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Petro-Canada  
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JUL 2 - 1991



Our File: P12-0088  
Your File: 8156-672

June 26, 1991

CASSELS, BROCK & BLACKWELL  
Barristers & Solicitors  
2100, 40 King Street West  
TORONTO, Ontario M5H 3C2

Attention: D. R. Arthurs

Dear Sirs:

Re: BRANDON, Manitoba

Further to your request for a copy of our report we advise as follows.

Although it is not our general practice to release confidential opinions from experts retained on certain properties, we are making an exception in this case. Accordingly, we enclose for your information and limited circulation to your client, a copy of the report provided to us on the Brandon property.

We will retain your report applicable to that portion of the old Gulf Refinery site purchased by Canadian Tire. We note from the report prepared for Canadian Tire that there was considerable contamination arising from the storage tanks operated by Canadian Tire for their service station on the site.

It is apparent from the expert's reports that it would be appropriate to meet with the Department of the Environment together with all parties who currently occupy a portion of the former refinery lands.

.. 2

*over  
states*

*W. H. is then  
not keeping  
done*

Cassels, Brock & Blackwell  
June 26, 1991  
Page 2

We are currently exploring this possibility with the Department of the Environment and will be contacting you further should such a meeting be considered beneficial.

Yours truly,

**PETRO-CANADA**



M.A. Bell  
Senior Counsel  
Western Region

gja

Enclosure

cc Ministry of Environment  
Attention: B. Derupt

J. King, 1532 PCCE  
G. Raymond, 1166 PCCE



# O'CONNOR ASSOCIATES ENVIRONMENTAL INC.

201, 1144 - 29 AVENUE N.E., CALGARY, ALBERTA T2E 7P1 TELEPHONE: (403) 250-9790 FAX: (403) 291-5150 WATTS: (800) 661-8141

February 7, 1991


10-303.2

Petro-Canada Inc.  
111 - 5th Avenue S.W.  
Calgary, Alberta  
T2P 3E3

*function* Attention: Mr. J.P. King, P.Eng.

Dear Sir:

Re: Environmental Investigation  
Petro-Canada Service Station and  
Farm Service Centre  
18th Street and Richmond Avenue  
Brandon, Manitoba

*see over  
get this*  Under the authorization of Petro-Canada Inc., a subsurface environmental investigation was carried out at the Petro-Canada Service Station and Farm Service Centre in Brandon, Manitoba. The primary objective of the investigation was to determine the nature and extent of any petroleum contamination which may exist in the subgrade soils and groundwater as a result of former refinery operations prior to 1969 and the more recent service station and bulk plant petroleum marketing operations. The initial investigation findings were presented in our preliminary report dated 90/12/12. The following report describes the site features, outlines the investigation procedures and summarizes the study results along with pertinent conclusions.

## SITE FEATURES

The Petro-Canada Service Station and Farm Service Centre are located near the southern city limits and on the east side of Highway No. 10. The site location and regional topographic features are indicated on Drawing No. 1.1. The ground surface in this area slopes toward the southeast. Local surface drainage appears to flow toward the Little Souris River which is located approximately 14 km to the southeast. The Assiniboine River which flows through Brandon (from west to east) is located approximately 3.5 km north of the Petro-Canada site.

.../2

The current land uses in the vicinity of the site are shown on Drawing No. 1.2. The surrounding properties are occupied primarily by light industrial and commercial developments. The Petro-Canada Service Station and Farm Service Centre as well as the Murray Chevrolet Car Dealership, the Burger King food outlet and the Canadian Tire Store are located on the hydrocarbon storage and processing areas of the former refinery. The eastern portion of the City of Brandon Cemetery is situated on a parcel of the former refinery property which apparently was not developed.

A site plan showing the existing petroleum storage and dispensing facilities at the service station and farm service centre is presented on Drawing No. 1.3.

According to regional geologic information for the Brandon area, the subgrade soils consist of glaciolacustrine silts and sands overlying a glacial till derived primarily from Paleozoic carbonate rocks.

The primary source of potable water in the City of Brandon is treated water obtained from the Assiniboine River. Although there are water wells adjacent to the site as indicated in our report dated November 1985, none of the wells within a 1 km radius of the former refinery are, to our knowledge, currently being used as a source of drinking water.

#### SITE INVESTIGATION

On 90/11/29 all underground utilities at the service station and bulk plant were located in preparation for a shallow vapour survey and subsurface drilling program. A metal detector survey and a shallow vapour survey were carried out on 90/11/29 and 90/11/30. Shallow probe holes, each 0.6 m deep, were drilled at 51 locations on the service station site and at 42 locations on the bulk plant site. Subsurface vapour concentrations were measured in the probe holes to assist in determining the extent of any subsurface hydrocarbons.

On 90/11/30 and 90/12/01 boreholes were drilled at 9 locations on the bulk plant site and 4 locations on the service station site as indicated on Drawing No. 1.3. Stratigraphic information and soil vapour concentrations were recorded in the field and are presented on the borehole logs in Appendix A. Soil samples from BH2, BH4, BH9 and BH12 were retained for laboratory chemical analyses. A monitoring piezometer was installed in each of the boreholes to facilitate future measurements of subsurface liquid levels and vapour concentrations. The borehole locations and reference elevations were surveyed on 90/12/02.

.../3



Subsurface conditions were monitored in the boreholes immediately following drilling on 90/12/02 and subsequently on 91/01/14. Representative groundwater samples were obtained from 4 of the boreholes on 90/12/02 and retained for laboratory analyses.

#### SUBSURFACE CONDITIONS

##### Stratigraphy

The stratigraphy at the site is illustrated on the cross-section presented on Drawing No. 1.4. Detailed stratigraphic information is presented on the logs in Appendix A. The natural soil profile consisted of clay and sand overlying silty clay till. Approximately 1 m of organic clay was encountered in BH3; all other boreholes on the bulk plant and service station properties encountered gravel fill at the surface. The surface of the service station property was paved with asphaltic concrete.

Fill materials (gravel and clay with wood and concrete fragments) were encountered in the boreholes located in the area of the present aboveground tanks and pump islands on the bulk plant site (BH4, BH7 and BH8). Fill materials apparently were also intersected in the boreholes advanced on the service station site. These fill materials which may extend to depths of 3 m to 4 m at some locations are believed to have been placed during construction and/or demolition activities at the former refinery. Due to the variability in soil types in the upper 3 m to 4 m, it is difficult to differentiate between the glaciolacustrine sands, silts and clays and the fill materials. Black petroleum staining was observed in BH1, BH4, BH7 and BH8 and petroleum odours were noted in all of the boreholes except BH11 and BH12.

##### Groundwater Conditions

10/13  
Groundwater levels in the boreholes on 91/01/14 ranged from 1.99 m (BH6) to 3.02 m (BH8) below grade. Based on this set of monitoring data, the principal direction of groundwater flow across the service station and western portion of the bulk plant site appeared to be north to northeast at an average gradient of 0.01 as indicated on Drawing No. 1.5. The direction of groundwater flow over the eastern portion of the bulk plant site appeared, however, to be east.


.../4



### Subsurface Vapour Concentrations

Vapour concentrations measured in the shallow probe holes on 90/11/29 and 90/11/30 at the service station and bulk plant sites are presented on Drawing No. 1.6. Subsurface vapour concentrations exceeding 100% LEL were detected in the area west of the aboveground tank compound and south of the propane tank. Elevated vapour concentrations exceeding 10% LEL were detected over a large portion of both sites. Supplementary field testing indicated that the vapours were composed of both low molecular weight hydrocarbons (such as methane) and petroleum constituents.

