DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-218

DIST. 4 REGION

W.P. No. 407-85-02

CONT. No.

W. O. No.

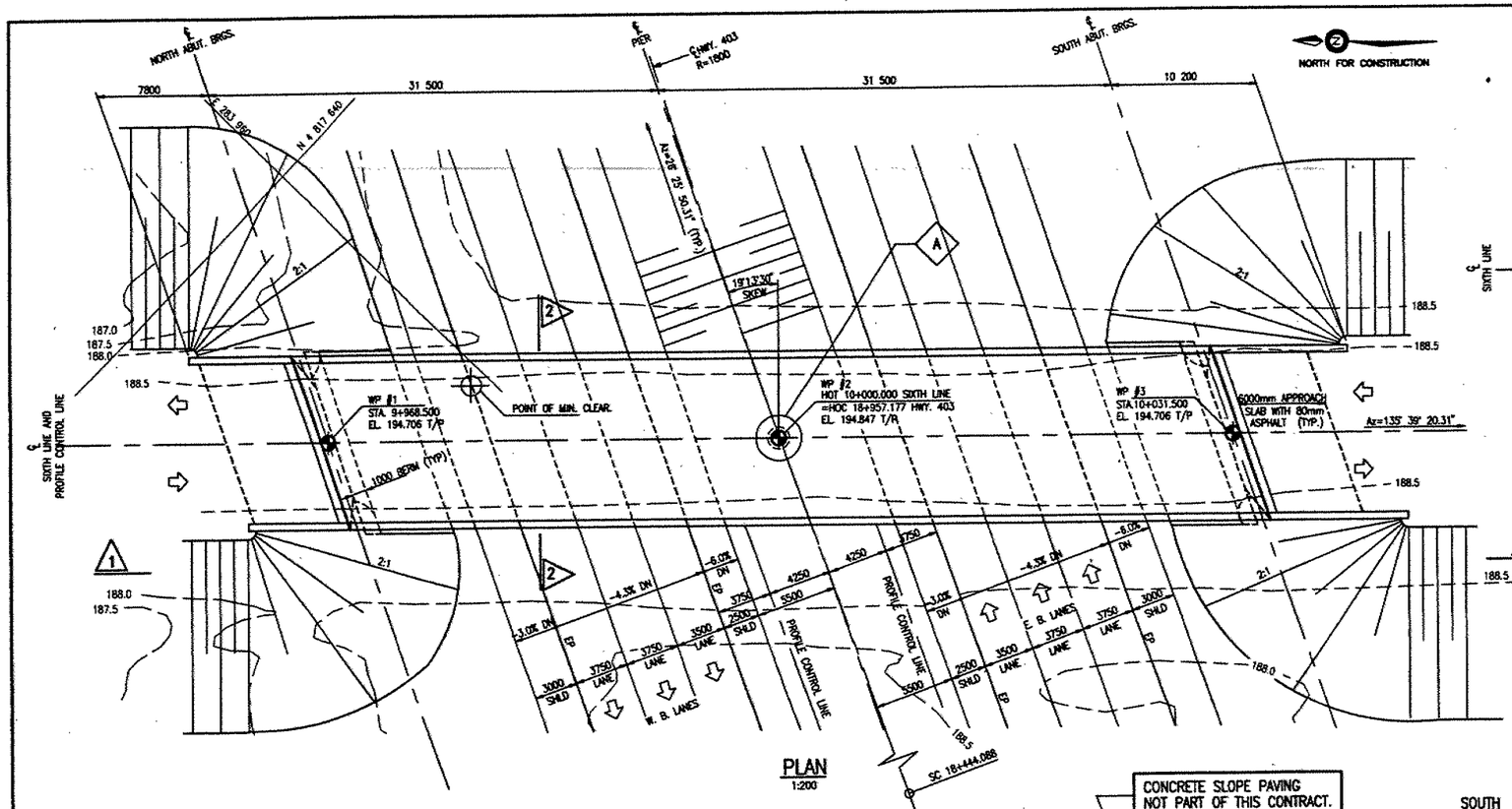
STR. SITE No. 10-489

HWY. No. 403

LOCATION HWY 403 & SIXTH LINE UNDERPASS

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



PLAN
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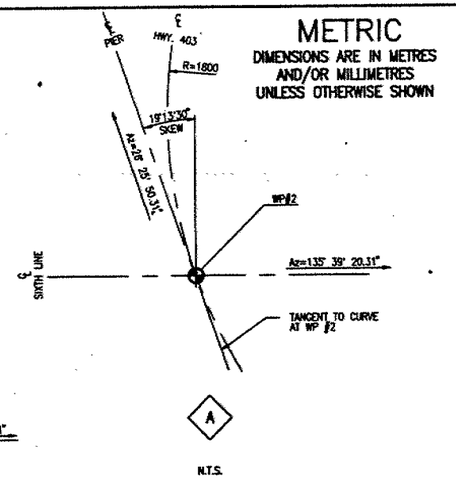


METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

DIST. No. 4	
CONT. No.	
WP. No. 407-85-02	
HWY. 403 SIXTH LINE UNDERPASS	SHEET
GENERAL ARRANGEMENT	

FENCO MacLAREN

GENERAL NOTES

CLASS OF CONCRETE

DECK AND COLUMN	35 MPa
REMAINDER	30 MPa

CLEAR COVER TO REINFORCING STEEL

FOOTINGS		100 ± 25
DECK	– TOP	70 ± 20
	– BOTTOM AND SIDES	50 ± 10
REMAINDER		70 ± 20

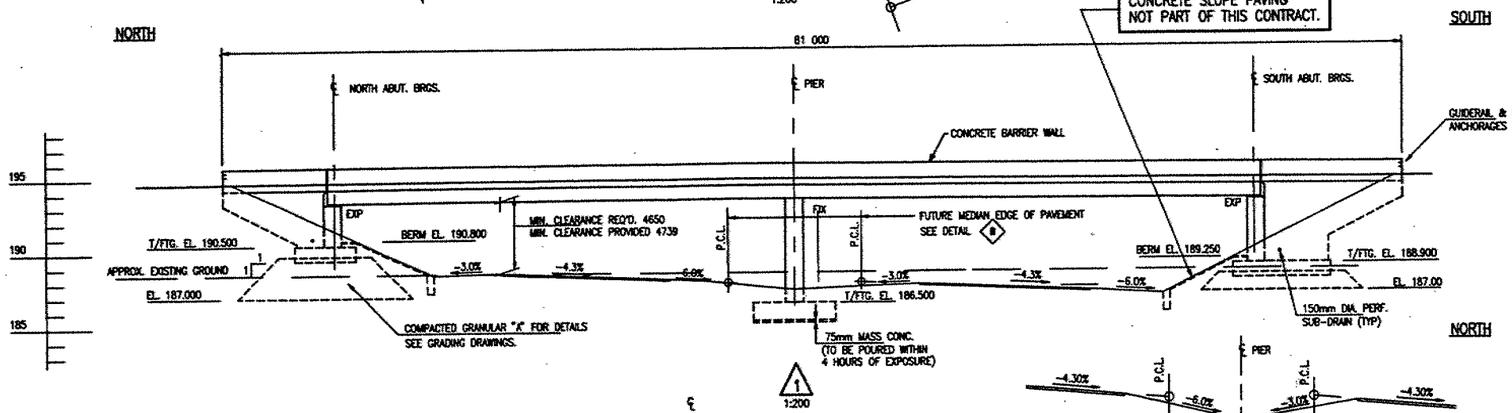
UNLESS OTHERWISE SPECIFIED

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

CONSTRUCTION NOTES

THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESSES FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.

