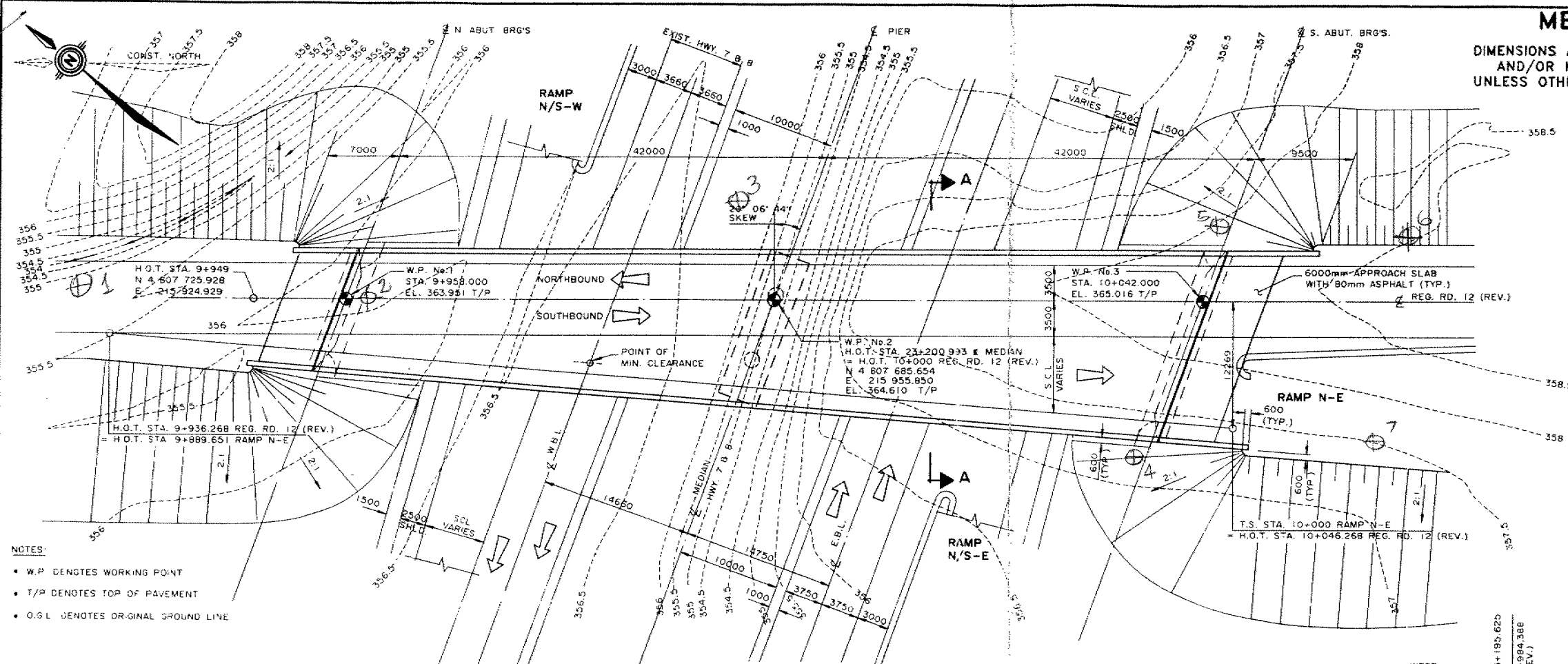


G.I.-30 SEPT. 1976

GEOCRES No. 40P7-56DIST. 3 REGION W.P. No. 161-88-01CONT. No. 94-12W. O. No. STR. SITE No. 33-359HWY. No. 7 & 8LOCATION Hwy 7 & 8 / Reg. Rd. 12
MudspansNo. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:



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

totten sims hubicki associates
 ENGINEERS, ARCHITECTS AND PLANNERS

GENERAL NOTES

CLASS OF CONCRETE

- DECK AND PIER COLUMNS 35MPa
- REMAINDER 30MPa

CLEAR COVER TO REINFORCING STEEL

- FOOTINGS 100 ±25mm
- ABUTMENTS, WINGWALLS
 FRONT FACE 80 ±20mm
 BACK FACE 70 ±20mm
- PIER COLUMNS 80 ±20mm
- DECK
 TOP SLAB TOP 70 ±20mm
 TOP SLAB BOTTOM 40 ±10mm
 BOTTOM SLAB TOP 40 ±10mm
 BOTTOM SLAB BOTTOM 50 ±10mm
 WEBS 60 ±10mm
- REMAINDER 70 ±20mm

REINFORCING STEEL

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

CONSTRUCTION NOTES

- IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN IN THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT

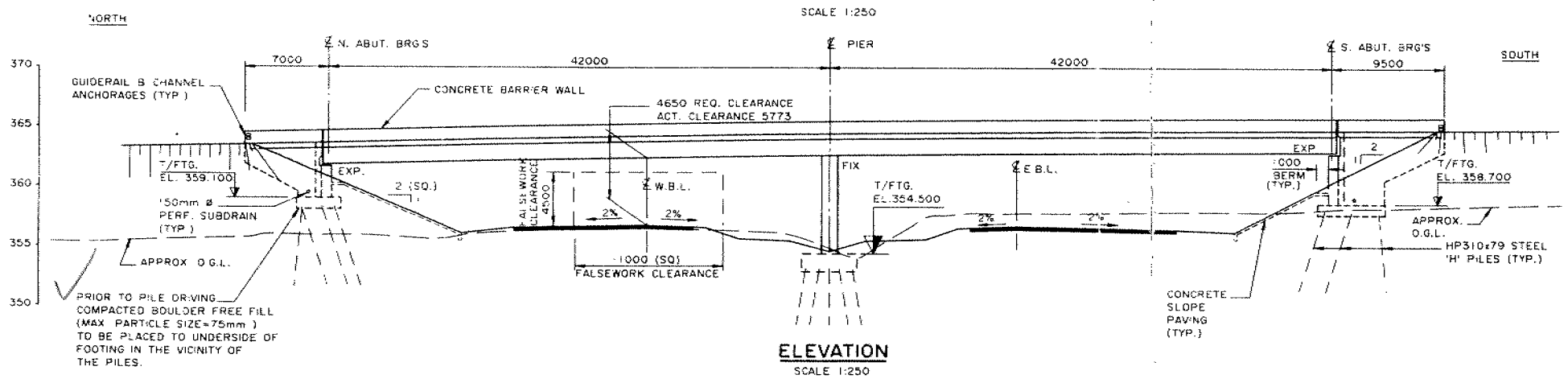
LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATION & SOIL STRATA
3. FOOTING LAYOUT
4. FOOTING REINFORCING
5. NORTH ABUTMENT
6. SOUTH ABUTMENT
7. N.W. & N.E. WINGWALLS
8. S.W. & S.E. WINGWALLS
9. PIER DETAILS
10. DECK DETAILS
11. LONGITUDINAL TENDONS I
12. LONGITUDINAL TENDONS II
13. TRANSVERSE TENDONS
14. DECK REINFORCING I
15. DECK REINFORCING II
16. DECK REINFORCING III
17. DECK REINFORCING IV
18. DECK REINFORCING V
19. BARRIER WALL
20. JOINT ANCHORAGE & ARMOURING
21. 6000mm APPROACH SLAB
22. DETAILS OF CONCRETE SLOPE PAVING
23. PILE DRIVING - STEAM & DIESEL HAMMERS
24. STANDARDS I
25. STANDARDS II
26. AS CONSTRUCTED ELEV. & DIM.
27. QUANTITIES - STRUCTURE I
28. QUANTITIES - STRUCTURE II

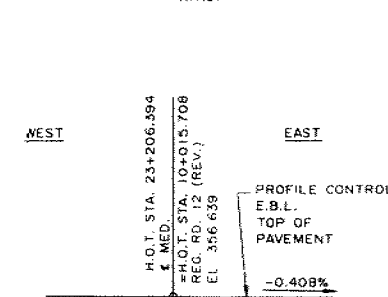


APPLICABLE STANDARD DRAWINGS

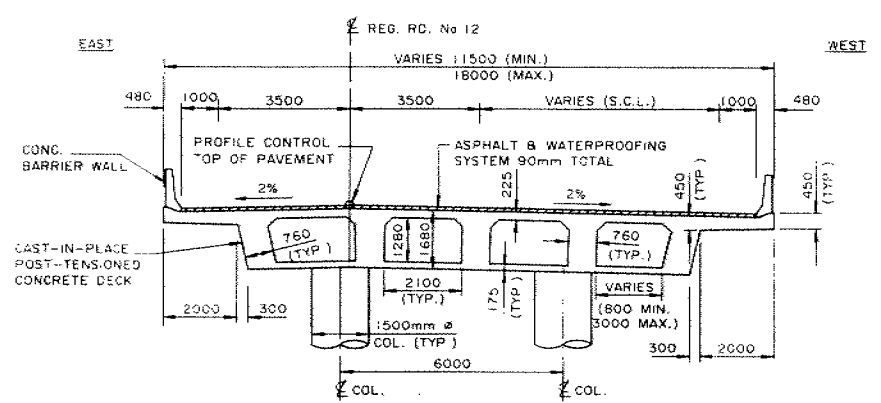
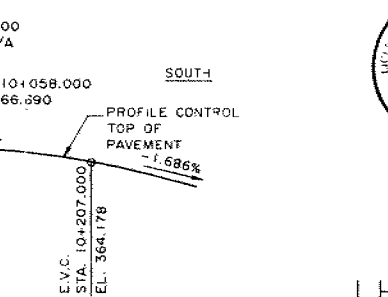
- DD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS
- DD-4602 FALSEWORK CLEARANCE



PROFILE ALONG E
EXIST. W.B.L. HWY. 7 & 8
 N.T.S.



PROFILE ALONG E
E.B.L. HWY. 7 & 8
 N.T.S.



PROFILE ALONG E REG. RD. No.12
 N.T.S.



DRAWING NOT TO BE SCALED
 100 mm ON ORIGINAL DRAWING

B.M.
EL. 354.955
 GEODETIC DATUM
 TOP OF RIB
 43.1m LT 23+324.9

REVISIONS	DATE	BY	DESCRIPTION

CT 康 康 康 康

STAFF

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 94-12



Ministry of
Transportation

Ontario

INDEX

<u>Page No:</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3 - 91	Foundation Investigation Report for Regional Road 12 Underpass W.P. 161-88-01, Site 33-359 Hwy. 7 & 8, District 2/3, London Township Road 16 Underpass W.P. 162-88-01, Site 33-360 Hwy. 7 & 8, District 2/3, London Regional Road 51 W.P. 163-88-01/02, Site 33-361E/W Hwy. 7 & 8, District 2/3, 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

2

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 68.5kg, 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 1" 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/0.3 m)	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

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c 1	COMPRESSION INDEX
C_s 1	SWELLING INDEX
C_a 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
σ'_{vo} kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p kPa	PRECONSOLIDATION PRESSURE
τ_f kPa	SHEAR STRENGTH
c' kPa	EFFECTIVE COHESION INTERCEPT
ϕ' °	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u kPa	APPARENT COHESION INTERCEPT
ϕ_u °	APPARENT ANGLE OF INTERNAL FRICTION
τ_R kPa	RESIDUAL SHEAR STRENGTH
τ_r kPa	REMOULDED SHEAR STRENGTH
S_f 1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s kg/m ³	DENSITY OF SOLID PARTICLES	e 1, %	VOID RATIO	e_{min} 1, %	VOID RATIO IN DENSEST STATE
γ_s kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n 1, %	POROSITY	I_D 1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w kg/m ³	DENSITY OF WATER	w 1, %	WATER CONTENT	D mm	GRAIN DIAMETER
γ_w kN/m ³	UNIT WEIGHT OF WATER	S_r %	DEGREE OF SATURATION	D_n mm	n PERCENT - DIAMETER
ρ kg/m ³	DENSITY OF SOIL	w_L %	LIQUID LIMIT	C_u 1	UNIFORMITY COEFFICIENT
γ kN/m ³	UNIT WEIGHT OF SOIL	w_p %	PLASTIC LIMIT	h m	HYDRAULIC HEAD OR POTENTIAL
ρ_d kg/m ³	DENSITY OF DRY SOIL	w_s %	SHRINKAGE LIMIT	q m ³ /s	RATE OF DISCHARGE
γ_d kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p %	PLASTICITY INDEX = $w_L - w_p$	v m/s	DISCHARGE VELOCITY
ρ_{sat} kg/m ³	DENSITY OF SATURATED SOIL	I_L 1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i 1	HYDRAULIC GRADIENT
γ_{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
ρ' kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max} 1, %	VOID RATIO IN LOOSEST STATE	j kN/m ³	SEEPAGE FORCE
γ' kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL				

For

Regional Road 12 Underpass

W.P. 161-88-01, Site 33-359

Hwy. 7 & 8, District 3, Stratford

INTRODUCTION

This report contains the results of a soils investigation carried out at the above mentioned site to provide information for the design and construction of the proposed underpass.

The field work for this project was carried out between 90 12 14 and 91 01 16, and comprised of seven sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 29.4 (elevation 327.7 m) below the existing ground level using a continuous flight-hollow stem auger and BW casing.

SITE DESCRIPTION

The site under investigation is located approximately 40 m east of the present intersection of Hwy. 7 & 8 and Regional Road 12 in the Regional Municipality of Waterloo.

The topography of the site is generally undulating with isolated knolls. Physiographically the area is located in the Region known as the "Waterloo Hills". The surface is composed of sandy hills, some of these being ridges of sandy till while others are kames and kame moraines with outwash sands occupying the intervening hollows.

SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of stratified sandy silt to silty sand deposit interbedded with very stiff to hard clayey silt at various depths. For classification purposes, the soils encountered at this site can be divided into three different zones.

- a) Sandy Silt to Silty Sand
- b) Clayey Silt to Silty Clay
- c) Silty Sand, some 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. 1618801-A.* This drawing also shows the locations and elevations of the borings. Description of the strata encountered at this site are given below.

Sandy Silt to Silty Sand

This sandy silt to silty sand deposit was encountered immediately below the topsoil and in some boreholes it was encountered immediately below the fill. The thickness of this deposit varies from 3.0 m to a maximum of 16.8 m within the area where this layer was fully penetrated. In this deposit, occasional silt and clayey silt seams were also encountered at various depths. The Grain Size Distribution Test results are shown on Figure 1 in an envelope form. The gradation analyses indicate that this deposit is predominantly composed of sand and silt and the composition varies over a wide range (sand 22% to 92% and silt 8% to 78%). This deposit on the south side of Hwy. 7 and 8 was observed to be loose to compact ('N' values 4 blows/0.3 m to 26 blows/0.3 m) up to a depth of about 2.0 m to 8.0 m, whereas on the north side, it was observed to be compact to dense. Below these depths, this deposit was observed to be dense to very dense state of compaction.

Clayey Silt to Silty Clay

This clayey deposit was intercepted twice in majority of the boreholes and the thickness varies from 1.3 m to a maximum of 6.9 m within the area where this layer was fully penetrated. The natural moisture content was observed to vary from 11% to 20.5% with an average value of 16.6%. The Atterberg Limits determined for the representative soil samples of this deposit are

* Drawing No 2 of the Contract Drawings.

shown on Figure 2. The consistency of this stratum was observed to be very stiff to hard, however, the Standard Penetration test results were observed to vary very widely ('N' Values 17 blows/0.3 m to over 100 blows/0.3 m).

Silty Sand, some Gravel

In majority of the boreholes, this granular deposit was encountered immediately below the clayey silt to silty clay layer and in some boreholes, it was encountered twice. The thickness of this deposit varies from as low as 0.9 m to a maximum of 7.7 m. The Grain Size Distribution test results are shown on Figure 3 in an envelope form. The Standard Penetration Test results vary over a wide range ('N' values 23 blows/0.3 m to over 100 blows/0.3 m).

Groundwater Conditions

The groundwater level was encountered in all the boreholes, and was observed between 4.3 m and 7.5 m (elevation 352.2 and elevation 347.8 m) below the existing ground level. The groundwater level at each borehole location is as follows.

<u>BH. No.</u>	<u>Elevation</u>
1	347.8
2	350.4
3	352.0
4	351.7
5	351.2
6	352.2
7	350.6

MISCELLANEOUS

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



M. Vasavithasan

M. Vasavithasan, P. Eng.
Foundation Engineer

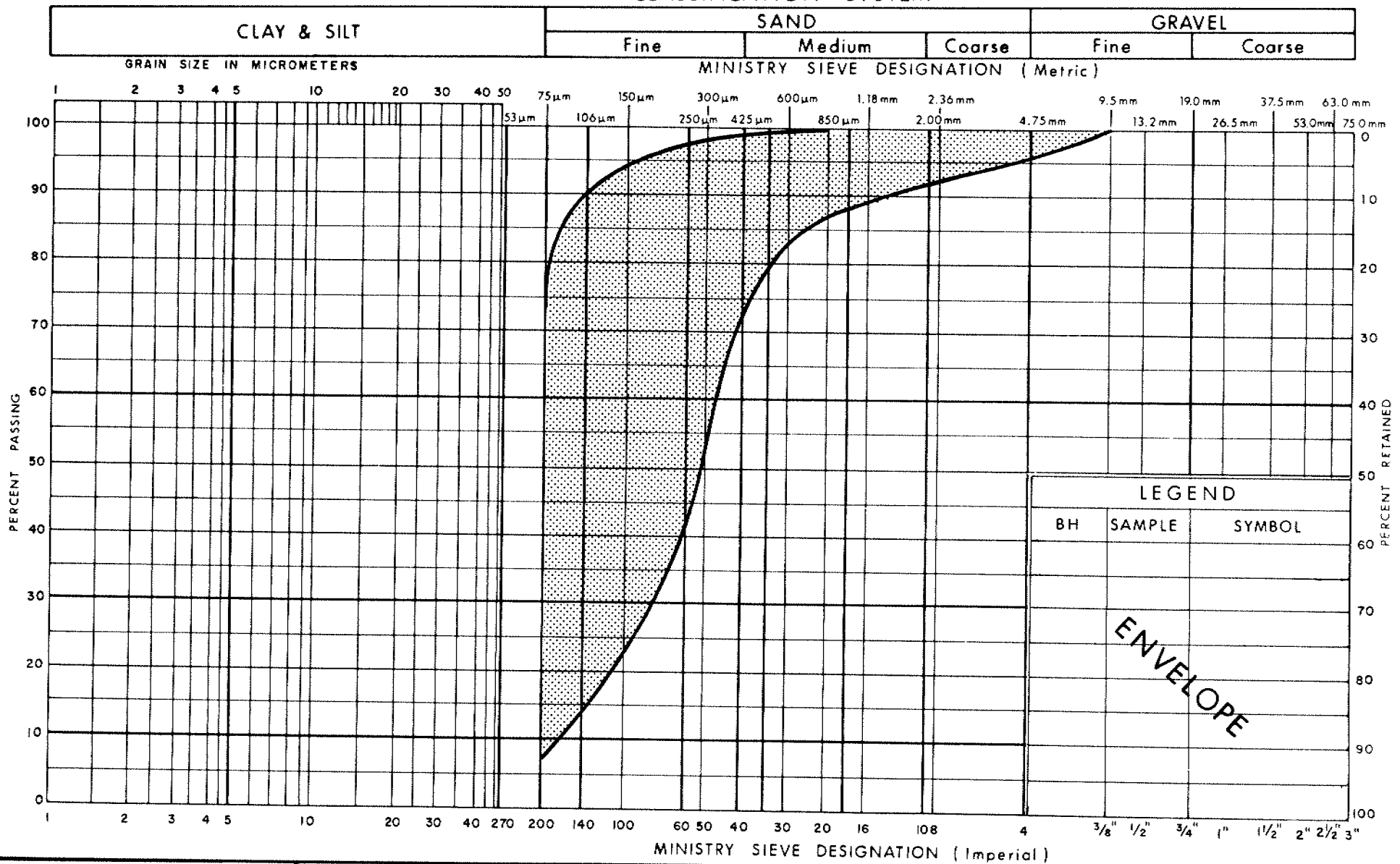


D. Dundas

D. Dundas, P. Eng.
Chief Foundation Engineer
(Acting)

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



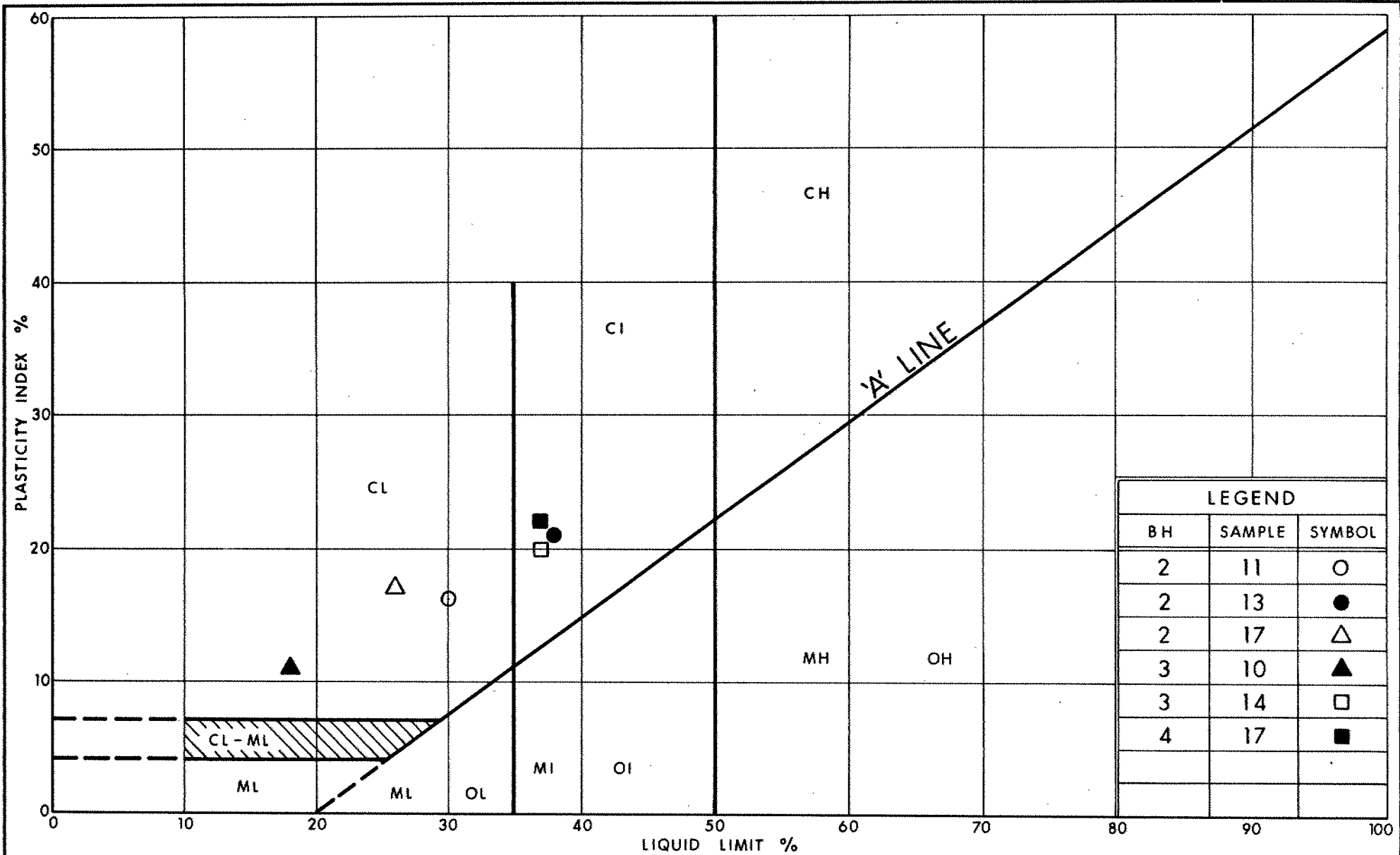
Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND

