

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 40I14-117

DIST. 2 REGION                     

W.P. No. 58-85-03

CONT. No. 91-08

W. O. No.                     

STR. SITE No. 19-374

HWY. No. 401

LOCATION Hwy 401 & Victoria Side road  
U' pass

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.                     

REMARKS:

METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

DIST 2  
CONT No  
WP No 58-85-03

VICTORIA ROAD UNDERPASS

GENERAL ARRANGEMENT

**DILLON**  
Consulting Engineers & Planners

### GENERAL NOTES

#### 1. CLASS OF CONCRETE

UNLESS OTHERWISE NOTED 30 MPa

#### 2. CLEAR COVER TO REINFORCING STEEL

FOOTINGS	100 ± 25
ABUTMENTS, WINGWALLS	
FRONT FACE	80 ± 20
BACK FACE	70 ± 20
PIERS	80 ± 20
DECK	
TOP	70 ± 20
BOTTOM	40 ± 10
REMAINDER, UNLESS NOTED	70 ± 20

#### 3. REINFORCING STEEL

REINFORCING STEEL SHALL BE GRADE 400 UNLESS OTHERWISE SPECIFIED  
BAR MARKS WITH SUFFIX "C" DENOTE COATED BARS

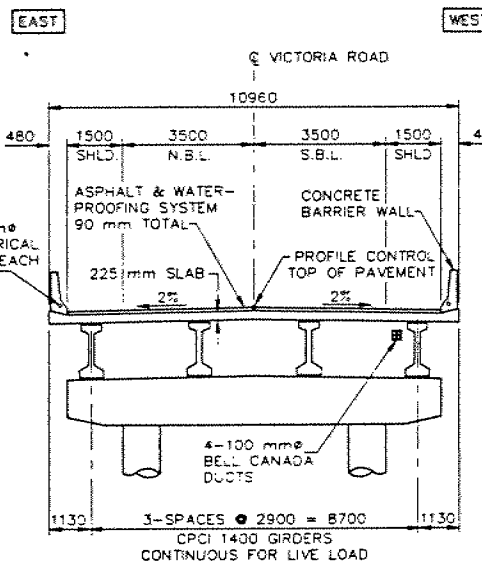
#### 4. CONSTRUCTION NOTES

IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED BEARING HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

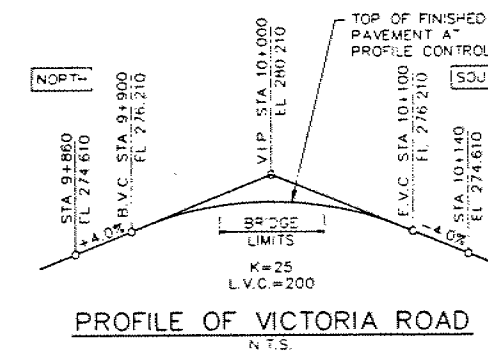
COMPACTED FILL MAXIMUM GRAIN SIZE 75mm  
SHALL BE PLACED UP TO THE BOTTOM OF FOOTING ELEVATION PRIOR TO DRIVING PILES

### LIST OF DRAWINGS

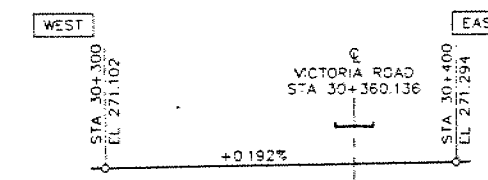
1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS & SOIL STRATA
3. FOOTING LAYOUT
4. FOOTING REINFORCING
5. ABUTMENT LAYOUT
6. ABUTMENT REINFORCING
7. PIERS
8. PRESTRESSED GIRDERS
9. DECK DETAILS AND SCREED ELEVATIONS
10. DECK REINFORCING
11. JOINT ANCHORAGE AND ARMOURING
12. BARRIER WALL
13. 6000 mm APPROACH SLAB
14. DETAILS OF CONC SLOPE PAVING
15. PILE DRIVING-STEAM & DIESEL HAMMERS
16. STANDARD DETAILS
17. AS CONSTRUCTED ELEV & DIM
18. ELECTRICAL EMBEDDED WORK
19. QUANTITIES - STRUCTURE I
20. QUANTITIES - STRUCTURE II



TYPICAL DECK CROSS SECTION  
SCALE 1:100



PROFILE OF VICTORIA ROAD  
N.T.S.



PROFILE OF HWY 401 WBL  
N.T.S.

### LEGEND

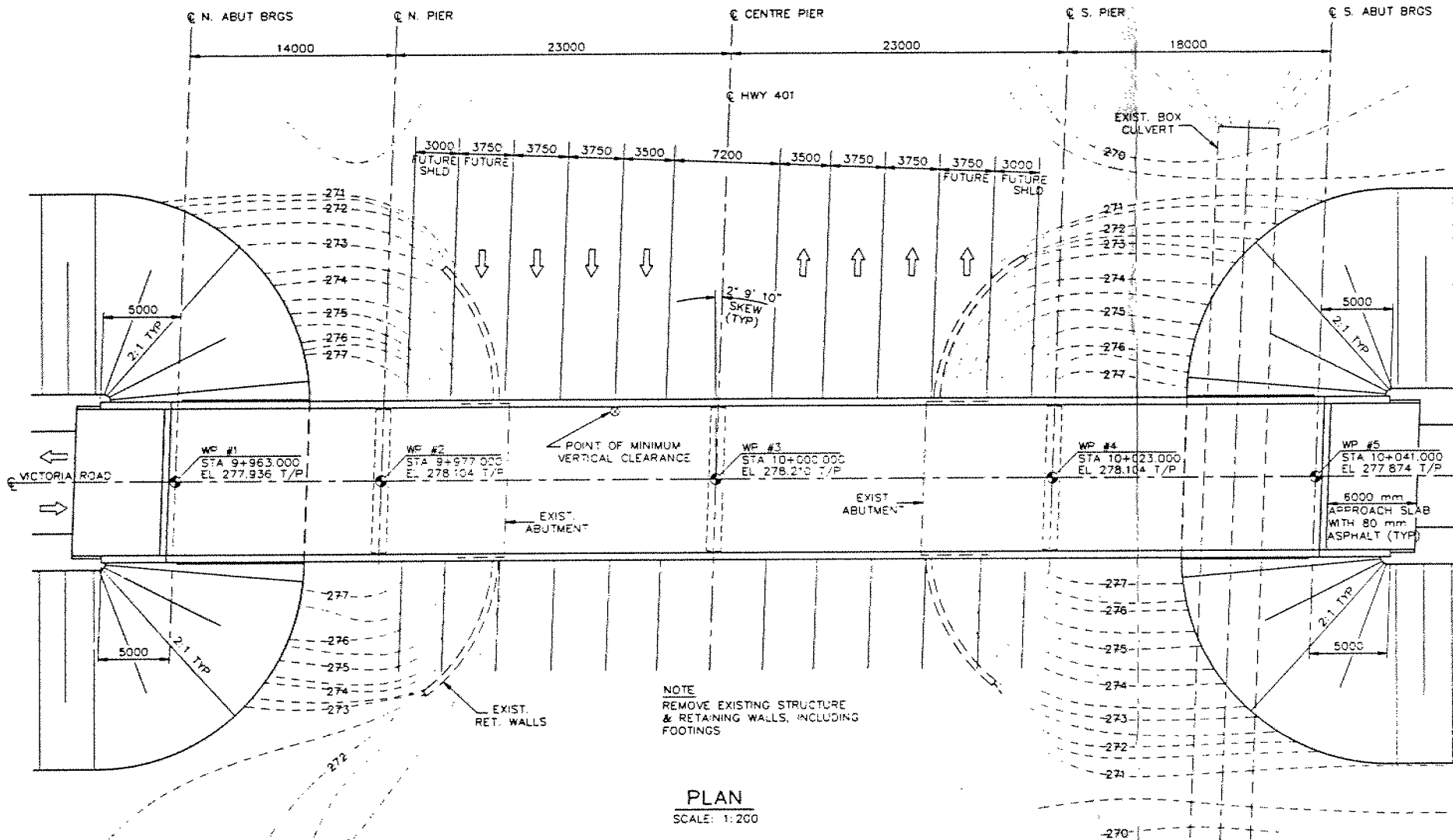
WP DENOTES WORKING POINT  
T/P DENOTES TOP OF PAVEMENT

