

**INITIAL ENVIRONMENTAL ASSESSMENT  
OF THE FORMER  
GUELPH COAL GASIFICATION PLANT  
FINAL REPORT**



**CH2M HILL  
ENGINEERING  
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FINAL REPORT**

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## 1.0 INTRODUCTION

### 1.1 Background

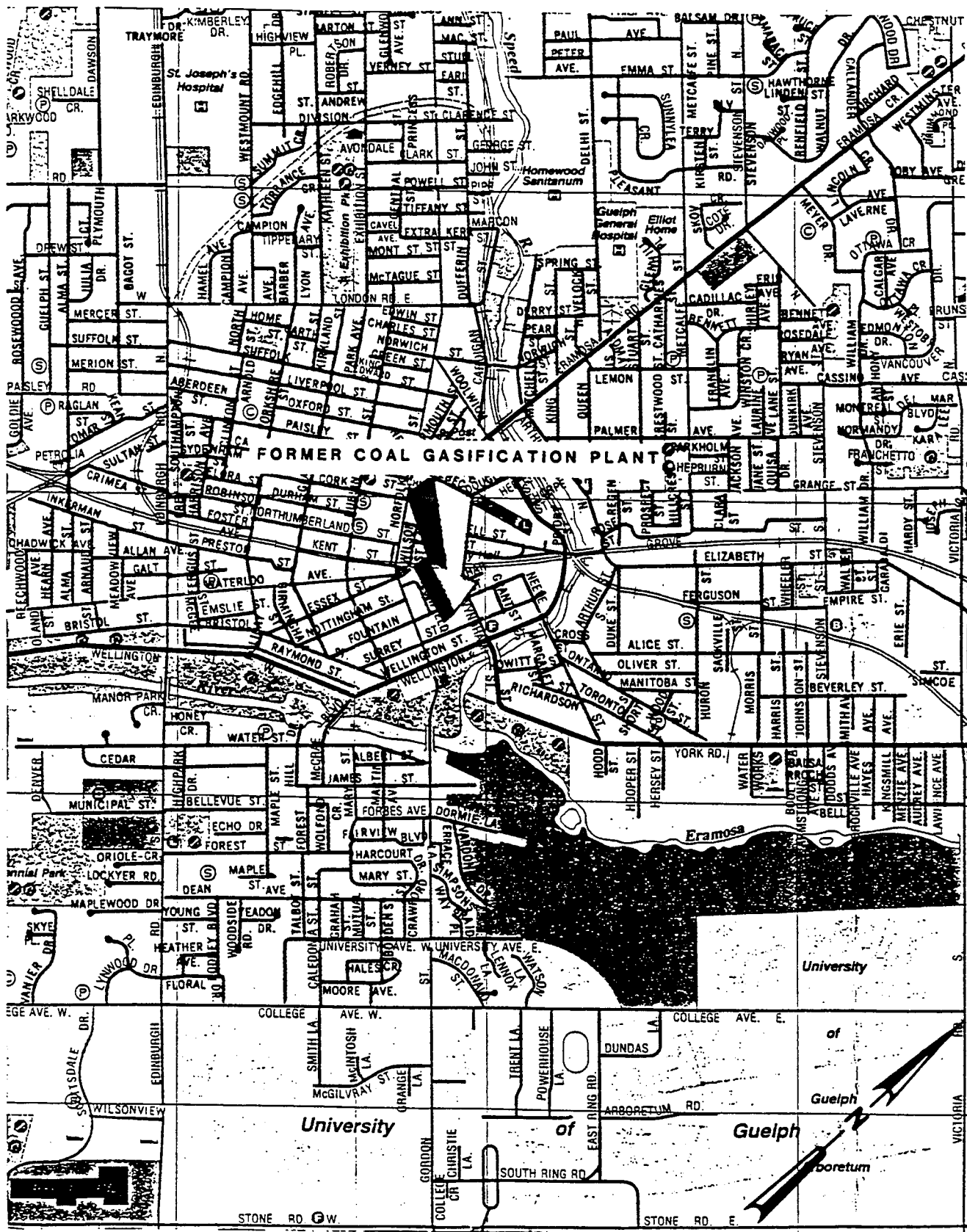
Concern regarding the potential adverse health and environmental implications resulting from manufactured gas plant wastes prompted the Ontario Ministry of the Environment (MOE) to develop a province wide inventory for these plants. This initial study documented readily available evidence of waste presence and general site characteristics. Further investigations were subsequently launched at sites where wastes were confirmed to be present. The approach adopted for sites where no wastes were apparent during the inventory study visit was to commission a further site investigation study at each of these "low priority" sites to verify the absence of coal tar contamination. Two of these "low priority" sites are presently owned by Union Gas Limited.

In January of 1988, Union Gas Ltd. issued a Request for Proposal (RFP) for an initial investigation of two "low priority" former coal gasification plants at Brantford and Guelph. A separate proposal was requested for each site. In early 1988, CANVIRO was selected to conduct the initial study at the former coal gasification plant site in Guelph (see location on Figure 1). However, the study was delayed through much of 1988 and work commenced in February 1989.

### 1.2 Objectives

The specific objectives of the investigation, as outlined in the RFP, are as follows:

- i) determine whether or not coal gasification plant wastes are present;
- ii) if present, determine how these wastes occur onsite (in storage tanks, in soil, etc.), and obtain some indication of their distribution;
- iii) if present and not contained, determine contaminant concentrations, waste volumes and potential for migration through exposure pathways (ie. soil, air groundwater and surface water;
- iv) if present, determine whether or not the wastes are impacting on, or pose an imminent threat of impact on, human health and safety, or the environment, or both;
- v) if present and not contained, determine if migrating wastes pose an imminent threat of impact on human health and/or environment, recommend remedial alternatives.



**FIGURE 1 : SITE LOCATION PLAN SHOWING THE  
FORMER GUELPH COAL GASIFICATION PLANT**

### 1.3 Scope of Work

The scope of work for this investigation is summarized below as documented in correspondence to J. Chuby, Union Gas dated January 16, 1989:

#### i) Drilling into former gas holder

One borehole was advanced into the former gas holder identified on Union Gas property. This work includes:

- i) Sampling of fill materials and/or wastes
- ii) Monitoring of air emissions as described in CANVIRO proposal dated February 18, 1988 (CANVIRO, 1988)
- iii) estimation of waste quantity
- iv) not penetrating the bottom of the gas holder
- v) sealing of the borehole if leakage of wastes is remotely possible
- vi) repair of asphalt damaged during drilling
- vii) analysis of liquid tar from the gas holder for polynuclear aromatic hydrocarbons (PAHs) and coal tar acids

#### ii) Additional Air Sampling

Additional air sampling was performed in the Union Gas office and at the site perimeter as requested in your correspondence dated January 5, 1989 and as described under Task 2 (p. 18-21) in CANVIRO (1988).

#### iii) Modified drilling and monitoring well installation

Two (2) of the three (3) monitoring wells originally proposed (CANVIRO, 1988) plus two (2) additional wells requested (total of 4 wells) were to be installed using modified drilling protocols to mitigate the migration of contaminants into the bedrock. The modified protocols are summarized as follows:

- i) Drill to bedrock surface and sample soil/fill using continuous samples or split spoons as appropriate.
- ii) Examine samples for evidence of coal tar and other gas plant wastes.
- iii) If gross contamination is present (ie. liquid coal tar) which could flow through the subsurface, a steel casing will be seated in the upper bedrock and grouted in place prior to coring of bedrock. Once grout has set, the bedrock will be cored to a depth of 3m (10 feet). Core will be examined for evidence of wastes and lithology. These observa-



tions will be summarized in a borehole log. A monitoring well will be installed in the bedrock.

- iv) If no contamination or minor contamination are evident, the bedrock will be cored through the augers and a monitoring well will be installed as described above.
- v) All monitoring wells in the bedrock will be open holes unless bedrock caves into the drillhole. Otherwise, wells will consist of two inch nominal diameter flush threaded PVC monitor well pipe with a sand pack, bentonite seal, bentonite grout annular sealant. All wells will include a flush mounted valve box and locking cap as described in CANVIRO (1988).
- vi) All monitoring wells will be developed, hydraulically tested and sampled as described in CANVIRO (1988). Groundwater will be analyzed for all parameters listed in CANVIRO (1988) plus coal tar acids. Analysis will be conducted at all four (4) wells plus two (2) QA/QC samples.
- vii) Drilling equipment will be decontaminated between drilling locations if wastes are encountered.
- viii) One analysis of soil for PAHs and coal tar acids was budgeted.
- iv) Test Pit Excavation

One test pit was to be excavated at the north side of the gas holder identified as Gas Holder #1 in CANVIRO (1988). The following observations were logged:

  - i) Presence of wastes
  - ii) Condition and type of fill
  - iii) Presence and condition of Gas Holder #1 and Gas Holder #2
  - iv) Presence and condition of an abandoned sewer line

The excavated material was to be recompacted as best as possible and the excavated area repaired at CANVIRO's expense. An allowance for one soil sample analyzed for PAHs and acid phenolics was made.

v) Disposal of Hazardous Waste

Any soil or wastes which cannot be replaced in the boreholes were to be considered as hazardous wastes and disposed of as such.

vi) Confirm Origin of Wastes

If the origin of wastes is uncertain, testing was to be performed in an attempt to resolve this question if possible. Discussions with analytical organic chemists at CANVIRO and CH2M HILL labs indicated that no simple proven method existed to resolve the origin of tar substances. The proposed method involved comparing the GC/MS "fingerprint" of the waste in question to potential source materials. The following samples were necessary for this approach:

- i) Background or control (ie. uncontaminated soil from same area)
- ii) Material or waste in question (ie. from borehole or test pit)
- iii) Possible onsite coal tar source (ie. Union Gas holder) (analyzed under item (i) Drilling into Former Gas Holder)
- iv) Possible offsite coal tar source (ie. City of Guelph holder) assuming a sample can be obtained

Three (3) additional analyses have been budgeted for PAHs and coal tar acids. The results of this analysis will be compared to ascertain the probable origin of the waste in question.

vii) Sewer Inspections, and Analysis of Sewer Sediment and Soil Gas Survey

This work, which had been included in the original proposal, was eliminated from the study.

Minor revisions were made to the scope of work to adapt to conditions encountered during the investigations. These revisions, which were approved by Union Gas personnel, are documented later in this report.

## **2.0 FIELD SAMPLING PROGRAM**

### **2.1 Borehole Drilling and Sampling**

A subsurface drilling investigation was performed at the Union Gas site to:

- i) determine if coal gasification wastes were present in the subsurface on Union Gas property.
- ii) determine the approximate extent of any wastes encountered, and
- iii) to evaluate if the wastes are contained or uncontained.

Environmental Systems Ltd. of Ingersoll, Ontario was retained as the drilling contractor. A truck-mounted CME 55 drill rig with hollow stem augers, rock coring and rotary drilling capabilities was utilized. When drilling through the initial 30 to 70 cm of weathered dolostone a tri-cone bit was used and a diamond bit core barrel was used for drilling further into the rock.

Soil samples were generally collected at 75 cm intervals using a split spoon sampler. Supplementary samples were collected from drill cuttings. Rock cores were collected using a continuous core barrel sampler.

A total of seven boreholes were drilled at the Union Gas site. Locations are shown on Figure 2 at the back of this report and borehole logs are enclosed in Appendix A. During drilling both soil samples, rock core, rock cuttings and drilling equipment were continually inspected for visual and olfactory evidence of coal tar. Ambient air was analyzed for the presence of organics using a HNU photoionization meter.

At BH1 brown silty sand was found down to 1.37 m where bedrock was encountered. No odours were detected from the fill. The borehole was drilled to a depth of 5.26 m. The bedrock core showed no major zones of contamination, however, some black staining was found in some fractures as noted in the logs (see Appendix A).

At BH2, black and brown silty sand was found to 0.6 m where bedrock was encountered. The lower 30 cm of silt and sand showed evidence of contamination. This borehole was not advanced into the bedrock and was relocated closer to the property boundary as BH5.

Bedrock at BH3 was encountered at 1.80 m. The bedrock here was highly fractured to 5.84 m where drilling ceased. The soil did not contain any contamination but the bedrock was discoloured and had a slight odour throughout.

At BH4 bedrock was encountered at 2.64 m. Coal tar contaminated sand and gravel was found from 2.13 m to 2.43 m. Above the 2.13 m depth, clean brown sand and gravel with some clay was found. The bedrock from 2.64 m to 5.82 m exhibited dark staining throughout.

At BH5, bedrock was encountered at 1.12 m. Contaminated gravel was present from 0.28 to 0.40 m and 0.76 to 1.12 m. A concrete slab was encountered from .41 to .76 m.

BH6 was drilled to 1.98 m at which depth auger refusal halted further drilling. Sand and gravel was saturated with coal tar from 1.35 to 1.98 m. There was no evidence of contamination in the sand and gravel to 1.15 m.

BH7 was drilled over the former gas holder 1.5 m south of the north edge of the former gas holder (see location in Figure 2). A 0.45 m thick concrete pad was encountered just below the asphalt. Under the concrete lay 0.76 m of gravel of which the bottom 0.37 m was contaminated with coal tar. The bedrock was encountered at 1.27 m. The top portion of the rock was heavily stained with coal tar.

## **2.2            Test Pit Excavation and Sampling**

Three test pits were excavated at the north side of the gas holder identified as Gas Holder #1 on Figure 2. The locations of the pits can also be seen on Figure 2.

Test pit 1 was excavated from the concrete wall at the north property line to the edge of the gas holder. Slightly contaminated fill consisting of black, brown and clay loam was detected at 1.0 m. At the south end of the test pit, at a depth of 1.5 m, a broken 30 cm diameter ceramic pipe was discovered containing coal tar and coal tar saturated sediment. The orientation of the pipe was west to east. This pipe may be part of the abandoned storm sewer shown on Figure 2. Contaminated fill surrounded the broken 30 cm pipe. HNU readings in the pit fluctuated between 3-10 ppm. At the south end of the pit a 45 cm thick concrete slab (possibly the bottom of former Gas Holder #1) was discovered under the asphalt. The slab rested directly on bedrock at this location (see Test Pit log in Appendix A for further detail).

Test pit 2 was excavated diagonally in a southeast direction from the fence in the northwest corner of the site. The top of a 75 cm diameter open-ended cast iron pipe was found at a depth of 30 cm. From discussions with a former Union Gas employee (Bert Gibbons) it is likely that this may have been the main gas pipeline to the remainder of the plant on the present City property. The pipe contained a large quantity of black contaminated sediment. The sand continued southward from the iron pipe along a concrete ditch that tapered southward. Contaminated soil was found throughout the length of the trench.

Test pit 3 was dug from the southern limit of test pit 1 along the edge of the holder. The 45 cm diameter pipe containing coal tar saturated sediment found in test pit 1 continued westward at a depth of 1.5 m. The fill below 1 m showed various degrees of discolouration and gave off a strong odour.

## 2.3

### Monitoring Well Installation

A total of 4 monitoring wells were installed throughout the site. Their locations are shown on Figure 2 and logs of the well completion are shown in Appendix A.

Two of the 3 monitoring wells originally proposed (CANVIRO 1988) plus 2 additional wells requested by Union Gas were installed using modified drilling protocols to mitigate the migration of contaminants into the bedrock. In boreholes where liquid coal tar was observed in the overburden, this involved installation of a surface casing to the bedrock surface prior to drilling deeper. A surface casing was installed at BH4 and BH5 as shown in the borehole logs. Once the boreholes were drilled to a depth of approximately 3 m in bedrock, monitoring wells were installed. Two inch nominal diameter flush threaded PVC monitor well pipe with a 5 ft long slotted screens were used. At each well location the slotted screen portion of the pipe rested in the bedrock. The borehole annulus was backfilled with clean grade 3 sand forming a filter pack around the screen. Vertical flow of groundwater along the borehole annulus was minimized by emplacement of a bentonite seal above the sand pack. All wells were mounted in a flush housing with screwed down cap. All monitoring well pipe and screen was sealed in plastic up to the time of field use.

## 2.4

### Well Development

After the completion of the monitoring well installations, all wells were developed to remove drilling induced perturbations and to obtain representative samples (utilizing a dedicated PVC bailer at each well). The surging effect created during development caused both fluids and loose sediments or rock dust to be drawn into the well which was followed by removal of the sediment laden groundwater.

Development fluids as well as excess fluids bailed during sampling were disposed of into the Guelph sanitary sewer system ensuring that no more than one third of an estimated 277 L/min of fluid entered the sanitary sewer at any one time (in accordance with MOE guidelines - see Appendix E for detailed calculations).

To ensure representative groundwater samples, CANVIRO initiated the above-mentioned methodology to address the following points:

- i) Removal of fines from the vicinity of the well screen to enhance free flow of groundwater into the installation.
- ii) Reduce the amount of fines during sampling to minimize any adverse effects on sample integrity.
- iii) Removal of stagnant water or any other perturbations created during drilling (ie. from the well casing and surrounding filter pack) minimizing any further sampling biases.

In excess of three well volumes were extracted at all monitoring locations prior to sampling. The groundwater was monitored for pH, electrical conductivity and

temperature at all monitoring locations until stable readings occurred to ensure stabilization of water quality prior to sampling.

## **2.5            Groundwater Sampling**

One round of groundwater samples was collected and analyzed for this project as proposed. The proper withdrawal and preparation of groundwater samples for analysis of both inorganic and organic constituents is of paramount concern because they are likely the most critical steps in preserving sample integrity. Although a rigid set of sampling guidelines minimizes sample perturbations, it does not eliminate the problem altogether.

To preserve sample integrity, the field sampling approach outlined below was implemented:

- i) Utilization of clean previously unused dedicated PVC bailers
- ii) Minimizing agitation in the wells when lowering bailers
- iii) Using bottom loading bailers to ensure minimal sample alteration
- iv) Consistently sampling from approximately the same depth in the well
- v) Minimizing the head space for volatile organic compound (VOC) samples by forming a positive meniscus before capping
- vi) Minimizing contact with direct sunlight for VOC samples
- vii) Rinsing of sample bottles with a small volume of groundwater at each location prior to collection of a representative sample
- viii) Rinsing of filtration apparatus and filter media with distilled water followed by rinsing with groundwater from each monitoring location prior to use.
- ix) Replacement of filter media after every sample location
- x) Use of clean surgical gloves to avoid physical contact with the sample.
- xi) Filtering samples for PAHs and acid phenolics in the field
- xii) Filtering and preserving samples for metals, phenols, cyanide, total Kjeldahl nitrogen, total organic carbon, ammonia, COD and sulphide
- xiii) Minimizing the head space for both anion and alkalinity samples
- xiv) Minimizing contact with the plastic cap for samples analyzed for PAHs and acid phenolics by using an aluminum foil separation film
- xv) Storing and transporting samples in a cool, dark environment

The sampling approach described above provided emphasis on minimizing sample perturbations and with that in mind, the samples were considered to be representative of the groundwater in the bedrock beneath the site.