FIG No 1

W P 161-88-01



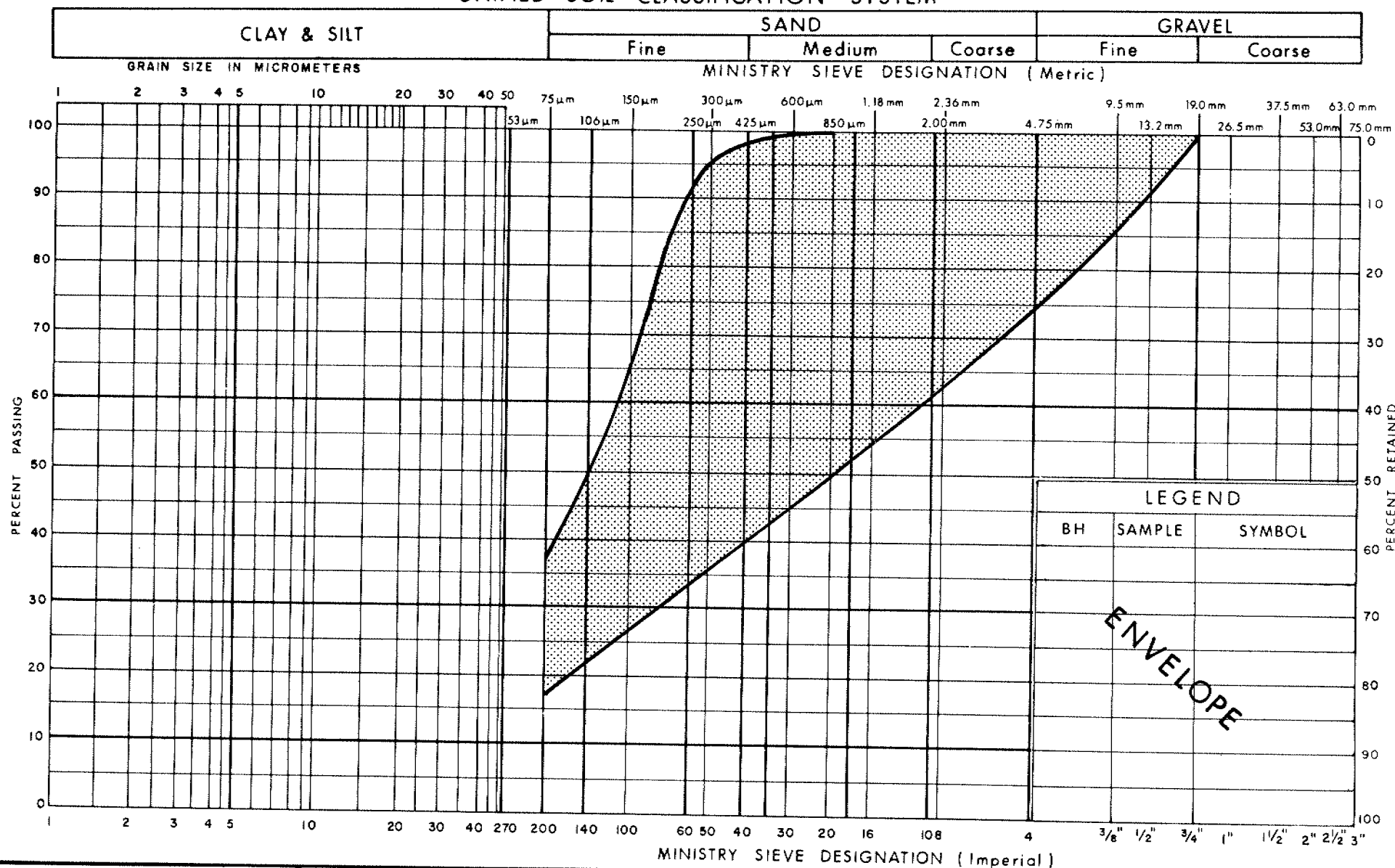
Ministry of
Transportation

PLASTICITY CHART CLAYEY SILT TO SILTY CLAY

FIG No 2

W P 161-88-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

SILTY SAND, SOME GRAVEL

FIG No 3

W P 161-88-01

RECORD OF BOREHOLE No 1 1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 740.0; E 215 915.6 ORIGINATED BY M V
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W CASING COMPILED BY M V
 DATUM GEODETIC DATE 91 01 09 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
355.3	E - N Ramp Shoulder													
352.8	SAND and GRAVEL, Some Silt (F.H.)													
0.7	SANDY SILT to SILTY SAND, Compact to Dense		1	SS	30									
			2	SS	17									
			3	SS	28									
			4	SS	37									
351.6	CLAYEY SILT, With Occasional Sand Seams, Very Stiff to Hard		5	SS	22									
3.7			6	SS	33									
			7	SS	33									
			8	SS	23									
348.1	SILTY SAND, With Occasional Silt Seams Compact to Dense		9	SS	56									
7.2			10	SS	28									
			11	SS	37									
			12	SS	34									
339.6			13	SS	45									
15.7	End of Borehole													

RECORD OF BOREHOLE No 2

1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 717.0; E 215 931.9 ORIGINATED BY M V
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 91 01 10 TO 91 01 14 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	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					
356.1	Ground Surface													
0.0			1	SS	19									0 22 (78)
			2	SS	12									
			3	SS	16									
			4	SS	10									
	SANDY SILT to SILTY SAND, With Occasional Silt Seams, Compact to Dense		5	SS	33									0 76 (24)
			6	SS	25									
			7	SS	29									0 3 (97)
			8	SS	52									
			9	SS	31									
346.7			10	SS	15									
9.4			11	SS	23									
	CLAYEY SILT to SILTY CLAY, With Occasional Sand Seams, Very Stiff to Hard		12	SS	53									
			13	SS	59									
340.7			14	SS	49									
15.4			15	SS	98									28 47 (25)
	Silty Sand With Gravel SILTY SAND, With Occasional Silt Seams, Dense to Very Dense		16	SS	60									
333.0			17	SS	64									
23.1	CLAYEY SILT, With Silt Seam, Hard													
329.7														
26.4	SILT, Trace of Sand, Very Dense													
328.4			18	SS	124	15cm								0 4 (96)
27.7	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

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 694.4; E 215 961.1 ORIGINATED BY M.V.
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M.V.
 DATUM GEODETIC DATE 91 01 14 TO 91 01 16 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	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					
356.3	Hwy. 7 & 8 EBL Shoulder													
0.0	Organics Silt, Trace of Sand		1	SS	12		356							0 5 (95)
			2	SS	13									
			3	SS	10									4 74 (22)
			4	SS	5									
	SANDY SILT to SILTY SAND, Loose to Compact		5	SS	23									
			6	SS	24									
			7	SS	10									
			8	SS	10									
349.1			9	SS	18									0 92 (8)
7.2	CLAYEY SILT		10	SS	46									
347.9	With Occasional Sand Seam, Hard													
8.4			11	SS	23									
	SILTY SAND, Trace of Gravel, Compact to Dense		12	SS	48									
344.8														
11.5			13	SS	107									
			14	SS	133									
	CLAYEY SILT to SILTY CLAY, Hard		15	SS	130									
337.9														
18.4			16	SS	82									
			17	SS	153									
	SILTY SAND, With Occasional Silt Seams, Dense to Very Dense													
			18	SS	37									0 62 (38)
			19	SS	90									
328.4														
			20	SS	108									
27.9	End of Borehole													

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 648.6; E 215 965.2 ORIGINATED BY M V&M.P
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 17 TO 90 12 19 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	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					
357.1	Ground Surface													
0.0	SILTY SAND, some Gravel, Compact, (Fill)		1	SS	26		356							
355.0			2	SS	13									
2.1	SILTY SAND, Some Gravel, Loose to Compact		3	SS	7									
353.4			4	SS	21		354							21 61 (18)
3.7	CLAYEY SILT, With Occasional Silt Seams, Trace of Sand, Stiff to Very Stiff		5	SS	18									0 8 (92)
350.6			6	SS	19		352							
6.5			7	SS	12									
			8	SS	—									
			9	SS	31		350							
			10	SS	39									
			11	SS	40		348							
			12	SS	57									
	SANDY SILT to SILTY SAND, With Occasional Silt and Clayey Silt Seams, Compact to Dense		13	SS	11		346							0 57 (43)
			14	SS	20									
			15	SS	19		344							
			16	SS	79		342							2 24 (74)
			17	SS	124									
337.5			18	SS	115		340							
19.6			19	SS	60		338							
			20	SS	72		336							
327.7							334							
29.4	End of Borehole						332							
							330							
							328							

RECORD OF BOREHOLE No 5

1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 655.9; E 215 987.6 ORIGINATED BY M V&M P
DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W CASING COMPILED BY M V
DATUM GEODETIC DATE 90 12 19 & 90 12 20 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT 7 KN/m ³	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 _P	W	W _L		
358.0	Ground Surface													
0.0	Organics													
	Silt		1	SS	7									
			2	SS	14									
			3	SS	25									
			4	SS	23									
			5	SS	14									
			6	SS	11									
			7	SS	4									
			8	SS	16									
			9	SS	9									
			10	SS	6									
			11	SS	10									
			12	SS	29									
			13	SS	20									
			14	SS	29									
			15	SS	33									
341.2														
16.8	CLAYEY SILT, Trace of Sand,													
339.9	Hard													
18.1			16	SS	79									
	SILTY SAND, Some Gravel,													
	Very Dense													
336.0			17	SS	128									
22.0	CLAYEY SILT,													
	With Occasional Sand and													
	Silt Seams,													
333.2	Hard		18	SS	81									
24.8	End of Borehole													

RECORD OF BOREHOLE No 6

1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 641.0; E 215 997.8 ORIGINATED BY M P
DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 12 14 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
358.6	Ground Surface												
0.0	Organics		1	SS	12		358						
	Silt & Clayey Silt		2	SS	14		356						
			3	SS	22		354						
			4	SS	21		352						
			5	SS	32		350						
			6	SS	8		348						
			7	SS	15		346						
			8	SS	12		344						
			9	SS	26								
			10	SS	9								
			11	SS	17								
			12	SS	10								
342.9			13	SS	18								
15.7	End of Borehole												

RECORD OF BOREHOLE No 7 1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 631.5; E 215 980.4 ORIGINATED BY M V&M P
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 17 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
357.4	Ground Surface												
0.0	SILTY SAND, Loose to Compact, (Fill)	Organics	1	SS	8								
355.3			2	SS	14								
2.1	SILTY SAND, Some Gravel, Dense		3	SS	31								
354.4													
3.0	CLAYEY SILT, Some Sand, Very Stiff		4	SS	17								
			5	SS	21								
			6	SS	24								
351.6			7	SS	26								
5.8	SANDY SILT to SILTY SAND, Loose to Compact		8	SS	15								
			9	SS	15								
			10	SS	8								
346.7													
10.7	End of Borehole												

For

Township Road 16 Underpass
Hwy. 7 & 8, Township of Wilmot
W.P. 162-88-01, Site 33-360
District 3, Stratford

INTRODUCTION

This report contains the results of a soils investigation carried out at the above mentioned site to provide information for the design and construction of the proposed underpass.

The field work for this project was carried out between 90 12 03 and 90 12 13, and comprised of five sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 40.1 m (elevation 323.0 m) below the existing ground level using a continuous flight hollow stem auger and BW casing.

SITE DESCRIPTION

The site under investigation is located approximately 40 m east of the present intersection of Hwy. 7 & 8 and Township Road 16 in the Township of Wilmot.

The topography of the site is generally undulating with isolated knolls. Physiographically the area is located in the Region known as the "Waterloo Hills". The surface is composed of sandy hills, some of these being ridges of sandy till while others are kames and kame moraines with outwash sands occupying the intervening hollows.

SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of stratified silty sand to sandy silt deposit interbedded with dense to very dense sand and gravel and very stiff to hard clayey silt layers. For classification purposes, the soils encountered at this site can be divided into four different zones.

- a) Silty Sand to Sandy Silt
- b) Sand and Gravel, some Silt
- c) Clayey Silt
- d) Silty Sand

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. 1628801-A.* This drawing also shows the locations and elevations of the borings. Description of the strata encountered at this site are given below.

Silty Sand to Sandy Silt

This sandy deposit was encountered in all the boreholes immediately below the topsoil. The thickness of this deposit varies from 14.1 m to 18.1 m and extends to elevation 346.0 m to elevation 343.8 m. The Grain Size Distribution Test results are shown on Figure 1 in an envelope form. The gradation analyses indicate that this deposit is predominantly composed of sand and silt and the composition varies over a wide range (sand 22% to 91% and silt 9% to 78%). The Standard Penetration Test results of this deposit up to a depth of 4 m to 7 m below ground level vary from 2 blows/0.3 m to 28 blows/0.3 m and below this depth, it was observed to be in dense to very dense state of compaction ('N' values 31 blows/0.3 m to 77 blows/0.3 m).

Sand and Gravel, some Silt

This stratum intersect the silty sand to sandy silt deposit at depth varying from 1.3 m to 6.6 m below the existing ground level. The thickness of this stratum varies from a few centimetres to a maximum of 5.2 m within the area where this layer was fully penetrated. The Grain Size Distribution Test results are shown on Figure 2 in an envelope form. The test results indicate that this deposit is predominantly composed of sand and gravel (gravel 33% to 50%, sand 41% to 58%). The Standard Penetration Test results vary over a wide range (17 blows/0.3 m to over 100 blows/0.3 m).

* Drawing No 2 of the Contract Drawings.

Clayey Silt

This clayey deposit was encountered immediately below the silty sand to sandy silt layer at about elevation 346.0 m to elevation 343.8 m. The thickness of this deposit varies from 3.6 m to 7.9 m and extends to elevation 341.0 m to elevation 338.1 m. The natural moisture content was observed to vary from 12% to 17.5% with an average value of 14.4%. The Atterberg Limits determined for the representative soil samples of this deposit are shown on Figure 3. The consistency of this stratum was observed to be very stiff to hard, however, the Standard Penetration Test results were observed to vary very widely ('N' values 17 blows/0.3 m to over 100 blows/0.3 m).

Silty Sand, trace of Gravel

The clayey silt layer is underlain by this silty sand deposit. The Grain Size Distribution Test results are shown on Figure 4 in an envelope form. The Standard Penetration Test results of this deposit vary from 31 blows/0.3 m to 104 blows/0.3 m indicating dense to very dense state of compaction. The full extent of this deposit was not proven, however, this layer extends to the depth probed (i.e. elevation 323.0 m).

Groundwater Conditions

The groundwater level was encountered in all the boreholes, and was observed between 9.6 m and 13.3 m (elevation 353.3 m and 349.8 m) below the existing ground level. The groundwater level at each borehole location is as follows:

<u>BH. No.</u>	<u>Elevation</u>
1	350.6
2	349.8
3	353.3
4	352.6
5	352.8

MISCELLANEOUS

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



M. Vasavithasan

M. Vasavithasan, P. Eng.
Foundation Engineer

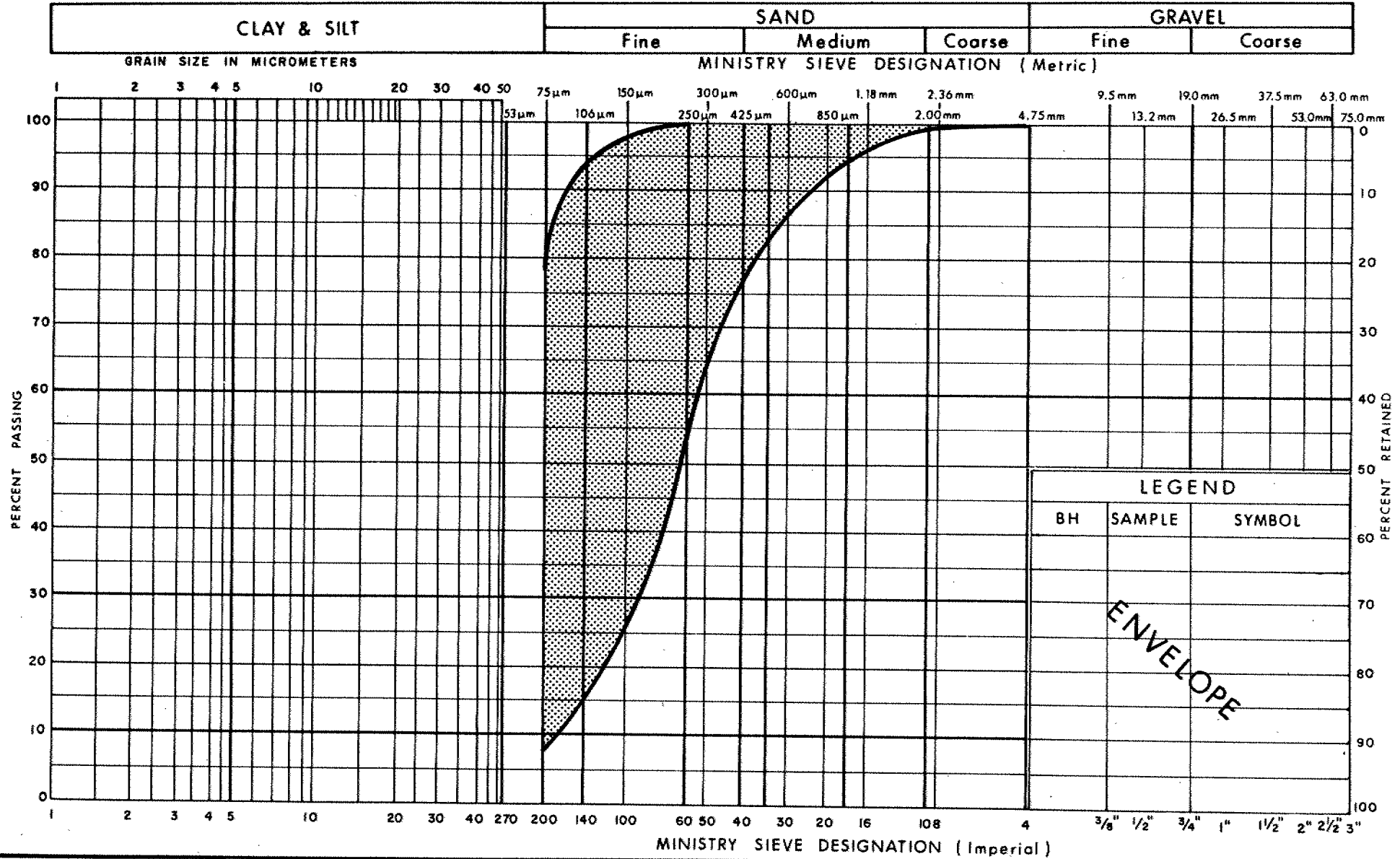


D. Dundas

D. Dundas, P. Eng.
Chief Foundation Engineer
(Acting)

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

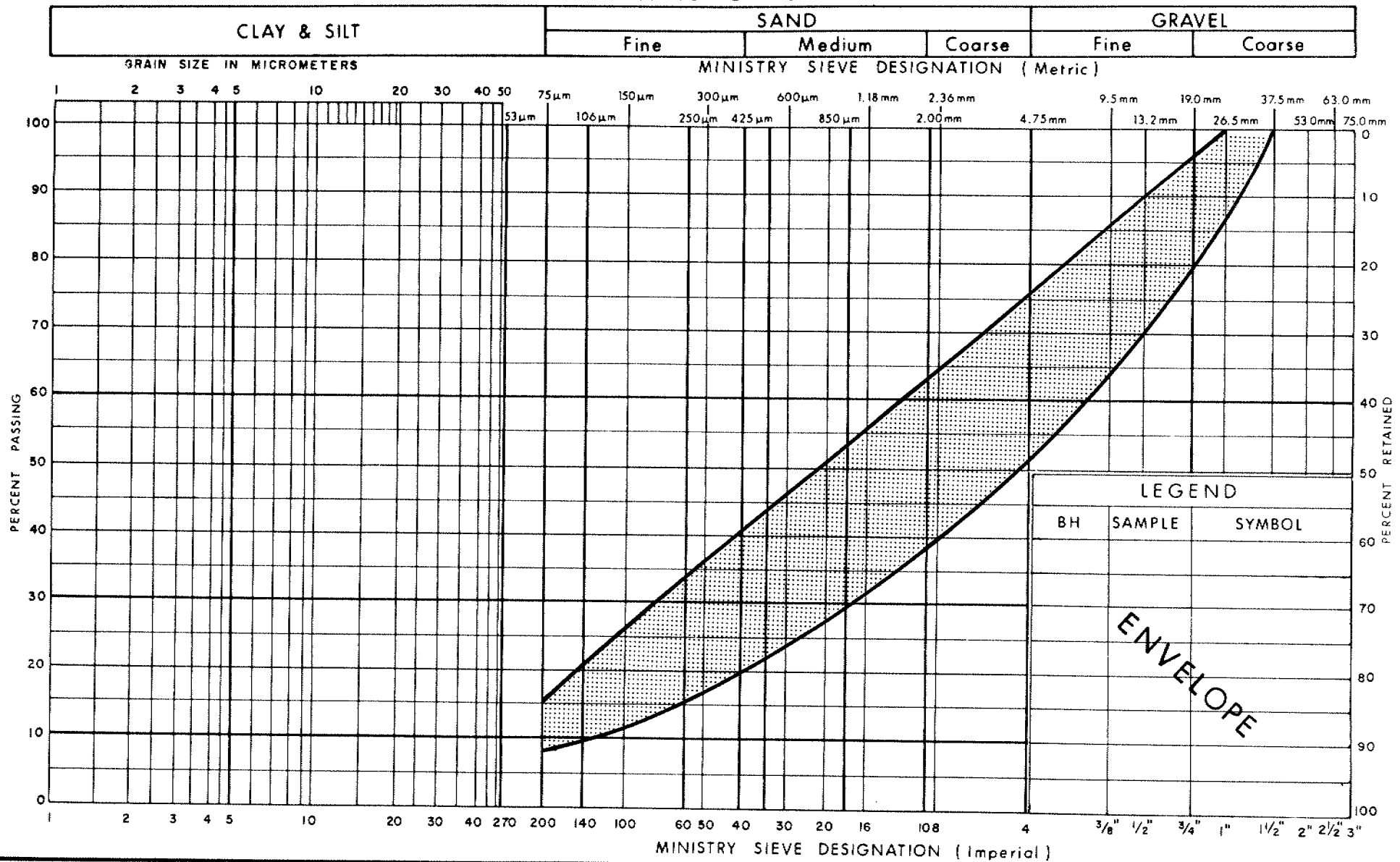
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY SAND TO SANDY SILT

FIG No 1

W P 162-88-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

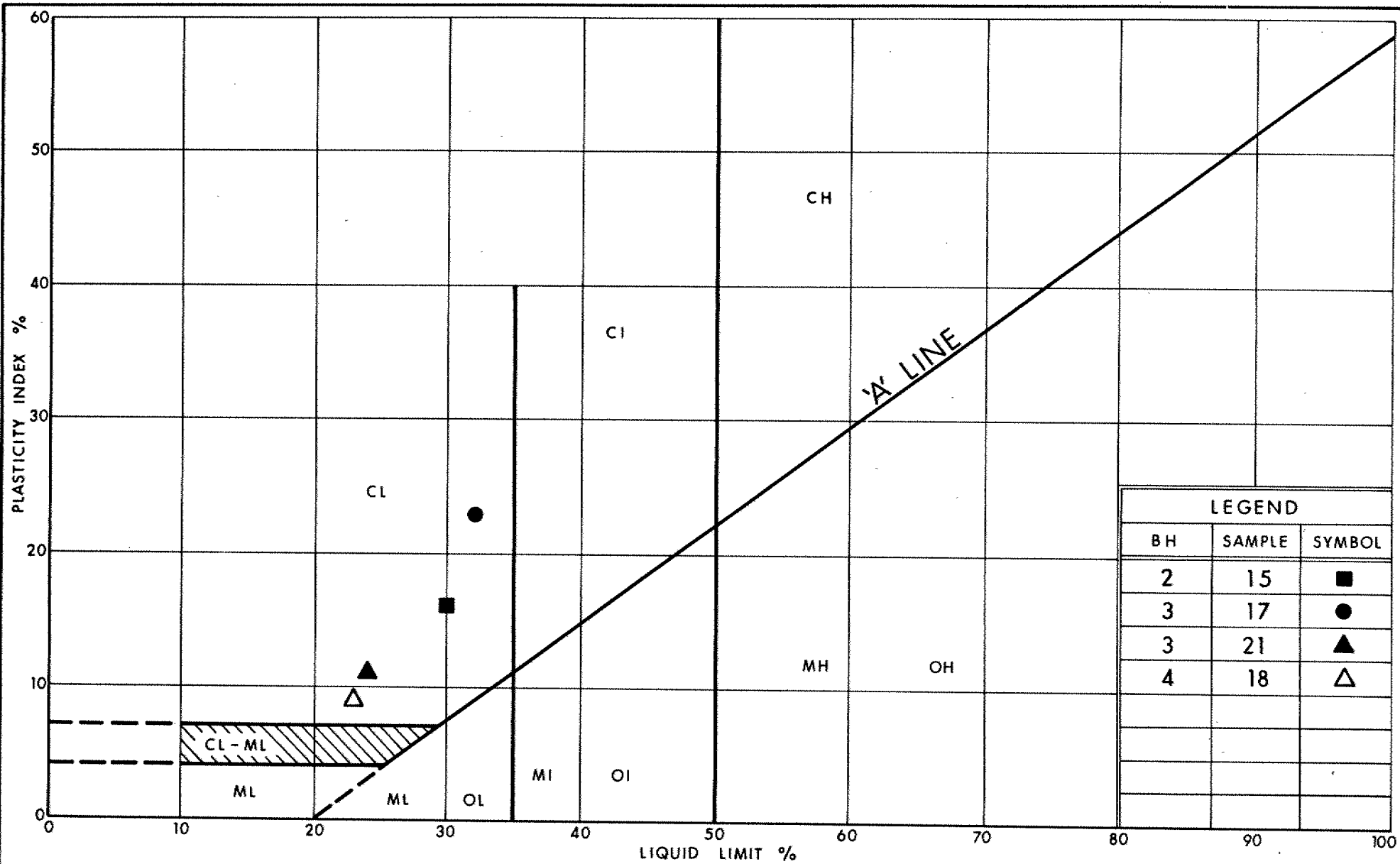
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

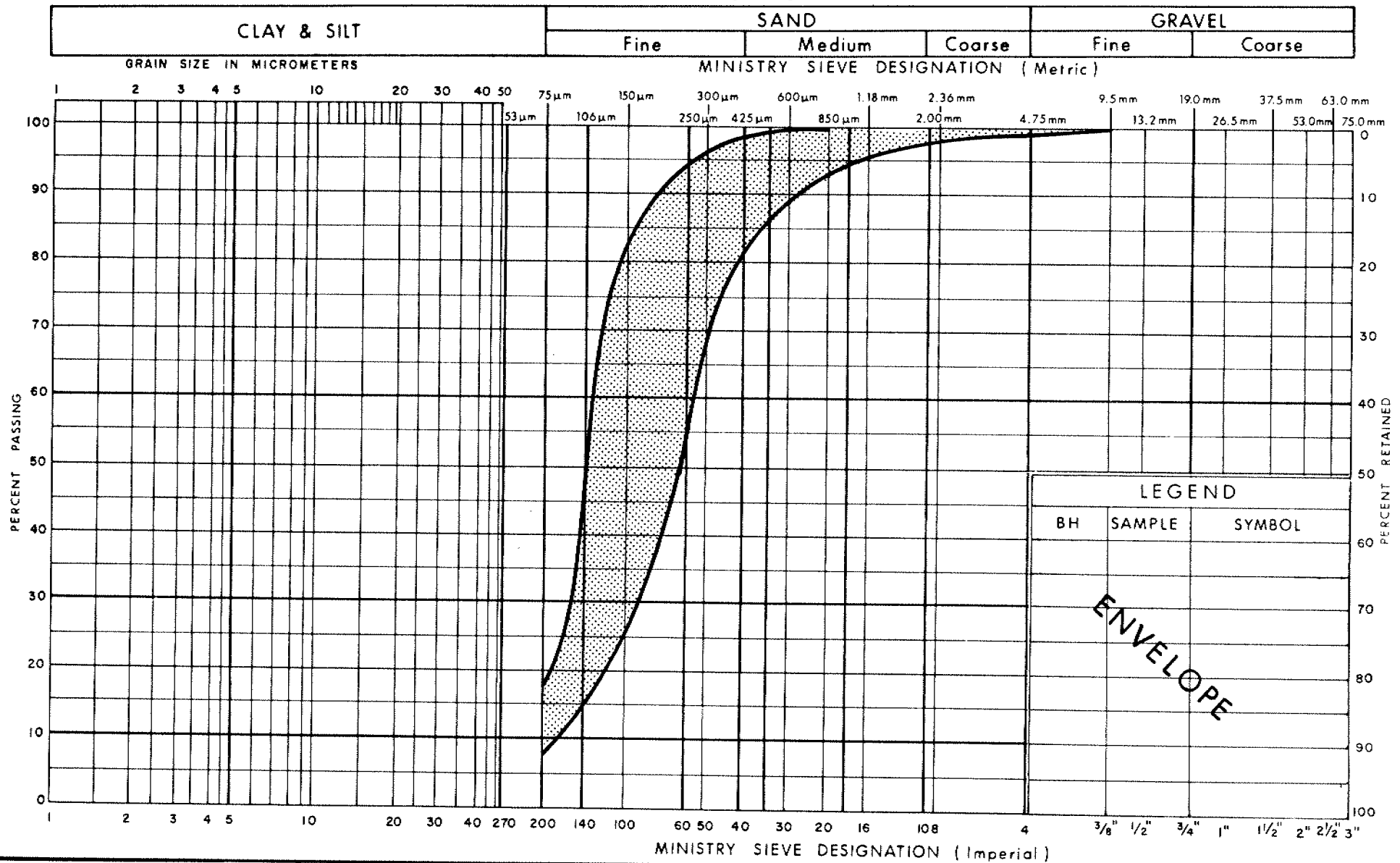
SAND & GRAVEL, SOME SILT

FIG No 2

W P 162 - 88 - 01



UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY SAND, TRACE OF GRAVEL

FIG No 4

W P 162-88-01

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 162 - 88 - 01 LOCATION CO - ORDS. N 4 806 703.8; E 212 489.5 ORIGINATED BY M V
DIST 3 HWY 7 & 8 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
DATUM GEODETIC DATE 90 12 04 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
363.9	Ground Surface												
0.0	Organics		1	SS	25								
			2	SS	7								
	Compact to Very Loose		3	SS	3								
			4	SS	17								
	Sand & Gravel, Some Silt		5	SS	41								
			6	SS	60								
			7	SS	38								
			8	SS	42								
			9	SS	42								
	SILTY SAND to SANDY SILT		10	SS	52								
	Dense to Very Dense		11	SS	60								
			12	SS	60								
348.2			13	SS	54								
15.7	End of Borehole												

RECORD OF BOREHOLE No 2 1 OF 2 METRIC

W.P. 162 - 88 - 01 LOCATION CO - -ORDS. N 4 806 689.3; E 212 496.1 ORIGINATED BY M V
 DIST 3 HWY. HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETTIC DATE 90 12 04 TO 90 12 07 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	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					
363.1	Ground Surface													
0.0	Organics		1	SS	5		362							39 46 (15)
	Loose		2	SS	17									0 86 (14)
	Sand & Gravel, Some Silt		3	SS	10									0 87 (13)
			4	SS	17									
			5	SS	15									
	Compact		6	SS	17									
			7	SS	22									
			8	SS	20									
			9	SS	32									
			10	SS	60									0 84 (16)
			11	SS	48									
			12	SS	42									
	SILTY SAND to SANDY SILT, With Occasional Silt Seams, Dense to Very Dense		13	SS	58									0 22 (78)
			14	SS	49									
344.6			15	SS	53									
18.5	CLAYEY SILT Very Stiff to Hard		16	SS	26									
341.0			17	SS	—									
22.1			18	SS	31									
	SILTY SAND, Trace of Gravel, Dense to Very Dense													
332.6														
30.5														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2 2 OF 2 METRIC

W.P. 162 - 88 - 01 LOCATION CO - -ORDS. N 4 806 689.3; E 212 496.1 ORIGINATED BY M V
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 04 TO 90 12 07 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100
332.6	Continued SILTY SAND, Trace of Gravel, Dense to Very Dense		19	SS	104		332										
30.5																	
			20	SS	37												
			21	SS	79		328										
							326										
323.0			22	SS	57		324										
40.1	End of Borehole																

RECORD OF BOREHOLE No 3 1 OF 1 METRIC

W.P. 162 - 88 - 01 LOCATION CO - ORDS. N 4 806 661.9; E 212 521.3 ORIGINATED BY M V&M P
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M V
 DATUM GEODETIC DATE 90 12 13 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
364.1	Ground Surface											
0.0	Organics											
	SILTY SAND, Some Gravel, Compact to Dense		1	SS	26							
			2	SS	28							
361.4			3	SS	34							
2.7	SILTY SAND to SANDY SILT, Compact		4	SS	15							
			5	SS	15							
			6	SS	18							
358.2			7	SS	21							
5.9	SAND and GRAVEL, Some Silt, Dense		8	SS	54							
			9	SS	48							
355.9			10	SS	44							
8.2			11	SS	22							
			12	SS	26							
			13	SS	31							
			14	SS	40							
	SILTY SAND to SANDY SILT, Compact to Very Dense		15	SS	77							
			16	SS	74							
346.0			17	SS	37							
18.1			18	SS	40							
			19	SS	34							
	CLAYEY SILT, Very Stiff to Hard		20	SS	18							
			21	SS	115							
338.1			22	SS	73							
337.7	SILTY SAND, Tr. Gravel, Very Dense											
25.4	End of Borehole											

RECORD OF BOREHOLE No 4 1 OF 2 METRIC

W.P. 162 - 88 - 01 LOCATION CO - ORDS. N 4 806 634.8; E 212 542.3 ORIGINATED BY M V
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 10 TO 90 12 12 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIMIT MOISTURE CONTENT LIMIT		UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						W _p W W _L	WATER CONTENT (%) 10 20 30	
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100								
363.5	Ground Surface															
0.0	Organics		1	SS	15		362									
			2	SS	10											
	SILTY SAND to SANDY SILT, Compact		3	SS	14		360						0 39 (61)			
			4	SS	15											
			5	SS	19											
			6	SS	23											
357.5			7	SS	27		358									
6.0			8	SS	34											
	SAND and GRAVEL, Some Silt, Dense to Very Dense		9	SS	33											
			10	SS	42		356									
			11	SS	144		354						50 41 (9)			
352.3			12	SS	29		352									
11.2			13	SS	41											
			14	SS	44		350									
	SILTY SAND to SANDY SILT, Dense to Very Dense		15	SS	55		348									
			16	SS	47		346						0 22 (78)			
343.8			17	SS	17		344									
19.7	CLAYEY SILT, With Occasional Sand Seams, Very Stiff to Hard		18	SS	34		342									
338.4							340									
25.1			19	SS	—		338									
	SILTY SAND, Trace of Gravel, Very Dense						336									
333.0							334									

30.5

Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 4 2 OF 2 METRIC

W.P. 162 - 88 - 01 LOCATION CO - ORDS. N 4 806 634.8; E 212 542.3 ORIGINATED BY M V
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 10 TO 90 12 12 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 ³	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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) 10 20 30 W _p W W _L			
333.0	Continued		20	SS	63											
30.5	SILTY SAND, Trace of Gravel, Very Dense						332									1 83 (16)
328.0			21	SS	74		330									
35.5	End of Borehole															

RECORD OF BOREHOLE No 5

1 OF 1 METRIC

W.P. 162 - 88 - 01 LOCATION CO - ORDS. N 4 806 619.6; E 212 554.1 ORIGINATED BY M.V.
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S) COMPILED BY M.V.
 DATUM GEODETIC DATE 90 12 10 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
362.4	Ground Surface												
0.0	Organics												
	Very Loose to Loose		1	SS	7								
			2	SS	2								
	Silty Sand, With Gravel		3	SS	25								
			4	SS	17								
	SILTY SAND to SANDY SILT, Compact		5	SS	13								
356.8			6	SS	17								
5.6			7	SS	36								
	SAND and GRAVEL, Some Silt, Dense to Very Dense		8	SS	54								
			9	SS	31								
			10	SS	29								
351.7													
10.7	End of Borehole												
350.5													
11.9	End of Cone Test												

FOUNDATION INVESTIGATION REPORT
FOR
HIGHWAYS 7 & 8 OVERPASS AT REGIONAL ROAD 51
SITES 33-361E AND 33-361W
W.P. 163-88-01 AND 163-88-02
DISTRICT 3
SOUTHWESTERN REGION, LONDON

1.0 INTRODUCTION

This report presents the results of a geotechnical investigation for the proposed Highway 7 and 8 overpass at Regional Road 51, near New Hamburg, Ontario. The investigation was carried out for the Ministry of Transportation, in order to provide geotechnical input for the design of the structures and related earth works.

The fieldwork was carried out between 91 01 16 and 91 01 28 under the supervision of an engineer and a technician. The work consisted of putting down eight boreholes and twelve dynamic cone penetration tests. Borings were advanced by hollow stem continuous flight augers to depths ranging between 25 and 33 m.

.../...

2.0 FIELD AND LABORATORY WORK

The boreholes and cone test locations in the field were laid out by Geo-Canada Ltd., with the assistance of preliminary site plans provided by M.T.O. The actual borehole and cone test locations were subsequently surveyed by M.T.O., who also established the borehole and cone test elevations.

In the boreholes, soil samples were taken by the standard penetration test method at 0.76 m intervals of depth within the upper 6 m of the soil strata; below 6 m, the sampling interval was increased to 1.5 m. In soft to firm cohesive soils, in situ vane shear tests were performed in the boreholes to assess the undrained shear strength of the soil, and relatively undisturbed soil samples were also taken by pushing thin walled shelby tube samplers into these cohesive soils.

Piezometers were installed in six boreholes to monitor the groundwater conditions. The piezometers were read daily during the fieldwork, and three additional times in the four week period following completion of the fieldwork.

The soil samples were re-examined and selectively tested in the laboratory. Representative samples were tested for their index properties such as moisture content, grain size distribution and consistency (Atterberg) limits. One dimensional consolidation, unconfined compression and standard Proctor compaction tests were also performed. The test results are summarized on the Records of Boreholes attached to this report, and are plotted on Figures 1 to 10, inclusive.

The enclosed Drawing Nos. 1638801-A* and 1638802-A* show the borehole locations.

* Drawing No 2 of the Contract Drawings.

.../...

3.0 SITE DESCRIPTION

The site is located approximately 60 m to the east of the present intersection of Highways 7 and 8, and Regional Road 51 in the Township of Wilmot, Ontario. It is about 20 km west of Waterloo, and about 2 km east of the Nith River.

The area surrounding the site is a series of rolling hills which gently slope toward the southwest. Just north of the highway, the Baden Hills are a prominent feature. The highway itself slopes down from east to west, crossing a tributary stream of the Nith River, at about 300 m west of Regional Road 51.

Geologically, the site is located near the west limit of the physiographic region known as the Waterloo Hills. These hills are formed of either ridges of sandy till or kame moraines. The moraines were laid down towards the end of the last ice age as the Wisconsin Glacier started to retreat from the area. The intervening low areas between the hills are mostly occupied by outwash sands. The Baden hills to the north of the site are sand and gravel domes about 60 m high. Around the base are areas of outwash sand and numerous kettle lakes and smaller swamps. West of the Waterloo Hills is the Stratford Till Plain, which is a generally flat, poorly drained plain. The dominant soil type in this plain is a clay loam.

4.0 SUBSURFACE CONDITIONS

4.1 General

The general stratigraphy at the site consists of a thick deposit of stratified silt, clayey silt and silty clay, which is underlain by silty clay (till) at depths ranging between 20.6 and 27.2 m. (For brevity and ease of expression, the stratified silt, clayey silt and silty clay deposit will be referred to in this report as the "Silt and Clay" stratum). The silt and clay deposit is firm to very stiff while the underlying silty clay (till) stratum is hard. A relatively thin layer of silty clay with a glacial till structure overlies the silt and clay stratum at three of the borehole locations. In Boreholes 5 to 8, which were drilled through the existing embankment of the highway, a 3.7 to 5.2 m thick sand and silty clay fill was encountered.

