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LOCATION Hwy 401 Service Centre E-7

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-400

Ministry of Transportation

Ontario

PROJECT NO. 10455

REPORT TO

McNEELY ENGINEERING CONSULTANTS

ON

FOUNDATION INVESTIGATION

W.P. 2623-90-00
HIGHWAY 401 SERVICE CENTRE, E-7
WASHROOM FACILTIY
HIGH MAST LIGHTS P1, P2, P3 AND P4
DISTRICT 9, OTTAWA

MINISTRY OF TRANSPORTATION

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April 20, 1994

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FOUNDATION INVESTIGATION REPORT

for

W.P. 2623-90-00
Highway Service Centre E-7
Washroom Facility
High Mast Lights P1, P2, P3 and P4

District 9, Ottawa

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at the above noted site between December 1, 1993 and February 28, 1994. The investigation was carried out in accordance with our letters of proposal submitted to McNeely Engineering Consultants Limited on November 8 and 22, 1993 and February 8, 1994, in order to establish soil parameters for the design of the foundations for a small building and four high mast lights (HMLs). Authorization to carry out this work was received from Mr. E. Vickers, P.Eng. of McNeely Engineering acting on behalf of the Ministry of Transportation of Ontario (MTO) in a letter dated November 24, 1993.

This report contains factual information obtained from the investigation pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

The Highway 401 Service Centre E-7 is located north of the west bound lanes of Highway 401, 7.3 km west of the Thousand Island Parkway, in Leeds County near Brockville, Ontario, as shown on the Key Plan in Drawing No. 10455-1 in the Appendix. An existing rest stop at this location includes a Wendy's Restaurant, a Tim Horton's, and an Esso Service Centre with parking located to the northeast. In addition, there is an existing picnic area located approximately 375 m northeast of the main service centre. Facilities in the picnic area include a small washroom structure.

Physiographically, the site lies in the area known as Leeds Knobs and Flats. The surface is dominated by bedrock outcrops surrounded by clay plains. Bedrock in the area consists of undifferentiated Precambrian rocks. Overburden thickness varies from 0 m to over 20 m.

The ground surface in the vicinity of the existing washroom structure in the picnic area is generally grass covered and flat. Drainage is towards a swampy area to the southeast. A bedrock outcrop is present 30 m north of the existing washroom.

The ground surface south and west of the existing Wendy's Restaurant is generally a flat, open field with scattered trees. Drainage is to the south towards a swampy area. A bedrock outcrop lies to the northwest of the area.

The area north of the Wendy's Restaurant is already developed to some extent. The ground surface is generally flat and gravel covered. It is evident that rock fill has been placed at some locations. A bedrock outcrop exists 20 m to the southwest.

3.0 PROCEDURE

3.1 Field Investigation

The initial field work for the investigation was carried out on December 2 and 3, 1993. Six (6) boreholes, numbered 93-1 through 93-6 inclusive were put down at the locations established in the field by McNeely Engineering Limited. A second field investigation was performed on February 18, 1994 to acquire information at the revised locations of three of the HMLs. Three (3) additional boreholes were put down at the locations established in the field by MTO, as shown in Drawing No. 10455-1 in the Appendix. The locations were cleared of underground utilities prior to drilling by McNeely Engineering Limited.

The boreholes were put down to depths ranging from 0.7 m to 15 m using a track mounted CME 55 power auger drill equipped with 200 mm outside diameter hollow-stem augers. The soils were sampled at regular intervals by conducting Standard Penetration Tests in the 1993 boreholes. The 1994, supplementary investigation was performed to confirm soil and rock conditions with a more limited sampling program. All soil samples recovered were stored in moisture-proof bags and were returned to our laboratory for detailed classification by a geotechnical engineer.

Standpipe piezometers were installed in Boreholes 93-1, 93-2, 93-3, 93-5 and 93-6. The groundwater levels presented on the Borehole Records were measured on December 3 and 8, 1993.

A percolation test was performed at a location approximately 12 m east of the proposed washroom structure. The excavation of the percolation test hole and performance of the test were carried out in accordance with MOEE guidelines.

3.2 Survey

The 1993 borehole locations were surveyed and staked by McNeely Engineering Limited prior to drilling. Ground surface elevations were determined at each borehole location by Jacques, Whitford Limited personnel. Ground surface elevation for Boreholes 93-1 and 93-2, which are located in the picnic area, were referenced to the floor slab of the existing washroom, which is understood to be at an elevation of 95.00 m Geodetic at the south end of the building.

The ground surface elevations at the remaining boreholes were determined with respect to the Geodetic elevation contours presented on the base plan, Drawing No. 5099-2 provided by McNeely Engineering Limited. The 1994 borehole locations were surveyed and staked by MTO prior to drilling. Ground surface elevations at each borehole location were also determined by MTO.

3.3 Laboratory Testing

All soil samples recovered were stored in moisture proof bags and returned to our laboratory for detailed classification and testing. Selected samples were subjected to moisture content, Atterberg limits, grain size distribution, pH, sulphate and chloride tests. Samples remaining after testing will be stored for a period of three months after issuance

4.0 RESULTS OF THE INVESTIGATION

4.1 Subsurface Profile

The subsurface profile observed in the boreholes are presented in detail on the Borehole Records provided in the Appendix and are summarized in Table 1 which is also provided in the Appendix. An explanation of the symbols and terms used to describe the Borehole Records is also provided. The borehole locations are indicated in Drawing No. 10455-1 in the Appendix.

In general, the observed stratigraphy consists of the existing surficial materials including topsoil and fill, overlying silt overlying till. Bedrock was encountered in five (5) of the boreholes. A summary of the observed subsurface conditions is provided below.

4.1.1 Surficial Materials

A thin layer of surficial topsoil/rootmat was encountered in BH 93-2, 93-5, 93-6, 94-1 and 94-2. Thickness of the topsoil ranged from none to 600 mm. A layer of asphalt, 125 mm in thickness, was encountered at ground surface in BH 94-3. This was underlain by 200 mm of Granular A gravel.

Fill material was encountered immediately below the surficial materials described above or at ground surface in Boreholes 93-1 through 93-4 and 94-3. The fill was composed of silty clay material with some sand in the picnic area (BH 93-1 and 93-2) and was measured to be approximately 1.5 m in thickness. A hydrometer test was performed on a representative sample of this soil and the results indicate that it is composed of 0% gravel, 18% sand and 82% silt and clay sized particles (see Grain Size Curve, Figure 10455-2 in the Appendix). The D_{10} of the tested sample is less than 0.001 mm. In the vicinity of the restaurant, the fill, where present, varied between 0.7 and 1.8 m in thickness and consisted of sand, gravel and boulders. Some rock fill was observed at some locations in the vicinity of Borehole 93-5.

A thin layer, 0.8 m in thickness, of organic silt was encountered beneath the fill in Borehole 93-3. This material probably represents the original ground surface prior to placement of the fill.

4.1.2 Silty Clay

A silty clay was encountered underlying the fill and the organic silt in Borehole 93-3. This layer was found to be 1.9 m in thickness. A representative sample was determined to have a liquid limit of 37%, a plastic limit of 20% and a natural moisture content of 27%. This soil can be classified as a medium plastic clay (See Plasticity Chart, Figure 10455-1 in the Appendix). A hydrometer test was also performed on this soil and the results indicate that it is composed of 0% gravel, 3% sand and 97% silt and clay sized particles (See Grain Size Curve, Figure 10455-2 in the Appendix).

Undrained shear strength of the silty clay was estimated to be over 100 kPa on the basis of pocket penetrometer testing of the two recovered split spoon samples. The silty clay is stiff to very stiff in consistency.

4.1.3 Silt

A complex sequence of silt was encountered below the soil units described previously in all boreholes except Borehole 93-4. The components of this material include very fine grained silt, with occasional fine sand seams as well as seams of very hard clay towards the bottom of the unit. The thickness of this silt sequence ranged from 2.4 to 14.0 m.

A grain size distribution carried out on a selected sample is shown on Figure 2 in the Appendix. Standard Penetration Test N-values recorded for this material ranged from 2 to 40 indicating a loose to dense relative density with a decrease in density being indicated with depth. Moisture content tests carried out on representative samples indicated moisture contents ranging from 18% to 34% with an average of 24%.

4.1.4 Silty Sand and Gravel Till

A glacial till deposit consisting of silty sand and gravel was encountered beneath the silt unit in the boreholes located in the picnic area. The till was found to be 0.7 and 0.2 m in thickness in Boreholes 93-1 and 93-2 respectively. The till was grey in colour and very wet. The Standard Penetration N-value on the one test performed in this unit was 6 which is indicative of a loose material.

4.1.5 Bedrock

Bedrock was inferred by auger refusal at Boreholes 93-1, 93-4, 93-5, 93-6, 94-1 and 94-3. Bedrock was proven by coring in Boreholes 93-2 and 93-3. The depth to bedrock varied from 0.7 m at Borehole 93-4 to over 15 m at BH 94-2. The core recovered consisted of a massive granitic gneiss. The core recoveries were 60% and 100% and the RQD values were 20% and 83% indicating the rock to be very severely fractured to sound. Only a thin weathered zone, less than 25 mm, was observed at the top of the bedrock. The unconfined compressive strength of this deposit is estimated to be greater than 15 MPa.

4.2 Groundwater

Standpipes piezometers were installed in the Boreholes 93-1, 93-2, 93-3, 93-5 and 93-6 and readings were taken on completion of drilling and on December 8, 1993. The groundwater levels are shown on the Borehole Records. The readings indicate groundwater levels very close to the ground surface in all of the boreholes with the exception of BH 93-3. Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

4.3 Percolation Testing

The results of the in-situ percolation test carried out near the location of the proposed washroom facility indicate that the surface soils are relatively impermeable. The "T" time was found to be greater than 50 min/cm.

5.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of B. Prevost, C.E.T. utilizing equipment owned and operated by Johnston Drilling Limited. The report was written by both of the undersigned.

