	2.62	2.65	10.9	26.1	1.86	18.6	1.1	12.3	17	14.4	6.51	4.88	3.96
Organic Matter (%)	%					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH						-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7.4	-	-	-	-	-	-	-
Metals																														
Aluminum	ug/g					12600	9960	12900	12500	9850	9040	11200	10000	10500	9320	8350	9400	7750	7900	9490	3980	8630	9400	9570	7300	7230	9480	5900	7240	8920
Antimony	ug/g					0.5	1.7	<0.3	1	<0.3	0.5	0.6	0.3	0.3	<0.3	<0.3	0.8	0.4	0.6	<0.3	<0.3	0.5	<0.3	0.5	<0.3	<0.3	0.5	<0.3	<0.3	0.8
Arsenic	ug/g	**7.24**	**41.6**	**50**		4.3	**7.59**	3.7	3.3	3.6	3.1	6.67	4	5.3	3.5	3.6	4.4	2.8	3.1	5.86	4.8	3	**10.5**	4.2	6.48	6.95	**8.73**	5.46	5.59	4.1
Barium	ug/g					64	98.9	61.3	64.2	29.7	71.2	114	51.8	68.7	24.9	35.8	68.7	34.3	30.8	48.6	29.7	31.4	45.9	32.2	33.6	33.9	48.4	26.3	32.6	36.5
Beryllium	ug/g					0.15	0.15	0.15	0.16	0.08	0.07	0.15	0.11	0.16	0.07	0.08	0.1	0.07	0.07	0.12	0.08	0.06	0.14	0.08	0.09	0.1	0.13	0.07	0.08	0.08
Bismuth	ug/g					0.6	0.9	0.9	0.7	<0.4	<0.4	0.7	0.5	0.6	0.4	0.7	0.7	0.5	<0.4	1	<0.4	0.4	0.9	0.6	<0.4	<0.4	0.7	<0.4	<0.4	<0.4
Cadmium	ug/g	**0.7**	**4.2**	**5**	**0.6**	0.41	0.38	0.28	0.28	0.25	0.23	0.56	0.4	0.55	0.19	0.4	0.41	0.55	0.57	**1.14**	**0.85**	0.26	**2.53**	0.28	**0.94**	**1.51**	**1.75**	0.48	**0.63**	0.47
Calcium	ug/g					8160	6660	7340	6870	8790	11600	11550	7590	9170	6960	6290	7150	6020	5530	7250	10600	7170	6990	-	5550	5000	7940	-	-	-
Chromium	ug/g	**52.3**	**160**	**190**		22.2	18.3	22.4	19.3	16.4	13.8	24.6	21.6	24.1	13.6	13.4	16.6	13.7	13.8	17.1	10.6	14.1	24.9	18.6	16.3	16	19.4	13.2	16.3	22.8
Cobalt	ug/g					4.95	4.19	4.96	5.01	3.76	3.56	4.81	4.12	3.99	3.59	3.28	3.97	3.05	3.12	3.96	1.87	3.54	3.96	4.02	2.97	2.95	4.04	2.57	3.24	3.82
Copper	ug/g	**18.7**	**108**	**130**		**49.3**	**52.9**	**74.7**	**46**	**26.3**	**21.7**	**63.9**	**35.3**	**45**	**19**	**23.8**	**36.1**	**24.1**	**26**	**71.4**	**51.7**	**22**	**68.8**	**25.3**	**32.4**	**43.2**	**49.3**	**23**	**33.9**	**29.7**
Iron	ug/g					16200	35500	16600	16400	12200	11600	16700	13200	15900	11400	10400	12100	9810	9950	13600	9820	10700	15400	12000	10300	11200	14100	10000	11200	12100
Lead	ug/g	**30.2**	**112**	**130**		**49.8**	**37**	**50.2**	**37.9**	8.54	5.12	**43.8**	18.5	26.9	4.18	9.97	17.6	9.45	9.94	**53.4**	**32.4**	5.24	**36.7**	4.88	10	15.2	21.3	4.62	6.5	4.65
Lithium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	ug/g					5100	4050	5030	5050	4450	4260	5450	4720	5320	4050	3940	4560	3680	3790	5310	4930	4050	7120	4530	4530	4870	6300	3930	4210	4510
Manganese	ug/g					181	134	183	180	153	150	186	158	174	148	129	138	121	121	135	63.2	137	134	150	108	103	138	95.3	118	139
Mercury	ug/g	**0.13**	**0.7**	**0.84**	**0.75**	0.122	0.128	0.091	**0.137**	0.067	0.051	**0.27**	**0.136**	**0.199**	0.047	0.09	**0.128**	0.1	**0.146**	**0.464**	**0.186**	0.066	**0.289**	0.052	**0.14**	**0.183**	**0.202**	**0.221**	0.092	0.07
Molybdenum	ug/g					1.77	1.23	0.69	0.71	0.76	0.72	2.38	1.33	1.59	0.51	1.16	1.09	1.43	1.4	4.16	3.02	0.75	13.6	0.7	5.11	6.77	10.6	1.71	2.53	1.34
Nickel	ug/g					11.2	10.3	11.1	15.7	8.5	7.25	12.4	11	11.4	7.26	7.25	8.84	6.64	9.59	9.88	5.65	7.64	13.3	9.49	8.52	8.65	10.8	6.97	8.27	11
Phosphorus	ug/g					472	514	489	482	398	419	516	462	526	386	335	445	328	329	588	425	383	677	466	481	481	617	506	445	478
Potassium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	ug/g					0.9	1.7	0.6	0.4	0.8	0.5	1.2	0.9	1.4	0.5	0.5	0.5	0.6	0.9	1.3	1	0.4	1.8	0.7	1.2	1	1.5	0.6	0.7	1.2
Silicon	ug/g					137	133	182	219	135	132	98.7	148	106	141	131	110	143	147	122	108	132	129	127	105	130	148	147	144	164
Silver	ug/g					0.08	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	<0.05	0.33	<0.05	<0.05	0.07	<0.05	<0.05	0.52	0.36	<0.05	0.28	<0.05	<0.05	0.1	0.22	<0.05	<0.05	<0.05
Sodium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	ug/g					53.8	47.6	42.3	39.6	44.3	58.7	74.1	42.9	65.4	31.3	35.2	42.8	31.5	30	52.1	90.3	33.3	68.1	143	47.3	44.9	59.6	507	335	320
Sulfur	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thorium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	ug/g					<0.2	<0.2	<0.2	0.6	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	0.5	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tin	ug/g					3.8	2.2	2.6	3.4	1.5	1.6	4	2.8	4	1.4	1.8	2.9	2	2.3	15.5	5	1.6	3.8	1.5	2	2.6	3.2	1.9	1.7	1.4
Titanium	ug/g					-	959	-	-	-	-	1200	1250	1010	-	1190	1230	1150	1110	953	330	1300	651	-	745	654	1010	648	880	1160
Uranium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	ug/g					45.6	37.6	46.6	44.2	38.1	37	44.3	39.4	40.2	35.6	33.5	38.5	31.8	30.5	36.1	20.1	34.9	39.9	38	30.9	31.1	42.1	23.7	31	36.6
Zinc	ug/g	**124**	**271**	**330**		85.3	96.9	72.1	74.4	34.9	32.8	88.3	55.8	78.6	26.4	35.7	53.1	45	42.1	119	117	30.2	**184**	34.6	58	85.3	110	32.8	50.9	41.1
Zirconium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons																														
Naphthalene	ug/g	**0.0346**	**0.391**	**0.47**		**0.28**	-	-	-	-	-	**0.47**	-	-	**0.07**	-	**0.42**	**0.1**	**0.07**	-	-	-	**0.27**	-	**0.32**	-	**0.23**	**0.12**	-	-
Acenaphthene	ug/g	**0.00671**	**0.0889**	**0.11**		**0.07**	-	-	-	-	-	*<0.05*	-	-	<0.05	-	*<0.05*	*<0.05*	*<0.05*	-	-	-	**0.08**	-	<0.05	-	**0.06**	**0.06**	-	-
Acenaphthylene	ug/g	**0.00587**	**0.128**	**0.15**		**0.05**	-	-	-	-	-	**0.06**	-	-	<0.05	-	**0.06**	<0.05	<0.05	-	-	-	**0.12**	-	**0.09**	-	**0.11**	**0.07**	-	-
Fluorene	ug/g	**0.0212**	**0.144**	**0.17**		**0.06**	-	-	-	-	-	**0.1**	-	-	<0.05	-	**0.08**	<0.05	<0.05	-	-	-	**0.12**	-	**0.11**	-	**0.12**	**0.1**	-	-
Phenanthrene	ug/g	**0.0867**	**0.544**	**0.65**		**0.83**	-	-	-	-	-	0.98	-	-	**0.15**	-	**0.59**	**0.21**	**0.17**	-	-	-	**1.02**	-	**0.7**	-	**0.75**	**0.72**	-	-
Anthracene	ug/g	**0.0469**	**0.245**	**0.29**		**0.25**	-	-	-	-	-	**0.27**	-	-	<0.05	-	**0.13**	**0.06**	**0.05**	-	-	-	**0.61**	-	**0.28**	-	**0.47**	**0.3**	-	-
Fluoranthene	ug/g	**0.113**	**1.494**	**1.8**		**1.05**	-	-	-	-	-	**1.08**	-	-	0.07	-	**0.31**	**0.25**	**0.16**	-	-	-	**2.56**	-	**0.66**	-	**1.21**	**2.18**	-	-
Pyrene	ug/g	**0.153**	**1.398**	**1.7**		**1.04**	-	-	-	-	-	**0.86**	-	-	0.06	-	**0.26**	**0.24**	**0.16**	-	-	-	**2.12**	-	**0.64**	-	**1.71**	**1.57**	-	-
Benz(a)anthracene	ug/g	**0.0748**	**0.693**	**0.83**		**0.52**	-	-	-	-	-	**0.39**	-	-	0.05	-	**0.18**	**0.09**	0.06	-	-	-	**0.77**	-	**0.27**	-	**0.65**	**1.5**	-	-
Chrysene	ug/g	**0.108**	**0.846**	**1**		**0.56**	-	-	-	-	-	**0.47**	-	-	0.05	-	**0.18**	**0.13**	0.07	-	-	-	**0.99**	-	**0.31**	-	**1.16**	**1.03**	-	-
Benzo(b)fluoranthene	ug/g					0.25	-	-	-	-	-	0.14	-	-	<0.05	-	0.07	0.06	<0.05	-	-	-	0.39	-	0.11	-	0.37	0.27	-	-
Benzo(k)fluoranthene	ug/g					0.22	-	-	-	-	-	0.13	-	-	<0.05	-	0.07	<0.05	<0.05	-	-	-	0.37	-	0.11	-	0.31	0.26	-	-
Benzo(a)pyrene	ug/g	**0.0888**	**0.763**	**0.92**		**0.49**	-	-	-	-	-	**0.26**	-	-	<0.05	-	**0.1**	0.06	<0.05	-	-	-	**0.39**	-	**0.15**	-	**0.49**	**0.25**	-	-
Indeno(1,2,3-c,d)pyrene	ug/g					0.57	-	-	-	-	-	0.24	-	-	<0.05	-	0.08	<0.05	<0.05	-	-	-	0.32	-	0.13	-	0.37	0.17	-	-
Dibenz(a,h)anthracene	ug/g	**0.00622**	**0.135**	**0.16**		0.08	-	-	-	-	-	<0.05	-	-	<0.05	-	<0.05	<0.05	<0.05	-	-	-	<0.05	-	<0.05	-	0.06	<0.05	-	-
Benzo(g,h,i)perylene	ug/g					0.48	-	-	-	-	-	0.25	-	-	<0.05	-	0.08	<0.05	<0.05	-	-	-	0.31	-	0.12	-	0.3	0.14	-	-
Total PAHs	ug/g			**20**	**2.5**	**6.8**	-	-	-	-	-	**5.7**	-	-	0.45	-	**2.61**	1.2	0.74	-	-	-	**10.465**	-	**4**	-	**8.37**	**7.74**	-	-

a - Canadian Council of Ministers of the Environment (CCME) Interim Maine Sediment Quality Guidelines (ISQG); CCME 2001

b - Canadian Council of Ministers of the Environment (CCME) Probable Effect Levels; CCME 2001

c - British Columbia Contaminated Sites Regulations (BC CSR) Typical Marine Sediment Criteria (BC CSR 2011)

d - Environment Canada Disposal at Sea Program; Lower Action Limits, Environment Canada 2011

e - Phoenix Enviornmental Services Ltd. 2002. Sediment Chemistry Investigation Report Ladysmith Harbour Proposed Waterfront Re-Development Ladysmith, B.C. Dated September 2002

f - Levelton Engineering Ltd. 2000. Preliminary Site Investigation Stage I and Stage II Lot 4, Plan 45800, District Lot 8G, Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, BC

g - Levelton Engineering Ltd. 2000. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated October 25, 2000

h - Phoenix Environmental Services Ltd. 1999. Environmental Impact Assessment Report Proposed Ladysmith Marina and Waterfront Development Project Ladysmith, B.C. Dated December 1999

I - G3 Consulting Ltd. 2005. Report on Ladysmith Harbour Foreshore Fill Sampling & Analysis. Dated March 2005

FDA = Field Duplicate Available; FD = Field Duplicate.

Bold and underlined values are equal to or exceed the CCME Marine Sediment Guideline ISQG

Bold and outlined values are equal to or exceed the CCME Marine Sediment Guideline PEL

Bold, yellow highlighted and outlined values are equal to or exceed the BC CSR Marine Sediment Criteria

Bold and blue highlighted values are equal to or exceed the Ocean Disposal Limit

italics values indicate detections limits grater than guideline.

APPENDIX I
Table I-1: Summary of Ladysmith Harbour's Historical Bulk Sediment Chemistry Data
1999-2005

Location Depth (m) Soil Type Date Sampled QA/QC Data Source	Units	CCME Marine Sediment Guideline ISQG [a]	CCME Marine Sediment Guideline PEL [b]	BC CSR Marine Sediment Criteria [c]	Ocean Disposal Lower Action Limits [d]	G8 0-0.15 Grab 8/6/2002 Phoenix[e]	H9 0-0.15 Grab 8/6/2002 FDA Phoenix[e]	H9 0-0.15 Grab 8/6/2002 FD Phoenix[e]	N8 0-0.15 Grab 8/6/2002 FDA Phoenix[e]	N8 0-0.15 Grab 8/6/2002 FD Phoenix[e]	E8 0-0.15 Grab 8/7/2002 FDA Phoenix[e]	E8 0-0.15 Grab 8/7/2002 FD Phoenix[e]	F6 0-0.15 Grab 8/7/2002 Phoenix[e]	F7 0-0.15 Grab 8/7/2002 Phoenix[e]	I8 0-0.15 Grab 8/7/2002 FDA Phoenix[e]	I8 0-0.15 Grab 8/7/2002 FD Phoenix[e]	I9 0-0.15 Grab 8/7/2002 FDA Phoenix[e]	I9 0-0.15 Grab 8/7/2002 FD Phoenix[e]	I10 0-0.15 Grab 8/7/2002 Phoenix[e]	J7 0-0.15 Grab 8/7/2002 Phoenix[e]	J8 0-0.15 Grab 8/7/2002 Phoenix[e]	J9 0-0.15 Grab 8/7/2002 Phoenix[e]	K8 0-0.15 Grab 8/7/2002 Phoenix[e]	K9 0-0.15 Grab 8/7/2002 Phoenix[e]	K10 0-0.15 Grab 8/7/2002 FDA Phoenix[e]	K10 0-0.15 Grab 8/7/2002 FD Phoenix[e]	L8 0-0.15 Grab 8/7/2002 Phoenix[e]	L9 0-0.15 Grab 8/7/2002 Phoenix[e]	M8 0-0.15 Grab 8/7/2002 Phoenix[e]	N7 0-0.15 Grab 8/7/2002 Phoenix[e]	F3 0-0.15 Grab 8/7/2002 FD Phoenix[e]	CJ8 0.5 Core 8/7/2002 Phoenix[e]	CJ8 1.5 Core 8/7/2002 Phoenix[e]	CJ8 2.5 Core 8/7/2002 Phoenix[e]	CN8 0.5 Core 8/7/2002 Phoenix[e]
TOC (%)	%					25.9	30.1	31.4	31.3	34	23.7	23	21.9	29.6	27.3	27.7	22.4	21.9	28.4	19.1	30.4	28.6	43.3	29.5	28.5	-	33.7	26.4	20.1	31.5	11.3	26.2	38.3	44.5	48.6
Organic Matter (%)	%					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH						-	-	-	-	-	-	-	7.4	7.4	7.4	7.4	7.1	-	-	-	7.3	-	-	-	-	-	-	-	7	-	-	-	-	-	-
Metals																																				
Aluminum	ug/g					6570	5830	5470	9750	9410	7210	7500	9160	6590	9060	8480	9660	9170	10700	10900	10200	10900	7750	9170	10100	9780	8540	12000	12800	10600	8080	8870	6260	7870	7470
Antimony	ug/g					0.5	<0.3	0.7	<0.5	<0.5	0.3	<0.3	0.6	<0.3	<0.4	<0.4	<0.5	<0.5	<0.5	0.4	<0.4	<0.5	<0.5	<0.4	0.5	0.6	<0.5	<0.5	<0.3	<0.5	0.4	<0.5	<0.5	<0.5	<0.5
Arsenic	ug/g	7.24	41.6	50		11.4	5.64	6.45	5.7	4.5	8.46	7.56	13	9.83	10.6	11	2.7	2.9	4.8	14.3	9.26	4.7	4.4	3.7	5.7	5.8	3.2	4.7	3.4	4.4	6.11	2.1	2.1	3.5	1.7
Barium	ug/g					33.7	50	46.3	134	181	38.6	34.4	40.7	34.6	78.8	73.6	104	105	125	71.7	106	148	207	113	129	133	171	159	143	191	40.2	210	148	178	224
Beryllium	ug/g					0.13	0.17	0.17	0.37	0.44	0.13	0.12	0.15	0.12	0.21	0.2	0.26	0.29	0.37	0.21	0.28	0.46	0.41	0.31	0.42	0.42	0.41	0.42	0.46	0.43	0.1	0.5	0.28	0.38	0.42
Bismuth	ug/g					<0.4	<0.4	<0.4	<0.7	<0.7	0.4	<0.4	1	0.5	<0.6	0.7	<0.6	<0.6	<0.7	0.8	1	<0.7	<0.7	<0.6	<0.7	<0.7	<0.7	0.7	0.4	<0.7	<0.4	<0.7	<0.7	<0.7	<0.7
Cadmium	ug/g	0.7	4.2	5	0.6	1.78	1.17	1.22	0.44	0.4	1.62	1.5	2.82	1.94	2.17	2.11	0.4	0.36	0.13	3.22	2.08	0.12	0.43	0.65	0.09	0.12	0.13	0.19	0.06	0.48	1.24	0.21	0.44	0.59	0.08
Calcium	ug/g					-	7000	7370	8490	9660	6520	6230	10600	6330	6690	5250	10700	10500	3460	19100	9720	3520	6240	4400	5100	2890	6630	4700	5360	19600	6210	6630	13700	5740	21800
Chromium	ug/g	52.3	160	190		18.1	17.3	20.7	35.3	34.8	17.7	18.1	23.7	18	25.8	23.3	24.8	25.5	32.8	28.7	27.7	35.3	28.1	26	35.7	39.3	34.2	40.3	37.9	36.1	16.8	31.6	22.9	25.6	30
Cobalt	ug/g					2.96	3.27	3.29	5.66	5.41	3.04	3.07	3.92	2.87	4.24	3.97	4.18	4.24	5.65	4.69	4.94	5.55	5.95	4.75	5.33	4.99	5.49	6.49	5.62	6.12	3.29	5.13	4.5	6.1	5.79
Copper	ug/g	18.7	108	130		59.1	57.1	61	53.2	55.9	56.7	56	75.6	56.9	57.4	63.2	39.7	39.2	46.6	67.4	60.3	49.3	43.4	61.3	55.7	50	45.2	66.7	52.4	57.3	40.1	47.4	40.6	45.1	45.4
Iron	ug/g					1400	11500	12000	9570	8590	12800	12600	15100	12000	12300	11300	9240	9070	10600	16400	12700	15700	7100	9530	11700	11000	7600	13300	1270	9230	11700	6450	5750	7310	6110
Lead	ug/g	30.2	112	130		29.2	42.6	59.8	10.6	9.7	32	30	30.3	27.2	20.3	19.6	13.2	13.2	18.6	36.2	19.1	12.2	8.99	25.7	12.6	20.6	13.1	59.9	11.8	11	16	9.34	9.04	10.8	6.42
Lithium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	ug/g					6780	7470	7870	3790	3470	6880	6270	7720	7440	6230	6200	4500	4370	4400	7570	6120	4030	3770	5210	4390	4370	3520	5270	4510	4140	4970	3010	3600	3670	2800
Manganese	ug/g					90.4	82.7	80.4	102	130	104	103	119	88.1	104	102	107	104	164	138	110	134	89.7	98.5	87.7	83.2	77.8	112	150	131	125	75.6	67.8	104	132	
Mercury	ug/g	0.13	0.7	0.84	0.75	0.14	0.176	0.195	0.218	0.223	0.161	0.175	0.261	0.158	0.219	0.217	0.152	0.108	0.264	0.271	0.226	0.161	0.243	0.242	0.141	0.089	0.288	0.3	0.244	0.281	0.147	0.1	0.411	0.243	0.206
Molybdenum	ug/g					13.3	10.2	12.5	1.91	1.77	17.7	15.3	17.4	15.3	11.7	12.3	2.6	2.46	1.29	11.8	11	1.02	2.53	5.38	1.5	2.27	0.67	0.98	0.31	1.01	5.47	1.83	6.38	4.78	0.87
Nickel	ug/g					10	12.9	12.8	29.6	28.3	10.1	10	13	9.82	19.7	18.6	19	19.6	24	15.4	23	27.6	24.8	21	27.8	29.8	26.3	36.6	25	30.4	9.22	25.8	19.3	22.5	26.3
Phosphorus	ug/g					654	538	581	288	280	523	510	728	634	571	552	299	318	454	812	607	290	338	392	276	273	297	434	301	358	568	157	246	279	173
Potassium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	ug/g					1.7	1.3	2.3	1.6	2.1	1.2	1.1	2	1.7	1.7	1.5	<0.4	0.5	0.7	2.3	2.5	1.1	2.1	0.9	<0.4	0.6	3.1	1	0.9	1.7	1	0.8	0.8	1.7	2.9
Silicon	ug/g					122	173	158	283	220	114	134	142	135	254	336	268	277	317	112	206	350	249	229	597	442	357	363	148	268	139	350	344	172	383
Silver	ug/g					0.17	0.07	0.22	<0.10	<0.09	0.3	0.18	0.3	0.18	0.09	<0.08	<0.09	<0.09	<0.09	0.18	0.1	<0.10	<0.10	0.15	<0.10	<0.10	<0.1	<0.09	<0.05	<0.09	<0.05	<0.10	<0.1	<0.09	<0.10
Sodium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	ug/g					247	103	110	86.6	91.8	77.3	71.9	91.2	82.8	85.8	73.9	111	119	78.6	110	96.8	67.9	136	87.6	82.2	65.5	111	87.6	62.2	174	48.4	73.1	113	105	227
Sulfur	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thorium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	ug/g					<0.2	<0.2	<0.2	<0.4	<0.4	<0.2	<0.2	<0.2	<0.2	<0.3	<0.3	<0.4	<0.4	<0.4	0.3	<0.3	<0.4	<0.4	<0.3	<0.4	<0.4	<0.4	<0.4	<0.2	<0.4	<0.2	<0.4	<0.4	<0.04	<0.4
Tin	ug/g					3.4	3.2	4.8	1.8	1.8	3.7	3.6	3.5	6.4	3.3	3.6	2	1.9	1.9	2.4	2.8	1.5	2.3	2.5	1.8	2	2.1	2.3	0.5	1.9	3	1.4	2.5	2.9	2.3
Titanium	ug/g					468	422	422	411	367	503	555	606	450	517	514	530	578	518	628	557	338	452	446	403	415	460	413	177	414	852	360	400	465	404
Uranium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	ug/g					37.5	34.4	36.4	46	50.3	37.5	37.2	43.6	35.2	43.7	44.2	40.9	43.2	51.8	48.8	48.5	49.5	45.3	45.3	49.7	50.2	49.4	53.7	47.1	50.3	33.8	50	40.2	45.2	44.2
Zinc	ug/g	124	271	330		120	105	116	50	50	142	117	162	130	111	107	57.8	83.4	50.2	157	103	68.6	38.3	78.7	113	120	39.2	66.9	46.8	53.6	84.4	40.9	47.6	42.9	26.9
Zirconium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons																																				
Naphthalene	ug/g	0.0346	0.391	0.47		0.34	-	-	3.01	2.57	-	-	0.24	0.25	-	-	2.17	3.38		0.99	-	-	-	-	-	-	3.26	-	-	-	-	-	3.13	2.95	2.63
Acenaphthene	ug/g	0.00671	0.0889	0.11		<0.05	-	-	*<0.05*	*<0.05*	-	-	*<0.05*	*<0.05*	-	-	*<0.05*	*<0.05*		*<0.05*	-	-	-	-	-	-	*<0.05*	-	-	-	-	-	*<0.05*	*<0.05*	*<0.05*
Acenaphthylene	ug/g	0.00587	0.128	0.15		0.1	-	-	*<0.05*	0.23	-	-	0.08	0.07	-	-	0.52	1.32		0.45	-	-	-	-	-	-	0.27	-	-	-	-	-	0.51	0.18	0.17
Fluorene	ug/g	0.0212	0.144	0.17		0.12	-	-	0.5	0.48	-	-	0.13	0.11	-	-	0.59	1.19		0.61	-	-	-	-	-	-	0.59	-	-	-	-	-	0.77	0.41	0.43
Phenanthrene	ug/g	0.0867	0.544	0.65		0.77	-	-	4.5	5.13	-	-	0.72	0.74	-	-	3.83	3.81		2.19	-	-	-	-	-	-	8.09	-	-	-	-	-	5.72	3.23	4.05
Anthracene	ug/g	0.0469	0.245	0.29		0.28	-	-	0.72	0.89	-	-	0.36	0.3	-	-	0.7	0.61		1.08	-	-	-	-	-	-	1.35	-	-	-	-	-	0.99	0.43	0.92
Fluoranthene	ug/g	0.111	1.494	1.8		0.694	-	-	0.72	0.99	-	-	0.95	0.93	-	-	1.72	1.48		1.84	-	-	-	-	-	-	1.12	-	-	-	-	-	1.21	0.55	0.38
Pyrene	ug/g	0.153	1.398	1.7		0.84	-	-	0.7	0.89	-	-	1.2	0.91	-	-	1.26	1.01		2.46	-	-	-	-	-	-	1.21	-	-	-	-	-	1.02	0.5	0.48
Benz(a)anthracene	ug/g	0.0748	0.693	0.83		0.36	-	-	0.71	0.75	-	-	0.42	0.37	-	-	0.51	0.32		1.11	-	-	-	-	-	-	1.06	-	-	-	-	-	0.8	<0.05	0.63
Chrysene	ug/g	0.108	0.846	1		0.36	-	-	0.68	0.75	-	-	0.43	0.41	-	-	0.7	0.43		1.08	-	-	-	-	-	-	1.1	-	-	-	-	-	0.78	<0.05	0.61
Benzo(b)fluoranthene	ug/g					0.13	-	-	0.11	0.1	-	-	0.23	0.13	-	-	0.15	0.12		0.32	-	-	-	-	-	-	0.21	-	-	-	-	-	0.16	0.09	0.11
Benzo(k)fluoranthene	ug/g					0.11	-	-	0.1	0.11	-	-	0.19	0.15	-	-	0.14	0.09		0.28	-	-	-	-	-	-	0.19	-	-	-	-	-	0.15	0.08	0.11
Benzo(a)pyrene	ug/g	0.0888	0.763	0.92		0.19	-	-	0.26	0.25	-	-	0.24	0.2	-	-	0.24	0.18		0.44	-	-	-	-	-	-	0.41	-	-	-	-	-	0.35	0.21	0.26
Indeno(1,2,3-c,d)pyrene	ug/g					0.17	-	-	<0.05	<0.05	-	-	0.19	0.12	-	-	<0.05	<0.05		0.21	-	-	-	-	-	-	<0.05	-	-	-	-	-	<0.05	<0.05	<0.05
Dibenz(a,h)anthracene	ug/g	0.00622	0.135	0.16		<0.05	-	-	<0.05	<0.05	-	-	<0.05	<0.05	-	-	<0.05	<0.05		0.05	-	-	-	-	-	-	<0.05	-	-	-	-	-	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	ug/g					0.13	-	-	0.12	<0.05	-	-	0.11	0.1	-	-	<0.05	<0.05		0.15	-	-	-	-	-	-	<0.05	-	-	-	-	-	0.15	0.08	0.16
Total PAHs	ug/g			20	2.5	4.84	-	-	12.13	13.14	-	-	5.49	4.79	-	-	12.53	13.94		13.26	-	-	-	-	-	-	18.86	-	-	-	-	-	15.74	8.71	10.94

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italics values indicate detections limits grater than guideline.

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Table I-1: Summary of Ladysmith Harbour's Historical Bulk Sediment Chemistry Data
1999-2005

Location Depth (m) Soil Type Date Sampled QA/QC Data Source	Units	CCME Marine Sediment Guideline ISQG [a]	CCME Marine Sediment Guideline PEL [b]	BC CSR Marine Sediment Criteria [c]	Ocean Disposal Lower Action Limits [d]	E6-R1 surface grab 4-Feb-05 G3[i]	E6-R2 surface grab 4-Feb-05 G3[i]	E6-R3 surface grab 4-Feb-05 G3[i]	E6 0-0.05 core 5-Feb-05 G3[i]	E6 1.2-1.25 core 5-Feb-05 G3[i]	E6 2.76-2.8 core 2-Feb-05 G3[i]	F6-R1 surface grab 4-Feb-05 G3[i]	F6-R2 surface grab 4-Feb-05 G3[i]	F6-R3 surface grab 4-Feb-05 G3[i]	F6 0-0.05 core 2-Feb-05 G3[i]	F6 2.04-2.12 core 2-Feb-05 G3[i]	F6 3.85-3.9 core 2-Feb-05 G3[i]	F7-R1 surface grab 4-Feb-05 G3[i]	F7-R2 surface grab 4-Feb-05 G3[i]	F7-R3 surface grab 4-Feb-05 G3[i]	I8-R1 surface grab 4-Feb-05 G3[i]	I8-R2 surface grab 4-Feb-05 G3[i]	I8-R3 surface grab 4-Feb-05 G3[i]	I8 0-0.04 core 2-Feb-05 G3[i]	I8 3.05-3.1 core 2-Feb-05 G3[i]	I8 5.5-5.55 core 2-Feb-05 G3[i]	J7-R1 surface grab 3-Feb-05 G3[i]	J7-R2 surface grab 3-Feb-05 G3[i]
TOC (%)	%					-	22.2	-	-	-	-	-	30.3	-	-	-	-	-	25.2	-	-	40.3	-	-	-	-	-	-	28.6
Organic Matter (%)	%					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH						7.47	7.06	7.32	7.56	9.02	8.6	6.68	6.91	7.01	6.71	8.56	9.12	6.92	7.32	6.94	7.15	7.04	6.75	7.08	8.78	8.89	7.52	7.54
Metals																													
Aluminum	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	ug/g					<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	ug/g	**7.24**	**41.6**	**50**		**15.3**	**12.9**	**9.8**	**10.5**	6.1	6.4	**12.9**	**15.8**	**12.6**	**8.2**	**9.1**	<5.0	**15.6**	**14.5**	**14.2**	**7.9**	**9.8**	7	6.8	<5.0	<5.0	**13**	**14.3**
Barium	ug/g					40.4	39.1	41.8	34.2	48.2	51.7	22.4	30.7	30.4	14.2	18.7	23.6	42.1	39.1	30.9	62.8	58.5	53.6	75.9	169	135	82.9	54.5
Beryllium	ug/g					<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	ug/g	**0.7**	**4.2**	**5**	**0.6**	**3.28**	**2.58**	**1.2**	**2.59**	<0.10	<0.10	**2.34**	**2.94**	**2.52**	**1.27**	**1.48**	<0.10	**3**	**3.12**	**2.35**	**0.63**	**1.07**	0.59	**0.81**	0.2	0.13	**1.42**	**3.35**
Calcium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromium	ug/g	**52.3**	**160**	**190**		27.4	25.1	18.8	23	21.5	25.1	18.6	21.7	21.2	15.2	15.1	20	24.9	25.8	21.5	18.5	15.2	17.4	16.3	9.2	10.7	24.4	26.1
Cobalt	ug/g					4.8	4.4	3.9	4.4	7.7	9.8	3.2	3.8	3.6	2.8	4.3	6	4.3	4.4	3.8	3.9	3.4	3.8	3.9	4.5	4.4	4.4	4.6
Copper	ug/g	**18.7**	**108**	**130**		**111**	**95.2**	**97.7**	**92.9**	**29.8**	**44.7**	**84.4**	**82.3**	**84.9**	**64**	**16.5**	**22.5**	**80.6**	**83.3**	**75**	**70.2**	**63.3**	**51.4**	**56.2**	**45.3**	**49.6**	**138**	**344**
Iron	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead	ug/g	**30.2**	**112**	**130**		*<50*	*<50*	**82**	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*150*	*<50*
Lithium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	ug/g	**0.13**	**0.7**	**0.84**	**0.75**	**0.287**	**0.354**	**0.359**	**0.749**	0.0493	0.0621	**0.202**	**0.243**	**0.248**	**0.174**	0.0298	0.014	**0.237**	**0.25**	**0.233**	**0.385**	**0.332**	**0.273**	**0.259**	**0.271**	**0.253**	**0.22**	**0.236**
Molybdenum	ug/g					16.3	9.6	<4.0	17.6	<4.0	<4.0	24.8	17	16.9	18.8	9.6	<4.0	18.9	15.8	20.2	<4.0	5.4	4.8	9.7	<4.0	<4.0	10.9	12.5
Nickel	ug/g					19.2	18.4	13.6	17.3	20.1	23.8	15.1	17.5	16.5	11.1	12.3	13.5	19.1	19.5	17	20.7	15.7	18.2	19.2	15.6	16.7	15.2	20.7
Phosphorus	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium	ug/g					<2.0	<2.0	<4.0	<2.0	<2.0	<2.0	<4.0	<3.0	<5.0	<2.0	<2.0	<2.0	<3.0	<3.0	<3.0	<2.0	<4.0	<3.0	<3.0	<2.0	<2.0	<2.0	<2.0
Silicon	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Silver	ug/g					<2.0	<2.0	<2.0	2.4	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium	ug/g																												
Sulfur	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thorium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	ug/g					<5.0	<5.0	<5.0	8.4	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	ug/g					43.5	41.6	36.7	43.9	57.6	58.2	41.8	46.8	43.3	36.2	41.3	77.6	47.6	46.3	45.1	38.9	41.4	35.7	40	32.7	38.7	38.8	46.5
Zinc	ug/g	**124**	**271**	**330**		**209**	**215**	113	**225**	39.9	41	**218**	**192**	**186**	**213**	22.5	23.8	**159**	**179**	**170**	74.6	91	76	84.2	36.9	33.8	**275**	**206**
Zirconium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons																													
Naphthalene	ug/g	**0.0346**	**0.391**	**0.47**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthene	ug/g	**0.00671**	**0.0889**	**0.11**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthylene	ug/g	**0.00587**	**0.128**	**0.15**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	ug/g	**0.0212**	**0.144**	**0.17**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	ug/g	**0.0867**	**0.544**	**0.65**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	ug/g	**0.0469**	**0.245**	**0.29**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	ug/g	**0.113**	**1.494**	**1.8**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	ug/g	**0.153**	**1.398**	**1.7**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benz(a)anthracene	ug/g	**0.0748**	**0.693**	**0.83**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	ug/g	**0.108**	**0.846**	**1**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	ug/g	**0.0888**	**0.763**	**0.92**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	ug/g	**0.00622**	**0.135**	**0.16**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total PAHs	ug/g			**20**	**2.5**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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TOC (%)	%					-	-	-	-	-	-	36.4	-	-	-	-	18.9	-	-	-	-	-	-	-	-	-	-	8.65	8.24	2.81	16.2	18.6	22.4	-
Organic Matter (%)	%					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.4	14.7	5	28.9	33.1	39.8	-
pH						7.33	8.04	8.09	8.04	8.64	7.79	7.22	7.07	8.52	8.61	8.42	8.84	8.57	8.03	7.9	8.1	8	6.4	7.9	7.9	7.45	7.52	7.44	7.68	7.49	7.17	7.48
Metals																																	
Aluminum	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24900	20400	15800	25600	27400	23000	10100
Antimony	ug/g					<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	ug/g	**7.24**	**41.6**	**50**		**13.9**	**12.7**	**8.2**	**9.6**	**8.5**	5.9	**12.3**	**15.6**	6.1	<5.0	<5.0	5.1	<5.0	<5.0	4.5	4.1	4	4.9	6.8	**9**	**13**	<2	**14**	**12**	**19**	**13**	**8**
Barium	ug/g					55.9	59.5	30.9	29.9	42.5	97.9	62	56.6	80.6	86.7	132	93.1	115	142	42.7	23.8	33.8	29.2	30	24	125	94.9	80.6	125	143	102	64.4
Beryllium	ug/g					<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.2	0.1	0.1	0.1	0.2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bismuth	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	<5	<5	<5	<5	<5
Cadmium	ug/g	**0.7**	**4.2**	**5**	**0.6**	**2.97**	**2.34**	**2.55**	**2.25**	<0.10	0.43	**2.31**	**3.48**	<0.10	0.13	<0.10	<0.10	<0.10	0.19	<0.2	<0.2	<0.2	<0.2	0.3	**0.6**	0.4	**0.6**	0.2	**1.8**	**2.4**	**1.7**	**0.9**
Calcium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15400	13600	12500	13600	13900	12700	30000
Chromium	ug/g	**52.3**	**160**	**190**		24	28.8	29.6	28	31.4	16.6	20.8	27.3	28.2	27.2	21.6	25.6	26.4	28.2	19.6	22.8	17	14	19	20	37	30.2	24	32	32	34.6	12.9
Cobalt	ug/g					4.6	5.3	6.1	5.8	10.9	4.3	4.1	5.2	6.3	5.8	5.3	5.6	6.3	6	5.2	4.5	5.1	5.2	5.3	6.3	9.2	7.1	6.9	6.5	6.6	6.7	2.8
Copper	ug/g	**18.7**	**108**	**130**		**81.2**	**83.8**	**31.4**	**29.5**	**36.7**	**55.6**	**72.4**	**91.6**	**61.7**	**65.2**	**72.1**	**63.4**	**64.5**	**69.5**	**34.7**	**54.2**	**40.9**	**35.9**	**62**	**69**	**70.8**	**62.4**	**29.1**	**69.5**	**81.6**	**110**	**76.2**
Iron	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27000	21000	16000	22000	22000	24000	16000
Lead	ug/g	**30.2**	**112**	**130**		*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	*<50*	30	**39**	17	14	**38**	**165**	**47**	30	7	14	24	**99**	**44**
Lithium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20.8	16.5	12.1	22.5	21.2	20.2	5.8
Magnesium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11800	9640	7530	13000	14300	13000	10800
Manganese	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	361	241	213	186	184	205	72.2
Mercury	ug/g	**0.13**	**0.7**	**0.84**	**0.75**	**0.261**	**0.212**	**0.41**	0.0384	0.0324	**0.323**	**0.308**	**0.292**	**0.275**	**0.247**	**0.459**	**0.236**	**0.149**	**0.149**	0.05	**0.54**	<0.05	<0.05	**0.13**	0.1	**0.24**	**0.65**	<0.002	**0.18**	**0.24**	<0.002	<0.002
Molybdenum	ug/g					16.7	16.1	5.1	4.9	<4.0	<4.0	12.1	17.9	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	1.7	2.8	2.5	2.1	2.7	5.8	<1	3	<1	5	6	20	7
Nickel	ug/g					20.5	23.8	21.6	20.5	27.8	21.6	19.3	23.6	40.8	38.5	27.9	34.6	39.1	37.2	15.9	14.7	14	16.4	16	24	19.6	15.8	12.6	18.9	18.6	18.9	8.9
Phosphorus	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	740	568	453	942	1040	792	601
Potassium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3840	3350	2280	5200	6400	4710	2870
Selenium	ug/g					<3.0	<2.0	<3.0	<2.0	<2.0	<2.0	<2.0	<3.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<2	<2	<2
Silicon	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	389	459	618	121	487	295	2910
Silver	ug/g					<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2	<2	<2	<2	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5
Sodium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13600	125800	7500	38100	49700	33000	32800
Strontium	ug/g																			-	-	-	-	-	-	76	67	54	88	98	90	169
Sulfur	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7400	8900	2770	15500	18300	21600	22300
Thorium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	2	1	2	2	<1
Thallium	ug/g																			-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	ug/g					<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<2	<2	<2	<2	<2	<2	8	8	3	1	6	7	6
Titanium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1730	1450	1440	1190	1180	1200	406
Uranium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<5	<5	<5	<5	7	11	15
Vanadium	ug/g					48.9	43.7	48.8	47.7	64	38.6	45.4	54.8	40.9	38.7	44.2	38.2	40.4	44	30.6	30.7	32.9	32.1	28	28	70	60	52	62	59	67	29
Zinc	ug/g	**124**	**271**	**330**		**139**	**140**	40.3	36	49.1	46.9	**125**	**165**	79.4	72.1	41.7	72.1	70.6	65.6	**132**	**134**	98.3	**131**	**130**	**189**	109	104	43.8	115	**167**	**207**	**182**
Zirconium	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.4	7.7	7	7.9	7.4	7.2	2.9
Polycyclic Aromatic Hydrocarbons																																	
Naphthalene	ug/g	**0.0346**	**0.391**	**0.47**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthene	ug/g	**0.00671**	**0.0889**	**0.11**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthylene	ug/g	**0.00587**	**0.128**	**0.15**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	ug/g	**0.0212**	**0.144**	**0.17**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	ug/g	**0.0867**	**0.544**	**0.65**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	ug/g	**0.0469**	**0.245**	**0.29**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluoranthene	ug/g	**0.113**	**1.494**	**1.8**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pyrene	ug/g	**0.153**	**1.398**	**1.7**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benz(a)anthracene	ug/g	**0.0748**	**0.693**	**0.83**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chrysene	ug/g	**0.108**	**0.846**	**1**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(b)fluoranthene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(k)fluoranthene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(a)pyrene	ug/g	**0.0888**	**0.763**	**0.92**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenz(a,h)anthracene	ug/g	**0.00622**	**0.135**	**0.16**		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	ug/g					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total PAHs	ug/g			**20**	**2.5**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

a - Canadian Council of Ministers of the Environment (CCME) Interim Maine Sediment Quality Guidelines (ISQG); CCME 2001

b - Canadian Council of Ministers of the Environment (CCME) Probable Effect Levels; CCME 2001

c - British Columbia Contaminated Sites Regulations (BC CSR) Typical Marine Sediment Criteria (BC CSR 2011)
d - Environment Canada Disposal at Sea Program; Lower Action Limits, Environment Canada 2011

e - Phoenix Enviornmental Services Ltd. 2002. Sediment Chemistry Investigation Report Ladysmith Harbour Proposed Waterfront Re-Development Ladysmith, B.C. Dated September 2002

f - Levelton Engineering Ltd. 2000. Preliminary Site Investigation Stage I and Stage II Lot 4, Plan 45800, District Lot 8G, Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, BC

g - Levelton Engineering Ltd. 2000. Detailed Site Investigation Lot 4, Plan 45800, District Lot 8G, District Lot 11G and Lot 1, Plan VIP64405, Oyster Land District. Ladysmith, B.C. Dated October 25, 2000

h - Phoenix Environmental Services Ltd. 1999. Environmental Impact Assessment Report Proposed Ladysmith Marina and Waterfront Development Project Ladysmith, B.C. Dated December 1999
I - G3 Consulting Ltd. 2005. Report on Ladysmith Harbour Foreshore Fill Sampling & Analysis. Dated March 2005
FDA = Field Duplicate Available; FD = Field Duplicate.

Bold and underlined values are equal to or exceed the CCME Marine Sediment Guideline ISQG
Bold and outlined values are equal to or exceed the CCME Marine Sediment Guideline PEL
Bold, yellow highlighted and outlined values are equal to or exceed the BC CSR Marine Sediment Criteria

Bold and blue highlighted values are equal to or exceed the Ocean Disposal Limit
italics values indicate detections limits grater than guideline.

Table I-2: Summary of Ladysmith Harbour Historical Bulk Sediment Chlorophenol Chemistry Data
2002

Location	CCME Marine Sediment Guideline ISQG a	CCME Marine Sediment Guideline PEL b	BC CSR Marine Sediment Criteria c	Ocean Disposal Lower Action Limits d	A3	B4	B4	D7	F4	F6	J8
SCN					185977-1	185977-52	185977-3	185977-14	185977-19	185977-30	185977-38
Depth (m)					0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15	0-0.15
Soil Type					Grab	Grab	Grab	Grab	Grab	Grab	Grab
Date Sampled					6-Aug-02	6-Aug-02	6-Aug-02	6-Aug-02	6-Aug-02	7-Aug-02	7-Aug-02
QA/QC											
Source					Phoenix[e]	Phoenix[e]	Phoenix[e]	Phoenix[e]	Phoenix[e]	Phoenix[e]	Phoenix[e]
Chlorinated Phenols											
Monochlorophenols					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
dichlorophenols					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Trichlorophenols					<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Tetrachlorophenols				**1**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Pentachlorophenol			**0.69**	**1**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:
Results are expressed in micrograms per gram (ug/g) unless othwise indicated.
a - Canadian Council of Ministers of the Environment (CCME) Interim Maine Sediment Quality Guidelines (ISQG); CCME 2001
b - Canadian Council of Ministers of the Environment (CCME) Probable Effect Levels; CCME 2001
c - British Columbia Contaminated Sites Regulations (BC CSR) Typical Marine Sediment Criteria (BC CSR 2011)
d - Environment Canada Disposal at Sea Program; Lower Action Limits, Environment Canada 2011

e - Phoenix Enviornmental Services Ltd. 2002. Sediment Chemistry Investigation Report Ladysmith Harbour Proposed Waterfront Re-Development Ladysmith, B.C. Dated September 2002

Bold and yellow highlighted values are equal to or exceed the BC CSR Marine Sediment Criteria
Bold and blue highlighted values are equal to or exceed the Ocean Disposal Limit
italics values indicate detections limits grater than guideline.

APPENDIX II

Laboratory Reports

2009 Program

Analysis Report

CANTEST

REPORT ON: Analysis of Soil Samples

REPORTED TO: Golder Associates Ltd.
500-4260 Still Creek Dr
Burnaby, BC
V5C 6C6

Att'n: Adrian deBruyn

CHAIN OF CUSTODY: 16739, 16743, 16746, 16749
PROJECT NUMBER: 09-1436-5008

NUMBER OF SAMPLES: 44

REPORT DATE: December 9, 2009 14:42:59

DATE SUBMITTED: October 22, 2009

GROUP NUMBER: 101030084

SAMPLE TYPE: Soil

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Simultaneously Extractable Metals - analysis was performed using Inductively Coupled Plasma Spectroscopy (ICP), Inductively Coupled Plasma Mass Spectroscopy (ICP/MS) or by other techniques as described.

Acid Volatile Sulphide/Simultaneously Extractable Metals - analysis was performed using procedures based on "Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable Metals in Sediment", U.S. EPA Draft Analytical Method, December 1991. Sulphides in the sample are volatilized by acidification, then trapped in aqueous solution, and measured using gravimetric analysis. The Simultaneously Extractable Metals, liberated from the sample during acidification, are determined using the analysis techniques described.

Mercury - analysis was performed using Cold Vapour Atomic Absorption Spectrophotometry.

Arsenic, antimony, cadmium, lead, selenium - analysis was performed using Inductively Coupled Plasma/Mass Spectroscopy (ICP/MS).

CCME Petroleum Hydrocarbons in Soil - analysis was performed using Canadian Council of Ministers of the Environment (CCME) "Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil" approved December 2000. The method involves extraction of the different hydrocarbon fractions and analysis by gas chromatography with flame ionization detection (GC/FID).

Canada-Wide Standard for Petroleum Hydrocarbons in Soil (F2,F3 and F4 Fractions) - The F2 to F4 Fractions (nC10 to nC50) analysis was performed based on the CCME Reference Method for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil - Tier 1 Method (2001). Analysis involves extraction with50:50 hexane:acetone, silica-gel

(Continued)

CANTEST LTD.

Anna Becalska, PhD
Coordinator, Trace Metals

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

Canada-Wide Standard for Petroleum Hydrocarbons in Soil (F2,F3 and F4 Fractions)

cleanup and quantitation using Gas Chromatography with a Flame Ionization Detector (GC-FID).

Moisture in Soil - analysis was performed gravimetrically by heating a separate sample portion at 105 C and measuring the weight loss.

pH in Soil or Solid - analysis was performed based on procedures described in the "Manual on Soil Sampling and Methods of Analysis" (1993) published by the Canadian Society of Soil Science. The test was performed using a deionized water leach with measurement by pH meter.

Total Organic Carbon - samples were digested in acid then analyzed using a Leco Induction Furnace combustion/volumetric analysis technique.

Polynuclear Aromatic Hydrocarbons - analysis was performed using procedures based on U.S. EPA Methods 625/8270, involving extraction, clean-up steps, and analysis using GC/MS.

Particle Size Analysis - The particle size distribution is determined in accordance with Methods of Soil Analysis Part 1-Physical and Mineralogical Methods(2nd Ed), UBC Methods Manual for Soil Analysis(1981) and Soil Sampling and Methods of Analysis(1993). The % gravel, sand, silt and clay are determined by a combination of a standard dry sieve, wet sieve and pipetting techiques. Particle size limits used to define size fractions are based according to Canadian Soil Survey Committee(CSSC) and U.S. Department of Agriculture(USDA) classification scheme. Winnipeg Lab D-675 Berry St. Wpg, MB R3H1A7

CSSC Textural Category - C = Clay, S = Sand, SI = Silt, L = Loam, CL = Clay Loam, SC = Sandy Clay, SIL = Silt Loam, SIC = Silty Clay, LS = Loamy Sand, SL = Sandy Loam, HC = Heavy Clay, SCL = Sandy Clay Loam, SICL = Silty Clay Loam.Performed at Cantest Ltd Winnipeg, Unit-D Berry St, Winnipeg, Manitoba R3H 1A7.

Silver in Soil - analysis was performed using Inductively Coupled Plasma Mass Spectrometry (ICP/MS).

Arsenic in Soil - analysis was performed using Inductively Coupled Plasma Mass Spectrometry (ICP/MS).

Cadmium in Soil - analysis was performed using Inductively Coupled Plasma Mass Spectrometry (ICP/MS).

Mercury in Soil - analysis was performed using Cold Vapour Atomic Fluorescence.

Molybdenum in Soil - analysis was performed using an acid digestion followed by determination using Inductively Coupled Plasma Mass Spectrometry (ICP/MS).

Strong Acid Leachable Metals in Soil - analysis was performed using B.C. MOELP Method "Strong Acid Leachable Metals in Soil, Version 1.0". The method involves drying the sample at 60 C, sieving using a 2 mm (10 mesh) sieve and digestion using a mixture of hydrochloric and nitric acids. Analysis was performed using Inductively Coupled Argon Plasma Spectroscopy (ICAP) or by specific techniques as described.

(Continued)

Selenium in Soil - analysis was using Inductively Coupled Plasma Mass Spectrometry (ICP/MS).

Thallium in Soil - analysis was performed using Inductively Coupled Plasma Mass Spectrometry (ICP/MS).

Particle Size Analysis - Standard - This analysis is appropriate for most samples. These particle size limits are used to define the size fractions: gravel, coarse to medium sand, fine sand, silt and clay, according to the CSSC and USDA Classification schemes. Soil testure is determined according to CSSC definition of texture. The size fractions that are analyzed are 2.0, 0.250, 0.125, 0.053 and 0.002 mm. The % Sand, % Silt and % Clay are based on the <2mm fraction of the sample by weight. Analysis was performed at CANTEST LTD., Unit "D" 675 Berry Steet, Winnipeg, Manitoba R3H 1A7.

TEST RESULTS:

(See following pages)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Conventional Parameters in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Moisture	Total Organic Carbon C	pH
16739-01	Oct 19/09	910300417	73.1	9.33	6.8
16739-02	Oct 19/09	910300421	74.0	7.72	6.9
16739-03	Oct 19/09	910300422	66.6	11.3	6.9
16739-04	Oct 19/09	910300423	60.4	8.30	7.2
16739-05	Oct 19/09	910300426	15.4	1.14	7.7
16739-06	Oct 19/09	910300429	16.3	1.23	7.6
16739-07	Oct 19/09	910300431	70.1	11.2	6.7
16739-08	Oct 19/09	910300435	67.4	11.0	6.8
16739-09	Oct 19/09	910300436	32.9	1.65	7.3
16743-01	Oct 20/09	910300438	27.0	10.1	7.7
16743-02	Oct 20/09	910300440	20.3	3.43	8.3
16743-03	Oct 20/09	910300442	66.3	28.6	7.0
16743-04	Oct 20/09	910300446	66.7	10.7	6.8
16743-05	Oct 20/09	910300451	16.7	6.03	7.8
16743-06	Oct 20/09	910300455	57.6	43.3	7.3
16743-07	Oct 20/09	910300461	71.5	12.5	7.3
16743-08	Oct 20/09	910300470	20.8	6.03	8.3
16743-09	Oct 20/09	910300475	29.0	1.68	6.9
16743-10	Oct 20/09	910300477	24.5	1.24	7.0
16743-11	Oct 20/09	910300480	17.1	1.31	8.1
16743-12	Oct 20/09	910300482	49.9	8.14	7.0
16746-01	Oct 20/09	910300487	71.5	15.7	6.6
16746-02	Oct 20/09	910300489	71.5	15.8	7.3
16746-03	Oct 21/09	910300493	31.1	1.76	6.7
16746-04	Oct 21/09	910300494	27.5	1.88	7.0
16746-05	Oct 21/09	910300496	14.8	1.12	7.3
16746-06	Oct 21/09	910300497	39.5	2.96	7.1
16746-07	Oct 21/09	910300498	50.0	3.43	7.2
16746-08	Oct 21/09	910300499	60.7	3.91	6.8
16746-09	Oct 21/09	910300500	46.7	4.31	7.2
16746-10	Oct 21/09	910300501	52.6	11.7	6.8
16746-11	Oct 21/09	910300502	69.6	8.82	6.4
16746-12	Oct 21/09	910300503	65.0	9.74	7.1
16749-01	Oct 21/09	910300504	74.3	25.6	6.7
16749-02	Oct 21/09	910300505	74.6	20.6	6.8
16749-03	Oct 21/09	910300506	61.6	25.0	6.9
16749-04	Oct 21/09	910300507	59.0	8.91	6.9
16749-05	Oct 21/09	910300508	60.9	9.71	7.0

(Continued on next page)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Conventional Parameters in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Moisture	Total Organic Carbon C	pH
16749-06	Oct 21/09	910300509	69.6	5.83	6.7
16749-07	Oct 22/09	910300512	27.4	9.80	7.2
16749-08	Oct 22/09	910300513	22.5	9.42	7.2
16749-09	Oct 22/09	910300517	59.0	9.52	6.7
16749-10	Oct 22/09	910300518	22.7	3.17	7.6
16749-11	Oct 22/09	910300519	24.4	2.35	7.4
REPORTING LIMIT			0.1	0.5	0.1
UNITS			%	% dry wt.	pH units

% = percent

% dry wt. = percent, dry weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-01	16739-02	16739-03	16739-04	
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	
CANTEST ID:	910300417	910300421	910300422	910300423	REPORTING LIMIT
ANALYSIS DATE:	Nov 2/09	Nov 8/09	Nov 2/09	Nov 2/09	
Naphthalene	0.17	0.39	0.22	0.13	0.01
2-Methylnaphthalene	0.34	0.61	0.49	0.27	0.05
Acenaphthylene	0.040	0.082	<	0.028	0.005
Acenaphthene	0.053	0.19	0.097	0.049	0.005
Fluorene	0.10	0.28	0.15	0.08	0.01
Phenanthrene	0.42	0.91	0.65	0.32	0.01
Anthracene	0.16	0.53	0.24	0.12	0.01
Total LMW-PAH's	1.27	2.99	1.85	0.98	
Fluoranthene	0.50	2.1	0.85	0.41	0.01
Pyrene	0.69	1.8	0.89	0.44	0.01
Benzo(a)anthracene	0.18	0.87	0.26	0.11	0.01
Chrysene	0.26	0.40	0.42	0.20	0.01
Benzo(b)fluoranthene	0.28	0.64	0.35	0.16	0.01
Benzo(k)fluoranthene	0.10	0.19	0.11	0.05	0.01
Benzo(a)pyrene	0.13	0.30	0.16	0.08	0.01
Indeno(1,2,3-cd)pyrene	0.09	0.13	0.09	0.04	0.01
Dibenz(a,h)anthracene	0.024	0.034	0.019	0.008	0.005
Benzo(g,h,i)perylene	0.08	0.14	0.08	0.03	0.01
Total HMW-PAH's	2.33	6.60	3.22	1.53	
Total PAH's	3.60	9.59	5.08	2.52	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-05	16739-06	16739-07	16739-08	
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	
CANTEST ID:	910300426	910300429	910300431	910300435	REPORTING LIMIT
ANALYSIS DATE:	Nov 2/09	Nov 2/09	Nov 2/09	Nov 2/09	
Naphthalene	0.02	0.07	0.33	0.39	0.01
2-Methylnaphthalene	0.07	0.10	0.58	0.67	0.05
Acenaphthylene	<	0.039	0.042	0.047	0.005
Acenaphthene	0.008	0.074	0.087	0.11	0.005
Fluorene	0.02	0.10	0.14	0.16	0.01
Phenanthrene	0.10	0.80	0.54	0.64	0.01
Anthracene	0.02	0.13	0.12	0.17	0.01
Total LMW-PAH's	0.23	1.31	1.84	2.19	
Fluoranthene	0.15	1.3	0.42	0.40	0.01
Pyrene	0.10	0.76	0.36	0.39	0.01
Benzo(a)anthracene	0.04	0.14	0.10	0.11	0.01
Chrysene	0.07	0.41	0.12	0.12	0.01
Benzo(b)fluoranthene	0.04	0.16	0.15	0.12	0.01
Benzo(k)fluoranthene	0.01	0.06	0.06	0.06	0.01
Benzo(a)pyrene	0.02	0.06	0.08	0.08	0.01
Indeno(1,2,3-cd)pyrene	<	0.04	0.05	0.04	0.01
Dibenz(a,h)anthracene	<	0.007	0.010	0.011	0.005
Benzo(g,h,i)perylene	<	0.03	0.05	0.05	0.01
Total HMW-PAH's	0.42	2.96	1.41	1.38	
Total PAH's	0.66	4.27	3.25	3.57	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

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REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-09	16743-01	16743-02	16743-03	
DATE SAMPLED:	Oct 19/09	Oct 20/09	Oct 20/09	Oct 20/09	
CANTEST ID:	910300436	910300438	910300440	910300442	REPORTING LIMIT
ANALYSIS DATE:	Nov 2/09	Nov 2/09	Nov 2/09	Nov 2/09	
Naphthalene	0.07	0.96	0.87	0.69	0.01
2-Methylnaphthalene	0.15	2.2	2.1	1.3	0.05
Acenaphthylene	0.012	0.13	0.11	0.077	0.005
Acenaphthene	0.015	0.093	0.082	0.18	0.005
Fluorene	0.03	0.23	0.23	0.29	0.01
Phenanthrene	0.16	2.4	2.1	1.2	0.01
Anthracene	0.03	0.37	0.24	0.24	0.01
Total LMW-PAH's	0.46	6.39	5.74	3.98	
Fluoranthene	0.08	0.91	0.17	0.70	0.01
Pyrene	0.07	0.81	0.25	0.61	0.01
Benzo(a)anthracene	0.03	0.49	0.27	0.20	0.01
Chrysene	0.04	0.53	0.27	0.26	0.01
Benzo(b)fluoranthene	0.03	0.38	0.14	0.22	0.01
Benzo(k)fluoranthene	0.01	0.11	0.03	0.09	0.01
Benzo(a)pyrene	0.01	0.27	0.11	0.10	0.01
Indeno(1,2,3-cd)pyrene	<	0.14	0.04	0.07	0.01
Dibenz(a,h)anthracene	<	0.048	0.024	0.017	0.005
Benzo(g,h,i)perylene	0.01	0.18	0.09	0.06	0.01
Total HMW-PAH's	0.28	3.88	1.39	2.33	
Total PAH's	0.74	10.3	7.13	6.31	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-04	16743-05	16743-06	16743-07	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	
CANTEST ID:	910300446	910300451	910300455	910300461	REPORTING LIMIT
ANALYSIS DATE:	Nov 2/09	Nov 4/09	Nov 4/09	Nov 3/09	
Naphthalene	0.35	1.9	0.80	0.58	0.01
2-Methylnaphthalene	0.64	5.0	0.52	0.54	0.05
Acenaphthylene	0.050	<	<	<	0.005
Acenaphthene	0.11	0.25	0.20	0.17	0.005
Fluorene	0.18	0.53	0.24	0.22	0.01
Phenanthrene	0.73	3.2	0.99	0.77	0.01
Anthracene	0.15	0.51	0.33	0.23	0.01
Total LMW-PAH's	2.21	11.4	3.08	2.51	
Fluoranthene	0.49	0.81	0.68	0.82	0.01
Pyrene	0.42	0.79	0.85	0.88	0.01
Benzo(a)anthracene	0.17	0.50	0.34	0.27	0.01
Chrysene	0.28	0.62	0.36	0.34	0.01
Benzo(b)fluoranthene	0.28	0.30	0.28	0.22	0.01
Benzo(k)fluoranthene	0.09	0.05	0.10	0.07	0.01
Benzo(a)pyrene	0.14	0.23	0.22	0.13	0.01
Indeno(1,2,3-cd)pyrene	0.08	<	0.07	0.04	0.01
Dibenz(a,h)anthracene	0.016	<	0.017	0.011	0.005
Benzo(g,h,i)perylene	0.07	0.16	0.08	0.04	0.01
Total HMW-PAH's	2.03	3.46	2.99	2.82	
Total PAH's	4.24	14.9	6.06	5.33	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

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CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-08	16743-09	16743-10	16743-11	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	
CANTEST ID:	910300470	910300475	910300477	910300480	REPORTING LIMIT
ANALYSIS DATE:	Nov 3/09	Nov 3/09	Nov 3/09	Nov 3/09	
Naphthalene	1.4	0.67	0.15	0.02	0.01
2-Methylnaphthalene	3.7	0.64	0.18	0.03	0.02
Acenaphthylene	<	<	<	<	0.005
Acenaphthene	<	0.31	0.27	<	0.005
Fluorene	<	0.46	0.21	<	0.01
Phenanthrene	2.6	2.0	0.60	0.03	0.01
Anthracene	0.33	0.62	0.20	<	0.01
Total LMW-PAH's	8.03	4.70	1.63	0.08	
Fluoranthene	0.38	1.0	2.0	0.06	0.01
Pyrene	0.47	1.3	1.2	0.04	0.01
Benzo(a)anthracene	0.39	0.67	0.42	0.03	0.01
Chrysene	0.46	0.74	0.49	0.03	0.01
Benzo(b)fluoranthene	0.21	0.47	0.30	0.02	0.01
Benzo(k)fluoranthene	0.04	0.17	0.10	<	0.01
Benzo(a)pyrene	0.19	0.45	0.14	<	0.01
Indeno(1,2,3-cd)pyrene	0.04	0.12	0.03	<	0.01
Dibenz(a,h)anthracene	0.023	0.046	0.009	<	0.005
Benzo(g,h,i)perylene	0.10	0.13	0.03	<	0.01
Total HMW-PAH's	2.30	5.09	4.71	0.17	
Total PAH's	10.3	9.79	6.34	0.25	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-12	16746-01	16746-02	16746-03	REPORTING LIMIT
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 21/09	
CANTEST ID:	910300482	910300487	910300489	910300493	
ANALYSIS DATE:	Nov 3/09	Nov 3/09	Nov 3/09	Nov 3/09	
Naphthalene	0.10	0.13	0.07	0.02	0.01
2-Methylnaphthalene	0.17	0.23	0.10	0.04	0.02
Acenaphthylene	<	<	<	<	0.005
Acenaphthene	0.025	0.042	0.033	<	0.005
Fluorene	0.04	0.08	0.05	<	0.01
Phenanthrene	0.22	0.56	0.23	0.04	0.01
Anthracene	0.08	0.13	0.10	<	0.01
Total LMW-PAH's	0.64	1.17	0.59	0.10	
Fluoranthene	0.38	0.85	0.33	0.03	0.01
Pyrene	0.34	0.62	0.45	0.03	0.01
Benzo(a)anthracene	0.15	0.16	0.10	0.02	0.01
Chrysene	0.26	0.29	0.17	0.01	0.01
Benzo(b)fluoranthene	0.15	0.16	0.12	<	0.01
Benzo(k)fluoranthene	0.06	0.06	0.04	<	0.01
Benzo(a)pyrene	0.09	0.08	0.05	<	0.01
Indeno(1,2,3-cd)pyrene	0.02	0.02	0.01	<	0.01
Dibenz(a,h)anthracene	0.007	0.005	<	<	0.005
Benzo(g,h,i)perylene	0.03	0.02	0.01	<	0.01
Total HMW-PAH's	1.48	2.27	1.29	0.09	
Total PAH's	2.12	3.44	1.88	0.19	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-04	16746-05	16746-06	16746-07	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	
CANTEST ID:	910300494	910300496	910300497	910300498	REPORTING LIMIT
ANALYSIS DATE:	Nov 3/09	Nov 3/09	Nov 3/09	Nov 3/09	
Naphthalene	0.02	<	0.07	0.03	0.01
2-Methylnaphthalene	0.03	<	0.16	0.05	0.02
Acenaphthylene	<	<	<	<	0.005
Acenaphthene	<	<	0.017	0.012	0.005
Fluorene	<	<	0.03	0.02	0.01
Phenanthrene	0.03	<	0.15	0.06	0.01
Anthracene	<	<	0.03	0.01	0.01
Total LMW-PAH's	0.08		0.45	0.19	
Fluoranthene	0.02	0.05	0.11	0.05	0.01
Pyrene	0.02	0.04	0.09	0.04	0.01
Benzo(a)anthracene	<	<	0.03	0.01	0.01
Chrysene	<	0.01	0.05	0.01	0.01
Benzo(b)fluoranthene	<	0.01	0.03	<	0.01
Benzo(k)fluoranthene	<	<	<	<	0.01
Benzo(a)pyrene	<	<	0.01	<	0.01
Indeno(1,2,3-cd)pyrene	<	<	<	<	0.01
Dibenz(a,h)anthracene	<	<	<	<	0.005
Benzo(g,h,i)perylene	<	<	<	<	0.01
Total HMW-PAH's	0.04	0.12	0.32	0.11	
Total PAH's	0.13	0.12	0.77	0.30	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-08	16746-09	16746-10	16746-11	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	
CANTEST ID:	910300499	910300500	910300501	910300502	REPORTING LIMIT
ANALYSIS DATE:	Nov 4/09	Nov 6/09	Nov 6/09	Nov 6/09	
Naphthalene	0.06	0.05	0.27	0.13	0.01
2-Methylnaphthalene	0.09	0.10	0.49	0.23	0.05
Acenaphthylene	<	<	<	<	0.005
Acenaphthene	0.026	0.017	0.089	0.028	0.005
Fluorene	0.03	0.03	0.13	0.05	0.01
Phenanthrene	0.12	0.09	0.62	0.20	0.01
Anthracene	0.03	0.03	0.18	0.05	0.01
Total LMW-PAH's	0.35	0.31	1.78	0.69	
Fluoranthene	0.10	0.12	0.67	0.16	0.01
Pyrene	0.08	0.09	0.71	0.13	0.01
Benzo(a)anthracene	0.02	0.07	0.18	0.06	0.01
Chrysene	0.03	0.09	0.36	0.08	0.01
Benzo(b)fluoranthene	0.03	0.07	0.22	0.06	0.01
Benzo(k)fluoranthene	0.02	0.03	0.09	0.02	0.01
Benzo(a)pyrene	0.01	0.05	0.18	0.03	0.01
Indeno(1,2,3-cd)pyrene	<	0.03	0.13	0.02	0.01
Dibenz(a,h)anthracene	<	0.007	0.045	<	0.005
Benzo(g,h,i)perylene	<	0.02	0.09	0.02	0.01
Total HMW-PAH's	0.35	0.57	2.67	0.58	
Total PAH's	0.64	0.88	4.45	1.27	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-12	16749-01	16749-02	16749-03	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	
CANTEST ID:	910300503	910300504	910300505	910300506	REPORTING LIMIT
ANALYSIS DATE:	Nov 6/09	Nov 6/09	Nov 3/09	Nov 9/09	
Naphthalene	0.12	0.15	0.13	1.2	0.01
2-Methylnaphthalene	0.20	0.22	0.20	2.6	0.05
Acenaphthylene	<	<	<	<	0.005
Acenaphthene	0.037	0.084	0.029	0.27	0.005
Fluorene	0.06	0.12	0.04	0.46	0.01
Phenanthrene	0.30	0.41	0.19	4.5	0.01
Anthracene	0.10	0.13	0.06	0.40	0.01
Total LMW-PAH's	0.81	1.12	0.65	9.43	
Fluoranthene	0.64	0.38	0.22	2.6	0.01
Pyrene	0.63	0.39	0.19	1.6	0.01
Benzo(a)anthracene	0.10	0.07	0.03	0.38	0.01
Chrysene	0.21	0.19	0.05	0.64	0.01
Benzo(b)fluoranthene	0.17	0.10	0.05	0.36	0.01
Benzo(k)fluoranthene	0.06	0.03	0.01	0.08	0.01
Benzo(a)pyrene	0.06	0.06	0.02	0.19	0.01
Indeno(1,2,3-cd)pyrene	0.03	0.02	<	0.06	0.01
Dibenz(a,h)anthracene	0.007	0.006	<	<	0.005
Benzo(g,h,i)perylene	0.03	0.03	<	0.10	0.01
Total HMW-PAH's	1.94	1.28	0.58	6.00	
Total PAH's	2.76	2.40	1.23	15.4	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

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CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-04	16749-05	16749-06	16749-07	REPORTING LIMIT
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 22/09	
CANTEST ID:	910300507	910300508	910300509	910300512	
ANALYSIS DATE:	Nov 6/09	Nov 6/09	Nov 6/09	Nov 9/09	
Naphthalene	0.66	0.15	0.16	1.4	0.01
2-Methylnaphthalene	1.3	0.30	0.29	3.9	0.05
Acenaphthylene	<	<	<	<	0.005
Acenaphthene	0.080	0.042	0.046	0.16	0.005
Fluorene	0.16	0.07	0.07	0.37	0.01
Phenanthrene	1.0	0.30	0.30	2.8	0.01
Anthracene	0.18	0.06	0.09	0.34	0.01
Total LMW-PAH's	3.38	0.93	0.96	8.97	
Fluoranthene	0.42	0.22	0.25	0.48	0.01
Pyrene	0.40	0.18	0.21	0.53	0.01
Benzo(a)anthracene	0.22	0.06	0.08	0.31	0.01
Chrysene	0.30	0.09	0.12	0.37	0.01
Benzo(b)fluoranthene	0.22	0.09	0.08	0.17	0.01
Benzo(k)fluoranthene	0.07	0.03	0.03	0.14	0.01
Benzo(a)pyrene	0.12	0.03	0.04	0.12	0.01
Indeno(1,2,3-cd)pyrene	0.07	0.02	0.03	0.03	0.01
Dibenz(a,h)anthracene	0.017	0.006	0.008	<	0.005
Benzo(g,h,i)perylene	0.06	0.03	0.03	0.07	0.01
Total HMW-PAH's	1.89	0.76	0.88	2.23	
Total PAH's	5.28	1.69	1.83	11.2	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-08	16749-09	16749-10	16749-11	
DATE SAMPLED:	Oct 22/09	Oct 22/09	Oct 22/09	Oct 22/09	
CANTEST ID:	910300513	910300517	910300518	910300519	REPORTING LIMIT
ANALYSIS DATE:	Nov 6/09	Nov 6/09	Nov 6/09	Nov 6/09	
Naphthalene	1.5	0.67	<	0.11	0.01
2-Methylnaphthalene	3.9	1.5	0.02	0.24	0.02
Acenaphthylene	<	<	<	<	0.005
Acenaphthene	<	<	<	0.02	0.005
Fluorene	<	<	<	<	0.01
Phenanthrene	2.8	0.98	0.02	0.21	0.01
Anthracene	0.37	0.13	<	0.04	0.01
Total LMW-PAH's	8.57	3.27	0.04	0.38	
Fluoranthene	0.46	0.22	0.02	0.09	0.01
Pyrene	0.51	0.24	0.04	0.09	0.01
Benzo(a)anthracene	0.32	0.15	<	0.04	0.01
Chrysene	0.42	0.17	<	0.05	0.01
Benzo(b)fluoranthene	0.21	0.11	<	0.04	0.01
Benzo(k)fluoranthene	0.07	0.02	<	0.01	0.01
Benzo(a)pyrene	<	0.07	<	0.02	0.01
Indeno(1,2,3-cd)pyrene	<	0.03	<	0.01	0.01
Dibenz(a,h)anthracene	<	0.013	<	<	0.005
Benzo(g,h,i)perylene	0.12	0.05	<	0.02	0.01
Total HMW-PAH's	2.11	1.08	0.06	0.37	
Total PAH's	10.7	4.36	0.10	0.75	

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

CCME Petroleum Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	F2-Napth (C10-C16)	F3-PAH (C16-C34)
16739-01	Oct 19/09	910300417	<	960
16739-02	Oct 19/09	910300421	<	790
16739-03	Oct 19/09	910300422	83	800
16739-04	Oct 19/09	910300423	<	240
16739-05	Oct 19/09	910300426	<	<
16739-06	Oct 19/09	910300429	<	<
16739-07	Oct 19/09	910300431	84	780
16739-08	Oct 19/09	910300435	82	700
16739-09	Oct 19/09	910300436	<	210
16743-01	Oct 20/09	910300438	220	540
16743-02	Oct 20/09	910300440	220	520
16743-03	Oct 20/09	910300442	100	630
16743-04	Oct 20/09	910300446	180	1100
16743-05	Oct 20/09	910300451	230	830
16743-06	Oct 20/09	910300455	150	870
16743-07	Oct 20/09	910300461	170	1100
16743-08	Oct 20/09	910300470	210	560
16743-09	Oct 20/09	910300475	<	250
16743-10	Oct 20/09	910300477	<	180
16743-11	Oct 20/09	910300480	<	<
16743-12	Oct 20/09	910300482	<	450
16746-01	Oct 20/09	910300487	<	<
16746-02	Oct 20/09	910300489	110	690
16746-03	Oct 21/09	910300493	<	<
16746-04	Oct 21/09	910300494	<	110
16746-05	Oct 21/09	910300496	<	<
16746-06	Oct 21/09	910300497	<	120
16746-07	Oct 21/09	910300498	<	140
16746-08	Oct 21/09	910300499	<	160
16746-09	Oct 21/09	910300500	<	230
16746-10	Oct 21/09	910300501	<	370
16746-11	Oct 21/09	910300502	<	400
16746-12	Oct 21/09	910300503	<	440
16749-01	Oct 21/09	910300504	<	490
16749-02	Oct 21/09	910300505	<	240
16749-03	Oct 21/09	910300506	<	270
16749-04	Oct 21/09	910300507	95	330
16749-05	Oct 21/09	910300508	<	270

(Continued on next page)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

CCME Petroleum Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	F2-Napth (C10-C16)	F3-PAH (C16-C34)
16749-06	Oct 21/09	910300509	<	400
16749-07	Oct 22/09	910300512	180	400
16749-08	Oct 22/09	910300513	180	510
16749-09	Oct 22/09	910300517	90	380
16749-10	Oct 22/09	910300518	<	<
16749-11	Oct 22/09	910300519	<	130
REPORTING LIMIT			70	100
UNITS			µg/g	µg/g

µg/g = micrograms per gram, on a dry weight basis.
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

CCME Petroleum Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	F2 (C10-C16) uncorrected	F3 (C16-C34) uncorrected	F4 (C34-C50)
16739-01	Oct 19/09	910300417	<	960	<
16739-02	Oct 19/09	910300421	<	790	<
16739-03	Oct 19/09	910300422	83	800	<
16739-04	Oct 19/09	910300423	<	240	<
16739-05	Oct 19/09	910300426	<	<	<
16739-06	Oct 19/09	910300429	<	<	<
16739-07	Oct 19/09	910300431	84	780	<
16739-08	Oct 19/09	910300435	82	700	<
16739-09	Oct 19/09	910300436	<	210	<
16743-01	Oct 20/09	910300438	220	540	<
16743-02	Oct 20/09	910300440	220	520	<
16743-03	Oct 20/09	910300442	100	630	<
16743-04	Oct 20/09	910300446	180	1100	<
16743-05	Oct 20/09	910300451	230	830	<
16743-06	Oct 20/09	910300455	150	870	<
16743-07	Oct 20/09	910300461	170	1100	<
16743-08	Oct 20/09	910300470	210	560	<
16743-09	Oct 20/09	910300475	<	250	<
16743-10	Oct 20/09	910300477	<	180	<
16743-11	Oct 20/09	910300480	<	<	<
16743-12	Oct 20/09	910300482	<	450	<
16746-01	Oct 20/09	910300487	<	<	<
16746-02	Oct 20/09	910300489	110	690	<
16746-03	Oct 21/09	910300493	<	<	<
16746-04	Oct 21/09	910300494	<	110	<
16746-05	Oct 21/09	910300496	<	<	<
16746-06	Oct 21/09	910300497	<	120	<
16746-07	Oct 21/09	910300498	<	140	<
16746-08	Oct 21/09	910300499	<	160	<
16746-09	Oct 21/09	910300500	<	230	<
16746-10	Oct 21/09	910300501	<	370	<
16746-11	Oct 21/09	910300502	<	400	<
16746-12	Oct 21/09	910300503	<	440	<
16749-01	Oct 21/09	910300504	<	490	<
16749-02	Oct 21/09	910300505	<	240	<
16749-03	Oct 21/09	910300506	<	270	<
16749-04	Oct 21/09	910300507	95	330	<
16749-05	Oct 21/09	910300508	<	270	<

(Continued on next page)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

CCME Petroleum Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	F2 (C10-C16) uncorrected	F3 (C16-C34) uncorrected	F4 (C34-C50)
16749-06	Oct 21/09	910300509	<	400	<
16749-07	Oct 22/09	910300512	180	400	<
16749-08	Oct 22/09	910300513	180	510	<
16749-09	Oct 22/09	910300517	90	380	<
16749-10	Oct 22/09	910300518	<	<	<
16749-11	Oct 22/09	910300519	<	130	<
REPORTING LIMIT			70	100	500
UNITS			µg/g	µg/g	µg/g

µg/g = micrograms per gram, on a dry weight basis.
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16739-01	16739-02	16739-03	16739-04	
DATE SAMPLED:		Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:		910300417	910300421	910300422	910300423	
Acid Volatile Sulphide		12.6	0.8	1.4	1.3	0.2
Cadmium	Cd	0.0028	0.0016	0.0018	0.0025	0.0009
Copper	Cu	<	<	<	<	0.006
Lead	Pb	0.018	0.006	0.006	0.013	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	0.010	0.010	<	0.019	0.009
Zinc	Zn	0.357	0.229	0.291	2.131	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16739-05	16739-06	16739-07	16739-08	
DATE SAMPLED:		Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:		910300426	910300429	910300431	910300435	
Acid Volatile Sulphide		<	1.0	1.8	3.3	0.2
Cadmium	Cd	<	<	0.0024	0.0028	0.0009
Copper	Cu	0.010	<	<	<	0.006
Lead	Pb	<	<	0.005	0.006	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	0.012	<	0.009
Zinc	Zn	0.049	0.060	0.172	0.213	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16739-09	16743-01	16743-02	16743-03	
DATE SAMPLED:		Oct 19/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:		910300436	910300438	910300440	910300442	
Acid Volatile Sulphide		0.7	1.0	<	3.9	0.2
Cadmium	Cd	<	<	<	0.0031	0.0009
Copper	Cu	<	<	0.065	<	0.006
Lead	Pb	<	<	0.013	0.007	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	0.013	<	0.009
Zinc	Zn	0.033	0.079	0.089	0.222	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16743-04	16743-05	16743-06	16743-07	
DATE SAMPLED:		Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:		910300446	910300451	910300455	910300461	
Acid Volatile Sulphide		3.9	16.3	3.2	29.3	0.2
Cadmium	Cd	0.0032	<	0.0022	0.0048	0.0009
Copper	Cu	<	0.012	<	<	0.006
Lead	Pb	0.007	0.005	0.005	0.011	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	<	0.013	0.009
Zinc	Zn	0.277	0.036	0.219	0.430	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16743-08	16743-09	16743-10	16743-11	
DATE SAMPLED:		Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:		910300470	910300475	910300477	910300480	
Acid Volatile Sulphide		0.2	0.2	0.3	0.6	0.2
Cadmium	Cd	<	<	<	<	0.0009
Copper	Cu	0.068	<	<	0.011	0.006
Lead	Pb	0.009	0.016	<	<	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	<	<	0.009
Zinc	Zn	0.062	0.081	0.081	0.043	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16743-12	16746-01	16746-02	16746-03	
DATE SAMPLED:		Oct 20/09	Oct 20/09	Oct 20/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300482	910300487	910300489	910300493	
Acid Volatile Sulphide		1.4	4.5	17.5	0.5	0.2
Cadmium	Cd	<	0.0039	0.0065	0.0028	0.0009
Copper	Cu	<	<	<	<	0.006
Lead	Pb	0.006	0.010	0.027	<	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	0.012	<	0.009
Zinc	Zn	0.083	0.281	0.763	0.051	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16746-04	16746-05	16746-06	16746-07	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300494	910300496	910300497	910300498	
Acid Volatile Sulphide		<	1.6	1.9	3.2	0.2
Cadmium	Cd	0.0021	0.0010	<	0.0055	0.0009
Copper	Cu	<	<	<	0.007	0.006
Lead	Pb	<	<	<	0.011	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	<	<	0.009
Zinc	Zn	0.041	0.029	0.047	0.193	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16746-08	16746-09	16746-10	16746-11	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300499	910300500	910300501	910300502	
Acid Volatile Sulphide		3.2	1.8	6.3	4.5	0.2
Cadmium	Cd	0.0041	0.0015	0.0012	0.0033	0.0009
Copper	Cu	<	<	<	<	0.006
Lead	Pb	0.009	<	<	0.008	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	<	<	0.009
Zinc	Zn	0.182	0.070	0.129	0.193	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16746-12	16749-01	16749-02	16749-03	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300503	910300504	910300505	910300506	
Acid Volatile Sulphide		6.7	8.3	4.8	3.6	0.2
Cadmium	Cd	0.0033	0.0035	0.0029	0.0009	0.0009
Copper	Cu	<	<	<	<	0.006
Lead	Pb	0.008	0.010	0.013	0.012	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	0.016	<	0.009
Zinc	Zn	0.290	0.354	0.313	0.139	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16749-04	16749-05	16749-06	16749-07	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:		910300507	910300508	910300509	910300512	
Acid Volatile Sulphide		2.8	12.7	5.8	0.6	0.2
Cadmium	Cd	0.0019	0.0026	0.0032	<	0.0009
Copper	Cu	<	<	<	<	0.006
Lead	Pb	0.008	0.005	0.008	<	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	<	<	0.009
Zinc	Zn	0.144	0.140	0.231	0.047	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		16749-08	16749-09	16749-10	16749-11	
DATE SAMPLED:		Oct 22/09	Oct 22/09	Oct 22/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:		910300513	910300517	910300518	910300519	
Acid Volatile Sulphide		0.4	2.2	1.1	<	0.2
Cadmium	Cd	<	0.0023	0.0015	0.0009	0.0009
Copper	Cu	<	<	<	<	0.006
Lead	Pb	<	0.006	<	<	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	<	<	<	<	0.009
Zinc	Zn	0.067	0.154	0.042	0.036	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16739-01	16739-02	16739-03	16739-04	
DATE SAMPLED:		Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:		910300417	910300421	910300422	910300423	
Antimony	Sb	0.6	<	<	<	0.1
Arsenic	As	12.9	9.1	15.9	9.0	0.1
Barium	Ba	16	12	24	18	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	2.7	2.0	3.9	1.9	0.2
Chromium	Cr	22	14	25	18	2
Cobalt	Co	4	3	5	4	1
Copper	Cu	84	53	80	51	1
Lead	Pb	37.6	18.8	24.0	15.6	0.2
Mercury	Hg	0.28	0.18	0.24	0.17	0.01
Molybdenum	Mo	18.2	18.2	15.1	11.8	0.1
Nickel	Ni	17	12	20	14	2
Selenium	Se	1.8	1.3	2.1	1.4	0.2
Silver	Ag	0.5	0.2	0.3	0.2	0.1
Thallium	Tl	0.3	0.2	0.4	0.2	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	37	34	40	33	1
Zinc	Zn	193	145	177	117	1
Aluminum	Al	6840	4350	8200	6500	10
Boron	B	141	188	115	94	1
Calcium	Ca	7950	7310	5580	6580	1
Iron	Fe	15100	10700	16700	13000	2
Magnesium	Mg	7410	6930	7570	5970	1
Manganese	Mn	114	74	135	117	1
Phosphorus	P	724	604	792	698	20
Potassium	K	1720	1560	1900	1290	10
Sodium	Na	23400	25200	24100	15900	5
Strontium	Sr	92	87	69	68	1
Titanium	Ti	357	230	376	390	1
Zirconium	Zr	4	3	5	4	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16739-05	16739-06	16739-07	16739-08	
DATE SAMPLED:		Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:		910300426	910300429	910300431	910300435	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	2.3	4.3	9.4	9.2	0.1
Barium	Ba	13	26	25	24	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	<	0.3	3.3	3.1	0.2
Chromium	Cr	12	14	24	24	2
Cobalt	Co	4	5	4	4	1
Copper	Cu	42	29	67	70	1
Lead	Pb	3.5	3.1	18.2	17.2	0.2
Mercury	Hg	0.03	0.05	0.25	0.24	0.01
Molybdenum	Mo	0.3	0.9	15.4	14.7	0.1
Nickel	Ni	10	11	20	20	2
Selenium	Se	0.3	0.3	1.9	1.6	0.2
Silver	Ag	<	<	0.3	0.3	0.1
Thallium	Tl	<	0.3	0.3	0.3	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	24	25	38	38	1
Zinc	Zn	26	36	130	129	1
Aluminum	Al	6060	6780	8300	8250	10
Boron	B	9	8	98	92	1
Calcium	Ca	5710	4550	5370	5500	1
Iron	Fe	9550	11700	14600	14700	2
Magnesium	Mg	3820	4180	7060	6880	1
Manganese	Mn	125	145	133	134	1
Phosphorus	P	419	415	669	662	20
Potassium	K	492	547	1760	1750	10
Sodium	Na	2180	2050	21100	21700	5
Strontium	Sr	25	19	63	63	1
Titanium	Ti	540	517	359	350	1
Zirconium	Zr	1	2	5	5	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16739-09	16743-01	16743-02	16743-03	
DATE SAMPLED:		Oct 19/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:		910300436	910300438	910300440	910300442	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	5.2	4.3	2.1	12.0	0.1
Barium	Ba	22	67	63	37	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	1.4	0.3	<	4.2	0.2
Chromium	Cr	14	21	25	25	2
Cobalt	Co	4	4	4	5	1
Copper	Cu	24	44	47	76	1
Lead	Pb	5.0	10.7	8.3	17.8	0.2
Mercury	Hg	0.09	0.17	0.24	0.26	0.01
Molybdenum	Mo	2.4	1.0	0.4	9.7	0.1
Nickel	Ni	12	21	25	21	2
Selenium	Se	0.5	0.6	0.8	1.8	0.2
Silver	Ag	<	<	0.1	0.3	0.1
Thallium	Tl	0.4	<	<	0.3	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	22	26	22	35	1
Zinc	Zn	37	42	35	162	1
Aluminum	Al	6480	5800	5180	8350	10
Boron	B	27	27	19	72	1
Calcium	Ca	4580	9660	6960	6310	1
Iron	Fe	9320	7440	6070	14300	2
Magnesium	Mg	4170	3410	3140	6340	1
Manganese	Mn	112	97	92	132	1
Phosphorus	P	447	283	180	673	20
Potassium	K	848	1140	841	1640	10
Sodium	Na	7470	4440	2330	17000	5
Strontium	Sr	35	86	82	66	1
Titanium	Ti	454	144	103	361	1
Zirconium	Zr	2	7	6	5	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16743-04	16743-05	16743-06	16743-07	
DATE SAMPLED:		Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:		910300446	910300451	910300455	910300461	
Antimony	Sb	<	<	0.7	<	0.1
Arsenic	As	12.2	2.5	14.3	13.7	0.1
Barium	Ba	37	36	28	31	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	3.4	<	3.7	3.4	0.2
Chromium	Cr	26	14	24	24	2
Cobalt	Co	5	3	5	5	1
Copper	Cu	77	38	77	81	1
Lead	Pb	18.1	8.9	21.6	21.6	0.2
Mercury	Hg	0.27	0.22	0.26	0.33	0.01
Molybdenum	Mo	9.7	1.0	13.8	12.9	0.1
Nickel	Ni	21	15	21	21	2
Selenium	Se	1.8	0.6	2.0	1.9	0.2
Silver	Ag	0.3	<	0.3	0.3	0.1
Thallium	Tl	0.3	<	0.3	0.3	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	35	22	39	38	1
Zinc	Zn	140	26	167	170	1
Aluminum	Al	8710	3030	7920	7810	10
Boron	B	68	46	90	86	1
Calcium	Ca	6100	7890	11200	14500	1
Iron	Fe	14200	3280	17800	17500	2
Magnesium	Mg	6210	2430	6680	6530	1
Manganese	Mn	131	44	136	134	1
Phosphorus	P	688	351	806	792	20
Potassium	K	1600	671	1740	1700	10
Sodium	Na	16500	5100	19000	19400	5
Strontium	Sr	69	159	92	107	1
Titanium	Ti	343	180	328	324	1
Zirconium	Zr	5	5	5	5	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16743-08	16743-09	16743-10	16743-11	
DATE SAMPLED:		Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:		910300470	910300475	910300477	910300480	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	2.7	3.3	2.9	3.2	0.1
Barium	Ba	91	25	17	16	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	<	0.4	0.4	<	0.2
Chromium	Cr	24	12	9	12	2
Cobalt	Co	4	4	3	4	1
Copper	Cu	46	34	24	19	1
Lead	Pb	8.4	52.3	6.0	3.3	0.2
Mercury	Hg	0.30	0.10	0.07	0.06	0.01
Molybdenum	Mo	0.5	1.5	1.8	0.8	0.1
Nickel	Ni	26	10	7	11	2
Selenium	Se	0.6	0.3	0.4	0.3	0.2
Silver	Ag	<	<	<	<	0.1
Thallium	Tl	<	0.1	0.2	0.3	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	23	23	17	22	1
Zinc	Zn	53	56	32	28	1
Aluminum	Al	5850	6140	4020	6500	10
Boron	B	20	15	19	8	1
Calcium	Ca	18300	3010	3430	4970	1
Iron	Fe	7680	10200	7160	10200	2
Magnesium	Mg	3550	3740	2990	4100	1
Manganese	Mn	169	120	90	140	1
Phosphorus	P	191	370	313	550	20
Potassium	K	945	679	551	556	10
Sodium	Na	2930	4200	5110	2460	5
Strontium	Sr	102	24	25	24	1
Titanium	Ti	73	499	403	472	1
Zirconium	Zr	6	2	2	1	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16743-12	16746-01	16746-02	16746-03	
DATE SAMPLED:		Oct 20/09	Oct 20/09	Oct 20/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300482	910300487	910300489	910300493	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	8.4	10.9	10.6	5.6	0.1
Barium	Ba	18	24	33	17	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	1.5	3.2	3.4	3.7	0.2
Chromium	Cr	15	23	21	12	2
Cobalt	Co	3	4	4	3	1
Copper	Cu	61	64	132	20	1
Lead	Pb	39.4	17.4	29.8	3.7	0.2
Mercury	Hg	0.28	0.24	0.21	0.08	0.01
Molybdenum	Mo	5.7	13.3	14.7	3.0	0.1
Nickel	Ni	12	19	17	9	2
Selenium	Se	1.0	1.7	1.8	0.8	0.2
Silver	Ag	0.5	0.3	0.3	<	0.1
Thallium	Tl	0.2	0.3	0.3	0.6	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	26	38	34	18	1
Zinc	Zn	106	120	183	40	1
Aluminum	Al	5790	7870	6750	5400	10
Boron	B	63	101	99	17	1
Calcium	Ca	9230	8220	56700	3980	1
Iron	Fe	12800	14600	13500	8060	2
Magnesium	Mg	5420	6670	6740	3220	1
Manganese	Mn	121	129	110	91	1
Phosphorus	P	562	710	753	863	20
Potassium	K	1170	1730	1690	717	10
Sodium	Na	14700	20800	22600	5690	5
Strontium	Sr	69	72	218	27	1
Titanium	Ti	418	383	297	330	1
Zirconium	Zr	3	5	4	1	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16746-04	16746-05	16746-06	16746-07	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300494	910300496	910300497	910300498	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	4.8	4.3	10.3	7.0	0.1
Barium	Ba	19	14	24	27	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	3.5	0.9	1.7	3.2	0.2
Chromium	Cr	11	10	16	18	2
Cobalt	Co	3	4	4	4	1
Copper	Cu	19	17	30	38	1
Lead	Pb	3.4	1.6	7.7	9.5	0.2
Mercury	Hg	0.07	0.04	0.12	0.15	0.01
Molybdenum	Mo	2.6	1.1	4.7	4.5	0.1
Nickel	Ni	9	9	13	14	2
Selenium	Se	0.7	0.4	1.2	1.0	0.2
Silver	Ag	<	<	0.1	0.2	0.1
Thallium	Tl	0.6	0.6	0.4	0.4	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	16	21	29	25	1
Zinc	Zn	39	23	48	70	1
Aluminum	Al	4730	5920	5820	7440	10
Boron	B	15	6	57	29	1
Calcium	Ca	3640	3790	5040	5830	1
Iron	Fe	7450	8950	11600	11800	2
Magnesium	Mg	3040	3470	5050	4760	1
Manganese	Mn	87	121	111	119	1
Phosphorus	P	725	442	647	648	20
Potassium	K	701	484	984	1140	10
Sodium	Na	5980	2140	9170	10100	5
Strontium	Sr	25	18	44	44	1
Titanium	Ti	305	587	477	410	1
Zirconium	Zr	1	<	3	2	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16746-08	16746-09	16746-10	16746-11	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300499	910300500	910300501	910300502	
Antimony	Sb	<	<	0.6	<	0.1
Arsenic	As	10.1	7.8	11.5	12.9	0.1
Barium	Ba	31	24	28	34	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	3.7	3.0	2.1	3.7	0.2
Chromium	Cr	23	15	31	26	2
Cobalt	Co	4	3	5	5	1
Copper	Cu	56	35	300	71	1
Lead	Pb	13.3	7.6	20.9	17.5	0.2
Mercury	Hg	0.22	0.15	0.38	0.24	0.01
Molybdenum	Mo	6.6	7.5	16.9	9.5	0.1
Nickel	Ni	18	13	25	21	2
Selenium	Se	1.4	1.2	1.3	1.7	0.2
Silver	Ag	0.3	0.2	0.2	0.3	0.1
Thallium	Tl	0.3	0.5	0.3	0.3	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	29	25	33	36	1
Zinc	Zn	94	62	131	123	1
Aluminum	Al	8280	6090	6640	8780	10
Boron	B	38	39	80	63	1
Calcium	Ca	4230	4580	14400	4660	1
Iron	Fe	13900	11000	21200	15200	2
Magnesium	Mg	5970	4380	5800	6600	1
Manganese	Mn	133	110	181	137	1
Phosphorus	P	673	769	591	729	20
Potassium	K	1490	1020	1330	1730	10
Sodium	Na	14400	10100	14400	18900	5
Strontium	Sr	43	37	89	59	1
Titanium	Ti	361	416	358	361	1
Zirconium	Zr	3	2	4	5	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16746-12	16749-01	16749-02	16749-03	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:		910300503	910300504	910300505	910300506	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	13.5	13.6	13.5	7.9	0.1
Barium	Ba	27	21	22	20	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	3.4	3.0	3.4	1.1	0.2
Chromium	Cr	23	24	24	15	2
Cobalt	Co	4	4	4	3	1
Copper	Cu	71	80	85	57	1
Lead	Pb	18.9	20.8	32.4	25.2	0.2
Mercury	Hg	0.23	0.23	0.24	0.23	0.01
Molybdenum	Mo	13.5	15.1	15.7	11.6	0.1
Nickel	Ni	18	19	19	14	2
Selenium	Se	1.8	1.8	1.6	1.1	0.2
Silver	Ag	0.3	0.3	0.3	0.2	0.1
Thallium	Tl	0.3	0.3	0.4	<	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	38	36	35	29	1
Zinc	Zn	169	159	199	83	1
Aluminum	Al	7550	6630	7210	4400	10
Boron	B	109	128	97	109	1
Calcium	Ca	17800	6420	6820	4940	1
Iron	Fe	15300	16300	16200	9950	2
Magnesium	Mg	7020	7420	7900	5760	1
Manganese	Mn	125	121	124	72	1
Phosphorus	P	740	746	766	488	20
Potassium	K	1790	1790	1980	1290	10
Sodium	Na	23000	25000	28100	17300	5
Strontium	Sr	104	84	90	87	1
Titanium	Ti	332	330	333	203	1
Zirconium	Zr	5	4	4	4	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16749-04	16749-05	16749-06	16749-07	
DATE SAMPLED:		Oct 21/09	Oct 21/09	Oct 21/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:		910300507	910300508	910300509	910300512	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	9.5	12.2	13.8	3.0	0.1
Barium	Ba	42	33	30	56	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	2.3	2.8	3.7	0.2	0.2
Chromium	Cr	26	22	25	24	2
Cobalt	Co	5	5	5	4	1
Copper	Cu	67	61	73	39	1
Lead	Pb	18.4	12.8	19.3	9.3	0.2
Mercury	Hg	0.33	0.21	0.25	0.25	0.01
Molybdenum	Mo	7.5	7.8	10.8	1.5	0.1
Nickel	Ni	23	18	20	25	2
Selenium	Se	1.3	1.4	1.8	0.9	0.2
Silver	Ag	0.2	0.2	0.3	<	0.1
Thallium	Tl	0.2	0.3	0.3	<	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	33	32	37	25	1
Zinc	Zn	106	90	145	40	1
Aluminum	Al	6950	7500	7700	5570	10
Boron	B	57	62	76	27	1
Calcium	Ca	5280	6060	4950	7820	1
Iron	Fe	11600	16300	15900	7010	2
Magnesium	Mg	5430	6150	6920	3580	1
Manganese	Mn	117	139	136	103	1
Phosphorus	P	528	679	736	255	20
Potassium	K	1360	1460	1780	984	10
Sodium	Na	11300	15100	20300	3340	5
Strontium	Sr	70	57	60	83	1
Titanium	Ti	280	398	379	131	1
Zirconium	Zr	6	4	5	8	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Strong Acid Soluble Metals in Soil

CLIENT SAMPLE IDENTIFICATION:		16749-08	16749-09	16749-10	16749-11	
DATE SAMPLED:		Oct 22/09	Oct 22/09	Oct 22/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:		910300513	910300517	910300518	910300519	
Antimony	Sb	<	<	<	<	0.1
Arsenic	As	3.6	9.3	4.6	5.2	0.1
Barium	Ba	53	28	20	21	1
Beryllium	Be	<	<	<	<	1
Cadmium	Cd	0.3	1.9	0.9	0.9	0.2
Chromium	Cr	22	19	13	12	2
Cobalt	Co	4	4	4	4	1
Copper	Cu	43	61	18	20	1
Lead	Pb	7.9	11.4	2.9	3.3	0.2
Mercury	Hg	0.20	0.26	0.06	0.07	0.01
Molybdenum	Mo	1.1	16.1	2.0	2.6	0.1
Nickel	Ni	24	18	11	11	2
Selenium	Se	0.6	1.4	0.4	0.4	0.2
Silver	Ag	0.1	0.2	<	<	0.1
Thallium	Tl	<	0.1	0.5	0.5	0.1
Tin	Sn	<	<	<	<	5
Vanadium	V	23	32	21	22	1
Zinc	Zn	46	77	28	31	1
Aluminum	Al	5950	6320	5460	5660	10
Boron	B	20	81	12	14	1
Calcium	Ca	7260	3890	3410	3440	1
Iron	Fe	7550	9820	9140	9800	2
Magnesium	Mg	3520	5150	3660	3850	1
Manganese	Mn	97	98	113	121	1
Phosphorus	P	238	442	376	374	20
Potassium	K	1050	1250	610	620	10
Sodium	Na	3330	12400	3540	3530	5
Strontium	Sr	68	50	21	22	1
Titanium	Ti	83	194	455	504	1
Zirconium	Zr	6	6	2	2	1

Results expressed as micrograms per gram, on a dry weight basis. (µg/g)
< = Less than reporting limit

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Type of Particle Size Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	PSA Standard
16739-01	Oct 19/09	910300417	COMPLETE
16739-02	Oct 19/09	910300421	COMPLETE
16739-03	Oct 19/09	910300422	COMPLETE
16739-04	Oct 19/09	910300423	COMPLETE
16739-05	Oct 19/09	910300426	COMPLETE
16739-06	Oct 19/09	910300429	COMPLETE
16739-07	Oct 19/09	910300431	COMPLETE
16739-08	Oct 19/09	910300435	COMPLETE
16739-09	Oct 19/09	910300436	COMPLETE
16743-01	Oct 20/09	910300438	COMPLETE
16743-02	Oct 20/09	910300440	COMPLETE
16743-03	Oct 20/09	910300442	COMPLETE
16743-04	Oct 20/09	910300446	COMPLETE
16743-05	Oct 20/09	910300451	COMPLETE
16743-06	Oct 20/09	910300455	COMPLETE
16743-07	Oct 20/09	910300461	COMPLETE
16743-08	Oct 20/09	910300470	COMPLETE
16743-09	Oct 20/09	910300475	COMPLETE
16743-10	Oct 20/09	910300477	COMPLETE
16743-11	Oct 20/09	910300480	COMPLETE
16743-12	Oct 20/09	910300482	COMPLETE
16746-01	Oct 20/09	910300487	COMPLETE
16746-02	Oct 20/09	910300489	COMPLETE
16746-03	Oct 21/09	910300493	COMPLETE
16746-04	Oct 21/09	910300494	COMPLETE
16746-05	Oct 21/09	910300496	COMPLETE
16746-06	Oct 21/09	910300497	COMPLETE
16746-07	Oct 21/09	910300498	COMPLETE
16746-08	Oct 21/09	910300499	COMPLETE
16746-09	Oct 21/09	910300500	COMPLETE
16746-10	Oct 21/09	910300501	COMPLETE
16746-11	Oct 21/09	910300502	COMPLETE
16746-12	Oct 21/09	910300503	COMPLETE
16749-01	Oct 21/09	910300504	COMPLETE
16749-02	Oct 21/09	910300505	COMPLETE
16749-03	Oct 21/09	910300506	COMPLETE
16749-04	Oct 21/09	910300507	COMPLETE
16749-05	Oct 21/09	910300508	COMPLETE

(Continued on next page)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Type of Particle Size Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	PSA Standard
16749-06	Oct 21/09	910300509	COMPLETE
16749-07	Oct 22/09	910300512	COMPLETE
16749-08	Oct 22/09	910300513	COMPLETE
16749-09	Oct 22/09	910300517	COMPLETE
16749-10	Oct 22/09	910300518	COMPLETE
16749-11	Oct 22/09	910300519	COMPLETE
REPORTING LIMIT			-
UNITS			-

- = text or without units

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-01	16739-02	16739-03	16739-04	
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:	910300417	910300421	910300422	910300423	
Pipette Size 0.053 mm	58.51	47.71	72.67	32.37	-
Pipette Size 0.002 mm	12.50	18.95	25.41	6.98	-
Sieve 2 mm, ASTM #10	90.53	83.31	99.03	83.45	-
Sieve 0.250mm, 250um, #60	80.24	64.22	93.65	60.17	-
Sieve 0.125mm, 125um, #120	70.86	56.14	88.27	42.40	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-05	16739-06	16739-07	16739-08	
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:	910300426	910300429	910300431	910300435	
Pipette Size 0.053 mm	3.19	4.44	68.55	66.28	-
Pipette Size 0.002 mm	1.53	2.00	23.57	20.81	-
Sieve 2 mm, ASTM #10	84.72	90.30	92.74	92.90	-
Sieve 0.250mm, 250um, #60	31.32	31.25	88.74	87.82	-
Sieve 0.125mm, 125um, #120	7.09	10.24	83.86	83.37	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-09	16743-01	16743-02	16743-03	
DATE SAMPLED:	Oct 19/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:	910300436	910300438	910300440	910300442	
Pipette Size 0.053 mm	13.78	16.94	7.25	65.41	-
Pipette Size 0.002 mm	5.29	4.22	2.30	16.20	-
Sieve 2 mm, ASTM #10	95.86	90.95	67.01	97.27	-
Sieve 0.250mm, 250um, #60	58.15	59.56	20.48	86.97	-
Sieve 0.125mm, 125um, #120	21.64	38.38	10.73	80.25	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-04	16743-05	16743-06	16743-07	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:	910300446	910300451	910300455	910300461	
Pipette Size 0.053 mm	63.73	16.37	63.93	66.00	-
Pipette Size 0.002 mm	13.49	4.60	7.55	8.41	-
Sieve 2 mm, ASTM #10	95.26	77.74	91.50	93.49	-
Sieve 0.250mm, 250um, #60	84.84	31.16	83.70	86.10	-
Sieve 0.125mm, 125um, #120	78.31	21.61	77.22	79.28	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-08	16743-09	16743-10	16743-11	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:	910300470	910300475	910300477	910300480	
Pipette Size 0.053 mm	11.73	15.02	5.79	4.32	-
Pipette Size 0.002 mm	3.18	4.14	2.59	1.54	-
Sieve 2 mm, ASTM #10	78.38	92.83	97.82	69.96	-
Sieve 0.250mm, 250um, #60	36.94	66.67	70.22	27.18	-
Sieve 0.125mm, 125um, #120	21.24	32.43	13.68	8.07	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-12	16746-01	16746-02	16746-03	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300482	910300487	910300489	910300493	
Pipette Size 0.053 mm	22.27	62.19	65.67	18.51	-
Pipette Size 0.002 mm	7.61	14.96	9.98	5.15	-
Sieve 2 mm, ASTM #10	87.22	88.70	90.09	99.94	-
Sieve 0.250mm, 250um, #60	63.36	83.91	79.57	95.08	-
Sieve 0.125mm, 125um, #120	32.55	78.69	75.50	68.32	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-04	16746-05	16746-06	16746-07	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300494	910300496	910300497	910300498	
Pipette Size 0.053 mm	19.19	4.83	13.58	50.09	-
Pipette Size 0.002 mm	5.96	1.64	5.69	14.12	-
Sieve 2 mm, ASTM #10	99.18	99.04	91.42	99.79	-
Sieve 0.250mm, 250um, #60	93.86	39.74	56.47	94.81	-
Sieve 0.125mm, 125um, #120	55.30	16.83	23.41	78.44	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-08	16746-09	16746-10	16746-11	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300499	910300500	910300501	910300502	
Pipette Size 0.053 mm	74.28	31.56	38.20	74.52	-
Pipette Size 0.002 mm	23.58	11.41	5.21	25.43	-
Sieve 2 mm, ASTM #10	99.98	96.70	83.91	99.38	-
Sieve 0.250mm, 250um, #60	99.54	77.48	63.87	97.38	-
Sieve 0.125mm, 125um, #120	97.09	51.55	52.20	92.66	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-12	16749-01	16749-02	16749-03	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300503	910300504	910300505	910300506	
Pipette Size 0.053 mm	67.17	51.67	80.97	38.76	-
Pipette Size 0.002 mm	10.63	17.43	15.10	13.22	-
Sieve 2 mm, ASTM #10	92.08	75.21	96.92	94.45	-
Sieve 0.250mm, 250um, #60	86.94	66.75	93.46	72.74	-
Sieve 0.125mm, 125um, #120	82.17	61.69	90.24	56.88	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-04	16749-05	16749-06	16749-07	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:	910300507	910300508	910300509	910300512	
Pipette Size 0.053 mm	48.25	44.85	76.77	15.54	-
Pipette Size 0.002 mm	17.85	15.53	27.83	5.74	-
Sieve 2 mm, ASTM #10	97.67	96.09	99.70	97.80	-
Sieve 0.250mm, 250um, #60	81.21	79.63	97.04	62.09	-
Sieve 0.125mm, 125um, #120	61.97	63.23	92.44	29.35	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-08	16749-09	16749-10	16749-11	
DATE SAMPLED:	Oct 22/09	Oct 22/09	Oct 22/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:	910300513	910300517	910300518	910300519	
Pipette Size 0.053 mm	10.52	38.27	7.65	8.96	-
Pipette Size 0.002 mm	3.29	12.11	3.22	3.36	-
Sieve 2 mm, ASTM #10	77.74	89.38	99.62	99.43	-
Sieve 0.250mm, 250um, #60	36.41	60.97	68.84	56.85	-
Sieve 0.125mm, 125um, #120	18.19	50.75	19.47	24.60	-

Results expressed as percent passing (PCTP)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-01	16739-02	16739-03	16739-04	
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:	910300417	910300421	910300422	910300423	
>2.00 mm	9.47	16.69	0.97	16.55	-
<2.00 mm & >0.053 mm	32.02	35.60	26.36	51.09	-
<0.053 mm & >0.002 mm	46.01	28.76	47.26	25.38	-
<0.002 mm	12.50	18.95	25.41	6.98	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-05	16739-06	16739-07	16739-08	
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09	REPORTING LIMIT
CANTEST ID:	910300426	910300429	910300431	910300435	
>2.00 mm	15.28	9.70	7.26	7.10	-
<2.00 mm & >0.053 mm	81.53	85.86	24.19	26.61	-
<0.053 mm & >0.002 mm	1.66	2.44	44.98	45.47	-
<0.002 mm	1.53	2.00	23.57	20.81	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-09	16743-01	16743-02	16743-03	
DATE SAMPLED:	Oct 19/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:	910300436	910300438	910300440	910300442	
>2.00 mm	4.14	9.05	32.99	2.73	-
<2.00 mm & >0.053 mm	82.09	74.01	59.75	31.86	-
<0.053 mm & >0.002 mm	8.49	12.73	4.95	49.21	-
<0.002 mm	5.29	4.22	2.30	16.20	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-04	16743-05	16743-06	16743-07	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:	910300446	910300451	910300455	910300461	
>2.00 mm	4.74	22.26	8.50	6.51	-
<2.00 mm & >0.053 mm	31.52	61.37	27.57	27.49	-
<0.053 mm & >0.002 mm	50.25	11.77	56.38	57.59	-
<0.002 mm	13.49	4.60	7.55	8.41	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-08	16743-09	16743-10	16743-11	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT
CANTEST ID:	910300470	910300475	910300477	910300480	
>2.00 mm	21.62	7.17	2.18	30.04	-
<2.00 mm & >0.053 mm	66.65	77.81	92.03	65.64	-
<0.053 mm & >0.002 mm	8.55	10.88	3.20	2.78	-
<0.002 mm	3.18	4.14	2.59	1.54	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-12	16746-01	16746-02	16746-03	
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300482	910300487	910300489	910300493	
>2.00 mm	12.78	11.30	9.91	0.06	-
<2.00 mm & >0.053 mm	64.95	26.51	24.42	81.43	-
<0.053 mm & >0.002 mm	14.66	47.23	55.69	13.37	-
<0.002 mm	7.61	14.96	9.98	5.15	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-04	16746-05	16746-06	16746-07	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300494	910300496	910300497	910300498	
>2.00 mm	0.82	0.96	8.58	0.21	-
<2.00 mm & >0.053 mm	79.99	94.21	77.84	49.71	-
<0.053 mm & >0.002 mm	13.23	3.19	7.89	35.97	-
<0.002 mm	5.96	1.64	5.69	14.12	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-08	16746-09	16746-10	16746-11	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300499	910300500	910300501	910300502	
>2.00 mm	0.02	3.30	16.09	0.62	-
<2.00 mm & >0.053 mm	25.70	65.14	45.71	24.86	-
<0.053 mm & >0.002 mm	50.71	20.16	32.99	49.08	-
<0.002 mm	23.58	11.41	5.21	25.43	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-12	16749-01	16749-02	16749-03	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09	REPORTING LIMIT
CANTEST ID:	910300503	910300504	910300505	910300506	
>2.00 mm	7.92	24.79	3.08	5.55	-
<2.00 mm & >0.053 mm	24.91	23.54	15.95	55.70	-
<0.053 mm & >0.002 mm	56.54	34.25	65.87	25.54	-
<0.002 mm	10.63	17.43	15.10	13.22	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-04	16749-05	16749-06	16749-07	
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:	910300507	910300508	910300509	910300512	
>2.00 mm	2.33	3.91	0.30	2.20	-
<2.00 mm & >0.053 mm	49.42	51.24	22.93	82.26	-
<0.053 mm & >0.002 mm	30.40	29.32	48.95	9.80	-
<0.002 mm	17.85	15.53	27.83	5.74	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-08	16749-09	16749-10	16749-11	
DATE SAMPLED:	Oct 22/09	Oct 22/09	Oct 22/09	Oct 22/09	REPORTING LIMIT
CANTEST ID:	910300513	910300517	910300518	910300519	
>2.00 mm	22.26	10.62	0.38	0.57	-
<2.00 mm & >0.053 mm	67.23	51.11	91.97	90.47	-
<0.053 mm & >0.002 mm	7.22	26.17	4.43	5.59	-
<0.002 mm	3.29	12.11	3.22	3.36	-

Results expressed as percent, on a weight basis (%)

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-01	16739-02	16739-03	16739-04	REPORTING LIMIT	UNITS
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09		
CANTEST ID:	910300417	910300421	910300422	910300423		
CSSC Textural Category	SIL	L	L	SL	-	-
%Sand <2.00 mm & >0.053 mm	35.37	42.73	26.62	61.22	-	%
%Silt <0.053 mm & >0.002 mm	50.82	34.52	47.72	30.42	-	%
%Clay <0.002 mm	13.81	22.75	25.66	8.37	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-05	16739-06	16739-07	16739-08	REPORTING LIMIT	UNITS
DATE SAMPLED:	Oct 19/09	Oct 19/09	Oct 19/09	Oct 19/09		
CANTEST ID:	910300426	910300429	910300431	910300435		
CSSC Textural Category	S	S	L	L	-	-
%Sand <2.00 mm & >0.053 mm	96.24	95.09	26.08	28.65	-	%
%Silt <0.053 mm & >0.002 mm	1.96	2.70	48.50	48.95	-	%
%Clay <0.002 mm	1.81	2.21	25.42	22.40	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16739-09	16743-01	16743-02	16743-03		
DATE SAMPLED:	Oct 19/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT	UNITS
CANTEST ID:	910300436	910300438	910300440	910300442		
CSSC Textural Category	LS	LS	S	SIL	-	-
%Sand <2.00 mm & >0.053 mm	85.63	81.37	89.18	32.75	-	%
%Silt <0.053 mm & >0.002 mm	8.86	13.99	7.39	50.59	-	%
%Clay <0.002 mm	5.51	4.64	3.43	16.65	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-04	16743-05	16743-06	16743-07		
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT	UNITS
CANTEST ID:	910300446	910300451	910300455	910300461		
CSSC Textural Category	SIL	LS	SIL	SIL	-	-
%Sand <2.00 mm & >0.053 mm	33.09	78.94	30.13	29.40	-	%
%Silt <0.053 mm & >0.002 mm	52.75	15.14	61.62	61.60	-	%
%Clay <0.002 mm	14.16	5.92	8.25	9.00	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-08	16743-09	16743-10	16743-11		
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 20/09	REPORTING LIMIT	UNITS
CANTEST ID:	910300470	910300475	910300477	910300480		
CSSC Textural Category	LS	LS	S	S	-	-
%Sand <2.00 mm & >0.053 mm	85.03	83.82	94.08	93.83	-	%
%Silt <0.053 mm & >0.002 mm	10.91	11.72	3.27	3.98	-	%
%Clay <0.002 mm	4.06	4.46	2.64	2.20	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16743-12	16746-01	16746-02	16746-03	REPORTING LIMIT	UNITS
DATE SAMPLED:	Oct 20/09	Oct 20/09	Oct 20/09	Oct 21/09		
CANTEST ID:	910300482	910300487	910300489	910300493		
CSSC Textural Category	SL	SIL	SIL	LS	-	-
%Sand <2.00 mm & >0.053 mm	74.47	29.89	27.11	81.48	-	%
%Silt <0.053 mm & >0.002 mm	16.81	53.24	61.82	13.38	-	%
%Clay <0.002 mm	8.72	16.87	11.07	5.15	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-04	16746-05	16746-06	16746-07	REPORTING LIMIT	UNITS
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09		
CANTEST ID:	910300494	910300496	910300497	910300498		
CSSC Textural Category	LS	S	LS	L	-	-
%Sand <2.00 mm & >0.053 mm	80.65	95.13	85.15	49.81	-	%
%Silt <0.053 mm & >0.002 mm	13.34	3.22	8.63	36.05	-	%
%Clay <0.002 mm	6.01	1.65	6.22	14.14	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-08	16746-09	16746-10	16746-11	REPORTING LIMIT	UNITS
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09		
CANTEST ID:	910300499	910300500	910300501	910300502		
CSSC Textural Category	SIL	SL	SL	L	-	-
%Sand <2.00 mm & >0.053 mm	25.70	67.36	54.47	25.02	-	%
%Silt <0.053 mm & >0.002 mm	50.71	20.84	39.31	49.39	-	%
%Clay <0.002 mm	23.58	11.79	6.21	25.59	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16746-12	16749-01	16749-02	16749-03	REPORTING LIMIT	UNITS
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 21/09		
CANTEST ID:	910300503	910300504	910300505	910300506		
CSSC Textural Category	SIL	L	SIL	SL	-	-
%Sand <2.00 mm & >0.053 mm	27.05	31.30	16.46	58.97	-	%
%Silt <0.053 mm & >0.002 mm	61.40	45.53	67.96	27.04	-	%
%Clay <0.002 mm	11.54	23.17	15.58	13.99	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-04	16749-05	16749-06	16749-07		
DATE SAMPLED:	Oct 21/09	Oct 21/09	Oct 21/09	Oct 22/09	REPORTING LIMIT	UNITS
CANTEST ID:	910300507	910300508	910300509	910300512		
CSSC Textural Category	L	SL	CL	LS	-	-
%Sand <2.00 mm & >0.053 mm	50.60	53.33	23.00	84.11	-	%
%Silt <0.053 mm & >0.002 mm	31.12	30.51	49.09	10.02	-	%
%Clay <0.002 mm	18.28	16.16	27.91	5.87	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	16749-08	16749-09	16749-10	16749-11	REPORTING LIMIT	UNITS
DATE SAMPLED:	Oct 22/09	Oct 22/09	Oct 22/09	Oct 22/09		
CANTEST ID:	910300513	910300517	910300518	910300519		
CSSC Textural Category	LS	SL	S	S	-	-
%Sand <2.00 mm & >0.053 mm	86.47	57.18	92.32	90.99	-	%
%Silt <0.053 mm & >0.002 mm	9.29	29.27	4.45	5.63	-	%
%Clay <0.002 mm	4.24	13.54	3.23	3.38	-	%

- = text or without units

% = percent, on a weight basis

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

Batch Quality Control for Simultaneously Extracted Metals-reported in micromoles- in Soil (QC# 129762)

Parameter		Duplicate (R.P.D.) 910300417	Duplicate Limits	Duplicate (R.P.D.) 910300499	Duplicate Limits
Cadmium	Cd	3.6	20	11.5	20
Lead	Pb	5.4	20	12	20
Zinc	Zn	3.6	20	13.8	20

umoles/gram = micromoles per gram (dry wt.)
R.P.D. = Relative Percent Difference

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Batch Quality Control for Conventional Parameters in Soil

Parameter	QC Type	QC Result	Units	Lower Limit	Upper Limit
Total Organic Carbon C	Ring Standard (TOC&TC in Soil)	102.7	% Recovery	101	111
	Duplicate	0.0	R.P.D.	0	20
	Duplicate	0.0	R.P.D.	0	20
	Duplicate	0.0	R.P.D.	0	20
	Duplicate	0.0	R.P.D.	0	20

% dry wt. = percent, dry weight basis
R.P.D. = Relative Percent Difference

Batch Quality Control for Percent Passing on Sieves and Pipettes in Soil (QC# 130126)

Parameter	Soil Pipette Verif %<53um (% Recovery) 910300475	Soil Pipette Verif %<53um Limits
Pipette Size 0.053 mm	100	95 - 105

PCTP = percent passing

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Batch Quality Control for Percent Passing on Sieves and Pipettes in Soil (QC# 130127)

Parameter	Duplicate (R.P.D.) 910300518	Duplicate Limits	Soil Pipette Verif %<53um (% Recovery) 910300519	Soil Pipette Verif %<53um Limits
Pipette Size 0.053 mm	12.3	20	99	95 - 105
Pipette Size 0.002 mm	9.5	20	-	-
Sieve 0.250mm, 250um, #60	4.1	20	-	-
Sieve 0.125mm, 125um, #120	0.3	20	-	-

PCTP = percent passing
R.P.D. = Relative Percent Difference

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Batch Quality Control for Strong Acid Soluble Metals in Soil (QC# 128893)

Parameter		Blank (ug/g)	Blank Limits	CAN MET Till-1 (% Recovery)	CAN MET Till-1 Limits	Duplicate (R.P.D.) 910300044	Duplicate Limits
Antimony	Sb	< 0.1	10	-	-	-	-
Arsenic	As	-	-	-	-	0	30
Barium	Ba	< 1	1	87	74 - 120	4	30
Beryllium	Be	< 1	1	16	10.4 - 30.4	NC	30
Cadmium	Cd	< 0.2	0.2	61	3 - 197	PASS	30
Chromium	Cr	< 2	0.2	77	73 - 113	26.7	30
Cobalt	Co	< 1	1	92	70 - 142	15.4	30
Copper	Cu	< 1	0.2	83	75 - 113	4.1	30
Lead	Pb	< 0.2	5	103	65 - 171	6.6	30
Mercury	Hg	< 0.01	0.001	77	33 - 174	0	30
Molybdenum	Mo	< 0.1	4	30	5 - 90	0	30
Nickel	Ni	< 2	2	89	49 - 149	PASS	30
Selenium	Se	< 0.2	0.2	-	-	NC	30
Silver	Ag	-	-	-	-	NC	30
Thallium	Tl	< 0.1	0.001	-	-	NC	30
Tin	Sn	< 5	5	-	-	NC	30
Vanadium	V	< 1	1	94	69 - 152	20.8	30
Zinc	Zn	< 1	1	84	79 - 114	8.3	30
Aluminum	Al	< 10	10	-	-	4.8	30
Boron	B	< 1	1	-	-	NC	30
Calcium	Ca	< 1	1	61	51 - 106	4.4	30
Iron	Fe	< 2	2	-	-	8.6	30
Magnesium	Mg	< 1	1	-	-	6	30
Manganese	Mn	< 1	1	-	-	6.7	30
Phosphorus	P	< 20	20	-	-	10	30
Potassium	K	< 10	10	-	-	8.9	30
Sodium	Na	< 5	5	-	-	8	30
Strontium	Sr	< 1	1	-	-	0	30
Titanium	Ti	< 1	1	-	-	1.6	30
Zirconium	Zr	< 1	1	-	-	PASS	30

ug/g = micrograms per gram
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Batch Quality Control for Strong Acid Soluble Metals in Soil (QC# 128893)

Parameter		Duplicate (R.P.D.) 910300105	Duplicate Limits	Duplicate (R.P.D.) 910300339	Duplicate Limits	Duplicate (R.P.D.) 910300364	Duplicate Limits
Arsenic	As	0	30	-	-	0	30
Barium	Ba	12.1	30	-	-	5	30
Beryllium	Be	NC	30	-	-	NC	30
Cadmium	Cd	NC	30	-	-	NC	30
Chromium	Cr	0	30	-	-	PASS	30
Cobalt	Co	PASS	30	-	-	PASS	30
Copper	Cu	5.7	30	-	-	20	30
Lead	Pb	5.5	30	-	-	4.4	30
Mercury	Hg	0	30	0	30	0	30
Molybdenum	Mo	PASS	30	-	-	PASS	30
Nickel	Ni	PASS	30	-	-	PASS	30
Selenium	Se	NC	30	-	-	NC	30
Silver	Ag	NC	30	-	-	NC	30
Thallium	Tl	NC	30	-	-	NC	30
Tin	Sn	NC	30	-	-	NC	30
Vanadium	V	15.4	30	-	-	0	30
Zinc	Zn	5.7	30	-	-	9.8	30
Aluminum	Al	8.6	30	-	-	4.4	30
Boron	B	NC	30	-	-	0	30
Calcium	Ca	6.9	30	-	-	2.9	30
Iron	Fe	23.9	30	-	-	6.8	30
Magnesium	Mg	7	30	-	-	0.6	30
Manganese	Mn	7.4	30	-	-	0.6	30
Phosphorus	P	9.5	30	-	-	26	30
Potassium	K	1.3	30	-	-	5.6	30
Sodium	Na	13.7	30	-	-	13.7	30
Strontium	Sr	5.1	30	-	-	7.3	30
Titanium	Ti	13.6	30	-	-	6.7	30
Zirconium	Zr	NC	30	-	-	PASS	30

ug/g = micrograms per gram
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Batch Quality Control for Strong Acid Soluble Metals in Soil (QC# 128893)

Parameter		Duplicate (R.P.D.) 910300393	Duplicate Limits	Duplicate (R.P.D.) 910300422	Duplicate Limits	Duplicate (R.P.D.) 910300446	Duplicate Limits
Arsenic	As	22.2	30	2.5	30	3.3	30
Barium	Ba	3.9	30	0	30	10.8	30
Beryllium	Be	NC	30	NC	30	NC	30
Cadmium	Cd	NC	30	0	30	5.9	30
Chromium	Cr	PASS	30	0	30	7.7	30
Cobalt	Co	PASS	30	PASS	30	PASS	30
Copper	Cu	0	30	1.2	30	13	30
Lead	Pb	8	30	1.7	30	4.4	30
Mercury	Hg	0	30	4.1	30	0	30
Molybdenum	Mo	NC	30	2.6	30	3.1	30
Nickel	Ni	PASS	30	0	30	4.7	30
Selenium	Se	NC	30	9.5	30	5.7	30
Silver	Ag	NC	30	PASS	30	PASS	30
Thallium	Tl	NC	30	PASS	30	PASS	30
Tin	Sn	NC	30	NC	30	NC	30
Vanadium	V	PASS	30	2.5	30	0	30
Zinc	Zn	12.5	30	0.6	30	9.3	30
Aluminum	Al	7.3	30	0.9	30	0.6	30
Boron	B	0	30	6.1	30	5.9	30
Calcium	Ca	14	30	8.2	30	2.3	30
Iron	Fe	6.1	30	0.6	30	1.4	30
Magnesium	Mg	18.5	30	5	30	2.7	30
Manganese	Mn	5.4	30	0.7	30	0.8	30
Phosphorus	P	6.2	30	1.5	30	5.1	30
Potassium	K	1.4	30	1.1	30	4.4	30
Sodium	Na	9.9	30	7.9	30	0.6	30
Strontium	Sr	4.4	30	11.6	30	8.7	30
Titanium	Ti	17.8	30	0	30	6.4	30
Zirconium	Zr	NC	30	PASS	30	0	30

ug/g = micrograms per gram
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Batch Quality Control for Strong Acid Soluble Metals in Soil (QC# 128893)

Parameter		Duplicate (R.P.D.) 910300489	Duplicate Limits	Duplicate (R.P.D.) 910300503	Duplicate Limits	Duplicate (R.P.D.) 910300518	Duplicate Limits
Arsenic	As	3.8	30	3.7	30	4.3	30
Barium	Ba	24.2	30	18.2	30	4.9	30
Beryllium	Be	NC	30	NC	30	NC	30
Cadmium	Cd	14.9	30	3	30	PASS	30
Chromium	Cr	9.5	30	0	30	15.4	30
Cobalt	Co	PASS	30	PASS	30	PASS	30
Copper	Cu	1.5	30	0	30	16.2	30
Lead	Pb	0.7	30	1.1	30	3.4	30
Mercury	Hg	9.5	30	4.3	30	0	30
Molybdenum	Mo	2	30	8.1	30	14.6	30
Nickel	Ni	0	30	0	30	8.7	30
Selenium	Se	11.1	30	5.4	30	PASS	30
Silver	Ag	PASS	30	PASS	30	NC	30
Thallium	Tl	PASS	30	PASS	30	PASS	30
Tin	Sn	NC	30	NC	30	NC	30
Vanadium	V	3	30	2.7	30	0	30
Zinc	Zn	3.8	30	4.7	30	14.3	30
Aluminum	Al	3.1	30	0.9	30	2	30
Boron	B	12.1	30	8.2	30	16.7	30
Calcium	Ca	1.4	30	13	30	5	30
Iron	Fe	4.4	30	0.7	30	1.5	30
Magnesium	Mg	2.7	30	4.4	30	2.5	30
Manganese	Mn	1.8	30	0.8	30	5.3	30
Phosphorus	P	5.6	30	0.5	30	7.4	30
Potassium	K	4.1	30	7.2	30	2.5	30
Sodium	Na	2.2	30	13.9	30	1.1	30
Strontium	Sr	2.3	30	2.9	30	14.6	30
Titanium	Ti	2.7	30	5.1	30	7.7	30
Zirconium	Zr	PASS	30	PASS	30	PASS	30

ug/g = micrograms per gram
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

REPORTED TO: Golder Associates Ltd.

REPORT DATE: December 9, 2009 14:42:59

GROUP NUMBER: 101030084

CANTEST

Batch Quality Control for Strong Acid Soluble Metals in Soil (QC# 128893)

Parameter		Duplicate (R.P.D.) 910310061	Duplicate Limits	Duplicate (R.P.D.) 910310075	Duplicate Limits	Duplicate (R.P.D.) 910310092	Duplicate Limits
Arsenic	As	18.2	30	12.5	30	16.2	30
Barium	Ba	10.3	30	9.9	30	17.7	30
Beryllium	Be	NC	30	NC	30	NC	30
Cadmium	Cd	NC	30	8.7	30	NC	30
Chromium	Cr	PASS	30	8	30	0	30
Cobalt	Co	PASS	30	0	30	0	30
Copper	Cu	0	30	12	30	6.9	30
Lead	Pb	11.8	30	24.6	30	14	30
Mercury	Hg	NC	30	0	30	0	30
Molybdenum	Mo	PASS	30	6.2	30	28.6	30
Nickel	Ni	PASS	30	16.7	30	PASS	30
Selenium	Se	NC	30	NC	30	NC	30
Silver	Ag	NC	30	NC	30	NC	30
Thallium	Tl	NC	30	NC	30	NC	30
Tin	Sn	NC	30	NC	30	NC	30
Vanadium	V	8.7	30	3.2	30	2.7	30
Zinc	Zn	25.6	30	4.6	30	2.8	30
Aluminum	Al	22.9	30	7.9	30	4.5	30
Boron	B	PASS	30	PASS	30	PASS	30
Calcium	Ca	19.6	30	1.5	30	6.9	30
Iron	Fe	17.2	30	10.7	30	2.2	30
Magnesium	Mg	16.2	30	0.5	30	10.6	30
Manganese	Mn	27.3	30	10.9	30	14.4	30
Phosphorus	P	7.7	30	3.7	30	21	30
Potassium	K	12	30	13.8	30	18.3	30
Sodium	Na	17.4	30	10.2	30	3.4	30
Strontium	Sr	27.3	30	6.5	30	14.3	30
Titanium	Ti	21.4	30	5.7	30	16.7	30
Zirconium	Zr	NC	30	PASS	30	NC	30

ug/g = micrograms per gram
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

Batch Quality Control for Strong Acid Soluble Metals in Soil (QC# 128893)

Parameter		Duplicate (R.P.D.) 910310151	Duplicate Limits
Arsenic	As	12.8	30
Barium	Ba	25.5	30
Beryllium	Be	NC	30
Cadmium	Cd	PASS	30
Chromium	Cr	5.7	30
Cobalt	Co	13.3	30
Copper	Cu	9.5	30
Lead	Pb	10.2	30
Mercury	Hg	2.6	30
Molybdenum	Mo	25	30
Nickel	Ni	PASS	30
Selenium	Se	NC	30
Silver	Ag	NC	30
Thallium	Tl	NC	30
Tin	Sn	NC	30
Vanadium	V	5.5	30
Zinc	Zn	1	30
Aluminum	Al	2.4	30
Boron	B	PASS	30
Calcium	Ca	2.6	30
Iron	Fe	2	30
Magnesium	Mg	3	30
Manganese	Mn	18.5	30
Phosphorus	P	8.5	30
Potassium	K	13.2	30
Sodium	Na	3.7	30
Strontium	Sr	5.3	30
Titanium	Ti	5.8	30
Zirconium	Zr	NC	30

ug/g = micrograms per gram
R.P.D. = Relative Percent Difference
PASS = Duplicate sample results were in the range of one to five times the detection limit. R.P.D. calculation is not applicable in this range. Acceptance criteria is a maximum difference between the duplicates equivalent to the value of the detection limit.
NC = Not Calculated. Duplicate sample results were less than the detection limit. Relative Percent Difference calculation is not defined for analyte levels of less than detection limit.

Batch Quality Control Frequency Summary

PAH's in Soil Sample Prep (Batch# 128862)

QC Type	No. Samples
Blank	1
NIST 1941b Org Marine Sediment	1

SALM in Soil Digestion (Batch# 128893)

QC Type	No. Samples
CAN MET Till-1	1
Blank	3
Duplicate	14

PAH's in Soil Sample Prep (Batch# 128953)

QC Type	No. Samples
Blank	1
Duplicate	1
NIST 1941b Org Marine Sediment	1

Leco Analysis Soils/Solids (Batch# 129732)

QC Type	No. Samples
Ring Standard (TOC&TC in Soil)	1
Blank	1
Duplicate	2

Leco Analysis Soils/Solids (Batch# 129751)

QC Type	No. Samples
Ring Standard (TOC&TC in Soil)	1
Blank	1
Duplicate	2

(Continued on next page)

Batch Quality Control Frequency Summary

Acid Volatile Sulphide Prep (Batch# 129762)

QC Type	No. Samples
Duplicate	2

Particle Size Prep - Winnipeg (Batch# 130126)

QC Type	No. Samples
Soil Pipette Verif %<53um	1

Particle Size Prep - Winnipeg (Batch# 130127)

QC Type	No. Samples
Duplicate	1
Soil Pipette Verif %<53um	1

PAH's in Soil Sample Prep (Batch# 128862)

QC Type	No. Samples
Batch Size	14

SALM Metals in Soil Sieve (Batch# 128863)

QC Type	No. Samples
Batch Size	150

PAH's in Soil Sample Prep (Batch# 128871)

QC Type	No. Samples
Batch Size	14

(Continued on next page)

Batch Quality Control Frequency Summary

SALM in Soil Digestion (Batch# 128893)

QC Type	No. Samples
Batch Size	142

PAH's in Soil Sample Prep (Batch# 128918)

QC Type	No. Samples
Batch Size	14

PAH's in Soil Sample Prep (Batch# 128919)

QC Type	No. Samples
Batch Size	14

CCME HCs - SOIL PREP (Batch# 128927)

QC Type	No. Samples
Batch Size	15

CCME HCs - SOIL PREP (Batch# 128928)

QC Type	No. Samples
Batch Size	18

CCME HCs - SOIL PREP (Batch# 128929)

QC Type	No. Samples
Batch Size	18

(Continued on next page)

Batch Quality Control Frequency Summary

PAH's in Soil Sample Prep (Batch# 128953)

QC Type	No. Samples
Batch Size	14

Leco Analysis Soils/Solids (Batch# 129732)

QC Type	No. Samples
Batch Size	20

Leco Analysis Soils/Solids (Batch# 129751)

QC Type	No. Samples
Batch Size	24

Acid Volatile Sulphide Prep (Batch# 129762)

QC Type	No. Samples
Batch Size	44

Particle Size Prep - Winnipeg (Batch# 130125)

QC Type	No. Samples
Batch Size	13

Particle Size Prep - Winnipeg (Batch# 130126)

QC Type	No. Samples
Batch Size	13

(Continued on next page)

Batch Quality Control Frequency Summary

Particle Size Prep - Winnipeg (Batch# 130127)

QC Type	No. Samples
Batch Size	8

Particle Size Prep - Winnipeg (Batch# 130266)

QC Type	No. Samples
Batch Size	10

SAMPLE RECEIPT FORM / CHEMICAL ANALYSIS FORM

FILE #: PR91796

CLIENT: Golder Associates
500 – 4260 Still Creek Drive
Burnaby, BC
V5C 6C6

Phone – 604-298-6623
Fax – 604-298-5253

RECEIVED BY: V. Ionescu **DATE/TIME:** December 2, 200 (12:20 p.m.)
CONDITION: ok, 10˚C, sample#39 (PR91833) may have leaked. Approx 200 uL remaining

# of Containers	Sample Type	Sample (Client Codes)	Lab Codes	Test Requested
1	Hexane extract	1	PR91796	PAH
1	Hexane extract	2	PR91797	PAH
1	Hexane extract	3	PR91798	PAH
1	Hexane extract	4	PR91799	PAH
1	Hexane extract	6	PR91800	PAH
1	Hexane extract	7	PR91801	PAH
1	Hexane extract	8	PR91802	PAH
1	Hexane extract	9	PR91803	PAH
1	Hexane extract	10	PR91804	PAH
1	Hexane extract	11	PR91805	PAH
1	Hexane extract	12	PR91806	PAH
1	Hexane extract	13	PR91807	PAH
1	Hexane extract	14	PR91808	PAH
1	Hexane extract	15	PR91809	PAH
1	Hexane extract	16	PR91810	PAH
1	Hexane extract	17	PR91811	PAH
1	Hexane extract	18	PR91812	PAH
1	Hexane extract	19	PR91813	PAH
1	Hexane extract	20	PR91814	PAH
1	Hexane extract	21	PR91815	PAH
1	Hexane extract	22	PR91816	PAH
1	Hexane extract	23	PR91817	PAH
1	Hexane extract	24	PR91818	PAH
1	Hexane extract	25	PR91819	PAH
1	Hexane extract	26	PR91820	PAH
1	Hexane extract	27	PR91821	PAH
1	Hexane extract	28	PR91822	PAH
1	Hexane extract	29	PR91823	PAH
1	Hexane extract	30	PR91824	PAH
1	Hexane extract	31	PR91825	PAH
1	Hexane extract	32	PR91826	PAH
1	Hexane extract	33	PR91827	PAH

1	Hexane extract	34	PR91828	PAH
1	Hexane extract	35	PR91829	PAH
1	Hexane extract	36	PR91830	PAH
1	Hexane extract	37	PR91831	PAH
1	Hexane extract	38	PR91832	PAH
1	Hexane extract	39	PR91833	PAH
1	Hexane extract	40	PR91834	PAH
1	Hexane extract	NC	PR91835	PAH
1	Hexane extract	PC	PR91836	PAH
1	Hexane extract	B	PR91837	PAH

STORAGE: Stored at 4 °C

ANALYTES: HRGC/HRMS analysis for polycyclic aromatic hydrocarbons (PAH)

SPECIAL INSTRUCTIONS: PAH: SOP LAB03; EPA 8270 modified

METHODOLOGY

Reference Method: PAH: SOP LAB03; EPA 8270 modified

Data summarized in Data Report Attached

Report sent to: Adrian DeBruyn Date: December 21, 2009

Comments: Results relate only to items tested. Extract weights are provided on the final report.