## 2.6 Water Level Monitoring

Water level measurements were collected on four days throughout the duration of the investigation. An audible water level meter was used. All of the Union Gas monitoring wells as well as some of the City of Guelph wells were monitored. The results are documented in Appendix B.

It is noteworthy that cross-contamination between monitoring wells was avoided by decontamination of the water level probe between wells. The procedure involved either i) cleaning the water level meter with a soap and distilled water solution and rinsing with distilled water or ii) cleaning and rinsing with distilled water and wiping dry with a clean absorbent cloth.

## 2.7 Hydraulic Response Testing

The in situ horizontal hydraulic conductivity at each monitoring location was obtained by performing hydraulic response or bail tests. The methodology required an instantaneous change in the water level in the monitoring well initiated by removal of a known volume of groundwater. The recovery of the water level versus time was recorded with a stopwatch and water level meter.

Plots of normalized drawdown versus time including a detailed table of hydraulic conductivity calculations are presented in Appendix D.

Table 1 summarizes the results of the hydraulic response tests which were analyzed according to the methods of Hvorslev (1951), enabling the completion of computations for horizontal hydraulic conductivity.

<b>Table 1</b> <b>HYDRAULIC CONDUCTIVITIES FROM ANALYSIS OF RESPONSE TESTS</b>		
<b>Location</b>	<b>Test</b>	<b>Hydraulic Conductivity (cm/sec)</b>
BH1	1	$1.0 \times 10^{-2}$
	2	$6.2 \times 10^{-3}$
Average		$8.1 \times 10^{-3}$
BH3	1	$5.8 \times 10^{-4}$
BH4	1	$1.0 \times 10^{-3}$
BH5	1	$6.3 \times 10^{-3}$

## 2.8 Air Sampling

The air quality at the Union Gas site was assessed using an HNU photoionization detector, the results of which are presented in Table 2. The HNU analyzes the total organic vapour concentration in the air. The HNU is calibrated to isobutylene in air. Background readings were less than 1 ppm on all occasions.

<b>Table 2</b> <b>RESULTS OF AIR QUALITY MONITORING</b>	
<b>Location</b>	<b>Organic Vapour Concentration (ppm)</b>
Inside BH1	<1
Inside BH2	16
Inside BH3	1
Inside BH4	68
Inside BH5	61
Inside BH6	15
Inside BH7	8
Ambient Air Outside Boreholes	<1
Inside Test Pits	



### 3.0 DELINEATION AND CHARACTERIZATION OF WASTES/FILL

#### 3.1 Physical and Chemical Characterization

##### 3.1.1 Gas Holder Characteristics

The top of the former gas holder, identified as Iron Gas Holder #1 on Figure 2 was penetrated by drilling at BH7. The holder appears to be 27 m in diameter as outlined by a circular slumping pattern in the asphalt on the Union Gas property parking lot, and confirmed from borehole drilling and test pit digging. The actual size of the gas holder is larger than the 20 m diameter gas holder shown on the fire insurance plans provided with the request for proposal and shown in CANVIRO's proposal to Union Gas (CANVIRO, 1988). During drilling a 45 cm thick concrete slab was discovered under the 5 cm of asphalt that is the parking lot. The northern outside edge of this slab rested on dolostone, as indicated during test pit 1 excavation. However, during the drilling of the borehole which was 1.5 m south of the test pit, the slab was found to be resting on 76 cm of gravel overlying dolostone.

This 45 cm thick concrete pad appears to be the base of the former gas holder, which would suggest that the former gas holder was an above ground tank. It appears the holder was built directly on bedrock but considering the uneven fractured nature of the bedrock at the site, gravel was apparently placed in bedrock depressions to give the holder a flush base.

No coal tar contamination was found above the holder because it appears that the asphalt for this parking lot was placed directly on the top of the concrete slab. Below the concrete base, 39 cm of uncontaminated gravel lay on top of 37 cm of contaminated gravel, which suggests that some wastes found their way under the holder. However, insufficient sample quantity was obtained for chemical analysis.

##### 3.1.2 Fill Properties

The fill investigated during borehole drilling and test pit excavation ranged from sand and gravel to a variety of brown clay loams. The actual fill for each borehole and test pit is outlined in the borehole and test pit logs in Appendix A. Soil samples were collected from visually contaminated soil from throughout the site. The samples were analyzed for PAHs and coal tar acids as shown in Table 3.

One sample was analyzed from Test Pit No. 1 where coal tar contaminated soil was taken in and around the broken 30 cm pipe discussed in Section 2.2. This sample had thick black streams of contamination and had a strong odour.

A second sample was collected from Test Pit No. 2 in the northwest corner of the site and analyzed. The sample was taken from in and around the 45 cm cast iron pipe. The sample contained black stained sand which also had a strong coal tar like odour.

Table 3 COMPARISON OF CHEMICAL ANALYSIS OF WASTES AND FILL TO AVAILABLE GUIDELINES							
Parameter	Location Sample	TP1 2185-01	TP2 2185-02	Method Detection Limit (ppb)	BH1 2185-03	BH4 2185-04	Method Detection Limit (ppb)
Coal Tar Acids (ppb)							
Phenol		<800	<800	800	118	115	8.0
o-Cresol		<800	43,320	800	29.7	18.6	8.0
m-Cresol		<800	35,530	800	89.7	194	8.0
p-Cresol		<800	23,399	800	39.19	39.2	8.0
2,6-Dimethyl phenol		<800	<800	800	<8	<8	8.0
2,5-Dimethyl phenol		<800	<800	800	<8	<8	8.0
2,4-Dimethyl phenol		<800	<800	800	<8	<8	8.0
3,5-Dimethyl phenol		<800	<800	800	<8	<8	8.0
2,3-Dimethyl phenol		<800	<800	800	<8	<8	8.0
3,4-Dimethyl phenol		<800	<800	800	<8	<8	8.0
Resorcinol		<800	<800	800	<8	8	8.0
Surrogate Recovery (%) (2-Fluorophenol)		NR	NR	800	110	120	8.0
Note: Guidelines for coal tar acids in soils not available at the present time. NR = Not reported							

Table 3  
(Continued)

Parameter	CCREM Interim Guidelines (mg/kg = ppm)			Location Sample	TP1 2185-01	TP2 2185-02	Method Detection Limit (ppm)	BH1 2185-03	BH4 2185-04	Method Detection Limit (ppm)
	A	B	C							
Polynuclear Aromatic Hydrocarbons(PAHs) (ppm)										
Naphthalene	0.1	5	50		387.8	37.11	2.4	<.024	1.258	0.024
Acenaphthylene					155.0	14.35	0.96	0.14	0.403	0.0096
Acenaphthene					80.52	15.71	0.96	<.0096	0.975	0.0096
Fluorene					128.8	10.50	0.96	<.0096	0.397	0.0096
Phenanthrene	0.1	5	50		367.5	32.56	0.32	0.125	1.02	0.0032
Anthracene					144.1	15.61	0.48	0.068	0.276	0.0048
Fluoroanthene					180.8	39.35	0.80	0.256	0.402	0.008
Pyrene	0.1	5	50		265.4	64.75	0.80	0.266	0.357	0.008
Benzo(a)anthracene	0.1	1.0	10		109.9	29.77	3.36	0.19	0.197	0.0336
Crysene					95.78	27.77	3.36	0.208	0.203	0.0336
Benzo(b)fluoranthene	0.1	1.0	10		110.5*	42.93*	2.24	0.528*	0.427*	0.0224
Benzo(k)fluoranthene	0.1	1.0	10		-	-	-	-	-	0.0224
Benzo(a)pyrene	0.1	1.0	10		65.60	24.79	1.92	0.316	0.224	0.0192
Indeno(1,2,3-cd)pyrene	0.1	1.0	10		35.05	16.76	2.40	0.378	0.203	0.024
Dibenzo(a,h)anthracene	0.1	1.0	10		7.61	3.63	1.92	0.089	0.086	0.0192
Benzo(g,h,i)anthracene	0.1	1.0	10		42.57	20.20	1.92	0.468	0.234	0.0192
% Recovery Surrogates										
D8-naphthalene					0 <sup>1</sup>	0 <sup>1</sup>		104	141	
D12-chrysene					0 <sup>1</sup>	0 <sup>1</sup>		74	121	
* From CCREM (1988) * Compound co-eluted with Benzo(k)fluoranthene <sup>1</sup> Due to initial sample dilution, surrogate recovery could not be calculated.										

A third sample was taken from the split spoon from BH1 in the southwest corner of the site. The most visually contaminated fill from the borehole was found from a depth of 35 to 97 cm. The sample consisted primarily of brown silt and sand.

A fourth sample was obtained from drill cuttings at BH4, at the east end of the site. Drill cuttings from 1 to 2 m deep were sampled and analyzed. The cuttings were dark gray with a metallic sheen and had a strong odour.

Collection of a sample of coal tar from BH8 on the City property was attempted with the intention of comparing the GC/MS "fingerprint" for possible source identification. However, this monitoring well could not be located in the field. Contact with City and Environmental Strategies personnel lead to the conclusion that the well had been damaged and it could not be sampled.

All four soil samples contained varying concentrations of PAHs. The most contaminated sample for PAHs was from TP1 which contained significant concentrations of all 16 PAH compounds analyzed for. Concentrations of PAHs at TP1 were 2 to 12 times higher than at TP2 which in turn were 10 times higher than concentrations measured from BH1 and BH4 samples.

Coal tar acids were also detected at the sampling locations. TP2 showed the highest concentrations of o-cresol, m-cresol, and p-cresol. Concentrations ranged from 23,399 to 43,320 ppb, for these compounds at TP2. Because these concentrations were so high, the method detection limit for TP1 and TP2 had to be raised 100 times the MDL of 8.0 ppb used for BH1 and BH4. As a result other phenolic compounds listed on the table for coal tar analysis of TP1 and TP2 indicated no detectable concentrations present although concentrations may be present below the 800 ppb level.

Phenol was detected at BH1 and BH4 at a concentration of 118 ppb and 115 ppb, respectively. BH1 and BH4 also had o-cresol, m-cresol, and p-cresol concentrations ranging from 18.6 to 194 ppb.

Only BH4 indicated the presence of 3,5-Dimethyl phenol with a concentration of 21.5 ppb.

### **3.2 Compliance with Regulatory Guidelines**

The most pertinent regulatory guidelines regarding coal gasification plant residues are the CCREM (1988) guidelines for PAHs in soil at coal tar site, which were reportedly adopted in October 1988. No guidelines are available for coal tar acids although they are specific to coal tar and are considered to be positive indicators of coal tar presence. The CCREM guidelines are listed in Table 3.

Interpretation of the A, B, C criteria developed by CCREM is outlined in the Executive Summary of this document enclosed in Appendix F of this report.

Interpretation of chemical analysis of soil and fill is documented as follows:

- i) Significant concentrations of PAH compounds were detected at each of the 4 sampling locations onsite.
- ii) All PAH compound concentrations at TP1 with the exception of Dibenzo(a,h)anthracene exceeded value "C" of the CCREM guidelines which considers the soil significantly contaminated. Some PAH concentrations at TP1 were detected in excess of 10 times criteria limits.
- iii) At TP2, most of the PAH "C" criteria limits were also exceeded, but not to as large an extent as TP1.
- iv) Soil from BH1 and BH4 also contained various concentrations of PAHs. Most of the concentrations exceeded Value "A" criteria set by CCREM which consider the soil slightly contaminated.

### 3.3 Estimation of Waste Quantities

The quantity of waste present on the site was estimated for four groups of material, as follows:

- i) Group I - All soil/fill which either exceeded the CCREM "C" guideline or which exhibited visual evidence of coal tar. This material is considered as hazardous based on the MOE policy as outlined in MOE (1987).
- ii) Group II - All soil/fill which either exceeded the CCREM "B" guideline but not the "C" guideline or which exhibited visual staining but no free coal tar. This material is probably suitable for disposal at a municipal landfill but this should be confirmed based on B(a)P levels in the acetic acid leachate procedure.
- iii) Group III - All soils exceed the CCREM "A" criteria but not the "B" criteria.
- iv) Group IV - All soils with PAH values less than the CCREM "A" criteria.

The actual quantity of waste present was determined by interpolating between observations at boreholes and test pits and extrapolation to the property boundaries of the former coal gasification plant (not the entire Union Gas property). The extent of contamination was divided into three areas. These three areas are as follows:

- Iron Gas Holder - the area occupied by the extent of the iron gas holder
- Area A - the area defined to the south by the north wall of the Union Gas building; to the east and west by the east and west

property lines; and to the north by the southern edge of the iron gas holder and the southern limit of Area C.

- Area C - The area defined to the north by the north property line; to the south by the north edge of the iron gas holder; and to the east and west by the east and west property line to approximately 9 metres south of the north property line

The wastes present onsite fell into either Group I or Group III, described earlier in this section. This was based on the results of the lab analysis of soil sampled onsite.

The estimated quantities of waste/fill are summarized as follows:

Waste Group I			
Location	Average Depth	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )
Iron Gas Holder	0.75 m	536	402
Area C	1.0 m	140	140
Total			542

Waste Group III			
Location	Average Depth	Area (m <sup>2</sup> )	Volume (m <sup>3</sup> )
Iron Gas Holder	0.75 m	536	402
Area A	2 m	852	1704
Area C	1 m	140	140
Total			2246

It should be noted that these quantities are only estimates based on a limited number of measurements across the site.

## **4.0 HYDROGEOLOGIC INTERPRETATION**

The hydrogeological investigation conducted as part of this study was limited in depth to the upper 3 m of bedrock. Areally, the investigation is focussed on the Union Gas property although a limited amount of data was collected from offsite wells installed on behalf of the City of Guelph by Environmental Strategies (1988). The main emphasis of CANVIRO's work was in assessing the impact of the former Guelph Gas Plant on the Union Gas property. Other available information, in particular the Environmental Strategies (1988) investigation, is referenced frequently as it pertains to offsite conditions and impacts.

### **4.1 Conceptualization of Groundwater Flow**

A conceptualization of groundwater flow was developed through the assimilation of physical information generated in this investigation. Water table elevations from various monitoring wells collected on and off site enabled CANVIRO to determine groundwater flow directions as discussed in Section 4.1.2 (see Figure 3).

This investigation was focussed on the shallow bedrock and wells were not drilled below approximately 3 metres into the bedrock. The investigation was aimed at assessing horizontal movement of groundwater and dissolved contaminants. Vertical migration of dissolved or separate phase contaminants was not assessed as part of this initial study.

The conceptualization of groundwater flow at the Union Gas site is that flow occurs predominantly in the uppermost fractured bedrock. However, the depth of the upper fractured zone was not delineated as part of this investigation. Groundwater flow is believed to be primarily towards the Speed River with localized perturbations in the flow pattern caused by buried utilities.

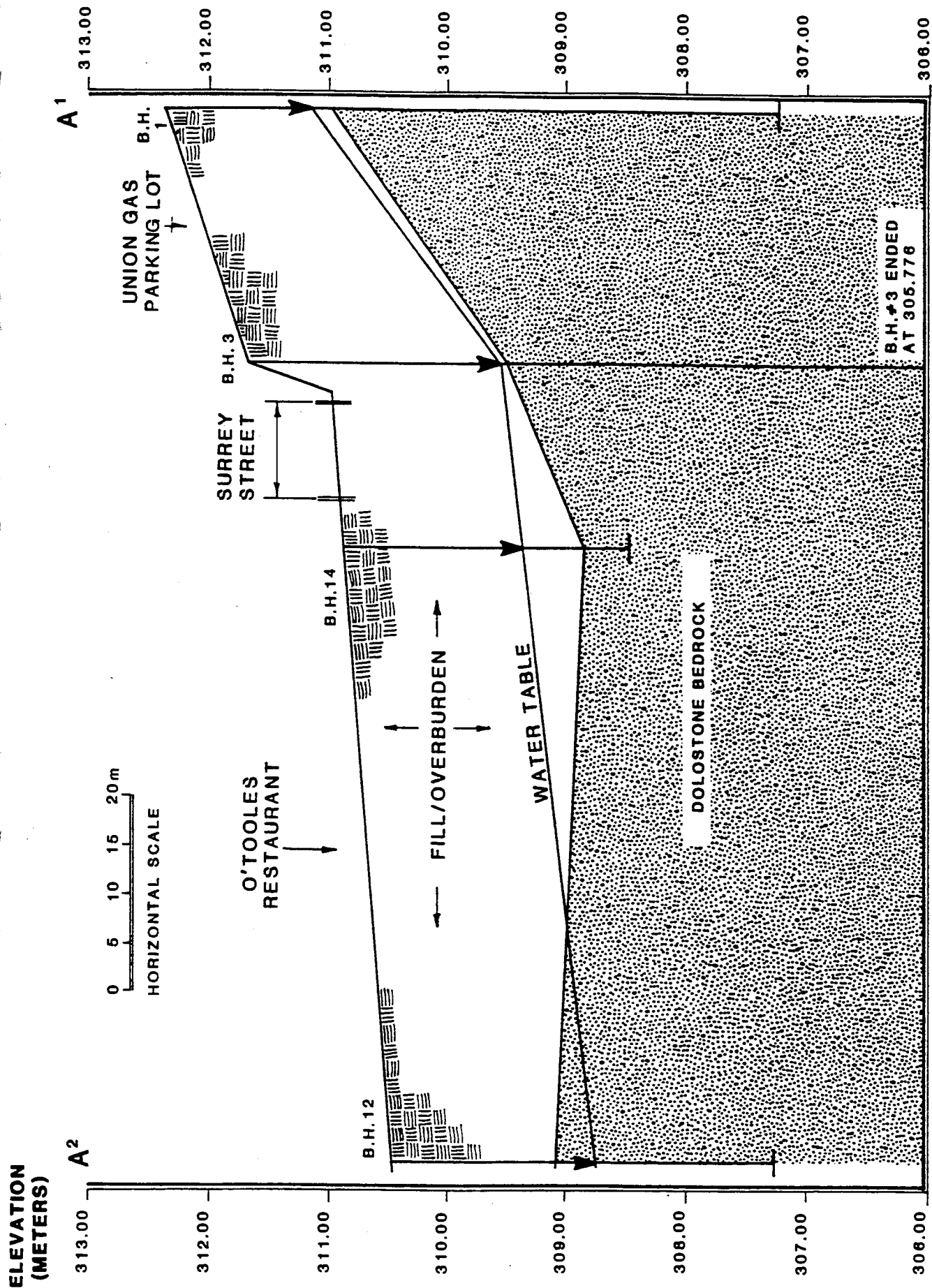
### **4.2 Physical Hydrogeology**

#### **4.2.1 Geology**

The geology of the site can be described in general as a variety of shallow fill materials overlying dolostone bedrock. The fill material varies in content and depth throughout the site as determined from the borehole drilling and test pit excavation. The fill material consists primarily of silty sands and silty clay with sand and gravel found under the base of the iron gas holder and in the northeast corner of the site. The maximum depth on the fill onsite is 2.64 m. Under the fill lies dolostone bedrock. Figure 4 illustrates a cross-section through the site showing site geology.







