Peel River Waste Site:
Site Investigations

Final Report

Prepared for:
Peel River Working Group

By:
Royal Roads University – Applied Research Division
&
Indian and Northern Affairs Canada,
Waste Management Program, Yukon Region

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EXECUTIVE SUMMARY

The Peel River Waste Site, located in the Yukon on the north side of the Peel River, 4 km upstream of its confluence with the Caribou River, was used for exploratory drilling activities during the mid-1960's by Shell Resources Canada. Project personnel and drilling equipment were stationed on site until 1967 when the project was abandoned. A cleanup of the site was conducted by Shell in 1975, following which demolition debris and other materials including bagged drilling mud, bagged cement were buried in a pit on-site. The Peel River has changed its course over the years and in 1994, the northeast bank of the river encroached on the disposal pit, exposing the debris.

A preliminary site investigation conducted by the Northwest Territories Municipal and Community Affairs and a follow-up investigation by AGRA Earth and Environmental Ltd. identified DDT contamination in soil samples collected from locations near the Peel River shoreline. Additional information was needed to determine the distribution of DDTs and other possible contaminants at the Peel River Waste Site and, as such, representatives from Royal Roads University - Applied Research Division and DIAND Waste Management Program, Yukon Region, undertook a more thorough investigation on behalf of the Peel River Working Group.

Field investigations were conducted between April 11 and 25, 2000, during which soil samples were collected from 33 boreholes advanced in or around the waste disposal pit to depths of up to 8 m below the present ground surface. Sediments and water samples were also obtained from locations below the waste pit along the Peel River. The samples were analyzed using a combination of field and laboratory techniques for organochlorine pesticides, including DDTs, metals, hydrocarbons, volatile organic compounds and polychlorinated biphenyls (PCBs).

The results were evaluated by using the 1999 Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines. The following conclusions can be drawn from the current site investigation:

- Debris including wood, metals, bentonite, cement and an unidentifiable brown fibrous material was generally located at a depth of 3 to 4 m below ground surface on the upper bench and extended to a maximum vertical thickness of up to 2 m. The approximate volume of this debris was estimated to be 3000 cubic metres. Snow cover along the cut bench precluded any observation of the extent of exposed debris along the riverbank.
- The concentrations of DDT and its related products in a number of soil and sediment samples exceeded the CCME environmental quality guideline for residential/park land of 0.7 ppm. This DDT contamination was associated with waste materials.
- Low levels of DDTs were found in the Peel River sediment samples that confirmed the past offsite transport of DDT-contaminated groundwater and/or soils into the Peel River. These samples contained concentrations of DDT that

could result in localized impacts based on CCME Interim Sediment Quality Guidelines.

- The concentrations of DDTs in the three water samples collected directly below the waste pit were generally below detection or very low.
- Of the metals analyzed, only arsenic and barium were found to occur at concentrations exceeding the CCME residential/parkland soil quality guidelines. However, the concentrations of these metals in extracts obtained using BC Special Waste Extraction Procedure/Leachate Extraction Protocols were below the BC Leachate Quality Standards.
- A limited number of the screened soil samples were contaminated with one or more of the following organic substances - chloroform and dichloromethane, benzene, ethylbenzene, toluene, xylenes, naphthalene and light extractable petroleum hydrocarbons.
- Polychlorinated biphenyls (PCBs) and other chlorinated pesticides were not detected in any of the samples analyzed.
- The observed distribution of DDT-contaminated soils was consistent with the presence of a buried source or sources on the eastern side of the waste pit and contaminant migration, entrained along with other organic substances towards the river. Based on a DDT soil remediation guideline of 0.7 ppm, the volume of DDT contaminated soil was estimated to be 1100 cubic metres.

Remedial options for the Peel River Waste Site, which were presented to the Peel River Working Group for consideration, may be divided into these major categories:

- Option 1 – Risk Management, consisting of leaving the existing materials in place and properly securing the waste site to reduce any erosion;
- Option 2 – Complete removal of the waste site, including non-hazardous debris, any hazardous materials found (should they exist) and soils with contaminant concentrations exceeding the appropriate standards, criteria or provisional criteria;
- Option 3 – Partial removal of contaminant hotspots (especially for DDT) followed by engineered closure including slope stabilization; or,
- Option 4 – In situ remediation - including biodegradation, solidification, solvent extraction, and electrochemical focusing.

While risk management through river bank stabilization and partial encapsulation (Option 1) may be considered, a cursory analysis suggests that erosional forces of the Peel River flood waters and the movement of ice during spring break-up would make any long-term, effective stabilization solution both challenging and cost-prohibitive to implement. Removal of major source areas of DDTs and other contaminants such as various solvents and petroleum hydrocarbon products (Option 3) might be considered as the most cost-efficient mechanism for curtailing future entry into the Peel River ecosystem.

TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOGRAPHS

1. INTRODUCTION

1.1 Background

The Peel River Waste Site is located in the Yukon on the north side of the Peel River, four kilometers upstream of its confluence with the Caribou River at 66° 30.98' N, 134° 04.26'W. The closest community is Fort McPherson, N.W.T., situated 105 km to the north. Eagle Plains, a highway lodge and service station, is located 120 km to the west (Figure 1.1). The site is within the Tetlit Gwich'in Comprehensive Land Claim Agreement.

During the mid-1960's, Shell Resources Canada carried out exploratory drilling in the area where approximately 4 ha was cleared and an airstrip was constructed on a gravel bar nearby. Project personnel and drilling equipment were stationed on site until 1967 when the project was abandoned. Equipment and reusable materials were removed off-site. A final cleanup of the site was conducted by Shell in 1975. Two wooden trailers that were on site were demolished. The demolition debris and other materials including bagged drilling mud, bagged cement and miscellaneous debris were buried in a pit on-site. The Peel River changed its course over the years and in 1994, the northeast bank of the river encroached on the disposal pit, exposing the debris.

An investigation was conducted during a site inspection in August 1994. Results of this investigation indicated there were no potential contaminants of concern at the site. A short-term stabilization program was conducted in September 1994. This was followed by an electromagnetic survey in March 1995 to delineate the extent of debris in the pit (Power, 1995).

Debris buried in the pit continued to be exposed by the river as such, Indian and Northern Affairs Canada (DIAND), Shell, and the Gwich'in Tribal Council initiated a joint project in 1994 to pick up the exposed debris for aesthetic reasons.

In October 1998, representatives of the Northwest Territories Municipal and Community Affairs collected 10 soil samples from the site. The samples were composited and analyzed by Enviro-Test Laboratories in Edmonton for organochlorine insecticides. It was found that the composite contained 79 ppm (mg/kg) of DDT, 11 ppm of DDD and 3.2 ppm of DDE.

This result led to additional investigations by AGRA Earth and Environmental Ltd. (AGRA, 1999) on behalf of the Gwich'in Tribal Council, Shell Canada, DIAND, and the Peel River Working Group. The investigation was initiated with a site visit in June 1999 during which 11 soil samples were collected and analyzed on site using immunoassay based field test kits. The samples were subsequently analyzed at Enviro-Test Laboratories and found to contain DDT, DDE and DDD at concentrations ranging from < 0.002 to 3.3 ppm. Additional sampling and analysis was therefore recommended.

A follow up to the June 18 investigation was conducted on September 18 and 19, 1999 during which 40 samples were collected. The samples were analyzed in two sets to reduce the analysis cost and determine if areas of relatively high DDT contamination could be differentiated from other less contaminated areas. Twenty-five samples were analyzed in the first batch. The concentrations of total DDT in most of the samples were less than the Canadian Council of Ministers of the Environment (CCME) criterion for total DDT in parkland soils of 0.7 ppm (mg/kg) apart from three samples. These three samples contained 7.02, 27 and 53 ppm (mg/kg) of total DDT. On the basis of the above results, the remaining 14 samples were also analyzed. High concentrations of total DDT (up to 266 ppm) were found in seven of the samples. These samples were collected from locations at or below the June 1999 water level.

1.2 Brief Overview of DDT, DDE and DDD

The name DDT is derived from Dichloro-Diphenyl-Trichloroethane and is commonly applied to 1,1,1-trichloro-2,2-*bis*-(p-chlorophenyl) ethane (p,p'-DDT) and its other isomeric forms o,p'-DDT and m,p'-DDT. Commercial pesticides that contain these compounds are generally called DDTs. The pesticide formulations contain several similar compounds (Table 1.1). Commercial pesticides usually contain 70 – 80% of the p,p'-DDT isomer and up to 30% of the o,p'-DDT isomer. Once introduced into the environment, these active ingredients are transformed, either metabolically or photochemically, into a number of chemically similar compounds. The most common of these metabolites or degradation products are the isomeric forms of DDE (Dichloro-Dichlorophenyl-Ethylene) and DDD (Dichloro-Diphenyl-Dichloroethane). Small amounts of DDE and DDD are also found as impurities in technical grade DDT.

In this report the term total DDT refers to the sum of the six isomers presented in Table 1.1

Table 1.1: Chemical Names of DDT, DDD and DDE isomers

Common Name	Isomeric Forms	Chemical Name
DDT	p, p'-DDT or 4,4'-DDT	1,1,1-trichloro-2,2-*bis*-(p-chlorophenyl) ethane
	o, p'-DDT or 2,4'-DDT	1,1,1-trichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane
DDE	p, p'-DDE or 4,4'-DDE	1,1-dichloro-2,2-*bis* (p-chlorophenyl) ethylene
	o, p'-DDE or 2,4'-DDE	1,1-dichloro-2- (o-chlorophenyl)-2-(p-chlorophenyl) ethylene
DDD	p, p'-DDD or 4,4'-DDD	1,1-dichloro-2,2-*bis* (p-chlorophenyl) ethane
	o, p'-DDD or 2,4'-DDD	1,1-dichloro-2-(o-chlorophenyl)-2-(p-chlorophenyl) ethane

Technical grade DDT is a white, crystalline or waxy, tasteless, odourless solid at room temperature. It is not very volatile and not very soluble in water but is highly soluble in organic solvents (CCME, 1999). DDT was discovered to have insecticidal properties during the Second World War and its use significantly reduced the incidence of insect

borne diseases such as malaria and typhus. The low cost of DDT, its high activity against insects, ease of application and persistence encouraged its use by civilians after the war. It was used extensively to control a wide range of insect pests on agricultural lands. Swamps, forests as well as residential areas were sprayed with DDT to control insect pests. It was sold for household use in granules, aerosols, smoke candles, lotions, and charges for vaporizers (CCME, 1999).

Early investigations indicated that excessive use of DDT could kill fish, birds and other wildlife. Residues of DDT were found in plant and animal tissue and cows milk, but these were accepted as unavoidable hazards and of little concern. During the 1950's and 1960's, residues of DDT and other organochlorine insecticides were detected in soils and small amounts in water and sediments. Thinning of bird eggshells and birth deformities in birds were also linked to DDT and other organochlorine compounds. Humans were exposed to DDT through ingesting food containing DDT residues and there were indications that DDT and other organochlorine insecticides were accumulated in humans and other animals (bioaccumulation). Other pathways for human exposure to DDT included ingestion of contaminated soil particles, inhalation of contaminated air and adsorption through the skin.

Short-term exposure to DDT affects primarily the nervous system; highly exposed soldiers in the Second World War had suffered aching joints, tremors and depression. Long-term exposure to low doses results in some reversible changes in the level of liver enzymes. Because of these observed effects, its high persistence, bioaccumulation and long-range transport, the use of DDT was banned in many developed countries including Canada and the USA in the early 1970's. However, it is still being used in many countries around the world.

1.3 Scope and Objectives

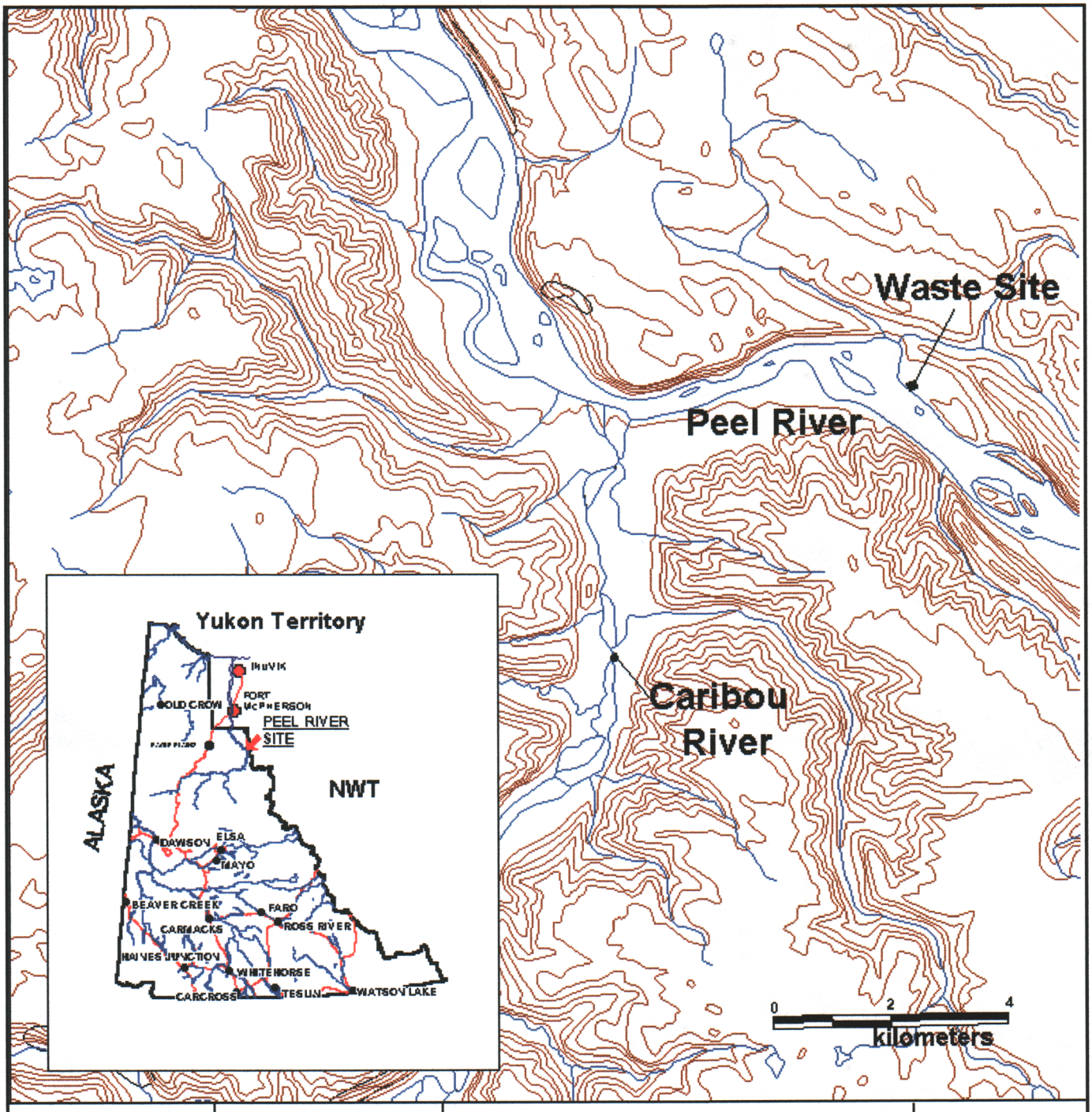
Additional information was needed to determine the distributions of DDTs and other possible contaminants at the Peel River Waste Site and, as such, a more thorough investigation was undertaken in 2000. The main objectives were to –

- Conduct a detailed investigation to identify the source and delineate the extent of surface and subsurface DDT contamination at the Peel River Waste Site;
- Determine if other contaminants such as hydrocarbons and metals were present;
- Evaluate erosion control measures and carry out slope stabilization, if appropriate;
- Conduct an environmental assessment of the data obtained; and,
- Define cleanup/remedial options, if required.

Field investigations were conducted between April 11 and 25, 2000. The field program was followed by laboratory analysis for organochlorine pesticides including DDTs,

metals, hydrocarbons, volatile organic compounds and polychlorinated biphenyls (PCBs). The results were evaluated by using the Canadian Environmental Quality Guidelines (CCME, 1999).

This report presents the results and interpretations of the detailed site investigation.



ROYAL ROADS UNIVERSITY	Indian and Northern Affairs Canada Waste Management Program Yukon Region	PEEL RIVER WASTE SITE INVESTIGATION	DATE: Dec 2000
		GENERAL SITE LOCATION	FIGURE **1.1**

2. METHODOLOGY

2.1 Field Investigations

The field investigation was conducted from April 11 to 25, 2000. A Detailed Work Plan was developed and submitted to DIAND Waste Management Program for review prior to the initiation of field investigation activities. Copies of this Work Plan were circulated by DIAND to the Peel River Working Group (Table 2.1) for review. Comments received from the working group were incorporated into the work plan.

The field team included representatives from:

- DIAND Waste Management (Rick Seaman and Werner Liebau);
- Gwich'n Tribal Council (Norman Snowshoe);
- Royal Roads University (Matt Dodd); and,
- Beck Drilling (borehole installation).

The major objective of the field investigation was the delineation of the extent of subsurface DDTs contamination. Specific tasks included:

- Drilling 33 boreholes;
- Collection of surface and sub-surface soil samples from boreholes
- Collection of sediments from eight locations along the Peel River;
- Use of field test methods for the screening analysis of contaminants in soil;
- A field quality assurance/quality control program;
- Complete documentation of site conditions and sampling program; and,
- Initiation of erosion control measures.

A second site visit was conducted on May 31, 2000 by DIAND Waste Management personnel (Rick Seaman and Werner Liebau) to complete the water sampling program and erosion control measures. Water samples were taken at five locations.

Table 2.1: Peel River Working Group

NAME	ORGANIZATION	E-MAIL/PHONE	FAX
RICHARD NERYSOO	Gwich'in Tribal Council	867-777-4869 (Inuvik)	867-777-4538
JOHN BAINBRIDGE	Gwich'in Tribal Council	867-777-4869 (Inuvik)	867-777-4538
NORMAN SNOWSHOE	Gwich'in Tribal Council	snowshoe@inuvik.nwt 867-777-4869 (Inuvik)	867-777-4538
ABE WILSON	Designated Gwich'in Org.	867-952-2330 (Fort McPherson)	867-952-2212
ROBERT ALEXIE SR.	Renewable Res. Council	867-952-2330 (Fort McPherson)	867-952-2212
WILBERT FIRTH	Rat River Dev. Corp.	wfirth@internorth.com 867-952-2330 (Fort McPherson)	867-952-2212
PETER ROSS	Gwich'ya Gwich'in Council	867-953-3201 (Tsiigèhnijik)	867-953-3302
RANDY HETMAN	Shell Canada Ltd.	randy.hetman@shell.ca 403-691-2521 (Calgary)	403-269-7895
CARL BONKE	Shell Canada Ltd.	403-691-3079/403-288-7253 (Calgary)	403-269-7948 403-288-7253
BRETT HARTSHORNE	DIAND - Waste Management	hartshorneb@inac.gc.ca 867-667-3268 (Whitehorse)	867-667-3199
MARK PALMER	DIAND - Contaminants	palmerm@inac.gc.ca 867-667-3271 (Whitehorse)	867-667-3199
ADVISORY MEMBERS:			
DON HELFRICK	GNWT - Hazardous Waste	(Yellowknife)	867-873-0221
DEBORAH ARCHIBALD	GNWT - Renewable Res.	deb_archibald@gov.nt.ca 867-920-3343 (Yellowknife)	867-873-0254
FRANK HAMILTON	GNWT - Health	(Yellowknife)	867-873-0442
RON MORRISON	GNWT - Resources, Wildlife, EcDev	867-777-7286 (Inuvik)	867-777-7321
SPENCER PHILLIPO	GNWT - MACA	(Inuvik)	867-777-7352
	FT. MCPHERSON - Mayor	(Fort McPherson)	867-952-2725
ADRIAN D'HONT	DIAND - NWT	867-669-2668 (Yellowknife)	867-669-2833
SCOTT GALLUPE	DIAND - NWT - Water Resources	gallupes@inac.gc.ca 867-777-3361 (Inuvik)	867-777-
CONSULTANT:			
MATT DODD	Royal Roads University - ARD	matt.dodd@royalroads.ca 250-391-2583 (Victoria)	250-391-2560
INFORMATION:			
RICK SEAMAN	DIAND - Waste Management	seamanr@inac.gc.ca 867-667-3273 (Whitehorse)	867-667-3199
ERIC SOPROVICH	Environment Canada	867-667-3410 (Whitehorse)	867-667-7962
BRIAN FERGUSON	Dept. of Fisheries and Oceans	867-393-6722 (Whitehorse)	867-393-6738
RUTH HALL	YTG - Environmental Protection	ruth.hall@gov.yk.ca 867-667-5851 (Whitehorse)	867-393-6205
TERRY SEWELL	DIAND - Yukon	(Whitehorse)	867-667-6038
BOB OVERVOLD	DIAND - NWT	(Yellowknife)	867-669-2833
JOE BALLANTYNE	DIAND - Yukon	(Whitehorse)	867-667-3199

2.2 Mobilization and Demobilization

All the equipment and material necessary for the site assessment and erosion control measures were acquired and gathered during three weeks prior to mobilization, and stored at the Waste Management storage facility at Range Road in Whitehorse. For the transport to Eagle Plains, a 5-ton truck and pick-up were used; the vehicles were pre-loaded on Friday, April 7, 2000.

On Monday, April 10, the equipment and materials were transported to Eagle Plains via the North Klondike and Dempster highways, where the Waste Management personnel (Rick Seaman and Werner Liebau) met up with the representative of the Gwich'in Tribal Council, Norman Snowshoe.

The mobilization from Eagle Plains to the Peel River site was accomplished in several stages by helicopter over the course of five days. For Tuesday, April 11, a Trans North Air helicopter (Bell Jet Ranger 206) based in Dawson was hired and some equipment, including a tent, a snow blower and shovels, were flown to the site. Work commenced to remove snow and to set up a tent on site as an emergency shelter and equipment storage.

On the following day, April 12, the crew was grounded due to a leaking transmission seal on the helicopter, which required an engineer, parts and specialized tools to come from Whitehorse. Another helicopter from Fireweed Helicopters (Bell Jet Ranger 206), also based in Dawson, was secured for the following day.

In the late afternoon of April 12, the drilling crew (Beck Drilling) and the drilling equipment arrived in Eagle Plains from Calgary, Alberta.

On Thursday, April 13, snow removal continued and more tools and fuel were flown to the site as an internal load. In the evening, a medium helicopter (Bell-Huey 204), operated by Fireweed Helicopters, Whitehorse arrived in Eagle Plains to serve as a means of air transport for the remainder of the project.

On Friday, April 14, the medium helicopter transported three sling loads of drilling equipment, while snow removal continued on site. The Royal Roads representative (Matt Dodd) arrived at Eagle Plains by fixed wing aircraft at noon along with a second snow blower. The snow blower was taken to the site in the afternoon by helicopter and snow removal continued.

Saturday, April 15, the assessment crew was grounded due to snow and low clouds. One sling load with drilling equipment and fuel was transported to the site once the weather improved in the late afternoon.

Work resumed and the drilling began on Sunday, April 16, when the last sling load with erosion control material was transported to the vicinity of the site, completing the mobilization phase.

Air-rotary drilling was completed on Friday, April 21, and the compressor was removed on Saturday, April 22. During this attempt, the compressor was severely damaged.

Drilling operations on the lower riverbank and sediment sampling were completed on Sunday, April 23, and most of the drilling equipment was transported in two sling loads back to Eagle Plains.

On Monday, April 24, the last sling load of drilling equipment was taken along with an internal load, including the two snow blowers and various tools. The remaining equipment was removed from the site as another internal load.

At Eagle Plains, the equipment was re-organized and loaded onto vehicles. Samples and personal gear were packed and loaded on Tuesday, April 25, to leave for Whitehorse the same day. Soil samples were shipped via airfreight to Vancouver, BC on Wednesday, April 26. The equipment was unloaded at the Waste Management storage facility, completing the demobilization phase.

2.3 Subsurface Investigations

A combination of step-out sampling from hot-spot locations, on the basis of data from the 1999 investigations by AGRA, and grid sampling was used to establish borehole locations. Three main transects were set up on site. The first was laid parallel to the top bench, 1 m from the edge. The second transect was placed along the slope between the water level and the top bench while the third consisted of sediment sampling locations along the river bed below the site. The grid was adjusted such that grid centres consisted of previous sampling locations on the basis of visible markers found on site. Boreholes were drilled along the grid points. Step-outs from the grid on the upper bench were also conducted to delineate the extent of buried debris. Locations of boreholes are indicated on Figure 2.1.

The site was covered with snow with depths of up to 1.5 m at various locations (Photograph 2.1). Prior to drilling two snow blowers were used to remove heavy snow cover on the upper bench and along the transects on the slope and the river (Photograph 2.2).

Boreholes were advanced using either an air rotary system or a solid stem auger, which were operated by Beck Drilling, Calgary. The air-rotary drill was equipped with an ODEX system that cut a hole and advanced a casing simultaneously. Drill cuttings were delivered to the surface between the drill rods and casing using compressed air via a cyclone. The cuttings were collected in two-foot sections into containers placed below the cyclone (Photograph 2.3). Following observation and recording of physical characteristics including particle size, odour, moisture content, sub-samples were collected for field and laboratory analysis.

Airflow into the cyclone was obstructed by bentonite, which was encountered in a number of boreholes. As such, a solid stem auger was used in instances where bentonite was encountered in neighboring boreholes (Photographs 2.4 and 2.5). Samples were retrieved off the auger flights following the removal of surface layers. The depth of each

borehole, samples collected and field screening results are given in borehole logs attached as Appendix A.

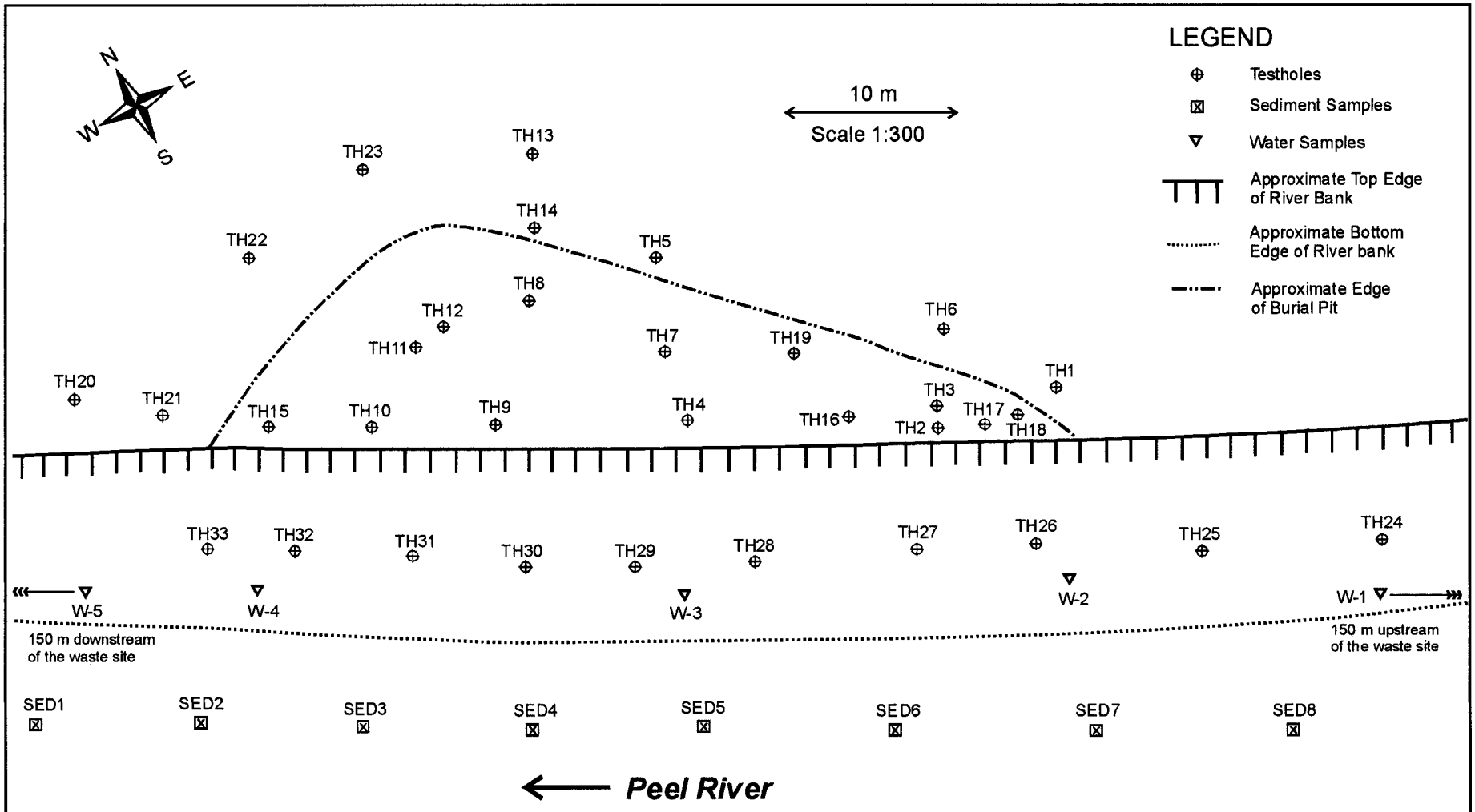
Visual observation of waste materials in drill cutting was used to delineate the burial pit. There were auger refusals at a few locations in the waste pit. Some of these refusals were attributed to large metal objects as suggested by metallic shavings observed in drill cuttings. These locations that included the east side of the pit (in the vicinities of TH2 and TH3) corresponded to areas identified as containing metallic debris during the March 1995 electromagnetic survey.

Debris was generally located at a depth of 3 to 4 m below ground surface on the upper bench and extended to a maximum vertical depth of up to 2 m. Snow cover along the cut bench precluded observation of the extent of exposed debris along the river bank.

The approximate edge of the pit based on waste including bentonite, wood, metal shavings, cement and an unidentifiable brown fibrous material is indicated on Figure 2.1.

The volume of waste was estimated as follows:

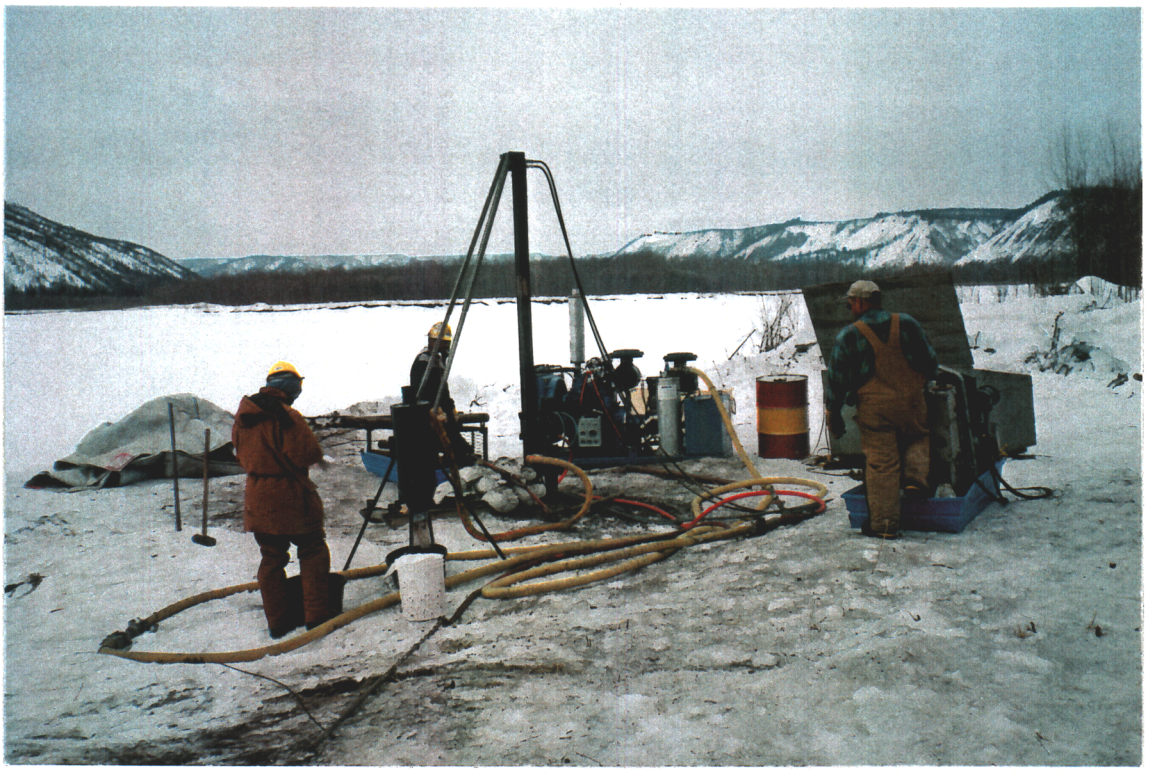
- areal extent: 1,000 m^2 approximate
- estimated average depth 2.0 m
- estimated volume 2,000 m^3 approximate
- with 50% contingency 3,000 m^3 approximate estimated



ROYAL ROADS UNIVERSITY	**Indian and Northern Affairs Canada** Waste Management Program Yukon Region	**PEEL RIVER WASTE SITE INVESTIGATION** LOCATIONS OF TESTHOLES, SEDIMENT AND WATER SAMPLES PROJECT NO.: 2000-005A | DATE: Dec 2000	FIGURE **2.1**

Photograph 2.1: Aerial view of the Peel River Waste Site in April 2000

Photograph 2.2: Snow removal from the upper bench prior to drilling



Photograph 2.3: Drilling with the air rotary system on the upper bench

Photograph 2.4: Drilling with the solid stem auger along the cutbank

Photograph 2.5: Auger flight showing bentonite layer and other waste materials

2.4 Sediment and Water Sampling

Three water samples were collected from locations below the waste site along the Peel River. For background purposes, one water sample was collected approximately 150 m upstream of the waste site while another sample was obtained 150 m downstream. Sediment samples were also taken from eight locations below the waste site. Sampling locations are shown in Figure 2.1.

2.5 Sampling Protocols

All samples were collected, transported, and stored under conditions required for maintaining sample integrity. The general protocols presented in the Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites (CCME, 1993) was used.

2.5.1 Surface Water

Grab surface water samples were collected directly into the appropriate sampling containers during the second site visit by DIAND Waste Management personnel on May 30. Three samples were taken along the waste site, and one sample each up- and down-stream from the site at a distance of 150 m from the respective edges of the waste pit (Figure 2.1).

The container was held at the base and the neck plunged below the surface (25 - 40 cm). It was tilted such that the neck pointed to the water flow during filling. Disposable gloves were worn during sampling, and changed after each sample, to reduce the possibility of cross-contamination.

Samples designated for organic analyses (DDTs, light/heavy extractable hydrocarbons and polycyclic aromatic hydrocarbons) were placed into 1 L amber glass jars. Total metals in water samples were placed into 250 mL plastic containers and preserved with nitric acid. For dissolved metals, the samples were placed into the containers without preservatives and shipped to the laboratory. On arrival in the laboratory, these samples were filtered through 0.45 μm membrane filters and preserved with nitric acid prior to analysis.

2.5.2 Subsurface Soils

Subsurface soil samples were obtained using stainless steel scoops. The scoops were pre-cleaned by washing with laboratory detergent (Sparkleen™), rinsing with distilled-deionized water and methanol. They were then baked at 400°C for three hours, cooled and wrapped in baked aluminum foil to preclude contaminants. Samples designated for field analyses were placed into 125 mL amber glass jars with aluminum foil lined-lid while those earmarked for laboratory analyses (metals, hydrocarbons pesticides and PCBs) were placed into 250 mL glass jars with Teflon lined lids. For volatile organic compounds

analyses, the samples were placed into 125 ml glass jars and sealed with Teflon-lined lids. Disposable gloves were worn and changed after every sample to reduce the possiblity of cross-contamination.

Subsurface profiles were described based on visual examination of the auger cuttings and rotary chips prior to sampling. Drill cuttings from the ODEX system were placed into containers (in two-foot sections) from which sub-samples were collected using stainless steel scoops for analysis. Samples were removed from the flight of the solid stem auger, homogenized and placed into the containers.

2.5.3 Sediment Samples

A hole was drilled in the ice on the river and a stainless steel hand auger equipped with a split spoon sampler was used to obtain sediments. The sediment was placed into an aluminum-lined bowl, homogenized and aliquots placed into appropriate containers as used for sub-surface soils.

2.5.4 Sample Handling

All the labeled sample containers were placed into coolers and shipped to the Analytical Laboratory via Canadian Airlines guaranteed cargo. Chain of custody forms accompanied the shipment.

2.6 Analytical Program

2.6.1 Potential Contaminants of Concern

The previous site investigations and historical usage of the site suggested the following possible contaminants might be of concern with regard to human health or ecological risk at or around the Peel River Waste Site:

- **Organochlorine Pesticides** including DDT and its metabolites DDD and DDE – these compounds have been identified in soils at levels exceeding the CCME criteria for parkland use.
- **Other Persistent Organochlorine Compounds** such as PCBs – these compounds were previously used in transformers and hydraulic fluids and subset of samples were screened to confirm that they were not contaminants of potential concern at Peel River.
- **Hydrocarbons** (aliphatics, monocyclic aromatics such as benzene, toluene, ethylbenzene and xylene, light and heavy extractable petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons) – since the site was used as an exploration site, drilling, disposal of waste fuels and oils and other activities could have contributed a complex suite of hydrocarbons to the environment.

- **Metals and metalloids** – the presence of subsurface refuse disposal areas required a further examination of soil samples for these metals/metalloids.
- **Volatile Organic Compounds** (VOCs) – these are generally used in solvents, degreasers and paint thinners and include monocyclic aromatic hydrocarbons, halogenated compounds and light hydrocarbons (C5 – C9). These compounds are often not found in historic spills since they do not persist in soil. They evaporate rapidly from surface water or soils but may enter groundwater where they persist. Examples of analytes in this group include halogenated volatiles such as carbon tetrachloride, chlorobenzene, chloroethane, chloroform, chloromethane, dibromochloromethane,1,2-dichlorobenzene 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, 1,2-dichloroethane, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1-dichloroethylene, dichloromethane, 1,2-dichloropropane, cis-1,3-dichloropropylene, trans-1,3-dichloropropylene, 1,1,1,2-tetrachloroethane, 1,1,2,2-tetrachloroethane, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, trichlorofluoromethane and vinyl chloride.

The analytical program consisted of:

- Contaminant screening of soil and water samples using field test methods (PID, PetroFLAG™, immunoassay-based field test kits for DDTs and PCBs), with at least 20% of these also subjected to laboratory analysis as per US EPA protocols for field test kits;
- Laboratory analyses at Analytical Services Laboratory (ASL), Vancouver and Axys Analytical Services (Axys); and,
- Collection and submission of field duplicates for at least 10% of the samples.

2.6.2 Field Analysis

Field test methods, including a volatile organic compounds detector (Photoionization Detector, PID), Immunoassay-based test kits and PetroFLAG™ Analyzer were used on a large number of subsurface samples as a preliminary screening tool for VOCs, DDTs, hydrocarbons, and PCBs prior to laboratory analysis. This helped to maximize analytical data relative to analytical costs.

2.6.2.1 Jar Headspace Analysis for Volatile Organic Compounds

The Jar Headspace Procedure is a quick and simple field screening procedure used to determine the presence of volatile organic compounds in soil. The procedure involved collecting a soil or water sample, placing it in an airtight container and then analyzing the headspace vapor using a portable analytical instrument such as a photoionization detector (PID). The "headspace" is the area between the sample and the top of the container. This procedure has been incorporated into US EPA and Environment Canada protocols. (Driscoll, 1993; Environment Canada, 1997).

A PE Photovac™ Photoionization Detector (Model PE 2020) was used in this program. This detector measured the concentrations of VOCs in the 1-2000 parts per million (V/V) range and was calibrated using 100 ppm isobutylene in accordance with the manufacturer's specification.

The soil sample was collected into a 125 mL glass jar that was half-filled with soil. The jar was sealed with an aluminum lined screw-on lid and kept at ambient temperatures on site. At the end of the workday, the sealed jars were transported to Eagle Plains Lodge and placed in the First Aid Room, which was set up as a temporary laboratory. The samples were shaken and allowed to warm up to room temperature for at least 30 minutes. Each lid was then carefully removed leaving the aluminum foil lining in place. The foil was then pierced using the vapour probe and care was taken to sample only the headspace. The maximum reading on the PID was recorded. The sample was retained and sub-samples were later analyzed by immunoassay and PetroFLAG™ test kits.

2.6.2.2 Immunoassay Field Test Kits

Samples were screened in the field for total DDT (includes DDT, DDD and DDE isomers) using Diagnostics Inc. Field Test Kits. The kits utilize the enzyme linked immuno-sorbent assay, which is based on antibodies that are specifically designed to bind to target analyte molecules. These have been accepted for US EPA SW-846 Methods (US EPA, 2000a). Immunoassay test kits were also be used to screen some of the samples for PCBs.

The immunoassay was carried out on site according to the manufacturer's instructions. A 5 g portion of soil was weighed and extracted with 10 mL methanol. The soil-methanol mixture was filtered and an aliquot of the extract used for subsequent analysis. At least 20% of the samples were subjected to laboratory analysis as per US EPA protocols for field test kits.

2.6.2.3 PetroFLAG™ Hydrocarbon Analyzer

The PetroFLAG™ hydrocarbon analysis system (Dexsil Corporation, One Hamden Park Drive, Hamden, CT 06517) is a turbidimetric method designed to quickly analyze soil samples for any type of hydrocarbon. It responds to all types of hydrocarbons regardless of the source or state of degradation. The response factor however, is dependent on the type of hydrocarbon. A table containing the response factor for a number of hydrocarbon contaminants is supplied with the kit (e.g., diesel fuel has a response factor of 5 whiles weathered gasoline has a response factor of 2). The specially designed analyzer is easily calibrated with a blank and a single calibration standard. When a prepared sample is placed in the analyzer, it uses the calibration data to convert the optical reading into a preliminary concentration. Following this, the selected response factor is used to calculate the correct concentration. The method has been incorporated into Draft Update IVA of US EPA SW-846 Method 9074 (US EPA, 2000b).

The samples were analyzed on site using the manufacturers instructions (Dexsil, 1998). A portion of the soil sample (between 2 to 10 g) was extracted with a solvent mixture composed primarily of methanol. The resulting mixture was allowed to settle and the free liquid was decanted into the barrel of a filter-syringe assembly. The liquid was then filtered through a 0.2-μm filter into a vial containing an aqueous emulsifier development solution. The solution was allowed to develop for 10 minutes. During the development, any hydrocarbons present precipitated out and became suspended in solution. The developed sample was then placed in a turbidity meter that had been calibrated using a blank and a single calibration standard. The analyzer then reported the concentration of total extractable petroleum hydrocarbons present in the sample.

2.6.3 Laboratory Analysis

Samples collected during the field programs were submitted to Analytical Services Laboratory (ASL), Vancouver, for metal and routine organic analyses and to Axys Analytical Services, Sidney, for DDTs in water analyses. High resolution gas chromatographic/high resolution mass spectrometry techniques, with a greater amount of prior clean up as employed by Axys was required to detect DDTs in the river water at very low concentrations. ASL and Axys Laboratories have been evaluated and accredited by the Canadian Association for Environmental Laboratories. Laboratory methods are included in reports attached to Appendix B.

Prior to and throughout the field program, Royal Roads liaised with the laboratories to ensure that all QA/QC objectives, such as detection limits, proper sample containers, sample delivery, etc., were met. Selected samples based on field screening tests were targeted for immediate analysis on the chain-of-custody forms submitted to the lab; additional samples were archived and frozen for later analysis as warranted, based on the initial round of analyses.

2.6.4 Quality Assurance and Quality Control

The project team utilized a field QA/QC program that incorporate measures to ensure the integrity of the soil and water samples collected. The QA/QC program included –

- Documentation (date, time, site identification, site conditions, sampling equipment, sample type, preservatives, etc.) of sampling;
- Collection of field duplicates for at least 10% of all samples;
- Collection of background samples; and,
- Copies of the chain-of-custody forms.

2.6.5 Summary of Sampling and Analytical Program

2.6.5.1 Soils/Sediment Samples

The overall sampling and analytical program for soil/sediment samples is presented in Table 2.2. A synopsis follows:

- 112 samples were screened on site for DDTs using immunoassay test kits, 50 of these were analyzed in the laboratory for organochlorine pesticides including DDTs;
- 65 samples were analyzed on site for total extractable petroleum hydrocarbons with the PetroFLAG™ test kits and 16 were re-analyzed in the laboratory for Light/Heavy Extractable Hydrocarbons (LEPH/HEPH);
- 34 samples were screened for PCBs with the immunoassay test kits, 10 of which were analyzed in the laboratory;
- 118 soil/sediment samples were screened for Volatile Organic Compounds (VOCs) while 8 were analyzed in the laboratory; and,
- 23 samples were analyzed in the laboratory for metals.

