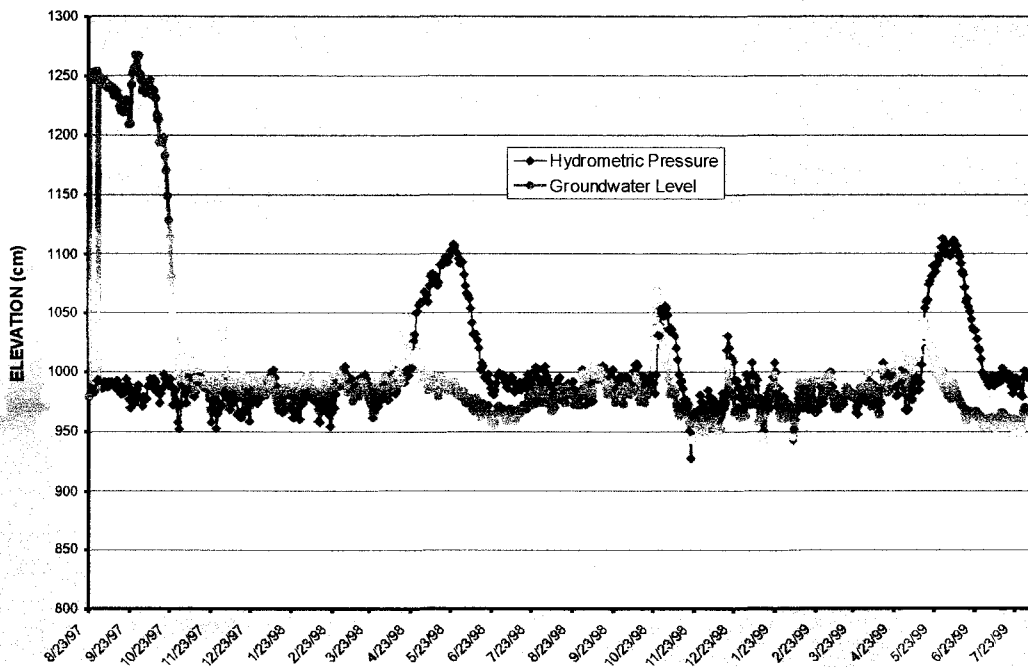


BORDER PUMP STATION AND RAINY HOLLOW, B.C., CANADA: 1999 ANNUAL MONITORING PROGRAM



Prepared for:
**INDIAN AND NORTHERN AFFAIRS, CANADA
WASTE MANAGEMENT PROGRAM
YUKON REGION**

Prepared by:



Applied Research Division

March 2000

**BORDER PUMP STATION AND RAINY HOLLOW,
BRITISH COLUMBIA, CANADA:
1999 ANNUAL MONITORING PROGRAM**

Prepared for:

Indian and Northern Affairs Canada
Waste Management Program, Whitehorse, Yukon

By:

Royal Roads University – *Applied Research Division*

March 2000

EXECUTIVE SUMMARY

Border Station and Rainy Hollow are adjacent sites located in Northern British Columbia. These sites were previously constructed and operated as the first of several 'booster' pumping stations along the Haines-Fairbanks Pipeline (Border Station), or were used for supporting operations in the case of Rainy Hollow. They were operated from the mid-1950s to 1972. Following the discovery of DDT containing canisters buried in a dump at Rainy Hollow, a preliminary site investigation was conducted in 1994. This investigation indicated that hydrocarbons and DDTs (sum of all the isomers p,p'-DDT, o,p'-DDT, p,p'-DDD, o,p'-DDD, p,p'-DDE, and o,p'-DDE) were present in soil and groundwater at Rainy Hollow. In the following summer, hydrocarbon contamination of subsurface soil and groundwater at the Border Station site was also identified in a study, which was part of preliminary environmental assessments along the Haines-Fairbanks Pipeline.

A detailed site investigation (DSI) and a screening-level risk assessment were conducted at both sites in 1996. These confirmed the presence of DDTs and hydrocarbon contamination in subsurface soils and groundwater at the sites. There was some evidence that both DDTs and hydrocarbons were being introduced to the Klehini River through the discharge of contaminated groundwater. Remedial activities were conducted in the summer of 1997, based on the results of detailed site investigation and recommendations derived from an ecological and human health risk assessment. A groundwater model, including a monitoring program, was developed. In order to validate the groundwater model and achieve the objectives outlined in the program, an annual monitoring program was initiated in 1997 and continued through 1999. The water level in one well was measured daily with a continuous recorder. Samples of groundwater and surface water were collected from Rainy Hollow and Border Station and analyzed for DDTs, metals and hydrocarbons. As a result, there is groundwater data for 1996 through 1998, with additional data collected in 1999 as described in this report.

The results of the 1999 monitoring program indicate a remarkable overall consistency in the concentrations of DDTs, hydrocarbons and metals in groundwater and surface water samples collected from Rainy Hollow and Border Station over the four year period (1996 to 1999). There has been no increase in the concentrations of the original contaminants of potential concern at the site since 1996, either in the groundwater entering the Klehini River, or in the river water collected adjacent to the site. This generally reaffirms the validity of the 1996 groundwater model predictions. This, along with the original risk assessment and subsequent risk management activities, leads to the conclusion that there remain no unacceptable risks to wildlife or humans at or near the site.

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1. INTRODUCTION

1.1 Overview

Border Station and Rainy Hollow are adjacent sites located in Northern British Columbia (Figure 1.1). These sites were previously constructed and operated as the first of several 'booster' pumping stations along the Haines Fairbanks Pipeline (Border Station), or were used for supporting operations in the case of Rainy Hollow. Preliminary environmental investigations conducted at these sites indicated that petroleum hydrocarbons and DDTs (sum of all the isomers p,p'-DDT, o,p'-DDT, p,p'-DDD, o,p'-DDD, p,p'-DDE, and o,p'-DDE) were present in soil and groundwater at Rainy Hollow (Golder, 1995; UMA, 1995; and Royal Roads, 1996a,b,c). A detailed site investigation (DSI) and screening-level risk assessment conducted at the sites in 1996 confirmed the presence of DDTs and hydrocarbon contamination in subsurface soils and groundwater at the sites. There was also some evidence of the migration of these contaminants into the adjacent Klehini River. The results of the risk assessment, however, suggested that the concentration of total DDTs and hydrocarbon in groundwater and at the outflow face into the Klehini River did not constitute an elevated risk to aquatic life. A conceptual model of contaminant transport was developed (Royal Roads, 1996), and a groundwater monitoring program established.

Based on the results and recommendations of the DSI, remedial activities were conducted in 1997 and 1998 (Royal Roads, 1998, 1999). The conceptual model for contaminant transport presented in the DSI report was also evaluated and expanded in 1997 (Woodbury, 1997). This program, which formed the basis of post-remediation monitoring, was generally intended to:

- Confirm the original predictions of the fate and concentrations of DDTs;
- Allow, if necessary, refinements to the model, thus ensuring the long-term validity of contaminant fate predictions;
- Permit further intervention at the site, including a possible re-evaluation of remedial/risk-management strategies, through comparison with pre-defined action triggers; and,
- Provide assurances that contaminants other than DDTs - including hydrocarbons and various metals – are not entering the Klehini River at potentially deleterious concentrations.

These objectives would be accomplished through measurement of groundwater levels and determination of the concentrations of DDTs, hydrocarbon and metals in a selected number of existing wells and mini-piezometers.

The program was initiated in 1997 and continued in 1998. Water level in one well was measured daily using a continuous recorder. Samples of groundwater and surface water were collected from Rainy Hollow and Border Station and analyzed for DDTs, metals and

hydrocarbons. As a result, there is good quality groundwater data for 1996 through 1998, with additional data collected in 1999 as described herein. The results of the annual monitoring program, up to the end of 1998, indicated that there had been no increase in the concentrations of the original contaminants of potential concern at the site since 1996. This included groundwater entering the Klehini River, as well as river water collected adjacent to the site (Royal Roads, 1999). A set of response triggers was recommended within the context of the original groundwater model used, as well as risk to the Klehini River ecosystem.

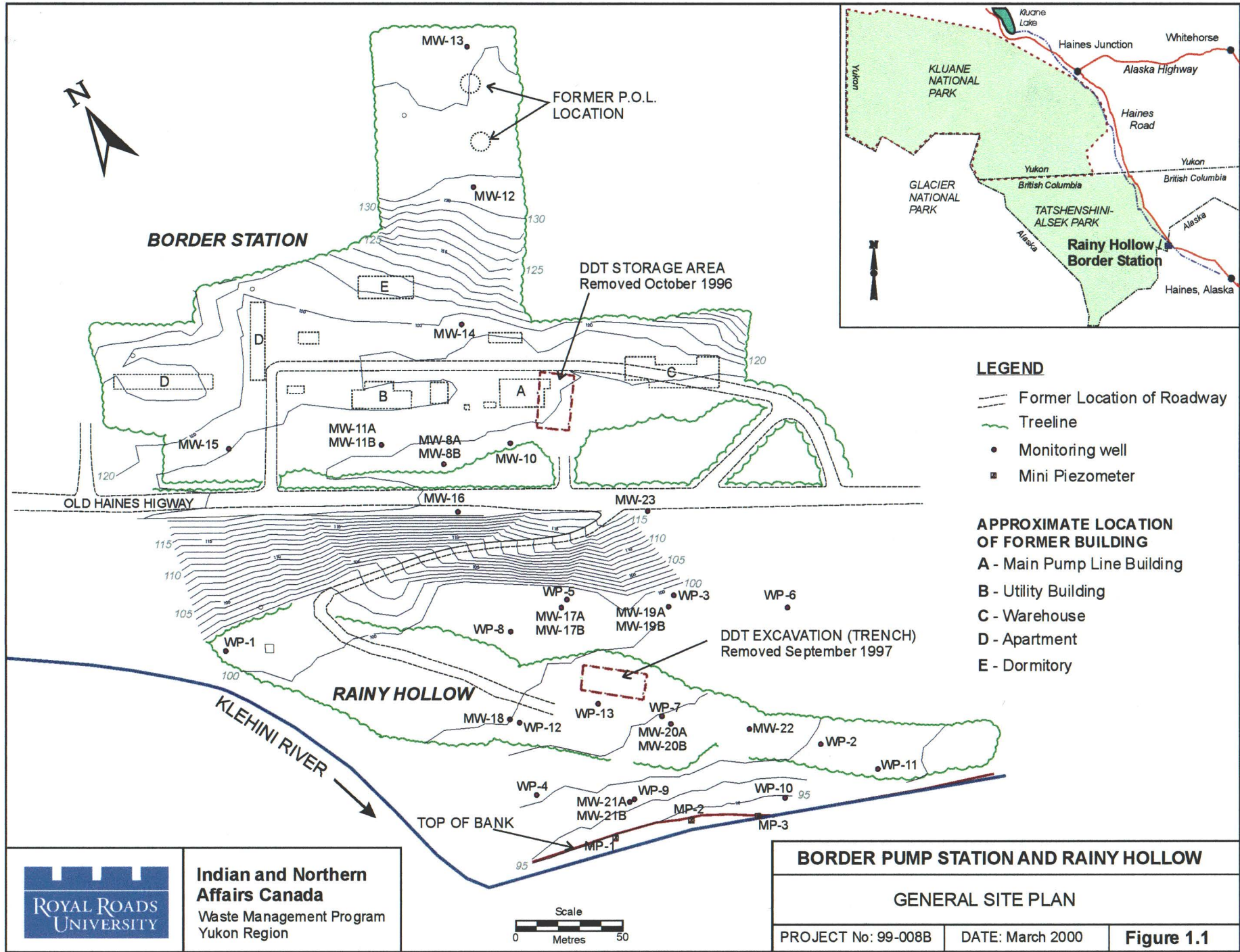
1.2 Objectives of the 1999 Monitoring Program

The main objectives, and associated tasking, of the 1999 Monitoring Program included:

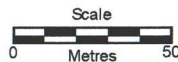
- Assessment of condition and vegetation re-establishment of encapsulated areas.
- Measurement of water levels and downloading of data from the Solinst Levellogger™.
- Determination of the concentrations of DDTs, volatile hydrocarbons, extractable hydrocarbons and dissolved metals in groundwater and surface water samples.
- Evaluation of the data obtained with respect to the validity of the groundwater conceptual model.

In order to achieve these objectives, a field sampling program was conducted on August 6 and 7, 1999. This was followed by laboratory analysis of the water samples collected for DDTs, metals and hydrocarbons.

This report presents the results of the 1999 monitoring program and incorporates the results and recommendations from the 1997 and 1998 monitoring studies.



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2. METHODS AND FIELD OBSERVATIONS

2.1 Field Program

The field sampling program was conducted on August 6 and 7, 1999. The field team comprised representatives from:

- Royal Roads University – Matt Dodd, Ph.D.;
- DIAND Waste Management, Whitehorse – Susanne Aichele; and,
- UMA Engineering, Winnipeg – Tom Wingrove, P.Eng.

Activities conducted by the field team included the collection of groundwater and surface water samples, retrieval of data from the Solinst Levelloggers™ and inspection of the gravel encapsulated areas for vegetation re-establishment.

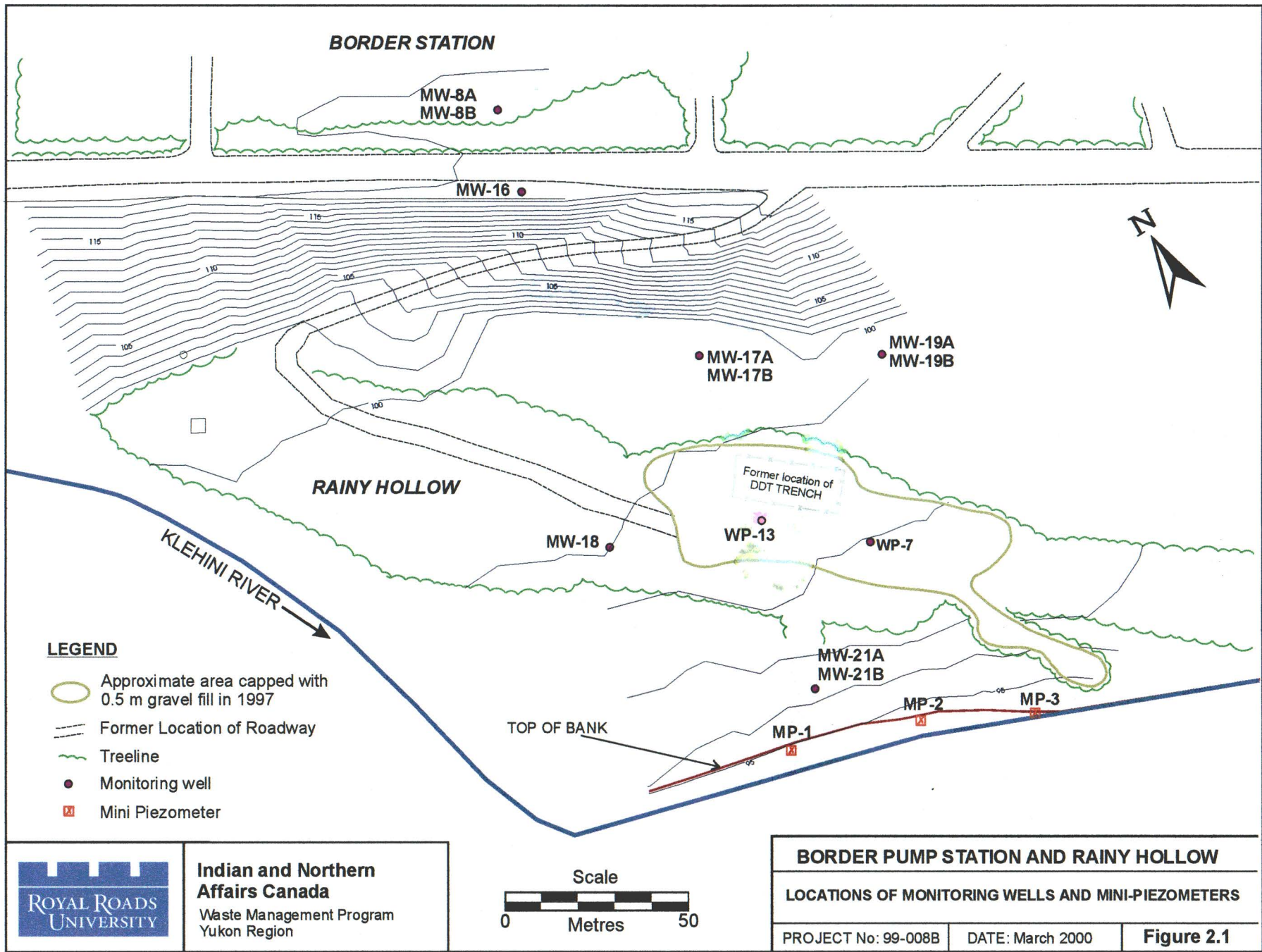
2.2 Sampling Locations

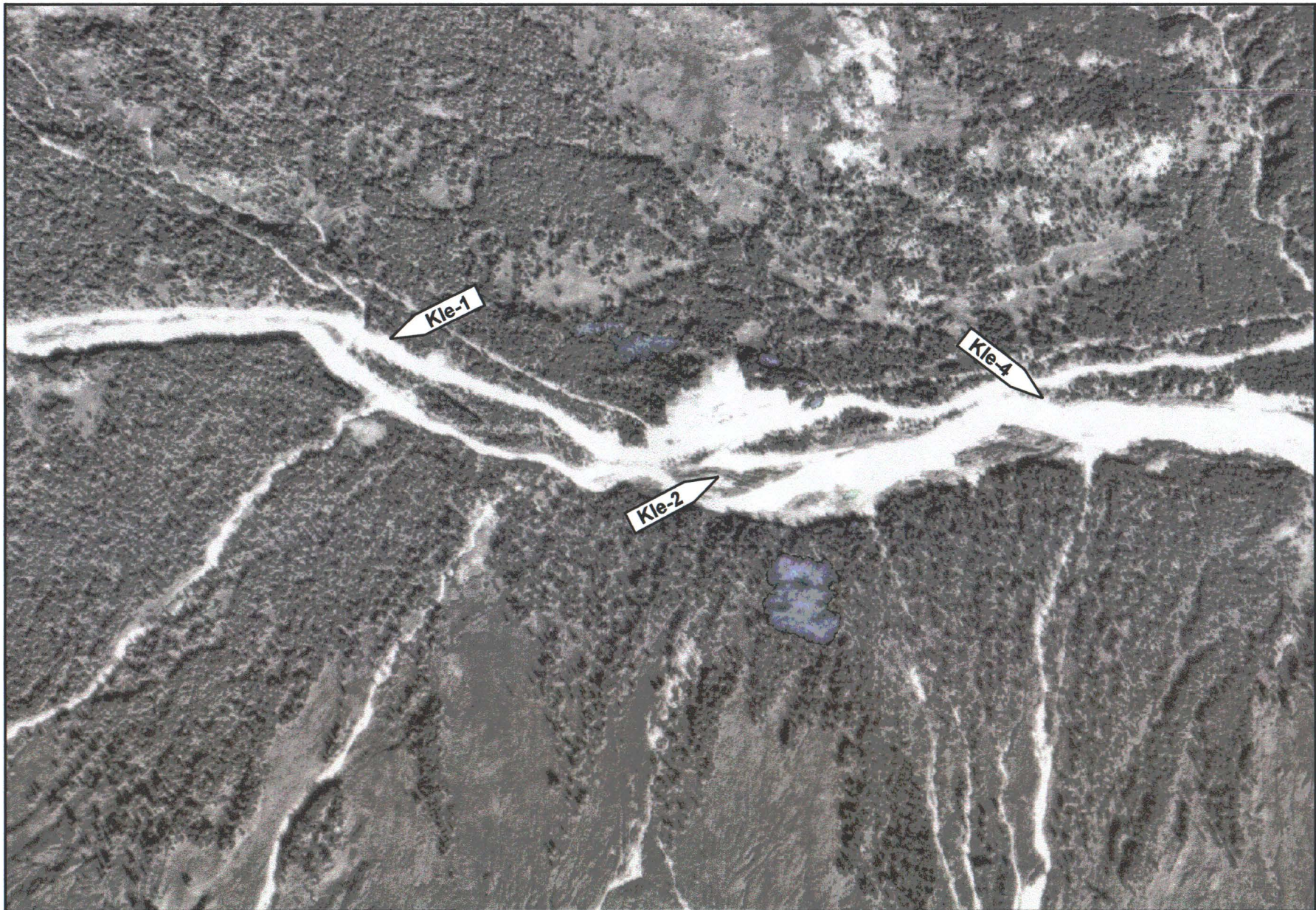
To achieve the objectives outlined above in Chapter 1, groundwater from monitoring wells and mini-piezometers was collected. The locations of the wells and mini-piezometers are presented in Figure 2.1; brief descriptions are given below:

- MW-8B and MW-16 – located on the upper bench, used to ascertain the migration of hydrocarbons towards Rainy Hollow;
- MW-17A&B – a set of nested wells situated along the groundwater flow path from the upper bench and up gradient from the DDT Trench at Rainy Hollow;
- WP-7, WP-13 and MW-21, – located down gradient from the Trench;
- MW-18 – not directly influenced by either the DDT Trench or hydrocarbon contamination from the upper bench and was, therefore, selected to provide data on the lower site background conditions; and,
- MP-1, MP-2 and MP-3, – represent the three mini-piezometers situated along the bank of the Klehini River.

Surface water samples were collected from three locations along the Klehini River (Figure 2.2) as follows:

- Kle-1 – Downstream of the confluence of Seltat Creek and Klehini River, at approximately 1.1 km north and upstream of Rainy Hollow;
- Kle-2 – Inside of gravel bar adjacent to mini-piezometer MP-2; and,
- Kle-4 – South of Rainy Hollow, at approximately 1 km downstream of the site.