Vapour concentrations measured in the soil samples obtained during drilling are plotted on the borehole logs in Appendix A. Vapour concentrations exceeding 10% LEL were detected in the soil samples from all 9 boreholes located on the bulk plant site (BH1 to BH9) and in 1 borehole on the service station property (BH10). The maximum soil vapour concentration recorded was 80% LEL in a soil sample from BH4 at 2.4 m below grade. Soil vapour concentrations in BH11, BH12 and BH13 did not exceed 200 ppm. The soil vapour concentrations did not exceed 200 ppm below a depth of 4.2 m in any of the boreholes suggesting that the petroleum contamination has not penetrated extensively into the clay till unit.

*old product*  Subsurface vapour concentrations measured in the boreholes on 90/12/02 and 91/01/14 are summarized in Table 1.1 and are presented on Drawings No. 1.7 and 1.8, respectively. Vapour concentrations exceeding 100% LEL were detected in BH4, BH5 and BH7 on both monitoring dates and in BH9 on 90/12/02. Vapour concentrations exceeding 100% LEL were not detected on the service station site. Elevated vapour concentrations exceeding 20% LEL but less than 100% LEL were detected in BH1, BH2, BH6, BH8 and BH12 on 90/12/02; the vapour concentrations in BH6 and BH12 decreased to less than 20% LEL on 91/01/12. Supplementary monitoring indicated that a portion of the vapours in the boreholes were composed of low molecular weight hydrocarbons such as methane.

Petroleum vapours were not detected (<5 ppm) in the sanitary sewer manholes and storm sewer catch basins on and adjacent to the Petro-Canada service station and bulk plant sites on 90/12/02. On 91/01/14 the vapour concentrations measured in the same manholes and catch basins (immediately after they were cleared of snow and ice) did not exceed 60 ppm.

### Liquid Hydrocarbons at the Water Table

Liquid petroleum product was not detected at the water table in any of the boreholes on 90/12/02 or 91/01/14. BH1 had been destroyed during recent site grading and could not be accessed on 91/01/14. It should be noted, however, that liquid product could accumulate in some of the boreholes under different groundwater conditions.

.../5



## RESULTS OF LABORATORY ANALYSES

Soil and water samples were selected from 4 boreholes for confirmatory chemical analyses. The soil samples were obtained from BH2 (1.5 m to 2.0 m), BH4 (2.4 m), BH9 (1.5 m to 2.0 m) and BH10 (3.0 m); the groundwater samples were recovered from the same 4 boreholes.

The results of the soil chemical analyses are summarized in Table 1.2.

The hydrochemical test results on the groundwater samples are summarized in Table 1.3.

*Sub* Gas chromatography analyses of the extractable hydrocarbons in the water and soil samples identified petroleum hydrocarbon constituents with patterns resembling weathered gasoline in BH2 and BH9 and a gasoline/diesel mixture in BH4. Extractable hydrocarbons in the samples from BH12 did not have a readily discernible pattern.

## CONCLUSIONS

1. Petroleum hydrocarbon contamination was identified in the subgrade soils and shallow groundwater over a substantial portion of the Petro-Canada service station and bulk plant sites. The contamination was characterized by elevated vapour concentrations, petroleum odours, staining and elevated concentrations of residual petroleum hydrocarbon constituents in the subgrade soils as well as dissolved hydrocarbons in the groundwater.
2. The present data suggest that large releases of petroleum products have not occurred recently at the site since no liquid petroleum hydrocarbons accumulated at the water table within the initial 45 days after drilling the boreholes. There is presently no evidence to suggest that the liquid hydrocarbons at the water table beneath the adjacent properties originated from the Petro-Canada site.
3. The results of laboratory chemical analyses of hydrocarbons in the soil and groundwater samples suggest that some weathering of the low molecular weight hydrocarbon constituents has occurred.

.../6



4. The occurrence of methane in the subsurface may be due to anaerobic biodegradation of residual petroleum hydrocarbons and/or the decay of natural organics in the fill materials at the site. Anaerobic biodegradation of petroleum hydrocarbons is a relatively slow natural process which is a further indication that the subsurface hydrocarbon contamination may have been present at this site for a considerable time period.
5. The pattern of groundwater flow observed at the site on 91/01/14 indicated that liquid phase contaminants were migrating toward the north-northeast over the western portion of the Petro-Canada site and toward the east over the eastern part of the site.

#### CLOSURE

This report has been prepared in accordance with generally accepted hydrogeological and environmental engineering practices for the exclusive use of Petro-Canada Inc. Information presented herein was obtained while conducting authorized investigations at the Petro-Canada Service Station and Farm Service Centre in Brandon, Manitoba. Although the data were collected only at site-specific locations, the reported information is believed to provide a reasonable representation of general environmental conditions at the site. Should any questions arise regarding the information presented herein, please contact the undersigned.

Respectfully submitted,

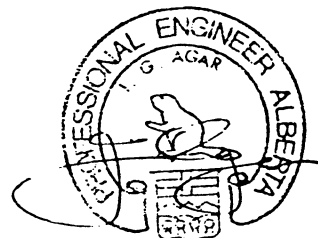
O'CONNOR ASSOCIATES ENVIRONMENTAL INC.



E.M. Goldie, P.Geol.

EMG/jg

cc: Ms. M. Bell, Petro-Canada, Calgary



J.G. Agar, P.Eng.

Manitoba Temporary  
Licence No: 98-90  
Licence Expires: 91/07/09





**TABLE 1.1**  
**BOREHOLE VAPOUR CONCENTRATIONS**  
**(% LEL)**

<u>DATE</u>	<u>BH1</u>	<u>BH2</u>	<u>BH3</u>	<u>BH4</u>	<u>BH5</u>	<u>BH6</u>	<u>BH7</u>	<u>BH8</u>	<u>BH9</u>	<u>BH10</u>	<u>BH11</u>	<u>BH12</u>	<u>BH13</u>
90/12/02	22	30	<1	>100	>100	38	>100	42	>100	6	<1	1	38
91/01/14	a	41	<1	>100	>100	11	>100	32	96	2	2	18	2

a - borehole destroyed by grader



TABLE 1.2  
RESULTS OF SOIL ANALYSES  
(ug/g unless otherwise noted)

CONSTITUENT	BH2 (1.5 m - 2.0 m)	BH4 (2.4 m)	BH9 (1.5 m - 2.0 m)	BH10 (3.0 m)	DETECTION LIMIT
Benzene	0.50	3.16	0.10	0.82	0.005
Toluene	3.1	1.3	0.25	0.85	0.005
Ethyl Benzene	2.2	0.41	0.045	0.45	0.005
Xylenes	2.3	0.99	0.41	0.28	0.005
Total Hydrocarbons <sup>a</sup>	4523	15259	222	318	5
Lead	6	<5	<5	<5	2