### APPLICABLE STANDARD DRAWINGS

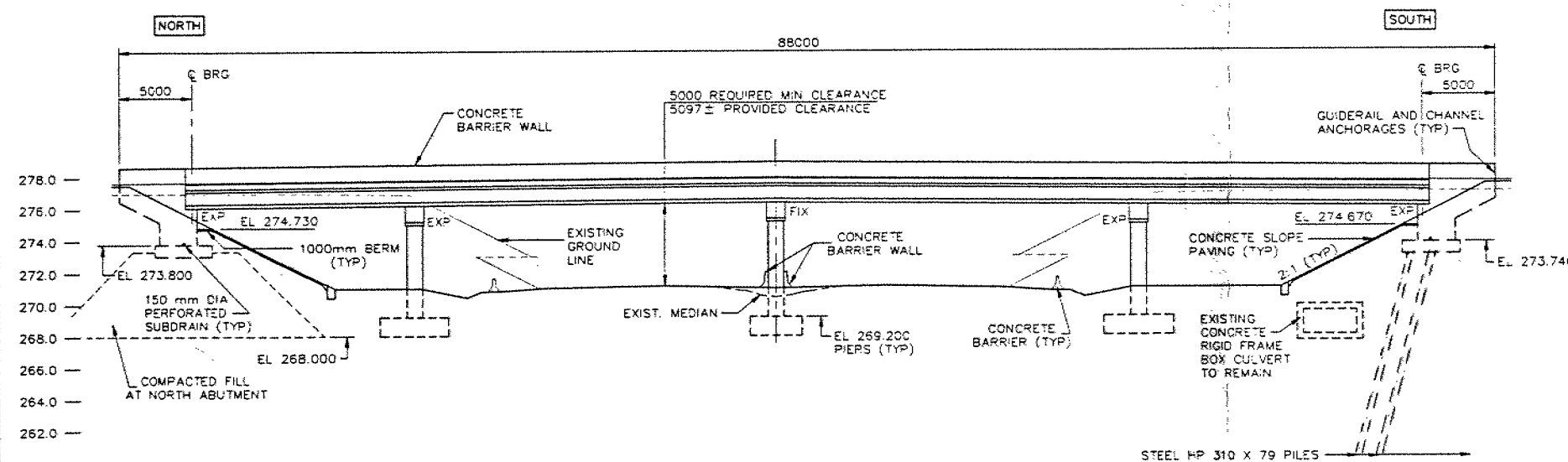
- DD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS  
DD-4603 FALSEWORK CLEARANCES



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CLQ	CHK ACZ	LOADING OHBDC-A-83
DRAWN	G.E.	CHK LTL	SITE NO 19-374
			DATE 90-06
			DWG



PLAN  
SCALE 1:200



ELEVATION  
SCALE 1:200

BM 277.569  
GEODETIC DATUM  
CUT CROSS ON N.W. CORNER  
CONC. SIDEWALK (BRIDGE)  
24.5 LT 30+354.5

ALL PILES ARE HP 310 X 79

PILE SPACING IS MEASURED AT UNDERSIDE OF FOOTING

DESIGN LOAD      [    ULS : 800 kN  
                             SLS : 500 kN

DRIVE PILES IN ACCORDANCE WITH SS103-11 OR SS103-12  
FOR AN ULTIMATE CAPACITY OF 1500 kN PER PILE  
BUT MUST BE DRIVEN BELOW ELEV. 258.000

PILE DATA			
LOCATION	NO. REQ'D.	BATTER	LENGTH
SOUTH ABUT	10	1 : 4	15700
	4	1 : 10	15300

W. P. DATA			
WP	STATION	CO-ORDINATES	
		NORTH	EAST
1	9+963.000	4 756 535.010	416 156.395
2	9+977.000	4 756 521.267	416 159.067
3	10+000.000	4 756 498.690	416 163.457
4	10+023.000	4 756 476.113	416 167.847
5	10+041.000	4 756 458.444	416 171.283

**DILLON**  
Consulting Engineers & Planners



REVISIONS										
	DATE	BY	DESCRIPTION					DATE	90-CE	
	DESIGN	DLO	CHK	ACZ	LOADING	0-BDC-A-83			DWC	3
	DRAWN	TL	CHK	G.S	SITE	18-374			DWC	3

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 91-08



Ministry of  
Transportation

INDEX

<u>Page No:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3-18	Foundation Investigation Report for  Victoria Sideroad Underpass W.P. 58-85-03, Site 19-374 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 (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
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

### 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
$S_f$	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						

FOUNDATION INVESTIGATION REPORT  
for  
Victoria Sideroad Underpass  
Hwy. 401, Town of Westminster  
W.P. 58-85-03, Site 19-374  
District 2, London

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### 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 replacement bridge and approaches.

The field work for this project was carried out between 90 02 07 and 90 02 21, and comprised of four sampled boreholes and Dynamic Cone Penetration Test adjacent to two of the boreholes.

Boreholes 101 to 104 were advanced to a maximum depth of 27.9 m below the existing Victoria Road level (El: 249.5) using continuous flight hollow stem auger and BW casing.

### SITE DESCRIPTION

The site under investigation is located at the crossing of Hwy. 401 and Victoria Sideroad in the Town of Westminster.

The topography of the site with the exception of the existing crossing (fills) is generally undulating with drumlins to the east. Physiographically the area is located in the region known as the "Caradoc Sand Plains and London Annex" and consist of silt and sand, apparently of Lacustrine Formation.

The existing bridge is a single span reinforced concrete rigid frame box structure. The clear span between the face of the abutments is about 28.7 m.

The structure as well as the side slopes of the approach fill are in very good condition. The bridge and the retaining walls are supported on 324 mm diameter, approximately 10.7 m long steel tube piles founded at about Elevation 258.0±.

#### SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of fill underlain by natural soil predominantly composed of silt which overlies sandy deposit. The sandy deposit is underlain by sand and silt with varying proportions of clay and gravel sized particles (glacial till). Despite the geological history of this area, glacial till was encountered near the terminal depth and the silt and sand deposits encountered on top are apparently of Lacustrine Formation. For classification purposes, the soils encountered at this site can be divided into four different zones:

- a) Approach fill
- b) Silt, Some Clay, Trace Sand
- c) Sand, Some Silt, Trace Gravel
- d) Sand and Silt, Some Clay & Gravel

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. A stratigraphical profile is shown on Drawing No: 588503-A.\* This drawing also shows the locations and elevations of the borings. In addition, information gathered from the site investigation carried out for the existing bridge foundation is also included in this report. Description of the strata encountered are given below.

#### Approach Fill

This fill which was placed to raise the finished grade of the Victoria Sideroad consists of sand (Granular "A" and "B") and layers of clayey silt and sandy silt. The thickness of the granular fill varies from 0.9 m to maximum of 7.5 m near the abutments of the existing bridge. The Standard Penetration Test results

\* DWG NO 2 OF THE CONTRACT DWG'S



indicate that this granular fill is in compact to very dense state of compaction (N - Values 26 to 74 blows/30 cm).

The granular material is underlain by 1.0 m to 5.7 m of fill containing layers of clayey silt and sandy silt. The Standard Penetration Test values in this fill varies from 5 blows/30 cm to 27 blows/30 cm.

#### Silt, Some Clay, Trace Sand

The approach fill is underlain by this deposit. The thickness of this silty deposit varies from 6.5 m to 9.4 m and extends to elevation 263.5 to 260.5. The gradation tests carried out on representative soil samples are shown on Figure #1 in an envelope form. The gradation analyses indicate that this deposit is predominantly composed of silt with varying proportions of clay. The natural moisture content of this deposit varies from 16.5% to 20.5% with an average value of 18%. The standard Penetration Test results varies from 19 blows/30 cm to 71 blows/30 cm with an average value of 40 blows/30 cm and these results indicate that this stratum is in compact to very dense state of compaction.

#### Sand, Some Silt, Trace Gravel

The silty deposit is underlain by this sandy stratum which extends to elevation 256.6 to 255.4. The thickness of this sandy deposit varies from 4.3 m to 7.6 m. The gradation test results are shown on Figure #2 in an envelope form. These results indicate that this deposit is predominantly composed of sand (83% to 92%). The Standard Penetration Test results indicate that this stratum is in compact to very dense state of compaction (N - Values 21 blows/30 cm to 116 blows/30 cm).

#### Sand and Silt, Some Clay, Trace Gravel

The sandy deposit is underlain by this glacial till stratum. The gradation test results are shown on Figure #3 in an envelope form. These results indicate 20% to 49% sand and 51% to 77% silt and clay. The Standard Penetration Test results

indicate that this stratum is in very dense state of compaction (N-Values 62 blows/30 cm to over 100 blows/30 cm).

### Ground Water Conditions

The ground water was encountered in all the boreholes, and was observed between 13.9 m and 15.4 m below the existing Victoria Sideroad level. However, water level could not be established in borehole #103. The ground water elevation at each borehole location is as follows:

<u>Borehole No:</u>	<u>Elevation</u>
101	262.5
102	261.9
103	Not Established
104	263.3

### MISCELLANEOUS

The field work 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 and approved by Mr. M. Devata, Chief Foundation Engineer.