_____

David Hope, PChem, CEO

DATA REPORT

Client: Golder Associates
Contact: Lizanne Meloche

Date Extracted: n/a
Date Analysed: 9-Dec-09

	Client ID:	1	2	3	4	6	7
	PRL ID:	PR91796	PR91797	PR91798	PR91799	PR91800	PR91801
	Extract Wt. (g):	1.55	1.47	1.6	1.23	1.79	1.74
Compound	**DL**						
	ng/sample	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**
Naphthalene	0.1	0.43	0.55	0.47	0.32	0.52	0.48
Acenaphthylene	0.1	0.13	0.18	0.15	0.11	0.1	ND
Acenaphthene	0.2	ND	0.35	0.95	0.32	0.34	ND
Fluorene	0.1	0.41	0.3	1.1	0.16	0.23	0.34
Phenanthrene	0.1	0.82	1.9	7.9	1.6	2.5	1.1
Anthracene	0.1	0.24	0.56	1.5	0.79	1.4	0.65
Fluoranthene	0.1	2.7	9.1	23	9.4	10	4.1
Pyrene	0.1	1.7	5.5	13	10	14	6.9
Benz(a)anthracene	0.1	0.46	1.4	3.2	1.6	2.3	1.2
Chrysene	0.1	0.38	1.9	3.4	1.1	1.3	0.6
Benzo(b+j)fluoranthene	0.2	0.7	1.3	2.2	2	2.2	1.6
Benzo(k)fluoranthene	0.1	0.38	1.1	1.9	1.5	1.7	1.6
Benzo(a)pyrene	0.5	ND	0.59	1	0.62	1.1	0.79
Indeno(1,2,3-cd)pyrene	1.0	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1.0	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	1.0	ND	ND	ND	ND	ND	ND

Patrick Pond, Chief Technical Officer

ND - none detected

Form Name: DOC13 Data Report PAH 5-Nov-08 DGH

DATA REPORT

Client: Golder Associates
Contact: Lizanne Meloche

Date Extracted: n/a
Date Analysed: 9-Dec-09

	Client ID:	8	9	10	11	12	13
	PRL ID:	PR91802	PR91803	PR91804	PR91805	PR91806	PR91807
	Extract Wt. (g):	1.4	1.59	1.61	1.53	1.05	1.59
Compound	**DL ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**
Naphthalene	0.1	0.49	0.22	0.29	0.17	0.29	0.43
Acenaphthylene	0.1	0.12	0.13	ND	ND	ND	ND
Acenaphthene	0.2	0.22	0.22	0.26	0.2	0.68	0.21
Fluorene	0.1	0.12	0.16	0.21	0.19	0.55	0.12
Phenanthrene	0.1	0.97	1.7	1.3	0.77	3.2	0.97
Anthracene	0.1	0.83	1.4	0.9	0.47	2.1	0.62
Fluoranthene	0.1	7.3	6.5	8.9	4.3	14	23
Pyrene	0.1	14	23	13	4.6	11	22
Benz(a)anthracene	0.1	1.7	2.3	1.8	0.8	2.4	2.8
Chrysene	0.1	0.75	0.76	1.1	0.44	1.5	2.6
Benzo(b+j)fluoranthene	0.2	2.7	4.6	2	0.91	1.3	2.3
Benzo(k)fluoranthene	0.1	2.7	4.2	1.6	0.63	1.3	1.7
Benzo(a)pyrene	0.5	1.1	1.8	0.55	ND	0.66	0.9
Indeno(1,2,3-cd)pyrene	1.0	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1.0	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	1.0	ND	ND	ND	ND	ND	ND

Patrick Pond, Chief Technical Officer

ND - none detected

Form Name: DOC13 Data Report PAH 5-Nov-08 DGH

DATA REPORT

Client: Golder Associates
Contact: Lizanne Meloche

Date Extracted: n/a
Date Analysed: 9-Dec-09

	Client ID:	14	15	16	17	18	19
	PRL ID:	PR91808	PR91809	PR91810	PR91811	PR91812	PR91813
	Extract Wt. (g):	1.62	1.76	1.69	1.37	1.44	1.38
Compound	**DL ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**
Naphthalene	0.1	0.35	0.46	0.65	0.27	0.37	0.33
Acenaphthylene	0.1	ND	ND	0.19	0.13	ND	ND
Acenaphthene	0.2	0.21	0.23	0.33	ND	0.33	0.31
Fluorene	0.1	0.18	0.12	0.38	0.1	0.21	0.15
Phenanthrene	0.1	0.71	0.99	1.9	0.78	0.82	0.74
Anthracene	0.1	0.55	0.43	0.77	0.39	0.56	0.23
Fluoranthene	0.1	1.9	3.3	4.6	4.4	6.3	3.6
Pyrene	0.1	2.9	3.5	4.1	3.3	7.6	1.9
Benz(a)anthracene	0.1	0.87	0.78	1	1.1	1.7	0.86
Chrysene	0.1	0.77	0.54	0.73	0.81	0.83	0.93
Benzo(b+j)fluoranthene	0.2	0.64	0.78	1.2	0.68	1.7	0.73
Benzo(k)fluoranthene	0.1	0.54	0.56	0.63	0.63	1.4	0.19
Benzo(a)pyrene	0.5	ND	ND	0.68	ND	0.6	ND
Indeno(1,2,3-cd)pyrene	1.0	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1.0	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	1.0	ND	ND	ND	ND	ND	ND

Patrick Pond, Chief Technical Officer

ND - none detected

Form Name: DOC13 Data Report PAH 5-Nov-08 DGH

DATA REPORT

Client: Golder Associates
Contact: Lizanne Meloche

Date Extracted: n/a
Date Analysed: 9-Dec-09

	Client ID:	20	21	22	23	24	25
	PRL ID:	PR91814	PR91815	PR91816	PR91817	PR91818	PR91819
	Extract Wt. (g):	1.54	1.36	1.45	1.44	1.59	1.49
Compound	**DL**						
	ng/sample	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**
Naphthalene	0.1	0.37	2.6	0.51	0.48	0.71	0.36
Acenaphthylene	0.1	0.11	0.14	ND	ND	0.12	0.11
Acenaphthene	0.2	0.32	2.5	ND	ND	0.28	ND
Fluorene	0.1	ND	1.2	0.14	0.16	0.48	0.23
Phenanthrene	0.1	0.76	6.9	0.95	1	2.2	0.8
Anthracene	0.1	0.77	2.8	0.27	0.2	0.46	0.3
Fluoranthene	0.1	5.9	8.3	2.6	2.3	1.1	2.3
Pyrene	0.1	11	16	1.6	1.1	0.71	1.8
Benz(a)anthracene	0.1	2	2.2	0.63	0.69	0.42	0.75
Chrysene	0.1	1.1	1.3	0.95	0.79	0.39	0.64
Benzo(b+j)fluoranthene	0.2	1.6	1.9	0.56	0.46	ND	0.51
Benzo(k)fluoranthene	0.1	1.3	1.8	0.36	0.28	ND	ND
Benzo(a)pyrene	0.5	1	0.71	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	1.0	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1.0	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	1.0	ND	ND	ND	ND	ND	ND

Patrick Pond, Chief Technical Officer

ND - none detected

Form Name: DOC13 Data Report PAH 5-Nov-08 DGH

DATA REPORT

Client: Golder Associates
Contact: Lizanne Meloche

Date Extracted: n/a
Date Analysed: 10-Dec-09

Compound	DL	Client ID:	26	27	28	29	30	31
		PRL ID:	PR91820	PR91821	PR91822	PR91823	PR91824	PR91825
		Extract Wt. (g):	1.61	1.27	1.35	1.58	1.68	1.55
	ng/sample		ng/sample	ng/sample	ng/sample	ng/sample	ng/sample	ng/sample
Naphthalene	0.1		0.69	0.72	0.27	0.67	0.3	0.28
Acenaphthylene	0.1		0.24	ND	0.16	0.13	0.12	0.1
Acenaphthene	0.2		2.5	0.32	0.27	ND	ND	ND
Fluorene	0.1		3.4	0.24	0.16	0.24	0.35	ND
Phenanthrene	0.1		21	1.7	1.2	0.98	1.7	0.94
Anthracene	0.1		13	0.59	0.47	0.39	0.74	ND
Fluoranthene	0.1		163	5.1	5.5	4.3	4.1	1.1
Pyrene	0.1		113	4.4	3.2	2.9	3.3	0.82
Benz(a)anthracene	0.1		23	1.2	1.1	0.56	2.1	0.36
Chrysene	0.1		16	0.92	0.88	0.43	1.2	0.63
Benzo(b+j)fluoranthene	0.2		12	0.74	0.99	0.4	1.3	0.21
Benzo(k)fluoranthene	0.1		11	1	0.53	0.44	1	0.34
Benzo(a)pyrene	0.5		6.7	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	1.0		ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1.0		ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	1.0		ND	ND	ND	ND	ND	ND

Patrick Pond, Chief Technical Officer

ND - none detected

Form Name: DOC13 Data Report PAH 5-Nov-08 DGH

DATA REPORT

Client: Golder Associates
Contact: Lizanne Meloche

Date Extracted: n/a
Date Analysed: 10-Dec-09

	Client ID:	32	33	34	35	36	37
	PRL ID:	PR91826	PR91827	PR91828	PR91829	PR91830	PR91831
	Extract Wt. (g):	1.3	1.59	1.24	1.42	1.43	0.99
Compound	**DL ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**
Naphthalene	0.1	0.53	0.67	0.19	0.48	0.26	0.21
Acenaphthylene	0.1	0.18	ND	0.13	ND	ND	ND
Acenaphthene	0.2	ND	ND	ND	ND	ND	ND
Fluorene	0.1	0.24	0.3	0.13	0.16	0.2	0.21
Phenanthrene	0.1	1.8	1.4	0.81	0.45	0.56	1.2
Anthracene	0.1	0.44	0.18	0.17	0.17	0.13	0.36
Fluoranthene	0.1	1.5	0.59	1.2	0.65	1.7	1.8
Pyrene	0.1	1.5	0.57	0.54	0.89	0.94	1.4
Benz(a)anthracene	0.1	0.45	0.23	0.37	0.35	0.57	0.47
Chrysene	0.1	0.61	0.51	0.5	0.29	0.6	0.52
Benzo(b+j)fluoranthene	0.2	ND	ND	ND	0.28	0.21	0.29
Benzo(k)fluoranthene	0.1	ND	ND	ND	ND	0.51	ND
Benzo(a)pyrene	0.5	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	1.0	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	1.0	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	1.0	ND	ND	ND	ND	ND	ND

Patrick Pond, Chief Technical Officer

ND - none detected

Form Name: DOC13 Data Report PAH 5-Nov-08 DGH

DATA REPORT

Client: Golder Associates
Contact: Lizanne Meloche

Date Extracted: n/a
Date Analysed: 10-Dec-09

	Client ID:	38	39	40	NC	PC	B
	PRL ID:	PR91832	PR91833	PR91834	PR91835	PR91836	PR91837
	Extract Wt. (g):	1.31	0.17	1.7	1.75	1.28	1.64
Compound	**DL**						
	ng/sample	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**	**ng/sample**
Naphthalene	0.1	0.3	ND	0.63	0.31	693	0.47
Acenaphthylene	0.1	ND	ND	0.14	0.11	611	0.13
Acenaphthene	0.2	ND	ND	ND	ND	919	ND
Fluorene	0.1	0.17	ND	0.28	0.26	482	0.12
Phenanthrene	0.1	0.54	0.12	1.5	0.95	258	0.51
Anthracene	0.1	0.15	ND	0.32	ND	245	ND
Fluoranthene	0.1	1.9	0.38	2.9	0.8	234	0.16
Pyrene	0.1	1.5	0.44	2.4	0.88	193	0.16
Benz(a)anthracene	0.1	0.61	0.38	0.75	0.46	94	0.36
Chrysene	0.1	0.51	0.34	0.87	0.21	82	0.2
Benzo(b+j)fluoranthene	0.2	0.4	ND	0.6	ND	89	0.26
Benzo(k)fluoranthene	0.1	0.17	ND	0.48	0.12	76	0.45
Benzo(a)pyrene	0.5	ND	ND	ND	ND	78	ND
Indeno(1,2,3-cd)pyrene	1.0	ND	ND	ND	ND	83	ND
Dibenz(a,h)anthracene	1.0	ND	ND	ND	ND	52	ND
Benzo(ghi)perylene	1.0	ND	ND	ND	ND	79	ND

Patrick Pond, Chief Technical Officer

ND - none detected

Form Name: DOC13 Data Report PAH 5-Nov-08 DGH

JP PetroGraphics

Client:	Vancouver Petrographics-Golder & Associates
Project #:	09-1436-5008-5000
Contact:	Jim Vinnell, VanPetro [vanpetro@vanpetro.com]; Adrian de Bruyn
Petrography by:	Judith Potter, Ph.D., P.Geol. jpp@sitogeo.com
Date:	05-Jan-10

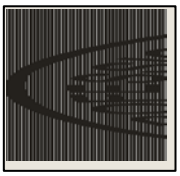
Samples #	% coal HVB rank (Up Cret)	% shaley coal (hvb) (Up Cret)	% organic-rich mud or mudstone	% coal char	% recent phyterals- mineralized wood, wood, peat, algae, bark, spores, fungal & faunal remains	% shale - mudstone, - clays
Priority #1						
16741-02	4.3	1.0	-	0.7	43.0	20.4
16741-04	3.7	3.3	1.3	1.7	16.7	18.3
16741-07	9.7	2.0	4.3	0.4	22.3	22.7
16741-08	8.3	1.7	3.3	-	31.7	8.3
16745-02	25.0	19.7	1.0	-	-	8.0
16745-03	20.0	1.0	34.0	-	14.3	4.0
16745-04	18.3	3.3	5.0	0.7	16.7	12.7
16745-08	17.0	29.0	12.0	-	0.3	4.7
16745-10	5.0	1.3	0.3	-	18.4	14.7
16745-11	3.0	0.3	0.3	-	3.3	6.3
16748-03	3.7	-	4.0	2.0	4.7	4.0
16748-04	6.3	1.3	1.0	0.3	9.0	11.3
16748-06	7.0	1.0	1.3	-	31.0	15.4
Priority #2	**January 11, 2010**					
16741-01	6.7	3.7	-	-	40.0	13.3
16741-03	9.0	3.7*	-	1.0	34.5	2.7
16741-05	1.3	1.3	1.7	2.3	1.0	9.7
16741-06	0.7	1.3	1.3	0.3	2.0	8.0
16741-09	6.7	2.0	0.7	-	11.7	12.3
16745-01	15.0	9.7	0.3	0.7	0.7	27.6
16745-05	66.8	11.0	2.3	-	9.3	5.0
16745-06	17.3	2.3	4.3	-	30.0	8.3
16745-07	25.7*	4.6	-	0.3	33.0	4.7
16745-09	10.3	0.7	1.0	1.3	9.0	9.0
*16748-28**	9.7**	-	0.4	0.3	1.3	19.7
Priority #3	January 19, 2010					
16745-12	10.3	-	-	-	30.7	9.7
16748-01	18.7	1.7	2.0	0.3	40.3	4.3
16748-02	11.0	0.7	1.0	0.7	28.7	16.0
16748-05	-	-	-	-	0.4	9.3
16748-08	16.7	4.7		-	3.0	6.7
16748-09	9.0	1.0		0.3	22.7	5.0
16748-10	15.0	2.0	5.0	0.7	46.3	-

16748-11	17.0	2.3	2.0	1.0	23.7	2.7
16748-12	14.0	2.3	3.7	-	38.3	2.3
16751-01	13.0	3.7	4.0	-	50.0	-
16751-02	11.4	1.3	0.7	-	29.3	1.3
16751-03	43.7	5.3	5.0	1.0	29.6	1.7
16751-04	33.7	13.7	6.7	-	17.3	1.7
16751-05	21.3	5.3	2.3	-	13.7	2.0
16751-06	19.3	0.7	2.0	0.3	31.7	1.0
16751-07	28.7	26.0	4.3	1.3	2.3	6.7
16751-08	16.3	25.7	3.0	0.3	0.7	13.7
16751-09	23.7	9.0	9.0	-	37.0	0.7
16751-10	6.3	1.3	0.7		4.0	4.7
16751-11	11.7	2.0	1.0		5.7	4.7

*based on 300 points per slide

all point counting done under reflected, white light, using oil immersion objectives at X600

90, Patterson Close SW, Calg
Tel: (403) 240-0240
jpp@sitogeo.com



% coaly shale-mud-stone (recent)	Inorganic		Total*	Other
	pyrite, silica, silicates	salts (Na, Ca, Fe carbonates) & sulphides		
7.0	23.3	0.3	100.0	
28.4	20.3	6.3	100.0	
20.3	12.3	0.7	94.7	+ 5.3% iron oxide
28.7	17.0	0.7	99.7	+ 0.3% iron oxides
42.3	1.3	2.7	100.0	
21.0	5.0	0.7	100.0	
39.3	2.7	1.3	100.0	
33.3	-	3.7	100.0	
0.3	28.0	32.0	100.0	
3.0	49.3	33.0	98.5	+ 1.5% iron oxides
4.3	31.0*	46.3	100.0	
16.7	30.7	22.7	99.3	+ 0.7% iron oxide
11.7	14.3	18.3	100.0	
28.3	1.7	6.3	100.0	
45.7	1.7	1.7	100.0	
0.7	44.3	37.3	99.6	+ 0.4% iron oxide
-	37.7	48.7*	100.0	
2.3	39.7	24.3	99.7	+ 0.3% iron oxide
27.0	18.7	0.3	100.0	
5.3	0.3	-	100.0	
35.5	1.0	1.0	99.7	+ 0.3% iron oxide
27.7	2.3	1.0	99.3	+ 0.7% iron oxide
11.3	19.7	37.3	99.6	+ 0.4% iron oxide
24.3	9.3	31.3	96.3	+ 3.7% iron oxide
14.3	21.7	12.7	99.4	+ 0.6% iron oxides
20.7	2.3	8.0	98.3	+ 1.7% iron oxide
33.7	0.7	7.0	99.5	+ 0.5% iron oxide
-	47.0	42.0	98.7	+ 1.3% iron oxide
48.0	9.3	11.3	99.7	+ 0.3% iron oxide
28.0	17.7	16.3	100.0	
12.3	11.3	7.0	99.6	+ 0.4% iron oxide

46.7	2.0	2.0	99.4	+ 0.6% iron oxides
31.0	0.7	6.7	99.0	+ 1.9% iron oxides
23.0	1.3	2.7	97.7	+ 2.3% iron oxides
53.0	0.7	1.3	99.0	+ 1.0% iron oxide
10.7	1.0	1.0	99.0	+ 1.0% iron oxide
23.0	1.3	2.3	99.7	+ 0.3% iron oxides
35.0	7.0	10.7	97.3	+ 2.7% iron oxides
43.7	0.7	-	99.4	+ 0.6% iron oxides
25.7	1.7	3.3	100.0	
35.7	0.7	3.3	99.4	+ 0.6% iron oxides
15.7	0.7	4.2	100.0	
5.0	37.3	40.0	99.3	+ 0.7% iron oxide
0.7	42.3	31.7	99.8	+ 0.2% iron oxide

magnification

ıry, Alberta, T3H 3K2, Canada

Comments
/hydroxies
/hydroxies
coarse sediment- particles over 250µm
fine sediment
carbonates include siderite
inorganic dominates by silicates, salts
*mostly transparent-translucent mineral ?silica
/hydroxies
*organic elements in shale are recent
/hydroxies
* largely ?siderite assocaited with sulphides
/hydroxies
sample predominantly Cretaceous coal
/hydroxies
*ca. 2% of coal may be low rank coal
/hydroxides
**16748-07 missing from sample set; 16748-28 originally not included*
**much of coal is low rank coaly matter
/hydroxides
/hydroxides
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TOXICITY TESTS CONDUCTED ON LADYSMITH HARBOUR MARINE SEDIMENTS (OCTOBER 2009) PROJECT: 09-1436-5008 - FINAL REPORT

Prepared for:

Golder Associates
500-4260 Still Creek Drive
Burnaby, British Columbia
Canada V5C 6C6

Prepared by:

Ecotoxicology Group
CANTEST Ltd.
4606 Canada Way
Burnaby, BC
Canada V5G 1K5

CANTEST Project No.: 2-11-1024

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EXECUTIVE SUMMARY

A total of 44 sediment samples were collected from Ladysmith Harbour, British Columbia, October 19- 22, 2009. The samples were received at CANTEST on October 22, 2009, where they were stored in the dark at 4 ± 2 °C, prior to testing.

As per the client's instruction, 19 of the 44 samples were tested with *Eohaustorius estuarius* using the 10-day Acute Survival and Reburial Test, as described by Environment Canada's Biological Test Methods (EPS 1/RM/35). Testing with *E. estuarius* was initiated on November 13, 2009 and November 20, 2009. The reburial test was performed using amphipods recovered from each sediment sample, immediately following their 10 day exposure.

In addition to the amphipod test, the sediments were evaluated with the Echinoid Fertilization Test, 20-day *Neanthes arenaceodentata* Survival and Growth Test, and the *Vibrio fischeri* Light Inhibition Test (Microtox™). These tests were initiated with 9 of the 19 samples as specified by Golder Associates.

The *N. arenaceodentata* test was initiated on November 20, 2009 and was conducted under conditions outlined in the Puget Sound Estuary Program (PSEP 1995).

The fertilization success of gametes of the echinoderm, *Strongylocentrotus purpuratus,* was conducted according to the Environment Canada's Biological Test Method: Fertilization Assay Using Echinoids Test (EPS 1/RM/27). The Echinoid Fertilization test was performed on November 19, 2009. Gametes were exposed to centrifuged porewater from each of the selected sediments.

The Solid Phase Light Inhibition Microtox™ test was conducted using the bacteria *Vibrio fischeri* using the Environment Canada Biological Method for Determining the Toxicity of a Sediment Using Luminescent Bacteria (EPS 1/RM/42).

The test results are summarized as follows:

Of the 19 samples tested with the amphipod, *E. estuarius*, 16740-01, 16740-03, 16740-04, 16740-05, 16744-01, 16744-03, 16744-06 and 16744-09 were found to have significant reductions in mean amphipod survival compared to the negative control. Mean reburial for all samples tested was 100%.

Seven samples were found to have significantly lower mean echinoderm fertilization compared to the negative control: 16740-02, 16740-04, 16740-07, 16744-03, 16744-11, 16747-03 and 16747-06.

The 20 day *N. arenaceodentata* test results showed that neither mean survival nor growth was significantly reduced in any of the samples statistically compared to the negative control.

The estimated IC50 values for all samples tested were >5000 mg/L for the Solid Phase Light Inhibition Microtox™ tests. The standard interpretation of IC50 values exceeding this concentration is that they are practically non-toxic.

All tests were considered valid as survival in the laboratory controls met and/or exceeded the requirements outlined in the respective test protocols.

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SECTION

1 SEDIMENT DESCRIPTION

1.1 Sample Information

A total of 44 sediment samples were collected from Ladysmith Harbour, BC, October 19- 22, 2009. The samples were received at CANTEST in good condition on October 22, 2009. Of the 44 samples, 19 were selected for toxicity testing with *Eohaustorius estuarius*, and of these 9 were selected for further assessment with a battery of toxicity tests. All toxicity tests were initiated between November 13, 2009 and November 27, 2009. Sample receipt information, along with the Chain-of-Custody Forms, are available in Appendix A.

The volume of sediment supplied, either 5L or 10L, was dependant on the number of tests requested for each sediment sample. All samples arrived at our laboratory in satisfactory condition, and there were no apparent events during shipping and handling which might compromise the quality of the samples. The samples varied in colour, texture, grain size and content. Upon opening the sample pails, a description of the sample was noted ("Sediment Sample Descriptions" in Appendix A). The sediments from each sample were thoroughly homogenised before their distribution into the test vessels. Any headspace in the pails was replaced with nitrogen gas prior to re-sealing the pail. When not in use, the sediments were stored without light at 4 ± 2°C.

1.2 Porewater and Sediment Characterisation

Prior to toxicity testing, porewater aliquots were collected from the sediment samples for ammonia, sulphides, salinity, temperature and pH measurements.

Analysis of ammonia and in porewater was performed at the CANTEST Environmental Quality Laboratory. A Flow Injection Analysis method was employed to determine the total ammonia concentrations as N (mg/L) in the samples. This involved treating the aqueous sample with sodium hydroxide to form gaseous phase ammonia. Acid-base indicators present in the mixture reacted with ammonia and the product was then quantified photometrically at 590 nm. Un-ionized ammonia was determined using the Un-ionized Ammonia Calculator (Seawater) Spreadsheet (Colt 2002), adjusting for salinity, pH, and temperature. The results for total and unionized ammonia are located in Appendix A.

The measurement of Sulphide in porewater was also performed at CANTEST Environmental Quality Laboratory. The protocol used in the analysis of sulphides was based on Method 4500-S2 D (Standard Methods, 21ST Edition), and Method X031(BC Laboratory Manual). Sulphides data may be located in the chemistry reports for porewater analysis in Appendix A.

Homogenized sub-samples of all sediments were analyzed for grain size analysis, Total Organic Carbon (TOC) content, and Moisture Content. Table 1-1 summarizes the results of these analyses.

Table 1-1: Results for percent Total Organic Carbon, Grain size and Moisture Content for Ladysmith Harbour Sediments, collected October 2009.

Sample ID	CANTEST Login ID	Total Organic Carbon (%)	Moisture Content (%)	Grain size (%)		
				Sand	Silt	Clay
MB Control	-	<0.5	19.2	99.07	0.34	0.6
CB Control	-	3.1	60	3.63	50.99	45.38
16740-01	910300222	9.33	73.1	35.37	50.82	13.81
16740-03	910300227	11.3	66.6	26.62	47.72	25.66
16740-05	910300229	1.14	15.4	96.24	1.96	1.81
16740-06	910300230	1.23	16.3	95.09	2.70	2.21
16740-09	910300233	1.65	32.9	85.63	8.86	5.51
16744-01	910300234	10.1	27.0	81.37	13.99	4.64
16744-05	910300238	6.03	16.7	78.94	15.14	5.92
16744-06	910300239	43.3	57.6	30.13	61.62	8.25
16744-09	910300242	1.68	29.0	83.82	11.72	4.46
16747-07	910300251	3.43	50.0	49.81	36.05	14.14
16744-11	910300243	1.31	17.1	93.83	3.98	2.20
16740-04	910300228	8.3	60.4	61.22	30.42	8.37
16740-02	910300226	7.72	74.0	42.73	34.52	22.75
16740-07	910300231	11.2	70.1	26.08	48.50	25.42
16744-03	910300236	28.6	66.3	32.75	50.59	16.65
16744-08	910300241	6.03	20.8	85.03	10.91	4.06
16747-06	910300250	2.96	39.5	85.15	8.63	6.22
16744-02	910300235	3.43	20.3	89.18	7.39	3.43
16747-03	910300247	1.76	31.1	81.48	13.38	5.15

Note: MB=Mackenzie Beach, CB= Chesapeake Bay. Particle size categories: sand < 4.75mm- >0.075mm, silt < 0.075mm- >0.002mm, clay <0.002mm.

1.3 Negative Control Sediment

The negative control sediment used in the amphipod tests, was collected intertidally from Mackenzie Beach, Tofino, BC. This sandy sediment has been used as a negative control in previous studies within our laboratory, and has been found to be non-toxic to a variety of organisms. It was sieved with the appropriate seawater before use.

The control sediment used in the *Neanthes arenaceodentata* test was provided by an organism supplier, and was collected from Chesapeake Bay, NH. Preparation of the sediment for use as a negative control included press-sieving the material through a 250um stainless steel screen, rinsing the sediment with control water, then by freezing the sediment for a minimum of 72-h to eliminate any potential indigenous organisms that might be present.

Previous *N. arenaceodentata* tests that have utilized this sediment as a negative control have demonstrated satisfactory and consistent performance for both the survival and growth endpoints.

1.4 Overlying Water

The overlying water was uncontaminated seawater obtained from the Vancouver Aquarium. The seawater was pumped from Burrard Inlet from a depth of 40-45 feet and filtered through a gravity sand filter, with sand mesh size 22. After filtration, the seawater was held in a concrete reservoir (retention time approximately 4 hours) before passing through a UV sterilizer.

At CANTEST, the seawater was stored at 4 ± 2°C. Before its use in tests, the seawater was passed through a U.V sterilizer equipped with an inline 1µm filter. Volumes required for testing were gradually brought to the appropriate test temperature overnight while vigorously aerating.

SECTION

2 10-DAY ACUTE AMPHIPOD TEST

2.1 Test Methods and Conditions

The survival and reburial of the amphipod *Eohaustorius estuarius*, was assessed according to the Environment Canada Test Method "Reference Method for Determining Acute lethality of Sediment to Marine or Estuarine Amphipods" (1998).

Two 10-day *E. estuarius* tests were initiated; the first on November 13, 2009, and the second on November 20, 2009, with reburial commencing on test end dates, November 23, 2009 and November 30, 2009, respectively. See Table 2-1 for details regarding the specific methods and conditions employed in both toxicity tests. Results of the reburial test are presented in Appendix B.

Table 2-1: Summary of Test Methods and Conditions for the 10-d Acute Amphipod Survival Test

Parameter	**Conditions and Methods**
Test Type and Duration	10 Day, Static (non-renewal)
Temperature	15 ± 2° C
Salinity	28 ± 2 ‰
Photoperiod and Illuminance	Continuous Light. Wide spectrum cool white fluorescent lights used to provide 500-1000 lux.
Aeration	2-3 bubbles/ second. Clean oil-free air supplied to each test vessel via micro-bore plastic tubing
Test Chamber	1 L Jars with plastic lids containing small opening for airline tubing.
Sediment Volume	175 ml of homogenized sediment (≈ 2cm depth)
Overlying Water	Vancouver Aquarium seawater; U.V sterilized, filtered and aerated before use.
Overlying Water Volume	800 ml

Parameter	Conditions and Methods
Overlying Water Quality	Day 0 and Day 10: temperature, pH, salinity, and dissolved oxygen, and ammonia measurements on a composite water sample. On Days 3, 5, 7: dissolved oxygen and temperature.
Replicates	5 per sample, plus an additional replicate for water quality measurements
Control Sediment	Mackenzie Beach Sand. Rinsed with overlying water.
Organisms/ replicate	20
Organism size and source	Amphipods sized 3-5mm, field collected by Seacology staff from Mackenzie Beach, Tofino, BC. See section 2.2.3 for more details.
Feeding	None.
Observations	Organism behaviour during test, visible mortalities and/or abnormal behaviour were recorded in the Test Observations Page (Appendix B)
Endpoints	Survival and Reburial
Test Validity Criteria	≥ 90% mean survival in the negative controls. No less than 80% survival in any one control replicate.
Data Analysis	Data were assessed for normality using Shapiro-Wilks Test, and homogeneity of variance by Bartlett's Test and/or Levene's Test. Significant differences between the mean survival in the samples and the negative control were determined by parametric analysis (equal variance two-sample t tests). Statistical bench sheets available in Appendix B.
Statistical Software	CETIS™ version 1.7.0revO. Tidepool Scientific Software (Copyright 2000-2009).

2.2 Quality Assurance/Quality Control

2.2.1 Reference Toxicant Results

Water-only reference toxicant tests, using cadmium chloride ($CdCl_2 \cdot 2.5H_20$), were performed with each amphipod test to assess the performance of the test organism and the precision of the results. The LC50 of each reference toxicant test was calculated and compared to previous test results plotted in a control chart. The control charts are included in Appendix B. Methods used in preparing the control charts were taken from the CANTEST SOP "Standard Operating Procedure for the Control Charting of Reference Toxicant Tests" (DCN 80-E-008) and from Environment Canada (1990).

The LC50 value for the reference toxicant test initiated on November 13, 2009, with 95% Confidence Limits, was 9.1 (6.8, 11.7) mg/L Cd^{2+}. The previous mean for this species, with 2 SD, was 8.2 (4.4, 12.1) mg/L Cd^{2+}.

The LC50 value for the reference toxicant test initiated on November 20, 2009, with 95% Confidence Limits, was 10.1 (8.1, 12.5) mg/L Cd^{2+}. The previous mean for this species, with 2 SD, was 8.3 (4.6, 12.0) mg/L Cd^{2+}.

2.2.2 Test Validity Criteria

Survival data in the negative controls were considered be acceptable if the mean percent survival in the negative control was greater than or equal to 90%, and survival was greater than or equal to 80% in each replicate (Environment Canada, 1998). The mean negative control survival was determined to be 98% in the test initiated on November 13, 2009, and 99% in the test initiated November 20, 2009.

2.2.3 Organism Collection Information

E. estuarius were collected by Seacology (SE), North Vancouver, BC on November 8- 9, 2009, from Mackenzie Beach (Lat. 49° 8' 01"Long. 125° 54' 20"), Tofino, BC. The amphipods were delivered to CANTEST on November 10, 2009.

All holding containers, buckets, pipettes, sieves, and the hands of collectors were thoroughly rinsed in marine water adjacent to the amphipod collection site before commencing the collection of amphipods.

Sediment containing amphipods was carefully sieved using a 1 mm mesh sieve while submerged in 26‰ water collected on site. Larger debris and gravel, retained in the sieve was immediately removed to prevent abrasions to amphipods by larger objects. The screen was floated in water and the contents retained in the sieve were inspected for the presence of predator organisms, which were removed when observed. Amphipods were transferred using a wide-bore glass pipette from the submerged sieve and counted into holding containers. Sieved sediment was used to fill amphipod holding containers to a sediment depth of 1 cm or placed in plastic bags for use as reference sediment. Holding containers were filled with amphipods to a density of 1 amphipod per centimeter squared. Containers were stored in a cooler with cold packs to maintain temperature between 13 and 15°C. Between transportation events, while in the field and immediately prior to the return to Vancouver, the holding containers were opened to allow uninhibited exchange of oxygen. To prevent spillage holding containers are sealed only immediately after collection while on site and immediately prior to the return trip to Vancouver. If necessary, water changes, which included the removal of injured and/or inactive amphipods, were performed every 36 hours before the amphipods were delivered to CANTEST.

The following key taken from “Marine Invertebrates of the Pacific Northwest” (Kozloff 1996) was used to identify the marine amphipods used in this test as *Eohaustorius estuarius*:

1a) One or both gnathopods simple

- 2b) Eyes absent or indistinct; article 5 of gnathopod 2 without a posterodistal lobe projecting alongside article 6; rami of uropod 3 slender or foliaceous, but not paddlelike
- 3b) Articles 4 and 5 of antenna 2 broad and with many long setae; pereopods 6 and 7 broad; pereopod 6 appearing subchelate
- 5b) Article 2 of pereopod 7 lacking a posteroproximal tooth; article 5 of adult pereopod 7 with 2 groups of spines along the anterior margin

7b) Article 7 of gnathopod 1 half as long as article 4

8b) Article 5 of pereopod 4 without spines along its posteroproximal margin; article 6 of pereopod 5 approximately equal in length to article 5; article 2 of pereopod 7 with proximal posterior corner smoothly rounded.

2.2.4 Summary of Organism and Sample Holding Information

Upon arrival of the amphipods at CANTEST, temperature, dissolved oxygen concentration, pH, and salinity were measured in a representative sample of the shipping water. The holding containers were carefully placed in a large aquarium of aerating Vancouver Aquarium seawater. Any salinity or temperature adjustments to the holding water of the amphipods did not exceed 5‰ or 3°C per day. The animals were not fed during the holding period. Partial water changes were conducted as necessary. Bench sheets of daily water quality with observations of number dead, emerged, and inactive amphipods during the holding period and the amphipod lengths are presented in Appendix B.

Amphipods were held in the laboratory for 2-10 days in negative control sediment under static conditions at 15 ± 2°C. See the bench sheets for “Acclimation and Holding Conditions” in Appendix B for more details.

2.3 Results

Total and percent survival in each replicate and mean ± SD in each control and test sediment are presented in Appendix B. Overall mean survival in the samples ranged from 69 to 99%. The results for the mean survival comparisons, between the control and the samples are in Tables 2-2 and 2-3.

Total and unionized ammonia concentrations, pH, temperature, and salinity in overlying water at test initiation (Day 0) and completion (Day 10) are presented in Appendix B. For all other daily water quality measurements, see the bench-sheets in Appendix B.

Directly after test initiation, it was observed that many of the amphipods appeared to be actively avoiding certain test sediments; specifically, avoidance behaviour was noted in all replicates of samples 16740-01, 16740-02, 16740-03, 16740-09, 16744-06, and 16744-11.

Table 2-2: Mean Amphipod Survival in the 10 Day Acute Tests (initiated November 13, 2009)

Sample ID	CANTEST Login ID	Mean Survival ± SD (%)
Control	-	98.0 ± 4.5
16740-01	910300222	92.0 ± 2.7*
16740-03	910300227	92.0 ± 4.5*
16740-05	910300229	91.0 ± 2.2*
16740-06	910300230	96.0 ± 2.2
16740-09	910300233	95.0 ± 3.5
16744-01	910300234	91.0 ± 5.5*
16744-05	910300238	91.0 ± 9.6
16744-06	910300239	88.0 ± 5.7*
16744-09	910300242	69.0 ± 15.6*
16747-07	910300251	93.0 ± 5.7

Note: Asterisks indicate that there is a statistically significant decrease in the sample mean compared to the negative control (*).

Table 2-3: Mean Amphipod Survival in the 10 Day Acute Tests (initiated November 20, 2009)

Sample ID	CANTEST Login ID	Mean Survival ± SD (%)
Control	-	99.0 ± 2.2
16744-11	910300243	95.0 ± 6.1
16740-04	910300228	93.0 ± 2.7*
16740-02	910300226	80.0 ± 44.7
16740-07	910300231	98.0 ± 2.7
16744-03	910300236	95.0 ± 3.5*
16744-08	910300241	96.0 ± 6.5
16747-06	910300250	98.0 ± 2.7
16744-02	910300235	73.0 ± 37.3
16747-03	910300247	99.0 ± 2.2

Note: Asterisks indicate that there is a statistically significant decrease in the sample mean compared to the negative control (*).

2.4 Discussion

Both sets of tests met the test validity criteria, the mean survival in the controls was 98% and 99%, respectively. The total mean survival in the test sediments ranged from 69.0 to 99.0%, with

samples 16740-01, 16740-03, 16740-04, 16740-05, 16744-01, 16744-03, 16744-06 and 16744-09 being significantly different from their respective negative control.

Two samples, 16740-02 and 16744-02, had one or two replicates where indigenous crabs were discovered at the end of the test. It is possible that their presence impacted the survival of the seeded amphipods. However, neither sample mean was found to be significantly lower than the control mean.

SECTION

3 20-DAY *NEANTHES ARENACEODENTATA* TEST

3.1 Test Methods and Conditions

The survival and growth of *Neanthes arenaceodentata* was assessed according to the test protocol "Juvenile Polychaete Sediment Bioassay", outlined in the Puget Sound Estuary Program (1995). The 20-d Growth and Survival Tests were initiated on November 20, 2009 using the 9 selected sediment samples. See Table 3-1 for details regarding the specific methods and conditions employed in this study.

Table 3-1: Summary of Test Methods and Conditions for the *20-d Neanthes arenaceodentata* Survival and Growth Test

Parameter	**Conditions and Methods**
Test Type and Duration	20 Days, Static-renewal
Temperature	20 ± 1° C
Salinity	28 ± 2 ‰
Photoperiod and Illumination	24 hours continuous light. Wide spectrum cool white fluorescent lights used to provide ambient laboratory light.
Aeration	< 100 bubbles/ minute. Clean oil-free air supplied to each test vessel via micro-bore plastic tubing
Test Chamber	1L Jars. Plastic lids containing a small opening for airline tubing, placed on top.
Sediment Volume	175 ml of homogenized sediment (≈ 2 cm depth)
Overlying Water	Vancouver Aquarium seawater. Water, U.V sterilized, filtered and aerated before use.
Overlying Water Quality	Day 0 and Day 20: temperature, pH, salinity, dissolved oxygen and ammonia measurements. Every third day directly before water renewal; pH, salinity, dissolved oxygen and temperature measurements.
Overlying Water Volume and Renewals	800 ml. 30% renewals every third day directly after recording water quality measurements.
Replicates	5 per sample, plus an additional replicate for water quality measurements.
Control Sediment	Two control sediments Chesapeake Bay Sediment and Mackenzie Beach Sand. Rinsed thoroughly with overlying water.
Organisms/ replicate	5

Parameter	Conditions and Methods
Organism Source and age	Don Reish, California State University, Long Beach, CA. Average worm weight at test initiation was 0.83 mg.
Feeding	Every second day: 40 mg Tetramarine® per replicate delivered in seawater slurry.
Observations	Organism behaviour during test, visible mortalities and/or abnormal behaviour were recorded in the Test Observations Page (Appendix C)
Endpoints	Survival and Growth
Test Validity Criteria	≥ 90% mean survival in the negative controls.
Data Analysis	Data were assessed for normality using Shapiro-Wilks Test, and homogeneity of variance by Bartlett's Test and/or Levene's Test. Analyses of mean survival, mean dry weight and mean growth, comparing the samples to the negative control were completed using parametric two sample t- tests (equal and unequal variance). Statistical Bench sheets available in Appendix C.
Statistical Software	CETIS™ version 1.7.0rev0. Tidepool Scientific Software (Copyright 2000-2009).

3.2 Quality Assurance/Quality Control

3.2.1 Reference Toxicant Results

A water-only reference toxicant test using cadmium chloride ($CdCl_2 \cdot 2.5H_20$) was initiated on November 20, 2009. The reference toxicant test is used to assess the performance of the test organism and the precision of the results. The LC50 and 95% confidence intervals, after a 96 hour test period, were calculated then entered into a control chart. The results were then compared with those of previous tests with this test organism, which are included in Appendix C. Methods used in preparing the control chart were taken from the CANTEST SOP "Standard Operating Procedure for the Control Charting of Reference Toxicant Tests" (DCN 80-E-008) and from Environment Canada (1990).

The LC50 value for the reference toxicant test, with 95% Confidence Limits, was 9.8 (8.2, 11.6) mg/L Cd^{2+}. The previous mean for this species, with 2 SD, was 8.6 (5.2, 12.1) mg/L Cd^{2+}.

3.2.2 Test Validity Criteria

Survival data in the negative controls were considered be acceptable if the mean percent survival in the negative control was greater than or equal to 90% (PSEP, 1995). The mean negative control survival was determined to be 100%.

3.2.3 Organism Holding Information

The *Neanthes* arenaceodentata were laboratory-reared by the supplier, Don Reish, at the California State University, located in Long Beach, CA. The organisms were shipped in Whirlpacks® for overnight delivery, and arrived at CANTEST in satisfactory condition on November 17, 2009.

Upon arrival, temperature, dissolved oxygen concentration, pH, and salinity were measured in a representative sample of the shipping water. The organisms were carefully transferred into glass Pyrex™ dishes, and aeration was supplied. Holding water was added to the dishes after initial water quality had been determined. Any salinity or temperature adjustments to the holding water of the amphipods did not exceed 3‰ or 2°C per day. The animals were fed a small amount of ground Tetramarine™ upon arrival. Bench-sheets with recorded water quality, observations of number dead, emerged, and inactive organisms during the holding period are presented in Appendix C.

3.3 Results

Total and percent survival, dry weight, growth rate in each replicate, and mean ± SD in each control and test sediment, are summarized in Appendix C. Table 3-2 summarizes the significant differences in mean survival, and mean individual dry weight, between the control and the sample sediments.

Total and unionized ammonia concentrations, pH, temperature, and salinity in overlying water, at test initiation (Day 0) and completion (Day 20), are presented in Appendix C. For all other daily water quality measurements, see the bench-sheets in Appendix C.

Table 3-2: Results for the Mean Survival, Individual Dry Weight, and Growth Rate Comparisons for the 20-d *Neanthes arenaceodentata* Test

Sample ID	CANTEST Login ID	Mean Survival ± SD (%)	Mean Ind. Dry Weight ± SD(mg)	Mean Growth Rate ± SD (mg/day)
Control	-	100 ± 0.0	12.8 ± 3.5	0.60 ± 0.17
16744-11	910300243	96.0 ± 8.9	12.7 ± 4.0	0.59 ± 0.20
16740-04	910300228	84.0 ± 26.1	10.0 ± 3.0	0.46 ± 0.15
16740-02	910300226	100 ± 0.0	13.3 ± 2.7	0.62 ± 0.14
16740-07	910300231	100 ± 0.0	12.0 ± 2.9	0.56 ± 0.14
16744-03	910300236	100 ± 0.0	12.5 ± 1.4	0.58 ± 0.07
16744-08	910300241	100 ± 0.0	10.9 ± 3.5	0.50 ± 0.17
16747-06	910300250	100 ± 0.0	11.5 ± 2.7	0.53 ± 0.14
16744-02	910300235	100 ± 0.0	9.0 ± 3.9	0.41 ± 0.19
16747-03	910300247	100 ± 0.0	10.4 ± 2.8	0.48 ± 0.14

3.4 Discussion

The tests met the validity criteria; the mean survival in the control was 100%. The total mean survival in the test ranged from 84% to 100%, with no significant differences between the control sediment and the samples. Mean dry weight ranged from 9.0 to 13.3 mg per individual worm. Mean growth rate, measured per individual worm, per day, ranged from 0.41 to 0.62 mg in the test. No significant reductions in dry weight and growth rate were seen in any of the samples.

SECTION

4 *STRONGLYOCENTROTUS PURPURATUS* FERTILIZATION TEST

4.1 Test Methods and Conditions

The successful fertilization of echinoderm eggs was assessed according to the Environment Canada Biological Test Method "Fertilization Assay Using Echinoids (Sand Dollars or Sea Urchins)" EPS 1/RM/27. Echinoderm fertilization tests were initiated on the centrifuged porewater of 9 selected test sediments, on November 19, 2009. See Table 4-1 for details regarding the specific methods and conditions employed in this test.

Table 4-1: Summary of Test Methods and Conditions for the Echinoderm Fertilization Test

Parameter	Conditions and Methods
Test Type and Duration	20 minute fertilization; 10 minutes sperm exposure only, followed by another 10 minutes exposure with both sperm and eggs.
Temperature	15 ± 1° C
Salinity	30 ± 2 ‰
Lighting	Broad spectrum fluorescent lighting
Aeration	None during test. Pre-aeration for ≤ 20 minutes if the Dissolved oxygen content is less than 40% or greater than 100% saturation. See Test Data sheets in Appendix D
Test Chamber	20 ml borosilicate glass tubes
Test solution volume	5 ml
Control Water	Vancouver Aquarium seawater, from Burrard Inlet, 40-45' deep inlet, gravity sand filtered with sand mesh size 22. Seawater was additionally filtered, UV sterilized and aerated before use.
Renewal Water	None
Replicates	4 replicates/sample
Test Species	*Strongylocentrotus purpuratus* – Purple Sea Urchin
Age of Test Organisms	Recently spawned eggs and sperm
Organisms/ replicate	1051 eggs and 19711 sperm were added to each test vessel. The sperm:egg ratio was 18.75:1. See Calculation of Gamete Density sheet in Appendix D

Parameter	Conditions and Methods
Organism Source and size	Marine Research and Educational Products, Carlsbad, CA. Sea Urchins were between 3-9 cm in diameter and gravid
Feeding	None
Water Quality	DO, pH, salinity and temperature in the 100% porewater before mixing and at test initiation for each concentration
Endpoints	Fertilization rate
Test Validity Criteria	≥50% or <100% fertilization in the control.
Data Analysis	Data were assessed for normality using Shapiro-Wilks Test, and homogeneity of variance by Bartlett's Test. Analyses of mean fertilization rate, comparing the samples to the negative control were completed using parametric two sample t- tests (equal variance).
Statistical Software	CETIS™ version 1.7.0revO. Tidepool Scientific Software (Copyright 2000-2009).

4.2 Quality Assurance/Quality Control

4.2.1 Reference Toxicant Results

A water-only reference toxicant test, using copper sulphate ($CuSO_4$), was initiated on November 19, 2009. The reference toxicant test is used to assess the performance of the test organism and the precision of the results. The LC50 and 95% confidence intervals were calculated then entered into a control chart. The results were then compared with those of previous tests with this test organism, which are included in Appendix D. Methods used in preparing the control chart were taken from the CANTEST SOP "Standard Operating Procedure for the Control Charting of Reference Toxicant Tests" (DCN 80-E-008) and from Environment Canada (1990).

The IC50 value for the current reference toxicant test, with 95% Confidence Limits, was 37.7 (34.1, 40.4) µg/L Cu^{2+}. The previous mean for this species, with 2 SD, was 39.4 (5.5, 73.3) µg/L Cu^{2+}.

4.2.2 Test Validity Criteria

Survival data in the negative control was considered be acceptable as the mean percent fertilization in the negative control was greater than or equal to 50%, and less than 100%. The mean percent fertilization in the negative control was 94%.

4.2.3 Organism Holding Information

The *Stronglyocentrotus purpuratus* were field-collected by Steve Lepage of Marine Research and Educational Products, located in Carlsbad, CA. The organisms were held for at least 24 hours

prior to shipment to CANTEST. The sea urchins were shipped in Styrofoam coolers, with ice packs, and arrived at CANTEST in good condition on November 19, 2009.

Upon arrival, the sea urchins were transferred to glass aquaria filled with gently aerating sea water and held there prior to test initiation. Bench-sheets with recorded water quality, acclimation activities, and spawning records during the holding period are presented in Appendix D.

4.3 Results

Total and percent fertilization, in each replicate, and mean ± SD in the control and test sediment porewater samples, are presented in Appendix D. The mean fertilization rate ± SD for the control and test samples are summarized in Table 4-2.

For water quality measurements, see the bench-sheets in Appendix D.

Table 4-2: Results for Mean Fertilization Comparisons for the Echinoderm Fertilization Test

CANTEST Sample ID	CANTEST Login ID	Mean Fertilization ± SD (%)
Control	-	94 ± 5
16740-02	910300226	2 ± 2*
16740-04	910300228	45 ± 14*
16740-07	910300231	4 ± 4*
16744-02	910300235	95 ± 3
16744-03	910300236	2 ± 1*
16744-08	910300241	93 ± 7
16744-11	910300243	84 ± 4*
16747-03	910300247	8 ± 4*
16747-06	910300250	1 ± 0*

Note: Asterisks indicate that there is a statistically significant decrease in the sample mean as compared to the negative control (*).

4.4 Discussion

The test met validity criteria as the mean percent fertilization in the negative control was 94%. The total mean percent fertilization in the test ranged from 1% to 95%. Significant reductions in mean fertilization when compared to the negative control were found in samples 16740-02, 16740-04, 16740-07, 16744-03, 16744-11, 16747-03, and 16747-06.

SECTION

5 MICROTOX

5.1 Test Methods and Conditions

The acute solid-phase Microtox® test was performed using the luminescent bacteria *Vibrio fischeri.* The analyses were performed according to the Environment Canada Biological Test Method "Reference Method for Determining the Toxicity of Sediment Using Luminescent Bacteria in a Solid-Phase Test" EPS 1/RM/42, April 2002. The tests were performed on November 26, 2009 and November 27, 2009, using the 9 selected sediment samples. See Table 5-1 for details regarding the specific method and conditions employed in this test.

Table 5-1: Summary of Test Methods and Conditions for the Solid Phase Microtox™ Test

Parameter	Conditions and Methods
Test Type and Duration	Light Inhibition, 30 minute exposure
Temperature	15 ± 0.5° C
Salinity	No adjustment
Colour/Turbidity	No correction required
Aeration	None required
Test Chamber	15mL Polycarbonate tubes, Disposable cuvettes for light readings
Reconstitution solution	Pure, non-toxic water
Control/Dilution Water	3.5% NaCl solution
Primary Dilution	7.0 ± 0.05g homogenized sediment/35mL diluent
Inoculum	20 µL
Incubation	20 minutes at test temperature
Replicates	3 for Control, 1 for each concentration
Concentrations	12, with a maximum concentration of 197,000 mg/L
Organism species/source	*Vibrio fischeri.* Strategic Diagnostics Inc. Strain NRRL B-11177
Water Quality	Temperature readings at each stage
Endpoints	IC50 (mg/L) normalized for moisture content of sediment
Test Validity Criteria	Coefficient of Variation of mean light readings in the controls is ≤12%
Data Analysis	IC50 (mg/L)
Statistical Software	MicrotoxOmni™ Version 1.18

5.2 Quality Assurance/Quality Control

5.2.1 Reference Toxicant Results

A water-only reference toxicant test, using HS-5, a standard marine sediment reference material that was produced by the Marine Analytical Chemistry Standards Program at the National Research Council, was initiated on November 26, 2009. The IC50 of the reference toxicant test was calculated and compared in a control chart with those of previous tests. The control chart is included in Appendix E. Methods used in preparing the control chart was taken from the CANTEST SOP "Standard Operating Procedure for the Control Charting of Reference Toxicant Tests" (DCN 80-E-008) and from Environment Canada (1990).

The IC50 value for the reference toxicant test, with 95% Confidence Limits, was 5753 (5646, 5861) mg/L HS-5. The historical previous mean for this test, with 2 SD, is 4892 (2746, 8714) mg/L HS-5.

5.2.2 Test Validity Criteria

The tests were considered valid because the coefficient of variation representing the mean light readings in the controls was ≤12%. The coefficient of variation of the control light readings ranged from 0.83 – 6.17. Table 5-2 summarizes the mean and SD of coefficient of variation for control light readings.

Table 5-2: Mean, Standard Deviation and Coefficient of Variation of the Control Light Readings

Sample ID	Mean	SD	CV (%)
16740-02	89.98	1.08	1.20
16740-04	91.60	0.76	0.83
16740-07	100.01	6.17	6.17
16744-02*	95.93	4.02	4.19
16744-03*	93.57	2.86	3.06
16744-08	99.48	3.55	3.57
16744-11*	96.90	4.59	4.74
16747-03*	94.69	5.70	6.01
16747-06	102.32	4.14	4.04

*Sample was tested twice. Result from repeated test is reported.

5.3 Results

The IC50 value and 95% confidence limits for the 30 minute exposure of the samples for both wet and dry weights are summarised in Table 5-3. The detailed reports are presented in Appendix E.

The IC50 was calculated by MicroToxOmni™ Software, Version 1.18 (Azur Environmental 1999), using the autocalc feature.

Table 5-3: Thirty Minute IC50 Values for Ladysmith Harbour Marine Sediment Samples (mg/L)

Sample ID	Wet Weight IC50	Lower CI	Upper CI	Dry Weight IC50	Lower CI	Upper CI
16740-02	66550	37740	117300	16616	9423	29286
16740-04	603100	167000	2178000	196478	54405	709550
16740-07	136200	123400	150400	33143	30028	36598
16744-02	145900	104100	204700	104340	74447	146390
16744-03	83030	45820	150500	25152	13880	45591
16744-08	297900	97150	913300	224972	73367	689717
16744-11	34280	30920	38010	26990	24345	29927
16747-03	405300	130200	126200	251659	80844	783600
16747-06	143200	74910	273800	68450	35807	130876

5.4 Discussion

The tests met the validity criteria, because the coefficient of variation values of less than 12%. The IC50 values were greater than 5000 mg/L (dry weight), indicating that the samples are considered to be practically non toxic. A summary of values indicating levels of toxicity is presented in Table 5-4.

Table 5-4 Interpretation of Solid Phase Microtox® Test Results (Buday 2000)

IC50 (mg/L)	Level of Toxicity
>5,000	Practically non toxic
1,000-5,000	Marginally toxic
<1000	Toxic

SECTION

6 REFERENCES

ASTM. 1993. Standard Guide for Conducting Solid Phase 10-Day Static Sediment Toxicity Tests with Marine and Estuarine Amphipods. E 1367-92. Annual Book of Standards. American Society for Testing Materials. Philadelphia, Pa.

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Buday, C. 2000. Unpublished Data on the Interpretation of Solid Phase Microtox® Results. Pacific Environmental Science Centre, Environment Canada, North Vancouver, BC.

Colt, J. 2002. Un-ionized Ammonia Calculator (Seawater). Fish Spreadsheet Appendices. *In* Fish Hatchery Management, Second Edition. Gary A. Wedemeyer, editor. American Fisheries Society, Bethesda, MD.

Dewitt, T.H., Swartz, R.C. and J.O. Lamberson. 1989. Measuring the Toxicity of Estuarine Sediments. Environmental Toxicology and Chemistry. 8: 1035-1048.

Environment Canada. 1990. Guidance Document for Control of Toxicity Test Precision Using Reference Toxicants. EPS 1/RM/12. Conservation and Protection, Ottawa, ON.

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CANTEST Standard Operating Procedure for the Sediment Mixing Procedures for Toxicity Tests (DCN 80-E-010).

CANTEST Standard Operating Procedure for Operation and Maintenance of YSI Dissolved Oxygen Meters (DCN 80-M-003).

CANTEST Standard Operating Procedure for Operation and Maintenance of the Accumet Basic pH Meters (DCN 80-M-004).

CANTEST Standard Operating Procedure for the Control Charting of Reference Toxicant Tests. (DCN 80-E-008).

CANTEST Standard Operating Procedure for the Operation and Maintenance of WTW Conductivity Meters (DCN 80-M-001).

CANTEST Test Method for the Marine or Estuarine Amphipod 10 day Survival and Re-burial Test. (DCN 80-C-035).

CANTEST Test Method for the Echinoid 20 Minute Fertilization Test. (DCN 80-C-029).

PSEP (Puget Sound Estuary Program). 1995. Echinoderm Embryo Sediment Bioassay. Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound. Puget Sound Water Quality Authority, Olympia, WA.

APPENDICES

APPENDIX

A SAMPLE INFORMATION AND CHAIN OF CUSTODY RECORDS

~1 misc. white pails 43VOCJ

CHAIN-OF-CUSTODY RECORD/ANALYSIS REQUEST

№ 16740 page 1 of 9

Golder Associates
500–4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone: 604-298-6623 Fax: 604-298-5253

Project Number: 09 1436 5008		Laboratory Name: CANTEST.	
[redacted]		Address:	
Golder Contact: Adrian deBruyn	Golder E-mail Address: adebruyn @golder.com	Tel/Fax:	Contact:

Office the final reports should be sent to:

- [x] 500–4260 Still Creek Drive, Burnaby, BC V5C 6C6, Tel: 604-298-6623, Fax: 604-298-5253
- [ ] 202–2790 Gladwin Road, Abbotsford, BC V2T 4S8, Tel: 604-850-8786, Fax: 604-850-8756
- [ ] 2640 Douglas Street, Victoria, BC V8T 4M1, Tel: 250-881-7372, Fax: 250-881-7470

2 pails 1 VOCJ 10-90144

Analyses Required

	Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Number of Containers	Bioavailability	~~Hold (contact Adrian DeBruyn)~~	HOLD (contact Adrian DeBruyn)			1010300052			RUSH	Remarks (over)
3	16740 -01		Sed	19/10/09		~~3~~	✓	~~✓~~	✓			910300222				
3	16740 -02		"	"		~~3~~	✓	~~✓~~	✓							226
2	16740 -03		"	"		~~2~~	✓	~~✓~~	✓							227
3	16740 -04		"	"		~~3~~	✓	~~✓~~	✓							228
2	16740 -05		"	"		~~2~~	✓	~~✓~~	✓							229
2	16740 -06		"	"		~~2~~	✓	~~✓~~	✓							230
3	16740 -07		"	"		~~3~~	✓		✓							231
1	16740 -08		"	"		~~1~~	✓									232
2	16740 -09		"	"		~~2~~	✓		✓							233
	-10															
	-11															
	-12															

Sampler's Signature	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by: KS	Date Oct 22 2009	Time 4:11
	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C) / Cooler opened by:	Date	Time

WHITE: Golder copy YELLOW: Lab copy PINK: Lab returns with Final Report

CHAIN-OF-CUSTODY RECORD/ANALYSIS REQUEST

№ 16744 page 2 of 4

Golder Associates
500–4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone: 604-298-6623 Fax: 604-298-5253

Project Number: 09 1436 5008		Laboratory Name: CANTEST
		Address:
Golder Contact: Adrian deBruyn	Golder E-mail Address: adebruyn @golder.com	Tel/Fax: / Contact:

Office the final reports should be sent to:

- ☒ 500–4260 Still Creek Drive, Burnaby, BC V5C 6C6, Tel: 604-298-6623, Fax: 604-298-5253
- ☐ 202–2790 Gladwin Road, Abbotsford, BC V2T 4S8, Tel: 604-850-8786, Fax: 604-850-8756
- ☐ 2640 Douglas Street, Victoria, BC V8T 4M1, Tel: 250-881-7372, Fax: 250-881-7470

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Analyses Required: Number of Containers	Bioavailability	HOLD (contact Adrian DeBruyn)							RUSH	Remarks (over)
16744 -01		Sed	20/10/09		2	✓	✓								234
16744 -02		"	"		3	✓	✓								235
16744 -03		"	"		3	✓	✓								236
16744 -04		"	"		1	✓									237
16744 -05		"	"		2	✓	✓								238
16744 -06		"	"		2	✓	✓								239
16744 -07		"	"		1	✓									240
16744 -08		"	"		3	✓	✓								241
16744 -09		"	"		2	✓	✓								242
16744 -10		"	"		3	✓	✓		HOLD						
16744 -11		"	"		3	✓	✓								243
16744 -12		"	"		1	✓									244

Sampler's Signature	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by: KS	Date: Oct 22 2009	Time: 4:11
	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C)	Cooler opened by:	Date / Time

WHITE: Golder copy YELLOW: Lab copy PINK: Lab returns with Final Report

CHAIN-OF-CUSTODY RE RD/ANALYSIS REQUEST

№ 16747 page 3 of 4

Golder Associates
500–4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone: 604-298-6623 Fax: 604-298-5253

Project Number: 09 1436 5608		Laboratory Name: CANTEST
[redacted]		Address:
Golder Contact: Adriaan deBruyn	Golder E-mail Address: adebruyn @golder.com	Tel/Fax: / Contact:

Office the final reports should be sent to:

- ☑ 500–4260 Still Creek Drive, Burnaby, BC V5C 6C6, Tel: 604-298-6623, Fax: 604-298-5253
- ☐ 202–2790 Gladwin Road, Abbotsford, BC V2T 4S8, Tel: 604-850-8786, Fax: 604-850-8756
- ☐ 2640 Douglas Street, Victoria, BC V8T 4M1, Tel: 250-881-7372, Fax: 250-881-7470

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Number of Containers	Analyses Required: Bioavailability	Analyses Required: Hold (Contact Adriaan deBruyn)	RUSH	Remarks (over)
16747 -01		Sed	20/10/09		1	✓			245
16747 -02		11	11		1	✓			246
16747 -03		11	21/10/09		2	✓	✓		247
16747 -04		11	11		1	✓			248
16747 -05		11	11		1	✓			249
16747 -06		11	11		2	✓	✓		250
16747 -07		11	11		2	✓	✓		251
16747 -08		11	11		1	✓			252
16747 -09		11	11		1	✓			253
16747 -10		11	11		1	✓			254
16747 -11		11	11		1	✓			255
16747 -12		11	11		1	✓			256

Sampler's Signature	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Comments:	Method of Shipment:	Waybill No.:	Received for Lab by: KS	Date [illegible]	Time 4:11	
	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C)	Cooler opened by:	Date	Time

WHITE: Golder copy YELLOW: Lab copy PINK: Lab returns with Final Report

Associates
500-[illegible] Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone: 604-298-6623 Fax: 604-298-5253

ANALYSIS REQUEST

№ 16[illegible]0

page 4 of

Project Number: 09 1436 [illegible]008

Laboratory Name: CANTEST

Address:

Golder Contact: Adrian deBruyn

Golder E-mail Address: adebruyn @golder.com

Tel/Fax:

Contact:

Office the final reports should be sent to:

- [x] 500-4260 Still Creek Drive, Burnaby, BC V5C 6C6, Tel: 604-298-6623, Fax: 604-298-5253
- [ ] 202-2790 Gladwin Road, Abbotsford, BC V2T 4S8, Tel: 604-850-8786, Fax: 604-850-8756
- [ ] 2640 Douglas Street, Victoria, BC V8T 4M1, Tel: 250-881-7372, Fax: 250-881-7470

Analyses Required

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Number of Containers	Bioavailability									RUSH	Remarks (over)
16750 -01		Sed	21/10/09		1	✓										257
16750 -02		"	"		1	✓										258
16750 -03		"	"		1	✓										259
16750 -04		"	"		1	✓										260
16750 -05		"	"		1	✓										261
16750 -06		"	"		1	✓										262
16750 -07		"	"		1	✓										263
16750 -08		"	22/10/09		1	✓										264
16750 -09		"	"		1	✓										265
16750 -10		"	"		1	✓										266
16750 -11		"	"		1	✓										267
-12		"	"		1	✓										

Sampler's Signature	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Comments:	Method of Shipment:	Waybill No.:				
	Shipped by:	Shipment Condition: Seal Intact:	Received for Lab by: KS	Date Oct 22 2009	Time 4:11	
			Temp (°C)	Cooler opened by:	Date	Time

WHITE: Golder copy YELLOW: Lab copy PINK: Lab returns with Final Report

CANTEST WORK ORDER

Quote# **Group#** 101030052

(GOL001) Golder Associates Ltd. 500-4260 Still Creek Dr Burnaby, BC V5C 6C6 Att'n: Adrian deBruyn Phone# (604) 298-6623 Fax# (604) 298-5253	Received: Oct 22/09 Entered: Oct 30/09 12:25 pm by vdg # samples: 43 Sampler: # bottles: 70 P.O.# Project: Project# 09-1436-5008 Site: Due Date: Jan 6/10

Bottle Types:	Special Instructions:
27 x MISC. WHITE PAILS 43 x VOCJ - BETX/volatile jar	Samples stored in tox cold room. HG# 10-90144

910300222 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-01
ECO-TOX

910300226 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-02
ECO-TOX

910300227 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-03
ECO-TOX

910300228 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-04
ECO-TOX

910300229 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-05
ECO-TOX

910300230 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-06
ECO-TOX

Log-In and labelling checked by:	Date:						
Invoicing Information	Dept:	61	62	63	64	65	66	67

CANTEST WORK ORDER

Group# 101030052

(GOL001) Golder Associates Ltd. 500-4260 Still Creek Dr Burnaby, BC V5C 6C6 Att'n: Adrian deBruyn Phone# (604) 298-6623 Fax# (604) 298-5253	Received: Oct 22/09 Entered: Oct 30/09 12:25 pm by vdg # samples: 43 Sampler: # bottles: 70 P.O.# Project: Project# 09-1436-5008 Site: Due Date: Jan 6/10

910300231 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-07
ECO-TOX

910300232 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-08
ECO-TOX

910300233 Matrix: SOLID Sampled: 10/19/09 Sample Type: Soil COC: 16740
Id: 16740-09
ECO-TOX

910300234 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-01
ECO-TOX

910300235 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-02
ECO-TOX

910300236 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-03
ECO-TOX

910300237 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-04
ECO-TOX

910300238 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-05
ECO-TOX

910300239 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-06
ECO-TOX

910300240 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-07
ECO-TOX

910300241 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-08
ECO-TOX

CANTEST WORK ORDER

Group# 101030052

(GOL001) Golder Associates Ltd. 500-4260 Still Creek Dr Burnaby, BC V5C 6C6 Att'n: Adrian deBruyn Phone# (604) 298-6623 Fax# (604) 298-5253	Received: Oct 22/09 Entered: Oct 30/09 12:25 pm by vdg # samples: 43 Sampler: # bottles: 70 P.O.# Project: Project# 09-1436-5008 Site: Due Date: Jan 6/10

910300242 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-09
ECO-TOX

910300243 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-11
ECO-TOX

910300244 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16744
Id: 16744-12
ECO-TOX

910300245 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16747
Id: 16747-01
ECO-TOX

910300246 Matrix: SOLID Sampled: 10/20/09 Sample Type: Soil COC: 16747
Id: 16747-02
ECO-TOX

910300247 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-03
ECO-TOX

910300248 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-04
ECO-TOX

910300249 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-05
ECO-TOX

910300250 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-06
ECO-TOX

910300251 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-07
ECO-TOX

910300252 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-08
ECO-TOX

CANTEST WORK ORDER

Group# 101030052

(GOL001) Golder Associates Ltd. 500-4260 Still Creek Dr Burnaby, BC V5C 6C6 Att'n: Adrian deBruyn Phone# (604) 298-6623 Fax# (604) 298-5253	Received: Oct 22/09 Entered: Oct 30/09 12:25 pm by vdg # samples: 43 Sampler: # bottles: 70 P.O.# Project: Project# 09-1436-5008 Site: Due Date: Jan 6/10

910300253 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-09
ECO-TOX

910300254 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-10
ECO-TOX

910300255 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-11
ECO-TOX

910300256 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16747
Id: 16747-12
ECO-TOX

910300257 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16750
Id: 16750-01
ECO-TOX

910300258 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16750
Id: 16750-02
ECO-TOX

910300259 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16750
Id: 16750-03
ECO-TOX

910300260 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16750
Id: 16750-04
ECO-TOX

910300261 Matrix: SOLID Sampled: 10/21/09 Sample Type: Soil COC: 16750
Id: 16750-05
ECO-TOX

910300262 Matrix: SOLID Sampled: 10/22/09 Sample Type: Soil COC: 16750
Id: 16750-06
ECO-TOX

910300263 Matrix: SOLID Sampled: 10/22/09 Sample Type: Soil COC: 16750
Id: 16750-07
ECO-TOX

CANTEST **WORK ORDER**

Group# 101030052

(GOL001) Golder Associates Ltd. 500-4260 Still Creek Dr Burnaby, BC V5C 6C6 Att'n: Adrian deBruyn Phone# (604) 298-6623 Fax# (604) 298-5253	Received: Oct 22/09 Entered: Oct 30/09 12:25 pm by vdg # samples: 43 Sampler: # bottles: 70 P.O.# Project: Project# 09-1436-5008 Site: Due Date: Jan 6/10

910300264 Matrix: SOLID Sampled: 10/22/09 Sample Type: Soil COC: 16750
Id: 16750-08
ECO-TOX

910300265 Matrix: SOLID Sampled: 10/22/09 Sample Type: Soil COC: 16750
Id: 16750-09
ECO-TOX

910300266 Matrix: SOLID Sampled: 10/22/09 Sample Type: Soil COC: 16750
Id: 16750-10
ECO-TOX

910300267 Matrix: SOLID Sampled: 10/22/09 Sample Type: Soil COC: 16750
Id: 16750-11
ECO-TOX

CANTEST Ltd.

Sediment Sample Descriptions

Client # / Name: GOL001- Golder Associates. **Project #:** 2-11-1024

CANTEST Sample Name	CANTEST Login #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed	Endemic Animals Removed	Odour	Centrifuged for porewater? Y/N	Purged with N_2?	Analyst
16744-09	910300242	16744-09	2009 Nov 12	fine sand dark brown	shells	none	H2S like	Y	yes	CB
16740-05	910300229	16740-05	2009 Nov 12	large grain sand dk brown	shells, grass		sulphides	Y	yes	LS
16740-01	910300222	16740-01	2009 Nov 12	mud like dark brown portion of berry pebbles	no debris found	none	H2S smell like	Y	yes	CB
16740-03	910300227	16740-03	2009 Nov 12	silty clay dk brown	wood	worms	sulfides	Y	yes	LS
16744-06	910300239	16744-06	2009 Nov 12	silty dark brown	wood, shells.	none	sulphides	Y	Yes	MG
16744-05	910300238	16744-05	2009 Nov 12	silty dark brown	shells, twigs	~~shells~~ none	decomp.	Y	yes	MG
16740-06	910300230	16740-06	2009 Nov 12	fine sand dark brown	rock, small stones, wood chips		H2S like	Y	yes	CB
16740-09	910300233	16740-09	2009 Nov 12	dk brown silty	wood, shells	amphipods	sulfides	Y	yes	LS

CANTEST Ltd.

Sediment Sample Descriptions

Client # / Name: GOL001- Golder Associates

Project #: 2-11-1024

CANTEST Sample Name	CANTEST Login #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed	Endemic Animals Removed	Odour	Centrifuged for porewater? Y/N	Purged with N_2?	Analyst
16744-01	910300234	16744-01	2009 Nov.12	Coarse grainy like (sandy) dark brown	worms (dead & alive) small stones	worms	H_2S	Y	yes	CB
16747-07	910300251	16747-07	2009 Nov.12	Silty clay dark brown	none	none	pungent mud = clay	Y	yes	CB

CANTEST Ltd.

Sediment Sample Descriptions

Client # / Name: \\GOL001- Golder Associates

Project #: 2-11-1024

CANTEST Sample Name	CANTEST Login #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed	Endemic Animals Removed	Odour	Centrifuged for porewater? Y/N	Purged with N_2?	Analyst
16744-11	910300243	16744-11	2009 Nov 19	dark brown-grey sandy	shells.	none	H_2S-like	Y	yes	MG
16740-04	910300228	16740-04	2009 Nov 19	dark brown silty	Tree bark, wood chips, pine cone	None	H_2S-like	Y	yes	KP
16740-02	910300226	16740-02	2009 Nov 19	dark brown wood pulp-silt	Tree bark, wood chips.	none	sulphur odour	Y	yes	MG
16740-07	910300231	16740-07	2009 Nov 19	dark brown silty	Tree bark	none	Sulphur odour	Y	yes	KP
16744-03	WEMG 2009 Nov 18 ~~9103003~~ 910300236	WEMG 2009 Nov 18 ~~9~~ 16744-03	2009 Nov 19	dark brown grey silt	wood	none	sulphur odour	Y	yes	MG
16744-08	910300241	16744-08	2009 Nov 19	black sandy	rocks	crabs 5-30mm worms	sulphur odour	Y	yes	KP
16747-06	910300250	16747-06	2009 Nov 19	dark brown sand-silt	wood	amphipods	mild H_2S	Y	yes	MG
16744-02	910300235	16744-02	2009 Nov 19	dark brown-black sandy	rocks	crabs 5-10mm	none	Y	yes	MG

CANTEST Ltd.

Sediment Sample Descriptions

Client # / Name: * GOL001 - Golder Associates

Project #: 2-11-1024

CANTEST Sample Name	CANTEST Login #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed	Endemic Animals Removed	Odour	Centrifuged for porewater? Y/N	Purged with N_2?	Analyst
16747-03	910300247	16747-03	2009Nov19	Silty Clay Grey-brown	None	none	mild Sulphur odour	Y	Yes	KP

Table A-1: Summary of Pore Water Measurements (November 12, 2009)

Un-ionized Ammonia Calculator

This spreadsheet computes concentration of un-ionized ammonia in seawater as a function of total ammonia, pH, temperature, and salinity. pH can be measured on the "NBS" scale or Hansson scales. If this this confuses you, you are probably using the "NBS" scale and your measured pH values should be entered in Column C.

User information is only needed in cells outlined with double lines. This spreadsheet assumes that total ammonia is reported as nitrogen; computed un-ionized ammonia will also be reported as nitrogen.

Pore Water

Subsample Date	Sample ID	Temp (°C)	Measured pH (NBS)	Total Ammonia Nitrogen (mg/L)	Salinity (‰)	Working pH	Ionic Strength (M)	pKa (infinite dilution)	pKa (SW)	Mole Fraction	Un-ionized Ammonia-N (mg/L)	Un-ionized Ammonia-N (µg/L)
12-Nov-09	16744-06	15.2	7.4	9.18	30	7.25	0.616	9.558	9.65	0.0039	0.0362	36.2
	16744-05	15.0	7.6	9.58	30	7.45	0.616	9.564	9.66	0.0061	0.0589	58.9
	16740-03	15.1	7.3	9.05	30	7.15	0.616	9.561	9.65	0.0031	0.0282	28.2
	16740-01	15.3	7.3	9.57	30	7.15	0.616	9.554	9.65	0.0032	0.0302	30.2
	16744-09	15.1	7.5	7.49	31	7.35	0.638	9.561	9.66	0.0049	0.0365	36.5
	16747-07	15.2	7.3	5.31	30	7.15	0.616	9.558	9.65	0.0031	0.0167	16.7
	16740-09	15.2	7.6	22.80	30	7.45	0.616	9.558	9.65	0.0062	0.1422	142.2
	16740-05	15.1	7.6	46.70	30	7.45	0.616	9.561	9.65	0.0062	0.2891	289.1
	16744-01	15.3	7.6	8.69	31	7.45	0.638	9.554	9.65	0.0062	0.0541	54.1
	16740-06	15.3	7.7	25.90	30	7.55	0.616	9.554	9.65	0.0079	0.2046	204.6

References

Spreadsheet

http://www.fisheries.org/html/publications/epubs/fhm2e/ammonia_swc.xls

pKa for Ammonia in Freshwater

K. Emerson, R.C. Russo, R.C. Lund, & R.V. Thurson, Aqueous ammonia equilibrium calculations: effects of pH and temperature, J. Fish. Res. Board of Canada, 32:2379-2383, 1975

pKa for Ammonia in Seawater

K.H. Khoo, C.H. Culberson, and R.G. Bates, Thermodynamics of the dissociation of ammonium ion in seawater from % to 40 C, Journal of Solution Chemistry, 6:281-290, 1977.

Ionic Strength of Seawater

M. Whitfield, The hydrolysis of ammonia ions in sea water - a theoretical study, Journal of Marine Biological Association of the United Kingdoms, 54:565-580, 1974.

Measure of pH in Seawater

I. Hansson, A new set of pH scales and standard buffers for sea water, Deep-Sea Research, 20:479-491, 1973.

Interelationship of Hansson's pH scale with the NBS scale

F.J. Millero, The pH of estuarine waters, Limnology and Oceanography, 31:839-847, 1986.

Proofed: KF 2009 Dec 16

Analysis Report

CANTEST

REPORT ON: Analysis of Water Sample

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard / Marriah Grey

CHAIN OF CUSTODY: 2132816
PROJECT NAME: Ladysmith
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 10

REPORT DATE: November 23, 2009

DATE SUBMITTED: November 13, 2009

GROUP NUMBER: 101113161

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

Sulfide in Water - was performed based on Method 4500-S2 D in Standard Methods (21st Edition) and Method X031 in the BC Laboratory Manual (2005).

TEST RESULTS:

(See following page)

CANTEST LTD.

Tim Matsushita
Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: November 23, 2009

GROUP NUMBER: 101113161

CANTEST

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N	Sulphide S
16740-01 (Porewater)	Nov 12/09	911130509	9.57	<
16740-03 (Porewater)	Nov 12/09	911130510	9.05	<
16740-05 (Porewater)	Nov 12/09	911130511	46.7	<
16740-06 (Porewater)	Nov 12/09	911130512	25.9	<
16740-09 (Porewater)	Nov 12/09	911130513	22.8	<
16744-01 (Porewater)	Nov 12/09	911130514	8.69	<
16744-05 (Porewater)	Nov 12/09	911130515	9.58	<
16744-06 (Porewater)	Nov 12/09	911130516	9.18	24.4
16744-09 (Porewater)	Nov 12/09	911130517	7.49	<
16747-07 (Porewater)	Nov 12/09	911130518	5.31	<
REPORTING LIMIT			0.01	0.05
UNITS			mg/L	mg/L

mg/L = milligrams per liter
< = Less than reporting limit

CANTEST Ltd.

Porewater Measurements

Client # & Name: GOL001 - Golder Associates

Test Type: 10-d marine amphipod (Environment Canada)

Date Measured: 2009 Nov 12

Test Date: 2009 Nov 13

Sample ID	Salinity (‰)	Temperature (°C)	pH	NH_3 / Sulfide Sample Taken	Analyst
16744-06	30 2009 Nov 12	15.2	7.4	both taken	MG
16744-05	~~3~~ 30	15.0	7.6	both taken	MG
16740-03	30	15.1	7.3	both taken	MG
16740-01	30	15.3	7.3	both taken	MG
16744-09	31	15.1	7.5	both taken	MG
16747-07	30	15.2	7.3	both taken	MG
16740-09	30	15.2	7.6	both taken	MG
16740-05	30	15.1	7.6	both taken	MG
16744-01	31	15.3	7.6	both taken	MG
16740-06	30	15.3	7.7	both taken	MG

Comments

Homogenized sediment samples. Aliquots placed in 50 ml centrifuge tubes. Centrifuged @ 4°C for 30 mins - 5000 rpm. decanted porewater into subsample bottles. Recorded pH.

2009 Nov 12 M. Grey

CANTEST Ltd.

20-d *Neanthes areanceodentata* Survival and Growth Test

Table A-1: Summary of Pore Water Measurements (November 19, 2009)

Un-ionized Ammonia Calculator

This spreadsheet computes concentration of un-ionized ammonia in seawater as a function of total ammonia, pH, temperature, and salinity. pH can be measured on the "NBS" scale or Hansson scales. If this this confuses you, you are probably using the "NBS" scale and your measured pH values should be entered in Column C.

User information is only needed in cells outlined with double lines. This spreadsheet assumes that total ammonia is reported as nitrogen; computed un-ionized ammonia will also be reported as nitrogen.

Pore Water

Subsample Date	Sample ID	Temp (°C)	Measured pH (NBS)	Total Ammonia Nitrogen (mg/L)	Salinity (‰)	Working pH	Ionic Strength (M)	pKa (infinite dilution)	pKa (SW)	Mole Fraction	Un-ionized Ammonia-N (mg/L)	Un-ionized Ammonia-N (µg/L)
19-Nov-09	16744-11	15.8	7.7	32.8	30	7.55	0.616	9.538	9.63	0.0082	0.2690	269.0
	16740-04	15.4	7.5	8.1	30	7.35	0.616	9.551	9.64	0.0050	0.0408	40.8
	16740-02	15.7	7.6	12	30	7.45	0.616	9.541	9.63	0.0065	0.0777	77.7
	16740-07	15.8	7.3	1.8	30	7.15	0.616	9.538	9.63	0.0033	0.0059	5.9
	16744-03	15.9	7.3	4.97	30	7.15	0.616	9.535	9.63	0.0033	0.0164	16.4
	16744-08	15.6	7.6	9.3	30	7.45	0.616	9.544	9.64	0.0064	0.0598	59.8
	16747-06	15.5	7.5	14.2	31	7.35	0.638	9.548	9.64	0.0050	0.0714	71.4
	16744-02	15.6	7.7	10.1	30	7.55	0.616	9.544	9.64	0.0081	0.0816	81.6
	16747-03	15.0	7.3	6.79	30	7.15	0.616	9.564	9.66	0.0031	0.0210	21.0

References

Spreadsheet

http://www.fisheries.org/html/publications/epubs/fhm2e/ammonia_swc.xls

pKa for Ammonia in Freshwater

K. Emerson, R.C. Russo, R.C. Lund, & R.V. Thurson, Aqueous ammonia equilibrium calculations: effects of pH and temperature, J. Fish. Res. Board of Canada, 32:2379-2383, 1975

pKa for Ammonia in Seawater

K.H. Khoo, C.H. Culberson, and R.G. Bates, Thermodynamics of the dissociation of ammonium ion in seawater from % to 40 C, Journal of Solution Chemistry, 6:281-290, 1977.

Ionic Strength of Seawater

M. Whitfield, The hydrolysis of ammonia ions in sea water - a theoretical study, Journal of Marine Biological Association of the United Kingdoms, 54:565-580, 1974.

Measure of pH in Seawater

I. Hansson, A new set of pH scales and standard buffers for sea water, Deep-Sea Research, 20:479-491, 1973.

Interelationship of Hansson's pH scale with the NBS scale

F.J. Millero, The pH of estuarine waters, Limnology and Oceanography, 31:839-847, 1986.

Proofed by K. Pomeroy

2009 DEC 17

CANTEST Ltd.

Porewater Measurements

Client # & Name: GOL001 - Golder Associates Test Type: Various

Date Measured: 2009 Nov 19 Test Date: Various

Sample ID	Salinity (‰)	Temperature (°C)	pH	NH_3 / Sulfide Sample Taken	Analyst
16740-02	30	15.7	7.6	both taken	MG
16740-04	30	15.4	7.5	both taken	MG
16740-07	30	15.8	7.3	both taken	MG
16744-02	30	15.6	7.7	both taken	MG
16744-03	30	15.9	7.3	both taken	MG
16744-08	30	15.6	7.6	both taken	MG
16744-11	30	15.8	7.7	both taken	MG
16747-03	30	15.0	7.3	both taken	MG
16747-06	31	~~15.0~~ 15.5 [illegible] 2009 Nov 19	7.5	both taken	MG

Proofed: KT 2009 Dec 18

Comments

2009 Nov 19 - Samples homogenized. 2 x 500 ml aliquots per sample were centrifuged @ 5000 rpm, 4°C for 30 minutes. The porewater was then decanted into a beaker, roughly 50 ml was then sub-sampled into a glass amber jar for sulphides analysis, then preserved. Another 50 ml was sub-sampled for ammonia, which was then preserved. The remaining pore water was then used for the echinoderm fertilization ~~H~~ test. [illegible] 2009 Nov 19 Water quality data ~~was~~ transcribed from the Echinoderm Fertilization Data Sheet, prior to any sample manipulations. (ie. aeration). MG

Analysis Report

CANTEST

REPORT ON: Analysis of Water Samples

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard/M. Grey

CHAIN OF CUSTODY: 2132812
PROJECT NAME: Ladysmith
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 9

REPORT DATE: December 17, 2009

DATE SUBMITTED: December 10, 2009

GROUP NUMBER: 101210015

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

Sulfide in Water - was performed based on Method 4500-S2 D in Standard Methods (21st Edition) and Method X031 in the BC Laboratory Manual (2005).

TEST RESULTS:

(See following page)

CANTEST LTD.

Tim Matsushita
Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 17, 2009

GROUP NUMBER: 101210015

CANTEST

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N	Sulphide S
16744-11	Nov 19/09	912100018	32.8	<
16740-04	Nov 19/09	912100019	8.10	<
16740-02	Nov 19/09	912100020	12.0	<
16740-07	Nov 19/09	912100021	1.8	<
16744-03	Nov 19/09	912100022	4.97	<
16744-08	Nov 19/09	912100023	9.30	<
16747-06	Nov 19/09	912100024	14.2	<
16744-02	Nov 19/09	912100025	10.1	<
16747-03	Nov 19/09	912100026	6.79	<
REPORTING LIMIT			0.01	0.05
UNITS			mg/L	mg/L

mg/L = milligrams per liter
< = Less than reporting limit

Porewater chemistry

Analysis Report

CANTEST

REPORT ON: Analysis of Soil Samples

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard/ Marriah Grey

CHAIN OF CUSTODY: 2132811
PROJECT NAME: Ladysmith
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 2

REPORT DATE: December 18, 2009

DATE SUBMITTED: December 10, 2009

GROUP NUMBER: 101210022

SAMPLE TYPE: Soil

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Moisture in Soil - analysis was performed gravimetrically by heating a separate sample portion at 105 C and measuring the weight loss.

Total Organic Carbon - samples were digested in acid then analyzed using a Leco Induction Furnace combustion/volumetric analysis technique.

Particle Size Analysis - The particle size distribution is determined in accordance with Methods of Soil Analysis Part 1-Physical and Mineralogical Methods(2nd Ed), UBC Methods Manual for Soil Analysis(1981) and Soil Sampling and Methods of Analysis(1993). The % gravel, sand, silt and clay are determined by a combination of a standard dry sieve, wet sieve and pipetting techiques. Particle size limits used to define size fractions are based according to Canadian Soil Survey Committee(CSSC) and U.S. Department of Agriculture(USDA) classification scheme. Winnipeg Lab D-675 Berry St. Wpg, MB R3H1A7

Particle Size Analysis - Engineering - This analysis is appropriate for particle size fractions that must be defined according to the American Society for Testing (ASTM) & Unified Soil Classification Systems, this is common for engineering purposes. These particle size limits are used to define the size fractions: gravel, coarse, medium, & fine sand, silt & clay, according to the ASTM (D-2487) classification. The size fractions analyzed are 4.75, 2.0, 0.425, 0.075, & 0.002 mm. %Sand, Silt & Clay are based on the <4.75mm fraction of the sample by weight. Wpg Lab, D-675 Berry St. Wpg, MB R3H1A7

TEST RESULTS:

(See following pages)

CANTEST LTD.

Marnie Kolach, BSc.
Manager, CANTEST Winnipeg

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 18, 2009

GROUP NUMBER: 101210022

CANTEST

Conventional Parameters in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Moisture	Total Organic Carbon C
Mackenzie Beach Sand	Nov 19/09	912100061	19.2	<
Chesapeake Bay Sediment	Nov 19/09	912100079	60.0	3.1
REPORTING LIMIT			0.1	0.5
UNITS			%	% dry wt.

% = percent
< = Less than reporting limit

% dry wt. = percent, dry weight basis

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 18, 2009

GROUP NUMBER: 101210022

%Sand, %Silt and %Clay in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	%Sand <4.75 mm & >0.075 mm	%Silt <0.075 mm & >0.002 mm	%Clay <0.002 mm
Mackenzie Beach Sand	Nov 19/09	912100061	99.07	0.34	0.60
Chesapeake Bay Sediment	Nov 19/09	912100079	3.63	50.99	45.38
REPORTING LIMIT			-	-	-
UNITS			%	%	%

% = percent, on a weight basis

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 18, 2009

GROUP NUMBER: 101210022

Type of Particle Size Analysis in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	PSA Engineering
Mackenzie Beach Sand	Nov 19/09	912100061	COMPLETE
Chesapeake Bay Sediment	Nov 19/09	912100079	COMPLETE
REPORTING LIMIT			-
UNITS			-

- = text or without units

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 18, 2009

GROUP NUMBER: 101210022

CANTEST

Percent Passing on Sieves and Pipettes in Soil

CLIENT SAMPLE IDENTIFICATION:	Mackenzie Beach Sand	Chesapeake Bay Sediment	
DATE SAMPLED:	Nov 19/09	Nov 19/09	REPORTING LIMIT
CANTEST ID:	912100061	912100079	
Pipette Size 0.075 mm	0.93	96.37	-
Pipette Size 0.002 mm	0.60	45.38	-
Sieve 4.75 mm, ASTM #4	100.0	100.0	-
Sieve 2 mm, ASTM #10	100.0	100.0	-
Sieve 0.425mm, 425um, #40	99.99	99.99	-

Results expressed as percent passing (PCTP)

Percent Retained on Sieves - % By Weight in Soil

CLIENT SAMPLE IDENTIFICATION:	Mackenzie Beach Sand	Chesapeake Bay Sediment	
DATE SAMPLED:	Nov 19/09	Nov 19/09	REPORTING LIMIT
CANTEST ID:	912100061	912100079	
<0.002 mm	0.60	45.38	-
>4.75 mm	0.00	0.00	-
<4.75 mm & >0.075 mm	99.07	3.63	-
<0.075 mm & >0.002 mm	0.34	50.99	-

Results expressed as percent, on a weight basis (%)

APPENDIX

B 10 DAY ACUTE AMPHIPOD RAW DATA

Eohaustorius estuarius

10-d Survival and Reburial Test #1

2009 November 13 – 2009 November 23

Eohaustorius 10-d Survival and Reburial Sediment Test — **Cantest Ltd.**

Analysis ID:	01-5999-1906	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	11 Dec-09 16:04	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	16-1930-6013	**Test Type:**	Survival-Reburial	**Analyst:**	
Start Date:	13 Nov-09 16:30	**Protocol:**	EC/EPS 1/RM/35	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	23 Nov-09 12:00	**Species:**	Eohaustorius estuarius	**Brine:**	
Duration:	9d 20h	**Source:**	Other	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
20091113(CTL)	16-7932-5209	12 Nov-09 12:00	12 Nov-09 12:00	28h	Golder Associates (Burnaby)	Ladysmith Harbour
910300222	17-8731-4563	19 Oct-09 12:00	22 Oct-09 16:11	25d 4h		
910300227	17-8229-5112	19 Oct-09 12:00	22 Oct-09 16:11	25d 4h		
910300229	10-2341-9236	19 Oct-09 12:00	22 Oct-09 16:11	25d 4h		
910300230	20-0057-8306	19 Oct-09 12:00	22 Oct-09 16:11	25d 4h		
910300233	06-1996-2917	19 Oct-09 12:00	22 Oct-09 16:11	25d 4h		General Misc. Bioassays
910300234	20-2679-6311	20 Oct-09 12:00	22 Oct-09 16:11	24d 4h		Ladysmith Harbour
910300238	16-8636-2979	20 Oct-09 12:00	22 Oct-09 16:11	24d 4h		
910300239	20-1243-1658	20 Oct-09 12:00	22 Oct-09 16:11	24d 4h		
910300242	06-2378-9935	20 Oct-09 12:00	22 Oct-09 16:11	24d 4h		
910300251	18-0283-0091	21 Oct-09 12:00	22 Dec-09 16:11	23d 4h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
20091113(CTL)	Sediment Control	Golder	Negative Control		
910300222	Marine/Estuarine Sedim	Golder	16740-01		
910300227	Marine/Estuarine Sedim	Golder	16740-03		
910300229	Marine/Estuarine Sedim	Golder	16740-05		
910300230	Marine/Estuarine Sedim	Golder	16740-06		
910300233	Marine/Estuarine Sedim	Golder	16740-09		
910300234	Marine/Estuarine Sedim	Golder	16744-01		
910300238	Marine/Estuarine Sedim	Golder	16744-05		
910300239	Marine/Estuarine Sedim	Golder	16744-06		
910300242	Marine/Estuarine Sedim	Golder	16744-09		
910300251	Marine/Estuarine Sedim	Golder	16747-07		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					5.39%

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
20091113(CTL)		910300222	2.6869	1.8595	0.089469	0.0138	Significant Effect
		910300227	2.2922	1.8595	0.10158	0.0255	Significant Effect
		910300229	3.2184	1.8595	0.085815	0.0061	Significant Effect
		910300230	1.0241	1.8595	0.08868	0.1679	Non-Significant Effect
		910300233	1.2724	1.8595	0.099501	0.1195	Non-Significant Effect
		910300234	2.2111	1.8595	0.1186	0.0290	Significant Effect
		910300238	1.5815	1.8595	0.15015	0.0762	Non-Significant Effect
		910300239	3.3092	1.8595	0.10794	0.0054	Significant Effect
		910300242	4.9088	1.8595	0.16181	0.0006	Significant Effect
		910300251	1.5995	1.8595	0.11919	0.0742	Non-Significant Effect

2009 Dec 17
Analyst: H. Grey QA: NS 2009 Dec 17

Eohaustorius 10-d Survival and Reburial Sediment Test — Cantest Ltd.

Analysis ID:	01-5999-1906	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	11 Dec-09 16:04	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	0.6006761	0.06006761	10	5.9071	<0.0001	Significant Effect
Error	0.4474224	0.01016869	44			
Total	1.048099	0.0702363	54			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Bartlett Equality of Variance	13.561	23.209	0.1940	Equal Variances
Distribution	Shapiro-Wilk Normality	0.97206		0.2275	Normal Distribution

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091113(CTL)	5	0.98	0.96299	0.99701	0.9	1	0.0083045	0.044721	4.56%	0.0%
910300222	5	0.92	0.90958	0.93042	0.9	0.95	0.0050854	0.027386	2.98%	6.12%
910300227	5	0.92	0.90299	0.93701	0.85	0.95	0.0083045	0.044721	4.86%	6.12%
910300229	5	0.91	0.90149	0.91851	0.9	0.95	0.0041522	0.02236	2.46%	7.14%
910300230	5	0.96	0.95149	0.96851	0.95	1	0.0041523	0.022361	2.33%	2.04%
910300233	5	0.95	0.93655	0.96345	0.9	1	0.0065653	0.035355	3.72%	3.06%
910300234	5	0.91	0.88917	0.93083	0.85	1	0.010171	0.054772	6.02%	7.14%
910300238	5	0.91	0.87342	0.94658	0.75	1	0.01786	0.096177	10.57%	7.14%
910300239	5	0.88	0.85832	0.90168	0.8	0.95	0.010586	0.057009	6.48%	10.2%
910300242	5	0.69	0.63077	0.74923	0.5	0.85	0.028917	0.15572	22.57%	29.59%
910300251	5	0.93	0.90832	0.95168	0.85	1	0.010586	0.057009	6.13%	5.1%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091113(CTL)	5	1.4168	1.3811	1.4525	1.249	1.4588	0.017416	0.093786	6.62%	0.0%
910300222	5	1.2875	1.2675	1.3076	1.249	1.3453	0.0097882	0.052711	4.09%	9.12%
910300227	5	1.2916	1.2618	1.3214	1.1731	1.3453	0.014533	0.078261	6.06%	8.84%
910300229	5	1.2683	1.2519	1.2847	1.249	1.3453	0.007992	0.043038	3.39%	10.48%
910300230	5	1.368	1.3487	1.3873	1.3453	1.4588	0.0094236	0.050747	3.71%	3.45%
910300233	5	1.3487	1.3205	1.377	1.249	1.4588	0.013796	0.074295	5.51%	4.81%
910300234	5	1.2758	1.2349	1.3167	1.1731	1.4588	0.01995	0.10743	8.42%	9.95%
910300238	5	1.2891	1.2304	1.3478	1.0472	1.4588	0.02865	0.15429	11.97%	9.01%
910300239	5	1.2247	1.1906	1.2589	1.1071	1.3453	0.016663	0.089731	7.33%	13.56%
910300242	5	0.98966	0.92482	1.0545	0.7854	1.1731	0.031658	0.17048	17.23%	30.15%
910300251	5	1.3143	1.2731	1.3555	1.1731	1.4588	0.020126	0.10838	8.25%	7.24%

2009 Dec 17
Analyst: M. Greig QA: NS 2009 Dec 17

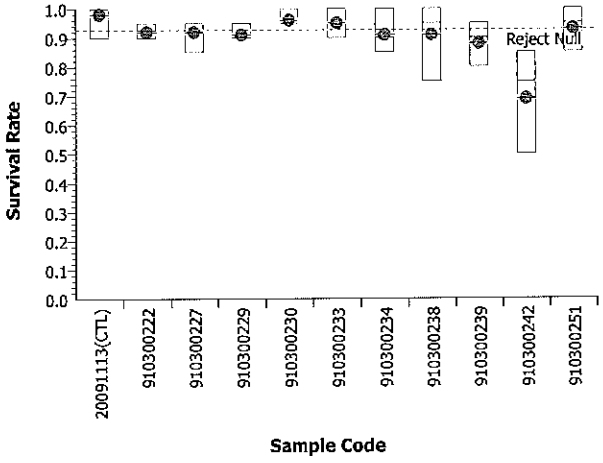
Eohaustorius 10-d Survival and Reburial Sediment Test — Cantest Ltd.

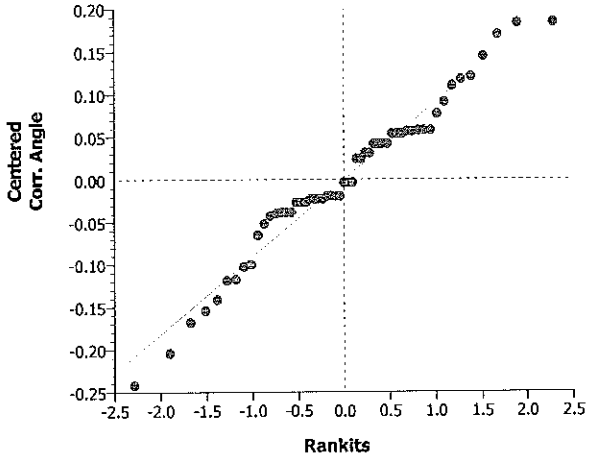
Analysis ID:	01-5999-1906	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	11 Dec-09 16:04	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
20091113(CTL)	1	1	1	1	0.9
910300222	0.9	0.95	0.9	0.9	0.95
910300227	0.85	0.95	0.95	0.95	0.9
910300229	0.9	0.9	0.9	0.9	0.95
910300230	1	0.95	0.95	0.95	0.95
910300233	0.9	0.95	1	0.95	0.95
910300234	0.9	0.9	0.85	1	0.9
910300238	0.75	0.9	0.95	1	0.95
910300239	0.95	0.8	0.9	0.85	0.9
910300242	0.85	0.8	0.5	0.75	0.55
910300251	0.85	0.95	0.95	1	0.9

Graphics





2009 Dec17
Analyst: M. Gray QA: NS 2009 Dec17

Sample ID	Log In ID	# Surviving	Survival (%)	Mean Survival (%)	SD	# Emerged	% Emerged	Mean Emerged (%)	SD
Control	-	20	100	98.0	4.5	0	0	0	0
		20	100			0	0		
		20	100			0	0		
		20	100			0	0		
		18	90			0	0		
16740-01	910300222	18	90	92.0	2.7	0	0	0	0
		19	95			0	0		
		18	90			0	0		
		18	90			0	0		
		19	95			0	0		
16740-03	910300227	17	85	92.0	4.5	0	0	0	0
		19	95			0	0		
		19	95			0	0		
		19	95			0	0		
		18	90			0	0		
16740-05	910300229	18	90	91.0	2.2	0	0	0	0
		18	90			0	0		
		18	90			0	0		
		18	90			0	0		
		19	95			0	0		
16740-06	910300230	20	100	96.0	2.2	0	0	0	0
		19	95			0	0		
		19	95			0	0		
		19	95			0	0		
		19	95			0	0		
16740-09	910300233	18	90	95.0	3.5	0	0	0	0
		19	95			0	0		
		20	100			0	0		
		19	95			0	0		
		19	95			0	0		
16744-01	910300234	18	90	91.0	5.5	0	0	0	0
		18	90			0	0		
		17	85			0	0		
		20	100			0	0		
		18	90			0	0		
16744-05	910300238	15	75	91.0	9.6	0	0	0	0
		18	90			0	0		
		19	95			0	0		
		20	100			0	0		
		19	95			0	0		
16744-06	910300239	19	95	88.0	5.7	0	0	0	0
		16	80			0	0		
		18	90			0	0		
		17	85			0	0		
		18	90			0	0		
16744-09	910300242	17	85	69.0	15.6	0	0	0	0
		16	80			0	0		
		10	50			0	0		
		15	75			0	0		
		11	55			0	0		
16747-07	910300251	17	85	93.0	5.7	0	0	0	0
		19	95			0	0		
		19	95			0	0		
		20	100			0	0		
		18	90			0	0		

M. Greg 2009 Dec 11
proofed: NS 2009 Dec 16

CANTEST Ltd. Enviro. Canada Marine Amphipod 10 Day Sediment Test
Test Conditions and Survival Data

Client # & Name: *GOL001 - Golder Associates
Start Date & Time: 2009 Nov 13 @ ~~1430~~ 1630 (WEMG 2009 Nov 13)
Sample Date: Oct 19 - Oct 21, 2009
End Date: 2009 Nov 23
Sample Received: Oct 22, 2009
Species: Eohaustorius estuarius
CANTEST Project #: 2-11-1024
Organism Lot #: SE091110
Analyst(s): M. Grey-Tamaki, K. Pomeroy, A. Pagdonnelen
Sample ID: Control
CANTEST #: N/A

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov. 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	15.0	14.7	15.5	14.9	15.0
D.O. (mg/L)	8.4	8.3	8.2	8.1	8.4
pH	7.8				7.8
Salinity (‰)	27				30
Analyst	MG	APag	APag	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	20	20	20	20	18
Analyst	MG	MG	MG	MG	MG

Ammonia Sample Taken

Initial	Final
√MG	√MG

Sample ID: 16740-01
CANTEST #: 910300222

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov. 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.9	15.4	14.9	14.9	14.9
D.O. (mg/L)	8.3	8.2	8.4	8.1	8.5
pH	7.9				8.0
Salinity (‰)	27				31
Analyst	MG	APag	APag	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	18	19	18	18	19
Analyst	KP	KP	KP	KP	KP

Ammonia Sample Taken

Initial	Final
√MG	√MG

CANTEST Ltd. **Enviro. Canada Marine Amphipod 10 Day Sediment Test**
Test Conditions and Survival Data

Sample ID: 16740-03 **CANTEST #:** 910300227

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov. 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.6	15.5	14.9	14.9	14.8
D.O. (mg/L)	8.4	8.2	8.3	8.1	8.4
pH	7.9				8.0
Salinity (‰)	28				31
Analyst	MG	MG	MG	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	17	19	19	19	18
Analyst	MG	MG	MG	MG	MG

Ammonia Sample Taken

Initial	Final
MG ✓	MG ✓

Sample ID: 16740-05 **CANTEST #:** 910300229

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.2	15.4	14.9	14.6	14.8
D.O. (mg/L)	8.4	8.1	8.6	8.2	8.4
pH	8.0				8.2
Salinity (‰)	28				31
Analyst	MG	MG	MG	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	18	18	18	18	19
Analyst	MG	MG	MG	MG	MG

Ammonia Sample Taken

Initial	Final
MG ✓	MG ✓

CANTEST Ltd. **Enviro. Canada Marine Amphipod 10 Day Sediment Test**
Test Conditions and Survival Data

Sample ID: 16740-06 **CANTEST #:** 910300230

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 14	2009 Nov. 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.4	15.4	14.9	14.7	14.9
D.O. (mg/L)	8.5	8.3	8.6	8.2	8.5
pH	8.0				8.1
Salinity (‰)	28				31
Analyst	MG	AMag	AMag	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	20	19	19	19	19
Analyst	AMag	AMag	AMag	AMag	AMag

Ammonia Sample Taken

Initial	Final
✓ MG	✓ MG

Sample ID: 16740-09 **CANTEST #:** 910300233

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov. 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.3	15.3	14.9	14.8	14.7
D.O. (mg/L)	8.5	8.2	8.5	8.0	8.6
pH	7.9				8.1
Salinity (‰)	27				31
Analyst	MG	AMag	AMag	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	18	19	20	19	19
Analyst	MG	MG	MG	MG	MG

Ammonia Sample Taken

Initial	Final
✓ MG	✓ MG

Sample ID: 16744-01 **CANTEST #:** 9103000234

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov. 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.4	15.1	14.6	14.6	14.6
D.O. (mg/L)	8.4	8.3	8.6	8.2	8.5
pH	8.0				8.1
Salinity (‰)	28				31
Analyst	MG	AMcq	AMcq	MG	MK

	# Alive				
Replicate	A	B	C	D	E
	18	18	17	20	18
Analyst	KP	KP	KP	KP	KP

Ammonia Sample Taken

Initial	Final
√ MG	√ MG

Sample ID: 16744-05 **CANTEST #:** 9103000238

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov 16	2009 Nov 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.6	15.2	14.6	14.6	14.7
D.O. (mg/L)	8.4	8.3	8.6	8.2	8.5
pH	8.0				8.0
Salinity (‰)	28				31
Analyst	MG	AMcq	AMcq	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	15	18	19	20	19
Analyst	MG	MG	MG	MG	MG

Ammonia Sample Taken

Initial	Final
√ MG	√ MG

Test Conditions and Survival Data

Sample ID: 16744-06 **CANTEST #:** 910300239

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov. 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.2	15.2	14.6	14.7	14.8
D.O. (mg/L)	8.5	8.2	8.5	8.2	8.4
pH	7.9				8.3
Salinity (‰)	28				31
Analyst	MG	AMcG	AMcG	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	19	16	18	17	19
Analyst	MG	MG	MG	MG	MG

Ammonia Sample Taken

Initial	Final
√ MG	MG ✓

Sample ID: 16744-09 **CANTEST #:** 910300242

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov 16	2009 Nov. 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.2	15.3	14.7	14.8	14.7
D.O. (mg/L)	8.5	7.0	8.4	8.1	8.5
pH	7.9				8.0
Salinity (‰)	28				31
Analyst	MG	AMcG	AMcG	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	17	16	10	15	11
Analyst	KT	KT	KT	KT	KT

Ammonia Sample Taken

Initial	Final
√ MG	MG ✓

CANTEST Ltd. **Enviro. Canada Marine Amphipod 10 Day Sediment Test**
Test Conditions and Survival Data

Sample ID: 16747-07 **CANTEST #:** 910300251

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 13	2009 Nov 16	2009 Nov 18	2009 Nov 20	2009 Nov 23
Temperature(°C)	14.9	15.1	14.6	14.8	14.7
D.O. (mg/L)	8.4	8.1	8.5	7.9	8.5
pH	7.9				7.9
Salinity (‰)	27				31
Analyst	MG	AP	AP	MG	MG

	# Alive				
Replicate	A	B	C	D	E
	17	19	19	20	18
Analyst	KT	KT	MG	KT	KT

Ammonia Sample Taken

Initial	Final
MG V	MG V

Sample ID: _____ **CANTEST #:** _____

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date					
Temperature(°C)					
D.O. (mg/L)					
pH					
Salinity (‰)					
Analyst					

	# Alive				
Replicate	A	B	C	D	E
Analyst					

Ammonia Sample Taken

Initial	Final

CANTEST Ltd. **Marine Amphipod 10 Day Acute Survival Sediment Test** Page 1 of 2
Reburial/Emerged Data at Test Termination

Client # & Name: #GOL001 - Golder Associates Start Date & Time: 2009 Nov 13 @ 16:30

Sample Date: 2009 Oct 19-21 End Date: 2009 Nov 23

Sample Received: 2009 Oct 22 Species: E. estuarius

CANTEST Project #: 2-11-1024 Organism Lot #: SE091110

Analyst(s): M. Grey, Kitamaki

Sample ID: Control CANTEST #: N/A

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	Kt	Kt	Kt	Kt	Kt

Sample ID: 16740-01 CANTEST #: 9103002222

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16740-03 CANTEST #: 9103002227

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16740-05 CANTEST #: 9103002229 Nov 20 2009 Dec 09

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16740-06 CANTEST #: 9103002230

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16740-09 CANTEST #: 9103002233

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

CANTEST Ltd. **Marine Amphipod 10 Day Acute Survival Sediment Test**
Reburial/Emerged Data at Test Termination

Sample ID: 16744-01 **CANTEST #:** 910300234

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16744-05 **CANTEST #:** 910300238

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16744-06 **CANTEST #:** 910300239

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16744-09 **CANTEST #:** 910300242

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: 16747-07 **CANTEST #:** 910300251

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	MG	MG	MG	MG	MG

Sample ID: _____ **CANTEST #:** _____

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
Analyst		M. Gray 2009			

Sample ID: _____ **CANTEST #:** _____

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
Analyst					

Randomization Chart for Amphipod Tests
Use the coloured dots to find appropriate concentrations
Position Map

Back Wall

5	10	
4	9	
3	8	
2	7	
1	6	etc...

Front of Counter

Client # GOL001 Date: 13-Nov

Position #	Treatment	Replicate	Colour
12	Control	A	Dk Blue
50	Control	B	Dk Blue
45	Control	C	Dk Blue
15	Control	D	Dk Blue
52	Control	E	Dk Blue
60	Control	Measure	Dk Blue
30	16744-09	A	Green
55	16744-09	B	Green
48	16744-09	C	Green
2	16744-09	D	Green
38	16744-09	E	Green
23	16744-09	Measure	Green
25	16740-05	A	Yellow
21	16740-05	B	Yellow
46	16740-05	C	Yellow
65	16740-05	D	Yellow
10	16740-05	E	Yellow
41	16740-05	Measure	Yellow
34	16740-01	A	White
32	16740-01	B	White
47	16740-01	C	White
16	16740-01	D	White
59	16740-01	E	White
58	16740-01	Measure	White
5	16740-03	A	Lt blue
37	16740-03	B	Lt blue
8	16740-03	C	Lt blue
18	16740-03	D	Lt blue
6	16740-03	E	Lt blue
61	16740-03	Measure	Lt blue
27	16744-06	A	Lt orange
22	16744-06	B	Lt orange
26	16744-06	C	Lt orange
31	16744-06	D	Lt orange
44	16744-06	E	Lt orange
19	16744-06	Measure	Lt orange

Position #	Treatment	Replicate	Colour
42	16744-05	A	Pink
43	16744-05	B	Pink
54	16744-05	C	Pink
57	16744-05	D	Pink
39	16744-05	E	Pink
17	16744-05	Measure	Pink
51	16740-06	A	Orang
56	16740-06	B	Oran e
28	16740-06	C	Ora ge
36	16740-06	D	O nge
63	16740-06	E	O ange
64	16740-06	Measure	range
24	16740-09	A	Lt green
11	16740-09	B	Lt green
13	16740-09	C	Lt green
62	16740-09	D	Lt green
29	16740-09	E	Lt green
33	16740-09	Measure	Lt green
49	16744-01	A	Red
7	16744-01	B	Red
1	16744-01	C	Red
66	16744-01	D	Red
40	16744-01	E	Red
9	16744-01	Measure	Red
20	16747-07	A	Flag
14	16747-07	B	Flag
4	16747-07	C	Flag
53	16747-07	D	Flag
3	16747-07	E	Flag
35	16747-07	Measure	Flag

white is fine

CANTEST Ltd.

Marine Amphipod 10 Day Acute Survival Sediment Test
Aeration Checks

Client # & Name: GOL001 ~ Golder Associates Start Date & Time: 2009 Nov 13 @ 16:30

Sample IDs: Various

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

	Day -1	Day 0	1	2	3	4	5	6	7	8	9	10
Date	2009 Nov 12	~~2009 Nov 13~~ 2009 Nov 13 MG	2009 Nov 14	2009 Nov 15	2009 Nov 16	2009 Nov 17	2009 Nov 18	2009 Nov 19	2009 Nov 20	2009 Nov 21	2009 Nov 22	2009 Nov 23
Early AM	—	✓ MG	✓ APaq	✓ LS	✓ APaq	✓ APaq	✓ APaq	✓ MG	✓ MG	✓ MB	✓ APaq	✓ APaq
Mid-day	—	✓ APaq	✓ APaq	✓ LS	✓ APaq	✓ APaq	✓ APaq	✓ MG	✓ MG	✓ MB	✓ APaq	✓ MG
Late PM	✓ MG	✓ MG	✓ APaq	✓ LS	✓ APaq	✓ APaq	✓ APaq	✓ MG	✓ APaq	✓ MB	✓ MG	—

Comments:

2009 Nov 12 set aeration @ 16:30. MG

2009 Nov 16 @ 825 found 01-Rep B+E, 06-Rep B+C and 09-Rep Measure not aerating. 01 Rep B DO: 7.9, 01-Rep E DO: 7.9, 06-Rep B DO: 7.9, 06-Rep C DO: 7.7, 09-Rep Measure DO: 7.9.

2009 Nov 21 - 06 Rep E not aerating - DO = 8.0 mg/L - MB + Ctl Rep C = 8.6 mg/L

5 Rep A = 8.4 mg/L ; 3 Rep A = 8.2 mg/L (All on Right hand bench.) - MB

2009 Nov 22 - aeration rate adjusted for all replicates, increased rate slightly. MG

~~2009 Dec 18~~

10-d Marine Amphipod Observations Form

Date: 2009 Nov 13 Sample ID's: Various

Client # & Name: *GOL001 - Golder Associates Project No. 2-11-1024

2009 Nov 13 - seeded test @ 16:30. Amphipods burying in most MG samples. Some are showing signs of avoidance: in 16740-03 amphipods remaining in water column. Also in ~~16740-05~~ 16744-06 (NEW ADDED), same behavior. Some avoidance by amphipods (~50%) in 16740-01 + 16740-09.

2009 Nov 15 - Checked aeration at 09:33, all lines good. One amphipod emerged + swimming in 16747-07 E and 16744-06 D. Dead amphipods laying on sediment surface in 16744-09B, 16744-06C, 16740-09B. L Stanoff 2009 Nov 15

2009 Nov 20 - 2 amphipods emerged in 40-01, rep measure. MG
1 amphipod emerged in 44-06 rep C. MG

2009 Nov 22 - Some visible morts in samples 16744-09, rep C; MG 16744-01, rep A; 16744-01, rep E; 16740-01, rep B.

M. Grey 2009 Dec 17

CANTEST Ltd.

Summary of Overlying Water Measurements in 10-d Amphipod Test (November 13, 2009)

Un-ionized Ammonia Calculator

This spreadsheet computes concentration of un-ionized ammonia in seawater as a function of total ammonia, pH, temperature, and salinity. pH can be measured on the "NBS" scale or Hansson scales. If this this confuses you, you are probably using the "NBS" scale and your measured pH values should be entered in Column C.

User information is only needed in cells outlined with double lines. This spreadsheet assumes that total ammonia is reported as nitrogen; computed un-ionized ammonia will also be reported as nitrogen.

Overlying Water

Subsample Date	Sample ID	Temp (°C)	Measured pH (NBS)	Total Ammonia Nitrogen (mg/L)	Salinity (‰)	Working pH	Ionic Strength (M)	pKa (infinite dilution)	pKa (SW)	Mole Fraction	Un-ionized Ammonia-N (mg/L)	Un-ionized Ammonia-N (µg/L)
11/13/2009 (Day 0)	Control	15.0	7.8	0.16	27	7.65	0.553	9.564	9.65	0.0100	0.0016	1.6
	16744-06	14.2	7.9	1.02	28	7.75	0.574	9.591	9.68	0.0117	0.0119	11.9
	16744-05	14.6	8.0	0.95	28	7.85	0.574	9.577	9.66	0.0151	0.0143	14.3
	16740-03	14.6	7.9	0.82	28	7.75	0.574	9.577	9.66	0.0120	0.0099	9.9
	16740-01	14.9	7.9	1.10	27	7.75	0.553	9.567	9.65	0.0124	0.0137	13.7
	16744-09	14.2	7.9	0.77	28	7.75	0.574	9.591	9.68	0.0117	0.0090	9.0
	16747-07	14.9	7.9	0.54	27	7.75	0.553	9.567	9.65	0.0124	0.0067	6.7
	16740-09	14.3	7.9	2.16	27	7.75	0.553	9.587	9.67	0.0119	0.0256	25.6
	16740-05	14.2	8.0	4.18	28	7.85	0.574	9.591	9.68	0.0147	0.0613	61.3
	16744-01	14.4	8.0	0.97	28	7.85	0.574	9.584	9.67	0.0149	0.0144	14.4
	16740-06	14.4	8.0	2.22	28	7.85	0.574	9.584	9.67	0.0149	0.0330	33.0
11/13/2009 (Day 10)	Control	15.0	7.8	0.22	30	7.65	0.616	9.564	9.66	0.0097	0.0021	2.1
	16744-06	14.8	8.3	2.62	31	8.15	0.638	9.571	9.67	0.0294	0.0769	76.9
	16744-05	14.7	8.0	2.32	31	7.85	0.638	9.574	9.67	0.0148	0.0344	34.4
	16740-03	14.8	8.0	1.92	31	7.85	0.638	9.571	9.67	0.0149	0.0287	28.7
	16740-01	14.9	8.0	3.16	31	7.85	0.638	9.567	9.66	0.0150	0.0475	47.5
	16744-09	14.7	8.0	2.68	31	7.85	0.638	9.574	9.67	0.0148	0.0397	39.7
	16747-07	14.7	7.9	1.49	31	7.75	0.638	9.574	9.67	0.0118	0.0176	17.6
	16740-09	14.7	8.1	6.05	31	7.95	0.638	9.574	9.67	0.0186	0.1124	112.4
	16740-05	14.8	8.2	11.00	31	8.05	0.638	9.571	9.67	0.0235	0.2580	258.0
	16744-01	14.6	8.1	3.81	31	7.95	0.638	9.577	9.67	0.0184	0.0703	70.3
	16740-06	14.9	8.1	5.36	31	7.95	0.638	9.567	9.66	0.0189	0.1011	101.1

plotted by MG 2010 Jan 07

References

Spreadsheet

http://www.fisheries.org/html/publications/epubs/fhm2e/ammonia_swc.xls

pKa for Ammonia in Freshwater

K. Emerson, R.C. Russo, R.C. Lund, & R.V. Thurson, Aqueous ammonia equilibrium calculations: effects of pH and temperature, J. Fish. Res. Board of Canada, 32:2379-2383, 1975

pKa for Ammonia in Seawater

K.H. Khoo, C.H. Culberson, and R.G. Bates, Thermodynamics of the dissociation of ammonium ion in seawater from % to 40 C, Journal of Solution Chemistry, 6:281-290, 1977.

Ionic Strength of Seawater

M. Whitfield, The hydrolysis of ammonia ions in sea water - a theoretical study, Journal of Marine Biological Association of the United Kingdoms, 54:565-580, 1974.

Measure of pH in Seawater

I. Hansson, A new set of pH scales and standard buffers for sea water, Deep-Sea Research, 20:479-491, 1973.

Interelationship of Hansson's pH scale with the NBS scale

F.J. Millero, The pH of estuarine waters, Limnology and Oceanography, 31:839-847, 1986.

lstaudt 2009Dec23

Analysis Report

CANTEST

REPORT ON: Analysis of Water Sample

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard/Marriah Grey

CHAIN OF CUSTODY: 2180162, 2180161
PROJECT NAME: Ladysmith
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 11

REPORT DATE: November 23, 2009

DATE SUBMITTED: November 13, 2009

GROUP NUMBER: 101113139

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

TEST RESULTS:

(See following page)

CANTEST LTD.

per Tim Matsushita
Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: November 23, 2009

GROUP NUMBER: 101113139

CANTEST

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N
Control (Overlying)	Nov 13/09	911130430	0.16
16740-01(Overlying)	Nov 13/09	911130431	1.10
16740-03(Overlying)	Nov 13/09	911130432	0.82
16740-05(Overlying)	Nov 13/09	911130433	4.18
16740-06(Overlying)	Nov 13/09	911130434	2.22
16740-09(Overlying)	Nov 13/09	911130435	2.16
16744-01(Overlying)	Nov 13/09	911130436	0.97
16744-05(Overlying)	Nov 13/09	911130437	0.95
16744-06(Overlying)	Nov 13/09	911130438	1.02
16744-09(Overlying)	Nov 13/09	911130439	0.77
16747-07(Overlying)	Nov 13/09	911130440	0.54
REPORTING LIMIT			0.01
UNITS			mg/L

mg/L = milligrams per liter

Day 0 Amphipod Overlying Water
Test #4

Analysis Report

REPORT ON: Analysis of Water Samples

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard / Marriah Grey

CHAIN OF CUSTODY: 2132808
PROJECT NAME: Ladysmith
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 11

REPORT DATE: December 18, 2009

DATE SUBMITTED: December 10, 2009

GROUP NUMBER: 101210021

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

TEST RESULTS:

(See following page)

CANTEST LTD.

Tim Matsushita
FOR Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 18, 2009

GROUP NUMBER: 101210021

CANTEST

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N
Control	Nov 23/09	912100039	0.22
16740-01	Nov 23/09	912100041	3.16
16740-03	Nov 23/09	912100042	1.92
16740-05	Nov 23/09	912100043	11.0
16740-06	Nov 23/09	912100044	5.36
16740-09	Nov 23/09	912100045	6.05
16744-01	Nov 23/09	912100047	3.81
16744-05	Nov 23/09	912100048	2.32
16744-06	Nov 23/09	912100049	2.62
16744-09	Nov 23/09	912100050	2.68
16747-07	Nov 23/09	912100051	1.49
REPORTING LIMIT			0.01
UNITS			mg/L

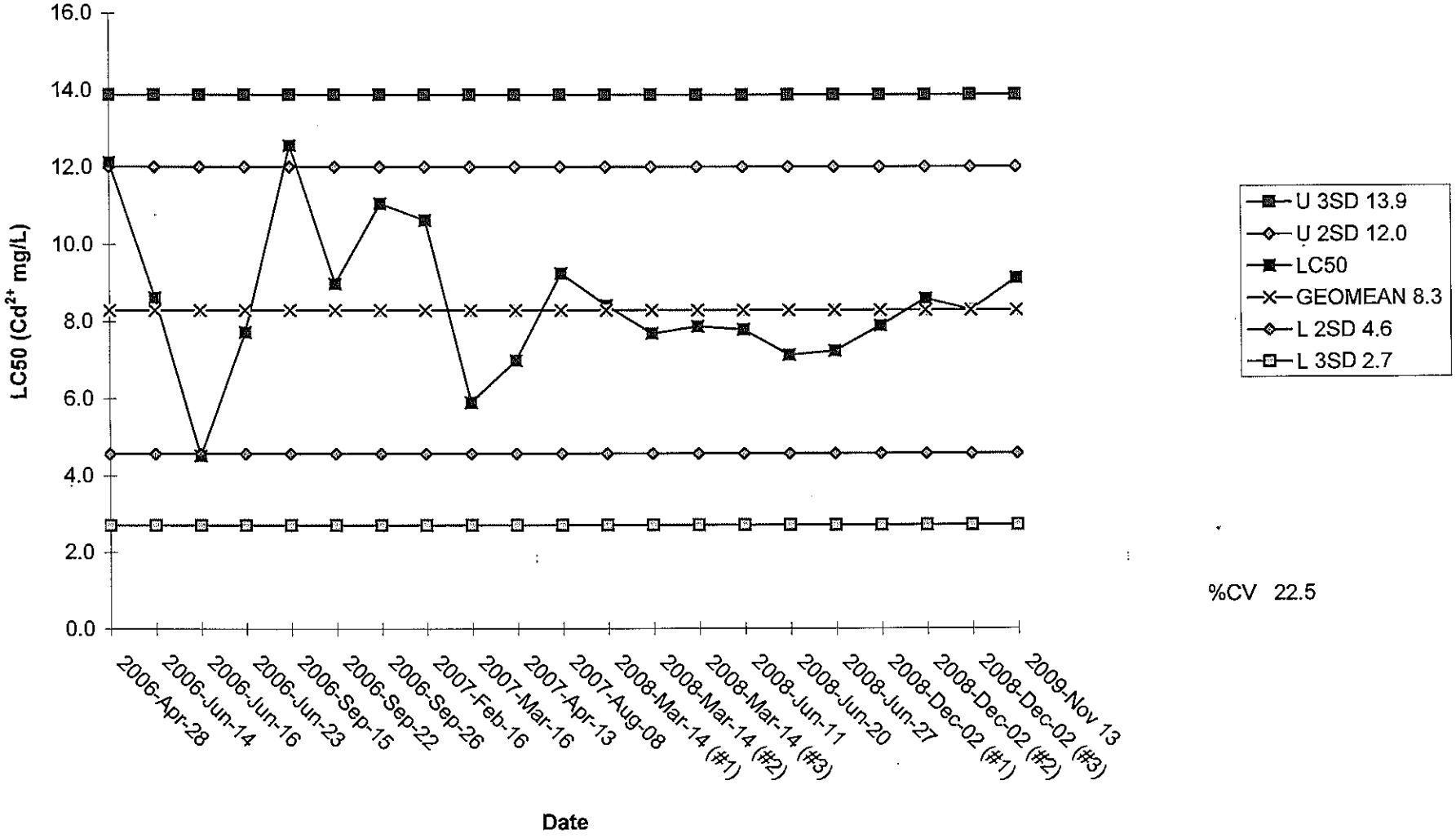
mg/L = milligrams per liter

Day 10 Amphipod Overlying water
Test ##

Cantest Ltd.
Burnaby, BC

Eohaustorius estuarius

96-hr Water-Only Reference Toxicant Control Chart using Cadmium (2^+)



%CV 22.5

Eohaustorius estuarius

10-d Survival and Reburial Test #2

2009 November 20 – 2009 November 30

Eohaustorius 10-d Survival and Reburial Sediment Test — **Cantest Ltd.**

Analysis ID:	19-8567-8411	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	17 Dec-09 16:18	**Analysis:**	Nonparametric-Two Sample	**Official Results:**	Yes
Batch ID:	05-1600-3278	**Test Type:**	Survival-Reburial	**Analyst:**	M. Grey
Start Date:	20 Nov-09 16:42	**Protocol:**	EC/EPS 1/RM/35	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Nov-09 12:00	**Species:**	Eohaustorius estuarius	**Brine:**	
Duration:	9d 19h	**Source:**	Other	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
20091120(CTL)	18-5351-5497	20 Oct-09 12:00	20 Nov-09 12:00	31d 5h	Golder Associates (Burnaby)	Ladysmith Harbour
910300243	01-8316-7750	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300228	08-1020-7122	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300226	12-8595-1757	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300231	10-5257-4682	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300236	07-0341-6256	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300241	14-9647-5657	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300250	06-5107-8408	21 Oct-09 12:00	22 Oct-09 16:11	30d 5h		
910300235	09-7523-9221	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300247	00-5995-0583	21 Oct-09 16:11	22 Oct-09 16:11	30d 1h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
20091120(CTL)	Sediment Control	Golder	Negative Control		
910300243	Marine/Estuarine Sedim	Golder	16744-11		
910300228	Marine/Estuarine Sedim	Golder	16740-04		
910300226	Marine/Estuarine Sedim	Golder	16740-02		
910300231	Marine/Estuarine Sedim	Golder	16740-07		
910300236	Marine/Estuarine Sedim	Golder	16744-03		
910300241	Marine/Estuarine Sedim	Golder	16744-08		
910300250	Marine/Estuarine Sedim	Golder	16747-06		
910300235	Marine/Estuarine Sedim	Golder	16744-02		
910300247	Marine/Estuarine Sedim	Golder	16747-03		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					14.54%

Mann-Whitney U Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	Ties	P-Value	Decision(5%)
20091120(CTL)		910300243	18		2	0.1548	Non-Significant Effect
		910300228	23.5		1	0.0079	Significant Effect
		910300226	13		1	0.5000	Non-Significant Effect
		910300231	15		2	0.3452	Non-Significant Effect
		910300236	20.5		2	0.0476	Significant Effect
		910300241	15.5		2	0.2738	Non-Significant Effect
		910300250	15		2	0.3452	Non-Significant Effect
		910300235	16		1	0.2738	Non-Significant Effect
		910300247	12.5		2	0.5000	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	0.5231013	0.05812237	9	0.91444	0.5226	Non-Significant Effect
Error	2.542434	0.06356084	40			
Total	3.065535	0.1216832	49			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Bartlett Equality of Variance	64.228	21.666	<0.0001	Unequal Variances
Distribution	Shapiro-Wilk Normality	0.74819		<0.0001	Non-normal Distribution

2009 Dec 18 2009 Dec 18
Analyst: M. Grey QA: KT

Eohaustorius 10-d Survival and Reburial Sediment Test — **Cantest Ltd.**

Analysis ID:	19-8567-8411	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	17 Dec-09 16:18	**Analysis:**	Nonparametric-Two Sample	**Official Results:**	Yes

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091120(CTL)	5	0.99	0.98149	0.99851	0.95	1	0.0041523	0.022361	2.26%	0.0%
910300243	5	0.95	0.92671	0.97329	0.85	1	0.011371	0.061237	6.45%	4.04%
910300228	5	0.93	0.91958	0.94042	0.9	0.95	0.0050854	0.027386	2.94%	6.06%
910300226	5	0.8	0.62989	0.97011	0	1	0.083045	0.44721	55.9%	19.19%
910300231	5	0.98	0.96958	0.99042	0.95	1	0.0050855	0.027386	2.79%	1.01%
910300236	5	0.95	0.93655	0.96345	0.9	1	0.0065653	0.035355	3.72%	4.04%
910300241	5	0.96	0.9352	0.9848	0.85	1	0.012106	0.065192	6.79%	3.03%
910300250	5	0.98	0.96958	0.99042	0.95	1	0.0050855	0.027386	2.79%	1.01%
910300235	5	0.73	0.58793	0.87207	0.25	1	0.069357	0.3735	51.16%	26.26%
910300247	5	0.99	0.98149	0.99851	0.95	1	0.0041523	0.022361	2.26%	0.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091120(CTL)	5	1.4361	1.4168	1.4554	1.3453	1.4588	0.0094235	0.050747	3.53%	0.0%
910300243	5	1.3562	1.3117	1.4008	1.1731	1.4588	0.021735	0.11705	8.63%	5.56%
910300228	5	1.3068	1.2867	1.3268	1.249	1.3453	0.0097882	0.052711	4.03%	9.0%
910300226	5	1.1894	0.96032	1.4185	0.11204	1.4588	0.11184	0.60227	50.64%	17.18%
910300231	5	1.4134	1.3897	1.437	1.3453	1.4588	0.011541	0.062153	4.4%	1.58%
910300236	5	1.3487	1.3205	1.377	1.249	1.4588	0.013796	0.074295	5.51%	6.08%
910300241	5	1.3789	1.3313	1.4265	1.1731	1.4588	0.023234	0.12512	9.07%	3.98%
910300250	5	1.4134	1.3897	1.437	1.3453	1.4588	0.011541	0.062153	4.4%	1.58%
910300235	5	1.1169	0.93756	1.2963	0.5236	1.4588	0.087562	0.47154	42.22%	22.22%
910300247	5	1.4361	1.4168	1.4554	1.3453	1.4588	0.0094235	0.050747	3.53%	0.0%

2009Dec18 2009Dec18
Analyst: M.Grey QA: KT

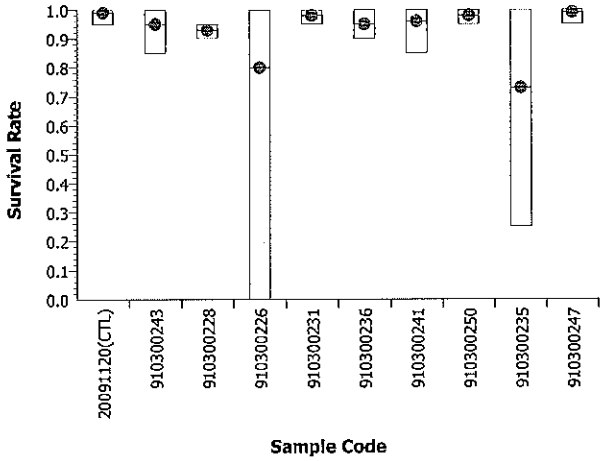
Eohaustorius 10-d Survival and Reburial Sediment Test — **Cantest Ltd.**

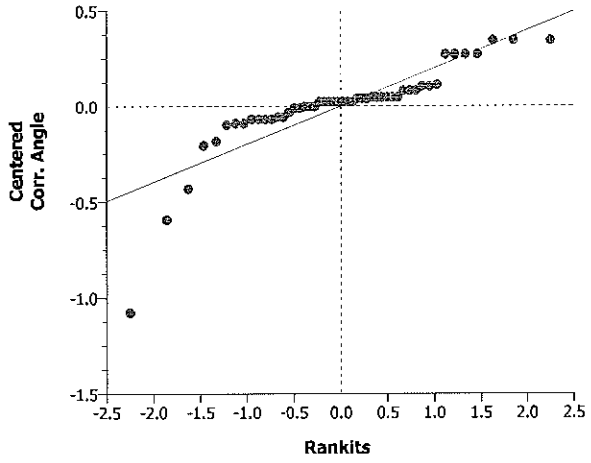
Analysis ID:	19-8567-8411	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	17 Dec-09 16:18	**Analysis:**	Nonparametric-Two Sample	**Official Results:**	Yes

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
20091120(CTL)	1	1	1	1	0.95
910300243	1	1	0.95	0.95	0.85
910300228	0.95	0.9	0.95	0.9	0.95
910300226	0	1	1	1	1
910300231	0.95	0.95	1	1	1
910300236	0.95	1	0.95	0.9	0.95
910300241	0.85	1	0.95	1	1
910300250	0.95	0.95	1	1	1
910300235	0.4	1	1	1	0.25
910300247	1	1	0.95	1	1

Graphics





2009 Dec 18 Analyst: M. Grey 20090018 QA: KA

Marine Amphipod Survival and Reburial Summary

Sample ID	Log In ID	# Surviving	Survival (%)	Mean Survival (%)	SD	# Emerged	% Emerged	Mean Emerged (%)	SD
Control	-	20	100	99.0	2.2	0	0	0	0
		20	100			0	0		
		20	100			0	0		
		20	100			0	0		
		19	95			0	0		
16744-11	910300243	20	100	95.0	6.1	0	0	0	0
		20	100			0	0		
		19	95			0	0		
		19	95			0	0		
		17	85			0	0		
16740-04	910300228	19	95	93.0	2.7	0	0	0	0
		18	90			0	0		
		19	95			0	0		
		18	90			0	0		
		19	95			0	0		
16740-02	910300226	0	0	80.0	44.7	0	0	0	0
		20	100			0	0		
		20	100			0	0		
		20	100			0	0		
		20	100			0	0		
16740-07	910300231	19	95	98.0	2.7	0	0	0	0
		19	95			0	0		
		20	100			0	0		
		20	100			0	0		
		20	100			0	0		
16744-03	9106300236	19	95	95.0	3.5	0	0	0	0
		20	100			0	0		
		19	95			0	0		
		18	90			0	0		
		19	95			0	0		
16744-08	910300241	17	85	96.0	6.5	0	0	0	0
		20	100			0	0		
		19	95			0	0		
		20	100			0	0		
		20	100			0	0		
16747-06	910300250	19	95	98.0	2.7	0	0	0	0
		19	95			0	0		
		20	100			0	0		
		20	100			0	0		
		20	100			0	0		
16744-02	910300235	8	40	73.0	37.3	0	0	0	0
		20	100			0	0		
		20	100			0	0		
		20	100			0	0		
		5	25			0	0		
16747-03	910300247	20	100	99.0	2.2	0	0	0	0
		20	100			0	0		
		19	95			0	0		
		20	100			0	0		
		20	100			0	0		

Note: Shaded Replicates indicate the presence of predatory organisms. It is likley that the seeded amphipods were adversely affected by their presence. The Water Quality replicates for samples 16744-02 and 16740-02 were sieved and in both cases all 20 amphipods were recovered.

Proofed: KT2009DEC18

CANTEST Ltd. Enviro. Canada Marine Amphipod 10 Day Sediment Test
Test Conditions and Survival Data

Client # & Name: #GOL001- Golder Associates
Start Date & Time: 2009 Nov 20 @ 1642
Sample Date: Oct 19 - Oct 21, 2009
End Date: 2009 Nov 30
Sample Received: Oct 22, 2009
Species: E. estuarius
CANTEST Project #: 2-11-1024
Organism Lot #: SE091110
Analyst(s): M. Grey, K. Tamaki, C. Belfiore, N. Shergill, K. Pomeroy
Sample ID: Control
CANTEST #: N/A

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 Nov 23	2009 Nov 25	2009 Nov 27	2009 Nov 30
Temperature(°C)	15.0	14.9	15.0	15.4	15.6
D.O. (mg/L)	8.1	8.5	8.4	8.5	8.2
pH	7.8				7.9
Salinity (‰)	29				29
Analyst	MG	KP	KP	WB	NS

	# Alive				
Replicate	A	B	C	D	E
	20	20	20	20	19
Analyst	NS	NS	NS	NS	NS

Ammonia Sample Taken

Initial	Final
MG	NS

Sample ID: 16744-11
CANTEST #: 910300243

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 Nov 23	2009 Nov 25	2009 Nov 27	2009 Nov 30
Temperature(°C)	14.7	14.9	14.9	15.4	15.3
D.O. (mg/L)	8.1	8.5	8.3	8.4	8.2
pH	7.9				8.0
Salinity (‰)	30				31
Analyst	MG	KP	KP	WB	NS

	# Alive				
Replicate	A	B	C	D	E
	20	20	19	19	17
Analyst	KP	KP	KP	KP	KP

Ammonia Sample Taken

Initial	Final
MG	NS

CANTEST Ltd. **Enviro. Canada Marine Amphipod 10 Day Sediment Test**
Test Conditions and Survival Data

Sample ID: 16740-04 **CANTEST #:** 9103002228

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 NOV 23	2009 NOV 25	2009 NOV 27	2009 NOV 30
Temperature(°C)	15.0	15.0	15.0	15.4	15.1
D.O. (mg/L)	8.1	8.1	8.3	8.3	8.4
pH	7.9				8.0
Salinity (‰)	30				31
Analyst	MS	KP	KP	MB	NS

	# Alive				
Replicate	A	B	C	D	E
	19	18	19	18	19
Analyst	NS	NS	NS	NS	NS

Ammonia Sample Taken

Initial	Final
MS	NS

Sample ID: 16740-02 **CANTEST #:** 9103002226

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 NOV 23	2009 NOV 25	2009 NOV 27	2009 NOV 30
Temperature(°C)	14.7	14.9	15.0	15.3	15.1
D.O. (mg/L)	8.1	8.5	8.3	8.3	8.4
pH	7.9				8.0
Salinity (‰)	30				31
Analyst	MS	KP	KP	MB	NS

	# Alive				
Replicate	A	B	C	D	E
	0 Ⓐ	20	20	20	20
Analyst	KP	KP	KP	KP	KP

Ammonia Sample Taken

Initial	Final
MS	NS

Ⓐ One 1.5 cm wide crab in replicate. Measure - 20 alive.
↳ Note: Used for stats instead of Rep A. (DS 2009 Dec. 16)

Sample ID: 16740-07 **CANTEST #:** 910300231

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 Nov 23	2009 Nov 25	2009 Nov 27	2009 Nov 30
Temperature(°C)	14.8	14.9	14.8	15.4	15.0
D.O. (mg/L)	8.1	8.3	8.4	8.3	8.6
pH	7.9				8.0
Salinity (‰)	30				31
Analyst	MF	KP	KP	MB	NS

	# Alive				
Replicate	A	B	C	D	E
	19	19	20	20	20
Analyst	CB	CB	CB	CB	CB

Ammonia Sample Taken

Initial	Final
MF	NS

Sample ID: 16744-03 **CANTEST #:** 910300236

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 Nov 23	2009 Nov 25	2009 Nov 27	2009 Nov 30
Temperature(°C)	14.7	15.0	15.0	15.4	15.0
D.O. (mg/L)	8.1	8.5	8.3	8.3	8.8
pH	7.9				8.1
Salinity (‰)	31				31
Analyst	MF	KP	KP	MB	NS

	# Alive				
Replicate	A	B	C	D	E
	19	20	19	18	19
Analyst	NS	NS	NS	NS	NS

Ammonia Sample Taken

Initial	Final
MF	NS

CANTEST Ltd. **Enviro. Canada Marine Amphipod 10 Day Sediment Test**
Test Conditions and Survival Data

Sample ID: 16744-08 **CANTEST #:** 910300241

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 Nov 23	2009 Nov 25	2009 Nov 27	2009 Nov 30
Temperature(°C)	15.0	15.2	15.2	15.6	15.2
D.O. (mg/L)	8.1	8.4	8.3	8.3	8.8
pH	8.0				8.1
Salinity (‰)	31				31
Analyst	MG	KP	KP	CB	NS

	# Alive				
Replicate	A	B	C	D	E
	17	20	19	20	20
Analyst	KP	KP	KP	KP	KP

Ammonia Sample Taken

Initial	Final
MG	NS

Sample ID: 16747-06 **CANTEST #:** 910300250

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 Nov 20	2009 Nov 23	2009 Nov 25	2009 Nov 27	2009 Nov 30
Temperature(°C)	15.0	15.0	15.1	15.4	15.1
D.O. (mg/L)	8.1	8.4	8.2	8.3	8.5
pH	8.0				8.1
Salinity (‰)	30				31
Analyst	MG	KP	KP	CB	NS

	# Alive				
Replicate	A	B	C	D	E
	19	19	20	20	20
Analyst	CB	CB	CB	CB	CB

Ammonia Sample Taken

Initial	Final
MG	NS

CANTEST Ltd. **Enviro. Canada Marine Amphipod 10 Day Sediment Test**
Test Conditions and Survival Data

Sample ID: 16744-02 **CANTEST #:** 910300235

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 NOV 20	2009 NOV 23	2009 NOV 25	2009 NOV 27	2009 NOV 30
Temperature(°C)	14.8	15.0	15.0	15.3	15.0
D.O. (mg/L)	8.2	8.5	8.2	8.4	8.7
pH	8.0				8.1
Salinity (‰)	30				31
Analyst	MB	KP	KP	MB	NS

	# Alive				
Replicate	A	B	C	D	E
	20 8	20	20	20	5
Analyst	KT	KT	KT	KT	KT

- Rep A+E both had crabs. Rep A had 1 crab, Rep E had 3 crabs KT 2009 NOV 30

Measure 20 alive KP
└ Note: used for stats, instead of Rep E. NS 2009 Dec 16

Ammonia Sample Taken

Initial	Final
MF	NS

Sample ID: 16747-03 **CANTEST #:** 910300247

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2009 NOV 20	2009 NOV 23	2009 NOV 25	2009 NOV 27	2009 NOV 30
Temperature(°C)	14.8	15.0	15.1	15.4	15.0
D.O. (mg/L)	8.1	8.4	8.2	8.3	8.8
pH	8.0				8.1
Salinity (‰)	31				31
Analyst	MB	KP	KP	MB	NS

	# Alive				
Replicate	A	B	C	D	E
	20	20	19	20	20
Analyst	KP	KP	KP	KP	KP

Ammonia Sample Taken

Initial	Final
MF	NS

CANTEST Ltd. **Marine Amphipod 10 Day Acute Survival Sediment Test**
Reburial/Emerged Data at Test Termination

Client # & Name: GOL001 - Golder Associates
Start Date & Time: 2009 Nov 20 @ 1647
Sample Date: Oct 19 - 21, 2009
End Date: 2009 Nov 30
Sample Received: Oct 22, 2009
Species: Eohaustorius estuarius
CANTEST Project #: 2-11-1024
Organism Lot #: SE091110
Analyst(s): M. Grey, K. Pomeroy
Sample ID: Control
CANTEST #: N/A

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16744-11
CANTEST #: 910300243

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16740-04
CANTEST #: 910300228

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16740-02
CANTEST #: 910300226

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16740-07
CANTEST #: 910300231

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16744-03
CANTEST #: 910300236

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

CANTEST Ltd. **Marine Amphipod 10 Day Acute Survival Sediment Test**
Reburial/Emerged Data at Test Termination

Sample ID: 16744-08 **CANTEST #:** 910300241

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16747-06 **CANTEST #:** 910300250

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16744-02 **CANTEST #:** 910300235

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: 16747-03 **CANTEST #:** 910300247

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
	0	0	0	0	0
Analyst	KP	KP	KP	KP	KP

Sample ID: _____ **CANTEST #:** _____

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
Analyst					

Sample ID: _____ **CANTEST #:** _____

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
Analyst					

Sample ID: _____ **CANTEST #:** _____

	# Emerged after 1 hour in Control Sediment				
Replicate	A	B	C	D	E
Analyst					

10-d Marine Amphipod Observations Form

Date: 2009 Nov 20 Sample ID's: Various

Client # & Name: *GOL001 Golder Associates Project No. 2-11-1024

2009 Nov 20 - Some amphipods actively avoiding sediments. MG
primarily in samples: 16744-11, 16740-02,

2009 Nov 22 - Marks visible in 16740-02, rep A; 16744-11, rep C MG

2009 Nov 23 - No emergent amphipods. MG

2009 Nov 26 - One emergent amphipod in 16740-02 Rep A MG

2009 Nov 27 - No emergent amphipods - MG

2009 Nov 29 - No emergent amphipods NS

2009 Nov 30 - test takedown NS

M. Gray 2009 Dec 18

CANTEST Ltd.