LIST OF DRAWINGS



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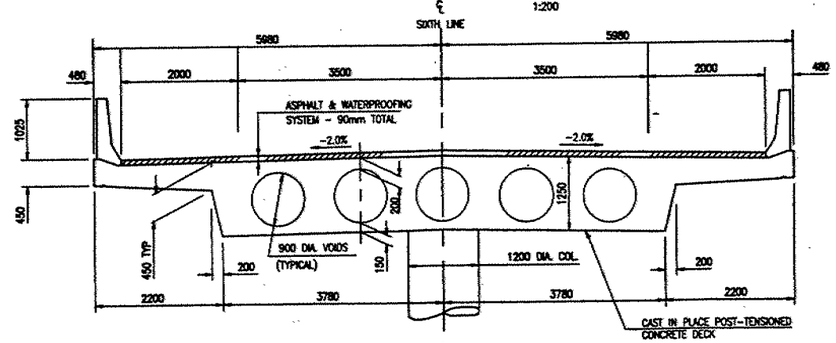
B
N.T.S.

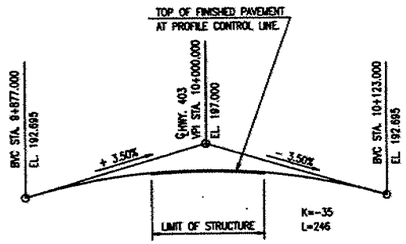


2
1:50

PROFILE HWY. 403

N.T.S.

NOTES:
WP DENOTES WORKING POINT
T/P DENOTES TOP OF PAVEMENT
P.C.L. DENOTES PROFILE CONTROL LINE



PROFILE SIXTH LINE

N.T.S.

APPLICABLE STANDARD DRAWINGS :

OPSD 3501.01 GRANULAR BACKFILL REQ'MTS
OPSD 4010.0 GUIDERAIL AND CHANNEL ANCHORAGE

BM 188.103m
GEODETIC DATUM
SOUTH WESTERLY CORNER OF CONC. CULVERT UNDER SIXTH LINE. CUT CROSS 11.3m RT. 9+944.30

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	W.Y.C.	CHK. B.T.P.	CODE OHBDC-91	LOAD		DATE	MAY 1994
DRAWN	F.J.W.	CHK. W.Y.C.	SITE 10-489	STRUCT.	SCHEME		DWG. 1

FILE: 85319-GA

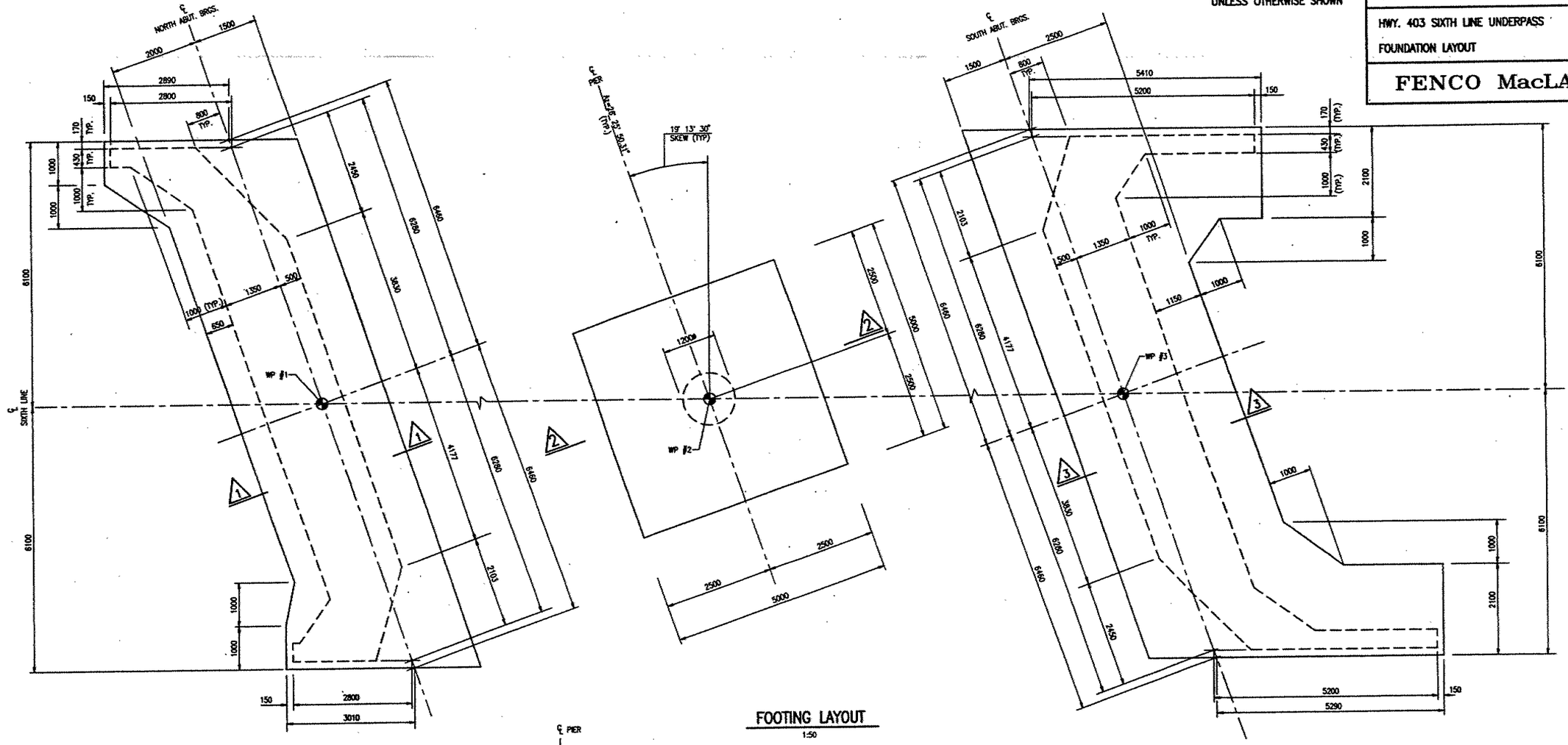
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT. No.
WP. No.407-85-02

HWY. 403 SIXTH LINE UNDERPASS
FOUNDATION LAYOUT

SHEET

FENCO MacLAREN



FOOTING LAYOUT
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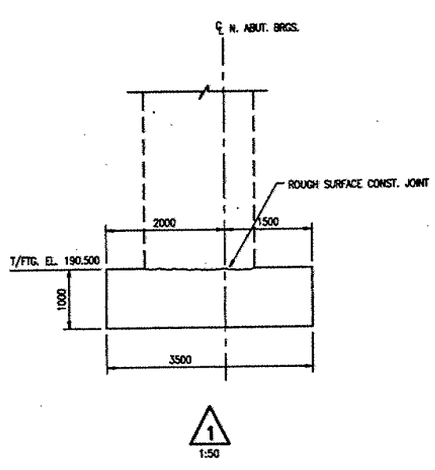

