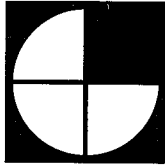


John Bell



**Environmental
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THE CITY OF
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ENVIRONMENTAL
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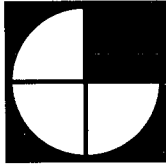
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| <input type="checkbox"/> Data Graphs: E.03. | <input type="checkbox"/> WS Arkell: E.09. | <input type="checkbox"/> Eastview: E.16. |
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**BEDROCK GROUND WATER
MONITOR INSTALLATIONS
FORMER GUELPH GAS WORKS**

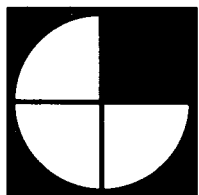
**SUBMITTED TO:
CITY OF GUELPH**

**SUBMITTED BY:
ENVIRONMENTAL STRATEGIES LIMITED**

OCTOBER, 1990

ESL 90-908

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*Professional Services
in Environmental
Management*

Environmental Strategies Limited

October 10, 1990

ESL 90-908

City of Guelph
59 Carden Street
Guelph, Ontario
N1H 3A1

Attention: Mr. J.K. Bull
Director of Operations
City Engineers' Department

Dear Sirs:

Re: Bedrock Ground Water Monitor Installations
Former Guelph Gas Works

In July, 1988, Environmental Strategies Limited (ESL) completed a site investigation report on the former Guelph Gas Works site (our project reference ESL 87-907). The Ministry of the Environment reviewed the report and recommended minor additional tasks in a letter dated November 24, 1988. The recommendations included installation and sampling of additional ground water monitors at each of site locations 12 and 15. In addition, as discussed with the City, the shallow overburden monitor at site 14 across from the Union Gas site was also resampled.

This work was authorized in February, 1990 and completed in mid March, 1990. The purpose of this letter is to summarize the results of this work.

1.0 SCOPE AND METHODOLOGY

Bedrock monitors were installed at sites 12 and 15 to investigate the possibility of downward movement of coal tar wastes into the bedrock (Figure 1). The monitors were to be completed 10 m into the bedrock or to an unfractured layer if encountered. Ground water samples from each new bedrock monitor as well as monitor 14-I were analyzed for phenols, ammonium, free and total cyanide, polycyclic aromatic hydrocarbons (PAHs), volatile organics and ICP metals.

Field installation and sampling techniques are outlined in Appendix A. Borehole logs, ground water monitor details and ground water quality results are included in Appendices B to D. One set of water level elevations were also collected from monitor sites 12, 14, and 15 and are included in Appendix C.

2.0 DRILLING AND MONITORING RESULTS

Monitor site 12 is located in a commercial area along Wellington Street, approximately 80 m south of the Works (Figure 1). Fill and sands & gravels extend to 4.9 m below ground and included some poor quality soils of unknown origin. The bedrock monitor, 12-II, was installed from 5.2 to 10.6 m below ground.

Monitor site 15 is located on the south side of Surrey Street, about 10 m south of the Gas Works, in an area where coal tar contaminants were previously encountered in fill and sands & gravels overlying the bedrock (Figure 1). Bedrock was encountered about 2.4 m below ground. The bedrock monitor, 15-II, was installed from 2.7 to 9.6 m below ground.

At each site, the bedrock was grey-brown fine-grained dolostone with occasional shaley stringers. Thin to medium bedding and locally vuggy sections were present. Vertical fracturing was noted to 2.5 m below the bedrock surface (or 5 m below ground level) at site 15 but was not observed at site 12. Some fractures at site 15 were stained or contained black tarry material. Unfortunately, the upper monitor seal did not extend over the full depth of vertical fractures at site 15. Consequently, ground water elevations and the water quality sample collected from this bedrock monitor are probably not representative of bedrock water.

The ground water elevations collected at monitor sites 12, 14 and 15 confirm that the water table slopes southwards away from the Gas Works. Shallow ground water moves laterally away from the Works as well as vertically downward. Vertical hydraulic gradients were downward between shallow and bedrock monitors at sites 12 and 15.

3.0 GROUND WATER QUALITY RESULTS

A summary of the ground water quality analyses from the present study is included in Tables 1 to 3. A blind duplicate analyzed with the ground water samples verified that the analyses are precise and reproducible. In the initial site studies (ESL, 1987), ground water effects from the Works were indicated by elevated concentrations of phenols, ammonium, cyanide and PAHs.

Monitor 15-II is the closest bedrock monitor to the site. As discussed above, the ground water sample analyzed from this monitor is probably not representative of bedrock waters. These analyses reported 22.5 µg/L phenols, 19.9 mg/L of ammonium, 0.190 mg/L of total cyanides and 460 µg/L of PAHs. These results are similar to shallow ground water quality previously reported in monitor 15-I (GLL, 1987) which included 30 µg/L of phenols and 2500 µg/L PAHs.

Monitor 14-I was sampled to confirm if Gas Works effects were present in shallow ground water across Surrey Street and downgradient from the Works. Minor indications were evident from the initial sampling (GLL, 1987). Similar effects were reported from the present analyses including ground water concentrations of 0.77 mg/L ammonium, 0.130 mg/L total cyanide and 2.7 µg/L PAHs. Iron and manganese concentrations were slightly above drinking water objectives. Trace non specific volatile organics (benzene, xylene and trichloroethane) were also detected.

