CANADIAN TIRE CORPORATION, LIMITED

POST OFFICE BOX 770, STATION K, M4P 2V8 (416) 480-3000

FAX COVER PAGE

C0243

DATE: Nov 1, 1990

SENT ON BEHALF OF: Hugh Law - Real Estate Manager (416) 480-3188

DIRECT THE FOLLOWING TO: MANITOBA ENVIRONMENTAL DEPARTMENT

ATTN BRIAN DURUPT

FAX NUMBER: 204-945-5229

NUMBER OF PAGES: 34 - 20 + 14 TOTAL - this time - pages 19 - 32 incl. (INCLUSIVE OF COVER PAGE)

Re [illegible]

COMMENTS: [illegible] a copy of the 1985 [illegible] report done [illegible]. The report was [illegible] with the consent of Petrocan.

Hugh Law

ORIGINAL TO FOLLOW: YES ___ NO X

VIA MAIL ______ VIA COURIER ______

Linda Elford
TELEPHONE (416) 480-3094
FAX NO. (416) 480-3990

CANADIAN TIRE CORPORATION LIMITED
POST OFFICE BOX 770, STATION K, M4P 2V8 (416) 480-3000

November 1. 1990

Manitoba Environmental Department

Attn Brian Dirupt

It was a pleasure to have a short conversation with you re our Brandon property the problem of hydrocarbon vapours and the proposed remediation of same

I am advised that Walter Kroon will be supplying you today with a full copy of the report which he prepared for us dated June 18th 1980

It would be helpful to us in the remediation planning if you could provide us with copies of all reported spills on the Petrocan Lands - dates, location quantities and product type.

We will be in contact further with our proposed remediation plan incorporating in one ~~preliminary~~ proposed steps 1 & 2.

Thank you
[signature]

1.0 INTRODUCTION

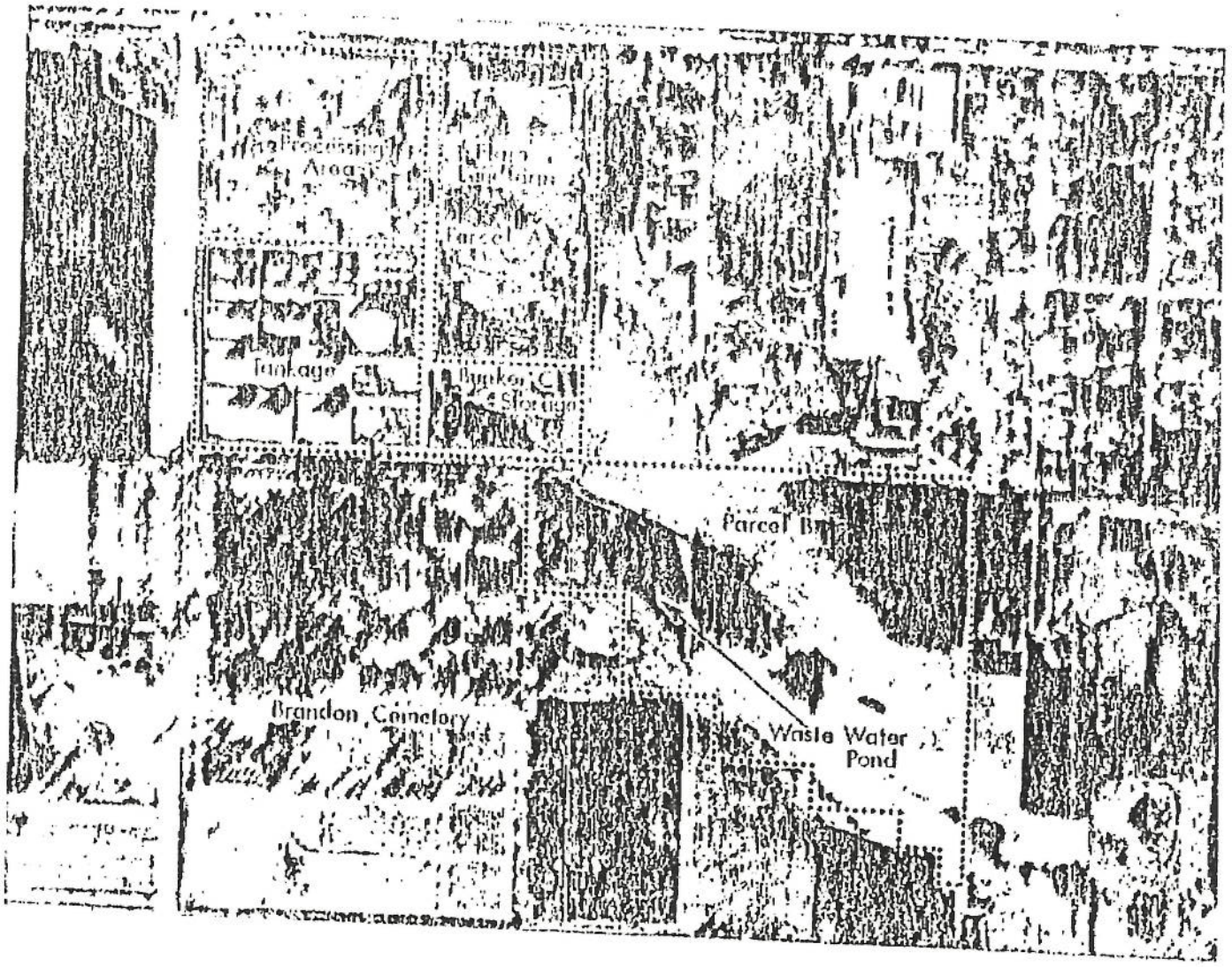
1.1 Authorization

At the request of Dr. S.K. Ray, P.Eng. of Petro-Canada Products Inc., M.J. O'Connor & Associates Ltd. were authorized to investigate soil and groundwater conditions at the site of the former Gulf Canada refinery in Brandon Manitoba. The purpose of the study was to investigate the nature and distribution of possible soil and groundwater contamination under certain areas of the former refinery site.

1.2 Background

A refinery was initially constructed at the Brandon site in 1937-38 to process crude oil from southern Manitoba and Saskatchewan. The refinery, which was designed to process up to 1500 barrels of petroleum per day, was relatively small by present day standards. Refining operations were discontinued in 1969. Tankage and other plant facilities were dismantled and removed during 1969 and 1970.

Drawing No. 1.1 is a 1958 aerial photograph of the refinery site. The area labelled Parcel A on Drawing No. 1.1 was developed for commercial purposes following the shut-down of the refinery. Parcel B, the 9.6 hectare (24 acre) area of land located southeast of the former plant site was retained by Gulf Canada and has not been developed to date. The present environmental study was initiated in order to identify any environmental concerns which might affect the future land use.



1950 Aerial Photograph
of the
Brandon Refinery

M.J. O'CONNOR & ASSOCIATES LTD.

JOB No.:	10-103	DATE:	85/11
DRAWN BY:	HG	DWG. No.:	1.1

1.3 Scope

The study was designed to investigate subsurface soil and groundwater conditions at the site. The principal objectives of the study were:

1. Investigate whether the soil and groundwater under the site had been affected by previous plant operations.

2. Determine the nature and distribution of any contaminants and the significance of the measured concentrations.

3. Evaluate the potential for offsite contaminant migration.

4. Identify the potential environmental impact of the present conditions and any constraints on future land-use.

1.4 Methodology

The site investigation included a study of historical aerial photographs, a review of regional geological information, a site reconnaissance and a subsurface investigation. Ten (10) boreholes were drilled to facilitate soil and groundwater sampling and in situ monitoring. A survey of local water wells which are presently being used for irrigation or drinking water supplies was also conducted.