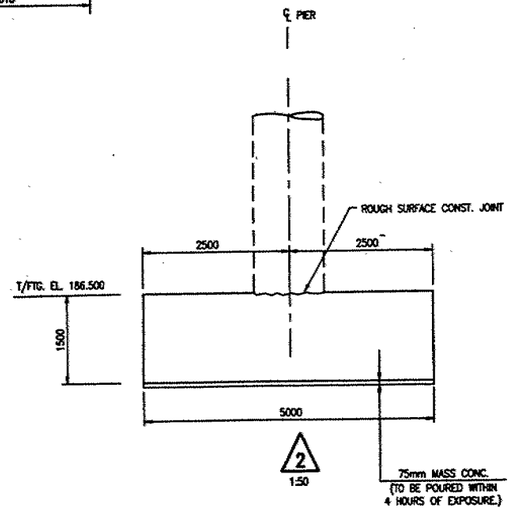

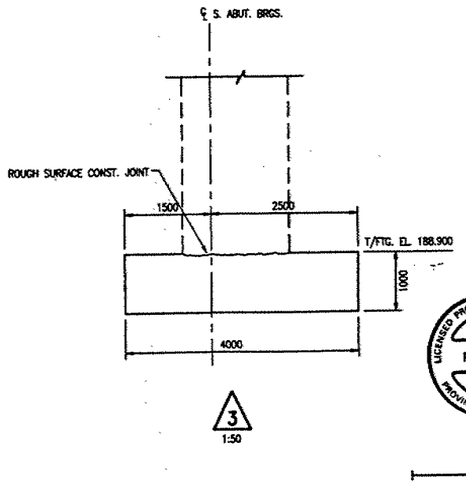

WORKING POINT COORDINATE			
WP	STATION	NORTH	EAST
1	9+968.500	N 4 817 624.982	E 283 949.100
2	10+000.000	N 4 817 602.455	E 283 971.118
3	10+031.500	N 4 817 579.928	E 283 993.135

P. F. YONG — LICENSED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

W-Y. CHOW — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS			
DATE	BY	DESCRIPTION	

DESIGN	P. Y.	CHK. B.T.P.	CODE	OHBDC-91	LOAD	DATE	MAY 1994
DRAWN	S. LEE	CHK. W.Y.C.	SITE	10-489	STRUCT.	SCHEME	DWG. 3

FILE: 6311-FTG (1-50)

FILE

Ministry
of
Transportation
Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 407-85-02 DIST 4

HWY 403 STR SITE 10-489

Bridge Structure
Hwy. 403 - Sixth Line Underpass

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GEOCRES 30M12-218 DATE JUL 0 2 1992

FOUNDATION INVESTIGATION REPORT
For
Bridge Structure
Hwy. 403 - Sixth Line Underpass
W.P. 407-85-02, Site 10-489
District 4, Burlington

INTRODUCTION

This report summarizes the information obtained from a foundation investigation carried out at the above mentioned site where a single two span structure is proposed to carry the existing Sixth Line Road over the proposed Hwy. 403.

The fieldwork was carried out between 91 12 30 and 92 01 03. Five boreholes (BH 1 to BH 5) 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 10.7 m and 15.4 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. 4078502-A.

SITE DESCRIPTION AND GEOLOGY

The site is located on the proposed alignment of Hwy. 403 where it crosses the existing Sixth Line Road in the Town of Oakville, Regional Municipality of Halton. The proposed structure is located approximately 2.0 km north of the existing Hwy. 5. The topography in the area is generally flat to gently undulating. Land use in the vicinity of the site is primarily agricultural and dairy farming.

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 palaeozoic shale. Underlying the glacial deposit are the red Queenston shale from which the till's reddish colour is derived.

SUBSURFACE CONDITIONS

The subsoil conditions are generally uniform across the site. The overburden consists of a thick deposit of cohesive glacial till composed of a heterogeneous mixture of clayey silt, sand and gravel underlain by shale and siltstone bedrock. A thin layer of non-cohesive glacial till is sandwiched within a thick deposit of cohesive glacial till. The thickness of upper cohesive glacial till layer was found to range from 6.3 m at BH's 3 and 4 to about 7.8 m at BH 2.

Underlying this stratum is a non-cohesive glacial till which can be described as a Heterogeneous mixture of silt, sand and gravel. The thickness of this layer ranges from 3.0 m at BH 4 to 4.4 m at BH's 2 and 3.

Underneath this layer, the lower layer of cohesive glacial till was encountered which is underlain by shale and siltstone bedrock. The maximum thickness of this deposit was found to be about 2.4 m at BH 3.

Sound bedrock was proven in two boreholes by obtaining up to 1.5 m of NQ rock core. The top of bedrock ranged from an elevation of 174.0 m at BH 1 to an elevation of 174.1 m at BH 2 which are corresponded to 13.9 m below the existing ground surface.

A thin layer of clayey silt with trace of organics was encountered at all five borehole locations underneath a thin layer of topsoil of about 0.3 m thick. The thickness of this layer ranges from 0.5 m to 1.1 m.

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 showing soil stratigraphy based on borehole data, are shown on Dwg. No. 4078502-A. A detailed description of the subsurface conditions encountered is given below.

Clayey Silt

All five boreholes encountered some 0.5 to 1.1 m of clayey silt material. No Grain

Size Distribution analyses were carried out on this material. However, through visual observation, it is apparent that this material can be classified as a clayey silt with trace of organics.

Topsoil was encountered from the ground surface at all five borehole locations. The thickness of this layer is about 0.3 m at all boreholes. Through the visual observation, this material can also be classified as a clayey silt with some organics.

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

This stratum was encountered underneath the clayey silt layer and immediately above the bedrock. This deposit consists of a heterogeneous mixture of clayey silt with varying amounts of sand and gravel. The maximum thickness of these layers was found to be 7.8 m at BH 2 for the upper layer and 2.4 m at BH 3 for the lower layer.

Atterberg Limit tests were performed on these samples and the results are plotted on Figure 1 and summarized as follows:

Properties	Range (%)	Average (%)
Natural Moisture Content (w)	11.0 - 13.5	12.4
Liquid Limit (w_L)	23.0 - 28.0	25.1
Plastic Limit (w_p)	14.0 - 17.0	15.4
Plasticity Index (I_p)	8.0 - 11.0	9.7

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

Grain Size Distribution tests were carried out on the cohesive glacial till material. Figure 2 in the Appendix shows the result. 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 15 to over 100 blows/0.3 m indicating the consistency of this deposit as stiff to hard.

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

This stratum was encountered between the upper and lower cohesive glacial till at all borehole locations. The maximum thickness of this layer was found to be about 4.4 m at BH's 2 and 3.

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

Properties	Range (%)	Average (%)
Natural Moisture Content (w)	7.0 - 11.5	9.8
Liquid Limit (w_L)	13.0 - 16.0	14.3
Plastic Limit (w_P)	11.0 - 13.0	11.8
Plasticity Index (I_P)	1.0 - 5.0	2.5

From the plasticity chart, it is evident that the layer can be classified as a heterogeneous mixture of silt, sand and gravel, trace to some clay with occasional boulders (CL-ML or ML).

Grain Size Distribution tests were carried out on this material as shown on Figure 4 in an envelope form. 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

Bedrock was cored in two boreholes by obtaining up to 1.5 m of NQ rock cores at BH 3. The top of the bedrock ranged from elevations 174.0 m to 174.1 m which correspond to 13.9 m below the existing ground surface. The bedrock is in a slightly weathered to unweathered state from the bedrock surface.

The bedrock is a red shale with interbedded green siltstone (approximately 80% shale, 20% siltstone) of the Queenston Formation. Detailed description of the rock is

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. The Core Recoveries (CR) range between 85 and 98 percent and Rock Quality Designation (RQD) values range from 11 to 31 percent. Based on these results, the rock can be classified as weak to very weak and slightly to unweathered.

