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GEOCRES No. 30M4-64

DIST. 4 REGION                     

W.P. No. 55-75-01

CONT. No. ~~82~~ 82-61

W. O. No.                     

STR. SITE No.                     

HWY. No. 6N

LOCATION Caledonia By-Pass,  
Storm Sewer

No of PAGES -                     

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     

REMARKS:                     

G.I.-30 SEPT. 1976

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82 - 61



Ministry of  
Transportation and  
Communications



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NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.

'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

SS SPLIT SPOON  
WS WASH SAMPLE  
ST SLOTTED TUBE SAMPLE  
BS BLOCK SAMPLE  
CS CHUNK SAMPLE  
TW THINWALL OPEN  
TP THINWALL PISTON  
OS OSTERBERG SAMPLE  
FS FOIL SAMPLE  
RC ROCK CORE  
PH T.W. ADVANCED HYDRAULICALLY  
FM T.W. ADVANCED MANUALLY

##### EARTH PRESSURE TERMS

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  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  
 $\beta$  ANGLE OF SLOPE  
 $N_q, N_c, N_{\gamma}$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

##### INDEX PROPERTIES

$\gamma$  UNIT WEIGHT OF SOIL (BULK DENSITY)  
 $\gamma_w$  UNIT WEIGHT OF WATER  
 $\gamma_d$  UNIT DRY WEIGHT OF SOIL (DRY DENSITY)  
 $\gamma'$  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

$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_f$  PEAK SHEAR STRENGTH  
 $\tau_R$  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  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  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

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:  
 $\phi'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'$  = EFFECTIVE NORMAL STRESS

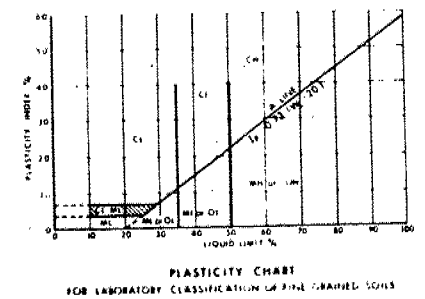
##### HYDRAULIC TERMS

$h$  HYDRAULIC HEAD OR POTENTIAL  
 $q$  RATE OF DISCHARGE  
 $v$  VELOCITY OF FLOW  
 $i$  HYDRAULIC GRADIENT  
 $j$  SEEPAGE FORCE PER UNIT VOLUME  
 $\eta$  COEFFICIENT OF VISCOSITY  
 $k$  COEFFICIENT OF HYDRAULIC CONDUCTIVITY  
 $k_h$   $k$  IN HORIZONTAL DIRECTION  
 $k_v$   $k$  IN VERTICAL DIRECTION  
 $\alpha_v$  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)

# EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75 mm AND BASING FRACTIONS ON ESTIMATED MASS)					GROUP SYMBOL	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA				
COARSE GRAINED SOILS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 75 mm MOST THAN HALF OF MATERIAL IS LARGER THAN 75 mm	GRAVELS	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZE	GM	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	GIVE TYPE, NAME, IF NECESSARY, INDICATE APPROX. % OF SAND & GRAVEL; MAX. SIZE; ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS. LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION; & SYMBOL IN PARENTHESES  FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS.	DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 µm). COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% GW, GP, SW, SP MORE THAN 12% GW, GC, SM, SC 5% TO 12% <u>BORDERLINE CASES</u> REQ. USE OF DUAL SYMBOLS					
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING	GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES		C <sub>u</sub> = $\frac{D_{60}}{D_{10}}$ GREATER THAN 4 C <sub>c</sub> = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR GW ATTERBERG LIMITS BELOW A-LINE, OR I <sub>p</sub> LESS THAN 4 ABOVE A-LINE WITH I <sub>p</sub> BETWEEN 4 AND 7 ARE <u>BORDERLINE CASES</u> REQUIRING USE OF DUAL SYMBOLS ATTERBERG LIMITS ABOVE A-LINE WITH I <sub>p</sub> GREATER THAN 7					
		SANDS	CLEAN SANDS (LITTLE OR NO FINES)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		C <sub>u</sub> = $\frac{D_{60}}{D_{10}}$ GREATER THAN 4 C <sub>c</sub> = $\frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SW ATTERBERG LIMITS BELOW A-LINE OR I <sub>p</sub> LESS THAN 4 ABOVE A-LINE WITH I <sub>p</sub> BETWEEN 4 AND 7 ARE <u>BORDERLINE CASES</u> REQUIRING USE OF DUAL SYMBOLS ATTERBERG LIMITS ABOVE A-LINE WITH I <sub>p</sub> GREATER THAN 7					
			SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES							
	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE ML BELOW)	SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES								
		PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)	SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES								
	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 µm							GIVE TYPE, NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR IN WET CONDITION, ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESES  FOR UNDISTURBED SOILS ADD INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOULDED STATES, MOISTURE & DRAINAGE CONDITIONS.				
	FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 µm MOST THAN HALF OF MATERIAL IS SMALLER THAN 75 µm	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)		TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)		ML	INORGANIC SILTS & SANDY SILTS OF SLIGHT PLASTICITY, ROCK FLOUR		
				NONE	QUICK		NONE		CL	CLAYEY SILTS (INORGANIC), GRAVELLY CLAYS, SANDY CLAYS, LEAN CLAYS		
				MEDIUM TO HIGH	NONE TO VERY SLOW		MEDIUM		OL	ORGANIC SILT OF LOW PLASTICITY, ORGANIC SANDY SILTS		
LIQUID LIMIT BETWEEN 35% AND 50%			NONE TO SLIGHT	SLOW TO QUICK	SLIGHT	MI	INORGANIC COMPRESSIBLE FINE SANDY SILT WITH CLAY OF MEDIUM PLASTICITY, CLAYEY SILTS					
			HIGH	NONE	MEDIUM TO HIGH	CI	SILTY CLAYS (INORGANIC) OF MEDIUM PLASTICITY					
			SLIGHT TO MEDIUM	VERY SLOW	SLIGHT	OI	ORGANIC SILTY CLAYS OF MEDIUM PLASTICITY					
LIQUID LIMIT GREATER THAN 50%		SLIGHT TO MEDIUM	SLOW TO NONE	MEDIUM	MH	INORGANIC SILTS, HIGHLY COMPRESSIBLE MICACEOUS OR DIATOMEACEOUS FINE SANDY SILTS, ELASTIC SILTS						
		HIGH TO VERY HIGH	NONE	HIGH	CH	CLAYS (INORGANIC) OF HIGH PLASTICITY, FAT CLAYS						
		MEDIUM TO HIGH	NONE TO VERY SLOW	SLIGHT TO MEDIUM	OH	ORGANIC CLAYS OF HIGH PLASTICITY						
HIGHLY ORGANIC SOILS					PE	PEAT & OTHER HIGHLY ORGANIC SOILS						

USE GRAIN SIZE CURVE IN IDENTIFYING THE FRACTIONS AS GIVEN UNDER FIELD IDENTIFICATION



BOUNDARY CLASSIFICATIONS: SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATIONS OF GROUP SYMBOLS. FOR EXAMPLE GM-GC, WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

## FOUNDATION INVESTIGATION REPORT

For

Subway Outlet Storm Sewers

Sta: 69 + 00 - 100 + 00 (South Storm Sewer)

Sta: 100 + 00 - 115 + 50 (North Storm Sewer)

W.P. 55-75-01

District #4 (Hamilton)

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### INTRODUCTION

This report contains the results of the foundation investigations carried out for the proposed storm sewers located south and north of the Grand River in the vicinity of Caledonia. The fieldwork was carried out during the period of May 4-25, 1977, utilizing a continuous flight auger machine equipped with a 3½ inch I.D. hollow stem augers mounted on a muskeg vehicle.

Borings, numbered from 101 to 112 cover the south storm sewer, while the boreholes #113-#118 cover the north storm sewer.

### SITE DESCRIPTION

One of the storm sewers is located south of the Grand River (Sta: 60 + 00 - Sta: 100 + 00). It will extend from the future C.N.R. structure (Hagersville Subdivision Line) southerly to McKenzie Creek. The terrain adjacent to the proposed alignment is flat to gently rolling and used for farming purposes.

A second storm sewer will be located north of the Grand River (Sta: 100 + 00 - Sta: 115 + 50) parallel to the future C.N.R. relocation. The topography of the general area surrounding the site may be described as generally flat to gently undulating. The land is being used for grazing purposes. Underground mining (gypsum) operations are being carried out by Domtar Ltd. just north of the site.

Phsiographically, both sites are located in the region referred to as the Haldimand Clay Plain.

#### SUBSURFACE CONDITIONS

##### General

The overburden within the investigated area was found to consist of about four different types of deposits:

- Clayey silt to silt
- Silty clay (stratified)
- Silty sand
- Glacial till

Only the silty clay and the glacial till deposits were encountered at each sewer location.

The boundaries of the different deposits are shown on the Record of Borehole Sheets. The estimated stratigraphical profiles of Sheet No. 52-1 of the contract drawings are based upon this information. From ground level downward, the various strata is described in some detail with regard to soil types and soil properties as follows:

##### Clayey Silt to Silt

This deposit was encountered in boreholes 101 to 105 immediately from ground level to a maximum depth of about 12 feet. The material in the deposit consists mainly of clayey silt to silt, traces of sand and organics. The consistency is estimated to be very stiff.

### Silty Clay (Stratified)

This stratum appears to be the predominant type of subsoil across the sites investigated and it was encountered at each boring location immediately below ground level or the above described clayey silt to silt deposit. The thickness was found to vary from 19 to 40 feet. Reference should be made to the Record of Borehole Sheets for the lower boundary elevation. The material in the deposit consists mainly of silty clay with numerous, irregular clayey silt and silt laminations up to 0.5" in thickness. Pockets of sand were also encountered within the main deposit. Some of the silt layers appear to be water bearing.

The consistency was found to vary randomly from stiff to very stiff.

Physical properties of the deposit as determined from the field and laboratory tests are as follows:

		<u>Range</u>
Plastic Limit	(%)	15 - 23
Liquid Limit	(%)	29 - 54
Natural Moisture Content	(%)	24 - 41
Bulk Density	(PCF)	113 -125
<u>Undrained Shear Strength</u>		
Unconfined Compression		1000-3050
Field Vane		1040-2000+
Sensitivity		2.0-4.5

Grain-size distribution test results are shown in envelope form on Fig. 1.



### Silty Sand

This stratum was encountered in boreholes 104 and 105 only below the silty clay deposit. The maximum thickness is about 11 feet.

The material in the stratum consists mainly of sands and silts. In addition, occasional thin layers and pockets of clayey silt were also encountered. Mechanical analysis performed on four samples indicate that the sand and silt sizes are about 77% and 23% respectively.

