Appendix C: Geotechnical Reports

Terraprobe

Consulting Geotechnical Engineers & Hydrogeologists
Construction & Materials Inspection & Testing

GEOTECHNICAL INVESTIGATION
PROPOSED WATERMAIN
NAVY STREET
OAKVILLE, ONTARIO

PREPARED FOR: **The Regional Municipality of Halton**
Planning and Public Works Department
Design and Construction Division
1151 Bronte Road
OAKVILLE, Ontario
L6J 6E1

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Our Ref: 973052-4

July 9, 1997

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Terraprobe
Consulting Geotechnical Engineers & Hydrogeologists
Construction & Materials Inspection & Testing

July 9, 1997

Our ref: 973052-4
Stoney Creek Office

The Regional Municipality of Halton
Planning and Public Works Department
Design and Construction Division
1151 Bronte Road
OAKVILLE, Ontario
L6J 6E1

Attention: Mr. Teik Lim, P. Eng.
Design Supervisor

RE: GEOTECHNICAL INVESTIGATION
PROPOSED WATERMAIN
NAVY STREET
OAKVILLE, ONTARIO

Dear Sirs:

This report presents the results of a geotechnical investigation carried out for the design of watermain proposed for a section of Navy Street in Oakville, Ontario. The location of the site is shown on the Key Plan, Figure 1.

1. TERMS OF REFERENCE

A proposal for carrying out a geotechnical investigation for the design of the watermains and waste watermains proposed for various locations within the Region of Halton, including the site under consideration in this report, was outlined in our letter of June 3, 1997. In general, the work plan consisted of drilling two boreholes at specified locations and reporting the results. A discussion of the geotechnical engineering aspects to be considered in the design of the watermain was to be provided based on the results of the two boreholes.

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2. PROCEDURE

The field work for this investigation was carried out on June 25, 1997, during which time boreholes numbered 1 and 2 were drilled. The locations of boreholes are shown on the Location Plan, Figure 2.

The boreholes were drilled using a truck mounted power auger supplied and operated by a specialist drilling contractor. The boreholes were advanced using nominal 95mm intside diameter hollow stem continuous flight augers. Standard Penetration testing and sampling was carried out at 0.75 metre intervals of depth in each borehole using 35 millimetre inside diameter split spoon sampling equipment. After the drilling, sampling, and logging was completed, the boreholes were loosely backfilled with augered cuttings. A perforated standpipe was installed in one of the boreholes in order to carry out short-term monitoring of the groundwater level. The pavement surface at the boreholes was restored using cold mix asphaltic concrete.

The field work was supervised throughout by members of our engineering staff who located the boreholes, cleared underground utilities at the borehole locations, directed the drilling and sampling operations, determined ground surface elevations at the borehole locations, and cared for the samples obtained. The boreholes were located in the field with respect to the existing road alignments and topographical features shown the site plans provided by the Region. The road surface elevations at the borehole locations were referenced to site bench marks also provided by the Region. All of the elevations are understood to have been referred to geodetic datum.

All of the samples recovered in the course of the investigation were brought to our Stoney Creek laboratory for further examination and water content determinations. Soil samples were submitted to Fine Analysis Laboratories Ltd. for analyses of a suite of inorganic parameters and Total Petroleum Hydrocarbons (TPH, heavy oil fraction) to identify potential constraints regarding the off-site disposal of surplus excavated materials, and for a suite of analyses designed to assess the aggressiveness of the subsurface environment to underground plant. The latter analyses included determination of electrical resistivity, pH, oxygen-reduction potential (redox), sulphite, chloride, and water soluble sulphate.

3. SUBSURFACE CONDITIONS

3.1 General

The subsurface soil, rock, and groundwater conditions encountered in the boreholes are presented on the attached Log of Borehole sheets. The stratigraphic boundaries indicated are inferred from non-continuous samples and observations of drilling resistance and typically represent a transition from one soil type to another. These boundaries should not be interpreted to represent exact planes of geological change. The subsurface conditions have been confirmed at the borehole locations only, and will vary between and beyond the borehole locations.

The following discussion has been simplified in terms of the major soil strata for the purposes of geotechnical design.

3.2 Soil Conditions

In general, the boreholes encountered pavement structure overlying strata of sand and silty sand, silt and clayey silt.

Pavement

The pavement structure penetrated at the borehole locations consisted of about 75mm of asphaltic concrete and about 325 to 375mm of granular base material.

Silty Sand

A stratum of silty fine to medium sand was encountered below the pavement in both boreholes. N values of 12 and 23 blows per 0.3m were determined in the standard penetration testing carried out within the silty fine to medium sand. The natural water content of samples of the silty fine to medium sand recovered from the standard penetration testing was about 9 percent.

Sand, Sand and Gravel

A layer of fine to medium sand was encountered below the silty fine to medium sand in borehole 2. The fine to medium sand had an N value of 35 blows per 0.3m and a natural water content of about 20 percent.

A 0.6m thick layer of sand and gravel was encountered below the silty fine to medium sand in borehole1.

Silt

Borehole 1 was terminated in a stratum of silt and borehole 2 fully penetrated a 0.7m thick stratum of silt. The N values determined in the silt ranged from 27 to 37 blows per 0.3m. The natural water content of the silt was in the range of about 18 to 21 percent.

Clayey Silt

Borehole 2 was terminated in a stratum of clayey silt. N values of 9 and 22 blows per 0.3m were measured in the clayey silt which hjad natural water contents of about 18 and 20 percent.

3.3 Groundwater Conditions

Borehole 2 was dry during and immediately following drilling. The water level in borehole 1 immediately after drilling was at a depth of 3.5m below the existing ground surface or at about elevation 84.0m. The waterlevel in the standpipes in borehole 1, was at a depth of about 2.8m below the ground surface, or at about elevation 84.7m one day after installation.

It should be noted that the groundwater conditions reported above should not necessarily be interpreted as representing stabilized conditions. Fluctuations in groundwater levels will occur due to seasonal variations and precipitation conditions.

4. CHEMICAL ANALYSES

4.1 Soil Quality

Analyses for a suite of inorganic parameters and TPH were carried out on a near surface sample of the silty fine to medium sand from borehole 1 by Fine Analysis Laboratories Ltd. The results of the analyses are detailed in the Certificate of Analysis included in Appendix A, and summarized in Table I along with the corresponding soil remediation criteria as detailed in Tables A and C of the Guideline For Use at Contaminated Sites in Ontario (MOEE, 1996). The parameter concentrations reported were less than the MOEE 1996 criteria for both surface and subsurface soil criteria for a potable groundwater condition, for agricultural land-use and for fine grained soil.