Monitor 12-II was the furthest downgradient bedrock monitor from the Gas Works. The only Gas Works effects detected in ground water in the bedrock at this site were ammonium concentrations of 9 mg/L. A total of 29.3 µg/L of non specific volatile organic indicators such as benzene, toluene and xylene and trihalomethanes were also detected. Shallow ground water at this site was previously found to contain 3 µg/L phenols, 0.73 mg/L ammonium, 110 mg/L total cyanide and 13 µg/L PAHs.

4.0 DISCUSSION

Based on the results of this study, it appears that ground water movement within the upper bedrock is enhanced by natural partings and fractures. Ground water moves laterally as well as vertically within this zone. Coal tar wastes are more viscous than ground water and less mobile. The bedrock depression on-site acts to contain coal tar wastes. Any wastes beyond this depression would migrate southeastward along the slope of the bedrock surface.

At site 15, the closest off-site monitor location beyond the Gas Works, fractures containing tarry material were observed to 5 m below ground level. Deeper penetration of coal tar wastes was not evident at this site or any other off-site locations previously investigated (ESL, 1988). There were only minor indications of dissolved coal tar constituents in the shallow ground water at site 14, further downgradient and opposite the Union Gas site.

Page 4
City of Guelph
October 10, 1990

Ground water effects from the Gas Works were previously found in the shallow ground water at monitor site 12, 80 m south of the Gas Works. The present study indicates that these effects decrease with depth at site 12 and are only evident in ammonium concentrations.

The results of the present study suggest that water quality effects from the former Gas Works occur at shallow depths in the bedrock off-site and appear to decrease with depth.

Thank you for allowing us to be of service. Please call if you have any comments or questions.