Standard Penetration tests carried out within the main deposit indicate that the relative density varies from compact to very dense. The obtained 'N' values ranged between 12 and 59 blows per foot. The natural moisture content ranges from 15 to 20%.

### Heterogeneous Mixture of Gravel, Sand, Silt and Clay

Beneath the silty clay and/or silty sand deposits is a glacial till stratum composed of a heterogeneous mixture of gravel, sand, silt and clay. The lower boundary was not determined since most of the borings were terminated in this deposit. The matrix of this till is basically granular in nature. There are random localized zones within this material, where the matrix is cohesive i.e. clayey silt binding coarser sized particles.

Standard Penetration tests carried out in this deposit gave 'N' values ranging from 32 to over 100 blows per foot. Based on these results, it is estimated that the relative density of the stratum varies from dense to very dense.

### GROUNDWATER CONDITIONS

Groundwater level observations have been carried out during the course of field investigation by recording the water levels in the open boreholes. The results indicate variations in groundwater levels across both sites. Artesian groundwater conditions were encountered along the proposed southerly storm sewer once the borings penetrated through the silty clay stratum down into the granular type glacial till deposit. When the artesian pressure condition was encountered, the groundwater rose instantaneously up to about elevation 633<sup>±</sup>. In borehole 103, the groundwater level reached elevation 660<sup>±</sup>.

The observations were continued for several days after the completion of boring. The final groundwater levels are summarized on Sheet No. 52-1 of the contract drawings and on the individual Record of Borehole Sheets.

No artesian conditions were encountered in boreholes #112, 114, 115, 116, and 117. A plot of peizometric head versus elevation is shown on Fig. 2.

P. Payer, P. Eng.  
Foundations Engineer



*K.G. Selby*  
K.G. Selby, P. Eng.  
Senior Foundations Engineer

## APPENDIX

RECORD OF BOREHOLE NO 101

WP 55-75-01

LOCATION Co-ords. N 15,644,350; E 871,805

ORIGINATED BY RVV

DIST 4 HWY 6N

BORING DATE May 4-5, 1977

COMPILED BY RNO

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger & Cone Test

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
672.5	Ground Level															
0.0	Clayey silt to silt		1	SS	17	670										
665.5	Very Stiff		2	SS	20											
7.0	Brown		3	SS	10											
	Gray		4	SS	13											
	Silty clay layers of clayey silt and silt Trace of sand		5	SS	10											
	Stiff to Very Stiff		6	SS	10											
			7	SS	13											
			8	SS	11											
			9	TW	PH											
			10	SS	7											
625.5			11	SS	7											
47.0	Glacial Till		12	SS	63/	18"										
622.5																
50.0	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

11

RECORD OF BOREHOLE NO 102

WP 55-75-01

LOCATION Co-ords. N 15,644,148; E 871,660

ORIGINATED BY RVV

DIST 4 HWY 6N

BORING DATE May 5, 1977

COMPILED BY RNO

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N° VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
674.8	Ground Level															
0.0	Clayey silt to silt Very Stiff Trace of organics		1	SS	17	670										0 2 74 24
			2	SS	21											
			3	SS	20											
662.8			4	SS	17											
12.0	Silty clay		5	SS	16	660										
			6	SS	9											
	Brown		7	SS	13											
	Grey															
	Layers of clayey silt and silt		8	SS	11	650										
	Pockets of sand		9	SS	9											
	Stiff		10	SS	11	640										
	to		11	SS	10											
	Very Stiff		12	SS	11	630										
629.0			13	SS	32											
45.8	Heterogeneous mixture of gravel, sand & clayey silt, comp.															
623.3	Glacial Till															0 53 43 4
51.5	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 103

WP 55-75-01 LOCATION Co-ords. N 15,643,947; E 871,515 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 6, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger & Cone Test CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES		20	40	60	100	$w_p$	$w$	$w_L$		
670.3	Ground Level														
0.0	Clayey silt to silt, Traces of sand, Organics		1	SS	19										
			2	SS	24										
	Very Stiff		3	SS	24										
659.1			4	SS	18										
11.2	Silty clay		5	SS	6										
	Layers of clayey silt & silt		6	SS	10										
	Trace of sand		7	TW	PH										
	Stiff		8	SS	8										
	to		9	SS	8										
	Very Stiff		10	SS	8										
			11	SS	7										
			12	SS	7										
622.3															
48.0	End of Borehole														
605.8															
64.5	End of Cone Test														

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 104

WP 55-75-01

LOCATION Co-ords. N 15,643,665; E 871,310

ORIGINATED BY RVV

DIST 4 HWY 6N

BORING DATE May 9, 1977

COMPILED BY RNO

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

 CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p \quad w \quad w_L$ WATER CONTENT % 20 40 60	UNIT WEIGHT $\gamma$ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
661.0	Ground Level													
0.0	Clayey silt to silt, Traces of sand, Organics Very Stiff		1	SS	19									
653.0			2	SS	18									
8.0	Silty clay Layers of clayey silt and silt  Trace of sand  Stiff to Very Stiff		3	SS	18									
			4	SS	13									
			5	TW	PH									
633.5			6	SS	12									
27.5	Silty sand Occasional pockets and layers of clayey silt		7	SS	59									
624.5	Dense to Very Dense		8	SS	46									
36.5	End of Borehole													

 20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 105

WP 55-75-01

LOCATION Co-ords. N 15,643,505; E 871,195

ORIGINATED BY RVV

DIST 4 HWY 6N

BORING DATE May 9, 10, 1977

COMPILED BY RNO

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N° VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
660.5	Ground Level					660										
658.0	Clayey silt to silt															
2.5	Silty clay layers of clayey silt & silt		1	SS	12											
			2	SS	13											
			3	SS	12											
	Trace of sand		4	SS	13	650										0 0 48 52
			5	SS	14											
	Stiff		6	SS	16											
	to		7	SS	15	640										
637.5	Very Stiff															
23.0	Silty sand Occasional clayey silt pockets and layers		8	SS	10											0 75 (25)
	Compact		9	SS	12	630										0 77 (23)
			10	SS	18											
622.0																
38.5	Heterogeneous mixture of gravel, sand, silt, clay, Compact to very dense		11	SS	28	620										
			12	SS	81											43 46 (11)
611.5	Glacial Till		13	SS	25/6"											
49.0	End of Borehole Probable bedrock				Refusal											

OFFICE REPORT ON SOIL EXPLORATION



## RECORD OF BOREHOLE № 106

W P 55-75-01

LOCATION Co-ords. N 15,642,815; E 870,692

ORIGINATED BY RVV

DIST 4 HWY 6N

BORING DATE May 10, 1977

COMPILED BY RNO

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY ES

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT	LIQUID LIMIT ——— $w_L$	UNIT WEIGHT  $\gamma$ PCF	REMARKS					
ELEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	'N' VALUES		20 40 60 80 100	PLASTIC LIMIT ——— $w_p$							
							SHEAR STRENGTH PSF						WATER CONTENT — $w$		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						$w_p$ $w$ $w_L$		
						WATER CONTENT %									
653.8	Ground Level						20 40 60								
0.0	Silty clay					650									
	Layers of clayey silt and silt		1	SS	14										
	Trace of sand		2	SS	10										
	Stiff to Very Stiff		3	SS	12	↓	> +			0 1 46 53					
			4	SS	8	640	> +								
			5	SS	5		+ s=2.2								
			6	SS	5		+ s=3.3								
624.8			7	TW	PH	630	+ s=2.4			123.5					
29.0	Heterogeneous mixture of gravel, sand, silt, clay.		8	SS	73		$\sigma$ + s=4.3			25 37 33 5					
619.6	Very Dense Glacial Till					620									
34.2	Refusal End of Borehole														

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 107

WP 55-75-01 LOCATION Co-ords. N 15,642,252; E 870,280 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 11, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger & Cone Test CHECKED BY *[Signature]*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ $w$ $w_L$ WATER CONTENT % 20 40 60	UNIT WEIGHT $\gamma$ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
647.8	Ground Level													
0.0	Silty clay Layers of clayey silt and silt Trace of sand  Stiff to Very Stiff		1	SS	11									0 0 43 57
			2	SS	18									
			3	SS	14									
			4	SS	10									
			5	SS	5									
			6	TW	PH									
			7	SS	6									
			8	SS	6									
620.8			9	SS	144									
27.0	Heterogeneous mixture of gravel, sand, silt & clay Very Dense													
614.5	Glacial Till													
33.3	End of Borehole Probable Bedrock													

20  
15 5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE NO 108

WP 55-75-01 LOCATION Co-ords. N 15,642,535; E 870,485 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 11, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT % 20 40 60	UNIT WEIGHT $\gamma$	REMARKS  % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	N VALUES		20	40	60	80	100			
651.7	Ground Level													
0.0	Silty clay					650								
	Layers of clayey silt and silt		1	SS	19									
	Trace of sand		2	SS	12	640								
	Stiff to Very stiff		3	SS	5									
			4	SS	5	630								
627.7														
24.0	Heterogeneous mixture of gravel, sand, silt clay Loose to v. dense		5	SS	6									19 38 28 15
621.2	Glacial Till		6	SS	50/6									
30.5	End of Borehole Probable Bedrock													

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 109

WP 55-75-01

LOCATION Co-ords. N 15,642,057; E 870,142

ORIGINATED BY RVV


DIST 4 HWY 6N

BORING DATE May 11, 1977

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
649.8	Ground Level													
0.0	Silty clay		1	SS	13									
	Layers of clayey silt and silt		2	SS	8									
	Trace of sand		3	SS	6									
	Stiff to		4	SS	5									
	Very Stiff		5	SS	3									
622.8			6	SS	54									
27.0	Glacial Till													
618.8	Very Dense													
31.0	End of Borehole													

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

RECORD OF BOREHOLE NO 110

WP 55-75-01 LOCATION Co-ords. N 15,641,668; E 870,060 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 12, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY EP

SOIL PROFILE		SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ pcf	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE		20	40	60	80	100	$w_p$	$w$		
644.0	Ground Level													
0.0	Silty clay		1	SS	17									
	Layers of clayey silt & silt		2	SS	14									0 0 38 62
	Trace of sand		3	SS	12									
			4	SS	12									
	Stiff		5	SS	5									
	to		6	SS	6									0 0 38 62
	Very Stiff		7	SS	4									
			8	SS	PH								119	0 1 31 68
			9	SS	5									
613.5														
612.0	Glacial Till		10	SS	43/6									30 39 23 8
32.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 111