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

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

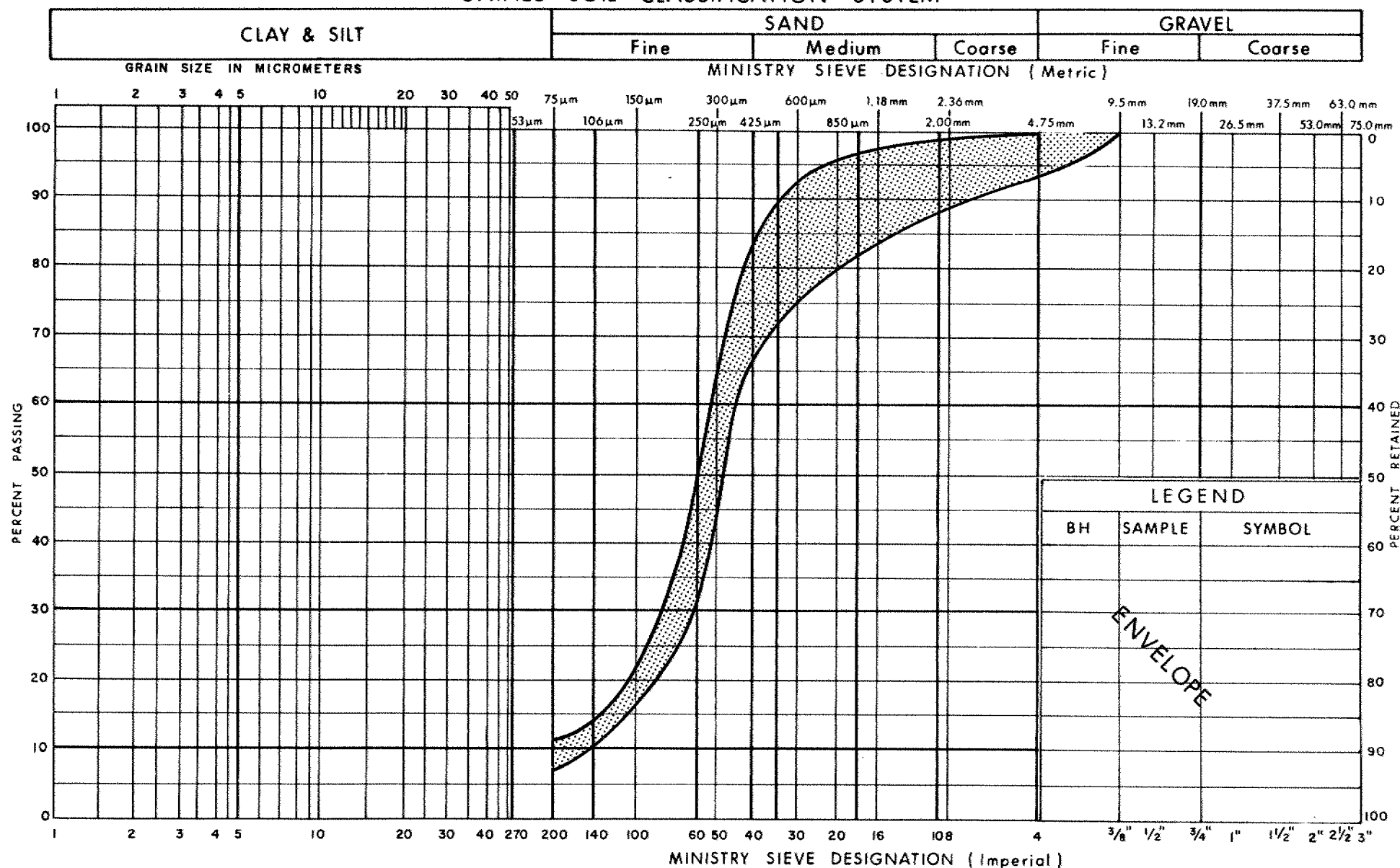
APPENDIX



GRAIN SIZE DISTRIBUTION  
SILT SOME CLAY, TRACE SAND

W P 58-85-03

## UNIFIED SOIL CLASSIFICATION SYSTEM



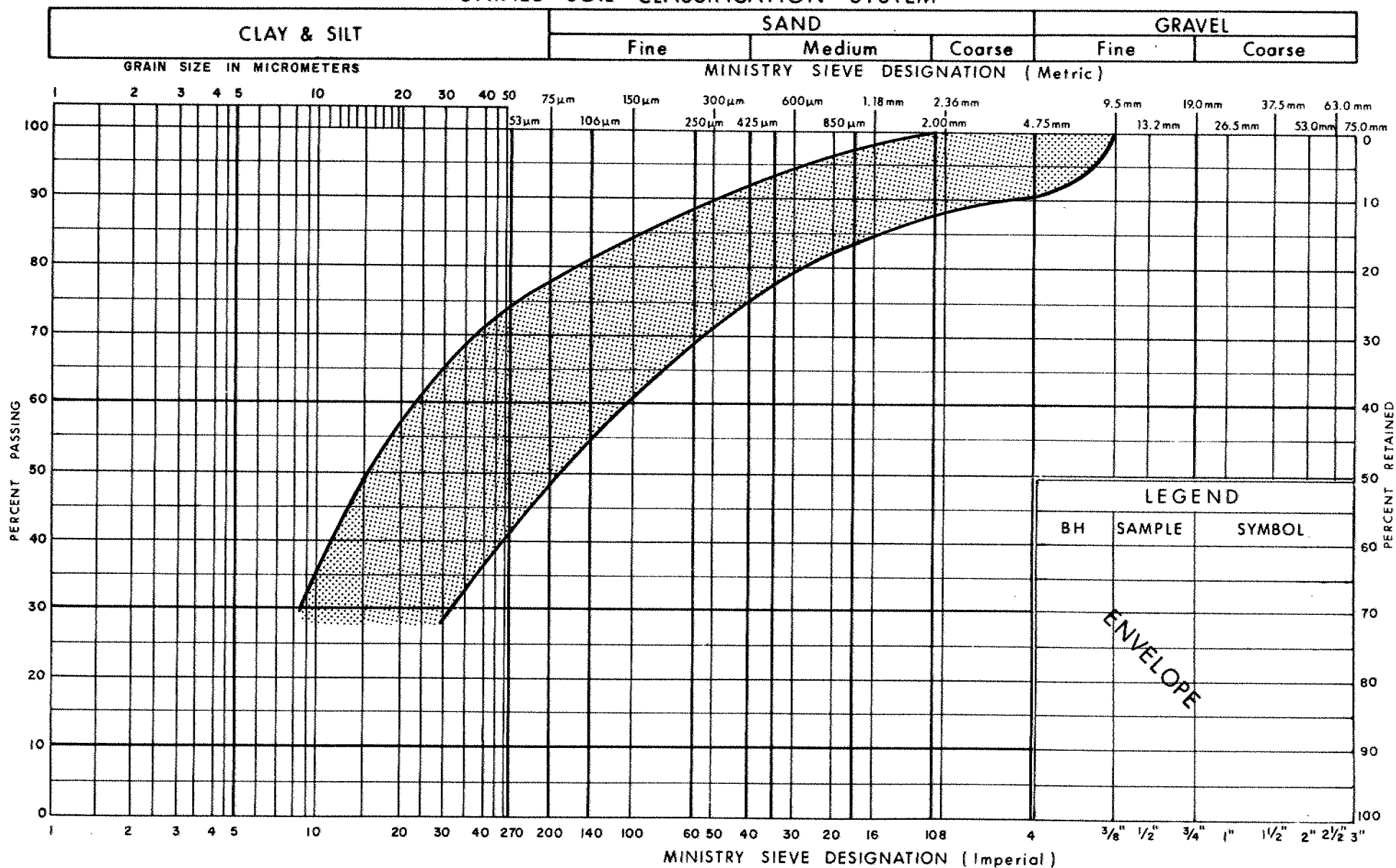
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**GRAIN SIZE DISTRIBUTION**  
**SAND, SOME/TRACE SILT & GRAVEL**

FIG No 2

W P 58 - 85 - 03

## UNIFIED SOIL CLASSIFICATION SYSTEM



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

FIG No 3

W P 58-85-03

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 10 + 014 O/S 4.6m RT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 10 CHECKED BY Y.L.

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 60 80 100	20 40 60 80 100					
270.0	Ground Level													
0.0	Silt, Some Clay And Sand, Compact to Dense		1	TO	23	*	268						20.0	
			2	TO	25		256						20.1	
			3	TO	38		264						19.3	
			4	TO	51		262						20.1	
			5	TO	23		260						19.4	
260.5			6	TO	39		258							
9.5	Sand, Some Silt And Gravel, Dense		7	SS	36		256							
			8	SS	37									
256.6	Sand And Silt, Some Clay And Gravel, Very Dense (Glacial Till)		9	SS	71									
13.4			10	SS	167									
254.6														
15.4	End of Borehole													
	* Water Level Not Established													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 10 + 014 O/S 4.6m LT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 12 CHECKED BY Y.L.

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 80 100	20 40 60 80 100					
270.2	Ground Level													
0.0	Silt, Some Sand And Clay, Compact to Dense		1	TO	14	*	268							
			2	TO	36		266						20.4	
			3	TO	38		264						20.6	
			4	TO	43		262						20.9	
			5	TO	19		260						20.2	
261.1	Sand, Some Silt And Gravel, Compact to Dense		6	TO	27		258							
9.1			7	SS	41									
			8	SS	31									
257.1	Silt And Sand, Some Clay And Gravel, Very Dense (Glacial Till)		9	SS	88									
13.1														
256.0														
14.2	End of Borehole													
	* Water Level Not Established													



# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 09 + 985 O/S 6.0m LT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 15 CHECKED BY A.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		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	W <sub>P</sub> W W <sub>L</sub>					
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100		WATER CONTENT (%) 10 20 30				
270.5	Ground Level													
0.0	Silt, Some Sand And Clay, Compact to Dense		1	TO	19	*	268					20.7		
			2	TO	39			266						20.5
			3	TO	39			264						20.7
			4	TO	40			262						20.0
262.1			5	TO	46			260						
8.4	Sand, Some Silt And Gravel, Dense to Very Dense		6	SS	43		258							
			7	SS	43		256							
			8	SS	69									
256.6	Sand And Silt, Some Clay And Gravel, Dense to Very Dense (Glacial Till)		9	SS	42		254					23.9		
13.9			10	SS	100		252							
255.3														
15.2	End of Borehole													
	* Water Level Not Established													

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 09 + 985 O/S 6.0m RT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 17 CHECKED BY A.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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 80 100	W <sub>P</sub>	W	W <sub>L</sub>			
270.5	Ground Level							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) 10 20 30					
0.0	Silt, Some Sand And Clay, Dense to Very Dense		1	TO	36	*	268						21.9		
			2	TO	41			266							
			3	TO	67			264	133	120/13cm					21.2
			4	TO	54			262							24.0
261.1	Sand, Some Silt And Gravel, Dense		5	TO	39		260								
9.4			6	SS	37										
			7	SS	45			258							
256.5	Sand And Silt, Some Clay And Gravel, Very Dense, (Till)						256								
14.0 255.6			8	SS	70							23.5			
14.9	End of Borehole														
	Water Level Not Established														

+3, x5: Numbers refer to  
Sensitivity

20  
15-5 (%) STRAIN AT FAILURE  
10

# RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 9 + 958 O/S 2.6m RT. CL VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 FEB 07 TO 90 FEB 09 CHECKED BY D.T.