Marine Amphipod 10 Day Acute Survival Sediment Test
Aeration Checks

Client # & Name: #GOL001 - Golder Associates

Start Date & Time: 2009 Nov 19 @ 1642 (MMG 2009 Nov 20)

Sample IDs: Various

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

	Day -1	Day 0	1	2	3	4	5	6	7	8	9	10
Date	2009 Nov 19	2009 Nov 20	2009 Nov 21	2009 Nov 22	2009 Nov 23	2009 Nov 24	2009 Nov 25	2009 Nov 26	2009 Nov 27	2009 Nov 28	2009 Nov 29	2009 Nov 30
Early AM	—	✓ MG	✓ MB	✓ AMcq	✓ AMcq	✓ KP	✓ KP	✓ MB	✓ MB	✓ KP	✓ AMcq	✓ KP
Mid-day	—	✓ MG	✓ MB	✓ AMcq	✓ MG	✓ KP	✓ KP	✓ MB	✓ MB	✓ KP	✓ AMcq	—
Late PM	MG ✓	✓ MG	✓ MB	✓ MG	✓ KP	✓ KP	✓ KP	✓ MB	✓ MB	✓ MG	✓ AMcq	—

Comments:

Set aeration @ 18:30 on Nov 19, 2009 MG

2009 Nov 24 Aeration off in 44-08 Rep E DO: 8.2 mg/L, and 40-04 Rep O DO: 8.2 mg/L

M. Greig 2009 Dec 18

Randomization Chart for Amphipod Tests
Use the coloured dots to find appropriate concentrations
Position Map

Back Wall

5	10
4	9
3	8
2	7
1	6

etc...

Front of Counter

20-Nov 2009 (A)

Client # GOL001 Date: (A) ~~13-Nov~~ 2009

Position #	Treatment	Replicate	Colour
58	Control	A	Dk Blue
4	Control	B	Dk Blue
49	Control	C	Dk Blue
7	Control	D	Dk Blue
16	Control	E	Dk Blue
38	Control	Measure	Dk Blue
10	16744-11	A	Green
43	16744-11	B	Green
34	16744-11	C	Green
51	16744-11	D	Green
41	16744-11	E	Green
23	16744-11	Measure	Green
26	16740-04	A	Yellow
47	16740-04	B	Yellow
32	16740-04	C	Yellow
13	16740-04	D	Yellow
22	16740-04	E	Yellow
15	16740-04	Measure	Yellow
46	16740-02	A	White
3	16740-02	B	White
9	16740-02	C	White
57	16740-02	D	White
17	16740-02	E	White
24	16740-02	Measure	White
30	16740-07	A	Lt blue
18	16740-07	B	Lt blue
25	16740-07	C	Lt blue
52	16740-07	D	Lt blue
8	16740-07	E	Lt blue
53	16740-07	Measure	Lt blue

Position #	Treatment	Replicate	Colour
31	16744-03	A	Pink
44	16744-03	B	Pink
5	16744-03	C	Pink
59	16744-03	D	Pink
19	16744-03	E	Pink
27	16744-03	Measure	Pink
35	16744-08	A	Lt orange
54	16744-08	B	Lt orange
60	16744-08	C	Lt orange
6	16744-08	D	Lt orange
12	16744-08	E	Lt orange
40	16744-08	Measure	Lt orange
37	16747-06	A	Lt green
45	16747-06	B	Lt green
2	16747-06	C	Lt green
39	16747-06	D	Lt green
36	16747-06	E	Lt green
50	16747-06	Measure	Lt green
11	16744-02	A	Red
20	16744-02	B	Red
42	16744-02	C	Red
1	16744-02	D	Red
33	16744-02	E	Red
21	16744-02	Measure	Red
55	16747-03	A	Flag
28	16747-03	B	Flag
56	16747-03	C	Flag
14	16747-03	D	Flag
48	16747-03	E	Flag
29	16747-03	Measure	Flag

Revised 2009 Dec 16

Summary of Overlying Water Measurements in 10-d Amphipod Test (November 20, 2009)

Un-ionized Ammonia Calculator

This spreadsheet computes concentration of un-ionized ammonia in seawater as a function of total ammonia, pH, temperature, and salinity. pH can be measured on the "NBS" scale or Hansson scales. If this this confuses you, you are prebably using the "NBS" scale and your measured pH values should be entered in Column C.

User information is only needed in cells outlined with double lines. This spreadsheet assumes that total ammonia is reported as nitrogen; computed un-ionized ammonia will also be reported as nitrogen.

Overlying Water

Subsample Date	Sample ID	Temp (°C)	Measured pH (NBS)	Total Ammonia Nitrogen (mg/L)	Salinity (‰)	Working pH	Ionic Strength (M)	pKa (infinite dilution)	pKa (SW)	Mole Fraction	Un-ionized Ammonia-N (mg/L)	Un-ionized Ammonia-N (µg/L)
11/20/2009 (Day 0)	Control	15.0	7.8	0.10	29	7.65	0.595	9.564	9.65	0.0098	0.0010	1.0
	16744-11	14.7	7.9	2.51	30	7.75	0.616	9.574	9.67	0.0119	0.0299	29.9
	16740-04	15.0	7.9	1.01	30	7.75	0.616	9.564	9.66	0.0122	0.0123	12.3
	16740-02	14.7	7.9	1.09	30	7.75	0.616	9.574	9.67	0.0119	0.0130	13.0
	16740-07	14.8	7.9	1.30	30	7.75	0.616	9.571	9.66	0.0120	0.0156	15.6
	16744-03	14.7	7.9	0.62	31	7.75	0.638	9.574	9.67	0.0118	0.0073	7.3
	16744-08	15.0	8.0	0.93	31	7.85	0.638	9.564	9.66	0.0152	0.0141	14.1
	16747-06	15.0	8.0	1.52	30	7.85	0.616	9.564	9.66	0.0153	0.0232	23.2
	16744-02	14.8	8.0	1.28	30	7.85	0.616	9.571	9.66	0.0151	0.0193	19.3
	16747-03	14.8	8.0	0.69	31	7.85	0.638	9.571	9.67	0.0149	0.0103	10.3
11/30/2009 (Day 10)	Control	15.6	7.9	0.23	29	7.75	0.595	9.544	9.63	0.0129	0.0030	3.0
	16744-11	15.3	8.0	6.48	31	7.85	0.638	9.554	9.65	0.0155	0.1004	100.4
	16740-04	15.1	8.0	2.31	31	7.85	0.638	9.561	9.66	0.0153	0.0353	35.3
	16740-02	15.1	8.0	3.58	31	7.85	0.638	9.561	9.66	0.0153	0.0547	54.7
	16740-07	15.0	8.0	3.47	31	7.85	0.638	9.564	9.66	0.0152	0.0526	52.6
	16744-03	15.0	8.1	1.41	31	7.95	0.638	9.564	9.66	0.0190	0.0268	26.8
	16744-08	15.2	8.1	2.38	31	7.95	0.638	9.558	9.65	0.0193	0.0459	45.9
	16747-06	15.1	8.1	3.48	31	7.95	0.638	9.561	9.66	0.0191	0.0666	66.6
	16744-02	15.0	8.1	4.07	31	7.95	0.638	9.564	9.66	0.0190	0.0774	77.4
	16747-03	15.0	8.1	1.80	31	7.95	0.638	9.564	9.66	0.0190	0.0342	34.2

References

Spreadsheet
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K.H. Khoo, C.H. Culberson, and R.G. Bates, Thermodynamics of the dissociation of ammonium ion in seawater from % to 40 C, Journal of Solution Chemistry, 6:281-290, 1977.

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I. Hansson, A new set of pH scales and standard buffers for sea water, Deep-Sea Research, 20:479-491, 1973.

Interelationship of Hansson's pH scale with the NBS scale
F.J. Millero, The pH of estuarine waters, Limnology and Oceanography, 31:839-847, 1986.

Analysis Report

CANTEST

REPORT ON: Analysis of Water Samples

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard / Marriah Grey

CHAIN OF CUSTODY: 2182566
PROJECT NAME: Ladysmith
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 10

REPORT DATE: December 24, 2009

DATE SUBMITTED: December 17, 2009

GROUP NUMBER: 101217109

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

TEST RESULTS:

(See following page)

CANTEST LTD.

pp Tim Matsushita
Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 24, 2009

GROUP NUMBER: 101217109

Conventional Parameters in Water Day 0 Amphipods Test #2

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N
Control	Nov 20/09	912170390	0.10
16740-02	Nov 20/09	912170393	1.09
16740-04	Nov 20/09	912170394	1.01
16740-07	Nov 20/09	912170395	1.30
16744-02	Nov 20/09	912170396	1.28
16744-03	Nov 20/09	912170397	0.62
16744-08	Nov 20/09	912170398	0.93
16744-11	Nov 20/09	912170399	2.51
16747-03	Nov 20/09	912170400	0.69
16747-06	Nov 20/09	912170401	1.52
REPORTING LIMIT			0.01
UNITS			mg/L

mg/L = milligrams per liter

Analysis Report

CANTEST

REPORT ON: Analysis of Water Samples

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard

CHAIN OF CUSTODY: 2180187
PROJECT NAME: Golder Acute Amphipods
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 10

REPORT DATE: December 7, 2009

DATE SUBMITTED: November 30, 2009

GROUP NUMBER: 101130024

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

TEST RESULTS:

(See following page)

CANTEST LTD.

per: Tim Matsushita
Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 7, 2009

GROUP NUMBER: 101130024

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N
Final 16744-02	Nov 30/09	911300088	4.07
Final 16740-02	Nov 30/09	911300090	3.58
Final 16744-11	Nov 30/09	911300091	6.48
Final Control	Nov 30/09	911300092	0.23
Final 16747-03	Nov 30/09	911300093	1.80
Final 16744-03	Nov 30/09	911300094	1.41
Final 16740-04	Nov 30/09	911300095	2.31
Final 16740-07	Nov 30/09	911300096	3.47
Final 16744-08	Nov 30/09	911300097	2.38
Final 16747-06	Nov 30/09	911300098	3.48
REPORTING LIMIT			0.01
UNITS			mg/L

mg/L = milligrams per liter

CANTEST Ltd.

Marine Amphipod
10 Day Acute Survival Sediment Test

Instructions: Add 175 mL sediment to each test vessel.
Add 900 mL control seawater to each test vessel by pouring the seawater over a diffuser held just above the water level. Use a separate diffuser for each sediment.
Randomize the test vessels, add a lid, insert airline

Client # & Name: * GOL001 - Golder Associated

Source of Seawater: Vancouver Aquarium

Seawater Batch: Nov 9, 2009

Date Used: Nov 12, 2009 ; Nov 13, 2009

Sample IDs: Various

Water Quality Before Use:

D.O. (mg/L): 8.6 pH: 7.8

Temperature (°C): 14.6 Salinity (‰) : 29

Analyst: MG

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Length Measurements

Client # & Name: GOL001-Golder Associate: Species: Eohaustorius estuarius

Start Date: 2009 Nov 13 Organism Lot #: SE091110

Sample IDs: Various

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3.5
2	3.0
3	3.0
4	5.0
5	4.0
6	2.5
7	3.0
8	3.0
9	4.0
10	5.0
11	4.5
12	4.5
13	3.0
14	4.0
15	5.0
16	4.0
17	3.5
18	3.5
19	5.0
20	3.0
Average	3.80
SD	0.82
Analyst	A. Pag

checked: as 2009 nov 16

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Length Measurements

Client # & Name: * GOL001 - Golder Associates Species: E. estuarius

Start Date: 2009 Nov 13 @ 16:30 Organism Lot #: SE091110

Sample IDs: Various

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3.5
2	3.0
3	3.0
4	3.0
5	4.0
6	2.5
7	3.0
8	3.0
9	4.0
10	3.0
11	4.5
12	4.5
13	3.0
14	4.0
15	5.0
16	4.0
17	3.5
18	3.5
19	5.0
20	3.0
Average	#DIV/0!
SD	#DIV/0!
Analyst	AP aq

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Length Measurements

Client # & Name: GOL001-Golder Associates Species: Eohaustorius estuarius

Start Date: 2009 Nov 20 Organism Lot #: SE091110

Sample IDs: Various

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3.0
2	2.5
3	3.0
4	3.5
5	3.0
6	3.0
7	2.5
8	4.0
9	4.0
10	2.0
11	4.0
12	3.5
13	4.0
14	3.5
15	3.0
16	4.0
17	3.0
18	3.0
19	3.0
20	3.5
Average	3.25
SD	0.57
Analyst	A. Pag

Proofed: KDS 2009 Dec 16

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Length Measurements

Client # & Name: #60001 - Golder Associates Species: E. estuarius

Start Date: 2009 Nov 20 @ 1642 Organism Lot #: SEC091110

Sample IDs: Various

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3.0
2	2.5
3	3.0
4	3.5
5	3.0
6	3.0
7	2.5
8	4.0
9	4.0
10	2.0
11	4.0
12	3.5
13	4.0
14	3.5
15	3.0
16	4.0
17	3.0
18	3.0
19	3.0
20	3.5
Average	#DIV/0!
SD	#DIV/0!
Analyst	APaq

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Acclimation and Holding Conditions

Tank A

Species: E. estuarius
Organism Lot #: SE091110
Date Collected: 2009 Nov 8-9
# of Organisms Ordered: ~2900
Date Arrived: 2009 Nov 9 10 (weight 2351)
Final Estimate # of Organisms: ~3000
Upon Arrival: Temperature (°C): 13.8 D.O. (mg/L): 8.5 pH: 7.6 Salinity (‰): 24
Number Dead: 7 Number Inactive: 2 Number Emerged: 2

Instructions: Gently place containers of amphipods+sediment into aquaria with aerating seawater. Remove any dead amphipods.
Daily, record water quality in a representative sample of holding water and record # dead, etc.
Replace 10-50% of holding water with fresh water as necessary.

Seawater Type: Vancouver Aquarium
Seawater Batch: 2009 Nov @ 9

Acclimation/Holding Conditions:

Date	2009 Nov 9 @	2009 Nov 10 @	2009 Nov 11 @	2009 Nov 12 @ 13	2009 Nov 14	2009 Nov 15	2009 Nov 16	2009 Nov 17	2009 Nov 18	2009 Nov 19	2009 Nov 20	
Parameter / Day	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Day 8**	**Day 9**	**Day 10**	**Day 11**
pH	7.8		7.8	7.8			7.6	7.9		7.9		
Temperature (°C)	14.6		14.8	14.2			14.7	14.4		14.4		
D.O. (mg/L)	8.6		8.4	8.3			8.4	8.3		8.3		
Salinity (‰)	29		28	28			29	29		29		
Dead	7		4	10 +3			4	4		0		
Inactive	2		0	0			0	0		0		
Emerged	2		0	0			0	0		0		
Analyst	MG		MG	MG			MG	MG		MG		

@ we MG 2009 Nov 13

Date				
Parameter / Day	**Day 12**	**Day 13**	**Day 14**	
pH				
Temperature (°C)				
D.O. (mg/L)				
Salinity (‰)				**Total**
Dead				
Inactive				
Emerged				
Analyst				

Water Renewals:

Date	2009 Nov 12	2009 Nov 13	2009 Nov 16	2009 Nov 19
Parameter / Day	2	3	6	9
Seawater Batch	091109	091109	091109	091109
pH	7.8	7.9	7.9	7.9
Temperature (°C)	14.6	14.4	14.5	14.5
D.O. (mg/L)	8.6	8.5	8.5	8.5
Salinity (‰)	29	28	28	28
% Vol Renewed	20	25	25	25
Analyst	MG	MG	MG	MG

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Acclimation and Holding Conditions

Tank B

Species: E. estuarius
Organism Lot #: SE091110
Date Collected: 2009 Nov 8-9
# of Organisms Ordered: ~7900
Date Arrived: 2009 Nov 9 & 10 we ML 2009 Nov 13
Final Estimate # of Organisms: ~3000
Upon Arrival: Temperature (°C): 14.0 D.O. (mg/L): 8.5 pH: 7.6 Salinity (‰) : 24
Number Dead: 2 Number Inactive: 0 Number Emerged: 0

Instructions: Gently place containers of amphipods+sediment into aquaria with aerating seawater. Remove any dead amphipods.
Daily, record water quality in a representative sample of holding water and record # dead, etc.
Replace 10-50% of holding water with fresh water as necessary.

Seawater Type: Vancouver Aquarium
Seawater Batch: 2009 Nov 89 we ML 2009 2009 Nov 13

Acclimation/Holding Conditions:

Date	2009 Nov 9 & 10	2009 Nov 10 & 11	2009 Nov 11 & 12	2009 Nov 13	2009 Nov 14	2009 Nov 15	2009 Nov 16	2009 Nov 17	2009 Nov 18	2009 Nov 19	2009 Nov 20	
Parameter / Day	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Day 8**	**Day 9**	**Day 10**	**Day 11**
pH	7.8		7.8	7.8			7.9	7.9		7.9		
Temperature (°C)	14.6		14.8	14.2			14.7	14.5		14.4		
D.O. (mg/L)	8.6		8.3	8.3			8.5	8.3		8.2		
Salinity (‰)	29		28	27			28	29		29		
Dead	3		6	8+4			4	5		0		
Inactive	0		0	0			0	0		0		
Emerged	0		0	0			0	0		0		
Analyst	ML		ML	ML			ML	ML		ML		

@ we ML 2009 Nov 13

Date				
Parameter / Day	**Day 12**	**Day 13**	**Day 14**	
pH				
Temperature (°C)				
D.O. (mg/L)				
Salinity (‰)				**Total**
Dead				
Inactive				
Emerged				
Analyst				

Water Renewals:

Date	2009 Nov 12	2009 Nov 13	2009 Nov 16	2009 Nov 19
Parameter / Day	2	3	6	9
Seawater Batch	091109	091109	091109	091109
pH	7.8	14.4	7.9	~~8.0~~ 7.9
Temperature (°C)	14.6	8.5	14.5	14.5
D.O. (mg/L)	8.6	8.5	8.5	8.5
Salinity (‰)	29	28	28	28
% Vol Renewed	20	25		25
Analyst	ML	ML	PCG	ML

@ we ML 2009 Nov 19

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Acclimation and Holding Conditions

Tank C

Species: E. estuarius
Organism Lot #: SE091110
Date Collected: 2009 Nov 8-9
# of Organisms Ordered: ~2900
Date Arrived: 2009 Nov 10
Final Estimate # of Organisms: ~3000
Upon Arrival: Temperature (°C): 13.5 D.O. (mg/L): 8.3 pH: 7.5 Salinity (‰): 24
Number Dead: 1 Number Inactive: 0 Number Emerged: 0

Instructions: Gently place containers of amphipods+sediment into aquaria with aerating seawater. Remove any dead amphipods.
Daily, record water quality in a representative sample of holding water and record # dead, etc.
Replace 10-50% of holding water with fresh water as necessary.

Seawater Type: Vancouver Aquarium
Seawater Batch: Nov 9, 2009

Acclimation/Holding Conditions:

Date	2009 Nov 10	2009 Nov 10	2009 Nov 11	2009 Nov 12								
Parameter / Day	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Day 8**	**Day 9**	**Day 10**	**Day 11**
pH	7.8		7.8	7.8								
Temperature (°C)	14.6		14.8	14.1				M. Cota 2009 Nov 18				
D.O. (mg/L)	8.6		8.4	8.4								
Salinity (‰)	29		28	28								
Dead	1		6	11+5			4 incons					
Inactive	0		0	0								
Emerged	0		0	0								
Analyst	MG		MG	MG								

Date				
Parameter / Day	**Day 12**	**Day 13**	**Day 14**	
pH				
Temperature (°C)				
D.O. (mg/L)				
Salinity (‰)				**Total**
Dead				
Inactive				
Emerged				
Analyst				

Dwe MG 2009 Nov 13

Water Renewals:

Date	2009 Nov 12	2009 Nov 13		
Parameter / Day	2	3		
Seawater Batch	091109	091109		
pH	7.8	7.9		
Temperature (°C)	14.6	14.4		
D.O. (mg/L)	8.6	8.5		
Salinity (‰)	29	28		
% Vol Renewed	20	25		
Analyst	MG	MG		

CANTEST Ltd.
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test Tank D
Acclimation and Holding Conditions

Species: E. estuarius
Organism Lot #: SE091110
Date Collected: 2009 Nov 8-9
# of Organisms Ordered: ~2900
Date Arrived: 2009 Nov 10
Final Estimate # of Organisms: ~3000
Upon Arrival: Temperature (°C): 13.5 D.O. (mg/L): 8.3 pH: 7.5 Salinity (‰): 24
Number Dead: 0 Number Inactive: 0 Number Emerged: 0

Instructions: Gently place containers of amphipods+sediment into aquaria with aerating seawater. Remove any dead amphipods.
Daily, record water quality in a representative sample of holding water and record # dead, etc.
Replace 10-50% of holding water with fresh water as necessary.

Seawater Type: Vancouver Aquarium
Seawater Batch: Nov 9, 2009

Acclimation/Holding Conditions:

Date	2009 Nov 10	2009 Nov 11	2009 Nov 12	2009 Nov 13								
Parameter / Day	**Day 0**	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**	**Day 8**	**Day 9**	**Day 10**	**Day 11**
pH	7.8		7.8	7.7								
Temperature (°C)	14.6		14.8	14.2								
D.O. (mg/L)	8.6		8.4	8.3								
Salinity (‰)	29		28	28								
Dead	0		1	12+8								
Inactive	0		0	0								
Emerged	0		0	0								
Analyst	MG		MG	MG								

Date				
Parameter / Day	**Day 12**	**Day 13**	**Day 14**	
pH				
Temperature (°C)				
D.O. (mg/L)				
Salinity (‰)				**Total**
Dead				
Inactive				
Emerged				
Analyst				

@ VR MG 2009 Nov 13

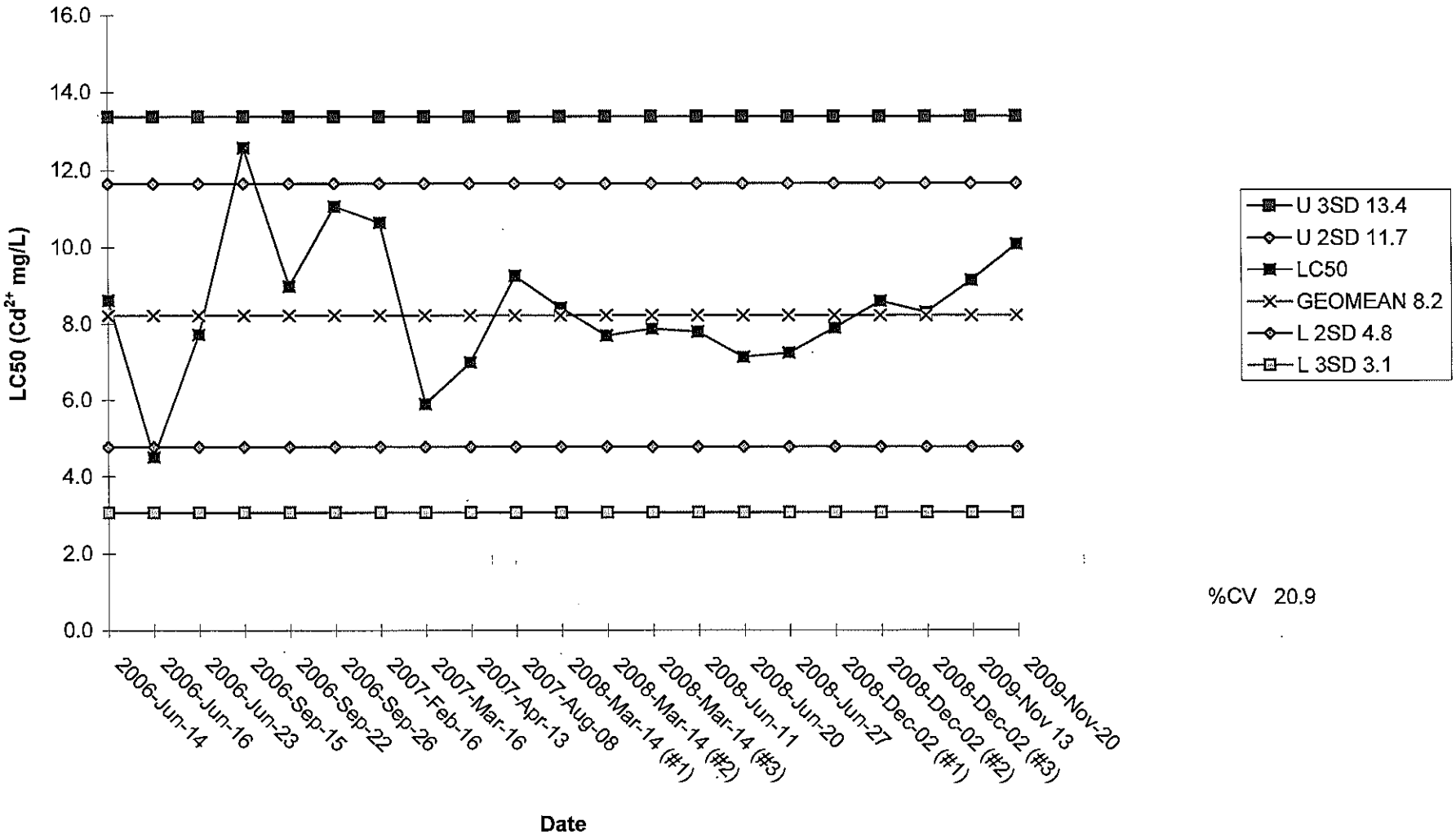
Water Renewals:

Date	2009 Nov 12	2009 Nov 13		
Parameter / Day	2	3		
Seawater Batch	09/11/09	09/11/09		
pH	7.8	7.9		
Temperature (°C)	14.6	14.4		
D.O. (mg/L)	8.6	8.5		
Salinity (‰)	29	28		
% Vol Renewed	20	75		
Analyst	MG	MG		

Cantest Ltd.
Burnaby, BC

Eohaustorius estuarius

96-hr Water-Only Reference Toxicant Control Chart using Cadmium (2^+)



%CV 20.9

APPENDIX

C 20 DAY *NEANTHES ARENACEODENTATA* RAW DATA

Neanthes 20-d Survival and Growth Sediment Test — **Cantest Ltd.**

Analysis ID:	11-8039-8035	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 17:09	**Analysis:**	Nonparametric-Two Sample	**Official Results:**	Yes
Batch ID:	11-7005-6399	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	20 Nov-09 17:30	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	10 Dec-09 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	
Duration:	19d 19h	**Source:**	Don Reish, California State University	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
20091120 (CTL)	20-3580-6427	20 Nov-09 12:00	20 Nov-09 12:00	5h	Golder Associates (Burnaby)	Ladysmith Harbour
910300243	01-8316-7750	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300228	08-1020-7122	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300226	12-8595-1757	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300231	10-5257-4682	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300236	07-0341-6256	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300241	14-9647-5657	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300250	06-5107-8408	21 Oct-09 12:00	22 Oct-09 16:11	30d 5h		
910300235	09-7523-9221	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300247	00-5995-0583	21 Oct-09 16:11	22 Oct-09 16:11	30d 1h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
20091120 (CTL)	Sediment Control	Golder	Negative Control		
910300243	Marine/Estuarine Sedim	Golder	16744-11		
910300228	Marine/Estuarine Sedim	Golder	16740-04		
910300226	Marine/Estuarine Sedim	Golder	16740-02		
910300231	Marine/Estuarine Sedim	Golder	16740-07		
910300236	Marine/Estuarine Sedim	Golder	16744-03		
910300241	Marine/Estuarine Sedim	Golder	16744-08		
910300250	Marine/Estuarine Sedim	Golder	16747-06		
910300235	Marine/Estuarine Sedim	Golder	16744-02		
910300247	Marine/Estuarine Sedim	Golder	16747-03		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					10.43%

Mann-Whitney U Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	Ties	P-Value	Decision(5%)
20091120 (CTL)		910300243	15		1	0.3452	Non-Significant Effect
		910300228	17.5		1	0.1548	Non-Significant Effect
		910300226	12.5		1	0.5000	Non-Significant Effect
		910300231	12.5		1	0.5000	Non-Significant Effect
		910300236	12.5		1	0.5000	Non-Significant Effect
		910300241	12.5		1	0.5000	Non-Significant Effect
		910300250	12.5		1	0.5000	Non-Significant Effect
		910300235	12.5		1	0.5000	Non-Significant Effect
		910300247	12.5		1	0.5000	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	0.1470254	0.01633616	9	1.7338	0.1130	Non-Significant Effect
Error	0.3768871	0.009422177	40			
Total	0.5239125	0.02575833	49			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Mod Levene Equality of Variance	1.836	3.0665	0.1025	Equal Variances
Distribution	Shapiro-Wilk Normality	0.46758		<0.0001	Non-normal Distribution

Analyst: M. Grey QA: KT

Neanthes 20-d Survival and Growth Sediment Test — Cantest Ltd.

Analysis ID:	11-8039-8035	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 17:09	**Analysis:**	Nonparametric-Two Sample	**Official Results:**	Yes

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091120 (CTL)	5	1	1	1	1	1	0	0	0.0%	0.0%
910300243	5	0.96	0.92598	0.99402	0.8	1	0.016609	0.089443	9.32%	4.0%
910300228	5	0.84	0.74081	0.93919	0.4	1	0.048423	0.26077	31.04%	16.0%
910300226	5	1	1	1	1	1	0	0	0.0%	0.0%
910300231	5	1	1	1	1	1	0	0	0.0%	0.0%
910300236	5	1	1	1	1	1	0	0	0.0%	0.0%
910300241	5	1	1	1	1	1	0	0	0.0%	0.0%
910300250	5	1	1	1	1	1	0	0	0.0%	0.0%
910300235	5	1	1	1	1	1	0	0	0.0%	0.0%
910300247	5	1	1	1	1	1	0	0	0.0%	0.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091120 (CTL)	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%
910300243	5	1.2977	1.2571	1.3382	1.1071	1.3453	0.019776	0.1065	8.21%	3.54%
910300228	5	1.1655	1.056	1.2751	0.68472	1.3453	0.05346	0.28789	24.7%	13.36%
910300226	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%
910300231	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%
910300236	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%
910300241	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%
910300250	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%
910300235	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%
910300247	5	1.3453	1.3452	1.3454	1.3453	1.3453	0	0	0.0%	0.0%

2009Dec18 2009Dec18
Analyst: N. Gray QA: KT

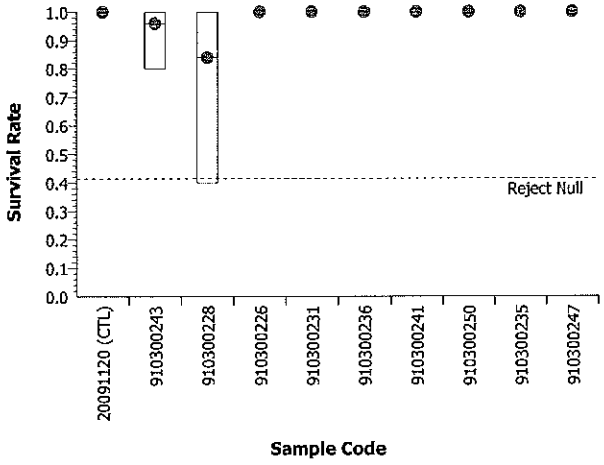
Neanthes 20-d Survival and Growth Sediment Test — **Cantest Ltd.**

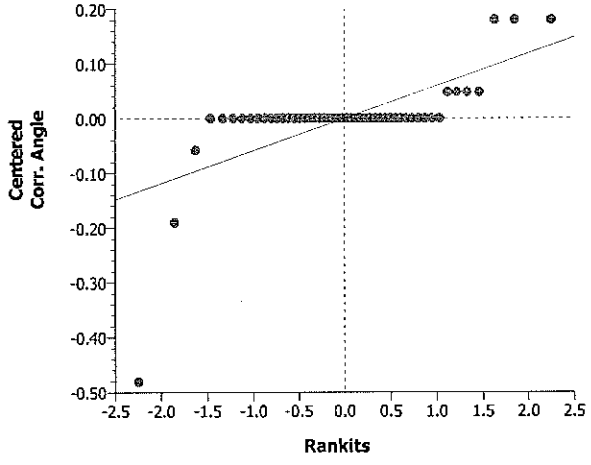
Analysis ID:	11-8039-8035	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 17:09	**Analysis:**	Nonparametric-Two Sample	**Official Results:**	Yes

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
20091120 (CTL)	1	1	1	1	1
910300243	1	1	1	0.8	1
910300228	1	0.4	0.8	1	1
910300226	1	1	1	1	1
910300231	1	1	1	1	1
910300236	1	1	1	1	1
910300241	1	1	1	1	1
910300250	1	1	1	1	1
910300235	1	1	1	1	1
910300247	1	1	1	1	1

Graphics





2009 Dec 18 Analyst: M. Grey 2009 Dec 18 QA: KT

CETIS Analytical Report

Neanthes 20-d Survival and Growth Sediment Test — Cantest Ltd.

Analysis ID:	02-3104-1208	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 17:10	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	11-7005-6399	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	20 Nov-09 17:30	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	10 Dec-09 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	
Duration:	19d 19h	**Source:**	Don Reish, California State University	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
20091120 (CTL)	20-3580-6427	20 Nov-09 12:00	20 Nov-09 12:00	5h	Golder Associates (Burnaby)	Ladysmith Harbour
910300243	01-8316-7750	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300228	08-1020-7122	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300226	12-8595-1757	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300231	10-5257-4682	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300236	07-0341-6256	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300241	14-9647-5657	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300250	06-5107-8408	21 Oct-09 12:00	22 Oct-09 16:11	30d 5h		
910300235	09-7523-9221	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300247	00-5995-0583	21 Oct-09 16:11	22 Oct-09 16:11	30d 1h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
20091120 (CTL)	Sediment Control	Golder	Negative Control		
910300243	Marine/Estuarine Sedim	Golder	16744-11		
910300228	Marine/Estuarine Sedim	Golder	16740-04		
910300226	Marine/Estuarine Sedim	Golder	16740-02		
910300231	Marine/Estuarine Sedim	Golder	16740-07		
910300236	Marine/Estuarine Sedim	Golder	16744-03		
910300241	Marine/Estuarine Sedim	Golder	16744-08		
910300250	Marine/Estuarine Sedim	Golder	16747-06		
910300235	Marine/Estuarine Sedim	Golder	16744-02		
910300247	Marine/Estuarine Sedim	Golder	16747-03		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run					28.89%

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
20091120 (CTL)		910300243	0.050448	1.8595	4.4122	0.4805	Non-Significant Effect
		910300228	1.3602	1.8595	3.8203	0.1054	Non-Significant Effect
		910300226	-0.22686	1.8595	3.6821	0.5869	Non-Significant Effect
		910300231	0.43901	1.8595	3.7376	0.3361	Non-Significant Effect
		910300236	0.23099	1.8595	3.101	0.4116	Non-Significant Effect
		910300241	0.89013	1.8595	4.0745	0.1997	Non-Significant Effect
		910300250	0.66654	1.8595	3.6714	0.2619	Non-Significant Effect
		910300235	1.6385	1.8595	4.3235	0.0700	Non-Significant Effect
		910300247	1.2021	1.8595	3.7089	0.1318	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	86.54568	9.616186	9	0.99105	0.4626	Non-Significant Effect
Error	388.1211	9.703028	40			
Total	474.6668	19.31921	49			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Dacision(1%)
Variances	Bartlett Equality of Variance	4.5911	21.666	0.8684	Equal Variances
Distribution	Shapiro-Wilk Normality	0.95532		0.0567	Normal Distribution

2009 Dec 18 2009 Dec 18

Analyst: M. Gray QA: KH

Neanthes 20-d Survival and Growth Sediment Test — Cantest Ltd.

Analysis ID:	02-3104-1208	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 17:10	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

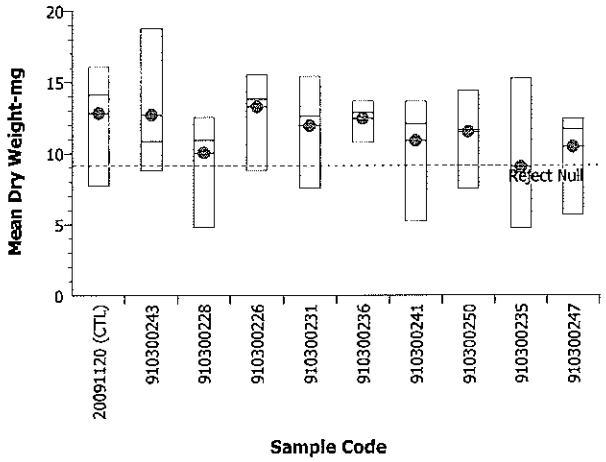
Mean Dry Weight-mg Summary

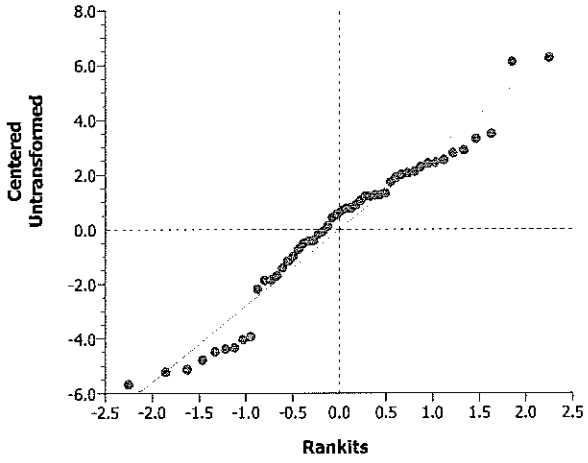
Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091120 (CTL)	5	12.837	11.517	14.157	7.706	16.136	0.64443	3.4704	27.03%	0.0%
910300243	5	12.718	11.191	14.244	8.776	18.812	0.74524	4.0132	31.56%	0.93%
910300228	5	10.043	8.8979	11.188	4.81	12.568	0.55894	3.01	29.97%	21.77%
910300226	5	13.286	12.24	14.332	8.794	15.556	0.51061	2.7497	20.7%	-3.5%
910300231	5	11.955	10.868	13.041	7.566	15.428	0.53034	2.856	23.89%	6.87%
910300236	5	12.452	11.933	12.971	10.746	13.702	0.25333	1.3642	10.96%	3.0%
910300241	5	10.887	9.5712	12.202	5.206	13.664	0.64225	3.4586	31.77%	15.19%
910300250	5	11.521	10.483	12.559	7.482	14.4	0.50676	2.729	23.69%	10.25%
910300235	5	9.0276	7.5551	10.5	4.696	15.272	0.71885	3.8711	42.88%	29.68%
910300247	5	10.44	9.3741	11.505	5.66	12.432	0.52018	2.8013	26.83%	18.68%

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
20091120 (CTL)	16.136	14.148	15.232	10.964	7.706
910300243	18.812	8.776	10.872	10.528	14.6
910300228	12.568	4.81	10.82	11.09	10.926
910300226	12.86	8.794	15.392	15.556	13.83
910300231	12.716	12.628	15.428	7.566	11.436
910300236	13.702	11.288	10.746	13.652	12.872
910300241	10.162	5.206	13.664	13.316	12.086
910300250	13.568	14.4	7.482	10.528	11.628
910300235	8.946	15.272	4.696	8.614	7.61
910300247	5.66	10.254	11.68	12.432	12.172

Graphics





2009 Dec 18 Analyst: M.GM 2009 Dec 18 QA: KT

Neanthes 20-d Survival and Growth Sediment Test — **Cantest Ltd.**

Analysis ID:	09-3643-1208	**Endpoint:**	Growth Rate-mg/day	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 17:10	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	11-7005-6399	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	20 Nov-09 17:30	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	10 Dec-09 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	
Duration:	19d 19h	**Source:**	Don Reish, California State University	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
20091120 (CTL)	20-3580-6427	20 Nov-09 12:00	20 Nov-09 12:00	5h	Golder Associates (Burnaby)	Ladysmith Harbour
910300243	01-8316-7750	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300228	08-1020-7122	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300226	12-8595-1757	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300231	10-5257-4682	19 Oct-09 12:00	22 Oct-09 16:11	32d 5h		
910300236	07-0341-6256	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300241	14-9647-5657	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300250	06-5107-8408	21 Oct-09 12:00	22 Oct-09 16:11	30d 5h		
910300235	09-7523-9221	20 Oct-09 12:00	22 Oct-09 16:11	31d 5h		
910300247	00-5995-0583	21 Oct-09 16:11	22 Oct-09 16:11	30d 1h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
20091120 (CTL)	Sediment Control	Golder	Negative Control		
910300243	Marine/Estuarine Sedim	Golder	16744-11		
910300228	Marine/Estuarine Sedim	Golder	16740-04		
910300226	Marine/Estuarine Sedim	Golder	16740-02		
910300231	Marine/Estuarine Sedim	Golder	16740-07		
910300236	Marine/Estuarine Sedim	Golder	16744-03		
910300241	Marine/Estuarine Sedim	Golder	16744-08		
910300250	Marine/Estuarine Sedim	Golder	16747-06		
910300235	Marine/Estuarine Sedim	Golder	16744-02		
910300247	Marine/Estuarine Sedim	Golder	16747-03		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run					30.89%

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
20091120 (CTL)		910300243	0.050448	1.8595	0.22061	0.4805	Non-Significant Effect
		910300228	1.3602	1.8595	0.19101	0.1054	Non-Significant Effect
		910300226	-0.22686	1.8595	0.18411	0.5869	Non-Significant Effect
		910300231	0.43901	1.8595	0.18688	0.3361	Non-Significant Effect
		910300236	0.23099	1.8595	0.15505	0.4116	Non-Significant Effect
		910300241	0.89013	1.8595	0.20373	0.1997	Non-Significant Effect
		910300250	0.66654	1.8595	0.18357	0.2619	Non-Significant Effect
		910300235	1.6385	1.8595	0.21618	0.0700	Non-Significant Effect
		910300247	1.2021	1.8595	0.18545	0.1318	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	0.2163642	0.02404047	9	0.99105	0.4626	Non-Significant Effect
Error	0.9703028	0.02425757	40			
Total	1.186667	0.04829803	49			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Bartlett Equality of Variance	4.5911	21.666	0.8684	Equal Variances
Distribution	Shapiro-Wilk Normality	0.95532		0.0567	Normal Distribution

Analyst: 2009Dec18 QA: 2009Dec18

Neanthes 20-d Survival and Growth Sediment Test — **Cantest Ltd.**

Analysis ID:	09-3643-1208	**Endpoint:**	Growth Rate-mg/day	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 17:10	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

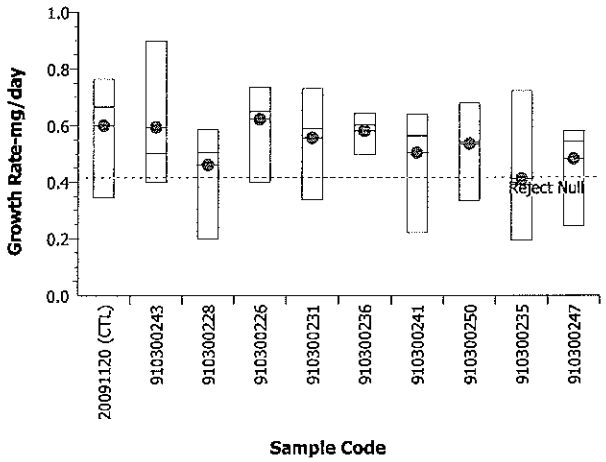
Growth Rate-mg/day Summary

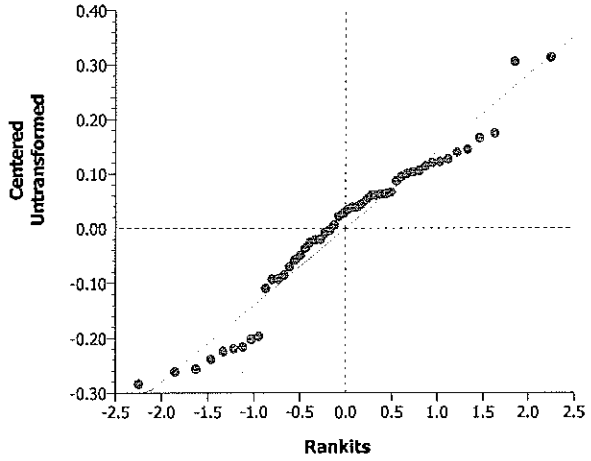
Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091120 (CTL)	5	0.60036	0.53436	0.66636	0.3438	0.7653	0.032221	0.17352	28.9%	0.0%
910300243	5	0.59438	0.51805	0.6707	0.3973	0.8991	0.037262	0.20066	33.76%	1.0%
910300228	5	0.46064	0.40339	0.51789	0.199	0.5869	0.027947	0.1505	32.67%	23.27%
910300226	5	0.62282	0.57052	0.67512	0.3982	0.7363	0.02553	0.13749	22.08%	-3.74%
910300231	5	0.55624	0.50192	0.61056	0.3368	0.7299	0.026517	0.1428	25.67%	7.35%
910300236	5	0.5811	0.55515	0.60705	0.4958	0.6436	0.012666	0.06821	11.74%	3.21%
910300241	5	0.50284	0.43706	0.56862	0.2188	0.6417	0.032113	0.17293	34.39%	16.24%
910300250	5	0.53456	0.48266	0.58646	0.3326	0.6785	0.025338	0.13645	25.53%	10.96%
910300235	5	0.40988	0.33626	0.4835	0.1933	0.7221	0.035943	0.19356	47.22%	31.73%
910300247	5	0.48048	0.4272	0.53376	0.2415	0.5801	0.026009	0.14006	29.15%	19.97%

Growth Rate-mg/day Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
20091120 (CTL)	0.7653	0.6659	0.7201	0.5067	0.3438
910300243	0.8991	0.3973	0.5021	0.48488	0.6885
910300228	0.5869	0.199	0.4995	0.513	0.5048
910300226	0.6015	0.3982	0.7281	0.7363	0.65
910300231	0.5943	0.5899	0.7299	0.3368	0.5303
910300236	0.6436	0.5229	0.4958	0.6411	0.6021
910300241	0.4666	0.2188	0.6417	0.6243	0.5628
910300250	0.6369	0.6785	0.3326	0.4849	0.5399
910300235	0.4058	0.7221	0.1933	0.3892	0.339
910300247	0.2415	0.4712	0.5425	0.5801	0.5671

Graphics





2009 Dec 18 2009 Dec 18
Analyst: M. Grey QA: KT

20-d *Neanthes areanaceodentata* Survival and Growth Test

Summary of Survival Data for Neanthes Test

Cantest Sample ID	Replicate	Cantest Login ID	# exposed	# Surviving at 20 days	% Survival	Mean Survival (%)	SD (%)
CTRL	A	-	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		
16744-11	A	910300243	5	5	100.0	96.0	8.9
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	4	80.0		
	E		5	5	100.0		
16740-04	A	910300228	5	5	100.0	84.0	26.1
	B		5	2	40.0		
	C		5	4	80.0		
	D		5	5	100.0		
	E		5	5	100.0		
16740-02	A	910300226	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		
16740-07	A	910300231	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		
16744-03	A	910300236	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		
16744-08	A	910300241	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		
16747-06	A	910300250	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		
16744-02	A	910300235	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		
16747-03	A	910300247	5	5	100.0	100.0	0.0
	B		5	5	100.0		
	C		5	5	100.0		
	D		5	5	100.0		
	E		5	5	100.0		

Proofed : LS 2009Dec23

CANTEST Ltd.

20-d *Neanthes areanceodentata* Survival and Growth Test

Summary of Dry Weight Data for Neanthes Test

Cantest Sample ID	Replicate	Cantest Login ID	Pan Count	Total Dry Weight (mg)	Individual Dry Weight per Worm (mg)	Mean Individual Dry Weight (mg)	SD (mg)
CTRL	A	-	5	80.68	16.14	12.84	3.5
	B		5	70.74	14.15		
	C		5	76.16	15.23		
	D		5	54.82	10.96		
	E		5	38.53	7.71		
16744-11	A	910300243	5	94.06	18.81	12.72	4.0
	B		5	43.88	8.78		
	C		5	54.36	10.87		
	D		4	42.11	10.53		
	E		5	73.00	14.60		
16740-04	A	910300228	5	62.84	12.57	10.04	3.0
	B		2	9.62	4.81		
	C		4	43.28	10.82		
	D		5	55.45	11.09		
	E		5	54.63	10.93		
16740-02	A	910300226	5	64.30	12.86	13.29	2.7
	B		5	43.97	8.79		
	C		5	76.96	15.39		
	D		5	77.78	15.56		
	E		5	69.15	13.83		
16740-07	A	910300231	5	63.58	12.72	11.95	2.9
	B		5	63.14	12.63		
	C		5	77.14	15.43		
	D		5	37.83	7.57		
	E		5	57.18	11.44		
16744-03	A	910300236	5	68.51	13.70	12.45	1.4
	B		5	56.44	11.29		
	C		5	53.73	10.75		
	D		5	68.26	13.65		
	E		5	64.36	12.87		
16744-08	A	910300241	5	50.81	10.16	10.89	3.5
	B		5	26.03	5.21		
	C		5	68.32	13.66		
	D		5	66.58	13.32		
	E		5	60.43	12.09		
16747-06	A	910300250	5	67.84	13.57	11.52	2.7
	B		5	72.00	14.40		
	C		5	37.41	7.48		
	D		5	52.64	10.53		
	E		5	58.14	11.63		
16744-02	A	910300235	5	44.73	8.95	9.03	3.9
	B		5	76.36	15.27		
	C		5	23.48	4.70		
	D		5	43.07	8.61		
	E		5	38.05	7.61		
16747-03	A	910300247	5	28.30	5.66	10.44	2.8
	B		5	51.27	10.25		
	C		5	58.40	11.68		
	D		5	62.16	12.43		
	E		5	60.86	12.17		

Proofed: KT 2009Dec18

Summary of Growth Rate Data for Neanthes Test

Cantest Sample ID	Replicate	Cantest Login ID	Initial Weight	Ind. Dry Weight (mg)	Growth rate (mg/day)	Mean Growth Rate (mg/day)	SD (mg)
CTRL	A	-	0.83	16.14	0.77	0.60	0.17
	B		0.83	14.15	0.67		
	C		0.83	15.23	0.72		
	D		0.83	10.96	0.51		
	E		0.83	7.71	0.34		
16744-11	A	910300243	0.83	18.81	0.90	0.59	0.20
	B		0.83	8.78	0.40		
	C		0.83	10.87	0.50		
	D		0.83	10.53	0.48		
	E		0.83	14.60	0.69		
16740-04	A	910300228	0.83	12.57	0.59	0.46	0.15
	B		0.83	4.81	0.20		
	C		0.83	10.82	0.50		
	D		0.83	11.09	0.51		
	E		0.83	10.93	0.50		
16740-02	A	910300226	0.83	12.86	0.60	0.62	0.14
	B		0.83	8.79	0.40		
	C		0.83	15.39	0.73		
	D		0.83	15.56	0.74		
	E		0.83	13.83	0.65		
16740-07	A	910300231	0.83	12.72	0.59	0.56	0.14
	B		0.83	12.63	0.59		
	C		0.83	15.43	0.73		
	D		0.83	7.57	0.34		
	E		0.83	11.44	0.53		
16744-03	A	910300236	0.83	13.70	0.64	0.58	0.07
	B		0.83	11.29	0.52		
	C		0.83	10.75	0.50		
	D		0.83	13.65	0.64		
	E		0.83	12.87	0.60		
16744-08	A	910300241	0.83	10.16	0.47	0.50	0.17
	B		0.83	5.21	0.22		
	C		0.83	13.66	0.64		
	D		0.83	13.32	0.62		
	E		0.83	12.09	0.56		
16747-06	A	910300250	0.83	13.57	0.64	0.53	0.14
	B		0.83	14.40	0.68		
	C		0.83	7.48	0.33		
	D		0.83	10.53	0.48		
	E		0.83	11.63	0.54		
16744-02	A	910300235	0.83	8.95	0.41	0.41	0.19
	B		0.83	15.27	0.72		
	C		0.83	4.70	0.19		
	D		0.83	8.61	0.39		
	E		0.83	7.61	0.34		
16747-03	A	910300247	0.83	5.66	0.24	0.48	0.14
	B		0.83	10.25	0.47		
	C		0.83	11.68	0.54		
	D		0.83	12.43	0.58		
	E		0.83	12.17	0.57		

CANTEST Ltd.

20 day *Neanthes arenaceodentata* Survival and Growth Test
Conditions and Survival Data

Client # & Name: *GOL001 - Golder Associates

Start Date and Time: 2009 Nov 20 @ 1730

Client Project #: 09-1436-5008

End Date: 2009 Dec 10

CANTEST Project #: 2-11-1024

Wt.* at Start of Test (~~g~~ mg): 0.83 /worm

Organism Lot #: DR091117

Statistics File: NA-GOL001-0109

Analyst(s): M. Grey, K. Pomeroy, C Beltrain, A. Pagdonsolan
NShergill

*average weight

Sample ID: Control

CANTEST #: N/A

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.0	19.4	19.1	19.8	19.5	19.4	19.6	20.3
D.O. (mg/L)	7.5	7.6	7.7	7.5	7.8	7.6	7.7	7.5
pH	80	7.8	7.9	7.7	7.7	7.0	7.7	7.6
Salinity (‰)	30	30	31	30	30	30	30	30
Analyst	MG	KP	WB	APag	CB	CB	CB	APag

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	MG	MG	MG	MG	MG	MG	MG

Sample ID: 16744-11

CANTEST#: 910300243

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.0	19.3	19.3	19.8	19.6	19.2	19.2	20.3
D.O. (mg/L)	7.6	7.6	7.7	7.6	7.8	7.9	7.7	7.5
pH	8.1	8.0	8.0	8.1	8.1	8.1	8.2	8.0
Salinity (‰)	31	31	31	31	30	30	31	30
Analyst	MG	KP	WB	APag	CB	CB	CB	APag

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	~~5~~ 4	5	Initial	Final
Analyst	MG	APag	NS	~~MG~~ APag	MG	MG	MG

@WEMG 2009 Dec 10

CANTEST Ltd.

20 Day *Neanthes arenaceodentata* Survival and Growth Test
Conditions and Survival Data

Client # & Name: #GOL001 - Golder Associates Start Date and Time: 2009 Nov 20 @ 17:30

Sample ID: 16740-04 CANTEST #: 9103002228

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B (MG 2009 Dec 01)	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.1 (2009 Nov 20)	19.1	19.2	19.4	19.4	19.4	19.2	20.2
D.O. (mg/L)	7.5	7.7	7.7	7.7	7.7	7.8	7.7	7.5
pH	8.1	8.0	8.0	8.2	8.1	8.0	8.0	7.9
Salinity (‰)	31	31	31	31	31	31	31	31
Analyst	MG	KP	MB	APaq	CB	CB	CB	APaq

(1) MG MG 2009 Nov 20

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	2	4	5	5	Initial	Final
Analyst	APaq	APaq	APaq	MG	APaq	MG	MG

Sample ID: 16740-02 CANTEST#: 9103002226

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B (MG 2009 Dec 01)	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.3	19.5	19.4	19.8	19.7	19.0	19.8	20.3
D.O. (mg/L)	7.5	7.3	7.7	7.5	7.7	7.8	7.6	7.6
pH	8.0	7.9	8.0	8.2	8.1	8.1	8.1	7.9
Salinity (‰)	31	31	31	31	31	31	31	30
Analyst	MG	KP	MB	APaq	CB	CB	CB	APaq

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	NS	MG	NS	NS	KP	MG	MG

CANTEST Ltd.

20 Day *Neanthes arenaceodentata* Survival and Growth Test
Conditions and Survival Data

Client # & Name: #GOL001 - Golder Associates Start Date and Time: 2009 Nov 20 @ 17:30

Sample ID: 16740-07 CANTEST #: 9103002311

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.2	19.4	19.4	19.6	19.6	19.4	19.5	20.3
D.O. (mg/L)	7.4	7.5	7.7	7.6	7.8	7.9	7.7	7.5
pH	8.0	7.9	7.9	8.1	8.1	8.0	8.1	7.9
Salinity (‰)	31	31	31	31	31	30	31	30
Analyst	MG	KP	WB	AReq	CB	CB	CB	AReq

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	MG/KP	WB	KP	KP	KP	MG	MG

Sample ID: 16744-03 CANTEST#: 9103002361

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.0	19.3	19.8	19.8	19.7	19.4	19.8	20.5
D.O. (mg/L)	7.5	7.4	7.4	7.5	7.4	7.7	7.5	7.4
pH	8.0	8.0	8.0	8.2	8.1	8.0	8.1	7.8
Salinity (‰)	31	31	31	31	31	31	31	31
Analyst	MG	KP	WB	AReq	CB	CB	CB	AReq

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	MG	MG	MG	MG	NS	MG	MG

@ 7.9 WE AReq 2009 Dec 10

CANTEST Ltd.

20 Day *Neanthes arenaceodentata* Survival and Growth Test
Conditions and Survival Data

Client # & Name: # GOL001 - Golder Associates Start Date and Time: 2009 Nov 20 @ 17:30

Sample ID: 16744-08 CANTEST #: 910300241

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.0	19.4	19.5	19.7	19.7	19.3	19.8	20.5
D.O. (mg/L)	7.5	7.5	7.6	7.4	7.7	7.7	7.6	7.4
pH	8.1	8.0	8.0	8.1	8.0	7.9	8.1	7.9
Salinity (‰)	30	31	31	31	30	30	30	30
Analyst	MG	KP	MB	APaq	CB	CB	CB	APaq

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	MG	MG	MG	MG	MG	MG	MG

Sample ID: 16747-06 CANTEST#: 910300250

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec 10
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.0	19.1	19.3	19.4	19.1	19.0	19.5	20.2
D.O. (mg/L)	7.5	7.7	7.6	7.4	7.8	8.0	7.7	7.6
pH	8.1	8.1	8.1	8.1	8.1	8.3	8.1	8.0
Salinity (‰)	31	31	31	32	31	31	32	32
Analyst	MG	KP	MB	APaq	CB	CB	CB	APaq

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	APaq	NS	KP	APaq	KP	MG	MG

CANTEST Ltd.

20 Day *Neanthes arenaceodentata* Survival and Growth Test
Conditions and Survival Data

Client # & Name: #GA001 - Golder Associates Start Date and Time: 2009 Nov 20 @ 17:30

Sample ID: 16744-02 CANTEST #: 9103000235

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov. 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec. 10
~~Replicate~~	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.5	19.2	19.3	19.7	19.5	19.0	19.5	20.5
D.O. (mg/L)	7.5	7.7	7.6	7.5	7.7	8.2	7.6	7.5
pH	8.1	8.1	8.1	8.2	8.1	8.1	8.1	7.9
Salinity (‰)	31	31	31	31	31	31	31	31
Analyst	MG	KP	CB	APaq	CB	CB	CB	APaq

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	NS	NS	KP	NS	NS	MG	MG

Sample ID: 16747-03 CANTEST#: 9103000247

Date	2009 Nov 20	2009 Nov 23	2009 Nov 26	2009 Nov. 29	2009 Dec 02	2009 Dec 05	2009 Dec 08	2009 Dec. 10
~~Replicate~~	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (°C)	19.0	19.1	19.3	19.7	19.3	19.4	19.3	20.2
D.O. (mg/L)	7.5	7.7	7.7	7.5	7.7	8.1	7.7	7.6
pH	8.1	Ⓐ ~~8.1~~ 8.0	8.0	8.1	8.1	7.8	8.0	7.9
Salinity (‰)	31	31	31	31	31	31	31	31
Analyst	MG	KP	CB	APaq	CB	CB	CB	APaq

Replicate	A	B	C	D	E	Ammonia Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	APaq	APaq	APaq	APaq	APaq	MG	MG

Ⓐ WE KP 2009 Nov 23

CANTEST Ltd.

Neanthes Test
Aeration Checks

Client # & Name: GOL001 - Golder Associates Start Date & Time: 2009 Nov 20 @ 1730

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

	Day 0	1	2	3	4	5	6	7	8	9	Day 10
Date	2009 Nov 20	2009 Nov 21	2009 Nov 22	2009 Nov 23	2009 Nov 24	2009 Nov 25	2009 Nov 26	2009 Nov 27	2009 Nov 28	2009 Nov 29	2009 Nov 30
Early AM	✓ MG	✓ WB	✓ APag	✓ APag	✓ KP	✓ KP	✓ WB	✓ WB	✓ KT	✓ APag	✓ APag
Mid-day	✓ MG	✓ DJ	✓ APag	✓ KP	✓ KP	✓ KP	✓ WB	✓ WB	✓ KT	✓ APag	✓ APag
Late PM	✓ MG	✓ WB	✓ MG	✓ KP	✓ KP	✓ KP	✓ KT	✓ WB	✓ MG	✓ APag	✓ APag

	11	12	13	14	15	16	17	18	19	Day 20
Date	2009 Dec 01	2009 Dec 02	2009 Dec 03	2009 Dec 04	2009 Dec 05	2009 Dec 06	2009 Dec 07	2009 Dec 08	2009 Dec 09	2009 Dec 10
Early AM	CB	CB	KP	MG	CB	KP	MG	CB	CB	APag
Mid-day	CB	CB	CB	MG	CB	KP	MG	CB	CB	—
Late PM	CB	CB	KP	KP	✓ KT	KP	MG	CB	CB	—

Comments:

Set aeration @ 18:00 on Nov 19, 2009. WE KP 2009 Nov 24 ~~2009 Nov 24~~ MG

2009 Nov 24, Control Rep D low aeration rate. DO: 5.8 mg/L ~75% sat KP

4002 Rep Reserve, #58, 47-06 #59A, 44-08 Rep E #60, 40-02 Rep A #54 & 40-04 Rep E

airlines re-connected - done in 2 minutes CB 2009 Dec 02

M. Gray 2009 Dec 18

CANTEST Ltd.

Neanthes 20 Day Survival and Growth Test
Feeding Record

Client # & Name: #GOL001- Golder Associates Start Date & Time: 2009 Nov 20 @

Grind Tetramarine™ and sieve through a 0.50 mm screen.

# of replicates: 60 Tetramarine™ per ~~day~~ vial (g): 3.0
WE MG 2009 Nov 18

volume of seawater (ml): 75

Day	Date	Analyst	Conc'n of Feed (mg/mL)	1 mL Feed (√)
0	2009 Nov 20	KP	40	✓
2	2009 Nov 22	APCG	40	✓
4	2009 Nov 24	KP	40	✓
6	2009 Nov 26	KF	40	✓
8	2009 Nov. 28	CB	40	✓
10	2009 Nov. 30	APCG	40	✓
12	2009 Dec 02	CB	40	✓
14	2009 Dec 04	MG	40	✓
16	2009 Dec 06	KP	40	✓
18	2009 Dec 08	CB	40	✓

Add ground tetramarine to the volume of seawater indiated above. Place slurry on stirplate and let spin for at least 5 minutes.

Comments:

M. Grey 2009 Dec 18

Cantest Ltd.

Neanthes Initial Seawater Measurements

Client # & Name: *GOLD01 - Golden Associates **Test Initiation Date:** 2009 Nov 20

Seawater Arrival Date: 2009 Nov **Type of Seawater:** Vancouver Aquarium

Date	Day	Temperature (°C)	D.O. (mg/L)	pH	Salinity (‰)	30% Water Renewal	Analyst
2009 Nov 17	—	20.5	8.0	7.9	29	N/A	MG
2009 Nov 19	Day -1	20.0	8.1 (A)	8.0	28	N/A	MG
2009 Nov 20	Day 0	19.4	~~7.8~~ 7.0	7.8	30	N/A	MG
2009 Nov 23 ~~2009 Nov 20~~	Day 3	(B) ~~17.3~~ 19.1	(B) ~~8.0~~ 7.8	(B) ~~7.8~~ 7.9	(B) ~~28~~ 31	(B) ~~N/A~~ Y	~~AR~~ (B) KP
2009 Nov 26	Day 6	19.1	7.7	7.8	30	YES	KP
2009 Nov 29	Day 9	19.3	7.7	7.8	31	YES	ARG
2009 Dec 02	Day 12	19.3	7.8	7.2	28.	YES	CB
2009 Dec 05	Day 15	19.1	7.8	7.0	~~28.8~~ 29 (C)	YES	CB
2009 Dec 08	Day 18	19.6	7.7	7.8	~~28.9~~ 29 (C)	YES	CB

(C) WE CB 2009 Dec 10
(A) WE MG 2009 Nov 20
(B) WE MG 2009 Nov. 20

Comments:

N. Gray 2009 Dec 18

Randomization Chart for Neanthes Test
Use the coloured dots to find appropriate concentrations
Position Map

Back Wall

5	10	
4	9	
3	8	
2	7	
1	6	etc...

Front of Counter

Client # GOL001 Date: 20-Nov

Position #	Treatment	Replicate	Colour
18	Control	A	Dk Blue
2	Control	B	Dk Blue
27	Control	C	Dk Blue
25	Control	D	Dk Blue
16	Control	E	Dk Blue
37	Control	Measure	Dk Blue
30	16744-11	A	Green
35	16744-11	B	Green
46	16744-11	C	Green
50	16744-11	D	Green
22	16744-11	E	Green
39	16744-11	Measure	Green
29	16740-04	A	Yellow
47	16740-04	B	Yellow
21	16740-04	C	Yellow
51	16740-04	D	Yellow
55	16740-04	E	Yellow
24	16740-04	Measure	Yellow
54	16740-02	A	White
4	16740-02	B	White
48	16740-02	C	White
40	16740-02	D	White
56	16740-02	E	White
58	16740-02	Measure	White
42	16740-07	A	Lt blue
20	16740-07	B	Lt blue
31	16740-07	C	Lt blue
7	16740-07	D	Lt blue
43	16740-07	E	Lt blue
52	16740-07	Measure	Lt blue

Position #	Treatment	Replicate	Colour
33	16744-03	A	Pink
53	16744-03	B	Pink
5	16744-03	C	Pink
36	16744-03	D	Pink
34	16744-03	E	Pink
38	16744-03	Measure	Pink
1	16744-08	A	Lt orange
44	16744-08	B	Lt orange
23	16744-08	C	Lt orange
28	16744-08	D	Lt orange
60	16744-08	E	Lt orange
41	16744-08	Measure	Lt orange
59	16747-06	A	Lt green
49	16747-06	B	Lt green
9	16747-06	C	Lt green
26	16747-06	D	Lt green
11	16747-06	E	Lt green
12	16747-06	Measure	Lt green
32	16744-02	A	Red
15	16744-02	B	Red
3	16744-02	C	Red
8	16744-02	D	Red
19	16744-02	E	Red
10	16744-02	Measure	Red
17	16747-03	A	Flag
6	16747-03	B	Flag
45	16747-03	C	Flag
57	16747-03	D	Flag
14	16747-03	E	Flag
13	16747-03	Measure	Flag

CANTEST Ltd. ***Neanthes arenaceodentata* Initial Dry Weights**

Client # & Name: *GO001 - Golder Associates Start Date and Time: 2009 Nov 20 @ 1730

Sample Date: 2009 Oct 19-21 End Date: 2009 Dec 10

Sample Received: 2009 Oct 22 Stats File ID: N/A

Weighing Dates: 2009 Nov 21 ; 2009 Nov 20 Average weight (Day 0): 0.83 mg per worm

Analyst(s): WBrassil ; APaqdonsolan NShergill

Boat #	# Worms	Boat Weight (g)	Worms + Boat weight (g)	Total Worm weight (g)	Individual worm weight (g)
N-A	5	1.13622	1.13729	0.00107	0.00021
N-B	5	1.16944	1.17170	0.00226	0.00045
N-C	5	1.17293	1.17681	0.00388	0.00078
N-D	5	1.16643	1.17030	0.00387	0.00077
N-E	5	1.15358	1.15732	0.00374	0.00075
NS 2009 Dec 11 N-~~6~~F	5	1.16298	1.16790	0.00492	0.00098
Analyst		APaq	WB NS	WB NS	WB NS

Comments:
2009 Nov 20 - NA boat for small, NB-medium neanthes, NC-large neanthes APaq
2009 Nov 20 - ~~NB, NC, N~~ ND, NE, NF pans used for initial weights. Three cups, from the group of cups used ~~for~~ to weigh 2009 Nov 20 ~~seeding~~ the test, were selected at random for initial weight measurements MG
The average estimated individual worm weight on Day 0 = 0.83mg MG

CANTEST Ltd.

Neanthes arenaceodentata 28-d Test
Dry Weights

Client # & Name: GOL001-Golder Associates
Start Date and Time: 2009 Nov 20 @ 17:30
Sample Date: 2009 Oct 19-21
End Date: 2009 Dec 10
Sample Received: 2009 Oct 22
Weighing Dates: 2009 Dec 10; 2009 Dec 11
Organism Lot #: DR091117
CANTEST # Various
Sample ID(s): Various
Stats File ID: NA-GOL001-0109
Analyst(s): M. Grey, N. Shergill

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
1	CTRL	A	5	1.15278	1.23346	80.68	16.14	12.84	3.47
2		B	5	1.17368	1.24442	70.74	14.15		
3		C	5	1.17540	1.25156	76.16	15.23		
4		D	5	1.15905	1.21387	54.82	10.96		
5		E	5	1.18315	1.22168	38.53	7.71		
6	16744-11	A	5	1.15982	1.25388	94.06	18.81	12.72	4.01
7		B	5	1.17220	1.21608	43.88	8.78		
8		C	5	1.16464	1.21900	54.36	10.87		
9		D	4	1.17579	1.21790	42.11	10.53		
10		E	5	1.17663	1.24963	73.00	14.60		
11	16740-04	A	5	1.16289	1.22573	62.84	12.57	10.04	3.01
12		B	2	1.15756	1.16718	9.62	4.81		
13		C	4	1.17154	1.21482	43.28	10.82		
14		D	5	1.15574	1.21119	55.45	11.09		
15		E	5	1.16564	1.22027	54.63	10.93		
16	16740-02	A	5	1.17597	1.24027	64.30	12.86	13.29	2.75
17		B	5	1.17550	1.21947	43.97	8.79		
18		C	5	1.14276	1.21972	76.96	15.39		
19		D	5	1.16984	1.24762	77.78	15.56		
20		E	5	1.17279	1.24194	69.15	13.83		
21	16740-07	A	5	1.16789	1.23147	63.58	12.72	11.95	2.86
22		B	5	1.17726	1.24040	63.14	12.63		
23		C	5	1.15170	1.22884	77.14	15.43		
24		D	5	1.15072	1.18855	37.83	7.57		
25		E	5	1.16043	1.21761	57.18	11.44		
26	16744-03	A	5	1.17830	1.24681	68.51	13.70	12.45	1.36
27		B	5	1.16753	1.22397	56.44	11.29		
28		C	5	1.16046	1.21419	53.73	10.75		
29		D	5	1.16348	1.23174	68.26	13.65		
30		E	5	1.16134	1.22570	64.36	12.87		
31	QA/QC	QA/QC	0	1.17795	1.17784	-0.11	-	-	-
32	QA/QC	QA/QC	0	1.15850	1.15831	-0.19	-	-	-
1		A	5	1.15283	1.23353	80.70	-	-	-

Proofed KT 2009Dec18

CANTEST Ltd.

Neanthes arenaceodentata 28-d Test
Dry Weights

Client # & Name: GOL001-Golder Associates
Start Date and Time: 2009 Nov 20 @ 17:30
Sample Date: 2009 Oct 19-21
End Date: 2009 Dec 10
Sample Received: 2009 Oct 22
Weighing Dates: 2009 Dec 10; 2009 Dec 11
Organism Lot #: DR091117
CANTEST # Various
Sample ID(s): Various
Stats File ID: NA-GOL001-0109
Analyst(s): M. Grey, N. Shergill

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
33	16744-08	A	5	1.15945	1.21026	50.81	10.16	10.89	3.46
34		B	5	1.17830	1.20433	26.03	5.21		
35		C	5	1.17661	1.24493	68.32	13.66		
36		D	5	1.17291	1.23949	66.58	13.32		
37		E	5	1.16347	1.22390	60.43	12.09		
38	16747-06	A	5	1.16654	1.23438	67.84	13.57	11.52	2.73
39		B	5	1.16339	1.23539	72.00	14.40		
40		C	5	1.17149	1.20890	37.41	7.48		
41		D	5	1.16379	1.21643	52.64	10.53		
42		E	5	1.17195	1.23009	58.14	11.63		
43	16744-02	A	5	1.17774	1.22247	44.73	8.95	9.03	3.87
44		B	5	1.16158	1.23794	76.36	15.27		
45		C	5	1.17738	1.20086	23.48	4.70		
46		D	5	1.16391	1.20698	43.07	8.61		
47		E	5	1.16902	1.20707	38.05	7.61		
48	16747-03	A	5	1.15946	1.18776	28.30	5.66	10.44	2.80
49		B	5	1.15566	1.20693	51.27	10.25		
50		C	5	1.18038	1.23878	58.40	11.68		
51		D	5	1.16438	1.22654	62.16	12.43		
52		E	5	1.16830	1.22916	60.86	12.17		
53	QA/QC	QA/QC	0	1.15593	1.15563	-0.30	-	-	-
54	QA/QC	QA/QC	0	1.17160	1.17148	-0.12	-	-	-
33		A	5	1.15948	1.21036	50.88	-	-	-

Proofed: KT 2009 Dec 18

CANTEST Ltd.

Neanthes arenaceodentata 28-d Test
Dry Weights

Client # & Name: #GOL001 - Golder Associates
Sample Date: Oct 19 - Oct 21, 2009
Sample Received: Oct 22, 2009
Organism Lot #: DR091117
Sample ID(s): Various
Analyst(s): M. Greg, N Shergill

Start Date and Time: 2009 Nov 20 @ 17:30
End Date: 2009 Nov Dec 10 (Dec 10, 2009 Dec 15)
Weighing Dates: 2009 Dec. 10, 2009 Dec. 11
CANTEST # Various
Stats File ID: NA-GOL001-0109

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
1	CTRL	A	5	1.15278	1.23346	0.00	#DIV/0!	#DIV/0!	#####
2		B	5	1.17388	1.24442	0.00	#DIV/0!		
3		C	5	1.17540	1.25156	0.00	#DIV/0!		
4		D	5	1.15905	1.21387	0.00	#DIV/0!		
5		E	5	1.18315	1.22168	0.00	#DIV/0!		
6	16744-11	A	5	1.15982	1.25388	0.00	#DIV/0!	#DIV/0!	#####
7		B	5	1.17220	1.21608	0.00	#DIV/0!		
8		C	5	1.16464	1.21900	0.00	#DIV/0!		
9		D	©4	1.17579	1.21790	0.00	#DIV/0!		
10		E	©4	1.17663	1.24963	0.00	#DIV/0!		
11	16740-04	A	5 5	1.16289	1.22573	0.00	#DIV/0!	#DIV/0!	#####
12		B	2	1.15756	1.16718	0.00	#DIV/0!		
13		C	4	1.17154	1.21482	0.00	#DIV/0!		
14		D	5	1.15574	1.21119	0.00	#DIV/0!		
15		E	5	1.16564	1.22027	0.00	#DIV/0!		
16	16740-02	A	5	1.17597	1.24027	0.00	#DIV/0!	#DIV/0!	#####
17		B	5	1.17550	1.21947	0.00	#DIV/0!		
18		C	5	1.14276	1.21972	0.00	#DIV/0!		
19		D	©5	1.16984	1.24762	0.00	#DIV/0!		
20		E	5	1.17279	1.24194	0.00	#DIV/0!		
21	16740-07	A	5	1.16789	1.23147	0.00	#DIV/0!	#DIV/0!	#####
22		B	5	1.17726	1.24040	0.00	#DIV/0!		
23		C	5	1.15170	1.22884	0.00	#DIV/0!		
24		D	5	1.15072	1.18055	0.00	#DIV/0!		
25		E	5	1.16043	1.21761	0.00	#DIV/0!		
26	16744-03	A	5	1.17830	1.24681	0.00	#DIV/0!	#DIV/0!	#####
27		B	5	1.16753	1.22397	0.00	#DIV/0!		
28		C	5	1.16046	1.21419	0.00	#DIV/0!		
29		D	5	1.16348	1.22318 (B)	0.00	#DIV/0!		
30		E	5	1.16134	1.21570	0.00	#DIV/0!		
31	QA/QC	QA/QC	0	1.17795	1.17784	0.00	-	-	-
32	QA/QC	QA/QC	0	1.15850	1.15831	0.00	-	-	-
1		A	5	NS 1.15283	1.23353	0.00	-	-	-

WE NS 2009 DEC 10

(B) 1.23174 NS 2009 DEC 11

©16/6 2009 Dec 17 - rechecked worm #5 in pans.

CANTEST Ltd.

Neanthes arenaceodentata 28-d Test
Dry Weights

Client # & Name: *GOL001 - Golder Associates
Start Date and Time: 2009 Nov 20 @ 4:30
Sample Date: Oct 19 - Oct 21, 2009
End Date: 2009 Dec 10
Sample Received: Oct 22, 2009
Weighing Dates: 2009 Dec 10, 2009 Dec 11
Organism Lot #: DR091117
CANTEST #: Various
Sample ID(s): Various
Stats File ID: NA-GOL001-0109
Analyst(s): M. Grey - NS Morgill

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
33	16744-08	A	⑧4 5	1.15945	1.21026	0.00	#DIV/0!	#DIV/0!	#####
34		B	5	1.17830	1.20433	0.00	#DIV/0!		
35		C	5	1.17661	1.24493	0.00	#DIV/0!		
36		D	5	1.17291	1.23949	0.00	#DIV/0!		
37		E	5	1.16347	1.22390	0.00	#DIV/0!		
38	16747-06	A	5	1.16654	1.23438	0.00	#DIV/0!	#DIV/0!	#####
39		B	5	1.16339	1.23539	0.00	#DIV/0!		
40		C	5	1.17149	1.20890	0.00	#DIV/0!		
41		D	5	1.16379	1.21643	0.00	#DIV/0!		
42		E	5	1.17195	1.23009	0.00	#DIV/0!		
43	16744-02	A	5	1.17774	1.22247	0.00	#DIV/0!	#DIV/0!	#####
44		B	5	1.16158	1.23794	0.00	#DIV/0!		
45		C	5	1.17738	1.20086	0.00	#DIV/0!		
46		D	5	1.16391	~~1.20706~~ Ⓐ	0.00	#DIV/0!		
47		E	5	1.16902	1.20707	0.00	#DIV/0!		
48	16747-03	A	5	1.15946	1.18776	0.00	#DIV/0!	#DIV/0!	#####
49		B	5	1.15566	1.20693	0.00	#DIV/0!		
50		C	5	~~1.18044~~ *	1.23878	0.00	#DIV/0!		
51		D	5	1.16438	1.22654	0.00	#DIV/0!		
52		E	5	1.16830	1.22916	0.00	#DIV/0!		
53	QA/QC	QA/QC	0	1.15593	1.15563	0.00	-	-	-
54	QA/QC	QA/QC	0	1.17160	1.17148	0.00	-	-	-
33		A	⑧46	1.15948	1.21036	0.00	-	-	-

(50) * 1.18038 NS 2009 Dec 10
Ⓐ 1.20698 NS 2009 Dec 11

Ⓑ No 2009 Dec 18 - rechecked numbers in pans.

CANTEST Ltd.

Summary of Overlying Water Measurements for Neanthes Test

Un-ionized Ammonia Calculator

This spreadsheet computes concentration of un-ionized ammonia in seawater as a function of total ammonia, pH, temperature, and salinity. pH can be measured on the "NBS" scale or Hansson scales. If this this confuses you, you are probably using the "NBS" scale and your measured pH values should be entered in Column C.

User information is only needed in cells outlined with double lines. This spreadsheet assumes that total ammonia is reported as nitrogen; computed un-ionized ammonia will also be reported as nitrogen.

Overlying Water

Subsample Date	Sample ID	Temp (°C)	Measured pH (NBS)	Total Ammonia Nitrogen (mg/L)	Salinity (‰)	Working pH	Ionic Strength (M)	pKa (infinite dilution)	pKa (SW)	Mole Fraction	Un-ionized Ammonia-N (mg/L)	Un-ionized Ammonia-N (µg/L)
11/20/2009 (Day 0)	Control	19.0	8.0	2.46	30	7.85	0.616	9.434	9.53	0.0205	0.0505	50.53
	16744-11	19.0	8.1	2.45	31	7.95	0.638	9.434	9.53	0.0255	0.0625	62.5
	16740-04	19.0	8.1	0.84	31	7.95	0.638	9.434	9.53	0.0255	0.0214	21.4
	16740-02	19.3	8.0	1.17	31	7.85	0.638	9.425	9.52	0.0208	0.0243	24.3
	16740-07	19.2	8.0	1.14	31	7.85	0.638	9.428	9.52	0.0207	0.0236	23.6
	16744-03	19.0	8.0	0.66	31	7.85	0.638	9.434	9.53	0.0204	0.0134	13.4
	16744-08	19.0	8.1	0.85	30	7.95	0.616	9.434	9.53	0.0257	0.0219	21.9
	16747-06	19.0	8.1	1.32	31	7.95	0.638	9.434	9.53	0.0255	0.0337	33.7
	16744-02	19.5	8.1	1.28	31	7.95	0.638	9.418	9.51	0.0264	0.0338	33.8
	16747-03	19.0	8.1	0.70	31	7.95	0.638	9.434	9.53	0.0255	0.0178	17.8
12/10/2009 (Day 20)	Control	20.3	7.6	8.53	30	7.45	0.616	9.393	9.48	0.0091	0.0777	77.7
	16744-11	20.3	8.0	11.30	30	7.85	0.616	9.393	9.48	0.0226	0.2549	254.9
	16740-04	20.2	7.9	9.80	31	7.75	0.638	9.396	9.49	0.0177	0.1736	173.6
	16740-02	20.3	7.9	8.84	30	7.75	0.616	9.393	9.48	0.0180	0.1591	159.1
	16740-07	20.3	7.9	8.62	30	7.75	0.616	9.393	9.48	0.0180	0.1552	155.2
	16744-03	20.3	7.8	8.30	31	7.65	0.638	9.393	9.49	0.0142	0.1181	118.1
	16744-08	20.5	7.9	7.94	30	7.75	0.616	9.387	9.48	0.0183	0.1450	145.0
	16747-06	20.2	8.0	9.04	32	7.85	0.659	9.396	9.49	0.0220	0.1990	199.0
	16744-02	20.5	7.9	9.10	31	7.75	0.638	9.387	9.48	0.0181	0.1648	164.8
	16747-03	20.2	7.9	10.50	31	7.75	0.638	9.396	9.49	0.0177	0.1860	186.0

proofed by MB 2010 Jan 07

References

Spreadsheet
http://www.fisheries.org/html/publications/epubs/fhm2e/ammonia_swc.xls

pKa for Ammonia in Freshwater
K. Emerson, R.C. Russo, R.C. Lund, & R.V. Thurson, Aqueous ammonia equilibrium calculations: effects of pH and temperature, J. Fish. Res. Board of Canada, 32:2379-2383, 1975

pKa for Ammonia in Seawater
K.H. Khoo, C.H. Culberson, and R.G. Bates, Thermodynamics of the dissociation of ammonium ion in seawater from % to 40 C, Journal of Solution Chemistry, 6:281-290, 1977.

Ionic Strength of Seawater
M. Whitfield, The hydrolysis of ammonia ions in sea water - a theoretical study, Journal of Marine Biological Association of the United Kingdoms, 54:565-580, 1974.

Measure of pH in Seawater
I. Hansson, A new set of pH scales and standard buffers for sea water, Deep-Sea Research, 20:479-491, 1973.

Interelationship of Hansson's pH scale with the NBS scale
F.J. Millero, The pH of estuarine waters, Limnology and Oceanography, 31:839-847, 1986.

LStanoff 2009Dec23

Analysis Report

REPORT ON: Analysis of Water Samples

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard / Marriah Grey

CHAIN OF CUSTODY: 2181991
PROJECT NAME: Ladysmith
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 10

REPORT DATE: December 24, 2009

DATE SUBMITTED: December 17, 2009

GROUP NUMBER: 101217102

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

TEST RESULTS:

(See following page)

CANTEST LTD.

Tim Matsushita
Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 24, 2009

GROUP NUMBER: 101217102

Conventional Parameters in Water Day 0 Neanthes

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N
Control	Nov 20/09	912170353	2.46
16740-02	Nov 20/09	912170354	1.17
16740-04	Nov 20/09	912170355	0.84
16740-07	Nov 20/09	912170356	1.14
16744-02	Nov 20/09	912170357	1.28
16744-03	Nov 20/09	912170358	0.66
16744-08	Nov 20/09	912170359	0.85
16744-11	Nov 20/09	912170360	2.45
16747-03	Nov 20/09	912170361	0.70
16747-06	Nov 20/09	912170362	1.32
REPORTING LIMIT			0.01
UNITS			mg/L

mg/L = milligrams per liter

Analysis Report

CANTEST

REPORT ON: Analysis of Water Sample

REPORTED TO: CANTEST Ltd. (Toxicology Division)
4606 Canada Way
Burnaby, BC
V5G 1K5

Att'n: Janet Pickard/Marriah Grey

CHAIN OF CUSTODY: 2181990
PROJECT NAME: Ladysmith. Overlying Ammonia for Day 10 Amphi
PROJECT NUMBER: 2-11-1024
P.O. NUMBER: 2-11-1024

NUMBER OF SAMPLES: 10

REPORT DATE: December 22, 2009

DATE SUBMITTED: December 17, 2009

GROUP NUMBER: 101217040

SAMPLE TYPE: Water

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Ammonia in Water - was performed using Flow Injection Analysis where the aqueous sample is injected into a carrier stream, which merges a sodium hydroxide stream. Gaseous ammonia is formed, which diffuses through a gas permeable membrane into an indicator stream. This indicator stream is comprised of a mixture of acid-base indicators, which will react with the ammonia gas; resulting in a colour shift which is measured photometrically @ 590 nm.

TEST RESULTS:

(See following page)

CANTEST LTD.

Tim Matsushita
Coordinator, Water Laboratory

4606 Canada Way, Burnaby, BC V5G 1K5
Tel: 604 734 7276 Fax: 604 731 2386

REPORTED TO: CANTEST Ltd. (Toxicology Division)

REPORT DATE: December 22, 2009

GROUP NUMBER: 101217040

CANTEST

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Ammonia Nitrogen N
16744-11	Dec 10/09	912170080	11.3
16740-04	Dec 10/09	912170082	9.80
16740-02	Dec 10/09	912170083	8.84
16740-07	Dec 10/09	912170084	8.62
16744-03	Dec 10/09	912170085	8.30
16744-08	Dec 10/09	912170086	7.94
16747-06	Dec 10/09	912170087	9.04
16744-02	Dec 10/09	912170088	9.10
16747-03	Dec 10/09	912170089	10.5
Control	Dec 10/09	912170090	8.53
REPORTING LIMIT			0.01
UNITS			mg/L

mg/L = milligrams per liter

LS we 20090dec23 Neanthes Final
~~Day10 Amphipod~~ Overlying Water
~~Test #2~~

CANTEST Ltd. ***Neanthes arenaceodentata*** **Acclimation and Holding Conditions**

1 of 8.1

Species: Neanthes arenaceodentata

Organism Lot #: DR091117

Holding Conditions

	Before Water Addition				After Water Addition				
Date & Time	Salinity (‰)	Temperature (°C)	pH	DO (mg/L)	Salinity (‰)	Temperature (°C)	pH	DO (mg/L)	Analyst
2009 Nov 17 @ 1245	34	18.2	7.1	6.9	—	—	—	—	MG
A					30	19.1	7.6	7.5	MG
B					31	19.2	7.6	7.5	MG
C					30	19.0	7.6	7.7	MG
D					31	18.9	7.6	7.8	MG
A									
B									
C									

2009 Nov 20 M. Gray

2009 Nov 18 M. Gray

Feeding

Date	2009 Nov 17	2009 Nov 18	2009 Nov 19						
Analyst	MG	MG	MG						

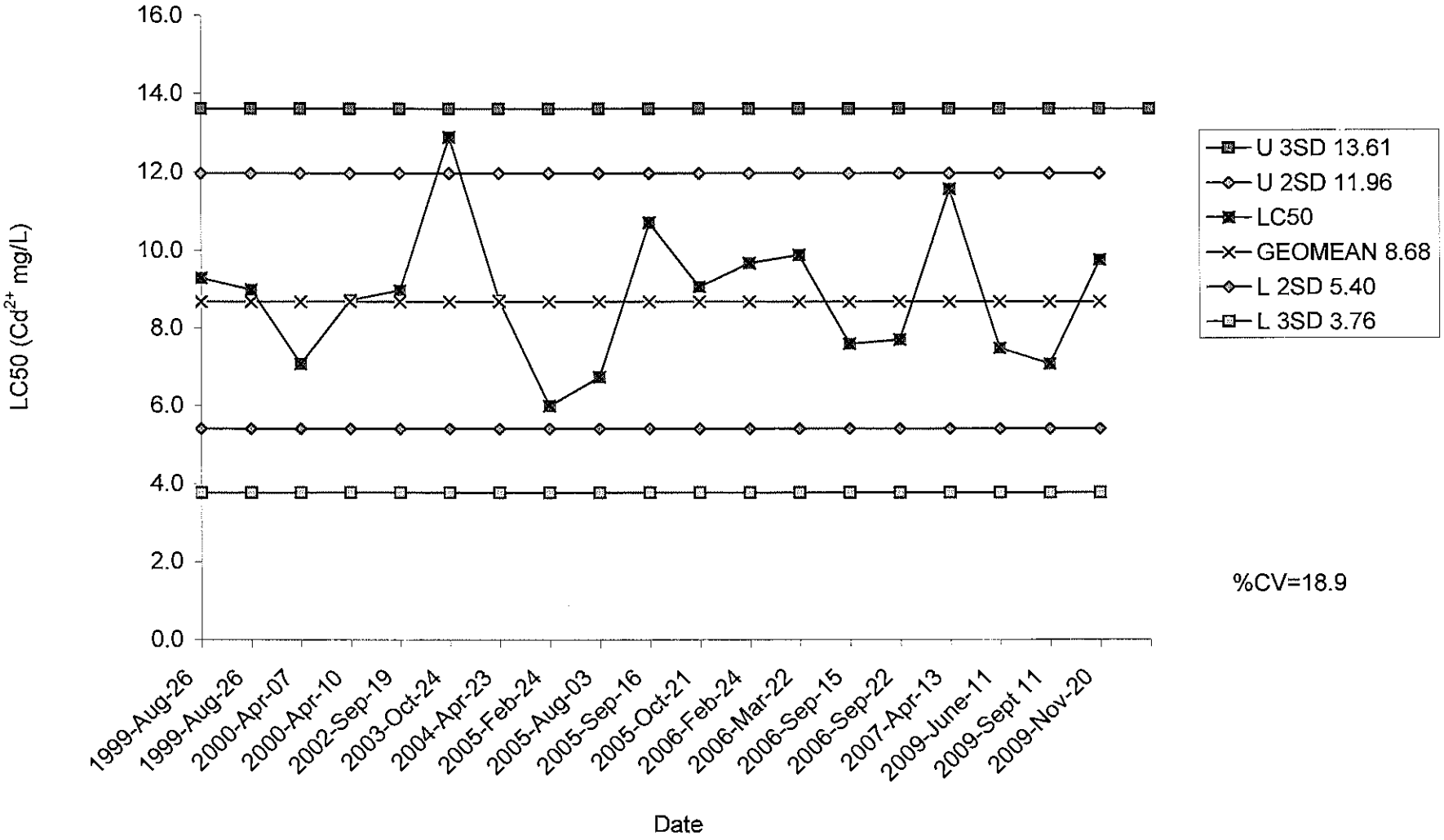
M. Gray 2009 Nov 2

Culture Health

Date	Total Number	Deaths	Removed	% Mortality (Previous 7 days)	Comments (e.g appearance)	Analyst
2009 Nov 17	~660	0	0	0		MG
2009 Nov 18	~660	0	0	0		MG
2009 Nov 19	~660	0	0	0		MG

Cantest Ltd.
Vancouver, BC

Neanthes arenaceodentata
96-hr Reference Toxicant Control Chart for Cadmium Chloride



APPENDIX

D *STRONGYLOCENTROTUS PURPURATUS* RAW DATA

CETIS Analytical Report

Test Code: 21-2811-9915/SPF-GOL001-0109

Echinoid Sperm Cell Fertilization Test — Cantest Ltd.

Analysis ID:	08-2469-8432	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 14:11	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	20-3869-4691	**Test Type:**	Fertilization	**Analyst:**	
Start Date:	19 Nov-09 19:41	**Protocol:**	EC/EPS 1/RM/27	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	19 Nov-09 20:01	**Species:**	Strongylocentrotus purpuratus	**Brine:**	
Duration:	20m	**Source:**	Marine Research and Educational Products	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
20091119(CTL)	15-6026-2664	19 Nov-09 12:00	19 Nov-09 12:00	8h	Golder Associates (Burnaby)	Ladysmith Harbour
910300226	12-8595-1757	19 Oct-09 12:00	22 Oct-09 16:11	31d 8h		
910300228	08-1020-7122	19 Oct-09 12:00	22 Oct-09 16:11	31d 8h		
910300231	10-5257-4682	19 Oct-09 12:00	22 Oct-09 16:11	31d 8h		
910300235	09-7523-9221	20 Oct-09 12:00	22 Oct-09 16:11	30d 8h		
910300236	07-0341-6256	20 Oct-09 12:00	22 Oct-09 16:11	30d 8h		
910300241	14-9647-5657	20 Oct-09 12:00	22 Oct-09 16:11	30d 8h		
910300243	01-8316-7750	20 Oct-09 12:00	22 Oct-09 16:11	30d 8h		
910300247	00-5995-0583	21 Oct-09 16:11	22 Oct-09 16:11	29d 4h		
910300250	06-5107-8408	21 Oct-09 12:00	22 Oct-09 16:11	29d 8h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
20091119(CTL)	Sediment Control	Golder	Negative Control		
910300226	Marine/Estuarine Sedim	Golder	16740-02		
910300228	Marine/Estuarine Sedim	Golder	16740-04		
910300231	Marine/Estuarine Sedim	Golder	16740-07		
910300235	Marine/Estuarine Sedim	Golder	16744-02		
910300236	Marine/Estuarine Sedim	Golder	16744-03		
910300241	Marine/Estuarine Sedim	Golder	16744-08		
910300243	Marine/Estuarine Sedim	Golder	16744-11		
910300247	Marine/Estuarine Sedim	Golder	16747-03		
910300250	Marine/Estuarine Sedim	Golder	16747-06		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C > T	Not Run					4.55%

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
20091119(CTL)		910300226	19.849	1.8595	0.11226	<0.0001	Significant Effect
		910300228	7.4483	1.8595	0.14952	<0.0001	Significant Effect
		910300231	16.335	1.8595	0.13091	<0.0001	Significant Effect
		910300235	-0.28519	1.8595	0.10619	0.6086	Non-Significant Effect
		910300236	22.373	1.8595	0.099446	<0.0001	Significant Effect
		910300241	0.15891	1.8595	0.14338	0.4388	Non-Significant Effect
		910300243	3.1842	1.8595	0.10427	0.0065	Significant Effect
		910300247	17.64	1.8595	0.11193	<0.0001	Significant Effect
		910300250	24.009	1.8595	0.096382	<0.0001	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	14.34216	1.593574	9	200.47	<0.0001	Significant Effect
Error	0.3179704	0.00794926	40			
Total	14.66013	1.601523	49			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Bartlett Equality of Variance	17.33	21.666	0.0438	Equal Variances
Distribution	Shapiro-Wilk Normality	0.98007		0.5549	Normal Distribution

2009Dec18 2009Dec18

Analyst: QA: KT

Echinoid Sperm Cell Fertilization Test — Cantest Ltd.

Analysis ID: 08-2469-8432 **Endpoint:** Fertilization Rate **CETIS Version:** CETISv1.7.0
Analyzed: 18 Dec-09 14:11 **Analysis:** Parametric-Two Sample **Official Results:** Yes

Fertilization Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091119(CTL)	5	0.936	0.91687	0.95513	0.88	0.99	0.0093403	0.050299	5.37%	0.0%
910300226	5	0.022	0.013326	0.030674	0	0.06	0.0042345	0.022804	103.65%	97.65%
910300228	5	0.452	0.4001	0.5039	0.31	0.61	0.025339	0.13646	30.19%	51.71%
910300231	5	0.042	0.026928	0.057072	0	0.1	0.0073578	0.039623	94.34%	95.51%
910300235	5	0.95	0.93924	0.96076	0.9	0.97	0.0052523	0.028284	2.98%	-1.5%
910300236	5	0.02	0.016196	0.023804	0.01	0.03	0.001857	0.01	50.0%	97.86%
910300241	5	0.928	0.90243	0.95357	0.82	0.99	0.012484	0.067231	7.24%	0.85%
910300243	5	0.836	0.82213	0.84987	0.81	0.9	0.0067722	0.036469	4.36%	10.68%
910300247	5	0.076	0.059952	0.092048	0.05	0.15	0.0078345	0.04219	55.51%	91.88%
910300250	5	0.008	0.0062989	0.0097011	0	0.01	0.0008305	0.0044721	55.9%	99.15%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
20091119(CTL)	5	1.3345	1.2913	1.3778	1.2171	1.4706	0.021115	0.11371	8.52%	0.0%
910300226	5	0.13629	0.10862	0.16396	0.050021	0.24747	0.013509	0.07275	53.38%	89.79%
910300228	5	0.73563	0.68265	0.78861	0.5905	0.89631	0.025863	0.13927	18.93%	44.88%
910300231	5	0.18459	0.14319	0.226	0.050021	0.32175	0.020214	0.10886	58.97%	86.17%
910300235	5	1.3508	1.3287	1.3729	1.249	1.3967	0.01079	0.058104	4.3%	-1.22%
910300236	5	0.13808	0.124	0.15216	0.10017	0.17408	0.0068743	0.037019	26.81%	89.65%
910300241	5	1.3223	1.273	1.3716	1.1326	1.4706	0.024068	0.12961	9.8%	0.92%
910300243	5	1.156	1.1359	1.1761	1.1198	1.249	0.0098105	0.052831	4.57%	13.38%
910300247	5	0.27279	0.2454	0.30018	0.22551	0.3977	0.013371	0.072005	26.4%	79.56%
910300250	5	0.090138	0.081608	0.098669	0.050021	0.10017	0.0041644	0.022426	24.88%	93.25%

2009 Dec 18
Analyst: M. Greg QA: 18 2009 Dec23

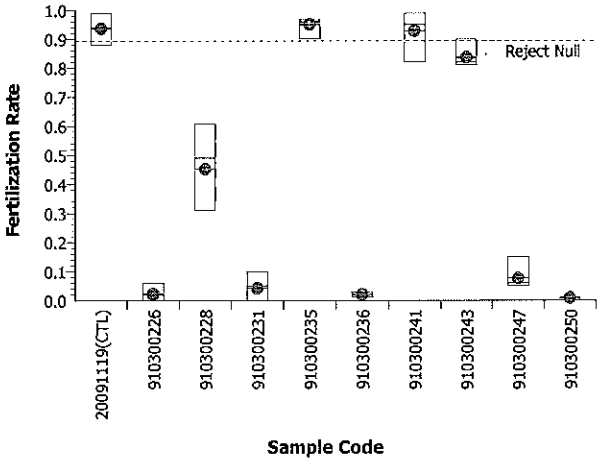
Echinoid Sperm Cell Fertilization Test — **Cantest Ltd.**

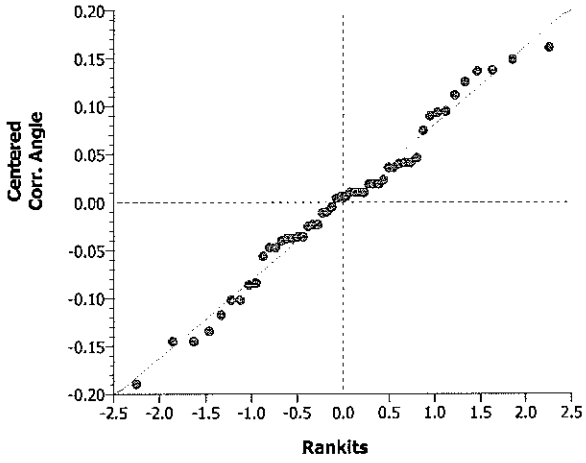
Analysis ID:	08-2469-8432	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	18 Dec-09 14:11	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Fertilization Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
20091119(CTL)	0.88	0.99	0.94	0.98	0.89
910300226	0.06	0.02	0.02	0.01	0
910300228	0.54	0.31	0.49	0.61	0.31
910300231	0	0.1	0.01	0.05	0.05
910300235	0.9	0.96	0.96	0.97	0.96
910300236	0.01	0.02	0.03	0.03	0.01
910300241	0.95	0.99	0.91	0.97	0.82
910300243	0.81	0.83	0.82	0.9	0.82
910300247	0.15	0.05	0.05	0.06	0.07
910300250	0.01	0	0.01	0.01	0.01

Graphics





Analyst: 09 Dec 18 QA: 15 2009Dec15

CANTEST Ltd.

Echinoderm Fertilization Test
Summary of Test Data

Species: *S. purpuratus* | Organism Lot #: MR091119

Client # & Name: GOL001 Golder Associates | Start Date: Nov. 19, 2009 @ 19:41

Sample ID: Various | Date Counted: Dec. 3 & 4, 2009

Stats. File ID: SP-GOL001-0109 | Analyst(s): L. Stavroff, M. Lauder

Concentration	Replicate	Total # Counted	# Fertilized	# Unfertilized	% Fertilized	Mean	SD
Seawater Control	A	100	88	12	88%	94%	5%
	B	100	99	1	99%		
	C	100	94	6	94%		
	D	100	98	2	98%		
	E	100	89	11	89%		
16740-02	A	100	6	94	6%	2%	2%
	B	100	2	98	2%		
	C	100	2	98	2%		
	D	100	1	99	1%		
	E	100	0	100	0%		
16740-04	A	100	54	46	54%	45%	14%
	B	100	31	69	31%		
	C	100	49	51	49%		
	D	100	61	39	61%		
	E	100	31	69	31%		
16740-07	A	100	0	100	0%	4%	4%
	B	100	10	90	10%		
	C	100	1	99	1%		
	D	100	5	95	5%		
	E	100	5	95	5%		
16744-02	A	100	90	10	90%	95%	3%
	B	100	96	4	96%		
	C	100	96	4	96%		
	D	100	97	3	97%		
	E	100	96	4	96%		
16744-03	A	100	1	99	1%	2%	1%
	B	100	2	98	2%		
	C	100	3	97	3%		
	D	100	3	97	3%		
	E	100	1	99	1%		
16744-08	A	100	95	5	95%	93%	7%
	B	100	99	1	99%		
	C	100	91	9	91%		
	D	100	97	3	97%		
	E	100	82	18	82%		
16744-11	A	100	81	19	81%	84%	4%
	B	100	83	17	83%		
	C	100	82	18	82%		
	D	100	90	10	90%		
	E	100	82	18	82%		
16747-03	A	100	15	85	15%	8%	4%
	B	100	5	95	5%		
	C	100	5	95	5%		
	D	100	6	94	6%		
	E	100	7	93	7%		
16747-06	A	100	1	99	1%	1%	0%
	B	100	0	100	0%		
	C	100	1	99	1%		
	D	100	1	99	1%		
	E	100	1	99	1%		
Analyst			ML	ML			

Checked by M. Gray 2009 Dec 18

Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\2-11\2-11-1024 Golder Ladysmith seds\Echinoderm\Echinoderm Fertilisation - Summary of Test Data

ECHINODERM FERTILIZATION TEST
Sample Data Sheet

CANTEST

Client # & Name: GOL001 Golder Test Date & Time: 2009 NOV 19 @ 1941-2001

CANTEST I.D. #: Various ~~FoxCalc~~ STATS File: JP-GOL001-0109

Sample Date: Oct 19-21, 2009 Organism Lot: MR091119

Samples Received: Oct 22, 2009 Test Volume (mL): 5

- POST AERATION

CONTROL: Temp. (°C): 14.3 pH: 7.9 D.O. (mg/L): 8.5 Salinity (‰): 30

Control Water Date: VanAqua 2009NOV19 Date Counted: Dec 2 (R3) (A) 2009 Dec 4 2009

Analyst(s): K. Pomeroy M. Lauder

TEST	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Replicate	A	B	C	D	E
SW Control	30	14.3	7.9	8.5	fertilized	88	99	94	99	89
					unfertilized	12	1	6	2	11
16740-02	30	15.2	7.8	7.3	fertilized	6	2	2	1	0
					unfertilized	94	98	98	99	100
16740-04	30	15.1	7.7	7.2	fertilized	54	51	49	61	31
					unfertilized	46	69	51	39	69
16740-07	30	15.3	7.8	6.2	fertilized	0	10	1	5	5
					unfertilized	100	90	99	95	95
16744-02	30	15.6	7.7	5.2	fertilized	90	96	96	97	96
					unfertilized	10	4	4	3	4
16744-03	30	15.3	7.6	6.3	fertilized	1	2	3	3	1
					unfertilized	99	98	97	97	99
16744-08	30	15.6	7.6	5.6	fertilized	95	99	91	97	82
					unfertilized	5	1	9	3	NC (18 MEL 2009 DEC 4 WE)
16744-11	30	15.8	7.7	4.1	fertilized	81	83	82	90	82
					unfertilized	19	17	18	10	18
16747-03	30	15.0	7.3	4.8	fertilized	15	5	5	6	7
					unfertilized	85	95	95	94	93
16747-06	31	15.5	7.5	5.9	fertilized	1	0	1	1	1
					unfertilized	99	100	99	99	99
Analyst	KP	KP	KP	KP	Analyst	MEL	MEL	MEL	MEL	MEL

Comments: Preaeration: 16740-04 7 min, 16740-07 18 min, 16740-02 7 min
16744-03 15 min. KP

(A) MEL 2009 DEC 4 WE

ECHINODERM FERTILIZATION TEST

Sample Data Sheet

CANTEST

Client # & Name: GOL001 - Golder Associates Test Date & Time: 2009 Nov 19 @ 1941-2001

CANTEST I.D. #: Various ToxCalc / STATS File: SP-GOL001-0109

Sample Date: Oct 19-21, 2009 Organism Lot: MR091119-S purpuratus

Samples Received: Oct 22, 2009 Test Volume (mL): 5

CONTROL: Temp. (°C): 14.3 pH: 7.9 D.O. (mg/L): 8.5 Salinity (‰): 30

Control Water Date: Vanfaqua 2009 Nov 19 Date Counted: N/A

Analyst(s): LStaunoff, K. Pomeroy

TEST	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Replicate	A	B	C	D	E
SW Control	30	14.3	7.9	8.5	fertilized					
					unfertilized					
16740-02	30	15.7	7.6	2.3	fertilized					
					unfertilized					
16740-04	30	15.4	7.5	3.1	fertilized					
					unfertilized					
16740-07	30	15.8	7.3	1.1	fertilized					
					unfertilized					
16744-02	30	15.6	7.7	5.2	fertilized					
					unfertilized					
16744-03	30	15.9	7.3	2.7	fertilized					
					unfertilized					
16744-08	30	15.6	7.6	5.6	fertilized					
					unfertilized					
16744-11	30	15.8	7.7	4.1	fertilized					
					unfertilized					
16747-03	30	15.0	7.3	4.8	fertilized					
					unfertilized					
16747-06	31	15.5	7.5	5.9	fertilized					
					unfertilized					
Analyst	KP	KP	KP	KP	Analyst					

LStaunoff 2009 Nov 20

Comments: Porewater samples. (pre-aeration)

CANTEST Ltd.

ECHINODERM FERTILIZATION TEST
Fertilization Trial Sperm Dilutions

Species: *Strongylocentrotus purpuratus*

Client #(s): NOR203, HOW001, PAC145 Test Date: 2009 Nov 19
Organism Lot #: MR091119 Analyst(s): L.Stavroff

Egg Counts: **204**, **209**, **219**, **209**

Number of eggs added to each test tube: 1051.25

Average: **210.3**

Put Ave. # of sperm in 452.25 <-- this box

Xs = # Sperm/mL = 452250000
Xe = # eggs added =Average of egg density counts = **210.3**
Vs = volume of suspension (microlitres) = **10**
Conversion factor (microlitres/ml) = 1000

Calculation:

Trial Ratio	Xs	Xe	Vs	Conversion factor	Total Volume	mL Sperm	Total Volume (mL)
0.585	452250000	218.8	10	1000	35332.58	**0.01**	353.33
1.17	452250000	210.3	10	1000	18384.71	**0.01**	183.85
2.34	452250000	210.3	10	1000	9192.35	**0.02**	183.85
4.6875	452250000	210.3	10	1000	4588.82	**0.02**	91.78
9.375	452250000	210.3	10	1000	2294.41	**0.02**	45.89
18.75	452250000	210.3	10	1000	1147.21	**0.1**	114.72
37.50	452250000	210.3	10	1000	573.60	**0.1**	57.36
75	452250000	210.3	10	1000	286.80	**0.1**	28.68
150	452250000	210.3	10	1000	143.40	**1**	143.40
300	452250000	210.3	10	1000	71.70	**1**	71.70
600	452250000	210.3	10	1000	35.85	**1**	35.85
900	452250000	210.3	10	1000	23.90	**1**	23.90

Calculation is: Xs/((Xe/Vs)*trial ratio*conversion factor)

0.02mL = 20uL	0.1mL = 100uL

CANTEST

ECHINOID FERTILIZATION TEST:
Calculations of Gamete Densities

Species: S. purpuratus

Client #(s): NOR203, PAC145, HOW001, GOL001 **Test Date:** 2009NOV19
Organism Lot #: MR091119 **Analyst(s):** LStavroff
Exposure Time: 10 min. sperm & 10 min. sperm plus egg
Test Volume: 5.0 mL

Egg Density Counts:
per 10 µL / 1 sue 2009NOV19
1) ~~195~~ 204
2) 209
3) 219
4) 209

175-225

Average = 210.3

#of Eggs Added to Each Test Tube = 1051.25 = $\frac{\text{average eggs} * X_E}{10\ (\mu L)}$

X_E = volume of egg suspension added
X_E = 50 µL

2.5 mL eggs + 30 mL H_2O

Sperm Density Calculations:

Medium square on the hemocytometer	Count 1	Count 2	Count 3	Count 4	
1	93	93	100	83	
2	91	84	74	83	
3	87	88	92	108	
4	78	106	95	90	
5	98	84	83	94	Average
Total (5 large squares in the corners and the center of the field)	447	455	449	458	452.25

Initial Concentration (C_i)
 # Sperm/mL = $\frac{\text{(dilution factor) (\# sperm counted)(hemocytometer conversion factor) mm}^3\text{/mL}}{\text{\# of small squares counted}}$

 # Sperm/mL = $\frac{\text{(100)(average \# of sperms counted in 5 large size squares: 452.25)(800)(1000)}}{80}$ = 452250000

Sperm = # sperm/mL 452250000 /(# of eggs added 1051.25/volume of suspension 50 µL X ratio 18.75 X 1000(µL)/1 mL) **Dilution** or total volume of sperm suspension including 1 mL (0.5 mL) of concentrated sperm stock and seawater required to dilute the sperm stock given a desired ratio
= 1147.2 = **Total Volume** (V_f)

Concentration of Sperm Stock Used in Test:
$C_iV_i = C_fV_f$
initial Concentration * 1 mL = C_f * total volume after dilution $\frac{(452250000)(1mL)}{(1147.2)}$ = C_f = 394220.7

# of Sperm Added to Each Test Tube = $X_S * C_f$
= 19711

Sperm:Egg Ratio is $\frac{\text{\#sperm added}}{\text{\#eggs added}}$ or 18.75 :1

X_S = volume of sperm suspension added = 0.05 mL (= # uL x 1mL/1000 uL)

Notes: Trial Ratio 18.75 Counts 97/3, 94, 6 #Males 13 #Females 5 used for tests

CANTEST Ltd.

Echinoid Fertilization Test
Acclimation and Holding Conditions

Species: S. purpuratus

Organism Lot #: MR091119 **Tank ID:** A

Arrival Conditions * Not enough water to perform water quality 2009Nov19

Date	Total Number	Salinity (‰)	Temperature (°C)	pH	DO (mg/L)	Comments	Analyst
			LStalnoff 2009Nov19				

Holding Conditions

Date	Initial Salinity (‰)	Initial Temperature (°C)	Initial pH	Initial DO (mg/L)	Final Salinity (‰)	Final Temperature (°C)	Final pH	Final DO (mg/L)	Analyst
2009Nov19	30	14.6	7.9	8.5					LS
					LStalnoff 2009Nov19				

Feeding Not Applicable

Date				LStalnoff 2009Nov19				
Analyst								

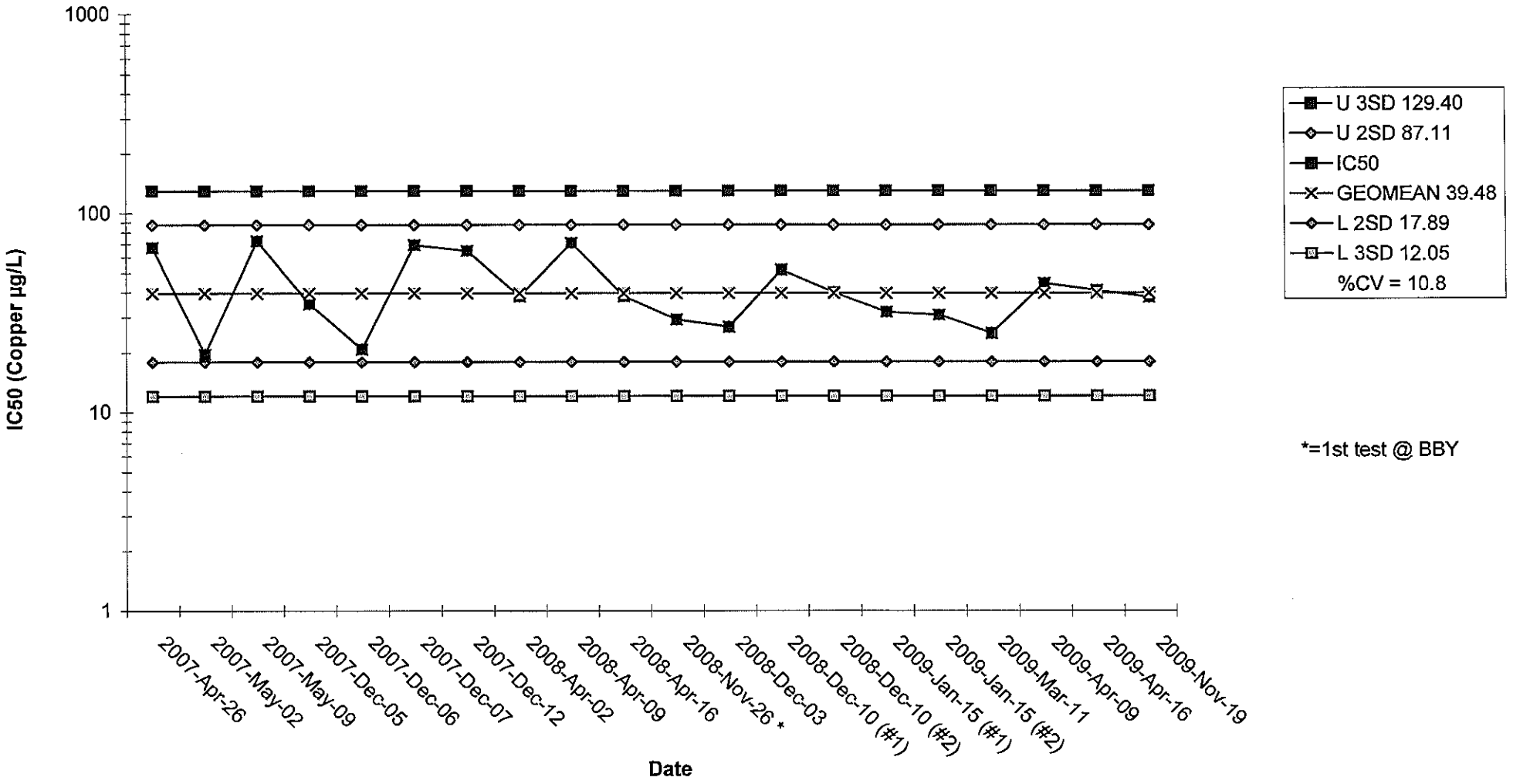
Culture Health

Date	Total Number	Deaths	Removed	% Mortality (Previous 7 days)	Comments (e.g appearance)	Analyst
2009Nov19	44	0	0	0		LS
					LStalnoff 2009Nov19	

CANTEST Ltd.

Strongylocentrotus purpuratus (Sea Urchins)

20 Minute Fertilization Reference Toxicant Control Chart for Cu^{2+}



*=1st test @ BBY

APPENDIX

E SOLID PHASE MICROTOX™ RAW DATA

Solid Phase Microtox® Data Sheet - Control Light Readings

CANTEST

Customer Sample ID	CANTEST ID	Control Light Readings	Mean	SD	CV (%)
16744-11	910300243	107.69	97.96	9.20	9.39
		96.79			
		89.41			
16740-04	910200228	92.33	91.60	0.76	0.83
		91.65			
		90.81			
16740-02	91300226	90.68	89.98	1.08	1.20
		88.73			
		90.52			
16740-07	910300231	107.10	100.01	6.17	6.17
		97.03			
		95.90			
16744-03	910300236	95.93	102.08	6.17	6.04
		102.03			
		108.27			
16744-08	910300241	95.45	99.48	3.55	3.57
		100.84			
		102.16			
16747-06	910300250	98.45	102.32	4.14	4.04
		101.82			
		106.68			
16744-02	910300235	56.21	72.26	20.68	28.63
		95.60			
		64.96			
16747-03	910300247	100.44	99.57	3.64	3.66
		95.57			
		102.69			
16744-03 B	910300236	94.66	93.57	2.86	3.06
		90.32			
		95.73			
16744-02 B	910300235	93.47	95.93	4.02	4.19
		100.57			
		93.76			
16747-03 B	910300247	92.67	94.69	5.70	6.01
		101.12			
		90.28			
16744-11 B	910300243	95.36	96.90	4.59	4.74
		102.07			
		93.28			
			#DIV/0!	#DIV/0!	#DIV/0!
			#DIV/0!	#DIV/0!	#DIV/0!
			#DIV/0!	#DIV/0!	#DIV/0!

Data Entered by K. Tomsons Date 2009 NOV 17

Data Checked by M. Greg Date 2009 Dec 18

Revision: 00
Revision Date: September 30, 2009
Document Control Number: 80-SPREADSHT-021-00

Printed on: 27-11-2009

Solid Phase Microtox® ry Weight Calculations

CANTEST

Client Code & Name: GOL001 Golder Assoc.
Weigh Date 1: 2009 Dec 03
Date / Time in Oven: 2009 Dec 03 @ 1500

Project Number: 2-11-1024
Date / Time Out of Oven: 2009 Dec 05 @ 1500
Weigh Date 2: 2009 Dec 05

Balance AIN: 004686
Oven AIN: 003502
Actual Oven Temperature Range (°C): 96-96

Sample ID & CANTEST #	Empty Boat Weight (g)	Wet Sample (g)	Boat + Dry Sample (g)	Dry Sample (g)	Dry/Wet Ratio	Mean Dry/Wet	Wet Weight Values (mg/L)			Dry Weight Values (mg/L)		
							IC50	Lower CL	Upper CL	IC50	Lower CL	Upper CL
16744-11	1.17	4.99	5.14	**3.97**	**0.80**	**0.79**	34280	30920	38010	**26990**	**24345**	**29927**
910300243	1.16	5.00	5.09	**3.93**	**0.79**							
	1.15	5.01	5.06	**3.91**	**0.78**							
16740-04	1.16	5.00	2.76	**1.60**	**0.32**	**0.33**	603100	167000	2178000	**196478**	**54405**	**709550**
910300228	1.17	5.01	2.82	**1.65**	**0.33**							
	1.16	5.00	2.80	**1.64**	**0.33**							
16740-02	1.15	4.99	2.45	**1.30**	**0.26**	**0.25**	66550	37740	117300	**16616**	**9423**	**29286**
910300226	1.17	4.99	2.39	**1.22**	**0.24**							
	1.15	5.00	2.37	**1.22**	**0.24**							
16740-07	1.14	4.99	2.40	**1.26**	**0.25**	**0.24**	136200	123400	150400	**33143**	**30028**	**36598**
910300231	1.18	5.00	2.34	**1.16**	**0.23**							
	1.15	5.01	2.38	**1.23**	**0.25**							
16744-03	1.15	5.00	2.66	**1.51**	**0.30**	**0.30**	83030	45820	150500	**25152**	**13880**	**45591**
910300236	1.17	5.01	2.68	**1.51**	**0.30**							
	1.15	5.01	2.68	**1.53**	**0.31**							
16744-08	1.17	4.98	4.96	**3.79**	**0.76**	**0.76**	297900	97150	913300	**224972**	**73367**	**689717**
910300241	1.17	5.00	5.02	**3.85**	**0.77**							
	1.17	5.01	4.85	**3.68**	**0.73**							
16747-06	1.18	5.00	3.50	**2.32**	**0.46**	**0.48**	143200	74910	273800	**68450**	**35807**	**130876**
910300250	1.16	5.00	3.60	**2.44**	**0.49**							
	1.17	5.00	3.58	**2.41**	**0.48**							
16744-02	1.16	4.99	4.74	**3.58**	**0.72**	**0.72**	145900	104100	204700	**104340**	**74447**	**146390**
910300235	1.16	5.00	4.72	**3.56**	**0.71**							
	1.16	5.00	4.74	**3.58**	**0.72**							

Data Entered by (Signature/Date): LS (for MGrey 2009Dec18)

Data Checked by (Signature/Date): 2009Dec23

Revision: 00
Revision Date: September 30, 2009
Document Control Number: 80-SPREADSHT-020-00

Printed on: 12/23/2009

Solid Phase Microtox® ry Weight Calculations

CANTEST

Client Code & Name: GOL001 Golder Assoc.
Weigh Date 1: 2009 Dec 03
Date / Time in Oven: 2009 Dec 03 @ 1500

Project Number: 2-11-1024
Date / Time Out of Oven: 2009 Dec 05 @ 1500
Weigh Date 2: 2009 Dec 05

Balance AIN: 004686
Oven AIN: 003502
Actual Oven Temperature Range (°C): 96-96

Sample ID & CANTEST #	Empty Boat Weight (g)	Wet Sample (g)	Boat + Dry Sample (g)	Dry Sample (g)	Dry/Wet Ratio	Mean Dry/Wet	Wet Weight Values (mg/L)			Dry Weight Values (mg/L)		
							IC50	Lower CL	Upper CL	IC50	Lower CL	Upper CL
16747-03	1.16	5.01	4.27	3.11	0.62	0.62	405300	130200	1262000	251659	80844	783600
910300247	1.16	5.00	4.28	3.12	0.62							
	1.17	5.00	4.26	3.09	0.62							
				0.00	#DIV/0!	#DIV/0!				#DIV/0!	#DIV/0!	#DIV/0!
				0.00	#DIV/0!							
				0.00	#DIV/0!							
				0.00	#DIV/0!	#DIV/0!				#DIV/0!	#DIV/0!	#DIV/0!
				0.00	#DIV/0!							
				0.00	#DIV/0!							
				0.00	#DIV/0!	#DIV/0!				#DIV/0!	#DIV/0!	#DIV/0!
				0.00	#DIV/0!							
				0.00	#DIV/0!							
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				0.00	#DIV/0!							
				0.00	#DIV/0!	#DIV/0!				#DIV/0!	#DIV/0!	#DIV/0!
				0.00	#DIV/0!							
				0.00	#DIV/0!							
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				0.00	#DIV/0!							
				0.00	#DIV/0!							

