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DIST. 4 REGION

W.P. No. 199-77-21

CONT. No. 93-43

W. O. No.

STR. SITE No. 10-477

HWY. No. 403

LOCATION Hwy 403 & Hwy 5

Underpass

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976



Ministry
of
Transportation

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

CONT. 93-43

WP 199-77-21 DIST 4

HWY 403 STR SITE 10-477

Hwy. 403 - Hwy. 5 Underpass

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FOUNDATION INVESTIGATION REPORT
For
Bridge Structure
Hwy. 403 - Hwy. 5 Underpass
W.P. 199-77-21, Site No. 10-477
District 4, Burlington

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site where four span twin structures are proposed to carry the existing Hwy. 5 over the proposed Hwy. 403.

The fieldwork was carried out between 90 04 25 and 90 04 27. Seven boreholes (BH 1 to BH 7) were advanced and sampled as part of this project by means of hollow stem augers with a conventional diamond drill (NW casing and NQ core barrel) adopted for rock sampling purposes. These boreholes extended down to depths of 9.2 and 10.8 m below the existing ground surface.

This report contains factual information obtained from this investigation pertaining to structure foundations, approach embankments and related earthworks for the bridge structure as shown on Dwg. No. 1997721-A.

SITE DESCRIPTION AND GEOLOGY

The site is located on the proposed alignment of Hwy. 403 where it crosses the existing Hwy. 5 in the City of Burlington, Regional Municipality of Halton. The proposed structure is located approximately 800 m east of the existing Guelph Line. The topography in the area is generally flat to gently undulating with ground surface sloping to the southeast. Land use in the vicinity of the site is primarily residential subdivision development.

Physiographically, the site is located in the "Peel Plain" region (Ref. Chapman and Putnam, 1984) which is characterized by a glacial till containing large amount of paleozoic shale. Underlying the glacial deposit are the red Queenston shale from which the till's reddish colour is derived.

SUBSURFACE CONDITIONS

The subsoil conditions encountered across the site were generally uniform consisting primarily of two distinct deposits. The upper layer consists of a cohesive till with the maximum thickness of about 3.6 at BH's 3 and 5.

Underlying this stratum is a non-cohesive glacial till which can be described as a heterogeneous mixture of sandy silt, gravel and clay underlain by shale and siltstone bedrock. The maximum thickness of this deposit was found to be about 4.2 m at BH 6. These deposits are of glacial origins.

The upper portion of the shale was found to be weathered down to approximate El. 151.0 m with a maximum thickness of about 2.3 m at BH 3.

Thin layers of road fill materials and clayey silt topsoils were encountered at all seven borehole locations. However, it should be noted that at BH 7 a thin layer of sandy silt was found immediately underneath the topsoil with an approximate thickness of 0.8 m. This layer contains water bearing sand layers.

The boundaries between the various soil types, in situ and laboratory test results are shown on the attached Record of Borehole sheets in the Appendix. The locations and elevations of the boreholes, along with a profile and sections showing soil stratigraphy based on borehole data, are shown on Dwg. No. 1997721-A.

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

Fill Material

All seven boreholes encountered some 1.4 m of fill material whose composition ranged from a brown reworked clayey silt to sand and gravel or Granular 'A' material.

An Atterberg Limit test and a Grain Size Distribution analysis were carried out on clayey silt as shown on Figures 1 and 2. Through visual observation and a Atterberg Limit test, it is apparent that the fill material can be classified as a clayey silt to sand and gravel or Granular 'A' material.

Topsoil

Topsoil was encountered at five borehole locations. The thickness of this layer is about 0.7 m at BH's 4 and 6. An Atterberg Limit test and a Grain Size Distribution analysis were carried out on this material. Through the Atterberg Limit test and visual observation, the material can be classified as a clayey silt.

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

This stratum encountered underneath the fill material or topsoil. This deposit consists of a heterogeneous mixture of clayey silt of low plasticity with varying amounts of sand and gravel. The thickness of this layer was found to be the maximum 3.6 m at BH's 3 and 5.

Atterberg Limit tests were performed on these samples and the results are plotted on Figure 3 and summarized as follows:

<u>Property</u>	<u>Range (%)</u>	<u>Average (%)</u>
Natural Moisture Content (w)	10.0-23.0	14.8
Liquid Limit (w _L)	22.5-30.0	25.8
Plastic Limit (w _p)	12.5-18.5	15.6
Plasticity Index (I _p)	6.0-15.0	10.3

From the plasticity chart, it is evident that the layer can be classified as a heterogeneous mixture of clayey silt, sand and gravel with low plasticity (CL or CL-ML).

Grain Size Distribution tests were carried out on this cohesive glacial till material. Figure 4 in the Appendix shows the results. An increasing frequency of fragments of weathered shale was encountered within the lower portion of this till.

In this stratum, the 'N' value ranges from 5 to 74 blows/0.3 m indicating the consistency of this deposit described as firm to hard.

Heterogeneous Mixture of Sandy Silt, Gravel and Clay (Glacial Till)

This deposit was encountered immediately below the cohesive glacial till in all borehole locations. the thickness of this layer ranges from 2.6 m at BH 3 to 4.2 m at BH 6.

Atterberg Limit tests were performed on this material and the results are plotted on Figure 5 and summarized as follows:

<u>Property</u>	<u>Range (%)</u>	<u>Average (%)</u>
Natural Moisture Content (w)	7.5-10.5	8.8
Liquid Limit (w_L)	14.5-16.5	15.4
Plastic Limit (w_p)	12.0-14.0	13.3
Plasticity Index (I_p)	1.0-3.0	2.2

From the plasticity chart, it is evident that the layer can be classified as a heterogeneous mixture of sandy silt, gravel and clay (ML).

Grain Size Distribution tests were carried out on this material. Figure 6 in the Appendix shows the results. This layer is basically non-plastic. In this stratum, the 'N' values are over 100 blows/0.3 m indicating a state of compaction described as very dense.

Bedrock

In each of the borings, split spoon samples of the weathered portion of the bedrock were recovered before augering was terminated. Sound bedrock was proven in three boreholes by obtaining up to 3.0 m of NQ rock cores. The top of the bedrock ranged from El. 151.7 to 154.4 m which are corresponded to 8.6 m and 7.0 m below the existing ground surface. The upper 0.6 m to 2.3 m is in a highly weathered state, with layers of broken shale and red clayey silt.

The bedrock is a red shale with green siltstone (approximately 80% shale, 20% siltstone) of the Queenston formation. Detailed description of the rock are attached in the Appendix entitled "Rock Core Description".

The Core Recovery (CR) and Rock Quality Designation (RQD) values were determined in situ and also in the laboratory to evaluate the competence and integrity of the rock. Core Recoveries (RC) range between 48 and 95 percent and Rock Quality Designation (RQD) values range from 30 to 73 percent. Based on these results, the rock can be classified as weak to very weak and slightly weathered.

GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurements of water levels in the open boreholes. All boreholes were dry or the water levels were close to the boundary between the till and weathered bedrock surface at the time of site investigation. However, groundwater level in BH 2, BH 3 and BH 7 after a couple of hours later was found to be higher than that of others with approximate El. 157.4 m at BH 2 and 158.6 m at BH 3 which correspond to depths of 4.1 m and 2.4 m below the existing ground surface. These high groundwater levels are probably attributed to some water bearing sand layers within cohesive glacial till. Two piezometers were installed at BH's 1 and 5. Upon completion of rock coring, the induced drill water remained perched within the borehole, indicating a low permeability both for the till and shale strata.

DISCUSSION AND RECOMMENDATIONS

The recommendations in this report apply to the bridge structure and related approaches.

It is proposed to construct underpass structure that will carry the existing Hwy. 5 over the proposed Hwy. 403 eastbound and westbound lanes. The proposed structure is a twin four span bridge. A proposed Hwy. 5 profile grade, ranging from 166.2 m at west abutment to 166.0 m at east abutment with a proposed Hwy. 403 profile grade of about 158.0 m, will necessitate minimum approach cuts in the order of 4.2 m at west abutment and 2.8 m at east abutment with 4.0 to 5.2 m fill above the existing ground surface.

Recommendations pertaining to the foundations of the new structure and related earth works are summarized as follows.

Structure Foundations

West Abutment

In consideration of the competent nature of the subsoils, the structure may be supported on spread footings composed of compacted Granular 'A' core as high as possible.

In this case, existing fill materials and topsoils should be excavated down to El. 160 m and the excavation can be backfilled with compacted Granular 'A' core to an elevation where a minimum 1.2 m cover is provided to the underside of the footings. Details of this scheme are shown on Figure 7.