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			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED								+ FIELD VANE		
							20	40	60	80	100	10	20	30				
277.1	Asphalt Surface																	
0.0	100 mm Asphalt																	
275.7	Sand With Gravel, Some Silt Compact, (Fill)																	
1.4	Layers of Clayey Silt and Sandy Silt, Some Gravel, Stiff/Compact (Fill)		1	SS	25													
			2	SS	12													
			3	SS	19													
			4	SS	27													
270.0	Silt Some Clay, Trace of Sand, Dense to Very Dense		5	SS	29													
7.1			6	SS	39													
			7	SS	44													
			8	SS	41													
			9	SS	46													
			10	SS	69													
			11	SS	52													
			12	SS	36													
263.5	Sand, Some Gravel, Trace of Silt, Dense to Very Dense		13	SS	54													
13.6			14	SS	27													
			15	SS	51													
			16	SS	63													
255.9	Sand And Silt, Some Clay, Trace of Gravel, Very Dense (Glacial Till)		17	SS	49													
21.2			18	SS	85													
			19	SS	89													
			20	SS	100													
252.3	End of Borehole																	
24.8																		

# RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 9 + 974.0/S 3.0m LT. CL. VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT AUGER (H.S.) & BW CASING COMPILED BY M.V.  
 DATUM GEODETTIC DATE 90 FEB 20 TO 90 FEB 21 CHECKED BY D.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
277.3	Asphalt Surface													
0.0	100 mm Asphalt													
	Sand With Gravel, Some Silt And Cobbles, Dense (Fill)		1	SS	42		276							
			2	SS	47		274							
			3	SS	60		272							
270.8			4	SS	44									
6.5	Silt With Sand, Some Clay, Trace of Sand And Organics, Compact		5	SS	16		270							
269.8			6	SS	19									
7.5	Silt, Some Clay And Sand, Compact to Dense		7	SS	27									
			8	SS	27		268							0 0 87 13
			9	SS	31									
			10	SS	30									
			11	SS	43		266							
			12	SS	35									
	Silty Clay Very Stiff		13	SS	20		264							0 0 (100)
262.2			14	SS	48		262							
15.1	Sand, Some Silt And Gravel, Dense to Very Dense		15	SS	116		260							
			16	SS	60									2 88 (10)
			17	SS	58		258							
256.4			18	SS	130		256							4 27 (69)
20.9	Sand And Silt, Some Clay And Gravel, Very Dense (Glacial Till)		19	SS	126		254							
254.0														
23.3	End of Borehole													

# RECORD OF BOREHOLE No 103

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 10 + 025 O/S 2.7m RT. CL. VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT AUGER (H.S.) & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 FEB 16 TO 90 FEB 20 CHECKED BY D.T.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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		
277.4	Asphalt Surface													
0.0	100 mm Asphalt		1	SS	26		276							
			2	SS	30									
	Sand With Gravel, Some Silt and Cobbles, Compact to Dense (Fill)		3	SS	40		274							
			4	SS	42									
			5	SS	74		272							
269.9														
7.5	Silt And Sand, Some Clay, Trace of Gravel And Organics, Compact		6	SS	16		270							
268.4			7	SS	21									
9.0			8	SS	50		268							
	Silt, Some Clay, Trace of Sand, Dense to Very Dense		9	SS	41									
			10	SS	35									
			11	SS	35		266							
			12	SS	49									
			13	SS	67									0 0 85 15
			14	SS	61		264							0 0 89 11
	Silty Clay Very Stiff to Hard		15	SS	30		262							
260.5			16	SS	63									
16.9			17	SS	77		260							
	Sand, Some Silt And Gravel, Dense to Very Dense		18	SS	43		258							6 83 (11)
256.2			19	SS	134		256							
21.2			20	SS	70									
	Sand And Silt, Some Clay, Trace of Gravel, Dense to Very Dense (Glacial Till)		21	SS	73		254							
			22	SS	127		252							
249.5			23	SS	112		250							
27.9	End of Borehole • Water Level Not Established													

# RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 10 + 043 O/S 2.6m LT. CL. VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 FEB 09 TO 90 FEB 14 CHECKED BY D.T.

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 60 80 100	20 40 60 80 100					
277.0	Asphalt Surface													
0.0 276.1	Sand With Gravel, Some Silt (Fill)													
0.9	Layers of Clayey Silt and Sandy Silt, Some Gravel, Firm to Very Stiff/Loose to Compact		1	SS	7		276							
			2	SS	5									
			3	SS	13		274							
			4	SS	20		272							
			5	SS	21		270							
270.5	Silt, Some Clay, Trace of Sand, Compact to Very Dense		6	SS	29									
6.5			7	SS	22									
			8	SS	51									
			9	SS	57									
			10	SS	39									
			11	SS	58									
			12	SS	40									
			13	SS	38									
			14	SS	71									
			15	SS	29									
261.2	Sand, Some Silt And Gravel, Compact to Very Dense						262							
15.8			16	SS	60		260							
			17	SS	21		258							
256.6	Sand And Silt, Some Clay And Gravel, Very Dense (Glacial Till)		18	SS	65		256							
20.4			19	SS	62		254							
			20	SS	122		252							
			21	SS	120		250							
			22	SS	126		248							
247.6														
29.4	End of Borehole													

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

WP 58-85-03

DIST 2

HWY 401

STR SITE 19-374

Victoria Sideroad Underpass

*CONT 91-08*

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FOUNDATION INVESTIGATION REPORT  
for  
Victoria Sideroad Underpass  
Hwy. 401, Town of Westminster  
W.P. 58-85-03, Site 19-374  
District 2, London

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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 replacement bridge and approaches.

The field work for this project was carried out between 90 02 07 and 90 02 21, and comprised of four sampled boreholes and Dynamic Cone Penetration Test adjacent to two of the boreholes.

Boreholes 101 to 104 were advanced to a maximum depth of 27.9 m below the existing Victoria Road level (El: 249.5) using continuous flight hollow stem auger and BW casing.

SITE DESCRIPTION

The site under investigation is located at the crossing of Hwy. 401 and Victoria Sideroad in the Town of Westminster.

The topography of the site with the exception of the existing crossing (fills) is generally undulating with drumlins to the east. Physiographically the area is located in the region known as the "Caradoc Sand Plains and London Annex" and consist of silt and sand, apparently of Lacustrine Formation.

The existing bridge is a single span reinforced concrete rigid frame bon structure. The clear span between the face of the abutments is about 28.7 m.



The structure as well as the side slopes of the approach fill are in very good condition. The bridge and the retaining walls are supported on 324 mm diameter approximately 10.7 m long steel tube piles founded at about Elevation 258.0±.

#### SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of fill underlain by natural soil predominantly composed of silt which overlies sandy deposit. The sandy deposit is underlain by sand and silt with varying proportions of clay and gravel sized particles (glacial till). Despite the geological history of this area, glacial till was encountered near the terminal depth and the silt and sand deposits encountered on top are apparently of Lacustrine Formation. For classification purposes, the soils encountered at this site can be divided into four different zones:

- a) Approach fill
- b) Silt, Some Clay, Trace Sand
- c) Sand, Some Silt, Trace Gravel
- d) Sand and Silt, Some Clay & Gravel

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. A stratigraphical profile is shown on Drawing No: 588503-A. This drawing also shows the locations and elevations of the borings. In addition, information gathered from the site investigation carried out for the existing bridge foundation is also included in this report. Description of the strata encountered are given below.

#### Approach Fill

This fill which was placed to raise the finished grade of the Victoria Sideroad consists of sand (Granular "A" and "B") and layers of clayey silt and sandy silt. The thickness of the granular fill varies from 0.9 m to maximum of 7.5 m near the abutments of the existing bridge. The Standard Penetration Test results

indicate that this granular fill is in compact to very dense state of compaction (N - Values 26 to 74 blows/30 cm).

The granular material is underlain by 1.0 m to 5.7 m of fill containing layers of clayey silt and sandy silt. The Standard Penetration Test values in this fill varies from 5 blows/30 cm to 27 blows/30 cm.

Silt, Some Clay, Trace Sand

The approach fill is underlain by this deposit. The thickness of this silty deposit varies from 6.5 m to 9.4 m and extends to elevation 263.5 to 260.5. The gradation tests carried out on representative soil samples are shown on Figure #1 in an envelope form. The gradation analyses indicate that this deposit is predominantly composed of silt with varying proportions of clay. The natural moisture content of this deposit varies from 16.5% to 20.5% with an average value of 18%. The standard Penetration Test results varies from 19 blows/30 cm to 71 blows/30 cm with an average value of 40 blows/30 cm and these results indicate that this stratum is in compact to very dense state of compaction.