GROUNDWATER CONDITIONS

Groundwater conditions were observed through the measurements of water levels in the open boreholes. The groundwater level was found to be approximate elevation between 179.2 m at BH 3 and 184.9 m at BH 2 which correspond to depths of 9.0 m and 3.3 m below the existing ground surface.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct an underpass that will carry the existing Sixth Line Road over the proposed Hwy. 403 east and westbound lanes. The proposed structure is a single two span bridge (31.5 m X 31.5 m). A proposed Sixth Line Road profile grade of 194.5 m at both abutments with a proposed Hwy. 403 profile grade of about 188.0 m at westbound lane and 187.0 m at eastbound lane (trench elevation 186.5 m), will necessitate minimum approach cuts in the order of 0.5 m at north abutment and 2.0 m at south abutment with an approximate 6 m fill above the existing ground surface.

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

Structure Foundations

North and South Abutments

In consideration of the competent nature of the subsoils, the structure may be supported on spread footings on compacted Granular "A" Core as high as possible. In this case, existing road fill materials and topsoil should be excavated down to elevation 187.0 m and the excavation can be backfilled with compacted Granular "A" core to an elevation where a minimum 1.2 m frost cover is provided to the underside of the footings. Details of this scheme are shown on Figure 5.

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 close-type of abutment can be supported on spread footings within stiff to hard clayey silt 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)
North Abutment	675	450	at or below 186.8 m
South Abutment	510	340	at or below 185.3 m

Pier

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 at S.L.S. Type II (kPa)	Proposed Footing Elevation (m)
975	650	at or below 185.3

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.

Other Considerations

Sliding Resistance

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

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 the purpose of the O.H.B.D.C.

	Granular 'A'	Granular 'B'
Angle of Internal Friction (ø)	35°	30°
Unit Weight (kN/m^3), γ	22.8	21.2
Coefficient of Active Earth Pressure (Ka)	0.27	0.33
Coefficient of Earth Pressure at Rest (Ko)	0.43	0.5

The earth pressure coefficient at rest is to be used when the design of 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 lower groundwater levels and 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 footings 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.

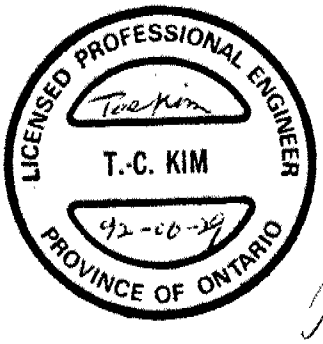
No stability problems are anticipated for the proposed permanent embankments and cut slopes constructed to a 2H.1V geometry. However, the slope surface should be protected from erosion of glacial till by a thin layer of topsoil.

Temporary cut slopes will also stand at 2H:1V geometry.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of R. Ng, Trainee Engineer from Central Region. The equipment was owned and operated by Master Soil Investigations Ltd., Toronto, Ontario.

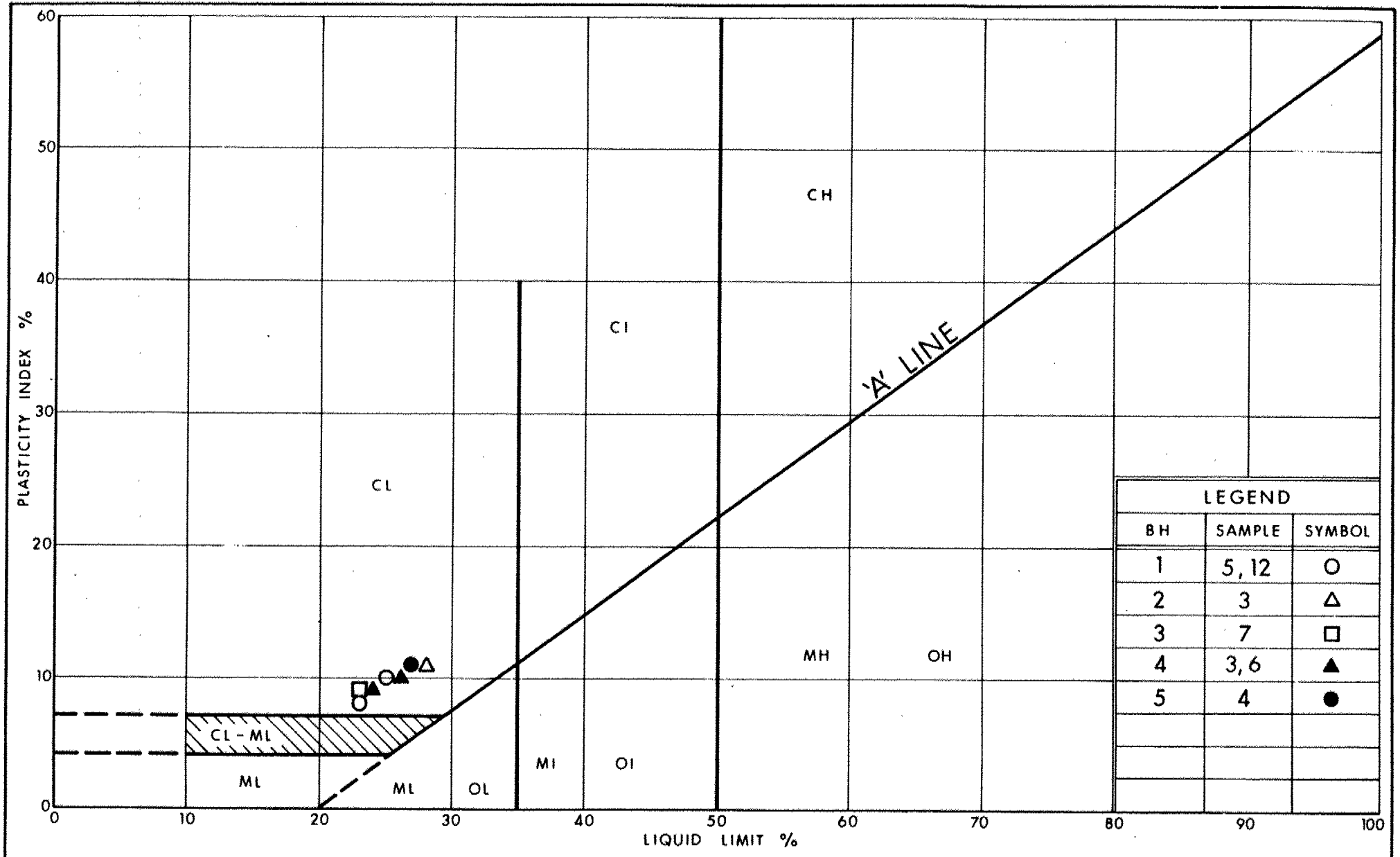
This report was written by Tae C. Kim, Senior Foundation Engineer, and reviewed by M.S. Devata, Chief Foundation Engineer.