At the time of the investigation the groundwater level was high. It was recorded close to the existing ground surface in Boreholes 2 to 4.

Details of the subsurface conditions are presented in the Records of Boreholes attached to this report. In the following paragraphs, the relevant properties of the various soil units are briefly described.

4.2 Sand Fill

Sand fill was encountered in Boreholes 5 to 8 which were drilled through the existing highway embankment. It extends from the ground surface or the underside of the granular road base to depths ranging from 0.6 to 3.7 m.

.../...

The sand is poorly graded and contains a trace to some gravel, and a trace of silt. The grading curves of two samples of the sand fill are shown on Figure 1. These samples contain 3 to 15% gravel, 77 to 86% sand, and 8 to 11% silt and clay. Their moisture contents are 9 to 13%. Traces of organic matter and topsoil are also found in the sand fill.

The standard penetration blow counts ('N'-values) recorded in the sand fill vary from 18 to 62 blows per 0.3 m. The dynamic cone penetration blow counts are between 24 and 50 blows per 0.3 m. These results indicate compact to very dense conditions.

4.3 Clayey Silt Fill

The compaction of the fill materials in Boreholes 5, 6 and 7 changed from sand to clayey silt at 0.6 to 3.0 m depth. The thickness of the clayey silt fill ranges from 1.1 to 4.6 m, resulting in a total fill thickness of 4.1 to 5.2 m at the borehole locations.

The clayey silt fill also contains a trace of sand and gravel, and some organic matter. It has moisture contents of 16 to 18%. A typical sample of the clayey silt fill was found to have a liquid limit of 30%, plastic limit of 18%, and a plasticity index of 12.

SPT 'N'-values ranging from 10 to 35 blows per 0.3 m were recorded in the clayey silt fill, suggesting stiff to hard consistency.

4.4 Upper Silty Clay

A relatively thin layer of silty clay was found at the surface of Boreholes 1 and 3, and underneath the existing fill in Borehole 7. The thickness of this stratum is about 1.4 to 2.6 m.

This is a well-graded soil in which silt and clay are the dominant soil fractions. It also contains some sand and a trace of gravel. 'N'-values of 14 to 33 blows per 0.3 m recorded in this deposit suggest that it is stiff to hard. The embedded gravel in the silty clay give it a till like structure and suggest glacial origin.

A standard Proctor compaction test performed on the silty clay obtained a maximum dry density of 18.7 kN/m^3 at an optimum moisture content of 13.5%.

4.5 Stratified Silt and Clay

This deposit forms the majority of the soil profile in each borehole. It extends from the existing ground surface or the underside of the shallow surficial soils (fill or silty clay) to depths between 20.6 and 27.2 m (El. 318.9 to 322.6 m).

This is a stratified deposit comprised of alternate layers of silt, clayey silt, silty clay and clay. It also contains a trace to some sand. The thickness of the individual layers varies from a few millimetres to a few centimetres. The silt layers are non plastic to slightly plastic, often wet, and dilatant. The clayey layers are low to medium or occasionally highly plastic.

Figures 2 and 3 show the grading curves of the predominantly silty and the more clayey samples of this deposit, respectively. The nine silt or clayey silt samples shown on Figure 2 contain no gravel, 1 to 37% sand (mostly less than 30%), 52 to 88% silt, and 10 to 23% clay. The eight silty clay or clay samples shown on Figure 3 contain 0 to 3% sand, 16 to 62% silt (mostly over 50%), and 34 to 83% clay.

The natural moisture contents of the stratified silt and clay deposit range from 11 to 31%. Some of the samples are non plastic, while some have low to high plasticity. The liquid limits, plastic limits, and plasticity indices of twenty-two clayey soil samples tested are 11 to 72%, 15 to 30%, and 5 to 42, respectively. Their liquidity indices vary from 0.01 to 1.4. The results of the Atterberg limit tests plotted on the Plasticity Charts are shown on Figures 7A, 7B and 7C.

In Borehole 3, an approximately 1.0 m thick sand layer was found embedded in the silt and clay deposit at about El. $341 \pm$ m. Figure 4 shows the grading curve of this sand which is composed of 4% gravel, 93% sand, and 3% soil fines (silt and clay).

The 'N'-values recorded in the stratified silt and clay deposit range from 8 to 36 blows per 0.3 m. In situ vane shear tests performed in the weaker layers revealed undrained shear strength of 50 to over 75 kPa. Due to the random presence of silt layers however, the validity or the relevance of these tests can be questioned. An unconfined compression test on a sufficiently long clayey sample obtained an undrained shear strength value of 59 kPa. These test results indicate that the consistency of this soil stratum is firm to hard, but mostly stiff to very stiff.

The dynamic cone penetration blow counts in this material vary widely, from 3 blows per 0.3 m near the surface to over 100 blows at greater depth. The higher penetration resistances can probably be attributed to the rapid build up of friction or adhesion on the shaft of the drill rods.

The results of two one dimensional consolidation tests of the silt and clay deposit are shown on Figures 9 and 10. The initial void ratios of the tested samples are between 0.61 and 0.65, and the compression indices are 0.085 and 0.018, respectively.

4.6 Lower Silty Clay (Glacial Till)

Underlying the stratified silt and clay deposit in all the boreholes is a silty clay (till). The surface of this deposit was contacted between Elevations 322.6 and 318.9 m. The thickness of this stratum is not known as it extends beyond the bottom of the holes. It is a well graded deposit as shown by the grading curves of four samples of this soil (Figure 5). These samples contain 0 to 25% gravel, 2 to 32% sand, 28 to 59% silt, and 32 to 39% clay.

The natural moisture contents of this material are between 16 and 24%. Its liquid limits, plastic limits, and plasticity indices are 33 to 44%, 17 to 18%, and 15 to 24, respectively (see Figure 8). The liquidity indices are between -0.1 and 0.25. The 'N'-values in the silty clay till range from 32 blows per 0.3 m to 60 blows for 125 mm. The above test results show that this is a low to medium plastic silty clay of hard consistency.

4.7 Groundwater Conditions

Piezometers were installed in six boreholes. These were monitored over a period of four weeks.

The results are summarized in Table 1 below.

The water levels in the piezometers were rising at a slow rate, and some may not have reached equilibrium even at the end of the monitoring period. However, it is inferred that the water levels will stabilize at about El. 344 m. Further readings should be able to confirm this.

TABLE 1
WATER LEVEL READINGS

BH	Date	91.01.17	91.01.18	91.01.22	91.01.27	91.01.31	91.02.08	91.02.22
	Ground Surface Elev. (m)	Water Level (Depth/Elev.)						
2	343.0	$\frac{11.1}{331.9}$	$\frac{8.5}{334.5}$	$\frac{4.5}{338.5}$	$\frac{3.7}{338.3}$	$\frac{2.3}{340.7}$	$\frac{1.6}{341.4}$	$\frac{0.9}{342.1}$
3	344.5	---	$\frac{26.5}{318.0}$	$\frac{9.4}{335.1}$	$\frac{3.7}{340.8}$	$\frac{0.1}{344.4}$	$\frac{0.4}{344.1}$	$\frac{0.2}{344.3}$
4	344.7	---	---	$\frac{9.2}{335.5}$	$\frac{6.2}{338.5}$	$\frac{0.9}{343.8}$	$\frac{0.6}{344.1}$	$\frac{0.1}{344.6}$
5	346.0	---	---	$\frac{23.8}{322.2}$	$\frac{7.6}{338.4}$	$\frac{3.6}{342.4}$	$\frac{2.9}{343.1}$	$\frac{2.7}{343.3}$
6	346.6	---	---	---	dry	$\frac{4.9}{341.7}$	$\frac{4.3}{342.3}$	$\frac{3.8}{342.8}$
7	346.9	---	---	---	$\frac{31.6}{315.3}$	$\frac{20.4}{326.5}$	$\frac{11.3}{335.6}$	$\frac{5.4}{341.5}$

Note: The preceding report is a copy of the factual information from the Foundation Report prepared by Geo-Canada Limited (consulting geotechnical engineers for this project), under the technical supervision of the M.T.O. Foundation Design Section.



D. Dundas

D. Dundas, P. Eng.
Chief Foundation Engineer
(Acting)

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 163-88-01 LOCATION Sta. 18+178.3 O/S 10.9 m R/C/L Hwy 7 & 8
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering
DATUM Geodetic DATE 91 01 16/17
ORIGINATED BY PWD
COMPILED BY JN
CHECKED BY TPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
343.2	Ground Surface																
0.0	150 mm Topsoil SILTY CLAY trace of gravel moist brown till like very stiff		1	SS	21	*	342										
341.8																	
1.4	SILT AND CLAY stratified alternate layers of silt, clayey silt silty clay and clay grey stiff to very stiff		2	SS	11												
			3	SS	18												
			4	SS	9		340										
			5	SS	11												
			6	SS	9												
			7	SS	11		338										
			8	SS	13												
	silt layers predominate						336										
	clay layers predominate		9	SS	9												
							334										
			10	SS	11												
	silt layers predominate		11	TV	PH		332										
			12	SS	13												
331.2																	

Pushed Shelby
Tube at 9.9 m.
no recovery.
Consolidation
Test Fig. 9

21.0 0 4 86 10

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No. 1 (CONT.) METRIC

W P 163-88-01 LOCATION Sta. 18+178.3 O/S 10.9m Rt. C/I Hwy 7 & 8 ORIGINATED BY PWD
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
DATUM Geodetic DATE 91 01 16/17 CHECKED BY IPL

[illegible]

+3, x5: Numbers refer to Sensitivity

20
15 
10

15 \pm 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 1 (CONT.) - METRIC

W P 163-88-01 LOCATION Sta. 18+178.3 O/S 10.9 m Rr C/L Hwy 7 & 8 ORIGINATED BY PWD
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
 DATUM Geodetic DATE 91 01 16/17 CHECKED BY IPL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80					
319.2	Continuation															
24.0	SILTY CLAY (TILL)															
318.5	hard		21	SS	66	150 mm										
24.7	END OF BOREHOLE Borehole backfilled groundwater conditions not established															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

MÉTRIC

W P 163-88-01 LOCATION Sta. 18+212.0, O/S 27.5 m Rt. C/L Hwy 7 & 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
DATUM Geodetic DATE 91 01 16/17 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPo ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
343.0	Ground Surface												
0.0	300 mm Topsoil												
	SILT AND CLAY stratified												
	moist, brown wet, grey												
	alternate layers of silt, clayey silt, silty clay and clay stiff to very stiff												
			1	SS	11								0 3 50 47
			2	SS	16								
			3	SS	11								0 6 77 17
			4	SS	14								
			5	SS	21								
			6	SS	18								
			7	SS	16								
			8	SS	8								
			9	SS	20								
			10	SS	20								
			11	SS	13								0 3 77 20
			12	SS	13								
			13	SS	10								
	clay layers predominate between 10 m and 18 m depth												
331.0													
329.0	Continued												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2 (CONT.) METRIC

W P 163-BB-01 LOCATION Sta. 18+212.0, O/S 27.5 m Br. C/I Hwy 7 & 8 ORIGINATED BY SC
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
 DATUM Geodetic DATE 91 01 16/17 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
331.0	Continuation												
12.0	SILT AND CLAY as above stiff to very stiff		14	SS	18		330						
			15	SS	13		328						
			16	SS	22		326						
			17	SS	15		324						
			18	SS	16		322						
			19	SS	22								
			20	SS	28								
			21	SS	68								
321.4													
21.6	SILTY CLAY some sand trace of gravel grey very stiff to hard (Glacial Till)						320						
319.0													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 x 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2 (CONT.) METRIC

W P 163-88-01 LOCATION Sta. 18+212.0, O/S 27.5 m Rt. G/L Hwy 7 & 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
DATUM Geodetic DATE 91 01 16/17 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kP_0 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
319.0	Continuation													
24.0	SILTY CLAY some sand trace of gravel grey hard (Glacial Till)		22	SS	41		318						44	0 32 32 36
316.8			23	SS	60/		PIEZOMETER							
26.2	END OF BOREHOLE				125 mm									
	Date	W.L.												
	91.01.17	331.9												
	91.01.18	334.5												
	91.01.22	338.5												
	91.01.27	338.3												
	91.01.31	340.7												
	91.02.08	341.4												
	91.02.22	342.1												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No. 3

METRIC

W P 163-88-01 LOCATION Sta. 18+229.5, O/S 10.0 m Rt. C/L Hwy 7 & 8 ORIGINATED BY PWD
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
DATUM Geodetic DATE 91 01 17/18 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
344.5	Ground Surface													GR SA SI CL
0.0	170 mm Topsoil SILTY CLAY trace of embedded gravel brown till structure stiff		1	SS	14		344							
343.1							344.3							
1.4	SILT AND CLAY stratified alternate layers of silt, clayey silt, silty clay and clay		2	SS	14									0 13 64 23
			3	SS	19		342							
	sand seam trace of gravel wet		4	SS	9									4 93 (3)
	grey stiff to very stiff		5	SS	10		340							
			6	SS	8									
			7	SS	9		338							
	silt layers predominate		8	TW	PH									20.2 0 5 77 18
			9	SS	15									
			10	SS	11*		336							
	very stiff to hard		11	SS	21									no recovery 1st attempt
			12	SS	33		334							
	firm		13	SS	8									
332.5														

OFFICE REPORT ON SOIL EXPLORATION

*3, *5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3 (CONT.) METRIC

W P 163-88-01 LOCATION Sta. 18+229.5, 0/5 10.0 m Rt. C/L Hwy 7 & 8 ORIGINATED BY PWD
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
 DATUM Geodetic DATE 91 01 17/18 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
332.5	Continuation																
12.0	SILT AND CLAY (as above) very stiff to stiff		14	SS	24		332										
	silt layers predominate																
	clay layers predominate																
			15	SS	9		330										
			16	SS	12												
			17	SS	19		328										
			18	SS	17		326										
			19	SS	14		324										
			20	SS	18												
	hard						322										
	mostly clay		21	SS	36	*											
320.5																	
24.0	Continuation																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (% STRAIN AT FAILURE

*
No recovery
1st attempt



RECORD OF BOREHOLE No 3 (CONT.) METRIC

W P 163-88-01 LOCATION Sta. 18+229.5, O/S 10.0 m Rt. C/L Hwy 7 & 8 ORIGINATED BY PWD
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
DATUM Geodetic DATE 91 01 17/18 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
320.5	Continuation																
24.0	SILTY CLAY some sand trace of embedded gravel grey hard (Glacial Till)		22	SS	64		320										1 27 34 38
			23	SS	64		318										
316.6			24	SS	70		PIEZOMETER										
27.9	END OF BOREHOLE Date W.L. 91.01.18 318.0 91.01.22 335.1 91.01.27 340.8 91.01.31 344.4 91.02.08 344.1 91.02.22 344.3																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 \div 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

METRIC

W P 163-88-01 LOCATION Sta. 18+250.1, O/S 23.2 m Rt. C/L Hwy 7 & 8 ORIGINATED BY SC
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
 DATUM Geodetic DATE 91 01 18 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80
344.7	Ground Surface															
0.0	350 mm Topsoil SILT AND CLAY --- stratified						Seal									
			1	SS	14		W.L. 344.6	91.02.22								
			2	SS	13			Cone Test								
	brown, silt layers predominate grey, more clay		3	SS	20											
			4	SS	10											
	alternate layers of silt, clayey silt and silty clay		5	SS	20											
	stiff to very stiff		6	SS	22											
			7	SS	13											
			8	SS	17											
			9	SS	12											
			10	SS	14											
	clay layers predominate silt layers predominate		11	SS	20											
332.7																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 (CONT.) METRIC

W P 163-88-01 LOCATION Sta. 18+250.1, O/S 23.2 m Rt. C/L Hwy 7 & 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
DATUM Geodetic DATE 91 01 18 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
332.7	Continuation																GR SA SI CL
12.0	SILT AND CLAY as above very stiff		12	SS	17		332										
			13	SS	22		330										
			14	SS	22												
	silt layers predominate clay layers predominate firm						328										
			15	SS	7												
	hard trace of gravel		16	SS	30		326										
	very stiff to stiff		17	SS	20												
							324										
	silt layers predominate wet		18	SS	13												
			19	SS	19		322										
320.7																	

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4 (CONT.) METRIC

W P 163-88-01 LOCATION Sta. 18+250.1, O/S 23.2 m Rte. C/L Hwy 7 and 8 ORIGINATED BY SC
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
 DATUM Geodetic DATE 91 01 18 CHECKED BY IPL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80	100	W _p	W		
320.7	Continuation															
24.0	SILT AND CLAY as above mainly silt layers very stiff		20	SS	26											
318.9																
25.8	SILTY CLAY some sand grey hard (Glacial Till)		21	SS	70											
316.8			22	SS	59											
27.9	END OF BOREHOLE No further progress due to lack of augers Date W.L. 91.01.22 335.5 91.01.27 338.5 91.01.31 343.8 91.02.08 344.1 91.02.22 344.6															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 163-88-02 LOCATION Sta. 18+153.0, O/S 25.0 m LT, C/L Hwy 7 & 8 ORIGINATED BY PWD
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
 DATUM Geodetic DATE 91 01 21/22 CHECKED BY IPL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
346.0	Ground Surface												
0.0	FILL sand												
	clayey silt and sand moist brown	1	SS	10									15 77 (8)
		2	SS	19									
		3	SS	18									
		4	SS	15									
		5	SS	11									
	some organics grey/brown	6	SS	23									
340.8	5.2 SILT AND CLAY												
	stratified alternate layers of silt, clayey silt silty clay and clay grey stiff	7	SS	14									
		8	SS	12									0 4 83 13
		9	SS	12									
	silt layers predominate clay layers predominate	10	SS	8									0 1 16 83 Pushed Shelby Tube at 9.9 m but no recovery
		11	SS	13									
	clay layers predominate silt layers predominate	12	TW	PH									
334.0													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+153.0, O/S 25.0 m LT. C/L Hwy 7 & 8 ORIGINATED BY PWD
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Conc Test COMPILED BY JN
 DATUM Geodetic DATE 91 01 21/22 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100											
								SHEAR STRENGTH kPo							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT				
								O UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE							W_p W W_L				
							WATER CONTENT (%)					10 20 30							
334.0	Continuation																		
12.0	SILT AND CLAY																		
	as above		13	SS	13								0						
	stiff to very stiff																		
			14	SS	12		332												
			15	SS	14								10	1 65 34					
			16	SS	10		330												
			17	SS	13								0						
			18	SS	14		326												
			19	SS	23								0						
			20	SS	23		324												
322.0																			
24.0	Continued													Soil backed up 3 m into hollow stem augers					

OFFICE REPORT ON SOIL EXPLORATION

\times^3, \times^5 Numbers refer to
Sensitivity

20
15 \rightarrow 5 (%) STRAIN AT FAILURE
10

Soil backed
up 3 m
into hollow
stem augers



RECORD OF BOREHOLE No 5 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+153.0, O/S 25.0 m LT, C/L Hwy 7 & 8 ORIGINATED BY PWD
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow stem Augering and Cone Tests COMPILED BY JN
DATUM Geodetic DATE 91 01 22 CHECKED BY IPL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80					
322.0	Continuation															
24.0	SILTY CLAY some sand, gravel															
	grey hard (Glacial Till)		21	SS	36										41	25 15 28 32
			22	SS	38											
			23	SS	32											
			24	SS	36											
316.6																
29.4	END OF BOREHOLE															
	Date W.L.															
	91.01.22 322.2															
	91.01.27 338.4															
	91.01.31 342.4															
	91.02.08 343.1															
	91.02.22 343.3															

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6

METRIC

W P 163-88-02

LOCATION Sta. 18+183.7, O/S 9.2 m Lt. C/L Hwy 7 and 8

ORIGINATED BY SC

DIST 3 HWY 7 and 8

BOREHOLE TYPE Hollow Stem Augering

COMPILED BY JN

DATUM Geodetic

DATE 91 01 24

CHECKED BY IPL

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100				W _p	W	W _L		
								SHEAR STRENGTH kPa								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				WATER CONTENT (%)				
								20 40 60 80 100								
346.6	Ground Surface															
0.0	600 mm granular road base															
	FILL															
	sand		1	SS	18											
	trace of gravel, asphalt, moist brown		2	SS	54											
	clayey silt trace of sand grey		3	SS	16											
			4	SS	13											
342.3																
4.3	SILT AND CLAY															
	stratified alternate layers of silt, clayey silt silty clay and clay		5	SS	20											
	clay layers predominate, brown silt layers grey predominate		6	SS	16											
			7	SS	17											
	firm to stiff		8	SS	9											
			9	SS	18											
			10	SS	21											
	silt layers predominate clay layers predominate		11	SS	10											
			12	SS	17											
			13	SS	13											
336.6																

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



RECORD OF BOREHOLE No 6 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+183.7; O/S 9.2 m Lt. C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
DATUM Geodetic DATE 91 01 24 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				NATURAL MOISTURE CONTENT			UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%)				
334.6	Continuation														GR SA SI CL	
12.0	SILT AND CLAY															
	as above		14	SS	14		334									
	grey															
	stiff to very stiff															
			15	SS	26		332									
			16	SS	14		330									
			17	SS	18											
			18	SS	27		328									
			19	SS	19		326									
			20	SS	15		324									
			21	SS	19											
322.6															Soil backed up 0.6 m into augers	

