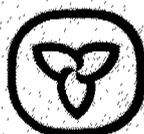


# **FOUNDATION INVESTIGATION REPORT**

**CONTRACT NO. 92-18**



Ministry of  
Transportation

Ontario

## INDEX

<u>Page No.:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3	Foundation Investigation Report for  Sweaburg Rd. Overpass W.P. 481-89-02, Site 23-167 Hwy. 401, District 2 London  Cedar Cr. N/S-W Ramp Bridge W.P. 510-90-01, Site 23-442 Hwy. 401, District 2 London  Cedar Cr. W-N/S Ramp Bridge W.P. 511-90-01, Site 23-443 Hwy. 401, District 2 London

**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.

# EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

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 OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

R Q D (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$m^2/s$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kN/m^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$kN/m^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$kN/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kN/m^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kN/m^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$kN/m^3$	SEEPAGE FORCE
$\gamma'$	$kN/m^3$	UNIT WEIGHT OF SUBMERGED SOIL						

FOUNDATION INVESTIGATION REPORT

For

Sweaburg Road Overpass

W.P. 481-89-02, Site 23-167

Hwy. 401, District 2, London

INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site to provide information for the design and construction of the proposed widening of Sweaburg Road Overpass.

The field work for this project was carried out between 90 03 29 and 90 04 04, and comprised of four sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 18.6 m below the existing ground level (El. 281.7 m) using a continuous flight hollow stem auger.

SITE DESCRIPTION

The site under investigation is located at the crossing of Hwy. 401 and Sweaburg Road in the City of Woodstock.

The topography of the site with the exception of the existing crossing (fills) is generally undulating with a group of kames to the northwest and drumlins to the south. Physiographically the area is located in the region known as the "Oxford Till Plain".

SURBSURFACE CONDITIONS

The underlying subsoil at this site consists of silt, sand and gravel underlain by hard heterogeneous mixture of clayey silt, sand and gravel (glacial till). For classification purposes, the soils encountered at this site can be divided into four different zones.

- a) Sand with Gravel, some Silt (Subgrade Fill).
- b) Silty Sand to Sandy Silt.
- c) Sand & Gravel, some Silt.
- d) Heterogeneous mixture of Clayey Silt, Sand & Gravel (Glacial Till).

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. Two stratigraphical sections are shown on Drawing No. 4818902-A.\* This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

#### Sand with Gravel, some Silt (Subgrade Fill)

This subgrade fill which was encountered on the northern side of the bridge consists of loose to compact sand with varying proportions of silt and gravel. The thickness of the fill was observed to be in the range of 1.3 m to 1.4 m and extends to El. 299.7 m.

#### Silty Sand to Sandy Silt

This deposit was encountered only on the southern side of the bridge and was observed immediately below the topsoil and layers of silt and organic silt. The thickness of this deposit varies from 9.0 m to 10.2 m and extends to elevation 290.6 m to 290.1 m. The results of the gradation tests carried out on representative soil samples are shown on Figure 1 in an envelope form. These test results indicate that this deposit is predominantly composed of sand and silt with varying proportions of gravel. The natural moisture content varies from 8% to 9.5% with an average value of 9%. The Standard Penetration Test results varies from 11 blows/30 cm to 34 blows/30 cm. These results indicate that this stratum is in a compact to dense state of compaction.

\* SHEET NO 300 OF THE CONTRACT DWG'S

### Sand and Gravel, some Silt

This layer was encountered immediately below the subgrade fill and silty deposit on the northern side of the bridge. The thickness of this layer was observed to vary from 9.1 m to 9.4 m and extends to El. 290.7 to 287.6 m. The Grain Size Distribution Test results are shown on Figure 2 in an envelope form. The Standard Penetration Test results indicate that this stratum is in a compact to very dense state of compaction ('N' Values 13 blows/30 cm to over 100 blows/30 cm).

### Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)

The glacial till deposit was encountered in all the boreholes in the depth range of El. 287.6 to 290.7 m. The gradation test results are shown on Figure 3 in an envelope form. These results indicate 5% to 12% gravel, 30% to 32% sand and 58% to 64% clayey silt. The Standard Penetration Test results in this stratum vary from 72 blows/30 cm to over 100 blows/30 cm indicating hard consistency.

### Groundwater Conditions

The groundwater was encountered in all the boreholes, and was observed between 1.5 m and 2.0 m below the existing ground level. However, the high water level encountered may be due to spring run-off. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>
1	295.7 not stabilized
2	299.0
3	299.6
4	299.4

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. M. Vasavithasan. The equipment used was owned and operated by London Soil Test. This report was prepared by Mr. M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer, Mr. M. Devata, Chief Foundation Engineer.



*P. Payer*

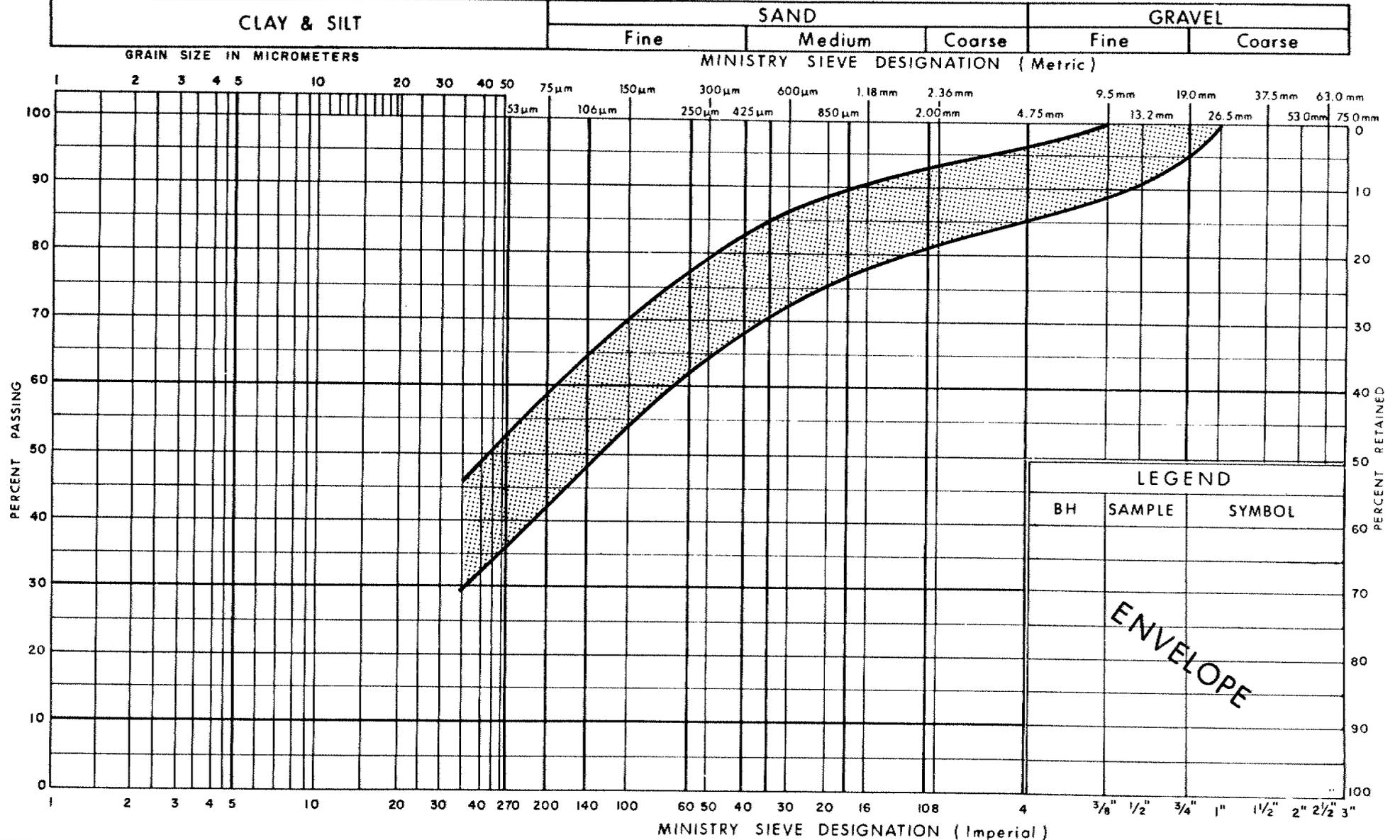
P. Payer, P. Eng.  
Senior Foundation Engineer

*M. S. Devata*

M.S. Devata, P. Eng.  
Chief Foundation Engineer

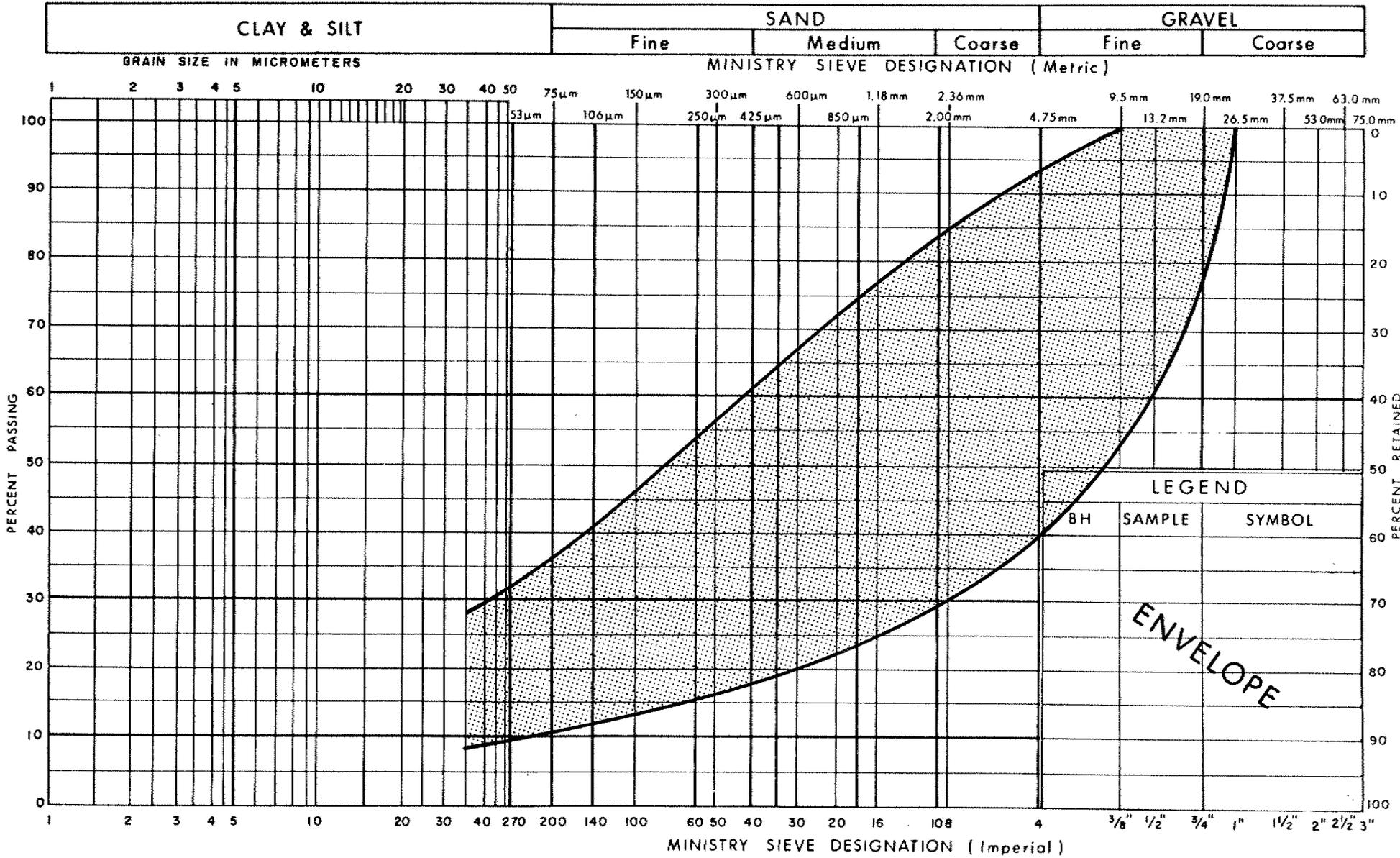
**APPENDIX**

# UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
<div style="font-size: 2em; transform: rotate(-15deg); opacity: 0.5;">ENVELOPE</div>		

# UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND  
BH SAMPLE SYMBOL

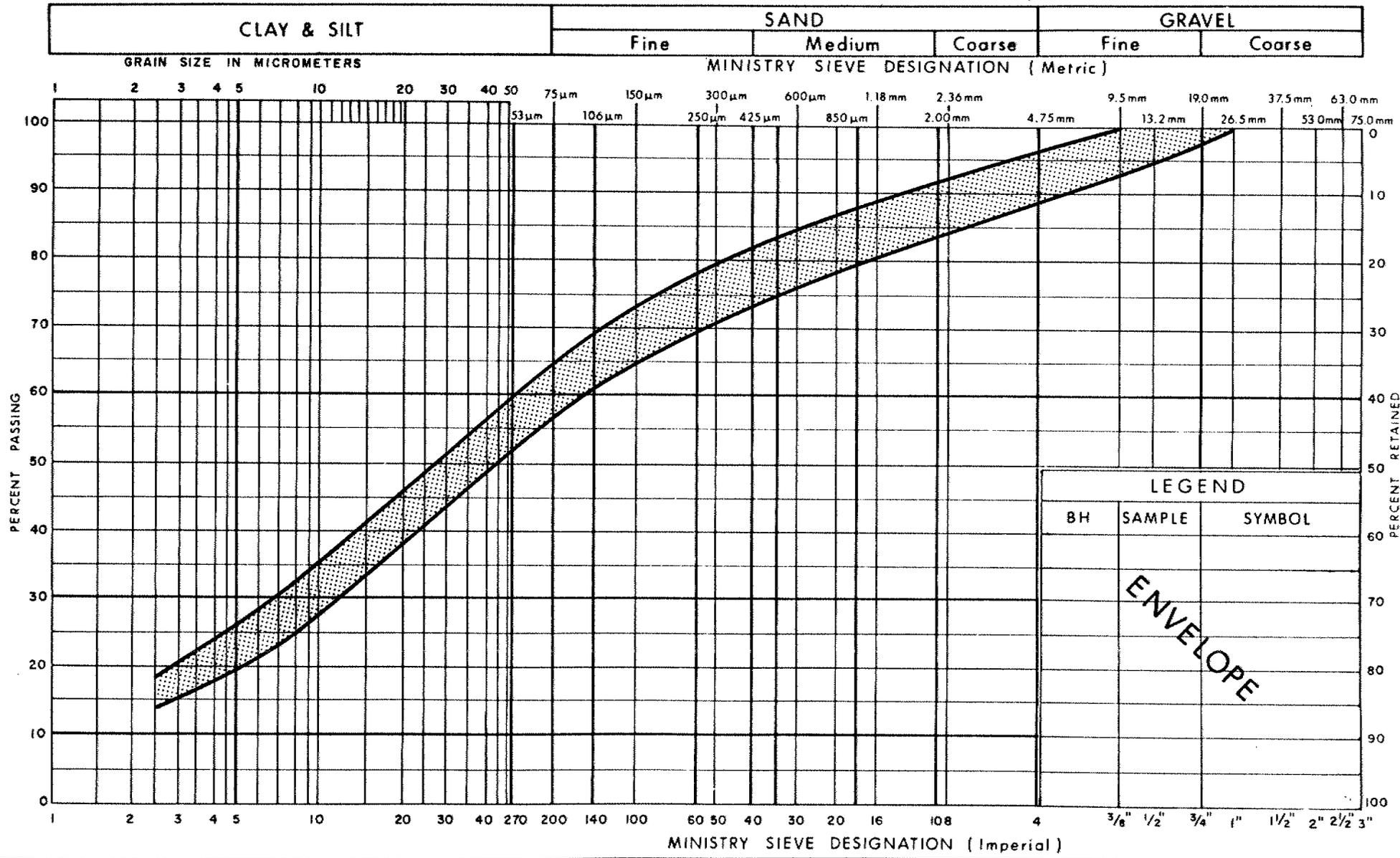
ENVELOPE



GRAIN SIZE DISTRIBUTION  
SAND & GRAVEL, SOME SILT

FIG No 2  
W P 481-89-02

UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
ENVELOPE		



GRAIN SIZE DISTRIBUTION  
 HET MIXTURE OF  
 CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 3  
 W P 481-89-02

RECORD OF BOREHOLE No 1

1 OF 1

METRIC 11

W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 705.0; E 202 572.0 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 03 29 & 90 03 30 CHECKED BY P P

SOIL PROFILE		STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION		NUMBER	TYPE			'N' VALUES	20						40
300.3	Ground Surface													
0.0	Topsail													
	Silty Sand to Sandy Silt Some Gravel, Trace of Clay, Compact		1	SS	14								9 42 (49)	
			2	SS	19									14 44 (42)
			3	SS	14									
			4	SS	19									
			5	SS	21									
			6	SS	20									
			7	SS	34									12 35 (53)
			8	SS	19									
	Silt, Some Clay, Trace of Sand, Compact		9	SS	11								0 2 88 10	
290.1			10	SS	12									
10.2	Heterogeneous Mixture of Clayey Silt, Sand And Gravel Hard ( Glacial Till )		11	SS	72									
			12	SS	121									12 30 (58)
			13	SS	136	/25cm								
281.7			14	SS	95	/15cm								
18.6	End of Borehole * Note: Water Level Not Stabilized													

RECORD OF BOREHOLE No 2

1 OF 1 METRIC 12

W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 760.8; E 202 549.6 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 03 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W			W <sub>L</sub>
301.0	Sweaburg Rd. Shoulder													
0.0	Sand With Gravel, Some Silt													
289.7	Loose ( Fill )		1	SS	9									
1.3	Silt, Trace of Sand, Trace of Clay, Compact		2	SS	11									
			3	SS	13									
			4	SS	15									
297.0			5	SS	30									
4.0	Sand And Gravel, Some Silt Dense to Very Dense		6	SS	55								19 44 (37)	
			7	SS	39									
			8	SS	20									
			9	SS	75									59 29 (12)
			10	SS	60	/15cm								
			11	SS	100	/15cm								
			12	SS	75	/13cm								8 30 44 17
287.6	Heterogeneous Mixture of Clayey Silt, Sand And Gravel Hard ( Glacial Till )		13	SS	90	/15cm								
283.9														
17.1	End of Borehole													

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

RECORD OF BOREHOLE No 3

1 OF 1

METRIC 13

W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 743.1; E 202 536.6 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 04 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
301.2	Ground Surface												
0.0	Sand With Silt, Some Gravel, Trace of Organics, Compact ( Fill )		1	SS	19								
299.8			2	SS	22								
1.4	Sand And Gravel, Some Silt Compact to Very Dense		3	SS	20								
			4	SS	25								
			5	SS	13								
			6	SS	26								
			7	S	66								
			8	SS	36								
			9	SS	46								
			10	SS	101	/15cm							
290.7				11	SS	100	/13cm						
10.5		Heterogeneous Mixture of Clayey Silt, Sand And Gravel, Hard ( Glacial Till )		12	SS	80	/15cm						
284.1			13	SS	95	/15cm							
17.1	End of Borehole												

RECORD OF BOREHOLE No 4

1 OF 1

METRIC 14

W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 682.0; E 202 558.0 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE: TEST & HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 02 & 90 04 03 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80			100	W <sub>p</sub>
301.0	Ground Surface														
0.0	Silt, Some Sand, Trace of Gravel, Pockets of Peat & Organic Silt, Very Loose		1	SS	4										
299.6			2	SS	27										
1.4	Sandy Silt to Silty Sand, Trace of Gravel, Trace of Clay, Compact		3	SS	16									9 43 (48)	
			4	SS	13										
			5	SS	15										
			6	SS	22										
			7	SS	24										
			8	SS	20										
			9	SS	30										6 35 (59)
			10	SS	11										
290.6				11	SS	72									8 32 47 13
10.4		Heterogeneous Mixture of Clayey Silt, Sand And Gravel, Hard ( Glacial Till )		12	SS	50	/10cm								
			13	SS	75	/10cm									5 31 48 16
			14	SS	100	/15cm									
282.6															
18.4	End of Borehole														

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

## FOUNDATION INVESTIGATION REPORT

For

Cedar Creek N/S-W Ramp Bridge  
W.P. 510-90-01, Site No. 23-442  
Hwy. 401, District 2, London

### INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site to provide information for the design and construction of the proposed bridge at the Cedar Creek crossing.

The field work for this project was carried out between 91 04 04 and 91 04 08, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to these holes.

Boreholes were advanced to a maximum depth of 18.7 m below the existing ground level (El. 266.2 m) using a continuous flight hollow stem auger and BW casing. Rock cores were obtained in both boreholes using BXL size core barrel.

### SITE DESCRIPTION

The site under investigation is located between Hwy. 401 and Athlone Avenue in the City of Woodstock.

The topography of the site with the exception of the existing crossings at Hwy. 401 and Cedar Creek and Athlone Avenue and Cedar Creek (embankments), and the flood plain of the Creek is generally undulating with drumlins to the south. The site as well as the alignment of the Creek was modified to the present condition by the construction of the existing bridges and prior to the construction of these bridges, the Creek was meandering at this location. Physiographically the area is located in the region known as the "Oxford Till Plain".

## SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of compact to loose alluvial sand with varying proportions of gravel and silt underlain by stiff to very stiff clayey silt with occasional sand and silt seams. The clayey silt layer is underlain by very dense sand with varying proportions of gravel and silt which overlies the limestone bedrock. For classification purposes, the soils encountered at this site can be divided in to six different zones.

- a) Organic Silt, some Sand
- b) Sandy Gravel, trace of Silt
- c) Sand to Sandy Silt, trace of Gravel
- d) Clayey Silt
- e) Gravelly Sand, some Silt
- f) Limestone Bedrock

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 5109001-A\*. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

Initially, it was planned to widen the bridge at the crossing of Hwy. 401 and Cedar Creek, and to provide information for the design of foundation, a site investigation was carried out in April of 1990. The Record of Borehole sheets of this investigation are also appended to this report.

### Organic Silt, some Sand

This organic silt with varying proportions of sand was encountered immediately below the existing ground level. The east side of the creek is slightly marshy and the organic content was observed to be more on this side. The thickness of this deposit varies from 1.1 m to 1.3 m and extends to elevation 283.8 m to 283.6 m.

\* SHEET NO 335 OF THE CONTRACT DWG'S

### Sandy Gravel, trace of Silt

This alluvial sandy gravel layer was encountered immediately below the organic silt deposit. The thickness of this layer varies from 1.1 m to 2.3 m and extends to elevation 281.3 m to 282.7 m. The results of the Gradation Test carried out on representative soil samples are shown on Figure 1 in an envelope form. These test results indicate 48% to 58% gravel, 32% to 49% sand and 3% to 10% silt. The Standard Penetration Test results were observed to vary between 12 blows/0.3 m and 22 blows/0.3 m and these results indicate that this stratum is in a compact state of compaction.

### Sand to Sandy Silt, trace of Gravel

The sandy gravel deposit is underlain by this stratum. The thickness of this layer varies from 3.6 m to 4.2 m and extends to elevation 278.5 m to 277.7 m. The result of Gradation Test carried out on representative soil samples are shown on Figure 2 and this result indicates 0% to 15% gravel, 47% to 80% sand and 5% to 53% silt. The Standard Penetration Test results were observed to vary between 7 blows/0.3 m and 21 blows/0.3 m. These test results indicate loose to compact state of compaction.

### Clayey Silt

The sand to sandy silt deposit is underlain by this clayey stratum. The thickness of this layer varies from 2.8 m to 3.6 m and extends to elevation 274.9 m. Occasional sand and silt seams varying in thickness from a few millimetres to a maximum of 0.4 m were also intercepted in this stratum. The natural moisture content was observed to vary from 18.0% to 18.5%. The Atterberg Limits determined for the representative soil samples of this deposit are shown on Figure 3. The Standard Penetration Test results were observed to vary from 6 blows/0.3 m to 15 blows/0.3 m. However, the in situ Vane Shear Test results were observed to vary from 65 kPa to over 100 kPa. The shear strength values indicate stiff to very stiff consistency.

### Gravelly Sand, some Silt

The clayey silt is underlain by this deposit. The thickness of this deposit varies from 4.7 m to 5.2 m and extends to elevation 270.2 m to 269.7 m. The Grain Size Distribution Test results are shown on Figure 4 in an envelope form. These results indicate about 5% to 30% gravel, 45% to 79% sand and 14% to 28% silt. The Standard Penetration Test results indicate that this stratum is in very dense state of compaction (N-values 58 blows/0.3 m to over 100 blows/0.3 m).

### Bedrock

The project area is underlain by limestone bedrock of the Detroit River Group. The thickness of the weathered rock was observed in the range of 200 mm to 400 mm and the elevation of the unweathered rock is expected to be in the depth range of elevation 270.0 m to 269.3 m.

The RQD values measured from BX size cores (0% to 31%) indicate that the bedrock up to the depth of coring may be classified as very poor to poor quality rock.

The detail description of the bedrock is included in the Appendix of this report.

### Groundwater Conditions

The groundwater level was observed at or near the creek water level (elevation 284.0 m). However, artesian condition was encountered at about elevation 269.5 m in the fractured zone of the bedrock on the east side of the creek and the water level rose to about 0.2 m above the existing ground level (ie elevation 285.1 m). Seasonal fluctuation of the groundwater level may be expected. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>	<u>Remarks</u>
101	284.0 m	Water level rose to 0.2 m above ground level (i.e. elevation 285.1 m)
102	284.0 m	

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. M. Vasavithasan, Foundation Engineer. The equipment used was owned and operated by London Soil Test Ltd. This report was prepared by Mr. M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer, approved by Mr. M. Devata, Chief Foundation Engineer.



