

O'CONNOR ASSOCIATES



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• O'CONNOR ASSOCIATES GEOTECHNICAL INC.

• O'CONNOR ASSOCIATES ENVIRONMENTAL INC.

• O'CONNOR ASSOCIATES MANAGEMENT SERVICES LTD.

January 3, 1989.

10-907

Esso Petroleum Canada
3011 - 101 Avenue
Edmonton, Alberta
T6P 1X7

Attention: Mr. W.J. Holtz, P.Eng.

Dear Sir:

Re: Red River Esso
(60256A)
Selkirk, Manitoba

NOTICE

ACCESS TO INFORMATION ACT

These documents and the information contained in them are confidential - property of Imperial Oil and any disclosure of same is governed by the provisions of each of the applicable provincial or territorial Freedom of Information legislation, the Privacy Act (Canada) 1980-81-82-83, c.111, Sch. II "1", and the Access to Information Act (Canada) 1980-81-82-83, c.111, Sch. I "1", as such legislation may be amended or replaced from time to time.

RECEIVED APR 06 2005

Under your authorization, subsurface investigations have been carried out at the above captioned site on 88/11/11 and 88/12/06. This supplementary work was designed to better delineate the subsurface contamination which was identified in the tank backfill piezometers and to provide information for the design of appropriate remedial measures. A site plan showing the locations of the boreholes, catch basins and manholes is included for your reference as Drawing No. 1.1.

SITE FEATURES AND GEOLOGY

The Esso service station, is located on the northwest side of Main Street (Highway 9) between Pacific Avenue and Rosser Avenue in Selkirk, Manitoba (Drawing No. 1.2). Residential properties are located directly northwest of the service station, southwest across Pacific Avenue and southeast across Main Street. Commercial buildings exist north of the site across Rosser Avenue and south of the site across Main Street. The site is situated approximately 600 m west of the Red River.

The town's water is supplied from a water well which is located approximately 600 m northeast of the site adjacent to the water filtration plant shown on Drawing No. 1.2. According to Public Works personnel the well intake is located 49 m below grade. The water from this well is supplemented with water from the Red River during dry months in the summer.



.../2

According to preliminary mapping of the area by the Manitoba government, the surficial geology beneath the site is a glaciolacustrine deposit of silt rich and/or pebble rich clay (1977-WPG-13).

SITE INVESTIGATION

The subsurface investigation was carried out in 2 phases; 5 boreholes were drilled on 88/11/11 and an additional 6 boreholes were drilled on 88/12/06. Stratigraphic information and soil vapour concentrations were recorded at the time of drilling and are presented on the logs in Appendix A. Monitoring piezometers were installed in each borehole to facilitate future measurement of groundwater levels, product thicknesses and subsurface vapour concentrations. The locations of the piezometers were surveyed relative to a temporary bench mark. The catch basins, manholes and piezometers, including the 4 located in the tank backfill, were monitored on 88/11/28, 88/12/09 and 88/12/20. The VES extraction rate was also measured on 88/11/03, 88/11/21, 88/11/28, 88/12/09 and on 88/12/20.

SUBSURFACE CONDITIONS

Stratigraphy

The natural soil profile encountered in the boreholes consisted of silt topsoil overlying silty clay which extended below the 6.1 m depth of investigation. The clay unit was fractured, laminated and contained silt and sand lenses. Surficial asphalt and sand and gravel fill were noted in BH5, BH6, BH7, BH9, BH10 and BH11. A cross-section illustrating the stratigraphy is presented on Drawing No. 1.3.

Groundwater

Piezometric surface elevations measured in the boreholes on 88/12/20 suggest that the water table is in the clay unit 2.4 m to 4.0 m below the ground surface (Drawing No. 1.3). The groundwater in the tank backfill area appeared to be mounded and was 1.5 m to 2.2 m below grade. Based on preliminary monitoring, the principal direction of groundwater flow appears to be south and southeast toward the Red River (Drawing No. 1.4). The fluid levels in BH6 to BH11 may not have reached equilibrium with the groundwater regime as of 88/12/20.



Subsurface Vapours

Subsurface vapour concentrations measured in soil samples obtained during drilling are plotted on the borehole logs in Appendix A. Slightly elevated vapour concentrations (>200 ppm) were only detected in BH3, BH4, BH7 and BH10.

The areal distribution of subsurface vapour concentrations measured in the piezometers on 88/12/20 is presented on Drawing No. 1.5. Vapour concentrations exceeding 100% LEL were detected in all 4 tank backfill piezometers (the VES fan was not operational on 88/12/20), in BH1 and in BH11. Elevated vapour concentrations were also noted in BH4, BH7 and BH10.

Vapour concentrations measured in the sewer manholes and catch basins on and adjacent to the site did not exceed 100 ppm on 88/12/20.