Table 2.2: Sampling and Analytical Program for April 2000 Peel River Waste Site Investigations

Bore-hole	Samples Collected		Number of Samples Analyzed in the Field				Number of Samples Analyzed in the Laboratory				
	Sample No.	Depth (m)	PID	DDT	PCB	EPH	OCP	LEPH/HEPH	VOC	PCB	Metals
TH-1	TH1-1	0.6 -1.2	1	1	-	1	-	-	-	-	1
	TH1-2	3.6 - 4.0	1	1	-	-	-	-	-	-	-
	TH1-3	4.0 - 4.3	1	1	-	-	1	-	-	1	-
	TH1-4	4.3 - 4.9	1	1	-	1	-	-	-	-	-
	TH1-5	6.1 - 6.7	1	1	1	-	-	-	-	-	-
TH-2	TH2-1	0.0 - 0.6	1	1	-	-	-	-	-	-	-
	TH2-2	2.1 - 2.7	1	1	-	1	-	-	-	1	1
	TH2-3	3.3 - 3.6	1	1	1	1	1	-	-	-	-
	TH2-4	3.6 - 4.3	1	1	1	-	-	-	-	-	1
TH3	TH3-1	3.3 - 3.6	1	1	1	1	-	-	-	-	-
	TH3-2	4.0 - 4.3	1	1	-	1	1	-	-	1	1
TH4	TH4-1	0.0 - 0.6	1	1	-	-	-	-	-	-	-
	TH4-2	2.4 - 2.7	1	1	1	1	-	-	-	-	-
	TH4-3	4.0 - 4.3	1	1	1	1	1	-	-	1	-
	TH4-4	5.5 - 5.8	1	1	1	1	-	-	-	-	-
	TH4-5	7.3 - 7.6	1	1	-	-	1	-	-	-	-
	TH4-6	7.6 - 7.9	1	-	1	-	-	-	-	-	-
TH5	TH5-1	0.0 - 0.6	1	1	1	-	1	-	-	-	-
	TH5-2	1.8 - 2.1	1	-	-	-	-	-	-	-	
	TH5-3	4.3 - 4.6	1	1	-	1	1	-	-	-	-
	TH5-4	5.5 - 5.8	1	-	-	-	-	-	-	-	
	TH5-5	7.0 - 7.3	1	1	1	1	1	1	1	1	1
TH6	TH6-1	0.0 - 0.6	1	1	1	-	-	-	-	-	-
	TH6-2	1.8 - 2.1	1	-	-	-	-	-	-	-	
	TH6-3	4.0 - 4.3	1	1	1	1	1	-	-	-	-
	TH6-4	4.9 - 5.2	1	1	-	-	-	-	-	-	-
	TH6-5	5.2 - 5.5	1	-	-	-	-	-	-	-	

continued

Notes:

PID: Headspace analysis for volatile organic compounds (VOCs) using a Portable Photoionization Detector

DDT: Sum of DDT, DDD and DDE isomers

PCB: Total polychlorinated biphenyls

EPH: Total extractable petroleum hydrocarbons using PetroFLAG™ test kits

OCP: Organochlorine pesticides including DDT, DDD and DDE isomers

VOC: Volatile organic compounds

Table 2.2: Continued

Bore-hole	Samples Collected		Number of Samples Analyzed in the Field				Number of Samples Analyzed in the Laboratory				
	Sample No.	Depth (m)	PID	DDT	PCB	EPH	OCP	LEPH/HEPH	VOC	PCB	Metals
TH7	TH7-1	0.3 - 0.6	1	1	1	-	-	-	-	-	-
	TH7-2	2.4 - 3.0	1	1	-	-	-	-	-	-	-
	TH7-3	3.6 - 4.0	1	1	1	1	1	-	-	-	1
	TH7-4	3.6 - 4.0	1	1	-	1	1	-	-	-	1
	TH7-5	4.3 - 4.6	1	1	-	-	-	1	-	-	1
	TH7-6	5.2 - 5.5	1	1	-	-	-	-	-	-	-
	TH7-7	7.3 - 7.6	1	1	-	-	-	-	-	-	-
TH8	TH8-1	0.6 - 0.9	1	1	-	-	-	-	-	-	-
	TH8-2	1.8 -2.1	1	1	-	-	-	-	-	-	-
	TH8-3	3.6 - 4.0	1	1	1	-	-	-	1	-	-
	TH8-4	5.2 -5.5	1	1	-	1	1	1	-	-	-
	TH8-5	6.7 -7.3	1	1	-	-	-	-	-	-	-
TH9	TH9-1	0.0 - 0.6	1	1	1	1	-	-	-	-	-
	TH9-2	0.0 - 0.6	1	1	-	1	-	-	-	-	-
	TH9-3	3.0 - 3.3	1	1	-	-	1	-	-	-	-
	TH9-4	4.9 - 5.2	1	1	1	-	1	-	-	-	-
	TH9-5	6.7 - 7.0	1	1	-	-	-	-	-	-	-
TH10	TH10-1	0.6 - 0.9	1	1	-	-	1	-	-	-	-
	TH10-2	1.2 - 1.5	1	1	-	-	-	-	-	-	-
	TH10-3	3.0 - 3.3	1	1	-	1	-	-	-	-	-
	TH10-4	3.3 - 3.6	1	1	-	-	-	-	-	-	-
	TH10-5	4.3 - 4.6	1	1	1	-	1	-	-	-	-
TH11	TH11-1	0.0 - 0.6	1	1	1	-	-	-	-	-	-
	TH11-2	1.2 - 1.5	1	1	-	1	-	-	-	-	-
TH12	TH12-1	3.0 - 3.3	1	1	-	1	1	-	-	-	-
TH13	TH13-1	0.0 - 0.6	1	1	1	1	1	-	-	-	-
	TH13-2	3.0 -3.3	1	1	1	1	-	-	-	-	-
	TH13-3	4.3 - 4.6	1	1	-	-	1	-	-	-	-
TH14	TH14-1	0.0 - 0.6	1	1	1	-	1	-	-	-	-
	TH14-2	2.7 - 3.0	1	1	-	1	-	-	-	-	-

continued

Notes:

PID: Headspace analysis for volatile organic compounds (VOCs) using a Portable Photoionization Detector

DDT: Sum of DDT, DDD and DDE isomers

PCB: Total polychlorinated biphenyls

EPH: Total extractable petroleum hydrocarbons using PetroFLAG™ test kits

OCP: Organochlorine pesticides including DDT, DDD and DDE isomers

VOC: Volatile organic compounds

Table 2.2: Continued

Bore-hole	Samples Collected		Number of Samples Analyzed in the Field				Number of Samples Analyzed in the Laboratory				
	Sample No.	Depth (m)	PID	DDT	PCB	EPH	OCP	LEPH/HEPH	VOC	PCB	Metals
TH15	TH15-1	1.5 - 1.8	1	1	-	1	1	1	-	-	-
	TH15-2	2.7 - 3.0	1	1	1	1	-	-	-	-	-
	TH15-3	4.0 - 4.3	1	1	-	1	-	-	-	-	-
TH16	TH16-1	2.7 - 3.0	1	1	-	1	-	-	-	-	-
	TH16-2	3.0 - 3.3	1	1	-	1	1	1	1	1	-
	TH16-3	3.3 - 3.6	1	1	1	1	1	1	1		
	TH16-4	4.0 - 4.3	1	1	1	1	-	-	-	-	-
TH17	TH17-1	2.7 - 3.0	1	1	-	1	-	1	1	-	-
	TH17-2	3.0 - 3.3	1	1	-	1	1	1	1	-	1
	TH17-3	3.0 - 3.3	1	1	1	1	1		1		1
TH18	TH18-1	0.0 - 0.6	1	1	-	1	-	-	-	-	-
	TH18-2	3.3 - 3.6	1	1	1	1	1	1	-	-	1
	TH18-3	4.3 - 4.6	1	1	-	1	1	1	1	-	1
TH19	TH19-1	0.6 - 0.9	1	1	-	1	1	-	-	1	-
	TH19-2	3.3 - 3.6	1	1	1	1	1	-	-	-	-
TH20	TH20-1	0.9 - 1.2	1	1	1	1	-	-	-	-	-
	TH20-2	3.0 - 3.3	1	1	1	-	-	-	-	-	-
	TH20-3	4.0 - 4.3	1	1	-	-	1	-	-	-	-
TH21	TH21-1	2.7 - 3.0	1	1	1	-	-	-	-	-	-
	TH21-2	4.3 - 4.6	1	1	-	-	-	-	-	-	1
TH22	TH22-1	0.9 - 1.2	1	1	-	-	1	-	-	-	-
	TH22-2	4.3 - 4.6	1	1	-	1	-	-	-	-	-
TH23	TH23-1	0.6 - 0.9	1	1	-	1	1	-	-	-	-
	TH23-2	2.7 - 3.0	1	1	-	1	-	-	-	-	-
	TH23-3	4.0 - 4.3	1	1	1	-	-	-	-	-	-
TH24	TH24-1	0.0 - 0.6	1	1	-	1	-	-	-	1	-
	TH24-2	1.5 - 1.8	1	1	1	1	1	-	-	-	-
	TH24-3	2.7 - 3.0	1	1	-	-	-	1	-	-	1
TH25	TH25-1	0.3 - 0.9	1	1	1	1	-	-	-	-	-
	TH25-2	2.1 - 2.4	1	1	1	1	1	-	-	-	1
TH26	TH26-1	0.3 - 0.9	1	1	-	-	1	-	-	-	1

continued

Notes:

PID: Headspace analysis for volatile organic compounds (VOCs) using a Portable Photoionization Detector

DDT: Sum of DDT, DDD and DDE isomers

PCB: Total polychlorinated biphenyls

EPH: Total extractable petroleum hydrocarbons using PetroFLAG™ test kits

OCP: Organochlorine pesticides including DDT, DDD and DDE isomers

VOC: Volatile organic compounds

Table 2.2: Continued

Bore-hole	Samples Collected		Number of Samples Analyzed in the Field				Number of Samples Analyzed in the Laboratory				
	Sample No.	Depth (m)	PID	DDT	PCB	EPH	OCP	LEPH/HEPH	VOC	PCB	Metals
TH27	TH27-1	0.0 - 0.3	1	1	-	1	1	-	-	-	1
	TH27-2	0.9 - 1.2	1	1	-	1	-	-	-	1	-
	TH27-3	2.1 - 2.4	1	1	-	1	1	-	-	-	1
TH28	TH28-1	0.0 - 0.3	1	1	-	1	-	-	-	-	-
	TH28-2	2.1 - 2.4	1	1	-	1	1	1	-	1	1
	TH28-3	2.7 - 3.0	1	1	-	1	-	-	-	-	-
TH29	TH29-1	0.0 - 0.3	1	1	-	1	1	-	-	1	-
	TH29-2	1.2 - 1.5	1	1	-	1	1	1	-	-	1
	TH29-3	2.7 - 3.0	1	1	-	1	-	1	1	-	-
TH30	TH30-1	0.0 - 0.3	1	1	-	-	1	-	-	-	-
	TH30-2	0.0 - 0.3	1	1	-	-	1	-	-	-	-
	TH30-3	0.3 - 0.6	1	1	-	-	-	-	-	-	-
	TH30-4	1.2 - 1.5	1	1	-	-	-	-	-	-	-
	TH30-5	2.7 - 3.0	1	1	-	-	-	-	-	-	-
TH31	TH31-1	0.0 - 0.3	1	1	-	-	-	-	-	-	1
	TH31-2	0.9 - 1.2	1	1	-	1	1	-	-	-	-
	TH31-3	2.7 - 3.0	1	1	-	-	1	-	-	-	-
TH32	TH32-1	0.0 - 0.3	1	1	-	-	-	-	-	-	-
	TH32-2	0.9 - 1.2	1	1	-	-	1	-	-	-	-
TH33	TH33-1	0.6 - 0.9	1	1	-	-	-	-	-	-	1
	TH33-2	1.2 - 1.5	1	1	-	1	1	-	-	-	-
	TH33-3	2.7 - 3.0	1	1	-	-	-	-	-	-	-
Sediments											
SED1	SED1	0.0 - 0.3	1	1	-	-	-	-	-	-	1
SED2	SED2	0.0 - 0.3	1	1	-	1	1	-	-	-	-
SED3	SED3	0.0 - 0.3	1	1	-	1	1	-	-	-	-
SED4	SED4	0.0 - 0.3	1	1	-	1		-	-	-	1
SED5	SED5	0.0 - 0.3	1	1	-	1	1	1	-	-	-
SED6	SED6	0.0 - 0.3	1	1	-	1	1	-	-	-	-
SED7	SED7	0.0 - 0.3	1	1	-	1		1	-	-	-
SED8	SED8	0.0 - 0.3	1	1	-	1	1	1	-	-	-
Total Number Analyzed			**118**	**112**	**34**	**65**	**50**	**16**	**8**	**10**	**23**

Notes:

PID: Headspace analysis for volatile organic compounds (VOC) using a Portable Photoionization Detector

DDT: Sum of DDT, DDD and DDE isomers

PCB: Total polychlorinated biphenyls

EPH: Total extractable petroleum hydrocarbons using PetroFLAG™ test kits

OCP: Organochlorine pesticides including DDT, DDD and DDE isomers

VOC: Volatile organic compounds

2.6.5.2 Water Samples

Five water samples were collected and all of them were analyzed for the following:

- DDTs by high resolution GC/MS at Axys in order to achieve a detection limit of <0.001µg/L;
- Total metals;
- Dissolved metals; and,
- Light/heavy extractable hydrocarbons (LEPH/HEPH).

2.7 Erosion Control

As an interim measure to secure the riverbank during periods of high water between the site investigation and final remediation work, Waste Management personnel evaluated and covered the bank with a liner and mesh, where appropriate. The original intent was to place a 12 mil polyethylene liner, on the bank and secure it in place with a 9 gauge, galvanized chain-link mesh. The snow cover at the site during the April investigation, however, precluded the installation of the liner. A section of the mesh however, was installed using 15 mm x 1.2 m re-bar pegs with a large washer welded on one end.

In order to avoid further erosion at the Peel River Waste Site, DIAND Waste Management re-visited the site on May 31, 2000, to fasten the chain-link fencing to the riverbank. The team flew to the site via helicopter from Mayo, Yukon. Upon arrival, the water level of the Peel River was found normal for the season and the water fast flowing, high in turbidity, and with a considerable amount of wood debris afloat. On the site and on most low-lying areas along the river, large slabs of ice were still present from the spring break-up. The slabs on site had caused some damage to the chain-link fencing laid out along the top of the bank during the site assessment in April. Some of the damage was repaired by cutting the fencing and pinning it down again, where possible, with 15 mm x 1.2 m re-bar pegs. The presence of the large slabs of ice, and the slippery conditions on the steep riverbank prevented the team from laying down the 12-mil polyethylene liner as originally anticipated. The chain-link material, however, was successfully strung out and fastened to the bank.

2.8 Health and Safety Program

As part of the field investigation program, a Health and Safety Program designed to meet the requirements of applicable Canadian Occupational Health and Safety Regulations, the Workers Compensation Board (WCB), Workplace Hazardous Materials Information System (WHMIS) and territorial statutes was implemented. The program was attached as an appendix to the work plan and reviewed by the working group prior to its implementation.

The Field Investigation Team was properly equipped with necessary personal protective equipment - using National Institute for Occupational Health and Safety (NIOSH)

guidelines and cold weather gear. A first aid kit was provided along with emergency shelter and survival equipment. All team members familiarized themselves with the Safety Program and Emergency Response Plan and were given specific instructions on actions to be taken in case of safety violations, accidents, personal injury and emergencies.

3. RESULTS AND DISCUSSIONS

3.1 Data Presentation

To facilitate the presentation and ease of readability, all soil/sediment results are presented in ppm (parts per million, equivalent to mg/kg or µg/g). Data for water are given in ppb (parts per billion, equivalent to ng/mL or µg/L).

3.2 Environmental Criteria

The environmental criteria used for contaminants in this report is based on the confirmation of the presence of contaminated media using the:

- **CCME (Canadian Council of Ministers of the Environment) Canadian Environmental Quality Guidelines (EQGs) (CCME, 1999)**

The EQGs provide a broad range of environmental assessment and management functions, which are relevant to this investigation including the following:

- A national benchmark to determine impairment of socially-relevant resource uses;
- Scientific benchmarks or targets in the assessment and remediation of contaminated sites; and,
- The scientific basis for the development of site specific objectives.

Thus, comparisons of contaminant concentrations in samples collected from the site with the EQGs provides a simple, screening-level evaluation of the likelihood of risk to humans, fish, other animals, plants, and other living receptors that use the site or are part of the larger ecosystem. Contaminant concentrations that exceed the benchmarks do not necessarily result in harmful impacts; rather, environmental concentrations below the benchmarks are very unlikely to cause harm. Contaminant concentrations in excess of the relevant criterion or standard may or may not lead to elevated risk depending on a large suite of site-specific conditions, including the organisms present.

The CCME EQGs for soil samples are divided into four land use categories:

- Agricultural;
- Residential/Parkland;
- Commercial; and,
- Industrial.

Peel River is currently used for recreational purposes and the residential/parkland criteria are therefore the most appropriate for soil samples. The agricultural criteria were deemed inappropriate since they were developed for land use involving intensive

and repeated sowing and harvesting of plants and intense livestock husbandry, and are based on scientific information such as the bioaccumulation of contaminants by livestock feeding exclusively on plants grown in contaminated soils.

The CCME EQGs for water are discussed under four categories for freshwater:

- Community – guidelines for this water use are provided for maximum acceptable concentrations (MAC) or interim maximum acceptable concentrations (IMAC);
- Recreational and Aesthetic – guidelines are narrative and no numerical values are given;
- Aquatic life – water is used as a habitat for any component of the freshwater ecosystem; and,
- Agricultural - irrigation water use and consumption by livestock.

For surface water samples collected at Peel River, Aquatic Life (AW) water guidelines are relevant, as are community and recreational uses.

A hole was drilled through the ice on the river following which samples comprising of sand and gravel were collected from the Peel River bed. These samples were considered as sediments in this report and were evaluated using the CCME Sediment Quality Guidelines for the Protection of Aquatic Life (CCME, 1999).

Two sediment quality assessment values are available:

- TEL (Threshold Effects Level) – this represents the concentration below which adverse biological effects are expected to occur rarely; and,
- PEL (Probable Effects Level) – defines the concentration above which adverse effects are expected to occur frequently.

Both TEL and PEL values are presented and used for the Peel River sediment samples.

The low water solubility, high lipid solubility and high soil/sediment adsorption coefficient (Koc) of DDT and its metabolites cause them to be preferentially incorporated into sediments and accumulate in the tissues of aquatic organisms rather than remain in the water column. As such, sediments represent an important route of exposure for aquatic biota to DDTs. The CCME sediment quality guidelines are scientific tools that synthesize information regarding the relationships between the sediment concentrations of DDTs and any adverse biological effects resulting from exposure to these chemicals. They were developed from the available toxicological information according to the formal protocol established by CCME. Further details on the derivation and evaluation of Canadian ISQGs and PELs for both freshwater and marine sediments are given in protocols reprinted in the CCME Canadian Environmental Quality Guidelines (CCME, 1999).

3.2.1 Guidelines for DDT

Table 3.1 contains the CCME EQGs for DDT. For soil samples, soil quality guidelines refers to total DDT which is the sum of the concentrations of 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT.

Data for sediments are presented as ISQG (Interim Sediment Quality Guidelines) and PEL (Probable Effects Level). The ISQGs and PELs refer to DDT (sum of the concentrations of 2,4'-DDT, and 4,4'-DDT), DDE (sum of the concentrations of 2,4'-DDE, and 4,4'-DDE) and DDD (sum of the concentrations of 2,4'-DDD, and 4,4'-DDD) in surficial sediments. Note that this is different from the soil quality guideline that is the sum of the concentrations of all six isomers. There are currently no CCME guidelines for DDT in water since environmental exposure to DDT is primarily through sediment, soil and/tissue (CCME, 1999).

Table 3.1: Canadian Environmental Quality Guidelines for DDT

Parameter	Soil	Freshwater Sediment		Fresh Water	
	Residential/Park (ppm)	ISQG (ppm)	PEL (ppm)	Aquatic Life (ppb)	Community MAC (ppb)
DDD (2,4'-DDD + 4,4'-DDD)	-	0.00354	0.00851	-	-
DDE (2,4'-DDE + 4,4'-DDE)	-	0.00142	0.00675	-	-
DDT (2,4'-DDT + 4,4'-DDT)	-	0.00119	0.0047	-	-
Total DDT	0.7	-	-	-	-

Notes:

ISQG: Interim sediment quality guideline
PEL: Probable effect level
MAC: Minimum acceptable concentration
Total DDT: Sum of the concentrations of 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT.

3.2.2 Other Persistent Chlorinated Organic Compounds

Table 3.2 contains guidelines for persistent chlorinated organic compounds including polychlorinated biphenyls (PCBs) and pesticides other than DDTs. There are generally no guidelines for chlorinated pesticides in soil and water samples; guidelines are however, available for sediment samples.

Table 3.2: Canadian Environmental Quality Guidelines for Persistent Chlorinated Organic Compounds

Parameter	Soil	Freshwater Sediment		Fresh Water	
	Residential/Park (ppm)	ISQG (ppm)	PEL (ppm)	Aquatic Life (µg/L)	Community MAC (µg/L)
Polychlorinated Biphenyls (PCBs)	0.5	0.0341	0.277		
Pesticides					
Aldrin	-	-	-	-	-
alpha-BHC	-	-	-	-	-
beta-BHC	-	-	-	-	-
delta-BHC	-	-	-	-	-
Chlordane (Total)	-	0.0045	0.00887	-	-
Dieldrin	-	0.00285	0.00667	-	-
Endosulfan I	-	-	-	-	-
Endosulfan II	-	-	-	-	-
Endosulfan Sulfate	-	-	-	-	-
Endrin	-	0.00267	0.0624	-	-
Endrin Aldehyde	-	-	-	-	-
Heptachlor	-	0.0006	0.0027	-	-
Heptachlor Epoxide	-	-	-	-	-
Lindane (gamma - BHC)	-	0.00094	0.00138	0.01	-
Methoxychlor	-	-	-	-	900
Mirex	-	-	-	-	-
cis-Nonachlor	-	-	-	-	-
trans-Nonachlor	-	-	-	-	-

Notes:
ISQG: Interim sediment quality guideline
PEL: Probable effect level
MAC: Minimum acceptable concentration

3.2.3 Hydrocarbons

The CCME EQGs for hydrocarbons are given in Table 3.3. These include the monocyclic aromatic hydrocarbons (benzene, toluene, ethylbenzene, xylenes and styrene - collectively referred to as BTEX), Volatile Petroleum Hydrocarbon (VPH), Polycyclic Aromatic Hydrocarbons (PAH), Extractable Hydrocarbons (EPH), Light Extractable Hydrocarbons (LEPH) and Heavy Extractable Hydrocarbons (HEPH). VPH is obtained by subtracting the concentrations of benzene, toluene, ethylbenzene and xylenes from that of Volatile Hydrocarbons (VH) that elute between n-hexane (nC6) and n-decane (nC10). The concentrations for LEPHs are derived by the subtraction of naphthalene and phenanthrene from the EPH (C10-C19) values. Similarly, HEPHs are calculated by subtracting the concentrations of benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a) pyrene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene and pyrene from the EPH (C19-C31) data.

The CCME EQGs for extractable hydrocarbons are currently under development as such standards for EPH, LEPH and HEPH were adapted from the:

- **Yukon Renewable Resources, Contaminated Sites Regulation (Yukon CSR, 1996).**

Table 3.3: Canadian Environmental Quality Guidelines for Hydrocarbons

Parameter	Soil	Freshwater Sediment		Fresh Water	
	Residential/Park (ppm)	ISQG (ppm)	PEL (ppm)	Aquatic Life (µg/L)	Community MAC (µg/L)
Volatiles					
Benzene	0.5	-	-	370	5
Ethylbenzene	1.2	-	-	90	-
Styrene	5	-	-	72	-
Toluene	0.8	-	-	2.0	-
Xylenes (totals)	1	-	-	-	-
VPH C6-10	-	-	-	-	-
PAHs					
Acenaphthene	-	0.00671	0.0889	5.8	-
Acenaphthylene	-	0.00587	0.128	-	-
Acridine	-	-	-	4.4	-
Anthracene	-	0.0469	0.245	0.012	-
Benz(a)anthracene	1	0.0317	0.385	0.018	-
Benzo(a)pyrene	0.7	0.0319	0.782	0.015	0.01
Benzo(b)fluoranthene	1	-	-	-	-
Benzo(g,h,i)perylene	-	-	-	-	-
Benzo(k)fluoranthene	1	-	-	-	-
Chrysene	-	0.0571	0.862	-	-
Dibenz(a,h)anthracene	1	0.0622	0.135	-	-
Fluoranthene	-	0.111	2.355	0.04	-
Fluorene	-	0.0212	0.144	3.0	-
Indeno(1,2,3-c,d)pyrene	1	-	-	-	-
Naphthalene	0.6	0.0346	0.391	1.1	-
Phenanthrene	5	0.0419	0.515	0.4	-
Pyrene	10	0.053	0.875	0.025	-
Extractables					
EPH (C10-18)	-	-	-	-	-
EPH (C19-31)	-	-	-	-	-
LEPH*	1000	-	-	-	-
HEPH*	1000	-	-	-	-

Notes:

ISQG: Interim sediment quality guideline
PEL: Probable effect level
MAC: Minimum acceptable concentration
*L/HEPH: Values adapted from Yukon Contaminated Sites Regulation (1996)

3.2.4 Metals

Guidelines for metals are summarized in Table 3.4.

Table 3.4: Summary of Canadian Environmental Quality Guidelines for Metals

Parameter	Soil	Freshwater Sediment		Fresh Water	
	Residential/Park (ppm)	ISQG (ppm)	PEL (ppm)	Aquatic Life (ppb)	Community MAC (ppb)
Aluminum	-	-	-	5 – 100[1]	-
Antimony	20	-	-	-	6 (IMAC)
Arsenic	12	5.9	17	5.0	25 (IMAC)
Barium	500	-	-	-	1000
Beryllium	4	-	-	-	-
Boron	-	-	-	-	5000 (IMAC)
Cadmium	10	0.6	3.5	0.017	-
Calcium	-	-	-	-	-
Chromium	64	37.3	90	8.9 (as Cr III)	50
Cobalt	50	-	-	-	-
Copper	63	35.7	197	2 – 4[2]	-
Iron	-	-	-	300	-
Lead	140	35	91.3	1 – 7[2]	10
Magnesium	-	-	-	-	-
Manganese	-	-	-	-	-
Mercury	6.6	0.17	0.486	0.1	1
Molybdenum	-	-	-	73	-
Nickel	50	-	-	25 – 150[2]	-
Selenium	3	-	-	1.0	10
Silver	20	-	-	0.1	-
Thallium	1	-	1	0.8	1
Uranium	-	-	-	-	100
Zinc	200	123	315	30	-

Notes:

ISQG: Interim sediment quality guideline
PEL: Probable effect level
MAC: Minimum acceptable concentration
1: Guideline is dependent on pH
2: Guideline is dependent on Hardness

3.2.5 Halogenated Volatile Organic Compounds

There are currently no CCME EQGs for sediments. Data is available for soil samples and these are given in Table 3.5 below.

Table 3.5: Summary of Canadian Environmental Quality Guidelines for Halogenated Volatile Organic Hydrocarbons in Soils

Parameter	Soil
	Residential/Park (ppm)
Bromodichloromethane	-
Bromoform	-
Carbon Tetrachloride	5
Chlorobenzene	2
Chloroethane	5
Chloroform	5
Chloromethane	5
Dibromochloromethane	1
1,2-Dichlorobenzene	1
1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	1
1,1-Dichloroethane	5
1,2-Dichloroethane	5
cis-1,2-Dichloroethylene	5
trans-1,2-Dichloroethylene	5
1,1-Dichloroethylene	5
Dichloromethane	5
1,2-Dichloropropane	5
cis-1,3-Dichloropropylene	5
trans-1,3-Dichloropropylene	5
1,1,1,2-Tetrachloroethane	5
1,1,2,2-Tetrachloroethane	5
Tetrachloroethylene	0.2
1,1,1-Trichloroethane	5
1,1,2-Trichloroethane	5
Trichloroethylene	3
Trichlorofluoromethane	-
Vinyl Chloride	5

3.3 Results for DDT

3.3.1 DDT in Soil Samples

A majority of the subsurface samples collected were screened on site for total DDT with the immunoassay test kits. Samples from a number of boreholes contained concentrations that exceeded 1 ppm (Table 3.6). These boreholes included TH3, TH4, TH16, TH19, TH26, TH27, TH28 and TH29, which were all on the eastern side of the site (Figure 3.1). This confirmed the results of the previous investigation that indicated elevated levels of DDT on the eastern side of the waste side. Total DDT at concentrations between 0.2 – 1.0 ppm was generally detected in the remaining boreholes.

The results of the laboratory analysis confirmed the presence of DDTs in subsurface samples on the upper bench and surface/subsurface samples along the slope below the bench (cutbank). The total DDT concentrations in a number of samples identified as contaminated through field screening exceeded the CCME environmental quality guideline for residential/park land of 0.7 ppm (Table 3.7, shaded area). The results are also presented in Figure 3.1.

The DDT contamination was associated with waste materials as depicted in two cross-sections through the waste pit. Figure 3.2 represents a cross section along boreholes (TH5, TH19, TH16, and TH25) which were found to contain high levels of total DDT using both field and laboratory methods. One sediment sample (SED7) is also included. The second cross section (Figure 3.3) is for boreholes TH23, TH12, TH9, TH29 and SED5.

Table 3.6: Concentration of Total DDTs (ppm) in Soil Samples as Determined with Immunoassay Field Test Kits

Test-Hole	Sample No.	Depth (m)	Total DDTs	Bore-Hole	Sample No.	Depth (m)	Total DDTs	Bore-Hole	Sample No.	Depth (m)	Total DDTs
TH-1	TH1-1	0.6 -1.2	< 0.2	TH9	TH9-1	0.0 - 0.6	< 0.2	TH21	TH21-1	2.7 - 3.0	< 0.2
	TH1-2	3.6 - 4.0	< 0.2		TH9-2	0.0 - 0.6	< 0.2		TH21-2	4.3 - 4.6	0.2 - 1
	TH1-3	4.0 - 4.3	< 0.2		TH9-3	3.0 - 3.3	< 0.2	TH22	TH22-1	0.9 - 1.2	< 0.2
	TH1-4	4.3 - 4.9	< 0.2		TH9-4	4.9 - 5.2	0.2 - 1		TH22-2	4.3 - 4.6	< 0.2
	TH1-5	6.1 - 6.7	< 0.2		TH9-5	6.7 - 7.0	< 0.2	TH23	TH23-1	0.6 - 0.9	0.2 - 1
TH-2	TH2-1	0.0 - 0.6	< 0.2	TH10	TH10-1	0.6 - 0.9	< 0.2		TH23-2	2.7 - 3.0	< 0.2
	TH2-2	2.1 - 2.7	0.2 - 1		TH10-2	1.2 - 1.5	0.2 - 1		TH23-3	4.0 - 4.3	~ 0.2
	TH2-3	3.3 - 3.6	0.2 - 1		TH10-3	3.0 - 3.3	0.2 - 1	TH24	TH24-1	0.0 - 0.6	0.2 - 1
	TH2-4	3.6 - 4.3	0.2		TH10-4	3.3 - 3.6	< 0.2		TH24-2	1.5 - 1.8	0.2 - 1
TH3	TH3-1	3.3 - 3.6	< 0.2		TH10-5	4.3 - 4.6	0.2 - 1		TH24-3	2.7 - 3.0	0.2 - 1
	TH3-2	4.0 - 4.3	1 - 10	TH11	TH11-1	0.0 - 0.6	0.2 - 1	TH25	TH25-1	0.3 - 0.9	0.2 - 1
TH4	TH4-1	0.0 - 0.6	0.2 - 1		TH11-2	1.2 - 1.5	0.2 - 1		TH25-2	2.1 - 2.4	0.2 - 1
	TH4-2	2.4 - 2.7	0.2 - 1	TH12	TH12-1	3.0 - 3.3	0.2 - 1	TH26	TH26-1	0.3 - 0.9	> 10
	TH4-3	4.0 - 4.3	> 10	TH13	TH13-1	0.0 - 0.6	1 - 10	TH27	TH27-1	0.0 - 0.3	1 - 10
	TH4-4	5.5 - 5.8	0.2 - 1		TH13-2	3.0 -3.3	0.2 - 1		TH27-2	0.9 - 1.2	> 10
	TH4-5	7.3 - 7.6	0.2 -1		TH13-3	4.3 - 4.6	< 0.2		TH27-3	2.1 - 2.4	> 10
	TH4-6	7.6 - 7.9		TH14	TH14-1	0.0 - 0.6	0.2 - 1	TH28	TH28-1	0.0 - 0.3	> 10
TH5	TH5-1	0.0 - 0.6	< 0.2		TH14-2	2.7 - 3.0	< 0.2		TH28-2	2.1 - 2.4	> 10
	TH5-3	4.3 - 4.6	< 0.2	TH15	TH15-1	1.5 - 1.8	0.2 - 1		TH28-3	2.7 - 3.0	1 - 10
	TH5-5	7.0 - 7.3	< 0.2		TH15-2	2.7 - 3.0	< 0.2	TH29	TH29-1	0.0 - 0.3	1 - 10
TH6	TH6-1	0.0 - 0.6	< 0.2		TH15-3	4.0 - 4.3	< 0.2		TH29-2	1.2 - 1.5	~ 0.2
	TH6-3	4.0 - 4.3	< 0.2	TH16	TH16-1	2.7 - 3.0	< 0.2		TH29-3	2.7 - 3.0	~ 0.2
	TH6-4	4.9 - 5.2	< 0.2		TH16-2	3.0 - 3.3	0.2 - 1	TH30	TH30-1	0.0 - 0.3	< 0.2
TH7	TH7-1	0.3 - 0.6	< 0.2		TH16-3	3.3 - 3.6	1 - 10		TH30-2	0.0 - 0.3	< 0.2
	TH7-2	2.4 - 3.0	< 0.2		TH16-4	4.0 - 4.3	> 10		TH30-3	0.3 - 0.6	< 0.2
	TH7-3	3.6 - 4.0	0.2 - 1	TH17	TH17-1	2.7 - 3.0	0.2 - 1		TH30-4	1.2 - 1.5	< 0.2
	TH7-4	3.6 - 4.0	0.2 - 1		TH17-2	3.0 - 3.3	0.2 - 1		TH30-5	2.7 - 3.0	< 0.2
	TH7-5	4.3 - 4.6	0.2 - 1		TH17-3	3.0 - 3.3	0.2 - 1	TH31	TH31-1	0.0 - 0.3	< 0.2
	TH7-6	5.2 - 5.5	< 0.2	TH18	TH18-1	0.0 - 0.6	< 0.2		TH31-2	0.9 - 1.2	0.2 - 1
	TH7-7	7.3 - 7.6	< 0.2		TH18-2	3.3 - 3.6	0.2 - 1		TH31-3	2.7 - 3.0	~ 0.2
TH8	TH8-1	0.6 - 0.9	< 0.2		TH18-3	4.3 - 4.6	0.2 -1	TH32	TH32-1	0.0 - 0.3	< 0.2
	TH8-2	1.8 - 2.1	0.2 - 1	TH19	TH19-1	0.6 - 0.9	0.2 - 1		TH32-2	0.9 - 1.2	< 0.2
	TH8-3	3.6 - 4.0	0.2 - 1		TH19-2	3.3 - 3.6	> 10	TH33	TH33-1	0.6 - 0.9	< 0.2
	TH8-4	5.2 - 5.5	0.2 - 1	TH20	TH20-1	0.9 - 1.2	~ 10		TH33-2	1.2 - 1.5	< 0.2
	TH8-5	6.7 - 7.3	0.2 - 1		TH20-2	3.0 - 3.3	< 0.2		TH33-3	2.7 - 3.0	< 0.2
					TH20-3	4.0 - 4.3	< 0.2				

Table 3.7: DDT Concentration (ppm) in Soil Samples as Determined by Laboratory Analysis (Shaded Areas Exceed CCME R/P guideline of 0.7 ppm)

Borehole	Sample #	2,4'-DDD	4,4'-DDD	2,4'-DDE	4,4'-DDE	2,4'-DDT	4,4'-DDT	Total DDT
TH1	TH1-3	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.002	-
TH2	TH2-3	0.013	0.015	< 0.002	0.002	0.003	0.017	0.05
TH3	TH3-2	0.008	0.069	0.006	0.042	0.042	0.304	0.47
TH4	TH4-3	0.068	0.14	0.021	0.079	1.04	3.52	4.9
	TH4-5	0.005	0.008	< 0.002	0.004	0.011	0.045	0.073
TH5	TH5-1	0.002	< 0.001	< 0.002	< 0.001	0.003	0.006	0.011
	TH5-3	0.001	< 0.001	< 0.002	< 0.001	0.002	0.006	0.009
TH6	TH6-3	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.002	-
TH7	TH7-3	0.02	0.027	< 0.002	0.013	0.036	0.048	0.14
	TH7-4	0.115	0.113	0.013	0.085	0.257	0.269	0.85
TH8	TH8-3	0.04	0.066	0.005	0.031	0.034	0.113	0.29
TH9	TH9-3	< 0.001	0.003	< 0.002	< 0.001	0.003	0.008	0.014
	TH9-4	0.02	0.036	0.003	0.013	0.006	0.02	0.098
TH10	TH10-1	< 0.001	0.003	< 0.002	< 0.001	0.001	0.01	0.014
	TH10-5	< 0.001	0.001	< 0.002	< 0.001	< 0.001	< 0.002	0.001
TH12	TH12-1	0.003	0.006	< 0.002	< 0.001	0.004	0.019	0.032
TH13	TH13-1	0.017	0.049	< 0.002	0.012	0.121	0.204	0.40
	TH13-3	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	0.004	0.004
TH14	TH14-1	0.003	0.031	< 0.002	< 0.001	0.021	0.202	0.26
TH15	TH15-1	0.003	0.012	< 0.002	0.002	0.011	0.023	0.051
TH16	TH16-2	0.006	0.009	< 0.002	0.001	0.002	0.009	0.027
	TH16-3	0.187	0.193	0.023	0.134	0.355	2.33	3.2
TH17	TH17-2	0.014	0.013	< 0.002	0.004	0.003	0.012	0.046
	TH17-3	0.017	0.016	< 0.002	0.005	0.003	0.014	0.055
TH18	TH18-2	0.014	0.04	< 0.002	0.003	0.004	0.015	0.076
	TH18-3	0.024	0.022	< 0.002	0.004	0.011	0.028	0.089
TH19	TH19-1	0.008	0.007	< 0.002	0.003	0.005	0.016	0.039
	TH19-2	0.719	2.31	0.013	0.086	4.94	22.4	30
TH20	TH20-3	0.011	0.03	< 0.002	0.001	0.023	0.045	0.11
TH22	TH22-1	0.005	0.002	< 0.002	< 0.001	0.005	0.017	0.029
TH23	TH23-1	0.01	0.055	< 0.002	0.003	0.068	0.168	0.30
TH24	TH24-2	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.002	-
TH25	TH25-2	0.007	0.009	0.002	0.008	0.014	0.042	0.082
TH26	TH26-1	0.557	0.796	0.321	1.99	1.36	7.49	12
TH27	TH27-1	0.103	0.35	0.01	0.092	0.187	1.09	1.8
	TH27-3	3.17	6.67	0.041	0.173	8.68	32.9	52
TH28	TH28-2	0.111	0.167	0.028	0.1	0.457	1.02	1.5
TH29	TH29-1	0.019	0.034	0.003	0.038	0.377	0.779	1.2
	TH29-2	0.018	0.063	< 0.002	0.005	0.009	0.085	0.18
TH30	TH30-1	< 0.001	< 0.001	< 0.002	< 0.001	0.001	0.002	0.003
	TH30-2	0.001	0.001	< 0.002	0.001	0.004	0.009	0.016
TH31	TH31-2	0.004	0.004	< 0.002	0.017	0.011	0.03	0.066
	TH31-3	0.004	0.006	< 0.002	0.002	0.013	0.053	0.078
TH32	TH32-2	0.001	0.001	< 0.002	< 0.001	0.004	0.012	0.018
TH33	TH33-2	< 0.001	< 0.001	< 0.002	< 0.001	< 0.001	< 0.002	-

3.3.2 Estimation of DDT-Contaminated Soil Mass

Field test kit results for total DDT (which includes the sum of p,p'-DDT, o,p'-DDT, p,p'-DDE, o,p'-DDE, p,p'-DDD, and o,p'-DDD) suggested that the major portion of subsurface soil samples contained DDTs in the range of 0.2 to 1 ppm (Table 3.6). As shown in Table 3.6, boreholes with soil samples confirmed to contain total DDT at concentrations in excess of the CCME residential/park land soil quality guideline of 0.7 ppm (based on risks to raptors through trophic transfer) included TH4, TH7, TH16, TH19, and TH26 through TH29.

The maximum concentration of total DDT encountered was 52 ppm in TH27-3, at a depth of 2.1 to 2.4 m. The surface sample, TH27-1 (0 to 0.3 m depth) was also contaminated with DDT (1.8 ppm). This suggests that the DDT contaminated soil mass may be over approximately 2.5 m thick near the centre of a possible leachate plume. For TH16, field test kit results indicate substantial DDT contamination in the sample from the maximum excavation depth of 4.0 to 4.3 m (TH16-4: > 10 ppm). The sample from TH16-3, at a depth of 3.3 to 3.6 m exhibited a field test kit result of 1-10 ppm DDTs and a laboratory result of 3.2 ppm. Had sample TH16-4 been analyzed in the laboratory, it is likely that a result much greater than 3.2 ppm, as shown on Figure 3.1, would have been observed.

The observed distribution of DDT-contaminated soils is consistent with the presence of a buried source or sources in the vicinity of TH16/TH19 and contaminated leachate migration, entrained along with other organic substances including BTEX and dichloromethane toward the river in a southerly to southwesterly direction. Figure 3.4 shows the inferred extent of spatial contamination of subsurface soils with a concentration exceeding 0.7 ppm. Samples could not be obtained below the layer containing debris at TH2 and TH3 due to auger refusal.

Based on the preceding analysis and a DDTs soil remediation guideline of 0.7 ppm, the volume of DDT contaminated soil is estimated as follows:

- areal extent: 450 m^2 approximate
- estimated average depth: 1.5 m
- estimated volume: 675 m^3 approximate
- with 50% contingency: approx. 1,100 m^3 approximate

3.3.3 Special Waste/Leachate Extraction Procedure (SWEP/LEP)

Five soil samples were subjected to the Special Waste/Leachate Extraction Procedure (SWEP/LEP) outlined in the Waste Management Act, British Columbia Special Waste Regulation (BC, Reg. 63/88) to ascertain if they contained leachable toxic waste. For DDTs a waste is considered "Special Waste" if it produces an extract with a total DDT concentration in excess of 3 ppm (mg/L) as given in the Leachate Quality Standards presented in Schedule 4 of the Special Waste Regulation.

The concentrations of DDTS in all the SWEP/LEP extracts were below detection (Table 3.8); the complete laboratory report is attached to Appendix B. Thus even though elevated levels of DDTs exceeding the residential parkland standard were found in soils samples at the Peel River Waste Site, the contaminated materials are not considered as "Special Waste" under the BC Special Waste Regulations.

Table 3.8: Concentration (ppm) of Leachable DDTs in Soil Samples Subjected to the Special Waste/Leachate Extraction Procedure

Sample ID	TH4-3	TH7-4	TH16-3	TH19-2	TH26-1
Physical Tests					
Moisture %	16.4	12.5	42.1	31.7	60.4
Initial SWEP pH	8.15	8.50	8.36	9.35	8.89
Final SWEP pH	5.44	5.42	5.46	5.41	5.32
DDTs (ppm or mg/L)					
2,4'-DDD	< 0.0001	< 0.0001	< 0.0001	< 0.0002	< 0.0006
4,4'-DDD	< 0.00005	< 0.00005	< 0.00005	< 0.0001	< 0.0003
2,4'-DDE	< 0.0001	< 0.0001	< 0.0001	< 0.0002	< 0.0006
4,4'-DDE	< 0.00005	< 0.00005	< 0.00005	< 0.0001	< 0.0003
2,4'-DDT	< 0.0001	< 0.0001	< 0.0001	< 0.0002	< 0.0006
4,4'-DDT	< 0.0001	< 0.0001	< 0.0001	< 0.0002	< 0.0006

3.3.4 DDTs in Sediments

The Peel River would be expected to rapidly dilute contaminated soils eroded from the waste pit as well as contaminated groundwater entering the river. The transient nature of river water and sediment near the site, therefore, would be expected to limit the extent to which elevated concentrations of DDT will be observed. Table 3.8 shows the DDT data for Peel River surface sediments in the vicinity of the waste pit. Sample SED8 was upstream from the waste pit inputs, and was deemed to represent a reference sample affected only by more diffuse sources, such as contributed through long-range atmospheric transport and deposition in the watershed. This sample contained 0.003 ppm of DDT that exceeded the Interim Sediment Quality Guideline (ISQG) but was lower than the PEL while DDT concentrations in the remaining samples were at least an order of magnitude higher (0.01 to 2.4 ppm) and greater than the PEL. Comparable results were obtained for DDD and DDE in that elevated levels greater than the ISQG were detected in the sediments obtained from locations directly below the waste pit. Detectable levels of DDT and metabolites were present in all five sediment samples analyzed in the laboratory (Table 3.9).

The DDT concentrations in Peel River sediment confirm the past offsite transport of DDT-contaminated groundwater and/or soils into the Peel River, at concentrations that could result in localized impacts.

Table 3.9: Concentration of DDTs (ppm) in Sediment Samples

Sample No.	Field Test Kit	Laboratory Analysis		
	Total DDT[1]	DDD[2]	DDE[3]	DDT[4]
CCME ISQG[5]	-	*0.0035*	*0.00142*	*0.00119*
CCME PEL[6]	-	*0.00851*	*0.00675*	*0.00477*
SED-1	< 0.2	-	-	-
SED-2	< 0.2	0.008	0.001	0.017
SED-3	0.2 - 1	0.098	0.006	2.4
SED-4	< 0.2	-	-	-
SED-5	0.2 - 1	0.042	0.047	0.13
SED-6	0.2 - 1	0.033	0.002	0.21
SED-7	< 0.2	-	-	-
SED-8	< 0.2	0.001	< 0.001	0.003

Notes:

1. Total DDT: Sum of the concentrations of 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, and 4,4'-DDT.
2. DDT: Sum of the concentrations of 2,4'-DDT, and 4,4'-DDT.
3. DDD: Sum of the concentrations of 2,4'-DDD and 4,4'-DDD.
4. DDE: Sum of the concentrations of 2,4'-DDE and 4,4'-DDE.
5. ISQG: Interim sediment quality guideline
6. PEL: Probable effect level

3.3.5 DDTs in Peel River Water

The concentrations of DDTs in five surface water samples collected from Peel River are presented in Table 3.10. Sample Peel W-1 was obtained 150 m up stream of the river and therefore was used as the site control. DDTs in this sample occurred at concentrations below the detection limits except for p,p'-DDD. Although p,p' DDD was detected in Peel W-1 (0.00036 ppb), the concentration was comparable to that found in the laboratory procedural blank (0.00022 ppb).

The concentrations of DDTs in the three samples collected directly below the waste site (Peel W-2, W-3 and W-4) were generally below detection or very low. Similar results were obtained for sample Peel W-5 obtained 150 m down gradient of the waste site.

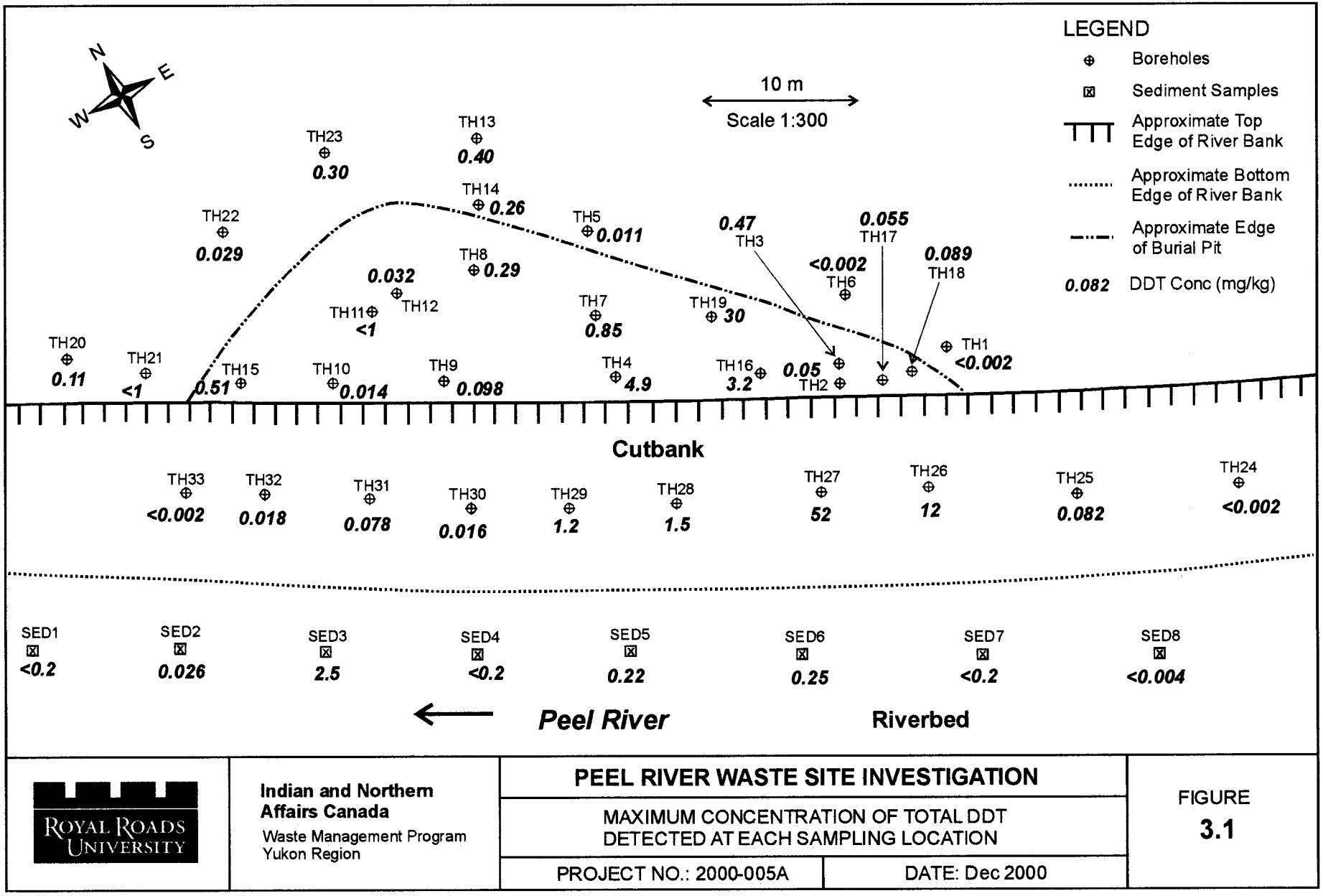
There are currently no CCME standards for DDTs in water. The Yukon CSR recommends a standard of 0.01 ppb for freshwater aquatic life for groundwater. Allowing for a ten-fold dilution for water in the receiving environment of the river would imply a standard of 0.001 ppb DDT. The results obtained for surface water samples in this investigation are all below the Yukon standard for freshwater aquatic life. Thus though elevated levels of DDTs were found in soil and sediment samples at he waste site, the concentrations of DDTs detected in the river are very low.