*P. Payer*

P. Payer, P. Eng.  
Senior Foundation Engineer

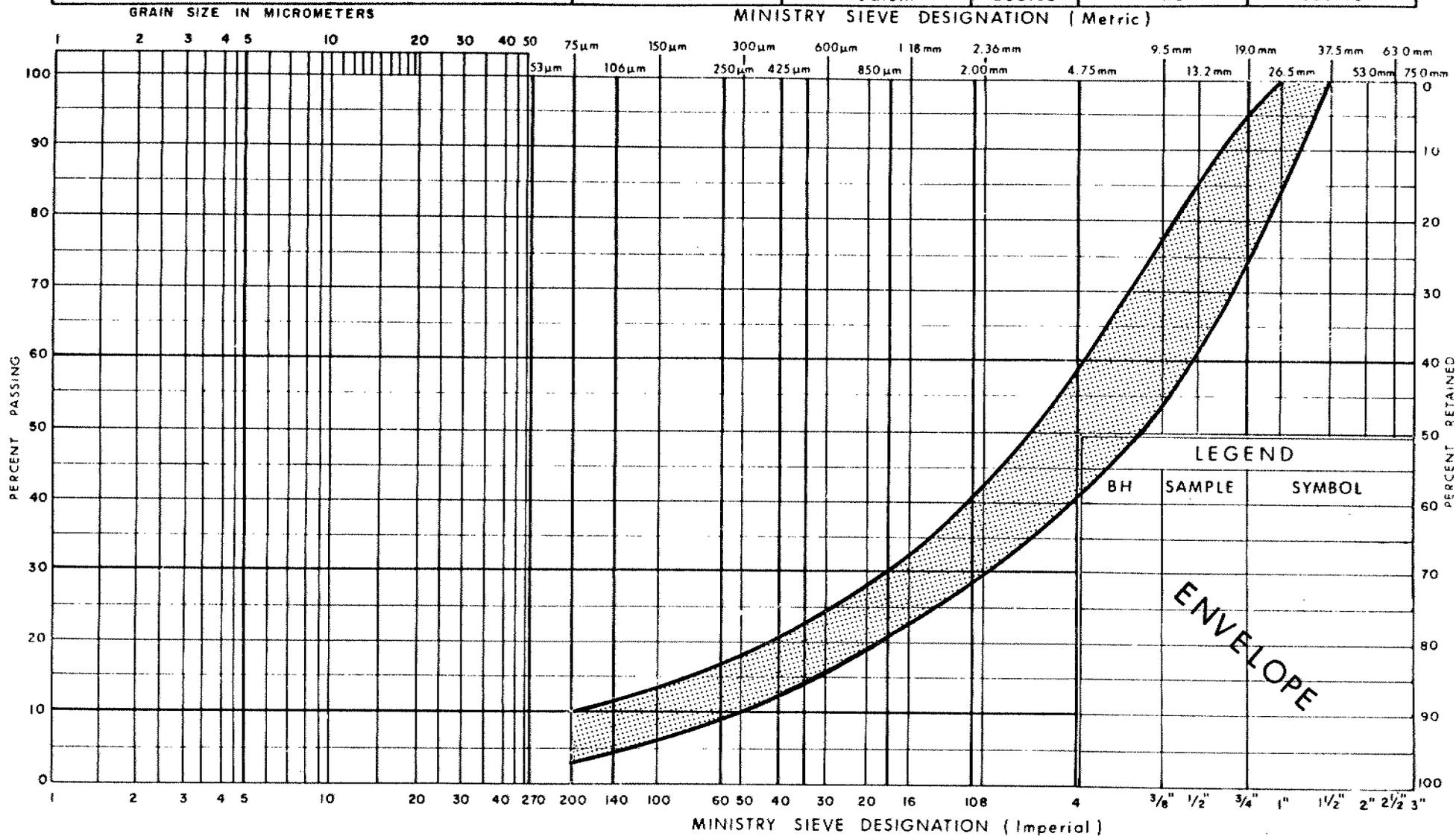
*M. S. Devata*

M.S. Devata, P. Eng.  
Chief Foundation Engineer

**APPENDIX**

### UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



**LEGEND**

BH	SAMPLE	SYMBOL
----	--------	--------

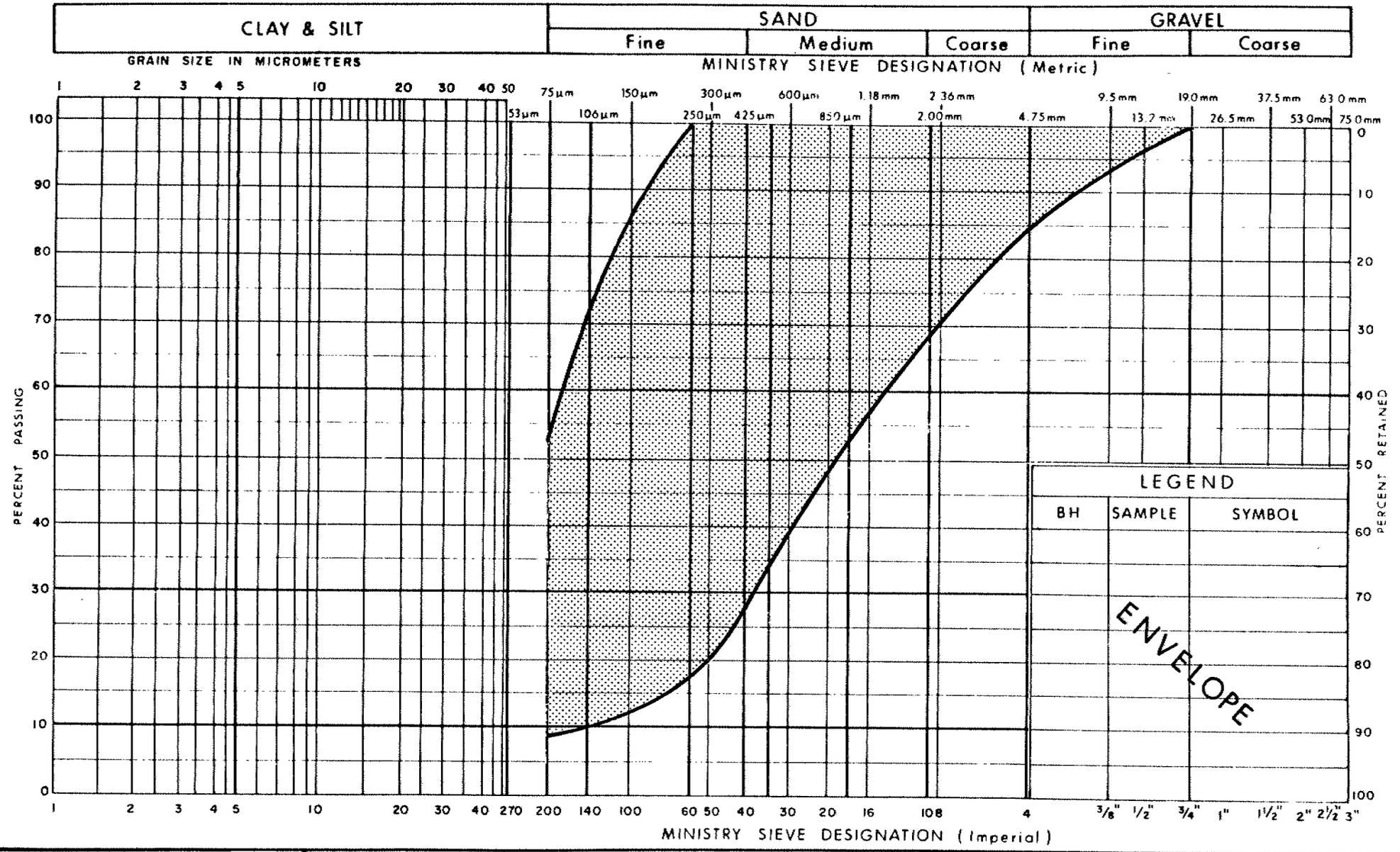
ENVELOPE



**GRAIN SIZE DISTRIBUTION**  
**SANDY GRAVEL, TRACE OF SILT**

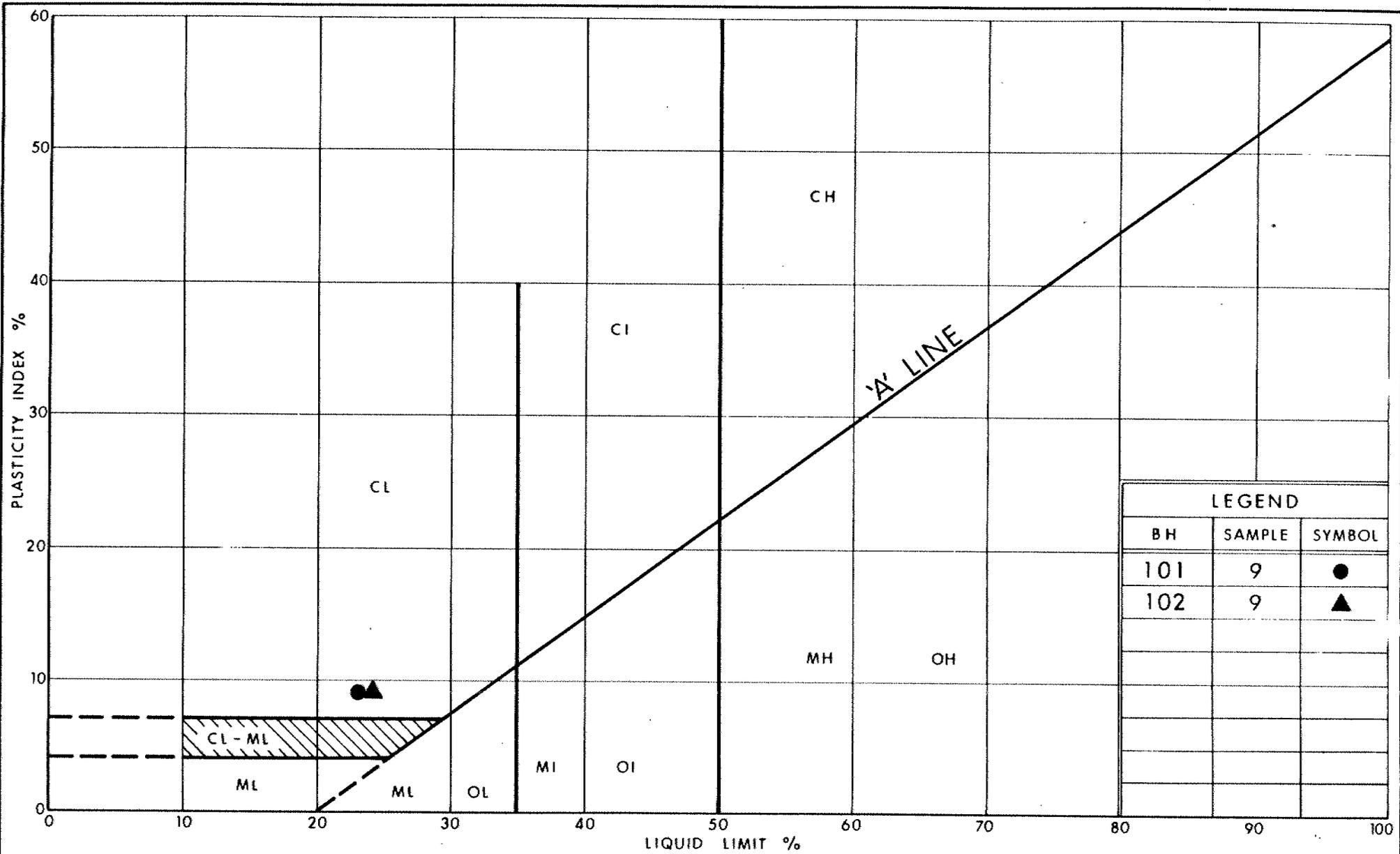
FIG No 1  
 W P 510-90-01

# UNIFIED SOIL CLASSIFICATION SYSTEM



**GRAIN SIZE DISTRIBUTION  
SAND TO SANDY SILT  
SOME/TRACE GRAVEL**

FIG No 2  
W P 510-90-01



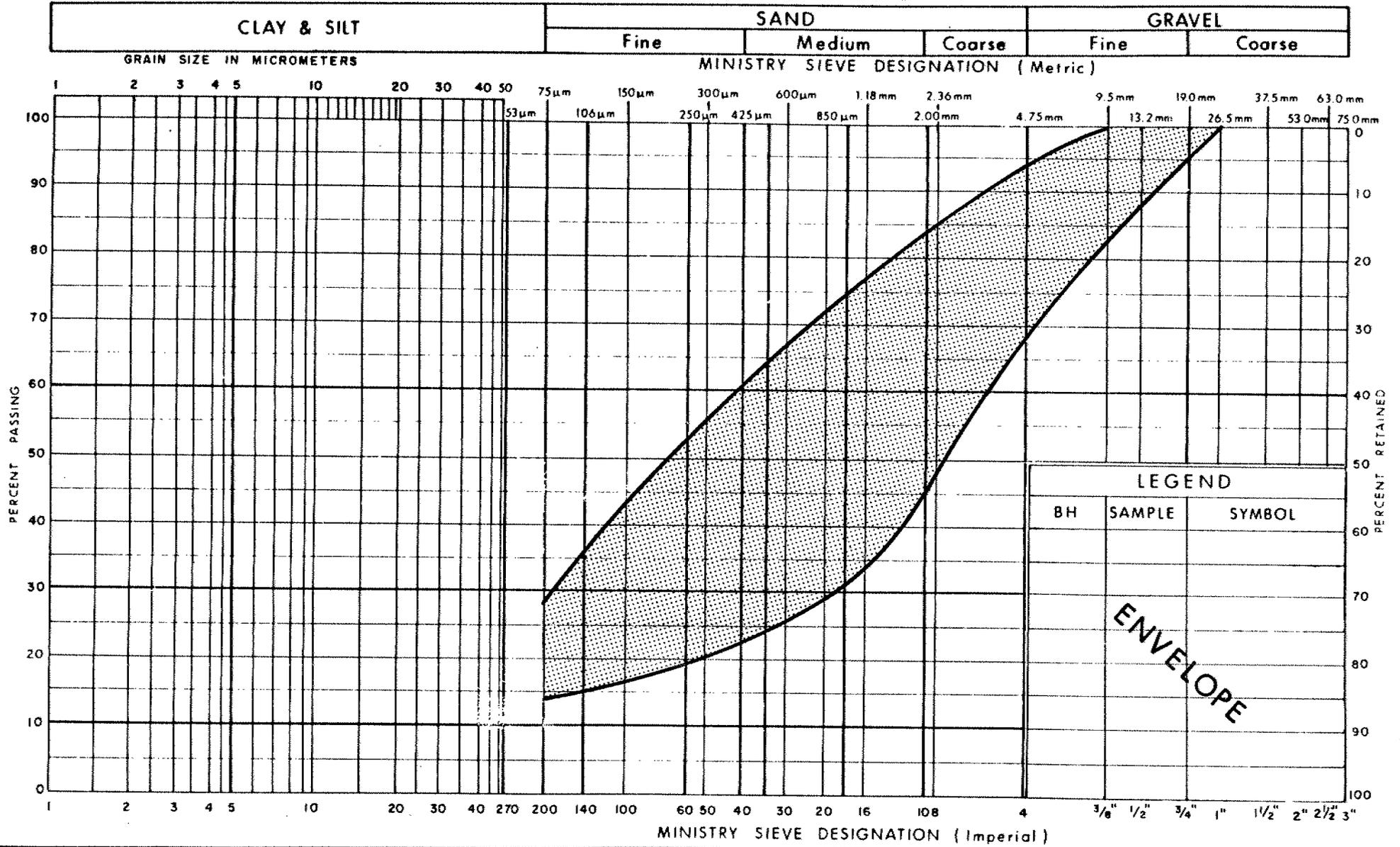
LEGEND		
BH	SAMPLE	SYMBOL
101	9	●
102	9	▲



PLASTICITY CHART  
CLAYEY SILT

FIG No 3  
W P 510-90-01

UNIFIED SOIL CLASSIFICATION SYSTEM



RECORD OF BOREHOLE No 101

1 OF 1

METRIC 25

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 883.6; E 203 945.2 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, H.S. AUGER & B.W. CASING COMPILED BY M V  
 DATUM GEODETIC DATE 91 04 04 & 91 04 05 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40
284.9	Ground Surface													
0.0	ORGANIC SILT, With Occasional Peat Layers, Some Sand													
283.8			1	SS	14									
1.1	SANDY GRAVEL, Trace of Silt, Compact		2	SS	14							48	49 (3)	
282.7			3	SS	16									
2.2	SAND to SANDY SILT, Some/Trace Gravel, Occasional Clayey Silt Seams, Compact to Loose		4	SS	21							15	80 (5)	
			5	SS	11									
			6	SS	10									
			7	SS	9							0	47 (53)	
278.5			8	SS	9									
6.4	CLAYEY SILT, With Occasional Silt Seams, Stiff to Very Stiff		9	SS	6									
274.9			10	SS	11									
10.0	GRAVELLY SAND, Some Silt Very Dense		11	SS	104									
			12	SS	61								22	64 (14)
			13	SS	58								14	58 (28)
270.2	Weathered LIMESTONE BEDROCK, Unweathered		14	RC BX	REC 70%								RQD 0%	
268.5			15	RC BX	REC 97%								RQD 0%	
16.4	End of Borehole													

\* Note:  
 Artesian Condition Encountered at About El: 269.5 in the Fractured Zone of the Bedrock. Water Level Rose to 0.2m Above the Ground Level ( ie El:285.1 )

RECORD OF BOREHOLE No 102

1 OF 1

METRIC 26

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 872.9; E 203 923.4 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, H.S. AUGER & B.W. CASING COMPILED BY M V  
 DATUM GEODETIC DATE 91 04 05 & 91 04 08 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
284.9	Ground Surface												
0.0	ORGANIC SILT, With Occasional Peat Layers, Some Sand and Gravel,		1	SS	5								
283.6			2	SS	12								
1.3	SANDY GRAVEL, Trace of Silt, Compact		3	SS	16								58 32 (10)
	Clayey Silt, Some Sand & Gravel		4	SS	22								
281.3			5	SS	18								
3.6	SANDY SILT, Occasional Clayey Silt Seams, Compact to Loose		6	SS	12								0 48 (52)
			7	SS	14								
277.7			8	SS	7								
7.2	CLAYEY SILT, Trace of Sand, Stiff		9	SS	15								
			10	SS	14								
274.9			11	SS	77								5 79 (16)
10.0	GRAVELLY SAND, Some Silt Very Dense		12	SS	100	/8cm							30 45 (25)
			13	SS	119								
269.7	Weathered												
15.2	LIMESTONE BEDROCK Unweathered		14	RC BX	REC 82%								RQD 8%
			15	RC BX	REC 100%								RQD 31%
266.2													
18.7	End of Borehole												

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

RECORD OF BOREHOLE No 3

1 OF 1

METRIC 27

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 873.6; E 203 947.6 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER & BW CASING COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 09 & 90 04 11 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
284.8	Ground Surface												
0.0	Sandy Silt to Clayey Silt, Some Gravel, Trace of Organics Compact/Stiff		1	SS	12								
283.4			2	SS	29								
1.4	Sandy Gravel, Some Silt		3	SS	16								0 93 (?)
			4	SS	22								
			5	SS	24								
			6	SS	32								0 96 (+)
			7	SS	32								
	SAND, Trace of Silt, Compact to Dense		8	SS	61								
			9	SS	28								
275.8													
9.0	CLAYEY SILT, Stiff		10	SS	10								0 0 60 40
274.8													
10.0	SAND and GRAVEL, Some Silt, Very Dense		11	SS	100	/13cm							54 35 (11)
270.6													
14.2	End of Borehole Probable Bedrock  Note: Formerly BH# 3 of W.P. 481 - 89 - 04												

RECORD OF BOREHOLE No 4

1 OF 1

METRIC 28

W.P. 510 - 90 - 01 LOCATION CO - ORDS. N 4 774 818.2; E 203 958.5 ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 04 11 & 90 04 16 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
285.4	Ground Surface												
0.0	Topsoil												
	SAND, Some Silt, Some Gravel, Trace of Organics, Loose to Compact		1	SS	19								
			2	SS	6								
282.6	Organic Silt & Peat		3	SS	15								
2.8			4	SS	12								
	SAND, Some Silt, Trace of Gravel, Compact		5	SS	12								
			6	SS	24								
			7	SS	15								
278.9			8	SS	15								
6.5	Layered CLAYEY SILT and SANDY SILT, Stiff/Compact		9	SS	15								
			10	SS	13								
274.7			11	SS	92								
10.7	SAND and GRAVEL, Some Silt, Very Dense		12	SS	89								
