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GEOCRES No. 30M13-110

DIST. 6 REGION

W.P. No. 140-87-01

CONT. No. 93-86

W. O. No.

STR. SITE No. 37-1313

HWY. No. 407

LOCATION Hwy 400 N/S - 407 E Ramp
over W-N/S Jane St. Ramp

No of PAGES - (East Bound Basketweave) -

=====
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO. 93-86



Ministry of
Transportation

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	Ramp Structure Hwy. 400 N/S - 407 E Ramp (Over W-N/S Jane St. Ramp) W.P. 140-87-01 Site 37-1313 Hwy. 400/407 Dist. 6 Toronto
	Jane St. N/S-W Ramp over 407 E - 400 N/S Ramp (Westbound Basketweave) W.P. 140-87-02(R) Site 37-1314 Hwy. 400/407 Dist. 6 Toronto
	Jane St. Underpass at Hwy. 407 W.P. 140-87-04/05 Site 37-1315 Hwy. 407 Dist. 6 Toronto
	Black Creek Culvert W.P. 140-87-08 Site 37-1319 Hwy. 407 Dist. 6 Toronto
	Black Creek Culvert and Jane St. W.P. 140-87-09 Site 37-1318 Hwy. 407 Dist. 6 Toronto

Note: For purposes of the contract, this report supersedes all other Foundation Reports prepared by, or for the Ministry in connection with the above mentioned project.

EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT
For
Ramp Structure Hwy. 400 N/S-407 E Ramp
(over W-N/S Jane Street Ramp)
W.P. 140-87-01, Site 37-1313
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted west of Jane Street, along the proposed Highway 407 corridor at the above mentioned structure site. This report applies to the proposed structure, its retaining walls and related approaches.

SITE DESCRIPTION AND GEOLOGY

This site is located north of Steeles Avenue, south of Highway 7, west of Jane Street along the proposed Highway 407 corridor in the Township of Vaughan. It is located on land used for agricultural purposes. The terrain surrounding the site is level to undulating.

Physiographically, the region has been described by Chapman and Putman (1973) as the Peel Plain. The Peel Plain is basically a bevelled till plain, containing large amounts of Palaeozoic shale and limestone, and some areas are modified by a veneer of varved clay.

FIELD INVESTIGATION

The fieldwork was carried out during the period from 90 01 31 to 90 02 07 and consisted of ten boreholes, with all of them accompanied by dynamic cone penetration tests. The borings were advanced by hollow stem augers (95 and 83 mm I.D.) using machines mounted on muskeg vehicles.

Sampled boreholes were advanced to depths ranging from 8.1 to 24.8 m below the ground surface. From the surface the cone tests advanced to depths ranging from 2.9 to 7.5 m below the ground surface. In general, subsoil sampling was conducted at 0.7 m intervals for the surficial 6.1 m, at 1.5 m

intervals to 12 m below ground level and at 3 m intervals to 18 m at 6 m intervals to less for the remainder of each borehole. All samples were retrieved using a split spoon sampler in accordance with Standard Penetration Test (ASTM D1586). All samples were identified in the field and again in the laboratory where they were returned for applicable testing.

Groudwater levels were obtained in the open boreholes and monitored until they were backfilled. The boreholes were backfilled either following their completion or at the completion of the investigation. Survey information for the location and elevation of the boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and property of the soil, the following laboratory tests have been conducted:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Natural Moisture Contents

SUBSURFACE CONDITIONS

General

The elevation of the ground level at the site ranged from 192.2 m at the west end to 193.8 m at the east end. The subsurface conditions at the site consist mainly of 5.2 to 8.8 m (to elevation 183.6) of clayey silt, with sand, trace of gravel The top of which was topsoil. The bottom 5.9 to 2.3 m of this deposit contains layers of sandy silt. Underlying this deposit at El. 190.5 to 183.6 m was a grey clayey silt to silty clay trace of sand which is a lacustrine layer. All of the boreholes ended within this deposit, therefore the stratum was 16 m plus thick.

The plan, location of borings and the subsoil stratigraphical profile are shown on Drawing 1408701-A*. The boundaries between various soil types, field and laboratory test results as well as ground water levels are plotted on the Record of Borehole sheets also in the Appendix of this report. A description of the soil types encountered are given below.

Clayey Silt, with Sand, trace of Gravel; Till

The glacial till was found from the surface (elevation 192.2 to 193.8) to the top of the clayey silt to silty clay deposit. The deposit consisted of clayey silt, with sand, trace of gravel and ranged in depth from 5.2 to 8.8 m. The upper half was brown in colour, while the lower half which was 2.9 to 3.5 m below ground level was grey with occasional sandy silt layers.

A grain size distribution envelope for the material (excluding the occasional sandy silt layers) 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. They are plotted in Figure 2. A summary of the physical properties of the fine grained portion is provided below:

	<u>Range</u>
Natural Moisture Content (w)	6-20%
Liquid Limit (w_L)	8-29%
Plastic Limit (w_p)	11-18%

The test results indicate a clayey silt of low plasticity.

Grain size distribution tests were carried out on the sandy silt layers that were present 2.9 to 3.5 m below the surface. Figure 3 is the test results in envelope form. Atterberg Limits were also obtained, which indicate that the fine grained portion is a silt of low plasticity, shown in Figure 4. A summary of the physical properties of the fine grained portion is provided below:

	<u>Range</u>
Natural Moisture Content (w)	7-12%
Liquid Limit (w_L)	14-18%
Plastic Limit (w_p)	12-17%

The 'N' values obtained from the standard penetration tests ranged from 8 to 145. The high values may have resulted from large aggregates such as boulders and cobbles which are characteristic of till deposits. The consistency of the till was found to be stiff to hard.

Clayey Silt to Silt Clay, trace of Sand; Lacustrine

This deposit of clayey silt to silty clay was found underlying the clayey silt till at elevation 183.5/188. All of the boreholes terminated within this lacustrine deposit. The thickness of the deposit is therefore 16 metres plus.

The grain size distribution tests as determined by mechanical analyses for this deposit are given in envelope form in Figure 5. Atterberg Limits were also obtained to evaluate the behaviour of the fine grained portion of the material. They are plotted in Figure 6. A summary of the physical properties of the fine grained portion is provided below:

	<u>Range</u>
Natural Moisture Content (w)	12-28%
Liquid Limit (w_L)	23-79%
Plastic Limit (w_p)	13-18%

The test result therefore indicate a clayey silt to silty clay of low to intermediate plasticity, trace of sand.

The 'N' values obtained from the standard penetration tests ranged from 16 to 139. Typical 'N' values ranged however from 22 to 65. The high values may have resulted from large aggregates such as boulders and cobbles. The consistency of the till was found to be very stiff to hard.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. These observations are recorded on the Record of Borehole sheets as well as on Drawing 1408701-A**.

Measurements obtained at the time of the investigation revealed the following water levels.

<u>Borehole</u>	<u>Elevation (m)</u>
40	184.3*
41	185.0*
42	185.5
43	184.6
44	192.8
45	184.5 (not stabilized)
46	183.1*
47	190.9
48	191.3
49	192.6

*Note water level not stabilized.

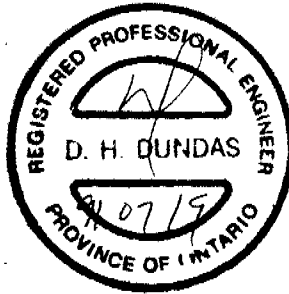
The boreholes indicate the ground water level to be in general about 0.6 m below the ground surface at approximate elevation 192.8 m. It should be noted that groundwater levels are subject to seasonal fluctuations and may therefore vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of P. Marks, Foundation Engineer and Bill Cung, Engineer Trainee. The equipment was owned and operated by Marathon Drilling Co. Ltd. and Master Soils Investigations.

** DWG NO 2 OF THE CONTRACT DWG'S

The project was carried out by P. Marks under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by P. Marks, reviewed by Dr. B. Iyer and approved by M.S. Devata, Chief Foundation Engineer.



D. Dundas

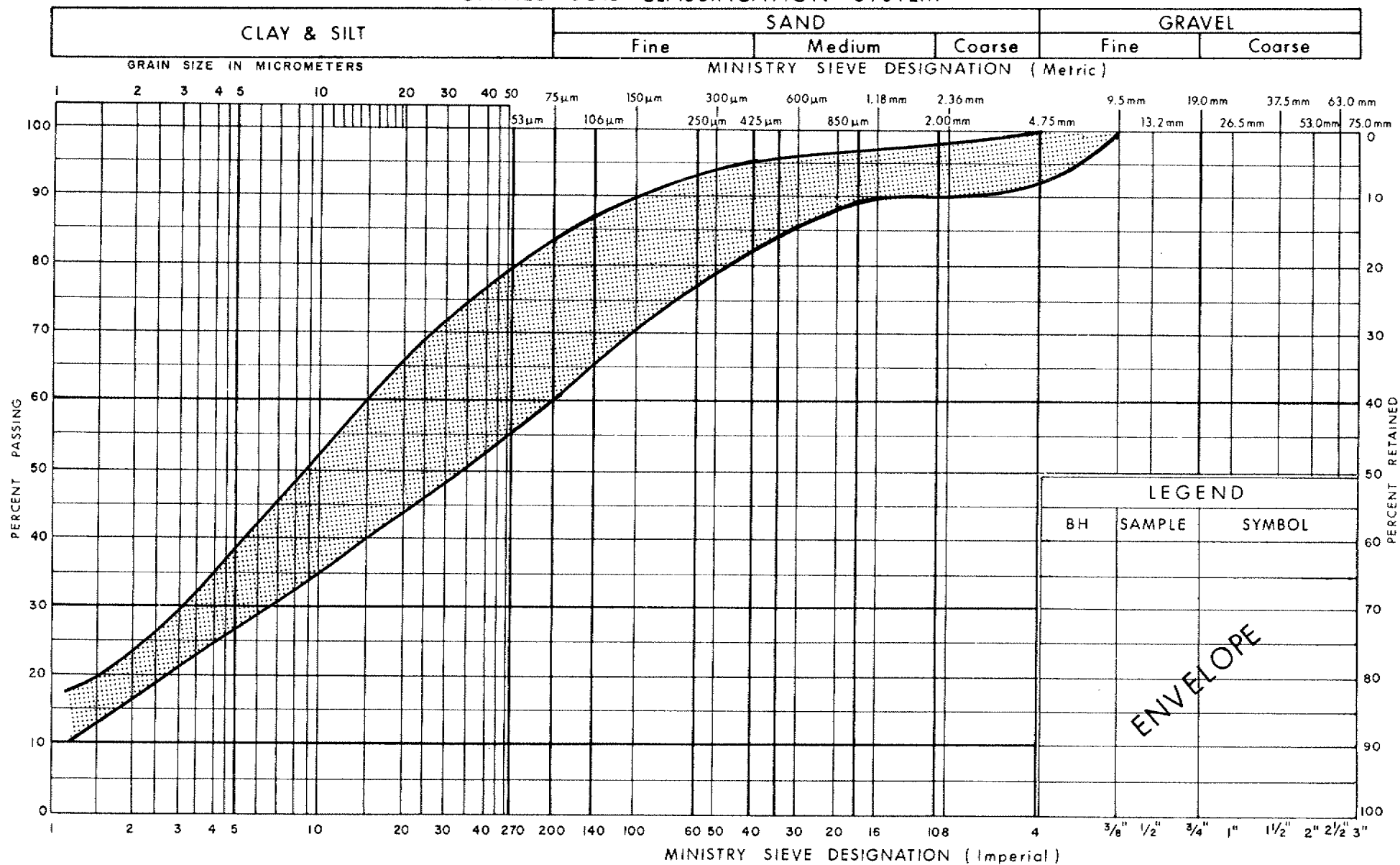
D. Dundas, P. Eng.
Sr. Foundation Engineer

M. Devata

M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM



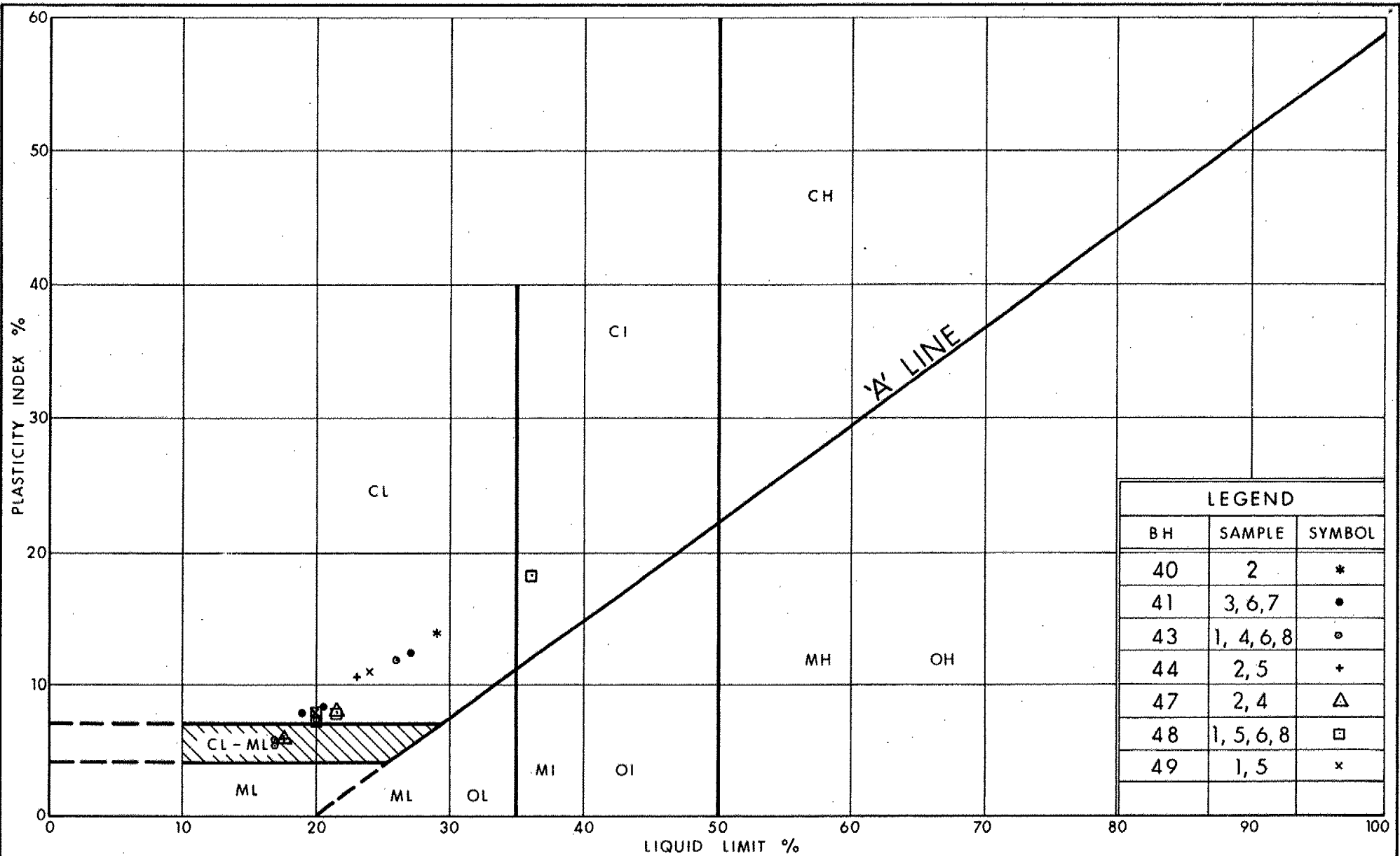
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GRAIN SIZE DISTRIBUTION
CLAYEY SILT,
WITH SAND, TRACE OF GRAVEL (TILL)

FIG No 1

W P 140-87-01



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PLASTICITY CHART
CLAYEY SILT,
WITH SAND, TRACE OF GRAVEL (TILL)

FIG No 2

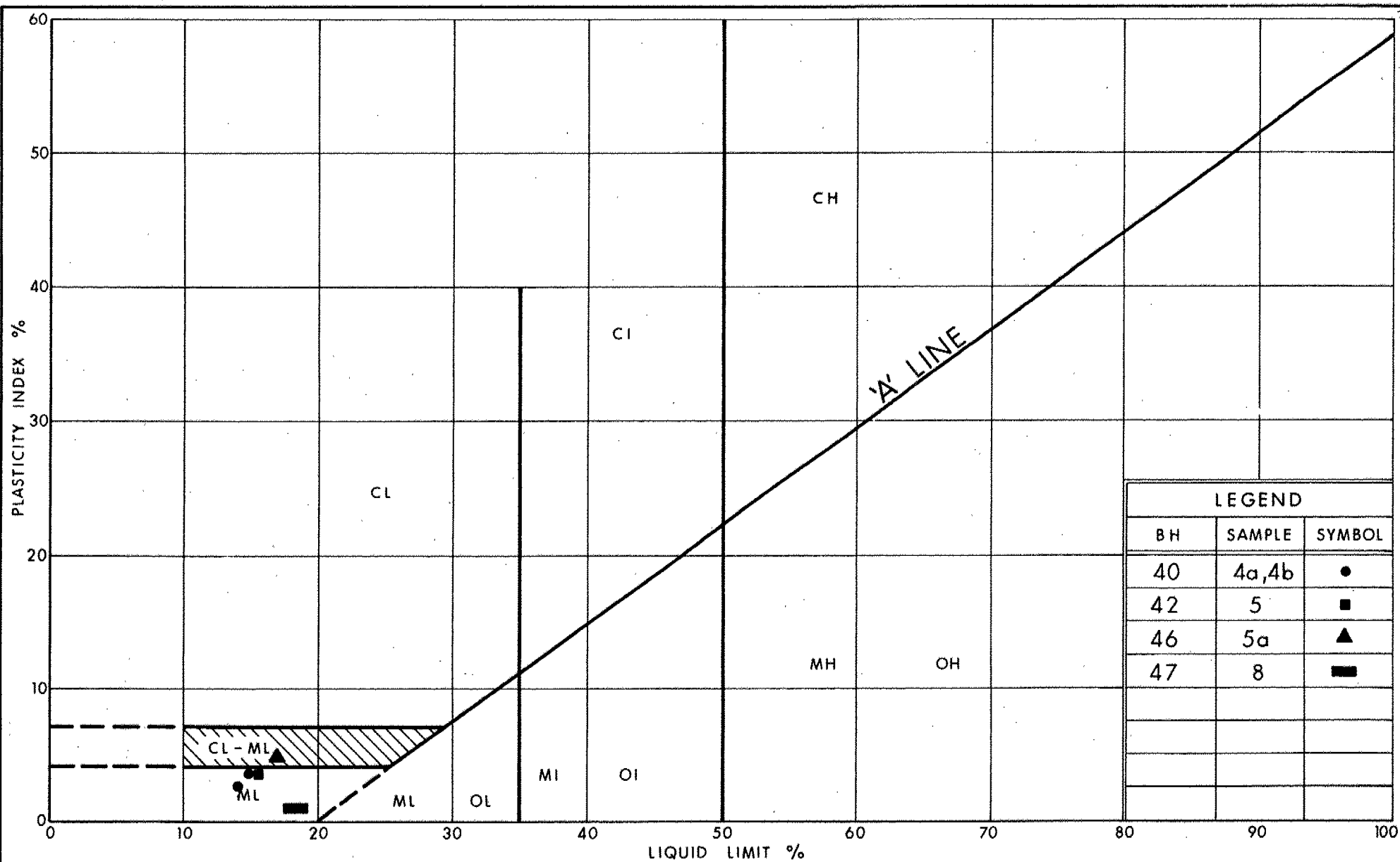
W P 140-87-01



OCCASIONAL SANDY SILT LAYERS

FIG No 3

W P 140-87-01



LEGEND		
BH	SAMPLE	SYMBOL
40	4a, 4b	•
42	5	■
46	5a	▲
47	8	■



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PLASTICITY CHART SANDY SILT LAYERS

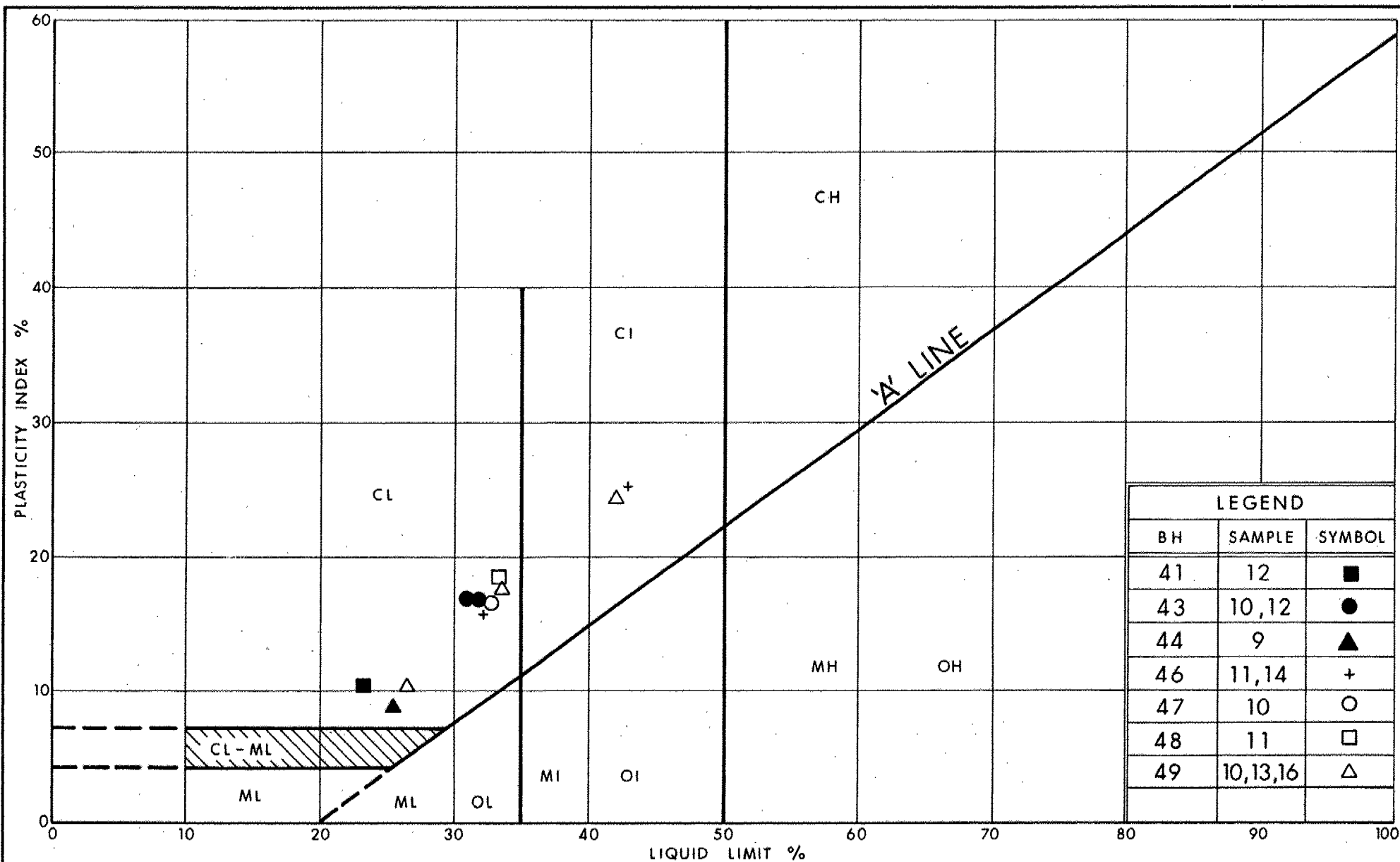
FIG No 4

W P 140-87-01



GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY,
TRACE OF SAND

W P 140-87-01



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PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND

FIG No 6

W P 140-87-01

RECORD OF BOREHOLE No 40

1 OF 1

METRIC 16

W.P. 140-87-01 LOCATION Co-ord: N 4849133 ; E 302414
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.)
 DATUM Geodetic DATE 90-02-06
 ORIGINATED BY P.M.
 COMPILED BY P.M.
 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
182.5	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	19									
			2	SS	21									1 18 (81)
			3	SS	29									
	brown		4	SS	47									4 39 47 10
	grey		5	SS	52									
	occasional sandy silt layers		6	SS	63									
186.6	Very Stiff to Hard		7	SS	47									
5.9			8	SS	35									
	CLAYEY SILT to SILTY CLAY		9	SS	22									
	Trace of Sand		10	SS	58									
	Occasional thin silt layers		11	SS	64									
	(Locustrine)													
	Hard		12	SS	65									
179.9														
12.6	End of Borehole													
	• Water Level Not Stabilized													

RECORD OF BOREHOLE No 41

1 OF 1

METRIC 17

W.P. 140-87-01 LOCATION Co-ord: N 4849134 ; E 302446 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-02 to 90-02-05 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
192.5	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	16									
			2	SS	14									
			3	SS	23									
	brown		4	SS	44		190							4 31 (65)
	grey		5	SS	35									
	occasional sandy silt layers		6	SS	30		188							1 30 50 19
			7	SS	62									3 29 46 22
185.6	Very Stiff to Hard		8	SS	47		186							
7.0														
	CLAYEY SILT to SILTY CLAY		9	SS	45		184							
	Trace of Sand		10	SS	35									
	Occasional thin silt layers (Locustrine)		11	SS	53		182							
180.0	Hard		12	SS	29		180							
12.6	End of Borehole													
	* Water Level Not Stabilized													

RECORD OF BOREHOLE No 42

1 OF 1

METRIC 18

W.P. 140-87-01 LOCATION Co-ord: N 4849135 ; E 302476
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.)
 DATUM Geodetic DATE 90-02-05 to 90-02-06
 ORIGINATED BY P.M.
 COMPILED BY P.M.
 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
192.8	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	15									
			2	SS	12									
			3	SS	21									
			4	SS	38									
			5	SS	80									
187.6	Stiff to Hard		6	SS	97									
5.2	CLAYEY SILT To SILTY CLAY Some Sand		7	SS	60									
			8	SS	53									
			9	SS	48									
	Occasional thin silt layers (Locustrine)													
183.2	Hard		10	SS	60									
9.6	End of Borehole													
	* Water Level Not Stabilized													

RECORD OF BOREHOLE No 43

1 OF 1

METRIC 19

W.P. 140-87-01 LOCATION Co-ord: N 4849136 ; E 302505 ORIGINATED BY P.M.

DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.

DATUM Geodetic DATE 90-02-01 to 90-02-02 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
193.4	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	12		192							2 31 (67)
			2	SS	14									
	brown		3	SS	11									
	grey		4	SS	8		190							3 30 (67)
	Occasional sandy silt layers		5	SS	46									3 31 52 14
			6	SS	99									4 26 (70)
	Stiff to Hard		7	SS	33		188							
186.7			8	SS	34									1 18 60 21
6.7														
	CLAYEY SILT to SILTY CLAY		9	SS	21		186							
	Some Sand		10	SS	33									
	Occasional thin silt layers (Lacustrine)		11	SS	44		184							
	Hard													0 6 (94)
180.8			12	SS	49		182							
12.6	End of Borehole													

RECORD OF BOREHOLE No 44

1 OF 1

METRIC 20

W.P. 140-87-01 LOCATION Co-ord: N 4849137 ; E 302534
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.)
 DATUM Geodetic DATE 90-01-31 to 90-02-01
 ORIGINATED BY P.M.
 COMPILED BY P.M.
 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	WATER CONTENT (%)		
193.8	Ground Level												
0.0	Topsoil												
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	18								
			2	SS	16								
			3	SS	21								
	brown grey Occasional sandy silt layers Very Stiff to Hard		4	SS	14								
			5	SS	32								
			6	SS	33								
188.8			7	SS	39								
5.8	CLAYEY SILT to SILTY CLAY Trace of Sand Occasional thin silt layers (Locustrine) Hard		8	SS	42								
			9	SS	43								
185.4			10	SS	60								
8.4	End of Borehole												

RECORD OF BOREHOLE No 45

1 OF 1 METRIC 21

W.P. 140-87-01 LOCATION Co-ord: N 4849120 ; E 302380 ORIGINATED BY B.C.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (S.S.) COMPILED BY P.M.
 DATUM Ceodetic DATE 90-02-07 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	WATER CONTENT (%) 20 40 60	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
191.5	Ground Surface													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Glacial Till)		1	SS	16									
			2	SS	28									
	brown		3	SS	38									
	grey		4	SS	133									
	Occasional sandy silt layers		5	SS	145									
			6	SS	120	/18cm								
185.6	Very Stiff to Hard		7	SS	120	/18cm								
5.9	CLAYEY SILT to SILTY CLAY, Trace of Sand (Lacustrine)		8	SS	114									
183.4	Hard		9	SS	75									
8.1	End of Borehole													
	• Water Level Not Stabilized													

RECORD OF BOREHOLE No 46

1 OF 1

METRIC 22

W.P. 140-87-01 LOCATION Co-ords: N4 849 121 ; E 302 414 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-05 to 90-02-06 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED 20 40 60 80 100	+ FIELD VANE × LAB VANE 20 40 60 80 100						
192.2	Ground Level														
0.0	Topsail ----- CLAYEY SILT With Sand, Trace of Gravel (Till) brown grey Occasional sandy silt layers Stiff to Hard		1	SS	8	192									
			2	SS	12	190									3 18 66 13
			3	SS	20										
			4	SS	42	188									3 18 66 13
			5	SS	48										2 34 (64)
			6	SS	97										
			7	SS	118	186									2 35 53 10
6.2			8	SS	86										
			9	SS	32	184									
183.5			10	SS	55	182									
8.7	CLAYEY SILT to SILTY CLAY Trace of Sand Occasional thin silt layers (Locustrine) Very Stiff to Hard		11	SS	41	180									1 4 (95)
12.5			12	SS	28	178									
			13	SS	17	176									
			14	SS	18	174									
			15	SS	23	172									0 0 (100)
167.4					170										
24.8	End of Borehole • Water Level Not Stabilized				168										

RECORD OF BOREHOLE No 47

1 OF 1

METRIC 23

W.P. 140-87-01 LOCATION Co-ords: N4 849 122.0; E302 446 ORIGINATED BY P.M.

DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.

DATUM Geodetic DATE 90-02-05 to 90-02-06 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
192.4	Ground Level													
0.0	Topsoil		1	SS	21									
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		2	SS	28									
	brown		3	SS	40									
	grey		4	SS	76									
	Occasional sandy silt layers		5	SS	55									
			6	SS	127									
			7	SS	98									
	Very Stiff to Hard		8	SS	118									
185.1														
7.3	CLAYEY SILT to SILTY CLAY		9	SS	65									
	Trace of Sand (Locustrine)													
182.8	Hard		10	SS	139									
9.6	End of Borehole													

RECORD OF BOREHOLE No 48

1 OF 1

METRIC 24

W.P. 140-87-01 LOCATION Co-ords: N4 849 123 ; E 302 478 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-01 to 90-02-05 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
192.7	Ground Level													
0.0	Topsoil		1	SS	26									
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		2	SS	23									2 26 53 19
	brown		3	SS	31									
	grey		4	SS	86									6 39 43 12
	Occasional sandy silt layers		5	SS	49									
			6	SS	54									1 21 (78)
			7	SS	69									
			8	SS	61									
184.6	Very Stiff to Hard		9	SS	79									
8.1	CLAYEY SILT to SILTY CLAY													
	Trace of Sand (Lacustrine)		10	SS	98									
181.9	Hard		11	SS	103									1 4 (95)
10.8	End of Borehole													

RECORD OF BOREHOLE No 49

1 OF 1

METRIC 25

W.P. 140-87-01 LOCATION Co-ords: N 4 849 124 ; E 302 511 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-01-31 to 90-02-01 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
193.2	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	10		192							5 32 (63)
			2	SS	9									
	brown		3	SS	19									
	grey		4	SS	10		190							5 21 (74)
			5	SS	17									
	Occasional sandy silt layers		6	SS	16		188							
			7	SS	16									
			8	SS	27		186							
	Stiff to Hard		9	SS	53									
184.4														
8.8			10	SS	44		184							0 5 (95)
	CLAYEY SILT to SILTY CLAY		11	SS	22		182							
	Trace of Sand		12	SS	23		180							
			13	SS	22		178							0 0 (100)
	Occasional thin layers of silt (Lacustrine)		14	SS	16		176							
			15	SS	19		172							
	Very Stiff to Hard						170							
168.4			16	SS	25									0 0 (100)
24.8	End of Borehole													

FOUNDATION INVESTIGATION REPORT

For

Jane Street N/S-W Ramp over 407 E-400 N/S Ramp
(Westbound Basketweave)

W.P. 140-87-02 (R), Site 37-1314

Highway 407, District 6, TorontoINTRODUCTION

This report summarizes the results of a foundation investigation carried out at the aforementioned site. It is proposed to construct a three (3) span structure that carries the Jane Street N/S-W ramp over the Hwy. 407E-Hwy.400N/S ramp. This report describes the subsurface conditions at the site.

SITE DESCRIPTION

The site is located in a sector of land situated approximately midway between the existing Jane Street and Hwy. 400, approximately 0.5 km south of existing Hwy. 7 and immediately north of the proposed Hwy. 407 in the Town of Vaughan, Regional Municipality of York. A drainage channel approximately 5 m in depth is located approximately 250-300 m west of the site. The site can be accessed via an existing gravel road located off of Jane Street.

The terrain at the site is generally flat but slopes gently upward in an easterly direction. Ground surface elevations ranged from 194.3 m to 196.7 m from the western to the eastern boundary limits of the site.

The land at the site is used primarily as agricultural farmland. A paved parking lot which is located southeast of the site serves as a temporary storage area for construction equipment and materials. A residential home also exists east of the site and immediately west of existing Jane Street.

Physiographically, the site lies in the geological domain known as the Bolton Area, an area that covers approximately 1200 square kilometres located at the northwestern border of the Municipality of Metropolitan Toronto. The Bolton area has drumlins, till plains, moraines and numerous other features associated

with deglaciation. The area was covered with the Wisconsin glacier of the Pleistocene period that advanced into the region approximately 50,000 years ago and retreated approximately 15,000 years ago.

The overburden deposits at the site consist of moraine tills of the Halton Till Formation underlain by glaciolacustrine sediments deposited by Lake Peel, a body of water impounded between lobes of projecting ice. The Halton Till is primarily a silt till composed of varying percentages of clay, silt, sand and gravel. The glaciolacustrine deposits generally consist of stratified silt, clayey silt and/or silty clay.

The surficial deposits of the Cenozoic era are underlain by bedrock of the Paleozoic era. Bedrock consists of grey, thinly bedded shales with interbedded limestone from the Dundas Meaford Formation. Bedrock topographical maps reveal that the bedrock exists at depths approximately 70-80 m below the natural ground surface at the site location.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing conducted. The procedures employed are discussed below.