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

Factored Bearing Capacity at U.L.S.	900 kPa
Bearing Capacity at S.L.S. Type II	350 kPa

The alternative to this may be to support the structure on spread footings constructed within very stiff to hard clayey silt till deposit at or below El.

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

Factored Bearing Capacity at U.L.S. 500 kPa
Bearing Capacity at S.L.S. Type II 320 kPa

Alternatively, the closed-type of abutment can be supported on spread footings within hard or very dense glacial till for the following recommended values:

Factored Bearing Capacity at U.L.S. (kPa)	Allowable Capacity at S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
750	500	158
1000	-	<157

East Abutment

In consideration of the weak nature of the subsoil at this location, existing fill material, topsoils and weak sandy silt layer should be excavated down to El. 157 m and excavation can be backfilled with compacted Granular 'A' as high as possible as shown on Figure 7.

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

Factored Bearing Capacity at U.L.S. 900 kPa
Bearing Capacity at S.L.S. Type II 350 kPa

Alternatively, the closed-type of abutments can be supported on spread footings within very dense glacial till for a factored capacity at the U.L.S. of 1000 kPa below the El. 156 m.

Piers

In consideration of the competent nature of subsoils, spread footings can be founded on native glacial till with the following design parameters:

	Factored Bearing Capacity at U.L.S. (kPa)	Allowable Capacity S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
West	1000	650	at or below 157
Piers	1000	-	<156
Centre	900	600	at or below 157
Piers	1000	-	<156
East	650	420	at or below 157
Piers	1000	-	<156

A footing width of 2.5 m with an embedded depth of 1.2 m was used in the calculation of the above capacities. The magnitude of the differential settlement of the footings is anticipated to be within 25 mm, provided the subsoil is not disturbed by construction activities.

Sliding resistance may be computed by assuming a coefficient of friction of 0.57 for cohesive till and 0.7 for non-cohesive till and Granular 'A' material to apply between the underside of footings and the founding soil.

The design of shallow foundation founded on an unyielding type of medium such as glacial till, will be not governed by settlement since the bearing capacity at S.L.S. Type II is much larger than the Factored Bearing Capacity at the U.L.S.

Other Considerations

Lateral Earth Pressures on 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 for purpose of the O.H.B.C.D.

	Granular 'A'	Granular 'B'
Angle of Internal Friction, ϕ	35°	30°
Unit Weight (kN/m ³), γ	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	0.50

The earth pressure coefficient at rest is to be used in design of 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.

Dewatering

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the glacial till. However, if localized seepage or surface water to accumulate in excavations, it can be controlled by perimeter ditches and pumping from corner sumps.

Frost Protection

The footings should be placed so as to have a minimum earth cover of 1.2 m to allow for frost protection.

Approaches and Excavations

The base of all footing excavations should be covered immediately upon exposure with a working slab of lean concrete to protect the exposed glacial till from disturbing and softening within 4 hours of exposure. All organic and softened material should be stripped from within the plan limits of the immediate approach embankments prior to placement of any fill. The site should be properly graded and ditched to allow for free drainage in order to prevent ponding of water around the structure and possible softening of the founding till.

No stability problems are anticipated for permanent embankment and cut slopes constructed to a 2:1 geometry. However, the slope surface should be protected from erosion of the glacial till by a thin layer of topsoil.

Temporary cut slopes will stand at a 2.0:1 geometry, however, these slopes will weather rapidly and show signs of surficial distress if not protected in a reasonable length of time.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Tae C. Kim, Sr. Foundation Engineer, and Frank Reynolds, Technician for Northwestern Region. The equipment was owned and operated by Marathon Drilling Co. Ltd. and Master Soil Investigation Co. Ltd., Toronto.

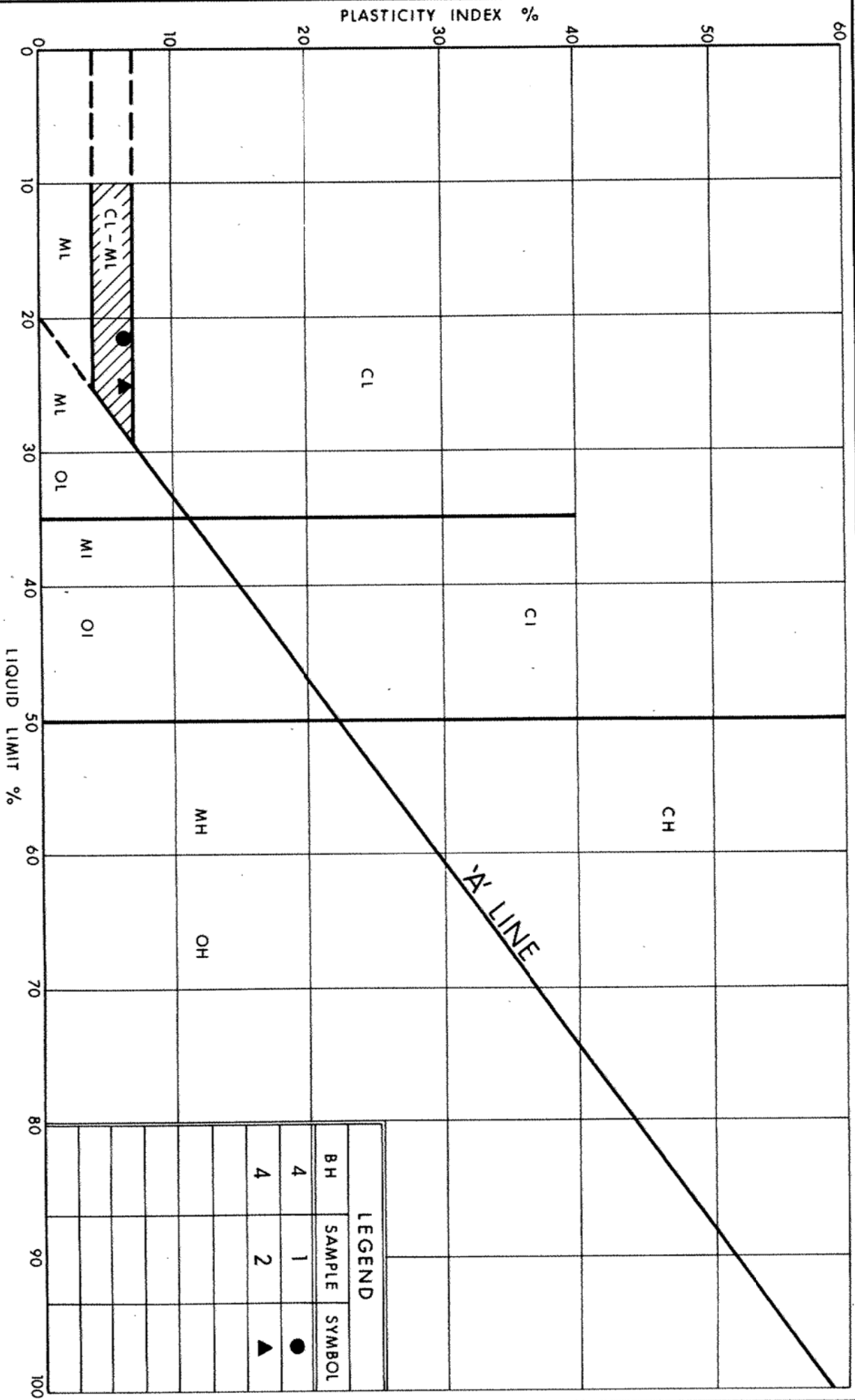
This report was written by Tae C. Kim, Sr. Foundation Engineer, reviewed by P. Payer, Sr. Foundation Engineer and approved by M. Devata, Chief Foundation Engineer.