Yours very truly,
ENVIRONMENTAL STRATEGIES LIMITED



for P.K. Lee, P.Eng.,
Consulting Engineering Geologist,
Vice-President

TJK:emh

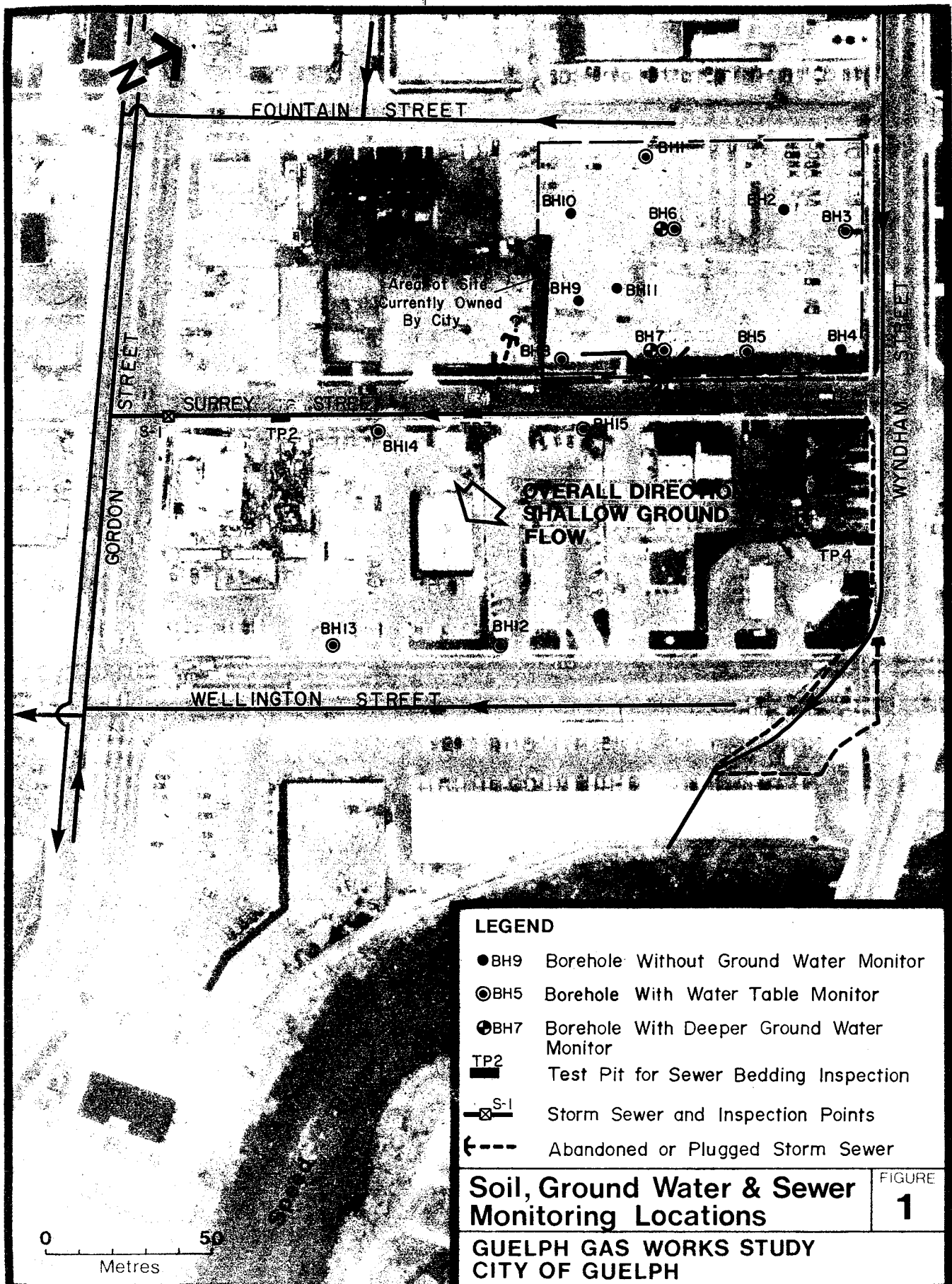


TABLE 1: SUMMARY OF GENERAL WATER QUALITY ANALYSIS RESULTS
PROJECT NO.: 90-908

Constituent		ODWO	Field Blank	14-I	14-I (lab repeat)	12-II	15-II	15-II (blind duplicate)
Phenols	mg/L	0.002	<0.0005	<0.0005	<0.0005	0.0020	0.0225	0.0160
Ammonia (as nitrogen)	mg/L	-	<0.02	0.54	0.54	9.00	19.9	19.1
Total cyanide	mg/L	0.2	<0.001	0.130	0.120	0.025	0.190	0.140
Free cyanide	mg/L	-	<0.001	<0.001	<0.001	<0.001	0.005	0.007
Silver	mg/L	0.05	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Aluminum	mg/L	-	<0.05	0.10	0.20	<0.05	<0.05	<0.05
Boron	mg/L	5.0	<0.005	0.139	0.144	0.064	0.065	0.068
Barium	mg/L	1.0	<0.005	0.223	0.224	0.116	0.101	0.100
Beryllium	mg/L	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Calcium	mg/L	-	<0.05	189	188	77.3	117	117
Cadmium	mg/L	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Chromium	mg/L	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	<1.0	<0.01	0.01	<0.01	<0.01	<0.01	<0.01
Total iron	mg/L	<0.03	<0.01	0.40	0.35	0.01	0.55	0.49
Potassium	mg/L		<0.05	9.5	9.6	7.6	10.1	10.2
Magnesium	mg/L		<0.01	52.5	51.8	59.6	61.0	59.8
Manganese	mg/L	<0.05	<0.01	0.37	0.36	0.02	0.06	0.05
Molybdenum	mg/L		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Sodium	mg/L		<0.5	539	538	90.3	453	430
Nickel	mg/L		<0.05	0.10	0.09	0.10	0.10	0.08
Phosphorus	mg/L		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Lead	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Silicon	mg/L		<0.05	5.97	5.89	5.48	6.52	6.44
Strontium	mg/L		<0.001	0.600	0.605	1.68	0.625	0.632
Thorium	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Titanium	mg/L		<0.005	0.014	<0.005	<0.005	<0.005	<0.005
Vandium	mg/L		0.019	<0.005	0.019	0.009	0.006	<0.005
Zinc	mg/L	5.0	0.01	0.11	0.10	0.02	0.03	0.02
Zirconium	mg/L		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

NOTES: ODWO - Ontario Drinking Water Objectives

TABLE 2: SUMMARY OF VOLATILE ORGANIC RESULTS
PROJECT NO.: 90-908

Compound	M.D.L. (ug/L)	Lab Blank	14-I	12-II	15-II	15-II (lab repeat)	15-II (field duplicate)
Chloromethane	2.0	ND	ND	ND	ND	ND	ND
Vinyl chloride	2.0	ND	ND	ND	ND	ND	ND
Bromomethane	2.0	ND	ND	ND	ND	ND	ND
Chloroethane	5.0	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	1.0	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	0.5	ND	ND	ND	ND	ND	ND
Dichloromethane	1.0	ND	ND	ND	ND	ND	ND
Trans-1,2-dichloromethane	0.2	ND	ND	ND	ND	ND	ND
1,2-dichloroethane	0.2	ND	ND	ND	ND	ND	ND
Chloroform	0.2	ND	ND	0.2	ND	ND	ND
1,1,1-Trichloroethane	0.2	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	0.2	ND	ND	ND	ND	ND	ND
Benzene	0.1	ND	3.3	24.3	1110	1180	1140
1,2-Dichloroethane	0.2	ND	ND	ND	ND	ND	ND
Trichloroethane	0.2	ND	2.0	ND	ND	ND	ND
1,2-Dichloropropane	0.2	ND	ND	ND	ND	ND	ND
Bromodichloromethane	0.2	ND	ND	0.3	ND	ND	ND
Cis-1,3-dichloropropene	0.5	ND	ND	ND	ND	ND	ND
Toluene	0.2	ND	ND	1.6	164	154	137
Trans-1,3-dichloropropene	0.5	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	0.5	ND	ND	ND	ND	ND	ND
Tetrachloroethane	0.5	ND	ND	ND	ND	ND	ND
Dichromochloromethane	1.0	ND	ND	*0.2	ND	ND	ND
Chlorobenzene	0.2	ND	ND	ND	ND	ND	ND
Ethylbenzene	0.2	ND	ND	0.9	160	131	153
M-xylene & P-xylene	0.2	ND	ND	0.9	125	110	107
O-xylene	0.2	ND	*0.1	0.9	85	75	73
Bromoform	2.0	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	1.0	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	0.2	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	0.2	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	0.2	ND	ND	ND	ND	ND	ND

ND - not detected

M.D.L. - method detection limit

* - detection at level below stated M.D.L.

