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DIST. 6 REGION

W.P. No. 127-66-71

CONT. No. 82-108

W. O. No.

STR. SITE No. 24-81-465A

HWY. No. 401/403

LOCATION Bridge #23, 403 EB Core  
over 401

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

G.I.-30 SEPT. 1976

REVISIONS					
DATE	BY	DESCRIPTION			
DESIGN JAM.	CHECK G.H.	LOADING DOC A-7	DATE MAY 82		
DRAWING J.N.	CHECK JAM.	SITE 24-BI-46A DWG			

**ISSUED**

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DIST No. 6  
CONT No.  
WP No. 127-66-71



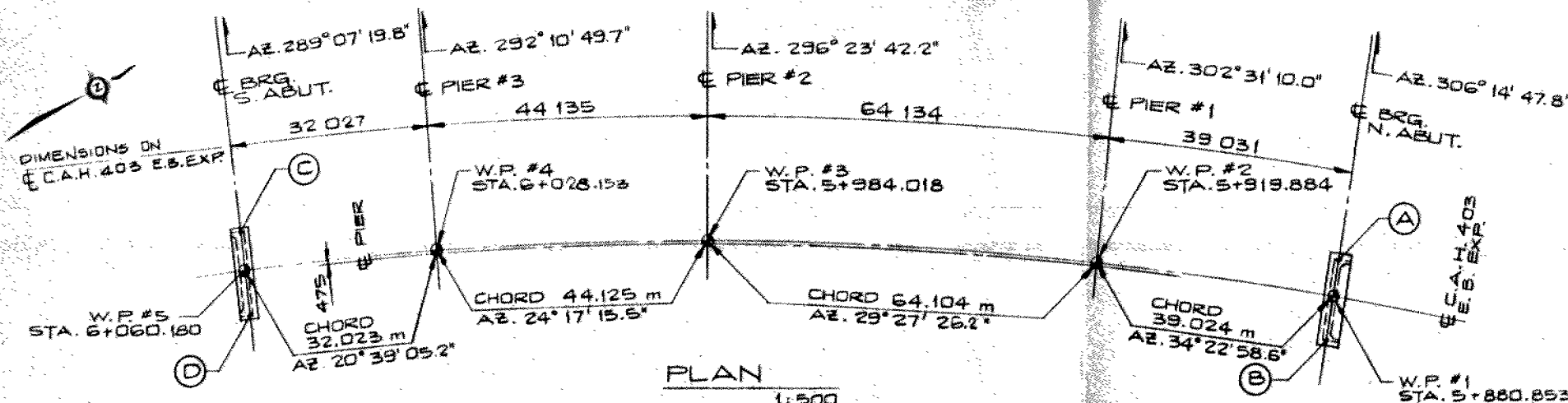
HWY. 403 E. B. EXPRESS  
OVER HWY. 401 E. B. COLLECTOR  
& RAMP 'W. DIXIE' (BRIDGE No. 23)  
FOOTING LAYOUT

SHEET

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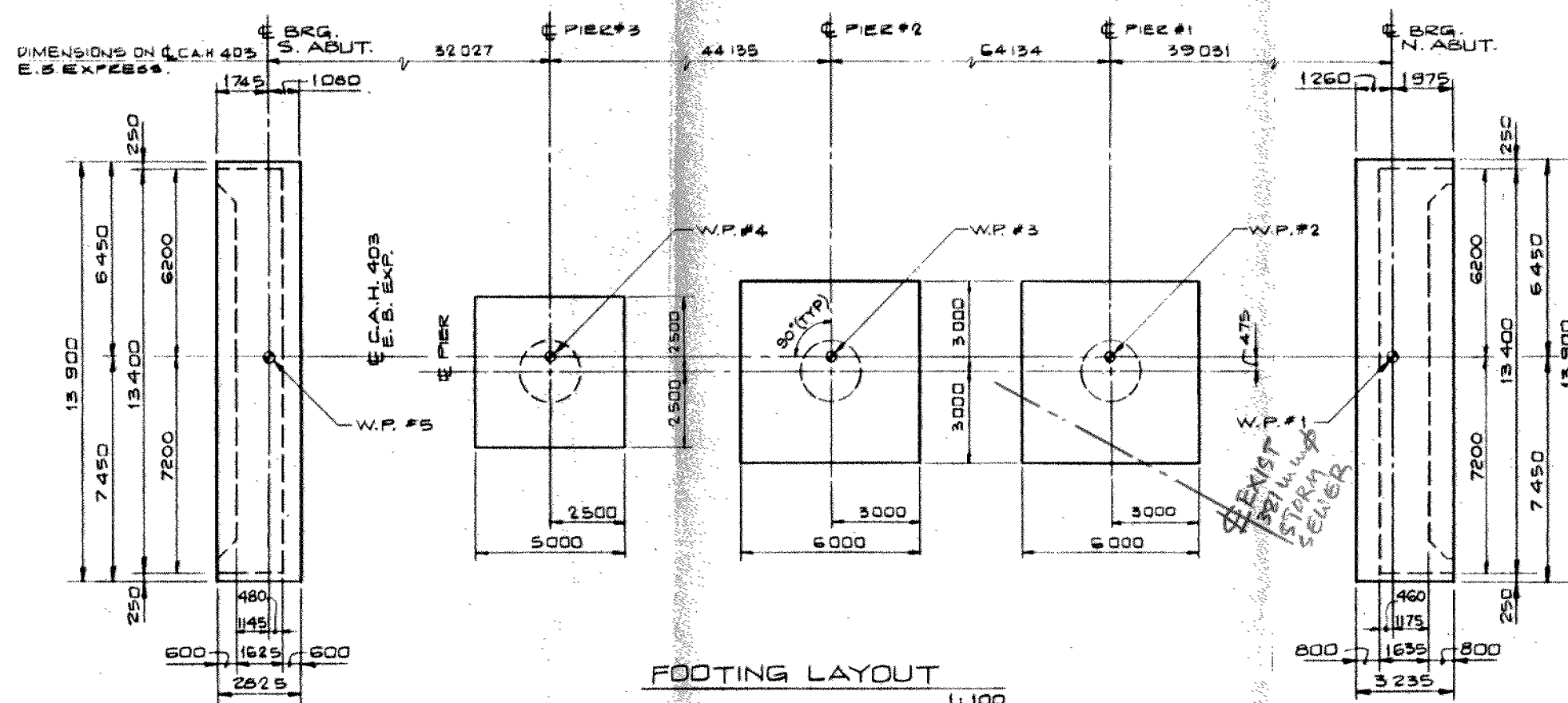
**METRIC**

DIMENSIONS ARE IN MILLIMETRES  
UNLESS OTHERWISE SHOWN.  
ELEVATIONS, COORDINATES, CURVE  
AND ALIGNMENT DATA ARE IN METRES.  
STATIONS ARE IN KILOMETRES + METRES.



PLAN  
1:500

CO-ORDINATES		
POINT	NORTH	EAST
W.P. #1	833 261.568	292 423.754
A	833 265.233	292 418.754
B	833 257.310	292 429.561
W.P. #2	833 229.362	292 401.717
W.P. #3	833 173.545	292 370.192
W.P. #4	833 133.326	292 352.043
W.P. #5	833 103.360	292 340.749
C	833 105.391	292 334.891
D	833 101.002	292 347.552



FOOTING LAYOUT  
1:100



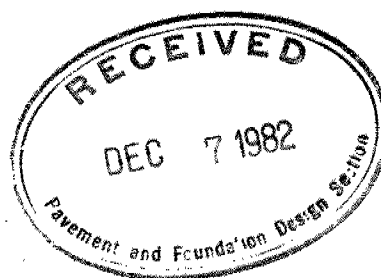
DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN G.E. CHECK JABL. LOADING ON DOCA 7 DATE MAY 82  
DRAWING J.N. CHECK JABL. SITE 24-81-465A DWG 5

# FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82 - 108



Ministry of  
Transportation and  
Communications

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NOTE: For purposes of the contract this report supersedes all other foundation reports prepared by or for the Ministry in connection with the above mentioned project.

## EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

**JOINTING AND BEDDING:**

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

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

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

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	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

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	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
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

3

For

Bridge #23

Highway 403 E.B. Core

Over Highway 401 E.B. Collector and

Dixie Road Sub-Collector

W.P. 127-66-71, Site 24-81-465A

Hwy. 403, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural site.

The fieldwork was carried out between 82 02 16 and 82 03 15 and consisted of advancing 5 sampled boreholes using solid stem continuous flight augers with bedrock being cored in two of the borings. The depth of borings ranged from 1.1 metres to 12.0 metres terminating within the shale bedrock.

Site Description and Geology

The structure site is located immediately west of the existing Hwy. 401 E.B. Collector structure (Bridge #49) over Heart Lake which was constructed under Contract 75-16 as part of the Hwy. 401/403 Interchange complex.

Land use in the area is changing from predominately farming to industrial subdivision development. Topography across the site is generally flat to gently undulating with ground surface sloping gradually towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation, is composed of cohesive glacial till, whose thickness varies from nil to 15 metres. The overburden is underlain by shale bedrock of the Meaford-Dundas Formation, Ordovician Period.



### Subsurface Conditions

Borings carried out at the structure site indicates generally uniform subsurface conditions. The overburden consists of a shallow deposit of cohesive glacial till underlain by shale bedrock. The upper portion of the shale was found to be weathered. In previous cut areas, exposed shale has been covered with a thin veneer of fill.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 2, which should be read in conjunction with the borehole sheets and this report.

The various soil types encountered are briefly described in the following paragraphs.

### Silty Clay, Gravel and Sand (Glacial Till)

The surficial deposit overlying the site consists of a shallow deposit of glacial till composed of a silty clay of intermediate plasticity with varying amounts of gravel and some sand. Typical grain size distribution curves for representative samples from this deposit are shown on Figure 1. An increasing frequency of fragments, and detached slabs of weathered shale and limestone were encountered within the lower portion of this till. A thin veneer of fill consisting of the reworked parent till of the area was found to overly shale where previous highway cuts had been advanced.

Results of limited water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	9-16	12
Liquid Limit	(W <sub>L</sub> ) %	35-36	36
Plastic Limit	(W <sub>p</sub> ) %	17-20	19
Plasticity Index	(I <sub>p</sub> ) %	15-18	17

These results indicate the cohesive matrix of the glacial till consists of an inorganic silty clay of intermediate plasticity (CI).

Based on interpretation of Standard Penetration Test 'N' values ranging from 5 to in excess of 100 blows per 0.3 metres, the consistency of this deposit ranges from firm to hard.

#### Bedrock

The shale bedrock was encountered immediately beneath the glacial till deposit across the site. The upper 1.3 to 2.9 metres of the bedrock is in a weathered condition. The natural bedrock surface varies between elevations 169.5 to 176.4 corresponding to depths of approximately 0.8 to 2.9 metres below original ground surface prior to cut excavations for the existing Hwy. 401 collectors.

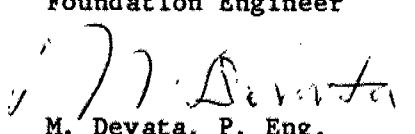
Bedrock surface is sloping gently in a northeasterly direction across the site.

