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W.P. No. 103-69-19

CONT. No. 89-69

W. O. No.

STR. SITE No. 24-441

HWY. No. 410

LOCATION Courtney Park Dr. Underpass

No of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

W.P. 103-89-19

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 89-69

Ontario
Ministry of
Transportation and
Communications

I N D E X

NOTE: **For the purposes of this Contract, this report supersedes all other reports prepared by or for the Ministry in connection with the above-noted project.**

EXPLANATION OF TERMS USED IN REPORT

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

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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_p	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_p	%	PLASTICITY INDEX = $w_L - w_p$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE
e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

FOUNDATION INVESTIGATION REPORT
For
Courtney Park Drive Underpass
2.0 Kilometres North of Hwy. 401/410
WP 103-69-19, Site 24-441
Hwy. 410, District 6, Toronto

INTRODUCTION

This report summarizes the results obtained from a foundation investigation carried out at the aforementioned site. The existing Courtney Park Drive Underpass will be "twinned" with a similar structure located adjacent to and south of the present bridge. The purpose of the investigation was to:

1) Determine subsurface conditions at the site;

2) Provide pertinent geotechnical recommendations regarding structure foundations and related earthworks.

SITE DESCRIPTION

The site is located adjacent to and immediately south of the existing Courtney Park Drive Underpass, situated approximately 2.0 kilometres north of Highway 401 on Highway 410 in the City of Mississauga.

The terrain surrounding the site is generally flat and used primarily for agriculture. Construction of the Hwy. 410 southbound was in progress at the time of the field investigation. Industrial units were also in the construction phase approximately 1.0 kilometre east of 410 on Courtney Park Drive.

Geologically, the site is located in the physiographic region known as the Peel Plain. The characteristic deposit in this area is a cohesive glacial till. The overburden is underlain by shale bedrock of the Dundas-Meaford Formation.

Field Investigation

A total of eight sampled boreholes were advanced at locations spread across the site between 87 11 30 to 87 12 07. The boreholes were located in the vicinity of the proposed abutments and piers and through the embankment fills. Seven dynamic cone penetration tests accompanied the sampled boreholes.

Continuous flight solid stem auger equipment was used to advance the boreholes with subsoil samples retrieved by a split spoon sampler in accordance with the standard penetration test (ASTM D1586). The samples were identified in the field and then transported to the laboratory for applicable testing on selected samples.

Water levels were obtained in the open boreholes until approximate stabilized levels were observed.

Survey information related to location and elevation of boreholes was provided by Wyllie and Ufnal Consulting Engineers.

Laboratory Analyses

The laboratory analyses consisted of:

1) Atterberg Limit tests/grain size analyses;
2) unit weight tests;
3) natural moisture content determination.

Subsurface Conditions

The characteristic deposit in this area is an overconsolidated heterogeneous mixture of silty clay, sand and gravel (glacial till) underlain by shale bedrock. The thickness of the overburden was found to

be in the order of 12-14 m. The soil in the embankments adjacent to the wing walls and approaches consists of fill that is somewhat similar to the natural soil. Approach fills are in the order of 6-8 m high.

Factual data on the subsurface conditions is contained on the Record of Borehole Sheets. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections of the borings are provided on Dwg. 1036919-A.

A detailed description of the subsurface conditions encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand and Gravel (Glacial Till)

A heterogeneous unstratified mixture of silty clay, sand and gravel is the predominant deposit at the site. It extends beneath the surface to bedrock for a thickness range of 12-14 m. A grain size distribution envelope for the soil as determined by mechanical analyses is given in Figure 1 . Atterberg limits were also obtained to evaluate the behaviour of the fine grained portion of the material and the results are plotted in Figure 2 . A summary of the indices are provided in Table 1 below. Unit weights are also included.

Table 1

		Range	Avg.
Natural Moisture Content	(W) %	9-15	12
Liquid Limit	(W_L) %	14-27	23
Plastic Limit	(Wp) %	10-14	12.5
Unit Weight	(KN/m^3)	22.6-23.6	23

It is evident from the results that the deposit is cohesive and predominantly of low plasticity. At lower depths (10 m - 14 m/Elev. 176 m to 172 m), the silt content increases and the soil becomes less cohesive.

Pockets of dense silt (lacustrine deposition) were also sampled in areas across the site. The silt layer thickness ranges from 0.75 m to 3.0 m and was confronted at an approximate elevation of 178.0 m.

The consistency of the deposit as indicated by 'N' values of the Standard

Penetration Test is primarily hard. However, a weaker zone of very stiff material is interlayered between a hard upper crust and hard material below. This weaker zone has a thickness range of 1.5 m to 6 m and was encountered at a depth range of 3.0 m to 9.0 m (Elev. 182.9 m to 177 m).

Fill Material (Mixture of Silty Clay, Sand, Gravel and Shale Fragments)

The approach fills were composed of an irregular mixture of silty clay, sand and gravel, with geotechnical properties similar to the natural soil. Shale fragments were also identified in the samples recovered. Hard augering within the fill also indicated the probability of boulders and cobbles. Grain size distribution curves for the fill material are illustrated in Figure 3 . The fill depth sampled on the top of the embankments adjacent to the wing walls ranged from 6.0 to 8.2 m.

Atterberg limits were also obtained and the results are plotted in Figure 4 . A summary of the indices and unit weights are provided in Table 2 below.

Table 2

		Range	Avg.
Natural Moisture Content	(W) %	9.5-18.5	14
Liquid Limit	(W_L) %	30-48	38
Plastic Limit	(Wp) %	16-24.5	18.6
Unit Weight	(KN/m^3)	21-22.1	21.8

The results reveal that the fill is cohesive with a low to intermediate plasticity range. 'N' values which range from 4 to 29 indicate a state of compaction ranging from low to high.

Bedrock Conditions

According to available information, bedrock consists of a shale from the Dundas-Meaford Formation. It occurs at elevations between 172.0 m and 174.0 m.

No rock coring was carried out but shale bedrock was identified in various split spoon samples.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Measurements revealed stabilized levels ranging from 0.4 m to 2.4 m below original ground level. Water levels obtained in the open boreholes penetrating the fill ranged from 0.5 m to 2.0 m above the natural soil.

T. Sangiuliano, P. Eng.
Foundation Engineer

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

APPENDIX

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 495.5; E 290 528.4 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 11 30 and 87 12 01 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.5	Ground Surface										
0.0	Mixture of Silty Clay Sand and Gravel (Fill) Occ. Shale Fragments Brown Grey		1	SS	19	*	192			22.1	
			2	SS	19						
			3	SS	15						
			4	SS	15		190				
			5	SS	26						
			6	SS	22		188				14 30 35 21
185.3	Hard		7	SS	38		186				
8.2	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till) Hard Brown Grey		8	SS	59						
			9	SS	60/	12 cm	184			22.9	
			10	SS	54						
			11	SS	44		182				
178.3			12	SS	60/	7 cm					
15.2	Silt with Interbedded Sand Seams Trace of Clay Grey Very Dense		13	SS	100/	15 cm	180				
175.2			14	SS	80/	12 cm					
18.3			15	SS	100/	12 cm	178				
172.0			16	SS	80/	12 cm	176				
21.5	End of Borehole Probable Bedrock										
	* Note: Groundwater Level Not Established. Borehole Caved at a Depth of 5.2 m						174				

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 464.4; E 290 509.6 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
186.3	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)					▼	186				
	Hard		1	SS	50					23.1	
	Brown Grey		2	SS	25		184				
			3	SS	20					22.6	
			4	SS	24		182				
			5	SS	19						6 25 44 25
	Very Stiff		6	SS	29		180			22.9	
			7	SS	90						
			8	SS	60/10 cm						
	Hard		9	SS	70/12 cm		178				
			10	SS	60/7 cm						
175.6			11	SS	60/7 cm		176				
10.7	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+³, x³ : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

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Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 474.4; E 290 498.2 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 02 and 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
186.5	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	70		186	120/20 cm		22.8	
	Brown Grey		2	SS	37		184			23.1	3 32 40 25
	Hard		3	SS	41		182				
			4	SS	23		180			23.2	5 35 48 12
	Very Stiff		5	SS	80/15 cm						
			6	SS	60/7 cm		178				
	Hard		7	SS	120/7 cm		176			22.7	3 45 44 8
174.2			8	SS	100/15 cm						
12.3	End of Borehole Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 4 METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 458.9; E 290 470.3 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY TS
DATUM Geodetic DATE 87 12 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
186.0	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till) Very Stiff to Hard Brown Grey		1	SS	80	▼	184				3 29 52 16
			2	SS	27		182				
	Stiff		3	SS	17						5 32 43 20
			4	SS	38		180				
			5	SS	110		178				
			6	SS	100		176				
174.9			7	SS	105						
11.1	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

$15 \overset{20}{\underset{10}{\diamond}} 5$ (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5 METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 446.6; E 290 481.5 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 03 CHECKED BY GP.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.2	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	68		186	120/15 cm			
	Brown Grey		2	SS	38		184				5 27 47 21
	Hard		3	SS	45						
			4	SS	29		182				6 28 42 24
			5	SS	25						
	Very Stiff		6	SS	25		180				
			7	SS	Bounding						
			8	SS	110		178				
	Hard		9	SS	100/15 cm						4 23 66 7
			10	SS	100/15 cm		176				
173.9			11	SS	100/12 cm		174				
12.3	End of Borehole Probable Bedrock										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
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RECORD OF BOREHOLE No 6

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 433.6; E 290 448.2 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 04 CHECKED BY

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, x LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.0	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	55	▼	186			23.1	12 23 41 24
	Brown Grey — Hard		2	SS	50		184				
			3	SS	24						
			4	SS	29		182			23.6	8 32 44 16
			5	SS	30						
	Very Stiff		6	SS	18						
			7	SS	55		180				
			8	SS	75						13 30 32 25
	Silt Very Dense		9	SS	70		178				
			10	SS	100		176				
	Hard		11	SS	100/15 cm						
173.2			12	SS	100/7 cm		174				
13.8	End of Borehole Probable Bedrock										

