

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M 13-83

DIST. 6 REGION

W.P. No. 138-87-06

CONT. No. 90-60

W. O. No.

STR. SITE No. 37-269

HWY. No. 400

LOCATION Hwy 400 over C.W.R.  
(Bridge #5)

No. of PAGES -

=====

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

DIST No 6  
CONT No  
WP No 138-87-06



HIGHWAY 400 OVER CNR  
(STRUCTURE 5)  
GENERAL ARRANGEMENT

SHEET

Gregg and Edens Limited  
engineers : planners : economists

## GENERAL NOTES:

- CLASS OF CONCRETE.  
MASS CONCRETE 20 MPa  
REMAINDER 30 MPa
- REINFORCING STEEL  
GRADE 400 UNLESS NOTED OTHERWISE  
BAR MARKS WITH SUFFIX 'C' DENOTE  
COATED BARS
- CLEAR COVER TO REINFORCING STEEL  
FOOTINGS 100 ± 25 mm  
ABUTMENTS AND WINGWALLS  
FRONT FACE 80 ± 20 mm  
BACK FACE 70 ± 20 mm  
DECK  
TOP 70 ± 20 mm  
BOTTOM 50 ± 10 mm  
REMAINDER UNLESS NOTED  
OTHERWISE 70 ± 20 mm

## CONSTRUCTION NOTES

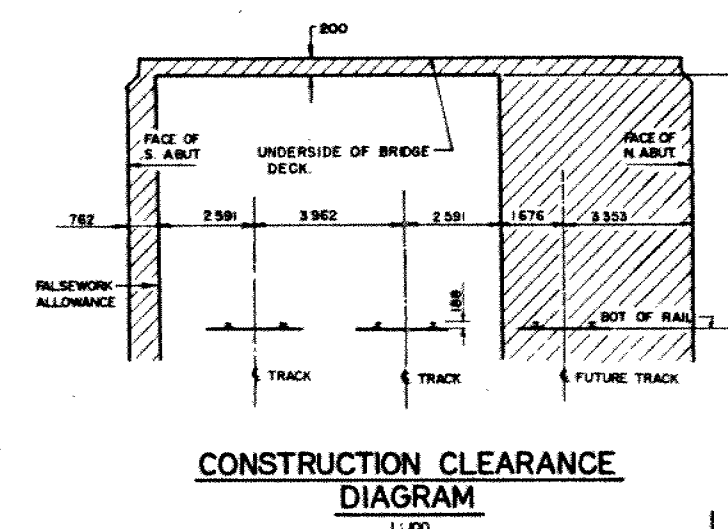
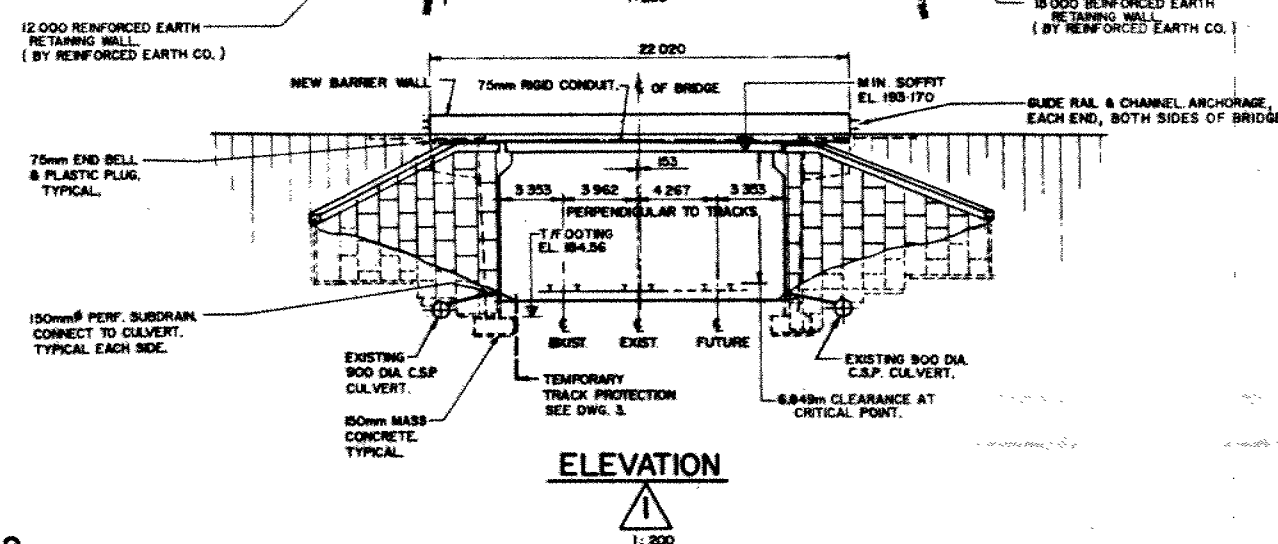
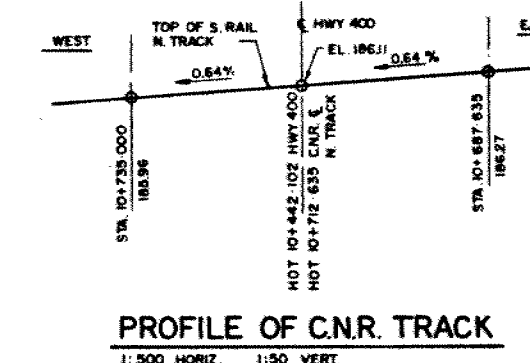
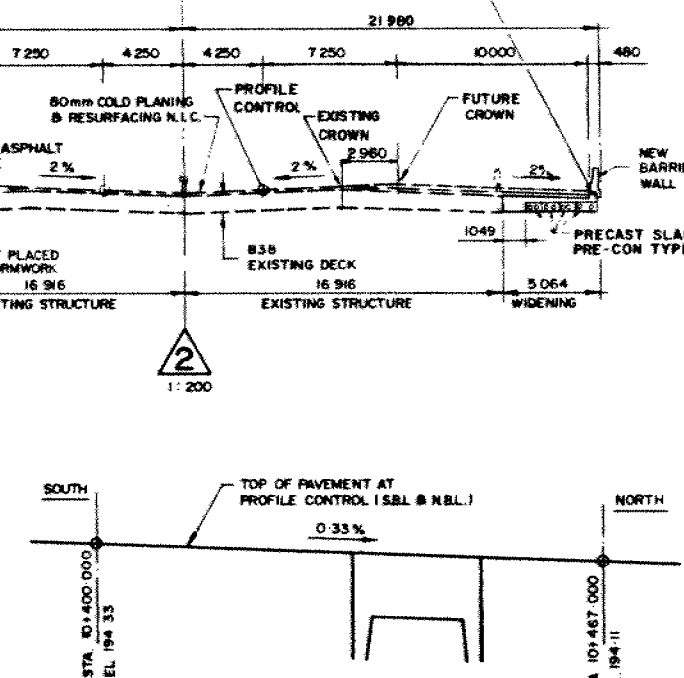
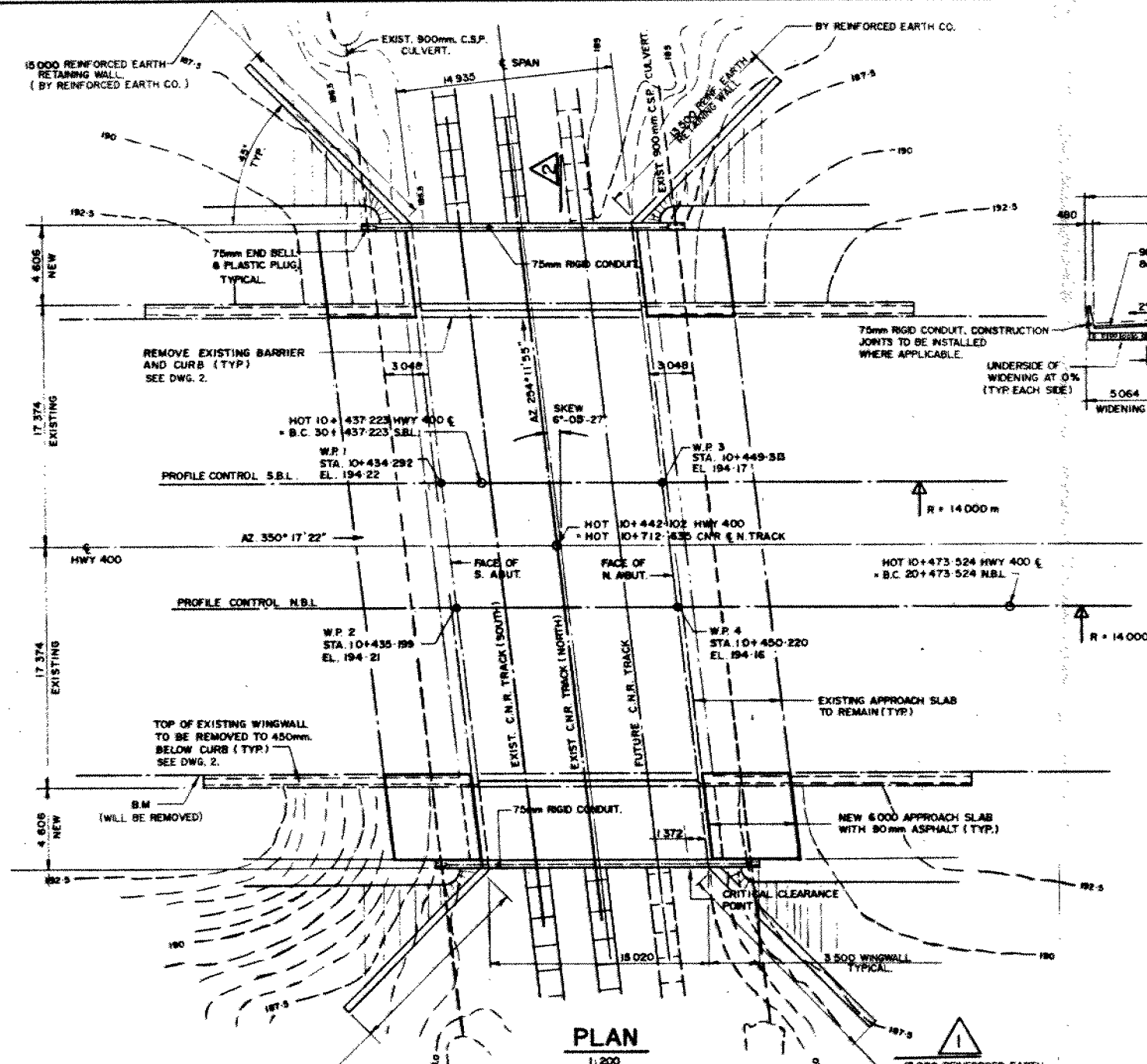
- BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH ABUTMENTS, KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATIONS BE GREATER THAN 500 mm.
- CONTRACTOR TO VERIFY EXISTING DIMENSIONS AND ELEVATIONS OF EXISTING STRUCTURE.