The rock is described as a dark grey, fine textured, soft shale interbedded with thin layers of light grey, fine to medium texture, medium hard limestone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock.

#### Groundwater Conditions

A stabilized borehole water level was obtained in only one boring at a depth of 9.1 metres corresponding to elevation 164.1. No other natural water levels were encountered during augering operations in the other borings. Upon completion of rock coring, the induced drill water remained perched within the borings, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Heart Lake Road geometry effectively drains the immediate structure site to an minimum elevation of approximately 170.

  
T. J. Kazmierowski, P. Eng.  
Foundation Engineer

  
M. Devata, P. Eng.  
Senior Foundations Engineer

APPENDIX

# RECORD OF BOREHOLE No 1

METRIC

W P 127-66-71 LOCATION Co-ords. N 4 833 271.0 E 282 421.5 ORIGINATED BY V.P.  
DIST 6 HWY 401 & 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 16 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100							
								SHEAR STRENGTH							
173.2	Ground Surface														
0.0	Grey Brown (Glacial Till) Silty Clay some Sand & Gravel Shale fragments throughout		1	SS	5		172							41 14 30 15	
			2	SS	6										
170.3	Firm		3	SS	5									24 14 41 21	
2.9	Grey		4	SS	95		170								
			5	SS	70/	11 cm									
			6	SS	70/	6 cm									
	Weathered						168								
	Shale		7	SS	60/	1 cm									
	Bedrock						166								
	occasional thin layers of Limestone		8	SS	60/	1 cm									
			9	SS	60/	1 cm	164								
			10	SS	90/	3 cm	162								
161.2															
12.0	End of Borehole						160								

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



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Ontario

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# RECORD OF BOREHOLE No 2

METRIC

W P 127-66-71 LOCATION Co-ords. N 4 833 230.5; E 292 406.0 ORIGINATED BY V.P.  
DIST 6 HWY 401/403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 17 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ 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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
170.3	Ground Surface											
0.0	Silty Clay Fill						170					
169.5	some Sand & Limestone											
0.76	Grey frag.		1	SS	70	0 cm						
	Weathered Shale		2	BW RC	REC 100		168					
	Bedrock thin layers of Limestone		3	BW RC	REC 100		166					
165.7	End of Borehole											
4.6	WL NOT ENCOUNTERED						164					

\*3, x5: Numbers refer to Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 3

METRIC

W P 127-66-71 LOCATION Co-ords. N 4 833 166.5; E 292 379.0 ORIGINATED BY V.P.  
DIST 6 HWY 403/401 BOREHOLE TYPE Solid Stem Augers COMPILED BY T.J.K.  
DATUM Geodetic DATE 82 03 15 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
170.2	Ground Surface												
0.0	Grey Weathered Shale Bedrock		1	SS	48		170						
168.3	Refusal to Augers End of Borehole		2	SS	75/	15 cm							
1.86	WL NOT ENCOUNTERED						168						
171.5	Ground Surface												
0.0	Grey Weathered Shale Bedrock		1	SS	50/	6 cm							
170.4	Refusal to Augers End of Borehole						170						
1.1	WL NOT ENCOUNTERED						168						

# RECORD OF BOREHOLE No 4

Co-ords N 4 833 132.5; E 292 351.5



# RECORD OF BOREHOLE No 5

METRIC

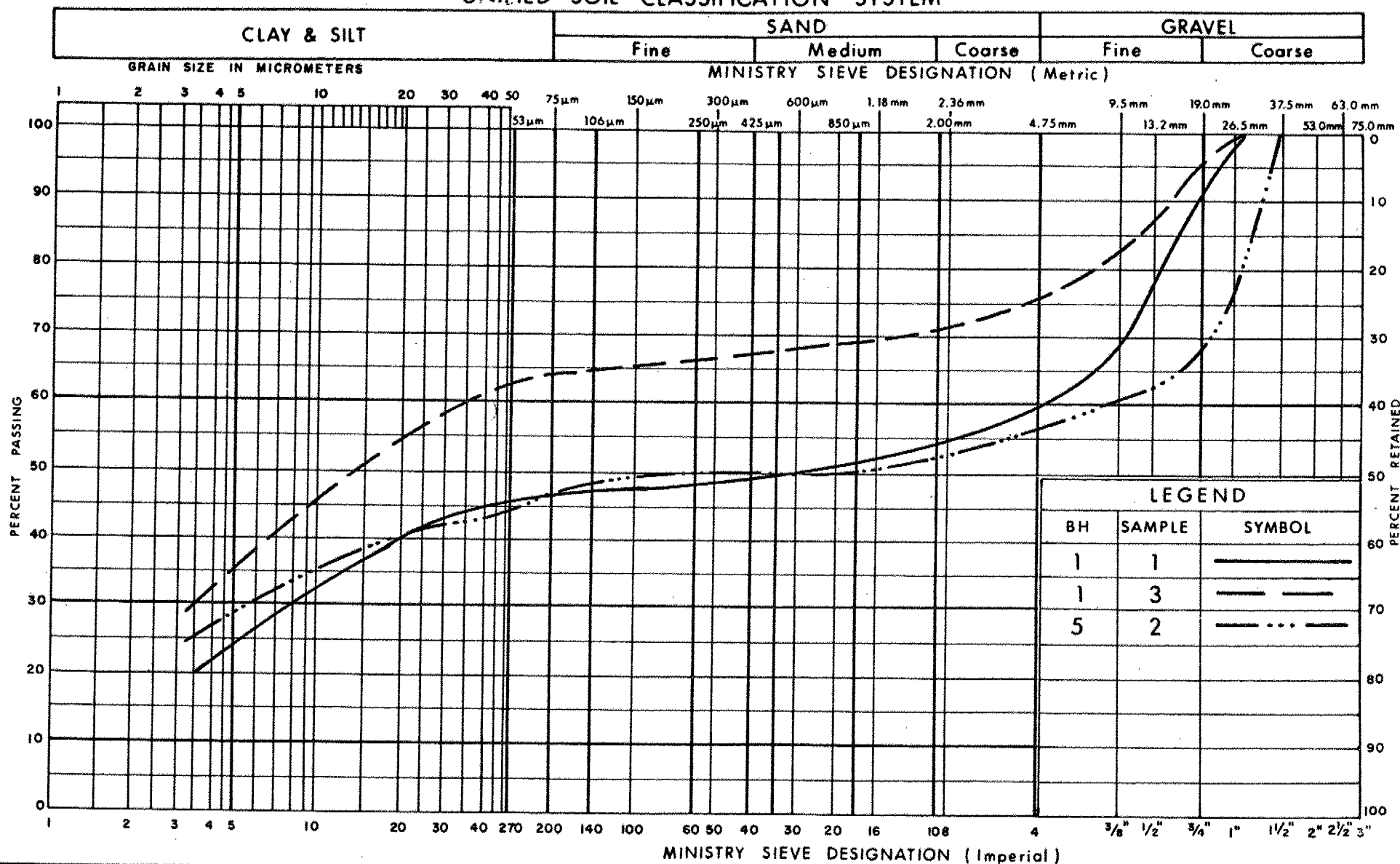
W P 127-66-71 LOCATION Co-ords. N 4 833 101.0; E 292 329.0 ORIGINATED BY V.P.  
DIST 6 HWY 403/401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 19 to 82 03 11 CHECKED BY \_\_\_\_\_

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
179.3	Ground Surface													
0.0	Brown (Glacial Till) Silty Clay and Gravel trace of Sand		1	SS	60									
	Shale and Limestone Fragments		2	SS	52									
176.4	Hard		3	SS	60	5 cm								
2.9	Grey		4	SS	50	8 cm								
	Weathered		5	SS	40	8 cm								
	Shale Bedrock occasional thin Limestone layers		6	BXL RC	REC 93%									
			7	BXL RC	REC 100%									
			8	BXL RC	REC 100%									
171.9	End of Borehole													
7.36	WL NOT ENCOUNTERED						170							

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM



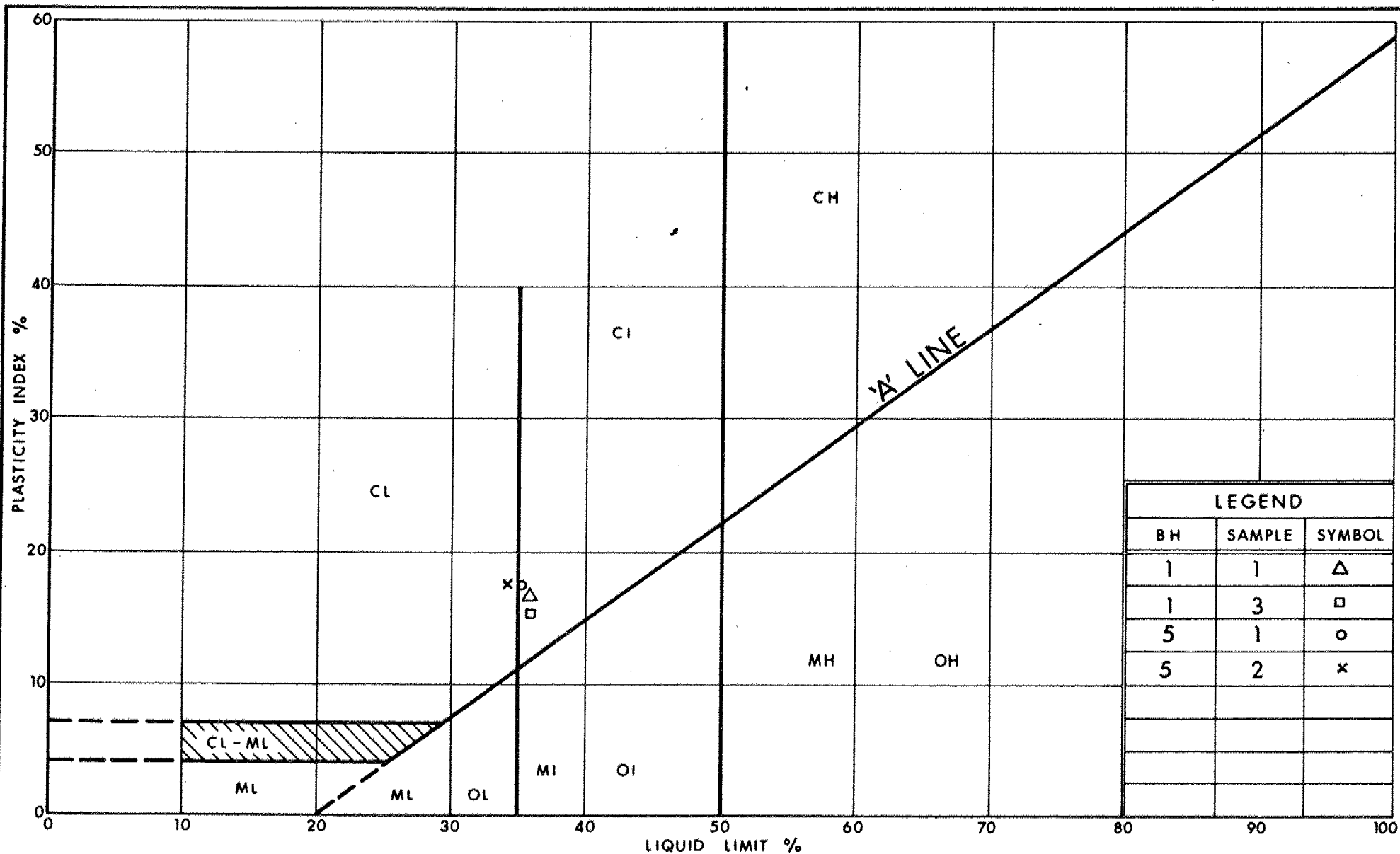
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**GRAIN SIZE DISTRIBUTION**  
**GLACIAL TILL**  
**SILTY CLAY SOME SAND VARIOUS AMOUNTS OF GRAVEL**

FIG No 1

W P 127-66-71





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**PLASTICITY CHART  
(GLACIAL TILL MATRIX)**  
SILTY CLAY OF INTERMEDIATE PLASTICITY

FIG No 2

W P 127-66-71

For

Bridge #26

Highway 403 W.B. Expressway Over

Highway 401 E.B. Collector and

Dixie Road Sub-Collector

W.P. 127-66-72, Site 24-81-466

Hwy. 403, District 6, Toronto.INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural site.