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BORDER PUMP STATION AND RAINY HOLLOW

WATER SAMPLING LOCATIONS ALONG THE KLEHINI RIVER

PROJECT No: 99-008B

DATE: March 2000

Figure 2.2

2.3 Re-Vegetation on Capped Areas

Surface soils contaminated with DDTs at concentrations exceeding 10 mg/kg were excavated from the vicinities of the former Temporary Storage Facility and the trench, and disposed off-site during the 1997 site remediation activities (Royal Roads, 1998). This was to curtail the possible exposure pathways for DDTs in surface soils to wildlife and humans. The remaining contaminated soils with DDTs concentrations in the range of 1 to 10 mg/kg and hydrocarbon-contaminated soils with concentrations exceeding 1000 mg/kg were capped using a minimum of 0.5m of clean granular material. Vegetation re-establishments on these gravel-encapsulated areas were assessed by visual observation during the 1999 monitoring program. Representative photographs of the lower site (Rainy Hollow), the former Temporary Storage Area, and the former POL storage area are given in Appendix A. A map showing the encapsulated area (Figure 2.3) along with orientation of the photographs is included in the appendices.

2.4 Sampling Protocols

Analytical Services Laboratory (ASL) and Axys Analytical Laboratories (Axys) provided appropriate pre-cleaned sampling jars and preservatives.

The tops of the buried wells, which were up to 0.5 m below the surface, were located using a combination of reference maps and a metal detector. The wells were then excavated and opened. To prevent cross-contamination, disposable gloves were worn and changed after every sample.

The static water level in each well was measured using a Solinst™ water level meter equipped with an interface probe (Solinst Model No. 122). Each well was purged and sampled using the dedicated Waterra™ tubing and foot valve installed during the detailed site investigation. At least three well volumes of water were withdrawn from the well and discarded. Following this, an aliquot of the subsequent purge water was placed into a 50 mL disposable Evergreen™ polyethylene vial and the pH, conductivity and temperature of the purge water was measured. Purging was continued until three consecutive measurements of pH, temperature and conductivity were within ten percent. Electrical conductivity measurements were performed with a Cole Palmer conductivity meter (Model No. 1481-60), which was calibrated with a 1413 μS standard solution, while a Barnet pH meter (Model 30), calibrated with pH 7 and pH 4 standard solutions was used for the pH and temperature determinations. The pH, conductivity and thermal probes were rinsed with distilled water and wiped with Kimwipes™ after each determination. Static water levels, volumes of purge water, pH, temperature, conductivity and the samples collected were recorded on Groundwater Sampling Data Sheets, which are attached to this report as Appendix B.

Samples designated for DDT analyses were placed into 1 L amber glass jars while 500 mL amber glass jars were used for extractable hydrocarbons. These jars were capped with either Teflon or aluminum lined lids. For volatile organic compound analysis, an

aliquot of groundwater was placed into a 40 mL vial containing sulfuric acid as a preservative and sealed with a Teflon-lined septum lid.

Samples earmarked for dissolved metals analyses were field filtered using disposable in-line 700 cm² x 0.45 µm membrane filter (Gelman Sciences). The filtered sample was placed directly into a 250 mL plastic container and preserved with nitric acid.

Grab surface water samples from the Klehini River were collected directly into the appropriate sampling containers. The container was held at the base and the neck plunged below the surface (25 - 40 cm) and tilted such that the neck pointed to the water flow during filling.

All the labeled sample containers were placed into coolers and shipped to the analytical laboratory via Canadian Air Cargo. Chain of custody forms accompanied the shipment and these are attached to the laboratory reports in Appendix C.

2.5 Levelogger

Two Solinst M5 Leveloggers™ (Model No. 300, Serial No. 3312 and 3313) were installed in monitoring well MW-19B on 23 August 1997. One Levelogger was set below the water level to measure the depth of water in the well. The second Levelogger was placed in the borehole above the highest expected water level to measure barometric pressure. The two Leveloggers were set to record daily at 1200 hrs. Data from the Leveloggers were retrieved, and the Leveloggers were re-set in MW19B.

A second site visit was conducted on September 28, 1999 during which the Levelogger placed above the water level in MW-19B was retrieved and installed into MW-18.

2.6 Quality Assurance and Quality Control

A field QA/QC program, which incorporates measures to ensure the integrity of the groundwater samples collected, was utilized. The QA/QC program included:

- documentation of date, time, site identification, site conditions, sampling equipment, preservatives, etc.) on sampling sheets which will be attached to the report as an appendix;
- the use of dedicated sampling equipment for each well to avoid cross-contamination;
- thorough cleaning of all field instrumentation (pH meter, conductivity meter and water level meter) prior to sampling at each well and the use of disposable gloves;
- collection of a field duplicate from MP-2;
- chain-of-custody procedures; and,
- transportation under conditions that retain the sample integrity.

2.7 Laboratory Analysis

The samples were analyzed at Analytical Services Laboratory (ASL), Vancouver, BC and Axys Analytical Services (Axys), Sidney, BC. Both ASL and Axys have been evaluated and accredited by the Canadian Association for Environmental Laboratories (CAEL). A summary of the analytical program is given in Table 2.1.

In order to achieve detection limits of less than 0.01 µg/L in groundwater samples (British Columbia Contaminated Sites Regulation standard for the protection of aquatic life), analysis for DDT and its metabolites (DDD and DDE) were carried out by high-resolution gas chromatography/mass spectrometry at Axys. The targeted detection limit for each of the DDT, DDD and DDE isomers was 0.001 µg/L.

ASL conducted the analysis for dissolved metals, volatile petroleum hydrocarbons (VPH) including benzene, toluene, ethylbenzene and xylene (BTEX), and extractable petroleum hydrocarbons (EPH). Under both the Yukon and British Columbia Contaminated Sites Regulations, extractable hydrocarbons are classified into Light Extractable Petroleum Hydrocarbons (LEPH) and Heavy Extractable Petroleum Hydrocarbons (HEPH). The concentrations of LEPHs in a sample are obtained by initially quantifying extractable petroleum hydrocarbons (EPH) in the range C10 to C19. The concentrations of un-substituted PAHs that fall in this range are then obtained in a separate analysis and subtracted from the total EPH (C10 to C19) to arrive at concentrations for LEPHs. Similarly, HEPHs comprise the EPH fraction from C19 to C31, after subtracting concentrations of un-substituted PAHs that fall in this range. Results obtained to date for Rainy Hollow and Border Station Rainy Hollow indicate that un-substituted PAHs do not constitute a significant part of the EPH fraction (i.e., uniformly less than 1% of the EPH total concentration, or below detection). As such data for EPHs (C10 to C19) and LEPHs have been directly comparable. Corresponding results have also been obtained for EPHs (C19 to C31) and HEPHs. To this end, hydrocarbons in the C10 to C31 range were determined as EPH [(C10 to C19) and (C19 to C31)], rather than LEPH and HEPH during the 1999 monitoring programs.

Table 2.1: Summary of the Analytical Program

Parameter	DDT, DDD & DDE ¹	EPH ²	BTEX/VPH	Dissolved Metals
<i>Monitoring Wells</i>				
MW-16		1	1	
MW-17A	1	1	1	1
MW-17B	1	1	1	
MW-18	1	1	1	1
MW-21A	1	1	1	1
MW-21B	1	1	1	
WP-7	1	1	1	1
WP-13	1	1	1	1
<i>Mini-Piezometers</i>				
MP-1	1	1	1	1
MP-2	1	1	1	1
MP-2 (Field Duplicate)	1	1	1	1
MP-3	1	1	1	1
<i>Klehini River</i>				
Kle-1	1			1
Kle-2	1			1
Kle-4	1			1
Total	14	12	12	12

¹ Includes individual results for p,p'-DDT, o,p'-DDT, p,p'-DDD, o,p'-DDD, p,p'-DDE, o,p'-DDE.

² EPH: Extractable Petroleum Hydrocarbons (see text).

3. RESULTS AND DISCUSSION

3.1 Re-Vegetation on Capped Areas

Representative photographs of vegetation re-establishment on gravel-encapsulated areas are given in Appendix A. Small amounts of vegetation including fireweed, horsetail, grasses and sedges are beginning to establish on the gravel cap at Rainy Hollow (Appendix A: Photographs 1 to 5). The regeneration is more pronounced around the edges where less disturbance occurred and more shelter is provided. Some of the young trees which had begun to previously establish themselves at the site, primarily balsam poplar and willow, have become buried up to the crown level by the capping activities, giving them a bush-like appearance. The leaves of the trees were a healthy green (see Photograph 10), indicating they did not appear to be suffering any ill-effects from the capping. Monitoring of these trees should be continued.

Re-vegetation on the cap at the former Temporary Storage Facility on the Border Station site is relatively minimal (Photographs 6 to 8), by comparison. The area that showed the greatest vegetation growth was the access road constructed to the POL storage area on the upper bench. This road was almost covered with clover, chrysanthemum, grasses and sedges (Photograph 9). As with the Temporary Storage Area, re-vegetation at the former POL storage area (Photograph 10) and the local caps (Photographs 11 to 12) was minimal. This may be due to the fact that this upper area is higher, drier and more exposed than the Rainy Hollow site, and natural vegetation re-establishment would be subject to greater wind and dust erosion from the capping there. The lack of any topsoil, providing organic matter, nutrients and other eco-physiological advantages to plants (e.g., mycorrhizal associations), in the gravel cap will also probably prolong the period required for complete natural reclamation.

3.2 Groundwater Conditions

Groundwater levels measured in August 1999 are summarized in Table 3.2. Groundwater elevations measured in 1996 and 1998 are included in this table for comparison. Water levels were approximately 20 cm. higher than in 1998, but the slope of the water table, or horizontal gradient, remains relatively constant. Therefore the groundwater flux to the Klehini River is also unchanged.

Table 3.1: Groundwater Levels for Monitoring Wells Measured in August 1999

Well Number	Date/Time	Depth to Water Level from Top of Rim (m)	Depth to Bottom of Well from Top of Rim (m)	1999 Ground-water Elevation (m)	1998 Ground-water Elevation (m)	1996 Ground-water Elevation (m)
WP-7	Aug 6/10:50 PM	1.72	2.63	96.30	96.07	96.11
WP-13	Aug 6/9:00 AM	2.38	3.94	96.40	96.18	96.08
MW-16	Aug 6/4:20 PM	18.80	21.40	99.00	98.80	98.20
MW-17A	Aug 6/3:00 PM	1.63	5.68	97.42	97.28	97.39
MW-18	Aug 6/10:20 AM	1.88	7.39	96.32	96.10	96.30
MW19A	Aug 7/10:00 AM	2.02	-	96.19	95.95	96.22
MW-21A	Aug 6/11:15 AM	0.29	1.63	94.01	93.98	93.85
MW-21B	Aug 6/11:40 AM	0.26	6.87	93.72	93.67	93.87
MW-19A	Sept 28	1.72		96.49		
MW-18	Sept 28	1.857		96.34		

Data from the two Solinst Levelloggers™, which were retrieved on August 7, 1999, are presented graphically in Figure 3.1. The loggers appeared to be working well. Water levels typically fluctuate within about a 50 cm range, or elevation 95.8 m to 96.3 m seasonal spikes reach 96.8m. The short spikes in water level correlate to spring, where the snow pack melts into the overburden and recharges the water table. There also appeared to be occasional spikes in late fall that likely correlate to significant late season precipitation events.

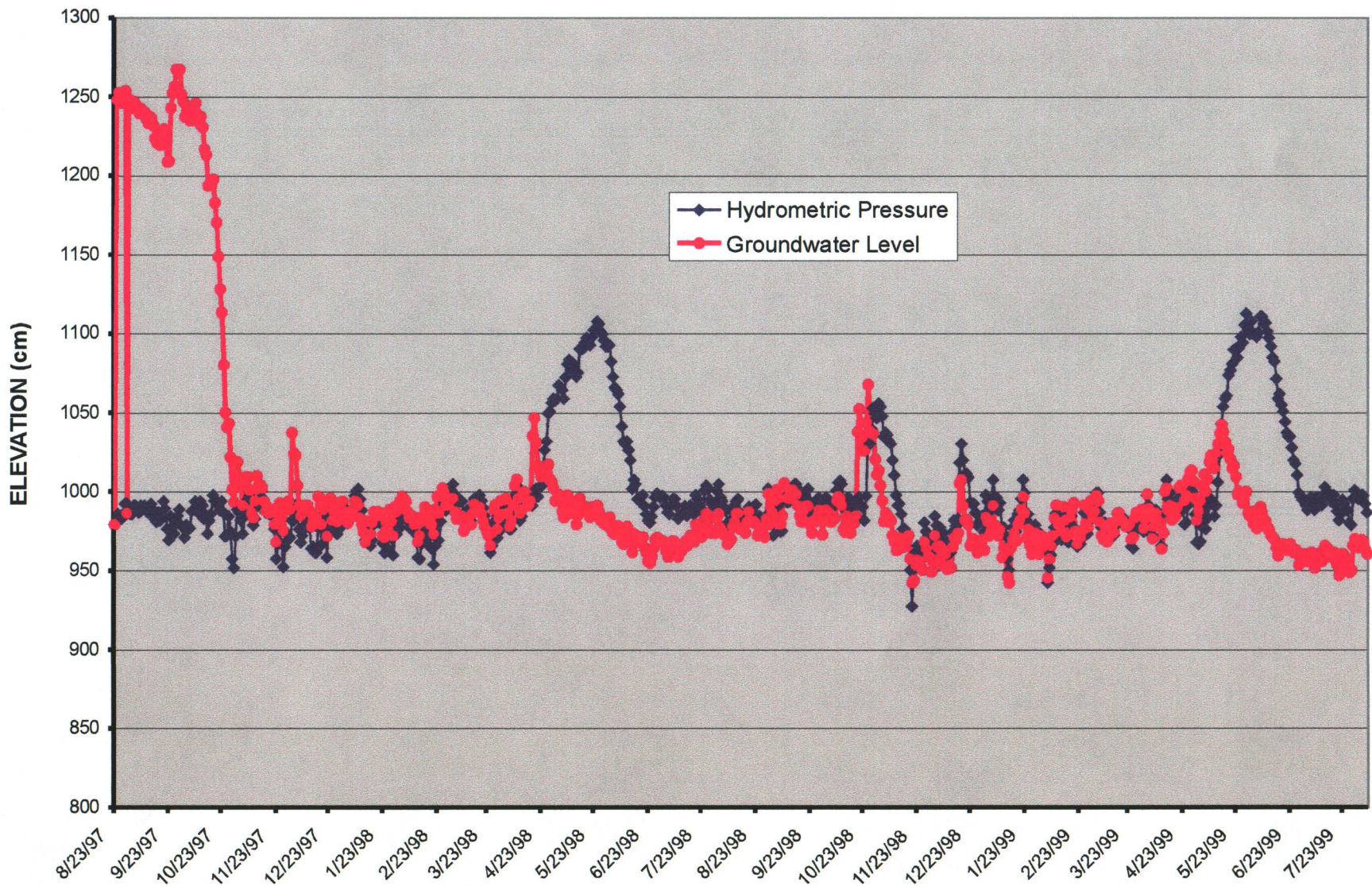


Figure 3.1: Rainy Hollow Groundwater Level and Hydrometric Pressure from August 1997 to 1999

3.3 Presentation of Analytical Results

Laboratory analytical results obtained are summarized in tables presented in this chapter. Complete laboratory reports, which contain analytical methods and QA/QC data, are given in Appendix B.

3.4 Evaluation of Analytical Results

Data obtained for groundwater samples were evaluated using generic numerical water standards presented in Schedule 6 of the 1997 BC Contaminated Sites Regulations (BC CSR). The standards for aquatic life (AW) were employed. For surface waters collected from the Klehini River, the CCME (Canadian Council of Ministers of the Environment) Canadian Environmental Quality Guidelines for Freshwater (CCME, 1999) were also used. Summaries of the standards and guidelines used are given in Table 3.2. The data was also evaluated with respect to the groundwater model.

Table 3.2: BC CSR Water Standards and CCME (1999) Canadian Environmental Quality Guidelines (in µg/L)

Parameter	BC CSR Aquatic Life Standard (AW) ¹	CCME Freshwater Aquatic Life	Parameter	BC CSR Aquatic Life Standard (AW) ¹	CCME Freshwater Aquatic Life
<i>Volatiles</i>			<i>Chlorinated Organic</i>		
Benzene	3000	370	DDTs	0.010	---
Ethylbenzene	7000	90	<i>General parameters</i>		
Toluene	3000	2.0	pH		6.5 to 9
Xylenes (total)	---	---	Conductivity		
<i>VH (C5-9)</i>			<i>Metals</i>		
VPH	15,000 ²	---	aluminum		5 to 100 ³
<i>Extractables</i>			antimony	300	---
EPH (C10-19)	5,000 ²	---	arsenic	500	5
EPH (C19-31)	---	---	barium	10,000	---
LEPH	500 ²	---	beryllium	53	---
HEPH	---	---	boron	---	---
<i>PAHs</i>			cadmium	2 – 18 ⁴	0.017
Acenaphthene	60	5.8	chromium	20	---
Acenaphthylene	---	---	cobalt	500	---
Acridine	0.5	4.4	copper	20 to 0 ⁴	2 to 4 ⁴
Anthracene	1	0.012	iron		300
Benz(a)anthracene	1	0.018	lead	40 to 160 ⁴	1 to 7 ⁴
Benzo(a)pyrene	0.1	0.015	manganese		---
Benzo(b)fluoranthene	---	---	mercury	1	0.1
Benzo(g,h,i)perylene	---	---	molybdenum	10,000	73
Benzo(k)fluoranthene	---	---	nickel	250 to 1,500	25 to 150 ⁴
Chrysene	---	---	selenium	10	1
Dibenz(a,h)anthracene	---	---	silver	1	0.1
Fluoranthene	2	0.04	thallium	3	0.8
Fluorene	120	3	Uranium	3,000	---
Indeno(1,2,3-c,d)pyrene	---	---	zinc	300	30 ⁵
Naphthalene	10	1.1			
Phenanthrene	3	0.4			
Pyrene	0.2	0.025			

Notes:

All values are in µ/L unless otherwise stated.

1. Aquatic life standards assume minimum 1:10 dilution
2. Values taken from BC CSR Amendments (BC MELP, 1999)
3. Guideline or standard varies with pH
4. Guideline or standard varies with water hardness
5. Tentative guideline because of insufficient evidence

3.5 DDTs

The concentrations of DDTs (sum of all DDT, DDD and DDE isomers analyzed) in the water samples collected in 1999 are given in Table 3.3. These results, along with data from the 1996 to 1998 monitoring program are presented graphically in Figure 3.2.

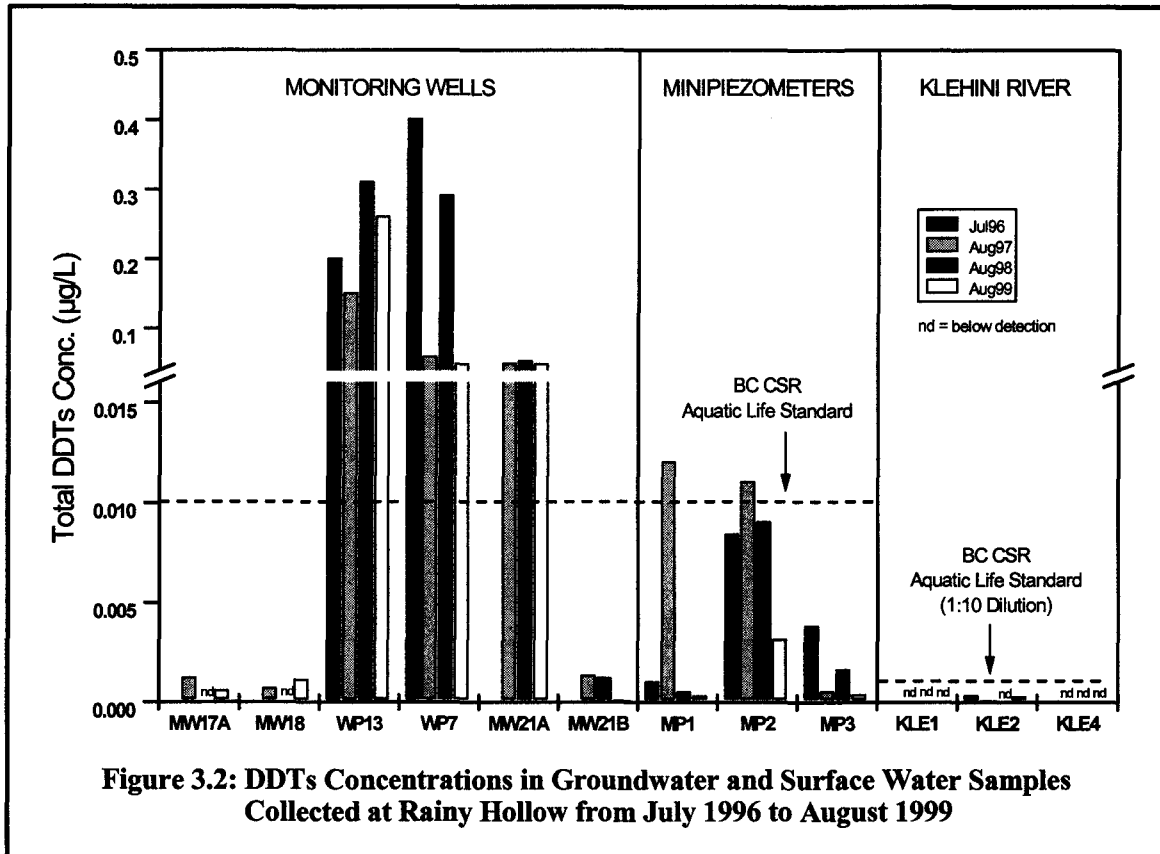


Figure 3.2: DDTs Concentrations in Groundwater and Surface Water Samples Collected at Rainy Hollow from July 1996 to August 1999

Detectable levels of DDTs (0.00054 and 0.00025 µg/L, respectively) were found in MW-17A and MW-17B. These are two nested wells located up gradient of the Trench where the DDT containing canisters were recovered in 1994. DDT concentrations in a sample from MW-18, which is located west of the Trench and is not directly influenced by contamination from either the Trench or the upper bench, was 0.0011 µg/L. As depicted in Figure 3.2, concentrations in these wells are generally comparable to those obtained over the previous monitoring period.