WP 55-75-01

LOCATION Co-ords N 15,641,310; E 869,932

ORIGINATED BY RVV

DIST 4 HWY 6N

BORING DATE May 12 1977

COMPILED BY RVV

DATUM Geodetic

BOREHOLE TYPE Hollow Stem auger

CHECKED BY SP.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
655.3	Ground Level						500	1000	1500	2000	2500	20	40	60		GR SA SI CL
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	19	650										0 0 67 33
			2	SS	9											
			3	SS	9	640										
			4	SS	11											
			5	SS	11	630										0 0 40 60
			6	SS	10											
			7	SS	9	620										
			8	SS	7											
617.3																
43.0	Glacial Till															
608.8	Dense		9	SS	49	610										27 30 34 0
46.5	End of Borehole															

RECORD OF BOREHOLE NO 112

WP 55-75-01 LOCATION Co-ords N 15,640,995; E 869,862 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 13, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$		UNIT WEIGHT $\gamma$ PCF	REMARKS  % GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N VALUES		20 40 60 80 100					$w_p$ — $w$ — $w_L$				
							SHEAR STRENGTH PSF					WATER CONTENT %				
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE									
635.0	Ground Level					ELEV	500	1000	1500	2000	2500	20	40	60		
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	11	630									113	0 1 28 71
			2	SS	17											
			3	SS	14											
			4	SS	12											
			5	SS	7	620										
			6	TV	PH											
616.6			7	SS	42											
613.5	Glacial Till Dense															21 30 40 9
21.5	End of Borehole															

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

## RECORD OF BOREHOLE NO 113

WP 55-75-01 LOCATION Co-ords N 15,654,362; E 876,248 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 16, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ pcf	REMARKS  % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	IN VALUES		SHEAR STRENGTH PSF					WATER CONTENT %				
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE					$w_p$ $w$ $w_L$				
						20	40	60	80	100						
672.0	Ground Level					500	1000	1500	2000	2500	20	40	60			
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	7											
			2	SS	15											
			3	SS	16											
			4	SS	11											
			5	SS	13											
			6	SS	13											
			7	SS	7											
			8	SS	8											
			9	TV	PH											
			10	SS	8											
			11	SS	9											
635.8			12	SS	14											
36.2	Heterogeneous mixture of Gravel, Sand, Silt		13	SS	100/5"											
631.7	Clay very Dense Glacial															
40.3	End of Borehole Probable Bedrock															

OFFICE REPORT ON SOIL EXPLORATION



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

23

RECORD OF BOREHOLE NO 114

WP 55-75-01 LOCATION Co-ords N 15,654,263; E 876,632 ORIGINATED BY RTV  
 DIST 4 HWY 6N BORING DATE May 20, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT %	UNIT WEIGHT $\gamma$ pcf	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100			
658.5	Ground Level						500	1000	1500	2000	2500	20	40	60
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	12	650								
			2	SS	19									0 6 38 56
			3	SS	11	640								0 0 65 35
			4	SS	7									
			5	TV	PH									
635.0														
23.5	End of Borehole													

20  
15  $\diamond$  5 % STRAIN AT FAILURE  
10

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 115

WP 55-75-01 LOCATION Co-ords N 15,654,165; E 876,910 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 20 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
669.8	Ground Level															
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	20											
			2	SS	13											
			3	SS	10											
			4	SS	13											
			5	SS	12											
			6	SS	7											
			7	SS	12											
644.5			8	SS	17											
25.3	Heterogeneous mixture of Gravel, Sand, Silt, Clay Compact to very Dense Glacial Till		9	SS	57											
635.8																
34.0	End of Borehole															

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10

RECORD OF BOREHOLE NO 116

WP 55-75-01 LOCATION Co-ords N 15,654,070 ; E 877,200 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 20, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY Sp

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT				LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$	
666.0	Ground Level														
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to Very Stiff		1	SS	16	660									0 1 46 53
			2	SS	17										
			3	SS	14										
			4	SS	16	650									
645.9	Heterogeneous Mixture of Gravel, Sand, Silt and Clay Compact to Dense Glacial till		5	TM	PH										17 29 40 14
20.1			6	SS	39										
			7	SS	38	640									
634.5			8	SS	28										7 22 47 24
31.5	End of Borehole														

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 117

WP 55-75-01 LOCATION Co-ords N 15,653,988 ; E 977,393 ORIGINATED BY RVV  
 DIST 4 HWY 4N BORING DATE May 20, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY GP

SOIL PROFILE		SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT % 20 40 60	UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE					
646.0	Ground Level								
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff		1	SS	9	640 ↓			
			2	SS	8				
			3	SS	6				
			4	SS	9				
634.0	End of Borehole								
12.0									

OFFICE REPORT ON SOIL EXPLORATION

## RECORD OF BOREHOLE NO 118

WP 55-75-01

LOCATION Co-ords N 15,654,468; E 876,035

ORIGINATED BY RVV

DIST 4 HWY 6N

BORING DATE May 25, 1977

COMPILED BY RNO

DATUM Geodetic

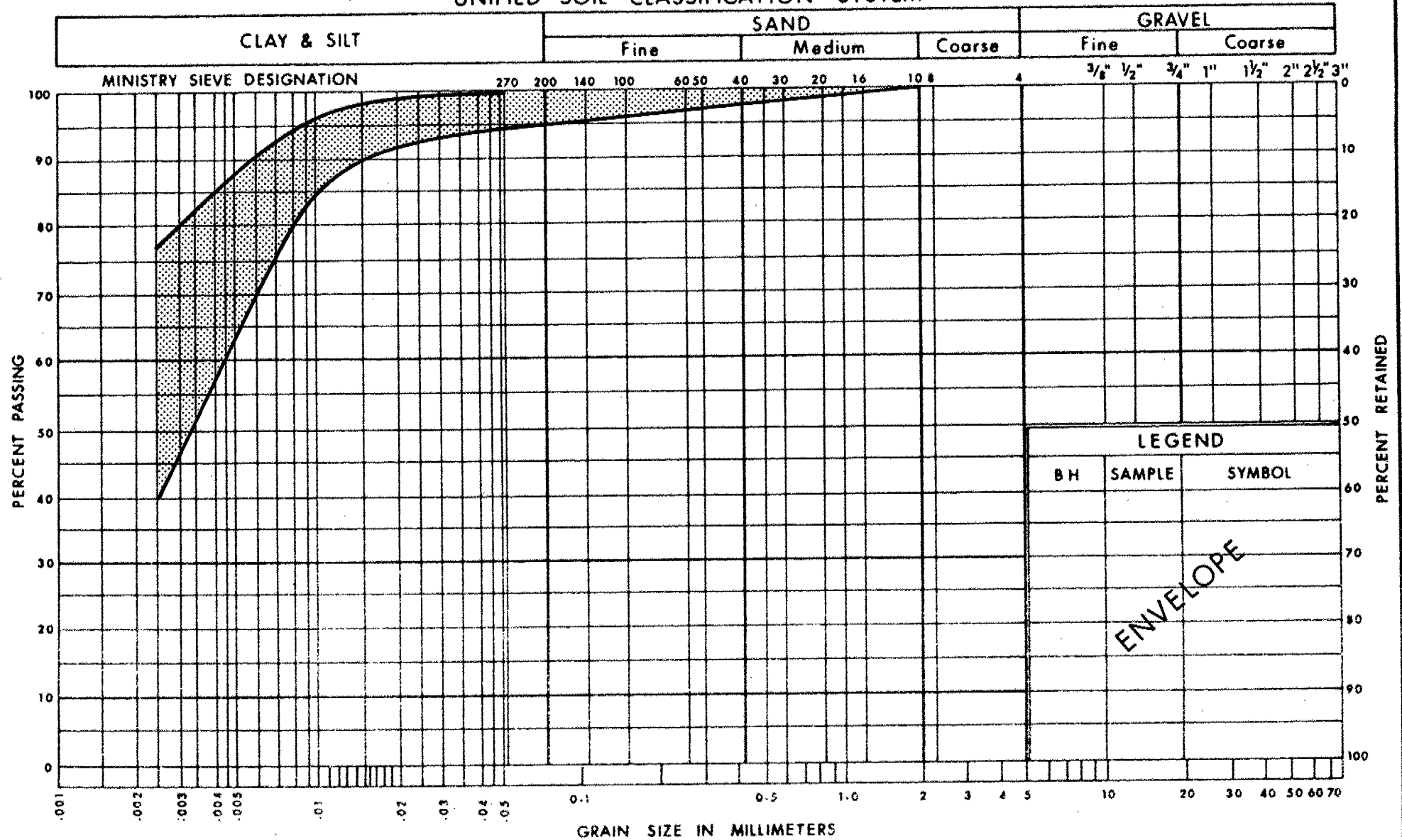
BOREHOLE TYPE Hollow Stem Auger

CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
680.5	Ground Level															
0.0	Silty Clay Layers of Clayey Silt, and Silt Traces of Sand and Gravel Stiff to very Stiff		1	SS	32											
			2	SS	5	670										
			3	SS	18											
			4	SS	23	660										
			5	SS	24											
			6	SS	26	650										
			7	SS	28											
642.5			8	SS	53	640										
38.0	Heterogeneous Mixture of Gravel, Sand, Silt Clay Dense to very Dense Glacial Till		9	SS	35											
632.0																
48.5	End of Borehole Probable Bedrock															
	NOTE Estimated Water Level From Adjacent Field Investigation															