The fieldwork was carried out between 82 02 16 and 82 02 19 and consisted of advancing 3 sampled boreholes using solid stem continuous flight augers with bedrock being cored in two of the borings. The depth of borings ranged from 2.6 metres to 12.3 metres terminating within the shale bedrock.

Site Description and Geology

The structure site is located immediately east of the existing Hwy. 403 W.B. Collector structure (Bridge #27) over Hwy. 401 E.B. Collector and Dixie Road Sub-Collector which was constructed under Contract 75-16 as part of the Hwy. 401/403 Interchange complex.

Land use in the area is changing from predominately farming to industrial subdivision development. Topography across the site is generally flat to gently undulating with ground surface sloping gradually towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation, is composed of cohesive glacial till, whose thickness varies from nil to 15 metres. The overburden is underlain by shale bedrock of the Meaford-Dundas Formation, Ordovician Period.

### Subsurface Conditions

Borings carried out at the structure site indicates generally uniform subsurface conditions. The overburden consists of a shallow deposit of cohesive glacial till underlain by shale bedrock. The upper portion of the shale was found to be weathered. In previous highway cut areas, exposed shale has been covered with a thin veneer of fill.

The boundaries between the various soil types, insitu and laboratory test results are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 2, which should be read in conjunction with the borehole sheets and this report.

The various soil types encountered are briefly described in the following paragraphs.

#### Silty Clay, Gravel and Sand (Glacial Till)

The surficial deposit overlying the site consists of a shallow deposit of glacial till composed of a silty clay of intermediate plasticity with varying amounts of gravel and some sand. Typical grain size distribution curves for representative samples from this deposit are shown on Figure 1. An increasing frequency of fragments, and detached slabs of weathered shale and limestone were encountered within the lower portion of this till. A thin veneer of fill consisting of the reworked parent till of the area was found to overly shale where previous highway cuts had been advanced.

Results of limited water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	8-22	16
Liquid Limit	(W <sub>L</sub> ) %	40-43	42
Plastic Limit	(W <sub>p</sub> ) %	19-20	20
Plasticity Index	(I <sub>p</sub> ) %	19-24	22

These results indicate the cohesive matrix of the glacial till consists of an inorganic silty clay of intermediate plasticity (CI).

Based on interpretation of Standard Penetration Test 'N' values ranging from 27 to in excess of 100 blows per 0.3 metres, the consistency of this deposit ranges from very stiff to hard.

#### Bedrock


The shale bedrock was encountered immediately beneath the glacial till deposit across the site. The upper 0.8 to 2.1 metres of the bedrock is in a weathered condition. The natural bedrock surface varies between elevations 177.1 to 177.5 corresponding to depths of approximately 2.6 to 2.1 metres below original ground surface prior to cut excavations for the existing Hwy. 401 collectors.

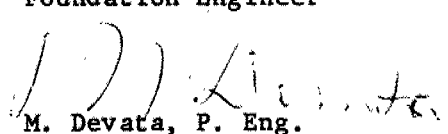
Bedrock surface is sloping gently in a northeasterly direction across the site.

The rock is described as a dark grey, fine textured, soft shale interbedded with thin layers of light grey, fine to medium texture, medium hard limestone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock.

#### Groundwater Conditions

No stabilized water levels were obtained during augering operations in the three borings. Upon completion of rock coring, the induced drill water remained perched within the borings, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Dixie Road Sub-collector geometry effectively drains the immediate structure site to an minimum elevation of approximately 173, however a perched water table within the glacial till can be expected during periods of high rainfall.

  
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Foundation Engineer

  
M. Devata, P. Eng.  
Senior Foundations Engineer

A P P E N D I X

# RECORD OF BOREHOLE No 1

METRIC

17

W P 127-66-72 LOCATION Co-ords. N 4 833 185 E 292 261 ORIGINATED BY V.P.  
DIST 6 HWY 401/403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82-02-16 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
179.7	Ground Surface																
0.0	(Glacial Till)																
	Silty Clay, some Sand & Gravel, fragments and slabs of Lime-Stone & Weathered Shale V. Stiff to Hard		1	SS	27												
177.1			2	SS	70/13	cm											
2.6	End of Borehole Refusal to Augers on probable bedrock.		3	SS	70/13	cm											
	WL NOT ENCOUNTERED																



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# RECORD OF BOREHOLE No 2

METRIC

18

W P 127-66-72 LOCATION Co-ords. N 4 833 155: E 292 252 ORIGINATED BY V.P.  
DIST 6 HWY 401/403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82-02-18 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
173.0	Ground Surface																
172.4	Fill																
0.6	<u>weathered</u>		1	SS	80/	10 cm											
	Grey Shale Bedrock with thin layers of Limestone		2	SS	60/	5 cm											
	Good Quality		3	BXL RC	REC 100%												
166.9	End of Borehole																
6.1	WL NOT ENCOUNTERED																

+3, x5: Numbers refer to  
Sensitivity

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



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# RECORD OF BOREHOLE No 3

METRIC

19

W P 127-66-72 LOCATION Co-ords. N 4 833 078; E 292 248 ORIGINATED BY V.P.  
DIST 6 HWY 401/403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82-02-19 CHECKED BY \_\_\_\_\_

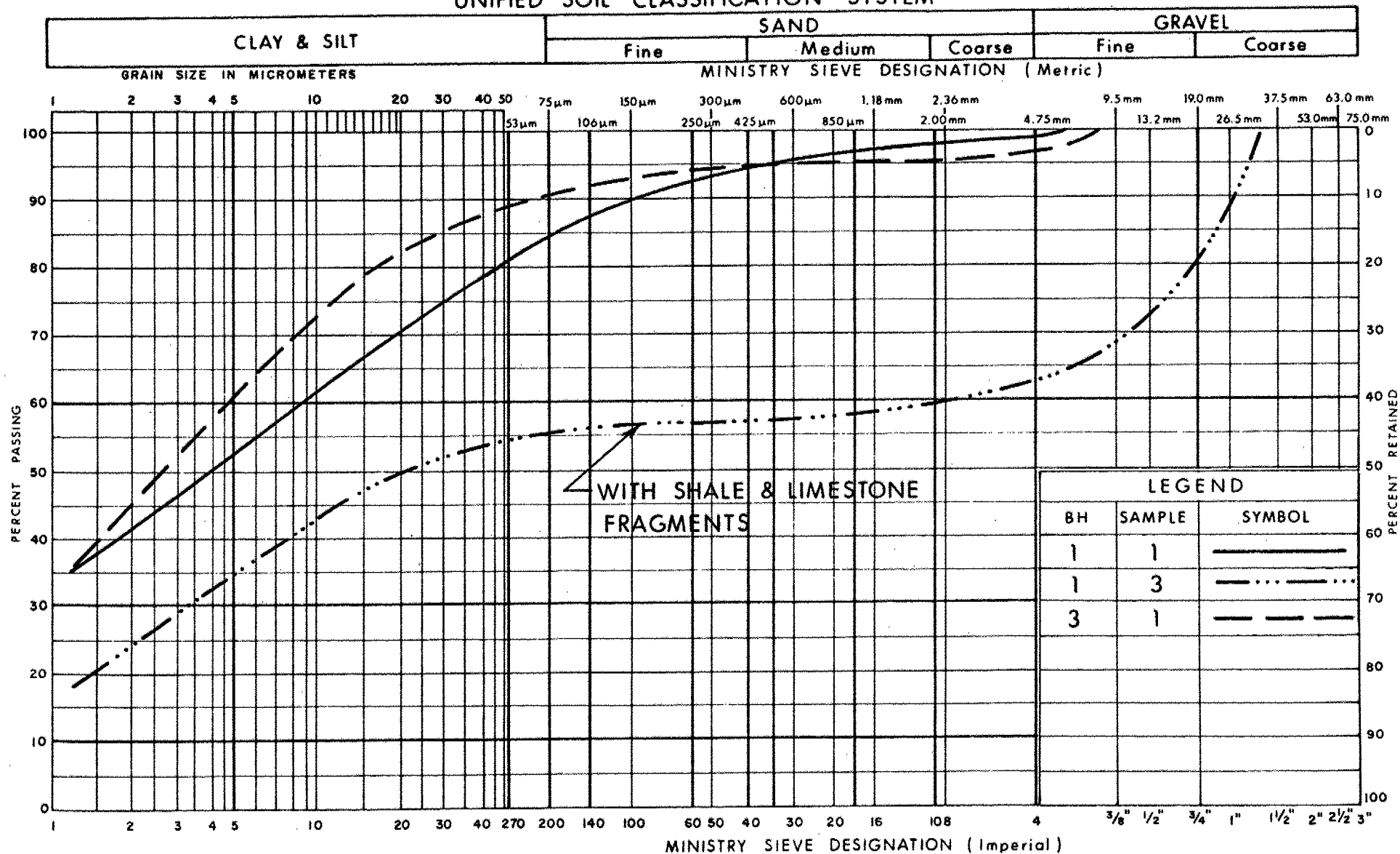
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
179.6	Ground Surface													
0.0	(Glacial Till) Silty Clay with Sand & Gravel occ. Limestone fragments.		1	SS	50/	3 cm	178							
177.5	Grey, brown, hard		2	SS	75/	11 cm								
2.1	Grey		3	SS	70/	8 cm								
			4	SS	70/	6 cm	176							
	<u>weathered</u>		5	SS	75/	11 cm								
	Shale Bedrock with layers of Limestone		6	SS	50/	2 cm								
			7	SS	50/	3 cm	174							
			8	SS	50/	0 cm	172							
			9	EXL RC	--		170							
			10	EXL RC	REC 100%									
			11	EXL RC	REC 100%		168							
167.3	End of Borehole													
12.3	WL NOT ENCOUNTERED						166							

+<sup>3</sup>, x<sup>5</sup>: Numbers refer to Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