**FIGURE 4: CROSS SECTION THROUGH UNION GAS  
AND ADJACENT PROPERTIES**

#### 4.2.2 Groundwater Flow System

This section is a detailed evaluation of the physical hydrogeologic data and is aimed at quantifying groundwater velocities and flow directions through the site.

The direction of groundwater flow through the Union Gas property as shown in Figure 3, is to the southeast shifting to the south offsite.

Groundwater velocities, specifically Average Linear Velocities ( $v$ ) are calculated according to Darcy's Law as follows:

$$v = \frac{Ki}{n}$$

$K$  = hydraulic conductivity

$i$  = hydraulic gradient

$n$  = porosity

Groundwater flow is considered to occur primarily within the bedrock where the hydraulic conductivities varied from  $8.1 \times 10^{-3}$  to  $5.8 \times 10^{-4}$  cm/sec. A mean value of  $4 \times 10^{-3}$  cm/sec was used in calculations.

The horizontal hydraulic gradient ( $i$ ) at the site based on measurements for March 15, 1989 was 0.067.

A porosity of 0 to 20 percent was reported for limestone and dolomite by (Freeze and Cherry, 1979). A mid-range value of 10 percent was used in calculations.

Based on the properties outlined above the average linear groundwater velocity is estimated at approximately 800 to 900 meters per year. These velocities are extremely high but re-checking all data proved that calculations were correct. Such high velocities would not be expected under natural gradient (ie. non-pumping) conditions. However, no municipal or industrial wells were identified immediately downgradient of the site. Potential causes of such high gradients and velocities may be related to preferential flow of groundwater along the sanitary sewer backfill or infiltration to the sanitary sewer. The sanitary sewer is located below the bedrock surface and the water table along Surrey Street. Further evidence supporting the presence of a hydraulic "sink" or drain along Surrey Street is manifest in the flattening of hydraulic gradients to the east relative to those across the Union Gas property. Further examination of bedrock cores provided additional insight into the unusually high gradients observed. Rock Quality Designation (RQD) values were determined for all core and these are tabulated in Appendix A. The RQD for BH3 was atypically low (0-14%) suggesting that a fracture zone exists in this vicinity. Furthermore, the upper 1.1 m of bedrock was so fractured that it could not be cored and it was subsequently drilled with conventional rotary methods. RQD for the remaining boreholes was fair (34-61%). The fracture zone apparent at BH3 may be acting like a drain resulting in higher hydraulic gradients in this area. This issue is discussed further later in this report based on chemical analysis of groundwater.

### 4.3 Groundwater Quality

#### 4.3.1 Quality Assurance/Quality Control (QA/QC)

The importance of obtaining precise and accurate groundwater quality data cannot be over-emphasized. Furthermore, an understanding of limitations in the reliability of water quality data is essential in developing a representative site characterization. To this end, both sampling and laboratory based QA/QC programs were undertaken.

##### 4.3.1.1 Sampling Program

A sampling QA/QC program, beyond the extensive sampling protocols described in Section 2.5, consisted primarily of the use of trip blanks and duplicate samples.

Trip blanks were prepared with organic free distilled water at the laboratory. Trip blanks were transported to the site and returned to the lab in a similar manner to actual samples to provide an indication of contamination induced by bottle preparation or ambient conditions during transportation. The trip blank was labelled as BH7.

Duplicates were collected at BH1 and analyzed for the same parameters as other samples. The duplicates were labelled as BH1 and BH1B.

The trip blank generally contained non-detectable to negligible concentrations of most parameters which are not of significance in the interpretation of the results. The apparent presence of these compounds at similar concentrations in actual samples was subsequently considered to be erroneous. Such samples were henceforth treated as having non-detected concentrations in these special cases.

Duplicate analysis ideally provide an indication of the precision of the analytical method provided both samples have the same water chemistry. Duplicate samples were prepared by subsampling a composite groundwater sample. Samples requiring filtering were collected sequentially following filtration of the composite sample.

Comparison of concentrations between duplicates showed good precision for all parameters except for VOCs and coal tar acids. In these cases the percentage surrogate recovery varied a great deal between BH1 and its duplicate, BH1B. However, when the concentrations were corrected for surrogate recovery (as shown in brackets in Table 6) the concentrations showed good agreement.

##### 4.3.1.2 Laboratory Program

Only the laboratory QA/QC program results reported with the chemical analysis are discussed in this report. Detailed internal laboratory protocols are not outlined but are available from CANVIRO Analytical Laboratories Ltd. (CALL), upon request.

Analytical protocols for VOCs, coal tar acids and PAH analysis include the use of surrogates, spikes and blanks.

For PAHs, surrogate recoveries for D8-naphthalene and D12-chrysene ranged from 20 to 117 percent but recoveries generally averaged in the 80 percent range (see Table 6 and Appendix C). These values suggest that PAH concentrations may be underestimated. The method spike recovery for PAHs ranged from 49 to 118 percent which slightly underestimates the theoretical value of 100 percent. The method spikes are indicative of the accuracy of the analysis. The lab blank for PAHs showed non-detectable concentrations of all chemicals.

The surrogate recoveries for 2-fluorophenol in coal tar acid analysis ranged from 39 to 113 percent. Method spike recovery for coal tar acid analysis ranged from 23 to 83 percent which also underestimates the theoretical value of 100 percent. The lab blank showed very low concentrations of phenol and m-cresol. These compounds are lab or sampling induced. As a result, similar or lower concentrations in the actual groundwater samples were considered erroneous.

Five surrogates were used for VOCs. These surrogates were d5-bromoethane, d4-1,2-dichloroethane, d8-toluene, bromochloropropane, and d10-ethylbenzene. Recoveries for these compounds ranged from 29 to 139 percent with the average recovery being 88 percent. The lab blank showed a very low concentration (0.8 ppb) of toluene. Toluene concentrations in well water ranged from 25 to 702 ppb. Because of these higher levels, this concentration in the lab blank is considered insignificant. The trip blank also contained a concentration of 0.8 ppb for toluene. Surrogate recoveries were especially low for the duplicate sample at BH1. Because of this the sample concentrations for toluene and benzene were adjusted to the d8-toluene surrogate recovery percentage and the remainder of the VOCs for the samples at BH1 were adjusted to the d10-ethylbenzene surrogate recovery percentage. These adjusted figures for groundwater samples at BH1 are shown in brackets on Table 6 where good agreement is evident.

#### 4.3.1.3 Charge-Balance Error

The charge-balance error was calculated to provide an indication of any erroneous chemical analysis based on the requirement for electrically neutral solutions. This approach is relevant to major ion concentrations and provides little insight in to the reliability of other analysis.

The charge-balance errors for groundwater samples were calculated according to Freeze and Cherry (1979) and are summarized in Table 4.

**Table 4**  
**SUMMARY OF CHARGE-BALANCE ERRORS FOR**  
**GROUNDWATER ANALYSIS**

Location	Charge-Balance Error
Sampling Date March 1, 1989	
BH1	2.9%
BH1 (duplicate)	2.5%
BH3	3.0%
BH4	0.6%
BH5	5.7%

Values less than the suggested range of 5 percent (Freeze and Cherry, 1979) to 12 percent (Keith et al, 1983) are considered acceptable. All the charge balance errors for the analysis fall within this range which indicates a high reliability of the reported concentrations.

#### 4.3.2 Inorganic Geochemistry

Inorganic analysis of groundwater included major cations and anions, trace metals (including cyanide and arsenic), alkalinity, pH, temperature, and electrical conductivity. The results are shown on Table 5.

#### Inorganic Indicators

The pH, temperature and electrical conductivity were measured in the field before they were filtered and bottled. Temperatures ranged from 8.2°C to 12.7°C. Electrical conductivity which is an expression of the water's ability to conduct an electrical current, ranged between 3.7 mS/cm and 4.9 mS/cm. Electrical conductivity provides a good indication of changes in the groundwater's mineral concentration. There was little change in electrical conductivity between each well onsite. pH levels ranged from 7.5 to 7.9 during sampling and 7.1 to 7.9 under laboratory conditions.

#### Anions

Chloride was the dominant anion present in groundwater. The highest concentrations of chloride were found in the upgradient wells, BH1 and BH5. The two downgradient wells (BH3 and BH4) showed lower concentration of this halide. Sulphate was also found at higher concentrations in the upgradient wells and may be related to spent oxide from the coal gasification process. The purifier building where spent oxide was generated was located on what is now City property. These two parameters suggest that their source originates upgradient of BH1 and BH5 because concentrations downgradient are lower. All other anions were of low to non-detectable concentrations.

**Table 5**  
**COMPARISON OF CHEMICAL ANALYSIS OF INORGANIC CHEMICALS**  
**TO AVAILABLE WATER QUALITY GUIDELINES**

Parameter	Surface Water Quality Objectives (mg/L)	Drinking Water Objectives (mg/L)	Location	BH1 2175-01	BH1B (Duplicate of BH1) 2175-02	BH3 2175-03	BH4 2175-04	BH5 2175-05	BH7 (Trip Blank) 2175-06	Method Detection Limit
<b>Anions (mg/L)</b>										
Fluoride	NC	2.4 <sup>1a</sup>		<0.19 1370	<0.19 1380	<0.19 1040	<0.19 1180	<0.19 1270	<0.19 0.30	0.19 NR
Chloride	NC	250 <sup>1b</sup>		<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
Nitrite	0.06 <sup>4</sup>	1 <sup>1a</sup>		<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	0.19
Bromide	NC	10 <sup>1a</sup>		<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	0.09
Nitrate	NC	500 <sup>1b</sup>		<0.55	<0.55	<0.55	<0.55	<0.55	<0.55	0.55
Phosphate	NC			79.6	106	10.4	51.7	74.8	<0.59	0.59
<b>Sulphate</b>										
<b>Inorganic Indicators</b>										
Alkalinity (mg/L as CaCO <sub>3</sub> )	6.5 - 9.0	8.6 - 8.3 <sup>b</sup>		658 7.1	658 7.1	584 7.8	640 7.9	698 7.3	5 6.2	NR NR
<b>Other Inorganic Parameters</b>										
Ammonia (mg/L)	0.02 <sup>3</sup>			3.3	3.2	10.5	13.5	2.5	<0.05	0.05
TKN (mg/L)				4.8	4.9	13.5	19.9	3.4	<1.0	1.0
<b>Parameters Analyzed During Sampling</b>										
Temperature		<15 <sup>2b</sup>		8.2	8.2	12.7	10.1	8.0	NA	NR
pH	6.5 - 9.0	6.5 - 8.3 <sup>2b</sup>		7.6	7.6	7.8	7.9	7.5	NA	NR
Electrical Conductivity (mS/cm)				4.9	4.9	4.9	3.7	4.3	4.6	NR

Table 5  
(Continued)

Parameter	Surface Water Quality Objectives (mg/L)	Drinking Water Objectives <sup>1</sup> (mg/L)	Location Sample	BH1 2175-01	BH1B (Duplicate of BH1) 2175-02	BH3 2175-03	BH4 2175-04	BH5 2175-05	BH7 (Trip Blank) 2175-06	Method Detection Limit
Aluminum	0.1 <sup>4</sup>	NC		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Arsenic	0.1 <sup>3</sup>	0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Barium	1.0	1.0		0.14	0.14	0.12	0.11	0.13	<0.01	0.01
Beryllium	0.011 <sup>3</sup>	0.0039		<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Boron	NC	5.0		0.18	0.16	0.12	0.17	0.17	<0.01	0.01
Cadmium	0.0002 <sup>3</sup>	0.005		0.01	0.01	0.007	0.01	0.009	0.006	NC
Calcium	NC	NC		220	210	140	120	240	0.15	NR
Chromium	0.1 <sup>3</sup>	0.5		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Cobalt	NC	NC		0.04	0.07	0.04	0.07	0.05	<0.03	0.03
Copper	0.005 <sup>3</sup>	1.0		0.02	0.02	0.01	0.01	0.02	<0.01	0.01
Cyanide	0.005 <sup>3</sup>	0.2 <sup>1</sup>		1.15	1.04	0.93	1.98	1.65	<0.05	0.05
Iron	0.3 <sup>3</sup>	0.3		1.60	2.13	0.20	0.47	2.10	0.02	NR
Lead	0.005-0.025 <sup>3</sup>	0.05		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10
Magnesium	NC	NC		100	100	78.8	110	120	<0.05	0.05
Manganese	NC	0.5		0.08	0.08	0.11	0.18	0.12	<0.01	0.01
Nickel	0.025 <sup>3</sup>	NC		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Phosphorus	0.010 <sup>3</sup>	NC		<0.13	<0.13	<0.13	<0.13	<0.13	<0.13	0.13
Potassium	NC	NC		14	14	12	17	12	<1	1
Silver	0.0001 <sup>3</sup>	0.05		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Sodium	NC	NC		850	870	690	740	810	1.85	NR
Strontium	NC	NC		0.96	0.88	0.85	0.69	0.76	<0.04	0.04
Sulphide	0.002 <sup>3</sup>	0.05 <sup>1</sup>		0.02	0.03	<0.02	<0.02	0.04	<0.02	0.02
Vanadium	NC	NC		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Zinc	0.030 <sup>3</sup>	5.0		<0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.01

<sup>1</sup>Ontario Drinking Water Objectives (MOE, 1984)

<sup>2</sup>Maximum acceptable levels in water used for domestic consumption, (Health & Welfare, 1987)

<sup>3</sup>Provincial Water Quality Objectives (MOE, 1984)

<sup>4</sup>CCREM (1987)

<sup>a</sup>Health Related Guideline

<sup>b</sup>Aesthetic Guideline

NR = Not reported

NA = Not analyzed

NC = No criteria

## Trace Metals and Cations

The trace metal and cation scan also indicates higher concentrations of certain metals in the two upgradient wells. Iron, copper, calcium and sodium concentrations for BH1 and BH5 are higher than for BH3 and BH4 while other analysis show little or no change in groundwater concentrations between the monitoring wells.

High concentrations of cyanide were detected at all 4 wells onsite. Concentrations ranged from 0.93 to 1.98 mg/L. Cyanide is a contaminant associated with spent oxide generated by the cleaning of coal gas prior to distribution. The purifier building at the former coal gasification plant was located adjacent to the plant site now owned by the City. No spent oxide was identified on the Union Gas property.

Low sulphide concentrations were detected at BH1 and BH5 with non-detectable concentrations detected at the downgradient wells, BH3 and BH4. Sulphide in groundwater is usually precipitated from solution so typically little to no sulphide is detected in groundwater.

## Other Inorganic Parameters

TKN measures both ammonia and organic nitrogen. TKN in the groundwater samples ranged from 3.4 to 19.9 mg/L. The highest concentrations were detected at BH3 and BH4 downgradient of the site.

Ammonia is the most reduced inorganic form of nitrogen in groundwater. Ammonia concentrations range from 2.5 to 13.5 mg/L in the monitoring wells. The highest concentrations are found in the downgradient wells, BH3 and BH4. The ammonia building was located on the property now owned by the City (see Figures 2 and 3).

### 4.3.3 Organic Geochemistry

Groundwater was analyzed for groups of specific organic compounds as well as selected indicators of dissolved organic chemicals.

#### 4.3.3.1 Specific Organic Chemical Groups

Analysis for specific organic chemical groups included a partial suite of volatile organic compounds (VOCs), as well as polynuclear aromatic hydrocarbons (PAHs) and coal tar acids.

## Volatile Organic Compounds

Surrogate recoveries were variable between the six (6) samples analyzed for VOCs. Discussions with CANVIRO Analytical Laboratories Ltd.'s (CALL's) Chief Chemist, Mr. D. Sutherland, determined that it would be appropriate to correct the reported concentrations for surrogate recovery to perform a valid comparison between the concentrations at different locations. All VOC concentrations in Table 6 have been corrected for surrogate recovery and are shown in brackets. The remainder of this discussion pertains to corrected concentrations.



