DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-188

DIST. 6 REGION

W.P. No. 21-79-17

CONT. No. 87-43

W. O. No.

STR. SITE No.

HWY. No. 410

LOCATION Hwy 410 & Steeles Ave. Culvert

No OF PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 87 - 43

Ontario

Ministry of
Transportation and
Communications

INDEX

NOTE: For purposes of the contract, this report supercedes all other foundation 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 $\bar{N}$.

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

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
Prop. Culverts and Extensions
in vicinity of
Hwy. 410 - Steeles Ave. Interchange
W.P. 21-79-17
Hwy. 410, District 6, Toronto

INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation carried out at the following four culvert sites.

Culvert 1, on Hwy. 410 at Sta. 10+281 ±
Culvert 2, on Hwy. 410 at Sta. 10+680 ±
Culvert 3, on Steeles Ave. at Sta. 9+797 ±
Culvert 4, on Steeles Ave. at Sta. 10+407 ±

The fieldwork for this investigation was conducted between 84 08 10 and 84 08 14, and consisted of the following:

Culvert "1" - two sampled boreholes (2.6 and 5.0 m deep) advanced by means of hollow stem augers, and one cone penetration test

Culvert "2" - two 4.9 m deep sampled boreholes advanced by means of hollow stem augers, and one cone penetration test

Culvert "3" - three sampled boreholes (4.1, 4.1, and 5.6 m deep) advanced by means of hollow stem augers, and two cone penetration tests

Culvert "4" - two 4.8 m deep sampled boreholes advanced by means of hollow stem augers, and two cone penetration tests.

SITE DESCRIPTION AND GEOLOGY

The sites are located in the vicinity of the proposed Hwy. 410 - Steeles Ave. interchange in the City of Brampton, Regional Municipality of Peel.

North of Steeles Ave., land use is predominantly industrial. South of Steeles Ave., land use still remains agricultural. Topography across the site is generally flat with the ground surface sloping gently towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit in the area investigated is generally composed of a cohesive glacial till whose thickness was not fully established in this investigation. The till overburden is underlain by shale bedrock of the Georgian Bay Formation (Formerly known as the Meaford-Dundas). The bedrock elevation was not determined in this investigation.

The "Peel Plain" region is well drained by Credit, Oakville, and Etobicoke Creeks, which have cut deep valleys in the overburden. There are no extensive undrained depressions, swamps or bogs in the region, although in many of the interstream areas drainage is still imperfect. Locally, drainage at the sites is presently accomplished by means of creeks, roadside ditches and culverts.

SUBSURFACE CONDITIONS - CULVERT "1" (BH 10, 11)

General

The predominant soil at this site is composed of a cohesive glacial till deposit which can be generally described as a heterogeneous mixture of silty clay, sand, gravel, with a variable gradation. The full depth of this deposit was not investigated.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borehole Sheets in the Appendix (BH 10, BH 11). The location of the two boreholes are shown in plan and profile on Sheet No. 49-1 of the contract drawings, along with an estimated stratigraphical section.

The following is a description of the soils encountered at the site:

Glacial Till (Het. Mixture Silty Clay, Sand, Gravel)

This cohesive till deposit was the only soil type identified at the site with the exception of a sandy silt layer encountered in BH 11.

The silty clay till was found at an approximate elevation of 191 and was investigated down to elev. 187.1. The full extent of this deposit was not established in this investigation.

The upper 2.5-3 m of this deposit is brown in colour, and at places, exhibits signs of oxidation. At elevation 189±, the colour of this deposit changes to a distinct grey. The colour boundary is indicated on the log sheets.

Based on visual observation, this till material has a tendency to become less cohesive with depth. The matrix of the upper 3 m ± of this till can generally be considered a silty clay of low plasticity (CL group). With depth, however, the deposit gradually changes to a CL-ML material, and eventually to a ML material. Within the depths investigated, the till always remained cohesive to some extent. Results of Atterberg Limits testing carried out on 2 samples of this cohesive deposit are shown on Fig. 1 and indicate the following:

BH #	SAMPLE #	DEPTH (m)	W %	W_p %	W_L %	I_p %	Group
10	2	1.7	11	24.5	17	7.5	CL-ML
11	5	4.0	7	14.5	11.5	3	ML

The results of grain size distribution tests carried out on the same two samples of this material are shown on Fig. 2 and are summarized as follows:

BH #	SAMPLE #	DEPTH (m)	Gr. %	Sa %	Si %	Cl %
10	2	1.7	15	20	43	22
11	5	4.0	9	32	48	11

Based on Standard Penetration test 'N' values generally ranging from 30 to 86 blows/300 mm, the consistency of this till deposit is considered as being hard throughout.

Sandy Silt

An isolated sandy silt layer was encountered at elevation 189 ± in BH #11, and has a depth of approximately 0.5 m.

The grain size distribution of this material (shown on Fig. 2) indicates that this non-cohesive layer is composed of 44% Gr, 22% Sa, 30% Si, and 4% Cl.

Excavations extending into this material have the potential to experience basal instability in the form of "boiling" as a result of an unbalanced hydrostatic head.

Groundwater Conditions

Groundwater elevations were not measured, however, it is believed that the groundwater level at this site corresponds approximately to water level in the creek which was at elevation 190.5 ± at the time of the investigation.

SUBSURFACE CONDITIONS - CULVERT "2" (BH 12, 13)

The predominant soil at this site is composed of a cohesive glacial till deposit which can be generally described as a heterogeneous mixture silty clay, sand, gravel, with a variable gradation. The full depth of this deposit was not investigated.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borehole Sheets in the Appendix (BH 12, BH 13). The location of the two boreholes are shown in plan and profile on Sheet No. 49-1 of the contract drawings, along with an estimated stratigraphical section.

The following is a description of the soils encountered at the site:

Glacial Till (Het. Mixture Silty Clay, Sand, Gravel)

This cohesive till deposit was the only soil type identified at the site with the exception of a limited surficial fill at both boreholes.

The silty clay till was found at an approximate elevation of 191.3 to 191.5 (below 1.2 to 1.9 m of silty clay fill) and was investigated down to elevation 188.3. The full extent of this deposit was not established in this investigation.

The upper 2.0-2.5m of this deposit is brown in colour, and at places, exhibits signs of oxidation. At elevation 189.5 ±, the colour of this deposit changes to a distinct grey. The colour boundary is indicated on the log sheets.

Based on visual observation, this till material has a tendency to become less cohesive with depth. The upper 3 m ± of this deposit generally is composed of silty clay matrix of low plasticity (CL group). However the till changes to a CL-ML matrix at deeper elevations within the depths investigated, the till always remained cohesive. Results of Atterberg Limits testing carried out on 3 samples of this material are shown on Fig. 3.

The results of grain size distribution testing carried out on the same 3 samples are shown on Fig. 4.

Based on Standard Penetration test 'N' values generally well over 30 blows/300 mm, this till material is considered to have a hard consistency.

Fill

Cohesive silty clay till was found as the surficial material in both boreholes. No laboratory tests were conducted on this fill material. This fill has a reddish-brown colour, and at places, was found to contain organic fibres and roots.

Groundwater Conditions

Groundwater elevation measurement was taken in one of the two boreholes, however, the hole was "dry". Due to the impermeable nature of the cohesive silty clay till, it is possible that the groundwater level was not stabilized at the time of the measurement. It is believed that the groundwater level at this site occurs between elevation 191 and 192.

SUBSURFACE CONDITIONS - CULVERT "3" (BH 14, 15, 16)

General

The predominant soil at this site is composed of a cohesive glacial till deposit which can be generally described as a heterogeneous mixture of silty clay, sand, gravel, with a variable composition. The full depth of this deposit was not investigated. Overlying the till is a silty clay fill.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borehole Sheets in the Appendix (BH 14, BH 15, BH 16). The location of the three boreholes are shown in plan and profile on Sheet No. 49-2 of the contract drawings, along with estimated stratigraphical section.

The following is a description of the soils encountered at the site:

Glacial Till (Het. Mixture Silty Clay, Sand, Gravel)

This till deposit was the only soil type identified at the site with the exception of a silty clay fill layer overlying the native deposit.

The heterogeneous mixture silty clay, sand, gravel (till) was found at an approximate elevation of 193.5 ± and was investigated down to elevation 190.4. The full extent of this deposit was not established in this investigation.

Generally, the upper 2.5 m of this deposit is brown in colour and is slightly oxidized. Between elevation 191.5 and 192.5 the till changes colour to a distinct grey. The colour boundary is indicated on the log sheets.

Characteristically, the till in the immediate area of this site has a tendency to become less cohesive with depth. The matrix of the upper 2.5 m ± of this till can generally be considered a silty clay of low plasticity (CL group). With depth, however, the material changes gradually to a CL-ML material.

The upper 0.7 ± m zone of the till deposit in BH 14 was found to be a sandy silt of slight plasticity (ML); this material may be susceptible to boiling if subjected to an unbalanced hydrostatic head.

Results of Atterberg Limits testing carried out on 4 samples of the till deposit are shown on Fig. 5 in the Appendix and can be summarized as follows:

BH #	SAMPLE #	DEPTH (m)	W %	W_p %	W_L %	I_p %	Group
14	2	1.7	12	16.5	15.5	1	ML
15	2	1.7	12.5	25.5	17	8.5	CL
16	4	4.0	7.5	21	14.5	6.5	CL-ML

The results of grain size distribution tests conducted on the four samples of this material are shown on Fig. 6 in the Appendix.

Based on the interpretation of Standard Penetration test 'N' values, the silty clay till has generally a hard consistency. The non-cohesive sandy silt till encountered in BH 14 is in a compact state.

Fill

Cohesive silty clay fill was encountered surficially at each of the 3 boreholes. No laboratory tests were conducted on this fill. The fill material varies in colour, however, is generally reddish-brown with patches of grey and black. The fill appears to have between 20% and 30% sand and gravel content.

Groundwater Conditions

A groundwater elevation measurement was taken in BH 15 and indicated the level to be at elevation 193.8 ±, which corresponds approximately to the water level in the creek.

SUBSURFACE CONDITIONS - CULVERT "4" (BH 17, 18)

General

The predominant deposit at this site is of a glacial origin. The till deposit is of two types; cohesive and non-cohesive. Overlying the till is a cohesive

silty clay fill. Between the fill and the till, a 0.8 m ± layer of very loose sand was encountered at BH 18.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borehole Sheets in the Appendix (BH 17, BH 18). The location of the two boreholes are shown in plan and profile on Sheet No. 49-2 of the contract drawings, along with an estimated stratigraphical section.

The following is a description of the soils encountered at the site.

Glacial Till

In BH 17, the till was encountered at elevation 190.6, and extending down to elevation 189.1 ±, the till is of a cohesive nature with a hard consistency. The layer is brown in colour. Atterberg Limits testing carried out on one sample of this material is summarized as follows: W=9.5%, W_L=25%, W_p=14%, I_p=11%, and indicates that the till matrix is a silty clay of low plasticity (CL group). A gradation curve for this material is shown on Fig. 7 in the Appendix.

Underlying this cohesive material in BH 17 is a grey non-cohesive till described as a very dense silty sand. This layer extends down from elevation 189.1 to at least elevation 187.2. The full depth of this till was not established. If this non-cohesive material is subjected to an unbalanced hydrostatic head, "boiling" may result. A gradation curve for this material is shown on Fig. 7 in the Appendix.

In BH 18, the till was encountered at elevation 189.4, and extending down to elevation 188.7 ±, the till is of a cohesive nature with a hard consistency. The layer is brown in colour. Based on a visual inspection, this upper till matrix can be considered to be a silty clay of low plasticity (CL group).

Underlying this cohesive material in BH 18 is a grey non-cohesive till described as a very dense silty sand. This layer extends down from elevation 188.7 to at least elevation 187.5. The full depth of this till was not established. If this non-cohesive material is subjected to an unbalanced hydrostatic head, "boiling" may result.

Silty Sand

In BH 18, overlying the silty clay till is a layer of very loose silty sand, trace clay, gravel. This silty sand underlies the fill material. If this stratum is subjected to an unbalanced hydrostatic head, "boiling" may result. This layer extends from elevation 190.2 ± to elevation 189.4 ± in BH 18, and was not encountered in BH 17. A gradation curve for this material is shown on Fig.7.

Silty Clay (Fill)

Approximately the upper 2 m of material encountered in each borehole consisted of a silty clay fill. This fill has a reddish-brown colour, and at places was found to contain organic fibres and roots. Small grey clay pockets are also evident. Based on 1 Atterberg Limits test (W=16%, W_L=29.5%, W_p=18.5%, I_p=11%), the fill can be considered to be a CL material.

Groundwater Conditions

Groundwater levels taken in both boreholes indicate that the groundwater level at the site varies from elevation 190.8 (BH 18) to elevation 191.2 (BH 17). However, it is believed that the groundwater level is stable at elevation 190.8 ±.

L. Politano, P. Eng.
Project Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer (East)

APPENDIX

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 10

METRIC

W P 21-79-17 LOCATION Co-ords. N 4 837 544.0; E 288 111.0 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84 08 14 CHECKED BY RS

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
191.3	Ground Surface										
0.0	Topsoil					*	191				
	Heterogeneous Mixture of Silty Clay, Sand Gravel (Glacial Till) (Brown) Hard		1	SS	30						
			2	SS	30		190				14 20 44 22
188.7	Probable Cobbles		3	SS	100/ 5 cm		189				
2.6	End of Borehole Refusal to Auger (Probable Boulder)										

* Water Level not established

$+^3$, $\times^5$: 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 11

METRIC

W P 21-79-17 LOCATION Co-ords. N 4 837 558.5; E 288 084.6 ORIGINATED BY JA
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA
DATUM Geodetic DATE 84 08 14 CHECKED BY RS

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
192.1	Ground Surface										
0.0	Silty Clay Some Sand Gravel (Fill)		1	SS	20	*	192				
190.9											
1.2	Heterogenous Mixture of Silty Clay Sand, Gravel (Glacial Till) (Brown) Hard		2	SS	35		191				
			3	SS	41		190				
	Sandy Silt & Gravel Trace Clay V.Dense (Grey) Hard		4	SS	100/13 cm		189		○		44 22 30 4
			5	SS	77		188		○		9 32 48 11
187.1			6	SS	86						
5.0	End of Borehole										

* Water Level not established

+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 12

METRIC

W P 21-79-17 LOCATION Co-ords N 4 837 899.6; E 287 944.2 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Core Test COMPILED BY JA

DATUM Geodetic DATE 84-08-14 CHECKED BY RS

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
193.2	Ground Surface										
0.0	Silty Clay (Fill) Stiff		1	SS	16	*	193				
191.3			2	SS	9		192				
1.9	Heterogenous Mixture of Silty Clay Sand, Gravel (Glacial Till) Brown Grey Hard		3	SS	40		191				
			4	SS	100		190		○		27 24 34 15
			5	SS	100/ 28 cm		189		○		12 30 43 15
188.3			6	SS	100/ 15 cm						
4.9	End of Borehole					✓					

* Borehole dry at completion

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 13

METRIC

W P 21-79-17 LOCATION Co-ords N 4 837 903.5; E 287 914.3 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA

DATUM Geodetic DATE 84-08-14 CHECKED BY RS

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 W_p / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.7	Ground Surface										
0.0	Silty Clay (Fill) Firm		1	SS	8	*	192				
191.5											
1.2	Heterogeneous Mixture of Silty Clay Sand, Gravel (Glacial Till)		2	SS	21		191				
			3	SS	88		190				
			4	SS	83				○ —		12 33 40 15
	Brown Cobbles Grey		5	SS	50/3 cm		189				
	Very Stiff to Hard										
187.8			6	SS	100/20 cm		188				
4.9	End of Borehole										

* Water Level not established

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 14

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 047.3; E 287 608.2 ORIGINATED BY JA
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA
DATUM Geodetic DATE 84-08-10 CHECKED BY RS

ELEV / DEPTH	SOIL PROFILE 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
194.9	Ground Surface										
0.0	Silty Clay with Sand, Gravel (Fill) Stiff		1	SS	11	*	194				
193.5											
1.4	Sandy Silt, trace clay some gravel (Glacial Till) Compact		2	SS	17		193		○ H		22 40 31 7
192.7											
2.2	Heterogeneous Mixture of Silty Clay, Sand Gravel (Glacial Till)		3	SS	100				○		3 38 45 14
	Cobble		4	SS	64/ 5 cm		192				
	Brown / Grey										
190.8	Hard		5	SS	100/ 18 cm		191				
4.1	End of Borehole										

* Water Level not established

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 15

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 064.5; E 287 621.8 ORIGINATED BY JA
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA
DATUM Geodetic DATE 84-08-10 CHECKED BY RS

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
194.5	Ground Surface										
0.0	Silty Clay Some Sand trace gravel (Fill)										
193.4			1	SS	14		194				
1.1	Hetergeneous Mixture of Silty Clay Sand, Gravel (Glacial Till)		2	SS	36		193		o		5 24 50 21
	Brown / Grey		3	SS	100/28 cm		192				
			4	SS	84/10 cm						
	Hard						191				
190.4			5	SS	86/10 cm						
4.1	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 16