4.2 Corrosion Potential

The results of the corrosivity analyses carried out on a sample of the clayey silt recovered from borehole 2 are detailed in the Certificate of Analysis included in Appendix A and summarized in Table II. Based on the reported parameters, the subsurface environment is not considered to be particularly aggressive to gray and ductile cast iron pipe. The water soluble sulphate concentration for the sample tested was about 0.05 percent which is below the range of concentrations described as Moderate in Table 10 of CSA Standard A23.1-94.

5. DISCUSSION

5.1 General

The following discussion is based on our interpretation of the factual data obtained during this investigation and is intended for the use of the design engineer only. Comments made regarding the construction aspects are provided only in as much as they may impact on design considerations. Contractors bidding on or undertaking these works, should make their own assessment regarding the nature and adequacy of the factual information, as is affects their construction techniques, scheduling, equipment selection and the like.

It is understood that the proposed services will have invert depths in the range of about 3 to 4m below the existing ground surface. In the absence of specific design details regarding the proposed servicing, the following discussion should be regarded as preliminary. The geotechnical aspects of the proposed work should be reviewed by this office at the final design stage.

5.2 Excavation

Prior to excavating for the watermain, all existing asphaltic concrete should be removed and disposed of at an appropriate off-site location. Depending on the actual invert depths, excavation for the services will generally encounter surficial fill, sand and silty sand, silt and clayey silt.

It is anticipated that the relatively shallow cuts required for the services can be carried out using conventional open-cut techniques. Depending on the invert elevations and the actual groundwater conditions at the time of construction, groundwater seepage in the excavations for the watermain should be is expected. The anticipated volumes of groundwater seepage can probably be managed by pumping from properly filtered sumps located as required in the excavations.

Side slope inclinations of 1 horizontal to 1 vertical or flatter are generally considered appropriate for temporary unsupported excavations at the site, however localized slumping should be expected within any fill materials encountered particularly if backfill for existing adjacent services is encountered. Where existing utilities are located within the zone of influence of the excavations, temporary support should be provided as considered necessary to minimize potential disturbance. The locations and depths of any utilities which would potentially be affected by the proposed work should be identified prior to commencing the excavation and assessed by this office and the owner of the plant.

Temporary support will be required for vertically cut trenches. The selection of a temporary support system will depend on the extent of ground deformation which can be tolerated adjacent to the trench. If ground deformation adjacent to the trench is not of particular concern, it may be feasible to use a conventional trench liner box certified for the ground conditions anticipated. In areas where ground deformation adjacent to the trench is of concern, vertical trench walls should be supported using properly designed and installed braced shoring.

Surface water should be directed away from open excavations and all excavations should conform to the current requirements of the Occupational Health and Safety Act.

5.3 Backfill

Bedding for the pipes should consist of well graded free draining granular material such as Granular "A", which is compatible with the size and type of pipe. All bedding material should be uniformly compacted to at least 95 percent of Standard Proctor Maximum Dry Density (SPMDD).

Depending on the invert depth, a significant volume of silty sand, sand and sand and gravel is likely to be encountered. Smaller volumes of the underlying silt and clayey silt are expected. Selective re-use of the silty sand, sand, and sand and gravel (which were encountered to a depth of about 2.3m in the boreholes) for trench backfill could be considered if it is feasible to separate these materials from the underlying silt and clayey silt. The silt and clayey silt are generally not considered suitable for re-use on this project. Reuse of the excavated silt and clayey silt as trench backfill is not recommended. Imported material to be used as backfill should consist of a well graded granular material form a Region approved source.

The general trench backfill should be placed and uniformly compacted in loose lift thicknesses of 300mm or less, to at least 95 percent of standard Proctor maximum dry density (SPMDD). The upper metre of backfill, comprising the pavement subgrade, should be uniformly compacted to at least 98 percent of SPMDD.

5.4 Soil Quality Issues

Based on the results of the chemical characterization analyses, no concerns regarding the quality of the soils tested have been identified. Further, provided that the existing bituminous pavement materials are separated and disposed of at an appropriate facility, no major constraints regarding the disposal or handling of the remainder of the excavated materials have been identified at this stage, however currently accepted protocols for disposal should be followed. Additional analyses may be required as a condition of final acceptance of the material at a specific disposal site.

5.5 Aggressiveness of Subsurface to Underground Plant

The results of the analyses carried out on a sample of the silty clay till indicate that the subsurface environment is not particularly aggressive with respect to portland cement concrete. Underground concrete plant site should be designed for an S-3 or a Moderate degree of exposure. Criteria for the design of concrete mixes for various classes of exposure are provided in CSA standard A23.1-94, Table 10 and Section 15.5.

With respect to gray or ductile cast iron pipe, the need for special design measures for corrosion protection has not been identified on the basis of the testing carried out.

5.6 Roadway Pavements

Although the design of the roadway pavements is not within the terms of reference of this report, the performance of the completed or restored pavements will be highly dependent on the quality and uniformity of the underground construction. To this end, a regular program of geotechnical inspection and testing should be carried out during construction. All final subgrade subsurfaces should be inspected by the geotechnical engineer prior to placing pavement materials and insitu density testing should be carried out to confirm the degree of compaction achieved in all backfill, granular pavement materials and asphaltic concrete.

In cases where the full width of the roadway pavements are to be reconstructed, it is recommended that the construction of the wearing course of asphaltic concrete be delayed for at least 1 year after construction of the binder course. Prior to placing the wearing course, the binder course should be evaluated and any remedial work carried out, as required, in preparation for final construction.

We trust that this report meets your current requirements. If any point requires further clarification, please do not hesitate to contact our office.

Yours Truly,

Terraprobe Limited

REGISTERED PROFESSIONAL ENGINEER
J. G. MUCKLE
PROVINCE OF ONTARIO

J.G. Muckle, P. Eng., Associate
JGM

TABLE I

SUMMARY OF SOIL QUALITY ANALYSES
PROPOSED WATERMAIN
NAVY STREET
OAKVILLE, ONTARIO

Parameter	BH 1 SA 1 (Fill)	[1]Table A Criteria	[2]Table C Criteria
[3]pH	7.64		
[4]Electrical Conductivity	0.29	N/A	N/A
[3]SAR	0.39	N/A	N/A
Antimony	1.8	13	44
Arsenic	3.1	25	50
Barium	13.5	1000	2500
Beryllium	<0.5	1.2	1.2
Cadmium	<0.5	25	41
Chromium (total)	15.9	1000	2500
Chromium VI	<0.5	10	600
Cobalt	4.2	50	2500
Copper	10.1	200	2500
Lead	9.7	200	1000
Mercury	<0.1	10	57
Molybdenum	0.5	5	550
Nickel	5.8	200	710
Selenium	0.5	2	2500
Silver	<0.5	25	240
Vanadium	24.8	250	910
Zinc	10.5	800	2500
T PH (heavy oils)	410	1000	1000

TABLE I - continued

SUMMARY OF SOIL QUALITY ANALYSES
PROPOSED WATERMAIN
NAVY STREET
OAKVILLE, ONTARIO

Notes: Table to be read with accompanying report.