+3, x5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7 METRIC

W P 103-69-19 LOCATION Co-ords. N 834 426.2; E 290 420.3 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL ✦ FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.8	Ground Surface										
0.0	Mixture of Silty Clay Sand and Gravel (Fill) Occasional Shale Fragments Brown		1	SS	6		192				
			2	SS	4		190				16 20 42 22
			3	SS	8	▼	188			22.1	
186.9	Very Stiff		4	SS	26						
6.9	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till) Very Stiff to Hard Brown Grey		5	SS	55		186			48%	
			6	SS	40		184				
			7	SS	31		182				
	Stiff		8	SS	16						
			9	SS	34		180				
			10	SS	75/	15 cm	178				
			11	SS	100/	15 cm					
175.4			12	SS	100/	15 cm	176				
18.4	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 ; Numbers refer to Sensitivity

15 ◇ 5 (20 / 10) (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8 METRIC

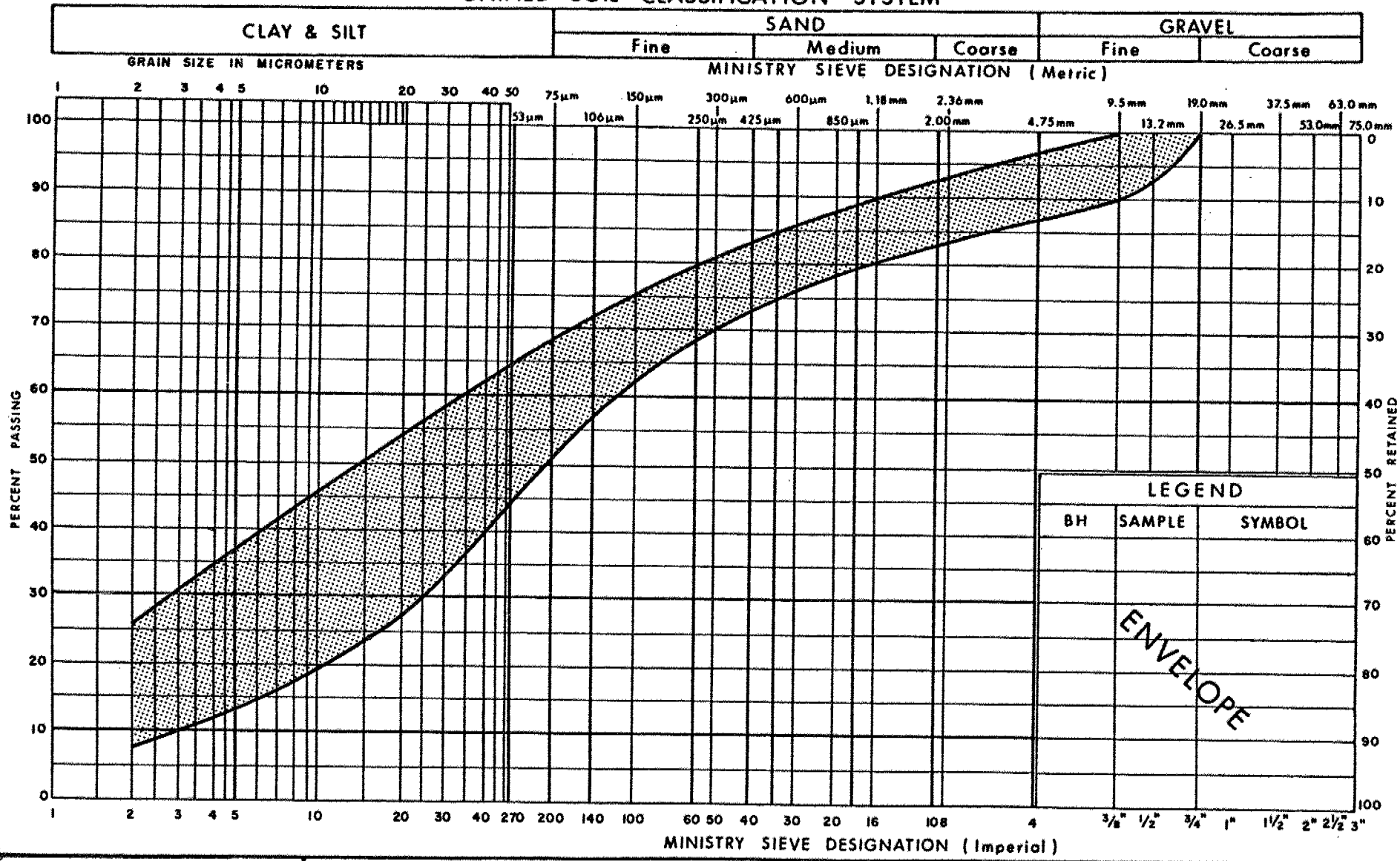
W P 103-69-19 LOCATION Co-ords. N 4 834 433.9; E 290 388.4 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 07 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2	Ground Surface										
0.0	Mixture of Silty Clay Sand and Gravel (Fill)		1	SS	29		192				
	Occasional Shale Fragments		2	SS	27		190				
	Grey-Brown Mottled		3	SS	21		188			21.0	1 12 62 25
187.1											
6.1	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		4	SS	42		186				
	Hard		5	SS	57						
			6	SS	28		184				
	Brown Grey		7	SS	22		182				
	Very Stiff		8	SS	75/15 cm						
			9	SS	100/15 cm		180				
	Sandy Silt Very Dense		10	SS	80		178				
			11	SS	80/15 cm						
	Hard		12	SS	80/7 cm		176				
173.2			13	SS	100/15 cm		174				
20.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

UNIFIED SOIL CLASSIFICATION SYSTEM



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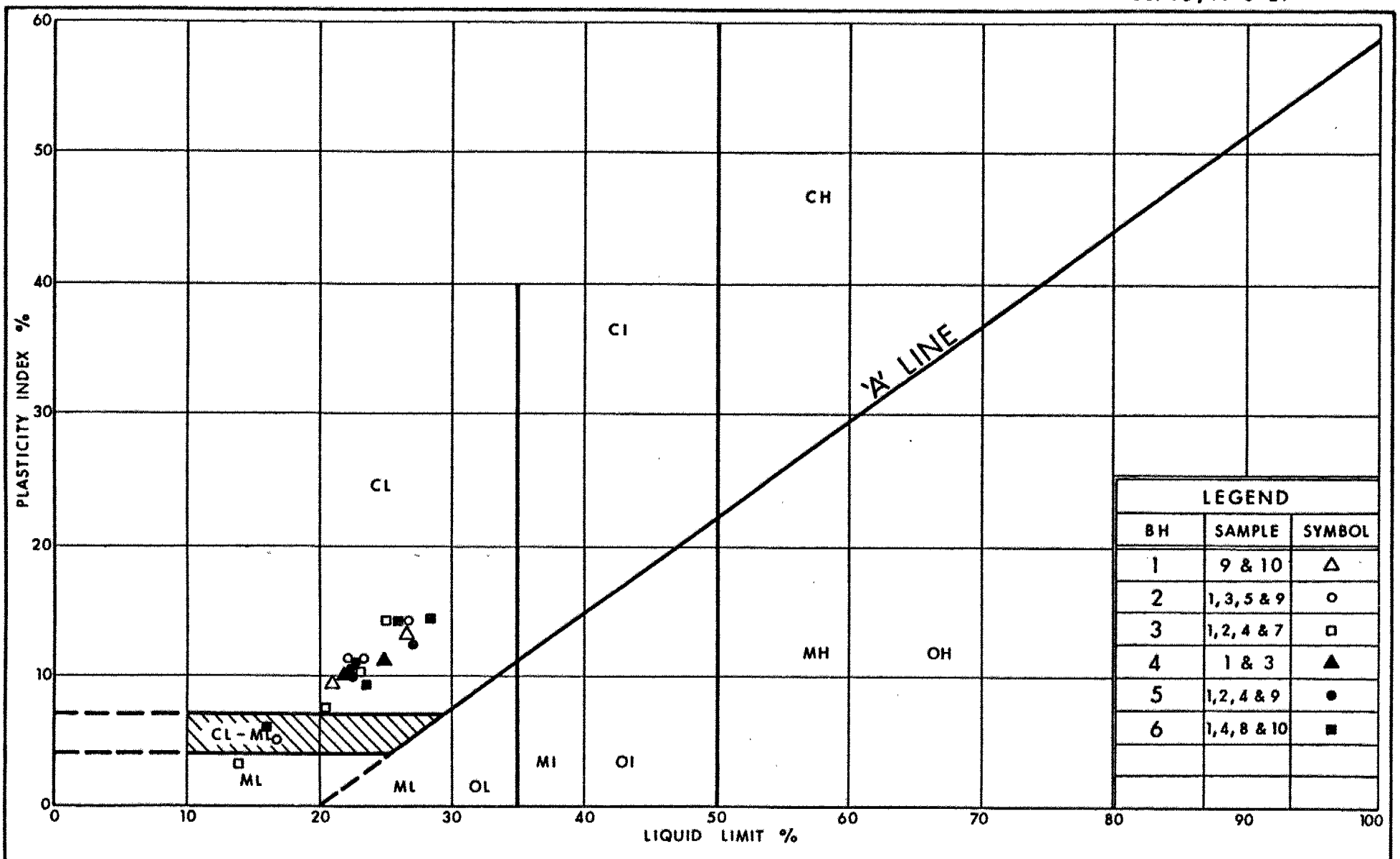
GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF
SILTY CLAY, SAND & GRAVEL (Glacial Till)