TABLE 3: SUMMARY OF POLYNUCLEAR AROMATIC HYDROCARBON ANALYSES
PROJECT NO.: 90-908

Compound	M.D.L. (ug/L)	Lab Blank	14-I	14-I (lab repeat)	12-II	15-II	15-II (blind duplicate)
Napthalene	0.5	ND	ND	ND	ND	356	811
Acenaphthylene	0.5	ND	ND	ND	ND	22.0	26.2
Acenaphthene	0.5	ND	ND	ND	ND	53.6	57.6
Fluorene	0.5	ND	ND	ND	ND	16.5	18.0
Phenanthrene	0.5	ND	ND	ND	ND	10.8	13.0
Anthranthene	0.5	ND	ND	ND	ND	1.8	1.4
Fluoranthene	0.5	ND	1.0	0.5	ND	1.3	1.1
Pyrene	0.5	ND	1.7	0.8	ND	1.6	1.2
Benzo(A)anthracene	1.0	ND	ND	ND	ND	ND	ND
Benzo(B)fluoranthene	1.0	ND	ND	ND	ND	ND	ND
Benzo(K)fluoranthene	1.0	ND	ND	ND	ND	ND	ND
Benzo(A)pyrene	1.0	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-CD)pyrene	1.0	ND	ND	ND	ND	ND	ND
Dibenzo(A,H)anthracene	1.0	ND	ND	ND	ND	ND	ND
Benzo(GHI)perylene	1.0	ND	ND	ND	ND	ND	ND

ND - not detected

M.D.L. - method detection limit

APPENDICES

APPENDIX A
FIELD METHODOLOGY

APPENDIX A

FIELD METHODOLOGY

A truck mounted Mobile B-61 drill rig was contracted from Longyear Canada Inc. to drill two boreholes adjacent to ESL monitors 12-I and 15-I. These boreholes were extended to 10.7 and 9.6 m, respectively. In order to avoid contamination of the bedrock at monitor 15-II, a large diameter borehole was augered to the bedrock surface and steel casing was installed through the augers before the augers were removed. This casing was then cemented into the ground. At monitor 12-II, a casing was cemented into the ground in the same manner although the casing had to be installed through some buried concrete.

The bedrock was cored to final depth using HQ coring equipment. The core was logged in the field. All water used in the drilling operations was municipal water supplied by the City of Guelph. Contaminated soils and cuttings were collected in pails or drums and transferred to the City for disposal.

Ground water monitors were installed in each of the boreholes. These consisted of 51 mm diameter, schedule 40, flush threaded PVC pipe and #10 machine slotted screens. A sand pack was placed around the screened interval to about 0.3 m below the bedrock/overburden interface where a peltonite seal was installed. The seal was placed such that there would be no communication of ground water between the bedrock and the overburden. A surface seal was also installed to prevent surface water run-off from entering the borehole.

A protective flush mount steel casing and cap were installed around each monitor. Lockable fittings were placed at the top of the monitor pipes.

Dedicated polyethylene tubing with Nadon check valves were installed in the monitors. The monitors were developed after drilling was complete in order to remove fines and flush the screen with representative ground water. Three well bore volumes were removed from each monitor. Water samples were collected and submitted to Barringer Magenta Laboratories for testing for phenols, ammonium, free and total cyanide, ICP metals, polycyclic aromatic

hydrocarbons (PAH's) and volatile organics. A set of blind duplicates (numbered BH 18) from BH 15-II was also collected. These were handled and analyzed in the same manner as the other samples.

APPENDIX B
BOREHOLE LOGS

SS	Split Spoon Sample		
SN	Non Standard Split Spoon Sample		
ST	Shelby Tube Sample		
DS	Denision Type Sample		
PS	Piston Type Sample		
CS	Continuous Sample		
GS	Grab Sample		
WS	Wash Sample		
BQ	BQ Core Sample		
HQ	HQ Core Sample		
NQ	NQ Core Sample		
DT	Dynamic Penetration Test		
VT	Field Vane Test (undisturbed)	-	+
VT	Field Vane Test (remoulded)	-	⊕

The number of blows by a 63.6 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

The number of blows by a 63.6 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split spoon sampler for a distance of 300 mm (12 in.).

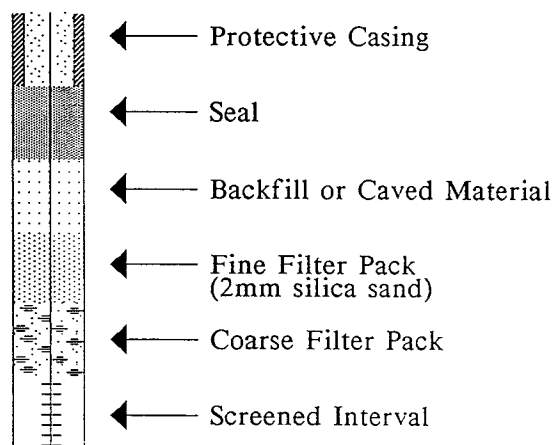
DTPL: Drier Than Plastic Limit
 APL: About Plastic Limit
 WTPL: Wetter Than Plastic Limit
 K: Hydraulic Conductivity (m/s)
 C_u: Shear Strength (kPa)

"trace", eg. trace sand	1 - 10
"some", eg. some sand	10 - 20
adjective, eg. sandy	20 - 35
"and", eg. and sand	35 - 50
noun, eg. sand	>50