OFFICE REPORT ON SOIL EXPLORATION

# UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY CLAY

FIG No 1

W P 55-75-01

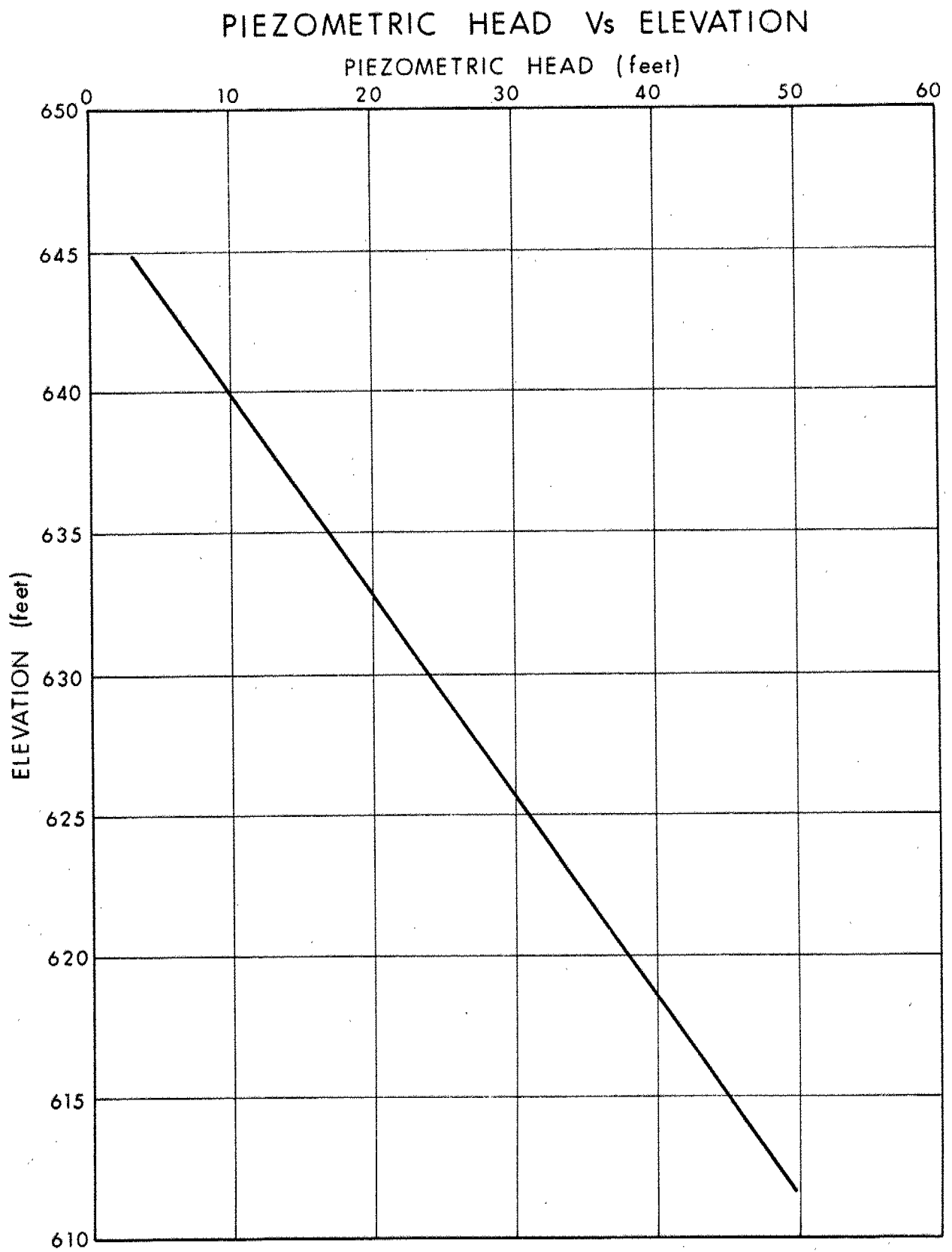


FIG 2

WP 55-75-01



Ontario

Ministry of  
Transportation and  
Communications

CONT 82-61

# foundation investigation and design report



ENGINEERING MATERIALS OFFICE  
SOIL MECHANICS SECTION

WP 55-75-01

DIST 4

HWY 6N

STR SITE N/A

Proposed Storm Sewers  
C.N.R. Southerly and Easterly

DISTRIBUTION

G.C.E. Burkhardt (3)  
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B.J. Giroux  
R.S. Pillar

R. Hore

R. Fitzgibbon )  
J. Anderson ) cover only  
G. Sloan )

Files ✓

SAMPLE DISPOSITION NOTICE		
TYPE	DISCARD AFTER	RECOMM. BY
JARS	77-08-22	1485
TUBES	_____	_____
ROCK CORES	_____	_____

# FOUNDATION INVESTIGATION REPORT

For

Proposed Storm Sewers  
C.N.R. Southerly and Easterly  
Hwy. 6N, District 4, Hamilton  
W.P. 55-75-01

---

## INTRODUCTION

This report contains the results of our foundation investigation carried out for the proposed storm sewers ("A" & "B") south and north of the Grand River in the vicinity of Caledonia. The fieldwork was carried out during the period of May 4 - 25, 1977, utilizing a continuous flight auger machine equipped with 3¼ inch I.D. hollow stem augers mounted on a musked vehicle.

## SITE DESCRIPTION

Storm sewer "A" is located south of the Grand River. It will extend from the future C.N.R. structure (Hagersville Subdivision Line) southerly to McKenzie Creek. The terrain adjacent to the proposed alignment is flat to gently rolling and used for farming purposes.

A second storm sewer ("B") will be located north of the Grand River parallel to the future C.N.R. relocation. The topography of the general area surrounding the site may be described as generally flat to gently undulating. The land is being used for grazing purposes. Underground mining (gypsum) operations are being carried out by Domtar Ltd. just north of the site.

Physiographically, both sites are located in the region referred to as the Haldimand Clay Plain.

## SUBSURFACE CONDITIONS

### General

The overburden within the investigated area was found to consist of about four different types of deposits.

Clayey silt to silt

Silty clay

Silty sand

Glacial till

Only the silty clay and the glacial till deposits were encountered at each boring location.

The boundaries of the different deposits are shown on the Record of Borehole Sheets attached to the Appendix. The estimated stratigraphical profile of Drawing 557501-A is based upon this information. From ground level downward, the various strata is described in some detail with regard to soil types and soil properties as follows:

Clayey Silt to Silt

This deposit was encountered in boreholes 101 to 105 immediately from ground level to a maximum depth of about 12 feet. The material in the deposit consists mainly of clayey silt to silt, traces of sand and organics. The consistency is estimated to be very stiff.

Silty Clay (Stratified)

This stratum appears to be the predominant type of subsoil accross the site investigated and it was encountered at each boring location immediately below ground level or the above described clayey silt to silt deposit. The thickness was found to vary from 19 to 40 feet. Reference should be made to the Record of Borehole Sheets for the lower boundary elevation. The material in the deposit consists mainly of silty clay with numerous, irregular clayey silt and silt laminations up to 0.5" in thickness. Pockets of sand were also encountered within the main deposit. Some of the silt layers appear to be water bearing.

The consistency of undrained shear strength was found to vary randomly from stiff to very stiff.

Physical properties of the deposit as determined from the field and laboratory tests are as follows.

		<u>Range</u>
Plastic Limit	(%)	15 - 23
Liquid Limit	(%)	29 - 54
Natural Moisture Content	(%)	24 - 41
Bulk Density	(PCF)	113 - 125
Undrained Shear Strength	(PSF)	
Unconfined Compression		1000 - 3050
Field Vane		1040 - 2000+
Sensitivity		2.0 - 4.5

Mechanical analysis test results are shown in envelope form on Fig. 1, attached to the appendix.

#### Silty Sand

This stratum was encountered in boreholes 104 and 105 only (Sewer "A"), below the silty clay deposit. The maximum thickness is about 11 feet.

The material in the stratum consists mainly of sands and silts. In addition, occasional thin layers and pockets of clayey silt were also encountered. Mechanical analysis performed on four samples indicate that the sand and silt sizes are about 77% and 23% respectively.

Standard Penetration tests carried out within the main deposit indicate that the relative density varies from compact to very dense. The obtained 'N' values ranged between 12 and 59 blows per foot. The natural moisture content ranges from 15 to 20%.

The stratum is expected to be quite pervious and to yield considerable amounts of water. As the main deposit lacks cohesion it is also expected that the slopes of the excavations extending below the groundwater level will be unstable and the base will 'boil' due to the unbalanced hydrostatic head.

#### Heterogeneous Mixture of Gravel, Sand, Silt and Clay

Beneath the silty clay and/or silty sand deposits is a glacial till stratum composed of a heterogeneous mixture of gravel, sand, silt and clay. The lower boundary was not determined since most of the borings were terminated in this deposit. The matrix of this till is basically granular in nature. There are random localized zones within this material, where the matrix is cohesive i.e. clayey silt binding coarser sized particles.

Standard Penetration tests carried out in this deposit gave 'N' values ranging from 32 to over 100 blows per foot. Based on these results, it is estimated that the relative density of the stratum varies from dense to very dense.

#### GROUNDWATER CONDITIONS

Groundwater level observations have been carried out during the course of field investigation by recording the water levels in the open boreholes. The results indicate variations in groundwater levels across both sites. Artesian groundwater conditions were encountered along the proposed sewer "A" once the borings penetrated through the silty clay stratum down into the granular type glacial till deposit. When the artesian pressure condition was encountered, the groundwater rose instantaneously up to about elevation 633<sup>+</sup>. In borehole 103, the groundwater level reached elevation 660<sup>+</sup>.

The observations were continued for several days after the completion of boring. The final groundwater levels are summarized on Drawing 557501-A and on the individual Record of Borehole Sheets.

No artesian conditions were encountered in boreholes # 112, 114, 115, 116, and 117. A plot of peizometric head versus elevation is shown on Fig. 2.

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to construct storm sewers on the Caledonia By-Pass (New Hwy. 6). One of the sewers (designated as sewer "A") will extend from the future C.N.R. structure (Hagersville Subdivision Line) southerly to McKenzie Creek covering an approximate distance of 4000 feet. (Sta: 100+00 to Sta. 60+00) and the second storm sewer (designated as sewer "B") will be located from the proposed E of Hwy. 6 N (Sta 651+30<sup>+</sup>) easterly and parallel to the C.N.R. relocation (Dunville Subdivision Line) for a distance of 1500 feet. The diameter will be 42 inches. The existing ground surface along the proposed sewer "A" alignment varies between elevation 676<sup>+</sup> and elevation 635<sup>+</sup> (out-fall end) while the invert level is sloping from elevation 633<sup>+</sup> to elevation 628<sup>+</sup>. To reach the proposed invert level up to 45 feet deep excavations will be required.

Along sewer "B" the ground profile varies from elevation 682<sup>+</sup> to elevation 650<sup>+</sup> and the proposed invert level between elevation 648<sup>+</sup> and elevation 644<sup>+</sup>. Excavations up to 35 feet will be required.

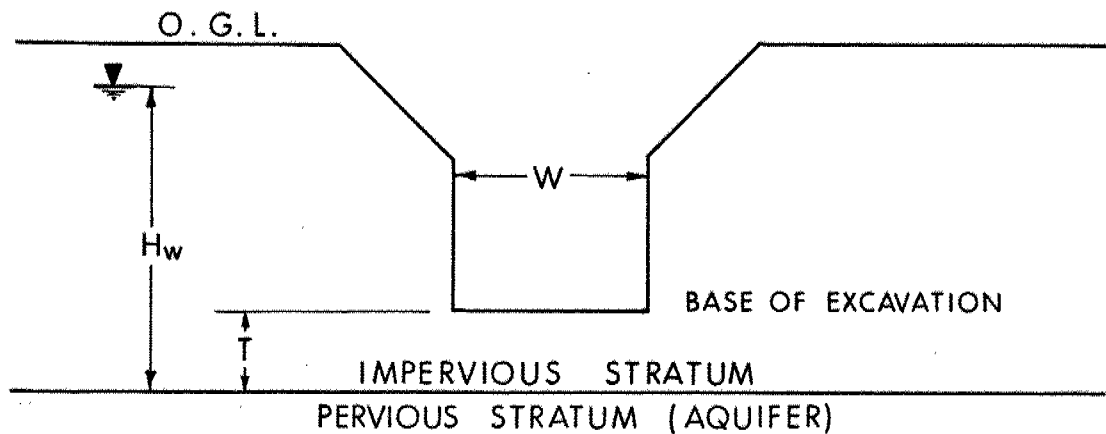
The subsoil and groundwater conditions encountered in the area under investigation have been discussed previously in this report. Indeed, stratigraphical profiles and the observed groundwater conditions along the proposed alignments (Sewers "A" and "B") and invert levels are shown on Drawing 557501-A. It is assumed that sewers "A" and "B" will be constructed by open-cut methods.