Respectfully submitted,

JACQUES, WHITFORD LIMITED

LICENSED PROFESSIONAL ENGINEER
F. J. GRIFFITHS
PROVINCE OF ONTARIO

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JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-1

CLIENT: McNeely Engineering Consultants

PROJECT No. 10455

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

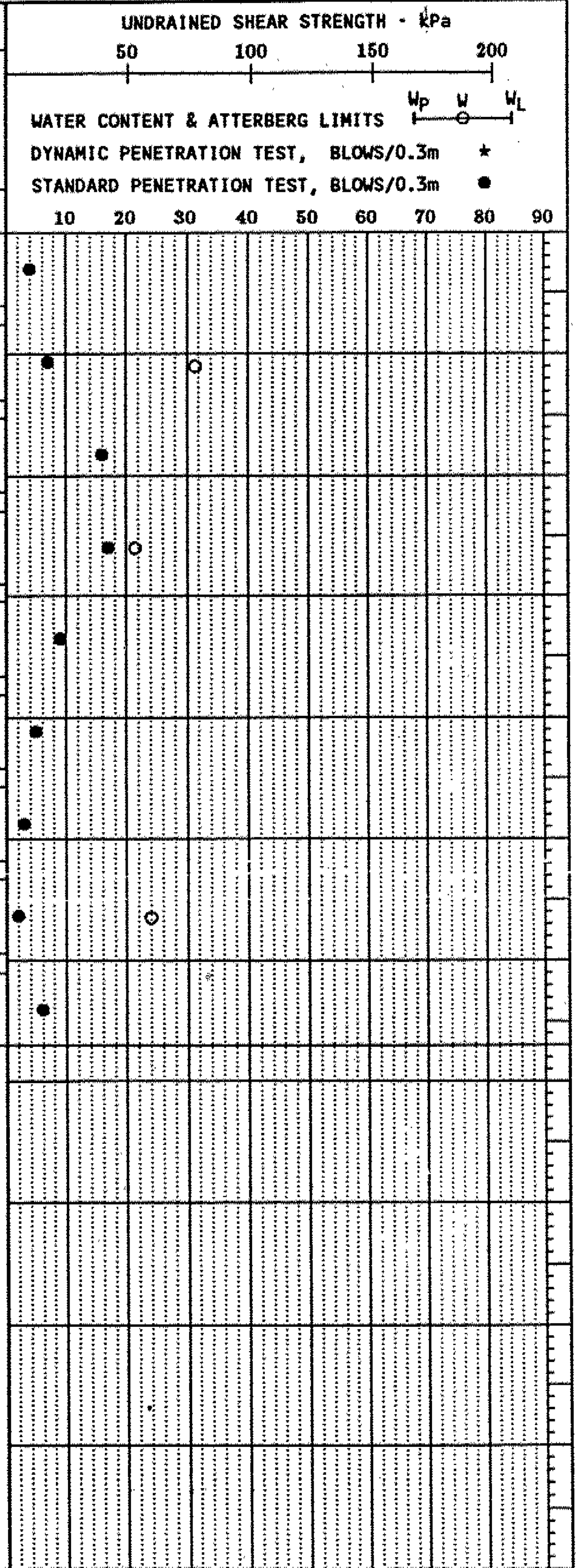
BOREHOLE No. 93-1

DATES: BORING 93-12-02

WATER LEVEL 93-12-08

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	94.51	Grass				
		Stiff, brown silty clay, some sand and gravel: FILL	SS	1	150	4
			SS	2	325	7
	92.7		SS	3	500	16
		Compact to very loose, brown to grey SILT, some clay, trace sand, moist to wet	SS	4	550	17
			SS	5	600	9
			SS	6	600	5
		- some sand lenses	SS	7	600	3
	88.5		SS	8	600	2
6		Loose, grey silty sand and gravel: TILL, wet	SS	9	150	6
	87.8	End of Borehole Auger Refusal Standpipe Installed				



◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD
LIMITED

BOREHOLE RECORD

93-2

CLIENT McNeely Engineering Consultants

LOCATION MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 93-12-02 WATER LEVEL 93-12-08

PROJECT No. 10455

BOREHOLE No. 93-2

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	94.19	Grass				
	93.9	250 mm Dark brown TOPSOIL	SS	1	400	7
		Stiff, brown silty clay with sand, some gravel: FILL	SS	2	500	17
	92.8	Dense to very loose, brown SILT, trace sand, wet	SS	3	450	13
			SS	4	600	21
		- some sand lenses	SS	5	500	34
			SS	6	600	3
	88.4	Loose, grey silty sand and gravel: TILL				
	88.2	Very severely fractured Granitic Gneiss: BEDROCK	BX	7	60%	20%
	87.5	End of Borehole Auger Refusal Installed standpipe				

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Depth (m): 0 1 2 3 4 5 6 7 8 9 10 11

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-3

CLIENT McNeely Engineering Consultants

LOCATION MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 93-12-03 WATER LEVEL 93-12-03

PROJECT No. 10455

BOREHOLE No. 93-3

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm	N-VALUE OR RQD	STANDARD PENETRATION TEST, BLOWS/0.3m
0	95.50	Gravel					
		Compact to dense, brown SAND and GRAVEL: FILL - boulders	GS	1			
	94.1		GS	2			
	93.3	Stiff, grey to dark grey ORGANIC SILT	SS	3	150	9	
		Brown to grey, stiff to very stiff SILTY CLAY, with sand and some organics, wet	SS	4	250	19	
	91.4		SS	5	400	9	
	89.0	Loose, grey SILT, some clay, trace sand	SS	6	500	8	
			SS	7	450	3	
	87.4	Sound Granitic Gneiss: BEDROCK	BX	8	100%	83%	
		End of borehole Standpipe Installed					

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-4

CLIENT: McNeely Engineering Consultants
LOCATION: MTO Service Centre Expansion, Hwy 401, E-7
DATES: BORING: 93-12-03
WATER LEVEL: dry 93-12-03

PROJECT No.: 10455
BOREHOLE No.: 93-4
DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	95.70	Gravel						
	95.0	Compact, brown Sand and Gravel: FILL -boulders			GS	1		
		End of Borehole Auger Refusal Inferred Bedrock						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Depth scale (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

▽ ▼

◘ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-5

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING: 93-12-03 WATER LEVEL: 93-12-08

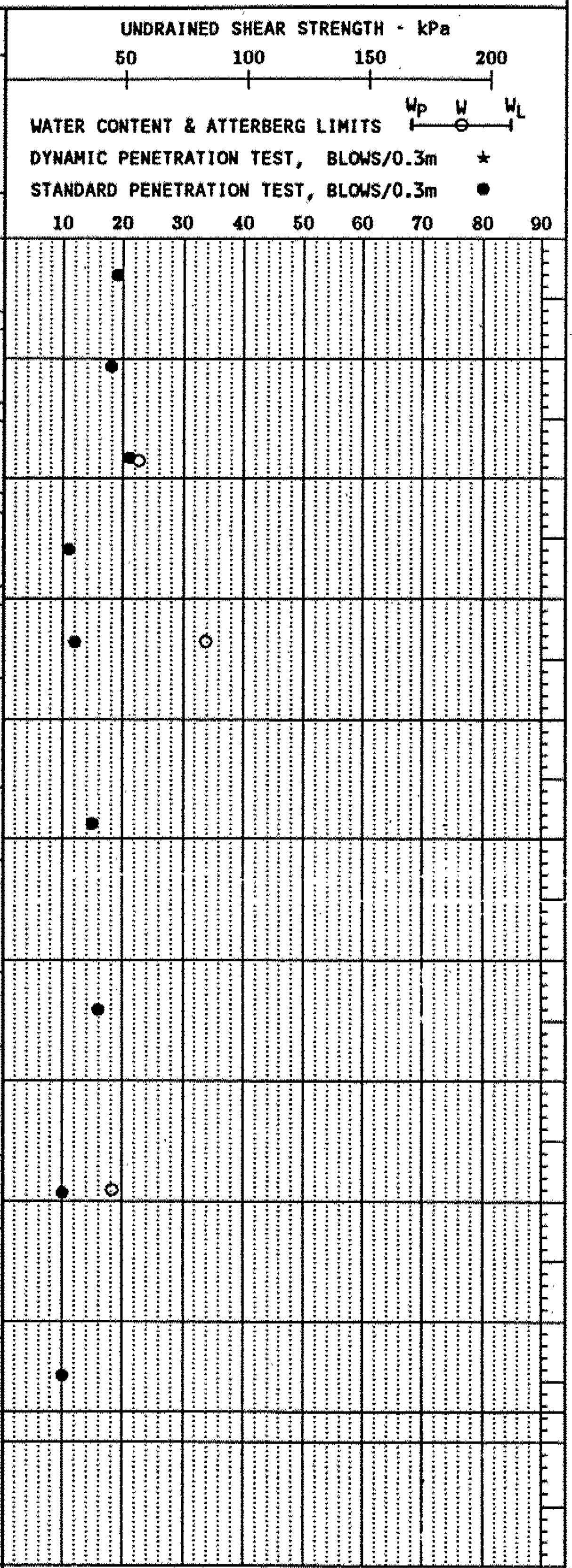
PROJECT No. 10455

BOREHOLE No. 93-5

DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	94.90	Grass				
		Soft, brown SILTY CLAY TOPSOIL, wet	SS	1	400	19
	94.3	Compact, brown SILT, some clay, trace sand	SS	2	350	18
			SS	3	200	21
			SS	4	350	11
			SS	5	450	12
			SS	6	500	15
		- some sand lenses	SS	7	450	16
			SS	8	600	10
		- seams of very hard clay	SS	9	450	10
	85.2	End of Borehole Standpipe Installed				

Columns: STRATA PLOT, WATER LEVEL



◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD
LIMITED

BOREHOLE RECORD

93-6

CLIENT McNeely Engineering Consultants

LOCATION MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 93-12-03 WATER LEVEL 93-12-08

PROJECT No. 10455

BOREHOLE No. 93-6

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY mm	N-VALUE OR RQD	SPT, BLOWS/0.3m
0	95.60	Grass					
	95.0	Brown SILTY ROOTMAT, moist					
1		Compact to dense, brown SILT, trace sand	SS	1	400	13	●
2			SS	2	300	24	●
		- sand lenses	SS	3	300	16	●
3		- some clay	SS	4	500	8	●
5			SS	5	600	11	●
6		- contains some seams of very hard clay	SS	6	400	40	●
9	85.9		SS	7	500	15	●
10		End of Borehole Standpipe Installed					
11							