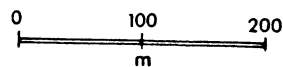
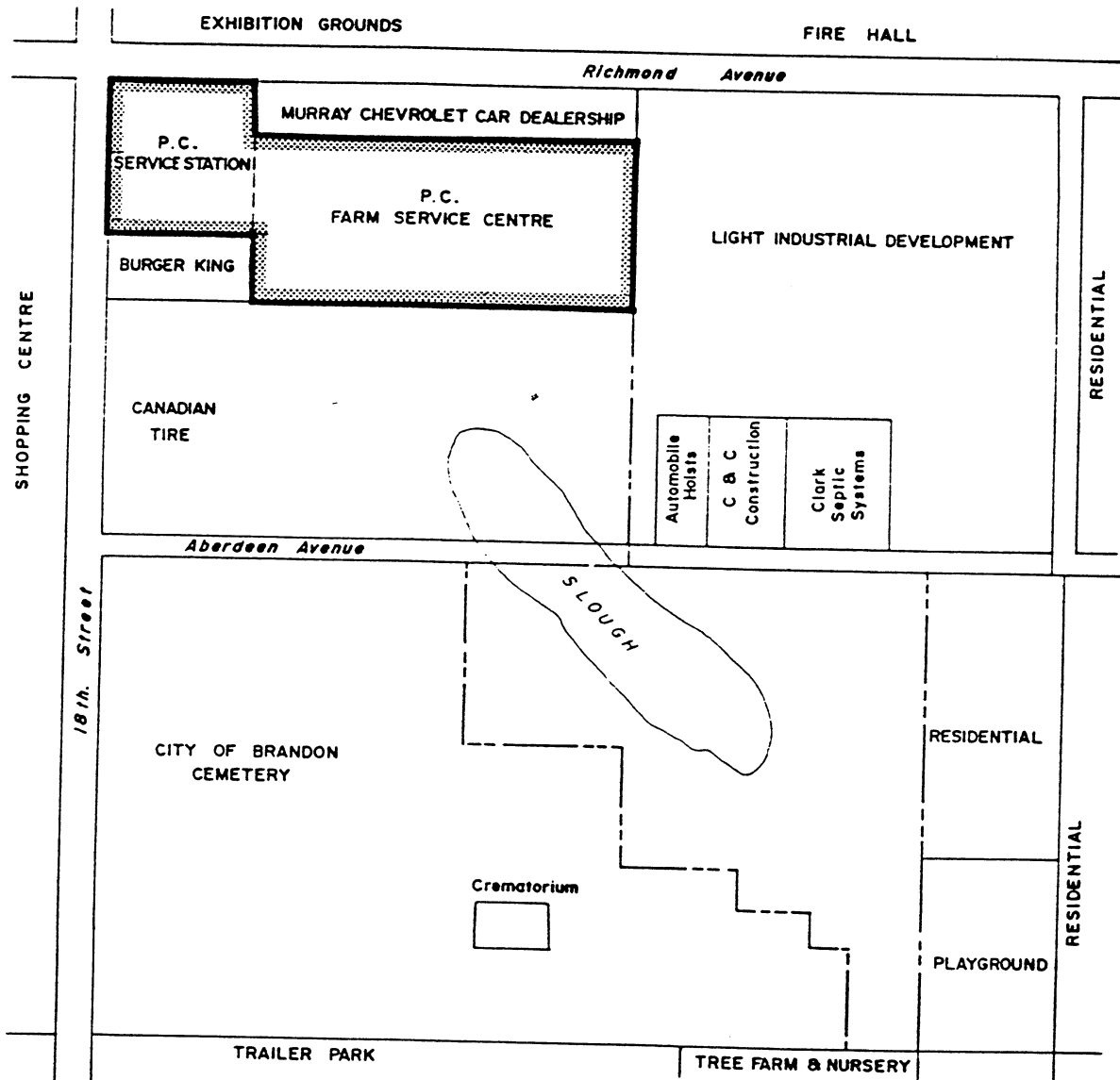
a - Total purgeable plus total extractable hydrocarbons

TABLE 1.3  
HYDROCHEMICAL RESULTS  
(mg/L)

<u>CONSTITUENT</u>	<u>BH2</u>	<u>BH4</u>	<u>BH9</u>	<u>BH12</u>	<u>DETECTION LIMIT</u>
Benzene	0.12	2.9	2.4	0.007	0.001
Toluene	ND	0.071	0.087	0.0091	0.001
Ethyl Benzene	0.036	0.980	0.340	0.0028	0.001
Xylenes	0.48	4.2	1.6	0.0084	0.001
Total Hydrocarbons <sup>a</sup>	8.440	60.2	19.5	0.002	0.1
Phenols	<0.002	0.060	<0.002	<0.002	0.001

