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GEOCRES No. 30M11-184

DIST. 6 REGION

W.P. No. 33-76-05

CONT. No.

W. O. No.

STR. SITE No.

HWY. No. NWMA

LOCATION N.W.M.A BETWEEN
WESTON RD & EGLINTON AVE

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 33-76-02/05

DIST 6

HWY NWMA

STR SITE Several

NWMA Road Between Eglinton Avenue
and Weston Road
(Feasibility study)

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GEOCRES 30M11-184

DATE FEB 16 1978

FOUNDATION INVESTIGATION REPORT

For

NWMA Road Between Eglinton Avenue
and Weston Road
(Feasibility study)
W.P. 33-76-02/05
District 6, Toronto

INTRODUCTION

The Soil Mechanics Section was requested by the Structural Section, Central Region, to carry out a necessary foundation investigation at the above mentioned location for the possible two different alignments (Line A and Line B). Due to the urgency of this project this Section was not provided with all the data; however, limited information was provided with Line B only. Subsequently, an investigation was carried out by this Section to determine the subsurface conditions at the two possible alternative alignments. This report contains the results of this investigation, together with our recommendations for various structure schemes, embankments and cuts. This report also contains our evaluations, based on a soil mechanics' point of view, of the two alignments so that the Region can determine which is the more economical alternative.

The fieldwork carried out during the period of November 23, 1977 to December 16, 1977, consisted of 9 sampled boreholes and 3 test pits. Eight of the borings were advanced to depths ranging from 40 feet to 157 feet below the ground surface, utilizing a CME 55 and a CME 750 auger machine equipped with 3¼" I.D. hollow stem augers. The remaining one boring was put down to a depth of 125 feet by means of a diamond drill rig adopted for soil sampling purposes. The three test pits were excavated by using a backhoe to a depth of 10 feet below the ground surface.

DESCRIPTION OF THE SITE AND GEOLOGY

The site is in the vicinity of Black Creek, bounded to the north by Eglinton Avenue and to the south by Weston Road, in the Borough of York, Metropolitan Toronto.

The proposed Line 'B' is located to the west of, and somewhat parallel to Black Creek. In most of the area along Line 'B', land fill has been placed to a height of up to about 35 feet above the original ground surface. This land fill in turn is adjoined in the southwest by CP and CN railway embankments, which are another 4 to 7 feet higher than the land fill elevations.

In the southern extremity of the site, the railway tracks cross Black Creek by means of two high level, three span plate girder structures. The embankments and the railway bridges appear to be in good working condition.

The proposed Line 'A' lies mostly to the east of Black Creek. The terrain where Line 'A' is located is low lying and relatively level. Most of the area along Line 'A' has been graded and developed into a public park.

The site is within the upper reaches of Lake Iroquois in the geological past. Under a thin mantle of Lake Iroquois deposit or recent deposits by Black Creek, subsoil in this area consists of a series of glacial and interglacial deposits of the Pleistocene epoch.

SUBSURFACE CONDITIONS

General

Along Line 'B', fill material was encountered in the land fill area west of the Black Creek, as well as in areas where the railway embankments and the west approach of Eglinton Avenue bridge over Black Creek are located. Both the land fill and the railway embankments have a maximum height of up to 35 feet. The land fill contains debris, wood and construction waste, whereas the railway embankments and the Eglinton Avenue Bridge west approach are constructed with silty sand.

Also along Line 'B' under the fill material, or in places under a granular stratum consisting of layers of silty sand, sandy silt and silt of variable thickness, is a deposit of clayey silt about 40 to 65 feet thick. Within the clayey silt deposit there are distinct layers of silt and silty sand. Underlying the clayey silt deposit is a layer of silty fine sand 5 to 15 feet thick which in turn is followed by a stratum of glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel. In one location the glacial till is underlain at elevation 240 by a 12 foot thick layer of silty clay which in turn is followed by a sand layer at elevation 228.

At the crossing of Line 'A' with Black Creek in the northern portion of the site, subsoil consists of a surficial 10 to 13 feet of loose to compact silty sand followed by a deposit of stiff to very stiff clayey silt.

Locations and elevations of the boreholes and test pits are shown in Dwg. No. 337605-A, together with the estimated stratigraphy. A description of the subsoil is as follows:

LINE 'B'

Fill

Land fill: A large part of the area along Line 'B' is overlain by land fill material to a maximum height of about 35 feet above the original ground surface. The composition of the land fill material is extremely nonhomogeneous. It contains debris, wood, metal, and construction waste such as concrete blocks, brick fragments mixed with sand and clay. The fill has not been subjected to any uniform degree of compaction. Further, the test pits revealed voids and cavities were randomly present within the fill, which indicates that the fill was placed by an end dumping method.

Railway embankment fill: The railway embankments are constructed with predominantly silty sand and have a maximum height of up to 35 feet.

The 'N' values within the fill range from 9 to 50 blows/feet which indicates the fill has been subjected to a moderate to very high degree of compaction.

Eglinton Avenue West approach fill near Black Creek crossing: The Eglinton Avenue West approach fill is also constructed with silty sand. The 'N' value recorded in this material indicates that the fill has been well compacted.