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

▣ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

94-1

CLIENT: McNeely Engineering Consultants

PROJECT No. 10455

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

BOREHOLE No. 94-1

DATES: BORING 94-02-18

WATER LEVEL -- -- --

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	95.38	Grass Surface						
0–1		Soft, brown, silty ROOTMAT, some clay, trace sand						
1	94.3	Firm, brown to grey SILT, some clay, trace sand						
~1.8					SS	1	550	16
~3.4					SS	2	500	17

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

Continued Next Page

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

94-1

CLIENT McNeely Engineering Consultants

LOCATION MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 94-02-18

WATER LEVEL ----

PROJECT No. 10455

BOREHOLE No. 94-1

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
10		Inferred SILT						
11	83.8							
		End of Borehole Auger refusal on inferred bedrock						
12								
13								
14								
15								
16								
17								
18								
19								
20								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

94-2

CLIENT	McNeely Engineering Consultants	PROJECT No.	10455
LOCATION	MTO Service Centre Expansion, Hwy 401, E-7	BOREHOLE No.	94-2
DATES: BORING	94-02-18	WATER LEVEL	-- -- --
		DATUM	Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	95.17	Grass Surface						
	94.9	TOPSOIL/ROOTMAT						
		Soft, brown SILTY CLAY						
1	94.0							
		Compact, brown to grey SILT, some clay, trace sand						
2					SS	1	600	30
3					SS	2	250	15
4								
5								
6								
7								
8								
9								
10								

UNDRAINED SHEAR STRENGTH - kPa

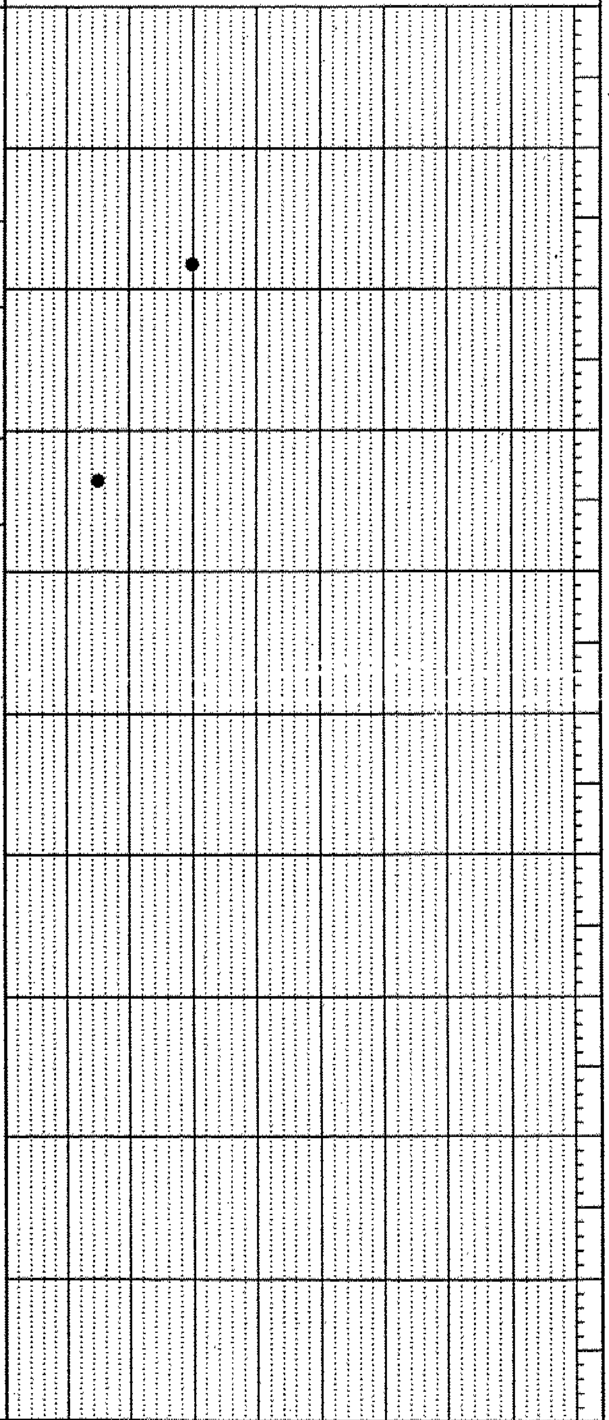
50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90



Continued Next Page

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD
LIMITED

BOREHOLE RECORD

94-2

CLIENT McNeely Engineering Consultants

LOCATION MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 94-02-18 WATER LEVEL ----

PROJECT No. 10455

BOREHOLE No. 94-2

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	N-VALUE OR RQD
10		Inferred SILT						
11								
12								
13								
14								
15	79.9							
		End of Borehole						
16								
17								
18								
19								
20								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_p W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD 94-3

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 94-02-18

WATER LEVEL: ---

PROJECT No. 10455

BOREHOLE No. 94-3

DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	95.66					
	95.5	ASPHALT				
		Brown sand and gravel, trace silt : FILL				
1.5			SS	1	100	8
2	93.5	Grey SILT, some clay, trace sand, trace gravel	BS	2		
3	92.6	Grey SILTY SAND	SS	3		33
4	91.4	End of Borehole Auger refusal on inferred bedrock				

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: Wp W WL

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

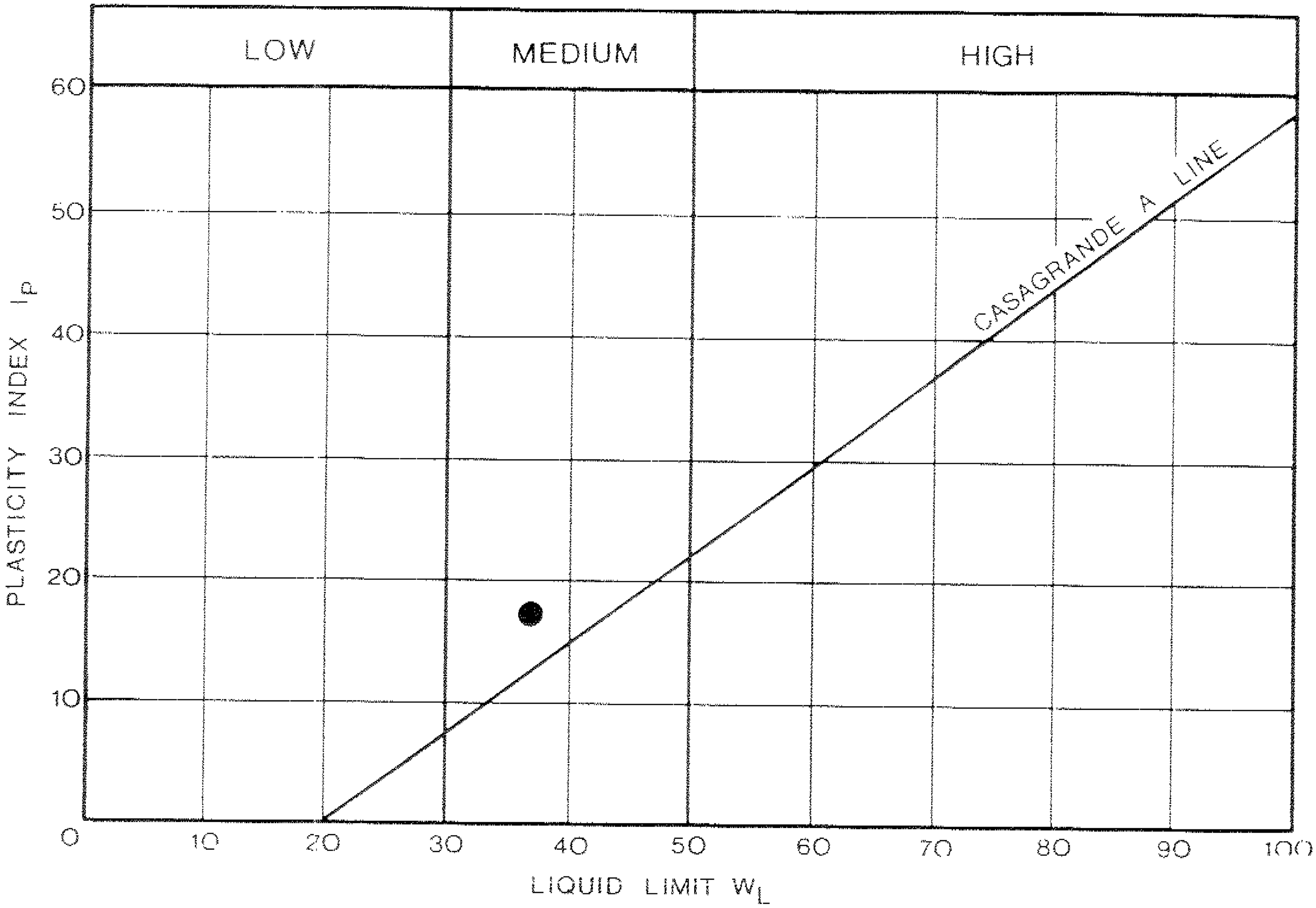
■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