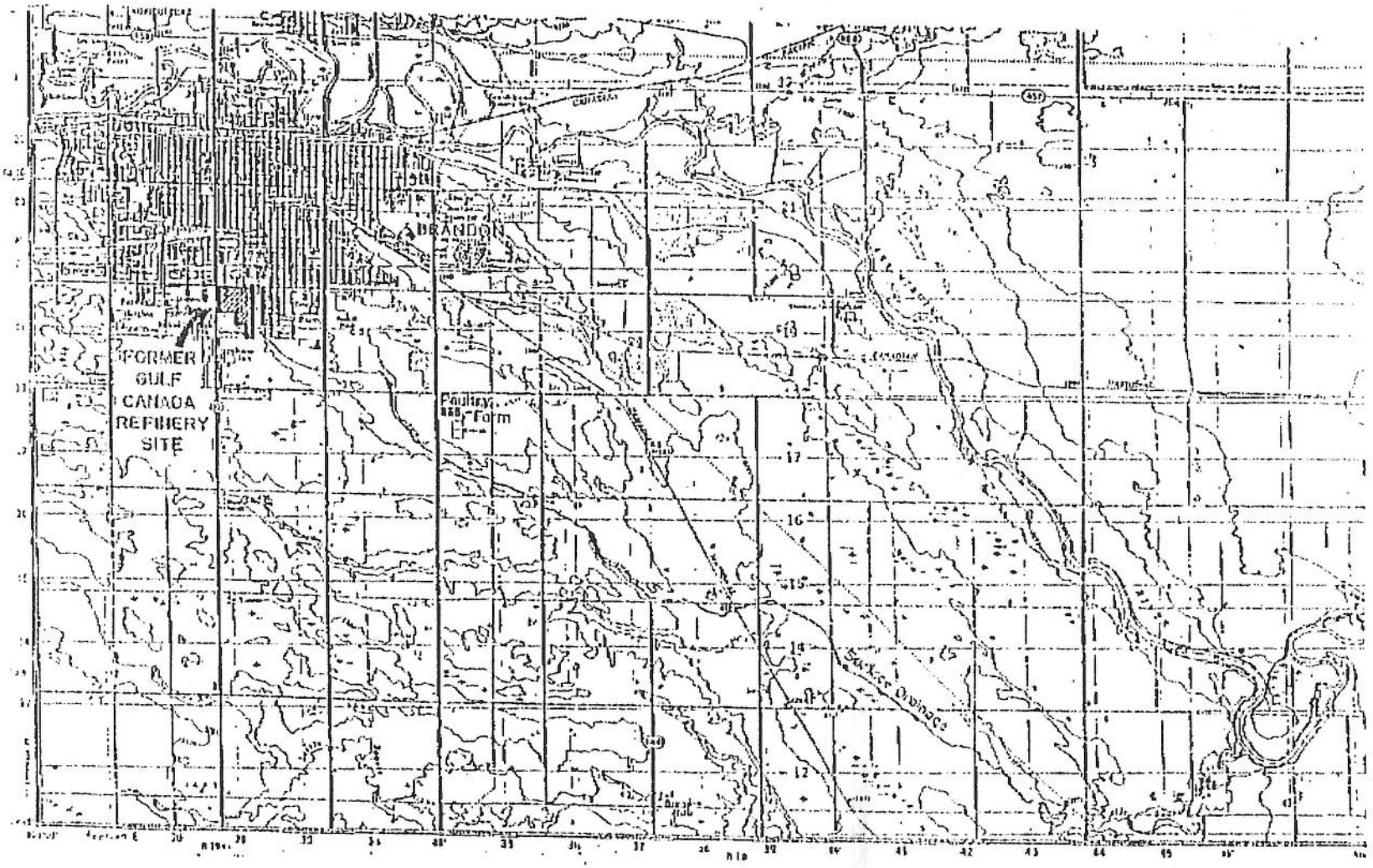
2.0 SITE FEATURES AND GEOLOGY

The City of Brandon is located in the Assiniboine River valley at an elevation of approximately 390 m (1280 ft.) above mean sea level. Drawing No. 2.1 is a topographic plan of the area showing the location of the former refinery site. The site is located within the City of Brandon in the NW 1/4 of Section 11 - Township 10 - Range 19 - West of the Principal Meridian.

As Drawing No. 2.1 shows, the ground surface at the site slopes toward the southeast. Local surface water drainage apparently flows southeastward through a low lying drainage gully on Parcel B into an intermittent stream which eventually intersects the Little Souris River approximately 14 km southeast of the site.

The present day land use in the vicinity of the site is shown on Drawing No. 2.2. Parcel B is bordered on the west by the City of Brandon cemetary and crematorium and on the east by a residential neighbourhood. The ground surface elevation of the Brandon cemetary site is approximately 6 to 8 m higher than that of Parcel B. Imported fill has been used to raise the elevation of the cemetary site. The area to the northeast is occupied by light industrial development. Parcel A is presently occupied by commercial developments.

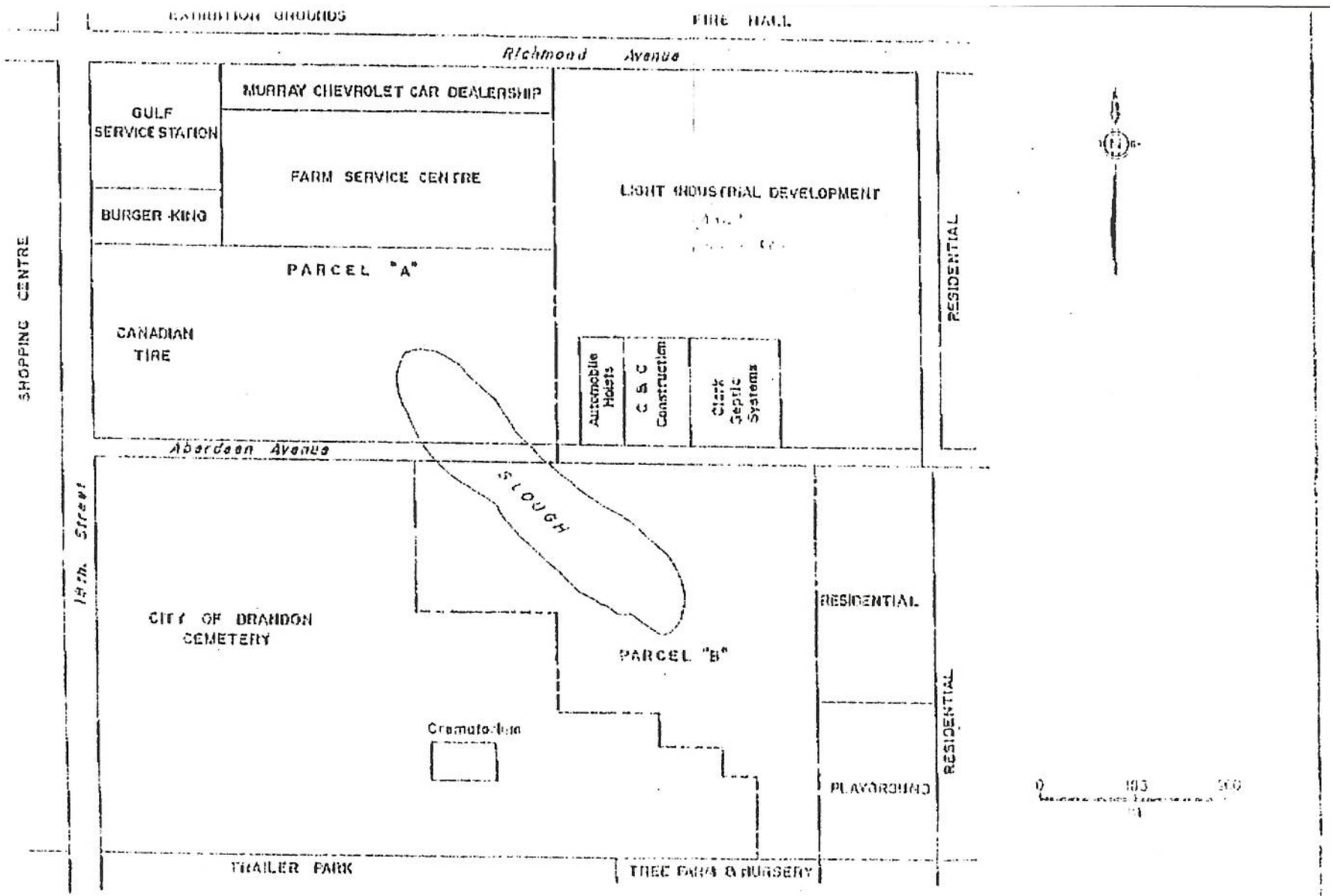
According to geological map AR80-7 the shallow Quaternary sediments in the vicinity of Brandon are comprised of glaciolacustrine sands and silts overlying a grey glacial till derived primarily from Paleozoic carbonate rocks.



Topographic Map
of the Brandon
Area

M.J. O'CONNOR & ASSOCIATES LTD.