## LIST OF DRAWINGS

- GENERAL ARRANGEMENT.
- STRUCTURE REMOVAL.
- TRACK PROTECTION.
- FOOTINGS.
- FRAME - EAST SIDE I
- FRAME - EAST SIDE II
- FRAME - WEST SIDE I
- FRAME - WEST SIDE II
- PRECAST SLABS.
- APPROACH SLABS.
- BARRIER WALLS.
- BRIDGE DATE & SITE NUMBER DATA
- AS CONSTRUCTED ELEV. & DIM.

## APPLICABLE STANDARD DRAWINGS

DD-4013 REV. 1  
DD-4015 REV. 1  
DD-4017 REV. 1  
DD-4018 REV. 1  
DD-4670 REV. 3  
OPSD-508.01 REV. 0  
DD-1613 REV. 2



B.M. 194.312  
GEODETIC DATUM  
CC ON S.E. CORNER OF CONC. BRIDGE  
17.0 RT 10+417.900

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN M.G.S. CHK			CODE CHDCC 1983 LOAD CLASS A DATE SEPT 88
DRAWN B.D. CHK			SITE 37-269 ISTRUCT SCHEME DWG 1



Ministry of  
Transportation and  
Communications

Cont 90-60

---

## **FOUNDATION DESIGN SECTION**

**foundation  
investigation and  
design report**

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

*06* *CONT 90-60*  
WP 138-87-~~87~~ DIST 6

HWY 400 STR SITE 37-269

Extension of Rigid Frame Structure  
Hwy. 400 and CNR Overhead  
Bridge #5

DISTRIBUTION

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

# FOUNDATION INVESTIGATION REPORT

For

Extension of Rigid Frame Structure

Hwy. 400 and CNR Overhead

Bridge #5

W.P. 138-87-~~87~~<sup>88</sup>, Site #37-269

Hwy. 400, District 6, Toronto

## INTRODUCTION

This report summarizes the results obtained from a Foundation Investigation carried out at the aforementioned site. The existing rigid frame structure will be extended (5.51 m) on either end to facilitate the widening of Hwy. 400 over the C.N.R. New retaining walls will also be required.

## SITE DESCRIPTION AND GEOLOGY

The site is located immediately adjacent to the existing C.N.R. Overhead at Hwy. 400 approximately 1 kilometre north of Steeles Avenue in the town of Vaughan.

The terrain surrounding the site is generally flat and partly occupied by the C.N.R. that travels east-west beneath Hwy. 400. Side slopes adjacent to the tracks illustrate the excavation cut required in advancing the CN railway. A single level industrial building exists approximately 1 km northwest of the site. At present, Hwy. 400 is an 8 lane paved roadway.

Geologically, the site is located in the physiographic region known as the Peel Plain. It consists of a bevelled till plain with a gently undulating rolling surface and limited relief. The till plain was deposited by the advance and retreat of the Wisconsin ice sheet during the Pleistocene epoch (over 5000 years ago).

## FIELD INVESTIGATION

Difficulty in obtaining access to the CNR-owned area of the site resulted in the field work being divided into two segments. The initial segment involved advancing four sampled boreholes accompanied by dynamic cone penetration tests

outside the CNR right-of-way between 88 01 15 to 88 01 21. The subsequent segment was implemented within the CNR right-of-way between 88 03 24 - 88 03 28 and consisted of four sampled boreholes accompanied by dynamic cone penetration tests.

Continuous flight hollow stem and solid stem auger equipment was used to advance the boreholes with subsoil samples retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). Washboring techniques were required upon encountering a sandy silt-sand layer at an approximate elevation of 182.0 m at the retaining wall locations. The samples were identified in the field and then transported to the laboratory for applicable testing on selected samples.

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

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

#### LABORATORY ANALYSES

To identify the behaviour, gradation and property of the soil, laboratory analyses consisted of:

- 1) Atterberg Limit tests/grain size analyses
- 2) Unit weight determination
- 3) Natural moisture content determination

#### SUBSURFACE CONDITIONS

In general, reasonably competent and uniform subsurface conditions were encountered across the site. Fill material consisting of approximately 3.0 m of well-graded sand overlying an additional 3.0 m thick mixture of clayey silt, sand and gravel was used for the approaches to the existing rigid frame structure.

The native surficial deposit was explored to a maximum thickness of 12.6 m and consists of clayey silt, some sand and a trace of gravel (glacial till) interbedded with a layer of silt-sandy silt of lacustrine origin.

The boundaries between the various soil types, in-situ and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. A plan of the site illustrating the locations and elevations of the boreholes and subsoil stratigraphical sections are provided on Dwg. 1388707-A.

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

Fill Material (Mixture of Clayey Silt, Sand and Gravel)

The fill material used for the existing approaches to the rigid frame structure consists of a well-graded, compact sand, trace of gravel extending to a depth of approximately 3.0 metres (road base and subbase) overlying a mixture of clayey silt, with/some sand and a trace of gravel that extends a further 3.0 metres before the natural surficial deposit is confronted. Grain size distribution curves for the lower mixture of fill material are illustrated in Figure 1.

Atterberg Limits were also obtained and the results are plotted in Figure 2. The results reveal that the fill is cohesive and of low plasticity. 'N' values indicate a low state of compaction.

Clayey Silt, some sand, trace gravel (Glacial till)

The predominant deposit encountered across the site consists of a clayey silt, some sand and a trace gravel (glacial till) interbedded with a confined stratum of silt-sandy silt of lacustrine origin. Occasional thin seams of non-cohesive silt are also present within the main cohesive clayey silt matrix. A band of organic inclusions was sampled in the upper 0.5 metres of the deposit.

The main component of the deposit is a clayey silt (CL) with random zones of less cohesive plastic silt (CL-ML). In general, the deposit is considered

cohesive. A grain size distribution envelope for the material as determined by mechanical analyses is given in Figure 3. Atterberg Limits were also obtained to evaluate the behaviour of the fine grained portion of the material and the results are plotted in Figure 4. A summary of the indices of the basic cohesive material matrix is provided in Table 1 below. Unit weights are also included.