As in previous years, DDTs at concentrations exceeding the BC CSR aquatic life standard of 0.01 µg/L BC CSR were found in groundwater samples obtained from the two wells located immediately down gradient of the Trench (WP-7; 0.05 µg/L and WP-13; 0.26

µg/L). The principal isomer in both of these samples was p,p'-DDD, the initial degradation product of DDT by either hydrolysis or reductive dehalogenation. The levels in WP-13 were relatively uniform over the entire monitoring period whereas there was a slight inter-annual variation in DDT concentrations for WP-7. The 1999 data for WP-7 were, however, comparable to the 1997 result. The year-to-year variation for monitoring wells installed as part of the 1996 DSI (MW series) is generally less than for well points (WP-7 and WP-13) which were installed in test pits as a follow up to the 1995 emergency response.

Detectable concentrations of DDT were also found in the nested wells located along the groundwater migration pathway to the Klehini River. Comparable levels (0.049, 0.053 and 0.049 µg/L), which exceeded the BC CSR AW standard, were found in the shallow well (MW-21A: screen set at around 0.5 to 2 m below ground surface) in 1997, 1998 and 1999, respectively. The concentrations in the deeper well (MW-21B), with the screen set at approximately 2.5 to 5 m below the ground surface, were an order of magnitude lower (0.0013, 0.0012 and 0.0013 µg/L in 1997, 1998 and 1999, respectively).

Groundwater samples from the mini-piezometers in 1999 contained DDTs at concentrations that were below BC CSR AW standard of 0.010 µg/L. The highest concentration of 0.0031 µg/L was found in MP-2, which is directly along the groundwater migration pathway to the Klehini River. This concentration is lower compared to that predicted by the groundwater model (0.007 µg/L). No significant increase in DDTs concentration was noted in MP-2 over the four-year period, rather, there was a slight decrease in 1999. This is consistent with the groundwater model predictions provided previously: Temporal changes in DDT fluxes at the interface are predicted to occur relatively slowly, and a substantial short-term increase in DDT inputs to the river is not predicted to occur.

Apart from one anomalous data point of 0.012 µg/L obtained in 1997, the concentrations in samples from MP-1 (up gradient of MP-2) and MP-3 (down gradient of MP-2) were consistently lower than the standard. As presented in the previous monitoring report (Royal Roads, 1999) the anomalous data was due to o,p'-DDT and p,p'-DDT contamination introduced during the installation of the new mini-piezometer. The dominant isomer was not p,p'-DDD, which is the major species in the groundwater plume. The mini-piezometers are susceptible to removal by water erosion during flood periods, and/or ice scouring during spring break up, since they are set at the edge of the river below the present high water mark. It is expected, therefore, that at least one of the three mini-piezometers may require replacement prior to each sampling event.

DDTs concentration in the water sample obtained from the Klehini River within 2 to 3 m of where contaminated groundwater would enter the river (Kle-2; 0.00025 µg/L) was well below the BC CSR standard of 0.001 µg/L, taking into account a ten-fold dilution of groundwater in the actual aquatic receiving environment. This result was comparable to the previous years' data. The levels in samples collected upstream (Kle-1) and downstream (Kle-4) of the site were below detection and also comparable to the previous results.

Table 3.3: DDT Concentration ($\mu\text{g/L}$) in Water Samples Collected from Border Station and Rainy Hollow in August 1999.

Sample #	Monitoring Wells							Minipiezometers				Klehini River		
	MW-17A	MW-17B	MW-18	MW-21A	MW-21B	WP-7	WP-13	MP-1	MP-2-1	MP-2-2	MP-3	Kle-1	Kle-2	Kle-4
o,p' DDE	<0.00013	<0.00022	<0.00022	<0.00025	<0.00019	<0.00056	<0.00031	<0.00010	<0.00045	<0.00032	<0.00046	<0.00018	<0.00038	<0.00044
p,p' DDE	0.00027	0.00025	0.00026	0.0003	0.0002	0.0017	0.00065	0.00028	0.00019	0.00026 ^{nq}	<0.00040	0.00033 ^{nq}	0.00025	<0.00016
o,p' DDD	0.00011	<0.00015	0.00027	0.011	0.00065	0.011	0.061	<0.00010	0.00049 ^{nq}	0.00052 ^{nq}	<0.00022	<0.00020	<0.00012	<0.00018
p,p' DDD	0.00016	<0.00016	0.0060	0.036	0.00064	0.035	0.20	<0.00011	0.0014	0.0015	0.0032 ^{nq}	<0.00007	<0.00013	<0.00019
o,p' DDT	<0.00014	<0.00020	<0.00013	<0.0021	<0.00038	<0.00054	0.00099	<0.00011	0.0015	0.0016	0.00035	<0.00024	<0.00016	<0.00022
p,p' DDT	<0.00020	<0.00029	<0.00019	<0.0031	<0.00055	<0.00079	0.0017	<0.00013	<0.00020	<0.00015	<0.00016	<0.00012	<0.00012	<0.00028
Total DDT	0.00054	0.00025	0.0011	0.047	0.0015	0.048	0.26	0.00028	0.0031	0.0031	0.00035	-	0.00025	-

Notes:

1. A field duplicate sample (MP-2-1 and MP-2-2) was collected at MP-2
2. All concentrations are expressed in micrograms per litre ($\mu\text{g/L}$)
3. < = less than the detection limit indicated
4. nq = Peak detected but did not meet quantification criteria
5. Shaded area indicate parameters that exceed the BC CSR aquatic life standard of $0.01\mu\text{g/L}$

3.6 Hydrocarbons

The concentration of hydrocarbons in groundwater samples was measured as BETX (benzene, toluene, ethylbenzene and xylenes) VHs (volatile hydrocarbons, C6 to 10), VPH (volatile petroleum hydrocarbons, calculated) and EPH (extractable hydrocarbons). Results obtained from the previous monitoring programs (Royal Roads, 1999) indicated that PAHs do not constitute a significant part of the EPH fraction, and site groundwater data for EPHs (C10 to 19) and LEPHs have been directly comparable. Corresponding results have also been obtained for EPHs (C19 to 31) and HEPHs. To this end, extractable hydrocarbons were determined as EPH, rather than LEPH and HEPH during the 1999 monitoring program.

Detectable concentrations of ethylbenzene, toluene, xylenes, VPH and EPH (C10 to 19) were found in groundwater samples obtained from various monitoring wells and mini-piezometers (Table 3.4). Groundwater samples from two of the wells contained EPH (C10 to 19) at concentrations that exceeded the new BC CSR AW standard of 5000 µg/L. These were MW-16 situated on the upper bench along the groundwater migration flow to Rainy Hollow (7,400 µg/L) and WP-7 immediately downgradient of the Trench (5,800 µg/L). VPH (C6 to 10) levels in WP-7 (2,100 µg/L) also exceeded the BC CSR AW standard. The EPH concentrations in these two wells were slightly higher than those obtained in 1998 as illustrated in Figure 3.3 below.

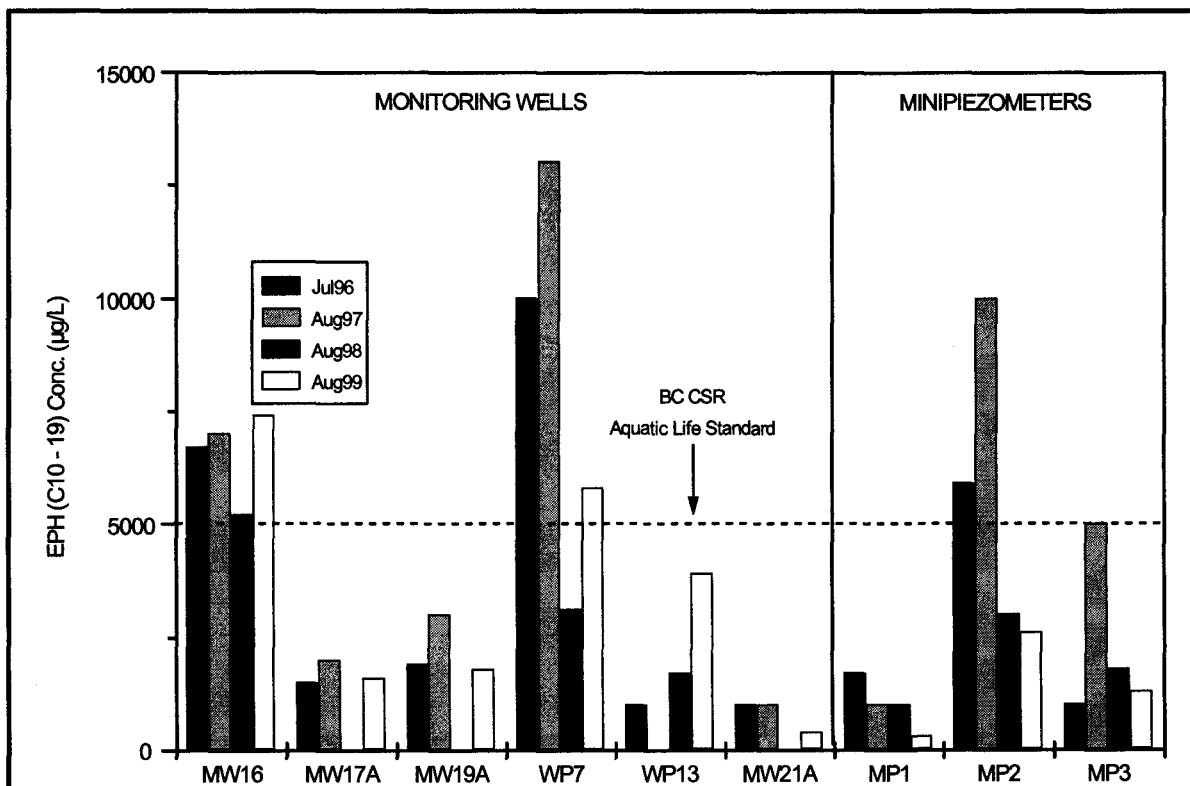


Figure 3.3: EPH Concentrations in Groundwater Collected at Border Station and Rainy Hollow from July 1996 to August 1999

There were also low levels of ethylbenzene, toluene, and xylenes in samples obtained from MW-16 and WP-7. Generally, the concentrations of ethylbenzene, toluene and xylenes obtained for samples from these and all the other wells at Rainy Hollow and Border Station over the monitoring period (1996 – 1999) have been consistently low and well below the BC CSR AW standard.

Monitoring wells MW-17A and 17B, a set of nested wells situated between the upper bench and the lower bench along the groundwater flowpath also contained detectable concentrations of ethylbenzene, toluene, xylenes, VH, VPH and EPH (C10 – 19). VPH (C6 to 10) concentrations, 1,600 and 1,800 µg/L respectively, exceeded the BC CSR AW standard of 1,500 µg/L.

Volatile petroleum hydrocarbons (200 µg/L) and EPH (C10 to 19) (3,900 µg/L) were found in WP-13 at levels which were below the standards. Concentrations in the nested wells located along the groundwater migration pathway to the Klehini River (MW-21A & B) were either below or slightly above detection.

Mini-piezometer MP-2 contained EPH (C10 to 19) at a concentration of 3800 µg/L while the level in MP-3 was 1,300 µg/L. Ethylbenzene and xylenes were also detected at low concentrations in samples from MP-2 and MP-3. None of these concentrations, which are comparable to the 1998 data, exceeded the BC CSR AW standard or the CCME freshwater guidelines. Samples from MP-1 did not contain detectable levels of any of the above parameters.

Table 3.4: Concentration of Volatile and Extractable Hydrocarbons ($\mu\text{g/L}$) in Water Samples Collected from Border Station and Rainy Hollow in 1999

Sample #	Monitoring Wells								Mini-Piezometers				BC CSR AW	
	MW-16	MW-17A	MW-17B	MW-18	MW-21A	MW-21B	WP-7	WP-13	MP-1	MP-2-1	MP-2-2	MP-3		
<i>Volatiles</i>														
Benzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3000
Ethylbenzene	0.9	19.8	15.1	<0.5	<0.5	<0.5	16.8	<0.5	<0.5	3.1	1.2	2.2	7000	
Toluene	<0.5	1.1	1.1	<0.5	<0.5	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	3000	
meta- & para-Xylene	0.8	21.2	15.9	<0.5	<0.5	<0.5	35.8	<0.5	<0.5	3.7	1.8	2.7	---	
ortho-Xylene	<0.5	4	2.3	<0.5	<0.5	<0.5	9.6	<0.5	<0.5	1.3	0.5	0.9		
VH C6-10	1,100	1,800	1,900	<100	<100	<100	2,100	200	<100	600	400	600	15,000	
VPH C6-10 (calc.)	1,100	1,700	1,800	<100	<100	<100	2,100	200	<100	600	400	600	1,500	
<i>Extractables</i>														
EPH (C10-19)	7,400	1,600	1,800	<300	400	<300	5,800	3,900	<300	3,800	1,400	1,300	5,000	
EPH (C19-32)	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	---	

Notes:

1. A field duplicate sample (MP-2-1 and MP-2-2) was collected at MP-2
2. All concentrations are expressed in microgram per litre ($\mu\text{g/L}$)
3. < = less than the detection limit indicated
4. VH = Volatile Hydrocarbons

3.7 Metals

Dissolved metal concentrations in groundwater samples were comparable to data from the previous monitoring programs in that they were either below detection or well below the BC CSR AW standard, with the exception of zinc (Table 3.5).

Table 3.5: Concentration of Dissolved Metals (µg/L) in Groundwater Samples Collected from Rainy Hollow in 1999

Sample #	MW-17A	MW-18	MW-21A	WP-7	WP-13	MP-1	MP-2-1	MP-2-2	MP-3	BC CSR AW
<i>Physical Tests</i>										
Hardness as CaCO ₃	223	255	285	223	269	236	254	256	237	
pH	6.24	7.05	6.47	6.20	6.20	6.70	6.55	6.55	6.45	
Conductivity (µS)	593	665	672	575	631	554	607	607	582	
<i>Dissolved Metals</i>										
Aluminum	<5	40	10	33	73	13	12	10	15	
Antimony	<200	<200	<200	<200	<200	<200	<200	<200	<200	300
Arsenic	<200	<200	<200	<200	<200	<200	<200	<200	<200	500
Barium	110	50	60	70	70	50	60	60	60	10,000
Beryllium	<5	<5	<5	<5	<5	<5	<5	<5	<5	53
Boron	<100	<100	<100	<100	<100	<100	<100	<100	<100	
Cadmium	<0.2	<0.2	<0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	180
Calcium	83,000	89,000	103,000	82,000	96,400	85,600	93,600	94,700	88,500	-
Chromium	<10	<10	<10	<10	<10	<10	<10	<10	<10	20
Cobalt	<10	<10	<10	<10	<10	<10	<10	<10	<10	500
Copper	<10	<10	<10	<10	<10	<10	<10	<10	<10	90
Iron	26,800	40	640	15,400	4,870	<30	8,030	8,560	5,720	
Lead	<1	<1	<2	<1	<1	<1	7	5	3	110
Magnesium	3,900	7,400	6,800	4,400	6,900	5,400	4,800	4,800	4,000	
Manganese	2,100	<5	1,500	1,590	888	<5	1,900	1,910	1,310	
Mercury	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1
Molybdenum	<30	<30	<30	<30	<30	<30	<30	<30	<30	10,000
Nickel	<50	<50	<50	<50	<50	<50	<50	<50	<50	1,500
Selenium	<1	<1	<2	<1	<1	<1	<1	<1	<1	10
Silver	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1
Sodium	3,000	18,000	11,000	3,000	5,000	8,000	3,000	3,000	2,000	
Thallium	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	3
Uranium	0.24	1.86	1.2	0.11	0.76	1.28	0.07	0.07	0.08	3,000
Zinc	<5	<5	<5	<5	<5	<5	3,120	2,620	1,460	300

Notes:

1. A field duplicate sample (MP-2-1 and MP-2-2) was collected at MP-2
2. All concentrations are expressed in micrograms per litre (µg/L) unless otherwise stated
3. < = less than the detection limit indicated

The elevated zinc concentrations however, are attributed to contamination by the galvanized up-riser of the mini-piezometer.

Total metal concentrations in the three water samples collected from the Klehini River are given in Table 3.6. A number of parameters occurred at concentrations that exceeded the CCME Environmental Quality Guidelines for Freshwater Aquatic life. Similar results were obtained during the 1998 monitoring program. However, the elevated levels were associated with particulate matter since dissolved metal concentrations of these parameters were mostly below detection. This is illustrated in Figure 3.4 which compares total and dissolved aluminum levels in the 1998 water samples.

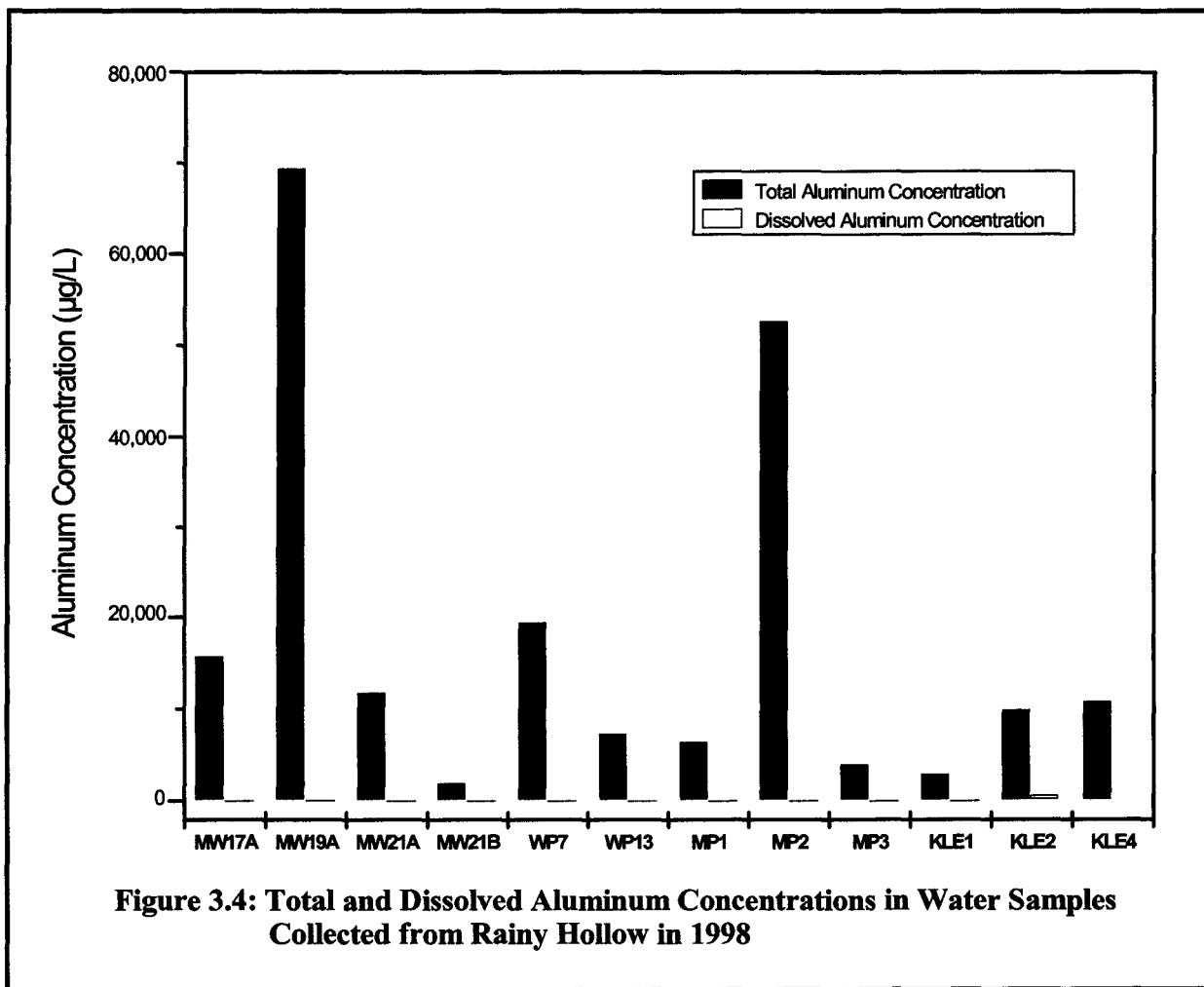


Table 3.6: Concentration of Total Metals ($\mu\text{g/L}$) in Surface Water Samples Collected from the Klehini River in 1999

Sample #	KLE-1	KLE-2	KLE-4	CCME Environmental Quality Guideline
<i>Physical Tests</i>				
Hardness as CaCO_3 (mg/L)	60.7	185	155	
pH	6.74	7.20	6.73	6.5 – 9.0
Conductivity (μS)	85	123	118	
<i>Total Metals</i>				
Aluminum	5,640	23,700	18,300	5 - 100
Antimony	0.4	0.5	0.5	—
Arsenic	1.9	5.8	4.9	5
Barium	40	130	110	—
Beryllium	<0.1	<0.1	<0.1	—
Boron	<100	<100	<100	500 - 6000
Cadmium	0.13	0.3	0.26	0.017
Calcium	17,400	46,700	39,700	—
Chromium	12.4	65.6	51	—
Cobalt	3.6	16.1	12.9	50
Copper	10	40.5	28	2 - 4
Iron	7,460	32,700	26,000	300
Lead	1.69	5.25	5.18	1 - 7
Magnesium	4,200	16,700	13,600	—
Manganese	0.15	0.626	0.504	—
Mercury	<0.05	<0.05	<0.05	2.6
Molybdenum	<30	<30	<30	73
Nickel	6	29	23	25 – 150
Potassium	<2,000	3,000	3,000	—
Selenium	<1	<1	<1	1.0
Silver	0.04	0.14	0.14	0.1
Sodium	2,000	3,000	2,000	—
Thallium	0.09	0.11	0.08	0.8
Titanium	450	2,230	1,620	—
Uranium	0.8	1.1	1	—
Vanadium	<30	90	70	—
Zinc	24	86	69	30

Notes:

 All concentrations are expressed in micrograms per litre ($\mu\text{g/L}$) unless otherwise stated.

< = less than the detection limit indicated

Shaded areas indicate parameters that exceed the CCME environmental quality guideline for fresh water.