Tae C. Kim
Tae C. Kim, P.Eng.
Sr. Foundation Engineer

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

APPENDIX



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

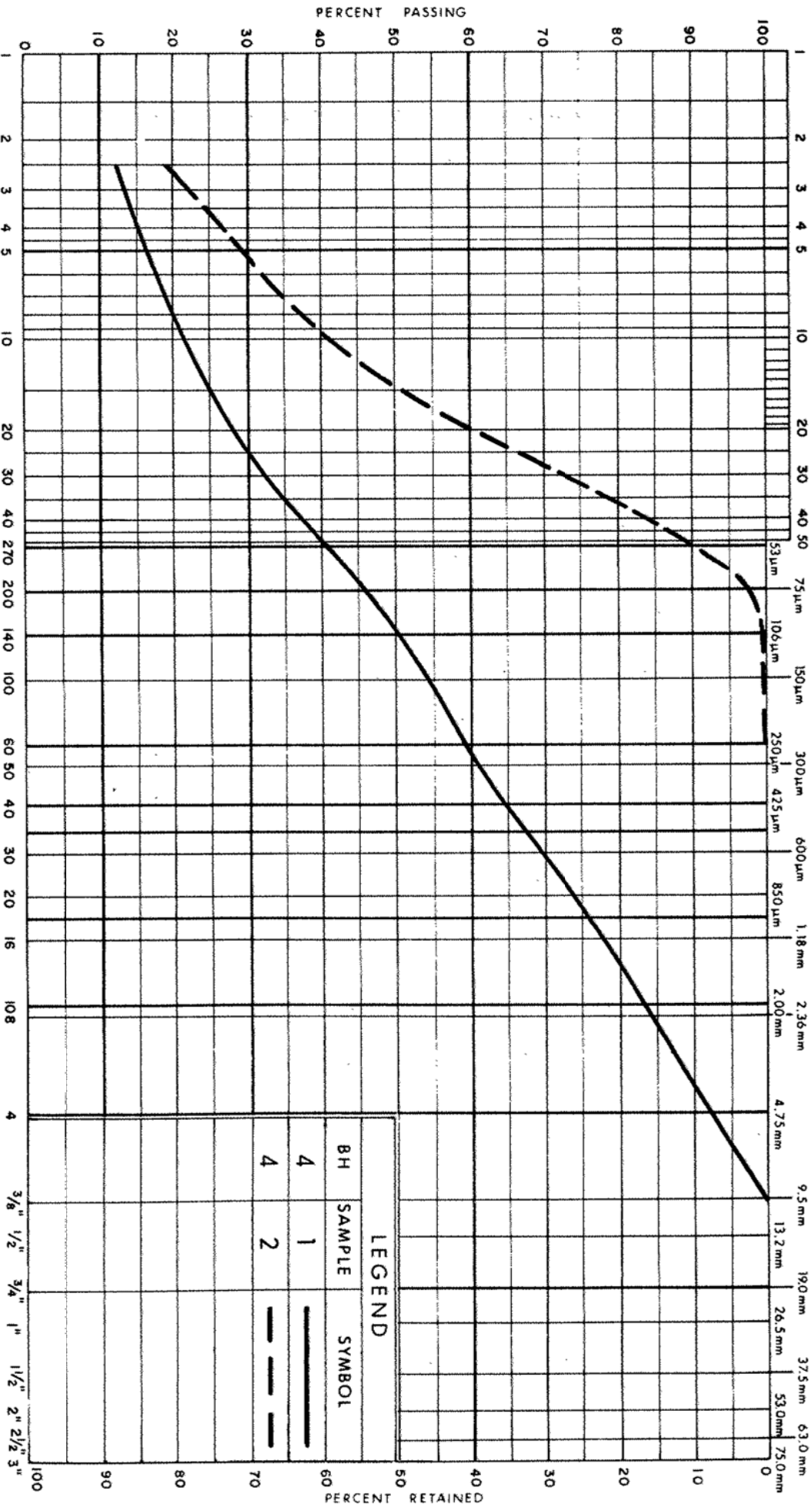
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



MINISTRY SIEVE DESIGNATION (Imperial)

GRAIN SIZE DISTRIBUTION

CLAYEY SILT (FILL) AND TOPSOIL

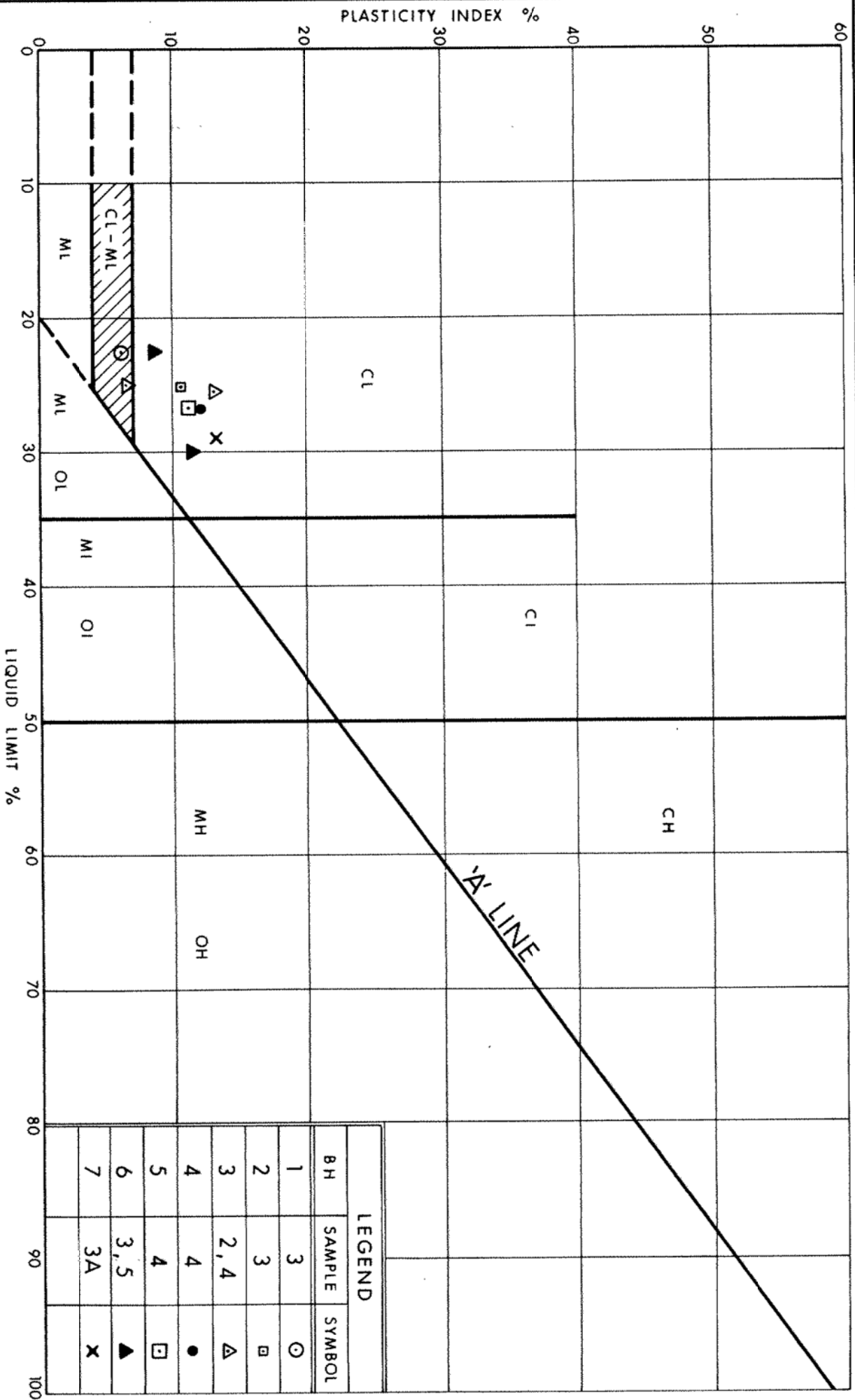
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Ontario