LS (for MGrey 2009Dec 18)

Data Entered by (Signature/Date): LS (for MGrey 2009Dec18)

Data Checked by (Signature/Date): 2009Dec23

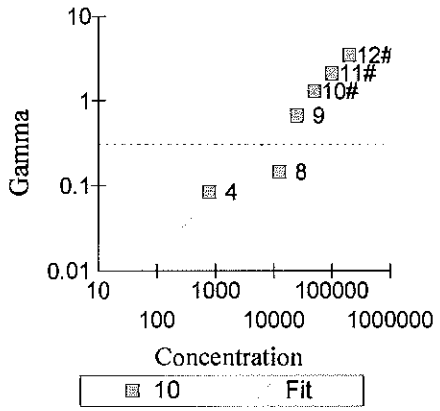
Revision: 00
Revision Date: September 30, 2009
Document Control Number: 80-SPREADSHT-020-00

Printed on: 12/23/2009

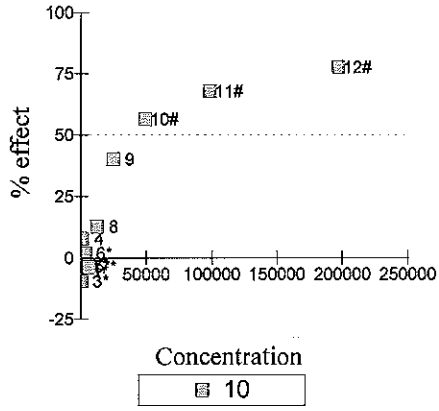
MicrotoxOmni Test Report

Date: 11/27/2009 04:44 PM
Test Protocol: EC SPT
Sample: 910300243 16744-11
Toxicant: Unknown
Reagent Lot no.: 09H1020A
Test description: Golder Associates GOL001
Test name: 2009NOV27 - GOL001 - 16744-11 - B
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	95.36		
Control	0.000	102.07		
Control	0.000	93.28		
1	96.19	102.22	-0.0520 *	-5.487%
2	192.4	99.13	-0.0224 *	-2.298%
3	384.8	106.10	-0.0866 *	-9.491%
4	769.5	89.36	0.0844	7.784%
5	1539	100.14	-0.0323 *	-3.340%
6	3078	95.11	0.0188 *	1.851%
7	6156	100.54	-0.0361 *	-3.753%
8	12310	84.64	0.1449	12.66%
9	24630	58.05	0.6693	40.09%
10	49250	42.21	1.296 #	56.44%
11	98500	31.19	2.107 #	67.81%
12	197000	21.70	3.466 #	77.61%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:34280mg/L (95% confidence range: 30920 to 38010)
95% Confidence Factor: 1.109
IC50 value was calculated from extrapolated data.
Estimating Equation:LOG C =1.409 x LOG G +4.535
Coeff. of Determination (R^2):1.000
Slope: 0.7097
Average control value: 96.90

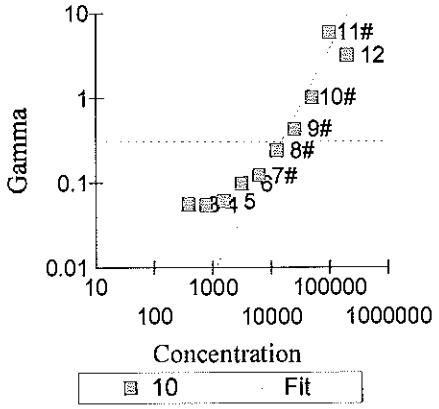
Signature: K. Pomeroy 27 NOV 2009

Printed: 11/27/2009 06:05 PM

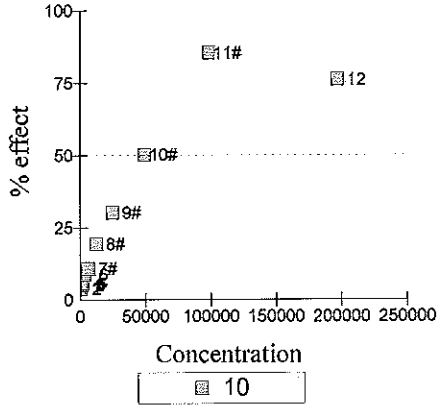
MicrotoxOmni Test Report

Date: 11/26/2009 03:46 PM
Test Protocol: EC SPT
Sample: 16744-11
Toxicant: -
Reagent Lot no.: 09f1005a
Test description: GOL001
Test name: Solid Phase Microtox - Golden Associates
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	107.69		
Control	0.000	96.79		
Control	0.000	89.41		
1	96.19	93.92	0.0430 *	4.127%
2	192.4	94.06	0.0415 *	3.984%
3	384.8	92.78	0.0558	5.291%
4	769.5	92.87	0.0548	5.199%
5	1539	92.35	0.0607	5.730%
6	3078	89.20	0.0982	8.946%
7	6156	87.25	0.1228 #	10.94%
8	12310	78.93	0.2411 #	19.43%
9	24630	68.26	0.4351 #	30.32%
10	49250	48.64	1.014 #	50.35%
11	98500	14.22	5.889 #	85.48%
12	197000	23.33	3.199	76.18%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:35470mg/L (95% confidence range: 22270 to 56490)
95% Confidence Factor: 1.593
Estimating Equation:LOG C =0.7113 x LOG G +4.550
Coeff. of Determination (R^2):0.9418
Slope: 1.324
Average control value: 97.96

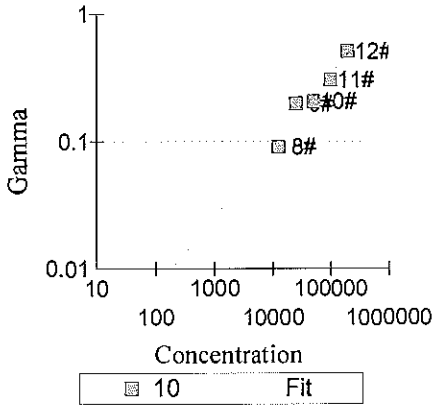
Signature: C. Belknap / 2009 Nov. 26 K. Pomeroy 2009 Nov 26

Printed: 11/26/2009 04:05 PM

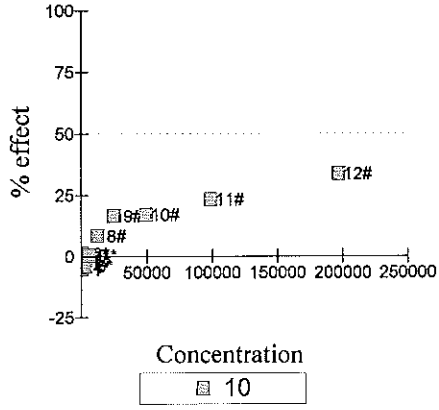
MicrotoxOmni Test Report

Date: 11/26/2009 02:52 PM
Test Protocol: EC SPT
Sample: 16740-04
Toxicant: -
Reagent Lot no.: 09f1005a
Test description: GOL001
Test name: Solid Phase Microtox - Gilden Associates 16740-04
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	92.33		
Control	0.000	91.65		
Control	0.000	90.81		
1	96.19	96.35	-0.0493 *	-5.189%
2	192.4	90.56	0.0114 *	1.132%
3	384.8	92.00	-0.0043 *	-0.4403%
4	769.5	95.45	-0.0403 *	-4.207%
5	1539	93.34	-0.0186 *	-1.903%
6	3078	95.17	-0.0375 *	-3.901%
7	6156	91.20	0.0043 *	0.4331%
8	12310	83.97	0.0908 #	8.326%
9	24630	76.47	0.1978 #	16.51%
10	49250	75.99	0.2054 #	17.04%
11	98500	70.27	0.3035 #	23.28%
12	197000	60.74	0.5080 #	33.69%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:603100mg/L (95% confidence range: 167000 to 2178000)
95% Confidence Factor: 3.611
IC50 value was calculated from extrapolated data.
Estimating Equation:LOG C =1.676 x LOG G +5.780
Coeff. of Determination (R^2):0.9363
Slope: 0.5585
Average control value: 91.60

Signature: C Belshan/2009 Nov. 26 K. Pomeroy 2009 NOV 26

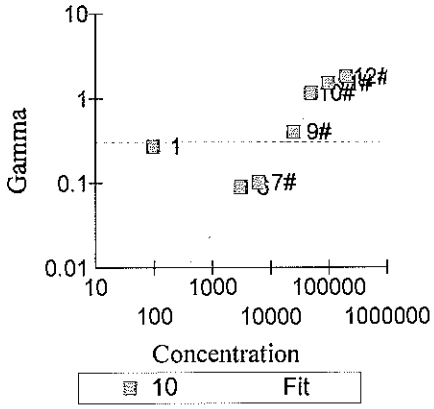
Printed: 11/26/2009 04:00 PM

MicrotoxOmni Test Report

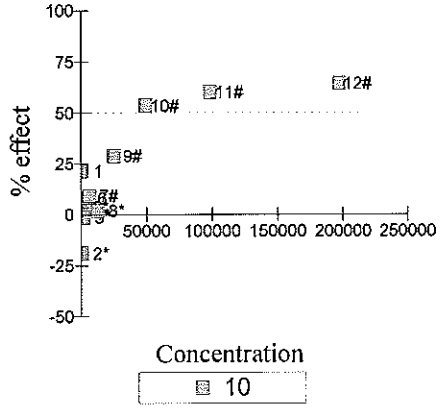
Date: 11/26/2009 05:11 PM

Test Protocol: EC SPT
Sample: 16740-02 910300226
Toxicant: Unknown
Reagent Lot no.: 09H1020A
Test description: Golder Associates GOL001
Test name: 2009Nov26-GOL001- 16740-02
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	90.68		
Control	0.000	88.73		
Control	0.000	90.52		
1	96.19	70.77	0.2714	21.35%
2	192.4	107.05	-0.1595 *	-18.98%
3	384.8	86.57	0.0393 *	3.786%
4	769.5	89.76	0.0024 *	0.2408%
5	1539	91.21	-0.0135 *	-1.371%
6	3078	82.55	0.0899	8.254%
7	6156	81.61	0.1025 #	9.299%
8	12310	88.23	0.0198 *	1.941%
9	24630	64.00	0.4059 #	28.87%
10	49250	41.75	1.155 #	53.60%
11	98500	35.86	1.509 #	60.15%
12	197000	32.04	1.808 #	64.39%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

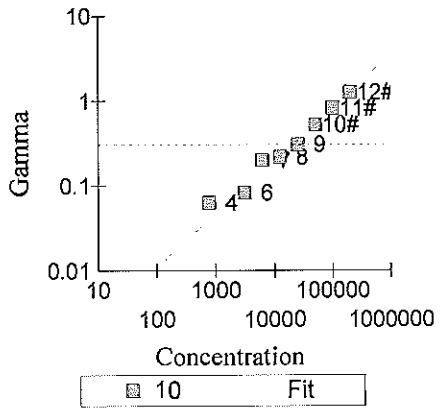
Calculations on 10 Mins data:
IC50 Concentration:66550mg/L (95% confidence range: 37740 to 117300)
95% Confidence Factor: 1.763
Estimating Equation:LOG C =1.082 x LOG G +4.823
Coeff. of Determination (R^2):0.9414
Slope: 0.8700
Average control value: 89.98

Signature: 2009 Nov. 26

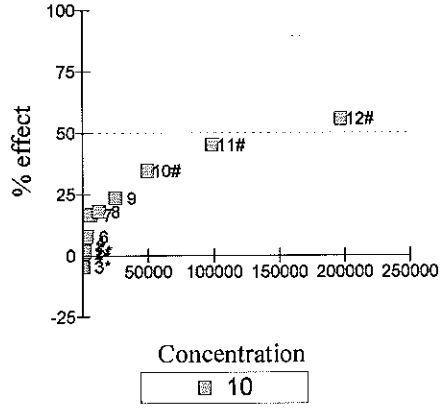
MicrotoxOmni Test Report

Date: 11/27/2009 10:15 AM
Test Protocol: EC SPT
Sample: 910300231 16740-07
Toxicant: Unknown
Reagent Lot no.: 09F1005A
Test description: Golder Associates GOL001
Test name: 2009NOV27 - GOL001 - 16740-07
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	107.10		
Control	0.000	97.03		
Control	0.000	95.90		
1	96.19	100.76	-0.0074 *	-0.7499%
2	192.4	99.06	0.0095 *	0.9499%
3	384.8	104.54	-0.0433 *	-4.530%
4	769.5	94.07	0.0631	5.939%
5	1539	98.29	0.0175 *	1.720%
6	3078	92.33	0.0831	7.679%
7	6156	83.33	0.2002	16.68%
8	12310	82.08	0.2184	17.93%
9	24630	76.55	0.3065	23.46%
10	49250	65.49	0.5271 #	34.52%
11	98500	54.92	0.8210 #	45.09%
12	197000	44.33	1.256 #	55.67%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:136200mg/L (95% confidence range: 123400 to 150400)
95% Confidence Factor: 1.104
Estimating Equation:LOG C =1.596 x LOG G +5.134
Coeff. of Determination (R^2):0.9999
Slope: 0.6264
Average control value: 100.01

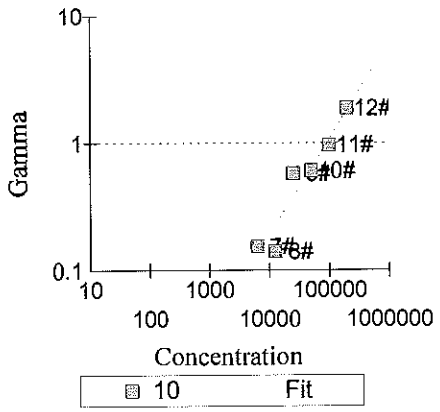
Signature: K. Pomeroy 27 NOV 2009

Printed: 11/27/2009 11:37 AM

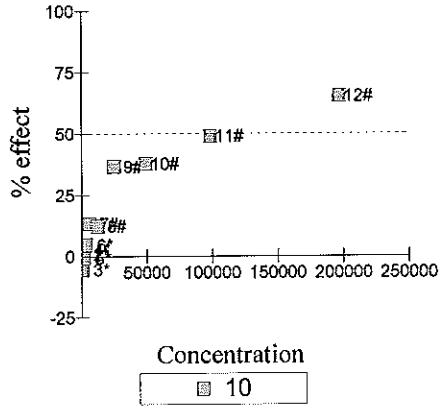
MicrotoxOmni Test Report

Date: 11/27/2009 03:41 PM
Test Protocol: EC SPT
Sample: 910300236 16744-03
Toxicant: Unknown
Reagent Lot no.: 09H1020A
Test description: Golder Associates GOL001
Test name: 2009NOV27 - GOL001 - 16744-03 - B
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	94.66		
Control	0.000	90.32		
Control	0.000	95.73		
1	96.19	93.00	0.0061 *	0.6092%
2	192.4	92.73	0.0090 *	0.8977%
3	384.8	98.66	-0.0515 *	-5.440%
4	769.5	90.75	0.0310 *	3.014%
5	1539	94.21	-0.0067 *	-0.6840%
6	3078	89.24	0.0485 *	4.628%
7	6156	81.14	0.1532 #	13.28%
8	12310	82.04	0.1405 #	12.32%
9	24630	59.34	0.5768 #	36.58%
10	49250	58.27	0.6058 #	37.73%
11	98500	47.68	0.9625 #	49.04%
12	197000	32.52	1.877 #	65.25%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:83030mg/L (95% confidence range: 45820 to 150500)
95% Confidence Factor: 1.812
Estimating Equation:LOG C =1.213 x LOG G +4.919
Coeff. of Determination (R^2):0.9175
Slope: 0.7564
Average control value: 93.57

Signature: K. Pomeroy 27NOV2009

Printed: 11/27/2009 04:29 PM

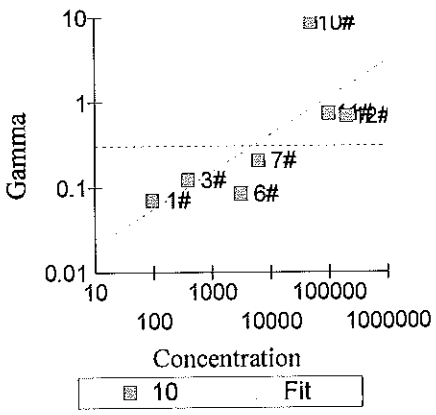
MicrotoxOmni Test Report

236

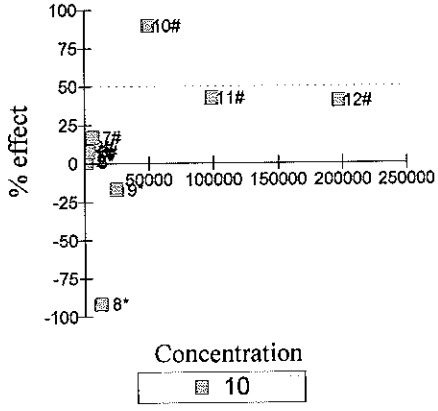
Date: 11/27/2009 10:15 AM

Test Protocol: EC SPT
Sample: 910300236 16744-03
Toxicant: Unknown
Reagent Lot no.: 09F1005A
Test description: Golder Associates GOL001
Test name: 2009Nov27-GOL001-16744-03
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	95.93		
Control	0.000	102.03		
Control	0.000	108.27		
1	96.19	95.29	0.0712 #	6.649%
2	192.4	99.89	0.0218 *	2.142%
3	384.8	90.95	0.1223 #	10.90%
4	769.5	98.20	0.0394 *	3.798%
5	1539	101.12	0.0094 *	0.9372%
6	3078	94.13	0.0844 #	7.785%
7	6156	84.64	0.2060 #	17.08%
8	12310	195.61	-0.4782 *	-91.63%
9	24630	119.30	-0.1444 *	-16.87%
10	49250	10.65	8.585 #	89.57%
11	98500	58.71	0.7387 #	42.48%
12	197000	60.65	0.6830 #	40.58%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:25280mg/L (95% confidence range: 2134 to 299400)
95% Confidence Factor: 11.85
Estimating Equation:LOG C =1.255 x LOG G +4.403
Coeff. of Determination (R^2):0.5474
Slope: 0.4363
Average control value: 102.08

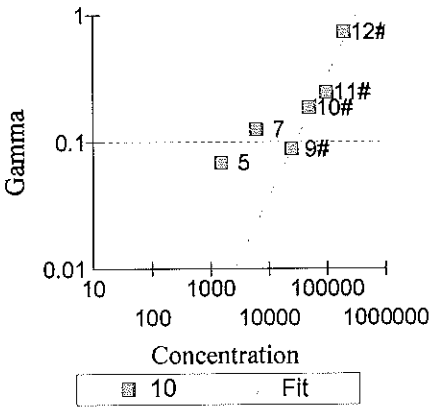
Signature: 2009 Nov 27

Printed: 11/27/2009 11:43 AM

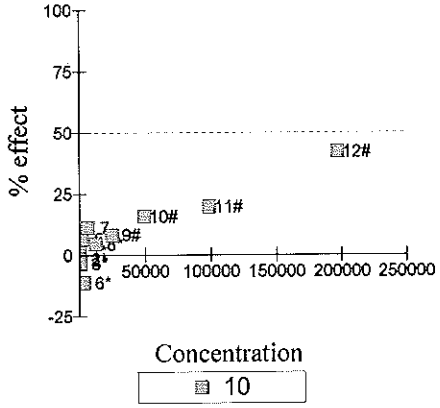
MicrotoxOmni Test Report

Date: 11/27/2009 12:03 PM
Test Protocol: EC SPT
Sample: 910300241 16744-08
Toxicant: Unknown
Reagent Lot no.: 09F1005A
Test description: Golder Associates GOL001
Test name: 2009NOV27 - GOL001 - 16744-08
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	95.45		
Control	0.000	100.84		
Control	0.000	102.16		
1	96.19	97.82	0.0170 *	1.672%
2	192.4	101.05	-0.0155 *	-1.575%
3	384.8	102.94	-0.0335 *	-3.475%
4	769.5	102.42	-0.0286 *	-2.952%
5	1539	93.09	0.0686	6.427%
6	3078	110.67	-0.1011 *	-11.24%
7	6156	88.34	0.1261	11.20%
8	12310	94.98	0.0474 *	4.527%
9	24630	91.42	0.0882 #	8.105%
10	49250	83.87	0.1862 #	15.69%
11	98500	79.85	0.2459 #	19.74%
12	197000	57.53	0.7292 #	42.17%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:297900mg/L (95% confidence range: 97150 to 913300)
95% Confidence Factor: 3.066
IC50 value was calculated from extrapolated data.
Estimating Equation:LOG C =0.9974 x LOG G +5.474
Coeff. of Determination (R^2):0.9519
Slope: 0.9544
Average control value: 99.48

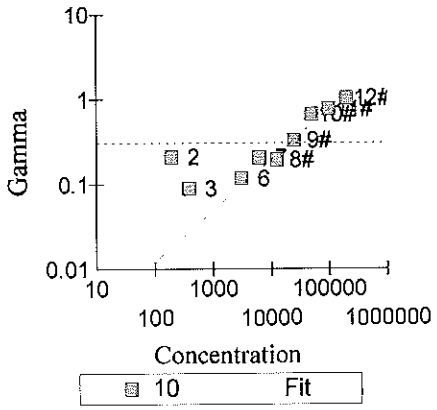
Signature: K. Pomeroy 27 Nov 2009

Printed: 11/27/2009 12:49 PM

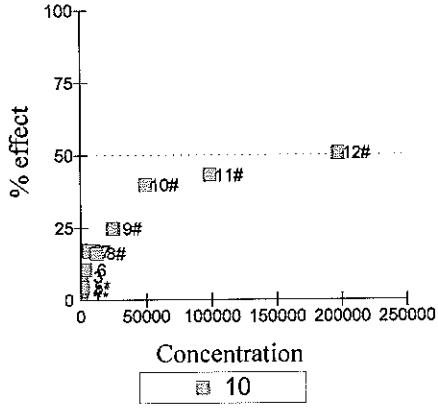
MicrotoxOmni Test Report

Date: 11/27/2009 12:04 PM
Test Protocol: EC SPT
Sample: 910300250 16747-06
Toxicant: Unknown
Reagent Lot no.: 09F1005A
Test description: Golder Associates GOL001
Test name: 2009NOV27 - GOL001 - 16747-06
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	98.45		
Control	0.000	101.82		
Control	0.000	106.68		
1	96.19	101.45	0.0085 *	0.8470%
2	192.4	84.57	0.2098	17.34%
3	384.8	93.91	0.0895	8.216%
4	769.5	98.87	0.0348 *	3.369%
5	1539	97.66	0.0476 *	4.551%
6	3078	91.53	0.1178	10.54%
7	6156	84.86	0.2057	17.06%
8	12310	85.68	0.1942 #	16.26%
9	24630	76.97	0.3293 #	24.77%
10	49250	61.48	0.6642 #	39.91%
11	98500	58.07	0.7620 #	43.24%
12	197000	50.50	1.026 #	50.64%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:143200mg/L (95% confidence range: 74910 to 273800)
95% Confidence Factor: 1.912
Estimating Equation:LOG C =1.567 x LOG G +5.156
Coeff. of Determination (R^2):0.9426
Slope: 0.6014
Average control value: 102.32

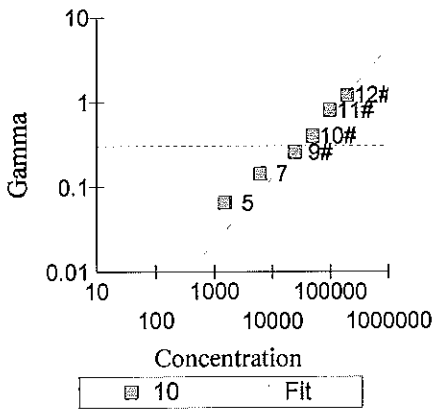
Signature: K. Pomeroy 27 NOV 2009

Printed: 11/27/2009 12:49 PM

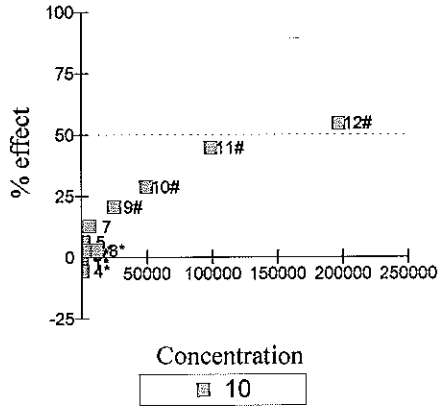
MicrotoxOmni Test Report

Date: 11/27/2009 03:41 PM
Test Protocol: EC SPT
Sample: 910300235 16744-02
Toxicant: Unknown
Reagent Lot no.: 09H1020A
Test description: Golder Associates GOL001
Test name: 2009NOV27 - GOL001 - 16744-02 - B
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	93.47		
Control	0.000	100.57		
Control	0.000	93.76		
1	96.19	98.49	-0.0259 *	-2.665%
2	192.4	94.84	0.0115 *	1.140%
3	384.8	94.82	0.0117 *	1.161%
4	769.5	101.25	-0.0525 *	-5.542%
5	1539	90.05	0.0653	6.133%
6	3078	93.32	0.0280 *	2.724%
7	6156	83.86	0.1440	12.59%
8	12310	93.28	0.0284 *	2.766%
9	24630	76.19	0.2591 #	20.58%
10	49250	68.40	0.4025 #	28.70%
11	98500	53.12	0.8060 #	44.63%
12	197000	43.50	1.205 #	54.66%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:145900mg/L (95% confidence range: 104100 to 204700)
95% Confidence Factor: 1.403
Estimating Equation:LOG C =1.292 x LOG G +5.164
Coeff. of Determination (R^2):0.9893
Slope: 0.7655
Average control value: 95.93

Signature: K. Pomeroy 27 NOV 2009

Printed: 11/27/2009 04:30 PM

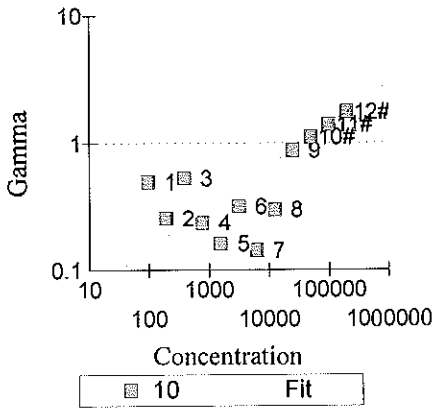
MicrotoxOmni Test Report

2 '235

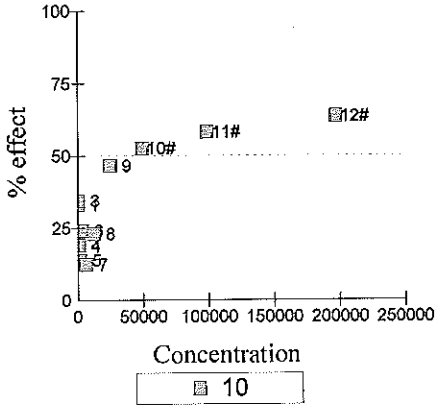
Date: 11/27/2009 12:55 PM

Test Protocol: EC SPT
Sample: 910300235 16744-02
Toxicant: -
Reagent Lot no.: 09F1005A
Test description: Golder Associates GOL001
Test name: 2009Nov27-GOL001-16744-02
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	56.21		
Control	0.000	95.60		
Control	0.000	64.96		
1	96.19	48.34	0.4948	33.10%
2	192.4	57.60	0.2545	20.28%
3	384.8	47.29	0.5279	34.55%
4	769.5	58.47	0.2358	19.08%
5	1539	62.20	0.1617	13.92%
6	3078	54.86	0.3171	24.08%
7	6156	63.23	0.1428	12.49%
8	12310	55.65	0.2984	22.98%
9	24630	38.58	0.8729	46.61%
10	49250	34.20	1.113 #	52.67%
11	98500	30.14	1.397 #	58.29%
12	197000	26.24	1.754 #	63.69%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:35550mg/L (95% confidence range: 35140 to 35960)
95% Confidence Factor: 1.012
IC50 value was calculated from extrapolated data.
Estimating Equation:LOG C =3.048 x LOG G +4.551
Coeff. of Determination (R^2):1.000
Slope: 0.3281
Average control value: 72.26

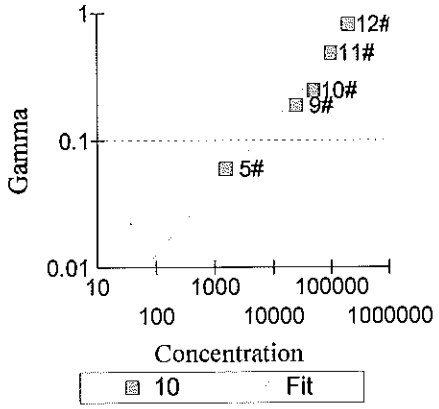
Signature: 2009 Nov 27

Printed: 11/27/2009 01:14 PM

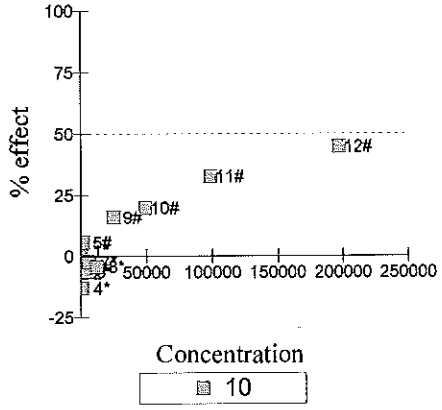
MicrotoxOmni Test Report

Date: 11/27/2009 04:44 PM
Test Protocol: EC SPT
Sample: 910300247 16747-03
Toxicant: Unknown
Reagent Lot no.: 09H1020A
Test description: Golder Associates GOL001
Test name: 2009NOV27 - GOL001 - 16747-03 - B
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	92.67		
Control	0.000	101.12		
Control	0.000	90.28		
1	96.19	92.44	0.0243 *	2.376%
2	192.4	101.05	-0.0629 *	-6.717%
3	384.8	99.57	-0.0490 *	-5.154%
4	769.5	107.03	-0.1153 *	-13.03%
5	1539	89.36	0.0596 #	5.629%
6	3078	100.61	-0.0588 *	-6.252%
7	6156	96.83	-0.0221 *	-2.260%
8	12310	98.73	-0.0409 *	-4.267%
9	24630	79.68	0.1884 #	15.85%
10	49250	76.05	0.2451 #	19.69%
11	98500	63.82	0.4837 #	32.60%
12	197000	52.34	0.8091 #	44.72%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:405300mg/L (95% confidence range: 130200 to 1262000)
95% Confidence Factor: 3.113
IC50 value was calculated from extrapolated data.
Estimating Equation:LOG C =1.847 x LOG G +5.608
Coeff. of Determination (R^2):0.9595
Slope: 0.5196
Average control value: 94.69

Signature: K. Pomeroy 27 NOV 2009

Printed: 11/27/2009 06:04 PM

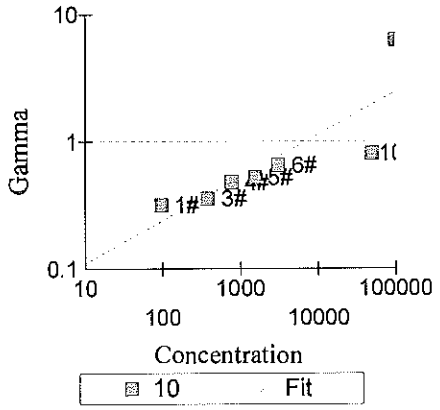
MicrotoxOmni Test Report

Date: 11/27/2009 12:55 PM

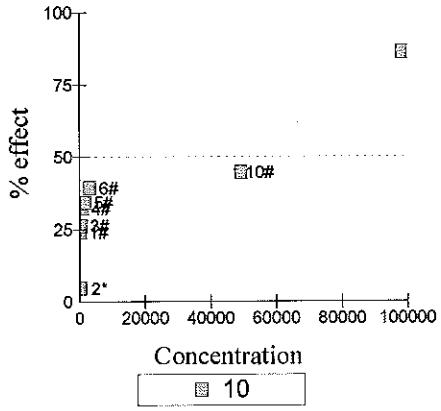
3 247

Test Protocol: EC SPT
Sample: 910300247 16747-03
Toxicant: -
Reagent Lot no.: 09F1005A
Test description: Golder Associates GOL001
Test name: 2009Nov27-GOL001-16747-03
Database file: Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\MicrotoxOmni\db1.mdb

Plot of Gamma vs Concentration



Plot of %Effect vs Concentration



10 Mins Data:

Sample	Conc	It	Gamma	% effect
Control	0.000	100.44		
Control	0.000	95.57		
Control	0.000	102.69		
1	96.19	75.59	0.3172 #	24.08%
2	192.4	94.86	0.0496 *	4.727%
3	384.8	73.39	0.3567 #	26.29%
4	769.5	67.39	0.4775 #	32.32%
5	1539	65.39	0.5227 #	34.33%
6	3078	60.40	0.6485 #	39.34%
7	6156	0.22	451.6 *	99.78%
8	12310	0.11	904.2 *	99.89%
9	24630	0.01	9956 *	99.99%
10	49250	55.12	0.8064 #	44.64%
11	98500	13.72	6.257 #	86.22%
12	197000	0.50	198.1 *	99.50%

- used in calculation; * - invalid data; D - deleted from calcs.
Autocalc has been used.

Calculations on 10 Mins data:
IC50 Concentration:5160mg/L (95% confidence range: 1106 to 24080)
95% Confidence Factor: 4.667
Estimating Equation:LOG C =2.100 x LOG G +3.713
Coeff. of Determination (R^2):0.7091
Slope: 0.3376
Average control value: 99.57

Signature: 2009 Nov 27

Printed: 11/27/2009 01:15 PM

ECOTOXICOLOGY

SOLID PHASE MICROTOX® - MULTIPLE SEDIMENT SAMPLES

Client Code and Name: GOL001 - Golder Associates

Reagent Lot: 09F1005A; 09H1020A (N)

Reagent Arrival Date: 2009 Sep 22

Reconstitution Solution Lot: SF1095

Reconstitution Solution Expiration Date: 2011 Jun 01

Reagent Expiration Date: 06/2011, 08/2011 (N) ②

CANTEST ID	Date Sampled	Date Received	Reagent Reconstitution Time	Inoculation Time	Water Bath Temperature Start 10 minutes (°C)	Water Bath Temperature End 10 minutes (°C)	Water Bath Temperature End Transfer (°C)
910300243	2009 Oct 20	2009 Oct 22	14:43	15:02	14.9	14.6	15.0
910300228	2009 Oct 19	2009 Oct 22	14:43	15:02	14.9	14.6	15.0
① 910300226	2009 Oct 19	2009 Oct 22	16:35	16:52	14.9	14.9	14.9
910300231	2009 Oct 19	2009 Oct 22	10:30	10:52	14.6	14.8	15.2
910300236	2009 Oct 20	2009 Oct 22	10:30	10:52	14.6	14.8	15.2
910300241	2009 Oct 20	2009 Oct 22	11:30	12:09	14.8	15.2	14.9
910300250	2009 Oct 21	2009 Oct 22	11:30	12:09	14.8	15.2	14.9
910500235	2009 Oct 20	2009 Oct 22	12:23	12:46	14.9	15.0	15.0
910300247	2009 Oct 21	2009 Oct 22	12:23	12:46	14.9	15.0	15.0
910300236	2009 OCT 20	2009 OCT 22	15:25	15:49	14.9	15.0	14.7
910300235	2009 OCT 20	2009 OCT 22	15:23	15:49	14.9	15.0	14.7
910300247	2009 OCT 21	2009 OCT 22	17:04	~~15:23~~ 17:23 ②	15.0	15.0	15.3
910300243	2009 OCT 20	2009 OCT 22	17:04	~~15~~ 17:23 ②	15.0	15.0	15.3
			K.Cox 2009 Dec 18				

② WE KP 2009 NOV 27

① (N) Crude Reagent from new box

CANTEST

Client Code and Name GDL-001 Golder Associates pH Meter AIN _____ Salinity Meter AIN _____

Pipette AINs 005131, 005132, S/N 1377177 Thermometer AIN 005164 and 4696

CANTEST ID	Lowest Turbid Concentration (mg/L)	Lowest Opaque Concentration (mg/L)	Filtrate Colour	Filename	Porewater pH	Porewater Salinity (‰)
910300243	12310	98500	light amber			
910300228	3078	24630	light amber			
910300226	12310	49250	light amber			
910300231	6156	49250	Brown			
910300236	6156	24630	brown amber			
910300241	49250	NA	light Brown			
910300250	12310	49250	light Brown			
910500235	12310	49250	light brown			
910300247	12310	49250	light brown			
910300 236	6156	49250	Brown			
910300 235	6156	NA	light Brown			
910 300 247	24630	98500	Brown			
910300 243	49250	NA	light Brown			

E. Gay 2009 Dec 18

ECOTOXICOLOGY
SOLID PHASE MICROTOX® - DRY WEIGHTS

CANTEST

Client Code and Name: 902 001 Golder Ogavick
Project Number: 211-1024
Date in Oven: 2009 Dec. 03
Date out of Oven: 2009 Dec 05
Time in Oven: 15:00 p.m.
Time Out of Oven: 15:00
Balance AIN: 004686
Oven AIN: 003502
Actual Oven Temperature Range (°C): ① ~~60 °C~~ 100 °C

Sample ID and CANTEST ID	Weigh Boat #	Boat Weight (g)	Wet Sample Weight (g)	Dry Boat & Sample Weight (g)
16744-11	1	1.17	4.99	5.14
	2	1.16	5.00	5.09
910300243	3	1.15	5.01	5.06
16740-04	4	1.16	5.00	2.76
	5	1.17	5.01	2.82
910300228	6	1.16	5.00	2.80
16740-02	7	1.15	4.99	2.45
	8	1.17	4.99	2.39
910300226	9	1.15	5.00	2.37
16740-07	10	1.14	4.99	2.40
	11	1.18	5.00	2.34
910300231	12	1.15	5.01	2.38
16744-03	13	1.15	5.00	2.66
	14	1.17	5.01	2.68
910300236	15	1.15	5.01	2.68
16744-08	16	1.17	4.98	4.96
	17	1.17	5.00	5.02
910300241	18	1.17	5.01	4.85
16747-06	19	1.18	5.00	3.50
	20	1.16	5.00	① ~~2.46~~ 3.60
910300250	21	1.17	5.00	3.58
16744-02	22	1.16	4.99	4.74
	23	1.16	5.00	4.72
910500235	24	1.16	5.00	4.74
Analyst		CB	CB	CB
Date		2009 Dec 03	2009 Dec 03	2009 Dec. 04

① 2009 Dec 05 CB

Revision: 00
Revision Date: October 8, 2009
Document Control Number: 80-F-107-00

Form approved by: Janet Pickard
Effective date: Oct 16, 2009

ECOTOXICOLOGY
SOLID PHASE MICROTOX® - DRY WEIGHTS

CANTEST

Client Code and Name	420L-001-Golder Associates	Project Number	211-1024
Date in Oven	2009 Dec 03	Date out of Oven	2009 Dec 05
Time in Oven	15:00	Time Out of Oven	15:00
Balance AIN	004686	Oven AIN	003502
Actual Oven Temperature Range (°C)	~~0~~ °C	100 °C	

Sample ID and CANTEST ID	Weigh Boat #	Boat Weight (g)	Wet Sample Weight (g)	Dry Boat & Sample Weight (g)
16747-03	25	1.16	5.01	4.27
910300247	26	1.16	5.00	4.28
	27	1.17	5.00	4.26
	QA#1	1.17		1.17
	QA#2	1.17		1.16
	#1	1.17	5.00	5.14

ECOTOXICOLOGY
MICROTOX® M 500 ANALYZER (AIN 003514) USAGE AND MAINTENANCE

CANTEST

Date	Project Number	Liquid or Solid Phase	Filter Checked	Filter Cleaned	# of Samples Tested	# of Reference Toxicant Tests	Comments / Maintenance / Problems	Analyst
2009 Nov. 26	2-111024	Liquid ☐ Solid ☑	Yes ☑ No ☐	Yes ☐ No ☐	93	1		CB
2009 Nov 27	2111024	Liquid ☐ Solid ☑	Yes ☐ No ☐	Yes ☐ No ☐	10	0		KP
		Liquid ☐ Solid ☐	Yes ☐ No ☐	Yes ☐ No ☐				
		Liquid ☐ Solid ☐	Yes ☐ No ☐	Yes ☐ No ☐				
		Liquid ☐ Solid ☐	Yes ☐ No ☐	Yes ☐ No ☐	LS Handoff 2009 Dec 23			
		Liquid ☐ Solid ☐	Yes ☐ No ☐	Yes ☐ No ☐				
		Liquid ☐ Solid ☐	Yes ☐ No ☐	Yes ☐ No ☐				
		Liquid ☐ Solid ☐	Yes ☐ No ☐	Yes ☐ No ☐				

ECOTOXICOLOGY
SOLID PHASE MICROTOX® - MULTIPLE SEDIMENT SAMPLES

CANTEST

Client Code and Name: GOL001 - Golden Associates
Homogenization Date(s): 2009 Nov. 26 / 2009 Nov 27
Project Number: 211-1024
Test Date(s): 2009 Nov. 26
Analyst(s): C. Belthorn, K. Pomeroy
Diluent Preparation Date: 2009 Nov. 16
Balance AIN: 004586

Sample ID	CANTEST ID	Amount of Sample (g)	Sample Description
16744-11	910300243	7.00	dark brown-grey, sand like, with pieces of shells
16740-04	910300228	6.99	dark brown-silty, w/chips of wood, H2S like odour
16740-02	910300226	7.00	dark brown-silt, with chips, wood & roots, H2S like odour
16740-07	910300231	7.00	dark brown-silty, H2S like odours
16744-03	910300236	7.00	dark brown-silty, H2S like odours
16744-08	910300241	7.00	black-grainy sand like, H2S like odours
16747-06	910300250	7.01	dark brown, mixture of sand + silt, H2S like odours
16744-02	910500235	7.00	dark brown sandy like, odours none
16747-03	910300247	7.00	dark brown-silty clay, H2S like odours
16744-03	910300 236	6.99	As above. Repeat test
16744-02	910300 235	7.00	As above. Repeat test
16747-03	910300 247	6.98	As above. Repeat test
16744-11	910300243	7.03	As above. Repeat test
			Standoff 20090223

ECOTOXICOLOGY
MICROTOX® SODIUM CHLORIDE DILUENT PREPARATION

CANTEST

NaCl Concentration (g/L)	Volume Prepared	Brand	Lot Number	Nominal Weight (g)	Actual Weight (g)	Balance AIN	Preparation Date	Discard Date	Analyst	Storage Location
3.5%	1 Liter	EMD	49030909	35 g	35.00015	003535	2009 Nov. 16	2009 Nov 27	CB	3506

Stanoff 2009 Dec 23

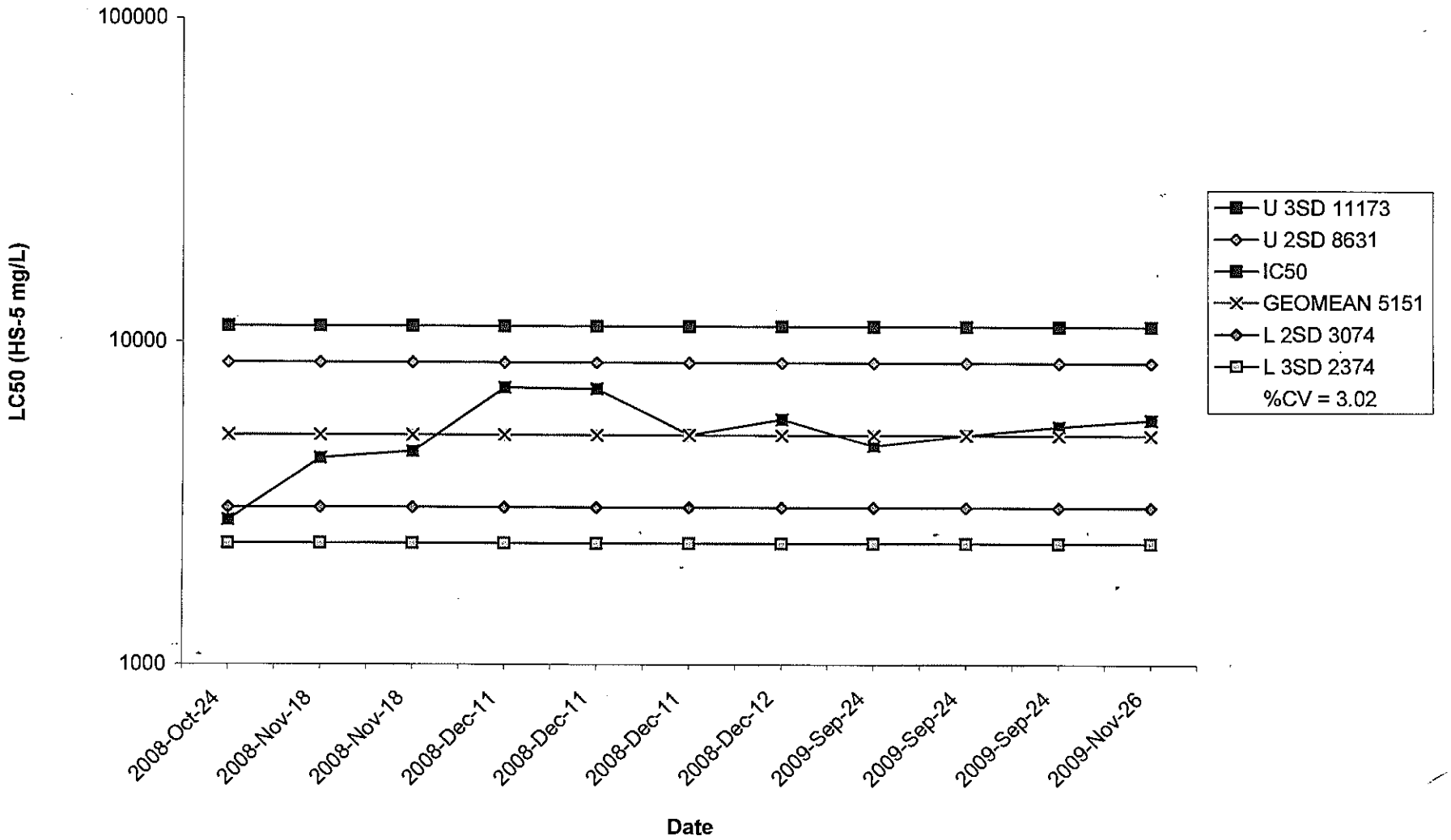
Revision: 00
Revision Date: October 8, 2009
Document Control Number: 80-F-105-00

Form approved by: Janet Rickard
Effective date: Oct. 16, 2009

CANTEST Ltd.
Burnaby, BC

Solid Phase Microtox

30 min Reference Toxicant Control Chart for HS-5



2010 Program

Maxxam

Your Project #: 09-1436-5008
Your C.O.C. #: 21774, 21775, 21776

Attention: Adrian de Bruyn
GOLDER ASSOCIATES LTD
4260 STILL CREEK DRIVE
Suite 500
BURNABY, BC
Canada V5C 6C6

Report Date: 2011/01/04

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0C3450
Received: 2010/12/21, 08:10

Sample Matrix: Soil
Samples Received: 20

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/MTBE Soil LH, VH, F1 SIM/MS	20	2010/12/22	2010/12/23	BBY8-SOP-00010	EPA SW846 8260C
Volatile F1-BTEX	20	N/A	2010/12/24		
CCME Hydrocarbons (F2-F4 in soil)	20	2010/12/22	2010/12/24	BBY8SOP-00030	CCME Soil Tier 1
Elements by ICPMS (total)	10	2010/12/22	2010/12/22	BBY7SOP-00004	Based on EPA 200.8
Elements by ICPMS (total)	5	2010/12/22	2010/12/23	BBY7SOP-00004	Based on EPA 200.8
Elements by ICPMS (total)	5	2010/12/31	2010/12/31	BBY7SOP-00004	Based on EPA 200.8
Simultaneously Extractable Metals-ICPMS	5	2010/12/30	2010/12/30	BBY7SOP-00001	Based on EPA 200.8
Moisture	20	N/A	2010/12/23	BBY8SOP-00017	Ont MOE -E 3139
PAH in Soil by GC/MS Lowlevel (Extended)	11	2010/12/22	2010/12/30	BRN SOP-00332 R5.0	Based on EPA 8270D
PAH in Soil by GC/MS Lowlevel (Extended)	9	2010/12/22	2010/12/31	BRN SOP-00332 R5.0	Based on EPA 8270D
Total LMW, HMW, Total PAH Calc	20	N/A	2011/01/04		PAHTOT-S
pH (2:1 DI Water Extract)	13	2010/12/22	2010/12/22	BBY6SOP-00028	Carter, SSMA 16.2
pH (2:1 DI Water Extract)	2	2010/12/22	2010/12/23	BBY6SOP-00028	Carter, SSMA 16.2
pH (2:1 DI Water Extract)	5	2010/12/31	2011/01/04	BBY6SOP-00028	Carter, SSMA 16.2
Sulfide (AVS) (soil) - Calc for umole/g	5	2010/12/21	2010/12/31	BRN SOP-00229 R2.0	Based EPA821-R91-100
Sulfide (AVS) (soil)	5	2010/12/30	2010/12/30	BBY6SOP-00007	Based EPA821-R91-100
Texture by Hydrometer, incl Gravel (Wet) (1)	15	2010/12/29	2010/12/29	EENVSOP-00076	MMFSPA Ch9
TOC Soil Subcontract (2)	20	2010/12/30	2010/12/30		

* Results relate only to the items tested.

(1) This test was performed by Maxxam Edmonton Environmental
(2) This test was performed by Maxxam Ontario (From Burnaby)

Encryption Key

VJ Oco
05 Jan 2011 09:06:44 -08:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

VJ OCO, Burnaby Customer Service
Email: VOco@maxxam.ca
Phone# (604) 639-8422

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		Z15990	Z15991	Z15992		Z15995	Z15996	Z15997		Z16001	Z16002		
Sampling Date		2010/12/16	2010/12/16	2010/12/16		2010/12/16	2010/12/16	2010/12/16		2010/12/17	2010/12/17		
	Units	**21774-01**	**21774-02**	**21774-03**	**RDL**	**21774-06**	**21774-07**	**21774-08**	**RDL**	**21774-12**	**21775-01**	**RDL**	**QC Batch**
Parameter													
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	N/A	ATTACHED	ATTACHED	ATTACHED	N/A	ATTACHED	ATTACHED	N/A	4538442
Calculated Parameters													
Sulphide	umole/g	28.5			0.5	51			1	1.18		0.02	4522343
MISCELLANEOUS													
Sulphide	ug/g	915			20	1620			40	37.8		0.8	4536272
Physical Properties													
% sand by hydrometer	%		28	31	2		59	60	2		44	2	4533957
% silt by hydrometer	%		38	21	2		16	<2	2		2	2	4533957
Clay Content	%		20	14	2		6	3	2		3	2	4533957
Gravel	%		15	34	2		19	36	2		51	2	4533957

Maxxam ID		Z16003	Z16004	Z16005		Z16010	Z16011	Z16012	Z16013		
Sampling Date		2010/12/17	2010/12/17	2010/12/17		2010/12/16	2010/12/16	2010/12/16	2010/12/17		
	Units	**21775-02**	**21775-03**	**21775-04**	**RDL**	**21775-09**	**21775-10**	**21775-11**	**21775-12**	**RDL**	**QC Batch**
Parameter											
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4538442
Calculated Parameters											
Sulphide	umole/g				0.02	11.4				0.3	4522343
MISCELLANEOUS											
Sulphide	ug/g				0.8	367				10	4536272
Physical Properties											
% sand by hydrometer	%	81	80	81	2		80	75	79	2	4533957
% silt by hydrometer	%	12	13	13	2		7	3	3	2	4533957
Clay Content	%	4	4	4	2		4	<2	<2	2	4533957
Gravel	%	3	4	3	2		9	21	16	2	4533957

N/A = Not Applicable
RDL = Reportable Detection Limit

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		Z16018		Z16019	Z16020	Z16021	Z16022		
Sampling Date		2010/12/16		2010/12/17	2010/12/17	2010/12/17	2010/12/17		
	Units	**21776-01**	**RDL**	**21776-02**	**21776-03**	**21776-04**	**21776-05**	**RDL**	**QC Batch**
Parameter									
Subcontract Parameter	N/A	ATTACHED	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4538442
Calculated Parameters									
Sulphide	umole/g		0.3	28.0				0.6	4522343
MISCELLANEOUS									
Sulphide	ug/g		10	897				20	4536272
Physical Properties									
% sand by hydrometer	%	51	2		65	34	45	2	4533957
% silt by hydrometer	%	2	2		22	39	28	2	4533957
Clay Content	%	<2	2		8	14	10	2	4533957
Gravel	%	46	2		5	14	16	2	4533957

N/A = Not Applicable
RDL = Reportable Detection Limit

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		Z15990	Z15991	Z15992	Z15995		Z15996		Z15997		Z16001		
Sampling Date		2010/12/16	2010/12/16	2010/12/16	2010/12/16		2010/12/16		2010/12/16		2010/12/17		
	Units	**21774-01**	**21774-02**	**21774-03**	**21774-06**	**QC Batch**	**21774-07**	**QC Batch**	**21774-08**	**QC Batch**	**21774-12**	**RDL**	**QC Batch**
Ext. Pet. Hydrocarbon													
F2 (C10-C16 Hydrocarbons)	mg/kg	120(1)	100(1)	77(1)	160(1)	4525234	270	4527562	170	4525234	19	10	4527562
F3 (C16-C34 Hydrocarbons)	mg/kg	680(1)	510(1)	450(1)	580(1)	4525234	810	4527562	310	4525234	140	10	4527562
F4 (C34-C50 Hydrocarbons)	mg/kg	170(1)	180	120(1)	200(1)	4525234	180	4527562	62	4525234	110	10	4527562
Reached Baseline at C50	mg/kg	YES	YES	YES	YES	4525234	YES	4527562	YES	4525234	NO	N/A	4527562
Surrogate Recovery (%)													
O-TERPHENYL (sur.)	%	95	97	91	97	4525234	101	4527562	94	4525234	90		4527562

Maxxam ID		Z16002		Z16003	Z16004		Z16005	Z16010		
Sampling Date		2010/12/17		2010/12/17	2010/12/17		2010/12/17	2010/12/16		
	Units	**21775-01**	**QC Batch**	**21775-02**	**21775-03**	**QC Batch**	**21775-04**	**21775-09**	**RDL**	**QC Batch**
Ext. Pet. Hydrocarbon										
F2 (C10-C16 Hydrocarbons)	mg/kg	<10	4527562	<10	<10	4525234	<10	56(1)	10	4527562
F3 (C16-C34 Hydrocarbons)	mg/kg	15	4527562	<10	40	4525234	<10	330(1)	10	4527562
F4 (C34-C50 Hydrocarbons)	mg/kg	<10	4527562	<10	<10	4525234	<10	120(1)	10	4527562
Reached Baseline at C50	mg/kg	YES	4527562	YES	YES	4525234	YES	YES	N/A	4527562
Surrogate Recovery (%)										
O-TERPHENYL (sur.)	%	95	4527562	93	94	4525234	95	95		4527562

Maxxam ID		Z16011		Z16012	Z16013		Z16018		
Sampling Date		2010/12/16		2010/12/16	2010/12/17		2010/12/16		
	Units	**21775-10**	**QC Batch**	**21775-11**	**21775-12**	**QC Batch**	**21776-01**	**RDL**	**QC Batch**
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/kg	35	4525234	<10	<10	4527562	<10	10	4525234
F3 (C16-C34 Hydrocarbons)	mg/kg	170	4525234	20	<10	4527562	<10	10	4525234
F4 (C34-C50 Hydrocarbons)	mg/kg	51	4525234	<10	<10	4527562	<10	10	4525234
Reached Baseline at C50	mg/kg	YES	4525234	YES	YES	4527562	YES	N/A	4525234
Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	97	4525234	93	89	4527562	91		4525234

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample contained > 50% moisture.

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		Z16019		Z16020		Z16021	Z16022		
Sampling Date		2010/12/17		2010/12/17		2010/12/17	2010/12/17		
	Units	**21776-02**	**QC Batch**	**21776-03**	**QC Batch**	**21776-04**	**21776-05**	**RDL**	**QC Batch**
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/kg	130(1)	4527562	120(1)	4525234	170(1)	170(1)	10	4527562
F3 (C16-C34 Hydrocarbons)	mg/kg	650(1)	4527562	710(1)	4525234	870(1)	790(1)	10	4527562
F4 (C34-C50 Hydrocarbons)	mg/kg	150(1)	4527562	180(1)	4525234	210(1)	230(1)	10	4527562
Reached Baseline at C50	mg/kg	YES	4527562	YES	4525234	YES	YES	N/A	4527562
Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	90	4527562	92	4525234	96	96		4527562

PHYSICAL TESTING (SOIL)

Maxxam ID		Z15990	Z15991	Z15992	Z15995	Z15996	Z15997	Z16001	Z16002	Z16003	Z16004		
Sampling Date		2010/12/16	2010/12/16	2010/12/16	2010/12/16	2010/12/16	2010/12/16	2010/12/17	2010/12/17	2010/12/17	2010/12/17		
	Units	**21774-01**	**21774-02**	**21774-03**	**21774-06**	**21774-07**	**21774-08**	**21774-12**	**21775-01**	**21775-02**	**21775-03**	**RDL**	**QC Batch**
Physical Properties													
Moisture	%	76	73	75	56	36	27	24	12	18	17	0.3	4523815

Maxxam ID		Z16005	Z16010	Z16011	Z16012	Z16013	Z16018	Z16019	Z16020	Z16021	Z16022		
Sampling Date		2010/12/17	2010/12/16	2010/12/16	2010/12/16	2010/12/17	2010/12/16	2010/12/17	2010/12/17	2010/12/17	2010/12/17		
	Units	**21775-04**	**21775-09**	**21775-10**	**21775-11**	**21775-12**	**21776-01**	**21776-02**	**21776-03**	**21776-04**	**21776-05**	**RDL**	**QC Batch**
Physical Properties													
Moisture	%	16	63	31	14	14	13	74	72	75	69	0.3	4523815

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample contained > 50% moisture.

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		Z15990	Z15995	Z16001	Z16010	Z16019		
Sampling Date		2010/12/16	2010/12/16	2010/12/17	2010/12/16	2010/12/17		
	Units	**21774-01**	**21774-06**	**21774-12**	**21775-09**	**21776-02**	**RDL**	**QC Batch**
SEM Metals by ICPMS								
SEM Cadmium (Cd)	umole/g	0.0204	0.0269	0.0020	0.0107	0.0253	0.0002	4538275
SEM Copper (Cu)	umole/g	0.005	0.006	0.287	0.057	0.028	0.004	4538275
SEM Lead (Pb)	umole/g	0.0746	0.0839	0.0820	0.0490	0.0866	0.0002	4538275
SEM Mercury (Hg)	umole/g	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.0003	4538275
SEM Nickel (Ni)	umole/g	0.184	0.260	0.156	0.126	0.183	0.004	4538275
SEM Zinc (Zn)	umole/g	2.08	66.3	0.727	1.15	2.37	0.008	4538275

CCME BTEX/F1 BY HS IN SOIL (SOIL)

Maxxam ID		Z15990	Z15991	Z15992		Z15995		Z15996		Z15997		Z16001		
Sampling Date		2010/12/16	2010/12/16	2010/12/16		2010/12/16		2010/12/16		2010/12/16		2010/12/17		
	Units	**21774-01**	**21774-02**	**21774-03**	**RDL**	**21774-06**	**RDL**	**21774-07**	**RDL**	**21774-08**	**RDL**	**21774-12**	**RDL**	**QC Batch**
Calculated Parameters														
F1 (C6-C10) - BTEX	mg/kg	<60	<60	<60	60	<30	30	<10	10	16	10	<10	10	4521447
Volatiles														
Methyl-tert-butylether (MTBE)	mg/kg	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	4527507
Benzene	mg/kg	<0.03(1)	<0.03(1)	<0.03(1)	0.03	<0.02(1)	0.02	<0.005	0.005	<0.02(2)	0.02	<0.005	0.005	4527507
Toluene	mg/kg	0.11(1)	0.07(1)	0.10(1)	0.03	0.09	0.02	0.06	0.02	0.10	0.02	<0.02	0.02	4527507
Ethylbenzene	mg/kg	<0.03(1)	<0.03(1)	<0.03(1)	0.03	0.03(1)	0.02	0.02	0.01	0.05	0.01	<0.01	0.01	4527507
m & p-Xylene	mg/kg	<0.04	<0.04	<0.04	0.04	0.09	0.04	0.08	0.04	0.22	0.04	<0.04	0.04	4527507
o-Xylene	mg/kg	<0.04	<0.04	<0.04	0.04	0.05	0.04	0.05	0.04	0.13	0.04	<0.04	0.04	4527507
Styrene	mg/kg	<0.03(1)	<0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	4527507
Xylenes (Total)	mg/kg	<0.04	<0.04	<0.04	0.04	0.14	0.04	0.12	0.04	0.35	0.04	<0.04	0.04	4527507
(C6-C10)	mg/kg	<60(1)	<60(1)	<60(1)	60	<30(1)	30	<10	10	16	10	<10	10	4527507
Surrogate Recovery (%)														
4-BROMOFLUOROBENZENE (sur.)	%	87	87	88		89		88		91		87		4527507
D10-ETHYLBENZENE (sur.)	%	89	92	98		91		84		84		100		4527507
D4-1,2-DICHLOROETHANE (sur.)	%	109	106	106		110		111		113		106		4527507
D8-TOLUENE (sur.)	%	91	91	92		91		96		91		100		4527507

RDL = Reportable Detection Limit
(1) - RDL raised due to high sample moisture content.
(2) - RDL raised due to failed ion ratio.

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CCME BTEX/F1 BY HS IN SOIL (SOIL)

Maxxam ID		Z16002	Z16003	Z16004	Z16005			Z16010			Z16011		
Sampling Date		2010/12/17	2010/12/17	2010/12/17	2010/12/17			2010/12/16			2010/12/16		
	Units	**21775-01**	**21775-02**	**21775-03**	**21775-04**	**RDL**	**QC Batch**	**21775-09**	**RDL**	**QC Batch**	**21775-10**	**RDL**	**QC Batch**
Calculated Parameters													
F1 (C6-C10) - BTEX	mg/kg	<10	<10	<10	<10	10	4521447	<40	40	4521447	<10	10	4521447
Volatiles													
Methyl-tert-butylether (MTBE)	mg/kg	<0.1	<0.1	<0.1	<0.1	0.1	4527507	<0.1	0.1	4527468	<0.1	0.1	4527507
Benzene	mg/kg	<0.005	<0.005	<0.005	<0.005	0.005	4527507	<0.02 (1)	0.02	4527468	<0.005	0.005	4527507
Toluene	mg/kg	<0.02	<0.02	<0.02	<0.02	0.02	4527507	<0.02	0.02	4527468	<0.02	0.02	4527507
Ethylbenzene	mg/kg	<0.01	<0.01	<0.01	<0.01	0.01	4527507	<0.02 (1)	0.02	4527468	<0.01	0.01	4527507
m & p-Xylene	mg/kg	<0.04	<0.04	<0.04	<0.04	0.04	4527507	<0.04	0.04	4527468	<0.04	0.04	4527507
o-Xylene	mg/kg	<0.04	<0.04	<0.04	<0.04	0.04	4527507	<0.04	0.04	4527468	<0.04	0.04	4527507
Styrene	mg/kg	<0.03	<0.03	<0.03	<0.03	0.03	4527507	<0.03	0.03	4527468	<0.03	0.03	4527507
Xylenes (Total)	mg/kg	<0.04	<0.04	<0.04	<0.04	0.04	4527507	<0.04	0.04	4527468	<0.04	0.04	4527507
(C6-C10)	mg/kg	<10	<10	<10	<10	10	4527507	<40 (1)	40	4527468	<10	10	4527507
Surrogate Recovery (%)													
4-BROMOFLUOROBENZENE (sur.)	%	85	87	82	85		4527507	95		4527468	87		4527507
D10-ETHYLBENZENE (sur.)	%	94	96	87	96		4527507	89		4527468	94		4527507
D4-1,2-DICHLOROETHANE (sur.)	%	109	109	106	109		4527507	90		4527468	118		4527507
D8-TOLUENE (sur.)	%	90	92	86	90		4527507	101		4527468	95		4527507

RDL = Reportable Detection Limit
(1) - RDL raised due to high sample moisture content.

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CCME BTEX/F1 BY HS IN SOIL (SOIL)

Maxxam ID		Z16012	Z16013	Z16018		Z16019		Z16020		Z16021		Z16022		
Sampling Date		2010/12/16	2010/12/17	2010/12/16		2010/12/17		2010/12/17		2010/12/17		2010/12/17		
	Units	**21775-11**	**21775-12**	**21776-01**	**RDL**	**21776-02**	**RDL**	**21776-03**	**RDL**	**21776-04**	**RDL**	**21776-05**	**RDL**	**QC Batch**
Calculated Parameters														
F1 (C6-C10) - BTEX	mg/kg	<10	<10	<10	10	<60	60	<50	50	<60	60	<50	50	4521447
Volatiles														
Methyl-tert-butylether (MTBE)	mg/kg	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	4527507
Benzene	mg/kg	<0.005	<0.005	<0.005	0.005	<0.03(1)	0.03	<0.03(1)	0.03	<0.03(1)	0.03	<0.02(1)	0.02	4527507
Toluene	mg/kg	<0.02	<0.02	<0.02	0.02	0.08(1)	0.03	0.07(1)	0.03	0.07(1)	0.03	0.08(1)	0.02	4527507
Ethylbenzene	mg/kg	<0.01	<0.01	<0.01	0.01	<0.03(1)	0.03	<0.03(1)	0.03	<0.03(1)	0.03	<0.02(1)	0.02	4527507
m & p-Xylene	mg/kg	<0.04	<0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.05	0.04	0.05	0.04	4527507
o-Xylene	mg/kg	<0.04	<0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.06	0.04	4527507
Styrene	mg/kg	<0.03	<0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	4527507
Xylenes (Total)	mg/kg	<0.04	<0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.05	0.04	0.10	0.04	4527507
(C6-C10)	mg/kg	<10	<10	<10	10	<60(1)	60	<50(1)	50	<60(1)	60	<50(1)	50	4527507
Surrogate Recovery (%)														
4-BROMOFLUOROBENZENE (sur.)	%	88	88	85		86		87		88		86		4527507
D10-ETHYLBENZENE (sur.)	%	96	95	96		92		92		95		90		4527507
D4-1,2-DICHLOROETHANE (sur.)	%	111	112	115		116		115		113		113		4527507
D8-TOLUENE (sur.)	%	91	90	89		89		90		91		89		4527507

RDL = Reportable Detection Limit
(1) - RDL raised due to high sample moisture content.

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Maxxam Job #: B0C3450
Report Date: 2011/01/04

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		Z15990		Z15991	Z15992		Z15995		Z15996	Z15997		
Sampling Date		2010/12/16		2010/12/16	2010/12/16		2010/12/16		2010/12/16	2010/12/16		
	Units	**21774-01**	**QC Batch**	**21774-02**	**21774-03**	**QC Batch**	**21774-06**	**QC Batch**	**21774-07**	**21774-08**	**RDL**	**QC Batch**
Physical Properties												
Soluble (2:1) pH	pH Units	7.08	4539281	7.64	7.38	4525076	7.63	4539281	7.97	8.22	0.01	4525076
Total Metals by ICPMS												
Total Aluminum (Al)	mg/kg	11400	4539236	8260	8140	4525068	8890	4539236	5830	6890	100	4525068
Total Antimony (Sb)	mg/kg	0.4	4539236	0.3	0.3	4525068	0.9	4539236	0.7	1.2	0.1	4525068
Total Arsenic (As)	mg/kg	7.3	4539236	5.2	4.2	4525068	16.2	4539236	9.6	11.5	0.2	4525068
Total Barium (Ba)	mg/kg	48.0	4539236	37.0	38.2	4525068	52.2	4539236	69.7	48.0	0.1	4525068
Total Beryllium (Be)	mg/kg	0.1	4539236	0.1	0.1	4525068	0.3	4539236	0.2	0.3	0.1	4525068
Total Bismuth (Bi)	mg/kg	0.2	4539236	0.1	0.1	4525068	0.1	4539236	<0.1	<0.1	0.1	4525068
Total Cadmium (Cd)	mg/kg	3.08	4539236	2.21	1.86	4525068	3.53	4539236	1.35	0.82	0.05	4525068
Total Calcium (Ca)	mg/kg	9290	4539236	13300	17400	4525068	9850	4539236	10800	74800	100	4525068
Total Chromium (Cr)	mg/kg	27	4539236	19	18	4525068	34	4539236	25	39	1	4525068
Total Cobalt (Co)	mg/kg	5.4	4539236	3.9	3.5	4525068	5.8	4539236	5.1	7.1	0.3	4525068
Total Copper (Cu)	mg/kg	77.9	4539236	52.3	49.7	4525068	82.3	4539236	55.7	82.2	0.5	4525068
Total Iron (Fe)	mg/kg	16900	4539236	13600	11300	4525068	32500	4539236	23900	42700	100	4525068
Total Lead (Pb)	mg/kg	25.7	4539236	15.6	17.1	4525068	23.2	4539236	14.0	12.9	0.1	4525068
Total Magnesium (Mg)	mg/kg	9020	4539236	6100	6970	4525068	7040	4539236	4030	4950	100	4525068
Total Manganese (Mn)	mg/kg	164	4539236	118	108	4525068	144	4539236	93.5	160	0.2	4525068
Total Mercury (Hg)	mg/kg	0.28	4539236	0.27	0.26	4525068	0.26	4539236	0.31	0.24	0.05	4525068
Total Molybdenum (Mo)	mg/kg	24.5	4539236	12.4	18.1	4525068	11.4	4539236	5.8	5.5	0.1	4525068
Total Nickel (Ni)	mg/kg	22.0	4539236	15.3	14.1	4525068	26.7	4539236	20.9	36.6	0.8	4525068
Total Phosphorus (P)	mg/kg	663	4539236	503	466	4525068	679	4539236	482	450	10	4525068
Total Potassium (K)	mg/kg	2340	4539236	1610	1740	4525068	1660	4539236	975	1340	100	4525068
Total Selenium (Se)	mg/kg	1.7	4539236	1.1	1.0	4525068	1.3	4539236	0.9	0.6	0.5	4525068
Total Silver (Ag)	mg/kg	0.28	4539236	0.15	0.21	4525068	0.21	4539236	0.08	0.09	0.05	4525068
Total Sodium (Na)	mg/kg	29000	4539236	17300	21300	4525068	13200	4539236	5480	4440	100	4525068
Total Strontium (Sr)	mg/kg	84.0	4539236	74.7	87.4	4525068	102	4539236	128	518	0.1	4525068
Total Thallium (Tl)	mg/kg	0.34	4539236	0.23	0.23	4525068	0.24	4539236	0.11	0.14	0.05	4525068
Total Tin (Sn)	mg/kg	2.0	4539236	1.5	1.6	4525068	3.2	4539236	2.5	4.6	0.1	4525068
Total Titanium (Ti)	mg/kg	467	4539236	409	439	4525068	326	4539236	133	56	1	4525068
Total Vanadium (V)	mg/kg	51	4539236	36	38	4525068	46	4539236	34	28	2	4525068
Total Zinc (Zn)	mg/kg	176	4539236	119	125	4525068	4920	4539236	2970	2880	1	4525068
Total Zirconium (Zr)	mg/kg	2.9	4539236	2.9	2.3	4525068	2.2	4539236	0.9	1.0	0.5	4525068

RDL = Reportable Detection Limit

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		Z16001		Z16002	Z16003	Z16004	Z16005		Z16010		Z16011		
Sampling Date		2010/12/17		2010/12/17	2010/12/17	2010/12/17	2010/12/17		2010/12/16		2010/12/16		
	Units	**21774-12**	**QC Batch**	**21775-01**	**21775-02**	**21775-03**	**21775-04**	**QC Batch**	**21775-09**	**QC Batch**	**21775-10**	**RDL**	**QC Batch**
Physical Properties													
Soluble (2:1) pH	pH Units	8.13	4539281	8.64	8.66	8.66	8.32	4525076	7.39	4539281	8.03	0.01	4525076
Total Metals by ICPMS													
Total Aluminum (Al)	mg/kg	9970	4539236	10200	9950	9750	10700	4525068	8690	4539236	8950	100	4525068
Total Antimony (Sb)	mg/kg	0.3	4539236	0.2	<0.1	<0.1	<0.1	4525068	0.3	4539236	0.1	0.1	4525068
Total Arsenic (As)	mg/kg	3.1	4539236	3.6	3.0	2.9	3.1	4525068	7.0	4539236	2.1	0.2	4525068
Total Barium (Ba)	mg/kg	27.8	4539236	17.9	14.1	14.6	16.4	4525068	29.1	4539236	29.7	0.1	4525068
Total Beryllium (Be)	mg/kg	0.1	4539236	0.1	<0.1	<0.1	0.1	4525068	0.1	4539236	<0.1	0.1	4525068
Total Bismuth (Bi)	mg/kg	<0.1	4539236	<0.1	<0.1	<0.1	<0.1	4525068	0.1	4539236	<0.1	0.1	4525068
Total Cadmium (Cd)	mg/kg	0.30	4539236	0.27	0.26	0.25	0.14	4525068	1.45	4539236	0.75	0.05	4525068
Total Calcium (Ca)	mg/kg	5570	4539236	11900	13000	12300	7840	4525068	7910	4539236	10500	100	4525068
Total Chromium (Cr)	mg/kg	16	4539236	15	14	14	15	4525068	19	4539236	14	1	4525068
Total Cobalt (Co)	mg/kg	5.1	4539236	5.2	4.9	4.9	5.5	4525068	4.4	4539236	4.3	0.3	4525068
Total Copper (Cu)	mg/kg	31.4	4539236	26.0	16.2	15.7	17.1	4525068	45.7	4539236	28.4	0.5	4525068
Total Iron (Fe)	mg/kg	13700	4539236	13900	14300	14000	15300	4525068	12800	4539236	10700	100	4525068
Total Lead (Pb)	mg/kg	20.0	4539236	5.4	1.1	1.0	1.2	4525068	13.1	4539236	6.5	0.1	4525068
Total Magnesium (Mg)	mg/kg	4800	4539236	5240	4690	4650	5030	4525068	5900	4539236	4580	100	4525068
Total Manganese (Mn)	mg/kg	169	4539236	173	169	164	178	4525068	133	4539236	141	0.2	4525068
Total Mercury (Hg)	mg/kg	0.20	4539236	0.11	0.07	0.08	0.07	4525068	0.16	4539236	0.19	0.05	4525068
Total Molybdenum (Mo)	mg/kg	1.4	4539236	1.0	1.8	1.9	1.6	4525068	6.7	4539236	3.0	0.1	4525068
Total Nickel (Ni)	mg/kg	12.5	4539236	12.8	11.3	10.9	11.4	4525068	14.5	4539236	11.6	0.8	4525068
Total Phosphorus (P)	mg/kg	368	4539236	380	434	426	305	4525068	536	4539236	442	10	4525068
Total Potassium (K)	mg/kg	695	4539236	786	663	601	624	4525068	1150	4539236	704	100	4525068
Total Selenium (Se)	mg/kg	<0.5	4539236	<0.5	<0.5	<0.5	<0.5	4525068	0.8	4539236	<0.5	0.5	4525068
Total Silver (Ag)	mg/kg	0.06	4539236	<0.05	<0.05	<0.05	<0.05	4525068	0.15	4539236	0.06	0.05	4525068
Total Sodium (Na)	mg/kg	2560	4539236	2040	2290	2100	2160	4525068	12000	4539236	3740	100	4525068
Total Strontium (Sr)	mg/kg	31.1	4539236	51.6	55.5	48.5	34.9	4525068	57.1	4539236	43.9	0.1	4525068
Total Thallium (Tl)	mg/kg	0.19	4539236	0.24	0.21	0.21	0.12	4525068	0.26	4539236	0.25	0.05	4525068
Total Tin (Sn)	mg/kg	1.6	4539236	0.6	0.2	0.2	0.2	4525068	1.6	4539236	0.9	0.1	4525068
Total Titanium (Ti)	mg/kg	992	4539236	1010	1080	1060	1150	4525068	707	4539236	972	1	4525068
Total Vanadium (V)	mg/kg	39	4539236	37	40	38	45	4525068	37	4539236	35	2	4525068
Total Zinc (Zn)	mg/kg	61	4539236	33	23	23	23	4525068	98	4539236	47	1	4525068
Total Zirconium (Zr)	mg/kg	2.2	4539236	2.4	2.3	2.3	2.8	4525068	2.6	4539236	2.6	0.5	4525068

RDL = Reportable Detection Limit

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		Z16012	Z16013	Z16018		Z16019		Z16020	Z16021		Z16022		
Sampling Date		2010/12/16	2010/12/17	2010/12/16		2010/12/17		2010/12/17	2010/12/17		2010/12/17		
	Units	**21775-11**	**21775-12**	**21776-01**	**QC Batch**	**21776-02**	**QC Batch**	**21776-03**	**21776-04**	**QC Batch**	**21776-05**	**RDL**	**QC Batch**
Physical Properties													
Soluble (2:1) pH	pH Units	8.60	8.00	8.89	4525076	7.41	4539281	7.33	7.02	4525097	7.09	0.01	4525076
Total Metals by ICPMS													
Total Aluminum (Al)	mg/kg	9340	8500	9100	4525068	9870	4539236	9620	7270	4525084	7520	100	4525068
Total Antimony (Sb)	mg/kg	0.1	0.2	0.1	4525068	0.4	4539236	0.6	0.3	4525084	0.2	0.1	4525068
Total Arsenic (As)	mg/kg	2.3	2.0	2.4	4525068	11.2	4539236	10.3	4.1	4525084	2.8	0.2	4525068
Total Barium (Ba)	mg/kg	21.4	12.6	15.1	4525068	44.2	4539236	43.3	30.8	4525084	39.9	0.1	4525068
Total Beryllium (Be)	mg/kg	<0.1	0.1	0.1	4525068	0.2	4539236	0.3	0.1	4525084	<0.1	0.1	4525068
Total Bismuth (Bi)	mg/kg	<0.1	<0.1	<0.1	4525068	0.2	4539236	0.2	0.2	4525084	0.2	0.1	4525068
Total Cadmium (Cd)	mg/kg	0.49	0.33	0.06	4525068	3.63	4539236	3.19	1.96	4525084	1.55	0.05	4525068
Total Calcium (Ca)	mg/kg	5540	4890	11400	4525068	12000	4539236	5190	4400	4525084	5420	100	4525068
Total Chromium (Cr)	mg/kg	16	15	16	4525068	25	4539236	25	17	4525084	16	1	4525068
Total Cobalt (Co)	mg/kg	5.1	5.0	5.1	4525068	5.0	4539236	4.8	3.5	4525084	3.9	0.3	4525068
Total Copper (Cu)	mg/kg	18.1	15.9	16.2	4525068	79.9	4539236	67.9	50.2	4525084	49.3	0.5	4525068
Total Iron (Fe)	mg/kg	12500	11000	12800	4525068	15600	4539236	16100	10400	4525084	9540	100	4525068
Total Lead (Pb)	mg/kg	1.0	0.9	1.1	4525068	24.7	4539236	22.8	19.8	4525084	14.8	0.1	4525068
Total Magnesium (Mg)	mg/kg	5210	4740	4960	4525068	7870	4539236	7110	6920	4525084	6490	100	4525068
Total Manganese (Mn)	mg/kg	197	163	184	4525068	139	4539236	137	99.6	4525084	103	0.2	4525068
Total Mercury (Hg)	mg/kg	0.07	<0.05	<0.05	4525068	0.29	4539236	0.23	0.19	4525084	0.28	0.05	4525068
Total Molybdenum (Mo)	mg/kg	0.5	0.4	0.3	4525068	13.6	4539236	20.0	17.4	4525084	13.2	0.1	4525068
Total Nickel (Ni)	mg/kg	12.6	11.5	12.2	4525068	20.2	4539236	20.0	13.8	4525084	15.3	0.8	4525068
Total Phosphorus (P)	mg/kg	365	346	374	4525068	702	4539236	634	457	4525084	426	10	4525068
Total Potassium (K)	mg/kg	614	554	706	4525068	2120	4539236	1870	1740	4525084	1540	100	4525068
Total Selenium (Se)	mg/kg	<0.5	0.5	<0.5	4525068	1.8	4539236	1.1	1.0	4525084	1.0	0.5	4525068
Total Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	4525068	0.23	4539236	0.22	0.19	4525084	0.21	0.05	4525068
Total Sodium (Na)	mg/kg	1750	2110	1680	4525068	25300	4539236	19900	26100	4525084	20000	100	4525068
Total Strontium (Sr)	mg/kg	22.8	21.3	71.5	4525068	85.1	4539236	65.8	61.9	4525084	76.9	0.1	4525068
Total Thallium (Tl)	mg/kg	0.26	0.27	0.07	4525068	0.37	4539236	0.33	0.25	4525084	0.18	0.05	4525068
Total Tin (Sn)	mg/kg	0.2	0.1	0.2	4525068	2.1	4539236	2.1	1.7	4525084	1.8	0.1	4525068
Total Titanium (Ti)	mg/kg	1020	1030	978	4525068	370	4539236	408	280	4525084	265	1	4525068
Total Vanadium (V)	mg/kg	36	35	37	4525068	45	4539236	48	39	4525084	40	2	4525068
Total Zinc (Zn)	mg/kg	26	24	26	4525068	170	4539236	151	163	4525084	109	1	4525068
Total Zirconium (Zr)	mg/kg	2.3	2.1	2.2	4525068	2.4	4539236	2.7	2.5	4525084	2.8	0.5	4525068

RDL = Reportable Detection Limit

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CCME PAH IN SOIL BY GC-MS (SOIL)

Maxxam ID		Z15990		Z15991		Z15992		Z15995		Z15996		Z15997		
Sampling Date		2010/12/16		2010/12/16		2010/12/16		2010/12/16		2010/12/16		2010/12/16		
	Units	**21774-01**	**RDL**	**21774-02**	**RDL**	**21774-03**	**RDL**	**21774-06**	**RDL**	**21774-07**	**RDL**	**21774-08**	**RDL**	**QC Batch**
Polycyclic Aromatics														
Naphthalene	mg/kg	0.57(1)	0.02	0.54(2)	0.005	0.29(1)	0.02	1.8(2)	0.005	4.6(2)	0.01	2.0(2)	0.005	4536352
2-Methylnaphthalene	mg/kg	1.2(1)	0.02	1.1(2)	0.005	0.63(1)	0.02	3.8(2)	0.005	9.6(2)	0.01	4.4(2)	0.005	4536352
Acenaphthylene	mg/kg	<0.1(3)	0.1	<0.08(3)	0.08	<0.06(1)	0.06	<0.2(3)	0.2	<0.5(3)	0.5	<0.2(3)	0.2	4536352
Acenaphthene	mg/kg	0.16(1)	0.02	0.15(2)	0.005	0.07(3)	0.02	0.31(2)	0.005	0.57(2)	0.01	0.20(2)	0.005	4536352
Fluorene	mg/kg	0.28(1)	0.02	0.26(2)	0.005	0.14(1)	0.02	0.71(2)	0.005	1.5(2)	0.01	<0.5(3)	0.5	4536352
Phenanthrene	mg/kg	1.1(1)	0.02	1.0(2)	0.005	0.61(1)	0.02	3.1(2)	0.005	7.1(2)	0.01	2.8(2)	0.005	4536352
Anthracene	mg/kg	0.27(1)	0.02	0.25(2)	0.005	0.13(1)	0.02	0.52(2)	0.005	1.1(2)	0.01	0.35(2)	0.005	4536352
Fluoranthene	mg/kg	0.91(1)	0.02	0.84(2)	0.005	0.48(1)	0.02	1.3(2)	0.005	1.7(2)	0.01	0.63(2)	0.005	4536352
Pyrene	mg/kg	0.73(1)	0.02	0.68(2)	0.005	0.41(1)	0.02	1.1(2)	0.005	1.7(2)	0.01	0.60(2)	0.005	4536352
Benzo(a)anthracene	mg/kg	0.34(1)	0.02	0.31(2)	0.005	0.18(1)	0.02	0.62(2)	0.005	1.1(2)	0.01	0.44(2)	0.005	4536352
Chrysene	mg/kg	0.40(1)	0.02	0.23(2)	0.005	0.15(1)	0.02	0.54(2)	0.005	1.2(2)	0.01	0.42(2)	0.005	4536352
Benzo(b&j)fluoranthene	mg/kg	0.35(1)	0.02	0.31(2)	0.005	0.19(1)	0.02	0.50(2)	0.005	0.71(2)	0.01	0.28(2)	0.005	4536352
Benzo(k)fluoranthene	mg/kg	0.08(1)	0.02	0.068(2)	0.005	0.05(1)	0.02	0.15(2)	0.005	0.21(2)	0.01	0.052(2)	0.005	4536352
Benzo(a)pyrene	mg/kg	<0.2(3)	0.2	<0.2(3)	0.2	<0.1(3)	0.1	<0.4(3)	0.4	<0.5(3)	0.5	<0.2(3)	0.2	4536352
Indeno(1,2,3-cd)pyrene	mg/kg	0.13(1)	0.03	0.09(2)	0.01	0.07(1)	0.03	0.16(2)	0.01	0.24(2)	0.02	0.07(2)	0.01	4536352
Dibenz(a,h)anthracene	mg/kg	<0.03(1)	0.03	<0.03(3)	0.03	<0.03(1)	0.03	<0.06(3)	0.06	<0.2(3)	0.2	<0.04(3)	0.04	4536352
Benzo(g,h,i)perylene	mg/kg	0.19(1)	0.03	0.16(2)	0.01	0.11(1)	0.03	0.30(2)	0.01	0.49(2)	0.02	0.18(2)	0.01	4536352
Low Molecular Weight PAH`s	mg/kg	3.6	0.1	3.4	0.08	1.9	0.06	10	0.2	24	0.5	9.7	0.5	4521449
High Molecular Weight PAH`s	mg/kg	3.1	0.2	2.7	0.2	1.6	0.1	4.7	0.4	7.4	0.5	2.7	0.2	4521449
Total PAH	mg/kg	6.7	0.2	6.1	0.2	3.5	0.1	15	0.4	32	0.5	12	0.5	4521449
Surrogate Recovery (%)														
D10-ANTHRACENE (sur.)	%	90		85		85		75		130		75		4536352
D12-BENZO(A)PYRENE (sur.)	%	90		85		80		80		110		75		4536352
D8-ACENAPHTHYLENE (sur.)	%	40(4)		40(4)		40(4)		60		100		65		4536352
D8-NAPHTHALENE (sur.)	%	90		85		80		75		130		80		4536352
TERPHENYL-D14 (sur.)	%	85		85		80		85		120		80		4536352

RDL = Reportable Detection Limit
(1) - RDL raised due to high sample moisture content and dilution.
(2) - RDL raised due to sample dilution.
(3) - RDL raised due to sample matrix interference.
(4) - Surrogate recovery below control limit - 1 surrogate failure allowed - Pot. low bias

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CCME PAH IN SOIL BY GC-MS (SOIL)

Maxxam ID		Z16001		Z16002		Z16003	Z16004	Z16005		Z16010		Z16011		
Sampling Date		2010/12/17		2010/12/17		2010/12/17	2010/12/17	2010/12/17		2010/12/16		2010/12/16		
	Units	**21774-12**	**RDL**	**21775-01**	**RDL**	**21775-02**	**21775-03**	**21775-04**	**RDL**	**21775-09**	**RDL**	**21775-10**	**RDL**	**QC Batch**
Polycyclic Aromatics														
Naphthalene	mg/kg	0.087	0.001	0.040	0.001	<0.001	<0.001	<0.001	0.001	0.49(1)	0.005	0.12	0.001	4536352
2-Methylnaphthalene	mg/kg	0.23	0.001	0.063	0.001	<0.001	<0.001	<0.001	0.001	1.0(1)	0.005	0.33	0.001	4536352
Acenaphthylene	mg/kg	<0.04(2)	0.04	<0.02(2)	0.02	<0.001	<0.001	<0.001	0.001	<0.06(2)	0.06	<0.02(2)	0.02	4536352
Acenaphthene	mg/kg	0.015	0.001	0.008	0.001	<0.001	<0.001	<0.001	0.001	0.11(3)	0.005	0.038	0.001	4536352
Fluorene	mg/kg	0.037	0.001	0.017	0.001	<0.001	<0.001	<0.001	0.001	0.16(3)	0.005	0.067	0.001	4536352
Phenanthrene	mg/kg	0.22	0.001	0.16	0.001	<0.001	<0.001	<0.001	0.001	0.73(1)	0.005	0.28	0.001	4536352
Anthracene	mg/kg	0.052	0.001	0.029	0.001	<0.001	<0.001	<0.001	0.001	0.28(1)	0.005	0.060	0.001	4536352
Fluoranthene	mg/kg	0.25	0.001	0.17	0.001	<0.001	<0.001	<0.001	0.001	0.70(1)	0.005	0.11	0.001	4536352
Pyrene	mg/kg	0.23	0.001	0.20	0.001	<0.001	<0.001	<0.001	0.001	0.90(1)	0.005	0.10	0.001	4536352
Benzo(a)anthracene	mg/kg	0.10	0.001	0.066	0.001	<0.001	<0.001	<0.001	0.001	0.28(1)	0.005	0.052	0.001	4536352
Chrysene	mg/kg	0.11	0.001	0.081	0.001	<0.001	<0.001	<0.001	0.001	0.38(1)	0.005	0.081	0.001	4536352
Benzo(b&j)fluoranthene	mg/kg	0.14	0.001	0.093	0.001	<0.001	<0.001	<0.001	0.001	0.25(3)	0.005	0.040	0.001	4536352
Benzo(k)fluoranthene	mg/kg	0.045	0.001	0.020	0.001	<0.001	<0.001	<0.001	0.001	0.18(3)	0.005	0.027	0.001	4536352
Benzo(a)pyrene	mg/kg	0.10	0.001	0.079	0.001	<0.001	<0.001	<0.001	0.001	0.18(3)	0.005	0.038	0.001	4536352
Indeno(1,2,3-cd)pyrene	mg/kg	0.080	0.002	0.058	0.002	<0.002	<0.002	<0.002	0.002	0.08(3)	0.01	0.017	0.002	4536352
Dibenz(a,h)anthracene	mg/kg	0.015	0.002	0.008	0.002	<0.002	<0.002	<0.002	0.002	0.04(3)	0.01	0.008	0.002	4536352
Benzo(g,h,i)perylene	mg/kg	0.079	0.002	0.064	0.002	<0.002	<0.002	<0.002	0.002	0.12(3)	0.01	0.036	0.002	4536352
Low Molecular Weight PAH`s	mg/kg	0.64	0.04	0.32	0.02	<0.001	<0.001	<0.001	0.001	2.8	0.06	0.89	0.02	4521449
High Molecular Weight PAH`s	mg/kg	1.2	0.002	0.84	0.002	<0.002	<0.002	<0.002	0.002	3.1	0.01	0.51	0.002	4521449
Total PAH	mg/kg	1.8	0.04	1.2	0.02	<0.002	<0.002	<0.002	0.002	5.9	0.06	1.4	0.02	4521449
Surrogate Recovery (%)														
D10-ANTHRACENE (sur.)	%	79		84		79	80	80		95		75		4536352
D12-BENZO(A)PYRENE (sur.)	%	75		85		81	78	78		90		72		4536352
D8-ACENAPHTHYLENE (sur.)	%	67		76		71	78	77		45(4)		57		4536352
D8-NAPHTHALENE (sur.)	%	76		74		71	78	75		90		68		4536352
TERPHENYL-D14 (sur.)	%	79		84		78	75	76		95		75		4536352

RDL = Reportable Detection Limit
(1) - RDL raised due to sample dilution. Matrix Spike outside acceptance criteria (10% of analytes failure allowed).
(2) - RDL raised due to sample matrix interference.
(3) - RDL raised due to sample dilution.
(4) - Surrogate recovery below control limit - 1 surrogate failure allowed - Pot. low bias

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CCME PAH IN SOIL BY GC-MS (SOIL)

Maxxam ID		Z16012		Z16013		Z16018		Z16019	Z16020		Z16021		
Sampling Date		2010/12/16		2010/12/17		2010/12/16		2010/12/17	2010/12/17		2010/12/17		
	Units	**21775-11**	**RDL**	**21775-12**	**RDL**	**21776-01**	**RDL**	**21776-02**	**21776-03**	**RDL**	**21776-04**	**RDL**	**QC Batch**
Polycyclic Aromatics													
Naphthalene	mg/kg	0.035	0.001	0.012	0.001	0.003	0.001	0.78(1)	0.96(1)	0.005	0.54(1)	0.02	4536352
2-Methylnaphthalene	mg/kg	0.084	0.001	0.029	0.001	0.005	0.001	1.7(1)	2.1(1)	0.005	1.2(1)	0.02	4536352
Acenaphthylene	mg/kg	<0.004(2)	0.004	<0.002(2)	0.002	<0.001	0.001	<0.1(2)	<0.1(2)	0.1	<0.09(2)	0.09	4536352
Acenaphthene	mg/kg	0.008	0.001	0.003	0.001	<0.001	0.001	0.28(1)	0.38(1)	0.005	0.19(1)	0.02	4536352
Fluorene	mg/kg	0.015	0.001	0.005	0.001	<0.001	0.001	0.45(1)	0.63(1)	0.005	0.37(1)	0.02	4536352
Phenanthrene	mg/kg	0.068	0.001	0.024	0.001	<0.005(2)	0.005	1.6(1)	2.1(1)	0.005	1.3(1)	0.02	4536352
Anthracene	mg/kg	0.011	0.001	0.004	0.001	<0.001	0.001	0.54(1)	0.75(1)	0.005	0.50(1)	0.02	4536352
Fluoranthene	mg/kg	0.017	0.001	0.006	0.001	0.001	0.001	1.4(1)	1.9(1)	0.005	1.3(1)	0.02	4536352
Pyrene	mg/kg	0.017	0.001	0.006	0.001	0.002	0.001	1.6(1)	2.6(1)	0.005	0.89(1)	0.02	4536352
Benzo(a)anthracene	mg/kg	0.011	0.001	0.004	0.001	0.001	0.001	0.49(1)	0.62(1)	0.005	0.32(1)	0.02	4536352
Chrysene	mg/kg	0.016	0.001	0.006	0.001	0.002	0.001	0.57(1)	0.73(1)	0.005	0.39(1)	0.02	4536352
Benzo(b&j)fluoranthene	mg/kg	0.007	0.001	0.003	0.001	0.001	0.001	0.38(1)	0.49(1)	0.005	0.24(1)	0.02	4536352
Benzo(k)fluoranthene	mg/kg	0.005	0.001	0.002	0.001	<0.001	0.001	0.32(1)	0.39(1)	0.005	0.19(1)	0.02	4536352
Benzo(a)pyrene	mg/kg	0.008	0.001	0.003	0.001	<0.001	0.001	0.31(1)	0.36(1)	0.005	0.20(1)	0.02	4536352
Indeno(1,2,3-cd)pyrene	mg/kg	0.003	0.002	<0.002	0.002	<0.002	0.002	0.13(1)	0.13(1)	0.01	0.09(1)	0.03	4536352
Dibenz(a,h)anthracene	mg/kg	<0.002	0.002	<0.002	0.002	<0.002	0.002	0.05(1)	0.06(1)	0.01	0.04(1)	0.03	4536352
Benzo(g,h,i)perylene	mg/kg	0.009	0.002	0.004	0.002	<0.002	0.002	0.20(1)	0.22(1)	0.01	0.16(1)	0.03	4536352
Low Molecular Weight PAH`s	mg/kg	0.22	0.004	0.076	0.002	0.008	0.005	5.3	6.9	0.1	4.1	0.09	4521449
High Molecular Weight PAH`s	mg/kg	0.094	0.002	0.034	0.002	0.007	0.002	5.5	7.5	0.01	3.8	0.03	4521449
Total PAH	mg/kg	0.32	0.004	0.11	0.002	0.014	0.005	11	14	0.1	7.9	0.09	4521449
Surrogate Recovery (%)													
D10-ANTHRACENE (sur.)	%	80		79		81		80	90		90		4536352
D12-BENZO(A)PYRENE (sur.)	%	80		79		81		75	85		85		4536352
D8-ACENAPHTHYLENE (sur.)	%	76		75		78		40(3)	45(3)		50		4536352
D8-NAPHTHALENE (sur.)	%	75		78		75		80	90		90		4536352
TERPHENYL-D14 (sur.)	%	80		81		85		80	90		90		4536352

RDL = Reportable Detection Limit
(1) - RDL raised due to sample dilution.
(2) - RDL raised due to sample matrix interference.
(3) - Surrogate recovery below control limit - 1 surrogate failure allowed - Pot. low bias

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

CCME PAH IN SOIL BY GC-MS (SOIL)

Maxxam ID		Z16022		
Sampling Date		2010/12/17		
	Units	**21776-05**	**RDL**	**QC Batch**
Polycyclic Aromatics				
Naphthalene	mg/kg	1.1(1)	0.005	4536352
2-Methylnaphthalene	mg/kg	2.4(1)	0.005	4536352
Acenaphthylene	mg/kg	<0.1(2)	0.1	4536352
Acenaphthene	mg/kg	0.33(1)	0.005	4536352
Fluorene	mg/kg	0.54(1)	0.005	4536352
Phenanthrene	mg/kg	2.2(1)	0.005	4536352
Anthracene	mg/kg	0.65(1)	0.005	4536352
Fluoranthene	mg/kg	1.2(1)	0.005	4536352
Pyrene	mg/kg	0.93(1)	0.005	4536352
Benzo(a)anthracene	mg/kg	0.40(1)	0.005	4536352
Chrysene	mg/kg	0.53(1)	0.005	4536352
Benzo(b&j)fluoranthene	mg/kg	0.27(1)	0.005	4536352
Benzo(k)fluoranthene	mg/kg	0.16(1)	0.005	4536352
Benzo(a)pyrene	mg/kg	0.24(1)	0.005	4536352
Indeno(1,2,3-cd)pyrene	mg/kg	0.08(1)	0.01	4536352
Dibenz(a,h)anthracene	mg/kg	0.04(1)	0.01	4536352
Benzo(g,h,i)perylene	mg/kg	0.17(1)	0.01	4536352
Low Molecular Weight PAH`s	mg/kg	7.1	0.1	4521449
High Molecular Weight PAH`s	mg/kg	4.1	0.01	4521449
Total PAH	mg/kg	11	0.1	4521449
Surrogate Recovery (%)				
D10-ANTHRACENE (sur.)	%	80		4536352
D12-BENZO(A)PYRENE (sur.)	%	75		4536352
D8-ACENAPHTHYLENE (sur.)	%	50		4536352
D8-NAPHTHALENE (sur.)	%	80		4536352
TERPHENYL-D14 (sur.)	%	80		4536352

RDL = Reportable Detection Limit
(1) - RDL raised due to sample dilution.
(2) - RDL raised due to sample matrix interference.

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

General Comments

Sample Z15990-01: ** SEM/AVS = 0.08 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z15995-01: ** SEM/AVS = 1.32 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z16001-01: ** SEM/AVS = 1.06 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z16010-01: ** SEM/AVS = 0.12 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z16019-01: ** SEM/AVS = 0.10 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4523815	Moisture	2010/12/23					<0.3	%	1.4	20		
4525068	Total Arsenic (As)	2010/12/22	103	75 - 125	100	75 - 125	<0.2	mg/kg	0.7	30	102	70 - 130
4525068	Total Beryllium (Be)	2010/12/22	103	75 - 125	100	75 - 125	<0.1	mg/kg	NC	30		
4525068	Total Cadmium (Cd)	2010/12/22	110	75 - 125	109	75 - 125	<0.05	mg/kg	0.6	30	104	70 - 130
4525068	Total Chromium (Cr)	2010/12/22	104	75 - 125	102	75 - 125	<1	mg/kg	2.3	30	102	70 - 130
4525068	Total Cobalt (Co)	2010/12/22	102	75 - 125	102	75 - 125	<0.3	mg/kg	2.4	30	98	70 - 130
4525068	Total Copper (Cu)	2010/12/22	NC	75 - 125	105	75 - 125	<0.5	mg/kg	0.8	30	97	70 - 130
4525068	Total Lead (Pb)	2010/12/22	106	75 - 125	104	75 - 125	<0.1	mg/kg	1.4	35	108	70 - 130
4525068	Total Mercury (Hg)	2010/12/22	100	75 - 125	110	75 - 125	0.10, RDL=0.05	mg/kg	3.9	35		
4525068	Total Nickel (Ni)	2010/12/22	97	75 - 125	100	75 - 125	<0.8	mg/kg	1.1	30	95	70 - 130
4525068	Total Selenium (Se)	2010/12/22	102	75 - 125	102	75 - 125	<0.5	mg/kg	NC	30		
4525068	Total Vanadium (V)	2010/12/22	NC	75 - 125	105	75 - 125	<2	mg/kg	0.9	30	106	70 - 130
4525068	Total Zinc (Zn)	2010/12/22	NC	75 - 125	105	75 - 125	<1	mg/kg	4.0	30	96	70 - 130
4525068	Total Aluminum (Al)	2010/12/22					<100	mg/kg	10.3	35	108	70 - 130
4525068	Total Antimony (Sb)	2010/12/22					<0.1	mg/kg	NC	30	93	70 - 130
4525068	Total Barium (Ba)	2010/12/22					<0.1	mg/kg	1.1	35	104	70 - 130
4525068	Total Calcium (Ca)	2010/12/22					<100	mg/kg	1	30	102	70 - 130
4525068	Total Iron (Fe)	2010/12/22					<100	mg/kg	4.4	30	101	70 - 130
4525068	Total Magnesium (Mg)	2010/12/22					<100	mg/kg	2.4	30	103	70 - 130
4525068	Total Manganese (Mn)	2010/12/22					<0.2	mg/kg	2.9	30	103	70 - 130
4525068	Total Molybdenum (Mo)	2010/12/22					<0.1	mg/kg	4.8	35	106	70 - 130
4525068	Total Phosphorus (P)	2010/12/22					<10	mg/kg	9.8	30	100	70 - 130
4525068	Total Strontium (Sr)	2010/12/22					<0.1	mg/kg	2.1	35	97	70 - 130
4525068	Total Thallium (Tl)	2010/12/22					<0.05	mg/kg	NC	30	89	70 - 130
4525068	Total Titanium (Ti)	2010/12/22					<1	mg/kg	3.8	35	104	70 - 130
4525068	Total Bismuth (Bi)	2010/12/22					<0.1	mg/kg	NC	30		
4525068	Total Potassium (K)	2010/12/22					<100	mg/kg	5.6	35		
4525068	Total Silver (Ag)	2010/12/22					<0.05	mg/kg	NC	35		
4525068	Total Sodium (Na)	2010/12/22					<100	mg/kg	5.5	35		
4525068	Total Tin (Sn)	2010/12/22					<0.1	mg/kg	2.3	35		
4525068	Total Zirconium (Zr)	2010/12/22					<0.5	mg/kg	NC	30		
4525076	Soluble (2:1) pH	2010/12/22			101	96 - 104			0	20		
4525084	Total Arsenic (As)	2010/12/23	102	75 - 125	103	75 - 125	<0.2	mg/kg	2.4	30	101	70 - 130
4525084	Total Beryllium (Be)	2010/12/23	98	75 - 125	103	75 - 125	<0.1	mg/kg	24.2	30		
4525084	Total Cadmium (Cd)	2010/12/23	105	75 - 125	104	75 - 125	<0.05	mg/kg	NC	30	99	70 - 130
4525084	Total Chromium (Cr)	2010/12/23	97	75 - 125	102	75 - 125	<1	mg/kg	0.6	30	100	70 - 130
4525084	Total Cobalt (Co)	2010/12/23	98	75 - 125	102	75 - 125	<0.3	mg/kg	1.8	30	98	70 - 130
4525084	Total Copper (Cu)	2010/12/23	NC	75 - 125	103	75 - 125	<0.5	mg/kg	0.8	30	94	70 - 130
4525084	Total Lead (Pb)	2010/12/23	110	75 - 125	104	75 - 125	<0.1	mg/kg	0.8	35	103	70 - 130
4525084	Total Mercury (Hg)	2010/12/23	108	75 - 125	95	75 - 125	<0.05	mg/kg	NC	35		

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4525084	Total Nickel (Ni)	2010/12/23	NC	75 - 125	103	75 - 125	<0.8	mg/kg	2.1	30	95	70 - 130
4525084	Total Selenium (Se)	2010/12/23	99	75 - 125	103	75 - 125	<0.5	mg/kg	NC	30		
4525084	Total Vanadium (V)	2010/12/23	NC	75 - 125	104	75 - 125	<2	mg/kg	0.5	30	104	70 - 130
4525084	Total Zinc (Zn)	2010/12/23	NC	75 - 125	102	75 - 125	<1	mg/kg	0.7	30	90	70 - 130
4525084	Total Aluminum (Al)	2010/12/23					<100	mg/kg	4.4	35	97	70 - 130
4525084	Total Antimony (Sb)	2010/12/23					<0.1	mg/kg	2.2	30	95	70 - 130
4525084	Total Barium (Ba)	2010/12/23					<0.1	mg/kg	2.4	35	102	70 - 130
4525084	Total Calcium (Ca)	2010/12/23					<100	mg/kg	0.8	30	94	70 - 130
4525084	Total Iron (Fe)	2010/12/23					<100	mg/kg	3.2	30	93	70 - 130
4525084	Total Magnesium (Mg)	2010/12/23					<100	mg/kg	1.4	30	94	70 - 130
4525084	Total Manganese (Mn)	2010/12/23					<0.2	mg/kg	0.9	30	98	70 - 130
4525084	Total Molybdenum (Mo)	2010/12/23					<0.1	mg/kg	1.7	35	96	70 - 130
4525084	Total Phosphorus (P)	2010/12/23					<10	mg/kg	1.7	30	100	70 - 130
4525084	Total Strontium (Sr)	2010/12/23					<0.1	mg/kg	0.5	35	94	70 - 130
4525084	Total Thallium (Tl)	2010/12/23					<0.05	mg/kg	NC	30	88	70 - 130
4525084	Total Titanium (Ti)	2010/12/23					<1	mg/kg	1.7	35	100	70 - 130
4525084	Total Bismuth (Bi)	2010/12/23					<0.1	mg/kg	NC	30		
4525084	Total Potassium (K)	2010/12/23					<100	mg/kg	1.3	35		
4525084	Total Silver (Ag)	2010/12/23					<0.05	mg/kg	NC	35		
4525084	Total Sodium (Na)	2010/12/23					<100	mg/kg	NC	35		
4525084	Total Tin (Sn)	2010/12/23					<0.1	mg/kg	3.9	35		
4525084	Total Zirconium (Zr)	2010/12/23					<0.5	mg/kg	16.0	30		
4525097	Soluble (2:1) pH	2010/12/23			102	96 - 104			1.3	20		
4525234	O-TERPHENYL (sur.)	2010/12/24	98	50 - 130	91	50 - 130	108	%				
4525234	F2 (C10-C16 Hydrocarbons)	2010/12/24	101	50 - 130	98	80 - 120	<10	mg/kg	1 (1)	40		
4525234	F3 (C16-C34 Hydrocarbons)	2010/12/24	107	50 - 130	107	80 - 120	<10	mg/kg	1.9 (1)	40		
4525234	F4 (C34-C50 Hydrocarbons)	2010/12/24	110	50 - 130	106	80 - 120	<10	mg/kg	2.6 (1)	40		
4525234	Reached Baseline at C50	2010/12/24							NC	50		
4527468	4-BROMOFLUOROBENZENE (sur.)	2010/12/23	95	70 - 130	104	70 - 130	103	%			96	70 - 130
4527468	D10-ETHYLBENZENE (sur.)	2010/12/23	91	50 - 130	75	50 - 130	81	%			75	50 - 130
4527468	D4-1,2-DICHLOROETHANE (sur.)	2010/12/23	91	70 - 130	89	70 - 130	86	%			84	70 - 130
4527468	D8-TOLUENE (sur.)	2010/12/23	102	70 - 130	103	70 - 130	104	%			106	70 - 130
4527468	Benzene	2010/12/23	86	60 - 140	79	60 - 140	<0.005	mg/kg	NC (2)	40		
4527468	Toluene	2010/12/23	89	60 - 140	83	60 - 140	<0.02	mg/kg	NC	40		
4527468	Ethylbenzene	2010/12/23	93	60 - 140	86	60 - 140	<0.01	mg/kg	NC (2)	40		
4527468	m & p-Xylene	2010/12/23	90	60 - 140	84	60 - 140	<0.04	mg/kg	NC	40		
4527468	o-Xylene	2010/12/23	89	60 - 140	84	60 - 140	<0.04	mg/kg	NC	40		
4527468	(C6-C10)	2010/12/23					<10	mg/kg	NC (2)	40	117	60 - 140
4527468	Methyl-tert-butylether(MTBE)	2010/12/23					<0.1	mg/kg	NC	40		
4527468	Styrene	2010/12/23					<0.03	mg/kg	NC	40		

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4527468	Xylenes (Total)	2010/12/23					<0.04	mg/kg	NC	40		
4527507	4-BROMOFLUOROBENZENE (sur.)	2010/12/23	88	70 - 130	88	70 - 130	86	%			90	70 - 130
4527507	D10-ETHYLBENZENE (sur.)	2010/12/23	95	50 - 130	90	50 - 130	89	%			79	50 - 130
4527507	D4-1,2-DICHLOROETHANE (sur.)	2010/12/23	106	70 - 130	108	70 - 130	107	%			105	70 - 130
4527507	D8-TOLUENE (sur.)	2010/12/23	92	70 - 130	91	70 - 130	91	%			94	70 - 130
4527507	Benzene	2010/12/23	111	60 - 140	121	60 - 140	<0.005	mg/kg	NC(2)	40		
4527507	Toluene	2010/12/23	93	60 - 140	101	60 - 140	<0.02	mg/kg	NC(2)	40		
4527507	Ethylbenzene	2010/12/23	102	60 - 140	113	60 - 140	<0.01	mg/kg	NC(2)	40		
4527507	m & p-Xylene	2010/12/23	99	60 - 140	111	60 - 140	<0.04	mg/kg	NC	40		
4527507	o-Xylene	2010/12/23	95	60 - 140	108	60 - 140	<0.04	mg/kg	NC	40		
4527507	(C6-C10)	2010/12/23					<10	mg/kg	NC(2)	40	101	60 - 140
4527507	Methyl-tert-butylether(MTBE)	2010/12/23					<0.1	mg/kg	NC	40		
4527507	Styrene	2010/12/23					<0.03	mg/kg	NC(2)	40		
4527507	Xylenes (Total)	2010/12/23					<0.04	mg/kg	NC	40		
4527562	O-TERPHENYL (sur.)	2010/12/24	85	50 - 130	99	50 - 130	97	%				
4527562	F2 (C10-C16 Hydrocarbons)	2010/12/24	102	50 - 130	99	80 - 120	<10	mg/kg	0.6(1)	40		
4527562	F3 (C16-C34 Hydrocarbons)	2010/12/24	113	50 - 130	107	80 - 120	<10	mg/kg	4.2(1)	40		
4527562	F4 (C34-C50 Hydrocarbons)	2010/12/24	111	50 - 130	107	80 - 120	<10	mg/kg	19.6(1)	40		
4527562	Reached Baseline at C50	2010/12/24							NC	50		
4533957	% sand by hydrometer	2010/12/29					<2	%	1.1	25	88	75 - 125
4533957	% silt by hydrometer	2010/12/29					<2	%	0.8	25	111	75 - 125
4533957	Clay Content	2010/12/29					<2	%	NC	25	101	75 - 125
4533957	Gravel	2010/12/29					<2	%	NC	25		
4536272	Sulphide	2010/12/30	NC	75 - 125	100	75 - 125	0.3, RDL=0.2	ug/g	8.6	30		
4536352	D10-ANTHRACENE (sur.)	2010/12/31	90	60 - 130	88	60 - 130	78	%				
4536352	D12-BENZO(A)PYRENE (sur.)	2010/12/31	85	60 - 130	88	60 - 130	71	%				
4536352	D8-ACENAPHTHYLENE (sur.)	2010/12/31	50	50 - 130	88	50 - 130	77	%				
4536352	D8-NAPHTHALENE (sur.)	2010/12/31	85	50 - 130	88	50 - 130	80	%				
4536352	TERPHENYL-D14 (sur.)	2010/12/31	90	60 - 130	88	60 - 130	81	%				
4536352	Naphthalene	2010/12/31	NC	40 - 130	75	40 - 130	<0.001	mg/kg	45.0(3)	50		
4536352	2-Methylnaphthalene	2010/12/31	NC	40 - 130	73	40 - 130	<0.001	mg/kg	41.1(3)	50		
4536352	Acenaphthylene	2010/12/31	52	40 - 130	74	40 - 130	<0.001	mg/kg	NC(4)	50		
4536352	Acenaphthene	2010/12/31	90	40 - 130	76	40 - 130	<0.001	mg/kg	8.3(3)	50		
4536352	Fluorene	2010/12/31	89	40 - 130	75	40 - 130	<0.001	mg/kg	5.4(3)	50		
4536352	Phenanthrene	2010/12/31	NC	40 - 130	74	40 - 130	<0.001	mg/kg	15.5(3)	50		
4536352	Anthracene	2010/12/31	NC	40 - 130	73	40 - 130	<0.001	mg/kg	14.2(3)	50		
4536352	Fluoranthene	2010/12/31	NC	40 - 130	72	40 - 130	<0.001	mg/kg	37.2(3)	50		
4536352	Pyrene	2010/12/31	NC	40 - 130	76	40 - 130	<0.001	mg/kg	23.8(3)	50		
4536352	Benzo(a)anthracene	2010/12/31	NC	40 - 130	65	40 - 130	<0.001	mg/kg	4.7(3)	50		
4536352	Chrysene	2010/12/31	NC	40 - 130	67	40 - 130	<0.001	mg/kg	10.1(3)	50		

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4536352	Benzo(b&j)fluoranthene	2010/12/31	79	40 - 130	72	40 - 130	<0.001	mg/kg	15.1(3)	50		
4536352	Benzo(k)fluoranthene	2010/12/31	85	40 - 130	68	40 - 130	<0.001	mg/kg	15.2(3)	50		
4536352	Benzo(a)pyrene	2010/12/31	82	40 - 130	73	40 - 130	<0.001	mg/kg	11.8(3)	50		
4536352	Indeno(1,2,3-cd)pyrene	2010/12/31	81	40 - 130	66	40 - 130	<0.002	mg/kg	30.3(3)	50		
4536352	Dibenz(a,h)anthracene	2010/12/31	77	40 - 130	62	40 - 130	<0.002	mg/kg	NC(3)	50		
4536352	Benzo(g,h,i)perylene	2010/12/31	74	40 - 130	64	40 - 130	<0.002	mg/kg	21.3(3)	50		
4538275	SEM Cadmium (Cd)	2010/12/30					<0.0002	umole/g				
4538275	SEM Copper (Cu)	2010/12/30					<0.004	umole/g				
4538275	SEM Lead (Pb)	2010/12/30					<0.0002	umole/g				
4538275	SEM Mercury (Hg)	2010/12/30					<0.0003	umole/g				
4538275	SEM Nickel (Ni)	2010/12/30					<0.004	umole/g				
4538275	SEM Zinc (Zn)	2010/12/30					<0.008	umole/g				
4539236	Total Arsenic (As)	2010/12/31	94	75 - 125	98	75 - 125	<0.2	mg/kg	3.4	30	101	70 - 130
4539236	Total Beryllium (Be)	2010/12/31	95	75 - 125	90	75 - 125	<0.1	mg/kg	NC	30		
4539236	Total Cadmium (Cd)	2010/12/31	98	75 - 125	97	75 - 125	<0.05	mg/kg	2.1	30	98	70 - 130
4539236	Total Chromium (Cr)	2010/12/31	NC	75 - 125	95	75 - 125	<1	mg/kg	1.0	30	100	70 - 130
4539236	Total Cobalt (Co)	2010/12/31	93	75 - 125	96	75 - 125	<0.3	mg/kg	0.8	30	97	70 - 130
4539236	Total Copper (Cu)	2010/12/31	NC	75 - 125	97	75 - 125	<0.5	mg/kg	0.1	30	94	70 - 130
4539236	Total Lead (Pb)	2010/12/31	NC	75 - 125	101	75 - 125	<0.1	mg/kg	2.0	35	106	70 - 130
4539236	Total Mercury (Hg)	2010/12/31	94	75 - 125	98	75 - 125	<0.05	mg/kg	3.5	35		
4539236	Total Nickel (Ni)	2010/12/31	93	75 - 125	96	75 - 125	<0.8	mg/kg	2.4	30	97	70 - 130
4539236	Total Selenium (Se)	2010/12/31	94	75 - 125	100	75 - 125	<0.5	mg/kg	NC	30		
4539236	Total Vanadium (V)	2010/12/31	NC	75 - 125	96	75 - 125	<2	mg/kg	0.6	30	105	70 - 130
4539236	Total Zinc (Zn)	2010/12/31	NC	75 - 125	95	75 - 125	<1	mg/kg	0.9	30	91	70 - 130
4539236	Total Aluminum (Al)	2010/12/31					<100	mg/kg	1.2	35	104	70 - 130
4539236	Total Antimony (Sb)	2010/12/31					<0.1	mg/kg	NC	30	94	70 - 130
4539236	Total Barium (Ba)	2010/12/31					<0.1	mg/kg	2.2	35	103	70 - 130
4539236	Total Calcium (Ca)	2010/12/31					<100	mg/kg	0.9	30	94	70 - 130
4539236	Total Iron (Fe)	2010/12/31					<100	mg/kg	1	30	93	70 - 130
4539236	Total Magnesium (Mg)	2010/12/31					<100	mg/kg	3.9	30	94	70 - 130
4539236	Total Manganese (Mn)	2010/12/31					<0.2	mg/kg	2.8	30	97	70 - 130
4539236	Total Molybdenum (Mo)	2010/12/31					<0.1	mg/kg	2.3	35	88	70 - 130
4539236	Total Phosphorus (P)	2010/12/31					<10	mg/kg	2.6	30	93	70 - 130
4539236	Total Strontium (Sr)	2010/12/31					<0.1	mg/kg	3.3	35	93	70 - 130
4539236	Total Thallium (Tl)	2010/12/31					<0.05	mg/kg	2.1	30	90	70 - 130
4539236	Total Titanium (Ti)	2010/12/31					<1	mg/kg	3.0	35	102	70 - 130
4539236	Total Bismuth (Bi)	2010/12/31					<0.1	mg/kg	NC	30		
4539236	Total Potassium (K)	2010/12/31					<100	mg/kg	4.4	35		
4539236	Total Silver (Ag)	2010/12/31					<0.05	mg/kg	6.8	35		
4539236	Total Sodium (Na)	2010/12/31					<100	mg/kg	3.2	35		

Maxxam Job #: B0C3450
Report Date: 2011/01/04

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4539236	Total Tin (Sn)	2010/12/31					<0.1	mg/kg	2.6	35		
4539236	Total Zirconium (Zr)	2010/12/31					<0.5	mg/kg	5.1	30		
4539281	Soluble (2:1) pH	2011/01/04			101	96 - 104			1.7	20		

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) - Sample contained > 50% moisture.
(2) - RDL raised due to high sample moisture content.
(3) - RDL raised due to sample dilution.
(4) - RDL raised due to sample matrix interference.

BOC3450

CHAIN-OF-CUSTODY RECORD/ANALYSIS REQUEST

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Golder Associates
500–4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone: 604-298-6623 Fax: 604-298-5253

Project Number: 09-1436-5008	Laboratory Name: Maxxam
[redacted]	Address: 4606 Canada Way Burnaby BC V5G 1K5
Golder Contact: Adrian de Bruyn	Golder E-mail Address: Adrian_deBruyn@golder.com
Tel/Fax: 1800-665-8566	Contact: VJ OCO

Office the final reports should be sent to:

- ☑ 500–4260 Still Creek Drive, Burnaby, BC V5C 6C6, Tel: 604-298-6623, Fax: 604-298-5253
- ☐ 202–2790 Gladwin Road, Abbotsford, BC V2T 4S8, Tel: 604-850-8786, Fax: 604-850-8756
- ☐ 2640 Douglas Street, Victoria, BC V8T 4M1, Tel: 250-881-7372, Fax: 250-881-7470

Analyses Required

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Number of Containers	Metals (CCME)	Grain size*	AVS/SEM	PAH/TOC	CCME PHC (F1-F4) fractions	Archive for Petrography** (1 Jar)	HOLD			RUSH	Remarks (over)
21774-01		Sed	16/12/10		3	X	X	X	X	X	X					
21774-02					3	X	X		X	X	X					
21774-03		75			3	X	X		X	X	X					
21774-04			17/12/10		3							X				
21774-05		55			3							X				
21774-06			16/12/10		3	X	X	X	X	X	X					
21774-07					3	X	X		X	X	X					
21774-08					3	X	X		X	X	X					
21774-09					3							X				
21774-10		5			3							X				
21774-11					3							X				
21774-12			17/12/10		3	X	X	X	X	X	X					

Sampler's Signature	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
[signature]	[signature]	Golder	Dec 20 2010	13:30		
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by:		Date	Time
	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C) 455 565	Cooler opened by: C. ROSEN	Date 10 12 21	Time 0810

* Grain size analysis via Sieve pipette method.

WHITE: Golder copy YELLOW: Lab copy PINK: Lab returns with Final Report

** Please archive one sample Jar for petrographic analysis

BOC3450

CHAIN-OF-CUSTODY RECORD/ANALYSIS REQUEST

No 21775 page 2 of 3

Golder Associates
500–4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone: 604-298-6623 Fax: 604-298-5253

Project Number: 09-1936-5008		Laboratory Name: Maxxam
[redacted]		Address: 4606 Canada Way Burnaby BC V5G 1K5
Golder Contact: Adrian de Bruyn	Golder E-mail Address: Adrian_deBruyn@golder.com	Tel/Fax: 1800-665-8566
		Contact: VJ OCO

Office the final reports should be sent to:

- ☑ 500–4260 Still Creek Drive, Burnaby, BC V5C 6C6, Tel: 604-298-6623, Fax: 604-298-5253
- ☐ 202–2790 Gladwin Road, Abbotsford, BC V2T 4S8, Tel: 604-850-8786, Fax: 604-850-8756
- ☐ 2640 Douglas Street, Victoria, BC V8T 4M1, Tel: 250-881-7372, Fax: 250-881-7470

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Number of Containers	Analyses Required: Metals (CCME)	Grain Size *	AVS - SEM	PAH / TOC	CCME PHC (F1-F4) fractions	Archive for Petrography ** (1 Jar)	HOLD			RUSH	Remarks (over)
21775-01		Sed	17/12/10		3	X	X		X	X	X					
21775-02		"	"		3	X	X		X	X	X					
21775-03		"	"		3	X	X		X	X						
21775-04		"	"		3	X	X		X	X	X					
21775-05		"	"		3							X				
21775-06		"	"		3							X				
21775-07		"	"		3							X				
21775-08		"	"		3							X				
21775-09		Sed	16/12/10		3	X	X	X	X	X	X					
21775-10		"	"		3	X	X		X	X	X					
21775-11		"	"		3	X	X		X	X						
21775-12		"	"		3	X	X		X	X	X					

Sampler's Signature	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by:	Date	Time
	Shipped by:	Shipment Condition: / Seal Intact:	Temp (°C) 4.5 5.6.5	Cooler opened by: C. ROSEN	Date 10 12 21 / Time 0810

*Grain size analysis via Sieve pipette method.

WHITE: Golder copy YELLOW: Lab copy PINK: Lab returns with Final Report

** Archive 1 jar for petrographic analysis.

BOC3450

CHAIN-OF-CUSTODY RECORD/ANALYSIS REQUEST

№ 21776 page 3 of 3

Golder Associates
500–4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone: 604-298-6623 Fax: 604-298-5253

Project Number: 09-1436-5008		Laboratory Name: Maxxam
[redacted]		Address: 4606 Canada Way Burnaby BC V5G 1K5
Golder Contact: Adrian de Bruyn	Golder E-mail Address: Adrian_de_Bruyn@golder.com	Tel/Fax: 1800-665-8566
		Contact: VJ OCO

Office the final reports should be sent to:

- ☑ 500–4260 Still Creek Drive, Burnaby, BC V5C 6C6, Tel: 604-298-6623, Fax: 604-298-5253
- ☐ 202–2790 Gladwin Road, Abbotsford, BC V2T 4S8, Tel: 604-850-8786, Fax: 604-850-8756
- ☐ 2640 Douglas Street, Victoria, BC V8T 4M1, Tel: 250-881-7372, Fax: 250-881-7470

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Number of Containers	Metals (CCME)	Grain Size *	AVS – SEM	PAH / TOC	CCME PHC (F1–F4) fractions	Archive for Petrographic **(1 Jar)**			RUSH	Remarks (over)
21776 -01		Sed	16/12/10		3	X	X		X	X	X				
21776 -02			7/12/10		3	X	X	X	X	X	X				
21776 -03					3	X	X		X	X	X				
21776 -04					3	X	X		X	X	X				
21776 -05		↓	↓		3	X	X		X	X	X				
-06															
-07															
-08															
-09															
-10															
-11															
-12															

Analyses Required

Sampler's Signature / Sample Storage (°C)	Relinquished by: Signature / Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
		Golder	Dec 20 2010	13:30		
		Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by:	Date	Time
	Shipped by:	Shipment Condition: / Seal Intact:	Temp (°C) 5.3 565 / Cooler opened by: C. Rosen	Date 10 12 21	Time 0810

* Grain size analysis via pipette method.

WHITE: Golder copy YELLOW: Lab copy PINK: Lab returns with Final Report

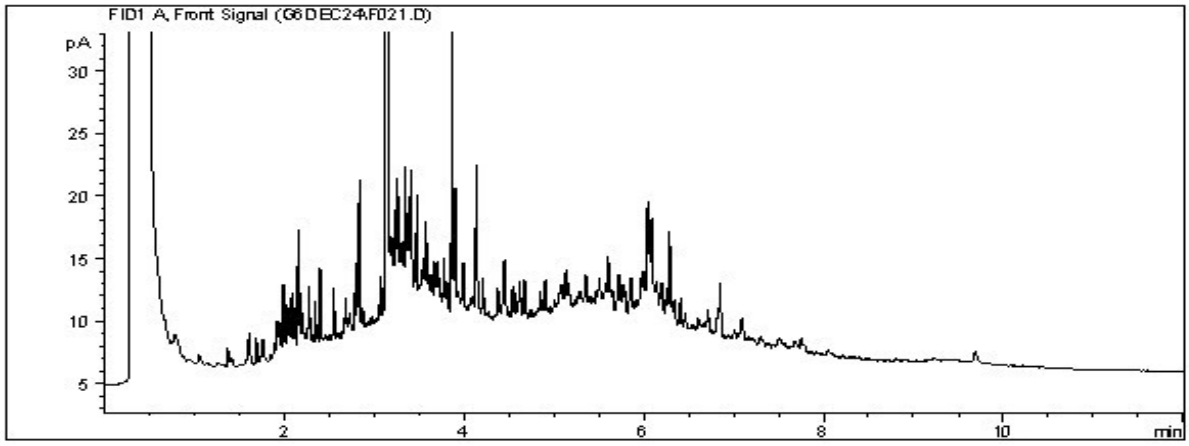
** Archive 1 Jar for petrographic analysis.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z15990

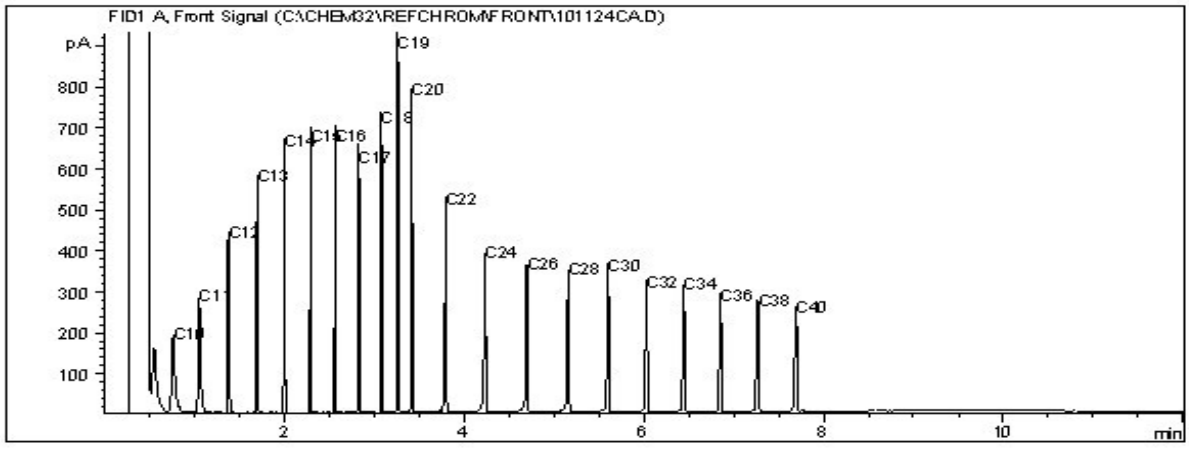
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-01

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

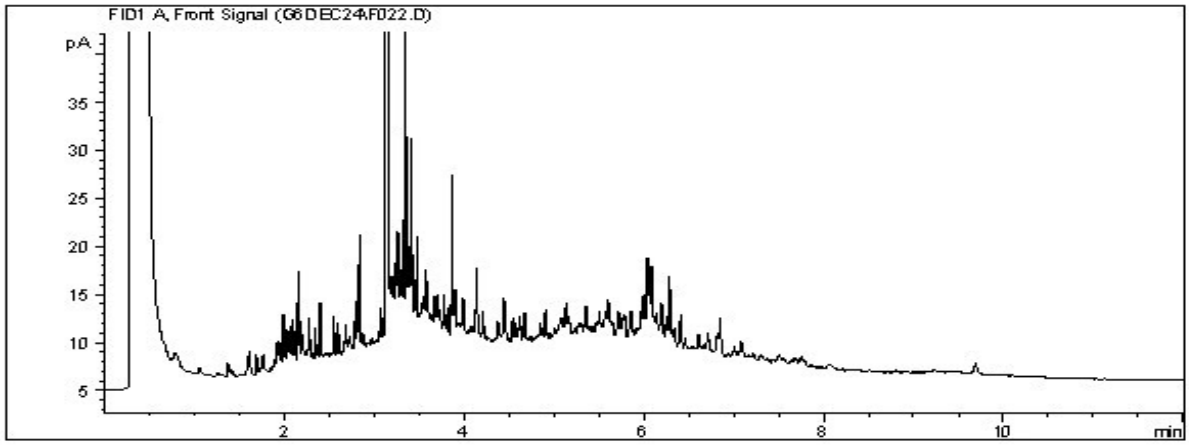
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z15990 Lab-Dup

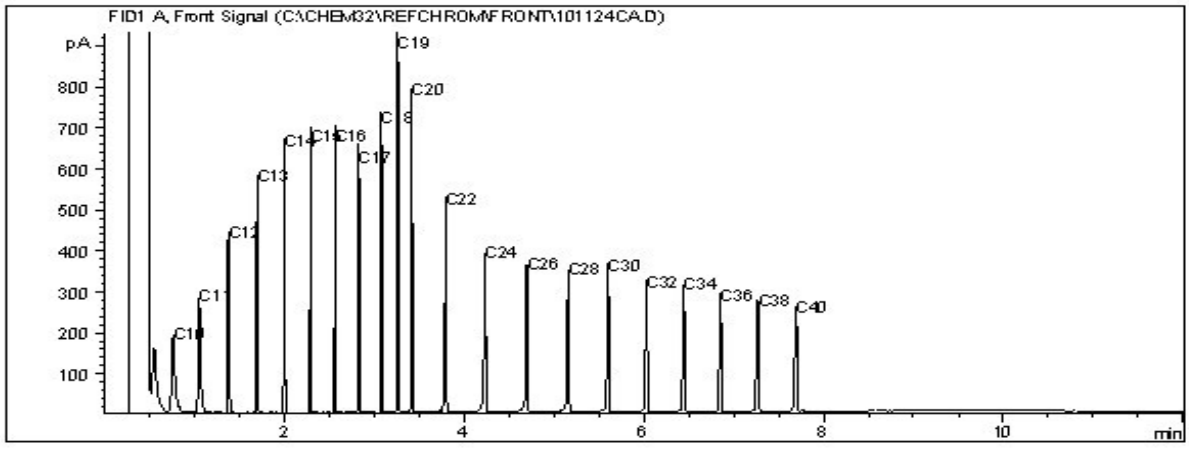
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-01

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

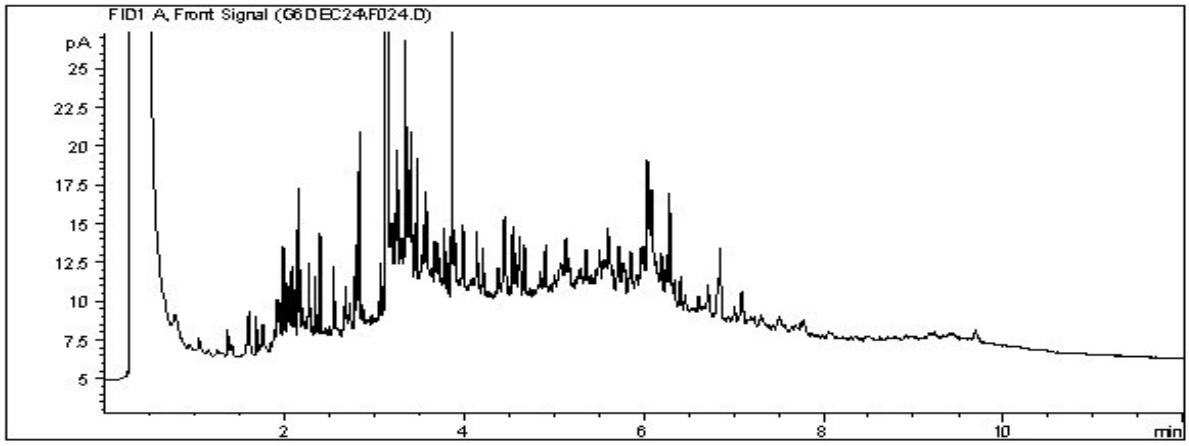
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z15991

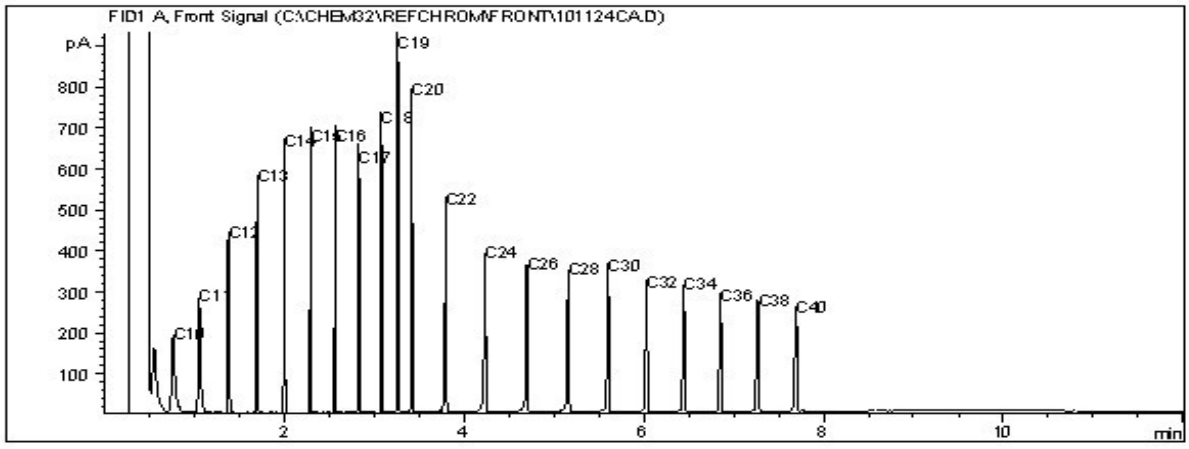
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-02

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

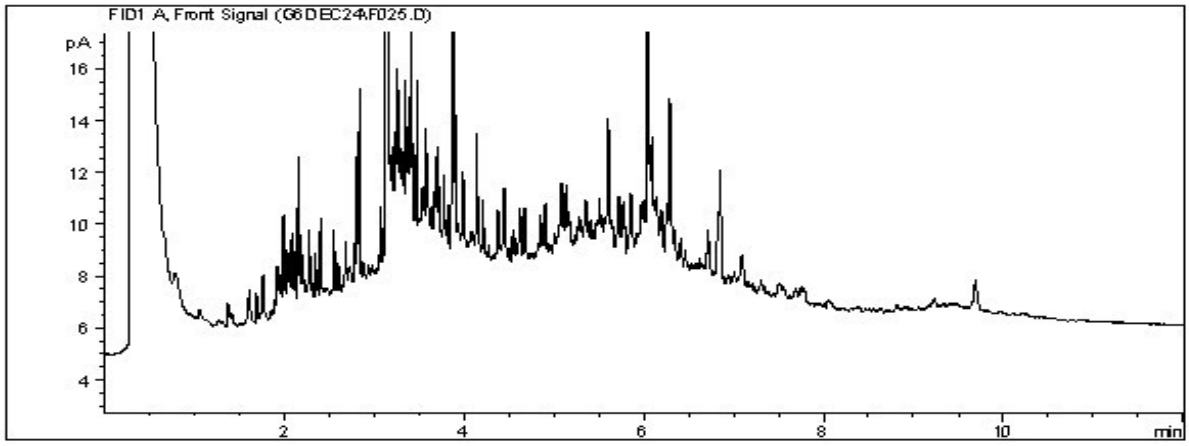
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z15992

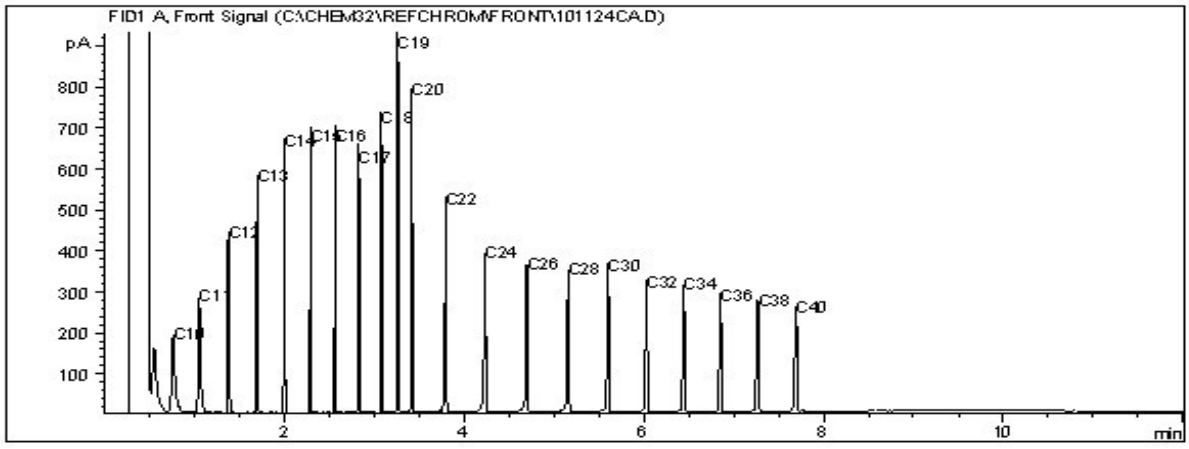
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-03

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

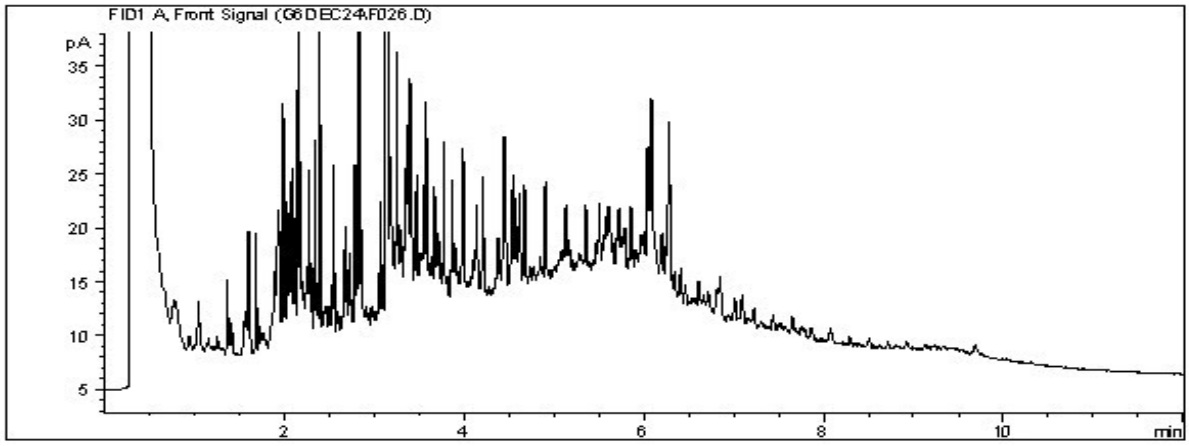
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z15995

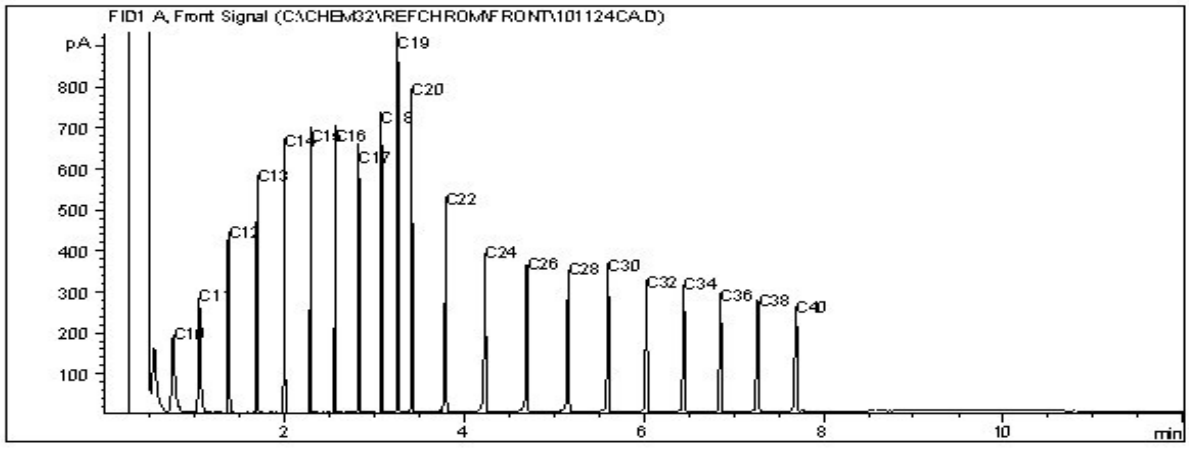
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-06

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

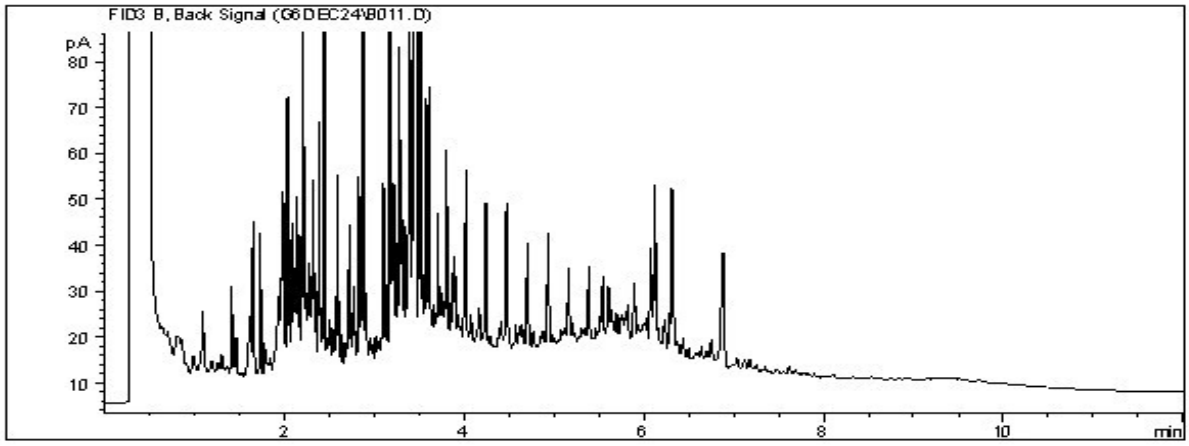
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z15996

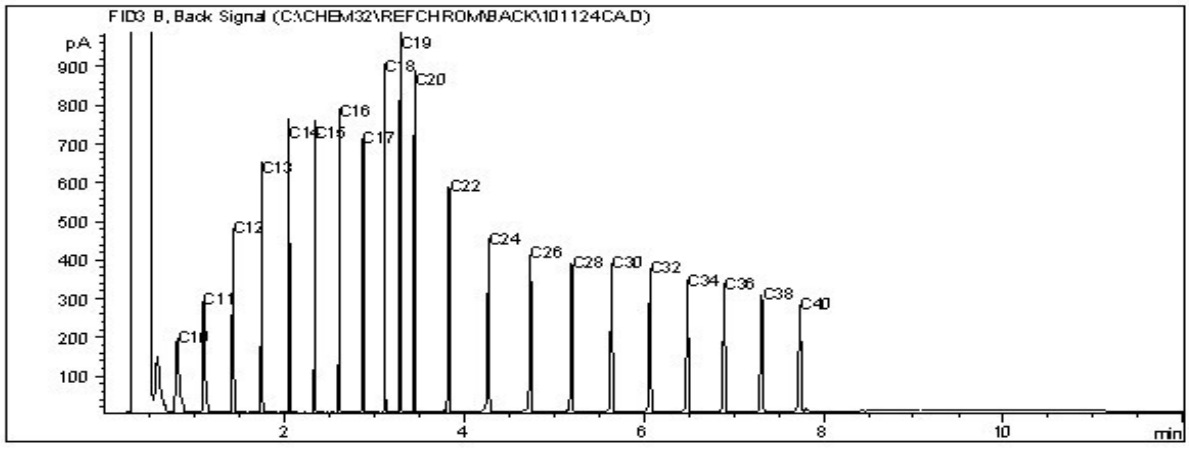
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-07

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

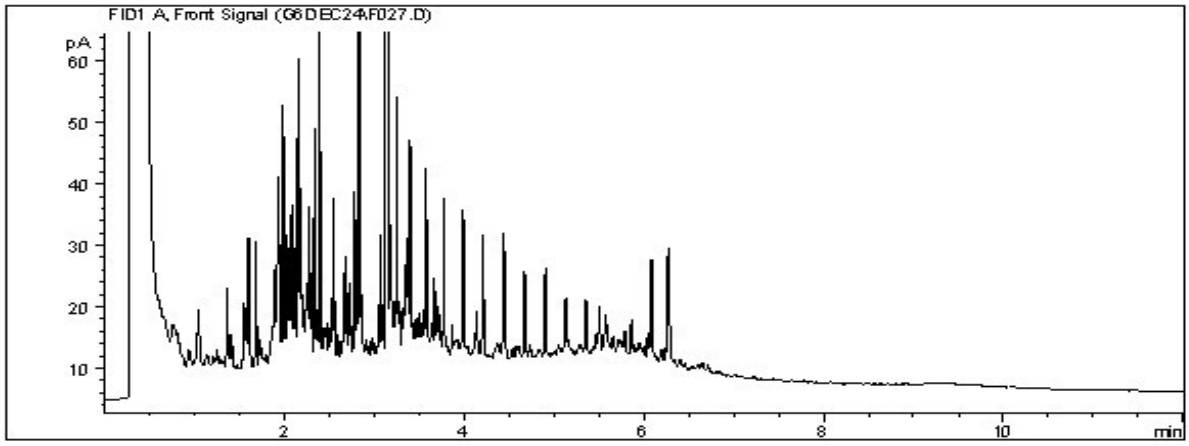
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z15997

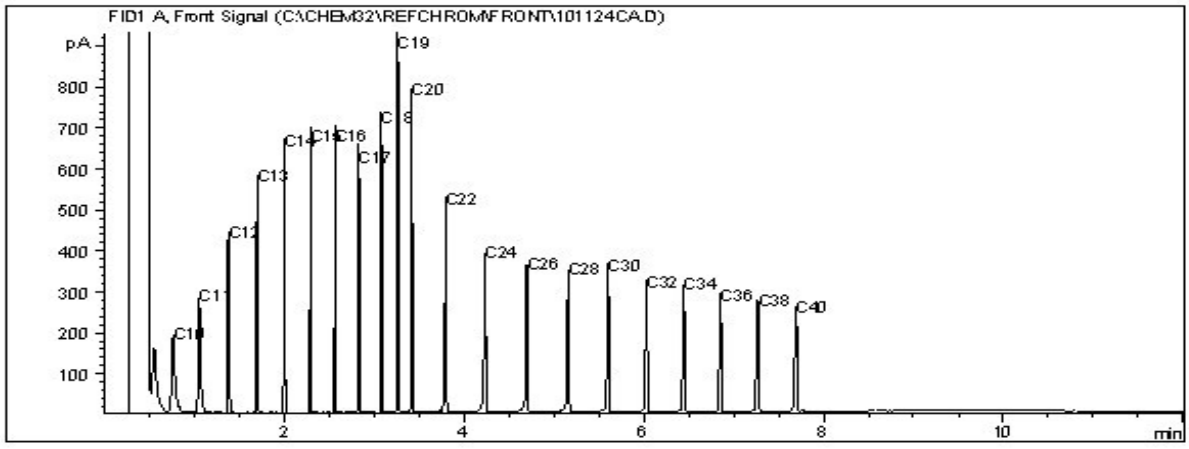
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-08

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

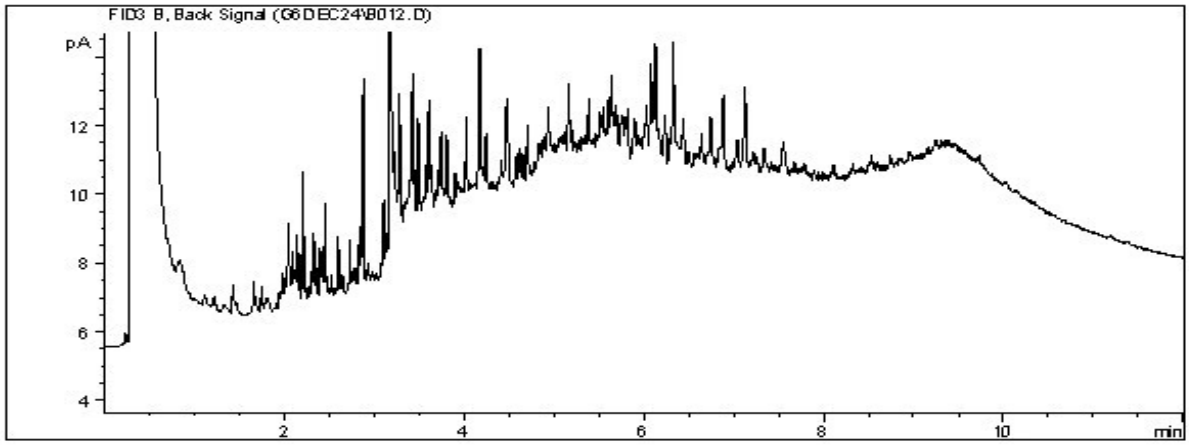
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16001

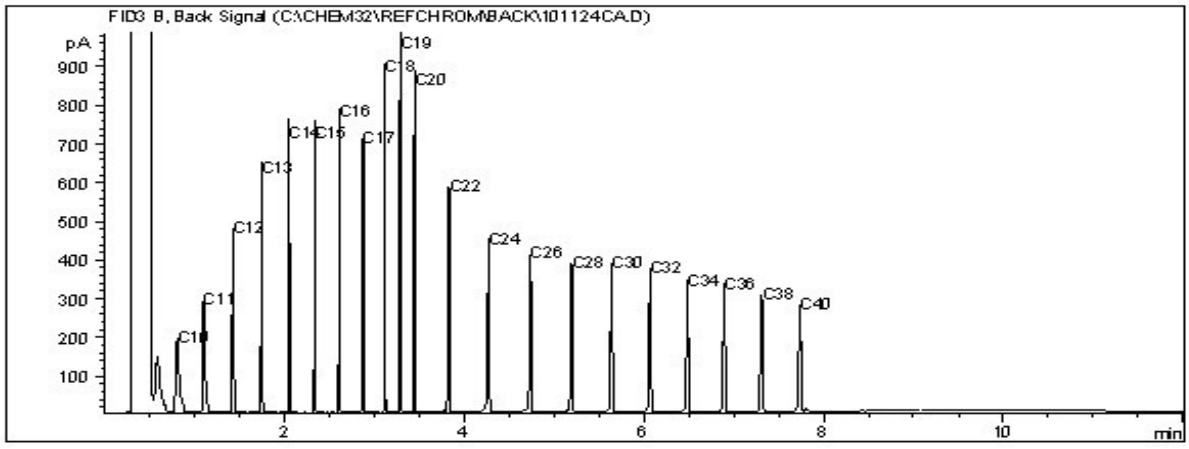
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21774-12

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

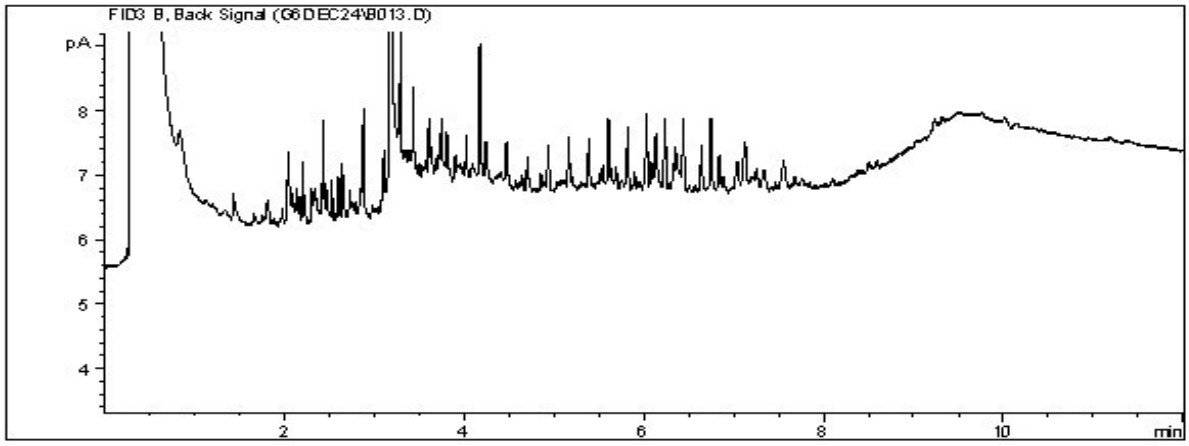
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16002

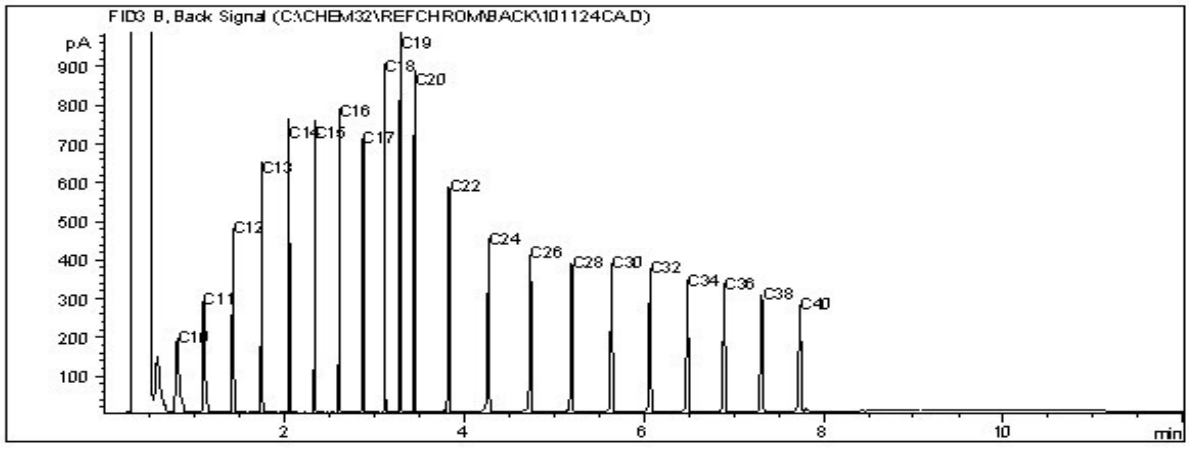
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-01

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

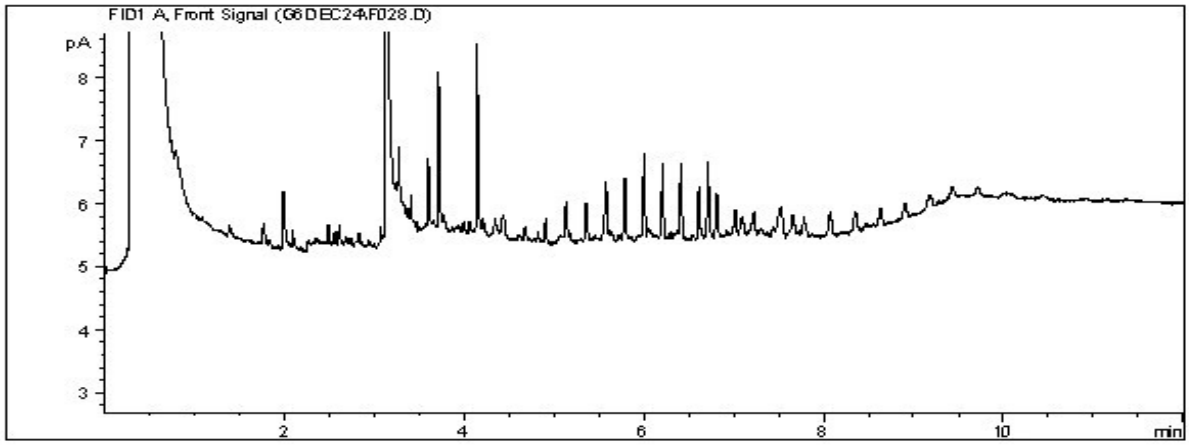
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16003