PLASTICITY CHART

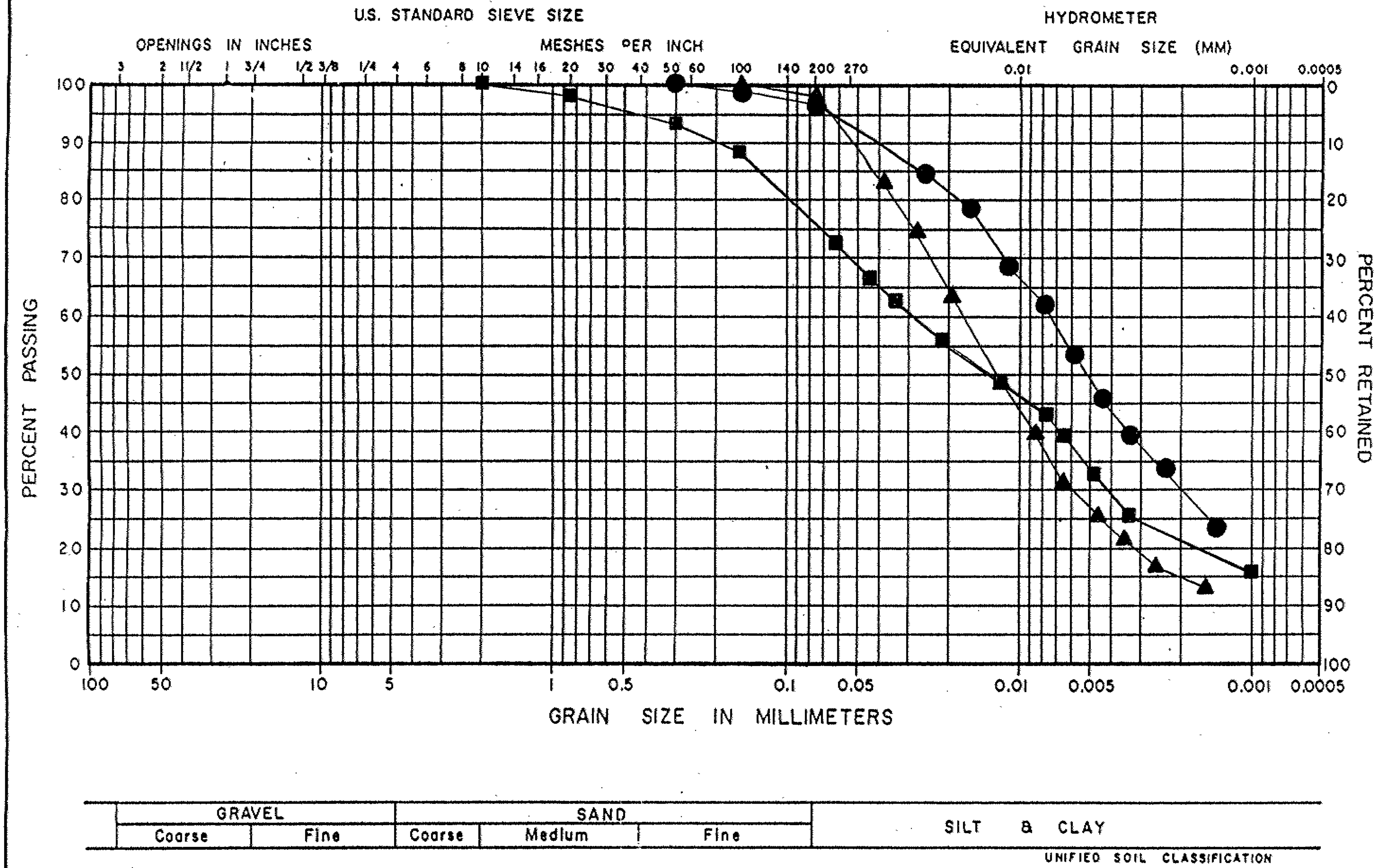
APPENDIX	1
FIGURE	1
PROJECT	10455



SYMBOL	BOREHOLE	DEPTH	DESCRIPTION
●	93-3	3.2 m	medium plastic silty clay

224 3/84

GRAIN SIZE DISTRIBUTION



	BOREHOLE	SAMPLE	DEPTH	DESCRIPTION
▲	93-1	5	3.4 m	silt some clay
●	93-3	5	3.2 m	silty clay
■	93-1	1	0.1 m	silty clay, some sand

APPENDIX 1
FIGURE 2
PROJECT 10455

FOUNDATION INVESTIGATION

W.P. 2623-90-00
HIGHWAY 401 SERVICE CENTRE, E-7
WASHROOM FACILITY
HIGH MAST LIGHTS P1, P2, P3 AND P4
DISTRICT 9, OTTAWA
CONT 94-400
MINISTRY OF TRANSPORTATION

GEOCRES # 31B-79

Recycled Paper

PROJECT NO. 10455

REPORT TO

McNEELY ENGINEERING CONSULTANTS

ON

FOUNDATION INVESTIGATION

W.P. 2623-90-00
HIGHWAY 401 SERVICE CENTRE, E-7
WASHROOM FACILTIY
HIGH MAST LIGHTS P1, P2, P3 AND P4
DISTRICT 9, OTTAWA

MINISTRY OF TRANSPORTATION

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April 20, 1994

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FOUNDATION INVESTIGATION REPORT

for

W.P. 2623-90-00
Highway Service Centre E-7
Washroom Facility
High Mast Lights P1, P2, P3 and P4

District 9, Ottawa

1.0 INTRODUCTION

This report presents the results of a foundation investigation carried out at the above noted site between December 1, 1993 and February 28, 1994. The investigation was carried out in accordance with our letters of proposal submitted to McNeely Engineering Consultants Limited on November 8 and 22, 1993 and February 8, 1994, in order to establish soil parameters for the design of the foundations for a small building and four high mast lights (HMLs). Authorization to carry out this work was received from Mr. E. Vickers, P.Eng. of McNeely Engineering acting on behalf of the Ministry of Transportation of Ontario (MTO) in a letter dated November 24, 1993.

This report contains factual information obtained from the investigation pertaining to the subsurface conditions.

2.0 SITE DESCRIPTION AND GEOLOGY

The Highway 401 Service Centre E-7 is located north of the west bound lanes of Highway 401, 7.3 km west of the Thousand Island Parkway, in Leeds County near Brockville, Ontario, as shown on the Key Plan in Drawing No. 10455-1 in the Appendix. An existing rest stop at this location includes a Wendy's Restaurant, a Tim Horton's, and an Esso Service Centre with parking located to the northeast. In addition, there is an existing picnic area located approximately 375 m northeast of the main service centre. Facilities in the picnic area include a small washroom structure.

Physiographically, the site lies in the area known as Leeds Knobs and Flats. The surface is dominated by bedrock outcrops surrounded by clay plains. Bedrock in the area consists of undifferentiated Precambrian rocks. Overburden thickness varies from 0 m to over 20 m.

The ground surface in the vicinity of the existing washroom structure in the picnic area is generally grass covered and flat. Drainage is towards a swampy area to the southeast. A bedrock outcrop is present 30 m north of the existing washroom.

The ground surface south and west of the existing Wendy's Restaurant is generally a flat, open field with scattered trees. Drainage is to the south towards a swampy area. A bedrock outcrop lies to the northwest of the area.

The area north of the Wendy's Restaurant is already developed to some extent. The ground surface is generally flat and gravel covered. It is evident that rock fill has been placed at some locations. A bedrock outcrop exists 20 m to the southwest.

3.0 PROCEDURE

3.1 Field Investigation

The initial field work for the investigation was carried out on December 2 and 3, 1993. Six (6) boreholes, numbered 93-1 through 93-6 inclusive were put down at the locations established in the field by McNeely Engineering Limited. A second field investigation was performed on February 18, 1994 to acquire information at the revised locations of three of the HMLs. Three (3) additional boreholes were put down at the locations established in the field by MTO, as shown in Drawing No. 10455-1 in the Appendix. The locations were cleared of underground utilities prior to drilling by McNeely Engineering Limited.

The boreholes were put down to depths ranging from 0.7 m to 15 m using a track mounted CME 55 power auger drill equipped with 200 mm outside diameter hollow-stem augers. The soils were sampled at regular intervals by conducting Standard Penetration Tests in the 1993 boreholes. The 1994, supplementary investigation was performed to confirm soil and rock conditions with a more limited sampling program. All soil samples recovered were stored in moisture-proof bags and were returned to our laboratory for detailed classification by a geotechnical engineer.

Standpipe piezometers were installed in Boreholes 93-1, 93-2, 93-3, 93-5 and 93-6. The groundwater levels presented on the Borehole Records were measured on December 3 and 8, 1993.

A percolation test was performed at a location approximately 12 m east of the proposed washroom structure. The excavation of the percolation test hole and performance of the test were carried out in accordance with MOEE guidelines.

3.2 Survey

The 1993 borehole locations were surveyed and staked by McNeely Engineering Limited prior to drilling. Ground surface elevations were determined at each borehole location by Jacques, Whitford Limited personnel. Ground surface elevation for Boreholes 93-1 and 93-2, which are located in the picnic area, were referenced to the floor slab of the existing washroom, which is understood to be at an elevation of 95.00 m Geodetic at the south end of the building.

The ground surface elevations at the remaining boreholes were determined with respect to the Geodetic elevation contours presented on the base plan, Drawing No. 5099-2 provided by McNeely Engineering Limited. The 1994 borehole locations were surveyed and staked by MTO prior to drilling. Ground surface elevations at each borehole location were also determined by MTO.

3.3 Laboratory Testing

All soil samples recovered were stored in moisture proof bags and returned to our laboratory for detailed classification and testing. Selected samples were subjected to moisture content, Atterberg limits, grain size distribution, pH, sulphate and chloride tests. Samples remaining after testing will be stored for a period of three months after issuance

4.0 RESULTS OF THE INVESTIGATION

4.1 Subsurface Profile

The subsurface profile observed in the boreholes are presented in detail on the Borehole Records provided in the Appendix and are summarized in Table 1 which is also provided in the Appendix. An explanation of the symbols and terms used to describe the Borehole Records is also provided. The borehole locations are indicated in Drawing No. 10455-1 in the Appendix.

In general, the observed stratigraphy consists of the existing surficial materials including topsoil and fill, overlying silt overlying till. Bedrock was encountered in five (5) of the boreholes. A summary of the observed subsurface conditions is provided below.

4.1.1 Surficial Materials

A thin layer of surficial topsoil/rootmat was encountered in BH 93-2, 93-5, 93-6, 94-1 and 94-2. Thickness of the topsoil ranged from none to 600 mm. A layer of asphalt, 125 mm in thickness, was encountered at ground surface in BH 94-3. This was underlain by 200 mm of Granular A gravel.

Fill material was encountered immediately below the surficial materials described above or at ground surface in Boreholes 93-1 through 93-4 and 94-3. The fill was composed of silty clay material with some sand in the picnic area (BH 93-1 and 93-2) and was measured to be approximately 1.5 m in thickness. A hydrometer test was performed on a representative sample of this soil and the results indicate that it is composed of 0% gravel, 18% sand and 82% silt and clay sized particles (see Grain Size Curve, Figure 10455-2 in the Appendix). The D_{10} of the tested sample is less than 0.001 mm. In the vicinity of the restaurant, the fill, where present, varied between 0.7 and 1.8 m in thickness and consisted of sand, gravel and boulders. Some rock fill was observed at some locations in the vicinity of Borehole 93-5.

A thin layer, 0.8 m in thickness, of organic silt was encountered beneath the fill in Borehole 93-3. This material probably represents the original ground surface prior to placement of the fill.