FIG No 2

W P 199-77-21



UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT

SAND

GRAVEL

Fine

Medium

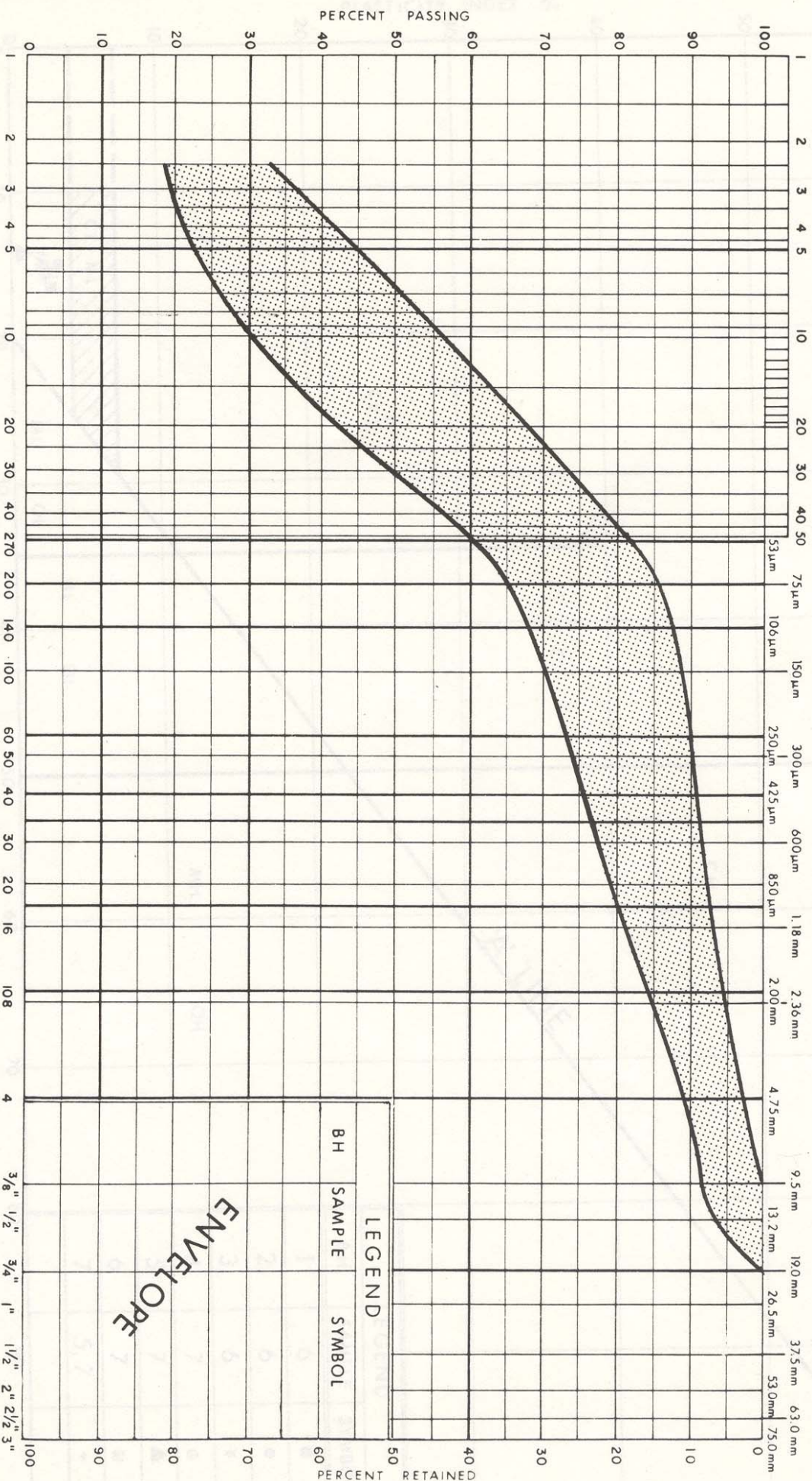
Coarse

Fine

Coarse

GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



LEGEND

BH SAMPLE SYMBOL

ENVELOPE

MINISTRY SIEVE DESIGNATION (Imperial)

3/8" 1/2" 3/4" 1" 1 1/2" 2" 2 1/2" 3"

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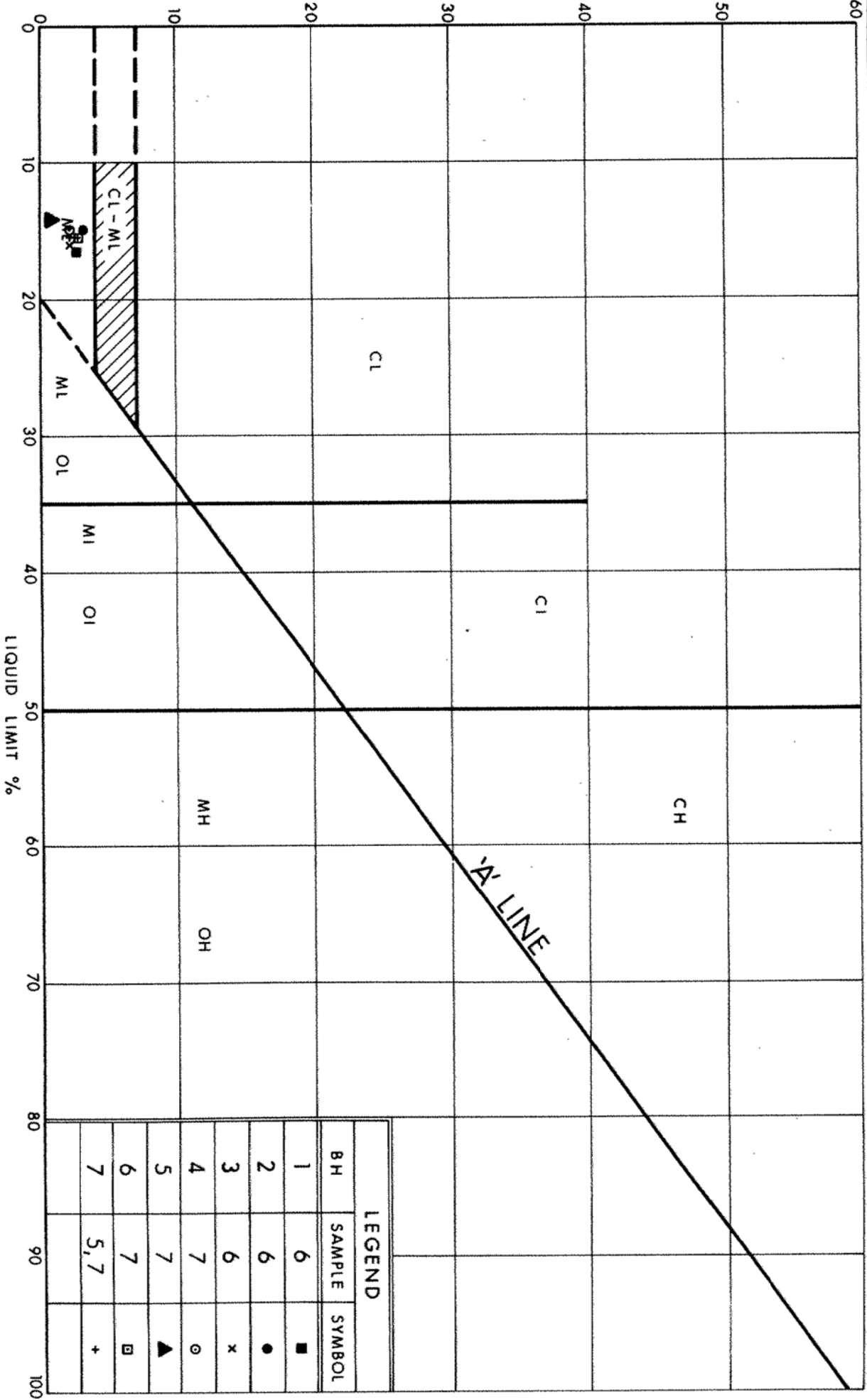
GRAIN SIZE DISTRIBUTION


HETEROGENEOUS MIXTURE OF

CLAYEY SILT, SAND & GRAVEL (Glacial Till)

FIG No 4

W P 199-77-21



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PLASTICITY CHART
HETEROGENEOUS MIXTURE OF
SANDY SILT, GRAVEL & CLAY (Glacial Till)