Field Investigation

The fieldwork for the investigation was carried out within two separate time periods. The original fieldwork was carried out between 90 02 07 and 90 02 12 and consisted of 8 sampled boreholes advanced to depths ranging from 7.0 m to 15.7 m below the ground surface. Two of the boreholes were accompanied by dynamic cone tests advanced to depths of 2.6 m to 5.1 m. The subsequent investigation, conducted to obtain additional soils information, was carried out on 90 07 30 and consisted of two sampled boreholes advanced to depths of 12.6 m.

Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance the boreholes in the overburden. In general, disturbed subsoil samples were retrieved at 0.7 m for the surficial 6 m and 1.5 m intervals thereafter. Sample retrieval was conducted in accordance with the Standard

Penetration Test (ASTM D1586). All samples were identified in the field and then returned to the laboratory for applicable testing.

Groundwater levels were obtained by monitoring the levels in the open boreholes throughout the duration of the field investigation. All open boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by Central Region Surveys and Plans.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents

Laboratory test results have been summarized in the subsequent section of this report entitled "Subsurface Conditions", and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

At the site, the elevation of the ground surface increases in an easterly direction from 194.3 m to 196.7 m. The subsoil stratigraphy at the site consists of a surficial veneer of topsoil, brown in colour and of thickness equivalent to approximately 0.5 m. The topsoil is underlain by a glacial till deposit consisting of a heterogeneous mixture of clayey silt, sand and gravel. The host material of the deposit is the cohesive clayey silt that binds the other grain sizes into a matrix. The thickness of this deposit is in the order of magnitude of 2.5 to 3.5 m. The deposit generally has a stiff to hard consistency.

The cohesive till deposit is underlain by a second till deposit consisting of a heterogeneous mixture of silt, sand and gravel. The host material of the deposit is primarily silt and consequently the deposit exhibits a cohesionless behaviour. The thickness of the deposit across the site generally ranges from approximately 1.5 to 4.6 m. However, at BH 57 this deposit was explored for a thickness of 9.1 m. The full extent of the deposit was not ascertained at this location. The deposit is in a dense to very dense state of condition.

Underlying the cohesionless till deposit exists a glaciolacustrine cohesive stratum consisting of a silty clay. This stratum can be categorized as having a hard consistency. The extent of this deposit was not determined in the investigation.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 1408702R-A.*

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

Topsoil

A thin veneer of topsoil that is brown in colour, moist and contains a rich, earthy odour is spread across the site. The thickness of this veneer is approximately 0.5 m.

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

The surficial topsoil is underlain by a unstratified glacial till deposit consisting of a heterogeneous mixture of clayey silt, sand and gravel. Occasional random sand seams are also present in the deposit. The thickness of the cohesive deposit ranges from 2.5 to 3.5 m extending to an elevation ranging from 190.8 to 193.7 m. The deposit has been generally oxidized throughout its full thickness and consequently brown in colour, although at some locations the lower metre or so is unoxidized and hence grey in colour.

* DWG NO 2 OF THE CONTRACT DWG'S

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 1 in the Appendix. The envelope illustrates that the grain sizes range from gravel to clay with a range of 56 to 75% of the material being fine grained (<75 micrometre). Although not encountered during the field investigation, boulders and cobbles are also characteristic components of till deposits and hence can exist in this deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1 below.

Table 1 - Het. Mix. of Clayey Silt,
and Gravel (Glacial Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	12-18	6
Liquid Limit (W_L %)	21-28	6
Plasticity Index (I_p %)	9-20	6
Unit Weight (kN/m^3)	19-21.6	6
SPT 'N' values (blows/0.3 m)	1-120/5 cm	32

The test results reveal that the fine grained portion of the deposit is of low plasticity and hence can be categorized as a clayey silt.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 1 blow/0.3 m to 120 blows/0.05 m. In general, however, the 'N' values exceed 15 blows/0.3 m in the lower 1-1.5 m of the deposit. The weaker material generally occurs within the upper 2 m of the deposit. Consequently, the deposit can be categorized as having a firm to stiff consistency for the upper 1-1.5 m and a very stiff to hard consistency for the lower thickness.

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

Underlying the cohesive till deposit exists a cohesionless till deposit composed of a heterogeneous mixture of silt, sand and gravel. Traces of clay are also present in the deposit. Boulders and cobbles are also present in this deposit

as evidenced by frequent auger grinding during borehole advancement in this deposit and auger refusal as encountered at BH 56.

The thickness of the deposit generally ranges from approximately 1.5 m to 4.6 m. However, at BH 57 the thickness of the deposit was explored to a depth of 9.1 m. (The full extent of the deposit was not penetrated at this location).

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 3 in the Appendix. The envelope illustrates the wide range of grain sizes typically inherent of till deposits. Silt, the main component of the deposit, comprises approximately 46 to 62% of the material.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted on Figure 4. A summary of the indices is provided in Table 2 below.

Table 2 - Het. Mix. of Silt, Sand
Gravel (Glacial Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	7-12	8
Liquid Limit (W_L %)	16-19	8
Plasticity Index (I_p %)	3-6	8
Unit Weight (kN/m^3)	21.8-23.3	5
SPT 'N' values (blows/0.3 m)	11->120	35

The test results reveal that the fine grained portion of the deposit behaves as a plastic silt.

Standard Penetration tests carried out in this deposit reveal 'N' values ranging from 11 blows/0.3 m to 120 blows/0.2 m. However, in general 'N' values exceed 30 blows/0.3 m and hence the deposit can be categorized as dense to very dense.

Silty Clay (Lacustrine)

The cohesionless till deposit is in turn underlain by a glaciolacustrine deposit consisting of a grey silty clay. The surface of this stratum is generally at an elevation ranging from 188.2 m to 190.7 m. The extent of the deposit was not determined during the investigation.

A grain size distribution envelope for this deposit as determined by hydrometer and sieve analysis is given in Figure 5 in the Appendix. The envelope illustrates that clay and silt percentages in the deposit range from 55-65% and 33-43% respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 6. A summary of the indices is provided in Table 3 below.

Table 3 - Silty Clay (Lacustrine)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	17-23	5
Liquid Limit (W_L %)	39-47	5
Plasticity Index (I_p %)	20-28	5
Unit Weight (kN/m^3)	20.3-21.8	6
SPT 'N' values (blows/0.3 m)	15-142	31

The test results reveal that the stratum is of intermediate plasticity and consequently can be categorized as a silty clay.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 15 blows/0.3 m to 142 blows/.25 m as tabulated in Table 3. However, in general 'N' values exceed 30 blows/0.3 m and consequently this stratum has a hard consistency.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater levels determined at the time of investigation ranged from 1 to 3.7 m below ground surface (El. 194 to 192.1 m).

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The initial fieldwork for this investigation conducted between 90 02 07 to 90 02 12, was carried out under the supervision of T. Sangiuliano, Foundation Engineer and B. Cung, Engineering Trainee, utilizing equipment owned and operated by Marathon Drilling and Master Soils Investigation. The subsequent fieldwork conducted on 90 07 30 was carried out under the supervision of M. Iampietro, Engineering Student, utilizing equipment owned and operated by Master Soils Investigation.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.

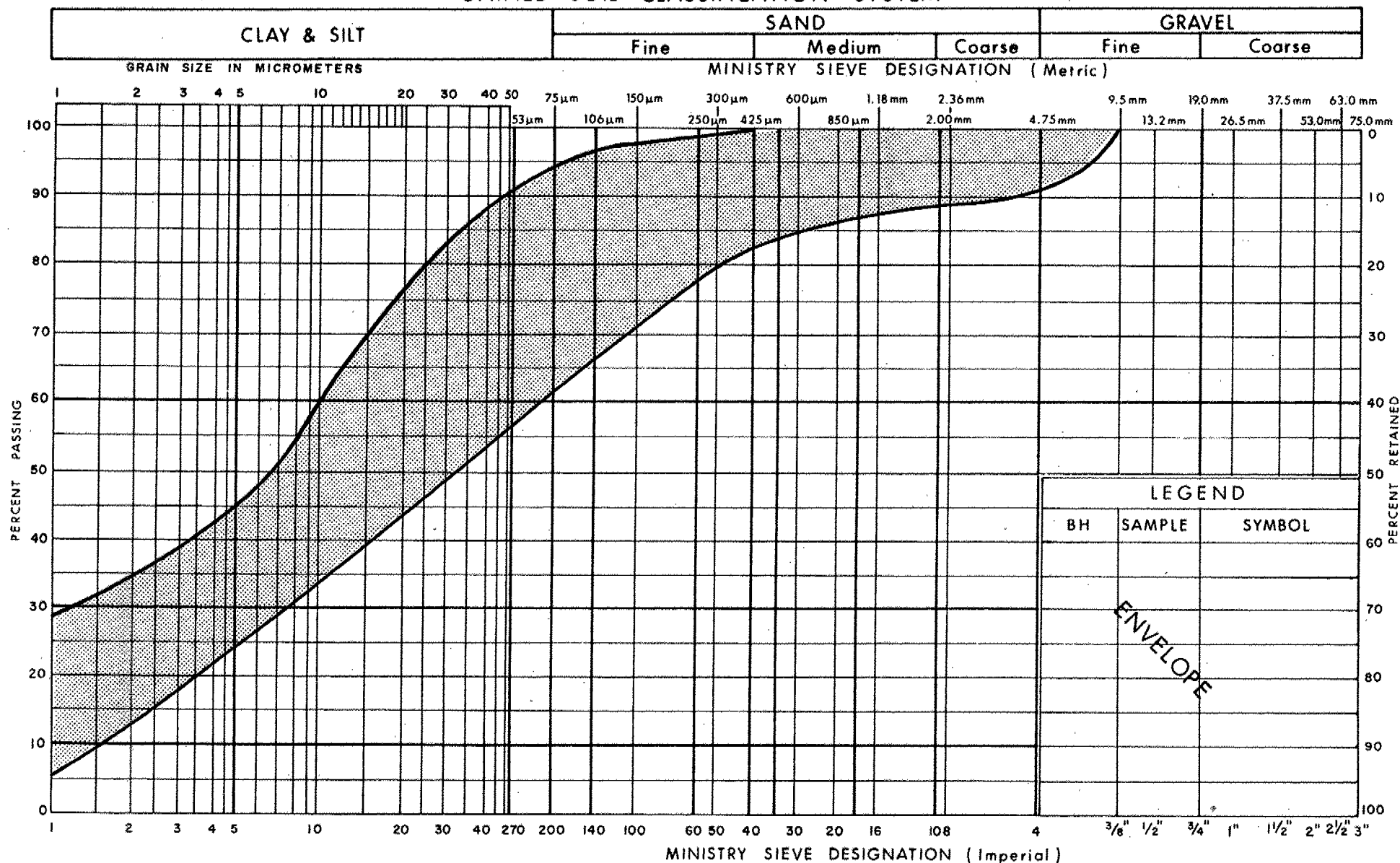


D. Dundas
D. Dundas, P. Eng.
Sr. Foundation Engineer

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

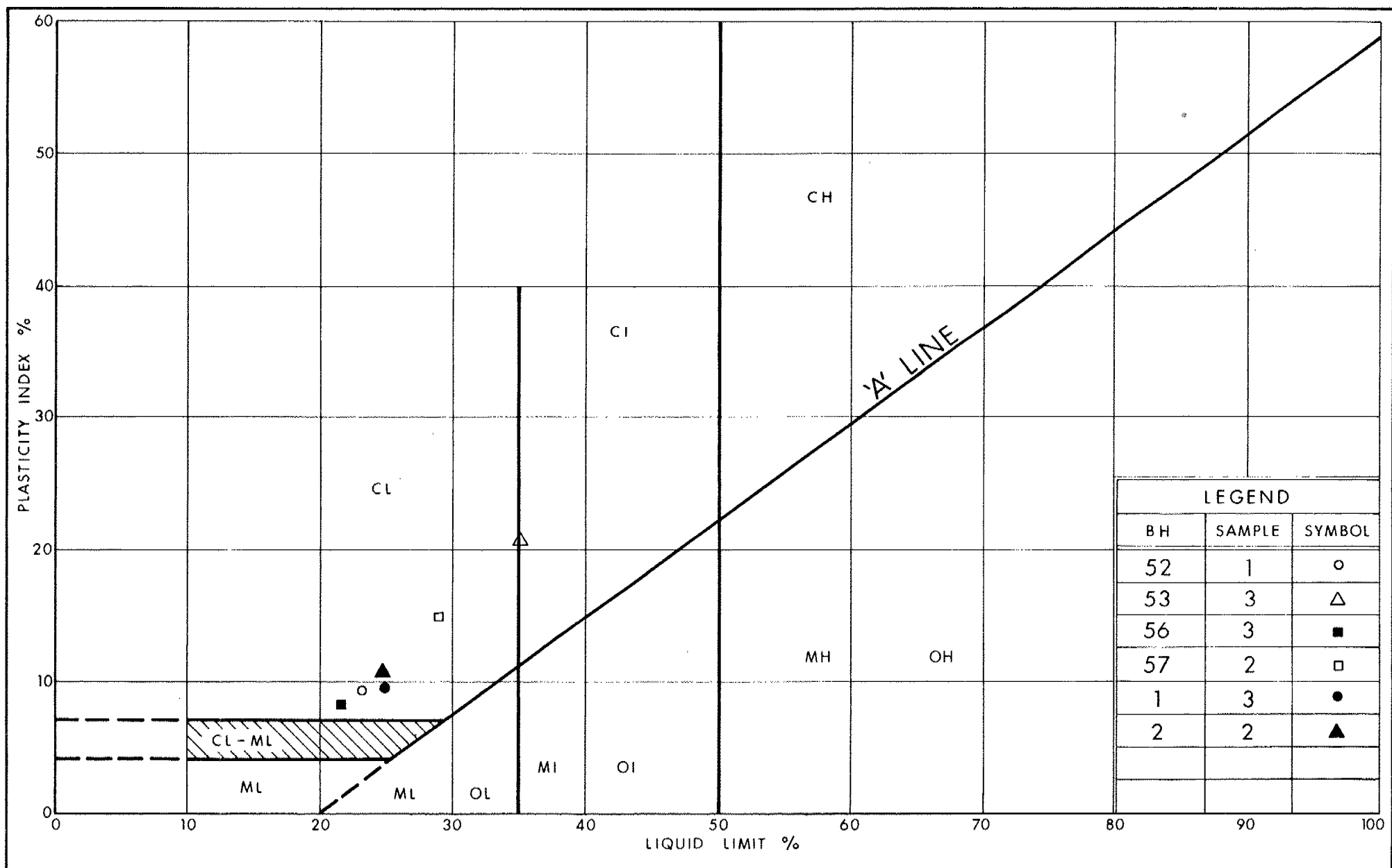


GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL
 (GLACIAL TILL)

FIG No 1

W P 140-87-02 R


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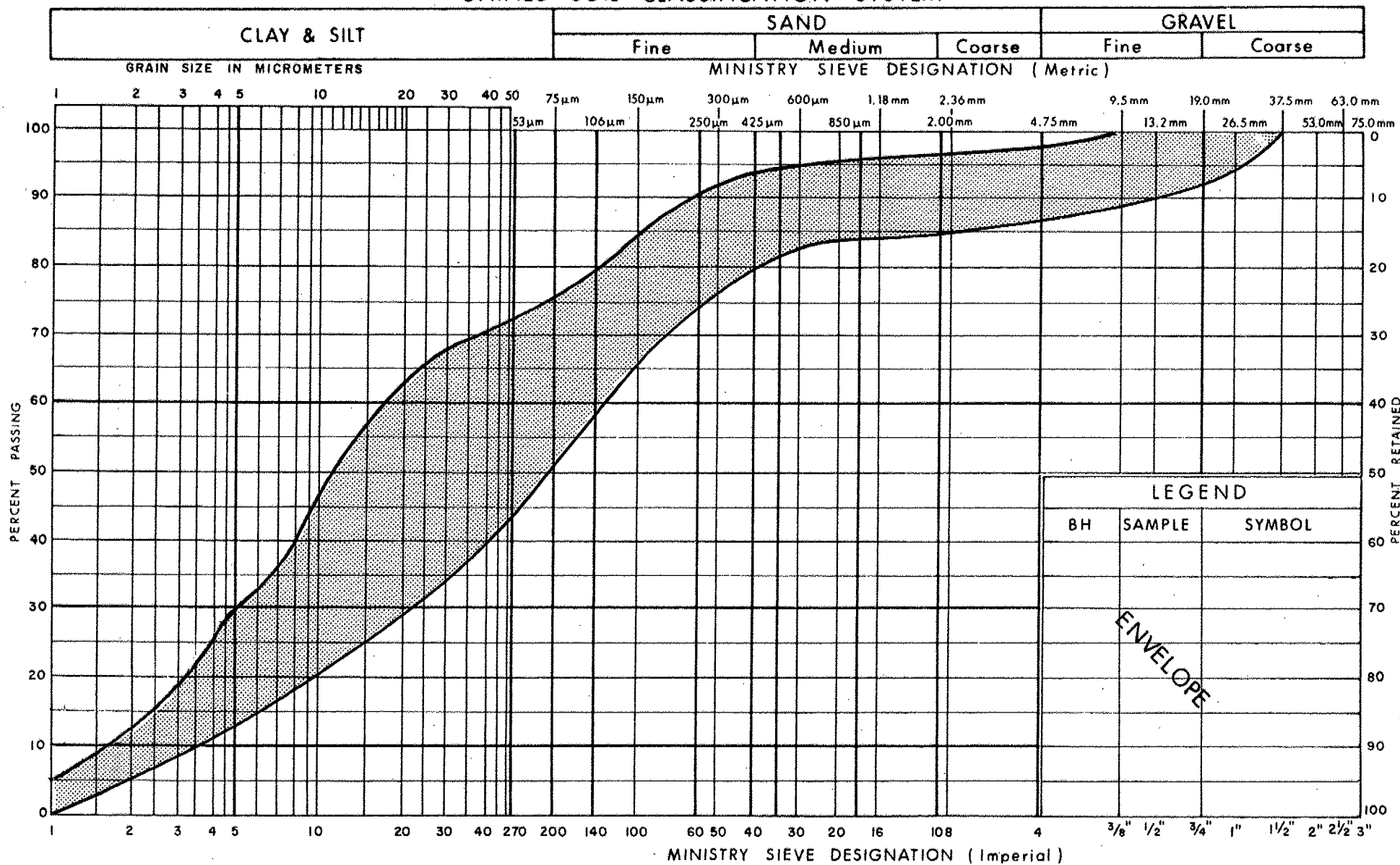
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PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL
(GLACIAL TILL)

FIG No 2

W P 140-87-02 R

UNIFIED SOIL CLASSIFICATION SYSTEM

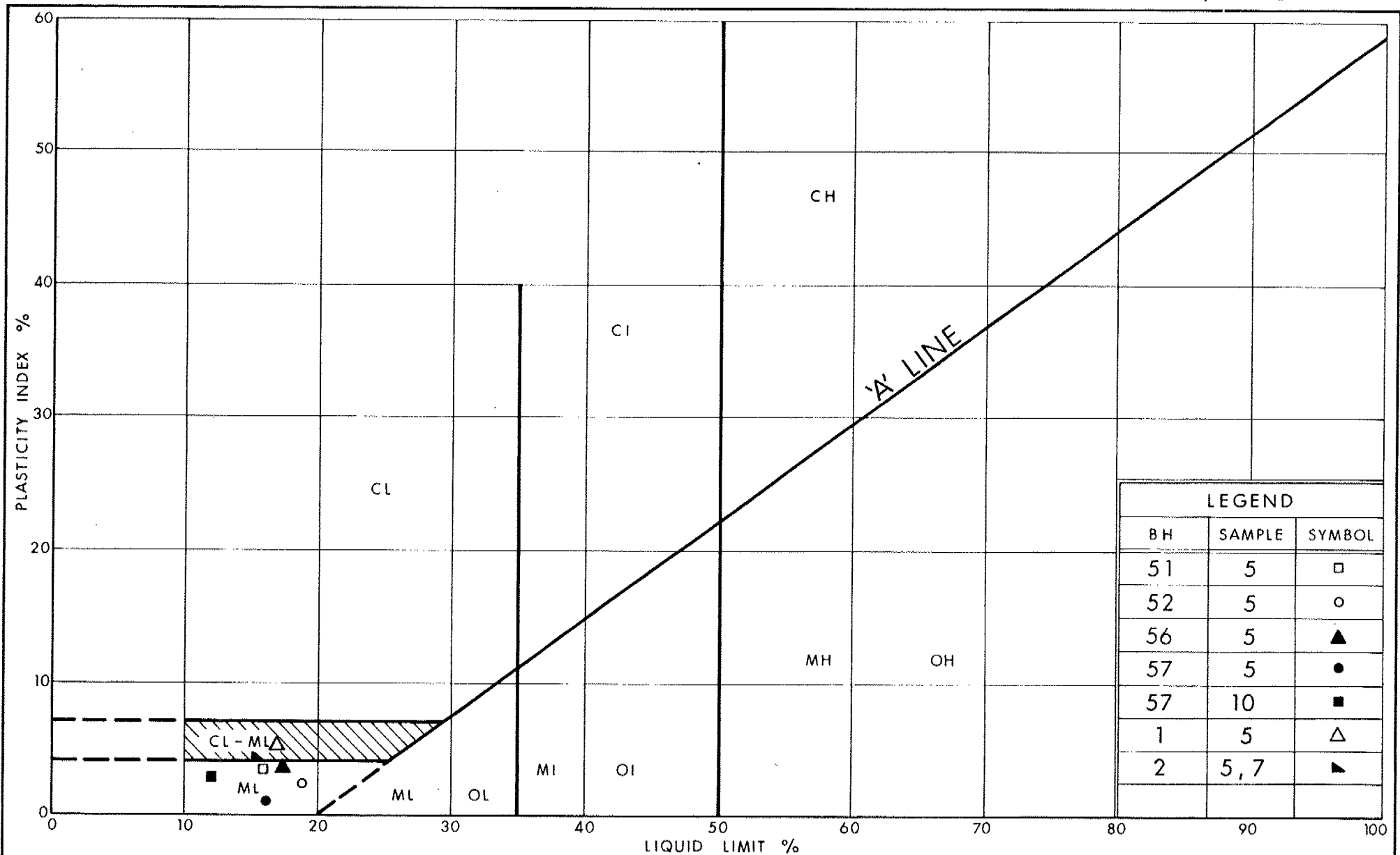


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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF SILT, SAND & GRAVEL
 (GLACIAL TILL)

FIG No 3

W P 140-87-02 R



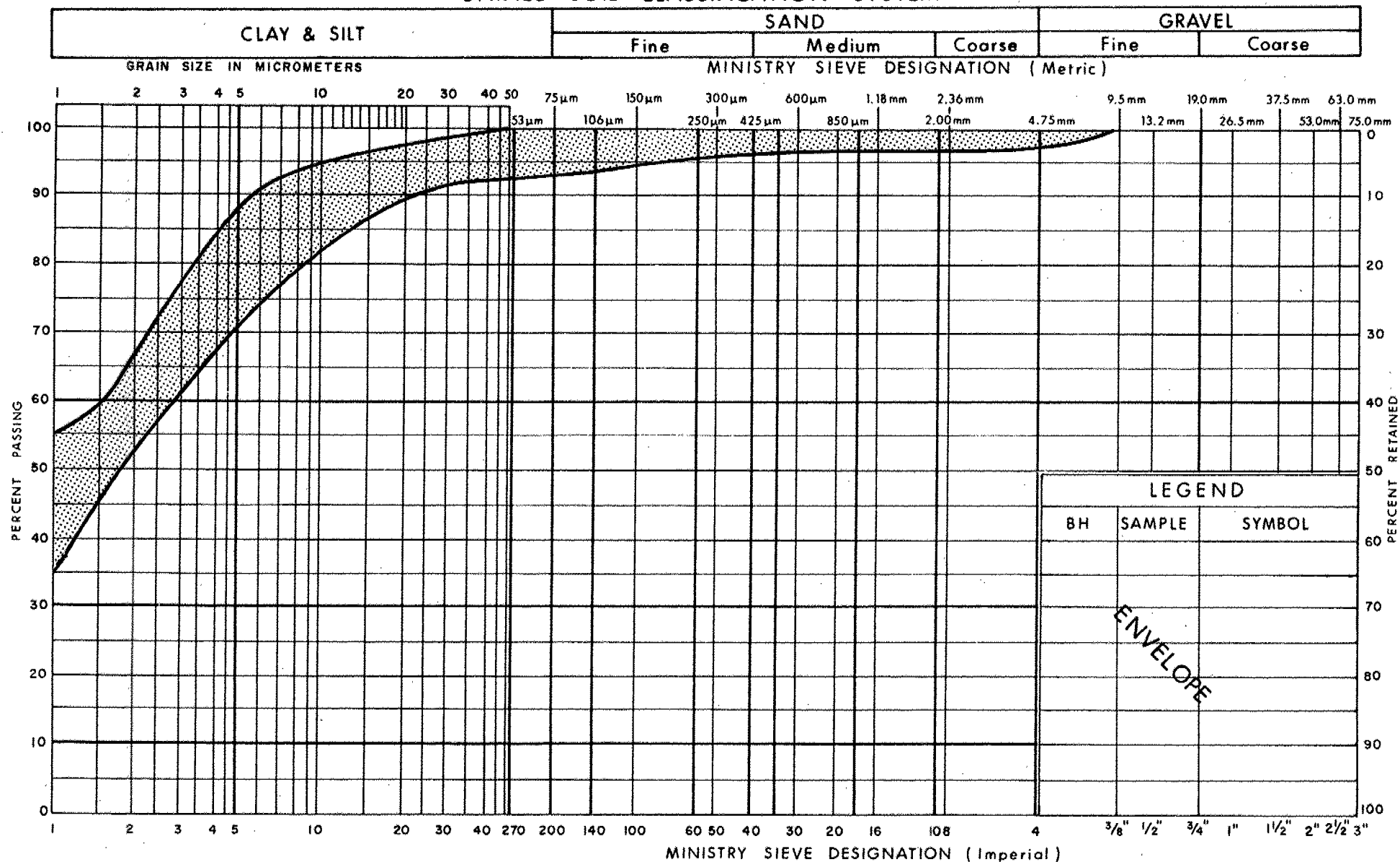
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Transportation

PLASTICITY CHART
HET MIXTURE OF SILT, SAND & GRAVEL
(GLACIAL TILL)

FIG No 4

W P 140-87-02 R

UNIFIED SOIL CLASSIFICATION SYSTEM

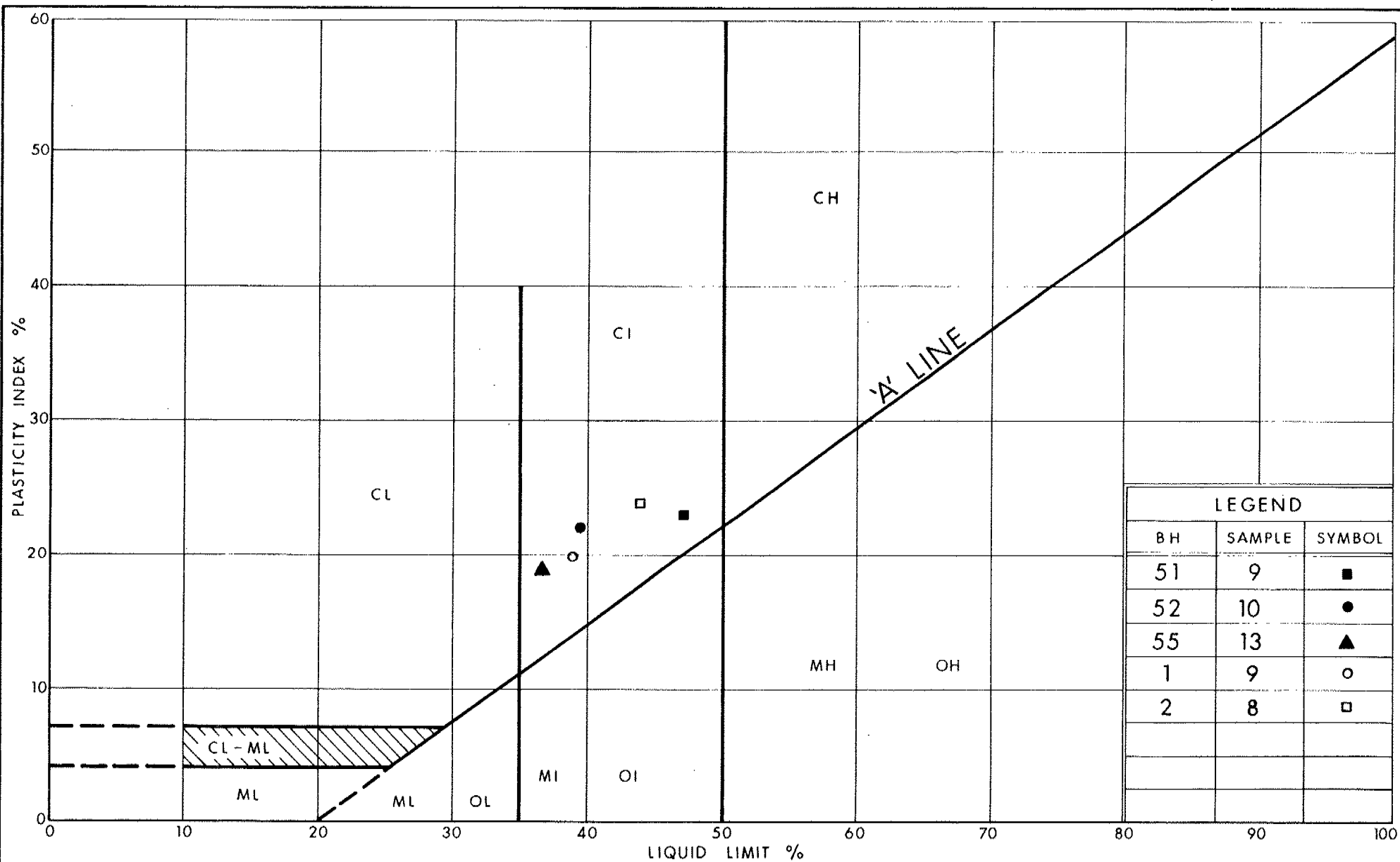


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GRAIN SIZE DISTRIBUTION
SILTY CLAY (LACUSTRINE)

FIG No 5

W P 140-87-02 R



LEGEND		
BH	SAMPLE	SYMBOL
51	9	■
52	10	●
55	13	▲
1	9	○
2	8	□



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Ontario

PLASTICITY CHART SILTY CLAY (LACUSTRINE)

FIG No 6

W P 140-87-02 R

RECORD OF BOREHOLE No 1

1 OF 1 METRIC 41

W.P. 140-87-02R LOCATION Co-ords: N 4 849 297.3 ; E 302 442.3 ORIGINATED BY MI
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI
DATUM Geodetic DATE 90 07 30 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
194.3	Ground Surface													
0.0	Topsoil		1	SS	16		194							
	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		2	SS	17									
	Brown, Stiff to Hard		3	SS	13		192						21.6	0 6 73 21
190.6			4	SS	70	/10cm								
3.7	Heterogeneous mixture of Silt, Sand and Gravel (Glacial Till)		5	SS	80		190							4 40 46 10
188.8	Grey, Very Dense		6	SS	53									
5.5			7	SS	66		188							
	Silty Clay (Lacustrine)		8	SS	72		186							
	Grey, Hard		9	SS	96								21.8	2 5 33 60
			10	SS	82		184							
181.7			11	SS	74		182							
12.6	End of Borehole													
	* GWL TAKEN ON 90 07 31													

RECORD OF BOREHOLE No 2

1 OF 1

METRIC 42

W.P. 140-87-02R LOCATION Co-ords: N 4 849 360.9 : E 302 544.3 ORIGINATED BY MI

DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY MI

DATUM Geodetic DATE 90 07 30 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										
196.5	Ground Surface																	
0.0	Topsoil		1	SS	16		196											
	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till)		2	SS	157													
	Brown, Very Stiff to Hard		3	SS	36		194											
192.8			4	SS	120	/5cm												
3.7			5	SS	50	/15cm												
	Heterogeneous mixture of Silt, Sand and Gravel (Glacial Till)		6	SS	65		192											
	Grey, Very Dense		7	SS	120	/28cm	190											
189.5			8	SS	50		188											
7.0			9	SS	43		186											
	Silty Clay (Lacustrine)		10	SS	48													
	Grey, Hard		11	SS	55		184											
183.9																		
12.6	End of Borehole																	
	• GWL TAKEN ON 90 07 31																	

RECORD OF BOREHOLE No 50

1 OF 1

METRIC 43

W.P. 140-87-02R LOCATION Co-ords: N 4 849 331 : E 302 466 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY TS
DATUM GEODETIC DATE 90 02 07-08 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
195.0	GROUND SURFACE													
194.5	Topsoil													
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	7		194							
192.7	Brown, Firm to V. Stiff		2	SS	17									
2.3	Brown		3	SS	118									
	Grey		4	SS	120	/28cm	192							
	Het. mixture of Silt, Sand and Gravel (Glacial Till)		5	SS	96									
189.7	Very Dense		6	SS	81		190							
5.3			7	SS	39									
			8	SS	58									
							188							
			9	SS	42									
	Silty Clay (Lacustrine)													
	Grey, Hard		10	SS	34		186							
			11	SS	47									
182.4							184							
			12	SS	57									
12.6	End of Borehole													

RECORD OF BOREHOLE No 51

1 OF 1

METRIC 44

W.P. 140-87-02R LOCATION Co-ords: N 4 849 336 ; E 302 497 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY TS
DATUM GEODETIC DATE 90 02 08 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20	40	60	80	100						
195.9	GROUND SURFACE																	
195.4	Topsoil																	
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown, Stiff to Hard		1	SS	13		194								20.4			
			2	SS	25													
192.9			3	SS	33													
3.0	Het. mixture of Silt, Sand and Gravel (Glacial Till) Grey, Very Dense		4	SS	103	/25cm	192									6 27 56 11		
			5	SS	125	/20cm												
			6	SS	120		190								22.1			
			7	SS	130													
189.3			8	SS	60													
6.6	Silty Clay (Lacustrine) Grey, Hard		9	SS	142	/25cm	188									0 1 37 62		
			10	SS	95		186											
184.8																		
11.1	End of Borehole		11	SS	57										20.3			

RECORD OF BOREHOLE No 52

1 OF 1

METRIC 45

W.P. 140-87-02R LOCATION Co-ords: N 4 849 340 ; E 302 528 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY TS
DATUM GEODETIC DATE 90 02 09 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
196.2	GROUND SURFACE																
195.7	Topsoil																
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	7												3 33 37 27
	Firm to Stiff		2	SS	6												
193.2			3	SS	20		194									19.0	
3.0			4	SS	11												
	Het. mixture of Silt, Sand and Gravel (Glacial Till)		5	SS	40		192										2 21 54 23
190.9	Grey		6	SS	38											21.8	
5.3			7	SS	30		190										
			8	SS	36												
	Silty Clay (Lacustrine)		9	SS	27		188										
	Grey, Very Stiff to Hard		10	SS	15											20.6	0 5 34 61
			11	SS	38		186										
183.6			12	SS	30		184										
12.6	End of Borehole																

RECORD OF BOREHOLE No 53

1 OF 1

METRIC 46

W.P. 140-87-02R

LOCATION Co-ords: N 4 849 344 ; E 302 562

ORIGINATED BY TS

DIST 5 HWY 407

BOREHOLE TYPE HS AUGER

COMPILED BY TS

DATUM CEODETIC

DATE 90 02 09 - 12

CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
196.7	GROUND SURFACE													
196.2	Topsoil													
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	13									
	Brown, Stiff to Hard		2	SS	18									
193.7			3	SS	35									
3.0			4	SS	45									
	Het. mixture of Silt, Sand and Gravel (Glacial Till)		5	SS	100									
	Grey, Very Dense		6	SS	104									
			7	SS	80									
189.1														
7.6	Silty Clay (Lacustrine)		8	SS	130									
187.1	Grey, Hard		9	SS	79									
9.6	End of Borehole													

RECORD OF BOREHOLE No 54

1 OF 1

METRIC 47

W.P. 140-87-02R LOCATION Co-ords: N 4 849 307 : E 302 433 ORIGINATED BY PM/TS

DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY TS

DATUM GEODETIC DATE 90 02 07 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
194.3	GROUND SURFACE													
193.8	Topsoil													
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	1									
			2	SS	15									
191.3	Stiff		3	SS	14									
3.0	Het. mixture of Silt, Sand and Gravel (Glacial Till)		4	SS	51									
	Very Dense		5	SS	56									
			6	SS	64									
188.2			7	SS	120	/25cm								
6.1			8	SS	86									
			9	SS	87									
	Silty Clay (Lacustrine)		10	SS	39									
	Grey, Hard		11	SS	60									
181.7			12	SS	58									
12.6	End of Borehole													

RECORD OF BOREHOLE No 55

1 OF 1

METRIC 48

W.P. 140-87-02R LOCATION Co-ords: N 4 849 313 ; E 302 467 ORIGINATED BY TS
DIST 5 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY TS
DATUM GEODETIC DATE 90 02 08 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
194.9	GROUND SURFACE													
194.4	Topsoil													
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till) Brown, Stiff to Very Stiff		1	SS	10									
			2	SS	12									
191.9			3	SS	29									
3.0	Het. mixture of Silt, Sand and Gravel (Glacial Till)		4	SS	78									
190.3	Grey, Very Dense		5	SS	65									
4.6			6	SS	38									
			7	SS	54									
			8	SS	40									
			9	SS	40									
			10	SS	37									
	Silty Clay (Lacustrine) Grey, Hard		11	SS	31									
			12	SS	32									
			13	SS	42									
179.2			14	SS	24									
15.7	End of Borehole													

RECORD OF BOREHOLE No 56

1 OF 1 METRIC 49

W.P. 140-87-02R LOCATION Co-ords: N 4 849 318 ; E 302 498 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY TS
 DATUM GEODETIC DATE 90 02 08 - 09 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
195.6	GROUND SURFACE																
195.1	Topsoil																
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till)		1	SS	2		194									19.8	
	Brown, Stiff		2	SS	10												
192.6			3	SS	16												8 28 48 16
3.0			4	SS	48		192										
	Het. mixture of Silt, Sand and Gravel (Glacial Till)		5	SS	120	/28cm											14 17 60 9
	Grey, Very Dense		6	SS	80	/15cm										23.0	
			7	SS	75		190										
188.6			8	SS	72												
7.0	End of Borehole Auger Refusal (Probable Boulder)																

RECORD OF BOREHOLE No 57

1 OF 1

METRIC 50

W.P. 140-87-02R LOCATION Co-ords: N 4 849 322 ; E 302 530 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS AUGER COMPILED BY TS
 DATUM GEODETTIC DATE 90.02.09 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
								20 40 60 80 100										
196.2	GROUND SURFACE																	
195.7	Topsoil																	
0.5	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till)	Brown	1	SS	9											2 24 38 36		
	Stiff to V. Stiff	Grey	2	SS	14													
192.7			3	SS	25													
			4	SS	20													
3.5			5	SS	45											2 28 54 16		
			6	SS	47													
			7	SS	32													
		Silty Clay (Locustrine)	8	SS	30													
	Het. mixture of Silt, Sand and Gravel (Glacial Till)		9	SS	72													
	Grey, Very Dense		10	SS	109											10 39 46 5		
			11	SS	136													
183.6			12	SS	125											23.1		
12.6	End of Borehole																	

FOUNDATION INVESTIGATION REPORT
For
Jane Street Underpass at Highway 407
W.P. 140-87-04/05, Site 37-1315
District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted just west of Jane Street at the proposed Highway 407 at the above mentioned structure site. This report applies to the proposed structure, its related approaches and future retaining walls.