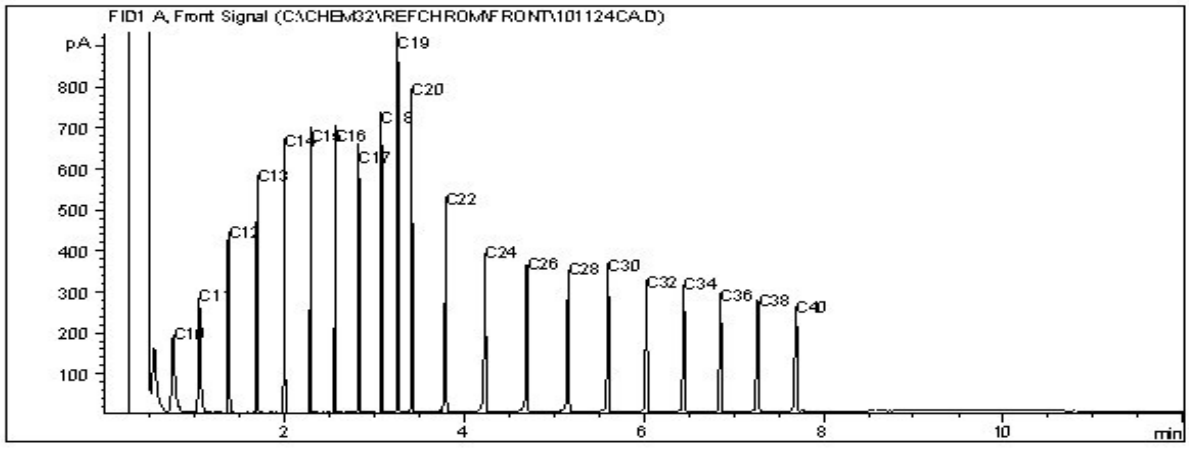
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-02

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

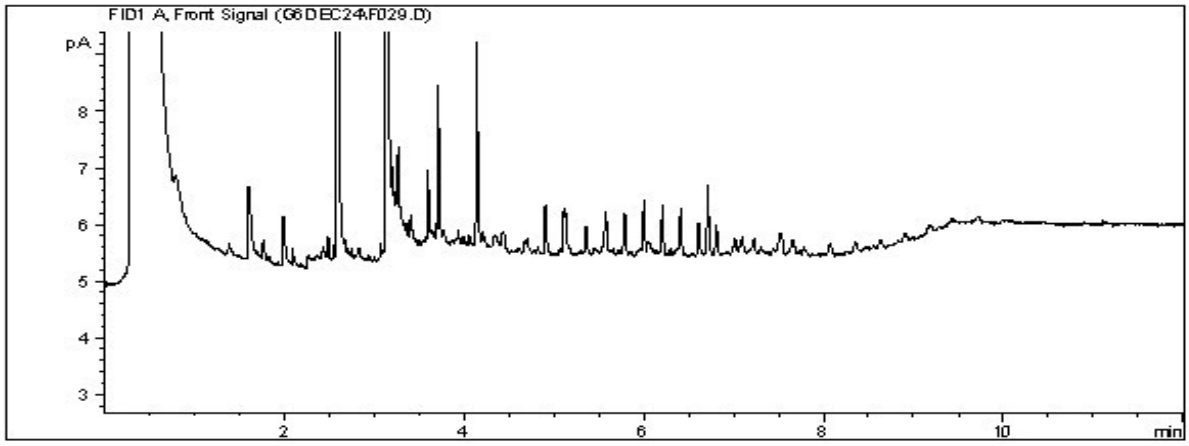
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16004

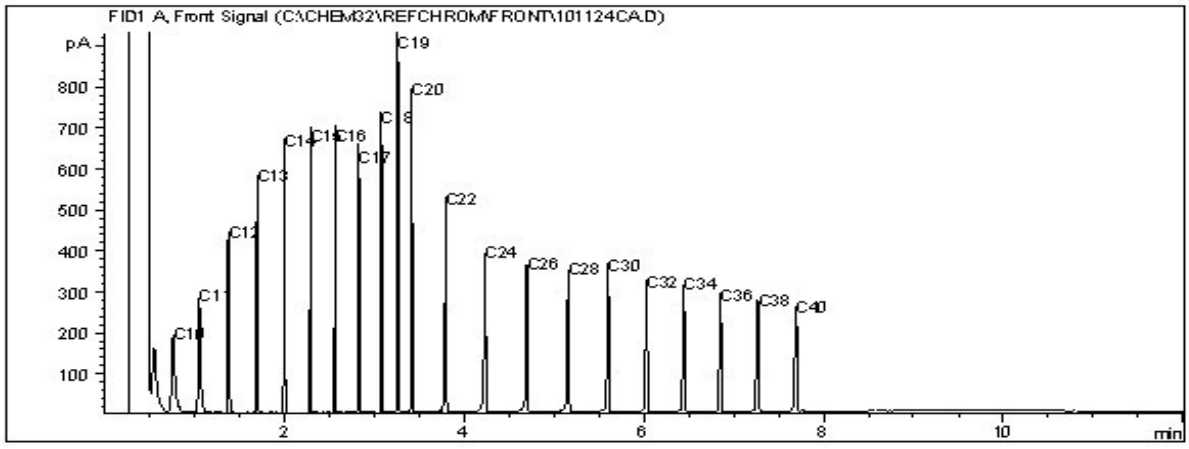
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-03

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

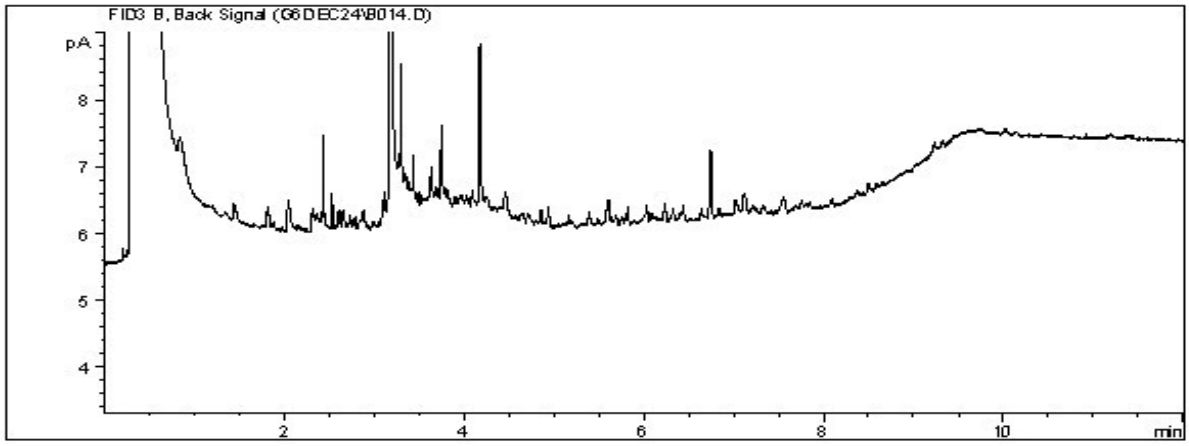
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16005

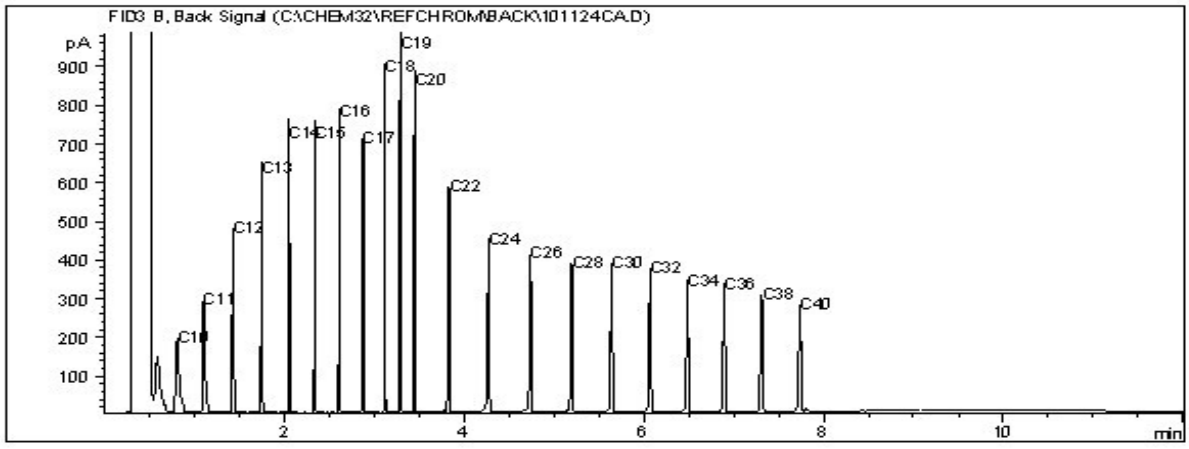
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-04

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

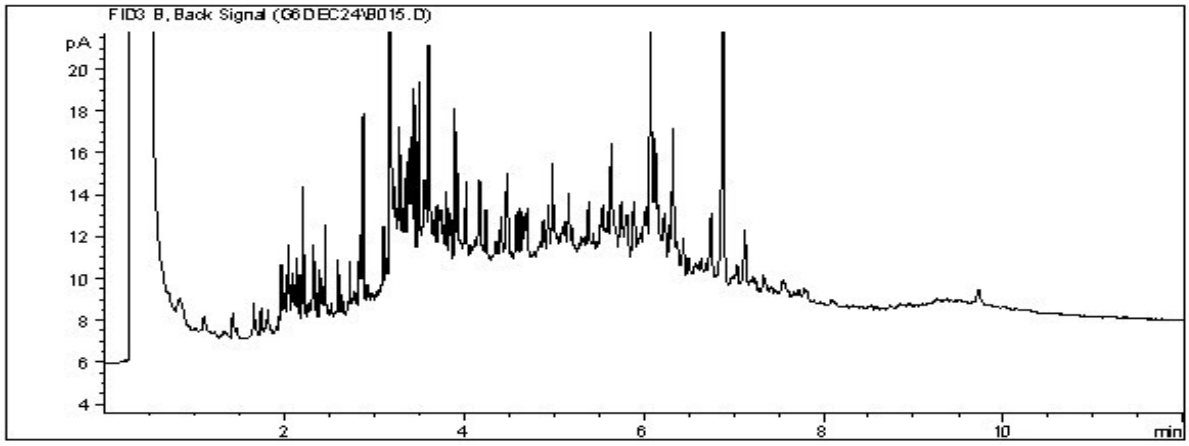
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16010

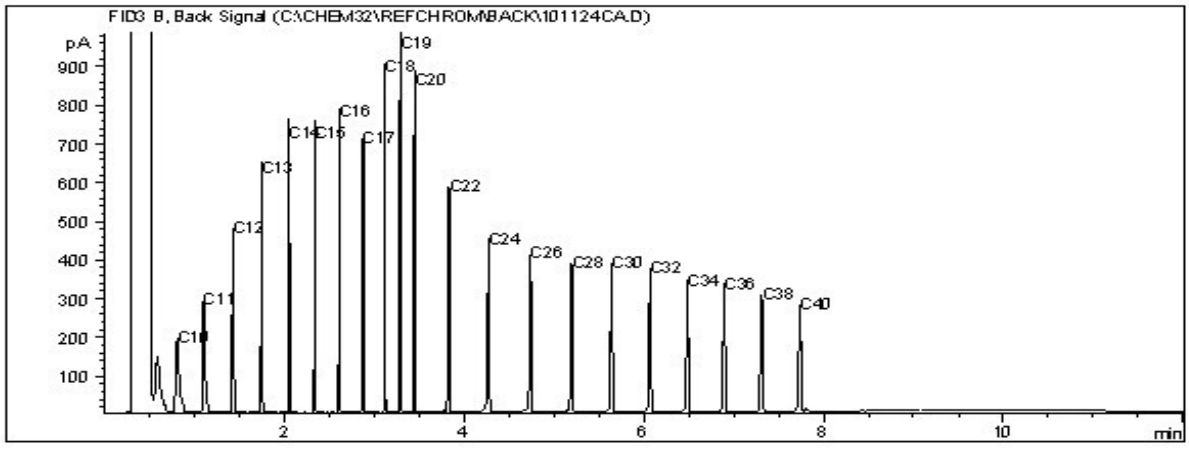
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-09

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

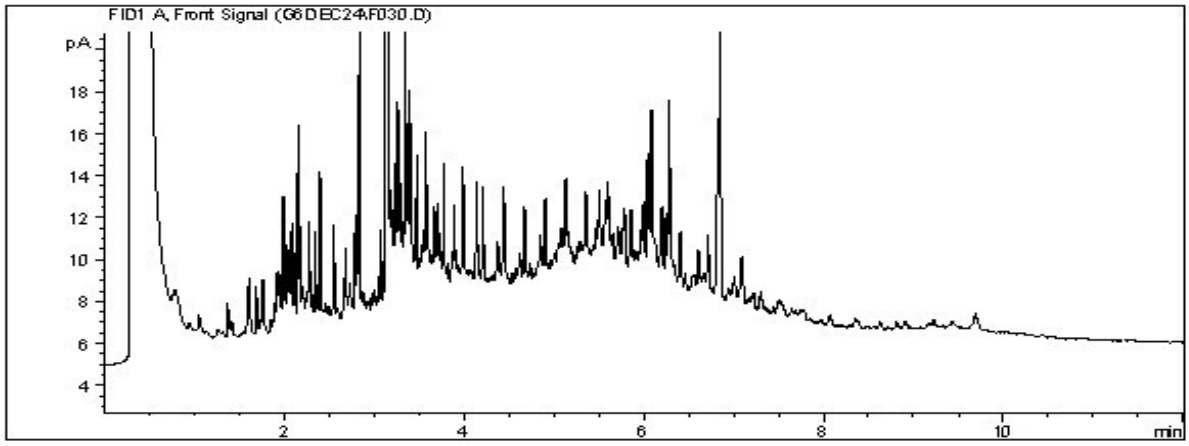
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16011

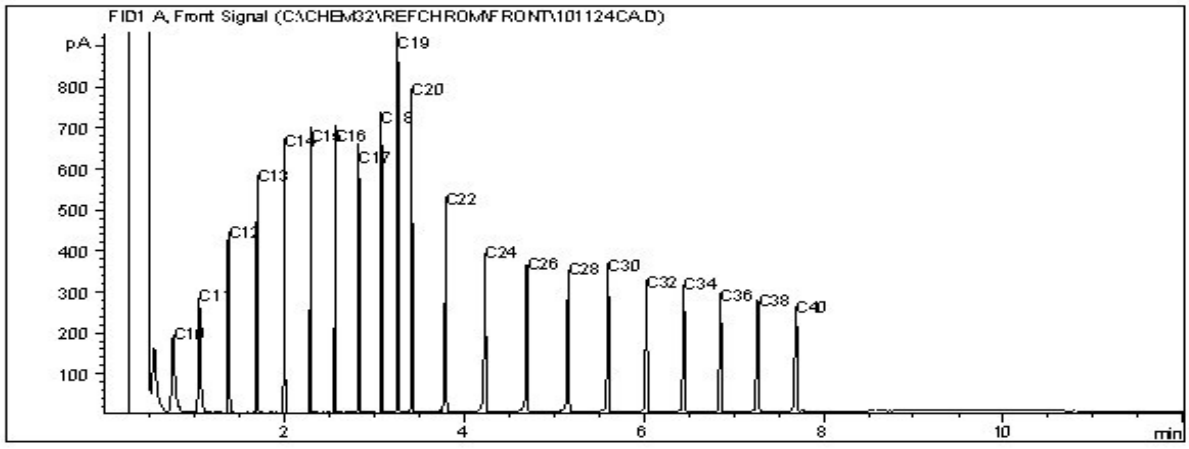
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-10

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

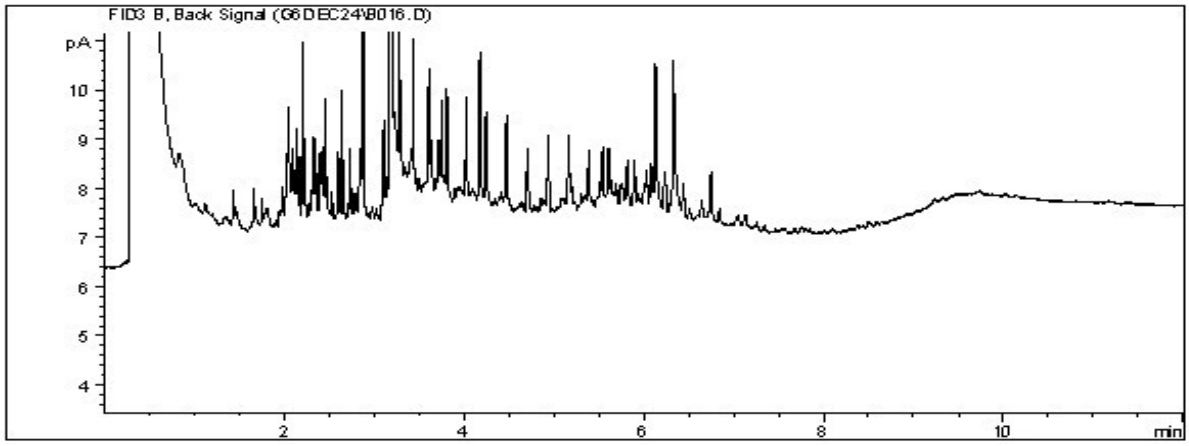
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16012

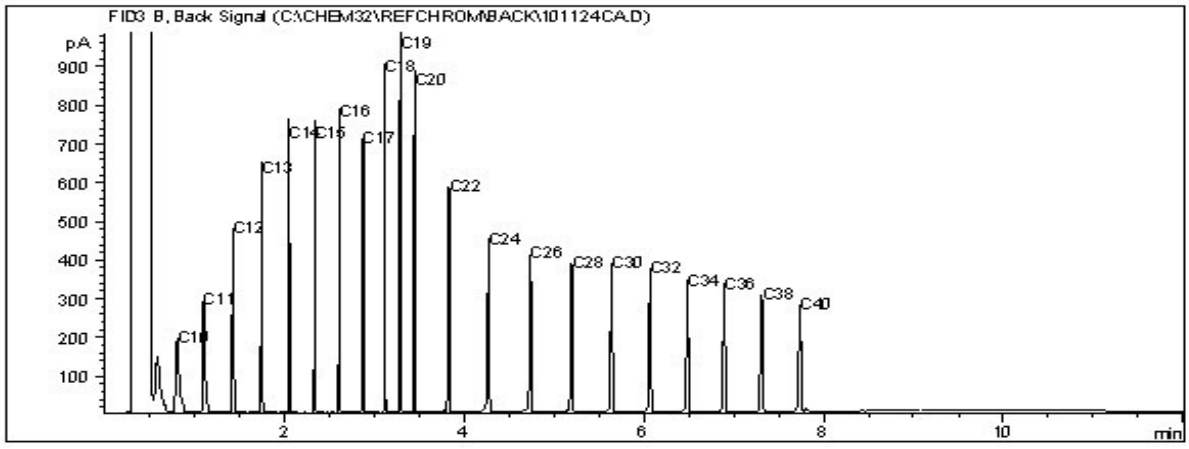
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-11

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

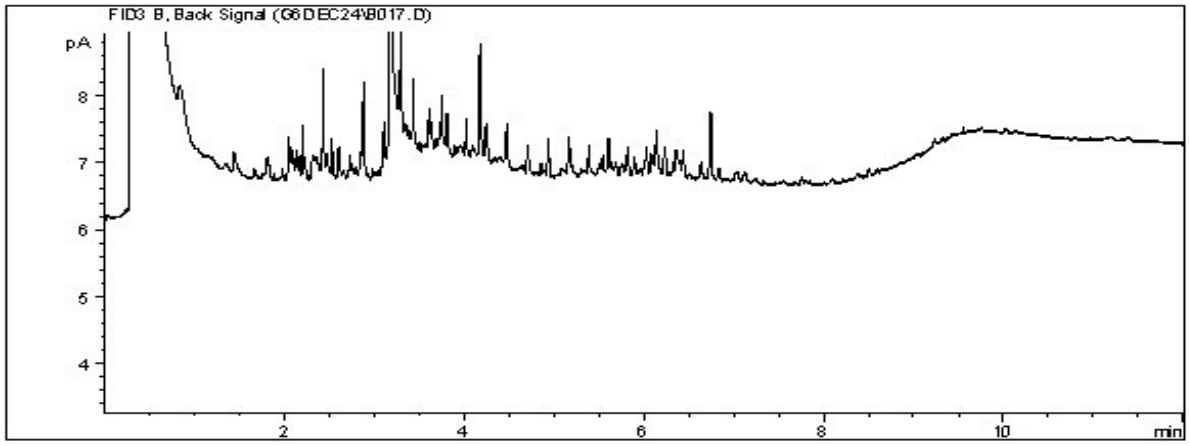
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16013

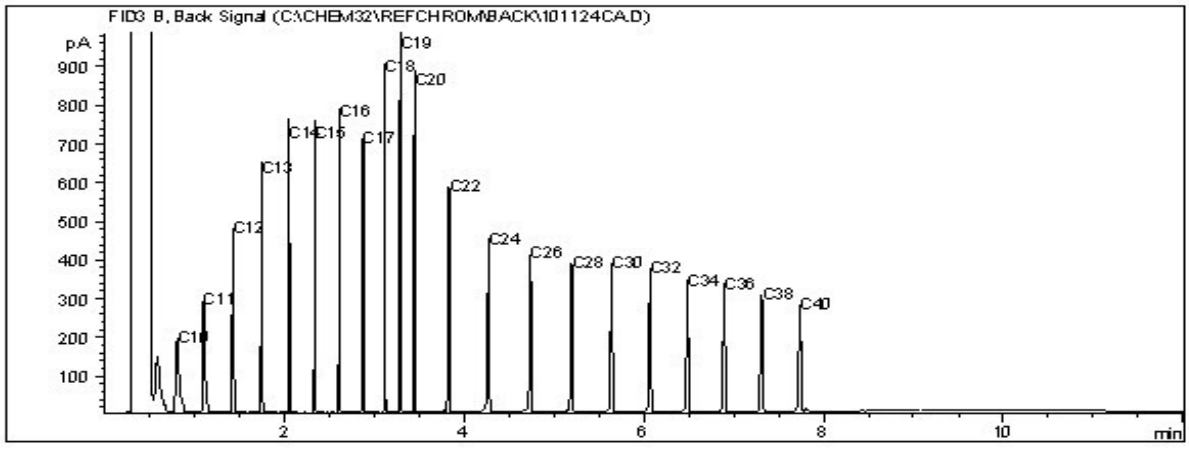
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21775-12

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

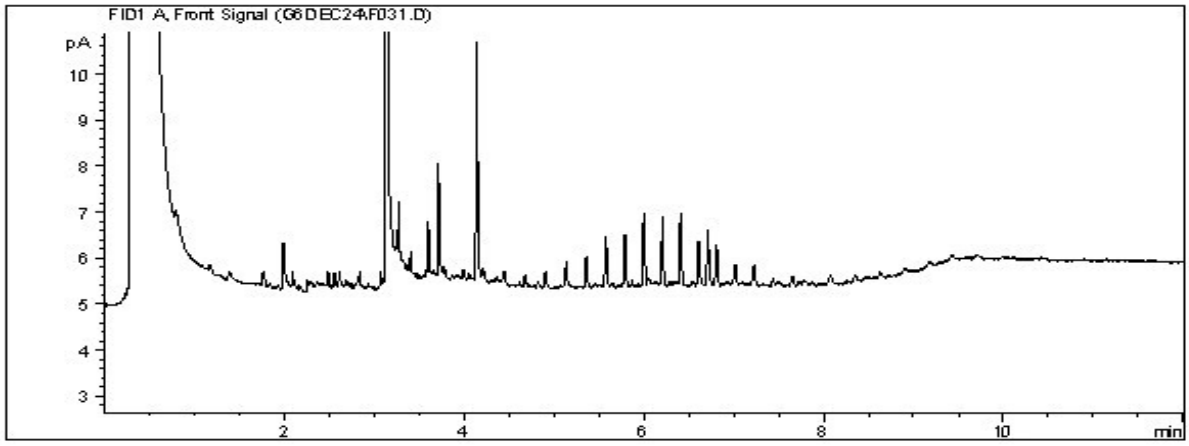
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16018

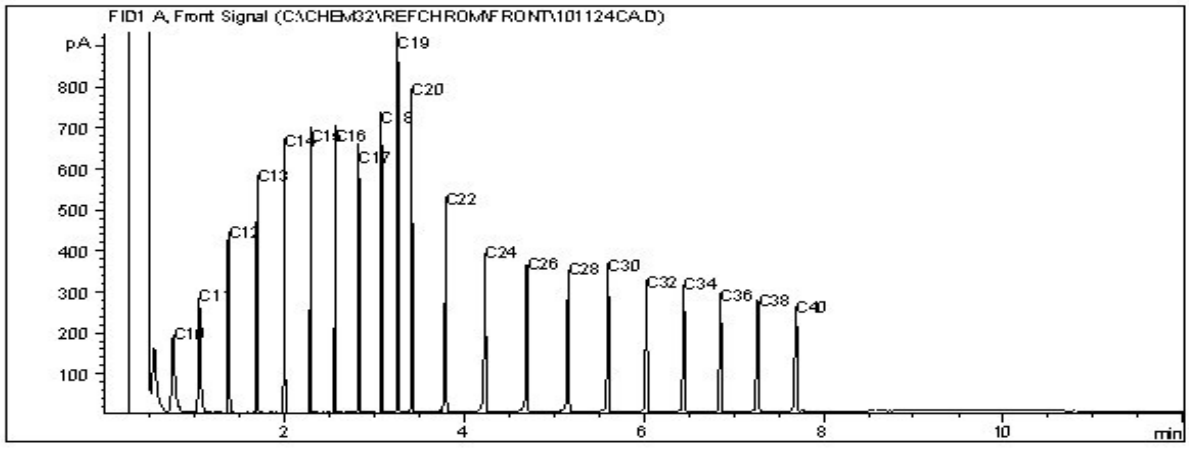
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21776-01

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

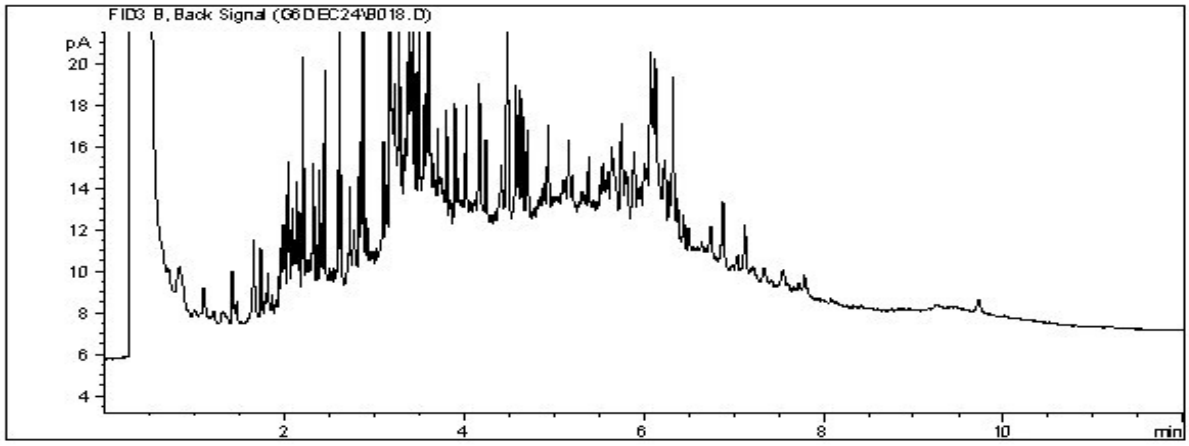
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16019

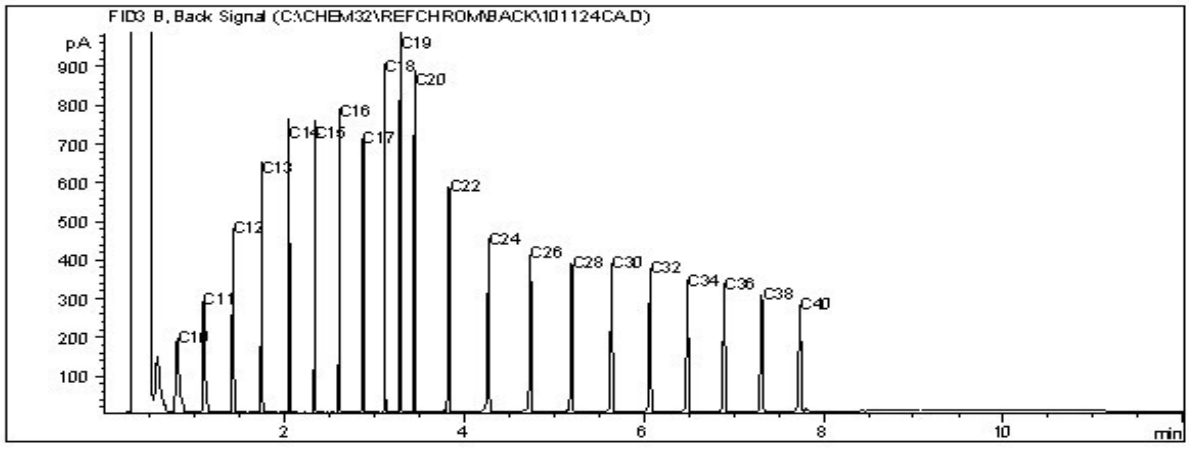
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21776-02

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

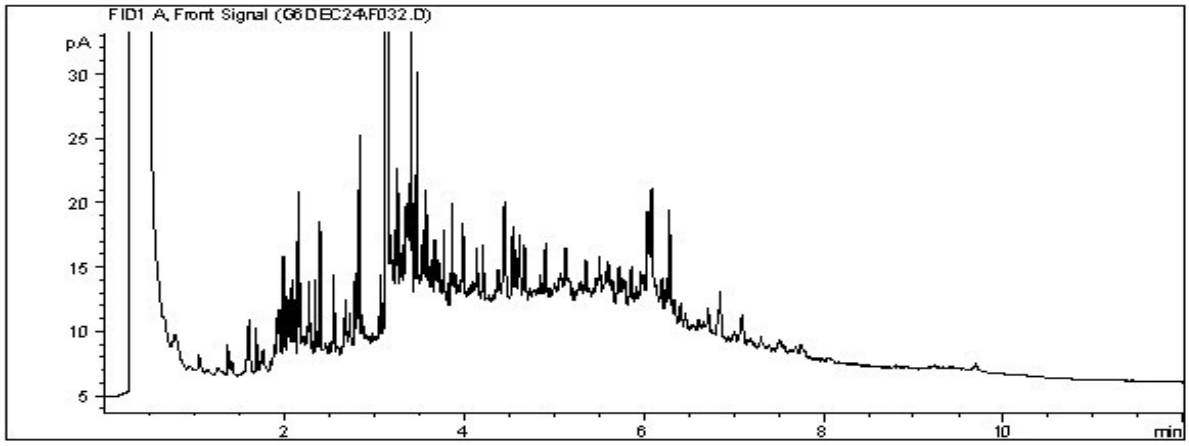
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16020

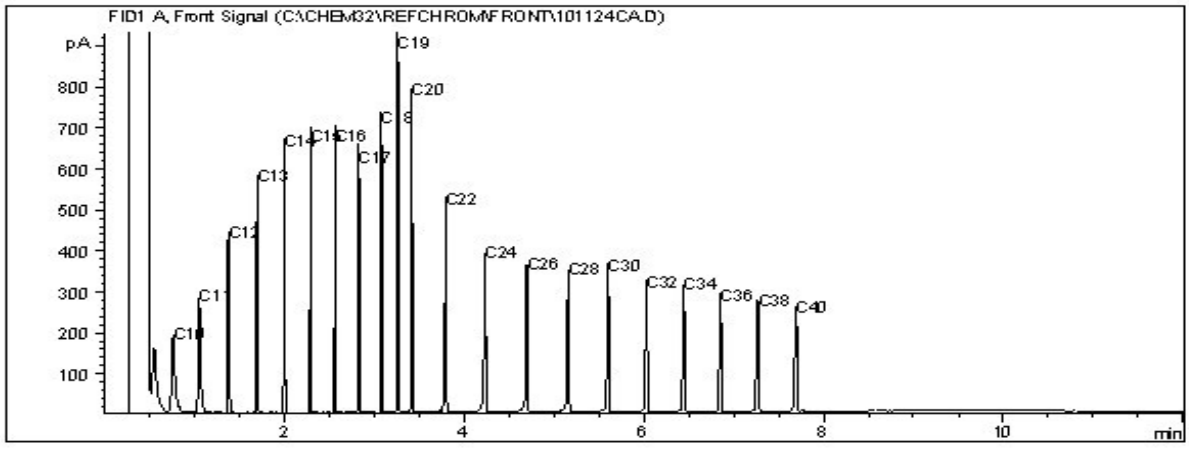
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21776-03

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

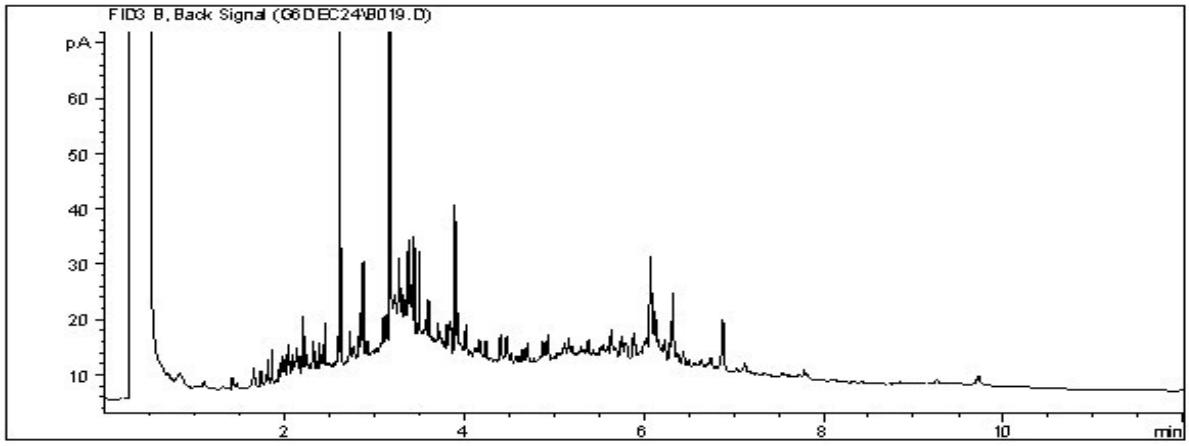
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16021

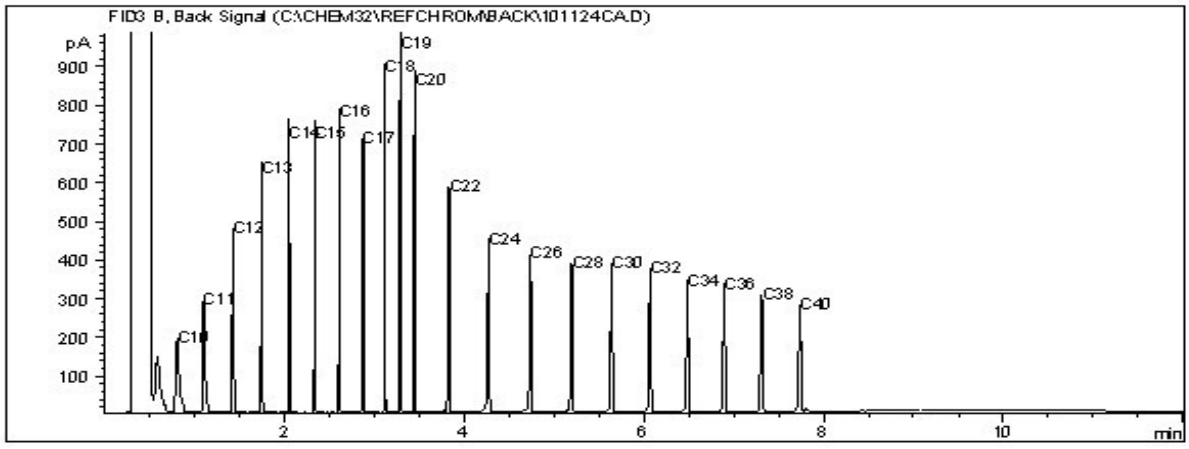
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21776-04

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

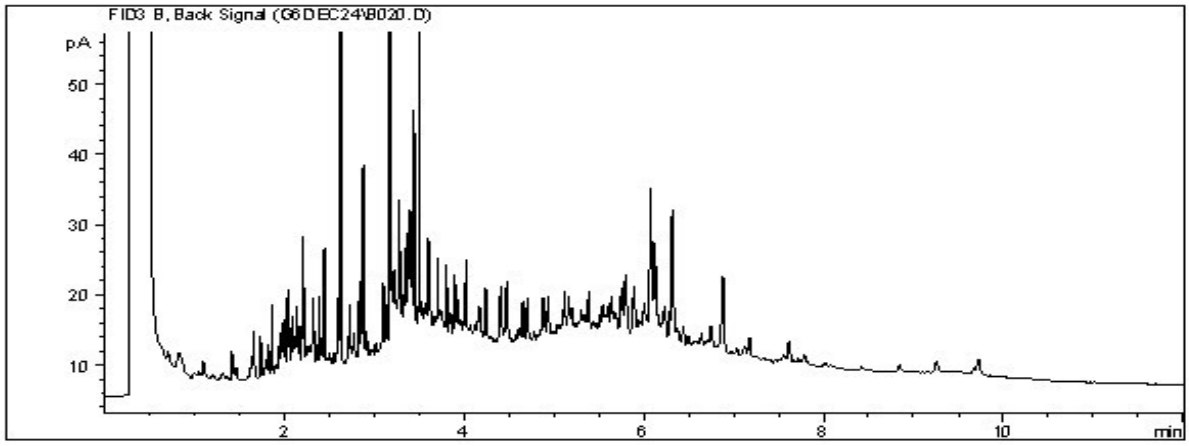
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/04
Maxxam Job #: B0C3450
Maxxam Sample: Z16022

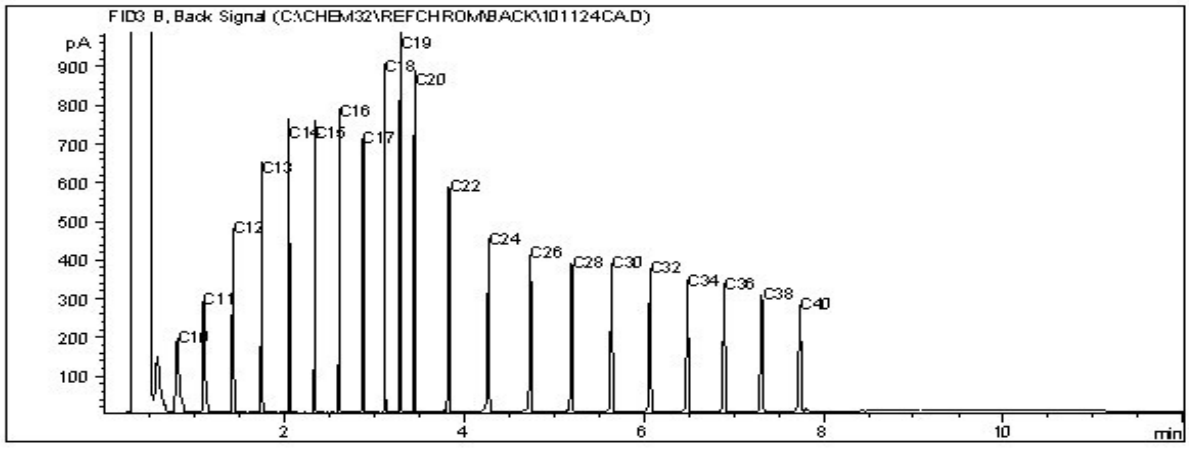
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008

Client ID: 21776-05

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Maxxam

Your Project #: B0C3450
Your C.O.C. #: SUB

Attention: Vj Oco
Maxxam Analytics
4606 Canada Way
Burnaby, BC
V5G 1K5

Report Date: 2010/12/30

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0I5433
Received: 2010/12/23, 12:35

Sample Matrix: Soil
Samples Received: 20

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Total Organic Carbon in Soil	18	N/A	2010/12/29	CAM SOP-00468	LECO Combustion
Total Organic Carbon in Soil	2	N/A	2010/12/30	CAM SOP-00468	LECO Combustion

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
* Results relate only to the items tested.

Encryption Key

Sean Conacher
30 Dec 2010 16:53:55 -05:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

MATHURA THIRUKKUMARAN, CS Rep
Email: MThirukkumaran@maxxam.ca
Phone# (905) 817-5700

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B0I5433
Report Date: 2010/12/30

Maxxam Analytics
Client Project #: B0C3450

RESULTS OF ANALYSES OF SOIL

Maxxam ID		IG2830	IG2831	IG2832	IG2833	IG2834	IG2835	IG2836	IG2837	IG2838		
Sampling Date		2010/12/16	2010/12/16	2010/12/16	2010/12/16	2010/12/16	2010/12/16	2010/12/17	2010/12/17	2010/12/17		
	Units	**Z15990-03R \ 21774-01**	**Z15991-02R \ 21774-02**	**Z15992-02R \ 21774-03**	**Z15995-03R \ 21774-06**	**Z15996-02R \ 21774-07**	**Z15997-02R \ 21774-08**	**Z16001-03R \ 21774-12**	**Z16002-02R \ 21775-01**	**Z16003-02R \ 21775-02**	**RDL**	**QC Batch**
Inorganics												
Total Organic Carbon	mg/kg	190000	170000	210000	190000	160000	97000	15000	8800	1600	500	2369370

Maxxam ID		IG2839	IG2840	IG2841	IG2842	IG2843	IG2844	IG2845		
Sampling Date		2010/12/17	2010/12/17	2010/12/16	2010/12/16	2010/12/16	2010/12/17	2010/12/16		
	Units	**Z16004-02R \ 21775-03**	**Z16005-02R \ 21775-04**	**Z16010-03R \ 21775-09**	**Z16011-02R \ 21775-10**	**Z16012-02R \ 21775-11**	**Z16013-02R \ 21775-12**	**Z16018-02R \ 21776-01**	**RDL**	**QC Batch**
Inorganics										
Total Organic Carbon	mg/kg	1800	3800	81000	36000	4100	3200	1300	500	2369370

Maxxam ID		IG2846	IG2847		IG2848		IG2849		
Sampling Date		2010/12/17	2010/12/17		2010/12/17		2010/12/17		
	Units	**Z16019-03R \ 21776-02**	**Z16020-02R \ 21776-03**	**QC Batch**	**Z16021-02R \ 21776-04**	**QC Batch**	**Z16022-02R \ 21776-05**	**RDL**	**QC Batch**
Inorganics									
Total Organic Carbon	mg/kg	180000	200000	2369370	250000	2369480	270000	500	2370174

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Job #: B0I5433
Report Date: 2010/12/30

Maxxam Analytics
Client Project #: B0C3450

Package 1	6.3°C

Each temperature is the average of up to three cooler temperatures taken at receipt

GENERAL COMMENTS

Maxxam Job #: B0I5433
Report Date: 2010/12/30

Maxxam Analytics
Client Project #: B0C3450

QUALITY ASSURANCE REPORT

			Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
2369370	Total Organic Carbon	2010/12/29	<500	mg/kg	0.4	35	97	N/A
2369480	Total Organic Carbon	2010/12/30	<500	mg/kg	0.2	35	99	N/A
2370174	Total Organic Carbon	2010/12/30	<500	mg/kg	21.7	35	92	N/A

N/A = Not Applicable
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Validation Signature Page

Maxxam Job #: B0I5433

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



EWA PRANJIC, M.Sc., C.Chem, Scientific Specialist

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Maxxam

Success Through Science®

Your Project #: 09-1436-5008/5000
Your C.O.C. #: 0086, G040858, G037375, G037377

Attention: Adrian de Bruyn
GOLDER ASSOCIATES LTD
4260 STILL CREEK DRIVE
Suite 500
BURNABY, BC
Canada V5C 6C6

Report Date: 2011/03/11

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0C2492
Received: 2011/02/23, 14:05

Sample Matrix: Sea Water
Samples Received: 13

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Hardness (calculated as CaCO3)	7	N/A	2010/12/31		
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	6	N/A	2011/03/02	BBY7SOP-00002	Based on EPA 200.8
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	7	N/A	2010/12/31	BBY7SOP-00002	Based on EPA 200.8
Elements by ICPMS (dissolved) - Seawater	6	N/A	2011/03/02	BBY7SOP-00002	Based on EPA 200.8
Elements by CRC ICPMS (dissolved)	7	N/A	2010/12/31	BBY7SOP-00002	Based on EPA 200.8
Ammonia-N (Total) (1)	7	N/A	2010/12/24	AB SOP-00007	EPA 350.1
Ammonia-N (Total) (1)	6	N/A	2011/02/28	AB SOP-00007	EPA 350.1
Filter and HNO3 Preserve for Metals	7	N/A	2010/12/23	BBY6WI-00001	Based on EPA 200.2
Filter and HNO3 Preserve for Metals	6	N/A	2011/02/24	BBY6WI-00001	Based on EPA 200.2
Sulphide	7	N/A	2010/12/29	BBY6SOP-00006	Based on SM-4500 S2D
Sulphide	6	N/A	2011/02/25	BBY6SOP-00006	Based on SM-4500 S2D
Total Suspended Solids	6	N/A	2011/03/01	BBY6SOP-00034	Based on SM - 2540 D
Total Suspended Solids-LowLevel	7	N/A	2010/12/22	BBY6SOP-00034	Based on SM-2540 D

Sample Matrix: Sediment
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Ecotox Report Attachment	1	2011/01/07	2011/03/11		
Ecotox Report Attachment	5	2011/03/11	2011/03/11		

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/MTBE Soil LH, VH, F1 SIM/MS	6	2010/12/22	2010/12/24	BBY8-SOP-00010	EPA SW846 8260C
Volatile F1-BTEX	6	N/A	2010/12/24		
CCME Hydrocarbons (F2-F4 in soil)	6	2010/12/22	2010/12/24	BBY8SOP-00030	CCME Soil Tier 1
Elements by ICPMS (total)	6	2010/12/23	2010/12/23	BBY7SOP-00004	Based on EPA 200.8
Simultaneously Extractable Metals-ICPMS	6	2011/01/04	2011/01/04	BBY7SOP-00001	Based on EPA 200.8
Moisture	6	N/A	2010/12/23	BBY8SOP-00017	Ont MOE -E 3139
PAH in Soil by GC/MS Lowlevel (Extended)	6	2010/12/22	2011/01/06	BRN SOP-00332 R5.0	Based on EPA 8270D
Total LMW, HMW, Total PAH Calc	6	N/A	2011/01/06		PAHTOT-S
pH (2:1 DI Water Extract)	6	2010/12/23	2010/12/23	BBY6SOP-00028	Carter, SSMA 16.2
Particle Size Distribution - Standard (2)	6	2010/12/29	2010/12/29		
Sulfide (AVS) (soil) - Calc for umole/g	6	2010/12/22	2011/01/05	BRN SOP-00229 R2.0	Based EPA821-R91-100
Sulfide (AVS) (soil)	6	2011/01/04	2011/01/04	BBY6SOP-00007	Based EPA821-R91-100
Texture Class (2)	6	N/A	2011/01/10		
TOC Soil Subcontract (3)	6	2011/01/06	2011/01/06		

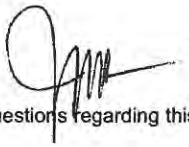
../2

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

* Results relate only to the items tested.

(1) This test was performed by Maxxam Edmonton Environmental
(2) This test was performed by Maxxam Winnipeg
(3) This test was performed by Maxxam Ontario (From Burnaby)

Encryption Key



VJ Oco
11 Mar 2011 15:33:41 -08:00

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

VJ OCO, Burnaby Customer Service
Email: VOco@maxxam.ca
Phone# (604) 639-8422

==========

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Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Maxxam Job #: B0C2492
Report Date: 2011/03/11

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		AA3434		AA3478		AA3479		AA3480	AA3481		
Sampling Date		2011/02/22		2011/02/22		2011/02/22		2011/02/23	2011/02/23		
	Units	**0086-02 POREWATER**	**RDL**	**0086-04 POREWATER**	**RDL**	**0086-06 POREWATER**	**RDL**	**0086-02 (SULF. AMENDED)**	**0086-04 (SULF. AMENDED)**	**RDL**	**QC Batch**
CONVENTIONALS											
Total Ammonia (N)	mg/L	11(1)	0.5	10(1)	0.5	9.1(1)	0.3	8.9(1)	7.8(1)	0.3	4665414
Calculated Parameters											
Filter and HNO3 Preservation	N/A	LAB	N/A	LAB	N/A	LAB	N/A	LAB	LAB	N/A	4657426
MISCELLANEOUS											
Sulphide	mg/L	12.2	0.3	34	1	27	1	0.022	0.028	0.005	4661454
Physical Properties											
Total Suspended Solids	mg/L	53	4	88	4	100	4	83	87	4	4668576

Maxxam ID		AA3482			Z18207		Z18208		Z18209		
Sampling Date		2011/02/23									
	Units	**0086-06 (SULF. AMENDED)**	**RDL**	**QC Batch**	**0086-01 POREWATER**	**RDL**	**0086-02 POREWATER**	**RDL**	**0086-03 POREWATER**	**RDL**	**QC Batch**
CONVENTIONALS											
Total Ammonia (N)	mg/L	6.6(1)	0.3	4665414	3.0(1)	0.3	2.7(1)	0.3	2.4(1)	0.3	4531369
Calculated Parameters											
Filter and HNO3 Preservation	N/A	LAB	N/A	4657426	LAB	N/A	LAB	N/A	LAB	N/A	4533846
MISCELLANEOUS											
Sulphide	mg/L	0.026	0.005	4661454	2.90(2)	0.05	3.5(2)	0.2	0.015	0.005	4534611
Physical Properties											
Total Suspended Solids	mg/L	66	4	4668576	86	1	110	1	120	1	4523747

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Detection limits raised due to dilution to bring analyte within the calibrated range.
(2) - Sample received at less than recommended preservation pH 9.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		Z18210		Z18211		Z18212		Z18213		
	Units	**0086-04 POREWATER**	**RDL**	**0086-05 POREWATER**	**RDL**	**0086-06 POREWATER**	**RDL**	**SW CONTROL**	**RDL**	**QC Batch**
CONVENTIONALS										
Total Ammonia (N)	mg/L	4.4(1)	0.3	2.8(1)	0.3	5.4(1)	0.3	0.33	0.05	4531369
Calculated Parameters										
Filter and HNO3 Preservation	N/A	LAB	N/A	LAB	N/A	LAB	N/A	LAB	N/A	4533846
MISCELLANEOUS										
Sulphide	mg/L	19.4	0.5	1.11	0.03	22.2	0.5	<0.005	0.005	4534611
Physical Properties										
Total Suspended Solids	mg/L	77	1	92	1	76	1	5	1	4523747

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Detection limits raised due to dilution to bring analyte within the calibrated range.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

ELEMENTS BY ATOMIC SPECTROSCOPY (SEA WATER)

Maxxam ID		AA3434	AA3478	AA3479	AA3480	AA3481	AA3482		
Sampling Date		2011/02/22	2011/02/22	2011/02/22	2011/02/23	2011/02/23	2011/02/23		
	Units	**0086-02 POREWATER**	**0086-04 POREWATER**	**0086-06 POREWATER**	**0086-02 (SULF. AMENDED)**	**0086-04 (SULF. AMENDED)**	**0086-06 (SULF. AMENDED)**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	ug/L	32	55	50	28	37	34	10	4658036
Dissolved Antimony (Sb)	ug/L	1.2	0.5	1.0	1.3	1.9	1.4	0.5	4658036
Dissolved Arsenic (As)	ug/L	40.5	81.3	69.9	42.9	85.1	71.5	0.5	4658036
Dissolved Barium (Ba)	ug/L	32	57	48	31	56	47	1	4658036
Dissolved Beryllium (Be)	ug/L	<1	<1	<1	<1	<1	<1	1	4658036
Dissolved Bismuth (Bi)	ug/L	<1	<1	<1	<1	<1	<1	1	4658036
Dissolved Boron (B)	ug/L	3920	4770	5250	4660	4840	5230	50	4658036
Dissolved Cadmium (Cd)	ug/L	0.10	0.13	0.14	0.14	0.18	0.14	0.05	4658036
Dissolved Chromium (Cr)	ug/L	1.2	1.2	2.9	1.7	2.0	2.3	0.5	4658036
Dissolved Cobalt (Co)	ug/L	<0.1	0.1	0.2	<0.1	0.1	0.1	0.1	4658036
Dissolved Copper (Cu)	ug/L	1.7	1.6	1.7	2.0	2.6	2.0	0.5	4658036
Dissolved Iron (Fe)	ug/L	81	53	80	75	64	68	2	4658036
Dissolved Lead (Pb)	ug/L	1.2	0.7	0.8	1.2	1.4	1.2	0.1	4658036
Dissolved Lithium (Li)	ug/L	155	167	173	170	163	165	20	4658036
Dissolved Manganese (Mn)	ug/L	12.4	2.0	3.6	12.2	2.2	3.3	0.5	4658036
Dissolved Molybdenum (Mo)	ug/L	8	5	8	8	6	9	1	4658036
Dissolved Nickel (Ni)	ug/L	0.6	1.0	1.0	0.6	0.6	0.9	0.2	4658036
Dissolved Phosphorus (P)	ug/L	2790	3050	2720	2980	2950	2670	50	4658036
Dissolved Selenium (Se)	ug/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	4658036
Dissolved Silicon (Si)	ug/L	18600	22700	23800	21000	22800	22800	100	4658036
Dissolved Silver (Ag)	ug/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4658036
Dissolved Strontium (Sr)	ug/L	7430	7510	7440	7410	7210	7290	10	4658036
Dissolved Thallium (Tl)	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4658036
Dissolved Tin (Sn)	ug/L	<1	<1	<1	<1	<1	<1	1	4658036
Dissolved Titanium (Ti)	ug/L	<10	<10	<10	<10	<10	<10	10	4658036
Dissolved Uranium (U)	ug/L	5.80	3.25	3.74	5.59	3.49	4.07	0.05	4658036
Dissolved Vanadium (V)	ug/L	<10	<10	<10	<10	<10	<10	10	4658036
Dissolved Zinc (Zn)	ug/L	2	2	3	3	3	2	1	4658036
Dissolved Calcium (Ca)	mg/L	389	383	388	396	373	373	1	4654876
Dissolved Magnesium (Mg)	mg/L	1080	1110	1120	1070	1080	1060	1	4654876
Dissolved Potassium (K)	mg/L	329	346	349	331	336	329	1	4654876
Dissolved Sodium (Na)	mg/L	9550	9690	9730	9250	9350	9130	1	4654876
Dissolved Sulphur (S)	mg/L	798	847	866	832	815	821	20	4654876

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

RESULTS OF CHEMICAL ANALYSES OF SEDIMENT

Maxxam ID		Z09675	Z09676	Z09677	Z09678	Z09679	Z09680		
Sampling Date		2010/12/15	2010/12/15	2010/12/15	2010/12/15	2010/12/15	2010/12/15		
	Units	**0086-01**	**0086-02**	**0086-03**	**0086-04**	**0086-05**	**0086-06**	**RDL**	**QC Batch**
Calculated Parameters									
No Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4700622

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		Z18215	Z18216		Z18217		Z18218		Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Parameter												
Subcontract Parameter	N/A	ATTACHED	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	ATTACHED	N/A	4547422
Calculated Parameters												
Sulphide	umole/g	11.6	14.7	0.6	2.04	0.06	7.2	0.3	9.3	12.6	0.6	4524145
MISCELLANEOUS												
Sulphide	ug/g	372	471	20	65	2	229	10	299	404	20	4541759
Physical Properties												
Texture	N/A	SILT LOAM	LOAM	N/A	SAND	N/A	SILT LOAM	N/A	SILT LOAM	LOAM	N/A	4524099

N/A = Not Applicable
RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/kg	68(1)	61(1)	23	100(1)	130(1)	150(1)	10	4527562
F3 (C16-C34 Hydrocarbons)	mg/kg	500(1)	470(1)	170	550(1)	700(1)	610(1)	10	4527562
F4 (C34-C50 Hydrocarbons)	mg/kg	140(1)	150(1)	110	140(1)	240(1)	160(1)	10	4527562
Reached Baseline at C50	mg/kg	YES	YES	YES	YES	YES	YES	N/A	4527562
Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	94	92	92	89	96	95		4527562

PARTICLE SIZE DISTRIBUTION ANALYSIS (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Percent Passing									
<0.002mm Pipette	%	8.96	10.57	1.60	22.32	24.52	17.19	0.01	4551597
<0.053mm Pipette	%	38.31	32.73	8.02	69.75	76.21	52.99	0.01	4551597
<0.125mm, Sieve #120	%	36.81	39.81	20.91	82.76	83.81	64.88	0.01	4551597
<0.250mm, Sieve #60	%	40.56	50.85	46.54	88.43	89.19	71.58	0.01	4551597
<2.00mm, Sieve #10	%	58.40	64.48	82.73	92.78	95.41	83.03	0.01	4551597
Percent of Entire Sample									
<0.002mm	%	8.96	10.57	1.60	22.32	24.52	17.19	0.01	4551597
<0.053mm & >0.002mm	%	29.35	22.16	6.42	47.43	51.69	35.79	0.01	4551597
<2.00mm & >0.053mm	%	20.08	31.75	74.72	23.03	19.20	30.05	0.01	4551597
>2.00mm	%	41.61	35.52	17.27	7.22	4.60	16.97	0.01	4551597
% of the <2mm Fraction									
% Clay <0.002mm	%	15.35	16.39	1.93	24.06	25.70	20.71	0.01	4551597
% Sand <2.00mm & >0.053mm	%	34.39	49.25	90.31	24.82	20.12	36.19	0.01	4551597
% Silt <0.053mm & >0.002mm	%	50.26	34.37	7.76	51.12	54.18	43.11	0.01	4551597

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample contained > 50% moisture.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

PHYSICAL TESTING (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Physical Properties									
Moisture	%	74	71	27	72	73	69	0.3	4526373

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
SEM Metals by ICPMS									
SEM Cadmium (Cd)	umole/g	0.0023	0.0016	0.0018	0.0027	0.0035	0.0026	0.0002	4542344
SEM Copper (Cu)	umole/g	0.040	0.033	0.255	0.043	0.062	0.048	0.004	4542344
SEM Lead (Pb)	umole/g	0.0074	0.0070	0.0840	0.0075	0.0105	0.0077	0.0002	4542344
SEM Mercury (Hg)	umole/g	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.0003	4542344
SEM Nickel (Ni)	umole/g	0.014	0.013	0.125	0.021	0.023	0.022	0.004	4542344
SEM Zinc (Zn)	umole/g	0.195	0.173	0.694	0.178	0.301	0.176	0.008	4542344

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

CCME BTEX/F1 BY HS IN SOIL (SOIL)

Maxxam ID		Z18215		Z18216		Z18217		Z18218		Z18219		Z18220		
	Units	**0086-01 SEDIMENT**	**RDL**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**RDL**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Calculated Parameters														
F1 (C6-C10) - BTEX	mg/kg	<60	60	<50	50	<10	10	<50	50	<60	60	<50	50	4524143
Volatiles														
Methyl-tert-butylether (MTBE)	mg/kg	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	4527833
Benzene	mg/kg	0.04(1)	0.03	<0.03(1)	0.03	<0.005	0.005	<0.03(1)	0.03	<0.03(1)	0.03	<0.02(1)	0.02	4527833
Toluene	mg/kg	0.09(1)	0.03	0.19(1)	0.03	<0.02	0.02	0.05(1)	0.03	0.07(1)	0.03	0.08(1)	0.02	4527833
Ethylbenzene	mg/kg	<0.03(1)	0.03	<0.03(1)	0.03	<0.01	0.01	<0.03(1)	0.03	<0.03(1)	0.03	0.02(1)	0.02	4527833
m & p-Xylene	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.04	0.04	<0.04	0.04	4527833
o-Xylene	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	4527833
Styrene	mg/kg	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	4527833
Xylenes (Total)	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.04	0.04	<0.04	0.04	4527833
(C6-C10)	mg/kg	<60(1)	60	<50(1)	50	<10	10	<50(1)	50	<60(1)	60	<50(1)	50	4527833
Surrogate Recovery (%)														
4-BROMOFLUOROBENZENE (sur.)	%	84		83		84		84		83		85		4527833
D10-ETHYLBENZENE (sur.)	%	82		83		86		82		83		84		4527833
D4-1,2-DICHLOROETHANE (sur.)	%	101		105		96		99		97		96		4527833
D8-TOLUENE (sur.)	%	94		92		96		95		94		94		4527833

RDL = Reportable Detection Limit
(1) - RDL raised due to high sample moisture content.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Physical Properties									
Soluble (2:1) pH	pH Units	7.64	7.39	7.83	7.33	7.33	7.62	0.01	4529385
Total Metals by ICPMS									
Total Aluminum (Al)	mg/kg	6520	8800	9590	11300	10400	10400	100	4528403
Total Antimony (Sb)	mg/kg	0.3	0.4	0.4	0.5	0.5	0.5	0.1	4528403
Total Arsenic (As)	mg/kg	9.4	10.9	4.0	12.2	12.9	11.2	0.2	4528403
Total Barium (Ba)	mg/kg	26.2	30.9	33.0	47.5	42.2	51.2	0.1	4528403
Total Beryllium (Be)	mg/kg	0.2	0.1	0.1	0.3	0.2	0.3	0.1	4528403
Total Bismuth (Bi)	mg/kg	0.1	0.2	<0.1	0.2	0.2	0.2	0.1	4528403
Total Cadmium (Cd)	mg/kg	2.76	2.62	0.34	3.70	3.72	3.25	0.05	4528403
Total Calcium (Ca)	mg/kg	60500	13100	5920	6590	6930	9140	100	4528403
Total Chromium (Cr)	mg/kg	19	21	15	27	26	27	1	4528403
Total Cobalt (Co)	mg/kg	3.3	4.3	4.8	5.1	4.7	5.1	0.3	4528403
Total Copper (Cu)	mg/kg	65.3	105	43.5	72.9	79.1	73.6	0.5	4528403
Total Iron (Fe)	mg/kg	13600	16700	13800	17500	16500	16300	100	4528403
Total Lead (Pb)	mg/kg	22.5	25.5	24.7	20.1	23.2	21.5	0.1	4528403
Total Magnesium (Mg)	mg/kg	6990	7320	4700	7780	7580	6970	100	4528403
Total Manganese (Mn)	mg/kg	108	140	152	154	137	142	0.2	4528403
Total Mercury (Hg)	mg/kg	0.51	0.23	0.08	0.26	0.25	0.29	0.05	4528403
Total Molybdenum (Mo)	mg/kg	12.3	10.8	1.4	9.9	13.1	8.9	0.1	4528403
Total Nickel (Ni)	mg/kg	15.2	16.1	12.2	21.5	19.9	21.2	0.8	4528403
Total Phosphorus (P)	mg/kg	625	701	423	730	714	671	10	4528403
Total Potassium (K)	mg/kg	1800	1790	824	2050	2010	1930	100	4528403
Total Selenium (Se)	mg/kg	1.2	1.6	<0.5	1.8	2.4	1.8	0.5	4528403
Total Silver (Ag)	mg/kg	0.18	0.26	0.09	0.29	0.26	0.26	0.05	4528403
Total Sodium (Na)	mg/kg	24100	22400	3130	20600	20900	18100	100	4528403
Total Strontium (Sr)	mg/kg	216	83.2	44.4	63.8	64.8	74.2	0.1	4528403
Total Thallium (Tl)	mg/kg	0.28	0.32	0.20	0.36	0.39	0.30	0.05	4528403
Total Tin (Sn)	mg/kg	3.0	2.4	1.6	1.7	1.9	1.5	0.1	4528403
Total Titanium (Ti)	mg/kg	263	533	885	525	436	394	1	4528403
Total Vanadium (V)	mg/kg	34	40	35	45	44	42	2	4528403
Total Zinc (Zn)	mg/kg	171	168	63	132	163	124	1	4528403
Total Zirconium (Zr)	mg/kg	1.4	3.7	2.1	2.2	2.0	1.7	0.5	4528403

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

CSR DISSOLVED METALS IN WATER (SEA WATER)

Maxxam ID		Z18207	Z18208	Z18209	Z18210	Z18211	Z18212	Z18213		
	Units	**0086-01 POREWATER**	**0086-02 POREWATER**	**0086-03 POREWATER**	**0086-04 POREWATER**	**0086-05 POREWATER**	**0086-06 POREWATER**	**SW CONTROL**	**RDL**	**QC Batch**
Misc. Inorganics										
Dissolved Hardness (CaCO3)	mg/L	5670	5540	5130	5520	5560	5330	5690	0.5	4523678
Dissolved Metals by ICPMS										
Dissolved Aluminum (Al)	mg/L	0.06	0.61	0.04	0.85	0.04	0.05	0.03	0.03	4529525
Dissolved Antimony (Sb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Arsenic (As)	mg/L	0.010	0.007	0.013	0.033	0.015	0.061	0.002	0.001	4529525
Dissolved Barium (Ba)	mg/L	0.03	0.03	0.02	0.06	0.03	0.05	0.01	0.01	4529525
Dissolved Beryllium (Be)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	4529525
Dissolved Bismuth (Bi)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Boron (B)	mg/L	4.9	5.0	5.2	5.1	4.9	5.2	4.9	0.5	4529525
Dissolved Cadmium (Cd)	mg/L	0.0002	<0.0001	0.0001	0.0002	0.0002	<0.0001	0.0002	0.0001	4529525
Dissolved Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Cobalt (Co)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Copper (Cu)	mg/L	<0.002	<0.002	<0.002	<0.002	0.148	<0.002	<0.002	0.002	4529525
Dissolved Iron (Fe)	mg/L	0.10	0.14	0.08	0.11	0.10	0.06	<0.05	0.05	4529525
Dissolved Lead (Pb)	mg/L	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	0.002	4529525
Dissolved Lithium (Li)	mg/L	0.16	0.15	0.15	0.16	0.15	0.16	0.17	0.05	4529525
Dissolved Manganese (Mn)	mg/L	0.02	0.01	0.09	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Mercury (Hg)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	4529525
Dissolved Molybdenum (Mo)	mg/L	0.04	0.02	0.06	<0.01	0.01	<0.01	<0.01	0.01	4529525
Dissolved Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Selenium (Se)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	4529525
Dissolved Silicon (Si)	mg/L	14	15	6	19	13	18	2	1	4529525
Dissolved Silver (Ag)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	4529525
Dissolved Strontium (Sr)	mg/L	6.79	6.57	6.19	6.63	6.38	6.44	6.56	0.01	4529525
Dissolved Thallium (Tl)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	4529525
Dissolved Tin (Sn)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Titanium (Ti)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Uranium (U)	mg/L	0.003	0.003	0.007	0.003	0.004	0.004	0.003	0.001	4529525
Dissolved Vanadium (V)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Zinc (Zn)	mg/L	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	0.05	4529525
Dissolved Zirconium (Zr)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Calcium (Ca)	mg/L	388	388	366	392	386	370	384	0.5	4523679
Dissolved Magnesium (Mg)	mg/L	1140	1110	1030	1100	1120	1070	1150	0.5	4523679
Dissolved Potassium (K)	mg/L	358	351	347	351	361	351	355	0.5	4523679
Dissolved Sodium (Na)	mg/L	9350	9310	8610	9140	9260	8990	9430	0.5	4523679
Dissolved Sulphur (S)	mg/L	964	953	853	946	898	891	985	30	4523679

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

DO NOT USE, DH4 110207 (SOIL)

Maxxam ID		Z18215		Z18216		Z18217		Z18218		Z18219		Z18220		
	Units	**0086-01 SEDIMENT**	**RDL**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**RDL**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Polycyclic Aromatics														
Naphthalene	mg/kg	0.25(1)	0.005	0.31(1)	0.005	0.14(1)	0.005	0.48(1)	0.005	0.65(2)	0.005	1.1(1)	0.005	4542849
2-Methylnaphthalene	mg/kg	0.55(1)	0.005	0.64(1)	0.005	0.29(1)	0.005	1.1(1)	0.005	1.4(2)	0.005	2.6(1)	0.005	4542849
Acenaphthylene	mg/kg	<0.08(3)	0.08	<0.07(3)	0.07	<0.04(3)	0.04	<0.08(3)	0.08	<0.1(3)	0.1	<0.2(3)	0.2	4542849
Acenaphthene	mg/kg	0.10(1)	0.005	0.10(1)	0.005	0.027(1)	0.005	0.18(1)	0.005	0.29(2)	0.005	0.34(1)	0.005	4542849
Fluorene	mg/kg	0.17(1)	0.005	0.16(1)	0.005	0.050(1)	0.005	0.26(1)	0.005	0.43(2)	0.005	0.56(1)	0.005	4542849
Phenanthrene	mg/kg	0.86(1)	0.005	0.72(1)	0.005	0.31(1)	0.005	1.2(1)	0.005	1.5(2)	0.005	2.4(1)	0.005	4542849
Anthracene	mg/kg	0.30(1)	0.005	0.31(1)	0.005	0.068(1)	0.005	0.33(1)	0.005	0.58(2)	0.005	0.49(1)	0.005	4542849
Fluoranthene	mg/kg	1.1(1)	0.005	0.94(1)	0.005	0.41(1)	0.005	1.1(1)	0.005	1.6(2)	0.005	1.6(1)	0.005	4542849
Pyrene	mg/kg	1.3(1)	0.005	1.2(1)	0.005	0.40(1)	0.005	0.94(1)	0.005	2.0(2)	0.005	1.3(1)	0.005	4542849
Benzo(a)anthracene	mg/kg	0.30(1)	0.005	0.35(1)	0.005	0.14(1)	0.005	0.34(1)	0.005	0.66(2)	0.005	0.54(1)	0.005	4542849
Chrysene	mg/kg	0.46(1)	0.005	0.43(1)	0.005	0.19(1)	0.005	0.42(1)	0.005	0.74(2)	0.005	0.66(1)	0.005	4542849
Benzo(b&j)fluoranthene	mg/kg	0.36(1)	0.005	0.38(1)	0.005	0.16(1)	0.005	0.30(1)	0.005	0.58(2)	0.005	0.39(1)	0.005	4542849
Benzo(k)fluoranthene	mg/kg	0.24(1)	0.005	0.27(1)	0.005	0.11(1)	0.005	0.20(1)	0.005	0.42(2)	0.005	0.28(1)	0.005	4542849
Benzo(a)pyrene	mg/kg	0.21(1)	0.005	0.23(1)	0.005	0.15(1)	0.005	0.21(1)	0.005	0.39(2)	0.005	0.32(1)	0.005	4542849
Indeno(1,2,3-cd)pyrene	mg/kg	0.11(1)	0.01	0.12(1)	0.01	0.10(1)	0.01	0.10(1)	0.01	0.18(1)	0.01	0.13(1)	0.01	4542849
Dibenz(a,h)anthracene	mg/kg	0.04(1)	0.01	0.04(1)	0.01	0.03(1)	0.01	0.05(1)	0.01	0.07(1)	0.01	0.07(1)	0.01	4542849
Benzo(g,h,i)perylene	mg/kg	0.15(1)	0.01	0.17(1)	0.01	0.15(1)	0.01	0.17(1)	0.01	0.26(2)	0.01	0.26(1)	0.01	4542849
Low Molecular Weight PAH`s	mg/kg	2.2	0.08	2.2	0.07	0.88	0.04	3.6	0.08	4.8	0.1	7.5	0.2	4524144
High Molecular Weight PAH`s	mg/kg	4.2	0.01	4.1	0.01	1.8	0.01	3.9	0.01	6.9	0.01	5.5	0.01	4524144
Total PAH	mg/kg	6.4	0.08	6.4	0.07	2.7	0.04	7.4	0.08	12	0.1	13	0.2	4524144
Surrogate Recovery (%)														
D10-ANTHRACENE (sur.)	%	100		100		100		95		95		100		4542849
D12-BENZO(A)PYRENE (sur.)	%	90		100		90		90		85		95		4542849
D8-ACENAPHTHYLENE (sur.)	%	60		60		90		60		55		60		4542849
D8-NAPHTHALENE (sur.)	%	95		95		90		90		95		95		4542849
TERPHENYL-D14 (sur.)	%	95		100		100		95		90		100		4542849

RDL = Reportable Detection Limit
(1) - RDL raised due to sample dilution.
(2) - RDL raised due to sample dilution. Matrix spike recovery outside control limit - High target compounds - No impact, spike Invalid.
(3) - RDL raised due to sample matrix interference.

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General Comments

Sample Z18215-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18216-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18217-01: ** SEM/AVS = 0.57 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18218-01: ** SEM/AVS = 0.04 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18219-01: ** SEM/AVS = 0.04 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18220-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

CSR DISSOLVED METALS IN WATER (SEA WATER) Comments

Sample Z18207-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18208-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18209-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18210-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18211-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18212-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18213-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4523747	Total Suspended Solids	2010/12/22			100	80 - 120	<1	mg/L				
4526373	Moisture	2010/12/23					<0.3	%	0	20		
4527562	O-TERPHENYL (sur.)	2010/12/24	85	50 - 130	99	50 - 130	97	%				
4527562	F2 (C10-C16 Hydrocarbons)	2010/12/24	102	50 - 130	99	80 - 120	<10	mg/kg	0.6(1)	40		
4527562	F3 (C16-C34 Hydrocarbons)	2010/12/24	113	50 - 130	107	80 - 120	<10	mg/kg	4.2(1)	40		
4527562	F4 (C34-C50 Hydrocarbons)	2010/12/24	111	50 - 130	107	80 - 120	<10	mg/kg	19.6(1)	40		
4527562	Reached Baseline at C50	2010/12/24							NC	50		
4527833	4-BROMOFLUOROBENZENE (sur.)	2010/12/23	86	70 - 130	86	70 - 130	83	%			88	70 - 130
4527833	D10-ETHYLBENZENE (sur.)	2010/12/23	88	50 - 130	74	50 - 130	82	%			73	50 - 130
4527833	D4-1,2-DICHLOROETHANE (sur.)	2010/12/23	98	70 - 130	97	70 - 130	94	%			94	70 - 130
4527833	D8-TOLUENE (sur.)	2010/12/23	94	70 - 130	94	70 - 130	96	%			98	70 - 130
4527833	Benzene	2010/12/24	103	60 - 140	99	60 - 140	<0.005	mg/kg	18.9	40		
4527833	Toluene	2010/12/24	89	60 - 140	85	60 - 140	<0.02	mg/kg	NC	40		
4527833	Ethylbenzene	2010/12/24	101	60 - 140	96	60 - 140	<0.01	mg/kg	NC	40		
4527833	m & p-Xylene	2010/12/24	98	60 - 140	93	60 - 140	<0.04	mg/kg	NC	40		
4527833	o-Xylene	2010/12/24	94	60 - 140	90	60 - 140	<0.04	mg/kg	NC	40		
4527833	(C6-C10)	2010/12/23					<10	mg/kg			108	60 - 140
4527833	Methyl-tert-butylether(MTBE)	2010/12/24					<0.1	mg/kg	NC	40		
4527833	Styrene	2010/12/24					<0.03	mg/kg	NC	40		
4527833	Xylenes (Total)	2010/12/24					<0.04	mg/kg	NC	40		
4528403	Total Arsenic (As)	2010/12/23	99	75 - 125	95	75 - 125	<0.2	mg/kg	12.2	30	100	70 - 130
4528403	Total Beryllium (Be)	2010/12/23	104	75 - 125	101	75 - 125	<0.1	mg/kg	NC	30		
4528403	Total Cadmium (Cd)	2010/12/23	103	75 - 125	95	75 - 125	<0.05	mg/kg	NC	30	104	70 - 130
4528403	Total Chromium (Cr)	2010/12/23	100	75 - 125	93	75 - 125	<1	mg/kg	4.0	30	102	70 - 130
4528403	Total Cobalt (Co)	2010/12/23	95	75 - 125	92	75 - 125	<0.3	mg/kg	4.3	30	96	70 - 130
4528403	Total Copper (Cu)	2010/12/23	99	75 - 125	95	75 - 125	<0.5	mg/kg	4.6	30	95	70 - 130
4528403	Total Lead (Pb)	2010/12/23	104	75 - 125	99	75 - 125	<0.1	mg/kg	1.2	35	106	70 - 130
4528403	Total Mercury (Hg)	2010/12/23	102	75 - 125	100	75 - 125	<0.05	mg/kg	NC	35		
4528403	Total Nickel (Ni)	2010/12/23	97	75 - 125	93	75 - 125	<0.8	mg/kg	3.0	30	97	70 - 130
4528403	Total Selenium (Se)	2010/12/23	97	75 - 125	96	75 - 125	<0.5	mg/kg	NC	30		
4528403	Total Vanadium (V)	2010/12/23	NC	75 - 125	94	75 - 125	<2	mg/kg	3.4	30	104	70 - 130
4528403	Total Zinc (Zn)	2010/12/23	NC	75 - 125	94	75 - 125	<1	mg/kg	6.3	30	92	70 - 130
4528403	Total Aluminum (Al)	2010/12/23					<100	mg/kg	4.8	35	105	70 - 130
4528403	Total Antimony (Sb)	2010/12/23					<0.1	mg/kg	NC	30	101	70 - 130
4528403	Total Barium (Ba)	2010/12/23					<0.1	mg/kg	5.4	35	105	70 - 130
4528403	Total Calcium (Ca)	2010/12/23					<100	mg/kg	4.1	30	101	70 - 130
4528403	Total Iron (Fe)	2010/12/23					<100	mg/kg	3.3	30	99	70 - 130
4528403	Total Magnesium (Mg)	2010/12/23					<100	mg/kg	2.3	30	101	70 - 130
4528403	Total Manganese (Mn)	2010/12/23					<0.2	mg/kg	3.3	30	101	70 - 130
4528403	Total Molybdenum (Mo)	2010/12/23					<0.1	mg/kg	8.6	35	95	70 - 130

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4528403	Total Phosphorus (P)	2010/12/23					<10	mg/kg	7.9	30	103	70 - 130
4528403	Total Strontium (Sr)	2010/12/23					<0.1	mg/kg	1.8	35	96	70 - 130
4528403	Total Thallium (Tl)	2010/12/23					<0.05	mg/kg	NC	30	94	70 - 130
4528403	Total Titanium (Ti)	2010/12/23					<1	mg/kg	17.6	35	108	70 - 130
4528403	Total Bismuth (Bi)	2010/12/23					<0.1	mg/kg	NC	30		
4528403	Total Potassium (K)	2010/12/23					<100	mg/kg	2.8	35		
4528403	Total Silver (Ag)	2010/12/23					<0.05	mg/kg	NC	35		
4528403	Total Sodium (Na)	2010/12/23					<100	mg/kg	NC	35		
4528403	Total Tin (Sn)	2010/12/23					<0.1	mg/kg	NC	35		
4528403	Total Zirconium (Zr)	2010/12/23					<0.5	mg/kg	NC	30		
4529385	Soluble (2:1) pH	2010/12/23			102	96 - 104			0.3	20		
4529525	Dissolved Arsenic (As)	2010/12/31	99	80 - 120	98	80 - 120	<0.0001	mg/L	3.9	20		
4529525	Dissolved Beryllium (Be)	2010/12/31	93	80 - 120	103	80 - 120	<0.0001	mg/L	NC	20		
4529525	Dissolved Cadmium (Cd)	2010/12/31	95	80 - 120	99	80 - 120	<0.00001	mg/L	15.3	20		
4529525	Dissolved Chromium (Cr)	2010/12/31	106	80 - 120	102	80 - 120	<0.001	mg/L	NC	20		
4529525	Dissolved Cobalt (Co)	2010/12/31	103	80 - 120	103	80 - 120	<0.0005	mg/L	1.1	20		
4529525	Dissolved Copper (Cu)	2010/12/31	100	80 - 120	103	80 - 120	<0.0002	mg/L	NC	20		
4529525	Dissolved Lead (Pb)	2010/12/31	91	80 - 120	105	80 - 120	<0.0002	mg/L	NC	20		
4529525	Dissolved Lithium (Li)	2010/12/31	97	80 - 120	105	80 - 120	<0.005	mg/L	NC	20		
4529525	Dissolved Nickel (Ni)	2010/12/31	NC	80 - 120	102	80 - 120	<0.001	mg/L	1.0	20		
4529525	Dissolved Selenium (Se)	2010/12/31	98	80 - 120	104	80 - 120	<0.0001	mg/L	0.05	20		
4529525	Dissolved Uranium (U)	2010/12/31	100	80 - 120	107	80 - 120	<0.0001	mg/L	NC	20		
4529525	Dissolved Vanadium (V)	2010/12/31	108	80 - 120	101	80 - 120	<0.005	mg/L	NC	20		
4529525	Dissolved Zinc (Zn)	2010/12/31	94	80 - 120	99	80 - 120	<0.005	mg/L	NC	20		
4529525	Dissolved Aluminum (Al)	2010/12/31					<0.003	mg/L	NC	20		
4529525	Dissolved Antimony (Sb)	2010/12/31					<0.0005	mg/L	NC	20		
4529525	Dissolved Barium (Ba)	2010/12/31					<0.001	mg/L	0.6	20		
4529525	Dissolved Bismuth (Bi)	2010/12/31					<0.001	mg/L	NC	20		
4529525	Dissolved Boron (B)	2010/12/31					<0.05	mg/L	2.4	20		
4529525	Dissolved Iron (Fe)	2010/12/31					<0.005	mg/L	NC	20		
4529525	Dissolved Manganese (Mn)	2010/12/31					<0.001	mg/L	1.1	20		
4529525	Dissolved Mercury (Hg)	2010/12/31					<0.00002	mg/L	NC	20		
4529525	Dissolved Molybdenum (Mo)	2010/12/31					<0.001	mg/L	NC	20		
4529525	Dissolved Silicon (Si)	2010/12/31					<0.1	mg/L	2.7	20		
4529525	Dissolved Silver (Ag)	2010/12/31					<0.00002	mg/L	NC	20		
4529525	Dissolved Strontium (Sr)	2010/12/31					<0.001	mg/L	2.4	20		
4529525	Dissolved Thallium (Tl)	2010/12/31					<0.00005	mg/L	NC	20		
4529525	Dissolved Tin (Sn)	2010/12/31					<0.005	mg/L	NC	20		
4529525	Dissolved Titanium (Ti)	2010/12/31					<0.005	mg/L	NC	20		
4529525	Dissolved Zirconium (Zr)	2010/12/31					<0.0005	mg/L	NC	20		

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4531369	Total Ammonia (N)	2010/12/24	93	80 - 120	102	90 - 110	<0.05	mg/L	NC	20		
4534611	Sulphide	2010/12/29	93	80 - 120	96	80 - 120	<0.005	mg/L	2.6	20		
4541759	Sulphide	2011/01/04	NC	75 - 125	105	75 - 125	<0.2	ug/g	16.0(2)	30		
4542344	SEM Cadmium (Cd)	2011/01/04					<0.0002	umole/g				
4542344	SEM Copper (Cu)	2011/01/04					<0.004	umole/g				
4542344	SEM Lead (Pb)	2011/01/04					<0.0002	umole/g				
4542344	SEM Mercury (Hg)	2011/01/04					<0.0003	umole/g				
4542344	SEM Nickel (Ni)	2011/01/04					<0.004	umole/g				
4542344	SEM Zinc (Zn)	2011/01/04					<0.008	umole/g				
4542849	D10-ANTHRACENE (sur.)	2011/01/06	100	60 - 130	93	60 - 130	101	%				
4542849	D12-BENZO(A)PYRENE (sur.)	2011/01/06	90	60 - 130	91	60 - 130	92	%				
4542849	D8-ACENAPHTHYLENE (sur.)	2011/01/06	70	50 - 130	85	50 - 130	97	%				
4542849	D8-NAPHTHALENE (sur.)	2011/01/06	95	50 - 130	85	50 - 130	100	%				
4542849	TERPHENYL-D14 (sur.)	2011/01/06	100	60 - 130	96	60 - 130	107	%				
4542849	Naphthalene	2011/01/06	NC	40 - 130	95	40 - 130	0.001, RDL=0.001	mg/kg	10.8(3)	50		
4542849	2-Methylnaphthalene	2011/01/06	NC	40 - 130	86	40 - 130	<0.001	mg/kg	12.6(3)	50		
4542849	Acenaphthylene	2011/01/06	74	40 - 130	91	40 - 130	<0.001	mg/kg	NC(4)	50		
4542849	Acenaphthene	2011/01/06	NC	40 - 130	97	40 - 130	<0.001	mg/kg	2.0(3)	50		
4542849	Fluorene	2011/01/06	NC	40 - 130	94	40 - 130	<0.001	mg/kg	3.5(3)	50		
4542849	Phenanthrene	2011/01/06	NC	40 - 130	95	40 - 130	<0.001	mg/kg	7.0(3)	50		
4542849	Anthracene	2011/01/06	NC	40 - 130	94	40 - 130	<0.001	mg/kg	0.6(3)	50		
4542849	Fluoranthene	2011/01/06	NC	40 - 130	92	40 - 130	<0.001	mg/kg	2.3(3)	50		
4542849	Pyrene	2011/01/06	NC	40 - 130	99	40 - 130	<0.001	mg/kg	2.4(3)	50		
4542849	Benzo(a)anthracene	2011/01/06	NC	40 - 130	85	40 - 130	<0.001	mg/kg	7.1(3)	50		
4542849	Chrysene	2011/01/06	NC	40 - 130	85	40 - 130	<0.001	mg/kg	6.3(3)	50		
4542849	Benzo(b&j)fluoranthene	2011/01/06	NC	40 - 130	96	40 - 130	<0.001	mg/kg	4.4(3)	50		
4542849	Benzo(k)fluoranthene	2011/01/06	NC	40 - 130	89	40 - 130	<0.001	mg/kg	4.4(3)	50		
4542849	Benzo(a)pyrene	2011/01/06	NC	40 - 130	91	40 - 130	<0.001	mg/kg	3.8(3)	50		
4542849	Indeno(1,2,3-cd)pyrene	2011/01/06	93	40 - 130	82	40 - 130	<0.002	mg/kg	0.2(3)	50		
4542849	Dibenz(a,h)anthracene	2011/01/06	89	40 - 130	77	40 - 130	<0.002	mg/kg	0.5(3)	50		
4542849	Benzo(g,h,i)perylene	2011/01/06	NC	40 - 130	81	40 - 130	<0.002	mg/kg	10.7(3)	50		
4658036	Dissolved Arsenic (As)	2011/03/02	104	75 - 125	98	75 - 125	<0.5	ug/L	NC	25		
4658036	Dissolved Barium (Ba)	2011/03/02	99	75 - 125	97	75 - 125	<1	ug/L	1.2	25		
4658036	Dissolved Beryllium (Be)	2011/03/02	92	75 - 125	91	75 - 125	<1	ug/L	NC	25		
4658036	Dissolved Cadmium (Cd)	2011/03/02	92	75 - 125	97	75 - 125	<0.05	ug/L				
4658036	Dissolved Chromium (Cr)	2011/03/02	97	75 - 125	96	75 - 125	<0.5	ug/L	NC	25		
4658036	Dissolved Cobalt (Co)	2011/03/02	95	75 - 125	98	75 - 125	<0.1	ug/L	NC	25		
4658036	Dissolved Copper (Cu)	2011/03/02	90	75 - 125	97	75 - 125	<0.5	ug/L				
4658036	Dissolved Lead (Pb)	2011/03/02	93	75 - 125	98	75 - 125	<0.1	ug/L				
4658036	Dissolved Lithium (Li)	2011/03/02	93	75 - 125	90	75 - 125	<20	ug/L	NC	25		

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			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4658036	Dissolved Manganese (Mn)	2011/03/02	94	75 - 125	97	75 - 125	<0.5	ug/L	3.2	25		
4658036	Dissolved Nickel (Ni)	2011/03/02	90	75 - 125	98	75 - 125	<0.2	ug/L				
4658036	Dissolved Selenium (Se)	2011/03/02	105	75 - 125	103	75 - 125	<0.5	ug/L	NC	25		
4658036	Dissolved Strontium (Sr)	2011/03/02	NC	75 - 125	97	75 - 125	<10	ug/L	0.9	25		
4658036	Dissolved Titanium (Ti)	2011/03/02	90	75 - 125	95	75 - 125	<10	ug/L				
4658036	Dissolved Uranium (U)	2011/03/02	105	75 - 125	98	75 - 125	<0.05	ug/L	1.2	25		
4658036	Dissolved Vanadium (V)	2011/03/02	100	75 - 125	93	75 - 125	<10	ug/L	NC	25		
4658036	Dissolved Zinc (Zn)	2011/03/02	91	75 - 125	103	75 - 125	<1	ug/L				
4658036	Dissolved Aluminum (Al)	2011/03/02					<10	ug/L	NC	25		
4658036	Dissolved Antimony (Sb)	2011/03/02					<0.5	ug/L	NC	25		
4658036	Dissolved Bismuth (Bi)	2011/03/02					<1	ug/L	NC	25		
4658036	Dissolved Boron (B)	2011/03/02					<50	ug/L	3.2	25		
4658036	Dissolved Iron (Fe)	2011/03/02					<2	ug/L				
4658036	Dissolved Molybdenum (Mo)	2011/03/02					<1	ug/L	NC	25		
4658036	Dissolved Phosphorus (P)	2011/03/02					<50	ug/L				
4658036	Dissolved Silicon (Si)	2011/03/02					<100	ug/L				
4658036	Dissolved Silver (Ag)	2011/03/02					<0.05	ug/L	NC	25		
4658036	Dissolved Thallium (Tl)	2011/03/02					<0.1	ug/L	NC	25		
4658036	Dissolved Tin (Sn)	2011/03/02					<1	ug/L	NC	25		
4661454	Sulphide	2011/02/25	72(5)	80 - 120	103	80 - 120	0.006, RDL=0.005	mg/L	NC(2)	20		
4665414	Total Ammonia (N)	2011/02/28	NC	80 - 120	101	90 - 110	<0.05	mg/L	2.3	20		
4668576	Total Suspended Solids	2011/03/01	106	80 - 120	98	80 - 120	<4	mg/L	NC	20		

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) - Sample contained > 50% moisture.
(2) - Matrix spike exceeds acceptance limits due to matrix interference. Re-analysis yields similar results.
(3) - RDL raised due to sample dilution.
(4) - RDL raised due to sample matrix interference.
(5) - Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

BCCQ492

CHAIN OF CUSTODY RECORD/ANALYSIS REQUEST

№ 0086 page 1 of 1

Golder Associates
500-4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone 604-298-6623 Fax 604-298-5253

Project Number:	Laboratory Name:
09-1436-5008 / 5000	~~Lab, Smith Harbour~~ Maxxam
[redacted]	Address: 4606 Canada Way, Burnaby BC V5G 1K5
Golder Contact: Adrian de Bruyn	Golder E-mail Address: Adrian_deBruyn@golder.com
Telephone/Fax: 1800-665-8566	Contact: VJ OCO

Office the final reports should be sent to:

- ☐ 500 – 4260 Still Creek Dr. Burnaby, B.C. V5C 6C6 Tel: 604-298-6623 Fax: 604-298-5253
- ☐ 202 – 2790 Gladwin Road Abbotsford, B.C. V2T 4S8 Tel: 604-850-8786 Fax: 604-850-8756
- ☑ 3795 Carey Road, 2nd floor Victoria, B.C. V8Z 6T8 Tel: 250-881-7372 Fax: 250-881-7470

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D / M / Y)	[redacted]	Number of Containers	Analyses Required: Toxicity-Echinoderm fert.	Porewater TIE	Hold	Bulk Sediment Chem	Porewater Extraction	Echinoderm fert. TIE on porewater	Porewater Chemistry			RUSH	Remarks (over)
0086 -01	[redacted]	Sed	15/12/10	[redacted]	4			✓	✓	✓	✓	✓				
0086 -02		Sed			4			✓	✓	✓	✓	✓				
0086 -03		Sed			4			✓	✓	✓	✓	✓				
0086 -04		Sed			4			✓	✓	✓	✓	✓				
0086 -05		Sed			4			✓	✓	✓	✓	✓				
0086 -06		Sed			4			✓	✓	✓	✓	✓				
-07																
-08																
-09																
-10																
-11																
-12																

Sampler's Signature:	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
[redacted]	[redacted]	Golder	Dec. 16/10	11:00		
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by:	Date	Time
Attn. Jeremy Keating And See email instructions	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C) 5, 4, 4	Cooler opened by: E. DAVIEL	Date 17/12/10 Time 09:15

WHITE: Golder Copy YELLOW: Lab Copy PINK: Lab Returns with Final Report

Temp(°C) each bucket: [illegible]

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

CHAIN OF CUSTODY RECORD

Page: ___ of ___

G 040858

Maxxam Job#: BOC2492

Invoice To: Require Report? Yes [X] No [ ]

Company Name:

Contact Name: 8287

Address:

PC:

Phone / Fax#: Ph: Fax:

E-mail

Report To:

Company Name:

Contact Name:

Address:

PC:

Phone / Fax#: Ph: Fax:

E-mail jpickard@maxxam.ca
jkeating@maxxam.ca

PO #:	
Quotation #:	
Project # :	
Proj. Name:	
Location:	
Sampled By:	

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [ ] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER
- [ ] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day [ ] 2 Day [ ] 3 Day

Date Required:

Special Instructions:

Return Cooler [ ] Ship Sample Bottles (please specify) [ ]

Add to job BOC2492

ANALYSIS REQUESTED

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	BTEX/VPH	VOC/VPH	EPH	PAH	CCME-PHC (Fractions 1-4 Plus BTEX)	CCME-PHC (Fractions 2-4)	CCME BTEX (Fraction 1 Plus BTEX)	PCB	Phenols by 4AAP	TOG	Dissolved Metals (Field Filtered?)	Field Filtered?	Totals Metals Field Acidified?	Nitrate	Chloride	Total Suspended Solids-TSS	pH	BOD	COD	Coliform, Total & E.coli	Asbestos	NH4AC-W SENDTO EDMONTON ENVIRONMENTAL			SULFIDES	
1	0086-02 Porewater		SEA	2011FEB22											X					X						X			X	
2	0086-04 Porewater		H_2O	2011FEB22											X					X						X			X	
3	0086-06 Porewater			2011FEB22											X					X						X			X	
4	0086-02 (Sulf. Amended)			2011FEB23											X					X						X			X	
5	0086-04 (Sulf. Amended)			2011FEB23											X					X						X			X	
6	0086-06 (Sulf. Amended)			2011FEB23											X					X						X			X	
7																														
8																														
9																														
10																														
11																														
12																														

Samples are from a Drinking Water Source? YES [ ] NO [ ]

Does source supply multiple households? YES [ ] NO [ ]

Laboratory Use Only

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
K. Pomery	2011 FEB 23	1205	C. Ross	11 02 23	1405	[ ]		Yes [ ] No [ ]

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

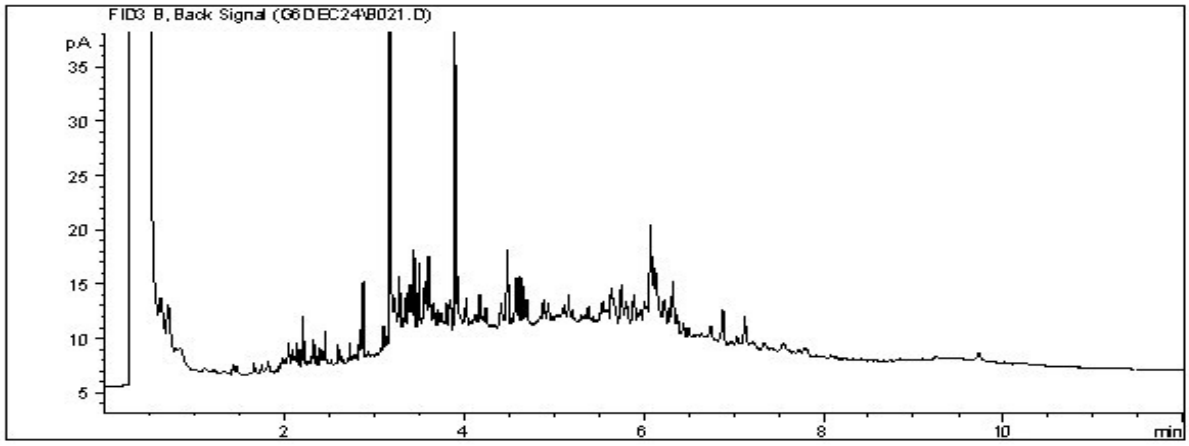
White: Maxxam Yellow: Client

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18215

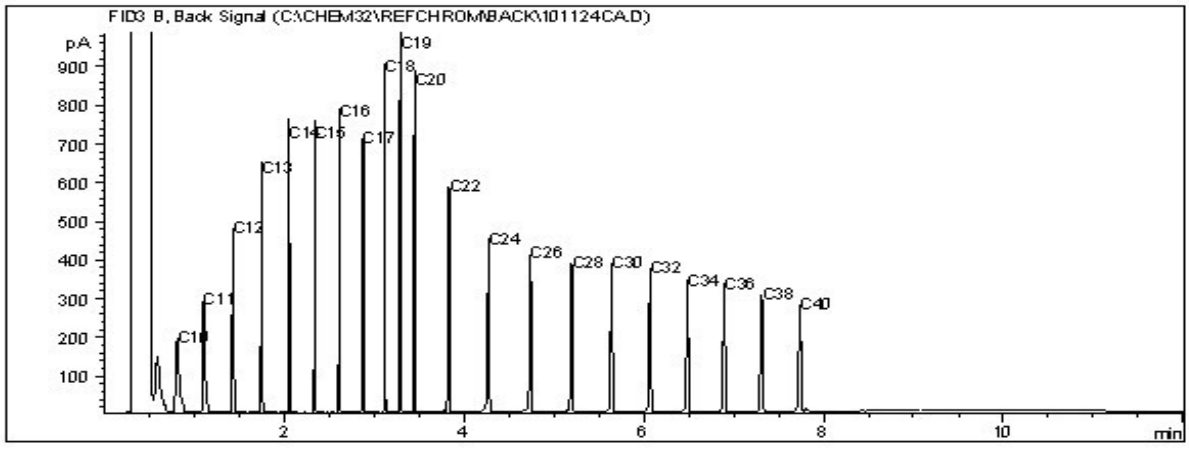
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-01 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

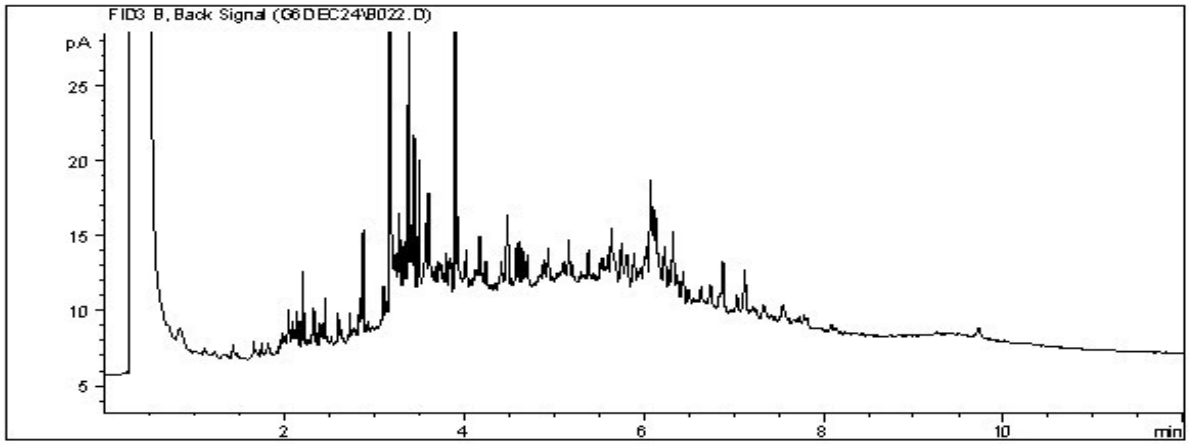
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18216

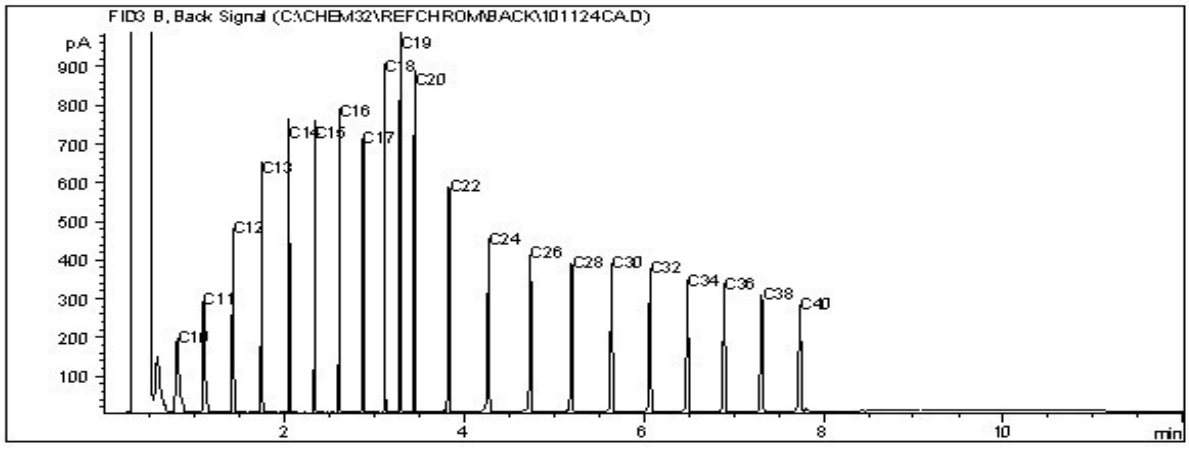
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-02 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

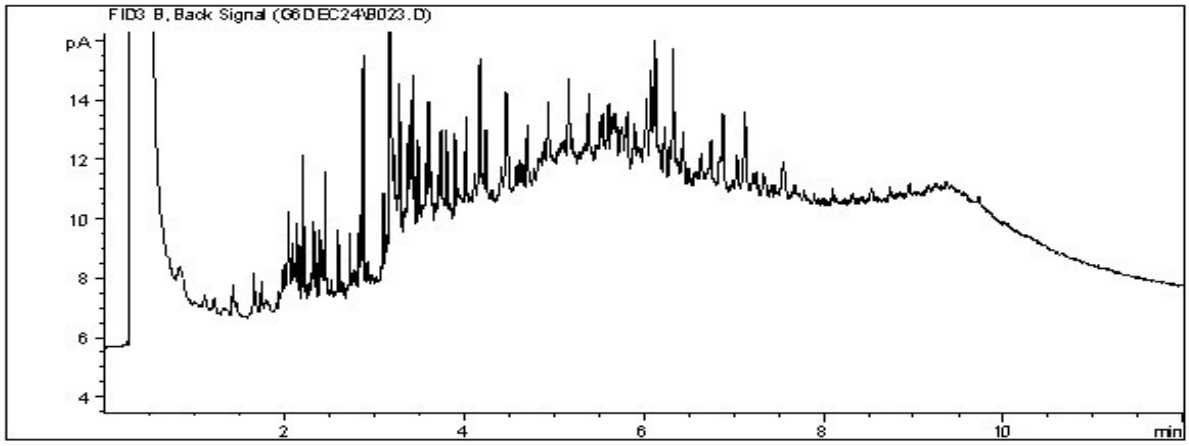
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18217

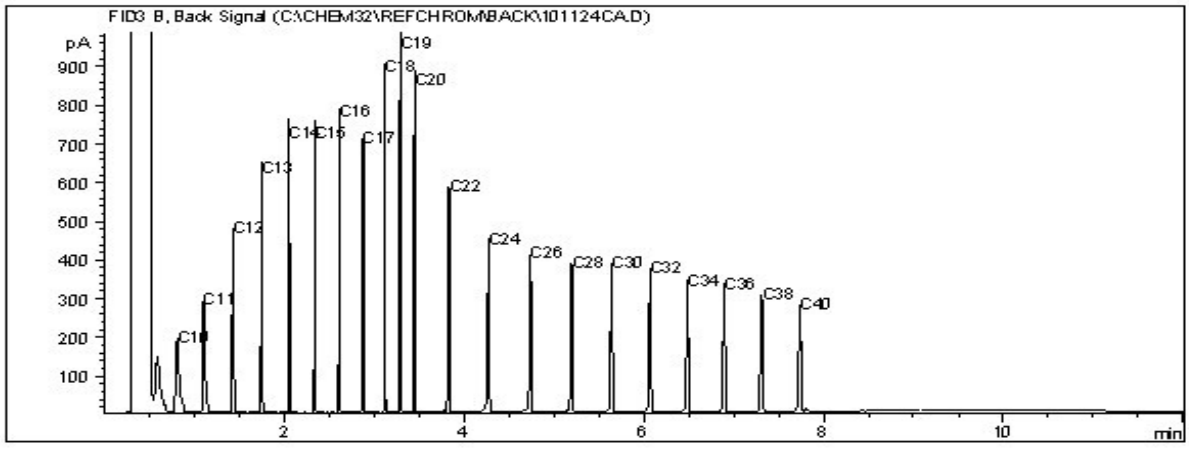
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-03 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

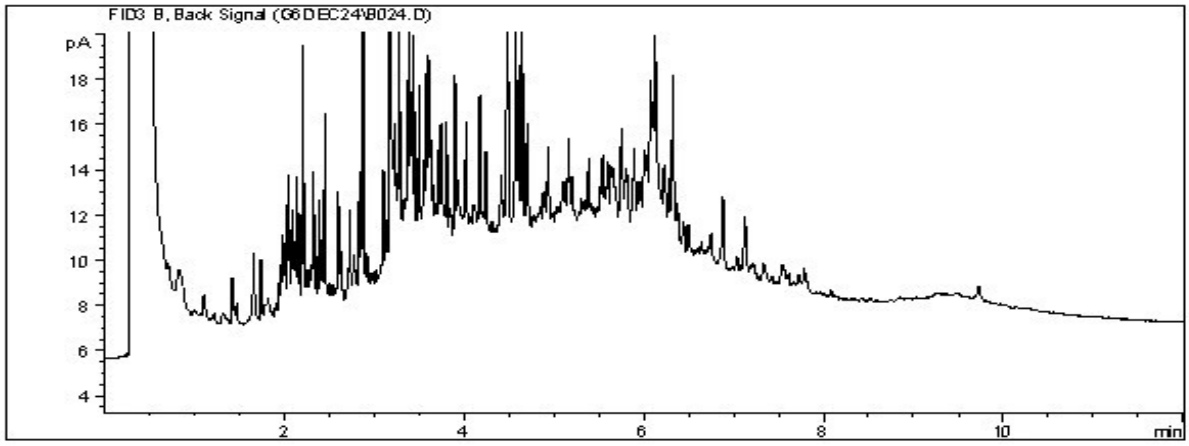
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18218

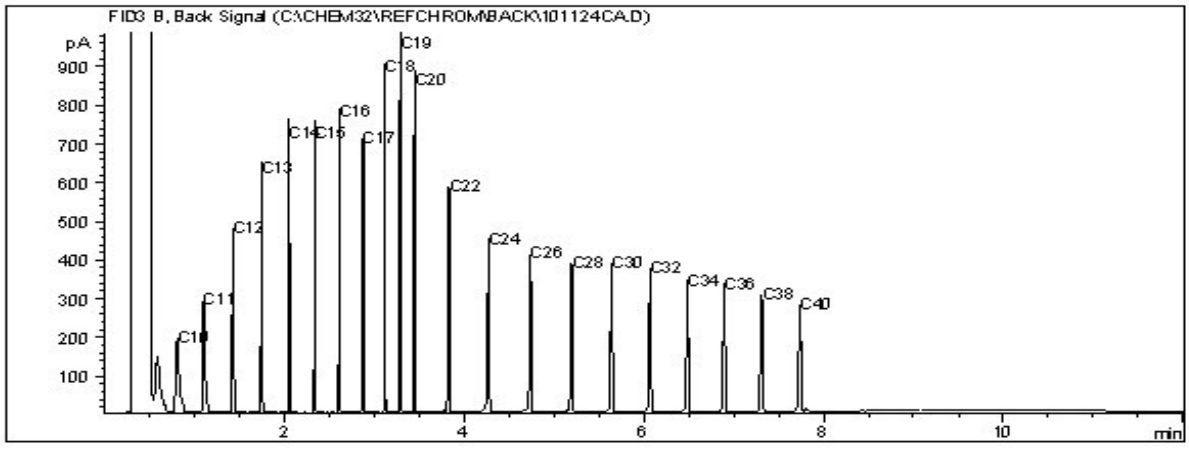
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-04 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

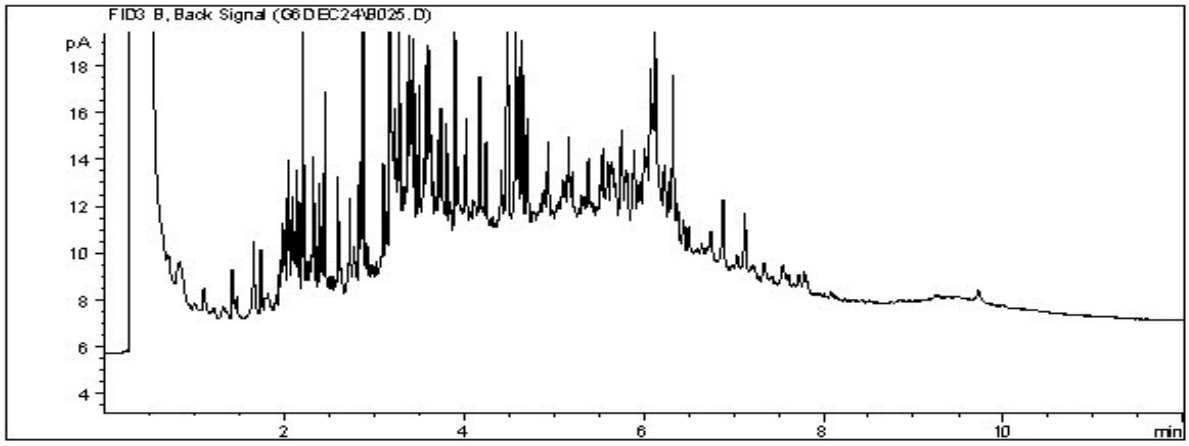
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18218 Lab-Dup

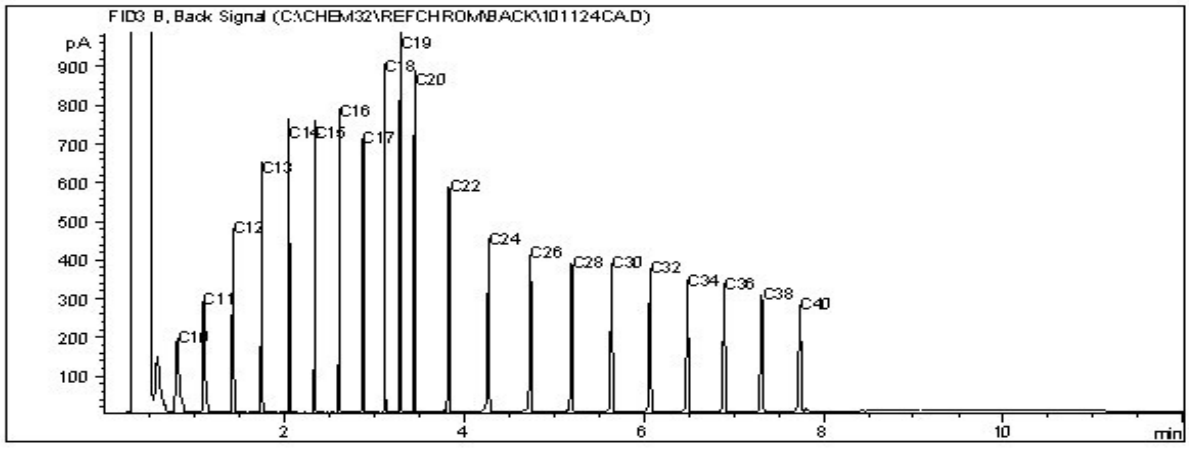
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-04 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

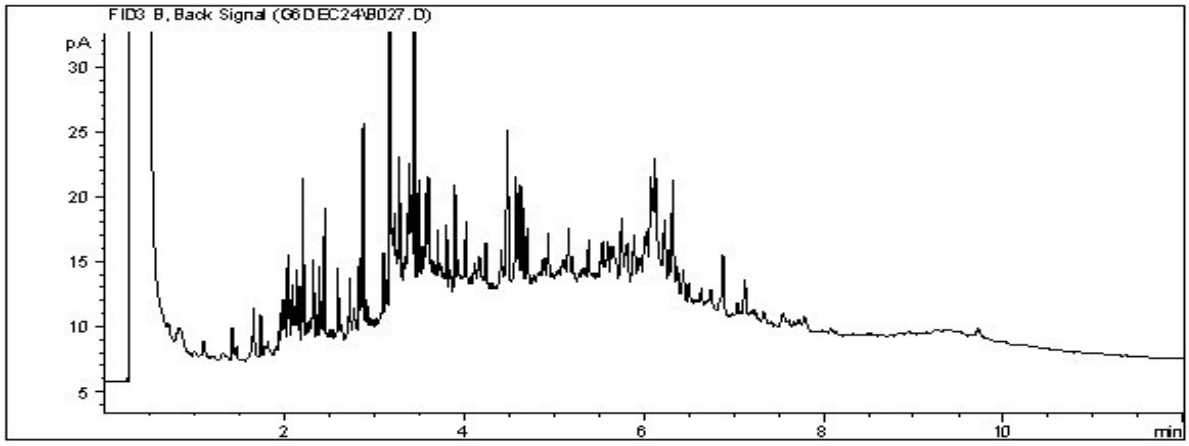
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18219

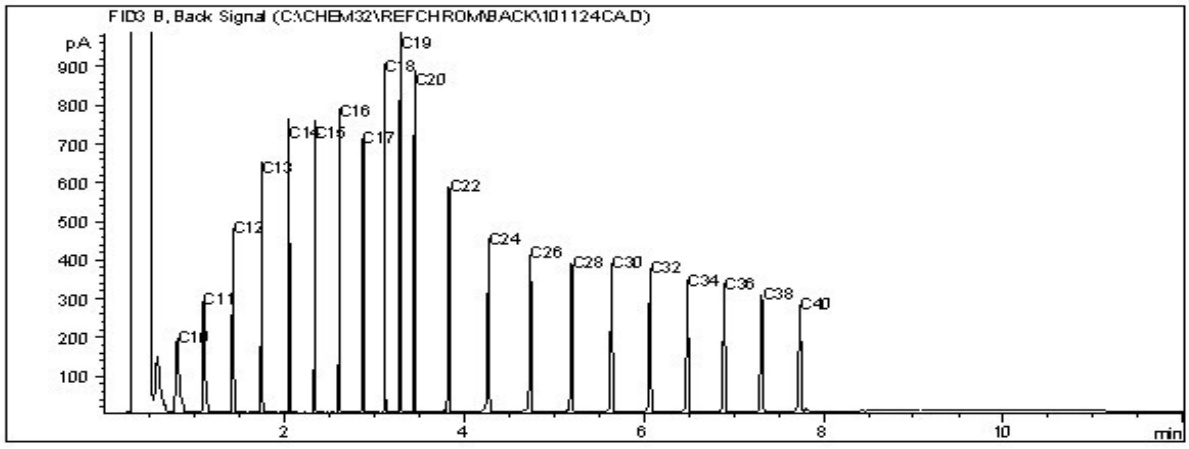
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-05 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

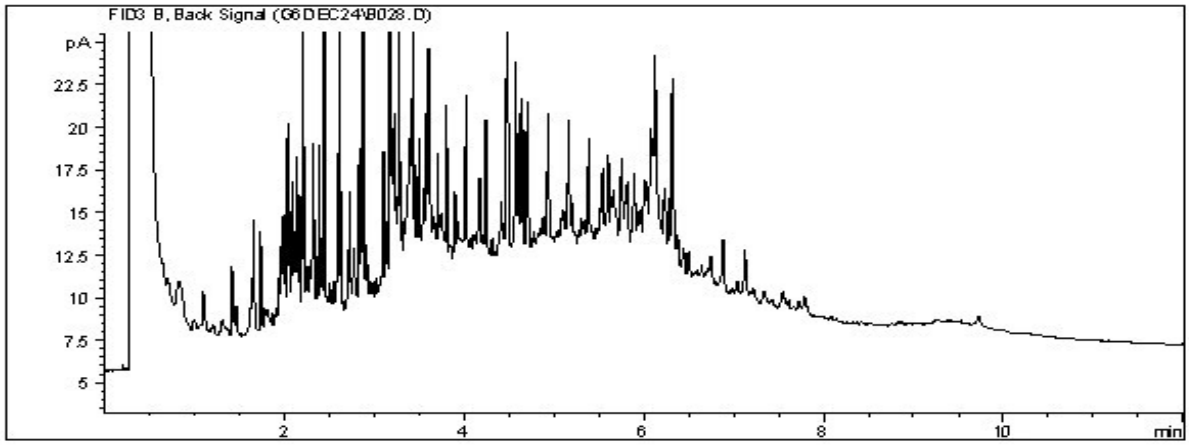
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18220

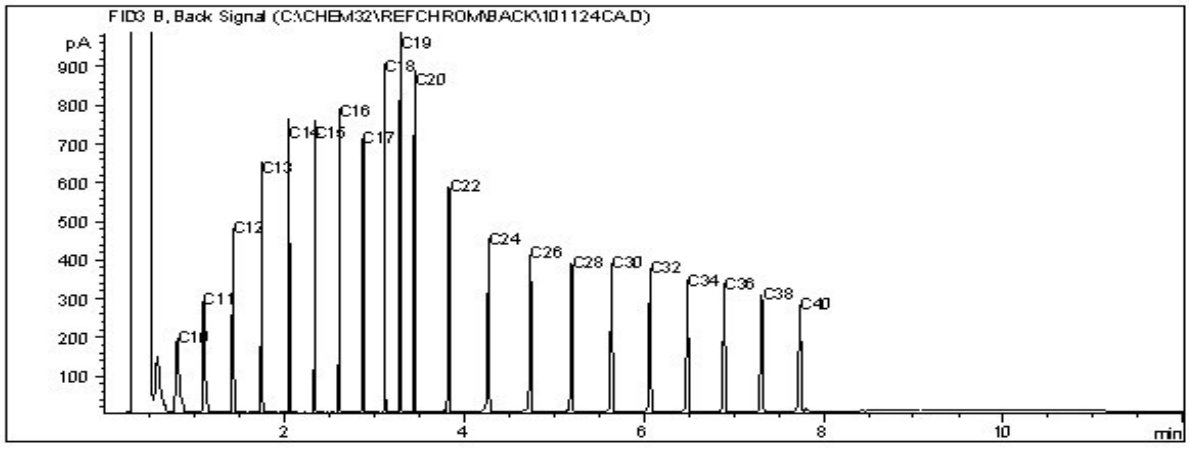
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-06 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

maxxam.ca
MAXXAM ANALYTICS
4606 Canada Way
Burnaby, BC V5G 1K5
Office (604) 734 7276
Toll Free: 1-800 665 8566
Fax (604) 731 2386

ECHINODERM FERTILIZATION TESTS CONDUCTED ON LADYSMITH HARBOUR MARINE SEDIMENTS (DECEMBER 2010) PROJECT: 09-1436-5008/5000 - FINAL REPORT

Prepared for:

Golder Associates
500-4260 Still Creek Drive
Burnaby, British Columbia
Canada V5C 6C6

Prepared by:

Ecotoxicology Group
Maxxam Analytics
4606 Canada Way
Burnaby, BC
Canada V5G 1K5

Maxxam Project No.: 2-11-1071

March 2011

EXECUTIVE SUMMARY

A total of 6 sediment samples were collected from Ladysmith Harbour, British Columbia, December 15, 2010. The samples were received at Maxxam on December 17, 2010, where they were stored in the dark at 4 ± 2°C, prior to testing.

The fertilization success of gametes of the echinoderm, *Strongylocentrotus purpuratus,* was measured according to the Environment Canada's Biological Test Method: Fertilization Assay Using Echinoids Test (EPS 1/RM/27). The Echinoid Fertilization test was performed on December 21, 2010. Gametes were exposed to centrifuged porewater from each of the selected sediments.

The test results are summarized as follows:

Five of the six sediment porewater samples were found to have significantly lower mean echinoderm fertilization compared to the negative control: 0086-01, 0086-02, 0086-04, 0086-05 and 0086-06.

The echinoderm fertilization tests were considered valid as fertilization in the laboratory control met the requirements outlined in the test protocol.

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B *Strongylocentrotus Purpuratus* Raw Data

C Porewater and Sediment Chemistry

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SECTION

1 SEDIMENT DESCRIPTION

1.1 Sample Information

A total of 6 sediment samples were collected from Ladysmith Harbour, BC, December 15, 2010. The samples were received at Maxxam in good condition on December 17, 2010. Sample receipt information, along with the Chain-of-Custody Form, is available in Appendix A.

All samples arrived at Maxxam in satisfactory condition, and there were no apparent events du2ring shipping and handling which might compromise the quality of the samples. The samples varied in colour, texture, grain size and content. Upon opening the sample pails, a description of the sample was noted ("Sediment Sample Descriptions" in Appendix A). The sediments from each sample were thoroughly homogenised before their distribution into the test vessels as per the Maxxam SOP for the "Sediment Mixing Procedures for Toxicity Tests" (DCN 80-E-010). Any headspace in the pails was replaced with nitrogen gas prior to re-sealing the pail. When not in use, the sediments were stored without light at 4 ± 2°C.

1.2 Porewater and Sediment Characterisation

Prior to toxicity testing, porewater aliquots were collected from the sediment samples for ammonia, sulphide and total suspended solids (TSS). Table 1-1 summarizes the results of these analyses. A copy of the chemistry reports containing the results of the ammonia, sulphide, TSS, hardness and metals analyses are in Appendix C.

Table 1-1: Results for Porewater Total Ammonia, Unionized Ammonia, Sulphides, and TSS

Sample ID	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)	Sulphide (mg/L)	TSS (mg/L)
0086-01	3.0	0.0140	2.90*	86
0086-02	2.7	0.0098	3.5*	110
0086-03	2.4	0.0113	0.015	120
0086-04	4.4	0.0184	19.4	77
0086-05	2.8	0.0107	1.11	92
0086-06	5.4	0.0248	22.2	76

* - Sample received at less than recommended preservation pH 9

Porewater un-ionized ammonia was determined using the Un-ionized Ammonia Calculator (Seawater) Spreadsheet (Colt 2002), adjusting for salinity, pH, and temperature. The spreadsheet used for unionized ammonia calculation is located in Appendix C.

Homogenized sub-samples of all sediments were analyzed for metals, AVS/SEM, petroleum hydrocarbons, PAHs, grain size, Total Organic Carbon (TOC) and moisture content. A copy of the chemistry reports containing the results of the above mentioned analyses are in Appendix C.

1.3 Laboratory Control Water

The laboratory control water was uncontaminated seawater obtained from the Vancouver Aquarium. The seawater was pumped from Burrard Inlet from a depth of 40-45 feet and filtered through a gravity sand filter, with sand mesh size 22. After filtration, the seawater was held in a concrete reservoir (retention time approximately 4 hours) before passing through a UV sterilizer.

At Maxxam, the seawater was stored at 4 ± 2°C. Before its use in tests, the seawater was passed through a UV sterilizer equipped with an inline 5 µm filter. Volumes required for testing were gradually brought to the appropriate test temperature overnight while vigorously aerating.

SECTION

2 *STRONGLYOCENTROTUS PURPURATUS* FERTILIZATION TEST

2.1 Test Methods and Conditions

The successful fertilization of echinoderm eggs was assessed according to the Environment Canada Biological Test Method "Fertilization Assay Using Echinoids (Sand Dollars or Sea Urchins)" EPS 1/RM/27 and the Maxxam SOP "Test Method for the Echinoid 20 Minute Fertilization Test" (DCN 80-C-029). Echinoderm fertilization tests were initiated on the centrifuged porewater of 6 test sediments, on December 21, 2010. See Table 2-1 for details regarding the specific methods and conditions employed in this test.

Table 2-1: Summary of Test Methods and Conditions for the Echinoderm Fertilization Test

Parameter	**Conditions and Methods**
Test Type and Duration	20 minute fertilization; 10 minutes sperm exposure only, followed by another 10 minutes exposure with both sperm and eggs.
Temperature	15 ± 1° C
Salinity	30 ± 2 ‰
Lighting	Broad spectrum fluorescent lighting
Aeration	None during test. No pre-aeration required.
Test Chamber	20 ml borosilicate glass tubes
Test solution volume	5 ml
Control Water	Vancouver Aquarium seawater, from Burrard Inlet, 40-45' deep inlet, gravity sand filtered with sand mesh size 22. Seawater was additionally filtered, UV sterilized and aerated before use.
Renewal Water	None
Replicates	5 replicates/sample
Test Species	*Strongylocentrotus purpuratus* – Purple Sea Urchin
Age of Test Organisms	Recently spawned eggs and sperm

Parameter	Conditions and Methods
Organisms/ replicate	970 eggs and 36375 sperm were added to each test vessel. The sperm:egg ratio was 37.5:1. See Calculation of Gamete Density sheet in Appendix B
Organism Source and size	Marine Research and Educational Products, Carlsbad, CA. Sea Urchins were between 3-9 cm in diameter and gravid.
Feeding	None
Water Quality	DO, pH, salinity and temperature in the 100% porewater before test initiation
Endpoints	Fertilization rate
Test Validity Criteria	≥50% and <100% fertilization in the control.
Data Analysis	Data were assessed for normality using Shapiro-Wilks Test, and homogeneity of variance by Bartlett's Test. Analyses of mean fertilization rate, comparing the samples to the negative control were completed using parametric two sample t-tests (equal variance).
Statistical Software	CETIS™ version 1.7.0revO. Tidepool Scientific Software (Copyright 2000-2009).

2.2 Quality Assurance/Quality Control

2.2.1 Reference Toxicant Results

A water-only reference toxicant test, using copper sulphate ($CuSO_4$), was initiated on December 21, 2010. The reference toxicant test is used to assess the performance of the test organism and the precision of the results. The LC50 and 95% confidence intervals were calculated then entered into a control chart. The results were then compared with those of previous tests with this test organism, which are included in Appendix B. Methods used in preparing the control chart were taken from the Maxxam SOP "Standard Operating Procedure for the Control Charting of Reference Toxicant Tests" (DCN 80-E-008) and from Environment Canada (1990).

The IC50 value for the current reference toxicant test, with 95% Confidence Limits, was 31.3 (29.5, 33.0) µg/L Cu^{2+}. The previous mean for this species, with 2 SD, was 31.4 (13.8, 71.8) µg/L Cu^{2+}.

2.2.2 Test Validity Criteria

Survival data in the negative control was considered be acceptable as the mean percent fertilization in the negative control was greater than or equal to 50%, and less than 100%. The mean percent fertilization in the negative control was 97%.

2.2.3 Organism Holding Information

The *Stronglyocentrotus purpuratus* were field-collected by Steve Lepage of Marine Research and Educational Products, located in Carlsbad, CA. The organisms were held for at least 24 hours prior to shipment to Maxxam. The sea urchins were shipped in Styrofoam coolers, with ice packs, and arrived at Maxxam in good condition on December 21, 2010.

Upon arrival, the sea urchins were transferred to glass aquaria filled with gently aerating sea water and held there prior to test initiation. Bench-sheets with recorded water quality, acclimation activities, and spawning records during the holding period are presented in Appendix B.

2.3 Results

Total and percent fertilization, in each replicate, and mean ± SD in the control and test sediment porewater samples, are presented in Appendix B. The mean fertilization rate ± SD for the control and test samples are summarized in Table 2-2.

For water quality measurements, see the bench-sheets in Appendix B.

Table 2-2: Results for Mean Fertilization Comparisons for the Echinoderm Fertilization Test

Maxxam Sample ID	Maxxam Login ID	Mean Fertilization ± SD (%)
Control	-	97 ± 2
0086-01	Z09675-01	16 ± 4*
0086-02	Z09676-01	10 ± 5*
0086-03	Z09677-01	97 ± 1
0086-04	Z09678-01	1 ± 1*
0086-05	Z09679-01	36 ± 5*
0086-06	Z09680-01	1 ± 1*

Note: Asterisks indicate that there is a statistically significant decrease in the sample mean as compared to the negative control (*).

2.4 Discussion

The test met validity criteria as the mean percent fertilization in the negative control was 97%. The total mean percent fertilization in the test ranged from 1% to 97%. Significant reductions in mean fertilization when compared to the negative control were found in samples all samples except 0086-03.

SECTION

3 REFERENCES

Colt, J. 2002. Un-ionized Ammonia Calculator (Seawater). Fish Spreadsheet Appendices. *In* Fish Hatchery Management, Second Edition. Gary A. Wedemeyer, editor. American Fisheries Society, Bethesda, MD.

Environment Canada. 1990. Guidance Document for Control of Toxicity Test Precision Using Reference Toxicants. EPS 1/RM/12. Conservation and Protection, Ottawa, ON.

Environment Canada. 1992. Biological Test Method: Fertilization Assay Using Echinoids (Sand Dollars and Sea Urchins). Including 1997 Amendments. EPS 1/RM/27. Conservation and Protection, Ottawa, ON.

Standard Operating Procedure for the Sediment Mixing Procedures for Toxicity Tests (DCN 80-E-010).

Standard Operating Procedure for the Control Charting of Reference Toxicant Tests. (DCN 80-E-008).

Test Method for the Echinoid 20 Minute Fertilization Test. (DCN 80-C-029).

APPENDICES

APPENDIX

A SAMPLE INFORMATION AND CHAIN OF CUSTODY RECORD

National Client: 103, Golder Associates Ltd

Client: GOLDER ASSOCIATES LTD
4260 STILL CREEK DRIVE
Suite 500
BURNABY BC
Canada V5C 6C6

Inv Attn: Accounts Payable

Task Order:
Line Item:

Printed: 2010/12/20 Version 4
Reception Date: 2010/12/17
Reception Time: 09:15
Login Date: 2010/12/17
REQUIRED DATE: 2011/03/16, 18:00
Quote Number: B01555

Report: same

Attention: Adrian de Bruyn
PHONE: (604) 297 - 2011Ext:
FAX: (604) 298 - 5253
EMAIL: Adrian_deBruyn@golder.com

Project Coordinator: VO1

P.O. Number:
PROJECT NUMBER: 09-1436-5008/5000
Site Location:
Site #:
Client Number: 1473
Rpt Address #:
Q.C. Samples: No

Maxxam Number	Client Sample ID/Report ID	Cont's	Store Code	Recd. OK	Sampling Date	MATRIX	Test Codes
Z09675-01R	0086-01	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-01						ECOTXSV-SD
Z09676-01R	0086-02	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-02						ECOTXSV-SD
Z09677-01R	0086-03	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-03						ECOTXSV-SD
Z09678-01R	0086-04	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-04						ECOTXSV-SD
Z09679-01R	0086-05	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-05						ECOTXSV-SD
Z09680-01R	0086-06	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-06						ECOTXSV-SD

Remarks: mbb

Inspected by: MBO
Date: 2010/12/17
Time: 09:43

Approved by: MBO
Date: 2010/12/17
Time: 09:58

Date of Sample Disposal:
Disposal by:

BOCQ492

CHAIN OF CUSTODY RECORD/ANALYSIS REQUEST

№ 0086 page 1 of 1

Golder Associates
500-4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone 604-298-6623 Fax 604-298-5253

Project Number: 09-1436-5008 / 5000	Laboratory Name: ~~[illegible]~~ Maxxam
[redacted]	Address: 4606 Canada Way, Burnaby BC V5G 1K5
Golder Contact: Adaan de Beuyn	Golder E-mail Address: Adaan_deBeuyn@golder.com
Telephone/Fax: 1800-665-8566	Contact: VJ OCO

Office the final reports should be sent to:

- ☐ 500 – 4260 Still Creek Dr. Burnaby, B.C. V5C 6C6 Tel: 604-298-6623 Fax: 604-298-5253
- ☐ 202 – 2790 Gladwin Road Abbotsford, B.C. V2T 4S8 Tel: 604-850-8786 Fax: 604-850-8756
- ☑ 3795 Carey Road, 2nd floor Victoria, B.C. V8Z 6T8 Tel: 250-881-7372 Fax: 250-881-7470

Analyses Required

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D / M / Y)	[redacted]	Number of Containers	Toxicity Echinoderm test	Porewater TTE	Hold	Bulk Sediment Chem	Porewater Extraction	Echinoderm test, TTE on porewater	Porewater Chemistry			RUSH	Remarks (over)
0086-01	[redacted]	Sed	15/12/10	[redacted]	4			✓	✓	✓	✓	✓				
0086-02	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-03	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-04	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-05	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-06	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
-07	[redacted]			[redacted]												
-08	[redacted]			[redacted]												
-09	[redacted]			[redacted]												
-10	[redacted]			[redacted]												
-11	[redacted]			[redacted]												
-12	[redacted]			[redacted]												

Sampler's Signature:	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
[signature]	[signature]	Golder	Dec. 16/10	11:00		
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by:	Date	Time
Attn. Jeremy Keating See email instructions	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C) ~~5, 4, 4~~ 2 / Cooler opened by: E. DAVIEL	Date 17/12/10	Time 09:15

WHITE: Golder Copy YELLOW: Lab Copy PINK: Lab Returns with Final Report

temp (°C) each bucket: 6 5 5 6 5 6 5 4 6 5 5 4 6 6 5 5 4 5 4 4 7 6 2 7

APPENDIX

B *STRONGYLOCENTROTUS PURPURATUS* RAW DATA

CETIS Analytical Report

Echinoid Sperm Cell Fertilization Test — **Maxxam Analytics**

Analysis ID:	01-0679-5145	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	10 Jan-11 11:10	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes
Batch ID:	06-4102-3479	**Test Type:**	Fertilization	**Analyst:**	L. Stavroff
Start Date:	21 Dec-10 19:45	**Protocol:**	EC/EPS 1/RM/27	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	21 Dec-10 20:05	**Species:**	Strongylocentrotus purpuratus	**Brine:**	Ocean Pure
Duration:	20m	**Source:**	Marine Research and Educational Products	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
CTRL2010Dec21	00-4685-8601	21 Dec-10 09:00		11h	Golder Associates (Burnaby)	2-11-1071 Golder Sed TIE
0086-01.	10-9048-6787	15 Dec-10 09:00	17 Dec-10 09:15	6d 11h		
0086-02.	18-8514-9412	15 Dec-10 09:00	17 Dec-10 09:15	6d 11h		
0086-03.	17-4639-3852	15 Dec-10 09:00	17 Dec-10 09:15	6d 11h		
0086-04.	21-2859-8667	15 Dec-10 09:00	17 Dec-10 09:15	6d 11h		
0086-05.	04-0346-3057	15 Dec-10 09:00	17 Dec-10 09:15	6d 11h		
0086-06.	15-0453-1158	15 Dec-10 09:00	17 Dec-10 09:15	6d 11h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
CTRL2010Dec21	SW Control	Golder	Negative Control		
0086-01.	Marine/Estuarine Sedim	Golder	0086-01		
0086-02.	Marine/Estuarine Sedim	Golder	0086-02		
0086-03.	Marine/Estuarine Sedim	Golder	0086-03		
0086-04.	Marine/Estuarine Sedim	Golder	0086-04		
0086-05.	Marine/Estuarine Sedim	Golder	0086-05		
0086-06.	Marine/Estuarine Sedim	Golder	0086-06		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C <> T	Not Run					3.47%

Dunnett's Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
CTRL2010Dec21		0086-01.	29.51	2.731	0.09326	<0.0001	Significant Effect
		0086-02.	32.41	2.731	0.09326	<0.0001	Significant Effect
		0086-03.	0.5359	2.731	0.09326	0.9870	Non-Significant Effect
		0086-04.	38.61	2.731	0.09326	<0.0001	Significant Effect
		0086-05.	22.55	2.731	0.09326	<0.0001	Significant Effect
		0086-06.	38.66	2.731	0.09326	<0.0001	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision
Extreme Value	Grubbs Single Outlier	2.609	2.978	0.2156	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	9.640347	1.606725	6	551.2	<0.0001	Significant Effect
Error	0.08161882	0.002914958	28			
Total	9.721967	1.609639	34			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Bartlett Equality of Variance	5.709	16.81	0.4566	Equal Variances
Distribution	Shapiro-Wilk Normality	0.9706		0.4612	Normal Distribution

2011Jan10 2011Jan10

Echinoid Sperm Cell Fertilization Test — **Maxxam Analytics**

Analysis ID:	01-0679-5145	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	10 Jan-11 11:10	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Fertilization Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
CTRL2010Dec21	5	0.974	0.9671	0.9809	0.95	0.99	0.008124	0.01817	1.87%	0.0%
0086-01.	5	0.16	0.1445	0.1755	0.11	0.22	0.01817	0.04062	25.39%	83.57%
0086-02.	5	0.098	0.0778	0.1182	0.05	0.18	0.02375	0.0531	54.19%	89.94%
0086-03.	5	0.97	0.9662	0.9738	0.96	0.98	0.004472	0.01	1.03%	0.41%
0086-04.	5	0.01	0.00731	0.01269	0	0.02	0.003162	0.007071	70.71%	98.97%
0086-05.	5	0.364	0.3458	0.3822	0.3	0.42	0.02135	0.04775	13.12%	62.63%
0086-06.	5	0.01	0.006196	0.0138	0	0.02	0.004472	0.01	100.0%	98.97%

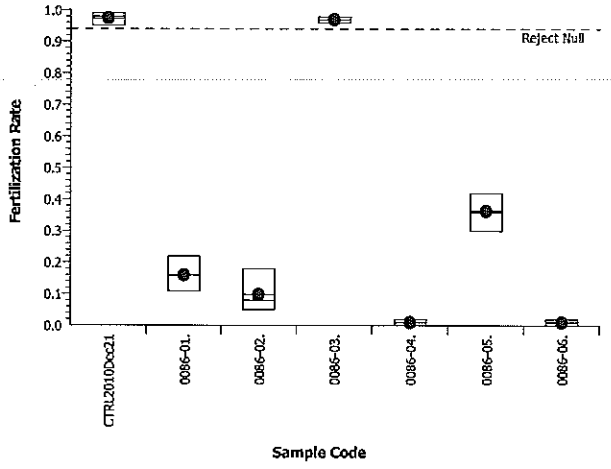
Angular (Corrected) Transformed Summary

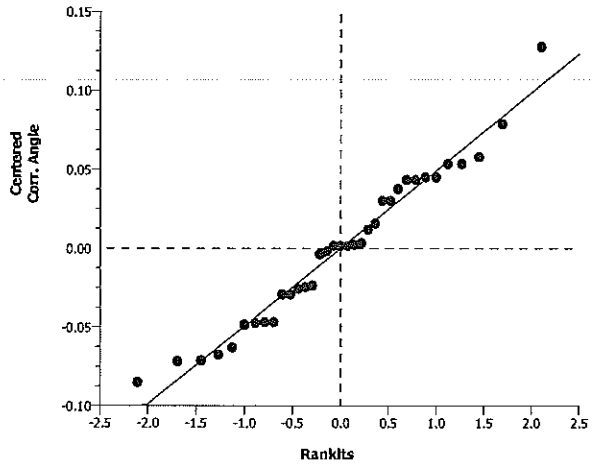
Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
CTRL2010Dec21	5	1.417	1.395	1.439	1.345	1.471	0.02579	0.05766	4.07%	0.0%
0086-01.	5	0.4093	0.3882	0.4303	0.3381	0.4882	0.02472	0.05527	13.5%	71.12%
0086-02.	5	0.3103	0.2774	0.3432	0.2255	0.4381	0.03868	0.08649	27.87%	78.1%
0086-03.	5	1.399	1.387	1.41	1.369	1.429	0.01331	0.02975	2.13%	1.29%
0086-04.	5	0.09848	0.0861	0.1109	0.05002	0.1419	0.01456	0.03256	33.07%	93.05%
0086-05.	5	0.6471	0.6281	0.6661	0.5796	0.7051	0.02229	0.04985	7.7%	54.33%
0086-06.	5	0.0968	0.07931	0.1143	0.05002	0.1419	0.02056	0.04598	47.5%	93.17%

Fertilization Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
CTRL2010Dec21	0.95	0.98	0.96	0.99	0.99
0086-01.	0.22	0.11	0.17	0.16	0.14
0086-02.	0.05	0.12	0.08	0.18	0.06
0086-03.	0.98	0.96	0.98	0.96	0.97
0086-04.	0.02	0.01	0.01	0.01	0
0086-05.	0.34	0.42	0.3	0.4	0.36
0086-06.	0.02	0	0	0.01	0.02

Graphics





2011Jan10 2011 Jan 10

Analyst: LS QA: PH

Maxxam Analytics

Echinoderm Fertilization Test
Summary of Test Data

Species: *S. purpuratus* | Organism Lot #: MR101221

Client # & Name: #1473 Golder | Start Date: 2010 December 21 @ 19:45

Sample ID: Various | Date Counted: 2010 December 23, 24

Stats. File ID: SPF-1473-0110 | Analyst(s): L. Stavroff

Concentration/ Sample	Replicate	Total # Counted	# Fertilized	# Unfertilized	% Fertilized	Mean	SD
Seawater Control	A	100	95	5	95%	97%	2%
	B	100	98	2	98%		
	C	100	96	4	96%		
	D	100	99	1	99%		
	E	100	99	1	99%		
0086-01	A	100	22	78	22%	16%	4%
	B	100	11	89	11%		
	C	100	17	83	17%		
	D	100	16	84	16%		
	E	100	14	86	14%		
0086-02	A	100	5	95	5%	10%	5%
	B	100	12	88	12%		
	C	100	8	92	8%		
	D	100	18	82	18%		
	E	100	6	94	6%		
0086-03	A	100	98	2	98%	97%	1%
	B	100	96	4	96%		
	C	100	98	2	98%		
	D	100	96	4	96%		
	E	100	97	3	97%		
0086-04	A	100	2	98	2%	1%	1%
	B	100	1	99	1%		
	C	100	1	99	1%		
	D	100	1	99	1%		
	E	100	0	100	0%		
0086-05	A	100	34	66	34%	36%	5%
	B	100	42	58	42%		
	C	100	30	70	30%		
	D	100	40	60	40%		
	E	100	36	64	36%		
0086-06	A	100	2	98	2%	1%	1%
	B	100	0	100	0%		
	C	100	0	100	0%		
	D	100	1	99	1%		
	E	100	2	98	2%		
Analyst			LS	LS			

Proofed By: P. Howes
2011 Jan 10

Maxxam Analytics **Echinoderm Fertilisation Test**

Summary of Test Data

Species: S. purpuratus
Client # & Name: #1473 Golder
Sample ID: Various
Sample Date: 2010Dec15
Stats. File ID: SDF-1473-0110

Start Date & Time: 2010Dec21@1945
Organism Lot: MR101221
Test Volume (mL): 5mL
Date Counted: 2010Dec23, 24

Seawater Source: Van Aquarium
Seawater Batch: 2010Dec14

Sample pre-aeration: See Initial WQ Sheet
Analyst(s): LStavroff, P. Hawes

Control Seawater WQ Measurements

Temp (°C): 14.0
DO (mg/L): 8.5
Salinity (‰): 30
pH: 7.8

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Replicate	A	B	C	D	E
SW Control	30	14.0	7.8	8.5	Fertilized	95	98	96	99	99
					Unfertilized	5	2	4	1	1
0086-01	30	14.4	7.5	4.0	Fertilized	22	11	17	16	14
					Unfertilized	78	89	83	84	86
0086-02	29	14.0	7.4	4.1	Fertilized	5	12	8	18	6
					Unfertilized	95	88	92	82	94
0086-03	28	14.3	7.5	6.4	Fertilized	98	96	98	96	97
					Unfertilized	2	4	2	4	3
0086-04	30	14.0	7.4	4.1	Fertilized	2	1	1	1	0
					Unfertilized	98	99	99	99	100
0086-05	30	14.8	7.4	5.0	Fertilized	34	42	30	40	36
					Unfertilized	66	58	70	60	64
0086-06	30	14.2	7.5	5.1	Fertilized	2	0	0	1	2
					Unfertilized	98	100	100	99	98
					Fertilized					
					Unfertilized					
					Fertilized					
					Unfertilized					
					Fertilized					
					Unfertilized					
					Fertilized					
					Unfertilized					
					Fertilized					
					Unfertilized					
Analyst	pH	pH	pH	pH	Analyst	LS	LS	LS	LS	LS

LStavroff 2010Dec21

Comments: SW filtered through 0.5 um filter + UV sterilized before use; on Dec 20/2010.