Table 3.10: Concentrations (ppb) of DDT in Peel River Surface Water Samples

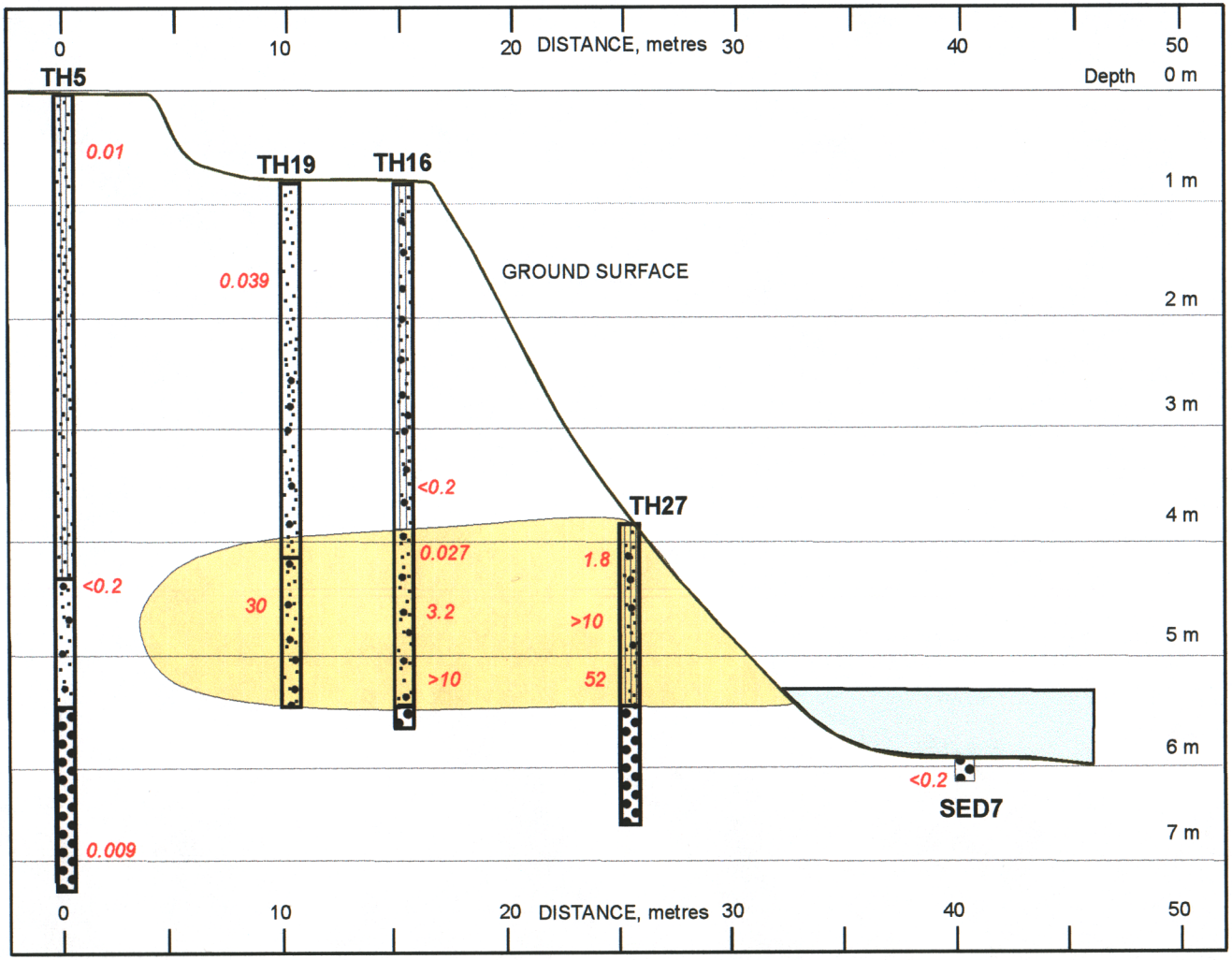
Sample #	o,p'-DDE	p,p'-DDE	o,p'-DDD	p,p'-DDD	o,p'-DDT	p,p'-DDT	Total DDTs
Lab Blank	< 0.00024	0.00022	< 0.00018	< 0.00020	< 0.00038	< 0.00045	0.00022
Peel W-1	< 0.00041	0.00036	< 0.00042	< 0.00045	< 0.00024	< 0.00028	0.00036
Peel W-2	< 0.00027	< 0.00023	< 0.00020	< 0.00021	0.000088 [nq]	0.00020	0.00020
Peel W-3	< 0.00019	0.00042	< 0.00013	< 0.00014	< 0.00011	< 0.00013	0.00042
Peel W-4	< 0.00026	< 0.00023	0.00028[nq]	< 0.00030	< 0.00035	< 0.00041	nd
Peel W-5	< 0.00084	0.00061	0.00041[nq]	< 0.00023	< 0.00023	< 0.00027	0.00061

Notes:

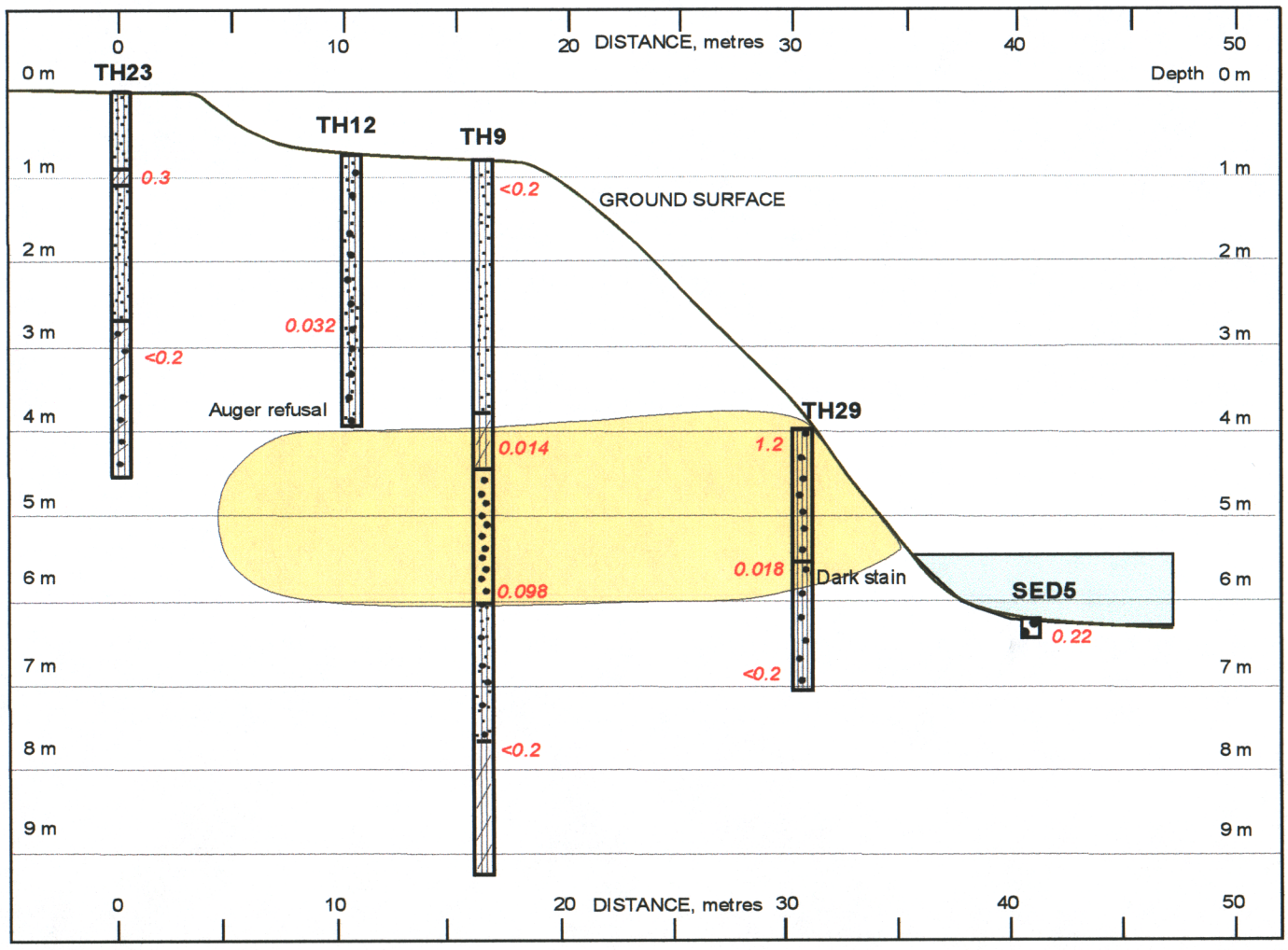
1. < = less than the detection limit indicated
2. nd = sum of total DDTs below detection
3. nq = peak detected but did not meet the quantification criteria



ROYAL ROADS UNIVERSITY	**Indian and Northern Affairs Canada** Waste Management Program Yukon Region	**PEEL RIVER WASTE SITE INVESTIGATION** MAXIMUM CONCENTRATION OF TOTAL DDT DETECTED AT EACH SAMPLING LOCATION PROJECT NO.: 2000-005A DATE: Dec 2000	FIGURE **3.1**



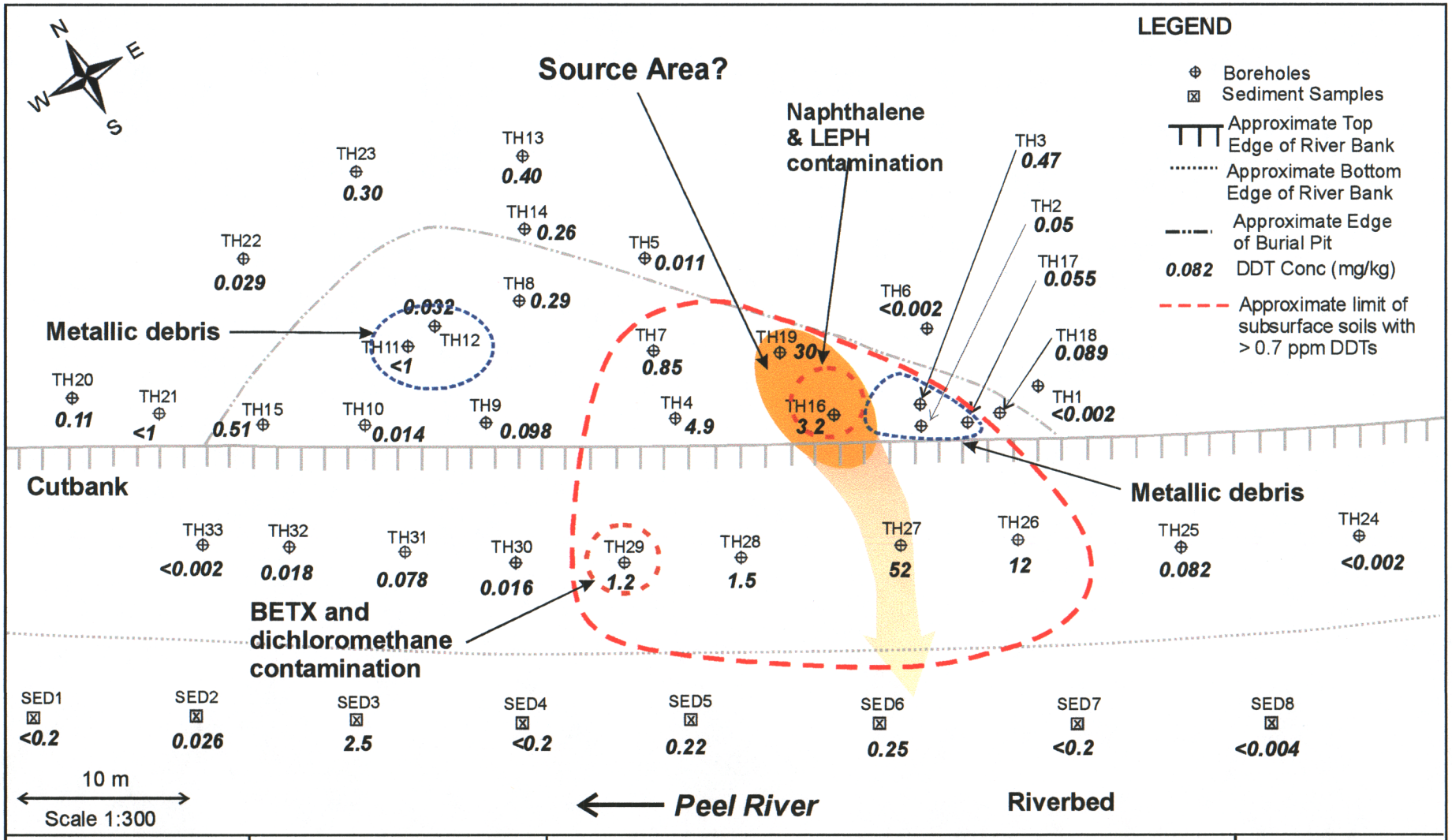
ROYAL ROADS UNIVERSITY	**Indian and Northern Affairs Canada** Waste Management Program Yukon Region	**PEEL RIVER WASTE SITE INVESTIGATION**	DATE: Dec 2000
		CROSS SECTION OF EASTERN SIDE OF WASTE PIT SHOWING SUBSURFACE PROFILE, TOTAL DDT CONCENTRATIONS AND AREA OF BURIED DEBRIS	Figure. **3.2**



LEGEND

- Silt
- Sand
- Gravel
- Sand and Gravel
- Sand and Silt
- Silt and Gravel
- Sand, Silt and Gravel
- Clay
- Approximate area containing debris including bentonite, cement, wood, fibrous material
- Approximate limits of ice on Peel River during the site investigation
- <0.2 Total DDT conc in ppm

ROYAL ROADS UNIVERSITY	**Indian and Northern Affairs Canada** Waste Management Program Yukon Region	**PEEL RIVER WASTE SITE INVESTIGATION**	DATE: Dec 2000
		CROSS SECTION OF MIDDLE SECTION OF WASTE PIT SHOWING SUBSURFACE PROFILE, TOTAL DDT CONCENTRATIONS AND AREA OF BURIED DEBRIS	Figure. **3.3**



Royal Roads University	**Indian and Northern Affairs Canada** Waste Management Program Yukon Region	**PEEL RIVER WASTE SITE INVESTIGATION** INFERRED EXTENT OF SOIL CONTAMINATION, EXCLUDING METALS/METALLOIDS PROJECT NO.: 2000-005A | DATE: Dec 2000	FIGURE **3.4**

3.4 Results for Other Persistent Chlorinated Hydrocarbons

This group of analytes included PCBs and chlorinated pesticides other than DDTs. Fifty samples were analyzed for chlorinated pesticides in the laboratory while immunoassay test kits were used to screen 34 samples for PCBs, 10 of which were reanalyzed in the laboratory. The concentrations of all these parameters were below detection. Detailed results are included in the laboratory report attached to Appendix B. The list of compounds and the concentrations in each of the samples analyzed (i.e., detection limits achieved for each analyte) are given in Table 3.11.

Table 3.11: Concentrations of Chlorinated Organic Compounds in Soil/Sediment Samples

Parameter	Concentration in Each Sample Analyzed (ppm)	CCME Environmental Quality Guidelines for Residential/Park Land Use (ppm)
Total Polychlorinated Biphenyls	< 0.05	0.5
Organochlorine Pesticides		
Aldrin	< 0.001	-
alpha-THC	< 0.001	-
beta-THC	< 0.002	-
delta-THC	< 0.001	-
cis-Chlordane (alpha)	< 0.001	-
trans-Chlordane (gamma)	< 0.001	-
Dieldrin	< 0.001	-
Endosulfan I	< 0.001	-
Endosulfan II	< 0.001	-
Endosulfan Sulfate	< 0.001	-
Endrin	< 0.005	-
Endrin Aldehyde	< 0.01	-
Heptachlor	< 0.002	-
Heptachlor Epoxide	< 0.001	-
Lindane (gamma - THC)	< 0.001	-
Methoxychlor	< 0.005	-
Mirex	< 0.001	-
cis-Nonachlor	< 0.001	-
trans-Nonachlor	< 0.001	-

3.5 Results for Metals

3.5.1 Metals in Soils

The concentrations of most of the metals and metalloids in the 23 samples analyzed were either below detection or well below the CCME EQG for residential/park land use (Table 3.12). The exceptions were arsenic and barium. Arsenic was consistently high in most of the samples and may be a reflection of local geological conditions. The elevated levels of barium may be attributed to drilling mud buried in the disposal pit. Barium compounds are used by the oil and gas industries to make drilling muds.

Table 3.12: Concentration of Metals and Metalloids (ppm) in Soil/Sediment Samples

Sample #	CCME R/P	TH1-1	TH2-2	TH2-4	TH3-2	TH7-3	TH7-4	TH7-5	TH17-2	TH17-3	TH18-2	TH18-3	TH21-2
Moisture %		11.6	12.9	24.7	27.4	13.2	14.5	28	21.2	19.1	23.1	20.5	12.9
pH		8.13	7.83	7.55	7.52	7.91	7.86	8.09	7.75	7.82	7.79	7.89	7.89
Total Metals													
Antimony	20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Arsenic	12	**12**	**14**	**13**	11	**12**	**13**	10	**14**	**14**	10	**14**	**12**
Barium	500	407	403	375	100	**566**	**577**	**596**	**822**	**632**	405	**507**	**516**
Beryllium	4	0.7	0.8	0.8	0.8	0.7	0.7	0.8	0.9	0.8	0.6	0.9	0.7
Cadmium	10	1.2	1.3	0.6	0.5	0.6	0.6	< 0.5	0.6	0.6	< 0.5	0.6	< 0.5
Chromium	64	37	36	35	40	33	35	33	43	36	29	41	40
Cobalt	50	8	11	9	8	8	8	7	9	10	7	10	8
Copper	63	32	30	26	56	45	44	45	29	29	21	28	25
Lead	140	< 50	< 50	< 50	< 50	< 50	140	< 50	< 50	< 50	< 50	< 50	< 50
Mercury	6.6	0.06	0.052	0.058	0.062	0.052	0.052	0.042	0.069	0.067	0.065	0.082	0.052
Molybdenum	-	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Nickel	50	29	36	29	27	27	28	22	32	32	22	32	27
Selenium	3	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Silver	20	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Thallium	1	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin	-	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	130	106	107	101	101	106	116	87	130	111	84	123	98
Zinc	200	104	120	108	145	109	109	92	116	120	86	118	95

continued

Notes:

Shaded areas indicate parameters that equal or exceed the CCME residential/park guidelines

Table 3.12: Continued

Sample #	CCME R/P	TH24-3	TH25-2	TH26-1	TH27-1	TH27-3	TH28-2	TH29-2	TH31-1	TH33-1	SED-1	SED-4
Moisture%		14.8	14.1	71.2	69.5	27.8	51.5	55.8	26.5	10.6	13.1	15.5
pH		8.29	8.29	8.97	10	9.09	9.44	9.98	7.97	8.15	8.23	8.1
Total Metals												
Antimony	20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
Arsenic	12	7	10	< 5	6	< 5	< 5	< 5	**15**	**16**	11	**14**
Barium	500	323	342	**2070**	**761**	169	248	**3510**	**507**	430	438	319
Beryllium	4	< 0.5	< 0.5	0.7	0.9	< 0.5	0.8	1.6	0.8	0.8	0.6	0.5
Cadmium	10	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	0.5	< 0.5	< 0.5
Chromium	64	28	17	20	29	12	12	6	34	37	25	21
Cobalt	50	4	7	2	4	4	2	< 2	9	8	6	9
Copper	63	15	22	10	13	15	6	3	26	24	18	17
Lead	140	< 50	< 50	73	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50
Mercury	6.6	0.026	0.031	0.03	0.038	0.015	0.021	0.019	0.059	0.052	0.032	0.168
Molybdenum	-	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4	< 4
Nickel	50	16	24	7	12	10	7	< 5	32	31	24	27
Selenium	3	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Silver	20	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Thallium	1	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin	-	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Vanadium	130	72	52	34	44	28	28	11	112	127	91	84
Zinc	200	42	72	35	56	32	37	41	119	99	74	96

Notes:

Shaded areas indicate parameters that equal or exceed the CCME residential/park guidelines

3.5.2 Special Waste/Leachate Extraction Procedure (SWEP/LEP)

Five of the soil samples were subsequently subjected to the Special Waste/Leachate Extraction Procedure (SWEP/LEP) outlined in the Waste Management Act, British Columbia Special Waste Regulation (BC, Reg. 63/88) to ascertain if they contained leachable toxic waste. A waste is considered "Special Waste" if it produces an extract with a contaminant concentration greater than those prescribed in the Leachate Quality Standards presented in Schedule 4 of the regulation.

Results for leachable metals in five soil samples are given in Table 3.13 below; the complete laboratory report is attached to Appendix B.

Metal concentrations in all the extracts were below the Leachate Quality Standards (Table 3.13) even though high levels of metals such as barium (up to 3510 ppm) were found in the soil samples. The metal-contaminated soils are therefore, not considered as "Special Waste" under the BC Contaminated Sites Regulation.

Table 3.13: Concentration (ppm) of Leachable Metals in Soil Samples Subjected to the Special Waste/Leachate Extraction Procedure

Sample ID	TH1-1	TH7-4	TH26-1	TH29-2	TH31-1	Leachate Quality Standard
Physical Tests						
Moisture %	10.5	16	71.4	54.6	13.2	
Initial SWEP pH	8.91	8.80	9.72	9.93	8.76	
Final SWEP pH	5.46	5.46	5.85	5.51	6.34	
Extractable Metals						
Arsenic	< 0.2	< 0.2	<1	< 0.2	< 0.2	5.0
Barium	0.80	0.73	9.9	68.3	0.42	100
Boron	< 0.1	< 0.1	< 0.5	< 0.1	< 0.1	500
Cadmium	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	0.5
Chromium	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	5.0
Copper	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	100
Lead	< 0.05	< 0.05	< 0.3	< 0.05	< 0.05	5.0
Mercury	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005	0.1
Selenium	< 0.2	< 0.2	<1	< 0.2	< 0.2	1.0
Silver	< 0.01	< 0.01	< 0.05	< 0.01	< 0.01	5.0
Zinc	0.06	0.11	0.3	< 0.05	< 0.05	500

3.5.3 Metals in Water

Five water samples were analyzed for total metals (Table 3.14) and dissolved metals (Table 3.15). The metal concentrations for most of the metals exceeded the CCME EQG for aquatic life use. Elevated metal concentrations were generally associated with particulate matter as suggested by dissolved metal concentrations.

Table 3.14: Concentration of Total Metals (ppb) in Peel River Water Samples

Parameter	CCME EQGs		Concentration in Water Samples (ppb)				
	Aquatic Life (ppb)	Community MAC (ppb)	PeelW-1	PeelW-2	PeelW-3	PeelW-4	PeelW-5
Hardness as $CaCO_3$ (mg/L)			87.9	92.4	92.5	92.9	89.4
Aluminum	5 – 100	-	22,700	32,800	31,000	26,300	26,600
Antimony	-	6	< 200	< 200	< 200	< 200	< 200
Arsenic	5.0	25	< 200	< 200	< 200	< 200	< 200
Barium	-	1000	980	1,190	1,190	1,100	1,030
Beryllium	-	-	< 5	< 5	< 5	< 5	< 5
Boron	-	5000	200	200	200	200	200
Cadmium	0.017	-	1.0	1.0	1.0	1.0	0.9
Calcium	-	-	51,500	52,000	50,800	48,000	46,400
Chromium	-	50	40	60	60	50	50
Cobalt	-	-	10	20	20	20	10
Copper	2 – 4	-	40	40	50	50	40
Iron	300	-	34,400	42,700	41,900	40,300	35,400
Lead	1 – 7	10	20	23	21	20	22
Magnesium	-	-	20,000	21,500	21,200	19,400	18,800
Manganese	-	-	462	518	501	485	444
Mercury	0.1	1	0.20	0.12	0.20	0.21	0.16
Molybdenum	73	-	< 30	< 30	< 30	< 30	< 30
Nickel	25 – 150	-	< 50	60	50	50	< 50
Selenium	1.0	10	2	2	2	2	2
Silver	0.1	-	0.2	0.4	0.3	0.3	0.3
Thallium	0.8	1	0.6	0.7	0.7	0.6	0.6
Uranium	-	100	2.25	2.48	2.39	2.24	2.19
Zinc	30	-	180	206	204	205	179

Table 3.15: Concentration of Dissolved Metals (ppb) in Peel River Water Samples

Parameter	CCME EQGs		Concentration in Water Samples (ppb)				
	Aquatic Life (ppb)	Community MAC (ppb)	PeelW-1	PeelW-2	PeelW-3	PeelW-4	PeelW-5
Aluminum	5 – 100	-	107	157	130	101	130
Antimony	-	6	< 200	< 200	< 200	< 200	< 200
Arsenic	5.0	25	< 200	< 200	< 200	< 200	< 200
Barium	-	1000	50	60	60	60	60
Beryllium	-	-	< 5	< 5	< 5	< 5	< 5
Boron	-	5000	< 100	< 100	< 100	< 100	< 100
Cadmium	0.017	-	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Calcium	-	-	24,800	26,200	26,200	26,400	25,400
Chromium	-	50	< 10	< 10	< 10	< 10	< 10
Cobalt	-	-	< 10	< 10	< 10	< 10	< 10
Copper	2 – 4	-	< 10	< 10	< 10	< 10	< 10
Iron	300	-	250	310	280	280	310
Lead	1 – 7	10	< 1	< 1	< 1	< 1	< 1
Magnesium	-	-	6,300	6,500	6,600	6,600	6,300
Manganese	-	-	13	11	11	10	12
Mercury	0.1	1	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	73	-	< 30	< 30	< 30	< 30	< 30
Nickel	25 – 150	-	< 50	< 50	< 50	< 50	< 50
Selenium	1.0	10	< 1	< 1	< 1	< 1	< 1
Silver	0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thallium	0.8	1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Uranium	-	100	0.47	0.48	0.49	0.46	0.46
Zinc	30	-	< 5	< 5	< 5	< 5	< 5

3.6 Results for Hydrocarbons

3.6.1 Hydrocarbons in Soil/Sediments

A PetroFLAG™ hydrocarbon analysis system was used to screen a number of soil samples in the field. The test kit responds to all types of hydrocarbons regardless of the source or state of degradation. The response factor however, is dependent on the type of hydrocarbon. A table containing the response factor for a number of hydrocarbon contaminants is supplied with the kit (e.g., diesel fuel has a response factor of 5 whiles weathered gasoline has a response factor of 2). Since information on hydrocarbon contamination at the site was unknown at the time of the site investigation, a response factor of 5 was arbitrarily chosen for all analysis. The results of the field screening are given in Table 3.16.

Elevated levels of total extractable hydrocarbons (> 1000 ppm) were found in a number of boreholes, which prompted laboratory analysis for hydrocarbons in soil/sediment samples as BETX (Benzene, ethylbenzene, toluene and xylene) EPH (extractable hydrocarbons), LEPHs (light extractable petroleum hydrocarbons), HEPHs (Heavy Extractable Petroleum Hydrocarbons) and PAHs (Polycyclic Aromatic Hydrocarbons). Data obtained are given in Table 3.17.

Detectable concentrations of BETX, PAHs, LEPH and HEPH were found in some of the samples (Table 3.17). No guidelines exist for extractable hydrocarbons in the 1999 CCME EQGs as such the Yukon CSR standard for hydrocarbons was used to evaluate LEPH and HEPH data. Only one of the samples (TH16-2) analyzed in the laboratory contained LEPH (2410 ppm) at a concentration that exceeded the Yukon CSR standard for residential/parkland use. A black stain with hydrocarbon odour was associated with this sample that also contained DDTs in excess of the CCME R/P guideline.

Though elevated levels of EPH (> 1000 ppm) were found in other samples using PetroFLAG™ test kits, the corresponding laboratory results were less than the standard (< 1000 ppm). This discrepancy may be attributed to the response factor of 5 used in the field analysis. Hydrocarbon distribution reports attached to the laboratory reports indicated different types of hydrocarbon products were present at the site. For example, TH16-2 contained mostly diesel, TH17-1 was comprised of heavy oils while TH18-3 had a mixture of diesel and heavy oils.

Data for PAHs was similar to the EPH results in that only TH16 contained a PAH (naphthalene) at concentrations which was greater than the CCME environmental quality guideline. For volatile hydrocarbons, the levels of BTEX in one of the samples (TH29-3) were greater than the CCME guidelines. Other volatile organic compounds in this sample were also elevated and are discussed further in Section 3.7.

Table 3.16: PetroFLAG™ Field Test Kit Results for Extractable Petroleum Hydrocarbons (ppm) in Soil/Sediment Samples

Borehole	Sample No.	Depth (m)	Concentration (ppm)	Borehole	Sample No.	Depth (m)	Concentration (ppm)
TH-1	TH1-1	0.6 -1.2	577	TH18	TH18-1	0.0 - 0.6	434
	TH1-4	4.3 - 4.9	514		TH18-2	3.3 - 3.6	2295
TH2	TH2-2	2.1 - 2.7	899		TH18-3	4.3 - 4.6	1672
	TH2-3	3.3 - 3.6	1200	TH19	TH19-1	0.6 - 0.9	542
TH3	TH3-1	3.3 - 3.6	225		TH19-2	3.3 - 3.6	338
	TH3-2	4.0 - 4.3	1771	TH20	TH20-1	0.9 - 1.2	72
TH4	TH4-2	2.4 - 2.7	1133		TH22-2	4.3 - 4.6	42
	TH4-3	4.0 - 4.3	1970	TH23	TH23-1	0.6 - 0.9	250
	TH4-4	5.5 - 5.8	892		TH23-2	2.7 - 3.0	156
TH5	TH5-3	4.3 - 4.6	321	TH24	TH24-1	0.0 - 0.6	57
TH6	TH6-3	4.0 - 4.3	279		TH24-2	1.5 - 1.8	66
TH7	TH7-3	3.6 - 4.0	687	TH25	TH25-1	0.3 - 0.9	97
	TH7-4	3.6 - 4.0	622		TH25-2	2.1 - 2.4	48
TH8	TH8-3	3.6 - 4.0	1750	TH27	TH27-1	0.0 - 0.3	11
	TH8-4	5.2 - 5.5	846		TH27-2	0.9 - 1.2	429
TH9	TH9-1	0.0 - 0.6	313		TH27-3	2.1 - 2.4	198
	TH9-2	0.0 - 0.6	286	TH28	TH28-1	0.0 - 0.3	185
TH10	TH10-3	3.0 - 3.3	230		TH28-2	2.1 - 2.4	250
	TH10-5	4.3 - 4.6	428		TH28-3	2.7 - 3.0	257
TH11	TH11-2	1.2 - 1.5	197	TH29	TH29-1	0.0 - 0.3	145
TH12	TH12-1	3.0 - 3.3	78		TH29-2	1.2 - 1.5	482
TH13	TH13-1	0.0 - 0.6	177		TH29-3	2.7 - 3.0	278
	TH13-2	3.0 -3.3	70	TH31	TH31-2	0.9 - 1.2	230
TH14	TH14-2	2.7 - 3.0	134	TH33	TH33-2	1.2 - 1.5	132
TH15	TH15-1	1.5 - 1.8	157				
	TH15-2	2.7 - 3.0	> 2000	*Sediments*	SED2	0.0 - 0.3	102
	TH15-3	4.0 - 4.3	179		SED3	0.0 - 0.3	120
TH16	TH16-1	2.7 - 3.0	395		SED4	0.0 - 0.3	68
	TH16-2	3.0 - 3.3	1948		SED5	0.0 - 0.3	305
	TH16-3	3.3 - 3.6	1733		SED6	0.0 - 0.3	104
	TH16-4	4.0 - 4.3	459		SED7	0.0 - 0.3	138
TH17	TH17-1	2.7 - 3.0	626		SED8	0.0 - 0.3	796
	TH17-2	3.0 - 3.3	1698				
	TH17-3	3.0 - 3.3	1733				

Table 3.17: Concentration of Hydrocarbons (ppm) in Soil/Sediment Samples Analyzed in the Laboratory

Parameter	CCME R/P	TH7-5	TH8-4	TH15-1	TH16-2	TH16-3	TH17-1	TH17-2	TH18-2
Non-halogenated Volatiles									
Benzene	0.5	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-
Ethylbenzene	1.2	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-
Styrene	5	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-
Toluene	0.8	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-
meta- & para-Xylene	1	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-
ortho-Xylene	1	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	-
PAHs									
Acenaphthene	-	< 0.01	< 0.01	< 0.01	< 0.4	< 0.1	< 0.02	< 0.03	< 0.04
Acenaphthylene	-	< 0.01	< 0.01	< 0.01	< 0.2	< 0.05	< 0.01	< 0.02	< 0.02
Anthracene	-	< 0.01	< 0.01	< 0.01	< 0.03	< 0.02	< 0.01	< 0.01	< 0.01
Benz(a)anthracene	1	0.01	< 0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
Benzo(a)pyrene	0.7	< 0.01	< 0.01	0.01	0.02	0.01	0.02	0.02	0.02
Benzo(b)fluoranthene	1	0.02	0.01	0.04	0.05	0.03	0.05	0.05	0.05
Benzo(g,h,i)perylene	-	0.04	0.02	0.1	0.1	0.06	0.11	0.09	0.1
Benzo(k)fluoranthene	1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Chrysene	-	0.02	< 0.01	0.03	0.05	0.03	0.04	0.04	0.04
Dibenz(a,h)anthracene	1	< 0.01	< 0.01	0.01	0.01	< 0.01	0.01	0.01	0.01
Fluoranthene	-	0.03	< 0.01	0.02	0.03	0.02	0.02	0.02	0.03
Fluorene	-	0.02	< 0.01	0.01	0.47	0.16	0.03	0.06	0.05
Indeno(1,2,3-c,d)pyrene	1	< 0.01	< 0.01	0.01	0.01	< 0.01	0.02	0.01	0.02
Naphthalene	0.6	0.09	0.03	0.11	1.9	0.61	0.17	0.25	0.17
Phenanthrene	5	0.11	0.04	0.12	0.53	0.24	0.16	0.19	0.19
Pyrene	10	0.08	0.01	0.03	0.05	0.04	0.04	0.04	0.05
Extractable Hydrocarbons									
EPH10-19	-	< 300	< 200	< 200	2420	647	< 200	286	209
EPH19-32	-	659	< 200	< 200	< 200	< 200	< 200	< 200	< 200
LEPH*	1000	< 300	< 200	< 200	2410	646	< 200	286	208
HEPH*	1000	659	< 200	< 200	< 200	< 200	< 200	< 200	< 200

continued

Notes:

Shaded areas indicate parameters that equal or exceed the CCME residential/park guidelines

* L/HEPH: Values adapted from Yukon Contaminated Sites Regulation (1996)

Table 3.17: Continued

Parameter	CCME R/P	TH18-3	TH24-3	TH28-2	TH29-2	TH29-3	SED-5	SED-7	SED-8
Non-halogenated Volatiles									
Benzene	0.5	< 0.01	-	-	-	5	-	-	-
Ethylbenzene	1.2	< 0.01	-	-	-	3	-	-	-
Styrene	5	< 0.01	-	-	-	< 1	-	-	-
Toluene	0.8	< 0.01	-	-	-	9	-	-	-
meta- & para-Xylene	1	< 0.01	-	-	-	9	-	-	-
ortho-Xylene	1	< 0.01	-	-	-	4	-	-	-
PAHs									
Acenaphthene	-	< 0.04	< 0.01	< 0.01	< 0.01	< 0.4	< 0.01	< 0.01	< 0.02
Acenaphthylene	-	< 0.02	< 0.01	< 0.01	< 0.01	< 0.08	< 0.01	< 0.01	< 0.02
Anthracene	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.06	< 0.01	< 0.01	< 0.01
Benz(a)anthracene	1	0.01	< 0.01	< 0.01	< 0.01	0.06	< 0.01	< 0.01	< 0.01
Benzo(a)pyrene	0.7	0.02	< 0.01	< 0.01	< 0.01	0.05	< 0.01	< 0.01	0.01
Benzo(b)fluoranthene	1	0.05	0.02	0.01	< 0.01	0.09	0.02	0.01	0.04
Benzo(g,h,i)perylene	-	0.09	0.03	0.02	< 0.01	0.04	0.05	0.03	0.09
Benzo(k)fluoranthene	1	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01
Chrysene	-	0.04	0.01	< 0.01	< 0.01	0.09	0.02	0.01	0.03
Dibenz(a,h)anthracene	1	0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	< 0.01	0.01
Fluoranthene	-	0.02	< 0.01	< 0.01	< 0.01	0.03	0.01	< 0.01	0.02
Fluorene	-	0.07	< 0.01	< 0.01	0.01	0.59	0.01	< 0.01	< 0.05
Indeno(1,2,3-c,d)pyrene	1	0.01	< 0.01	< 0.01	< 0.01	0.03	0.01	< 0.01	0.01
Naphthalene	0.6	0.18	0.04	0.04	0.04	0.5	0.06	0.04	0.19
Phenanthrene	5	0.19	0.04	0.04	0.04	0.62	0.08	0.05	< 0.2
Pyrene	10	0.04	0.01	0.01	< 0.01	0.16	0.03	0.01	0.04
Extractable Hydrocarbons									
EPH10-19	-	306	< 200	< 400	< 400	477	< 200	< 200	1050
EPH19-32	-	< 200	< 200	< 400	< 400	< 400	< 200	< 200	< 200
LEPH*	1000	306	< 200	< 400	< 400	476	< 200	< 200	1050
HEPH*	1000	< 200	< 200	< 400	< 400	< 400	< 200	< 200	< 200

Notes:

Shaded areas indicate parameters that equal or exceed the CCME residential/park guidelines

* L/HEPH: Values adapted from Yukon Contaminated Sites Regulation (1996)

3.6.2 Hydrocarbons in Water

Hydrocarbon concentrations were either below detection or well below the CCME benchmark (Table 3.18).

Table 3.18: Concentration of Hydrocarbons (ppb) in Peel River Water Samples

Parameter	CCME Aquatic Life	Peel W-1	Peel W-2	Peel W-3	Peel W-4	Peel W-5
PAHs						
Acenaphthene	5.8	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	4.4	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	0.012	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benz(a)anthracene	0.018	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	0.015	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Benzo(b)fluoranthene	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(g,h,i)perylene	-	0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	0.04	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	3.0	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-c,d)pyrene	-	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Naphthalene	1.1	0.21	0.06	0.11	0.17	0.16
Phenanthrene	0.4	0.26	0.07	0.14	0.19	0.19
Pyrene	0.025	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Extractable Hydrocarbons						
EPH10-19	-	< 300	< 300	< 300	< 300	< 300
EPH19-32	-	< 1000	< 1000	< 1000	< 1000	< 1000
LEPH	-	< 300	< 300	< 300	< 300	< 300
HEPH	-	< 1000	< 1000	< 1000	< 1000	< 1000

3.7 Results for Halogenated Volatile Organic Compounds

The concentrations of these compounds, which are generally found in solvents, paint thinners and degreasers, were generally below detection except for one sample (Table 3.19). The noted exception was the presence of dichloromethane (CH_2Cl_2) at a concentration of 26 ppm and chloroform ($CHCl_3$) at concentration of 3 ppm in sample TH29-3 (depth of 2.7 to 3.0 m). For comparison, the CCME residential/parkland 1991 criterion for chlorinated aliphatics in general is 5 ppm. This sample also contained

elevated levels of BETX compounds (see Section 3.6). No other VOCs were detected in any of the samples analyzed.

Table 3.19: Concentration of Halogenated Volatile Organic Compound (ppm) in Peel River Soil Samples

Parameter	CCME R/P	TH8-3	TH16-2	TH16-3	BH17-1	TH17-2	TH17-3	TH18-3	TH29-3
Bromodichloromethane	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Bromoform	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Carbon Tetrachloride	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Chlorobenzene	2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Chloroethane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Chloroform	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	3
Chloromethane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Dibromochloromethane	1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,2-Dichlorobenzene	1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,3-Dichlorobenzene	1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,4-Dichlorobenzene	1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,1-Dichloroethane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,2-Dichloroethane	5	< 0.01	0.01	< 0.01	0.01	0.01	0.01	< 0.01	< 1
cis-1,2-Dichloroethylene	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
trans-1,2-Dichloroethylene	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,1-Dichloroethylene	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Dichloromethane	5	< 0.4	< 0.3	< 0.4	< 0.3	< 0.5	< 0.5	< 0.6	26
1,2-Dichloropropane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
cis-1,3-Dichloropropylene	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
trans-1,3-Dichloropropylene	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,1,1,2-Tetrachloroethane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,1,2,2-Tetrachloroethane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Tetrachloroethylene	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,1,1-Trichloroethane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
1,1,2-Trichloroethane	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Trichloroethylene	3	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Trichlorofluoromethane	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1
Vinyl Chloride	5	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 1

Notes:

Shaded areas indicate parameters that equal or exceed the CCME residential/park guidelines

In particular, the absence of these contaminants of potential concern in the majority of borehole soil samples collected is attested to by photoionization detector (PID) results for the field screening of VOC (Table 3.20). A PID reading of greater than 100 ppm is generally indicative of elevated soil organic vapour concentrations and may or may not correspond to an exceedance of relevant soil quality guidelines, depending on the substance(s) present. PID readings of less than 20 ppm are routinely observed in natural, uncontaminated soils, and naturally occurring volatile substances can occasionally elevate PID readings well beyond this level. All PID readings in excess of 100 ppm have been highlighted in Table 3.20. These samples were analyzed in the laboratory and only TH29-3 contained a VOC at a level that exceeded the CCME residential/park land use guidelines.

Table 3.20: Concentration (ppm) of Volatile Organic Compounds (VOC) in Soil/Sediment Samples as Determined by Head Space Analysis Using a Portable Photoionization Detector (PID)

Sample No.	VOC Conc. (ppm)	Sample No.	VOC Conc. (ppm)	Sample No.	VOC Conc. (ppm)	Sample No.	VOC Conc. (ppm)
TH1-1	22.9	TH7-3	19.7	TH15-3	4.9	TH27-2	82
TH1-2	1.8	TH7-4	26	TH16-1	48	TH27-3	70
TH1-3	13.3	TH7-5	8.8	TH16-2	23	TH28-1	23
TH1-4	4.6	TH7-6	10.4	TH16-3	92	TH28-2	16
TH1-5	10.2	TH7-7	9.4	TH16-4	55	TH28-3	10.8
TH2-1	1.6	TH8-1	7.9	TH17-1	68	TH29-1	2.3
TH2-2	4.6	TH8-2	8.7	TH17-2	113	TH29-2	202
TH2-3	18.6	TH8-3	17.8	TH17-3	156	TH29-3	744
TH2-4	35	TH8-4	14.6	TH18-1	15.1	TH30-1	4.8
TH3-1	1	TH8-5	8.3	TH18-2	79	TH30-2	3.5
TH3-2	18.7	TH9-1	3.4	TH18-3	24	TH30-4	10.4
TH4-1	2.3	TH9-2	2.9	TH19-1	21	TH30-5	4.8
TH4-2	30	TH9-3	13.5	TH19-2	28	TH31-1	3
TH4-3	44	TH9-4	18.1	TH20-1	1.8	TH31-2	3.2
TH4-4	12	TH9-5	10.7	TH20-2	1.3	TH31-3	2.2
TH4-5	10.8	TH10-1	1	TH20-3	2.2	TH32-1	1.9
TH4-6	6.5	TH10-2	1	TH21-1	4.5	TH32-2	2.7
TH5-1	3.2	TH10-3	15.3	TH21-2	3	TH33-1	1.3
TH5-2	2.3	TH10-4	21	TH22-1	1.5	TH33-2	2.2
TH5-3	5.7	TH10-5	2.2	TH22-2	1.4	TH33-3	1.2
TH5-4	5.3	TH11-1	2.1	TH23-1	2.2	***Sediments***	
TH5-5	6.7	TH11-2	2.2	TH23-2	1.3		
TH6-1	2.5	TH12-1	4.1	TH23-3	1.2	SED1	2.8
TH6-2	2.2	TH13-1	1.5	TH24-1	1.4	SED2	2.4
TH6-3	9.1	TH13-2	1	TH24-2	1.9	SED3	2.1
TH6-4	7.3	TH13-3	0.9	TH24-3	1.8	SED4	1.9
TH6-5	5.8	TH14-1	1.6	TH25-1	1.5	SED5	3.1
TH7-1	2.1	TH14-2	1.3	TH25-2	1.7	SED6	1.6
TH7-2	1.6	TH15-1	1.7	TH26-1	1.9	SED7	2.7
TH7-3	19.7	TH15-2	86	TH27-1	4.5	SED8	14.8

Notes:

1. PID = Photoionization Detector
2. PID readings greater than 100 ppm have been highlighted.

3.8 Quality Assurance Quality Control Results

3.8.1 Field QA/QC

The field QA/QC program incorporated measures, which ensured the integrity of the soil, sediment and water samples. Aspects of the program are described in the following sections.

3.8.1.1 Sampling Protocols

In order to guarantee that all the samples collected maintained their integrity prior to analysis, the general protocols presented in Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites (CCME, 1993) were used. Briefly, each sample was collected using dedicated pre-cleaned equipment. The auger was clean between boreholes by removing all brushing and removing all residual soils. All the samples were placed in appropriate pre-cleaned containers supplied by the analytical laboratories. The containers were labeled, placed in coolers and transported via Canadian Air Cargo to the laboratory for analysis. Sample information was recorded on the chain-of-custody forms, copies of which accompanied the shipment.

All events were documented in field notebooks. Records included date, time, site identification, site conditions, sample type, preservatives, visual characteristics, odour, and chain of custody.

3.8.1.2 Field Duplicate Samples

In addition to samples collected to meet the objective of the overall program, four field duplicate samples were taken to meet the QA/QC objective of monitoring precision/reproducibility of sampling activities (Table 3.21).

Table 3.21: Field Duplicate Samples Collected at Peel River

Borehole	Sampling Depth (m)	Designation of Field Duplicates
TH7	3.6 - 4.0	TH7-3 and TH7-4
TH9	0.0 - 0.6	TH9-1 and TH9-2
TH17	3.0 - 3.3	TH17-2 and TH17-3
TH30	0.0 - 0.3	TH30-1 and TH30-2

3.8.2 Laboratory QA/QC

Water and soil/sediment samples were analyzed at Analytical Services Laboratory (ASL), Vancouver, BC. ASL has been evaluated and accredited by the Canadian Association for Environmental Laboratories (CAEL).

Prior to and throughout the field program, the laboratory was contacted to ensure that all QA/QC objectives; such as detection limits, proper sample containers, and sample delivery; were being met.

The QA/QC program, set up to monitor data quality and reliability on an ongoing basis, included running all samples in batches of varying sizes with control samples, which accompanied the set through the entire analytical procedure. These control samples included the following:

- analytical or procedural duplicates to monitor precision or reproducibility of the results;
- procedural blanks to monitor interferences from potential laboratory contamination;
- internal spike standards; and,
- standard reference materials.

Laboratory QA/QC data for soil, sediment and water samples are included in the laboratory reports attached to Appendix B.

3.8.3 Evaluation of Quality Control Samples

Field duplicate samples were submitted to the laboratory for analysis as individual samples. The data obtained was evaluated by direct comparison or by using the relative percent difference (RPD) when only two samples are available. The RPD is expressed mathematically as:

$$RPD = 100 \times \left[\frac{(x_1 - x_2)}{\left\{ \frac{(x_1 + x_2)}{2} \right\}} \right]$$

where x_1 and x_2 are the concentrations of the analytes above the detection limits

Where more than two measurements are available, the Relative Standard Deviation (RSD) or the Coefficient of Variation (CV) is used. Mathematically,

$$RSD = CV = 100 \times \frac{S}{x_i}$$

Where x_i is the arithmetic mean and S is the standard deviation.

Values of RPD or RSD less than 30% indicate reasonable to good precision, while those exceeding this value are considered fair to poor.

3.8.4 QA/QC Results for DDTs

Analyzing four pairs of duplicate samples using field test kits and three pairs in the laboratory monitored reproducibility for the analysis for DDTs and metabolites in soil samples. The concentrations of total DDTs in duplicate samples as determined with the field test kits were comparable (Table 3.22) indicating good reproducibility for field test kit analyses. Laboratory results for TH7-3 and TH7-4 were however, poor in that the relative percent difference (RPD) ranged from 122 to 150%. This poor reproducibility was due to sample heterogeneity in that substrate was comprised of sand, gravel, silt and debris including wood chips and brown fibrous material. The RPD for TH17-2 and TH17-3 (15 to 22%) indicated good precision. DDTs concentrations for TH30-1 and TH30-2 were either below detection or within 5% of the detection limit, which also indicated good precision.

Table 3.22: DDTs Concentrations, Mean and Relative Percent Difference (RPD) for Duplicate Soil Samples

Parameter	Concentration (ppm)		Mean	RPD (%)	Concentration (ppm)		Mean	RPD (%)
	TH7-3	TH7-4			TH9-1	TH9-2		
Field Test Kit								
Total DDT	0.2 – 1	0.2 – 1	0	0	0.2 – 1	0.2 – 1	0	0
Laboratory								
2,4'-DDD	0.02	0.115	0.0675	140	-	-	-	-
4,4'-DDD	0.027	0.113	0.07	122	-	-	-	-
2,4'-DDE	< 0.002	0.013	-	-	-	-	-	-
4,4'-DDE	0.013	0.085	0.049	146	-	-	-	-
2,4'-DDT	0.036	0.257	0.1465	150	-	-	-	-
4,4'-DDT	0.048	0.269	0.1585	139	-	-	-	-

Parameter	Concentration (ppm)		Mean	RPD (%)	Concentration (ppm)		Mean	RPD (%)
	TH17-2	TH17-3			TH30-1	TH30-2		
Field Test Kit								
Total DDT	0.2 – 1	0.2 – 1	0	0	< 0.2	< 0.2	-	-
Laboratory								
2,4'-DDD	0.014	0.017	0.0155	19.4	< 0.001	0.001	-	-
4,4'-DDD	0.013	0.016	0.0145	20	< 0.001	0.001	-	-
2,4'-DDE	< 0.002	< 0.002	-	-	< 0.002	< 0.002	-	-
4,4'-DDE	0.004	0.005	0.0045	22	< 0.001	0.001	-	-
2,4'-DDT	0.003	0.003	0.003	0	0.001	0.004	-	-
4,4'-DDT	0.012	0.014	0.013	15.4	0.002	0.009	-	-

3.8.5 QA/QC Results for Other Persistent Chlorinated Hydrocarbons

The concentrations of all the parameters in the three field duplicate samples analyzed were below detection. The analytes in this group included PCBs and chlorinated pesticides other than DDTs.

3.8.6 QA/QC Results for Volatile Organic Compounds

The concentrations of halogenated VOCs in one pair of a field duplicate sample analyzed in the laboratory were all below detection except for 1,2-dichloroethane, which was found at 0.01 ppm in both samples. This indicated good reproducibility for laboratory VOC analysis.

For headspace analysis of VOCs, four pairs of duplicate soil samples were analyzed (Table 3.23) using the portable photoionization detector (PID). The RPD ranged from 16 to 32% indicating good to fair precision for the analysis.

Table 3.23: Portable Photoionization Detector (PID) Results Mean and Relative Percent Difference (RPD) for Duplicate Soil Samples

Field Duplicate Sample Number	VOC concentration using PID (ppm)	Mean	Relative Percent Difference (%)
TH7-3	19.7	22.85	28
TH7-4	26		
TH9-1	3.4	3.15	16
TH9-2	2.9		
TH17-2	113	134	32
TH17-3	156		
TH30-1	4.8	4.15	31
TH30-2	3.5		

3.8.7 QA/QC Results for Hydrocarbons

In order to monitor the reproducibility for EPH in soil/sediment analysis, three sets of field duplicate samples were analyzed using the PetroFLAG™ test kits (Table 3.24). Good precision was indicated for the samples based on the RPD values found (2.0 to 9.9%).

Table 3.24: Extractable Petroleum Hydrocarbon Concentration, Mean and Relative Percent Difference (RPD) for Duplicate Soil Samples

Field Duplicate Sample Number	EPH Concentration (ppm)	Mean	Relative Percent Difference (%)
TH7-3	687	654	9.9
TH7-4	622		
TH9-1	313	299	9.0
TH9-2	286		
TH17-2	1698	1716	2.0
TH17-3	1733		

3.8.8 QA/QC Results for Metals

Two pairs of field duplicate samples were used to monitor total metal analysis. Good precision was obtained for all of the detectable analytes based on the RPD values that ranged from 0.0 to 26% (Table 3.25).

Table 3.25: Total Metal Concentrations, Mean and Relative Percent Difference (RPD) for Duplicate Soil Samples

Parameter	Concentration (ppm)		Mean	RPD (%)	Concentration (ppm)		Mean	RPD (%)
	TH7-3	TH7-4			TH17-2	TH17-3		
Physical Tests								
Moisture %	13.2	14.5	13.85	9.4	21.2	19.1	20.15	10.4
pH	7.91	7.86	7.885	0.6	7.75	7.82	7.785	0.9
Total Metals								
Antimony	< 20	< 20	-	-	< 20	< 20	-	-
Arsenic	12	13	12.5	8.0	14	14	14	0.0
Barium	566	577	571.5	1.9	822	632	727	26
Beryllium	0.7	0.7	0.7	0.0	0.9	0.8	0.85	11.8
Cadmium	0.6	0.6	0.6	0.0	0.6	0.6	0.6	0.0
Chromium	33	35	34	5.9	43	36	39.5	17.7
Cobalt	8	8	8	0.0	9	10	9.5	10.5
Copper	45	44	44.5	2.2	29	29	29	0.0
Lead	< 50	140	-	-	< 50	< 50	-	-
Mercury	0.052	0.052	0.052	0.0	0.069	0.067	0.068	2.9
Molybdenum	< 4	< 4	-	-	< 4	< 4	-	-
Nickel	27	28	27.5	3.6	32	32	32	0.0
Selenium	< 2	< 2	-	-	< 2	< 2	-	-
Silver	< 2	< 2	-	-	< 2	< 2	-	-
Thallium	< 2	< 2	-	-	< 2	< 2	-	-
Tin	< 10	< 10	-	-	< 10	< 10	-	-
Vanadium	106	116	111	9.0	130	111	120.5	15.8
Zinc	109	109	109	0.0	116	120	118	3.4

4. CONCLUSIONS AND RECOMMENDATIONS

Based on preliminary indications of DDT contaminated soil at the Peel River Waste Site, a detailed study was undertaken to –

- delineate the spatial and vertical extent of DDT-contaminated soils;
- screen for the presence of additional contaminants and/or contaminating materials;
- study re-mobilization of DDT from the waste site into adjacent sediments and water from the Peel River; and,
- define options for site remediation and/or risk management.

An examination of short-term erosion control measures was also made as part of interim risk management options for the contaminated soil within the Waste Pit.

Thirty-three new boreholes were advanced in or around the pit to depths below the present-day ground surface of up to approximately 8 m. Most completed borehole depths were shallower than, often due to auger refusal. Based on visual and olfactory clues, two to six soil samples were obtained from each hole (Table 2.2) and analyzed using field techniques. A substantial subset of these samples was sent for laboratory analysis.

4.1 Contaminant Screen

DDT and its related products were identified as contaminants of potential concern in a large subset of soil samples analyzed (Table 3.7 and 3.8). DDT and its related products were the only chlorinated pesticides detected; PCBs and the remaining chlorinated pesticides were not detected in any of the samples analyzed. The concentrations of DDTs encountered suggested that technical DDT products were disposed of into the waste pit. Based on information available to the present time, however, it is not clear whether the DDT was introduced to the landfill as a relatively concentrated product contained within drums in a liquid solvent (such as xylenes or dichloromethane), or in some other form. One possibility, for example, is that the DDT had already been introduced to contaminated soils at the time of site closure based on previous spillage around storage and handling areas. This appears unlikely based on spatial distribution pattern (see Section 4.2, below).

It would be helpful to ascertain the disposal practices during closure that contributed to the DDT contamination. If, for example, it cannot be excluded that barrels containing liquid products are located within the landfill, extra precautionary measures will be required as part of remediation and excavation.