JOB No.:	10-303	DATE:	85/11
DRAWN BY:	MJ	DWG No.:	3.1



Site Plan of the Former Brandon Refinery and Surrounding Areas

M. J. O'CONNOR & ASSOCIATES LTD

JOB No. 13-13 | DATE 1977

DRAWN BY: RJ | DWG No.:

3.0 SITE INVESTIGATION

The investigation of the Brandon refinery site was carried out in several phases which included:

1. A study of historical aerial photographs dating from 1958 to 1982.

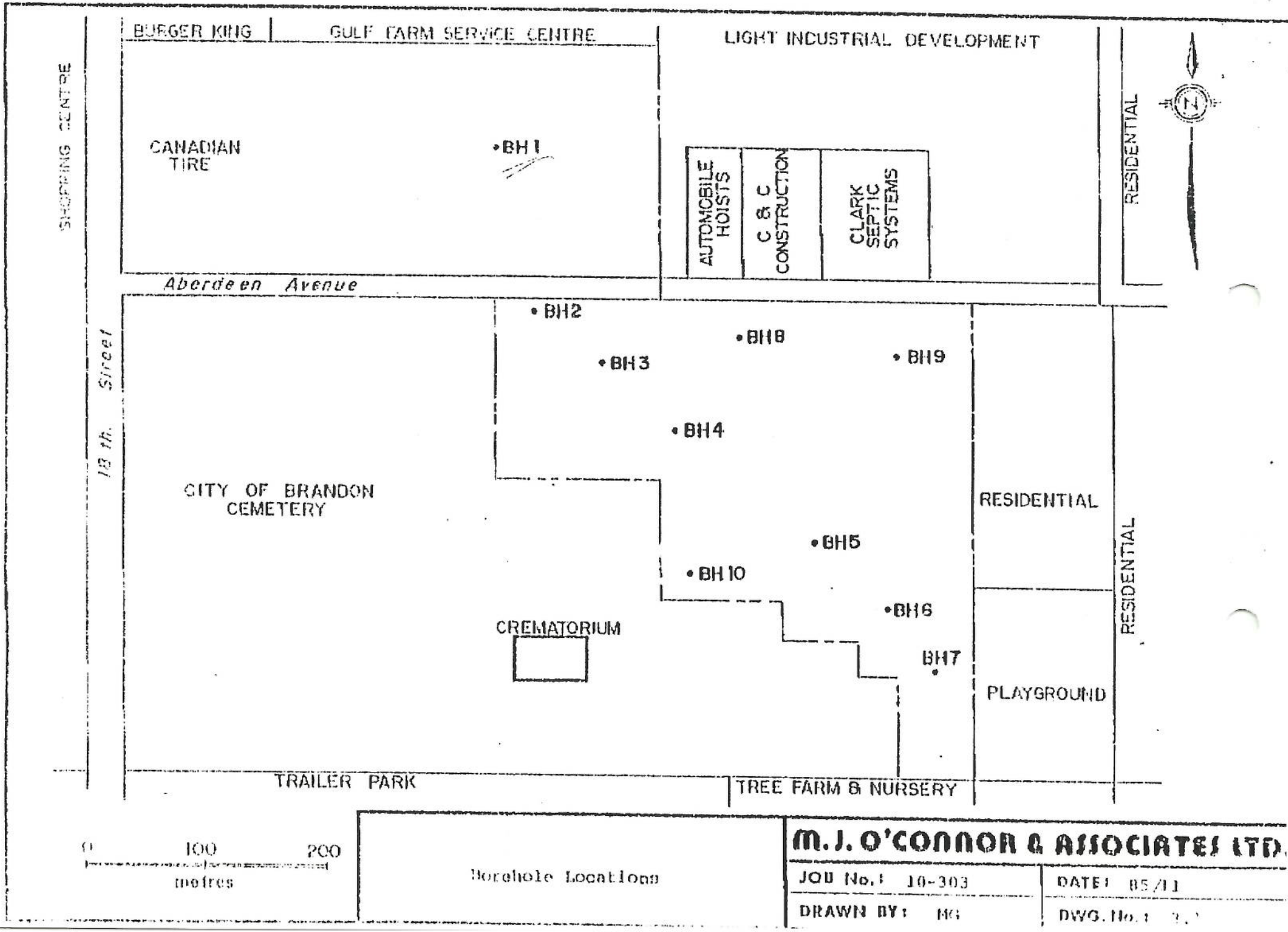
2. A review of published regional geological and hydrogeological information.

3. A site reconnaissance with retired Gulf Canada personnel familiar with the site and the history of refinery operations.

4. A drilling and subsurface investigation.

5. A survey of water wells in the vicinity of the site.

Borehole locations were selected on the basis of information obtained during the site reconnaissance. A total of 10 boreholes were drilled at the site on 85/09/19 using a truck-mounted auger drilling rig. The borehole locations are shown on Drawing No. 3.1. Undisturbed soil samples were recovered from the boreholes using thin-walled Shelby tubes. These soil samples were retained for chemical analysis. Auger cutting samples were also retained for monitoring of soil vapour levels, physical classification and moisture content determination. Stratigraphic logs of the boreholes are presented in Appendix A. Monitoring piezometers were installed in each of the boreholes to facilitate groundwater monitoring and sampling. Protective metal casings with locking caps were installed over each of the piezometers.


BURGER KING
GULF FARM SERVICE CENTRE
LIGHT INDUSTRIAL DEVELOPMENT
SHOPPING CENTRE
CANADIAN TIRE
BH1
AUTOMOBILE HOISTS
C & C CONSTRUCTION
CLARK SEPTIC SYSTEMS
RESIDENTIAL
Aberdeen Avenue
18 th. Street
BH2
BH8
BH3
BH9
BH4
CITY OF BRANDON CEMETERY
RESIDENTIAL
BH5
BH10
BH6
CREMATORIUM
BH7
RESIDENTIAL
PLAYGROUND
TRAILER PARK
TREE FARM & NURSERY
0
100
200
metres
Borehole Locations
M.J. O'CONNOR & ASSOCIATES LTD.
JOB No.: 10-303
DATE: 85/11
DRAWN BY: MG
DWG. No.:

The ground surface and top of casing elevations were surveyed following drilling and installation of the piezometers.

Piezometric elevations, separable hydrocarbon thicknesses and subsurface vapour concentrations were monitored in all of the boreholes on 85/09/20 and again on 85/10/02. Groundwater samples were abstracted from the piezometers on 85/09/21 in accordance with methods recommended by Environment Canada. The groundwater samples were preserved on site and transported to the laboratory within a 24 hour period in accordance with the requirements of the analytical protocol.

The available records for water wells in the immediate vicinity of the Brandon refinery site were obtained from the Water Resources Branch of the Manitoba Department of Natural Resources. Since these records were known to be out of date and incomplete, a survey was also conducted to obtain data on water wells in the area which are presently being used for irrigation or as drinking water sources.

4.0 RESULTS OF THE INVESTIGATION

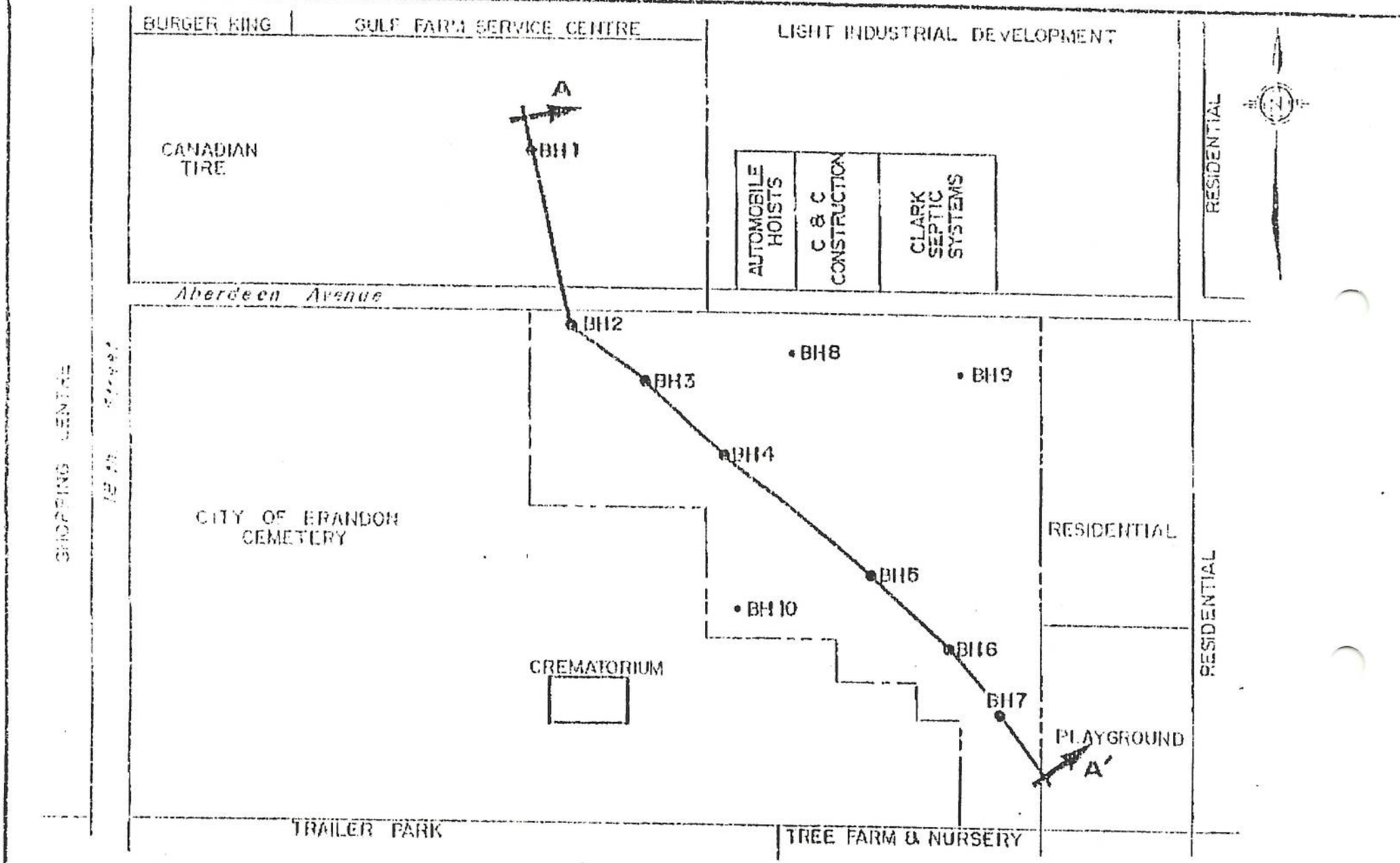
4.1 Stratigraphic Conditions

The soil profile under the Brandon refinery site generally consists of sand and/or silt overlying clay till. Topsoil thicknesses ranging from about 500 mm to 750 mm were encountered in most of the boreholes on Parcel b.