Sand, Some Silt, Trace Gravel

The silty deposit is underlain by this sandy stratum which extends to elevation 256.6 to 255.4. The thickness of this sandy deposit varies from 4.3 m to 7.6 m. The gradation test results are shown on Figure #2 in an envelope form. These results indicate that this deposit is predominantly composed of sand (83% to 92%). The Standard Penetration Test results indicate that this stratum is in compact to very dense state of compaction (N - Values 21 blows/30 cm to 116 blows/30 cm).

Sand and Silt, Some Clay, Trace Gravel

The sandy deposit is underlain by this glacial till stratum. The gradation test results are shown on Figure #3 in an envelope form. These results indicate 20% to 49% sand and 51% to 77% silt and clay. The Standard Penetration Test results

indicate that this stratum is in very dense state of compaction (N-Values 62 blows/30 cm to over 100 blows/30 cm).

Ground Water Conditions

The ground water was encountered in all the boreholes, and was observed between 13.9 m and 15.4 m below the existing Victoria Sideroad level. However, water level could not be established in borehole #103. The ground water elevation at each borehole location is as follows:

<u>Borehole No:</u>	<u>Elevation</u>
101	262.5
102	261.9
103	Not Established
104	263.3

## DISCUSSION AND RECOMMENDATIONS

### General

It is proposed to widen Hwy. 401 to a divided eight lane facility and the existing bridge will be replaced with four span (14.0 m end spans and 23.0 m centre spans) structure. The proposed profile grade is set at El: 278.0± which is about 0.5 m higher than the existing grade.

### Structure Foundation

Considering the subsoil conditions at the site, it is recommended that the piers be supported on spread footings placed at about elevation 268.0±. Alternatively, the soil up to Elevation 268.0± may be removed and replaced with compacted granular material and the footings may be placed a minimum of 1.2 m below the proposed finished grade.

The widening of Hwy. 401 will require removal and backfilling of existing approach fill. In view of this, the foundation for the abutments may be founded on engineered fill placed on competent ground. Any spongy or soft areas observed within the base width of the embankment should be removed before placing the engineered fill.

However, the engineered fill for both abutment and pier foundations should be placed as per Figure #4 appended to this report.

The following bearing capacity values are recommended for the design of the footings placed on natural ground as well as on engineered fill.

Factored Bearing Capacity at U.L.S. = 800 kPa

Bearing Capacity at S.L.S. Type II = 350 kPa

Alternatively, the piers and abutments may be supported on piles driven to about elevation 258.0±. The following bearing capacity values are recommended for the

design of the closed end pipe and steel H-Piles.

	Pile Type	
	324 mm O.D. <u>Pipe</u>	HP 310 X 79 <u>H-Pile</u>
Factored Capacity at U.L.S	900 kN	800 kN
Capacity at S.L.S. Type II	550 kN	500 kN

Driving of piles shall be carefully monitored and controlled employing the Hiley Dynamic Pile Driving Formula driven in accordance with MTO Standards SS103-10 or SS 103-11 assuming an ultimate capacity as follows:

Pile Type	Ultimate Capacity (kN)
HP 310 x 79	1500
Pipe Pile	1650

Ground water table was encountered well below the recommended founding elevation of the shallow foundations and no ground water problems are anticipated at this site. However, considering the subsoil conditions, the option of spread footing is favoured for the proposed structure.

Earth pressure should be computed as per Section 6.1.2.2 of the code 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	$\phi = 35^{\circ}$	$\phi = 30^{\circ}$
Unit Weight (kN/m <sup>3</sup> )	$\gamma = 22.8$	$\gamma = 21.2$

The coefficient of friction value of  $\tan 20^\circ$  may be assumed for the estimate of sliding resistance, if footings are placed on natural ground and if the footings are placed on compacted granular material, a coefficient of friction value of  $\tan 30^\circ$  may be assumed.

#### Approach Embankment

The proposed finished grade is set about 0.5 m higher than the existing grade. The maximum height of approach fill is expected to be about 7 m. Considering the competent subsoil conditions encountered at this site, no stability problems are anticipated for the approach embankments constructed with 2 horizontal to 1 vertical side slopes. The fill material should consist of well compacted acceptable material. The top soil as well as any spongy or soft areas observed within the base width of the embankment should be removed before placing the fill.

#### Other Considerations

The spread footings as well as the pile caps should have a minimum of 1.2 m earth cover for frost protection. The engineered fill should be placed as per Figure #4.

MISCELLANEOUS

The field work 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 and approved by Mr. M. Devata, Chief Foundation Engineer.

*M. Vasavithasan*

M. Vasavithasan, P. Eng.  
Foundation Engineer



*M. Devata*

M. Devata, P. Eng.  
Chief Foundation Engineer

APPENDIX



## 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:

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
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

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$\text{m}^2/\text{s}$	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 = $\frac{c_u}{\tau_r}$