a - Total purgeable plus total extractable hydrocarbons





Site Location and Surrounding Land Use

**O'CONNOR ASSOCIATES**

JOB NO.: 10-303.2

DATE: 91/01/21

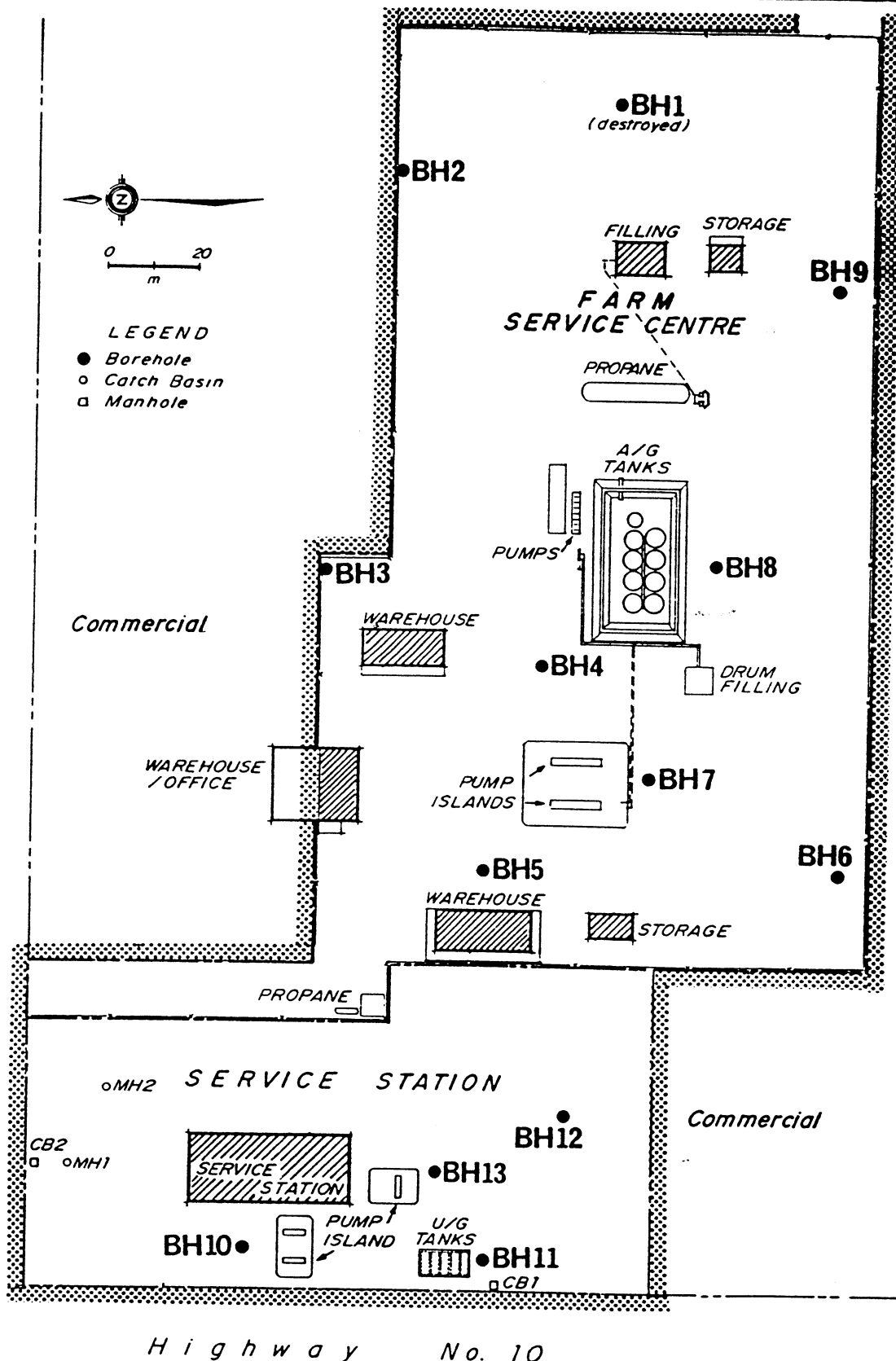
DRAWN BY: MG

DWG. NO.: 1.2

Commercial Avenue

Richmond Avenue

Commercial



Highway No. 10

Commercial

Site Plan

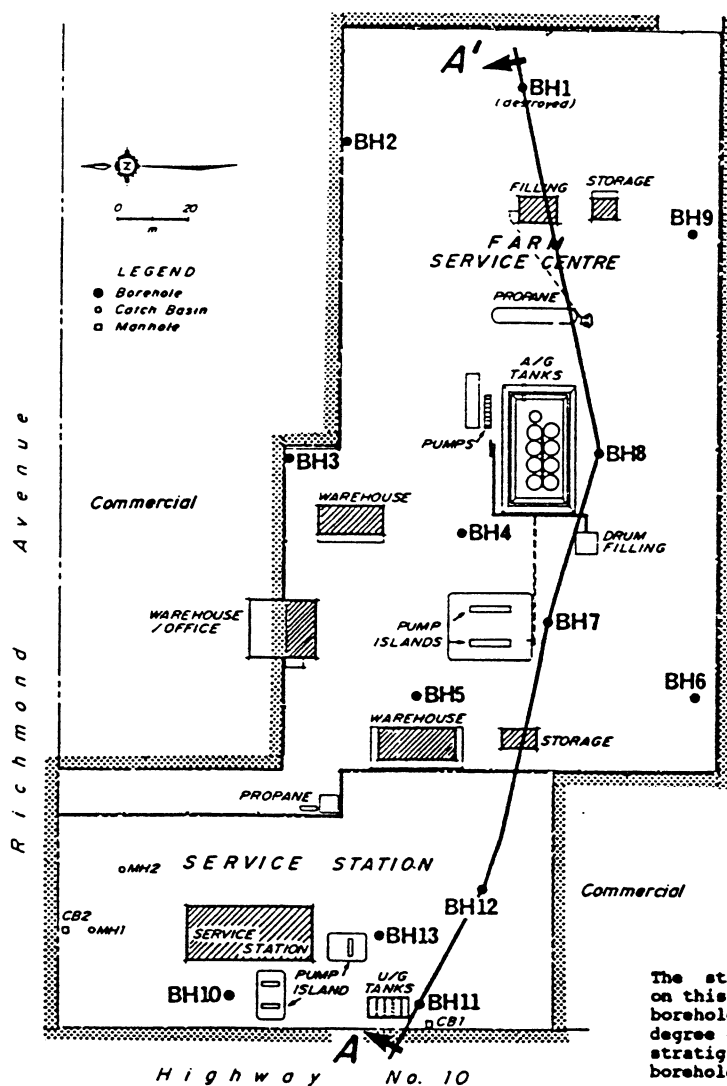
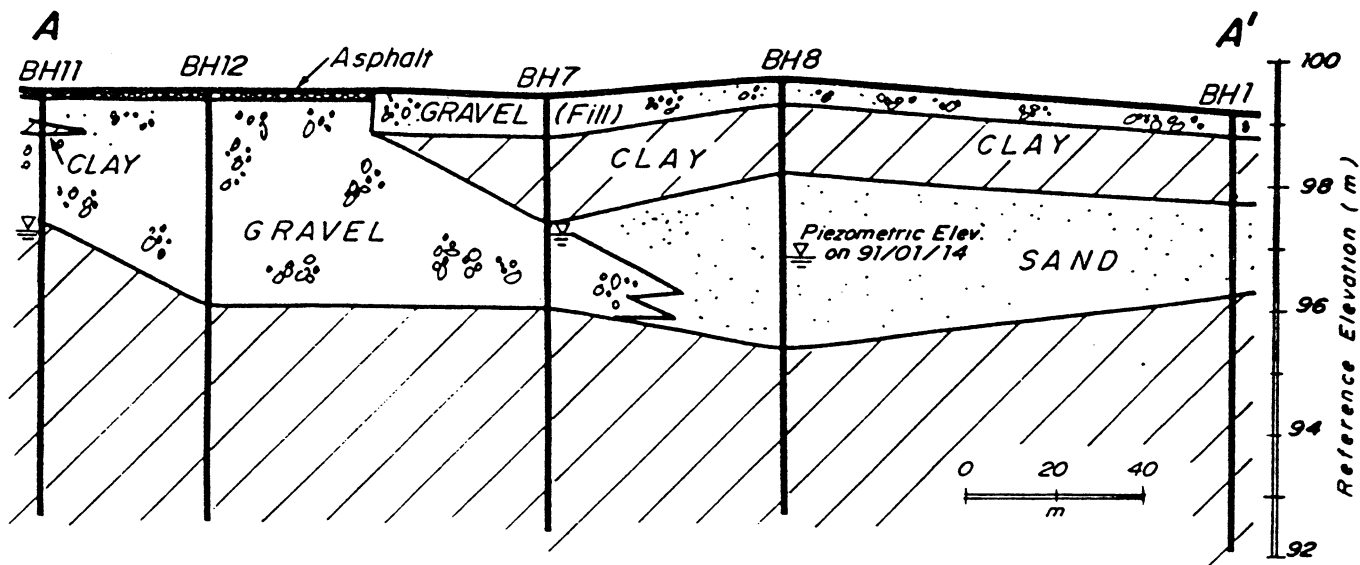
**O'CONNOR ASSOCIATES**

JOB NO.: 10-303.2

DATE: 90/12/07

DRAWN BY: MG

DWG. NO.: 1.3



The stratigraphic and hydrogeological information shown on this drawing has been interpreted from site specific borehole data. Subsurface conditions are known with some degree of accuracy only at the borehole locations. Actual stratigraphic and hydrogeological conditions between boreholes may vary from those indicated on this drawing.