Drawing No. 4.1 shows the plan location of cross section A-A through BH1 to BH7, inclusive. Variation of the soil profile across the site is illustrated in the stratigrahic cross section presented in Drawing No. 4.2. Significant undulation of the till surface is apparent in this drawing. The sand stratum overlying the clay till surface was found to have been replaced by silt at two locations (see logs of BH4 and BH10).

4.2 Groundwater Flow

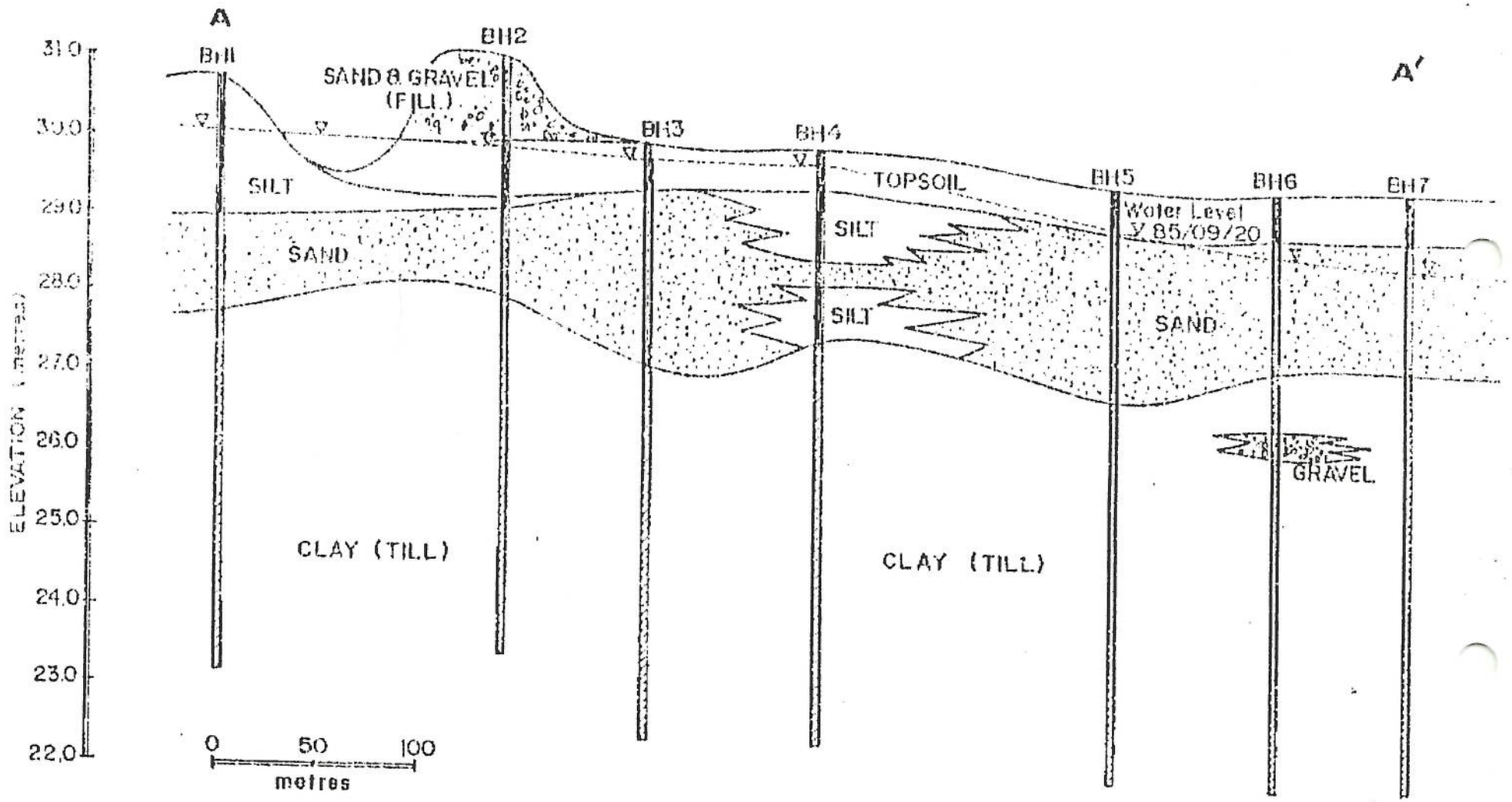
Contours of the piezometric surface elevations measured on 85/09/20 and 85/10/02 are shown on Drawings No. 4.3 and 4.4, respectively. The principal directions of groundwater flow indicated on the drawings vary from southeast to east, however flow directions and gradients may vary seasonally depending on local runoff conditions and infiltration of surface waters in the vicinity of the refinery site. The potential for offsite migration of subsurface contaminants is largely controlled by the direction and rate of groundwater flow. Groundwater flow rates through the sand stratum are expected to be significantly greater than rates through the clay till. Estimated groundwater flow velocities through the sand stratum range from approximately 0.1 to 2.0 m/a, based on the measured piezometric gradients and estimated soil permeability. Higher velocities may occur at certain times of the year if steeper piezometric gradients develop.



Site Plan and
Location of
Cross-Section A-A'

M.J. O'CONNOR & ASSOCIATES LTD

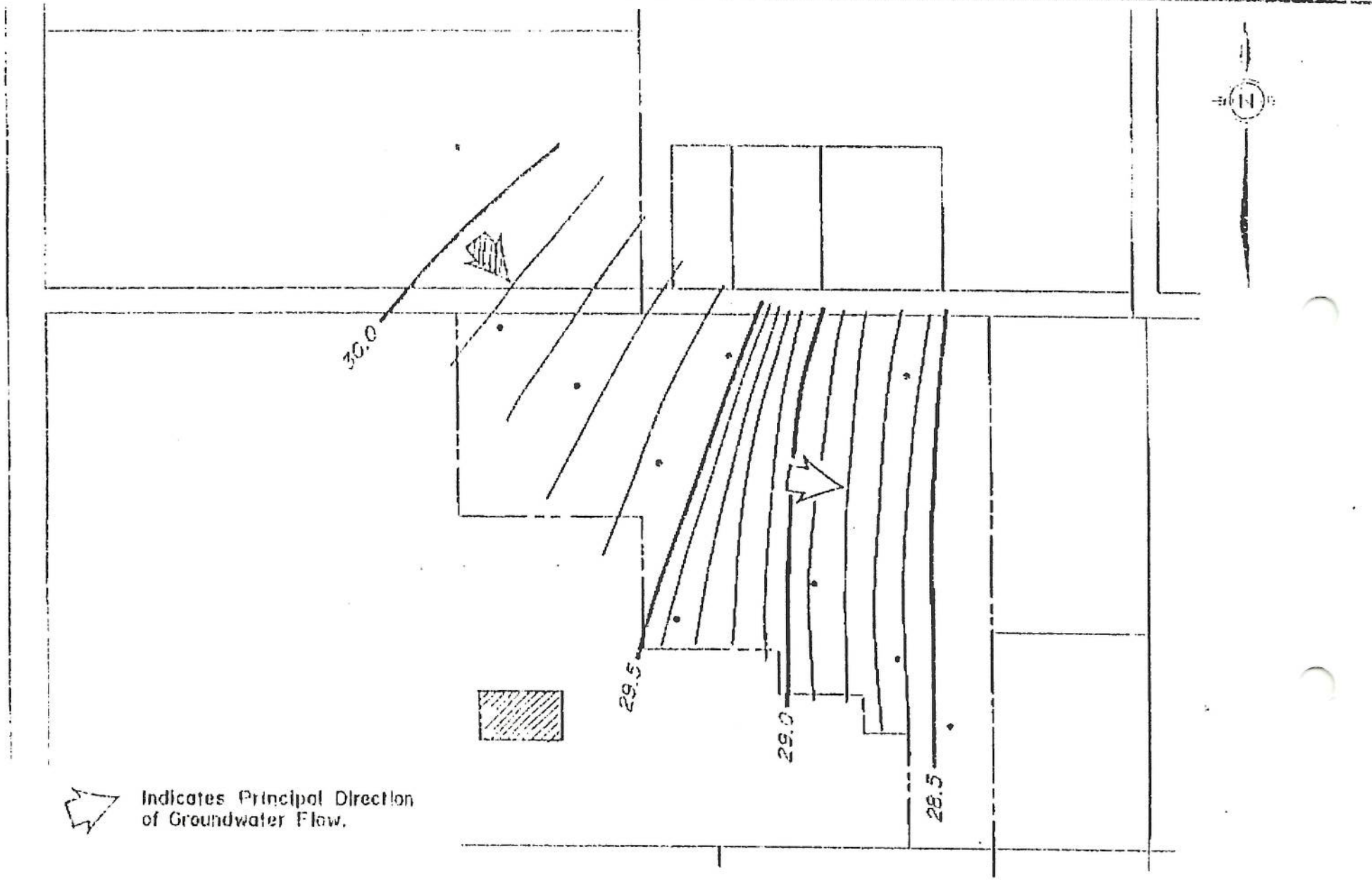
JOB No.: 10-303	DATE: 85/11
DRAWN BY: MG	DWG. No.: 4.1