Certificate of Analysis provided in Appendix A.

All units in ppm except as noted.

[1]Table A: MOEE 1996 Surface soil remediation for agricultural, residential/parkland, and industrial commercial landuse in a potable groundwater situation.
(Lowest landuse concentration shown and for fine grained soil when applicable)

[2]Table C: MOEE 1996 Subsurface soil remediation for agricultural, residential/parkland, and industrial commercial land-use in a potable groundwater situation.
(Lowest land-use concentration shown and for fine grained soil when applicable)

[3] No units

[4] mS/cm

TABLE II

SUMMARY OF CORROSIVITY ANALYSES
PROPOSED WATERMAIN
NAVY STREET
OAKVILLE, ONTARIO

	Borehole 2 SA4
Sample Description	Clayey Silt
pH	7.92
Sulphate (SO_4) (ppm)	496.2
Sulphide (ppm)	<0.5
Chloride (ppm)	443
Soil Resistivity (ohm-cm)	3125
Redox Potential (mv)	268

Notes: Analyses by Fine Analysis Laboratories Ltd.
Table to be read with accompanying report.

Terraprobe Limited

ABBREVIATIONS TERMINOLOGY, AND GENERAL INFORMATION

Sampling Method

SS - split spoon
ST - shelby tube
AS - auger sample
RC - rock core

Penetration Resistance

Standard Penetration Resistance ('N' values) is defined as the number of blows by a hammer of 63.5kg. mass (140 lbs.) falling freely for a distance of 0.76m (30 inches) required to advance a standard 50mm (2 inch) diameter split spoon sampler for a distance of 0.3m (12 inches).

Dynamic Cone Penetration Resistance is defined as the number of blows By a hammer of 63.5 kg. mass (140 lbs.) falling freely for a distance of 0.76m (30 inches) required to advance a conical steel point of 50mm diameter and with 60 degree sides on 'A' size drill rods for a distance of 0.3m (12 inches).

Soil Description

Cohesionless Soils

Relative Density	'N' Value
very loose	<4
loose	4 - 10
compact	10 - 30
dense	30 - 50
very dense	>5

Cohesive Soils

Consistency	Undrained Shear Strength (kPa)	'N'
very soft	<12	<2
soft	12 - 15	2 - 4
firm	25 - 50	4 - 8
stiff	50 - 100	8 - 16
very stiff	100 - 200	16 - 32
hard	>200	>32

Soil Composition	% By Weight
'trace' (eg. trace silt)	<10
'some' (eg. some gravel)	10-20
'adjective' (eg. sandy)	20-35
'and' (e.g. sand and gravel)	35-50

General Information

The recommendations provided in this report are based on the factual information obtained from the boreholes and on the general information provided for the proposed project.
Site investigations by means of boreholes and/or test pit identifies subsurface conditions at the location and time of sampling only. Ground conditions at locations away from the boreholes and test pits may vary.
Recommendations are made by interpretation of this factual data for specific conditions such as size, configuration and location of the proposed project. Changes in project conditions should be reviewed by the Geotechnical consultant as they may affect the recommendations provided.
In order to identify possible changes in ground conditions between the sample locations and their effect on the project, it is recommended that site inspections be carried out during construction by qualified Geotechnical personnel.

Terraprobe

PROJECT No: 973052-4

CLIENT: Region of Halton

LOCATION: See Plan Figure 2

LOG OF BOREHOLE 1

BORING DATE: June 25, 1997

ELEVATION DATUM: Geodetic

SAMPLER HAMMER, 63.5kg; DROP, 760mm

BORING METHOD: CME 55 Truckmounted Rig - 95mm Inside Diameter Hollow Stem Auger

Depth (m)	Description	Elev. / Depth (m)	Sample Number	Type	"N" Value	Installation Information
0	GROUND SURFACE (75mm ASPHALTIC CONCRETE)	87.50 / 0.00				
	GRANULAR ROAD BASE (FILL)	87.10 / 0.40				
1	Compact, brown, SILTY fine to medium SAND.	85.80 / 1.70	1	SS	12	
2	Compact, brown, SAND & GRAVEL.	85.20 / 2.30	2	SS	28	DRILL CUTTINGS
3–5	Compact to dense, brown to grey, SILT; with seams and layers of fine sand.	82.47 / 5.03	3	SS	31	06/26/97
			4	SS	37	ENC.
			5	SS	27	SLOTTED PIPE
	END OF BOREHOLE					

PENETRATION RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH kPa: nat.V – +, rem.V – ⊕, Q – ●, U – ○; 20 40 60 80

WATER CONTENT (%): wP – w – wL; 10 20 30

NOTES:
Water level at elev'n 84.0m on completion.

Water level in stand-pipe at elevation 84.65m, June 26, '97.

SHEET 1 OF 1

OAKVILLE-1.DWG

Terraprobe

PROJECT No: 973052-4
CLIENT: Region of Halton
LOCATION: See Plan Figure 2

LOG OF BOREHOLE 2

BORING DATE: June 25, 1997
ELEVATION DATUM: Geodetic
SAMPLER HAMMER, 63.5kg; DROP, 760mm

BORING METHOD: CME 55 Truckmounted Rig - 95mm Inside Diameter Hollow Stem Auger

DEPTH SCALE IN METRES	DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	"N" VALUE	WATER CONTENT (%)
0	GROUND SURFACE (75mm ASPHALTIC CONCRETE)	88.53 / 0.00				
	GRANULAR ROAD BASE (FILL)	88.08 / 0.45				
1	Compact, brown, SILTY fine to medium SAND.	87.03 / 1.50	1	SS	23	o
2	Compact, brown, fine to medium SAND; trace silt.	86.28 / 2.25	2	SS	35	o
	Compact, brown, SILT; interlayered with fine to medium sand.	85.63 / 2.90	3	SS	35	o
3–5	Stiff to very stiff, brown to grey, CLAYEY SILT; trace gravel.	83.50 / 5.03	4	SS	22	o
			5	SS	9	o
5	END OF BOREHOLE					