FIG No 1
W P 103-69-19

17

Oct 75, FF-S-21



LEGEND		
BH	SAMPLE	SYMBOL
1	9 & 10	△
2	1, 3, 5 & 9	○
3	1, 2, 4 & 7	□
4	1 & 3	▲
5	1, 2, 4 & 9	●
6	1, 4, 8 & 10	■

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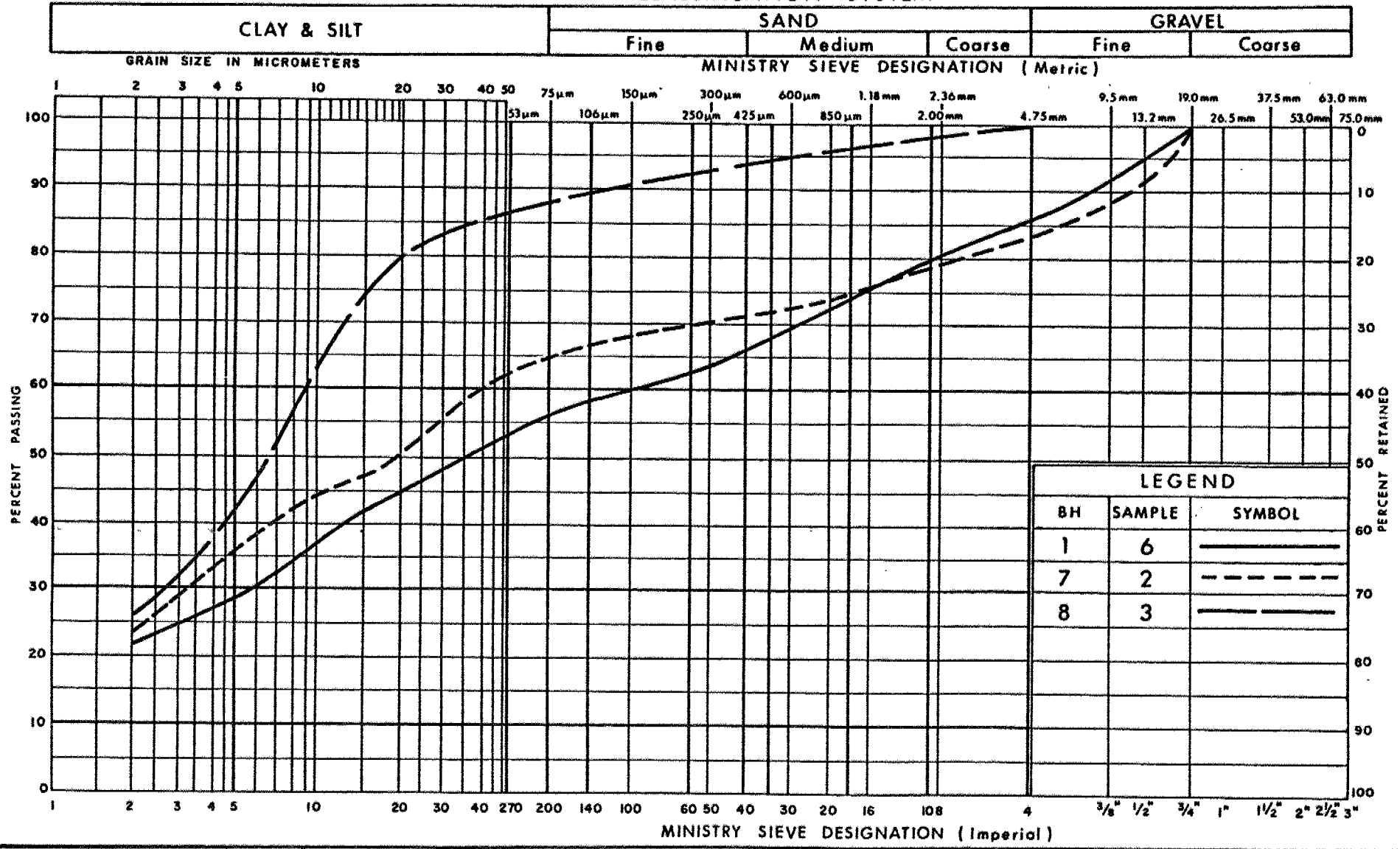
PLASTICITY CHART
HETEROGENEOUS MIXTURE OF
SILTY CLAY, SAND & GRAVEL (Glacial Till)

FIG No 2
W P 103-69-19

18

78 12 M

UNIFIED SOIL CLASSIFICATION SYSTEM



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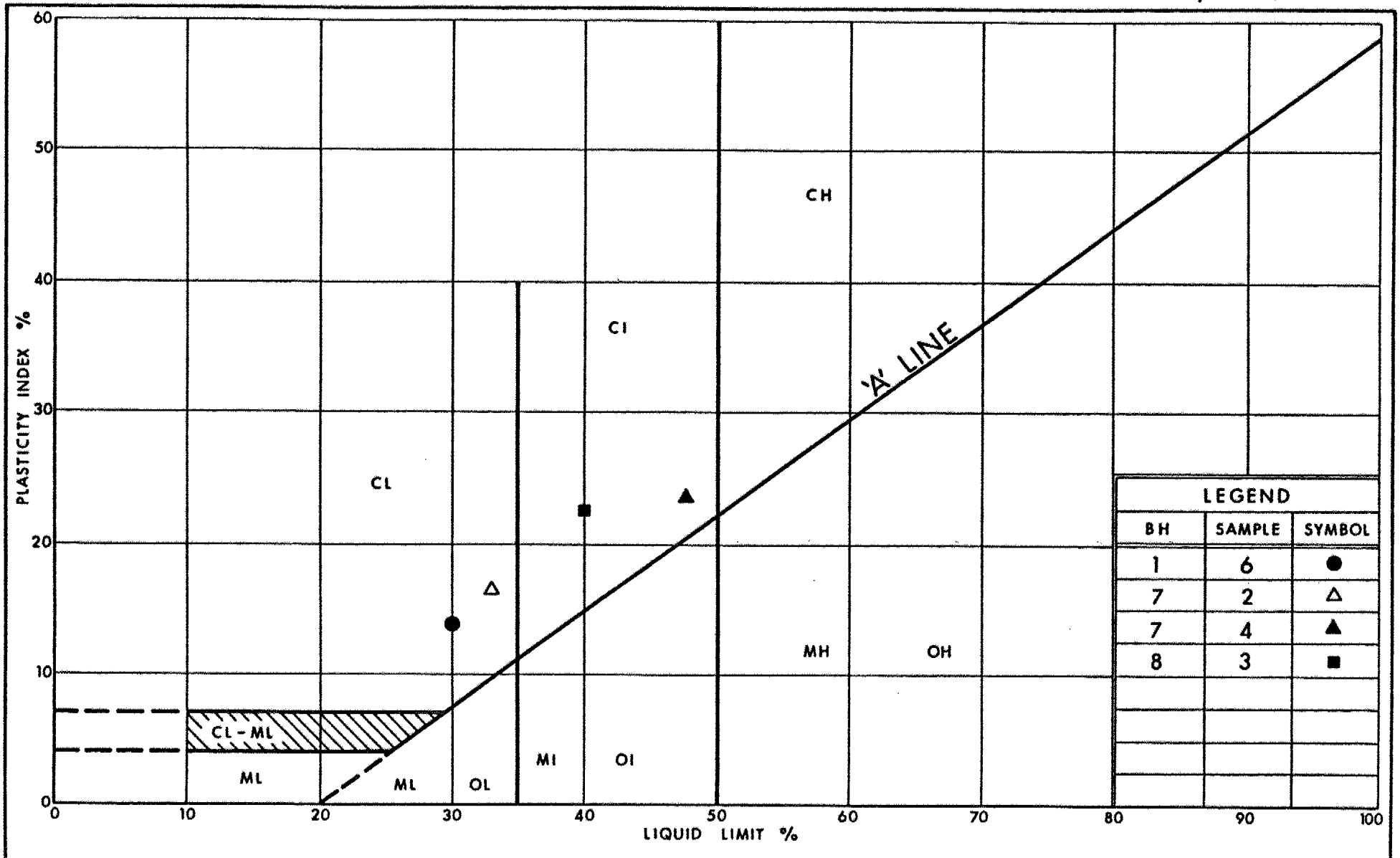
GRAIN SIZE DISTRIBUTION
IRREGULAR MIXTURE OF SILTY CLAY, SAND & GRAVEL
OCC SHALE FRAGMENTS (Fill)

FIG No 3
W P 103-69-19

61

Oct 75, FF-S-21



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PLASTICITY CHART
IRREGULAR MIXTURE OF SILTY CLAY, SAND & GRAVEL
OCC SHALE FRAGMENTS (Fill)

FIG No 4
W P 103-69-19

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FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 103-69-19 DIST 6

HWY 410 STR SITE 24-441

Courtney Park Drive Underpass

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
A. Wittenberg
J. Smrcka (2)
K. Bassi
J.H. Peer
T. Yakutchuk
G. Szekreny
B. Steeves (Cover Only)
M. MacLean (Cover Only)
File

GEOCRES 30M12-204 DATE JAN - 7 1988

FOUNDATION INVESTIGATION REPORT
For
Courtney Park Drive Underpass
2.0 Kilometres North of Hwy. 401/410
WP 103-69-19, Site 24-441
Hwy. 410, District 6, Toronto

INTRODUCTION

This report summarizes the results obtained from a foundation investigation carried out at the aforementioned site. The existing Courtney Park Drive Underpass will be "twinned" with a similar structure located adjacent to and south of the present bridge. The purpose of the investigation was to:

1) Determine subsurface conditions at the site;

2) Provide pertinent geotechnical recommendations regarding structure foundations and related earthworks.

SITE DESCRIPTION

The site is located adjacent to and immediately south of the existing Courtney Park Drive Underpass, situated approximately 2.0 kilometres north of Highway 401 on Highway 410 in the City of Mississauga.

The terrain surrounding the site is generally flat and used primarily for agriculture. Construction of the Hwy. 410 southbound was in progress at the time of the field investigation. Industrial units were also in the construction phase approximately 1.0 kilometre east of 410 on Courtney Park Drive.

Geologically, the site is located in the physiographic region known as the Peel Plain. The characteristic deposit in this area is a cohesive glacial till. The overburden is underlain by shale bedrock of the Dundas-Meaford Formation.

Field Investigation

A total of eight sampled boreholes were advanced at locations spread across the site between 87 11 30 to 87 12 07. The boreholes were located in the vicinity of the proposed abutments and piers and through the embankment fills. Seven dynamic cone penetration tests accompanied the sampled boreholes.

Continuous flight solid stem auger equipment was used to advance the boreholes with subsoil samples retrieved by a split spoon sampler in accordance with the standard penetration test (ASTM D1586). The samples were identified in the field and then transported to the laboratory for applicable testing on selected samples.

Water levels were obtained in the open boreholes until approximate stabilized levels were observed.

Survey information related to location and elevation of boreholes was provided by Wyllie and Ufnal Consulting Engineers.

Laboratory Analyses

The laboratory analyses consisted of:

1) Atterberg Limit tests/grain size analyses;
2) unit weight tests;
3) natural moisture content determination.