Stratigraphic Cross-Section

M.J. O'CONNOR & ASSOCIATES LTD.

JOB No.:	10-303	DATE:	85/11
DRAWN BY:	MG	DWG. No.:	4.2

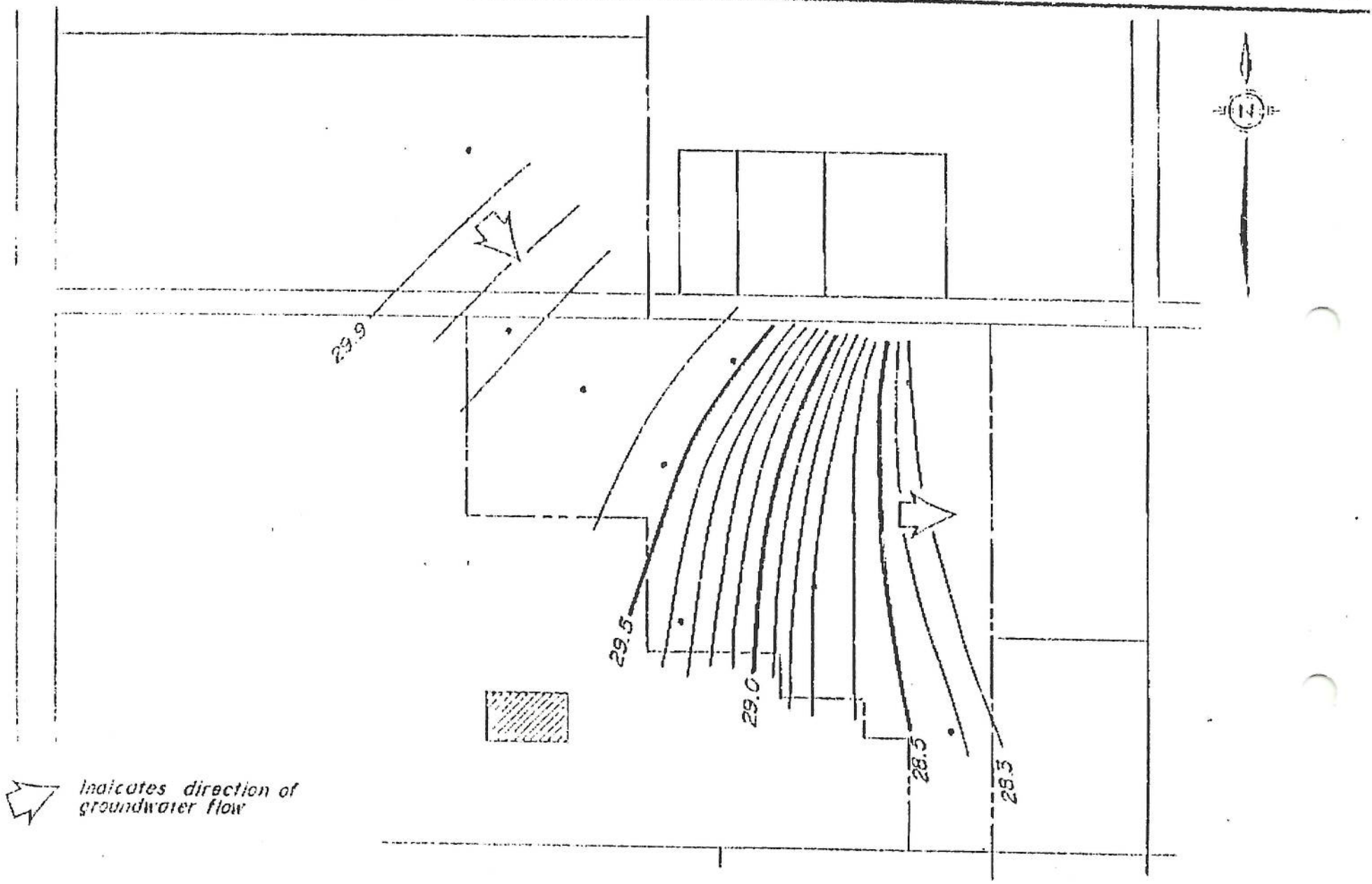


0 100 200
metres

Piezometric Surface Elevations
(m)
85/09/20

M.J. O'CONNOR & ASSOCIATES LTD

JOB No.: 30-303	DATE: 85/11
DRAWN BY: DG	DWG. No.: 4.3



Piezometric Surface Elevations
(m)
85/10/02

M.J. O'CONNOR & ASSOCIATES LTD.

JOB No.:	10-303	DATE:	85/11
DRAWN BY:	MG	DWG. No.:	4.4

4.3 Subsurface Vapour Levels

Hydrocarbon vapour concentrations measured in soil samples obtained from the boreholes are presented on the logs in Appendix A. Significant vapour concentrations were detected in some of the soil samples. Elevated vapour levels were detected both in the sand stratum and at depth in the underlying clay till. This indicates that some contaminant has probably flowed through these strata in the past. The highest vapour levels were detected in samples from BH1, located on Parcel A.

The vapour concentrations measured in the piezometers on 85/09/20 and 85/10/02 are presented on Drawings No. 4.5 and 4.6, respectively. Elevated vapour levels were detected in BH1 (on Parcel A) but were substantially lower in boreholes located to the south and east on Parcel B. The absolute extent of the vapour plume cannot be delineated accurately with the present information.