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 060.3; E 287 572.0 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84-08-10 CHECKED BY AS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
196.3	Ground Surface						
0.0	Silty Clay Some Sand Gravel (Fill)					*	196
			1	SS	19		195
193.8							
2.5	Heterogeneous Mixture of Silty Clay Sand, Gravel (Glacial Till) Brown Grey		2	SS	12		194
			3	SS	27		193
			4	SS	86		
	Hard		5	SS	100/13 cm		192
190.7			6	SS	59/10 cm		191
5.6	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE

100/25 cm

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

17 25 44 14

* Water Level not established

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 17

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 545.0; E 288 007.8 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA

DATUM Geodetic DATE 84-08-13 CHECKED BY RS

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 (%)		
192.0	Ground Surface							20 40 60 80 100	Wp W WL; 10 20 30	γ	GR SA SI CL
0.0	Silty Clay (Fill)		1	SS	7	▽	191				
190.6											
1.4	Heterogeneous Mixture of Silty Clay Sand, Gravel (Glacial Till) Hard Brown		2	SS	35		190				
			3	SS	52						3 31 48 18
189.1								100/28 cm			
2.9	Silty Sand, trace clay some gravel (Glacial Till) Very Dense (Grey)		4	SS	100/10 cm		189				16 45 34 5
			5	SS	100/23cm		188				
187.2			6	SS	55/10 cm						
4.8	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 18

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 551.6; E 287 959.6 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

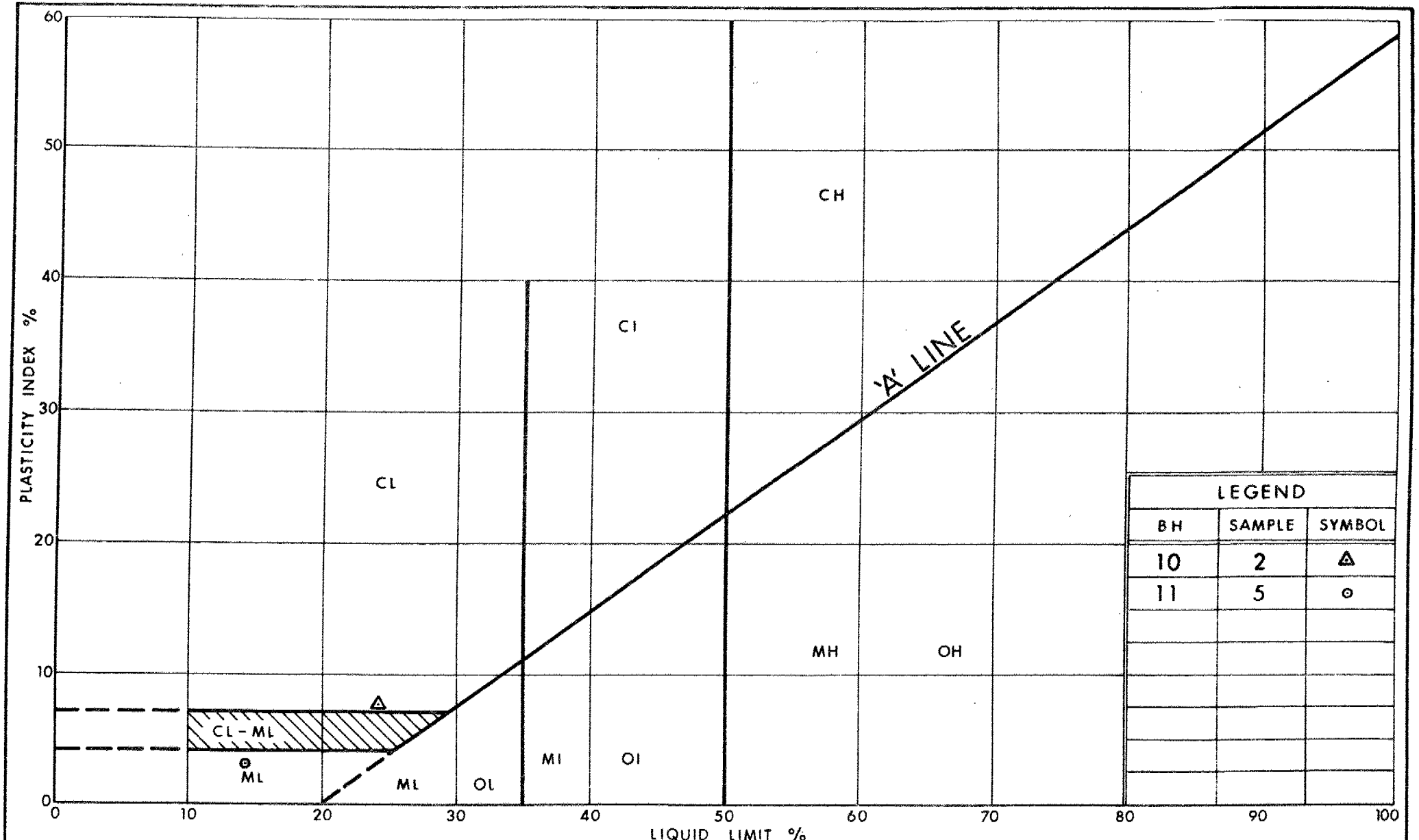
DATUM Geodetic DATE 84-08-10 & 84-08-13 CHECKED BY RS

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						
192.3	Ground Surface										
0.0	Silty Clay (Fill)		1	SS	14		192				
			2	SS	5	▽	191		o ⊢—⊣		
190.2											
2.1	Silty Sand trace clay, gravel Very Loose		3	SS	1		190		o		8 66 16 10
189.4								100/ 15 cm			
2.9	Heterogenous Mixture of Silty Clay Sand Gravel		4	SS	100/ 18 cm		189				
188.7	(Glacial Till) Hard										
3.6	Silty Sand trace clay, some gravel (Glacial Till) Very Dense (Grey)		5	SS	37/ 5 cm		188				
187.5			6	SS	100/ 8 cm						
4.8	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



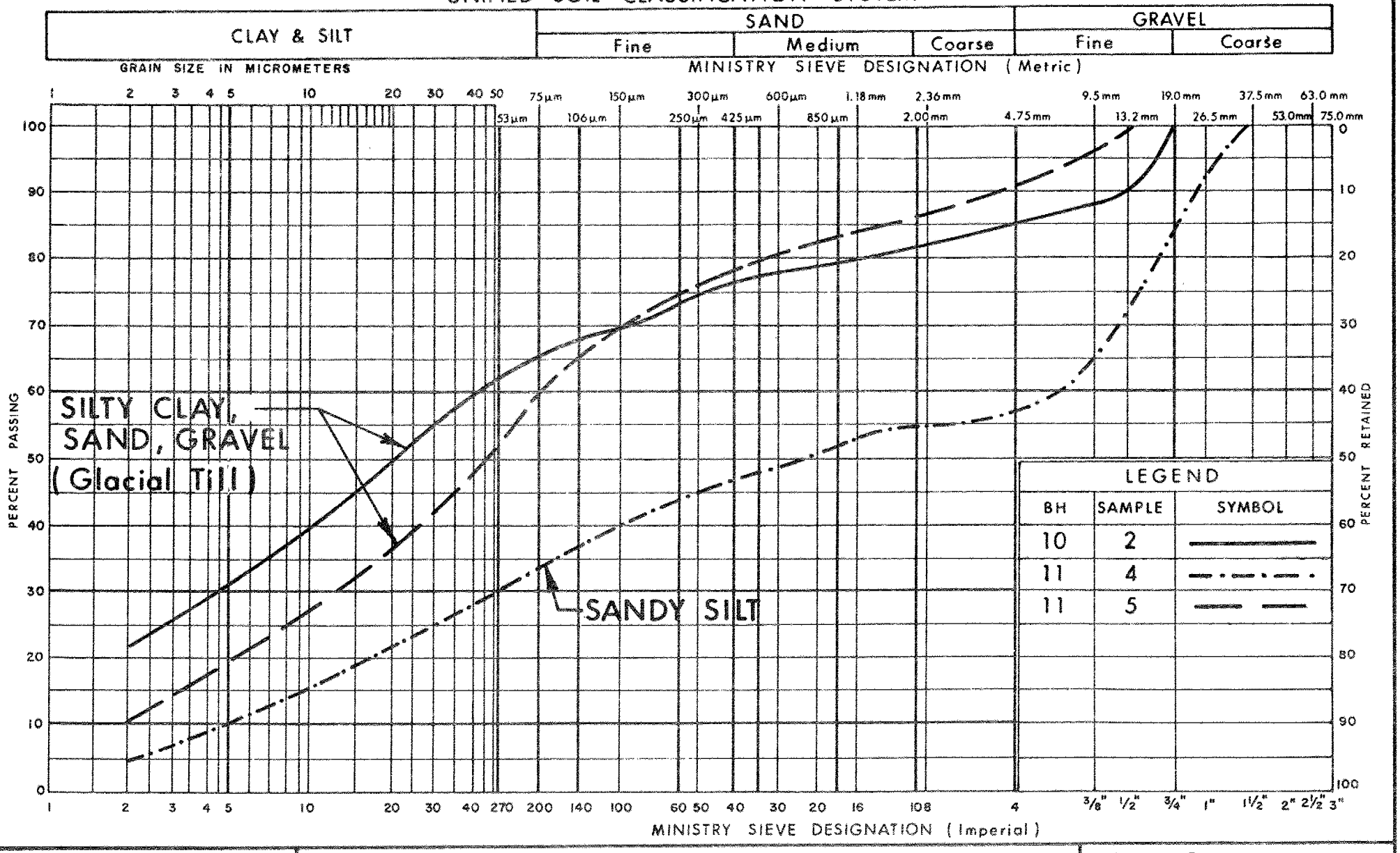
Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

HET MIXTURE OF SILTY CLAY, SAND, GRAVEL
(GLACIAL TILL)

FIG No 1
W P 21-79-17
CULVERT No 1

UNIFIED SOIL CLASSIFICATION SYSTEM

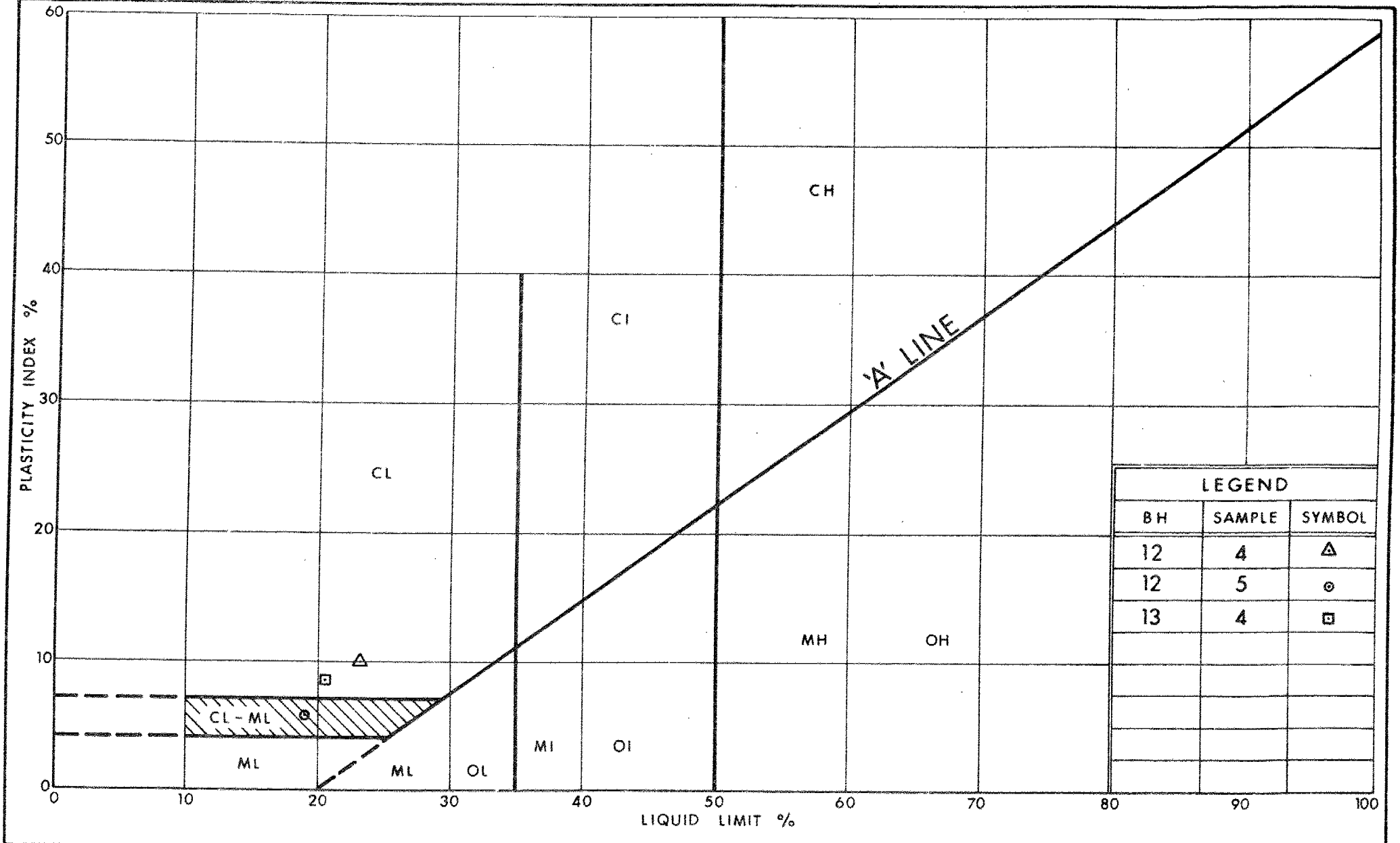


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 2
W P 21 - 79 - 17
CULVERT No 1

22

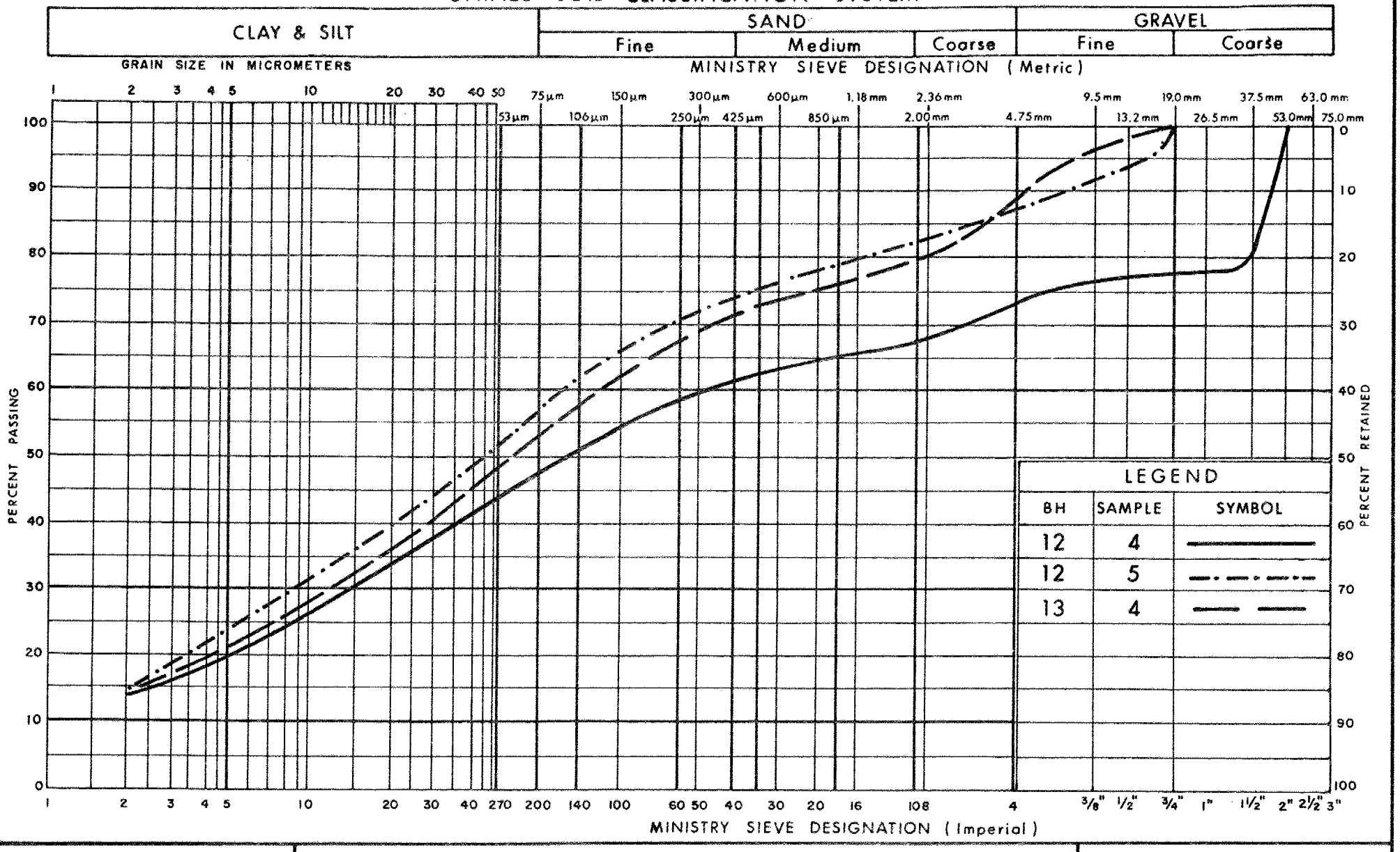


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART
HET MIXTURE OF SILTY CLAY, SAND, GRAVEL
(GLACIAL TILL)