## UNIFIED SOIL CLASSIFICATION SYSTEM



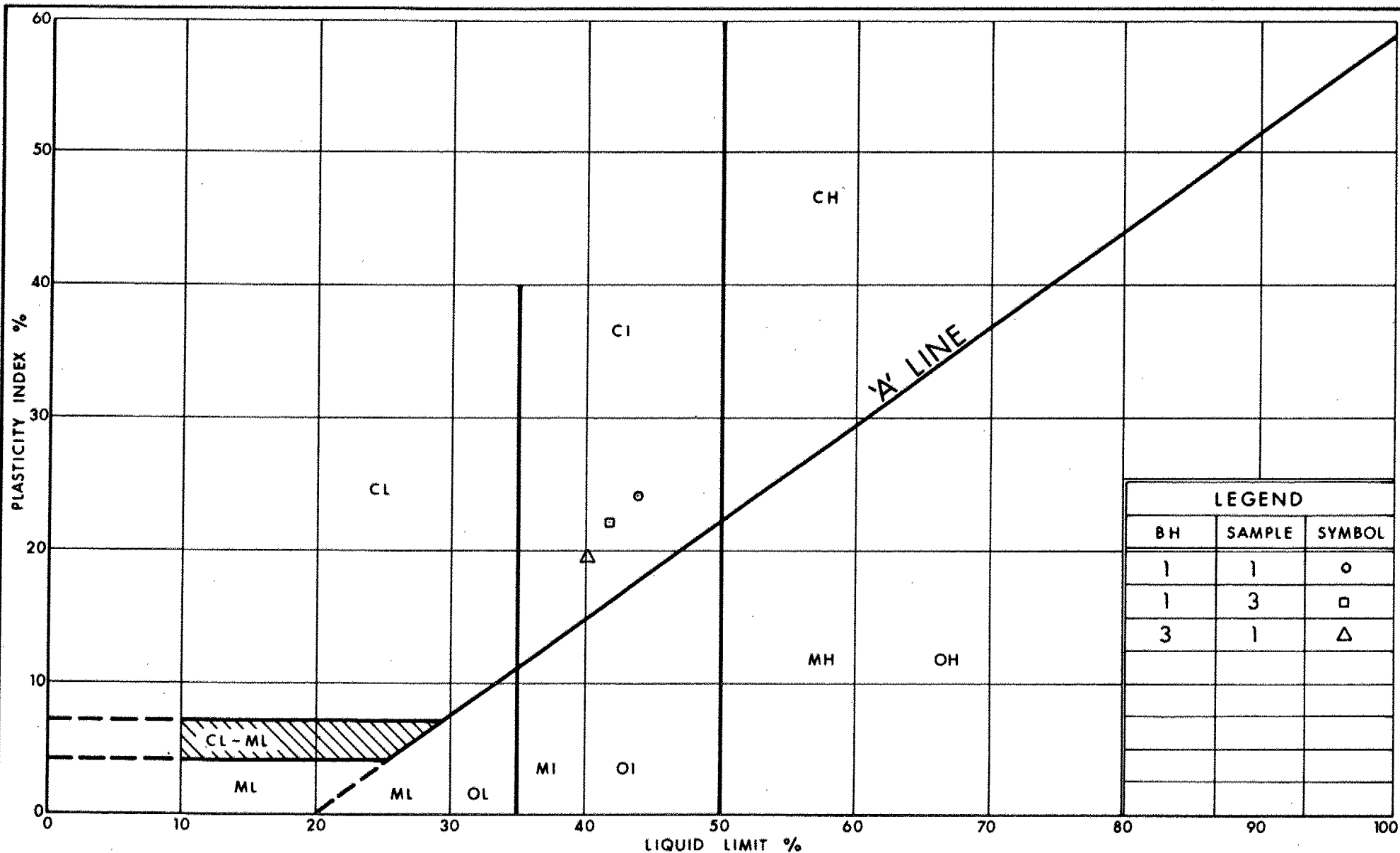
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GRAIN SIZE DISTRIBUTION  
(GLACIAL TILL)  
SILTY CLAY SOME SAND & GRAVEL

FIG No 1

W P 127-66-72



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PLASTICITY CHART  
(GLACIAL TILL MATRIX)  
SILTY CLAY OF INTERMEDIATE PLASTICITY

FIG No 2

W P 127-66-72

# FOUNDATION INVESTIGATION REPORT

22

For

Bridge #54

Highway 403 E.B. Core

Over Heart Lake Road

W.P. 127-66-73, Site 24-81-465B

Hwy. 403, District 6, Toronto.

## INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural site.

The fieldwork was carried out between 82 02 09 and 82 02 16 and consisted of advancing 2 sampled boreholes (BH 10 & 11) using solid stem continuous flight augers with bedrock being cored in each boring. The depth of borings ranged from 12.3 metres to 13.4 metres terminating within the intact shale bedrock.

## Site Description and Geology

The structure site is located immediately north of the existing Hwy. 401 E.B. Collector structure (Bridge #49) over Heart Lake which was constructed under Contract 75-16 as part of the Hwy. 401/403 Interchange complex.

Land use in the area is changing from predominately farming to industrial subdivision development. Topography across the site is generally flat to gently undulating with ground surface sloping gradually towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation, is composed of cohesive glacial till, whose thickness varies from nil to 15 metres. The overburden is underlain by shale bedrock of the Meaford-Dundas Formation, Ordovician Period.

## Subsurface Conditions

Borings carried out at the structure site indicates generally uniform subsurface conditions. The overburden consists of a shallow deposit of cohesive glacial till underlain by shale bedrock. The upper portion of the shale was found to be weathered.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 2. This drawing should be read in conjunction with the Borehole Sheets and this report.

The various soil types encountered are briefly described in the following paragraphs.

#### Silty Clay, Gravel and Sand (Glacial Till)

The surficial deposit overlying the site consists of a shallow deposit of glacial till composed of a silty clay of intermediate plasticity with varying amounts of gravel and a trace of sand. Typical grain size distribution curves for representative samples from this deposit are shown on Figure 1. An increasing frequency of fragments, and detached slabs of weathered shale and limestone were encountered within the lower portion of this till.

Results of water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	12-14	13
Liquid Limit	(W <sub>L</sub> ) %	35-45	39
Plastic Limit	(W <sub>p</sub> ) %	19-21	20
Plasticity Index (I <sub>p</sub> ) %		16-24	19

These results indicate the cohesive matrix of the glacial till consists of an inorganic silty clay of intermediate plasticity (CI).

Based on interpretation of Standard Penetration Test 'N' values ranging from 22 to in excess of 100 blows per 0.3 metres, the consistency of this deposit ranges from very stiff to hard.

#### Bedrock

The shale bedrock was encountered immediately beneath the glacial till deposit across the site. The upper 2.2 to 3.0 metres of the bedrock is in a weathered condition. The bedrock surface varies between elevations 169.0 to 169.9 corresponding to depths of approximately 2.1 to 2.9

metres below original ground surface prior to cut excavations for the existing Heart Lake Road.

Bedrock surface is sloping gently in a northeasterly direction across the site.

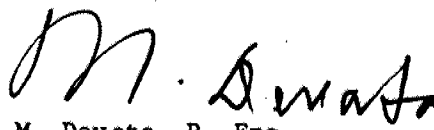
The rock is described as a dark grey, fine textured, soft shale interbedded with thin layers of light grey, fine to medium texture, medium hard limestone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock.

#### Groundwater Conditions

No natural groundwater level was encountered during augering operations in either boring. Upon completion of rock coring, the induced drill water remained perched within the borings, indicating a low permeability for both the till and shale strata. The existing Heart Lake Road cut effectively drains the immediate structure site to an approximate elevation of 162.5.



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Foundation Engineer



M. Devata, P. Eng.  
Senior Foundations Engineer

## A P P E N D I X



# RECORD OF BOREHOLE No 10

METRIC

26

W P 127-66-73

LOCATION Co-ords. N 4 833 330.0;

E 292 490.0

ORIGINATED BY V.P.

DIST 6 HWY 403

BOREHOLE TYPE Solid Stem Augers

COMPILED BY V.P.

DATUM Geodetic

DATE 82 02 09

CHECKED BY *JS*

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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH							
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				WATER CONTENT (%) 10 20 30					
171.1	Ground Surface														
0.0	(Glacial Till)														
	Silty Clay, Gravel	1	SS	22											
	trace of Sand														
	Very Stiff to Hard	2	SS	44											
169.0	occ. Shale Frags.														
2.1															
	Grey	3	SS	90	15 cm										
		4	SS	90	15 cm										
		5	SS	90	10 cm										
	Weathered	6	SS	90	8 cm										
	Shale														
	Bedrock	7	SS	50	2 cm										
	occasional thin														
	layers of Limestone	8	SS	60	9 cm										
		9	SS	70	5 cm										
		10	BW	REC											
			RC	100											
		11	BW	REC											
			RC	95											
158.8															
12.3	End of Borehole														
	WL NOT ENCOUNTERED														

+3, x5; Numbers refer to  
Sensitivity

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



# RECORD OF BOREHOLE No 11

METRIC

27

W P 127-66-73 LOCATION Co-ords. N 4 833 294.0; E 292 440.0 ORIGINATED BY V.P.  
DIST 6 HWY 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 16 CHECKED BY 37

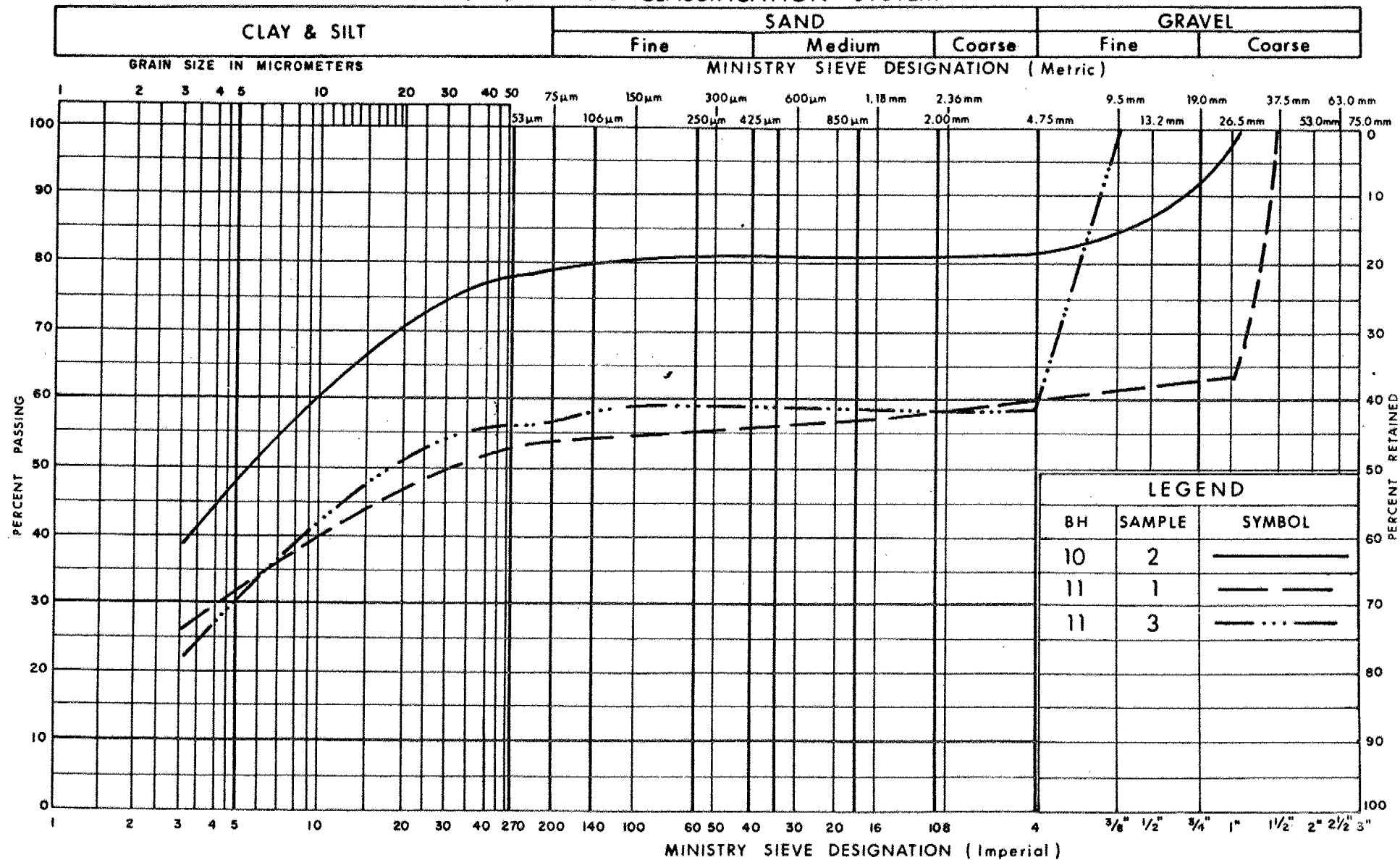
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH			WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	x LAB VANE	10	20		
172.8	Ground Surface														
0.0	Grey Brown (Glacial Till) Silty Clay, Gravel trace of Sand occ. shale fragments		1	SS	33		172							40 7 32 21	
			2	SS	80										
			3	SS	70	2 cm	170							41 2 39 18	
169.9	Hard		4	SS	50	13 cm									
2.9	Grey		5	SS	50	0 cm									
			6	SS	60	8 cm	168								
	Weathered		7	SS	60	1 cm	166								
	Shale Bedrock occasional thin layers of Limestone		8	SS	50	5 cm	164								
			9	BW RC	REC 100		162								
			10	BW RC	REC 100		160								
158.9	End of Borehole														
13.9	WL NOT ENCOUNTERED						158								