ECOTOXICOLOGY
ACCLIMATION AND HOLDING CONDITIONS

MaxXam

Organism: S. purpuratus
Organism Lot #: MR1012-2021 issue 2010Dec21
Supplier: MREP
Customer #: #1473

Arrival Date & Time: 2010Dec21@11:00
Age upon Arrival: grand
Ordered: 50
Study/Project # : 2-11-1071

Arrival Conditions

Bag ID	# Dead	# Inactive	Salinity (‰) OR Conductivity (µS/cm)	Temperature (°C)	pH	DO (mg/L)	Feeding	Analyst
A	1	0	n/a	n/a	n/a	n/a	No	LS

Container ID: n/a

Daily Conditions During Holding/Acclimation

	Observations		Water Quality					
Date	# Dead	# Inactive	Salinity (‰) OR Conductivity (µS/cm)	Temperature (°C)	pH	DO (mg/L)	Feeding	Analyst

LStalnoff 2010Dec21

Comments (e.g., feeding times and quantities, behaviour, acclimation conditions):	Analyst	Date
Organisms were used upon arrival. Not enough water in box to perform arrival water quality	LS ↓	2010Dec21 ↓

LStalnoff 2010Dec21

Revision: 01
Revision Date: March 25, 2010
Document Control Number: 80-F-089-01

Form approved by: Janet Rickard
Effective date: Apr 01, 2010

Maxxam Analytics

ECHINODERM FERTILIZATION TEST
Fertilization Trial Sperm Dilutions

Species: *Strongylocentrotus purpuratus*

Client #(s): #1473 Test Date: 2010 Dec 21
Organism Lot #: MR101221 Analyst(s): L.Stavroff

Egg Counts: **188**, **200**, **200**, **188**

Number of eggs added to each test tube: 970

Average: **194.0**

Put Ave. # of sperm in <-- this box

Xs = # Sperm/mL = 733250000 733.25
Xe = # eggs added =Average of egg density counts = **194.0**
Vs = volume of suspension (microlitres) = **10**
Conversion factor (microlitres/ml) = 1000
Calculation:

Trial Ratio	Xs	Xe	Vs	Conversion factor	Total Volume	mL Sperm	Total Volume (mL)
0.585	733250000	218.8	10	1000	57286.05	**0.01**	572.86
1.17	733250000	194.0	10	1000	32304.61	**0.01**	323.05
2.34	733250000	194.0	10	1000	16152.30	**0.01**	161.52
4.6875	733250000	194.0	10	1000	8063.23	**0.01**	80.63
9.375	733250000	194.0	10	1000	4031.62	**0.01**	40.32
18.75	733250000	194.0	10	1000	2015.81	**0.1**	201.58
37.50	733250000	194.0	10	1000	1007.90	**0.1**	100.79
75	733250000	194.0	10	1000	503.95	**0.1**	50.40
150	733250000	194.0	10	1000	251.98	**0.1**	25.20
300	733250000	194.0	10	1000	125.99	**1**	125.99
600	733250000	194.0	10	1000	62.99	**1**	62.99
900	733250000	194.0	10	1000	42.00	**1**	42.00

Calculation is: Xs/((Xe/Vs)*trial ratio*conversion factor)

0.01mL = 10uL	0.1mL = 100uL

Maxxam

ECHINOID FERTILIZATION TEST:
Calculations of Gamete Densities

Species: S. purpuratus

Client #(s): #1473 Gober Test Date: 2010Dec21

Organism Lot #: MR101221 Analyst(s): LStanhoff

Exposure Time: 10 min. sperm & 10 min. sperm plus egg

Test Volume: 5.0 mL

Egg Density Counts:

per 10 µL

1) 188 3) 200

2) 200 4) 184

Average = 194

# of Eggs Added to Each Test Tube = $\frac{\text{average eggs} * X_E}{10\ (\mu L)}$

= 970

Sperm Density Calculations:

Medium square on the hemocytometer	Count 1	Count 2	Count 3	Count 4	
1	106	134	157	159	
2	132	130	173	153	
3	137	127	161	165	
4	125	153	142	157	
5	123	140	172	187	Average
Total (5 large squares in the corners and the center of the field)	623	684	805	~~818~~ 821 (A)	733.25

X_E = volume of egg suspension added

X_E = 50 µL

Initial Concentration (C_i) (A) LStanhoff 2010Dec21

 # Sperm/mL = $\frac{\text{(dilution factor) (\# sperm counted)(hemocytometer conversion factor) mm}^3\text{/mL}}{\text{\# of small squares counted}}$

 # Sperm/mL = $\frac{(100)(\text{average \# of sperms counted in 5 large size squares: } 733.25)(800)(1000)}{80}$ = 733250000

Sperm = # sperm/mL 733250000 **/(# of eggs added** 970 **/volume of suspension** 50 µL X **ratio** 37.5 X **1000(µL)/1 mL) Dilution** or total volume of sperm suspension including 1 mL (0.5 mL) of concentrated sperm stock and seawater required to dilute the sperm stock given a desired ratio

= 1007.9 = **Total Volume** (V_f)

Concentration of Sperm Stock Used in Test:

$C_iV_i = C_fV_f$ (733250000)X(1mL) = C_f(1007.9)

initial Concentration * 1 mL = C_f * total volume after dilution _____ = C_f = 727502.7

# of Sperm Added to Each Test Tube = $X_S * C_f$

= ~~36357~~ 36375 LStanhoff 2010Dec06

Sperm:Egg Ratio is $\frac{\text{\#sperm added}}{\text{\#eggs added}}$ or 37.5 :1

X_S = volume of sperm suspension added = 0.05 mL (= # µL x 1mL/1000 µL)

Notes: Trial Ratio 37.5 Counts 99/1 96/4 #Males 12 #Females 9 used for tests

Maxxam

Sediment Sample Descriptions

Client # / Name: 1473 Golder Associates **Project #:** 2-11-1071

Maxxam Sample Name	Sample #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed	Endemic Animals Removed	Odour	Centrifuged for porewater? Y/N	Purged with N_2?	Analyst
0086-01	Z09675-01R	0086-01	2010Dec21	Brown Silt	Shells, Bark wood	none	H_2S	Y	Y	WP
0086-02	Z09676-01R	0086-02	2010 Dec21	Silt, sand dark brown	Wood,	none	H_2S	Y	Y	WP 2010Dec21 RM
0086-03	Z09677-01R	0086-03	2010Dec21	Sand & silt, dark brown	Wood	none	H_2S	Y	Y	RM
0086-04	Z09678-01R	0086-04	2010DEC21	Silt dark brown	Bark, wood	none	H_2S	Y	Y	WP
0086-05	Z09679-01R	0086-05	2010Dec21	Silty & Sand. Dark brown	Wood fibres	none	H_2S	Y	Y	RM
0086-06	Z09680-01R	0086-06	2010DEC21	Silt dark brown	Bark	none	H_2S	Y	Y	WP
				LStawoff 2010Dec21						

Maxxam **Marine Sediment Porewater Measurements**

Client # & Name: 1473 Golder Associates Date Measured: 2010Dec21

Porewater Collection Method: Centrifuged for 30 min @ 5000 rpm.

Sample ID	Salinity (‰)	Temperature (°C)	pH	Ammonia/ Sulfide Samples Taken	Analyst
0086-01	30	22.3	7.4	✓	KM
0086-02	29	22.9	7.3	✓	KM
0086-03	28	22.4	7.5	✓	KM
0086-04	30	23.7	7.4	✓	KM
0086-05	30	22.5	7.4	✓	KM
0086-06	30	22.3	7.4	✓	KM

LStavroff 2010Dec21

Comments

Maxxam Analytics **Echinoderm Fertilisation Test**

Porewater Samples - Initial Water Quality Sheet

Client # & Name: #1473 Golder

Seawater Source: Van Aqua

Seawater Batch: 2010Dec14

Analyst(s): LStawoff, P.Hawes

Start Date & Time: 2010Dec21@ 19:45

Control Seawater WQ Measurements:

Temp (°C): 14.0

DO (mg/L): 8.5

Salinity (‰): 30

pH: 7.8

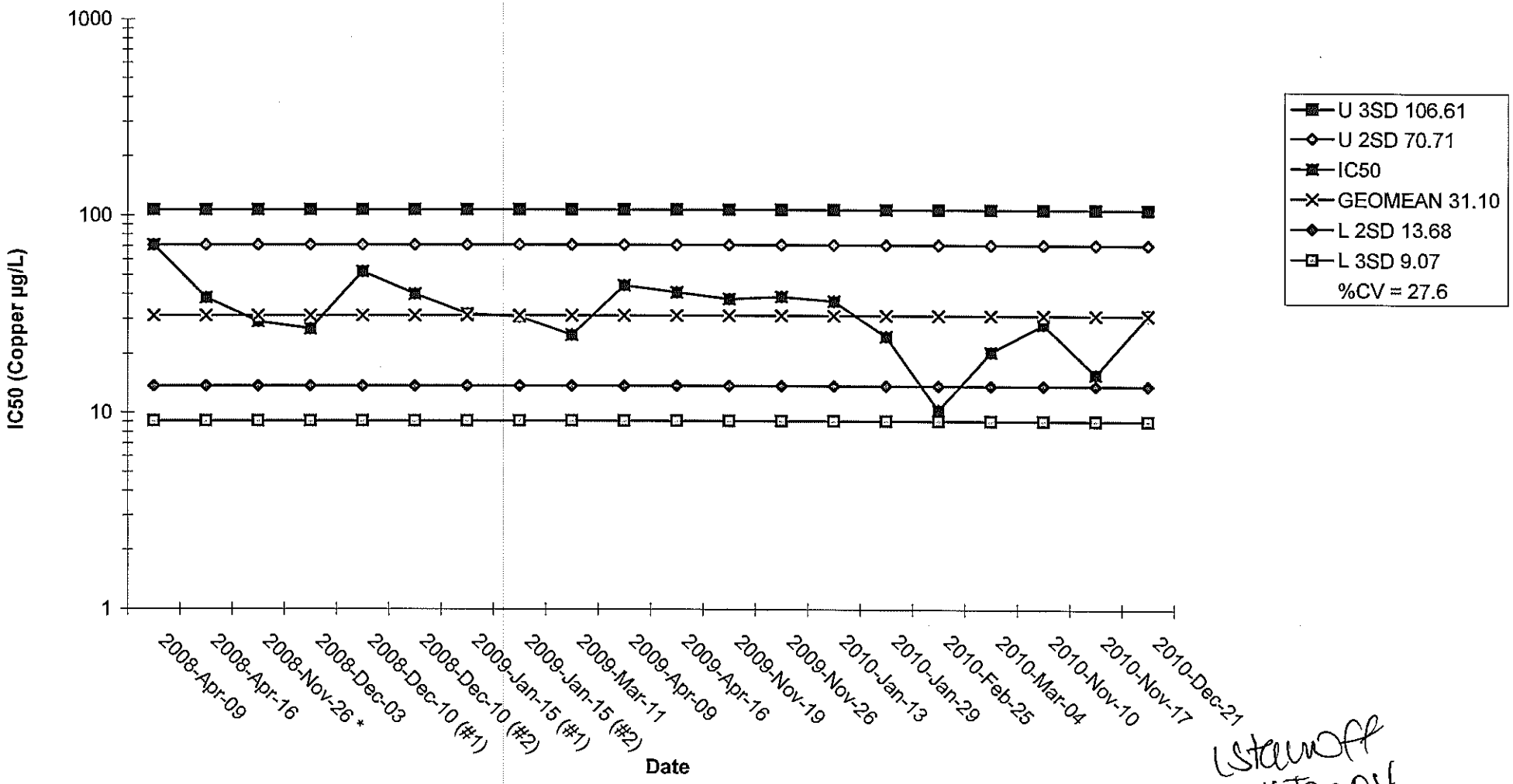
Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Aeration Time (min)	Analyst
SW Control	30	14.0	7.8	8.5	No	PH
0086-01	30	14.4	7.5	4.0	No	PH
0086-02	29	14.0	7.4	4.1	No	PH
0086-03	28	14.3	7.5	6.4	No	PH
0086-04	30	16.0	7.4	4.1	No	PH
0086-05	30	14.8	7.4	5.0	No	PH
0086-06	30	14.2	7.5	5.1	No	PH
					LStawoff 2010Dec21	
	PH	PH	PH	PH		

Comments:

Maxxam Analytics

Strongylocentrotus purpuratus (Sea Urchins)

20 Minute Fertilization Reference Toxicant Control Chart for Cu^{2+}



LStanoff
2011Jan04

APPENDIX

C POREWATER AND SEDIMENT CHEMISTRY

Maxxam Analytics

Sediment Porewater Characterisation

Summary of Pore Water Measurements (December 21, 2010)

Un-ionized Ammonia Calculator

This spreadsheet computes concentration of un-ionized ammonia in seawater as a function of total ammonia, pH, temperature, and salinity. pH can be measured on the "NBS" scale or Hansson scales. If this this confuses you, you are probably using the "NBS" scale and your measured pH values should be entered in Column C.

User information is only needed in cells oultined with double lines. This spreadsheet assumes that total ammonia is reported as nitrogen; computed un-ionized ammonia will also be reported as nitrogen.

Pore Water

Subsample Date	Sample ID	Temp (°C)	Measured pH (NBS)	Total Ammonia Nitrogen (mg/L)	Salinity (‰)	Working pH	Ionic Strength (M)	pKa (infinite dilution)	pKa (SW)	Mole Fraction	Un-ionized Ammonia-N (mg/L)	Un-ionized Ammonia-N (µg/L)
21-Dec-10	0086-01	14.4	7.5	3.0	30	7.35	0.616	9.584	9.68	0.0047	0.0140	14.0
	0086-02	14.0	7.4	2.7	29	7.25	0.595	9.597	9.69	0.0036	0.0098	9.8
	0086-03	14.3	7.5	2.4	28	7.35	0.574	9.587	9.67	0.0047	0.0113	11.3
	0086-04	16.0	7.4	4.4	30	7.25	0.616	9.531	9.62	0.0042	0.0184	18.4
	0086-05	14.8	7.4	2.8	30	7.25	0.616	9.571	9.66	0.0038	0.0107	10.7
	0086-06	14.2	7.5	5.4	30	7.35	0.616	9.591	9.68	0.0046	0.0248	24.8

References

Spreadsheet

http://www.fisheries.org/html/publications/epubs/fhm2e/ammonia_swc.xls

pKa for Ammonia in Freshwater

K. Emerson, R.C. Russo, R.C. Lund, & R.V. Thurson, Aqueous ammonia equilibrium calculations: effects of pH and temperature, J. Fish. Res. Board of Canada, 32:2379-2383, 1975

pKa for Ammonia in Seawater

K.H. Khoo, C.H. Culberson, and R.G. Bates, Thermodynamics of the dissociation of ammonium ion in seawater from % to 40 C, Journal of Solution Chemistry, 6:281-290, 1977.

Ionic Strength of Seawater

M. Whitfield, The hydrolysis of ammonia ions in sea water - a theoretical study, Journal of Marine Biological Association of the United Kingdoms, 54:565-580, 1974.

Measure of pH in Seawater

I. Hansson, A new set of pH scales and standard buffers for sea water, Deep-Sea Research, 20:479-491, 1973.

Interelationship of Hansson's pH scale with the NBS scale

F.J. Millero, The pH of estuarine waters, Limnology and Oceanography, 31:839-847, 1986.

Your Project #: 09-1436-5008/5000
Your C.O.C. #: 0086, G037375

Attention: Adrian de Bruyn
GOLDER ASSOCIATES LTD
4260 STILL CREEK DRIVE
Suite 500
BURNABY, BC
Canada V5C 6C6

Report Date: 2010/12/31

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0C2492
Received: 2010/12/17, 09:15

Sample Matrix: Sea Water
Samples Received: 7

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Hardness (calculated as CaCO3)	7	N/A	2010/12/31		
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	7	N/A	2010/12/31	BBY7SOP-00002	Based on EPA 200.8
Elements by CRC ICPMS (dissolved)	7	N/A	2010/12/31	BBY7SOP-00002	Based on EPA 200.8
Ammonia-N (Total) (1)	7	N/A	2010/12/24	AB SOP-00007	EPA 350.1
Filter and HNO3 Preserve for Metals	7	N/A	2010/12/23	BRN WI-00006 R1.0	Based on EPA 200.2
Sulphide	7	N/A	2010/12/29	BBY6SOP-00006	SM - 4500 S2 D
Total Suspended Solids-LowLevel	7	N/A	2010/12/22	BBY6SOP-00034	Based on SM-2540 D

* Results relate only to the items tested.

(1) This test was performed by Maxxam Edmonton Environmental

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

VJ OCO, Burnaby Customer Service
Email: VOco@maxxam.ca
Phone# (604) 639-8422

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Analytics - Partial/Rush Results

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Maxxam Job #: B0C2492
Report Date: 2010/12/31

Maxxam Analytics - Partial/Rush Results

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		Z18207		Z18208		Z18209		
	Units	**0086-01 POREWATER**	**RDL**	**0086-02 POREWATER**	**RDL**	**0086-03 POREWATER**	**RDL**	**QC Batch**
CONVENTIONALS								
Total Ammonia (N)	mg/L	3.0(1)	0.3	2.7(1)	0.3	2.4(1)	0.3	4531369
Calculated Parameters								
Filter and HNO3 Preservation	N/A	LAB	N/A	LAB	N/A	LAB	N/A	4533846
MISCELLANEOUS								
Sulphide	mg/L	2.90(2)	0.05	3.5(2)	0.2	0.015	0.005	4534611
Physical Properties								
Total Suspended Solids	mg/L	86	1	110	1	120	1	4523747

Maxxam ID		Z18210		Z18211		Z18212		Z18213		
	Units	**0086-04 POREWATER**	**RDL**	**0086-05 POREWATER**	**RDL**	**0086-06 POREWATER**	**RDL**	**SW CONTROL**	**RDL**	**QC Batch**
CONVENTIONALS										
Total Ammonia (N)	mg/L	4.4(1)	0.3	2.8(1)	0.3	5.4(1)	0.3	0.33	0.05	4531369
Calculated Parameters										
Filter and HNO3 Preservation	N/A	LAB	N/A	LAB	N/A	LAB	N/A	LAB	N/A	4533846
MISCELLANEOUS										
Sulphide	mg/L	19.4	0.5	1.11	0.03	22.2	0.5	<0.005	0.005	4534611
Physical Properties										
Total Suspended Solids	mg/L	77	1	92	1	76	1	5	1	4523747

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Detection limits raised due to dilution to bring analyte within the calibrated range.
(2) - Sample received at less than recommended preservation pH 9.

Maxxam Job #: B0C2492
Report Date: 2010/12/31

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

CSR DISSOLVED METALS IN WATER (SEA WATER)

Maxxam ID		Z18207	Z18208	Z18209	Z18210	Z18211	Z18212	Z18213		
	Units	**0086-01 POREWATER**	**0086-02 POREWATER**	**0086-03 POREWATER**	**0086-04 POREWATER**	**0086-05 POREWATER**	**0086-06 POREWATER**	**SW CONTROL**	**RDL**	**QC Batch**
Misc. Inorganics										
Dissolved Hardness (CaCO3)	mg/L	5670	5540	5130	5520	5560	5330	5690	0.5	4523678
Dissolved Metals by ICPMS										
Dissolved Aluminum (Al)	mg/L	0.06	0.61	0.04	0.85	0.04	0.05	0.03	0.03	4529525
Dissolved Antimony (Sb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Arsenic (As)	mg/L	0.010	0.007	0.013	0.033	0.015	0.061	0.002	0.001	4529525
Dissolved Barium (Ba)	mg/L	0.03	0.03	0.02	0.06	0.03	0.05	0.01	0.01	4529525
Dissolved Beryllium (Be)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	4529525
Dissolved Bismuth (Bi)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Boron (B)	mg/L	4.9	5.0	5.2	5.1	4.9	5.2	4.9	0.5	4529525
Dissolved Cadmium (Cd)	mg/L	0.0002	<0.0001	0.0001	0.0002	0.0002	<0.0001	0.0002	0.0001	4529525
Dissolved Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Cobalt (Co)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Copper (Cu)	mg/L	<0.002	<0.002	<0.002	<0.002	0.148	<0.002	<0.002	0.002	4529525
Dissolved Iron (Fe)	mg/L	0.10	0.14	0.08	0.11	0.10	0.06	<0.05	0.05	4529525
Dissolved Lead (Pb)	mg/L	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	0.002	4529525
Dissolved Lithium (Li)	mg/L	0.16	0.15	0.15	0.16	0.15	0.16	0.17	0.05	4529525
Dissolved Manganese (Mn)	mg/L	0.02	0.01	0.09	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Mercury (Hg)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	4529525
Dissolved Molybdenum (Mo)	mg/L	0.04	0.02	0.06	<0.01	0.01	<0.01	<0.01	0.01	4529525
Dissolved Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Selenium (Se)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	4529525
Dissolved Silicon (Si)	mg/L	14	15	6	19	13	18	2	1	4529525
Dissolved Silver (Ag)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	4529525
Dissolved Strontium (Sr)	mg/L	6.79	6.57	6.19	6.63	6.38	6.44	6.56	0.01	4529525
Dissolved Thallium (Tl)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	4529525
Dissolved Tin (Sn)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Titanium (Ti)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Uranium (U)	mg/L	0.003	0.003	0.007	0.003	0.004	0.004	0.003	0.001	4529525
Dissolved Vanadium (V)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Zinc (Zn)	mg/L	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	0.05	4529525
Dissolved Zirconium (Zr)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Calcium (Ca)	mg/L	388	388	366	392	386	370	384	0.5	4523679
Dissolved Magnesium (Mg)	mg/L	1140	1110	1030	1100	1120	1070	1150	0.5	4523679
Dissolved Potassium (K)	mg/L	358	351	347	351	361	351	355	0.5	4523679
Dissolved Sodium (Na)	mg/L	9350	9310	8610	9140	9260	8990	9430	0.5	4523679
Dissolved Sulphur (S)	mg/L	964	953	853	946	898	891	985	30	4523679

RDL = Reportable Detection Limit

Maxxam Analytics - Partial/Rush Results

Maxxam Job #: B0C2492
Report Date: 2010/12/31

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Maxxam Analytics - Partial/Rush Results

CSR DISSOLVED METALS IN WATER (SEA WATER) Comments

Sample Z18207-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18208-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18209-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18210-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18211-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18212-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18213-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Maxxam Job #: B0C2492
Report Date: 2010/12/31

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Maxxam Analytics - Partial/Rush Results

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
4523747	Total Suspended Solids	2010/12/22			100	80 - 120	<1	mg/L		
4529525	Dissolved Arsenic (As)	2010/12/31	99	80 - 120	98	80 - 120	<0.0001	mg/L	3.9	20
4529525	Dissolved Beryllium (Be)	2010/12/31	93	80 - 120	103	80 - 120	<0.0001	mg/L	NC	20
4529525	Dissolved Cadmium (Cd)	2010/12/31	95	80 - 120	99	80 - 120	<0.00001	mg/L	15.3	20
4529525	Dissolved Chromium (Cr)	2010/12/31	106	80 - 120	102	80 - 120	<0.001	mg/L	NC	20
4529525	Dissolved Cobalt (Co)	2010/12/31	103	80 - 120	103	80 - 120	<0.0005	mg/L	1.1	20
4529525	Dissolved Copper (Cu)	2010/12/31	100	80 - 120	103	80 - 120	<0.0002	mg/L	NC	20
4529525	Dissolved Lead (Pb)	2010/12/31	91	80 - 120	105	80 - 120	<0.0002	mg/L	NC	20
4529525	Dissolved Lithium (Li)	2010/12/31	97	80 - 120	105	80 - 120	<0.005	mg/L	NC	20
4529525	Dissolved Nickel (Ni)	2010/12/31	NC	80 - 120	102	80 - 120	<0.001	mg/L	1.0	20
4529525	Dissolved Selenium (Se)	2010/12/31	98	80 - 120	104	80 - 120	<0.0001	mg/L	0.05	20
4529525	Dissolved Uranium (U)	2010/12/31	100	80 - 120	107	80 - 120	<0.0001	mg/L	NC	20
4529525	Dissolved Vanadium (V)	2010/12/31	108	80 - 120	101	80 - 120	<0.005	mg/L	NC	20
4529525	Dissolved Zinc (Zn)	2010/12/31	94	80 - 120	99	80 - 120	<0.005	mg/L	NC	20
4529525	Dissolved Aluminum (Al)	2010/12/31					<0.003	mg/L	NC	20
4529525	Dissolved Antimony (Sb)	2010/12/31					<0.0005	mg/L	NC	20
4529525	Dissolved Barium (Ba)	2010/12/31					<0.001	mg/L	0.6	20
4529525	Dissolved Bismuth (Bi)	2010/12/31					<0.001	mg/L	NC	20
4529525	Dissolved Boron (B)	2010/12/31					<0.05	mg/L	2.4	20
4529525	Dissolved Iron (Fe)	2010/12/31					<0.005	mg/L	NC	20
4529525	Dissolved Manganese (Mn)	2010/12/31					<0.001	mg/L	1.1	20
4529525	Dissolved Mercury (Hg)	2010/12/31					<0.00002	mg/L	NC	20
4529525	Dissolved Molybdenum (Mo)	2010/12/31					<0.001	mg/L	NC	20
4529525	Dissolved Silicon (Si)	2010/12/31					<0.1	mg/L	2.7	20
4529525	Dissolved Silver (Ag)	2010/12/31					<0.00002	mg/L	NC	20
4529525	Dissolved Strontium (Sr)	2010/12/31					<0.001	mg/L	2.4	20
4529525	Dissolved Thallium (Tl)	2010/12/31					<0.00005	mg/L	NC	20
4529525	Dissolved Tin (Sn)	2010/12/31					<0.005	mg/L	NC	20
4529525	Dissolved Titanium (Ti)	2010/12/31					<0.005	mg/L	NC	20
4529525	Dissolved Zirconium (Zr)	2010/12/31					<0.0005	mg/L	NC	20
4531369	Total Ammonia (N)	2010/12/24	93	80 - 120	102	90 - 110	<0.05	mg/L	NC	20
4534611	Sulphide	2010/12/29	93	80 - 120	96	80 - 120	<0.005	mg/L	2.6	20

N/A = Not Applicable
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Maxxam

Success Through Science®

Your P.O. #: A70321
Your Project #: B0C2492
Your C.O.C. #: G037377

Attention: Leslie-Anne Stavroff
Maxxam Analytics (TOX Internal)
Burnaby-Ecotoxicology Division
4606 Canada Way
Burnaby, BC
CANADA V5G 1K5

Report Date: 2011/01/10

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0C3725
Received: 2010/12/21, 17:35

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/MTBE Soil LH, VH, F1 SIM/MS	6	2010/12/22	2010/12/24	BBY8-SOP-00010	EPA SW846 8260C
Volatile F1-BTEX	6	N/A	2010/12/24		
CCME Hydrocarbons (F2-F4 in soil)	6	2010/12/22	2010/12/24	BBY8SOP-00030	CCME Soil Tier 1
Elements by ICPMS (total)	6	2010/12/23	2010/12/23	BBY7SOP-00004	Based on EPA 200.8
Simultaneously Extractable Metals-ICPMS	6	2011/01/04	2011/01/04	BBY7SOP-00001	Based on EPA 200.8
Moisture	6	N/A	2010/12/23	BBY8SOP-00017	Ont MOE -E 3139
PAH in Soil by GC/MS Lowlevel (Extended)	6	2010/12/22	2011/01/06	BRN SOP-00332 R5.0	Based on EPA 8270D
Total LMW, HMW, Total PAH Calc	6	N/A	2011/01/06		PAHTOT-S
pH (2:1 DI Water Extract)	6	2010/12/23	2010/12/23	BBY6SOP-00028	Carter, SSMA 16.2
Particle Size Distribution - Standard (1)	6	2010/12/29	2010/12/29		
Sulfide (AVS) (soil) - Calc for umole/g	6	2010/12/22	2011/01/05	BRN SOP-00229 R2.0	Based EPA821-R91-100
Sulfide (AVS) (soil)	6	2011/01/04	2011/01/04	BBY6SOP-00007	Based EPA821-R91-100
Texture Class (1)	6	N/A	2011/01/10		
TOC Soil Subcontract (2)	6	2011/01/06	2011/01/06		

* Results relate only to the items tested.

(1) This test was performed by Maxxam Winnipeg
(2) This test was performed by Maxxam Ontario (From Burnaby)

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

ARSHDEEP KHALSA, Burnaby Customer Service
Email: AKhalsa@maxxam.ca
Phone# (604) 639-8432

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B0C3725
Report Date: 2011/01/10

Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Your P.O. #: A70321

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		Z18215		Z18216		Z18217		Z18218		Z18219		Z18220	
COC#		G037377		G037377		G037377		G037377		G037377		G037377	
	Units	**0086-01 SEDIMENT**	**RDL**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**RDL**	**0086-06 SEDIMENT**	**RDL**
Parameter													
Subcontract Parameter	N/A	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	N/A
Calculated Parameters													
F1 (C6-C10) - BTEX	mg/kg	<60	60	<50	50	<10	10	<50	50	<60	60	<50	50
Sulphide	umole/g	11.6	0.6	14.7	0.6	2.04	0.06	7.2	0.3	9.3	0.6	12.6	0.6
MISCELLANEOUS													
Sulphide	ug/g	372	20	471	20	65	2	229	10	299	20	404	20
Physical Properties													
Soluble (2:1) pH	pH Units	7.64	0.01	7.39	0.01	7.83	0.01	7.33	0.01	7.33	0.01	7.62	0.01
Physical Properties													
Texture	N/A	SILT LOAM	N/A	LOAM	N/A	SAND	N/A	SILT LOAM	N/A	SILT LOAM	N/A	LOAM	N/A

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220	
COC#		G037377	G037377	G037377	G037377	G037377	G037377	
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**
Ext. Pet. Hydrocarbon								
F2 (C10-C16 Hydrocarbons)	mg/kg	68(1)	61(1)	23	100(1)	130(1)	150(1)	10
F3 (C16-C34 Hydrocarbons)	mg/kg	500(1)	470(1)	170	550(1)	700(1)	610(1)	10
F4 (C34-C50 Hydrocarbons)	mg/kg	140(1)	150(1)	110	140(1)	240(1)	160(1)	10
Reached Baseline at C50	mg/kg	YES	YES	YES	YES	YES	YES	N/A
Surrogate Recovery (%)								
O-TERPHENYL (sur.)	%	94	92	92	89	96	95	

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample contained > 50% moisture.

Maxxam Job #: B0C3725
Report Date: 2011/01/10

Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Your P.O. #: A70321

PARTICLE SIZE DISTRIBUTION ANALYSIS (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220	
COC#		G037377	G037377	G037377	G037377	G037377	G037377	
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**
Percent Passing								
<0.002mm Pipette	%	8.96	10.57	1.60	22.32	24.52	17.19	0.01
<0.053mm Pipette	%	38.31	32.73	8.02	69.75	76.21	52.99	0.01
<0.125mm, Sieve #120	%	36.81	39.81	20.91	82.76	83.81	64.88	0.01
<0.250mm, Sieve #60	%	40.56	50.85	46.54	88.43	89.19	71.58	0.01
<2.00mm, Sieve #10	%	58.40	64.48	82.73	92.78	95.41	83.03	0.01
Percent of Entire Sample								
<0.002mm	%	8.96	10.57	1.60	22.32	24.52	17.19	0.01
<0.053mm & >0.002mm	%	29.35	22.16	6.42	47.43	51.69	35.79	0.01
<2.00mm & >0.053mm	%	20.08	31.75	74.72	23.03	19.20	30.05	0.01
>2.00mm	%	41.61	35.52	17.27	7.22	4.60	16.97	0.01
% of the <2mm Fraction								
% Clay <0.002mm	%	15.35	16.39	1.93	24.06	25.70	20.71	0.01
% Sand <2.00mm & >0.053mm	%	34.39	49.25	90.31	24.82	20.12	36.19	0.01
% Silt <0.053mm & >0.002mm	%	50.26	34.37	7.76	51.12	54.18	43.11	0.01

PHYSICAL TESTING (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220	
COC#		G037377	G037377	G037377	G037377	G037377	G037377	
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**
Physical Properties								
Moisture	%	74	71	27	72	73	69	0.3

RDL = Reportable Detection Limit

Maxxam Job #: B0C3725
Report Date: 2011/01/10

Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Your P.O. #: A70321

SEMIVOLATILE ORGANICS BY GC-MS (SOIL)

Maxxam ID		Z18215		Z18216		Z18217		Z18218		Z18219		Z18220	
COC#		G037377		G037377		G037377		G037377		G037377		G037377	
	Units	**0086-01 SEDIMENT**	**RDL**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**RDL**	**0086-06 SEDIMENT**	**RDL**
Polycyclic Aromatics													
Naphthalene	mg/kg	0.25(1)	0.005	0.31(1)	0.005	0.14(1)	0.005	0.48(1)	0.005	0.65(2)	0.005	1.1(1)	0.005
2-Methylnaphthalene	mg/kg	0.55(1)	0.005	0.64(1)	0.005	0.29(1)	0.005	1.1(1)	0.005	1.4(2)	0.005	2.6(1)	0.005
Acenaphthylene	mg/kg	<0.08(3)	0.08	<0.07(3)	0.07	<0.04(3)	0.04	<0.08(3)	0.08	<0.1(3)	0.1	<0.2(3)	0.2
Acenaphthene	mg/kg	0.10(1)	0.005	0.10(1)	0.005	0.027(1)	0.005	0.18(1)	0.005	0.29(2)	0.005	0.34(1)	0.005
Fluorene	mg/kg	0.17(1)	0.005	0.16(1)	0.005	0.050(1)	0.005	0.26(1)	0.005	0.43(2)	0.005	0.56(1)	0.005
Phenanthrene	mg/kg	0.86(1)	0.005	0.72(1)	0.005	0.31(1)	0.005	1.2(1)	0.005	1.5(2)	0.005	2.4(1)	0.005
Anthracene	mg/kg	0.30(1)	0.005	0.31(1)	0.005	0.068(1)	0.005	0.33(1)	0.005	0.58(2)	0.005	0.49(1)	0.005
Fluoranthene	mg/kg	1.1(1)	0.005	0.94(1)	0.005	0.41(1)	0.005	1.1(1)	0.005	1.6(2)	0.005	1.6(1)	0.005
Pyrene	mg/kg	1.3(1)	0.005	1.2(1)	0.005	0.40(1)	0.005	0.94(1)	0.005	2.0(2)	0.005	1.3(1)	0.005
Benzo(a)anthracene	mg/kg	0.30(1)	0.005	0.35(1)	0.005	0.14(1)	0.005	0.34(1)	0.005	0.66(2)	0.005	0.54(1)	0.005
Chrysene	mg/kg	0.46(1)	0.005	0.43(1)	0.005	0.19(1)	0.005	0.42(1)	0.005	0.74(2)	0.005	0.66(1)	0.005
Benzo(b&j)fluoranthene	mg/kg	0.36(1)	0.005	0.38(1)	0.005	0.16(1)	0.005	0.30(1)	0.005	0.58(2)	0.005	0.39(1)	0.005
Benzo(k)fluoranthene	mg/kg	0.24(1)	0.005	0.27(1)	0.005	0.11(1)	0.005	0.20(1)	0.005	0.42(2)	0.005	0.28(1)	0.005
Benzo(a)pyrene	mg/kg	0.21(1)	0.005	0.23(1)	0.005	0.15(1)	0.005	0.21(1)	0.005	0.39(2)	0.005	0.32(1)	0.005
Indeno(1,2,3-cd)pyrene	mg/kg	0.11(1)	0.01	0.12(1)	0.01	0.10(1)	0.01	0.10(1)	0.01	0.18(1)	0.01	0.13(1)	0.01
Dibenz(a,h)anthracene	mg/kg	0.04(1)	0.01	0.04(1)	0.01	0.03(1)	0.01	0.05(1)	0.01	0.07(1)	0.01	0.07(1)	0.01
Benzo(g,h,i)perylene	mg/kg	0.15(1)	0.01	0.17(1)	0.01	0.15(1)	0.01	0.17(1)	0.01	0.26(2)	0.01	0.26(1)	0.01
Low Molecular Weight PAH`s	mg/kg	2.2	0.08	2.2	0.07	0.88	0.04	3.6	0.08	4.8	0.1	7.5	0.2
High Molecular Weight PAH`s	mg/kg	4.2	0.01	4.1	0.01	1.8	0.01	3.9	0.01	6.9	0.01	5.5	0.01
Total PAH	mg/kg	6.4	0.08	6.4	0.07	2.7	0.04	7.4	0.08	12	0.1	13	0.2
Surrogate Recovery (%)													
D10-ANTHRACENE (sur.)	%	100		100		100		95		95		100	
D12-BENZO(A)PYRENE (sur.)	%	90		100		90		90		85		95	
D8-ACENAPHTHYLENE (sur.)	%	60		60		90		60		55		60	
D8-NAPHTHALENE (sur.)	%	95		95		90		90		95		95	
TERPHENYL-D14 (sur.)	%	95		100		100		95		90		100	

RDL = Reportable Detection Limit
(1) - RDL raised due to sample dilution.
(2) - RDL raised due to sample dilution. Matrix spike recovery outside control limit - High target compounds - No impact, spike Invalid.
(3) - RDL raised due to sample matrix interference.

Maxxam Job #: B0C3725
Report Date: 2011/01/10

Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Your P.O. #: A70321

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220	
COC#		G037377	G037377	G037377	G037377	G037377	G037377	
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**
SEM Metals by ICPMS								
SEM Cadmium (Cd)	umole/g	0.0023	0.0016	0.0018	0.0027	0.0035	0.0026	0.0002
SEM Copper (Cu)	umole/g	0.040	0.033	0.255	0.043	0.062	0.048	0.004
SEM Lead (Pb)	umole/g	0.0074	0.0070	0.0840	0.0075	0.0105	0.0077	0.0002
SEM Mercury (Hg)	umole/g	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.0003
SEM Nickel (Ni)	umole/g	0.014	0.013	0.125	0.021	0.023	0.022	0.004
SEM Zinc (Zn)	umole/g	0.195	0.173	0.694	0.178	0.301	0.176	0.008

RDL = Reportable Detection Limit

Maxxam Job #: B0C3725
Report Date: 2011/01/10

Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Your P.O. #: A70321

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220	
COC#		G037377	G037377	G037377	G037377	G037377	G037377	
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**
Total Metals by ICPMS								
Total Aluminum (Al)	mg/kg	6520	8800	9590	11300	10400	10400	100
Total Antimony (Sb)	mg/kg	0.3	0.4	0.4	0.5	0.5	0.5	0.1
Total Arsenic (As)	mg/kg	9.4	10.9	4.0	12.2	12.9	11.2	0.2
Total Barium (Ba)	mg/kg	26.2	30.9	33.0	47.5	42.2	51.2	0.1
Total Beryllium (Be)	mg/kg	0.2	0.1	0.1	0.3	0.2	0.3	0.1
Total Bismuth (Bi)	mg/kg	0.1	0.2	<0.1	0.2	0.2	0.2	0.1
Total Cadmium (Cd)	mg/kg	2.76	2.62	0.34	3.70	3.72	3.25	0.05
Total Calcium (Ca)	mg/kg	60500	13100	5920	6590	6930	9140	100
Total Chromium (Cr)	mg/kg	19	21	15	27	26	27	1
Total Cobalt (Co)	mg/kg	3.3	4.3	4.8	5.1	4.7	5.1	0.3
Total Copper (Cu)	mg/kg	65.3	105	43.5	72.9	79.1	73.6	0.5
Total Iron (Fe)	mg/kg	13600	16700	13800	17500	16500	16300	100
Total Lead (Pb)	mg/kg	22.5	25.5	24.7	20.1	23.2	21.5	0.1
Total Magnesium (Mg)	mg/kg	6990	7320	4700	7780	7580	6970	100
Total Manganese (Mn)	mg/kg	108	140	152	154	137	142	0.2
Total Mercury (Hg)	mg/kg	0.51	0.23	0.08	0.26	0.25	0.29	0.05
Total Molybdenum (Mo)	mg/kg	12.3	10.8	1.4	9.9	13.1	8.9	0.1
Total Nickel (Ni)	mg/kg	15.2	16.1	12.2	21.5	19.9	21.2	0.8
Total Phosphorus (P)	mg/kg	625	701	423	730	714	671	10
Total Potassium (K)	mg/kg	1800	1790	824	2050	2010	1930	100
Total Selenium (Se)	mg/kg	1.2	1.6	<0.5	1.8	2.4	1.8	0.5
Total Silver (Ag)	mg/kg	0.18	0.26	0.09	0.29	0.26	0.26	0.05
Total Sodium (Na)	mg/kg	24100	22400	3130	20600	20900	18100	100
Total Strontium (Sr)	mg/kg	216	83.2	44.4	63.8	64.8	74.2	0.1
Total Thallium (Tl)	mg/kg	0.28	0.32	0.20	0.36	0.39	0.30	0.05
Total Tin (Sn)	mg/kg	3.0	2.4	1.6	1.7	1.9	1.5	0.1
Total Titanium (Ti)	mg/kg	263	533	885	525	436	394	1
Total Vanadium (V)	mg/kg	34	40	35	45	44	42	2
Total Zinc (Zn)	mg/kg	171	168	63	132	163	124	1
Total Zirconium (Zr)	mg/kg	1.4	3.7	2.1	2.2	2.0	1.7	0.5

RDL = Reportable Detection Limit

Maxxam Job #: B0C3725
Report Date: 2011/01/10

Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Your P.O. #: A70321

BTEX BY GC-MS (SOIL)

Maxxam ID		Z18215		Z18216		Z18217		Z18218		Z18219		Z18220	
COC#		G037377		G037377		G037377		G037377		G037377		G037377	
	Units	**0086-01 SEDIMENT**	**RDL**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**RDL**	**0086-06 SEDIMENT**	**RDL**
Volatiles													
Methyl-tert-butylether (MTBE)	mg/kg	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1
Benzene	mg/kg	0.04(1)	0.03	<0.03(1)	0.03	<0.005	0.005	<0.03(1)	0.03	<0.03(1)	0.03	<0.02(1)	0.02
Toluene	mg/kg	0.09(1)	0.03	0.19(1)	0.03	<0.02	0.02	0.05(1)	0.03	0.07(1)	0.03	0.08(1)	0.02
Ethylbenzene	mg/kg	<0.03(1)	0.03	<0.03(1)	0.03	<0.01	0.01	<0.03(1)	0.03	<0.03(1)	0.03	0.02(1)	0.02
m & p-Xylene	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.04	0.04	<0.04	0.04
o-Xylene	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04
Styrene	mg/kg	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03
Xylenes (Total)	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.04	0.04	<0.04	0.04
(C6-C10)	mg/kg	<60(1)	60	<50(1)	50	<10	10	<50(1)	50	<60(1)	60	<50(1)	50
Surrogate Recovery (%)													
4-BROMOFLUOROBENZENE (sur.)	%	84		83		84		84		83		85	
D10-ETHYLBENZENE (sur.)	%	82		83		86		82		83		84	
D4-1,2-DICHLOROETHANE (sur.)	%	101		105		96		99		97		96	
D8-TOLUENE (sur.)	%	94		92		96		95		94		94	

RDL = Reportable Detection Limit
(1) - RDL raised due to high sample moisture content.

Maxxam Job #: B0C3725
Report Date: 2011/01/10

Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Your P.O. #: A70321

General Comments

Sample Z18215-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18216-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18217-01: ** SEM/AVS = 0.57 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18218-01: ** SEM/AVS = 0.04 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18219-01: ** SEM/AVS = 0.04 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18220-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Validation Signature Page

Maxxam Job #: B0C3725

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



ERIN SANTOS, Dip. Chemical and Biosciences, Laboratory Coordinator



TOM SHUM, BBY Scientific Specialist

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B0C3725

CHAIN OF CUSTODY RECORD

Page: 1 of 1

G 037377

Invoice To: Require Report? Yes ☒ No ☑

Company Name: Golder Associates

Contact Name: ~~Janet Pickard~~ WE KM 2010Dec21

Address:

PC:

Phone / Fax#: Ph: Fax:

E-mail: ~~jpickard@maxxam.ca~~ WE KM 2010Dec21

Report To:

Company Name:

Contact Name: Leslie-Anne Staroff & Jeremy Keating

Address:

PC:

Phone / Fax#: Ph: Fax:

E-mail: lstaroff@maxxam.ca jkeating@maxxam.ca

PO #: A70321

Quotation #:

Project # : B0C2492

Proj. Name:

Location:

Sampled By: K. Melling

REGULATORY REQUIREMENTS SERVICE REQUESTED:

☐ CSR ☐ CCME ☐ BC Water Quality ☐ Other ☐ DRINKING WATER

☐ Regular Turn Around Time (TAT) (5 days for most tests)

☐ RUSH (Please contact the lab) ☐ 1 Day ☐ 2 Day ☐ 3 Day

Date Required:

Special Instructions:

Return Cooler ☐ Ship Sample Bottles (please specify) ☐

*Send Grain Size to Winnipeg *

ANALYSIS REQUESTED

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	BTEX/VPH	VOC/VPH	EPH	LEPH/HEPH	CCME-PHC (Fractions 1-4 Plus BTEX)	CCME-PHC (Fractions 2-4)	CCME BTEX (Fraction 1 Plus BTEX)	PCB	Phenols by 4AAP	Phenols by GCMS	TOG	SWOG	MOG	Dissolved Metals	Field Filtered?	Field Acidified?	Totals Metals Field Acidified?	Nitrate	Nitrite	Ammonia	Chloride	Fluoride	Sulphate	Total Suspended Solids-TSS	TDS	pH	Conductivity	Alkalinity	BOD	COD	Coliform, Total & E.coli	Fecal	Asbestos	AVS/SEM	Grain size (sent to Winnipeg)	Metals	TOC	HOLD
1	0086-01 Sediment							✓	✓																												✓	✓	✓	✓	
2	0086-02 Sediment							✓	✓																												✓	✓	✓	✓	
3	0086-03 Sediment							✓	✓																												✓	✓	✓	✓	
4	0086-04 Sediment							✓	✓																												✓	✓	✓	✓	
5	0086-05 Sediment							✓	✓																												✓	✓	✓	✓	
6	0086-06 Sediment							✓	✓																												✓	✓	✓	✓	
7																																									
8																																									
9																																									
10																																									
11																																									
12																																									

Samples are from a Drinking Water Source? NO

Does source supply multiple households? YES

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:
K. Melling	2010Dec21	1735	J. Villocero	10/12/21	17:35

Time Sensitive ☐

Temperature on Receipt (°C): 20, 20, 20

Custody Seal on Cooler? Yes ☐ No ☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

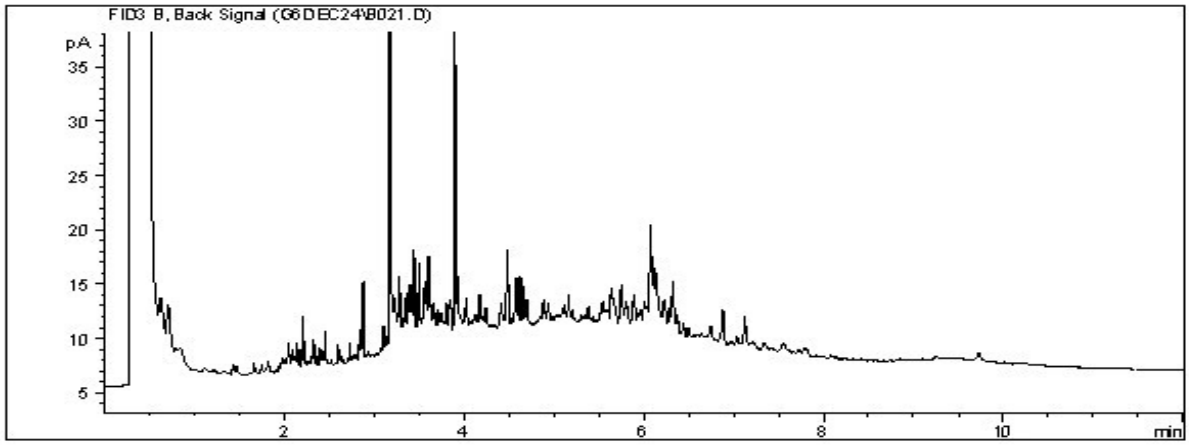
Maxxam International Corporation o/a Maxxam Analytics

Report Date: 2011/01/10
Maxxam Job #: B0C3725
Maxxam Sample: Z18215

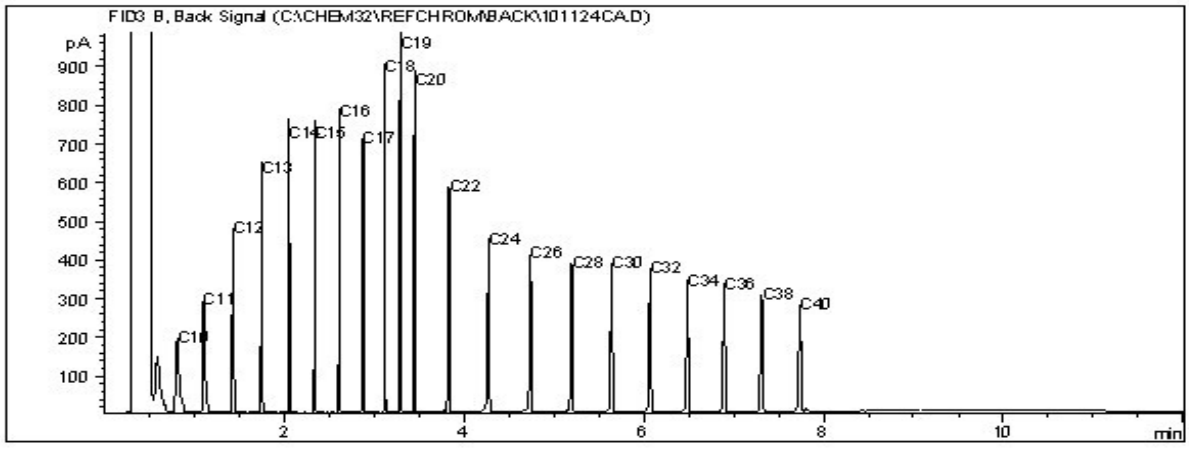
Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Client ID: 0086-01 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

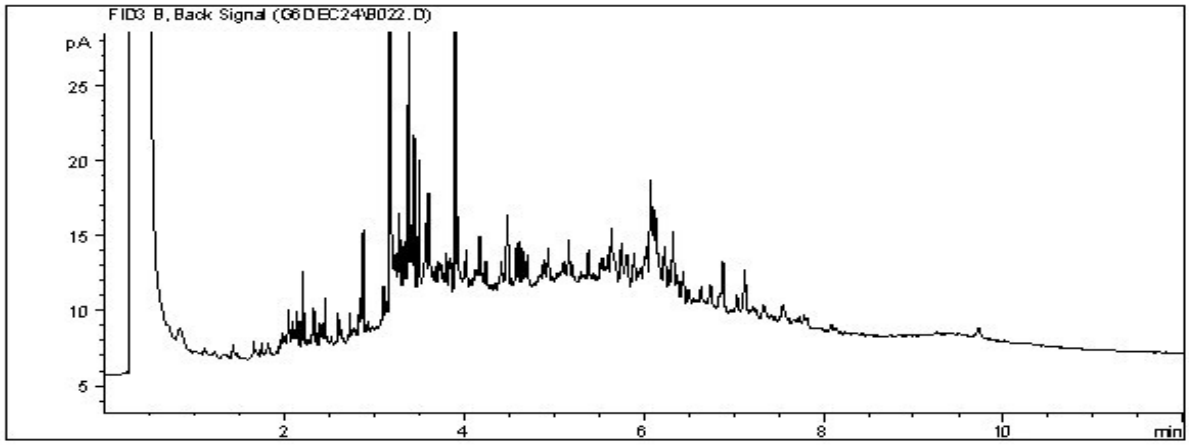
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/10
Maxxam Job #: B0C3725
Maxxam Sample: Z18216

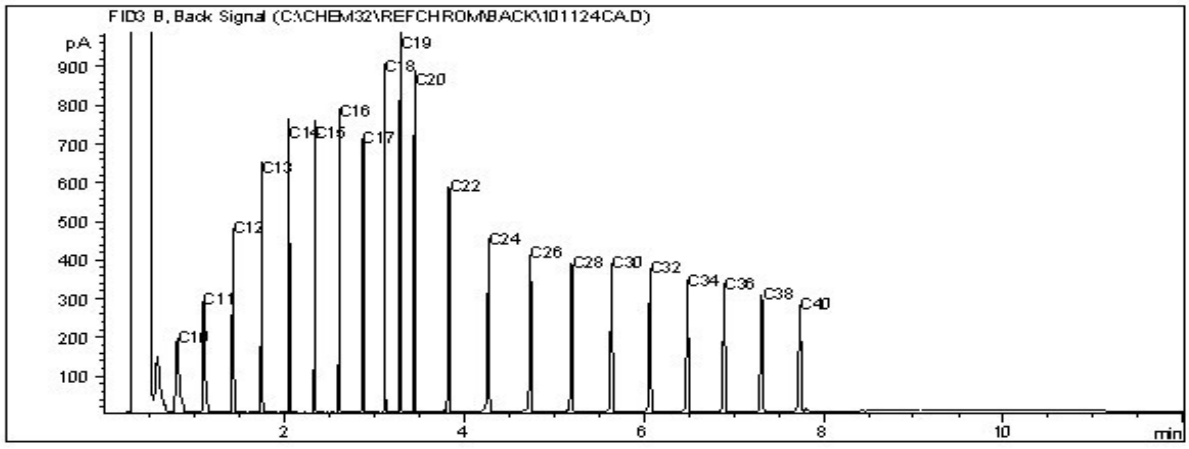
Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Client ID: 0086-02 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

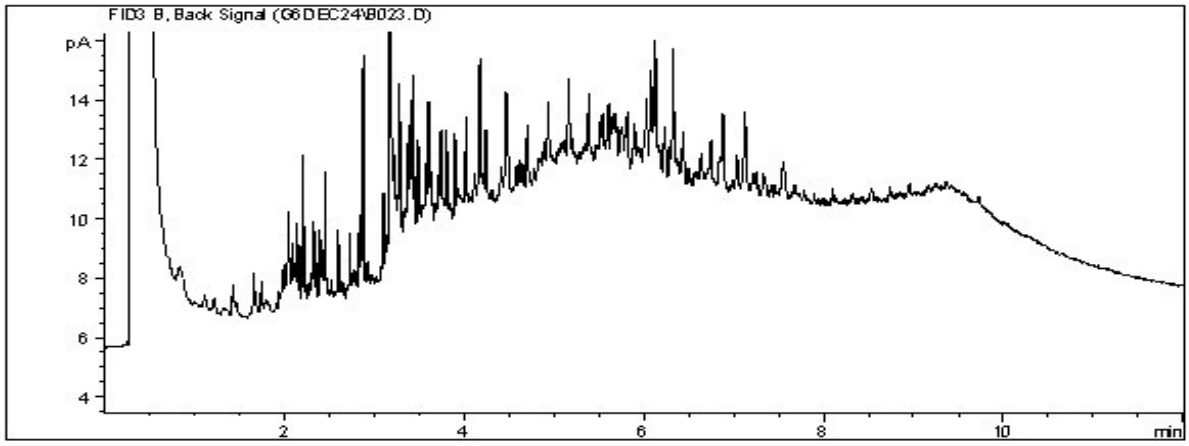
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/10
Maxxam Job #: B0C3725
Maxxam Sample: Z18217

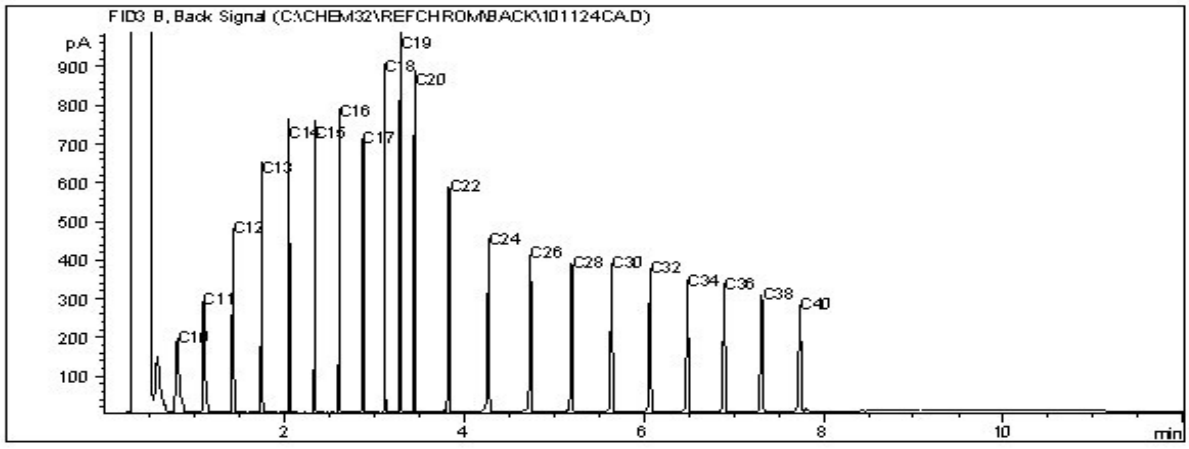
Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Client ID: 0086-03 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

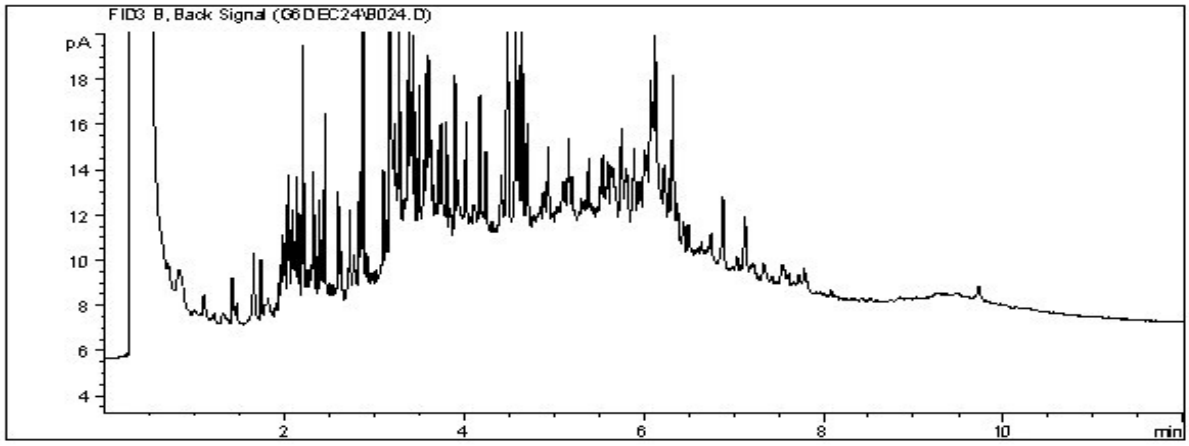
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/10
Maxxam Job #: B0C3725
Maxxam Sample: Z18218

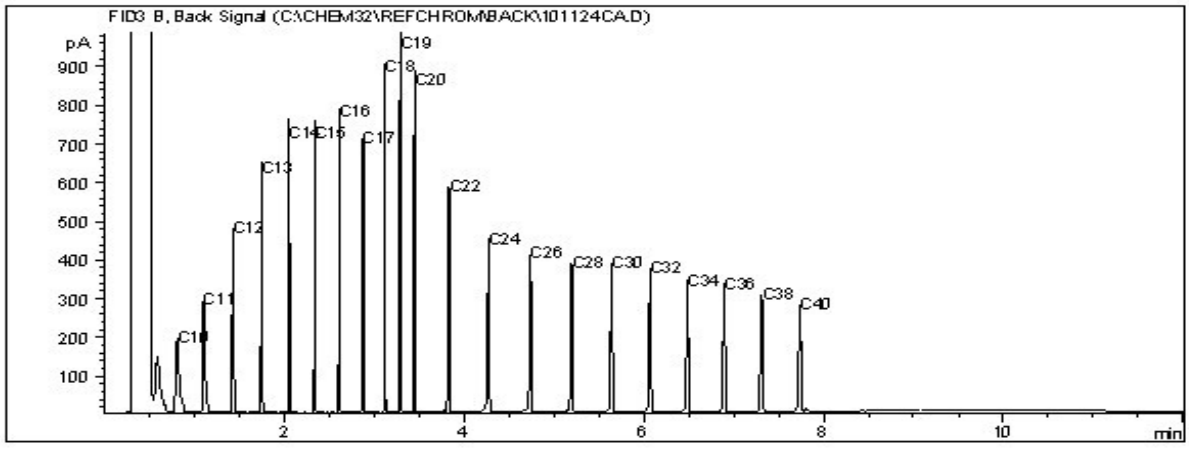
Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Client ID: 0086-04 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

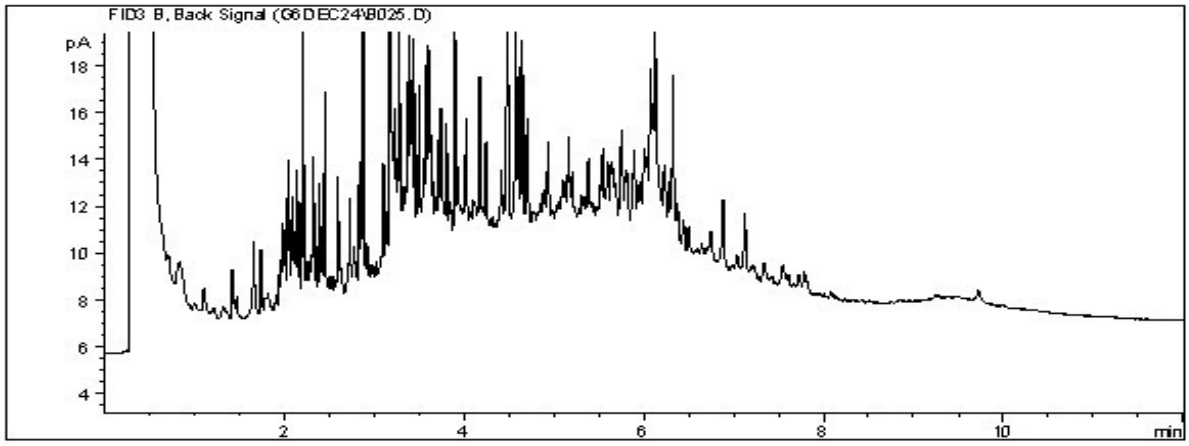
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/10
Maxxam Job #: B0C3725
Maxxam Sample: Z18218 Lab-Dup

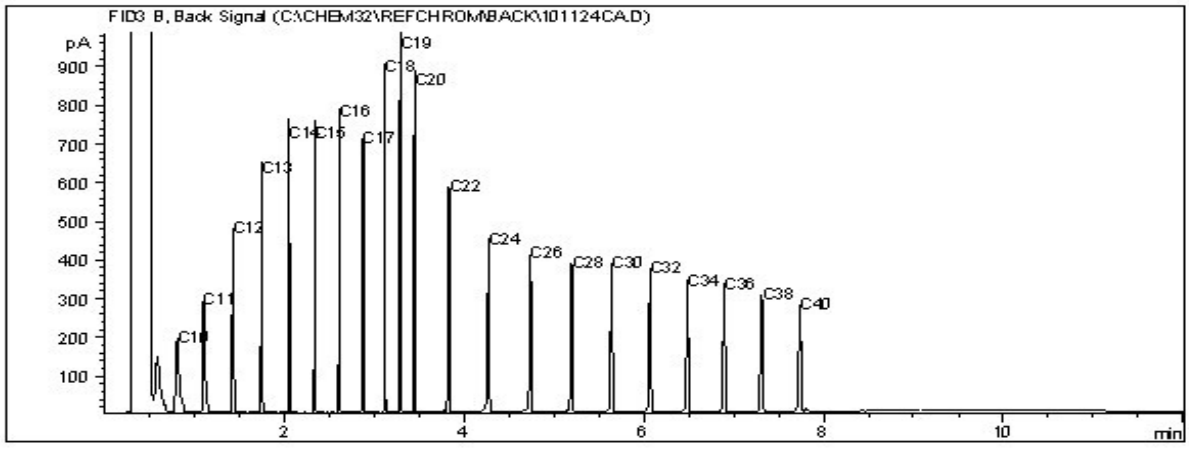
Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Client ID: 0086-04 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

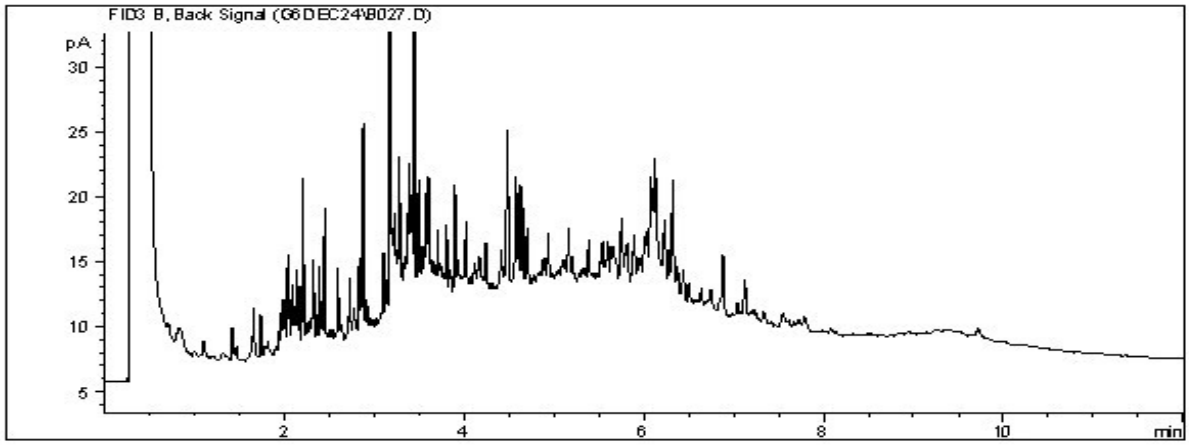
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/10
Maxxam Job #: B0C3725
Maxxam Sample: Z18219

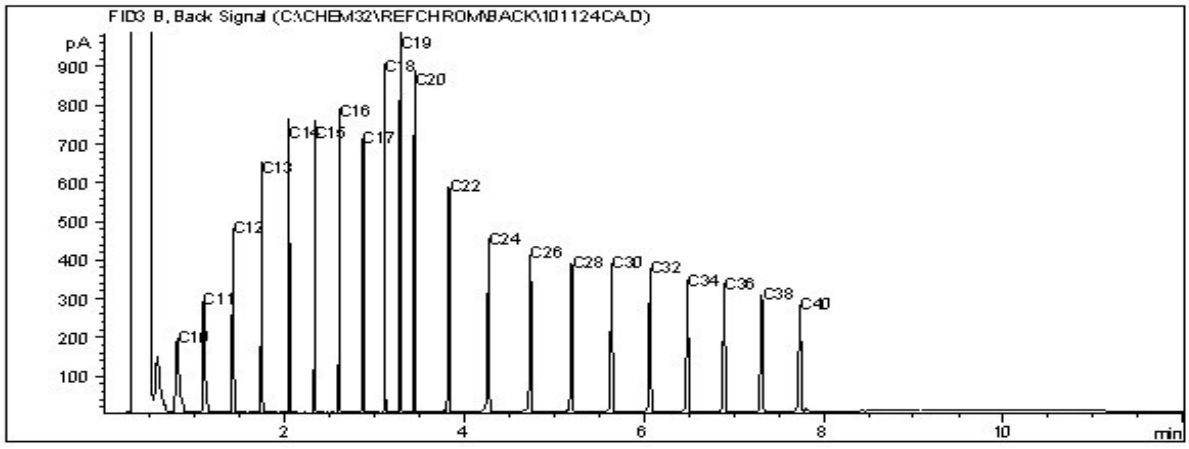
Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Client ID: 0086-05 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4	- C12	Diesel:	C8	- C22
Varsol:	C8	- C12	Lubricating Oils:	C20	- C40
Kerosene:	C7	- C16	Crude Oils:	C3	- C60+

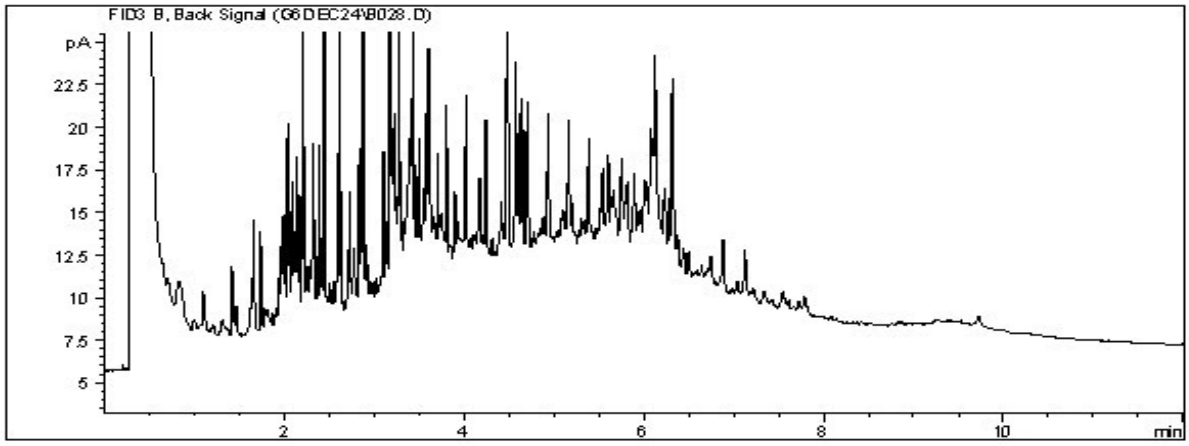
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/01/10
Maxxam Job #: B0C3725
Maxxam Sample: Z18220

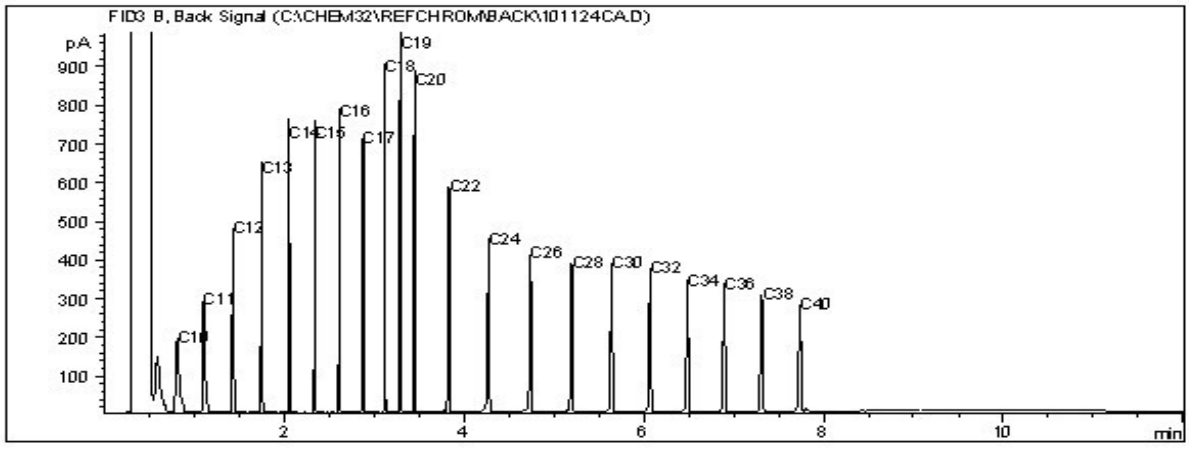
Maxxam Analytics (TOX Internal)
Client Project #: B0C2492

Client ID: 0086-06 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Your Project #: B0C3725
Your C.O.C. #: SUB

Attention: Arshdeep Khalsa
Maxxam Analytics
4606 Canada Way
Burnaby, BC
V5G 1K5

Report Date: 2011/01/06

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0I5491
Received: 2010/12/23, 12:35

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Method Reference
Total Organic Carbon in Soil	6	N/A	2011/01/05	CAM SOP-00468	LECO Combustion

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
* Results relate only to the items tested.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

ENVIRONMENTAL CUSTOMER SERVICE, Environmental Customer Service
Email: ecs@maxxam.ca
Phone# (905) 817-5700

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

Maxxam Job #: B0I5491
Report Date: 2011/01/06

Maxxam Analytics
Client Project #: B0C3725

RESULTS OF ANALYSES OF SOIL

Maxxam ID		IG3172	IG3173	IG3174	IG3174	IG3175	IG3176	IG3177		
	Units	**Z18215-06R \ 0086-01 SEDIME**	**Z18216-06R \ 0086-02 SEDIME**	**Z18217-06R \ 0086-03 SEDIME**	**Z18217-06R \ 0086-03 SEDIME Lab-Dup**	**Z18218-06R \ 0086-04 SEDIME**	**Z18219-06R \ 0086-05 SEDIME**	**Z18220-06R \ 0086-06 SEDIME**	**RDL**	**QC Batch**
Inorganics										
Total Organic Carbon	mg/kg	150000	100000	19000	18000	130000	160000	190000	500	2372396

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B0I5491
Report Date: 2011/01/06

Maxxam Analytics
Client Project #: B0C3725

Package 1	6.3°C

Each temperature is the average of up to three cooler temperatures taken at receipt

GENERAL COMMENTS

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B0I5491
Report Date: 2011/01/06

Maxxam Analytics
Client Project #: B0C3725

QUALITY ASSURANCE REPORT

			Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
2372396	Total Organic Carbon	2011/01/05	<500	mg/kg	6.8	35	99	80 - 120

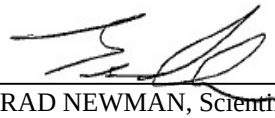
N/A = Not Applicable
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Validation Signature Page

Maxxam Job #: B0I5491

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



BRAD NEWMAN, Scientific Specialist

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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maxxam.ca
MAXXAM ANALYTICS
4606 Canada Way
Burnaby, BC V5G 1K5
Office (604) 734 7276
Toll Free: 1-800 665 8566
Fax (604) 731 2386

ECHINODERM FERTILIZATION TESTS CONDUCTED ON LADYSMITH HARBOUR MARINE SEDIMENTS (FEBRUARY 2011) PROJECT: 09-1436-5008/5000 - FINAL REPORT

Prepared for:

Golder Associates
500-4260 Still Creek Drive
Burnaby, British Columbia
Canada V5C 6C6

Prepared by:

Ecotoxicology Group
Maxxam Analytics
4606 Canada Way
Burnaby, BC
Canada V5G 1K5

Maxxam Project No.: 2-11-1071

May 2011

EXECUTIVE SUMMARY

A total of 6 sediment samples were collected from Ladysmith Harbour, British Columbia, December 15, 2010. The samples were received at Maxxam on December 17, 2010, where they were stored in the dark at 4 ± 2°C. The initial echinoderm fertilisation tests were conducted on December 21, 2010.

Toxicity observed in the original tests was thought to be caused by one of two likely agents, sulphides or metals. As a result, further testing was conducted on three of the sediments porewater (0086-02, 0086-04 and 0086-06). In order to remove the suspected toxicants, two manipulations of the sample were conducted. A range of EDTA concentrations was added to the porewater samples to determine if cationic metals present in the porewater would complex with EDTA resulting in a reduction of the observed toxicity.

The second manipulation involved removing sulphides with as little impact on the sample as possible. The samples were allowed to sit in open containers in a fume hood overnight so that the sulphides could be removed as naturally as possible.

The fertilization success of gametes of the echinoderm, *Strongylocentrotus purpuratus,* was measured according to the Environment Canada's Biological Test Method: Fertilization Assay Using Echinoids Test (EPS 1/RM/27). The Echinoid Fertilization tests were performed on February 22, 2011. Gametes were exposed to centrifuged porewater (unadjusted and amended) from each of the selected sediments.

The test results are summarized as follows:

Sample 0086-02 did not show significant toxicity in the unadjusted sample, therefore the sulphide and EDTA amendments could not produce a visible reduction in toxicity.

Samples 0086-04 and 0086-06 showed a significant reduction in toxicity using the sulphide-removal manipulation. EDTA showed smaller toxicity reductions, but it is unclear if this is the action of the EDTA or of loss of sulphides during pH adjustment of the samples.

The echinoderm fertilization tests were considered valid as fertilization in the laboratory controls met the requirements outlined in the test protocol.

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SECTION

1 SEDIMENT DESCRIPTION

1.1 Sample Information

A total of 6 sediment samples were collected from Ladysmith Harbour, BC, December 15, 2010. The samples were received at Maxxam in good condition on December 17, 2010. The samples were stored with no headspace (purged with nitrogen) after the initial testing and stored in the dark at 4 ± 2°C. The original sample receipt information, along with the Chain-of-Custody Form, is available in Appendix A.

After the initial echinoderm fertilisation tests on the sample porewater were conducted on December 21, 2010 three of the samples were selected for further testing (0086-02, 0086-04 and 0086-06). Two sample manipulations, EDTA chelation and sulphide removal, were performed.

Upon re-opening the sample pails, a description of the sample was noted ("Sediment Sample Descriptions" in Appendix A). The sediments from each sample were thoroughly homogenised before preparation of the porewater as per the Maxxam SOP for the "Sediment Mixing Procedures for Toxicity Tests" (DCN 80-E-010). Again any headspace in the pails was replaced with nitrogen gas prior to re-sealing the pail. When not in use, the sediments were stored without light at 4 ± 2°C.

1.2 Porewater and Sulphide Amended Sample Chemistry

Prior to toxicity testing, porewater aliquots were collected from the sediment samples for ammonia, sulphide and total suspended solids (TSS). Aliquots were also taken from the sulphide amended samples for the same analyses. Table 1-1 summarizes the results of these analyses. A copy of the chemistry reports containing the results of the ammonia, sulphide and TSS analyses are in Appendix C.

Table 1-1: Results for Porewater Total Ammonia, Unionized Ammonia, Sulphides, and TSS

Sample ID	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)	Sulphide (mg/L)	TSS (mg/L)
0086-02	11*	0.0506	12.2	53
0086-02 Sulfide Amended	8.9*	0.0648	0.022	83
0086-04	10*	0.0579	34	88
0086- 04 Sulfide Amended	7.8*	0.0904	0.028	87
0086-06	9.1*	0.0473	27	100
0086-06 Sulfide Amended	6.6*	0.0681	0.026	66

* - Detection limits raised due to dilution to bring analyte within calibration range

Porewater un-ionized ammonia was determined using the Un-ionized Ammonia Calculator (Seawater) Spreadsheet (Colt 2002), adjusting for salinity, pH, and temperature. The spreadsheet used for unionized ammonia calculation is located in Appendix C.

1.3 Laboratory Control Water

The laboratory control water was uncontaminated seawater obtained from the Vancouver Aquarium. The seawater was pumped from Burrard Inlet from a depth of 40-45 feet and filtered through a gravity sand filter, with sand mesh size 22. After filtration, the seawater was held in a concrete reservoir (retention time approximately 4 hours) before passing through a UV sterilizer.

At Maxxam, the seawater was stored at 4 ± 2°C. Before its use in tests, the seawater was passed through a UV sterilizer equipped with an inline 5 µm filter. Volumes required for testing were gradually brought to the appropriate test temperature overnight while vigorously aerating.

SECTION

2 *STRONGLYOCENTROTUS PURPURATUS* FERTILIZATION TEST

2.1 General Test Methods and Conditions

The successful fertilization of echinoderm eggs was assessed according to the Environment Canada Biological Test Method "Fertilization Assay Using Echinoids (Sand Dollars or Sea Urchins)" EPS 1/RM/27 and the Maxxam SOP "Test Method for the Echinoid 20 Minute Fertilization Test" (DCN 80-C-029). Echinoderm fertilization tests were initiated on the centrifuged porewater and sample manipulations of 3 test sediments, on February 24, 2011. See Table 2-1 for details regarding the specific methods and conditions employed in this test.

Table 2-1: Summary of Test Methods and Conditions for the Echinoderm Fertilization Test

Parameter	**Conditions and Methods**
Test Type and Duration	20 minute fertilization; 10 minutes sperm exposure only, followed by another 10 minutes exposure with both sperm and eggs.
Temperature	15 ± 1° C
Salinity	30 ± 2 ‰
Lighting	Broad spectrum fluorescent lighting
Aeration	None during test. No pre-aeration required.
Test Chamber	20 ml borosilicate glass tubes
Test solution volume	5 ml
Control Water	Vancouver Aquarium seawater, from Burrard Inlet, 40-45' deep inlet, gravity sand filtered with sand mesh size 22. Seawater was additionally filtered, UV sterilized and aerated before use.
Renewal Water	None
Replicates	5 replicates/sample
Test Species	*Strongylocentrotus purpuratus* – Purple Sea Urchin
Age of Test Organisms	Recently spawned eggs and sperm

Parameter	Conditions and Methods
Organisms/ replicate	990 eggs and 37120 sperm were added to each test vessel. The sperm:egg ratio was 37.5:1. See Calculation of Gamete Density sheet in Appendix B
Organism Source and size	Marine Research and Educational Products, Carlsbad, CA. Sea Urchins were between 3-9 cm in diameter and gravid.
Feeding	None
Water Quality	DO, pH, salinity and temperature in the 100% porewater before test initiation
Endpoints	Fertilization rate
Test Validity Criteria	≥50% and <100% fertilization in the control.
Data Analysis	Data were assessed for normality using Shapiro-Wilks Test, and homogeneity of variance by Bartlett's Test. Analyses of mean fertilization rate, comparing the adjusted samples to the unadjusted samples were completed using parametric two sample t- tests (equal variance).
Statistical Software	CETIS™ version 1.7.0revO. Tidepool Scientific Software (Copyright 2000-2009).

2.2 Sample Manipulation – EDTA Chelation Test

This test is commonly used to examine the potential toxicity for cationic metals such as zinc, aluminum, cadmium, and others to cause toxicity. Some cationic metals present in the sample will complex with EDTA and this will result in a reduction in the observed toxicity caused by EDTA added to the treated samples. The correct amount of EDTA to add for each treatment was estimated by finding the EC50 value of EDTA to echinoderm fertilisation in preliminary tests according to "Methods for Aquatic Toxicity Identification Evaluations, Phase I Toxicity Characterization Procedures" (US EPA, 1991).

2.3 EDTA Chelation Test

Each test treatment was prepared in 0.04 L of 100% sediment porewater. Test treatments were prepared as indicated in Table 2-2.

Table 2-2: EDTA Chelation Test

Sample Treatment (g EDTA/L)	Total Volume (L)	Amount of EDTA To Be Added (g)
0	0.04	0
0.8	0.04	0.0320
1.6	0.04	0.0640
2.4	0.04	0.0960
3.2	0.04	0.1280

The appropriate amount of EDTA was added to a total of 0.04 L of sample, which was sealed inside a ~42 mL vial. The vial had a small stir bar added, which allowed for constant mixing. The solutions were mixed overnight to solubilise all of the EDTA. The EDTA test treatments were pH adjusted to pH 7.5, if necessary, prior to testing. Before the tests were initiated, initial water quality was conducted.

2.4 Sample Manipulation – Sulphide Removal

Another potential cause for the toxicity initially observed was sulphides. In order to remove sulphides with as little impact on the sample as possible, aeration was not used in the manipulation.

2.5 Sulphide Amendment Test

An aliquot (~ 550 mL) of each sample was poured into a 600 mL glass beaker and allowed to sit open in a fume hood for ~20hrs. An aliquot of each sulphide amended sample was analysed for sulphides (see Table 1-1).

2.6 Quality Assurance/Quality Control

2.6.1 Reference Toxicant Results

A water-only reference toxicant test, using copper sulphate ($CuSO_4$), was initiated on February 24, 2011. The reference toxicant test is used to assess the performance of the test organism and the precision of the results. The LC50 and 95% confidence intervals were calculated, then compared with those of previous tests with this test organism. Methods used in preparing the control chart were taken from the Maxxam SOP “Standard Operating Procedure for the Control Charting of Reference Toxicant Tests” (DCN 80-E-008) and from Environment Canada (1990).

The EC50 value for the reference toxicant test, with 95% confidence limits, was 6.6 (5.1, 8.0) µg/L Cu^{2+}, outside of the previous mean for this species of 29.5 (14.2, 61.5) µg/L Cu^{2+}. This result does not invalidate the tests, as the test validity criteria were all passed.

2.6.2 Test Validity Criteria

Survival data in the negative control was considered be acceptable as the mean percent fertilization in the negative control was greater than or equal to 50%, and less than 100%. The mean percent fertilization in the negative control ranged from 66 - 96%.

2.6.3 Organism Holding Information

The *Stronglyocentrotus purpuratus* were field-collected by Steve Lepage of Marine Research and Educational Products, located in Carlsbad, CA. The organisms were held for at least 24 hours prior to shipment to Maxxam. The sea urchins were shipped in Styrofoam coolers, with ice packs, and arrived at Maxxam in good condition on February 22, 2011.

Upon arrival, the sea urchins were transferred to glass aquaria filled with gently aerating sea water and held there prior to test initiation.

2.7 Results

Total and percent fertilization, in each replicate, and mean ± SD in the seawater control, unadjusted samples, sulphide amended and EDTA amended porewater samples, are presented in Appendix B. The mean fertilization rate ± SD for the test samples are summarized in Tables 2-3 to 2-5.

For water quality measurements, see the bench-sheets in Appendix B.

Table 2-3: Sample 0086-02: Mean Fertilization Comparisons for the Echinoderm Fertilization Test

Maxxam Sample ID	**Mean Fertilization ± SD (%)**
Seawater Control	66 ± 2
0086-02 Unadjusted	93 ± 4
0086-02 Sulfide Amended	95 ± 2
0086-02 EDTA 0.8 g/L	93 ± 3
0086-02 EDTA 1.6 g/L	4 ± 2*
0086-02 EDTA 2.4 g/L	0 ± 0*

Note: Asterisks indicate that there is a statistically significant effect in the sample mean as compared to the Unadjusted sample (*).

Table 2-4: Sample 0086-04: Mean Fertilization Comparisons for the Echinoderm Fertilization Test

Maxxam Sample ID	Mean Fertilization ± SD (%)
Seawater Control	90 ± 4
0086-04 Unadjusted	2 ± 2
0086-04 Sulfide Amended	97 ± 3
0086-04 EDTA 0.8 g/L	10 ± 2
0086-04 EDTA 1.6 g/L	1 ± 1*
0086-04 EDTA 2.4 g/L	0 ± 0*
0086-04 EDTA 3.2 g/L	0 ± 0*

Note: Asterisks indicate that there is a statistically significant effect in the sample mean as compared to the Unadjusted sample (*).

Table 2-5: Sample 0086-06: Mean Fertilization Comparisons for the Echinoderm Fertilization Test

Maxxam Sample ID	Mean Fertilization ± SD (%)
Seawater Control	96 ± 2
0086-06 Unadjusted	0 ± 1
0086-06 Sulfide Amended	98 ± 1*
0086-06 EDTA 0.8 g/L	17 ± 2*
0086-06 EDTA 1.6 g/L	4 ± 1*
0086-06 EDTA 2.4 g/L	0 ± 0

Note: Asterisks indicate that there is a statistically significant effect in the sample mean as compared to the Unadjusted sample (*).

2.8 Discussion

The test met validity criteria as the mean percent fertilization in the negative control ranged from 66 - 96%. The total mean percent fertilization in the test ranged from 0% to 98%. Significant differences in mean fertilization when compared to the unadjusted sample were found for all three samples.

Sample 0086-02 did not show significant toxicity in the unadjusted sample. The increased toxicity seen in the higher concentrations of EDTA is likely solely due to the addition of EDTA, which becomes more toxic at higher concentrations. While the fertilisation in the controls was

lower than for the other two samples, the controls are still considered valid, as they showed greater than 50% fertilisation. In addition, the unadjusted sample showed very high fertilisation (93%), which indicates that the organisms were healthy and performing properly.

Sample 0086-04 and 0086-06 were greatly affected by the sulphide amendment. Both samples showed an increase in fertilisation of ≥95%. The EDTA manipulations provided only a slight increase in fertilisation in the 0.8 and 1.6 g/L treatments of each sample. A 17% increase in the 0086-06 EDTA 0.8 g/L was the most noticeable. It is difficult to tell with certainty if this apparent reduction in toxicity was due to the chelation of metals present, or if the short times that the samples were open for pH adjustment allowed sufficient sulphides to escape, thereby reducing the toxicity. No samples were taken from the EDTA adjusted samples for sulphide analysis.

SECTION

3 REFERENCES

Colt, J. 2002. Un-ionized Ammonia Calculator (Seawater). Fish Spreadsheet Appendices. *In* Fish Hatchery Management, Second Edition. Gary A. Wedemeyer, editor. American Fisheries Society, Bethesda, MD.

Environment Canada. 1990. Guidance Document for Control of Toxicity Test Precision Using Reference Toxicants. EPS 1/RM/12. Conservation and Protection, Ottawa, ON.

Environment Canada. 1992. Biological Test Method: Fertilization Assay Using Echinoids (Sand Dollars and Sea Urchins). Including 1997 Amendments. EPS 1/RM/27. Conservation and Protection, Ottawa, ON.

Standard Operating Procedure for the Sediment Mixing Procedures for Toxicity Tests (DCN 80-E-010).

Standard Operating Procedure for the Control Charting of Reference Toxicant Tests. (DCN 80-E-008).

Test Method for the Echinoid 20 Minute Fertilization Test. (DCN 80-C-029).

US EPA. 1991. Methods for Aquatic Toxicity Identification Evaluations- Phase I Toxicity Characterization Procedures. EPA/600/6-91/003.

APPENDIX

A SAMPLE INFORMATION AND CHAIN OF CUSTODY RECORD

Report Name: Entry

Job #: B0C2492
National Client: 103, Golder Associates Ltd

Client: GOLDER ASSOCIATES LTD
4260 STILL CREEK DRIVE
Suite 500
BURNABY BC
Canada V5C 6C6

Inv Attn: Accounts Payable

Task Order:
Line Item:

Printed: 2010/12/20 Version 4
Reception Date: 2010/12/17
Reception Time: 09:15
Login Date: 2010/12/17
REQUIRED DATE: 2011/03/16, 18:00
Quote Number: B01555

Report: same

Attention: Adrian de Bruyn
PHONE: (604) 297 - 2011Ext:
FAX: (604) 298 - 5253
EMAIL: Adrian_deBruyn@golder.com

Project Coordinator: VO1

P.O. Number:
PROJECT NUMBER: 09-1436-5008/5000
Site Location:
Site #:
Client Number: 1473
Rpt Address #:
Q.C. Samples: No

Maxxam Number	Client Sample ID/Report ID	Cont's	Store Code	Recd. OK	Sampling Date	MATRIX	Test Codes
Z09675-01R	0086-01	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-01						ECOTXSV-SD
Z09676-01R	0086-02	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-02						ECOTXSV-SD
Z09677-01R	0086-03	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-03						ECOTXSV-SD
Z09678-01R	0086-04	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-04						ECOTXSV-SD
Z09679-01R	0086-05	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-05						ECOTXSV-SD
Z09680-01R	0086-06	4-4PAL	N/A-VBG-0	Yes	2010/12/15	SED	DISPOSAL, ECOATTACHS
	0086-06						ECOTXSV-SD

Remarks: mbb

Inspected by: MBO
Date: 2010/12/17
Time: 09:43

Approved by: MBO
Date: 2010/12/17
Time: 09:58

Date of Sample Disposal:
Disposal by:

B0CQ492

CHAIN OF CUSTODY RECORD/ANALYSIS REQUEST

№ 0086 page 1 of 1

Golder Associates
500-4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone 604-298-6623 Fax 604-298-5253

Project Number: 09-1436-5008 / 5000	Laboratory Name: [illegible] Maxxam
[redacted]	Address: 4606 Canada Way, Burnaby BC V5G 1K5
Golder Contact: Adam de Bruyn / Golder E-mail Address: Adam_de_Bruyn@golder.com	Telephone/Fax: 1800-665-8566 / Contact: VJ OCO

Office the final reports should be sent to:

- ☐ 500 – 4260 Still Creek Dr. Burnaby, B.C. V5C 6C6 Tel: 604-298-6623 Fax: 604-298-5253
- ☐ 202 – 2790 Gladwin Road Abbotsford, B.C. V2T 4S8 Tel: 604-850-8786 Fax: 604-850-8756
- ☑ 3795 Carey Road, 2nd floor Victoria, B.C. V8Z 6T8 Tel: 250-881-7372 Fax: 250-881-7470

Analyses Required

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D/M/Y)	[redacted]	Number of Containers	Toxicity-Echinoderm Fert.	Porewater TTE	Hold	Bulk Sediment Chem	Porewater Extraction	Echinoderm test TTE on porewater	Porewater Chemistry			RUSH	Remarks (over)
0086-01	[redacted]	Sed	15/12/10	[redacted]	4			✓	✓	✓	✓	✓				
0086-02	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-03	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-04	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-05	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086-06	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
-07	[redacted]			[redacted]												
-08	[redacted]			[redacted]												
-09	[redacted]			[redacted]												
-10	[redacted]			[redacted]												
-11	[redacted]			[redacted]												
-12	[redacted]			[redacted]												

Sampler's Signature:	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
[signature]	[signature]	Golder	Dec. 16/10	11:00		
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company

Comments:	Method of Shipment:	Waybill No.:	Received for Lab by:	Date	Time
Attn. Jeremy Keating Add Sec email instructions					
	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C) 5,4,4 / Cooler opened by: E. DAVIEL	Date 17/12/10	Time 09:15

WHITE: Golder Copy YELLOW: Lab Copy PINK: Lab Returns with Final Report

[illegible] each bucket [illegible]

APPENDIX

B *STRONGYLOCENTROTUS PURPURATUS* RAW DATA

CETIS Analytical Report

Echinoid Sperm Cell Fertilization Test — **Maxxam Analytics**

Analysis ID:	05-5566-9858	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	23 Mar-11 16:58	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes
Batch ID:	00-5495-2287	**Test Type:**	Fertilization	**Analyst:**	L. Stavroff
Start Date:	24 Feb-11 15:00	**Protocol:**	EC/EPS 1/RM/27	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	24 Feb-11 15:20	**Species:**	Strongylocentrotus purpuratus	**Brine:**	Ocean Pure
Duration:	20m	**Source:**	Marine Research and Educational Products	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
0086-02 (UN)	12-9606-2723	22 Feb-11 12:00		51h	Golder Associates (Burnaby)	2-11-1071 Golder Sed TIE
0086-02 (SA)	15-7738-6406	22 Feb-11 12:00		51h		
0086-02 (0.8 E)	02-1610-2850	22 Feb-11 12:00		51h		
0086-02 (1.6 E)	13-0143-0988	22 Feb-11 12:00		51h		
0086-02 (2.4 E)	19-4499-9200	22 Feb-11 12:00		51h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
0086-02 (UN)	Marine Sediment Porew	Golder	0086-02 (UN)		
0086-02 (SA)	Marine Sediment Porew	Golder	0086-02 (SA)		
0086-02 (0.8 E)	Marine Sediment Porew	Golder	0086-02 (0.8 EDTA)		
0086-02 (1.6 E)	Marine Sediment Porew	Golder	0086-02 (1.6 EDTA)		
0086-02 (2.4 E)	Marine Sediment Porew	Golder	0086-02 (2.4 EDTA)		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C > T	Not Run					3.98%

Dunnett's Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
0086-02 (UN)		0086-02 (SA)	-1.369	2.305	0.03704	0.9911	Non-Significant Effect
		0086-02 (0.8 E)	0.2488	2.305	0.03704	0.7098	Non-Significant Effect
		0086-02 (1.6 E)	55.61	2.305	0.03704	<0.0001	Significant Effect
		0086-02 (2.4 E)	57.85	2.305	0.03704	<0.0001	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	5.061544	1.265386	4	1959	<0.0001	Significant Effect
Error	0.01292	0.0006459999	20			
Total	5.074464	1.266032	24			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Mod Levene Equality of Variance	2.725	4.893	0.0691	Equal Variances
Distribution	Shapiro-Wilk Normality	0.9447		0.1897	Normal Distribution

Fertilization Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0086-02 (UN)	5	0.93	0.9158	0.9442	0.87	0.96	0.01673	0.03742	4.02%	0.0%
0086-02 (SA)	5	0.952	0.9438	0.9602	0.92	0.97	0.009695	0.02168	2.28%	-2.37%
0086-02 (0.8 E)	5	0.926	0.9132	0.9388	0.89	0.96	0.01503	0.03362	3.63%	0.43%
0086-02 (1.6 E)	5	0.036	0.03023	0.04177	0.02	0.06	0.006782	0.01517	42.13%	96.13%
0086-02 (2.4 E)	5	0	0	0	0	0	0	0		100.0%

2011Mar23 2011Mar23

Analyst: LS QA: JK

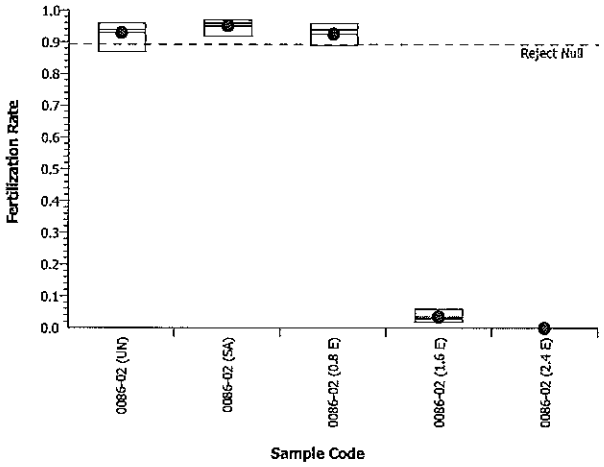
Echinoid Sperm Cell Fertilization Test — **Maxxam Analytics**

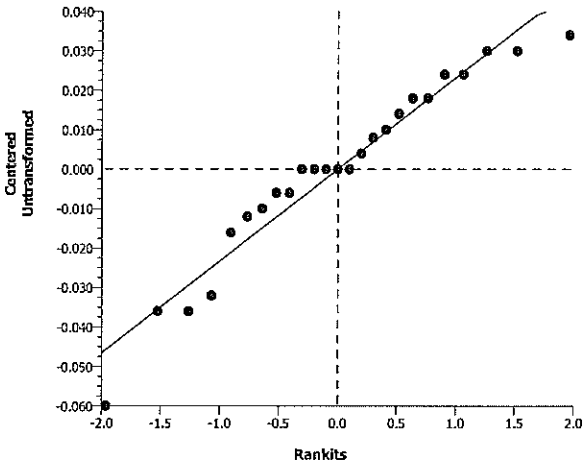
Analysis ID:	05-5566-9858	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	23 Mar-11 16:58	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Fertilization Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0086-02 (UN)	0.96	0.94	0.92	0.87	0.96
0086-02 (SA)	0.94	0.96	0.92	0.97	0.97
0086-02 (0.8 E)	0.89	0.89	0.96	0.95	0.94
0086-02 (1.6 E)	0.02	0.03	0.03	0.04	0.06
0086-02 (2.4 E)	0	0	0	0	0

Graphics





2011Mar23 Analyst: 15 2011Mar-23 QA: JK

Maxxam Analytics

Echinoderm Fertilization Test
Summary of Test Data

Species: *S. purpuratus*
Organism Lot #: MR110222
Client # & Name: #1473 Golder
Start Date: 2011 Feb 24 @ 15:00
Sample ID: 0086-02
Date Counted: 2011 Mar 04, 09
Stats. File ID: SPF-1473-0111
Analyst(s): L. Stavroff

Concentration	Replicate	Total # Counted	# Fertilized	# Unfertilized	% Fertilized	Mean	SD
Seawater Control	A	100	79	21	79%	66%	8%
	B	100	56	44	56%		
	C	100	66	34	66%		
	D	100	63	37	63%		
	E	100	66	34	66%		
0086-02	A	100	96	4	96%	93%	4%
Unadjusted	B	100	94	6	94%		
	C	100	92	8	92%		
	D	100	87	13	87%		
	E	100	96	4	96%		
0086-02	A	100	94	6	94%	95%	2%
Sulfide Amended	B	100	96	4	96%		
	C	100	92	8	92%		
	D	100	97	3	97%		
	E	100	97	3	97%		
0086-02	A	100	89	11	89%	93%	3%
EDTA 0.8 g/L	B	100	89	11	89%		
	C	100	96	4	96%		
	D	100	95	5	95%		
	E	100	94	6	94%		
0086-02	A	100	2	98	2%	4%	2%
EDTA 1.6 g/L	B	100	3	97	3%		
	C	100	3	97	3%		
	D	100	4	96	4%		
	E	100	6	94	6%		
0086-02	A	100	0	100	0%	0%	0%
EDTA 2.4 g/L	B	100	0	100	0%		
	C	100	0	100	0%		
	D	100	0	100	0%		
	E	100	0	100	0%		
Analyst			LS	LS			

Maxxam Analytics

Echinoderm Fertilisation Test
Summary of Test Data

Species: S. purpuratus

Client # & Name: #1473 Golder

Start Date & Time: 2011Feb~~23~~24 @ 1500-1520 LSWE2011Feb24

Sample ID: 0086-02

Organism Lot: MR110222

Sample Date: 2010Dec15

Test Volume (mL): 5

Stats. File ID: SPF-1473-0111

Date Counted: 2011Mar04, 09

Seawater Source: Van. Aquarium

Seawater Batch: 2010Dec14

Analyst(s): LStavoff

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Replicate	A	B	C	D	E
SW Control	30	15.2	7.8	8.3	Fertilized	79	56	66	63	66
					Unfertilized	21	44	34	37	34
0086-02 Unadjusted	29	14.1	7.5	2.7	Fertilized	96	94	92	87	96
					Unfertilized	4	6	8	13	4
0086-02 Sulf. Amended	29	14.1	~~8.0~~ 7.7 Ⓐ	4.4	Fertilized	94	96	92	97	97
					Unfertilized	6	4	8	3	3
0086-02 EDTA 0.8 g/L	29	15.4	~~6~~ 7.5 Ⓐ	7.7	Fertilized	89	89	96	95	94
					Unfertilized	11	11	4	5	6
0086-02 EDTA 1.6 g/L	29	15.7	7.5	7.5	Fertilized	2	3	3	4	6
					Unfertilized	98	97	97	96	94
0086-02 EDTA 2.4 g/L	29	15.8	7.5	7.3	Fertilized	0	0	0	0	0
					Unfertilized	100	100	100	100	100
0086-02 EDTA 3.2 g/L	29	15.7	7.3	6.9	Fertilized	0	0	0	0	0
					Unfertilized	100	100	100	100	100
Analyst	LS	LS	LS	LS	Analyst	LS	LS	LS	LS	LS

Comments: SW 5um filtered + UV sterilized on 2011Feb22. LS

All EDTA samples were pH adjusted to ~7.5. See Initial WQ datasheet. LS

Ⓐ LSWE2011Feb24

Maxxam Analytics

Echinoderm Fertilisation Test
Porewater Samples - Initial Water Quality Sheet

Client # & Name: #473 Golder ✓ Porewater Prep Date: 2011feb22

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Aeration Time (min)	pH Adjustment (Vol. of Acid or Base Used)	New pH	Analyst
0086-02 Unadjusted	LS 2011Feb24		7.5	LS 2011Feb24				
0086-02 Sulfide Amended			8.0					
0086-02 EDTA 0.8 g/L	LS 2011Feb23		6.4	LS 2011Feb23		5 drops 0.1N NaOH 2 drops 1N NaOH	7.5	JK
0086-02 EDTA 1.6 g/L			5.6			1 drop 0.1N NaOH 6 drops 1N NaOH	7.5	JK
0086-02 EDTA 2.4 g/L			5.1			6 drops 1N NaOH 1 drop 1N HCl	7.5	JK
0086-02 EDTA 3.2 g/L			4.7			5 drops 0.1N NaOH 5 drops 1N NaOH	7.5	JK
0086-02 EDTA 0.8 g/L (pH Adj)								
0086-02 EDTA 1.6 g/L (pH Adj.)								
0086-02 EDTA 2.4 g/L (pH Adj.)								
0086-02 EDTA 3.2 g/L (pH Adj.)								

Date Measured
2011Feb23

Comments: EDTA

Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\2-11\2-11-1071 Golder Sediment TIE\Phase 2\Porewater initial WQ (0086-02)

Maxxam Analytics

Echinoderm Fertilisation Test
Porewater Samples - Initial Water Quality Sheet

Client # & Name: #1473 Golder

Porewater Prep Date: 2011Feb22

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Aeration Time (min)	pH Adjustment (Vol. of Acid or Base Used)	New pH	Analyst
0086-02 Unadjusted	29	14.1	7.5	2.7*	n/a	—	n/a	LS
0086-02 Sulfide Amended	29	14.1	7.7	4.4		—	n/a	LS
0086-02 EDTA 0.8 g/L	LS 2011Feb24		7.1	LS 2011Feb24		3 drops 0.1N NaOH	7.5	JK
0086-02 EDTA 1.6 g/L			7.0			3 drops 0.1N NaOH	7.5	JK
0086-02 EDTA 2.4 g/L			6.2			3 drops 0.1N NaOH 2 drops 1N NaOH	7.5	JK
0086-02 EDTA 3.2 g/L			5.3			4 drops 0.1N NaOH 4 drops 1N NaOH	7.5	JK
0086-02 EDTA 0.8 g/L (pH Adj)	29	15.4	7.5	7.7		—	n/a	LS
0086-02 EDTA 1.6 g/L (pH Adj.)	29	15.7	7.5	7.5		—	n/a	LS
0086-02 EDTA 2.4 g/L (pH Adj.)	29	15.8	7.5	7.3		—	n/a	LS
0086-02 EDTA 3.2 g/L (pH Adj.)	29	15.9	7.3	6.9	↓	—	n/a	LS

Date measured: 2011 Feb24

Comments: *Below 40% saturation

CETIS Analytical Report

Echinoid Sperm Cell Fertilization Test — **Maxxam Analytics**

Analysis ID:	08-2095-6475	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	23 Mar-11 16:56	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes
Batch ID:	00-5495-2287	**Test Type:**	Fertilization	**Analyst:**	L. Stavroff
Start Date:	24 Feb-11 15:00	**Protocol:**	EC/EPS 1/RM/27	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	24 Feb-11 15:20	**Species:**	Strongylocentrotus purpuratus	**Brine:**	Ocean Pure
Duration:	20m	**Source:**	Marine Research and Educational Products	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
0086-04 (UN)	18-9035-4859	22 Feb-11 12:00		51h	Golder Associates (Burnaby)	2-11-1071 Golder Sed TIE
0086-04 (SA)	17-4010-2432	22 Feb-11 12:00		51h		
0086-04 (0.8 E)	07-0865-9106	22 Feb-11 12:00		51h		
0086-04 (1.6 E)	10-3252-9562	22 Feb-11 12:00		51h		
0086-04 (2.4 E)	08-2253-7458	22 Feb-11 12:00		51h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
0086-04 (UN)	Marine Sediment Porew	Golder	0086-04 (UN)		
0086-04 (SA)	Marine Sediment Porew	Golder	0086-04 (SA)		
0086-04 (0.8 E)	Marine Sediment Porew	Golder	0086-04 (0.8 EDTA)		
0086-04 (1.6 E)	Marine Sediment Porew	Golder	0086-04 (1.6 EDTA)		
0086-04 (2.4 E)	Marine Sediment Porew	Golder	0086-04 (2.4 EDTA)		

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	0	C < T	Not Run					143.5%

Dunnett's Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
0086-04 (UN)		0086-04 (SA)	84.59	2.305	0.02583	<0.0001	Significant Effect
		0086-04 (0.8 E)	7.138	2.305	0.02583	<0.0001	Significant Effect
		0086-04 (1.6 E)	-1.071	2.305	0.02583	0.9800	Non-Significant Effect
		0086-04 (2.4 E)	-1.428	2.305	0.02583	0.9925	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	3.52752	0.88188	4	2809	<0.0001	Significant Effect
Error	0.00628	0.000314	20			
Total	3.5338	0.882194	24			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Bartlett Equality of Variance	11.01	13.28	0.0264	Equal Variances
Distribution	Shapiro-Wilk Normality	0.8896		0.0110	Normal Distribution

Fertilization Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0086-04 (UN)	5	0.018	0.01068	0.02532	0	0.05	0.008602	0.01924	106.9%	0.0%
0086-04 (SA)	5	0.966	0.9554	0.9766	0.92	0.99	0.01249	0.02793	2.89%	-5267.0%
0086-04 (0.8 E)	5	0.098	0.0912	0.1048	0.09	0.13	0.008	0.01789	18.25%	-444.4%
0086-04 (1.6 E)	5	0.006	0.002598	0.009402	0	0.02	0.004	0.008944	149.1%	66.67%
0086-04 (2.4 E)	5	0.002	0.0002989	0.003701	0	0.01	0.002	0.004472	223.6%	88.89%

2011/MAR/23 2011-MAR-23
Analyst: LS QA: JK

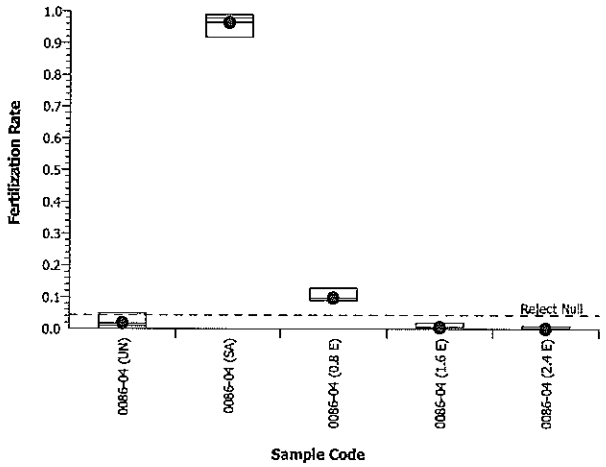
Echinoid Sperm Cell Fertilization Test — **Maxxam Analytics**

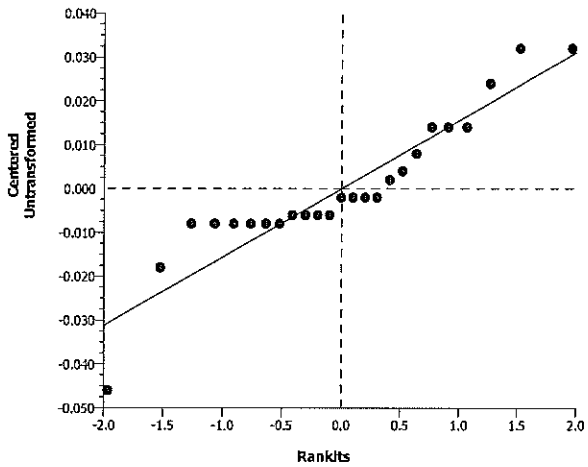
Analysis ID:	08-2095-6475	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	23 Mar-11 16:56	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Fertilization Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0086-04 (UN)	0	0.01	0.01	0.05	0.02
0086-04 (SA)	0.99	0.98	0.92	0.98	0.96
0086-04 (0.8 E)	0.09	0.09	0.09	0.13	0.09
0086-04 (1.6 E)	0	0.01	0.02	0	0
0086-04 (2.4 E)	0	0	0	0	0.01

Graphics





2011MAR23 Analyst: LS

2011Mar23 QA: JK

Maxxam Analytics

Echinoderm Fertilization Test
Summary of Test Data

Species: *S. purpuratus* | Organism Lot #: MR110222

Client # & Name: #1473 Golder | Start Date: 2011 Feb 24 @ 15:00

Sample ID: 0086-04 | Date Counted: 2011 Mar 09

Stats. File ID: SPF-1473-0211 | Analyst(s): L. Stavroff

Concentration	Replicate	Total # Counted	# Fertilized	# Unfertilized	% Fertilized	Mean	SD
Seawater Control	A	100	83	17	83%	90%	4%
	B	100	92	8	92%		
	C	100	92	8	92%		
	D	100	93	7	93%		
	E	100	89	11	89%		
0086-04	A	100	0	100	0%	2%	2%
Unadjusted	B	100	1	99	1%		
	C	100	1	99	1%		
	D	100	5	95	5%		
	E	100	2	98	2%		
0086-04	A	100	99	1	99%	97%	3%
Sulfide Amended	B	100	98	2	98%		
	C	100	92	8	92%		
	D	100	98	2	98%		
	E	100	96	4	96%		
0086-04	A	100	9	91	9%	10%	2%
EDTA 0.8 g/L	B	100	9	91	9%		
	C	100	9	91	9%		
	D	100	13	87	13%		
	E	100	9	91	9%		
0086-04	A	100	0	100	0%	1%	1%
EDTA 1.6 g/L	B	100	1	99	1%		
	C	100	2	98	2%		
	D	100	0	100	0%		
	E	100	0	100	0%		
0086-04	A	100	0	100	0%	0%	0%
EDTA 2.4 g/L	B	100	0	100	0%		
	C	100	0	100	0%		
	D	100	0	100	0%		
	E	100	1	99	1%		
0086-04	A	100	0	100	0%	0%	0%
EDTA 3.2 g/L	B	100	0	100	0%		
	C	100	0	100	0%		
	D	100	0	100	0%		
	E	100	0	100	0%		
Analyst			LS	LS			

Maxxam Analytics

Echinoderm Fertilisation Test
Summary of Test Data

Species: S. purpuratus

Client # & Name: #1473 Golder

Start Date & Time: 2011Feb~~23~~ 24 @ 1500-1520 uvez2011Feb24

Sample ID: 0086-04

Organism Lot: MR110222

Sample Date: 2010Dec15

Test Volume (mL): 5

Stats. File ID: SPF-1473-0211

Date Counted: 2011Mar09 ; 16, 17

Seawater Source: Van. Aquarium

Seawater Batch: 2010Dec14

Analyst(s): LStavoff

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Replicate	A	B	C	D	E
SW Control	30	15.2	7.8	8.3	Fertilized	83	92	92	93	89
					Unfertilized	17	8	8	7	11
0086-04 Unadjusted	29	14.1	7.6 ~~7.5~~ (A)	3.1	Fertilized	0	1	1	5	2
					Unfertilized	100	99	99	95	98
0086-04 Sulf. Amended	28	14.1	~~8.2~~ (B) 7.9	4.3	Fertilized	99	98	92	98	96
					Unfertilized	1	2	8	2	4
0086-04 EDTA 0.8 g/L	29	15.0	7.8	7.3	Fertilized	9	9	9	13	9
					Unfertilized	91	91	91	87	91
0086-04 EDTA 1.6 g/L	30	15.2	7.6	7.2	Fertilized	0	1	2	0	0
					Unfertilized	100	99	98	100	100
0086-04 EDTA 2.4 g/L	29	15.4	7.7	6.7	Fertilized	0	0	0	0	1
					Unfertilized	100	100	100	100	99
0086-04 EDTA 3.2 g/L	29	15.8	7.3	6.1	Fertilized	0	0	0	0	0
					Unfertilized	100	100	100	100	100
Analyst	LS	LS	LS	LS	Analyst	LS	LS	LS	LS	LS

Comments: SW 5 µm filtered & UV Sterilized 2011Feb22. LS
All EDTA samples were pH adjusted to ~7.5. See Initial WQ data sheet. LS

(A) LSUE 2011Feb24

Maxxam Analytics

Echinoderm Fertilisation Test
Porewater Samples - Initial Water Quality Sheet

Client # & Name: #473 Golder

Porewater Prep Date: 2011Feb22

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Aeration Time (min)	pH Adjustment (Vol. of Acid or Base Used)	New pH	Analyst
0086-04 Unadjusted			7.8					
0086-04 Sulfide Amended			7.5					
0086-04 EDTA 0.8 g/L			6.3			11 drops 0.1N NaOH 3 drops 1N NaOH	7.5	WP
0086-04 EDTA 1.6 g/L			5.6			7 drops 1N NaOH 1 drop 1N HCl	7.5	WP
0086-04 EDTA 2.4 g/L			5.1			6 drops 0.1N NaOH 7 drops 1N NaOH	7.5	WP
0086-04 EDTA 3.2 g/L			4.8			3 drops 0.1N NaOH 8 drops 1N NaOH	7.5	WP
0086-04 EDTA 0.8 g/L (pH Adj)								
0086-04 EDTA 1.6 g/L (pH Adj.)								
0086-04 EDTA 2.4 g/L (pH Adj.)								
0086-04 EDTA 3.2 g/L (pH Adj.)								

Date Measured
2011Feb23

Comments:

Maxxam Analytics

Echinoderm Fertilisation Test
Porewater Samples - Initial Water Quality Sheet

Client # & Name: #1473 Golder

Porewater Prep Date: 2011Feb22

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Aeration Time (min)	pH Adjustment (Vol. of Acid or Base Used)	New pH	Analyst
0086-04 Unadjusted	29	14.1	7.6	3.1	n/a		n/a	LS
0086-04 Sulfide Amended	28	14.1	7.9	4.3			n/a	LS
0086-04 EDTA 0.8 g/L	LS Feb24/2011		7.1	LS Feb24/2011		4 drops 0.1N NaOH	7.5	KT
0086-04 EDTA 1.6 g/L			7.0			4 drops 0.1N NaOH	7.5	KT
0086-04 EDTA 2.4 g/L			6.0			17 drops 0.1N NaOH 1 drop 1.0N NaOH	7.5	KT
0086-04 EDTA 3.2 g/L			5.1			1 drop 0.1N NaOH 4 drops 1N NaOH	7.5	KT
0086-04 EDTA 0.8 g/L (pH Adj)	29	15.0	7.8	7.3			n/a	LS
0086-04 EDTA 1.6 g/L (pH Adj.)	30	15.2	7.6	7.2			n/a	LS
0086-04 EDTA 2.4 g/L (pH Adj.)	29	15.4	7.7	6.7			n/a	LS
0086-04 EDTA 3.2 g/L (pH Adj.)	29	15.8	7.3	6.1			n/a	LS

Date Measured
2011Feb24

Comments:

Echinoid Sperm Cell Fertilization Test — **Maxxam Analytics**

Analysis ID:	18-6897-7062	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	23 Mar-11 17:01	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes
Batch ID:	00-5495-2287	**Test Type:**	Fertilization	**Analyst:**	L. Stavroff
Start Date:	24 Feb-11 15:00	**Protocol:**	EC/EPS 1/RM/27	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	24 Feb-11 15:20	**Species:**	Strongylocentrotus purpuratus	**Brine:**	Ocean Pure
Duration:	20m	**Source:**	Marine Research and Educational Products	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
0086-06 (UN)	12-2201-0947	22 Feb-11 12:00		51h	Golder Associates (Burnaby)	2-11-1071 Golder Sed TIE
0086-06 (SA)	04-8053-1933	22 Feb-11 12:00		51h		
0086-06 (0.8 E)	10-8479-8080	22 Feb-11 12:00		51h		
0086-06 (1.6 E)	04-9462-5782	22 Feb-11 12:00		51h		
0086-06 (2.4 E)	09-2383-7375	22 Feb-11 12:00		51h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
0086-06 (UN)	Marine Sediment Porew	Golder	0086-06 (UN)		
0086-06 (SA)	Marine Sediment Porew	Golder	0086-06 (SA)		
0086-06 (0.8 E)	Marine Sediment Porew	Golder	0086-06 (0.8 EDTA)		
0086-06 (1.6 E)	Marine Sediment Porew	Golder	0086-06 (1.6 EDTA)		
0086-06 (2.4 E)	Marine Sediment Porew	Golder	0086-06 (2.4 EDTA)		

Test Note: Shapiro-Wilk's test rejected normality of data distribution. Data was transformed and met assumptions for normality, See ANOVA assumptions table below.

Data Transform	Zeta	Alt Hyp	Monte Carlo	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	0	C < T	Not Run					191.4%

Dunnett's Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	P-Value	Decision(5%)
0086-06 (UN)		0086-06 (SA)	82.81	2.305	0.0381	<0.0001	Significant Effect
		0086-06 (0.8 E)	21.28	2.305	0.0381	<0.0001	Significant Effect
		0086-06 (1.6 E)	7.508	2.305	0.0381	<0.0001	Significant Effect
		0086-06 (2.4 E)	-1.213	2.305	0.0381	0.9863	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(5%)
Between	6.739255	1.684814	4	2466	<0.0001	Significant Effect
Error	0.01366686	0.0006833431	20			
Total	6.752922	1.685497	24			

ANOVA Assumptions

Attribute	Test	Test Stat	Critical	P-Value	Decision(1%)
Variances	Mod Levene Equality of Variance	0.9063	4.893	0.4851	Equal Variances
Distribution	Shapiro-Wilk Normality	0.9169		0.0435	Normal Distribution

2011MAR23 2011Mar23

Echinoid Sperm Cell Fertilization Test — Maxxam Analytics

Analysis ID:	18-6897-7062	**Endpoint:**	Fertilization Rate	**CETIS Version:**	CETISv1.7.0
Analyzed:	23 Mar-11 17:01	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Fertilization Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0086-06 (UN)	5	0.004	0.001917	0.006083	0	0.01	0.002449	0.005477	136.9%	0.0%
0086-06 (SA)	5	0.982	0.9788	0.9852	0.97	0.99	0.003742	0.008367	0.85%	-24450.0%
0086-06 (0.8 E)	5	0.168	0.1607	0.1753	0.15	0.2	0.008602	0.01924	11.45%	-4100.0%
0086-06 (1.6 E)	5	0.038	0.03304	0.04296	0.03	0.06	0.005831	0.01304	34.31%	-850.0%
0086-06 (2.4 E)	5	0	0	0	0	0	0	0		100.0%

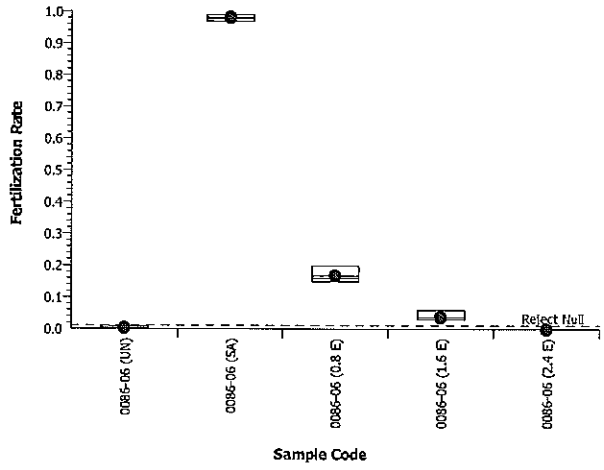
Angular (Corrected) Transformed Summary

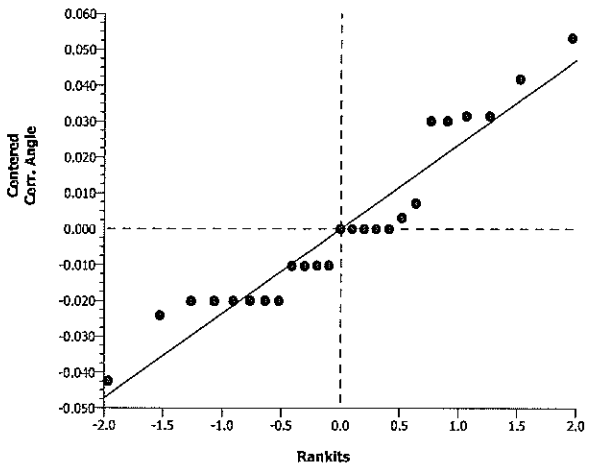
Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	Diff%
0086-06 (UN)	5	0.07008	0.05963	0.08053	0.05002	0.1002	0.01228	0.02747	39.19%	0.0%
0086-06 (SA)	5	1.439	1.427	1.451	1.397	1.471	0.01413	0.0316	2.2%	-1954.0%
0086-06 (0.8 E)	5	0.4219	0.4123	0.4315	0.3977	0.4636	0.0113	0.02527	5.99%	-502.0%
0086-06 (1.6 E)	5	0.1942	0.182	0.2064	0.1741	0.2475	0.01432	0.03203	16.49%	-177.1%
0086-06 (2.4 E)	5	0.05002	0.05002	0.05002	0.05002	0.05002	0	0	0.0%	28.62%

Fertilization Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0086-06 (UN)	0.01	0	0.01	0	0
0086-06 (SA)	0.99	0.98	0.97	0.99	0.98
0086-06 (0.8 E)	0.16	0.15	0.16	0.2	0.17
0086-06 (1.6 E)	0.04	0.03	0.03	0.03	0.06
0086-06 (2.4 E)	0	0	0	0	0

Graphics





2011/MAR/23 2011 Mar 23

Analyst: LS QA: JK

Maxxam Analytics

Echinoderm Fertilization Test
Summary of Test Data

Species: *S. purpuratus*
Organism Lot #: MR110222
Client # & Name: #1473 Golder
Start Date: 2011 Feb 24 @ 15:00
Sample ID: 0086-06
Date Counted: 2011 Mar 09
Stats. File ID: SPF-1473-0311
Analyst(s): L. Stavroff

Concentration	Replicate	Total # Counted	# Fertilized	# Unfertilized	% Fertilized	Mean	SD
Seawater Control	A	100	98	2	98%	96%	2%
	B	100	95	5	95%		
	C	100	97	3	97%		
	D	100	97	3	97%		
	E	100	93	7	93%		
0086-06	A	100	1	99	1%	0%	1%
Unadjusted	B	100	0	100	0%		
	C	100	1	99	1%		
	D	100	0	100	0%		
	E	100	0	100	0%		
0086-06	A	100	99	1	99%	98%	1%
Sulfide Amended	B	100	98	2	98%		
	C	100	97	3	97%		
	D	100	99	1	99%		
	E	100	98	2	98%		
0086-06	A	100	16	84	16%	17%	2%
EDTA 0.8 g/L	B	100	15	85	15%		
	C	100	16	84	16%		
	D	100	20	80	20%		
	E	101	17	84	17%		
0086-06	A	100	4	96	4%	4%	1%
EDTA 1.6 g/L	B	100	3	97	3%		
	C	100	3	97	3%		
	D	100	3	97	3%		
	E	100	6	94	6%		
0086-06	A	100	0	100	0%	0%	0%
EDTA 2.4 g/L	B	100	0	100	0%		
	C	100	0	100	0%		
	D	100	0	100	0%		
	E	100	0	100	0%		
Analyst			LS	LS			

Maxxam Analytics

Echinoderm Fertilisation Test
Summary of Test Data

Species: S. purpuratus

Client # & Name: #1473 Golder

Start Date & Time: 2011Feb23 24 LSWE2011Feb24 @ 1500-1520

Sample ID: 0086-06

Organism Lot: MR110222

Sample Date: 2010Dec15

Test Volume (mL): 5

Stats. File ID: SPF-1473-0311

Date Counted: 2011Mar16, 09

Seawater Source: Van. Aquarium

Seawater Batch: 2010Dec14

Analyst(s): LStaniff,

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Replicate	A	B	C	D	E
SW Control	30	15.2	7.8	8.3	Fertilized	98	95	97	97	93
					Unfertilized	2	5	3	3	7
0086-06 Unadjusted	29	15.7	7.5	3.7	Fertilized	1	0	1	0	0
					Unfertilized	99	100	99	100	100
0086-06 Sulf. Amended	29	15.7	~~8.1~~ 7.8 (A)	5.8	Fertilized	99	98	97	99	98
					Unfertilized	1	2	3	1	2
0086-06 EDTA 0.8 g/L	30	15.6	7.5	6.8	Fertilized	16	15	16	20	17
					Unfertilized	84	85	84	80	84
0086-06 EDTA 1.6 g/L	29	15.7	7.4	6.8	Fertilized	4	3	3	3	6
					Unfertilized	96	97	97	97	94
0086-06 EDTA 2.4 g/L	29	15.7	7.4	6.7	Fertilized	0	0	0	0	0
					Unfertilized	100	100	100	100	100
0086-06 EDTA 3.2 g/L	29	15.6	7.3	6.6	Fertilized					
					Unfertilized					
Analyst	LS	LS	LS	LS	Analyst	LS	LS	LS	LS	LS

Comments: SW 5µm filtered + UV Sterilized 2011Feb22. LS
All EDTA samples were pH adjusted to ~7.5. See Initial WQ data sheet. LS

(A) LSWE 2011Feb24

Maxxam Analytics

Echinoderm Fertilisation Test
Porewater Samples - Initial Water Quality Sheet

Client # & Name: #1473 Golder

Porewater Prep Date: 2011Feb22

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Aeration Time (min)	pH Adjustment (Vol. of Acid or Base Used)	New pH	Analyst
0086-06 Unadjusted								
0086-06 Sulfide Amended								
0086-06 EDTA 0.8 g/L			6.3			3drops 0.1NaOH +4drops 1.0NaOH	7.5	LS
0086-06 EDTA 1.6 g/L			5.6			6drops 1.0N NaOH 2drops 0.1N NaOH	7.5	LS
0086-06 EDTA 2.4 g/L			5.1			8drops 1.0N NaOH 7drops 0.1N NaOH	7.5	LS
0086-06 EDTA 3.2 g/L			4.8			10drops 1.0N NaOH	7.6	LS
0086-06 EDTA 0.8 g/L (pH Adj)								
0086-06 EDTA 1.6 g/L (pH Adj.)								
0086-06 EDTA 2.4 g/L (pH Adj.)								
0086-06 EDTA 3.2 g/L (pH Adj.)								

Date Measured
2011Feb23

Comments:

Maxxam Analytics

Echinoderm Fertilisation Test
Porewater Samples - Initial Water Quality Sheet

Client # & Name: #1473 Golder

Porewater Prep Date: 2011feb23

Sample	Salinity (‰)	Temp (°C)	pH	DO (mg/L)	Aeration Time (min)	pH Adjustment (Vol. of Acid or Base Used)	New pH	Analyst
0086-06 Unadjusted	29	15.7	~~7.80~~ 7.85	3.7	n/a		n/a	LS
0086-06 Sulfide Amended	29	15.7	~~7.57~~ 7.8	5.8			n/a	LS
0086-06 EDTA 0.8 g/L			7.4			1drop 0.1N NaOH	7.5	LS
0086-06 EDTA 1.6 g/L			7.1			4drops 0.1N NaOH	7.5	LS
0086-06 EDTA 2.4 g/L			6.1			1drop 1.0 N NaOH 4drops 0.1 N NaOH	7.5	LS
0086-06 EDTA 3.2 g/L			5.2			4drops 1.0 N NaOH 4drops 0.1 N NaOH	7.5	LS
0086-06 EDTA 0.8 g/L (pH Adj)	30	15.6	7.5	6.8			n/a	LS
0086-06 EDTA 1.6 g/L (pH Adj.)	29	15.7	7.4	6.8			n/a	LS
0086-06 EDTA 2.4 g/L (pH Adj.)	29	15.7	7.4	6.7			n/a	LS
0086-06 EDTA 3.2 g/L (pH Adj.)	29	15.6	7.3	6.6			n/a	LS

Salinity 2011feb24

DO 2011feb24

Date measured 2011feb24

Comments:

2011feb24. Minimal Sulfide odour in EDTA 0.8 + 1.6g/L. ~~Slight~~ Noticable smell in 2.4g/L, strong smell in 3.2g/L

Maxxam Analytics

ECHINODERM FERTILIZATION TEST
Fertilization Trial Sperm Dilutions

Species: *Strongylocentrotus purpuratus*

Client #(s): #1473 Test Date: 2011 Feb 24
Organism Lot #: MR110222 Analyst(s): L.Stavroff, K. Tamaki

Egg Counts: **170**, **216**, **219**, **187**

Number of eggs added to each test tube: 990

Average: **198.0**

Put Ave. # of sperm in <-- this box

Xs = # Sperm/mL = 170750000 170.75
Xe = # eggs added =Average of egg density counts = **198.0**
Vs = volume of suspension (microlitres) = **10**
Conversion factor (microlitres/ml) = 1000

Calculation:

Trial Ratio	Xs	Xe	Vs	Conversion factor	Total Volume	mL Sperm	Total Volume (mL)
0.585	170750000	218.8	10	1000	13340.05	**0.01**	133.40
1.17	170750000	198.0	10	1000	7370.72	**0.01**	73.71
2.34	170750000	198.0	10	1000	3685.36	**0.01**	36.85
4.6875	170750000	198.0	10	1000	1839.73	**0.01**	18.40
9.375	170750000	198.0	10	1000	919.87	**0.1**	91.99
18.75	170750000	198.0	10	1000	459.93	**0.1**	45.99
37.50	170750000	198.0	10	1000	229.97	**0.1**	23.00
75	170750000	198.0	10	1000	114.98	**0.1**	11.50
150	170750000	198.0	10	1000	57.49	**1**	57.49
300	170750000	198.0	10	1000	28.75	**1**	28.75
600	170750000	198.0	10	1000	14.37	**1**	14.37
900	170750000	198.0	10	1000	9.58	**1**	9.58

Calculation is: Xs/((Xe/Vs)*trial ratio*conversion factor)

0.01mL = 10uL	0.1mL = 100uL

MaxXam

ECHINOID FERTILIZATION TEST:
Calculations of Gamete Densities

Species: S. purpuratus

Client #(s): #1473 Test Date: 2011Feb24

Organism Lot #: MR1102252 Analyst(s): LStalwoff

Exposure Time: 10 min. sperm & 10 min. sperm plus egg

Test Volume: 5.0 mL

Egg Density Counts:

per 10 µL

1) 170 3) 219

2) 216 4) 187

Average = 198

# of Eggs Added to Each Test Tube = $\frac{\text{average eggs} * X_E}{10\ (\mu L)}$

= 990

Sperm Density Calculations:

Medium square on the hemocytometer	Count 1	Count 2	Count 3	Count 4	
1	39	29	34	34	
2	29	41	33	25	
3	33	41	29	46	
4	37	36	35	28	
5	45	32	35	28	Average
Total (5 large squares in the corners and the center of the field)	183	179	166	155	170.75

X_E = volume of egg suspension added

X_E = 50 µL

Initial Concentration (C_i)

 # Sperm/mL = $\frac{\text{(dilution factor) (\# sperm counted)(hemocytometer conversion factor) mm}^3\text{/mL}}{\text{\# of small squares counted}}$

 # Sperm/mL = $\frac{(100)(\text{average \# of sperms counted in 5 large size squares: } 170.75)(800)(1000)}{80}$ = 1707500000

Sperm = # sperm/mL 1707500000 **/(# of eggs added** 990 **/volume of suspension** 50 µL **X ratio** 37.5 **X 1000(µL)/1 mL) Dilution** or total volume of sperm suspension including 1 mL (0.5 mL) of concentrated sperm stock and seawater required to dilute the sperm stock given a desired ratio

= 230.0 = **Total Volume** (V_f)

Concentration of Sperm Stock Used in Test:

$C_iV_i = C_fV_f$

initial Concentration * 1 mL = C_f * total volume after dilution

$(1707500000)(mL) = C_f\ (230.0)$

$= C_f =$ 7423913

# of Sperm Added to Each Test Tube = $X_s * C_f$

= 37119.56

Sperm:Egg Ratio is $\frac{\text{\#sperm added}}{\text{\#eggs added}}$ or 37.5 :1

X_s = volume of sperm suspension added = 0.05 mL (= # µL x 1mL/1000 µL)

Notes: Trial Ratio 37.5 Counts 89/11, 89/11 #Males 6 #Females 11 used for tests

Maxxam

Sediment Sample Descriptions

Client # / Name: #1473 Golder

Project #: 2-11-1071

Maxxam Sample Name	Sample #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed	Endemic Animals Removed	Odour	Centrifuged for porewater? Y/N	Purged with N_2?	Analyst
0086-02	Z09676	0086-02	re-2011 Feb 22	DK Brown	wood, shells	N/A	Strong S	y	y	LS
0086-04	Z09678	0086-04	2011 FEB 22	DK brown	none	n/a	Strong S	y	y	KT
0086-06	Z09680	0086-06	2011 FEB 22	DK-Brown	none	n/a	Strong S	y	y	KT

Used on 2011 Feb 23

FORM: 1910F3V1

Z:\Divisions\Environmental Quality\Ecotoxicology\Private\Ecotox\BIOASSAY\FORMS\Sediment Tests Misc\Sample Description Form

2006/10/30

Maxxam **Marine Sediment Porewater Measurements**

Client # & Name: #1473 Golder Date Measured: 2011Feb22

Porewater Collection Method: spun@5000rpm for 25min

Sample ID	Salinity (‰)	Temperature (°C)	pH	Ammonia/ Sulfide Samples Taken	Analyst
0086-02	28.9	n/a	7.5	Y	LS
0086-04	29.4	n/a	7.6	Y	LS
0086-06	29.5	n/a	7.5	Y	LS

Istanoff 2011Feb23

Comments

Sulf. Amend → Vol ↓50mL (from 550mL → <500mL).
0086-02 new sal: 34.1. Added type 1 DI H_2O to marked volume (550mL); Salinity 28.7.
0086-04 new sal: 34.2. Topped up to 550mL/salinity 29.4
0086-06 new sal: 34.4. Topped up to 550mL; salinity 29.5.
Adjusted 2011Feb24 ~12pm; sat uncovered in fume hood for ~20hours. Istanoff.

APPENDIX

C POREWATER AND AMENDED SAMPLE CHEMISTRY

Maxxam Analytics

Sediment Porewater Characterisation

Summary of Pore Water Measurements (February 2011)

Un-ionized Ammonia Calculator

This spreadsheet computes concentration of un-ionized ammonia in seawater as a function of total ammonia, pH, temperature, and salinity. pH can be measured on the "NBS" scale or Hansson scales. If this this confuses you, you are probably using the "NBS" scale and your measured pH values should be entered in Column C.

User information is only needed in cells outlined with double lines. This spreadsheet assumes that total ammonia is reported as nitrogen; computed un-ionized ammonia will also be reported as nitrogen.

Pore Water

Subsample Date	Sample ID	Temp (°C)	Measured pH (NBS)	Total Ammonia Nitrogen (mg/L)	Salinity (‰)	Working pH	Ionic Strength (M)	pKa (infinite dilution)	pKa (SW)	Mole Fraction	Un-ionized Ammonia-N (mg/L)	Un-ionized Ammonia-N (µg/L)
22/02/2011 & 23/02/2011	0086-02	14.1	7.5	11.0	29	7.35	0.595	9.594	9.68	0.0046	0.0506	50.6
	0086-02 SA	14.1	7.7	8.9	29	7.55	0.595	9.594	9.68	0.0073	0.0648	64.8
	0086-04	14.1	7.6	10.0	29	7.45	0.595	9.594	9.68	0.0058	0.0579	57.9
	0086-04 SA	14.1	7.9	7.8	28	7.75	0.574	9.594	9.68	0.0116	0.0904	90.4
	0086-06	15.7	7.5	9.1	29	7.35	0.595	9.541	9.63	0.0052	0.0473	47.3
	0086-06 SA	15.7	7.8	6.6	29	7.65	0.595	9.541	9.63	0.0103	0.0681	68.1

SA - Sulphide Amended

References

Spreadsheet

http://www.fisheries.org/html/publications/epubs/fhm2e/ammonia_swc.xls

pKa for Ammonia in Freshwater

K. Emerson, R.C. Russo, R.C. Lund, & R.V. Thurson, Aqueous ammonia equilibrium calculations: effects of pH and temperature, J. Fish. Res. Board of Canada, 32:2379-2383, 1975

pKa for Ammonia in Seawater

K.H. Khoo, C.H. Culberson, and R.G. Bates, Thermodynamics of the dissociation of ammonium ion in seawater from % to 40 C, Journal of Solution Chemistry, 6:281-290, 1977.

Ionic Strength of Seawater

M. Whitfield, The hydrolysis of ammonia ions in sea water - a theoretical study, Journal of Marine Biological Association of the United Kingdoms, 54:565-580, 1974.

Measure of pH in Seawater

I. Hansson, A new set of pH scales and standard buffers for sea water, Deep-Sea Research, 20:479-491, 1973.

Interelationship of Hansson's pH scale with the NBS scale

F.J. Millero, The pH of estuarine waters, Limnology and Oceanography, 31:839-847, 1986.