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

M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX



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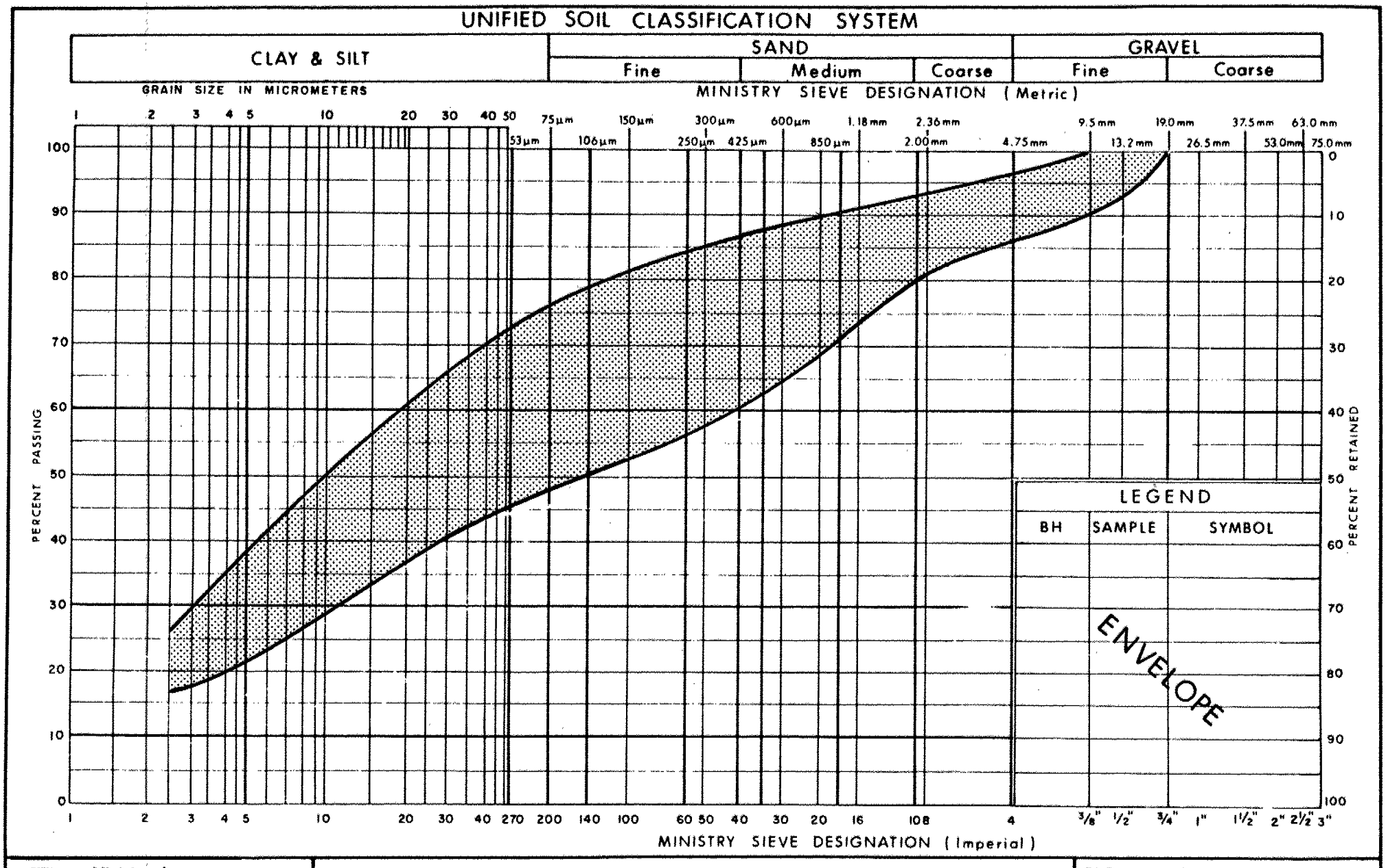
PLASTICITY CHART
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL
(Cohesive Glacial Till)

FIG No 1

W P 407-85-02

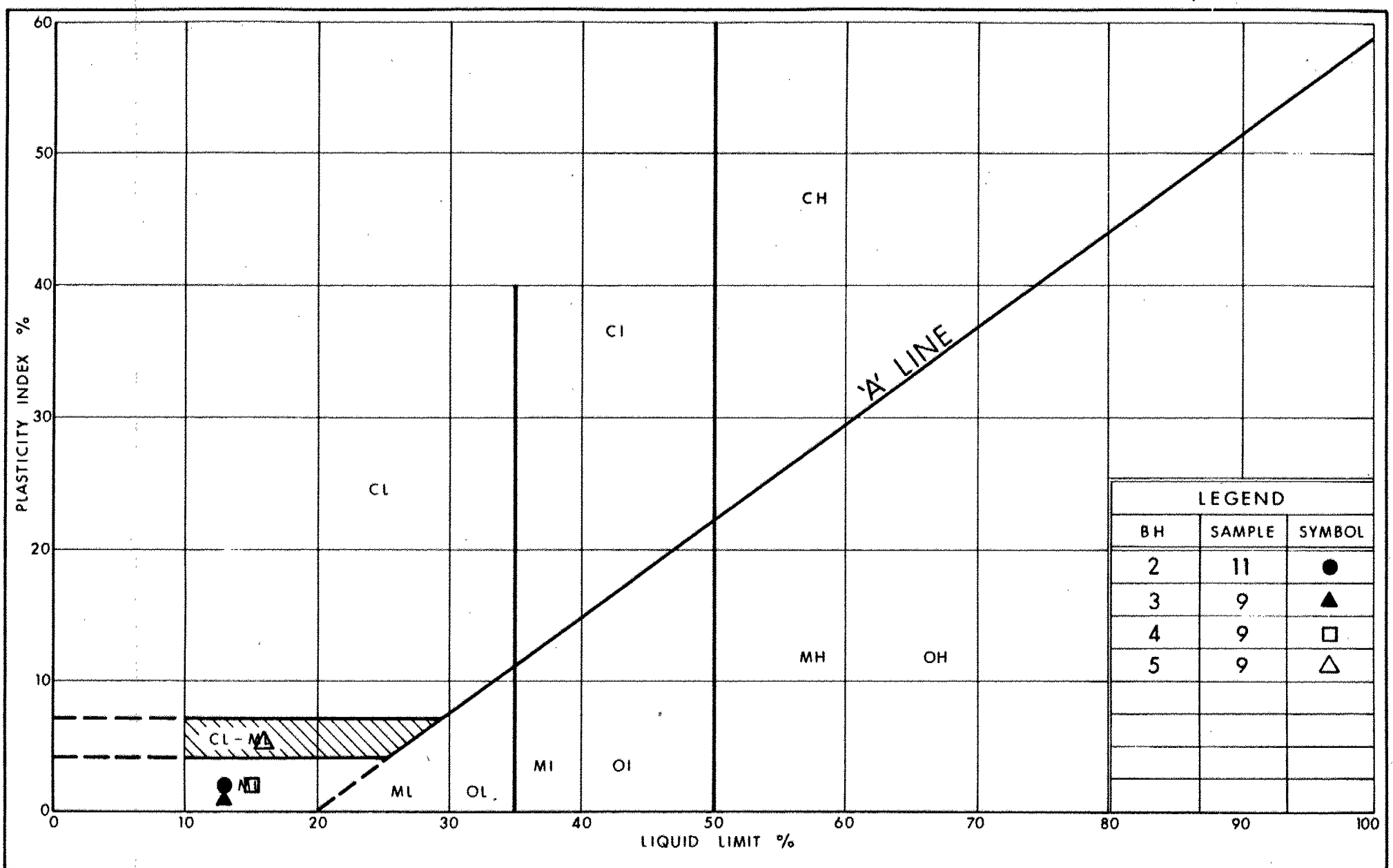


Ministry of Transportation
Ontario

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL
(Cohesive Glacial Till)