+3, x5: Numbers refer to  
Sensitivity

20  
15 → 5 (%) STRAIN AT FAILURE  
10



## UNIFIED SOIL CLASSIFICATION SYSTEM

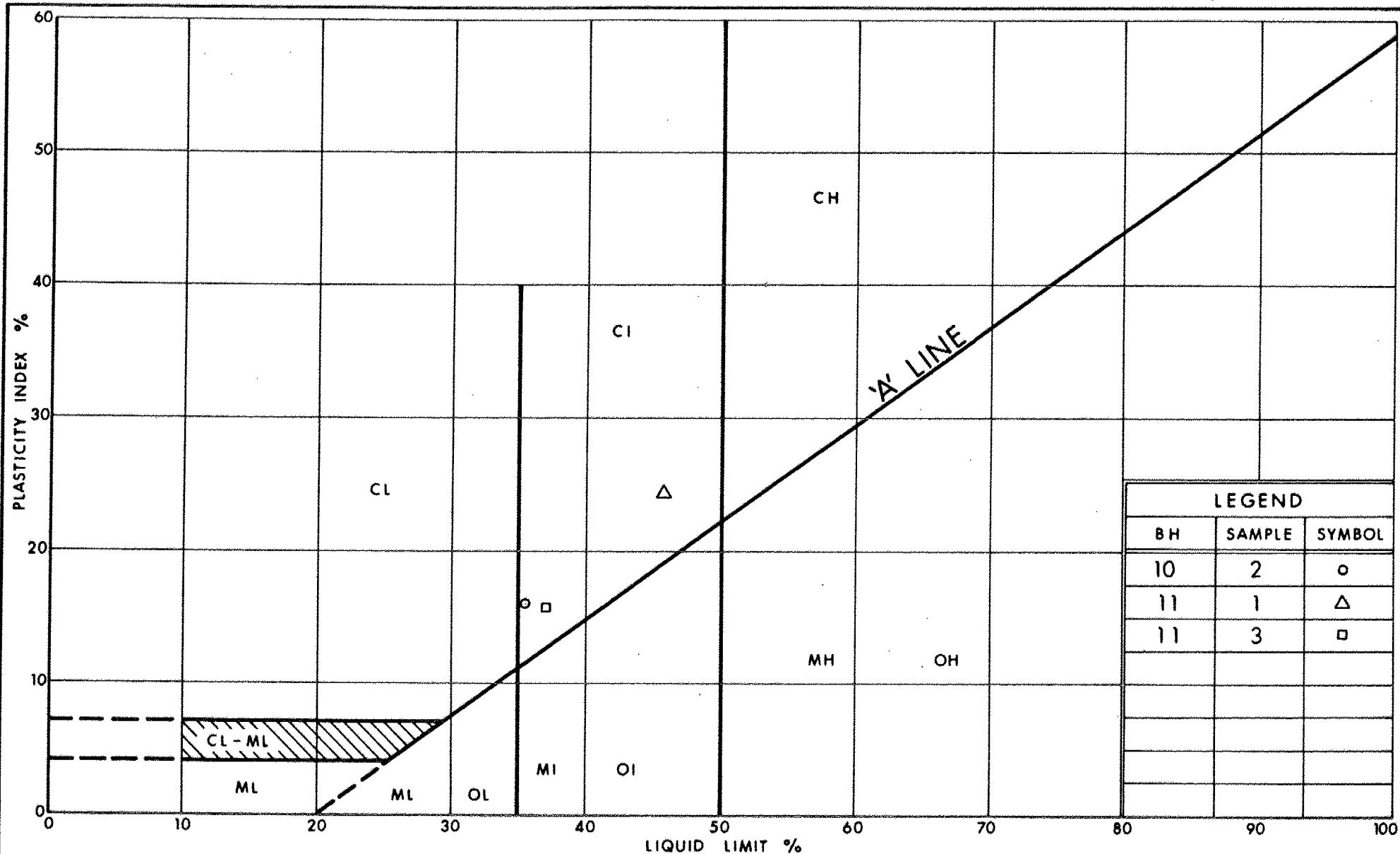


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# GRAIN SIZE DISTRIBUTION (GLACIAL TILL)

SILTY CLAY WITH VARYING AMOUNTS OF GRAVEL TRACE OF SAND

FIG No 1  
W P 127-66-73



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PLASTICITY CHART  
(GLACIAL TILL MATRIX)  
SILTY CLAY OF INTERMEDIATE PLASTICITY

FIG No 2

W P 127-66-73

For  
Bridge #24  
Highway 403 W.B. Core  
Over Highway 401 Core and  
Heart Lake Road  
W.P. 127-66-74, Site 24-81-467  
Hwy. 403, District 6, Toronto.

INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural site.

The fieldwork was carried out between 82 02 08 and 82 02 12 and consisted of advancing 5 sampled boreholes using solid stem continuous flight augers with bedrock being cored in three of the borings. The depth of borings ranged from 8.8 metres to 18.2 metres terminating within the shale bedrock.

Site Description and Geology

The structure site is located west of the existing Hwy. 401 E.B. Collector structure (Bridge #49) over Heart Lake which was constructed under Contract 75-16 as part of the Hwy. 401/403 Interchange complex.

Land use in the area is changing from predominately farming to industrial subdivision development. Topography across the site is generally flat to gently undulating with ground surface sloping gradually towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation, is composed of cohesive glacial till, whose thickness varies from nil to 15 metres. The overburden is underlain by shale bedrock of the Meaford-Dundas Formation, Ordovician Period.

### Subsurface Conditions

Borings carried out at the structure site indicates generally uniform subsurface conditions. The overburden consists of a shallow deposit of cohesive glacial till covered by 2 metres of fill at some pier locations and underlain by shale bedrock. The upper portion of the shale was found to be weathered. In previous cut areas, exposed shale has been covered with a thin veneer of fill.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 2, which should be read in conjunction with the borehole sheets and this report.

The various soil types encountered are briefly described in the following paragraphs.

### Fill Material

Borings at the two southerly pier locations encountered some 2 metres of fill material whose composition range from a grey reworked silty clay till and highly fragmented shale mixture to a brown sand and gravel with some silty clay. Based on interpretation of Standard Penetration Test 'N' values ranging from 25 to 56 blows per 0.3 metres, the fill appears to have undergone a relatively high degree of compactive effort.

In addition, a thin veneer of fill consisting of the reworked parent till of the area was found to overly shale where previous roadway cuts had been advanced.

### Silty Clay, Gravel and Sand (Glacial Till)

The natural surficial deposit overlying most of the site consists of a shallow deposit of glacial till composed of a silty clay of intermediate plasticity with varying amounts of gravel and some sand. Typical

grain size distribution curves for representative samples from this deposit are shown on Figure 1. An increasing frequency of fragments, and detached slabs of weathered shale and limestone were encountered within the lower portion of this till.

Results of water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	11-21	16
Liquid Limit	(W <sub>L</sub> ) %	35-40	38
Plastic Limit	(W <sub>p</sub> ) %	18-20	19
Plasticity Index	(I <sub>p</sub> ) %	17-21	19

These results indicate the cohesive matrix of the glacial till consists of an inorganic silty clay of intermediate plasticity (CI).

Based on interpretation of Standard Penetration Test 'N' values ranging from 12 to in excess of 100 blows per 0.3 metres, the consistency of this deposit ranges from stiff to hard.

#### Bedrock

The shale bedrock was encountered immediately beneath the glacial till deposit across the site. The upper 1.1 to 3.5 metres of the bedrock is in a weathered condition. The natural bedrock surface varies between elevations 174.5 to 169.1 corresponding to depths of approximately 2.4 to 2.6 metres below original ground surface prior to cut excavations for the existing Heart Lake Road.


Bedrock surface is sloping gently in a northeasterly direction across the site.

The rock is described as a dark grey, fine textured, soft shale interbedded with thin layers of light grey, fine to medium texture, medium hard limestone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone.

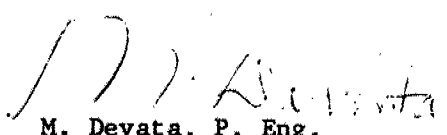
The highly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock.

#### Groundwater Conditions

Stabilized borehole water level readings taken in open boreholes indicated a groundwater surface ranging in depths corresponding to elevations 163 to 168.4. Generally, upon completion of rock coring operations, the induced drill water remained perched within the boreholes, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Heart Lake Road geometry effectively drains the immediate structure location to the respective roadway grades.