Subsurface Conditions

The characteristic deposit in this area is an overconsolidated heterogeneous mixture of silty clay, sand and gravel (glacial till) underlain by shale bedrock. The thickness of the overburden was found to

be in the order of 12-14 m. The soil in the embankments adjacent to the wing walls and approaches consists of fill that is somewhat similar to the natural soil. Approach fills are in the order of 6-8 m high.

Factual data on the subsurface conditions is contained on the Record of Borehole Sheets. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections of the borings are provided on Dwg. 1036919-A.

A detailed description of the subsurface conditions encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand and Gravel (Glacial Till)

A heterogeneous unstratified mixture of silty clay, sand and gravel is the predominant deposit at the site. It extends beneath the surface to bedrock for a thickness range of 12-14 m. A grain size distribution envelope for the soil as determined by mechanical analyses is given in Figure 1 . Atterberg limits were also obtained to evaluate the behaviour of the fine grained portion of the material and the results are plotted in Figure 2 . A summary of the indices are provided in Table 1 below. Unit weights are also included.

Table 1

		Range	Avg.
Natural Moisture Content	(W) %	9-15	12
Liquid Limit	(W_L) %	14-27	23
Plastic Limit	(Wp) %	10-14	12.5
Unit Weight	(KN/m^3)	22.6-23.6	23

It is evident from the results that the deposit is cohesive and predominantly of low plasticity. At lower depths (10 m - 14 m/Elev. 176 m to 172 m), the silt content increases and the soil becomes less cohesive.

Pockets of dense silt (lacustrine deposition) were also sampled in areas across the site. The silt layer thickness ranges from 0.75 m to 3.0 m and was confronted at an approximate elevation of 178.0 m.

The consistency of the deposit as indicated by 'N' values of the Standard

Penetration Test is primarily hard. However, a weaker zone of very stiff material is interlayered between a hard upper crust and hard material below. This weaker zone has a thickness range of 1.5 m to 6 m and was encountered at a depth range of 3.0 m to 9.0 m (Elev. 182.9 m to 177 m).

Fill Material (Mixture of Silty Clay, Sand, Gravel and Shale Fragments)

The approach fills were composed of an irregular mixture of silty clay, sand and gravel, with geotechnical properties similar to the natural soil. Shale fragments were also identified in the samples recovered. Hard augering within the fill also indicated the probability of boulders and cobbles. Grain size distribution curves for the fill material are illustrated in Figure 3 . The fill depth sampled on the top of the embankments adjacent to the wing walls ranged from 6.0 to 8.2 m.

Atterberg limits were also obtained and the results are plotted in Figure 4 . A summary of the indices and unit weights are provided in Table 2 below.

Table 2

		Range	Avg.
Natural Moisture Content	(W) %	9.5-18.5	14
Liquid Limit	(W_L) %	30-48	38
Plastic Limit	(Wp) %	16-24.5	18.6
Unit Weight	(KN/m^3)	21-22.1	21.8

The results reveal that the fill is cohesive with a low to intermediate plasticity range. 'N' values which range from 4 to 29 indicate a state of compaction ranging from low to high.

Bedrock Conditions

According to available information, bedrock consists of a shale from the Dundas-Meaford Formation. It occurs at elevations between 172.0 m and 174.0 m.

No rock coring was carried out but shale bedrock was identified in various split spoon samples.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Measurements revealed stabilized levels ranging from 0.4 m to 2.4 m below original ground level. Water levels obtained in the open boreholes penetrating the fill ranged from 0.5 m to 2.0 m above the natural soil.

Discussions and Recommendations

A two-span structure (36 m - 36 m) similar to the existing overpass and located adjacent and south of the existing structure is to be constructed. The bridge is designed to facilitate increased traffic as a result of rapid residential and industrial growth in the area. The new structure will form a component of the planned partial interchange at Courtney Park Drive and Hwy. 410. The profile grade of the new bridge has been set at 194.0 m and that of Hwy. 410 at the crossing at 187.2 m. Evaluations on whether to remove the existing wing walls in preparation of a proposed core collector system and bridge conversion from a two-span to four-span in the future is in progress. The following itemizes our recommendations for:

(1) structure foundations
(2) temporary shoring
(3) approach fills
(4) granular backfill to structures

Structure Foundations

The proposed structure may be supported on spread footings founded within the natural soil at the same elevations as the existing adjacent bridge footings. All footings must have a minimum earth cover of 1.2 m for frost protection. For purposes of the O.H.B.D.C. the following design values are recommended.

Abutments, Piers, Retaining Walls:	Factored Bearing Capacity at U.L.S.	450 KPa
	Bearing Capacity at @.L.S. Type II	300 KPa

In view of the overconsolidated nature of the overburden settlements induced will be minimal. The magnitude of the total and differential settlements should not exceed 25 mm.

To ensure resistance against horizontal movement of the footings caused by lateral loading an adhesion of 75 KPa can be assumed between the underside of the rough concrete footing and the soil.

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the glacial till deposit. Localized seepage into excavations can be controlled by perimeter ditches and pumping from sumps.

In view of the close proximity of the existing bridge footings, excavation of the new footings should be monitored closely to avoid any undermining. In addition the soil at founding elevation should be void of any fill that may have been used in the construction of the existing footings. This material is to be removed and replaced with mass concrete.

Temporary Shoring

In the event that it is decided to remove the wing walls, temporary shoring will be required to resist applicable earth pressures. It is recommended that the shoring take the form of a soldier pile and lagging system. For design purposes, the following parameters are provided.

Material	ϕ	γ
Fill	25°	22 KN/m^3
Granular (Behind Existing Abutments and Wing Walls)	30°	21.2 KN/m^3

Surcharge pressures and hydrostatic pressures should be incorporated in the design. If required, the system can be supported by soil anchors using an adhesion of 75 KPa. The anchors must be tested for pull-out to confirm the capacity of the soil.

The soldier piles can be installed in pre-augered holes or driven into the soil penetrating at least 2 m below the abutment footing elevation.

Approach Fills

No stability problems are anticipated for approach fills and embankments constructed with standard 2H:1V side and forward slopes. Approach fills in the order of magnitude of 7.5 m will be required. All softened and/or organic material within the planned limits of the immediate approaches should be excavated for their full depth prior to fill placement. The total immediate settlement of the fill and natural subsoil has been predicted as 75-100 mm. Shear keys should be instituted where new fills abut against existing fills.

Granular Backfill to Structures

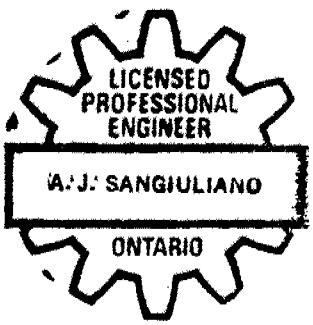
Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments to prevent hydrostatic pressure build-up. Design parameters of the soil are given below:

	Granular 'A'	Granular 'B'
Angle of Internal Friction (Ø)	35°	30°
Unit Weight (KN/m^3)	22.8	21.2
Coefficient of Active Earth Pressure (KA)	0.27	0.33
Coefficient of Earth Pressure at Rest	0.43	0.5

Weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill. If the abutment walls are rigid and unyielding the earth pressure coefficient at rest should be used in the calculation of lateral earth pressures.

Miscellaneous

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, utilizing equipment owned and operated by Master Soil Drilling, Toronto. This report was written by T. Sangiuliano and reviewed by Mr. M. S. Devata, Chief Foundation Engineer (East).



T. Sangiuliano, P.Eng.
Foundation Engineer

M. S. Devata, P.Eng.
Chief Foundation Engineer (East)

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (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 = $\frac{c_u}{\tau_r}$

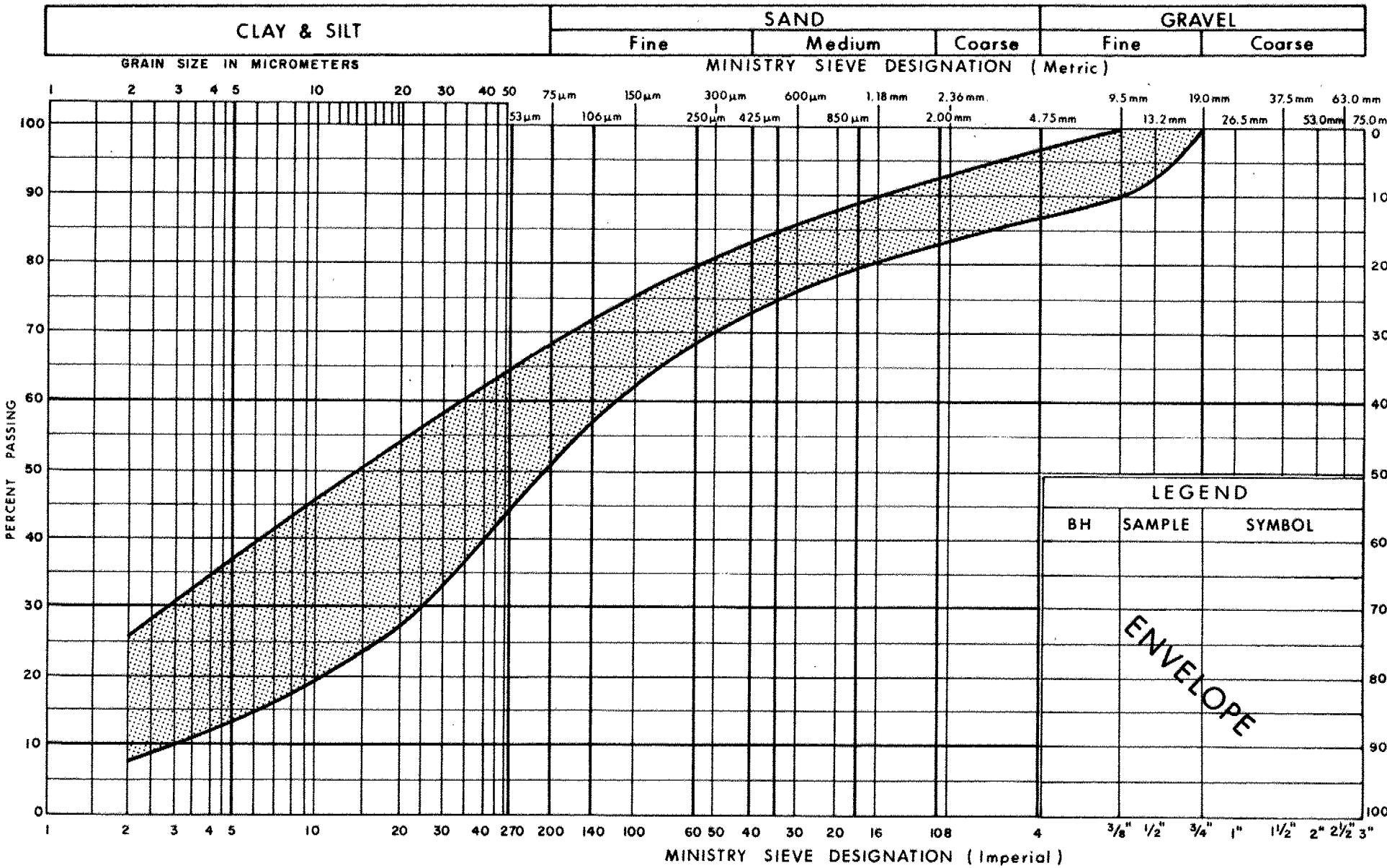
PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE

e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC- GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