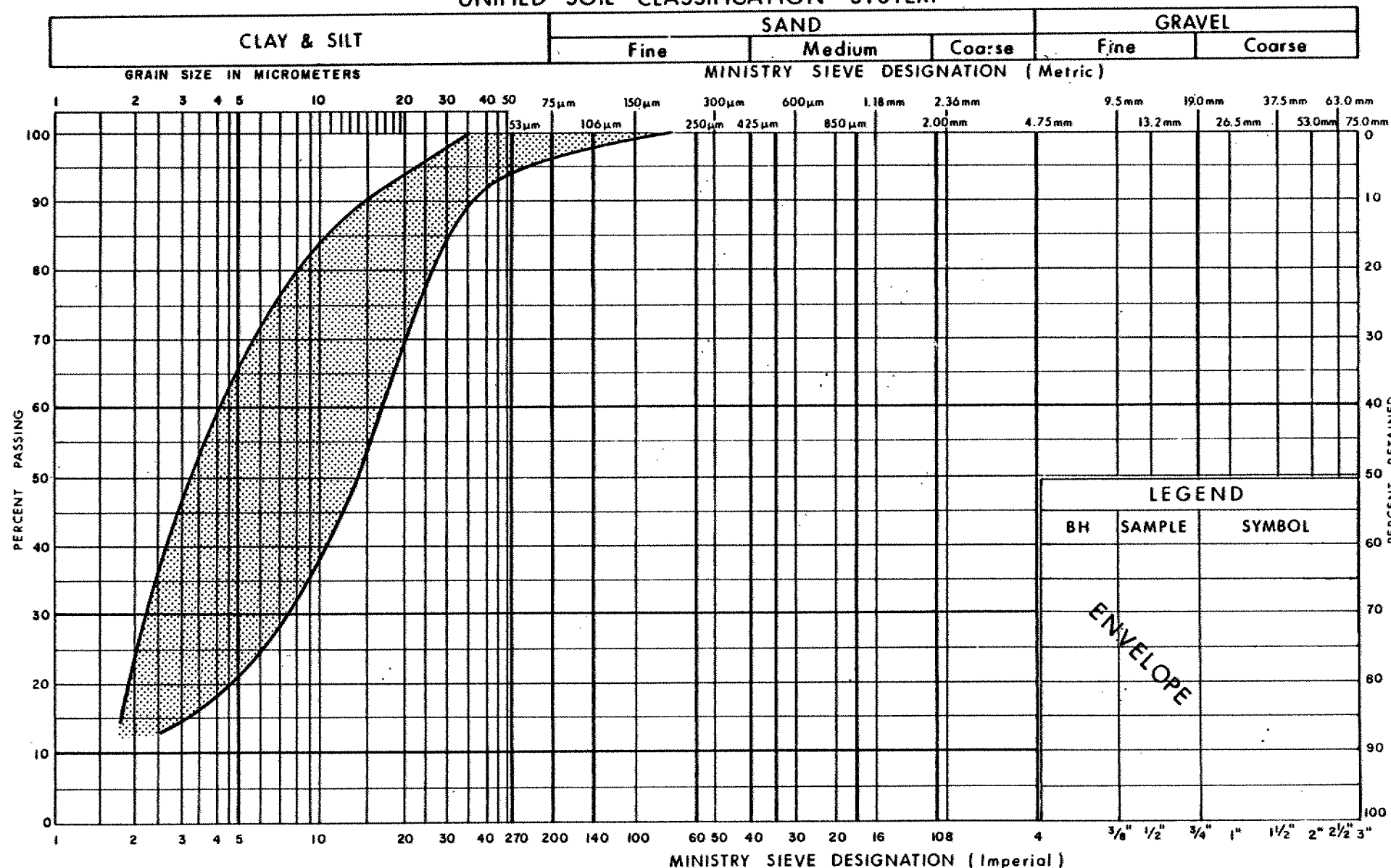
### STRESS AND STRAIN

$u_w$	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

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

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

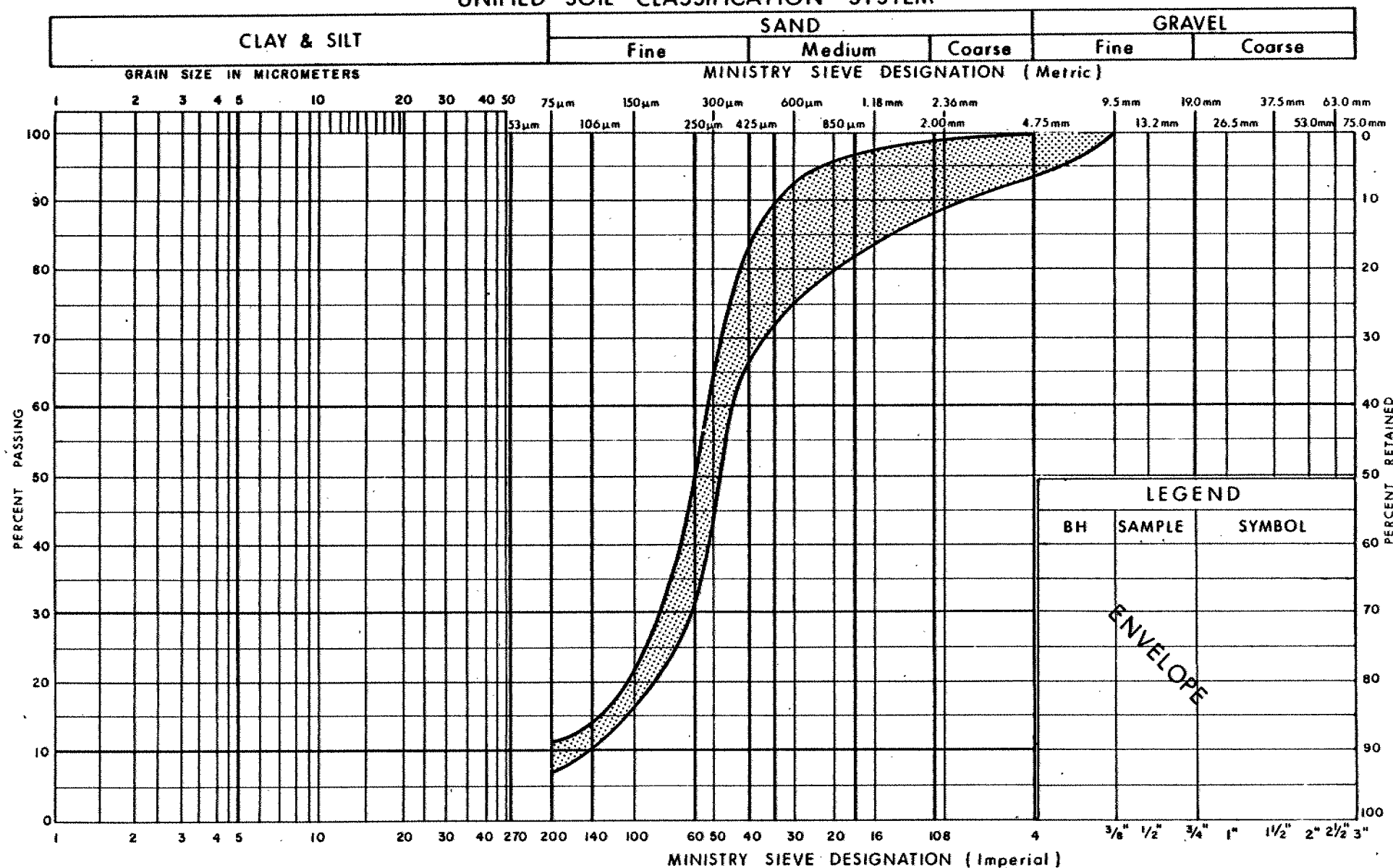
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
SILT SOME CLAY, TRACE SAND

FIG No 1

W P 58-85-03

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

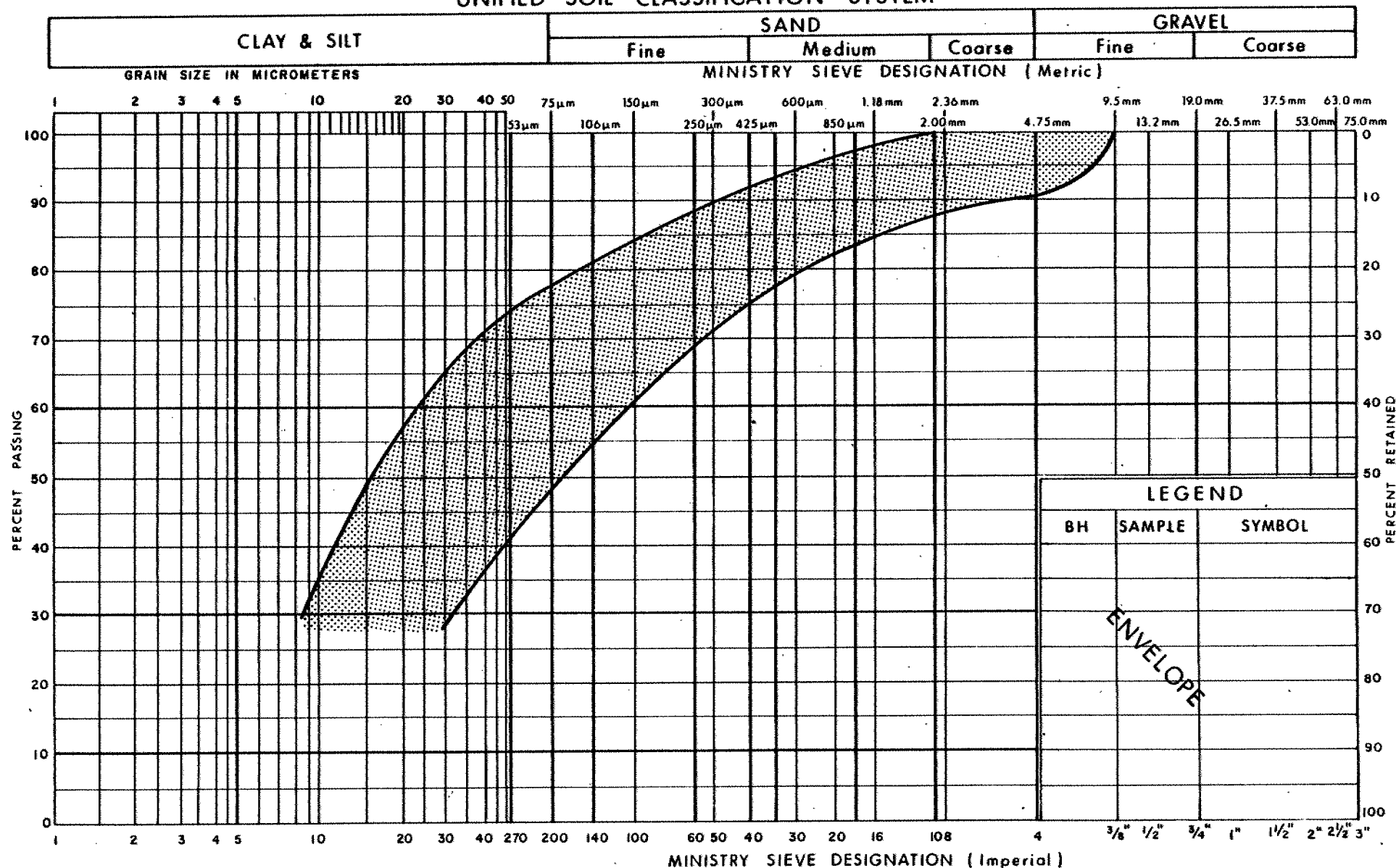
Ministry of  
Transportation

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

FIG No 2

W P 58 - 85 - 03

## UNIFIED SOIL CLASSIFICATION SYSTEM



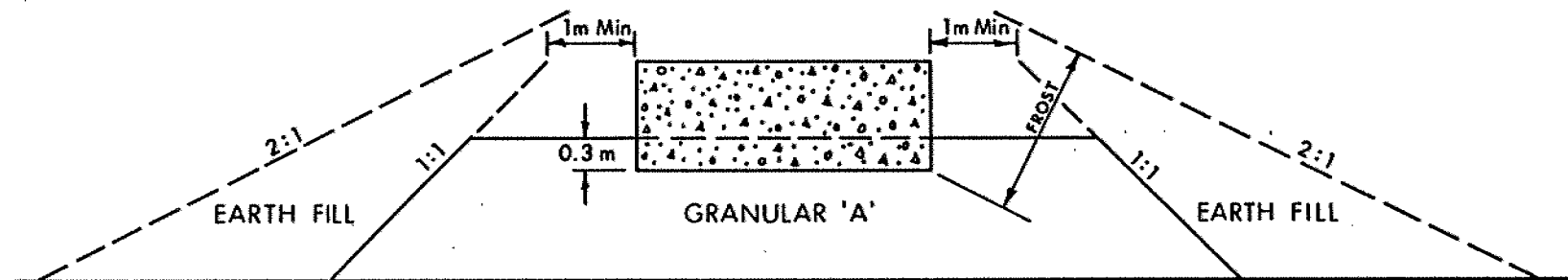
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Transportation