### Sewers Constructed By Open-cut Methods

The excavations for both sewers will generally be carried out within the stratified cohesive stratum. The only exception to this is between Sta. 841<sup>+</sup> to Sta. 93<sup>+</sup> (Sewer "A") where the invert level traverses the silty sand stratum.

Temporary cuts (within the cohesive deposit) up to 20 feet deep and provided with 1:1 slopes will be stable against rotational type failure. If for some reason(s) the slopes will be steeper, the excavations should be properly sheeted and braced.

The field investigations have shown that over most of the area, a hydrostatic pressure equal to the fill head of the prevailing water level exists within the basically granular type glacial till stratum. Consequently, the possibility of ground heave exists where the base of the sewer trench is within a certain distance of the glacial till deposit. The safe distance against basal heave of the cut between the cohesive (impervious) and glacial till (aquifer) deposits can be determined using the following method.



$$FS = \frac{T \gamma W + 2T S_u}{\gamma_w H_w W}$$

Where

FS: Factor of safety with respect to basal stability of excavation

T : Vertical distance between base of the trench and the pervious (aquifer) glacial till stratum (in feet).

W : Bottom width of excavation (in feet).

H<sub>w</sub>: Unbalanced hydrostatic water pressure head acting at the boundary of the pervious and impervious strata (in feet).

$S_u$ : Undrained shear strength of the impervious subsoil (in PSF).  
(Recommended value: 1200 PSF).

$\gamma$ : Bulk unit weight of impervious subsoil (in PCF). (Recommended value: 122 PCF).

$\gamma_w$ : Bulk unit weight of water (in PCF)

Excavations carried out within the relatively impervious cohesive overburden and at a safe vertical distance above the glacial till stratum should not present any major dewatering problems. It is believed that if a particular segment of the excavations are carried out in a relatively short period of time and are backfilled immediately after the completion of sewer construction, any groundwater seepage or surface run-off into the excavation can be handled by employing standard techniques, such as pumping from sumps. It is recommended that the excavation and sewer construction be proceeded from the out-fall end.

Should the base of trenches be closer than the computed safe vertical distance above the pervious glacial till stratum, steps should be taken to lower the prevailing hydrostatic pressure to prevent basal heave.

As mentioned previously, between Sta. 84<sup>+</sup> and Sta 93<sup>+</sup> (Sewer "A") the excavation will intersect the highly permeable silty sand stratum which is susceptible to 'Boiling' when subjected to unbalanced hydrostatic pressure. In order to prevent this the hydrostatic pressure within the silt sand stratum should be lowered to a level at least 2 feet below the trench base and must be maintained at this level until the backfilling of the trench is completed.

The future performance of the sewer pipes depend to a great extent on the type and quality of the bedding used. It is, therefore, recommended that the bedding adhere to standards currently used by the Ministry, specifically for class "B" bedding on yielding foundations (Standard DD-823 Class B-2) and be placed in dry conditions. Backfill for the sewer excavations should comply with M.T.C. standard DD-813-B.




### OTHER CONSIDERATIONS

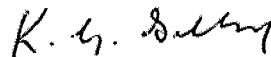
Comments and recommendations relating to the dewatering and stability of the excavations mentioned in the foregoing are based on the assumption that the groundwater conditions, as determined during the course of the field investigation, will apply during construction. However, it will be the responsibility of the contractor to determine exactly the conditions which prevail during construction, and to take such actions as are necessary to prevent the trench base from heave and/or 'boiling' and to provide safe, dry working conditions. It is believed that, if the sewers are constructed from the out-fall ends the situation will improve considerably. In addition, permanent drainage of the sewer trenches into each manhole is recommended by providing a shorth length (about 20 feet) of 6" diameter perforated pipe surrounded with a suitable filter.

### MISCELLANEOUS

The field investigation was carried out under the supervision of Mr. R. Van Veen, Project Engineer. The equipments used were owned and operated by Geocon Ltd. and Master Soil Investigation Ltd. This report was written by Mr. P. Payer.

  
P. Payer, P. Eng.  
Senior Engineer



  
K.G. Selby, P. Eng.  
Supervising Engineer

PP/KGS/kr

## APPENDIX

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 101

WP 55-75-01 LOCATION Co-ords. N 15,644,350; E 871,805 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 4-5, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger & Cone Test CHECKED BY *EP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$ $w_p$ — $w$ — $w_L$ WATER CONTENT % 20 40 60	UNIT WEIGHT $\gamma$ PCF	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100			
672.5	Ground Level													
0.0	Clayey silt to silt		1	SS	17	670								
665.5	Very Stiff		2	SS	20									
7.0	Brown		3	SS	10									
	Grey		4	SS	13	660								0 0 25 75
	Silty clay layers of clayey silt and silt Trace of sand		5	SS	10									
	Stiff to Very Stiff		6	SS	10									
			7	SS	13	650								
			8	SS	11	640								
			9	TW	PH								123	
			10	SS	7	630								0 2 56 42
625.5			11	SS	7									1 0 44 55
47.0	Glacial Till		12	SS	63/18"									
50.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 102

WP 55-75-01 LOCATION Co-ords. N 15,644,148; E 871,660 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 5, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
674.8	Ground Level															
0.0	Clayey silt to silt Very Stiff Trace of organics		1	SS	17	670										0 2 74 24
			2	SS	21											
			3	SS	20											
662.8			4	SS	17											
12.0	Silty clay		5	SS	16	660										
			6	SS	9											
	Brown		7	SS	13											
	Grey															
	Layers of clayey silt and silt		8	SS	11	650										0 0 59 41
	Pockets of sand		9	SS	9											
	Stiff		10	SS	11	640										
	to		11	SS	10											
	Very Stiff															
629.0			12	SS	11	630										
45.8	Heterogeneous mixture of gravel, sand & clayey silt, comp.															
623.3	Glacial Till		13	SS	32											0 53 43 4
51.5	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

WP 55-75-01 LOCATION Co-ords. N 15,643,947; E 871,515 ORIGINATED BY RVV  
DIST 4 HWY 6N BORING DATE May 6, 1977 COMPILED BY RNO  
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger & Cone Test CHECKED BY [Signature]

15  $\frac{20}{10}$  5 % STRAIN AT FAILURE

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 104

WP 55-75-01 LOCATION Co-ords. N 15,643,665; E 871,310 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 9, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$ PCF	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
661.0	Ground Level															
0.0	Clayey silt to silt, Traces of sand, Organics Very Stiff		1	SS	19	660										
653.0			2	SS	18											
8.0	Silty clay Layers of clayey silt and silt  Trace of sand  Stiff to Very Stiff		3	SS	18	650										
			4	SS	13											
			5	TW	PH	640										
633.5			6	SS	12											
27.5	Silty sand Occasional pockets and layers of clayey silt		7	SS	59	630										0 76 (24)
624.5	Dense to Very Dense		8	SS	46											0 80 (20) 6 22 47 25
36.5	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 105

WP 55-75-01 LOCATION Co-ords. N 15,643,505; E 871,195 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 9, 10, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
660.5	Ground Level															
0.0 658.0	Clayey silt to silt					660										
2.5	Silty clay layers of clayey silt & silt		1	SS	12											
			2	SS	13											
			3	SS	12											
	Trace of sand		4	SS	13	650										0 0 48 52
			5	SS	14											
	Stiff		6	SS	16											
	to		7	SS	15	640										
637.5	Very Stiff															
23.0	Silty sand Occasional clayey silt pockets and layers		8	SS	10											0 75 (25)
	Compact		9	SS	12	630										0 77 (23)
			10	SS	18											
622.0																
38.5	Heterogeneous mixture of gravel, sand, silt, clay, Compact to very dense		11	SS	28	620										
			12	SS	81											43 46 (11)
611.5	Glacial Till															
49.0	End of Borehole Probable bedrock		13	SS	25/0"											
					Refusal											

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 106

WP 55-75-01 LOCATION Co-ords. N 15,642,815; E 870,692 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 10, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$ PCF	REMARKS  % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
653.8	Ground Level															
0.0	Silty clay					650										
	Layers of clayey silt and silt		1	SS	14											
	Trace of sand		2	SS	10											
			3	SS	12											
	Stiff to Very Stiff		4	SS	8	640										
			5	SS	5											
			6	SS	5											
			7	TW	PH	630										
624.8																
29.0	Heterogeneous mixture of gravel, sand, silt, clay		8	SS	73											
619.6	Very Dense glacial Till					620										
34.2	Refusal End of Borehole															



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 107

WP 55-75-01 LOCATION Co-ords. N 15,642,252; E 870,280 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 11, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger & Cone Test CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS  % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
647.8	Ground Level															
0.0	Silty clay Layers of clayey silt and silt Trace of sand  Stiff to Very Stiff		1	SS	11											0 0 43 57
			2	SS	18											
			3	SS	14											
			4	SS	10											
			5	SS	5											
			6	TW	PH											
			7	SS	6											
			8	SS	6											
620.8			9	SS	144/											
27.0	Heterogeneous mixture of gravel, sand, silt & clay Very Dense															
614.5	Glacial Till															
33.3	End of Borehole Probable Bedrock															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 108


WP 55-75-01 LOCATION Co-ords. N 15,642,535; E 870,485 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 11, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [Signature]



SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
651.7	Ground Level															
0.0	Silty clay					650										
	Layers of clayey silt and silt		1	SS	19											
	Trace of sand		2	SS	12	640										
	Stiff to Very stiff		3	SS	5											
			4	SS	5	630										
627.7																
24.0	Heterogeneous mixture of gravel, sand, silt clay Loose to v. dense		5	SS	6											
621.2	Glacial Till		6	SS	50/6	"										
30.5	End of Borehole Probable Bedrock															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 109

WP 55-75-01 LOCATION Co-ords. N 15,642,057; E 870,142 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 11, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY 

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
649.8	Ground Level															
0.0	Silty clay Layers of clayey silt and silt  Trace of sand  Stiff to  Very Stiff		1	SS	13											
			2	SS	8	640										
			3	SS	6											
			4	SS	5	630										
622.8			5	SS	3											
27.0	Glacial Till															
618.8	Very Dense		6	SS	54	620										
31.0	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 110

WP 55-75-01 LOCATION Co-ords. N 15,641,668; E 870,060 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 12, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY EP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$ PCF	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
644.0	Ground Level															
0.0	Silty clay		1	SS	17	640										
	Layers of clayey silt & silt		2	SS	14											0 0 38 62
	Trace of sand		3	SS	12											
			4	SS	12											
	Stiff		5	SS	5	630										
	to		6	SS	6											0 0 38 62
	Very Stiff		7	SS	4											
			8	SS	PH	620									119	0 1 31 68
			9	SS	5											
613.5																
612.0	Glacial Till		10	SS	43/6											30 39 23 8
32.0	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 111

WP 55-75-01 LOCATION Co-ords N 15,641,310 ; E 869,932 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 12 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem auger CHECKED BY GP.