Table 1

	<u>Range</u>	<u>Avg.</u>
Natural Moisture Content (w) %	6.5-22.5	11.6
Liquid Limit ( $w_L$ ) %	13-33.5	21.2
Plastic Limit ( $w_p$ ) %	9-17.5	13.7
Unit Weight ( $kN/m^3$ )	20.2-23.7	22.1

It is evident from the results, the deposit is primarily of low plasticity. In general, lower moisture contents were observed beneath the confined cohesionless silt-sandy silt layer. In addition, the silt content within the till deposit increases beneath the interbedded silt-sandy silt layer and consequently the soil becomes less cohesive and at places the material is only slightly plastic.

Although cobbles and boulders were not encountered during the investigation, they are a characteristic component of these types of deposits and consequently can be assumed to exist in this deposit.

The consistency of the cohesive deposit as indicated by 'N' values of the Standard Penetration Test varies from stiff to hard. Generally, the deposit may be considered to be hard.

A significant layer of silt-sandy silt interbedded with sand seams exists at elevations ranging from elevation 180.6 m to 182.7 m within the predominant till deposit. This layer is a lacustrine deposit and is generally very dense with occasional seams of compact sand. Grain size distribution curves illustrating the gradation of the deposit is provided in Figure 5. This cohesionless layer is water bearing and the fact the the material backed up in the hollow stem augers during drilling indicates that the stratum is perhaps under subartesian head.



GROUNDWATER CONDITIONS

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Measurements revealed stabilized levels at an elevation ranging from 186.1 metres to 186.0 metres. These levels correspond to depths within 2 metres of the native surficial deposit.

## DISCUSSION AND RECOMMENDATIONS

It is proposed to extend the existing rigid frame structure by lengthening the north and south abutments an equidistance of 5.5 m on either end. The additional length will facilitate a two lane widening of Hwy. 400 and will also require installation of new retaining walls. The following itemizes our recommendations for:

- 1) structure foundations
- 2) approach fills
- 3) granular backfill to structures
- 4) construction considerations

### Structure Foundations

The proposed abutment structure extension and the retaining walls at the four locations may be supported on spread footings founded within the upper clayey silt at the same elevation as the existing adjacent bridge footings (elevation 183.6). Step-down footings may be used to support the retaining walls. The design values for purposes of the O.H.B.D.C. are provided in Table 3. The underside of all footings should be provided with a minimum 1.2 metres of earth cover for frost protection.

In view of the overconsolidated nature of the founding soil, differential and total settlements induced should not exceed 25 mm. Consequently, the extension footings can be rigidly attached to the existing footings.

Sliding resistance between concrete and the foundation soil should be calculated in accordance with Section 6.7.3.3.2 of the O.H.B.D.C. assuming an unfactored adhesion value of 75 kPa.

Sliding resistance can be supplemented by constructing shear keys in the founding soil below the base of the footing.

<u>Structure</u>	<u>Elevation (m)</u>	Allowable Capacity at S.L.S. Type II <u>(kPa)</u>	Factored Capacity at U.L.S. <u>(kPa)</u>	Founding <u>Material</u>
South Abutment	183.6	500	750	Clayey Silt (Glacial Till)
North Abutment	183.6	500	750	Clayey Silt (Glacial Till)
Retaining Walls	183.6	500	750	Clayey Silt
	183.6-185	300	450	(Glacial Till)

TABLE 3

### Approach Fills

No stability problems are anticipated for the approach fills that will reach heights of up to 6 metres provided that the fills are constructed with 2H:1V side and forward slopes. All softened and/or organic material should be excavated for their full depth within the planned limits prior to fill placement. In view of the competent subsoil conditions, no deep-seated failures are anticipated in the native soil with the standard fill slopes. Fill settlements up to 0.75% of the total fill height can be expected and consequently differential settlements may result with respect to the existing consolidated fills. To minimize these differential movements, it is recommended that the new fill be left in place as long as possible prior to paving operations.

In addition, to further supplement resistance to settlement and slope instability, the new approach fills are to "benched" to the existing fills in accordance with MTO standards.

### Granular Backfill to Structures

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

	<u>Granular 'A'</u>	<u>Granular 'B'</u>
Angle of Internal Friction ( $\phi$ )	35°	30°
Unit Weight (kN/m <sup>3</sup> )	22.8	21.2
Coefficient of Active Earth Pressure ( $K_a$ )	0.27	0.33
Coefficient of Earth Pressure at Rest ( $K_0$ )	0.43	0.5

The earth pressure coefficient at rest is to be used in design if the abutment walls are rigid and unyielding. Weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill.

## CONSTRUCTION CONSIDERATIONS

### (a) Footing Excavation

Excavation of the new footings should be monitored closely to avoid any undermining of the existing bridge footings. The soil at the founding elevation should be void of any fill that may have been used in the construction of the existing footings. Any softened or organic material should also be removed and replaced with mass concrete. A working slab should be placed to protect the footing founding soil against weathering within 4 hours of exposure.

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the glacial till deposit. Conventional pumping techniques will suffice in discharging any localized seepage.

### (b) Track Protection

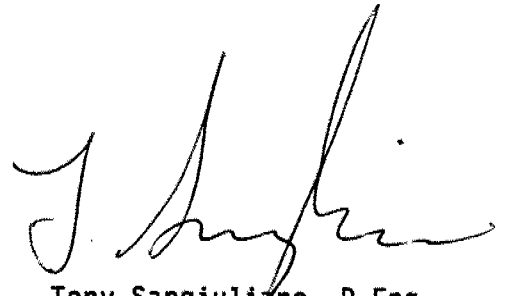
In view of the close proximity of the railroad tracks to the south abutment footings, a track protection scheme will be required during the excavation and construction of the foundation. One suitable method of protection is a soldier pile-timber lagging shoring system. Earth pressures are to be computed in accordance with Section 6.6.1.2 of the O.H.B.D.C. For design purposes the following parameters are provided:

<u>Material</u>	<u><math>\gamma</math> (kN/m<sup>3</sup>)</u>	<u><math>c_u</math> (unfactored) (kPa)</u>	<u><math>\phi^\circ</math></u>
Clayey Silt (Glacial Till)	22	150	-
Silt (Lacustrine)	20	-	30°

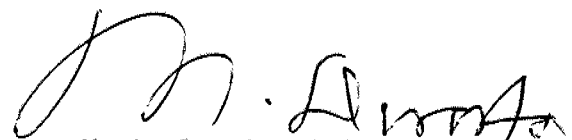
Upon completion of the foundation work, the soldier piles should be cut off 1 m below the final grade and left in place.