Of the metals analyzed, only arsenic and barium were found to occur at concentrations exceeding the CCME residential/parkland soil quality guidelines/criteria (Tables 3.10). The metal results are also summarized in Table 4.1 below. These two metals/metalloids are often observed at naturally elevated concentrations based on site geology. The maximum concentration observed for arsenic

(16 ppm), for example, is only slightly higher than the average natural soil background concentrations on a Canada-wide basis (CCME, 1999). Some elevation of subsurface soil concentrations of barium, in particular, might be due to the presence of drilling muds disposed in the waste pit; however, the exceedance of the CCME residential/parkland soil quality guidelines for arsenic and barium chromium for much of the soil mass is likely to be associated with naturally elevated concentrations at the site. Furthermore, leachable metals concentrations in extracts obtained from using BC Special Waste Extraction Procedure/Leachate Extraction Protocols were below the Leachate Quality Standards (Table 3.13). The metal-contaminated soils are therefore, not considered as "Special Waste" under the BC Contaminated Sites Regulation. **Any possible remediation based on metals/metalloids, therefore, should first consider adjustments for concentrations associated with natural mineralization at the Peel River site.**

The metals arsenic and barium cannot be excluded as contaminants of potential concern based on levels in subsurface soils documented herein. Further work would be useful to identify the natural background concentrations in the Peel River area and allow a better evaluation of requirements for remediation or risk management.

Table 4.1: Summary of Results for Metals in Soil/Sediment Samples (ppm)

Parameter	CCME R/P Guideline	Number Analyzed	Min Conc'n	Max Conc'n	Mean Conc'n	Standard Deviation	Upper 95%ile	Number exceeding CCME R/P
pH		21	7.52	10	8.30	0.747	9.98	
Total Metals								
Antimony	20	21	< 20	< 20	-	-	-	0%
Arsenic	12	21	< 5	16	11.9	2.70	15.2	71.4%
Barium	500	21	100	3510	679	758	2070	52.4%
Beryllium	4	21	0.6	1.6	0.82	0.210	1.01	0%
Cadmium	10	21	< 0.5	1.3	0.70	0.276	1.25	0%
Chromium	64	21	6	43	30.1	10.6	41	0%
Cobalt	50	21	< 2	11	7.15	2.60	10.1	0%
Copper	63	21	3	56	25.9	13.5	45	0.0%
Lead	140	21	< 50	140	106	47.4	137	0.0%
Mercury	6.6	21	0.015	0.082	0.047	0.018	0.069	0.0%
Molybdenum	-	21	< 4	< 4	-	-	-	-
Nickel	50	21	< 5	36	24.1	8.98	32.2	0.0%
Selenium	3	21	< 2	< 2	-	-	-	0.0%
Silver	20	21	< 2	< 2	-	-	-	0.0%
Thallium	1	21	< 2	< 2	-	-	-	-
Tin	-	21	< 2	< 2	-	-	-	-
Vanadium	130	21	11	130	84.7	36.9	127	0.0%
Zinc	200	21	32	145	88.3	34.5	120	0.0%

As shown in Table 3.16, BETX compounds (benzene, ethylbenzene, toluene, xylenes) were detected in one of the soil samples analyzed: Sample TH29-3 contained benzene (5 ppm), ethylbenzene (3 ppm), toluene (9 ppm) and xylenes (sum of 13 ppm), all of which exceeded the CCME guidelines.

For PAHs (polycyclic aromatic hydrocarbons), only two soil samples had concentrations of naphthalene in excess of the CCME R/P guideline of 0.6 ppm. Sample TH16-2 (3.0 to 3.3 m depth) and 16-3 (3.3 to 3.6 m depth) contained 1.6 and 0.61 ppm respectively of naphthalene. No other PAHs were found to be present in excess of the CCME 1999 guidelines or 1991 criteria. Sample TH16-2 was the only sample that had LEPH (2410 ppm) at a concentration that exceeded the Yukon CSR standard for residential/parkland use. A black stain with hydrocarbon odour was associated with this sample that also contained DDTs in excess of the CCME R/P guideline.

As noted in Section 3.7, VOCs (volatile organic compounds) generally were found to occur at concentrations lower than the relevant CCME soil quality guidelines in the eight soil samples analyzed. The noted exception was the presence of dichloromethane at a concentration of 26 ppm and chloroform at concentration of 3 ppm in sample TH29-3 (depth of 2.7 to 3.0 m). For comparison, the CCME residential/parkland 1991 criterion for chlorinated aliphatics in general is 5 ppm. No other VOCs were detected in any of the samples analyzed. This same sample also had elevated levels of BETX compounds (see above).

Thus only a limited number of the screened soil samples were contaminated with one or more of the following organic substances:

- Chloroform and dichloromethane;
- BETX;
- Naphthalene; and,
- LEPH.

Contamination of the waste soils by these substances was much more limited in distribution than for DDTs. In particular, the absence of these contaminants of potential concern in the majority of borehole soil samples collected is attested to by photoionization detector (PID) results for the field screening of VOCs (Table 3.18). A PID reading of greater than 100 ppm is generally indicative of elevated soil concentrations based on a more accurate laboratory-based analysis and may or may not correspond to an exceedance of relevant soil quality guidelines, depending on the substance(s) present. PID readings of less than 20 ppm are routinely observed in natural soils, and naturally occurring volatile substances can occasionally elevate PID readings well beyond this level. Relatively elevated PID readings were obtained from subsurface soil samples collected from boreholes TH15 to TH18, and TH27 to TH29. As shown in Figure 3.1, boreholes TH17 and TH18 were advanced into the eastern end of the pit above the cut bank while TH15 was on the western edge of the waste pit, also above the cutbank. Boreholes TH27-29 were advance in contiguous areas below the cut bank and toward the centre of the landfill.

The waste pit in the vicinity of TH2, TH3, TH16, TH17 and TH18 contained large amounts of metal debris, which resulted in auger 'refusal' (in ability to excavate beyond a certain depth) at several of the boreholes advanced in this area. The combination of PID results, metal debris, and auger refusal suggests that this area should be checked for buried barrels with residual product or waste.

The subsurface soils in the vicinity of TH27-29 exhibited a more uniformly distributed black oily staining. One possibility is that the organics contamination in this area represents leachate migration (along a down-gradient direction) from other source areas in the landfill. **In particular, the results herein suggest a possible connection between a source area (possibly buried barrels) in the vicinity of TH17/18 and a contaminated plume migration, affecting the area of TH27-29.**

4.2 Remedial Options and Supporting Rationale

This study provides further evidence of contamination of subsurface soil within a previously closed waste pit by DDT, as well as for the release to and limited contamination of sediments in the adjacent aquatic environment of the Peel River. Based on the spatial and vertical distribution of contamination, it is suggested that the landfill contains a source of technical DDT mixtures and possibly other organic solvents such as dichloromethane and monoaromatic hydrocarbons.

The co-occurrence of a substantial contaminant source (i.e. for DDTs), a relatively sensitive ecosystem containing valued and ecologically important aquatic 'ecological receptors', and an operating transport pathway between the two suggests the possibility of unacceptable ecological risks under the present conditions. There are at least three transport mechanisms by which DDT might continue to be introduced to the Peel River:

1. Through subsurface transport of DDT either dissolved in groundwater or entrained in other nonpolar solvents that co-occur in the landfill;

2. Via direct erosion into the river of DDT-contaminated soils; and,

3. Through surface runoff from areas of the riverbank where DDT-contaminated groundwater emerges or DDT-contaminated soils have been exposed.

Under some circumstances there may be merits in more critically examining and predicting fluxes of DDT into the aquatic ecosystem through, for example, groundwater mediated pathways, and the associated concentrations in Peel River sediments and water. An ecological and human health risk assessment might also be advocated, in order to more directly examine evidence of toxicological risks. In the case of the Peel River site, however, it is clear that the unfortunate location of the Waste Pit in the Peel River flood plain, coupled with the recent changes in river channel, will result in continued, direct erosion of DDT-contaminated soils into the river.

Based on existing information, the remedial options for the Peel River Waste Site may be divided into these major categories, each of which are explained briefly below. These are the following:

- **Option 1 – Risk Management**, consisting of leaving the existing materials in place and properly securing the waste site to reduce any erosion;
- **Option 2 – Complete removal of the waste site**, including non-hazardous debris, any hazardous materials found (should they exist) and soils with contaminant concentrations exceeding the appropriate standards, criteria or provisional criteria;
- **Option 3 – Partial removal of contaminant hotspots (especially for DDT) followed by engineered closure** including slope stabilization; or,
- **Option 4 – *In situ* remediation** - including biodegradation, solidification, solvent extraction, and electrochemical focusing.

It is recommended that the first three options should be presented to the Peel River Working Group for analysis and selection of an appropriate option. The fourth option – *In situ* remediation – should be excluded from the analysis owing to either a lack of technical credibility in achieving any remedial objectives, practicality of implementation, cost effectiveness, or any combination thereof. The following recommendations should be considered when reviewing the options:

1. **Risk Management** – While risk management through river bank stabilization and partial encapsulation (Option 1) may be considered, a cursory analysis would suggest that the erosional forces of Peel River flood waters and the movement of ice during spring break-up would render a long-term, effective stabilization solution both challenging and cost-prohibitive to implement. There are also substantial financial risks in attempting to manage the contaminant risks through engineered stabilization technologies owing to the requirement to routinely monitor the integrity of stabilization structures and possibly re-design them or undertake future maintenance work. It appears the most effective method would be the removal of the contaminated substrate.

2. **Removal of all Major Contaminant Sources** – Major source areas of DDTs and other contaminants such as various solvents and petroleum hydrocarbon products would be removed as the most cost-efficient mechanism for curtailing future entry into the Peel River ecosystem. The extent to which as-yet-to-be released materials exist in the waste pit has yet to be determined. Additional characterization should be considered, ideally as part of the complete or partial removal effort. Characterization, in this context, includes use of excavation equipment to identify the extent and character of hazardous and non-hazardous materials within the pit. This measure is necessitated by the lack of adequate documentation on the closure, as well as discrepancies between the recent investigations and accounts of the assumed contents of the waste pit. The ability to undertake an effective

remediation will undoubtedly depend on logistics of mobilization and demobilization into this area, which is isolated from permanent, all-season roads. The constraints associated with snow-free periods, as well as fluctuations in the level of the Peel River, will also be important to consider. Much of the area requiring investigation and remediation is at a lower elevation than the maximum Peel River water levels during or immediately following spring break-up, or later on in the fall during extended rainy periods, which are variable from year to year.

3. **DDT-Contaminated Subsurface Soils** – Given the limited scope of this investigation, the CCME (1999) DDT soil quality guidelines were used as a benchmark for defining DDT-contaminated soils. In particular, a value of 0.7 ppm total DDTs (sum of the concentrations for p,p'-DDT, o,p'-DDT, p,p'-DDE, o,p'-DDE, p,p'-DDD, o,p'-DDD) was used herein. This soil quality standard, however, was derived based on the back-calculation of ecologically protective soil concentrations using a model scenario involving trophic transfer (biomagnification of DDT) and ecosystem uptake over the entire foraging range of the species involved (i.e., soils → earthworms → American robin → kestrel). Where the potential for biomagnification is limited by a more limited spatial extent of contamination, wherein uptake in diet is limited by dilution from feeding in uncontaminated areas, a value of 0.7 ppm is a highly conservative estimate of soil concentrations of DDT beyond which biological effects might be expected.

   There may be some merits to deriving, through a quantitative risk assessment, site-specific soil remediation standards for DDT in direct consideration of the major exposure scenarios and ecological receptors found at the Peel River site. It is anticipated, however, that a major portion of remedial costs would be associated with mobilization and equipment costs, as opposed to soil removal and treatment or disposal costs. A DDT soil remediation benchmark of 0.7 ppm, therefore, is not anticipated to substantively elevate remediation costs. An approximate estimate of the spatial and vertical extent of soils contaminated with DDT at levels in excess of this is provided in Section 3.3. An approximate (rough-order-of magnitude: ROM) estimate of contaminated soil volumes – based on existing information – is 1,100 m^3.

4. **Peel River Sediments** – As shown on Map 3.4, limited sampling demonstrated the presence of DDTs in the riverbed sediments adjacent to the waste site. The in-place sediments are expected to undergo erosion and further mixing with clean sediments and/or burial over time. In addition, limited degradation of the various DDT compounds in sediments is expected, albeit at a relatively slow rate (i.e., over years). Studies completed to the present time have not directly or indirectly assessed the risks to aquatic life or their consumer based on in-place sediment contamination with DDT. Before the remediation DDT-contaminated river bed sediments is considered, it would be useful to better evaluate (i) the extent of re-distribution of DDTs from the site across and down the Peel River, and (ii) levels of DDTs in the aquatic food web, in comparison with areas farther up river. The demonstration of either a very limited spatial distribution or absence of elevated

DDT levels in benthos and bottom-feeding fish, or of important human dietary items, in the Peel River would suggest the absence of unacceptable risks from in-place sediment contamination

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APPENDICES

APPENDIX A:
BOREHOLE LOGS

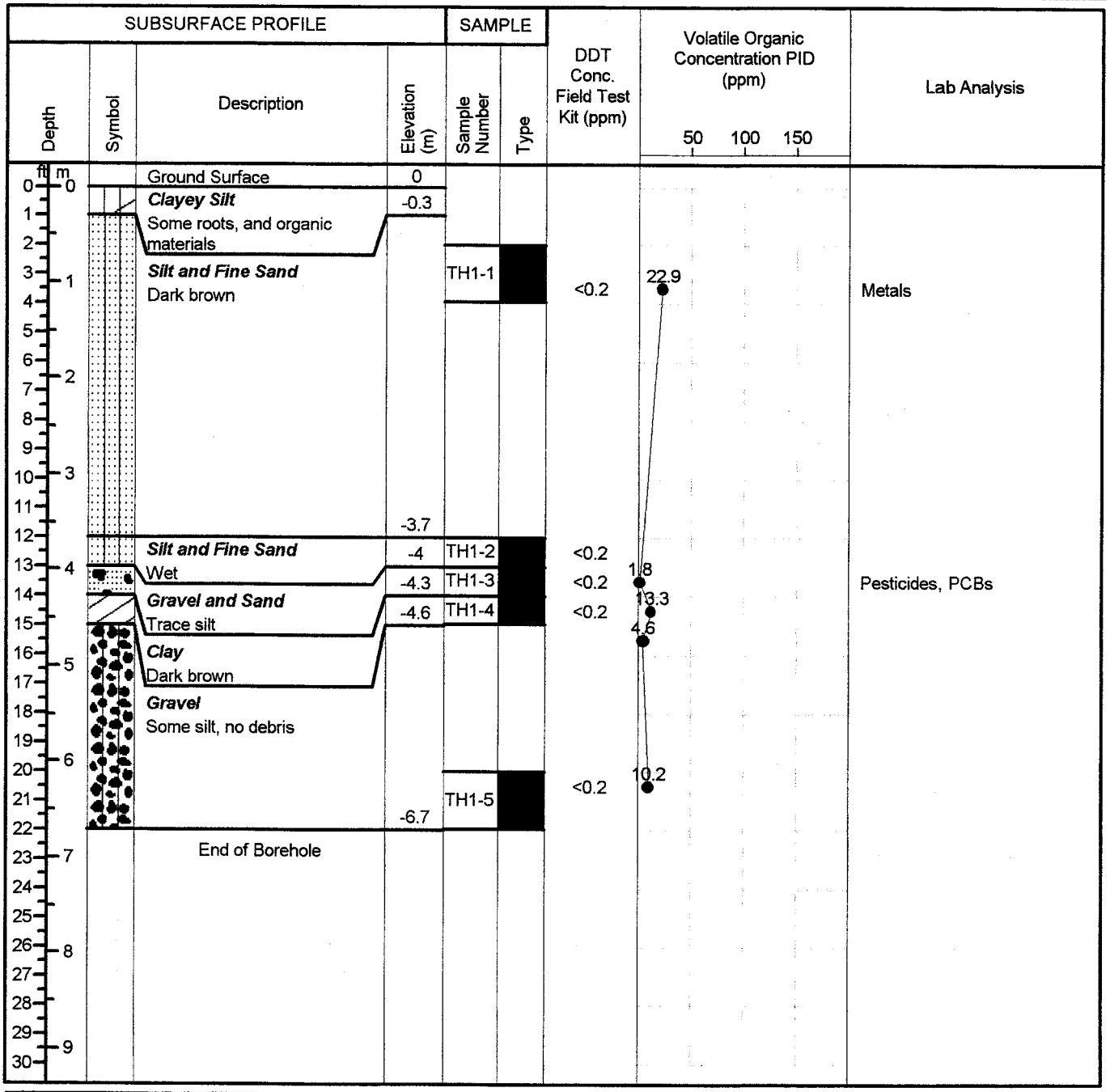
Log of Borehole: TH-1

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Air Rotary,ODEX

Drill Date: April 17, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

Checked by:

Sheet: 1 of 1

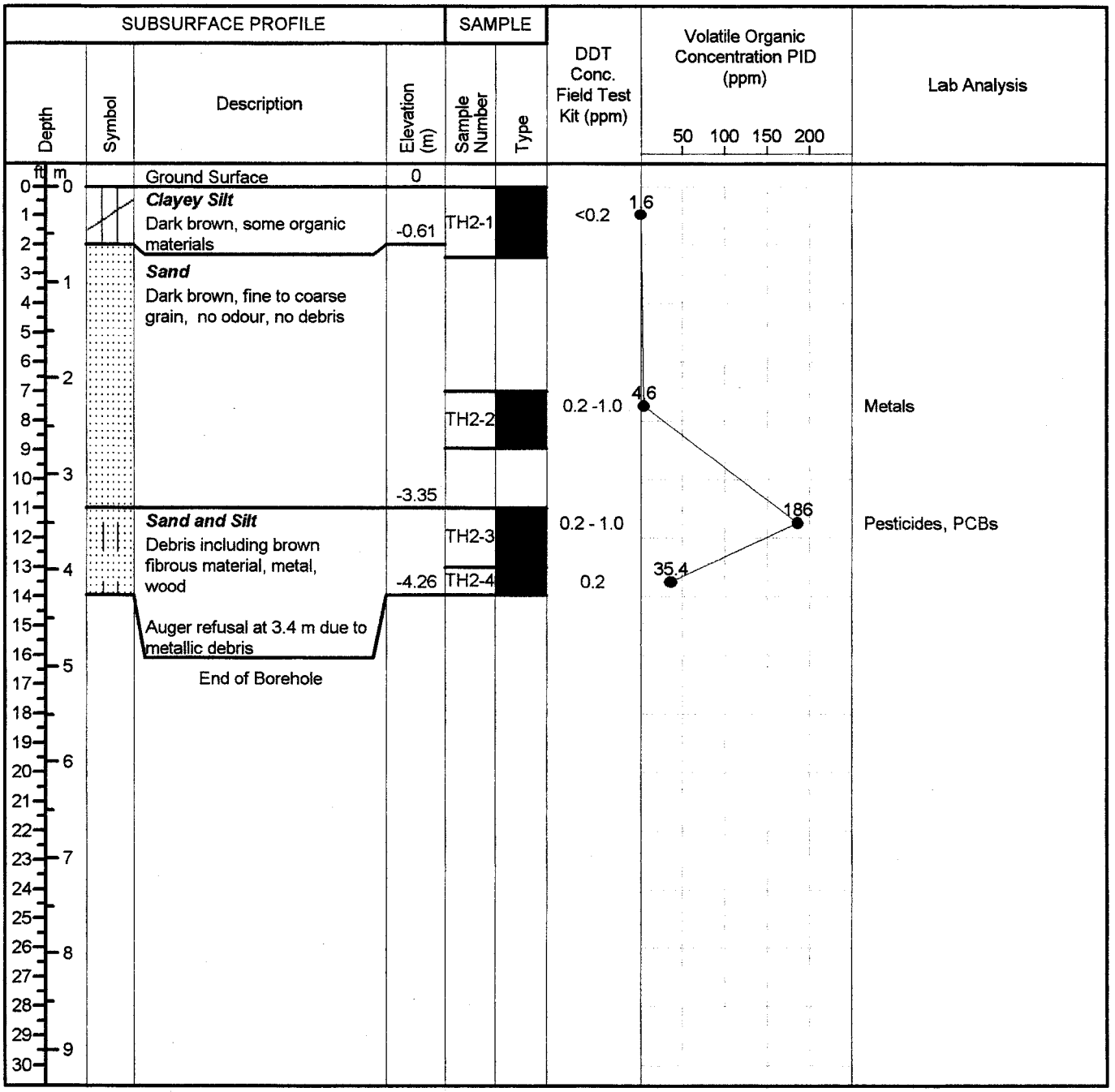
Log of Borehole: TH-2

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Air Rotary,ODEX

Drill Date: April 17, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
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Sheet: 1 of 1

Log of Borehole: TH-3

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE				
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type	DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm) 50 100 150	Lab Analysis
0 / 0		Ground Surface	0					
1		***Clayey Silt*** Dark brown, some roots and organic material	-0.61					
2 / 1		***Sand*** Dark brown, fine to coarse grain, no odour, no debris						
3 / 2								
4 / 3			-3.4					
5 / 4		***Sand and Silt*** Debris including brown fibrous material, metal, wood, burlap bag, plastic		TH3-1		<0.2	1	
6 / 5			-4.3	TH3-2		1 - 10	18.7	Pesticides, metals, PCBs
7 / 6		Auger refusal at 4.3 m due to metallic debris						
8 / 7		End of Borehole						
9 / 8								
30 / 9								

Drill Method: Air Rotary,ODEX

Drill Date: April 18, 2000

Driller: Beck

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Sheet: 1 of 1

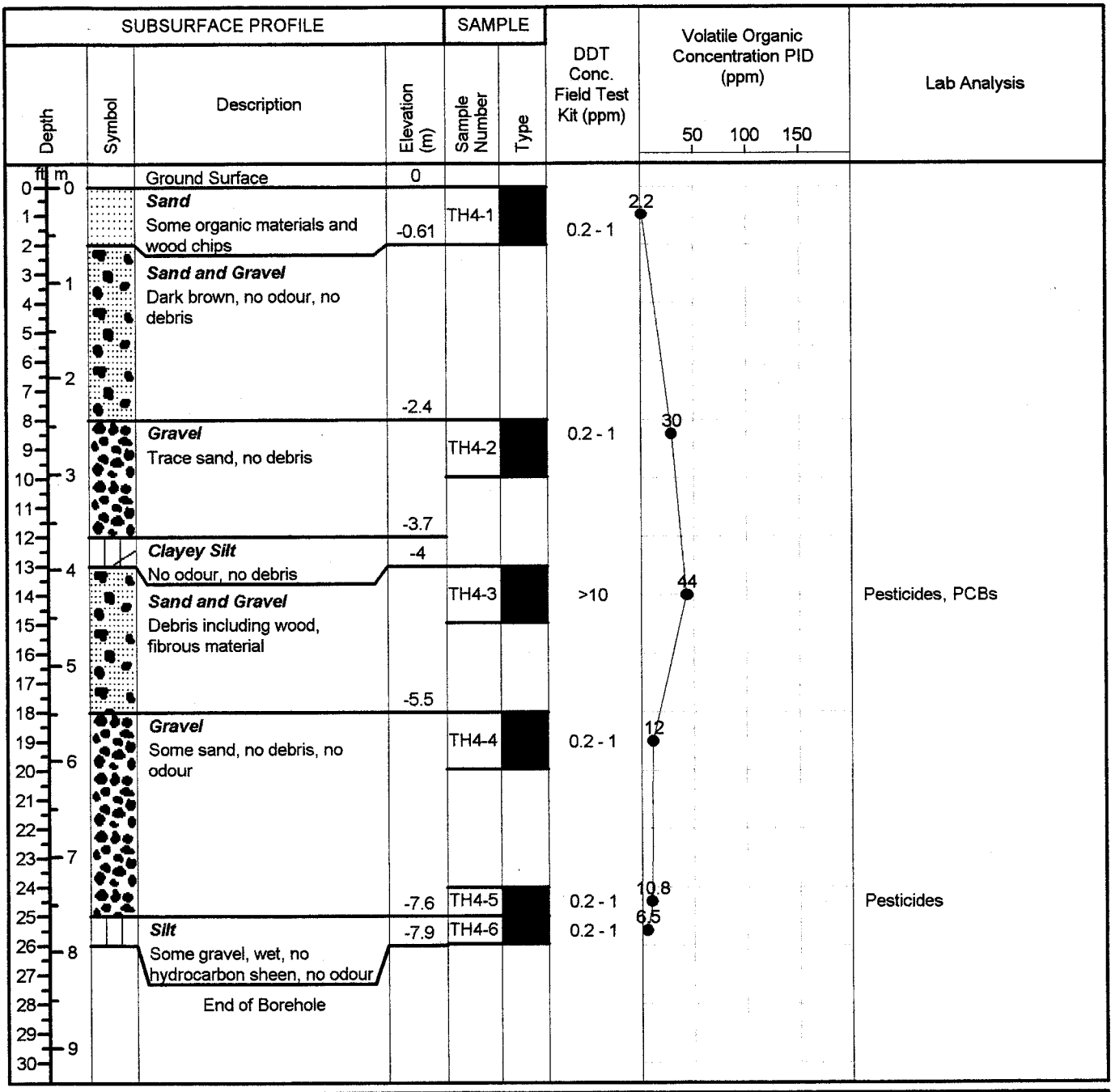
Log of Borehole: TH-4

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem/Air Rotary,ODEX

Drill Date: April 18, 2000

Driller: Beck

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Sheet: 1 of 1

Log of Borehole: TH-5

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
0 / 0		Ground Surface	0					
0–3 / 0–1		***Sand and Silt*** Some organic materials, wood fibres		TH5-1		<0.2	3.2	Pesticides
6–10 / 2–3				TH5-2			2.2	
			-3.4					
11–13 / 3–4		***Sand and Silt*** Moist, dark brown, no debris		TH5-3		<0.2	5.7	
			-4.3					
14–17 / 4–5		***Sand and Gravel*** No odour, no debris						Pesticides
			-5.5					
18–20 / 5–6		***Gravel*** Some silt, clay, no odour, no debris		TH5-4			5.3	
22–23 / 6–7			-7	TH5-5		<0.2	6.7	
		End of Borehole						

Drill Method: Solid Stem/Air Rotary,ODEX

Drill Date: April 18, 2000

Driller: Beck

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Sheet: 1 of 1

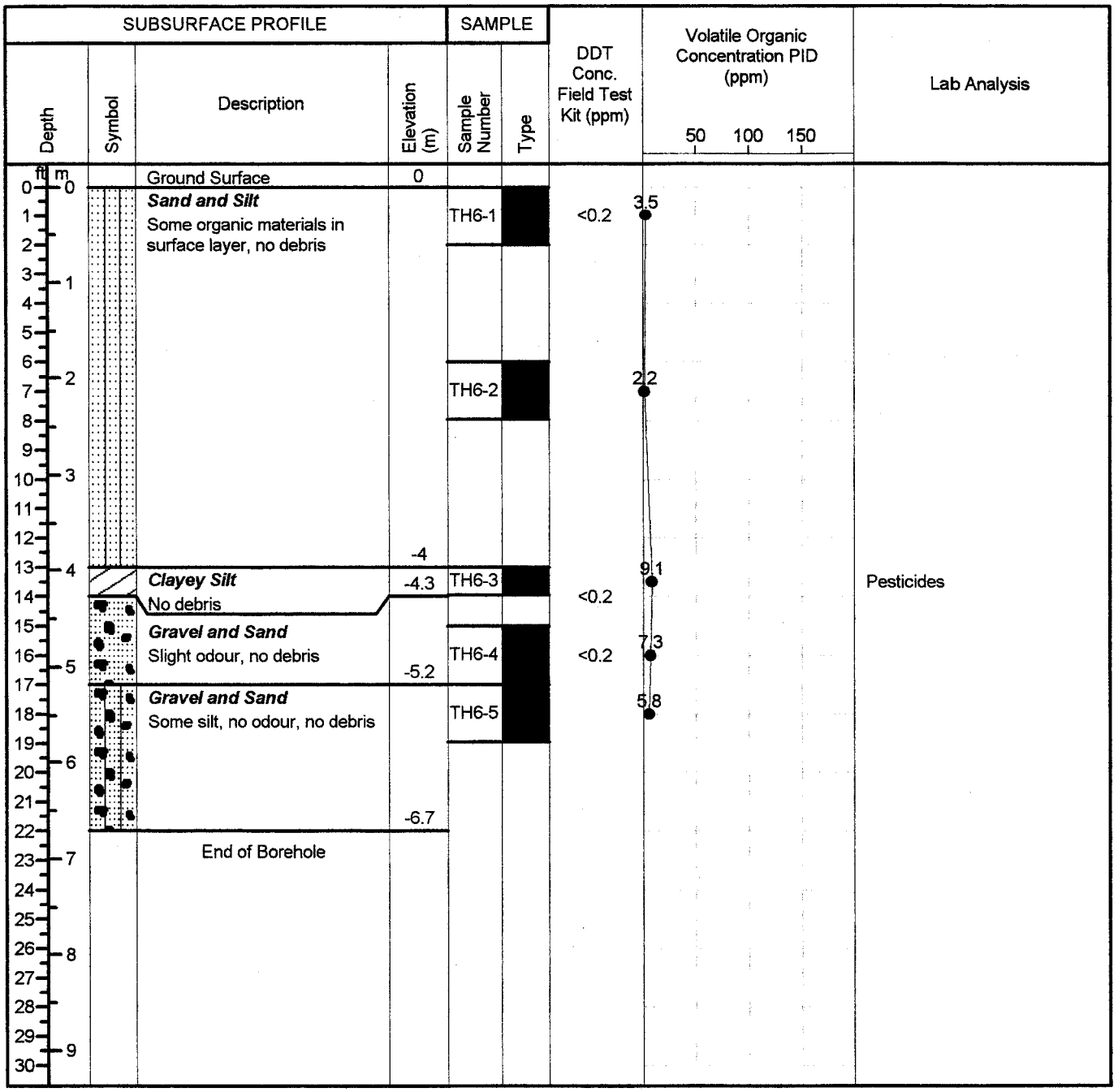
Log of Borehole: TH-6

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem/Air Rotary,ODEX

Drill Date: April 18, 2000

Driller: Beck

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Sheet: 1 of 1

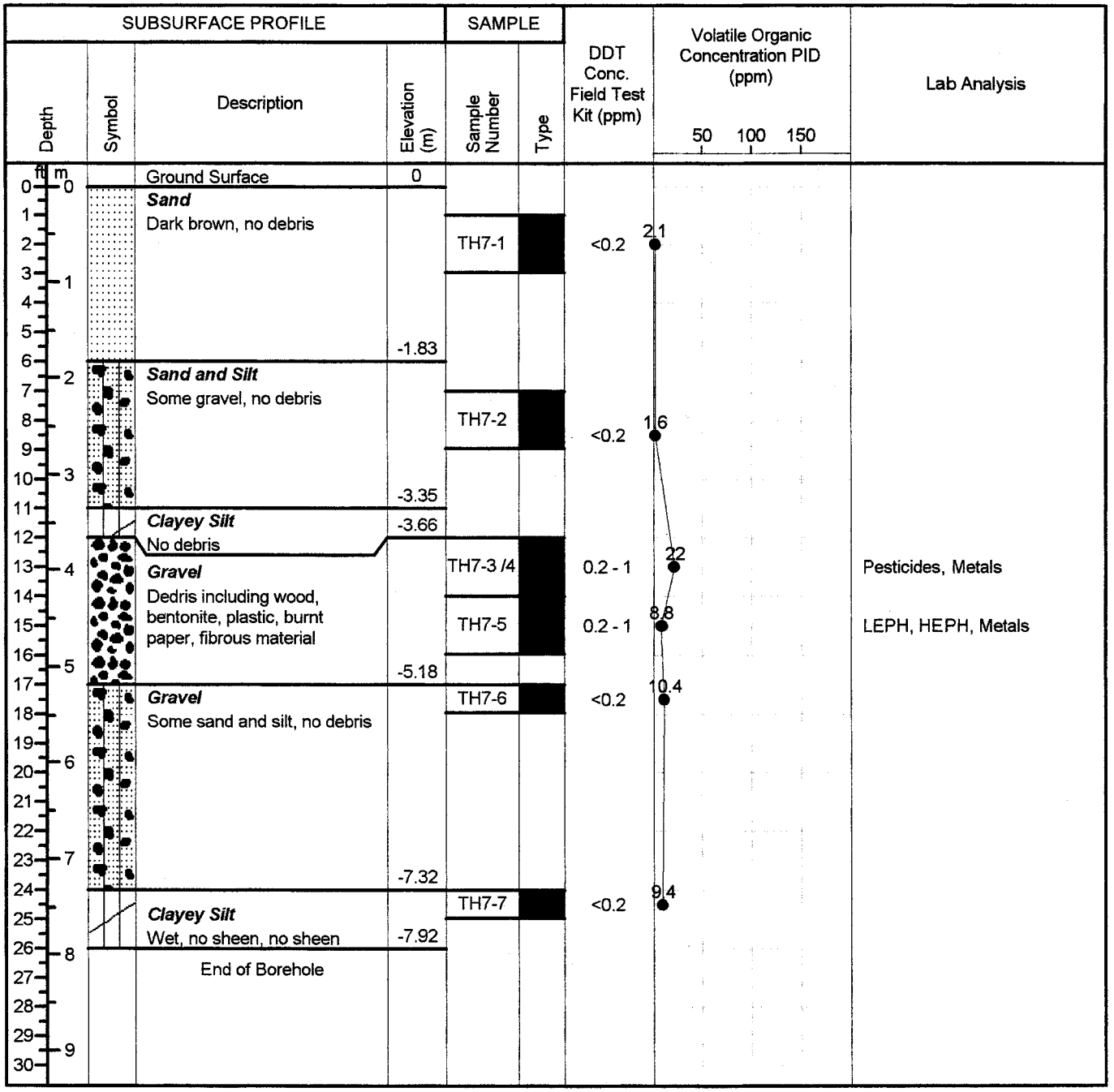
Log of Borehole: TH-7

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem/Air Rotary,ODEX

Drill Date: April 19, 2000

Driller: Beck

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Sheet: 1 of 1

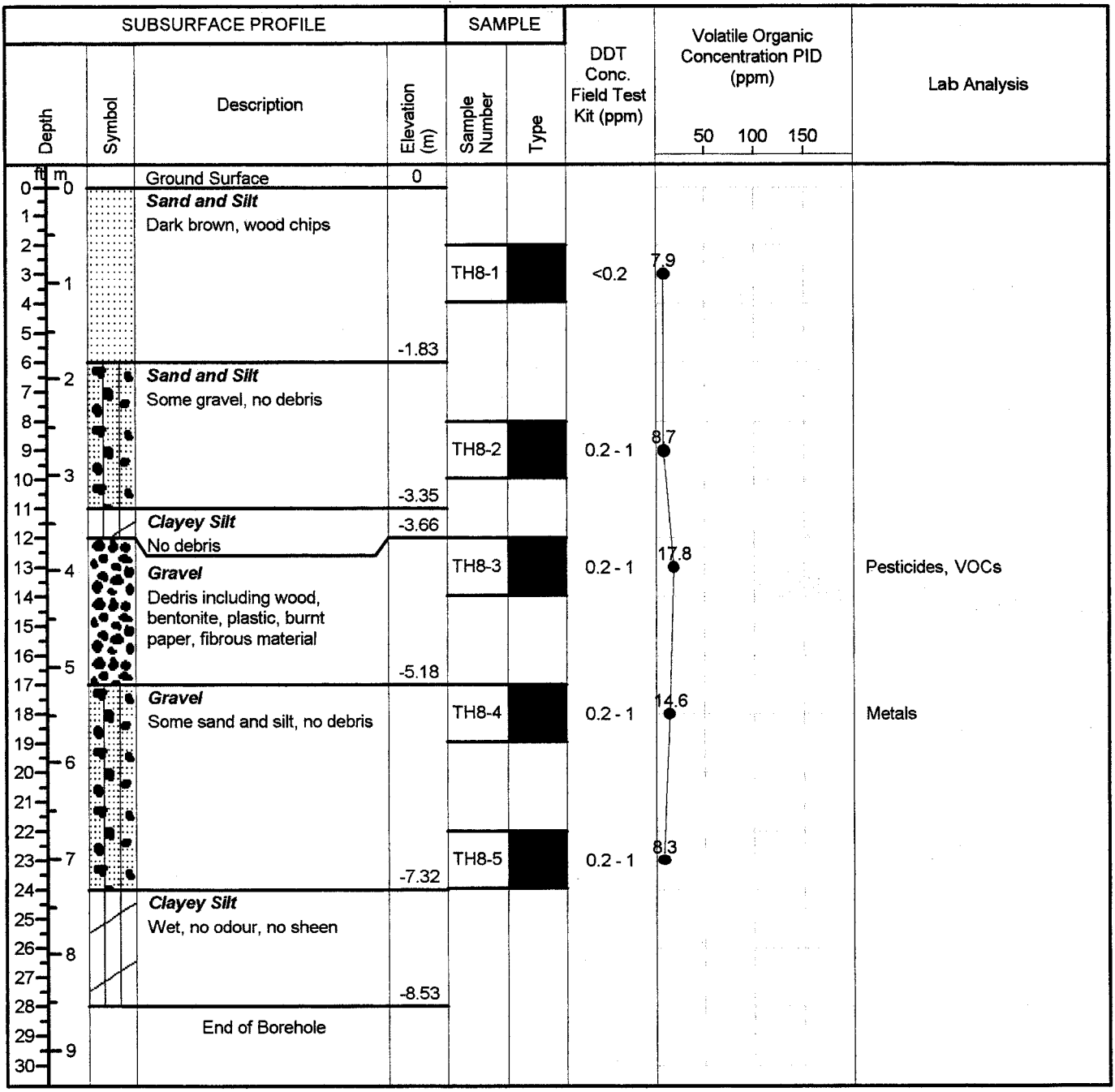
Log of Borehole: TH-8

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem/Air Rotary,ODEX

Drill Date: April 19, 2000

Driller: Beck

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Sheet: 1 of 1

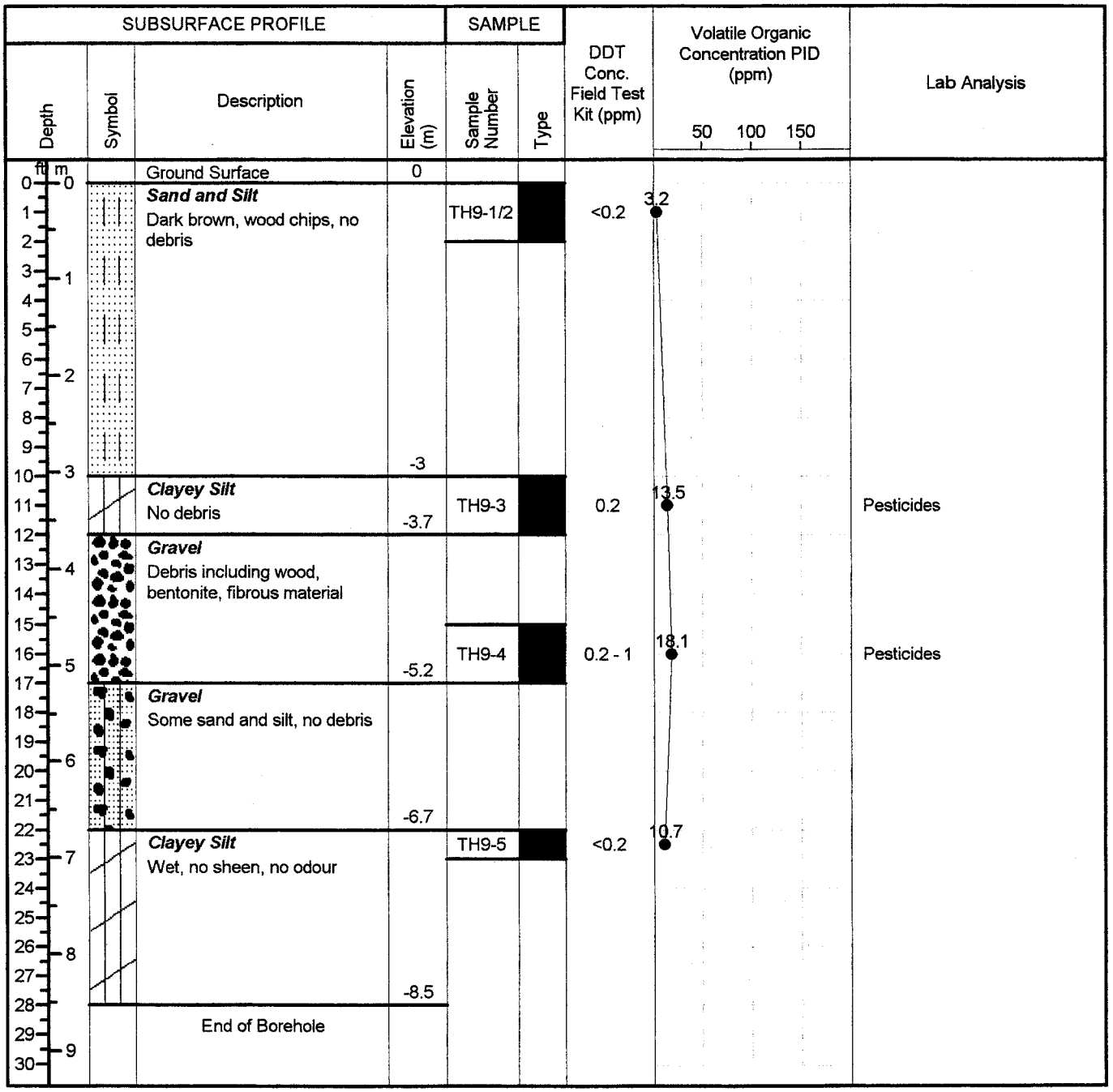
Log of Borehole: TH-9

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem/Air Rotary,ODEX

Drill Date: April 19, 2000

Driller: Beck

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Sheet: 1 of 1

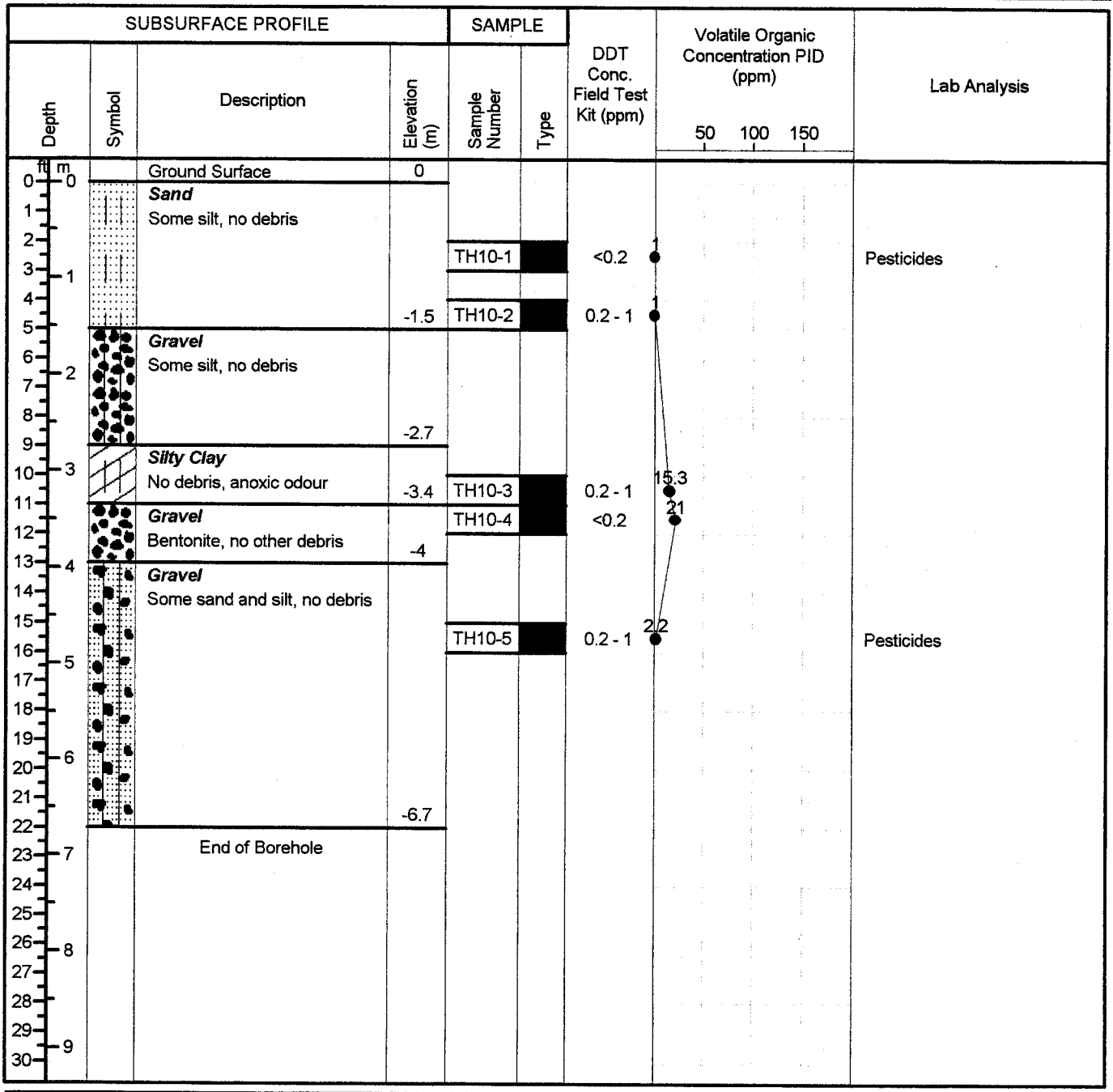
Log of Borehole: TH-10

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem/Air Rotary,ODEX

Drill Date: April 20, 2000

Driller: Beck

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Logged by: M.D

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Sheet: 1 of 1

Log of Borehole: TH-11

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
ft m		Ground Surface	0					
0 0		***Sand, Silt and Gravel*** No debris		TH11-1				
1						0.2 - 1	2.1	
2 3 1								
4		Auger refusal at 1.5 m	-1.5	TH11-2		0.2 - 1	2.2	
5 6		End of Borehole						
7 2								
8 9								
10 3								
11 12								
13 4								
14 15								
16 5								
17 18								
19 6								
20 21								
22 23 7								
24 25								
26 8								
27 28								
29 9								
30								

Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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V9B 5Y2

Logged by: M.D

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Sheet: 1 of 1

Log of Borehole: TH-12

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
0 / 0		Ground Surface	0					
		Sand, Silt and Gravel Wood, no other debris						
1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9 / 10 / 11 / 12 / 13 / 14 / 15 / 16 / 17 / 18 / 19 / 20 / 21 / 22 / 23 / 24 / 25 / 26 / 27 / 28 / 29 / 30 — 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8 / 9		Auger refusal at 3.35 m		TH12-1		0.2 - 1	4.1	Pesticides
			-3.35					
		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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V9B 5Y2

Logged by: M.D

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Sheet: 1 of 1

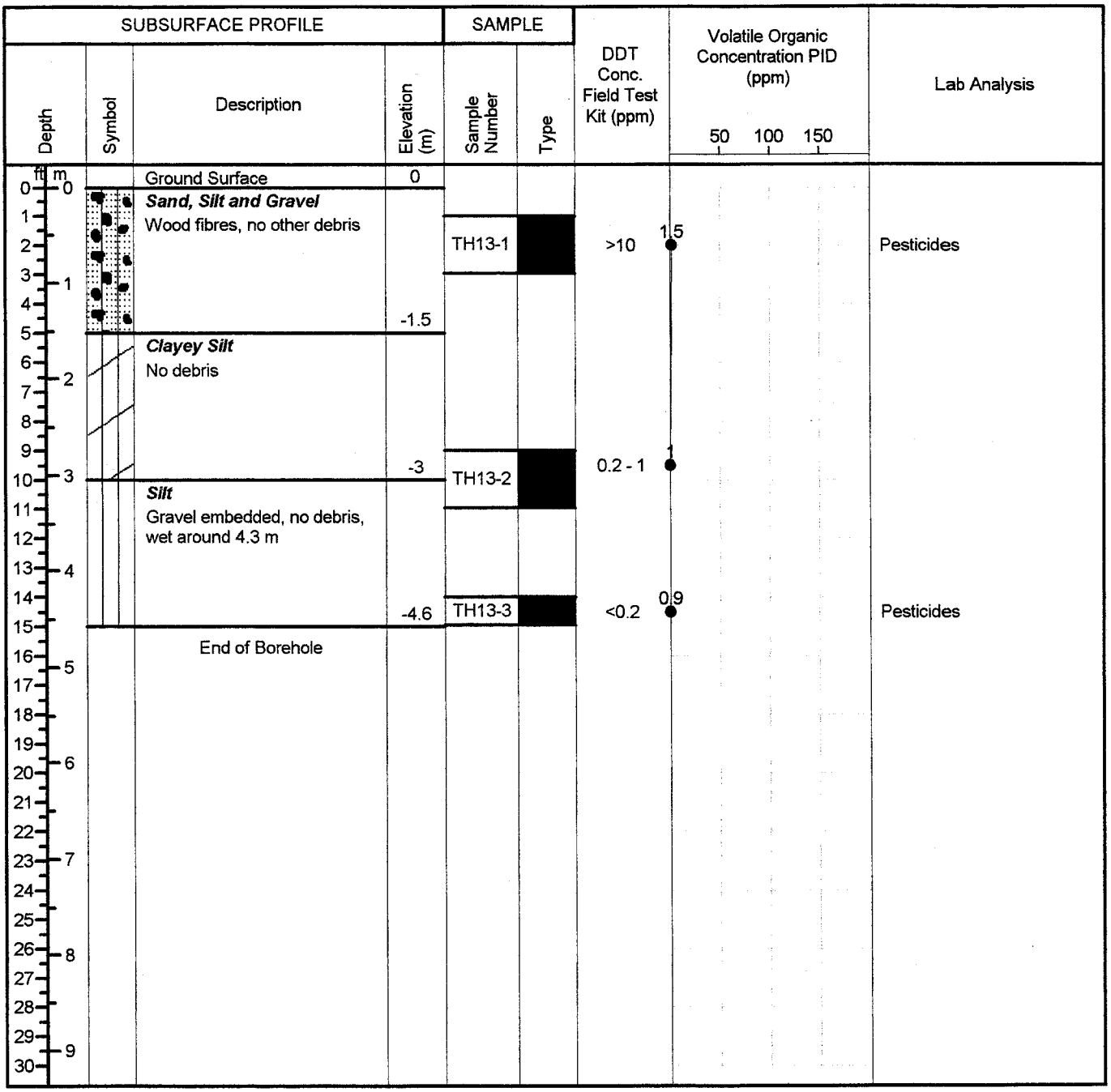
Log of Borehole: TH-13

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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Sheet: 1 of 1

Log of Borehole: TH-14

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
0 / 0		Ground Surface	0					
0–5 / 0–1		***Sand and Silt*** Wood fibres, no other debris	-1.5	TH14-1		0.2 - 1	1.2	Pesticides
5–15 / 1–4		***Clayey Silt*** No debris	-4.6	TH14-2		<0.2	1.3	
15 / 4		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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Sheet: 1 of 1

Log of Borehole: TH-15

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

Depth (ft / m)	Description	Elevation (m)	Sample Number	Type	DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
0 / 0	Ground Surface	0					
0–3 / 0–1	***Sand and Gravel*** No debris		TH15-1		0.2 - 1	1.7	Pesticides, LEPH/HEPH
3–9 / 1–2		-2.7	TH15-2		<0.2	86	
9–13 / 3–4	***Sand and Gravel*** Mostly bentonite, no other debris	-4					
13–15 / 4–4.6	***Silt*** Gravel embedded, no debris	-4.6	TH15-3		<0.2	4.9	
	End of Borehole						