UNIFIED SOIL CLASSIFICATION SYSTEM



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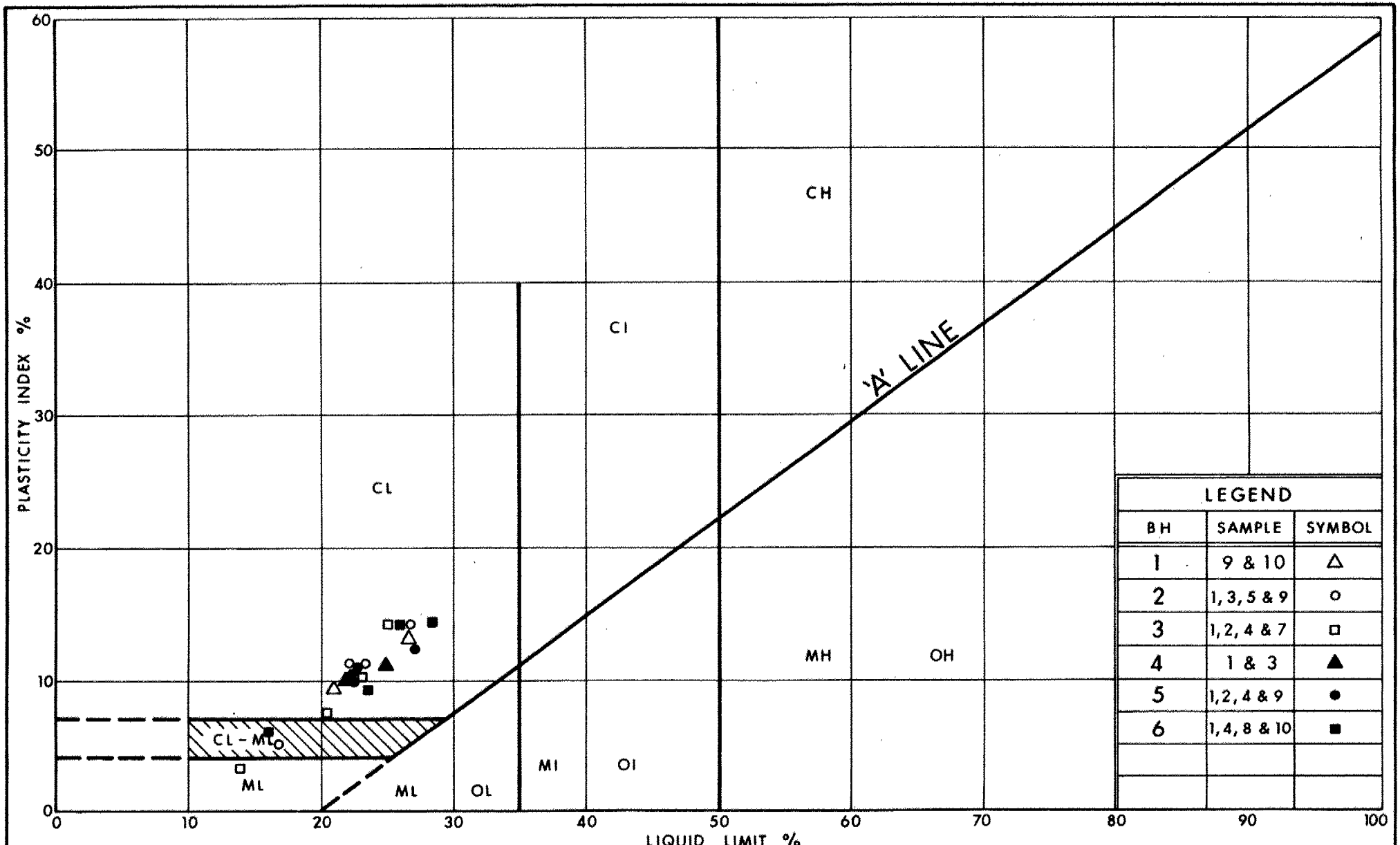
GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF
SILTY CLAY, SAND & GRAVEL (Glacial Till)

FIG No 1
W P 103-69-19



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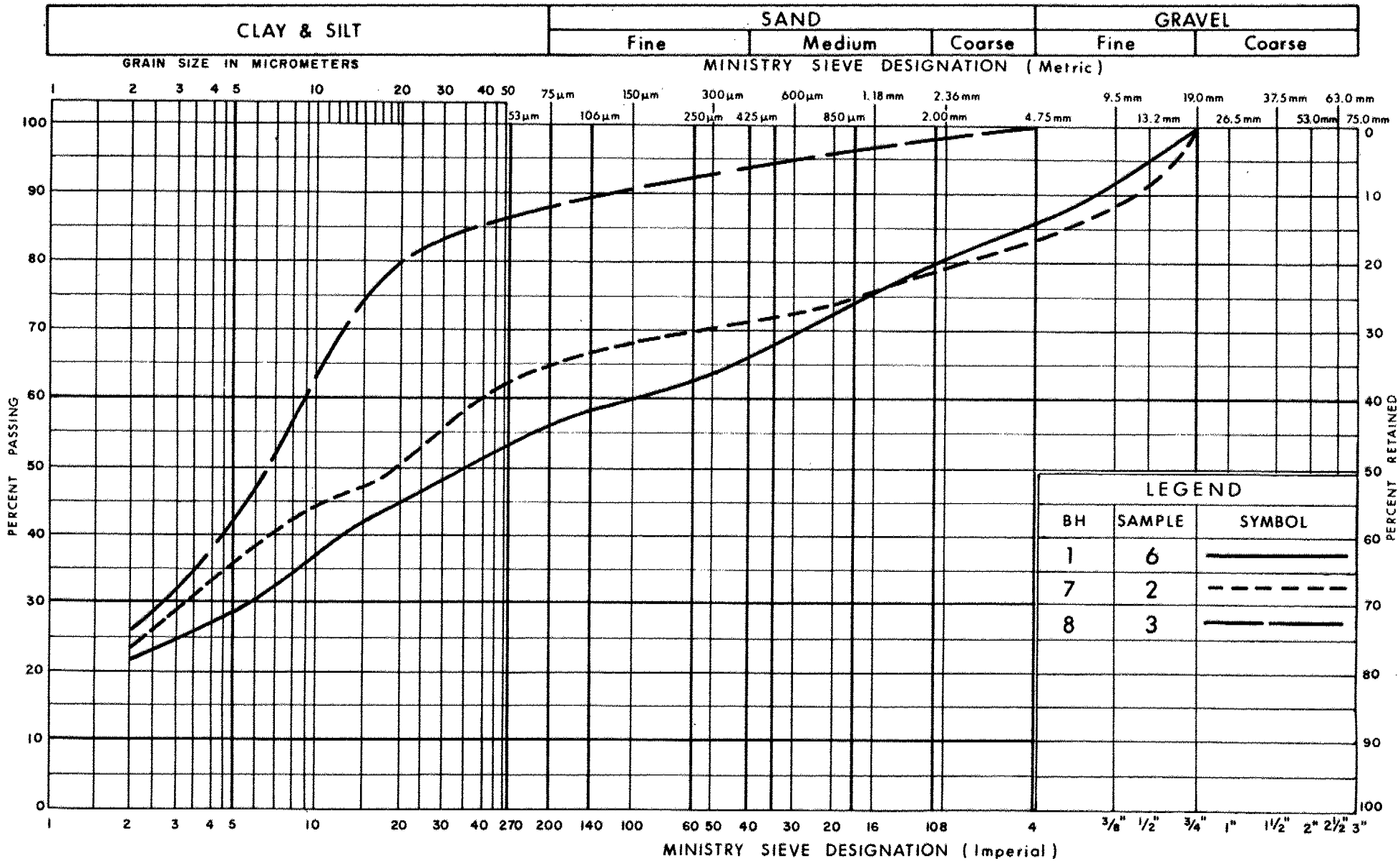
PLASTICITY CHART
HETEROGENEOUS MIXTURE OF
SILTY CLAY, SAND & GRAVEL (Glacial Till)