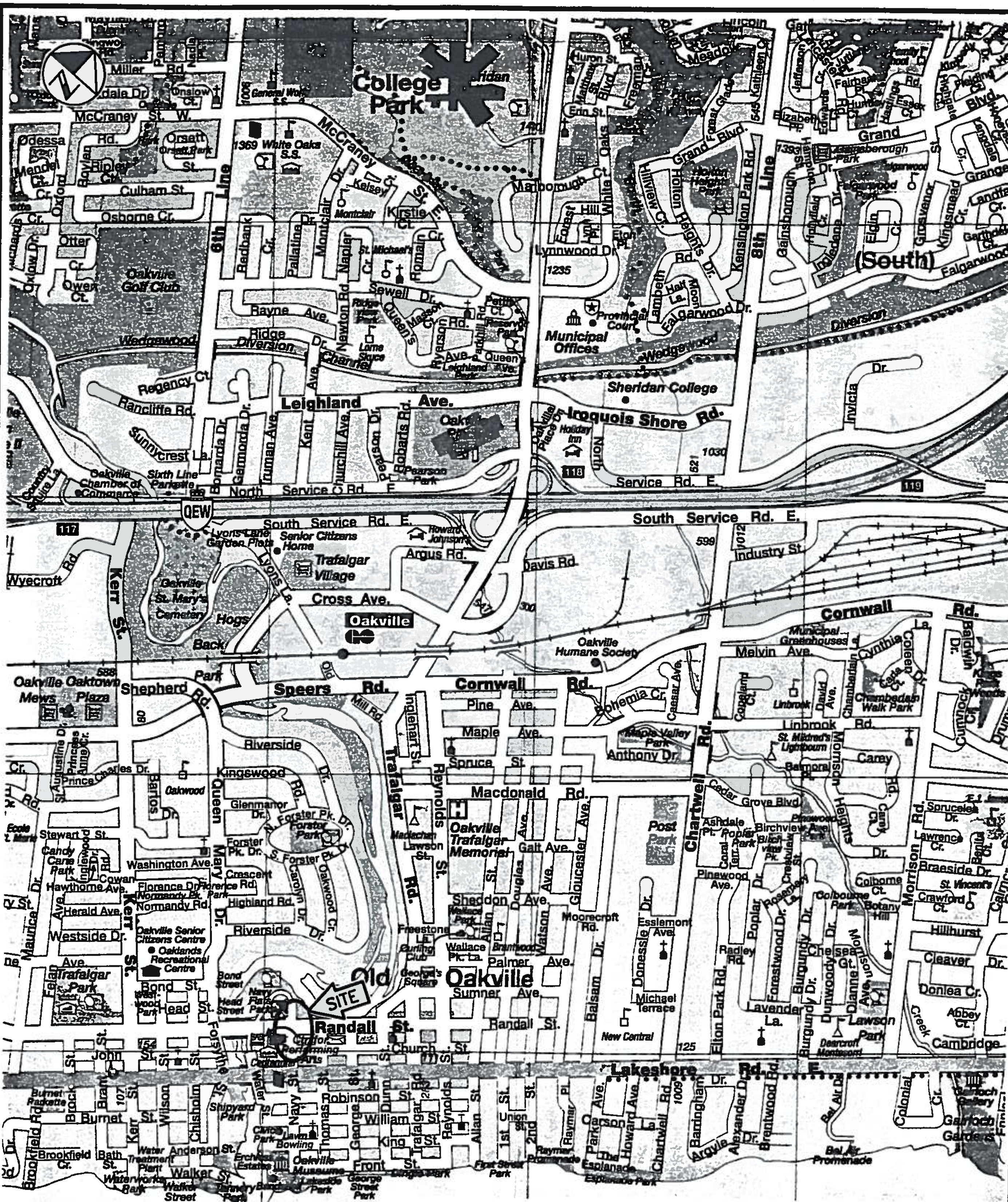
PENETRATION RESISTANCE PLOT: 20 40 60 80
SHEAR STRENGTH kPa: nat.V – + ; rem.V – ⊕ ; Q – ● ; U – O ; 20 40 60 80
WATER CONTENT (%): wP — w — wL ; 10 20 30

INSTALLATION INFORMATION

NOTES:
Borehole dry upon completion of drilling.