FIG No 3
W P 21-79-17
CULVERT No 2

UNIFIED SOIL CLASSIFICATION SYSTEM

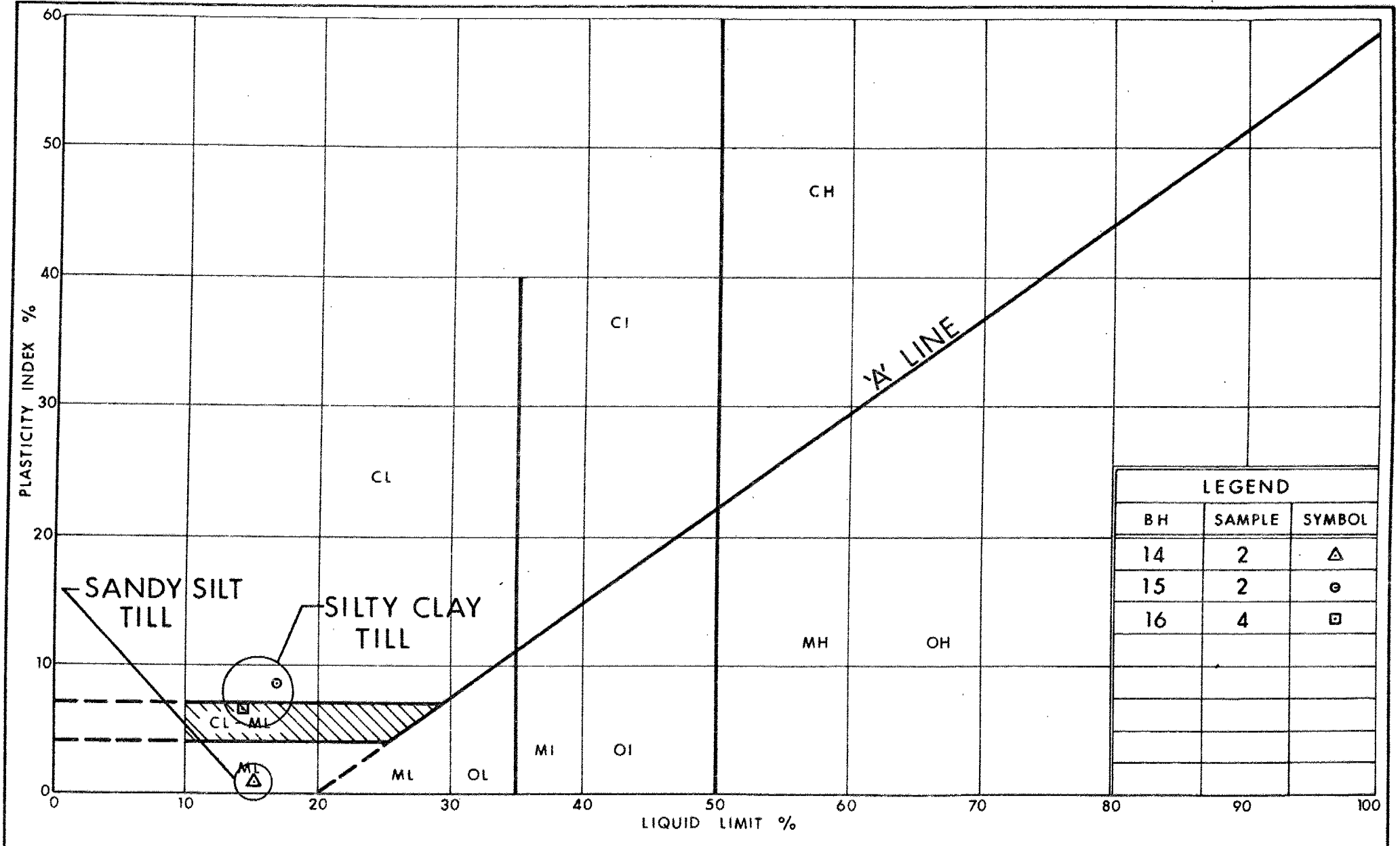


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

HET MIXTURE OF SILTY CLAY, SAND, GRAVEL
(GLACIAL TILL)

FIG No 4
W P 21-79-17
CULVERT No 2

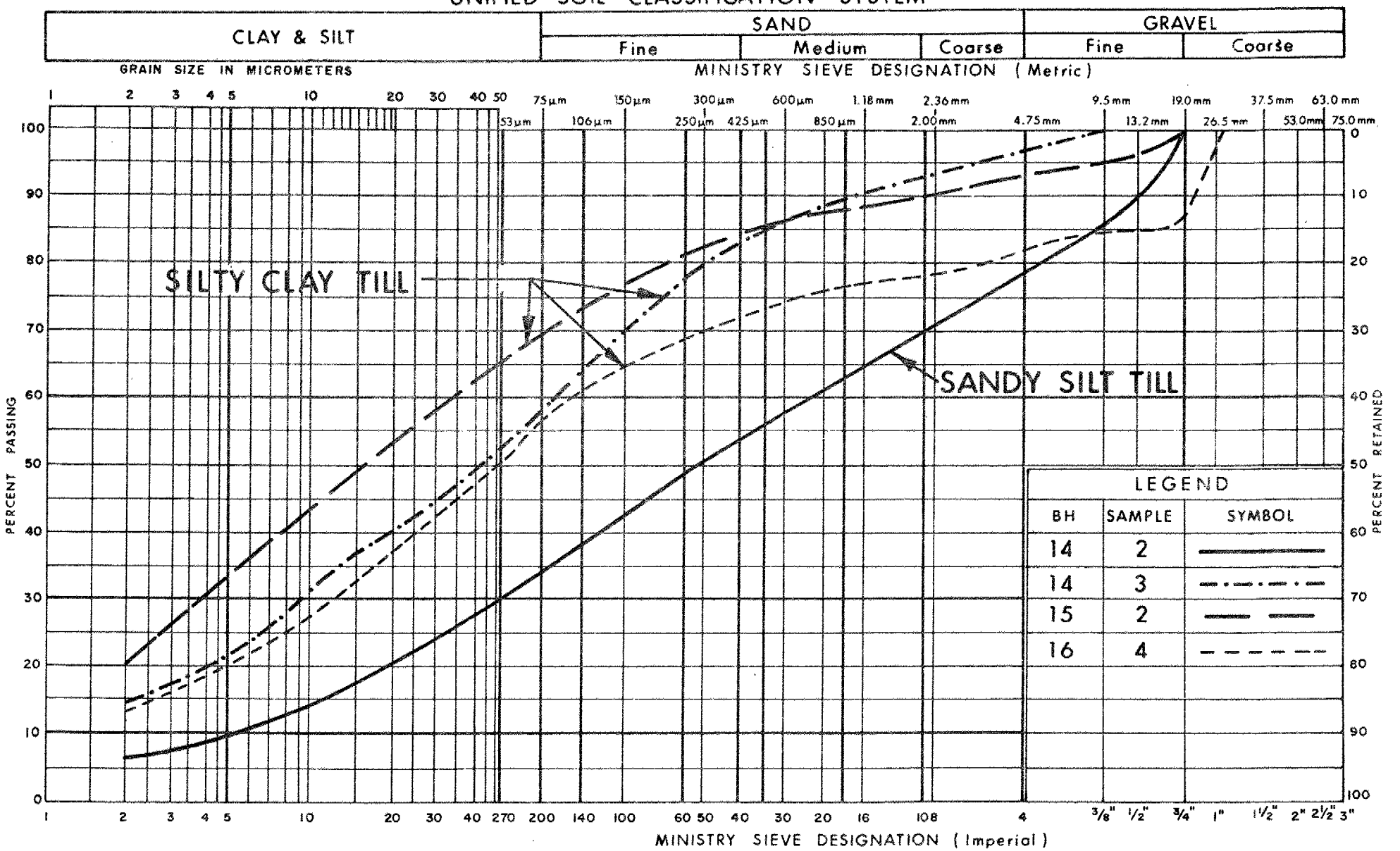


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

FIG No 5
W P 21-79-17
CULVERT No 3

UNIFIED SOIL CLASSIFICATION SYSTEM

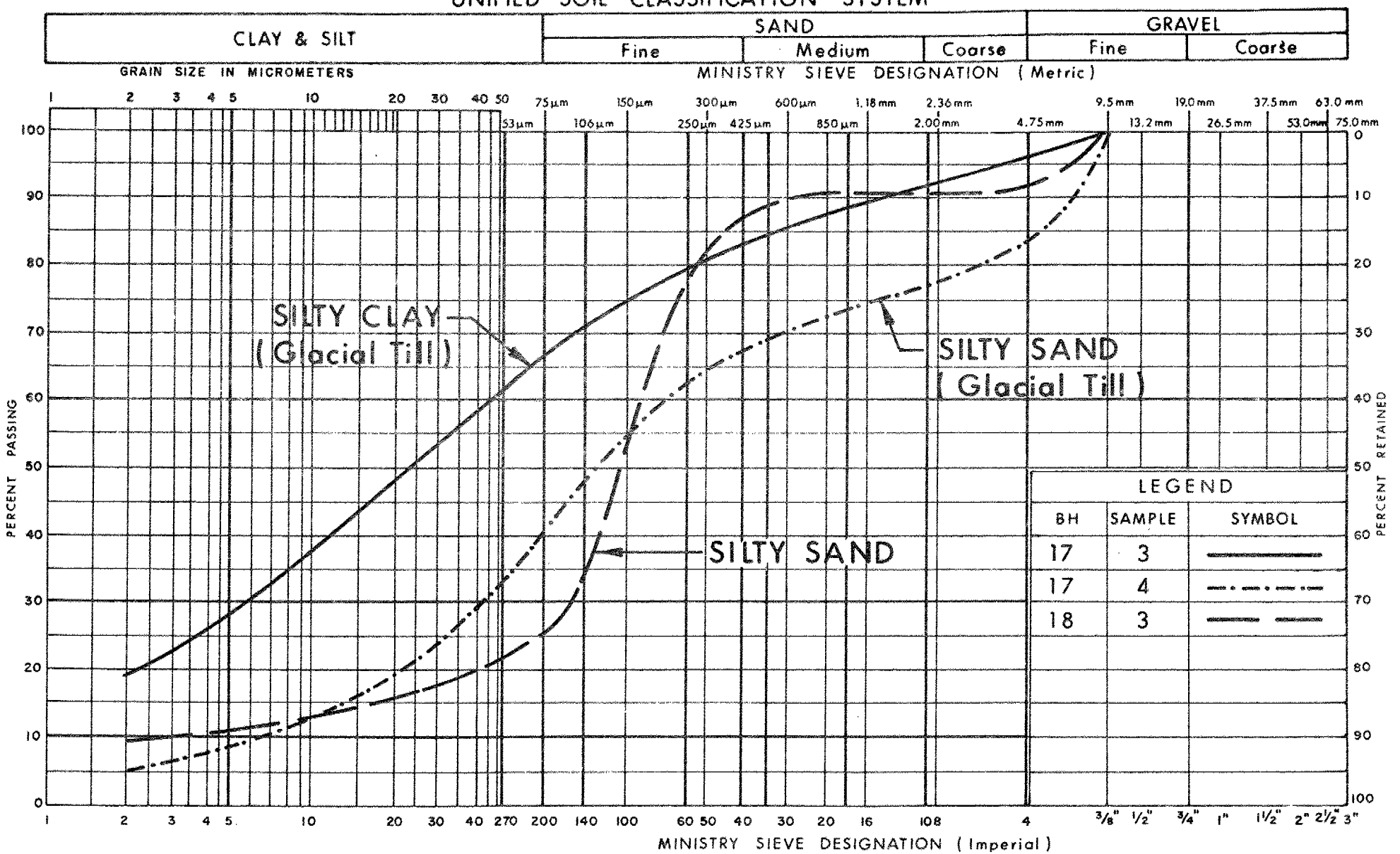


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 6
W P 21-79-17
CULVERT No 3

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 7
W P 21-79-17
CULVERT No 4

27

Foundation Investigation Report

For

Steeles Ave. Underpass
W.P. 21-79-18; Site 24-81-488
Hwy. 410, District 6, Toronto

Introduction

This report summarizes the factual information obtained from a foundation investigation carried out at the above-mentioned site between 84 08 07 and 84 08 09. The fieldwork consisted of 6 sampled boreholes ranging in depth from 7.7 m to 9.3 m below the existing ground surface. Four of the 6 boreholes were advanced by means of washboring and the remaining 2 boreholes were advanced by conventional hollow stem augers. In addition to split-spoon sampling in all boreholes, cone penetration tests were conducted on 4 of the boreholes.

Site Description and Geology

The site is located at the proposed Hwy. 410-Steeles Ave. Underpass in the City of Brampton, Regional Municipality of Peel.

North of Steeles Ave. land use is predominently industrial. South of Steeles Avenue, land use still remains agricultural. Topography across the site is generally flat with the ground surface sloping gently south towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit in the area investigated is composed of a cohesive glacial-till whose thickness was not fully established. The till overburden is underlain by shale bedrock of the Georgian Bay Formation (formerly known as the Meaford-Dundas). The bedrock elevation was not determined in this investigation.

The "Peel Plain" region is well drained by Credit, Oakville and Etobicoke Creeks, which have cut deep valleys in the overburden. There are no extensive undrained depressions, swamps or bogs in the region, although in many of the interstream areas, drainage is still imperfect. Locally, drainage at the site of the proposed underpass is presently accomplished by means of creeks, roadside ditches and culverts.

Subsurface Conditions

General

The predominant soil at this site is composed of a cohesive glacial till deposit which can be generally described as a heterogeneous mixture of silty clay, sand and gravel. The full depth of this deposit was not established in this investigation.

The boundaries between the subsoil types, in-situ and laboratory test results, as well as groundwater levels are shown in the Record of Borehole Sheets in the Appendix. The location of the 6 boreholes are shown in plan and profile on Dwg. #2 of the Contract along with three estimated stratigraphical sections.

The following is a description of the glacial till encountered at the site.

Glacial Till

This glacial deposit was the only soil type identified in this investigation, with the exception of sand and gravel along the shoulder areas, or topsoil (and possibly some fill) surficially at B.H. 4.

With the exception of B.H. 4, the glacial till was found at elev. 196.5 - 197 underlying sand and gravel shoulder material. At B.H. 4, the till was found under approximately 1 m$\pm$ of topsoil/ fill at elev. 196.6. The till was investigated down to elev. 188.2, and the full extent of the stratum was not established.

Generally, the upper 3 m± of this glacial till deposit is brown in colour and exibits signs of oxidation. Between elev. 193 and 194, the colour of this stratum changes distinctly to grey. This boundary is indicated on the log sheets in the Appendix.

The results of Atterberg Limits testing carried out on 13 samples of this cohesive deposit are plotted on Figure 1 (in the Appendix) and indicate that the till matrix is generally a silty clay of low plasticity (CL Group). Limits tests on two samples B.H. 1 #9, B.H. 6 #8) obtained from elevations lower than 190± reveal that the till matrix appears to change to a silt of low plasticity (ML Group).

Without including the results of the two ML samples, the following is a summary of the 11 tests conducted on CL samples:

		Range	Average
Natural Moisture Content	W	7-11%	9%
Plastic Limit	W_p	20-29%	23%
Liquid Limit	W_L	12-17%	14%
Plasticity Index	I_p	8-13%	9%

The two tests carried out on ML samples result in the following averages:

$W = 8\%$
$W_p = 15\%$
$W_L = 12\%$
$I_p = 3\%$

The results of grain size distribution tests carried out on 14 samples of this glacial till material can be summarized into 3 distinct groupings, as follows:

(i) upper brown CL zone
(ii) upper grey CL zone
(iii) lower grey ML zone

Group	# of Samples Tested	Range %				Average %			
		Gr	Sa	Si	Cl	Gr	Sa	Si	Cl
(i)	4	15-12	24-30	41-50	17-23	8	27	44	21
(ii)	8	9-28	16-33	33-48	10-21	19	28	40	12
(iii)	2	3-15	37-40	44-51	4-6	9	39	48	5

Considering these results, it can be stated that the clay-size particle content tends to generally decrease with depth, while the sand content increases with depth. The silt content remains approximately constant with depth, while the upper grey zone has a greater gravel content than the remainder of the stratum.

Based on visual inspection of the soil samples, the till appears to become less cohesive with depth, however, always remaining cohesive to some extent at depths investigated.

Figure 2 in the Appendix shows the results of the grain size distribution tests in envelope form and includes all 14 test results.

Standard Penetration Test 'N' values generally ranging from more than 30 blows/300 m to 100 blows/50 mm indicate that the till deposit has a hard consistency throughout.

Groundwater Conditions

Where established, the groundwater level was determined at the time of the investigation by measuring in the open boreholes. The two measurements taken result in the groundwater level varying from elev. 193.9 to 195.9. However, due to the relative impermeable nature of the till matrix, and the possibility that the lower reading may not have been stabilized, it is believed that the groundwater level at the site occurs at elev. 196±.