322.6 CONTINUED

+3, x⁵: Numbers refer to
Sensitivity20
15 \div 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+183.7, O/S 9.2 m Lt, C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
DATUM Geodetic DATE 91 01 24 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80					
322.6	Continuation															
24.0 322.3	SILT AND CLAY															
24.3	SILTY CLAY some sand trace of gravel grey hard (Glacial Till)		22	SS	38											
			23	SS	62											
			24	SS	52											
317.2			25	SS	50											
29.4	END OF BOREHOLE Date W.L. 91.01.27 dry 91.01.31 341.7 91.02.08 342.3 91.02.22 342.8															

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC

W P 163-88-02 LOCATION Sta. 18+203.9, O/S 23.2 m tr, C/L Hwy 7 and 8 ORIGINATED BY SC
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
 DATUM Geodetic DATE 91 01 21/22 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
346.9	Ground Surface													
0.0	600 mm granular road base FILL sand some silt		1	SS	42		Seal							
			2	SS	29									
			3	SS	24									
	trace of decomposed wood dark brown/black clayey silt trace gravel brown		4	SS	35									
342.8														
4.1	SILTY CLAY some sand trace of embedded gravel brown till structure very stiff to hard		5	SS	21									
			5A	AS										
			6	SS	33									
340.2														
6.7	SILT AND CLAY stratified alternate layers of silt, clayey silt, silty clay and clay		7	SS	15									
			8	SS	13									
			9	SS	14									
	clay layers predominate silt layers predominate		10	SS	16									
	grey stiff to very stiff		11	SS	22									
			12	SS	20									
			13	SS	24									
334.9														

OFFICE REPORT ON SOIL EXPLORATION

+3, x³: Numbers refer to Sensitivity
 20
 15
 10
 5 (%) STRAIN AT FAILURE

MDD=18.7 kN/m³
 OMC=13.5%

0 2 59 30

RECORD OF BOREHOLE No 7 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+ 203.9, O/S 23.2 m tr, C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
DATUM Geodetic DATE 91 01 21/22 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100				
334.9	Continuation															
12.0	SILT AND CLAY															
	as above		14	SS	24		334									
	stiff to		15	SS	17											
	very stiff		16	SS	16											
							332									
	silt layers predominate		17	SS	9											
	clay layers predominate															
			18	SS	18		330									
			19	SS	15		328									
			20	SS	20		326									
			21	SS	16											
							324									
			22	SS	16											
322.9																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 7 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+203.9, O/S 23.2 m Lt. C/L Hwy 7 & 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering and Cone Test COMPILED BY JN
DATUM Geodetic DATE 91 01 21/22 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
322.9	Continuation																
24.0	SILT AND CLAY as above very stiff		23	SS	19												
320.8			24	SS	37												
26.1	SILTY CLAY some sand trace of gravel grey hard (Glacial Till)		25	SS	59												
			26	SS	59												
			27	SS	44												
			28	SS	47												
314.4																	
32.5	END OF BOREHOLE Date W.L. 91.01.27 315.3 91.01.31 326.5 91.02.08 335.6 91.02.22 341.5																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8

METRIC

W P 163-86-02 LOCATION Sta. 18+230.4, O/S 8.9 m L.R. C/L Hwy 7 & 8 ORIGINATED BY PWD
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
DATUM Geodetic DATE 91 01 24 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
347.3	Ground Surface																
0.0	Granular road base - FILL																
	sand trace of gravel		1	SS	34		346							0			3 86 (11)
			2	SS	48												
			3	SS	30												
	with organics (Topsoil)		4	SS	62		344							0			
343.6																	
3.7	SILT AND CLAY		5	SS	27									10-11			0 37 52 11
	Stratified alternate layers of silt, clayey silt, silty clay, and clay		6	SS	11		342			>+							
			7	SS	12					>+				0			
	silt layers predominate clay layers predominate		8	SS	12					>+							
							340			>+							
	grey stiff to very stiff		9	SS	13									10-11			0 1 62 37
			10	SS	11		338			>+							
	clay layers predominate		11	TW	PH									10-11			
	silt layers predominate firm		12	SS	6		336			>+				0			
335.3																	
12.0	Continued																

Consolidation Test
Fig.10

21.1 0 3 59 38

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+230.4, O/S 8.9 m Lt, C/L Hwy 7 & 8 ORIGINATED BY FWD
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
 DATUM Geodetic DATE 91 01 24 CHECKED BY IPL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
335.3	Continuation												
12.0	SILT AND CLAY as above stiff to very stiff		13	SS	18								
						334							
			14	SS	13							44	0 0 47 53
						332							
			15	SS	23								
						330							
	silt layers predominat clay layers predominate		16	SS	21								
						328							
	hard		17	SS	23								
						326							
	very stiff		18	SS	34								0 0 50 50
						324							
			19	SS	24								
			20	SS	22								
323.3	Continued												

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8 (CONT.) METRIC

W P 163-88-02 LOCATION Sta. 18+230.4, O/S 8.9 m Lt. C/L Hwy 7 and 8 ORIGINATED BY PWD
DIST 3 HWY 7 and 8 BOREHOLE TYPE Hollow Stem Augering COMPILED BY JN
DATUM Geodetic DATE 91 01 24 CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
323.3	Continuation																
24.0	SILT AND CLAY as above very stiff		21	SS	29	*	322										
	clay layers predominate silt layers predominate		22	SS	17												
320.1																	
27.2	SILTY CLAY some sand trace of gravel grey hard (Glacial Till)		23	SS	68		320										
			24	SS	60		318										
			25	SS	57		316										
314.8			26	SS	77												
32.5	END OF BOREHOLE * Groundwater condition not established																

OFFICE REPORT ON SOIL EXPLORATION

*³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

W P 163-88-01 LOCATION Sta. 18+187.0. O/S 23.7 Rt C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Cone Penetration Test COMPILED BY JN
DATUM Geodetic DATE 91 01 21 CHECKED BY IPL

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No CT 2

METRIC

W P 163-88-01

LOCATION Sta. 18+196.8, O/S 10.0 m Rct. C/L Hwy 7 and 8

ORIGINATED BY PWD

DIST 3 HWY 7 and 8

BOREHOLE TYPE Augering and Cone Penetration Test

COMPILED BY JN

DATUM Geodetic

DATE 91 01 21

CHECKED BY IPL

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



W P 163-88-01 LOCATION Sta. 18+196.8, O/S 10.0 m Rt. C/L Hwy 7 and 8 ORIGINATED BY PWD
DIST 3 HWY 7 and 8 BOREHOLE TYPE Augering and cone penetration test COMPILED BY JN
DATUM Geodetic DATE 91 01 21 CHECKED BY IPL

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No CT 3

METRIC

W P 163-88-01 LOCATION Sta. 18+242.7, O/S 25.6 m Rt. C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Augering and Cone Penetration Test COMPILED BY JN
DATUM Geodetic DATE 91 01 17 CHECKED BY IPL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20	40	60	80			100	W _p
344.0	Ground Surface						SHEAR STRENGTH kPa				WATER CONTENT (%)				
0.0	320 mm Topsoil						○ UNCONFINED + FIELD VANE								
	SILT AND CLAY layered brown						● QUICK TRIAXIAL x LAB VANE								
						342									
340.0						340									Augered to 4.0 m without sampling
4.0	END OF AUGERING						Cone Test								
						338									
						336									
						334									
333.3															
10.7	END OF CONE TEST														

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 \diamond 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No. CT 4 METRIC

W P 163-88-01 LOCATION Sta. 18+245.7, O/S 10.7 m Rt. C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Augering and Cone Penetration Test COMPILED BY JN
DATUM Geodetic DATE 91 01 17 CHECKED BY IPL

[illegible]

*3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No CT 5

METRIC

W P 163-88-02 LOCATION Sta. 18+164.5, O/S 8.8 m Lt, C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Augering and Cone Penetration Test COMPILED BY JN
DATUM Geodetic DATE 91 01 25 CHECKED BY 1PL

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No CT 6

METRIC

W P 163-88-02

LOCATION Sta. 18+173.5, O/S 23.3 m Lt. C/L Hwy 7 and 8

ORIGINATED BY PWD

DIST 3 HWY 7 and 8

BOREHOLE TYPE Augering and Cone Penetration Test

COMPILED BY JN

DATUM Geodetic

DATE 91 01 24

CHECKED BY IPL

[illegible]

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No CT 6 (CONT) METRIC

W P 163-88-02 LOCATION Sta. 18+173.5, O/S 23.3 m Lt C/L Hwy 7 and 8 ORIGINATED BY SC
 DIST 3 HWY 7 and 8 BOREHOLE TYPE Augering and Cone Penetration Test COMPILED BY JN
 DATUM Geodetic DATE 91 01 24 CHECKED BY IPL

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
334.4	Continuation									
12.0						334				
332.1						332				
14.3	END OF CONE TEST									

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No CT 7

METRIC

W P 163-88-02

LOCATION Sta. 18+212.8, O/S 8.9 m LE C/L Hwy 7 and 8

ORIGINATED BY SC

DIST 3 HWY 7 and 8

BOREHOLE TYPE Augering and Cone Penetration Test

COMPILED BY JN

DATUM Geodetic

DATE 91 01 25

CHECKED BY IPL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
346.9	Ground Surface																
0.0	FILL sand and gravel																
346.0																	
0.9	FILL sand brown																
341.9																	
5.0	SILT AND CLAY layered brown																
339.9																	
7.0	END OF AUGERING																
334.9																	

Augered to 7.0 m without sampling

Cone Test

Continued

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No CT 8

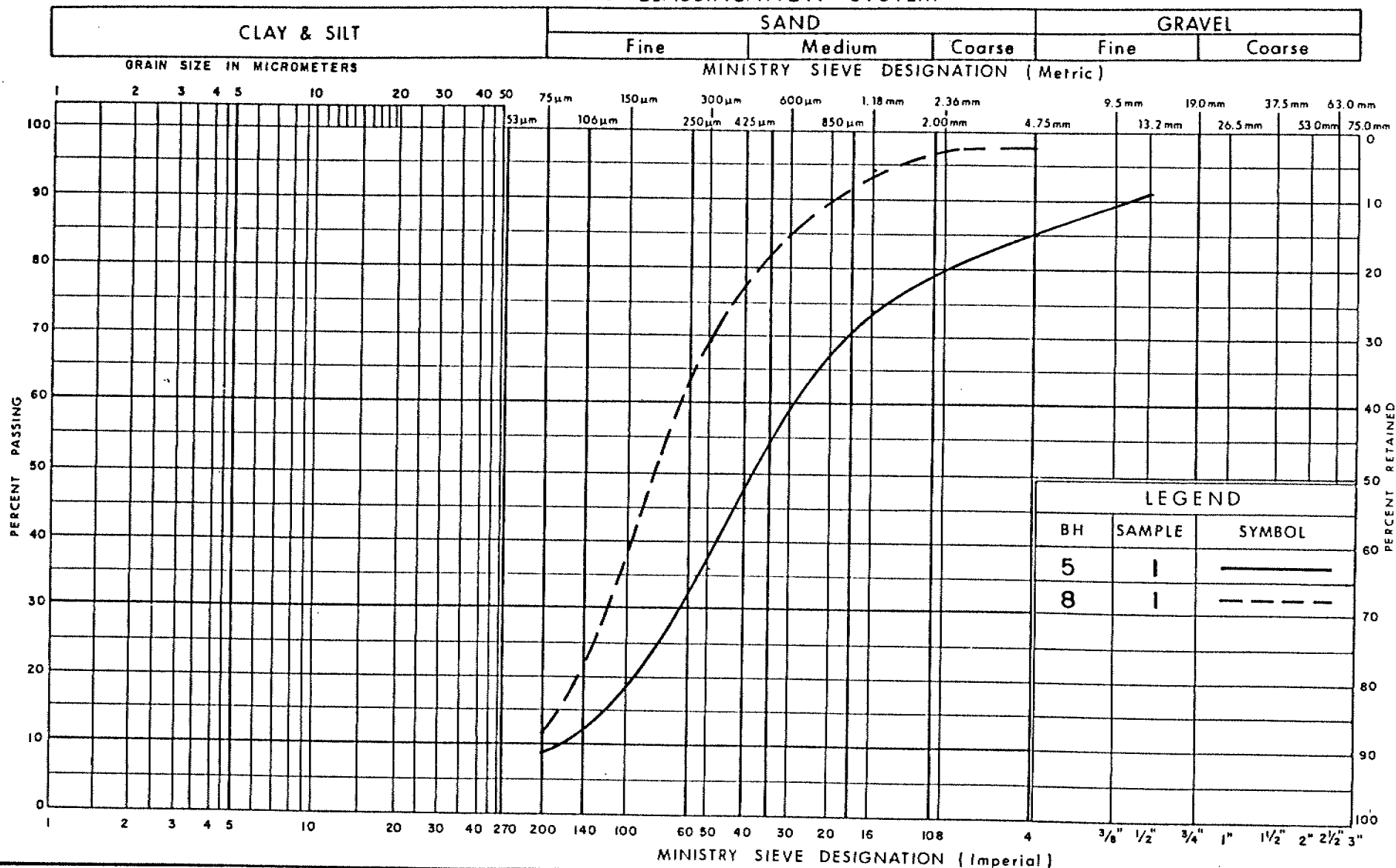
METRIC

W P 163-88-02 LOCATION Sta. 18+220.4, O/S 23.4 m Lr. C/L Hwy 7 and 8 ORIGINATED BY SC
DIST 3 HWY 7 and 8 BOREHOLE TYPE Augering and Cone Penetration Test COMPILED BY JN
DATUM Geodetic DATE 91 01 24 CHECKED BY IPL

[illegible]

+3, x5: Numbers refer to Sensitivity

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

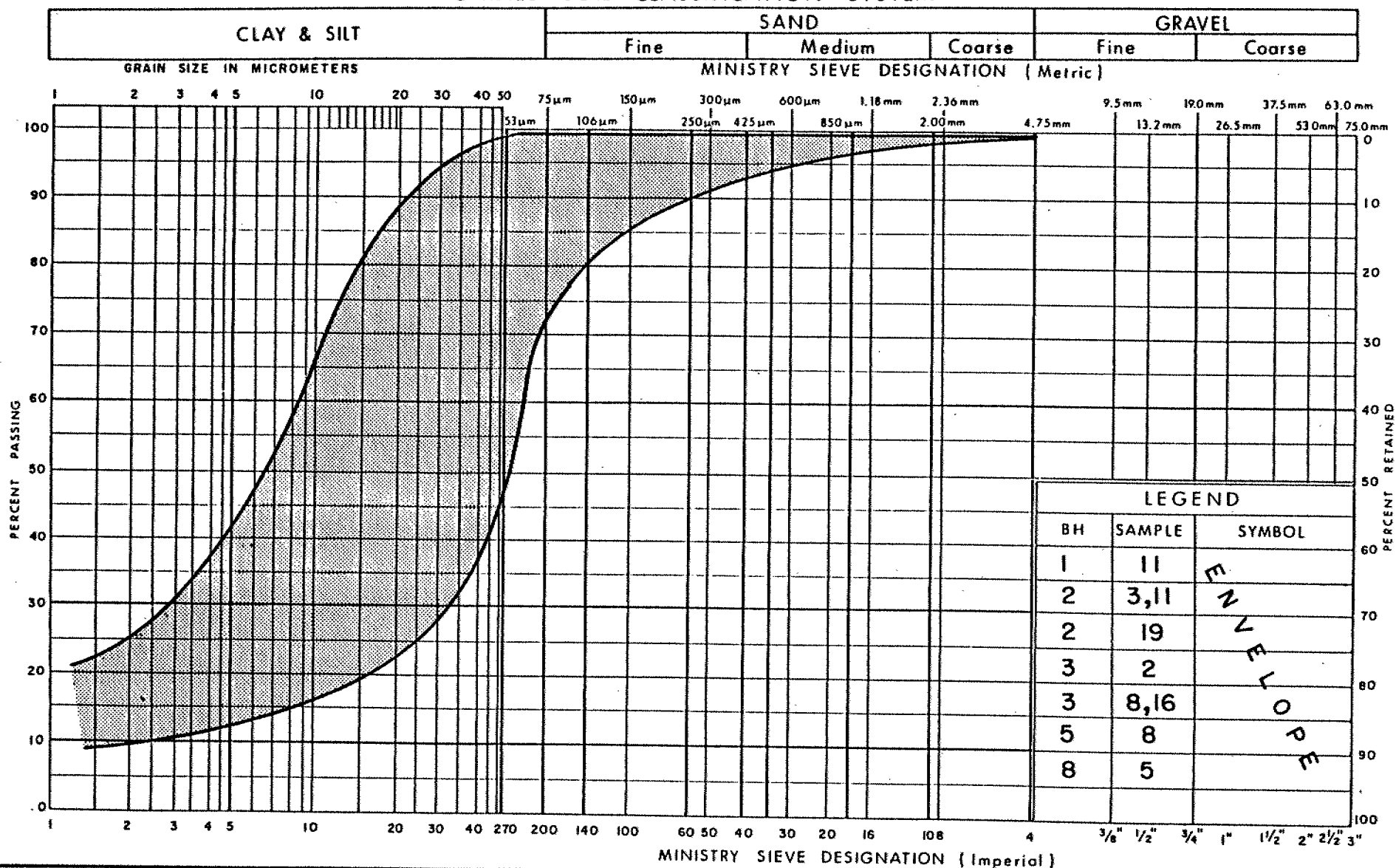
GRAIN SIZE DISTRIBUTION

SAND FILL

FIG No 1

W P 163-88-01/02

UNIFIED SOIL CLASSIFICATION SYSTEM



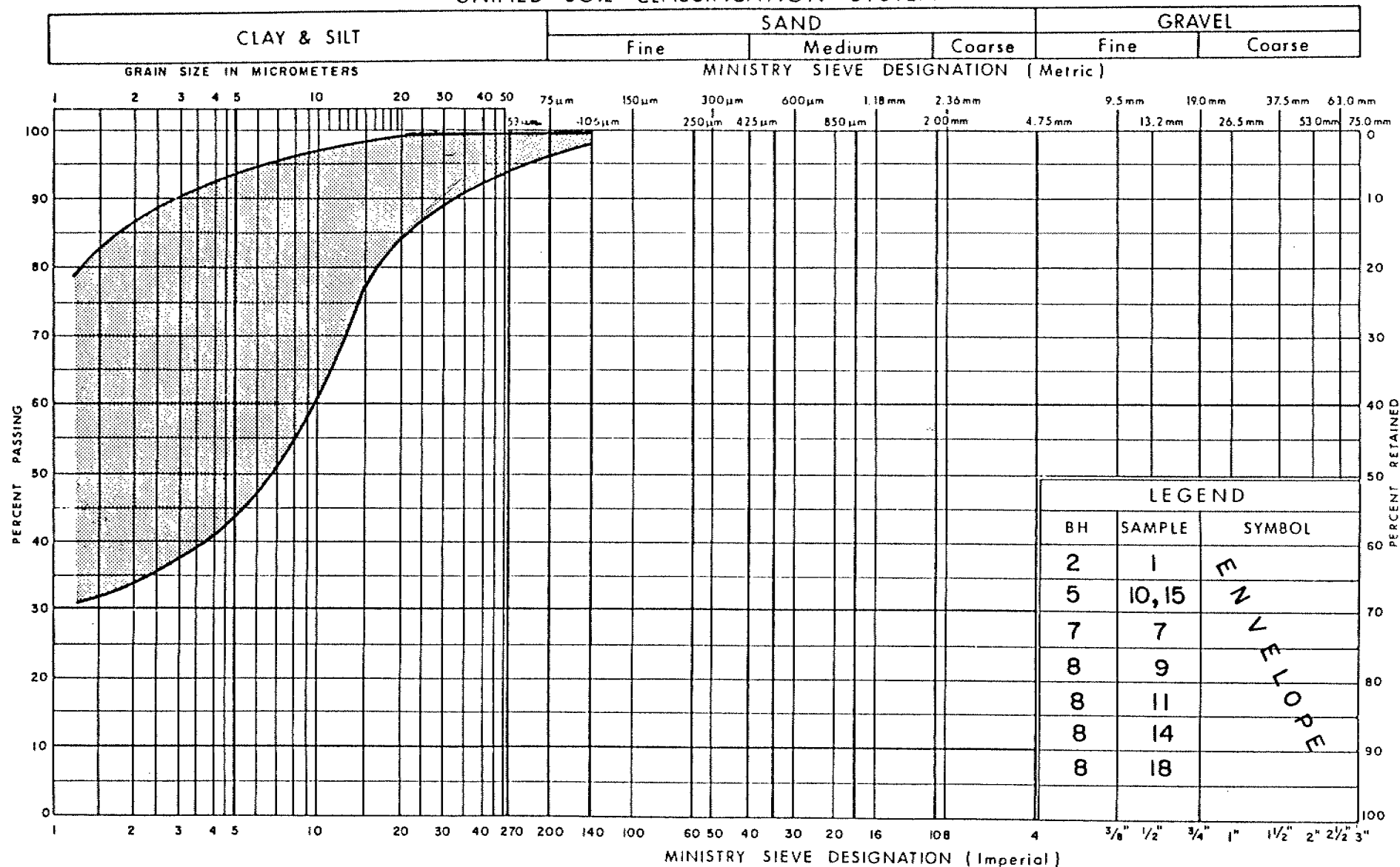
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
STRATIFIED SILT AND CLAY
 SILT AND CLAYEY SILT LAYERS, TRACE TO SOME SAND