Stratigraphic Cross Section

**O'CONNOR ASSOCIATES**

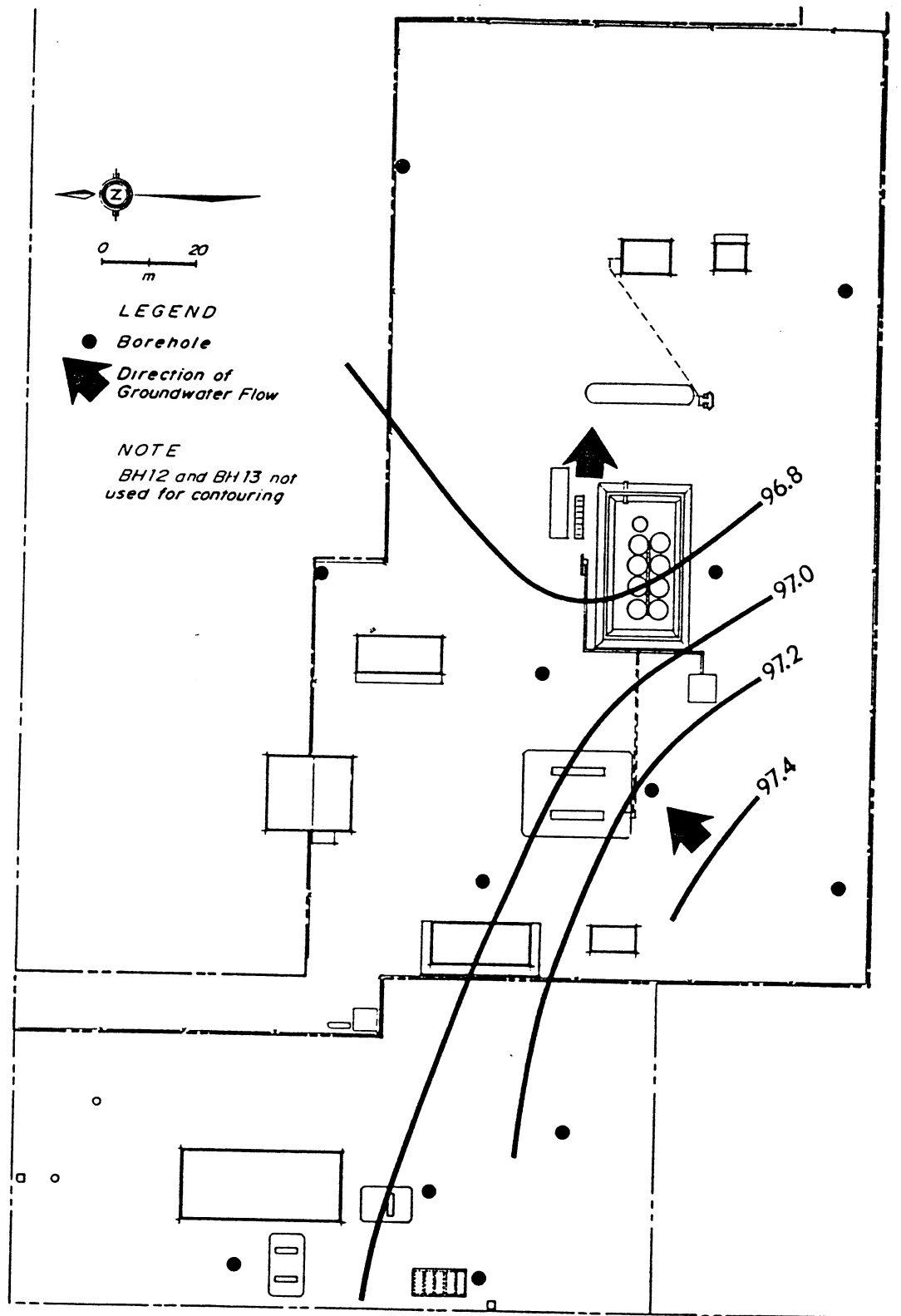
JOB NO.: 10-303.2

DATE: 91/01/21

DRAWN BY: MG

DWG. NO.: 1.4

Richmond Avenue



Highway No. 10

Elevation of the Piezometric Surface  
(m)

91/01/14

**O'CONNOR ASSOCIATES**

JOB NO.: 10-303.2

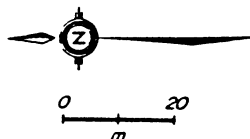
DATE : 91/01/21

DRAWN BY: MG

DWG. NO.: 1.5



Richmond Avenue

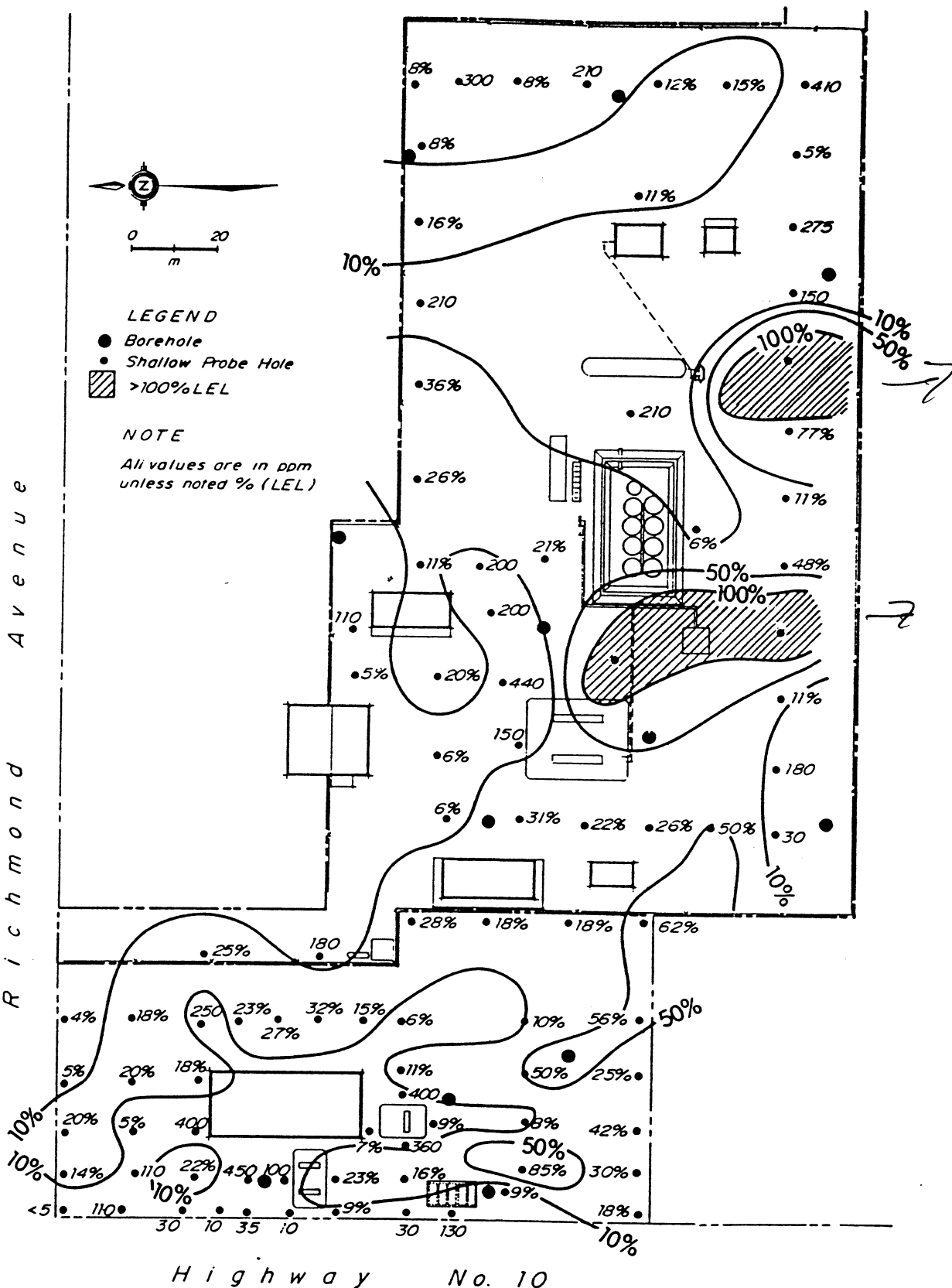


LEGEND

- Borehole
- Shallow Probe Hole
- ▨ >100% LEL

NOTE

All values are in ppm unless noted % (LEL)



Correlate  
to C.E.