**Table 6**  
**COMPARISON OF CHEMICAL ANALYSIS OF ORGANIC CHEMICALS**  
**TO AVAILABLE WATER QUALITY CRITERIA**

Parameter	Surface Water Quality Objectives <sup>2</sup> (µg/L)	Drinking Water Objectives <sup>1</sup> (µg/L)	Location	BH1 2175-01	BH1B (Duplicate of BH1) 2175-02	BH3 2175-03	BH4 2175-04	BH5 2175-05	BH7 (Trip Blank) 2175-06	Method Detection Limit
<b>Volatile Organic Compounds (ppb)</b>										
Benzene	300	5		1049 (1589)	692 (1384)	1866 (1829)	1787 (1354)	442 (1028)	1.3 (1.2)	0.4
Toluene	300	24 <sup>a</sup>		702 (1064)	540 (1080)	25 (25)	378 (286)	221 (514)	0.8 (0.74)	0.7
m&p-Xylene	NC	300 <sup>a</sup>		861 (1163)	683 (1313)	48 (56)	428 (375)	630 (1370)	0.6 (0.55)	0.6
o-Xylene	700	24 <sup>a</sup>		300 (405)	231 (444)	<2.6 (<3.1)	578 (507)	219 (476)	<2.6 (<2.4)	2.6
ethyl benzene	NC	300 <sup>a</sup>		416 (562)	307 (590)	227 (267)	299 (262)	248 (539)	0.4 (0.37)	0.4
<b>Surrogate Recovery (%)</b>										
Bromochloropropane				90	58	102	130	50	130	-
d10-Ethylbenzene				74	52	85	114	46	116	-
d5-Bromoethane				82	42	123	139	29	55	-
d4-1,2-Dichloroethane				98	71	83	94	61	132	-
d8-Toluene				66	50	102	132	43	108	-
<b>Notes:</b> NC = No criteria available Bracketed concentrations have been corrected for surrogate recovery (d5-toluene recovery used to correct benzene and toluene concentrations; d10-ethylbenzene recovery used to correct remaining concentrations) <sup>1</sup> Health & Welfare Canada (1987) <sup>2</sup> CCREM (1987) <sup>a</sup> An aesthetic objective										

Table 6  
(Continued)

Parameter	Drinking Water Objectives (µg/L)	Location Sample #	BH11 2175-01	BH1B Duplicate of BH1 2175-02	BH13 2175-03	BH14 2175-04	BH5 2175-05	BH7 (Trip Blank) 2175-06	Method Detection Limit
<u>Coal Tar Acids</u>									
Phenol	NC		4.14 (10.6)	8.35 (7.39)	12.68	15.20	2.49	0.45	0.05
o-Cresol	NC		10.55 (27.1)	33.15 (19.34)	0.57	35.66	4.92	<0.05	0.05
m-Cresol	NC		11.20 (28.7)	30.49 (26.98)	0.79	34.87	2.19	0.47	0.05
p-Cresol	NC		4.19 (10.74)	15.69 (13.88)	0.24	7.26	1.10	<0.05	0.05
2,6-Dimethyl phenol	NC		5.21 (13.36)	23.77 (21.04)	51.41	34.63	2.71	<0.05	0.05
2,5-Dimethyl phenol	NC		8.47 (21.72)	43.81 (38.77)	0.33	33.73	3.54	<0.05	0.05
2,4-Dimethyl phenol	NC		12.02 (30.82)	44.81 (39.65)	0.96	54.63	5.50	<0.05	0.05
3,5-Dimethyl phenol	NC		8.66 (22.2)	28.16 (24.92)	1.65	47.13	5.08	<0.05	0.05
2,3-Dimethyl phenol	NC		3.04 (7.79)	11.40 (10.08)	0.55	15.61	1.34	<0.05	0.05
3,4-Dimethyl phenol	NC		4.12 (10.56)	11.89 (10.52)	0.48	21.03	1.96	<0.05	0.05
Resorcinol	NC		0.06 (0.15)	0.15 (0.13)	<	4.86	4.57	<0.05	0.05
Surrogate Recovery (%) (2-Fluorophenol)			39	113	106	43	43	79	-
NC = No criteria available									

Table 6  
(Continued)

Parameter	CCREM Interim Guideline			Drinking Water Guidelines (ppb)	Surface Water Criteria (ppb)	Location Sample #	BH1 2175-01	BH1B (Duplicate of BH1) 2175-02	BH13 2175-03	BH14 2175-04	BH5 2175-05	BH7 (Trip Blank) 2175-06	Method Detection Limit
	A	B	C										
Polynuclear Aromatic Hydrocarbons (PAHs) (ppb)													
Naphthalene	0.2	2	20	NC	620.0 <sup>1*</sup>		1131	1140	17.9	629	2100	<0.15	0.15
Acenaphthylene				NC	NC		35.0	42.6	4.83	8.55	57.7	<0.06	0.06
Acenaphthene				20*	520.0 <sup>1*</sup>		9.63	9.58	2.45	21.0	16.6	<0.06	0.06
Fluorene				NC	200.2		16.9	16.5	0.64	4.67	23.1	<0.06	0.06
Phenanthrene	0.2	2	20	NC	NC		22.6	25.9	1.80	5.88	33.4	<0.02	0.02
Anthracene				0.7*	NC		3.15	4.57	0.27	0.67	7.08	<0.03	0.03
Fluoranthene				188.0	42.0 <sup>3*</sup>		0.44	1.32	0.18	0.38	4.03	<0.05	0.05
Pyrene	0.2	2	20	NC	200.0 <sup>4</sup>		0.53	1.57	0.24	0.54	2.91	<0.05	0.05
Benzo(a)anthracene	0.01	0.1	1	NC	NC		<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	0.21
Chrysene				NC	NC		<0.21	<0.21	<0.21	<0.21	<0.21	<0.21	0.21
Benzo(b)fluoranthene	0.01	0.1	1	NC	NC		<0.14	<0.14	<0.14	0.28	<0.14	<0.14	0.14
Benzo(k)fluoranthene	0.01	0.1	1	NC	NC		<0.14	<0.14	<0.14	0.28	<0.14	<0.14	0.14
Benzo(a)pyrene	0.01	0.1	1	NC	NC		<0.21	<0.12	<0.12	0.14	<0.12	<0.12	0.12
Indeno(1,2,3-cd)pyrene	0.01	0.1	1	0.01 <sup>5</sup>	0.01 <sup>Δ</sup>		<0.15	<0.15	<0.15	<0.15	<0.15	<0.15	0.15
Dibenzo(a,h)anthracene	0.01	0.1	1	NC	NC		<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	0.12
Benzo(g,h,i)anthracene	0.01	0.1	1	NC	NC		<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	0.12
% Recovery Surrogates													
d8-Naphthalene							84	75	-	-	20	37	-
d12-Chrysene							112	107	101	87	117	86	-

Value A is based on drinking water criteria  
Value B is an intermediate value, approximately 5 to 10 times above the value of A  
Value C is the value considered to be the level at which contamination is significant

+ ODWO - Ontario Drinking Water Objectives  
<sup>1</sup> WHO - World Health Organization Drinking Water Guideline  
<sup>Δ</sup> GLSAB - Great Lakes Advisory Board (IJC, 1983) Annual Report of the Aquatic Ecosystems Objective Committee  
<sup>\*</sup> USEPA - United States Environmental Protection Agency

<sup>1</sup> Chronic to freshwater aquatic life  
<sup>2</sup> To control undesirable taste and odour  
<sup>3</sup> Human health - with fish consumption  
<sup>4</sup> Human health - without fish consumption

**Table 6**  
**COMPARISON OF CHEMICAL ANALYSIS OF ORGANIC CHEMICALS**  
**TO AVAILABLE WATER QUALITY CRITERIA**

Parameter	Surface Water Quality Objectives <sup>2</sup> (µg/L)	Drinking Water Objectives <sup>1</sup> (µg/L)	Location Sample #	BIII 2175-01	BHIB (Duplicate of BIII) 2175-02	BIII 2175-03	BII4 2175-04	BIII5 2175-05	BH7 (Trip Blank) 2175-06	Method Detection Limit
Phenols (µg/L)	1 <sup>1</sup>	2 <sup>1</sup>		330	350	190	2200	158	<1	1
TOC (DOC) (mg/L)	NC	NC		15.2	16.5	10.9	21.5	19.9	0.82	NR
COD (mg/L)	NC	NC		155	127	57	103	116	17	NR

<sup>1</sup>MOE (1984)

NC = No criteria available

NR = Not reported

VOCs analysis in groundwater (Table 6) showed detectable concentrations for the selected compounds analyzed (only benzene, toluene, xylene and ethyl benzene-BTXE) at each well with the exception of ethyl benzene at BH3. Concentrations of toluene and o-xylene were highest at BH1, and m&p-xylene was highest at BH5, both are upgradient wells. Benzene concentrations were highest at BH3 but for all 4 other parameters BH3 had significantly lower concentrations.

BTXE are chemicals which are indicative of coal tar and other petroleum products. The presence of these chemicals at upgradient wells may be due to migration from adjacent properties. One possible source could be the underground storage tanks located in the southwest portion of the former plant now owned by the City (see Figures 2 and 3).

#### Polynuclear Aromatic Hydrocarbons

PAH analysis (Table 6) showed high concentrations of naphthalene, acenaphthylene, fluorene, phenanthrene and anthracene at upgradient wells BH1 and BH5, with lower concentration at BH3 and BH4. PAH concentration at BH3 are significantly lower than all other wells onsite. As well as the PAHs mentioned above detectable concentrations of acenaphthene, fluoranthene and pyrene were reported in all four wells. Concentrations of benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene were only detected in BH4.

PAHs present in upgradient wells may also be attributable to offsite sources as discussed previously for VOCs.

#### Coal Tar Acids

Coal tar acid analysis (Table 6) in groundwater showed detectable concentrations of all the coal tar acids at each well with the exception of resorcinol at BH3. Except for phenol and 2,6-dimethyl phenol, all 7 other coal tar acid concentrations were significantly lower at BH3. The highest concentrations for coal tar acids were found at BH4 with BH1 having similar concentrations.

#### 4.3.3.2 Organic Chemical Indicators

Indicators of organic chemical contamination (Table 6) analyzed as part of this study included dissolved organic carbon (DOC), phenols, and total organic carbon (TOC).

Dissolved Organic Carbon (DOC) was detected at all monitoring wells. Concentration ranged from 10.9 to 21.5. DOC bears a direct relationship with both biochemical and chemical oxygen demands and varies with the composition of organic matter present. DOC is lowest at BH3 and highest at BH4.

High phenol (or total phenol) concentrations were found in all groundwater samples ranging from 158 µg/L at BH5 to 2200 µg/L at BH4. Phenolic compounds are released by the distillation of coal. Phenols are highly soluble have low sorption and high biodegradability. As such, they are highly mobile in groundwater and are frequently used as indicators of groundwater contamination.

Chemical Oxygen Demand (COD) is a measure of the amount of oxygen required to chemically oxidize organic matter in the groundwater. COD concentrations in the groundwater onsite varied from 57 mg/L to 155 mg/L. The lowest COD concentration was measured at BH3.

#### 4.3.4 Compliance with Water Quality Guidelines

Groundwater concentrations were compared to current guideline values in order to determine if groundwater quality was in compliance or not. Groundwater concentrations were compared to the Ontario Ministry of the Environment's 'Ontario Drinking Water Objectives' wherever possible or to other guidelines and criteria as referenced on Tables 5 and 6. Drinking water guidelines were used as the most immediate impact of contamination is on groundwater quality which is most commonly used as a supply of potable water (although this is not the case in the immediate vicinity of the site). Groundwater concentrations have also been compared to surface water quality guidelines as shallow contaminated groundwater may flow into the Speed River to the east.

#### Anions

Chloride was the only anion which exceeded drinking water objectives. All four monitoring wells had groundwater chloride concentrations in excess of four to five times the maximum concentrations (250 mg/L) recommended by the MOE.

High chloride concentrations may be the result of road salting. Industrial processes and the disinfection of sewage also contribute to high chloride concentrations although such facilities were not identified upgradient of the site.

#### Trace Metals and Cations

Of all the trace metals, cadmium, iron and cyanide, exceeded the Ontario Drinking Water Objectives for most wells onsite. Iron concentrations were 1.5 to 7 times higher than O.D.W.O. at BH1, BH4 and BH5. Groundwater from BH3 did not exceed the O.D.W.O. for iron. Cadmium concentrations slightly exceeded the 0.005 mg/L limit for groundwater at all 4 wells ranging from 0.007 mg/L at BH3 to 0.01 mg/L at BH1 and 4. Cyanide may be derived from spent oxide located on the gas plant property.

#### Other Inorganic Parameters

Ammonia exceeds the surface water guideline at 0.02 mg/L (MOE, 1984) at all wells.

#### Volatile Organic Compounds (VOCs)

VOC analysis shows excessively high concentrations at all monitoring wells. VOC analysis demonstrates that all compounds analyzed (ie. BTXE) exceed available drinking water objectives in all instances except ethyl benzene, m&p-xylene and o-xylene at BH3 and o-xylene at BH4 and BH5.

Benzene exceeds both the Health and Welfare Canada (1987) guidelines as well as the less stringent freshwater aquatic life guidelines set by CCREM (1987) at all well locations. Toluene concentrations also exceed CCREM guidelines at BH1.

### Organic Indicators

All concentrations of phenols (total phenols) at the monitoring wells exceeded maximum concentrations for domestic consumption set by Health and Welfare Canada (1987) and MOE (1984) as well as surface water quality (MOE, 1984). Concentrations in excess of 75 to 1000 times acceptable maximum concentrations were detected. Phenols in these high concentrations are considered toxic and impair the taste and odour of groundwater.

The highest phenols were detected at BH4 which is downgradient of the subsurface coal tar deposits discovered during borehole drilling and test pit excavation. The high phenols in groundwater at BH4 indicate that they are likely the result of upgradient coal tar deposits.

DOC (filtered TOC) exceeds the ODWO at all wells.

### Coal Tar Acids

Drinking water or other water quality criteria were not available for coal tar acids.

### Polynuclear Aromatic Hydrocarbons

PAH concentrations in groundwater were compared to the CCREM guidelines for coal tar sites shown in Table 6 and enclosed in Appendix G. PAHs in groundwater exceed the "C" level at which contamination is considered significant for at least one PAH at all wells except BH3. The "C" guideline is exceeded for naphthalene and phenanthrene. The CCREM guideline suggests that groundwater above level "C" should either be monitored or decontaminated. Concentrations at BH3 exceed the CCREM "B" for one PAH, namely naphthalene.

#### 4.3.5 Assessment of the Origin of Groundwater Contamination

A conclusive assessment of the origin of groundwater contamination is difficult based on the lack of available information on historical waste management practices. However, some insight into this issue has been obtained as a result of this investigation.

Inorganic contamination of groundwater probably originated from a source beyond the Union Gas property. In particular, cyanide is a contaminant which is known to be associated with spent oxide from coal gasification. Spent oxide would have been generated at the purifier building located on what is now City property. No evidence of spent oxide was observed during the subsurface investigation at the Union Gas property. The limited depth of overburden over bedrock further minimizes the potential for this material to be present onsite. Furthermore, the elevated levels of cyanide at the upgradient property boundary and the direction of groundwater flow suggest that an offsite source is probable.

## 5.0 IMPACT ASSESSMENT

Exposure pathways and potential impacts attributable to coal gasification residues present on the Union Gas property are identified and assessed in this chapter. The potential onsite and offsite impacts identified are assessed separately.

### 5.1 Onsite

#### 5.1.1 Contaminant Migration in Groundwater

The onsite impact of contaminants present in groundwater beneath the Union Gas property is considered to be minimal as groundwater is not used as a water supply. Although elevated levels of many contaminants exist, no impact on human health or the environment could be identified on the Union Gas property. However, contaminants present in groundwater may migrate offsite due to advection with the ambient flow of groundwater to the southeast. The impacts associated with offsite migration are discussed in Section 5.2.

#### 5.1.2 Coal Tar Migration

Coal tar can migrate through the subsurface in both soil pores and bedrock fractures. Black staining of fracture surfaces in the bedrock was observed at all boreholes, presumably due to coal tar migration. However, no actual coal tar was identified. This suggests that coal tar may have migrated along fractures in the past but that it is no longer occurring.

Coal tar was present in fill in test pits and boreholes at many locations across the site. The fact that it remains in place at least 32 years following cessation of gas production suggests that it is contained under present site conditions and that migration of tar as an immiscible liquid is not actively occurring. However, the remaining tar acts as a source of dissolved contaminants to groundwater.

Migration of coal tar as an immiscible liquid is not viewed as a concern under present site conditions. However, future disturbance of the waste may cause further migration and should be avoided or conducted in a manner which prevents release of contaminants.

#### 5.1.3 Impact on Union Gas Operations

The potential impacts of buried wastes and gas plant residues on the present Union Gas operation are identified and discussed in this section. Two primary exposure pathways were identified:

- i) Vapour migration
- ii) Direct contact



Migration of vapours was addressed by analysis of air quality on the Union Gas property as discussed in Section 2.8. Background readings were non-detectable (less than 1 ppm) on all occasions. Non-detectable levels of organic vapour were observed in ambient air around the Union Gas property and at all locations tested inside the Union Gas building. Detectable organic vapours were generally observed in the subsurface in both boreholes and test pits. Concentrations ranged from non-detectable to 68 ppm.

It is evident that organic vapours were not detected in or around the Union Gas building. These organic vapour readings are expressed as isobutylene and provide an indication of the relative concentration of other compounds. The MOL Time Weighted Average Exposure Value (TWAEV) for several compounds associated with gas plant residues are as follows:

<u>Compound</u>	<u>TWAEV (ppm)</u>
Benzene	5
Toluene	100
Xylene (all isomers)	100
Naphthalene	10

Although direct comparison of these TWAEV with organic vapour measurements is not rigorously correct, organic vapour readings in and around the Union Gas building were less than the TWAEV suggesting that air quality is probably acceptable relative to MOL workplace standards.

Air quality in the subsurface contains elevated organic vapour readings. However, human intake of these vapours is unlikely as the exterior surface of the site is largely paved and the Union Gas building is constructed with a concrete floor. Furthermore, non-detectable organic vapour readings were measured at all above ground locations. It was concluded that the potential onsite impacts from vapour migration are minimal. However, any future development of the site should recognize the potential for vapour migration and be designed accordingly.

The potential for direct contact with gas plant residues is unlikely unless excavation occurs at the site as no residues are exposed at ground surface.

## 5.2 Offsite

The investigation conducted by CANVIRO focussed on the Union Gas property and included minimal offsite work. The potential offsite impacts of conditions on the Union Gas property were estimated based on information available from other sources, primarily Environmental Strategies (1988).

### 5.2.1 Speed River Water Quality

Speed River water quality could be affected in three ways:

- i) Migration of contaminants in groundwater with eventual discharge to the river;
- ii) Infiltration of contaminated groundwater to storm sewers which discharge directly to the river;
- iii) Infiltration of contaminated groundwater to the sanitary sewers with eventual discharge to the river following treatment at the sewage treatment plant.

Offsite contamination of groundwater was investigated by Environmental Strategies (1988). Coal tar derived contaminants were detected as far downgradient as Wellington Street at a distance of approximately 80 metres from the property boundary at BH12. Concentrations diminished quite rapidly with distance from the site and concentrations at Wellington Street exceeded drinking water guidelines for only a few parameters. No contamination was observed immediately across Surrey Street from the Union Gas property (at BH14) with the exception of cyanide.

The distance at which dissolved contaminants were found and the levels of contamination are low relative to the estimated groundwater flow rate and source area concentrations. It is apparent that attenuation of contaminants in groundwater is probably occurring. This is most likely due to diffusion of contaminants into the rock matrix, a process termed "matrix diffusion". Other possible attenuating mechanisms may include biodegradation, dispersion and sorption.

Alternatively, vertical migration of contaminated groundwater may be occurring based on the downward vertical gradient identified in Environmental Strategies (1988). Vertical migration may be enhanced by density effects in the groundwater plume. Such an occurrence would also explain why relatively little contamination was observed along Wellington Street and along Surrey Street at BH14 as monitoring wells penetrated only 1 to 3 metres into rock. The extent of contamination at depth in the bedrock has not been addressed to date. However, the occurrence of contamination at depth is not viewed as a significant environmental impact.

A third explanation exists with regard to the limited extent of contamination downgradient of the Union Gas property. The absence of contamination at BH14 may be due to the impact of preferential groundwater flow along the sanitary sewer backfill as discussed earlier. Contaminated groundwater may be intercepted and re-directed along or into the sanitary sewers. The impact of groundwater contamination at depth or sanitary sewer infiltration is probably minimal. However, migration of contaminants along the sewer backfill may result in relatively rapid transport towards the Speed River.