FIG No 2

W P 163-88-01/02

UNIFIED SOIL CLASSIFICATION SYSTEM



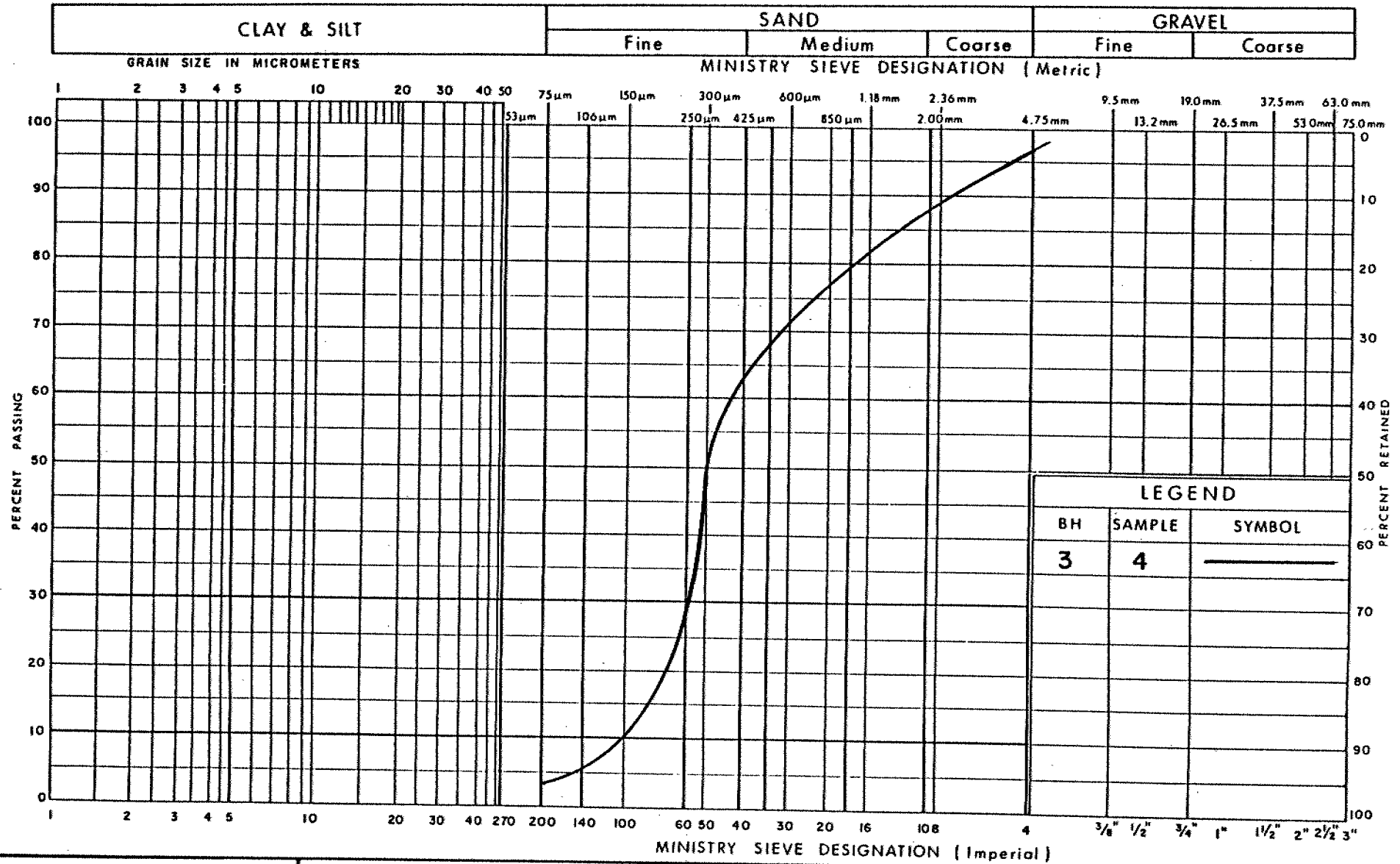
Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
STRATIFIED SILT AND CLAY
SILTY CLAY AND CLAY LAYERS

FIG No 3

W P 163-88-01/02

UNIFIED SOIL CLASSIFICATION SYSTEM

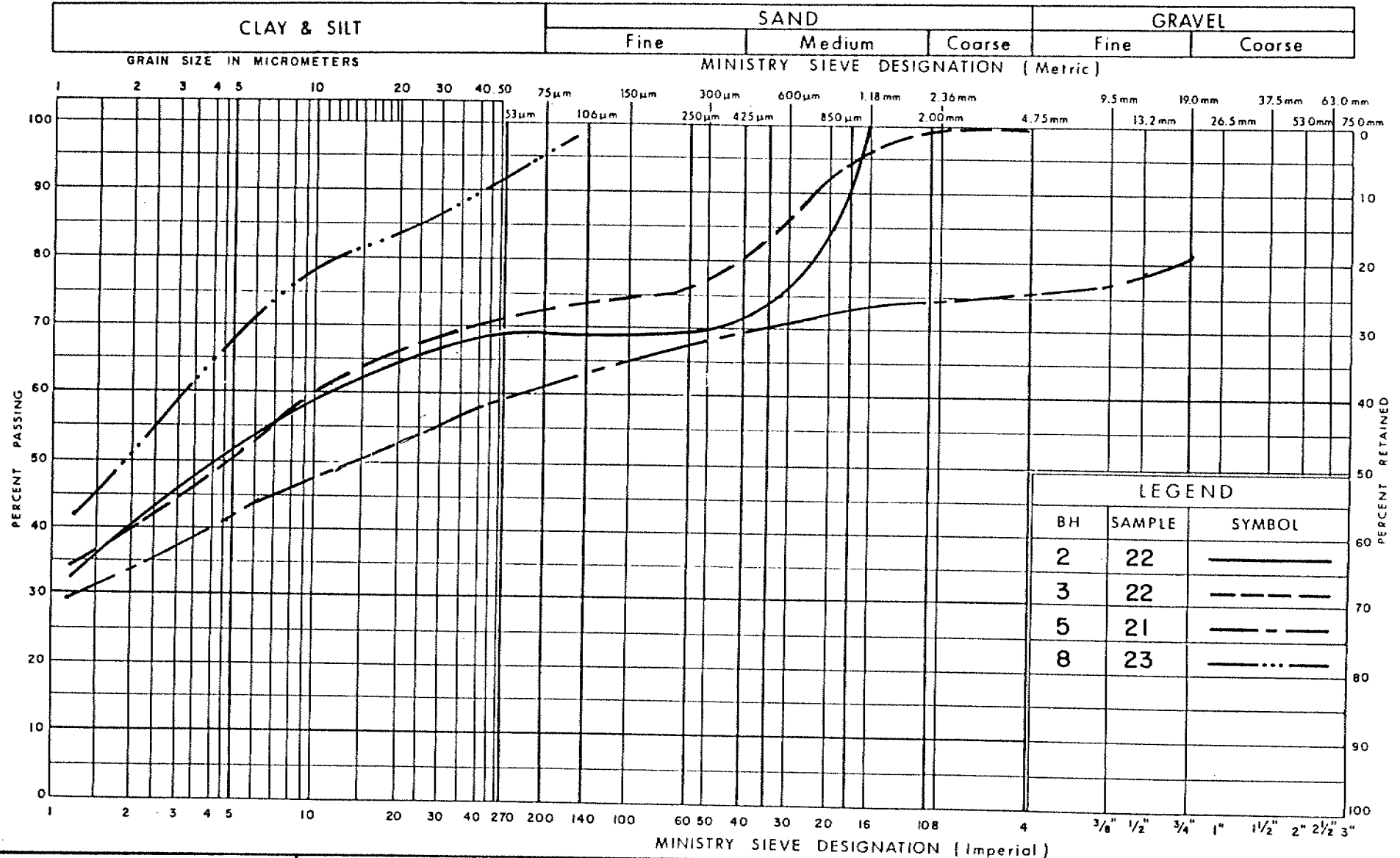


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SAND, TRACE OF GRAVEL AND SILT

FIG No 4
W P 163-88-01/02

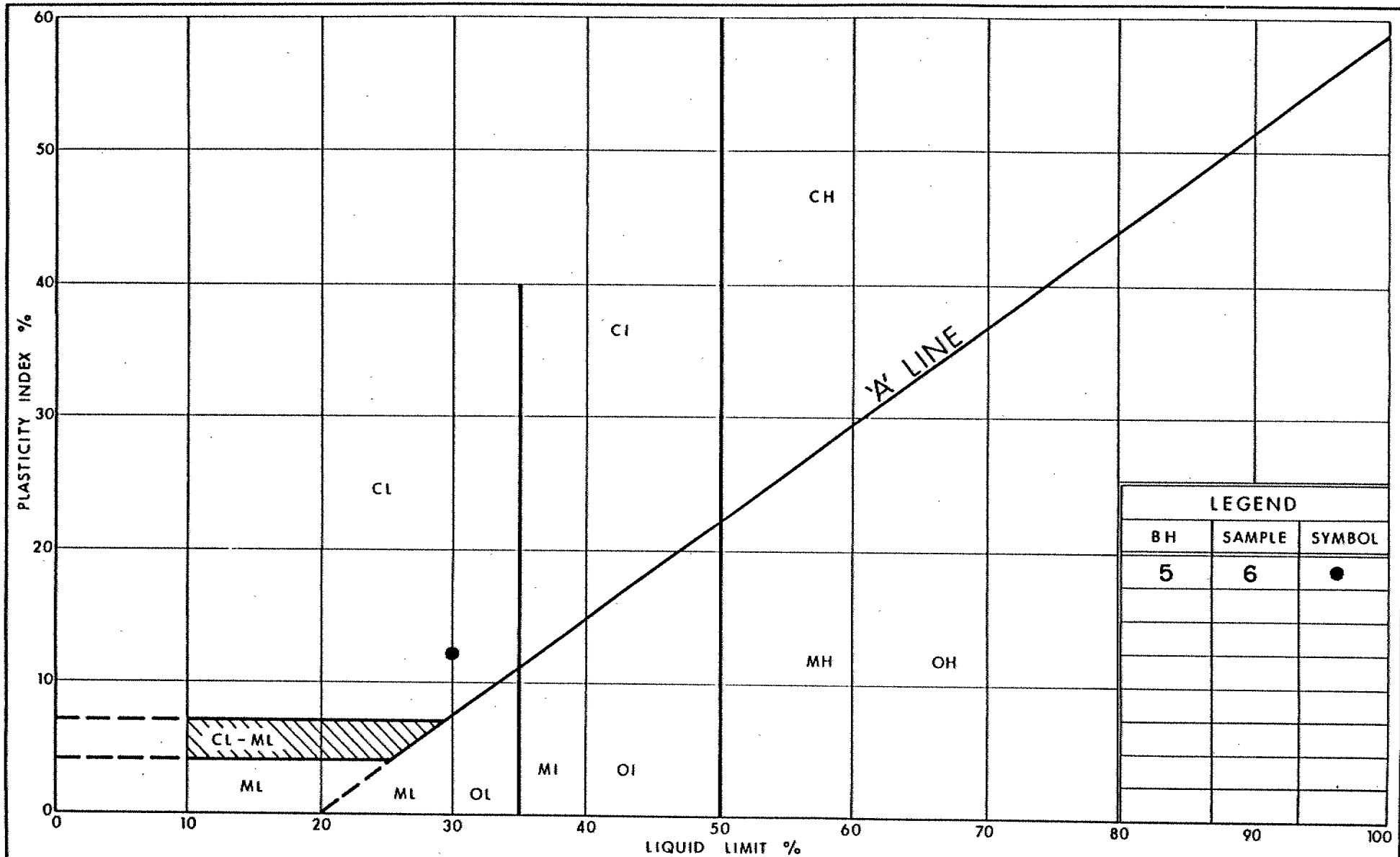
UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY CLAY WITH TRACE TO SOME SAND AND GRAVEL
(GLACIAL TILL)