Silt, Sandy Silt and Silty Sand

In the northern extremity of the site along Line 'B', a granular stratum consisting of layers of silt, sandy silt and silty sand was encountered immediately below the ground surface. This deposit has a total thickness of 30 feet and has a relative density estimated to be loose to compact on the basis of 'N' values which range from 10 to 20 blows/foot.

Clayey Silt

This deposit underlies the fill material or the surficial granular stratum. The thickness varies from 40 to 65 feet. The material in this deposit is composed of clayey silt with some sand and a trace of gravel. Typical grain size distribution summarized in an envelope form is given in Figure 2.

Within this deposit there are distinct layers of silt and silty sand, with a thickness of up to 15 feet. Typical identity indices of the clayey silt are summarized in the following tabular form:

<u>Identity Indices</u>	<u>Range</u>
Natural Moisture Content (W%)	10 - 25
Plastic Limit (W_L %)	12 - 19
Liquid Limit (W_P %)	23 - 30
Bulk Density (pcf)	124 - 128

The undrained shear strengths of the clayey silt are generally in excess of 2000 psf, except in one location in the southern extremity of the site where the clayey silt in the upper 5 feet has an undrained shear strength in the order of 1000 psf. On the basis of the undrained strength, together with 'N' values from 10 to 65 blows/foot it is estimated that the consistency of the clayey silt varies from stiff to hard, being generally very stiff.

Silty Fine Sand

This layer is intercepted immediately below the clayey silt deposit. It is composed of silty fine sand and has a thickness of 5 to 15 feet, being thinner in the southern portion of the site. Typical grain size distribution

is given in Figure 3 in an envelope form. The 'N' values of 5 to 25 blows/foot indicate that the silty fine sand has a loose to compact relative density.

Glacial Till

Underlying the silty fine sand is a deposit of glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel. In one particular location, the glacial till is found to have a thickness of 40 feet. The composition of the glacial till is made up of about 7% gravel, 30% sand, 44% silt and 19% clay. It has a natural moisture content of about 12%, a plastic limit of 11%, and a liquid limit of 18%. It is estimated from the 'N' values, which range from 30 blows/foot to 90 blows/foot, that the consistency of the glacial till is very stiff to hard.

Silty Clay

In one particular location, the boring was extended below the glacial till into a layer of silty clay at elevation 240. This layer of silty clay has a thickness of about 12 feet. The silty clay has a natural moisture content of 24%, a plastic limit of 18% and a liquid limit of 35%. The 'N' value of 24 blows per foot indicates that the silty clay has a very stiff consistency.

Sand

The above mentioned silty clay layer is followed by a sand layer at elevation 228. The full extent of the sand was not explored.

LINE 'A'

At the crossing of Line 'A' with Black Creek in the northern portion of the site, subsoil consists of a surficial 10 to 13 feet of loose to compact silty sand followed by a deposit of stiff to very stiff clayey silt.

The clayey silt stratum along Line 'A' is similar to the one along Line 'B'. The description of the material in the cohesive stratum, therefore, can be referred to the previous section where the clayey silt along Line 'B' was described.

GROUNDWATER CONDITIONS

The stabilized groundwater level was found to be at approximately elev. 338.0 to 342.5, except in one location in the northern extremity of the site where

the groundwater level was observed to be at elevation 358.0. Within the land fill, there were occasional perched water tables which were revealed by our test pits and drilling operation.

The water level in the Black Creek during the time of investigation was at approximately elevation 338.5.

DISCUSSION AND RECOMMENDATIONS

Two alignments, Line 'A' and Line 'B', have been proposed for NWMA Road southerly from Eglinton Avenue to Weston Road. The locations of these two alignments, together with the profile grade of Line 'B', are shown in Dwg. No. 337605-A. The profile grade of Line 'A' is not yet available. For feasibility study purposes the following recommendations are given.

LINE 'B'

- CNR and CPR Subways and Associated Retaining Walls (Ref. BH. 2, 2B, 6, T.P.1)

At the proposed railway crossings the profile grade of Line 'B' varies from elevation 352 to elevation 357, at a 2% gradient in a northerly direction. It is understood that a two span structure is proposed at each railway crossing. In addition, retaining walls up to 35 feet high are required between two subway structures to retain the high fills on either side of NWMA Road. As per the site plan supplied by the Region, a 54"Ø sewer was built in this area running from north to south and very close to the center pier location of the proposed CNR subway.

Strength and compressibility of the subsoil at the footing formation levels are such that spread footings are not the most suitable choice at this location. It is, therefore, recommended that the proposed closed abutments and piers for both subway structures, as well as the associated retaining walls, should be supported on piles. Two types of piles may be considered. For example, #14 Class 'A' treated timber piles driven to approximate tip elevations of 320 can be designed for 25 tons/pile. Alternatively, 12 3/4" O.D. steel tube piles driven to elevation 270. can be designed for 50 tons/pile.

In order to construct the subway structures a temporary detour for CNR and CPR tracks will be required during construction. According to the available information, this detour will be located between the existing CNR and CPR tracks. With regard to the design and construction of the detour the following should be considered:

1. In our opinion, the center pier should be eliminated and a single span subway should be considered. This will eliminate special measures required for the 54"Ø sewer in this area.

If the center pier is eliminated, this will minimize the enclosed sheeted coffer dam cost for the pier construction in the proximity of the high fills.