Alternatively, the fracture zone identified near BH3 may be redirecting contaminated groundwater prior to reaching BH14. Migration of contaminants in this

fracture zone is most likely to be to the south based on; the absence of a fracture zone in the other study locations, the absence of contamination to the east and the groundwater flow direction observed in this study.

The impact of contaminant loading to the Speed River through discharge of contaminated groundwater was addressed in Environmental Strategies (1988) by chemical analysis of river water and sediments.

River water samples were analyzed for phenol, ammonium, cyanide, dissolved metals and PAHs. No PAHs or phenols were detected. Only cyanide and lead were detected above the Provincial Water Quality Objectives (PWQOs).

No samples were collected to assess upstream water quality. However, these analysis suggest that no measurable impact existed at the time due to phenol or PAHs, both of which are indicative of coal gasification wastes. Similar results were observed with respect to PAHs and phenols further downstream. The cyanide may be associated with the gas plant but lead likely originated from another source.

Sediment samples were also collected in the Speed River. These analysis found total PAH concentrations which varied from 2.2 to 15.4  $\mu\text{g/gm}$  (ppm) (Environmental Strategies, 1988). These sediments exceed the International Joint Commission guideline of 1  $\mu\text{g/gm}$  (ppm) in waterway sediment (Richardson, 1987). No upstream sediment samples were collected to assess ambient levels in the Speed River. As a comparison, the range of concentrations for one PAH, benzo(a)pyrene (B(a)P), is available for Great Lakes surficial sediment. B(a)P ranges from 56 to 173 ng/gm (ppb) in Lake Erie and 76 to 306 ng/gm (ppb) in Lake Ontario (CANVIRO 1988). Environmental Strategies (1988) reported B(a)P at concentrations ranging from non-detectable (method detection limit = 0.2  $\mu\text{g/L}$ ) to 0.8  $\mu\text{g/L}$  (0.8 ppb). Although direct comparison of these concentrations is not appropriate due to the difference in units, it is clear that values in Speed River sediments are low compared to Lake Ontario and Lake Erie.

As a further comparison, the total PAH concentration in Speed River sediments are less than the cleanup criteria of 35 ppm adopted at Port Stanley for the Kettle Creek Sediment Investigation (CANVIRO 1988). However, this cleanup guideline was site specific and does not necessarily apply to the Speed River sediments.

Point (ii), infiltration of contaminated groundwater with discharge directly to the river was investigated and reported in Environmental Strategies (1988). At present, a storm sewer running southwest along Surrey Street drains storm water from the Union Gas property. In 1986, the City of Guelph detected coal tar seeping from the Union Gas property sewer connection to the sewer. This connection may be the pipe uncovered in Test Pits 1 and 3 during this investigation. The connection was subsequently sealed.

Tar like sediments were not identified in the Surrey Street storm sewer during a later inspection by Environmental Strategies. Similarly, no coal tar was observed in sewer bedding for the Surrey Street storm sewer adjacent to and south of the Union Gas property.

The migration of coal tar derived chemicals into the storm sewer was further addressed by Environmental Strategies who collected a sample of sewer water from a manhole at the corner of Surrey and Gordon Streets. The concentration of phenols was 16 µg/L. No PAHs were detected and no other analysis were conducted. It should be noted that phenols are not specific to coal tar and their presence in the storm sewers does not confirm that contaminants from the former gas plant are reaching the sewer.

Review of the elevation of storm sewers relative to the water table showed that both coincide closely. Given that water table fluctuations occur seasonally, it is conceivable that contaminated groundwater could enter the storm sewers during periods of high water table, specifically spring and fall. Sewer elevations were compared to water level elevations and it was concluded that groundwater could be entering the sewers at certain times of the year. For instance, on April 4, 1989, groundwater levels were above sewer elevations at all locations adjacent to the site. However, on March 15, 1989, water levels at the south end of Union Gas property were beneath the sewers suggesting that infiltration was unlikely in this area at that time. The date of sample collection by Environmental Strategies is not reported although it is evident that most sampling was performed during the winter season. As such, the storm water conditions may not have been assessed at the most appropriate time. The impact of storm sewer infiltration should be reassessed under higher water table conditions during the spring and fall seasons.

Further observations of note regarding sewer construction were that all sewers appear to be constructed above the bedrock surface. The type of sewer backfill was not documented.

Point (iii), infiltration of contaminated groundwater to the sanitary sewer has not been addressed to date. However, Environmental Strategies did not observe any evidence of coal tar during excavation of sewer backfill adjacent to the Union Gas property on Surrey Street. Furthermore, contaminants entering the sanitary sewer must pass through the sewage treatment plant prior to discharge. Many of the contaminants associated with coal tar, in particular PAHs are treated and removed quite effectively in a conventional activated sludge treatment plant (CANVIRO, 1984). Therefore, the potential environmental impact from infiltration of contaminants to the sanitary sewer is considered to be minimal.

Movement of contaminated groundwater along the sanitary sewer backfill was identified as a potential migration pathway. This could result in a shorter travel time to the Speed River. However, this possibility was not investigated in detail as part of this study.

#### 5.2.2 City of Guelph Water Supply Aquifer

The water supply for the City of Guelph is surface water (obtained upstream of the site) augmented by municipal wells. The nearest municipal well is located across the Speed River from the site to the north at a distance of approximately 2.5 km. The majority of remaining wells are reportedly located in the northwest quadrant of the City. This area is upgradient from the Union Gas property and it is improbable that dissolved contaminants will flow in the direction of the wells. Immiscible coal

tar may migrate along bedding planes in the bedrock which dips to the southwest. Therefore, movement of coal tar towards the wells is unlikely to occur.

It is apparent that the potential impact of gas plant residues is minimal based on the distance to existing wells. Future installation of municipal wells near the site may be impacted by existing groundwater contamination. Any plans for future development of groundwater supplies should consider this possibility.

#### 5.2.3 General Groundwater Usage

Piped water is presently available to all properties likely to be affected by the migration of coal tar derived chemicals. As such, it is unlikely that the property owners would exploit groundwater resources in the area. The potential for this impact is considered minimal.

#### 5.2.4 Other

Other potential offsite impacts identified are as follows:

- i) Vapour migration into basements and buried utilities
- ii) Migration of contaminated groundwater or tar into basement sumps

Migration of vapours into nearby basements may occur. However, the gas plant residues have been in place for up to 118 years. If vapour migration was to occur, it would have been more predominant at an earlier date as vapour concentrations would be expected to dissipate with time, particularly since the cessation of gas production. Offsite vapour migration was not investigated as part of this study.

Migration of coal tar and contaminated groundwater into basement sumps may occur in buildings downgradient of the site (ie. to the southwest). This may be accompanied by olfactory evidence of contamination. The major impact of fluids in sumps would be either through vapour emission at levels above acceptable guidelines or through direct contact with fluids, such as dermal exposure. Ingestion of these liquids is unlikely. The presence of sumps in building downgradient of the site was not investigated.

## 6.0

## REMEDIAL MEASURES

Previous sections of this report dealt with the methodology and results of the investigation portion of this study. Based on these findings, this chapter has been prepared to identify, screen and evaluate remedial action alternatives pertaining to the Union Gas property. This investigation is an initial study and does not encompass an offsite investigation of conditions. Therefore, the remedial measures discussed in this chapter deal solely with onsite conditions.

### 6.1

#### Statement of Purpose and Need

The overall purpose of the remedial action is to cost-effectively mitigate and minimize environmental damage to and provide adequate protection of public health and the environment, resulting from the presence and release of contaminants from the former Guelph coal gasification plant.

The need for remedial action arises out of the impact of coal gasification plant residues identified in Chapter 5.0. In Section 5.1, no major environmental or human health impacts were identified onsite based on current site conditions. Based on the absence of any significant onsite impacts at this time and the low probability of future onsite impacts, we do not perceive a need to implement remedial measures.

If the site is redeveloped or construction activities are undertaken in the future, remedial measures may be warranted. The conditions which warrant remedial action include but are not limited to the following:

- i) If fill materials containing gas plant residues are excavated, they should be treated as hazardous waste and disposed of at an approved facility.
- ii) If subsurface conditions must be disturbed, the impact on waste migration should first be assessed to mitigate increased release of contaminants.
- iii) If new buildings are proposed, the design should incorporate provisions to minimize vapour and fluid migration into basements.
- iv) Any groundwater collected such as in basements sumps or otherwise (ie. water supply) should be analyzed and managed according to relevant regulations.

## 7.0

## CONCLUSIONS

The conclusions in this report are based on information determined at borehole and test pit locations. Soil and other conditions between and beyond these locations may differ from those encountered at these locations and conditions may become apparent during future excavation or other work which could not be detected or anticipated at the time of the site investigation.

Conclusions regarding the investigation of the former Guelph coal gasification plant owned by Union Gas are as follows:

- The subsurface strata consists of 0.6 to 2.6 metres of fill material overlying fractured dolomite bedrock.
- Investigation of the former gas holder suggests that this structure was placed on a concrete foundation resting on bedrock and that it consisted of a concrete slab on grade which was the base for an above ground tank.
- Coal tar contaminated fill was observed in all boreholes and test pits beneath and in the immediate vicinity of the former gas holder on the northern portion of the site (excluding BH2). No visual evidence of coal tar contamination was observed in the fill in the southern portion of the site.
- Staining of fracture surfaces in the bedrock, presumably by coal tar, was observed in all boreholes penetrating the bedrock. However, no free coal tar was observed suggesting that staining is a remnant of historical migration.
- Ambient organic vapour concentrations in the Union Gas building and around the site were non-detectable. Measureable organic vapour levels were detected in the subsurface at all locations where contamination was evident.
- Chemical analysis of wastes and fill materials confirmed the presence of coal tar derived chemicals, specifically chemicals in the coal tar acids group.
- Chemical analysis of PAHs in wastes and fill materials demonstrated that levels exceed the CCREM "C" guideline suggesting that restoration will likely be required, prior to redevelopment of the property, at least in selected portions of the site.

- The estimated quantities of wastes are as follows:

<u>Group</u>	<u>Quantity (m<sup>3</sup>)</u>
I	540
II	-
III	2250
IV	-

- Groundwater flow occurs primarily in the fractured bedrock, is oriented to the southeast and is estimated to flow at 800 to 900 metres/year. The reason for such unnaturally high flow rates appears to be related to a groundwater "sink" or drain along Surrey Street which may be attributable to preferential flow of groundwater along the sanitary sewer backfill or within the sewer itself.
- Groundwater near the upgradient property line has elevated levels of several inorganic and organic chemicals which may originate from adjacent properties. These include:
  - i) Inorganic Chemicals
    - chloride
    - sodium
    - cadmium
    - cyanide
  - ii) Organic Chemicals
 

<ul style="list-style-type: none"> <li>- benzene</li> <li>- toluene</li> <li>- m&amp;p-xylene</li> <li>- o-xylene</li> <li>- ethyl benzene</li> <li>- naphthalene</li> <li>- fluorene</li> </ul>	<ul style="list-style-type: none"> <li>- phenanthrene</li> <li>- anthracene</li> <li>- fluoranthene</li> <li>- pyrene</li> <li>- DOC</li> <li>- COD</li> </ul>
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------
- A number of parameters exceed available drinking water guidelines in groundwater. These include:
  - i) Inorganic Chemicals
    - chloride
    - cadmium
    - cyanide
  - ii) Organic Chemicals
 

<ul style="list-style-type: none"> <li>- benzene</li> <li>- toluene</li> <li>- m&amp;p-xylene</li> <li>- o-xylene</li> <li>- ethyl benzene</li> <li>- acenaphthene</li> </ul>	<ul style="list-style-type: none"> <li>- anthracene</li> <li>- benzo(a)pyrene</li> <li>- phenols</li> <li>- ammonia</li> <li>- DOC</li> </ul>
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Of these, all but acenaphthene and benzo(a)pyrene, exceed drinking water guidelines at upgradient monitoring wells.

- Concentrations of naphthalene and phenanthrene exceed the CCREM "C" guideline at which groundwater contamination is considered significant at one or more monitoring wells. The CCREM "B" guideline is exceeded for three parameters at BH4.
- The onsite impact of coal gasification plant residues on human health and the environment are considered minimal in their present form.
- The offsite impact of coal gasification plant residues was not investigated as part of this study but appears to be minimal based on studies by others.
- No need exists to implement remedial measures at this time based on the absence of a significant onsite impact and the low probability of future onsite impacts.

## 8.0

## RECOMMENDATIONS

The recommendations developed as a result of this initial investigation of the portion of the former Guelph coal gasification plant owned by Union Gas are as follows:

- Remediation of contaminated soils and fill is not necessary at this time to address onsite impacts and should not be implemented.
- Soil and fill excavated at the site in the future should be replaced in the excavation where possible and covered to minimize the potential for human contact through exposure at ground surface.
- Any re-development or construction projects which are to occur on these Union Gas Limited properties and are likely to disturb, cause or result in human contact with the coal tar waste materials, should not be undertaken unless appropriate occupational health and safety, and environmental practices are employed. Handling practices should: (i) be developed, implemented and supervised by qualified personnel, (ii) include utilization of appropriate MOE guidelines like the "proposed Interim Guidelines for PAH Contamination at Abandoned Coal Tar Sites", and (iii) include a provision of notification to the Ministry's Waste Management Branch, prior to commencement.
- Removal of contaminated soil/fill, as part of future site redevelopment, should not be completed until adjacent portions of the former coal gasification plant and other contaminated lands are remediated, as these properties may be contributing to contamination beneath the Union Gas property.
- The source of contaminants present at the upgradient property boundary should be investigated on adjacent portions of the former plant located upgradient of the Union Gas property. This should include chemical analysis of groundwater for PAHs, VOCs (BTXE only), phenols and cyanide.
- Although the potential for adverse impacts from offsite migration appears minimal based on work by others, the following activities are recommended to confirm this assessment:
  - i) sampling of storm water in the Surrey Street storm sewer upstream and downstream of the site during a period with a high water table
  - ii) Sampling of the City well BH14 to confirm that it is uncontaminated

- iii) Analysis of samples in (i) and (ii) for PAHs, VOCs (BTXE only), phenols, and cyanide
- iv) Migration of contaminated groundwater to the south through the fracture zone identified at BH3 should be investigated if it is confirmed that BH14 and the storm sewer on Surrey Street are uncontaminated.

## 9.0 REFERENCES

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**Appendix A**  
**BOREHOLE AND TEST PIT LOGS**

APPENDIX A  
ROCK QUALITY DESIGNATION (RQD) ANALYSIS

BH No./ Interval (feet)	Length Cored (ft)	Intact Recovery Pieces > 10 cm (cm/ft)	RQD (%)	RQD Description	Fracture Spacing	Fracture Description
BH #1 7'0"-17'3"	10'3" or 10.25'	136 cm = 4.46'	44%	Fair	Moderately Wide	7' to 12'3" yellow to milky white limestone/dolomite, variable porosity wavy to irregular narrow, smooth to rough fractures oriented <30° to core axis
BH #1	as above	as above	as above	as above	as above	12'3" to 17'3" as above but off white to grey colour and 3-5% vuggy RQD constant throughout
BH #3 10'6"-14'	3'6" or 3.5'	0	0%	very poor	very close 1 cm - 5 cm	Grey fossiliferous, vuggy dolostone with irregular narrow smooth to rough fractures. Very broken fractures at variable orientations
BH #3 14'-19'2"	5'2" or ~ 5.2'	22 cm .72'	14%	very poor	very close 5 cm - 11 cm	Lithology same as above but core less broken Fractures oriented 10-30° to core axis with some steeper
BH #4 8'8"-19'9"	11'1" or 11.08'	116 cm or 3.8'	34%	fair	moderately wide 3 cm - 14 cm	Layered dolostone, vuggy 5-10% and fossiliferous, variable porosity with depth. Wavy to irregular, narrow smooth and rough fractures about 80-90% and wide fractures. ~ 10% oriented 10-30° to core axis some steeper and some <10° to core axis grey colour.
BH #5 3'8"-14'2"	10'6" or 10.5'	196 cm or 6.4'	61%	fair	moderately wide 2 cm - 25 cm	White fossiliferous dolomite/limestone, little or no vugs. Relatively homogeneous. No obvious layering or laminations. Fractures straight to wavy, narrow and smooth oriented 0 to 10° to core axis. Core has gritty texture.
BH #7 4'2"-7'6"	3'4" or 3.3'	49 cm or 1.6'	49%	fair	moderately wide 2 cm - 20 cm	White to yellow white dolostone fossiliferous, variable porosity. Fractures irregular wavy, narrow smooth to rough and oriented 0-10° to Core Axis.



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SHEET 1 OF 7

# SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY LOCATION GUELPH, ONT

ELEVATION 312.366 m.a.s.l DRILLING CONTRACTOR ENVIRONMENTAL SYSTEMS

DRILLING METHOD AND EQUIPMENT FOLLOW STEM AUGER, DIAMOND CORER

WATER LEVEL AND DATE Feb 13-Feb 17, 1989 START \_\_\_\_\_ FINISH \_\_\_\_\_ LOGGER D.GRAHAM/D.G.W

DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-6"-5" (N)	SOIL DESCRIPTION SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	INTERVAL	TYPE AND NUMBER	RECOVERY (m)				
1		SS1	0.15	3-9-6-12	- asphalt - old asphalt or slag		well casing flush with ground surface
		SS2	0.50	9-4-16-30/5cm	- soft soil with natural organics and gravel, no odour - silty sand, brown, wet, probably saturated Auger refusal at 1.47m		volclay grout
2					- tricone ahead to fit long core barrel in hole, no sample (1.47-2.13m)		
3		RC	1.52		- very light coloured dolostone with fossils, fairly porous - little iron staining in the fractures - no rubble zones		PVC riser pipe (flush threaded)
4		RC	1.47		- colour grading darker towards bottom, black staining in the fractures towards the bottom - no major zones of contamination - no rubble zones		sand filter pack
5							PVC screened pipe (25mm slots)
							bottom of screen to bottom of well is 0.24m

# SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY

LOCATION GUELPH, ONT

ELEVATION 312.366 m.a.s.l

DRILLING CONTRACTOR

ENVIRONMENTAL SYSTEMS

DRILLING METHOD AND EQUIPMENT HOLLOW STEM AUGER, DIAMOND CORER

START DATE Feb 13-Feb 17, 1989

START

FINISH

LOGGER D. GRAHAM/D.G.W

START		FINISH		D. GRAHAM/D.G.W			
DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (m)	6"-6"-5" (N)	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
1		SS1	0.15	3-9-6-12	- asphalt - old asphalt or slag		well casing flush with ground surface
		SS2	0.50	9-4-16-30/5cm	- soft soil with natural organics and gravel, no odour - silty sand, brown, wet, probably saturated Auger refusal at 1.47m		volclay grout
		RC	1.52		- tricone ahead to fit long core barrel in hole, no sample (1.47-2.13m) - very light coloured dolostone with fossils, fairly porous - little iron staining in the fractures - no rubble zones		PVC riser pipe (flush threaded)
		RC	1.47		- colour grading darker towards bottom, black staining in the fractures towards the bottom - no major zones of contamination - no rubble zones		sand filter pack
							PVC screened pipe (25mm slots)
							bottom of screen to bottom of well is 0.24m





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BH-2

SHEET 2 OF 7

## SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY

LOCATION GUELPH, ONT

ELEVATION \_\_\_\_\_ DRILLING CONTRACTOR

ENVIRONMENTAL SYSTEMS

DRILLING METHOD AND EQUIPMENT HOLLOW STEM AUGER, DIAMOND CORER

WATER LEVEL AND DATE Feb 13-Feb 17, 1989

START \_\_\_\_\_

FINISH \_\_\_\_\_

LOGGER D. GRAHAM/D.G.W

DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS 5'-5'-5' (N)	SOIL DESCRIPTION SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (m)				DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
0.25		SS2		32/15cm	-asphalt -auger down, no sampling -cuttings were brown sand with wood then dark brown silty sand		<u>no</u> well installation hole backfilled with native material
0.50		SS3	0.08	+100/15cm	-dark brown/black silty sand -slight odour -pushing off boulder -pushing off boulder again -drilled through (dolostone boulder) -slight odour		
0.75				84/4cm			
1					Auger refusal at 0.91m		

# SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY

LOCATION GUELPH, ONT

ELEVATION 311.606 m.a.s.l.