L. Politano, P. Eng.
Project Foundations Engineer

M. Devata, P. Eng.
Chief Foundations Engineer
(East)

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 263.8; E 287 743.5 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring Cone Test COMPILED BY LP

DATUM Geodetic DATE 84 08 08 CHECKED BY RS

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						
197.2	Ground Surface										
0.0	Sand & Gravel (shoulder)					*	197				
196.5											
0.7	Heterogenous Mixture of Silty Clay with Sand trace to some gravel (Glacial Till) Hard						196				
			1	SS	33						
			2	SS	48		195	100/ 25 cm			
			3	SS	48		194				8 29 41 22
	Brown / Grey										
			4	SS	53		193				
			5	SS	51						
							192				
			6	SS	42						
			7	SS	133		191				22 30 37 11
			8	SS	100/ 13 cm		190				
			9	SS	100/ 15 cm						15 37 44 4
							189				
188.5			10	SS	100/ 15 cm						
8.7	End of Borehole										

* W.L. not established

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2 METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 248.0; E 287 762.6 ORIGINATED BY JA
DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring COMPILED BY JA
DATUM Geodetic DATE 84 08 07 CHECKED BY RS

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 ○ 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
197.1	Ground Surface										
0.0	Sand & Gravel (shoulder)					*	197				
196.4											
0.7	Heterogeneous Mixture of Silty Clay with sand trace to some gravel (Glacial Till) Hard		1	SS	33		196				
			2	SS	39		195				
			3	SS	48		194		o —		5 26 46 23
	Brown / Grey		4	SS	90		193				
			5	SS	62						
			6	SS	77		192				
			7	SS	100/ 5 cm		191		o		12 32 46 10
			8	SS	100/ 13 cm		190				
189.4			9	SS	100/ 10 cm						
7.7	End of Borehole										

* W.L. not established

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 3

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 214.5; E 287 746.8 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84 08 07 CHECKED BY RS

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
197.5	Ground Surface										
0.0 / 196.8	Sand and Gravel (shoulder)						197				
0.7	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till) Hard		1	SS	9		196				
			2	SS	27						
			3	SS	32		195	100/	25 cm		
	Brown Grey		4	SS	64		194				12 30 41 17
			5	SS	42						
			6	SS	72		193				
			7	SS	82		192				23 30 34 13
			8	SS	128						
			9	SS	90/ 10 cm		191				
			10	SS	100/ 18 cm		190				
			11	SS	100/ 13 cm		189				
188.2			12	SS	100/ 18 cm						
9.3	End of Borehole * W.L. not established										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 214.3; E 287 693.0 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Washboring, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84 08 08 CHECKED BY RS

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 (o 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
197.6	Ground Surface										
0.0	Topsoil, Fill					*	197				
196.6											
0.9	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till) Hard						196				
			1	SS	49						
			2	SS	67		195	100/ 28 cm			
	Brown Grey		3	SS	61						
			4	SS	75		194				
			5	SS	132/25 cm		193		o ⊢		9 33 48 10
			6	SS	136		192				
			7	SS	100/15 cm				o ⊢		28 26 33 13
			8	SS	100/13 cm		191				
189.6			9	SS	100/15 cm		190				
7.9	End of Borehole										

* W.L. not established

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

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 191.0; E 287 685.5 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA

DATUM Geodetic DATE 84 08 09 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
197.7 / 0.0	Ground Surface										
197.0 / 0.7	Sand and Gravel (shoulder)										
	Heterogeneous Mixture of Silty Clay with sand some gravel (Glacial Till) Hard		1	SS	41		197				
			2	SS	62		196				
	Brown / Grey		3	SS	41	▼	195				
			4	SS	38		194				
			5	SS	78		193		○ —		15 28 42 15
			6	SS	100/ 15 cm		192		○ —		14 30 41 15
			7	SS	100/ 8 cm		191				
189.8 / 7.9	End of Borehole		8	SS	100/ 13 cm		190				

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 6

METRIC

W P 21-79-18 LOCATION Co-ords. N 4 838 174.2; E 287 703.4 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

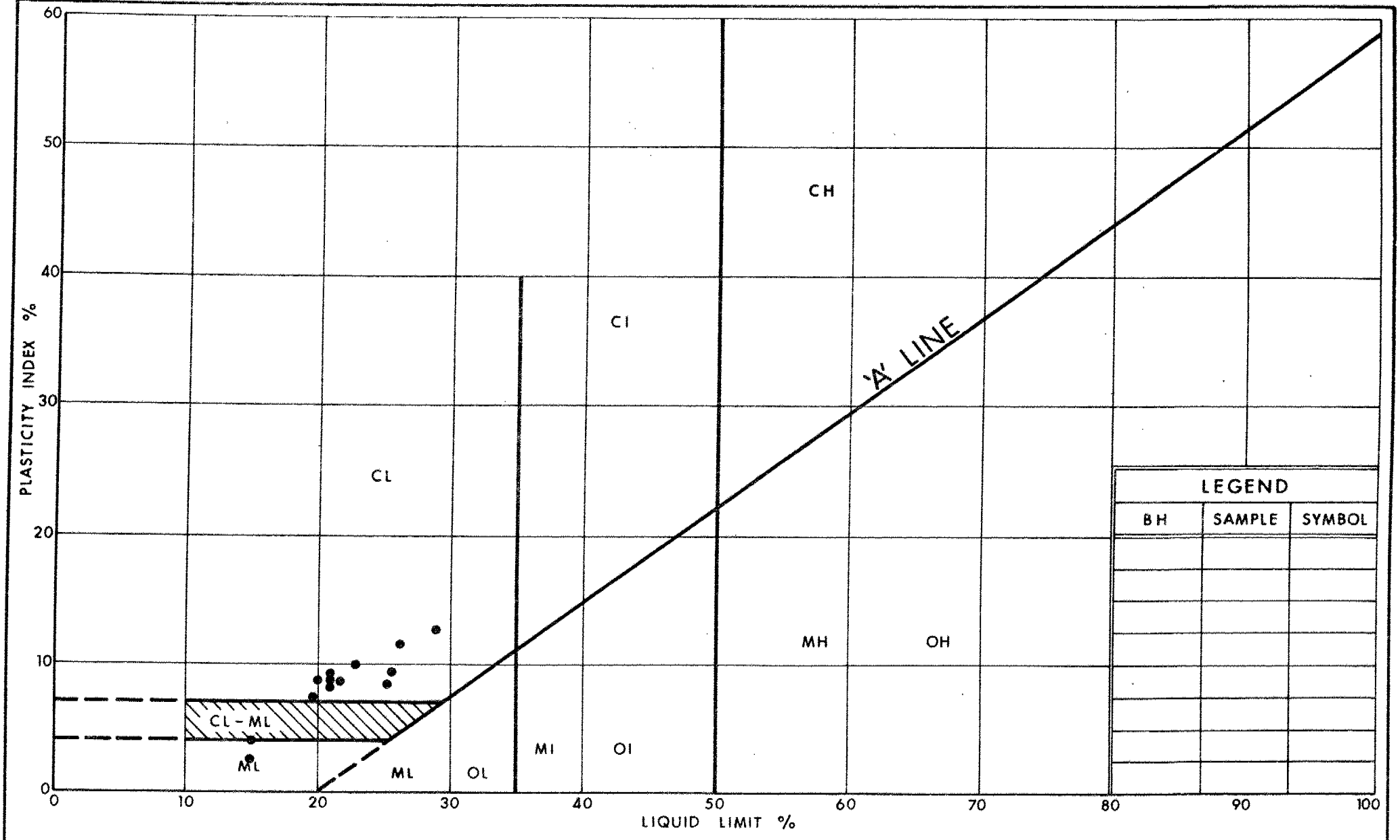
DATUM Geodetic DATE 84 08 09 CHECKED BY

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
197.8	Ground Surface										
0.0 / 197.1	Sand and Gravel (shoulder)										
0.7	Heterogeneous Mixture of Silty Clay some to with sand trace to some gravel (Glacial Till)		1	SS	24	▼	197				
	Hard		2	SS	40		196				5 24 50 21
	Brown / Grey		3	SS	32		195				
			4	SS	23		194				
			5	SS	37		193				
			6	SS	63		192				
			7	SS	100		191				21 16 42 21
			8	SS	100/ 20 cm		190				3 40 51 6
189.1			9	SS	100/ 20 cm						
8.7	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

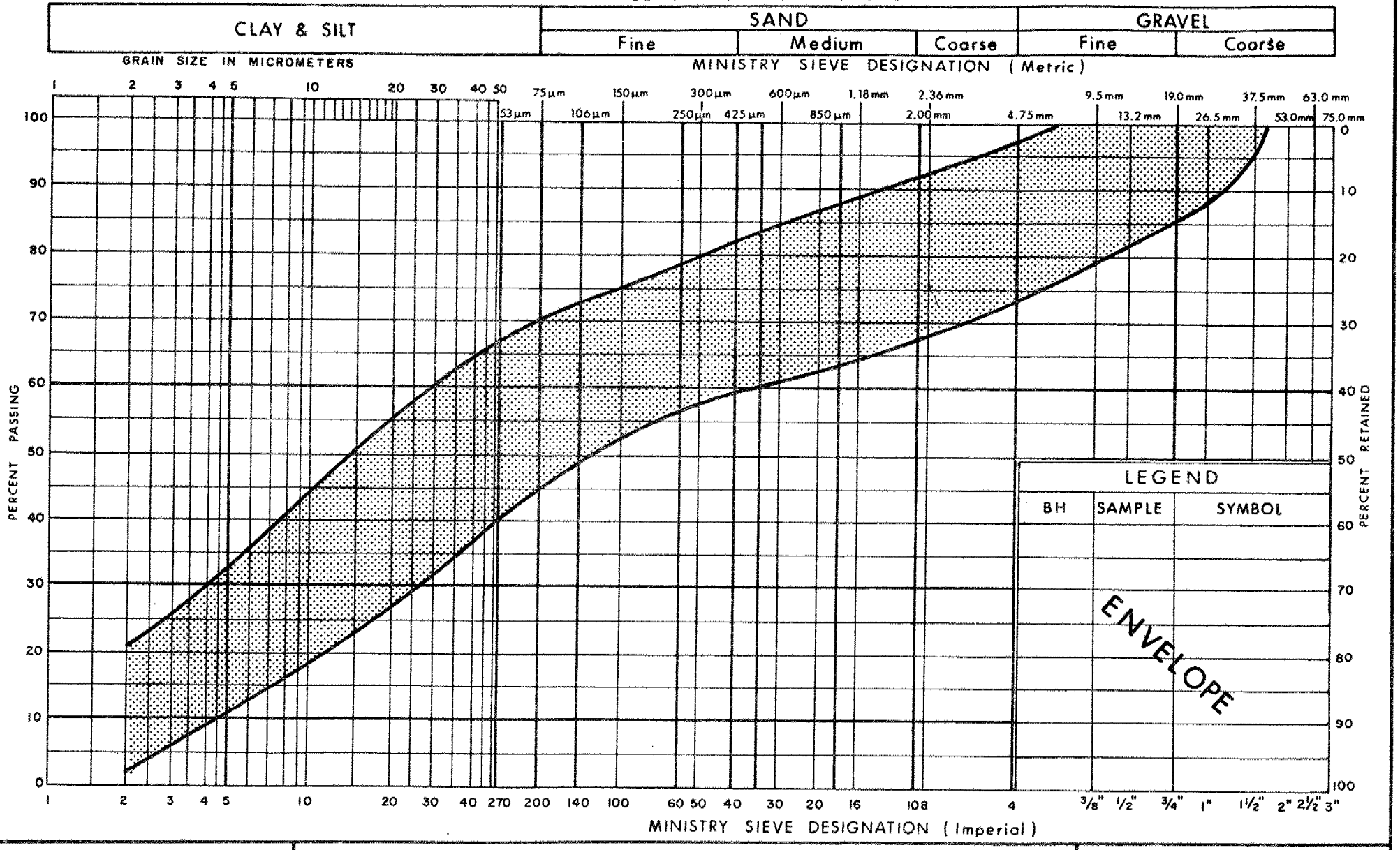
PLASTICITY CHART

HET MIXTURE OF SILTY CLAY, SOME TO WITH SAND, GRAVEL
(GLACIAL TILL)

FIG No 1

W P 21-79-18

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

HET MIXTURE OF SILTY CLAY, SOME TO WITH SAND, GRAVEL (GLACIAL TILL)

FIG No 2

W P 21-79-18

40

CONT 87-43

Ontario

Ministry of
Transportation and
Communications

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 21-79-17 DIST 6

HWY 410 STR SITE

410 & Steeles Ave. Culverts

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
A. Wittenberg
J. Smrcka (2)
K. Bassi
J.H. Peer
R. Hore
R. Fitzgibbon (Cover Only)
T.J. Kovich (Cover Only)

GEOCRES 30M12-188

DATE NOV - 2 1984

FOUNDATION INVESTIGATION REPORT

For

Prop. Culverts and Extensions

in vicinity of

Hwy. 410 - Steeles Ave. Interchange

W.P. 21-79-17

Hwy. 410, District 6, Toronto

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation carried out at the following four culvert sites.

Culvert 1, on Hwy. 410 at Sta. 10+300 ±

Culvert 2, on Hwy. 410 at Sta. 10+700 ±

Culvert 3, on Steeles Ave. at Sta. 9+800 ±

Culvert 4, on Steeles Ave. at Sta. 10+430 ±

The fieldwork for this investigation was conducted between 84-08-10 and 84-08-14, and consisted of the following:

Culvert "1" - two sampled boreholes (2.6 and 5.0 m deep) advanced by means of hollow stem augers, and one cone penetration test

Culvert "2" - two 4.9 m deep sampled boreholes advanced by means of hollow stem augers, and one cone penetration test

Culvert "3" - three sampled boreholes (4.1, 4.1, and 5.6 m deep) advanced by means of hollow stem augers, and two cone penetration tests

Culvert "4" - two 4.8 m deep sampled boreholes advanced by means of hollow stem augers, and two cone penetration tests.

SITE DESCRIPTION AND GEOLOGY

The sites are located in the vicinity of the proposed Hwy. 410 - Steeles Ave. interchange in the City of Brampton, Regional Municipality of Peel.

North of Steeles Ave., land use is predominantly industrial. South of Steeles Ave., land use still remains agricultural. Topography across the site is generally flat with the ground surface sloping gently towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit in the area investigated is generally composed of a cohesive glacial till whose thickness was not fully established in this investigation. The till overburden is underlain by shale bedrock of the Georgian Bay Formation (Formerly known as the Meaford-Dundas). The bedrock elevation was not determined in this investigation.

The "Peel Plain" region is well drained by Credit, Oakville, and Etobicoke Creeks, which have cut deep valleys in the overburden. There are no extensive undrained depressions, swamps or bogs in the region, although in many of the interstream areas drainage is still imperfect. Locally, drainage at the sites is presently accomplished by means of creeks, roadside ditches and culverts.

SUBSURFACE CONDITIONS - CULVERT "1" (BH 10, 11)

General

The predominant soil at this site is composed of a cohesive glacial till deposit which can be generally described as a heterogeneous mixture of silty clay, sand, gravel, with a variable gradation. The full depth of this deposit was not investigated.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borehole Sheets in the Appendix (BH 10, BH 11). The location of the two boreholes are shown in plan and profile on Drawing No. 217917-A, along with an estimated stratigraphical section.

The following is a description of the soils encountered at the site:

Glacial Till (Het. Mixture Silty Clay, Sand, Gravel)

This cohesive till deposit was the only soil type identified at the site with the exception of a sandy silt layer encountered in BH 11.

The silty clay till was found at an approximate elevation of 191 and was investigated down to elev. 187.1. The full extent of this deposit was not established in this investigation.

The upper 2.5 - 3 m of this deposit is brown in colour, and at places, exhibits signs of oxidation. At elevation 189±, the colour of this depsoit changes to a distinct grey. The colour boundary is indicated on the log sheets.

Based on visual observation, this till material has a tendency to become less cohesive with depth. The matrix of the upper 3 m ± of this till can generally be considered a silty clay of low plasticity (CL group). With depth, however, the deposit gradually changes to a CL-ML material, and eventually to a ML material. Within the depths investigated, the till always remained cohesive to some extent. Results of Atterberg Limits testing carried out on 2 samples of this cohesive deposit are shown on Fig. 1 and indicate the following:

BH #	SAMPLE #	DEPTH (m)	W %	W_p %	W_L %	I_p %	Group
10	2	1.7	11	24.5	17	7.5	CL-ML
11	5	4.0	7	14.5	11.5	3	ML

The results of grain size distribution tests carried out on the same two samples of this material are shown on Fig. 2 and are summarized as follows:

BH #	SAMPLE #	DEPTH (m)	Gr. %	Sa %	Si %	Cl %
10	2	1.7	15	20	43	22
11	5	4.0	9	32	48	11

Based on Standard Penetration test 'N' values generally ranging from 30 to 86 blows/300 mm, the consistency of this till deposit is considered as being hard throughout.

Sandy Silt

An isolated sandy silt layer was encountered at elevation 189 ± in BH #11, and has a depth of approximately 0.5 m.

The grain size distribution of this material (shown on Fig. 2) indicates that this non-cohesive layer is composed of 44% Gr, 22% Sa, 30% Si, and 4% Cl.

Excavations extending into this material have the potential to experience basal instability in the form of "boiling" as a result of an unbalanced hydrostatic head.