Highway No. 10

Vapour Concentrations in Shallow Probe Holes

90/11/29 and 90/11/30

**O'CONNOR ASSOCIATES**

JOB NO.: 10-303.2

DATE: 91/01/21

DRAWN BY: MG

DWG. NO.: 1.6

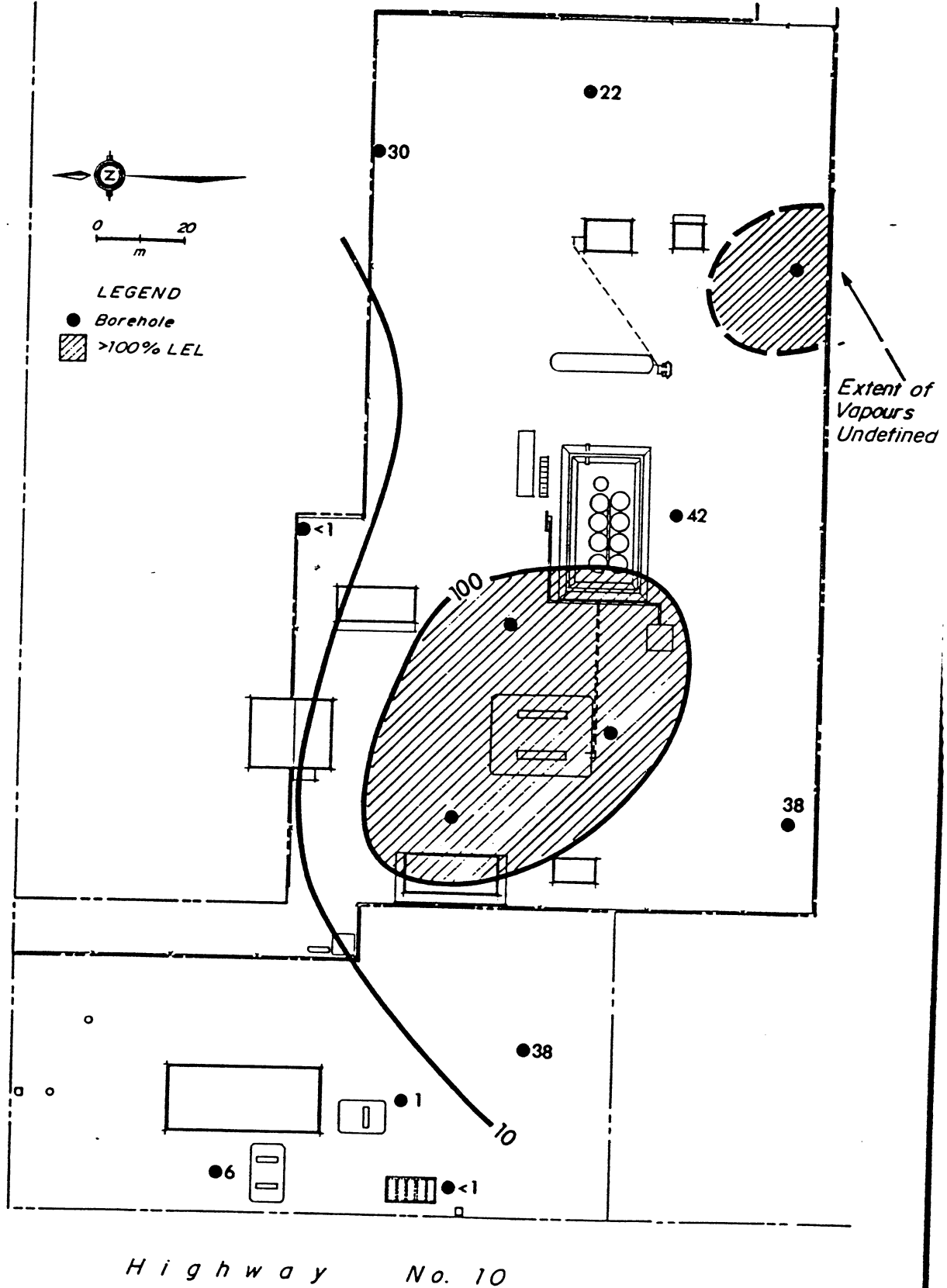
Richmond Avenue



0 20  
m

LEGEND

- Borehole
- ▨ >100% LEL



Subsurface Vapour Concentrations  
(% LEL)  
90/12/02

**O'CONNOR ASSOCIATES**

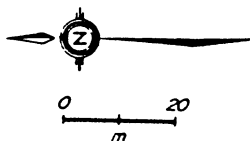
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DATE: 90/12/07

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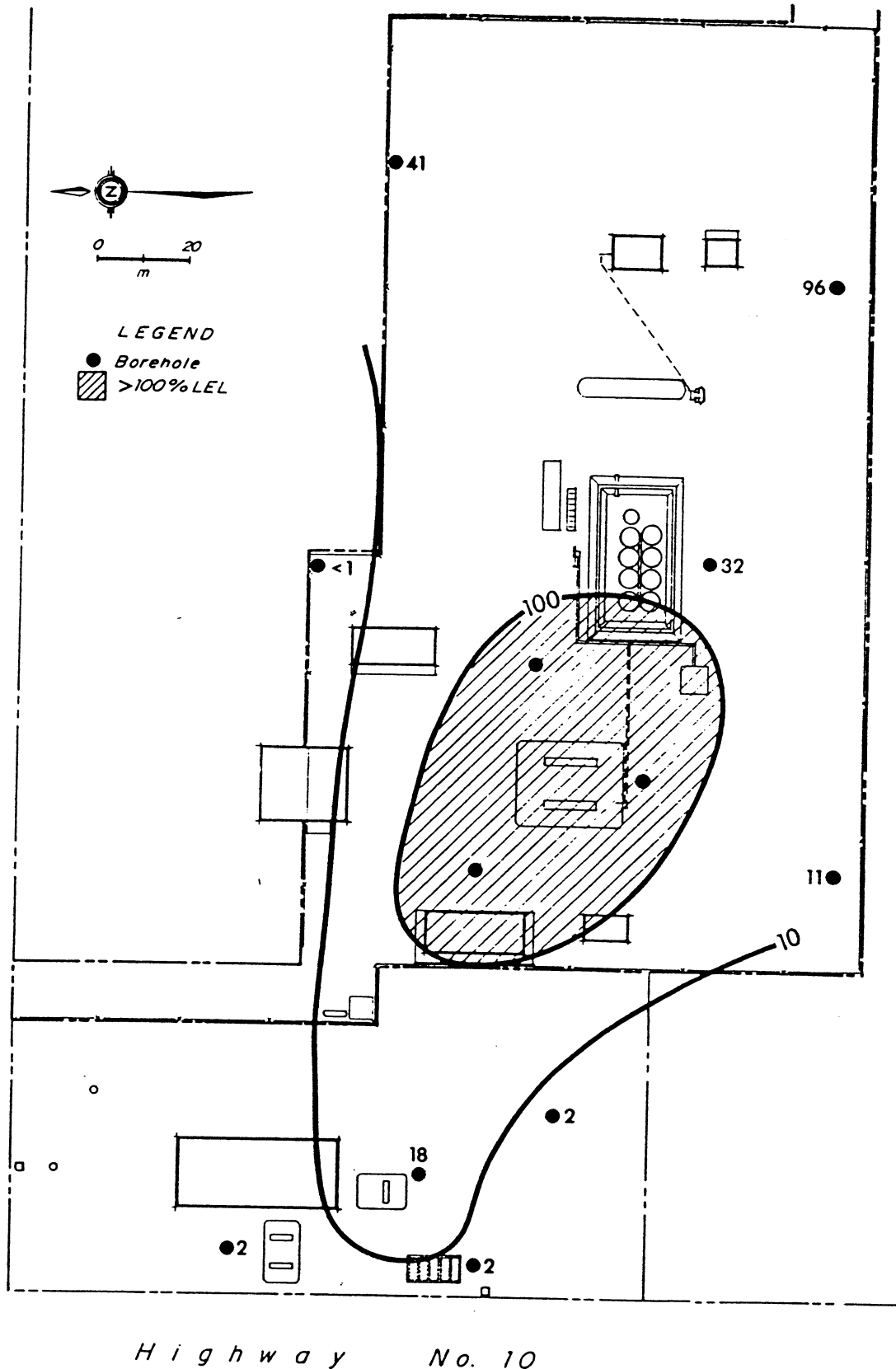
DWG. NO.: 1.7

Richmond Avenue



LEGEND

- Borehole
- ▨ >100% LEL



Subsurface Vapour Concentrations  
(% LEL)  
91/01/14.

**O'CONNOR ASSOCIATES**

JOB NO.: 10-303.2

DATE : 91/01/21

DRAWN BY: MG

DWG. NO.: 1.8

**APPENDIX A**  
**BOREHOLE LOGS**



<b>PROJECT:</b> Petro-Canada Farm Centre		<b>GD ELEV.:</b> 99.163 m		<b>HOLE No.:</b> BH1	
<b>LOCATION:</b> Brandon, MB		<b>TPC ELEV.:</b> 99.289 m		<b>DRILL:</b> Auger	
<b>SAMPLE TYPE:</b> <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	GRAVEL - dark brown, sandy, dry, compact								
-2	CLAY - black, some gravel, some sand, damp, compact, noticeable petroleum odour	X	5						
-3	SAND - gray, some gravel, moist, compact, noticeable petroleum odour	X	10						
-4	- trace gravel, wet, black product staining at 2.6 m	X	15						
-5	CLAY - gray, silty, trace gravel, moist, stiff, noticeable petroleum odour								
-6	- sand lens, noticeable petroleum odour at 4.1 m								
-7	- increasing gravel with depth								
-8	END OF HOLE AT 7.0 m.								
-9	Monitoring piezometer installed to 4.9 m.								