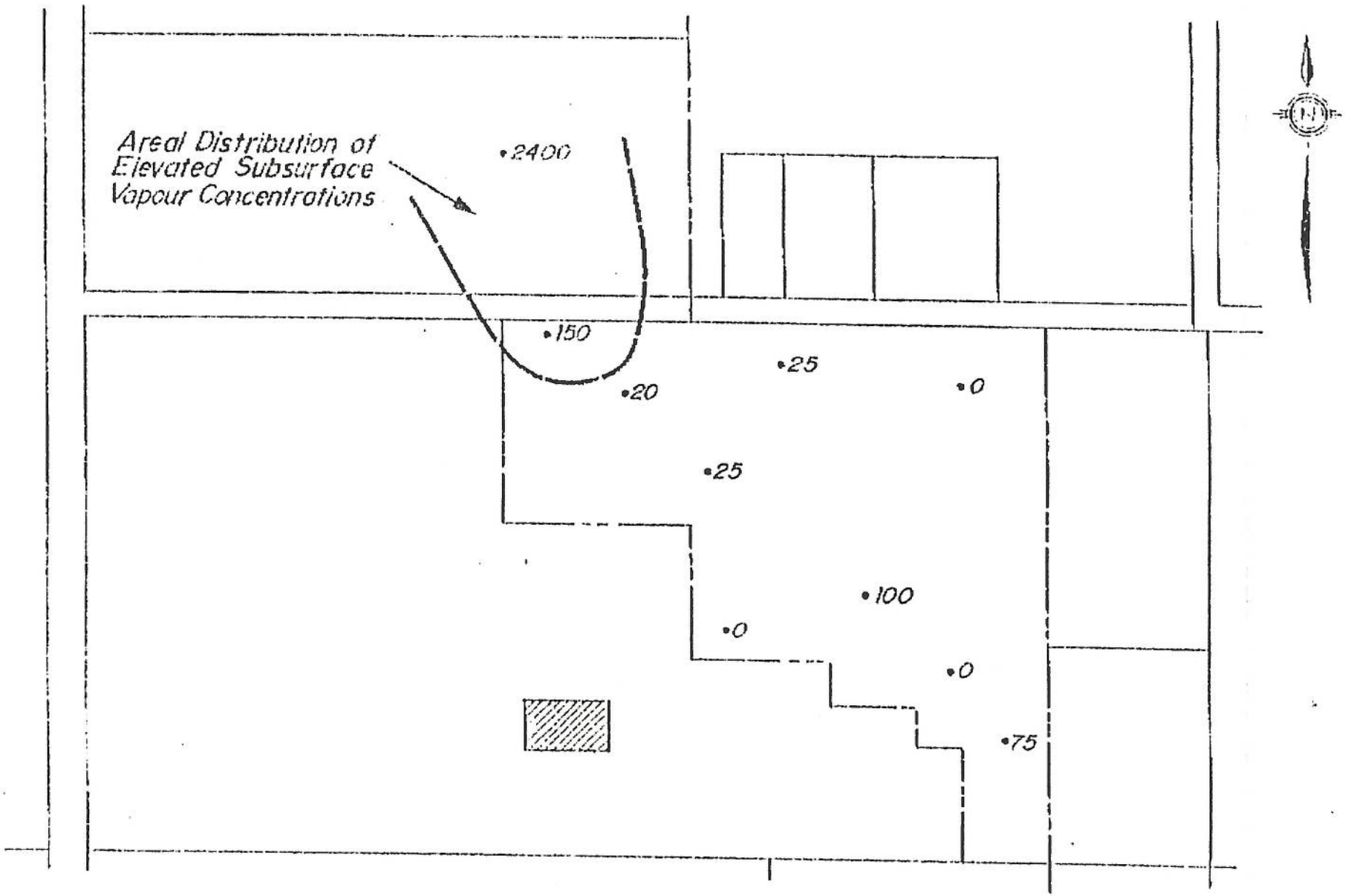
4.4 Separable Hydrocarbons

Although visible hydrocarbon staining was observed in some of the soil samples from BH1 and BH2, separable hydrocarbons were not detected at the water table in any of the piezometers on 85/09/20 and 85/10/02.

4.5 Soil Chemistry

4.5.1 Analytical Protocol

Undisturbed soil samples from the test holes were analyzed to measure the parameters listed in Table 4.1. Concentrations of a range of inorganic constituents were determined for each of the soil samples by inductively coupled argon plasma emission spectroscopy (ICP). The concentrations of selected metals including cadmium, lead, mercury and

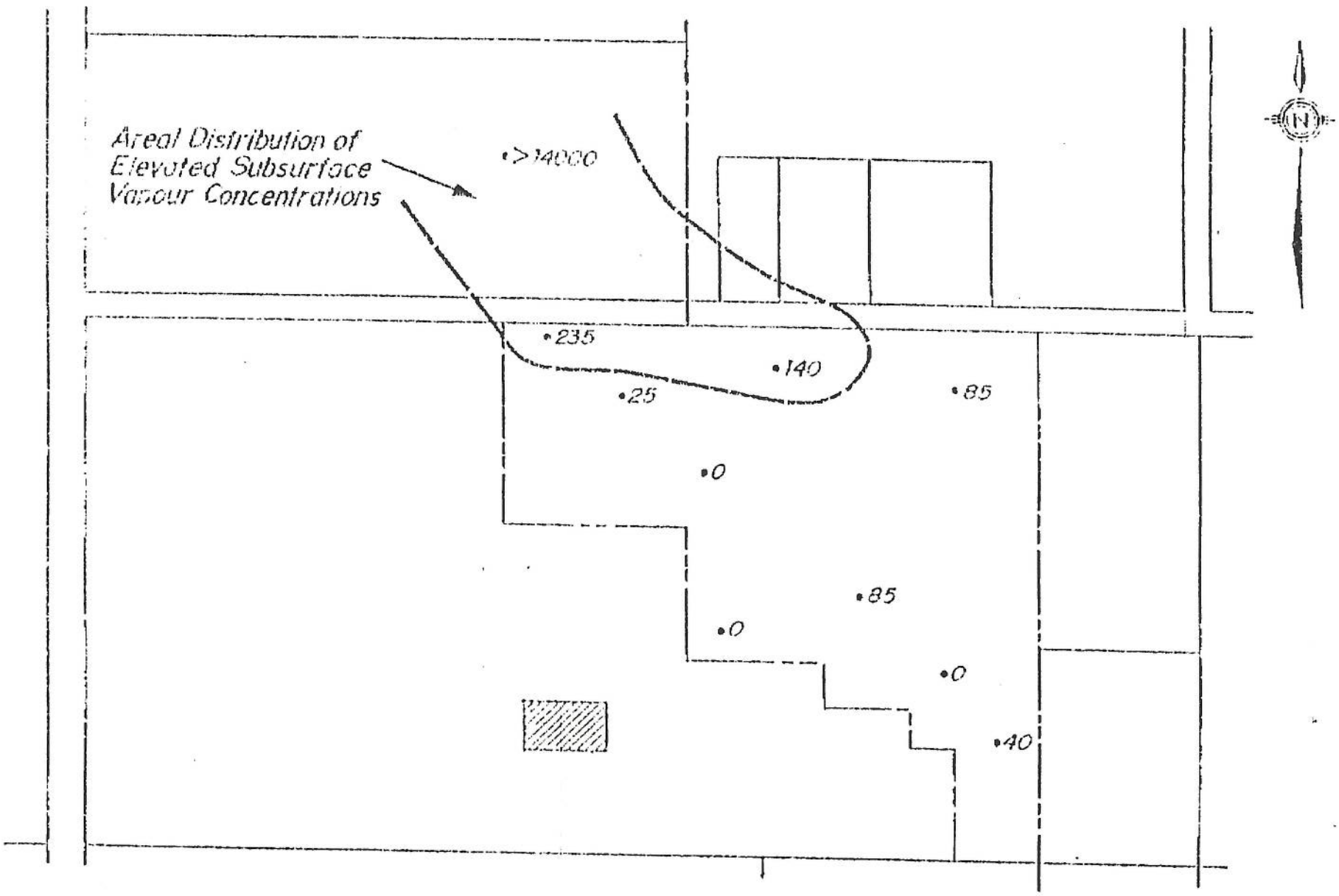


0 100 200
metres

Hydrocarbon Vapour Concentrations
(ppm)
05/09/20

M.J. O'CONNOR & ASSOCIATES LTD

JOB No.: 10-303	DATE: 05/11
DRAWN BY: MG	DWG. No.: 4.5



0 100 200
Metres

Hydrocarbon Vapour Concentrations
(ppm)
85/10/02

M.J. O'CONNOR & ASSOCIATES LTD.

JOB No.: 10-303	DATE: 85/11
DRAWN BY: MG	DWG. No.: 4.6

TABLE 4.1

ANALYTICAL PROTOCOL FOR SOILS

Parameter	Units	Analytical Method
pH	pH units	pH meter
Electrical Conductance	mS/cm	Conductivity Meter
Na	µg/g	ICP*
Ca	µg/g	ICP
Mg	µg/g	ICP
K	µg/g	ICP
SAR		
TKN	%	Automated Phenate Method
Petroleum Hydrocarbons (Oil & Grease)	%	Soxhlet Extraction
Al	µg/g	ICP
B	µg/g	ICP
Ba	µg/g	ICP
Be	µg/g	ICP
Cd	µg/g	AA**
Co	µg/g	ICP
Cu	µg/g	ICP
Cr	µg/g	ICP
Fe	µg/g	ICP
Pb	µg/g	AA
Mn	µg/g	ICP
Mo	µg/g	ICP
Ni	µg/g	ICP
Si	µg/g	ICP
Sr	µg/g	ICP
V	µg/g	ICP
Zn	µg/g	ICP
Li	µg/g	ICP
Hg	µg/g	AA (HYDR)***
As	µg/g	AA (HYDR)***

* ICP denotes inductively coupled argon plasma emission spectroscopy.

** AA denotes atomic absorption spectroscopy.

*** AA (HYDR) indicates hydride digestion followed by atomic absorption spectroscopy.

arsenic were determined independently by atomic absorption spectroscopy (AA). The petroleum hydrocarbon contents of the soil samples were determined by solvent extraction. The sodium adsorption ratio (SAR), total Kjeldahl nitrogen (TKN) concentration, electrical conductance and pH were also determined for each of the soil samples. Chemical analyses of the soils were performed by Chemex Labs Ltd.

4.5.2 Soil Clean-up Criteria

Criteria which have recently been used for the clean-up of contaminated surficial soils at several Canadian refineries are summarized in Table 4.2. These criteria are presented for comparison with the analytical results for soils from the Brandon site.