SITE DESCRIPTION AND GEOLOGY

This site is located north of Steeles Avenue, south of Highway 7, just west of Jane Street at the proposed Highway 407 in the Township of Vaughan. It is located on land used for agricultural purposes. The terrain surrounding the site is level to undulating.

Physiographically, the region has been described by Chapman and Putman (1973) as the Peel Plain. The Peel Plain is basically a bevelled till plain, containing large amounts of Palaeozoic shale and limestone, and some areas are modified by a veneer of varved clay.

FIELD INVESTIGATION

The fieldwork was carried out during the period from 90 01 18 to 90 01 31 and consisted of ten boreholes, with all of them accompanied by dynamic cone penetration tests. The borings were advanced by hollow stem augers (95 and 83 mm I.D.) using machines mounted on muskeg vehicles.

Sampled boreholes were advanced to depths ranging from 9.6 to 43.3 m below the ground surface. From the surface the cone tests advanced to depths ranging from 3.3 to 7.1 m below the ground surface. In general, subsoil sampling was conducted at 0.7 m intervals for the surficial 6.1 m, at 1.5 m

intervals, to 12 m below ground level and at 3 m intervals to 18 m at 6 m intervals to less for the remainder of the borehole. All samples were retrieved using a split spoon sampler in accordance with Standard Penetration Test (ASTM D1586). All samples were identified in the field and again in the laboratory where they were returned for applicable testing.

Groudwater levels were obtained in the open boreholes and monitored until they were backfilled. The boreholes were backfilled either following their completion or at the completion of the investigation. Survey information for the location and elevation of the boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and property of the soil, the following laboratory tests have been conducted:

- 1) Atterberg Limits
- 2) Grain Size Distribution
- 3) Natural Moisture Content

SUBSURFACE CONDITIONS

General

The elevation of the ground level at the site ranged from 198.1 to 199.3 m. The subsurface conditions at the site consist mainly of 0.6 m of topsoil over 5± m of clayey silt, with sand, trace of gravel. The bottom 3 m of this deposit contains layers of sandy silt. Underlying this layer approximately 5.3 (elevation 194 m) below the ground level was a grey clayey silt to silty clay trace of sand which is a lacustrine deposit found to elevation 159.5 m± where it was underlain by a very dense silty sand layer.

The plan, location of borings and the subsoil stratigraphical profile are shown on Drawing 140870405-A*.

The boundaries between various soil types, field and laboratory test results as well as ground water levels are plotted on the Record of Borehole sheets also in the Appendix of this report. A description of the soil types encountered are given below.

Clayey Silt, with Sand, trace of Gravel

This material was found from the surface (elevation 199.3 to 198.1 m) to the grey clayey silt to silty clay deposit. The top half metre from the surface consisted of an organic topsoil. The layer ranged in thickness from 2.2 to 3.7 m.

The upper half was brown in colour, while the lower half (2.1 to 3.7 m below the ground surface) was grey with occasional sandy silt layers.

A grain size distribution envelope for the material (excluding the occasional sandy silt layers) 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. The limits have been plotted in Figure 2. A summary of the physical properties of the fine grained portion is provided below.

	<u>Range</u>
Natural Moisture Content (w)	9-32%
Liquid Limit (w_L)	17-47%
Plastic Limit (w_p)	11-19%

The test results indicate a clayey silt of low plasticity.

Grain size distribution tests were carried out on the sandy silt layers that were present 2.1 to 3.7 m below the surface. Figure 3 shows the test results in envelope form. The natural moisture content (w) of the layers ranged from 7 to 19%.

* DWG NO 2 OF THE CONTRACT DWG'S

The 'N' values obtained from the Standard Penetration tests ranged from 6 to 77. The high values may have resulted from cobbles which are characteristic of till deposits. The consistency of the till was found to range from firm to hard.

Clayey Silt to Silty Clay, trace of Sand, trace of Gravel

This deposit of clayey silt to silty clay was found underlying the clayey silt till, at elevations 194.9/190.4 m. Most of the boreholes terminated within this lacustrine deposit, however three of the boreholes extended into the underlying silty sand deposit. The deposit is approximately 35 m± thick.

The grain size distribution tests are determined by mechanical analyses indicate trace of sand and gravel. The results for the deposit are given in envelope form in Figure 4. Atterberg Limits were also obtained to evaluate the behaviour of the fine grained portion of the material. These limits are plotted in Figure 5. A summary of the physical properties of the fine grained portion is provided below.

	<u>Range</u>
Natural Moisture Content (w)	14-21%
Liquid Limit (w _L)	25-38%
Plastic Limit (w _p)	13-20%

The test results indicate a clayey silt to silty clay of low to intermediate plasticity.

The 'N' values obtained from the standard penetration tests ranged from 20 to 120. The high values may have resulted from large aggregates such as cobbles and boulders. The consistency of the till was found to be very stiff to hard.

Silty Sand

Underlying the deposit above, approximately 39.8 m± below ground level was a deposit of lacustrine silty sand, which only three boreholes reached. All three boreholes terminated within the deposit.

The 'N' values obtained from the standard penetration tests were 120 for 13 to 30 cm. The denseness of the deposit was therefore found to be very dense.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. These observations are recorded on the Record of Borehole sheets as well as on Drawing 140870405-A*.

Measurements obtained at the time of the investigation revealed the following water levels.

<u>Borehole</u>	<u>Elevation (m)</u>
30	197.2
31	197.4
32	193.0 (not stabilized)
33	198.1
34	(not established)
35	197.1
36	197.9
37	197.4
38	194.1 (not stabilized)
39	198.7 (not stabilized)

The boreholes indicate the ground water level to be in general about 0.4 m below the ground surface at approximate elevation 198.7 m. It should be noted that groundwater levels are subject to seasonal fluctuations and may therefore vary from the values given in this report.

* DWG NO 2 OF THE CONTRACT DWG'S

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of P. Marks, Foundation Engineer. The equipment was owned and operated by Marathon Drilling Co. Ltd. and Master Soils Investigations.

The project was carried out by P. Marks under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by P. Marks, reviewed by Dr. B. Iyer and approved by M.S. Devata, Chief Foundation Engineer.

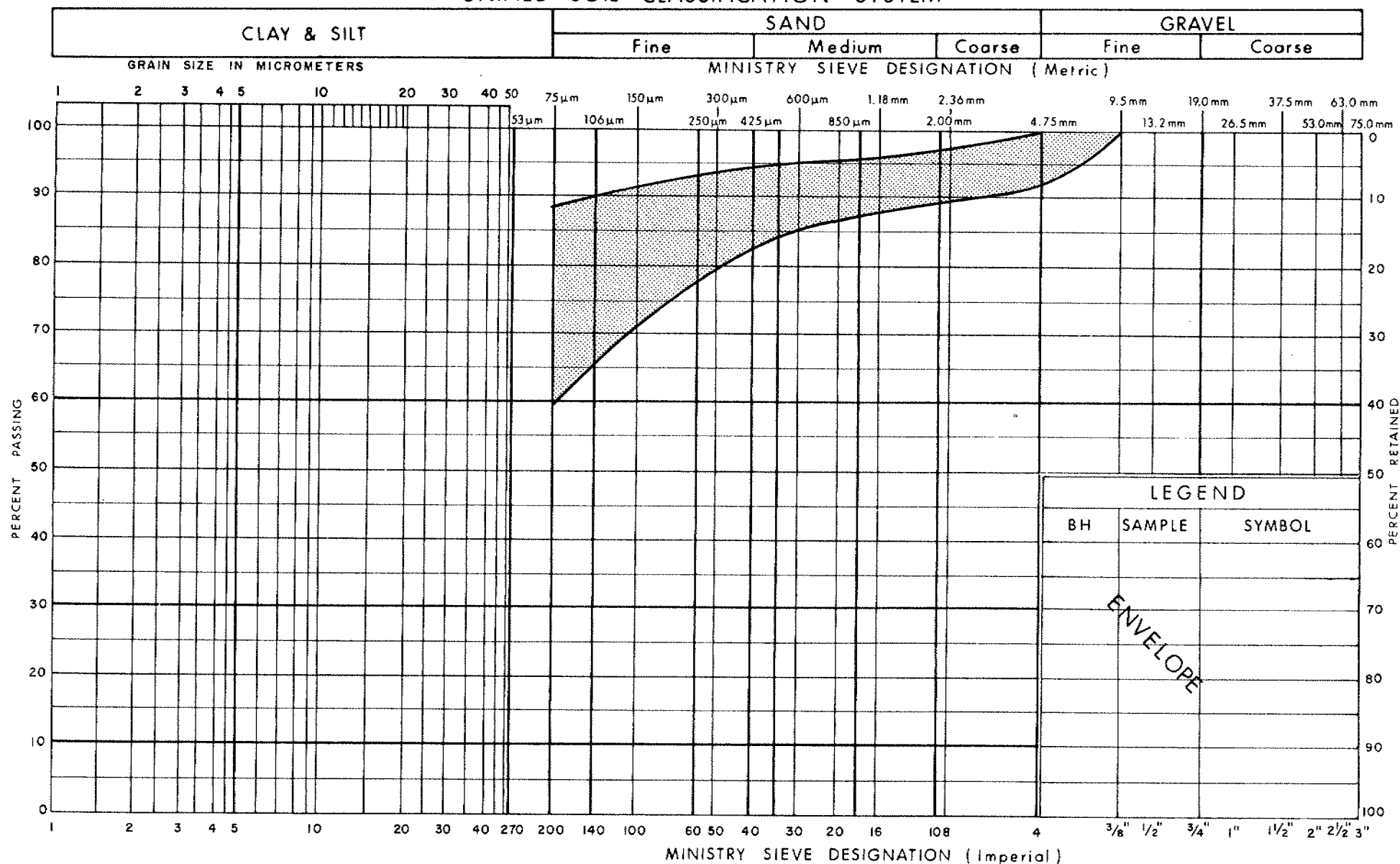


D. Dundas
D. Dundas, P. Eng.
Sr. Foundation Engineer

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

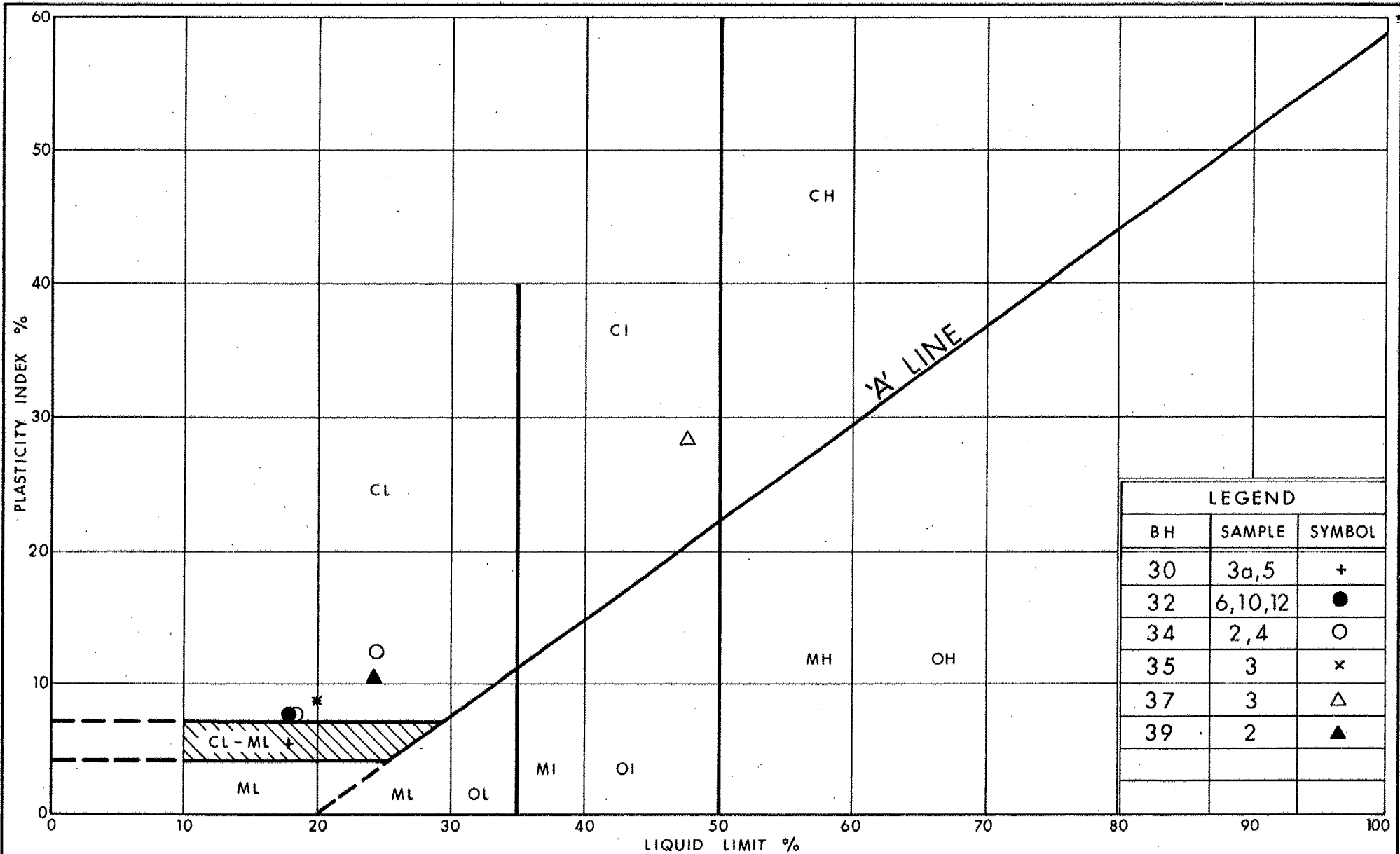


Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND & GRAVEL

FIG No 1

W P 140-87-04/05



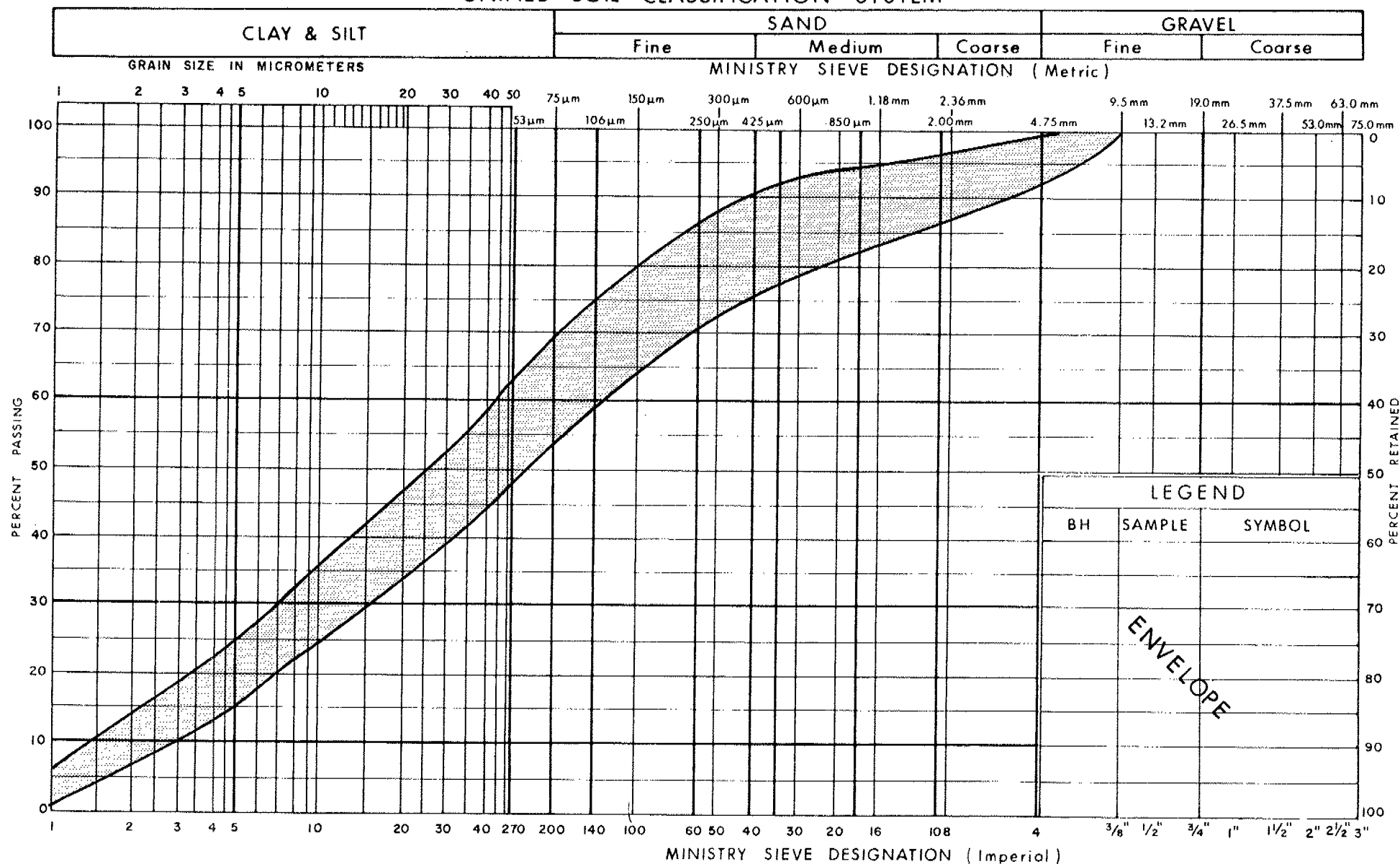
Ministry of
Transportation
Ontario

PLASTICITY CHART
CLAYEY SILT
WITH SAND, TRACE OF GRAVEL

FIG No 2

W P 140-87-04/05

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

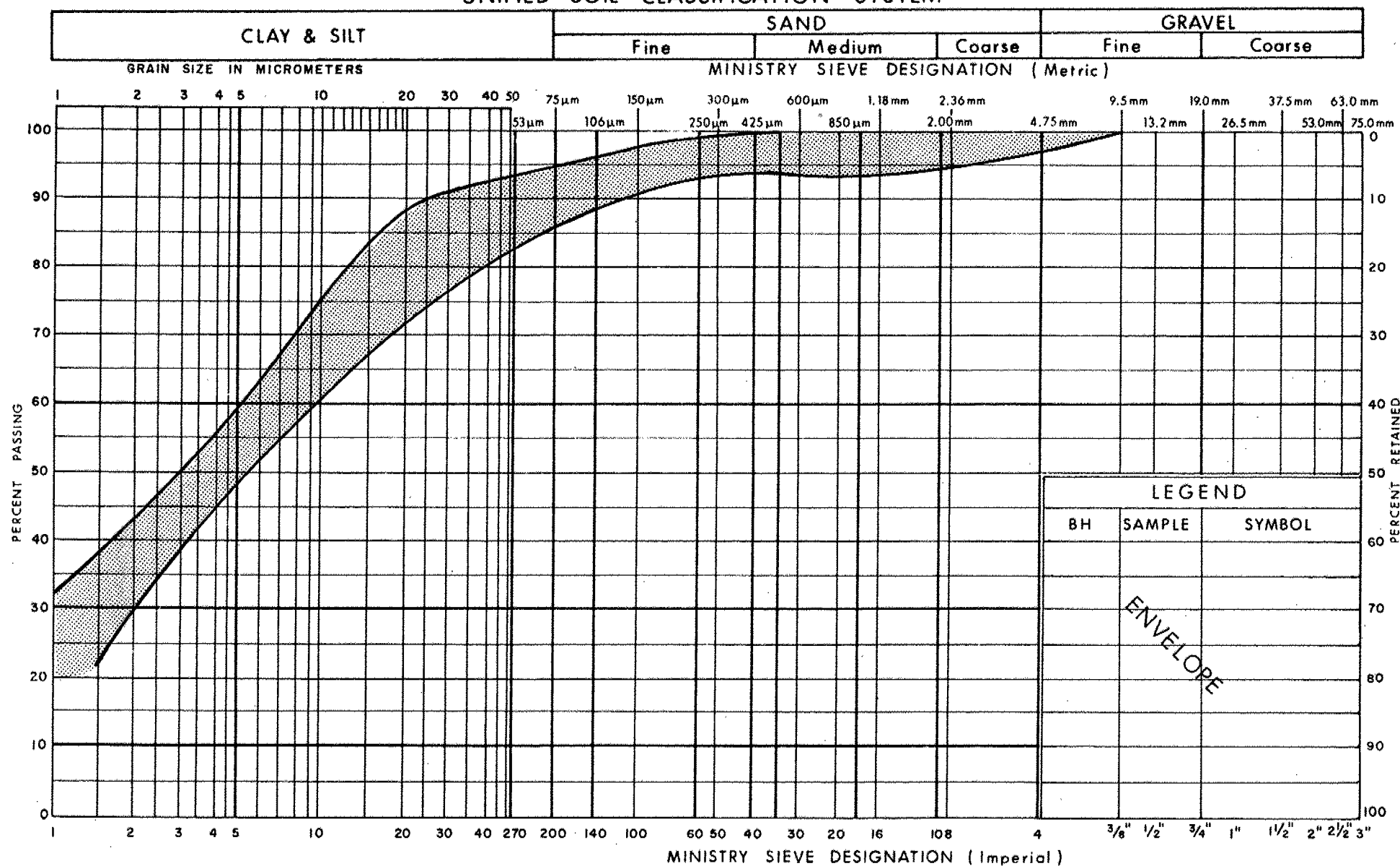
Ontario

GRAIN SIZE DISTRIBUTION SANDY SILT LAYERS

FIG No 3

W P 140-87-04/05

UNIFIED SOIL CLASSIFICATION SYSTEM



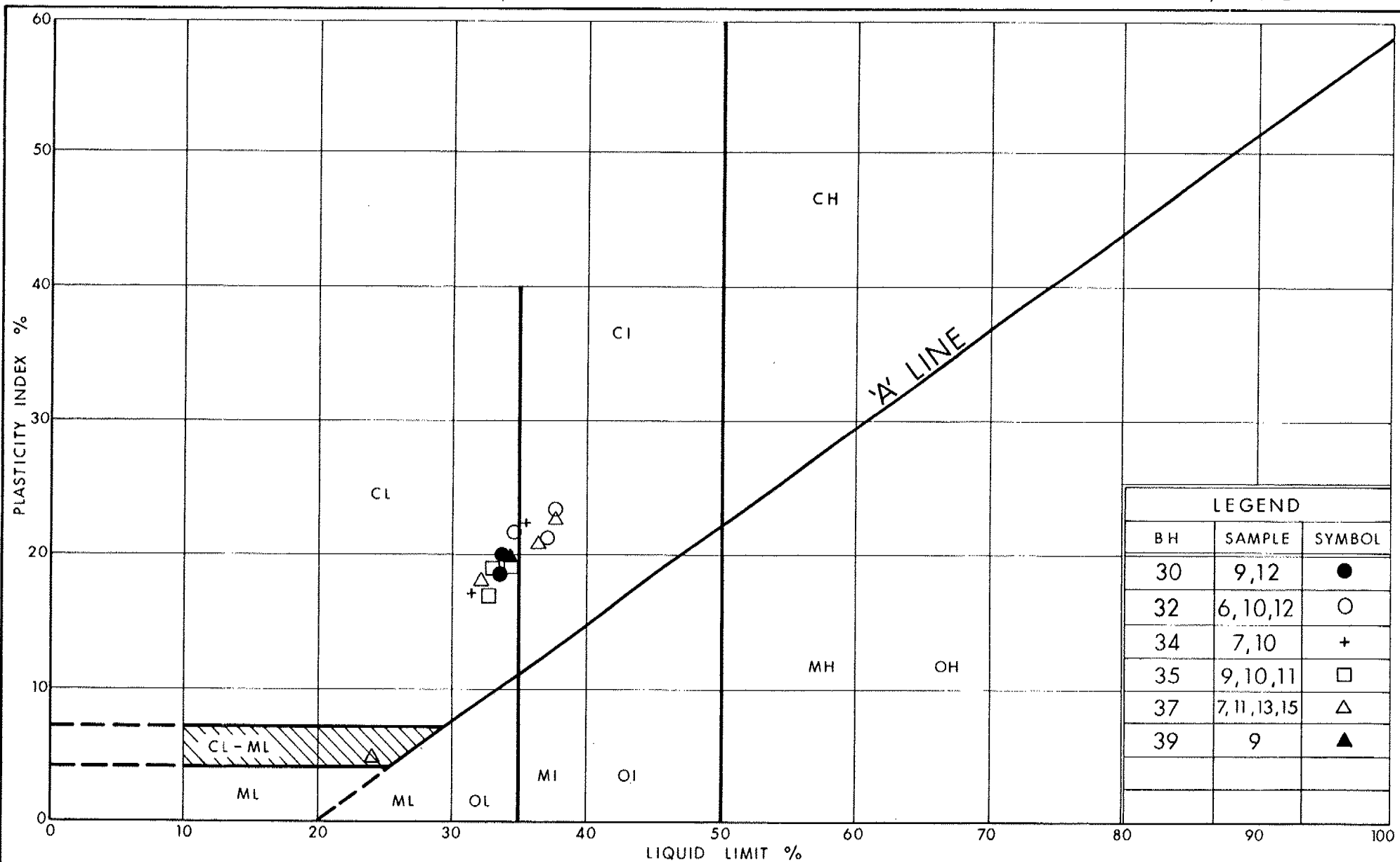
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Ontario

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND & GRAVEL

FIG No 4

W P 140-87-04/05



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Transportation
Ontario

PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND & GRAVEL

FIG No 5

W P 140-87-04/05

RECORD OF BOREHOLE No 30

1 OF 1

METRIC 63

W.P. 140-87-04 LOCATION Co-ord: N 4849286 : E 302921
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.)
 DATUM Geodetic DATE 90-01-31

ORIGINATED BY P.M.

COMPILED BY P.M.

CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
198.3	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	15									
			2	SS	15									
			3	SS	29									
	brown grey		4	SS	21									
			5	SS	63									
	Occasional Sandy Silt Layers		6	SS	43									
			7	SS	38									
	Stiff to Hard		8	SS	50									
191.3														
7.0	CLAYEY SILT to SILTY CLAY		9	SS	35									
	Trace of Sand, Trace of Gravel		10	SS	48									
	Occasional thin silt layers (Lacustrine)		11	SS	51									
	Hard													
185.7			12	SS	43									
12.6	End of Borehole													
	• Water Level Not Stabilized													

RECORD OF BOREHOLE No 31

1 OF 2 METRIC 64

W.P. 140-87-04 LOCATION Co-ord: N 4849307 ; E 302905 ORIGINATED BY P.M.
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.); NX Casing COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-18 to 90-01-23 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80
198.6																
0.0	Topsoil															
	CLAYEY SILT With Sand, Trace of Gravel (Till) Firm to Stiff		1	SS	11											
			2	SS	6											
	Brown		3	SS	14											
	Grey		4	SS	39											
	Occasional Sandy Silt to Silty Sand		5	SS	28											
	Firm To Very Stiff		6	SS	29											
193.0			7	SS	18											
5.6			8	SS	20											
			9	SS	25											
			10	SS	35											
			11	SS	30											
			12	SS	20											
	CLAYEY SILT TO SILTY CLAY Trace of Sand, Trace of Gravel		13	SS	25											
	Occasional thin silt layers (Lacustrine) Very Stiff to Hard		14	SS	39											
			15	SS	48											
			16	SS	46											
			17	SS	27											
			18	SS	18											
			19	SS	41											
			20	SS	36											

Continued

+3, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 31

2 OF 2

METRIC 65

W.P. 140-87-04 LOCATION Co-ord: N 4849307 : E 302905 ORIGINATED BY P.M.
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.); NX Casing COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-18 to 90-01-23 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
30.5	Continued						168										
			21	SS	38		166										
	Clayey Silt to Silty Clay Trace of Sand (locustrine)						164										
	Hard		22	SS	35		162										
159.3							160										
39.3			23	SS	120	/15cm	158										0 17 76 7
	Silty Sand (Locustrine)		24	SS	120	/13cm											
	Very Dense																
155.8			25	SS	120	/13cm	156										0 72 21 7
42.8	End of Borehole																

RECORD OF BOREHOLE No 32

1 OF 1

METRIC 66

W.P. 140-87-04 LOCATION Co-ord: N 4849345 ; E 302894 ORIGINATED BY P.M.
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-29 to 90-01-30 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
198.8	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	15									
			2	SS	18									6 38 43 13
	brown grey		3	SS	14									8 22 (70)
	Occasional Sandy Silt Layers		4	SS	19									
194.4	Stiff to Hard		5	SS	38									0 34 56 10
4.4			6	SS	54									4 5 64 27
	CLAYEY SILT to SILTY CLAY		7	SS	87									
	Trace of Sand, Trace of Gravel		8	SS	39									
			9	SS	53									
	Occasional thin silt layers		10	SS	56									0 5 (95)
			11	SS	52									
	(Locustrine)		12	SS	52									0 5 (95)
	Hard													
184.3														
14.5	End of Borehole													

RECORD OF BOREHOLE No 33

1 OF 2 METRIC 67

W.P. 140-87-04 LOCATION Co-ord: N 4849369 : E 302882 ORIGINATED BY P.M.
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-24 to 90-01-26 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
199.3													
0.0	Topsoil		1	SS	12								
	Clayey Silt, Some Sand, Trace of Gravel (Till) Stiff		2	SS	8								
			3	SS	8								
	Silty Sand Layers		4	SS	25								
194.9			5	SS	48								
4.4			6	SS	35								
	CLAYEY SILT to SILTY CLAY		7	SS	46								
	Trace of Sand, Trace of Gravel		8	SS	30								
	Thin layers of silt		9	SS	28								
			10	SS	34								
			11	SS	30								
			12	SS	36								
			13	SS	32								
	(Lacustrine)		14	SS	55								
	Very Stiff to Hard												
			15	SS	104								
168.8													

30.5 Continued

+3, x5 Numbers refer to Sensitivity

20 15-25 (%) STRAIN AT FAILURE 10

Continued

RECORD OF BOREHOLE No 33

2 OF 2

METRIC 68

W.P. 140-87-04 LOCATION Co-ord: N 4849369 : E 302882 ORIGINATED BY P.M.
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-24 to 90-01-26 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
30.5	Continued		16	SS	33		168										
	SILTY CLAY						166										
	Trace of Sand		17	SS	23		164										
	with thin layers of silt						162										
	Very Stiff to Hard						160										
159.3			19	SS	88		158										
40.0	Silty Sand		20	SS	120												
	(Lacustrine)																
156.2	Very Dense		21	SS	125												
43.1																	

RECORD OF BOREHOLE No 34

1 OF 1 METRIC 69

W.P. 140-87-04 LOCATION Co-ord: N 4849399 ; E 302882 ORIGINATED BY P.M.
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-30 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
199.3	Ground Level													
0.0	Topsoil					*								
	CLAYEY SILT With Sand, trace of Gravel (Till)		1	SS	20									
			2	SS	16									
			3	SS	10									
	brown		4	SS	8									
	grey		5	SS	41									
194.7	Stiff to Hard		6	SS	73									
4.6	CLAYEY SILT to SILTY CLAY		7	SS	100									
	Trace of Sand, Trace of Gravel		8	SS	104									
	Occasional thin silt layers (Locustrine)		9	SS	82									
	Hard		10	SS	42									
189.7	End of Borehole													
9.6	* Water Level Not Established													

RECORD OF BOREHOLE No 35

1 OF 1

METRIC 70

W.P. 140-87-04 LOCATION Co-ord: N 4849292 ; E 302942 ORIGINATED BY P.M.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Ceodetic DATE 90-01-31 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
198.1	Ground Level												
0.0	Topsoil												
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	6								
			2	SS	6								
	brown		3	SS	14								3 37 (60)
	grey		4	SS	21								
	Occasional Sandy Silt Layers		5	SS	31								
			6	SS	27								2 29 58 11
191.9	Firm to Very Stiff		7	SS	21								0 70 (30)
6.2			8	SS	36								
	CLAYEY SILT to SILTY CLAY		9	SS	41								1 16 (83)
	Trace of Sand, Trace of Gravel		10	SS	33								0 5 54 41
	Occasional thin silt layers (Locustrine)		11	SS	27								0 6 (94)
185.5	Very Stiff to Hard		12	SS	35								
12.6	End of Borehole												

RECORD OF BOREHOLE No 36

1 OF 2 METRIC 71

W.P. 140-87-04 LOCATION Co-ord: N 4849314 : E 302929 ORIGINATED BY P.M.
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-18 to 90-01-23 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
198.5	Ground Level												
0.0	Topsoil												
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	22								
			2	SS	15								
			3	SS	17								
	brown		4	SS	13								
	grey		5	SS	77								
193.8			6	SS	45								
4.7			7	SS	100								
	CLAYEY SILT to SILTY CLAY		8	SS	64								
	Trace of Sand, Trace of Gravel		9	SS	74								
	Occasional thin silt layers		10	SS	107								
			11	SS	85								
			12	SS	56								
	(Locustrine)		13	SS	55								
			14	SS	60								
			15	SS	87								
			16	SS	113								
			17	SS	44								
	Hard		18	SS	61								
			19	SS	120	/18cm							
			20	SS	51								
168.0			21	SS	91								

30.5 Continued

+3, x5: Numbers refer to Sensitivity

20 15-5 (%) STRAIN AT FAILURE 10

Continued

RECORD OF BOREHOLE No 36

2 OF 2

METRIC 72

W.P. 140-87-04 LOCATION Co-ord: N 4849314 ; E 302929 ORIGINATED BY P.M.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-18 to 90-01-23 CHECKED BY P.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20					
197.4	Continued												
30.8	End of Borehole												
	• Occasional Sandy Silt Layers												
	** CLAYEY SILT to SILTY CLAY Trace of Sand												
	With thin silt layers (Locustrine)												
	Hard												

RECORD OF BOREHOLE No 37

1 OF 1

METRIC 73

W.P. 140-87-04 LOCATION Co-ord: N 4849353 ; E 302920
 DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.)
 DATUM Geodetic DATE 90-01-29 to 90-01-30
 ORIGINATED BY P.M.
 COMPILED BY P.M.
 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20	40							60	80	100
								o UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE										
198.7	Ground Level							20	40	60	80	100						
0.0	Topsoil		1	SS	10													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		2	SS	11													
			3	SS	17													
	brown		4	SS	17													
	grey		5	SS	48													
	Occasional Sandy Silt Layers		6	SS	37													
193.5	Stiff to Hard		7	SS	52													
5.2			8	SS	39													
	CLAYEY SILT to SILTY CLAY		9	SS	33													
	Trace of Sand, Trace of Gravel		10	SS	29													
			11	SS	27													
			12	SS	27													
			13	SS	20													
	Occasional thin silt layers		14	SS	41													
			15	SS	56													
	(Locustrine)																	
	Very Stiff to Hard																	
168.2																		

30.5 End of Borehole

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

RECORD OF BOREHOLE No 38

1 OF 2 METRIC 74

W.P. 140-87-04 LOCATION Co-ord: N 4849376 : E 302903 ORIGINATED BY P.M.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.); Washboring COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-24 to 90-01-25 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%) 20 40 60				
199.1	0.0	Topsoil												
		CLAYEY SILT, With Sand, Trace of Gravel (Till)	1	SS	23									
			2	SS	40									
		brown	3	SS	16									
		grey	4	SS	14									
		Occasional Sandy Silt Layers	5	SS	34									
			6	SS	38									
			7	SS	39									
			8	SS	64									
		Very Stiff to Hard	9	SS	67									
190.4	8.7		10	SS	64									
		CLAYEY SILT to SILTY CLAY	11	SS	82									
		Trace of Sand, Trace of Gravel	12	SS	78									
			13	SS	38									
		Occasional thin silt layers	14	SS	54									
		(Lacustrine)	15	SS	46									
			16	SS	105									
		Hard	17	SS	42									
			18	SS	79									
168.6	30.5													

Continued

+3, x5: Numbers refer to Sensitivity

20 15 10 (%) STRAIN AT FAILURE

Continued

RECORD OF BOREHOLE No 38

2 OF 2

METRIC 75

W.P. 140-87-04 LOCATION Co-ord: N 4849376 : E 302903 ORIGINATED BY P.M.
DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.); Washboring COMPILED BY P.M.
DATUM Geodetic DATE 90-01-24 to 90-01-26 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
30.5	Continued		19	SS	58												
	CLAYEY SILT to SILTY CLAY Trace of Sand With thin silt layers (Locustrine) Hard		20	SS	44												
			21	SS	71												
159.3			22	SS	120												
39.8	SILTY SAND varved (locustrine)		23	SS	120												
155.8	Very Dense		24	SS	120	/5cm											
43.3	End of Borehole •WL Not Stabilized																

RECORD OF BOREHOLE No 39

1 OF 1 METRIC 76

W.P. 140-87-04 LOCATION Co-ord: N 4849405 ; E 302905 ORIGINATED BY P.M.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-01-30 to 90-01-31 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		w _p w w _L				
								SHEAR STRENGTH kPo ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%) 20 40 60				
199.1	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	7									
			2	SS	6									
			3	SS	38									
			4	SS	27									
194.5	Firm to Hard		5	SS	29									
4.6	CLAYEY SILT to SILTY CLAY		6	SS	33									
	Trace of Sand, Trace of Gravel		7	SS	38									
	Occasional thin silt layers (Lacustrine)		8	SS	31									
	Very Stiff to Hard		9	SS	25									
189.5			10	SS	33									
9.6	End of Borehole													

FOUNDATION INVESTIGATION REPORT
For
Proposed Crossing
at
Black Creek Culvert
and
Proposed Hwy. 407
W.P. 140-87-08, Site 37-1319
Highway 407, District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to construct a reinforced box concrete culvert to transmit the waters of the Black Creek beneath the Hwy. 407 and associated ramps. The proposed profile grade of the Hwy. 407 and associated ramps varies from elevation 198.0 m to 200.6 m. Consequently, approach fills in the order of magnitude of 7 to 9.5 m will be required. Equivalently, depths of culvert roof cover ranges from 1.8 m to 4.4 m.

SITE DESCRIPTION AND GEOLOGY

The site is located colinear and adjacent to Black Creek in the valley area bounded by Jane Street to the west and Pellar Street to the north in the Town of Vaughan, Regional Municipality of York. Agricultural farmland and a three storey building bound the site to the east. Residential homes are located at the southern limits of the site.

The Black Creek which has a width ranging from approximately 2 to 4 m meanders in a river valley approximately 100 m in width. The depth of the creek ranges from approximately 0.5 m to 1.0 m. The water level at the time of the investigation was generally 0.3 to 0.6 m in depth.

Valley slopes are generally 4H:1V or flatter and are covered primarily with a combination of trees, shrubs and grasses. The valley floor is also populated with this vegetation.

A series of corrugated steel pipe culverts exist along the Black Creek alignment used to bridge existing unpaved and paved roadways that intersect the creek at the site. The most noticeable culvert exists approximately 75 m south of Pellar Street, constructed to access vehicular traffic to the 3 storey structure located east of the site. The roof of this culvert has been exposed as a result of the loss of the backfill cover. The cause of this soil loss may have been attributable to "piping" effects caused by high upstream water levels permeating through the joints of the existing timber headwall.

The area surrounding the site consists predominantly of industrial and commercial units.

Physiographically, the site lies in the geological domain known as the Bolton Area, an area that covers approximately 1200 square kilometers located at the northwestern border of the Municipality of Metropolitan Toronto. The Bolton Area has drumlins, till plains, moraines, meltwater channels and numerous other features associated with deglaciation. The area was covered with the Wisconsin glacier of the Pleistocene period that advanced into the region approximately 50,000 years ago and retreated approximately 15,000 years ago. The Black Creek, a tributary of the Humber River was formed by the advancement and retreat of the Ontario ice lobe.

The overburden deposits at the site consist of moraine tills of the Halton Till Formation underlain by glaciolacustrine sediments deposited by Lake Peel, a body of water impounded between lobes of projecting ice. The Halton Till is primarily a silt till composed of varying percentages of clay, silt, sand and gravel. The glaciolacustrine deposits generally consists of stratified silt, clayey silt and/or silty clay.

The surficial deposits of the Cenozoic era are underlain by bedrock of the Paleozoic era. Bedrock consists of grey, thinly bedded shales with interbedded limestone from the Dundas Meaford Formation. Bedrock topographical maps reveal that the bedrock exists at depths approximately 70-80 m below the natural ground surface at the site location.

INVESTIGATION PROCEDURE

Field Investigation

The fieldwork for the investigation was carried out between 90 02 12 to 90 02 21 and consisted of 9 sampled boreholes advanced to depths ranging from 15.7 to 36.9 m below the natural ground surface.

Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance the boreholes in the overburden.

In general, subsoil samples were retrieved at 0.7 m intervals for the surficial 4.5 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Relatively undisturbed samples were also randomly retrieved in the weaker cohesive clayey silt material underlying the surficial moraine till deposit at the site. These samples were retrieved via a shelly tube sampler in accordance with standard practice (ASTM D1587) at 1.5 m intervals. In situ vane tests were also conducted in the cohesive soils, generally at 1.5 m intervals, to determine the undisturbed and remoulded undrained shear strengths of the soil. The test was conducted employing the standard MTO 'N' vane in accordance with ASTM D2573.

All samples were identified in the field and then returned to the laboratory for applicable testing.

Groundwater levels were obtained by monitoring the levels in the open borehole throughout the duration of the field investigation. All open boreholes were backfilled at the completion of the fieldwork.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Consolidation Tests

Laboratory test results have been summarized in the subsequent section of this report entitled Subsurface Conditions, and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The soil stratigraphy at the site consists of a surficial glacial till deposit consisting of a heterogeneous mixture of silt to clayey silt, sand and gravel. The main component of this till varies from a cohesionless silt to a cohesive clayey silt. The deposit is generally in a loose to compact or stiff to very stiff state. The thickness of this deposit ranges from 6.1 m to 14.2 m but is generally in the order of 10 m.

The till deposit is underlain by a clayey silt to silt deposit. The surface of this stratum varies from elevation 186.9 m to 178.6 m and its thickness is generally in the 3 to 9 m range. High natural moisture contents, generally in the 18-27% range characterize this stratum. The denseness/consistency of the stratum varies randomly and is generally loose to very loose or very soft to stiff.

The silt to clayey silt stratum is underlain by a cohesionless silt and/or sand with some silt stratum. The stratum extends for a thickness ranging from 4.6 m to 7.6 m or Elev. 166.8 to 172.2 m. This stratum is generally loose to compact.

A cohesive clayey silt to silty clay stratum with nodules and seams of interbedded silt underlies the cohesionless silt and sand stratum. This deposit is of a hard consistency and ranges in thickness from 7.6 m to 12.5 m. In general, the stratum is of thickness in the order of 12.2 to 12.5 m.

Underlying the cohesive clayey silt to silty clay, a very dense deposit of silt with a trace of sand exists. The surface of this deposit is at elevation of 159.2 to 159.5 m. The extent of this deposit was not determined during the investigation.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 1408708-A.

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

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

The surficial deposit at the site consists of a heterogeneous mixture of silt to clayey silt, sand and gravel. The deposit extends from the ground surface at an elevation ranging from 192.5 to 193.0 for a thickness ranging from 6.1 m to 14.2 m. The deposit is generally oxidized and brown in colour for the surficial 1 to 1.5 m and unoxidized and grey below.

The main component of the till deposit varies from a silt to clayey silt across the site and also within the vertical extent of the deposit. Some black organics containing wood components also occur within the upper metre of the deposit at various locations.

Random layers of clayey silt of glaciolacustrine origin were also found interbedded within the till deposit. The interbeds are generally 0.5 to 2 m in thickness and of stiff consistency.

A grain size distribution envelope for the till deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 1 in the Appendix. The envelope reveals a wide range of grain size characteristics of unstratified till deposits. The range in clay and silt percentages is approximately 10-18% and 39-45% which assists in explaining the varying behaviour of the deposit

across the site. Sand compositions present in the deposit range from 27-41% and gravel sizes amount to generally less than 10% of the deposit. Although not encountered during the field investigation, boulders and cobbles are also characteristic components of till deposits and hence can exist in this deposit.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the fine grained portion of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1 below.

Table 1 - Het. Mix. of Clayey Silt-Silt, Sand
and Gravel (Glacial Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	8-21	11
Liquid Limit (w_L %)	14-22	11
Plasticity Index	3-10	11
Unit Weight (kN/m^3)	22.1-23.2	5

The test results reveal that the fine grained portion of the deposit ranges in behaviour from a plastic silt to a clayey silt of low plasticity. Natural moisture contents are generally less than plastic limit of soil or within the liquid limit - plastic limit range (w_L-w_p) indicating that the soil is in a plastic to semisolid state.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 1 blow/0.3 m to 49 blows/0.3 m. Relatively lower 'N' values were encountered in the segment of the culvert bounded by BH's 4 to 6 inclusive which happens to correspond to the length of the culvert supporting the proposed Hwy. 407 eastbound/westbound lanes. The 'N' values improve north and south of this central segment. N-values determined by the Standard Penetration test are summarized in Table 2 below.

Table 2 - SPT 'N' Values

<u>Location*</u>	<u>BH's</u>	<u>'N' Values⁺</u> (blows/0.3 m)	<u>Denseness/Consistency</u>
North	1-3	8-40	loose-compact/firm-stiff
Central	4-6	2-15	v. loose-compact/v. soft-stiff
South	7-9	6-49	firm-hard

*see Dwg. 1408708-A

+excluding 'N' Values in surficial organic enriched material

Clayey Silt to Silt

Underlying the glacial till deposit exists a deposit that varies from a clayey silt to silt both in the vertical and horizontal plane. The surface of this stratum is generally at an elevation ranging from 182 to 186.9 m. At BH 3, however, the surface of this stratum is at elevation 178.6. The thickness of this stratum ranges from 3 to 9.1 m but is generally in the 4 to 7 m range.

A grain size distribution envelope for this deposit is illustrated in Figure 3 in the Appendix. The envelope identifies the high silt content of 74 to 92%. Clay percentages, however, are also present in the range of 5 to 25%. Hence the stratum can behave as a cohesive or cohesionless material.

Atterberg Limit tests were taken to define the behaviour of the soil and the results are plotted in Figure 4 in the Appendix and summarized in Table 3 below.

Table 3 - Clayey Silt to Silt

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	24-27	8
Liquid Limit (w _L %)	20-28	8
Plastic Limit (I _p)	5-13	8
Unit Weight (kN/m ³)	19-20.2	2
Undrained Shear Strength (C _u) (kPa)		
- Field Vane	40->120	23
- Unconfined*	43-54	2
Sensitivity	2-4	23

*some of the samples were too dilated and hence the test was not conducted

The test results reveal that this stratum ranges in behaviour from a plastic silt to a clayey silt of low plasticity. Natural moisture contents generally exceed the liquid limit of the soil and hence the liquidity index generally exceeds unity.

In situ vane tests were conducted in the anisotropic, non-homogeneous soil, to determine the undrained shear strength (c_u) of the cohesive soil. Unconfined compression tests were also conducted in the laboratory to determine the undrained shear strength. Results of field and lab tests are plotted on the Record of Borehole sheets in the Appendix and summarized in Table 3 above. The results reveal that the undrained shear strength values of the soil range from 40-120 kPa. Consequently, the cohesive portion of the soil has a firm to very stiff consistency.

The sensitivity of the soil as defined by the ratio of the undrained strength in the undisturbed state to the undrained strength, at the same water content, in the remoulded state was also determined by the field vane test and the results are tabulated in Table 3 and identified on the Record of Borehole sheets. Sensitivity values range from 2 to 4 indicating that the soil has a low sensitivity.

The compressibility characteristics of the soil were determined by conducting consolidation tests on representative samples of the clayey silt material. Pertinent data is summarized in Table 4 below. The results reveal that the soil has relatively large preconsolidation pressures (p_c) indicating that the soil has been preconsolidated in the past in excess of the existing effective overburden pressure by a magnitude ranging from 236 to 239 kPa. In addition, compression indices of the soil range from .05 to .07, revealing that the material will not experience significant displacement under applied pressure.

The results (e-log p curves) of consolidation tests are illustrated in Figures 5 & 5a in the Appendix.

Table 4 - Compressibility Characteristics

<u>Sample</u>	<u>Depth</u> <u>(m)</u>	<u>El.</u> <u>(m)</u>	<u>Initial</u> <u>Void</u> <u>Ratio</u> <u>(e_o)</u>	<u>Compression</u> <u>Index</u> <u>(C_c)</u>	<u>Overconsolidation</u> <u>Pressure</u> <u>($p_c - p'_{o}$)</u> <u>(kPa)</u>
BH 4, TW9	9.3	183.6	.67	.05	236
BH 5, TW12	13.9	179.1	.88	.05	237
BH 9, TW12	12.4	181.1	.67	.07	239

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 1 blow/0.3 m to 30 blows/0.3 m. In general, however, 'N' values are less than 10 blows/0.3 m, confirming the relatively weak nature of the soil.

Silt to Sand, some silt

The clayey silt to silt stratum is underlain by a cohesionless deposit consisting of a silt with interbedded silty sand or a sand with some silt. The surface of this deposit exists generally at an elevation ranging from 174.4 m to 179.3 m and extends for a thickness ranging from 4.6 m to 7.6 m. A grain size distribution envelope illustrating the gradation of this deposit is shown in Figure 6 in the Appendix. Some gravel zones also randomly exist in the deposit.

The fact that sloughing of the borehole occurred upon penetration into this deposit indicates that the deposit is under a subartesian head. "Blow back" in the order of 2 to 3 m was observed when sampling through this material. A head of water was required to balance the unbalanced hydrostatic head so that penetration through this soil could be achieved.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2 blows/0.3 m to 54 blows/0.3 m. In view of the fact that the lower 'N' values may be the product of disturbance caused by unbalanced hydrostatic head and the higher 'N' values a result of gravel sizes randomly present in the deposit, 'N' values are generally in the 5 blows/0.3 m to 15 blows/0.3 m indicating a denseness of loose to compact.

Clayey Silt to Silty Clay with random nodules/seams of silt

The cohesionless silt/sand deposit is underlain by a cohesive stratum consisting of a clayey silt to silty clay with random nodules/seams of silt. The nodules and seams are generally 5 to 10 mm in thickness and are light grey in colour. The main deposit is of a dark grey hue. The surface of the stratum exists at an elevation ranging from 172.7 to 166.8 m or approximately 21.3 to 25.9 m below the natural ground surface. The thickness of the stratum is approximately 7.6 to 12.5 m.

A grain size distribution envelope for the material is illustrated in Figure 7 in the Appendix. The envelope illustrates that clay and silt percentages range from 22 to 65% and 29 to 78% respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 8 in the Appendix and summarized in Table 5 below.

Table 5 - Clayey Silt to Silty Clay

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	22-28	4
Liquid Limit (w _L %)	31-50	4
Plasticity Index (I _p %)	15-30	4

The test results reveal that the stratum varies in plasticity from low (clayey silt) to intermediate (silty clay).

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 23 blows/0.3 m to 55 blows/0.3 m and consequently this stratum has a very stiff to hard consistency.

Silt, trace/some Sand

The cohesive clayey silt to silty clay stratum is underlain by a very dense cohesionless silt. This silt stratum also contains traces to some sand. The surface of the stratum exists at approximate elevation 159.2 m to 159.7 m. The extent of the deposit was not determined during the investigation.

A grain size distribution envelope illustrating the gradation of this material is provided in Figure 9 in the Appendix.

Standard Penetration tests carried out in this deposit revealed large 'N' values ranging from 120 blows/0.3 m to 180 blows/.15 m. These 'N' values indicate that the deposit is in a very dense state of condition.

GROUNDWATER CONDITIONS

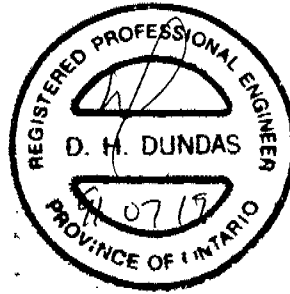
Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater levels determined at the time of investigation ranged from 1 to 2.5 m below ground surface (Elevation 193.2 to 190.3 m). These water levels correlate approximately to the water level of the flowing Black Creek.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in this report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, and B. Chung, Engineering Trainee, utilizing equipment owned and operated by Marathon Drilling and Master Soils Investigation.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.

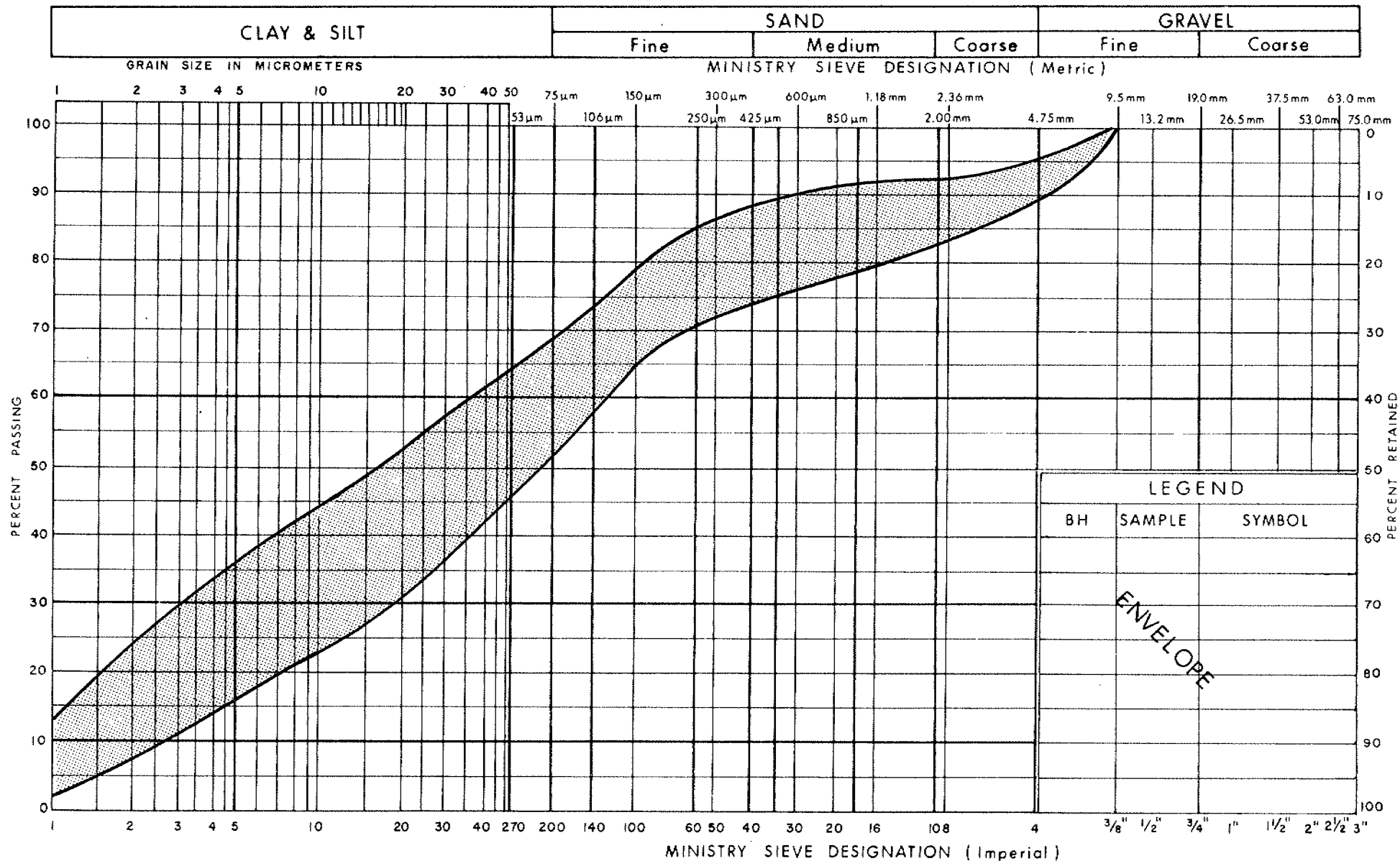


D. Dundas
D. Dundas, P. Eng.
Sr. Foundation Engineer

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

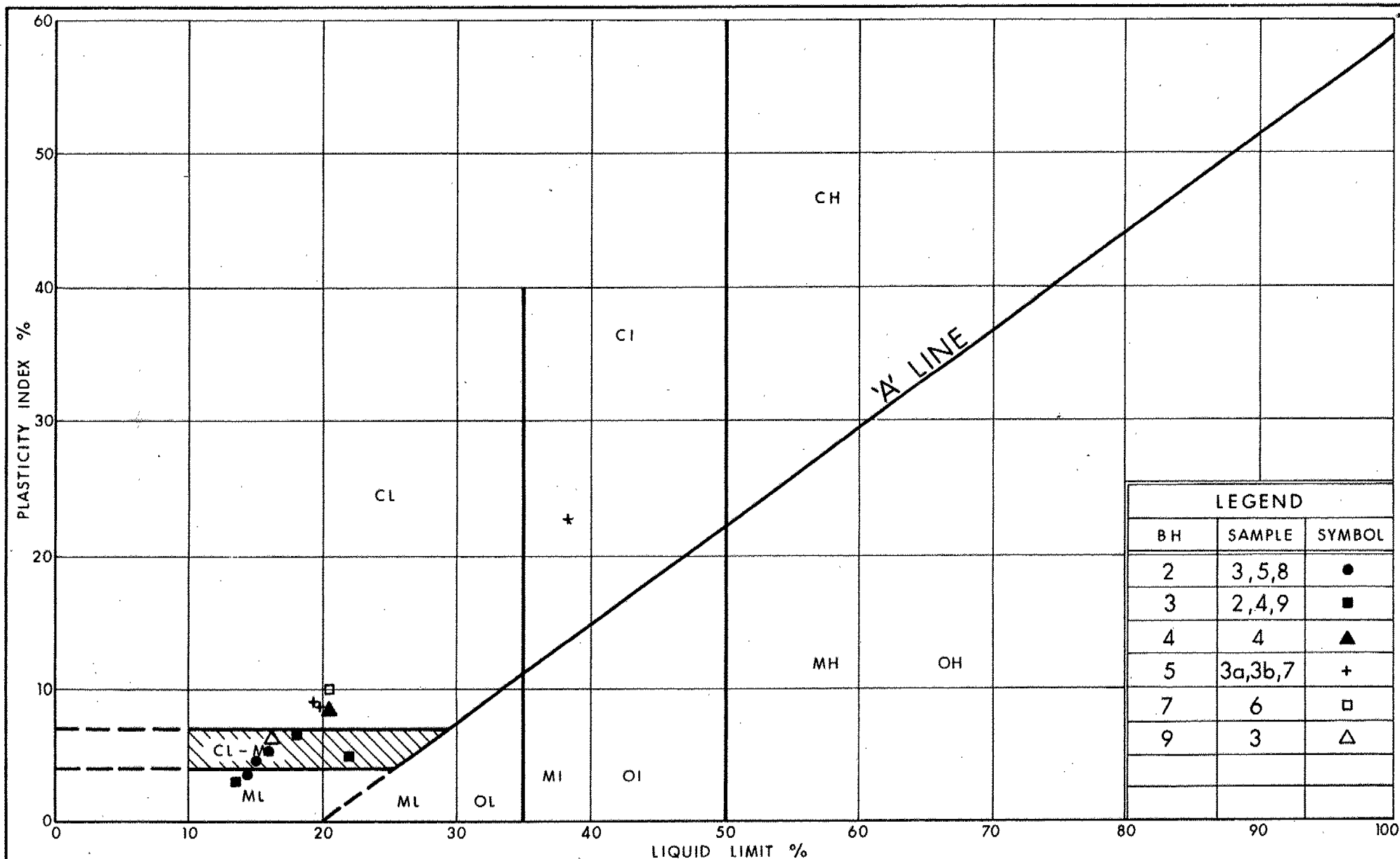


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GRAIN SIZE DISTRIBUTION
HETEROGENEOUS MIXTURE OF SILT TO CLAYEY SILT,
SAND & GRAVEL (GLACIAL TILL)

FIG No 1

W P 140-87-08



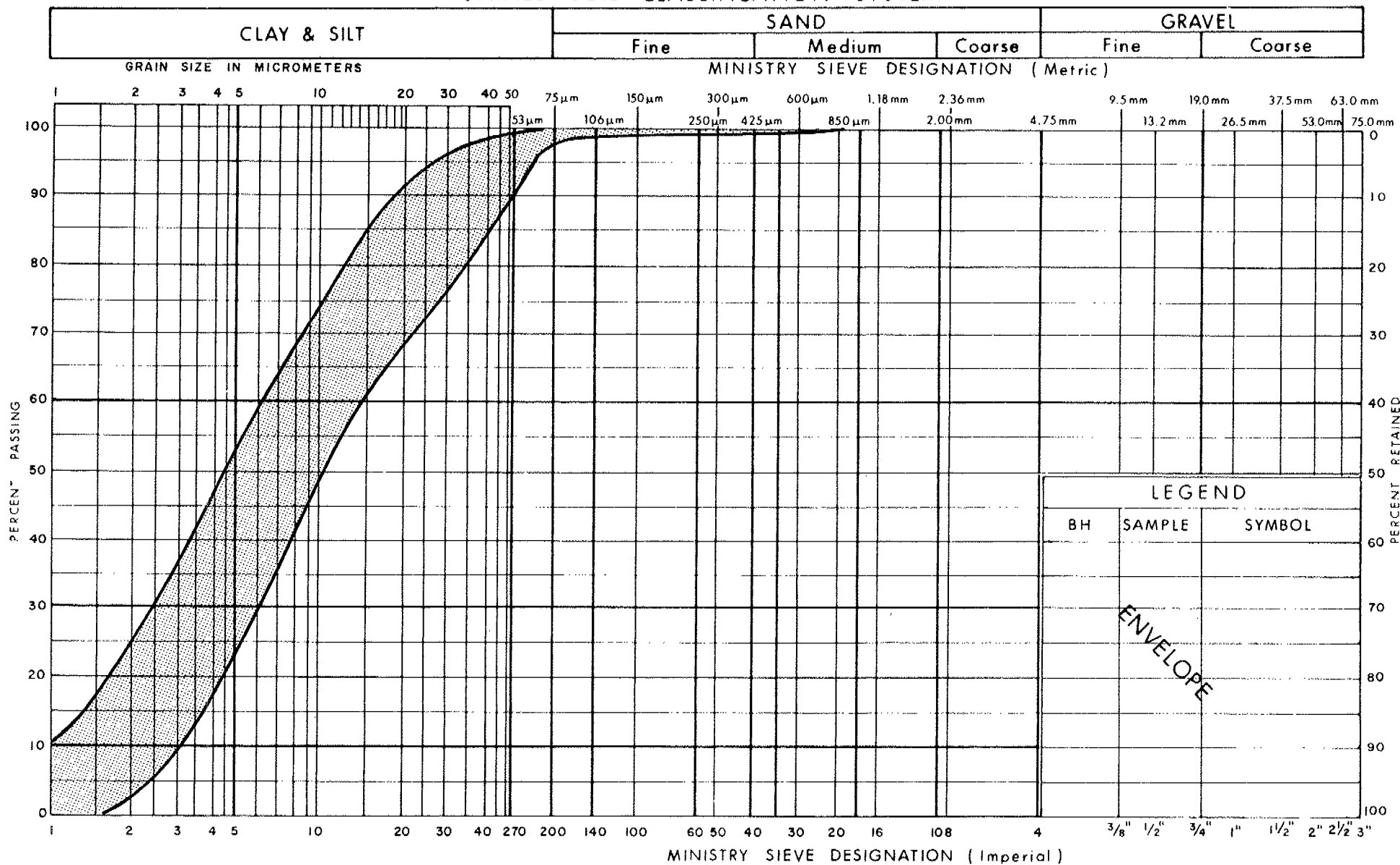
Ministry of
Transportation
Ontario

PLASTICITY CHART
HETEROGENEOUS MIXTURE OF CLAYEY SILT,
SAND & GRAVEL (GLACIAL TILL)