DRILLING CONTRACTOR

ENVIRONMENTAL SYSTEMS

DRILLING METHOD AND EQUIPMENT HOLLOW STEM AUGER, DIAMOND CORE

WATER LEVEL AND DATE Feb 13-Feb 17, 1989

START

FINISH

LOGGER D. GRAHAM/D.G.W

DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (%)				
				6"-6'-6" (N)	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS TESTS AND INSTRUMENTATION
1		SS1	0.15	20-16-20-13	- asphalt - dark brown gravel fill - no odour		well casing flush with ground surface
		SS2	0.25	5-5-8-7	- dark brown/grey sandy clay and gravel - saturated - no odour		backfill
2		SS3		13-39-45	- light brown dense sand or very weathered dolomite - very slight odour Auger refusal at 2.11m - very broken up bedrock, attempt to core but unsuccessful - triconed ahead to solid rock		PVC riser pipe (flush threaded)
3		RC			- very broken rubble - darkly stained, no sign of free coal tar, but slight tar contamination in wash water		volclay grout
4		RC			- very broken rubble - dark staining - bottom 10cm solid		sand filter pack
5		RC	1.00		- frequent fractures, reasonably intact - dark coloured rock with black stained fractures coated with a hard black crust - some vugs with calcite crystals; rubble zone at 5.18m		PVC screened pipe (25mm slots)
		RC	0.64		- dark coloured rock with frequent fractures that are stained black - no rubble zones		bottom of screen to well bottom, 0.24m

# SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY LOCATION GUELPH, ONT

ELEVATION 312.136 m.a.s.l. DRILLING CONTRACTOR ENVIRONMENTAL SYSTEMS

DRILLING METHOD AND EQUIPMENT HOLLOW STEM AUGER, DIAMOND CORER

WATER LEVEL AND DATE Feb 13-Feb 17, 1989 START \_\_\_\_\_ FINISH \_\_\_\_\_ LOGGER D. GRAHAM/D.G.W

DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (m)				
				6"-5"-5" (N)	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS TESTS AND INSTRUMENTATION
1		SS1	0.20	38-12-11-8	- grass and top soil - dry, brown sand and gravel probably fill		well casing flush with ground surface
		SS2		9-9-5-4	- darker brown sand and gravel probably fill		concreted surface casing
2		SS3	0.33	5-17-18-19	- moist brown clayey and silty sand		backfill
		SS4		17-102/5cm	- coal tar in bottom of spoon - cuttings dark grey, odourous metallic sheen, VOC and PAH sample taken (grab) - brown sand and gravel Auger refusal at 2.69m		PVC riser pipe (flush threaded)
3		RC	3.20		- dark coloured rock - frequent fractures with dark staining throughout - fracture zones at: 3.45-3.55m and 5.05m		volclay grout
4							sand filter pack
5					note: lost at bottom of screen - steel rod - nylon measuring tape - duct tape (possible source of solvent from glue)		PVC screened pipe (25mm slots)
							bottom of screen to well bottom is 0.15m

# SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY LOCATION GUELPH, ONT

ELEVATION 312.236 m.a.s.l

DRILLING CONTRACTOR ENVIRONMENTAL SYSTEMS

DILLING METHOD AND EQUIPMENT HOLLOW STEM AUGER, DIAMOND CORER

WATER LEVEL AND DATE Feb 13-Feb 17, 1989

START

FINISH

LOGGER D. GRAHAM/D.G.W

DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS 6"-5"-6" (N)	SOIL DESCRIPTION SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
	INTERVAL	TYPE AND NUMBER	RECOVERY (m)				
1		SS1		3-14-40 /2cm	<ul style="list-style-type: none"> <li>- asphalt</li> <li>- clean yellow coloured gravel possibly crushed bedrock</li> <li>- gravel stained black with strong odour (0.28-0.41m)</li> <li>- concrete slab (0.41-0.76m)</li> <li>- gravel with coal tar</li> </ul>		<ul style="list-style-type: none"> <li>- well casing flush with ground surface *</li> <li>- volclay grout</li> </ul>
2		RC	1.07		<ul style="list-style-type: none"> <li>- Top of rock 1.12m</li> <li>- bedrock with stained fractures</li> <li>- top 35cm very porous</li> <li>- at 1.35m wide fracture with coal tar</li> <li>- fracture zones at: 1.65m and 2.09-2.11m</li> </ul>		<ul style="list-style-type: none"> <li>- PVC riser pipe (flush threaded)</li> </ul>
3		RC	1.45		<ul style="list-style-type: none"> <li>- mostly solid rock with dark staining in fractures</li> <li>- fracture zones at: 2.56-2.59m and 2.76-2.78m</li> </ul>		<ul style="list-style-type: none"> <li>- sand filter pack</li> <li>- PVC screened pipe (25mm slots)</li> </ul>
4		RC	0.61		<ul style="list-style-type: none"> <li>- solid rock with dark staining in fractures</li> </ul>		<ul style="list-style-type: none"> <li>- bottom of screen to well bottom is 0.23m</li> </ul>
5							

\* note concreted surface casing used to concrete slab at 0.41m

PROJECT NUMBER  
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BORING NUMBER  
BH-6

SHEET 6 OF 7

## SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY LOCATION GUELPH, ONT

ELEVATION \_\_\_\_\_ DRILLING CONTRACTOR ENVIRONMENTAL SYSTEMS

DRILLING METHOD AND EQUIPMENT HOLLOW STEM AUGER, DIAMOND CORER

WATER LEVEL AND DATE Feb 13-Feb 17, 1989 START \_\_\_\_\_ FINISH \_\_\_\_\_ LOGGER D.GRAHAM/D.G.W

FINISH		LOGGER		D.G. GRANT D.G.W			
DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER	RECOVERY (m)	6"-6" (N)	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
		SS1	0.10	90/15cm	-asphalt -gravel sub-grade -yellow weathered dolostone sand and gravel		no well installation  hole backfilled with native material
0.5		SS2	0.05	12-9-16-9	-soft, dark brown to black sand and some gravel -cuttings very dark to black -no odour		
1		SS3	0.25		-down same hole to recover sample -gravel in tip -some sand with gravel -very black cuttings, no odour		
1.5		SS4		2-2-35-42	-free coal tar in bottom of spoon -cobble in split spoon tip coated with tar -silty dark sand saturated		
2		SS5		16-64	-sand and gravel saturated with coal tar  Auger refusal at 1.98m		
2.5							



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BH-7 (Gas Holder) SHEET 7 OF 7

## SOIL BORING LOG

PROJECT UNION GAS-COAL GASIFICATION PLANT STUDY

LOCATION GUELPH, ONT

ELEVATION \_\_\_\_\_ DRILLING CONTRACTOR

ENVIRONMENTAL SYSTEMS

DRILLING METHOD AND EQUIPMENT HOLLOW STEM AUGER, DIAMOND CORER

WATER LEVEL AND DATE Feb 13-Feb 17, 1989

START \_\_\_\_\_

FINISH \_\_\_\_\_

LOGGER D. GRAHAM/D.G.W

		START		FINISH		D.G. GRAHAM/D.G.W	
DEPTH BELOW SURFACE (m)	SAMPLE			STANDARD PENETRATION TEST RESULTS	SOIL DESCRIPTION	SYMBOLIC LOG	LOGGER
	INTERVAL	TYPE AND NUMBER	RECOVERY (m)				COMMENTS
				5-5-5 (N)	SOIL NAME, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL		DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
					-asphalt		
					-concrete		1.5 metres from edge of concrete foundation
0.5							tricone to bottom of concrete phase
					-clean, yellow gravel, soft		split spoon sample to bedrock
					-probably crushed bedrock		
1		SS1					rock core to bottom of hole
					-stained gravel, odour and		no well installation
					-some free tar		hole backfilled with volclay grout to the surface
1.5		RC	0.79				
					-grey dolostone		
					-top very stained and broken up		
					-some free product		
					-strong odour		
2							
2.5							



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TEST PIT NUMBER

TP1 (East pit)

SHEET 1 OF 3

## TEST PIT LOG

PROJECT Former Coal Gas Plant Site LOCATION Guelph LOGGER FM

ELEVATION \_\_\_\_\_ CONTRACTOR Wm Marshall

EXCAVATION EQUIPMENT \_\_\_\_\_ DATE EXCAVATED Feb 15, 1989

APPROX. DIMENSIONS: Length 2.5m Width 1m Maximum Depth 2.0m

DEPTH BELOW SURFACE (FT)	SAMPLE		SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER			
0"-2"			ASPHALT/SOD		
0"- 20"			@South end-Concrete slab @North end-Brown/grey/black fill		-Possible bottom of Holder
20"- 6'		Ttl	@South end: partially fractured dolostone bedrock @North end: mixed fill black/brown/grey sand and gravel and clay slight odour in lower profile evidence of waste at 3ft		-at approx. 5' part of a 12" Ø ceramic pipe (running w-e) was found containing coal tar -one sample (Ttl) was taken for PAH's & Acid phenolics
6'			BEDROCK (Dolostone)		HNU READING background reading 0.1ppm in bottom of pit 3 of 10 ppm



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PROJECT NUMBER

KI23906.AO

TEST PIT NUMBER

TP2 (west pit)

SHEET 2 OF 3

## TEST PIT LOG

PROJECT Former Coal Gas Plant Site

LOCATION Guelph

LOGGER FM

ELEVATION \_\_\_\_\_

CONTRACTOR Wm Marshall

EXCAVATION EQUIPMENT Backhoe

DATE EXCAVATED Feb 15, 1989

APPROX. DIMENSIONS: Length 4m Width 2m Maximum Depth 0.8m

DEPTH BELOW SURFACE (FT)	SAMPLE		SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER			DIFFICULTY IN EXCAVATION, RUNNING GRAVEL CONDITION, COLLAPSE OF WALLS, SAND HEAVE, DEBRIS ENCOUNTERED, WATER SEEPAGE, GRADATIONAL CONTACTS, TESTS, INSTRUMENTATION
0-2"			ASPHALT/SOD		
2"- 18"			Black/Brown/Grey Fill bottom 4" contaminated with coal tar		
18"- 2.5'		TT2	<u>At NORTH END OF TRENCH</u>  a 30" Ø open ended cast iron pipe filled with coal tar contaminated sand emptied into a concrete sub- trench (top of trench is flush with top of cast iron pipe) which tapered to the south. The concrete sub-trench contains the same material as the cast iron pipe.		TT2-Sample of coal tar contaminated sand was taken at 2' depth. PAH's & Acid phenolics  <u>HMU READING</u> 2-8 ppm in pit





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PROJECT NUMBER

KI23906.AO

TEST PIT NUMBER

TP3 (middle pit)

SHEET 3 OF 3

## TEST PIT LOG

PROJECT Former Coal Gas Plant Site

LOCATION Guelph

LOGGER FM

ELEVATION \_\_\_\_\_

CONTRACTOR Wm Marshall

EXCAVATION EQUIPMENT Backhoe

DATE EXCAVATED Feb 15, 1989

APPROX. DIMENSIONS: Length 7m Width 1-2m Maximum Depth 2m

DEPTH BELOW SURFACE (FT)	SAMPLE		SOIL DESCRIPTION	SYMBOLIC LOG	COMMENTS
	INTERVAL	TYPE AND NUMBER			
0"-2"			ASPHALT/SOD		
2"-4'10"			BLACK/BROWN/GREY/FILL -bottom 18" contaminated with coal tar products		In the middle of the pit at 1' 10"-4'10" a concrete block extended from the fence at the north to the concrete pad of the gas holder to the south
4'10"-5'10"			Fractured 12" Ø ceramic pipe filled with coal tar contaminated sediment and water. Pipe went from east to west running under concrete block		
5'10"-6'			FRACTURED DOLOSTONE (Bedrock)		<u>HNU READING</u> 3-10 ppm @ bottom of pit

**Appendix B**  
**WATER LEVEL ELEVATIONS**

APPENDIX B  
SUMMARY OF WATER LEVEL READING AT THE  
GUELPH COAL GASIFICATION PLANT SITE

<u>Well</u>	<u>Date</u>	<u>Water Level (m below ground level)</u>	<u>Elevation at top of monitoring well (masl)</u>	<u>Water Table Elevation (masl)</u>
<u>Union Gas Wells</u>				
BH 1	Feb 28/89	1.35	312.366	311.02
BH 3	Feb 28/89	2.22	311.606	309.39
BH 4	Feb 28/89	2.75	312.136	309.39
BH 5	Feb 28/89	1.12	312.236	311.12
<u>Union Gas Wells</u>				
BH 1	Mar 1/89	1.31	312.366	311.06
BH 3	Mar 1/89	2.19	311.606	309.42
BH 4	Mar 1/89	2.80	312.136	309.34
BH 5	Mar 1/89	1.05	312.236	311.19
<u>City Wells</u>				
BH 6	Mar 1/89	2.22	315.250	313.03
BH 3	Mar 1/89	Dry (2.72)	316.05	≤313.33
<u>Union Gas Wells</u>				
BH 1	Mar 15/89	1.22	312.366	311.15
BH 3	Mar 15/89	2.09	311.606	309.52
BH 4	Mar 15/89	2.70	312.136	309.44
BH 5	Mar 15/89	0.97	312.236	311.27
<u>City Wells</u>				
BH 3	Mar 15/89	Dry (2.72)	316.050	≤313.33
BH 6	Mar 15/89	2.22	315.250	313.03
BH 12	Mar 15/89	1.72	310.470	308.75
BH 14	Mar 15/89	1.52	310.870	309.35
BH 15	Mar 15/89	1.47	311.650	310.18

<u>Well</u>	<u>Date</u>	<u>Water Level (m below ground level)</u>	<u>Elevation at top of monitoring well (masl)</u>	<u>Water Table Elevation (masl)</u>
<u>Union Gas Wells</u>				
BH 1	Apr 4/89	0.97	312.366	311.40
3	Apr 4/89	1.67	311.606	309.94
4	Apr 4/89	2.27	312.136	309.87
5	Apr 4/89	0.72	312.236	311.52
<u>City Wells</u>				
BH 6	Apr 4/89	1.87	315.250	313.38
12	Apr 4/89	1.46	310.470	309.01
14	Apr 4/89	1.36	310.870	309.51
15	Apr 4/89	1.38	311.650	310.27

**Appendix C**  
**RESULTS OF CHEMICAL ANALYSIS**



**CANVIRO**  
Analytical Laboratories Ltd.

R E P O R T   O F   A N A L Y S I S

CLIENT Canviro Consultants

PROJECT NO 89-2175

ATTENTION Mr. Brian Whiffin

RECEIVED March 2, 1989

ADDRESS 180 King Street, Suite 600  
Waterloo, Ontario  
L2P 1J8

REPORTED March 31, 1989

SAMPLE IDENTIFICATION			PARAMETERS FOR ANALYSIS
LAB NO.	DATE	DESCRIPTION	POTASSIUM mg/L
2175-01	03/02/89	MW1A	14
2175-02	03/02/89	MW1B	14
2175-03	03/02/89	MW3	12
2175-04	03/02/89	MW4	17
2175-05	03/02/89	MW5	12
2175-06	03/02/89	MW7	<1

RESPECTFULLY YOURS

DOUGLAS McCALLUM  
LABORATORY SUPERVISOR



**CANVIRO**  
Analytical Laboratories Ltd.

REPORT OF ANALYSIS

CLIENT Canviro Consultants

PROJECT NO 88-2175

ATTENTION Mr. Brian Whiffin

RECEIVED March 2, 1988

ADDRESS 180 King Street, Suite 600  
Waterloo, Ontario  
N2P 1J8

REPORTED March 31, 1989

SAMPLE IDENTIFICATION			PARAMETERS FOR ANALYSIS								
LAB NO.	DATE	DESCRIPTION	pH	TOC mg/L	COD mg/L	* NH3-N mg/L	* TKN-N mg/L	ALKALINITY mg/L as CaCO3	PHENOL ug/L	CYANIDE mg/L	SULPHIDE mg/L
2175-01	03/02/89	MW1A	7.1	15.2	155	3.3	4.8	658	330	1.15	0.02
2175-02	03/02/89	MW1B	7.1	16.5	127	3.2	4.9	658	350	1.04	0.03
2175-03	03/02/89	MW3	7.8	10.9	57	10.5	13.5	584	190	0.93	<0.02
2175-04	03/02/89	MW4	7.9	21.5	103	13.5	19.9	640	2200	1.98	<0.02
2175-05	03/02/89	MW5	7.3	19.9	116	2.5	3.4	698	158	1.65	0.04
2175-06	03/02/89	MW7	6.2	0.82	**17	<0.05	<1.0	5	<1	<0.05	<0.02