MISCELLANEOUS

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



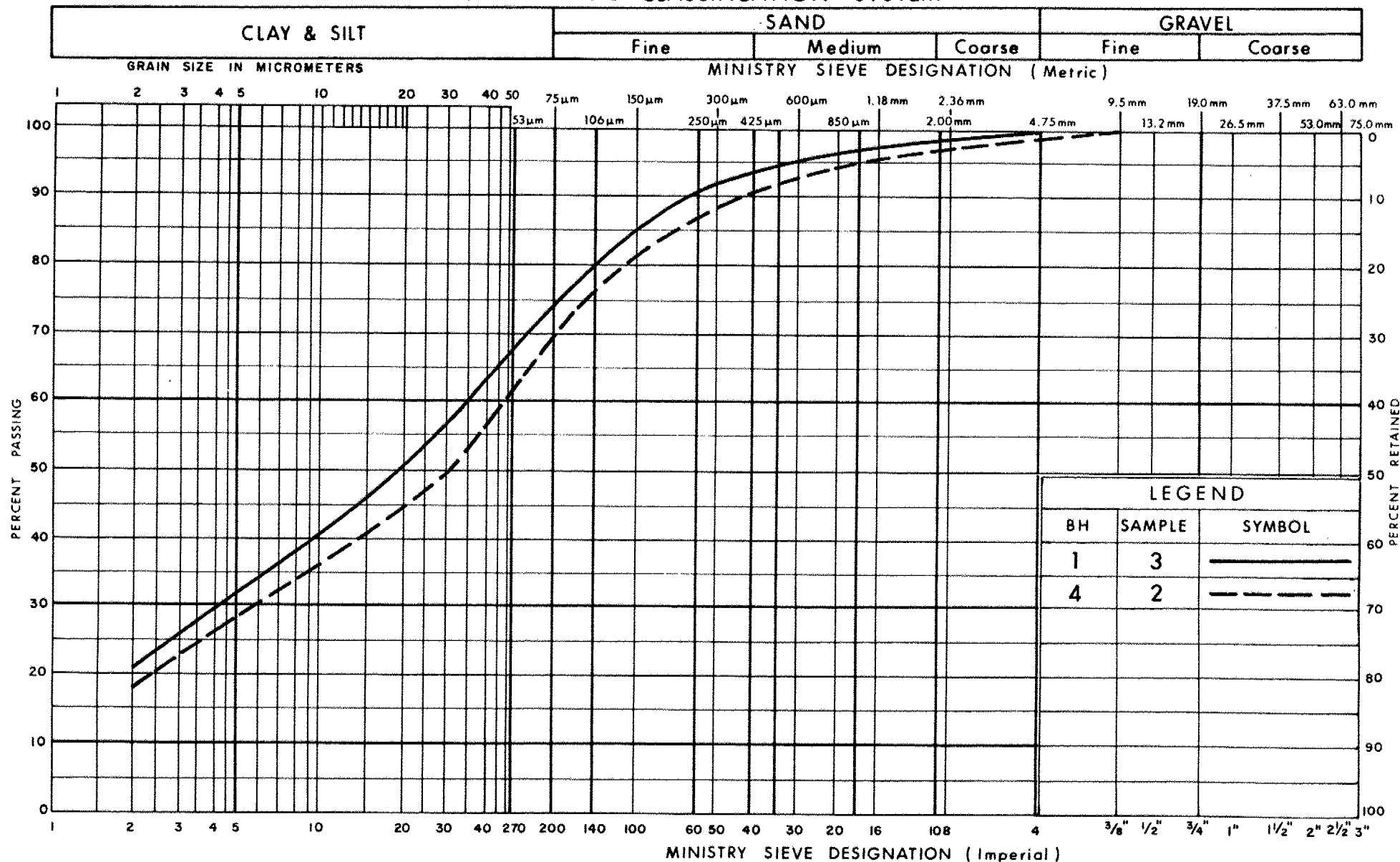
Tony Sangiuliano, P.Eng.  
Foundation Engineer



Murty Devata, P.Eng.  
Chief Foundation Engineer  
(East)