4. CONCLUSIONS AND RECOMMENDATIONS

The data presented in Chapter 3 indicates a remarkable overall consistency in the concentrations of DDTs, hydrocarbons and metals in groundwater and surface water samples collected from Rainy Hollow and Border Station over a four-year period. This generally reaffirms the validity of the 1996 groundwater model predictions.

Based on previous investigations, it is estimated that mini-piezometer MP-2 is located in the approximate centre of the DDT-contaminated groundwater plume. The concentration of DDTs in samples collected from MP-2 from 1996 through 1999 were as follows: 1996 – 0.0084 µg/L; 1997 – 0.011 µg/L; 1998 – 0.009 µg/L; and, 1999 – 0.003 µg/L. These indicate a slight decrease in DDT concentration in 1999. The total DDTs concentrations over the four year period in monitoring well MW-21A (between the former Trench location and the river) have been consistently low relative to the groundwater concentrations closer to the original burial trench. The concentrations were also below the BC CSR water quality standards: 1996 – <0.1 µg/L³; 1997 – 0.0049 µg/L; 1998 – 0.0053 µg/L; and, 1999 – 0.0047 µg/L. DDTs concentrations in water samples from the Klehini River within 2 to 3 m of where contaminated groundwater would enter the river (Kle-2) have also been consistently below 0.001 µg/L. Similar results have been obtained for extractable petroleum hydrocarbons (C10 to 19).

The results obtained to date have also been below the recommended response triggers which are for total DDTs concentration – 0.050 µg/L for MP-2 and 0.001 µg/L for Kle-2 and with respect to EPH (C10 to 19) – 15,000 µg/L for MP-2 and 50 µg/L for Kle-2.

Natural reclamation (re-vegetation) of the gravel capped areas at the Rainy Hollow and Border Station sites has been slow owing to the general lack of any topsoil in the substrate, and relatively exposed nature of the sites. The most successful groundcover colonization has occurred along the road up to the POL storage area at Border Station due to the presence of topsoils. Young trees (balsam poplar and willow) appear to have fared relatively well from partial burial in the capped areas, but it is recommended that these and ground vegetation establishment continue to be monitored, at least on a qualitative basis, as part of the program. If a more quantitative assessment is desired, then it is recommended that a series of permanent 1 m² ground cover plots be established randomly around the sites to collect and monitor the progress and composition of vegetation re-colonization.

Water levels reflect seasonal and annual variations, however the normal range of fluctuation is in the order of 50 cm. The horizontal gradient, and resultant groundwater flux to the Klehini River over the past three years has been relatively constant. Spikes in water levels are associated with spring recharge and late season precipitation. Any impact on groundwater flux to the river associated with these events is nominal as they are of short duration.

It is concluded that there has been no increase in the concentrations of the original contaminants of potential concern at the site since 1996 – in groundwater entering the Klehini River, or in river

³ A detection limit of 0.1 µ/L was used for all individual isomers.

water collected adjacent to the site. This, along with the original risk assessment and subsequent risk management activities, leads to the conclusion that there remain no unacceptable risks to wildlife or humans at or near the site.

Finally, as with the recommendation of the original contaminant transport model (Woodbury, 1997), the monitoring program should be continued for one more year. The frequency of subsequent monitoring programs would be revisited following review of the data.

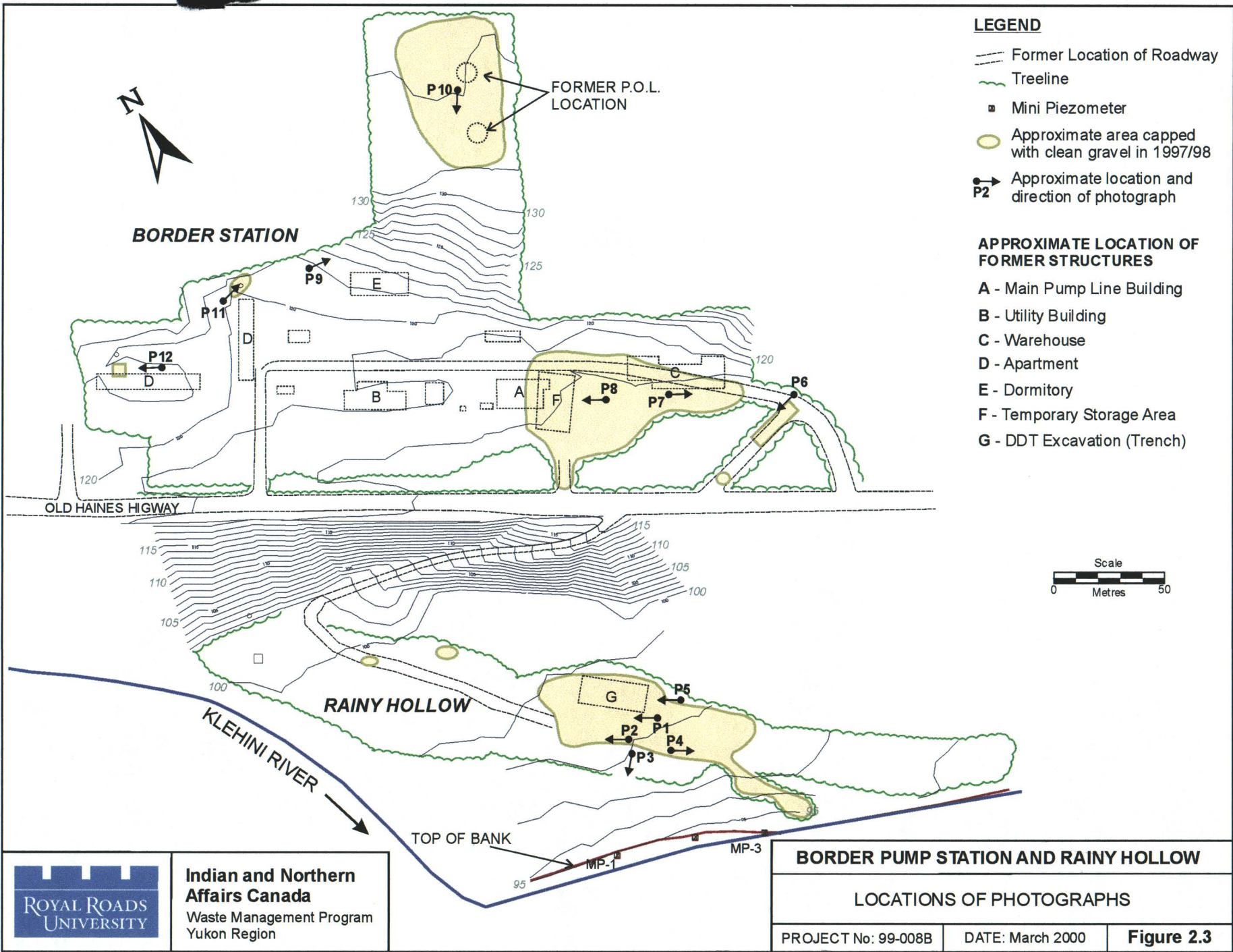
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**APPENDIX A:
PHOTOGRAPHS OF RE-VEGETATION ASSESSMENT**

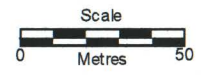


LEGEND

- Former Location of Roadway
- Treeline
- Mini Piezometer
- Approximate area capped with clean gravel in 1997/98
- Approximate location and direction of photograph

APPROXIMATE LOCATION OF FORMER STRUCTURES

- A - Main Pump Line Building
- B - Utility Building
- C - Warehouse
- D - Apartment
- E - Dormitory
- F - Temporary Storage Area
- G - DDT Excavation (Trench)



BORDER PUMP STATION AND RAINY HOLLOW		
LOCATIONS OF PHOTOGRAPHS		
PROJECT No: 99-008B	DATE: March 2000	Figure 2.3



Indian and Northern Affairs Canada
 Waste Management Program
 Yukon Region



Photograph 1: Looking northwest from the central part of the capped area at Rainy Hollow



Photograph 2: Looking north along the western edge of the gravel capped area at Rainy Hollow



Photograph 3: View of the access road to Klehini River towards the locations of the mini-piezometers



Photograph 4: Looking south along the western edge of the gravel cap at Rainy Hollow



Photograph 5: Looking north along the eastern edge of the cap, close to where the Trench was formerly located at Rainy Hollow



Photograph 6: Local gravel cap along road leading south of former Temporary Storage Area at Border Station



Photograph 7: Gravel pad over former Temporary Storage Area looking southeast



Photograph 8: Gravel pad over former Temporary Storage Area looking northwest



Photograph 9: Looking east along access road constructed for delivering gravel to the former POL storage area



Photograph 10: Former POL storage area looking southwest



Photograph 11: Local gravel cap over hydrocarbon stained area on the northern side of Border Station looking towards former POL site



Photograph 12: Gravel cap over hydrocarbon stained area northwest of site looking northwest

**APPENDIX B:
GROUNDWATER SAMPLING SHEETS**

Groundwater Sampling Data Sheet
 Royal Roads University - Applied Research Division

Well No: MW-16 Location: Rainy Hollow
 Date: Aug 6/99 Weather: Sunny
 Time: 4:10 pm Temperature: 24°C
 Samples Collected by: S. Aichele / M. Dodel

MONITORING WELL INFORMATION			
Depth to water from top of casing	A	<u>18.793</u>	meters
Depth to bottom of well from top of casing	B	<u>21.4000</u>	meters
Diameter of standpipe	C	<u>0.05</u>	meters
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>5.2</u>	litres
(B-A)*1.1(for 1 inch i.d. well)			litres

WELL PURGING					
Start	<u>4:15 pm</u>	Volume purged (well vol x 3)	<u>15.6</u>	litres	
Finish		Method	<u>water</u>		
TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>4:25</u>	<u>16 L</u>	<u>9.4</u>	<u>6.09</u>	<u>437</u>	
<u>4:30</u>	<u>5 L</u>	<u>7.0</u>	<u>5.78</u>	<u>429</u>	
<u>4:35</u>	<u>5 L</u>	<u>7.2</u>	<u>5.91</u>	<u>430</u>	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks
<u>1</u>	<u>4:35</u>	<u>Glass</u>	<u>40ml</u>	<u>—</u>	<u>H2SO4</u>	<u>BTEX / VPH</u>
<u>2</u>	<u>4:37</u>	<u>Glass</u>	<u>40 ml</u>	<u>—</u>	<u>H2SO4</u>	<u>BTEX / VPH</u>
<u>3</u>	<u>4:40</u>	<u>Glass</u>	<u>500 ml</u>	<u>—</u>	<u>NO</u>	<u>EDH</u>
<u>4</u>						
<u>5</u>						
<u>6</u>						
<u>7</u>						
<u>8</u>						
<u>9</u>						
<u>10</u>						

OBSERVATIONS			
Odour	<input type="checkbox"/> No	<input type="checkbox"/> Yes	If yes _____
Sheen	<input type="checkbox"/> No	<input type="checkbox"/> Yes	If yes _____
Other:	_____		

EQUIPMENT LIST			
pH Meter (model & serial #)	_____	Calibration	_____
Cond. meter (model & serial #):	_____	Calibration	_____
Water Level Meter:	_____		
Pump:	_____		
Other:	_____		

Groundwater Sampling Data Sheet
 Royal Roads University - Applied Research Division

Well No: MW-17A Location: Rainy Hollow
 Date: August 6/99 Weather: Sunny
 Time: 3:00 pm Temperature: 24°C
 Samples Collected by: m. Dodd / S. Ritchie

MONITORING WELL INFORMATION			
Depth to water from top of casing	A	<u>1.027</u>	meters
Depth to bottom of well from top of casing	B	<u>5.682</u>	meters
Diameter of standpipe	C	<u>0.050</u>	meters
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>8</u>	litres
(B-A)*1.1(for 1 inch i.d. well)			litres

WELL PURGING					
Start	<u>3:00 pm</u>	Volume purged (well vol x 3)	<u>24</u>	litres	
Finish	<u>3:20 pm</u>	Method	<u>waterra</u>		
TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>3:07</u>	<u>24</u>	<u>-</u>	<u>6.51</u>	<u>625</u>	
<u>3:12</u>	<u>45L</u>	<u>8.1</u>	<u>6.45</u>	<u>622</u>	
<u>3:15</u>	<u>5L</u>	<u>6.8</u>	<u>6.39</u>	<u>615</u>	
<u>3:18</u>	<u>5L</u>	<u>7.1</u>	<u>6.38</u>	<u>616</u>	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks / Analysis
<u>1</u>	<u>3:20</u>	<u>Glass</u>	<u>40 ml</u>	<u>NO</u>	<u>H2SO4</u>	<u>BIEX / VPH</u>
<u>2</u>	<u>3:21</u>	<u>Glass</u>	<u>40 ml</u>	<u>NO</u>	<u>H2SO4</u>	<u>BIEX / VPH</u>
<u>3</u>	<u>3:25</u>	<u>Glass</u>	<u>500 ml</u>	<u>NO</u>	<u>NO</u>	<u>EPH</u>
<u>4</u>	<u>3:26</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDIS (A x YS)</u>
<u>5</u>	<u>3:28</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDIS (A x YS)</u>
<u>6</u>	<u>3:30</u>	<u>Plastic</u>	<u>250 ml</u>	<u>0.45</u>	<u>HNO3</u>	<u>Dissolved metals</u>
<u>7</u>						
<u>8</u>						
<u>9</u>						
<u>10</u>						

OBSERVATIONS

Odour No Yes If yes Hydrocarbon

Sheen No Yes If yes _____

Other: slightly turbid

EQUIPMENT LIST

pH Meter (model & serial #) _____ Calibration _____

Cond. meter (model & serial #): _____ Calibration _____

Water Level Meter: _____

Pump: _____

Other: _____

Groundwater Sampling Data Sheet

Royal Roads University - Applied Research Division

Well No: 17 B Location: RAINY HOLLOW
 Date: Aug 6/99 Weather: Sunny
 Time: _____ Temperature: 25°C
 Samples Collected by: M. DODD / T. WINGROVE

MONITORING WELL INFORMATION		
Depth to water from top of casing	A	<u>1.597</u> meters
Depth to bottom of well from top of casing	B	<u>8.564</u> meters
Diameter of standpipe	C	<u>6.050</u> meters
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>14</u> litres
(B-A)*1.1(for 1 inch i.d. well)		_____ litres

WELL PURGING		
Start	<u>3:30</u>	Volume purged (well vol x 3) <u>42</u> litres
Finish	_____	Method _____

TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>3:37</u>	<u>42</u>	<u>8.0</u>	<u>6.38</u>	<u>611</u>	
<u>3:40</u>	<u>5</u>	<u>6.6</u>	<u>6.43</u>	<u>598</u>	
<u>3:42</u>	<u>5</u>	<u>7.2</u>	<u>6.20</u>	<u>596</u>	
<u>3:45</u>	<u>5</u>	<u>6.5</u>	<u>6.24</u>	<u>593</u>	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks
1	<u>3:45 pm</u>	<u>Glass</u>	<u>40 ml</u>	<u>NO</u>	<u>H2SO4</u>	<u>BTEX / UPH</u>
2	<u>3:46</u>	<u>Glass</u>	<u>40 ml</u>	<u>NO</u>	<u>H2SO4</u>	<u>BTEX / UPH</u>
3	<u>3:48</u>	<u>Glass</u>	<u>500 ml</u>	<u>NO</u>	<u>NONE</u>	<u>EPH</u>
4	<u>3:50</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NONE</u>	<u>DDIS (AXYS)</u>
5	<u>3:55</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDIS (AXYS)</u>
6						
7						
8						
9						
10						

OBSERVATIONS	
Odour <input type="checkbox"/> No <input checked="" type="checkbox"/> Yes Sheen <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes Other: _____	If yes <u>Hydrocarbon odour</u> If yes _____ <u>Turbid, gray water</u>
EQUIPMENT LIST	
pH Meter (model & serial #): _____	Calibration _____
Cond. meter (model & serial #): _____	Calibration _____
Water Level Meter: _____	
Pump: _____	
Other: _____	

Groundwater Sampling Data Sheet
 Royal Roads University - Applied Research Division

Well No: MW-18 Location: Rainy Hollow
 Date: Aug 6/99 Weather: partly cloudy
 Time: _____ Temperature: 18°C
 Samples Collected by: F. Wingrove / M. Dodd

MONITORING WELL INFORMATION			
Depth to water from top of casing	A	<u>1.883</u> meters	Δ
Depth to bottom of well from top of casing	B	<u>7.386</u> meters	<u>5.503</u>
Diameter of standpipe	C	<u>0.050</u> meters	
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>11</u> litres	
(B-A)*1.1 (for 1 inch i.d. well)		_____ litres	

WELL PURGING					
Start _____	Volume purged (well vol x 3)	<u>33</u> litres			
Finish _____	Method	<u>watering</u>			
TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>10:22</u>	<u>5.1</u>	<u>10.8</u>	<u>7.05</u>	<u>665</u>	
<u>10:27</u>	<u>5.1</u>	<u>6.7</u>	<u>7.03</u>	<u>659</u>	
<u>10:29</u>	<u>5.1</u>	<u>6.4</u>	<u>7.05</u>	<u>709</u>	
<u>10:31</u>	<u>5.1</u>	<u>6.7</u>	<u>7.05</u>	<u>665</u>	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks
1	10:25	Glass	40 ml	NO	H2SO4	BTEX / UPH
2	10:37	Glass	40 ml	NO	H2SO4	
3	10:40	Glass	500 ml	NO	NO	EDH
4	10:42	Glass	1 L	NO	NO	DDTS
5	10:45	Glass	1 L	NO	NO	DDTS
6	10:50	Plastic	250 ml	0.45µm	Nitric acid	Dissolved metals
7						
8						
9						
10						

OBSERVATIONS	
Odour <input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	If yes <u>by dis carbon</u>
Sheen <input type="checkbox"/> No <input type="checkbox"/> Yes	If yes _____
Other:	<u>Murky - med. brown colour</u>
EQUIPMENT LIST	
pH Meter (model & serial #): _____	Calibration _____
Cond. meter (model & serial #): _____	Calibration _____
Water Level Meter: _____	
Pump: _____	
Other: _____	

Groundwater Sampling Data Sheet
 Royal Roads University - Applied Research Division

Well No: MW-21A Location: RAINY HOLLOW
 Date: Aug 6, 1999 Weather: 20°
 Time: 11:15 am Temperature: Partially Cloudy
 Samples Collected by: M. Dodd / J. Wingrove

MONITORING WELL INFORMATION

Depth to water from top of casing	A	<u>0.293</u>	meters	Δ
Depth to bottom of well from top of casing	B	<u>1.633</u>	meters	0.340
Diameter of standpipe	C	<u>0.057</u>	meters	
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>0.68</u>	litres	
(B-A)*1.1 (for 1 inch i.d. well)			litres	

WELL PURGING

Start 11:15 am Volume purged (well vol x 3) 2 litres
 Finish 11:20 am Method water

TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>11:23</u>	<u>2L</u>	<u>9.7</u>	<u>6.43</u>	<u>680</u>	
<u>11:25</u>	<u>1.5 L</u>	<u>8.4</u>	<u>6.54</u>	<u>685</u>	
<u>11:27</u>	<u>1.5 L</u>	<u>8.6</u>	<u>6.47</u>	<u>672</u>	

SAMPLE BOTTLES FILLED

No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks / analysis
<u>1</u>	<u>11:30</u>	<u>40 ml Glass</u>		<u>NO</u>	<u>H2SO4</u>	<u>WTEX / VPH</u>
<u>2</u>	<u>11:32</u>	<u>Glass</u>	<u>40 ml</u>	<u>NO</u>	<u>H2SO4</u>	<u>WTEX / VPH</u>
<u>3</u>	<u>11:35</u>	<u>Glass</u>	<u>500 ml</u>	<u>NO</u>	<u>NO</u>	<u>EPH</u>
<u>4</u>	<u>11:40</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDIS (AXYS)</u>
<u>5</u>	<u>11:42</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDIS (AXYS)</u>
<u>6</u>	<u>11:45</u>	<u>Plastic</u>	<u>250 ml</u>	<u>45µm</u>	<u>HNO3</u>	<u>Dissolved metals</u>
<u>7</u>						
<u>8</u>						
<u>9</u>						
<u>10</u>						

OBSERVATIONS

Odour No Yes If yes Hydro carbon
 Sheen No Yes If yes slight
 Other: milky-grey

EQUIPMENT LIST

pH Meter (model & serial #) _____ Calibration _____
 Cond. meter (model & serial #): _____ Calibration _____
 Water Level Meter: _____
 Pump: _____
 Other: _____

Groundwater Sampling Data Sheet
 Royal Roads University - Applied Research Division

Well No: MW21B - deep Location: Rainy Hollow
 Date: Aug 6 / 99 Weather: partly cloudy
 Time: 11:40 am Temperature: 20°C
 Samples Collected by: J. Wingrave / M. Dudd

MONITORING WELL INFORMATION			
Depth to water from top of casing	A	<u>0.260</u>	meters Δ
Depth to bottom of well from top of casing	B	<u>6.870</u>	meters
Diameter of standpipe	C	<u>6.610</u>	meters
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>13.2</u>	litres
(B-A)*1.1 (for 1 inch i.d. well)			litres

WELL PURGING					
Start	<u>11:40</u>	Volume purged (well vol x 3)	<u>40</u>	litres	
Finish	<u>11:47</u>	Method			
TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>11:47</u>	<u>40L</u>	<u>6.7</u>	<u>6.52</u>	<u>705</u>	
<u>11:50</u>	<u>5L</u>	<u>6.3</u>	<u>6.49</u>	<u>721</u>	
<u>11:52</u>	<u>5L</u>	<u>6.0</u>	<u>6.36</u>	<u>710</u>	<u>pH 6.36</u>

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks
<u>1</u>	<u>11:55</u>	<u>glass</u>	<u>40 ml</u>	<u>-</u>	<u>H2SO4</u>	
<u>2</u>	<u>11:56</u>	<u>glass</u>	<u>40 ml</u>	<u>-</u>	<u>H2SO4</u>	
<u>3</u>	<u>11:58</u>	<u>glass</u>	<u>500 ml</u>	<u>-</u>	<u>-</u>	
<u>4</u>	<u>12:00</u>	<u>glass</u>	<u>1L</u>	<u>-</u>	<u>-</u>	<u>BDTS</u>
<u>5</u>	<u>12:02</u>	<u>glass</u>	<u>1L</u>	<u>-</u>	<u>-</u>	<u>IDTS</u>
<u>6</u>						
<u>7</u>						
<u>8</u>						
<u>9</u>						
<u>10</u>						