4.1.2 Silty Clay

A silty clay was encountered underlying the fill and the organic silt in Borehole 93-3. This layer was found to be 1.9 m in thickness. A representative sample was determined to have a liquid limit of 37%, a plastic limit of 20% and a natural moisture content of 27%. This soil can be classified as a medium plastic clay (See Plasticity Chart, Figure 10455-1 in the Appendix). A hydrometer test was also performed on this soil and the results indicate that it is composed of 0% gravel, 3% sand and 97% silt and clay sized particles (See Grain Size Curve, Figure 10455-2 in the Appendix).

Undrained shear strength of the silty clay was estimated to be over 100 kPa on the basis of pocket penetrometer testing of the two recovered split spoon samples. The silty clay is stiff to very stiff in consistency.

4.1.3 Silt

A complex sequence of silt was encountered below the soil units described previously in all boreholes except Borehole 93-4. The components of this material include very fine grained silt, with occasional fine sand seams as well as seams of very hard clay towards the bottom of the unit. The thickness of this silt sequence ranged from 2.4 to 14.0 m.

A grain size distribution carried out on a selected sample is shown on Figure 2 in the Appendix. Standard Penetration Test N-values recorded for this material ranged from 2 to 40 indicating a loose to dense relative density with a decrease in density being indicated with depth. Moisture content tests carried out on representative samples indicated moisture contents ranging from 18% to 34% with an average of 24%.

4.1.4 Silty Sand and Gravel Till

A glacial till deposit consisting of silty sand and gravel was encountered beneath the silt unit in the boreholes located in the picnic area. The till was found to be 0.7 and 0.2 m in thickness in Boreholes 93-1 and 93-2 respectively. The till was grey in colour and very wet. The Standard Penetration N-value on the one test performed in this unit was 6 which is indicative of a loose material.

4.1.5 Bedrock

Bedrock was inferred by auger refusal at Boreholes 93-1, 93-4, 93-5, 93-6, 94-1 and 94-3. Bedrock was proven by coring in Boreholes 93-2 and 93-3. The depth to bedrock varied from 0.7 m at Borehole 93-4 to over 15 m at BH 94-2. The core recovered consisted of a massive granitic gneiss. The core recoveries were 60% and 100% and the RQD values were 20% and 83% indicating the rock to be very severely fractured to sound. Only a thin weathered zone, less than 25 mm, was observed at the top of the bedrock. The unconfined compressive strength of this deposit is estimated to be greater than 15 MPa.

4.2 Groundwater

Standpipes piezometers were installed in the Boreholes 93-1, 93-2, 93-3, 93-5 and 93-6 and readings were taken on completion of drilling and on December 8, 1993. The groundwater levels are shown on the Borehole Records. The readings indicate groundwater levels very close to the ground surface in all of the boreholes with the exception of BH 93-3. Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated.

4.3 Percolation Testing

The results of the in-situ percolation test carried out near the location of the proposed washroom facility indicate that the surface soils are relatively impermeable. The "T" time was found to be greater than 50 min/cm.

5.0 DISCUSSIONS AND RECOMMENDATIONS

5.1 General

The expansion to the existing service centre at this location includes increasing the amount of parking available by constructing two new lots, each approximately 15,000 square metres in area. Lighting in these areas will be provided by four new high mast lights (HML). It is understood that the proposed HMLs will likely be 30 to 35 m high, free standing structures with single individual foundations. MTO is also proposing to expand the picnic facilities at the rest stop and make improvements to the access roads, parking areas and the washroom facility which will be serviced by a septic field. The locations of the proposed washroom and high mast lights are shown on the attached Drawing No. 10455-1 in the Appendix.

The proposed washroom site is underlain by up to 1.8 m metres of fill. This material, in its present state, is not suitable for the support of spread footing foundations or a slab-on-grade. Therefore, this material will need to be removed and replaced with approved structural fill. It is understood that the building will be only minimally heated. All footings should, therefore, be provided with at least 1.5 m of soil cover or equivalent insulation. Insulation below the floor slabs will also need to be provided.

The founding soils for the HMLs P1, P2 and P4 will be silts. HML P3 will be founded in bedrock.

The presence of a loose silt material below the water table at depth may provide some construction difficulties for deep excavations. Construction considerations are provided in Section 5.6.

5.2 Site Grading and Preparation

All existing fill and other deleterious materials should be removed from beneath the building area and beyond the footing perimeter by a distance equal to the depth of fill being removed. The depth and extent of the fill removal should be inspected and approved to confirm that all existing fill material is removed prior to placing new structural fill.

Structural fill used for grading beneath the building area should consist of approved clean granular material, such as OPSS Granular B, Type II. This material should be tested and approved prior to delivery to the site. The structural fill should be placed in lifts no thicker than 300 mm and compacted using suitable compaction equipment. Structural fill placed beneath the building should be compacted to at least 98% Standard Proctor maximum dry density. Care should be taken immediately adjacent to walls to avoid overcompaction of the soil which may result in damage to the wall.

Most of the existing fill material encountered on site is not suitable for re-use as structural fill. The existing fill could be utilized as landscaping material in a non-structural capacity.

Due to the nature of the native soils at the site, general site grading within 10 metres of the building perimeter should be restricted to less than 1.0 m above existing grades. Should higher amounts of fill be proposed, its location and height should be reviewed by the geotechnical consultant to assess the anticipated repercussions.

5.3 Foundation

The footings should be placed on native soils or on structural fill which in turn is placed on native soil. The following bearing capacities are recommended for the anticipated foundation soils:

Footing Depth, metres	Bearing Capacity at ULS, Kpa	Bearing Capacity at SLS Type II, Kpa
1.6	100	70
3.0	175	120

Strip footings may be designed using the above bearing values and a maximum width of 600 mm. Square footings can be designed using the above bearing values provided they are no larger than 1.0 m in width. The above allowable bearing pressures with the maximum recommended footing sizes could produce approximate total settlements of up to 25 mm and differential settlements up to 19 mm.

The base of all footing excavations should be inspected by a geotechnical engineer prior to concrete placement to confirm the above design pressures and to ensure there is no soil disturbance. Any disturbed material identified during the inspection will need to be removed and wasted.

For minimally heated buildings, footings should be provided with 1.5 metres of soil to protect against frost action. Extruded polystyrene insulation could be considered to reduce the soil cover.

5.4 Floor Slab

The recommendations provided herein are based on the assumption that the average floor slab load will not exceed 10 kPa. Should a greater average load be proposed, the geotechnical consultant should review the recommendations presented herein.

The floor (or basement slab) for the proposed building may be constructed as a slab-on-grade provided that the area beneath the slab is prepared in accordance with the recommendations provided in Section 6.2. A modulus of subgrade reaction, k, of 25 MPa/m may be used for the design of the floor slab. The slab should float independently of all load bearing walls and columns.

A layer of free draining, granular soil should be placed immediately beneath the slab-on-grade for levelling and support purposes. It is recommended that at least 200 mm of approved 19 mm clearstone be used. This material should be compacted to no less than 98% Standard Proctor maximum dry density. A weeping tile system should be installed at footing level if the slab is below exterior grades. The system should be directed to a positive, frost-free outlet.

Insulation should be provided beneath the slab of this minimally heated building to prevent possible frost related damage. It is recommended that a layer of extruded polystyrene insulation, such as HI 40, 50 mm in thickness, be placed horizontally below the entire slab. It is also recommended that insulation 50 mm thick be placed vertically along the inside of the exterior foundation walls to a depth of 1.5 m below the final exterior grade.

5.5 Earthquake Considerations

As outlined in the National Building Code of Canada (NBCC), 1990, buildings and their foundations must be designed to resist a minimum earthquake force. The NBCC formula for obtaining the minimum earthquake force is dependent upon several factors, four of which are the Foundation Factor, Zonal Velocity Ratio and the Acceleration and Velocity Related Seismic Zones. The recommended Foundation Factor, F, is 1.3 for the soils encountered at this site. The Zonal Velocity Ratio, v, of 0.05, the Acceleration Related Seismic Zone, Z_a, of 3 and the Velocity Related Seismic Zone, Z_v, of 1 are recommended for this site based on the NBCC values for Brockville.

5.6 Excavation and Backfilling

The groundwater table is relatively high at the project site, thus dewatering of excavations will be required. Furthermore, past experience with construction of footings on loose silt soils indicates that this layer should be dewatered prior to excavation.

Consideration could be given to dewatering the site to 1.0 m below proposed depth of excavation by the construction of a perimeter drainage system outside the perimeter of the building. The excavation for the drain installation should be maintained at least two metres away from the proposed footing excavation to avoid disturbing the foundation soils. Alternatively, consideration could be given to installing a series of sump pits to dewater the site to 1.0 m below the proposed excavation depth.

The dewatered surficial silts at this site should be considered a Type 3 soil as defined by the Occupational Health and Safety Act and, therefore, excavation slopes are required to be no steeper than 1 horizontal to 1 vertical from the bottom.

Services for the proposed structure are to consist solely of electricity. Backfill for service trenches should consist of excavated material replaced and compacted in lifts. However, where the service trenches extend below paved areas, the trench should be backfilled with material matching the excavation walls. All backfill material below paved areas should be placed in lifts and compacted to at least 95% of Standard Proctor maximum dry density. Reinstatement of the pavement structure should match existing conditions.

5.7 High Mast Light Foundations

The foundations for High Mast Lights will likely consist of concrete piles or caissons. The foundations must be designed to resist overturning moments caused by wind loading and should be designed in accordance with the methods described in B.B. Broms in the following papers:

Broms, B.B. 1964. "Lateral Resistance of Piles in Cohesive Soils". J. of Soil Mech. and Found. Div., ASCE, vol 90, SM2: 27-63.

Broms, B.B. 1964. "Lateral Resistance of Piles in Cohesionless Soils". J. of Soil Mech. and Found. Div., ASCE, vol 90, SM3: 123-156.

Broms, B.B. 1965. "Design of Laterally Loaded Piles". J. of Soil Mech. and Found. Div., ASCE, vol 91, SM3: 79-99.