FIG No 2
W P 103-69-19

UNIFIED SOIL CLASSIFICATION SYSTEM



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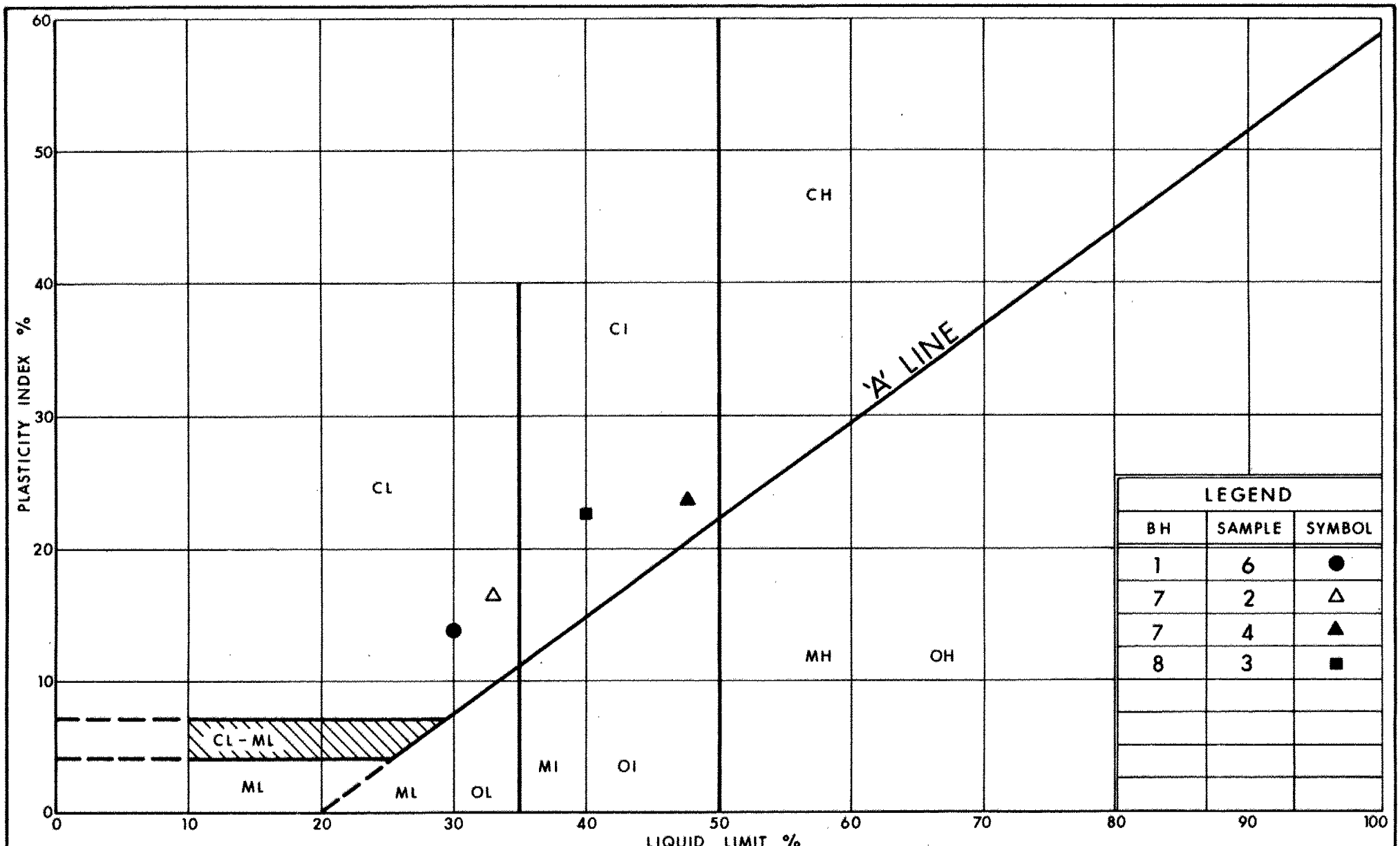
GRAIN SIZE DISTRIBUTION
IRREGULAR MIXTURE OF SILTY CLAY, SAND & GRAVEL
OCC SHALE FRAGMENTS (Fill)

FIG No 3
W P 103-69-19



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PLASTICITY CHART
IRREGULAR MIXTURE OF SILTY CLAY, SAND & GRAVEL
OCC SHALE FRAGMENTS (Fill)

FIG No 4
WP 103-69-19

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 495.5; E 290 528.4 ORIGINATED BY TS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS

DATUM Geodetic DATE 87 11 30 and 87 12 01 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.5	Ground Surface										
0.0	Mixture of Silty Clay Sand and Gravel (Fill) Occ. Shale Fragments Brown Grey		1	SS	19	*	192			22.1	
			2	SS	19						
			3	SS	15						
			4	SS	15		190				
			5	SS	26		188				
			6	SS	22						14 30 35 21
185.3	Hard		7	SS	38		186				
8.2	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till) Hard Brown Grey		8	SS	59						
			9	SS	60/	12 cm	184			22.9	
			10	SS	54		182				
			11	SS	44						
178.3			12	SS	60/	7 cm	180				
15.2	Silt with Interbedded Sand Seams Trace of Clay Grey Very Dense		13	SS	100/	15 cm	178				
175.2			14	SS	80/	12 cm	176				
18.3			15	SS	100/	12 cm	174				
172.0			16	SS	80/	12 cm					
21.5	End of Borehole Probable Bedrock										

* Note: Groundwater Level Not Established. Borehole Caved at a Depth of 5.2 m

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

OFFICE RÉPORT ON-SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 464.4; E 290 509.6 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 02 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
186.3	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)					▼	186				
	Hard		1	SS	50					23.1	
	Brown Grey		2	SS	25		184				
			3	SS	20					22.6	
			4	SS	24		182				
			5	SS	19						6 25 44 25
	Very Stiff		6	SS	29		180			22.9	
			7	SS	90						
			8	SS	60/10 cm						
	Hard		9	SS	70/12 cm		178				
			10	SS	60/7 cm						
175.6			11	SS	60/7 cm		176				
10.7	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

15 (20 / 10) S (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 474.4; E 290 498.2 ORIGINATED BY TS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS

DATUM Geodetic DATE 87 12 02 and 03 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.5	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	70		186	120/20 cm		22.8	
	Brown Grey		2	SS	37		184			23.1	3 32 40 25
	Hard		3	SS	41		182				
			4	SS	23		180			23.2	5 35 48 12
	Very Stiff		5	SS	80/15 cm						
			6	SS	60/7 cm		178				
	Hard		7	SS	120/7 cm		176			22.7	3 45 44 8
174.2			8	SS	100/15 cm						
12.3	End of Borehole Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 (%) STRAIN AT FAILURE / 10

OFFICE REPORT ON-SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 458.9; E 290 470.3 ORIGINATED BY TS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger COMPILED BY TS

DATUM Geodetic DATE 87 12 03 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.0	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till) Very Stiff to Hard Brown Grey		1	SS	80	▼	184				3 29 52 16
			2	SS	27		182				
	Stiff		3	SS	17						5 32 43 20
			4	SS	38		180				
			5	SS	110		178				
			6	SS	100		176				
174.9			7	SS	105						
11.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE 10

OFFICE REPORT ON, SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 5

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 446.6; E 290 481.5 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 03 CHECKED BY GP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.2	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	68	▼	186	120/15 cm			
	Brown / Grey		2	SS	38		184				5 27 47 21
	Hard		3	SS	45						
			4	SS	29		182				6 28 42 24
			5	SS	25						
	Very Stiff		6	SS	25		180				
			7	SS	Bounding						
			8	SS	110		178				
	Hard		9	SS	100/15 cm						4 23 66 7
			10	SS	100/15 cm		176				
173.9			11	SS	100/12 cm		174				
12.3	End of Borehole Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

OFFICE REPORT ON-SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 433.6; E 290 448.2 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 04 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.0	Ground Surface										
0.0	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		1	SS	55		186			23.1	12 23 41 24
	Brown / Grey — Hard		2	SS	50		184				
			3	SS	24						
			4	SS	29		182			23.6	8 32 44 16
			5	SS	30						
	Very Stiff		6	SS	18						
			7	SS	55		180				
			8	SS	75						13 30 32 25
	Silt Very Dense		9	SS	70		178				
			10	SS	100		176				
	Hard		11	SS	100/15 cm						
173.2			12	SS	100/7 cm		174				
13.8	End of Borehole Probable Bedrock										

+³, ×⁵ : Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON -SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7

METRIC

W P 103-69-19 LOCATION Co-ords. N 834 426.2; E 290 420.3 ORIGINATED BY TS

DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS

DATUM Geodetic DATE 87 12 04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)	γ kN/m³	GR SA SI CL
193.8	Ground Surface							20 40 60 80 100	10 20 30		
0.0	Mixture of Silty Clay Sand and Gravel (Fill) Occasional Shale Fragments Brown		1	SS	6		192				
			2	SS	4		190				16 20 42 22
			3	SS	8	▼	188			22.1	
186.9	Very Stiff		4	SS	26					48%	
6.9	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till) Very Stiff to Hard Brown Grey		5	SS	55		186				
			6	SS	40		184				
			7	SS	31		182				
	Stiff		8	SS	16						
			9	SS	34		180				
			10	SS	75/ 15 cm		178				
			11	SS	100/ 15 cm						
175.4			12	SS	100/ 15 cm		176				
18.4	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+³, ×⁵ : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P 103-69-19 LOCATION Co-ords. N 4 834 433.9; E 290 388.4 ORIGINATED BY TS
DIST 6 HWY 410 BOREHOLE TYPE Solid Stem Auger, Cone Test COMPILED BY TS
DATUM Geodetic DATE 87 12 07 CHECKED BY

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.2	Ground Surface										
0.0	Mixture of Silty Clay Sand and Gravel (Fill) Occasional Shale Fragments Grey-Brown Mottled		1	SS	29		192				
			2	SS	27		190				
			3	SS	21		188			21.0	1 12 62 25
187.1											
6.1	Heterogeneous Mixture of Silty Clay Sand and Gravel (Glacial Till)		4	SS	42		186				
			5	SS	57						
	Hard		6	SS	28		184				
	Brown / Grey		7	SS	22		182				
	Very Stiff		8	SS	75/15 cm						
			9	SS	100/15 cm		180				
	Sandy Silt Very Dense		10	SS	80		178				
			11	SS	80/15 cm						
	Hard		12	SS	80/7 cm		176				
173.2			13	SS	100/15 cm		174				
20.0	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-0-207 82 04

METRIC

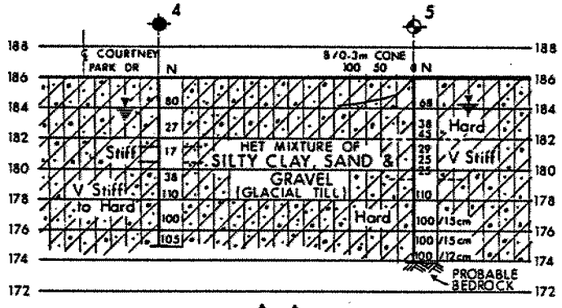
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 103-69-19