			13	SS	55	/15cm							31 55 (14)
269.6	Weathered		14	RC BX	REC 62%								RQD 0%
15.8	LIMESTONE BEDROCK, Unweathered		15	RC BX	REC 96%								RQD 9%
266.2			16	RC BX	REC 100%								RQD 0%
19.2	End of Borehole Note: Formerly BH# 4 of W.P. 481 - 89 - 04												

**ROCK CORE DESCRIPTION**  
**WP 510-90-01**

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
101	14	14.86-15.54	70	0	14.86-16.36	LIMESTONE with chert nodules and abundant fossils (corals, stromatoporoids), pale yellowish brown (matrix) to white (fossils); medium crystalline; medium strong; unweathered to slightly weathered; fractures very close to extremely close spaced, flat to near vertical, undulating, smooth to rough.
	15	15.54-16.36	97	0		
102	14	15.65-17.17	82	8	15.65-18.69	LIMESTONE with chert nodules and abundant fossils (corals, stromatoporoids), pale yellowish brown (matrix) to white (fossils); medium crystalline; medium strong; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, undulating, smooth to rough.
	15	17.17-18.69	100	31		

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

## FOUNDATION INVESTIGATION REPORT

For

Cedar Creek W-N/S Ramp Bridge  
W.P. 511-90-01, Site No. 23-443  
Hwy. 401, District 2, London

### INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site to provide information for the design and construction of the proposed bridge at the Cedar Creek crossing.

The field work for this project was carried out between 91 03 26 and 91 04 03, and comprised of two sampled boreholes and Dynamic Cone Penetration Test adjacent to these holes.

Boreholes were advanced to a maximum depth of 17.9 m below the existing ground level (El. 266.7 m) using a continuous flight hollow stem auger and BW casing. Rock cores were obtained in both boreholes using BXL size core barrel.

### SITE DESCRIPTION

The site under investigation is located about 120 m south of the existing bridge at the crossing of Hwy. 401 and Cedar Creek in the City of Woodstock.

The topography of the site with the exception of the existing crossing (embankment) and the flood plain of the Creek is generally undulating with drumlins to the south. The site as well as the alignment of the Creek was modified to the present condition by the construction of the existing bridge and prior to the construction of this bridge, the Creek was meandering at this location. Physiographically the area is located in the region known as the "Oxford Till Plain".

## SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of loose to compact alluvial sand with varying proportions of gravel underlain by stiff to very stiff clayey silt with occasional sand and silt seams. The clayey silt layer is underlain by dense to very dense gravelly sand which overlies the limestone bedrock. For classification purposes, the soils encountered at this site can be divided in to six different zones.

- a) Surficial Deposits
- b) Gravelly Sand, trace of Silt
- c) Sand, trace of Silt
- d) Clayey Silt
- e) Gravelly Sand, some Silt
- f) Limestone Bedrock

The subsurface conditions encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 5119001-A.\* This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

Initially, it was planned to widen the bridge at the crossing of Hwy. 401 and Cedar Creek, and to provide information for the design of foundation, a site investigation was carried out in April of 1990. The Record of Borehole sheets of this investigation are also appended to this report.

### Surficial Deposits

This surficial sandy silt to organic silt deposit was encountered immediately below the existing ground level. The west side of the creek is slightly marshy and the organic content was observed to be more on this side. The thickness of this deposit varies from 0.9 m to 1.1 m and extends to elevation 283.9 m to 283.7 m.

\* SHEET NO 349 OF THE CONTRACT DWG'S

### Gravelly Sand, trace of Silt

This alluvial gravelly sand layer was encountered immediately below the surficial deposit. The thickness of this layer is about 2.7 m and extends to elevation 281.2 m to 281.0 m. The results of the Gradation Test carried out on representative soil samples are shown on Figure 1 in an envelope form. These test results indicate 40% to 47% gravel, 45% to 52% sand and 8% silt. The Standard Penetration Test results were observed to vary between 16 blows/0.3 m and 27 blows/0.3 m and these results indicate that this stratum is in a compact state of compaction.

### Sand, trace of Silt

The gravelly sand deposit is underlain by this stratum. The thickness of this layer varies from 1.3 m to 1.6 m and extends to elevation 279.6 m. The result of Gradation Test carried out on a representative soil sample is shown on Figure 2 and this result indicates sand content in the order of 92%. The Standard Penetration Test results were observed to vary between 7 blows/0.3 m and 21 blows/0.3 m. These test results indicate loose to compact state of compaction.