## APPENDIX

## UNIFIED SOIL CLASSIFICATION SYSTEM



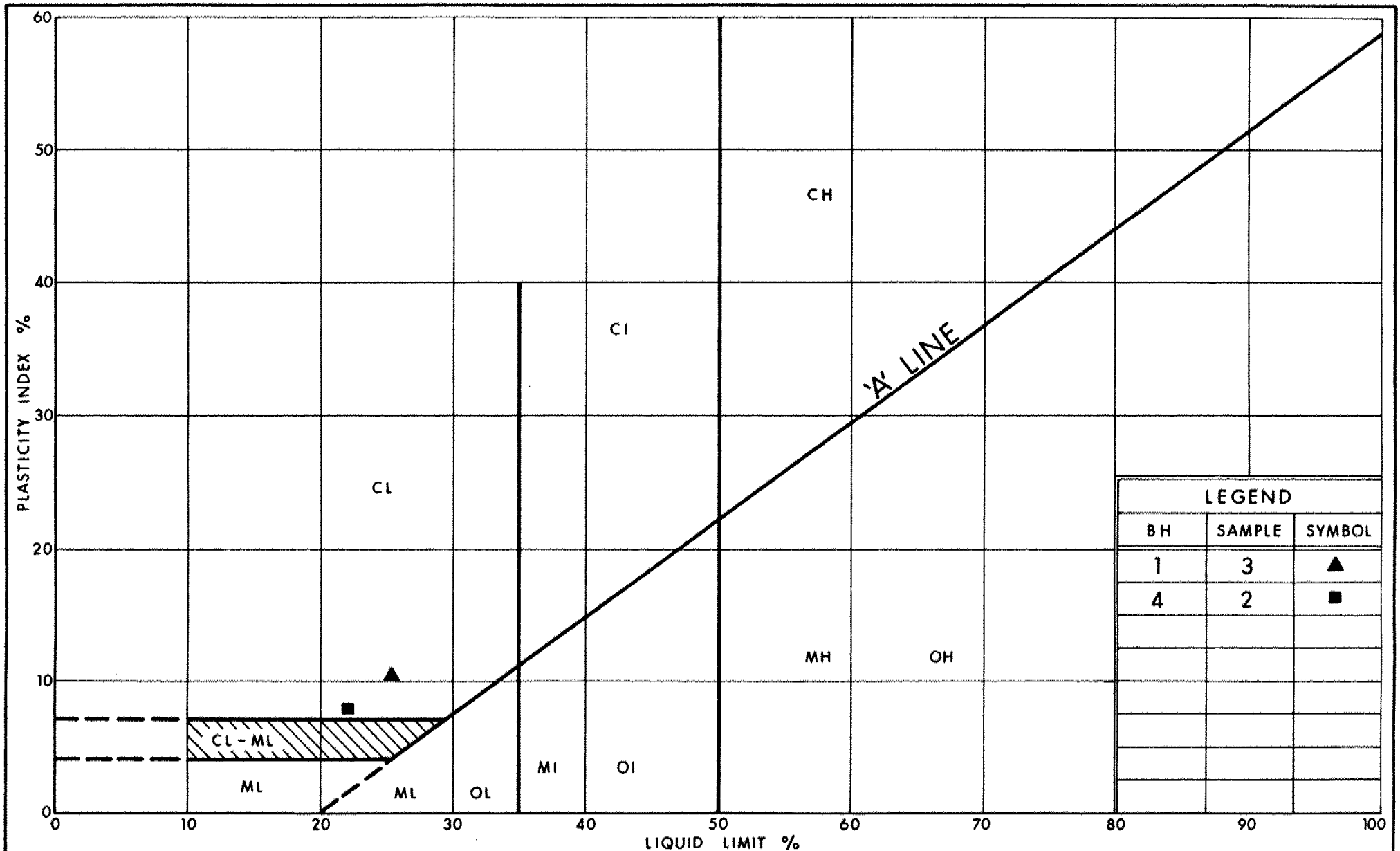
Ministry of  
Transportation

**GRAIN SIZE DISTRIBUTION**  
MIXTURE OF  
CLAYEY SILT, SAND & GRAVEL (Fill)

FIG No 1

W P 138-87-07





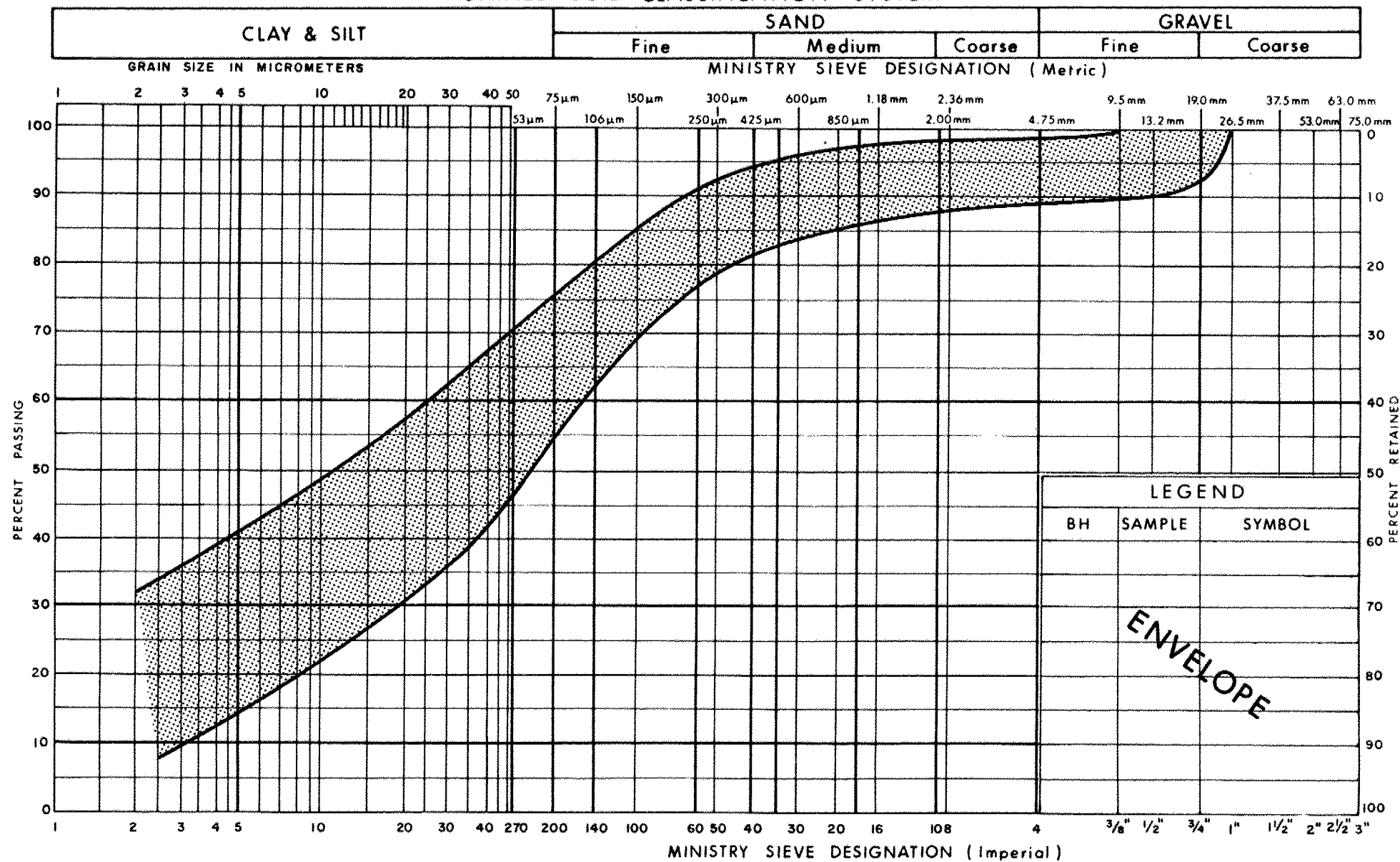
Ministry of  
Transportation

# PLASTICITY CHART MIXTURE OF CLAYEY SILT, SAND & GRAVEL (Fill)

FIG No 2

W P 138-87-07

## UNIFIED SOIL CLASSIFICATION SYSTEM

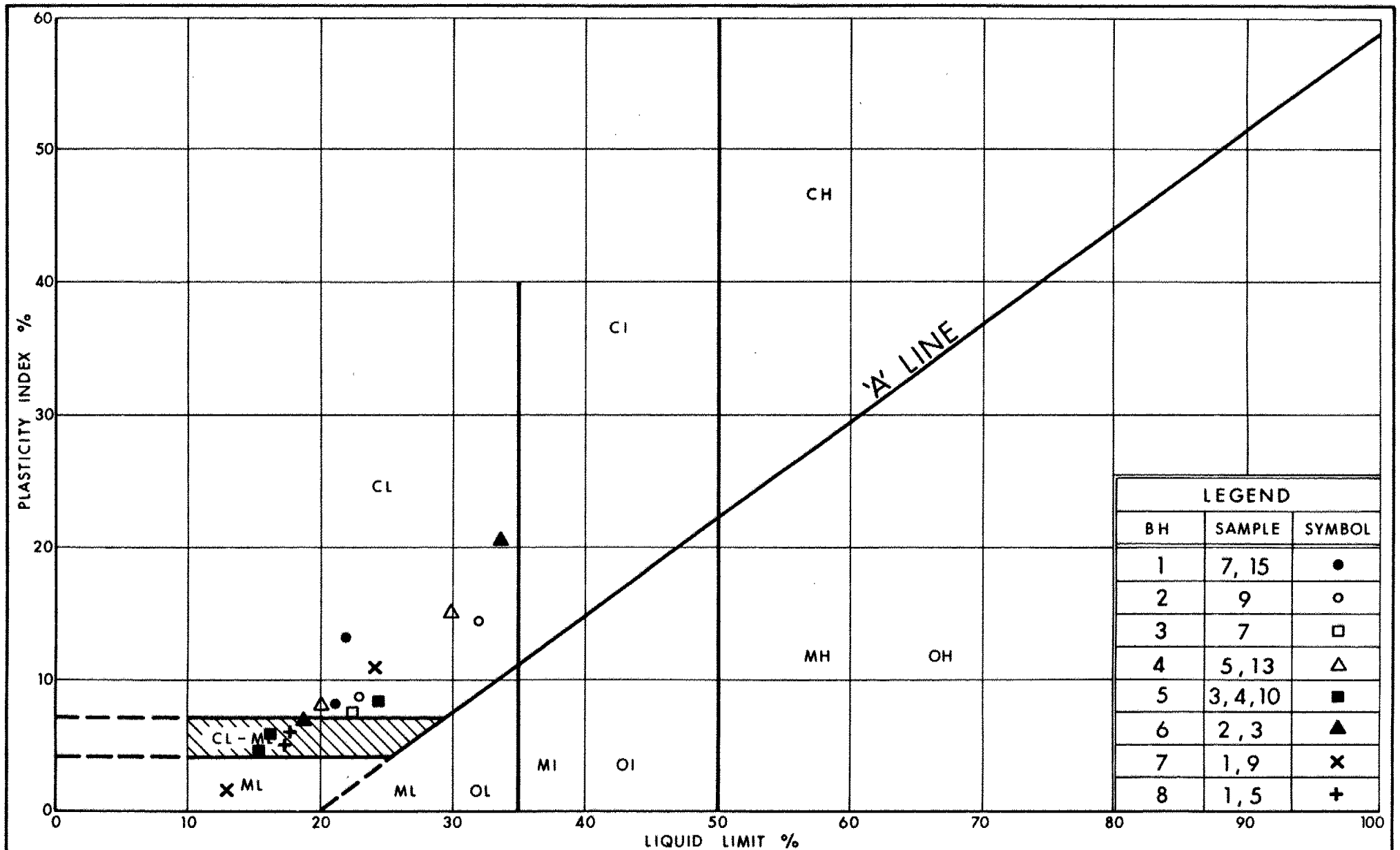


Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
CLAYEY SILT, WITH/SOME SAND, TRACE GRAVEL  
(Glacial Till)