<b>O'CONNOR ASSOCIATES</b>	<b>DATE:</b> 90/11/30	<b>JOB No.:</b> 10-303.2
	<b>LOGGED BY:</b> JNM	<b>DWG.No.:</b> A-1

<b>PROJECT:</b> Petro-Canada Farm Centre		<b>GD ELEV.:</b> 99.831 m		<b>HOLE No.:</b> BH2	
<b>LOCATION:</b> Brandon, MB		<b>TPC ELEV.:</b> 99.449 m		<b>DRILL:</b> Auger	
<b>SAMPLE TYPE:</b> <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				
	GRAVEL - dark brown, sandy, damp, compact, frozen								
1	CLAY - black, some gravel, trace sand, moist, stiff, noticeable petroleum odour								
2		X	5						
3	- light brown, silty, some gravel, moist, stiff, some fine grained sand lenses								
4		X	10						
5	- moisture content increasing below 4.9 m								
6		X	15						
7	END OF HOLE AT 6.1 m.  Monitoring piezometer installed to 6.1 m.								
8			20						
9			25						
			30						

<b>O'CONNOR ASSOCIATES</b>	<b>DATE:</b> 90/11/30	<b>JOB No.:</b> 10-303.2
	<b>LOGGED BY:</b> JNM	<b>DWG.No.:</b> A-2

<b>PROJECT:</b> Petro-Canada Farm Centre		<b>GD ELEV.:</b> 100.043 m		<b>HOLE No.:</b> BH3	
<b>LOCATION:</b> Brandon, MB		<b>TPC ELEV.:</b> 99.595 m		<b>DRILL:</b> Auger	
<b>SAMPLE TYPE:</b> <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
				▲ 100   200   300   400 ● 20   40   60   80		
-1	CLAY - black, gravelly some sand, moist, compact, trace organics, noticeable petroleum odour			▲		∇ 91/01/14
	SAND - brown, damp, compact		5	▲		
-2	- gray, some gravel below 1.7 m					
	CLAY - olive brown, some gravel, moist, stiff, noticeable petroleum odour			●		
-3			10	▲		
-4	- olive gray, silty, some gravel, moist to wet, soft			▲		
			15	▲		
-5				▲		
-6			20	▲		
-7	END OF HOLE AT 6.1 m.  Monitoring piezometer installed to 6.1 m.					
-8			25			
-9			30			

<b>O'CONNOR ASSOCIATES</b>	<b>DATE:</b> 90/11/30	<b>JOB No.:</b> 10-303.2
	<b>LOGGED BY:</b> JNM	<b>DWG.No.:</b> A-3

<b>PROJECT:</b> Petro-Canada Farm Centre		<b>GD ELEV.:</b> 99.402 m		<b>HOLE No.:</b> BH4	
<b>LOCATION:</b> Brandon, MB		<b>TPC ELEV.:</b> 99.504 m		<b>DRILL:</b> Auger	
<b>SAMPLE TYPE:</b> <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	200		
	GRAVEL (FILL) - dark brown, sandy, dry, compact								
-1	CLAY (FILL) - black, some gravel, some sand, damp, compact, some organics, noticeable petroleum odour								
-2	SAND (FILL) - gray, trace gravel, moist, compact, noticeable petroleum odour	X	5						
	- coarse grained below 2.0 m								
-3	CLAY (FILL) - black, some gravel, some sand, moist, compact	X	10						
-4	GRAVEL (FILL) - some clay, wet, black product staining at 2.7 m								
-5	SAND - black, some silt, trace gravel, wet, compact, noticeable petroleum odour	X	15						
-6	CLAY - olive gray, silty, some gravel, moist, stiff								
-7									
-8	END OF HOLE AT 7.0 m.								
	Monitoring piezometer installed to 6.4 m.								
-9									

<b>O'CONNOR ASSOCIATES</b>	<b>DATE:</b> 90/12/01	<b>JOB No.:</b> 10-303.2
	<b>LOGGED BY:</b> JNM	<b>DWG.No.:</b> A-4



<b>PROJECT:</b> Petro-Canada Farm Centre		<b>GD ELEV.:</b> 99,404 m		<b>HOLE No.:</b> BH5	
<b>LOCATION:</b> Brandon, MB		<b>TPC ELEV.:</b> 99,518 m		<b>DRILL:</b> Auger	
<b>SAMPLE TYPE:</b> <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
				▲ 100 200 300 400 ● 20 40 60 80		
	GRAVEL - brown, some sand, dry, compact, frozen					
-1	SAND - black, some gravel, some clay, dry, compact, trace organics, noticeable petroleum odour					
-2	- gray, damp, noticeable petroleum odour at 1.1 m	X	5			
	- trace gravel, coarse grained, moist, sand lens from 2.0 m to 2.4 m					
-3	- black, some gravel, wet, noticeable petroleum odour at 2.4 m	X	10			
	- gray, trace shale, sand bed at 3.2 m					
-4	CLAY - gray, silty, some gravel, moist, stiff, noticeable petroleum odour					
-5			15			
-6	- sandy below 5.7 m					
			20			
-7	END OF HOLE AT 6.2 m.					
	Monitoring piezometer installed to 5.9 m.					
-8			25			
-9			30			

<b>O'CONNOR ASSOCIATES</b>	<b>DATE:</b> 90/12/01	<b>JOB No.:</b> 10-303.2
	<b>LOGGED BY:</b> JNM	<b>DWG. No.:</b> A-5

PROJECT: Petro-Canada Farm Centre

GD ELEV.: 100.166 m

HOLE No.: BH6

LOCATION: Brandon, MB

TPC ELEV.: 99.587 m

DRILL: Auger

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ☐ CORE ☐ DISTURBED ☐ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations				N	OTHER TESTS	
				%LEL		ppm				
				▲ 100	● 20	200	40			300
	GRAVEL - brown, sandy, dry, compact									
1	CLAY - black, trace gravel, trace sand, moist, stiff, frozen, noticeable petroleum odour									
2	SAND - gray to black, some gravel, moist, compact, noticeable petroleum odour	X	5							
	- wet at 1.4 m									
3	CLAY - olive gray, silty, moist, stiff, noticeable petroleum odour	X	10							
4	- olive brown, silty, moist, soft, some oxidation, sand lenses, noticeable petroleum odour at 2.3 m	X	15							
5	- gray, silty, some gravel, trace sand, moist, stiff	X	20							
6	- wet below 4.6 m									
	- sandy, trace gravel below 5.8 m									
7	END OF HOLE AT 6.4 m.									
	Monitoring piezometer installed to 6.1 m.									
8										
9										
O'CONNOR ASSOCIATES				DATE: 90/12/01				JOB No.: 10-303.2		
				LOGGED BY: JNM				DWG.No.: A-6		

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O'CONNOR ASSOCIATES



DATE: 90/12/01

JOB No.: 10-303.2

LOGGED BY: JNM

DWG. No.: A-6

<b>PROJECT:</b> Petro-Canada Farm Centre	<b>GD ELEV.:</b> 99.411 m	<b>HOLE No.:</b> BH7
<b>LOCATION:</b> Brandon, MB	<b>TPC ELEV.:</b> 99.508 m	<b>DRILL:</b> Auger
<b>SAMPLE TYPE:</b> <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		
	GRAVEL (FILL) - dark brown, sandy, dry, compact, noticeable petroleum odour								
-1	CLAY (FILL) - black, some gravel, some sand, moist, stiff, noticeable petroleum odour								
	- wood fragments at 1.5 m	X	5						
-2	GRAVEL (FILL) - black, some sand, some clay, wet, hydrocarbon staining, compact, wood fragments, noticeable petroleum odour								
-3		X	10						
-4	CLAY - gray, silty, some gravel, moist, stiff, noticeable petroleum odour								
		X	15						
-5									
-6									
-7									
-8	END OF HOLE AT 7.0 m.								
	Monitoring piezometer installed to 6.7 m.								
-9									