### Clayey Silt

The sandy deposit is underlain by this clayey stratum. The thickness of this layer varies from 5.1 m to 5.6 m and extends to elevation 274.5 m to 274.1 m. Occasional sand and silt seams varying in thickness from a few millimetres to a maximum of 1.0 m were also intercepted in this stratum. The natural moisture content was observed to vary from 16.5% to 24% with an average value of 20.5%. The Atterberg Limits determined for the representative soil samples of this deposit are shown on Figure 3. The Standard Penetration Test results were observed to vary from 6 blows/0.3 m to 12 blows/0.3 m. However, the in situ Vane Shear Test results were observed to vary from 58 kPa to over 100 kPa. The shear strength values indicate stiff to very stiff consistency.

### Gravelly Sand, some Silt

The clayey silt is underlain by this deposit. The thickness of this deposit varies from 4.0 m to 4.2 m and extends to elevation 270.3 m to 270.1 m. The Grain Size Distribution Test results are shown on Figure 4 in an envelope form. These results indicate about 37% gravel, 42% to 43% sand and 20% to 21% silt. The Standard Penetration Test results indicate that this stratum is in dense to very dense state of compaction (N-values 40 blows/0.3 m to over 100 blows/0.3 m).

### Bedrock

The project area is underlain by limestone bedrock of the Detroit River Group. The thickness of the weathered rock was observed in the range of 100 mm to 300 mm and the elevation of the unweathered rock is expected to be in the depth range of elevation 270.2 m to 269.8 m.

The RQD values measured from BX size cores (0% to 22%) indicate that the bedrock up to the depth of coring may be classified as very poor quality rock.

The detail description of the bedrock is included in the Appendix of this report.

### Groundwater Conditions

The groundwater level was observed at or near the creek water level (elevation 284.7 m to 284.1 m). However, artesian condition was encountered at about elevation 269.2 m to 269.4 m in the fractured zone of the bedrock and the water level rose to about 0.4 m to 0.5 m above the existing ground level (ie elevation 285.0 m to 285.5 m). Seasonal fluctuation of the groundwater level may be expected. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>	<u>Remarks</u>
201	284.1 m	Water level rose to 0.4 m above ground level (i.e. elevation 285.0 m)
202	284.7 m	Water level rose to 0.5 m above ground level (i.e. elevation 285.5 m)

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of Mr. M. Vasavithasan, Foundation Engineer. The equipment used was owned and operated by London Soil Test Ltd. This report was prepared by Mr. M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer, approved by Mr. M. Devata, Chief Foundation Engineer.



P. Payer, P. Eng.  
Senior Foundation Engineer

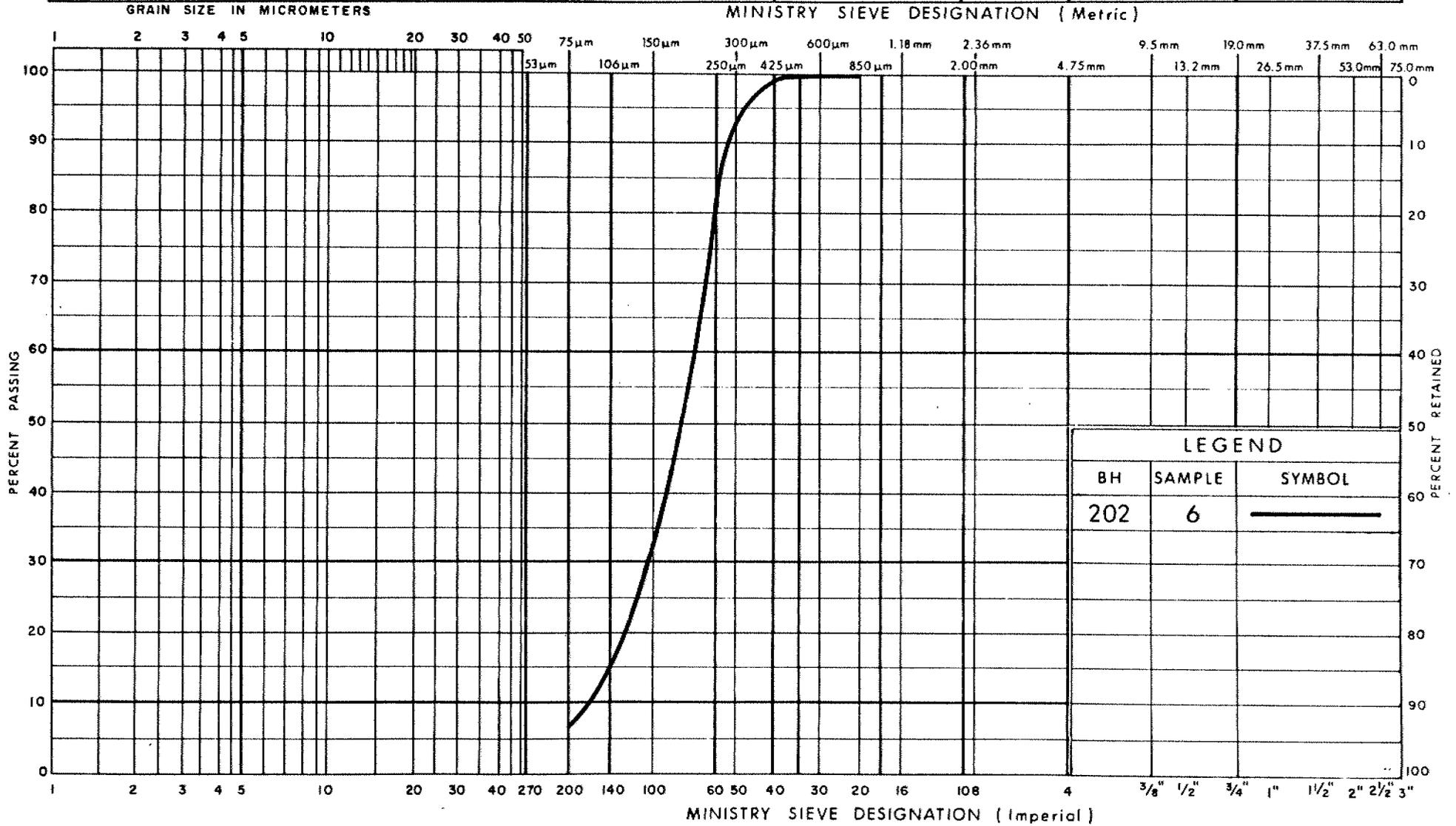
M.S. Devata, P. Eng.  
Chief Foundation Engineer

**APPENDIX**



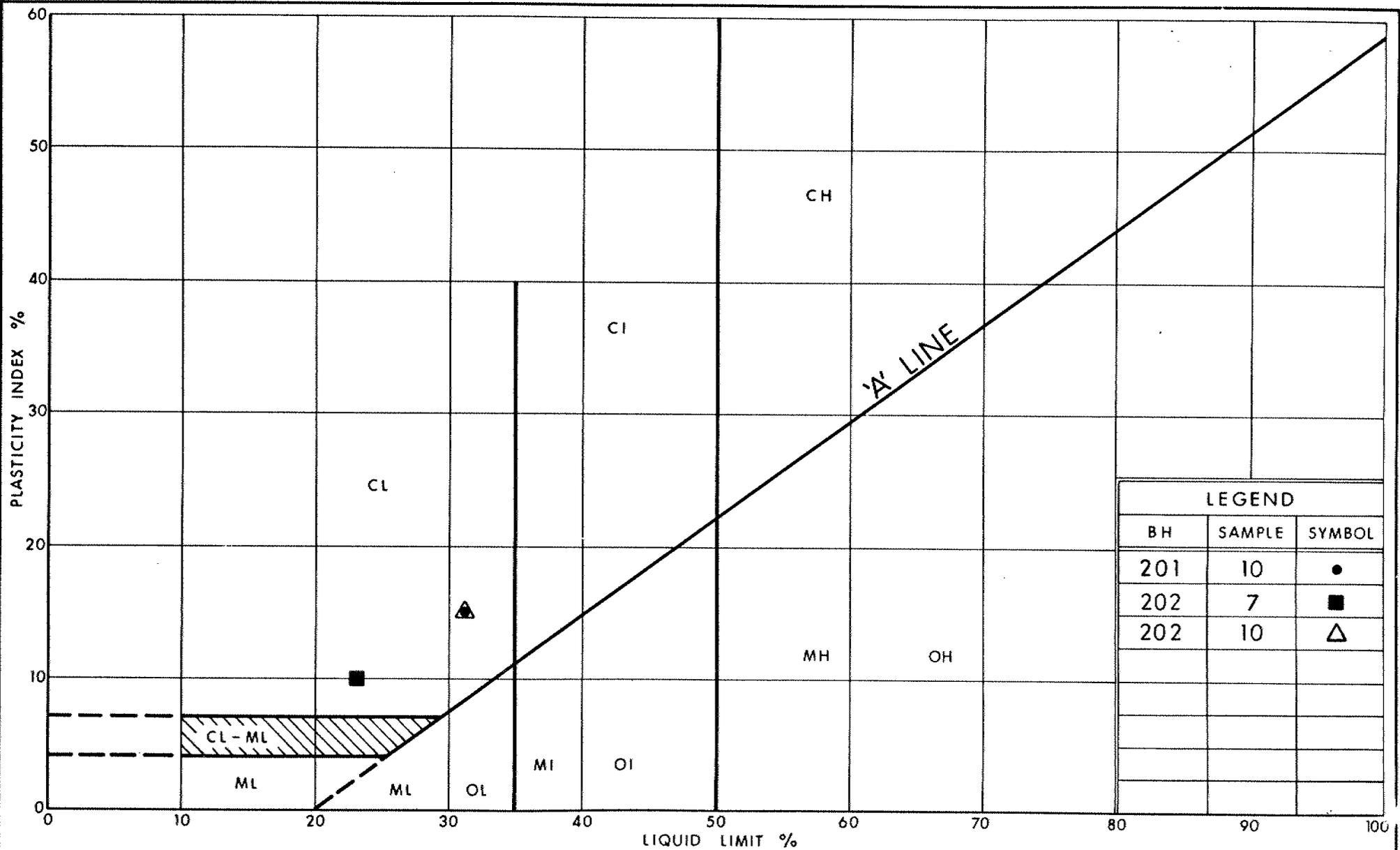
UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION  
SAND, TRACE OF SILT

FIG No 2  
W P 511-90-01



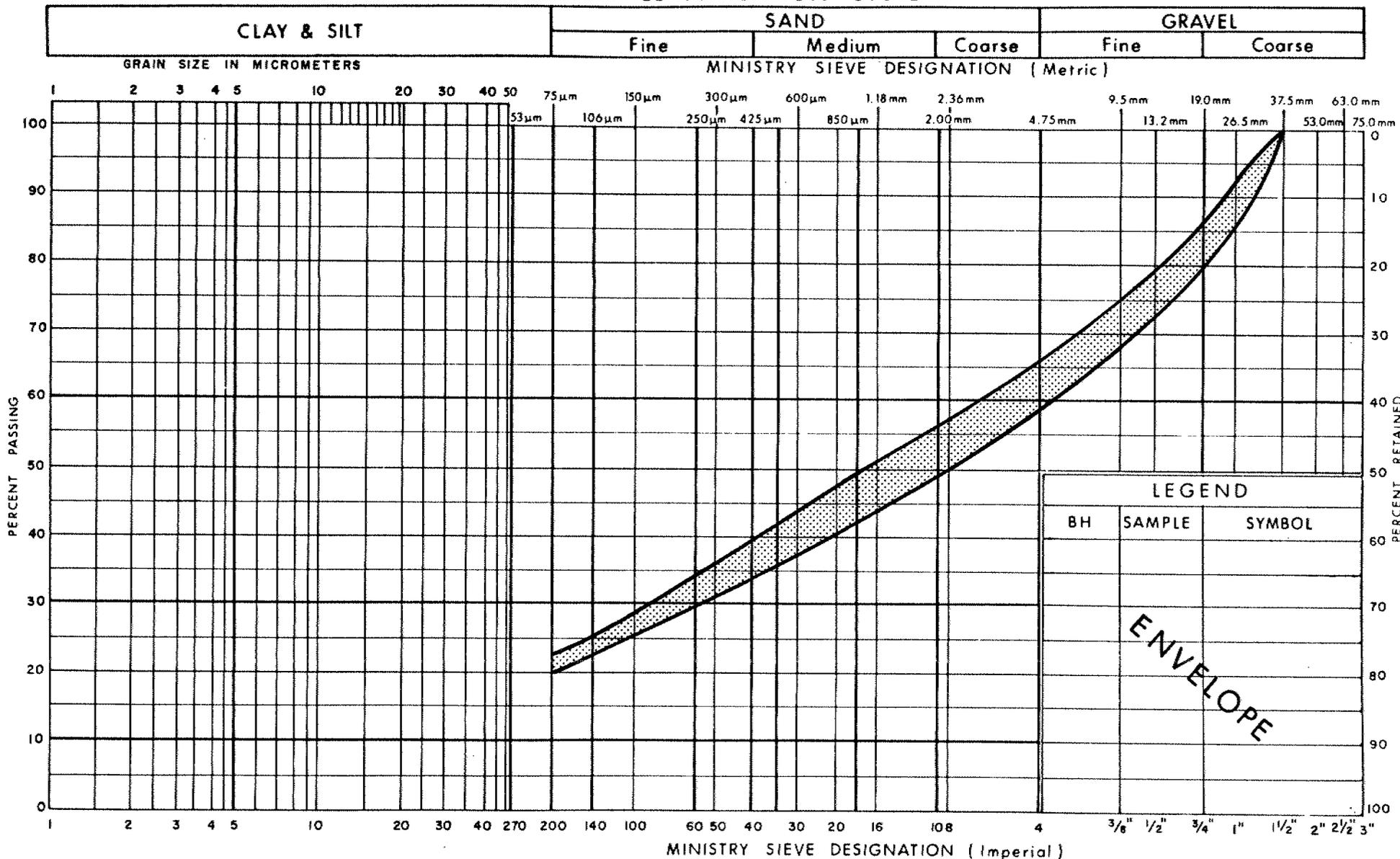
LEGEND		
BH	SAMPLE	SYMBOL
201	10	●
202	7	■
202	10	△