FIG No 5

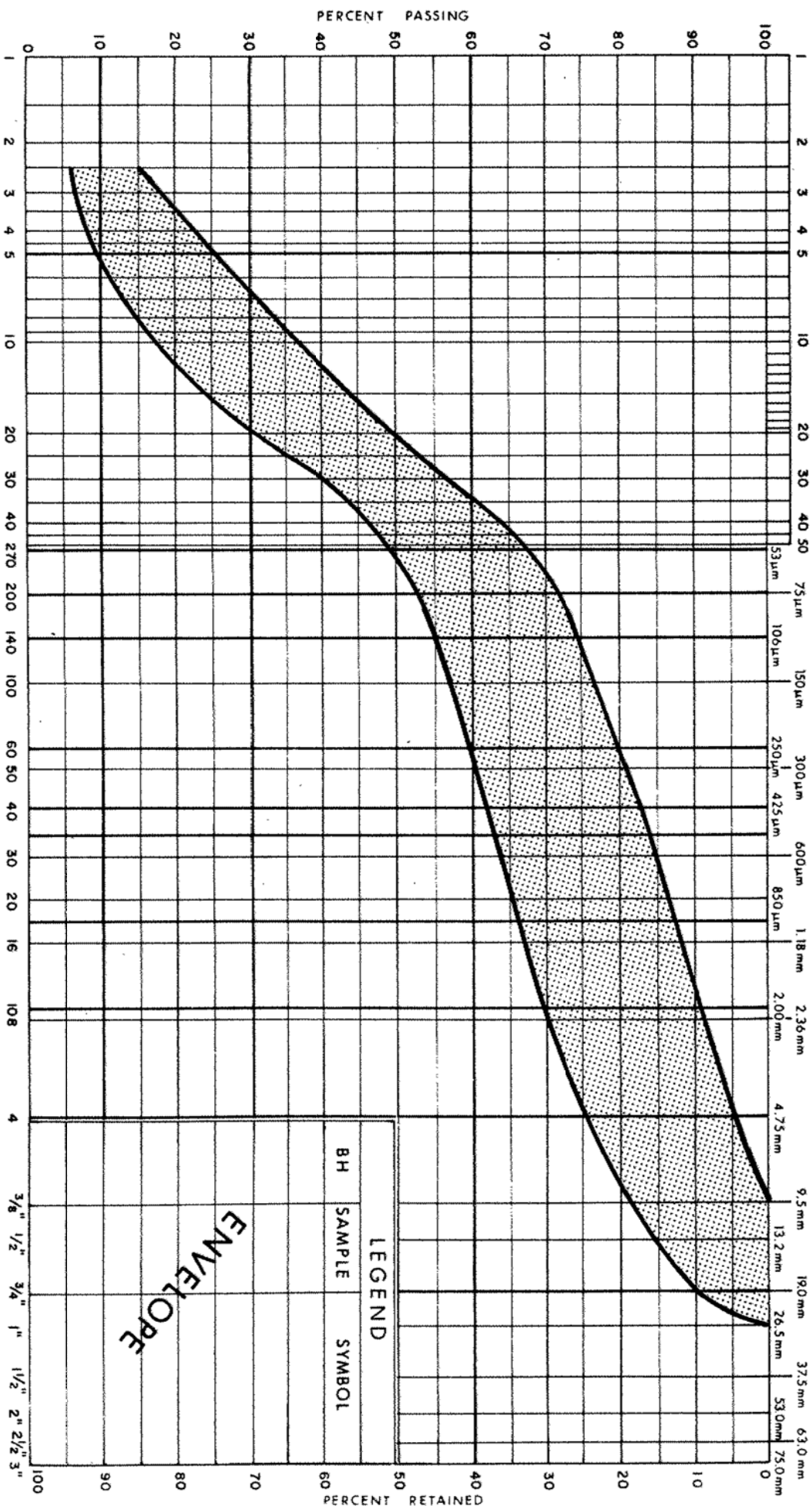
W P 199 - 77 - 21

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT		SAND		GRAVEL	
		Fine	Medium	Coarse	Coarse

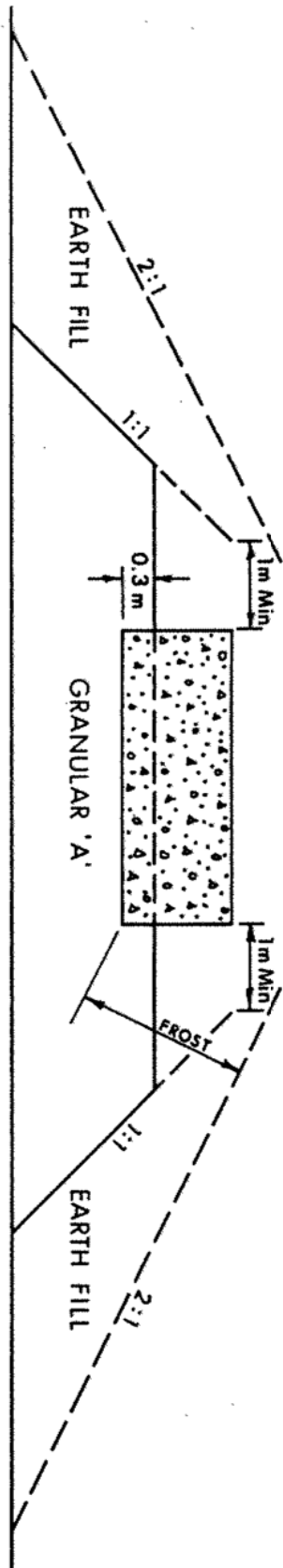
GRAIN SIZE IN MICROMETERS

MINISTRY SIEVE DESIGNATION (Metric)



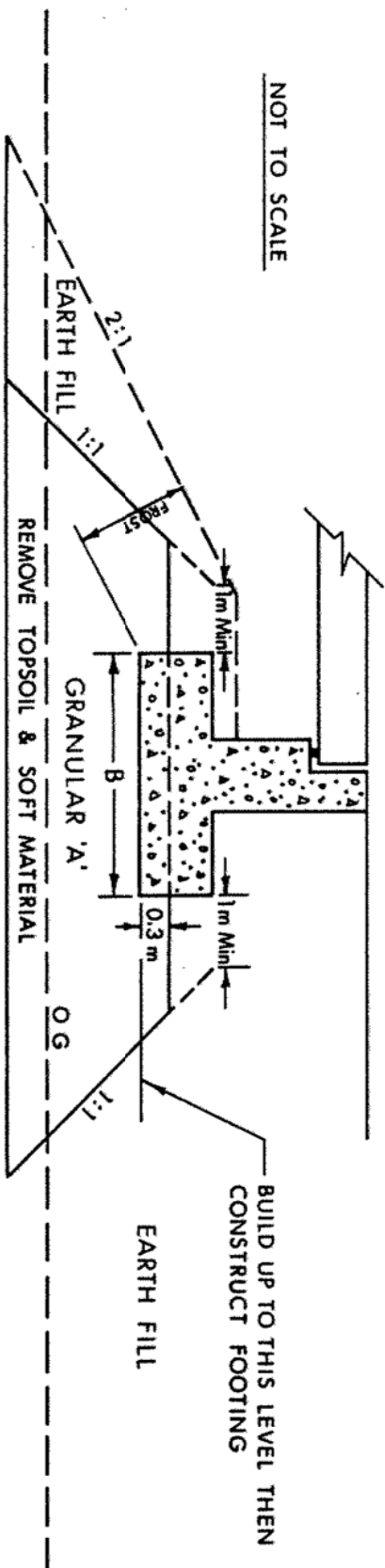
LEGEND	
BH SAMPLE	SYMBOL

ENVELOPE



X SECTION

NOT TO SCALE



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 MTO STANDARDS.
- 3 - CONSTRUCT CONCRETE FOOTING.
- 4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

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

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_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_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

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

RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 199-77-21 LOCATION Co-ord: N 4804 607.9 E 277 719.1 ORIGINATED BY T.K.
DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NQ Core COMPILED BY J.L.
DATUM Geodetic DATE April 26 and 27, 1990 CHECKED BY T.K.

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	20 40 60 80 100					
161.4	Ground Surface														
0.0	Granular 'A'														
160.5	Sand and Gravel (Fill)														
0.9	Clayey Silt (Fill)		1	SS	8										
160.0	Clayey Silt (Topsoil) Brown														
1.4	Reddish Brown		2	SS	20										
	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Very Stiff to Hard (Glacial Till)		3	SS	29										
			4	SS	41										
157.7			5	SS	100 /13cm										
3.7			6	SS	120 /13cm										
	Heterogeneous Mixture of Sandy Silt, Gravel and Clay Very Dense (Glacial Till)		7	SS	120 /10cm										
154.4	Reddish Brown														
7.0	Red		8	SS	120 /15cm										
	Bedrock Weathered Queenston Shale Sound		9	RC	REC 48%										
			10	RC	REC 81%										
150.6															
10.8	End of Borehole														
	• W.B.L. = Water Bearing Layer														
	• GROUND WATER CONDITIONS														
	PIEZO. NO.														
	GROUND WATER ELEVATION (Metres)														
	1														
	154.4														

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 199-77-21 LOCATION Co-ord: N 4804 635.1 E 277 717.6 ORIGINATED BY F.L.R.
DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.
DATUM Geodetic DATE April 25, 1990 CHECKED BY T.K.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
161.3	Ground Surface													
0.0	Clayey Silt (Fill)						161							
160.5														
0.8	Clayey Silt (Topsoil)		1	SS	23		160							
159.9	Reddish Brown													
1.4	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Very Stiff to Hard (Glacial Till)		2	SS	28		159							
			3	SS	30									
			4	SS	46		158							
157.7														
3.7	Heterogeneous Mixture of Sandy Silt, Gravel and Clay Very Dense (Glacial Till)		5	SS	120		157							
			6	SS	150		156							
			7	SS	100		155							
154.3	Reddish Brown													
7.0	Bedrock Queenston Shale		8	SS	100		154							
							153							
152.1	Weathered Sound		9	SS	180									
9.2	End of Borehole													
	* Borehole dry on completion, charged with water later													

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 199-77-21 LOCATION Co-ord: N 4804 865.8 E 277 741.8 ORIGINATED BY F.L.R.
DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.
DATUM Geodetic DATE April 25, 1990 CHECKED BY T.K.