The overburden soils at the site have been classified as cohesive or non-cohesive and have been assigned, as appropriate, values for unconfined compressive strength (q_u), or angle of internal friction (ϕ), and a total unit weight (γ_{sat}). Unconfined comprehensive strength (q_u), and total unit weight is also provided for bedrock. The soil and rock design parameters recommended for use on this project are listed in Table 1. When using this table, the following should be considered:

- The soil parameters provided represent unfactored values and will need to be factored during design in accordance with Limit State Design concepts.

- The unit weights given are saturated unit weights and should be reduced by 9.81 kN/m^3 below the groundwater table. The groundwater level may vary from the levels reported herein due to seasonal fluctuations.

- The material within the zone of frost penetration should not be included in the calculations of lateral resistance. At this site, the frost penetration depth is 1.5 m.

Open holes drilled within the silt and fill materials are not expected to remain open for long periods of time, particularly below the groundwater table. The use of casing or slurry stabilization techniques will likely be required if cast-in-place concrete caissons are to be used for this project. Furthermore, concrete placed below the groundwater table will likely require tremie techniques. Caisson installation may encounter cobbles and boulders in some locations in the vicinity of P2 and P4. The contractor should be advised of these potential construction difficulties.

It is anticipated that the foundation for HML P3 and possibly P4 will be drilled within or anchored to bedrock. The bedrock encountered in the field investigation was a very severely fractured to sound granitic gneiss. The capacity of grouted rock anchors may be taken as the **lesser** of:

- capacity calculated using an allowable grout/rock bond stress of 500 kPa, or:

- capacity calculated from a rock mass resistance assuming a 60° failure cone and a rock mass submerged unit weight of 15 kN/m^3, adjusted for anchor interactions defined by anchor spacing and length.

Grout should consist of a non-shrink material with a minimum unconfined compressive strength of 27 MPa. Proof loading of every second anchor installation should be undertaken to a maximum of 150% of the design load to verify the design.

Upon completion of the foundation installation, it is recommended that the ground surface surrounding each structure be graded to prevent water ponding at the base of the structure.

5.8 Cement Type and Corrosion Potential

Two (2) soil samples were submitted to Accutest Laboratories Limited in Nepean, Ontario for pH, sulphate and chloride testing. The test results are summarized below:

Borehole	Depth (m)	pH	Sulphate	Chloride
93-2	1.9	8.3	0.02%	0.006%
93-5	1.9	8.1	0.02%	0.004%

The soluble sulphate results indicate that a negligible degree of sulphate attack is expected for concrete in contact with the soil. A normal type 10 Portland cement should therefore be suitable for use in concrete at this site.

The pH levels, which give an indication to the level of potential attack on buried steel objects such as reinforcing steel, are between 5.5 and 9. The concentration of chloride, which is also an indicator of potential attack on buried steel objects, is below 250 ppm. No special corrosion problem is likely to exist.

5.9 Septic System

The results of the percolation test, the surficial soil type, and the high water table observed in the area proposed for the washroom facility, all indicate that a raised septic bed will be required.

6.0 MISCELLANEOUS

The field work for this investigation was carried out under the supervision of B. Prevost, C.E.T. utilizing equipment owned and operated by Johnston Drilling Limited. The report was written by both of the undersigned.

Respectfully submitted,

JACQUES, WHITFORD LIMITED

Fred J. Griffiths, Ph.D., P.Eng.

J.G.A. Raymond Haché, M.Sc., P.Eng.

APPENDIX

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil	-	mixture of soil and humus capable of supporting good vegetative growth
Peat	-	fibrous aggregate of visible and invisible fragments of decayed organic matter
Till	-	unstratified glacial deposit which may range from clay to boulders
Fill	-	any materials below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating successions of different soil types, e.g. silt and sand
Layer	-	>75 mm
Seam	-	2 mm to 75 mm
Parting	-	< 2 mm
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes
Uniformly Graded	-	predominantly of one grain size

Terminology describing soils on the basis of grain size and plasticity is based on the Unified Soil Classification System (USCS) (ASTM D-2488). The classification excludes particles larger than 76 mm (3 inches). This system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%

The standard terminology to describe cohesionless soils includes the compactness (formerly "relative density"), as determined by laboratory test or by the Standard Penetration Test 'N' - value.

Relative Density	'N' Value	Compactness %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Strength		'N' Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25-0.5	12.5-25	2-4
Firm	0.5-1.0	25-50	4-8
Stiff	1.0-2.0	50-100	8-15
Very Stiff	2.0-4.0	100-200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Rock Quality Designation (RQD)

The classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures.

RQD	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

Terminology describing rock mass:

Spacing (mm)	Bedding, Laminations, Bands	Discontinuities
2000-6000	*Very Thick*	*Very Wide*
600-2000	*Thick*	*Wide*
200-600	*Medium*	*Moderate*
60-200	*Thin*	*Close*
20-60	*Very Thin*	*Very Close*
<20	*Laminated*	*Extremely Close*
<6	*Thinly Laminated*	

Strength Classification	Uniaxial Compressive Strength (MPa)
Very Low	1-25
Low	25-50
Medium	50-100
High	100-200
Very High	>200

Terminology describing weathering:

Slight - Weathering limited to the surface of major discontinuities. Typically iron stained.

Moderate	-	Weathering extends throughout rock mass. Rock is not friable.
High	-	Weathering extends throughout rock mass. Rock is friable.

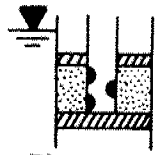
STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:

Boulders Cobbles Gravel	Sand	Silt	Clay	Organics	Asphalt	Concrete	Fill	Igneous Bedrock	Meta-morphic Bedrock	Sedi-mentary Bedrock

WATER LEVEL MEASUREMENT

Borehole or Standpipe



Piezometer

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
PS	Piston sample
BS	Bulk sample
WS	Wash sample

HQ, NQ, BQ, etc. Rock core samples obtained with the use of standard size diamond drilling bits.

N - VALUE

Numbers in this column are the results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and 'N' values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75).

OTHER TESTS

S	Sieve analysis
G_s	Specific gravity of soil particles
k	Permeability (cm/sec)
	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer
H	Hydrometer analysis
γ	Unit weight
C	Consolidation
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct shear
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$; the index corrected to a reference diameter of 50 mm)

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-1

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 93-12-02 WATER LEVEL 93-12-08

PROJECT No. 10455

BOREHOLE No. 93-1

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	94.51	Grass				
0–1.8		Stiff, brown silty clay, some sand and gravel: FILL	SS	1	150	4
			SS	2	325	7
1.8	92.7	Compact to very loose, brown to grey SILT, some clay, trace sand, moist to wet	SS	3	500	16
			SS	4	550	17
			SS	5	600	9
			SS	6	600	5
			SS	7	600	3
		- some sand lenses	SS	8	600	2
6.0	88.5	Loose, grey silty sand and gravel: TILL, wet	SS	9	150	6
6.7	87.8	End of Borehole Auger Refusal Standpipe Installed				

UNDRAINED SHEAR STRENGTH - kPa (50, 100, 150, 200)

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-2

CLIENT: McNeely Engineering Consultants
LOCATION: MTO Service Centre Expansion, Hwy 401, E-7
DATES: BORING 93-12-02 WATER LEVEL 93-12-08

PROJECT No. 10455
BOREHOLE No. 93-2
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	94.19	Grass				
	93.9	250 mm Dark brown TOPSOIL	SS	1	400	7
		Stiff, brown silty clay with sand, some gravel: FILL	SS	2	500	17
	92.8	Dense to very loose, brown SILT, trace sand, wet	SS	3	450	13
			SS	4	600	21
		- some sand lenses	SS	5	500	34
			SS	6	600	3
	88.4					
	88.2	Loose, grey silty sand and gravel: TILL				
	87.5	Very severely fractured Granitic Gneiss: BEDROCK	BX	7	60%	20%
		End of Borehole Auger Refusal Installed standpipe				

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-3

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 93-12-03 WATER LEVEL 93-12-03

PROJECT No. 10455

BOREHOLE No. 93-3

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD	WATER CONTENT (%)
0	95.50	Gravel					
		Compact to dense, brown SAND and GRAVEL: FILL - boulders	GS	1			
1	94.1		GS	2			
2	93.3	Stiff, grey to dark grey ORGANIC SILT	SS	3	150	9	
3		Brown to grey, stiff to very stiff SILTY CLAY, with sand and some organics, wet	SS	4	250	19	
	91.4		SS	5	400	9	Wp ≈ 20, W ≈ 27, WL ≈ 38
5		Loose, grey SILT, some clay, trace sand	SS	6	500	8	W ≈ 24
6	89.0		SS	7	450	3	
7	87.4	Sound Granitic Gneiss: BEDROCK	BX	8	100%	83%	
8		End of borehole Standpipe Installed					

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

Scale: 10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-4

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 93-12-03

WATER LEVEL: dry 93-12-03

PROJECT No. 10455

BOREHOLE No. 93-4

DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	95.70	Gravel						
		Compact, brown Sand and Gravel: FILL -boulders			GS	1		
	95.0	End of Borehole Auger Refusal Inferred Bedrock						