SHEET 1 OF 1

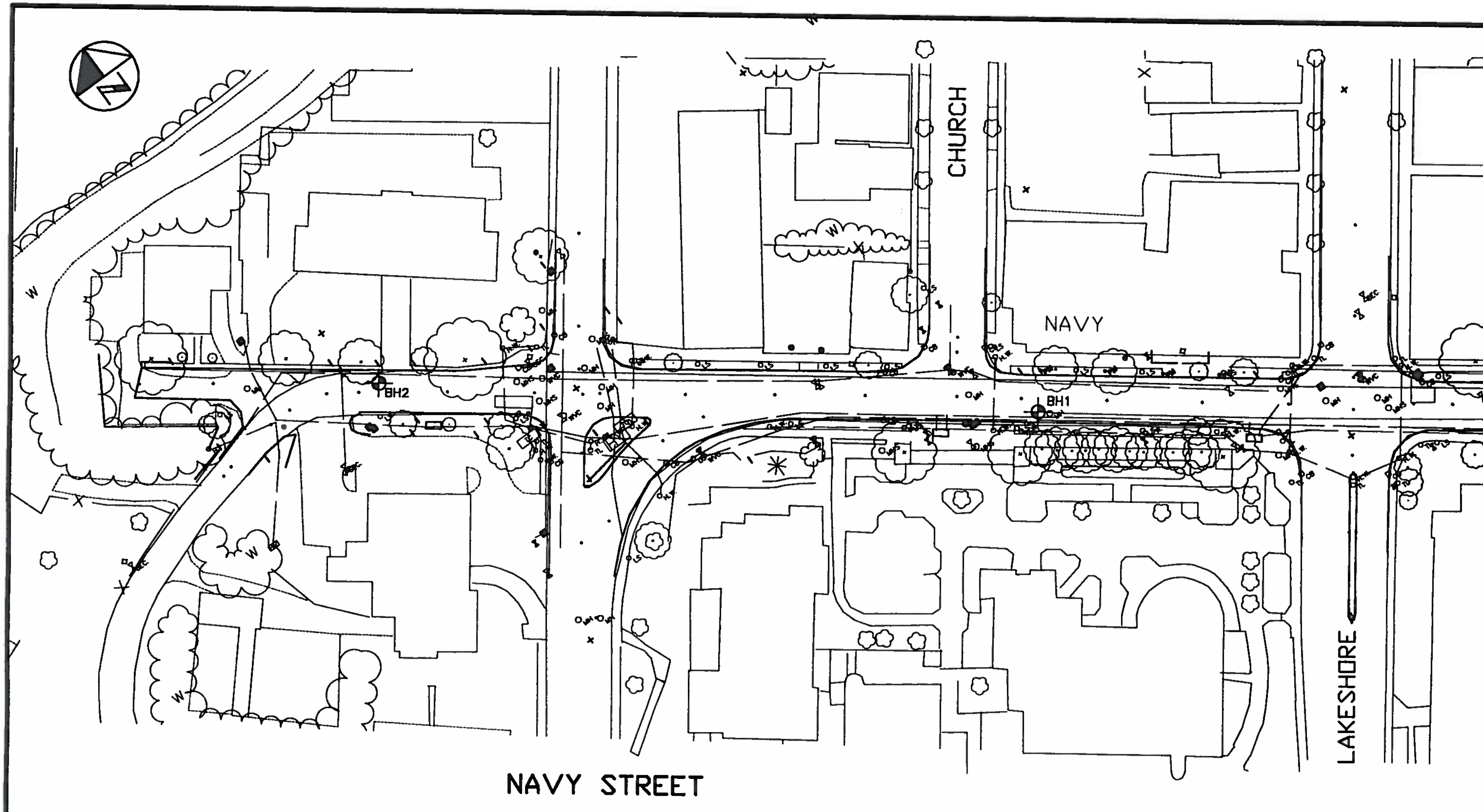
OAKVILLE-2.DWG



KEY PLAN
OAKVILLE, ONTARIO

Terraprobe

Job no.: 973052	FIGURE 1
Scale: N.T.S.	
Date: July, 1997	



LEGEND:
BH1 location of borehole

SCALE: (in metres)

0 25 50 75 100

NOTES:
all locations and scales are approximate.

LOCATION PLAN
OAKVILLE, ONTARIO

Terraprobe

Job no.:	973052-4
Scale:	as noted
Date:	July, 1997

FIGURE 2

APPENDIX A

Terraprobe Limited

FAL

Fine Analysis Laboratories Ltd.

236 Pritchard Road, Hamilton, Ontario L8W 3P7 Tel: (905) 574-4977 Fax: (905) 574-4766

CLIENT:	Terraprobe 903 Barton St. Unit #22 Stoney Creek, Ontario L8G 5E5	Phone: Fax:	905-643-7560 905-643-7559
ATTENTION:	Mr. G. Muckle		
DATE RECEIVED:	June 27/97		
DATE COMPLETED:	July 9/97		
PROJECT NUMBER:	973052		
SAMPLE ID.:	See Table #1		
REPORT NO.:	FA809AQ1-8		
SAMPLE TYPE:	Soil		

Notes:

-All results are blank corrected
-np = test not performed
-solids results are based on dry weight

Methods used by Fine Analysis Laboratories Ltd. are based upon those found in "Standard Methods for the Examination of Water and Wastewater", Seventeenth Edition , Published by the American Public Health Association, 1015 Fifteenth Street, NW, Washington, DC 20005. Other methods are based on the principles of MISA or EPA Methodologies.

Results: See attached sheet.

Yana L'Pris, M.Sc. C. Chem. Chemist FINE ANALYSIS LABORATORIES	Shahid Abdullah Senior Chemist FINE ANALYSIS LABORATORIES

Fine Analysis Laboratories employs a strict QA/QC program at all stages of analysis in order to maintain the principles of good laboratory practices. Valid methodologies are used to the best of our abilities, however, our liabilities are limited solely to the analytical cost of sample submitted.

THANK YOU FOR CONSIDERING FINE ANALYSIS LABORATORIES FOR ANALYTICAL SERVICES.

Fine Analysis Laboratories Ltd.

236 Pritchard Road, Hamilton, Ontario L8W 3P7 Tel: (905) 574-4977 Fax: (905) 574-4766

Report No.: FA809AQ1-8

INTRODUCTION: Fine Analysis Laboratories Ltd. obtained eight (8) samples, and was instructed to perform parameters listed in table #1.

Table #1

Sample ID.	Sample Type	Test Parameters	Lab Number
Oakville BH1 SA1	Soil	Decommissioning (1996) , TPH (heavy oils)	FA809AQ-1
Oakville BH2 SA4	Soil	pH, Resistivity, Redox Potential, Sulphide, Chloride, Sulphate	FA809AQ-2
Burlington BH3 SA1	Soil	Decommissioning (1996) , TPH (heavy oils	FA809AQ-3
Burlington BH2 SA3	Soil	pH, Resistivity, Redox Potential, Sulphide, Chloride, Sulphate	FA809AQ-4
Acton BH1 SA2	Soil	Decommissioning (1996) , TPH (heavy oils)	FA809AQ-5
Acton BH2 SA4	Soil	pH, Resistivity, Redox Potential, Sulphide, Chloride, Sulphate	FA809AQ-6
Milton BH2 SA1	Soil	Decommissioning (1996) , TPH (heavy oils)	FA809AQ-7
Milton BH3 SA4	Soil	pH, Resistivity, Redox Potential, Sulphide, Chloride, Sulphate	FA809AQ-8

Fine Analysis Laboratories Ltd.

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Report No.: FA809AQ1-8

>>>> CERTIFICATE OF ANALYSIS <<<<

Sample ID.	Lab Number	Resistivity (ohm-cm)	pH	Redox Potential (mv)	Sulphide (ppm)	Chloride (ppm)	Sulphate (ppm)
Oakville BH2 SA4	FA809AQ-2	3125.0	7.92	268	<0.5	443.0	496.2
Burlington BH2 SA3	FA809AQ-4	2631.6	7.86	300	<0.5	125.0	678.6
Acton BH2 SA4	FA809AQ-6	3030.3	7.99	290	<0.5	24.0	399.5
Milton BH3 SA4	FA809AQ-8	2777.8	7.76	254	<0.5	19.3	528.1

Fine Analysis Laboratories Ltd.

236 Pritchard Road, Hamilton, Ontario L8W 3P7 Tel: (905) 574-4977 Fax: (905) 574-4766

Report No.: FA809AQ1-8

PARAMETERS	MDL (ppm)	SAMPLE DATA (ppm)				
		Oakville BH1 SA1 FA809AQ-1	Burlington BH3 SA1 FA809AQ-3	Acton BH1 SA2 FA809AQ-5	Milton BH2 SA1 FA809AQ-7	
pH		7.64	7.58	7.71	7.60	
EC (mS/cm)	0.01	0.29	0.34	0.30	0.23	
SAR (1)	0.1	0.39	0.48	0.51	0.41	
Arsenic	0.5	3.1	2.0	4.3	3.2	
Cadmium	0.5	<0.5	<0.5	<0.5	<0.5	
Chromium (VI)	0.5	<0.5	<0.5	<0.5	<0.5	
Chromium Total	0.5	15.9	24.1	17.1	33.9	
Cobalt	0.5	4.2	3.3	6.5	5.1	
Copper	0.5	10.1	23.7	35.3	33.7	
Lead	0.5	9.7	19.7	142.2	34.8	
Mercury	0.1	<0.1	<0.1	<0.1	<0.1	
Nickel	0.5	5.8	7.9	4.4	5.2	
Selenium	0.5	0.5	0.8	0.5	0.7	
Silver	0.5	<0.5	<0.5	<0.5	<0.5	
Zinc	0.5	10.5	47.3	174.5	79.3	
Antimony	0.5	1.8	5.6	2.9	3.6	
Barium	0.5	13.5	56.6	60.1	129.1	
Vanadium	0.5	24.8	21.9	14.5	30.1	
Molybdenum	0.5	0.5	0.7	0.6	0.5	
Beryllium	0.5	<0.5	<0.5	<0.5	<0.5	

Fine Analysis Laboratories Ltd.