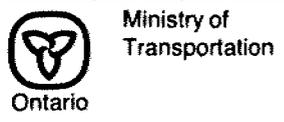
PLASTICITY CHART  
CLAYEY SILT

FIG No 3  
W P 511-90-01

# UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL
ENVELOPE		



**GRAIN SIZE DISTRIBUTION**  
**GRAVELLY SAND, SOME SILT**

FIG No 4  
 W P 511-90-01

RECORD OF BOREHOLE No 201

1 OF 1

METRIC 40

W.P. 511 - 90 - 01 LOCATION CO - ORDS: N 4 774 804.5; E 203 966.2 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, H.S. AUGER & B.W. CASING COMPILED BY M V  
 DATUM GEODETIC DATE 91 04 02 & 91 04 03 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER # CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
284.6	Ground Surface											GR SA SI CL	
0.0 283.7	ORGANIC SILT, With Sand												
0.9	GRAVELLY SAND, Trace of Silt, Compact	1	SS	19								47 45 (8)	
		2	SS	27									
		3	SS	16									
281.0		4	SS	17								14 79 (7)	
3.6 279.7	SAND, Trace of Silt, Loose to Compact	5	SS	7									
4.9	* Silt  CLAYEY SILT, With Occasional Silt and Sand Seams, Stiff to Very Stiff	6	SS	19									
		7	SS	9									
		8	SS	7									
		9	SS	8									
		10	SS	12									
274.1													
10.5	GRAVELLY SAND, Some Silt, Dense to Very Dense	11	SS	43								37 43 20	
		12	SS	94									
270.1	Weathered												
14.5	LIMESTONE BEDROCK Unweathered	13	RC BX	REC 95%								RQD 20%	
266.7		14	RC BX	REC 98%								RQD 22%	
17.9	End of Borehole												
	* Note: Artesian Condition Encountered at About El: 269.4 in the Fractured Zone of the bedrock. Water Level Rose to 0.4m Above the Ground Level (ie El:285.0)												

RECORD OF BOREHOLE No 202

1 OF 1

METRIC 41

W.P. 511 - 90 - 01 LOCATION CO - ORDS: N 4 774 812.2; E 203 991.0 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, H.S. AUGER & B.W. CASING COMPILED BY M V  
 DATUM GEODETTIC DATE 91 03 26 & 91 03 28 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER % CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	20	40	60
285.0	Ground Surface																			
0.0	SANDY SILT, Some Gravel, Trace of Clay and Organics		1	SS	7															
283.9	Organics		2	SS	22															
1.1	GRAVELLY SAND, Trace of Silt, Compact		3	SS	18															40 52 (B)
281.2			4	SS	17															
3.8	SAND, Trace of Silt, Compact		5	SS																
279.6			6	SS	21															0 92 (B)
5.4	Silt, Some Sand		7	SS	7															
			8	SS	9															
	CLAYEY SILT, With Occasional Silt and Sand Seams, Stiff to Very Stiff		9	SS	6															
274.5			10	SS	6															
10.5	GRAVELLY SAND, Some Silt, Dense to Very Dense		11	SS	40															37 42 (21)
			12	SS	123															
270.3	Weathered		13	RC	55%															RQD 0%
	LIMESTONE BEDROCK		14	RC	REC	97%														RQD 0%
	Unweathered		15	RC	REC	98%														RQD 0%
267.9																				
17.1	End of Borehole																			
	* Note: Artesian Condition Encountered at About El: 269.2 in the Fractured Zone of the Bedrock. Water Level Rose to 0.5m Above the Ground Level ( ie El:285.5 )																			

RECORD OF BOREHOLE No 1

1 OF 1

METRIC 42

W.P. 511 - 90 - 01 LOCATION CO - ORDS. N 4 774 818.2; E 203 958.5 ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 04 04 & 90 04 05 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40
285.3	Ground Surface													
0.0	Organic Silt & Clay, Soft													
0.7	SAND and GRAVEL, Some Silt, Trace of Organics, Compact to Dense		1	SS	13							45	47 (8)	
			2	SS	25								33	53 (14)
			3	SS	49									
281.6			4	SS	27									
3.7	CLAYEY SILT, With Intermittent Sand and Silt Seams, Stiff to Very Stiff		5	SS	20							0	2 71 27	
			6	SS	12									
			7	SS	17									
			8	SS	10									
			9	SS	12									
275.1			10	SS	17								0	0 62 38
10.2	SAND and GRAVEL, Some Silt, Dense to Very Dense		11	SS	44									
			12	SS	59								38	43 (19)
270.5			13	SS	96	/15cm								
14.8	LIMESTONE BEDROCK													
267.0	End of Borehole													
	Note: Below El:270.5 Borehole was Advanced With Bi-Cone  Formerly BH# 1 of W.P. 481 - 89 - 04													

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

RECORD OF BOREHOLE No 2

1 OF 1

METRIC 43

W.P. 511 - 90 - 01 LOCATION CO - ORDS. N 4 774 830.5; E 203 973.4 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER & BW CASING COMPILED BY M V  
 DATUM GEODETTIC DATE 90 04 05 & 90 04 09 CHECKED BY PP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40
285.0	Ground Surface													
0.0	SAND, Some Silt, Some Gravel, Trace of Organics, Compact		1	SS	22								24 62 (14)	
			2	SS	20									
			3	SS	14									
			4	SS	26									
281.0			4.0		5	SS	23							
		6	SS		6									
		7	SS		1									
		8	SS		7									
		9	SS		7									
		10	SS		11									
274.9	10.1		11	SS	8								0 1 57 42	
			12	SS	41									
			13	SS	80								51 39 (10)	
270.8	14.2		14	SS	100	/11cm								
			15	RC BX	REC 98%									RQD 0%
267.8	17.2		16	RC BX	REC 87%									RQD 0%
267.8	17.2	End of Borehole												
		Note: Formerly BH# 2 of W.P. 481 - 89 - 04												

**ROCK CORE DESCRIPTION**  
**WP 511-90-01**

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
201	13	14.78-16.36	95	20	14.78-17.88	LIMESTONE with chert nodules and abundant fossils (corals, stromatoporoids), pale yellowish brown (matrix) to white (fossils); medium crystalline; medium strong; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, undulating, smooth to rough.
	14	16.36-17.88	98	22		
202	13	14.81-15.06	55	0	14.81-17.07	LIMESTONE with chert nodules and abundant fossils (corals, stromatoporoids), pale yellowish brown (matrix) to white (fossils); medium crystalline; medium strong; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, undulating, smooth to rough.
	14	15.06-15.98	97	0		
	15	15.98-17.07	98	0		

\*CR = CORE RECOVERY

\*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 481-89-02 DIST 2  
HWY 401 STR SITE 23-167

Sweaburg Road Overpass

*CONT 92-18*

DISTRIBUTION

A. Ho (2)  
C.M. Bond  
A.E. Irving  
D.A. Waller (2)  
K.G. Bassi  
S.J. Dunham  
G. Szekreny  
D. Fusee (Cover Only)  
C.A. Rogers (Cover Only)  
File ✓

# FOUNDATION INVESTIGATION REPORT

For

Sweaburg Road Overpass

W.P. 481-89-02, Site 23-167

Hwy. 401, District 2, London

## INTRODUCTION

This report contains the results of a site investigation carried out at the above mentioned site to provide information for the design and construction of the proposed widening of Sweaburg Road Overpass.

The field work for this project was carried out between 90 03 29 and 90 04 04, and comprised of four sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 18.6 m below the existing ground level (El. 281.7 m) using a continuous flight hollow stem auger.

## SITE DESCRIPTION

The site under investigation is located at the crossing of Hwy. 401 and Sweaburg Road in the City of Woodstock.

The topography of the site with the exception of the existing crossing (fills) is generally undulating with a group of kames to the northwest and drumlins to the south. Physiographically the area is located in the region known as the "Oxford Till Plain".

## SURBSURFACE CONDITIONS

The underlying subsoil at this site consists of silt, sand and gravel underlain by hard heterogeneous mixture of clayey silt, sand and gravel (glacial till). For classification purposes, the soils encountered at this site can be divided into four different zones.

- a) Sand with Gravel, some Silt (Subgrade Fill).
- b) Silty Sand to Sandy Silt.
- c) Sand & Gravel, some Silt.
- d) Heterogeneous mixture of Clayey Silt, Sand & Gravel (Glacial Till).

The soils encountered during the course of the investigation, together with the field and laboratory test results are shown on the Record of Borehole sheets contained in the Appendix of this report. Two stratigraphical sections are shown on Drawing No. 4818902-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered are given below.

Sand with Gravel, some Silt (Subgrade Fill)

This subgrade fill which was encountered on the northern side of the bridge consists of loose to compact sand with varying proportions of silt and gravel. The thickness of the fill was observed to be in the range of 1.3 m to 1.4 m and extends to E1. 299.7 m.

Silty Sand to Sandy Silt

This deposit was encountered only on the southern side of the bridge and was observed immediately below the topsoil and layers of silt and organic silt. The thickness of this deposit varies from 9.0 m to 10.2 m and extends to elevation 290.6 m to 290.1 m. The results of the gradation tests carried out on representative soil samples are shown on Figure 1 in an envelope form. These test results indicate that this deposit is predominantly composed of sand and silt with varying proportions of gravel. The natural moisture content varies from 8% to 9.5% with an average value of 9%. The Standard Penetration Test results varies from 11 blows/30 cm to 34 blows/30 cm. These results indicate that this stratum is in a compact to dense state of compaction.

Sand and Gravel, some Silt

This layer was encountered immediately below the subgrade fill and silty deposit on the northern side of the bridge. The thickness of this layer was observed to vary from 9.1 m to 9.4 m and extends to El. 290.7 to 287.6 m. The Grain Size Distribution Test results are shown on Figure 2 in an envelope form. The Standard Penetration Test results indicate that this stratum is in a compact to very dense state of compaction ('N' Values 13 blows/30 cm to over 100 blows/30 cm).

Heterogeneous Mixture of Clayey Silt, Sand and Gravel (Glacial Till)

The glacial till deposit was encountered in all the boreholes in the depth range of El. 287.6 to 290.7 m. The gradation test results are shown on Figure 3 in an envelope form. These results indicate 5% to 12% gravel, 30% to 32% sand and 58% to 64% clayey silt. The Standard Penetration Test results in this stratum vary from 72 blows/30 cm to over 100 blows/30 cm indicating hard consistency.

Groundwater Conditions

The groundwater was encountered in all the boreholes, and was observed between 1.5 m and 2.0 m below the existing ground level. However, the high water level encountered may be due to spring run-off. The groundwater level at each borehole location is as follows:

<u>Borehole No.</u>	<u>Elevation</u>
1	295.7 not stabilized
2	299.0
3	299.6
4	299.4

## DISCUSSION AND RECOMMENDATIONS

### General

The existing bridge is a single span reinforced concrete rigid frame structure. The clear span between the face of the abutments is about 17 m. Several noticeable cracks were observed on the abutments and wing walls on the southern side of the bridge. However, the abutments and wing walls on the northern side appear in good condition. In addition, the reinforcement of the concrete deck slab has been exposed and corroded at several locations.

It appears from the drawings of the existing bridge that the abutments as well as the retaining walls are supported on spread footings placed at about El. 298.8 m.

It is proposed to widen the existing overpass at the crossing of Hwy. 401 and Sweaburg Road to provide additional lane on both sides of Hwy. 401.

### Structure Foundation

Considering the subsoil conditions at the site, it is recommended that the bridge abutments and associated retaining walls for the widening be supported on spread footings placed at about El. 298.8± m to match the elevation of the existing footing.