PID scale: 50 100 150

Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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Sheet: 1 of 1

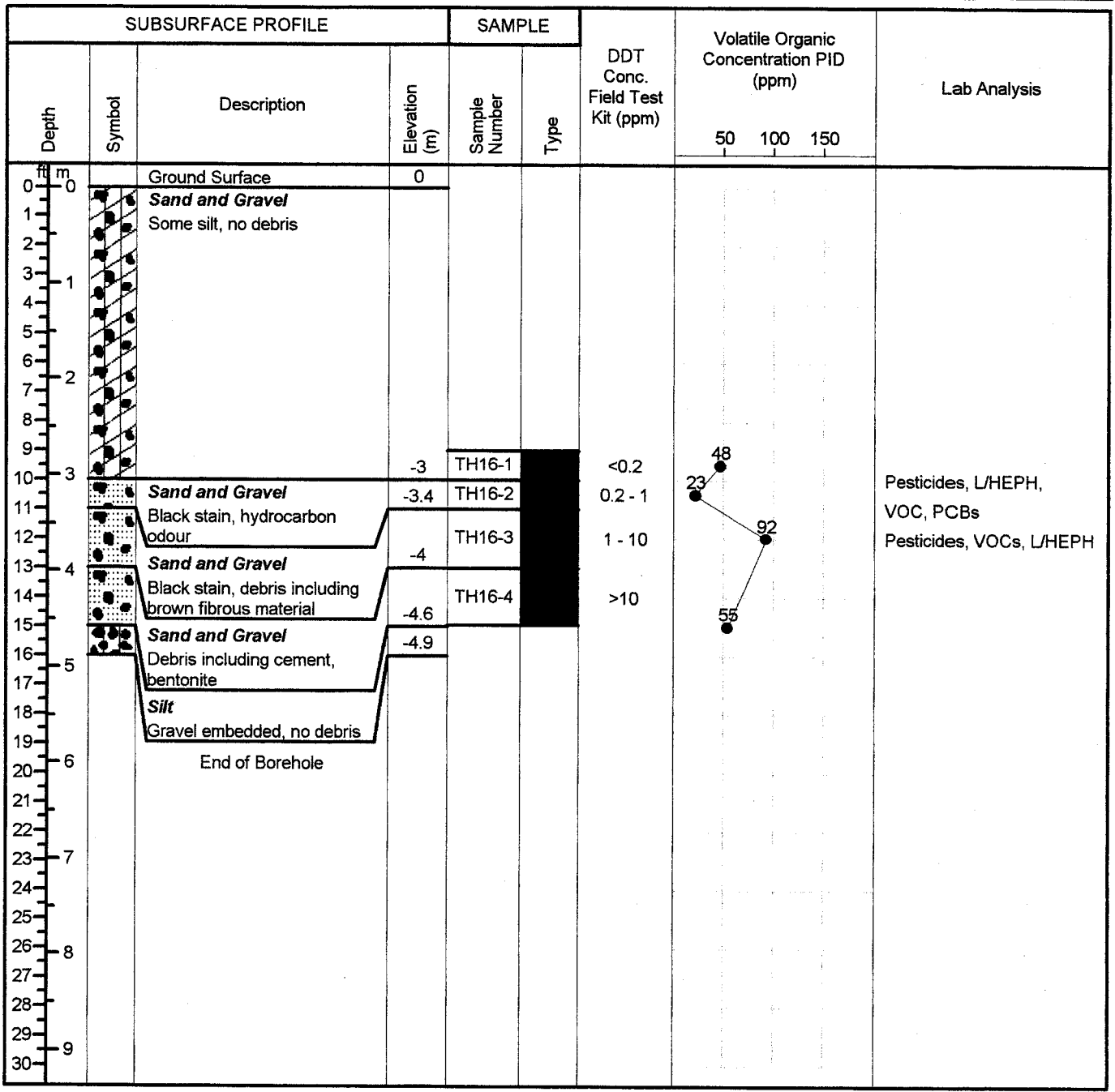
Log of Borehole: TH-16

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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Sheet: 1 of 1

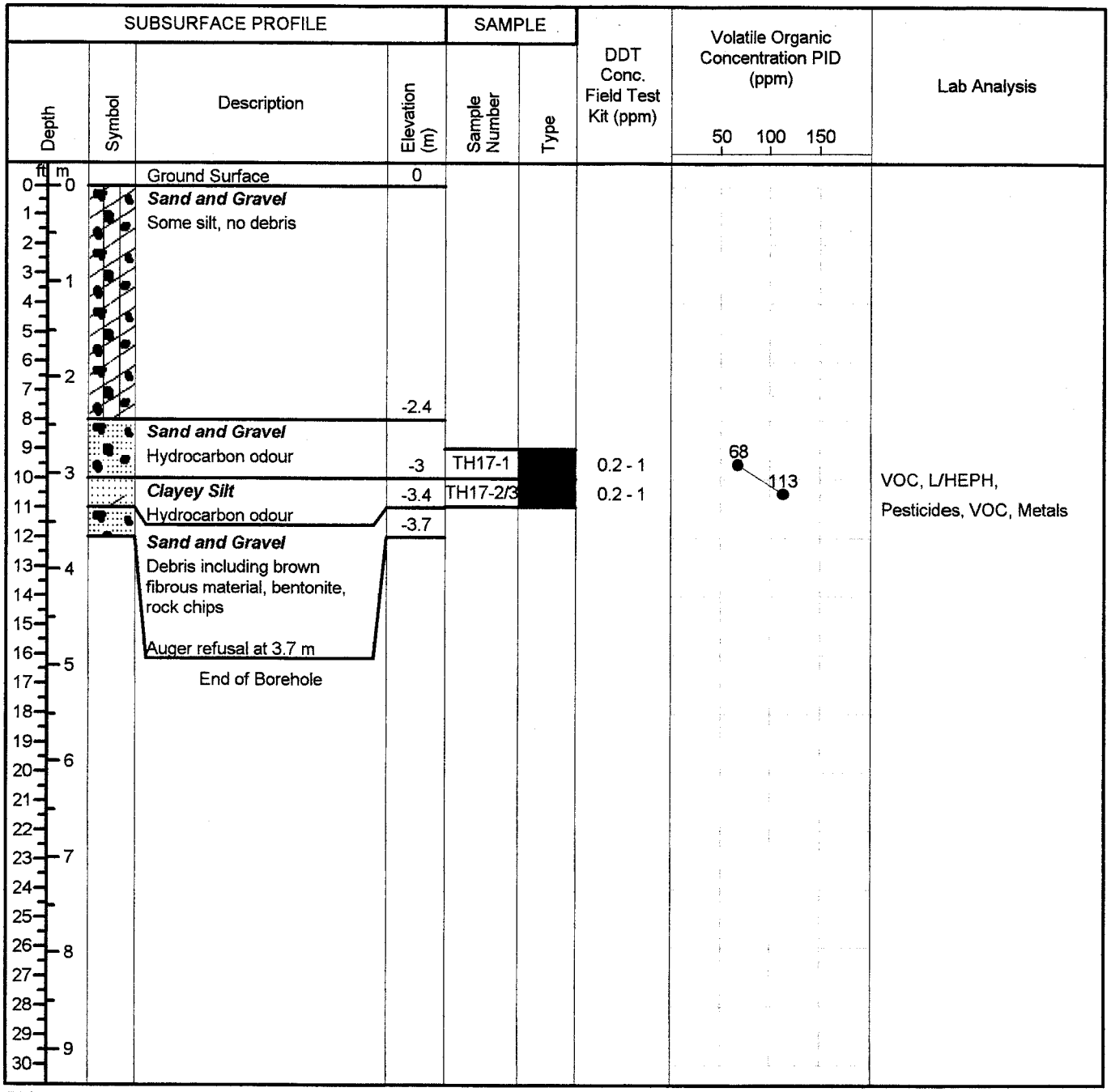
Log of Borehole: TH-17

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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Sheet: 1 of 1

Log of Borehole: TH-18

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
0 / 0		Ground Surface	0					
		Fine Sand and Silt No debris		TH18-1		<0.2	15	
10 / 3			-3					
		Clayey Silt	-3.4					
		No debris		TH18-2		0.2 - 1	79	Pesticides, L/HEPH, Metals
		Clayey Silt Fibrous material, slight odour, balck stain 3.4 - 3.7 m						
15 / 5			-4.6	TH18-3		0.2 - 1	24	Pesticides, L/HEPH, VOC Metals
		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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Sheet: 1 of 1

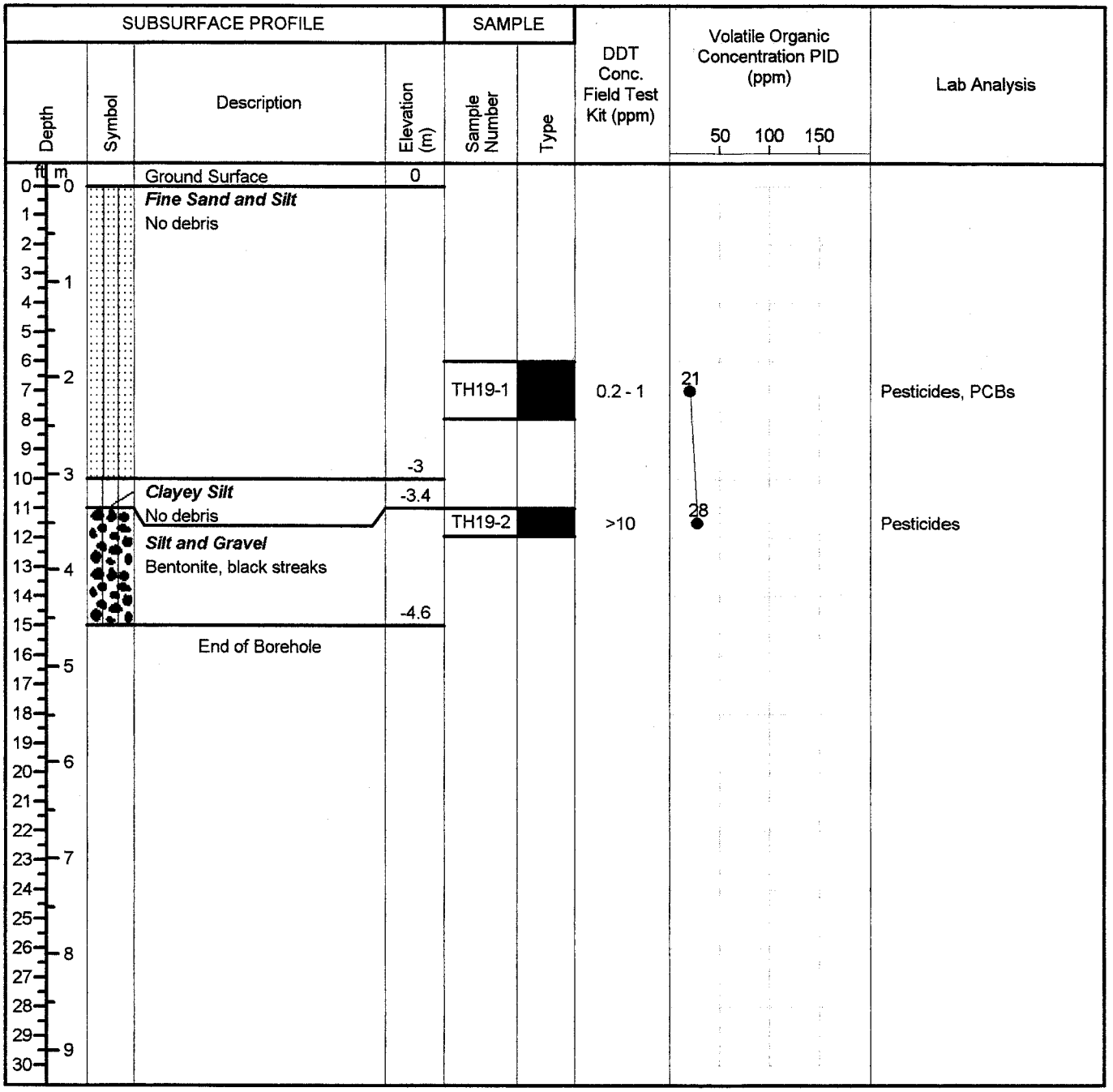
Log of Borehole: TH-19

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem

Drill Date: April 20, 2000

Driller: Beck

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V9B 5Y2

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Sheet: 1 of 1

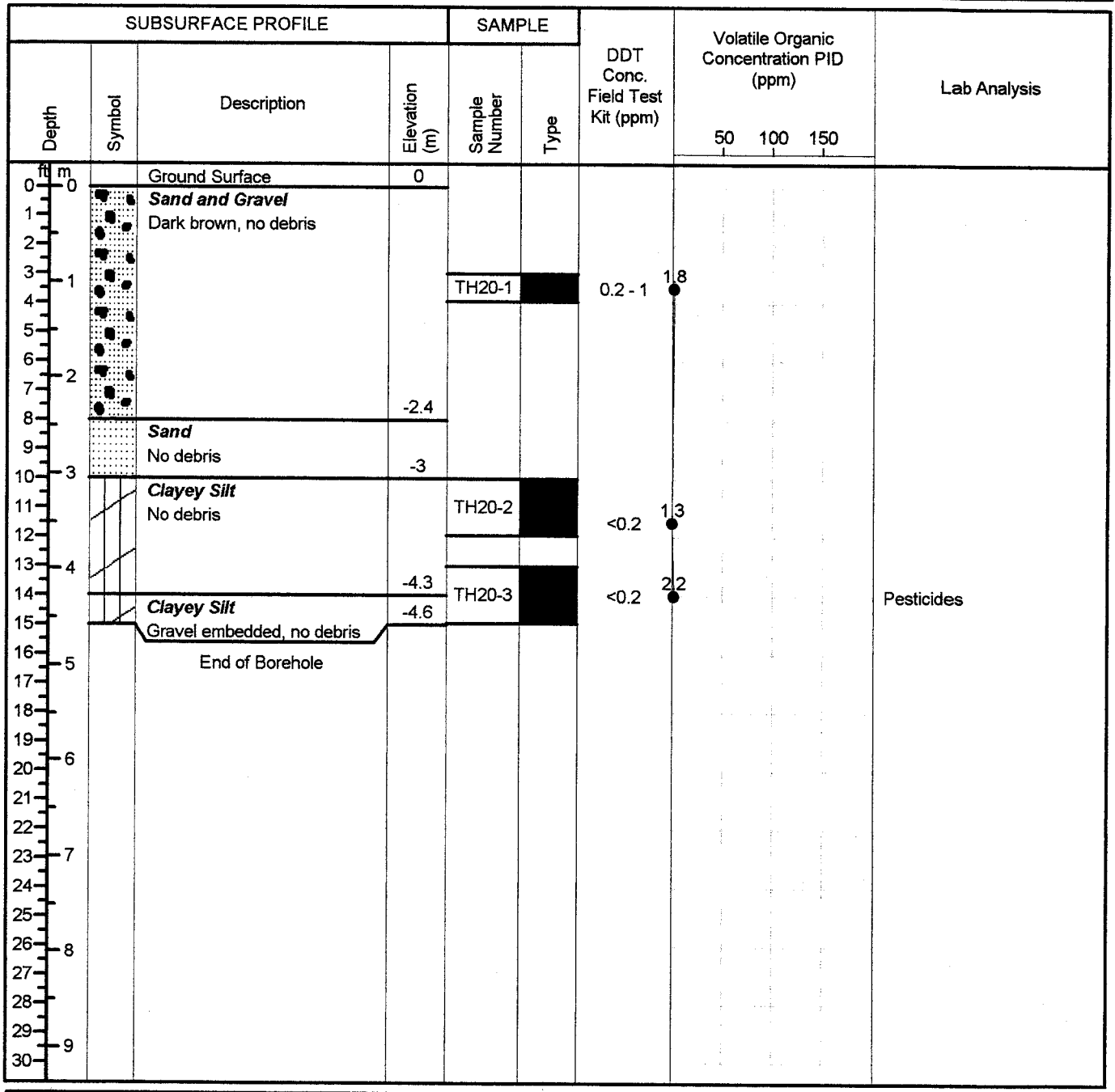
Log of Borehole: TH-20

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem

Drill Date: April 21, 2000

Driller: Beck

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Sheet: 1 of 1

Log of Borehole: TH-21

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
ft m		Ground Surface	0					
0 0		***Sand and Silt*** Gravel embedded, no debris						
10 3				TH21-1		<0.2	4.5	
14 4			-4.6	TH21-2		0.2 - 1	3	Metals
		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 21, 2000

Driller: Beck

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Sheet: 1 of 1

Log of Borehole: TH-22

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
ft m		Ground Surface	0					
0 0		***Sand and Silt*** No debris						
1			-0.91					
3 1		***Clayey Silt*** No debris	-1.2	TH22-1		<0.2	1.5	Pesticides
4 5 6 2 7 8		***Sand and Silt*** No debris						
9			-2.7					
10 3		***Clayey Silt*** Gravel embedded						
12 13 4								
14 15			-4.6	TH22-2		<0.2	1.4	
16		End of Borehole						
17 5 18 19								
20 6 21 22								
23 7 24 25								
26 8 27 28								
29 9 30								

Drill Method: Solid Stem

Drill Date: April 21, 2000

Driller: Beck

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Logged by: M.D

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Sheet: 1 of 1

Log of Borehole: TH-23

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE				
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type	DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm) 50 100 150	Lab Analysis
0 / 0		Ground Surface	0					
		Sand and Silt No debris						
			-0.91	TH23-1		0.2 - 1	2.2	Pesticides
3 / 1		***Clayey Silt***	-1.2					
		No debris						
		Sand and Silt No debris						
9 / 2			-2.7					
		Clayey Silt Gravel embedded		TH23-2		<0.2	1.3	
14 / 4			-4.6	TH23-3		<0.2	1.2	
		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 21, 2000

Driller: Beck

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Logged by: M.D

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Sheet: 1 of 1

Log of Borehole: TH-24

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm) 50 100 150	Lab Analysis
Depth ft / m	Symbol	Description	Elevation (m)	Sample Number	Type			
0 / 0		Ground Surface	0					
0–3 / 0–1		***Sand, Silt and Gravel*** No debris		TH24-1		0.2 - 1	14	PCBs
				TH24-2		0.2 - 1	19	Pesticides
			-3	TH24-3		0.2 - 1	18	
10 / 3		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 21, 2000

Driller: Beck

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2005 Sooke Road
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Sheet: 1 of 1

Log of Borehole: TH-25

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
ft m		Ground Surface	0					
0 0		***Sand, Silt and Gravel***						
1		No debris		TH25-1		0.2 - 1	1.5	
2								
3 1				TH24-2		0.2 - 1	1.7	Pesticides, Metals
4		Auger refusal at 1.5 m						
5			-1.5					
6		End of Borehole						
7 2								
8								
9								
10 3								
11								
12								
13 4								
14								
15								
16 5								
17								
18								
19								
20 6								
21								
22								
23 7								
24								
25								
26 8								
27								
28								
29								
30 9								

Drill Method: Solid Stem

Drill Date: April 22, 2000

Driller: Beck

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Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

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Sheet: 1 of 1

Log of Borehole: TH-26

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
0 / 0		Ground Surface	0					
		Sand and Silt	-0.3					
1		Bentonite		TH26-1		>10	1.9	Pesticides, Metals
2		***Sand and Gravel***						
3 / 1		Debris including wood, fibrous material						
4								
5								
6								
2			-2.1					
7		***Sand and Gravel***						
8		No debris						
9			-3					
10 / 3		End of Borehole						
11								
12								
13 / 4								
14								
15								
16								
17 / 5								
18								
19								
20 / 6								
21								
22								
23 / 7								
24								
25								
26 / 8								
27								
28								
29								
30 / 9								

Drill Method: Solid Stem

Drill Date: April 22, 2000

Driller: Beck

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Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

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Sheet: 1 of 1

Log of Borehole: TH-27

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
ft m		Ground Surface	0					
0 0		***Sand, Silt and Gravel*** Debris including bentonite, wood		TH27-1		1 - 10	45	Pesticides, Metals
3 1				TH27-2		>10	82	
7 2			-2.1	TH27-3		>10	70	Pesticides, PCBs, Metals
		Gravel No debris						
10 3			-3					
		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 22, 2000

Driller: Beck

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V9B 5Y2

Logged by: M.D

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Sheet: 1 of 1

Log of Borehole: TH-28

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
0 / 0		Ground Surface	0					
0 – 3 / 0 – 1		***Clayey Silt and Gravel*** Debris including bentonite, wood, black stain		TH28-1		>10	28	
7 / 2				TH28-2		>10	16	Pesticides, L/HEPH PCBs, Metals
			-2.7					
9 – 10 / 3		***Clayey Silt and Gravel***	-3	TH28-3		1 - 10	10	
		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 22, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

Checked by:

Sheet: 1 of 1

Log of Borehole: TH-29

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		250 500 750	
0 / 0		Ground Surface	0					
0–3 / 0–1		***Clayey Silt and Gravel*** Debris including bentonite, wood, metal straps, anoxic odour		TH29-1		1-10	23	Pesticides, PCBs
			-1.5	TH29-2		0.2	202	Pesticides, L/HEPH, Metals
5–10 / 2–3		***Clayey Silt*** Dark stain, anoxic odour						
			-3	TH29-3		0.2	744	L/HEPH, VOC
		End of Borehole						

Drill Method: Solid Stem

Drill Date: April 22, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

Checked by:

Sheet: 1 of 1

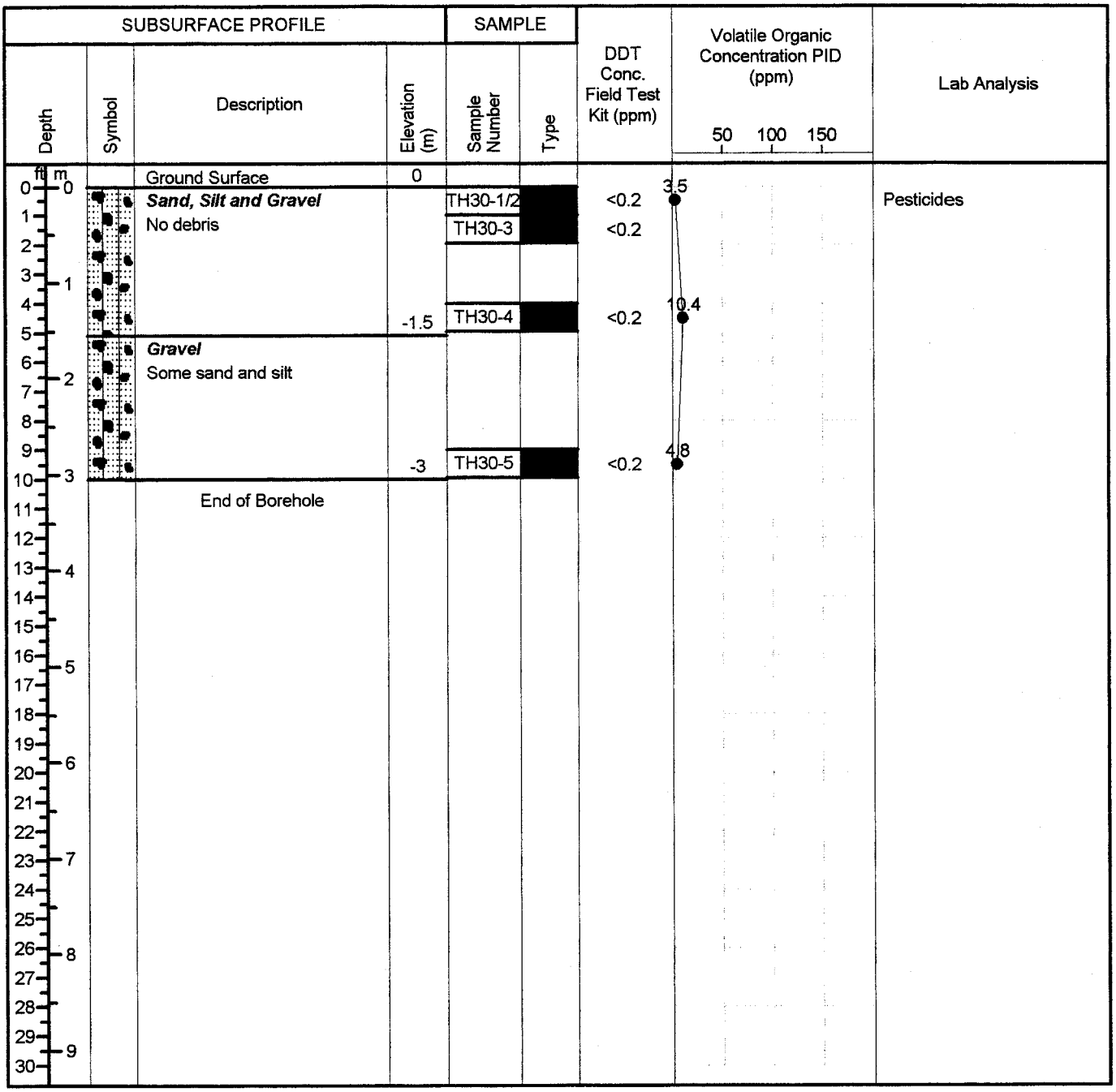
Log of Borehole: TH-30

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site



Drill Method: Solid Stem

Drill Date: April 23, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

Checked by:

Sheet: 1 of 1

Log of Borehole: TH-31

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
ft m		Ground Surface	0					
0 0		***Sand, Silt and Gravel***		TH31-1		<0.2	3.5	Metals
1		No debris						
2								
3 1				TH31-2		<0.2	10.4	Pesticides
4								
5								
6 2								
7								
8								
9								
10 3			-3	TH31-3		<0.2	4.8	Pesticides
11		End of Borehole						
12								
13 4								
14								
15								
16 5								
17								
18								
19								
20 6								
21								
22								
23 7								
24								
25								
26 8								
27								
28								
29								
30 9								

Drill Method: Solid Stem

Drill Date: April 23, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

Checked by:

Sheet: 1 of 1

Log of Borehole: TH-32

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm)	Lab Analysis
Depth (ft / m)	Symbol	Description	Elevation (m)	Sample Number	Type		50 100 150	
0 / 0		Ground Surface	0					
0–3 / 0–1		***Sand, Silt and Gravel*** No debris		TH32-1		<0.2	1.9	
				TH32-2		<0.2	2.7	Pesticides
10 / 3		End of Borehole	-3					

Drill Method: Solid Stem

Drill Date: April 23, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

Checked by:

Sheet: 1 of 1

Log of Borehole: TH-33

Project No: 2000-005A

Project: Peel River Site Investigation

Client: DIAND, Waste Management, Yukon Region

Location: Peel River Waste Site

SUBSURFACE PROFILE				SAMPLE		DDT Conc. Field Test Kit (ppm)	Volatile Organic Concentration PID (ppm) 50 100 150	Lab Analysis
Depth ft / m	Symbol	Description	Elevation (m)	Sample Number	Type			
0 / 0		Ground Surface	0					
		Sand, Silt and Gravel No debris						
2				TH33-1		<0.2	1,3	Metals
1								
4				TH33-2		<0.2	2,2	Pesticides
2								
9				TH33-3		<0.2	1,2	
3			-3					
10		End of Borehole						
4								
13								
5								
16								
6								
20								
7								
23								
8								
26								
9								
30								

Drill Method: Solid Stem

Drill Date: April 23, 2000

Driller: Beck

Royal Roads University, ARD
2005 Sooke Road
Victoria, BC, Canada
V9B 5Y2

Logged by: M.D

Checked by:

Sheet: 1 of 1

APPENDIX B1:

ASL LABORATORY REPORT FOR ORGANOCHLORINE PESTICIDES, PCBS, METALS, HYDROCARBONS AND VOCS IN SOIL SAMPLES

1988 Triumph Street, Vancouver, BC Canada V5L 1K5

analytical
service
laboratories
ltd.

FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date:	June 6, 2000
ASL File No.	L6581
Report On:	Peel River Soil Analysis
Report To:	**Royal Roads University** Applied Research Division 2005 Sooke Road Victoria, BC V9B 5Y2
Attention:	**Dr. Matthew Dodd**, Professor
Received:	April 27, 2000

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Frederick Chen, B.Sc. - Manager, Special Projects
Miles Gropen, B.Sc. - Project Chemist

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581

Sample ID		TH1-1	TH2-2	TH2-4	TH3-2	TH7-3
Sample Date		00 04 16	00 04 16	00 04 17	00 04 17	00 04 18
Sample Time		14:30	17:30	10:20	11:45	10:55
Physical Tests						
Moisture	%	11.6	12.9	24.7	27.4	13.2
pH		8.13	7.83	7.55	7.52	7.91
Total Metals						
Antimony	T-Sb	<20	<20	<20	<20	<20
Arsenic	T-As	12	14	13	11	12
Barium	T-Ba	407	403	375	100	566
Beryllium	T-Be	0.7	0.8	0.8	0.8	0.7
Cadmium	T-Cd	1.2	1.3	0.6	0.5	0.6
Chromium	T-Cr	37	36	35	40	33
Cobalt	T-Co	8	11	9	8	8
Copper	T-Cu	32	30	26	56	45
Lead	T-Pb	<50	<50	<50	<50	<50
Mercury	T-Hg	0.060	0.052	0.058	0.062	0.052
Molybdenum	T-Mo	<4	<4	<4	<4	<4
Nickel	T-Ni	29	36	29	27	27
Selenium	T-Se	<2	<2	<2	<2	<2
Silver	T-Ag	<2	<2	<2	<2	<2
Thallium	T-Tl	<2	<2	<2	<2	<2
Tin	T-Sn	<10	<10	<10	<10	<10
Vanadium	T-V	106	107	101	101	106
Zinc	T-Zn	104	120	108	145	109

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID		TH7-4	TH7-5	TH8-4	TH15-1	TH16-2
Sample Date		00 04 18	00 04 18	00 04 18	00 04 20	00 04 20
Sample Time		11:00	11:30	15:04	14:30	16:10
Physical Tests						
Moisture	%	14.5	28.0	4.9	11.3	21.4
pH		7.86	8.09	-	-	-
Total Metals						
Antimony	T-Sb	<20	<20	-	-	-
Arsenic	T-As	13	10	-	-	-
Barium	T-Ba	577	596	-	-	-
Beryllium	T-Be	0.7	0.8	-	-	-
Cadmium	T-Cd	0.6	<0.5	-	-	-
Chromium	T-Cr	35	33	-	-	-
Cobalt	T-Co	8	7	-	-	-
Copper	T-Cu	44	45	-	-	-
Lead	T-Pb	140	<50	-	-	-
Mercury	T-Hg	0.052	0.042	-	-	-
Molybdenum	T-Mo	<4	<4	-	-	-
Nickel	T-Ni	28	22	-	-	-
Selenium	T-Se	<2	<2	-	-	-
Silver	T-Ag	<2	<2	-	-	-
Thallium	T-Tl	<2	<2	-	-	-
Tin	T-Sn	<10	<10	-	-	-
Vanadium	T-V	116	87	-	-	-
Zinc	T-Zn	109	92	-	-	-

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581

Sample ID		TH16-3	BH17-1	TH17-2	TH17-3	TH18-2
Sample Date		00 04 20	00 04 20	00 04 20	00 04 20	00 04 20
Sample Time		16:15	16:30	16:50	16:55	17:30
Physical Tests						
Moisture	%	41.8	22.5	21.2	19.1	23.1
pH		-	-	7.75	7.82	7.79
Total Metals						
Antimony	T-Sb	-	-	<20	<20	<20
Arsenic	T-As	-	-	14	14	10
Barium	T-Ba	-	-	822	632	405
Beryllium	T-Be	-	-	0.9	0.8	0.6
Cadmium	T-Cd	-	-	0.6	0.6	<0.5
Chromium	T-Cr	-	-	43	36	29
Cobalt	T-Co	-	-	9	10	7
Copper	T-Cu	-	-	29	29	21
Lead	T-Pb	-	-	<50	<50	<50
Mercury	T-Hg	-	-	0.069	0.067	0.065
Molybdenum	T-Mo	-	-	<4	<4	<4
Nickel	T-Ni	-	-	32	32	22
Selenium	T-Se	-	-	<2	<2	<2
Silver	T-Ag	-	-	<2	<2	<2
Thallium	T-Tl	-	-	<2	<2	<2
Tin	T-Sn	-	-	<10	<10	<10
Vanadium	T-V	-	-	130	111	84
Zinc	T-Zn	-	-	116	120	86

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581

Sample ID		TH18-3	TH21-2	TH24-3	TH25-2	TH26-1
Sample Date		00 04 20	00 04 21	00 04 21	00 04 22	00 04 22
Sample Time		17:40	13:50	17:45	14:25	15:20
Physical Tests						
Moisture	%	20.5	12.9	14.8	14.1	71.2
pH		7.89	7.89	8.29	8.29	8.97
Total Metals						
Antimony	T-Sb	<20	<20	<20	<20	<20
Arsenic	T-As	14	12	7	10	<5
Barium	T-Ba	507	516	323	342	2070
Beryllium	T-Be	0.9	0.7	<0.5	<0.5	0.7
Cadmium	T-Cd	0.6	<0.5	<0.5	<0.5	<0.5
Chromium	T-Cr	41	40	28	17	20
Cobalt	T-Co	10	8	4	7	2
Copper	T-Cu	28	25	15	22	10
Lead	T-Pb	<50	<50	<50	<50	73
Mercury	T-Hg	0.082	0.052	0.026	0.031	0.030
Molybdenum	T-Mo	<4	<4	<4	<4	<4
Nickel	T-Ni	32	27	16	24	7
Selenium	T-Se	<2	<2	<2	<2	<2
Silver	T-Ag	<2	<2	<2	<2	<2
Thallium	T-Tl	<2	<2	<2	<2	<2
Tin	T-Sn	<10	<10	<10	<10	<10
Vanadium	T-V	123	98	72	52	34
Zinc	T-Zn	118	95	42	72	35

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID		TH27-1	TH27-3	TH28-2	TH29-2	TH29-3
Sample Date		00 04 22	00 04 22	00 04 22	00 04 22	00 04 22
Sample Time		15:50	16:00	16:10	16:45	16:50
Physical Tests						
Moisture	%	69.5	27.8	51.5	55.8	69.1
pH		10.0	9.09	9.44	9.98	-
Total Metals						
Antimony	T-Sb	<20	<20	<20	<20	-
Arsenic	T-As	6	<5	<5	<5	-
Barium	T-Ba	761	169	248	3510	-
Beryllium	T-Be	0.9	<0.5	0.8	1.6	-
Cadmium	T-Cd	<0.5	<0.5	<0.5	<0.5	-
Chromium	T-Cr	29	12	12	6	-
Cobalt	T-Co	4	4	2	<2	-
Copper	T-Cu	13	15	6	3	-
Lead	T-Pb	<50	<50	<50	<50	-
Mercury	T-Hg	0.038	0.015	0.021	0.019	-
Molybdenum	T-Mo	<4	<4	<4	<4	-
Nickel	T-Ni	12	10	7	<5	-
Selenium	T-Se	<2	<2	<2	<2	-
Silver	T-Ag	<2	<2	<2	<2	-
Thallium	T-Tl	<2	<2	<2	<2	-
Tin	T-Sn	<10	<10	<10	<10	-
Vanadium	T-V	44	28	28	11	-
Zinc	T-Zn	56	32	37	41	-

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581

Sample ID		TH31-1	TH33-1	SED-1	SED-4	SED-5
Sample Date		00 04 22	00 04 23	00 04 22	00 04 23	00 04 23
Sample Time		17:00	15:20	17:00	12:45	13:30
Physical Tests						
Moisture	%	26.5	10.6	13.1	15.5	25.2
pH		7.97	8.15	8.23	8.10	-
Total Metals						
Antimony	T-Sb	<20	<20	<20	<20	-
Arsenic	T-As	15	16	11	14	-
Barium	T-Ba	507	430	438	319	-
Beryllium	T-Be	0.8	0.8	0.6	0.5	-
Cadmium	T-Cd	0.6	0.5	<0.5	<0.5	-
Chromium	T-Cr	34	37	25	21	-
Cobalt	T-Co	9	8	6	9	-
Copper	T-Cu	26	24	18	17	-
Lead	T-Pb	<50	<50	<50	<50	-
Mercury	T-Hg	0.059	0.052	0.032	0.168	-
Molybdenum	T-Mo	<4	<4	<4	<4	-
Nickel	T-Ni	32	31	24	27	-
Selenium	T-Se	<2	<2	<2	<2	-
Silver	T-Ag	<2	<2	<2	<2	-
Thallium	T-Tl	<2	<2	<2	<2	-
Tin	T-Sn	<10	<10	<10	<10	-
Vanadium	T-V	112	127	91	84	-
Zinc	T-Zn	119	99	74	96	-

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	SED-7	SED-8
Sample Date	00 04 23	00 04 23
Sample Time	14:00	12:30
Physical Tests		
Moisture %	11.3	25.5

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH8-3	TH16-2	TH16-3	BH17-1	TH17-2
Sample Date	00 04 18	00 04 20	00 04 20	00 04 20	00 04 20
Sample Time	14:45	16:10	16:15	16:30	16:50
Halogenated Volatiles					
Bromodichloromethane	<0.01	<0.01	<0.01	<0.01	<0.01
Bromoform	<0.01	<0.01	<0.01	<0.01	<0.01
Carbon Tetrachloride	<0.01	<0.01	<0.01	<0.01	<0.01
Chlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01
Chloroethane	<0.01	<0.01	<0.01	<0.01	<0.01
Chloroform	<0.01	<0.01	<0.01	<0.01	<0.01
Chloromethane	<0.01	<0.01	<0.01	<0.01	<0.01
Dibromochloromethane	<0.01	<0.01	<0.01	<0.01	<0.01
1,2-Dichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01
1,3-Dichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01
1,4-Dichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01
1,1-Dichloroethane	<0.01	<0.01	<0.01	<0.01	<0.01
1,2-Dichloroethane	<0.01	0.01	<0.01	0.01	0.01
cis-1,2-Dichloroethylene	<0.01	<0.01	<0.01	<0.01	<0.01
trans-1,2-Dichloroethylene	<0.01	<0.01	<0.01	<0.01	<0.01
1,1-Dichloroethylene	<0.01	<0.01	<0.01	<0.01	<0.01
Dichloromethane	<0.4	<0.3	<0.4	<0.3	<0.5
1,2-Dichloropropane	<0.01	<0.01	<0.01	<0.01	<0.01
cis-1,3-Dichloropropylene	<0.01	<0.01	<0.01	<0.01	<0.01
trans-1,3-Dichloropropylene	<0.01	<0.01	<0.01	<0.01	<0.01
1,1,1,2-Tetrachloroethane	<0.01	<0.01	<0.01	<0.01	<0.01
1,1,2,2-Tetrachloroethane	<0.01	<0.01	<0.01	<0.01	<0.01
Tetrachloroethylene	<0.01	<0.01	<0.01	<0.01	<0.01
1,1,1-Trichloroethane	<0.01	<0.01	<0.01	<0.01	<0.01
1,1,2-Trichloroethane	<0.01	<0.01	<0.01	<0.01	<0.01
Trichloroethylene	<0.01	<0.01	<0.01	<0.01	<0.01
Trichlorofluoromethane	<0.01	<0.01	<0.01	<0.01	<0.01
Vinyl Chloride	<0.01	<0.01	<0.01	<0.01	<0.01
Non-halogenated Volatiles					
Benzene	<0.01	<0.01	<0.01	<0.01	<0.01
Ethylbenzene	<0.01	<0.01	<0.01	<0.01	<0.01
Styrene	<0.01	<0.01	<0.01	<0.01	<0.01
Toluene	<0.01	<0.01	<0.01	<0.01	<0.01
meta- & para-Xylene	<0.01	<0.01	<0.01	<0.01	<0.01
ortho-Xylene	<0.01	<0.01	<0.01	<0.01	<0.01

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sample ID	TH17-3	TH18-3	TH29-3
Sample Date	00 04 20	00 04 20	00 04 22
Sample Time	16:55	17:40	16:50
Halogenated Volatiles			
Bromodichloromethane	<0.01	<0.01	<1
Bromoform	<0.01	<0.01	<1
Carbon Tetrachloride	<0.01	<0.01	<1
Chlorobenzene	<0.01	<0.01	<1
Chloroethane	<0.01	<0.01	<1
Chloroform	<0.01	<0.01	3
Chloromethane	<0.01	<0.01	<1
Dibromochloromethane	<0.01	<0.01	<1
1,2-Dichlorobenzene	<0.01	<0.01	<1
1,3-Dichlorobenzene	<0.01	<0.01	<1
1,4-Dichlorobenzene	<0.01	<0.01	<1
1,1-Dichloroethane	<0.01	<0.01	<1
1,2-Dichloroethane	0.01	<0.01	<1
cis-1,2-Dichloroethylene	<0.01	<0.01	<1
trans-1,2-Dichloroethylene	<0.01	<0.01	<1
1,1-Dichloroethylene	<0.01	<0.01	<1
Dichloromethane	<0.5	<0.6	26
1,2-Dichloropropane	<0.01	<0.01	<1
cis-1,3-Dichloropropylene	<0.01	<0.01	<1
trans-1,3-Dichloropropylene	<0.01	<0.01	<1
1,1,1,2-Tetrachloroethane	<0.01	<0.01	<1
1,1,2,2-Tetrachloroethane	<0.01	<0.01	<1
Tetrachloroethylene	<0.01	<0.01	<1
1,1,1-Trichloroethane	<0.01	<0.01	<1
1,1,2-Trichloroethane	<0.01	<0.01	<1
Trichloroethylene	<0.01	<0.01	<1
Trichlorofluoromethane	<0.01	<0.01	<1
Vinyl Chloride	<0.01	<0.01	<1
Non-halogenated Volatiles			
Benzene	<0.01	<0.01	5
Ethylbenzene	<0.01	<0.01	3
Styrene	<0.01	<0.01	<1
Toluene	<0.01	<0.01	9
meta- & para-Xylene	<0.01	<0.01	9
ortho-Xylene	<0.01	<0.01	4

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH1-3	TH2-3	TH3-2	TH4-3	TH7-5
Sample Date	00 04 16	00 04 17	00 04 17	00 04 17	00 04 18
Sample Time	15:00	10:15	11:45	13:15	11:30
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	-	-	-	-	<0.01
Acenaphthylene	-	-	-	-	<0.01
Anthracene	-	-	-	-	<0.01
Benz(a)anthracene	-	-	-	-	0.01
Benzo(a)pyrene	-	-	-	-	<0.01
Benzo(b)fluoranthene	-	-	-	-	0.02
Benzo(g,h,i)perylene	-	-	-	-	0.04
Benzo(k)fluoranthene	-	-	-	-	<0.01
Chrysene	-	-	-	-	0.02
Dibenz(a,h)anthracene	-	-	-	-	<0.01
Fluoranthene	-	-	-	-	0.03
Fluorene	-	-	-	-	0.02
Indeno(1,2,3-c,d)pyrene	-	-	-	-	<0.01
Naphthalene	-	-	-	-	0.09
Phenanthrene	-	-	-	-	0.11
Pyrene	-	-	-	-	0.08
Extractable Hydrocarbons					
EPH10-19	-	-	-	-	<300
EPH19-32	-	-	-	-	659
LEPH	-	-	-	-	<300
HEPH	-	-	-	-	659
Polychlorinated Biphenyls					
Total Polychlorinated Biphenyls	<0.05	<0.05	<0.05	<0.05	-

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH8-4	TH15-1	TH16-2	TH16-3	BH17-1
Sample Date	00 04 18	00 04 20	00 04 20	00 04 20	00 04 20
Sample Time	15:04	14:30	16:10	16:15	16:30
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	<0.01	<0.01	<0.4	<0.1	<0.02
Acenaphthylene	<0.01	<0.01	<0.2	<0.05	<0.01
Anthracene	<0.01	<0.01	<0.03	<0.02	<0.01
Benz(a)anthracene	<0.01	0.01	0.01	<0.01	0.01
Benzo(a)pyrene	<0.01	0.01	0.02	0.01	0.02
Benzo(b)fluoranthene	0.01	0.04	0.05	0.03	0.05
Benzo(g,h,i)perylene	0.02	0.10	0.10	0.06	0.11
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.01	0.03	0.05	0.03	0.04
Dibenz(a,h)anthracene	<0.01	0.01	0.01	<0.01	0.01
Fluoranthene	<0.01	0.02	0.03	0.02	0.02
Fluorene	<0.01	0.01	0.47	0.16	0.03
Indeno(1,2,3-c,d)pyrene	<0.01	0.01	0.01	<0.01	0.02
Naphthalene	0.03	0.11	1.90	0.61	0.17
Phenanthrene	0.04	0.12	0.53	0.24	0.16
Pyrene	0.01	0.03	0.05	0.04	0.04
Extractable Hydrocarbons					
EPH10-19	<200	<200	2420	647	<200
EPH19-32	<200	<200	<200	<200	<200
LEPH	<200	<200	2410	646	<200
HEPH	<200	<200	<200	<200	<200
Polychlorinated Biphenyls					
Total Polychlorinated Biphenyls	-	-	<0.05	-	-

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH17-2	TH18-2	TH18-3	TH19-2	TH24-2
Sample Date	00 04 20	00 04 20	00 04 20	00 04 20	00 04 21
Sample Time	16:50	17:30	17:40	18:10	17:30
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	<0.03	<0.04	<0.04	-	-
Acenaphthylene	<0.02	<0.02	<0.02	-	-
Anthracene	<0.01	<0.01	<0.01	-	-
Benz(a)anthracene	0.01	0.01	0.01	-	-
Benzo(a)pyrene	0.02	0.02	0.02	-	-
Benzo(b)fluoranthene	0.05	0.05	0.05	-	-
Benzo(g,h,i)perylene	0.09	0.10	0.09	-	-
Benzo(k)fluoranthene	<0.01	<0.01	<0.01	-	-
Chrysene	0.04	0.04	0.04	-	-
Dibenz(a,h)anthracene	0.01	0.01	0.01	-	-
Fluoranthene	0.02	0.03	0.02	-	-
Fluorene	0.06	0.05	0.07	-	-
Indeno(1,2,3-c,d)pyrene	0.01	0.02	0.01	-	-
Naphthalene	0.25	0.17	0.18	-	-
Phenanthrene	0.19	0.19	0.19	-	-
Pyrene	0.04	0.05	0.04	-	-
Extractable Hydrocarbons					
EPH10-19	286	209	306	-	-
EPH19-32	<200	<200	<200	-	-
LEPH	286	208	306	-	-
HEPH	<200	<200	<200	-	-
Polychlorinated Biphenyls					
Total Polychlorinated Biphenyls	-	-	-	<0.05	<0.05

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH24-3	TH27-3	TH28-2	TH29-1	TH29-2
Sample Date	00 04 21	00 04 22	00 04 22	00 04 22	00 04 22
Sample Time	17:45	16:00	16:10	16:30	16:45
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	<0.01	-	<0.01	-	<0.01
Acenaphthylene	<0.01	-	<0.01	-	<0.01
Anthracene	<0.01	-	<0.01	-	<0.01
Benz(a)anthracene	<0.01	-	<0.01	-	<0.01
Benzo(a)pyrene	<0.01	-	<0.01	-	<0.01
Benzo(b)fluoranthene	0.02	-	0.01	-	<0.01
Benzo(g,h,i)perylene	0.03	-	0.02	-	<0.01
Benzo(k)fluoranthene	<0.01	-	<0.01	-	<0.01
Chrysene	0.01	-	<0.01	-	<0.01
Dibenz(a,h)anthracene	<0.01	-	<0.01	-	<0.01
Fluoranthene	<0.01	-	<0.01	-	<0.01
Fluorene	<0.01	-	<0.01	-	0.01
Indeno(1,2,3-c,d)pyrene	<0.01	-	<0.01	-	<0.01
Naphthalene	0.04	-	0.04	-	0.04
Phenanthrene	0.04	-	0.04	-	0.04
Pyrene	0.01	-	0.01	-	<0.01
Extractable Hydrocarbons					
EPH10-19	<200	-	<400	-	<400
EPH19-32	<200	-	<400	-	<400
LEPH	<200	-	<400	-	<400
HEPH	<200	-	<400	-	<400
Polychlorinated Biphenyls					
Total Polychlorinated Biphenyls	-	<0.05	<0.05	<0.05	-

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH29-3	SED-5	SED-7	SED-8
Sample Date	00 04 22	00 04 23	00 04 23	00 04 23
Sample Time	16:50	13:30	14:00	12:30
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	<0.4	<0.01	<0.01	<0.02
Acenaphthylene	<0.08	<0.01	<0.01	<0.02
Anthracene	<0.06	<0.01	<0.01	<0.01
Benz(a)anthracene	0.06	<0.01	<0.01	<0.01
Benzo(a)pyrene	0.05	<0.01	<0.01	0.01
Benzo(b)fluoranthene	0.09	0.02	0.01	0.04
Benzo(g,h,i)perylene	0.04	0.05	0.03	0.09
Benzo(k)fluoranthene	0.01	<0.01	<0.01	<0.01
Chrysene	0.09	0.02	0.01	0.03
Dibenz(a,h)anthracene	0.01	<0.01	<0.01	0.01
Fluoranthene	0.03	0.01	<0.01	0.02
Fluorene	0.59	0.01	<0.01	<0.05
Indeno(1,2,3-c,d)pyrene	0.03	0.01	<0.01	0.01
Naphthalene	0.50	0.06	0.04	0.19
Phenanthrene	0.62	0.08	0.05	<0.2
Pyrene	0.16	0.03	0.01	0.04
Extractable Hydrocarbons				
EPH10-19	477	<200	<200	1050
EPH19-32	<400	<200	<200	<200
LEPH	476	<200	<200	1050
HEPH	<400	<200	<200	<200

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH1-3	TH2-3	TH3-2	TH4-3	TH4-5
Sample Date	00 04 16	00 04 17	00 04 17	00 04 17	00 04 17
Sample Time	15:00	10:15	11:45	13:15	14:10
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.002	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	<0.001	0.013	0.008	0.068	0.005
4,4'-DDD	<0.001	0.015	0.069	0.140	0.008
2,4'-DDE	<0.002	<0.002	0.006	0.021	<0.002
4,4'-DDE	<0.001	0.002	0.042	0.079	0.004
2,4'-DDT	<0.001	0.003	0.042	1.04	0.011
4,4'-DDT	<0.002	0.017	0.304	3.52	0.045
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.005	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