Phase-Separated Hydrocarbons

The phase-separated product thicknesses measured at the water table on 88/12/20 are presented on Drawing No. 1.6 and a summary of product thicknesses recorded to date is presented in Table 1.1. Liquid petroleum product was detected in piezometers E2 and E4, and in BH1 and BH10 on 88/12/20. The apparent product thickness has increased in E2 from 120 mm, on 88/10/10 to 355 mm on 88/12/20. The product bailed from E4 was dark amber in colour but the product in the other 3 piezometers was light amber in colour.

REMEDIAL MEASURES

The discharge parameters measured for the tank backfill fan and for the fan connected to the catch basin are summarized in Tables 1.2 and 1.3, respectively. The 2 fan units extracted a combined total of 590 L of product between 88/10/11 and 88/12/20. Since the installation of the fan units, a total of 2340 L have been removed from the subsurface by vapour extraction.

CONCLUSIONS

Based on the results of the subsurface investigation, O'Connor Associates Environmental Inc. concludes that:

1. The natural soils beneath the service station property consist of silt topsoil overlying silty clay.

.../4



2. The groundwater table was located 2.4 m to 4.0 m below grade in the native soils and 1.5 m to 2.2 m below grade in the tank backfill on 88/12/20. Preliminary results indicate that the principal direction of groundwater flow is south to southeast. Subsequent monitoring will be required to confirm the flow direction.
3. Phase-separated product previously detected in the tank backfill appears to have migrated southeast to BH1 and BH10 (beneath Main Street). The extent of the product plume has not been defined southeast of the Esso property. Additional boreholes will therefore be required on public property.

The increasing product thickness in E2 and the colour of the product in E2, BH1 and BH10 suggest that ongoing product losses could be occurring.

4. Explosive vapour concentrations were present in the area of the tank backfill, in BH1 and in BH11. The extent of the vapour plume has not been defined south of the Esso property.
5. Elevated vapour concentrations have only been detected in the catch basin near the tank backfill (CB1) and a VES fan unit was installed to control vapour concentrations at CB1. Additional remedial measures will be required to reduce the risk of subsurface petroleum contamination impacting the other underground utilities on public property.
6. The tank backfill fan unit appears effective in extracting petroleum vapours and should therefore continue to operate for the present. Although extraction rates from the fan unit connected to the catch basin are less than 1 L/day, the unit should continue to operate to control petroleum vapour concentrations in the storm sewer line.

CLOSURE

This report has been prepared in accordance with generally accepted hydrogeological and environmental engineering practices for the exclusive use of Esso Petroleum Canada. Information presented herein was obtained while conducting authorized investigations and monitoring at Esso's Red River service station in Selkirk, Manitoba. Although the data were collected only at site-specific locations, the reported information is believed to provide a reasonable representation of the general environmental conditions at the site.



Esso Petroleum Canada
January 3, 1989
Page 5

10-907

Recommendations and estimated costs for further remedial work will be provided under separate cover. Should any questions arise regarding the information presented herein, please contact the undersigned.

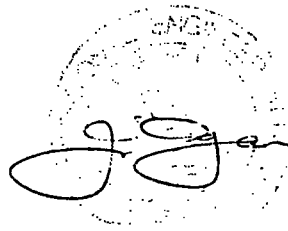
Respectfully submitted,

O'CONNOR ASSOCIATES ENVIRONMENTAL INC.



E.M. Goldie, M.I.T.

EMG/11f



J.G. Agar, P.Eng.

Manitoba Temporary
Licence No.: 122-88;
Licence Expires: 89/07/11



TABLE 1.1
 APPARENT PRODUCT THICKNESSES
 (mm)

<u>DATE</u>	<u>E2</u>	<u>E3</u>	<u>E4</u>	<u>BH1</u>	<u>BH10</u>
88/07/12	140 (4)	60 (0)	168 (794)		
88/08/10	80 (90)	5 (0)	90 (2)		
88/09/08	195 (4)	1 (0)	220 (0)		
88/09/12	10 (3)	0	1 (0)		
88/10/11	120 (0)	0	50 (0)		
88/11/28	240	0	0	220	
88/12/09	293	0	0	62	
88/12/20	355	0	256	100	170



TABLE 1.2

VAPOUR EXTRACTION PARAMETERS

VES 101

(connected to the tank backfill piezometers)

<u>DATE</u>	<u>TIMER READING</u> (hrs)	<u>VAPOUR CONCENTRATION</u> (% LEL)	<u>FLOW RATE</u> (ft/min)	<u>ESTIMATED EXTRACTION RATE</u> (L/day)
88/07/12	5 193	NR	NR	NR
88/08/10	5 589	20	>3 000	30
88/09/08	6 038	15	>3 000	22.5
88/09/12	6 127	11	>3 000	16.5
88/10/11	6 780	12	>3 000	18
88/11/03	7 277	10	>3 000	15
88/11/12	7 490.6	10	3 150	16
88/11/28	7 491	>100	>3 000	150
88/12/09	7 751.9	3	2 560	4
88/12/20	7 753	45 ^a	2 800	63

a - one hour after activation
 NR - no reading

Note: The electrical power was initially connected between 88/07/12 and 88/07/26 by a local electrician.