FIG No 3

W P 138-87-07



Ministry of  
Transportation

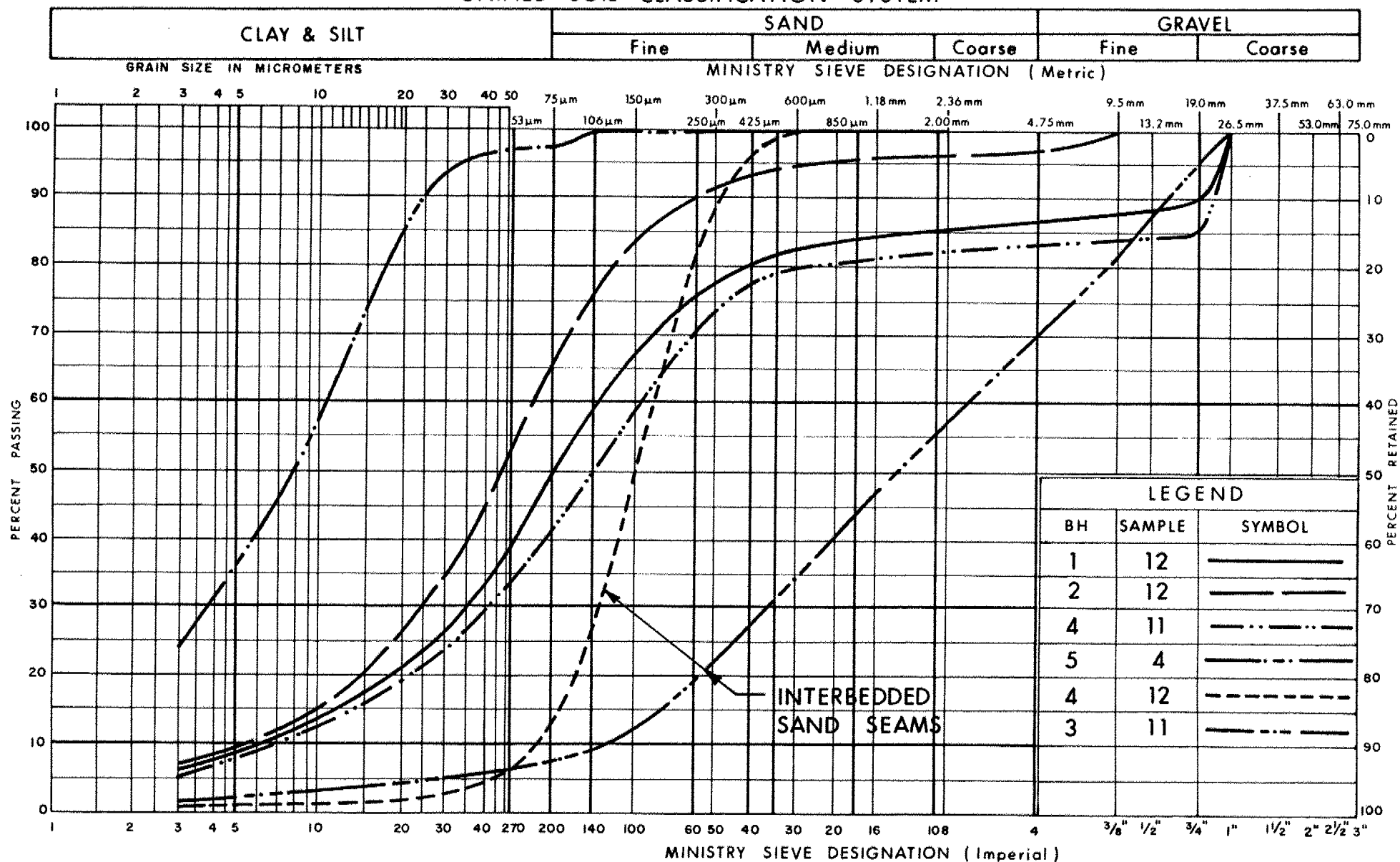
Ontario

# PLASTICITY CHART CLAYEY SILT, WITH/SOME SAND, TRACE GRAVEL (Glacial Till)

FIG No 4

W P 138-87-07

## UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of  
Transportation

GRAIN SIZE DISTRIBUTION  
SILT - SANDY SILT  
WITH INTERBEDDED SAND SEAMS

FIG No 5

W P 138-87-07

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

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

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$\text{kPa}^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$\text{m}^2/\text{s}$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{v0}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$\text{kg}/\text{m}^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{\min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$\text{kn}/\text{m}^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$
$\rho_w$	$\text{kg}/\text{m}^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$\text{kn}/\text{m}^3$	UNIT WEIGHT OF WATER	$S_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$\text{kg}/\text{m}^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$\text{kn}/\text{m}^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$\text{kg}/\text{m}^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$\text{m}^3/\text{s}$	RATE OF DISCHARGE
$\gamma_d$	$\text{kn}/\text{m}^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{\text{sat}}$	$\text{kg}/\text{m}^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{\text{sat}}$	$\text{kn}/\text{m}^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$\text{kg}/\text{m}^3$	DENSITY OF SUBMERGED SOIL	$e_{\max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$\text{kn}/\text{m}^2$	SEEPAGE FORCE
$\gamma'$	$\text{kn}/\text{m}^3$	UNIT WEIGHT OF SUBMERGED SOIL						

# RECORD OF BOREHOLE No 1

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 310.9; E 301 877.5 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Augers, Washbore & Cone Test COMPILED BY TS  
 DATUM Geodetic DATE 88 01 15 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT Wp NATURAL MOISTURE CONTENT W LIQUID LIMIT Wl WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
194.1	Asphalt Surface										
0.0	Sand Brown, Compact		1	SS	10		194	Augered			
191.0			2	SS	4		192				
3.1	Mixture of Clayey Silt, Sand and Gravel, Trace Organics, Soft (Fill)		3	SS	4		190			20.3	0 26 52 22
188.0			4	SS	11		188				
6.1	With Organics Stiff to V. Stiff Hard		5	SS	25		186			23.2	2 28 55 15
	Clayey Silt Some Sand, Trace Gravel, Brown (Glacial Till)		6	SS	21						
	Random Zones of Silt		7	SS	58		184				
182.7			8	SS	75						
11.4	Sandy Silt V. Dense Occ. Sand Seams		9	SS	55		182				13 36 48 3
	Compact		10	SS	120		180				
178.9	(Lacustrine)		11	SS	78		178				
15.2			12	SS	65						
			13	SS	10		176				7 25 45 23
175.4			14	SS	94						
18.7	End of Borehole		15	SS	93						
			16	SS	100						
<p>* NOTE Soil backed up in augers at 11.5 m. Advance by washboring inside augers.</p>											



Ministry  
of  
Transportation

## RECORD OF BOREHOLE No 2

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 267.0; E 301 885.0 ORIGINATED BY TS  
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger, Washbore & Cone Test COMPILED BY TS  
DATUM Geodetic DATE 88 01 19 CHECKED BY

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub>	WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE							
194.2	Asphalt Surface										
0.0	Sand Brown Compact		1	SS	15						
190.7			2	SS	7						
3.5	Mixture of Clayey Silt Sand and Gravel Soft (Fill)		3	SS	4					21.7	
188.1			4	SS	18						
6.1	With Organ. Clayey Silt Some Sand Trace Gravel Stiff to V. Stiff Brown Grey Hard		5	SS	19						6 22 39 33
			6	SS	14						1 23 41 35
			7	SS	21						
			8	SS	22						
			9	SS	110						
	(Glacial Till) Random Zones of Silt		10	SS	72					23.2	10 17 56 17
182.0			11	SS	120						
12.2	Sandy Silt V. Dense (Lacustrine)		12	SS	110/	23 cm					2 31 62 5
			13	SS	100/	15 cm					
178.7			14	SS	100/	23 cm					
15.5			15	SS	100/	15 cm					
175.5			16	SS	100						
18.7	End of Borehole										
	<p>* NOTE Soil backed up in augers at 12.4 m. Advance by washboring inside augers.</p>										

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 3

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 321.0; E 301 905.0 ORIGINATED BY TS  
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger, Washbore & Cone Test COMPILED BY TS  
DATUM Geodetic DATE 88 01 19 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%)					
194.1	Asphalt Surface													
0.0	Sand Brown Compact						Augered							
189.5	Mix. of Clayey Silt Sand and Gravel V. Stiff (Fill)		1	SS	10									
4.6			2	SS	30									
188.0			3	SS	10									
6.1	Stiff to V. Stiff Hard		4	SS	20									
	Clayey Silt Some Sand, Trace Gravel (Glacial Till) Random Zones of Silt		5	SS	45									
			6	SS	100									
			7	SS	100									
			8	SS	100									
			9	SS	80									
182.7			10	SS	100									
11.4	Sand With Gravel V. Dense (Lacustrine)		11	SS	100									
178.9			12	SS	100									
15.2			13	SS	60									
177.0														
17.1	End of Borehole													
	* NOTE Soil backed up in augers at 11.5 m, advance by washboring inside augers.													





Ministry  
of  
Transportation

# RECORD OF BOREHOLE No 4

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 274.0; E 301 913.0 ORIGINATED BY TS  
DIST 6 HWY 400 BOREHOLE TYPE Hollow Stem Auger, Washbore & Cone Test COMPILED BY TS  
DATUM Geodetic DATE 88 01 21 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								20 40 60 80 100										

194.2	Asphalt Surface						194							
0.0	Sand Brown Compact						192							
190.7	Mix. of Clayey Silt Sand and Gravel (Fill)		1	SS	6		190						21.9	2 27 54 17
3.5			2	SS	4		188						20.6	0 16 61 23
188.1	With Organics		3	SS	25		186						22.0	2 34 46 18
6.1	Clayey Silt Some/with Sand Trace Gravel		4	SS	28		184						20.3	1 12 31 56
	Brown Grey V.Stiff Hard		5	SS	19		182							
			6	SS	26		180							
	(Glacial Till)		7	SS	100		178							
	Random Zones of Silt		8	SS	55		176							
182.0	Sandy Silt Very Dense		9	SS	120								16	39 40 5
12.2	Compact		10	SS	110								0	85 14 1
179.0	Occ. Sand Seams (Lacustrine)		11	SS	120								23.7	3 33 47 17
15.2			12	SS	15									
			13	SS	100/15 cm									
			14	SS	100									
175.5			15	SS	100									
18.7	End of Borehole													
<p>*NOTE Soil backed up in augers at 12.4 m. Advance by washboring inside augers.</p>														