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					
161.0	Ground Surface													
0.0	Clayey Silt (Fill)													
160.2	Reddish Brown													
0.8	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Stiff to Hard (Glacial Till)		1	SS	12		160							3 24 56 17
	Sandy Silt Layer		2	SS	16		159							
			3	SS	20		158							4 10 58 28
			4	SS	18		157							
156.6			5	SS	74		156							
4.4	Heterogeneous Mixture of Sandy Silt, Gravel and Clay Very Dense (Glacial Till)		6	SS	150	/20cm	155							4 24 64 8
			7	SS	120	/8cm	154							
154.0	Reddish Brown						153							
7.0	Bedrock Queenston Shale		8	SS	120	/8cm	152							
151.7	Weathered Sand		9	SS	120	/15cm								
9.3	End of Borehole													
	Borehole dry on completion, charged with water later													

RECORD OF BOREHOLE No 4

1 OF 1 METRIC

W.P. 199-77-21 LOCATION Co-ord: N 4804 667.6 E 277 766.1 ORIGINATED BY F.L.R.
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NQ Core COMPILED BY J.L.
 DATUM Geodetic DATE April 25 and 26, 1990 CHECKED BY T.K.

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					
160.9	Ground Surface													
0.0	Cloyey Silt (Fill)		1	SS	14		160							9 44 36 11
159.5														
1.4	Cloyey Silt (Topsoil)		2	SS	5		159							0 2 83 15
158.8														
2.1	Heterogeneous Mixture of Cloyey Silt, Sand and Gravel Very Stiff to Hard (Glacial Till)		3	SS	16		158							
	----- Brown		4	SS	24		157							4 17 49 30
	----- Reddish Brown		5	SS	61		156							
156.5			6	SS	150		155							
4.4	Heterogeneous Mixture of Sandy Silt, Gravel and Clay Very Dense (Glacial Till)		7	SS	120	/9cm	154							8 31 55 6
153.2	Reddish Brown		8	SS	177		153							
7.7	Bedrock ----- Weathered Queenston Shale Sound		9	SS	100	/5cm	152							
			10	RC	REC		151							RQD 73%
150.2					95%									
10.7	End of Borehole													

METRIC

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 6

1 OF 1 METRIC

W.P. 199-77-21 LOCATION Co-ord: N 4804 727.3 E 277 813.1 ORIGINATED BY F.L.R.
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, and H.S. Auger COMPILED BY J.L.
 DATUM Geodetic DATE April 26, 1990 CHECKED BY T.K.

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					
160.3	Ground Surface													
0.0	Clayey Silt (Fill)		1	SS	16	DRY	160							
158.9							159							
1.4	Clayey Silt (Topsoil)		2	SS	17									
158.1							158							
2.1			3	SS	13									
	Brown Reddish Brown Heterogeneous Mixture of Clayey Silt, Sand and Gravel Very Stiff to Hard (Glacial Till)		4	SS	24		157							9 13 48 30
			5	SS	51		156							10 22 49 19
155.8			6	SS	106		155							
4.4			7	SS	120	/13cm	154							4 28 60 8
	Heterogeneous Mixture of Sandy Silt, Gravel and Clay Very Dense (Glacial Till)		8	SS	150	/23cm	153							
151.7							152							
8.6	Bedrock													
151.0	Queenston Shale	Weathered	9	SS	120	/10cm								
9.2	End of Borehole	Sound												

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.P. 199-77-21 LOCATION Co-ord: N 4804 754.6 E 277 811.6 ORIGINATED BY T.K.
 DIST 4 HWY 403 BOREHOLE TYPE Cone Test, H.S. Auger, and NQ Core COMPILED BY J.L.
 DATUM Geodetic DATE April 25, 1990 CHECKED BY T.K.

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					
160.1	Ground Surface													
0.0	Sand and Gravel (Fill)		1	SS	6		160							
158.8							159							
1.4	Clayey Silt (Topsoil)		2	SS	7		158							
1.7	Reddish Brown Sandy Silt w/ some Clay and Gravel		3	SS	2		157							
157.6			3-A	SS	2		156							11 37 39 13 0 4 68 28
2.5	Heterogeneous Mixture of Clayey Silt, Sand and Gravel Soft to Very Stiff (Glacial Till)		4	SS	17		155							
156.4			5	SS	101		154							
3.7			6	SS	120	/15cm	153							
	Heterogeneous Mixture of Sandy Silt, Gravel and Clay Very Dense (Glacial Till)		7	SS	120	/8cm	152							13 23 48 16
152.5	Reddish Brown Red		8	SS	143		151							
7.7	Weathered Bedrock Queenston Shale		9	RC	REC 75%									6 29 57 8
150.5														RQD 42%
9.6	End of Borehole * Borehole dry on completion, charged with water later													

ROCK CORE DESCRIPTION **WP 199-77-21**

Page 1 of 1

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	9	7.80-9.24	48	18	7.80-10.80	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (26%); very fine grained; weak to very weak rock; unweathered to slightly weathered; close to very close spaced fractures.
	10	9.24-10.80	81	52		
2						SHALE, expected as above (no core recovered).
3						SHALE, expected as above (no core recovered).
4	10	9.14-10.67	95	59	9.14-10.67	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (24%); very fine grained; weak to very weak rock; unweathered to slightly weathered; close to very close spaced fractures.
5						SHALE, expected as above (no core recovered).
6						SHALE, expected as above (no core recovered).
7	9	8.08-9.60	75	10	8.08-9.60	SHALE, dark reddish brown, interbedded with greyish green SILTSTONE (5%); very fine grained; weak to very weak rock; unweathered to slightly weathered; close to very close spaced fractures.

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

(NOTE: Depths are approximated where core recovery is less than 100%)

Logged by: DAW, Soils and Aggregates Section

CONT No
WP No 199-77-4

HIGHWAY 5

BORE HOLE LOCATIONS & SOIL STRATIGRAPHY



LEGEND

- Bore Hole
- Dynamic Cone Penetration
- Bore Hole & Cone
- Bore Hole & Cone
- Piezometer
- WL or Time of Infiltration

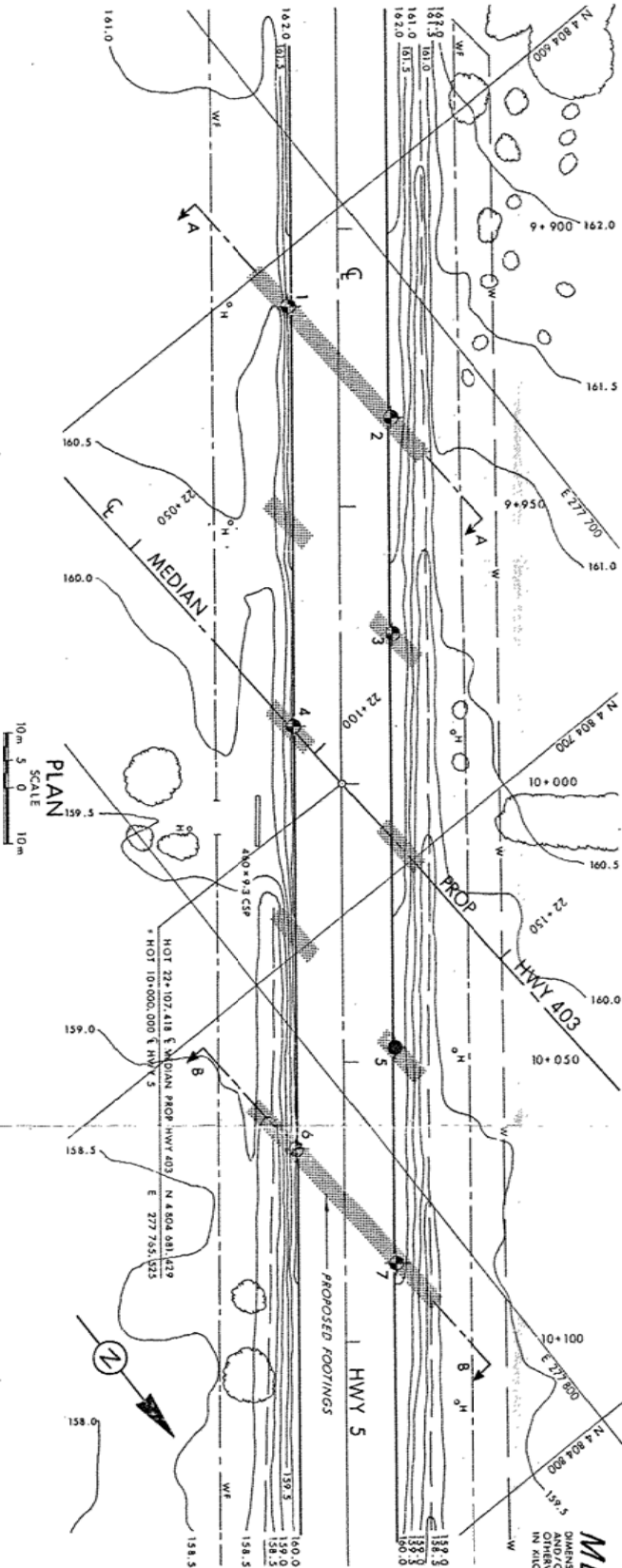
No	ELEVATION	CO-CONE
1	161.4	4 804 607
2	161.3	4 804 635
3	161.0	4 804 655
4	160.9	4 804 667
5	160.4	4 804 724
6	160.3	4 804 727
7	160.1	4 804 734