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-5

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

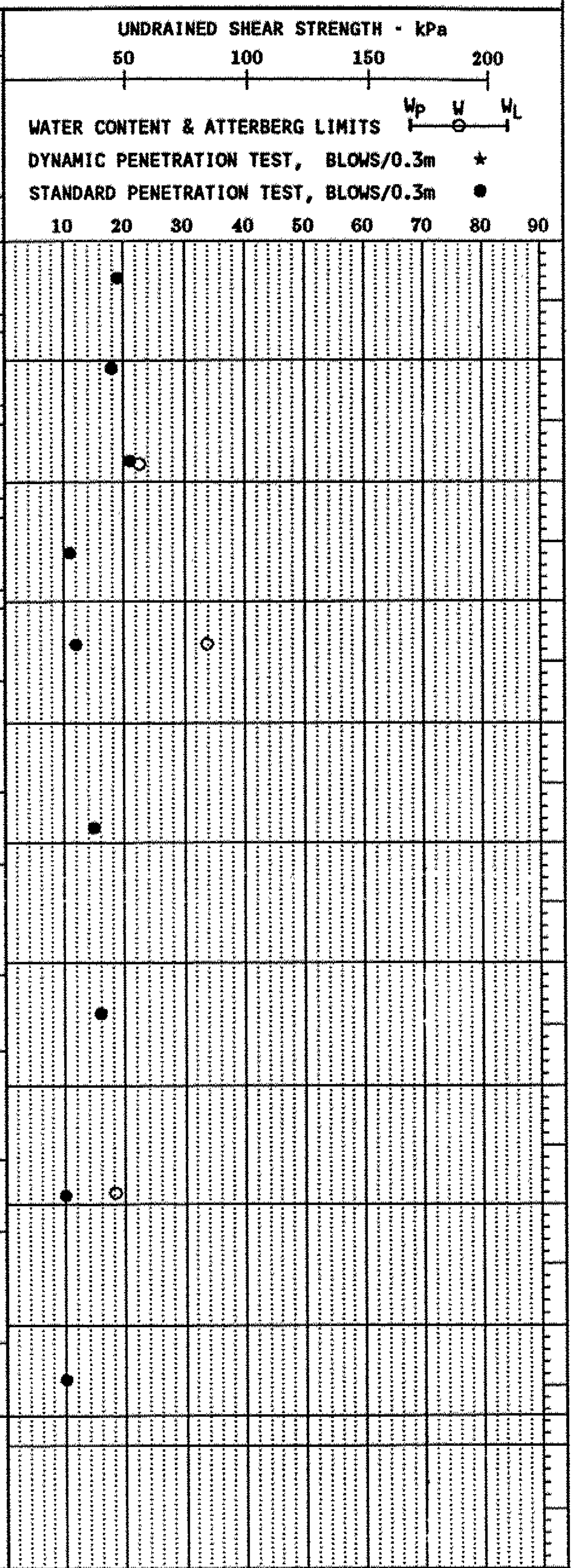
DATES: BORING 93-12-03 WATER LEVEL 93-12-08

PROJECT No. 10455

BOREHOLE No. 93-5

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	94.90	Grass						
		Soft, brown SILTY CLAY TOPSOIL, wet		▽	SS	1	400	19
	94.3							
1		Compact, brown SILT, some clay, trace sand			SS	2	350	18
2					SS	3	200	21
					SS	4	350	11
3					SS	5	450	12
5					SS	6	500	15
6		- some sand lenses			SS	7	450	16
8					SS	8	600	10
9		- seams of very hard clay			SS	9	450	10
	85.2	End of Borehole Standpipe Installed						



▽ ▼

◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

93-6

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 93-12-03 WATER LEVEL 93-12-08

PROJECT No. 10455

BOREHOLE No. 93-6

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD	STANDARD PENETRATION TEST, BLOWS/0.3m
0	95.60	Grass					
	95.0	Brown SILTY ROOTMAT, moist					
1		Compact to dense, brown SILT, trace sand	SS	1	400	13	13
2			SS	2	300	24	24
		- sand lenses	SS	3	300	16	16
3		- some clay	SS	4	500	8	8
5			SS	5	600	11	11
6		- contains some seams of very hard clay	SS	6	400	40	40
9	85.9		SS	7	500	15	15
10		End of Borehole Standpipe Installed					

UNDRAINED SHEAR STRENGTH - kPa: 50 100 150 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD
LIMITED

BOREHOLE RECORD

94-1

CLIENT McNeely Engineering Consultants
LOCATION MTO Service Centre Expansion, Hwy 401, E-7
DATES: BORING 94-02-18
WATER LEVEL ---
PROJECT No. 10455
BOREHOLE No. 94-1
DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD	SPT, BLOWS/0.3m
0	95.38	Grass Surface							
0–1		Soft, brown, silty ROOTMAT, some clay, trace sand							
1	94.3	Firm, brown to grey SILT, some clay, trace sand							
~1.8					SS	1	550	16	● 16
~3.4					SS	2	500	17	● 17

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
DYNAMIC PENETRATION TEST, BLOWS/0.3m ★
STANDARD PENETRATION TEST, BLOWS/0.3m ●
10 20 30 40 50 60 70 80 90

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

Continued Next Page

□ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

94-1

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 94-02-18

WATER LEVEL: ----

PROJECT No. 10455

BOREHOLE No. 94-1

DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES: TYPE	SAMPLES: NUMBER	SAMPLES: RECOVERY (mm)	SAMPLES: N-VALUE OR RQD
10		Inferred SILT						
11	83.8							
		End of Borehole Auger refusal on inferred bedrock						
12								
13								
14								
15								
16								
17								
18								
19								
20								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

94-2

CLIENT: McNeely Engineering Consultants

LOCATION: MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 94-02-18

WATER LEVEL: -- -- --

PROJECT No. 10455

BOREHOLE No. 94-2

DATUM: Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	95.17	Grass Surface				
	94.9	TOPSOIL/ROOTMAT				
		Soft, brown SILTY CLAY				
1	94.0					
		Compact, brown to grey SILT, some clay, trace sand				
2			SS	1	600	30
3			SS	2	250	15
4						
5						
6						
7						
8						
9						
10						

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS: W_P, W, W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

Continued Next Page

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD LIMITED

BOREHOLE RECORD

94-2

CLIENT McNeely Engineering Consultants

LOCATION MTO Service Centre Expansion, Hwy 401, E-7

DATES: BORING 94-02-18

WATER LEVEL - - -

PROJECT No. 10455

BOREHOLE No. 94-2

DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
10		Inferred SILT						
11								
12								
13								
14								
15	79.9							
		End of Borehole						
16								
17								
18								
19								
20								

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

JACQUES, WHITFORD
LIMITED

BOREHOLE RECORD

94-3

CLIENT McNeely Engineering Consultants — PROJECT No. 10455

LOCATION MTO Service Centre Expansion, Hwy 401, E-7 — BOREHOLE No. 94-3

DATES: BORING 94-02-18 — WATER LEVEL --- — DATUM Geodetic

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	95.66					
	95.5	ASPHALT				
		Brown sand and gravel, trace silt : FILL				
1.5			SS	1	100	8
2	93.5	Grey SILT, some clay, trace sand, trace gravel	BS	2		
3	92.6	Grey SILTY SAND	SS	3		33
4	91.4	End of Borehole Auger refusal on inferred bedrock				