\* = Analysis done by Probe

\*\* = Note Black Particulate in Sample

RESPECTFULLY YOURS

DOUGLAS McCALLUM  
LABORATORY SUPERVISOR



**CANVIRO**  
Analytical Laboratories Ltd.

ICAP SCAN

IDENTIFICATION	MW1A	MW1B	MW3	MW4	MW5	MW7
IDENTIFICATION NO.	2175-01	2175-02	2175-03	2175-04	2175-05	2175-06
	CONCENTRATION					
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ALUMINUM	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
BARIUM	0.14	0.14	0.12	0.11	0.13	<0.01
BERYLLIUM	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
BORON	0.18	0.16	0.12	0.17	0.17	<0.01
CADMIUM	0.010	0.010	0.007	0.010	0.009	0.006
CALCIUM	220	210	140	120	240	0.15
CHROMIUM	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
COBALT	0.04	0.07	0.04	0.07	0.05	<0.03
COPPER	0.02	0.02	0.01	0.01	0.02	<0.01
IRON	1.60	2.13	0.20	0.47	2.1	0.02
LEAD	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
MAGNESIUM	100	100	78.8	110	120	<0.05
MANGANESE	0.08	0.08	0.11	0.18	0.12	<0.01
NICKEL	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
PHOSPHORUS	<0.13	<0.13	<0.13	<0.13	<0.13	<0.13
SILVER	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
SODIUM	850	870	690	740	810	1.85
STRONTIUM	0.96	0.88	0.85	0.69	0.76	<0.04
VANADIUM	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
ZINC	<0.01	<0.01	0.04	<0.01	<0.01	<0.01
ARSENIC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
FLUORIDE	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
CHLORIDE	1370	1380	1040	1180	1270	0.30
NITRITE	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
BROMIDE	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19
NITRATE	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09
PHOSPHATE	<0.55	<0.55	<0.55	<0.55	<0.55	<0.55
SULPHATE	79.6	106	10.4	51.7	74.8	<0.59





**CANVIRO**  
Analytical Laboratories Ltd. REPORT OF ANALYSIS

CLIENT Canviro Consultants

PROJECT NO. 89-2175

ATTENTION Mr. Brian Whiffin

RECEIVED March 2, 1989

ADDRESS 180 King Street, Suite 600  
Waterloo, Ontario  
N2P 1J8

REPORTED March 31, 1989

VOLATILE ORGANIC COMPOUNDS

IDENTIFICATION NO.	LAB BLANK	2175-01	2175-02	2175-03	MDL
COMPOUND	ppb	ppb	ppb	ppb	ppb
Benzene	<	1049	692	1866	0.4
Toluene	(0.8)	702	540	25	0.7
m & p Xylene	<	861	683	48	0.6
Ethyl benzene	<	300	231	<	2.6
o-Xylene	<	416	307	227	0.4
% RECOVERY OF SURROGATES					
d5-Bromethane	95	82	42	123	
d4-1,2-Dichloroethane	118	98	71	83	
d8-Toluene	105	66	50	102	
Bromochloropropane	116	90	58	102	
d10-Ethylbenzene	107	74	52	85	

IDENTIFICATION NO.	2175-04	2175-05	2175-06	MDL
COMPOUND	ppb	ppb	ppb	ppb
Benzene	1787	442	1.3	
Toluene	378	221	0.8	0.7
m & p Xylene	428	630	0.6	0.6
Ethyl benzene	578	219	<	2.6
o-Xylene	299	248	0.4	0.4
% RECOVERY OF SURROGATES				
d5-Bromethane	139	29	55	
d4-1,2-Dichloroethane	94	61	132	
d8-Toluene	132	43	108	
Bromochloropropane	130	50	130	
d10-Ethylbenzene	114	46	116	

RESPECTFULLY YOURS

DALE SUTHERLAND  
CHIEF CHEMIST



**CANVIRO**  
Analytical Laboratories Ltd.

COAL TAR ACIDS ANALYSIS

IDENTIFICATION	LAB BLANK	MW1A	MW1B	MW3	MW4	MW5	MW7	MDL	% RECOVERY SPIKE
IDENTIFICATION NO.		2175-01	2175-02	2175-03	2175-04	2175-05	2175-06		
Phenol	0.38	4.14	8.35	12.68	15.20	2.49	0.45	0.05	68
o - Cresol	<	10.55	33.15	0.57	35.66	4.92	<	0.05	33
m - Cresol	0.23	11.20	30.49	0.79	34.87	2.19	0.47	0.05	72
p - Cresol	<	4.19	15.69	0.24	7.26	1.10	<	0.05	26
2,6 - Dimethyl phenol	<	5.21	23.77	51.41	34.63	2.71	<	0.05	23
2,5 - Dimethyl phenol	<	8.47	43.81	0.33	33.73	3.54	<	0.05	57
2,4 - Dimethyl phenol	<	12.02	44.81	0.96	54.63	5.50	<	0.05	52
3,5 - Dimethyl phenol	<	8.66	28.16	1.65	47.13	5.08	<	0.05	83
2,3 - Dimethyl phenol	<	3.04	11.40	0.55	15.61	1.34	<	0.05	45
3,4 - Dimethyl phenol	<	4.12	11.89	0.48	21.03	1.96	<	0.05	60
Resorcinol	<	0.06	0.15	<	4.86	4.57	<	0.05	66
% Recovery Surrogate (2-Fluorophenol)	85	39	113	106	43	43	79		100



**CANVIRO**  
Analytical Laboratories Ltd.

POLYNUCLEAR AROMATIC HYDROCARBONS

IDENTIFICATION	LAB BLANK	MW1A	MW1B	MW3	MW4	MW5	MW7	MDL	% RECOVERY SPIKE
IDENTIFICATION NO.		2175-01	2175-02	2175-03	2175-04	2175-05	2175-06		
COMPOUND	ppb	ppb	ppb	ppb	ppb	ppb	ppb	ppb	
Naphthalene	<	1131	1140	17.9	629	2100	<	0.15	118
Acenaphthylene	<	35.0	42.6	4.83	8.55	57.7	<	0.06	81
Acenaphthene	<	9.63	9.58	2.45	21.0	16.6	<	0.06	82
Fluorene	<	16.9	16.5	0.64	4.67	23.1	<	0.06	82
Phenanthrene	<	22.6	25.9	1.80	5.88	33.4	<	0.02	91
Anthracene	<	3.15	4.57	0.27	0.67	7.08	<	0.03	74
Fluoranthene	<	0.44	1.32	0.18	0.38	4.03	<	0.05	88
Pyrene	<	0.53	1.57	0.24	0.54	2.91	<	0.05	89
Benzo (a) anthracene	<	<	<	<	<	<	<	0.21	77
Chrysene	<	<	<	<	<	<	<	0.21	77
Benzo (b) fluoranthene	<	<	<	<	0.28**	<	<	0.14	62
Benzo (k) fluoranthene	<	<	<	<	**	<	<	0.14	68
Benzo (a) pyrene	<	<	<	<	0.14	<	<	0.12	59
Indeno (1,2,3-cd) pyrene	<	<	<	<	<	<	<	0.15	49
Dibenzo (a,h) anthracene	<	<	<	<	<	<	<	0.12	49
Benzo (ghi) perylene	<	<	<	<	<	<	<	0.12	52
% Recovery Surrogates									
D8-Naphthalene	87	84	75	*	*	20	37		
D12-Chrysene	69	112	107	101	87	117	86		

\* = Unable to Calculate due to Matrix Interference

\* = Benzo (b) and Benzo (k) Fluoranthene Co-elute, and is Represented as a Combined Result

**Appendix D**  
**HYDRAULIC RESPONSE TEST DATA**  
**AND ANALYSIS**

# HYDRAULIC CONDUCTIVITY CALCULATIONS (CASE 0)

VARIABLES											CALCULATIONS				ROCK CHARACTERISTICS
Location	d (cm)	M (DL)	L (cm)	D (cm)	T (s)	M/D>4 (DL)	dnd (cm)	ln(2ML)/D (DL)	QMLT (CMHRS)	Mh (CM/RS)	Mh (M/RS)				
BH1<1>LINE 1	5.08	1	224	9.61	5.4	23.309	25.806	3.842	9676.800	0.01025	0.0001025	DOLONITE (light in colour and very porous but less fractured than the darker dolomite)			
BH1<2>LINE 1	5.08	1	224	9.61	8.9	23.309	25.806	3.842	15948.800	0.00622	0.0000622	SMHE RS ABOVE			
BH3<1>LINE 1	5.08	1	214	9.61	98.9	22.268	25.806	3.796	163316.800	0.00058	0.0000058	DOLONITE (dark in colour and fractured) NOTE: The unfractured blocks of the darker dolomite is less porous than the lighter coloured dolomite)			
BH4<1>LINE 1	5.08	1	223	9.61	64.7	23.205	25.806	3.838	97584.800	0.00101	0.0000101	SMHE RS ABOVE			
BH5<1>LINE 1	5.08	1	193	9.61	9.8	20.083	25.806	3.693	15131.200	0.00630	0.0000630	DOLONITE (light in colour and very porous but less fractured than the darker dolomite)			

d - screen (pipe) diameter  
 M - constant  
 L - effective length of sand pack  
 D - diameter of borehole  
 T - basic time 10  
 DL - dimensionless  
 Mh - horizontal hydraulic conductivity

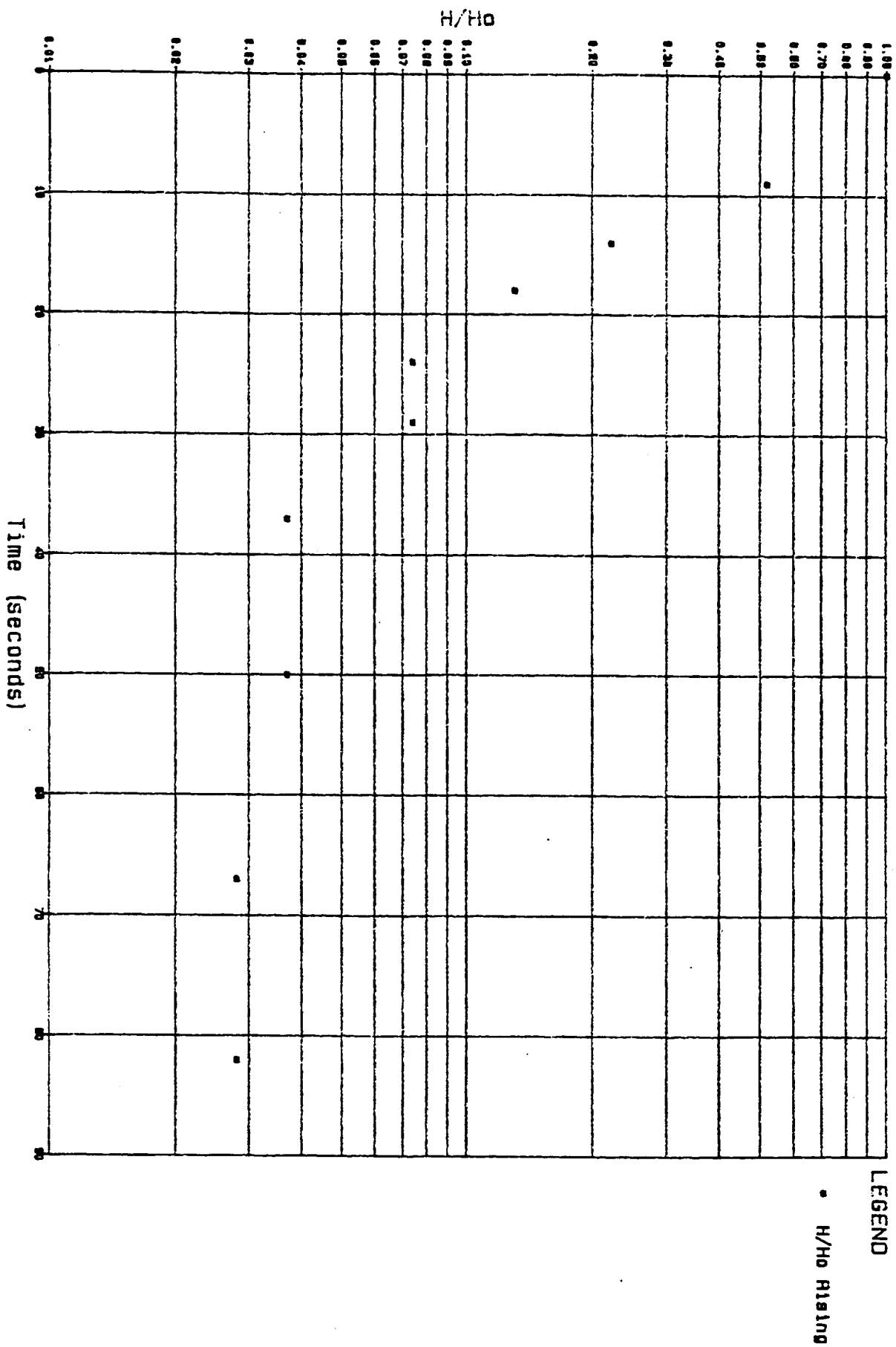


FIGURE D-2: BAIL TEST FOR BH1 (2)