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Foundation Engineer



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Senior Foundations Engineer

## A P P E N D I X



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# RECORD OF BOREHOLE No 1

METRIC

35

W P 127-66-74 LOCATION Co-ords. N 4 833 408.5; E 292 411.5 ORIGINATED BY V.P.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 08 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
171.7	Ground Surface																
0.0	Grey brown (Glacial Till) Silty Clay, some Sand and Gravel Stiff to Hard		1	SS	12	*	170										10 20 45 25
169.1			2	SS	12												
2.6			3	SS	100/23 cm												
	Weathered		4	SS	85/13 cm		168										
			5	SS	100/10 cm												
	Grey Shale		6	SS	70/8 cm		166										
	Bedrock with thin layers of Limestone		7	SS	50/1 cm												
			8	SS	90/8 cm		164										
			9	RC	95% REC												
			10	RC	100% BW REC												
			11	RC	100% BW REC		162										
161.1	End of Borehole																
10.6	* Note: Ground water level not established						160										

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10





# RECORD OF BOREHOLE No 2

METRIC

36

W P 127-66-74 LOCATION Co-ords. N 4 833 353.7 E 292 349.8 ORIGINATED BY V.P.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 11 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80
173.5	Ground Surface															
0.0	Grey Brown(Glacial Till) Silty Clay, some Sand and Gravel		1	SS	22									24 14 35 27		
171.8	Very stiff to Hard		2	SS	80/2	cm										
1.7	Grey		3	SS	80/10	cm										
	Weathered		4	SS	80/18	cm										
			5	SS	80/13	cm										
			6	SS	80/10	cm										
			7	SS	75/1	cm										
	Shale Bedrock with thin layers of Limestone		8	SS	60/1	cm										
			9	SS	60/1	cm										
163.3	Refusal to Auger End of Borehole															
10.2							162									

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 3 METRIC

37

W P 127-66-74 LOCATION Co-ords. N 4 833 304.8: E 292 331.9 ORIGINATED BY V.P.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 11 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH						
								○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE						
177.4	Ground Surface													
0.0	Grey (Fill) Reworked Silty Clay Till and Shale mixture		1	SS	25		176							2 17 47 34
175.3			2	SS	40									
2.1	(Glacial Till) Grey Brown Silty Clay Some Sand and Gravel Very Stiff to Hard		3	SS	28		174							34 10 32 24
			4	SS	23									
			5	SS	48									
			6	SS	64									
171.6							172							
5.8	Weathered		7	SS	70/2 cm		170							
			8	SS	70/13 cm									
			9	SS	50/1 cm		168							
			10	SS	60/1 cm		166							
			11	SS	70/2 cm		164							
							162							
			12	BW RC	100% REC		160							
			13	BW RC	100% REC									
159.2														
18.2	End of Borehole						158							

# RECORD OF BOREHOLE No 4 METRIC

38

W P 127-66-74 LOCATION Co-ords. N 4 833 270.8; E 292 290.7 ORIGINATED BY V.P.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 12 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100		
177.7	Ground Surface												
0.0	Brown Fill Sand and Gravel some Silty Clay		1	SS	53								28 42 21 9
175.9			2	SS	56	176							
1.8	Grey Brown (Glacial Till) Silty Clay, some Sand & Shale Fragments		3	SS	32								11 15 41 33
174.2	Hard		4	SS	78/25 cm	174							
3.5			5	SS	70/10 cm								
	Weathered		6	SS	70/13 cm								
			7	SS	70/8 cm	172							
	Grey Shale Bedrock with thin layers of Limestone		8	SS	70/8 cm	170							
			9	SS	70/5 cm	168							
			10	SS	60/2 cm	166							
			11	SS	60/1 cm	164							
162.5	Refusal to Augers End of Borehole					162							

+3, x5; Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 5 METRIC

39

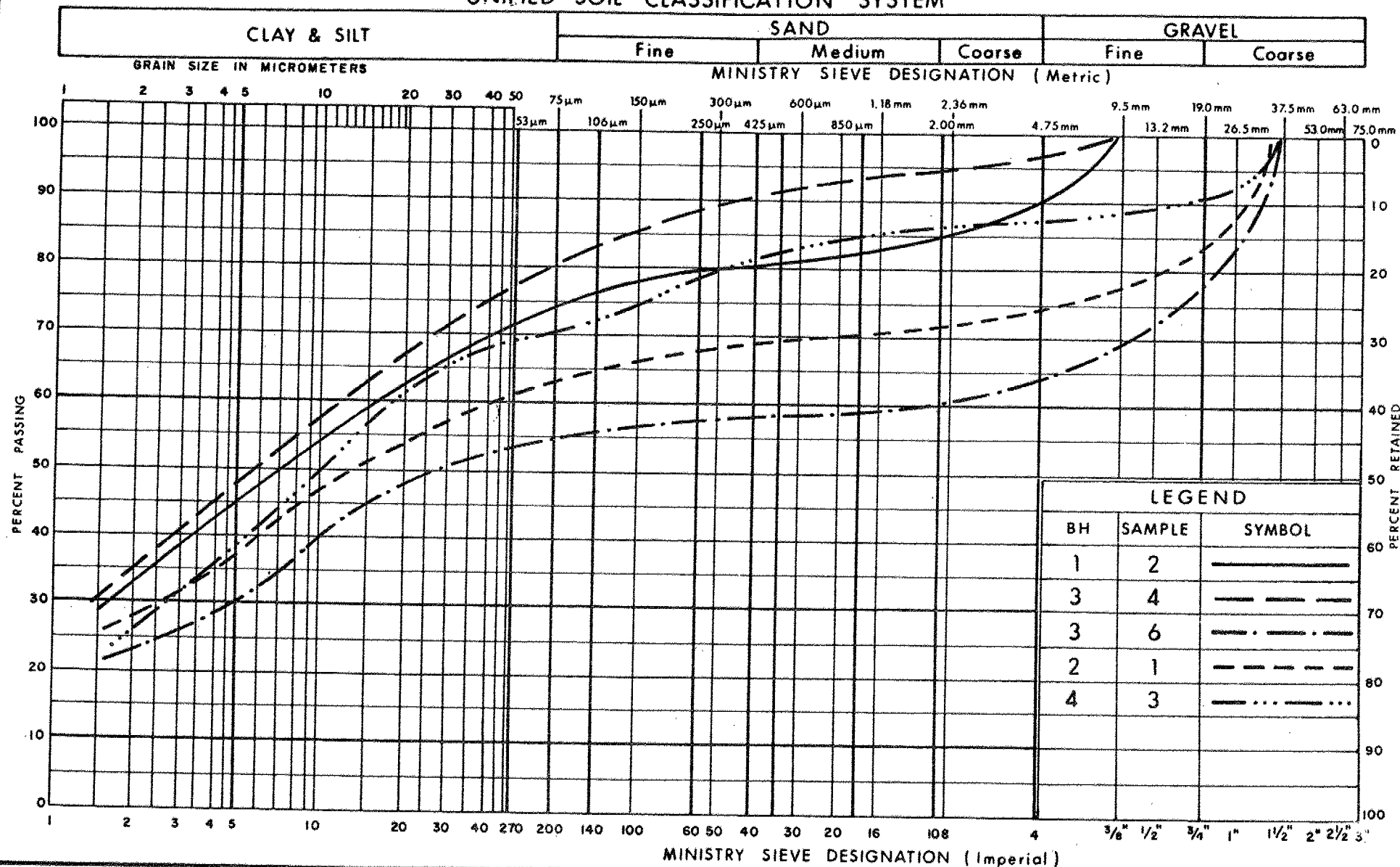
W P 127-66-74 LOCATION Co-ords. N 4 833 237.4 E 292 289.7 ORIGINATED BY V.P.  
DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 12 CHECKED BY \_\_\_\_\_

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
176.9	Ground Surface																
0.0	Grey Brown (Glacial Till) Silty Clay, some Sand & Gravel Very Stiff to Hard		1	SS	20	*	176										
			2	SS	70												
174.5			3	SS	70/5		174										
2.4	Weathered ----- Grey Shale Bedrock with thin layers of Limestone		4	SS	90/15												
			5	SS	40/0												
			6	SS	60/3		172										
			7	BW RC	100% REC		170										
			8	BW RC	95% REC												
168.1																	
8.8	End of Borehole  * Note: Ground water level not established						168										
							166										

+3, x<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE

## UNIFIED SOIL CLASSIFICATION SYSTEM



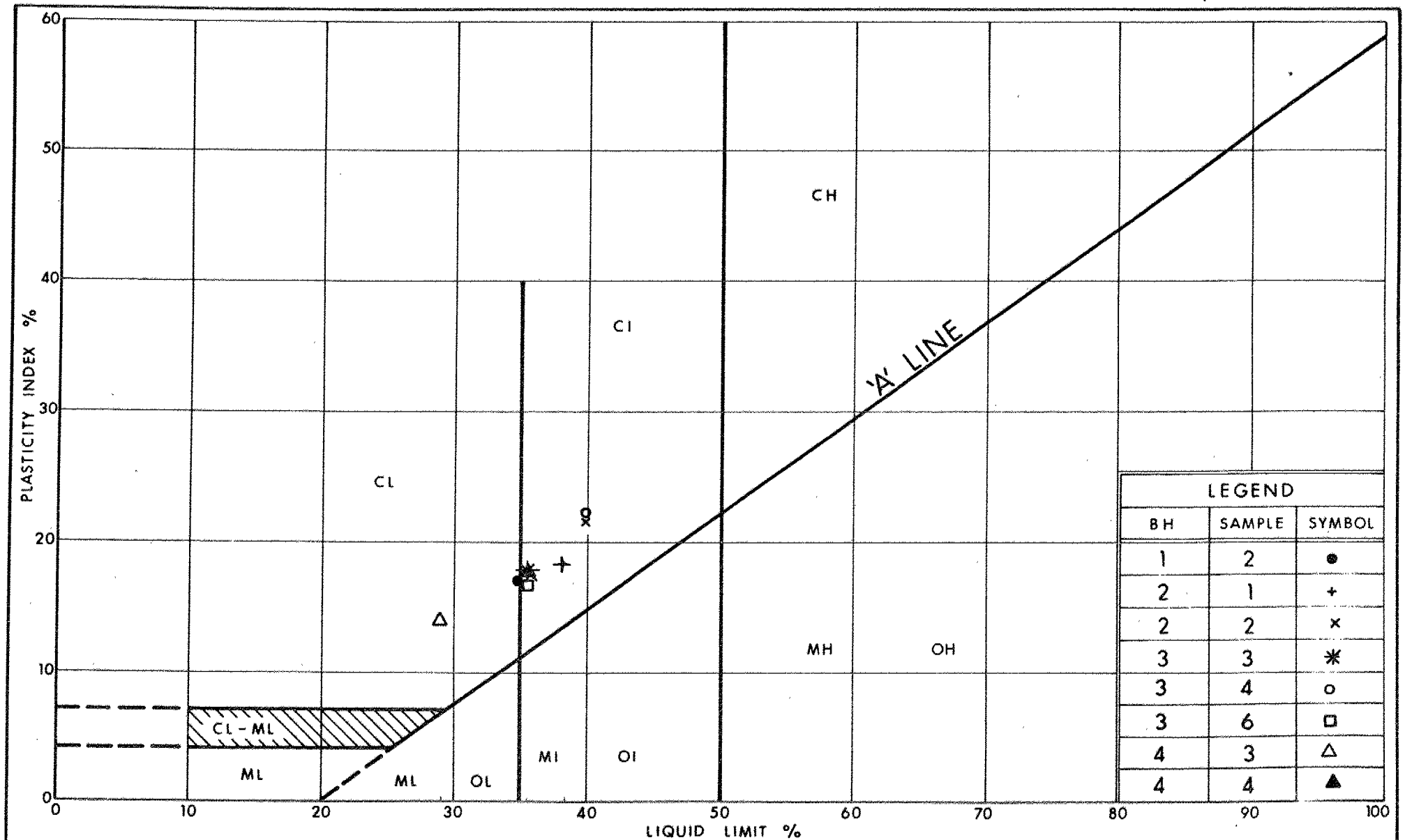
Ontario

Ministry of  
Transportation and  
CommunicationsGRAIN SIZE DISTRIBUTION  
( GLACIAL TILL )

SILTY CLAY SOME SAND &amp; VARIOUS AMOUNTS OF GRAVEL

FIG No 1

W P 127-66-74



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PLASTICITY CHART  
(GLACIAL TILL MATRIX)  
SILTY CLAY OF INTERMEDIATE PLASTICITY

FIG No 2

W P 127-66-74



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# foundation investigation and design report

ENGINEERING MATERIALS OFFICE  
PAVEMENT & FOUNDATION DESIGN SECTION

WP 127-66-71 DIST 6  
HWY 403 STR SITE 24-81-465A

Bridge #23, Highway 403 E.B. Core  
Over Highway 401 E.B. Collector and  
Dixie Road Sub-Collector

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# FOUNDATION INVESTIGATION REPORT

For

Bridge #23

Highway 403 E.B. Core

Over Highway 401 E.B. Collector and

Dixie Road Sub-Collector

W.P. 127-66-71, Site 24-81-465A

Hwy. 403, District 6, Toronto.