The following bearing capacity values may be used for the design of the footings:

#### a) North of Bridge

Factored Bearing Capacity at U.L.S. 650 kPa

Bearing Capacity at S.L.S. Type II 250 kPa

#### b) South of Bridge

Factored Bearing Capacity at U.L.S. 500 kPa

Bearing Capacity at S.L.S. Type II 200 kPa

The allowable bearing pressures recommended above are based on the assumption that the footing will be at least 2.5 m wide and will not be placed at a level higher than El. 298.8 m. The total settlement for this bearing pressure is expected to be within 25 mm.

However, bearing pressures higher than the recommended values could be achieved if the total settlement in excess of 25 mm can be tolerated.

Considering the construction difficulties and the disturbance to the existing foundations by the pile driving, the option of deep foundation is not recommended.

Earth pressure should be computed as per Section 6.1.2.2 of the O.H.B.D.C. and an unyielding foundation condition may be assumed for the computations. The Granular "A" or "B" backfill should be in accordance with the Special Provision No. 109F03. The following parameters are recommended for the granular backfill.

	<u>Granular "A"</u>	<u>Granular "B"</u>
Angle of Internal Friction $\phi =$	35°	30°
Unit Weight (kN/m <sup>3</sup> ) $\gamma =$	22.8	21.2

If the allowable bearing pressures recommended above are not adequate to resist the earth pressures induced by the fill consisting of Granular 'A' or 'B', light weight aggregate may be used for the backfill. The earth pressure may be computed assuming an angle of internal friction value of 35° and a unit weight of 12.5 kN/m<sup>3</sup>.

An unfactored coefficient of friction value of 0.5 may be assumed for the estimate of the sliding friction.

#### Approach Embankment

Considering the subsoil conditions at this site, no stability problems are anticipated for the approach embankment constructed with 2 horizontal to 1

vertical side slopes. The embankment fill should consist of well compacted acceptable material. The topsoil as well as any spongy or soft areas observed within the base width of the embankment should be removed before placing the fill. The benching for the approach fill shall be carried out in accordance with OPSD 208.01 dated 1988 12 01.

#### Other Considerations

As indicated before, the high water level encountered may be due to spring run-off. However, at the time of construction, if the ground water level is encountered above the proposed founding level, a dewatering scheme will be required to maintain dry base condition during the concreting for the footings. Steps also should be taken to prevent any surface water flow in to the excavation. The base of the excavation at the founding level should be covered with 150 mm thick lean concrete pad within 8 hours of exposure.

The footings should have a minimum of 1.2 m earth cover to protect against the frost penetration.

Some differential settlement is expected to take place between the new and the existing structure, especially on southern side of the bridge. In view of this, it is advisable to provide either a "slip" or "Isolation" joint between the existing and the new structures to accommodate the differential settlement.

#### MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. M. Vasavithasan. The equipment used was owned and operated by London Soil Test. This report was prepared by Mr. M. Vasavithasan, reviewed by Mr. P. Payer, Senior Foundation Engineer, Mr. M. Devata, Chief Foundation Engineer.

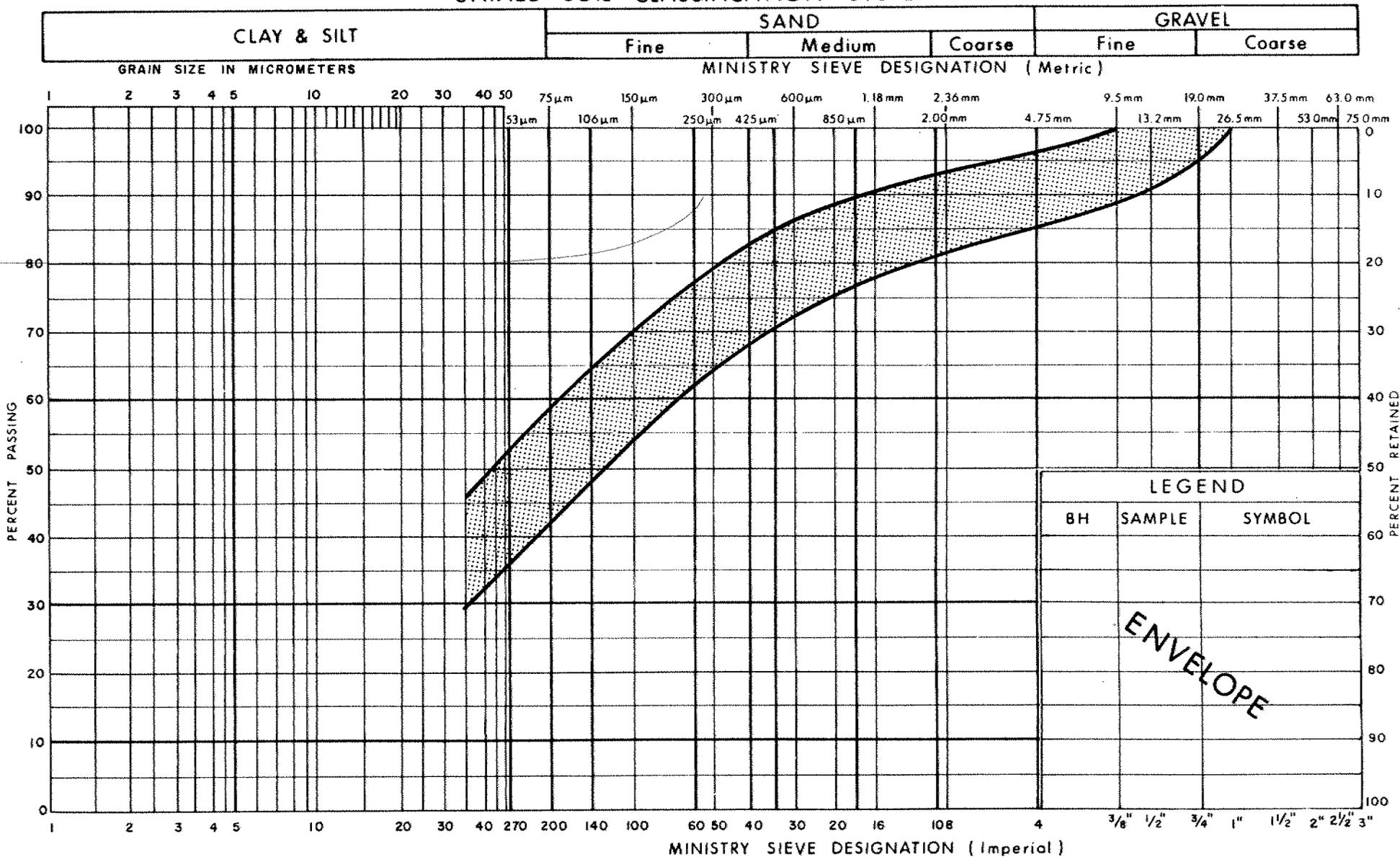


*M. Vasavithasan*  
M. Vasavithasan, P.Eng.  
Foundation Engineer

*M. Devata*  
M. Devata, P.Eng.  
Chief Foundation Engineer

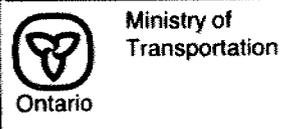
**APPENDIX**

### UNIFIED SOIL CLASSIFICATION SYSTEM



LEGEND		
BH	SAMPLE	SYMBOL

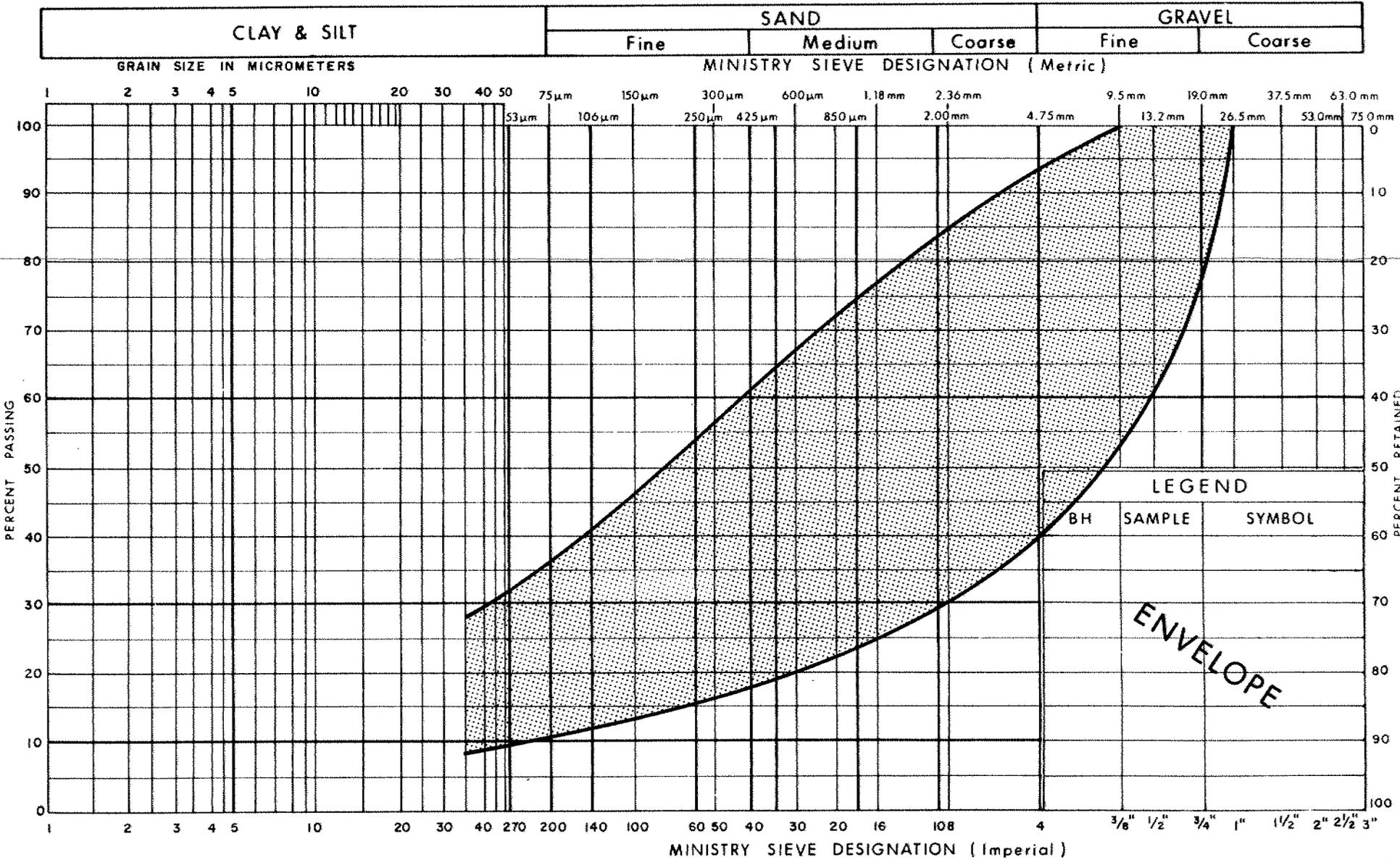
ENVELOPE



**GRAIN SIZE DISTRIBUTION**  
**SILTY SAND TO SANDY SILT**  
**SOME GRAVEL, TRACE CLAY**

FIG No 1  
 W P 481-89-02

### UNIFIED SOIL CLASSIFICATION SYSTEM



**GRAIN SIZE DISTRIBUTION  
SAND & GRAVEL, SOME SILT**

FIG No 2  
WP 481-89-02



## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

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 OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ 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	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	kN/m <sup>3</sup>	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	kg/m <sup>3</sup>	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_U$	1	UNIFORMITY COEFFICIENT
$\gamma$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	kg/m <sup>3</sup>	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	m <sup>3</sup> /s	RATE OF DISCHARGE
$\gamma_d$	kN/m <sup>3</sup>	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	kg/m <sup>3</sup>	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	kN/m <sup>3</sup>	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	kg/m <sup>3</sup>	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m <sup>3</sup>	SEEPAGE FORCE
$\gamma'$	kN/m <sup>3</sup>	UNIT WEIGHT OF SUBMERGED SOIL						

# RECORD OF BOREHOLE No 1 1 OF 1 METRIC

W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 705.0; E 202 572.0 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 03 29 & 90 03 30 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				NATURAL MOISTURE CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				W <sub>p</sub>	W		
300.3	Ground Surface														
0.0	Topsoil	-				300									
	Silty Sand to Sandy Silt Some Gravel, Trace of Clay. Compact	-	1	SS	14	298									9 42 (49)
		-	2	SS	19	296									14 44 (42)
		-	3	SS	14	294									12 35 (53)
		-	4	SS	19	292									0 2 88 10
		-	5	SS	21	290									
		-	6	SS	20	288									12 30 (58)
		-	7	SS	34	286									
		-	8	SS	19	284									
	-	9	SS	11	282										
290.1		-	10	SS	12	290									
10.2	Heterogeneous Mixture of Clayey Silt, Sand And Gravel Hard ( Glacial Till )	-	11	SS	72	288									12 30 (58)
		-	12	SS	121	286									
		-	13	SS	136	284									
		-	14	SS	95	282									
281.7	End of Borehole														
18.6	Note: Water Level Not Stabilized														