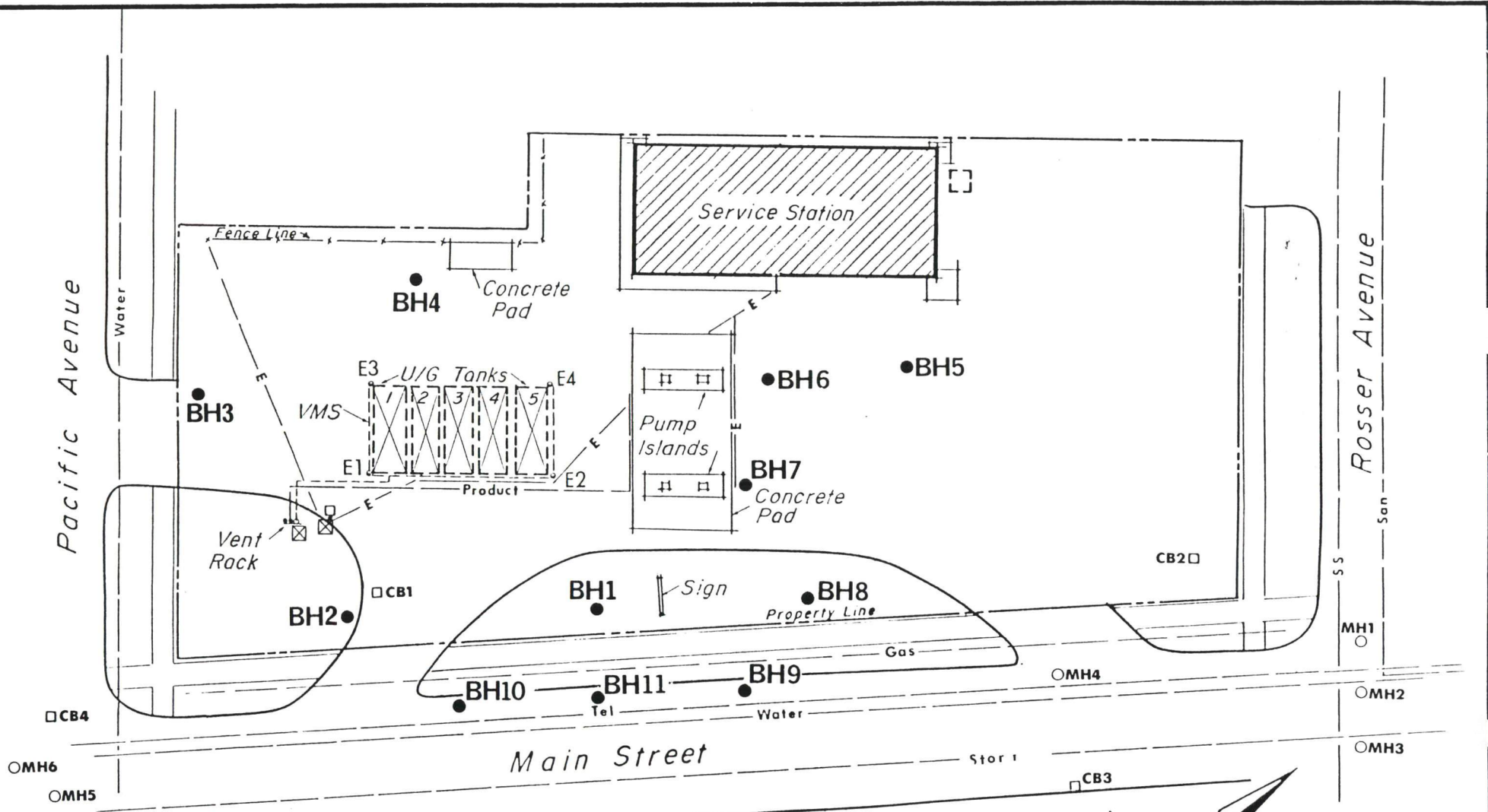


TABLE 1.3
 VAPOUR EXTRACTION PARAMETERS
 VES 182
 (located on CB1)

<u>DATE</u>	<u>TIME READING (hrs)</u>	<u>VAPOUR CONCENTRATIONS (% LEL)</u>	<u>FLOW RATE (ft/min)</u>	<u>ESTIMATED EXTRACTION RATE (L/day)</u>
88/09/12 ^a	NR	13	>3000	19.5
88/09/12 ^b	NR	2.2	>3000	3.3
88/10/11 ^c				
88/11/03	2586	3	>3000	4.5
88/11/12	2799.6	1.6	>6000	10
88/11/28	2800	22	>3000	33
88/12/09	3061	ND	2100	ND
88/12/20	3303	0.04	2200	0.04

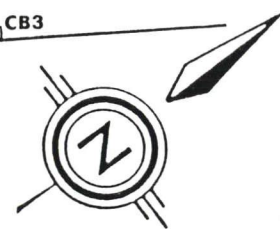
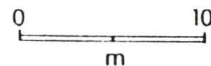
a - activation
 b - after 1 hour
 c - electrical not been installed
 NR - no reading
 ND - not detected