## INTRODUCTION:

This report summarizes the factual information obtained from a foundation investigation program performed at the above-mentioned structural site and provides detailed recommendations pertaining to the structure foundations and related earthworks.

The fieldwork was carried out between 82 02 16 and 82 03 15 and consisted of advancing 5 sampled boreholes using solid stem continuous flight augers with bedrock being cored in two of the borings. The depth of borings ranged from 1.1 metres to 12.0 metres terminating within the shale bedrock.

## Site Description and Geology

The structure site is located immediately west of the existing Hwy. 401 E.B. Collector structure (Bridge #49) over Heart Lake which was constructed under Contract 75-16 as part of the Hwy. 401/403 Interchange complex.

Land use in the area is changing from predominately farming to industrial subdivision development. Topography across the site is generally flat to gently undulating with ground surface sloping gradually towards Lake Ontario.

The site is located in the physiographic region known as the "Peel Plain". The characteristic deposit, in the vicinity of the area under investigation, is composed of cohesive glacial till, whose thickness varies from nil to 15 metres. The overburden is underlain by shale bedrock of the Meaford-Dundas Formation, Ordovician Period.

### Subsurface Conditions

Borings carried out at the structure site indicates generally uniform subsurface conditions. The overburden consists of a shallow deposit of cohesive glacial till underlain by shale bedrock. The upper portion of the shale was found to be weathered. In previous cut areas, exposed shale has been covered with a thin veneer of fill.

The boundaries between the various soil types, insitu and laboratory test results, as well as stabilized ground water levels, are shown on the attached Record of Borehole Sheets. The locations and elevations of the borings, along with a profile showing an estimated soil stratigraphy based on borehole data, are shown on Drawing No. 1276671-A.

The various soil types encountered are briefly described in the following paragraphs.

### Silty Clay, Gravel and Sand (Glacial Till)

The surficial deposit overlying the site consists of a shallow deposit of glacial till composed of a silty clay of intermediate plasticity with varying amounts of gravel and some sand. Typical grain size distribution curves for representative samples from this deposit are shown on Figure 1. An increasing frequency of fragments, and detached slabs of weathered shale and limestone were encountered within the lower portion of this till. A thin veneer of fill consisting of the reworked parent till of the area was found to overly shale where previous highway cuts had been advanced.

Results of limited water content and Atterberg Limit testing are plotted on the Plasticity Chart (Figure 2) and summarized as follows:

		<u>Range</u>	<u>Average</u>
Water Content	(w) %	9-16	12
Liquid Limit	(W <sub>L</sub> ) %	35-36	36
Plastic Limit	(W <sub>p</sub> ) %	17-20	19
Plasticity Index (I <sub>p</sub> ) %		15-18	17

These results indicate the cohesive matrix of the glacial till consists of an inorganic silty clay of intermediate plasticity (CI).

Based on interpretation of Standard Penetration Test 'N' values ranging from 5 to in excess of 100 blows per 0.3 metres, the consistency of this deposit ranges from firm to hard.

#### Bedrock

The shale bedrock was encountered immediately beneath the glacial till deposit across the site. The upper 1.3 to 2.9 metres of the bedrock is in a weathered condition. The natural bedrock surface varies between elevations 169.5 to 176.4 corresponding to depths of approximately 0.8 to 2.9 metres below original ground surface prior to cut excavations for the existing Hwy. 401 collectors.

Bedrock surface is sloping gently in a northeasterly direction across the site.

The rock is described as a dark grey, fine textured, soft shale interbedded with thin layers of light grey, fine to medium texture, medium hard limestone. This formation is generally weathered in the upper layers and frequently transitional with the overlying till layer containing frequent fragments and detached slabs of shale and limestone. The badly weathered zone of shale near the top of bedrock grades through a zone of moderate weathering into intact bedrock.

#### Groundwater Conditions

A stabilized borehole water level was obtained in only one boring at a depth of 9.1 metres corresponding to elevation 164.1. No other natural water levels were encountered during augering operations in the other borings. Upon completion of rock coring, the induced drill water remained perched within the borings, indicating a low permeability for both the till and shale strata. The depressed profile grades of the existing Hwy. 401/Heart Lake Road geometry effectively drains the immediate structure site to a minimum elevation of approximately 170.

#### DISCUSSION AND RECOMMENDATION

As part of the upgrading of Highways 401 and 403 to a collector/core network, East and West Bound Collector Overpass structures are required at the crossing of Hwy. 401 E.B. Expressway and Dixie Road Sub-collector. The proposed E.B. structure (Bridge #23) will consist of a 4 span (35 - 47 - 65 - 44 metres) continuous concrete structure some 13 metres wide. A proposed Hwy. 403 profile grade ranging from 182 to 177 , existing Hwy. 401 E.B. profile grade of 171.0, and average natural ground surface elevation of roughly 176 will necessitate maximum approach fill heights in the order of 2.0 metres.

In consideration of the proximity of competent shale bedrock to ground surface across the site, recommendations pertaining to the foundations of the new structure and related earthworks are summarized as follows:

The design of shallow foundations founded on an unyielding medium such as shale bedrock will not be governed by settlement since the bearing capacity at the S.L.S. Type II is much larger than the factored capacity at U.L.S. Perched abutments can be supported on spread footings founded within the weathered shale for a factored bearing capacity at the U.L.S. of 1,000 kPa.

Pier footings can be supported on shallow spread footings located and designed in a similar manner as the abutment footings or within the intact shale for a factored capacity at the U.L.S. of 1500 kPa.

A minimum earth cover of 1.25 metres should be provided to the underside of the footings, since the shale is considered susceptible to frost action.

The base of all footing excavations should be covered immediately upon exposure with a working slab of lean concrete to protect the exposed shale from weathering and softening.

Earth pressures against the abutment walls should be computed as per Subsection 6.6.1.2.2 of the O. H. B. D. C. Manual with provisions made from adequate drainage behind the abutment.

Provided backfill to the abutments consists of free draining granular material and adequate provisions are made for an appropriate drainage scheme, the following equivalent fluid pressures may be assumed for computation of earth pressures.

- a) At ultimate limit state
  - active condition 8.0 kPa/m
  - at rest condition 10.0 kPa/m
- b) At serviceability limit state
  - active condition 6.5 kPa/m
  - at rest condition 8.5 kPa/m

All organic and softened material should be stripped from within the plan limits of the immediate approach embankments prior to placement of any fill.

In addition, all new fill material should be properly benched in the existing slopes as per current MTC standards.

A constraint on the use of heavy vibratory equipment within a restricted distance to the back of abutment wall should be included as per current MTC directives.

Resistance to sliding of the abutment footings can be calculated assuming a coefficient of friction of 0.8 between the underside of the concrete footing and the rough shale surface.

No major dewatering difficulties are anticipated for footing excavations in consideration of the relatively low permeability of the shale bedrock. Localized seepage into excavations can be controlled by perimeter ditches and pumping from corner sumps.

No stability problems are anticipated for permanent embankment slopes constructed to a 2:1 geometry.

Temporary cut slopes will stand at a 1:1 geometry or steeper, 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 Mr. V. Parker, Field Technician, utilizing equipment owned and operated by Atcost Drilling Co., Toronto. This report was written by Mr. T. J. Kazmierowski, Foundations Engineer and reviewed by Mr. M. Devata, Senior Foundations Engineer.



A handwritten signature in black ink, appearing to read "T. J. Kazmierowski".

T. J. Kazmierowski, P. Eng.  
Foundation Engineer

A handwritten signature in black ink, appearing to read "M. Devata".

M. Devata, P. Eng.  
Senior Foundations Engineer

APPENDIX

# RECORD OF BOREHOLE No 1

W P 127-66-71 LOCATION Co-ords. N 4 833 271.0 E 282 421.5 ORIGINATED BY V.P.  
 DIST 6 HWY 401 & 403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
 DATUM Geodetic DATE 82 02 16 CHECKED BY \_\_\_\_\_

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
								PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT W <sub>p</sub> W W <sub>L</sub>			WATER CONTENT (%) 10 20 30			
173.2	Ground Surface													
0.0	Gray Brown (Glacial Till) Silty Clay some Sand & Gravel Shale fragments throughout		1	SS	5		172						41 14 30 15	
			2	SS	6									
170.3	Firm		3	SS	5								24 14 41 21	
2.9	Gray		4	SS	95		170							
			5	SS	70/	11 cm								
			6	SS	70/	6 cm	168							
	Weathered													
	Shale Bedrock occasional thin layers of Limestone		7	SS	60/	1 cm	166							
			8	SS	60/	1 cm								
			9	SS	60/	1 cm	164							
			10	SS	90/	3 cm	162							
161.2														
12.0	End of Borehole						160							

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





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Ontario

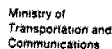
## RECORD OF BOREHOLE No 2

W P 127-66-71 LOCATION Co-ords. N 4 833 230.5; E 292 406.0 ORIGINATED BY V.P.  
DIST 6 HWY 401/403 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
DATUM Geodetic DATE 82 02 17 CHECKED BY \_\_\_\_\_



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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	W <sub>p</sub>	W	W <sub>L</sub>	WATER CONTENT (%)					
170.3	Ground Surface						170										
0.0	Silty Clay Fill																
169.5	some Sand & Limestone																
0.76	frag.		1	SS	70	0 cm											
	Grey																
	Weathered																
	Shale		2	BW	REC		168										
	Bedrock			RC	100												
	thin layers																
	of Limestone		3	BW	REC		166										
				RC	100												
165.7																	
4.6	End of Borehole						164										