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Report No.: FA809AQ1-8

>>>> CERTIFICATE OF ANALYSIS <<<<

BTEX, Total Purgeable Hydrocarbon
Total Extractable Hydrocarbon,
Total Petroleum Hydrocarbon Determination
Analysis date(s): June 27/97

Soil
Concentration Units:ug/g=ppm

PARAMETERS	MDL	LOQ	Oakville BH1 SA1 FA809AQ-1	Burlington BH3 SA1 FA809AQ-3	Acton BH1 SA2 FA809AQ-5	Milton BH2 SA1 FA809AQ-7
Benzene	0.02	0.05	np	np	np	np
Toluene	0.02	0.05	np	np	np	np
m,p-xylene	0.02	0.05	np	np	np	np
o-xylene	0.02	0.05	np	np	np	np
Total Xylene	0.02	0.05	np	np	np	np
Ethyl Benzene	0.02	0.05	np	np	np	np
Petroleum (Gas/Diesel)	0.2	0.25	np	np	np	np
Petroleum (Heavy oils)	0.2	0.25	410.3	280.3	1860.3	504.7
Resemblance	na	na				

TPH (Gas /Diesel) = summation of hydrocarbons from C5 up to and including C30 carbon chain length and is quantitated against gasoline, diesel, or oil standard (precision =/- 10%

TPH (Heavy oil) = summation of Hydrocarbons greater then C25

LOQ = Limit of quantitation = lowest level of the parameter that can be quantitatec with confidence.
MDL = Minimum Detection Limit
nd = parameters not detected.
na = not applicable.
np = test not performed
TR = Trace level less then LOQ
Note. Final results have been corrected for the presence of laboratory artifacts.

L.J. RAK ENGINEERING LTD.

Pr-650

C-236-2

March 3, 1983

The Regional Municipality of Halton
P.O. Box 7000
2316 South Service Road West
Oakville, Ontario
L6J 6E1

Attention: Mr. William Y.K. Wong, P.Eng.,
Project Co-ordinator, Design

Re: Geotechnical Investigations
Replacement of Pumping Stations
PR-738 Navy Street
PR-650 First Street
Oakville, Ontario

Dear Sirs:

We have completed the above investigations and submit the results together with our comments in this letter report.

The field work was carried out on March 1, 1983 and consisted of two boreholes, one at each pumping station and as shown on the enclosed drawings. Soil samples were taken using the Standard Penetration Test method. They will be stored for a period of three months following the date of this letter and then discarded unless other instructions are received.

Elevations referred to in this report are related to local bench marks (assumed elevation 100.00 m) defined as:

- Navy Street - top of Manhole, about 3 m in front of entrance to the existing pumping station.
- Frist Street - top of hydrant, 5 m NE of existing pumping station.

117 Disco Road, Rexdale, Ont. M9W 1M3 Phone: (416) 675-0160

The top of the hydrant on Frst Street is about 700 mm above ground level, defining the latter as about elevation 99.3. As a further reference, the manhole just north of the existing pumping station was tied in as elevation 99.24, comparing closely to the elevation of Borehole 4 at elevation 99.27.

SOIL & GROUNDWATER CONDITIONS

a) Navy Street - Borehole 3 was put down in this area, about 3 m north of the existing pumping station. The soil conditions in Borehole 3 are shown on the enclosed Data Sheet and consist of compact sandy silt to a depth of about 2.5 m followed by compact silt till which extends to a depth of 4.7 m where refusal was met. It is assumed, although not confirmed that bedrock exists at this depth.

   The borehole was dry during drilling and remained dry upon completion. The borehole is close to the shore of 16 - Mile Creek. The water level in the creek was about 4 m below the ground level at Borehole 3, i.e. at about elevation 96.6 and about 1.3 m above the bottom of the hole. It is estimated that the groundwater level at the borehole location would be close to elevation 97 i.e. in the silt till.

b) First Street - Borehole 4 was put down in this area and on the west side of the street to avoid burried utilities. The soil conditions in Borehole 4 are shown on the enclosed Data Sheet. The pavement consists of 50 mm of asphalt on a granular base about 250 mm in thickness. Fill, consisting of very loose silty sand with some clay, extends to a depth of about 1.4 m and is underlain by compact to dense stratified sandy silt with sand layer(s). The sandy silt extends to a depth of about 3.4 m and, in turn, is underlain by very dense silt till to a depth of about 6 m where refusal was met. The evidence would appear to indicate that weathered shale was penetrated near the bottom of the borehole and that auger refusal was caused by bedrock.

The borehole became wet at a depth of about 1.6 m, coinciding with the presence of a sand layer within the silt. The groundwater level shortly after completion of the borehole was measured at a depth of about 1.8 m below ground level.

COMMENTS

It is intended to replace the existing pumping stations at Navy and First Streets. The proposed depths of the new stations, nor the depths of the existing stations are known to us at this time. However, the specified borehole depths for both stations was 8 m or refusal. It is therefore assumed that the proposed pumping station depths are of the order of 8 m.

Boreholes 3 and 4 met refusal to both sampling and augering at depths of 4.7 m and 6.2 m respectively and it has been assumed that bedrock was reached at these levels. The assumed bedrock is overlain by silt till at both locations. The silt till is very dense in Borehole 4 and at least compact in Borehole 3.

On the basis of the results obtained in Borehole 3, it is considered that the minimum allowable bearing pressure of the silt till is of the order of 200 kPa. For foundations in rock, the minimum allowable bearing pressure is of the order of 1000 kPa. In Borehole 4, the silt till is very dense with a minimum allowable bearing pressure of 500 Kpa.

In the design of the pumping stations, the net addition of load at the bearing level will probably be very samall. The allowable bearing pressures referred to above should therefore be well in excess of those required.

The excavations for the pumping stations at both sites are in compact sandy silt, compact to very dense silt till and probably well into bedrock. In addition some surficial fill may be encountered at the First Street location.

The physical dimensions of the required excavations are not known, but excavation procedures will be governed mainly by lateral restrictions. It may be possible to carry out the upper part of the excavations in open cut, in which case side slopes of about 40 degrees would suffice. It is probable however that lateral restrictions will dictate that most of the excavation will need to be vertical and that the excavation sides will have to be properly sheeted and shored.