FIG No 2

W P 407 - 85 - 02

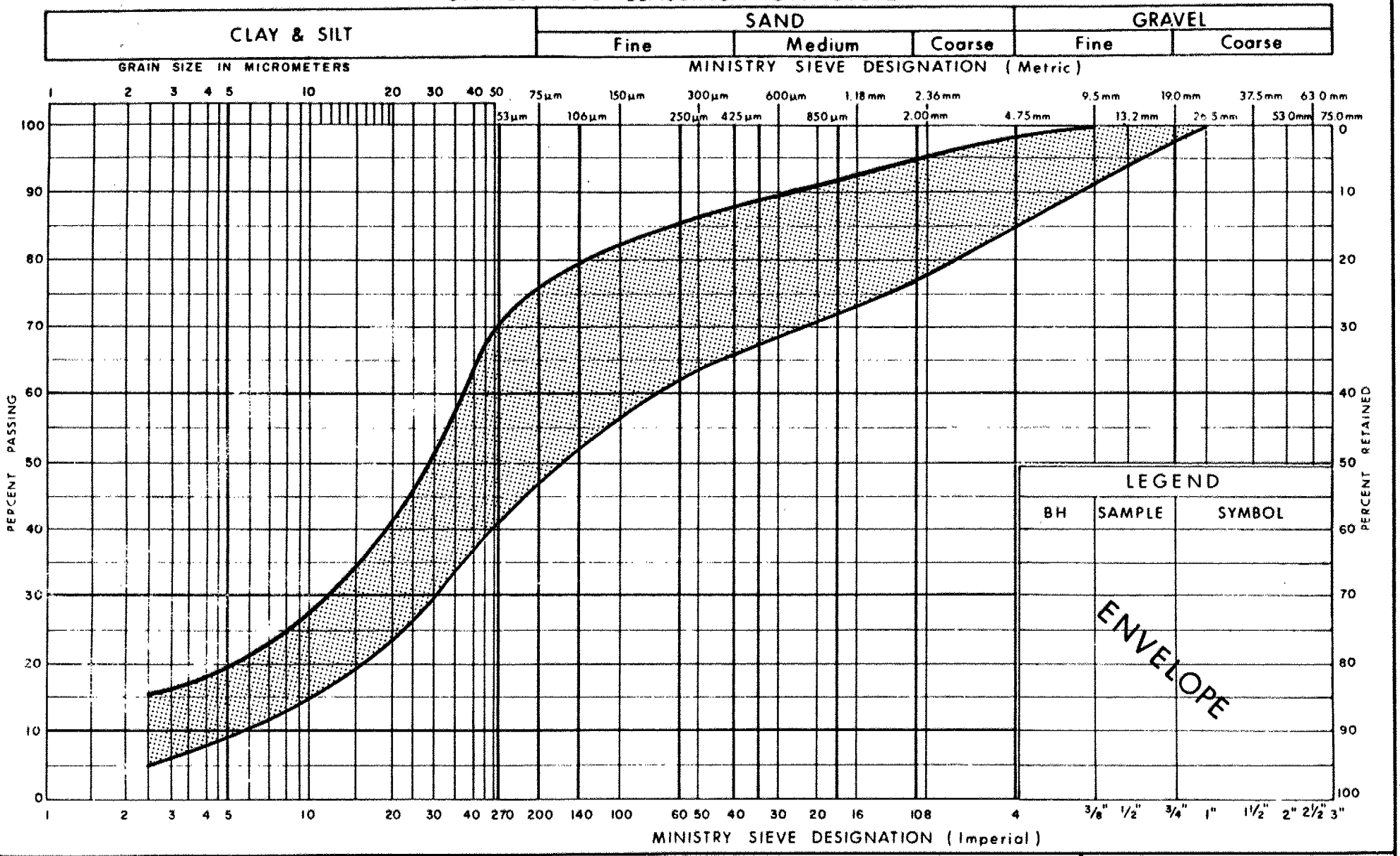


Ministry of Transportation
Ontario

PLASTICITY CHART
HET MIXTURE OF SILT, SAND & GRAVEL
(Non-Cohesive Glacial Till)

FIG No 3
W P 407-85-02

UNIFIED SOIL CLASSIFICATION SYSTEM

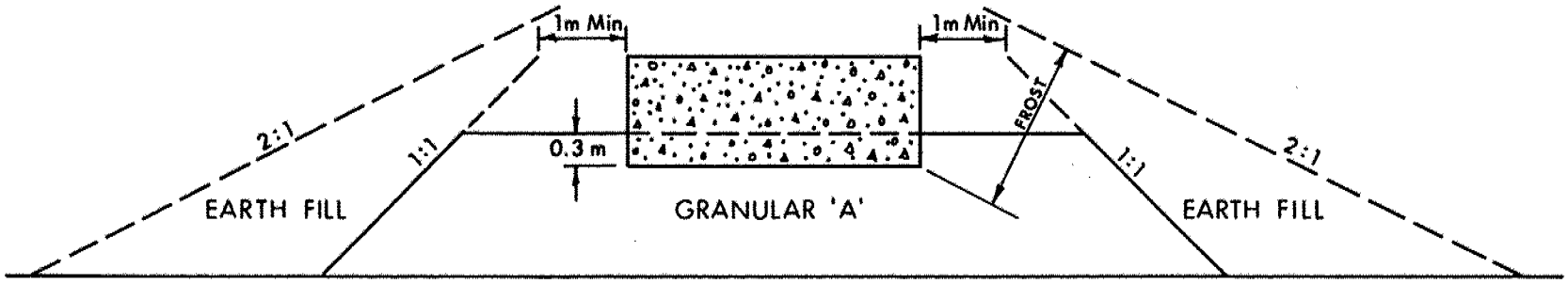


Ministry of Transportation
Ontario

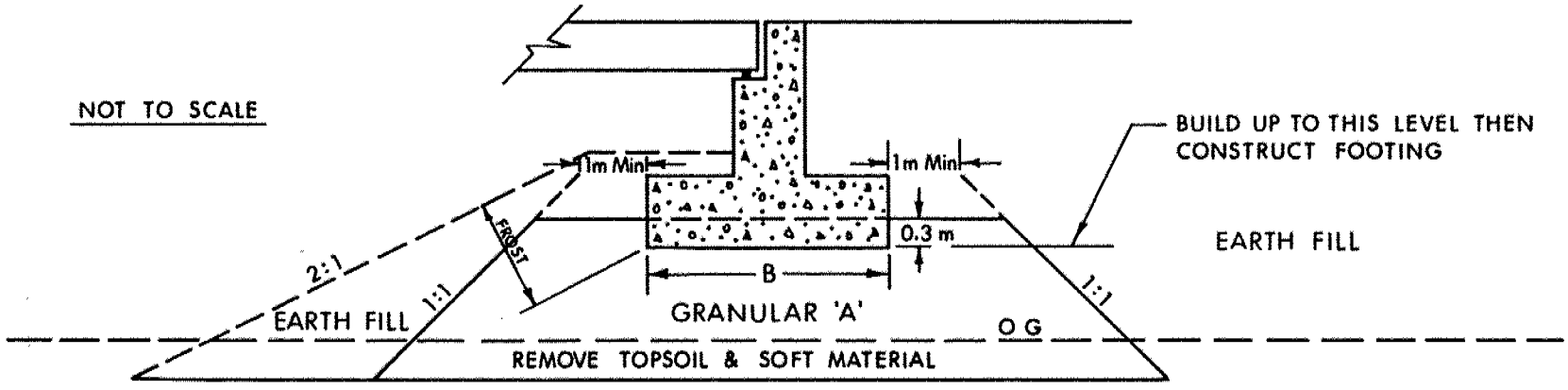
GRAIN SIZE DISTRIBUTION
HET MIXTURE OF SILT, SAND & GRAVEL
(Non-Cohesive Glacial Till)

FIG No 4

W P 407-85-02



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.