Groundwater Conditions

Groundwater elevations were not measured, however, it is believed that the groundwater level at this site corresponds approximately to water level in the creek which was at elevation 190.5 ± at the time of the investigation.

SUBSURFACE CONDITIONS - CULVERT "2" (BH 12, 13)

The predominant soil at this site is composed of a cohesive glacial till deposit which can be generally described as a heterogeneous mixture silty clay, sand, gravel, with a variable gradation. The full depth of this deposit was not investigated.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borhole Sheets in the Appendix (BH 12, BH 13). The location of the two boreholes are shown in plan and profile on Drawing No. 217917-A, along with an estimated stratigraphical section.

The following is a description of the soils encountered at the site:

Glacial Till (Het. Mixture Silty Clay, Sand, Gravel)

This cohesive till deposit was the only soil type identified at the site with the exception of a limited surficial fill at both boreholes.

The silty clay till was found at an approximate elevation of 191.3 to 191.5 (below 1.2 to 1.9 m of silty clay fill) and was investigated down to elevation 188.3. The full extent of this deposit was not established in this investigation.

The upper 2.0 - 2.5 m of this deposit is brown in colour, and at places, exhibits signs of oxidation. At elevation 189.5 ±, the colour of this deposit changes to a distinct grey. The colour boundary is indicated on the log sheets.

Based on visual observation, this till material has a tendency to become less cohesive with depth. The upper 3 m ± of this deposit generally is composed of silty clay matrix of low plasticity (CL group). However the till changes to a CL-ML matrix at deeper elevations within the depths investigated, the till always remained cohesive. Results of Atterberg Limits testing carried out on 3 samples of this material are shown on Fig. 3.

The results of grain size distribution testing carried out on the same 3 samples are shown on Fig. 4.

Based on Standard Penetration test 'N' values generally well over 30 blows/300 mm, this till material is considered to have a hard consistency.

Fill

Cohesive silty clay till was found as the surficial material in both boreholes. No laboratory tests were conducted on this fill material. This fill has a reddish-brown colour, and at places, was found to contain organic fibres and roots.

Groundwater Conditions

Groundwater elevation measurement was taken in one of the two boreholes, however, the hole was "dry". Due to the impermeable nature of the cohesive silty clay till, it is possible that the groundwater level was not stabilized at the time of the measurement. It is believed that the groundwater level at this site occurs between elevation 191 and 192.

SUBSURFACE CONDITIONS - CULVERT "3" (BH 14, 15, 16)

General

The predominant soil at this site is composed of a cohesive glacial till deposit which can be generally described as a heterogeneous mixture of silty clay, sand, gravel, with a variable composition. The full depth of this deposit was not investigated. Overlying the till is a silty clay fill.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borehole Sheets in the Appendix (BH 14, BH 15, BH 16). The location of the three boreholes are shown in plan and profile on Drawing No. 217917-B, along with estimated stratigraphical section.

The following is a description of the soils encountered at the site:

Glacial Till (Het. Mixture Silty Clay, Sand, Gravel)

This till deposit was the only soil type identified at the site with the exception of a silty clay fill layer overlying the native deposit.

The heterogeneous mixture silty clay, sand, gravel (till) was found at an approximate elevation of 193.5 ± and was investigated down to elevation 190.4. The full extent of this deposit was not established in this investigation.

Generally, the upper 2.5 m of this deposit is brown in colour and is slightly oxidized. Between elevation 191.5 and 192.5 the till changes colour to a distinct grey. The colour boundary is indicated on the log sheets.

Characteristically, the till in the immediate area of this site has a tendency to become less cohesive with depth. The matrix of the upper 2.5 m ± of this till can generally be considered a silty clay of low plasticity (CL group). With depth, however, the material changes gradually to a CL-ML material.

The upper 0.7 ± m zone of the till deposit in BH 14 was found to be a sandy silt of slight plasticity (ML); this material may be suceptible to boiling if subjected to an unbalanced hydrostatic head.

Results of Atterberg Limits testing carried out on 4 samples of the till deposit are shown on Fig. 5 in the Appendix and can be summarized as follows:

BH #	SAMPLE #	DEPTH (m)	W %	W_p %	W_L %	I_p %	Group
14	2	1.7	12	16.5	15.5	1	ML
15	2	1.7	12.5	25.5	17	8.5	CL
16	4	4.0	7.5	21	14.5	6.5	CL-ML

The results of grain size distribution tests conducted on the four samples of this material are shown on Fig. 6 in the Appendix.

Based on the interpretation of Standard Penetration test 'N' values, the silty clay till has generally a hard consistency. The non-cohesive sandy silt till encountered in BH 14 is in a compact state.

Fill

Cohesive silty clay fill was encountered surficially at each of the 3 boreholes. No laboratory tests were conducted on this fill. The fill material varies in colour, however, is generally reddish-brown with patches of grey and black. The fill appears to have between 20% and 30% sand and gravel content.

Groundwater Conditions

A groundwater elevation measurement was taken in BH 15 and indicated the level to be at elevation 193.8 ±, which corresponds approximately to the water level in the creek.

SUBSURFACE CONDITIONS - CULVERT "4" (BH 17, 18)

General

The predominant deposit at this site is of a glacial origin. The till deposit is of two types; cohesive and non-cohesive. Overlying the till is a cohesive silty clay fill. Between the fill and the till, a 0.8 m ± layer of very loose sand was encountered at BH 18.

The soil boundaries, in-situ and laboratory test results are shown on the Record of Borehole Sheets in the Appendix (BH 17, BH 18). The location of the two boreholes are shown in plan and profile on Drawing No. 217917-B, along with an estimated stratigraphical section.

The following is a description of the soils encountered at the site.

Glacial Till

In BH 17, the till was encountered at elevation 190.6, and extending down to elevation 189.1 ±, the till is of a cohesive nature with a hard consistency. The layer is brown in colour. Atterberg Limits testing carried out on one sample of this material is summarized as follows: W=9.5%, W_L=25%, W_p=14%, I_p=11%, and indicates that the till matrix is a silty clay of low plasticity (CL group). A gradation curve for this material is shown on Fig. 7 in the Appendix.

Underlying this cohesive material in BH 17 is a grey non-cohesive till described as a very dense silty sand. This layer extends down from elevation 189.1 to at least elevation 187.2. The full depth of this till was not established. If this non-cohesive material is subjected to an unbalanced hydrostatic head, "boiling" may result. A gradation curve for this material is shown on Fig. 7 in the Appendix.

In BH 18, the till was encountered at elevation 189.4, and extending down to elevation 188.7 ±, the till is of a cohesive nature with a hard consistency.

The layer is brown in colour. Based on a visual inspection, this upper till matrix can be considered to be a silty clay of low plasticity (CL group).

Underlying this cohesive material in BH 18 is a grey non-cohesive till described as a very dense silty sand. This layer extends down from elevation 188.7 to at least elevation 187.5. The full depth of this till was not established. If this non-cohesive material is subjected to an unbalanced hydrostatic head, "boiling" may result.

Silty Sand

In BH 18, overlying the silty clay till is a layer of very loose silty sand, trace clay, gravel. This silty sand underlies the fill material. If this stratum is subjected to an unbalanced hydrostatic head, "boiling" may result. This layer extends from elevation 190.2 ± to elevation 189.4 ± in BH 18, and was not encountered in BH 17. A gradation curve for this material is shown on Fig.7.

Silty Clay (Fill)

Approximately the upper 2 m of material encountered in each borehole consisted of a silty clay fill. This fill has a reddish-brown colour, and at places was found to contain organic fibres and roots. Small grey clay pockets are also evident. Based on 1 Atterberg Limits test (W=16%, W_L=29.5%, W_p=18.5%, I_p=11%), the fill can be considered to be a CL material.

Groundwater Conditions

Groundwater levels taken in both boreholes indicate that the groundwater level at the site varies from elevation 190.8 (BH 18) to elevation 191.2 (BH 17). However, it is believed that the groundwater level is stable at elevation 190.8 ±.

DISCUSSION AND RECOMMENDATIONS

Culvert "1" - Sta. 10+300 ± (on Hwy. 410)

In conjunction with the widening of Hwy. 410, it is proposed to construct a 56 m ± long extension to an existing 6 m wide box culvert. The existing culvert will be lengthened on the west side of Hwy. 410. The proposed invert elevations are as follows:

west limit of extension: Elevation 190.9
east limit of extension: Elevation 190.7

Recommendations for the design and construction of this culvert extension are as follows:

1. The founding elevation for this culvert should be at or below elevation 189.5, using a factored capacity at the U.L.S. of 450 kPa and an allowable capacity at the S.L.S. Type II of 300 kPa.

2. If the culvert bottom is to be founded at a level higher than elevation 189.5, Granular 'A' compacted to MTC specifications may be used to bring up the excavation from elevation 189.5 to the required elevation. The same loadings as above apply.

3. No unwatering problems are anticipated at this site, however, surface run-off and side seepage can be controlled by pumping from sumps.

Culvert "2" - Sta. 10+700 (on Hwy. 410)

In conjunction with the widening of Hwy. 410, it is proposed to construct a 57 m ± long extension to an existing 6 m wide box culvert. The existing culvert will be lengthened on the west side of Hwy. 410. The proposed invert elevations are as follows:

west limit of extension: Elevation 191.7
east limit of extension: Elevation 191.4

Recommendations for the design and construction of this culvert are as follows:

1. The founding elevation for this culvert should be at or below elevation 190.3, using a factored capacity at the U.L.S. of 600 kPa and an allowable capacity at the S.L.S. Type II of 400 kPa.

2. If the culvert bottom is to be founded at a level higher than elevation 190.3, Granular 'A' compacted to MTC specifications may be used to bring up the excavation from elevation 189.5 to the required elevation. The same loadings as above apply.

3. No unwatering problems are anticipated at this site, however, surface run-off and side seepage can be controlled by pumping from sumps.

Culvert "3" - Sta. 9+800 ± (on Steeles Ave.)

In conjunction with the widening of Hwy. 410 and its associated interchange at Steeles Ave., it is proposed to construct a 98 m ± long, 6 m wide culvert across Steeles Ave. in the vicinity of the above mentioned station (west of Hwy. 410). The proposed invert elevations are as follows:

south limit of culvert: Elevation 192.9
north limit of culvert: Elevation 193.5

Recommendations for the design and construction of this culvert are as follows:

1. The founding elevations for this culvert may be between elevation 193.2 and 192.5 using a factored capacity at the U.L.S. of 450 kPa and an allowable capacity at the S.L.S. Type II of 300 kPa. Alternatively, the founding elevation may be at or below elevation 192.5 using a factored capacity at the U.L.S. of 750 kPa and an allowable capacity at the S.L.S. Type II of 500 kPa.

2. If the culvert bottom is to be founded at a level higher than the elevations mentioned in 1. above, Granular 'A' compacted to MTC specifications may be used to bring up the excavation to the required elevation. The same loadings as above apply.

3. No unwatering problems are anticipated at this site. A compact sandy silt layer was, however, identified in BH 14, which may yield some seepage from the sides. This side seepage along with surface run-off can be controlled by pumping from sumps.

Culvert "4" - Sta. 10+430 ± (on Steeles Ave.)

In conjunction with the widening of Hwy. 410 and its associated interchange at Steeles Ave., it is proposed to construct a 48 m ± long, 2.5 m wide culvert across Steeles Ave. in the vicinity of the above mentioned station (east of Hwy. 410). The proposed invert elevations are as follows:

south limit of culvert: Elevation 190.8
north limit of culvert: Elevation 191.0

Recommendations for the design and construction of this culvert are as follows:

1. The founding elevation for this culvert should be at or below elevation 190.0, using a factored capacity at the U.L.S. of 450 kPa and an allowable capacity at the S.L.S. Type II of 300 kPa.

2. If the culvert bottom is to be founded at a level higher than elevation 190.0, Granular 'A' compacted to MTC specifications may be used to bring up the excavation from elevation 190.0 to the required elevation. Same loadings as 1. above apply.

3. A silty sand waterbearing deposit was encountered in BH 18. Unwatering of this deposit is required in order to prevent the founding level from "boiling" during the construction of the culvert.

General Recommendations (for all sites)

1. The excavation levels noted previously may have to be lowered in order to provide 1.2 m (or equivalent) frost protection. The frost cover should be measured from the lowest water level expected in the culvert.

2. It is anticipated that total settlements at each of the culvert sites will not exceed 25 mm.

3. Backfill requirements should conform to MTC standards.

4. For the backfill material, the following parameters are recommended:

	Granular 'A'	Granular 'B'
Angle of Internal Friction	= 35°	= 30°
Unit Weight (kN/m^3)	= 22.0	= 21.1

5. Earth pressure should be computed (assuming "at-rest" condition) as per Section 6.6.1.2 of the 1983 O.H.B.D.C.

6. The backfill operations should be carried out simultaneously on both sides of the proposed box culverts. Compaction and backfill should adhere to Ministry Directive B-131 ('Restriction on use of heavy vibratory equipment behind earth retaining structures, dated 81-11-24).

7. Precautions should be taken to prevent the founding stratum from being disturbed prior to pouring the culvert floor slabs. Pouring a 100 mm concrete pad as soon as possible (within 8 hours) after the excavation is opened should be used to protect the founding soil. All softened material should be removed prior to pouring this concrete.

8. Temporary construction slopes of 1.5:1 will be sufficient.

9. Permanent slopes of 2:1 will be stable.

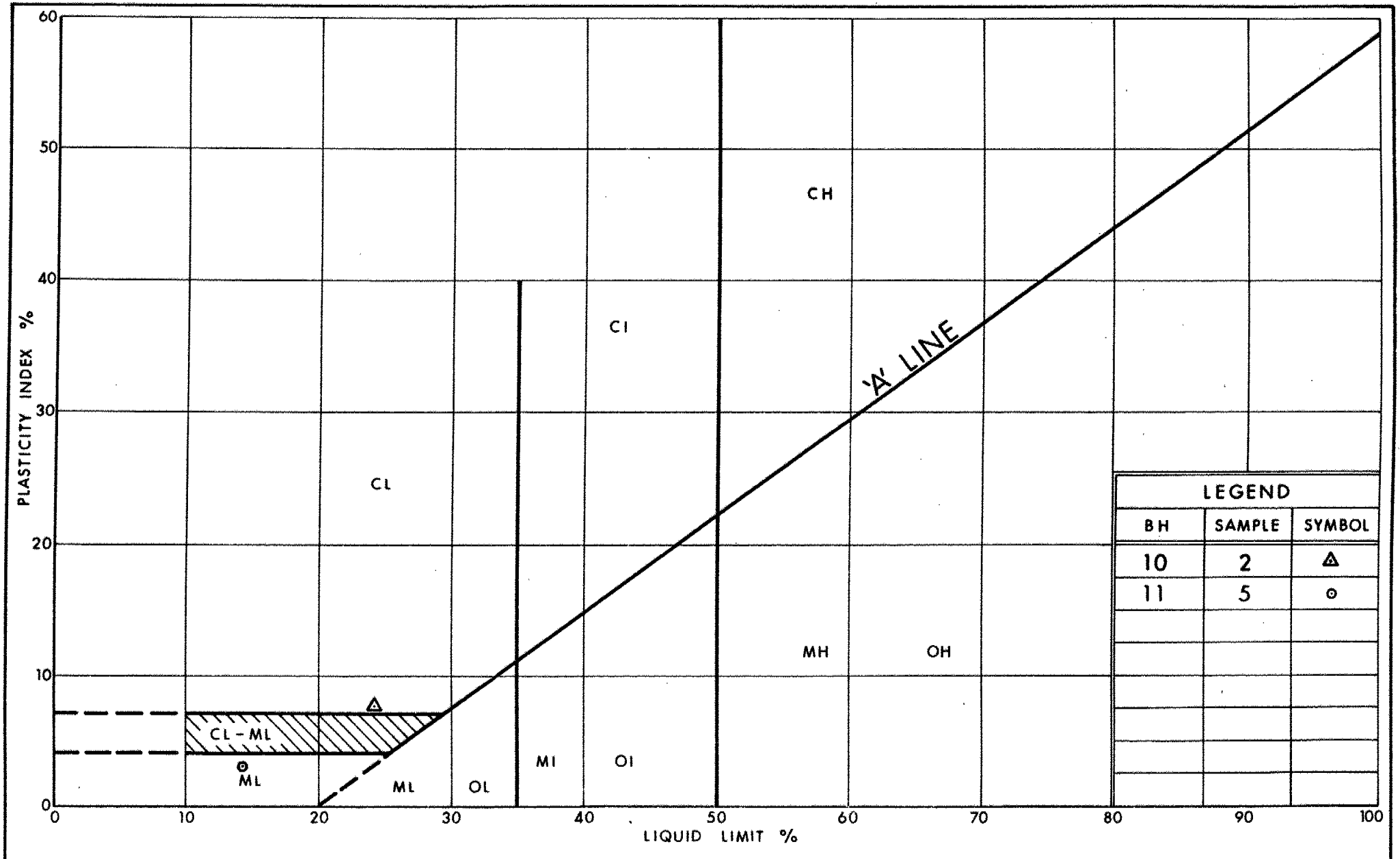
MISCELLANEOUS

The fieldwork for this project was supervised by J. Alter, Student Engineer. The equipment used was owned and operated by Dominion Soils Inc., Toronto. This report was prepared by L. Politano and reviewed by D. Dundas.