At the Navy Street location most, if not all of the excavation will probably be dry. The silt till has a low permeability (of the order of 10^{-4} to 10^{-5}cm/sec) and inflow of natural (or perched) groundwater should be controllable with normal pumping procedures. At the First Street site, an apparently stationnary groundwater level existed at a depth of about 1.8 m below ground level. It should be noted however that this depth coincides with that of a layer of sand. It is possible that groundwater is actually perched in this sand layer (or pocket) and that (if present during construction) it would "dry up" as the excavation proceeds. The contractor should, however, be prepared to seal off this layer, or dewater it, as required. If the natural groundwater level is at a depth of 1.8 m (i.e. not perched in the sand), excavation in the sandy silt to a depth of about 3.4 m will have to deal with it. The permeability of the sandy silt is estimated to be of the order of 10^{-4}cm/sec and, due to stratification, locally possibly greater. The contractor should therefore be prepared to employ more sophisticated dewatering methods, such as well points, to dewater the excavation below about elevation 97 if and as required.

The sandy silt and silt till at both locations are not ideal backfill materials as they may be difficult to compact to their original density. However, considering the quiet residential nature of the area of First Street and the minimal traffic demands at the Navy Street station, it is probably quite acceptable to use native backfill as long as some provision is made for future repair of the road surface.

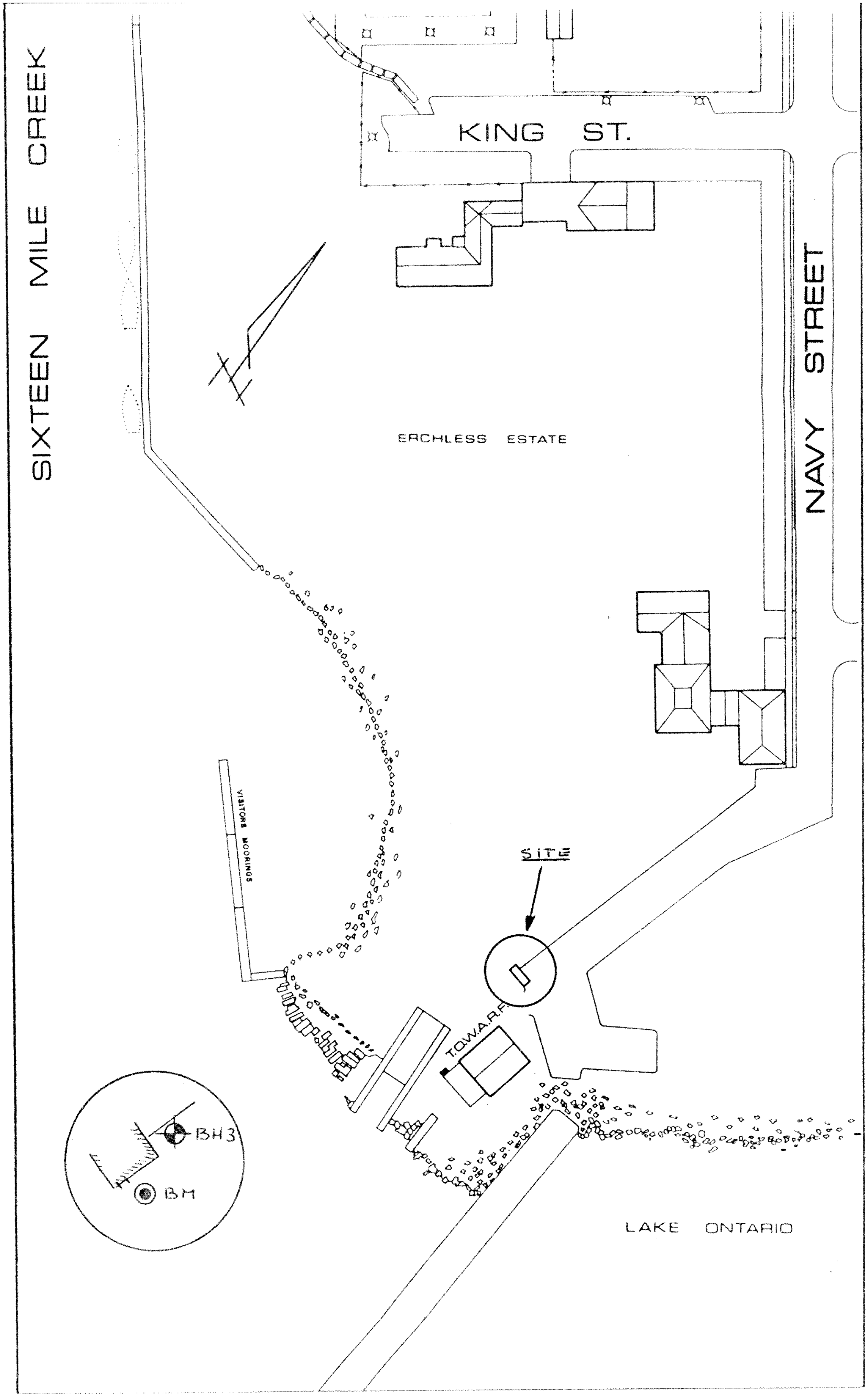
We believe that this letter contains the information required. However, should you need any clarification or if we can be of further assistance, please call us.