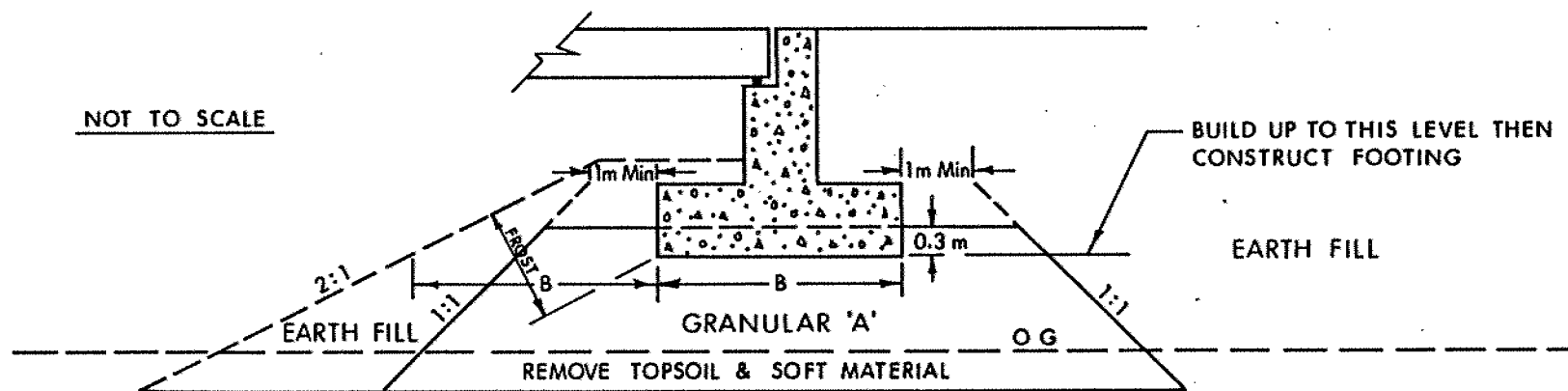
GRAIN SIZE DISTRIBUTION  
SAND & SILT  
SOME CLAY & GRAVEL

FIG No 3

W P 58-85-03



X SECTION



LONGITUDINAL SECTION

**NOTES:**

- 1 - REMOVE TOPSOIL &/OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' & EARTH FILL.
- 2 - PLACE GRANULAR 'A' & EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M T C STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



Ontario

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Transportation

ABUTMENT ON COMPACTED FILL  
SHOWING GRANULAR 'A' CORE

FIG No 4

W P 58-85-03

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 10 + 014 O/S 4.6m RT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 10 CHECKED BY Y.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
270.0	Ground Level													
0.0	Silt, Some Clay And Sand, Compact to Dense		1	TO	23	*	268						20.0	
			2	TO	25		266						20.1	
			3	TO	38		264						19.3	
			4	TO	51		262						20.1	
			5	TO	23		260						19.4	
260.5	Sand, Some Silt And Gravel, Dense		6	TO	39		258							
9.5			7	SS	36		256							
			8	SS	37									
256.6	Sand And Silt, Some Clay And Gravel, Very Dense (Glacial Till)		9	SS	71									
13.4			10	SS	167									
254.6													23.8	
15.4	End of Borehole													
	• Water Level Not Established													

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 10 + 014 O/S 4.6m LT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 12 CHECKED BY Y.L.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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		
270.2	Ground Level													
0.0						*								
	Silt, Some Sand And Clay, Compact to Dense		1	TO	14		268							
			2	TO	36		266						20.4	
			3	TO	38								20.6	
			4	TO	43		264						20.9	
			5	TO	19		262						20.2	
261.1														
9.1			6	TO	27		260							
	Sand, Some Silt And Gravel, Compact to Dense		7	SS	41		258							
257.1			8	SS	31									
13.1														
256.0	Silt And Sand, Some Clay And Gravel, Very Dense (Glacial Till)		9	SS	88								22.9	
14.2	End of Borehole													
	Water Level Not Established													

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 09 + 385 O/S 6.0m LT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 15 CHECKED BY A.L.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
270.5	Ground Level												
0.0					*								
	Silt, Some Sand And Clay, Compact to Dense		1	TO	19							20.7	
			2	TO	39							20.5	
			3	TO	39								
			4	TO	40							20.7	
262.1			5	TO	46							20.0	
8.4			6	SS	43								
	Sand, Some Silt And Gravel, Dense to Very Dense		7	SS	43								
			8	SS	69								
256.6			9	SS	42							23.9	
13.9	Sand And Silt, Some Clay And Gravel, Dense to Very Dense (Glacial Till)		10	SS	100	/5cm							
255.3													
15.2	End of Borehole												
	• Water Level Not Established												

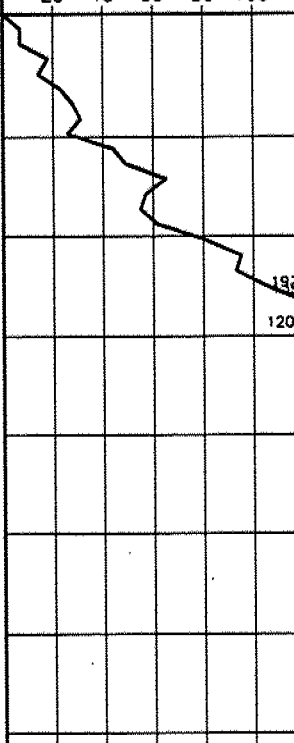


# RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA. 09 + 985 O/S 6.0m RT. CL. VICTORIA ROAD ORIGINATED BY \_\_\_\_\_  
 DIST 2 HWY 401 BOREHOLE TYPE BW CASING & CONE TEST COMPILED BY H.S.  
 DATUM GEODETIC DATE 1958 07 17 CHECKED BY A.L.

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						SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	WATER CONTENT (%)			
270.5	Ground Level						20 40 60 80 100										
0.0	Silt, Some Sand And Clay, Dense to Very Dense		1	TO	35	*		10 20 30			21.9						
			2	TO	41												
			3	TO	67											21.2	
			4	TO	54											24.0	
261.1	Sand, Some Silt And Gravel, Dense		5	TO	39												
9.4			6	SS	37												
			7	SS	45												
256.5	Sand And Silt, Some Clay And Gravel, Very Dense, (Till)		8	SS	70												
14.0																	
255.6											23.5						
14.9	End of Borehole																
	• Water Level Not Established																

# RECORD OF BOREHOLE No 101

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 9 + 958 O/S 2.6m RT. CL. VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 FEB 07 TO 90 FEB 09 CHECKED BY D.T.

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	60	80	100					
277.1	Asphalt Surface																
0.0	100 mm Asphalt																
275.7	Sand With Gravel, Some Silt Compact, (Fill)																
1.4			1	SS	25												
			2	SS	12												
	Layers of Clayey Silt and Sandy Silt, Some Gravel, Stiff/Compact (Fill)		3	SS	19												
			4	SS	27												
270.0			5	SS	29												
7.1			6	SS	39												
			7	SS	44												
	Silt Some Clay, Trace of Sand, Dense to Very Dense		8	SS	41												
			9	SS	46												
			10	SS	69												
			11	SS	52												
			12	SS	36												
263.5																	
13.6			13	SS	54												
			14	SS	27												
	Sand, Some Gravel, Trace of Silt, Dense to Very Dense		15	SS	51												
			16	SS	63												
			17	SS	49												
255.9																	
21.2			18	SS	85												
	Sand And Silt, Some Clay, Trace of Gravel, Very Dense (Glacial Till)		19	SS	89												
252.3			20	SS	100												
24.8	End of Borehole																

# RECORD OF BOREHOLE No 102

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 9 + 974 O/S 3.0m LT. CL. VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT AUGER (H.S.) & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 FEB 20 TO 90 FEB 21 CHECKED BY D.T.

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					
277.3	Asphalt Surface																
0.0	100 mm Asphalt																
	Sand With Gravel, Some Silt And Cobbles, Dense (Fill)		1	SS	42		276										
			2	SS	47		274										
			3	SS	60		272										
270.8			4	SS	44												
6.5	Silt With Sand, Some Clay, Trace of Sand And Organics, Compact		5	SS	16		270										
269.8			6	SS	19												
7.5	Silt, Some Clay And Sand, Compact to Dense		7	SS	27												
			8	SS	27		268										0 0 87 13
			9	SS	31												
			10	SS	30												
			11	SS	43		266										
			12	SS	35												
	Silty Clay Very Stiff		13	SS	20		264										0 0 (100)
262.2																	
15.1	Sand, Some Silt And Gravel, Dense to Very Dense		14	SS	48		262										
			15	SS	116		260										
			16	SS	60		258										2 88 (10)
			17	SS	58												
256.4							256										4 27 (69)
20.9	Sand And Silt, Some Clay And Gravel, Very Dense (Glacial Till)		18	SS	130												
			19	SS	126		254										
254.0																	
23.3	End of Borehole																

# RECORD OF BOREHOLE No 103

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 10 + 025 O/S 2.7m RT. CL. VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONTINUOUS FLIGHT AUGER (H.S.) & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 FEB 16 TO 90 FEB 20 CHECKED BY D.T.