NOTE: The complete foundation investigation report, including all test results, is available for review at the City of Burlington Engineering Department, 100 King Street West, 3rd Floor, Burlington, Ontario L7R 1A1.

DATE: 01/05/00
BY: [Signature]
CHECKED: [Signature]
DESIGNED: [Signature]

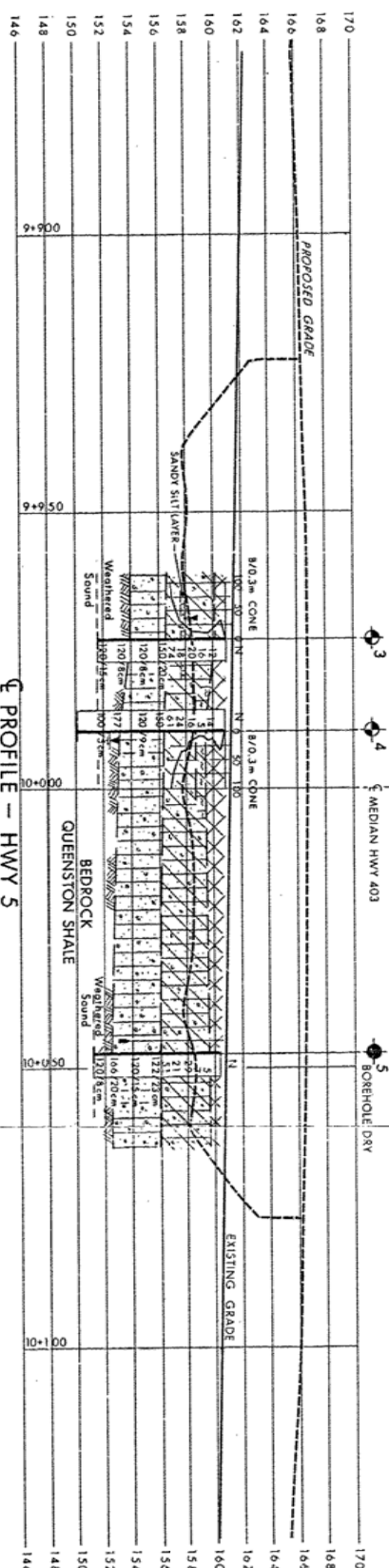
METRIC

DIMENSIONS ARE IN METRES
AND DIMENSIONS IN FEET AND INCHES
OTHERWISE SHOWN. STATIONS
IN KILOMETRES - METRES.



§ PROFILE - HWY 5

HOR 10m 3 28 ft
VERT 1m 3 28 ft

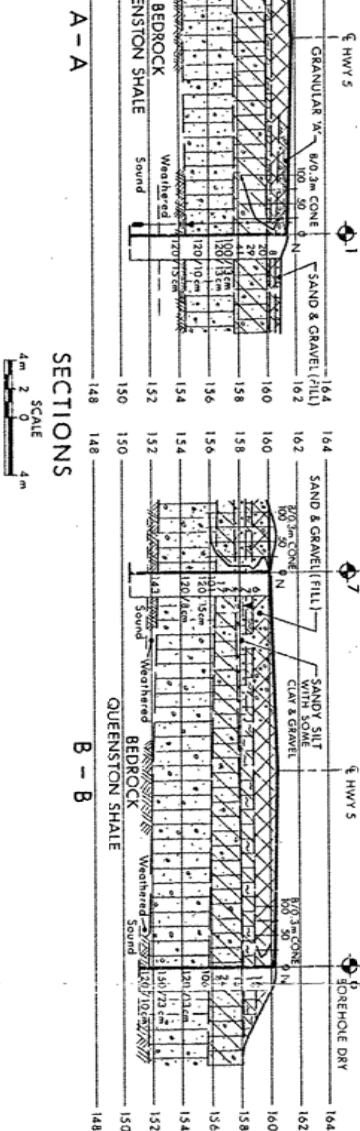


SOIL STRATIGRAPHY LEGEND

- CLAYEY SILT (FILL)
- CLAYEY SILT (TOPSOIL)
- HETEROGENEOUS MIXTURE OF CLAYEY SILT, SAND & GRAVEL Firm to Hard (Glacial Till)
- HETEROGENEOUS MIXTURE OF SANDY SILT, GRAVEL & CLAY Very Dense (Glacial Till)

SECTIONS

SCALE
4m 13 12 ft
2m 6 57 ft
0



SEND
TO

Ms. B. Berner
Foundation Design Section

-7839

FROM

Jim Marr

DEPT.

Central Region Structural Section

DATE

Mar 9/94

SUBJECT

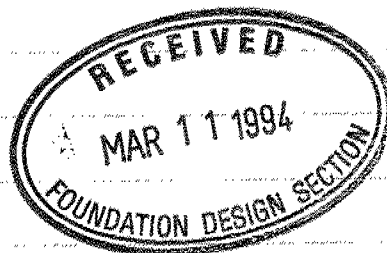
Soil Pressure for Shoring to Pier Cap, Cont 93-43, Hwy 403 & 5

As discussed in our telephone conversation today,
a soil pressure of approx 4.5 ksf (216 kpa) was
obtained from one set of frames for the above subject.

Please comment on this soil pressure.
A soil plate width of 235 mm was assumed
in the calculations

Thanks
Jim Marr

REPLY



REPLY FROM

REPLY DATE

memorandum



To: G. Al-Bazi
Design Engineer
Structural Office
7th Floor, Atrium Tower

From: Foundation Design Section
Room 315, Central Building

Re: Final Drawing Review
Hwy. 403 - Hwy. 5 Underpass
W.P. 199-77-21, Site 10-477
District 4, Burlington

Date: 1991 02 08

Further to your memo dated January 21, 1991, this letter summarizes our review on the submitted final drawings and provisions.

Based on the above review, it is concluded that the design confirms to our recommendations and comments. However, it should be emphasized that the base of footing excavations for both abutments and piers should be covered immediately upon exposure with a working slab of lean concrete or Granular 'A' material to protect the exposed glacial till from disturbing and softening within 4 hours of exposure. It should also be noted that the slope surface should be protected from erosion of fill material as per M.T.O. Standard.

We have no further comments. If you have any questions, please contact this office.

A handwritten signature in cursive script that reads "Tae C. Kim".

Tae C. Kim, P. Eng.
Sr. Foundation Engineer

for

M. Devata P. Eng.
Chief Foundation Engineer

TCK/mmj

CONCRETE SLOPE
PAVING IS NOT PART
OF THIS CONTRACT

SHEET

ENGINEERS
PLANNERS
ARCHITECTS

40 MPa
30 MPa

$$100 \pm 25$$

$$80 \pm 20$$

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

IF THE ACTUAL BEARING HEIGHTS ARE DIFFERENT FROM THE ASSUMED BEARING HEIGHTS GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE BEARING SEAT ELEVATIONS AND THE REINFORCING STEEL TO SUIT THE ACTUAL HEIGHTS.