Ministry of Transportation Ontario	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	FIG No 5 W P 407-85-02

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

PHYSICAL PROPERTIES OF SOIL

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

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

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

RECORD OF BOREHOLE No 1 1 OF 1 METRIC

W.P. 407-85-02 LOCATION Co-ord. N 4817 631.6 E 283 953.1 ORIGINATED BY R.N.

DIST 4 HWY 403 BOREHOLE TYPE S.S. Auger, Cone Tests and NQ Rock Core COMPILED BY R.N.

DATUM Geodetic DATE Dec. 30, 1991 CHECKED BY T.C.K.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.9	Ground Surface						
0.0 / 187.1	Topsoil Clayey silt, trace of organics						
0.8	Brown Grey Heterogeneous mixture of Clayey Silt, Sand and Gravel Very stiff to hard (Glacial Till)		1	SS	36		
			2	SS	36		
			3	SS	67		
			4	SS	61		
			5	SS	27		5 28 44 23
			6	SS	23		
			7	SS	20	▼	
180.1	Grey		8	SS	128 /27cm		
7.8	Brown Heterogeneous mixture of Silt, Sand and Gravel Very dense (Glacial Till)		9	SS	100 /23cm		5 45 47 3
176.3			10	SS	145 /28cm		
11.6	Heterogeneous mixture of Clayey Silt, Sand and Gravel, occasional shale fragments Hard (Glacial Till)		11	SS	100 /11cm		
174.0	Brown		12	SS	50 /3cm		14 38 33 15
13.9	Red Queenston shale bedrock		13	RC	REC 98%		RQD 11%
172.6							
15.3	End of Borehole						

ELEVATION SCALE: 186, 184, 182, 180, 178, 176, 174

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100 — 121; 120/20cm

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 (%) 10 20 30

UNIT WEIGHT γ kN/m³

+3, ×5 : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 2 1 OF 1 METRIC

W.P. 407-85-02 LOCATION Co-ord. N 4817 610.0 E 283 974.2 ORIGINATED BY R.N.

DIST 4 HWY 403 BOREHOLE TYPE S.S. Auger and Cone Tests COMPILED BY R.N.

DATUM Geodetic DATE Dec. 31, 1991 CHECKED BY T.C.K.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) / WATER CONTENT (%) (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
188.2	Ground Surface						188	124		
0.0 / 187.4	Topsoil Clayey silt, trace of organics									
0.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel Hard (Glacial Till) Brown		1	SS	31		186			
			2	SS	52					
			3	SS	69			o		4 27 46 23
			4	SS	66	▼				
	Grey		5	SS	39		184			
			6	SS	64	/18cm				
	Grey									
	Reddish brown		7	SS	29		182			
			8	SS	72					
179.6	Reddish brown						180			
8.6	Brown Heterogeneous mixture of Silt, Sand and Gravel, occasional shale fragments Very dense (Glacial Till)		9	SS	50	/13cm				
			10	SS	50	/8cm	178			
			11	SS	105	/21cm	176			2 35 53 10
175.2										
13.0 / 174.4	Het. mix. of clayey silt, sand and gravel (Glacial Till), Hard		12	SS	100	/5cm				
13.8	End of Borehole at probable bedrock									

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 1 OF 1 METRIC

W.P. 407-85-02 LOCATION Co-ord. N 4817 573.8 E 283 989.0 ORIGINATED BY R.N.

DIST 4 HWY 403 BOREHOLE TYPE S.S. Auger, Cone Tests and NQ Rock Core COMPILED BY R.N.

DATUM Geodetic DATE Dec. 31, 1991 and Jan. 2, 1992 CHECKED BY T.C.K.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%) w_P PLASTIC LIMIT, w NATURAL MOISTURE CONTENT, w_L LIQUID LIMIT	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.0	Ground Surface							20 40 60 80 100	10 20 30		
0.0 / 187.2	Topsoil — Clayey silt, trace of organics										
0.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel, Stiff to hard (Glacial Till) — Brown		1	SS	46						
			2	SS	42			136			
			3	SS	43		186				
			4	SS	20						
	Grey		5	SS	20		184				
			6	SS	15						
180.9	Grey		7	SS	18		182		o—⊣		6 27 43 24
7.1	Brown — Heterogeneous mixture of Silt, Sand and Gravel, Very dense (Glacial Till)		8	SS	90	/28cm					
			9	SS	50	/5cm	180		H		
176.5			10	SS	50	/8cm	178		o		9 36 45 10
11.5	Heterogeneous mixture of Clayey Silt, Sand and Gravel (Glacial Till) Hard — Brown		11	SS	50	/3cm	176				
174.1			12	SS	50	/3cm					
13.9	Red — Queenston shale bedrock		13	RC	REC 85%		174				RQD 31%
172.6											
15.4	End of Borehole										

+^{3}, ×^{5} : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 407-85-02 LOCATION Co-ord. N 4817 653.5 E 283 932.7 ORIGINATED BY R.N.

DIST 4 HWY 403 BOREHOLE TYPE S.S. Auger and Cone Tests COMPILED BY R.N.

DATUM Geodetic DATE Jan. 3, 1992 CHECKED BY T.C.K.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.2	Ground Surface										
0.0	Topsoil					DRY					
185.8	Clayey silt, some organics, Dark brown		1	SS	8	*					
1.4	Brown, Heterogeneous mixture of Clayey Silt, Sand and Gravel, Very stiff to hard (Glacial Till)		2	SS	26		186				
			3	SS	43				o		3 21 53 23
	Brown / Grey		4	SS	26		184				
			5	SS	18						
			6	SS	17				o		
	Grey / Reddish brown		7	SS	50	/13cm	182				
179.5	Reddish brown		8	SS	50	/13cm	180				
7.7	Brown, Heterogeneous mixture of Silt, Sand and Gravel, Very dense (Glacial Till)		9	SS	50	/5cm	178		o		4 19 65 12
176.5			10	SS	50	/3cm					
10.7	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5 1 OF 1 METRIC

W.P. 407-85-02 LOCATION Co-ord. N 4817 551.7 E 284 010.2 ORIGINATED BY R.N.

DIST 4 HWY 403 BOREHOLE TYPE S.S. Auger and Cone Tests COMPILED BY R.N.