FIG No 2

W P 140-87-08

UNIFIED SOIL CLASSIFICATION SYSTEM

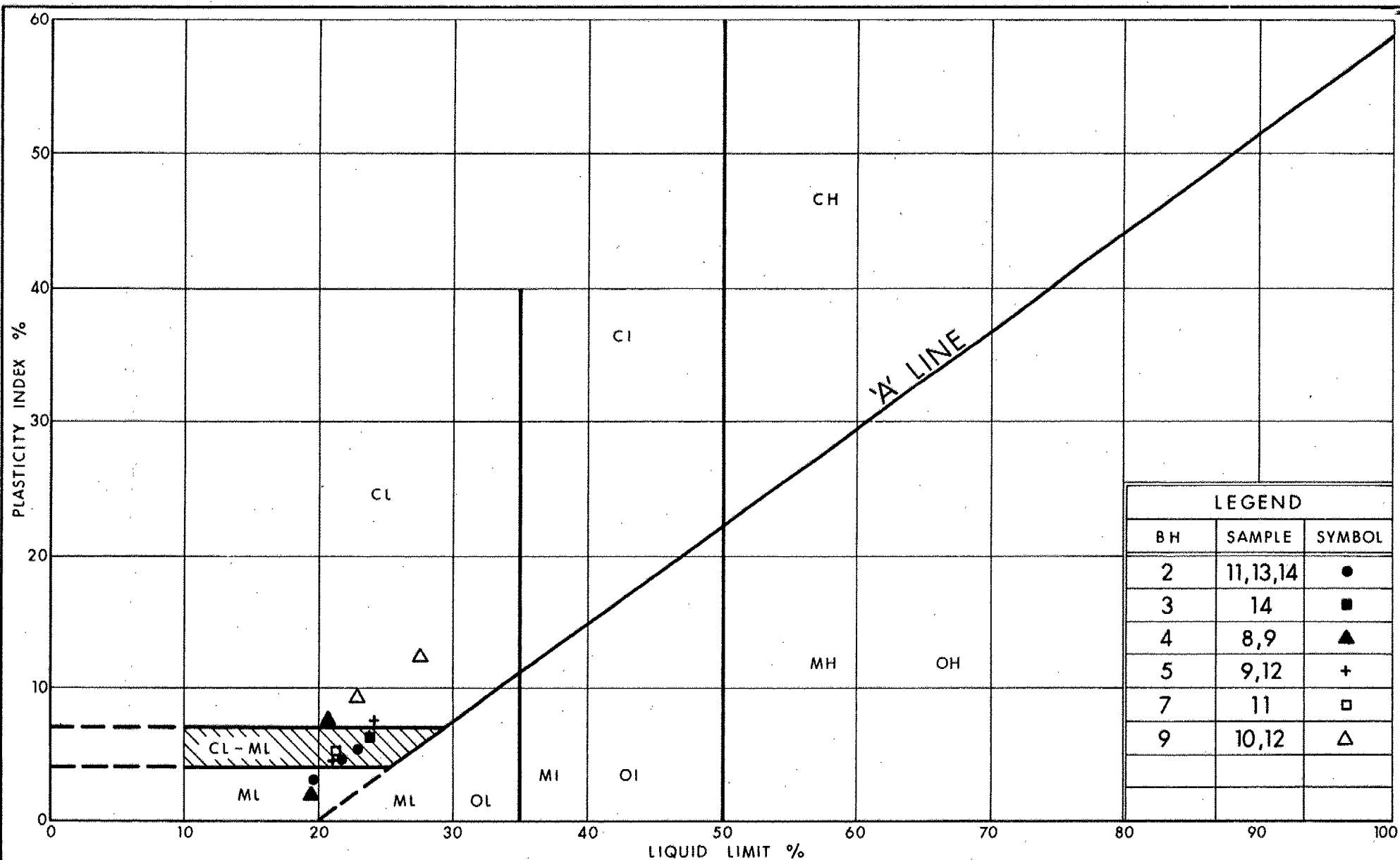


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Transportation

GRAIN SIZE DISTRIBUTION CLAYEY SILT TO SILT

FIG No 3

W P 140-87-08



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PLASTICITY CHART CLAYEY SILT TO SILT

FIG No 4

W P 140-87-08

VOID RATIO - PRESSURE CURVES

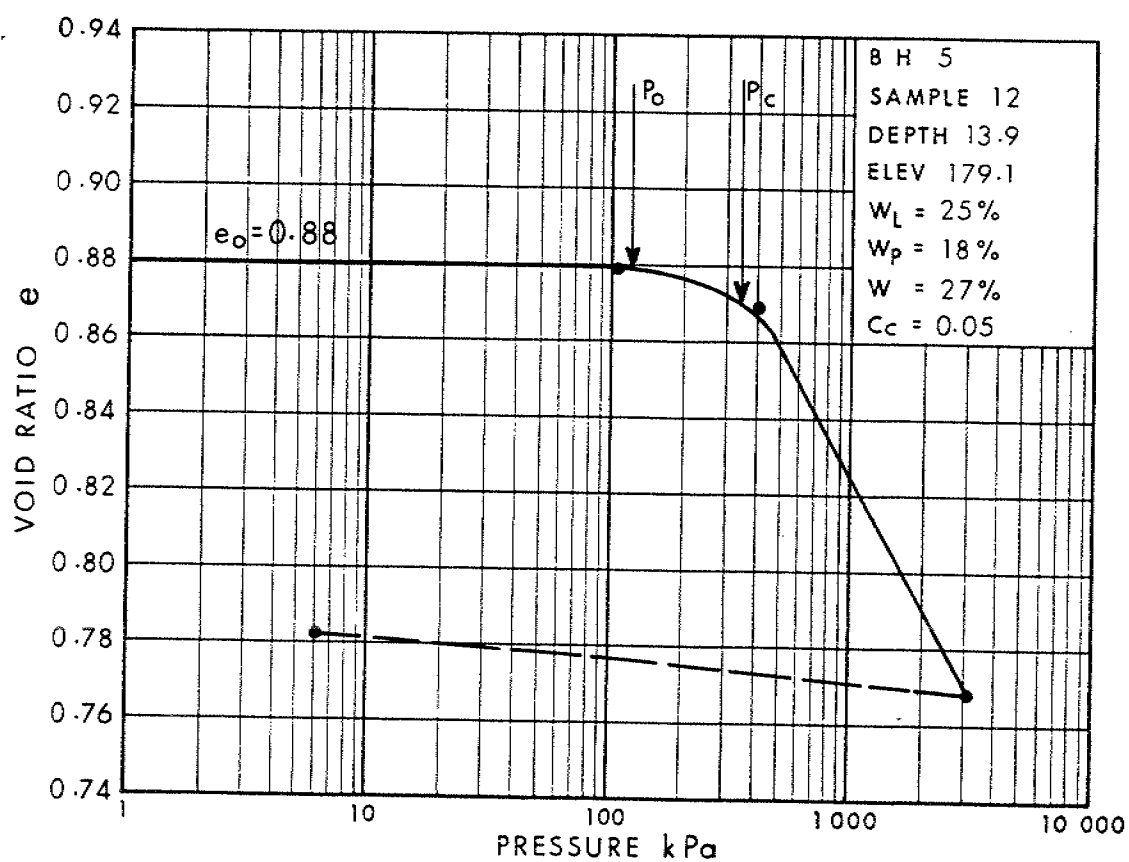
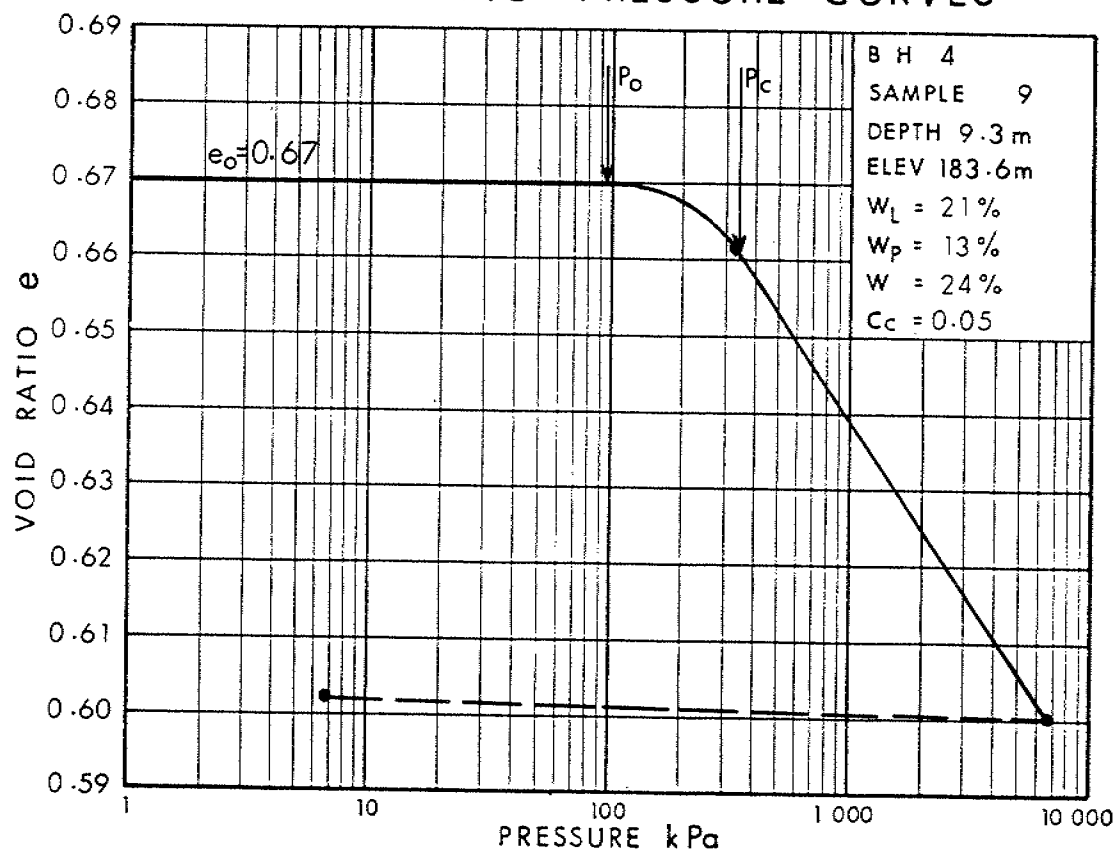


Fig 5

W P 140-87-08

VOID RATIO - PRESSURE CURVES

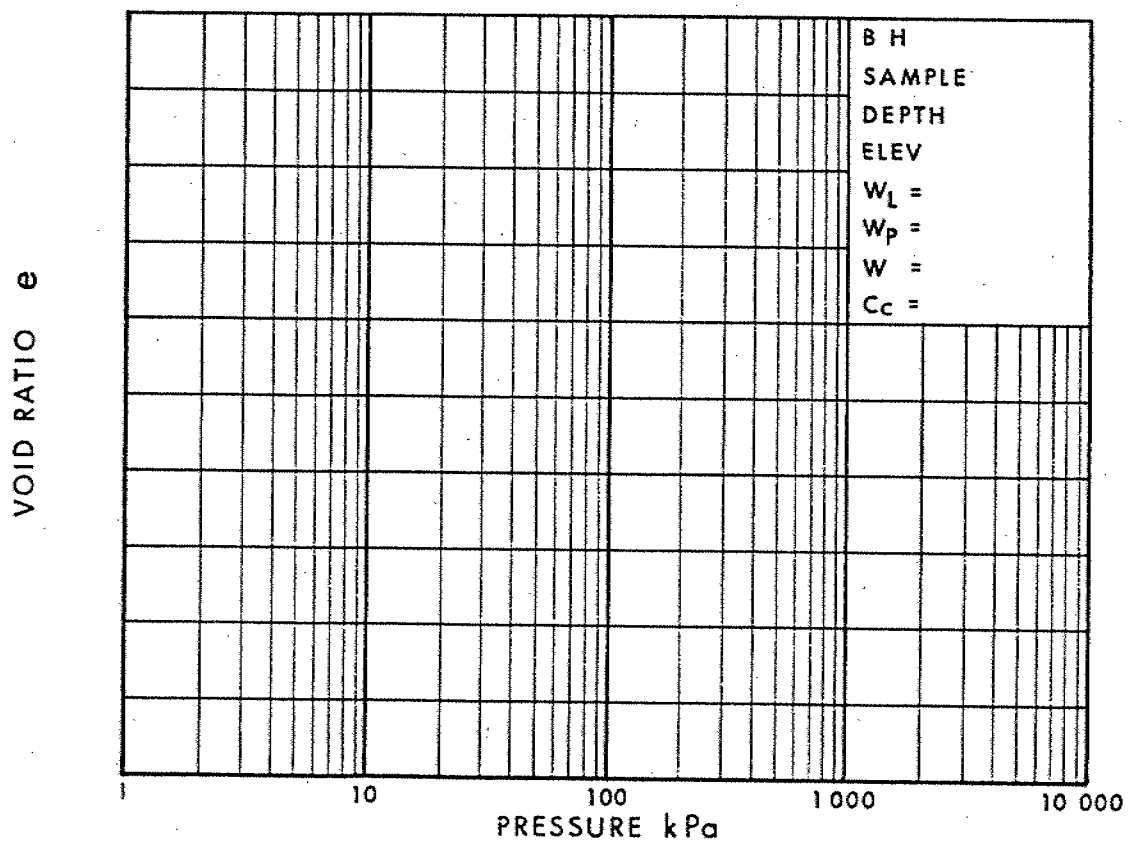
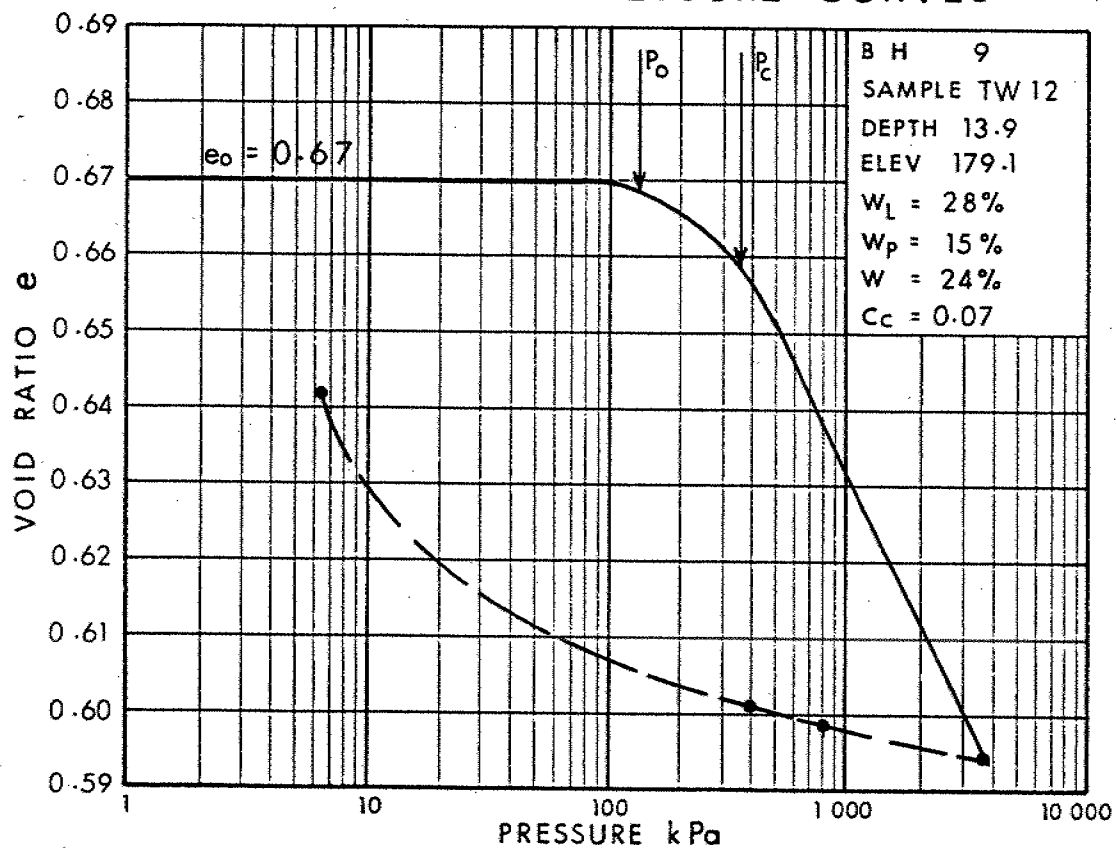
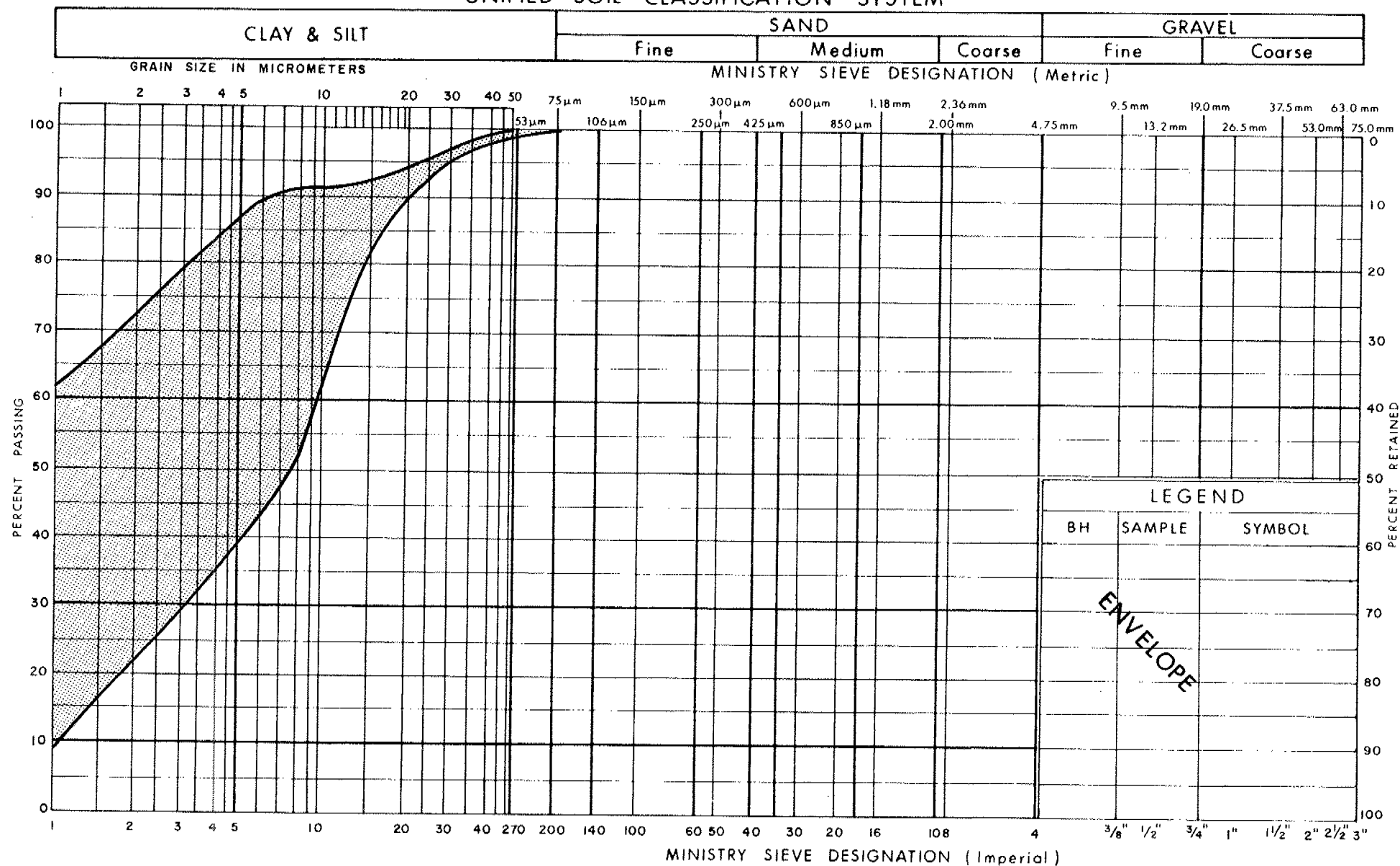


Fig 5a

W P 140-87-08

UNIFIED SOIL CLASSIFICATION SYSTEM



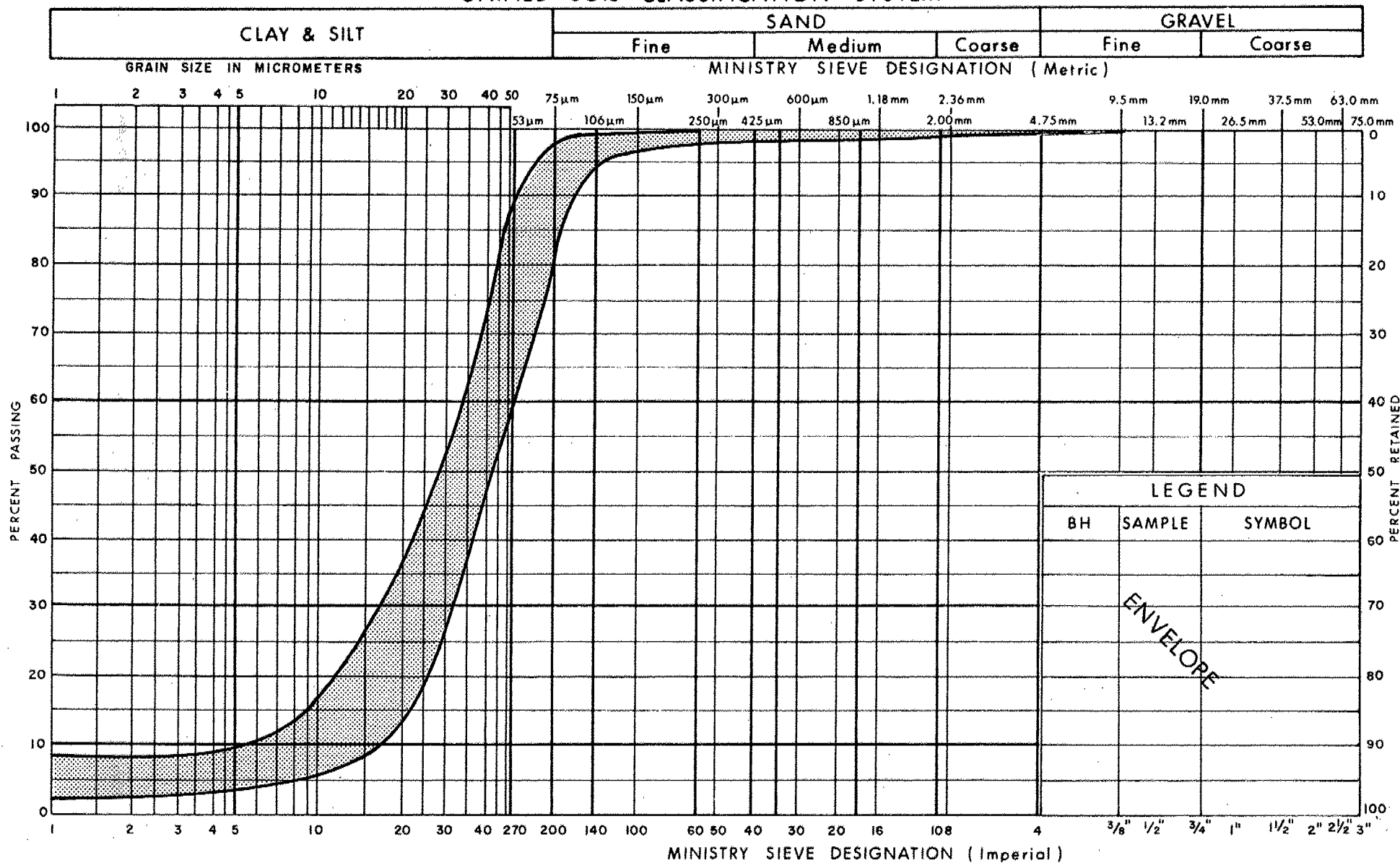
Ministry of
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GRAIN SIZE DISTRIBUTION
SILT, TRACE / SOME SAND

FIG No 6

W P 140-87-08

UNIFIED SOIL CLASSIFICATION SYSTEM

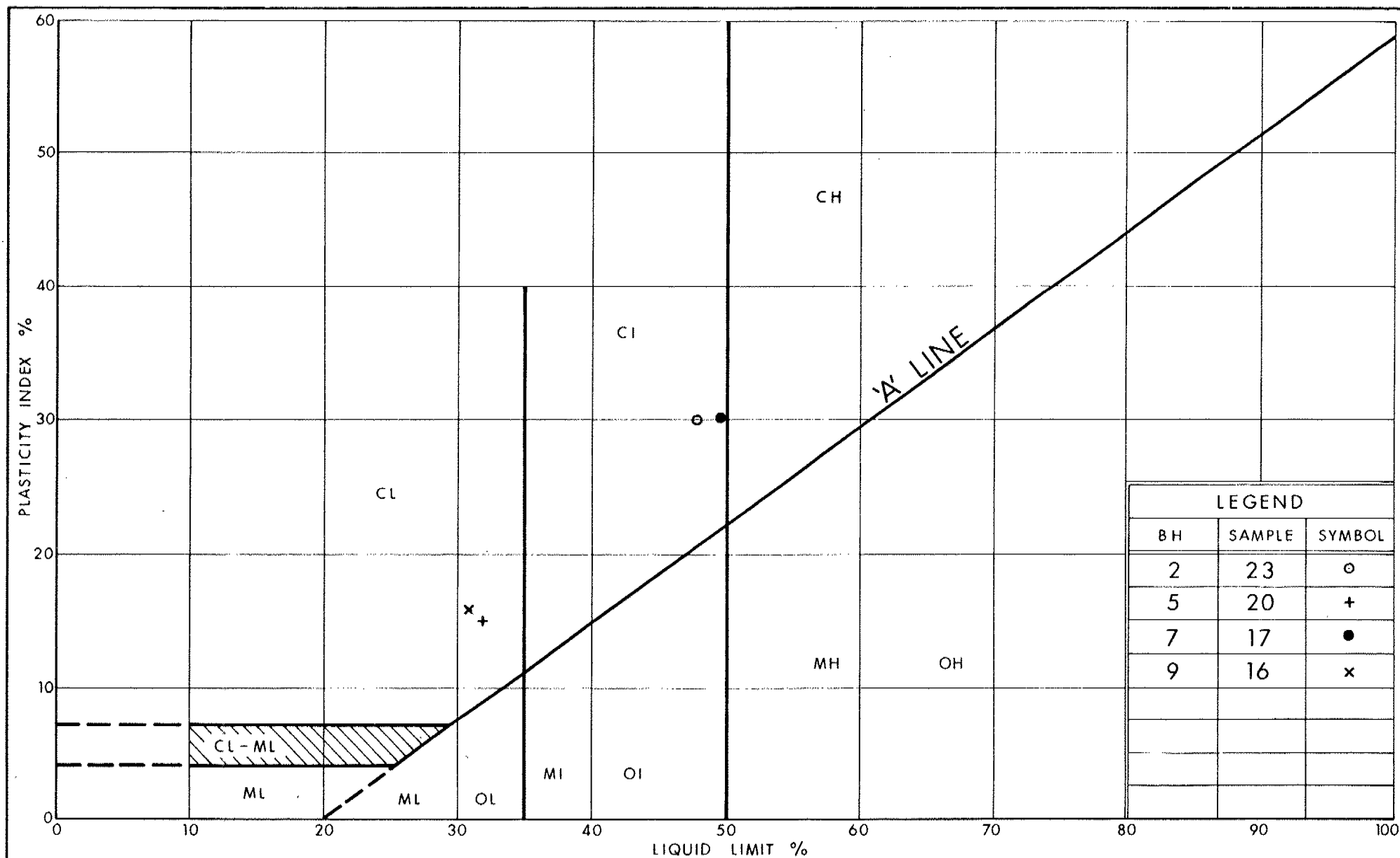


Ministry of
Transportation

**GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY
WITH RANDOM NODULES / SEAMS OF SILT**

FIG No 7

W P 140-87-08



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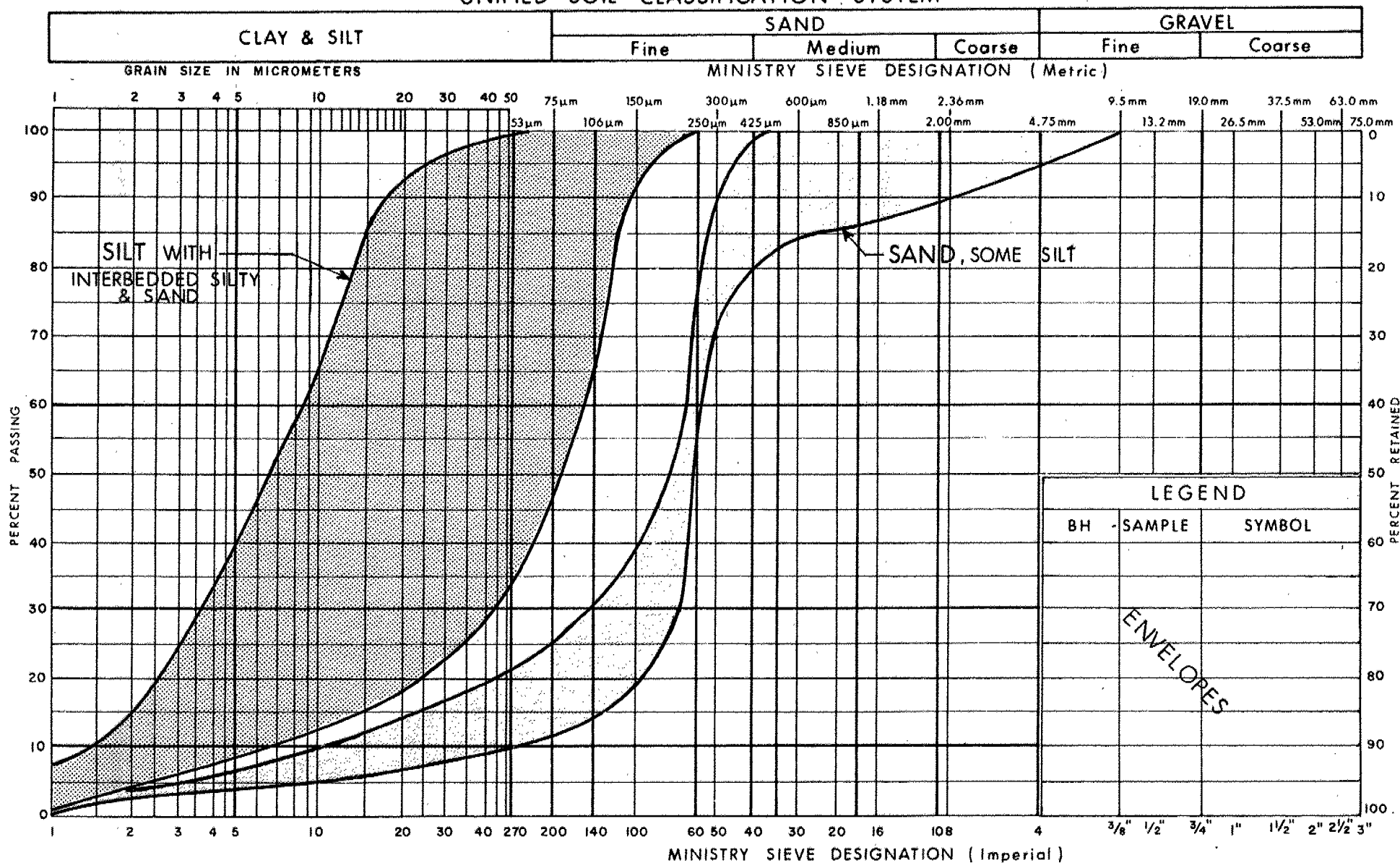
Ontario

PLASTICITY CHART CLAYEY SILT TO SILTY CLAY

FIG No 8

W P 140-87-08

UNIFIED SOIL CLASSIFICATION SYSTEM



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GRAIN SIZE DISTRIBUTION

SILT, TRACE / SOME SAND

FIG No 9

W P 140 -87-09

RECORD OF BOREHOLE No 1

1 OF 1

METRIC 100

W.P. 140-87-08 LOCATION Co-ords: N 4 849 293.5 ; E 303 074 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 16-19 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100		
193.4	Ground Surface													
0.0			1	SS	14		192							
			2	SS	18									
			3	SS	13									
			4	SS	28		190							
			5	SS	25									
			6	SS	19									
			7	SS	13		188							
			8	SS	40		186							
			9	SS	19		184							
182.3			10	SS	29									
11.1			11	SS	30		182							
			12	SS	10		180							
			13	TW	PH		178							
176.6			14	SS	6		176							
16.8			15	SS	5									
174.7														
18.7	End of Borehole													

RECORD OF BOREHOLE No 2

1 OF 2 METRIC 101

W.P. 140-87-08 LOCATION Co-ords: N 4 849 317 ; E 303 062 ORIGINATED BY TS

DIST 6 HWY 407 BOREHOLE TYPE HS Auger, Washbore, Cone Test COMPILED BY TS

DATUM Geodetic DATE 90 02 12-14 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
192.7	Ground Surface													
0.0			1	SS	8		192						23.2	
	Brown		2	SS	10		190							4 41 45 10
	Grey		3	SS	28		188							7 33 45 15
	Het. mixture of Silt, Sand and Gravel (Glacial Till) Loose to Compact		4	SS	8		186						22.4	
			5	SS	21		184							
			6	SS	23		182							
			7	SS	24		180							
			8	SS	24		178							
			9	SS	25		176							
183.6			10	SS	13		174							
9.1			11	SS	13		172							
	Clayey Silt/Silt Grey Firm to Stiff/Loose to Compact		12	SS	2		170							
			13	SS	2		168							
			14	TW	PH		166							
			15	SS	2		164							
174.4			16	SS	9									
18.3			17	SS	8									
	Silt to Silty Sand Grey, Loose to Compact		18	SS	11									
			19	SS	16									
			20	SS	30									
166.8			21	SS	29									
25.9			22	SS	37									
	Silty Clay with Random Nodules/ Seams of Silt Grey, Layered, Hard		23	SS	40									
162.2														
30.5														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 2

2 OF 2

METRIC 102

W.P. 140-87-08 LOCATION Co-ords: N 4 849 317 ; E 303 062 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger, Washbore, Cone Test COMPILED BY TS
 DATUM Geodetic DATE 90 02 12-14 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
162.2	Continued		24	SS	30		162						
30.5													
159.2													
33.5	Silt, Some Sand Grey, Very Dense		25	SS	110	/8cm	160						
155.8			26	SS	120	/15cm	158						
			27	SS	120	/15cm	156						
36.9	End of Borehole												

RECORD OF BOREHOLE No 3

1 OF 1 METRIC 103

W.P. 140-87-08 LOCATION Co-ords: N4 849 343 ; E 303 067 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 90 02 15 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100								10 20 30		
192.8	Ground Surface																	
0.0	Het. mixture of Silt, Sand and Gravel (Glacial Till) Compact		1	SS	21													
			2	SS	12													
			3	SS	10													
			4	SS	9													
			5	TW	PH													
			6	SS	16													
			7	SS	22													
			8	SS	20													
			9	SS	17													
			10	SS	26													
			11	SS	25													
			12	SS	20													
			13	SS	4													
			14	SS	17													
			15	SS	12													
178.6																		
14.2	Clayey Silt/Silt Grey, Stiff/Compact																	
174.1																		
18.7	End of Borehole																	

RECORD OF BOREHOLE No 4

1 OF 1

METRIC 104

W.P. 140-87-08 LOCATION Co-ords: N 4 849 366 ; E 303 055 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 14-16 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
192.9	Ground Surface													
0.0														
	Brown		1	SS	2		192							
	Grey		2	SS	7									
	Het. mixture of Silt, Sand and Gravel		3	SS	11									
	(Glacial Till)		4	SS	13		190							
	Clayey Silt (lacustrine)		5	SS	5									
	Loose to Compact		6	SS	3		188							
186.8														
6.1			7	SS	6		186							
			8	SS	5									
			9	TW	PH		184							
	Clayey Silt/Silt		10	TW	PH		182							
	Grey, Firm/Very Loose		11	SS	4		180							
			12	SS	2									
177.7							178							
15.2			13	SS	3									
	Silt		14	SS	2		176							
	Loose to Compact		15	SS	10		174							
			16	SS	4									
	Silty Sand		17	SS	8		172							
21.8	End of Borehole													