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_p$	$W$	$W_L$		
655.3	Ground Level						500	1000	1500	2000	2500	20	40	60		GR SA SI CL
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	19	650										0 0 67 33
			2	SS	9											
			3	SS	9	640										
			4	SS	11											
			5	SS	11	630										0 0 40 60
			6	SS	10											
			7	SS	9	620										
			8	SS	7											
612.3																
43.0	Glacial Till															
608.8	Dense		9	SS	49	610										27 30 34 9
46.5	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 112

WP 55-75-01 LOCATION Co-ords N 15,640,985; E 869,842 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 13, 1977 COMPILED BY RVV  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
635.0	Ground Level															
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	11	630										0 1 28 71
			2	SS	17											
			3	SS	14											
			4	SS	12											
			5	SS	7											
616.6	Glacial Till Dense		6	TW	PH	620									113	21 30 40 9
613.5			7	SS	42											
21.5	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 113

WP 55-75-01 LOCATION Co-ords N 15,654,362 ; E 876,348 ORIGINATED BY RVV  
DIST 4 HWY 6N BORING DATE May 16, 1977 COMPILED BY RNO  
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT — $w_L$ PLASTIC LIMIT — $w_p$ WATER CONTENT — $w$			UNIT WEIGHT $\gamma$ PCF	REMARKS % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$w_p$	$w$	$w_L$		
672.0	Ground Level															
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	7	670										
			2	SS	15											
			3	SS	16											
			4	SS	11											
			5	SS	13	660										
			6	SS	13											
			7	SS	7											
			8	SS	8	650										
			9	TW	PH											
			10	SS	8											
			11	SS	9	640										
635.8			12	SS	14											
36.2	Heterogeneous mixture of Gravel, Sand, Silt		13	SS	100/5"											
631.7	Clay very Dense Glacial Fill															
40.3	End of Borehole Probable Bedrock															

OFFICE REPORT ON SOIL EXPLORATION

## HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

WP 55-75-01 LOCATION Co-ords N 15,654,263; E 876,632 ORIGINATED BY RVV  
DIST 4 HWY 6N BORING DATE May 20, 1977 COMPILED BY RNO  
DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [Signature]

20  
15  $\phi$  5 % STRAIN AT FAILURE  
10



MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 115

WP 55-75-01 LOCATION Co-ords N 15,654,165; E 876,910 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 20 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
669.8	Ground Level															
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to very Stiff		1	SS	20											
			2	SS	13											
			3	SS	10											
			4	SS	13	660										
			5	SS	12											
			6	SS	7											
			7	SS	12	650										
644.5																
25.3	Heterogeneous mixture of Gravel, Sand, Silt, Clay Compact to very Dense Glacial Till		8	SS	17											
			9	SS	57	640										
635.8																
34.0	End of Borehole															

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 116

WP 55-75-01 LOCATION Co-ords N 15,654,070 ; E 877,200 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 20, 1977 COMPILED BY BNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $W_L$ PLASTIC LIMIT $W_P$ WATER CONTENT $W$			UNIT WEIGHT $\gamma$	REMARKS  % GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	N' VALUES		20	40	60	80	100	$W_P$	$W$	$W_L$		
666.0	Ground Level															
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff to Very Stiff		1	SS	16	660										0 1 46 53
			2	SS	17											
			3	SS	14											
			4	SS	16	650										
645.9	Heterogeneous Mixture of Gravel, Sand, Silt and Clay Compact to Dense Glacial till		5	TW	PH											17 29 40 14
20.1			6	SS	39											
			7	SS	38	640										
			8	SS	28											
634.5	End of Borehole															7 22 47 24
31.5																

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

RECORD OF BOREHOLE NO 117

WP 55-75-01 LOCATION Co-ords N 15,653,988 ; E 877,393 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 20, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY GP

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT $w_L$ PLASTIC LIMIT $w_p$ WATER CONTENT $w$			UNIT WEIGHT $\gamma$	REMARKS	
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 % $w_p$ — $w$ — $w_L$
646.0	Ground Level																
0.0	Silty Clay Layers of Clayey Silt and Silt Trace of Sand Stiff		1	SS	9	640 ▼											
			2	SS	8												
			3	SS	6												
			4	SS	9												
634.0	End of Borehole																
12.0																	

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS-ONTARIO

HIGHWAY ENGINEERING DIVISION - ENGINEERING MATERIALS OFFICE - SOIL MECHANICS SECTION

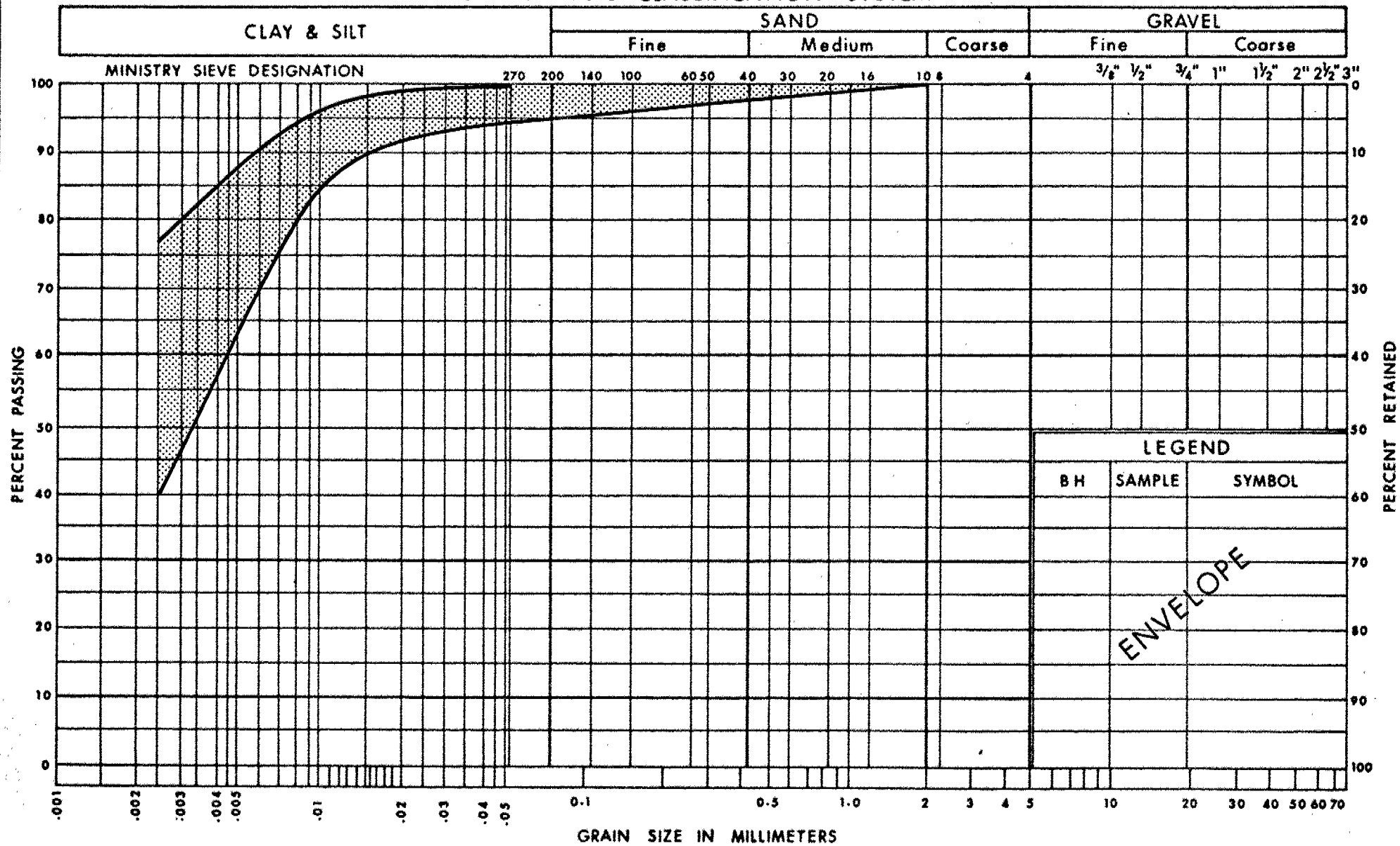
RECORD OF BOREHOLE NO 118

WP 55-75-01 LOCATION Co-ords N 15,654,468; E 876,035 ORIGINATED BY RVV  
 DIST 4 HWY 6N BORING DATE May 25, 1977 COMPILED BY RNO  
 DATUM Geodetic BOREHOLE TYPE Hollow Stem Auger CHECKED BY *CP*

SOIL PROFILE			SAMPLES			GROUND WATER ELEV	DYNAMIC CONE PENETRATION RESISTANCE PLOT					LIQUID LIMIT —WL PLASTIC LIMIT —WP WATER CONTENT —w			UNIT WEIGHT γ	REMARKS
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	Wp	w	WL		
680.5	Ground Level					680										
0.0	Silty Clay Layers of Clayey Silt, and Silt Traces of Sand and Gravel Stiff to very Stiff		1	SS	32											
			2	SS	5	670										
			3	SS	18											
			4	SS	23	660										
			5	SS	24											
			6	SS	26	650										
			7	SS	28											
642.5			8	SS	63	640										
38.0	Heterogeneous Mixture of Gravel, Sand, Silt Clay Dense to very Dense Glacial Till		9	SS	35											
632.0																
48.5	End of Borehole Probable Bedrock															
	NOTE Estimated Water Level From Adjacent Field Investigation															