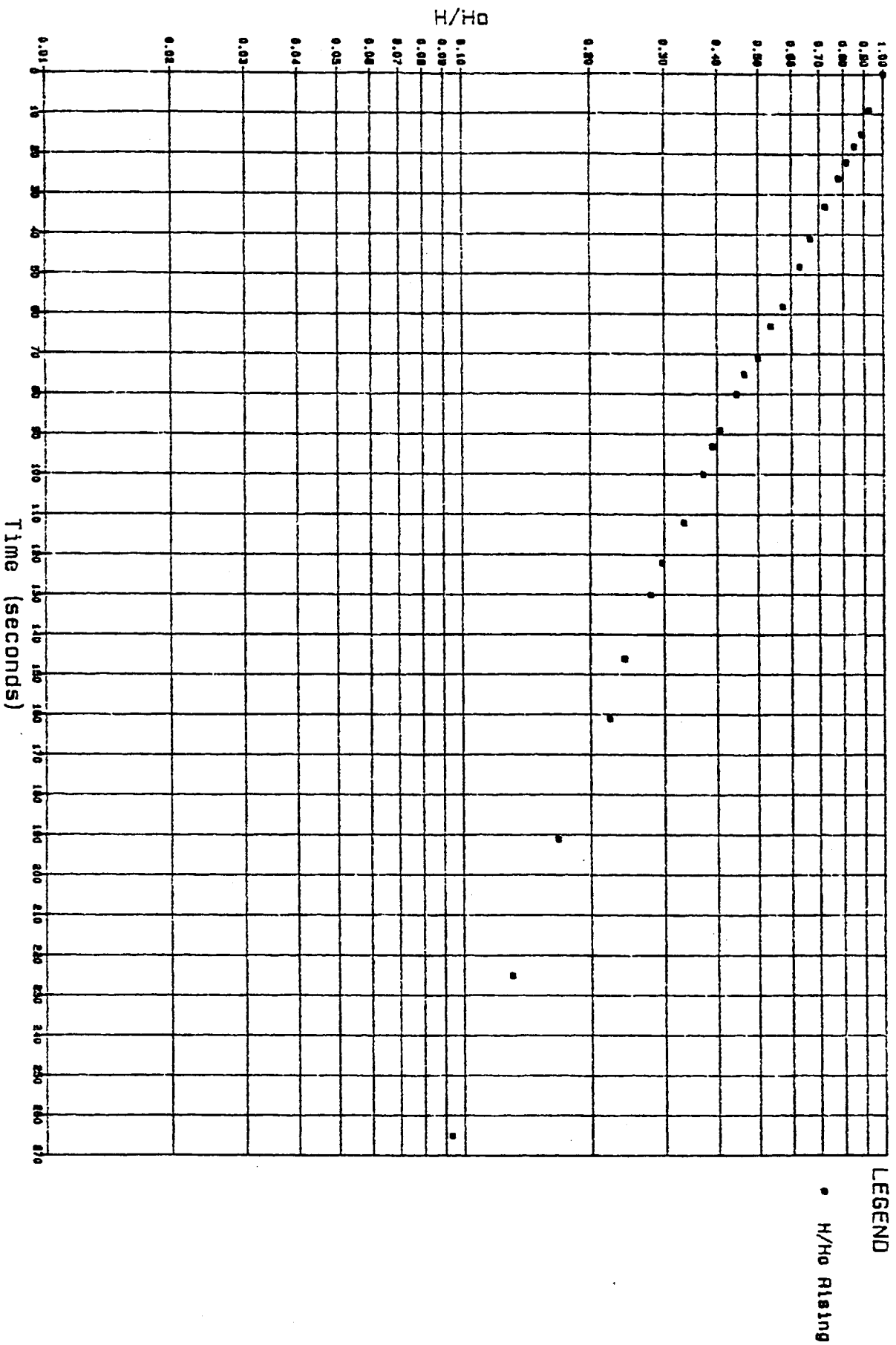


FIGURE D-3: BAIL TEST FOR BH3

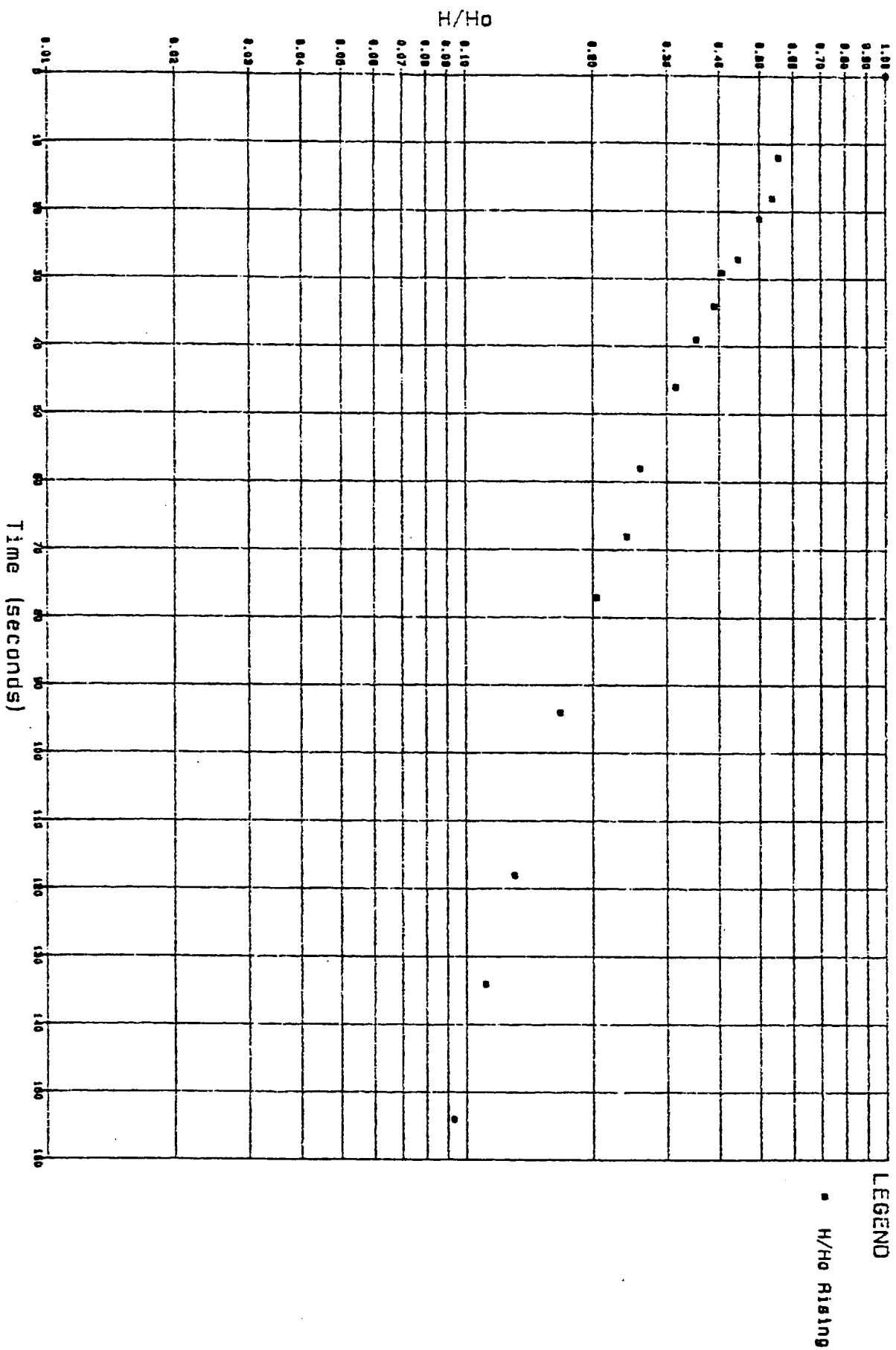


FIGURE D-4: BAIL TEST FOR BH4



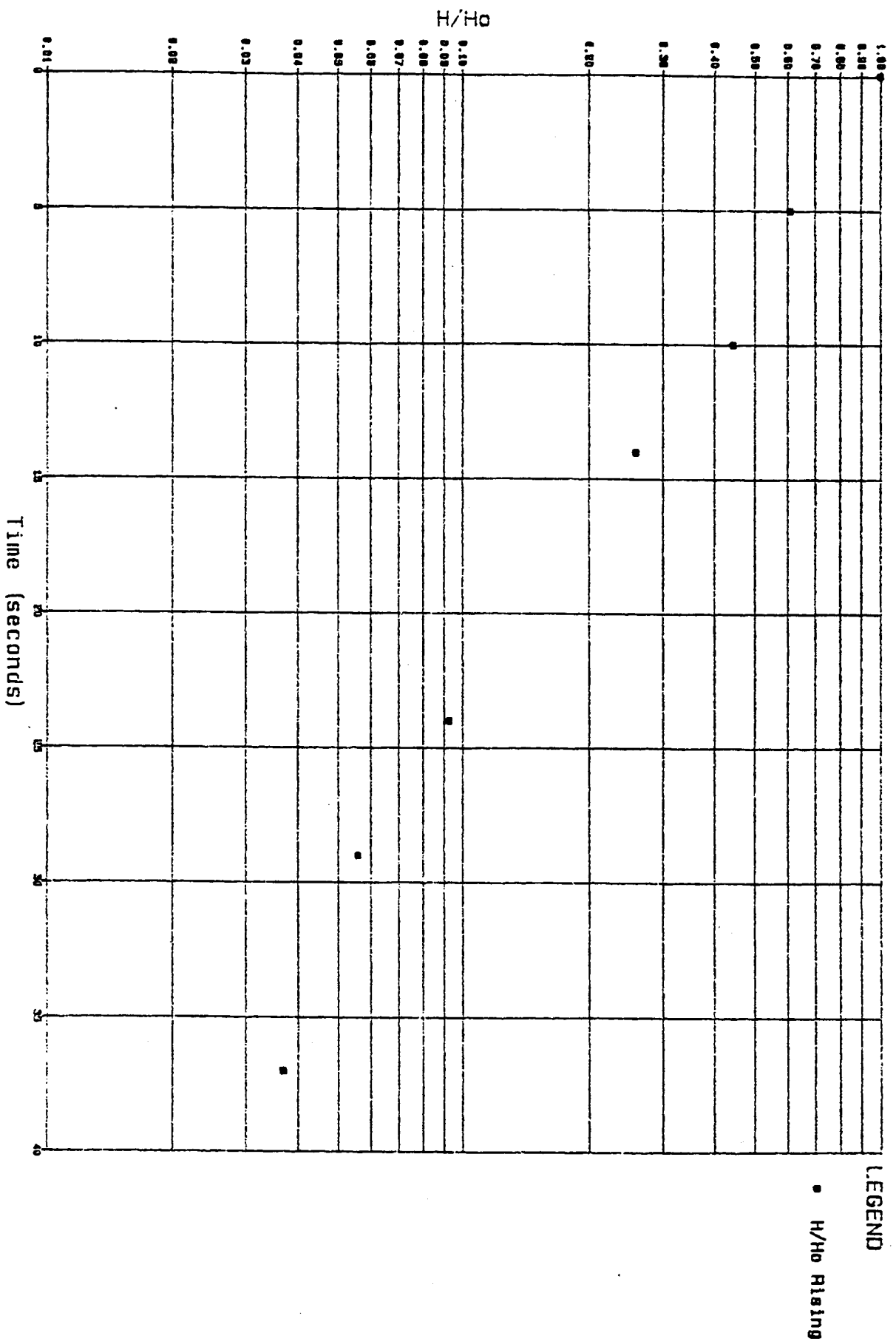


FIGURE D-5: BAIL TEST FOR BH5

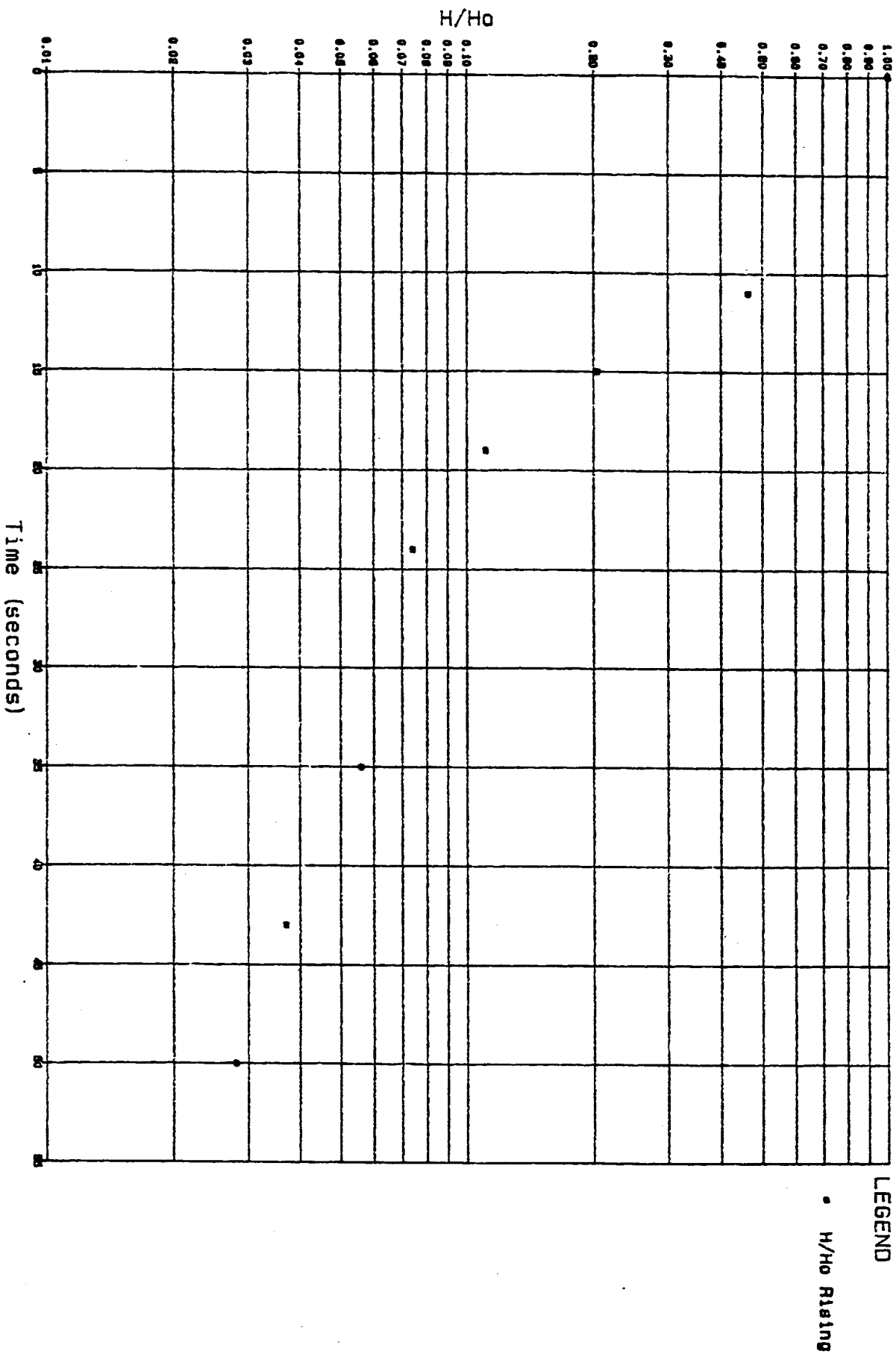


FIGURE D-1: BAIL TEST FOR BH1 (1)

**Appendix E**

**CALCULATIONS ON WASTEWATER INPUT  
TO GUELPH SANITARY SEWER SYSTEM**

## APPENDIX E ALLOWABLE SANITARY SEWER DISCHARGE RATE

In order to satisfy MOE guidelines, the following equation calculates the allowable discharge rate of collected waters to the sanitary sewer:

$$Q_{DS} = (Q_{EFF})(Q_{WWTP}) / (S_{BAP})(1 - E_{WWTP})$$

where:

$Q_{DS}$  = Allowable discharge rate of waters to sanitary sewer (litre/min)

$C_{EFF}$  = Maximum allowable incremental increase in WWTP effluent discharge ( $\mu\text{g/L}$ )

$Q_{WWTP}$  = Average WWTP operating flow rate (litre/min)

$S_{BAP}$  = Solubility limit of BAP ( $\mu\text{g/L}$ )

$E_{WWTP}$  = Assumed WWTP removal rate for BAP

For the Guelph site:

$C_{EFF}$  = 0.01  $\mu\text{g/L}$  (based on MOE guideline)

$Q_{WWTP}$  = 10,000,000 gpd = 31,750 litre/min (based on information from the City of Guelph)

$S_{BAP}$  = 3.8  $\mu\text{g/L}$

$E_{WWTP}$  = 0.7 (based on MOE guideline)

Therefore:

$$Q_{DS} = (0.01)(31,570) / (3.8)(1 - 0.7) = 277 \text{ L/min}$$

**Appendix F**

**CCREM INTERIM GUIDELINES FOR PAH  
CONTAMINATION AT ABANDONED  
COAL TAR SITES**



Ontario

Ministry  
of the  
Environment

Ministère  
de  
l'Environnement

135 St. Clair Avenue West  
Suite 100  
Toronto, Ontario  
M4V 1P5

135, avenue St. Clair ouest  
Bureau 100  
Toronto (Ontario)  
M4V 1P5

February 21, 1989

Mr. Brian Whiffin  
Canviro Consultants Ltd.  
180 King Street South, Suite 600  
Waterloo, Ontario  
N2J 1P8

Dear Mr. Whiffin:

In response to your request for a copy of the CCREM Interim Guidelines for PAH Contamination at Abandoned Coal Tar Sites document, I am able to provide you with a copy of the Executive Summary only at the present time. The complete report is currently being translated and printed. When copies become available, I will send you one.

If you have any questions regarding the information in the document, please contact me at (416) 323-5104 or fax (416) 323-5166, or in writing to:

Hazardous Contaminants Coordination Branch  
Ontario Ministry of the Environment  
7th floor, 40 St. Clair Avenue West  
Toronto, Ontario  
M4V 1P5

Thank you for your interest in this report.

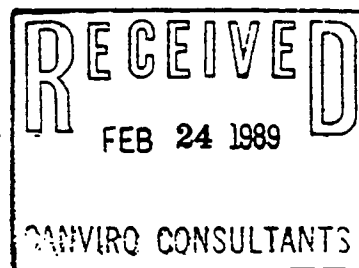
Yours very truly,

*Beverly Hanna Thorpe*

B. Hanna Thorpe  
Supervisor, Risk Assessment Unit  
Hazardous Contaminants Coordination Branch

BHT/lg  
enclosure

CC-17-04



- Two additional groups of contaminants (Group 3 and Group 4) are identified as substances of concern at coal tar waste sites. Guidelines for these contaminants have not been developed.

#### Interim Guidelines for Soil and Groundwater

- The principal media subject to contamination by coal tar wastes are soils in the immediate vicinity of the coal tar sites, and the groundwater. Sediment and surface water may also be of concern when the abandoned plant sites are located adjacent to waterbodies. Air contamination is of lesser general concern due to the relatively low volatility of the carcinogenic PAH. No guidelines have been recommended by the Working Group for PAH in air, sediments or surface water since existing standards for these media are very limited and not applicable to specific problems associated with contaminated coal tar sites.
- For soil and groundwater, the working group recommends adoption of modified "ABC" criteria (Table 1) from the Quebec Ministry of the Environment. The "ABC" criteria for groundwater have been modified to make them more consistent with the World Health Organization (WHO) drinking water guideline of .01 µg/L B(a)P. This value was adopted as being representative of all six carcinogenic PAH and was selected as an "A" value.
- It should be recognized that both the Quebec numbers and the recommended modified ABC values are based on limited toxicological information. The values are based on knowledge of different properties such as toxicity, bio-accumulation potential, etc. and not on risk assessment models.

#### Recommended Application of Guidelines

- The "ABC" approach provides a means to judge whether a site should be considered for further investigation and/or remediation. Depending on the use of the land, different investigative and/or remedial criteria should be considered.

INTERIM GUIDELINES FOR PAH CONTAMINATION  
AT ABANDONED COAL TAR SITES

- EXECUTIVE SUMMARY -

Background

- At their June 1987 meeting, the Toxic Substances Advisory Committee (TSAC) of the Canadian Council of Resource and Environment Ministers (CCREM) directed the Waste Management Committee to strike a working group to develop interim guidelines for polycyclic aromatic hydrocarbons (PAH) associated with coal tar waste sites. A detailed report which outlines the recommended guidelines and rationale has been prepared.
- The development of interim PAH guidelines was undertaken recognizing that several longer term initiatives such as the development of multi-media guidelines for PAH are underway. The interim PAH guidelines developed in this report are, therefore, intended for use by the member governments of the CCREM until definitive criteria are developed.

Contaminants of Concern

- Coal tar waste sites are contaminated with a complex mixture of toxic chemicals (Appendix A) of which PAH are generally considered to be the most toxic constituent group. The PAH group in turn comprises a number of individual compounds which have a wide range of toxicity. The carcinogenic potential of PAH is the main human health concern.
- For the purpose of developing interim guidelines, the PAH can be divided into two general groups. The substances in Group 1 consist of PAH designated as carcinogenic by the International Agency for Research on Cancer (IARC). The substances in Group 2, although not documented as being carcinogenic are good indicators of coal tar contamination.



- Investigative criteria are values above which detailed investigation is required to assess the extent of contamination and nature of any hazards, to determine if any remedial actions should be undertaken.
- Remedial criteria are values above which action is required to reduce exposure for humans or other biota. Action could include cleanup, other mitigation, and/or change in land use.

#### Residential or Farming Use

- Investigation Criteria is Value A.
- Remedial Criteria is Value B.

#### Commercial or Industrial Use

- Investigative Criteria is the Value B.
- Remedial Criteria is Value C.

TABLE 1

"ABC" VALUES FOR PAH IN SOIL AND GROUNDWATER  
AT COAL TAR WASTE SITES

HAAP	Conc. in soil (mg/kg dry weight)			Conc. in Groundwater (µg/L)		
	A	B	C	A	B	C
<b>Group 1</b>						
<u>Carcinogenic PAH</u>						
benzo(a)anthracene	0.1	1	10	0.01	0.1	1
benzo(b)fluoranthene	0.1	1	10	0.01	0.1	1
benzo(k)fluoranthene	0.1	1	10	0.01	0.1	1
benzo(a)pyrene	0.1	1	10	0.01	0.1	1
dibenz(a,h)anthracene	0.1	1	10	0.01	0.1	1
indeno(1,2,3-cd)pyrene	0.1	1	10	0.01	0.1	1
<b>Group 2</b>						
<u>Other PAH</u>						
naphthalene	0.1	5	50	0.2	2	20
phenanthrene	0.1	5	50	0.2	2	20
pyrene	0.1	10	100	0.2	2	20

Value A: This value represents the approximate achievable detection limits for PAH in soil.  
In groundwater, value A is based on drinking water criteria as described in the bold-faced paragraph above.

Range A-B: The soil or groundwater is slightly contaminated. At this level of contamination, groundwater generally falls within the range of quality standards and criteria where they exist. However, it is worthwhile to investigate possible sources of contamination, especially in the case of groundwater to ascertain whether new contaminants continue to enter the water. This may lead to intervention focusing on the soil, particularly if the water is used for drinking.

Usually at this level of soil or groundwater contamination, cleanup will not be necessary. However, should the land be redeveloped for especially sensitive purposes, e.g., residential or farming, it may be necessary to implement certain measures, such as the excavation of surficial layers of soil and/or the addition of a layer of clean soil.

Value B: This value is an intermediate value, approximately 5 to 10 times above value A.

Range B-C: The soil or groundwater is contaminated. At this level contamination of groundwater clearly exceeds drinking water standards where they exist and can no longer be used for that purpose.

Although the soil is contaminated, it will not automatically be cleaned up, unless the effect of contaminants on the groundwater necessitates such work.

However, restrictions on land use may be imposed when this level of contamination is observed in the soil. Restoration work may be necessary before the land is used for farming, residential or recreational purposes. Other less sensitive uses, e.g., industrial, commercial and so forth, may be contemplated without clean up being carried out. In all cases, the extent of the work required, e.g., the depth to which soil must be excavated and so on, will depend upon the nature of the contaminants, ultimate land use and the impact on groundwater and the environment in general.

Value C: This value is considered to be the level at which contamination is significant.

Range

Above C: The soil or groundwater is contaminated. Groundwater cannot be used for drinking. The water is seriously contaminated; unless it is decontaminated, it will have to be monitored closely.

Where the soil is contaminated, all uses of such land will be restricted. A thorough analysis must be conducted in all likelihood, restoration will have to be undertaken before redevelopment occurs.