OBSERVATIONS			
Odour	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes	If yes _____
Sheen	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes	If yes _____
Other:	<u>slightly murky - light brown</u>		
EQUIPMENT LIST			
pH Meter (model & serial #)	_____	Calibration	_____
Cond. meter (model & serial #):	_____	Calibration	_____
Water Level Meter:	_____		
Pump:	_____		
Other:	_____		

Groundwater Sampling Data Sheet
 Royal Roads University - Applied Research Division

Well No: WP-7 Location: Rainy Hollow
 Date: Aug 6/99 Weather: See well 13
 Time: _____ Temperature: _____
 Samples Collected by: M. Dodd / J. Wingrove

MONITORING WELL INFORMATION			
Depth to water from top of casing	A	<u>1.716</u>	meters
Depth to bottom of well from top of casing	B	<u>2.630</u>	meters
Diameter of standpipe	C	<u>0.050</u>	meters
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>1.83</u>	litres
(B-A)*1.1(for 1 inch i.d. well)			litres

WELL PURGING			
Start	<u>10:50 am</u>	Volume purged (well vol x 3)	<u>5.49</u> litres
Finish	<u>11:10 am</u>	Method	<u>water table</u>

TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>10:54</u>	<u>2L</u>	<u>9.9</u>	<u>6.21</u>	<u>578</u>	
<u>10:57</u>	<u>2L</u>	<u>10.3</u>	<u>6.27</u>	<u>571</u>	
<u>11:00</u>	<u>2L</u>	<u>9.7</u>	<u>6.20</u>	<u>575</u>	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks / Analysis
1	<u>11:00</u>	<u>Glass</u>	<u>40 ml</u>	<u>NO</u>	<u>#2504</u>	<u>BTEX / UPH</u>
2	<u>11:01</u>	<u>Glass</u>	<u>40 ml</u>	<u>NO</u>	<u>#2504</u>	<u>BTEX / UPH</u>
3	<u>11:04</u>	<u>Glass</u>	<u>500 ml</u>	<u>NO</u>	<u>NO</u>	<u>EPH</u>
4	<u>11:05</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDTS</u>
5	<u>11:08</u>	<u>Glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDTS</u>
6						
7	<u>11:10</u>	<u>250 ml</u>	<u>plastic</u>	<u>0.45 µm</u>	<u>Ni/Co and</u>	<u>Distilled water</u>
8						
9						
10						

OBSERVATIONS

Odour No Yes If yes hydrocarbon odour
 Sheen No Yes If yes hydrocarbon
 Other: murky - med. brown

EQUIPMENT LIST

pH Meter (model & serial #): _____ Calibration _____
 Cond. meter (model & serial #): _____ Calibration _____
 Water Level Meter: _____
 Pump: _____
 Other: _____

Groundwater Sampling Data Sheet

Royal Roads University - Applied Research Division

Well No: WR-13 Location: Rainy Hollow
 Date: Aug 6 1999 Weather: sunny with clouds
 Time: 8:40 am Temperature: 17°C
 Samples Collected by: Suzanne Aichele

MONITORING WELL INFORMATION		
Depth to water from top of casing	A	<u>2.38</u> meters
Depth to bottom of well from top of casing	B	<u>3.935</u> meters <u>0.155</u>
Diameter of standpipe	C	<u>0.050</u> meters
One well volume (B-A)*2 (for 2 inch i.d. well)		<u>3.110</u> litres
(B-A)*1.1(for 1 inch i.d. well)		litres

WELL PURGING			
Start	<u>9:00</u>	Volume purged (well vol x 3)	<u>9.5</u> litres
Finish	<u>10:00</u>	Method	<u>Watering</u>

TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
<u>9:40</u>	<u>25L</u>	<u>14.9</u>	<u>6.38</u>	<u>637</u>	
<u>9:</u>	<u>30L</u>	<u>12.8</u>	<u>6.27</u>	<u>623</u>	
	<u>35L</u>	<u>6.9</u>	<u>6.21</u>	<u>642</u>	
	<u>40L</u>	<u>6.3</u>	<u>6.20</u>	<u>633</u>	
<u>10:00</u>	<u>45L</u>	<u>6.2</u>	<u>6.10</u>	<u>631</u>	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks
<u>1</u>	<u>10:00</u>	<u>400ml</u>	<u>40ml</u>	<u>NO</u>	<u>H2SO4</u>	<u>DTEx</u>
<u>2</u>	<u>10:02</u>	<u>glass</u>	<u>40ml</u>	<u>NO</u>	<u>H2SO4</u>	<u>DTEx</u>
<u>3</u>	<u>10:05</u>	<u>glass</u>	<u>500ml</u>	<u>NO</u>	<u>NO</u>	<u>EPH</u>
<u>4</u>	<u>10:08</u>	<u>glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDT (1)</u>
<u>5</u>	<u>10:10</u>	<u>glass</u>	<u>1L</u>	<u>NO</u>	<u>NO</u>	<u>DDT (2)</u>
<u>6</u>	<u>10:15</u>	<u>plastic</u>	<u>250</u>	<u>0.45um</u>	<u>Nitric acid</u>	<u>Metals</u>
<u>7</u>						
<u>8</u>						
<u>9</u>						
<u>10</u>						

OBSERVATIONS			
Odour	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	If yes	<u>slight odor, hydrocarbon.</u>
Sheen	<input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	If yes	<u>slight sheen</u>
Other:	_____		

EQUIPMENT LIST	
pH Meter (model & serial #)	_____ Calibration _____
Cond. meter (model & serial #):	_____ Calibration _____
Water Level Meter:	_____
Pump:	_____
Other:	_____

Groundwater Sampling Data Sheet
 Royal Roads University - Applied Research Division

Well No: MP-2 Location: Rainy Hollow
 Date: Aug 6, 1995 Weather: cloudy
 Time: 12:35 pm Temperature: 20°C
 Samples Collected by: S. Archele / m. Dodd

MONITORING WELL INFORMATION			
Depth to water from top of casing	A	_____	meters
Depth to bottom of well from top of casing	B	_____	meters
Diameter of standpipe	C	_____	meters
One well volume (B-A)*2 (for 2 inch i.d. well)		_____	litres
(B-A)*1.1 (for 1 inch i.d. well)		_____	litres

WELL PURGING			
Start	<u>12:40 pm</u>	Volume purged (well vol x 3)	_____ litres
Finish	_____	Method	_____

TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
12:40 pm	2L	11.2	6.24	615	
12:42 pm	1L	9.6	6.49	616	
12:44 pm	1L	9.7	6.55	607	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks
1	12:45 pm	Glass	2x 40 ml	NO	H ₂ SO ₄	BTEX / VPH
2	12:40 pm	Glass	500 ml	NO	NO	EPH
3	12:50 pm	Glass	2x 1L	NO	NO	DDTS (AXYS)
4	12:55 pm	Glass	2x 40 ml	NO	H ₂ SO ₄	BTEX / VPH
5	12:52 pm	Glass	500 ml	NO	NO	EPH
6	12:53 pm	Glass	2 x 4L	NO	NO	DDTS
7	1:00 pm	Plastic	2 x 250 ml	0.45µm	HNO ₃	Dissolved metals
8						
9						
10						

OBSERVATIONS	
Odour <input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	If yes <u>Hydrocarbon</u>
Sheen <input type="checkbox"/> No <input checked="" type="checkbox"/> Yes	If yes <u>Hydrocarbon</u>
Other:	<u>Turbid - grey/brown</u>

EQUIPMENT LIST	
pH Meter (model & serial #)	_____ Calibration _____
Cond. meter (model & serial #):	_____ Calibration _____
Water Level Meter:	_____
Pump:	_____
Other:	<u>Field duplicate collected labelled</u> <u>MP-21 and MP-22</u>

Groundwater Sampling Data Sheet

Royal Roads University - Applied Research Division

Well No: MP-3 Location: Rainy Hollow
 Date: Aug 6, 1999 Weather: partially cloudy
 Time: 1:25 pm Temperature: 20°C
 Samples Collected by: S. Aichele / m. Dodd

MONITORING WELL INFORMATION			
Depth to water from top of casing	A	_____	meters
Depth to bottom of well from top of casing	B	_____	meters
Diameter of standpipe	C	_____	meters
One well volume (B-A)*2 (for 2 inch i.d. well)		_____	litres
(B-A)*1.1 (for 1 inch i.d. well)		_____	litres

WELL PURGING			
Start	<u>1:25 pm</u>	Volume purged (well vol x 3)	_____ litres
Finish	_____	Method	_____

TIME	Volume Removed	TEMP (°C)	pH	Conductivity (µS/cm)	Remarks
1:25 pm	1L	9.3	6.31	583	
1:28 pm	1L	9.5	6.47	581	
1:31 pm	1L	9.1	6.45	582	

SAMPLE BOTTLES FILLED						
No	Time Collected	Type of Container	Volume	Filter (µm)	Preservative	Remarks
1	1:35	Glass	40 ml	NO	H ₂ O ₂	BTEX / UPH
2		Glass	500 ml	NO	NO	EPH
3		Glass	1L x 2	NO	NO	DDIS (AXYS)
4		Plastic	250 ml	0.45µm	HNO ₃	Dissolved metals
5						
6						
7						
8						
9						
10						

OBSERVATIONS			
Odour	<input type="checkbox"/> No	<input checked="" type="checkbox"/> Yes	If yes <u>Slight hydrocarbon odour</u>
Sheen	<input checked="" type="checkbox"/> No	<input type="checkbox"/> Yes	If yes _____
Other:	_____		

EQUIPMENT LIST	
pH Meter (model & serial #)	_____ Calibration _____
Cond. meter (model & serial #):	_____ Calibration _____
Water Level Meter:	_____
Pump:	_____
Other:	_____

**APPENDIX C-1:
AXYS DATA REPORTS FOR DDT**



AXYS

Axys Analytical
Services Ltd

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

DATE:	21 September 1999	Our File: 9919
TO:	Matt Dodd	Batch ID: CLWG1936
ORGANIZATION:	Royal Roads University	Sample No.: L1912-1 to -7
ADDRESS:		
FAX:	391-2560	
FROM:	Doug Weir	No. of pages: 12

Attached are the Pesticide analysis results for seven water samples.

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

Regards

TEL: (250) 656-0881
E-MAIL: analytical@axys.com

FAX: (250) 656-4511
toll-free: 1-888-373-0881

BATCH SUMMARY

Batch ID: CLWG1936	Date: 11 September 1999
Analysis Type: DDD, DDE and DDT	Matrix Type: Water
BATCH MAKEUP	
Samples: 9919 L1912 -1 -2 -3 -4 -5 -6 -7	Blank: WG1936-1
	Reference or Spike: WG1936-2
	Duplicate: WG1936-3 (L1912-3)
Comments - 1. No analytical difficulties were encountered for this work and all QA/QC requirements were met.	

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February 1993

PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: Procedural Blank

AXYS ID:

WG1936-1

CLIENT: Royal Roads University

DATE:

09-Sep-1999

CLIENT No: 9919

SAMPLE TYPE: Blank

METHOD NO.:

CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT:

GC-MS

RUNFILE ID:

CL993662.D

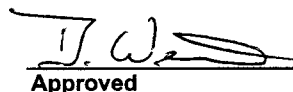
CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.27
p,p'-DDE	NDR 0.23	0.22
o,p'-DDD	ND	0.21
p,p'-DDD	ND	0.23
o,p'-DDT	ND	0.20
p,p'-DDT	ND	0.22

Surrogate Standards **% Recovery**

13C-Hexachlorobenzene	52
13C-p,p'-DDE	57
13C-p,p'-DDT	73
13C-PCB 101	53
13C-PCB 180	60

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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: Spike Matrix

AXYS ID: WG1936-2

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT No.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS

RUNFILE ID: CL993659.D

CONCENTRATION IN: ng/L

Compounds	Determined	Expected	% Recovery
o,p'-DDE	49	55	89
p,p'-DDE	48	51	94
o,p'-DDD	49	52	94
p,p'-DDD	47	48	98
o,p'-DDT	46	49	94
p,p'-DDT	47	46	102

Surrogate Standards % Recovery

13C-Hexachlorobenzene	59
13C-p,p'-DDE	73
13C-p,p'-DDT	74
13C-PCB 101	67
13C-PCB 180	75

1. Concentrations are recovery corrected
2. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: KLE-1 Aug 7/99 9:25am

AXYS ID: L1912-1

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT No.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS


RUNFILE ID: CL993663.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.18
p,p'-DDE	NDR 0.33	0.13
o,p'-DDD	ND	0.20
p,p'-DDD	ND	0.07
o,p'-DDT	ND	0.24
p,p'-DDT	ND	0.12

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	48
13C-p,p'-DDE	74
13C-p,p'-DDT	92
13C-PCB 101	69
13C-PCB 180	77

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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



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PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: KLE-2 Aug 6/99 1:05 pm

AXYS ID: L1912-2

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT No.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS

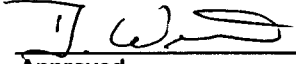
RUNFILE ID: CL993664.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.38
p,p'-DDE	0.25	0.12
o,p'-DDD	ND	0.12
p,p'-DDD	ND	0.13
o,p'-DDT	ND	0.16
p,p'-DDT	ND	0.12

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	68
13C-p,p'-DDE	91
13C-p,p'-DDT	100
13C-PCB 101	86
13C-PCB 180	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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



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PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: KLE-4 Aug 7/99 8:55am

AXYS ID: L1912-3

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT No.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS

RUNFILE ID: CL993670.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.44
p,p'-DDE	ND	0.16
o,p'-DDD	ND	0.18
p,p'-DDD	ND	0.19
o,p'-DDT	ND	0.22
p,p'-DDT	ND	0.28

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	58
13C-p,p'-DDE	71
13C-p,p'-DDT	87
13C-PCB 101	65
13C-PCB 180	70

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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.

Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D.: KLE-4 Aug 7/99 8:55am

AXYS ID:

WG1936-3

CLIENT: Royal Roads University

DATE:

Duplicate (L1912-3)

CLIENT No.: 9919

09-Sep-1999

SAMPLE TYPE: WATER

METHOD NO.:

CL-W-04/Ver.2

SAMPLE SIZE: 0.960 L

INSTRUMENT:

GC-MS

RUNFILE ID:

CL993665.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.30
p,p'-DDE	NDR 0.28	0.09
o,p'-DDD	ND	0.08
p,p'-DDD	ND	0.08
o,p'-DDT	ND	0.15
p,p'-DDT	ND	0.19

Surrogate Standards % Recovery

13C-Hexachlorobenzene	50
13C-p,p'-DDE	86
13C-p,p'-DDT	110
13C-PCB 101	78
13C-PCB 180	96

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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



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PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: MP-1 Aug 6/99 12:15pm.

AXYS ID: L1912-4

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT NO.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS


RUNFILE ID: CL993666.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.10
p,p'-DDE	0.28	0.07
o,p'-DDD	ND	0.10
p,p'-DDD	ND	0.11
o,p'-DDT	ND	0.11
p,p'-DDT	ND	0.13

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	54
13C-p,p'-DDE	90
13C-p,p'-DDT	110
13C-PCB 101	82
13C-PCB 180	97

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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



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PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: MP-22 Aug/99 1:05pm

AXYS ID: L1912-5

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT No.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS

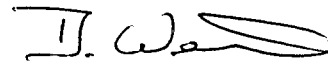
RUNFILE ID: CL993667.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.32
p,p'-DDE	NDR 0.26	0.07
o,p'-DDD	NDR 0.52	0.07
p,p'-DDD	1.5	0.08
o,p'-DDT	1.6	0.15
p,p'-DDT	ND	0.15

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	73
13C-p,p'-DDE	92
13C-p,p'-DDT	95
13C-PCB 101	88
13C-PCB 180	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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



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PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: MP-3 Aug 6/99

AXYS ID: L1912-6

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT No.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS

RUNFILE ID: CL993668.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.46
p,p'-DDE	ND	0.40
o,p'-DDD	ND	0.22
p,p'-DDD	NDR 0.32	0.07
o,p'-DDT	0.35	0.19
p,p'-DDT	ND	0.16

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	74
13C-p,p'-DDE	92
13C-p,p'-DDT	96
13C-PCB 101	87
13C-PCB 180	97

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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



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PCB/PESTICIDE ANALYSIS REPORT

CL002A

CLIENT SAMPLE I.D: MP-21 Aug 6/99 12:45pm

AXYS ID: L1912-7

CLIENT: Royal Roads University

DATE: 09-Sep-1999

CLIENT No.: 9919

SAMPLE TYPE: WATER

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1.00 L

INSTRUMENT: GC-MS


RUNFILE ID: CL993669.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.45
p,p'-DDE	0.19	0.07
o,p'-DDD	NDR 0.49	0.2
p,p'-DDD	1.4	0.09
o,p'-DDT	1.5	0.15
p,p'-DDT	ND	0.20

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	70
13C-p,p'-DDE	92
13C-p,p'-DDT	96
13C-PCB 101	84
13C-PCB 180	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
6. Due to similarities among the various Aroclor formulations and/or compositional changes caused by weathering, it is not always possible to identify unique Aroclor patterns in environmental samples. Where non-patterned PCBs are observed, Aroclors are quantified as a mixture of the 1242/1254/1260 formulations.



 Approved



AXYS

Axys Analytical
Services Ltd

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

DATE:	14 October 1999	Our File: 9919
TO:	Matt Dodd	Batch ID: CLWG1936
ORGANIZATION:	Royal Roads University	Sample No.: L1912 -8 to -14
ADDRESS:		
FAX:	391-2560	
FROM:	Doug Weir	No. of pages: 12

Attached are the Pesticide analysis results for seven water samples.

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

Regards

TEL: (250) 656-0881
E-MAIL: analytical@axys.com

FAX: (250) 656-4511
toll-free: 1-888-373-0881

BATCH SUMMARY

Batch ID: CLWG1937	Date: 12 October 1999
Analysis Type: DDD, DDE and DDT	Matrix Type: Water
BATCH MAKEUP	
Samples: 9919 L1912 -8 -9 -10 -11 -12 -13 -14	Blank: WG1937-1
	Reference or Spike: WG1937-2
	Duplicate: WG1937-3 (L1912-10)
Comments - 1. No analytical difficulties were encountered for this work and all QA/QC requirements were met.	

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February 1993

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D: Procedural Blank

AXYS ID: WG1937-1

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Blank

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS

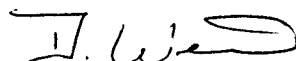
RUNFILE ID: CL993730.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.23
p,p'-DDE	ND	0.20
o,p'-DDD	ND	0.18
p,p'-DDD	ND	0.19
o,p'-DDT	ND	0.15
p,p'-DDT	ND	0.22

Surrogate Standards	% Recovery
13C-p,p'-DDE	84
13C-p,p'-DDT	98
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: WG1937-2

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS

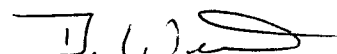
RUNFILE ID: CL993728.D

CONCENTRATION IN: ng/L

Compounds	Determined	Expected	% Recovery
o,p'-DDE	51	55	93
p,p'-DDE	49	51	96
o,p'-DDD	52	52	100
p,p'-DDD	50	48	104
o,p'-DDT	48	49	98
p,p'-DDT	50	46	109

Surrogate Standards	% Recovery
13C-p,p'-DDE	89
13C-p,p'-DDT	94
13C-PCB 101	79

1. Concentrations are recovery corrected


Approved

PCB/PESTICIDE ANALYSIS REPORT

CL002B

CLIENT SAMPLE I.D.: WP-7 06-AUG-99

AXYS ID: L1912-8

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS

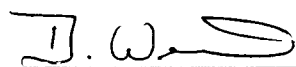
RUNFILE ID: CL993731.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.56
p,p'-DDE	1.7	0.47
o,p'-DDD	11	0.42
p,p'-DDD	35	0.44
o,p'-DDT	ND	0.54
p,p'-DDT	ND	0.79

Surrogate Standards	% Recovery
13C-p,p'-DDE	83
13C-p,p'-DDT	88
13C-PCB 101	71

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: WP-13 06-AUG-99

AXYS ID: L1912-9

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 0.96 L

INSTRUMENT: GC-MS


RUNFILE ID: CL993732.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.31
p,p'-DDE	0.65	0.27
o,p'-DDD	61	0.33
p,p'-DDD	200	0.35
o,p'-DDT	0.99	0.28
p,p'-DDT	1.7	0.40

Surrogate Standards	% Recovery
13C-p,p'-DDE	75
13C-p,p'-DDT	94
13C-PCB 101	62

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: MW-18 06-AUG-99

AXYS ID: L1912-10

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS

RUNFILE ID: CL993733.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.22
p,p'-DDE	0.26	0.19
o,p'-DDD	0.27	0.16
p,p'-DDD	0.60	0.17
o,p'-DDT	ND	0.13
p,p'-DDT	ND	0.19

Surrogate Standards	% Recovery
13C-p,p'-DDE	84
13C-p,p'-DDT	110
13C-PCB 101	72

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.: MW-18 06-AUG-99

AXYS ID: WG1937-3
Duplicate (L1912-10)

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 0.98 L

INSTRUMENT: GC-MS


RUNFILE ID: CL993734.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.21
p,p'-DDE	0.20	0.18
o,p'-DDD	ND	0.23
p,p'-DDD	NDR 0.3	0.25
o,p'-DDT	ND	0.23
p,p'-DDT	ND	0.33

Surrogate Standards	% Recovery
13C-p,p'-DDE	87
13C-p,p'-DDT	110
13C-PCB 101	72

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.: MW-17A 06-AUG-99

AXYS ID: L1912-11

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS


RUNFILE ID: CL993735.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.13
p,p'-DDE	0.27	0.11
o,p'-DDD	0.11	0.10
p,p'-DDD	0.16	0.11
o,p'-DDT	ND	0.14
p,p'-DDT	ND	0.20

Surrogate Standards	% Recovery
13C-p,p'-DDE	94
13C-p,p'-DDT	84
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.: MW-17B 06-AUG-99