Maxxam

Success Through Science®

Your Project #: 09-1436-5008/5000
Your C.O.C. #: 0086, G040858, G037375, G037377

Attention: Adrian de Bruyn
GOLDER ASSOCIATES LTD
4260 STILL CREEK DRIVE
Suite 500
BURNABY, BC
Canada V5C 6C6

Report Date: 2011/03/11

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B0C2492
Received: 2011/02/23, 14:05

Sample Matrix: Sea Water
Samples Received: 13

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Hardness (calculated as CaCO3)	7	N/A	2010/12/31		
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	6	N/A	2011/03/02	BBY7SOP-00002	Based on EPA 200.8
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	7	N/A	2010/12/31	BBY7SOP-00002	Based on EPA 200.8
Elements by ICPMS (dissolved) - Seawater	6	N/A	2011/03/02	BBY7SOP-00002	Based on EPA 200.8
Elements by CRC ICPMS (dissolved)	7	N/A	2010/12/31	BBY7SOP-00002	Based on EPA 200.8
Ammonia-N (Total) (1)	7	N/A	2010/12/24	AB SOP-00007	EPA 350.1
Ammonia-N (Total) (1)	6	N/A	2011/02/28	AB SOP-00007	EPA 350.1
Filter and HNO3 Preserve for Metals	7	N/A	2010/12/23	BBY6WI-00001	Based on EPA 200.2
Filter and HNO3 Preserve for Metals	6	N/A	2011/02/24	BBY6WI-00001	Based on EPA 200.2
Sulphide	7	N/A	2010/12/29	BBY6SOP-00006	Based on SM-4500 S2D
Sulphide	6	N/A	2011/02/25	BBY6SOP-00006	Based on SM-4500 S2D
Total Suspended Solids	6	N/A	2011/03/01	BBY6SOP-00034	Based on SM - 2540 D
Total Suspended Solids-LowLevel	7	N/A	2010/12/22	BBY6SOP-00034	Based on SM-2540 D

Sample Matrix: Sediment
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Ecotox Report Attachment	1	2011/01/07	2011/03/11		
Ecotox Report Attachment	5	2011/03/11	2011/03/11		

Sample Matrix: Soil
Samples Received: 6

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
BTEX/MTBE Soil LH, VH, F1 SIM/MS	6	2010/12/22	2010/12/24	BBY8-SOP-00010	EPA SW846 8260C
Volatile F1-BTEX	6	N/A	2010/12/24		
CCME Hydrocarbons (F2-F4 in soil)	6	2010/12/22	2010/12/24	BBY8SOP-00030	CCME Soil Tier 1
Elements by ICPMS (total)	6	2010/12/23	2010/12/23	BBY7SOP-00004	Based on EPA 200.8
Simultaneously Extractable Metals-ICPMS	6	2011/01/04	2011/01/04	BBY7SOP-00001	Based on EPA 200.8
Moisture	6	N/A	2010/12/23	BBY8SOP-00017	Ont MOE -E 3139
PAH in Soil by GC/MS Lowlevel (Extended)	6	2010/12/22	2011/01/06	BRN SOP-00332 R5.0	Based on EPA 8270D
Total LMW, HMW, Total PAH Calc	6	N/A	2011/01/06		PAHTOT-S
pH (2:1 DI Water Extract)	6	2010/12/23	2010/12/23	BBY6SOP-00028	Carter, SSMA 16.2
Particle Size Distribution - Standard (2)	6	2010/12/29	2010/12/29		
Sulfide (AVS) (soil) - Calc for umole/g	6	2010/12/22	2011/01/05	BRN SOP-00229 R2.0	Based EPA821-R91-100
Sulfide (AVS) (soil)	6	2011/01/04	2011/01/04	BBY6SOP-00007	Based EPA821-R91-100
Texture Class (2)	6	N/A	2011/01/10		
TOC Soil Subcontract (3)	6	2011/01/06	2011/01/06		

../2

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

GOLDER ASSOCIATES LTD
Maxxam Job #: B0C2492
Client Project #: 09-1436-5008/5000
Report Date: 2011/03/11

* Results relate only to the items tested.

(1) This test was performed by Maxxam Edmonton Environmental
(2) This test was performed by Maxxam Winnipeg
(3) This test was performed by Maxxam Ontario (From Burnaby)

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

VJ OCO, Burnaby Customer Service
Email: VOco@maxxam.ca
Phone# (604) 639-8422

==========

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Maxxam Job #: B0C2492
Report Date: 2011/03/11

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		AA3434		AA3478		AA3479		AA3480	AA3481		
Sampling Date		2011/02/22		2011/02/22		2011/02/22		2011/02/23	2011/02/23		
	Units	**0086-02 POREWATER**	**RDL**	**0086-04 POREWATER**	**RDL**	**0086-06 POREWATER**	**RDL**	**0086-02 (SULF. AMENDED)**	**0086-04 (SULF. AMENDED)**	**RDL**	**QC Batch**
CONVENTIONALS											
Total Ammonia (N)	mg/L	11(1)	0.5	10(1)	0.5	9.1(1)	0.3	8.9(1)	7.8(1)	0.3	4665414
Calculated Parameters											
Filter and HNO3 Preservation	N/A	LAB	N/A	LAB	N/A	LAB	N/A	LAB	LAB	N/A	4657426
MISCELLANEOUS											
Sulphide	mg/L	12.2	0.3	34	1	27	1	0.022	0.028	0.005	4661454
Physical Properties											
Total Suspended Solids	mg/L	53	4	88	4	100	4	83	87	4	4668576

Maxxam ID		AA3482			Z18207		Z18208		Z18209		
Sampling Date		2011/02/23									
	Units	**0086-06 (SULF. AMENDED)**	**RDL**	**QC Batch**	**0086-01 POREWATER**	**RDL**	**0086-02 POREWATER**	**RDL**	**0086-03 POREWATER**	**RDL**	**QC Batch**
CONVENTIONALS											
Total Ammonia (N)	mg/L	6.6(1)	0.3	4665414	3.0(1)	0.3	2.7(1)	0.3	2.4(1)	0.3	4531369
Calculated Parameters											
Filter and HNO3 Preservation	N/A	LAB	N/A	4657426	LAB	N/A	LAB	N/A	LAB	N/A	4533846
MISCELLANEOUS											
Sulphide	mg/L	0.026	0.005	4661454	2.90(2)	0.05	3.5(2)	0.2	0.015	0.005	4534611
Physical Properties											
Total Suspended Solids	mg/L	66	4	4668576	86	1	110	1	120	1	4523747

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Detection limits raised due to dilution to bring analyte within the calibrated range.
(2) - Sample received at less than recommended preservation pH 9.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		Z18210		Z18211		Z18212		Z18213		
	Units	**0086-04 POREWATER**	**RDL**	**0086-05 POREWATER**	**RDL**	**0086-06 POREWATER**	**RDL**	**SW CONTROL**	**RDL**	**QC Batch**
CONVENTIONALS										
Total Ammonia (N)	mg/L	4.4(1)	0.3	2.8(1)	0.3	5.4(1)	0.3	0.33	0.05	4531369
Calculated Parameters										
Filter and HNO3 Preservation	N/A	LAB	N/A	LAB	N/A	LAB	N/A	LAB	N/A	4533846
MISCELLANEOUS										
Sulphide	mg/L	19.4	0.5	1.11	0.03	22.2	0.5	<0.005	0.005	4534611
Physical Properties										
Total Suspended Solids	mg/L	77	1	92	1	76	1	5	1	4523747

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Detection limits raised due to dilution to bring analyte within the calibrated range.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

ELEMENTS BY ATOMIC SPECTROSCOPY (SEA WATER)

Maxxam ID		AA3434	AA3478	AA3479	AA3480	AA3481	AA3482		
Sampling Date		2011/02/22	2011/02/22	2011/02/22	2011/02/23	2011/02/23	2011/02/23		
	Units	**0086-02 POREWATER**	**0086-04 POREWATER**	**0086-06 POREWATER**	**0086-02 (SULF. AMENDED)**	**0086-04 (SULF. AMENDED)**	**0086-06 (SULF. AMENDED)**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	ug/L	32	55	50	28	37	34	10	4658036
Dissolved Antimony (Sb)	ug/L	1.2	0.5	1.0	1.3	1.9	1.4	0.5	4658036
Dissolved Arsenic (As)	ug/L	40.5	81.3	69.9	42.9	85.1	71.5	0.5	4658036
Dissolved Barium (Ba)	ug/L	32	57	48	31	56	47	1	4658036
Dissolved Beryllium (Be)	ug/L	<1	<1	<1	<1	<1	<1	1	4658036
Dissolved Bismuth (Bi)	ug/L	<1	<1	<1	<1	<1	<1	1	4658036
Dissolved Boron (B)	ug/L	3920	4770	5250	4660	4840	5230	50	4658036
Dissolved Cadmium (Cd)	ug/L	0.10	0.13	0.14	0.14	0.18	0.14	0.05	4658036
Dissolved Chromium (Cr)	ug/L	1.2	1.2	2.9	1.7	2.0	2.3	0.5	4658036
Dissolved Cobalt (Co)	ug/L	<0.1	0.1	0.2	<0.1	0.1	0.1	0.1	4658036
Dissolved Copper (Cu)	ug/L	1.7	1.6	1.7	2.0	2.6	2.0	0.5	4658036
Dissolved Iron (Fe)	ug/L	81	53	80	75	64	68	2	4658036
Dissolved Lead (Pb)	ug/L	1.2	0.7	0.8	1.2	1.4	1.2	0.1	4658036
Dissolved Lithium (Li)	ug/L	155	167	173	170	163	165	20	4658036
Dissolved Manganese (Mn)	ug/L	12.4	2.0	3.6	12.2	2.2	3.3	0.5	4658036
Dissolved Molybdenum (Mo)	ug/L	8	5	8	8	6	9	1	4658036
Dissolved Nickel (Ni)	ug/L	0.6	1.0	1.0	0.6	0.6	0.9	0.2	4658036
Dissolved Phosphorus (P)	ug/L	2790	3050	2720	2980	2950	2670	50	4658036
Dissolved Selenium (Se)	ug/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	4658036
Dissolved Silicon (Si)	ug/L	18600	22700	23800	21000	22800	22800	100	4658036
Dissolved Silver (Ag)	ug/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4658036
Dissolved Strontium (Sr)	ug/L	7430	7510	7440	7410	7210	7290	10	4658036
Dissolved Thallium (Tl)	ug/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	4658036
Dissolved Tin (Sn)	ug/L	<1	<1	<1	<1	<1	<1	1	4658036
Dissolved Titanium (Ti)	ug/L	<10	<10	<10	<10	<10	<10	10	4658036
Dissolved Uranium (U)	ug/L	5.80	3.25	3.74	5.59	3.49	4.07	0.05	4658036
Dissolved Vanadium (V)	ug/L	<10	<10	<10	<10	<10	<10	10	4658036
Dissolved Zinc (Zn)	ug/L	2	2	3	3	3	2	1	4658036
Dissolved Calcium (Ca)	mg/L	389	383	388	396	373	373	1	4654876
Dissolved Magnesium (Mg)	mg/L	1080	1110	1120	1070	1080	1060	1	4654876
Dissolved Potassium (K)	mg/L	329	346	349	331	336	329	1	4654876
Dissolved Sodium (Na)	mg/L	9550	9690	9730	9250	9350	9130	1	4654876
Dissolved Sulphur (S)	mg/L	798	847	866	832	815	821	20	4654876

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

RESULTS OF CHEMICAL ANALYSES OF SEDIMENT

Maxxam ID		Z09675	Z09676	Z09677	Z09678	Z09679	Z09680		
Sampling Date		2010/12/15	2010/12/15	2010/12/15	2010/12/15	2010/12/15	2010/12/15		
	Units	**0086-01**	**0086-02**	**0086-03**	**0086-04**	**0086-05**	**0086-06**	**RDL**	**QC Batch**
Calculated Parameters									
No Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	4700622

RESULTS OF CHEMICAL ANALYSES OF SOIL

Maxxam ID		Z18215	Z18216		Z18217		Z18218		Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Parameter												
Subcontract Parameter	N/A	ATTACHED	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	N/A	ATTACHED	ATTACHED	N/A	4547422
Calculated Parameters												
Sulphide	umole/g	11.6	14.7	0.6	2.04	0.06	7.2	0.3	9.3	12.6	0.6	4524145
MISCELLANEOUS												
Sulphide	ug/g	372	471	20	65	2	229	10	299	404	20	4541759
Physical Properties												
Texture	N/A	SILT LOAM	LOAM	N/A	SAND	N/A	SILT LOAM	N/A	SILT LOAM	LOAM	N/A	4524099

N/A = Not Applicable
RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

PETROLEUM HYDROCARBONS (CCME)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Ext. Pet. Hydrocarbon									
F2 (C10-C16 Hydrocarbons)	mg/kg	68(1)	61(1)	23	100(1)	130(1)	150(1)	10	4527562
F3 (C16-C34 Hydrocarbons)	mg/kg	500(1)	470(1)	170	550(1)	700(1)	610(1)	10	4527562
F4 (C34-C50 Hydrocarbons)	mg/kg	140(1)	150(1)	110	140(1)	240(1)	160(1)	10	4527562
Reached Baseline at C50	mg/kg	YES	YES	YES	YES	YES	YES	N/A	4527562
Surrogate Recovery (%)									
O-TERPHENYL (sur.)	%	94	92	92	89	96	95		4527562

PARTICLE SIZE DISTRIBUTION ANALYSIS (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Percent Passing									
<0.002mm Pipette	%	8.96	10.57	1.60	22.32	24.52	17.19	0.01	4551597
<0.053mm Pipette	%	38.31	32.73	8.02	69.75	76.21	52.99	0.01	4551597
<0.125mm, Sieve #120	%	36.81	39.81	20.91	82.76	83.81	64.88	0.01	4551597
<0.250mm, Sieve #60	%	40.56	50.85	46.54	88.43	89.19	71.58	0.01	4551597
<2.00mm, Sieve #10	%	58.40	64.48	82.73	92.78	95.41	83.03	0.01	4551597
Percent of Entire Sample									
<0.002mm	%	8.96	10.57	1.60	22.32	24.52	17.19	0.01	4551597
<0.053mm & >0.002mm	%	29.35	22.16	6.42	47.43	51.69	35.79	0.01	4551597
<2.00mm & >0.053mm	%	20.08	31.75	74.72	23.03	19.20	30.05	0.01	4551597
>2.00mm	%	41.61	35.52	17.27	7.22	4.60	16.97	0.01	4551597
% of the <2mm Fraction									
% Clay <0.002mm	%	15.35	16.39	1.93	24.06	25.70	20.71	0.01	4551597
% Sand <2.00mm & >0.053mm	%	34.39	49.25	90.31	24.82	20.12	36.19	0.01	4551597
% Silt <0.053mm & >0.002mm	%	50.26	34.37	7.76	51.12	54.18	43.11	0.01	4551597

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample contained > 50% moisture.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

PHYSICAL TESTING (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Physical Properties									
Moisture	%	74	71	27	72	73	69	0.3	4526373

ELEMENTS BY ATOMIC SPECTROSCOPY (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
SEM Metals by ICPMS									
SEM Cadmium (Cd)	umole/g	0.0023	0.0016	0.0018	0.0027	0.0035	0.0026	0.0002	4542344
SEM Copper (Cu)	umole/g	0.040	0.033	0.255	0.043	0.062	0.048	0.004	4542344
SEM Lead (Pb)	umole/g	0.0074	0.0070	0.0840	0.0075	0.0105	0.0077	0.0002	4542344
SEM Mercury (Hg)	umole/g	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	0.0003	4542344
SEM Nickel (Ni)	umole/g	0.014	0.013	0.125	0.021	0.023	0.022	0.004	4542344
SEM Zinc (Zn)	umole/g	0.195	0.173	0.694	0.178	0.301	0.176	0.008	4542344

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

CCME BTEX/F1 BY HS IN SOIL (SOIL)

Maxxam ID		Z18215		Z18216		Z18217		Z18218		Z18219		Z18220		
	Units	**0086-01 SEDIMENT**	**RDL**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**RDL**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Calculated Parameters														
F1 (C6-C10) - BTEX	mg/kg	<60	60	<50	50	<10	10	<50	50	<60	60	<50	50	4524143
Volatiles														
Methyl-tert-butylether (MTBE)	mg/kg	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	<0.1	0.1	4527833
Benzene	mg/kg	0.04(1)	0.03	<0.03(1)	0.03	<0.005	0.005	<0.03(1)	0.03	<0.03(1)	0.03	<0.02(1)	0.02	4527833
Toluene	mg/kg	0.09(1)	0.03	0.19(1)	0.03	<0.02	0.02	0.05(1)	0.03	0.07(1)	0.03	0.08(1)	0.02	4527833
Ethylbenzene	mg/kg	<0.03(1)	0.03	<0.03(1)	0.03	<0.01	0.01	<0.03(1)	0.03	<0.03(1)	0.03	0.02(1)	0.02	4527833
m & p-Xylene	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.04	0.04	<0.04	0.04	4527833
o-Xylene	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	4527833
Styrene	mg/kg	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	<0.03	0.03	4527833
Xylenes (Total)	mg/kg	<0.04	0.04	<0.04	0.04	<0.04	0.04	<0.04	0.04	0.04	0.04	<0.04	0.04	4527833
(C6-C10)	mg/kg	<60(1)	60	<50(1)	50	<10	10	<50(1)	50	<60(1)	60	<50(1)	50	4527833
Surrogate Recovery (%)														
4-BROMOFLUOROBENZENE (sur.)	%	84		83		84		84		83		85		4527833
D10-ETHYLBENZENE (sur.)	%	82		83		86		82		83		84		4527833
D4-1,2-DICHLOROETHANE (sur.)	%	101		105		96		99		97		96		4527833
D8-TOLUENE (sur.)	%	94		92		96		95		94		94		4527833

RDL = Reportable Detection Limit
(1) - RDL raised due to high sample moisture content.

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

CSR/CCME METALS IN SOIL (SOIL)

Maxxam ID		Z18215	Z18216	Z18217	Z18218	Z18219	Z18220		
	Units	**0086-01 SEDIMENT**	**0086-02 SEDIMENT**	**0086-03 SEDIMENT**	**0086-04 SEDIMENT**	**0086-05 SEDIMENT**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Physical Properties									
Soluble (2:1) pH	pH Units	7.64	7.39	7.83	7.33	7.33	7.62	0.01	4529385
Total Metals by ICPMS									
Total Aluminum (Al)	mg/kg	6520	8800	9590	11300	10400	10400	100	4528403
Total Antimony (Sb)	mg/kg	0.3	0.4	0.4	0.5	0.5	0.5	0.1	4528403
Total Arsenic (As)	mg/kg	9.4	10.9	4.0	12.2	12.9	11.2	0.2	4528403
Total Barium (Ba)	mg/kg	26.2	30.9	33.0	47.5	42.2	51.2	0.1	4528403
Total Beryllium (Be)	mg/kg	0.2	0.1	0.1	0.3	0.2	0.3	0.1	4528403
Total Bismuth (Bi)	mg/kg	0.1	0.2	<0.1	0.2	0.2	0.2	0.1	4528403
Total Cadmium (Cd)	mg/kg	2.76	2.62	0.34	3.70	3.72	3.25	0.05	4528403
Total Calcium (Ca)	mg/kg	60500	13100	5920	6590	6930	9140	100	4528403
Total Chromium (Cr)	mg/kg	19	21	15	27	26	27	1	4528403
Total Cobalt (Co)	mg/kg	3.3	4.3	4.8	5.1	4.7	5.1	0.3	4528403
Total Copper (Cu)	mg/kg	65.3	105	43.5	72.9	79.1	73.6	0.5	4528403
Total Iron (Fe)	mg/kg	13600	16700	13800	17500	16500	16300	100	4528403
Total Lead (Pb)	mg/kg	22.5	25.5	24.7	20.1	23.2	21.5	0.1	4528403
Total Magnesium (Mg)	mg/kg	6990	7320	4700	7780	7580	6970	100	4528403
Total Manganese (Mn)	mg/kg	108	140	152	154	137	142	0.2	4528403
Total Mercury (Hg)	mg/kg	0.51	0.23	0.08	0.26	0.25	0.29	0.05	4528403
Total Molybdenum (Mo)	mg/kg	12.3	10.8	1.4	9.9	13.1	8.9	0.1	4528403
Total Nickel (Ni)	mg/kg	15.2	16.1	12.2	21.5	19.9	21.2	0.8	4528403
Total Phosphorus (P)	mg/kg	625	701	423	730	714	671	10	4528403
Total Potassium (K)	mg/kg	1800	1790	824	2050	2010	1930	100	4528403
Total Selenium (Se)	mg/kg	1.2	1.6	<0.5	1.8	2.4	1.8	0.5	4528403
Total Silver (Ag)	mg/kg	0.18	0.26	0.09	0.29	0.26	0.26	0.05	4528403
Total Sodium (Na)	mg/kg	24100	22400	3130	20600	20900	18100	100	4528403
Total Strontium (Sr)	mg/kg	216	83.2	44.4	63.8	64.8	74.2	0.1	4528403
Total Thallium (Tl)	mg/kg	0.28	0.32	0.20	0.36	0.39	0.30	0.05	4528403
Total Tin (Sn)	mg/kg	3.0	2.4	1.6	1.7	1.9	1.5	0.1	4528403
Total Titanium (Ti)	mg/kg	263	533	885	525	436	394	1	4528403
Total Vanadium (V)	mg/kg	34	40	35	45	44	42	2	4528403
Total Zinc (Zn)	mg/kg	171	168	63	132	163	124	1	4528403
Total Zirconium (Zr)	mg/kg	1.4	3.7	2.1	2.2	2.0	1.7	0.5	4528403

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

CSR DISSOLVED METALS IN WATER (SEA WATER)

Maxxam ID		Z18207	Z18208	Z18209	Z18210	Z18211	Z18212	Z18213		
	Units	**0086-01 POREWATER**	**0086-02 POREWATER**	**0086-03 POREWATER**	**0086-04 POREWATER**	**0086-05 POREWATER**	**0086-06 POREWATER**	**SW CONTROL**	**RDL**	**QC Batch**
Misc. Inorganics										
Dissolved Hardness (CaCO3)	mg/L	5670	5540	5130	5520	5560	5330	5690	0.5	4523678
Dissolved Metals by ICPMS										
Dissolved Aluminum (Al)	mg/L	0.06	0.61	0.04	0.85	0.04	0.05	0.03	0.03	4529525
Dissolved Antimony (Sb)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Arsenic (As)	mg/L	0.010	0.007	0.013	0.033	0.015	0.061	0.002	0.001	4529525
Dissolved Barium (Ba)	mg/L	0.03	0.03	0.02	0.06	0.03	0.05	0.01	0.01	4529525
Dissolved Beryllium (Be)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	4529525
Dissolved Bismuth (Bi)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Boron (B)	mg/L	4.9	5.0	5.2	5.1	4.9	5.2	4.9	0.5	4529525
Dissolved Cadmium (Cd)	mg/L	0.0002	<0.0001	0.0001	0.0002	0.0002	<0.0001	0.0002	0.0001	4529525
Dissolved Chromium (Cr)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Cobalt (Co)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Copper (Cu)	mg/L	<0.002	<0.002	<0.002	<0.002	0.148	<0.002	<0.002	0.002	4529525
Dissolved Iron (Fe)	mg/L	0.10	0.14	0.08	0.11	0.10	0.06	<0.05	0.05	4529525
Dissolved Lead (Pb)	mg/L	<0.002	<0.002	<0.002	<0.002	0.005	<0.002	<0.002	0.002	4529525
Dissolved Lithium (Li)	mg/L	0.16	0.15	0.15	0.16	0.15	0.16	0.17	0.05	4529525
Dissolved Manganese (Mn)	mg/L	0.02	0.01	0.09	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Mercury (Hg)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	4529525
Dissolved Molybdenum (Mo)	mg/L	0.04	0.02	0.06	<0.01	0.01	<0.01	<0.01	0.01	4529525
Dissolved Nickel (Ni)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	4529525
Dissolved Selenium (Se)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.001	4529525
Dissolved Silicon (Si)	mg/L	14	15	6	19	13	18	2	1	4529525
Dissolved Silver (Ag)	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0002	4529525
Dissolved Strontium (Sr)	mg/L	6.79	6.57	6.19	6.63	6.38	6.44	6.56	0.01	4529525
Dissolved Thallium (Tl)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	4529525
Dissolved Tin (Sn)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Titanium (Ti)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Uranium (U)	mg/L	0.003	0.003	0.007	0.003	0.004	0.004	0.003	0.001	4529525
Dissolved Vanadium (V)	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	4529525
Dissolved Zinc (Zn)	mg/L	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	<0.05	0.05	4529525
Dissolved Zirconium (Zr)	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	4529525
Dissolved Calcium (Ca)	mg/L	388	388	366	392	386	370	384	0.5	4523679
Dissolved Magnesium (Mg)	mg/L	1140	1110	1030	1100	1120	1070	1150	0.5	4523679
Dissolved Potassium (K)	mg/L	358	351	347	351	361	351	355	0.5	4523679
Dissolved Sodium (Na)	mg/L	9350	9310	8610	9140	9260	8990	9430	0.5	4523679
Dissolved Sulphur (S)	mg/L	964	953	853	946	898	891	985	30	4523679

RDL = Reportable Detection Limit

Maxxam Job #: B0C2492
Report Date: 2011/03/11

GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

DO NOT USE, DH4 110207 (SOIL)

Maxxam ID		Z18215		Z18216		Z18217		Z18218		Z18219		Z18220		
	Units	**0086-01 SEDIMENT**	**RDL**	**0086-02 SEDIMENT**	**RDL**	**0086-03 SEDIMENT**	**RDL**	**0086-04 SEDIMENT**	**RDL**	**0086-05 SEDIMENT**	**RDL**	**0086-06 SEDIMENT**	**RDL**	**QC Batch**
Polycyclic Aromatics														
Naphthalene	mg/kg	0.25(1)	0.005	0.31(1)	0.005	0.14(1)	0.005	0.48(1)	0.005	0.65(2)	0.005	1.1(1)	0.005	4542849
2-Methylnaphthalene	mg/kg	0.55(1)	0.005	0.64(1)	0.005	0.29(1)	0.005	1.1(1)	0.005	1.4(2)	0.005	2.6(1)	0.005	4542849
Acenaphthylene	mg/kg	<0.08(3)	0.08	<0.07(3)	0.07	<0.04(3)	0.04	<0.08(3)	0.08	<0.1(3)	0.1	<0.2(3)	0.2	4542849
Acenaphthene	mg/kg	0.10(1)	0.005	0.10(1)	0.005	0.027(1)	0.005	0.18(1)	0.005	0.29(2)	0.005	0.34(1)	0.005	4542849
Fluorene	mg/kg	0.17(1)	0.005	0.16(1)	0.005	0.050(1)	0.005	0.26(1)	0.005	0.43(2)	0.005	0.56(1)	0.005	4542849
Phenanthrene	mg/kg	0.86(1)	0.005	0.72(1)	0.005	0.31(1)	0.005	1.2(1)	0.005	1.5(2)	0.005	2.4(1)	0.005	4542849
Anthracene	mg/kg	0.30(1)	0.005	0.31(1)	0.005	0.068(1)	0.005	0.33(1)	0.005	0.58(2)	0.005	0.49(1)	0.005	4542849
Fluoranthene	mg/kg	1.1(1)	0.005	0.94(1)	0.005	0.41(1)	0.005	1.1(1)	0.005	1.6(2)	0.005	1.6(1)	0.005	4542849
Pyrene	mg/kg	1.3(1)	0.005	1.2(1)	0.005	0.40(1)	0.005	0.94(1)	0.005	2.0(2)	0.005	1.3(1)	0.005	4542849
Benzo(a)anthracene	mg/kg	0.30(1)	0.005	0.35(1)	0.005	0.14(1)	0.005	0.34(1)	0.005	0.66(2)	0.005	0.54(1)	0.005	4542849
Chrysene	mg/kg	0.46(1)	0.005	0.43(1)	0.005	0.19(1)	0.005	0.42(1)	0.005	0.74(2)	0.005	0.66(1)	0.005	4542849
Benzo(b&j)fluoranthene	mg/kg	0.36(1)	0.005	0.38(1)	0.005	0.16(1)	0.005	0.30(1)	0.005	0.58(2)	0.005	0.39(1)	0.005	4542849
Benzo(k)fluoranthene	mg/kg	0.24(1)	0.005	0.27(1)	0.005	0.11(1)	0.005	0.20(1)	0.005	0.42(2)	0.005	0.28(1)	0.005	4542849
Benzo(a)pyrene	mg/kg	0.21(1)	0.005	0.23(1)	0.005	0.15(1)	0.005	0.21(1)	0.005	0.39(2)	0.005	0.32(1)	0.005	4542849
Indeno(1,2,3-cd)pyrene	mg/kg	0.11(1)	0.01	0.12(1)	0.01	0.10(1)	0.01	0.10(1)	0.01	0.18(1)	0.01	0.13(1)	0.01	4542849
Dibenz(a,h)anthracene	mg/kg	0.04(1)	0.01	0.04(1)	0.01	0.03(1)	0.01	0.05(1)	0.01	0.07(1)	0.01	0.07(1)	0.01	4542849
Benzo(g,h,i)perylene	mg/kg	0.15(1)	0.01	0.17(1)	0.01	0.15(1)	0.01	0.17(1)	0.01	0.26(2)	0.01	0.26(1)	0.01	4542849
Low Molecular Weight PAH`s	mg/kg	2.2	0.08	2.2	0.07	0.88	0.04	3.6	0.08	4.8	0.1	7.5	0.2	4524144
High Molecular Weight PAH`s	mg/kg	4.2	0.01	4.1	0.01	1.8	0.01	3.9	0.01	6.9	0.01	5.5	0.01	4524144
Total PAH	mg/kg	6.4	0.08	6.4	0.07	2.7	0.04	7.4	0.08	12	0.1	13	0.2	4524144
Surrogate Recovery (%)														
D10-ANTHRACENE (sur.)	%	100		100		100		95		95		100		4542849
D12-BENZO(A)PYRENE (sur.)	%	90		100		90		90		85		95		4542849
D8-ACENAPHTHYLENE (sur.)	%	60		60		90		60		55		60		4542849
D8-NAPHTHALENE (sur.)	%	95		95		90		90		95		95		4542849
TERPHENYL-D14 (sur.)	%	95		100		100		95		90		100		4542849

RDL = Reportable Detection Limit
(1) - RDL raised due to sample dilution.
(2) - RDL raised due to sample dilution. Matrix spike recovery outside control limit - High target compounds - No impact, spike Invalid.
(3) - RDL raised due to sample matrix interference.

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General Comments

Sample Z18215-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18216-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18217-01: ** SEM/AVS = 0.57 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18218-01: ** SEM/AVS = 0.04 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18219-01: ** SEM/AVS = 0.04 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

Sample Z18220-01: ** SEM/AVS = 0.02 [SEM IS THE SUM OF CD CU HG NI PB AND ZN] **

CSR DISSOLVED METALS IN WATER (SEA WATER) Comments

Sample Z18207-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18208-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18209-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18210-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18211-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18212-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

Sample Z18213-02 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4523747	Total Suspended Solids	2010/12/22			100	80 - 120	<1	mg/L				
4526373	Moisture	2010/12/23					<0.3	%	0	20		
4527562	O-TERPHENYL (sur.)	2010/12/24	85	50 - 130	99	50 - 130	97	%				
4527562	F2 (C10-C16 Hydrocarbons)	2010/12/24	102	50 - 130	99	80 - 120	<10	mg/kg	0.6(1)	40		
4527562	F3 (C16-C34 Hydrocarbons)	2010/12/24	113	50 - 130	107	80 - 120	<10	mg/kg	4.2(1)	40		
4527562	F4 (C34-C50 Hydrocarbons)	2010/12/24	111	50 - 130	107	80 - 120	<10	mg/kg	19.6(1)	40		
4527562	Reached Baseline at C50	2010/12/24							NC	50		
4527833	4-BROMOFLUOROBENZENE (sur.)	2010/12/23	86	70 - 130	86	70 - 130	83	%			88	70 - 130
4527833	D10-ETHYLBENZENE (sur.)	2010/12/23	88	50 - 130	74	50 - 130	82	%			73	50 - 130
4527833	D4-1,2-DICHLOROETHANE (sur.)	2010/12/23	98	70 - 130	97	70 - 130	94	%			94	70 - 130
4527833	D8-TOLUENE (sur.)	2010/12/23	94	70 - 130	94	70 - 130	96	%			98	70 - 130
4527833	Benzene	2010/12/24	103	60 - 140	99	60 - 140	<0.005	mg/kg	18.9	40		
4527833	Toluene	2010/12/24	89	60 - 140	85	60 - 140	<0.02	mg/kg	NC	40		
4527833	Ethylbenzene	2010/12/24	101	60 - 140	96	60 - 140	<0.01	mg/kg	NC	40		
4527833	m & p-Xylene	2010/12/24	98	60 - 140	93	60 - 140	<0.04	mg/kg	NC	40		
4527833	o-Xylene	2010/12/24	94	60 - 140	90	60 - 140	<0.04	mg/kg	NC	40		
4527833	(C6-C10)	2010/12/23					<10	mg/kg			108	60 - 140
4527833	Methyl-tert-butylether(MTBE)	2010/12/24					<0.1	mg/kg	NC	40		
4527833	Styrene	2010/12/24					<0.03	mg/kg	NC	40		
4527833	Xylenes (Total)	2010/12/24					<0.04	mg/kg	NC	40		
4528403	Total Arsenic (As)	2010/12/23	99	75 - 125	95	75 - 125	<0.2	mg/kg	12.2	30	100	70 - 130
4528403	Total Beryllium (Be)	2010/12/23	104	75 - 125	101	75 - 125	<0.1	mg/kg	NC	30		
4528403	Total Cadmium (Cd)	2010/12/23	103	75 - 125	95	75 - 125	<0.05	mg/kg	NC	30	104	70 - 130
4528403	Total Chromium (Cr)	2010/12/23	100	75 - 125	93	75 - 125	<1	mg/kg	4.0	30	102	70 - 130
4528403	Total Cobalt (Co)	2010/12/23	95	75 - 125	92	75 - 125	<0.3	mg/kg	4.3	30	96	70 - 130
4528403	Total Copper (Cu)	2010/12/23	99	75 - 125	95	75 - 125	<0.5	mg/kg	4.6	30	95	70 - 130
4528403	Total Lead (Pb)	2010/12/23	104	75 - 125	99	75 - 125	<0.1	mg/kg	1.2	35	106	70 - 130
4528403	Total Mercury (Hg)	2010/12/23	102	75 - 125	100	75 - 125	<0.05	mg/kg	NC	35		
4528403	Total Nickel (Ni)	2010/12/23	97	75 - 125	93	75 - 125	<0.8	mg/kg	3.0	30	97	70 - 130
4528403	Total Selenium (Se)	2010/12/23	97	75 - 125	96	75 - 125	<0.5	mg/kg	NC	30		
4528403	Total Vanadium (V)	2010/12/23	NC	75 - 125	94	75 - 125	<2	mg/kg	3.4	30	104	70 - 130
4528403	Total Zinc (Zn)	2010/12/23	NC	75 - 125	94	75 - 125	<1	mg/kg	6.3	30	92	70 - 130
4528403	Total Aluminum (Al)	2010/12/23					<100	mg/kg	4.8	35	105	70 - 130
4528403	Total Antimony (Sb)	2010/12/23					<0.1	mg/kg	NC	30	101	70 - 130
4528403	Total Barium (Ba)	2010/12/23					<0.1	mg/kg	5.4	35	105	70 - 130
4528403	Total Calcium (Ca)	2010/12/23					<100	mg/kg	4.1	30	101	70 - 130
4528403	Total Iron (Fe)	2010/12/23					<100	mg/kg	3.3	30	99	70 - 130
4528403	Total Magnesium (Mg)	2010/12/23					<100	mg/kg	2.3	30	101	70 - 130
4528403	Total Manganese (Mn)	2010/12/23					<0.2	mg/kg	3.3	30	101	70 - 130
4528403	Total Molybdenum (Mo)	2010/12/23					<0.1	mg/kg	8.6	35	95	70 - 130

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4528403	Total Phosphorus (P)	2010/12/23					<10	mg/kg	7.9	30	103	70 - 130
4528403	Total Strontium (Sr)	2010/12/23					<0.1	mg/kg	1.8	35	96	70 - 130
4528403	Total Thallium (Tl)	2010/12/23					<0.05	mg/kg	NC	30	94	70 - 130
4528403	Total Titanium (Ti)	2010/12/23					<1	mg/kg	17.6	35	108	70 - 130
4528403	Total Bismuth (Bi)	2010/12/23					<0.1	mg/kg	NC	30		
4528403	Total Potassium (K)	2010/12/23					<100	mg/kg	2.8	35		
4528403	Total Silver (Ag)	2010/12/23					<0.05	mg/kg	NC	35		
4528403	Total Sodium (Na)	2010/12/23					<100	mg/kg	NC	35		
4528403	Total Tin (Sn)	2010/12/23					<0.1	mg/kg	NC	35		
4528403	Total Zirconium (Zr)	2010/12/23					<0.5	mg/kg	NC	30		
4529385	Soluble (2:1) pH	2010/12/23			102	96 - 104			0.3	20		
4529525	Dissolved Arsenic (As)	2010/12/31	99	80 - 120	98	80 - 120	<0.0001	mg/L	3.9	20		
4529525	Dissolved Beryllium (Be)	2010/12/31	93	80 - 120	103	80 - 120	<0.0001	mg/L	NC	20		
4529525	Dissolved Cadmium (Cd)	2010/12/31	95	80 - 120	99	80 - 120	<0.00001	mg/L	15.3	20		
4529525	Dissolved Chromium (Cr)	2010/12/31	106	80 - 120	102	80 - 120	<0.001	mg/L	NC	20		
4529525	Dissolved Cobalt (Co)	2010/12/31	103	80 - 120	103	80 - 120	<0.0005	mg/L	1.1	20		
4529525	Dissolved Copper (Cu)	2010/12/31	100	80 - 120	103	80 - 120	<0.0002	mg/L	NC	20		
4529525	Dissolved Lead (Pb)	2010/12/31	91	80 - 120	105	80 - 120	<0.0002	mg/L	NC	20		
4529525	Dissolved Lithium (Li)	2010/12/31	97	80 - 120	105	80 - 120	<0.005	mg/L	NC	20		
4529525	Dissolved Nickel (Ni)	2010/12/31	NC	80 - 120	102	80 - 120	<0.001	mg/L	1.0	20		
4529525	Dissolved Selenium (Se)	2010/12/31	98	80 - 120	104	80 - 120	<0.0001	mg/L	0.05	20		
4529525	Dissolved Uranium (U)	2010/12/31	100	80 - 120	107	80 - 120	<0.0001	mg/L	NC	20		
4529525	Dissolved Vanadium (V)	2010/12/31	108	80 - 120	101	80 - 120	<0.005	mg/L	NC	20		
4529525	Dissolved Zinc (Zn)	2010/12/31	94	80 - 120	99	80 - 120	<0.005	mg/L	NC	20		
4529525	Dissolved Aluminum (Al)	2010/12/31					<0.003	mg/L	NC	20		
4529525	Dissolved Antimony (Sb)	2010/12/31					<0.0005	mg/L	NC	20		
4529525	Dissolved Barium (Ba)	2010/12/31					<0.001	mg/L	0.6	20		
4529525	Dissolved Bismuth (Bi)	2010/12/31					<0.001	mg/L	NC	20		
4529525	Dissolved Boron (B)	2010/12/31					<0.05	mg/L	2.4	20		
4529525	Dissolved Iron (Fe)	2010/12/31					<0.005	mg/L	NC	20		
4529525	Dissolved Manganese (Mn)	2010/12/31					<0.001	mg/L	1.1	20		
4529525	Dissolved Mercury (Hg)	2010/12/31					<0.00002	mg/L	NC	20		
4529525	Dissolved Molybdenum (Mo)	2010/12/31					<0.001	mg/L	NC	20		
4529525	Dissolved Silicon (Si)	2010/12/31					<0.1	mg/L	2.7	20		
4529525	Dissolved Silver (Ag)	2010/12/31					<0.00002	mg/L	NC	20		
4529525	Dissolved Strontium (Sr)	2010/12/31					<0.001	mg/L	2.4	20		
4529525	Dissolved Thallium (Tl)	2010/12/31					<0.00005	mg/L	NC	20		
4529525	Dissolved Tin (Sn)	2010/12/31					<0.005	mg/L	NC	20		
4529525	Dissolved Titanium (Ti)	2010/12/31					<0.005	mg/L	NC	20		
4529525	Dissolved Zirconium (Zr)	2010/12/31					<0.0005	mg/L	NC	20		

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4531369	Total Ammonia (N)	2010/12/24	93	80 - 120	102	90 - 110	<0.05	mg/L	NC	20		
4534611	Sulphide	2010/12/29	93	80 - 120	96	80 - 120	<0.005	mg/L	2.6	20		
4541759	Sulphide	2011/01/04	NC	75 - 125	105	75 - 125	<0.2	ug/g	16.0(2)	30		
4542344	SEM Cadmium (Cd)	2011/01/04					<0.0002	umole/g				
4542344	SEM Copper (Cu)	2011/01/04					<0.004	umole/g				
4542344	SEM Lead (Pb)	2011/01/04					<0.0002	umole/g				
4542344	SEM Mercury (Hg)	2011/01/04					<0.0003	umole/g				
4542344	SEM Nickel (Ni)	2011/01/04					<0.004	umole/g				
4542344	SEM Zinc (Zn)	2011/01/04					<0.008	umole/g				
4542849	D10-ANTHRACENE (sur.)	2011/01/06	100	60 - 130	93	60 - 130	101	%				
4542849	D12-BENZO(A)PYRENE (sur.)	2011/01/06	90	60 - 130	91	60 - 130	92	%				
4542849	D8-ACENAPHTHYLENE (sur.)	2011/01/06	70	50 - 130	85	50 - 130	97	%				
4542849	D8-NAPHTHALENE (sur.)	2011/01/06	95	50 - 130	85	50 - 130	100	%				
4542849	TERPHENYL-D14 (sur.)	2011/01/06	100	60 - 130	96	60 - 130	107	%				
4542849	Naphthalene	2011/01/06	NC	40 - 130	95	40 - 130	0.001, RDL=0.001	mg/kg	10.8(3)	50		
4542849	2-Methylnaphthalene	2011/01/06	NC	40 - 130	86	40 - 130	<0.001	mg/kg	12.6(3)	50		
4542849	Acenaphthylene	2011/01/06	74	40 - 130	91	40 - 130	<0.001	mg/kg	NC(4)	50		
4542849	Acenaphthene	2011/01/06	NC	40 - 130	97	40 - 130	<0.001	mg/kg	2.0(3)	50		
4542849	Fluorene	2011/01/06	NC	40 - 130	94	40 - 130	<0.001	mg/kg	3.5(3)	50		
4542849	Phenanthrene	2011/01/06	NC	40 - 130	95	40 - 130	<0.001	mg/kg	7.0(3)	50		
4542849	Anthracene	2011/01/06	NC	40 - 130	94	40 - 130	<0.001	mg/kg	0.6(3)	50		
4542849	Fluoranthene	2011/01/06	NC	40 - 130	92	40 - 130	<0.001	mg/kg	2.3(3)	50		
4542849	Pyrene	2011/01/06	NC	40 - 130	99	40 - 130	<0.001	mg/kg	2.4(3)	50		
4542849	Benzo(a)anthracene	2011/01/06	NC	40 - 130	85	40 - 130	<0.001	mg/kg	7.1(3)	50		
4542849	Chrysene	2011/01/06	NC	40 - 130	85	40 - 130	<0.001	mg/kg	6.3(3)	50		
4542849	Benzo(b&j)fluoranthene	2011/01/06	NC	40 - 130	96	40 - 130	<0.001	mg/kg	4.4(3)	50		
4542849	Benzo(k)fluoranthene	2011/01/06	NC	40 - 130	89	40 - 130	<0.001	mg/kg	4.4(3)	50		
4542849	Benzo(a)pyrene	2011/01/06	NC	40 - 130	91	40 - 130	<0.001	mg/kg	3.8(3)	50		
4542849	Indeno(1,2,3-cd)pyrene	2011/01/06	93	40 - 130	82	40 - 130	<0.002	mg/kg	0.2(3)	50		
4542849	Dibenz(a,h)anthracene	2011/01/06	89	40 - 130	77	40 - 130	<0.002	mg/kg	0.5(3)	50		
4542849	Benzo(g,h,i)perylene	2011/01/06	NC	40 - 130	81	40 - 130	<0.002	mg/kg	10.7(3)	50		
4658036	Dissolved Arsenic (As)	2011/03/02	104	75 - 125	98	75 - 125	<0.5	ug/L	NC	25		
4658036	Dissolved Barium (Ba)	2011/03/02	99	75 - 125	97	75 - 125	<1	ug/L	1.2	25		
4658036	Dissolved Beryllium (Be)	2011/03/02	92	75 - 125	91	75 - 125	<1	ug/L	NC	25		
4658036	Dissolved Cadmium (Cd)	2011/03/02	92	75 - 125	97	75 - 125	<0.05	ug/L				
4658036	Dissolved Chromium (Cr)	2011/03/02	97	75 - 125	96	75 - 125	<0.5	ug/L	NC	25		
4658036	Dissolved Cobalt (Co)	2011/03/02	95	75 - 125	98	75 - 125	<0.1	ug/L	NC	25		
4658036	Dissolved Copper (Cu)	2011/03/02	90	75 - 125	97	75 - 125	<0.5	ug/L				
4658036	Dissolved Lead (Pb)	2011/03/02	93	75 - 125	98	75 - 125	<0.1	ug/L				
4658036	Dissolved Lithium (Li)	2011/03/02	93	75 - 125	90	75 - 125	<20	ug/L	NC	25		

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QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4658036	Dissolved Manganese (Mn)	2011/03/02	94	75 - 125	97	75 - 125	<0.5	ug/L	3.2	25		
4658036	Dissolved Nickel (Ni)	2011/03/02	90	75 - 125	98	75 - 125	<0.2	ug/L				
4658036	Dissolved Selenium (Se)	2011/03/02	105	75 - 125	103	75 - 125	<0.5	ug/L	NC	25		
4658036	Dissolved Strontium (Sr)	2011/03/02	NC	75 - 125	97	75 - 125	<10	ug/L	0.9	25		
4658036	Dissolved Titanium (Ti)	2011/03/02	90	75 - 125	95	75 - 125	<10	ug/L				
4658036	Dissolved Uranium (U)	2011/03/02	105	75 - 125	98	75 - 125	<0.05	ug/L	1.2	25		
4658036	Dissolved Vanadium (V)	2011/03/02	100	75 - 125	93	75 - 125	<10	ug/L	NC	25		
4658036	Dissolved Zinc (Zn)	2011/03/02	91	75 - 125	103	75 - 125	<1	ug/L				
4658036	Dissolved Aluminum (Al)	2011/03/02					<10	ug/L	NC	25		
4658036	Dissolved Antimony (Sb)	2011/03/02					<0.5	ug/L	NC	25		
4658036	Dissolved Bismuth (Bi)	2011/03/02					<1	ug/L	NC	25		
4658036	Dissolved Boron (B)	2011/03/02					<50	ug/L	3.2	25		
4658036	Dissolved Iron (Fe)	2011/03/02					<2	ug/L				
4658036	Dissolved Molybdenum (Mo)	2011/03/02					<1	ug/L	NC	25		
4658036	Dissolved Phosphorus (P)	2011/03/02					<50	ug/L				
4658036	Dissolved Silicon (Si)	2011/03/02					<100	ug/L				
4658036	Dissolved Silver (Ag)	2011/03/02					<0.05	ug/L	NC	25		
4658036	Dissolved Thallium (Tl)	2011/03/02					<0.1	ug/L	NC	25		
4658036	Dissolved Tin (Sn)	2011/03/02					<1	ug/L	NC	25		
4661454	Sulphide	2011/02/25	72(5)	80 - 120	103	80 - 120	0.006, RDL=0.005	mg/L	NC(2)	20		
4665414	Total Ammonia (N)	2011/02/28	NC	80 - 120	101	90 - 110	<0.05	mg/L	2.3	20		
4668576	Total Suspended Solids	2011/03/01	106	80 - 120	98	80 - 120	<4	mg/L	NC	20		

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
QC Standard: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Spiked Blank: A blank matrix to which a known amount of the analyte has been added. Used to evaluate analyte recovery.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.
(1) - Sample contained > 50% moisture.
(2) - Matrix spike exceeds acceptance limits due to matrix interference. Re-analysis yields similar results.
(3) - RDL raised due to sample dilution.
(4) - RDL raised due to sample matrix interference.
(5) - Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

BOCQ492

№ 0086 page 1 of 1

CHAIN OF CUSTODY RECORD/ANALYSIS REQUEST

Golder Associates
500-4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone 604-298-6623 Fax 604-298-5253

Project Number: 09-1436-5008 / 5000	Laboratory Name: ~~Ladysmith Harbour~~ Maxxam
[redacted]	Address: 4606 Canada Way, Burnaby BC V5G 1K5
Golder Contact: Adrian de Bruyn / Golder E-mail Address: Adrian_deBruyn@golder.com	Telephone/Fax: 1800-665-8566 / Contact: VJ OCO

Office the final reports should be sent to:

- ☐ 500 – 4260 Still Creek Dr. Burnaby, B.C. V5C 6C6 Tel: 604-298-6623 Fax: 604-298-5253
- ☐ 202 – 2790 Gladwin Road Abbotsford, B.C. V2T 4S8 Tel: 604-850-8786 Fax: 604-850-8756
- ☑ 3795 Carey Road, 2nd floor Victoria, B.C. V8Z 6T8 Tel: 250-881-7372 Fax: 250-881-7470

Analyses Required

Sample Control Number (SCN)	[redacted]	Sample Matrix (over)	Date Sampled (D / M / Y)	[redacted]	Number of Containers	~~Toxicity-Echinoderm test~~	~~Porewater TIE~~	Hold	Bulk Sediment Chem	Porewater Extraction	Echinoderm test TIE on porewater	Porewater Chemistry			RUSH	Remarks (over)
0086 -01	[redacted]	Sed	15/12/10	[redacted]	4			✓	✓	✓	✓	✓				
0086 -02	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086 -03	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086 -04	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086 -05	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
0086 -06	[redacted]	Sed	↓	[redacted]	4			✓	✓	✓	✓	✓				
-07	[redacted]			[redacted]												
-08	[redacted]			[redacted]												
-09	[redacted]			[redacted]												
-10	[redacted]			[redacted]												
-11	[redacted]			[redacted]												
-12	[redacted]			[redacted]												

Sampler's Signature: [signature]	Relinquished by: Signature [signature]	Company Golder	Date Dec. 16/10	Time 11:00	Received by: Signature	Company
Sample Storage (°C)	Relinquished by: Signature	Company	Date	Time	Received by: Signature	Company
Comments: Attn. Jeremy Keating and see email instructions	Method of Shipment:	Waybill No.:	Received for Lab by:		Date	Time
	Shipped by:	Shipment Condition: Seal Intact:	Temp (°C) ~~5, 4, 4~~ CD	Cooler opened by: E. DAVIEL	Date 17/12/10	Time 09:15

WHITE: Golder Copy YELLOW: Lab Copy PINK: Lab Returns with Final Report

temp (°C) each bucket: 6 5 5 6 5 6 5 4 6 5 5 4 6 6 5 5 4 5 4 4 7 6 7 7

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

CHAIN OF CUSTODY RECORD

Page: ___ of ___

G 040858

Maxxam Job#: BOC2492

Invoice To: Require Report? Yes [X] No [ ]

Company Name:

Contact Name: 8287

Address:

PC:

Phone / Fax#: Ph: Fax:

E-mail

Report To:

Company Name:

Contact Name:

Address:

PC:

Phone / Fax#: Ph: Fax:

E-mail jpickard@maxxam.ca
jkeating@maxxam.ca

PO #:	
Quotation #:	
Project # :	
Proj. Name:	
Location:	
Sampled By:	

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [ ] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER
- [ ] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day [ ] 2 Day [ ] 3 Day

Date Required:

Special Instructions:

Return Cooler [ ] Ship Sample Bottles (please specify) [ ]

Add to job BOC2492

ANALYSIS REQUESTED

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	BTEX/VPH	VOC/VPH	EPH	PAH	CCME-PHC (Fractions 1-4 Plus BTEX)	CCME-PHC (Fractions 2-4)	CCME BTEX (Fraction 1 Plus BTEX)	PCB	Phenols by 4AAP	TOG	Dissolved Metals (Field Filtered?)	Field Filtered?	Totals Metals Field Acidified?	Nitrate	Chloride	Total Suspended Solids-TSS	pH	BOD	COD	Coliform, Total & E.coli	Asbestos	NH4AC-W SENDTO EDMONTON ENVIRONMENTAL			SULFIDES	
1	0086-02 Porewater		SEA	2011FEB22											X					X						X			X	
2	0086-04 Porewater		H_2O	2011FEB22											X					X						X			X	
3	0086-06 Porewater			2011FEB22											X					X						X			X	
4	0086-02 (Sulf. Amended)			2011FEB23											X					X						X			X	
5	0086-04 (Sulf. Amended)			2011FEB23											X					X						X			X	
6	0086-06 (Sulf. Amended)			2011FEB23											X					X						X			X	
7																														
8																														
9																														
10																														
11																														
12																														

Samples are from a Drinking Water Source? YES [ ] NO [ ]

Does source supply multiple households? YES [ ] NO [ ]

Laboratory Use Only

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
K. Pomery	2011 FEB 23	1205	C. Ross	11 02 23	1405	[ ]		Yes [ ] No [ ]

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

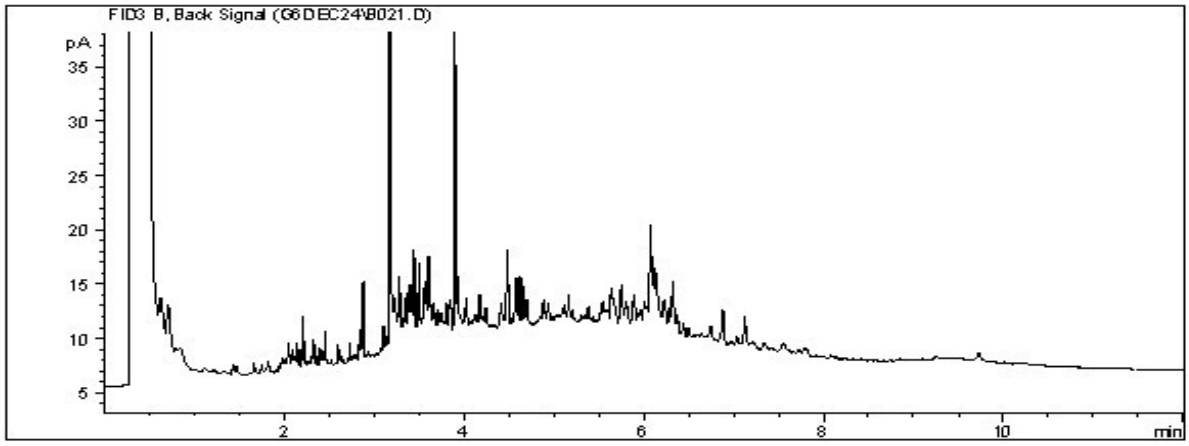
White: Maxxam Yellow: Client

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18215

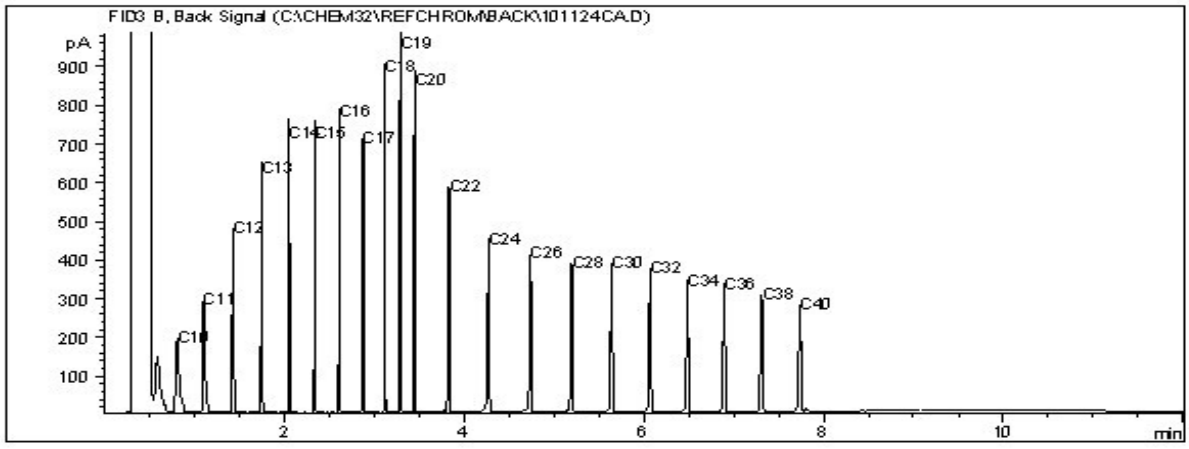
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-01 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

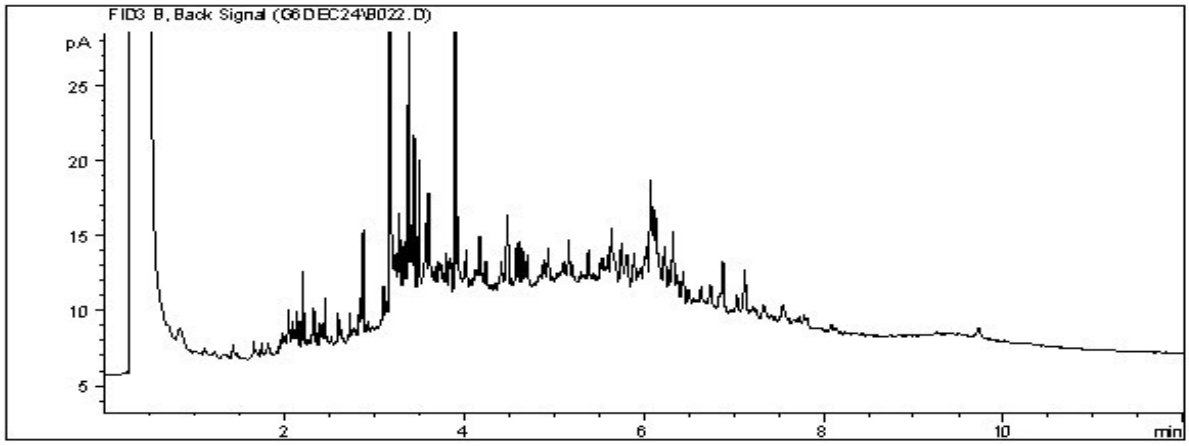
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18216

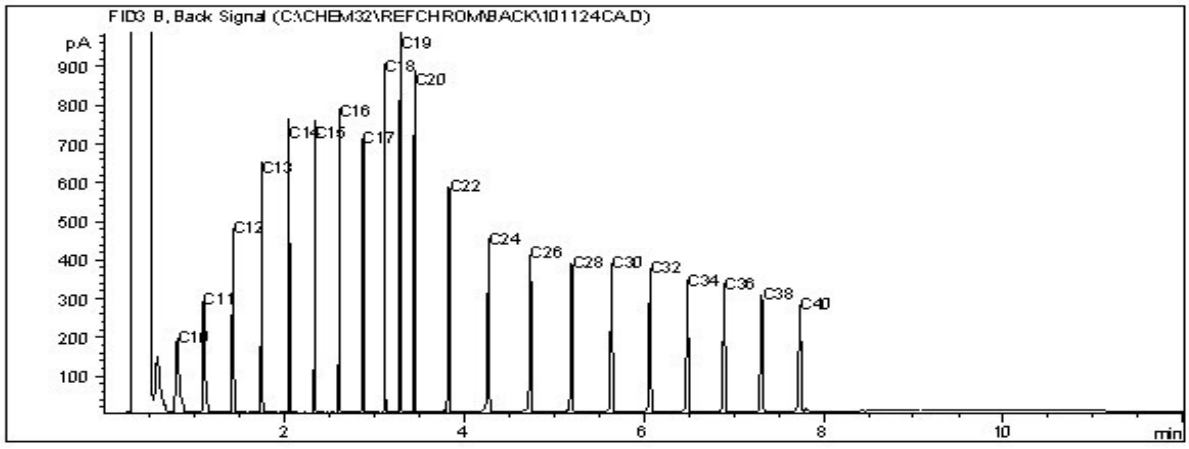
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-02 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

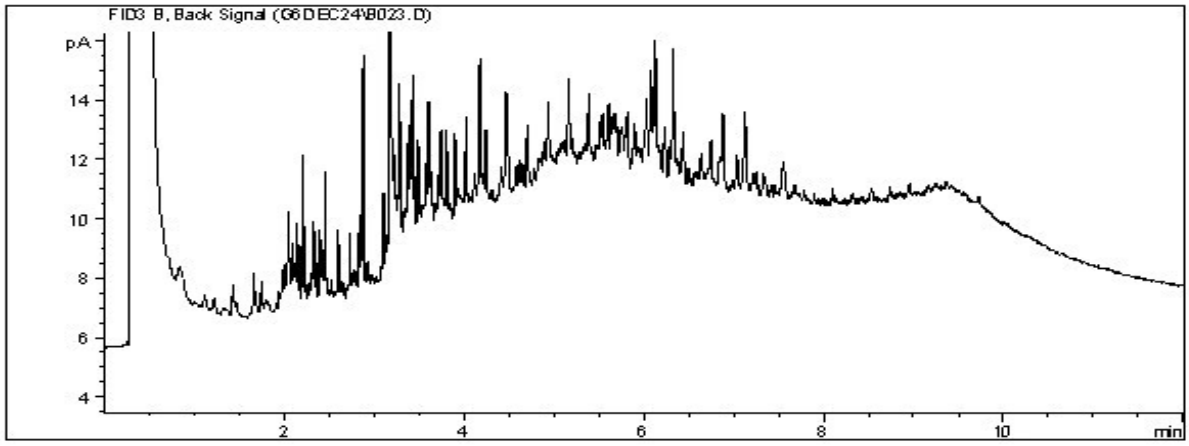
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18217

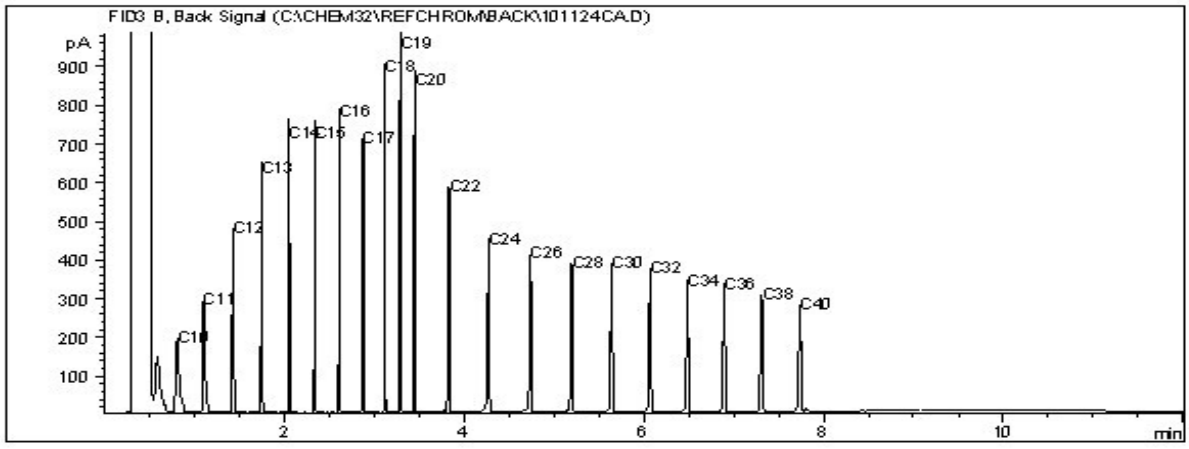
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-03 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

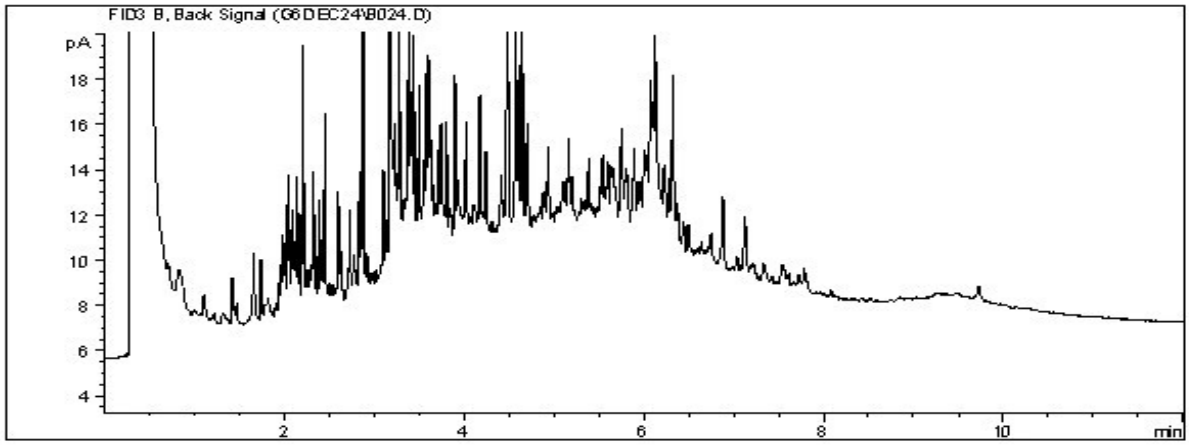
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18218

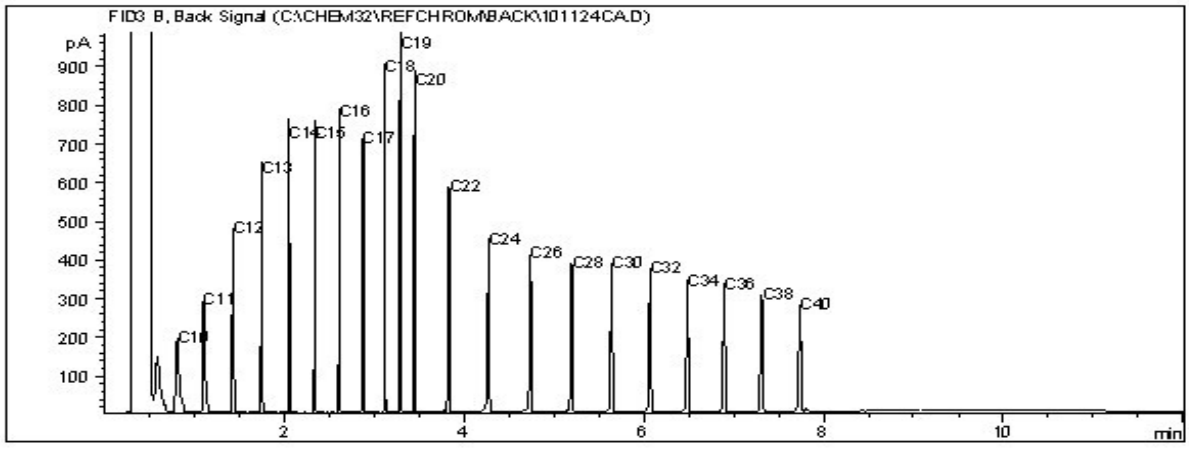
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-04 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

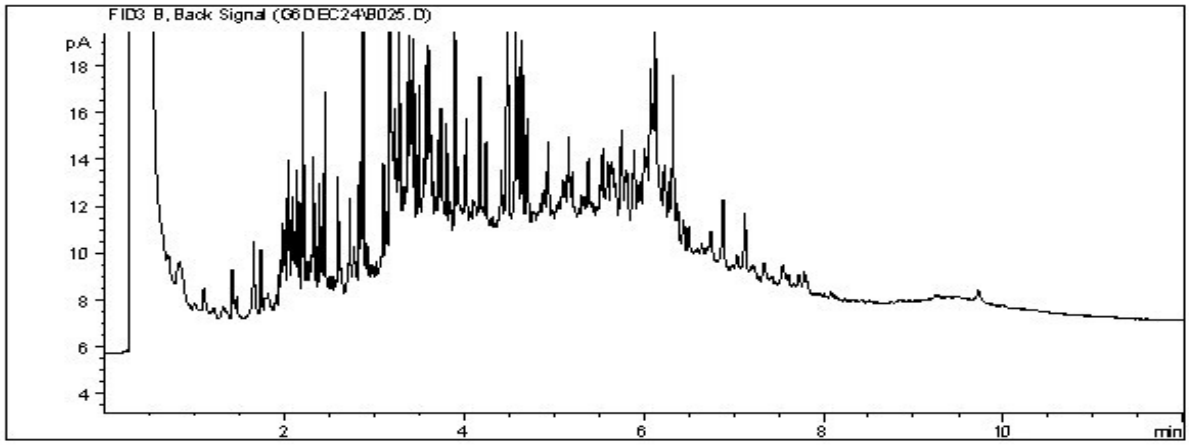
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18218 Lab-Dup

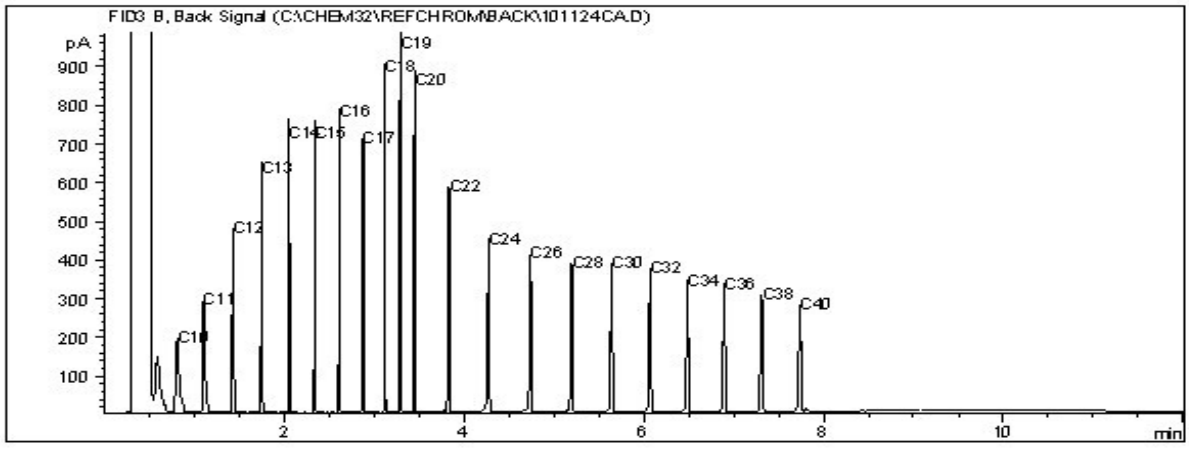
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-04 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

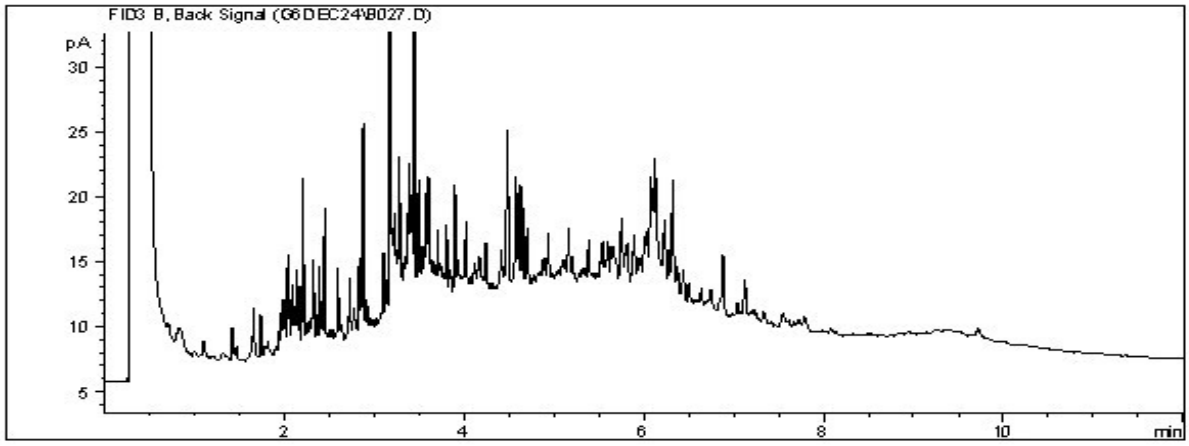
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18219

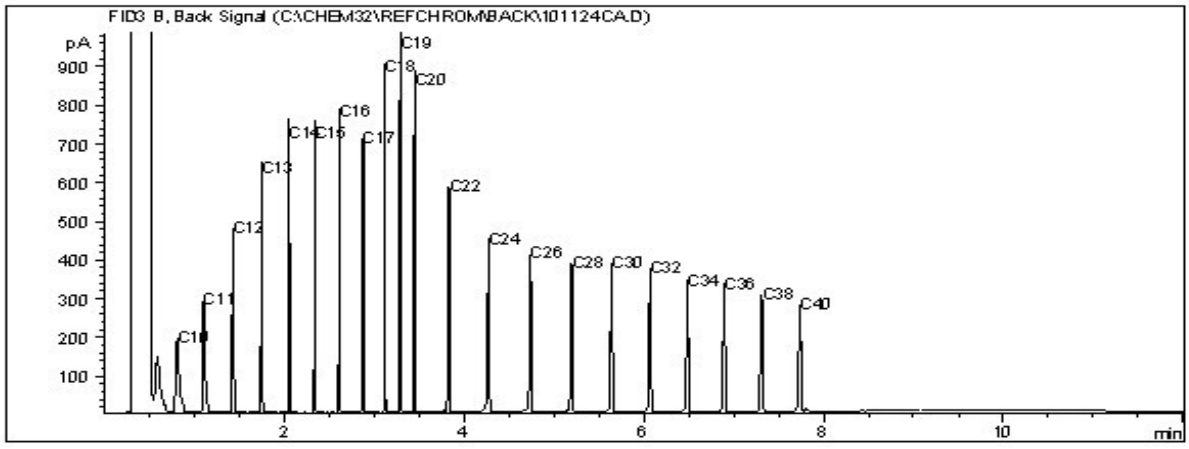
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-05 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

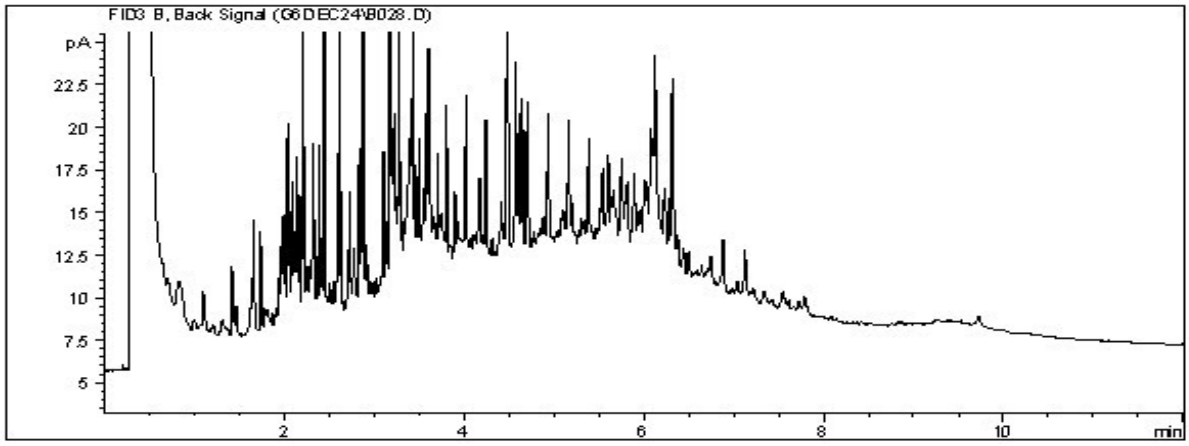
Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

Report Date: 2011/03/11
Maxxam Job #: B0C2492
Maxxam Sample: Z18220

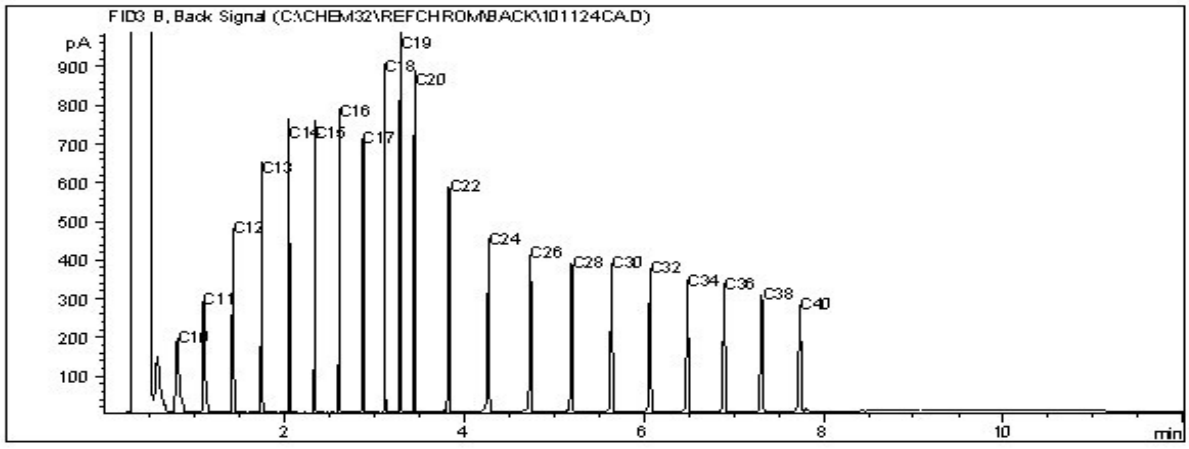
GOLDER ASSOCIATES LTD
Client Project #: 09-1436-5008/5000

Client ID: 0086-06 SEDIMENT

CCME Hydrocarbons (F2-F4 in soil) Chromatogram



Carbon Range Distribution - Reference Chromatogram



TYPICAL PRODUCT CARBON NUMBER RANGES

Gasoline:	C4 - C12	Diesel:	C8 - C22
Varsol:	C8 - C12	Lubricating Oils:	C20 - C40
Kerosene:	C7 - C16	Crude Oils:	C3 - C60+

Note: This information is provided for reference purposes only. Should detailed chemist interpretation or fingerprinting be required, please contact the laboratory.

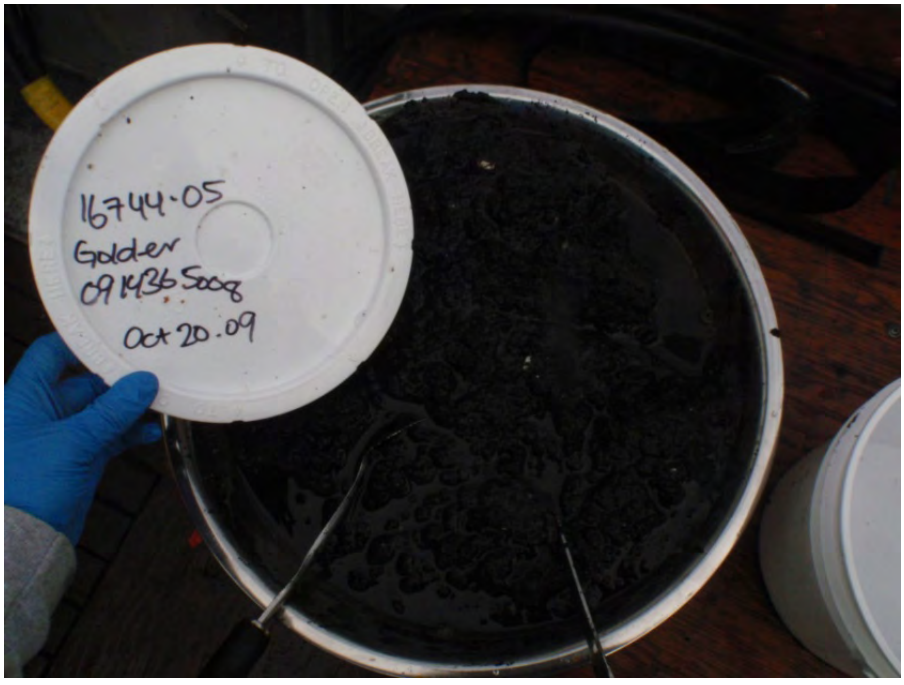
APPENDIX III

Field Sampling Photographs

October 2009 – Examples of Typical Sediment Conditions Observed in Grab Samples



Photograph 1: Site 31A – Dark grey/black silt, slight odour and presence of coal material noted in field log.



Photograph 2: Site 23A – Dark grey/black silt, slight odour, shell fragments and a presence of coal waste noted in field log.



Photograph 3: Site 1A – Dark grey with fine sand and silt with a slight odour, shell fragments and a slight sheen noted in field log.



Photograph 4: Site 4A – Dark grey with fine sand and silt with a slight odour, shell fragments and woody debris noted in field log.

December 2010 – Examples of Typical Sediment Conditions Observed in Sediment Core Samples



Photograph 5: Core sample taken from 2010-07, near Slack Point. Coal material noted in sample.



Photograph 6: Core sample taken from 2010-13, inner harbour and furthest site from Slack Point.

APPENDIX IV

Sediment Sampling Logs

Table 1: Sediment Characteristics for samples collected in Ladysmith Harbour 2009 and 2010

Station	Coordinates (UTM 10)		Date	Sample Type	Sediment Descriptions	Observed Debris in Sample	Water Depth (m)	Notes
	Latitude (D.M)	Longitude (D.M)						
1A	48 59.84308 N	123 48.98396 W	20-Oct-09	Grab	Dark Grey, fine sand and silt, slight odor (sulphur like)	Shell	2.5	Slight sheen on sample
2A	48 59.87454 N	123 48.91482 W	20-Oct-09	Grab	Dark Grey, Silt w/ course sand and gravel. Trace cobbles. No	Wood, Shell	5.0	-
3A	48 59.87928 N	123 48.82637 W	19-Oct-09	Grab	Dark Grey, fine to course sand w/ some silt. Trace cobble and gravel.	Shell	6.3	Slight sheen on sample
4A	48 59.78897 N	123 48.90981 W	20-Oct-09	Grab	Dark Grey, fine sand and silt, slight odor (sulphur like)	Wood, Shell	5.5	-
5A	48 59.82791 N	123 48.87373 W	20-Oct-09	Grab	Dark Grey, fine sand and silt, odor (sulphur like)	Shell	6.0	Slight sheen on sample
6A	48 59.85561 N	123 48.77600 W	19-Oct-09	Grab	Black/brown, slight odor (sulphur like)	Wood, Shell	5.2	-
7A	48 59.87825 N	123 48.73148 W	21-Oct-09	Grab	Dark grey, fine sand/silts, no distinct odor	Wood, Shell	8.0	Slight sheen on sample
8A	48 59.74687 N	123 48.87123 W	19-Oct-09	Grab	Black silt, odor (sulphur like)	Wood, Shell	5.0	-
9A	48 59.77708 N	123 48.82194 W	20-Oct-09	Grab	Black/brown silt, odor (sulphur like)	Wood, Shell	5.6	-
10A	48 59.80546 N	123 48.77384 W	19-Oct-09	Grab	Black/dark green silt, odor (sulphur like)	Wood	6.5	-
11A	48 59.83151 N	123 48.70753 W	20-Oct-09	Grab	Dark Grey, fine sand and silt, odor (sulphur like)	Wood	10.0	-
12A	48 59.74913 N	123 48.77934 W	19-Oct-09	Grab	Black/brown silt, odor (sulphur like)	Wood, Shell	5.0	-
13A	48 59.78390 N	123 48.72807 W	21-Oct-09	Grab	Dark Grey, fine sand and silt, odor (sulphur like)	Wood, Shell	8.5	-
14A	48 59.77492 N	123 48.66783 W	21-Oct-09	Grab	Dark Grey, fine sand and silt, odor (sulphur like)	Wood	9.8	-
15A	48 59.79842 N	123 48.67462 W	19-Oct-09	Grab	Black silt, odor (sulphur like)	Wood	10.3	Slight sheen on sample
16A	48 59.82700 N	123 48.64900 W	21-Oct-09	Grab	Dark Grey, fine sand and silt, strong odor (sulphur like)		10.8	-
17A	48 59.79600 N	123 48.58300 W	21-Oct-09	Grab	Dark Grey, fine sand and silt, slight odor (sulphur like)	Wood	11.7	-
18A	48 59.71600 N	123 48.78600 W	21-Oct-09	Grab	Dark Grey, fine sand and silt, slight odor (sulphur like)	Wood	5.0	-
19A	48 59.69000 N	123 48.73100 W	21-Oct-09	Grab	Black/dark grey sand and silt, slight odor (sulphur like)	Wood, Shell	6.3	-
20A	48 59.73511 N	123 48.72653 W	21-Oct-09	Grab	Dark Grey, fine sand and silt, slight odor (sulphur like)	Wood	6.0	-
21A	48 59.73494 N	123 48.64687 W	20-Oct-09	Grab	Black silt , no distinct odor	Wood, Glass	9.3	Slight sheen on sample
22A	48 59.75600 N	123 48.58300 W	20-Oct-09	Grab	Dark grey/green, sand/silts, odor (sulphur like)	Wood	11.0	-
23A	48 59.69100 N	123 48.65800 W	20-Oct-09	Grab	Black/Dark grey silts, odor (sulphur like)	Shell	2.0	Possible coal material
24A	48 59.71370 N	123 48.57133 W	20-Oct-09	Grab	Black/Dark grey silts and fine sand (trace gravel), no distinct odor	Wood	5.0	Possible coal material
25A	48 59.75100 N	123 48.51800 W	21-Oct-09	Grab	Dark Grey, fine sand and silt, slight odor (sulphur like)	Wood, Shell	40705.0	-
26A	48 59.90343 N	123 48.73658 W	19-Oct-09	Grab	Dark grey, sand/silts, no distinct odor	Shell	7.1	Slight sheen on sample
27A	48 59.88000 N	123 48.63800 W	22-Oct-09	Grab	Dark grey silt and fine sand, no distinct odor	-	12.1	-
28A	48 59.84200 N	123 48.56200 W	21-Oct-09	Grab	Dark grey silt and fine sand, no distinct odor	Wood	12.7	-
29A	48 59.80300 N	123 48.48900 W	22-Oct-09	Grab	Dark grey silt and fine sand, odor (sulphur like)	Wood	12.5	-
30A	48 59.76600 N	123 48.41300 W	19-Oct-09	Grab	Black/dark grey silts, odor (sulphur like)	Wood	11.5	-
31A	48 59.72012 N	123 48.40628 W	22-Oct-09	Grab	Black/Dark grey silt and sand, slight odor (sulphur like)	Shell	7.0	Possible coal material
32A	48 59.66127 N	123 48.35958 W	22-Oct-09	Grab	Black/Dark grey silt and sand, trace gravel, no distinct odor	Wood, Shell	10.0	Possible coal material
33A	48 59.62320 N	123 48.39210 W	20-Oct-09	Grab	Black silt and fine sand, no distinct odor	Wood	6.3	-
34A	48 59.59126 N	123 48.36072 W	22-Oct-09	Grab	Dark Grey, fine sand and silt, trace gravel, slight odor (sulphur like)	Shell	10.0	Possible coal material
35A	48 59.55128 N	123 48.40484 W	20-Oct-09	Grab	Black/Dark grey silts and fine sand, no distinct odor	Wood	7.5	-
36R	48 59.59510 N	123 47.48037 W	21-Oct-09	Grab	Dark grey trace silts and fine sand, no distinct odor	-	6.5	-
37R	49 00.73891 N	123 49.79793 W	21-Oct-09	Grab	Dark grey silt and fine sand, trace clay, odor (sulphur like)	Wood, Shell	7.4	-
38R	48 59.64208 N	123 47.62652 W	21-Oct-09	Grab	Dark silts and fine sand, trace clay, slight odor (sulphur like)	Shell	10.5	-
39R	49 00.58353 N	123 49.58432 W	21-Oct-09	Grab	Dark grey silt and fine sand, trace clay, odor (sulphur like)	-	8.0	-
40R	49 00.45167 N	123 49.24846 W	21-Oct-09	Grab	Grey silts and sand, no distinct odor	Wood	9.7	-
2010-10	48° 59.761 N	123° 48.770 W	15-Dec-10	Grab	Black/Dark grey silt and fine sand, odor (sulphur like)	Wood, Shell	4.6	Slight sheen on sample
2010-11	48° 59.814 N	123° 48.840 W	15-Dec-10	Grab	Black/Dark grey silt and fine sand, odor (sulphur like)	Wood, Shell	~20cm	-
2010-13	48° 59.846 N	123° 48.962 W	17-Dec-10	Core	Black/Dark grey silt and sand, no odor recorded	Wood, Shell	3.5	-
			15-Dec-10	Grab	Black/Dark grey silt and fine sand, slight odor (sulphur like)	Wood, Shell	3.7	-
2010-09	48° 59.805 N	123° 48.667 W	16-Dec-10	Core	Dark brown silt throughout core, odor (sulphur like)	Wood	8.4	-
			15-Dec-10	Grab	Black/Dark grey silt and fine sand, odor (sulphur like)	Wood, Shell	9.5	-
2010-08	48° 59.761 N	123° 48.681W	17-Dec-10	Core	Dark brown silt throughout core, odor (sulphur like)	Wood	7.5	-
			15-Dec-10	Grab	Black/Dark grey silt and fine sand, odor (sulphur like)	Wood, Shell	7.7	-
2010-07	48° 59.749 N	123° 48.555 W	16-Dec-10	Core	Black/Dark grey silt and sand first 6cm of core with slight odor (sulphur like). Black silt/sand beyond 6cm.	Wood, Shell	9.5	Possible coal material (sand size)
			15-Dec-10	Grab	Black/Dark grey silt and sand, odor (sulphur like)	Wood	9.7	-
2010-06	48° 59.725 N	123° 48.828 W	17-Dec-10	Core	Dark brown, fine sand and silt between 0 - 77cm, dark brown/black silt for 77cm- 125cm , odor (sulphur like)	Wood, Shell	2.9	-
2010-04	48° 59.719 N	123° 48.877 W	17-Dec-10	Core	Dark reddish brown, trace sand, no odor recorded	Wood	2.5	-
2010-03	48° 59.728 N	123° 48.840 W	17-Dec-10	Core	Dark brown silt and fine sand becoming dark grey fine sand and gravel, odor (sulphur like)	Wood, Metal	2.4	-
2010-12	48° 59.851 N	123° 48.802 W	16-Dec-10	Core	Dark brown, odor (sulphur like)	Wood, Shell	2.5	-

J. MORTIMER

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008 (5000)

Project Title: Ladysmith

Date: 19 OCT 09

Inspected by: M. SPANI / B. DE FREITAS

Station Number (ID): 8A ~~(6)~~ (8)
A=actual

Sampling Method: VAN VEEN / PONAR

8A= 48 59.747N

Weather: SUNNY CALM

Lat/Longitude: 123 48.871W

Sampling Depth: 5m

# of Attempts to Obtain Sample: 1 X VAN VEEN (SUCCESSFUL)
1X PONAR (SUCCESSFUL)

Time of Collection: 1013 - VAN VEEN
1043 - PONAR

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

BLACK, ODOUR (SULPHUROUS), MUD (SILT) TRACE ORGANICS (FINE WOODY DEBRIS), ~~BROKE~~ SHELL FRAGMENTS, AMPHIPODS.

Approx % collected in grab sample 95% VAN VEEN
80% PONAR %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

PHOTO OF HOMOGENIZED SAMPLE ✓
PHOTO OF SIEVE - BENTHICS ✓

Sample Control Number (SCN): CoC 16739-01 (CHEM) / 16740-01 (TOX & BIOAVAILABILITY)

Analysis for:

- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☒ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

16741-01 (PETROGRAPHY)

AEC:

# of Grabs for Analysis:

Other Notes:

NEXT TO DOCK RAMP
2X TOX PAILS ✓
1X 250ml PETRO ✓
3X 125ml CHEM ✓
1X 125ml BIOAVAILABILITY ✓
2 X 1L BENTHICS ✓

~~8A~~ 8A

SAMPLE NUMBER: 16739-01

16740-01
16741-01

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008 (5000)
Project Title: Ladysmith sampling
Date: 19 OCT 09
Inspected by: M SPANI / B. DE FREITAS
Station Number (ID): 12A (12)
A = Actual
Sampling Method: BOAR / VAN VEEN
Weather: SUNNY / CALM
Lat/Longitude: 12A = 48 59.749N 123 48.779W
Sampling Depth: 5M
# of Attempts to Obtain Sample: 1X POWER (SUCCESSFUL) 2X VAN VEEN (SUCCESSFUL)
Time of Collection: 1121 POWER 1127/1156 VAN VEEN

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
BLACK-DARK BROWN, ODOUR (SULPHUR) WOODY DEBRIS, ~~SOME SHELL~~ SHELL FRAGMENTS, SILT, ORGANICS (FINE WOODY MATERIAL) - LOTS AMONGST SEDIMENT

Approx % collected in grab sample ① 80% VAN VEEN ② 60% JAN VEEN %
75% POWER

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SAMPLE ✓
BENTHIC PHOTO IN SIEVE ✓
PHOTO OF STATION ALONGSIDE TUG

Sample Control Number (SCN): 16739-02 (CHEM) / 16740-02 (TOX & BIOAVAILABILITY)

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

16741-02 (PETRO)

AEC:
# of Grabs for Analysis:

Other Notes:
NEXT TO OLD TUG BOAT
4X 1L BENTHIC CONTAINERS ✓
1X 250ml PETRO ✓
3X 125ml CHEM ✓
1X 125ml BIO AVAILABILITY ✓
2X TOX BUCKETS ✓

SAMPLE NUMBER: 12A 16739-02 16740-02 (CoC) 16741-02

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 19 OCT 09
Inspected by: M. SPANI
Station Number (ID): 10A (10)
A = Actual
Sampling Method: VAN VEEN
Weather: CALM.
Lat/Longitude: 10A = 48 59.805N
123 48.774W
Sampling Depth: ~~6.4m~~ 6.5m
# of Attempts to Obtain Sample: 1X VAN VEEN
1 X PONAR
Time of Collection: 1223 VAN VEEN
1235 PONAR

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
BLACK - DARK GREEN, ODOUR (ANOXIC), LARGE WOODY DEBRIS
1 SMALL PLUMOSE ANEMONE, SILT.

Approx % collected in grab sample VAN VEEN = 90% %
PONAR = 95%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SAMPLE ✓
NO BENTHIC PHOTO

Sample Control Number (SCN): 16739-03 (CHEM) | 16740-03 (TOX & BIOAVAILABILITY)

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- 16741-03 (PETRO)
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes: BY ROCK - NEXT TO SAILBOAT
1X TOX BUCKET ✓
1 X 250ml PETRO ✓
3X 125ml CHEM ✓
1X 125ml BIO AVAIL ✓
2X BENTHICS ✓

16739-03
16740-03
16741-03

10A
SAMPLE NUMBER: _____

SEDIMENT SAMPLING LOG

Project No: 09-1436-5068
Project Title: LADYSMITH SEDIMENT
Date: 19OCT 09
Inspected by: M.SPANI / B. DE FREITAS
Station Number (ID): 6A (6) (A=Actual)
Sampling Method: VAN VEEN / PONAR
Weather: CALM, CLOUDY
Lat/Longitude: 6A = 48 59.856 N / 123 48.776 W
Sampling Depth: 5.2m
# of Attempts to Obtain Sample: 2X VAN VEEN SUCCESSFUL; 4X PONAR UNSUCCESSFUL; 4X PONAR SUCCESSFUL
Time of Collection: 12:12 / 12:24 VAN VEEN; 13:40 PONAR (RETAINED)

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
1 FISH (GUNNEL)
DARK BROWN - BLACK, SLIGHT ODOUR, LOTS OF WOODY DEBRIS (FINE - LARGE), SOME SHELL FRAGMENTS

Approx % collected in grab sample: ① 70% / ② 60% = VAN VEEN %
PONAR: ① 15% (REJECTED - WOOD) / ② 25% (REJECTED) / ③ 0% REJECT / ④ 0% / ⑤ 70% (RETAINED)

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
1 X PHOTO OF BENTHIC SAMPLE (PRE SIEVING) ✓
1 X PHOTO BENTHIC PHOTO IN SIEVE ✓

Sample Control Number (SCN): 16739-04 (CHEM) / 16740-04 (TOX + BIOAVAILABILITY) / 16741-04 (PETRO)

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC: # of Grabs for Analysis:

Other Notes:
OUTER END OF MARINA DOCK
2X TOX BUCKETS ✓
1 X 250 ml PETRO ✓
3X 125ml CHEM ✓
1 X 125 ml BIOAVAILABILITY
3 X BENTHICS ✓

6A
SAMPLE NUMBER: 16739-04 / 16740-04 / 16741-04

C of C

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 19 OCT 09
Inspected by: M SPANI / B. DEFREITAS
Station Number (ID): 3A (3) A=Actual
Sampling Method: PONAR / VAN VEEN
Weather: LIGHT WIND
Lat/Longitude: 3A 48 59.879N 123 48.826W
Sampling Depth: 6.3m
# of Attempts to Obtain Sample: 6x PONAR (REJECTED) 1x PONAR (ACCEPTED) 1x JANJEEN (REJECTED) 3x VAN VEEN (ACCEPTED)
Time of Collection: PONAR-1455 (ACCEPTED) VAN VEEN-1505 / 1510 / 1516

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

2nd VAN VEEN CONTAINED RED ROCK CRAB
DARK-GREY, SAND, COARSE SAND w/ SOME SILT, LOTS OF FINE SHELL FRAGMENTS, EELGRASS, TRACE COBBLES, TRACE GRAVEL, SLIGHT SHEEN
- SNAIL, RED ROCK CRAB

Approx % collected in grab sample PONAR 5% REJECT / 0% REJECT / 40% REJECT / 30% REJECT / 15% REJECT / 0% REJECT PONAR- 40% (ACCEPTED)
VAN VEEN- 20% (REJECTED) / 25% ACCEPTED / 30% ACCEPTED / 50% ACCEPTED

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

BENTHIC SIEVE PHOTO ✓
PHOTO OF GRABS COMING ABOARD w/EELGRASS
PHOTO OF HOMOGENIZED SAMPLE
PHOTO OF CRAB

Sample Control Number (SCN): CHEM 16739-05 / TOX & BIOANALYTIC 16740-05 / PETRO 16741-05

Analysis for:

- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
# of Grabs for Analysis:
Other Notes:

2nd VAN VEEN ACCEPTED CONTAINED ROOTED EELGRASS
- SITE 3A CLOSEBY TO NEW BREAKWATER

1x BENTHIC ✓
1x TOX ✓
1x 250 ml PETRO ✓
3x 125 ml CHEM ✓
1x 125ml BIOANALY ✓

16739-05
16740-05
16741-05

SAMPLE NUMBER: _____

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008

Project Title: LADYSMITH SAMPLING

Date: 19 OCTOBER 09

Inspected by: M. SPANN / B. DEFREITAS

Station Number (ID): 26A (26)
(A = Actual)

Sampling Method: VAN VEEN / PONAR

Weather: CALM

Lat/Longitude: 26A = 48 59.903N
123 48.737W

Sampling Depth: 7.1m

# of Attempts to Obtain Sample: 1x VAN VEEN (ACCEPTED)
3x PONAR (REJECTED)
1x PONAR (ACCEPTED)

Time of Collection: 1545 VAN VEEN
1605 PONAR (ACCEPTED)

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY SAND + SILT, SLIGHT SHEEN, SHELL FRAGMENTS, MUSSEL, POLYCHAETE WORM (RELATIVELY LARGE ANNELID), SMALL CANCER CRAB

Approx % collected in grab sample 70% - VAN VEEN
PONAR - 0% (JAWS OPEN W/DEBRIS) / 5% (DEBRIS-REJECTED) / 5% REJECTED / 50% ACCEPTED %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

- PHOTO OF HOMOGENIZED SAMPLE ✓
- PHOTO OF STATION
- PHOTO OF DEBRIS IN PONAR
- PHOTO OF BENTHIC SIEVE ✓

Sample Control Number (SCN): CHEM 16739-06 / TOX & BIOAVAIL 16740-06 / PETRO 16741-06

Analysis for:

- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:

# of Grabs for Analysis:

Other Notes: STATION LOCATED AT JOLDWIN & FLOATING / SEMI SUBMERGED DEBRIS (DOCKS, METAL PLATFORM)

1X TOX ✓
1X 250mL PETRO ✓
3X 125mL CHEM ✓
1X 125mL BIOAVAILABILITY ✓
1X BENTHIC CONTAINER

SAMPLE NUMBER: 16739-06
16740-06
16741-06

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 19 OCTOBER 09
Inspected by: M. SPANI / B. DE FREITAS
Station Number (ID): 15A
Sampling Method: PONAR / VAN VEEN
Weather: CALM
Lat/Longitude: 15A = 48 59.798N 123 48.675W
Sampling Depth: ~~10.3m~~ ~~11.5m~~ 10.3m
# of Attempts to Obtain Sample: 1X PONAR (SUCCESSFUL) 3X VAN VEEN (ACCEPTED)
Time of Collection: 1618 PONAR VV 1625 / 1635 / 1645

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
BLACK ; SILT, WOOD CHIPS & WOOD BARK, ODOUR (SULPHUR), SLIGHT SHEEN

Approx % collected in grab sample PONAR - 100%
VAN VEEN - ⊙ 95% / ⊙ 30% / ⊙ 90%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
BENTHIC SIEVE PHOTO
PHOTO OF VAN VEEN SAMPLE (SEDIMENT IN GRAB)
PHOTO OF HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16739-07 / TOX & BIOAVAILABILITY 16740-07 / PETRO 16741-07

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

DUPLICATES: CHEM 16739-08 / BIOAVAILABILITY 16740-08 (NO TOX) / PETRO 16741-08

AEC:
Other Notes: IN THE DOG PATCH
1X BENTHIC ✓
2X TOX ✓
2X 250ml PETRO ✓
2X 125ml BIO AVAIL ✓
6X 125ml CHEM ✓

# of Grabs for Analysis: (INCLUDES DUPLICATES)

DUPLICATES	SAMPLES
16739-08	16739-07
16740-08	16740-07
16741-08	16741-07

SAMPLE NUMBER: _____

Document1

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 19 OCT 09
Inspected by: M. SWAN / B. DEFRETTAS
Station Number (ID): 30A (SAME LOCATION AS 30)
Sampling Method: VAN VEEN / PONAR
Weather: LIGHT WIND
Lat/Longitude: 48 59.766N 123 48.413W
Sampling Depth: Hole 11.5m
# of Attempts to Obtain Sample: 1X VAN VEEN (REJECTED) 1X VAN VEEN (ACCEPTED) 1X PONAR (ACCEPTED) 1X PONAR (REJECTED)
Time of Collection: 1730 VAN VEEN (ACCEPTED) 1743 PONAR (ACCEPTED)

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY-BLACK, SILT, SOME WOODY DEBRIS (WOOD CHIPS & BARK), ODOUR (SULPHUR), SMALL CLAM

Approx % collected in grab sample: Van Veen ① 5% Reject / ② 80% ACCEPTED; PONAR ③ 5% REJECTED ④ %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTOGRAPH OF HOMOGENIZED SAMPLE
PHOTOGRAPH OF BENTHIC SIEVE

Sample Control Number (SCN): CHEM 16739-09 / TOX & BIOANAL 16740-09 / PETRO 16741-09

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
1X BENTHIC ✓
3X 125ml CHEM ✓
1X 125ml BIOANAL ✓
1X 250ml PETRO ✓
1X TOX ✓

16739-09
16740-09
SAMPLE NUMBER: 16741-09

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008

Project Title: LOWE SMITH SAMPLING

Date: 20 OCT 09

Inspected by: M. SPANN / B. DE FREITAS

Station Number (ID): 35A (35*)
A - Actual

Sampling Method: VAN VEEN / PONAR

35A - 48 59.551N

Weather: CALM

Lat/Longitude: 123 48.405W

Sampling Depth: 7.5m

0915 ~~0918~~ - unsuccessful *
0918 - Successful (Van Veen)

# of Attempts to Obtain Sample: 1x VAN VEEN (UNSUCCESSFUL)*
1x VAN VEEN (SUCCESSFUL)
1x PONAR SUCCESSFUL

Time of Collection: 0945 - SUCCESSFUL (PONAR)

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.): SILT & FINE SAND

DARK GREY - BLACK, SOFT, SHELL FRAGMENTS NO DISTINCT ODOUR, VERY FINE WOODY DEBRIS
LOTS OF POLYCHAETE WORMS (ANNELIDS) -

Approx % collected in grab sample: ① 5% ALL EELGRASS (REJECTED)* / ② 65% ACCEPTED - VAN VEEN
50% ACCEPTED - PONAR

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
Photo of sediment in grab
Photo of homogenized sample
Photo of Benthic Sieve

Sample Control Number (SCN): CHEM 16743-01 / BIOAUMIC-TOX 16744-01 / PETRO 16745-01

Analysis for:

- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC: _____ # of Grabs for Analysis: _____

Other Notes: * LOCATION OF PROPOSED 35 IN EELGRASS (REJECTED) - MOVED ACTUAL LOCATION OFFSHORE SLIGHTLY
3x 125ml CHEM
1x 125ml BIOAUMIC
1x 250ml PETRO
1x TOX BUCKET
1x BENTHIC

1674-01
1674-01
1674-01

SAMPLE NUMBER: _____

Document1

SEDIMENT SAMPLING LOG

Project No: 091436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI / B. DEFREITAS
Station Number (ID): 33A (33*)
A- Actual
Sampling Method: PONAR / VAN VEEN
33A = 48 59.623N
Weather: CALM
Lat/Longitude: 123 48.392W
Sampling Depth: 6.3 m
# of Attempts to Obtain Sample: 4 X PONAR REJECTED * / 1 X PONAR ACCEPTED
Time of Collection: PONAR 1025 ACCEPTED / VAN VEEN 1030/1035

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
BLACK, FINE SAND & SILT, SHELL FRAGMENTS, FINE WOOD DEBRIS
LOTS OF WORMS, NO DISTINCT ODOUR

Approx % collected in grab sample PONAR 20% REJECTED* / 20% REJECTED* / 20% REJECTED* / 20% REJECTED* %
PONAR - 35% ACCEPTED (ACTUAL)
VAN VEEN - 50% / 70%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
Photo of Benthic Sieve ✓
Photo of homogenized sample ✓

Sample Control Number (SCN): CHEM 16743-02 / BIOAVAIL & TOX 16744-02 / PETRO 16745-02

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
# of Grabs for Analysis:

Other Notes:
* LOCATION OF PROPOSED 33 REJECTED DUE TO DIFFICULTY OBTAINING SUBSTRATE - MOVED ACTUAL LOCATION OFFSHORE SLIGHTLY
2 X BENTHIC CONTAINERS ✓
2 X TOX PAILS ✓
3 X 125 ml CHEM ✓
1 X 125 ml BIO AVAIL ✓
1 X 250 ml PETRO ✓

16743-02
16744-02
16745-02

SAMPLE NUMBER: _____

Document1

SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI / B. DE FREITAS
Station Number (ID): 22A (SAME LOCATION AS 22)
Sampling Method: VAN VEEN / PONAR
Weather: CALM
Lat/Longitude: 48 59.756N 123 48.583W
Sampling Depth: 11m
# of Attempts to Obtain Sample: 2x VAN VEEN (SUCCESSFUL) 1x PONAR SUCCESSFUL
Time of Collection: VAN VEEN = @ 1102 / @ 1115 PONAR = 1140

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY-GREEN, ODOUR (SULPHUROUS?), FINE SILT & SOME FINE SAND, WOOD DEBRIS

Approx % collected in grab sample VAN VEEN @ 100% @ 100% PONAR 100% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SAMPLE
PHOTO OF BENTHIC SIEVE SAMPLE

Sample Control Number (SCN): 16743-03 CHEM | BIO AVAILABILITY & TOX 16744-03 | PETRO 16745-03

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

DUPLICATES
CHEM - 16743-04
BIOAVAIL - 16744-04 (NO TOX)
PETRO - 16745-04

AEC:
Other Notes:
# of Grabs for Analysis:

6x 125ml CHEM ✓
2x 250 ml PETRO ✓
2x 125 ml BIOAVAIL ✓
2x TOX BUCKETS ✓

INCLUDES DUPLICATES

DUPLICATES	SAMPLES
16743-04	16743-03
16744-04	16744-03
16745-04	16745-03

SAMPLE NUMBER: _____

Document1

SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANN
Station Number (ID): 23A (23)
SAME LOCATION AS 23
Sampling Method: PONAR / VAN VEEN
23 = 48 59.691N
Weather: CALM
Lat/Longitude: 123 48.658W
Sampling Depth: ~~2m~~ 2m (SHALLOW)
# of Attempts to Obtain Sample: 1X PONAR (ACCEPTED)
2X VAN VEEN (ACCEPTED)
Time of Collection: 1210 - PONAR
1235 / 1251 VAN VEEN

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY - BLACK, SLIGHT ODOUR, SAND & SILT (COAL WASTE?)
~~POS~~ SOME SHELL FRAGMENTS, ONE COCKLE,

Approx % collected in grab sample PONAR 35% ACCEPTED %
VAN VEEN @ 50% @ 50% ACC

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
Photograph of homogenized sample

Sample Control Number (SCN): CHEM 16743-05 / BIOAVAILABILITY & TOX 16744-05 / PETRO 16745-05

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
BENTHICS SIEVED W/ 500µm (0.5mm) NOT A 1mm SIEVE
2X BENTHICS ✓
3X 125 ml CHEM ✓
1X 125ml BIOAVAIL ✓
1X 250ml PETRO ✓
1X TOX BUCKET ✓

16743-05
16744-05
SAMPLE NUMBER: 16745-05

SEDIMENT SAMPLING LOG

Project No: 091436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI
Station Number (ID): 21A (21)
A=Actual
Sampling Method: VAN VEEN / PONAR
Weather: CALM / LIGHT WIND
Lat/Longitude: 21A = 48 59.735N
123 48.647W
Sampling Depth: 9.3m
# of Attempts to Obtain Sample: 2X VAN VEEN (SUCCESSFUL)
1X PONAR SUCCESSFUL
Time of Collection: ① 1356 ② 1405 VV
PONAR 1410

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
BLACK, SILTY, DEBRIS - GLASS, WOOD, LARGE PIECES OF BARK, SLIGHT SHEEN

Approx % collected in grab sample ① 50% ② 98% - VV
PONAR %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SAMPLE
PHOTO OF BENTHIC SIEVE SAMPLE

Sample Control Number (SCN): CHEM 16743-06 / BIOAVAIL & TOX 16744-06 / PETRO 16745-06

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT DUPLICATES
- ☐ AVS CEM CHEM 16743-07
- ☐ PFOA/PFOS BIOAVAIL ~~& TOX~~ (NO TOX) 16744-07
PETRO 16745-07

AEC:
# of Grabs for Analysis:
Other Notes:
ALONGSIDE STEEL SHIP
1X TOX ✓
6X 125ml CHEM ✓
2X 250ml PETRO ✓
2X 125ml BIOAVAIL ✓
INCLUDES DUPLICATES

DUPLICATES	SAMPLES
16743-07	16743-06
16744-07	16744-06
16745-07	16745-06

SAMPLE NUMBER: 16745-06

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SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI
Station Number (ID): 24A (24)
A= Actual
Sampling Method: PONAR / VAN VEEN
24A = 48 59.714 N
Weather: CALM w/ LIGHT GUSTS
Lat/Longitude: 123 48.571 W
Sampling Depth: 5m
# of Attempts to Obtain Sample: 1X PONAR ACCEPTED
1X VAN VEEN REJECTED
3X VAN VEEN ACCEPTED
Time of Collection: PONAR = 1430
VAN VEEN = 1442 / 1447 / 1452 (ACCEPTED)

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY BLACK SILT-FINE SAND, (WASTE COAL MATERIAL?), SOME FINE WOODY DEBRIS, TRACE GRAVEL, NO DISTINCT ODOUR
SMALL CANCER CRAB, LOTS OF WORMS

Approx % collected in grab sample PONAR - 45% ACCEPTED %
VAN VEEN 25% (REJECT COBBLE IN JAW) / 60% ACCEPTED / 40% ACCEPTED / 50% ACCEPTED

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- PHOTO OF HOMOGENIZED SAMPLE ✓
- PHOTO OF BENTHIC SIEVE ✓

Sample Control Number (SCN): CHEM 16743-08 / BIO ANAL TOX 16744-08 / PETRO 16745-08

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes: CLOSE TO SLAG POINT
2 X TOX ✓
3 X 125ml CHEM ✓
1 X 125ml BIO ANAL ✓
1 X 250 ml PETRO ✓
1 X BENTHIC CONTAINER ✓

16743-08
16744-08
SAMPLE NUMBER: 16745-08

SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI
Station Number (ID): 1A (1)
A = Actual
Sampling Method: VAN VEEN / PONAR
1A = 48 59.843N
Weather: CALM
Lat/Longitude: 123 48.984W
Sampling Depth: 2.5m
# of Attempts to Obtain Sample: 1 X VAN VEEN SUCCESSFUL
1 X PONAR SUCCESSFUL
Time of Collection: VAN VEEN 1528
PONAR 1538.

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY, FINE SAND & SILT, SLIGHT ODOUR, SLIGHT SHEEN, FEW SHELL FRAGMENTS, CRABS,

Approx % collected in grab sample VAN VEEN 65% %
PONAR 45%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

PHOTO OF HOMOGENIZED SAMPLE ✓
PHOTO OF BENTHIC SIEVE ✓

Sample Control Number (SCN): CHEM 16743-09 / BIOAVAIL & TOX 16744-09 / PETRO 16745-09

Analysis for:

☐ Full Metals	☐ PAH	☐ TBT
☐ Grain Size	☐ Benthic	☐ AVS CEM
☐ PCB	☐ Dioxins and Furans	☐ PFOA/PFOS
☐ Other		

AEC: # of Grabs for Analysis:
Other Notes:

1 X TOX ✓
3 X 125ml CHEM ✓
1 X 250ml PETRO ✓
1 X 125ml BIOAVAIL ✓

16743-09
16744-09
SAMPLE NUMBER: 16745-09

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SEDIMENT SAMPLING LOG

Project No: 091436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI
Station Number (ID): 5A (5)
A=Actual
Sampling Method: PONAR / VAN VEEN
5A = 48 59.828N
Weather: CALM / LIGHT WIND
Lat/Longitude: 123 48.874W
Sampling Depth: 6m
# of Attempts to Obtain Sample: 1X PONAR SUCCESSFUL 2X VAN VEEN SUCCESSFUL
Time of Collection: PONAR 1530
VAN VEEN 1555 / 18m

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, SILT & FINE SAND, SULPHUR LIKE ODOUR, HC SHEEN, WORM (ANNELID), SHELL FRAGMENTS, CRABS, (SMALL)

Approx % collected in grab sample PONAR ~~50~~ 40% ACCEPTED %
VAN VEEN 50%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SAMPLE
PHOTO OF BENTHIC SIEVE

Sample Control Number (SCN): CHEM 16743-10 / BIOAVAILBILITY & TOX 16744-10 / PETRO 16745-10

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
1 x 250ml PETRO ✓
3x 125ml ~~BIOAVAIL~~ CHEM ✓
1 x 125ml BIOAVAIL ✓
2x TOX BUCKETS ✓
1X BENTHICS ✓

16743-10
16744-10
SAMPLE NUMBER: 16745-10

SEDIMENT SAMPLING LOG

Project No: 091436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI
Station Number (ID): 2A (2)
A- Actual
Sampling Method: VAN VEEN / PONAR
2A = 48 59.875N
Weather: OVERCAST / LIGHT WIND
Lat/Longitude: 123 48.915W
Sampling Depth: 5m (DEPTH VARIES)
# of Attempts to Obtain Sample: 4X VAN VEEN ACCEPTED
4X PONAR
1 X PONAR ACCEPTED
Time of Collection: VAN VEEN = 1625/1633/1643/1645
PONAR 1502 (ACCEPTED)

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY, SILT W/COARSE SAND & GRAVEL, COBBLES, SHELL FRAGMENTS ~~NOT~~ SLIGHT NO DISTINCT ODOUR, SMALL CRABS, SOME WOODY DEBRIS

Approx % collected in grab sample VAN VEEN 30% / 30% / 30% / 30% %
PONAR 5% REJECTED / 0% REJECTED / 10% REJECTED / 5% REJECTED / 20% ACCEPTED

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SEDIMENT
PHOTO OF BENTHIC SIEVE

Sample Control Number (SCN): CHEM 16743-11 / BIOANAL TOX 16744-11 / PETRO 16745-11

Analysis for:
- ☐ Full Metals
- ☑ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:

Other Notes: CLOSE TO NEWLY CONSTRUCTED ROCK BREAKWATER
2X TOX PAIL ✓
3X 125ml CHEM ✓
1X 125ml BIOANAL ✓
1X 250ml PETRO ✓
1X BENTHIC CONTAINER ✓

SAMPLE NUMBER: 16743-11
16744-11
16745-11

SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI
Station Number (ID): 4A (4)
A = ACTUAL
Sampling Method: PONAR / VAN VEEN
4A 48 59.789N
Weather: OVERCAST CALM
Lat/Longitude: 123 48.910W
Sampling Depth: 5.5m
# of Attempts to Obtain Sample: 1X VAN VEEN SUCCESFUL
1X PONAR SUCCESFUL
Time of Collection: PONAR 1715
VAN VEEN 1723

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY, FINE SAND & SILT, SLIGHT ODOUR, FEW SHELL FRAGMENTS, SMALL CRAB, FINE WOODY DEBRIS.

Approx % collected in grab sample PONAR = 80%
VAN VEEN = 75%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

- HOMOGENIZED SAMPLE
- BENTHIC SIEVE SAMPLE

Sample Control Number (SCN): CHEM 16743-12 / BIOAVAIL ~~PFOS~~ 16744-12 / PETRO 16745-12

Analysis for:

- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:

LOCATED ALONGSIDE FLOATING DERELICT PLATFORM
NO TOX

3X 125ml CHEM ✓
1X 125ml BIOAVAIL ✓
1X 250ml PETRO ✓
2X BENTHIC CONTAINERS ✓

16743-12
16744-12
SAMPLE NUMBER: 16745-12

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SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANJI
Station Number (ID): 11A (11)
A= Actual
Sampling Method: VAN VEEN / PONAR
Weather: CALM & OVERCAST
Lat/Longitude: 11A = 48.59.832N
123 48.708W
Sampling Depth: 10m
# of Attempts to Obtain Sample: 1X VAN VEEN (SUCCESSFUL)
Time of Collection: 1750 - VAN VEEN
1758 - PONAR

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

LOTS OF LARGE WOODY DEBRIS
DARK GREY, ~~F~~ SILT & FINE SAND), LOTS OF SMALL WOODY DEBRIS,
ODOUR (SULPHUR LIKE).

Approx % collected in grab sample VAN VEEN = 50% (LOTS OF LARGE WOODY DEBRIS) %
PONAR:

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

PHOTO OF HOMOGENIZED SAMPLE

Sample Control Number (SCN): 16746-01 CHEM / ~~16747~~ 16747-01 BIOAVAIL / 16748-01 PETRO

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:

NO TOA
3X 125mL CHEM ✓
1X 125mL BIOAVAIL ✓
1X 250mL PETRO ✓

16746-01
16747-01
SAMPLE NUMBER: 16748-01

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SEDIMENT SAMPLING LOG

Project No: 091436 5008
Project Title: LADYSMITH SAMPLING
Date: 20 OCT 09
Inspected by: M. SPANI
Station Number (ID): 9A (9)
A = Actual
Sampling Method: PONAR / VAN VEEN
Weather: CALM
Lat/Longitude: 9A = 48 59.777N 123 48.822W
Sampling Depth: 5.6m
# of Attempts to Obtain Sample: 1X VAN VEEN SUCCESSFUL
1X PONAR SUCCESSFUL
Time of Collection: 1808 - VAN VEEN
1820 - PONAR

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
BLACK / DARK BROWN, SILT, SULPHUR ODOUR, WOODY DEBRIS
SHELL FRAGMENTS

FISH IN BENTHIC SAMPLE (SCULPIN)

Approx % collected in grab sample VAN VEEN 85% PONAR 80% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF FISH IN BENTHIC SAMPLE
PHOTO OF HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM ~~16764~~ 16746-02 CHEM / 16747-02 BIOAVAIL 16748-02 PETRO

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
# of Grabs for Analysis:
Other Notes: LOCATION BY MARITIME SOCIETY ~~[illegible]~~ MAR A
NO TOA
3X 125 ml chem ✓
1X 125 ml Bioavail ✓
1X 250 ml Petro ✓
2X BENTHIC ✓

SAMPLE NUMBER: 1674 167 16

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SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 21OCT 09
Inspected by: M. SPANN
Station Number (ID): 38R (38)
R= Reference
Sampling Method: POWAR / VAN VEEN
Weather: RAIN / CALM / REDUCED VIS
38R 48 59.642N
Lat/Longitude: 123 47.627W
Sampling Depth: 10.5m
# of Attempts to Obtain Sample: 1X POWAR SUCCESSFUL
2X VAN VEEN SUCCESSFUL
Time of Collection: POWAR 0855
VAN VEEN 0904 / 0912

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK FINE, SILT & FINE SAND, FEW SHELL FRAG, SLIGHT SULPHUR LIKE ODOUR, TRACE CLAY

Approx % collected in grab sample POWAR 90% 90%
VAN VEEN 95% / 90%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
BENTHIC HOMOGENIZED PHOTO
BENTHIC SIEVED PHOTO

Sample Control Number (SCN): CHEM 16746-03 / BIOANAL & TOX 16747-03 / PETRO 16748-03

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

DUPLICATES
CHEM 16746-04
BIOANAL 16747-04
PETRO 16748-04

AEC:
# of Grabs for Analysis:
Other Notes: REFERENCE SITE - LOCATED BETWEEN BURE ISLAND & DUNSMUIR ISLAND
1 X LARGE TOX BUCKET (=2+ BUCKETS)
6x 125ml CHEM
2x 125ml BIOANAL
2x 250ml PETRO
1X BENTHIC
INCLUDES DUPLICATES

DUPLICATES: 16746-04, 16747-04, 16748-04
SAMPLES: 16746-03, 16747-03, 16748-03
SAMPLE NUMBER:

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SEDIMENT SAMPLING LOG

Project No: 091436 5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPANI
Station Number (ID): 36R (36)
R = Reference
Sampling Method: VAN VEEN / PONAR
36R = 48 59.595N
Weather: RAIN / LIGHT WIND / REDUCED VIS
Lat/Longitude: 123 47.480W
Sampling Depth: 6.5m
# of Attempts to Obtain Sample: 1X VAN VEEN SUCCESSFUL
1X PONAR REJECTED
1X PONAR ACCEPTED
Time of Collection: 0943 VAN VEEN
0954 ~~1054~~ PONAR ACCEPTED

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY SAND, FINE SAND, TRACE SILT, NO DISTINCT ODOUR, LITTLE WORMS, SMALL CRUSTACEANS

Approx % collected in grab sample 65% VAN VEEN %
PONAR = 0% (JAWS OPEN W/ ROPE DEBRIS) / 35% ACCEPTED

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
Photo of homogenized sample
Photo of benthic sieve

Sample Control Number (SCN): CHEM 16746-05 / BIOANAL = 16747-05 / PETRO 16748-05

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:

Other Notes:
REFERENCE SITE - LOCATED ON MAP NORTH OF DUNSMUIR ISLANDS (NE)
NO TOX
1X BENTHICS
3X125mL CHEM
1X125mL BIOANAL
1X250 PETRO

16746-05
16747-05
SAMPLE NUMBER: 16748-05

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPANI
Station Number (ID): 28A (SAME AS 28)
Sampling Method: PONAR / VAN VEEN
Weather: LIGHT WIND / DRIZZLE / REDUCED VIS
Lat/Longitude: 48 59.842N 123 48.562W
Sampling Depth: 12.7m
# of Attempts to Obtain Sample: 1X PONAR SUCCESSFUL; 1X JAN VEEN REJECT; 2X JAN VEEN SUCCESSFUL
Time of Collection: PONAR HTS 1013; VAN VEEN HTS 1015 / 1026 REJECT / 1030

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, SILT W/FINE SAND, SMALL/FINE WOODY DEBRIS
NO DISTINCT ODOUR,
SMALL CRAB, SMALL WORM, SMALL CLAMS

Approx % collected in grab sample PONAR 75% / VAN VEEN 80% / WOODIN JAWS (REJECT) / 50% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
BENTHIC SIEVE PHOTO
HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16746-06 / BIOANALYTOX 16747-06 / PETRO 16748-06

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
# of Grabs for Analysis:
Other Notes:
3X125ml CHEM ✓
1X125ml BIOANALYTOX ✓
1X250ml PETRO ✓
1X LARGE TOX BUCKET (2 BUCKETS) ✓
2X BENTHICS ✓

SAMPLE NUMBER: 16746-06 / 16747-06 / 16748-06

Document1

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPANN
Station Number (ID): 37R (37)
R= REFENCE SITE
Sampling Method: VAN VEEN / PONAR
49 00.739N
Weather: LIGHT WIND
Lat/Longitude: 123 49.798W
Sampling Depth: 7.4m
# of Attempts to Obtain Sample: 1X VANVEEN SUCCESSFUL
1X PONAR SUCCESSFUL
Time of Collection: VAN VEEN 1050
PONAR 1058

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY SILT & FINE SAND ODOUR (SULPHUR LIKE), TRACE FINE WOOD DEBRIS, SHELLS & SHELL FRAGMENTS, TRA SOME CLAY.

Approx % collected in grab sample VAN VEEN 100% %
PONAR 100%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF BENTHIC SIEVE
PHOTO OF HOMOGENIZED SAMPLE

Sample Control Number (SCN) CHEM 16746-07 / BIOANALYTOX 16747-07 / PETRO 16748-07

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC: # of Grabs for Analysis:

Other Notes:
LOCATED TOWARDS THE NORTH END OF LADYSMITH HARBOUR
1X TOX ✓
3X 125ml CHEM ✓
1X 125ml BIOANAL ✓
1X 250ml PETRO ✓
1X BENTHIC ✓

16746-07
16747-07
SAMPLE NUMBER: 16748-07

SEDIMENT SAMPLING LOG

Project No: 0914365008
Project Title: LADY SMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPANI
Station Number (ID): 39R (39) REFERENCE
Sampling Method: PONAR / VAN VEEN
Weather: CALM
Lat/Longitude: 49 00.584 N 123 49.584 W
Sampling Depth: 8M
# of Attempts to Obtain Sample: 1X PONAR (SUCCESSFUL) 1X VAN VEEN (SUCCESSFUL)
Time of Collection: PONAR 1110 VAN VEEN 1115

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, SAND & SILT, SOME CLAY, SLIGHT ODOUR (SULPHUR-LIKE)

Approx % collected in grab sample: PONAR 100%. VAN VEEN 100% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SAMPLE
PHOTO OF BENTHIC SIEVE

Sample Control Number (SCN): CHEM 16746-08 / BIOANAL 16747-08 / PETRO 16748-08

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
# of Grabs for Analysis:
Other Notes:
REFERENCE LOCATION - UPSTREAM, NORTH OF MARINAS.
3 X 125ml CHEM ✓
1 X 125ml BIOANAL ✓
1 X 250ml PETRO ✓
1 X BENTHIC ✓

16746-08
16747-08
SAMPLE NUMBER: 16748-08

Document1

SEDIMENT SAMPLING LOG

Project No: 09 1436 - 5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPANI
Station Number (ID): 40R (40)
R=Reference location
Sampling Method: VAN VEEN / PONAR
Weather: CALM
Lat/Longitude: 49 00.452N 123 49.248W
Sampling Depth: 9.7M
# of Attempts to Obtain Sample: 1X VAN VEEN SUCCESSFUL
1X PONAR REJECTED
1X PONAR ACCEPTED
Time of Collection: VAN VEEN 1206
PONAR ~~1213~~ ~~1215~~ 1217 ACCEPTED

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
GREY, LARGER SMALL WOODY ~~PEBBLE~~, SAND & SILT, NO DISTINCT ODOUR

Approx % collected in grab sample VAN VEEN, 70% %
PONAR WOOD IN JAWS (REJECT) / 40% ACCEPTED

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF HOMOGENIZED SAMPLE ✓
PHOTO OF BENTHIC SIEVE ✓

Sample Control Number (SCN): CHEM 16746-09 / BIOAVAIL 16747-09 / PETRO 16748-09

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC: # of Grabs for Analysis:

Other Notes: REFERENCE LOCATION LOCATED NORTH-WEST OF WOODS ISLAND NEAR LOG BOOMING AREA
1X BENTHIC ✓
NO FOA
1X 125mL BIO AVAIL ✓
3X 125mL CHEM ✓
1X 250mL PETRO ✓

16746-09
16747-09
SAMPLE NUMBER: 16748-09

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPAWN
Station Number (ID): 7A (7)
A = Actual
Sampling Method: PONAR / VAN VEEN
48 59.878N
Weather: CALM
Lat/Longitude: 123 48.731W
Sampling Depth: 8m
PONAR 1235
# of Attempts to Obtain Sample: 1X PONAR (SUCCESSFUL)
Time of Collection: VAN VEEN 1240
1X VAN VEEN (SUCCESSFUL)

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, SILT & FINE SAND SMALL & FINE WOODY DEBRIS, NO DISTINCT ODOUR, SHELL FRAGMENTS; SLIGHT SHEEN
SMALL CRAB,

Approx % collected in grab sample PONAR 75%
VAN VEEN 90%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
PHOTO OF BENTHIC SIEVE
PHOTO OF HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16746-10 / BIOANAL 16747-10 / PETRO 16748-10

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
Other Notes: # of Grabs for Analysis:

NO TOX
1X 250ml PETRO ✓
1X 125ml BIOANALYTIC ✓
3X 125ml CHEM ✓
3X BENTHIC ✓

16746-10
16747-10
SAMPLE NUMBER: 16748-10

Document1

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPRAWT
Station Number (ID): 16A (SAME AS 16)
Sampling Method: VAN VEEN / PONAR
Weather: CALM, CLEAR
Lat/Longitude: 48 59.827N 123 48.649W
Sampling Depth: 10.8m
# of Attempts to Obtain Sample: 1X VAN VEEN SUCCESSFUL
1 X PONAR SUCCESSFUL
Time of Collection: VAN VEEN 1302
PONAR 1307

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, FINE SAND & SILT, SOME WOODY DEBRIS, STRONG ODOUR (SULPHUROUS)

Approx % collected in grab sample VAN VEEN 100% %
PONAR 100%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- BENTHIC SIEVE SAMPLE
- HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16746-11 / BIO ANAL 16747-11 / PETRO 16748-11

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
NO TOX
3X 125ml CHEM
1X 125ml BIO ANAL
1X 250 ml PETRO
1X BENTHIC ✓

16746-11
16747-11
SAMPLE NUMBER: 16748-11

SEDIMENT SAMPLING LOG

Project No: 09-1436 5008
Project Title: LADYSMITH SAMPLING
Date: 24 OCT 09
Inspected by: M. SPAWN
Station Number (ID): 13A (13)
A = ACTIVATE
Sampling Method: PONAR / VAN VEEN
Weather: CALM, CLEAR
Lat/Longitude: 48 59.784N 123 48.728W
Sampling Depth: 8.5m
# of Attempts to Obtain Sample: 1X PONAR REJECTED 1X PONAR ACCEPTED 1X PONAR SUCCESSFUL
Time of Collection: PONAR: 1325 SUCCESSFUL VAN VEEN: 1330

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY, SILT & FINE SANDS, LOTS OF LARGE & SMALL WOODY DEBRIS, MUSSEL SHELLS, ODOUR (SULPHUROUS)

Approx % collected in grab sample: PONAR - WOOD IN JAWS REJECT / 50% (ACCEPTED) %
VAN VEEN 85%.

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

- BENTHIC SIEVE PHOTO
- HOMOGENIZED SEDIMENT SAMPLE

Sample Control Number (SCN): CHEM 16746-12 / BIOAVAILABILITY 16747-12

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

PETRO - 16748-12

AEC:
# of Grabs for Analysis:
Other Notes:

NO TOX
3X125ml CHEM ✓
1X125ml BIOAVAIL ✓
1X250ml PETRO ✓
2X BENTHICS ✓

16746-12
16747-12
SAMPLE NUMBER: 16748-12

Document1

SEDIMENT SAMPLING LOG

Project No: 09-1456-5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SAWN
Station Number (ID): 20A
A= ACTUAL
Sampling Method: VAN VEEN / PONAR
20A 48 59.735N
Weather: CALM
Lat/Longitude: 123 48.727W
Sampling Depth: 6m
# of Attempts to Obtain Sample: 1X VAN VEEN UNSUCCESSFUL
1X VAN VEEN SUCCESSFUL
1X PONAR SUCCESSFUL
Time of Collection: VAN VEEN: 1350
PONAR: 1355

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, SILT & FINE SAND, LOTS OF WOODY DEBRIS (FINE, SMALL & LARGE), SLIGHT ODOUR (SULPHUR-LIKE)

Approx % collected in grab sample: ~~VAN VEEN~~ - WOODIN JAWS (REJECT) / 30% ACCEPT %
PONAR 90%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
HOMOGENIZED ~~BENTHIC~~ SAMPLE ✓
BENTHIC SIEVE SAMPLE ✓

Sample Control Number (SCN): CHEM 16749-01 / BIOANAL 16750-01 / PETRO 16751-01

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
NO TOX
3X125ml CHEM ✓
1X125ml BIOANAL ✓
1X250ml PETRO ✓
2X BENTHIC ✓

SAMPLE NUMBER: 16749-01 / 16750-01 / 16751-01

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH SAMPLING
Date: 21OCT09
Inspected by: M. SPANI
Station Number (ID): 18A (SAME AS 18)
Sampling Method: PONAR / VAN VEEN
18A 48 59.716N
Weather: CALM
Lat/Longitude: 123 48.786W
Sampling Depth: 5m
# of Attempts to Obtain Sample: 1X PONAR (SUCCESSFUL) 1X VAN VEEN (SUCCESSFUL)
Time of Collection: PONAR = 1423
VAN VEEN = 1426

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY SILTY FINE SAND, ~~LOTS OF~~ WOODY DEBRIS, SLIGHT ODOUR (SULPHUR LIKE)

Approx % collected in grab sample PONAR 100% %
VAN VEEN 80%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- BENTHIC SEDE
- HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16749-02 / BIOANALYTIC 16750-02 / PETRO 16751-02

Analysis for:
- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☐ Other
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
# of Grabs for Analysis:
Other Notes:
3x125ml CHEM ✓
1x125ml BIOANALYTIC ✓
1x250ml PETRO ✓
2x BENTHIC ✓

16749-02
16750-02
SAMPLE NUMBER: 16751-02

Document1

SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPANI
Station Number (ID): 19A (SAME AS 19)
Sampling Method: VAN VEEN / PONAR
Weather: CALM / SUNNY
Lat/Longitude: 48 59.69 N / 123 48.731 W
Sampling Depth: DEPTH VARIES (OBJECTS ON BOTTOM?) ~ 6.3 m
# of Attempts to Obtain Sample: 1X VAN VEEN SUCCESSFUL / 1X PONAR SUCCESSFUL
Time of Collection: VAN VEEN 1540 / PONAR 1545

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY - BLACK, SAND & SILT, FINE WOOD DEBRIS, FEW SHELL FRAGMENTS, SLIGHT SULPHUR-LIKE ODOUR

Approx % collected in grab sample VAN VEEN 85% / PONAR 70%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- SAMPLE PHOTO
- PHOTO OF BENTHIC SIEVE

Sample Control Number (SCN): CHEM 16749-03 / BIOANAL 16750-03 / PETRO 16751-03

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
NO TOX
3X 125mL CHEM
1X 125mL BIOANAL
1X 250mL PETRO
2X BENTHIC

16749-03
16750-03
SAMPLE NUMBER: 16751-03

SEDIMENT SAMPLING LOG

Project No: 0914365008
Project Title: LADYSMITH SAMPLING
Date: 21 OCT 09
Inspected by: M. SPANI
Station Number (ID): 25A (SAME AS 25)
Sampling Method: PONAR / VAN VEEN
Weather: CALM / SUNNY
Lat/Longitude: 48 59.751N 123 48.518W
Sampling Depth: DEPTH DROPS STEEPLY AROUND THIS SITE FROM 6m-11m SAMPLE AT 11.6m
# of Attempts to Obtain Sample: 1X PONAR SUCCESSFUL / 1X VAN VEEN SUCCESSFUL
Time of Collection: PONAR 1600 / VAN VEEN 1605

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY FINE SAND & SILT, FINE WOOD DEBRIS, SHELL FRAGMENTS, SLIGHT SULPHUROUS ODOUR

Approx % collected in grab sample: PONAR 85% / VAN VEEN 100%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- BENTHIC SIEVE
- HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16749-04 | BIOAVAIL 16750-04 | PETRO 16751-04

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
NO PAH
3X 125mL CHEM ✓
1X 125mL BIOAVAIL ✓
1X 250mL PETRO ✓
1X BENTHIC

16749-04
16750-04
SAMPLE NUMBER: 16751-04

Document1

SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADY SMITH SAMPLING
Date: 21 OCT 2009
Inspected by: M. SPANJI
Station Number (ID): 17A (SAME AS 17)
Sampling Method: VAN VEEN / PONAR
Weather: CALM / SUNNY
Lat/Longitude: 48 59.796N 123 48.583W
Sampling Depth: 11.7m
# of Attempts to Obtain Sample: 1X VANVEEN SUCCESSFUL
Time of Collection: VAN VEEN 1620 PONAR 1625

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, FINE SAND & SILT, LOTS OF WOODY DEBRIS, SLIGHT SULPHUROUS ODOUR

Approx % collected in grab sample VAN VEEN 85% PONAR 75%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
BENTHIC SIEVE PHOTO
HOMOGENIZED SAMPLE

Sample Control Number (SCN): ~~TECHEM~~ CHEM 16749-05 / BIOAVAIL 16750-05 / PETRO 16751-05

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
3X125ml CHEM ✓
1X125ml BIOAVAIL ✓
1X250ml PETRO ✓

16749-05
16750-05
SAMPLE NUMBER: 16751-05

SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 4 OCT 2009
Inspected by: M. SPANI.
Station Number (ID): 14A (14)
A = Actual
Sampling Method: PONAR / VAN VEEN
Weather: CALM
Lat/Longitude: 14A = 48 59.775N 123 48.668W
Sampling Depth: 9.8m
# of Attempts to Obtain Sample: 1X PONAR SUCCESSFUL, 1X VANVEEN SUCCESSFUL
Time of Collection: PONAR 1636
VAN VEEN 1640

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY, FINE SAND & SILT, WOODY DEBRIS, SULPHUROUS ODOUR

Approx % collected in grab sample PONAR 100% %
VAN VEEN 100%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

HOMOGENIZED SAMPLE
SIEVED BENTHIC SAMPLE

Sample Control Number (SCN): CHEM 16749-06 / BIOANAL 16750-06 / PETRO 16751-06

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:

3X 125mL CHEM ✓
1X 125mL BIOANAL ✓
1X 250mL PETRO ✓

16749-06
16750-06
SAMPLE NUMBER: 16751-06

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SEDIMENT SAMPLING LOG

Project No: ~~08~~ 09 1436 5008

Project Title: LADY SMITH SAMPLING

Date: 22nd OCT 09

Inspected by: M. SPIANU

Station Number (ID): 31A (31)
A = ACTUAL

Sampling Method: VAN VEEN / PONAR

Weather: CALM

Lat/Longitude: 31A = 48 59. 720N
123 48. 406W

Sampling Depth: 7m

# of Attempts to Obtain Sample: 1X VAN VEEN REJECTED*
1X VAN VEEN ACCEPTED
2X PONAR REJECTED
1X PONAR ACCEPTED

Time of Collection: VAN VEEN 0905 ACCEPTED
PONAR 0920 ACCEPTED

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY / BLACK SAND & SILT, SHELL FRAGMENTS
SLIGHT ODOUR, ~~APPEARS~~ PRESENCE OF COAL MATERIAL (?)

Approx % collected in grab sample VAN VEEN 70% REJECTED* / 65% ACCEPTED %
PONAR 20% REJECTED / 10% REJECTED / 25% ACCEPTED

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- BENTHIC SIEVE
- HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16749-07 / BIOANALYTICAL 16750-07 / PETRO 16751-07

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC: # of Grabs for Analysis:

Other Notes:
* LOCATION OF PROPOSED 31 IS IN UPPER INTERTIDAL ON SLAG POINT. INITIAL GRAB WAS TAKEN IN SHALLOW WATER & REJECTED. 31A WAS MOVED OFFSHORE SO AS TO BE ABLE TO OBTAIN SAMPLES
3x 125ml CHEM
1X 125ml BIOANALYTICAL
1x 250 ml PETRO
1X BENTHIC

SAMPLE NUMBER: 1674907
16750-07
16751-07

SEDIMENT SAMPLING LOG

Project No: 0911636 5008
Project Title: LADYSMITH SAMPLING
Date: 22 OCT 09
Inspected by: M. SPAAN
Station Number (ID): 32A (32)
A = ACTUAL
Sampling Method: PONAR / VAN VEEN
32A = 48 59.661 N
Weather: CALM
Lat/Longitude: 123 48.360W
Sampling Depth: 10m
# of Attempts to Obtain Sample: 1X PONAR SUCCESSFUL
1X VAN VEEN SUCCESSFUL
Time of Collection: PONAR 0935
VAN VEEN 0938

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
BLACK (DARK GREY) SAND & SILT TRACE GRAVEL (PRESENCE OF COAL MATERIAL ?), NO DISTINCT ODOUR, SMALL CRABS, WORMS, SNAILS, CLAMS

Approx % collected in grab sample PONAR 30% %
VAN VEEN 45%

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- BENTHIC SIEVE
- HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16749-08 / BIOANAL 16750-08 / PETRO 16751-08

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes: * ACTUAL LOCATION OF MOVED FURTHER OFFSHORE

3X 125ml CHEM
1X 125ml BIOANAL
1X 250ml PETRO
1X BENTHIC

SAMPLE NUMBER: 16749-08 / 16750-08 / 16751-08

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SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADYSMITH SAMPLING
Date: 22 OCT 09
Inspected by: M. JAANI
Station Number (ID): 34A (34*) A- ACTUAL
Sampling Method: VAN VEEN / PONAR
34A= 48 59.591N
Weather: CALM
Lat/Longitude: 123 48.361W
Sampling Depth: [6.5m REJECTED*] 10 ACTUAL
# of Attempts to Obtain Sample: 1X VAN VEEN REJECTED* 1X VAN VEEN ACCEPTED 1X PONAR ACCEPTED
Time of Collection: VAN VEEN 0935 (SUCCESSFUL) PONAR 1005

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY, FINE SAND & SILT, GRAVEL (COAL?), SLIGHT SULPHUR-LIKE ODOUR, SOME SHELL FRAGMENTS / WORMS.