OFFICE REPORT ON SOIL EXPLORATION

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation and  
Communications

GRAIN SIZE DISTRIBUTION  
SILTY CLAY

FIG No 1

W P 55-75-01

# PIEZOMETRIC HEAD Vs ELEVATION

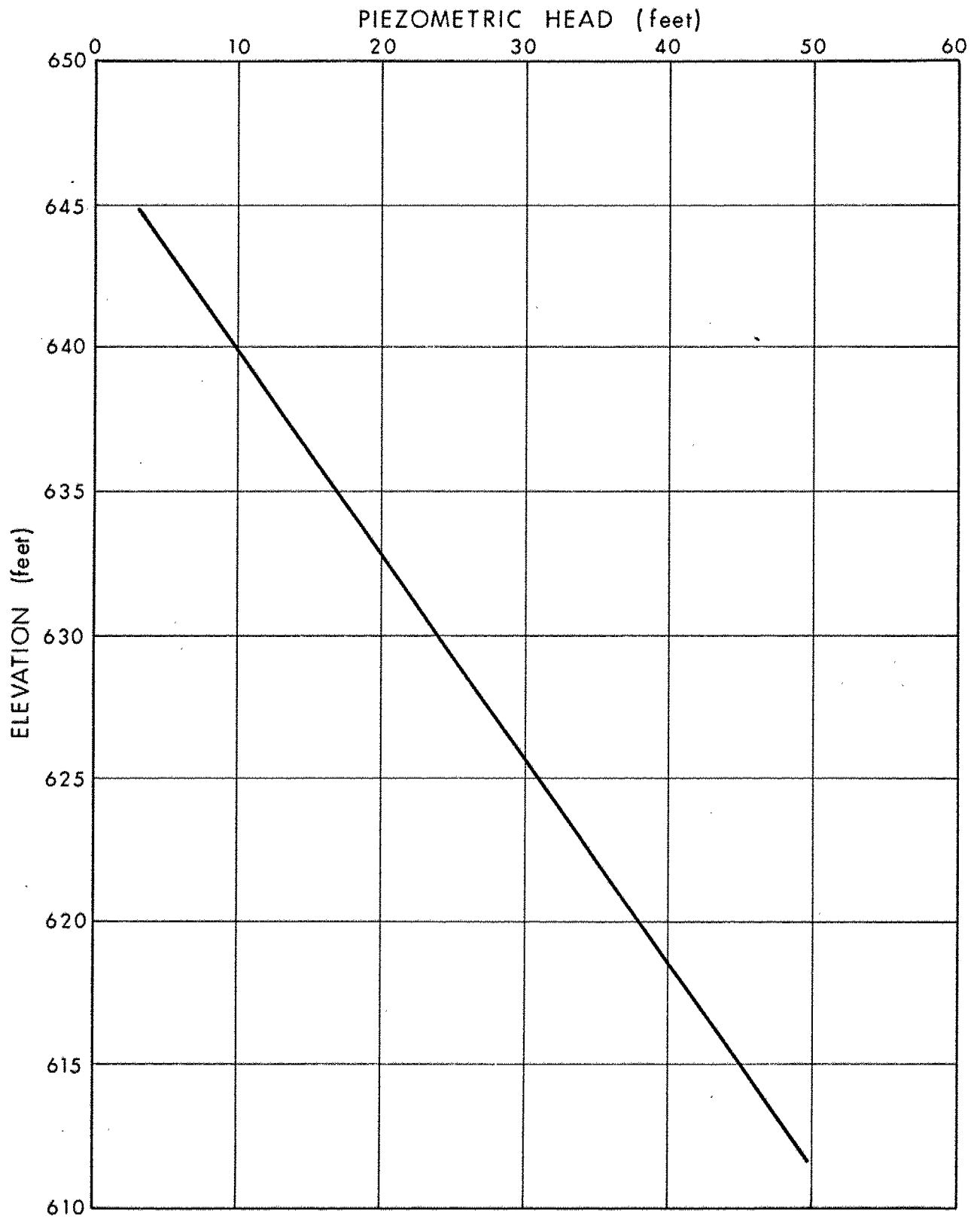


FIG 2

WP 55-75-01

# 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.  $\bar{C}U$  = 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

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  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  
 $\beta$  ANGLE OF SLOPE  
 $N_q, N_c, N_{\gamma}$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

### INDEX PROPERTIES

$\gamma$  UNIT WEIGHT OF SOIL (BULK DENSITY)  
 $\gamma_w$  UNIT WEIGHT OF WATER  
 $\gamma_d$  UNIT DRY WEIGHT OF SOIL (DRY DENSITY)  
 $\gamma'$  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 =  $\frac{w - w_P}{w_L - w_P}$   
 $I_c$  CONSISTENCY INDEX =  $\frac{w_L - w}{w_L - w_P}$   
 $A_c$  ACTIVITY =  $\frac{I_P \text{ of soil}}{I_P \text{ of } 2\mu m \text{ Soil Fraction}}$   
 $Om$  ORGANIC MATTER CONTENT  
 $S_x$  DEGREE OF SATURATION  
 $S$  SENSITIVITY =  $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

### STRENGTH PARAMETERS

$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_f$  PEAK SHEAR STRENGTH  
 $\tau_R$  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  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  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  
**NOTE:** EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:  
 $\phi'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'$  = EFFECTIVE NORMAL STRESS

### HYDRAULIC TERMS

$h$  HYDRAULIC HEAD OR POTENTIAL  
 $q$  RATE OF DISCHARGE  
 $v$  VELOCITY OF FLOW  
 $i$  HYDRAULIC GRADIENT  
 $j$  SEEPAGE FORCE PER UNIT VOLUME  
 $\eta$  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)

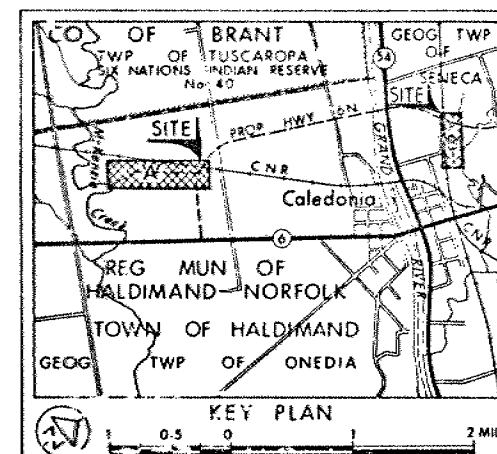
CONT No  
WP No 55-75-01

PROPOSED STORM SEWER 'A' & 'B'

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 at time of investigation May 1977
- W in Bore Hole #118 Estimated from adjacent field investigation

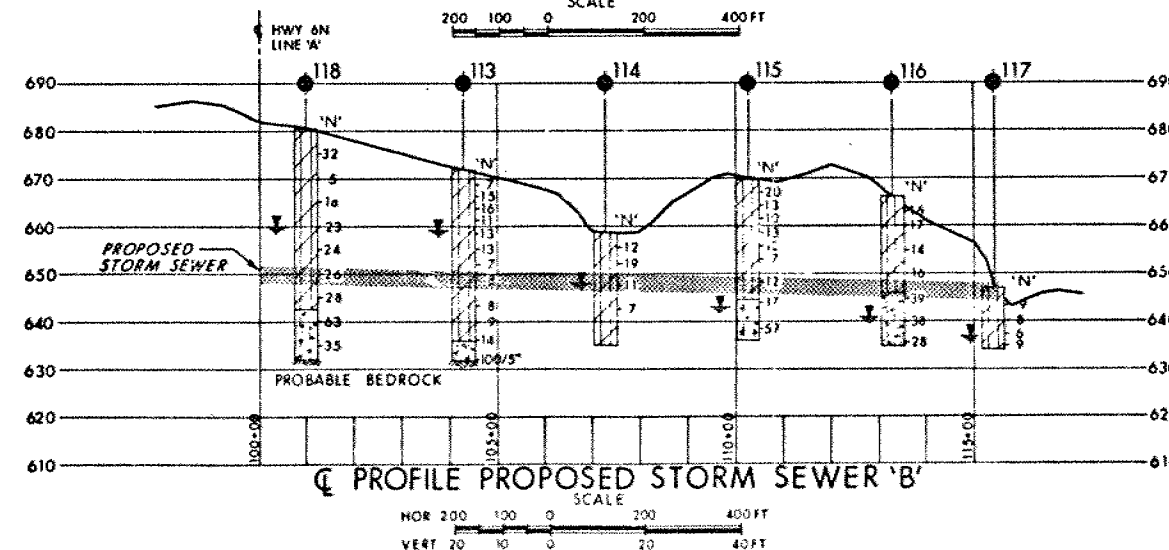
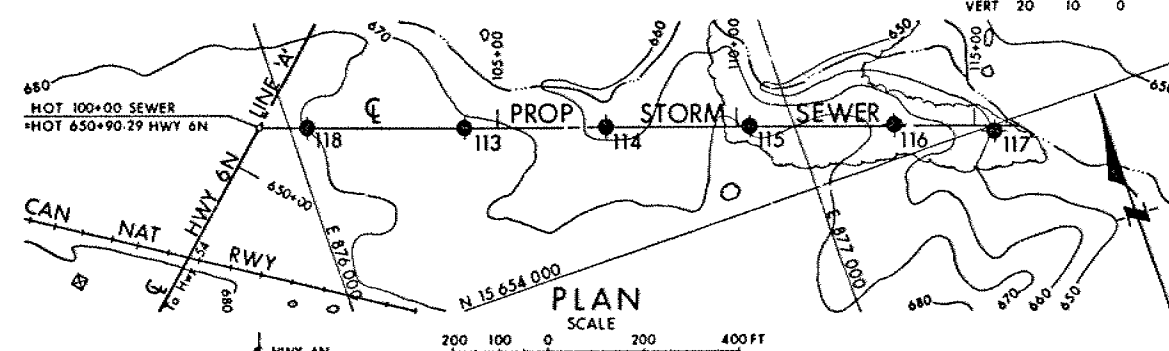
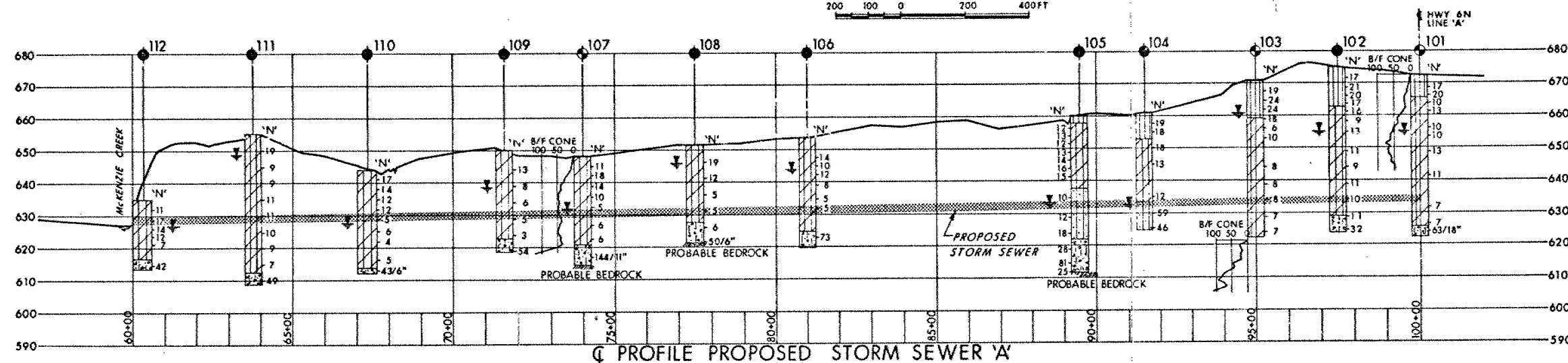
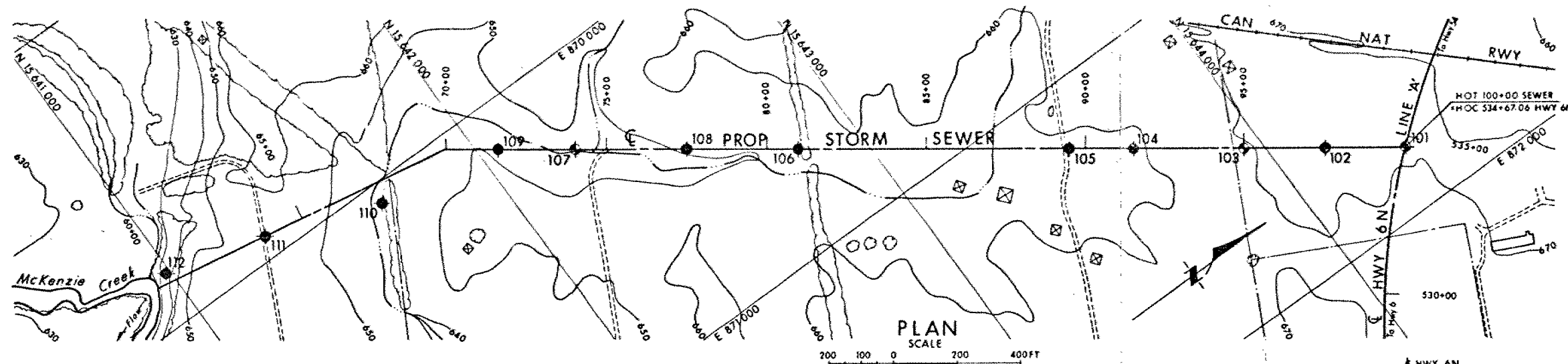
No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
101	672.5	15 644 350	871 805
102	674.8	15 644 148	871 660
103	670.3	15 643 947	871 515
104	661.0	15 643 665	871 310
105	660.5	15 643 505	871 195
106	653.8	15 642 815	870 692
107	647.8	15 642 252	870 280
108	651.7	15 642 535	870 485
109	649.8	15 642 057	870 142
110	644.0	15 641 668	870 060
111	655.3	15 641 310	869 932
112	635.0	15 640 985	869 842
113	672.0	15 654 362	876 348
114	658.5	15 654 263	876 632
115	669.8	15 654 165	876 910
116	666.0	15 654 070	877 200
117	646.0	15 653 988	877 393
118	680.5	15 654 468	876 035