+3, x5: Numbers refer to  
Sensitivity

20  
15  $\phi$  5 (%) STRAIN AT FAILURE  
10



Ministry  
of  
Transportation  
Ontario

# RECORD OF BOREHOLE No 5

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 296.9; E 301 874.1 ORIGINATED BY TS  
DIST 6 HWY 400 BOREHOLE TYPE Cone Test, Solid Stem Auger COMPILED BY TS  
DATUM Geodetic DATE 88 03 25 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH $kPa$ ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT $W_p$ NATURAL MOISTURE CONTENT $W$ LIQUID LIMIT $W_L$ WATER CONTENT (%) 10 20 30	UNIT WEIGHT $\gamma$ $kN/m^3$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
185.0	Ground Surface										
0.0	Clayey Silt Stiff Some Sand Hard Trace Gravel (Glacial Till) Brown Random Zones Grey of Silt		1	SS	15		184				
			2	SS	33						
181.5			3	SS	80		182				2 29 54 15
3.5			4	SS	41					21.3	0 3 80 17
	Silt Dense to V. Dense Occ. Sand Seams (Lacustrine)		5	SS	119						
			6	SS	53		180				
			7	SS	24						
178.4			8	SS	111		178				
6.6			9	SS	100	13 cm					
			10	SS	100	13 cm	176				3 40 44 13
			11	SS	110		174				
172.4			12	SS	118						
12.6	End of Borehole										

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 6

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 280.0; E 301 877.0 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE Cone Test, Solid Stem Auger COMPILED BY TS  
 DATUM Geodetic DATE 88 03 22 CHECKED BY \_\_\_\_\_

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
185.8	Ground Surface										
0.0	Clayey Silt Some Sand Stiff to V. Stiff Hard		1	SS	10		184			20.2	2 18 59 21
			2	SS	28						
			3	SS	100						
	Trace Gravel (Glacial Till)		4	SS	120						
	Random Zones of Silt		5	SS	100	15 cm	182				
181.2			6	SS	120						
4.6	Silt, Some Sand Trace Gravel, V. Dense (Lacustrine)		7	SS	100		180				
179.7			8	SS	100	15 cm					
6.1			9	SS	110		178				
			10	SS	100	15 cm	176				
			11	SS	100	15 cm	174				
173.3			12	SS	100	15 cm					
12.5	End of Borehole										

# RECORD OF BOREHOLE No 7

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 307.0; E 301 912.3 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE Cone Test, Solid Stem Auger COMPILED BY TS  
 DATUM Geodetic DATE 88 03 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	WATER CONTENT (%) 10 20 30
185.6	Ground Surface															
0.0	Clayey Silt Some Sand Trace Gravel Grey, Hard (Glacial Till)	Brown Grey	1	SS	42								22.1	5 20 55 20		
			2	SS	85											
182.6			3	SS	100											
3.0	Silt, V. Dense Occ. Sand Seams (Lacustrine)		4	SS	70											
			5	SS	80	15 cm								11 30 49 10		
180.6			6	SS	65											
5.0			7	SS	120											
			8	SS	120											
			9	SS	100	12 cm								4 40 52 4		
			10	SS	110											
			11	SS	100	15 cm										
			12	SS	60	7 cm										
173.3																
12.3	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

# RECORD OF BOREHOLE No 8

METRIC

W P 138-87-07 LOCATION Co-ords. N 4 848 291.0; E 301 915.0 ORIGINATED BY TS  
 DIST 6 HWY 400 BOREHOLE TYPE Cone Test, Solid Stem Auger COMPILED BY TS  
 DATUM Geodetic DATE 88 03 28 CHECKED BY

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER						
185.9	Ground Surface								
0.0	Clayey Silt Some Sand Trace Gravel	Stiff Hard	1	SS	12				
			2	SS	71				
	Brown Grey (Glacial Till) Random Zones of Silt		3	SS	100	15 cm		22.9	1 29 54 16
			4	SS	52				
			5	SS	37				
180.6			6	SS	120				
5.3	Silt, Dense (Lacustrine)		7	SS	48				
179.8			8	SS	91				
6.1			9	SS	100	15 cm			
			10	SS	80	15 cm			
			11	SS	100				
173.3			12	SS	100				
12.6	End of Borehole								

OFFICE REPORT ON SOIL EXPLORATION

**METRIC**

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

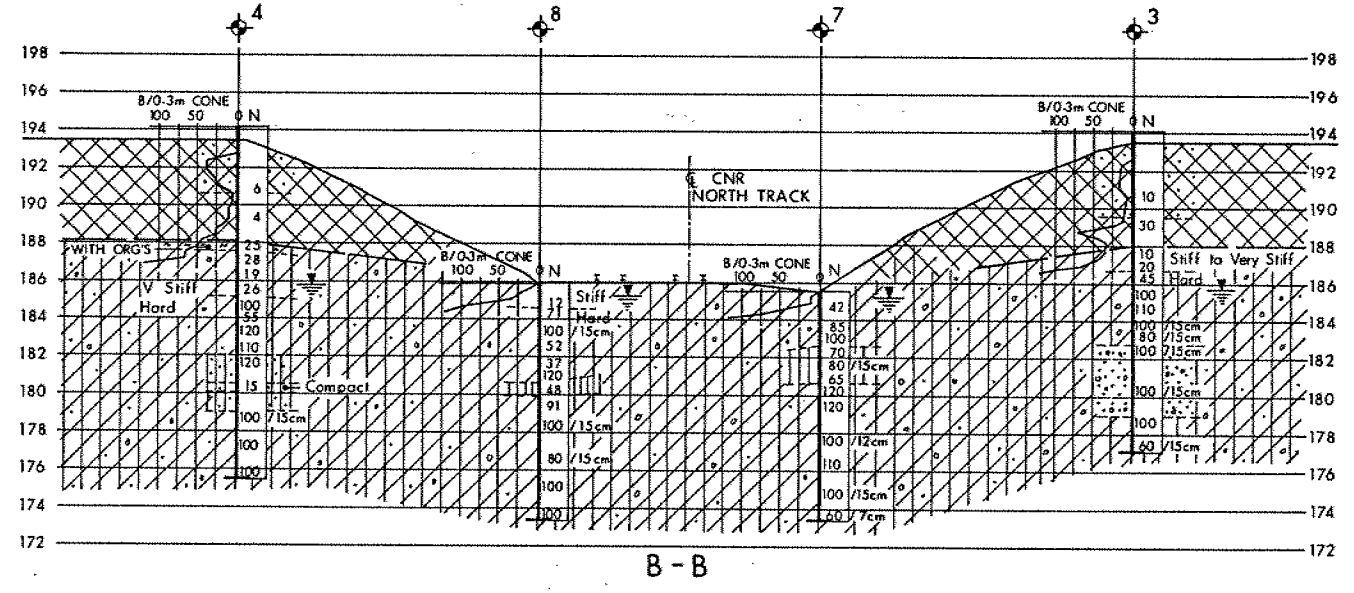
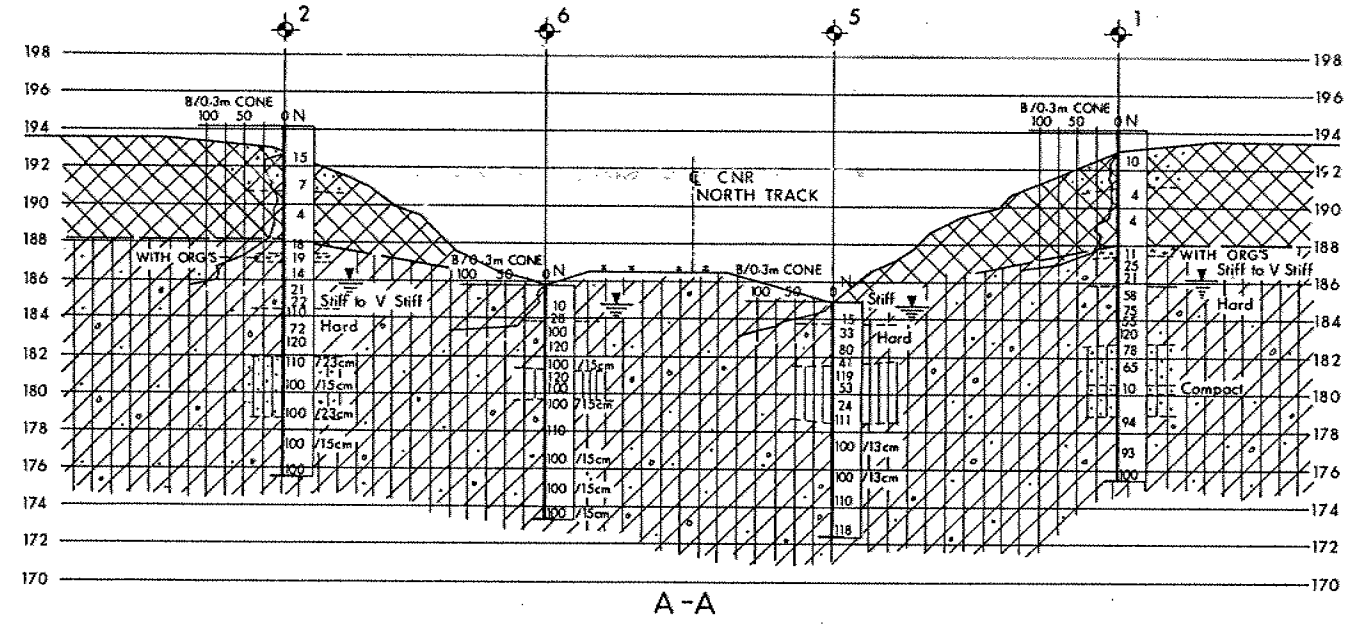
CONT No  
WP No 138-87-07