FIG No 5
W P 163-88-01/02



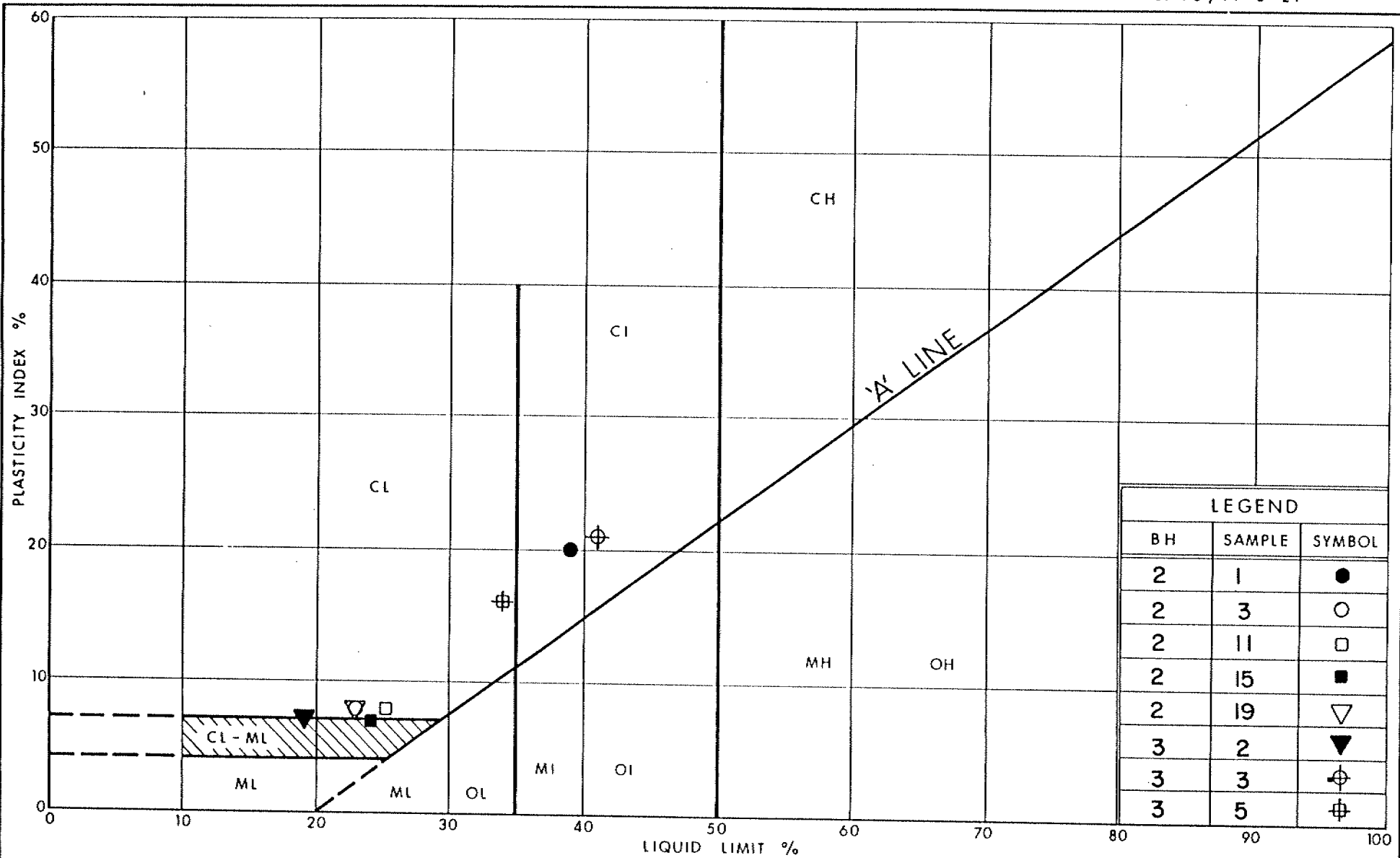
Ministry of
Transportation

Ontario

PLASTICITY CHART CLAYEY SILT FILL

FIG No 6

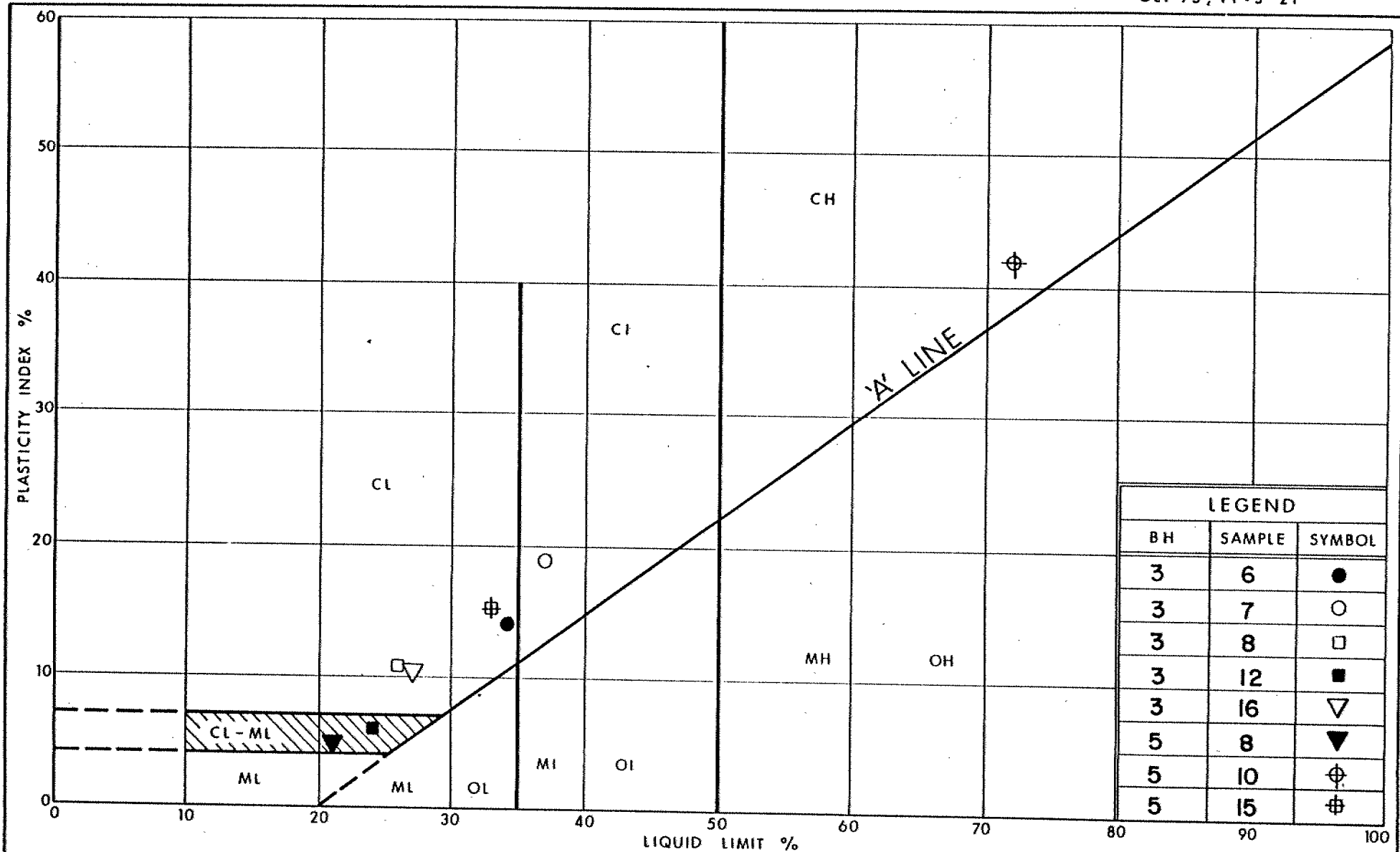
W P 163-88-01/02



Ministry of
Transportation
Ontario

PLASTICITY CHART STRATIFIED SILT AND CLAY

FIG No 7 A
W P 163-88-01/02

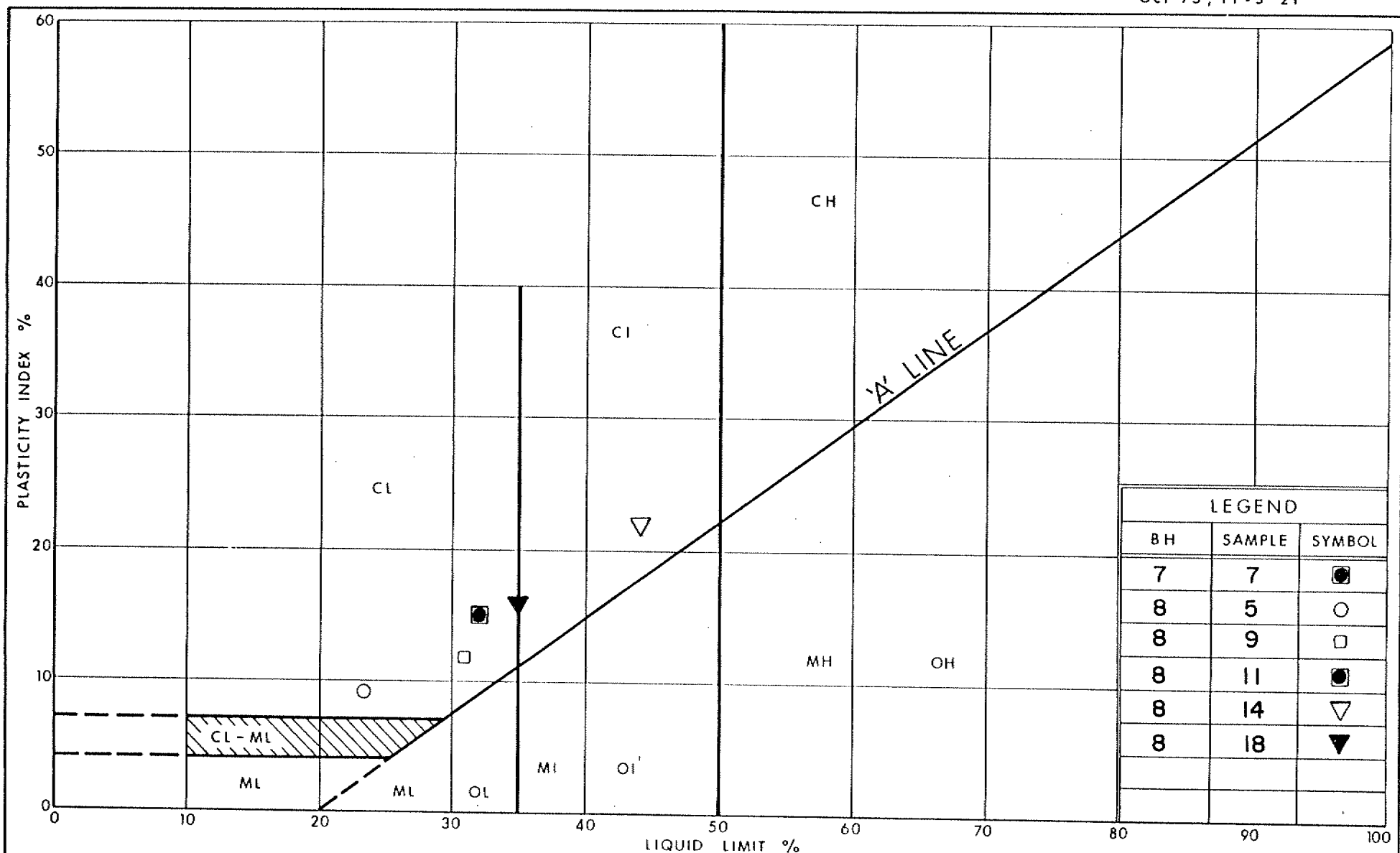


Ministry of
Transportation
Ontario

PLASTICITY CHART STRATIFIED SILT AND CLAY

FIG No 7B

W P 163-88-01/02

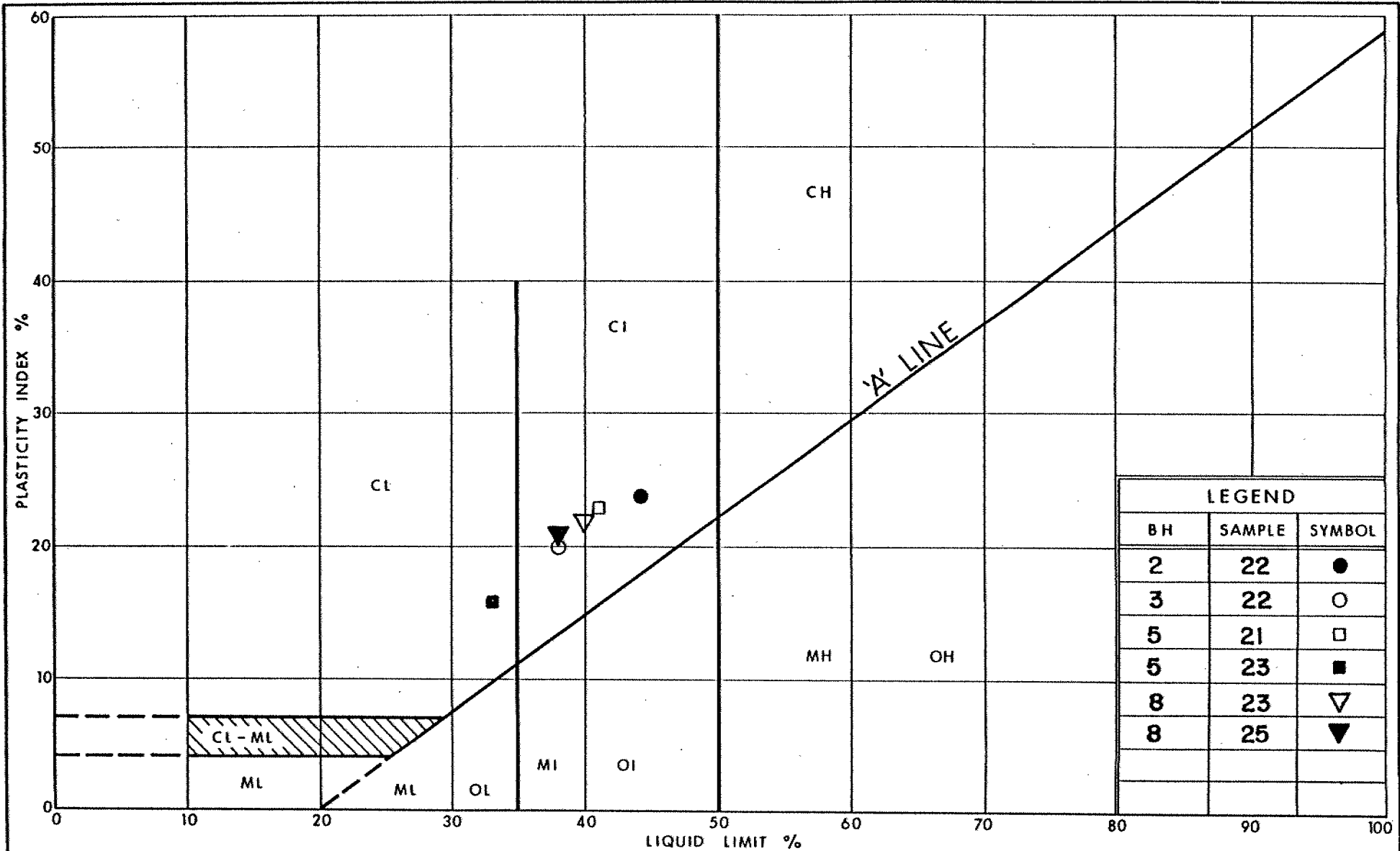


Ministry of
Transportation
Ontario

PLASTICITY CHART STRATIFIED SILT AND CLAY

FIG No 7C

W P 163-88-01/02



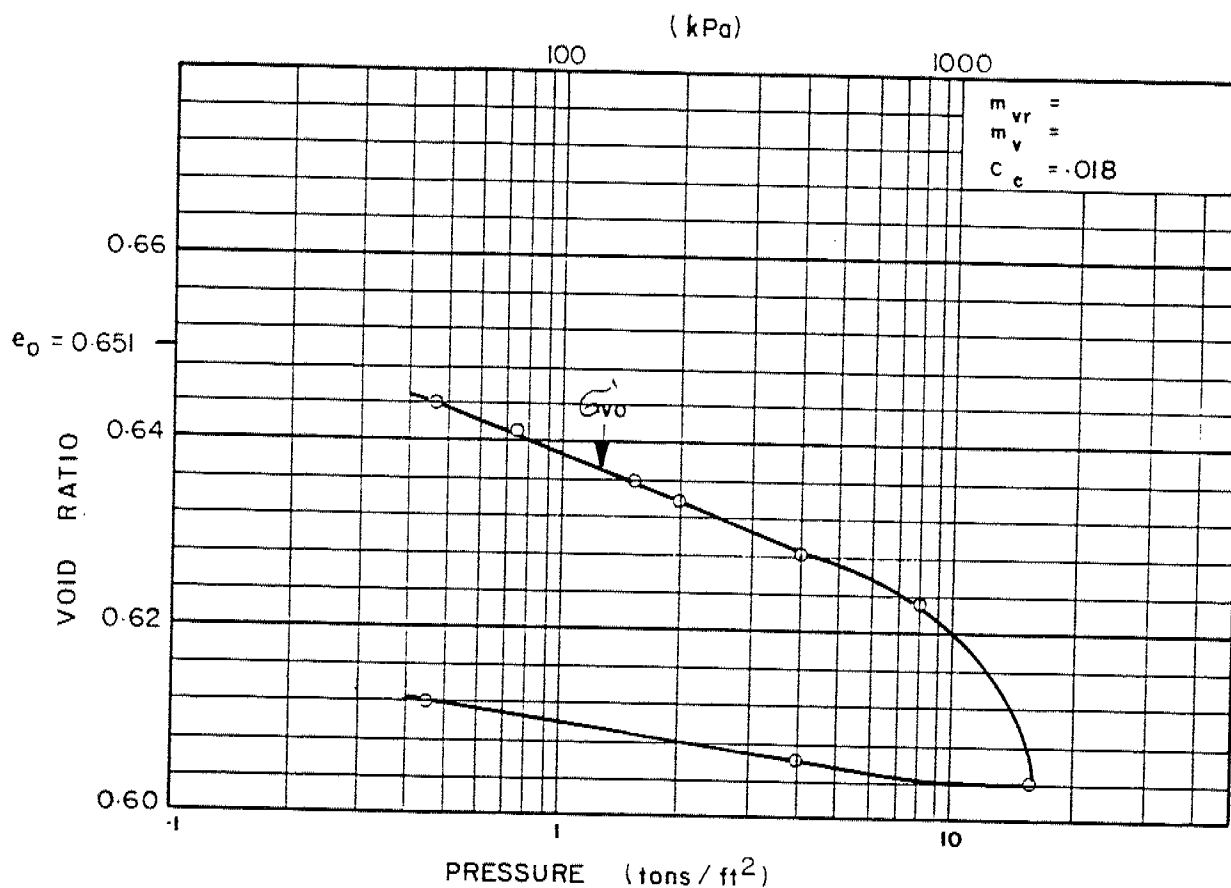
Ministry of
Transportation

Ontario

PLASTICITY CHART
SILTY CLAY
(GLACIAL TILL)

FIG No 8

W P 163-88-01/02



BOREHOLE 1

SAMPLE 11

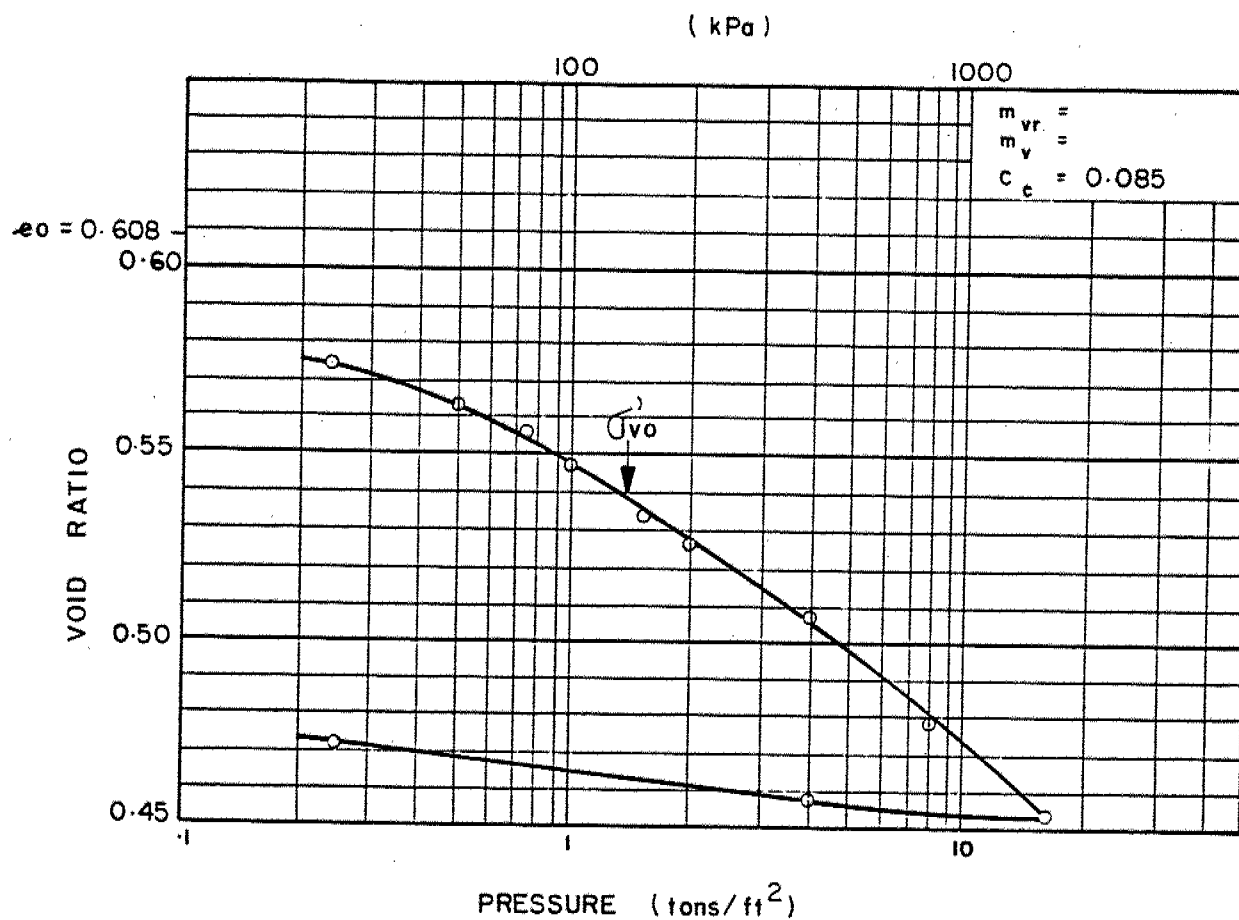
DEPTH/ELEV. 10.7 / 332.5m

CONSOLIDATION TEST

163-88-01/02

FIG. 9

GEO-CANADA LTD.



BOREHOLE 8
 SAMPLE 11
 DEPTH/ELEV. 10.8/336.5 m

CONSOLIDATION TEST

163-88-01/02

FIG. 10

GEO-CANADA LTD.

FILE COPY



Ministry
of
Transportation

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT. 94-12

WP 161-88-01 DIST 3
HWY 7 & 8 STR SITE 33-359

Regional Road 12 Underpass

DISTRIBUTION

A. Ho (2)
C.M. Bond
A.E. Irving
E.J. Zavitski (2)
K.G. Bassi
S.J. Dunham
E.A. Joseph
G. Laithwaite (Cover Only)
I. Bullen (Cover Only)
File

FOUNDATION INVESTIGATION REPORT
For
Regional Road 12 Underpass
W.P. 161-88-01, Site 33-359
Hwy. 7 & 8, District 3, Stratford

INTRODUCTION

This report contains the results of a soils investigation carried out at the above mentioned site to provide information for the design and construction of the proposed underpass.

The field work for this project was carried out between 90 12 14 and 91 01 16, and comprised of seven sampled boreholes and Dynamic Cone Penetration Test adjacent to these boreholes.

Boreholes were advanced to a maximum depth of 29.4 (elevation 327.7 m) below the existing ground level using a continuous flight-hollow stem auger and BW casing.

SITE DESCRIPTION

The site under investigation is located approximately 40 m east of the present intersection of Hwy. 7 & 8 and Regional Road 12 in the Regional Municipality of Waterloo.

The topography of the site is generally undulating with isolated knolls. Physiographically the area is located in the Region known as the "Waterloo Hills". The surface is composed of sandy hills, some of these being ridges of sandy till while others are kames and kame moraines with outwash sands occupying the intervening hollows.

SUBSURFACE CONDITIONS

The underlying subsoil at this site consists of stratified sandy silt to silty sand deposit interbedded with very stiff to hard clayey silt at various depths. For classification purposes, the soils encountered at this site can be divided into three different zones.

- a) Sandy Silt to Silty Sand
- b) Clayey Silt to Silty Clay
- c) Silty Sand, some 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. 1618801-A. This drawing also shows the locations and elevations of the borings. Description of the strata encountered at this site are given below.

Sandy Silt to Silty Sand

This sandy silt to silty sand deposit was encountered immediately below the topsoil and in some boreholes it was encountered immediately below the fill. The thickness of this deposit varies from 3.0 m to a maximum of 16.8 m within the area where this layer was fully penetrated. In this deposit, occasional silt and clayey silt seams were also encountered at various depths. The Grain Size Distribution Test results are shown on Figure 1 in an envelope form. The gradation analyses indicate that this deposit is predominantly composed of sand and silt and the composition varies over a wide range (sand 22% to 92% and silt 8% to 78%). This deposit on the south side of Hwy. 7 and 8 was observed to be loose to compact ('N' values 4 blows/0.3 m to 26 blows/0.3 m) up to a depth of about 2.0 m to 8.0 m, whereas on the north side, it was observed to be compact to dense. Below these depths, this deposit was observed to be dense to very dense state of compaction.

Clayey Silt to Silty Clay

This clayey deposit was intercepted twice in majority of the boreholes and the thickness varies from 1.3 m to a maximum of 6.9 m within the area where this layer was fully penetrated. The natural moisture content was observed to vary from 11% to 20.5% with an average value of 16.6%. The Atterberg Limits determined for the representative soil samples of this deposit are

shown on Figure 2. The consistency of this stratum was observed to be very stiff to hard, however, the Standard Penetration test results were observed to vary very widely ('N' Values 17 blows/0.3 m to over 100 blows/0.3 m).

Silty Sand, some Gravel

In majority of the boreholes, this granular deposit was encountered immediately below the clayey silt to silty clay layer and in some boreholes, it was encountered twice. The thickness of this deposit varies from as low as 0.9 m to a maximum of 7.7 m. The Grain Size Distribution test results are shown on Figure 3 in an envelope form. The Standard Penetration Test results vary over a wide range ('N' values 23 blows/0.3 m to over 100 blows/0.3 m).

Groundwater Conditions

The groundwater level was encountered in all the boreholes, and was observed between 4.3 m and 7.5 m (elevation 352.2 and elevation 347.8 m) below the existing ground level. The groundwater level at each borehole location is as follows.

<u>BH. No.</u>	<u>Elevation</u>
1	347.8
2	350.4
3	352.0
4	351.7
5	351.2
6	352.2
7	350.6

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct an underpass to carry the Regional Road 12 traffic over Hwy. 7 and 8. The structure will be a two span post-tensioned voided concrete deck with a pier column along the Hwy. 7 and 8 median. Each span will be approximately 42 m. The proposed profile grade of Regional Road 12 is set at about elevation 364.6± m. The proposed underpass will be located approximately 40 m east of the present intersection and the existing Hwy. 7 and 8 will serve as the future westbound lanes.

Structure Foundation

Considering the subsoil conditions at this site, it is recommended that the structure be supported on piles driven to about elevation 336.0 m. The following bearing capacity values may be used for the design of the HP 310x 79 piles.

Factored Bearing Capacity at U.L.S. = 900 kN

Bearing Capacity at S.L.S. Type II = 700 kN

Since the majority of the pile capacity is derived from shaft friction, it is advisable to use HP 310x79 piles.

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 SS103-11 assuming an ultimate capacity of 2100 kN.

The construction drawing may include the following.

"Pile to be driven in accordance with MTO Standard SS103-10 or SS103-11 using an ultimate capacity of _____ kN per pile must be driven below elevation _____ m.

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	$\phi = 35^\circ$	$\phi = 30^\circ$
Unit Weight (kN/m^3)	$\gamma = 22.8$	$\gamma = 21.2$

Approach Embankment

The proposed finished grade of the Regional Road 12 is set at about elevation $364.6 \pm$ m and the maximum height of approach fill above the existing ground level is expected to be about 8.0 m. No major stability problems are anticipated for the approach embankments constructed with 2H:1V side slopes. However, considering the fill height and the presence of loose to compact material up to about 2.0 m to 8.0 m below the existing ground level, settlement in the order of 25 mm to 40 mm may be expected due to the load imposed by the embankment. This settlement is expected to complete upon completion of the construction of the approach fill. The fill material should consist of well compacted acceptable material. The topsoil as well as any spongy or soft area observed within the base width of the embankment should be removed before placing the fill.

Other Considerations

The pile caps should have a minimum of 1.5 m earth cover to protect against frost penetration.

MISCELLANEOUS

The field work for this investigation was carried out under the supervision of M. Vasavithasan and Michael Plant. The equipment used was owned and

operated by London Soil test. This report was prepared by M. Vasavithasan, reviewed by P. Payer, Senior Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.