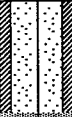

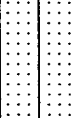

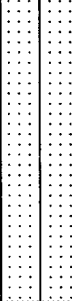

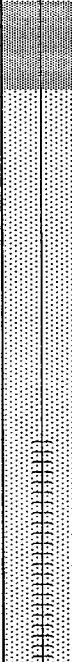
Note: Classification Divisions Based on Modified M.I.T Grain Size Scale

Relative Density	N Value
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	over 50

Consistency	C _u (kPa)	N Value
Very soft	0 to 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	over 200	over 30





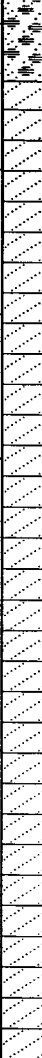
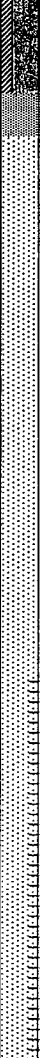
BOREHOLE LOG	PROJECT: 90-908	BOREHOLE: 12-II
GUELPH GAS WORKS STUDY Guelph, Ontario FOR: City of Guelph		DATE: 15 March 1990 GEOLOGIST PW ELEVATION ± 311.7 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						PRODUCT AND/OR VAPOURS		
				NUMBER	INTERVAL	TYPE	N	VALUE	% WATER		% REC	% RQD
1		<u>FILL</u> Dark brown to black fine to coarse sand with gravel, silt and clay. Moist.										
1.7												
1.8		<u>CONCRETE PAD</u> Concrete pad 0.10 m thick.										
2												
3		<u>SANDY GRAVEL WITH BOULDERS</u> Grey fine to medium sand and gravel with boulders.										
4												
4.9		<u>AMABEL FORMATION</u> <u>ERAMOSIA MEMBER</u> Grey-brown aphanitic to fine grained dolostone. Thin to medium bedded. Occasional shaley stringers and partings, becoming more frequent with depth. Locally vuggy sections with quartz infilling. Occasional fossils.										
5					1		HQ			100	48	No detectable odor or staining.
6												
7												
8												
9												

BOREHOLE LOG	PROJECT: 90-908	BOREHOLE: 12-II
GUELPH GAS WORKS STUDY Guelph, Ontario FOR: City of Guelph		DATE: 15 March 1990 GEOLOGIST PW ELEVATION ± 311.7 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						PRODUCT AND/OR VAPOURS	
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC		% RQD
10.7		Borehole terminated at 10.67 m in dolostone.									

BOREHOLE LOG	PROJECT: 90-908	BOREHOLE: 15-II
GUELPH GAS WORKS STUDY Guelph, Ontario FOR: City of Guelph		DATE: 14 March 1990 GEOLOGIST PW ELEVATION ±310.5 m ASL

DEPTH (m)	STRATIGRAPHY	STRATIGRAPHIC DESCRIPTION	MONITOR DETAILS & NUMBER	SAMPLE						PRODUCT AND/OR VAPOURS	
				NUMBER	INTERVAL	TYPE	N VALUE	% WATER	% REC		% RQD
0.7		FILL/TOPSOIL Brown fine to medium sand with rootlets. Moist.								Black slightly iridescent coating on soils. Slight to moderate creosote odor.	
1		SAND AND GRAVEL Dark brown fine to medium sand and gravel with some silt and clay. Moist.		1	HQ			74	0		Slight iridescent sheen on core pieces. No detectable odor or staining.
2		AMABEL FORMATION ERAMOSIA MEMBER Grey-brown aphanitic to fine grained dolostone. Thin to medium bedded. Occasional shaley stringers and partings, becoming more frequent with depth. Occasional vertical fractures, some infilled with quartz. Locally vuggy sections. Occasional fossils.		2	HQ			95	19	Minor black staining. No detectable odor.	
2.4											
3				3	HQ			100	63	Minor black staining. No detectable odor.	
4				4	HQ			100	27	Minor black staining. Some black tarry material in fractures. No detectable odor.	
5				5	HQ			100	55	No detectable staining or odor.	
6											
7				6	HQ			100	38	No detectable staining or odor.	
8											
9				7	HQ			100	75	No detectable staining or odor.	
9.6		Borehole terminated at 9.6 m in dolostone.									

APPENDIX C
GROUND WATER MONITOR DETAILS

**MONITOR DETAILS SUMMARY
PROJECT NO. 90-908**

BOREHOLE		MONITOR				SCREENED INTERVAL BELOW GRD	FILTER PACK		SEAL		BACKFILL		DEPTH TO WATER (MAR 15/90) (m)	ELEV. OF WATER (MAR 15/90) (m)
NO.	DIA. (mm)	DATE	DIA. (mm)	STICK-UP (m)	ELEVATION (m)		(m)	(m)	(m)	(m)	(m)	(m)		
12-II	94	MAR/90	51	-0.10	310.6	10.6 - 7.5	10.6 - 5.2	5.2 - 4.6	4.6 - 1.5	1.95	308.6			
12-I		DEC/87		-0.10	310.4	3.0 - 1.8				1.25	309.12			
14-I		DEC/87		-0.17	310.70	2.4 - 1.1				1.18	309.52			
15-II	94	MAR/90	51	-0.10	311.4	9.5 - 6.4	9.5 - 2.7	2.7 - 0.6		2.14	309.3			
15-I		DEC/87		-0.16	311.49	1.8 - 0.6				1.16	310.33			