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RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH5-1	TH5-3	TH6-3	TH7-3	TH7-4
Sample Date	00 04 17	00 04 17	00 04 17	00 04 18	00 04 18
Sample Time	15:15	15:40	17:20	10:55	11:00
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	0.002	0.001	<0.001	0.020	0.115
4,4'-DDD	<0.001	<0.001	<0.001	0.027	0.113
2,4'-DDE	<0.002	<0.002	<0.002	<0.002	0.013
4,4'-DDE	<0.001	<0.001	<0.001	0.013	0.085
2,4'-DDT	0.003	0.002	<0.001	0.036	0.257
4,4'-DDT	0.006	0.006	<0.002	0.048	0.269
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.001	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH8-3	TH9-3	TH9-4	TH10-1	TH10-5
Sample Date	00 04 18	00 04 18	00 04 18	00 04 20	00 04 20
Sample Time	14:45	16:55	17:00	10:20	11:00
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	0.040	<0.001	0.020	<0.001	<0.001
4,4'-DDD	0.066	0.003	0.036	0.003	0.001
2,4'-DDE	0.005	<0.002	0.003	<0.002	<0.002
4,4'-DDE	0.031	<0.001	0.013	<0.001	<0.001
2,4'-DDT	0.034	0.003	0.006	0.001	<0.001
4,4'-DDT	0.113	0.008	0.020	0.010	<0.002
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH12-1	TH13-1	TH13-3	TH14-1	TH15-1
Sample Date	00 04 20	00 04 20	00 04 20	00 04 20	00 04 20
Sample Time	12:30	13:30	13:45	14:00	14:30
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	0.003	0.017	<0.001	0.003	0.003
4,4'-DDD	0.006	0.049	<0.001	0.031	0.012
2,4'-DDE	<0.002	<0.002	<0.002	<0.002	<0.002
4,4'-DDE	<0.001	0.012	<0.001	<0.001	0.002
2,4'-DDT	0.004	0.121	<0.001	0.021	0.011
4,4'-DDT	0.019	0.204	0.004	0.202	0.023
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH16-2	TH16-3	TH17-2	TH17-3	TH18-2
Sample Date	00 04 20	00 04 20	00 04 20	00 04 20	00 04 20
Sample Time	16:10	16:15	16:50	16:55	17:30
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	0.006	0.187	0.014	0.017	0.014
4,4'-DDD	0.009	0.193	0.013	0.016	0.040
2,4'-DDE	<0.002	0.023	<0.002	<0.002	<0.002
4,4'-DDE	0.001	0.134	0.004	0.005	0.003
2,4'-DDT	0.002	0.355	0.003	0.003	0.004
4,4'-DDT	0.009	2.33	0.012	0.014	0.015
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH18-3	TH19-1	TH19-2	TH20-3	TH22-1
Sample Date	00 04 20	00 04 20	00 04 20	00 04 21	00 04 21
Sample Time	17:40	18:00	18:10	12:10	14:40
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.01	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.01	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.01	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.01	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.01	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.01	<0.001	<0.001
2,4'-DDD	0.024	0.008	0.719	0.011	0.005
4,4'-DDD	0.022	0.007	2.31	0.030	0.002
2,4'-DDE	<0.002	<0.002	0.013	<0.002	<0.002
4,4'-DDE	0.004	0.003	0.086	0.001	<0.001
2,4'-DDT	0.011	0.005	4.94	0.023	0.005
4,4'-DDT	0.028	0.016	22.4	0.045	0.017
Dieldrin	<0.001	<0.001	<0.01	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.01	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.01	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.01	<0.001	<0.001
Endrin	<0.005	<0.005	<0.01	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.01	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.01	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.01	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.01	<0.005	<0.005
Mirex	<0.001	<0.001	<0.01	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.01	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.01	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sample ID	TH23-1	TH24-2	TH25-2	TH26-1	TH27-1
Sample Date	00 04 21	00 04 21	00 04 22	00 04 22	00 04 22
Sample Time	15:05	17:30	14:25	15:20	15:50
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	0.010	<0.001	0.007	0.557	0.103
4,4'-DDD	0.055	<0.001	0.009	0.796	0.350
2,4'-DDE	<0.002	<0.002	0.002	0.321	0.010
4,4'-DDE	0.003	<0.001	0.008	1.99	0.092
2,4'-DDT	0.068	<0.001	0.014	1.36	0.187
4,4'-DDT	0.168	<0.002	0.042	7.49	1.09
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH27-3	TH28-2	TH29-1	TH29-2	TH30-1
Sample Date	00 04 22	00 04 22	00 04 22	00 04 22	00 04 22
Sample Time	16:00	16:10	16:30	16:45	16:40
Organochlorine Pesticides					
Aldrin	<0.005	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.005	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.005	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.005	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.005	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.005	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	3.17	0.111	0.019	0.018	<0.001
4,4'-DDD	6.67	0.167	0.034	0.063	<0.001
2,4'-DDE	0.041	0.028	0.003	<0.002	<0.002
4,4'-DDE	0.173	0.100	0.038	0.005	<0.001
2,4'-DDT	8.68	0.457	0.377	0.009	0.001
4,4'-DDT	32.9	1.02	0.779	0.085	0.002
Dieldrin	<0.005	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.005	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.005	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.005	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.005	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.005	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.005	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.005	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.005	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.005	<0.001	<0.001	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	TH30-2	TH31-2	TH31-3	TH32-2	TH33-2
Sample Date	00 04 22	00 04 23	00 04 23	00 04 23	00 04 23
Sample Time	16:45	09:50	10:00	10:45	15:20
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	0.001	0.004	0.004	0.001	<0.001
4,4'-DDD	0.001	0.004	0.006	0.001	<0.001
2,4'-DDE	<0.002	<0.002	<0.002	<0.002	<0.002
4,4'-DDE	0.001	0.017	0.002	<0.001	<0.001
2,4'-DDT	0.004	0.011	0.013	0.004	<0.001
4,4'-DDT	0.009	0.030	0.053	0.012	<0.002
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

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RESULTS OF ANALYSIS - Sediment/Soil File No. L6581

Sample ID	SED-2	SED-3	SED-5	SED-6	SED-8
Sample Date	00 04 22	00 04 22	00 04 23	00 04 23	00 04 23
Sample Time	17:20	17:40	13:30	13:45	12:30
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001
alpha-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
beta-BHC	<0.002	<0.002	<0.002	<0.002	<0.002
delta-BHC	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001	<0.001	<0.001	<0.001
2,4'-DDD	0.004	0.030	0.021	0.013	0.001
4,4'-DDD	0.004	0.068	0.021	0.020	<0.001
2,4'-DDE	<0.002	<0.002	0.011	<0.002	<0.002
4,4'-DDE	0.001	0.006	0.036	0.002	<0.001
2,4'-DDT	0.004	0.448	0.039	0.070	<0.001
4,4'-DDT	0.013	1.94	0.090	0.147	0.003
Dieldrin	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan I	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan II	<0.001	<0.001	<0.001	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001	<0.001	<0.001	<0.001
Endrin	<0.005	<0.005	<0.005	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.002	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001	<0.001	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001	<0.001	<0.001	<0.001
Methoxychlor	<0.005	<0.005	<0.005	<0.005	<0.005
Mirex	<0.001	<0.001	<0.001	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001	<0.001	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Appendix 1 - QUALITY CONTROL - Replicates

File No. L6581

Sediment/Soil		TH1-1	TH1-1
		00 04 16 14:30	QC # 195739
Physical Tests			
Moisture	%	11.6	11.7
Total Metals			
Antimony	T-Sb	<20	<20
Arsenic	T-As	12	14
Barium	T-Ba	407	427
Beryllium	T-Be	0.7	0.9
Cadmium	T-Cd	1.2	1.3
Chromium	T-Cr	37	41
Cobalt	T-Co	8	10
Copper	T-Cu	32	39
Lead	T-Pb	<50	<50
Mercury	T-Hg	0.060	0.072
Molybdenum	T-Mo	<4	<4
Nickel	T-Ni	29	34
Selenium	T-Se	<2	<2
Silver	T-Ag	<2	<2
Thallium	T-Tl	<2	<2
Tin	T-Sn	<10	<10
Vanadium	T-V	106	123
Zinc	T-Zn	104	127

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil	**TH5-3** 00 04 17 15:40	**TH5-3** QC # 195641
Organochlorine Pesticides		
Aldrin	<0.001	<0.001
alpha-BHC	<0.001	<0.001
beta-BHC	<0.002	<0.002
delta-BHC	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001
2,4'-DDD	0.001	<0.001
4,4'-DDD	<0.001	<0.001
2,4'-DDE	<0.002	<0.002
4,4'-DDE	<0.001	<0.001
2,4'-DDT	0.002	0.004
4,4'-DDT	0.006	0.007
Dieldrin	<0.001	<0.001
Endosulfan I	<0.001	<0.001
Endosulfan II	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001
Endrin	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01
Heptachlor	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001
Methoxychlor	<0.005	<0.005
Mirex	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001

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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil	**TH9-4**	**TH9-4**
	00 04 18 17:00	QC # 195642
Organochlorine Pesticides		
Aldrin	<0.001	<0.001
alpha-BHC	<0.001	<0.001
beta-BHC	<0.002	<0.002
delta-BHC	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001
2,4'-DDD	0.020	0.016
4,4'-DDD	0.036	0.032
2,4'-DDE	0.003	0.002
4,4'-DDE	0.013	0.011
2,4'-DDT	0.006	0.010
4,4'-DDT	0.020	0.038
Dieldrin	<0.001	<0.001
Endosulfan I	<0.001	<0.001
Endosulfan II	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001
Endrin	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01
Heptachlor	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001
Methoxychlor	<0.005	<0.005
Mirex	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001

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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil	**BH17-1**	**BH17-1**
	00 04 20 16:30	QC # 195647
Physical Tests		
Moisture %	22.5	21.3
Halogenated Volatiles		
Bromodichloromethane	<0.01	<0.01
Bromoform	<0.01	<0.01
Carbon Tetrachloride	<0.01	<0.01
Chlorobenzene	<0.01	<0.01
Chloroethane	<0.01	<0.01
Chloroform	<0.01	<0.01
Chloromethane	<0.01	<0.01
Dibromochloromethane	<0.01	<0.01
1,2-Dichlorobenzene	<0.01	<0.01
1,3-Dichlorobenzene	<0.01	<0.01
1,4-Dichlorobenzene	<0.01	<0.01
1,1-Dichloroethane	<0.01	<0.01
1,2-Dichloroethane	0.01	<0.01
cis-1,2-Dichloroethylene	<0.01	<0.01
trans-1,2-Dichloroethylene	<0.01	<0.01
1,1-Dichloroethylene	<0.01	<0.01
Dichloromethane	<0.3	<0.3
1,2-Dichloropropane	<0.01	<0.01
cis-1,3-Dichloropropylene	<0.01	<0.01
trans-1,3-Dichloropropylene	<0.01	<0.01
1,1,1,2-Tetrachloroethane	<0.01	<0.01
1,1,2,2-Tetrachloroethane	<0.01	<0.01
Tetrachloroethylene	<0.01	<0.01
1,1,1-Trichloroethane	<0.01	<0.01
1,1,2-Trichloroethane	<0.01	<0.01
Trichloroethylene	<0.01	<0.01
Trichlorofluoromethane	<0.01	<0.01
Vinyl Chloride	<0.01	<0.01

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil	**BH17-1** 00 04 20 16:30	**BH17-1** QC # 195647
Non-halogenated Volatiles		
Benzene	<0.01	<0.01
Ethylbenzene	<0.01	<0.01
Styrene	<0.01	<0.01
Toluene	<0.01	<0.01
meta- & para-Xylene	<0.01	<0.01
ortho-Xylene	<0.01	<0.01
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	<0.02	<0.02
Acenaphthylene	<0.01	<0.01
Anthracene	<0.01	<0.01
Benz(a)anthracene	0.01	0.01
Benzo(a)pyrene	0.02	0.02
Benzo(b)fluoranthene	0.05	0.05
Benzo(g,h,i)perylene	0.11	0.10
Benzo(k)fluoranthene	<0.01	<0.01
Chrysene	0.04	0.05
Dibenz(a,h)anthracene	0.01	0.01
Fluoranthene	0.02	0.02
Fluorene	0.03	0.03
Indeno(1,2,3-c,d)pyrene	0.02	0.01
Naphthalene	0.17	0.18
Phenanthrene	0.16	0.16
Pyrene	0.04	0.05
Extractable Hydrocarbons		
EPH10-19	<200	<200
EPH19-32	<200	<200
LEPH	<200	<200
HEPH	<200	<200

Results are expressed as milligrams per dry kilogram except where noted.
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LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil	**TH19-2** 00 04 20 18:10	**TH19-2** QC # 195648
Polychlorinated Biphenyls		
Total Polychlorinated Biphenyls	<0.05	<0.05
Organochlorine Pesticides		
Aldrin	<0.01	<0.01
alpha-BHC	<0.01	<0.01
beta-BHC	<0.01	<0.01
delta-BHC	<0.01	<0.01
cis-Chlordane (alpha)	<0.01	<0.01
trans-Chlordane (gamma)	<0.01	<0.01
2,4'-DDD	0.719	0.741
4,4'-DDD	2.31	2.35
2,4'-DDE	0.013	0.011
4,4'-DDE	0.086	0.063
2,4'-DDT	4.94	3.05
4,4'-DDT	22.4	11.1
Dieldrin	<0.01	<0.01
Endosulfan I	<0.01	<0.01
Endosulfan II	<0.01	<0.01
Endosulfan Sulfate	<0.01	<0.01
Endrin	<0.01	<0.01
Endrin Aldehyde	<0.01	<0.01
Heptachlor	<0.01	<0.01
Heptachlor Epoxide	<0.01	<0.01
Lindane (gamma - BHC)	<0.01	<0.01
Methoxychlor	<0.01	<0.01
Mirex	<0.01	<0.01
cis-Nonachlor	<0.01	<0.01
trans-Nonachlor	<0.01	<0.01

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Appendix 1 - QUALITY CONTROL - Replicates

File No. L6581

Sediment/Soil		TH21-2	TH21-2
		00 04 21 13:50	QC # 195740
Physical Tests			
Moisture	%	12.9	12.1
Total Metals			
Antimony	T-Sb	<20	<20
Arsenic	T-As	12	10
Barium	T-Ba	516	447
Beryllium	T-Be	0.7	0.6
Cadmium	T-Cd	<0.5	<0.5
Chromium	T-Cr	40	38
Cobalt	T-Co	8	7
Copper	T-Cu	25	23
Lead	T-Pb	<50	<50
Mercury	T-Hg	0.052	0.050
Molybdenum	T-Mo	<4	<4
Nickel	T-Ni	27	24
Selenium	T-Se	<2	<2
Silver	T-Ag	<2	<2
Thallium	T-Tl	<2	<2
Tin	T-Sn	<10	<10
Vanadium	T-V	98	100
Zinc	T-Zn	95	83

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil		**TH28-2**	**TH28-2**
		00 04 22 16:10	QC # 195649
Physical Tests			
Moisture	%	51.5	42.2
Total Metals			
Antimony	T-Sb	<20	<20
Arsenic	T-As	<5	6
Barium	T-Ba	248	366
Beryllium	T-Be	0.8	0.6
Cadmium	T-Cd	<0.5	<0.5
Chromium	T-Cr	12	11
Cobalt	T-Co	2	2
Copper	T-Cu	6	5
Lead	T-Pb	<50	<50
Mercury	T-Hg	0.021	0.038
Molybdenum	T-Mo	<4	<4
Nickel	T-Ni	7	7
Selenium	T-Se	<2	<2
Silver	T-Ag	<2	<2
Thallium	T-Tl	<2	<2
Tin	T-Sn	<10	<10
Vanadium	T-V	28	32
Zinc	T-Zn	37	31

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil	**TH28-2** 00 04 22 16:10	**TH28-2** QC # 195649
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	<0.01	<0.01
Acenaphthylene	<0.01	<0.01
Anthracene	<0.01	<0.01
Benz(a)anthracene	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01
Benzo(b)fluoranthene	0.01	0.01
Benzo(g,h,i)perylene	0.02	0.02
Benzo(k)fluoranthene	<0.01	<0.01
Chrysene	<0.01	<0.01
Dibenz(a,h)anthracene	<0.01	<0.01
Fluoranthene	<0.01	<0.01
Fluorene	<0.01	<0.01
Indeno(1,2,3-c,d)pyrene	<0.01	<0.01
Naphthalene	0.04	0.03
Phenanthrene	0.04	0.03
Pyrene	0.01	<0.01
Extractable Hydrocarbons		
EPH10-19	<400	<400
EPH19-32	<400	<400
LEPH	<400	<400
HEPH	<400	<400

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil		SED-1	SED-1
		00 04 22 17:00	QC # 195738
Physical Tests			
Moisture	%	13.1	11.7
Total Metals			
Mercury	T-Hg	0.032	0.033

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sediment/Soil	**SED-3**	**SED-3**
	00 04 22 17:40	QC # 195654
Organochlorine Pesticides		
Aldrin	<0.001	<0.001
alpha-BHC	<0.001	<0.001
beta-BHC	<0.002	<0.002
delta-BHC	<0.001	<0.001
cis-Chlordane (alpha)	<0.001	<0.001
trans-Chlordane (gamma)	<0.001	<0.001
2,4'-DDD	0.030	0.007
4,4'-DDD	0.068	0.007
2,4'-DDE	<0.002	<0.002
4,4'-DDE	0.006	0.001
2,4'-DDT	0.448	0.016
4,4'-DDT	1.94	0.036
Dieldrin	<0.001	<0.001
Endosulfan I	<0.001	<0.001
Endosulfan II	<0.001	<0.001
Endosulfan Sulfate	<0.001	<0.001
Endrin	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01
Heptachlor	<0.002	<0.002
Heptachlor Epoxide	<0.001	<0.001
Lindane (gamma - BHC)	<0.001	<0.001
Methoxychlor	<0.005	<0.005
Mirex	<0.001	<0.001
cis-Nonachlor	<0.001	<0.001
trans-Nonachlor	<0.001	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Moisture in Sediment/Soil

This analysis is carried out gravimetrically by drying the sample at 103 C for a minimum of six hours.

Recommended Holding Time:

Sample:	14 days
Reference:	Puget
For more detail see:	ASL "Collection & Sampling Guide"

pH in Soil

This analysis is carried out in accordance with procedures described in "Soil Sampling and Methods of Analysis" (CSSS). The procedure involves mixing the air-dried sample with deionized/distilled water. The pH of the solution is then measured using a standard pH probe. A one to two ratio of sediment to water is used for mineral soils and a one to ten ratio is used for highly organic soils.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050B or Method 3051, published by the United States Environmental Protection Agency (EPA). The sample is manually homogenized and a representative subsample of the wet material is weighed. The sample is then digested by either hotplate or microwave oven using a 1:1 ratio of nitric acid and hydrochloric acid. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000 series) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

Recommended Holding Time:

Sample/Extract:	6 months (Mercury = 28 days)
Reference:	EPA

For more detail see: ASL "Collection & Sampling Guide"

Volatile Organic Compounds in Sediment/Soil

This analysis is based on United States Environmental Protection Agency Methods 5030, 5035 and 8260. The procedure involves a purge and trap extraction of the volatile compounds and subsequent analysis by capillary column gas chromatography with mass selective detection.

Polycyclic Aromatic Hydrocarbons in Sediment/Soil

This analysis is carried out using a procedure adapted from EPA Methods 3500, 3630, and 8270 (Publ. #SW-846, 3rd ed., Washington, DC 20460) and 3545 (SW-846 Laboratory Manual - Update III, Federal Register, Vol 60, No.142/Tuesday, July 25, 1995, pg 37974-37980). The procedure uses an automated system to extract samples with a 1:1 mixture of hexane and acetone. A portion of the extract is exchanged to toluene, cleaned, and analysed by capillary column gas chromatography with mass spectrometric detection.

Recommended Holding Time:
Sample: 14 days Extract: 40 days
Reference: EPA
For more detail see ASL "Collection & Sampling Guide"

Extractable Hydrocarbons in Sediment/Soil

This analysis is carried out according to British Columbia Ministry of Environment, Lands and Parks (BCMELP) Analytical Method for Contaminated Sites "Extractable Petroleum Hydrocarbons in Solids by GC/FID, Version 2.1 July 1999". The procedure uses an automated system to extract samples with a 1:1 mixture of Hexane and Acetone. The extract is exchanged to Toluene and analysed by capillary column gas chromatography with flame ionization detection. Reported results include Polycyclic Aromatic Hydrocarbons (PAH) and are therefore not equivalent to Light and Heavy Extractable Petroleum Hydrocarbon (LEPH/HEPH).

Please note that in August of 1999, BCMELP replaced the EPH(C10-18) and EPH(C19-31) parameters with EPH(C10-19) and EPH(C19-32). These parameters were redefined so that they more accurately describe how the analysis is carried out. Results reported by ASL for the old and new parameters are equivalent. ASL implemented the new parameters on August 23, 1999.

Recommended Holding Time:
Sample: 14 days Extract: 40 days
Reference: BCMELP
For more detail see ASL "Collection & Sampling Guide"

Light and Heavy Extractable Petroleum Hydrocarbons in Solids

These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Light and Heavy Extractable Petroleum Hydrocarbons in Solids or Water". According to this method, LEPH and HEPH are calculated by subtracting selected Polynuclear Aromatic Hydrocarbon results from Extractable Petroleum Hydrocarbon results. To calculate LEPH, the individual results for naphthalene and phenanthrene are subtracted from EPH(C10-19). To calculate HEPH, the individual results for benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene, and pyrene are subtracted from EPH(C19-32). Analysis of Extractable Petroleum Hydrocarbons adheres to all prescribed elements of the BCMELP method "Extractable Petroleum Hydrocarbons in Solids by GC/FID"(Version 2.1, July 20, 1999).

Recommended Holding Time: Not Applicable

Organochlorine Pesticides and Polychlorinated Biphenyls in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3540, 3610, 3630, 3660, 8081 & 8082, published by the United States Environmental Protection Agency (EPA). The procedure involves a dichloromethane soxhlet extraction of a subsample of the sediment/soil which has been dried with anhydrous sodium sulphate. The extract is then solvent exchanged to hexane followed by one or more of the following clean-up procedures (if required): alumina clean-up, silica gel clean-up and/or sulphur clean-up. The final extract is analysed by capillary column gas chromatography with electron capture detection (GC/ECD).

Recommended Holding Time:
Sample: 14 days Extract: 40 days
Reference: EPA
For more detail see ASL "Collection & Sampling Guide"

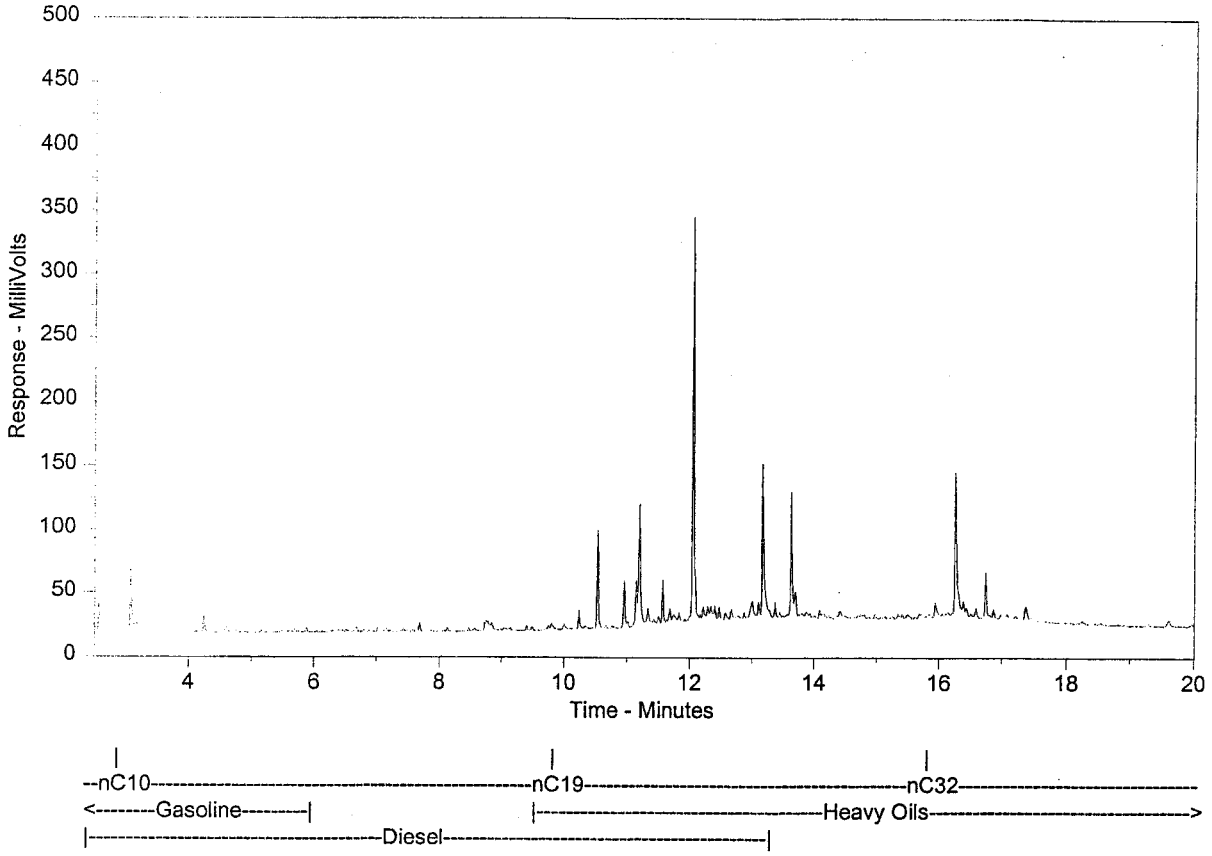
Organochloride Pesticides in Sediment/Soil

This analysis is carried out using procedures adapted from U.S. EPA Methods 3540, 3610 and 8081 (Publ. # SW-846 3rd ed., Washington, DC 20460. Updated January 1995). The procedure involves a soxlet extraction with dichloromethane. The extract is then solvent exchanged to hexane followed by an alumina column clean-up. The final extract is analysed by dual capillary column gas chromatography with electron capture detection.

End of Report

ASL Hydrocarbon Distribution Report

Client Sample ID: TH7-5
ASL Sample ID: **L6581-T--14**
File Name: m:\chrom\gc04\data\gc04_02mayB.0026.RAW
Run Information: Acquired on GC04, 5/3/00 7:29:09 AM



|----------Diesel----------|

Sample Amount = 4.6 (g or mL) Dilution Factor = 10.0

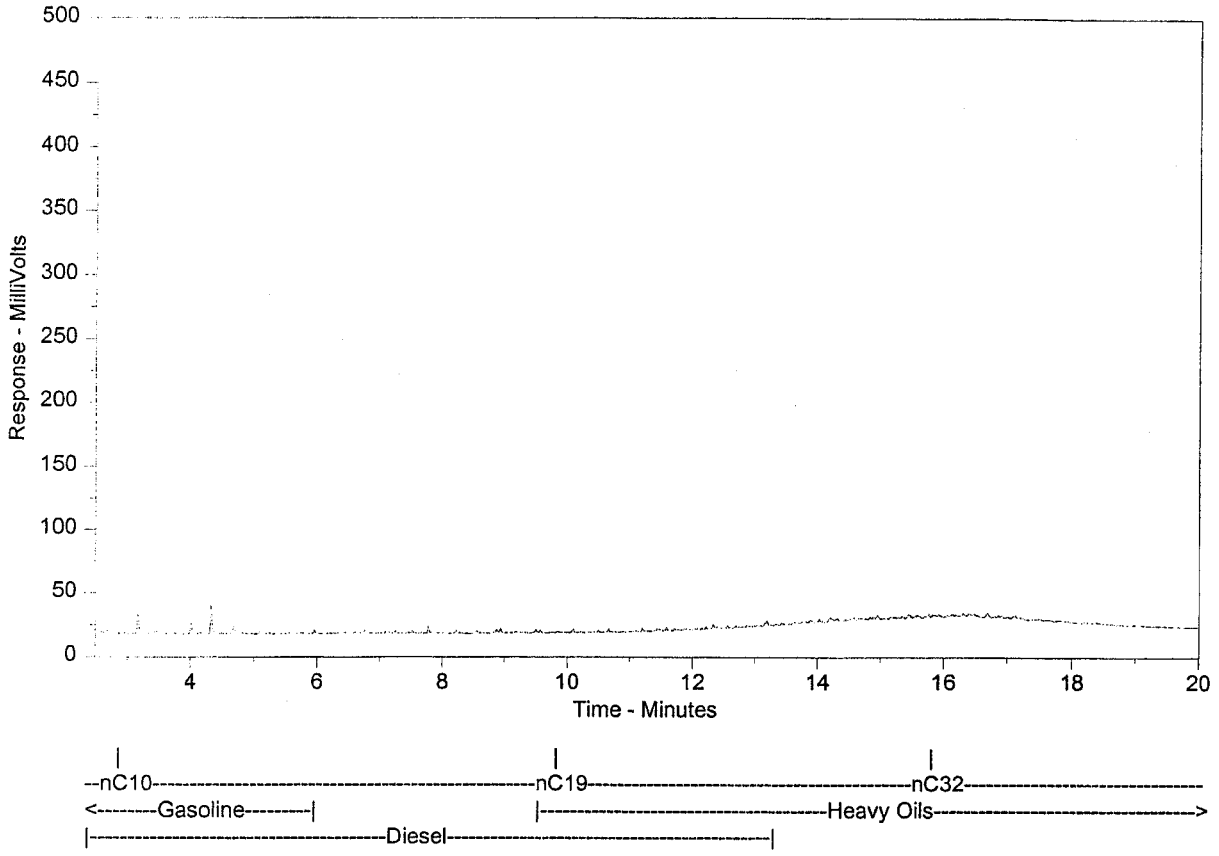
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH8-4
ASL Sample ID: **L6581-T--16**
File Name: m:\Chrom\gc04\data\gc04_29aprB.0016.RAW
Run Information: Acquired on GC04, 4/30/00 1:19:14 AM



Sample Amount = 10.9 (g or mL) Dilution Factor = 10.0

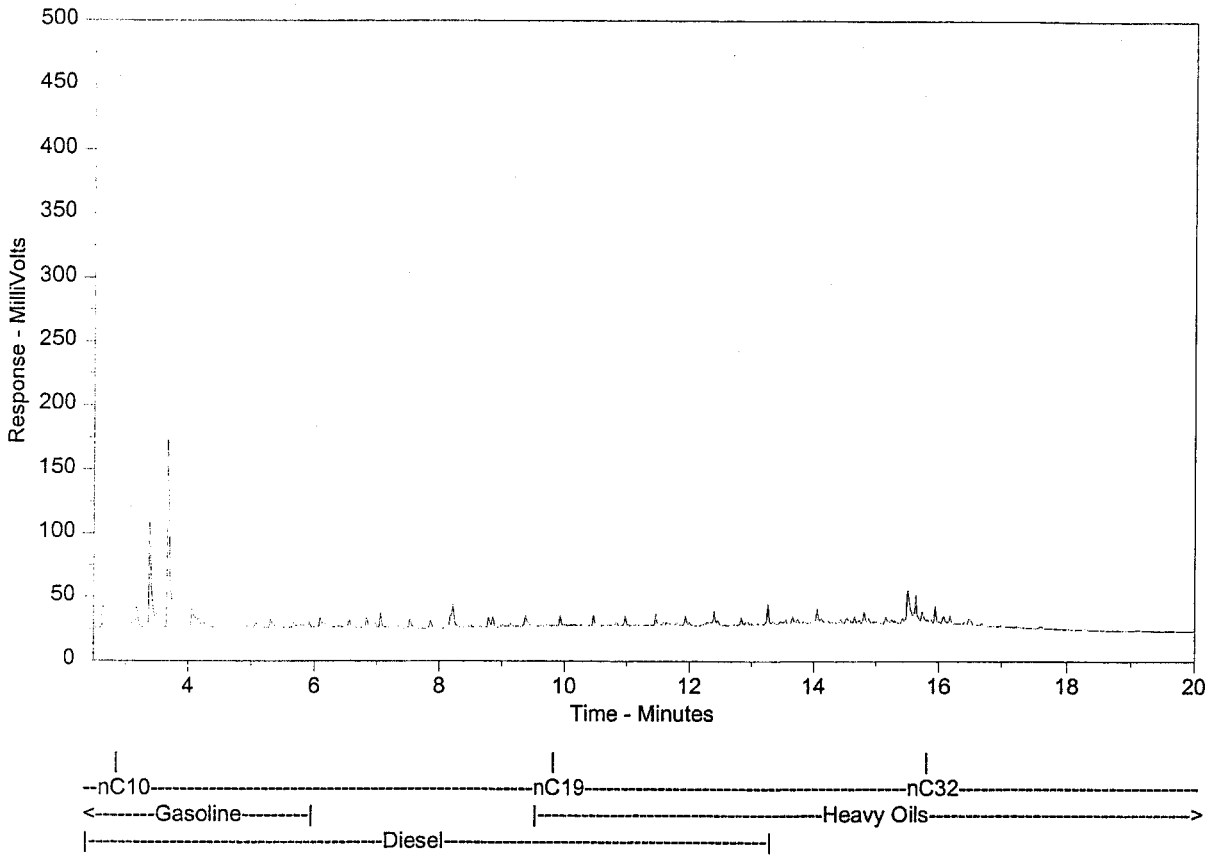
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH15-1
ASL Sample ID: **L6581-T--25**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0017.RAW
Run Information: Acquired on GC04, 4/30/00 1:50:39 AM



|----------Diesel----------|

Sample Amount = 8.0 (g or mL) Dilution Factor = 10.0

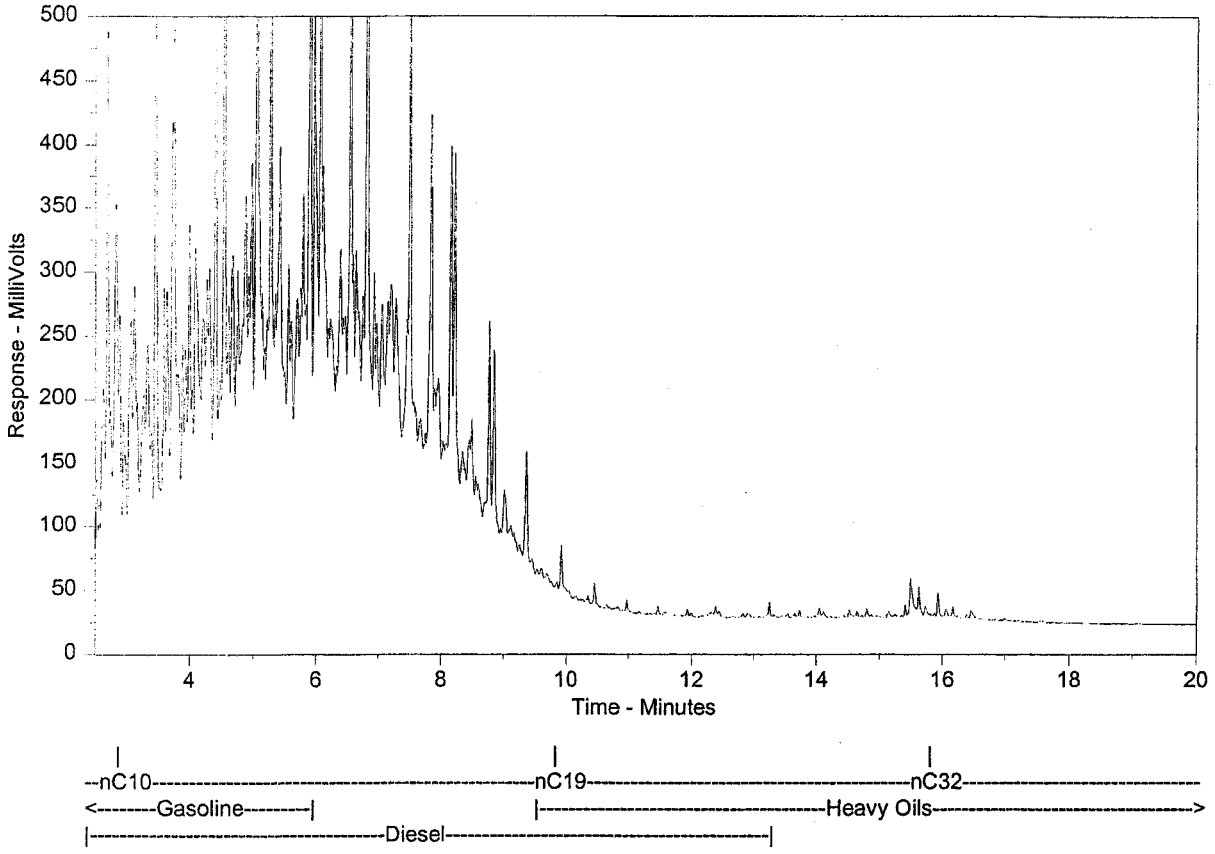
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH16-2
ASL Sample ID: **L6581-T--26**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0008.RAW
Run Information: Acquired on GC04, 4/29/00 9:07:50 PM



|----------Diesel----------|

Sample Amount = 9.0 (g or mL) Dilution Factor = 10.0

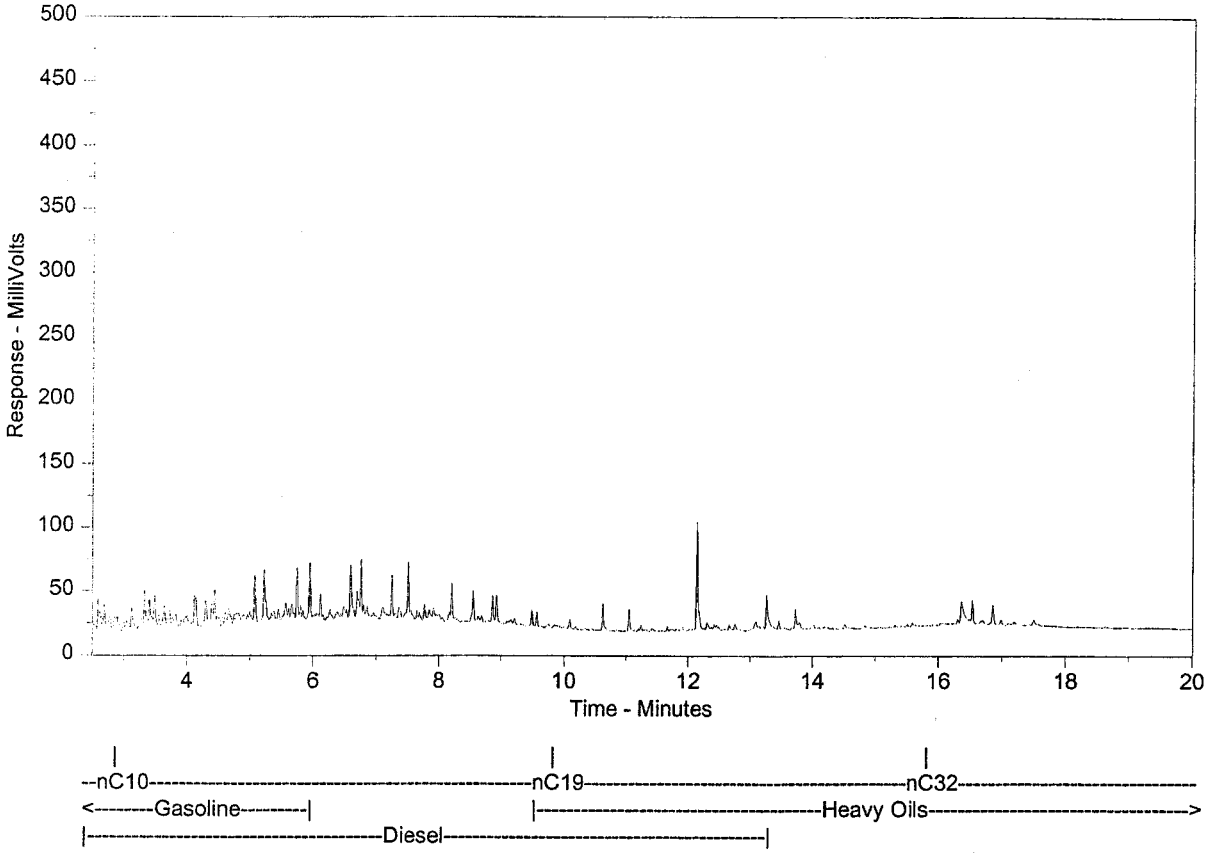
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH16-3
ASL Sample ID: **L6581-T--27**
File Name: m:\Chrom\gc04\data\gc04_29aprB.0008.RAW
Run Information: Acquired on GC04, 4/29/00 9:07:50 PM



|----------Diesel----------|

Sample Amount = 5.1 (g or mL) Dilution Factor = 10.0

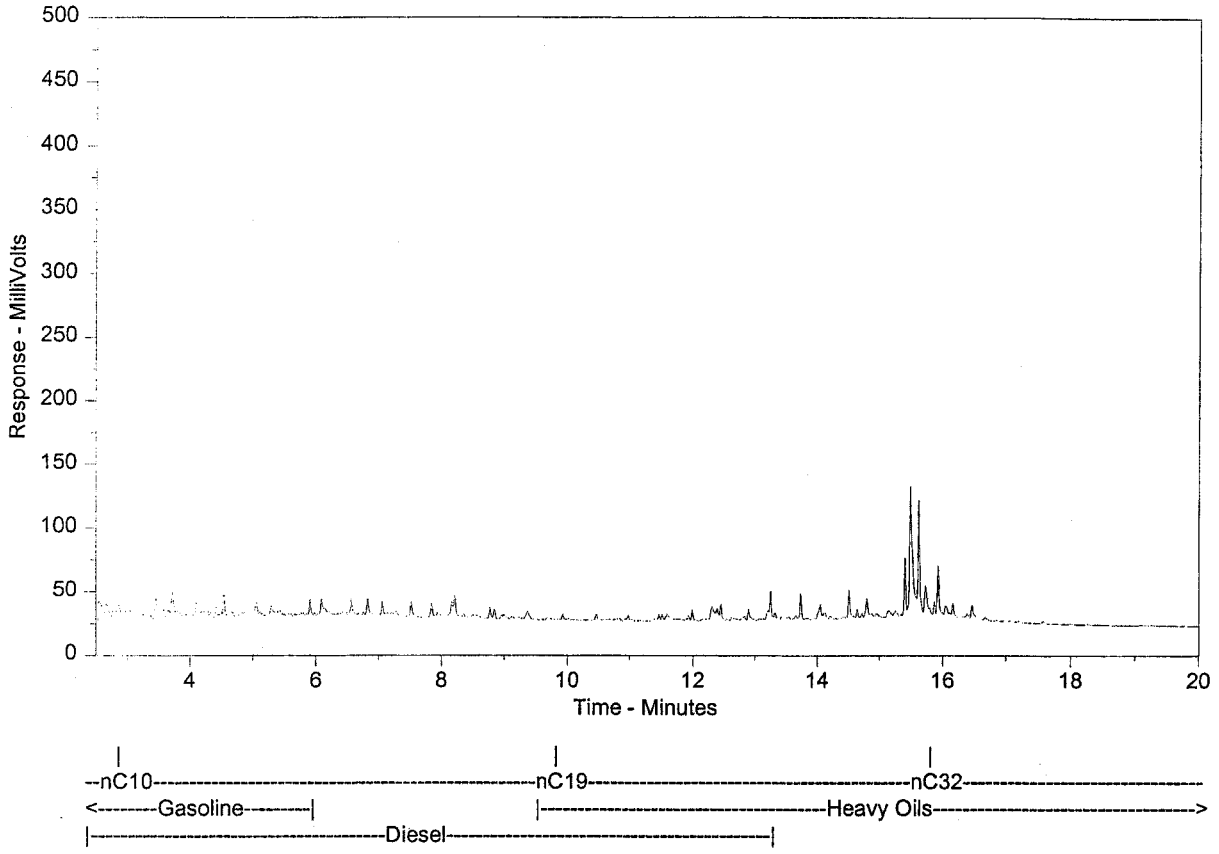
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: BH17-1
ASL Sample ID: **L6581-T--28**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0009.RAW
Run Information: Acquired on GC04, 4/29/00 9:39:15 PM



Sample Amount = 8.3 (g or mL) Dilution Factor = 10.0

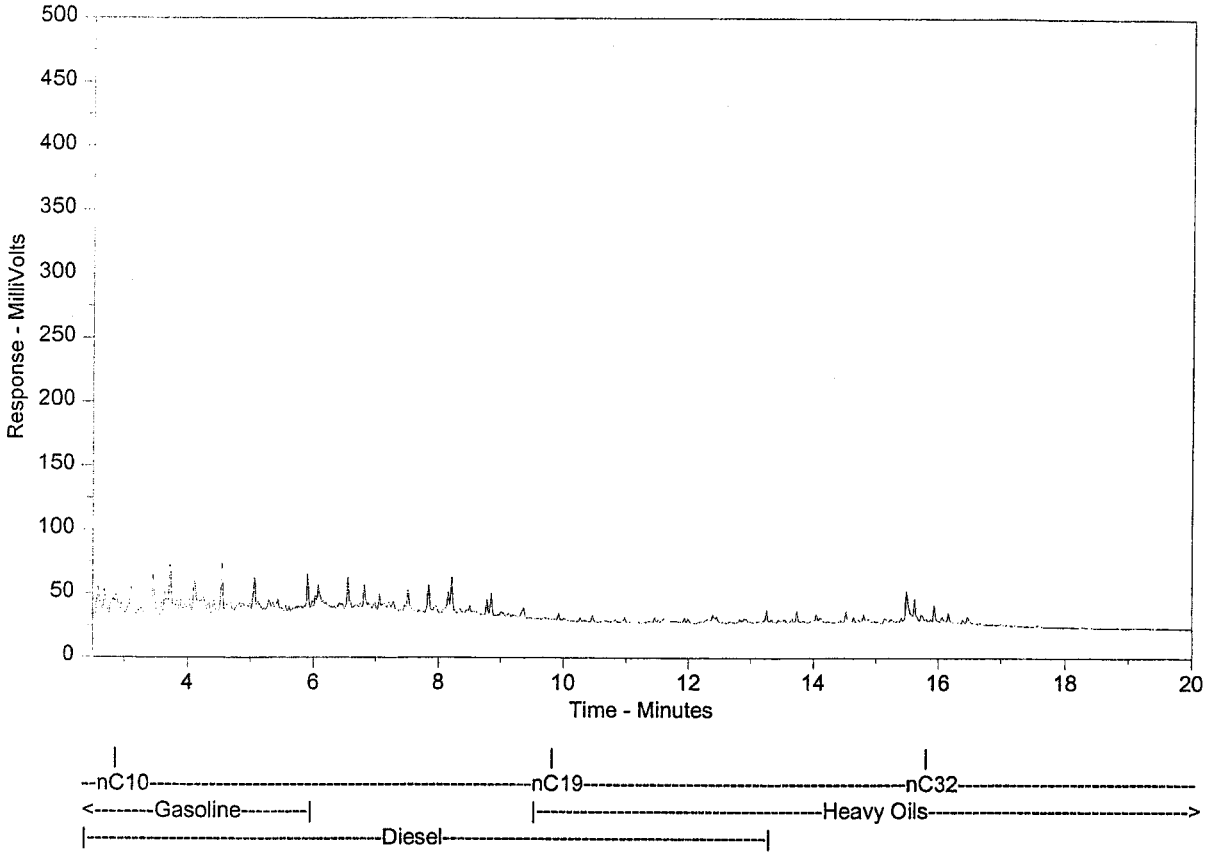
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH17-2
ASL Sample ID: **L6581-T--29**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0010.RAW
Run Information: Acquired on GC04, 4/29/00 10:10:39 PM



Sample Amount = 7.3 (g or mL) Dilution Factor = 10.0

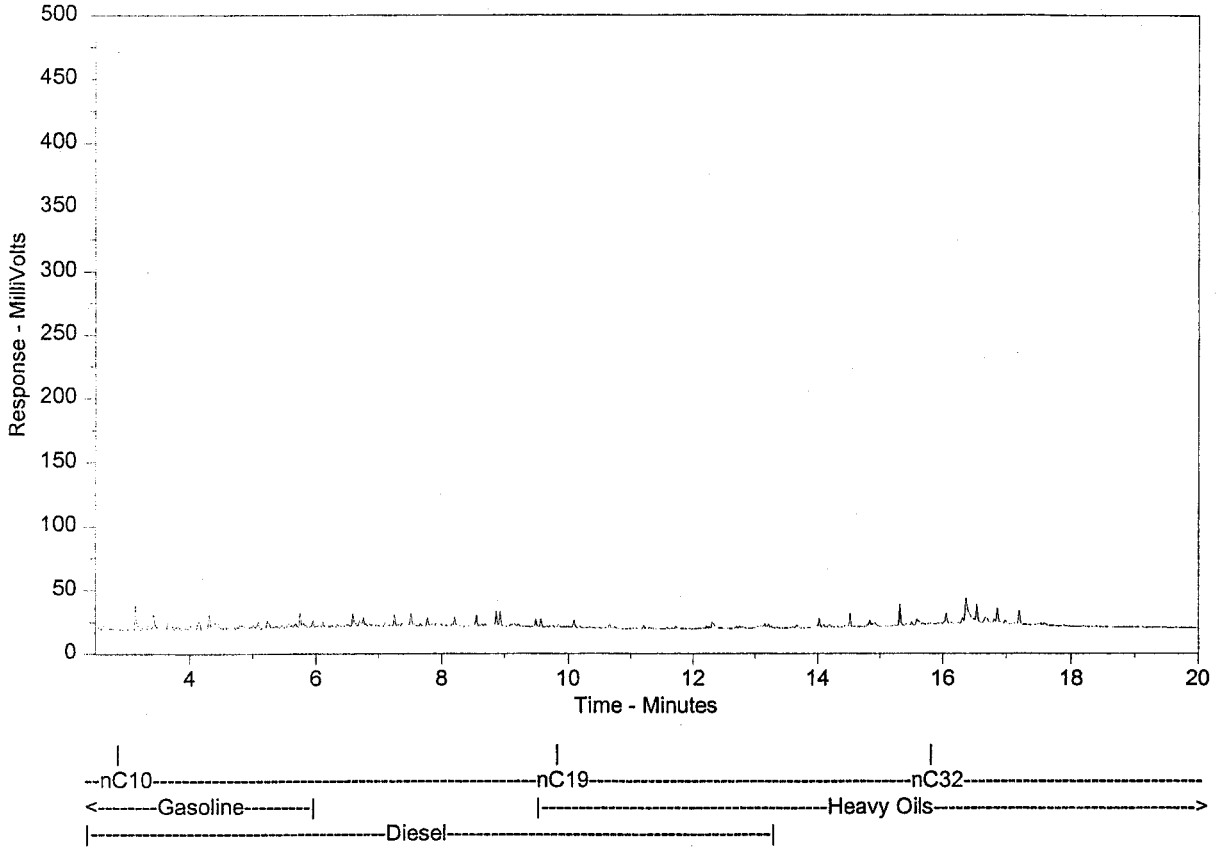
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH18-2
ASL Sample ID: **L6581-T--31**
File Name: m:\Chrom\gc04\data\gc04_29aprB.0010.RAW
Run Information: Acquired on GC04, 4/29/00 10:10:39 PM