# -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 6N Prop 6N  
S.W. & R.V. CHECKED July 7, 1977  
DRAWN BY: [Signature] DATE: [Date]  
REF PLAN No. B 144-B-3, Jan 1976  
SHEET 4  
PAGE 557501-A



# SOIL STRATIGRAPHY LEGEND

- CLAYEY SILT TO SILT  
TRACES OF SAND & ORGANICS  
Very Stiff
- SILTY CLAY  
LAYERS OF CLAYEY SILT & SILT  
TRACES OF SAND & GRAVEL  
Stiff to Very Stiff
- SILTY SAND  
OCC. POCKETS & LAYERS  
OF CLAYEY SILT  
Dense to Very Dense
- GLACIAL TILL  
HET. MIXTURE OF  
GRAVEL, SAND, SILT & CLAY  
Compact to Very Dense





INDEX

<u>Page No.</u>	<u>Description</u>
1	Index
2	Abbreviations & Symbols
3	M.T.C. Soil Classification System
4	Foundation Investigation Report For Subway Outlet Storm Sewers Sta: 60 + 00 to Sta: 100 + 00 (South) Sta: 100 + 00 to Sta: 115 + 50 (North) W.P. 55-75-01

NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above-mentioned project.

# FOUNDATION INVESTIGATION REPORT

For

Subway Outlet Storm Sewers

Sta: 69 + 00 - 100 + 00 (South Storm Sewer)

Sta: 100 + 00 - 115 + 50 (North Storm Sewer)

W.P. 55-75-01

District #4 (Hamilton)

---

## INTRODUCTION

This report contains the results of the foundation investigations carried out for the proposed storm sewers located south and north of the Grand River in the vicinity of Caledonia. The fieldwork was carried out during the period of May 4-25, 1977, utilizing a continuous flight auger machine equipped with a 3½ inch I.D. hollow stem augers mounted on a muskeg vehicle.

Borings, numbered from 101 to 112 cover the south storm sewer, while the boreholes #113-#118 cover the north storm sewer.

## SITE DESCRIPTION

One of the storm sewers is located south of the Grand River (Sta: 60 + 00 - Sta: 100 + 00). It will extend from the future C.N.R. structure (Hagarsville Subdivision Line) southerly to McKenzie Creek. The terrain adjacent to the proposed alignment is flat to gently rolling and used for farming purposes.

A second storm sewer will be located north of the Grand River (Sta: 100 + 00 - Sta: 115 + 50) parallel to the future C.N.R. relocation. The topography of the general area surrounding the site may be described as generally flat to gently undulating. The land is being used for grazing purposes. Underground mining (gypsum) operations are being carried out by Domtar Ltd. just north of the site.

Phsiographically, both sites are located in the region referred to as the Haldimand Clay Plain.

#### SUBSURFACE CONDITIONS

##### General

The overburden within the investigated area was found to consist of about four different types of deposits:

- Clayey silt to silt
- Silty clay (stratified)
- Silty sand
- Glacial till

Only the silty clay and the glacial till deposits were encountered at each sewer location.

The boundaries of the different deposits are shown on the Record of Borehole Sheets. The estimated stratigraphical profiles of Sheet No. 52-1 of the contract drawings are based upon this information. From ground level downward, the various strata is described in some detail with regard to soil types and soil properties as follows:

##### Clayey Silt to Silt

This deposit was encountered in boreholes 101 to 105 immediately from ground level to a maximum depth of about 12 feet. The material in the deposit consists mainly of clayey silt to silt, traces of sand and organics. The consistency is estimated to be very stiff.

Silty Clay (Stratified)

This stratum appears to be the predominant type of subsoil across the sites investigated and it was encountered at each boring location immediately below ground level or the above described clayey silt to silt deposit. The thickness was found to vary from 19 to 40 feet. Reference should be made to the Record of Borehole Sheets for the lower boundary elevation. The material in the deposit consists mainly of silty clay with numerous, irregular clayey silt and silt laminations up to 0.5" in thickness. Pockets of sand were also encountered within the main deposit. Some of the silt layers appear to be water bearing.

The consistency was found to vary randomly from stiff to very stiff.

Physical properties of the deposit as determined from the field and laboratory tests are as follows:

		<u>Range</u>
Plastic Limit	(%)	15 - 23
Liquid Limit	(%)	29 - 54
Natural Moisture Content	(%)	24 - 41
Bulk Density	(PCF)	113 -125
<u>Undrained Shear Strength</u>		
Unconfined Compression		1000-3050
Field Vane		1040-2000+
Sensitivity		2.0-4.5

Grain-size distribution test results are shown in envelope form on Fig. 1.

### Silty Sand

This stratum was encountered in boreholes 104 and 105 only below the silty clay deposit. The maximum thickness is about 11 feet.

The material in the stratum consists mainly of sands and silts. In addition, occasional thin layers and pockets of clayey silt were also encountered. Mechanical analysis performed on four samples indicate that the sand and silt sizes are about 77% and 23% respectively.

Standard Penetration tests carried out within the main deposit indicate that the relative density varies from compact to very dense. The obtained 'N' values ranged between 12 and 59 blows per foot. The natural moisture content ranges from 15 to 20%.

### Heterogeneous Mixture of Gravel, Sand, Silt and Clay

Beneath the silty clay and/or silty sand deposits is a glacial till stratum composed of a heterogeneous mixture of gravel, sand, silt and clay. The lower boundary was not determined since most of the borings were terminated in this deposit. The matrix of this till is basically granular in nature. There are random localized zones within this material, where the matrix is cohesive i.e. clayey silt binding coarser sized particles.

Standard Penetration tests carried out in this deposit gave 'N' values ranging from 32 to over 100 blows per foot. Based on these results, it is estimated that the relative density of the stratum varies from dense to very dense.

### GROUNDWATER CONDITIONS

Groundwater level observations have been carried out during the course of field investigation by recording the water levels in the open boreholes. The results indicate variations in groundwater levels across both sites. Artesian groundwater conditions were encountered along the proposed southerly storm sewer once the borings penetrated through the silty clay stratum down into the granular type glacial till deposit. When the artesian pressure condition was encountered, the groundwater rose instantaneously up to about elevation 633<sup>+</sup>. In borehole 103, the groundwater level reached elevation 660<sup>+</sup>.

The observations were continued for several days after the completion of boring. The final groundwater levels are summarized on Sheet No. 52-1 of the contract drawings and on the individual Record of Borehole Sheets.

No artesian conditions were encountered in boreholes #112, 114, 115, 116, and 117. A plot of peizometric head versus elevation is shown on Fig. 2.

P. Payer, P. Eng.  
Foundations Engineer

K.G. Selby, P. Eng.  
Senior Foundations Engineer



Ontario

Ministry of  
Transportation and  
Communications

Tel. 416-248-3252

Regional Geotechnical Section  
Central Region  
3501 Dufferin Street  
Downsview, Ontario  
M3K 1N6

October 4, 1977

McCormick, Rankin & Associates Ltd.  
Consulting Engineers  
60 Briarwood Avenue  
MISSISSAUGA, Ontario

Attention: Mr. J. Reiffenstein

Dear Sir:

Re: Backfill to Proposed Storm Sewers  
W.P. 55-75-01 - Highway 6N - Caledonia By-Pass

As was discussed at the recent Progress Meeting held in your office on September 21, 1977, the backfill for the proposed storm sewers should conform to M.T.C. standards which are as follows:

- (1) Backfill should be native material compacted to the Ministry's specification.
- (2) Where storm sewer 'A' crosses the existing Hydro service road station 85+60+ no special backfill treatment will be required.

Should further information be required, please do not hesitate to contact this office.

Yours truly,

*D.A. Mullett*  
D.A. Mullett

For: R.D. Gunter  
Head, Geotechnical Section

DAM:RDG:vdn

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