APPENDIX D

GROUND WATER QUALITY ANALYSES

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29-Mar-90

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BARRINGER LABORATORIES

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Authority: Ms. Patty Wong
Project: 90-908
Purchase order:

Job: 904707 Status: Final

Type	Sample	Phenols 4-AAP mg/L	NH3-N A. Col. mg/L	Total CN- A. Col. mg/L	Free CN- A. Col. mg/L	Ag ICAP mg/L	Al ICAP mg/L	B ICAP mg/L
water	BH14	<0.0005	0.54	0.130	<0.001	<0.005	0.10	0.139
	BH15	0.0020	9.00	0.025	<0.001	<0.005	<0.05	0.064
	BH17	0.0225	19.9	0.190	0.005	<0.005	<0.05	0.065
	BH18	0.0160	19.1	0.140	0.007	<0.005	<0.05	0.068
	Blank	<0.0005	<0.02	<0.001	<0.001	<0.005	<0.05	<0.005
	QC Standard (actual)	0.0100	0.50	1.02	1.00	<0.005	1.09	0.203
	QC Standard (expected)	0.0100	0.50	1.00	1.00	<0.005	1.00	0.200
	Repeat BH14	<0.0005	0.54	0.120	<0.001	<0.005	0.20	0.144

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Job: 904707 Status: Final

Type	Sample	Ba ICAP mg/L	Be ICAP mg/L	Ca ICAP mg/L	Cd ICAP mg/L	Co ICAP mg/L	Cr ICAP mg/L	Cu ICAP mg/L
water	BH14	0.223	<0.0005	189.	<0.005	<0.05	<0.01	<0.01
	BH16	0.116	<0.0005	77.3	<0.005	<0.05	<0.01	<0.01
	BH17	0.101	<0.0005	117.	<0.005	<0.05	<0.01	<0.01
	BH18	0.100	<0.0005	117.	<0.005	<0.05	<0.01	<0.01
	Blank	<0.005	<0.0005	<0.05	<0.005	<0.05	<0.01	<0.01
	QC Standard (actual)	0.508	0.0171	10.1	0.191	0.19	0.19	0.19
	QC Standard (expected)	0.500	0.0200	10.0	0.200	0.20	0.20	0.20
	Repeat BH14	0.224	<0.0005	188.	<0.005	<0.05	<0.01	0.01



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Type	Sample	Fe ICAP mg/L	K ICAP mg/L	Mg ICAP mg/L	Mn ICAP mg/L	Mo ICAP mg/L	Na ICAP mg/L	Ni ICAP mg/L
water	BH14	0.40	9.5	52.5	0.37	<0.2	539.	0.10
	BH16	0.01	7.6	59.6	0.02	<0.2	90.3	0.10
	BH17	0.55	10.1	61.0	0.06	<0.2	453.	0.10
	BH18	0.49	10.2	59.8	0.05	<0.2	430.	0.08
	Blank	<0.01	<0.5	<0.01	<0.01	<0.2	<0.5	<0.05
	QC Standard (actual)	1.03	2.0	10.5	0.20	1.0	48.2	0.18
	QC Standard (expected)	1.00	2.0	10.0	0.20	1.0	46.0	0.20
	Repeat BH14	0.35	9.6	51.8	0.36	<0.2	538.	0.09

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Type	Sample	P ICAP mg/L	Pb ICAP mg/L	Si ICAP mg/L	Sr ICAP mg/L	Th ICAP mg/L	Ti ICAP mg/L	V ICAP mg/L
water	BH14	<0.5	<0.05	5.97	0.600	<0.05	0.014	<0.005
	BH16	<0.5	<0.05	5.48	1.68	<0.05	<0.005	0.009
	BH17	<0.5	<0.05	6.52	0.625	<0.05	<0.005	0.006
	BH18	<0.5	<0.05	6.44	0.632	<0.05	<0.005	<0.005
	Blank	<0.5	<0.05	<0.05	<0.001	<0.05	<0.005	0.019
	QC Standard (actual)	<0.5	0.20	0.74	0.195	1.03	0.197	0.194
	QC Standard (expected)	1.0	0.20	1.00	0.200	1.00	0.200	0.200
	Repeat BH14	<0.5	<0.05	5.89	0.605	<0.05	<0.005	0.019

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Type	Sample	Zn ICAP mg/L	Zr ICAP mg/L
water	BH14	0.11	<0.02
	BH16	0.02	<0.02
	BH17	0.03	<0.02
	BH18	0.02	<0.02
	Blank	0.01	<0.02
	QC Standard (actual)	0.20	0.16
	QC Standard (expected)	0.20	0.20
	Repeat BH14	0.10	<0.02

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Abbreviations:

Analyses:

Phenols	: Phenolic compounds determined using the 4-AAP method
NH3-N	: Ammonia concentration expressed as nitrogen
Total CN-	: Total Cyanide
Free CN-	: Free Cyanide
Ag	: Silver concentration
Al	: Aluminum concentration
B	: Boron concentration
Ba	: Barium concentration
Be	: Beryllium concentration
Ca	: Calcium concentration
Cd	: Cadmium concentration
Co	: Cobalt concentration
Cr	: Chromium concentration
Cu	: Copper concentration
Fe	: Total Iron Concentration
K	: Potassium concentration
Mg	: Magnesium concentration
Mn	: Manganese concentration
Mo	: Molybdenum concentration
Na	: Sodium concentration
Ni	: Nickel concentration