L. Politano, P. Eng.
Project Foundations Engineer

D. Dundas, P. Eng.
Foundations Engineer
for
M. Devata, P. Eng.
Chief Foundations Engineer (East)

October 1984.



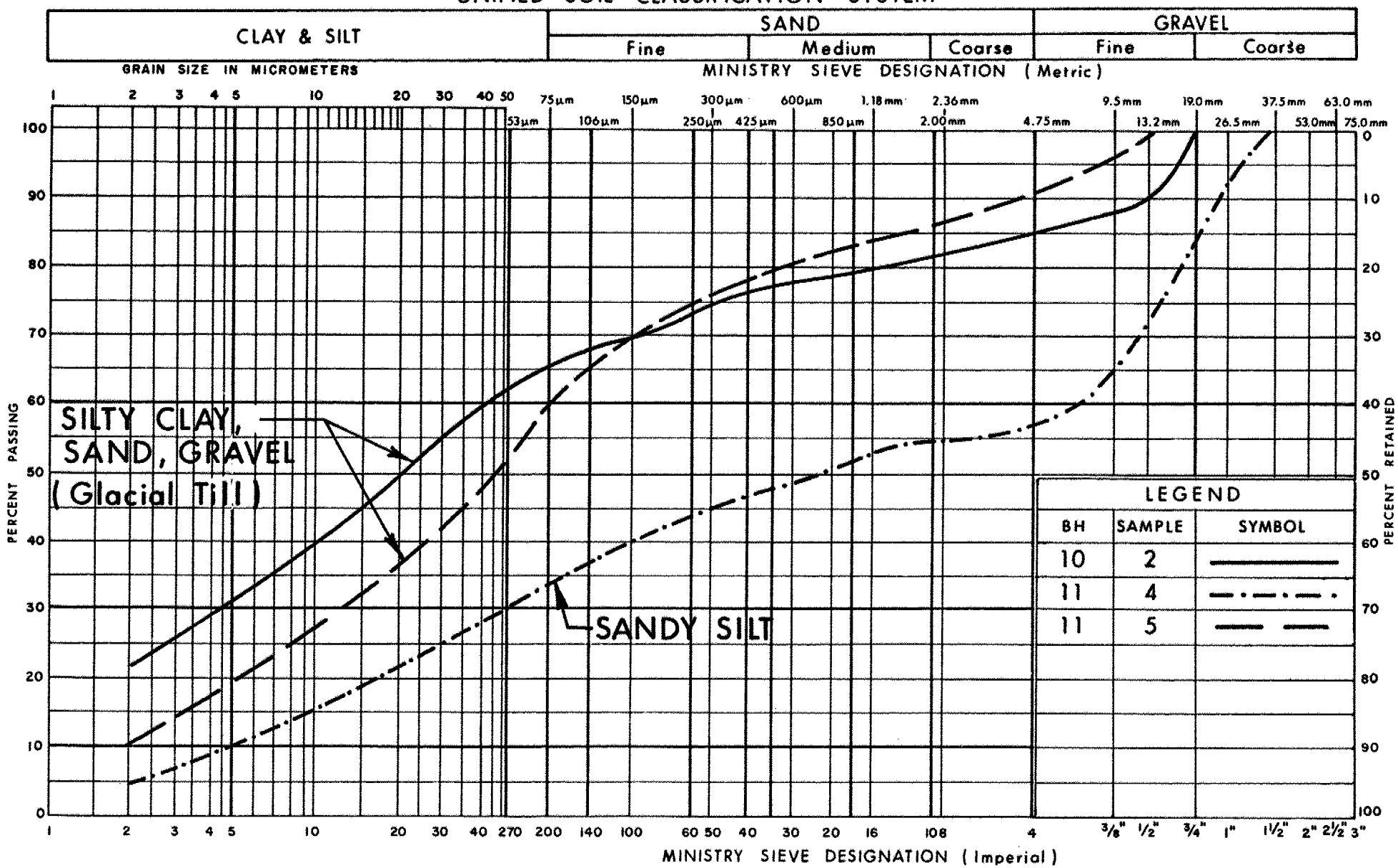
Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

HET MIXTURE OF SILTY CLAY, SAND, GRAVEL (GLACIAL TILL)

FIG No 1
W P 21-79-17
CULVERT No 1

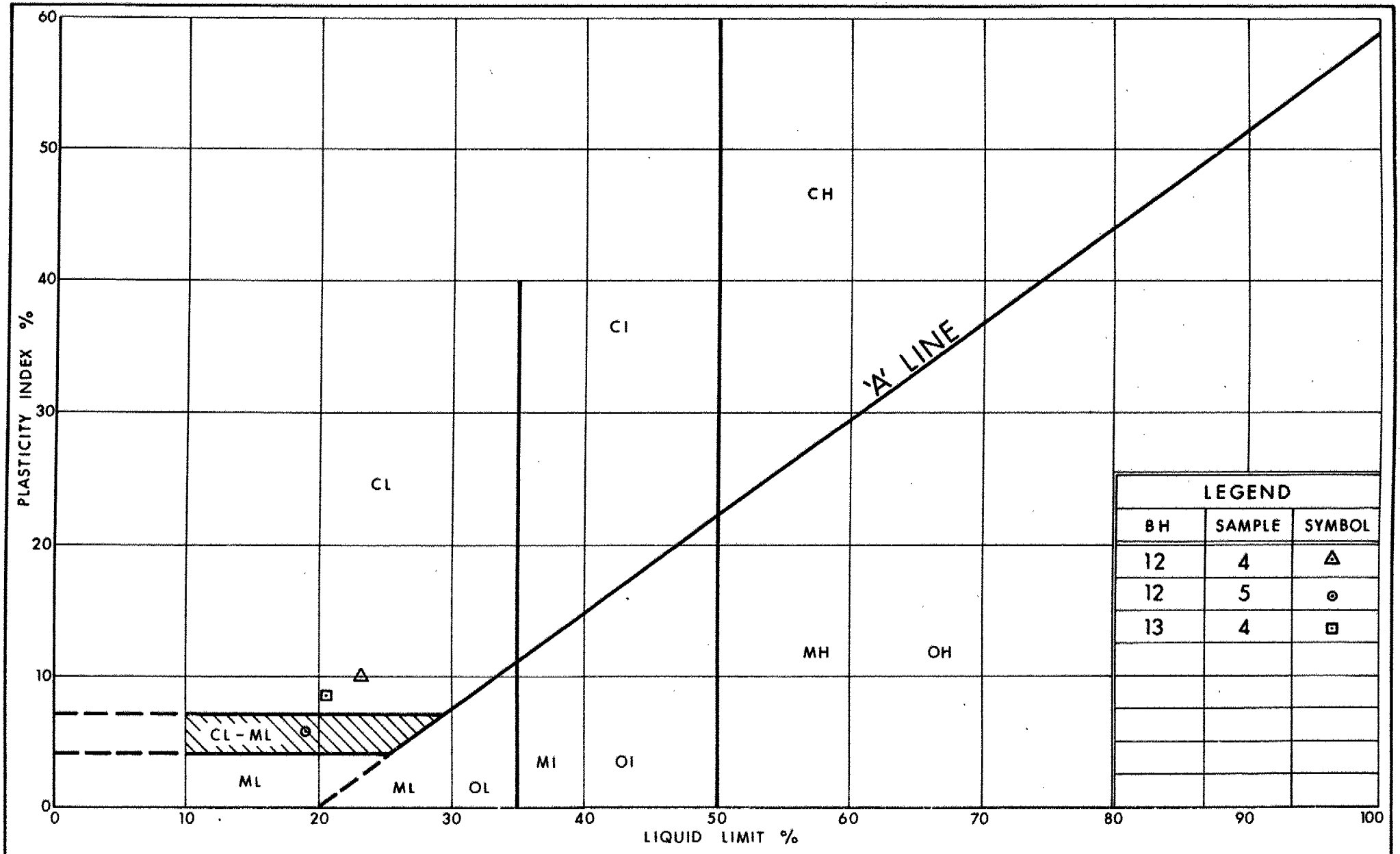
UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 2
W P 21 - 79-17
CULVERT No 1

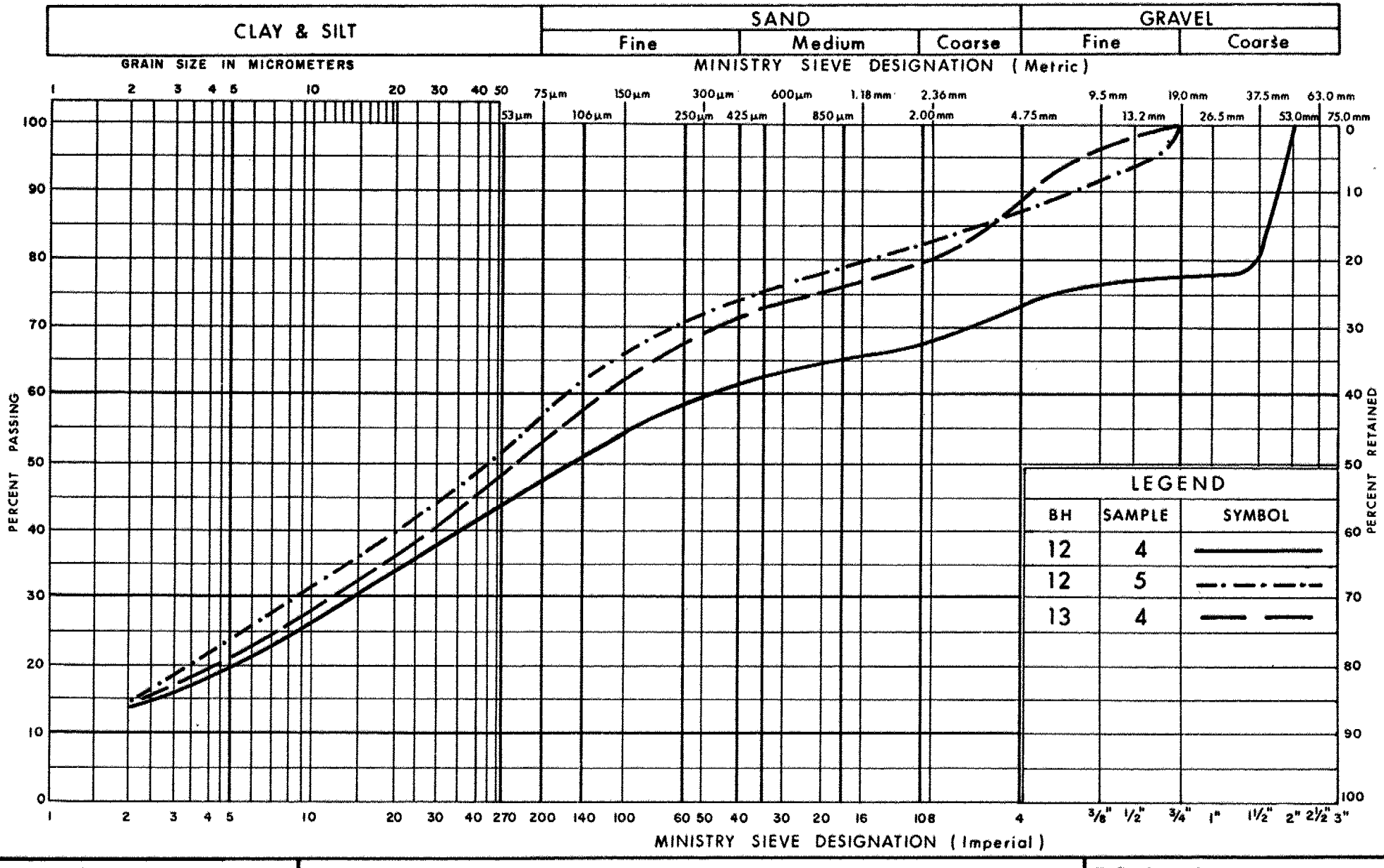


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART
HET MIXTURE OF SILTY CLAY, SAND, GRAVEL
(GLACIAL TILL)

FIG No 3
W P 21-79-17
CULVERT No 2

UNIFIED SOIL CLASSIFICATION SYSTEM

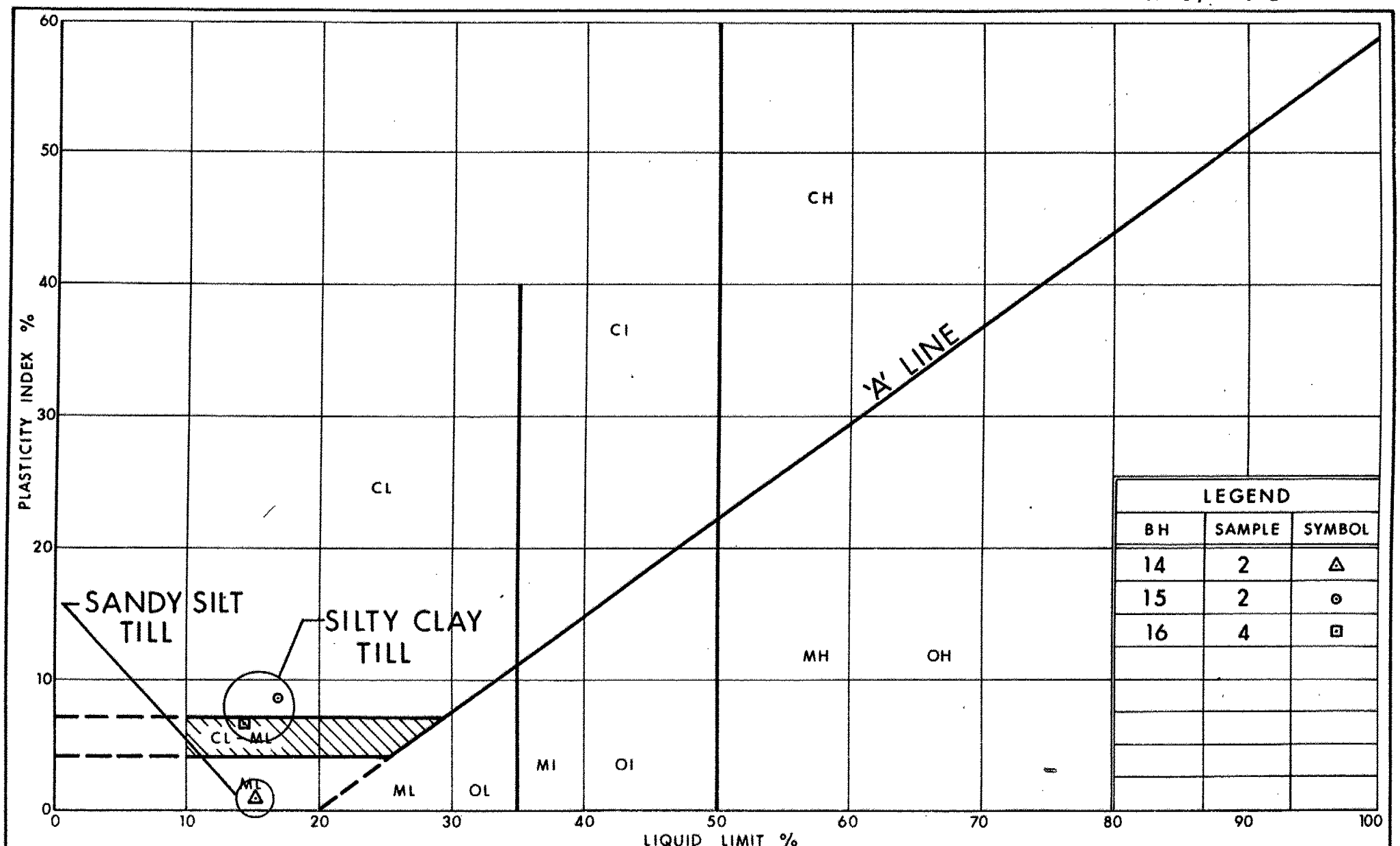


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

HET MIXTURE OF SILTY CLAY, SAND, GRAVEL
(GLACIAL TILL)