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 760.8; E 202 549.6 ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 04 03 CHECKED BY P.P.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 KN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa							
						20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	10 20 30					
301.0	Sweaburg Rd. Shoulder														
0.0	Sand With Gravel, Some Silt														
289.7	Loose ( Fill )		1	SS	9										
1.3	Silt, Trace of Sand, Trace of Clay, Compact		2	SS	11										
			3	SS	13										
			4	SS	15										
287.0			5	SS	30										
4.0	Sand And Gravel, Some Silt Dense to Very Dense		6	SS	55										
			7	SS	39										
			8	SS	20										
			9	SS	75										19 44 (37)
			10	SS	60	/15cm									59 29 (12)
			11	SS	100	/15cm									
287.8	Heterogeneous Mixture of Clayey Silt, Sand And Gravel Hard ( Glacial Till )		12	SS	75	/13cm									9 30 44 17
13.4			13	SS	90	/15cm									
283.9	End of Borehole														
17.1															

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 743.1; E 202 536.6 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 04 CHECKED BY P P

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40	60
301.2	Ground Surface														
0.0	Sand With Silt, Some Gravel,		1	SS	19										
299.8	Trace of Organics, Compact (Fill)		2	SS	22										
1.4	Sand And Gravel, Some Silt Compact to Very Dense		3	SS	20										
			4	SS	25										
			5	SS	13										
			6	SS	26										
			7	S	66										
			8	SS	36										
			9	SS	46										
290.7			10	SS	101	/15cm								6 76 (18)	
10.5			11	SS	100	/13cm									
284.1	Heterogeneous Mixture of Clayey Silt, Sand And Gravel, Hard ( Glacial Till )		12	SS	80	/15cm									
			13	SS	95	/15cm									
17.1	End of Borehole														

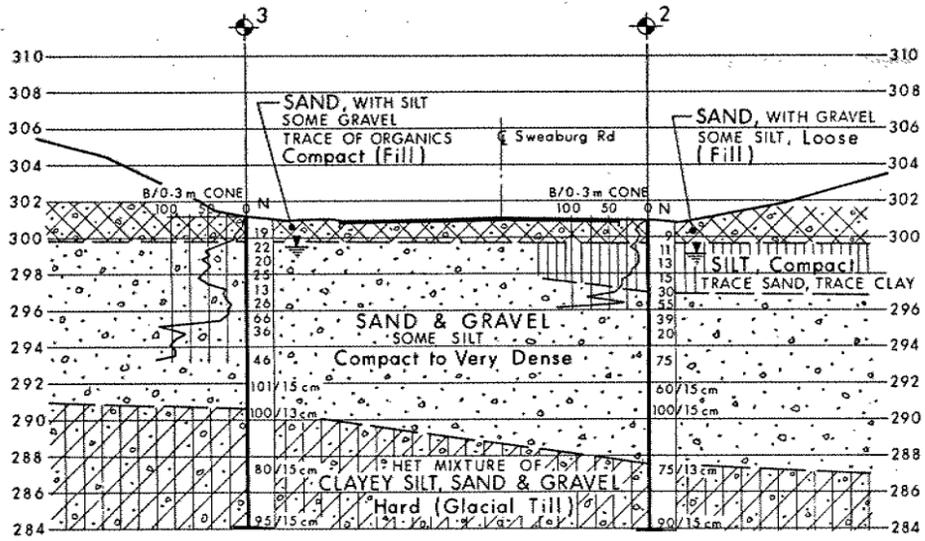
+3, x<sup>5</sup>: Numbers refer to Sensitivity 20  
15-5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 4 1 OF 1 METRIC

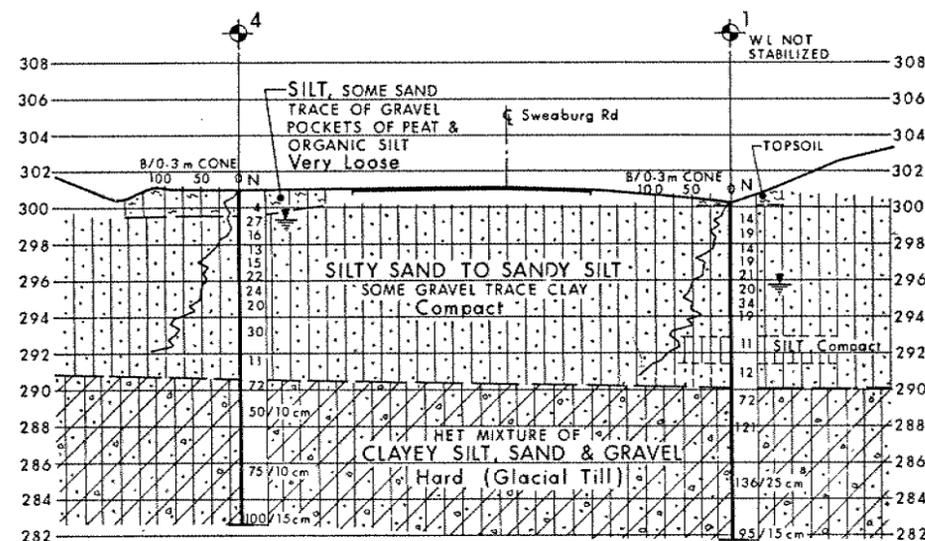
W.P. 481 - 89 - 02 LOCATION CO-ORDS. N 4 773 682.0; E 202 558.0 ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 04 02 & 90 04 03 CHECKED BY P.P.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		NATURAL MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80			100	W <sub>p</sub>	W	W <sub>L</sub>	7
301.0	Ground Surface																	
0.0	Silt, Some Sand, Trace of Gravel, Pockets of Peat & Organic Silt, Very Loose		1	SS	4													
299.6			2	SS	27													
1.4	Sandy Silt to Silty Sand, Trace of Gravel, Trace of Clay, Compact		3	SS	16												9 43 (48)	
		4	SS	13														
		5	SS	15														
		6	SS	22														
		7	SS	24														
		8	SS	20														
		9	SS	30													6 35 (59)	
		10	SS	11														
290.6		Heterogeneous Mixture of Clayey Silt, Sand And Gravel, Hard ( Glacial Till )		11	SS	72												8 32 47 13
10.4				12	SS	50	/10cm											
			13	SS	75	/10cm												5 31 48 16
282.6			14	SS	100	/15cm												
18.4	End of Borehole																	

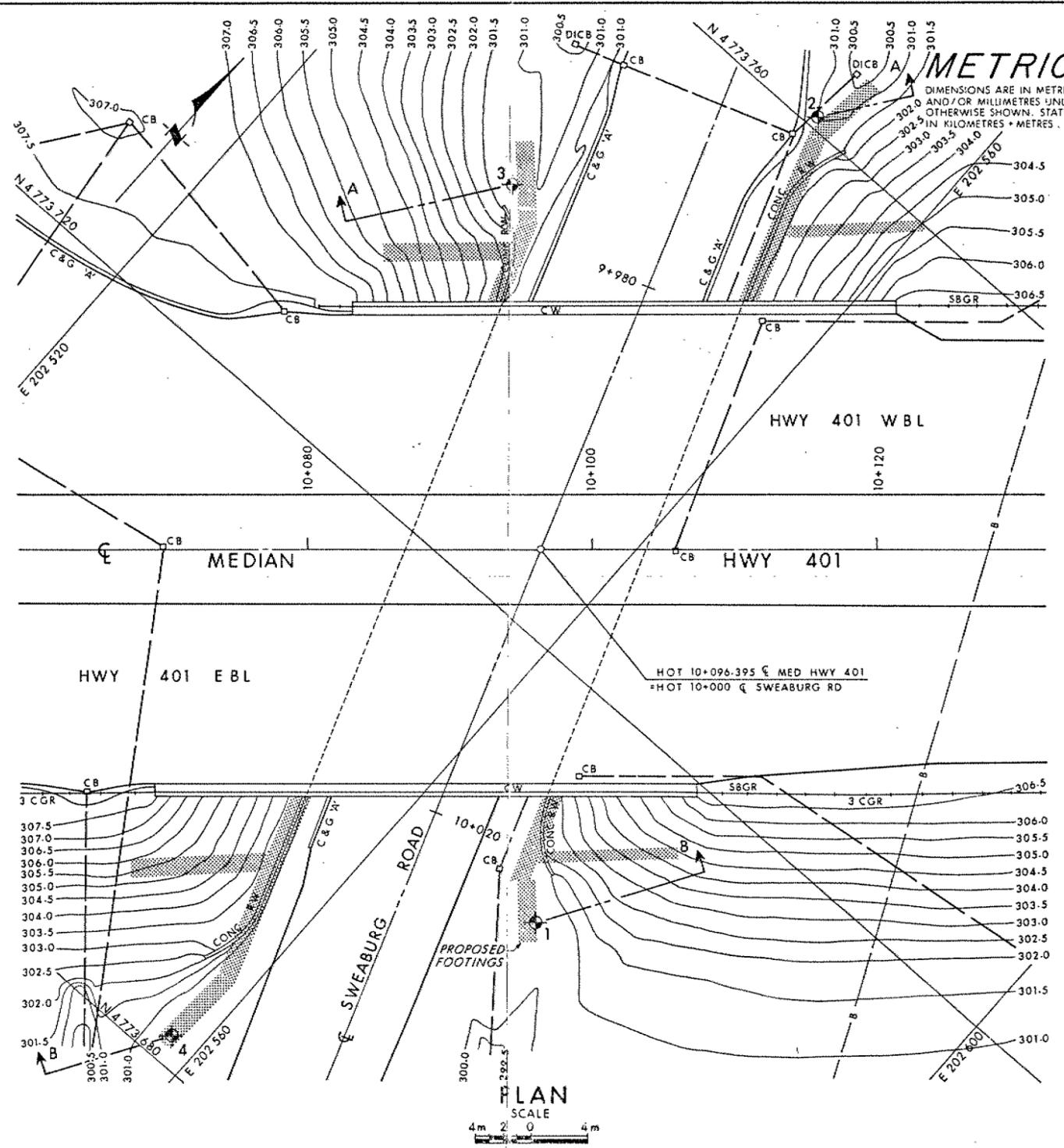
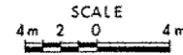
+3, x5: Numbers refer to Sensitivity  
 20 15-25 (%) STRAIN AT FAILURE  
 10



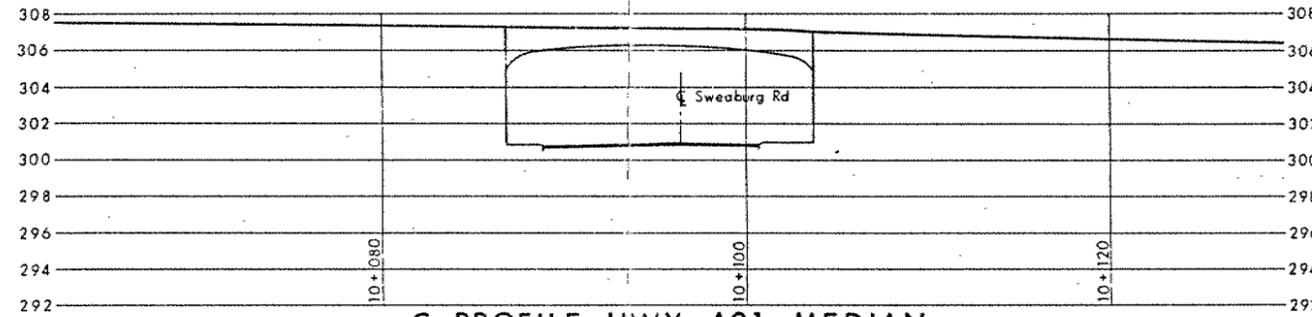
SECTION A-A



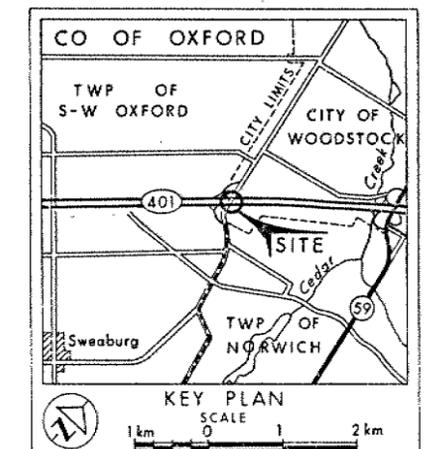
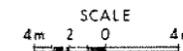
SECTION B-B



PLAN



PROFILE HWY 401 MEDIAN



LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 1990 03 and 04

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	300.3	4773705.0	202572.0
2	301.0	4773760.8	202549.6
3	301.2	4773743.1	202536.6
4	301.0	4773682.0	202558.0

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 40P2-43

HWY No 401	DATE 1990 05 31	DIST 2
SUB'D M.V. CHECKED	DATE 1990 05 31	SITE 23-167
DRAWN	CHECKED	APPROVED

DWG 4818902-A