AXYS ID: L1912-12

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS

RUNFILE ID: CL993736.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.22
p,p'-DDE	0.25	0.19
o,p'-DDD	ND	0.15
p,p'-DDD	ND	0.16
o,p'-DDT	ND	0.20
p,p'-DDT	ND	0.29

Surrogate Standards	% Recovery
13C-p,p'-DDE	87
13C-p,p'-DDT	81
13C-PCB 101	82

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: MW-21A 06-AUG-99

AXYS ID: L1912-13

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS


RUNFILE ID: CL993737.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.25
p,p'-DDE	0.30	0.21
o,p'-DDD	11	0.12
p,p'-DDD	36	0.13
o,p'-DDT	ND	0.21
p,p'-DDT	NDR 0.31	0.30

Surrogate Standards	% Recovery
13C-p,p'-DDE	76
13C-p,p'-DDT	86
13C-PCB 101	68

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: MW-21B 06-AUG-99

AXYS ID: L1912-14

CLIENT: Royal Roads University

DATE: 14-Oct-1999

CLIENT NO.: 9919

SAMPLE TYPE: Water

METHOD NO.: CL-W-04/Ver.2

SAMPLE SIZE: 1 L

INSTRUMENT: GC-MS

RUNFILE ID: CL993738.D

CONCENTRATION IN: ng/L

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.19
p,p'-DDE	0.20	0.16
o,p'-DDD	0.65	0.13
p,p'-DDD	0.64	0.13
o,p'-DDT	ND	0.38
p,p'-DDT	ND	0.55

Surrogate Standards	% Recovery
13C-p,p'-DDE	76
13C-p,p'-DDT	87
13C-PCB 101	67

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

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

Project Name/No: RAINY HOLLOW MONITORING
1999

RRU Contact: MATT DODD
Phone/Fax #: (250) 391-2583 / 391-2560 (fax)
E-mail: matt.dodd@royalroads.ca

Laboratory: AXYS ANALYTICAL
Lab Contact: LAURIE PHILLIPS
Phone/Fax #: (250) 656-0881

Sample #	Date	Time	Sample Type	Preservative	Analysis Requested						Remarks/Notes
					DDTS	1 ng/L					
KLE-1	Aug 7, 99	9:25am	water	None	X						
KLE-2	Aug 6, 99	9:25 AM	water	✓	X						
KLE-4	Aug 7, 99	8:55am	water	✓	X						
MIP-1	Aug 6, 99	12:15 PM	water	✓	X						
MIP-22	Aug 6, 99	1:05 PM	water	✓	X						
MIP-3	Aug 6, 99	1:25 PM	water	✓	X						
MIP-21	Aug 6, 99	12:45 PM	water	✓	X						
WIP-7	Aug 6, 99	11:10 AM	water	✓	X						
WIP-13	Aug 6, 99	10:10 AM	water	✓	X						
MW-18	Aug 6, 99	10:45 AM	water	✓	X						

Relinquished By: <u>DODD</u>	Date: <u>Aug 7, 99</u>	Received By:	Date:	Special Instructions: <u>DECANT BEFORE ANALYSIS</u>
	Time: <u>5:30 PM</u>		Time:	
Relinquished By:	Date:	Received By:	Date:	
	Time:		Time:	



2005 Sooke Road
Victoria, BC, V9B 5Y2

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

2/2

Project Name/No: RAINY HOLLOW MONITORING
1999

RRU Contact: MATT DODD
Phone/Fax #: (250) 341-2583 / 341-2560 (fax)
E-mail: matt.dodd@royalroads.ca

Laboratory: AXYS ANALYTICAL
Lab Contact: LAURIE PHILLIPS
Phone/Fax #: (250) 656 0881

Sample #	Date	Time	Sample Type	Preservative	Analysis Requested						Remarks/Notes
					DDTS	1.1g/L					
MW-17A	Aug 6 '99	3:25 PM	WATER	NONE	X						
MW-17B	✓	3:50 PM	WATER	NONE	X						
MW-21A	✓	11:40 AM	WATER	NONE	X						
MW-21B	✓	12:00 PM	WATER	NONE	X						

Relinquished By: <u>M. Dodd</u>	Date: <u>Aug 7, 99</u>	Received By:	Date:	Special Instructions: <u>DECANT BEFORE ANALYSIS</u>
	Time: <u>5:30 PM</u>		Time:	
Relinquished By:	Date:	Received By:	Date:	
	Time:		Time:	

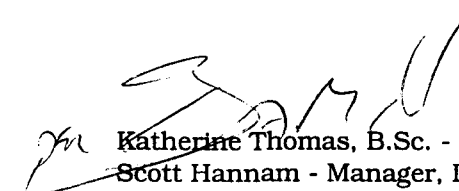
**APPENDIX C-2:
ASL CHEMICAL ANALYSIS REPORT FOR METALS AND
HYDROCARBONS**



CHEMICAL ANALYSIS REPORT

Date: August 25, 1999
ASL File No. K8379
Report On: Rainy Hallow Water Analysis
Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2
Attention: **Dr. Matthew Dodd**, Professor
Received: August 9, 1999

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:


Katherine Thomas, B.Sc. - Supervisor, Trace Metals Lab
Scott Hannam - Manager, Laboratory Operations



RESULTS OF ANALYSIS - Water

File No. K8379

Sample ID	KLE-1	KLE-2	KLE-4	MP-1	MP-3
Sample Date	99 08 07	99 08 06	99 08 07	99 08 06	99 08 06
Sample Time	09:25	13:05	08:55	12:15	13:35

Physical Tests

Hardness	CaCO3	60.7	185	155	236	237
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Total Metals

Aluminum	T-Al	5.64	23.7	18.3	-	-
Antimony	T-Sb	0.0004	0.0005	0.0005	-	-
Arsenic	T-As	0.0019	0.0058	0.0049	-	-
Barium	T-Ba	0.04	0.13	0.11	-	-
Beryllium	T-Be	<0.001	<0.001	<0.001	-	-
Boron	T-B	<0.1	<0.1	0.1	-	-
Cadmium	T-Cd	0.00013	0.00030	0.00026	-	-
Calcium	T-Ca	17.4	46.7	39.7	-	-
Chromium	T-Cr	0.0124	0.0656	0.0510	-	-
Cobalt	T-Co	0.0036	0.0161	0.0129	-	-
Copper	T-Cu	0.0100	0.0405	0.0280	-	-
Iron	T-Fe	7.46	32.7	26.0	-	-
Lead	T-Pb	0.00169	0.00525	0.00518	-	-
Magnesium	T-Mg	4.2	16.7	13.6	-	-
Manganese	T-Mn	0.150	0.626	0.504	-	-
Mercury	T-Hg	<0.00005	<0.00005	<0.00005	-	-
Molybdenum	T-Mo	<0.03	<0.03	<0.03	-	-
Nickel	T-Ni	0.006	0.029	0.023	-	-
Potassium	T-K	<2	3	3	-	-
Selenium	T-Se	<0.001	<0.001	<0.001	-	-
Silver	T-Ag	0.00004	0.00014	0.00014	-	-
Sodium	T-Na	2	3	2	-	-
Thallium	T-Tl	0.00009	0.00011	0.00008	-	-
Titanium	T-Ti	0.45	2.23	1.62	-	-
Uranium	T-U	0.0008	0.0011	0.0010	-	-
Vanadium	T-V	<0.03	0.09	0.07	-	-
Zinc	T-Zn	0.024	0.086	0.069	-	-

Results are expressed as milligrams per litre except where noted.

< = Less than the detection limit indicated.

EPH = Extractable Petroleum Hydrocarbons.

VPH = Volatile Petroleum Hydrocarbons.



RESULTS OF ANALYSIS - Water

File No. K8379

Sample ID	MP-21	MP-22	MW-17A	MW-18	MW-21A
Sample Date	99 08 06	99 08 06	99 08 06	99 08 06	99 08 06
Sample Time	12:45	12:55	15:20	10:35	11:30

Physical Tests

Hardness	CaCO3	254	256	223	255	285
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Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
EPH = Extractable Petroleum Hydrocarbons.
VPH = Volatile Petroleum Hydrocarbons.



RESULTS OF ANALYSIS - Water

File No. K8379

Sample ID	WP-7	WP-13
Sample Date	99 08 06	99 08 06
Sample Time	11:00	10:00

Physical Tests

Hardness	CaCO3	223	269
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Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
EPH = Extractable Petroleum Hydrocarbons.
VPH = Volatile Petroleum Hydrocarbons.



RESULTS OF ANALYSIS - Water

File No. K8379

Sample ID	MP-1	MP-3	MP-21	MP-22	MW-16
Sample Date	99 08 06	99 08 06	99 08 06	99 08 06	99 08 06
Sample Time	12:15	13:35	12:45	12:55	16:45

Dissolved Metals

Aluminum	D-Al	0.013	0.015	0.012	0.010	-
Antimony	D-Sb	<0.2	<0.2	<0.2	<0.2	-
Arsenic	D-As	<0.2	<0.2	<0.2	<0.2	-
Barium	D-Ba	0.05	0.06	0.06	0.06	-
Beryllium	D-Be	<0.005	<0.005	<0.005	<0.005	-
Boron	D-B	<0.1	<0.1	<0.1	<0.1	-
Cadmium	D-Cd	<0.0002	<0.0002	<0.0002	<0.0002	-
Calcium	D-Ca	85.6	88.5	93.6	94.7	-
Chromium	D-Cr	<0.01	<0.01	<0.01	<0.01	-
Cobalt	D-Co	<0.01	<0.01	<0.01	<0.01	-
Copper	D-Cu	<0.01	<0.01	<0.01	<0.01	-
Iron	D-Fe	<0.03	5.72	8.03	8.56	-
Lead	D-Pb	<0.001	0.003	0.007	0.005	-
Magnesium	D-Mg	5.4	4.0	4.8	4.8	-
Manganese	D-Mn	<0.005	1.31	1.90	1.91	-
Mercury	D-Hg	<0.00005	<0.00005	<0.00005	<0.00005	-
Molybdenum	D-Mo	<0.03	<0.03	<0.03	<0.03	-
Nickel	D-Ni	<0.05	<0.05	<0.05	<0.05	-
Selenium	D-Se	<0.001	<0.001	<0.001	<0.001	-
Silver	D-Ag	<0.0001	<0.0001	<0.0001	<0.0001	-
Sodium	D-Na	8	2	3	3	-
Thallium	D-Tl	<0.0001	<0.0001	<0.0001	<0.0001	-
Uranium	D-U	0.00128	0.00008	0.00007	0.00007	-
Zinc	D-Zn	<0.005	1.46	3.12	2.62	-

Non-halogenated Volatiles

Benzene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Ethylbenzene	<0.0005	0.0022	0.0031	0.0012	0.0009
Toluene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
meta- & para-Xylene	<0.0005	0.0027	0.0037	0.0018	0.0008
ortho-Xylene	<0.0005	0.0009	0.0013	0.0005	<0.0005
Volatile Hydrocarbons (VH) C6-10	<0.1	0.6	0.6	0.4	1.1
VPH C6-10 (calculated)	<0.1	0.6	0.6	0.4	1.1

Extractables

EPH (C10-19)	<0.3	1.3	3.8	1.4	7.4
EPH (C19-32)	<1	<1	<1	<1	<1

Results are expressed as milligrams per litre except where noted.

< = Less than the detection limit indicated.

EPH = Extractable Petroleum Hydrocarbons.

VPH = Volatile Petroleum Hydrocarbons.



RESULTS OF ANALYSIS - Water

File No. K8379

Sample ID	MW-17A	MW-17B	MW-18	MW-21A	MW-21B
Sample Date	99 08 06	99 08 06	99 08 06	99 08 06	99 08 06
Sample Time	15:20	15:45	10:35	11:30	11:55

Dissolved Metals

Aluminum	D-Al	<0.005	-	0.040	0.01	-
Antimony	D-Sb	<0.2	-	<0.2	<0.2	-
Arsenic	D-As	<0.2	-	<0.2	<0.2	-
Barium	D-Ba	0.11	-	0.05	0.06	-
Beryllium	D-Be	<0.005	-	<0.005	<0.005	-
Boron	D-B	<0.1	-	<0.1	<0.1	-
Cadmium	D-Cd	<0.0002	-	<0.0002	<0.0004	-
Calcium	D-Ca	83.0	-	89.9	103	-
Chromium	D-Cr	<0.01	-	<0.01	<0.01	-
Cobalt	D-Co	<0.01	-	<0.01	<0.01	-
Copper	D-Cu	<0.01	-	<0.01	<0.01	-
Iron	D-Fe	26.8	-	0.04	0.64	-
Lead	D-Pb	<0.001	-	<0.001	<0.002	-
Magnesium	D-Mg	3.9	-	7.4	6.8	-
Manganese	D-Mn	2.10	-	<0.005	1.50	-
Mercury	D-Hg	<0.00005	-	<0.00005	<0.00005	-
Molybdenum	D-Mo	<0.03	-	<0.03	<0.03	-
Nickel	D-Ni	<0.05	-	<0.05	<0.05	-
Selenium	D-Se	<0.001	-	<0.001	<0.002	-
Silver	D-Ag	<0.0001	-	<0.0001	<0.0002	-
Sodium	D-Na	3	-	18	11	-
Thallium	D-Tl	<0.0001	-	<0.0001	<0.0002	-
Uranium	D-U	0.00024	-	0.00186	0.00120	-
Zinc	D-Zn	<0.005	-	<0.005	<0.005	-

Non-halogenated Volatiles

Benzene	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Ethylbenzene	0.0198	0.0151	<0.0005	<0.0005	<0.0005
Toluene	0.0011	0.0011	<0.0005	<0.0005	<0.0005
meta- & para-Xylene	0.0212	0.0159	<0.0005	<0.0005	<0.0005
ortho-Xylene	0.0040	0.0023	<0.0005	<0.0005	<0.0005
Volatile Hydrocarbons (VH) C6-10	1.8	1.9	<0.1	<0.1	<0.1
VPH C6-10 (calculated)	1.7	1.8	<0.1	<0.1	<0.1

Extractables

EPH (C10-19)	1.6	1.8	<0.3	0.4	<0.3
EPH (C19-32)	<1	<1	<1	<1	<1

Results are expressed as milligrams per litre except where noted.
 < = Less than the detection limit indicated.
 EPH = Extractable Petroleum Hydrocarbons.
 VPH = Volatile Petroleum Hydrocarbons.

**RESULTS OF ANALYSIS - Water**

File No. K8379

Sample ID	WP-7	WP-13	ASL Travel Blank
Sample Date	99 08 06	99 08 06	
Sample Time	11:00	10:00	

Dissolved Metals

Aluminum	D-Al	0.033	0.073	-
Antimony	D-Sb	<0.2	<0.2	-
Arsenic	D-As	<0.2	<0.2	-
Barium	D-Ba	0.07	0.07	-
Beryllium	D-Be	<0.005	<0.005	-
Boron	D-B	<0.1	<0.1	-
Cadmium	D-Cd	<0.0002	<0.0002	-
Calcium	D-Ca	82.0	96.4	-
Chromium	D-Cr	<0.01	<0.01	-
Cobalt	D-Co	<0.01	<0.01	-
Copper	D-Cu	<0.01	<0.01	-
Iron	D-Fe	15.4	4.87	-
Lead	D-Pb	<0.001	<0.001	-
Magnesium	D-Mg	4.4	6.9	-
Manganese	D-Mn	1.59	0.888	-
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	3	5	-
Thallium	D-Tl	<0.0001	<0.0001	-
Uranium	D-U	0.00011	0.00076	-
Zinc	D-Zn	<0.005	<0.005	-

Non-halogenated Volatiles

Benzene	<0.0005	<0.0005	<0.0005
Ethylbenzene	0.0168	<0.0005	<0.0005
Toluene	0.0008	<0.0005	<0.0005
meta- & para-Xylene	0.0358	<0.0005	<0.0005
ortho-Xylene	0.0096	<0.0005	<0.0005
Volatile Hydrocarbons (VH) C6-10	2.1	0.2	<0.1
VPH C6-10 (calculated)	2.1	0.2	<0.1

Extractables

EPH (C10-19)	5.8	3.9	-
EPH (C19-32)	<1	<1	-

Results are expressed as milligrams per litre except where noted.

< = Less than the detection limit indicated.

EPH = Extractable Petroleum Hydrocarbons.

VPH = Volatile Petroleum Hydrocarbons.



Appendix 1 - QUALITY CONTROL - Replicates

File No. K8379

Water	MW-21A	MW-21A
	99 08 06 11:30	QC # 167451

Non-halogenated Volatiles

Benzene	<0.0005	<0.0005
Ethylbenzene	<0.0005	<0.0005
Toluene	<0.0005	0.0058
meta- & para-Xylene	<0.0005	<0.0005
ortho-Xylene	<0.0005	<0.0005
Volatile Hydrocarbons (VH) C6-10	<0.1	0.1
VPH C6-10 (calculated)	<0.1	0.1

Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.
EPH = Extractable Petroleum Hydrocarbons.
VPH = Volatile Petroleum Hydrocarbons.



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"

Volatile Organic Compounds in Water

This analysis is based on United States Environmental Protection Agency Methods 624/524 and 5030/8260. These procedures involve purge and trap extraction of the sample and subsequent analysis of the volatile components by capillary column gas chromatography with mass spectrometric detection.

Volatile Petroleum Hydrocarbons (VPH) in Water

Volatile Petroleum Hydrocarbons (VPH) is a calculation defined by British Columbia Ministry of Environment, Lands and Parks (BCMELP) Draft Method "Calculation of Volatile Petroleum Hydrocarbons in Solids or Water", June 1998. The concentrations of specific Monocyclic Aromatic Hydrocarbons (Benzene, Toluene, Ethylbenzene, Xylenes and Styrene) are subtracted from the collective concentration of Volatile Hydrocarbons (VH) that elute between n-hexane (nC6) and n-decane (nC10). Analysis of Volatile Hydrocarbons adheres to all prescribed elements of BCMELP method "Volatile Hydrocarbons in Water", June 1998.

Extractable Hydrocarbons in Water

This analysis is carried out using procedures adapted from U.S. EPA Methods 3510/8015 (Publ. #SW-846, 3rd ed., Washington, DC 20460) and British Columbia Ministry of Environment, Lands and Parks Method for "Extractable Petroleum Hydrocarbons in Water by GC/FID" (January 1996). The procedure involves a methylene chloride solvent extraction followed by analysis of the extract by capillary column gas chromatography with flame ionization detection. Results are not corrected for Polycyclic Aromatic Hydrocarbons (PAHs) for Extractable Petroleum Hydrocarbon (LEPH/HEPH) purposes.



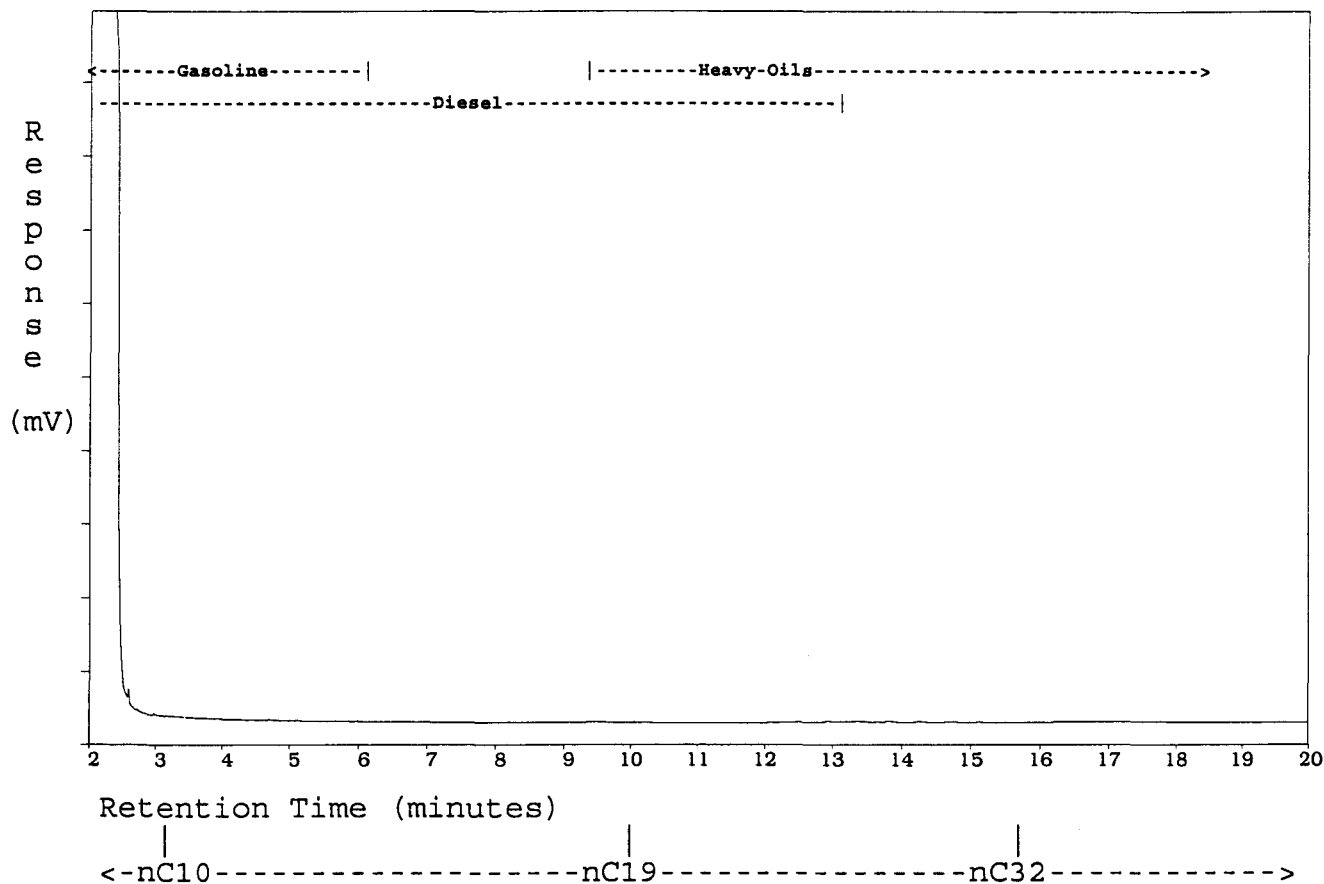
File No. K8379

APPENDIX 3
FIGURES

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MP-1 99 08 06 12:15

File Name: C:\TEH2\AU10\EH3AU10.58R ASL Sample ID: K8379-T--4 Sample acquired: AUG 11, 1999 10:10:36
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 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 top of this report represents the approximate hydrocarbon range of common petroleum products. The scale at the bottom of the report shows retention times with the approximate positions of key marker compounds indicated. Comparison of this report with those of reference standards may also assist in characterizing the hydrocarbons present.