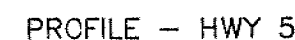
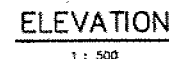
1. GENERAL ARRANGEMENT
2. SITE PLAN AND BORE HOLE DATA
3. FOOTING LAYOUT
4. ABUTMENT FOOTING REINFORCING
5. PIER FOOTING REINFORCING
6. WEST ABUTMENT LAYOUT
7. EAST ABUTMENT LAYOUT
8. ABUTMENT REINFORCING
9. WEST WINGWALL DETAILS
10. EAST WINGWALL DETAILS
11. WEST PIER DETAILS
12. CENTRE PIER DETAILS
13. EAST PIER DETAILS
14. PRESTRESSED CONCRETE GIRDER DETAILS
15. DECK DETAILS I
16. DECK DETAILS II
17. DECK REINFORCING I
18. DECK REINFORCING II
19. DIAPHRAGM DETAILS
20. BARRIER WALL
21. JOINT ANCHORAGE AND ARMOURING
22. 6000mm APPROACH SLAB
23. CONCRETE SLOPE PAVING (M.I.C.)
24. AS CONSTRUCTED ELEVATIONS & DIMS.
25. STANDARD DETAILS
26. QUANTITIES STRUCTURE

DD 3502 - MINIMUM GRANULAR BACKFILL REQUIREMENTS.

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



REVISIONS									
DATE	BY	DESCRIPTION							
DESIGN	TJW	CHECK	HRH	LOADING	CHB00-83 CLASS A	DATE	JAN. 91		
DEAWING	TJW	CHECK	TJW	SITE No.	10-477	DWD	1		



BENCH MARK
BM 156.954m
GEODETIC DATUM
PLAQUE ON S.E. CORNER
CULVERT, SOUTH FACE
22.7 LT STA. 10+338.5
HWY 5

DRAWN WITH CAD 12/04/90 15:23 D:\012858\515PCA

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

CONT No
WP No 199-77-21
HWY 403 - HWY 5
UNDERPASS
FOOTING LAYOUT



SHEET

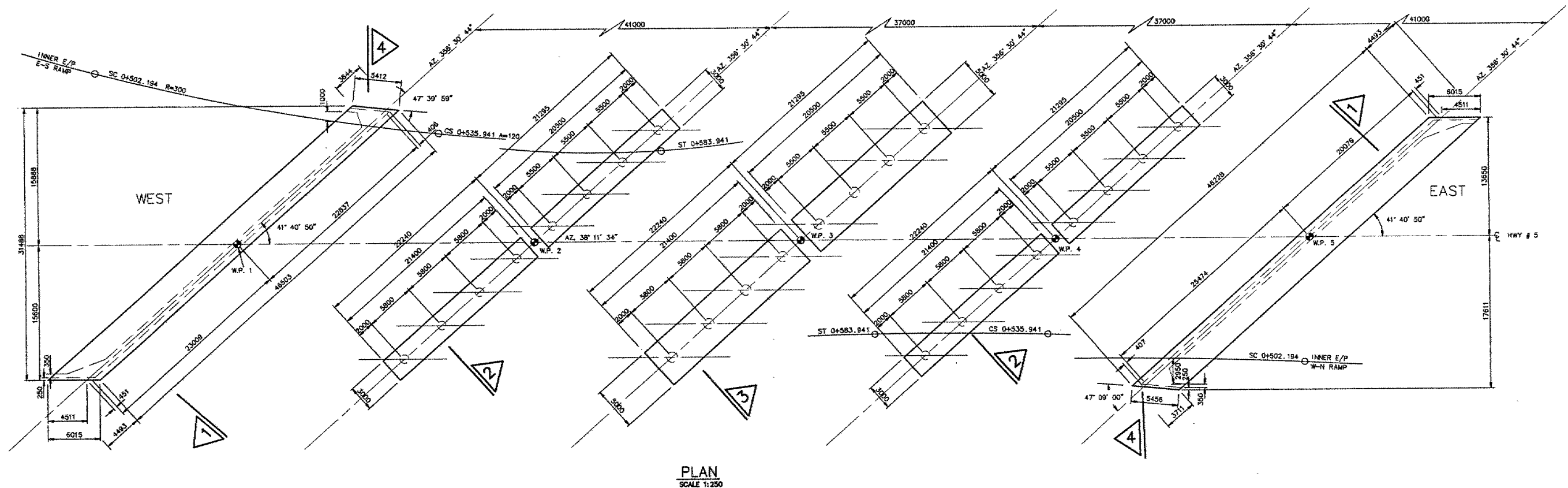
DELCAN

ENGINEERS
PLANNERS
ARCHITECTS

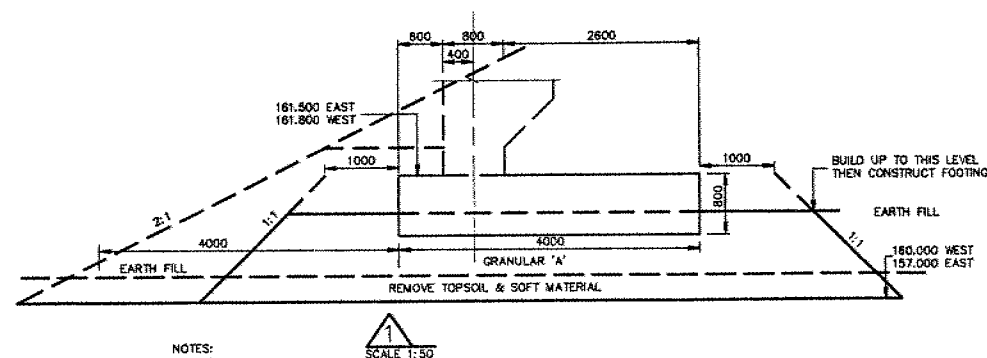
W.P. CO-ORDINATES		
W.P. No.	NORTHING	EASTING
1	4804620.126	277717.297
2	4804652.349	277742.648
3	4804681.429	277765.525
4	4804710.509	277788.402
5	4804742.732	277813.753

W-N RAMP CO-ORDINATES		
STATION INNER E/P	NORTHING	EASTING
CS 0+108.521	4804771.583	277788.466
SC 0+297.951	4804656.630	277904.517
CS 0+485.073	4804759.291	277865.418
SC 0+502.194	4804739.767	277834.148
CS 0+535.941	4804716.336	277809.883
ST 0+583.941	4804679.426	277779.218

E-S RAMP CO-ORDINATES		
STATION INNER E/P	NORTHING	EASTING
CS 0+108.521	4804591.275	277742.584
SC 0+297.951	4804706.228	277826.533
CS 0+485.073	4804603.567	277865.632
SC 0+502.194	4804623.091	277896.904
CS 0+535.941	4804646.522	277721.167
ST 0+583.941	4804683.432	277751.832

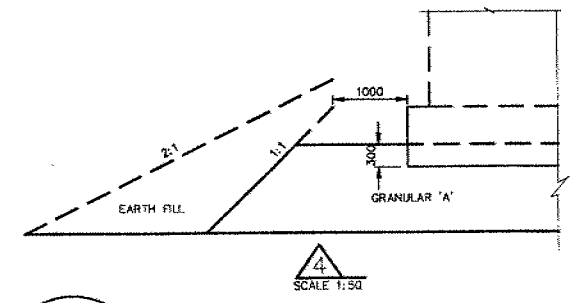
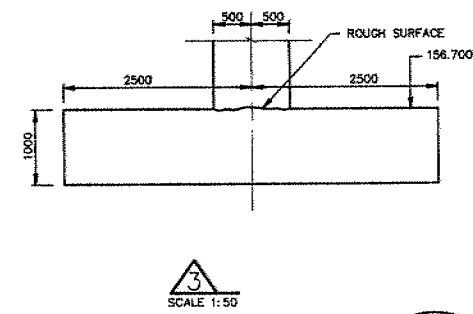
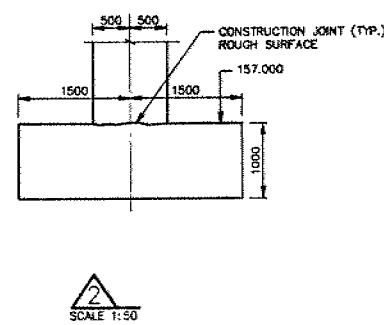


NOTE:
1. THIS DRAWING TO BE READ IN
CONJUNCTION WITH DRAWINGS 4 & 5.



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 THE SPECIAL PROVISIONS.
3. CONSTRUCT CONCRETE FOOTING
4. PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	CHECK	DESCRIPTION	DATE
1		TJW		DESIGN	
2		GMC		DRAWING	
3					
4					
5					
6					
7					
8					
9					
10					

January 1990

Hwy. 403 - Hwy. 5 U'Pass
W.P. 199-77-21, Site 10-477
District 6, Toronto



East Shoulder Looking West Along
Centre Line Hwy. 403



East Shoulder Looking East Along
Centre Line Hwy. 403