Sample Amount = 6.4 (g or mL) Dilution Factor = 10.0

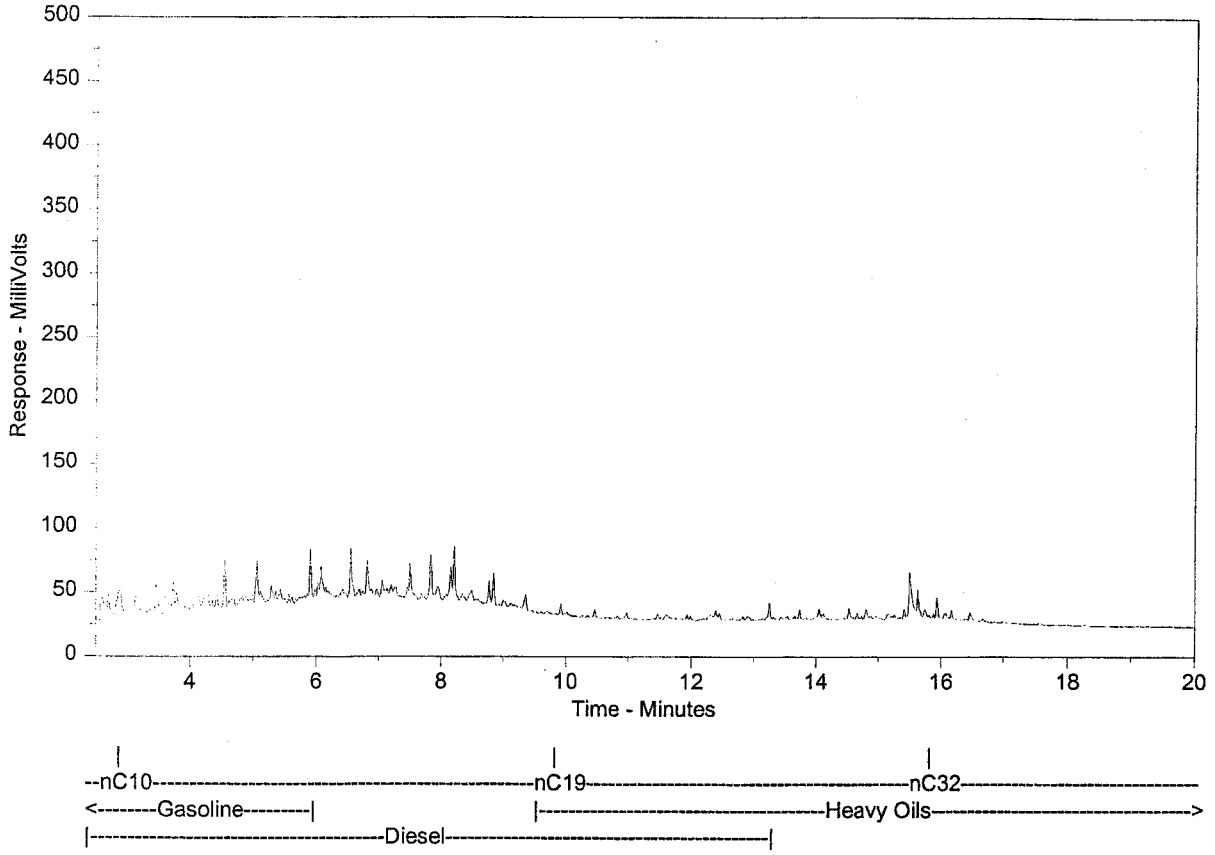
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH18-3
ASL Sample ID: **L6581-T--32**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0011.RAW
Run Information: Acquired on GC04, 4/29/00 10:42:10 PM



|----------Diesel----------|

Sample Amount = 8.5 (g or mL) Dilution Factor = 10.0

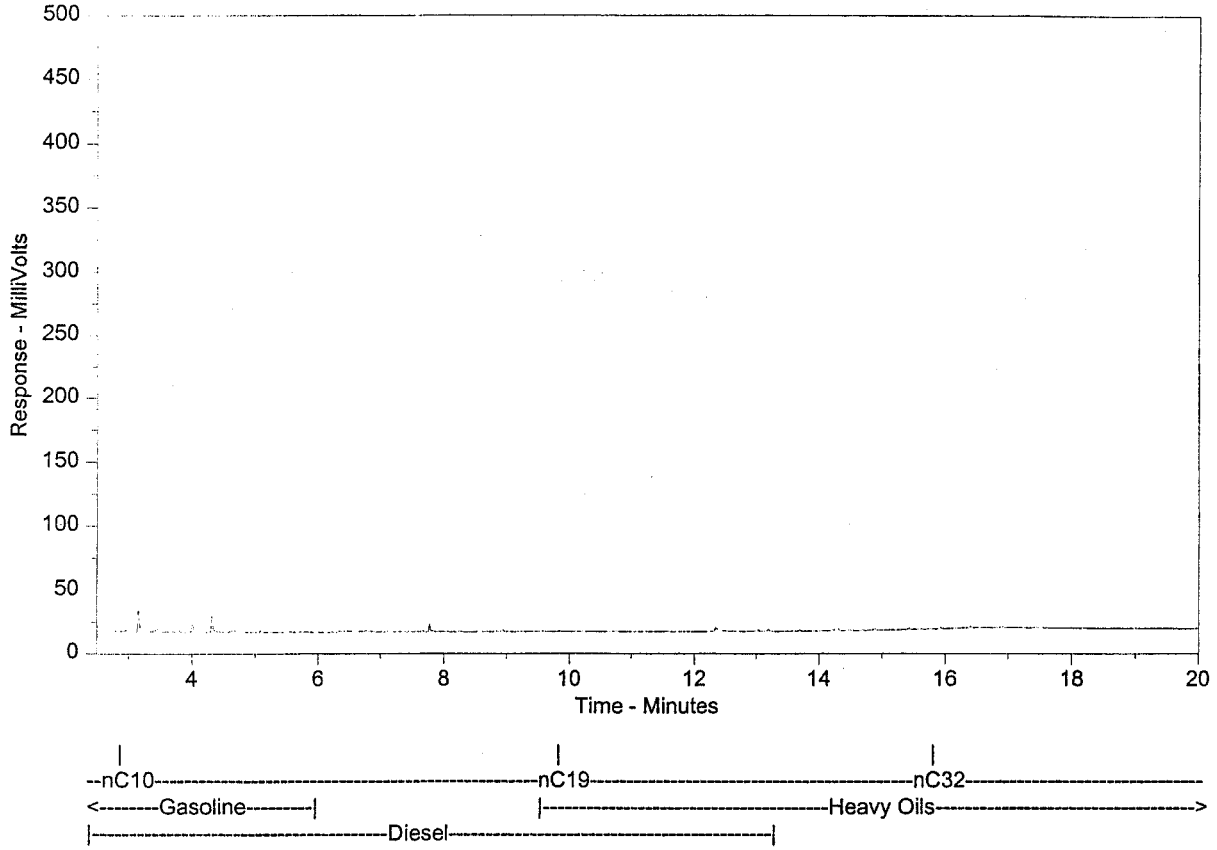
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH24-3
ASL Sample ID: **L6581-T--40**
File Name: m:\Chrom\gc04\data\gc04_29aprB.0011.RAW
Run Information: Acquired on GC04, 4/29/00 10:42:11 PM



Sample Amount = 7.1 (g or mL) Dilution Factor = 10.0

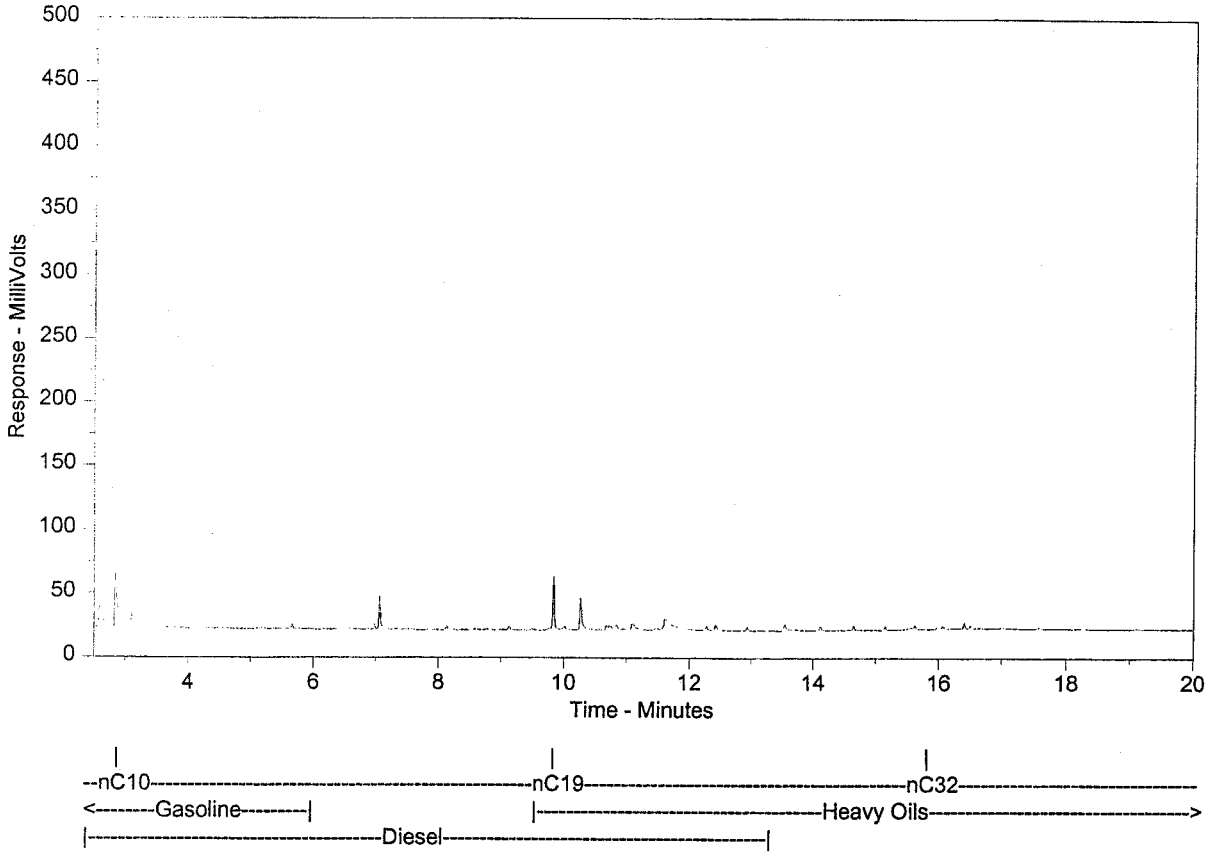
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH28-2
ASL Sample ID: **L6581-T--45**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0012.RAW
Run Information: Acquired on GC04, 4/29/00 11:13:35 PM



Sample Amount = 3.9 (g or mL) Dilution Factor = 10.0

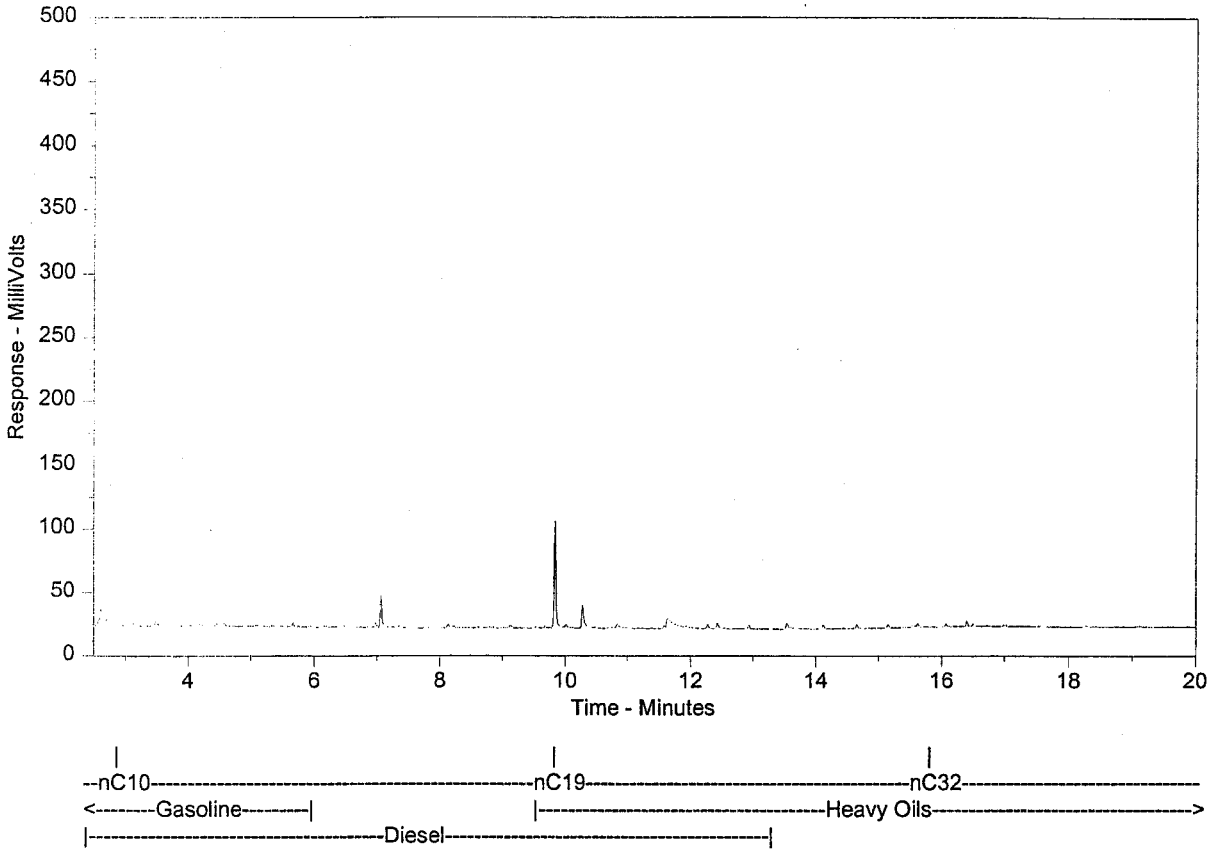
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH29-2
ASL Sample ID: **L6581-T--47**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0013.RAW
Run Information: Acquired on GC04, 4/29/00 11:45:01 PM



Sample Amount = 3.2 (g or mL) Dilution Factor = 10.0

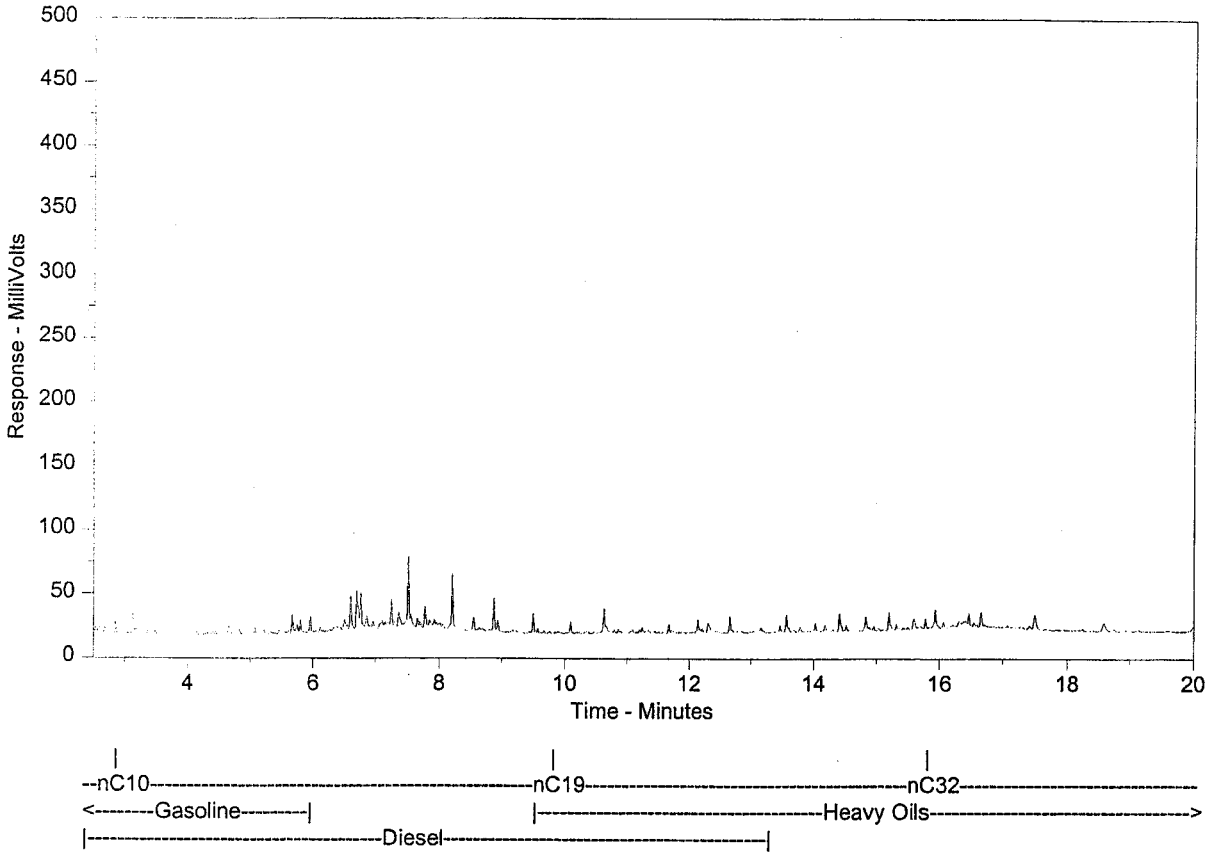
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: TH29-3
ASL Sample ID: **L6581-T--48**
File Name: m:\Chrom\gc04\data\gc04_29aprB.0013.RAW
Run Information: Acquired on GC04, 4/29/00 11:45:01 PM



Sample Amount = 3.1 (g or mL) Dilution Factor = 10.0

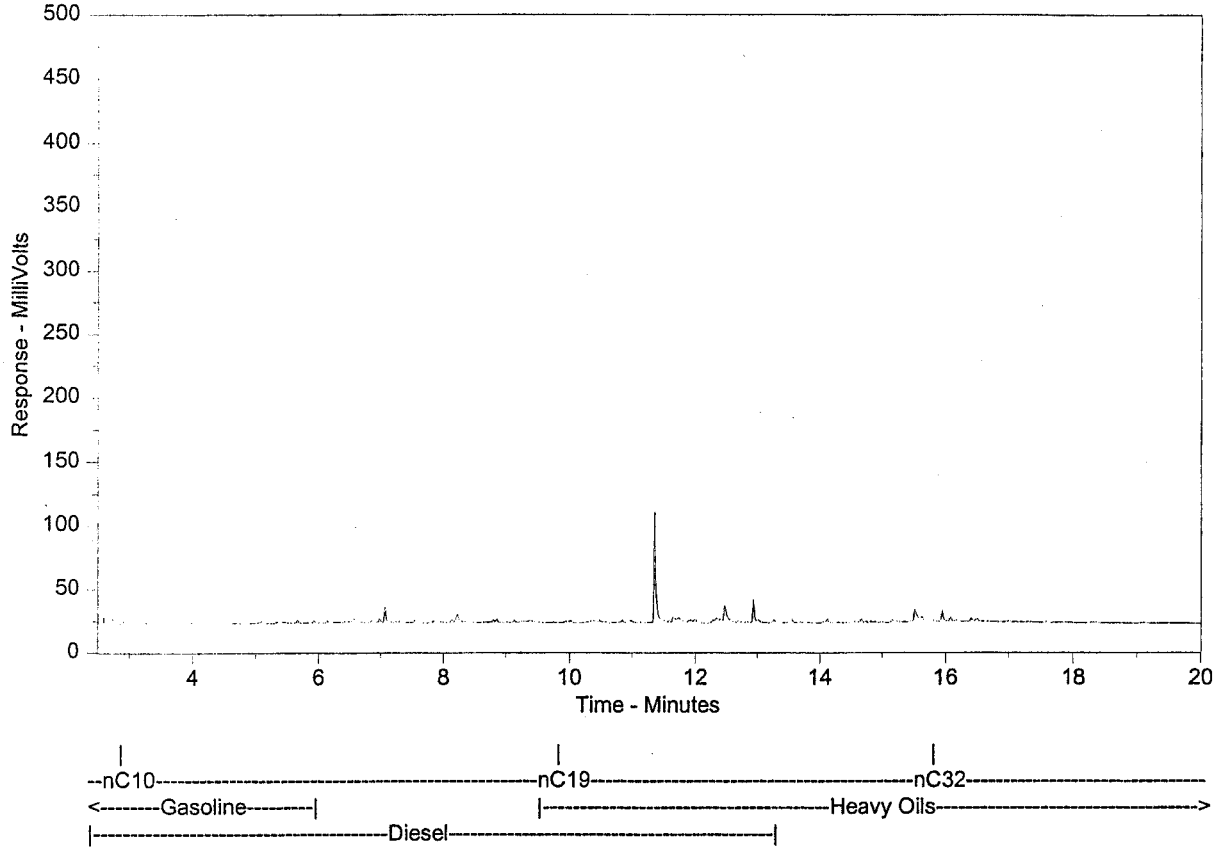
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: SED-5
ASL Sample ID: **L6581-T--61**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0014.RAW
Run Information: Acquired on GC04, 4/30/00 12:16:21 AM



Sample Amount = 6.5 (g or mL) Dilution Factor = 10.0

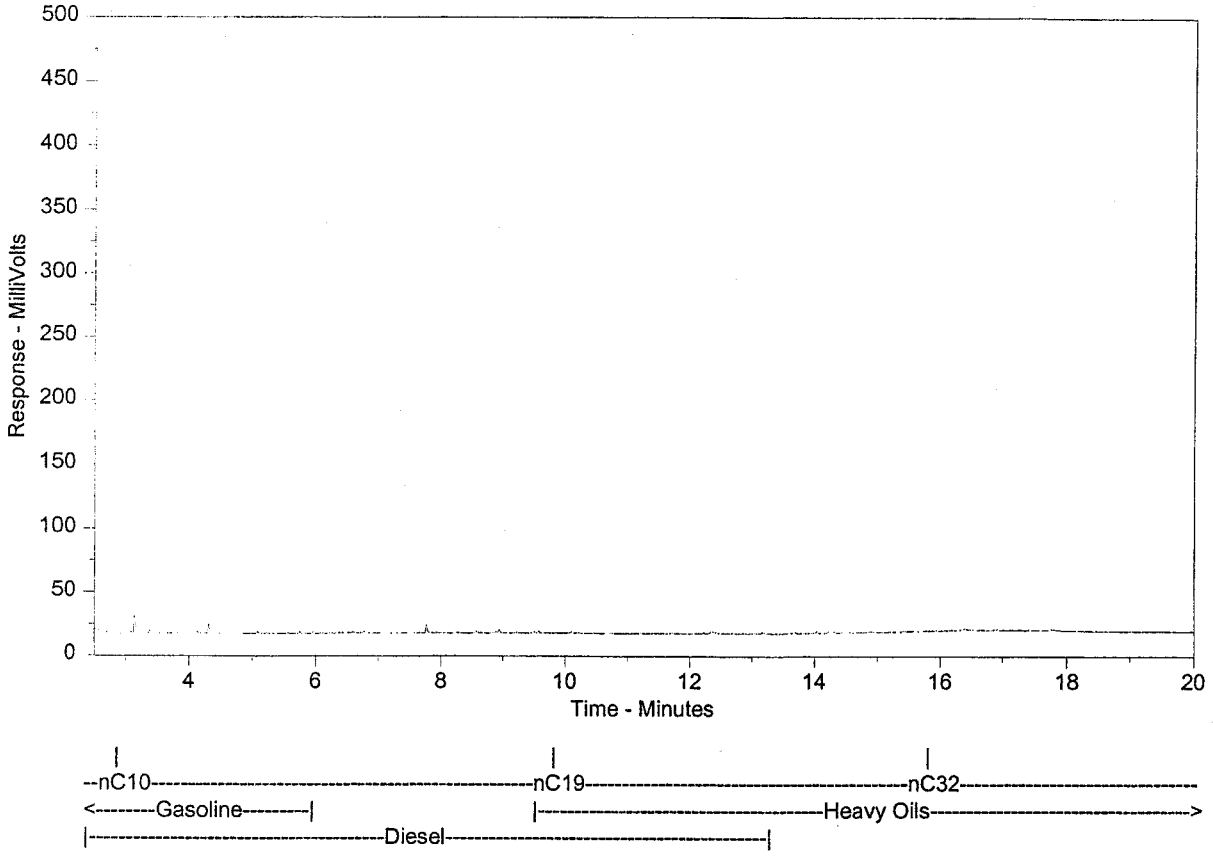
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products; and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: SED-7
ASL Sample ID: **L6581-T--63**
File Name: m:\Chrom\gc04\data\gc04_29aprB.0014.RAW
Run Information: Acquired on GC04, 4/30/00 12:16:21 AM



|----------Diesel----------|

Sample Amount = 9.4 (g or mL) Dilution Factor = 10.0

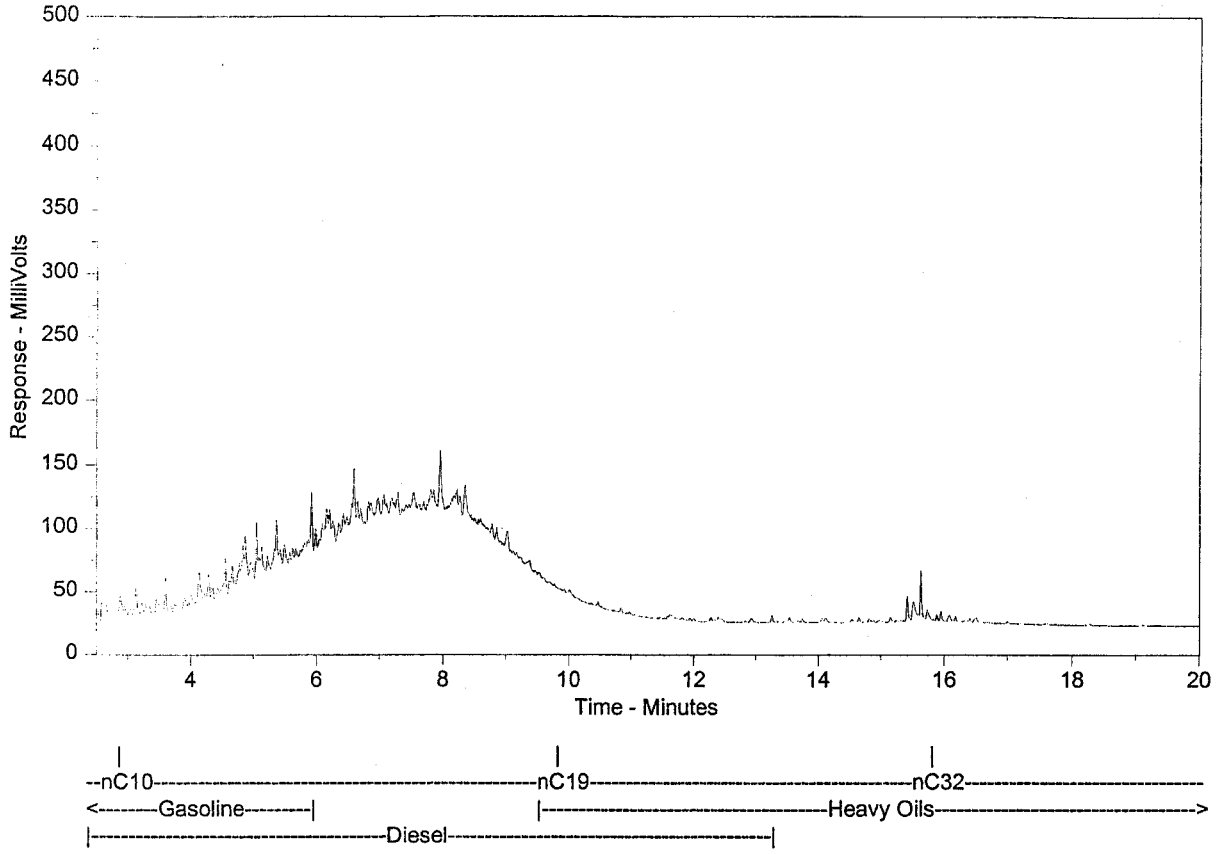
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: SED-8
ASL Sample ID: **L6581-T--64**
File Name: m:\Chrom\gc04\data\gc04_29aprA.0016.RAW
Run Information: Acquired on GC04, 4/30/00 1:19:14 AM



Sample Amount = 5.7 (g or mL) Dilution Factor = 10.0

The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

CLIENT: ROYAL ROADS UNIVERSITY
ADDRESS: 2005 SOOKE ROAD, CEDAR
CONTACT: MATT DODD
TELEPHONE: (250) 391-2583 FAX: (250) 391-2560
PROJECT NAME/NO.: PEEL RIVER
QUOTE / P.O. NO.:
DATE SUBMITTED: April 26 '00 ASL CONTACT: FRED CHEN

1988 Triumph Street
Vancouver, BC
Canada V5L 1K5
TEL: (604) 253-4188
TOLL FREE: (800) 665-0243
FAX: (604) 253-6700
Specialists in
Environmental Chemistry
analytical service laboratories ltd.

ANALYSIS REQUESTED

FOR LAB USE ONLY

LAB USE ONLY	SAMPLE IDENTIFICATION	DATE / TIME COLLECTED (Y M D)	MATRIX	DUP	PCBs	VOCs	HEAT & HEAP	METALS (AW)									NOTES
16581																	
1	TH1-1	00 04 16 2:30 PM	SPIL					X									
	TH1-2	✓ ✓ ✓ 2:45 PM	✓														
2	TH1-3	✓ ✓ ✓ 3:00 PM	✓	X	X												
	TH1-5	✓ ✓ ✓ 3:20 PM	✓														
3	TH2-2	✓ ✓ ✓ 5:30 PM	✓					X									
4	TH2-3	00 04 17 10:15 PM	✓	X	X												
5	TH2-4	✓ ✓ ✓ 10:20 PM	✓					X									
	TH3-1	✓ ✓ ✓ 11:00 PM	✓														
6	TH3-2	✓ ✓ ✓ 11:45 PM	✓	X	X			X									
	TH4-1	00 04 17 12:35 PM	✓														
7	TH4-3	✓ ✓ ✓ 1:15 PM	✓	X	X												
8	TH4-5	✓ ✓ ✓ 2:10 PM	✓	X													
9	TH5-1	✓ ✓ ✓ 3:15 PM	✓	X													
10	TH5-3	✓ ✓ ✓ 3:40 PM	✓	X													
	TH5-5	✓ ✓ ✓ 4:15 PM	✓														
	TH6-1	✓ ✓ ✓ 4:50 PM	✓														

TURN AROUND REQUIRED:
☒ ROUTINE (7 - 10 WORKING DAYS)
☐ RUSH (SPECIFY DATE):
SPECIAL INSTRUCTIONS:

SAMPLE CONDITION UPON RECEIPT:
☐ FROZEN
☐ COLD
☐ AMBIENT

RELINQUISHED BY:	DATE	RECEIVED BY:	DATE
	TIME April 26 00 8:00 am		TIME
RELINQUISHED BY:	DATE	RECEIVED BY:	DATE April 27
	TIME		TIME 10:00

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CLIENT: ROYAL ROADS UNIV
ADDRESS: 2005 SOOKE RD
CONTACT: MATT DODD
TELEPHONE: (250) 391-2583 FAX: 391-2560
PROJECT NAME/NO.: PEER RIVER
QUOTE / P.O. NO.:
DATE SUBMITTED: ASL CONTACT: FRED CHEN

ANALYSIS REQUESTED

FOR LAB USE ONLY

LAB USE ONLY	SAMPLE IDENTIFICATION	DATE / TIME COLLECTED Y	M	D		MATRIX	OCPs	PCBs	VOCs	HEPH & LEPH	ME DATLS (AW)	NOTES
	TH6-3	00	04	17	5:20 PM	SOIL	X					
	TH6-5	✓	✓	✓	5:40 PM	SOIL						
	TH7-1	00	04	18	10:35 AM	SOIL						
	TH7-3	✓	✓	✓	10:55 AM	✓	X				X	
	TH7-4	✓	✓	✓	11:00 AM	✓	X				X	
	TH7-5	✓	✓	✓	11:30 PM	✓				X	X	
	TH7-6	00	04	18	12:10 PM	✓						
	TH7-7	00	04	18	12:30 PM	✓						
	TH8-2	✓	✓	✓	2:30 PM	✓						
	TH8-3	✓	✓	✓	2:45 PM	✓	X		X			
	TH8-4	✓	✓	✓	3:00 PM	✓				X		
	TH9-1	00	04	18	4:45 PM	✓						
	TH9-2	00	04	18	4:50 PM	✓						
	TH9-3	00	04	18	4:55 PM	✓	X					
	TH9-4	00	04	18	5:00 PM	✓	X					
	TH10-1	00	04	20	10:20 AM	✓	X					

TURN AROUND REQUIRED:
☐ ROUTINE (7 - 10 WORKING DAYS)
☐ RUSH (SPECIFY DATE):
SPECIAL INSTRUCTIONS:

SAMPLE CONDITION UPON RECEIPT:
☐ FROZEN
☐ COLD
☐ AMBIENT

RELINQUISHED BY:	DATE Apr 26/00	RECEIVED BY:	DATE
	TIME 8.00 am		TIME
RELINQUISHED BY:	DATE	RECEIVED BY:	DATE
	TIME		TIME

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CLIENT: ROYAL ROADS UNIVERSITY
ADDRESS: 2005 SOOKE ROAD
CONTACT: MATT DODD
TELEPHONE: (250) 391-2593 FAX: 391-2560
PROJECT NAME/NO.: PEEL RIVER
QUOTE / P.O. NO.:
DATE SUBMITTED: ASL CONTACT: FRED CHEN

ANALYSIS REQUESTED

FOR LAB USE ONLY

LAB USE ONLY 11K551

	SAMPLE IDENTIFICATION	DATE / TIME COLLECTED (Y M D)	MATRIX	OCPs	PCBs	VOCs	HEPH/LEPH	METALS (AW)	NOTES
20	TH10-5	00 04 20 11:00 AM/PM	SOIL	X					
21	TH12-1	00 04 20 12:30 AM/PM	✓	X					
22	TH13-1	00 04 20 1:30 AM/PM	✓	X					
23	TH13-3	00 04 20 1:45 AM/PM	✓	X					
24	TH14-1	00 04 20 2:00 AM/PM	✓	X					
25	TH15-1	00 04 20 2:30 AM/PM	✓	X			X		
	TH15-3	00 04 20 2:50 AM/PM	✓						
	TH16-1	00 04 20 4:00 AM/PM	✓						
26	TH16-2	00 04 20 4:10 AM/PM	✓	X	X	X	X		
27	TH16-3	00 04 20 4:15 AM/PM	✓	✓		X	X		
28	TH17-1	00 04 20 4:30 AM/PM	✓			X	X		
29	TH17-2	00 04 20 4:50 AM/PM	✓	X		X	X	X	
30	TH17-3	00 04 20 4:55 AM/PM	✓	X		X		X	
	TH18-1	00 04 20 5:20 AM/PM	✓						
31	TH18-2	04 04 20 5:30 AM/PM	✓	X			X	X	
32	TH18-3	04 04 20 5:40 AM/PM	✓	X		X	X	X	

TURN AROUND REQUIRED:
- [x] ROUTINE (7 - 10 WORKING DAYS)
- [ ] RUSH (SPECIFY DATE):

SPECIAL INSTRUCTIONS:

SAMPLE CONDITION UPON RECEIPT:
- [ ] FROZEN
- [ ] COLD
- [ ] AMBIENT

RELINQUISHED BY:	DATE	RECEIVED BY:	DATE
	TIME 8:00 am		TIME
RELINQUISHED BY:	DATE	RECEIVED BY:	DATE APR 27
	TIME		TIME 1000

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PROJECT NAME/NO.: PEEL RIVER
QUOTE / P.O. NO.:
DATE SUBMITTED: April 26 '00 ASL CONTACT: FRED CATEN

ANALYSIS REQUESTED

FOR LAB USE ONLY

LAB USE ONLY	SAMPLE IDENTIFICATION	DATE / TIME COLLECTED (Y M D)	MATRIX	OCPs	PCBs	VOCs	HEPH & LEPH	METALS (dis)	NOTES
333	TH 19-1	00 04 20 6:00 AM (PM)	Soil	X					
334	TH19-2	00 04 20 6:10 AM (PM)		X	X				
27	TH 20-1	00 04 21 11:50 AM (PM)							
335	TH 20-3	00 04 21 12:10 AM (PM)		X					
14	TH 21-1	00 04 21 1:40 AM (PM)							
15	TH 21-2	00 04 21 1:50 AM PM						X	
337	TH 22-1	00 04 21 2:40 AM (PM)		X					
	TH 22-2	00 04 21 2:50 AM (PM)							
338	TH 23-1	00 04 21 3:05 AM PM		X					
17	TH 24-1	00 04 21 5:15 AM (PM)							
339	TH 24-2	00 04 21 5:30 AM (PM)		X	X				
340	TH 24-3	00 04 21 5:45 AM (PM)					X	X	
30	TH 25-1	00 04 22 2:00 AM (PM)							
41	TH 25-2	00 04 22 2:25 AM (PM)		X				X	
42	TH 26-1	00 04 22 3:20 AM (PM)		X				X	
343	TH 27-1	00 04 22 3:50 AM (PM)		X				X	

TURN AROUND REQUIRED:
- ☐ ROUTINE (7 - 10 WORKING DAYS)
- ☐ RUSH (SPECIFY DATE): _____

SPECIAL INSTRUCTIONS:

SAMPLE CONDITION UPON RECEIPT:
- ☐ FROZEN
- ☐ COLD
- ☐ AMBIENT

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
	April 26 '00	8:00 a.m.			
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
				April 27	1800

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FAX: (604) 253-6700
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ADDRESS: _____

CONTACT: _____

TELEPHONE: _____ FAX: _____

PROJECT NAME/NO.: _____

QUOTE / P.O. NO.: _____

DATE SUBMITTED: _____ ASL CONTACT: _____

ANALYSIS REQUESTED

FOR LAB USE ONLY

LAB USE ONLY	SAMPLE IDENTIFICATION	DATE / TIME COLLECTED Y	M	D		MATRIX	OCPs	PCBs	VOCs	HEPH & LEPH	MET TMS									NOTES
344	TH27-3	00	04	22	4:00 AM/PM	SOIL	X	X			X									
345	TH28-2	00	04	22	4:10 AM/PM	✓	X	X		X	X									
346	TH29-1	00	04	22	4:30 AM/PM	✓	X	X		[illegible]	[illegible]									
347	TH29-2	00	04	22	4:45 AM/PM	✓	X			X	X									
348	TH29-3	00	04	22	4:90 AM/PM	✓			X	X										
349	TH30-1	00	04	22	4:40 AM/PM	✓	X													
350	TH30-2	00	04	22	4:45 AM/PM	✓	X													
	TH30-3	00	04	23	10:00 AM/PM	✓														
358	TH30-4	00	04	23	10:30 AM/PM	✓														
357	TH30-5	00	04	23	10:30 AM/PM	✓														
351	TH31-1	00	04	22	5:00 AM/PM	✓					X									
352	TH31-2	00	04	23	9:50 AM/PM	✓	X													
353	TH31-3	04	04	23	10:00 AM/PM	✓	X													
1	TH32-1	04	04	23	10:40 AM/PM	✓														
354	TH32-2	04	04	23	10:45 AM/PM	✓	X	[illegible]												
355	TH33-1	04	04	23	3:20 AM/PM	✓					X									

TURN AROUND REQUIRED:

☑ ROUTINE (7 - 10 WORKING DAYS)

☐ RUSH (SPECIFY DATE): _____

SPECIAL INSTRUCTIONS:

SAMPLE CONDITION UPON RECEIPT:

☐ FROZEN
☐ COLD
☐ AMBIENT

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
[signature]	Apr 26 00	8:00 am			
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
			[signature]	APR 27	10:00

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CLIENT: ROYAL ROADS UNIV
ADDRESS: 2005 SOOKE RD
CONTACT: MATT DODD
TELEPHONE: (250) 391-2583 FAX: 391-2560
PROJECT NAME/NO.: PEEL RIVER
QUOTE / P.O. NO.:
DATE SUBMITTED: April 26, 00 ASL CONTACT: FRED CATEN

PAGE 6 OF 6

ANALYSIS REQUESTED

LAB USE ONLY	SAMPLE IDENTIFICATION	DATE / TIME COLLECTED Y	M	D		MATRIX	OCP	PCBS	VOC	HEPH/LEPH	METALS	BTEX/VPH	NOTES
56	TH33-2	00	04	23	3:20 PM	SOIL	✓						
	TH33-3	00	04	23	3:45 PM	SOIL							
57	SED-1	00	04	22	5:00 PM	SEDIMENT					X		
58	SED-2	00	04	22	5:20 PM	✓	X						
59	SED-3	00	04	22	5:40 PM	✓	X						
60	SED-4	00	04	23	12:45 PM	✓	[illegible]				X		
61	SED-5	00	04	23	1:30 PM	✓	X			X			
62	SED-6	00	04	23	1:45 PM	✓	X						
63	SED-7	00	04	23	2:00 PM	✓				X			
64	SED-8	00	04	23	12:30 PM	✓	X			X			
					: AM/PM								
					: AM/PM								
					: AM/PM								
					: AM/PM								
					: AM/PM								
					: AM/PM								

FOR LAB USE ONLY

TURN AROUND REQUIRED:
☐ ROUTINE (7 - 10 WORKING DAYS)
☐ RUSH (SPECIFY DATE): _____
SPECIAL INSTRUCTIONS:

SAMPLE CONDITION UPON RECEIPT:
☐ FROZEN
☐ COLD
☐ AMBIENT

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
[signature]	April 26 '00	8:00 AM			
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	DATE	TIME
			AJ	April 27	10:00

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CLIENT: _____

ADDRESS: _____

CONTACT: _____

TELEPHONE: _____ FAX: _____

PROJECT NAME/NO.: _____

QUOTE / P.O. NO.: _____

DATE SUBMITTED: _____ ASL CONTACT: _____

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TOLL FREE: (800) 665-0243
FAX: (604) 253-6700

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ANALYSIS REQUESTED

FOR LAB USE ONLY

LAB USE ONLY	SAMPLE IDENTIFICATION	DATE / TIME COLLECTED (Y M D)	MATRIX	NOTES
	VOCS C	AM / PM		
	TH 6-3	AM / PM		
	16-2	AM / PM		
	16-3	AM / PM		
	16-4	AM / PM		
	17-1	AM / PM		
	17-3	AM / PM		
	18-2	AM / PM		
	18-3	AM / PM		
		AM / PM		
		AM / PM		
		AM / PM		
		AM / PM		
		AM / PM		
		AM / PM		

TURN AROUND REQUIRED:

☐ ROUTINE (7 - 10 WORKING DAYS)

☐ RUSH (SPECIFY DATE): _____

SPECIAL INSTRUCTIONS:

SAMPLE CONDITION UPON RECEIPT:

☐ FROZEN

☐ COLD

☐ AMBIENT

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
			APR 27 / 1000

7 °C

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APPENDIX B2:

ASL LABORATORY REPORT FOR ORGANOCHLORINE PESTICIDES, PCBS, METALS, HYDROCARBONS AND VOCS IN WATER SAMPLES

1988 Triumph Street, Vancouver, BC Canada V5L 1K5

analytical
service
laboratories
ltd.

FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date: June 19, 2000

ASL File No. L7561

Report On: Peel River Water Analysis

Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2

Attention: **Dr. Matthew Dodd**, Professor

Received: June 2, 2000

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Frederick Chen, B.Sc. - Manager, Special Projects
Miles Gropen, B.Sc. - Project Chemist

RESULTS OF ANALYSIS - Water File No. L7561

Sample ID			Peel W-1	Peel W-2	Peel W-3	Peel W-4	Peel W-5
Sample Date			00 05 31	00 05 31	00 05 31	00 05 31	00 05 31
Sample Time			13:15	15:50	15:45	15:20	14:40
Physical Tests							
Hardness		CaCO3	87.9	92.4	92.5	92.9	89.4
Total Metals							
Aluminum	T-Al		22.7	32.8	31.0	26.3	26.6
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.2	<0.2	<0.2	<0.2	<0.2
Barium	T-Ba		0.98	1.19	1.19	1.10	1.03
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	T-B		0.2	0.2	0.2	0.2	0.2
Cadmium	T-Cd		0.0010	0.0010	0.0010	0.0010	0.0009
Calcium	T-Ca		51.5	52.0	50.8	48.0	46.4
Chromium	T-Cr		0.04	0.06	0.06	0.05	0.05
Cobalt	T-Co		0.01	0.02	0.02	0.02	0.01
Copper	T-Cu		0.04	0.04	0.05	0.05	0.04
Iron	T-Fe		34.4	42.7	41.9	40.3	35.4
Lead	T-Pb		0.020	0.023	0.021	0.020	0.022
Magnesium	T-Mg		20.0	21.5	21.2	19.4	18.8
Manganese	T-Mn		0.462	0.518	0.501	0.485	0.444
Mercury	T-Hg		0.00020	0.00012	0.00020	0.00021	0.00016
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.05	0.06	0.05	0.05	<0.05
Selenium	T-Se		0.002	0.002	0.002	0.002	0.002
Silver	T-Ag		0.0002	0.0004	0.0003	0.0003	0.0003
Sodium	T-Na		2	2	2	2	2
Thallium	T-Tl		0.0006	0.0007	0.0007	0.0006	0.0006
Uranium	T-U		0.00225	0.00248	0.00239	0.00224	0.00219
Zinc	T-Zn		0.180	0.206	0.204	0.205	0.179

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.
EPH10-19 is equivalent to EHw10-19.

RESULTS OF ANALYSIS - Water File No. L7561

Sample ID		Peel W-1	Peel W-2	Peel W-3	Peel W-4	Peel W-5
Sample Date		00 05 31	00 05 31	00 05 31	00 05 31	00 05 31
Sample Time		13:15	15:50	15:45	15:20	14:40
Dissolved Metals						
Aluminum	D-Al	0.107	0.157	0.130	0.101	0.130
Antimony	D-Sb	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	D-As	<0.2	<0.2	<0.2	<0.2	<0.2
Barium	D-Ba	0.05	0.06	0.06	0.06	0.06
Beryllium	D-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Boron	D-B	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	D-Cd	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Calcium	D-Ca	24.8	26.2	26.2	26.4	25.4
Chromium	D-Cr	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	D-Co	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	D-Cu	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	D-Fe	0.25	0.31	0.28	0.28	0.31
Lead	D-Pb	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	D-Mg	6.3	6.5	6.6	6.6	6.3
Manganese	D-Mn	0.013	0.011	0.011	0.010	0.012
Mercury	D-Hg	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	D-Mo	<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	D-Ni	<0.05	<0.05	<0.05	<0.05	<0.05
Selenium	D-Se	<0.001	<0.001	<0.001	<0.001	<0.001
Silver	D-Ag	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Sodium	D-Na	<2	<2	<2	<2	<2
Thallium	D-Tl	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Uranium	D-U	0.00047	0.00048	0.00049	0.00046	0.00046
Zinc	D-Zn	<0.005	<0.005	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.
EPH10-19 is equivalent to EHw10-19.

RESULTS OF ANALYSIS - Water

File No. L7561

Sample ID	Peel W-1	Peel W-2	Peel W-3	Peel W-4	Peel W-5
Sample Date	00 05 31	00 05 31	00 05 31	00 05 31	00 05 31
Sample Time	13:15	15:50	15:45	15:20	14:40
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Acenaphthylene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Acridine	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Anthracene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Benz(a)anthracene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Benzo(a)pyrene	0.00001	<0.00001	0.00001	0.00001	0.00001
Benzo(b)fluoranthene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Benzo(g,h,i)perylene	0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Benzo(k)fluoranthene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Chrysene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Dibenz(a,h)anthracene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Fluoranthene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Fluorene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Indeno(1,2,3-c,d)pyrene	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Naphthalene	0.00021	0.00006	0.00011	0.00017	0.00016
Phenanthrene	0.00026	0.00007	0.00014	0.00019	0.00019
Pyrene	0.00006	<0.00005	<0.00005	<0.00005	<0.00005
Extractable Hydrocarbons					
EPH10-19	<0.3	<0.3	<0.3	<0.3	<0.3
EPH19-32	<1	<1	<1	<1	<1
LEPH	<0.3	<0.3	<0.3	<0.3	<0.3
HEPH	<1	<1	<1	<1	<1

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.
EPH10-19 is equivalent to EHw10-19.

Appendix 1 - QUALITY CONTROL - Replicates

File No. L7561

Water			**Peel W-3**	**Peel W-3**
			00 05 31 15:45	QC # 199283
Physical Tests				
Hardness		CaCO3	92.5	89.2
Total Metals				
Aluminum	T-Al		31.0	28.5
Antimony	T-Sb		<0.2	<0.2
Arsenic	T-As		<0.2	<0.2
Barium	T-Ba		1.19	1.22
Beryllium	T-Be		<0.005	<0.005
Boron	T-B		0.2	0.2
Cadmium	T-Cd		0.0010	0.0010
Calcium	T-Ca		50.8	49.7
Chromium	T-Cr		0.06	0.05
Cobalt	T-Co		0.02	0.02
Copper	T-Cu		0.05	0.05
Iron	T-Fe		41.9	45.6
Lead	T-Pb		0.021	0.024
Magnesium	T-Mg		21.2	21.1
Manganese	T-Mn		0.501	0.520
Mercury	T-Hg		0.00020	<0.00005
Molybdenum	T-Mo		<0.03	<0.03
Nickel	T-Ni		0.05	0.06
Selenium	T-Se		0.002	0.002
Silver	T-Ag		0.0003	0.0004
Sodium	T-Na		2	2
Thallium	T-Tl		0.0007	0.0007
Uranium	T-U		0.00239	0.00241
Zinc	T-Zn		0.204	0.219

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.
EPH10-19 is equivalent to EHw10-19.

Appendix 1 - QUALITY CONTROL - Replicates

File No. L7561

Water		Peel W-3	Peel W-3
		00 05 31 15:45	QC # 199283
Dissolved Metals			
Aluminum	D-Al	0.130	0.114
Antimony	D-Sb	<0.2	<0.2
Arsenic	D-As	<0.2	<0.2
Barium	D-Ba	0.06	0.06
Beryllium	D-Be	<0.005	<0.005
Boron	D-B	<0.1	<0.1
Cadmium	D-Cd	<0.0002	<0.0002
Calcium	D-Ca	26.2	25.5
Chromium	D-Cr	<0.01	<0.01
Cobalt	D-Co	<0.01	<0.01
Copper	D-Cu	<0.01	<0.01
Iron	D-Fe	0.28	0.28
Lead	D-Pb	<0.001	<0.001
Magnesium	D-Mg	6.6	6.2
Manganese	D-Mn	0.011	0.011
Mercury	D-Hg	<0.00005	<0.00005
Molybdenum	D-Mo	<0.03	<0.03
Nickel	D-Ni	<0.05	<0.05
Selenium	D-Se	<0.001	<0.001
Silver	D-Ag	<0.0001	<0.0001
Sodium	D-Na	<2	<2
Thallium	D-Tl	<0.0001	<0.0001
Uranium	D-U	0.00049	0.00047
Zinc	D-Zn	<0.005	<0.005

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.
EPH10-19 is equivalent to EHw10-19.