4.5.3 Results of Laboratory Analyses

The ranges of measured concentrations in the soil samples are summarized in Table 4.3. Analytical data for all soil samples are included in Appendix B. The measured concentrations of oil and grease, trace metals and other inorganic constituents generally did not exceed the comparable clean-up criteria, but the measured values of SAR, electrical conductance and pH did exceed typical clean-up criteria at some locations indicating that these soils may be unsuitable for some agricultural crops. Specifically:

1. SAR values exceeding the clean-up criterion were measured in samples from BH1, BH2, BH5 and BH8.

2. The electrical conductances of soil samples from BH1, BH2, BH3, BH4, BH7 and BH8 were greater than the 2 mS/cm criterion.

TABLE 4.2

TYPICAL SOIL CLEAN-UP CRITERIA FOR CANADIAN REFINERIES

Parameter	CLEAN-UP CRITERIA	
	Industrial Land-Use	Residential Land-Use
pH	6 to 8	6 to 8
Conductance	2 mS/cm	2 mS/cm
Sodium Adsorption Ratio	15	15
Total Kjeldahl Nitrogen	0.6%	0.6%
Total Cadmium	8 µg/g	4 µg/g
Total Chromium	1000 µg/g	500 µg/g
Total Copper	300 µg/g	300 µg/g
Total Lead	1000 µg/g	500 µg/g
Total Mercury	2 µg/g	1 µg/g
Total Molybdenum	40 µg/g	40 µg/g*
Total Nickel	200 µg/g	200 µg/g
Total Zinc	800 µg/g	800 µg/g
Total Arsenic	50 µg/g	25 µg/g
Oil and Grease	2%	2%

* Reduce criterion to 5 µg/g if land to be used for grazing or growing of forage for consumption by ruminants.

TABLE 4.3

SUMMARY OF SOIL CHEMISTRY DATA

Constituent	Range of Measured Concentrations (µg/g)	Soil Clean-up Criteria for Residential Land Use (µg/g)
As	<1. - 39.	25
Cd	0.50 - 2.0	4
Cu	2.5 - 20.0	300
Cr	7.0 - 13.5	500
Pb	5. - 20.	500
Hg	0.015 - 0.025	1
Mb	<0.50 - 7.0	40
Ni	8.5 - 22.	200
Zn	16.5 - 40.5	800
Al	1910. - 5500.	—
S	7.5 - 149.5	—
Ba	51.5 - 194	—
Be	0.100 - 0.200	—
Co	2.0 - 10.0	—
Fe	6150. - 14 750.	—
Mn	210. - 805.	—
V	10.0 - 25.	—
Oil and Grease	0.024 - 0.059%	2%
TKN	<0.01 - 0.20%	0.5%
SAR	0.83 - 32.9	15
Conductance	1.14 - 6.66 mS/cm	2 mS/cm
pH	7.1 - 9.2	6.0 to 8.0
Ca	14 500. - 58 500.	—
Na	115. - 760.	—
Mg	7500. - 14 850.	—
K	265. - 1555.	—

3. The measured pH values of soils from BH1 and BH8 were 9.2 and 9.0, respectively, while pH values for samples from BH3, BH4, BH5 and BH6 were only slightly greater than clean-up criterion of 8.0.

These data indicate that the surficial soils at several locations contain elevated concentrations of adsorbed sodium. This condition may be a result of the past spillage of caustic soda reported by former refinery personnel. The measured concentration of arsenic in a soil sample from BH9 also exceeded the clean-up criteria, however, the possible source of this arsenic contamination is presently unknown.

4.6 Hydrochemistry

4.6.1 Groundwater Sampling and Analytical Protocol

Groundwater sampling was carried out in accordance with methods recommended by Environment Canada. Groundwater was purged from the piezometers prior to collecting samples to ensure the ingress of fresh groundwater. Dedicated sampling equipment which had been pre-sterilized was used for obtaining water samples from each of the piezometer installations.

Groundwater samples from 15 monitoring piezometers were analyzed to determine concentrations of selected organic and inorganic constituents. Analytical methods used to determine concentrations of the various constituents are summarized in Table 4.4. Concentrations of 20 inorganic constituents were determined for each sample in a single scan by inductively coupled argon plasma spectroscopy (ICP).

TABLE 4.4

ANALYTICAL METHODS FOR GROUNDWATER CHEMISTRY

Inorganic Constituents	Analytical Method
As	AA
B	ICP
Be	ICP
Cd	AA
Co	ICP
Cr	ICP
Cu	ICP
Hg	AA
Mo	ICP
Ni	ICP
Pb	AA
Se	AA
V	ICP
Zn	ICP
Al	ICP
Ba	ICP
Ca	ICP
Fe	ICP
K	ICP
Li	ICP
Mg	ICP
Mn	ICP
Na	ICP
Si	ICP
Sr	ICP
Chloride	Colourimetry (Thiocyanate)
Sulphate	Colourimetry (Methylthymol Blue)
Total Nitrogen (TKN)	Automated Phenate Method
Organic Constituents	
Phenol	Colourimetry (4-aminoantipyrine)
Petroleum Hydrocarbons	Infra Red Absorption
Benzene-Toluene-Xylene (BTX)	Gas Chromatography
Physical Properties	
pH	pH Meter
Conductivity	Conductivity Meter

Concentrations of arsenic, selenium, cadmium, lead and mercury were determined by atomic absorption spectroscopy (AA). Chemical analyses of the groundwater samples were performed by Chemex Labs Ltd.

4.6.2 Results of Hydrochemical Analyses

Analytical results for the groundwater samples are included in Appendix C. The ranges of the measured concentrations in the groundwater are summarized in Table 4.5 along with the comparative Canadian Drinking Water Guidelines (Ministry of Health and Welfare, 1979). Background concentrations in the shallow aquifer were not determined during the present study.

The areal distributions of some of the hydrochemical constituents are presented in Appendix D. Significant findings of the analytical study are summarized below:

1. The concentrations of the hydrochemical constituents are generally highest in BE1 and diminish toward the southeast, as illustrated in Appendix D. It should be noted that BE1 is not located on Parcel B, the area presently being considered for possible development.

2. Although dissolved petroleum hydrocarbons were identified in groundwater samples from 3 locations: BE1, BE2 and BE3, these groundwater samples did not contain detectable concentrations of benzene, toluene or xylene. The gas chromatography results indicate that the dissolved hydrocarbons are comprised mainly of constituents with molecular weights greater than that of C_{10} hydrocarbons.

3. The measured phenol concentrations in all 10 groundwater samples exceeded the Canadian Drinking Water Guideline of

TABLE 4.5

SUMMARY OF HYDROCHEMICAL DATA

Constituent	Range of Measured Concentrations (mg/L)	Canadian Drinking Water Guideline (mg/L)
Petroleum Hydrocarbons	0.4 - 156	--
Phenol	0.003 - 6.30	0.002
Benzene	<0.05	--
Toluene	<0.02	--
Xylene	<0.04	--
Chloride	3. - 1500.	250.
Sulphate	205. - 3600.	500.
TKN	1.6 - 22.	--
Ca	522. - 1727.	200.
Mg	209. - 611.	150.
Na	63. - 1169.	300.
K	16.4 - 45.6	--
SAR	0.6 - 66.2	--
As	0.0053 - 0.1400	0.0500
Sc	0.0004 - 0.0117	0.010
Cd	<0.001 - 0.003	0.0050
Pb	<0.002 - 0.028	0.050
Hg	<0.0001	0.001
Al	37.3 - 116.	--
B	0.09 - 0.66	5.0
Be	1.87 - 4.30	1.0
Co	0.053 - 0.14	--
Cr	0.090 - 0.260	0.050
Cu	0.38 - 1.46	1.000
Fe	101.0 - 309.0	0.30
Li	0.11 - 0.42	--
Mn	7.6 - 30.25	0.050
Mo	<0.001 - 0.061	--
Ni	0.11 - 0.34	--
V	0.16 - 0.47	--
Zn	0.60 - 1.51	5.0
Si	0.84 - 3.03	--
pH	7.35 - 7.99	--
Conductance (mS/cm)	1018. - 10 720.	--

0.002 mg/L, but this guideline is based on aesthetic criteria, i.e. taste and odour. Only the phenol concentration in BH1 exceeded the EPA[1] health criterion of 3.5 mg/L.

4. Concentrations of the inorganic constituents barium, chromium, manganese and iron exceeded the Canadian Drinking Water Guidelines in all of the groundwater samples. The sources of these constituents were not identified during the present study. Elevated concentrations of other trace metals were only detected at 4 locations: BH1 (arsenic), BH2 (copper and selenium), BH6 (copper) and BH8 (copper).

5. Measured chloride concentrations in BH1, BH2, BH3, BH4, BH5 and BH8 were found to be significantly greater than the comparable Canadian Drinking Water Guideline of 250 mg/L.