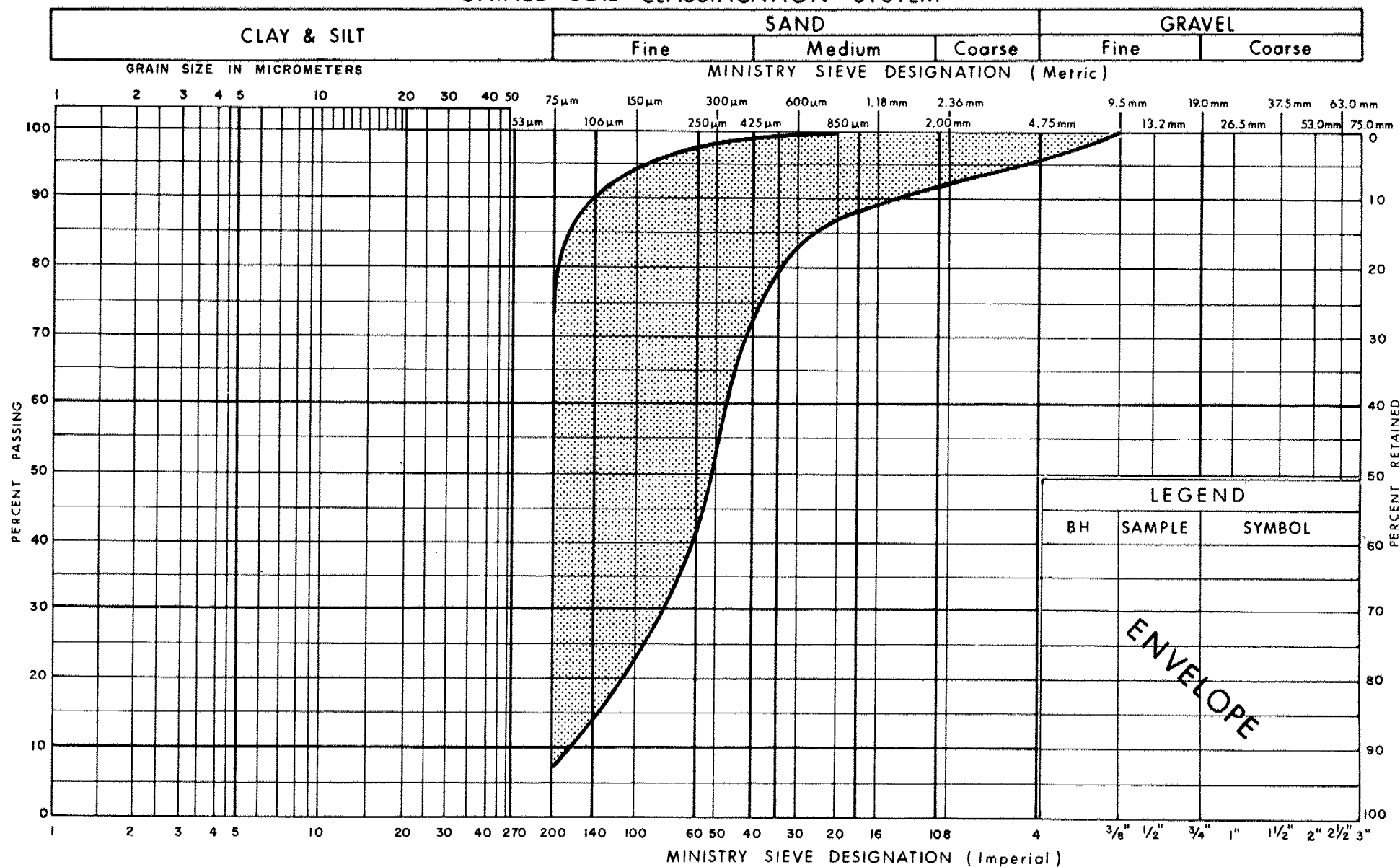


M. Vasavithasan
M. Vasavithasan, P.Eng.
Foundation Engineer

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

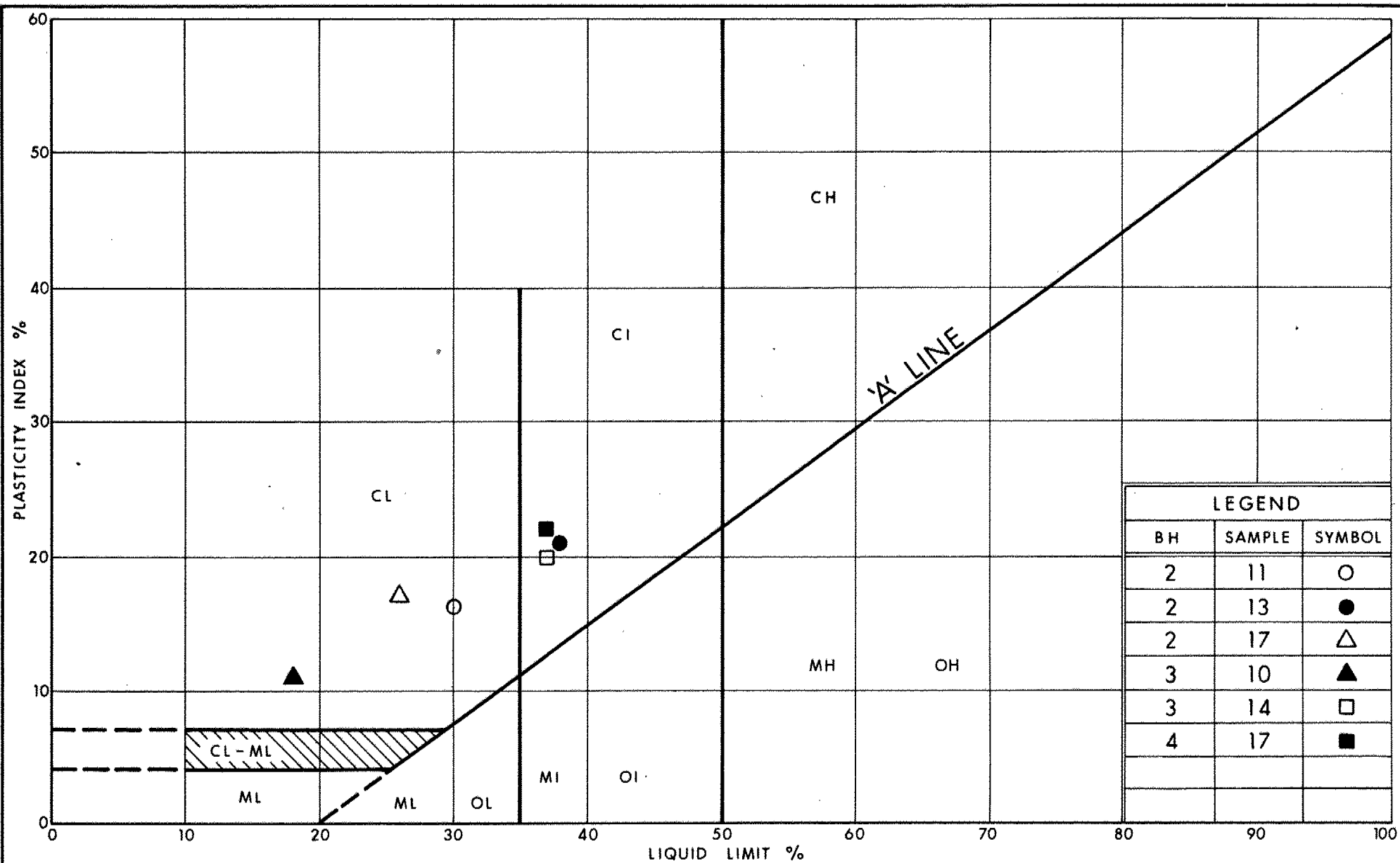


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND

FIG No 1

W P 161-88-01



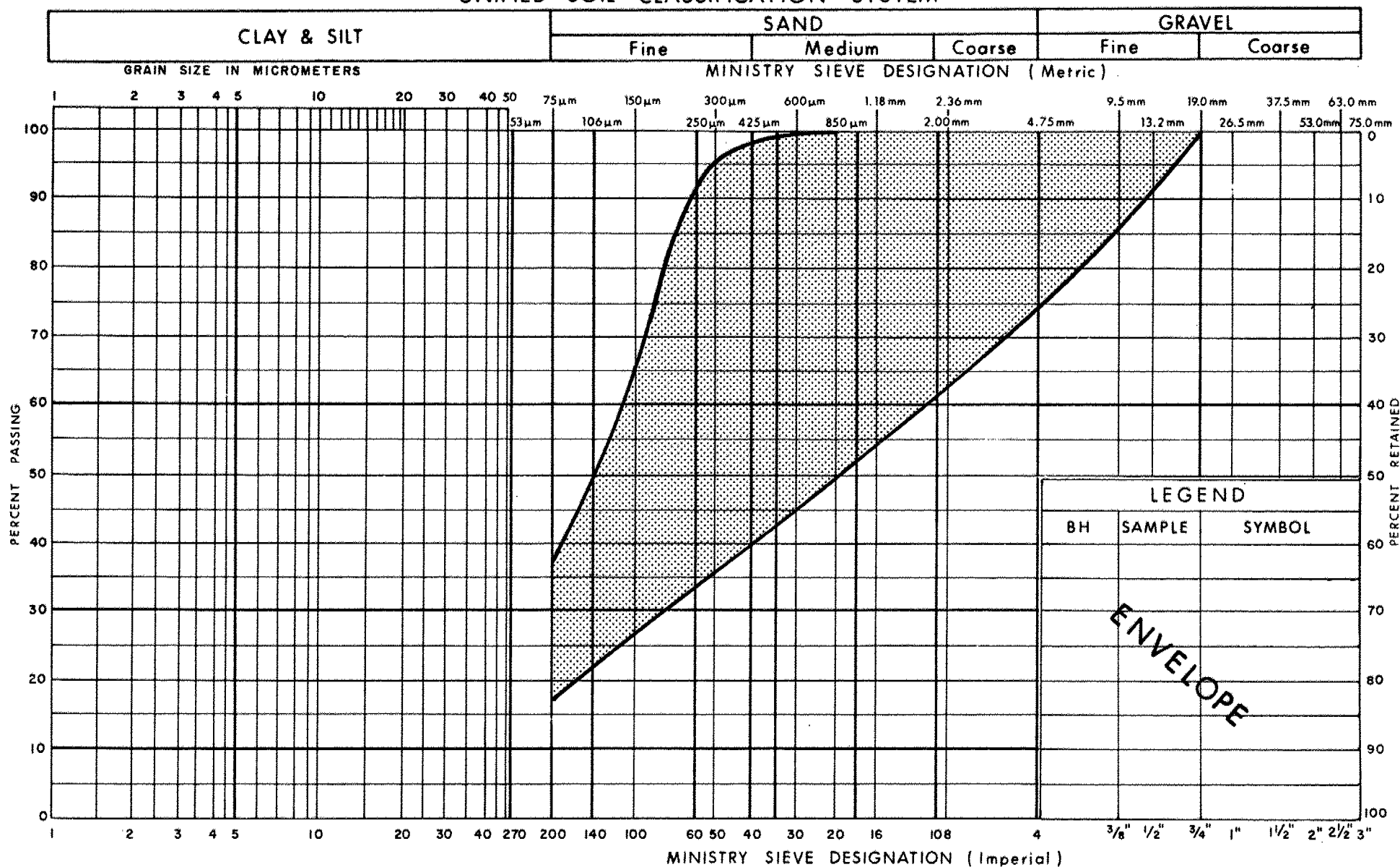
Ministry of
Transportation
Ontario

PLASTICITY CHART CLAYEY SILT TO SILTY CLAY

FIG No 2

W P 161-88-01

UNIFIED SOIL CLASSIFICATION SYSTEM



Ontario

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
SILTY SAND, SOME GRAVEL

FIG No 3

W P 161-88-01

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
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	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
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{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
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ²	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No 1 1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 740.0; E 215 915.6 ORIGINATED BY M V
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 91 01 09 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
355.3	E - N Ramp Shoulder													
354.8	SAND and GRAVEL, Some Silt (FILL)													
0.7			1	SS	30									
			2	SS	17									
	SANDY SILT to SILTY SAND, Compact to Dense		3	SS	28									
351.6			4	SS	37									
3.7			5	SS	22									
	CLAYEY SILT, With Occasional Sand Seams, Very Stiff to Hard		6	SS	33									
			7	SS	33									
			8	SS	23									
348.1														
7.2			9	SS	56									
			10	SS	28									
			11	SS	37									
	SILTY SAND, With Occasional Silt Seams Compact to Dense		12	SS	34									
339.6			13	SS	45									
15.7	End of Borehole													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 717.0; E 215 931.9 ORIGINATED BY M V
DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
DATUM GEODETIC DATE 91 01 10 TO 91 01 14 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	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					
356.1	Ground Surface													
0.0			1	SS	19									0 22 (78)
			2	SS	12									
			3	SS	16									
			4	SS	10									
			5	SS	33									0 76 (24)
			6	SS	25									
			7	SS	29									0 3 (97)
			8	SS	52									
			9	SS	31									
346.7			10	SS	15									
9.4			11	SS	23									
			12	SS	53									
			13	SS	58									
340.7			14	SS	49									
15.4			15	SS	98									
			16	SS	60									
333.0			17	SS	64									
23.1			18	SS	124	15cm								
329.7														
26.4														
328.4														
27.7														

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 694.4; E 215 951.1 ORIGINATED BY M V
DIST 3 HWY HWY 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W CASING COMPILED BY M V
DATUM GEODETIC DATE 91 01 14 TO 91 01 16 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	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 (%)
356.3	Hwy. 7 & 8 EBL Shoulder						20	40	60	80	100	10	20	30			
0.0	Organics Silt, Trace of Sand		1	SS	12										0 5 (95)		
			2	SS	13										4 74 (22)		
			3	SS	10												
			4	SS	5												
	SANDY SILT to SILTY SAND, Loose to Compact		5	SS	23												
			6	SS	24												
			7	SS	10												
			8	SS	10										0 92 (8)		
349.1			9	SS	18												
7.2	CLAYEY SILT		10	SS	46												
347.9	With Occasional Sand Seam, Hard																
8.4			11	SS	23												
	SILTY SAND, Trace of Gravel, Compact to Dense		12	SS	48												
344.8			13	SS	107												
11.5			14	SS	133												
			15	SS	130												
	CLAYEY SILT to SILTY CLAY, Hard																
337.9			16	SS	82												
18.4			17	SS	153												
			18	SS	37										0 62 (38)		
	SILTY SAND, With Occasional Silt Seams, Dense to Very Dense		19	SS	90												
328.4			20	SS	108												
27.9	End of Borehole																

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 648.6; E 215 965.2 ORIGINATED BY M V&M P
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 17 TO 90 12 19 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	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					
357.1	Ground Surface													
0.0	SILTY SAND, some Gravel, Compact, (Fill)	Organics	1	SS	26		356							
355.0			2	SS	13									
2.1	SILTY SAND, Some Gravel, Loose to Compact		3	SS	7		354							21 61 (18)
353.4			4	SS	21									
3.7	CLAYEY SILT, With Occasional Silt Seams, Trace of Sand, Stiff to Very Stiff		5	SS	18		352							0 8 (92)
			6	SS	19									
			7	SS	12									
350.6			8	SS	—									
6.5			9	SS	31		350							
			10	SS	39									
			11	SS	40		348							
			12	SS	57									
	SANDY SILT to SILTY SAND, With Occasional Silt and Clayey Silt Seams, Compact to Dense		13	SS	11		346							0 57 (43)
			14	SS	20									
			15	SS	19		344							
			16	SS	79		342							2 24 (74)
		Clayey Silt	17	SS	124		340							
337.5			18	SS	115		338							
19.6			19	SS	60		336							
			20	SS	72		334							
	CLAYEY SILT to SILTY CLAY, With Occasional Sand and Silt Seams, Hard						332							
							330							
327.7							328							
29.4	End of Borehole													

RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 655.9; E 215 987.6 ORIGINATED BY M V&M P
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 19 & 90 12 20 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
358.0	Ground Surface												
0.0	Organics												
	Silt		1	SS	7								
			2	SS	14								
			3	SS	25								
			4	SS	23								
			5	SS	14								
			6	SS	11								
			7	SS	4								
			8	SS	16								
			9	SS	9								
			10	SS	6								
	SANDY SILT to SILTY SAND, With Occasional Silt Seams, Loose to Compact		11	SS	10								
			12	SS	29								
			13	SS	20								
			14	SS	29								
			15	SS	33								
341.2													
16.8	CLAYEY SILT, Trace of Sand, Hard												
339.9													
18.1	SILTY SAND, Some Gravel, Very Dense		16	SS	79								
336.0			17	SS	128								
22.0	CLAYEY SILT, With Occasional Sand and Silt Seams, Hard												
333.2			18	SS	81								
24.8	End of Borehole												

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 641.0; E 215 997.8 ORIGINATED BY M.P.
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST & CONTINUOUS FLIGHT AUGER (H.S.) COMPILED BY M.V.
 DATUM GEODETIC DATE 90 12 14 CHECKED BY P.P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
358.6	Ground Surface												
0.0	Organics		1	SS	12								
	Silt & Clayey Silt		2	SS	14								
			3	SS	22								
			4	SS	21								
			5	SS	32								
			6	SS	8								
			7	SS	15								
			8	SS	12								
			9	SS	26								
			10	SS	9								
			11	SS	17								
			12	SS	10								
342.9			13	SS	18								
15.7	End of Borehole												

SANDY SILT to SILTY SAND,
With Occasional Silt and
Clayey Silt Seams
Compact

WATER CONTENT (%)
10 20 30

γ
kN/m³

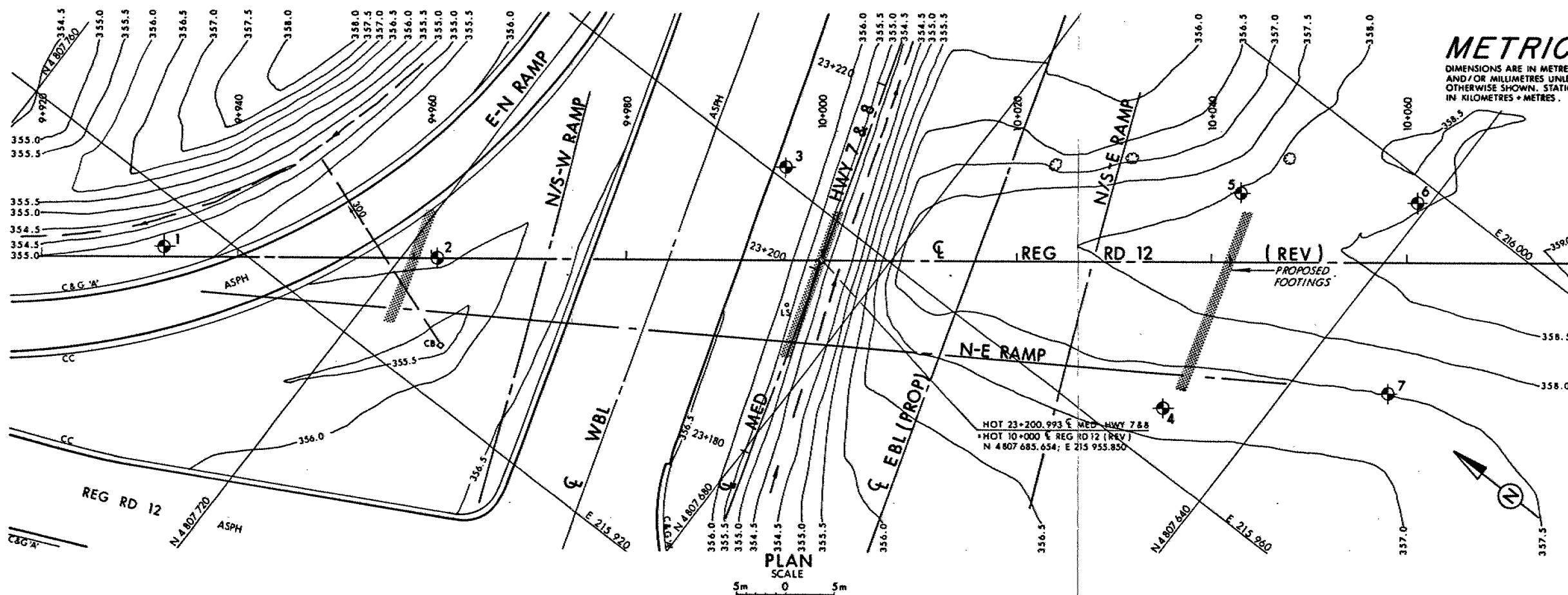
RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 161 - 88 - 01 LOCATION CO - ORDS. N 4 807 631.5; E 215 980.4 ORIGINATED BY M V&M P
 DIST 3 HWY HWY. 7 & 8 BOREHOLE TYPE CONE TEST, CONTINUOUS FLIGHT AUGER & B.W. CASING COMPILED BY M V
 DATUM GEODETIC DATE 90 12 17 CHECKED BY P P

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		W _P W W _L				
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%)				
357.4	Ground Surface													
0.0	Organics													
	SILTY SAND, Loose to Compact, (Fill)		1	SS	8									
355.3			2	SS	14									
2.1	SILTY SAND, Some Gravel, Dense		3	SS	31									
354.4			4	SS	17									
3.0	CLAYEY SILT, Some Sand, Very Stiff		5	SS	21									
			6	SS	24									
351.6			7	SS	26									
5.8	SANDY SILT to SILTY SAND, Loose to Compact		8	SS	15									
			9	SS	15									
			10	SS	8									
346.7														
10.7	End of Borehole													



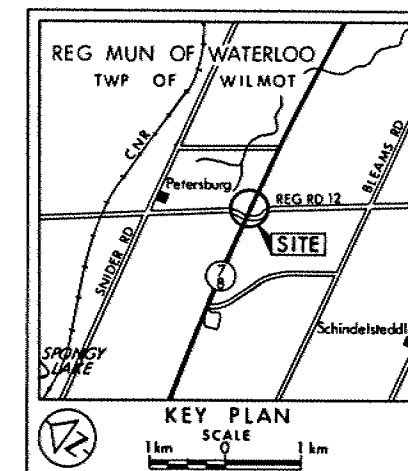
CONT No
WP No 161-88-01

REGIONAL ROAD 12 U'PASS

BORE HOLE LOCATIONS & SOIL STRATA



SHEET



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)
- W.L. at time of investigation
1990 12 and 1991 01

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	355.3	4 807 740.0	215 915.6
2	356.1	4 807 717.0	215 931.9
3	356.3	4 807 694.4	215 961.1
4	357.1	4 807 648.6	215 965.2
5	358.0	4 807 655.9	215 987.6
6	358.6	4 807 641.0	215 997.8
7	357.4	4 807 631.5	215 980.4

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 40P7-50

HWY No 7 & 8	CHECKED	DATE 1991 02 27	DIST 3
SUBMITTAL	CHECKED	DATE 1991 02 27	SITE 33-359
DRAWN R5	CHECKED	DATE 1991 02 27	DWG 1618801-A