2. During construction, special measures are required for the construction of the abutments and the connecting retaining walls in the proximity of the temporary railway embankments. In view of this, the following sequences of construction are suggested:

- a) the center portion of the retaining walls where the detours are to be located should be completed to its full height.
- b) the detour for CNR and CPR should be completed and the span between the retaining walls should be supported by timber cribs.
- c) after the detour is in operation, the sheeted coffer dam should be constructed for the remaining portion of the retaining walls and the abutments for the two proposed subways.

- Cut Sections in the Land fill Area (Ref. BH. 7, 8, T.P. 2 & 3)

The majority of the cut beyond the existing railway embankments is situated in the land fill area. The land fill is extremely nonhomogeneous and also contains occasional voids. In view of this, the proposed roadway will be subjected to differential settlements. To minimize post construction settlements and to have a better performance of the roadway, the following should be considered:

1. Excavate weak nonhomogeneous land fill material for a minimum depth of 10 feet below the proposed profile grade. Replace this excavation with well compacted granular type fill material. The temporary cut slopes can be constructed at $1\frac{1}{2}:1$; whereas the long-term slopes should not be steeper than 2:1.
2. Effective subsurface drainage system should be incorporated to control surface and subsurface water.

- Fill Sections (Ref. BH. 11)

Fills up to 5 feet proposed in this area will be stable with 2:1 slopes.

LINE 'A' AND LINE 'B'

- Structure Improvement at Black Creek and Weston Road (Ref. BH. 1)

Details of structure improvement are not available. However, for feasibility purposes, it can be assumed that the widened portion of the structure elements can be supported on #14 timber piles driven to elevation 300 for a design load of 25 tons/pile.

The slopes of the Black Creek channel should be protected with concrete lining, matching the existing downstream conditions.

LINE 'A'

As mentioned previously, the proposed grade or the structure details of this scheme are not available at this stage of study. It appears that this alignment will follow the existing Black Creek channel beneath the existing CNR and CPR high level structures.

If this alignment is chosen, the existing Black Creek should be confined in a box culvert so that the surface area can be utilized for the roadway of the proposed NWMA.

If such a scheme is to be adopted, further subsurface studies will be necessary to provide specific recommendations.

- Black Creek Crossing with NWMA (Ref. BH 9, 10)

Subsoil consists of a surficial 10 to 13 feet of loose to compact silty sand followed by an extensive stiff to very stiff clayey silt. In view of the subsurface conditions and the peak runoff conditions of Black Creek, we suggest that the abutments of the single span structure can be supported on spread footings at or below elevation 336 with an allowable load of $2\frac{1}{2}$ tsf. A temporary dewatering scheme will be required for the construction of the foundations below the creek water level.

Side slopes of the channel should not be constructed steeper than 2:1. In addition, concrete lining similar to the one used elsewhere should be considered.

CONCLUSIONS

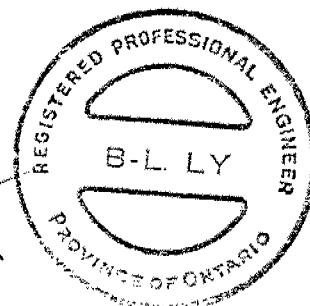
The final choice of the alignments should also be based on other considerations such as traffic intersection of Weston Road and NWMA Road, and the cost of a long box culvert in the vicinity of the existing high level bridges for Line 'A'.

It should be noted a detailed sequence of construction and temporary detour for CNR and CPR tracks during construction of the two subway structures for Line 'B' will be required.

In addition, subexcavation of land fill material of up to 10 feet in depth will be necessary for the cut section for Line 'B'.

The recommendations contained in this report are strictly for feasibility purposes only. A detailed subsurface investigation will be necessary once the choice of the alignments is finalized with the appropriate details of structure configuration and the related grades.

B. Ly
B. Ly, P. Eng.
Senior Engineer



M. Devata
M. Devata, P. Eng.
Supervising Engineer

February, 1978

APPENDIX

RECORD OF BOREHOLE No 1

W P 33-76-05 LOCATION Co-ords N 872 572 E 1 005 223 ORIGINATED BY B.L.
 DIST 6 HWY N W M A BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
 DATUM Geodetic DATE March 23, 1977 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
344.6	GROUND LEVEL																
0.0	Fill: Clayey Silt And Silty Sand		1	SS	9		340										
337.6			2	SS	6												
7.0	Clayey Silt: Some Sand And A Trace Of Gravel. Very Stiff		3	SS	6												2 16 50 32
			4	SS	5												
			5	TW	PH		330									124.0	
			6	SS	39												3 28 52 17
			7	SS	33												
			8	SS	39												
			9	SS	41												0 41 50 9
	Sandy Silt Trace Of Clay		10	SS	45		320										
			11	SS	37												
			12	SS	38		310										
			13	SS	26												
	Silt: Some Sand & Clay		14	SS	26		300										0 22 63 15
			15	SS	31												
	Stiff		16	SS	26		290										
			17	TW	PH											127.5	
280.6							280										
64.0	Sand: Fine To Medium Compact		18	SS	26												
276.6																	
68.0	Glacial Till		19	SS	37												
273.1																	
71.5	End Of Borehole																