6. Sodium adsorption ratios determined for groundwater samples from BH1, BH3, BH5 and BH8 indicate that the groundwater at these locations may be unsuitable for irrigation purposes.

7. Sulphate concentrations in groundwater samples from BH2, BH3, BH4, BH5, BH7 and BH8 exceeded the Canadian Drinking Water Guideline of 500 mg/L.

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1. EPA denotes the U.S. Environmental Protection Agency.

It should be noted when reviewing the above data that the Canadian Drinking Water Guidelines for iron, manganese, copper, chloride, phenol calcium, magnesium and sodium are based on aesthetic criteria such as taste, colour or hardness, rather than toxicity or health considerations. Halstead[1] reported that hard groundwater containing iron and sulphate is common in the shallow overburden aquifers of southern Manitoba. Trivalent chromium, the most commonly occurring state of chromium, is not considered to be toxic, although it may be oxidized during chlorination to hexavalent chromium, a more toxic form.

4.7 Water Well Survey

A total of 22 presently active water wells were identified in the vicinity of the former refinery site. The locations of these water wells are shown on Drawing No. 4.7. Relevant details about the well installations and groundwater usage were solicited from the present well users. Results of the well survey are outlined in Appendix E. Well location numbers in Appendix E correspond with the location numbers shown on Drawing No. 4.7. Supplementary water well records available from the Manitoba Department of Natural Resources are presented in Appendix F. The water well survey was deemed necessary because the Provincial Government records do not contain current information on groundwater use and well ownership.

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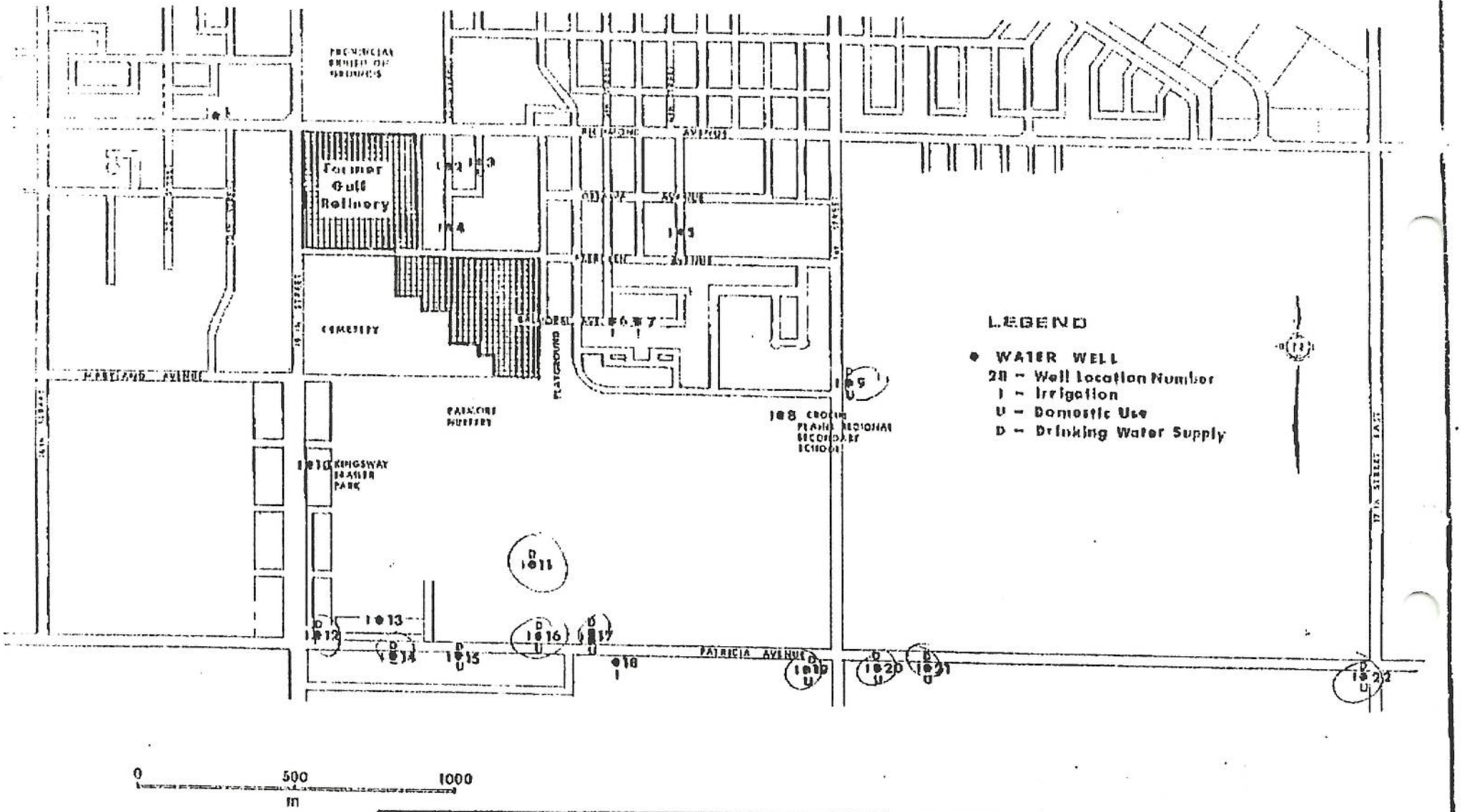
1. Halstead, E.C., 1969. Groundwater resources of the Brandon - Map Area, Manitoba. Geological Survey of Canada, Memoir 300.



Water Well Locations and Groundwater Usage

M.J. O'CONNOR & ASSOCIATES LTD.

JOB No.:	10-303	DATE:	85/11
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Groundwater use at each of the well locations is indicated by the symbols on Drawing No. 4.7. As shown on the drawing, 11 of the 22 wells are used directly as drinking water sources. These wells (Wells No. 9, 11, 12, 14, 15, 16, 17, 19, 20, 21 and 22) are all located at distances greater than 500 m from the plantsite. The wells which are located closer to the plantsite are primarily used for irrigation of lawns and gardens.

Based on the results of this study we conclude that contaminants in the groundwater under the plantsite are not likely to adversely affect the quality of the nearby drinking water wells in the immediate future, however, we consider long-term offsite migration of the contaminants to be possible if measures are not implemented to rehabilitate the aquifer.

5.0 CONCLUSIONS

On the basis of the foregoing study at the Brandon refinery site, we conclude that:

1. Significant levels of groundwater contamination were only identified in the test holes located on Parcel A (BH1) and the northwest portion of Parcel B. The highest contaminant levels are generally present in BH1 and diminish with distance toward the southeast.

2. Measured values of the sodium adsorption ratio (SAR), pH and electrical conductivity of soil samples from several of the boreholes exceeded typical soil clean-up criteria used at other Canadian refinery sites indicating that the soils may not be suitable for some agricultural crops, but the soils apparently do not contain high concentrations of trace metals or the other organic and inorganic constituents analyzed during this study.

3. Separable hydrocarbons were not detected in any of the monitoring wells, although dissolved petroleum hydrocarbons and hydrocarbon vapours were detected in samples from BH1, BH2 and BH3. Benzene, toluene and xylene were not, however, detected in the groundwater samples from these same piezometers.

4. Hydrochemical constituents which are present at some of the sampling locations in concentrations which exceed the Canadian Drinking Water Guidelines include: phenol, chloride, sulphate, sodium, calcium, magnesium, barium, arsenic, selenium, chromium, copper, iron and manganese. As previously noted, the drinking water guidelines for some of these constituents are based on aesthetic criteria rather than toxicity considerations.

5. Measured sodium adsorption ratios indicate that the groundwater under some areas of the site is unsuitable for irrigation purposes.

6. The principal directions of groundwater flow under the site at the time of monitoring were southeast and east. Depending on seasonal variations in the groundwater flow directions and piezometric gradients, there may be potential for offsite migration of the contaminants in the groundwater. Estimated groundwater flow rates through the sand stratum at the site range from about 0.1 to 2.0 m/a, however higher velocities may occur if steeper piezometric gradients develop.

7. It is evident that soil and groundwater constituents are present at the site at concentrations which exceed accepted soil clean-up criteria and the Canadian Drinking Water Guidelines. Unfortunately, this preliminary study does not provide sufficient information to map the probable distribution of these contaminants under the adjacent cemetary and the abandoned refinery site (Parcel A).

8. Although 11 of the 22 water wells near the site are presently used as drinking water sources, there appears to be very little risk that these wells will be affected in the near future by contaminants originating at the refinery site. Offsite migration of the contaminated groundwater may possibly occur over the long-term unless groundwater rehabilitation measures are implemented.

6.0 CLOSURE

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

Respectfully submitted,
M.J. O'CONNOR & ASSOCIATES LTD.

J.G. Agar, Ph.D., P.Eng.

JGA/jpc

M.J. O'Connor, Ph.D., P.Eng

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