- LEGEND
- Piezometer
 - U/G Utilities
 - Catch Basin
 - Vapour Management System
 - ⊗ VES Fan

TANK No	VOLUME	PRODUCT
1	5000 Gal.	RLD
2	5000 Gal.	RLD
3	5000 Gal.	RUL
4	5000 Gal.	RUL
5	5000 Gal.	PUL



Site Plan

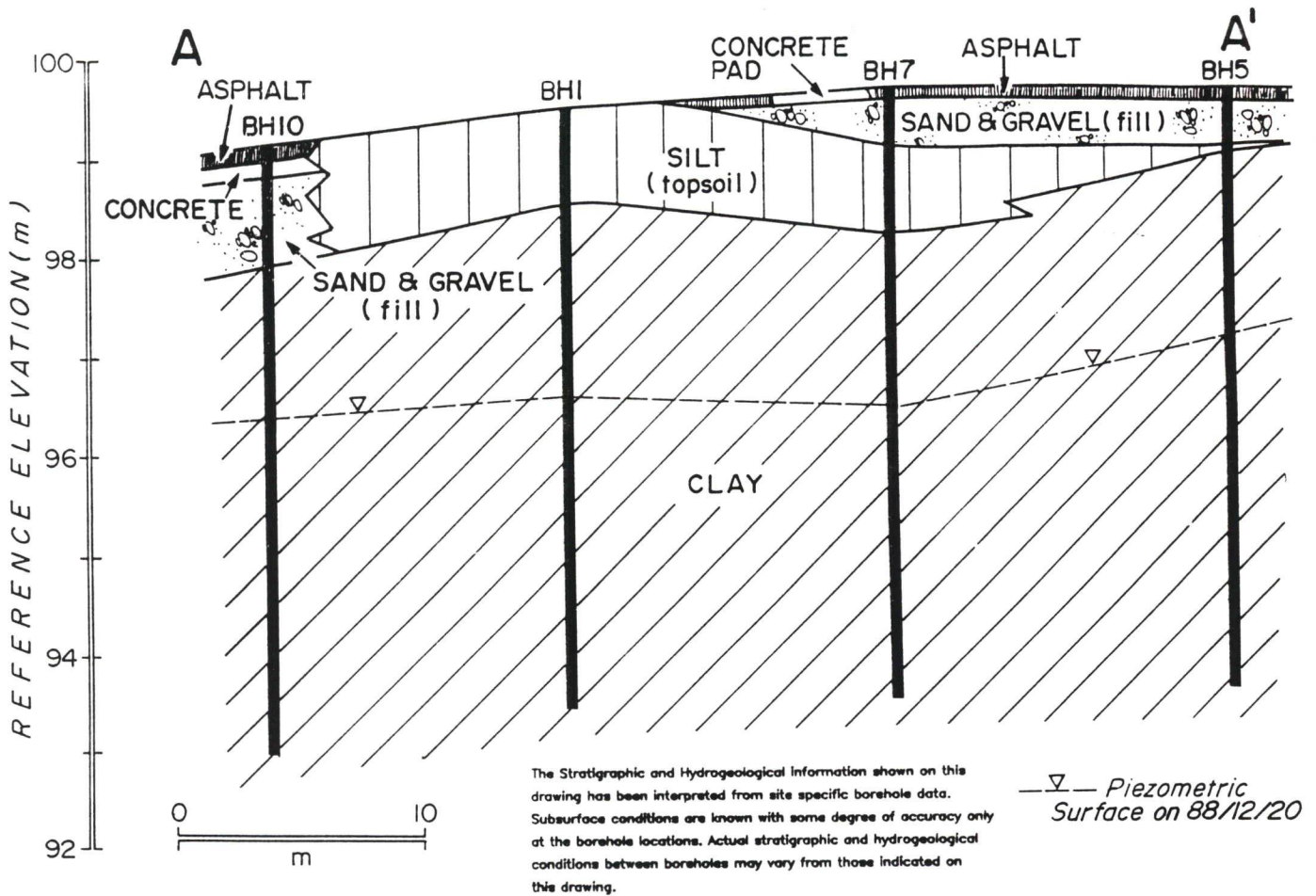
O'CONNOR ASSOCIATES

JOB NO.: 10-907

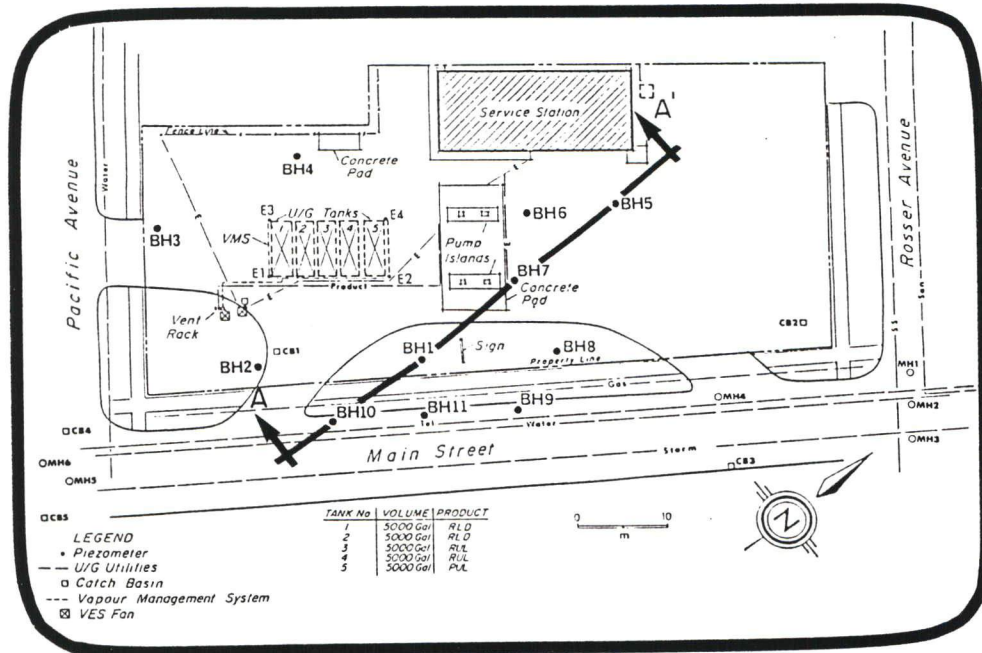
DATE: 88/12/22

DRAWN BY: DE

DWG. NO.: 1.1



Cross Section A-A'



Key Plan

Stratigraphic Cross Section A - A'