DATUM Geodetic DATE Jan. 2 & 3, 1992 CHECKED BY T.C.K.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, x LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.0	Ground Surface										
0.0 / 187.2	Topsoil — Clayey silt, trace of organics										
0.8	Heterogeneous mixture of Clayey Silt, Sand and Gravel; Very stiff to hard; (Glacial Till); Brown		1	SS	41						
			2	SS	57						
			3	SS	70		186				
			4	SS	83	/28cm			o ⊢⊣		10 20 45 25
	Grey		5	SS	45	▼	184				
			6	SS	27						
	Grey		7	SS	38		182				
	Reddish brown										
180.4	Reddish brown										
7.6	Brown; Heterogeneous mixture of Silt, Sand and Gravel, occasional boulders; Very dense; (Glacial Till)		8	SS	105	/26cm	180		o		14 38 43 5
			9	SS	50	/4cm			⊢⊣		
177.3			10	SS	50	/5cm	178				
10.7	End of Borehole										

+³, x⁵ ; Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

ROCK CORE DESCRIPTION
WP 407-85-02

CORE RECOVERY					CORE DESCRIPTION	
BH#	RC#	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
1	13	13.89-15.26	98	11	13.89-15.26	**SHALE**, greyish red, with interbedded greenish grey **SILTSTONE** (19%); very fine grained; weak to very weak; unweathered to slightly weathered; fractures close to extremely close spaced, flat to near vertical, planar to undulating, smooth.
3	13	13.87-15.39	85	31	13.87-15.39	**SHALE**, greyish red, with interbedded greenish grey **SILTSTONE** (15%); very fine grained; weak to very weak; unweathered to slightly weathered; fractures close to extremely close spaced, flat to dipping, planar to undulating, smooth.

***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

MINISTRY OF TRANSPORTATION, ONTARIO PH-0-207 88 10

METRIC

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

CONT No
WP No 407-85-02

SIXTH LINE UNDERPASS

BORE HOLE LOCATIONS & SOIL STRATA

SHEET

HOT 10+000 ℄ SIXTH LINE
HOC 18+957.177 ℄ PROP HWY 403
N 4 817 607.455, E 283 971.118

1.65 x 1.48 x 16.80 RIGID FRAME CONC BOX CULVERT

PROP HWY 403

SIXTH LINE

PROPOSED FOOTINGS

ASPH

WF

BUCM

H-2W

N 4 817 640

N 4 817 600

N 4 817 560

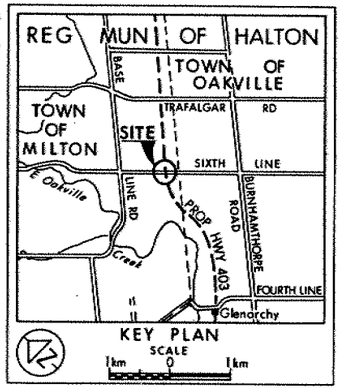
E 283 920

E 283 960

E 284 000

PLAN

SCALE 4m 0 4m



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 1991 12 and 1992 01.

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	187.9	4 817 631.6	283 953.1
2	188.2	4 817 610.0	283 974.2
3	188.0	4 817 573.8	283 989.0
4	187.2	4 817 653.5	283 932.7
5	188.0	4 817 551.7	284 010.2

4 BORE HOLE DRY

1 2 3 5

℄ PROPOSED HWY 403

PROPOSED GRADE

EXISTING GRADE

B/0.3m CONE

HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL Very Stiff to Hard (Glacial Till)

OCC SHALE FRAGMENTS

QUEENSTON SHALE BEDROCK

PROBABLE BEDROCK

HET MIXTURE OF SILT, SAND & GRAVEL Very Dense (Glacial Till)

HET MIXTURE OF CLAYEY SILT, SAND & GRAVEL Hard (Glacial Till)

TOPSOIL

CLAYEY SILT TRACE/SOME ORGANICS

Stiff to Hard

OCC BOULDERS

℄ PROFILE SIXTH LINE

SCALE 4m 0 4m

-≡NOTE≡-

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

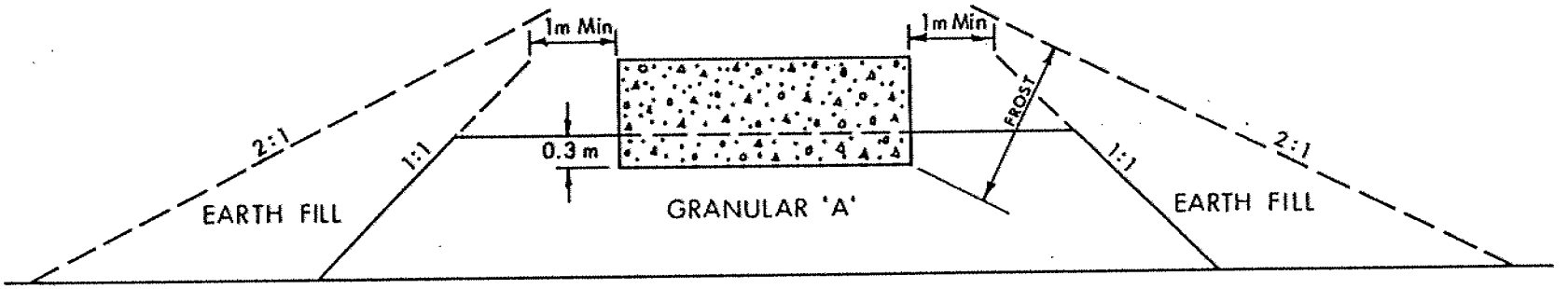
NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2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

REV	DATE	BY	DESCRIPTION

Geocres No 30M12-218

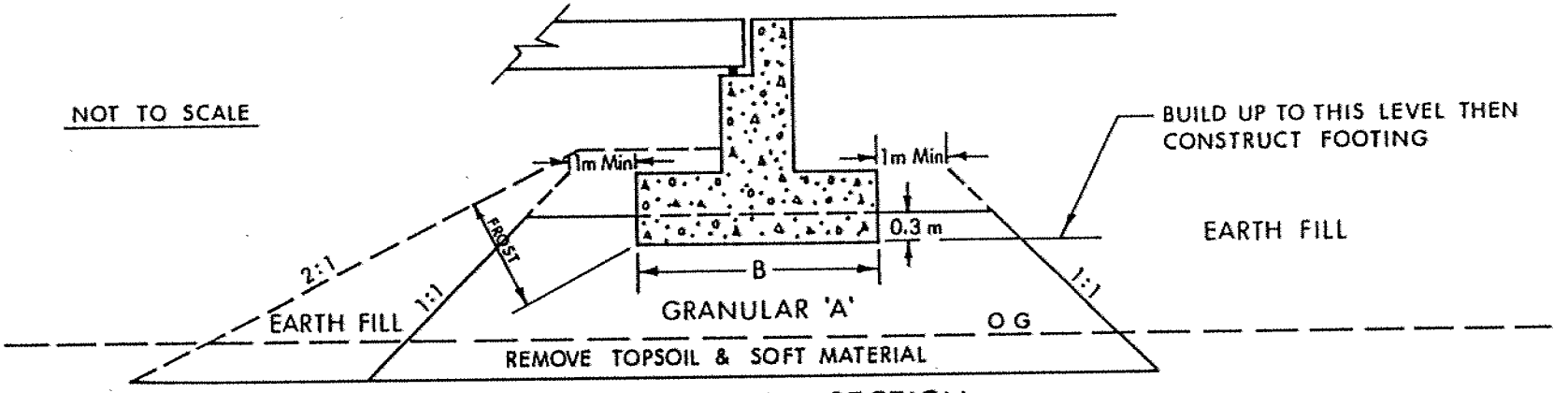
HWY No 403			DIST 4
SUBMD TCK	CHECKED EK	DATE 1992 06 15	SITE 10-489
DRAWN R S	CHECKED	APPROVED	DWG 4078502-A

REF No E-82-403-4; 1990 11



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 M T O STANDARDS.

3 - CONSTRUCT CONCRETE FOOTING.

4 - PLACE REMAINDER OF GRANULAR 'A' & EARTH FILL AS REQUIRED.

Ministry of Transportation Ontario	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE	FIG No 1 WP 407-85-02