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	80	100					
277.4	Asphalt Surface																
0.0	100 mm Asphalt		1	SS	26	*	276										
			2	SS	30												
	Sand With Gravel, Some Silt and Cobbles, Compact to Dense (Fill)		3	SS	40		274										
			4	SS	42		272										
			5	SS	74		270										
269.9			6	SS	16												
7.5	Silt And Sand, Some Clay, Trace of Gravel And Organics, Compact		7	SS	21		268										
268.4			8	SS	50		266										
9.0	Silt, Some Clay, Trace of Sand, Dense to Very Dense		9	SS	41												
			10	SS	35		264										
			11	SS	35												
			12	SS	49												
			13	SS	67												
			14	SS	61		262										
	Silty Clay Very Stiff to Hard		15	SS	30		260										
260.5			16	SS	63		258										
16.9	Sand, Some Silt And Gravel, Dense to Very Dense		17	SS	77												
			18	SS	43		256										
256.2			19	SS	134		254										
21.2	Sand And Silt, Some Clay, Trace of Gravel, Dense to Very Dense (Glacial Till)		20	SS	70												
			21	SS	73		252										
			22	SS	127												
249.5			23	SS	112		250										
27.9	End of Borehole • Water Level Not Established																

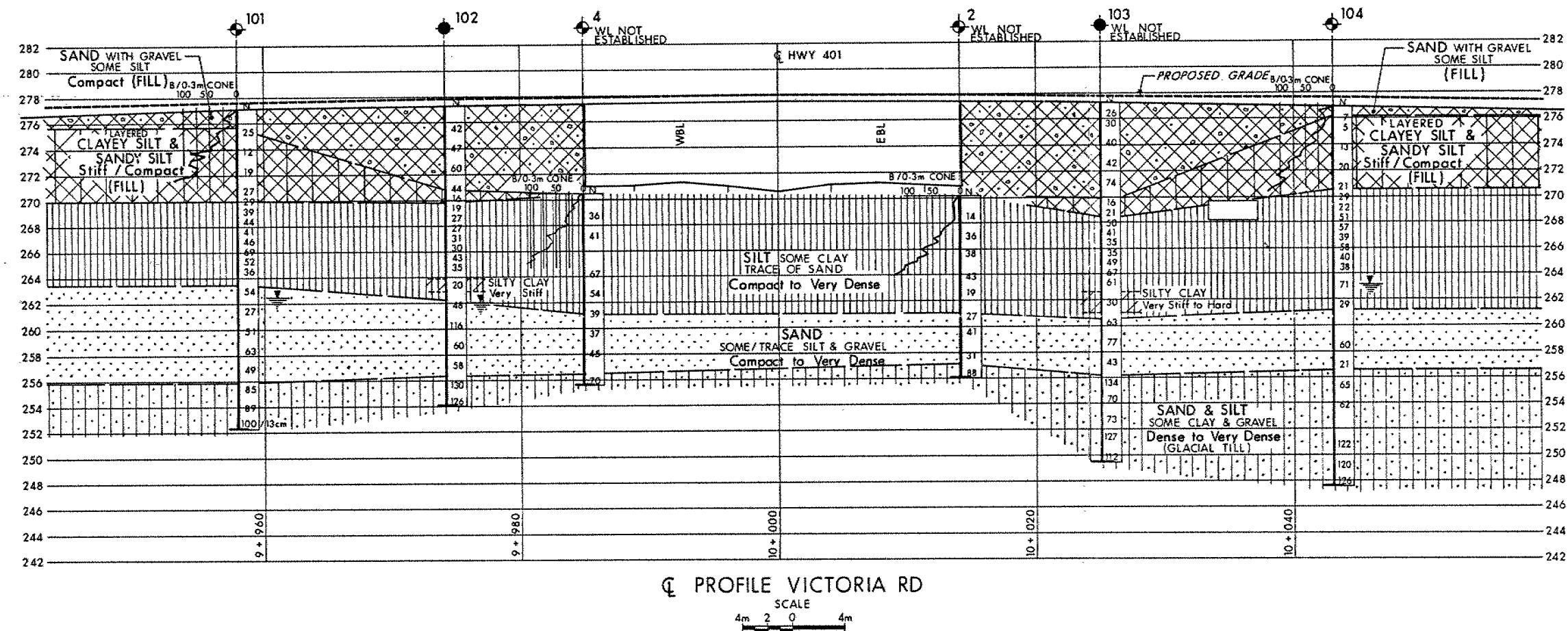
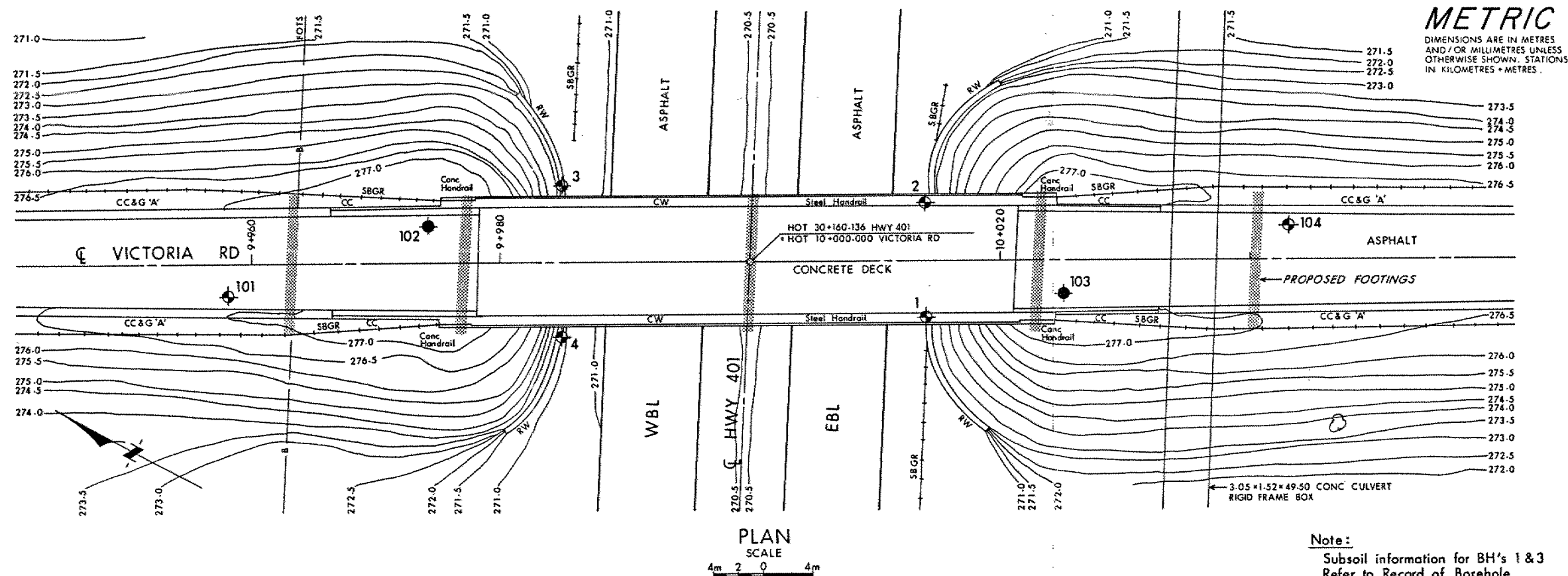
# RECORD OF BOREHOLE No 104

1 OF 1

METRIC

W.P. WP - 58 - 85 - 03 LOCATION STA 10 + 043 O/S 2.6m I.T. CL. VICTORIA ROAD ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & BW CASING COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 FEB 09 TO 90 FEB 14 CHECKED BY D.T.

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 60 80 100	20 40 60 80 100					
277.0	Asphalt Surface													
0.0 276.1	Sand With Gravel, Some Silt (Fill)													
0.9	Layers of Clayey Silt and Sandy Silt, Some Gravel, Firm to Very Stiff/Loose to Compact		1	SS	7		276							
			2	SS	5		274							
			3	SS	13		272							
			4	SS	20		270							
270.5	Silt, Some Clay, Trace of Sand, Compact to Very Dense		5	SS	21		268							
6.5			6	SS	29		266							
			7	SS	22		264							
			8	SS	51		262							
			9	SS	57		260							
			10	SS	39		258							
			11	SS	58		256							
			12	SS	40		254							
			13	SS	38		252							
			14	SS	71		250							
261.2	Sand, Some Silt And Gravel, Compact to Very Dense		15	SS	29		248							
15.8			16	SS	60		246							
			17	SS	21		244							
			18	SS	65		242							
256.6	Sand And Silt, Some Clay And Gravel, Very Dense (Glacial Till)		19	SS	62		240							
20.4			20	SS	122		238							
			21	SS	120		236							
			22	SS	126		234							
247.6	End of Borehole						248							
29.4														



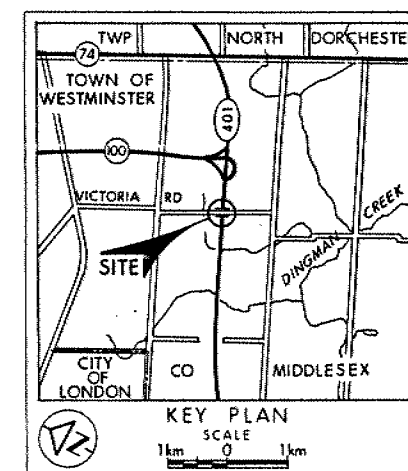
CONT No  
WP No 58-85-03

VICTORIA RD





BORE HOLE LOCATIONS &amp; SOIL STRATA



SHEET



LEGEND

- |   |                                      |
|---|--------------------------------------|
|  | Bore Hole                            |
|  | Dynamic Cone Penetration Test {Cone} |
|  | Bore Hole & Cone                     |
| N   | Blows/0.3m (Std PenTest, 475 J/blow) |
| CONE  | Blows/0.3m (60° Cone, 475 J/blow)    |
|  | WL at time of investigation          |
|   | 58 07 and 90 02                      |

No	ELEVATION	STATION	OFFSET
1	270.0	10 + 014	4.6 m R
2	270.2	10 + 014	4.6 m L
3	270.5	9 + 985	6.0 m L
4	270.5	9 + 985	6.0 m R
101	277.1	9 + 958	2.6 m R
102	277.3	9 + 974	3.0 m L
103	277.4	10 + 025	2.7 m R
104	277.0	10 + 043	2.6 m L

**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 40114-117

HWY No 401			DIST 2	
SUBMWD MV	CHECKED	DATE 90 03 06	SITE 19-374	
DRAWN DT	CHECKED	APPROVED	DWG 58 8503-A	