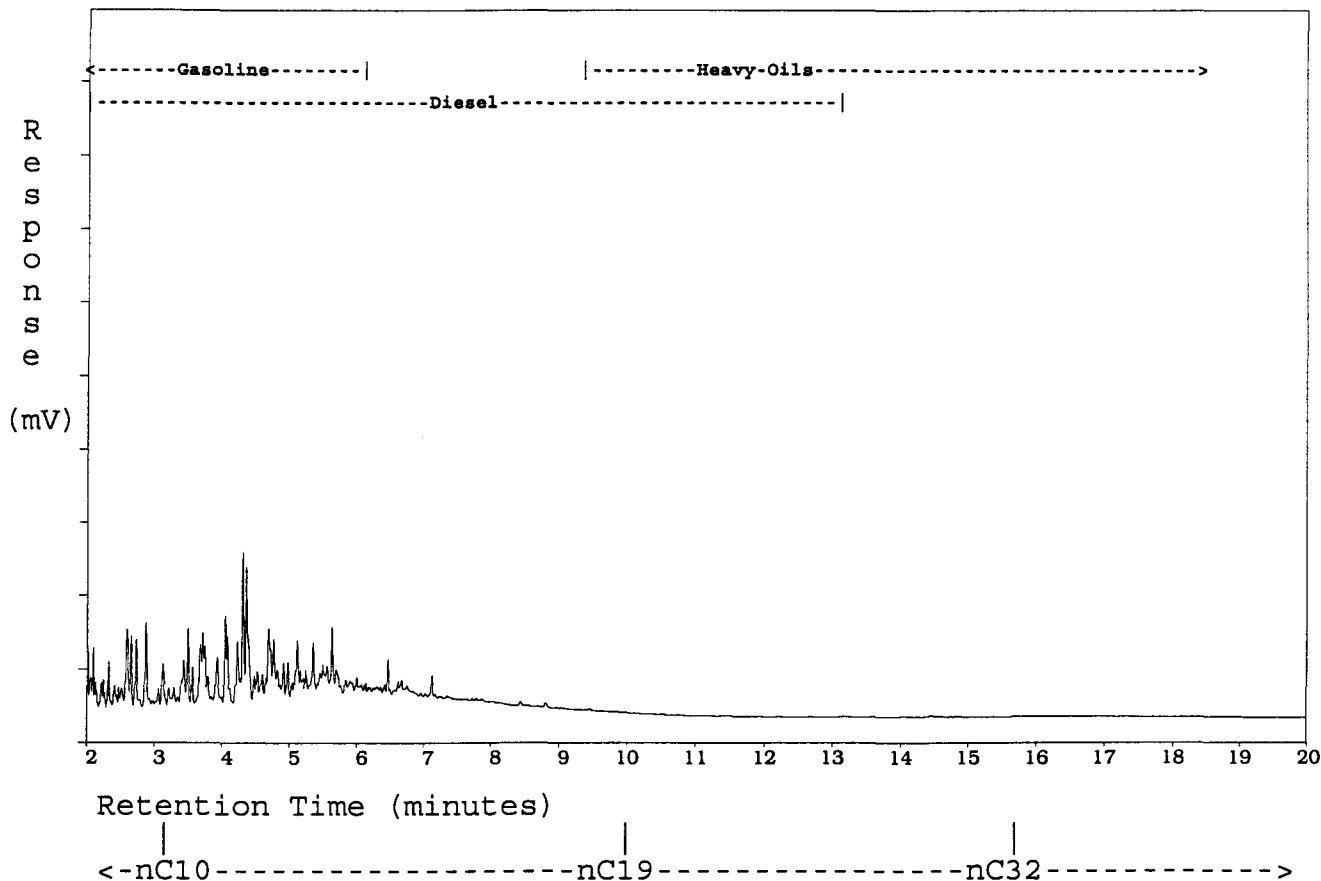
Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report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

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MP-3 99 08 06 13:35

File Name: C:\TEH2\AU10\EH3AU10.59R ASL Sample ID: K8379-T--5 Sample acquired: AUG 11, 1999 10:46:12

Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 545.0 Dilution: 1.0

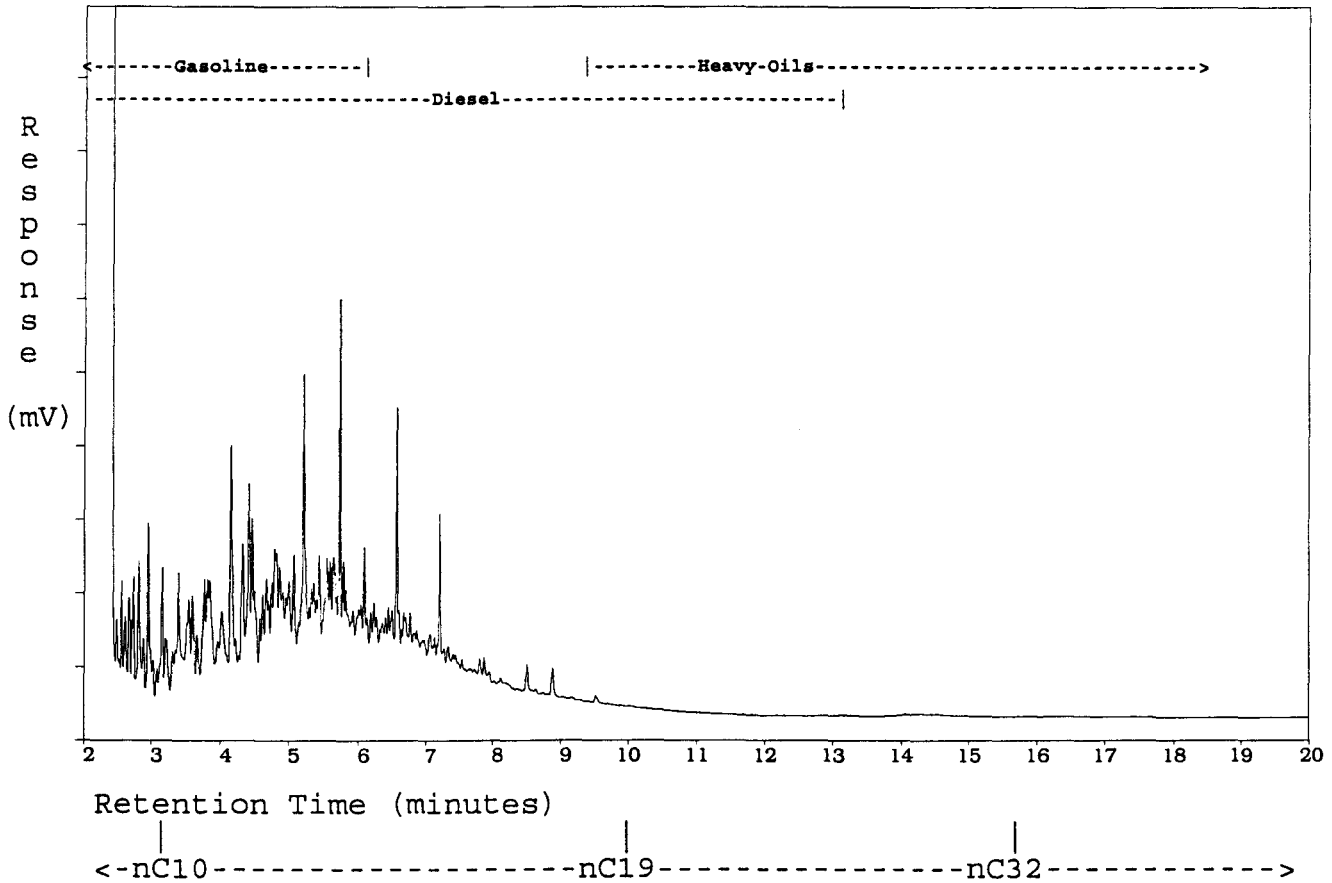
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MP-21 99 08 06 12:45

File Name: C:\TEH2\AU10\EH3AU10.60R ASL Sample ID: K8379-T--6 Sample acquired: AUG 11, 1999 10:46:12
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 545.0 Dilution: 1.0

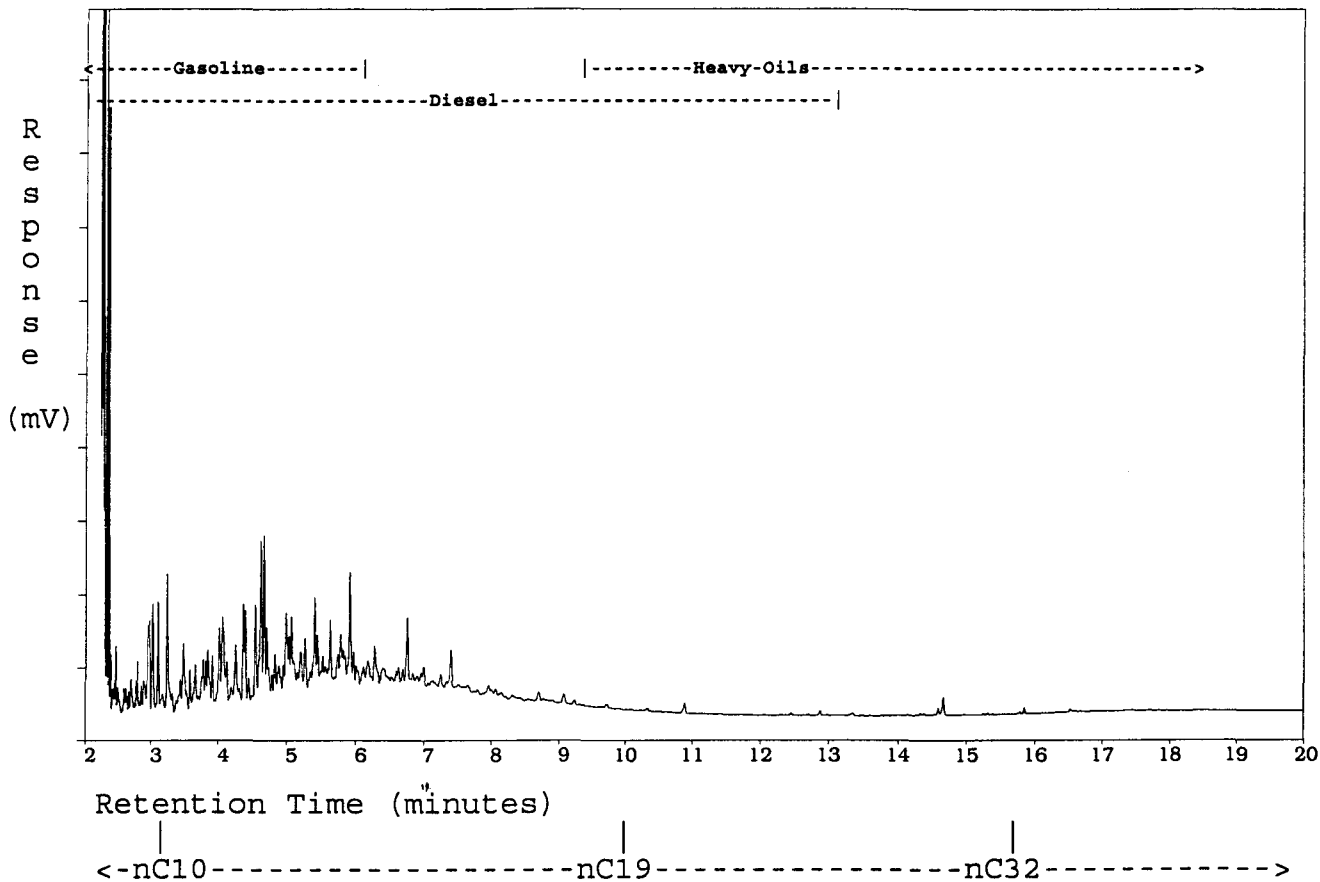
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MP-22 99 08 06 12:55

File Name: C:\TEH2\AU11\EH3AU11.13R ASL Sample ID: K8379-T--7 Sample acquired: AUG 11, 1999 19:01:24
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

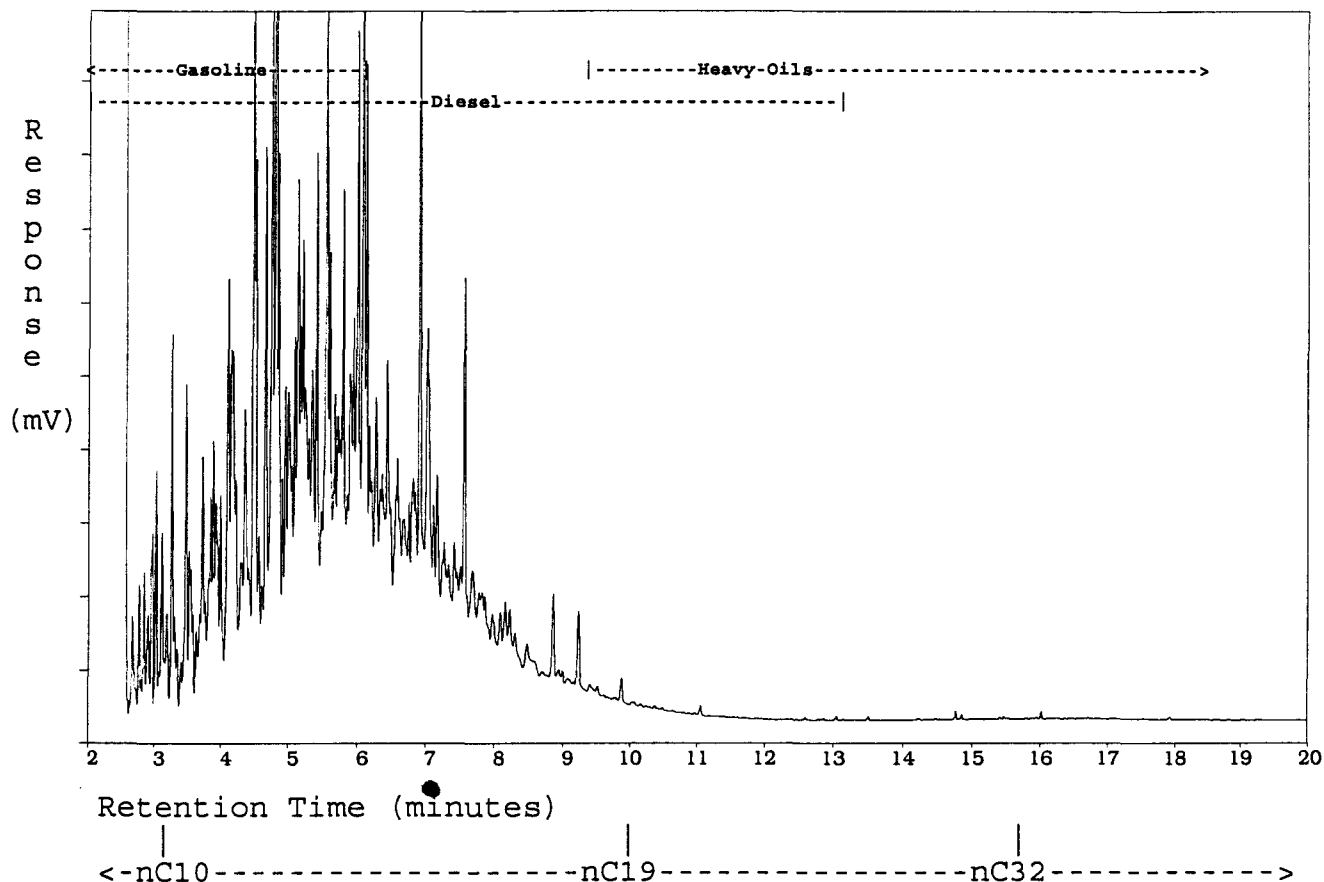
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MW-16 99 08 06 16:45

File Name: C:\TEH2\AU11\EH3AU11.12R ASL Sample ID: K8379-T--8 Sample acquired: AUG 11, 1999 18:25:36
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

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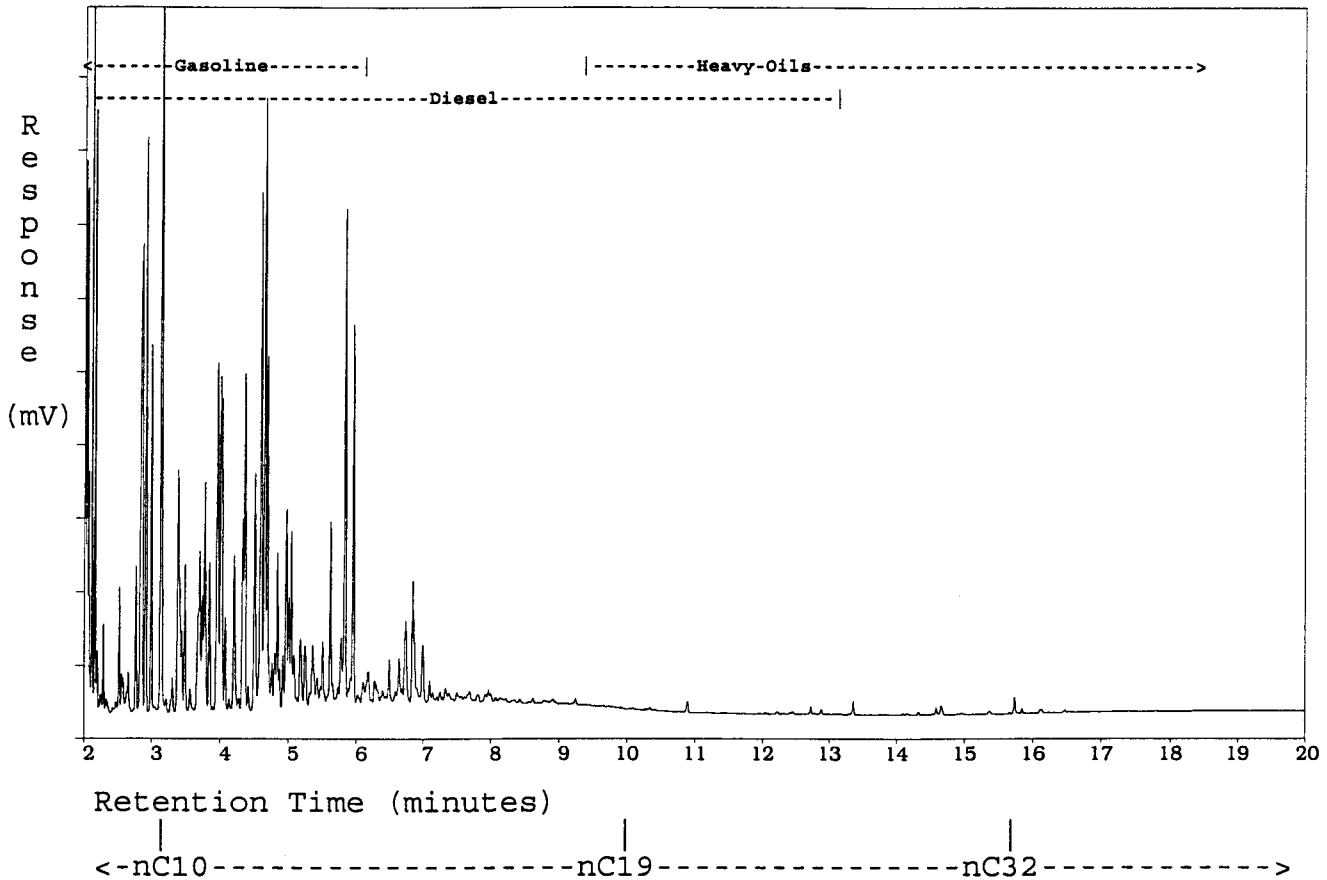
Note: This Hydrocarbon Distribution Report was produced using a temperature profile which was implemented on June 21st, 1999. Under these new conditions hydrocarbon compounds elute sooner than before, although characteristic patterns will appear similar. Please exercise caution when comparing this report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

HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MW-17A 99 08 06 15:20

File Name: C:\TEH2\AU11\EH3AU11.15R ASL Sample ID: K8379-T--9 Sample acquired: AUG 11, 1999 19:36:40

Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

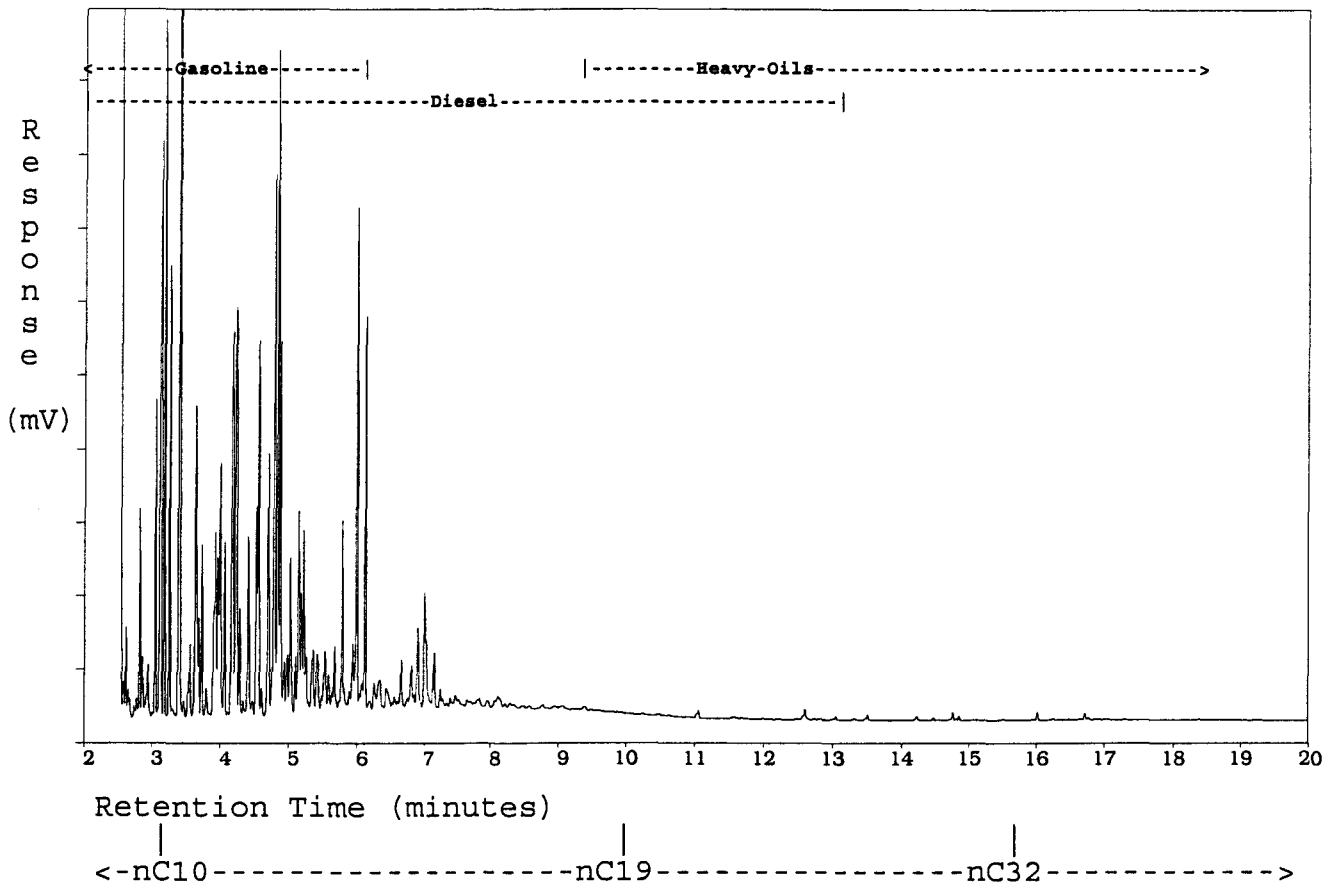
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MW-17B 99 08 06 15:45

File Name: C:\TEH2\AU11\EH3AU11.14R ASL Sample ID: K8379-T--10 Sample acquired: AUG 11, 1999 19:01:24
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

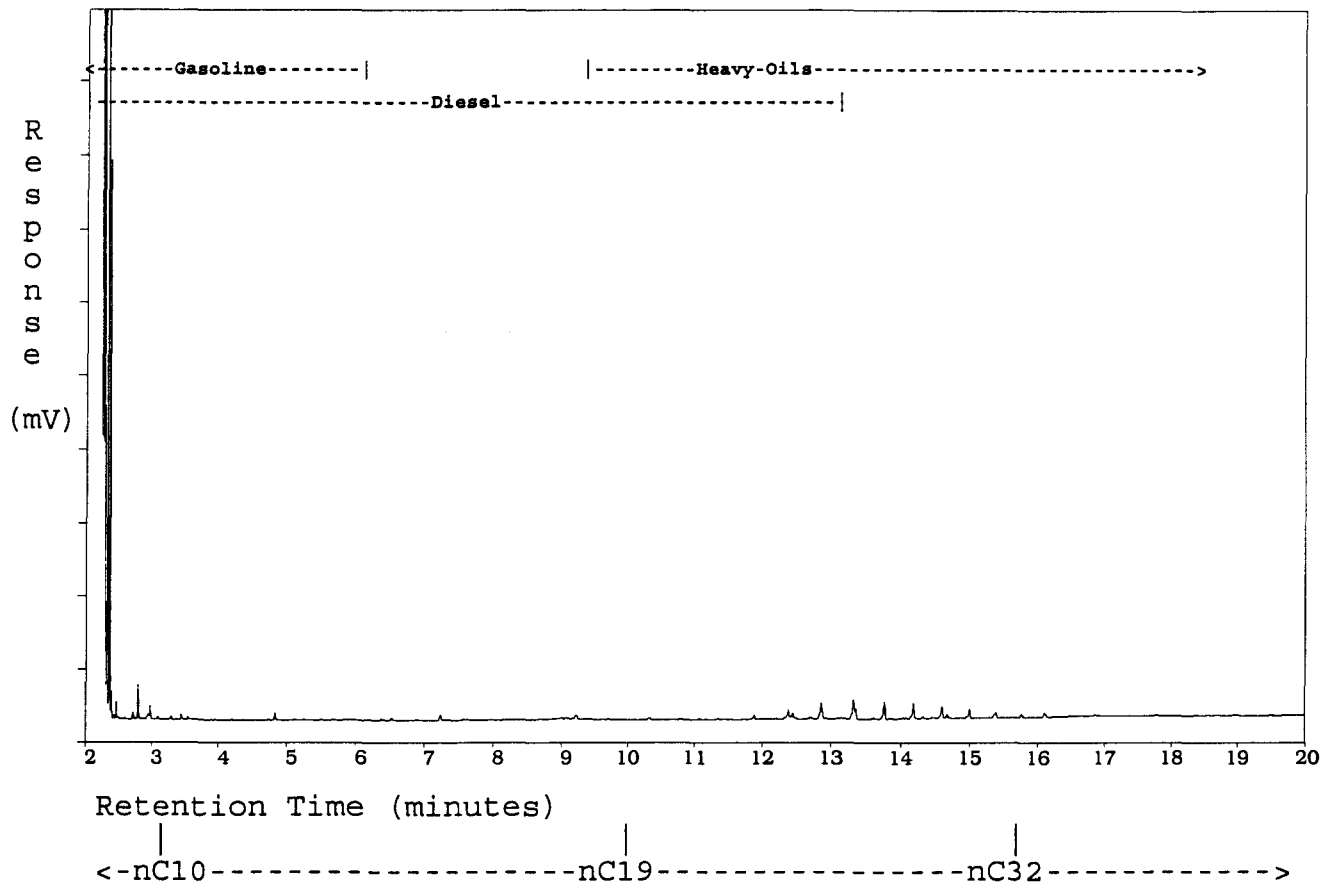
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MW-18 99 08 06 10:35

File Name: C:\TEH2\AU11\EH3AU11.17R ASL Sample ID: K8379-T--11 Sample acquired: AUG 11, 1999 20:12:08
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

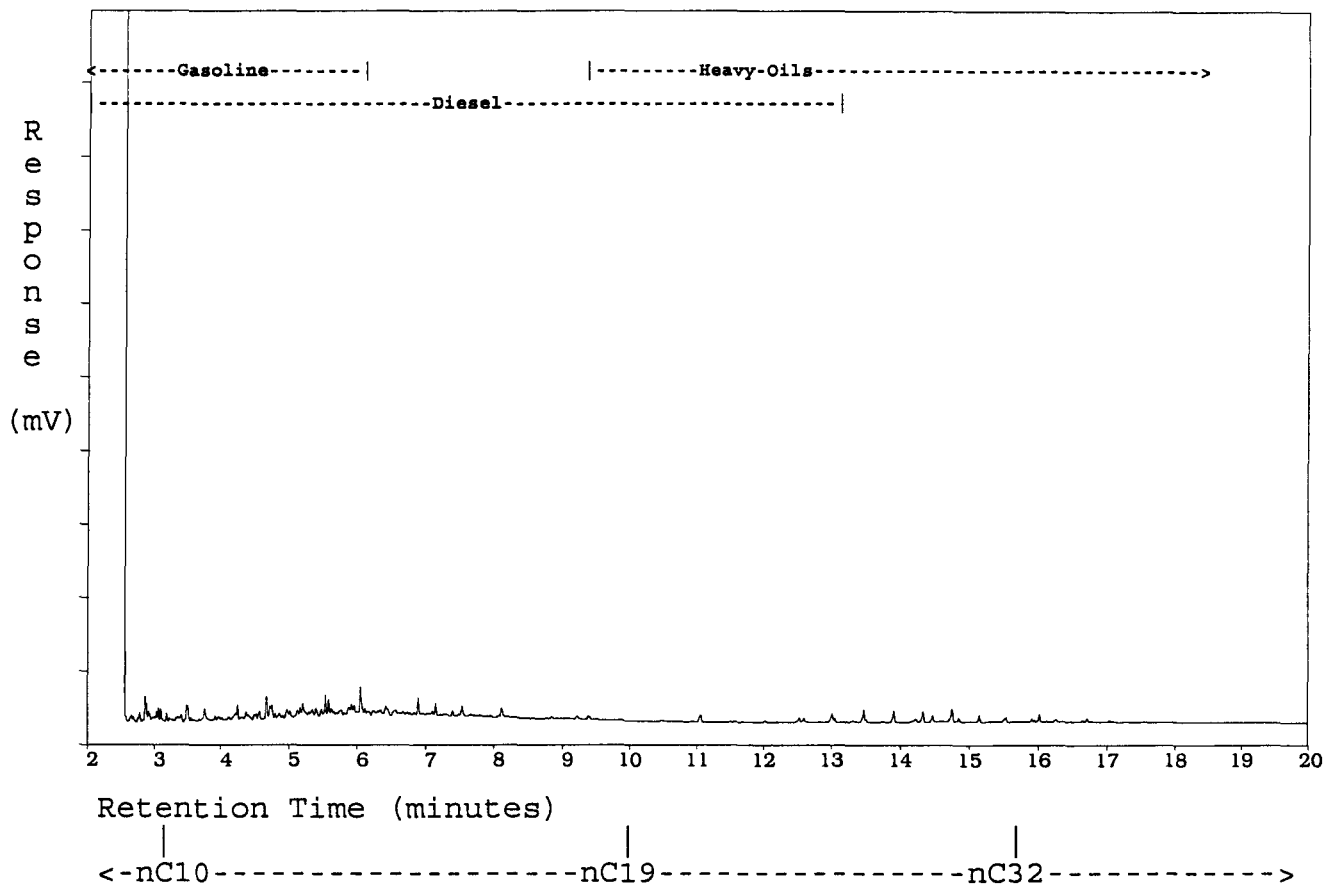
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MW-21A 99 08 06 11:30

File Name: C:\TEH2\AU11\EH3AU11.16R ASL Sample ID: K8379-T--12 Sample acquired: AUG 11, 1999 19:36:40
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

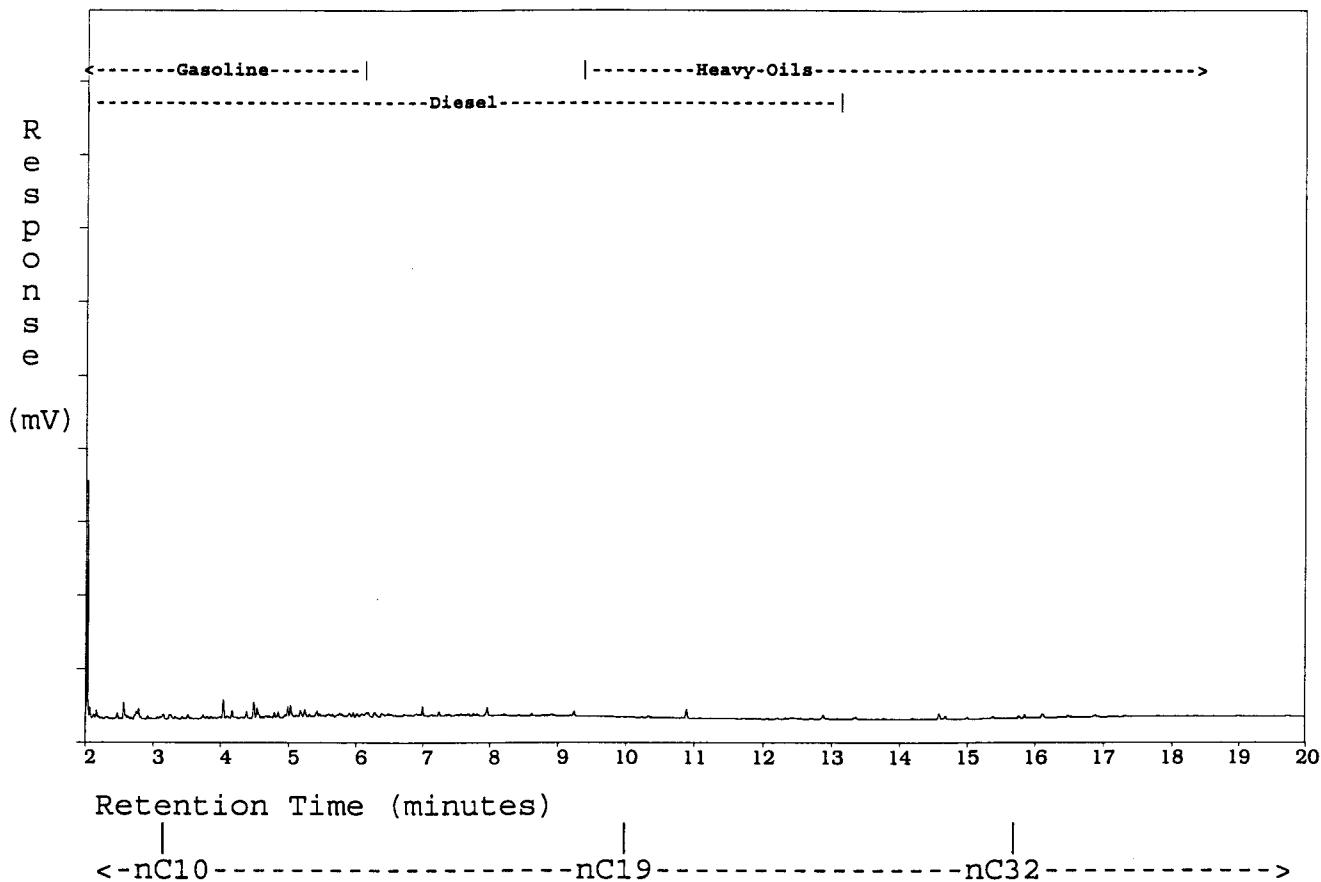
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: MW-21B 99 08 06 11:55

File Name: C:\TEH2\AU11\EH3AU11.19R ASL Sample ID: K8379-T--13 Sample acquired: AUG 11, 1999 20:47:42
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

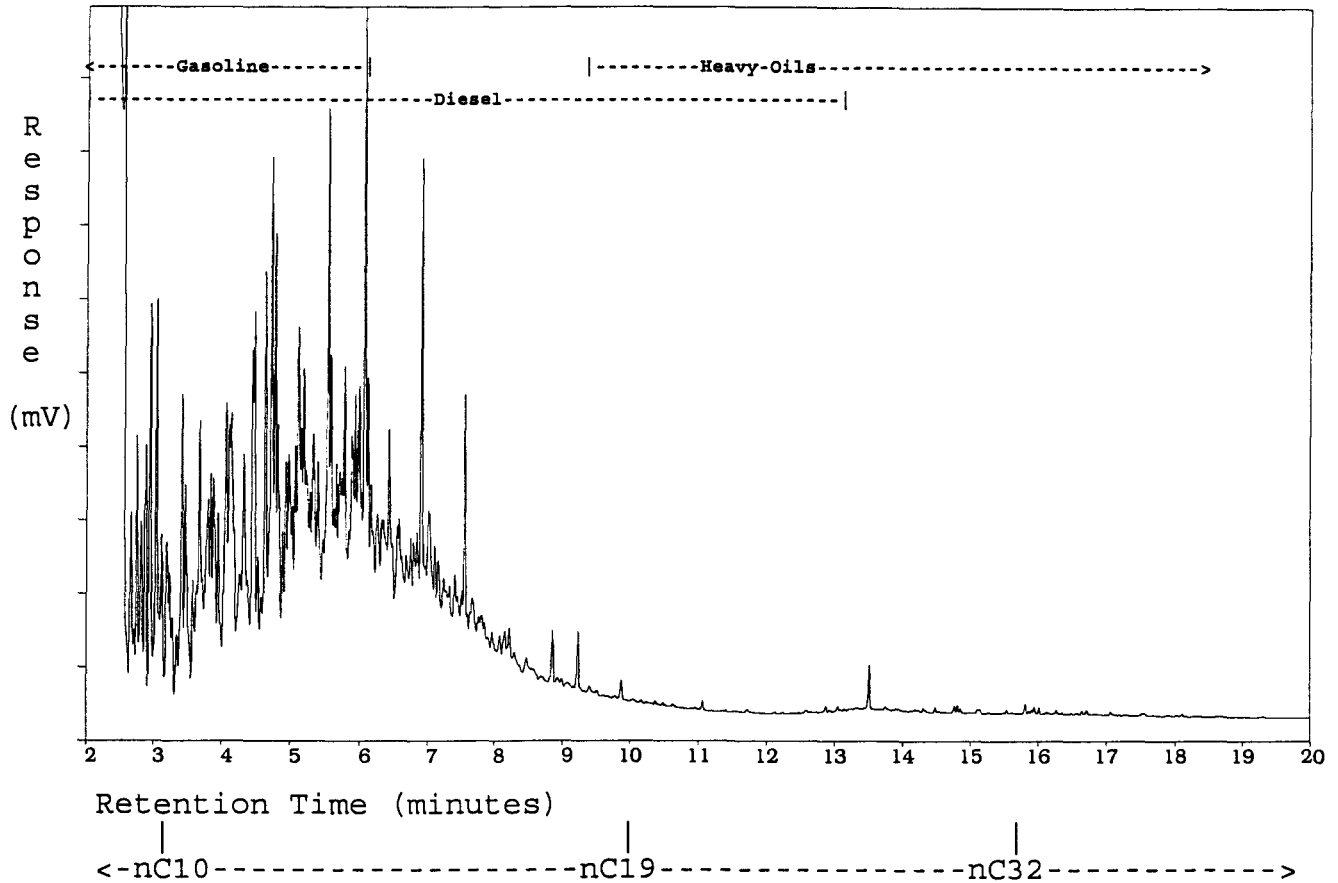
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: WP-7 99 08 06 11:00

File Name: C:\TEH2\AU11\EH3AU11.18R ASL Sample ID: K8379-T--14 Sample acquired: AUG 11, 1999 20:12:08
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

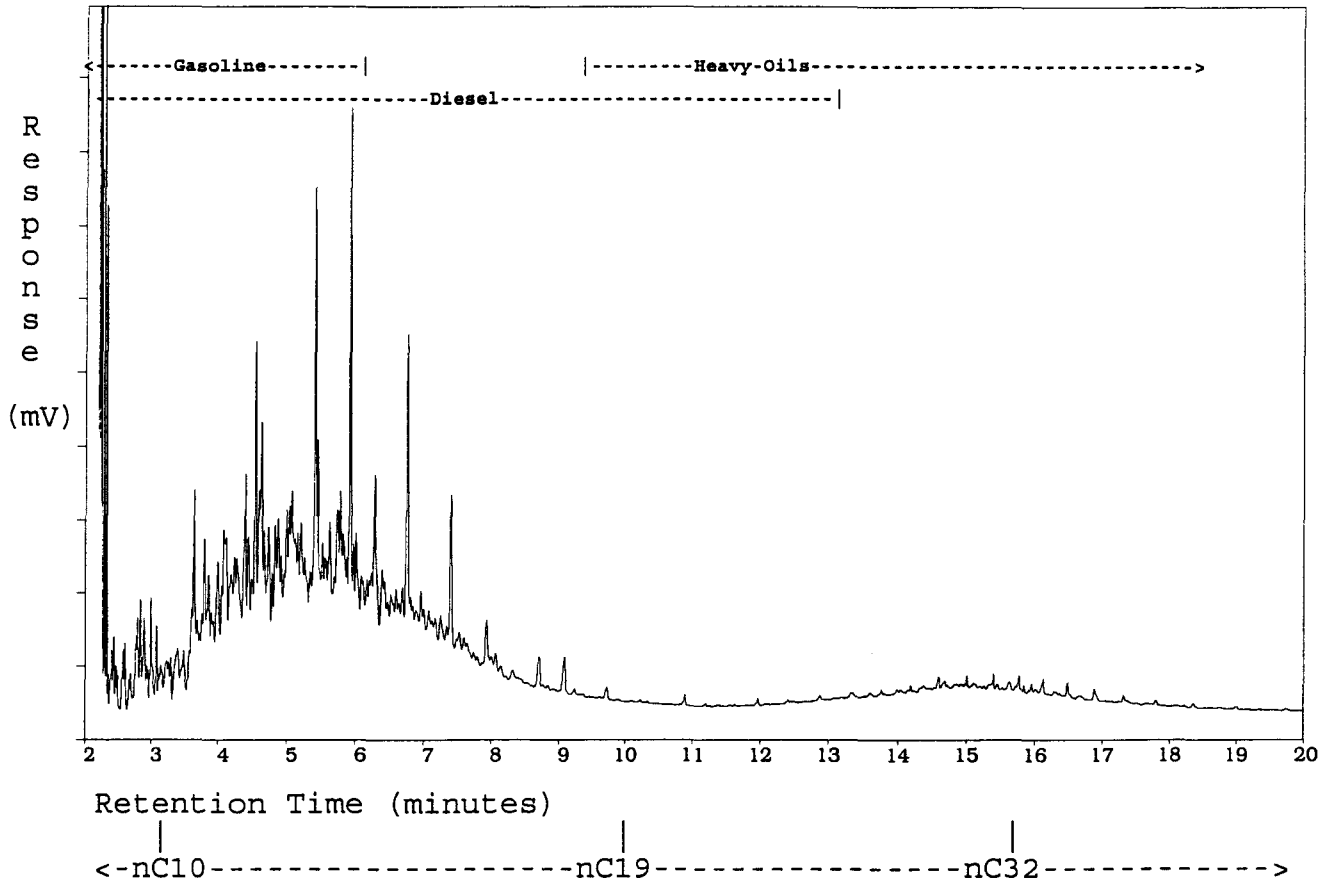
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HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: WP-13 99 08 06 10:00

File Name: C:\TEH2\AU11\EH3AU11.21R ASL Sample ID: K8379-T--15 Sample acquired: AUG 11, 1999 21:23:15
Chromatogram Scale: 50.0 millivolts



Sample Amt. (g or mL): 540.0 Dilution: 1.0

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