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Status: Final

P : Phosphorus concentration
Pb : Lead concentration
Si : Silicon concentration
Sr : Strontium concentration
Th : Thorium concentration
Ti : Titanium concentration
V : Vanadium concentration
Zn : Zinc concentration
Zr : Zirconium concentration

Methods:

4-AAP : Colourimetry using 4-AAP method
A. Col. : Automated Colourimetry
ICAP : Inductively-Coupled Argon Plasma Spectroscopy

Units:

mg/L : Milligrams per Liter - used for liquids

Quality control:

< : Result obtained was below the detection limit

Signed:

.....
Agnes Love, B.Sc.
Supervisor, Environmental Inorganic Services

ON THE EARTH AND ENVIRONMENTAL SCIENCES



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CLIENT: GARTNER LEE LTD.
PROJECT REF #90-908
W.O. # 90-4707V
MATRIX: WATER

VOLATILE ORGANICS RESULTS (EPA 624)

DATE: 23-Mar-90

ND = NOT DETECTED DF = DILUTION FACTOR
* = DETECTED AT A LEVEL BELOW STATED M.D.L.

COMPOUND	M.D.L. UG/L	REAGENT BLANK	BH14	12-II BH16	15-II BH17 DF=100	BH17 DF=100 REPEAT	15-II (dup) BH18 DF=100	TK.
1 CHLOROMETHANE	2.0	ND	ND	ND	ND	ND	ND	
2 VINYL CHLORIDE	2.0	ND	ND	ND	ND	ND	ND	
3 BROMOMETHANE	2.0	ND	ND	ND	ND	ND	ND	
4 CHLOROETHANE	5.0	ND	ND	ND	ND	ND	ND	
5 TRICHLOROFLUOROMETHANE	1.0	ND	ND	ND	ND	ND	ND	
6 1,1-DICHLOROETHENE	0.5	ND	ND	ND	ND	ND	ND	
7 DICHLOROMETHANE	1.0	ND	ND	ND	ND	ND	ND	
8 TRANS-1,2-DICHLOROETHENE	0.2	ND	ND	ND	ND	ND	ND	
9 1,1-DICHLOROETHANE	0.2	ND	ND	ND	ND	ND	ND	
10 CHLOROFORM	0.2	ND	ND	0.2	ND	ND	ND	
11 1,1,1-TRICHLOROETHANE	0.2	ND	ND	ND	ND	ND	ND	
12 CARBON TETRACHLORIDE	0.2	ND	ND	ND	ND	ND	ND	
13 BENZENE	0.1	ND	3.3	24.3	1110	1180	1140	
14 1,2-DICHLOROETHANE	0.2	ND	ND	ND	ND	ND	ND	
15 TRICHLOROETHENE	0.2	ND	2.0	ND	ND	ND	ND	
16 1,2-DICHLOROPROPANE	0.2	ND	ND	ND	ND	ND	ND	
17 BROMODICHLOROMETHANE	0.2	ND	ND	0.3	ND	ND	ND	
18 CIS-1,3-DICHLOROPROPENE	0.5	ND	ND	ND	ND	ND	ND	
19 TOLUENE	0.2	ND	ND	1.6	164	154	137	
20 TRANS-1,3-DICHLOROPROPENE	0.5	ND	ND	ND	ND	ND	ND	
21 1,1,2-TRICHLOROETHANE	0.5	ND	ND	ND	ND	ND	ND	
22 TETRACHLOROETHENE	0.5	ND	ND	ND	ND	ND	ND	
23 DIBROMOCHLOROMETHANE	1.0	ND	ND	*0.2	ND	ND	ND	
24 CHLOROBENZENE	0.2	ND	ND	ND	ND	ND	ND	
25 ETHYLBENZENE	0.2	ND	ND	0.9	160	131	153	
26 M-XYLENE & P-XYLENE	0.2	ND	ND	0.9	125	110	107	
27 O-XYLENE	0.2	ND	*0.1	0.9	85	75	73	
28 BROMOFORM	2.0	ND	ND	ND	ND	ND	ND	
29 1,1,2,2-TETRACHLOROETHANE	1.0	ND	ND	ND	ND	ND	ND	
30 1,3-DICHLOROBENZENE	0.2	ND	ND	ND	ND	ND	ND	
31 1,4-DICHLOROBENZENE	0.2	ND	ND	ND	ND	ND	ND	
32 1,2-DICHLOROBENZENE	0.2	ND	ND	ND	ND	ND	ND	

SURROGATE STANDARD RECOVERIES:

AMOUNT

33 FLUOROBENZENE	4 UG/L	98%	100%	119%	81%	90%	98%
34 4-BROMOFLUOROBENZENE	3 UG/L	100%	109%	102%	113%	112%	103%



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CLIENT: GARTNER LEE LTD.
PROJECT REF #90-908
W.O. # 90-4707V
MATRIX: WATER