RECORD OF BOREHOLE No 2

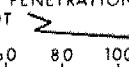
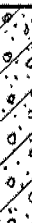
W P 33-76-05 LOCATION Co-ords. N 872 733 E 1 005 175 ORIGINATED BY B.L.
DIST 6 HWY N W M A BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
DATUM Geodetic DATE November 24, 1977 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
357.8	GROUND LEVEL															GR SA SI CL
0.0	Fill:		1	SS	9		350									
	Silty Sand To Sandy Silt		2	SS	5											
	Some Clay		3	SS	9											
			4	SS	7											
			5	SS	4											
			6	SS	4											
			7	SS	7		340									
336.8			8	SS	21											
21.0	Clayey Silt		9	SS	40											
			10	SS	64		330									
	Silty Sand Compact		11	SS	13											
	Some Sand And Trace Of Gravel		12	SS	50		320									0 73 22 5
			13	SS	40											
			14	SS	31		310									
	Very Stiff		15	SS	21											
			16	SS	19		300									
			17	SS	23											
	Becoming More Plastic		18	SS	19		290									
			19	SS	16											
284.8			20	SS	5		280									
73.0	Silty Fine Sand															
	A Trace Of Clay															
276.8																
81.0	Glacial Till		21	SS	39		270									
	Heterogeneous Mixture Of Clay, Silt, Sand & Gravel															
261.3	Very Stiff		22	SS	33											
96.5	End Of Borehole															

+3, x5: Numbers refer to 20
Sensitivity 15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6 cont

W P 33-76-05 LOCATION Co-ords. N.872 947 E 1 005.055 ORIGINATED BY O.J.
 DIST 6 HWY N W M A BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
 DATUM Geodetic DATE November 25, 1977 CHECKED BY _____


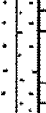



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH									
264.4	Ground Level																
106.5	Heterogeneous Mixture Of Clay, Silt, Sand And Gravel. Very Stiff To Hard		19	SS	72												
244.4			20	SS	35											5 31 43 21	
126.5	End Of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7

W P 33-76-05 LOCATION Co-ords. N 873 163 E 1 004 864 ORIGINATED BY B.L.
 DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
 DATUM Geodetic DATE November 25, 1977 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60						80	100
								SHEAR STRENGTH								10	20
						○ UNCONFINED + FIELD VANE											
						● QUICK TRIAXIAL x LAB VANE											
376.7	Ground Elevation																
0.0	Fill																
	Debris containing wood, brick fragments sand and clay		1	SS	9		370										
			2	SS	4												
			3	SS	5		360										
			4	SS	7												
			5	SS	9		350										
			6	SS	12												
		7	SS	5		340											
335.7			8	SS	13												
41.0	Clayey silt																
332.7																	
44.0	Silty sand, trace of clay, compact to dense		9	SS	27									0 47 46 7			
			10	SS	32												
323.7																	
53.0	Silt, trace of sand and clay		11	SS	47									0 7 82 11			
318.7																	
58.0	Clayey silt, trace of sand, very stiff		12	SS	51												
			13	SS	40		310							1 20 48 31			
			14	SS	30												
	Becoming more plastic						300										
			15	SS	24												
291.7																	
85.0	Silty sand, fine trace of gravel and clay, compact		16	SS	20									3 56 35 6			
							290										
281.7																	
95.0	Glacial till																
275.2			17	SS	50												
101.5	Cont.					cont.											

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7 cont

W P 33-76-05 LOCATION Co-ords. N 873,163 E 1,004,864 ORIGINATED BY B.L.
 DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
 DATUM Geodetic DATE November 25, 1977 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
275.2	Cont.																
101.5	Heterogeneous mixture of clay, silt, sand and gravel, very stiff		18	SS	56		270										
			19	SS	114		260										
			20	SS	32		250										
241.2																	
135.5	Silty clay, trace of sand and gravel, very stiff		21	SS	24		240										
229.2							230										
147.5	Sand, fine to medium		22	SS	2												
225.2																	
151.5	End of Borehole																
221.7																	
155.0	End of Cone Test						220										

+³, x⁵: Numbers refer to Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

W P 33-76-05 LOCATION Co-ords. N 873 435 E 1 004 856 ORIGINATED BY O.J.
 DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
 DATUM Ceodetic DATE November 29, 1977 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										WATER CONTENT (%)		
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
372.7	Ground Level													10 20 30						
0.0	Fill																			
	Debris containing wood, sand and construction waste		1	SS	12															
			2	SS	44															
			3	SS	34															
			4	SS	53															
			5	SS	12															
	Fill		6	SS	5															
	Silty Sand contaminated with organic		7	SS	6															
334.7			8	SS	16															
38.0	Silt, some sand and clay, compact to dense		9	SS	47											0 14 72 14				
			10	SS	40											0 7 82 11				
318.7			11	SS	62															
54.0	Clayey Silt, trace of sand and gravel, very stiff		12	SS	32															
			13	SS	37											4 10 52 34				
			14	SS	32															
			15	SS	33															
294.7			16	SS	57															
78.0	Sand																			
291.2																				
81.5	End of Borehole																			