Approx % collected in grab sample VAN VEEN 15% REJECTED / 85% ACCEPTED %
PONAR 60% ACCEPTED

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- BENTHIC PHOTO
- HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16749-09 / BIOMASS 16750-09 / PETRO 16751-09

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:
* LOCATION OF PROPOSED 34 REJECTED, 34A MOVED SLIGHTLY OFFSHORE
3X 125mL CHEM ✓
1X 125mL BIOMASS ✓
1X 250mL PETRO ✓
2X BENTHICS ✓

16749-09
16750-09
16751-09
SAMPLE NUMBER: _____

SEDIMENT SAMPLING LOG

Project No: 0916J6.5008
Project Title: LADYSMITH SAMPLING
Date: 22 OCT 09
Inspected by: M. SPANI
Station Number (ID): 29A (SAME AS 29)
Sampling Method: PONAR / VAN VEEN
Weather: CALM
Lat/Longitude: 48 59.803N / 123 48.489W
Sampling Depth: ~~12m~~ 12.5m
# of Attempts to Obtain Sample: 1X PONAR / 1X VAN VEEN
Time of Collection: PONAR 1016 / VAN VEEN 1022

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
DARK GREY, SAND & SILT, WOODY DEBRIS, SULPHUR-LIKE ODOUR

Approx % collected in grab sample: PONAR 50% / VAN VEEN 80% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
- BENTHIC SIEVE
- HOMOGENIZED SAMPLE

Sample Control Number (SCN): CHEM 16749-10 / BIOMAIL 16750-10 / PETRO 16751-10

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:

3X 125mL CHEM
1X 125mL BIOMAIL
1X 250mL PETRO
2X BENTHICS

16749-10
16750-10
SAMPLE NUMBER: 16751-10

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SEDIMENT SAMPLING LOG

Project No: 09 1436 5008
Project Title: LADY SMITH SAMPLING
Date: 22nd OCT 09
Inspected by: M. SPAWI
Station Number (ID): 27A (~~SAMPLE~~ SAME AS 27)
Sampling Method: VAN VEEN / PONAR
Weather: CALM
Lat/Longitude: 48 59.880N 123 48.638W
Sampling Depth: 12.1m
# of Attempts to Obtain Sample: 1x VAN VEEN / 1x PONAR
Time of Collection: VAN VEEN 1039 / PONAR 1045

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY, SAND & SOME SILT, NO DISTINCT ODOUR
WORMS

Approx % collected in grab sample: VAN VEEN 75% / PONAR 45% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

- HOMOGENIZED SAMPLE
- BENTHIC SIEVE

Sample Control Number (SCN): CHEM 16749-11 / BIOMAIL 16750-11 / PETRO 16751-11

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☐ Other

AEC:
# of Grabs for Analysis:
Other Notes:

3x125ml CHEM
1x125ml BIOMAIL
1x250 ml PETRO
1x BENTHICS

16749
16750
167

SAMPLE NUMBER: _____

REV 0.01

GOLDER ASSOCIATES LTD.

SEDIMENT CORE LOG

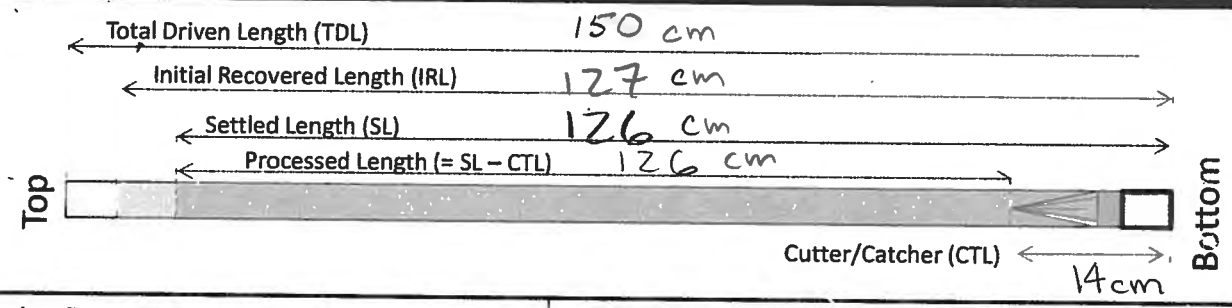
AUGUST 2009

Job No (Phase/Task): 09-1436-5008	**Project:** Ladysmith Harbour

Collection

Core ID (Station ID/Attempt) 2010-03	**Crew/Vessel** PR/MA/MS/KZ
Date (Time – 24hr) Dec 17 2010	**Coring System** Vibracore
Barrel Type/Liner Type Aluminum Barrel / PAB liners	**Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL)** 14 cm
Barrel Length/O.D./ Wall Thickness 150cm / 10cm / 0.2cm	**Liner O.D/Wall Thickness** 1 mm
Lateral Position 48° 59.728 N 123° 48.877 W	**Water Depth/Type** 2.4 m
	Reference Elevation (RE): Chart datum
Head Depth (to RE), Start (HDS) 150 cm	**Head Depth (to RE), Finish (HDF)** 0 cm
Initial Recovered Length (IRL) 127cm	**Notes** FULL PENETRATION, PREVIOUS RESECTION IN IMMEDIATE AREA 3X
Total Driven Length (TDL) = (HDS) - (HDF) 150cm	**Recovery = IRL/Penetration x 100**
	Accept for Processing (Y/N) Y

Processing



Processing Date Dec 18 2010	**Start Time/End Time (24 Hr)** 14:07
Settled Length (SL) 126 cm.	**Processed Length** 126 cm

Measured Depth (From Settled Mudline) (m)	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 - 126	loose, soft, ~~brown~~ Wet, Dark brown, ORGANICS (wood debris up to 70mm) Sulfur-like odour. Wood debris included bark and woodchips. metal debris (bolt)	0 - 10cm 21775-05 45 - 55cm 21775-06 95 - 105 cm DUP 21775-07 21775-08

Notes: *2066-02 is a field dup of 2066-01

Logged By RPC	**Reviewed By** RSJ

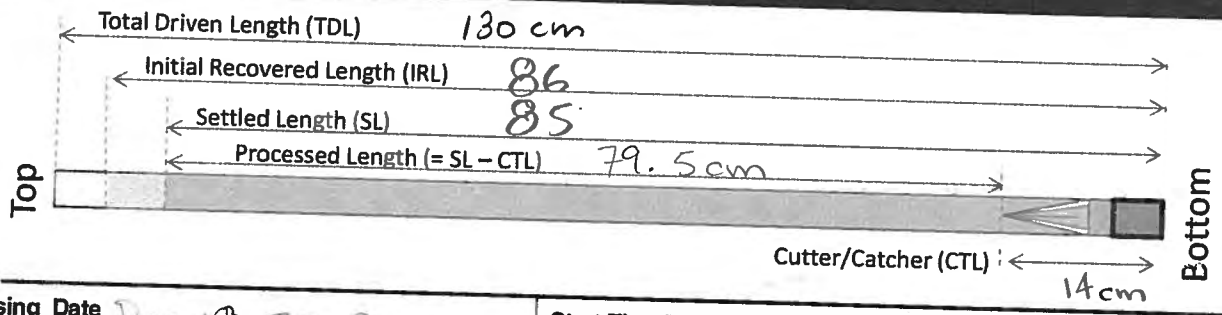
SEDIMENT CORE LOG

Job No (Phase/Task): 09-1436-5008	Project: Ladysmith Harbour

Collection

Core ID (Station ID/Attempt) 2010-04	Crew/Vessel PR/MA/MS/KZ
Date (Time – 24hr) Dec 2010	Coring System Vibracore
Barrel Type/Liner Type Aluminum Barrel PAB liner	Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL) 14 cm
Barrel Length/O.D./ Wall Thickness 150cm/10cm/0.2cm	Liner O.D/Wall Thickness 1mm
Lateral Position 48° 59.719N 123° 48.840W	Water Depth/Type 2.5m
	Reference Elevation (RE): Chart datum
Head Depth (to RE), Start (HDS) 150 cm	Head Depth (to RE), Finish (HDF) 20 cm
Initial Recovered Length (IRL) 86 m	Notes REJECTED IN SAME IMMEDIATE AREA 5X
Total Driven Length (TDL) = (HDS) - (HDF) 130cm	Recovery = IRL/Penetration x 100
	Accept for Processing (Y/N) Y

Processing



Processing Date Dec 18 2010	Start Time/End Time (24 Hr) 11:45
Settled Length (SL) 85cm	Processed Length

Measured Depth (From Settled Mudline) ~~(m)~~ cm	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 – 43 cm	~~[illegible]~~ loose, moist, Dark brown, ORGANICS (wood debris to approx 6mm). Trace sand	0-10cm 21774-04
43 – 79.5	loose, moist, Dark brow, ORGANICS (wood debris up to 70mm). Trace fine sand. (more sand noted at 79.5cm	45-55 cm 21774-05 70-79.5cm

Notes: *2066-02 is a field dup of 2066-01

Logged By RPC	Reviewed By RSJ

REV 0.01

GOLDER ASSOCIATES LTD.

SEDIMENT CORE LOG

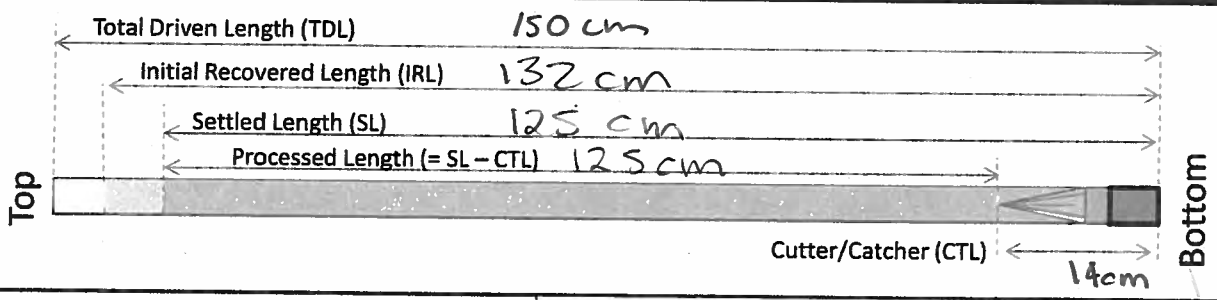
AUGUST 2009

Job No (Phase/Task): 09-1436-5008	**Project:** Ladysmith Harbour

Collection

Core ID (Station ID/Attempt) 2010-06	**Crew/Vessel** PR/MA/MS/KZ
Date (Time – 24hr) Dec 17 2010	**Coring System** Vibracore
Barrel Type/Liner Type Aluminum Barrel PAB liner	**Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL)** 14cm
Barrel Length/O.D./ Wall Thickness 150 cm / 10cm / 0.2cm	**Liner O.D/Wall Thickness** 1mm
Lateral Position 48°59.725 N 123°48.828 W	**Water Depth/Type** 2.9m
	Reference Elevation (RE): Chart datum
Head Depth (to RE), Start (HDS) 150cm	**Head Depth (to RE), Finish (HDF)** 0cm
Initial Recovered Length (IRL) 132 cm	**Notes** FULL PENETRATION; REJECTED TWICE BEFORE IN SAME SPOT
Total Driven Length (TDL) = (HDS) - (HDF) 150 cm	**Recovery = IRL/Penetration x 100**
	Accept for Processing (Y/N) Y

Processing



Processing Date Dec 18 2010	**Start Time/End Time (24 Hr)**
Settled Length (SL)	**Processed Length**

Measured Depth (From Settled Mudline) cm	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 – 77 cm	loose, moist, Red brown, ORGANICS (wood debris, bark and wood chips to 10cm) fine sand and silt, Shell fragments. Ghost shrimp.	0-10cm 21774-09 45-55 cm 121774 10
77 – 125 cm	loose, saturated, dark brown black, SILT, ORGANICS (wood debris + bark to 80mm), fine sand. clam Shell (bentnose) Sulfur-like odour	95-105cm 21774-11

Notes: *2066-02 is a field dup of 2066 1

Logged By [redacted]	**Reviewed By** RSJ

REV 0.01 GOLDER ASSOCIATES LTD. AUGUST 2009

REV 0.01

GOLDER ASSOCIATES LTD.

SEDIMENT CORE LOG

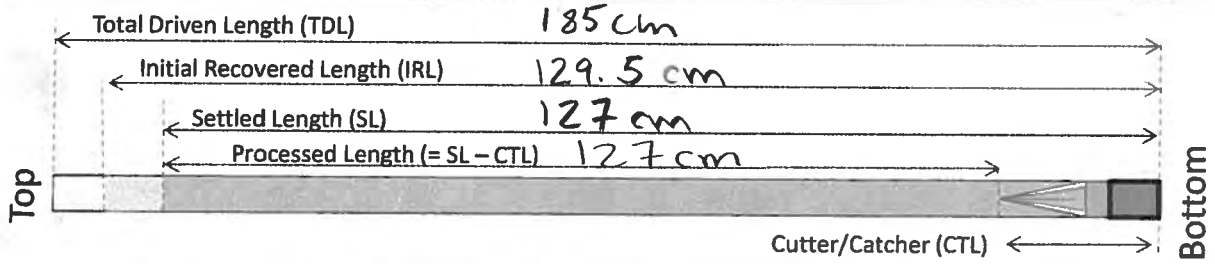
AUGUST 2009

Job No (Phase/Task): 09	**Project:** Ladysmith Harbour

Collection

Core ID (Station ID/Attempt) 2010-07	**Crew/Vessel** PR/MA/MS/KZ
Date (Time – 24hr) Dec 16 2010	**Coring System** Vibracore
Barrel Type/Liner Type Aluminum Barrel (10cm) PAB liner	**Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL)** 14cm
Barrel Length/O.D./ Wall Thickness 200cm / 10cm / 0.2cm	**Liner O.D/Wall Thickness** 1mm
Lateral Position 48° 59.749 N 123° 48.555 W	**Water Depth/Type** 9.5m
	Reference Elevation (RE): Chart datum
Head Depth (to RE), Start (HDS) 200 cm	**Head Depth (to RE), Finish (HDF)** 15 cm
Initial Recovered Length (IRL) 129.5 cm	**Notes** CLOSE to full PENETRATION
Total Driven Length (TDL) = (HDS) - (HDF) 185cm	**Recovery = IRL/Penetration x 100**
	Accept for Processing (Y/N) Y

Processing



Processing Date Dec 18 2010	**Start Time/End Time (24 Hr)**
Settled Length (SL) 127 cm	**Processed Length** 127 cm

Measured Depth (From Settled Mudline) (m) cm	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 - 6cm	Firm, moist, Dark grey/Black, SILT, fine sand	0-6mm 21774-06
6 - 55 cm	loose, moist, Dark Brown/Black, ORGANICS (wood debris/bark), Silt and sand. *sand size coal debris observed.	45-55cm 21774-07
55 - 90 cm	loose, moist, Black, Sand + Silt, sand size coal debris (up to 10mm), shell fragments	95-105cm 21774-08
90 - 127 cm	loose, moist Black, coarse sand and silt coal debris (up to 30mm), shell fragments	

Notes: 2066-02 is a field dup of 2066-01

Logged By RPC	**Reviewed By** RSJ

REV 0.01 GOLDER ASSOCIATES LTD. AUGUST 2009

REV 0.01

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SEDIMENT CORE LOG

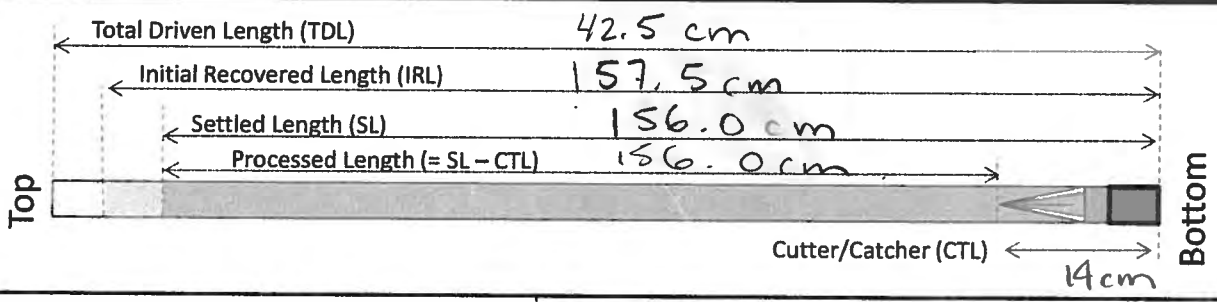
AUGUST 2009

Job No (Phase/Task): 09-1436-5008	**Project:** Ladysmith Harbour

Collection

Core ID (Station ID/Attempt) 2010 - 8	**Crew/Vessel** PR/MA/MS/KZ
Date (Time – 24hr) Dec 17 2010	**Coring System** Vibracore
Barrel Type/Liner Type Aluminum Barrel PAB liner	**Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL)** 14 cm
Barrel Length/O.D./ Wall Thickness 200 cm / 10cm / 0.2cm	**Liner O.D/Wall Thickness** 1mm
Lateral Position 48°59.761 N 123°48.681 W	**Water Depth/Type** 7.5m
	Reference Elevation (RE): Chart datum
Head Depth (to RE), Start (HDS) 200 cm	**Head Depth (to RE), Finish (HDF)** 0 cm
Initial Recovered Length (IRL) 157.5 cm	**Notes** 2 attempts were made to collect core Samp!
Total Driven Length (TDL) = (HDS) - (HDF) 200cm	**Recovery** = IRL/Penetration x 100
	Accept for Processing (Y/N) Y

Processing



Processing Date Dec 18 2010	**Start Time/End Time (24 Hr)** 15:50
Settled Length (SL) 156.0	**Processed Length** 156

Measured Depth (From Settled Mudline) (m)	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 - 66	Very loose, Wet, Dark Brown, SILT, Organics (sand size wood debris), fine sand, sulfur-like odour	0 - 10 21776-02 45 - 55 21776-03
66 – 120	V. loose, wet, Dark Brown, SILT, Organics (wood debris to 100mm), sulfur-like odour	95 - 105 21776-04
120 - 156	loose, wet, Dark brown SILT and ORGANICS (wood debris up to 60mm), sulfur-like odour.	145 - 156 21776-05

Notes: *2066-02 is a field dup of 2066-01 en.

Logged By RPC	**Reviewed By** RSJ

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REV 0.01

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SEDIMENT CORE LOG

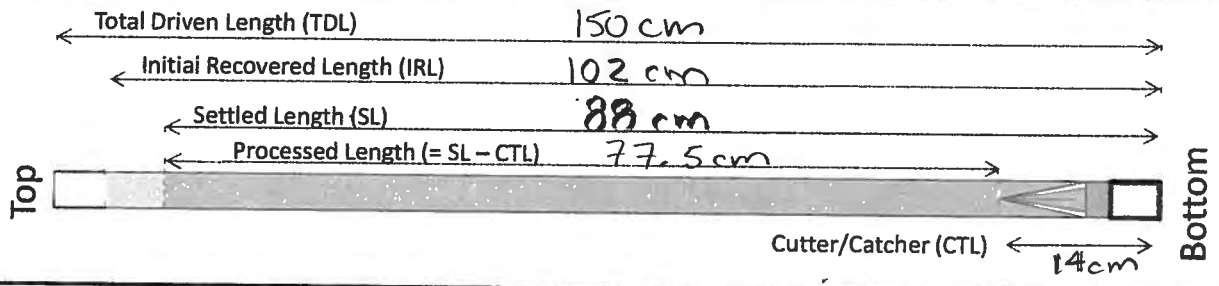
AUGUST 2009

Job No (Phase/Task): 09-1436-5008	**Project:** Ladysmith Harbour

Collection

Core ID (Station ID/Attempt) 2010-09	**Crew/Vessel** PR/MA/MS/KZ
Date (Time – 24hr) Dec 16 2010	**Coring System** Vibracore
Barrel Type/Liner Type Alum nom Barrel liner PAB	**Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL)** 14 cm
Barrel Length/O.D./ Wall Thickness 200 cm / 10cm / 0.2 cm	**Liner O.D/Wall Thickness** 1 mm
Lateral Position 48° 59.805 N 123° 48.667 W	**Water Depth/Type** 8.4 m
	Reference Elevation (RE): Chart datum
Head Depth (to RE), Start (HDS) 200 cm	**Head Depth (HDF)** cm
Initial Recovered Length (IRL) 102 cm	**Notes** 2 attempts
Total Driven Length (TDL) = (HDS) - (HDF) 150 cm	**Recovery = IRL/Penetration x 100**
	Accept for Processing (Y/N) Y

Processing



Processing Date Dec 18 2010	**Start Time/End Time (24 Hr)** 11:20
Settled Length (SL) 88	**Processed Length** 77.5 cm

Measured Depth (From Settled Mudline) cm	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 - 30	Soft, Saturated, Dark brown, SILT, fine sand fine wood debris, organics, Sulfur like odour	0-30 21774-01
30 - 65	Soft, Saturated, Dark brown, SILT, woody debris (organics) Sulphur-like odour	40-60 cm 21774-02
65 - 77.5	Soft, Saturated, Dark Brown, Wood Debris, Silt, organics, Sulphur-like odour	70-77.5 21774-03

Notes: *2066-02 is a field dup of 2066-01

Logged By Michelle Spani	**Reviewed By**

REV 0.01 GOLDER ASSOCIATES LTD. AUGUST 2009

REV 0.01

GOLDER ASSOCIATES LTD.

SEDIMENT CORE LOG

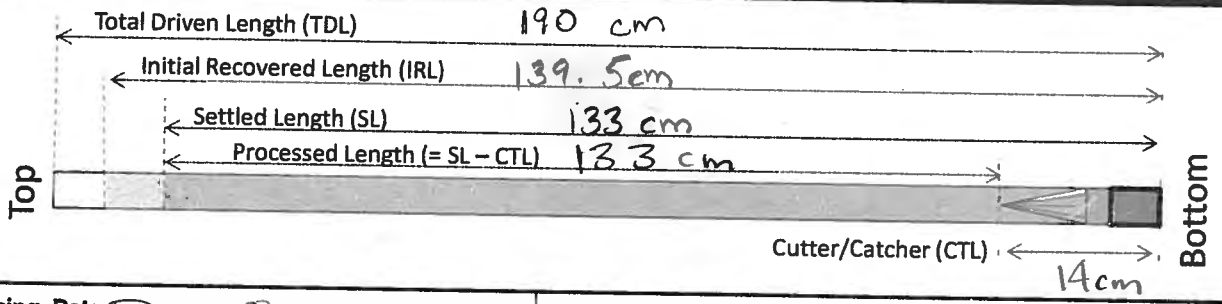
AUGUST 2009

Job No (Phase/Task): 09-1436-5008	**Project:** Ladysmith Harbour

Collection

Core ID (Station ID/Attempt) 2010-12	**Crew/Vessel** PR/MA/MS/KZ
Date (Time – 24hr) Dec 16 2010	**Coring System** Vibracore
Barrel Type/Liner Type Aluminum Barrel PAB liner	**Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL)** 14 cm
Barrel Length/O.D./ Wall Thickness 200cm/10cm/0.2m	**Liner O.D/Wall Thickness** 1mm
Lateral Position 48°59.851N 123°48.802W	**Water Depth/Type** 2.5m
	Reference Elevation (RE): Chart datum
Head Depth (to RE), Start (HDS) 200cm	**Head Depth (to RE), Finish (HDF)** 10cm
Initial Recovered Length (IRL) 139.5cm	**Notes**
Total Driven Length (TDL) = (HDS) - (HDF) 190cm	**Recovery** = IRL/Penetration x 100
	Accept for Processing (Y/N) Y

Processing



Processing Date Dec 18 2010	**Start Time/End Time (24 Hr)** 15:07
Settled Length (SL) 133cm	**Processed Length** 133cm

Measured Depth (From Settled Mudline) cm	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 - 43	loose, moist, Dark brown, ORGANICS (wood debris, bark up to 85mm), Silt, fine sand, sulfur-like odour.	0 - 15 cm 21775-09
43 - 73	soft, loose, moist, Dark grey/brown, SAND Organics (wood debris up to 40mm) silt, Shell fragments	45 - 55mm 21775-10
73 - 114	Firm, moist, grey (dark), Fine SAND, Silt.	95 - 105 DUP 21775-11 21775-12
114 - 133	Firm, moist, Dark grey, FINE SAND, GRAVEL, Silt, (gravel up to 70mm, sub angular)	120 - 133mm * 21776-01

Notes: *2066-02 is a field dup of 2066-01

Logged By RPC	**Reviewed By** RSJ

REV 0.01 GOLDER ASSOCIATES LTD. AUGUST 2009

* Ask if Section should be analyzed.

REV 0.01

GOLDER ASSOCIATES LTD.

SEDIMENT CORE LOG

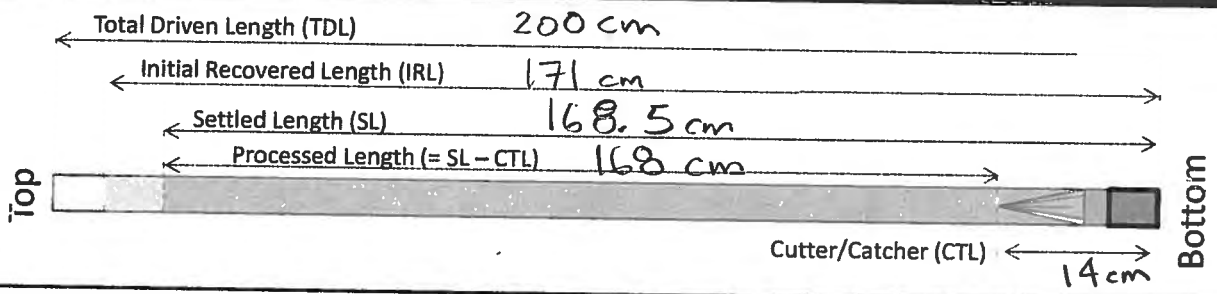
AUGUST 2009

Job No (Phase/Task):	09-1436-5008	Project:	Ladysmith Harbour

Collection

Core ID (Station ID/Attempt)	2010 - 13	Crew/Vessel	PR/MA/MS/KZ
Date (Time – 24hr)	Dec 17 2010	Coring System	Vibracore
Barrel Type/Liner Type	Aluminum Barrel PAB liner	Cutter & Catcher Throat I.D./ Total Length (Closed) (CTL)	14cm
Barrel Length/O.D./ Wall Thickness	200cm/10cm/0.2m	Liner O.D/Wall Thickness	1mm
Lateral Position	48°59.846 N 123°48.962 W	Water Depth/Type	3.5 m
		Reference Elevation (RE):	Chart datum
Head Depth (to RE), Start (HDS)	200 cm	Head Depth (to RE), Finish (HDF)	0 cm
Initial Recovered Length (IRL)	171 cm	Notes	2 attempts; SAMPLE SITE LOCATED ~10 m N OF ORIGINALLY PROPOSED SS LOCATION
Total Driven Length (TDL) = (HDS) - (HDF)	200cm	Recovery = IRL/Penetration x 100	
		Accept for Processing (Y/N)	Y

Processing



Processing Date	Dec 18 2010	Start Time/End Time (24 Hr)	13:45
Settled Length (SL)	168.5cm	Processed Length	168 cm

Measured Depth (From Settled Mudline) ~~(m)~~ cm	Description (Density, Moisture, Munsell Colour, MAJOR CONSTITUENT(S), other constituents, observations)	SCN# (s) and Depth(s) (m)
0 - 34 cm	Firm, Moist, Dark grey/black FINE SAND, SILT. Organics (wood debris up to 9cm) shell	0-10 cm 21774-12
34 - 60cm	firm, moist, Dark grey, FINE SAND, Gr (up to 45m), SILT, Shells (clams, bent nose)	45-55cm 21775-01
60 - 168cm	Firm, moist, Dark grey, FINE SAND, Silt, Shells (bent nonse, cockles and oyster shells)	95-105 cm 21775-02 21775-03 DUP 145-155 cm 21775-04

Notes: *2066-02 is a field dup of 2066-01

Logged By	RPC	Reviewed By	RSJ

REV 0.01 GOLDER ASSOCIATES LTD. AUGUST 2009

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: LADYSMITH HARBOUR
Date: DEC 15/2010
Inspected by: Michelle Spani
Station Number (ID): 2010-7 0086-06
Sampling Method: VAN VEEN
Weather: 5 KNOTS +5°C / RAIN / CLOUDY
Lat/Longitude: 48°59.749 / 123° 48.555 W
Sampling Depth: 9.7m
# of Attempts to Obtain Sample: 2
Time of Collection: 16:55

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

DARK GREY BLACK SILT ~~AND~~ WITH FINE SAND

SULFUR LIKE ODOUR
WOODY DEBRIS

Approx % collected in grab sample 90% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

PHOTOS TAKEN OF SAMPLE IN TOTE

Sample Control Number (SCN): 0086-06

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☑ Other tox testing

AEC: _____ # of Grabs for Analysis: _____
Other Notes:

SAMPLE NUMBER: _____

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: Ladysmith.
Date: Dec 15 2010
Inspected by: Michelle Spani
Station Number (ID): 2010-8 0086-05
Sampling Method: Van veen
Weather: overcast
Lat/Longitude: 48° 59.734 N 123° 48.681 W (SAME AS ORIGINAL)
Sampling Depth: 7.7m
# of Attempts to Obtain Sample: 2
Time of Collection: 16:41

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
Red rock crab
Dark grey black SILT w/ fine sand, wood debris, shell fragmen
Sulfur-like odour

Approx % collected in grab sample 85 % %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
photo of sediment in tote, photo of crab.

Sample Control Number (SCN): 0086-06

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☒ Other tox testing

AEC:
# of Grabs for Analysis: 2
Other Notes:

SAMPLE NUMBER: _____

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: Ladysmith harbour
Date: Dec 15 2010
Inspected by: Michelle Spani
Station Number (ID): 2010-9 0086-04
Sampling Method: Van Veen
Weather: overcast / Raining
Lat/Longitude: 48°59.805N / 123°48.667W } 5-10m NW OF original waypoint
Sampling Depth: 9.5m
# of Attempts to Obtain Sample: 2
Time of Collection: 16:04

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

Dark grey / black SILT with fine sand, ~~mantis~~ shrimp, slight sulfur-like odour, anemone, shell debris, wood debris. Slight sheen.

Approx % collected in grab sample 90% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

Photo of sample in tote. Photo of shrimp and anenome

Sample Control Number (SCN): 0086-04

Analysis for:

- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☒ Other Toxicity testing

AEC:
# of Grabs for Analysis: 2
Other Notes:

SAMPLE NUMBER: _____

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: Ladysmith
Date: Dec 15 2010
Inspected by: Michelle Spani
Station Number (ID): 2010-10
SCN 0086-01
Sampling Method: Van Veen
Weather: Overcast
Lat/Longitude: 48°59.761 N 123°48.770 W (DID NOT RELOCATE FROM ORIGINAL WYPT)
Sampling Depth: ~~m~~ 4.6m
# of Attempts to Obtain Sample: 3
Time of Collection: 14:44

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):
Jellyfish, (moon jelly) graceful crab, shell fragments, wood debris
Dark grey/black colour, SILT, fine sand, sulphur-like odour, slight sheen

Approx % collected in grab sample 80% %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):
photos taken of representative sample in grab.

Sample Control Number (SCN): 0086-01

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☒ Other Toxicity ~~testing~~

AEC:
Other Notes:
# of Grabs for Analysis: 3

3 grabs homogenized ~~in~~ in one sample
*Diesel spill occurred in harbour earlier today

SAMPLE NUMBER: 0086-01

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: Ladysmith
Date: Dec 15 2010
Inspected by: Michelle Spani
Station Number (ID): 2010-11 0086-02
Sampling Method: Van Veen
Weather: overcast
Lat/Longitude: 48° 59.814N 123° 48.840W
Sampling Depth: ~ 20cm
# of Attempts to Obtain Sample: 1
Time of Collection: 15:05

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

Dark grey/black, SILT / fine sand
Christmas coffee mug, Abundant wood fragments
shell debris, sulfur-like odour, No sheen.

48° 59.814N } SAME AS
123° 48.840W } provided by A.D.B.
DID NOT HAVE TO MOVE SITE

Approx % collected in grab sample 75 % %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

photo of sample in tote.

Sample Control Number (SCN): 0086-02

Analysis for:

- ☐ Full Metals
- ☐ Grain Size
- ☐ PCB
- ☒ Other Toxicity testing
- ☐ PAH
- ☐ Benthic
- ☐ Dioxins and Furans
- ☐ TBT
- ☐ AVS CEM
- ☐ PFOA/PFOS

AEC:
Other Notes:

# of Grabs for Analysis: 4

SAMPLE NUMBER: _____

Page _____ of _____

SEDIMENT SAMPLING LOG

Project No: 09-1436-5008
Project Title: ladysmith harbour
Date: Dec 15 2010
Inspected by: Michelle Spani
Station Number (ID): 2010-13 / 0086-03
Sampling Method: Van Veen
Weather: Overcast
Lat/Longitude: 48°59.846 N / 123°48.962 W (MOVED SED SAMPLING SITE OVER 5-10 m to the OFF TO BOAT AND HOLD POSITION (WAYPOINT ARE DIFFERENT THAN ORIGINAL PROVIDED BY A.D.B)
Sampling Depth: 3.7m
# of Attempts to Obtain Sample: 3
Time of Collection: 15:31 PM

Sediment Description (including colour, type/grain size, anthropogenic debris, organic material, shell, wood, odour, HC sheen, staining, organisms/biota etc.):

Dark grey/black, SILT fine sand, Shell fragments, Wood Debris
Slight sulfur-like odour,

Approx % collected in grab sample 80 i.e %

Photograph Notes (grab, sampling location, field sampling methods, public use, etc):

Photo of Sample in tote.

Sample Control Number (SCN): 0086-03

Analysis for:
- ☐ Full Metals
- ☐ PAH
- ☐ TBT
- ☐ Grain Size
- ☐ Benthic
- ☐ AVS CEM
- ☐ PCB
- ☐ Dioxins and Furans
- ☐ PFOA/PFOS
- ☒ Other toxicity testing

AEC:
Other Notes:

# of Grabs for Analysis: 3

SAMPLE NUMBER: _____

APPENDIX V

Sediment Data

APPENDIX V
Table V-1: Summary of Ladysmith Harbour Surface Sediment Bulk Chemistry Data
2009-2010

Sample ID CANTEST/Maxxam ID Sample Location Date Sampled QAQC	Units	CCME Marine Sediment Guideline ISQG [a]	CCME Marine Sediment Guideline PEL [b]	BC CSR Marine Sediment Criteria [c]	Ocean Disposal Lower Action Limits [d]	16743-09 910300475 1A 10/20/2009	16743-11 910300480 2A 10/20/2009	16739-05 910300426 3A 10/19/2009	16743-12 910300482 4A 10/20/2009	16743-10 910300477 5A 10/20/2009	16739-04 910300423 6A 10/19/2009	16746-10 910300501 7A 10/21/2009	16739-01 910300417 8A 10/19/2009	16746-02 910300489 9A 10/20/2009	16739-03 910300422 10A 10/19/2009	16746-01 910300487 11A 10/20/2009	16739-02 910300421 12A 10/19/2009	16746-12 910300503 13A 10/21/2009	16749-06 910300509 14A 10/21/2009	16739-07 910300431 15A 10/19/2009 FDA	16739-08 910300435 15A 10/19/2009 FD	16746-11 910300502 16A 10/21/2009	16749-05 910300508 17A 10/21/2009	16749-02 910300505 18A 10/21/2009	16749-03 910300506 19A 10/21/2009	16749-01 910300504 20A 10/21/2009	16743-06 910300455 21A 10/20/2009 FDA	16743-07 910300461 21A 10/20/2009 FD	16743-03 910300442 22A 10/20/2009 FDA	16743-04 910300446 22A 10/20/2009 FD
Parameter																														
General Parameters																														
Sand >0.053 mm	%					83.82	93.83	96.24	74.47	94.08	61.22	54.47	35.37	27.11	26.62	29.89	42.73	27.05	23	26.08	28.65	25.02	53.33	16.46	58.97	31.3	30.13	29.4	32.75	33.09
Silt <0.053 mm & >0.002 mm	%					11.72	3.98	1.96	16.81	3.27	30.42	39.31	50.82	61.82	47.72	53.24	34.52	61.4	49.09	48.5	48.95	49.39	30.51	67.96	27.04	45.53	61.62	61.6	50.59	52.75
Clay <0.002 mm	%					4.46	2.2	1.81	8.72	2.64	8.37	6.21	13.81	11.07	25.66	16.87	22.75	11.54	27.91	25.42	22.4	25.59	16.16	15.58	13.99	23.17	8.25	9	16.65	14.16
Moisture	%					29	17.1	15.4	49.9	24.5	60.4	52.6	73.1	71.5	66.6	71.5	74	65	69.6	70.1	67.4	69.6	60.9	74.6	61.6	74.3	57.6	71.5	66.3	66.7
Total Organic Carbon	% dry wt.					1.68	1.31	1.14	8.14	1.24	8.3	11.7	9.33	15.8	11.3	15.7	7.72	9.74	5.83	11.2	11	8.82	9.71	20.6	25	25.6	43.3	12.5	28.6	10.7
pH	pH units					6.9	8.1	7.7	7	7	7.2	6.8	6.8	7.3	6.9	6.6	6.9	7.1	6.7	6.7	6.8	6.4	7	6.8	6.9	6.7	7.3	7.3	7	6.8
Acid Volatile Sulphide (AVS)	umoles/gram					0.20	0.60	0.20	1.40	0.30	1.30	6.30	12.60	17.50	1.40	4.50	0.80	6.70	5.80	3.30	3.30	4.50	12.70	4.80	3.60	8.30	29.30	29.30	3.90	3.90
Simultaneously Extractable Metals (SEM)	umoles/gram					0.11	0.07	0.07	0.10	0.10	2.17	0.15	0.39	0.81	0.31	0.31	0.25	0.32	0.26	0.24	0.24	0.22	0.16	0.35	0.17	0.38	0.46	0.46	0.30	0.30
SEM:AVS [e]	umoles/gram					0.56	0.11	0.37	0.07	0.34	1.67	0.02	0.03	0.05	0.22	0.07	0.32	0.05	0.04	0.07	0.07	0.05	0.01	0.07	0.05	0.05	0.02	0.02	0.08	0.08
AVS-SEM [e]	umoles/gram					0.09	0.53	0.13	1.30	0.20	-0.87	6.15	12.21	16.69	1.09	4.19	0.55	6.38	5.54	1.60	3.06	4.28	12.54	4.45	3.43	7.92	2.96	28.84	3.65	3.60
Metals																														
Aluminum	ug/g					6140	6500	6060	5790	4020	6500	6640	6840	6750	8200	7870	4350	7550	7700	8300	8250	8780	7500	7210	4400	6630	7920	7810	8350	8710
Antimony	ug/g					< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.6	0.6	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.7	< 0.1	< 0.1	< 0.1
Arsenic	ug/g	**7.24**	**41.6**	**50**		3.3	3.2	2.3	**8.4**	2.9	**9**	**11.5**	**12.9**	**10.6**	**15.9**	**10.9**	**9.1**	**13.5**	**13.8**	**9.4**	**9.2**	**12.9**	**12.2**	**13.5**	**7.9**	**13.6**	**14.3**	**13.7**	**12**	**12.2**
Barium	ug/g					25	16	13	18	17	18	28	16	33	24	24	12	27	30	25	24	34	33	22	20	21	28	31	37	37
Beryllium	ug/g					< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Boron	ug/g					15	8	9	63	19	94	80	141	99	115	101	188	109	76	98	92	63	62	97	109	128	90	86	72	68
Cadmium	ug/g	**0.7**	**4.2**	**5**	**0.6**	0.4	< 0.2	< 0.2	**1.5**	0.4	**1.9**	**2.1**	**2.7**	**3.4**	**3.9**	**3.2**	**2**	**3.4**	**3.7**	**3.3**	**3.1**	**3.7**	**2.8**	**3.4**	**1.1**	**3**	**3.7**	**3.4**	**4.2**	**3.4**
Calcium	ug/g					3010	4970	5710	9230	3430	6580	14400	7950	56700	5580	8220	7310	17800	4950	5370	5500	4660	6060	6820	4940	6420	11200	14500	6310	6100
Chromium	ug/g	**52.3**	**160**	**190**		12	12	12	15	9	18	31	22	21	25	23	14	23	25	24	24	26	22	24	15	24	24	24	25	26
Cobalt	ug/g					4	4	4	3	3	4	5	4	4	5	4	3	4	5	4	4	5	5	4	3	4	5	5	5	5
Copper	ug/g	**18.7**	**108**	**130**		**34**	**19**	**42**	**61**	**24**	**51**	**300**	**84**	**132**	**80**	**64**	**53**	**71**	**73**	**67**	**70**	**71**	**61**	**85**	**57**	**80**	**77**	**81**	**76**	**77**
Iron	ug/g					10200	10200	9550	12800	7160	13000	21200	15100	13500	16700	14600	10700	15300	15900	14600	14700	15200	16300	16200	9950	16300	17800	17500	14300	14200
Lead	ug/g	**30.2**	**112**	**130**		**52.3**	3.3	3.5	**39.4**	6	15.6	20.9	**37.6**	29.8	24	17.4	18.8	18.9	19.3	18.2	17.2	17.5	12.8	**32.4**	25.2	20.8	21.6	21.6	17.8	18.1
Magnesium	ug/g					3740	4100	3820	5420	2990	5970	5800	7410	6740	7570	6670	6930	7020	6920	7060	6880	6600	6150	7900	5760	7420	6680	6530	6340	6210
Manganese	ug/g					120	140	125	121	90	117	181	114	110	135	129	74	125	136	133	134	137	139	124	72		136	134	132	131
Mercury	ug/g	**0.13**	**0.7**	**0.84**	**0.75**	0.1	0.06	0.03	**0.28**	0.07	**0.17**	**0.38**	**0.28**	**0.21**	**0.24**	**0.24**	**0.18**	**0.23**	**0.25**	**0.25**	**0.24**	**0.24**	**0.21**	**0.24**	**0.23**	**0.23**	**0.26**	**0.33**	**0.26**	**0.27**
Molybdenum	ug/g					1.5	0.8	0.3	5.7	1.8	11.8	16.9	18.2	14.7	15.1	13.3	18.2	13.5	10.8	15.4	14.7	9.5	7.8	15.7	11.6	15.1	13.8	12.9	9.7	9.7
Nickel	ug/g					10	11	10	12	7	14	25	17	17	20	19	12	18	20	20	20	21	18	19	14	19	21	21	21	21
Phosphorus	ug/g					370	550	419	562	313	698	591	724	753	792	710	604	740	736	669	662	729	679	766	488	746	806	792	673	688
Potassium	ug/g					679	556	492	1170	551	1290	1330	1720	1690	1900	1730	1560	1790	1780	1760	1750	1730	1460	1980	1290	1790	1740	1700	1640	1600
Selenium	ug/g					0.3	0.3	0.3	1	0.4	1.4	1.3	1.8	1.8	2.1	1.7	1.3	1.8	1.8	1.9	1.6	1.7	1.4	1.6	1.1	1.8	2	1.9	1.8	1.8
Silver	ug/g					< 0.1	< 0.1	< 0.1	0.5	< 0.1	0.2	0.2	0.5	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.3
Sodium	ug/g					4200	2460	2180	14700	5110	15900	14400	23400	22600	24100	20800	25200	23000	20300	21100	21700	18900	15100	28100	17300	25000	19000	19400	17000	16500
Strontium	ug/g					24	24	25	69	25	68	89	92	218	69	72	87	104	60	63	63	59	57	90	87	84	92	107	66	69
Thallium	ug/g					0.1	0.3	< 0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	< 0.1	0.3	0.3	0.3	0.3	0.3
Tin	ug/g					< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Titanium	ug/g					499	472	540	418	403	390	358	357	297	376	383	230	332	379	359	350	361	398	333	203	330	328	324	361	343
Vanadium	ug/g					23	22	24	26	17	33	33	37	34	40	38	34	38	37	38	38	36	32	35	29	36	39	38	35	35
Zinc	ug/g	**124**	**271**	**330**		56	28	26	106	32	117	**131**	**193**	**183**	**177**	120	**145**	**169**	**145**	**130**	**129**	123	90	**199**	83	**159**	**167**	**170**	**162**	**140**
Zirconium	ug/g					2	1	1	3	2	4	4	4	4	5	5	3	5	5	5	5	5	4	4	4	4	5	5	5	5
Hydrocarbons																														
F1-BTEX																														
F2-Napth (C10-C16)	ug/g					< 70	< 70	< 70	< 70	< 70	< 70	< 70	< 70	110	83	< 70	< 70	< 70	< 70	84	82	< 70	< 70	< 70	< 70	< 70	150	170	100	180
F2 (C10-C16) uncorrected	ug/g					< 70	< 70	< 70	< 70	< 70	< 70	< 70	< 70	110	83	< 70	< 70	< 70	< 70	84	82	< 70	< 70	< 70	< 70	< 70	150	170	100	180
F3-PAH (C16-C34)	ug/g					250	< 100	< 100	450	180	240	370	960	690	800	< 100	790	440	400	780	700	400	270	240	270	490	870	1100	630	1100
F3 (C16-C34) uncorrected	ug/g					250	< 100	< 100	450	180	240	370	960	690	800	< 100	790	440	400	780	700	400	270	240	270	490	870	1100	630	1100
F4 (C34-C50)	ug/g					< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500
Polycyclic Aromatic Hydrocarbons																														
Acenaphthene	ug/g	**0.00671**	**0.0889**	**0.11**		**0.31**	< 0.005	**0.008**	**0.025**	**0.27**	**0.049**	**0.089**	**0.053**	**0.033**	**0.097**	**0.042**	**0.19**	**0.037**	**0.046**	**0.087**	**0.11**	**0.028**	**0.042**	**0.029**	**0.27**	**0.084**	**0.2**	**0.17**	**0.18**	**0.11**
Acenaphthylene	ug/g	**0.00587**	**0.128**	**0.15**		< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	**0.028**	< 0.005	**0.04**	< 0.005	< 0.005	< 0.005	**0.082**	< 0.005	< 0.005	**0.042**	**0.047**	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	**0.077**	**0.05**
Anthracene	ug/g	**0.0469**	**0.245**	**0.29**		**0.62**	< 0.01	0.02	**0.08**	**0.2**	**0.12**	**0.18**	**0.16**	**0.1**	**0.24**	**0.13**	**0.53**	**0.1**	**0.09**	**0.12**	**0.17**	**0.05**	**0.06**	**0.06**	**0.4**	**0.13**	**0.33**	**0.23**	**0.24**	**0.15**
Benzo(a)anthracene	ug/g	**0.0748**	**0.693**	**0.83**		**0.67**	0.03	0.04	**0.15**	**0.42**	**0.11**	**0.18**	**0.18**	**0.1**	**0.26**	**0.16**	**0.87**	**0.1**	**0.08**	**0.1**	**0.11**	0.06	0.06	0.03	**0.38**	0.07	**0.34**	**0.27**	**0.2**	**0.17**
Benzo(a)pyrene	ug/g	**0.0888**	**0.763**	**0.92**		**0.45**	< 0.01	0.02	**0.09**	**0.14**	0.08	**0.18**	**0.13**	0.05	**0.16**	0.08	**0.3**	0.06	0.04	0.08	0.08	0.03	0.03	0.02	**0.19**	0.06	**0.22**	**0.13**	**0.1**	**0.14**
Benzo(b)fluoranthene	ug/g					0.47	0.02	0.04	0.15	0.3	0.16	0.22	0.28	0.12	0.35	0.16	0.64	0.17	0.08	0.15	0.12	0.06	0.09	0.05	0.36	0.1	0.28	0.22	0.22	0.28
Benzo(g,h,i)perylene	ug/g					0.13	< 0.01	< 0.01	0.03	0.03	0.03	0.09	0.08	0.01	0.08	0.02	0.14	0.03	0.03	0.05	0.05	0.02	0.03	< 0.01	0.1	0.03	0.08	0.04	0.06	0.07
Benzo(k)fluoranthene	ug/g					0.17	< 0.01	0.01	0.06	0.1	0.05	0.09	0.1	0.04	0.11	0.06	0.19	0.06	0.03	0.06	0.06	0.02	0.03	0.01	0.08	0.03	0.1	0.07	0.09	0.09
Chrysene	ug/g	**0.108**	**0.846**	**1**		**0.74**	0.03	0.07	**0.26**	**0.49**	**0.2**	**0.36**	**0.26**	**0.17**	**0.42**	**0.29**	**0.4**	**0.21**	**0.12**	**0.12**	**0.12**	0.08	0.09	0.05	**0.64**	**0.19**	**0.36**	**0.34**	**0.26**	**0.28**
Dibenz(a,h)anthracene	ug/g	**0.00622**	**0.135**	**0.16**		**0.046**	< 0.005	< 0.005	**0.007**	**0.009**	**0.008**	**0.045**	**0.024**	< 0.005	**0.019**	0.005	**0.034**	**0.007**	**0.008**	**0.01**	**0.011**	< 0.005	0.006	< 0.005	< 0.005	0.006	**0.017**	**0.011**	**0.017**	**0.016**
Fluoranthene	ug/g	**0.113**	**1.494**	**1.8**		**1**	0.06	**0.15**	**0.38**	**2**	**0.41**	**0.67**	**0.5**	**0.33**	**0.85**	**0.85**	**2.1**	**0.64**	**0.25**	**0.42**	**0.4**	**0.16**	**0.22**	**0.22**	**2.6**	**0.38**	**0.68**	**0.82**	**0.7**	**0.49**
Fluorene	ug/g	**0.0212**	**0.144**	**0.17**		**0.46**	< 0.01	0.02	**0.04**	**0.21**	**0.08**	**0.13**	**0.1**	**0.05**	**0.15**	**0.08**	**0.28**	**0.06**	**0.07**	**0.14**	0.16	**0.05**	**0.07**	**0.04**	**0.46**	**0.12**	**0.24**	**0.22**	**0.29**	**0.18**
Indeno(1,2,3-cd)pyrene	ug/g					0.12	< 0.01	< 0.01	0.02	0.03	0.04	0.13	0.09	0.01	0.09	0.02	0.13	0.03	0.03	0.05	0.04	0.02	0.02	< 0.01	0.06	0.02	0.07	0.04	0.07	0.08
Methylnaphthalene (2-)	ug/g	**0.0202**	**0.201**			**0.64**	**0.03**	**0.07**	**0.17**	**0.18**	0.27	0.49	0.34	**0.1**	0.49	0.23	0.61	**0.2**	0.29	0.58	0.67	0.23	0.3	**0.2**	2.6	0.22	0.52	0.54	1.3	0.64
Naphthalene	ug/g	**0.0346**	**0.391**	**0.47**		**0.67**	0.02	0.02	**0.1**	**0.15**	**0.13**	**0.27**	**0.17**	**0.07**	**0.22**	**0.13**	**0.39**	**0.12**	**0.16**	**0.33**	**0.39**	**0.13**	**0.15**	**0.13**	**1.2**	**0.15**	**0.8**	**0.58**	**0.69**	**0.35**
Phenanthrene	ug/g	**0.0867**	**0.544**	**0.65**		**2**	0.03	**0.1**	**0.22**	**0.6**	**0.32**	**0.62**	**0.42**	**0.23**	**0.65**	**0.56**	**0.91**	**0.3**	**0.3**	**0.54**	**0.64**	**0.2**	**0.3**	**0.19**	**4.5**	**0.41**	**0.99**	**0.77**	**1.2**	**0.73**
Pyrene	ug/g	**0.153**	**1.398**	**1.7**		**1.3**	0.04	0.1	**0.34**	**1.2**	**0.44**	**0.71**	**0.69**	**0.45**	**0.89**	**0.62**	**1.8**	**0.63**	**0.21**	**0.36**	**0.39**	0.13	**0.18**	**0.19**	**1.6**	**0.39**	**0.85**	**0.88**	**0.61**	**0.42**
Total HMW-PAH's	ug/g					5.09	0.17	0.42	1.48	4.71	1.53	2.67	2.33	1.29	3.22	2.27	6.6	1.94	0.88	1.41	1.38	0.58	0.76	0.58	6	1.28	2.99	2.82	2.33	2.03
Total LMW-PAH's	ug/g					4.7	0.08	0.23	0.64	1.63	0.98	1.78	1.27	0.59	1.85	1.17	2.99	0.81	0.96	1.84	2.19	0.69	0.93	0.65	9.43	1.12	3.08	2.51	3.98	2.21
Total PAH's	ug/g			**20**	**2.5**	**9.79**	0.25	0.66	2.12	**6.34**	**2.52**	**4.45**	**3.6**	1.88	**5.08**	**3.44**	**9.59**	**2.76**	1.83	**3.25**	**3.57**	1.27	1.69	1.23	**15.4**	2.4	**6.06**	**5.33**	**6.31**	**4.24**

Notes:

a - Canadian Council of Ministers of the Environment (CCME) Interim Maine Sediment Quality Guidelines (ISQG); CCME 2001
b - Canadian Council of Ministers of the Environment (CCME) Probable Effect Levels; CCME 2001
c - British Columbia Contaminated Sites Regulations (BC CSR) Typical Marine Sediment Criteria (BC CSR 2011)
d - Environment Canada Disposal at Sea Program; Lower Action Limits, Environment Canada 2011
e - the relationship between AVS and SEM is expressed both as a ratio (value exceeding 1 indicates excess of metals) and as a difference (value exceeding 0 indicates an excess of metals).
FDA: Field duplicate available, FD: Field duplicate

Bold and underlined values are equal to or exceed the CCME Marine Sediment Guideline ISQG
Bold and outlined values are equal to or exceed the CCME Marine Sediment Guideline PEL
Bold, yellow highlighted and outlined values are equal to or exceed the BC CSR Marine Sediment Criteria
Bold and blue highlighted values are equal to or exceed the Ocean Disposal Limit
italics values indicate detections limits grater than guideline.

APPENDIX V
Table V-1: Summary of Ladysmith Harbour Surface Sediment Bulk Chemistry Data
2009-2010

Sample ID CANTEST/Maxxam ID Sample Location Date Sampled QAQC	Units	CCME Marine Sediment Guideline ISQG [a]	CCME Marine Sediment Guideline PEL [b]	BC CSR Marine Sediment Criteria [c]	Ocean Disposal Lower Action Limits [d]	16743-05 910300451 23A 10/20/2009	16743-08 910300470 24A 10/20/2009	16749-04 910300507 25A 10/21/2009	16739-06 910300429 26A 10/19/2009	16749-11 910300519 27A 10/22/2009	16746-06 910300497 28A 10/21/2009	16749-10 910300518 29A 10/22/2009	16739-09 910300436 30A 10/19/2009	16749-07 910300512 31A 10/22/2009	16749-08 910300513 32A 10/22/2009	16743-02 910300440 33A 10/20/2009	16749-09 910300517 34A 10/22/2009	16743-01 910300438 35A 10/20/2009	16746-05 910300496 36R 10/21/2009	16746-07 910300498 37R 10/21/2009	16746-03 910300493 38R 10/21/2009 FDA	16746-04 910300494 38R 10/21/2009 FD	16746-08 910300499 39R 10/21/2009	16746-09 910300500 40R 10/21/2009	0086-01 SEDIMENT Z18215 2010-10 12/15/2010	0086-02 SEDIMENT Z18216 2010-11 12/15/2010	0086-03 SEDIMENT Z18217 2010-13 12/15/2010	0086-04 SEDIMENT Z18218 2010-09 12/15/2010	0086-05 SEDIMENT Z18219 2010-08 12/15/2010	0086-06 SEDIMENT Z18220 2010-07 12/15/2010
Parameter																													
General Parameters																													
Sand >0.053 mm	%					78.94	85.03	50.6	95.09	90.99	85.15	92.32	85.63	84.11	86.47	89.18	57.18	81.37	95.13	49.81	81.48	80.65	25.7	67.36	61.69	67.27	91.99	30.25	23.8	47.02
Silt <0.053 mm & >0.002 mm	%					15.14	10.91	31.12	2.7	5.63	8.63	4.45	8.86	10.02	9.29	7.39	29.27	13.99	3.22	36.05	13.38	13.34	50.71	20.84	29.35	22.16	6.42	47.43	51.69	35.79
Clay <0.002 mm	%					5.92	4.06	18.28	2.21	3.38	6.22	3.23	5.51	5.87	4.24	3.43	13.54	4.64	1.65	14.14	5.15	6.01	23.58	11.79	8.96	10.57	1.6	22.32	24.52	17.19
Moisture	%					16.7	20.8	59	16.3	24.4	39.5	22.7	32.9	27.4	22.5	20.3	59	27	14.8	50	31.1	27.5	60.7	46.7	74	71	27	72	73	69
Total Organic Carbon	% dry wt.					6.03	6.03	8.91	1.23	2.35	2.96	3.17	1.65	9.8	9.42	3.43	9.52	10.1	1.12	3.43	1.76	1.88	3.91	4.31	15	10	1.85	13	16	19
pH	pH units					7.8	8.3	6.9	7.6	7.4	7.1	7.6	7.3	7.2	7.2	8.3	6.7	7.7	7.3	7.2	6.7	7	6.8	7.2	7.64	7.39	7.83	7.33	7.33	7.62
Acid Volatile Sulphide (AVS)	umoles/gram					16.30	0.20	2.80	1.00	0.20	1.90	1.10	0.70	0.60	0.40	0.20	2.20	1.00	1.60	3.20	0.20	0.20	3.20	1.8	11.60	14.70	2.04	7.20	9.30	12.60
Simultaneously Extractable Metals (SEM)	umoles/gram					0.06	0.15	0.17	0.08	0.06	0.07	0.06	0.05	0.07	0.09	0.18	0.18	0.10	0.05	0.23	0.06	0.06	0.21	0.092	0.26	0.23	1.16	0.25	0.40	0.26
SEM:AVS [e]	umoles/gram					0.00	0.74	0.06	0.08	0.28	0.04	0.06	0.08	0.11	0.22	0.90	0.08	0.10	0.03	0.07	0.32	0.32	0.07	0.051	0.02	0.02	0.57	0.04	0.04	0.02
AVS-SEM [e]	umoles/gram					16.24	0.05	2.63	0.92	0.14	1.83	1.04	0.65	0.53	0.31	0.02	2.02	0.90	1.55	2.97	0.43	0.14	2.99	1.71	11.34	14.47	0.88	6.95	8.90	12.34
Metals																													
Aluminum	ug/g					3030	5850	6950	6780	5660	5820	5460	6480	5570	5950	5180	6320	5800	5920	7440	5400	4730	8280	6090	6520	8800	9590	11300	10400	10400
Antimony	ug/g					< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.3	0.4	0.4	0.5	0.5	0.5
Arsenic	ug/g	**7.24**	**41.6**	**50**		2.5	2.7	**9.5**	4.3	5.2	**10.3**	4.6	5.2	3	3.6	2.1	**9.3**	4.3	4.3	7	5.6	4.8	**10.1**	**7.8**	**9.4**	**10.9**	4	**12.2**	**12.9**	**11.2**
Barium	ug/g					36	91	42	26	21	24	20	22	56	53	63	28	67	14	27	17	19	31	24	26.2	30.9	33	47.5	42.2	51.2
Beryllium	ug/g					< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	0.2	0.1	0.1	0.3	0.2	0.3
Boron	ug/g					46	20	57	8	14	57	12	27	27	20	19	81	27	6	29	17	15	38	39						
Cadmium	ug/g	**0.7**	**4.2**	**5**	**0.6**	< 0.2	< 0.2	**2.3**	0.3	**0.9**	**1.7**	**0.9**	**1.4**	0.2	0.3	< 0.2	**1.9**	0.3	**0.9**	**3.2**	**3.7**	**3.5**	**3.7**	**3**	**2.76**	**2.62**	0.34	**3.7**	**3.72**	**3.25**
Calcium	ug/g					7890	18300	5280	4550	3440	5040	3410	4580	7820	7260	6960	3890	9660	3790	5830	3980	3640	4230	4580	60500	13100	5920	6590	6930	9140
Chromium	ug/g	**52.3**	**160**	**190**		14	24	26	14	12	16	13	14	24	22	25	19	21	10	18	12	11	23	15	19	21	15	27	26	27
Cobalt	ug/g					3	4	5	5	4	4	4	4	4	4	4	4	4	4	4	3	3	4	3	3.3	4.3	4.8	5.1	4.7	5.1
Copper	ug/g	**18.7**	**108**	**130**		**38**	**46**	**67**	**29**	**20**	**30**	18	**24**	**39**	**43**	**47**	**61**	**44**	17	**38**	**20**	**19**	**56**	**35**	**65.3**	**105**	**43.5**	**72.9**	**79.1**	**73.6**
Iron	ug/g					3280	7680	11600	11700	9800	11600	9140	9320	7010	7550	6070	9820	7440	8950	11800	8060	7450	13900	11000	13600	16700	13800	17500	16500	16300
Lead	ug/g	**30.2**	**112**	**130**		8.9	8.4	18.4	3.1	3.3	7.7	2.9	5	9.3	7.9	8.3	11.4	10.7	1.6	9.5	3.7	3.4	13.3	7.6	22.5	25.5	24.7	20.1	23.2	21.5
Magnesium	ug/g					2430	3550	5430	4180	3850	5050	3660	4170	3580	3520	3140	5150	3410	3470	4760	3220	3040	5970	4380	6990	7320	4700	7780	7580	6970
Manganese	ug/g					44	169	117	145	121	111	113	112	103	97	92	98	97	121	119	91	87	133	110	108	140	152	154	137	142
Mercury	ug/g	**0.13**	**0.7**	**0.84**	**0.75**	**0.22**	**0.3**	**0.33**	0.05	0.07	0.12	0.06	0.09	**0.25**	**0.2**	**0.24**	**0.26**	**0.17**	0.04	**0.15**	0.08	0.07	**0.22**	**0.15**	**0.51**	**0.23**	0.08	**0.26**	**0.25**	**0.29**
Molybdenum	ug/g					1	0.5	7.5	0.9	2.6	4.7	2	2.4	1.5	1.1	0.4	16.1	1	1.1	4.5	3	2.6	6.6	7.5	12.3	10.8	1.4	9.9	13.1	8.9
Nickel	ug/g					15	26	23	11	11	13	11	12	25	24	25	18	21	9	14	9	9	18	13	15.2	16.1	12.2	21.5	19.9	21.2
Phosphorus	ug/g					351	191	528	415	374	647	376	447	255	238	180	442	283	442	648	863	725	673	769	625	701	423	730	714	671
Potassium	ug/g					671	945	1360	547	620	984	610	848	984	1050	841	1250	1140	484	1140	717	701	1490	1020	1800	1790	824	2050	2010	1930
Selenium	ug/g					0.6	0.6	1.3	0.3	0.4	1.2	0.4	0.5	0.9	0.6	0.8	1.4	0.6	0.4	1	0.8	0.7	1.4	1.2	1.2	1.6	<0.5	1.8	2.4	1.8
Silver	ug/g					< 0.1	< 0.1	0.2	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	0.2	< 0.1	< 0.1	0.2	< 0.1	< 0.1	0.3	0.2	0.18	0.26	0.09	0.29	0.26	0.26
Sodium	ug/g					5100	2930	11300	2050	3530	9170	3540	7470	3340	3330	2330	12400	4440	2140	10100	5690	5980	14400	10100	24100	22400	3130	20600	20900	18100
Strontium	ug/g					159	102	70	19	22	44	21	35	83	68	82	50	86	18	44	27	25	43	37	216	83.2	44.4	63.8	64.8	74.2
Thallium	ug/g					< 0.1	< 0.1	0.2	0.3	0.5	0.4	0.5	0.4	< 0.1	< 0.1	< 0.1	0.1	< 0.1	0.6	0.4	0.6	0.6	0.3	0.5	0.28	0.32	0.2	0.36	0.39	0.3
Tin	ug/g					< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	3	2.4	1.6	1.7	1.9	1.5
Titanium	ug/g					180	73	280	517	504	477	455	454	131	83	103	194	144	587	410	330	305	361	416	263	533	885	525	436	394
Vanadium	ug/g					22	23	33	25	22	29	21	22	25	23	22	32	26	21	25	18	16	29	25	34	40	35	45	44	42
Zinc	ug/g	**124**	**271**	**330**		26	53	106	36	31	48	28	37	40	46	35	77	42	23	70	40	39	94	62	**171**	**168**	63	**132**	**163**	124
Zirconium	ug/g					5	6	6	2	2	3	2	2	8	6	6	6	7	< 1	2	1	1	3	2	1.4	3.7	2.1	2.2	2	1.7
Hydrocarbons																													
F1-BTEX																									<60	<50	<10	<50	<60	<50
F2-Napth (C10-C16)	ug/g					230	210	95	< 70	< 70	< 70	< 70	< 70	180	180	220	90	220	< 70	< 70	< 70	< 70	< 70	< 70						
F2 (C10-C16) uncorrected	ug/g					230	210	95	< 70	< 70	< 70	< 70	< 70	180	180	220	90	220	< 70	< 70	< 70	< 70	< 70	< 70	68	61	23	100	130	150
F3-PAH (C16-C34)	ug/g					830	560	330	< 100	130	120	< 100	210	400	510	520	380	540	< 100	140	< 100	110	160	230						
F3 (C16-C34) uncorrected	ug/g					830	560	330	< 100	130	120	< 100	210	400	510	520	380	540	< 100	140	< 100	110	160	230	500	470	170	550	700	610
F4 (C34-C50)	ug/g					< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	< 500	140	150	110	140	240	160
Polycyclic Aromatic Hydrocarbons																														
Acenaphthene	ug/g	**0.00671**	**0.0889**	**0.11**		**0.25**	< 0.005	**0.08**	**0.074**	**0.02**	**0.017**	< 0.005	**0.015**	**0.16**	< 0.005	**0.082**	< 0.005	**0.093**	< 0.005	**0.012**	< 0.005	< 0.005	**0.026**	**0.017**	**0.1**	**0.1**	0.027	**0.18**	**0.29**	**0.34**
Acenaphthylene	ug/g	**0.00587**	**0.128**	**0.15**		< 0.005	< 0.005	< 0.005	**0.039**	< 0.005	< 0.005	< 0.005	**0.012**	< 0.005	< 0.005	**0.11**	< 0.005	**0.13**	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	*<0.08*	*<0.07*	*<0.04*	*<0.08*	*<0.1*	*<0.2*
Anthracene	ug/g	**0.0469**	**0.245**	**0.29**		**0.51**	**0.33**	**0.18**	**0.13**	0.04	0.03	< 0.01	0.03	**0.34**	**0.37**	**0.24**	**0.13**	**0.37**	< 0.01	0.01	< 0.01	< 0.01	0.03	0.03	**0.3**	**0.31**	**0.068**	**0.33**	**0.58**	**0.49**
Benzo(a)anthracene	ug/g	**0.0748**	**0.693**	**0.83**		**0.5**	**0.39**	**0.22**	**0.14**	0.04	0.03	< 0.01	0.03	**0.31**	**0.32**	**0.27**	**0.15**	**0.49**	< 0.01	0.01	0.02	< 0.01	0.02	0.07	**0.3**	**0.35**	**0.14**	**0.34**	**0.66**	**0.54**
Benzo(a)pyrene	ug/g	**0.0888**	**0.763**	**0.92**		**0.23**	**0.19**	**0.12**	0.06	0.02	0.01	< 0.01	0.01	**0.12**	< 0.01	**0.11**	0.07	**0.27**	< 0.01	< 0.01	< 0.01	< 0.01	0.01	0.05	**0.21**	**0.23**	**0.15**	**0.21**	**0.39**	**0.32**
Benzo(b)fluoranthene	ug/g					0.3	0.21	0.22	0.16	0.04	0.03	< 0.01	0.03	0.17	0.21	0.14	0.11	0.38	0.01	< 0.01	< 0.01	< 0.01	0.03	0.07	0.36	0.38	0.16	0.3	0.58	0.39
Benzo(g,h,i)perylene	ug/g					0.16	0.1	0.06	0.03	0.02	< 0.01	< 0.01	0.01	0.07	0.12	0.09	0.05	0.18	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.15	0.17	0.15	0.17	0.26	0.26
Benzo(k)fluoranthene	ug/g					0.05	0.04	0.07	0.06	0.01	< 0.01	< 0.01	0.01	0.14	0.07	0.03	0.02	0.11	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.03	0.24	0.27	0.11	0.2	0.42	0.28
Chrysene	ug/g	**0.108**	**0.846**	**1**		**0.62**	**0.46**	**0.3**	**0.41**	0.05	0.05	< 0.01	0.04	**0.37**	**0.42**	**0.27**	**0.17**	**0.53**	0.01	0.01	0.01	< 0.01	0.03	0.09	**0.46**	**0.43**	**0.19**	**0.42**	**0.74**	**0.66**
Dibenz(a,h)anthracene	ug/g	**0.00622**	**0.135**	**0.16**		< 0.005	**0.023**	**0.017**	**0.007**	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	**0.024**	**0.013**	**0.048**	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	**0.007**	**0.04**	**0.04**	**0.03**	**0.05**	**0.07**	**0.07**
Fluoranthene	ug/g	**0.113**	**1.494**	**1.8**		**0.81**	**0.38**	**0.42**	**1.3**	0.09	0.11	0.02	0.08	**0.48**	**0.46**	**0.17**	**0.22**	**0.91**	0.05	0.05	0.03	0.02	0.1	**0.12**	**1.1**	**0.94**	**0.41**	**1.1**	**1.6**	**1.6**
Fluorene	ug/g	**0.0212**	**0.144**	**0.17**		**0.53**	< 0.01	**0.16**	**0.1**	< 0.01	**0.03**	< 0.01	**0.03**	**0.37**	< 0.01	**0.23**	< 0.01	**0.23**	< 0.01	0.02	< 0.01	< 0.01	**0.03**	**0.03**	**0.17**	**0.16**	**0.05**	**0.26**	**0.43**	**0.56**
Indeno(1,2,3-cd)pyrene	ug/g					< 0.01	0.04	0.07	0.04	0.01	< 0.01	< 0.01	< 0.01	0.03	< 0.01	0.04	0.03	0.14	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.03	0.11	0.12	0.1	0.1	0.18	0.13
Methylnaphthalene (2-)	ug/g	**0.0202**	**0.201**			**5**	**3.7**	**1.3**	**0.1**	**0.24**	**0.16**	0.02	**0.15**	**3.9**	**3.9**	**2.1**	**1.5**	**2.2**	< 0.02	**0.05**	**0.04**	**0.03**	**0.09**	**0.1**	**0.55**	**0.64**	**0.29**	**1.1**	**1.4**	**2.6**
Naphthalene	ug/g	**0.0346**	**0.391**	**0.47**		**1.9**	**1.4**	**0.66**	**0.07**	**0.11**	**0.07**	< 0.01	**0.07**	**1.4**	**1.5**	**0.87**	**0.67**	**0.96**	< 0.01	0.03	0.02	0.02	**0.06**	**0.05**	**0.25**	**0.31**	**0.14**	**0.48**	**0.65**	**1.1**
Phenanthrene	ug/g	**0.0867**	**0.544**	**0.65**		**3.2**	**2.6**	**1**	**0.8**	**0.21**	**0.15**	0.02	**0.16**	**2.8**	**2.8**	**2.1**	**0.98**	**2.4**	< 0.01	0.06	0.04	0.03	**0.12**	**0.09**	**0.86**	**0.72**	**0.31**	**1.2**	**1.5**	**2.4**
Pyrene	ug/g	**0.153**	**1.398**	**1.7**		**0.79**	**0.47**	**0.4**	**0.76**	0.09	0.09	0.04	0.07	**0.53**	**0.51**	**0.25**	**0.24**	**0.81**	0.04	0.04	0.03	0.02	0.08	0.09	**1.3**	**1.2**	**0.4**	**0.94**	**2**	**1.3**
Total HMW-PAH's	ug/g					3.46	2.3	1.89	2.96	0.37	0.32	0.06	0.28	2.23	2.11	1.39	1.08	3.88	0.12	0.11	0.09	0.04	0.35	0.57	2.2	2.2	0.88	3.6	4.8	7.5
Total LMW-PAH's	ug/g					11.4	8.03	3.38	1.31	0.38	0.45	0.04	0.46	8.97	8.57	5.74	3.27	6.39	-	0.19	0.1	0.08	0.35	0.31	4.2	4.1	1.8	3.9	6.9	5.5
Total PAH's	ug/g			**20**	**2.5**	**14.9**	**10.3**	**5.28**	**4.27**	0.75	0.77	0.1	0.74	**11.2**	**10.7**	**7.13**	**4.36**	**10.3**	0.12	0.3	0.19	0.13	0.64	0.88	**6.4**	**6.4**	**2.7**	**7.4**	**12**	**13**

Notes:

a - Canadian Council of Ministers of the Environment (CCME) Interim Maine Sediment Quality Guidelines (ISQG); CCME 2001
b - Canadian Council of Ministers of the Environment (CCME) Probable Effect Levels; CCME 2001
c - British Columbia Contaminated Sites Regulations (BC CSR) Typical Marine Sediment Criteria (BC CSR 2011)
d - Environment Canada Disposal at Sea Program; Lower Action Limits, Environment Canada 2011
e - the relationship between AVS and SEM is expressed both as a ratio (value exceeding 1 indicates excess of metals) and as a difference (value exceeding 0 indicates an excess of metals).
FDA: Field duplicate available, FD: Field duplicate

Bold and underlined values are equal to or exceed the CCME Marine Sediment Guideline ISQG
Bold and outlined values are equal to or exceed the CCME Marine Sediment Guideline PEL
Bold, yellow highlighted and outlined values are equal to or exceed the BC CSR Marine Sediment Criteria
Bold and blue highlighted values are equal to or exceed the Ocean Disposal Limit
italics values indicate detections limits grater than guideline.

APPENDIX V
Table V-2: Summary of Ladysmith Harbour Sediment Core Bulk Chemistry Data
2010 - 2011

Parameter / Sample Location / Depth (mbgs) / Sample ID / Maxxam Sample ID / Date Sampled / QAQC	Units	CCME Marine Sediment Guideline ISQG [a]	CCME Marine Sediment Guideline PEL [b]	BC CSR Marine Sediment Criteria [c]	Ocean Disposal Lower Action Limits [d]	2010-09 0 - 0.3 21774-01 Z15990 12/16/2010	2010-09 0.4 - 0.6 21774-02 Z15991 12/16/2010	2010-09 0.7 - 0.775 21774-03 Z15992 12/16/2010	2010-07 0 - 0.06 21774-06 Z15995 12/16/2010	2010-07 0.45 - 0.55 21774-07 Z15996 12/16/2010	2010-07 0.95 - 1.05 21774-08 Z15997 12/16/2010	2010-13 0 - 0.1 21774-12 Z16001 12/17/2010	2010-13 0.45 - 0.55 21775-01 Z16002 12/17/2010
General Parameters													
% sand by hydrometer	%					-	28	31	-	59	60	-	44
% silt by hydrometer	%					-	38	21	-	16	<2	-	2
Clay Content	%					-	20	14	-	6	3	-	3
Gravel	%					-	15	34	-	19	36	-	51
Moisture	%					76	73	75	56	36	27	24	12
Total Organic Carbon	% dry wt.					19	17	21	19	16	9.7	1.5	0.88
pH	pH units					7.08	7.64	7.38	7.63	7.97	8.22	8.13	8.64
Acid Volatile Sulphide (AVS)	umole/g					28.50			51.00			1.18	
Simultaneously Extractable Metals (SEM)	umole/g					2.36			66.68			1.25	
SEM:AVS [e]	umole/g					0.08			1.32			1.06	
AVS-SEM [e]	umole/g					26.14			-15.68			-0.07	
Total Metals													
Aluminum	ug/g					11400	8260	8140	8890	5830	6890	9970	10200
Antimony	ug/g					0.4	0.3	0.3	0.9	0.7	1.2	0.3	0.2
Arsenic	ug/g	**7.24**	**41.6**	**50**		**7.3**	5.2	4.2	**16.2**	**9.6**	**11.5**	3.1	3.6
Barium	ug/g					48.0	37.0	38.2	52.2	69.7	48.0	27.8	17.9
Beryllium	ug/g					0.1	0.1	0.1	0.3	0.2	0.3	0.1	0.1
Boron	ug/g					0.2	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	ug/g	**0.7**	**4.2**	**5**	**0.6**	**3.08**	**2.21**	**1.86**	**3.53**	**1.35**	**0.82**	0.30	0.27
Calcium	ug/g					9290	13300	17400	9850	10800	74800	5570	11900
Chromium	ug/g	**52.3**	**160**	**190**		27	19	18	34	25	39	16	15
Cobalt	ug/g					5.4	3.9	3.5	5.8	5.1	7.1	5.1	5.2
Copper	ug/g	**18.7**	**108**	**130**		**77.9**	**52.3**	**49.7**	**82.3**	**55.7**	**82.2**	**31.4**	**26.0**
Iron	ug/g					16900	13600	11300	32500	23900	42700	13700	13900
Lead	ug/g	**30.2**	**112**	**130**		25.7	15.6	17.1	23.2	14.0	12.9	20.0	5.4
Magnesium	ug/g					9020	6100	6970	7040	4030	4950	4800	5240
Manganese	ug/g					164	118	108	144	93.5	160	169	173
Mercury	ug/g	**0.13**	**0.7**	**0.84**	**0.75**	**0.28**	**0.27**	**0.26**	**0.26**	**0.31**	**0.24**	**0.20**	0.11
Molybdenum	ug/g					24.5	12.4	18.1	11.4	5.8	5.5	1.4	1.0
Nickel	ug/g					22.0	15.3	14.1	26.7	20.9	36.6	12.5	12.8
Phosphorus	ug/g					663	503	466	679	482	450	368	380
Potassium	ug/g					2340	1610	1740	1660	975	1340	695	786
Selenium	ug/g					1.7	1.1	1.0	1.3	0.9	0.6	<0.5	<0.5
Silver	ug/g					0.28	0.15	0.21	0.21	0.08	0.09	0.06	<0.05
Sodium	ug/g					29000	17300	21300	13200	5480	4440	2560	2040
Strontium	ug/g					84.0	74.7	87.4	102	128	518	31.1	51.6
Thallium	ug/g					0.34	0.23	0.23	0.24	0.11	0.14	0.19	0.24
Tin	ug/g					2.0	1.5	1.6	3.2	2.5	4.6	1.6	0.6
Titanium	ug/g					467	409	439	326	133	56	992	1010
Vanadium	ug/g					51	36	38	46	34	28	39	37
Zinc	ug/g	**124**	**271**	**330**		**176**	119	**125**	**4920**	**2970**	**2880**	61	33
Zirconium	ug/g					2.9	2.9	2.3	2.2	0.9	1.0	2.2	2.4

APPENDIX V
Table V-2: Summary of Ladysmith Harbour Sediment Core Bulk Chemistry Data
2010 - 2011

Parameter / Sample Location / Depth (mbgs) / Sample ID / Maxxam Sample ID / Date Sampled / QAQC	Units	CCME Marine Sediment Guideline ISQG [a]	CCME Marine Sediment Guideline PEL [b]	BC CSR Marine Sediment Criteria [c]	Ocean Disposal Lower Action Limits [d]	2010-09 0 - 0.3 21774-01 Z15990 12/16/2010	2010-09 0.4 - 0.6 21774-02 Z15991 12/16/2010	2010-09 0.7 - 0.775 21774-03 Z15992 12/16/2010	2010-07 0 - 0.06 21774-06 Z15995 12/16/2010	2010-07 0.45 - 0.55 21774-07 Z15996 12/16/2010	2010-07 0.95 - 1.05 21774-08 Z15997 12/16/2010	2010-13 0 - 0.1 21774-12 Z16001 12/17/2010	2010-13 0.45 - 0.55 21775-01 Z16002 12/17/2010
Monoaromatic Hydrocarbons													
Benzene	ug/g			2.5 [f]		<0.03	<0.03	<0.03	<0.02	<0.005	<0.02	<0.005	<0.005
Ethylbenzene	ug/g			7 000 [f]		<0.03	<0.03	<0.03	0.03	0.02	0.05	<0.01	<0.01
Methyl-tert-butylether (MTBE)	ug/g			320 [g]		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Styrene	ug/g					<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toluene	ug/g			350 [f]		0.11	0.07	0.10	0.09	0.06	0.10	<0.02	<0.02
m & p-Xylene	ug/g					<0.04	<0.04	<0.04	0.09	0.08	0.22	<0.04	<0.04
o-Xylene	ug/g					<0.04	<0.04	<0.04	0.05	0.05	0.13	<0.04	<0.04
Xylenes (Total)	ug/g					<0.04	<0.04	<0.04	0.14	0.12	0.35	<0.04	<0.04
VH6-10	ug/g					<60	<60	<60	<30	<10	16	<10	<10
Volatile F1-BTEX and CCME Hydrocarbons													
F1 (C6-C10) - BTEX	ug/g		320 [h]			<60	<60	<60	<30	<10	16	<10	<10
F2 (C10-C16 Hydrocarbons)	ug/g		260 [h]			120	100	77	160	270	170	19	<10
F3 (C16-C34 Hydrocarbons)	ug/g		1700 [h]			680	510	450	580	810	310	140	15
F4 (C34-C50 Hydrocarbons)	ug/g		3300 [h]			170	180	120	200	180	62	110	<10
Polycyclic Aromatic Hydrocarbons													
Acenaphthene	ug/g	0.00671	0.0889	0.11		0.16	0.15	0.07	0.31	0.57	0.2	0.015	0.008
Acenaphthylene	ug/g	0.00587	0.128	0.15		*<0.1*	*<0.08*	*<0.06*	*<0.2*	*<0.5*	*<0.2*	*<0.04*	*<0.02*
Anthracene	ug/g	0.0469	0.245	0.29		0.27	0.25	0.13	0.52	1.1	0.35	0.052	0.029
Benzo(a)anthracene	ug/g	0.0748	0.693	0.83		0.34	0.31	0.18	0.62	1.1	0.44	0.10	0.066
Benzo(a)pyrene	ug/g	0.0888	0.763	0.92		*<0.2*	*<0.2*	*<0.1*	*<0.4*	*<0.5*	*<0.2*	0.10	0.079
Benzo(b&j)fluoranthene						0.35	0.31	0.19	0.50	0.71	0.28	0.14	0.093
Benzo(g,h,i)perylene	ug/g					0.19	0.16	0.11	0.30	0.49	0.18	0.079	0.064
Benzo(k)fluoranthene	ug/g					0.08	0.068	0.05	0.15	0.21	0.052	0.045	0.020
Chrysene	ug/g	0.108	0.846	1		0.40	0.23	0.15	0.54	1.2	0.42	0.11	0.081
Dibenz(a,h)anthracene	ug/g	0.00622	0.135	0.16		*<0.03*	*<0.03*	*<0.03*	*<0.06*	*<0.2*	*<0.04*	0.015	0.008
Fluoranthene	ug/g	0.113	1.494	1.8		0.91	0.84	0.48	1.3	1.7	0.63	0.25	0.17
Fluorene	ug/g	0.0212	0.144	0.17		0.28	0.26	0.14	0.71	1.5	*<0.5*	0.037	0.017
Indeno(1,2,3-cd)pyrene	ug/g					0.13	0.09	0.07	0.16	0.24	0.07	0.080	0.058
2-Methylnaphthalene	ug/g	0.0202	0.201			1.2	1.1	0.63	3.8	9.6	4.4	0.23	0.063
Naphthalene	ug/g	0.0346	0.391	0.47		0.57	0.54	0.29	1.8	4.6	2.0	0.087	0.040
10/7/2011	ug/g	0.0867	0.544	0.65		1.1	1	0.61	3.1	7.1	2.8	0.22	0.16
Pyrene	ug/g	0.153	1.398	1.7		0.73	0.68	0.41	1.1	1.7	0.60	0.23	0.20
Total HMW-PAH's	ug/g					3.1	2.7	1.6	4.7	7.4	2.7	1.2	0.84
Total LMW-PAH's	ug/g					3.6	3.4	1.9	10	24	9.7	0.64	0.32
Total PAH's	ug/g			20	2.5	6.7	6.1	3.5	15	32	12	1.8	1.2

Notes:
a - Canadian Council of Ministers of the Environment (CCME) Interim Maine Sediment Quality Guidelines (ISQG); CCME 2001
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d - Environment Canada Disposal at Sea Program; Lower Action Limits, Environment Canada 2011

e - the relationship between AVS and SEM is expressed both as a ratio (value exceeding 1 indicates excess of metals) and as a difference (value exceeding 0 indicates an excess of metals).
f- CSR - Contaminated Sites Regurlation, Schedule 5 (Soil Standards). Ministry of the Environment British Columbia
g - CSR - Contaminated Sites Regurlation, Schedule 10 (Soil Standards). Agricultural, Urban Park, Residential Soil Standard. Ministry of the Environment British Columbia
h - CCME - Canadian Wide Standards for Petroleum Hydrocarbons (PHC) in soil. Tier I guideline (lowest guideline) for industrial use in coarse-grained soil was used
FDA: Field duplicate available, FD: Field duplicate

Bold and underlined values are equal to or exceed the CCME Marine Sediment Guideline ISQG
Bold and outlined values are equal to or exceed the CCME Marine Sediment Guideline PEL
Bold, yellow highlighted and outlined values are equal to or exceed the BC CSR Marine Sediment Criteria
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italics values indicate detections limits grater than guideline.

APPENDIX V
Table V-2: Summary of Ladysmith Harbour Sediment Core Bulk Chemistry Data
2010 - 2011

Parameter / Sample Location	2010-13	2010-13	2010-13	2010-12	2010-12	2010-12	2010-12	2010-12	2010-8	2010-8	2010-8	2010-8
Depth (mbgs)	0.95 - 1.05	0.95 - 1.05	1.45 - 1.55	0 - 0.15	0.45 - 0.55	0.95 - 1.05	0.95 - 1.05	1.2 - 1.3	0 - 0.1	0.45 - 0.55	0.95 - 1.05	1.45 - 1.56
Sample ID	21775-02	21775-03	21775-04	21775-09	21775-10	21775-11	21775-12	21776-01	21776-02	21776-03	21776-04	21776-05
Maxxam Sample ID	Z16003	Z16004	Z16005	Z16010	Z16011	Z16012	Z16013	Z16018	Z16019	Z16020	Z16021	Z16022
Date Sampled	12/17/2010	12/17/2010	12/17/2010	12/16/2010	12/16/2010	12/16/2010	12/17/2010	12/16/2010	12/17/2010	12/17/2010	12/17/2010	12/17/2010
QAQC	FDA	FD				FDA	FD					
General Parameters												
% sand by hydrometer	81	80	81	-	80	75	79	51	-	65	34	45
% silt by hydrometer	12	13	13	-	7	3	3	2	-	22	39	28
Clay Content	4	4	4	-	4	<2	<2	<2	-	8	14	10
Gravel	3	4	3	-	9	21	16	46	-	5	14	16
Moisture	18	17	16	63	31	14	14	13	74	72	75	69
Total Organic Carbon	0.16	0.18	0.38	8.1	3.6	0.41	0.32	0.13	18	20	25	27
pH	8.66	8.66	8.32	7.39	8.03	8.6	8	8.89	7.41	7.33	7.02	7.09
Acid Volatile Sulphide (AVS)				11.40					28.00			
Simultaneously Extractable Metals (SEM)				1.39					2.69			
SEM:AVS [e]				0.12					0.10			
AVS-SEM [e]				10.01					25.31			
Total Metals												
Aluminum	9950	9750	10700	8690	8950	9340	8500	9100	9870	9620	7270	7520
Antimony	<0.1	<0.1	<0.1	0.3	0.1	0.1	0.2	0.1	0.4	0.6	0.3	0.2
Arsenic	3.0	2.9	3.1	7.0	2.1	2.3	2.0	2.4	**11.2**	**10.3**	4.1	2.8
Barium	14.1	14.6	16.4	29.1	29.7	21.4	12.6	15.1	44.2	43.3	30.8	39.9
Beryllium	<0.1	<0.1	0.1	0.1	<0.1	<0.1	0.1	0.1	0.2	0.3	0.1	<0.1
Boron	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.2	0.2	0.2
Cadmium	0.26	0.25	0.14	**1.45**	**0.75**	0.49	0.33	0.06	**3.63**	**3.19**	**1.96**	**1.55**
Calcium	13000	12300	7840	7910	10500	5540	4890	11400	12000	5190	4400	5420
Chromium	14	14	15	19	14	16	15	16	25	25	17	16
Cobalt	4.9	4.9	5.5	4.4	4.3	5.1	5.0	5.1	5.0	4.8	3.5	3.9
Copper	16.2	15.7	17.1	**45.7**	**28.4**	18.1	15.9	16.2	**79.9**	**67.9**	**50.2**	**49.3**
Iron	14300	14000	15300	12800	10700	12500	11000	12800	15600	16100	10400	9540
Lead	1.1	1.0	1.2	13.1	6.5	1.0	0.9	1.1	24.7	22.8	19.8	14.8
Magnesium	4690	4650	5030	5900	4580	5210	4740	4960	7870	7110	6920	6490
Manganese	169	164	178	133	141	197	163	184	139	137	99.6	103
Mercury	0.07	0.08	0.07	**0.16**	**0.19**	0.07	<0.05	<0.05	**0.29**	**0.23**	**0.19**	**0.28**
Molybdenum	1.8	1.9	1.6	6.7	3.0	0.5	0.4	0.3	13.6	20.0	17.4	13.2
Nickel	11.3	10.9	11.4	14.5	11.6	12.6	11.5	12.2	20.2	20.0	13.8	15.3
Phosphorus	434	426	305	536	442	365	346	374	702	634	457	426
Potassium	663	601	624	1150	704	614	554	706	2120	1870	1740	1540
Selenium	<0.5	<0.5	<0.5	0.8	<0.5	<0.5	0.5	<0.5	1.8	1.1	1.0	1.0
Silver	<0.05	<0.05	<0.05	0.15	0.06	<0.05	<0.05	<0.05	0.23	0.22	0.19	0.21
Sodium	2290	2100	2160	12000	3740	1750	2110	1680	25300	19900	26100	20000
Strontium	55.5	48.5	34.9	57.1	43.9	22.8	21.3	71.5	85.1	65.8	61.9	76.9
Thallium	0.21	0.21	0.12	0.26	0.25	0.26	0.27	0.07	0.37	0.33	0.25	0.18
Tin	0.2	0.2	0.2	1.6	0.9	0.2	0.1	0.2	2.1	2.1	1.7	1.8
Titanium	1080	1060	1150	707	972	1020	1030	978	370	408	280	265
Vanadium	40	38	45	37	35	36	35	37	45	48	39	40
Zinc	23	23	23	98	47	26	24	26	**170**	**151**	**163**	109
Zirconium	2.3	2.3	2.8	2.6	2.6	2.3	2.1	2.2	2.4	2.7	2.5	2.8

APPENDIX V
Table V-2: Summary of Ladysmith Harbour Sediment Core Bulk Chemistry Data
2010 - 2011

Parameter	QAQC	Sample Location	2010-13	2010-13	2010-13	2010-12	2010-12	2010-12	2010-12	2010-12	2010-8	2010-8	2010-8	2010-8
		Depth (mbgs)	0.95 - 1.05	0.95 - 1.05	1.45 - 1.55	0 - 0.15	0.45 - 0.55	0.95 - 1.05	0.95 - 1.05	1.2 - 1.3	0 - 0.1	0.45 - 0.55	0.95 - 1.05	1.45 - 1.56
		Sample ID	21775-02	21775-03	21775-04	21775-09	21775-10	21775-11	21775-12	21776-01	21776-02	21776-03	21776-04	21776-05
		Maxxam Sample ID	Z16003	Z16004	Z16005	Z16010	Z16011	Z16012	Z16013	Z16018	Z16019	Z16020	Z16021	Z16022
		Date Sampled	12/17/2010	12/17/2010	12/17/2010	12/16/2010	12/16/2010	12/16/2010	12/17/2010	12/16/2010	12/17/2010	12/17/2010	12/17/2010	12/17/2010
		QAQC	FDA	FD				FDA	FD					
Monoaromatic Hydrocarbons														
Benzene			<0.005	<0.005	<0.005	<0.02	<0.005	<0.005	<0.005	<0.005	<0.03	<0.03	<0.03	<0.02
Ethylbenzene			<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.03	<0.02
Methyl-tert-butylether (MTBE)			<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Styrene			<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Toluene			<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.08	0.07	0.07	0.08
m & p-Xylene			<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	0.05
o-Xylene			<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.06
Xylenes (Total)			<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	0.10
VH6-10			<10	<10	<10	<40	<10	<10	<10	<10	<60	<50	<60	<50
Volatile F1-BTEX and CCME Hydrocarbons														
F1 (C6-C10) - BTEX			<10	<10	<10	<40	<10	<10	<10	<10	<60	<50	<60	<50
F2 (C10-C16 Hydrocarbons)			<10	<10	<10	56	35	<10	<10	<10	130	120	170	170
F3 (C16-C34 Hydrocarbons)			<10	40	<10	330	170	20	<10	<10	650	710	870	790
F4 (C34-C50 Hydrocarbons)			<10	<10	<10	120	51	<10	<10	<10	150	180	210	230
Polycyclic Aromatic Hydrocarbons														
Acenaphthene			<0.001	<0.001	<0.001	**0.11**	**0.038**	**0.008**	0.003	<0.001	**0.28**	**0.38**	**0.19**	**0.33**
Acenaphthylene			<0.001	<0.001	<0.001	*<0.06*	*<0.02*	<0.004	<0.002	<0.001	*<0.1*	*<0.1*	*<0.09*	*<0.1*
Anthracene			<0.001	<0.001	<0.001	**0.28**	**0.060**	0.011	0.004	<0.001	**0.54**	**0.75**	**0.5**	**0.65**
Benzo(a)anthracene			<0.001	<0.001	<0.001	**0.28**	0.052	0.011	0.004	0.001	**0.49**	**0.62**	**0.32**	**0.40**
Benzo(a)pyrene			<0.001	<0.001	<0.001	**0.18**	0.038	0.008	0.003	<0.001	**0.31**	**0.36**	**0.20**	**0.24**
Benzo(b&j)fluoranthene			<0.001	<0.001	<0.001	0.25	0.040	0.007	0.003	0.001	0.38	0.49	0.24	0.27
Benzo(g,h,i)perylene			<0.002	<0.002	<0.002	0.12	0.036	0.009	0.004	<0.002	0.20	0.22	0.16	0.17
Benzo(k)fluoranthene			<0.001	<0.001	<0.001	0.18	0.027	0.005	0.002	<0.001	0.32	0.39	0.19	0.16
Chrysene			<0.001	<0.001	<0.001	**0.38**	0.081	0.016	0.006	0.002	**0.57**	**0.73**	**0.39**	**0.53**
Dibenz(a,h)anthracene			<0.002	<0.002	<0.002	**0.04**	**0.008**	<0.002	<0.002	<0.002	**0.05**	**0.06**	**0.04**	**0.04**
Fluoranthene			<0.001	<0.001	<0.001	**0.70**	0.11	0.017	0.006	0.001	**1.4**	**1.9**	**1.3**	**1.2**
Fluorene			<0.001	<0.001	<0.001	**0.16**	**0.067**	0.015	0.005	<0.001	**0.45**	**0.63**	**0.37**	**0.54**
Indeno(1,2,3-cd)pyrene			<0.002	<0.002	<0.002	0.08	0.017	0.003	<0.002	<0.002	0.13	0.13	0.09	0.08
2-Methylnaphthalene			<0.001	<0.001	<0.001	**1**	**0.33**	**0.084**	**0.029**	0.005	**1.7**	**2.1**	**1.2**	**2.4**
Naphthalene			<0.001	<0.001	<0.001	**0.49**	**0.12**	**0.035**	0.012	0.003	**0.78**	**0.96**	**0.54**	**1.1**
	10/7/2011		<0.001	<0.001	<0.001	**0.73**	**0.28**	0.068	0.024	<0.005	**1.6**	**2.1**	**1.3**	**2.2**
Pyrene			<0.001	<0.001	<0.001	**0.90**	0.10	0.017	0.006	0.002	**1.6**	**2.6**	**0.89**	**0.93**
Total HMW-PAH's			<0.002	<0.002	<0.002	3.1	0.51	0.094	0.034	0.007	5.5	7.5	3.8	4.1
Total LMW-PAH's			<0.001	<0.001	<0.001	2.8	0.89	0.22	0.076	0.008	5.3	6.9	4.1	7.1
Total PAH's			<0.002	<0.002	<0.002	**5.9**	1.4	0.32	0.11	0.014	**11**	**14**	**7.9**	**11**

Notes:
a - Canadian Council of Ministers of the Environmen
b - Canadian Council of Ministers of the Environmen
c - British Columbia Contaminated Sites Regulations
d - Environment Canada Disposal at Sea Program; L
e - the relationship between AVS and SEM is expres
(value exceeding 0 indicates an excess of metals).
f- CSR - Contaminated Sites Regurlation, Schedule
g - CSR - Contaminated Sites Regurlation, Schedule
h - CCME - Canadian Wide Standards for Petroleum
FDA: Field duplicate available, FD: Field duplicate

Bold and underlined values are equal to or excee
Bold and outlined values are equal to or exceed
Bold, yellow highlighted and outlined values are
Bold and blue highlighted values are equal to or
italics values indicate detections limits grater than g

Table V-3: Ladysmith Harbour - Summary Porewater Chemistry Data for Tier I and Tier II TIE Testing

		Tier II						Tier 1					
STATION		2010-11	2010-11	2010-09	2010-09	2010-07	2010-07	2010-10	2010-11	2010-13	2010-09	2010-08	2010-07
MAXXAM ID		AA3434	AA3480	AA3478	AA3481	AA3479	AA3482	Z18207	Z18208	Z18209	Z18210	Z18211	Z18212
Sample ID		0086-02	0086-02 (Sulphide Amended)	0086-04	0086-04 (Sulphide Amended)	0086-06	0086-06 (Sulphide Amended)	0086-01	0086-02	0086-03	0086-04	0086-05	0086-06
Sample Type		POREWATER	POREWATER	POREWATER	POREWATER	POREWATER	POREWATER	POREWATER	POREWATER	POREWATER	POREWATER	POREWATER	POREWATER
Extraction Date	Units	22-Feb-11	22-Feb-11	22-Feb-11	22-Feb-11	22-Feb-11	22-Feb-11	21-Dec-10	21-Dec-10	21-Dec-10	21-Dec-10	21-Dec-10	21-Dec-10
Parameter													
Physical Tests													
Hardness (CaCO3)	mg/L	-	-	-	-	-		5670	5540	5130	5520	5560	5330
pH	not applicable	-	-	-	-	-		7.8	7.8	7.8	7.8	7.8	7.8
Total Suspended Solids	mg/L	53	83	88	87	100	66	86	110	120	77	92	76
Inorganics													
Total Ammonia (N)	mg/L	11	8.9	10	7.8	9.1	6.6	3	2.7	2.4	4.4	2.8	5.4
Sulphide	mg/L	12.2	0.022	34	0.028	27	0.026	2.9	3.5	0.015	19.4	1.11	22.2
Dissolved Metals													
Aluminum (Al)	mg/L	0.032	0.028	0.055	0.037	0.05	0.034	0.06	0.61	0.04	0.85	0.04	0.05
Antimony (Sb)	mg/L	0.0012	0.0013	0.0005	0.0019	0.001	0.0014	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Arsenic (As)	mg/L	0.0405	0.0429	0.0813	0.0851	0.0699	0.0715	0.01	0.007	0.013	0.033	0.015	0.061
Barium (Ba)	mg/L	0.032	0.031	0.057	0.056	0.048	0.047	0.03	0.03	0.02	0.06	0.03	0.05
Beryllium (Be)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (Bi)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Boron (B)	mg/L	3.92	4.66	4.77	4.84	5.25	5.23	4.9	5	5.2	5.1	4.9	5.2
Cadmium (Cd)	mg/L	0.0001	0.00014	0.00013	0.00018	0.00014	0.00014	0.0002	<0.0001	0.0001	0.0002	0.0002	<0.0001
Calcium (Ca)	mg/L	389	396	383	373	388	373	388	388	366	392	386	370
Chromium (Cr)	mg/L	0.0012	0.0017	0.0012	0.002	0.0029	0.0023	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt (Co)	mg/L	<0.0001	<0.0001	0.0001	0.0001	0.0002	0.0001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper (Cu)	mg/L	0.0017	0.002	0.0016	0.0026	0.0017	0.002	<0.002	<0.002	<0.002	<0.002	0.148	<0.002
Iron (Fe)	mg/L	0.081	0.075	0.053	0.064	0.08	0.068	0.1	0.14	0.08	0.11	0.1	0.06
Lead (Pb)	mg/L	0.0012	0.0012	0.0007	0.0014	0.0008	0.0012	<0.002	<0.002	<0.002	<0.002	0.005	<0.002
Lithium (Li)	mg/L	0.155	0.17	0.167	0.163	0.173	0.165	0.16	0.15	0.15	0.16	0.15	0.16
Manganese (Mn)	mg/L	0.0124	0.0122	0.002	0.0022	0.0036	0.0033	0.02	0.01	0.09	<0.01	<0.01	<0.01
Magnesium (Mg)	mg/L	1080	1070	1110	1080	1120	1060	1140	1110	1030	1100	1120	1070
Mercury (Hg)	mg/L	-	-	-	-	-	-	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum (Mo)	mg/L	0.008	0.008	0.005	0.006	0.008	0.009	0.04	0.02	0.06	<0.01	0.01	<0.01
Nickel (Ni)	mg/L	0.0006	0.0006	0.001	0.0006	0.001	0.0009	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus (P)	mg/L	2.79	2.98	3.05	2.95	2.72	2.67	-	-	-	-	-	-
Potassium (K)	mg/L	329	331	346	336	349	329	358	351	347	351	361	351
Selenium (Se)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Silicon (Si)	mg/L	18.6	21	22.7	22.8	23.8	22.8	14	15	6	19	13	18
Silver (Ag)	mg/L	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Sodium (Na)	mg/L	9550	9250	9690	9350	9730	9130	9350	9310	8610	9140	9260	8990
Strontium (Sr)	mg/L	7.43	7.41	7.51	7.21	7.44	7.29	6.79	6.57	6.19	6.63	6.38	6.44
Sulphur (S)	mg/L	798	832	847	815	866	821	964	953	853	946	898	891
Thallium (Tl)	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Tin (Sn)	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium (Ti)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Uranium (U)	mg/L	0.0058	0.00559	0.00325	0.00349	0.00374	0.00407	0.003	0.003	0.007	0.003	0.004	0.004
Vanadium (V)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc (Zn)	mg/L	0.002	0.003	0.002	0.003	0.003	0.002	<0.05	<0.05	<0.05	<0.05	0.09	<0.05
Zirconium (Zr)	mg/L	-	-	-	-	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

APPENDIX V
Table V-4: Summary of Ladysmith Harbour PAH Passive Sampler Results - 2009

Sample ID			1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Station			1A	2A	3A	4A	6A	7A	8A	9A	10A	11A	12A	13A	14A	15A	16A	17A	18A	19A	20A	21A	22A	23A
Pacific Rim Laboratory ID			PR91796	PR91797	PR91798	PR91799	PR91800	PR91801	PR91802	PR91803	PR91804	PR91805	PR91806	PR91807	PR91808	PR91809	PR91810	PR91811	PR91812	PR91813	PR91814	PR91815	PR91816	PR91817
Extract Date			27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09
Extract Wt. (g):			1.55	1.47	1.6	1.23	1.79	1.74	1.4	1.59	1.61	1.53	1.05	1.59	1.62	1.76	1.69	1.37	1.44	1.38	1.54	1.36	1.45	1.44
Parameter	**Units**	**Detection Limit**																						
Naphthalene	ng/sample[1]	0.1	0.43	0.55	0.47	0.32	0.52	0.48	0.49	0.22	0.29	0.17	0.29	0.43	0.35	0.46	0.65	0.27	0.37	0.33	0.37	2.6	0.51	0.48
Acenaphthylene	ng/sample	0.1	0.13	0.18	0.15	0.11	0.1	ND	0.12	0.13	ND	ND	ND	ND	ND	ND	0.19	0.13	ND	ND	0.11	0.14	ND	ND
Acenaphthene	ng/sample	0.2	ND	0.35	0.95	0.32	0.34	ND	0.22	0.22	0.26	0.2	0.68	0.21	0.21	0.23	0.33	ND	0.33	0.31	0.32	2.5	ND	ND
Fluorene	ng/sample	0.1	0.41	0.3	1.1	0.16	0.23	0.34	0.12	0.16	0.21	0.19	0.55	0.12	0.18	0.12	0.38	0.1	0.21	0.15	ND	1.2	0.14	0.16
Phenanthrene	ng/sample	0.1	0.82	1.9	7.9	1.6	2.5	1.1	0.97	1.7	1.3	0.77	3.2	0.97	0.71	0.99	1.9	0.78	0.82	0.74	0.76	6.9	0.95	1
Anthracene	ng/sample	0.1	0.24	0.56	1.5	0.79	1.4	0.65	0.83	1.4	0.9	0.47	2.1	0.62	0.55	0.43	0.77	0.39	0.56	0.23	0.77	2.8	0.27	0.2
Fluoranthene	ng/sample	0.1	2.7	9.1	23	9.4	10	4.1	7.3	6.5	8.9	4.3	14	23	1.9	3.3	4.6	4.4	6.3	3.6	5.9	8.3	2.6	2.3
Pyrene	ng/sample	0.1	1.7	5.5	13	10	14	6.9	14	23	13	4.6	11	22	2.9	3.5	4.1	3.3	7.6	1.9	11	16	1.6	1.1
Benz(a)anthracene	ng/sample	0.1	0.46	1.4	3.2	1.6	2.3	1.2	1.7	2.3	1.8	0.8	2.4	2.8	0.87	0.78	1	1.1	1.7	0.86	2	2.2	0.63	0.69
Chrysene	ng/sample	0.1	0.38	1.9	3.4	1.1	1.3	0.6	0.75	0.76	1.1	0.44	1.5	2.6	0.77	0.54	0.73	0.81	0.83	0.93	1.1	1.3	0.95	0.79
Benzo(b+j)fluoranthene	ng/sample	0.2	0.7	1.3	2.2	2	2.2	1.6	2.7	4.6	2	0.91	1.3	2.3	0.64	0.78	1.2	0.68	1.7	0.73	1.6	1.9	0.56	0.46
Benzo(k)fluoranthene	ng/sample	0.1	0.38	1.1	1.9	1.5	1.7	1.6	2.7	4.2	1.6	0.63	1.3	1.7	0.54	0.56	0.63	0.63	1.4	0.19	1.3	1.8	0.36	0.28
Benzo(a)pyrene	ng/sample	0.5	ND	0.59	1	0.62	1.1	0.79	1.1	1.8	0.55	ND	0.66	0.9	ND	ND	0.68	ND	0.6	ND	1	0.71	ND	ND
Indeno(1,2,3-cd)pyrene	ng/sample	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	ng/sample	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(ghi)perylene	ng/sample	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PAH	ng/sample		8.35[2]	24.73	59.77	29.52	37.69	19.36[3]	33	46.99	31.91	13.48	38.98	57.65	9.62	11.69	17.16	12.59	22.42	9.97	26.23	48.35	8.57	7.46
Total PAH	mg/g EVA		8.35	8.24	19.92	9.84	12.56	9.68	11.00	15.66	10.64	4.49	12.99	19.22	3.21	3.90	5.72	4.20	7.47	3.32	8.74	16.12	2.86	2.49

Sample ID			24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	NC Activated Carbon	PC	B
Station			24A	25A	26A	27A	28A	29A	30A	31A	32A	33A	34A	35A	36R	37R	38R	39R	40R	PR91835	Spike	Blank
Pacific Rim Laboratory ID			PR91818	PR91819	PR91820	PR91821	PR91822	PR91823	PR91824	PR91825	PR91826	PR91827	PR91828	PR91829	PR91830	PR91831	PR91832	PR91833	PR91834	27-Nov-09	PR91836	PR91837
Extract Date			27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	27-Nov-09	1.75	27-Nov-09	27-Nov-09
Extract Wt. (g):			1.59	1.49	1.61	1.27	1.35	1.58	1.68	1.55	1.3	1.59	1.24	1.42	1.43	0.99	1.31	0.17	1.7		1.28	1.64
Parameter	**Units**	**Detection Limit**																				
Naphthalene	ng/sample[1]	0.1	0.71	0.36	0.69	0.72	0.27	0.67	0.3	0.28	0.53	0.67	0.19	0.48	0.26	0.21	0.3	ND	0.63	0.31	693	0.47
Acenaphthylene	ng/sample	0.1	0.12	0.11	0.24	ND	0.16	0.13	0.12	0.1	0.18	ND	0.13	ND	ND	ND	ND	ND	0.14	0.11	611	0.13
Acenaphthene	ng/sample	0.2	0.28	ND	2.5	0.32	0.27	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	919	ND
Fluorene	ng/sample	0.1	0.48	0.23	3.4	0.24	0.16	0.24	0.35	ND	0.24	0.3	0.13	0.16	0.2	0.21	0.17	ND	0.28	0.26	482	0.12
Phenanthrene	ng/sample	0.1	2.2	0.8	21	1.7	1.2	0.98	1.7	0.94	1.8	1.4	0.81	0.45	0.56	1.2	0.54	0.12	1.5	0.95	258	0.51
Anthracene	ng/sample	0.1	0.46	0.3	13	0.59	0.47	0.39	0.74	ND	0.44	0.18	0.17	0.17	0.13	0.36	0.15	ND	0.32	ND	245	ND
Fluoranthene	ng/sample	0.1	1.1	2.3	163	5.1	5.5	4.3	4.1	1.1	1.5	0.59	1.2	0.65	1.7	1.8	1.9	0.38	2.9	0.8	234	0.16
Pyrene	ng/sample	0.1	0.71	1.8	113	4.4	3.2	2.9	3.3	0.82	1.5	0.57	0.54	0.89	0.94	1.4	1.5	0.44	2.4	0.88	193	0.16
Benz(a)anthracene	ng/sample	0.1	0.42	0.75	23	1.2	1.1	0.56	2.1	0.36	0.45	0.23	0.37	0.35	0.57	0.47	0.61	0.38	0.75	0.46	94	0.36
Chrysene	ng/sample	0.1	0.39	0.64	16	0.92	0.88	0.43	1.2	0.63	0.61	0.51	0.5	0.29	0.6	0.52	0.51	0.34	0.87	0.21	82	0.2
Benzo(b+j)fluoranthene	ng/sample	0.2	ND	0.51	12	0.74	0.99	0.4	1.3	0.21	ND	ND	ND	0.28	0.21	0.29	0.4	ND	0.6	ND	89	0.26
Benzo(k)fluoranthene	ng/sample	0.1	ND	ND	11	1	0.53	0.44	1	0.34	ND	ND	ND	ND	0.51	ND	0.17	ND	0.48	0.12	76	0.45
Benzo(a)pyrene	ng/sample	0.5	ND	ND	6.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	78	ND
Indeno(1,2,3-cd)pyrene	ng/sample	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	83	ND
Dibenz(a,h)anthracene	ng/sample	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	52	ND
Benzo(ghi)perylene	ng/sample	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	79	ND
Total PAH	ng/sample		6.87	7.8	385.53	16.93	14.73	11.44	16.21	4.78	7.25	4.45	4.04	3.72	5.68	6.46	6.25	1.66	10.87	4.1	4268	2.82
Total PAH	mg/g EVA		2.29	2.60	128.51	5.64	4.91	3.81	5.40	1.59	2.42	1.48	1.35	1.24	1.89	2.15	2.08	0.55	3.62	1.37	1422.67	0.94

Notes:
1 - Each "sample" consists of the extract from 3 vials which each contained 1 mL (equivalent to 1 mg) of EVA. The total mass of EVA per extract was 3 mg.
2 - 1 vial (1 mg of EVA) was extracted for this sample.
3 - 2 vials (2 mg of EVA) were extracted for this sample.

APPENDIX V
Table V-5: Summary of Coal Analysis of Ladysmith Harbour Sediments - 2009

Sample ID Sample Location Date Sampled QAQC	Units	16745-09 1A 10/20/2009	16745-11 2A 10/19/2009	16741-05 3A 10/19/2009	16745-12 4A 10/20/2009	16745-10 5A 10/20/2009	16741-04 6A 10/20/2009	16748-10 7A 10/21/2009	16741-01 8A 10/21/2009	16748-02 9A 10/20/2009	16741-03 10A 10/19/2009	16748-01 11A 10/20/2009	16741-02 12A 10/20/2009	16748-12 13A 10/19/2009	16751-06 14A 10/21/2009	16741-07 15A 10/19/2009 FDA	16741-08 15A Dup 10/20/2009 FD	16748-11 16A 10/22/2009	16751-05 17A 10/20/2009	16751-02 18A 10/22/2009	16751-03 19A 10/20/2009	16751-01 20A 10/22/2009	16745-06 21A 10/21/2009 FDA
Parameter																							
% Coal HVB rank (Up Cret)	%	10.3	3	1.3	10.3	5	3.7	15	6.7	11	9	18.7	4.3	14	19.3	9.7	8.3	17	21.3	11.4	43.7	13	17.3
% Shaley coal (hvb) (Up Cret)	%	0.7	0.3	1.3	0	1.3	3.3	2	3.7	0.7	3.7	1.7	1	2.3	0.7	2	1.7	2.3	5.3	1.3	5.3	3.7	2.3
Total % Coal	%	11	3.3	2.6	10.3	6.3	7	17	10.4	11.7	12.7	20.4	5.3	16.3	20	11.7	10	19.3	26.6	12.7	49	16.7	19.6

Sample ID Sample Location Date Sampled QAQC	Units	16745-07 21A Dup 10/20/2009 FD	16745-03 22A 10/19/2009 FDA	16745-04 22A Dup 10/21/2009 FD	16745-05 23A 10/21/2009	16745-08 24A 10/19/2009	16751-04 25A 10/22/2009	16741-06 26A 10/21/2009	16751-11 27A 10/21/2009	16748-06 28A 10/21/2009	16751-10 29A 10/21/2009	16741-09 30A 10/21/2009	16751-07 31A 10/21/2009	16751-08 32A 10/21/2009	16745-02 33A 10/20/2009	16751-09 34A 10/21/2009	16745-01 35A 10/21/2009	16748-05 36R 10/21/2009	16748-03 38R 10/20/2009 FDA	16748-04 38R Dup 10/19/2009 FD	16748-08 39R 10/19/2009	16748-09 40R 10/22/2009
Parameter																						
% Coal HVB rank (Up Cret)	%	25.7	20	18.3	66.8	17	33.7	0.7	11.7	7	6.3	6.7	28.7	16.3	25	23.7	15	0	3.7	6.3	16.7	9
% Shaley coal (hvb) (Up Cret)	%	4.6	1	3.3	11	29	13.7	1.3	2	1	1.3	2	26	25.7	19.7	9	9.7	0	0	1.3	4.7	1
Total % Coal	%	30.3	21	21.6	77.8	46	47.4	2	13.7	8	7.6	8.7	54.7	42	44.7	32.7	24.7	0	3.7	7.6	21.4	10

APPENDIX VI

Quality Assurance Quality Control

December 21, 2011
Report No. 09-1436-5008/5000

Golder Associates

Sample type	Surface Sediment (2009)																Sediment Cores (2010)							
Sample ID	16739-07	16739-08			16743-06	16743-07			16743-03	16743-04			16746-03	16746-04			21775-02	21775-03			21775-11	21775-12		
Sample Location	15A	15A			21A	21A			22A	22A			38R	38R			2010-13	2010-13			2010-12	2010-12		
Date Sampled	10/19/2009	10/19/2009	MDL	RPD (%)	10/20/2009	10/20/2009	MDL	RPD (%)	10/20/2009	10/20/2009	MDL	RPD (%)	10/21/2009	10/21/2009	MDL	RPD (%)	12/17/2010	12/17/2010	MDL	RPD (%)	12/16/2010	12/17/2010	MDL	RPD (%)
CANTEST/Maxxam ID	910300431	910300435			910300455	910300461			910300442	910300446			910300493	910300494			Z16003	Z16004			Z16012	Z16013		
QA/QC	FDA	FD			FDA	FD			FDA	FD			FDA	FD			FDA	FD			FDA	FD		
General Parameters				-				-				-				-				-				-
Moisture	70.1	67.4	-	-	57.6	71.5	-	-	66.3	66.7	-	-	31.1	27.5	-	-	18	17		-	14	14		-
Total Organic Carbon (%)	11.2	11	-	-	43.3	12.5	-	-	28.6	10.7	-	-	1.76	1.88	-	-	0.0016	0.0018		-	0.0041	0.0032		-
pH	6.7	6.8	-	-	7.3	7.3	-	-	7	6.8	-	-	6.7	7	-	-	8.66	8.66		-	8.6	8		-
Metals																								
Aluminum	8300	8250	10	1	7920	7810	10	1	8350	8710	10	4	5400	4730	10	13	9950	9750	100	2	9340	8500	100	9
Antimony	< 0.1	< 0.1	0.1	-	0.7	< 0.1	0.1	-	< 0.1	< 0.1	0.1	-	< 0.1	< 0.1	0.1	-	<0.1	<0.1	0.1	-	0.1	0.2	0.1	67
Arsenic	9.4	9.2	0.1	2	14.3	13.7	0.1	4	12	12.2	0.1	2	5.6	4.8	0.1	15	3.0	2.9	0.2	3	2.3	2.0	0.2	14
Barium	25	24	1	4	28	31	1	10	37	37	1	0	17	19	1	11	14.1	14.6	0.1	3	21.4	12.6	0.1	**52**
Beryllium	< 1	< 1	1	-	< 1	< 1	1	-	< 1	< 1	1	-	< 1	< 1	1	-	<0.1	<0.1	0.1	-	<0.1	0.1	0.1	-
Boron	98	92	1	6	90	86	1	5	72	68	1	6	17	15	1	13	<0.1	<0.1	0.1	-	<0.1	<0.1	0.1	-
Cadmium	3.3	3.1	0.2	6	3.7	3.4	0.2	8	4.2	3.4	0.2	21	3.7	3.5	0.2	6	0.26	0.25	0.05	4	0.49	0.33	0.05	**39**
Calcium	5370	5500	1	2	11200	14500	1	26	6310	6100	1	3	3980	3640	1	9	13000	12300	100	6	5540	4890	100	12
Chromium	24	24	2	0	24	24	2	0	25	26	2	4	12	11	2	9	14	14	1	0	16	15	1	6
Cobalt	4	4	1	0	5	5	1	0	5	5	1	0	3	3	1	0	4.9	4.9	0.3	0	5.1	5.0	0.3	2
Copper	67	70	1	4	77	81	1	5	76	77	1	1	20	19	1	5	16.2	15.7	0.5	3	18.1	15.9	0.5	13
Iron	14600	14700	2	1	17800	17500	2	2	14300	14200	2	1	8060	7450	2	8	14300	14000	100	2	12500	11000	100	13
Lead	18.2	17.2	0.2	6	21.6	21.6	0.2	0	17.8	18.1	0.2	2	3.7	3.4	0.2	8	1.1	1.0	0.1	10	1.0	0.9	0.1	11
Magnesium	7060	6880	1	3	6680	6530	1	2	6340	6210	1	2	3220	3040	1	6	4690	4650	100	1	5210	4740	100	9
Manganese	133	134	1	1	136	134	1	1	132	131	1	1	91	87	1	4	169	164	0.2	3	197	163	0.2	19
Mercury	0.25	0.24	0.01	4	0.26	0.33	0.01	24	0.26	0.27	0.01	4	0.08	0.07	0.01	13	0.07	0.08	0.05	13	0.07	<0.05	0.05	-
Molybdenum	15.4	14.7	0.1	5	13.8	12.9	0.1	7	9.7	9.7	0.1	0	3	2.6	0.1	14	1.8	1.9	0.1	5	0.5	0.4	0.1	22
Nickel	20	20	2	0	21	21	2	0	21	21	2	0	9	9	2	0	11.3	10.9	0.8	4	12.6	11.5	0.8	9
Phosphorus	669	662	20	1	806	792	20	2	673	688	20	2	863	725	20	17	434	426	10	2	365	346	10	5
Potassium	1760	1750	10	1	1740	1700	10	2	1640	1600	10	2	717	701	10	2	663	601	100	10	614	554	100	10
Selenium	1.9	1.6	0.2	17	2	1.9	0.2	5	1.8	1.8	0.2	0	0.8	0.7	0.2	13	<0.5	<0.5	0.5	-	<0.5	0.5	0.5	-
Silver	0.3	0.3	0.1	0	0.3	0.3	0.1	0	0.3	0.3	0.1	0	< 0.1	< 0.1	0.1	-	<0.05	<0.05	0.05	-	<0.05	<0.05	0.05	-
Sodium	21100	21700	5	3	19000	19400	5	2	17000	16500	5	3	5690	5980	5	5	2290	2100	100	9	1750	2110	100	19
Strontium	63	63	1	0	92	107	1	15	66	69	1	4	27	25	1	8	55.5	48.5	0.1	13	22.8	21.3	0.1	7
Thallium	0.3	0.3	0.1	0	0.3	0.3	0.1	0	0.3	0.3	0.1	0	0.6	0.6	0.1	0	0.21	0.21	0.05	0	0.26	0.27	0.05	4
Tin	< 5	< 5	5	-	< 5	< 5	5	-	< 5	< 5	5	-	< 5	< 5	5	-	0.2	0.2	0.1	0	0.2	0.1	0.1	67
Titanium	359	350	1	3	328	324	1	1	361	343	1	5	330	305	1	8	1080	1060	1	2	1020	1030	1	1
Vanadium	38	38	1	0	39	38	1	3	35	35	1	0	18	16	1	12	40	38	2	5	36	35	2	3
Zinc	130	129	1	1	167	170	1	2	162	140	1	15	40	39	1	3	23	23	1	0	26	24	1	8
Zirconium	5	5	1	0	5	5	1	0	5	5	1	0	1	1	1	0	2.3	2.3	0.5	0	2.3	2.1	0.5	9
Hydrocarbons																								
F1-BTEX			-	-			-	-			-	-			-	-	<10	<10		-	<10	<10		-
F2-Napth (C10-C16)	84	82	-	-	150	170	-	-	100	180	-	-	< 70	< 70	-	-	<10	<10		-	<10	<10		-
F2 (C10-C16) uncorrected	84	82	-	-	150	170	-	-	100	180	-	-	< 70	< 70	-	-	-	-		-	-	-		-
F3-PAH (C16-C34)	780	700	-	-	870	1100	-	-	630	1100	-	-	< 100	110	-	-	<10	40		-	20	<10		-
F3 (C16-C34) uncorrected	780	700	-	-	870	1100	-	-	630	1100	-	-	< 100	110	-	-	-	-		-	-	-		-
F4 (C34-C50)	< 500	< 500	-	-	< 500	< 500	-	-	< 500	< 500	-	-	< 500	< 500	-	-	<10	<10		-	<10	<10		-
Polycyclic Aromatic Hydrocarbons																								
Acenaphthene	0.087	0.11	0.005	23	0.2	0.17	0.005	16	0.18	0.11	0.005	**48**	< 0.005	< 0.005	0.005	-	<0.001	<0.001	0.001	-	0.008	0.003	0.001	91
Acenaphthylene	0.042	0.047	0.005	11	< 0.005	< 0.005	0.005	-	0.077	0.05	0.005	**43**	< 0.005	< 0.005	0.005	-	<0.001	<0.001	0.001	-	<0.004	<0.002	0.004	-
Anthracene	0.12	0.17	0.01	34	0.33	0.23	0.01	**36**	0.24	0.15	0.01	**46**	< 0.01	< 0.01	0.01	-	<0.001	<0.001	0.001	-	0.011	0.004	0.001	93
Benzo(a)anthracene	0.1	0.11	0.01	10	0.34	0.27	0.01	23	0.2	0.17	0.01	16	0.02	< 0.01	0.01	-	<0.001	<0.001	0.001	-	0.011	0.004	0.001	93
Benzo(a)pyrene	0.08	0.08	0.01	0	0.22	0.13	0.01	**51**	0.1	0.14	0.01	33	< 0.01	< 0.01	0.01	-	<0.001	<0.001	0.001	-	0.008	0.003	0.001	91
Benzo(b)fluoranthene	0.15	0.12	0.01	22	0.28	0.22	0.01	24	0.22	0.28	0.01	24	< 0.01	< 0.01	0.01	-	<0.001	<0.001	0.001	-	0.007	0.003	0.001	80
Benzo(g,h,i)perylene	0.05	0.05	0.01	0	0.08	0.04	0.01	67	0.06	0.07	0.01	15	< 0.01	< 0.01	0.01	-	<0.002	<0.002	0.002	-	0.009	0.004	0.002	77
Benzo(k)fluoranthene	0.06	0.06	0.01	0	0.1	0.07	0.01	**35**	0.09	0.09	0.01	0	< 0.01	< 0.01	0.01	-	<0.001	<0.001	0.001	-	0.005	0.002	0.001	86
Chrysene	0.12	0.12	0.01	0	0.36	0.34	0.01	6	0.26	0.28	0.01	7	0.01	< 0.01	0.01	-	<0.001	<0.001	0.001	-	0.016	0.006	0.001	91
Dibenz(a,h)anthracene	0.01	0.011	0.005	10	0.017	0.011	0.005	43	0.017	0.016	0.005	6	< 0.005	< 0.005	0.005	-	<0.002	<0.002	0.002	-	<0.002	<0.002	0.002	-
Fluoranthene	0.42	0.4	0.01	5	0.68	0.82	0.01	19	0.7	0.49	0.01	35	0.03	0.02	0.01	40	<0.001	<0.001	0.001	-	0.017	0.006	0.001	**96**
Fluorene	0.14	0.16	0.01	13	0.24	0.22	0.01	9	0.29	0.18	0.01	**47**	< 0.01	< 0.01	0.01	-	<0.001	<0.001	0.001	-	0.015	0.005	0.001	**100**
Indeno(1,2,3-cd)pyrene	0.05	0.04	0.01	22	0.07	0.04	0.01	55	0.07	0.08	0.01	13	< 0.01	< 0.01	0.01	-	<0.002	<0.002	0.002	-	0.003	<0.002	0.002	-
Methylnaphthalene (2-)	0.58	0.67	0.05	14	0.52	0.54	0.05	4	1.3	0.64	0.05	**68**	0.04	0.03	0.02	29	<0.001	<0.001	0.001	-	0.084	0.029	0.001	**97**
Naphthalene	0.33	0.39	0.01	17	0.8	0.58	0.01	32	0.69	0.35	0.01	**65**	0.02	0.02	0.01	0	<0.001	<0.001	0.001	-	0.035	0.012	0.001	**98**
Phenanthrene	0.54	0.64	0.01	17	0.99	0.77	0.01	25	1.2	0.73	0.01	**49**	0.04	0.03	0.01	29	<0.001	<0.001	0.001	-	0.068	0.024	0.001	**96**
Pyrene	0.36	0.39	0.01	8	0.85	0.88	0.01	3	0.61	0.42	0.01	**37**	0.03	0.02	0.01	40	<0.001	<0.001	0.001	-	0.017	0.006	0.001	**96**
Total HMW-PAH's	1.41	1.38	-	2	2.99	2.82	-	-	2.33	2.03	-	-	0.09	0.04	-	-	<0.002	<0.002	-	-	0.094	0.034	-	-
Total LMW-PAH's	1.84	2.19	-	17	3.08	2.51	-	-	3.98	2.21	-	-	0.1	0.08	-	-	<0.001	<0.001	-	-	0.22	0.076	-	-
Total PAH's	3.25	3.57	-	9	6.06	5.33	-	-	6.31	4.24	-	-	0.19	0.13	-	-	<0.002	<0.002	-	-	0.32	0.11	-	-

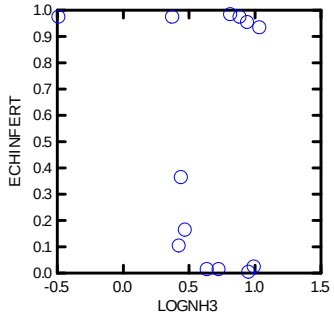
Notes:
Results are expressed as mg/L except where noted.
MDL = Method Detection Limit.
< Indicates value less than the detection limit indicated.
RPD = Relative Percent Difference = absolute value[100 x (sample - duplicate)/(sample + duplicate)/2].
If both values were < MDL, or if values were ≤5 times the MDL, RPD was not calculated ("-").
Value RPD > 35% where both values are > 5 times MDL

APPENDIX VII

Scatterplots of Echinoderm Toxicity and Porewater Chemistry

December 21, 2011
Report No. 09-1436-5008/5000

Golder Associates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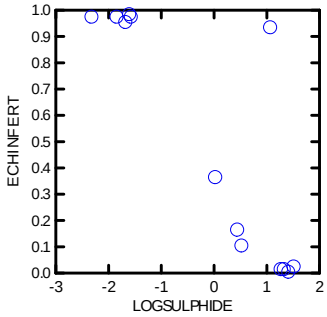
LOGNH3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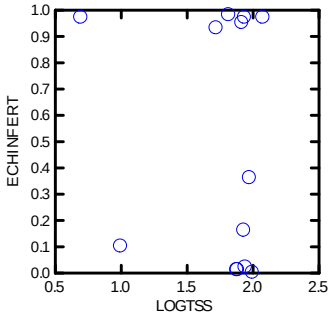
LOGSULPHIDE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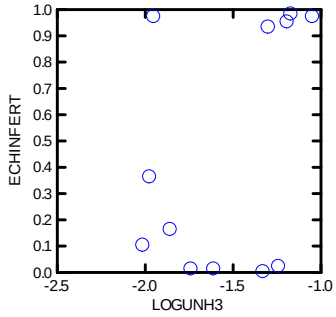
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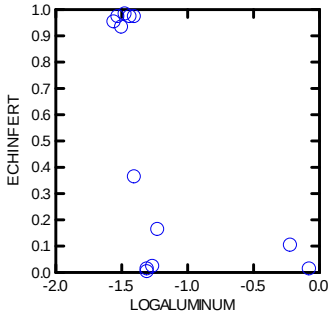
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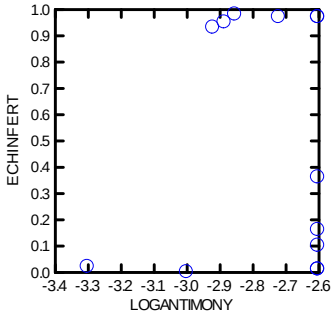
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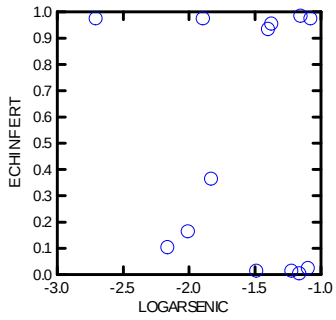
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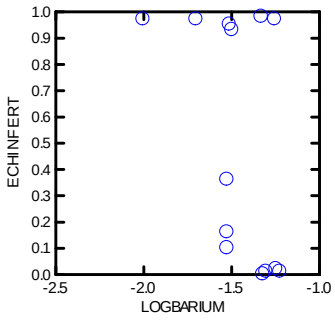
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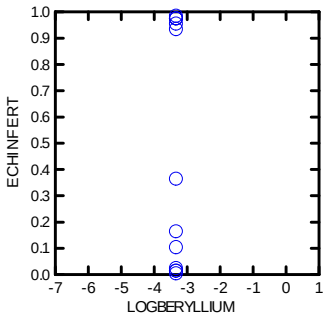
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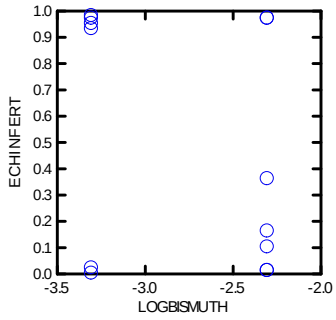
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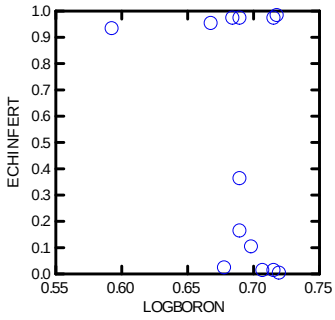
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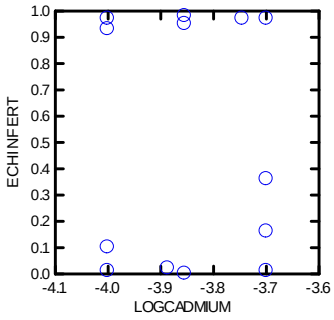
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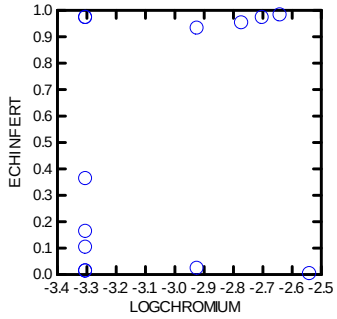
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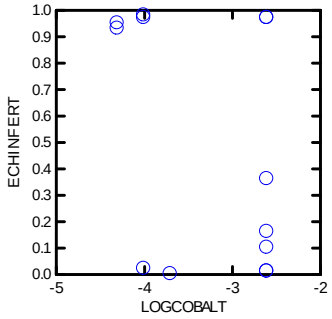
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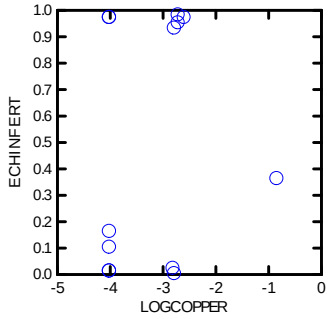
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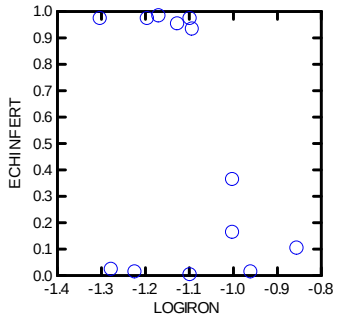
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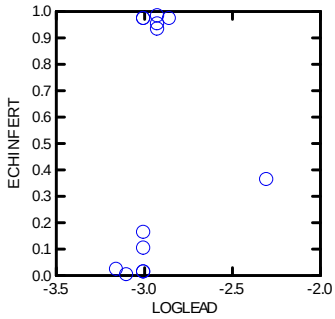
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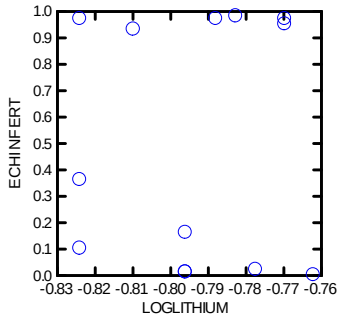
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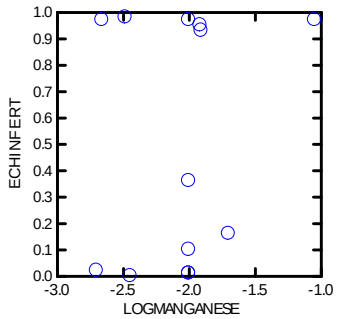
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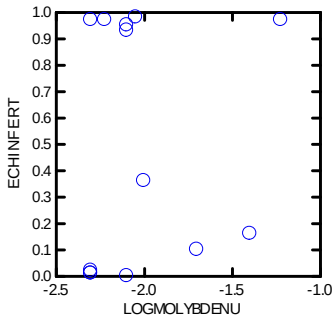
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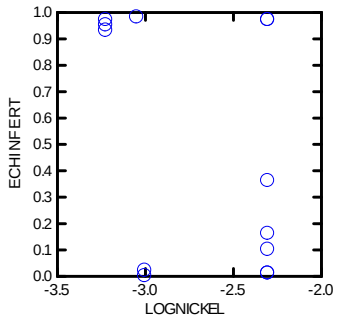
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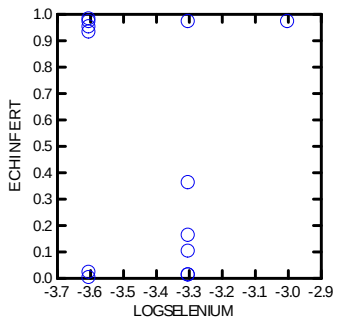
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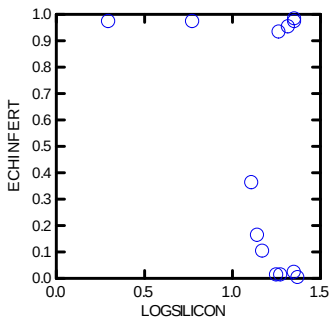
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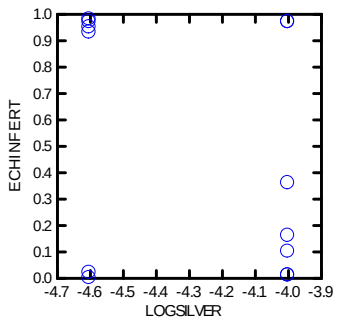
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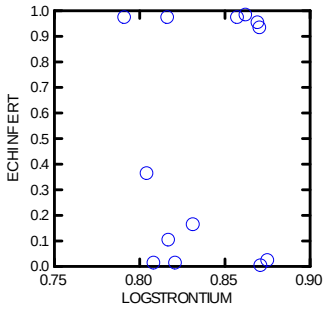
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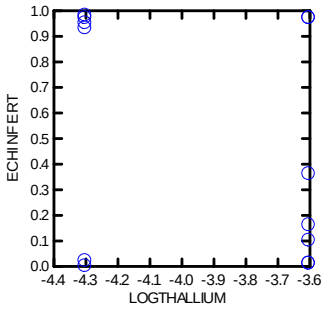
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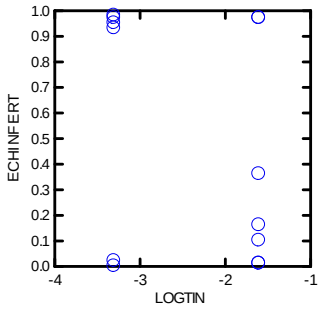
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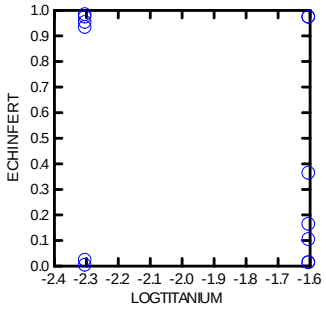
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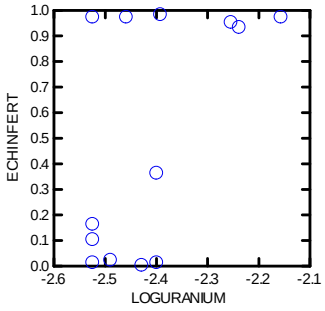
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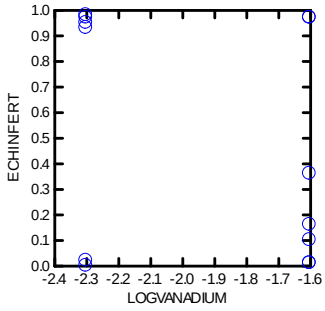
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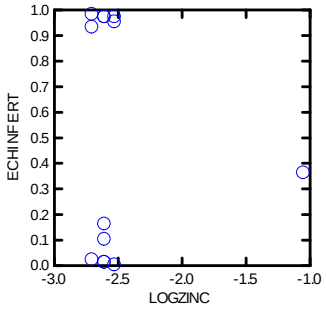
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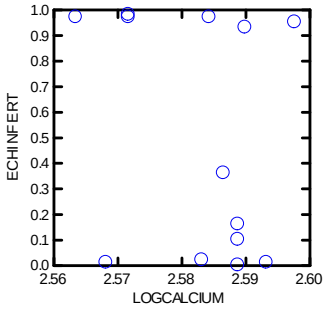
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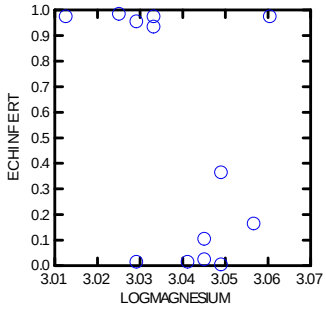
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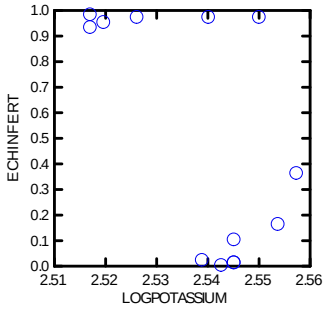
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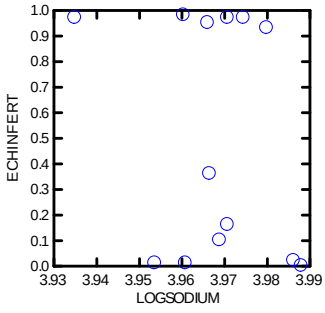
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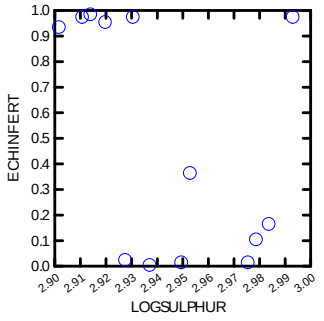
ECHINFERT
LOGSULPHUR

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

Africa	+ 27 11 254 4800
Asia	+ 852 2562 3658
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
500 - 4260 Still Creek Drive
Burnaby, British Columbia, V5C 6C6
Canada
T: +1 (604) 296 4200

Golder Associates