O'CONNOR ASSOCIATES



DATE: 90/12/01

JOB No.: 10-303.2

LOGGED BY: JNM

DWG.No.: A-7

**PROJECT:** Petro-Canada Farm Centre

**GD ELEV.:** 99.742 m

**HOLE No.:** BH8

**LOCATION:** Brandon, MB

**TPC ELEV.:** 99.850 m

**DRILL:** Auger

**SAMPLE TYPE:** ☒ SHELBY ☒ SPLIT SPOON ☐ CORE ☐ DISTURBED ☐ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations				N	OTHER TESTS
				● %LEL	▲ ppm	100	200		
				20	40	60	80		
1	GRAVEL (FILL) - brown, sandy, dry, compact, frozen								
	CLAY (FILL) - black, some gravel, some sand, moist, compact, frozen, trace organics, noticeable petroleum odour			●					
2	SAND (FILL) - gray, trace gravel, moist, compact, noticeable petroleum odour	X	5	●					
								▲	
3	- dark brown, coarse grained, trace gravel, moist, compact, hydrocarbon staining at 2.9 m	X	10	●					
				●					
4									
5	CLAY - gray, silty, trace gravel, moist, stiff, firm	X	15	▲					
				▲					
6									
7									
8	END OF HOLE AT 7.0 m.								
	Monitoring piezometer installed to 6.7 m.								
9									

**O'CONNOR ASSOCIATES**



**DATE:** 90/12/01

**JOB No.:** 10-303.2

**LOGGED BY:** JNM

**DWG. No.:** A-8

**PROJECT:** Petro-Canada Farm Centre**GD ELEV.:** 99.758 m**HOLE No.:** BH9**LOCATION:** Brandon, MB**TPC ELEV.:** 99.307 m**DRILL:** Auger**SAMPLE TYPE:** ☐ SHELBY ☒ SPLIT SPOON ☐ CORE ☐ DISTURBED ☐ NO RECOVERY ☐ OTHER

METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations				N	OTHER TESTS
				● %LEL	▲ ppm	100	200		
				20	40	60	80		
-1	GRAVEL - dark brown, some sand, dry, compact								
	CLAY - black, some gravel, some sand, damp, compact, noticeable petroleum odour			●					
-2	SAND - gray, trace gravel, damp to moist, compact, noticeable petroleum odour - black, wet below 2.4 m	<input checked="" type="checkbox"/>	5			●			
						●			
-3	- gravel bed at 3.5 m - some silt below 3.7 m	<input checked="" type="checkbox"/>	10		▲				
						▲			
-4	CLAY - gray, silty, some gravel, moist, stiff, noticeable petroleum odour	<input checked="" type="checkbox"/>	15	▲					
				▲					
-5			20	▲					
-6									
-7									
-8	END OF HOLE AT 7.0 m. Monitoring piezometer installed to 6.1 m.		25						
-9			30						

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**O'CONNOR ASSOCIATES****DATE:** 90/12/01**JOB No.:** 10-303.2**LOGGED BY:** JNM**DWG.No.:** A-9

<b>PROJECT:</b> Petro-Canada Farm Centre		<b>GD ELEV.:</b> 99,752 m		<b>HOLE No.:</b> BH10	
<b>LOCATION:</b> Brandon, MB		<b>TPC ELEV.:</b> 99,839 m		<b>DRILL:</b> Auger	
<b>SAMPLE TYPE:</b> <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	
				▲ 100 200 300 400 ● 20 40 60 80			
	ASPHALT - black, frozen						
1	GRAVEL - brown, some sand, dry, compact, noticeable petroleum odour			▲			
2	CLAY - black, some gravel, some sand, moist						
3	- gray, noticeable petroleum odour at 1.1 m			●			
4	- wet, noticeable petroleum odour at 2.7 m			●			
5				●			
6							
7	CLAY - gray, silty, some gravel, moist, stiff, firm	X	15	▲			
8				▲			
9				▲			
END OF HOLE AT 7.0 m.							
Monitoring piezometer installed to 6.7 m.							

<b>O'CONNOR ASSOCIATES</b>	<b>DATE:</b> 90/12/01	<b>JOB No.:</b> 10-303.2
	<b>LOGGED BY:</b> JNM	<b>DWG.No.:</b> A-10

<b>PROJECT:</b> Petro-Canada Farm Centre	<b>GD ELEV.:</b> 99,538 m	<b>HOLE No.:</b> BH11
<b>LOCATION:</b> Brandon, MB	<b>TPC ELEV.:</b> 99,607 m	<b>DRILL:</b> Auger
<b>SAMPLE TYPE:</b> <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		
	ASPHALT - black								
1	GRAVEL - brown, some sand, dry, compact, noticeable petroleum odour			▲					
	CLAY - black, some gravel, some sand, moist, compact, trace organics		5	▲					
2	GRAVEL - brown, some sand, damp, compact, noticeable petroleum odour			▲					
	CLAY - olive brown, silty, moist, stiff			▲					
3			10	▲					
	- gray, silty, some gravel, moist, stiff, firm	X		▲					
4				▲					
			15	▲					
5		X		▲					
				▲					
6			20	▲					
	- wet, compact, sand bed at 6.6 m			▲					
7									
	END OF HOLE AT 7.0 m.		25						
8	Monitoring piezometer installed to 6.7 m.								
9			30						

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DATE: 90/12/01

JOB No.: 10-303.2

LOGGED BY: JNM

DWG.No.: A-11

PROJECT: Petro-Canada Farm Centre

LOCATION: Brandon, MB

GD ELEV.: 99.488 m

HOLE No.: BH12

SAMPLE TYPE: ☒ SHELBY ☒ SPLIT SPOON ☐ CORE ☐ DISTURBED ☐ NO RECOVERY ☐ OTHER

TPC ELEV.: 99.552 m

DRILL: Auger

METRES	SOIL DESCRIPTION	SAMPLE TYPE	FEET	Vapour Concentrations				N	OTHER TESTS
				● %LEL	▲ ppm	100	200		
	ASPHALT - black			20	40	60	80		
1	GRAVEL - brown, sandy, dry, compact								
	- black, some clay, noticeable petroleum odour at 0.6 m								
2			5						
	- brown, wet below 2.6 m								
3									
4	CLAY - gray, silty, some gravel, moist, stiff, trace oxidation								
5			15						
6									
7	END OF HOLE AT 7.0 m.		20						
8	Monitoring piezometer installed to 6.7 m.		25						
9			30						

O'CONNOR ASSOCIATES



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JOB No.: 10-303.2

LOGGED BY: JNM

DWG. No.: A-12



<b>PROJECT:</b> Petro-Canada Farm Centre		<b>GD ELEV.:</b> 99.820 m		<b>HOLE No.:</b> BH13	
<b>LOCATION:</b> Brandon, MB		<b>TPC ELEV.:</b> 99.911 m		<b>DRILL:</b> Auger	
<b>SAMPLE TYPE:</b> <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 - black								
1	GRAVEL - brown, sandy, dry, compact			▲					
	- some clay, damp below 1.2 m				▲				
2	SAND - gray, some gravel, dry, compact		5	▲					
					▲				
3	- black, wet, noticeable petroleum odour at 2.9 m		10	▲					
				▲					
4	CLAY - gray, silty, some gravel, moist, stiff		15	▲					
				▲					
5				▲					
				▲					
6			20	▲					
	END OF HOLE AT 6.1 m.								
7	Monitoring piezometer installed to 5.5 m.								
8			25						
9			30						

<b>O'CONNOR ASSOCIATES</b> 	<b>DATE:</b> 90/12/01	<b>JOB No.:</b> 10-303.2
	<b>LOGGED BY:</b> JNM	<b>DWG.No.:</b> A-13