RECORD OF BOREHOLE No 5

1 OF 2 METRIC 105

W.P. 140-87-08 LOCATION Co-ords: N 4 849 393 : E 303 060 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger, Washbore COMPILED BY TS
DATUM Geodetic DATE 90 02 12-14 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
193.0	Ground Surface													
0.0	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till) Firm to Stiff		1	SS	4		192							
			2	SS	4									
			3	SS	14		190							7 27 44 22
			4	SS	13									
			5	SS	13									
			6	SS	8		188							
			7	SS	10									
186.9			8	SS	4		186						22.3	10 33 39 18
6.1			9	SS	8									
			10	SS	7		184							0 1 89 10
			11	SS	5		182							
			12	TW	PH		180						19.0	0 2 73 25 e _s = 0.879 C _c = 0.047
179.3			13	SS	2		178							
13.7			14	TW	PH									
			15	SS	13		176							0 30 61 9
			16	SS	15		174							0 89 (11)
			17	SS	54		172							
171.7			18	SS	55		170							
21.3			19	SS	43									
			20	SS	46		168							0 0 78 22
			21	SS	51		166							
			22	SS	50		164							
162.5														
30.5														

Continued

+3, x5, Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 5

2 OF 2

METRIC 106

W.P. 140-87-08 LOCATION Co-ords: N 4 849 393 ; E 303 060 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger, Washbore COMPILED BY TS
DATUM Geodetic DATE 90 02 12-14 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
162.5	Continued		23	SS	43		162										
30.5																	
159.5							160										
33.5			24	SS	105	/13cm											
	Silt, Some Sand																
	Grey, Very Dense		25	SS	180	/15cm	158										0 16 79 5
156.3			26	SS	200	/13cm											
36.7	End of Borehole																

RECORD OF BOREHOLE No 6

1 OF 1

METRIC 107

W.P. 140-87-08 LOCATION Co-ords: N 4 849 416 : E 303 048 ORIGINATED BY TS

DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS

DATUM Geodetic DATE 90 02 19 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
193.0	Ground Surface																
0.0																	
	Brown Grey Some Organics Very Soft		1	SS	2		192										
			2	SS	3												
	Clayey Silt (Locustrine) Stiff		3	SS	13		190										
			4	SS	15												
			5	SS	10												
			6	SS	8		188										
	Het. mixture of Clayey Silt to Silt, Sand and Gravel (Glacial Till)		7	SS	6		186										
	Firm to Stiff/ Loose to Compact		8	SS	5												
183.9																	
9.1			9	SS	6		184										
	Clayey Silt/Silt Grey Firm to Stiff/V. Loose to Loose		10	TW	PH		182										
			11	SS	7		180										
			12	SS	3												
177.8																	
15.2			13	SS	3		178										
	Silt Grey, Very Loose to Loose		14	SS	3		176										
174.3																	
			15	SS	8												
18.7	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (x) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7

1 OF 2 METRIC 108

W.P. 140-87-08 LOCATION Co-ords: N 4 849 455 ; E 303 046 ORIGINATED BY TS
 DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 90 02 19-21 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
193.2	Ground Surface													
0.0			1	SS	1		192							
	Some Organics Very Soft		2	SS	4									
	Clayey Silt (Locustrine)		3	SS	19									
			4	SS	19		190							
			5	SS	21									
	Het. mixture of Clayey Silt, Sand and Gravel		6	SS	13									
	(Glacial Till)		7	SS	6		188						9 29 44 18	
	Firm to Hard		8	SS	33		186							
			9	SS	32		184							
182.5			10	SS	21		182							
10.7			11	SS	8								0 0 84 16	
	Clayey Silt/Silt		12	SS	2		180							
	Grey, Firm/Loose to Compact		13	SS	1		178							
176.4														
16.8			14	SS	18		176						9 74 14 3	
	Sand, Some Silt						174							
	Grey, Compact													
171.9			15	SS	44		172							
21.3							170							
	Silty Clay		16	SS	41		168							
	Grey, Hard		17	SS	50		166							
162.7							164							
30.5														

Continued

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 7

2 OF 2

METRIC 109

W.P. 140-87-08 LOCATION Co-ords: N 4 849 455 ; E 303 046 ORIGINATED BY TS

DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS

DATUM Geodetic DATE 90 02 19-21 CHECKED BY BC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100		
162.7	Continued												
30.5			18	SS	48								0 0 29 71
159.2			19	SS	120	/15cm							
34.0	Silt, Tr. Sand Grey, Very Dense		20	SS	120	/25cm							0 5 86 9
156.2			21	SS	120	/23cm							
37.0	End of Borehole												

RECORD OF BOREHOLE No 9

1 OF 2 METRIC 110

W.P. 140-87-08 LOCATION Co-ords: N 4 849 510.7 ; E 303 026.9 ORIGINATED BY TS
 DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
 DATUM Geodetic DATE 90 02 19-20 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
193.5	Ground Surface													
0.0	Some Organics		1	SS	10		192							
	Brown		2	SS	22									
	Grey		3	SS	15									
			4	SS	25									
			5	SS	15									
	Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till) Stiff to Hard		6	SS	27									
			7	SS	20									
			8	SS	49									
			9	SS	48									
182.8			10	SS	8									
10.7	Clayey Silt Grey, Stiff to Hard		11	SS	9									
			12	TW	PH									
178.3			13	SS	5									
15.2	Sand, Some Silt Grey, Very Loose		14	SS	3									
172.2			15	SS	44									
21.3	Clayey Silt Grey, Very Stiff to Hard		16	SS	26									
			17	SS	23									
163.0														
30.5														

Continued

+³, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

Continued

RECORD OF BOREHOLE No 9

2 OF 2

METRIC 111

W.P. 140-87-08 LOCATION Co-ords: N 4 849 510.7 : E 303 026.9 ORIGINATED BY TS

DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS

DATUM Geodetic DATE 90 02 19-20 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	20	40	60	80
163.0	Continued		18	SS	23																
30.5																					
159.7																					
33.8																					
	Silt, Tr. Sand Grey, Very Dense		19	SS	120																
			20	SS	120	/18cm															
156.5			21	SS	120	/15cm															
37.0	End of Borehole																				

RECORD OF BOREHOLE No 10

1 OF 1

METRIC 112

W.P. 140-87-08 LOCATION Co-ords: N 4 849 551.2 ; E 303 020.9 ORIGINATED BY TS
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 21 CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20 40 60 80 100										10 20 30		
194.2	Ground Surface																			
0.0	Some Organics ----- Brown Grey Het. mixture of Clayey Silt, Sand and Gravel (Glacial Till) Very Stiff to Hard		1	SS	4		194													
			2	SS	14		192													
			3	SS	21		190													
			4	SS	25		188													
			5	SS	35		186													
			6	SS	32		184													
			7	SS	39		182													
			8	SS	27		180													
			9	SS	27															
			10	SS	30															
182.0																				
12.2	Clayey Silt Grey, Firm to Very Stiff		11	SS	16			182												
			12	SS	8		180													
179.0																				
178.5	Sandy Silt, Grey, Compact		13	SS	13															
15.7	End of Borehole																			

FOUNDATION INVESTIGATION REPORT
For
Proposed Crossing
at
Black Creek Culvert and Jane Street
W.P. 140-87-09, Site 37-1318
Highway 407, District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted at the aforementioned site. It is proposed to replace the existing 4.8 m x 2.1 m x 26 m rigid frame concrete box culvert with a 6 m x 4 m x 61.7 m rigid frame concrete box culvert located along an alignment rotated approximately 18° southwesterly from the existing alignment. The proposed culvert will support the proposed Jane S-407 E Ramp located almost colinear to the existing Jane Street, and the proposed realigned Jane Street. The proposed realigned Jane Street is to be a two lane roadway with a future widening proposal in both directions. The profile grade of the new Jane Street is at approximate elevation 196.1 m and consequently the proposed culvert will have a cover of up to 2.5 m.

SITE DESCRIPTION AND GEOLOGY

The site is located along and immediately west of the existing Black Creek Culvert crossing at Jane Street approximately 1 km north of Steeles Avenue in the Town of Vaughan, Regional Municipality of York. The meandering Black Creek runs its course in westerly direction perpendicular to Jane Street at the site. Upstream and at the eastern boundary of the site exists a cemetery. A man-made water retention pond is located at the western limits of the site. The oval-shaped pond is approximately 35 m long, 20 m wide and 1 to 2 m deep.

The existing Jane Street is a single lane paved roadway with unpaved shoulders. The Black Creek at the site is approximately 2 m wide and 1 m deep. Water

flowing in the creek bed at the time of the investigation was approximately 0.6 m in depth. The creek bed is located at the toe of a slope approximately 3H:1V situated north of the creek on the west side of the site. The height of this slope is approximately 5 m.

The land surrounding the site is occupied by residential homes located at the crest of the slope discussed above and also east of Jane Street, north of the site. The land southwest of the site is vacant and unoccupied.

Physiographically, the site lies in the geological domain known as the Bolton Area, an area that covers approximately 1200 square kilometres located at the northwestern border of the Municipality of Metropolitan Toronto. The Bolton area has drumlins, till plains, moraines, meltwater channels and numerous other features associated with deglaciation. The area was covered with the Wisconsin glacier of the Pleistocene period that advanced into the region approximately 50,000 years ago and retreated approximately 15,000 years ago. The Black Creek, a tributary of the Humber River was formed by the advancement and retreat of the Ontario ice lobe.

The overburden deposits at the site consist of moraine tills of the Halton Till Formation underlain by glaciolacustrine sediments deposited by Lake Peel, a body of water impounded between lobes of projecting ice. The Halton Till is primarily a silt till composed of varying percentages of clay, silt, sand and gravel. The glaciolacustrine deposits generally consist of stratified silt, clayey silt and/or silty clay.

The surficial deposits of the Cenozoic era are underlain by bedrock of the Paleozoic era. Bedrock consists of grey, thinly bedded shales with interbedded limestone from the Dundas Meaford Formation. Bedrock topographical maps reveal that the bedrock exists at depths approximately 70-80 m below the natural ground surface at the site location.

INVESTIGATION PROCEDURES

Field Investigation

The fieldwork for the investigation was carried out between 90 02 12 to 90 02 21 and consisted of 9 sampled boreholes advanced to depths ranging from 15.7 to 36.9 m below the natural ground surface.

Track mounted CME 55 equipment employing hollow stem augering techniques was used to advance the boreholes in the overburden. In general, subsoil samples were retrieved at 0.7 m intervals for the surficial 4.5 m and at 1.5 m intervals thereafter. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). All samples were identified in the field and then returned to the laboratory for applicable testing.

Groundwater levels were obtained by monitoring the levels in the open borehole throughout the duration of the field investigation. All open boreholes were backfilled at the completion of the fieldwork.

Survey information related to the location and elevation of boreholes was provided by Central Region Surveys and Plans.

Laboratory Analyses

To identify the behaviour, gradation and pertinent properties and characteristics of the soil, various laboratory tests were performed. These tests included:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Unit Weights
- 4) Natural Moisture Contents
- 5) Construction Tests

Laboratory test results have been summarized in the subsequent section of this report entitled Subsurface Conditions, and are illustrated on corresponding figures and boreholes included in the attached Appendix.

SUBSURFACE CONDITIONS

The ground surface elevation at the site varies from approximately 192.6 m at the existing Jane Street roadway to approximately 190.4 m located beyond the roadway. The subsoil stratigraphy at the site consists of approximately 1.5 m of brown, compact sand with traces of gravel that comprises the fill material overlying and adjacent to the existing concrete culvert. The fill material is underlain by a till deposit consisting of a heterogeneous mixture of silt to clayey silt, sand, gravel and boulders. The deposit exists surficially beyond the existing culvert west of Jane Street. The upper 1.2-1.8 m is black in colour, an indication of the organics present in the soil. The organic enriched soil is soft and weak. Underlying the organic enriched thickness, the deposit is grey and its consistency/denseness is generally hard/very dense. The behaviour of the main component varies randomly throughout the deposit from a plastic silt to a cohesive clayey silt. The thickness of the deposit is in the order of 7.6 m.

Underlying the till deposit exists a glaciolacustrine cohesive stratum consisting of a clayey silt. The deposit is generally very stiff to hard.

The boundaries between the various soil types, in situ and laboratory test results as well as groundwater levels established at the time of investigation, are shown on the attached Record of Borehole sheets in the Appendix. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 1408709-A.

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

Sand, trace Gravel (Fill Material)

Located as cover on the roof of the concrete box culvert and existing as backfill on the sides of the culvert, a brown sand with a trace of gravel exists. The fill material is brown, compact and moist.

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

A heterogeneous mixture of clayey silt to silt, sand, gravel and boulders underlies the fill material at the existing culvert location, and is present surficially west of the existing culvert. The deposit has a thickness of approximately 7.6 m.

The upper 1.2-1.8 m of the deposit is black and concentrated with some organics. As a result, the material is weak and highly compressible.

Below the upper organic thickness, the deposit is grey and consists of a wide range of grain sizes spanning from fine clay particle sizes to boulders.

Boulders were encountered throughout the deposit as evidenced by auger grinding and refusal witnessed during the boring operation. A grain size distribution envelope for this deposit is provided in Figure 1 in the Appendix. The envelope illustrates that clay and silt percentages range from 15 to 20% and 49 to 62% respectively.

The range of fine grained percentages reflects the varying behaviour of the fine grained portion of the till deposit. Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 2. A summary of the indices is provided in Table 1 below.

Table 1 - Het. Mix. of Clayey Silt/Silt, Sand
Gravel and Boulders (Glacial Till)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	8-10	4
Liquid Limit (W _L %)	16-23	4
Plasticity Index (I _p %)	4-11	4
Unit Weight (kN/m ³)	21.6-22.9	3
SPT 'N' values (blows/0.3 m)	2->120	20

The test results reveal that the fine grained portion of the deposit ranges in behaviour from a plastic silt to a low plasticity clayey silt.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 2-9 blows/0.3 m in the upper organic concentrated material and 20 blows/0.3 m to 120 blows/0.25 m in the lower thickness of the deposit. Based on this data, the organic material can be classified as soft to firm and the lower thickness has a consistency/denseness ranging from v.stiff/compact to hard/v.dense. In general the lower thickness can be considered as hard/v.dense.

Clayey Silt (Lacustrine)

The glacial till deposit is underlain by a glaciolacustrine deposit consisting of a grey clayey silt. The surface of this stratum is generally at an elevation ranging from 183.5 m to 182.8 m. The extent of this stratum was not determined during the investigation.

A grain size distribution envelope for this deposit as determined by mechanical sieve and hydrometer analysis is given in Figure 3 in the Appendix. The envelope illustrates that clay and silt percentages in the deposit range from 44-48% and 47-51% respectively.

Atterberg Limit tests were carried out to define the behaviour and plasticity of the soil and the results are plotted in Figure 4. A summary of the indices is provided in Table 2 below.

Table 2 - Clayey Silt (Lacustrine)

	<u>Range</u>	<u># of Tests</u>
Natural Moisture Content (w%)	16-20	2
Liquid Limit (W_L %)	32-35	2
Plasticity Index (I_p %)	17-18	2
Unit Weight (kN/m^3)	21.4-22.7	3
SPT 'N' values (blows/0.3 m)	7->100	8

The test results reveal that the stratum is of low plasticity and consequently can be categorized as a clayey silt.

Standard Penetration tests carried out in this deposit revealed 'N' values ranging from 7 blows/0.3 m to 100 blows/0.25 m as tabulated in Table 3 indicating a firm to hard consistency. However, in general 'N' values exceed 30 blows/0.3 m and consequently this stratum has a hard consistency.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Groundwater levels determined at the time of investigation ranged from 1 to 3 m below ground surface (Elevation 189.4 to 189.6 m), approximately equal to the stream water level.

Groundwater levels, in general, are subject to seasonal fluctuations and hence can vary from the values given in the report.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of T. Sangiuliano, Foundation Engineer, and B. Chung, Engineering Trainee, utilizing equipment owned and operated by Marathon Drilling and Master Soils Investigation.

The project was carried out by T. Sangiuliano under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by T. Sangiuliano, reviewed by Dr. B. Iyer and approved by Mr. M.S. Devata, Chief Foundation Engineer.

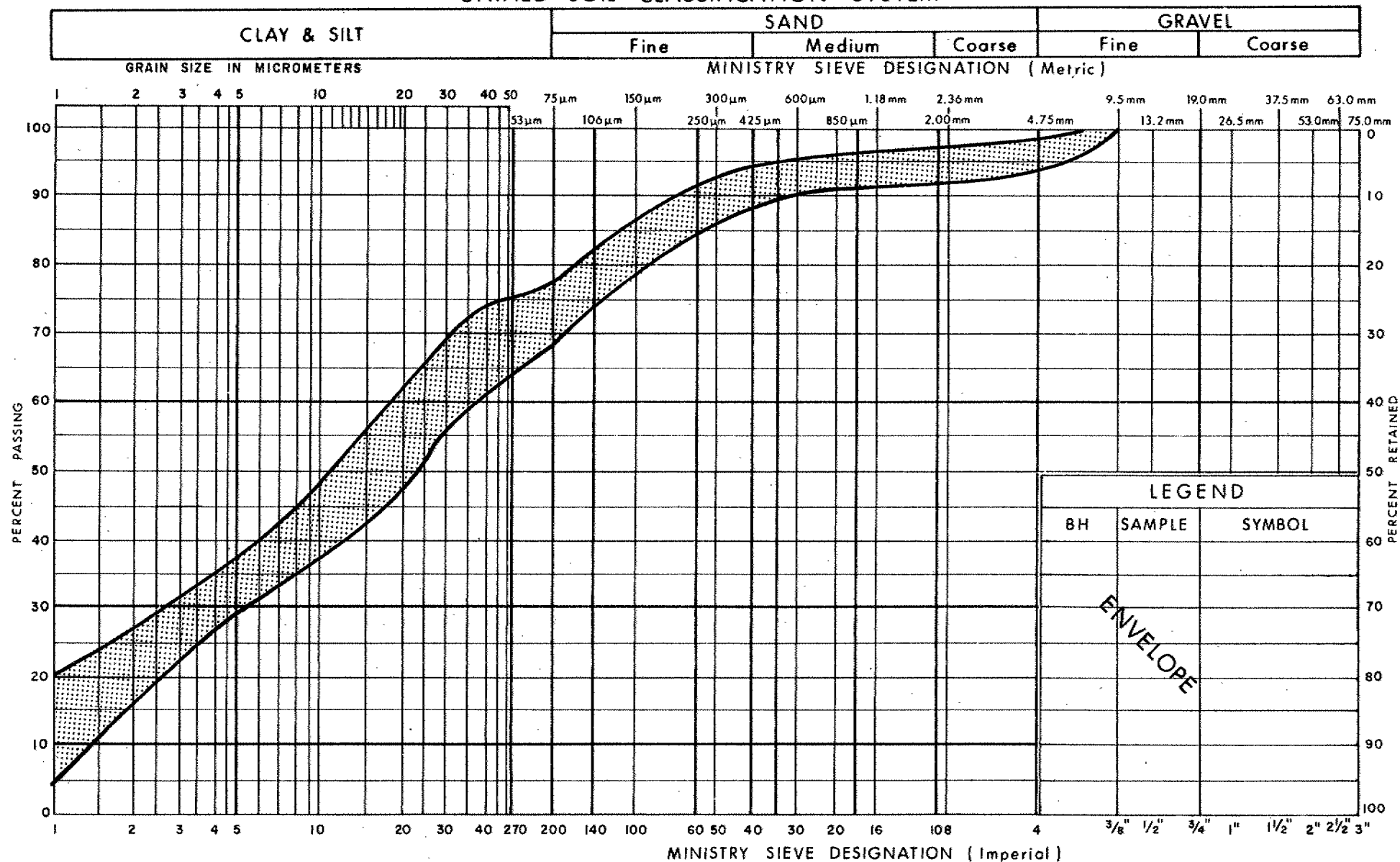


D. Dundas
D. Dundas, P. Eng.
Sr. Foundation Engineer

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

APPENDIX

UNIFIED SOIL CLASSIFICATION SYSTEM

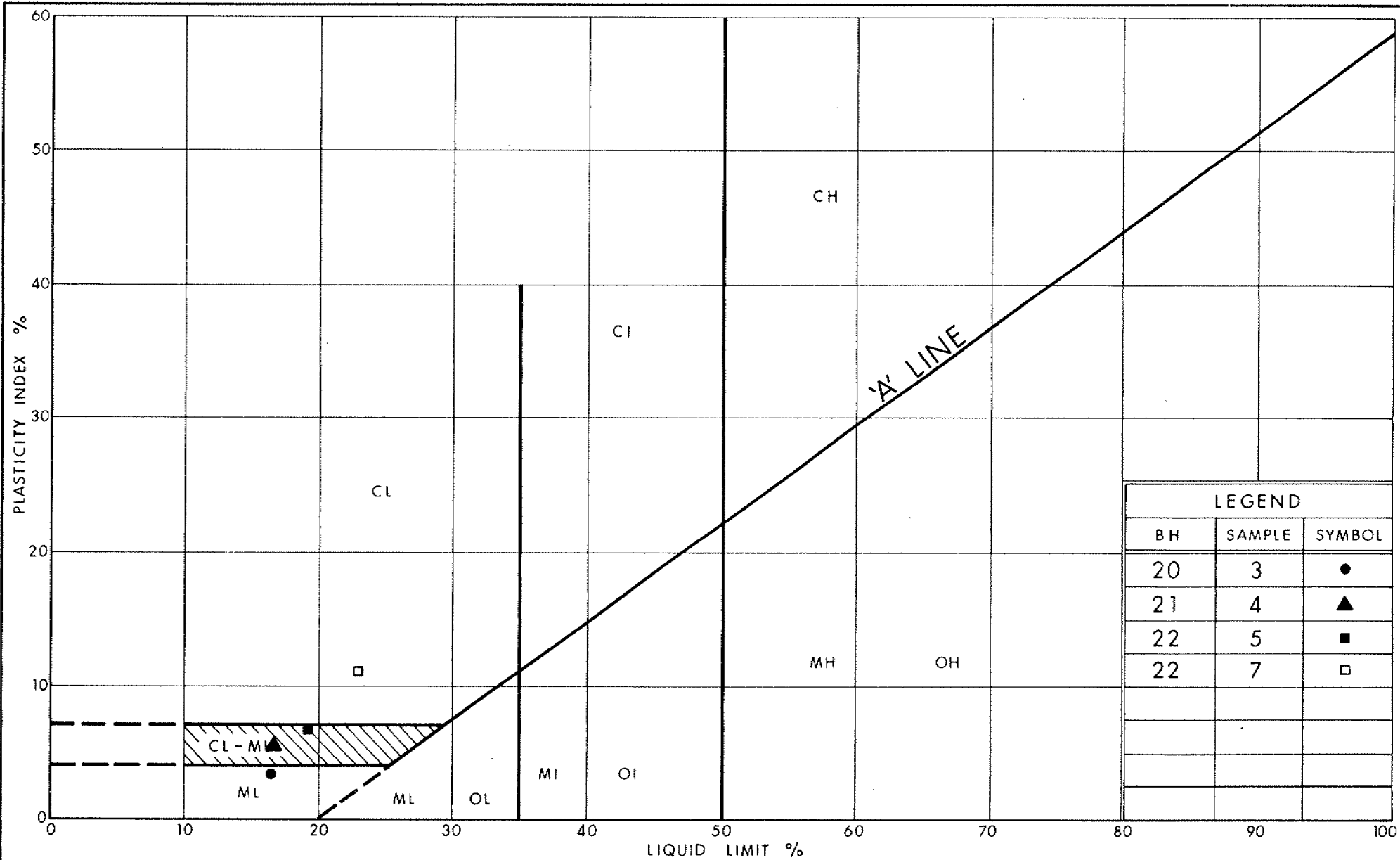


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GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT/SILT, SAND, GRAVEL & BOULDERS
(GLACIAL TILL)

FIG No 1

W P 140-87-09



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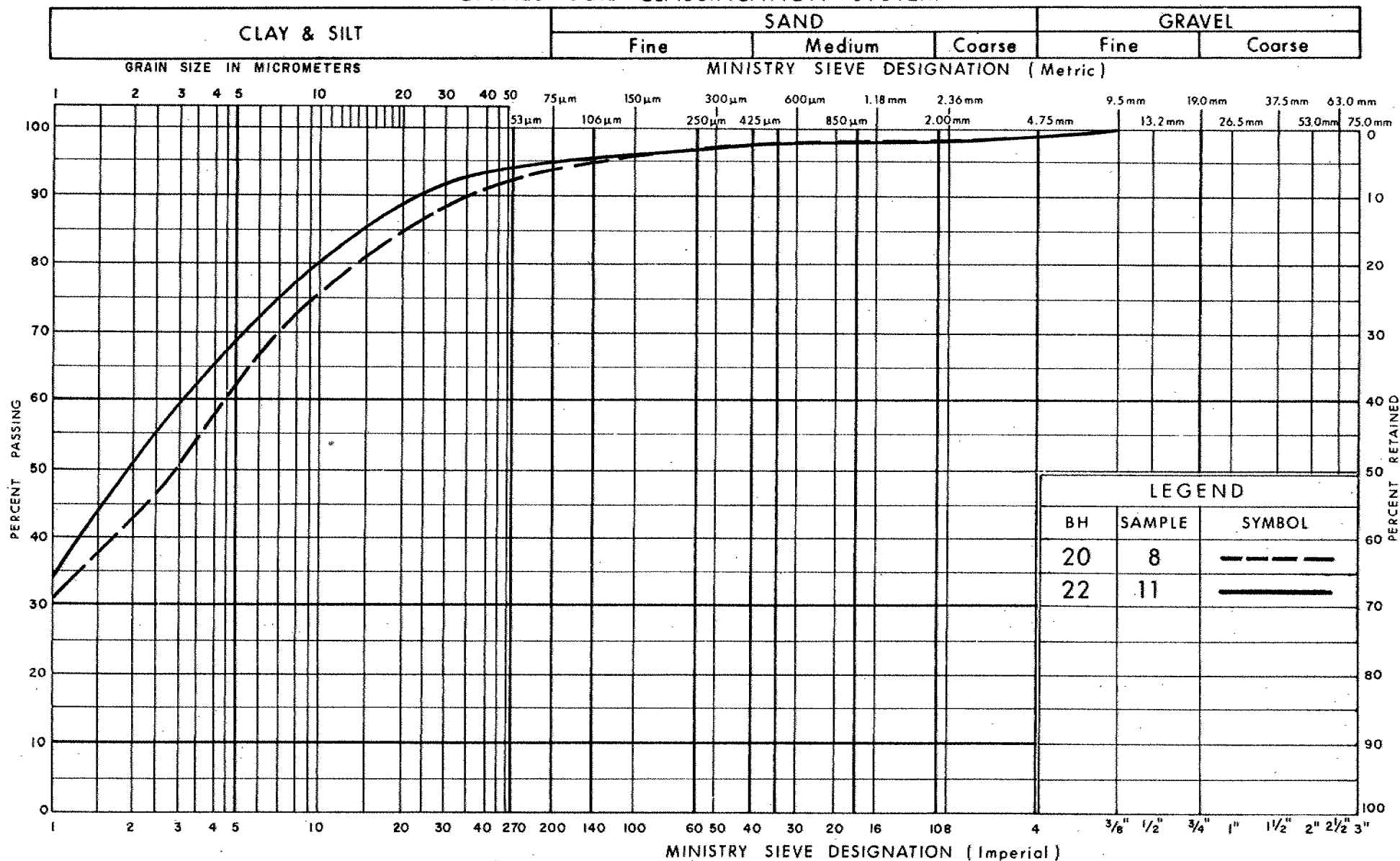
PLASTICITY CHART

HET MIXTURE OF CLAYEY SILT/SILT, SAND, GRAVEL & BOULDERS
(GLACIAL TILL)

FIG No 2

W P 140-87-09

UNIFIED SOIL CLASSIFICATION SYSTEM

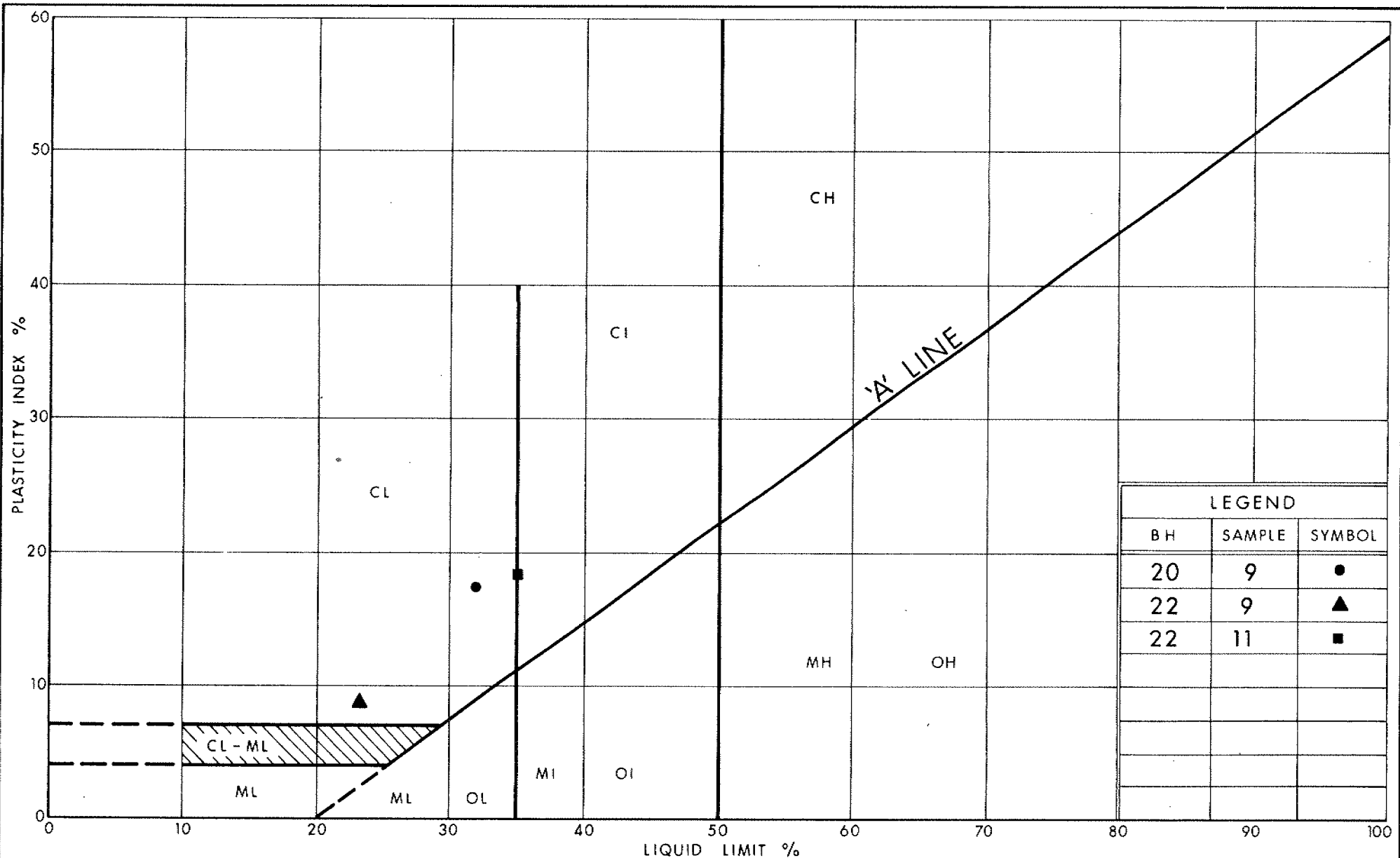


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GRAIN SIZE DISTRIBUTION
CLAYEY SILT
(LACUSTRINE)

FIG No 3

W P 140-87-09



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PLASTICITY CHART CLAYEY SILT (LACUSTRINE)

FIG No 4

W P 140-87-09

RECORD OF BOREHOLE No 20

1 OF 1

METRIC 125

W.P. 140-87-09 LOCATION Co-ords: N 4 849 024.5 : E 302 993.7 ORIGINATED BY BC
DIST 5 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 22 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
190.4	Ground Surface																
0.0	Some Organics Black, Loose ----- Grey		1	SS	6												
			2	SS	100	/20cm											
			3	SS	100	/23cm	188										6 21 54 19
			4	SS	*												
	Het. mixture of Silt, Sand, Gravel and Boulders (Glacial Till)		5	SS	51		186									22.4	
	Grey, Very Dense		6	SS	77												
			7	SS	60		184										
182.8																	
7.6			8	SS	77		182										
	Cloyey Silt (Lacustrine)		9	SS	100	/25cm											0 5 51 44
	Grey, Hard																
			10	SS	70		180									21.4	
177.8			11	SS	91		178										
12.6	End of Borehole * Sampler Bouncing (Probable Boulder)																

RECORD OF BOREHOLE No 21

1 OF 1

METRIC 126

W.P. 140-87-09 LOCATION Co-ords: N 4 849 036 ; E 303 008.7 ORIGINATED BY BC
DIST 6 HWY 407 BOREHOLE TYPE HS Auger COMPILED BY TS
DATUM Geodetic DATE 90 02 21 CHECKED BY TS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
190.6	Ground Surface																
0.0	Some Organics Black, Firm Grey		1	SS	9												
			2	SS	95												
	Het. mixture of Silt/Clayey Silt Sand, Gravel and Boulders (Glacial Till)		3	SS	29												
			4	SS	42												
	Grey, Very Dense/Hard		5	SS	78												
186.3							188									22.9	2 30 49 19
4.3	End of Borehole Auger Refusal (Probable Boulder) *Sampler Bouncing																

RECORD OF BOREHOLE No 22

1 OF 1

METRIC 127

W.P. 140-87-09 LOCATION Co-ords: N 4 849 056.9 ; E 303 036
DIST 5 HWY 407 BOREHOLE TYPE HS Auger
DATUM Geodetic DATE 90 02 22

ORIGINATED BY TS

COMPILED BY TS

CHECKED BY BC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
192.6	Ground Surface													
0.0	Sand, Tr. Gravel Brown, Compact (Fill)													
191.1														
1.5	Some Organics		1	SS	6		190							
	Block		2	SS	4									
	Grey Stiff		3	SS	2									
	Hard		4	SS	20									
			5	SS	70		188						21.6	2 21 62 15
			6	SS	120	/25cm								
	Het. mixture of Clayey Silt, Sand, Gravel and Boulders (Glacial Till)		7	SS	60		186							3 21 50 26
	Occasional Sand Seams													
	Grey, Hard		8	SS	60									
183.5							184							
9.1			9	SS	32								22.1	
	Clayey Silt (Lacustrine)		10	SS	17		182							
	Grey, Very Stiff to Hard		11	SS	23									
							180						20.7	0 5 47 48
178.4			12	SS	50									
14.2	End of Borehole													

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FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT. 93-86

WP 140-87-01 DIST 6
HWY 400 STR SITE 37-1313

Ramp Structure Hwy. 400 N/S-407 E Ramp
(over W-N/S Jane Street Ramp)

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FOUNDATION INVESTIGATION REPORT

For

Ramp Structure Hwy. 400 N/S-407 E Ramp
(over W-N/S Jane Street Ramp)

W.P. 140-87-01, Site 37-1313

District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation conducted west of Jane Street, along the proposed Highway 407 corridor at the above mentioned structure site. This report applies to the proposed structure, its retaining walls and related approaches.