FIG No 4
W P 21-79-17
CULVERT No 2

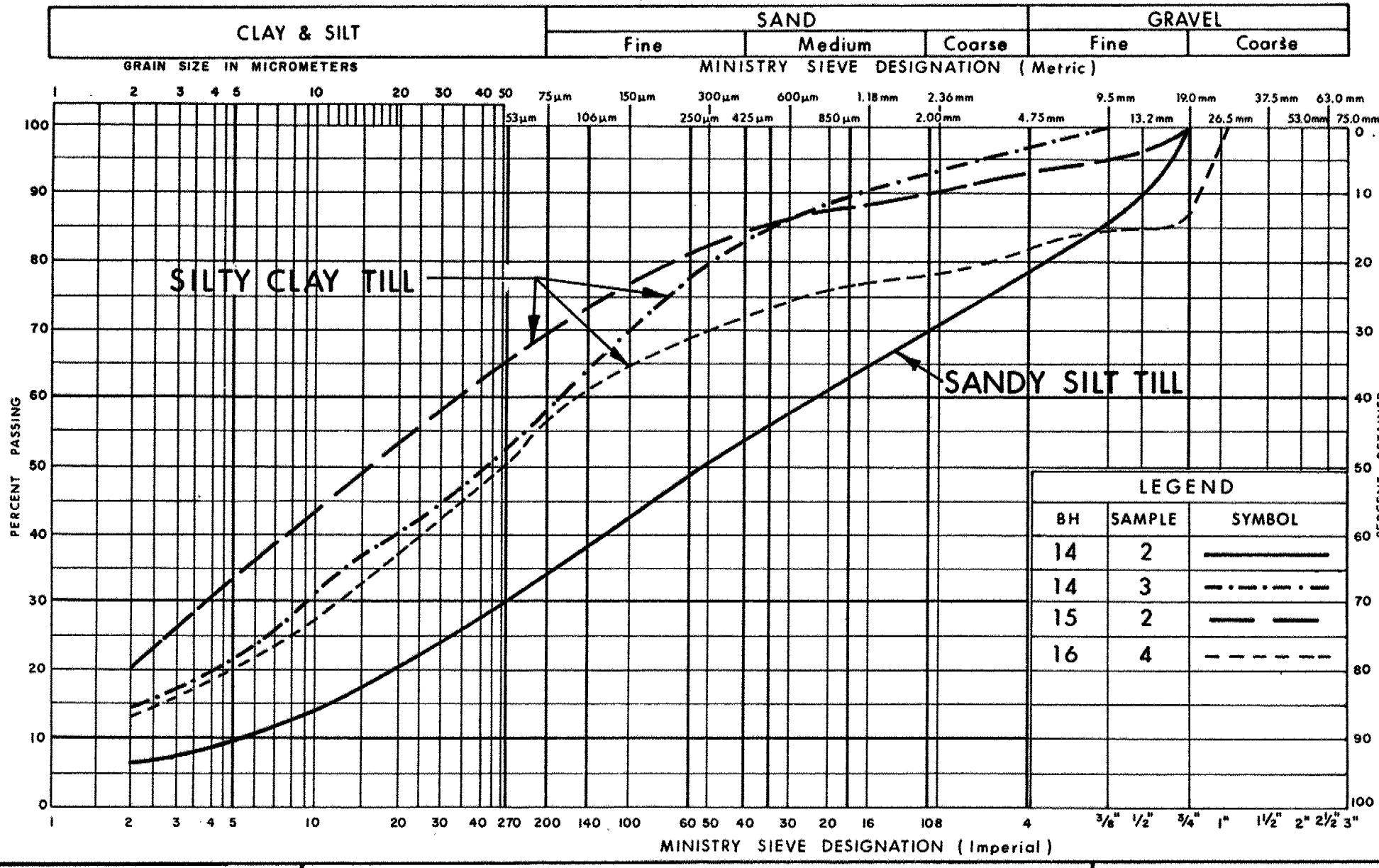


Ministry of Transportation and Communications
Ontario

PLASTICITY CHART

FIG No 5
W P 21-79-17
CULVERT No 3

UNIFIED SOIL CLASSIFICATION SYSTEM

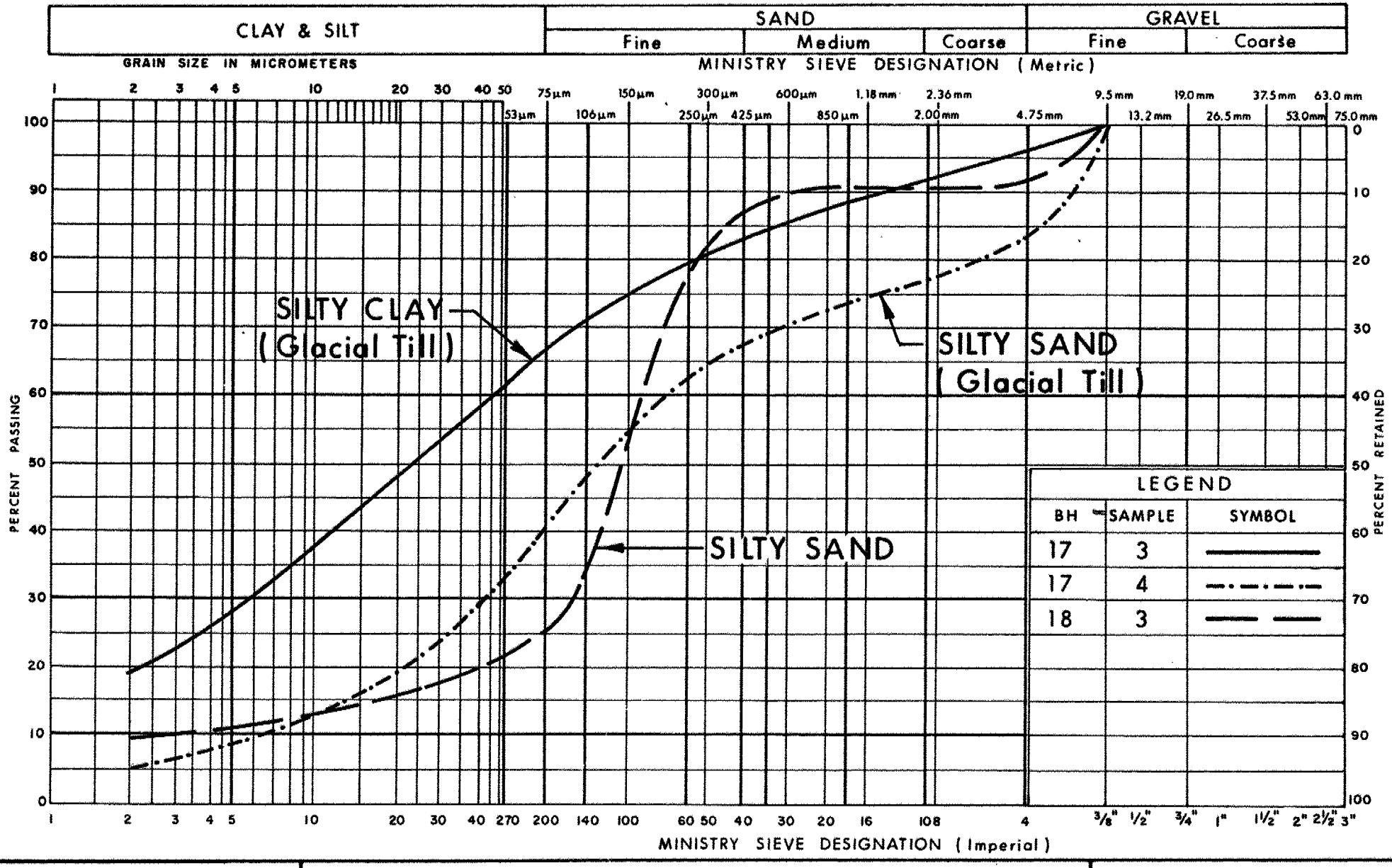


Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 6
W P 21-79-17
CULVERT No 3

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of Transportation and Communications
Ontario

GRAIN SIZE DISTRIBUTION

FIG No 7
W P 21-79-17
CULVERT No 4

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 10

METRIC

W P 21-79-17 LOCATION Co-ords. N 4 837 544.0; E 288 111.0 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84 08 14 CHECKED BY RS

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
191.3	Ground Surface										
0.0	Topsoil					*	191				
	Heterogeneous Mixture of Silty Clay, Sand Gravel (Glacial Till) (Brown) Hard		1	SS	30						
			2	SS	30		190				14 20 44 22
188.7	Probable Cobbles		3	SS	100/ 5 cm		189				
2.6	End of Borehole Refusal to Auger (Probable Boulder)										
	* Water Level not established										

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 11

METRIC

W P 21-79-17 LOCATION Co-ords. N 4 837 558.5; E 288 084.6 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA

DATUM Geodetic DATE 84 08 14 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
192.1	Ground Surface										
0.0	Silty Clay Some Sand Gravel (Fill)		1	SS	20	*	192				
190.9							191				
1.2	Heterogenous Mixture of Silty Clay Sand, Gravel (Glacial Till) (Brown) Hard		2	SS	35						
			3	SS	41		190				
	Sandy Silt & Gravel Trace Clay V. Dense		4	SS	100/13 cm		189		o		44 22 30 4
	(Grey) Hard		5	SS	77		188		o		9 32 48 11
187.1			6	SS	86						
5.0	End of Borehole										

* Water Level not established

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 12

METRIC

W P 21-79-17 LOCATION Co-ords N 4 837 899.6; E 287 944.2 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Core Test COMPILED BY JA

DATUM Geodetic DATE 84-08-14 CHECKED BY RS

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
193.2	Ground Surface										
0.0	Silty Clay (Fill) Stiff		1	SS	16	*	193				
			2	SS	9		192				
191.3											
1.9	Heterogenous Mixture of Silty Clay Sand, Gravel (Glacial Till) Brown Grey Hard		3	SS	40		191				
			4	SS	100		190		○		27 24 34 15
			5	SS	100/	28 cm	189		○		12 30 43 15
188.3			6	SS	100/	15 cm					
4.9	End of Borehole * Borehole dry at completion										

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 13

METRIC

W P 21-79-17 LOCATION Co-ords N 4 837 903.5; E 287 914.3 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA

DATUM Geodetic DATE 84-08-14 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH o 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
192.7	Ground Surface										
0.0	Silty Clay (Fill) Firm		1	SS	8	*	192				
191.5											
1.2	Heterogeneous Mixture of Silty Clay Sand, Gravel (Glacial Till)		2	SS	21		191				
			3	SS	88		190				
	Brown		4	SS	83				o		12 33 40 15
	Cobbles		5	SS	50/3 cm		189				
	Grey Very Stiff to Hard										
187.8			6	SS	100/20 cm		188				
4.9	End of Borehole										

* Water Level not established

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 14

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 047.3; E 287 608.2 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA

DATUM Geodetic DATE 84-08-10 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT N (20 40 60 80 100) / SHEAR STRENGTH (o 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						
194.9	Ground Surface										
0.0	Silty Clay with Sand, Gravel (Fill) Stiff		1	SS	11	*	194				
193.5											
1.4	Sandy Silt, trace clay some gravel (Glacial Till) Compact		2	SS	17		193		o H		22 40 31 7
192.7											
2.2	Heterogeneous Mixture of Silty Clay, Sand Gravel (Glacial Till) Cobble Brown Grey		3	SS	100				o		3 38 45 14
			4	SS	64/5 cm		192				
190.8	Hard		5	SS	100/18 cm		191				
4.1	End of Borehole										

* Water Level not established

+3, x5 : 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 15

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 064.5; E 287 621.8 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84-08-10 CHECKED BY RS

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
194.5	Ground Surface										
0.0	Silty Clay Some Sand trace gravel (Fill)					▼	194				
193.4			1	SS	14						
1.1	Hetergeneous Mixture of Silty Clay Sand, Gravel (Glacial Till)		2	SS	36		193		o ⊢		5 24 50 21
	Brown / Grey		3	SS	100/ 28 cm		192				
			4	SS	84/ 10 cm						
	Hard						191				
190.4			5	SS	86/ 10 cm						
4.1	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 16

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 060.3; E 287 572.0 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84-08-10 CHECKED BY RS

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
196.3	Ground Surface										
0.0	Silty Clay Some Sand Gravel (Fill)		1	SS	19	*	196				
193.8			2	SS	12		195				
2.5	Heterogeneous Mixture of Silty Clay Sand, Gravel (Glacial Till) Brown Grey		3	SS	27		194				
			4	SS	86		193	100/25 cm	○ —		17 25 44 14
	Hard		5	SS	100/13 cm		192				
190.7			6	SS	59/10 cm		191				
5.6	End of Borehole										

* Water Level not established

+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 17

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 545.0; E 288 007.8 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JA

DATUM Geodetic DATE 84-08-13 CHECKED BY RS

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						
192.0	Ground Surface										
0.0	Silty Clay (Fill)		1	SS	7	▼	191				
190.6											
1.4	Heterogeneous Mixture of Silty Clay Sand, Gravel (Glacial Till) Hard Brown		2	SS	35		190				
			3	SS	52			100/28 cm	○		3 31 48 18
189.1							189				
2.9	Silty Sand, trace clay some gravel (Glacial Till) Very Dense (Grey)		4	SS	100/10 cm				○		16 45 34 5
			5	SS	100/23cm		188				
187.2			6	SS	55/10 cm						
4.8	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

RECORD OF BOREHOLE No 18

METRIC

W P 21-79-17 LOCATION Co-ords N 4 838 551.6; E 287 959.6 ORIGINATED BY JA

DIST 6 HWY 410 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA

DATUM Geodetic DATE 84-08-10 & 84-08-13 CHECKED BY RS

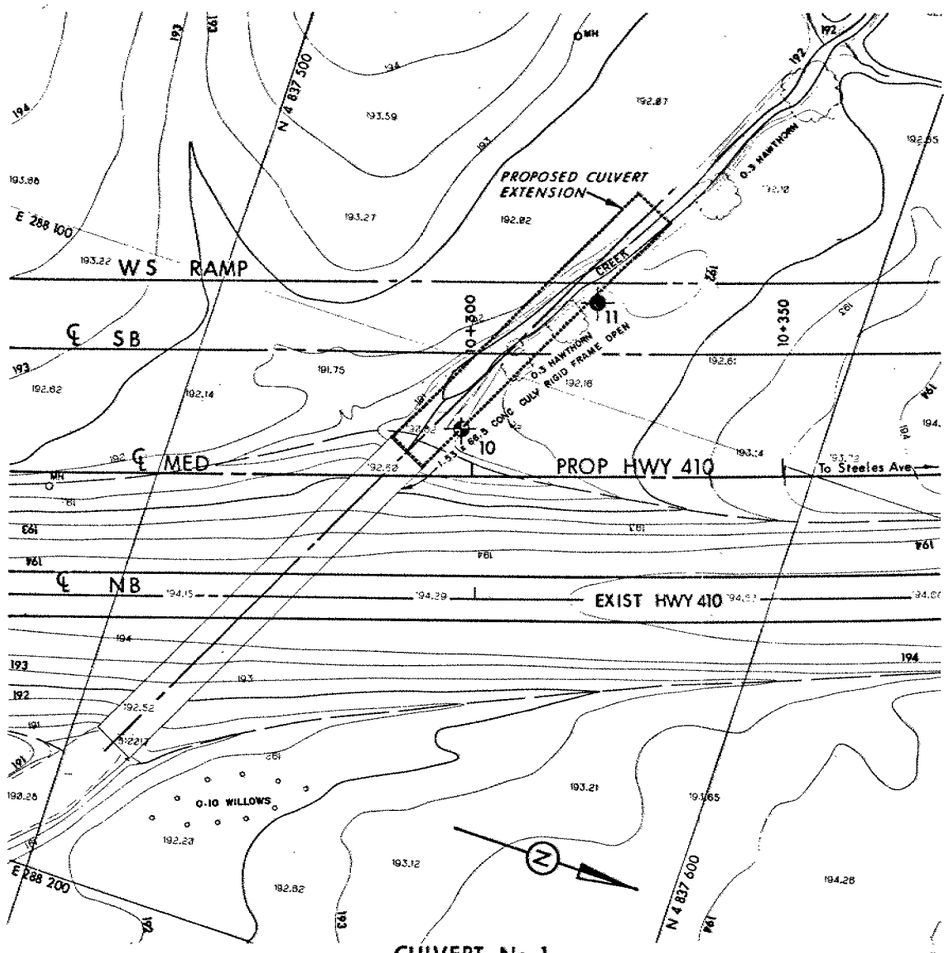
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
192.3	Ground Surface										
0.0	Silty Clay (Fill)		1	SS	14		192				
			2	SS	5	▼	191		○		
190.2											
2.1	Silty Sand trace clay, gravel Very Loose		3	SS	1		190		○		8 66 16 10
189.4											
2.9	Heterogenous Mixture of Silty Clay Sand Gravel (Glacial Till) Hard		4	SS	100/18 cm			100/15 cm			
188.7							189				
3.6	Silty Sand trace clay, some gravel (Glacial Till) Very Dense (Grey)		5	SS	37/5 cm						
187.5							188				
4.8	End of Borehole		6	SS	100/8 cm						