RECORD OF BOREHOLE No 9

W P 33-76-05 LOCATION Co-ords N 873 734 E 1.005 052 ORIGINATED BY O.J.
 DIST 6 HWY NWMA BOREHOLE TYPE Solid Stem Auger COMPILED BY B.L.
 DATUM Geodetic DATE December 1, 1977 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
							WATER CONTENT (%)										
							10 20 30										
349.1	Ground Level																
0.0	Silty sand, trace of clay and gravel, loose to compact	.	1	SS	13		340							0 6 78 16			
			2	SS	9												
340.6			3	SS	25												
8.5	Clayey silt, trace of sand and gravel, very stiff	/	4	SS	28												
			5	SS	27												
			6	SS	36												
			7	SS	32												
			8	SS	32												
			9	SS	27												
			10	SS	11												
			11	SS	9												
	Becoming more plastic	/															
307.6			12	SS	7												
41.5	End of Borehole																

RECORD OF BOREHOLE No 10

W P 33-76-05 LOCATION Co-ords. N 873 869 E 1 004 906 ORIGINATED BY O.J.
 DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
 DATUM Geodetic DATE November 30, 1977 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								20 40 60 80 100										10 20 30		
347.0	Ground Level																			
0.0	Silty sand, some gravel and clay		1	SS	8															
			2	SS	4															
336.0			3	SS	5															
11.0	Clayey silt, trace of sand and gravel, very stiff		4	SS	24															
			5	SS	18															
			6	SS	16															
			7	SS	26															
			8	SS	24															
			9	SS	16															
	Becoming more plastic		10	SS	25															
305.5			11	SS	22															
41.5	End of Borehole																			

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 11

W P 33-76-05 LOCATION Co-ords. N 874,245 E 1,004,595 ORIGINATED BY B.L.
 DIST 6 HWY NWMA BOREHOLE TYPE Hollow Stem Auger COMPILED BY B.L.
 DATUM Geodetic DATE December 1, 1977 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
368.1	Ground Level																GR SA SI CL
0.0	Fill, silty sand, some brick fragments and topsoil		1	SS	42		360										0 43 51 6
357.1			2	SS	23												
11.0	Silty sand, fine, grey, compact		3	SS	22		350										0 1 80 19
349.1			4	SS	11												
19.0	Silt, trace of sand, and occasional clay seams		5	SS	25		340										1 36 52 11
339.1			6	SS	12												
29.0	Sandy Silt, some clay and a trace of gravel		7	SS	13		330										
326.6			8	SS	30												
41.5	End of Borehole																