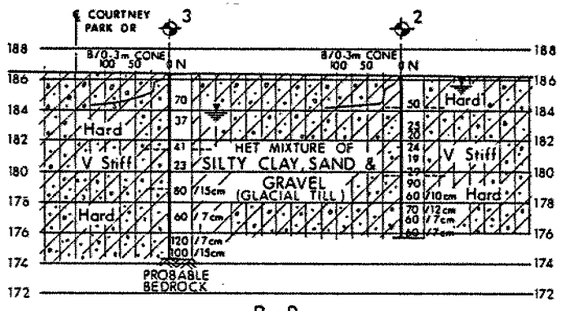
COURTNEY PARK DRIVE

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

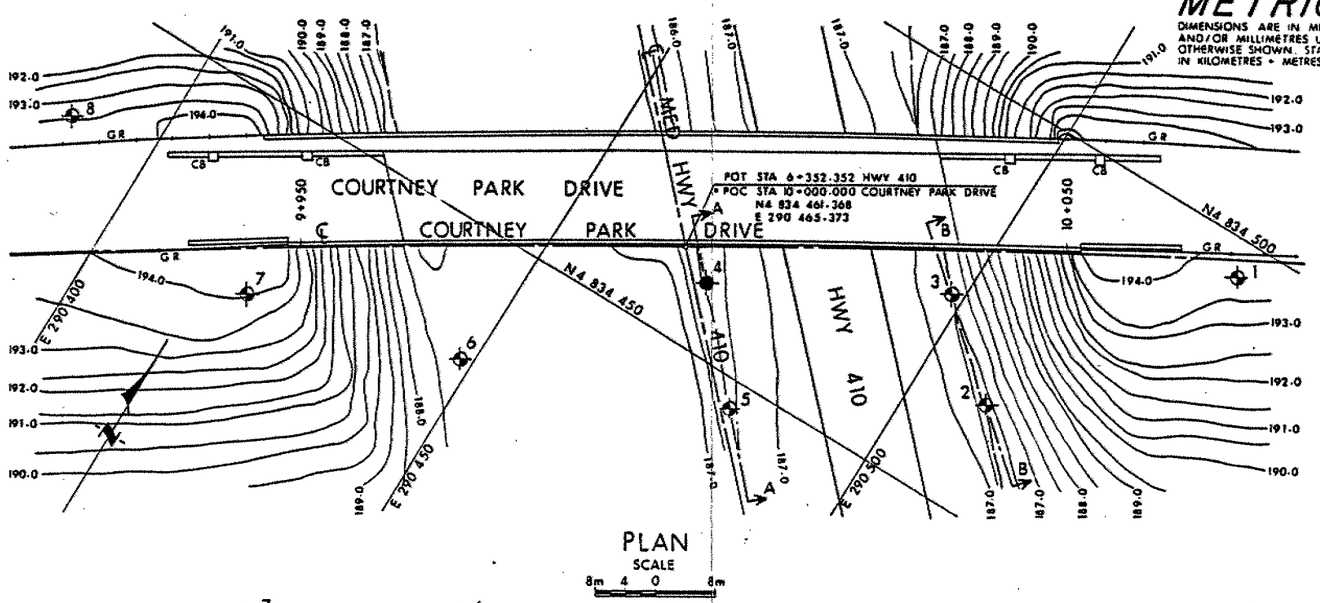


A-A

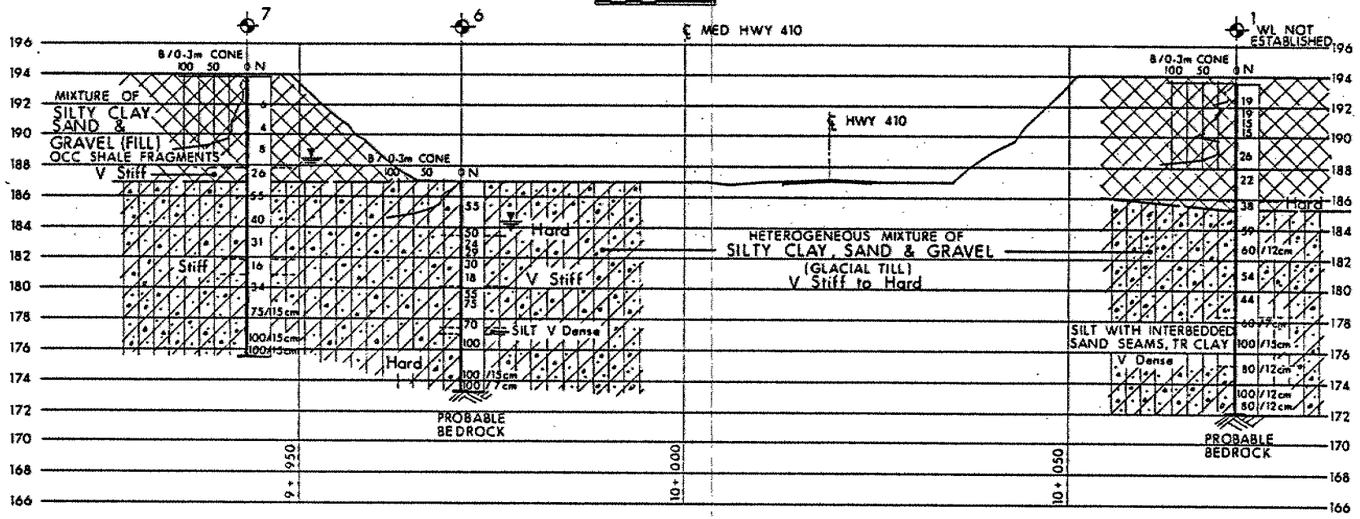


B-B

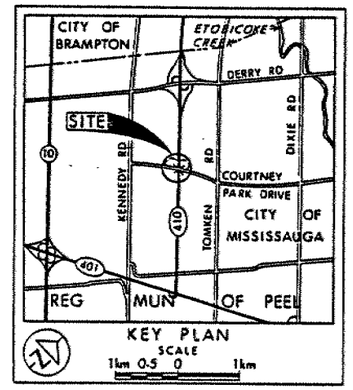
SECTIONS
SCALE
4m 2 0 4m



PLAN
SCALE
8m 4 0 8m



℄ PROFILE COURTNEY PARK DRIVE
SCALE
8m 4 0 8m Hor
4m 2 0 4m Vert



KEY PLAN
SCALE
1km 0.5 0 1km

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 87 11 and 87 12

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	193.5	4 834 495.5	290 528.4
2	186.3	4 834 464.4	290 509.6
3	186.5	4 834 474.4	290 498.2
4	186.0	4 834 458.9	290 470.3
5	186.2	4 834 446.6	290 481.5
6	187.0	4 834 433.6	290 448.2
7	193.8	4 834 426.2	290 420.3
8	193.2	4 834 433.9	290 388.4

NOTE:
Refer to Record of Borehole for Subsoil information for Borehole No 8.

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.