+3, ×5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

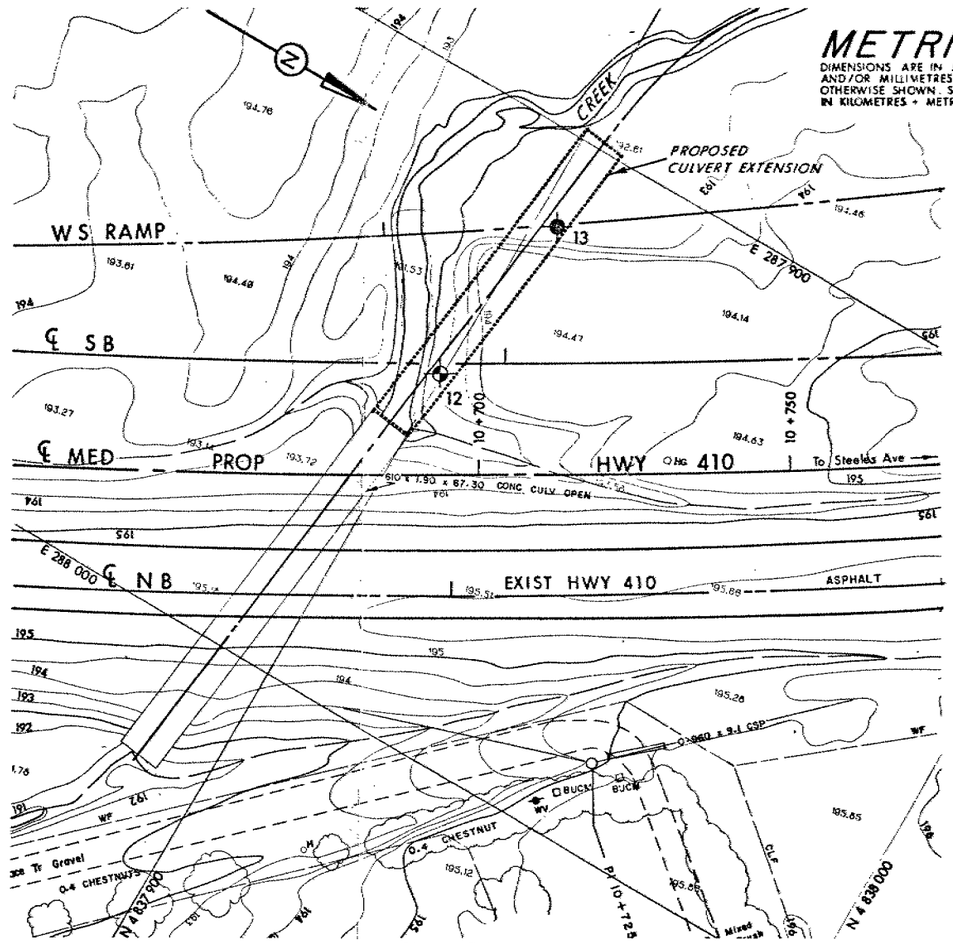
OFFICE REPORT ON SOIL EXPLORATION

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO FR-0-207 (Formerly 08-MT-308M 78-06)



CULVERT No 1

STA 10+300 (Approx), ℄ Med. Hwy 410

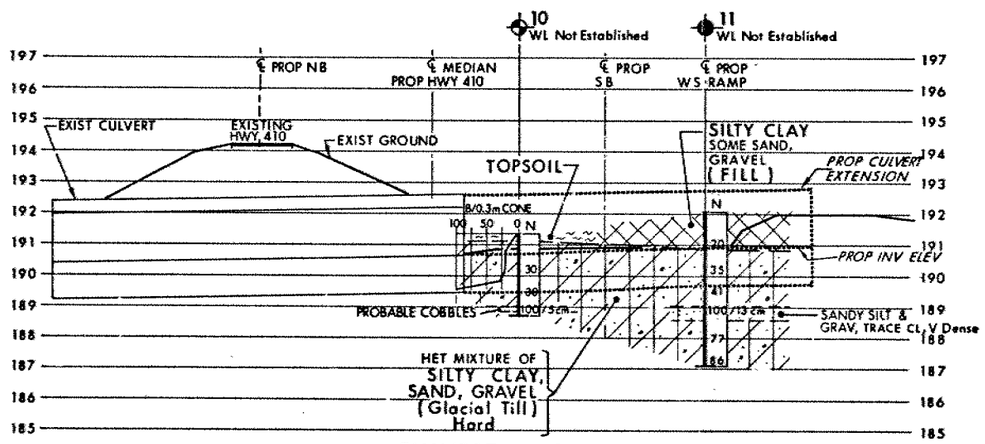


CULVERT No 2

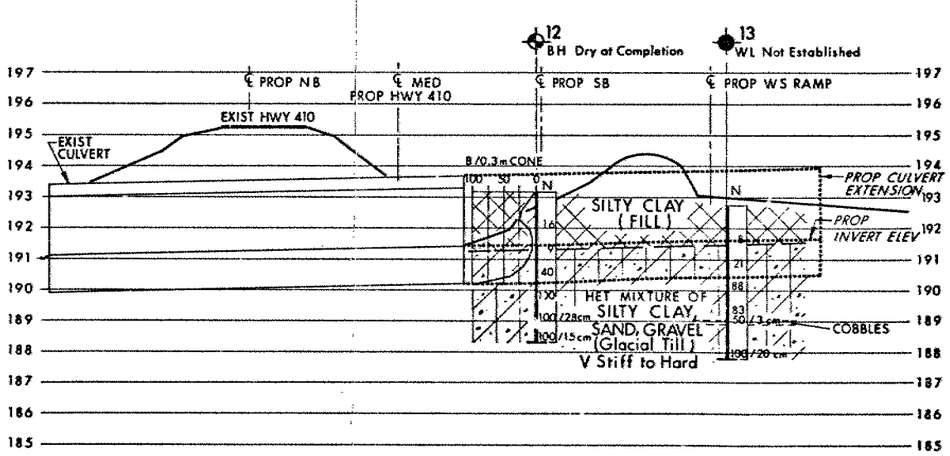
STA 10+700 (Approx), ℄ Med Hwy 410

PLANS

SCALE 10 0 10 m



CULVERT No 1



CULVERT No 2

℄ PROFILES ALONG PROPOSED CULVERTS

SCALE

HOR 10 5 0 10 m

VERT 2 1 0 2 m

CONT No

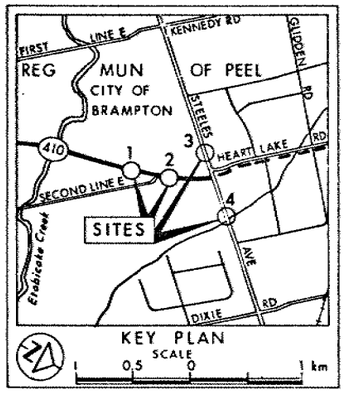
WP No 21-79-17

SHEET

CULVERTS

(Hwy 410)

BORE HOLE LOCATIONS & SOIL STRATA



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 Aug 1984 WL Not Established for BH's 10, 11 & 13 BH 12 Dry at Completion.

No	ELEVATION	CO-ORDINATES NORTH	EAST
10	191.3	4 837 544.0	288 111.0
11	192.1	4 837 558.5	288 084.6
12	193.2	4 837 899.6	287 944.2
13	192.7	4 837 903.5	287 914.3

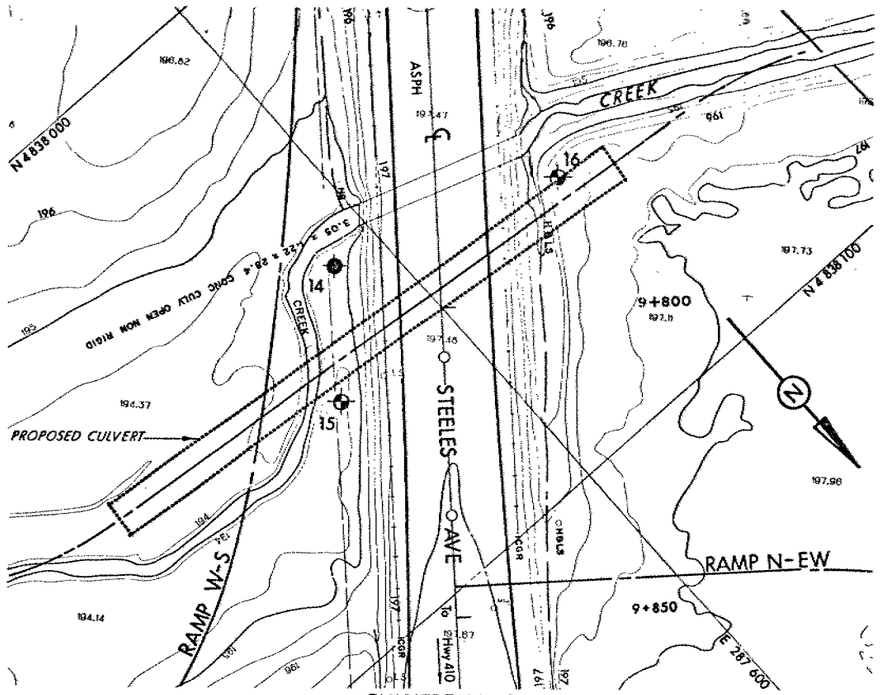
NOTE

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

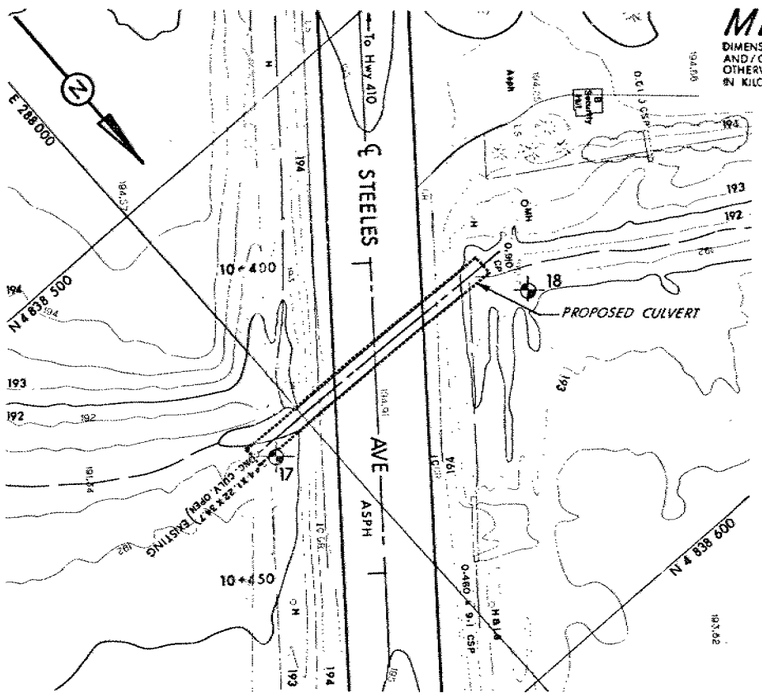
REVISIONS			
DATE	BY	DESCRIPTION	

Geocres No 30 M12-188

HWY No 410			DIST 6
SUBM'D LP	CHECKED	DATE Oct 30, 1984	SITE
DRAWN RS	CHECKED	APPROVED	DWG 217917-A



CULVERT No 3
STA 9+800 (Approx)



CULVERT No 4
STA 10+430 (Approx)

PLANS
SCALE
10 0 10 m

METRIC

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

CONT No
WP No 21-79-17

CULVERTS
(Steeles Ave)
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

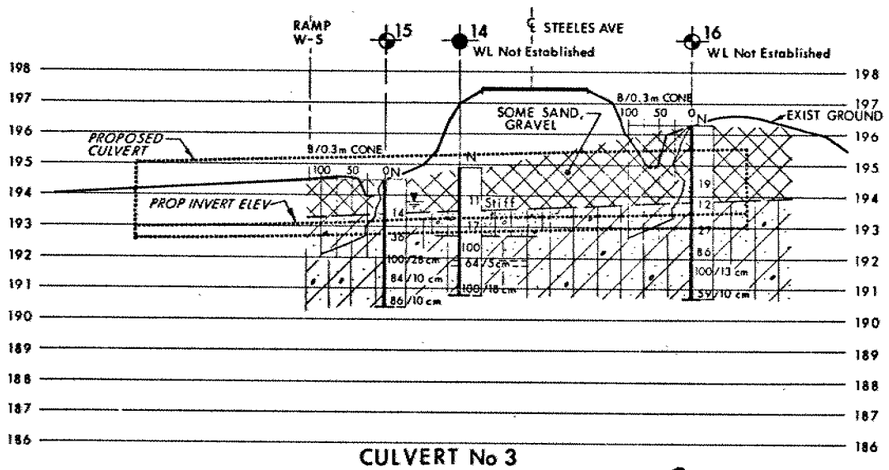
SEE DWG 217917-A

KEY PLAN
SCALE

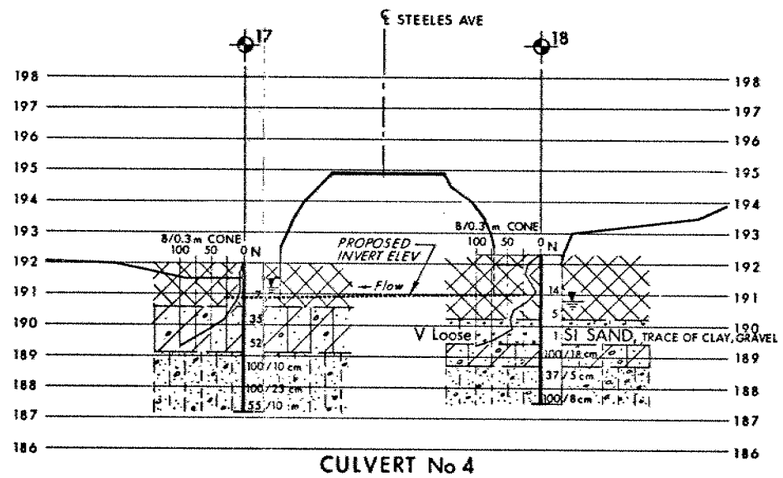
LEGEND

- 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 Aug 1984, WL Not Established for BH 14 and 16.

No	ELEVATION	CO-ORDINATES NORTH	EAST
14	194.9	4 838 047.3	287 608.2
15	194.5	4 838 064.5	287 621.8
16	196.3	4 838 060.3	287 572.0
17	192.0	4 838 545.0	288 007.8
18	192.3	4 838 551.6	287 959.6



CULVERT No 3



CULVERT No 4

℄ PROFILES ALONG PROPOSED CULVERTS

SCALE
HOR 10 5 0 10 m
VERT 2 1 0 2 m

SOIL STRATIGRAPHY LEGEND

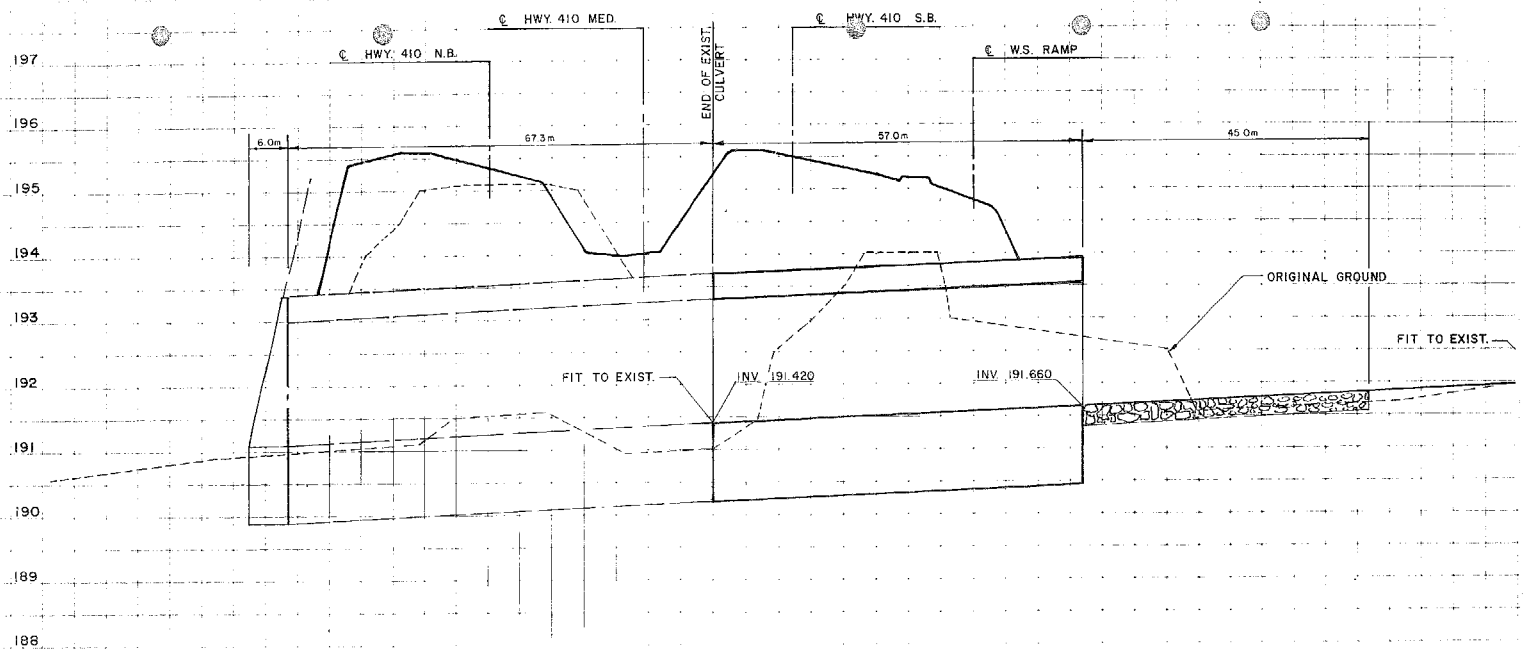
- SILTY CLAY (FILL)
- HET MIXTURE OF SILTY CLAY, SAND, GRAVEL (Glacial Till) Hard
- SANDY SILT TRACE OF CLAY, SOME GRAVEL (Glacial Till) Compact
- SILTY SAND TRACE OF CLAY, SOME GRAVEL (Glacial Till) Very Dense

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

REVISIONS	DATE	BY	DESCRIPTION

Geocres No 30M12-188

HWY No 410			DIST 6
SUBM'D L P	CHECKED	DATE Oct 30, 1984	SITE
DRAWN R S	CHECKED	APPROVED	DWG 217917-B



10+700 Hwy 410