UNDRAINED SHEAR STRENGTH - kPa: 50, 100, 150, 200

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

DYNAMIC PENETRATION TEST, BLOWS/0.3m ★

STANDARD PENETRATION TEST, BLOWS/0.3m ●

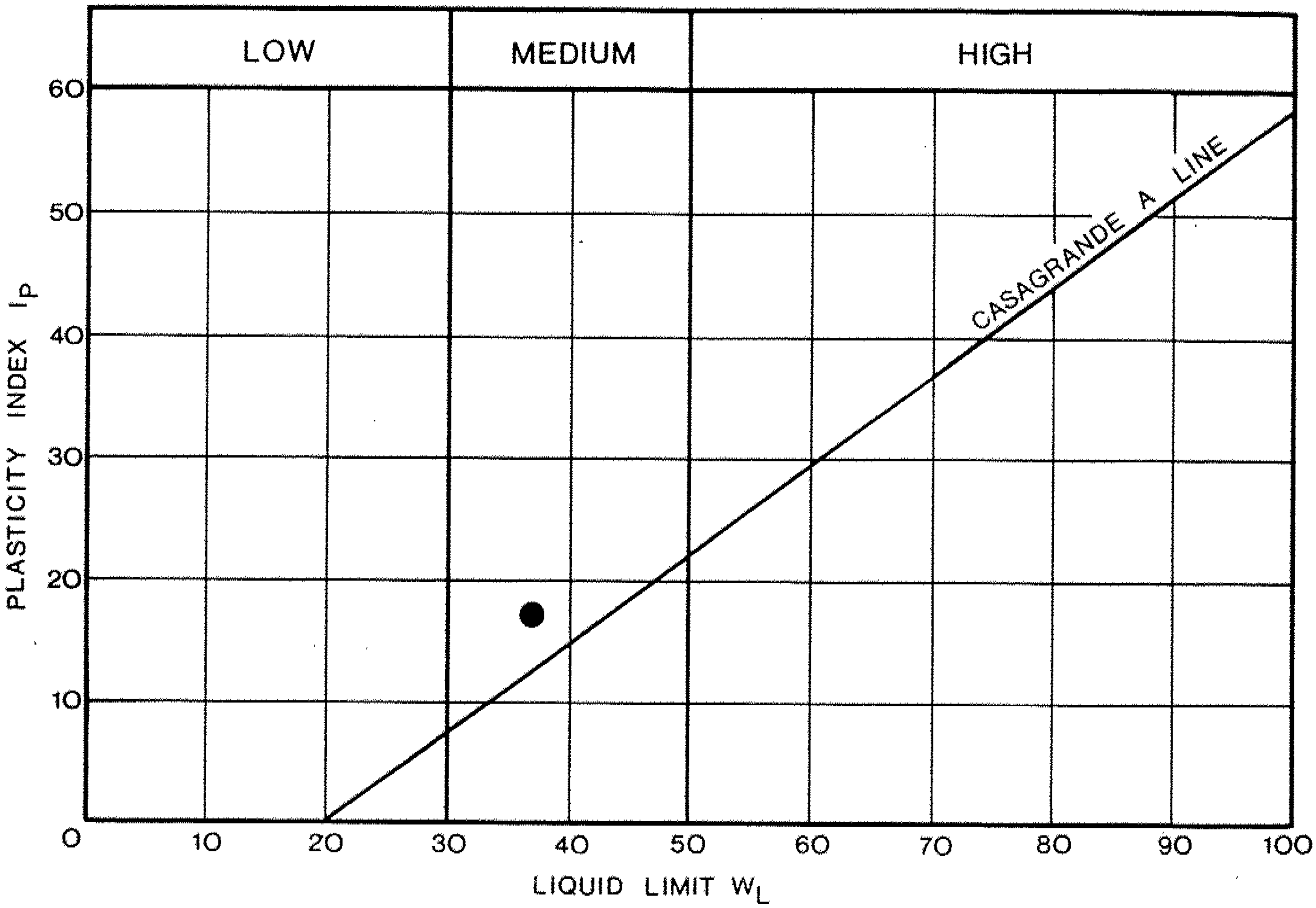
10 20 30 40 50 60 70 80 90

■ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

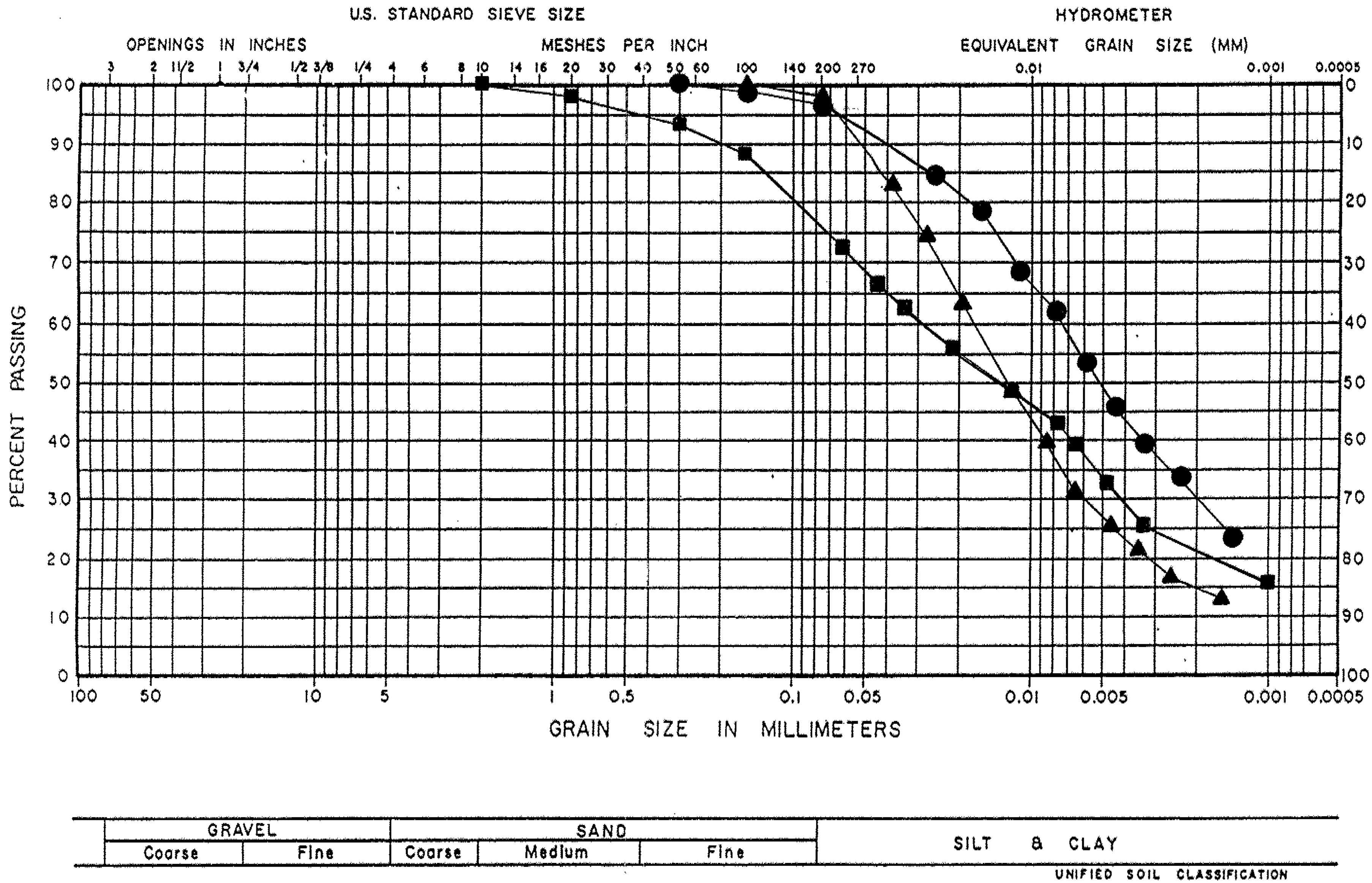
PLASTICITY CHART	APPENDIX 1 FIGURE 1 PROJECT 10455



SYMBOL	BOREHOLE	DEPTH	DESCRIPTION
●	93-3	3.2 m	medium plastic silty clay

224 3/84

GRAIN SIZE DISTRIBUTION



	BOREHOLE	SAMPLE	DEPTH	DESCRIPTION
▲	93-1	5	3.4 m	silt some clay
●	93-3	5	3.2 m	silty clay
■	93-1	1	0.1 m	silty clay, some sand

APPENDIX 1
FIGURE 2
PROJECT 10455

TABLE 1

SOIL PARAMETERS

HML	Borehole	Depth (m)	Elevation (m)	Type of Soil	Denseness or Consistency	ϕ	q_u (kPa)	γ_{sat} (kN/m^3)
P1	94-1	0-1.1 1.1-11.6 11.6-	95.4-94.3 94.3-83.8 83.8-	cohesive non-cohesive bedrock	soft compact to dense -	- 30° -	20 - 15 MPa	16 18 25
P2	94-2	0-1.2 1.2-15.2	95.2-94.0 94.0-79.9	cohesive non-cohesive	soft compact	- 30°	20 -	16 18
P3	93-4	0-0.7 0.7-	95.7-95.0 95.0-	fill bedrock	- -	- -	- 15 MPa	22 25
P4	94-3	0-2.1 2.1-3.0 3.0-4.3 4.3-	95.7-93.5 93.5-92.6 92.6-91.4 91.4-	fill non-cohesive non-cohesive bedrock	- compact loose -	- 30° 27° -	- - - 15 MPa	22 18 18 25

NOTES:

1. Soil parameters are ultimate values.
2. Unit weights are total unit weights.
3. Material within the zone of frost penetration, estimated to be 1.5 m at this site, should not be included in calculations of lateral resistance.

METRIC

PLATE No 24-401/19-23

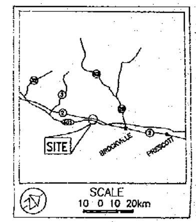
CONT No 2623 -
WP No ~~2263~~-90-00

SHEET

HIGHWAY 401 SERVICE CENTRE, E-7

BOREHOLE LOCATION PLAN

JACQUES, WHITFORD LIMITED



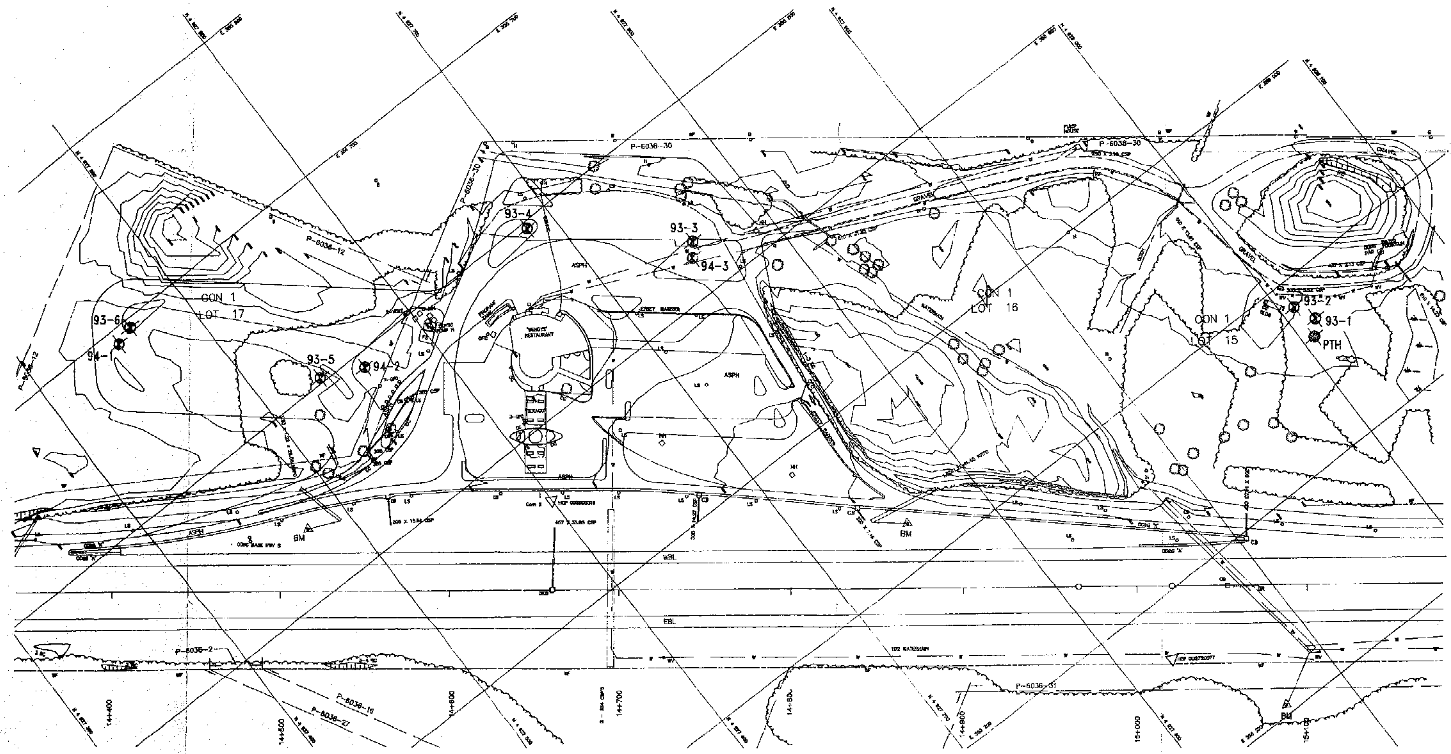
LEGEND

Borehole

Percolation Test Hole

BENCHMARK

No	ELEVATION	COORDINATES NORTH	EAST
93-1	94.51	4 928 014	356 128
93-2	94.19	4 928 008	356 115
93-3	95.50	4 927 756	355 870
93-4	95.70	4 927 684	355 804
93-5	94.90	4 927 535	355 797
93-6	95.60	4 927 465	355 705
PTH	--	4 928 007	356 136
94-1	95.38	4 927 454	355 709
94-2	95.17	4 927 559	355 808
94-3	95.66	4 927 750	355 878



SCALE
10 0 10 20
1 : 1250

REVISION	DATE	BY	DESCRIPTION
	94/02/18		BOREHOLES 94-1, 94-2 & 94-3 ADDED

GEOCRES * 31B-79

HWY No 401

SUBM'D	CHECKED	DATE 93/12/23	
DRAWN	CHECKED		