HWY 400 OVER CNR  
(BRIDGE-5)

BORE HOLE LOCATIONS & SOIL STRATA



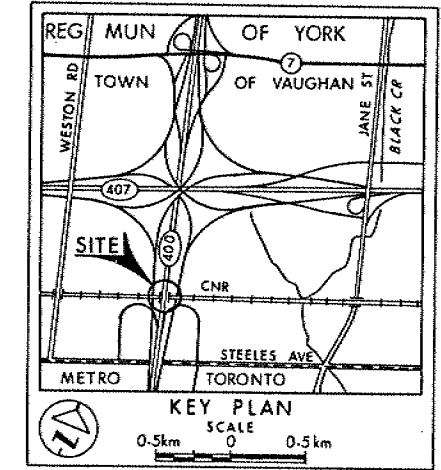
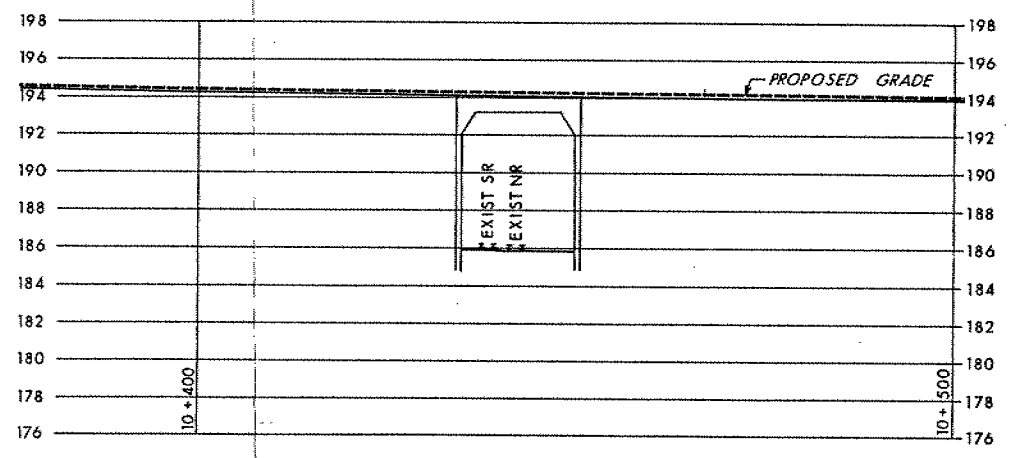
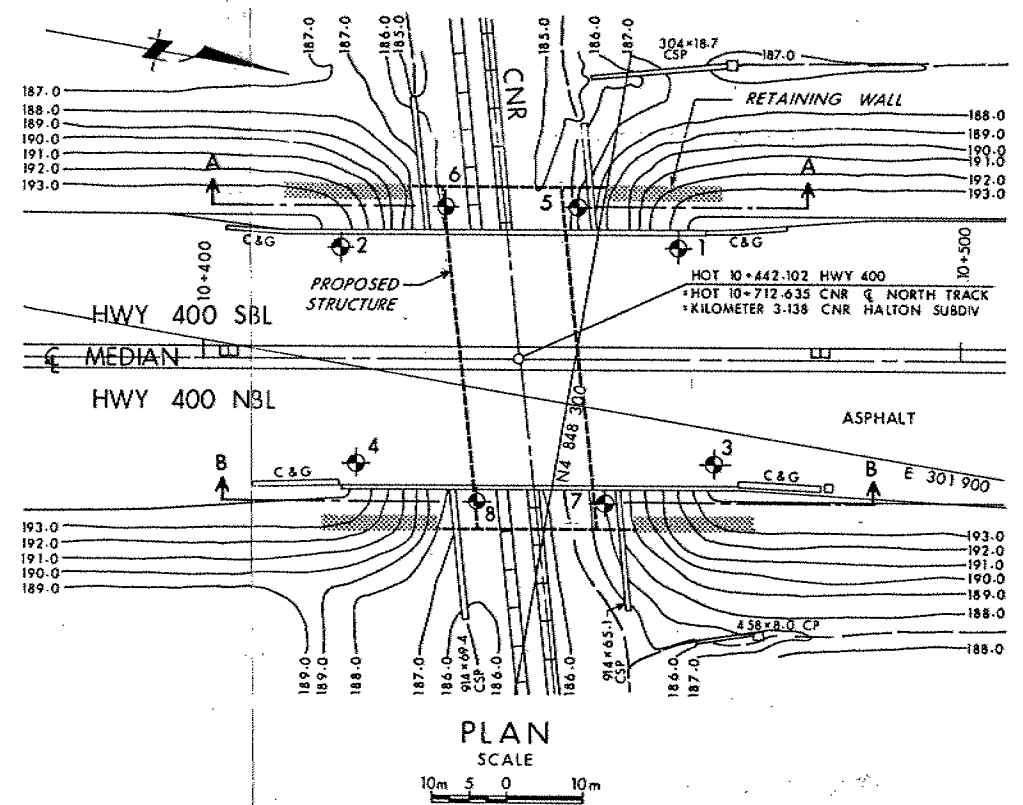
SHEET



**SECTIONS**  
SCALE  
4m 2 0 4m

**SOIL STRATIGRAPHY LEGEND**

- |  |   |  |   |  |  |
|--|---|--|---|--|--|
|  | SAND Compact (FILL)   |  | CLAYEY SILT<br>SOME/WITH SAND, TRACE GRAVEL<br>RANDOM ZONES OF SILT<br>Stiff to Hard (GLACIAL TILL) |  | SAND WITH GRAVEL<br>Very Dense (LACUSTRINE)  |
|  | MIXTURE OF<br>CLAYEY SILT, SAND & GRAVEL<br>TRACE ORGANICS<br>Soft to Very Stiff (FILL) |  | SANDY SILT<br>OCC SAND SEAMS<br>Very Dense (LACUSTRINE)   |  | SILT<br>SOME SAND, TRACE GRAVEL<br>OCCASIONAL SAND SEAMS<br>Dense to Very Dense (LACUSTRINE) |



**LEGEND**

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ◆ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation  
88 01 and 88 03

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	194.1	4 848 310.9	3 01 877.5
2	194.2	4 848 267.0	3 01 885.0
3	194.1	4 848 321.0	3 01 905.0
4	194.2	4 848 274.0	3 01 913.0
5	185.0	4 848 296.9	3 01 874.1
6	185.8	4 848 280.0	3 01 877.0
7	185.6	4 848 307.0	3 01 912.3
8	185.9	4 848 291.0	3 01 915.0

**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 30M13-83

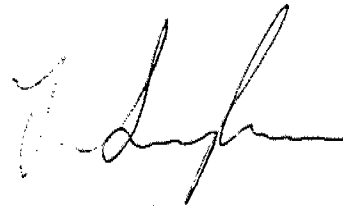
HWY No 400	DIST 6
SUBMIT TS CHECKED	DATE 88 06 13
DRAWN DT CHECKED	APPROVED
	SITE 37-269
	DWG 1388707-A

Free draining materials such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments to prevent hydrostatic pressure build-up. Weep holes in the abutment walls should be designed to drain any accumulation of water in the backfill. The following properties are recommended for these materials:

Granular 'A'	= 22.8 kN/m <sup>3</sup>	Ø = 35	K <sub>A</sub> = 0.27	K <sub>O</sub> = 0.43
Granular 'B'	= 21.2 kN/m <sup>3</sup>	Ø = 30	K <sub>A</sub> = 0.33	K <sub>O</sub> = 0.5

Lateral pressures should be computed in accordance with Section 6.6.1.2.1 of the code. If the abutment walls are rigid and unyielding, the earth pressure coefficient at rest should be used in the calculation.

If further information is required, please do not hesitate to contact this office.



T. Sangiuliano, P. Eng.  
Foundations Engineer

TS/mmj