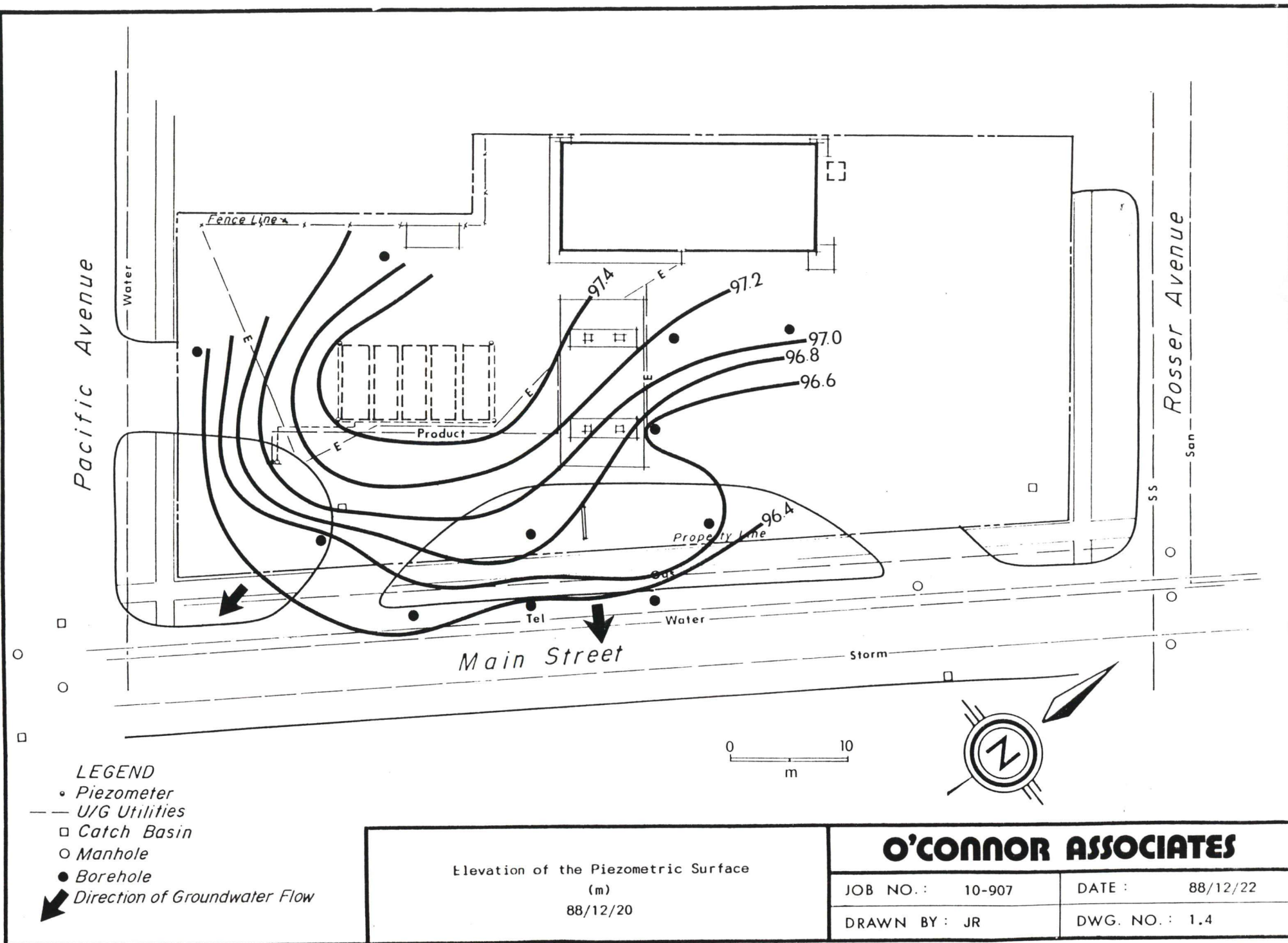
O'CONNOR ASSOCIATES

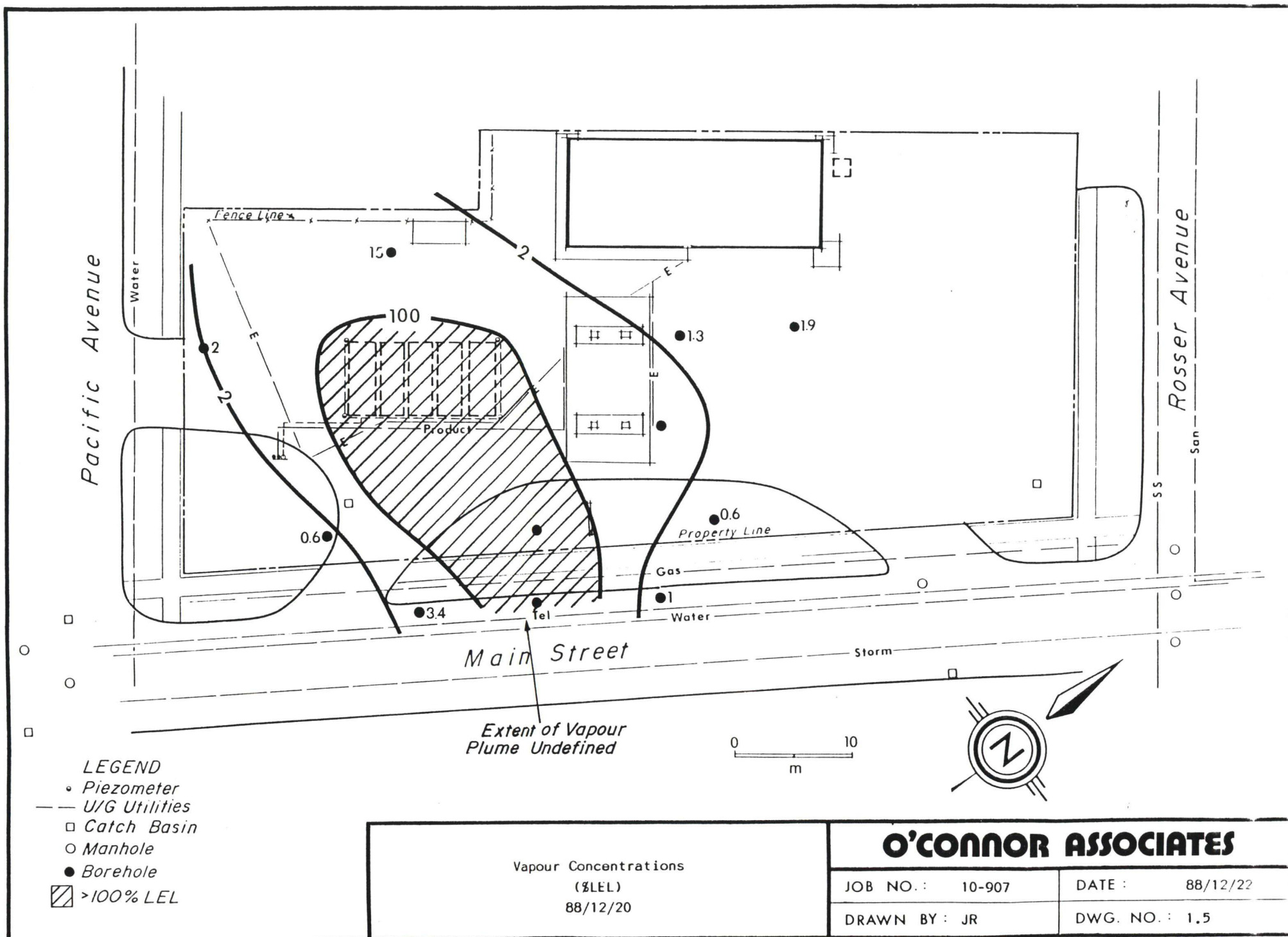
JOB NO. : 10-907

DATE : 88/12/22

DRAWN BY : JR

DWG. NO. : 1.3





- LEGEND**
- Piezometer
 - U/G Utilities
 - Catch Basin
 - Manhole
 - Borehole
 - ▨ >100% LEL