QUALITY CONTROL SPIKE PERCENT RECOVERIES

DATE: 23-Mar-90

COMPOUND	AMOUNT UG/L	REAGENT SPIKE
1 CHLOROMETHANE	10.0	87%
2 VINYL CHLORIDE	10.0	108%
3 BROMOMETHANE	10.0	126%
4 CHLOROETHANE	10.0	127%
5 TRICHLOROFLUOROMETHANE	5.0	112%
6 1,1-DICHLOROETHENE	5.0	104%
7 DICHLOROMETHANE	5.0	103%
8 TRANS-1,2-DICHLOROETHENE	5.0	114%
9 1,1-DICHLOROETHANE	5.0	91%
10 CHLOROFORM	5.0	96%
11 1,1,1-TRICHLOROETHANE	5.0	107%
12 CARBON TETRACHLORIDE	5.0	91%
13 BENZENE	5.0	106%
14 1,2-DICHLOROETHANE	5.0	108%
15 TRICHLOROETHENE	5.0	95%
16 1,2-DICHLOROPROPANE	5.0	94%
17 BROMODICHLOROMETHANE	5.0	108%
18 CIS-1,3-DICHLOROPROPENE	7.5	102%
19 TOLUENE	5.0	100%
20 TRANS-1,3-DICHLOROPROPENE	2.5	101%
21 1,1,2-TRICHLOROETHANE	5.0	97%
22 TETRACHLOROETHENE	5.0	104%
23 DIBROMOCHLOROMETHANE	5.0	95%
24 CHLOROBENZENE	5.0	94%
25 ETHYLBENZENE	5.0	103%
26 M-XYLENE & P-XYLENE	1.6	97%
27 O-XYLENE	1.6	101%
28 BROMOFORM	5.0	115%
29 1,1,2,2-TETRACHLOROETHANE	5.0	118%
30 1,3-DICHLOROBENZENE	3.1	98%
31 1,4-DICHLOROBENZENE	2.7	107%
32 1,2-DICHLOROBENZENE	3.2	100%

SURROGATE STANDARD RECOVERIES:

33 FLUOROBENZENE	3.6	104%
34 4-BROMOFLUOROBENZENE	3.0	104%



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CLIENT: GARTNER LEE LTD.
PROJECT REFERENCE #90-908
W.O. # 90-4707B
MATRIX: WATER

DATE: 29-Mar-90

ND = NOT DETECTED
‡ = DETECTED AT A LEVEL BELOW STATED M.D.L.

RESULTS OF ANALYSIS FOR PAH'S

COMPOUND	M.D.L. UG/L	REAGENT BLANK	BH14	BH14 REPEAT	12-II BH16	15-II BH17	15-II (dup) BH18	TK.
1 NAPHTHALENE	0.5	ND	ND	ND	ND	356	811	
2 ACENAPHTHYLENE	0.5	ND	ND	ND	ND	22.0	26.2	
3 ACENAPHTHENE	0.5	ND	ND	ND	ND	53.6	57.6	
4 FLUORENE	0.5	ND	ND	ND	ND	16.5	18.0	
5 PHENANTHRENE	0.5	ND	ND	ND	ND	10.8	13.0	
6 ANTHRACENE	0.5	ND	ND	ND	ND	1.8	1.4	
7 FLUORANTHENE	0.5	ND	1.0	0.5	ND	1.3	1.1	
8 PYRENE	0.5	ND	1.7	0.8	ND	1.6	1.2	
9 BENZO(A)ANTHRACENE	1.0	ND	ND	ND	ND	ND	ND	
10 CHRYSENE	1.0	ND	ND	ND	ND	ND	ND	
11 BENZO(B)FLUORANTHENE	1.0	ND	ND	ND	ND	ND	ND	
12 BENZO(K)FLUORANTHENE	1.0	ND	ND	ND	ND	ND	ND	
13 BENZO(A)PYRENE	1.0	ND	ND	ND	ND	ND	ND	
14 INDENO(1,2,3-CD)PYRENE	1.0	ND	ND	ND	ND	ND	ND	
15 DIBENZO(A,H)ANTHRACENE	1.0	ND	ND	ND	ND	ND	ND	
16 BENZO(GHI)PERYLENE	1.0	ND	ND	ND	ND	ND	ND	

SURROGATE STANDARD RECOVERIES:

	AMOUNT						
17 ACENAPHTHENE-D10	12 UG/L	64%	67%	47%	69%	87%	75%
18 PERYLENE-D12	12 UG/L	78%	15%	29%	85%	60%	43%



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CLIENT: GARTNER LEE LTD.
PROJECT REFERENCE #90-908
W.O. # 90-4707B
MATRIX: WATER

DATE: 29-Mar-90

QUALITY CONTROL SPIKE PERCENT RECOVERIES

COMPOUND	AMOUNT UG/L	REAGENT SPIKE	BH16 SPIKE
1 NAPHTHALENE	12	91%	94%
2 ACENAPHTHYLENE	12	128%	113%
3 ACENAPHTHENE	12	93%	77%
4 FLUORENE	12	100%	85%
5 PHENANTHRENE	12	106%	100%
6 ANTHRACENE	12	117%	94%
7 FLUORANTHENE	12	108%	85%
8 PYRENE	12	114%	90%
9 BENZO(A)ANTHRACENE	12	94%	51%
10 CHRYSENE	12	83%	50%
11 BENZO(B)FLUORANTHENE	12	66%	28%
12 BENZO(K)FLUORANTHENE	12	37%	33%
13 BENZO(A)PYRENE	12	46%	26%
14 INDENO(1,2,3-CD)PYRENE	12	24%	23%
15 DIBENZO(A,H)ANTHRACENE	12	26%	19%
16 BENZO(GHI)PERYLENE	12	24%	19%

SURROGATE STANDARD RECOVERIES:

17 ACENAPHTHENE-D10	12	98%	78%
18 PERYLENE-D12	12	72%	70%