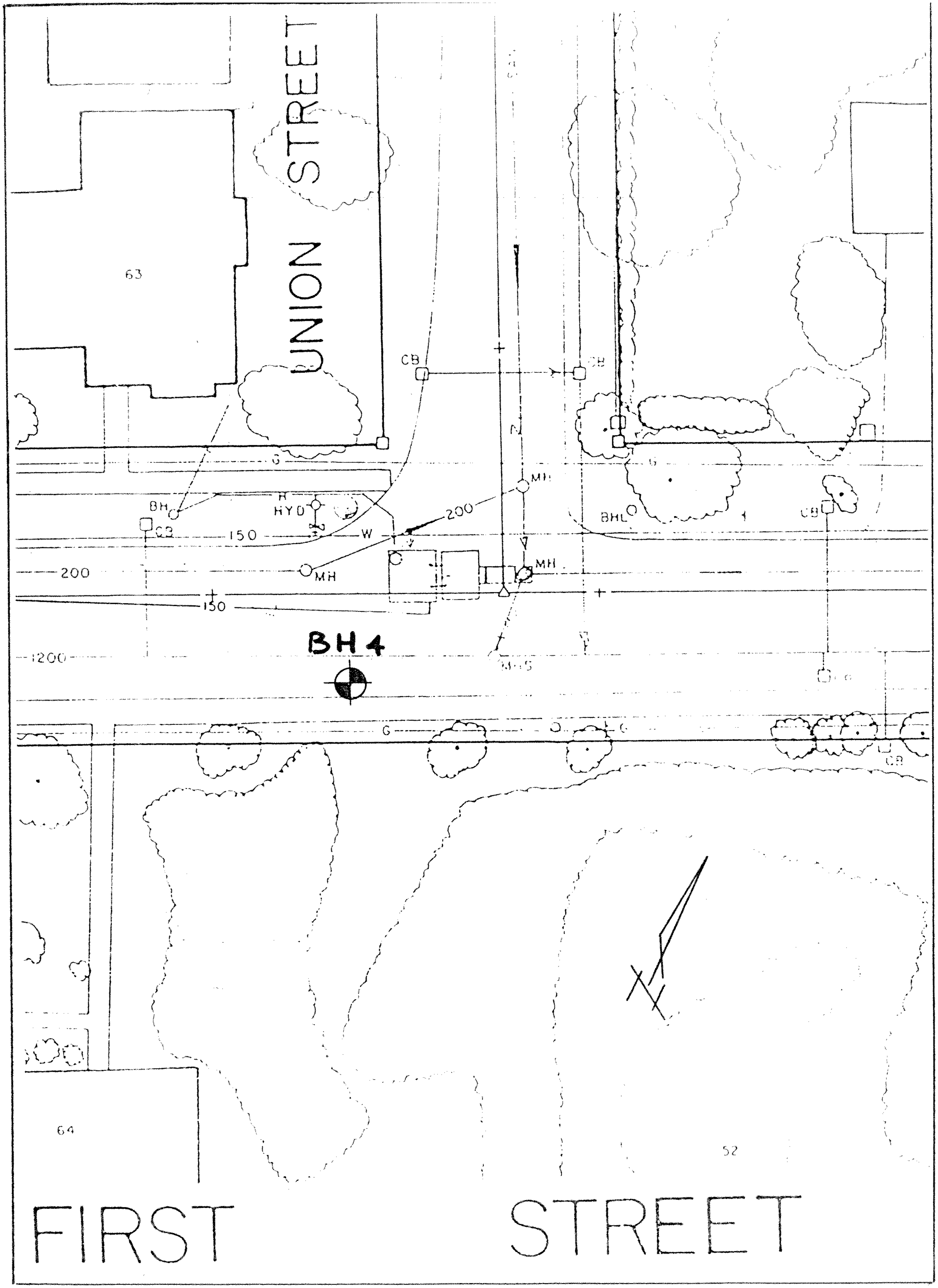
Yours very truly,

L.J. RAK ENGINEERING LTD.

A. Prior, P.Eng.

AP/mr


SIXTEEN MILE CREEK
KING ST.
NAVY STREET
ERCHLESS ESTATE
VISITORS MOORINGS
SITE
T.O.W.A.R.F.
BH3
BM
LAKE ONTARIO


UNION STREET
63
CB
CB
G
G
BH
HYD
200
MH
BHL
CB
CB
150
W
200
MH
MH
150
1200
BH 4
MHS
G
G
CB
64
52
FIRST STREET

L.J. RAK ENGINEERING LTD.

DATA SHEET FOR BOREHOLE 3 DRAWING

Project No. C-236-2 (Your No.)

Project PROPOSED PUMPING STATION

Location OAKVILLE, ONTARIO

Hole Location BOTTOM OF NAVY STREET

Date Drilled MAR. 1, 1983 Hole

Drilled by AUGER

Datum LOCAL

Field		Laboratory	
2" O.D. Split Tube		Natural Moisture	
2", 3" I.D. Shelby Tube		Plastic & Liquid Limit	
Rotary Core Sample		Lab Vane Test	◇
Auger or Wash Sample		Torvane	◆
2" Dia Cone		Unconfined Compression	⊕
Field Vane		Undrained Triaxial at Overburden Pressure	
Pressure Meter		Strain at Failure	
Sampler Pushed (pressure)	P( )	Sensitivity	
Water Table (definite, apparent)			

Symbol	Description / Classification	Elevation M	Depth M	Penetration Resistance, N, 350 ft lbs. blows/ft. (20, 40, 60, 80) / Shear Strength	Natural Water Content & Atterberg Limits (% dry weight) / Sensitivity	Sample Type & Number	Unit weight / Recovery %
	SANDY SILT to very silty fine SAND compact, reddish-brown, distinctly layered below ± 1.4 m	100.60	0.00				
				26		1	100%
				20		2	100%
	SILT TILL compact to very dense at depth, grey, clayey in upper part	98.10	2.50				
				18		3	35%
				60 blows - 125 mm		4	100%
	End of Borehole Sampler Refusal and subsequent Auger Refusal at same depth.	95.30	4.70				

Notes

Borehole dry.

Borehole 3

LJ. RAK ENGINEERING LTD.

DATA SHEET FOR BOREHOLE 4 DRAWING

Project No C-236-2 (Your No.)
Project PROPOSED PUMPING STATION
Location OAKVILLE, ONTARIO
Hole Location FIRST & UNION STREETS
Date Drilled MAR. 1, 1983 Hole
Drilled by AUGER
Datum LOCAL

Field
2" O.D. Split Tube
2", 3" I.D. Shelby Tube
Rotary Core Sample
Auger or Wash Sample
2" Dia. Cone
Field Vane
Pressure Meter
Sampler Pushed (pressure) P( )
Water Table (definite, apparent)

Laboratory
Natural Moisture
Plastic & Liquid Limit
Lab Vane Test
Torvane
Unconfined Compression
Undrained Triaxial at Overburden Pressure
Strain at Failure
Sensitivity

Symbol	Description / Classification	Elevation M	Depth M	Penetration Resistance, N, 350 ft lbs. blows/ft. (20, 40, 60, 80) / Shear Strength	Natural Water Content & Atterberg Limits (% dry weight) / Sensitivity	Sample Type & Number	Unit weight / Recovery %
	FILL silt and sand, some clay, very loose, grey-brown	99.27	0.00	4		1	100%
	SANDY SILT compact to dense, brown and reddish-brown, becoming grey at ± 2.5 m, partly stratified, layer of silty fine to medium sand at ± 1.8 m	97.87	1.40	29		2	100%
				44		3	100%
	SILT TILL very dense, grey, trace of clay,	95.87	3.40				
	becoming more clayey at bottom, possibly weathered shale			80		4	100%
				70 blows - 100 mm		5	100%
	End of Borehole	93.80	6.20				

Notes
1) Auger Refusal at 6.40 m
2) Borehole becoming wet at ± 1.6 m.
3) Water level at 1.83 m upon completion of borehole.

Borehole 4