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

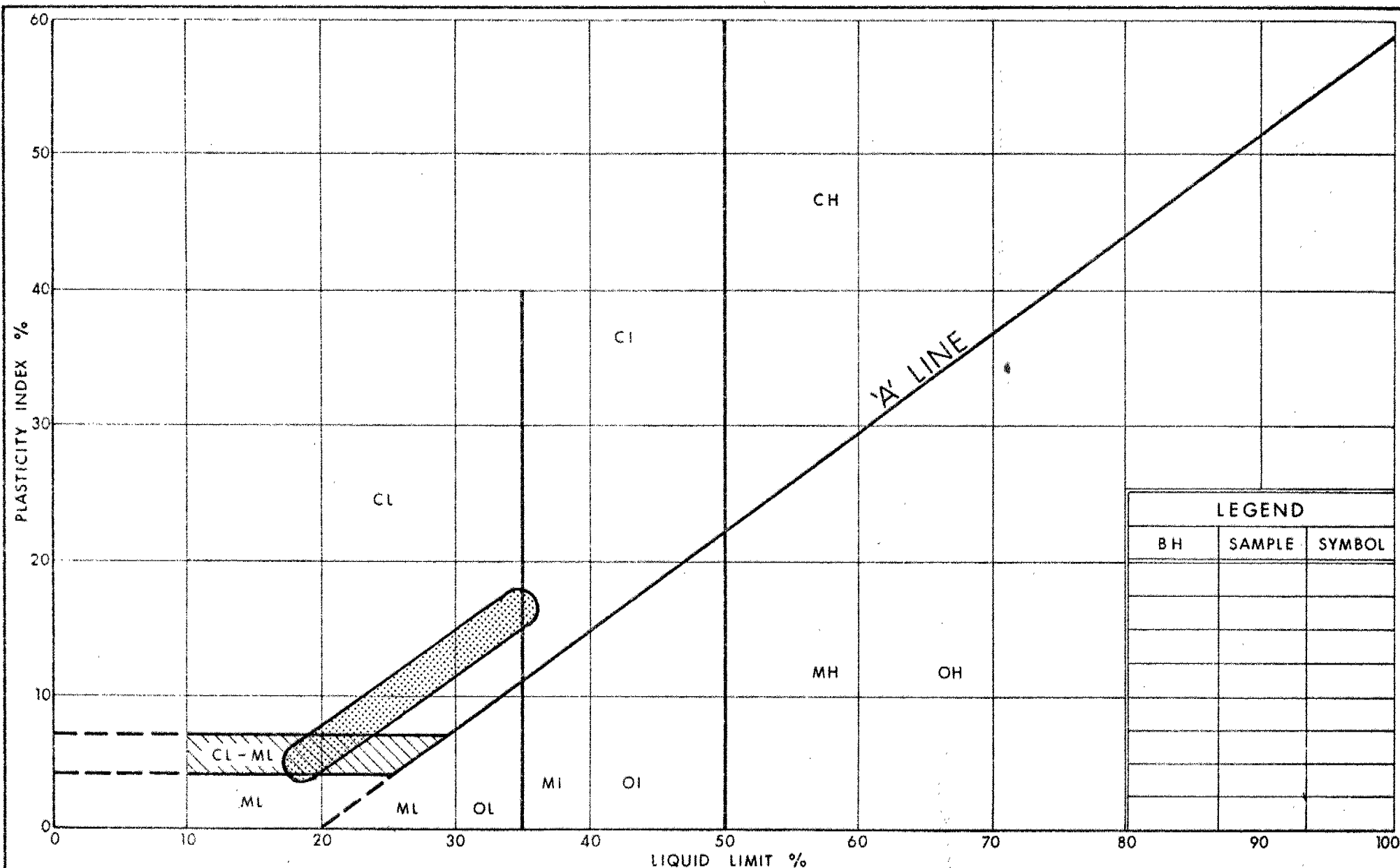
RECORD OF TEST PITS NO 1, 2 & 3

W P 33-76-05 LOCATION See Below ORIGINATED BY B.L.
DIST 6 HWY NWMA BOREHOLE TYPE Test Pit COMPILED BY S.O.
DATUM Geodetic DATE December, 1977 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60						80
								SHEAR STRENGTH			WATER CONTENT (%)					
								○ UNCONFINED + FIELD VANE								
								● QUICK TRIAXIAL x LAB VANE								
								<u>TEST PIT NO 1</u>								
372.0	Ground Level							Co-ords	N 872970	E 1005000						
0.0	Fill, silty sand with pieces of concrete and wood	X					370									
362.0		X														
10.0	End of Test Pit						360									
								<u>TEST PIT NO 2</u>								
								Co-ords	N 873030	E 1005020						
377.0	Ground Level															
0.0	Fill, debris, wood, metal, concrete and brick fragments	X					370									
367.0		X														
10.0	End of Test Pit						360									
								<u>TEST PIT NO 3</u>								
								Co-ords	N 873170	E 1004935						
376.5	Ground Level															
0.0	Fill, debris, wood, metal, concrete and brick fragments	X					370									
366.5		X														
10.0	End of Test Pit						360									