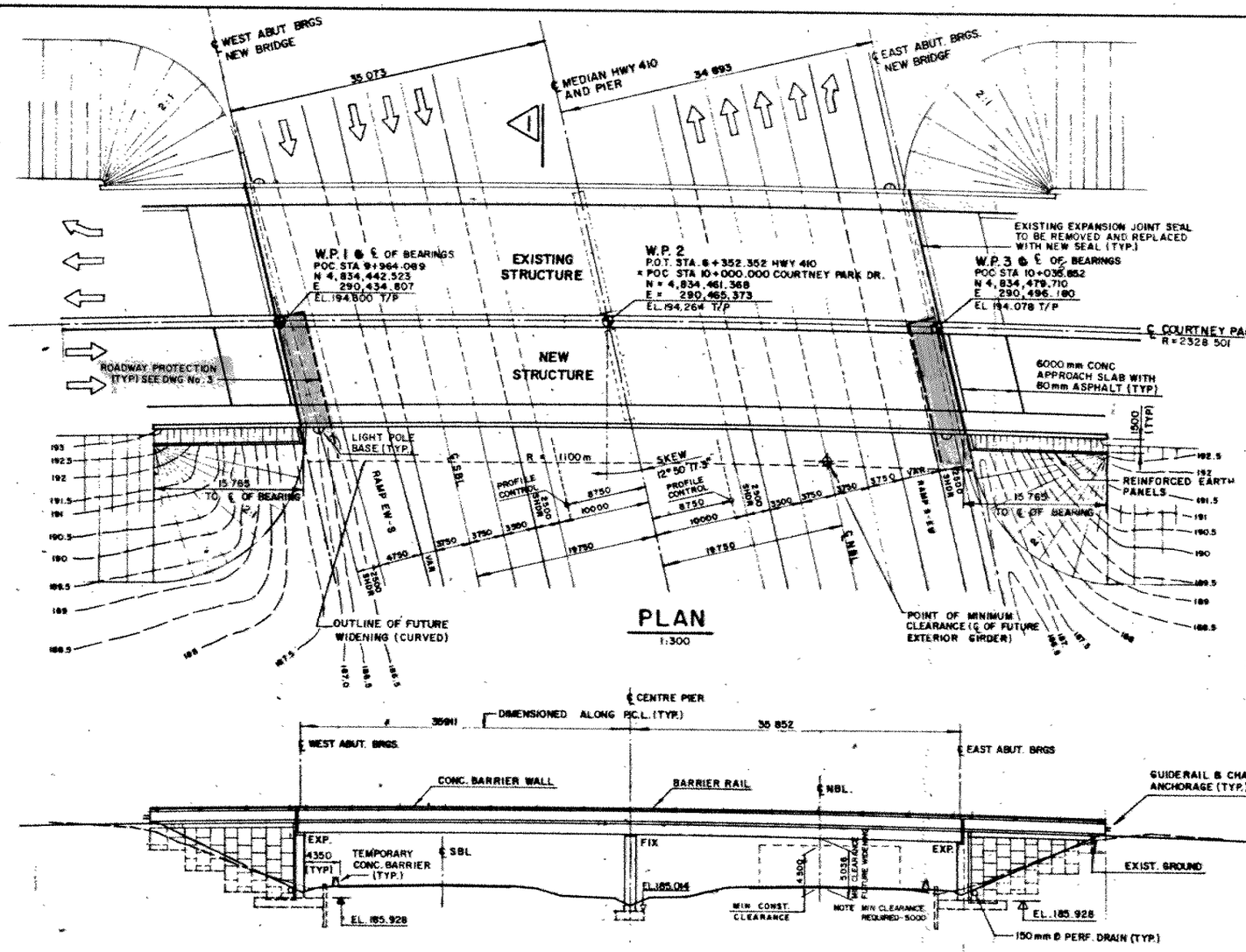
REV	DATE	BY	DESCRIPTION

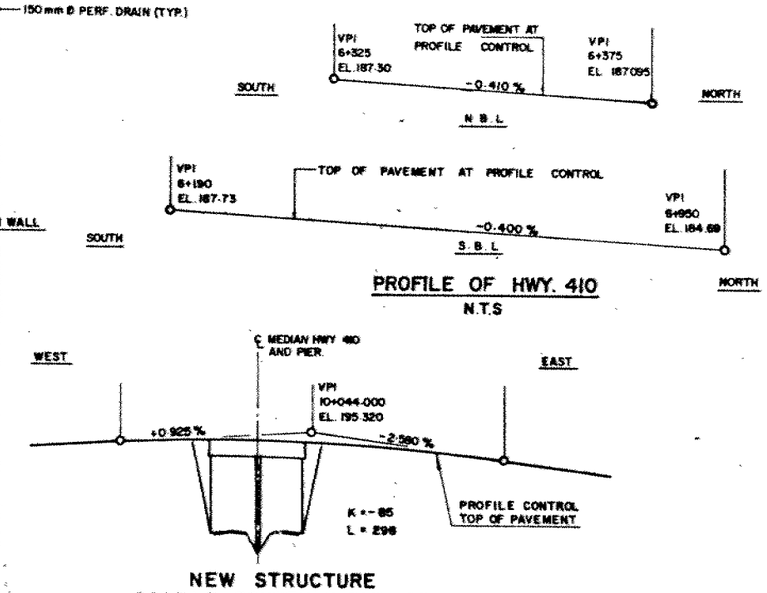
Geocres No 30M12-[redacted] 204

HWY No 410			DIST 6
SUBMD TS	CHECKED	DATE 88 01 04	SITE 24-441
DRAWN DT	CHECKED	APPROVED	DWG 1036919-A

REF No E-6086-1, 82 04

11480.00





BM 186 996
CUT 'T' E FACE OF CENTRE CONCRETE PILLAR 0·5 RT 6+360·3

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

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

James Sherlock
252-5451

ISSUED
JUL 8 1988
WYLLIE & UFNAL LIMITED

DIST No 6
CONT No
WP No 103-69-19

HWY 410 - COURTNEY PARK DRIVE UNDERPASS
GENERAL ARRANGEMENT

SHEET

Wyllie & Ufnal
consulting engineers

GENERAL NOTES

CLASS OF CONCRETE
* FOOTINGS 20 MPA
* REMAINDER 30 MPA

CLEAR COVER TO REINFORCING STEEL

* FOOTINGS	100 ± 25
* WINGWALLS	
FRONT FACE	80 ± 20
BACK FACE	70 ± 20
* PIERS & ABUTMENTS	80 ± 20
* DECK	
TOP	70 ± 20
BOTTOM	40 ± 10
* REMAINDER	70 ± 20

UNLESS OTHERWISE NOTED

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

CONSTRUCTION NOTES
* THE CONTRACTOR SHALL FINISH THE BEARING SEATS LEVEL TO THE SPECIFIED ELEVATIONS

W.P. DENOTES WORKING POINT
T/P DENOTES TOP OF PAVEMENT

LIST OF DRAWINGS

REGISTERED PROFESSIONAL ENGINEER CIVIL F. E. SCHOLAR PROVINCE OF ONTARIO

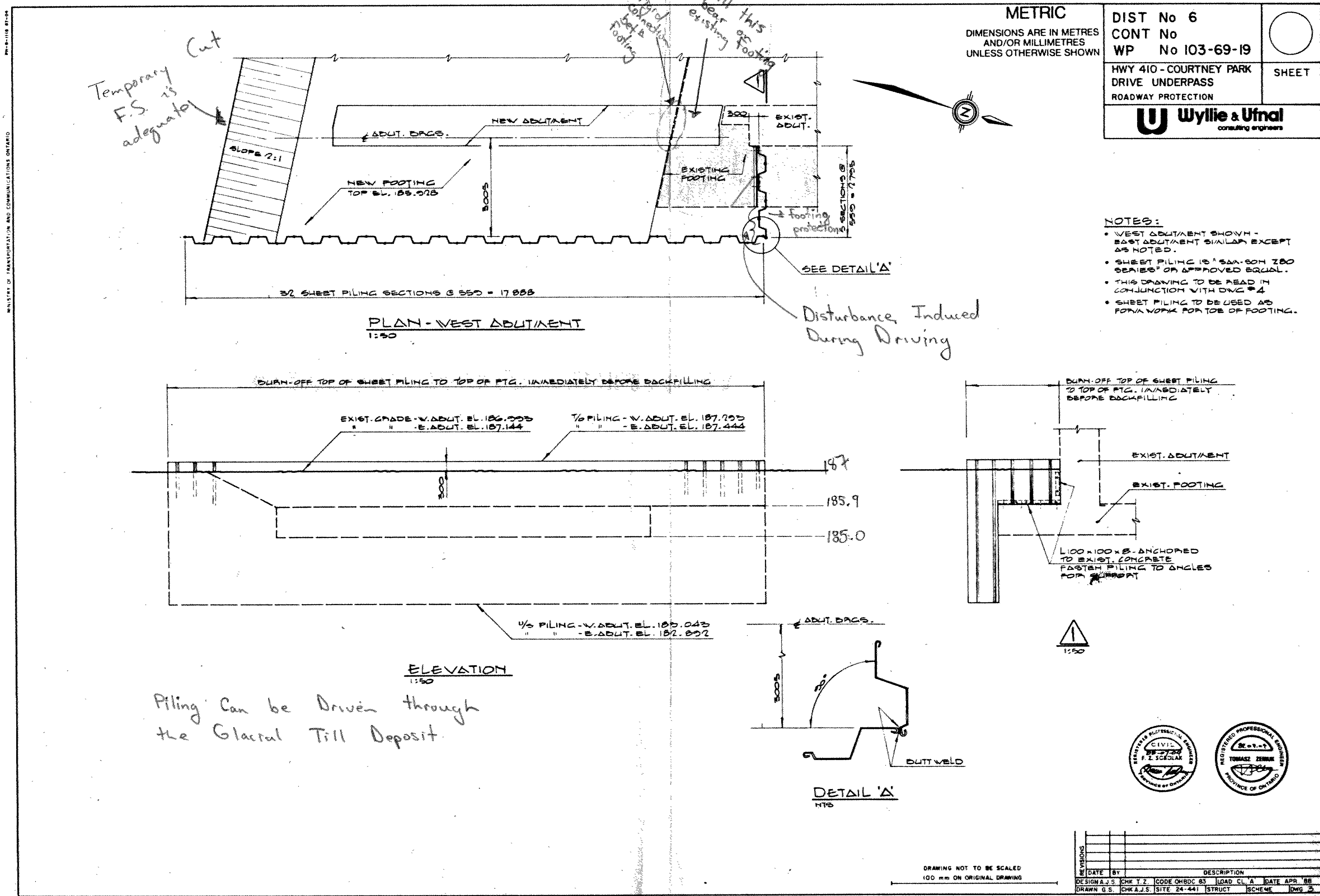
REGISTERED PROFESSIONAL ENGINEER TOMASZ ZEMBIK PROVINCE OF ONTARIO

APPLICABLE STANDARD DRAWINGS

DD 3502 - MINIMUM GRANULAR BACKFILL REQUIREMENTS
OPSD 508.02 - BRIDGE DECK WATERPROOFING
DD 4604 - FALSEWORK CLEARANCES

REVISIONS			
NO.	DATE	BY	DESCRIPTION
DESIGN J.C.S	CHECK T.Z.	LOADING ONBDC 83, CL.'A'	DATE APR '88
DRAWING G.S.	CHECK J.C.S.	SITE No. 24-441	DWG 1

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ONTARIO
FOR CONSTRUCTION


METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN
DIST No 6
CONT No
WP No 103-69-19
HWY 410 - COURTNEY PARK DRIVE UNDERPASS
ROADWAY PROTECTION
SHEET
Wyllie & Ufnal consulting engineers
Temporary Cut
F.S. is adequate
Will this bear on existing footing
Bond connection between new & existing footing
SLOPE 2:1
ADUT. BRGS.
NEW ABUTMENT
EXIST. ABUT.
300
EXISTING FOOTING
NEW FOOTING TOP EL. 185.928
3005
3 SECTIONS @ 555 = 2795
footing protection
SEE DETAIL 'A'
32 SHEET PILING SECTIONS @ 555 = 17 888
PLAN - WEST ABUTMENT
1:50
Disturbance Induced During Driving
NOTES:
• WEST ABUTMENT SHOWN - EAST ABUTMENT SIMILAR EXCEPT AS NOTED.
• SHEET PILING IS "SAA-SOH Z80 SERIES" OR APPROVED EQUAL.
• THIS DRAWING TO BE READ IN CONJUNCTION WITH DWG #4
• SHEET PILING TO BE USED AS FORM WORK FOR TOE OF FOOTING.
BURN-OFF TOP OF SHEET PILING TO TOP OF FTG. IMMEDIATELY BEFORE BACKFILLING
EXIST. GRADE - W. ABUT. EL. 186.993
" " - E. ABUT. EL. 187.144
T/O PILING - W. ABUT. EL. 187.293
" " - E. ABUT. EL. 187.444
300
187
185.9
185.0
U/S PILING - W. ABUT. EL. 183.043
" " - E. ABUT. EL. 182.892
ELEVATION
1:50
Piling Can be Driven through the Glacial Till Deposit
BURN-OFF TOP OF SHEET PILING TO TOP OF FTG. IMMEDIATELY BEFORE BACKFILLING
EXIST. ABUTMENT
EXIST. FOOTING
L100 x 100 x 8 - ANCHORED TO EXIST. CONCRETE
FASTEN PILING TO ANGLES FOR SUPPORT
1
1:50
ABUT. BRGS.
3005
70°
BUTT WELD
DETAIL 'A'
NTS
F. Z. SCSOLAK
TOMASZ ZEMBIK
PROVINCE OF ONTARIO
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING
REVISIONS
DATE
BY
DESCRIPTION
DESIGN A.J.S.
CHK T.Z.
CODE OHBDC 83
LOAD CL. A
DATE APR '88
DRAWN G.S.
CHK A.J.S.
SITE 24-441
STRUCT
SCHEME
DWG 3