SITE DESCRIPTION AND GEOLOGY

This site is located north of Steeles Avenue, south of Highway 7, west of Jane Street along the proposed Highway 407 corridor in the Township of Vaughan. It is located on land used for agricultural purposes. The terrain surrounding the site is level to undulating.

Physiographically, the region has been described by Chapman and Putman (1973) as the Peel Plain. The Peel Plain is basically a bevelled till plain, containing large amounts of Palaeozoic shale and limestone, and some areas are modified by a veneer of varved clay.

FIELD INVESTIGATION

The fieldwork was carried out during the period from 90 01 31 to 90 02 07 and consisted of ten boreholes, with all of them accompanied by dynamic cone penetration tests. The borings were advanced by hollow stem augers (95 and 83 mm I.D.) using machines mounted on muskeg vehicles.

Sampled boreholes were advanced to depths ranging from 8.1 to 24.8 m below the ground surface. From the surface the cone tests advanced to depths ranging from 2.9 to 7.5 m below the ground surface. In general, subsoil sampling was conducted at 0.7 m intervals for the surficial 6.1 m, at 1.5 m

intervals to 12 m below ground level and at 3 m intervals to 18 m at 6 m intervals to less for the remainder of each borehole. All samples were retrieved using a split spoon sampler in accordance with Standard Penetration Test (ASTM D1586). All samples were identified in the field and again in the laboratory where they were returned for applicable testing.

Groudwater levels were obtained in the open boreholes and monitored until they were backfilled. The boreholes were backfilled either following their completion or at the completion of the investigation. Survey information for the location and elevation of the boreholes was provided by Central Region Surveys and Plans.

LABORATORY ANALYSES

To identify the behaviour, gradation and property of the soil, the following laboratory tests have been conducted:

- 1) Atterberg Limits
- 2) Grain Size Distributions
- 3) Natural Moisture Contents

SUBSURFACE CONDITIONS

General

The elevation of the ground level at the site ranged from 192.2 m at the west end to 193.8 m at the east end. The subsurface conditions at the site consist mainly of 5.2 to 8.8 m (to elevation 183.6) of clayey silt, with sand, trace of gravel The top of which was topsoil. The bottom 5.9 to 2.3 m of this deposit contains layers of sandy silt. Underlying this deposit at El. 190.5 to 183.6 m was a grey clayey silt to silty clay trace of sand which is a lacustrine layer. All of the boreholes ended within this deposit, therefore the stratum was 16 m plus thick.

The plan, location of borings and the subsoil stratigraphical profile are shown on Drawing 1408701-A in the attached Appendix. The boundaries between various soil types, field and laboratory test results as well as ground water levels are plotted on the Record of Borehole sheets also in the Appendix of this report. A description of the soil types encountered are given below.

Clayey Silt, with Sand, trace of Gravel; Till

The glacial till was found from the surface (elevation 192.2 to 193.8) to the top of the clayey silt to silty clay deposit. The deposit consisted of clayey silt, with sand, trace of gravel and ranged in depth from 5.2 to 8.8 m. The upper half was brown in colour, while the lower half which as 2.9 to 3.5 m below ground level was grey with occasional sandy silt layers.

A grain size distribution envelope for the material (excluding the occasional sandy silt layers) 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. They are plotted in Figure 2. A summary of the physical properties of the fine grained portion is provided below:

	<u>Range</u>
Natural Moisture Content (w)	6-20%
Liquid Limit (w_L)	8-29%
Plastic Limit (w_p)	11-18%

The test results indicate a clayey silt of low plasticity.

Grain size distribution tests were carried out on the sandy silt layers that were present 2.9 to 3.5 m below the surface. Figure 3 is the test results in envelope form. Atterberg Limits were also obtained, which indicate that the fine grained portion is a silt of low plasticity, shown in Figure 4. A summary of the physical properties of the fine grained poriton is provided below:

	<u>Range</u>
Natural Moisture Content (w)	7-12%
Liquid Limit (w_L)	14-18%
Plastic Limit (w_p)	12-17%

The 'N' values obtained from the standard penetration tests ranged from 8 to 145. The high values may have resulted from large aggregates such as boulders and cobbles which are characteristic of till deposits. The consistency of the till was found to be stiff to hard.

Clayey Silt to Silt Clay, trace of Sand; Lacustrine

This deposit of clayey silt to silty clay was found underlying the clayey silt till at elevation 183.5/188. All of the boreholes terminated within this lacustrine deposit. The thickness of the deposit is therefore 16 metres plus.

The grain size distribution tests as determined by mechanical analyses for this deposit are given in envelope form in Figure 5. Atterberg Limits were also obtained to evaluate the behaviour of the fine grained portion of the material. They are plotted in Figure 6. A summary of the physical properties of the fine grained portion is provided below:

	<u>Range</u>
Natural Moisture Content (w)	12-28%
Liquid Limit (w_L)	23-79%
Plastic Limit (w_p)	13-18%

The test result therefore indicate a clayey silt to silty clay of low to intermediate plasticity, trace of sand.

The 'N' values obtained from the standard penetration tests ranged from 16 to 139. Typical 'N' values ranged however from 22 to 65. The high values may have resulted from large aggregates such as boulders and cobbles. The consistency of the till was found to be very stiff to hard.

GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. These observations are recorded on the Record of Borehole sheets as well as on Drawing 1408701-A in the Appendix. Measurements obtained at the time of the investigation revealed the following water levels.

<u>Borehole</u>	<u>Elevation (m)</u>
40	184.3*
41	185.0*
42	185.5
43	184.6
44	192.8
45	184.5 (not stabilized)
46	183.1*
47	190.9
48	191.3
49	192.6

*Note water level not stabilized.

The boreholes indicate the ground water level to be in general about 0.6 m below the ground surface at approximate elevation 192.8 m. It should be noted that groundwater levels are subject to seasonal fluctuations and may therefore vary from the values given in this report.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a single span rigid frame parallel to the lower ramp with retaining walls at the acute corners. The proposed clear span is about 11.5 m. A grade raise of approximately 4 to 7 m is needed to reach the proposed pavement grade at elevation 197 m \pm . A cut of approximately 2 m is required under the structure or for the W-N/S Jane Street Ramp proposed pavement grade at approximate elevation 191 m.

The following itemizes our recommendations for:

- 1) structure foundation
- 2) lateral earth pressures on abutments/retaining walls
- 3) approach fills
- 4) construction considerations

Structure Foundations

The proposed structure may be founded on spread footings.

Spread Footings

1. The proposed structure may be supported on spread footings at or below elevation 190 m. For the purposes of the O.H.B.D.C. the following design values are recommended.

Factored Capacity at U.L.S. 450 kPa

Bearing Capacity at S.L.S. Type II 300 kPa

In any localized weak zones are encountered during construction (east end, south wall) they should be subexcavated to their full extent and replaced with well compacted Granular 'A'.

Lean concrete (150 mm) should be placed within 4 hours of completion of excavation so as to guard against softening of the foundation material from weathering and seepage effects.

2. The proposed north and south abutments may also be supported on spread footings above elevation 190 m. For this alternative a section along the footings should be subexcavated to 190 m. The dimension of the subexcavations should be large enough to allow for the surface of the granular pad to be 1.0 m longer and 1.0 m wider than the footings as per attached Figure 1. If any localized weak zones are encountered during construction (east end, south wall) they should be subexcavated to their full extent and replaced with well compacted Granular 'A'. The ground should then be compacted, and a minimum of 0.6 m of compacted Granular 'A' placed in 0.3 m lifts, immediately after, so as to guard against softening of the foundation material. The remainder of the pad should be constructed with Granular 'A' fill as illustrated in Figure 1.

For the purposes of the O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S.	450 kPa
Bearing Capacity at S.L.S. Type II	300 kPa

It is anticipated that settlements induced within the proposed footing locations should not exceed 25 mm. If greater settlements can be tolerated the bearing capacity can be increased.

The underside of the footings should be provided with a minimum of 1.2 m earth cover for frost protection.

Sliding resistance between the concrete footing and the foundation soil should be calculated in accordance with Section 6.7.3.3.2 of the O.H.B.D.C. assuming the factored coefficient of the friction to be 0.45.

Lateral Earth Pressures on Abutments/Retaining Walls

To prevent hydrostatic pressure build-up backfill to abutments and retaining walls should consist of Granular 'A' or Granular 'B' in accordance with Ministry of Transportation Standards.

Lateral earth pressures should be computed in accordance with Section 6.6.1.2.1 of the O.H.B.D.C.. The active condition (K_a) will govern earth pressure design of the structure is yielding while the 'at rest' condition (K_o) will govern for an unyielding structure. The following parameters are provided for earth pressure computation.

	ϕ	γ	K_a	K_o
Granular 'A'	35°	22.8 kN/m ³	0.27	0.43
Granular 'B'	30°	21.2 kN/m ³	0.33	0.50

Note: The earth pressure coefficients apply to horizontal backfill only. Appropriate considerations should be given to account for sloping surface backfill.

Approach Embankments

Due to the competent nature of the natural soil, no deep-seated failures are anticipated through the foundation soils, for an effective height up to 7 m. Topsoil and surficial material should be removed prior to placing any fill. The fill should consist of well compacted acceptable material. Embankments should have side and forward slopes no steeper than 2H:1V designed and constructed in accordance with the appropriate Ministry Standards.

Total settlement of the fill and the foundation soil should be in the order of 25 to 35 mm. Most of this will be elastic compression and will have occurred immediately after completion of construction.

Construction Concerns

The following comments may be concern during construction:

1. The proposed grade line for W-N/S Jane Street Ramp is below the existing water level.
2. Subexcavation for the footings or pile caps if below elevation 192.6 m will require dewatering, since concrete should be placed in the 'dry'.

Due to the above comments it may be desirable to carry out the excavation for the W-N/S Jane Street Ramp prior to construction of the footings if the construction schedule permits. A pilot trench with conventional sump pumping techniques may be utilized at the footing locations to drain the subexcavation.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of P. Marks, Foundation Engineer and Bill Cung, Engineer Trainee. The equipment was owned and operated by Marathon Drilling Co. Ltd. and Master Soils Investigations.

The project was carried out by P. Marks under the general supervision of Dr. B. Iyer, Senior Foundation Engineer. The report was written by P. Marks, reviewed by Dr. B. Iyer and approved by M.S. Devata, Chief Foundation Engineer.



B. Iyer

Dr. B. Iyer, P.Eng.
Senior Foundation Engineer

M.S. Devata

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

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

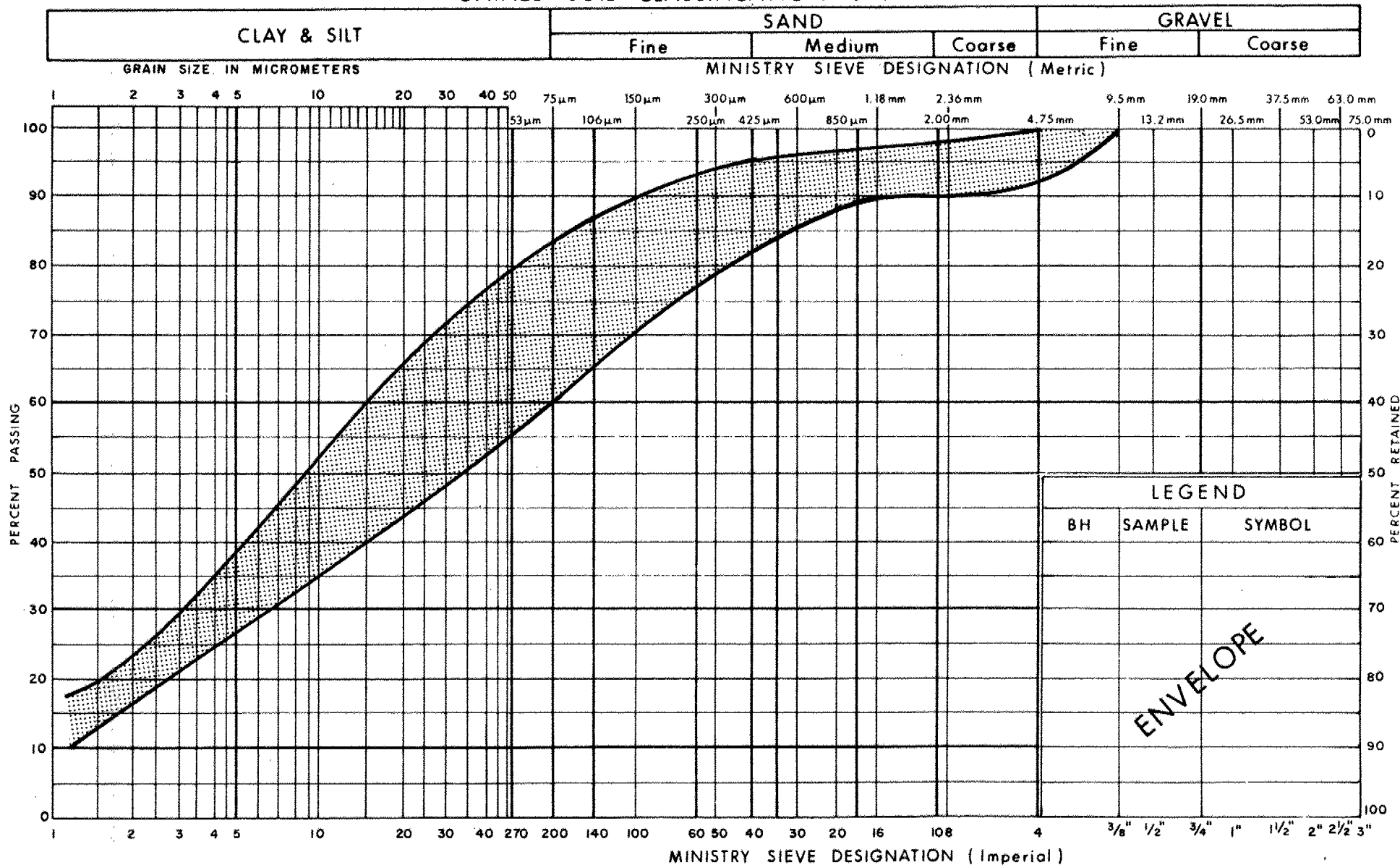
MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_f	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

UNIFIED SOIL CLASSIFICATION SYSTEM

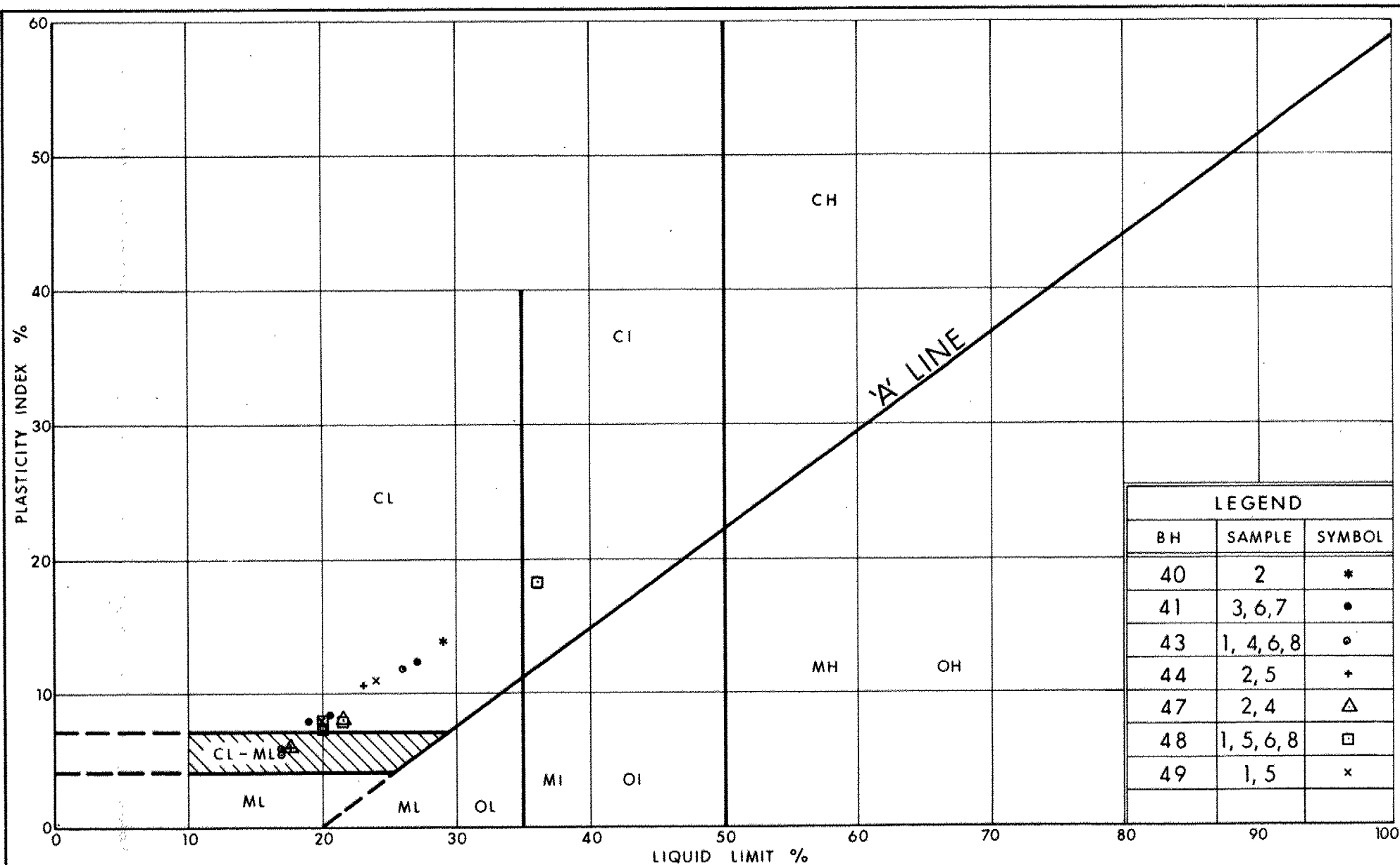


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GRAIN SIZE DISTRIBUTION
CLAYEY SILT,
WITH SAND, TRACE OF GRAVEL (TILL)

FIG No 1

W P 140-87-01



Ontario

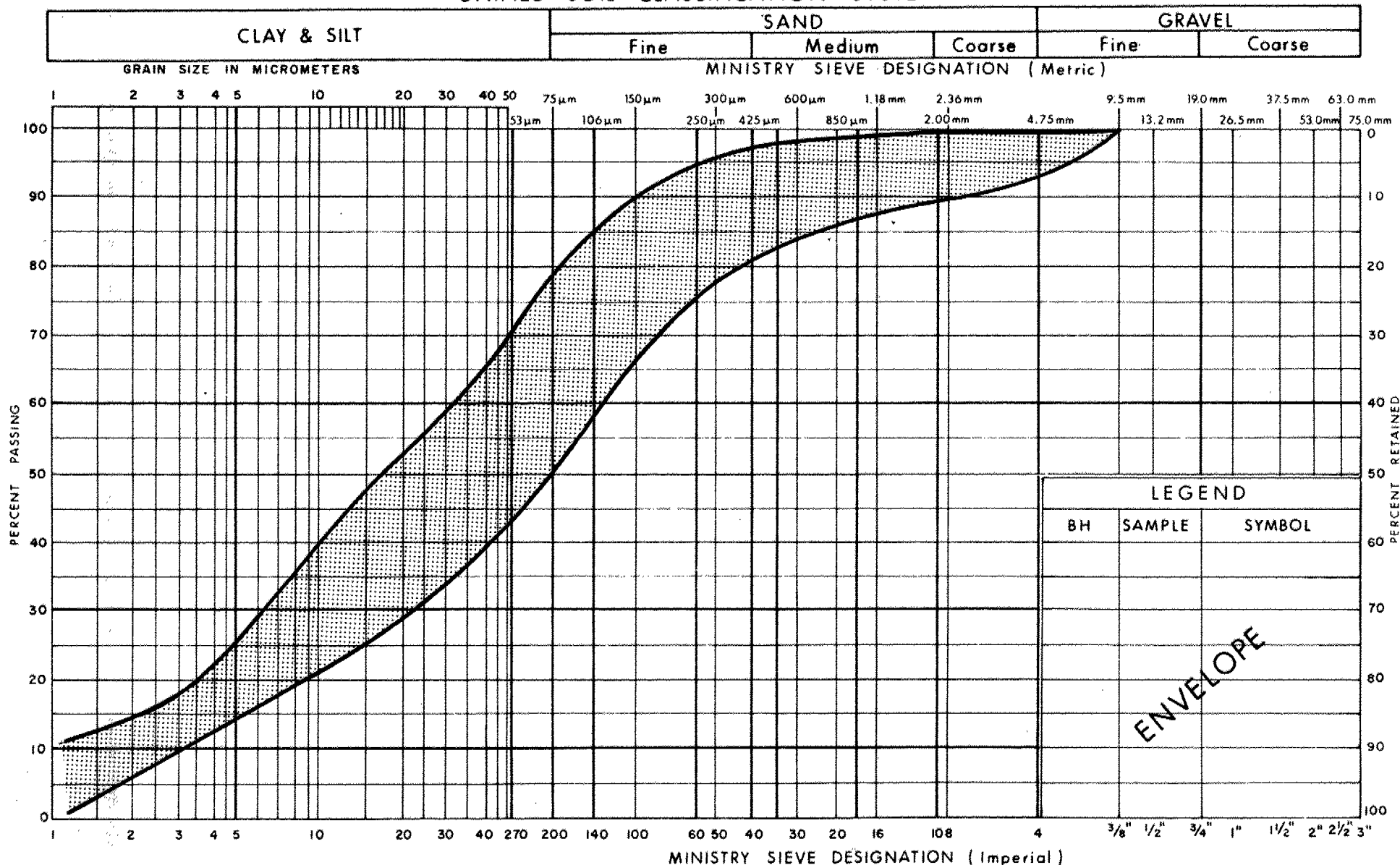
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PLASTICITY CHART CLAYEY SILT, WITH SAND, TRACE OF GRAVEL (TILL)

FIG No 2

W P 140-87-01

UNIFIED SOIL CLASSIFICATION SYSTEM



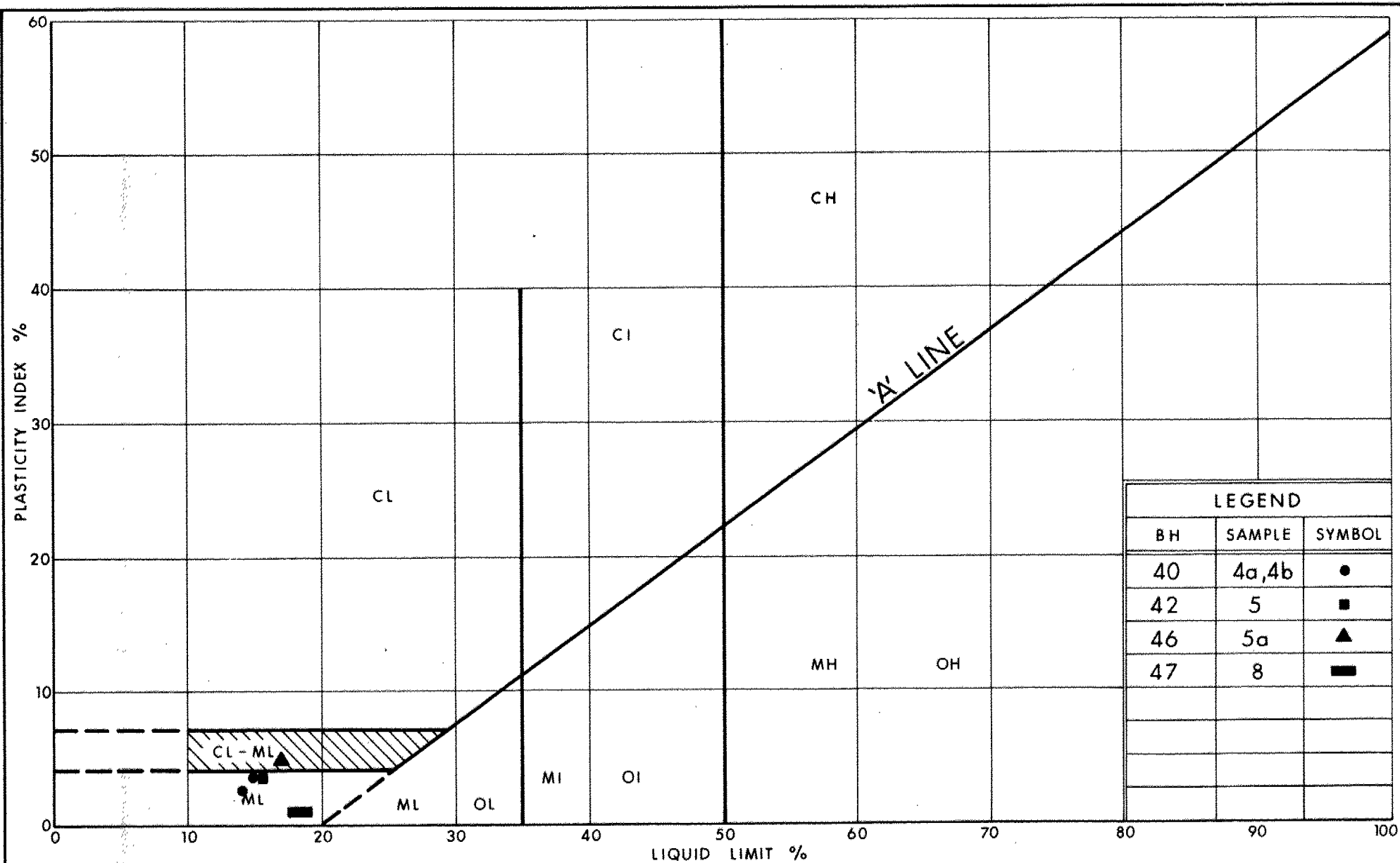
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GRAIN SIZE DISTRIBUTION

OCCASIONAL SANDY SILT LAYERS

FIG No 3

W P 140-87-01



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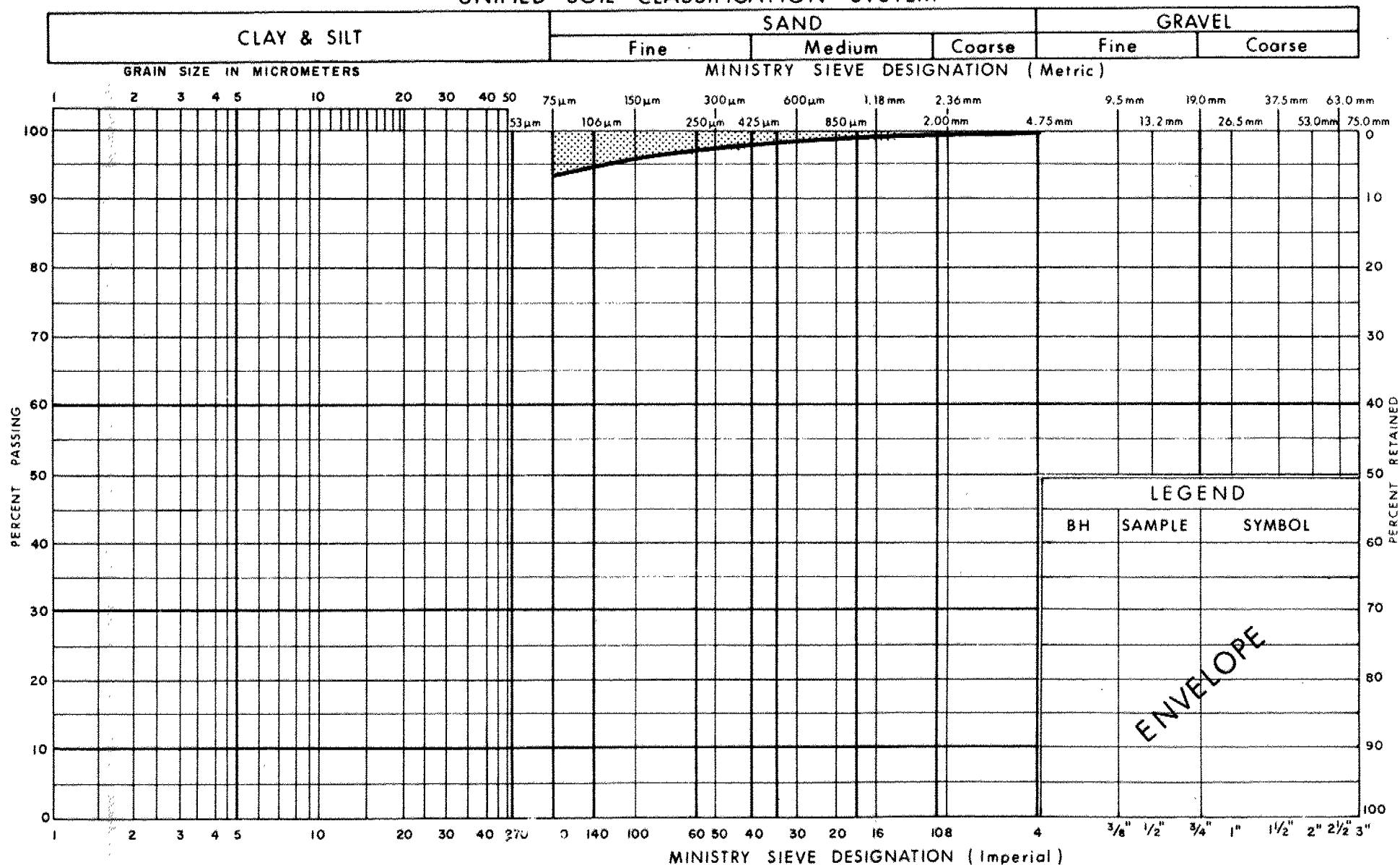
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PLASTICITY CHART SANDY SILT LAYERS

FIG No 4

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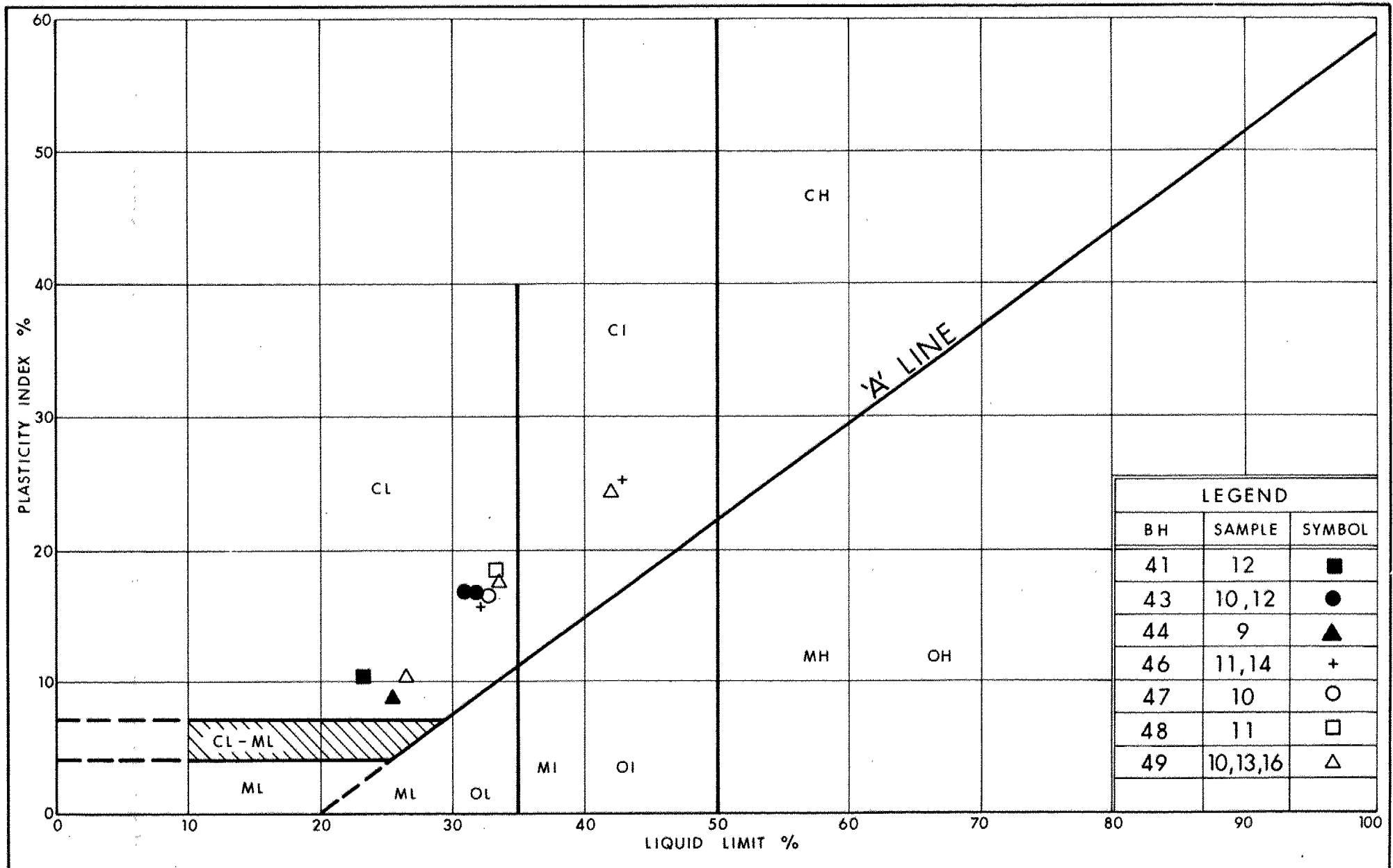
UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of
Transportation