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Conventional Parameters in Water

These analyses are carried out in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ASL "Collection & Sampling Guide"

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorption spectrophotometry (EPA Method 7470A/7471A).

Recommended Holding Time:

Sample:	28 days
Reference:	EPA
For more detail see:	ASL "Collection & Sampling Guide"

Polycyclic Aromatic Hydrocarbons in Water

This analysis is carried out using a procedure adapted by ASL from U.S. EPA Methods 3510, 3630 and 8270 (publ. #SW-846, 3rd Ed., Washington, DC 20460). The procedure involves the extraction of the sample with methylene chloride followed by silica column chromatography cleanup. This cleanup procedure has been found to effectively remove aliphatic and heterocyclic hydrocarbons which could potentially interfere with the analysis. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection.

Extractable Hydrocarbons in Water

This analysis is carried out according to British Columbia Ministry of Environment, Lands and Parks (BCMELP) Analytical Method for Contaminated Sites "Extractable Petroleum Hydrocarbons in Water by GC/FID, Version 2.1 July 1999". The procedure involves extraction of the entire water sample with Dichloromethane. The extract is exchanged to Toluene and analysed by capillary column gas chromatography with flame ionization detection. Reported results include Polycyclic Aromatic Hydrocarbons (PAH) and are therefore not equivalent to Light and Heavy Extractable Petroleum Hydrocarbon (LEPH/HEPH).

Please note that in August of 1999, BCMELP replaced the EPH(C10-18) and EPH(C19-31) parameters with EPH(C10-19) and EPH(C19-32). These parameters were redefined so that they more accurately describe how the analysis is carried out. Results reported by ASL for the old and new parameters are equivalent. ASL implemented the new parameters on August 23, 1999.

Recommended Holding Time:

Sample: 7 days Extract: 40 days
Reference: BCMELP
For more detail see ASL "Collection & Sampling Guide"

Light and Heavy Extractable Petroleum Hydrocarbons in Water

These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Light and Heavy Extractable Petroleum Hydrocarbons in Solids or Water". According to this method, LEPH and HEPH are calculated

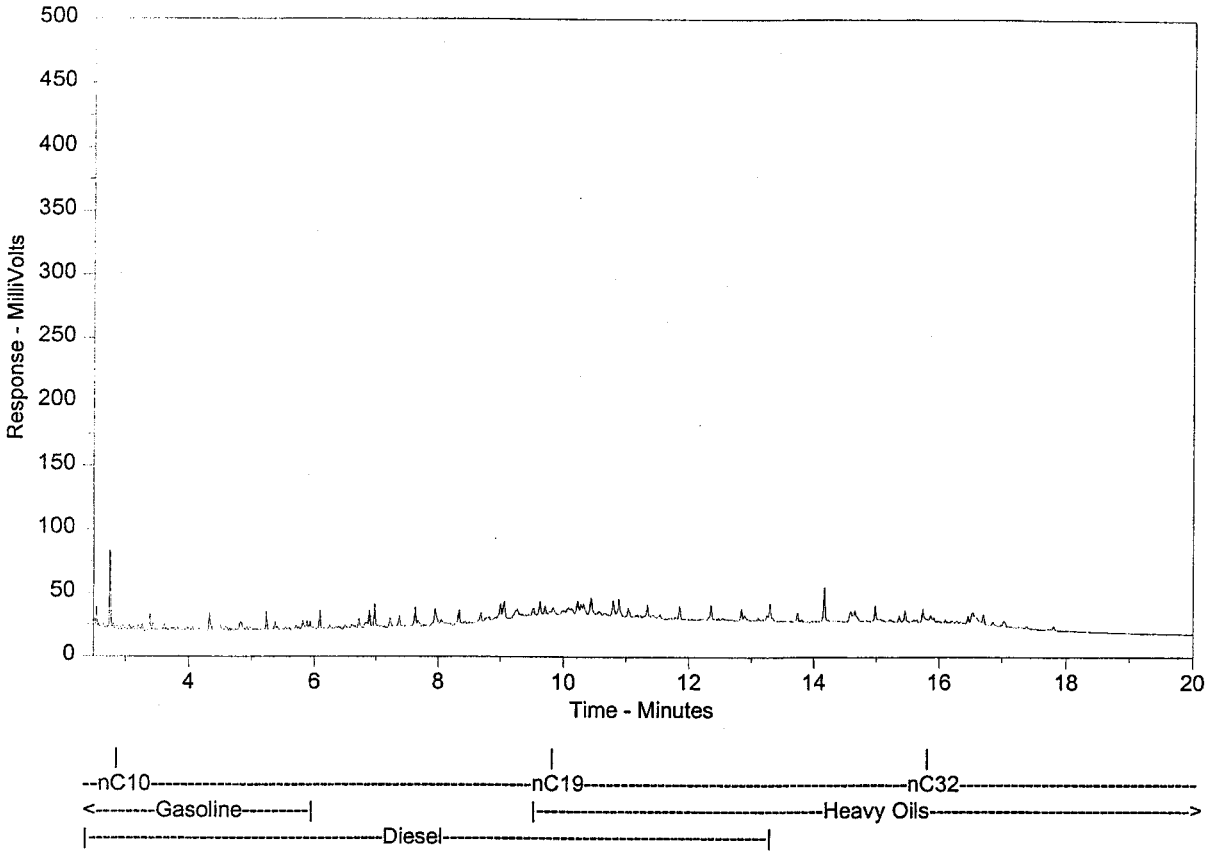
by subtracting selected Polynuclear Aromatic Hydrocarbon results from Extractable Petroleum Hydrocarbon results. To calculate LEPH, the individual results for acenaphthene, acridine, anthracene, fluorene, naphthalene, and phenanthrene are subtracted from EPH(C10-19). To calculate HEPH, the individual results for benz(a)anthracene, benzo(a)pyrene, fluoranthene, and pyrene are subtracted from EPH(C19-32). Analysis of Extractable Petroleum Hydrocarbons adheres to all prescribed elements of the BCMELP method "Extractable Petroleum Hydrocarbons in Water by GC/FID"(Version 2.1, July 20, 1999).

Recommended Holding Time: Not Applicable

End of Report

ASL Hydrocarbon Distribution Report

Client Sample ID: Peel W-1
ASL Sample ID: **L7561-T--1**
File Name: m:\chrom\gc12\data\gc12_04junB.0012.RAW
Run Information: Acquired on GC12, 6/5/00 9:31:46 PM



Sample Amount = 995.0 (g or mL) Dilution Factor = 1.0

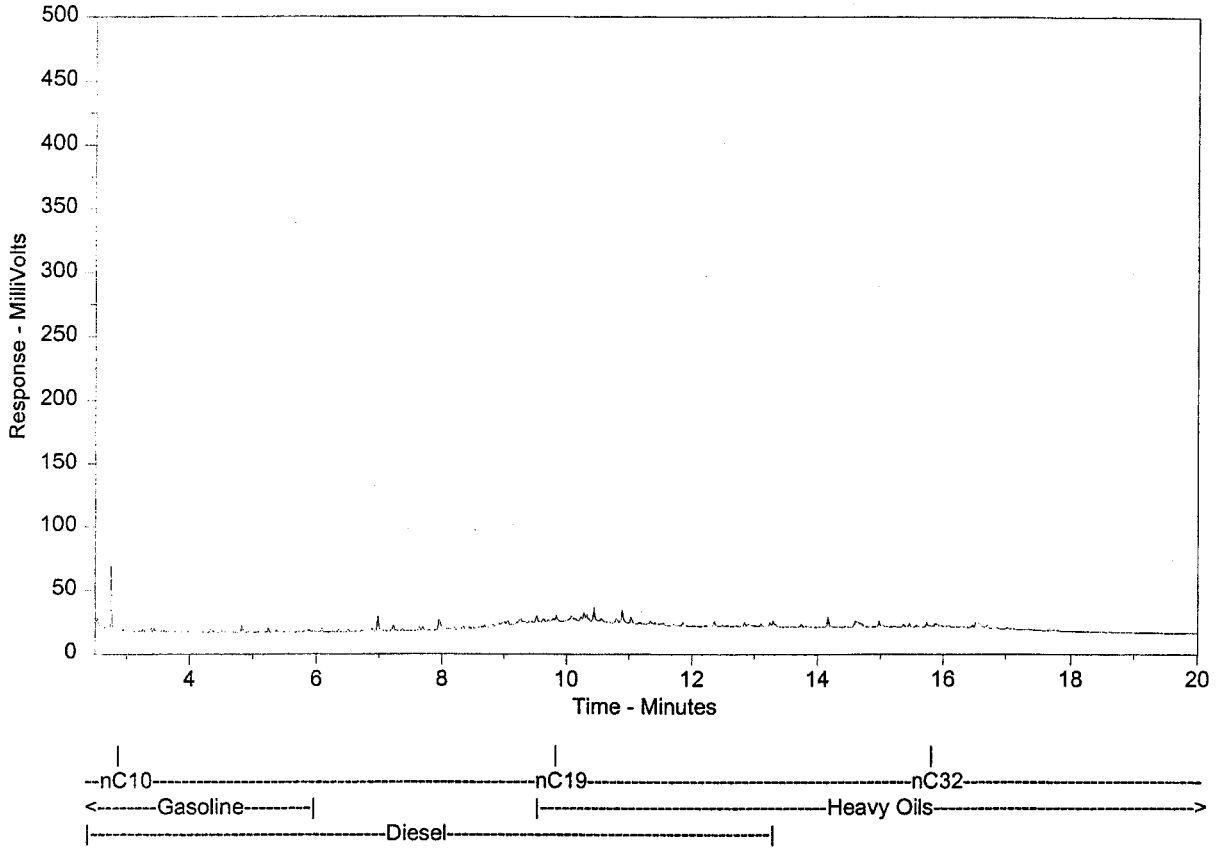
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: Peel W-2
ASL Sample ID: **L7561-T--2**
File Name: m:\chrom\gc12\data\gc12_04junB.0013.RAW
Run Information: Acquired on GC12, 6/5/00 10:03:16 PM



Sample Amount = 915.0 (g or mL) Dilution Factor = 1.0

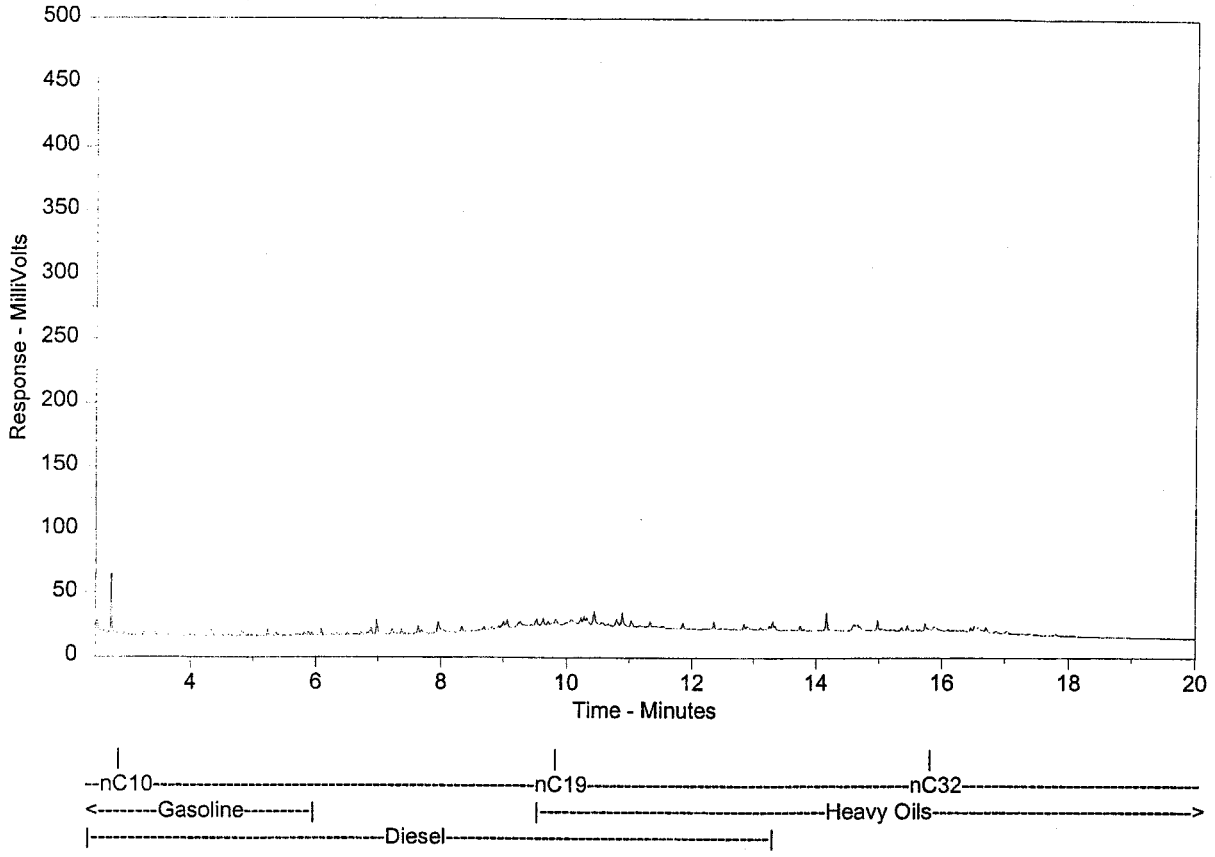
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: Peel W-3
ASL Sample ID: **L7561-T--3**
File Name: m:\chrom\gc12\data\gc12_04junB.0014.RAW
Run Information: Acquired on GC12, 6/5/00 10:34:42 PM



Sample Amount = 980.0 (g or mL) Dilution Factor = 1.0

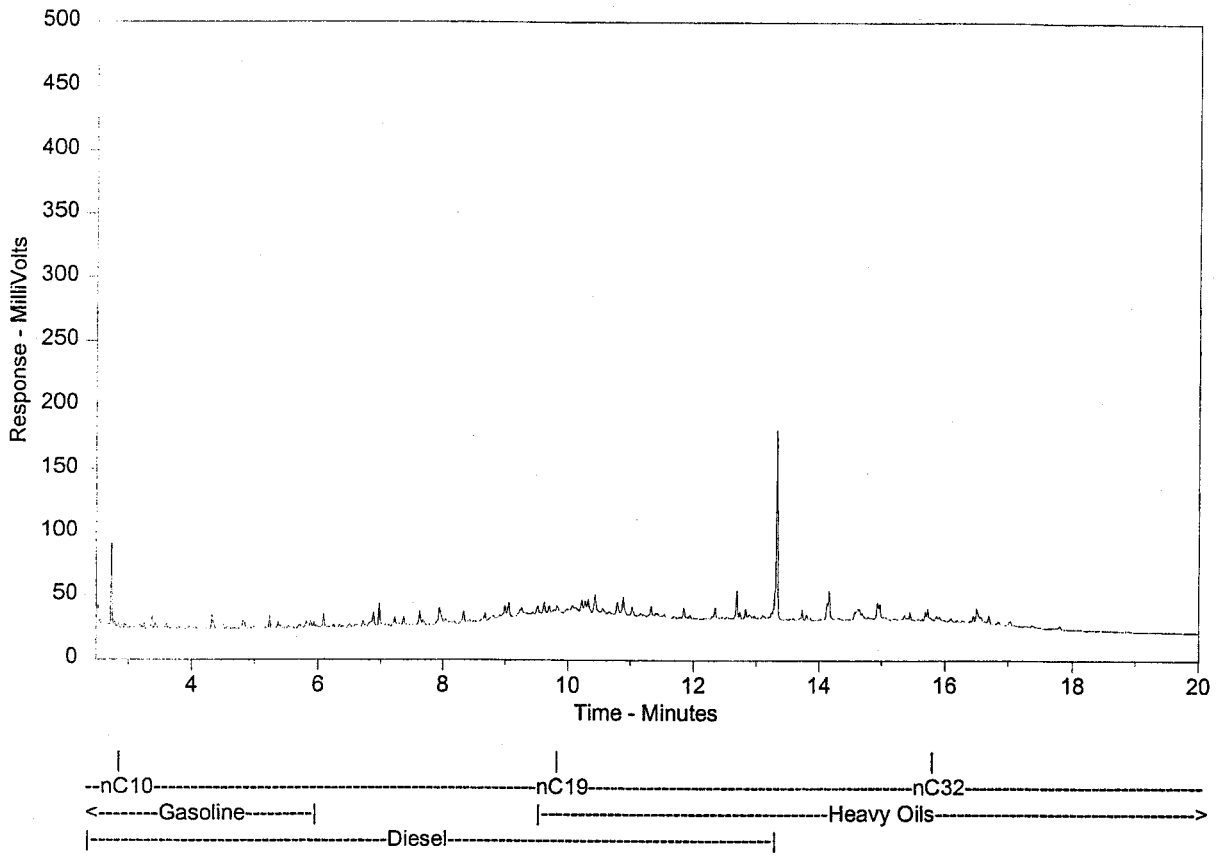
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: Peel W-4
ASL Sample ID: **L7561-T--4**
File Name: m:\chrom\gc12\data\gc12_04junB.0021.RAW
Run Information: Acquired on GC12, 6/6/00 10:51:27 AM



Sample Amount = 990.0 (g or mL) Dilution Factor = 1.0

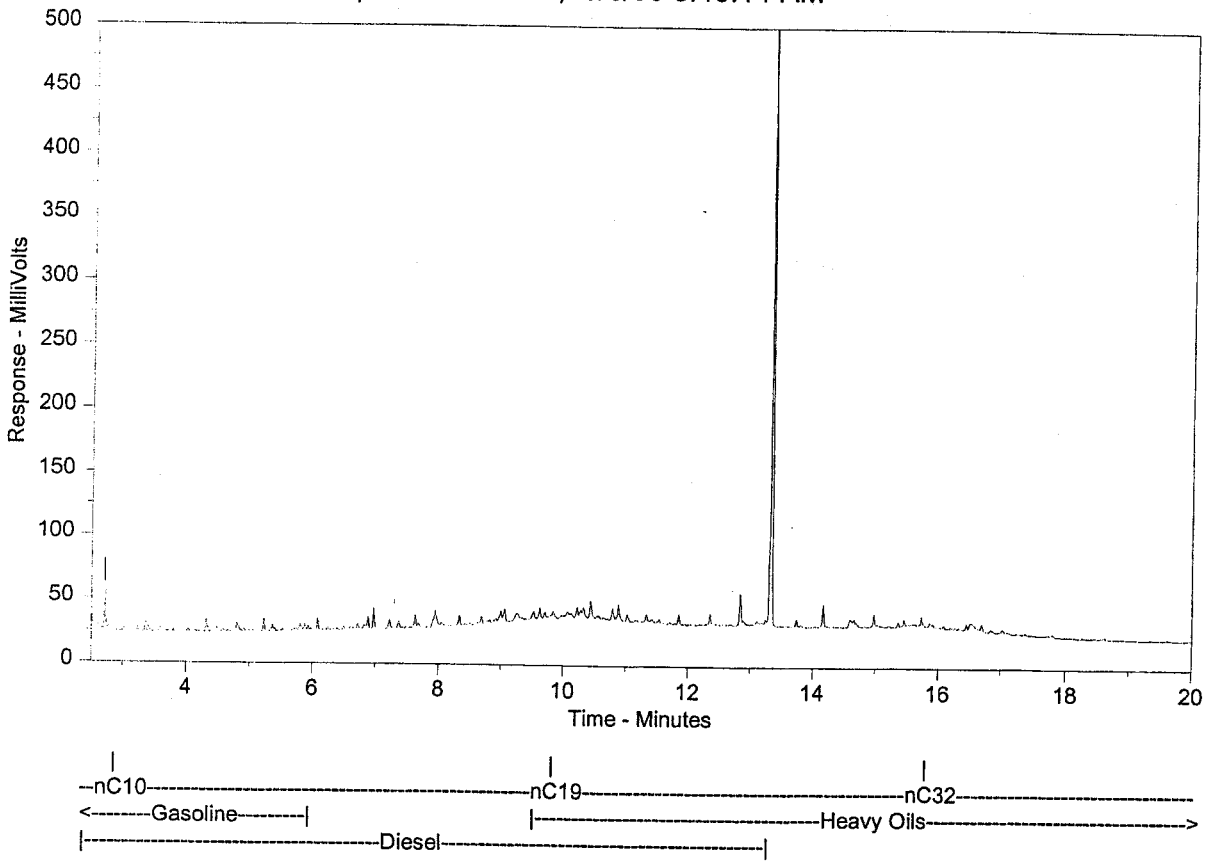
The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

ASL Hydrocarbon Distribution Report

Client Sample ID: Peel W-5
ASL Sample ID: **L7561-T--5**
File Name: m:\chrom\gc12\data\gc12_04junB.0017.RAW
Run Information: Acquired on GC12, 6/6/00 8:45:14 AM



|----------Diesel----------|

Sample Amount = 1000.0 (g or mL)

Dilution Factor = 1.0

The Hydrocarbon Distribution Report is intended to assist you in characterizing hydrocarbon products that may be present in your sample. The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products, and of three n-alkane hydrocarbon marker compounds. Comparison of this report with those of reference standards may also assist in characterizing hydrocarbons present in the sample.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor, and the scale at left.

Note: This report was produced using a temperature profile that was implemented on June 21st,1999. Under these new conditions, hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report to other reports produced prior to June 21st, 1999. A current library of reference products is available upon request.

APPENDIX B3:
AXYS LABORATORY REPORT FOR DDTS IN WATER SAMPLES

AXYS | Axys Analytical Services Ltd

PO Box 2219, 2045 Mills Road West
Sidney, British Columbia, Canada V8L 3S8

DATE:	22-Jul-2000	**Our File:**	9919
TO:	Matt Dodd	**Batch ID:**	CLWG3010
ORGANIZATION:	Royal Roads University	**Samples:**	L2253 -1 to -5
ADDRESS:			2553
FAX No.:	(250) 391-2560		
FROM:	Dale Hoover	**No. of pages:**	10

Please find attached the results for five water samples submitted for PCB/Pesticide analysis.

Should you have any questions, please do not hesitate to contact me.

Best Regards,

Axys Analytical Services Ltd.

TEL: (250) 655-5800 **FAX: (250) 655-5811**
E-MAIL: analytical@axys.com **toll-free: 1-888-373-0881**

BATCH SUMMARY

Batch ID:	DXWG3010	***Date:***	22-July-2000
Analysis Type:	DDD, DDE & DDT	***Matrix Type:***	Water

BATCH MAKEUP

Contract:	9919 ***Samples:***	L2553 -1 -2 -3 -4 -5	***Blank:*** WG3010-101
			Reference or Spike: WG3010-102
			Duplicate: WG3010-103

Comments:

1.

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D:	**Procedural Blank**	**AXYS ID:**	**WG3010-101**
CLIENT:	**Royal Roads University**	**DATE:**	**30-Jun-2000**
CLIENT NO.:	**9919**		
SAMPLE TYPE:	**Blank**	**METHOD NO.:**	**CL-W-04/Ver.2**
SAMPLE SIZE:	**1.00 L**	**INSTRUMENT:**	**GC-MS**
		RUNFILE ID:	**CL095548.D**
		CONCENTRATION IN:	**ng/L**

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.24
p,p'-DDE	0.22	0.21
o,p'-DDD	ND	0.18
p,p'-DDD	ND	0.20
o,p'-DDT	ND	0.38
p,p'-DDT	ND	0.45

Surrogate Standards	% Recovery
13C-p,p'-DDE	85
13C-p,p'-DDT	82
13C-PCB 101	73

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT CL002B

CLIENT SAMPLE I.D: Spiked Matrix
AXYS ID: WG3010-102

CLIENT: Royal Roads University
CLIENT NO.: 9919
SAMPLE TYPE: Water
DATE: 30-Jun-2000
METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L
INSTRUMENT: GC-MS
RUNFILE ID: CL095546.D
CONCENTRATION IN: ng/L

Compounds	Determined	Expected	% Recovery
o,p'-DDE	48	49	98
p,p'-DDE	49	47	104
o,p'-DDD	63	52	121
p,p'-DDD	66	50	132
o,p'-DDT	48	50	96
p,p'-DDT	45	45	100

Surrogate Standards	% Recovery
13C-p,p'-DDE	96
13C-p,p'-DDT	110
13C-PCB 101	80

1. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D:	**PEEL W-1**	**AXYS ID:**	**L2553-1 (A)**
CLIENT:	**Royal Roads University**	**DATE:**	**30-Jun-2000**
CLIENT NO.:	**9919**		
SAMPLE TYPE:	**Water**	**METHOD NO.:**	**CL-W-04/Ver.2**
SAMPLE SIZE:	**1.00 L**	**INSTRUMENT:**	**GC-MS**
		RUNFILE ID:	**CL095549.D**
		CONCENTRATION IN:	**ng/L**

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.40
p,p'-DDE	ND	0.35
o,p'-DDD	ND	0.22
p,p'-DDD	ND	0.24
o,p'-DDT	ND	0.42
p,p'-DDT	ND	0.50

Surrogate Standards	% Recovery
13C-p,p'-DDE	97
13C-p,p'-DDT	100
13C-PCB 101	84

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D:	**PEEL W-1**	**AXYS ID:**	**WG3010-103 (DUP L2553-1)**
CLIENT:	**Royal Roads University**	**DATE:**	**30-Jun-2000**
CLIENT NO.:	**9919**		
SAMPLE TYPE:	**Water**	**METHOD NO.:**	**CL-W-04/Ver.2**
SAMPLE SIZE:	**1.00 L**	**INSTRUMENT:**	**GC-MS**
		RUNFILE ID:	**CL095550.D**
		CONCENTRATION IN:	**ng/L**

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.41
p,p'-DDE	0.36	0.36
o,p'-DDD	ND	0.42
p,p'-DDD	ND	0.45
o,p'-DDT	ND	0.24
p,p'-DDT	ND	0.28

Surrogate Standards	% Recovery
13C-p,p'-DDE	99
13C-p,p'-DDT	95
13C-PCB 101	84

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

pc

Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D:	**PEEL W-2**	**AXYS ID:**	**L2553-2**
CLIENT:	**Royal Roads University**	**DATE:**	**30-Jun-2000**
CLIENT NO.:	**9919**		
SAMPLE TYPE:	**Water**	**METHOD NO.:**	**CL-W-04/Ver.2**
SAMPLE SIZE:	**1.00 L**	**INSTRUMENT:**	**GC-MS**
		RUNFILE ID:	**CL095551.D**
		CONCENTRATION IN:	**ng/L**

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.27
p,p'-DDE	ND	0.23
o,p'-DDD	ND	0.20
p,p'-DDD	ND	0.21
o,p'-DDT	NDR 0.088	0.073
p,p'-DDT	0.20	0.087

Surrogate Standards	% Recovery
13C-p,p'-DDE	100
13C-p,p'-DDT	85
13C-PCB 101	88

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D:	**PEEL W-4**	**AXYS ID:**	**L2553-4**
CLIENT:	**Royal Roads University**	**DATE:**	**30-Jun-2000**
CLIENT NO.:	**9919**		
SAMPLE TYPE:	**Water**	**METHOD NO.:**	**CL-W-04/Ver.2**
SAMPLE SIZE:	**1.00 L**	**INSTRUMENT:**	**GC-MS**
		RUNFILE ID:	**CL095552.D**
		CONCENTRATION IN:	**ng/L**

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.26
p,p'-DDE	ND	0.23
o,p'-DDD	NDR 0.28	0.27
p,p'-DDD	ND	0.30
o,p'-DDT	ND	0.35
p,p'-DDT	ND	0.41

Surrogate Standards	% Recovery
13C-p,p'-DDE	100
13C-p,p'-DDT	87
13C-PCB 101	90

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D:	**PEEL W-3**	**AXYS ID:**	**L2553-3**
CLIENT:	**Royal Roads University**	**DATE:**	**30-Jun-2000**
CLIENT NO.:	**9919**		
SAMPLE TYPE:	**Water**	**METHOD NO.:**	**CL-W-04/Ver.2**
SAMPLE SIZE:	**1.00 L**	**INSTRUMENT:**	**GC-MS**
		RUNFILE ID:	**CL095668.D**
		CONCENTRATION IN:	**ng/L**

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.19
p,p'-DDE	0.42	0.16
o,p'-DDD	ND	0.13
p,p'-DDD	ND	0.14
o,p'-DDT	ND	0.11
p,p'-DDT	ND	0.13

Surrogate Standards	% Recovery
13C-p,p'-DDE	99
13C-p,p'-DDT	100
13C-PCB 101	95

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D:	**PEEL W-5**	**AXYS ID:**	**L2553-5**
CLIENT:	**Royal Roads University**	**DATE:**	**30-Jun-2000**
CLIENT NO.:	**9919**		
SAMPLE TYPE:	**Water**	**METHOD NO.:**	**CL-W-04/Ver.2**
SAMPLE SIZE:	**1.00 L**	**INSTRUMENT:**	**GC-MS**
		RUNFILE ID:	**CL095669.D**
		CONCENTRATION IN:	**ng/L**

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.084
p,p'-DDE	0.61	0.073
o,p'-DDD	NDR 0.41	0.22
p,p'-DDD	ND	0.23
o,p'-DDT	ND	0.23
p,p'-DDT	ND	0.27

Surrogate Standards	% Recovery
13C-p,p'-DDE	100
13C-p,p'-DDT	100
13C-PCB 101	94

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

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Approved

APPENDIX B4:
ASL LABORATORY REPORT FOR SWEP/LEP ANALYSIS

1988 Triumph Street, Vancouver, BC Canada V5L 1K5

analytical
service
laboratories
ltd.

FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date: August 15, 2000

ASL File No. L6581a

Report On: Peel River Soil Analysis

Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2

Attention: **Dr. Matthew Dodd**, Professor

Received: April 27, 2000

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Frederick Chen, B.Sc. - Manager, Special Projects
Miles Gropen, B.Sc. - Project Chemist

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581a

Sample ID		TH1-1	TH1-1 SWEP	TH4-3	TH4-3 SWEP	TH7-4
Sample Date		00 04 16	00 04 16	00 04 17	00 04 17	00 04 18
Sample Time		14:30	14:30	13:15	13:15	11:00
Physical Tests						
Moisture	%	11.6	10.5	16.7	16.7	14.5
pH		8.13	-	-	-	7.86
Initial SWEP pH		-	8.91	-	8.73	-
Final SWEP pH		-	5.46	-	5.59	-
Total Metals						
Antimony	T-Sb	<20	-	-	-	<20
Arsenic	T-As	12	-	-	-	13
Barium	T-Ba	407	-	-	-	577
Beryllium	T-Be	0.7	-	-	-	0.7
Cadmium	T-Cd	1.2	-	-	-	0.6
Chromium	T-Cr	37	-	-	-	35
Cobalt	T-Co	8	-	-	-	8
Copper	T-Cu	32	-	-	-	44
Lead	T-Pb	<50	-	-	-	140
Mercury	T-Hg	0.060	-	-	-	0.052
Molybdenum	T-Mo	<4	-	-	-	<4
Nickel	T-Ni	29	-	-	-	28
Selenium	T-Se	<2	-	-	-	<2
Silver	T-Ag	<2	-	-	-	<2
Thallium	T-Tl	<2	-	-	-	<2
Tin	T-Sn	<10	-	-	-	<10
Vanadium	T-V	106	-	-	-	116
Zinc	T-Zn	104	-	-	-	109
Extractable Metals						
Arsenic	As	-	<0.2	-	-	-
Barium	Ba	-	0.80	-	-	-
Boron	B	-	<0.1	-	-	-
Cadmium	Cd	-	<0.01	-	-	-
Chromium	Cr	-	<0.01	-	-	-
Copper	Cu	-	<0.01	-	-	-
Lead	Pb	-	<0.05	-	-	-
Mercury	Hg	-	<0.00005	-	-	-
Selenium	Se	-	<0.2	-	-	-
Silver	Ag	-	<0.01	-	-	-
Uranium	U	-	<0.5	-	-	-
Zinc	Zn	-	0.06	-	-	-

Results are expressed as milligrams per dry kilogram except where noted.
SWEP results are expressed as milligrams per litre.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581a

Sample ID		TH7-4 SWEP	TH19-2	TH19-2 SWEP	TH26-1	TH26-1 SWEP
Sample Date		00 04 18	00 04 20	00 04 20	00 04 22	00 04 22
Sample Time		11:00	18:10	18:10	15:20	15:20
Physical Tests						
Moisture	%	16.0	13.6	32.1	71.2	71.4
pH		-	-	-	8.97	-
Initial SWEP pH		8.80	-	9.90	-	9.72
Final SWEP pH		5.46	-	5.59	-	5.85
Total Metals						
Antimony	T-Sb	-	-	-	<20	-
Arsenic	T-As	-	-	-	<5	-
Barium	T-Ba	-	-	-	2070	-
Beryllium	T-Be	-	-	-	0.7	-
Cadmium	T-Cd	-	-	-	<0.5	-
Chromium	T-Cr	-	-	-	20	-
Cobalt	T-Co	-	-	-	2	-
Copper	T-Cu	-	-	-	10	-
Lead	T-Pb	-	-	-	73	-
Mercury	T-Hg	-	-	-	0.030	-
Molybdenum	T-Mo	-	-	-	<4	-
Nickel	T-Ni	-	-	-	7	-
Selenium	T-Se	-	-	-	<2	-
Silver	T-Ag	-	-	-	<2	-
Thallium	T-Tl	-	-	-	<2	-
Tin	T-Sn	-	-	-	<10	-
Vanadium	T-V	-	-	-	34	-
Zinc	T-Zn	-	-	-	35	-
Extractable Metals						
Arsenic	As	<0.2	-	-	-	<1
Barium	Ba	0.73	-	-	-	9.9
Boron	B	<0.1	-	-	-	<0.5
Cadmium	Cd	<0.01	-	-	-	<0.05
Chromium	Cr	<0.01	-	-	-	<0.05
Copper	Cu	<0.01	-	-	-	<0.05
Lead	Pb	<0.05	-	-	-	<0.3
Mercury	Hg	<0.00005	-	-	-	<0.00005
Selenium	Se	<0.2	-	-	-	<1
Silver	Ag	<0.01	-	-	-	<0.05
Uranium	U	<0.5	-	-	-	<3
Zinc	Zn	0.11	-	-	-	<0.3

Results are expressed as milligrams per dry kilogram except where noted.
SWEP results are expressed as milligrams per litre.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581a

Sample ID		TH27-3	TH27-3 SWEP	TH29-2	TH29-2 SWEP	TH31-1
Sample Date		00 04 22	00 04 22	00 04 22	00 04 22	00 04 22
Sample Time		16:00	16:00	16:45	16:45	17:00
Physical Tests						
Moisture	%	27.8	31.1	55.8	54.6	26.5
pH		9.09	-	9.98	-	7.97
Initial SWEP pH		-	9.83	-	9.93	-
Final SWEP pH		-	5.27	-	5.51	-
Total Metals						
Antimony	T-Sb	<20	-	<20	-	<20
Arsenic	T-As	<5	-	<5	-	15
Barium	T-Ba	169	-	3510	-	507
Beryllium	T-Be	<0.5	-	1.6	-	0.8
Cadmium	T-Cd	<0.5	-	<0.5	-	0.6
Chromium	T-Cr	12	-	6	-	34
Cobalt	T-Co	4	-	<2	-	9
Copper	T-Cu	15	-	3	-	26
Lead	T-Pb	<50	-	<50	-	<50
Mercury	T-Hg	0.015	-	0.019	-	0.059
Molybdenum	T-Mo	<4	-	<4	-	<4
Nickel	T-Ni	10	-	<5	-	32
Selenium	T-Se	<2	-	<2	-	<2
Silver	T-Ag	<2	-	<2	-	<2
Thallium	T-Tl	<2	-	<2	-	<2
Tin	T-Sn	<10	-	<10	-	<10
Vanadium	T-V	28	-	11	-	112
Zinc	T-Zn	32	-	41	-	119
Extractable Metals						
Arsenic	As	-	-	-	<0.2	-
Barium	Ba	-	-	-	68.3	-
Boron	B	-	-	-	<0.1	-
Cadmium	Cd	-	-	-	<0.01	-
Chromium	Cr	-	-	-	<0.01	-
Copper	Cu	-	-	-	<0.01	-
Lead	Pb	-	-	-	<0.05	-
Mercury	Hg	-	-	-	<0.00005	-
Selenium	Se	-	-	-	<0.2	-
Silver	Ag	-	-	-	<0.01	-
Uranium	U	-	-	-	<0.5	-
Zinc	Zn	-	-	-	<0.05	-

Results are expressed as milligrams per dry kilogram except where noted.
SWEP results are expressed as milligrams per litre.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil

File No. L6581a

Sample ID		TH31-1 SWEP
Sample Date		00 04 22
Sample Time		17:00
Physical Tests		
Moisture	%	13.2
Initial SWEP pH		8.76
Final SWEP pH		6.34
Extractable Metals		
Arsenic	As	<0.2
Barium	Ba	0.42
Boron	B	<0.1
Cadmium	Cd	<0.01
Chromium	Cr	<0.01
Copper	Cu	<0.01
Lead	Pb	<0.05
Mercury	Hg	<0.00005
Selenium	Se	<0.2
Silver	Ag	<0.01
Uranium	U	<0.5
Zinc	Zn	<0.05

Results are expressed as milligrams per dry kilogram except where noted.
SWEP results are expressed as milligrams per litre.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sample ID	TH4-3	TH19-2	TH27-3	TH29-2
Sample Date	00 04 17	00 04 20	00 04 22	00 04 22
Sample Time	13:15	18:10	16:00	16:45
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	-	-	-	<0.01
Acenaphthylene	-	-	-	<0.01
Anthracene	-	-	-	<0.01
Benz(a)anthracene	-	-	-	<0.01
Benzo(a)pyrene	-	-	-	<0.01
Benzo(b)fluoranthene	-	-	-	<0.01
Benzo(g,h,i)perylene	-	-	-	<0.01
Benzo(k)fluoranthene	-	-	-	<0.01
Chrysene	-	-	-	<0.01
Dibenz(a,h)anthracene	-	-	-	<0.01
Fluoranthene	-	-	-	<0.01
Fluorene	-	-	-	0.01
Indeno(1,2,3-c,d)pyrene	-	-	-	<0.01
Naphthalene	-	-	-	0.04
Phenanthrene	-	-	-	0.04
Pyrene	-	-	-	<0.01
Extractable Hydrocarbons				
EPH10-19	-	-	-	<400
EPH19-32	-	-	-	<400
LEPH	-	-	-	<400
HEPH	-	-	-	<400
Polychlorinated Biphenyls				
Total Polychlorinated Biphenyls	<0.05	<0.05	<0.05	-

Results are expressed as milligrams per dry kilogram except where noted.
SWEP results are expressed as milligrams per litre.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

RESULTS OF ANALYSIS - Sediment/Soil File No. L6581a

Sample ID	TH4-3	TH7-4	TH19-2	TH26-1	TH27-3
Sample Date	00 04 17	00 04 18	00 04 20	00 04 22	00 04 22
Sample Time	13:15	11:00	18:10	15:20	16:00
Organochlorine Pesticides					
Aldrin	<0.001	<0.001	<0.01	<0.001	<0.005
alpha-BHC	<0.001	<0.001	<0.01	<0.001	<0.005
beta-BHC	<0.002	<0.002	<0.01	<0.002	<0.005
delta-BHC	<0.001	<0.001	<0.01	<0.001	<0.005
cis-Chlordane (alpha)	<0.002	<0.001	<0.01	<0.001	<0.005
trans-Chlordane (gamma)	<0.001	<0.001	<0.01	<0.001	<0.005
2,4'-DDD	0.068	0.115	0.719	0.557	3.17
4,4'-DDD	0.140	0.113	2.31	0.796	6.67
2,4'-DDE	0.021	0.013	0.013	0.321	0.041
4,4'-DDE	0.079	0.085	0.086	1.99	0.173
2,4'-DDT	1.04	0.257	4.94	1.36	8.68
4,4'-DDT	3.52	0.269	22.4	7.49	32.9
Dieldrin	<0.001	<0.001	<0.01	<0.001	<0.005
Endosulfan I	<0.001	<0.001	<0.01	<0.001	<0.005
Endosulfan II	<0.005	<0.001	<0.01	<0.001	<0.005
Endosulfan Sulfate	<0.001	<0.001	<0.01	<0.001	<0.005
Endrin	<0.005	<0.005	<0.01	<0.005	<0.005
Endrin Aldehyde	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.002	<0.002	<0.01	<0.002	<0.005
Heptachlor Epoxide	<0.001	<0.001	<0.01	<0.001	<0.005
Lindane (gamma - BHC)	<0.001	<0.001	<0.01	<0.001	<0.005
Methoxychlor	<0.005	<0.005	<0.01	<0.005	<0.005
Mirex	<0.001	<0.001	<0.01	<0.001	<0.005
cis-Nonachlor	<0.001	<0.001	<0.01	<0.001	<0.005
trans-Nonachlor	<0.001	<0.001	<0.01	<0.001	<0.005

Results are expressed as milligrams per dry kilogram except where noted.
SWEP results are expressed as milligrams per litre.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Sample ID	TH29-2
Sample Date	00 04 22
Sample Time	16:45

Organochlorine Pesticides

Aldrin	<0.001
alpha-BHC	<0.001
beta-BHC	<0.002
delta-BHC	<0.001
cis-Chlordane (alpha)	<0.001
trans-Chlordane (gamma)	<0.001
2,4'-DDD	0.018
4,4'-DDD	0.063
2,4'-DDE	<0.002
4,4'-DDE	0.005
2,4'-DDT	0.009
4,4'-DDT	0.085
Dieldrin	<0.001
Endosulfan I	<0.001
Endosulfan II	<0.001
Endosulfan Sulfate	<0.001
Endrin	<0.005
Endrin Aldehyde	<0.01
Heptachlor	<0.002
Heptachlor Epoxide	<0.001
Lindane (gamma - BHC)	<0.001
Methoxychlor	<0.005
Mirex	<0.001
cis-Nonachlor	<0.001
trans-Nonachlor	<0.001

Results are expressed as milligrams per dry kilogram except where noted.
SWEP results are expressed as milligrams per litre.
< = Less than the detection limit indicated.
LEPH & HEPH = Light and Heavy Extractable Petroleum Hydrocarbons.

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Moisture in Sediment/Soil

This analysis is carried out gravimetrically by drying the sample at 103 C for a minimum of six hours.

Recommended Holding Time:

Sample:	14 days
Reference:	Puget
For more detail see:	ASL "Collection & Sampling Guide"

pH in Soil

This analysis is carried out in accordance with procedures described in "Soil Sampling and Methods of Analysis" (CSSS). The procedure involves mixing the air-dried sample with deionized/distilled water. The pH of the solution is then measured using a standard pH probe. A one to two ratio of sediment to water is used for mineral soils and a one to ten ratio is used for highly organic soils.

Special Waste/Leachate Extraction Procedure (SWEP/LEP) for Metals

This analysis is carried out in accordance with the extraction procedure outlined in the Waste Management Act, British Columbia Special Waste Regulation - Schedule Reg. 63/88, February 29, 1988. In summary the sample is extracted for a 24 hour period using 0.5 N acetic acid to maintain the pH of the extract at 5.0. The resulting extract is then filtered through a 0.45 micron membrane filter and analysed by atomic absorption spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B & APHA 3120), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020 & APHA Method 3125).

Recommended Holding Time:

Sample:	6 months (Mercury = 28 days)
Extract:	6 months (Mercury = 28 days)
Reference:	EPA
For more detail see:	ASL "Collection & Sampling Guide"

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050B or Method 3051, published by the United States Environmental Protection Agency (EPA). The sample is manually homogenized and a representative subsample of the wet material is weighed. The sample is then digested by either hotplate or microwave oven using a 1:1 ratio of nitric acid and hydrochloric acid. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000 series) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

Recommended Holding Time:

Sample/Extract:	6 months (Mercury = 28 days)
Reference:	EPA
For more detail see:	ASL "Collection & Sampling Guide"

Polycyclic Aromatic Hydrocarbons in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3545, 3630 & 8270, published by the United States Environmental Protection Agency (EPA). The procedure uses an automated system (Accelerated Solvent Extractor - ASE) to extract a subsample of the sediment/soil with a 1:1 mixture of hexane and acetone. The extract is then solvent exchanged to toluene and undergoes a silica gel clean-up to remove sample components that could potentially interfere with the analysis. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection (GC/MS).

Recommended Holding Time:

Sample: 14 days Extract: 40 days
Reference: EPA
For more detail see ASL "Collection & Sampling Guide"

Extractable Hydrocarbons in Sediment/Soil

This analysis is carried out in accordance with the British Columbia Ministry of Environment, Lands and Parks (BCMELP) Analytical Method for Contaminated Sites "Extractable Petroleum Hydrocarbons in Solids by GC/FID, Version 2.1 July 1999". The procedure uses an automated system (Accelerated Solvent Extractor - ASE) to extract a subsample of the sediment/soil with a 1:1 mixture of hexane and acetone at high temperature and pressure. The extract is then solvent exchanged to toluene and analysed by capillary column gas chromatography with flame ionization detection (GC/FID). EPH results include Polycyclic Aromatic Hydrocarbons (PAH) and are therefore not equivalent to Light and Heavy Extractable Petroleum Hydrocarbons (LEPH/HEPH).

Recommended Holding Time:
Sample: 14 days Extract: 40 days
Reference: BCMELP
For more detail see ASL "Collection & Sampling Guide"

Light and Heavy Extractable Petroleum Hydrocarbons in Solids

These results are determined according to the British Columbia Ministry of Environment, Lands, and Parks Analytical Method for Contaminated Sites "Calculation of Light and Heavy Extractable Petroleum Hydrocarbons in Solids or Water". According to this method, LEPH and HEPH are calculated by subtracting selected Polycyclic Aromatic Hydrocarbon results from Extractable Petroleum Hydrocarbon results. To calculate LEPH, the individual results for Naphthalene and Phenanthrene are subtracted from EPH(C10-19). To calculate HEPH, the individual results for Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenz(a,h)anthracene, Indeno(1,2,3-c,d)pyrene, and Pyrene are subtracted from EPH(C19-32). Analysis of Extractable Petroleum Hydrocarbons adheres to all prescribed elements of the BCMELP method "Extractable Petroleum Hydrocarbons in Solids by GC/FID" (Version 2.1, July 20, 1999).

Recommended Holding Time: Not Applicable

Organochlorine Pesticides and Polychlorinated Biphenyls in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3540, 3610, 3630, 3660, 8081 & 8082, published by the United States Environmental Protection Agency

(EPA). The procedure involves a dichloromethane soxhlet extraction of a subsample of the sediment/soil which has been dried with anhydrous sodium sulphate. The extract is then solvent exchanged to hexane followed by one or more of the following clean-up procedures (if required): alumina clean-up, silica gel clean-up and/or sulphur clean-up. The final extract is analysed by capillary column gas chromatography with electron capture detection (GC/ECD).

Recommended Holding Time:
Sample: 14 days Extract: 40 days
Reference: EPA
For more detail see ASL "Collection & Sampling Guide"

Organochlorine Pesticides in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3540, 3610, 3630, 3660 & 8081, published by the United States Environmental Protection Agency (EPA). The procedure involves a soxhlet extraction of a subsample of the sediment/soil with dichloromethane. The extract is then solvent exchanged to hexane followed by one or more of the following clean-up procedures (if required): alumina clean-up, silica gel clean-up and/or sulphur clean-up. The final extract is analysed by dual capillary column gas chromatography with electron capture detection (GC/ECD).

Recommended Holding Time:
Sample: 14 days Extract: 40 days
Reference: EPA
For more detail see ASL "Collection & Sampling Guide"

End of Report

1988 Triumph Street, Vancouver, BC Canada V5L 1K5

analytical
service
laboratories
ltd.

FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date: December 13, 2000

ASL File No. M4040

Report On: Peel River Soil Analysis

Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2

Attention: **Dr. Matthew Dodd**, Professor

Received: November 2, 2000

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Frederick Chen, B.Sc. - Manager, Special Projects
Brent Makelki, B.Sc. - Manager, Client Services

REMARKS File No. M4040

Please note that the detection limits for some of the organochloride pesticide compounds were increased because of limited sample quantities available for analysis. Note that these samples were initially analyzed and reported in ASL File L6581 in May 2000.

RESULTS OF ANALYSIS - Sediment/Soil File No. M4040

Sample ID	TH4-3	TH7-4	TH19-2	TH16-3	TH26-1
Physical Tests					
Moisture %	16.4	12.5	31.7	42.1	60.4
Initial SWEP pH	8.15	8.50	9.35	8.36	8.89
Final SWEP pH	5.44	5.42	5.41	5.46	5.32
Organochlorine Pesticides					
2,4'-DDD	<0.0001	<0.0001	<0.0002	<0.0001	<0.0006
4,4'-DDD	<0.00005	<0.00005	<0.0001	<0.00005	<0.0003
2,4'-DDE	<0.0001	<0.0001	<0.0002	<0.0001	<0.0006
4,4'-DDE	<0.00005	<0.00005	<0.0001	<0.00005	<0.0003
2,4'-DDT	<0.0001	<0.0001	<0.0002	<0.0001	<0.0006
4,4'-DDT	<0.0001	<0.0001	<0.0002	<0.0001	<0.0006

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre, as per the requirements of the Special Waste Regulations, B.C. Reg.63/88.
< = Less than the detection limit indicated.

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Special Waste/Leachate Extraction Procedure for Organic Parameters

This analysis is carried out in accordance with the extraction procedure outlined in the Waste Management Act, British Columbia Special Waste Regulation - Schedule 4, BC Reg. 63/88, February 29, 1988. In summary, the sample is extracted for a 24 hour period using 0.5 N acetic acid to maintain the pH of the extract at 5.0. The resulting extract is then filtered through a 0.45 micron membrane filter and analysed using the appropriate organic water procedure.

Special Waste/Leachate Extraction Procedure (SWEP/LEP) for Metals

This analysis is carried out in accordance with the extraction procedure outlined in the Waste Management Act, British Columbia Special Waste Regulation - Schedule Reg. 63/88, February 29, 1988. In summary the sample is extracted for a 24 hour period using 0.5 N acetic acid to maintain the pH of the extract at 5.0. The resulting extract is then filtered through a 0.45 micron membrane filter and analysed by atomic absorption spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B & APHA 3120), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020 & APHA Method 3125).

Recommended Holding Time:

Sample:	6 months (Mercury = 28 days)
Extract:	6 months (Mercury = 28 days)
Reference:	EPA
For more detail see:	ASL "Collection & Sampling Guide"

Organochlorine Pesticides in Water (GC/ECD)

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Methods 3510, 3610, 3630, 3660 & 8081, published by the United States Environmental Protection Agency (EPA). The procedure involves extraction of the entire water sample with dichloromethane. The extract is then solvent exchanged to hexane followed by one or more of the following clean-up procedures (if required): alumina clean-up, silica gel clean-up and/or sulphur clean-up. The final extract is analysed by dual capillary column gas chromatography with electron capture detection (GC/ECD).

Recommended Holding Time:
Sample: 7 days Extract: 40 days
Reference: EPA
For more detail see ASL "Collection & Sampling Guide"

End of Report