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



LEGEND		
BH	SAMPLE	SYMBOL



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PLASTICITY CHART
CLAYEY SILT
SOME SAND TRACE OF GRAVEL

FIG No 1

W P 33-76-05



GRAIN SIZE DISTRIBUTION
CLAYEY SILT
SOME SAND TRACE OF GRAVEL

W P 33-76-05

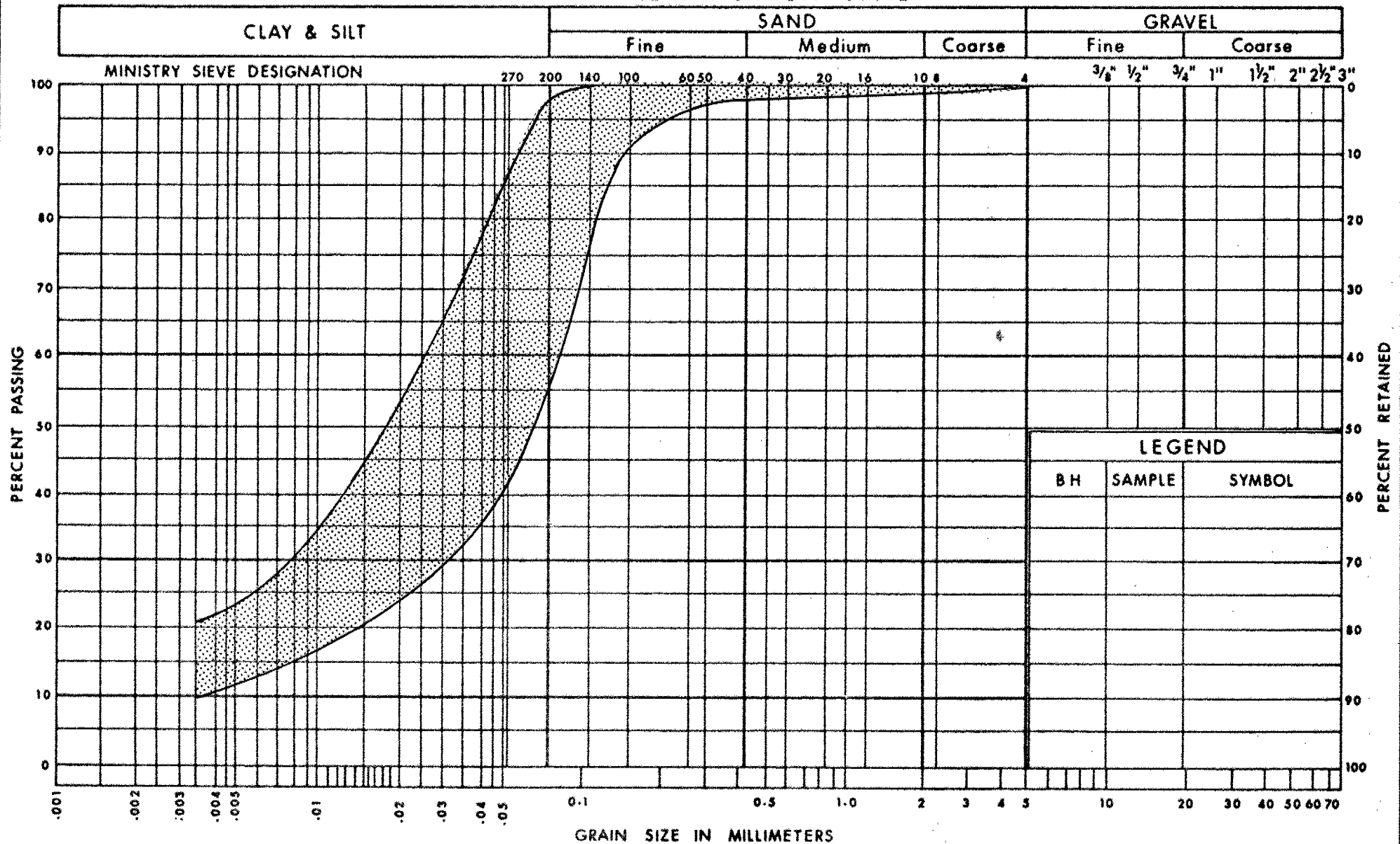


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GRAIN SIZE DISTRIBUTION
SILTY SAND
TRACE OF GRAVEL

W P 33-76-05

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

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GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILT
TRACE OF CLAY

FIG No 4

W P 33-76-05

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH AS FOLLOWS:

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF SPT 'N' VALUES AS FOLLOWS:

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. $\bar{C}IU$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

S S SPLIT SPOON
W S WASH SAMPLE
S T SLOTTED TUBE SAMPLE
B S BLOCK SAMPLE
C S CHUNK SAMPLE
T W THINWALL OPEN
T P THINWALL PISTON
O S OSTERBERG SAMPLE
F S FOIL SAMPLE
R C ROCK CORE
P H T.W. ADVANCED HYDRAULICALLY
P M T.W. ADVANCED MANUALLY

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

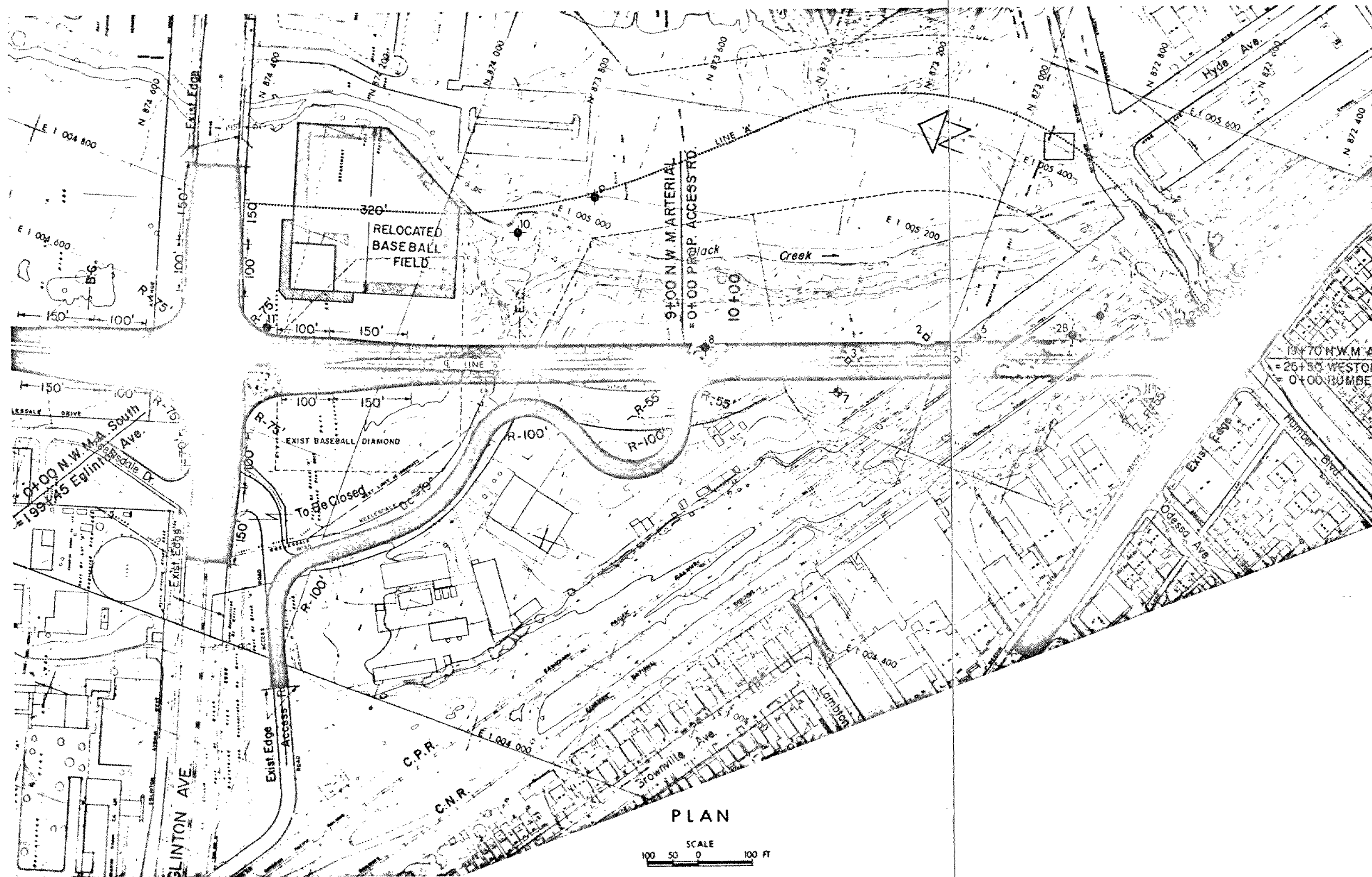
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS



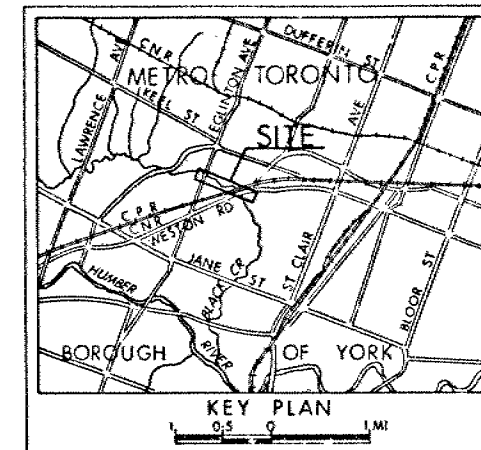
CONT No
WP No 33-76-05

N W METRO ARTERIAL

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- 'N' Blows/ft (Std Pen Test 350 ft lbs energy)
- CONE Blows/ft (60° Cone, 350 ft lbs energy)
- W.L. at time of investigation
- W.L. ESTABLISHED NOV & DEC 1977
- ◇ TEST PIT

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	344.6	872 572	1 005 223
2	357.8	872 733	1 005 175
2B	381.8	872 780	1 005 125
6	370.9	872 947	1 005 055
7	376.7	873 163	1 004 864
8	372.7	873 435	1 004 856
9	349.1	873 734	1 005 052
10	347.0	873 869	1 004 906
11	368.1	874 245	1 004 595
TP			
1	372.0	872 970	1 005 000
2	377.0	873 030	1 005 020
3	376.5	873 170	1 004 935

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

HWY No. N W METRO ARTERIAL DIST. 0
SLOMO B L CHECKED DATE SITE
DRAWN O J CHECKED DATE
DWG 337605-A



Ministry of
Transportation and
Communications

Memorandum

To: Mr. C. Mirza,
Head,
Soils Mechanics Section,
West Building, Downsview

From: G.C.E. Burkhardt,
Structural Section,
Central Region

Attention: Mr. M. Devata

Date: 1977-11-04

Our File Ref.

In Reply to

Subject: RE: N.W.M.A. Road, Foundation Investigation for
a Feasibility Study between Eglinton Avenue
and Weston Road, W.P. 33-76-05,
District 6, Toronto

The above mentioned W.P. was forwarded to your office with two different proposals for a Feasibility Foundation Investigation, in order to establish which line depending on the soil conditions, would be less expensive and feasible to build. The decision has been decided by Senior Management and a tight schedule has been established.

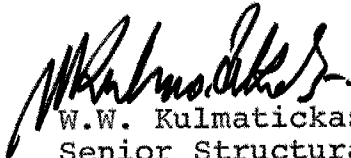
To extend the N.W.M.A. more information concerning the latter can be obtained also from the Advanced Planning Office Mr. C. Meyer.

As in our first request, we can only repeat that the location of the centrelines of the two locations is all the information we have, and due to the urgency of the job we are unable to supply you with all the data you require.

I hope the letter will clarify the problems, and you will be able to get us all the necessary information as soon as possible so that we may proceed with the detailed planning work.

If you need any additional information, please contact our office.

WK:gj


W.W. Kulmickas,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section





Memorandum

To: Mr. C. Mirza
Geotechnical Office
West Building

From: Structural Planning Office
Central Region

Attention: Mr. M. Devata

Date: 1st September, 1976

Our File Ref.

In Reply to

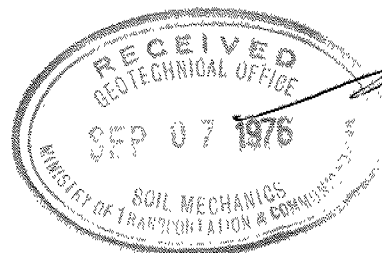
Subject: N.W. Metro Arterial
W.P.'s 33-76-02, 05
District #6

This office is presently undertaking a structural feasibility and cost study for the proposed N.W. Metro Arterial. This road will run from the present Hwy.400 terminus to the St. Clair /Weston Road area. The road will roughly follow the originally proposed Hwy.400 extension alignment to Eglinton Ave, and various schemes are being considered for the section south of Eglinton Ave.

We would be pleased if you could supply us with any soils information that you may have for this area and request your comments concerning any likely foundation problems.

I enclose a plan showing the general limits of the study area south of Eglinton and cross sections of typical retaining wall and tunnel structures adjacent to the railway tracks.

C.F. Farrell,
SENIOR STRUCTURAL PLANNING ENG
for:
G.C.E. Burkhardt,
REG. STRUCTURAL PLANNING ENG.



*ONE copy to be
forwarded to the
Planning Office
by 10/9/76*