GRAIN SIZE DISTRIBUTION
CLAYEY SILT TO SILTY CLAY,
TRACE OF SAND

FIG No 5

W P 140-87-01



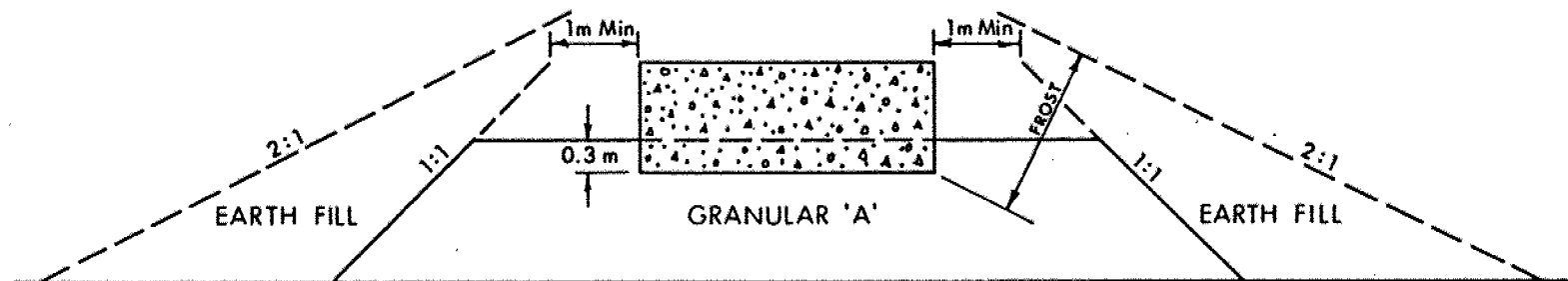
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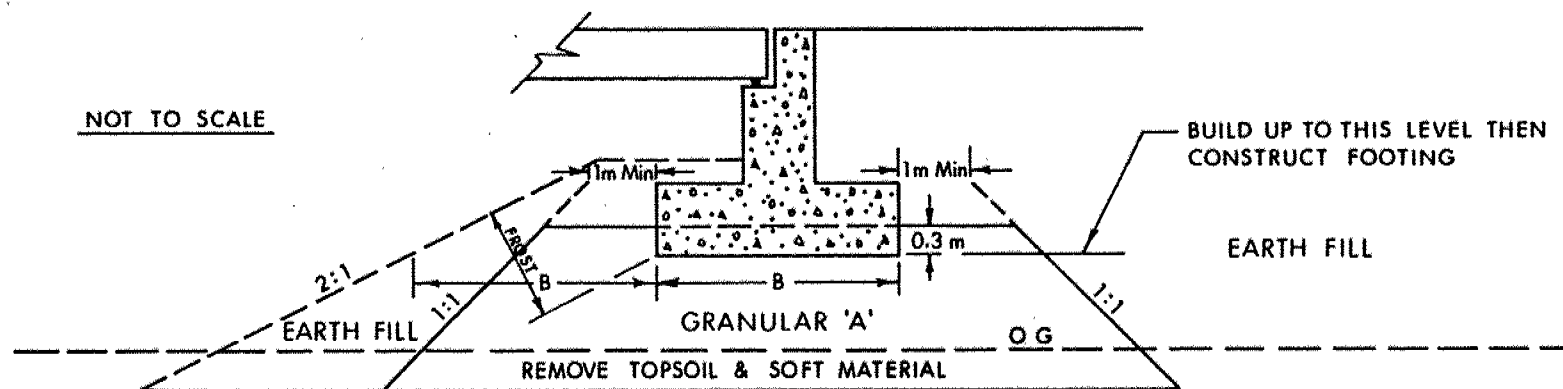
PLASTICITY CHART CLAYEY SILT TO SILTY CLAY TRACE OF SAND

FIG No 6

W P 140-87-01



X SECTION



LONGITUDINAL SECTION

NOTES:

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



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Transportation

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 7

W P 140-87-01

RECORD OF BOREHOLE No 40

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ord: N 4849133 ; E 302414 ORIGINATED BY P.M.
DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-06 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
192.5	Ground Level							SHEAR STRENGTH kPa						
								o UNCONFINED + FIELD VANE						
								• QUICK TRIAXIAL x LAB VANE						
								20	40	60	80	100		
								WATER CONTENT (%)						
								w _p — w — w _L						
								20 40 60						
0.0	Topsoil							FROZEN						
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	19									1 18 (81)
			2	SS	21									
			3	SS	29									
	brown		4	SS	47									4 39 47 10
	grey		5	SS	52									
	occasional sandy silt layers		6	SS	63									
186.6	Very Stiff to Hard		7	SS	47									
5.9			8	SS	35									
	CLAYEY SILT to SILTY CLAY		9	SS	22									
	Trace of Sand		10	SS	58									
	Occasional thin silt layers													
	(Lacustrine)		11	SS	64									
	Hard													
179.9			12	SS	65									
12.6	End of Borehole													
	• Water Level Not Stabilized													

RECORD OF BOREHOLE No 41

1 OF 1 METRIC

W.P. 140-87-01 LOCATION Co-ord: N 4849134 ; E 302446 ORIGINATED BY P.M.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-02-02 to 90-02-05 CHECKED BY P.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20						40	60	80	100	20
192.5	Ground Level																	
0.0	Topsail																	
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	18													
			2	SS	14													
			3	SS	23													
	brown		4	SS	44													
	grey		5	SS	35													
	occasional sandy silt layers		6	SS	30													
			7	SS	62													
			8	SS	47													
185.5	Very Stiff to Hard																	
7.0	CLAYEY SILT to SILTY CLAY		9	SS	45													
	Trace of Sand		10	SS	35													
	Occasional thin silt layers (Lacustrine)		11	SS	53													
180.0	Hard		12	SS	29													
12.6	End of Borehole																	
	- Water Level Not Stabilized																	

RECORD OF BOREHOLE No 42

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ord: N 4849135 ; E 302476 ORIGINATED BY P.M.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-02-05 to 90-02-05 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
192.8	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	15									
			2	SS	12									
			3	SS	21									
	brown		4	SS	38									
	gray		5	SS	80									
	occasional sandy silt layers		6	SS	97									
187.6	Stiff to Hard		7	SS	60									
5.2	CLAYEY SILT To SILTY CLAY		8	SS	53									
	Some Sand		9	SS	48									
	Occasional thin silt layers (Lacustrine)		10	SS	60									
183.2	Hard													
9.5	End of Borehole													
	• Water Level Not Stabilized													

RECORD OF BOREHOLE No 43

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ord: N 4849136 ; E 302505 ORIGINATED BY P.M.
 DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
 DATUM Geodetic DATE 90-02-01 to 90-02-02 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
193.4	Ground Level													
0.0	Topsoil													
	CLAYEY SILT With Sand, Trace of Gravel (Till)		1	SS	12		192							2 31 (67)
			2	SS	14									
			3	SS	11									
	brown		4	SS	8		190							3 30 (67)
	grey		5	SS	46									3 31 52 14
	Occasional sandy silt layers		6	SS	99									4 26 (70)
			7	SS	33		188							
186.7	Stiff to Hard		8	SS	34									1 18 60 21
6.7							186							
	CLAYEY SILT to SILTY CLAY		9	SS	21									
	Some Sand		10	SS	33		184							
	Occasional thin silt layers (Locustrine)		11	SS	44									0 6 (94)
	Hard						182							
180.8			12	SS	49									
12.6	End of Borehole													

RECORD OF BOREHOLE No 44

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ord: N 4849137 ; E 302534 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-01-31 to 90-02-01 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
193.8	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (TH)		1	SS	18									4 35 (61)
			2	SS	16									
			3	SS	21									
	brown		4	SS	14									
	grey		5	SS	32									7 22 (71)
	Occasional sandy silt layers		6	SS	33									
	Very Stiff to Hard		7	SS	39									1 14 (85)
188.8			8	SS	42									
5.8	CLAYEY SILT to SILTY CLAY Trace of Sand													
	Occasional thin silt layers (Locustrine)		9	SS	43									
185.4	Hard													
8.4	End of Borehole													

RECORD OF BOREHOLE No 45

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ord: N 4849120 ; E 302380 ORIGINATED BY B.C.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (S.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-07 CHECKED BY P.M.

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			20	40	60	80	100	w _p	w	w _L		
191.5	Ground Surface																
0.0	Topsoil																
	CLAYEY SILT, With Sand, Trace of Gravel (Glacial Till)		1	SS	16												
			2	SS	28												
	brown		3	SS	38												
	grey		4	SS	133												
	Occasional sandy silt layers		5	SS	145												
			6	SS	120	/18cm											
185.6	Very Stiff to Hard		7	SS	120	/18cm											
5.9	CLAYEY SILT to SILTY CLAY, Trace of Sand (Lacustrine) Hard		8	SS	114												
183.4			9	SS	75												
8.1	End of Borehole																
	• Water Level Not Stabilized																

RECORD OF BOREHOLE No 46

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ords: N4 849 121 ; E 302 414 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-05 to 90-02-06 CHECKED BY P.M.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100	20 40 60 80 100					
192.2	Ground Level												
0.0	Topsoil					192							
	CLAYEY SILT With Sand, Trace of Gravel (Till)		1	SS	8								
			2	SS	12								
	brown		3	SS	20								3 18 66 13
	grey		4	SS	42								3 18 66 13
	Occasional sandy silt layers		5	SS	48								2 34 (64)
			6	SS	97								
	Stiff to Hard		7	SS	118								
6.2			8	SS	86								2 35 53 10
			9	SS	32								
183.5													
8.7	CLAYEY SILT to SILTY CLAY		10	SS	55								
	Trace of Sand												
	Occasional thin silt layers		11	SS	41								1 4 (95)
12.5	(Lacustrine)												
	Very Stiff to Hard		12	SS	28								
			13	SS	17								
			14	SS	18								0 0 (100)
167.4													
24.8	End of Borehole		15	SS	23								
	* Water Level Not Stabilized												

RECORD OF BOREHOLE No 47

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ords: N4 849 122.0; E302 446 ORIGINATED BY P.M.
DIST 5 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-05 to 90-02-06 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
192.4	Ground Level																
0.0	Topsoil																
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	21												3 35 46 16
			2	SS	28												
	--- brown ---		3	SS	40												
	grey		4	SS	76												
	Occasional sandy silt layers		5	SS	65												
			6	SS	127												0 23 64 13
			7	SS	98												
	Very Stiff to Hard		8	SS	118												
185.1																	
7.3	CLAYEY SILT to SILTY CLAY		9	SS	65												
	Trace of Sand (Locustrine)																
182.8	Hard		10	SS	139												1 5 (94)
9.6	End of Borehole																

RECORD OF BOREHOLE No 48

1 OF 1

METRIC

W.P. 140-87-01 LOCATION Co-ords: N4 849 123 : E 302 478 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-02-01 to 90-02-05 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
192.7	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	26									2 26 53 19
			2	SS	23									
	brown		3	SS	31									
	grey		4	SS	86		190							6 39 43 12
	Occasional sandy silt layers		5	SS	49									
			6	SS	54		188							1 21 (78)
			7	SS	69									
			8	SS	61		186							
184.6	Very Stiff to Hard		9	SS	79									
8.1	CLAYEY SILT to SILTY CLAY						184							
	Trace of Sand		10	SS	98									
181.9	(Lacustrine) Hard													
			11	SS	103		182							1 4 (95)
10.8	End of Borehole													

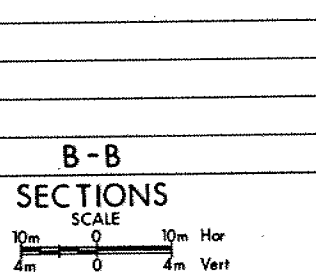
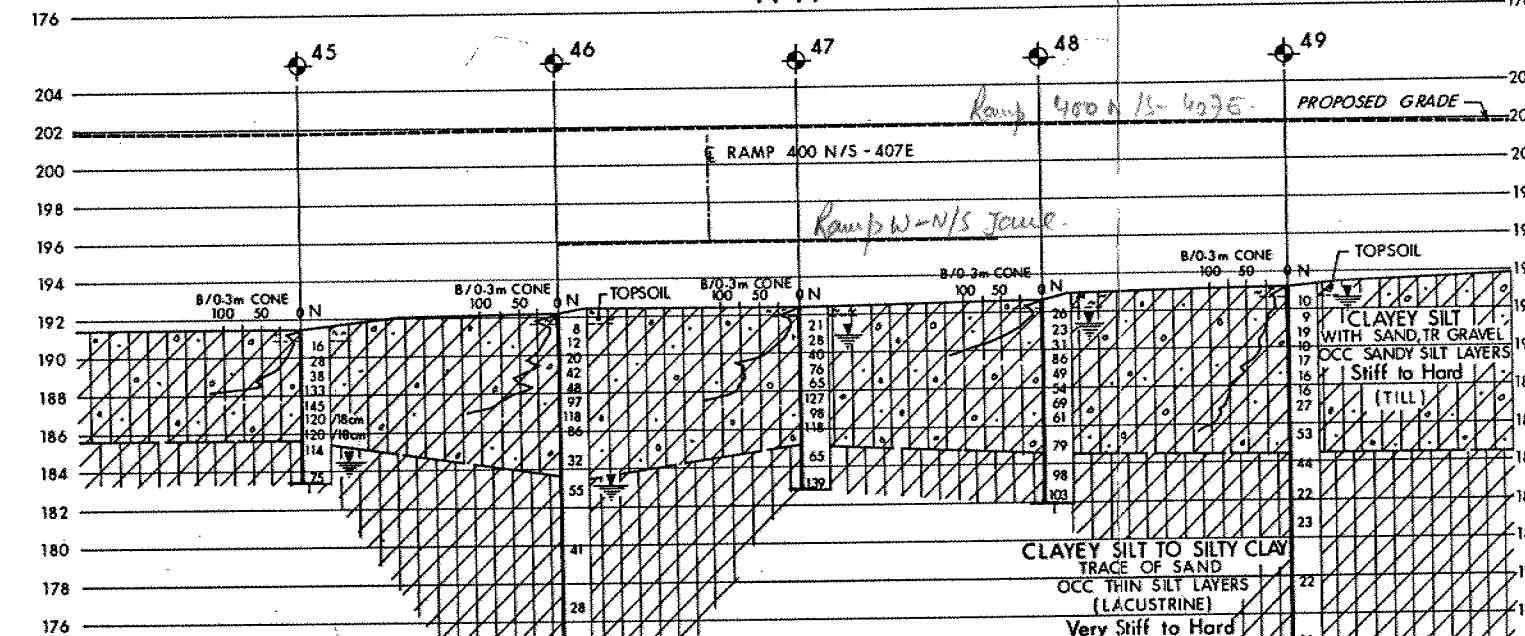
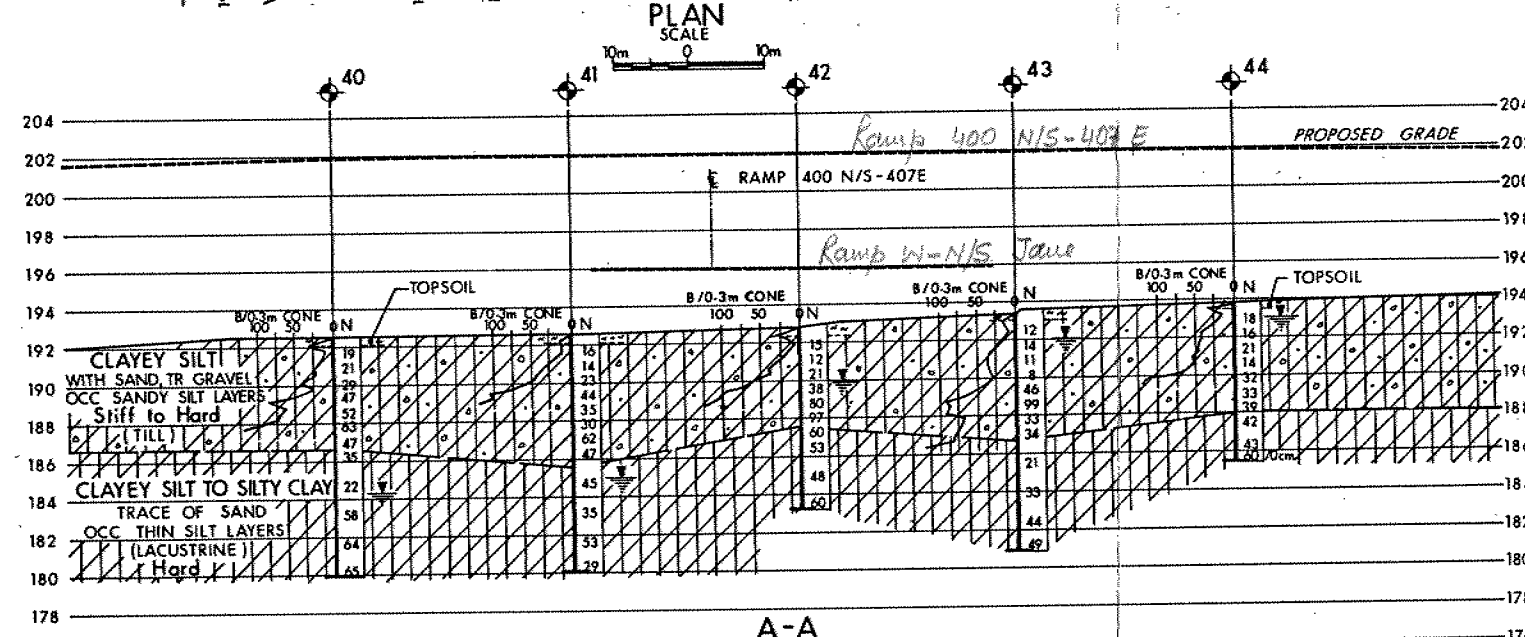
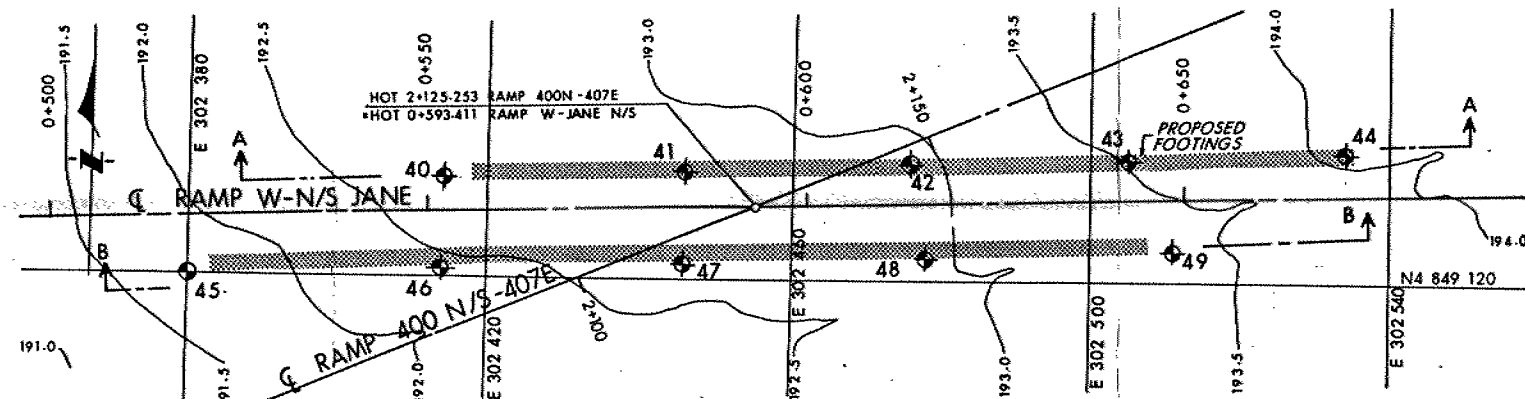
RECORD OF BOREHOLE No 49

1 OF 1

METRIC

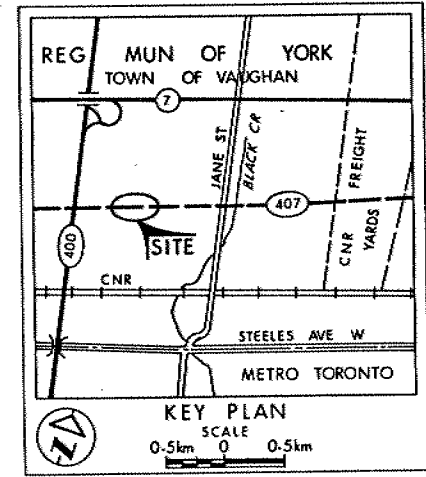
W.P. 140-87-01 LOCATION Co-ords: N 4 849 124 ; E 302 511 ORIGINATED BY P.M.
DIST 6 HWY 407 BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY P.M.
DATUM Geodetic DATE 90-01-31 to 90-02-01 CHECKED BY P.M.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT 7 kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
193.2	Ground Level													
0.0	Topsoil													
	CLAYEY SILT, With Sand, Trace of Gravel (Till)		1	SS	10									5 32 (63)
			2	SS	9									
	brown		3	SS	19									
	grey		4	SS	10									
			5	SS	17									5 21 (74)
	Occasional sandy silt layers		6	SS	16									
			7	SS	16									
			8	SS	27									
			9	SS	53									
184.4	Stiff to Hard													
8.8			10	SS	44									0 5 (95)
	CLAYEY SILT to SILTY CLAY		11	SS	22									
	Trace of Sand		12	SS	23									
			13	SS	22									0 0 (100)
	Occasional thin layers of silt (Lacustrine)		14	SS	16									
			15	SS	19									
	Very Stiff to Hard													
168.4			16	SS	25									0 0 (100)
24.8	End of Borehole													



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

CONT No WP No 140-87-01	 SHEET
HWY 400 N/S - 407 E RAMP OVER W-N/S JANE ST RAMP (EASTBOUND BASKETWEAVE) 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 90 01 and 90 02		

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
40	192.5	4 849 133.0	302 414.0
41	192.6	4 849 134.0	302 446.0
42	192.8	4 849 135.0	302 476.0
43	193.4	4 849 136.0	302 505.0
44	193.8	4 849 137.0	302 534.0
45	191.5	4 849 120.0	302 380.0
46	192.2	4 849 121.0	302 414.0
47	192.4	4 849 122.0	302 446.0
48	192.7	4 849 123.0	302 478.0
49	193.2	4 849 124.0	302 511.0

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

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

REV.	DATE	BY	DESCRIPTION

Geocres No 30M13-110

HWY No 407	DATE 90 08 09	DIST 6
SUBM'D PM [CHECKED]	SITE 37-1313	
DRAWN DT [CHECKED]	APPROVED	DWG 1408701-A

memorandum



To: V. Boehnke
Head, Structural Section
Central Region

Date: 1991 12 16

Attn: R.A. Jeffries

From: Foundation Design Section
Room 315, Central Bldg.

Re: Channel Excavations - Humber Flood Plain
Hwy. 407 - Humber River Crossing
W.P. 140-87-01 ✓
District 6, Toronto

We have completed our review of your submission related to the proposed excavations for the following channels and ponds:

- Fish Ponds and Channel
- Jersey Creek Channel
- Rainbow Channel
- Drain Channel

The invert elevations of these channels and ponds are up to 3 to 4 m below existing grade and some of these excavations are located relatively close to the proposed approach embankments of Hwy. 407.

STABILITY ANALYSES

To evaluate the overall stability of the embankment together with the proposed channel excavations, stability analyses were carried out for the following conditions:

1. Short term condition, using undrained shear strength parameters and artesian water pressures.
2. Long term condition, using "equivalent" undrained shear strength parameters (estimated using applicable effective shear strength parameters for subsoils together with long term groundwater conditions).

Based on the above analyses, it is recommended that a minimum 10 m wide bench should be incorporated between the toe of the approach embankment and the crest of the excavation for the channels and ponds.

.../2

CONSTRUCTION CONSIDERATIONS

It should be brought to the attention of the Contractor that the excavations discussed in this memo are to be carried out in the Humber Flood Plain Area. Further, some of the buried aquifers posses artesian water pressures rising to several meters above existing ground surface. There is a potential for basal heave to occur at some of these excavations, depending upon the type of soil strata and groundwater conditions encountered at those locations.

CLOSING REMARKS

Based on the results of the analyses carried out, all excavations should be located at least 10 m away from the toe of an 8 m high embankment built with a 2H to 1V slope.

An NSSP should be included in the contract package to handle potential problems associated with basal heave during excavations.

Please call this office if you want further elaboration on items covered in this memo. We would be pleased to assist you in the preparation of the NSSP mentioned above.



Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

BI/jb

cc: W. Lankinen
G. Cautillo/L. Crowder
W. Lachmaniuk - Giffels

memorandum



To: V. Boehnke
Head, Structural Section
Central Region

Attn: N. Garland

From: Foundation Design Section
Room 315, Central Bldg.

Re: Hwy. 407 - Jane St. Interchange
South Basketweave Structure
W.P. 140-87-01, Site 37-1313
District 6, Toronto

Date: 1991 08 16

We have reviewed the final design drawings submitted to our office on 91 07 09. We have the following general comments.

The underside of footings are shown at elevation 189.3 and 189.15 m. As per comments given in the Foundation Report, such excavations would extend below the groundwater level and would therefore require advance dewatering. Please refer to the Foundation Report regarding comments made in this regard.

We have no further comments. We regret any inconvenience caused due to the delay in forwarding our comments.



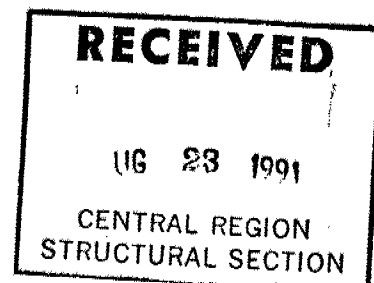
Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

7095

BI/me

Add Tender Item: 0902-0030 Dewatering Structure ?
Excavation

Add 1559P ?



memorandum



To: V. Boehnke
Head, Structural Section
Central Region

Date: 1990 06 29

Attn: N. Garland

From: Foundation Design Section
Room 315, Central Building

Re: Foundation Investigation Report
Ramp Structure Hwy. 400 N/S - 407 E Ramp
W.P. 140-87-01, Site 37-1313
District 6, Toronto

As discussed earlier today , please find herewith enclosed, a copy of our final report on the above project. The drawings and figures for this report are being drafted and will be included in our final submission of the foundation report for this project.

It is considered that the two retaining walls may be replaced by other types of walls, such as reinforced earth wall. If this option is favoured, based on economical and/or other considerations, we would appreciate the opportunity to review the proposed designs. No specific mention to the above options is made in our report.

We trust that the attached report, together with this memo, contains adequate information for your design needs.

A handwritten signature in cursive script, appearing to read "B. Iyer", with a horizontal line underneath.

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

BI/lh

memorandum



To: V. Boehnke
Head, Structural Section
Central Region

Date: 1990 03 16

Attn: N. Garland, Inter. Structural Engineer

From: Foundation Design Section
Room 315, Central Building

RE: Highway 400 N/S - 407 E Ramp over W-N/S
Jane Street Ramp (Eastbound Weave)
W.P. 140-87-01, Site 37-1313
District 6, Toronto

This memorandum gives preliminary recommendations regarding the design and construction of foundations and approaches for the above structure. This information is provided to you in advance of our final report, to facilitate your design to proceed. We will submit our final report on this project in the near future.

Subsurface Conditions

The elevation of the ground level at the site ranged from 192.2 m at the west end to 193.8 m at the east end. The subsurface conditions at the site consist mainly of 5.2 to 8.8 m (to elevation 183.6) of clayey silt, with sand, trace of gravel. The bottom 5.9 to 2.3 m of the deposit contains layers of sandy silt. Underlying this deposit at elevation 190.5 to 183.6 m was a grey clayey silt to silty clay, trace of sand lacustrine layer. All of the boreholes ended within this deposit, therefore the stratum was 16 m plus thick.

Measurements of the groundwater level obtained at the time of the investigation revealed levels as high as 0.6 m below the ground level corresponding to elevation 192.6 m. It should be noted that ground water levels are subject to seasonal fluctuations and may therefore vary from those given above.

Proposed Structure

It is proposed to construct a single span rigid frame parallel to the lower ramp with retaining walls at the acute corners. The proposed clear span is about 11.5 m. A grade raise of approximately 4 to 7 m is needed to reach the proposed pavement grade at elevation 197 m \pm . A cut of approximately 2 m is required under the structure or for the W-N/S Jane Street Ramp proposed pavement grade at approximate elevation 191 m.

Structure Foundations

The proposed structure may be founded on spread footings.

Spread Footings

1. The proposed structure may be supported on spread footings at or below elevation 190 m. For the purposes of the O.H.B.D.C. the following design values are recommended except for the north/east retaining wall:

Factored Capacity at U.L.S. 495 kPa
Bearing Capacity at S.L.S. Type II 330 kPa

The following reduced design values should be used for the north/east retaining wall:

Factored Capacity at U.L.S. 225 kPa
Bearing Capacity at S.L.S Type II 150 kPa

A lean concrete (150 mm thick) pad should be placed within 4 hours of completion of excavation so as to guard against softening of the foundation material from weathering and seepage effects.

2. The proposed north and south abutments may also be supported on spread footings above elevation 190 m. For this alternative, a section along the footings should be subexcavated to 190 m. The dimension of the subexcavations should be large enough to allow for the surface of the granular pad to be 1.0 m longer and 1.0 m wider than the footings as per attached Figure 1. The ground should then be compacted, and a minimum of 0.6 m of compacted Granular "A" placed in 0.3 m lifts, immediately after, so as to guard against softening of the foundation material. The remainder of the pad should be constructed with Granular "A" fill as illustrated in Figure 1.

For the purposes of the O.G.B.D.C., the following design values are recommended.

- i) For proposed structure except for north/east retaining wall.

Factored Capacity at U.L.S. 450 kPa
Bearing Capacity at S.L.S. Type II 300 kPa

- ii) For north/east retaining wall:

Factored Capacity at U.L.S. 225 kPa
Bearing Capacity at S.L.S. Type II 150 kPa

It is anticipated that settlements induced within the proposed footing locations should not exceed 25 mm. If greater settlements can be tolerated the bearing capacity can be increased.

The underside of the footings should be provided with a minimum of 1.2 m earth cover for frost protection.

Approach Embankments

Due to the competent nature of the natural soil, no deep-seated failures are anticipated through the foundation soils, for grade raises of 6 m, and cuts of 2 m. Topsoil and surficial material should be removed prior to placing any fill. The fill should consist of well compacted acceptable material. Embankments should have side and forward slopes no steeper than 2 horizontal to 1 vertical designed and constructed in accordance with the appropriate Ministry Standards.

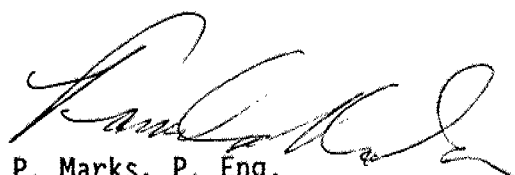
Total settlement of the fill and the foundation soil should be in the order of 20 to 35 mm. Most of this will be elastic compression and will have occurred immediately after completion of construction.

The following items should be considered during design:

1. The proposed grade line for Highway 407 is below the existing water level.
2. Subexcavation for the footings or pile caps if below elevation 192.6 may require dewatering.

Due to the above it may be desirable to carry out the excavation for the W-N/S Jane Street Ramp prior to construction of the footings. A pilot trench may be utilized at the footing locations to drain the subexcavation.

Should you require any further information please do not hesitate to contact this office.

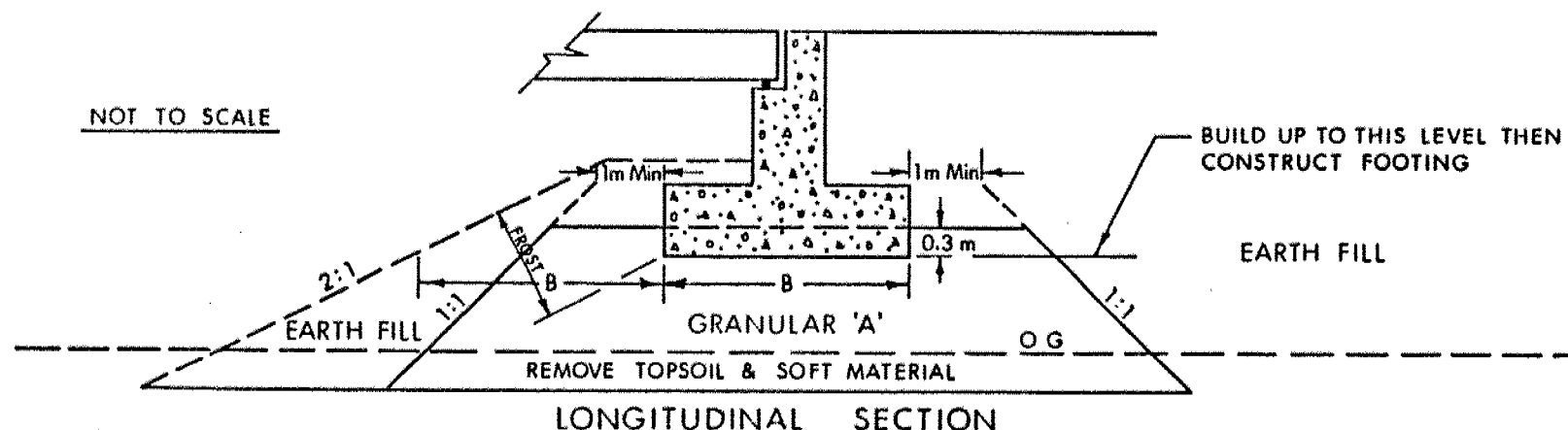
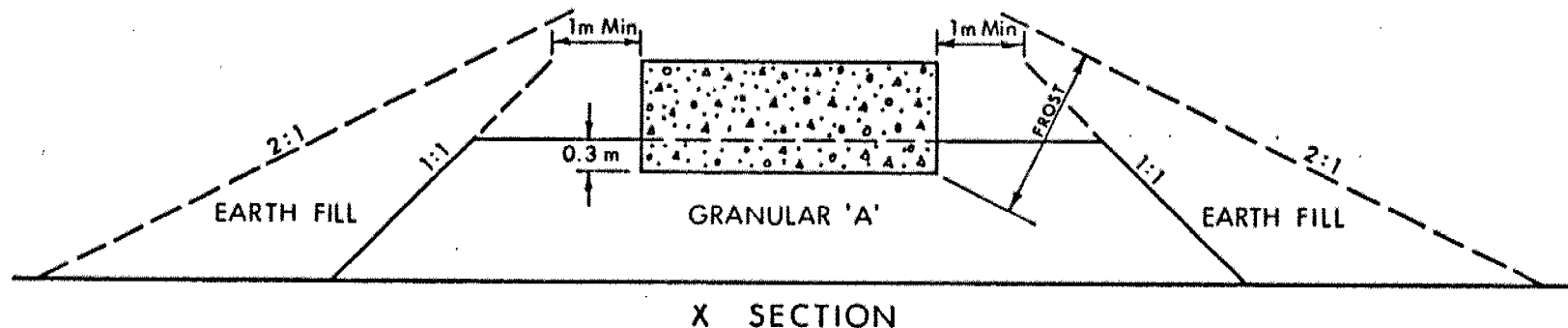

P. Marks, P. Eng.
Foundation Engineer

for

Dr. B. Iyer, P. Eng.
Sr. Foundation Engineer

BI/PM/mmj

Attach.



NOTES:

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



Ministry of
Transportation

ABUTMENT ON COMPACTED FILL
SHOWING GRANULAR 'A' CORE

FIG No 1

W P 140-87-01

EASTBOUND BASKETWEAVE AT
HWY 407/JANE ST INTERCHANGE
SITE 37-1313



LOOKING NORTH



LOOKING SOUTH

EASTBOUND BASKETWEAVE AT
HWY 407/JANE ST INTERCHANGE
SITE 37-1313



LOOKING EAST



LOOKING WEST