Vapour Concentrations (%LEL) 88/12/20		O'CONNOR ASSOCIATES	
		JOB NO.: 10-907	DATE: 88/12/22
		DRAWN BY: JR	DWG. NO.: 1.5

Pacific Avenue

Rosser Avenue

San

SS

Water

Fence Lines

Product

100

170

Main Street

Property Line

Gas

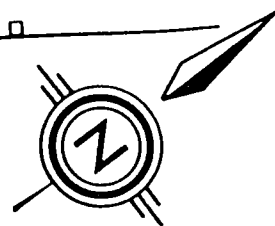
Water

Tel

Storm

Extent of Liquid Product
Plume Undefined

0 10
m



LEGEND

- Piezometer
- U/G Utilities
- Catch Basin
- Manhole
- Borehole

Apparent Thickness of Subsurface Hydrocarbons
(mm)
88/12/20

O'CONNOR ASSOCIATES

JOB NO. : 10-907

DATE : 88/12/22

DRAWN BY : JR

DWG. NO. : 1.6

APPENDIX A
BOREHOLE LOGS



PROJECT: Red River Esso Service Station		GD ELEV.: 99.665 m	HOLE No.: BH1			
LOCATION: Selkirk, MB (#60256A)		TPC ELEV.: 99.539 m	DRILL : Auger			
SAMPLE TYPE : <input type="checkbox"/> SHELBY <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> CORE <input type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> OTHER						
METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations	N	OTHER TESTS
				%LEL ▲ppm ▲ 100 ● 20 200 40 300 60 400 80		
	SILT (TOPSOIL) - dark brown, some clay, organics, damp					
-1-	CLAY - light grayish brown, silty, damp, firm					
-2-	- light olive brown, trace silt, silt inclusions, dry to damp, firm, laminated - stiff below 1.7 m, fractured - moist below 2.6 m		5			
-3-						
-4-	- olive brown, trace sand, occasional gravel, moist, soft, medium plasticity, laminated		10			
-5-						
-6-	- grayish brown, silty, gravelly, oxidized, laminated		15			
-7-						
-8-			20			
-9-	END OF HOLE AT 6.1 m. Monitoring piezometer installed to 6.1 m.					
			25			
			30			

O'CONNOR ASSOCIATES

DATE: 88/11/11

LOGGED BY: GMD

JOB No.: 10-907

DWG.No.: A-1

PROJECT: Red River Esso Service Station		GD ELEV.: 99.510 m		HOLE No.: BH2		
LOCATION: Selkirk, MB (60256A)		TPC ELEV.: 99.410 m		DRILL: Auger		
SAMPLE TYPE: <input type="checkbox"/> SHELBY <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> CORE <input type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> OTHER						
METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations ● %LEL ▲ ppm	N	OTHER TESTS
	SILT (TOPSOIL) - dark brown, organics, some clay, damp			▲ 100 200 300 400 ● 20 40 60 80		
1	CLAY - olive brown, silty, damp, firm, fractured, laminated					
	- trace silt below 1.2 m		5			
2						
	- moist below 2.4 m					
3			10			
	- silt inclusions and firm below 3.0 m					
4						
			15			
5	- trace gravel, moist, soft, laminated					
6	- grayish brown, moist, soft		20			
	END OF HOLE AT 6.1 m.					
7	Monitoring piezometer installed to 6.1 m.					
8			25			
9			30			
O'CONNOR ASSOCIATES				DATE: 88/11/11		JOB No.: 10-907
				LOGGED BY: GMD		DWG. No.: A-2

PROJECT: Red River Esso Service Station		GD ELEV.: 99.392 m		HOLE No.: BH3	
LOCATION: Selkirk, MB (#60256A)		TPC ELEV.: 99.274 m		DRILL: Auger	
SAMPLE TYPE: <input type="checkbox"/> SHELBY <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> CORE <input type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> OTHER					

METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations				N	OTHER TESTS
				● %LEL		▲ ppm			
				100	200	300	400		
	SILT (TOPSOIL) - dark brown and black, organics, some clay, damp								
1	CLAY - olive brown, trace silt, trace gravel, stiff, fractured, laminated - moist and firm below 2.1 m								
2									
3									
	- some silt and damp below 3.0 m								
4									
5									
	- gray, silty								
6									
7									
	END OF HOLE AT 6.1 m.								
	Monitoring piezometer installed to 6.1 m.								
8									
9									

O'CONNOR ASSOCIATES	DATE: 88/11/11	JOB No.: 10-907
	LOGGED BY: GMD	DWG.No.: A-3

PROJECT: Red River Esso Service Station		GD ELEV.: 99.611 m		HOLE No.: BH4	
LOCATION: Selkirk, MB (#60256A)		TPC ELEV.: 99.491 m		DRILL: Auger	
SAMPLE TYPE: <input type="checkbox"/> SHELBY <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> CORE <input type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> OTHER					

METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations				N	OTHER TESTS
				● %LEL		▲ ppm			
				100	200	300	400		
	SILT (TOPSOIL) - dark brown, organics, some clay, damp								
1	CLAY - olive brown, silty, damp, stiff, laminated								
	- fractured below 1.5 m		5						
2	- moist and firm below 2.1 m								
3	- noticeable petroleum odour at 3.0 m		10						
4									
	- grayish brown, some gravel, damp, firm		15						
5	- stiff below 4.6 m								
6	- trace gravel, trace silt inclusions		20						
	SILT - grayish brown, gravelly								
7	END OF HOLE AT 6.2 m.								
	Monitoring piezometer installed to 6.1 m.								
8									
9									

O'CONNOR ASSOCIATES	DATE: 88/11/11	JOB No.: 10-907
	LOGGED BY: GMD	DWG.No.: A-4

PROJECT: Red River Esso Service Station		GD ELEV.:		HOLE No.: BH5					
LOCATION: Selkirk, MB (#60256A)		TPC ELEV.:		DRILL: Auger					
SAMPLE TYPE: <input checked="" type="checkbox"/> SHELBY <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> CORE <input type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> OTHER									
METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations				N	OTHER TESTS
				● %LEL	▲ ppm				
				▲ 100 ● 20	200 40	300 60	400 80		
1	SAND AND GRAVEL (FILL) - light brown, some silt, some clay, damp, soft								
2	CLAY - dark brown and black, silty, organics, damp								
3	- olive brown, trace silt, damp, stiff, fractured, laminated		5						
4	- very stiff below 1.8 m								
5	- stiff below 2.4 m								
6	- firm below 3.0 m		10						
7	- olive brown, silt inclusions, moist, fractured								
8									
9	- grayish brown, laminated, silt lenses, some gravel, damp, stiff		15						
10	- olive brown, trace gravel, silt inclusions, moist, firm								
11			20						
12	END OF HOLE AT 6.1 m.								
13	Monitoring piezometer installed to 6.1 m.								
14			25						
15									
16			30						
17									
18									
19									
20									

DATE: 88/11/11


LOGGED BY: GMD

JOB No.: 10-907

DWG. No.: A-5

PROJECT: Red River Esso Service Station		GD ELEV.: 99.762 m		HOLE No.: BH6	
LOCATION: Selkirk, MB (#60256A)		TPC ELEV.: 99.698 m		DRILL: Auger	
SAMPLE TYPE: <input type="checkbox"/> SHELBY <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> CORE <input type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> OTHER					

METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations					N	OTHER TESTS
				%LEL		ppm				
				▲ 100 ● 20	200 40	300 60	400 80			
	ASPHALT (25 mm)									
	CONCRETE (75 mm)									
1	GRAVEL (FILL) - light reddish brown, oxidized, sandy, some silt, damp, dense, frozen to 0.3 m			▲						
2	SILT - dark olive brown with black mottling, some clay, moist, firm, laminated	X	5	▲						
3	CLAY - dark olive brown, oxidized, moist, very stiff, medium plasticity, laminated	X	10	▲						
4	- becoming moister with depth			▲						
	- wet below 2.1 m, fractured			▲						
	- trace sand and silt lenses below 3.3 m	X	15	▲						
5	- water seepage at 4.6 m			▲						
6	- dark gray		20	▲						
7	END OF HOLE AT 6.2 m. Monitoring piezometer installed to 6.1 m.									
8			25							
9			30							

O'CONNOR ASSOCIATES 	DATE: 88/12/06	JOB No.: 10-907
	LOGGED BY: GJB	DWG.No.: A-6

PROJECT: Red River Esso Service Station		GD ELEV.: 99,699 m		HOLE No.: BH7		
LOCATION: Selkirk, MB (#60256A)		TPC ELEV.: 99,741 m		DRILL: Auger		
SAMPLE TYPE: <input checked="" type="checkbox"/> SHELBY <input checked="" type="checkbox"/> SPLIT SPOON <input type="checkbox"/> CORE <input type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> OTHER						
METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations ● %LEL ▲ ppm	N	OTHER TESTS
	ASPHALT (50 mm)					
1	GRAVEL (FILL) - light reddish brown, oxidized, sandy, some silt, damp, dense, frozen to 0.3 m			▲		
2	SILT - olive brown, oxidized, some clay, trace sand, firm, wet		5			
	CLAY - dark olive brown, oxidized, some silt, moist, very stiff, medium plasticity, fractured			▲		
3	- water seepage at 3.0 m		10			
	- trace sand and silt lenses			▲		
4				▲		
				▲		
5	- light brown, silty, some sand, trace cobbles, wet, dense, laminae below 3.0 m		15			
				▲		
6			20			
	END OF HOLE AT 6.2 m.					
7	Monitoring piezometer installed to 6.1 m.					
8			25			
9			30			

O'CONNOR ASSOCIATES	DATE: 88/12/06	JOB No.: 10-907
	LOGGED BY: GJB	DWG.No.: A-7