+3, x5: Numbers refer to  
Sensitivity

20  
15  
10  
5 (%) STRAIN AT FAILURE



W P 127-66-71 LOCATION Co-ords. N 4 833 166.5; E 292 379.0 ORIGINATED BY V.P.  
DIST 6 HWY 403/401 BOREHOLE TYPE Solid Stem Augers COMPILED BY T.J.K.  
DATUM Geodetic DATE 82 03 15 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 Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20					
170.2	Ground Surface												
0.0	Grey Weathered Shale Bedrock		1	SS	48								
168.3			2	SS	75/	15 cm							
1.86	Refusal to Augers End of Borehole												
RECORD OF BOREHOLE No 4 Co-ords N 4 838 132.5; E 292 351.5													
171.5	Ground Surface												
0.0	Grey Weathered Shale Bedrock		1	SS	50/	6 cm							
170.4													
1.1	Refusal to Augers End of Borehole												

\*3, x<sup>5</sup>: Numbers refer to Sensitivity

# RECORD OF BOREHOLE No 5

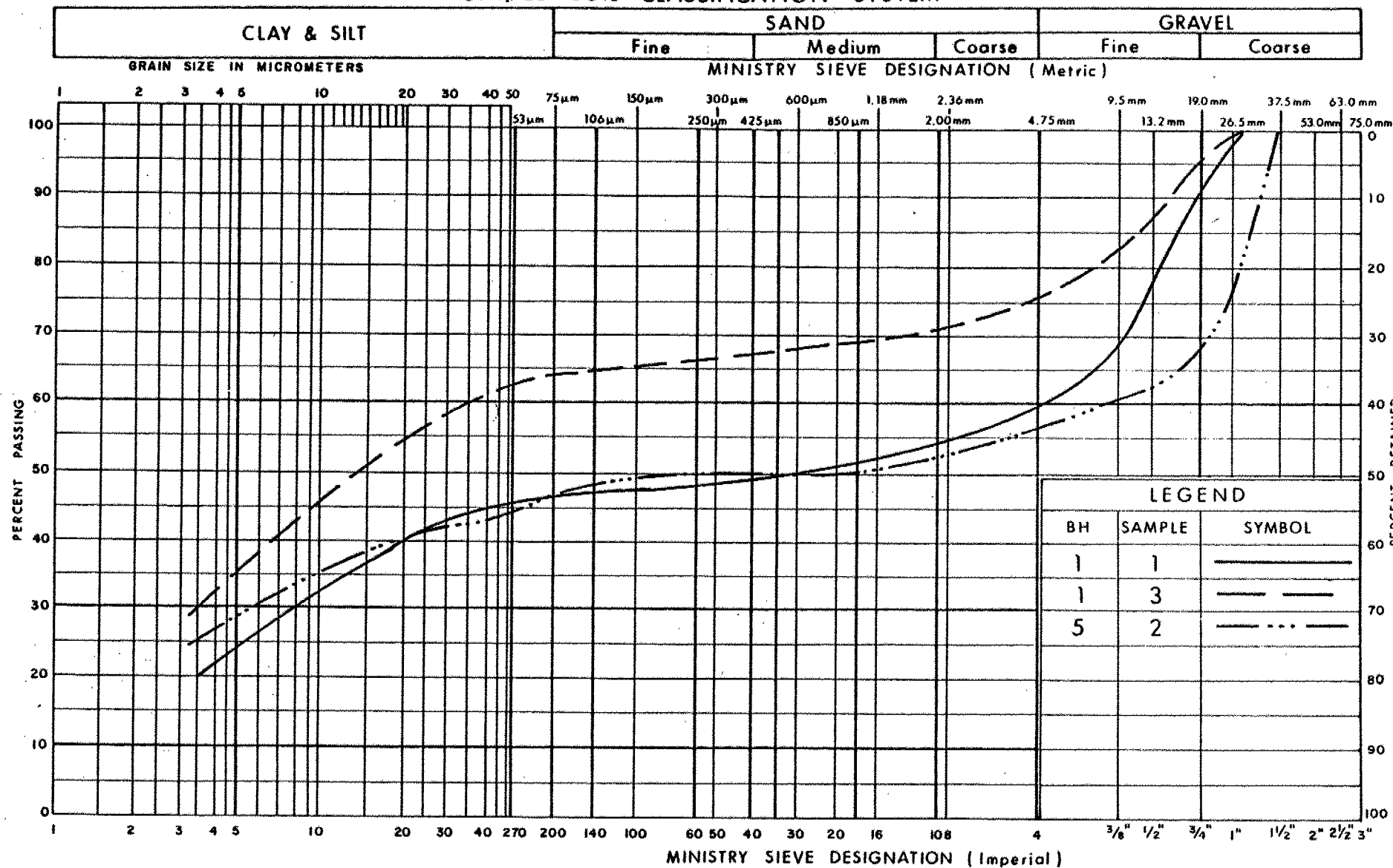
W P 127-66-71 LOCATION Co-ords. N 4 833 101.0; E 292 329.0 ORIGINATED BY V.P.  
 DIST 6 HWY 403/401 BOREHOLE TYPE Solid Stem Augers COMPILED BY V.P.  
 DATUM Geodetic DATE 82 02 19 to 82 03 11 CHECKED BY \_\_\_\_\_

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
179.3	Ground Surface													
0.0	Brown (Glacial Till) Silty Clay and Gravel trace of Sand		1	SS	60		178							
	Shale and Limestone Fragments		2	SS	52									
176.4	Hard		3	SS	60	5 CB								
2.9	Grey		4	SS	50	8 CB	176							
			5	SS	40	8 CB								
	Weathered Shale Bedrock occasional thin Limestone layers		6	BXL RC	REC 93%		174							
			7	BXL RC	REC 100%									
			8	BXL RC	REC 100%		172							
171.9														
7.36	End of Borehole						170							

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

## UNIFIED SOIL CLASSIFICATION SYSTEM

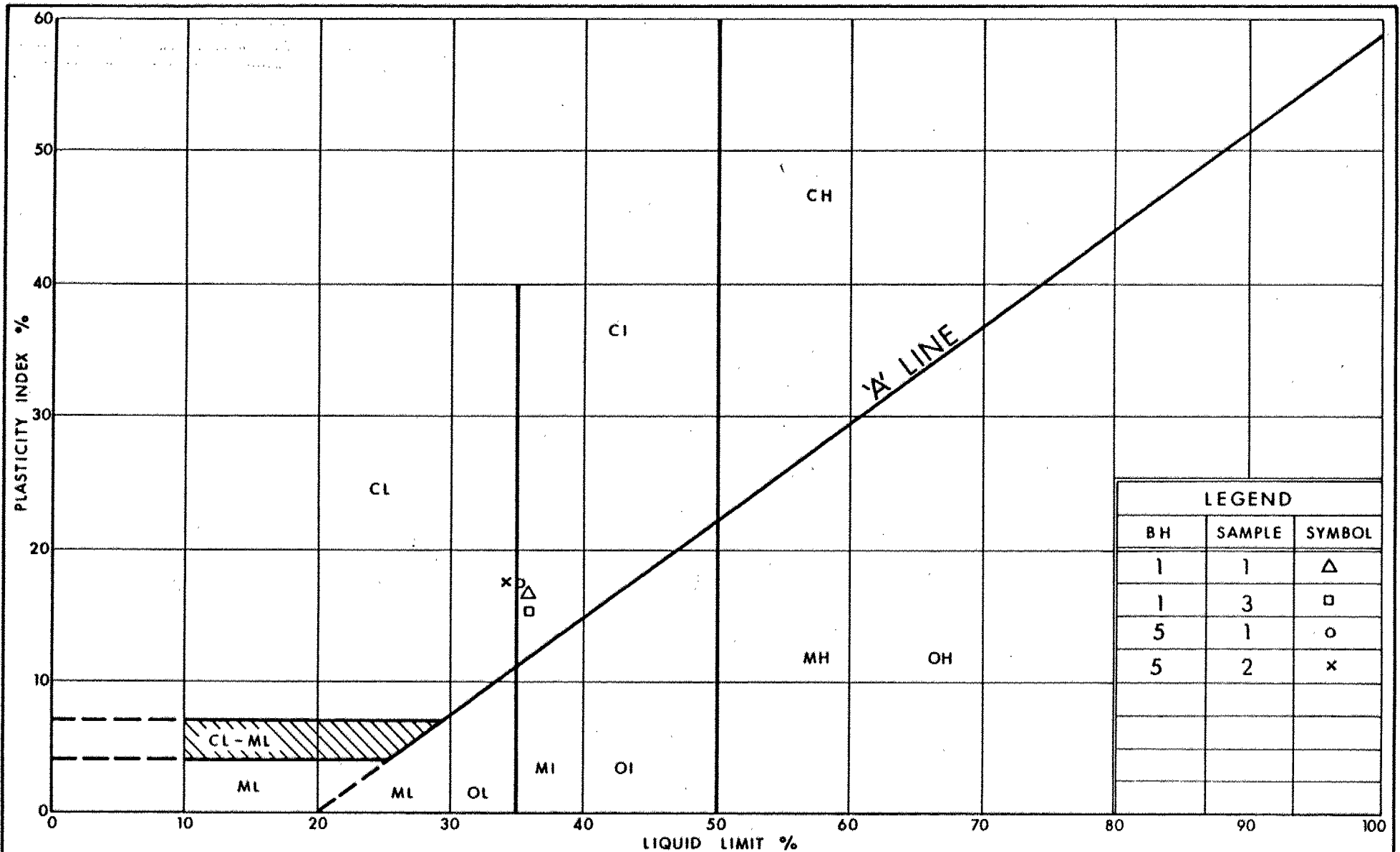


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**GRAIN SIZE DISTRIBUTION**  
**GLACIAL TILL**  
**SILTY CLAY SOME SAND VARIOUS AMOUNTS OF GRAVEL**

FIG No 1

W P 127-66-71



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PLASTICITY CHART  
(GLACIAL TILL MATRIX)  
SILTY CLAY OF INTERMEDIATE PLASTICITY

FIG No 2

W P 127-66-71

# EXPLANATION OF TERMS USED IN REPORT

**'N' VALUE:** AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS  $N_c$ .

**DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3):** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

**SOIL QUALITY:** SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

$S_u$ (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

**ROCK QUALITY:** 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 DRILLED IN THAT CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS & SYMBOLS

### LABORATORY TESTING

TRIAxIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG.  $CUU$  = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

### FIELD SAMPLING

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

### EARTH PRESSURE TERMS

$\mu$  COEFFICIENT OF FRICTION  
 $\delta$  ANGLE OF WALL FRICTION  
 $k_o$  COEFFICIENT OF EARTH PRESSURE AT REST  
 $k_a$  COEFFICIENT OF ACTIVE EARTH PRESSURE  
 $k_p$  COEFFICIENT OF PASSIVE EARTH PRESSURE  
 $i$  ANGLE OF INCLINATION OF SURCHARGE  
 $w$  SLOPE ANGLE-BACKFACE OF WALL  
 $\beta$  ANGLE OF SLOPE  
 $N_\gamma, N_q, N_c$  BEARING CAPACITY FACTORS  
 $D_f$  DEPTH OF FOOTING  
 $B, L$  FOOTING DIMENSIONS

### INDEX PROPERTIES

$\gamma$  UNIT WEIGHT OF SOIL (BULK DENSITY)  
 $\gamma_w$  UNIT WEIGHT OF WATER  
 $\gamma_d$  UNIT DRY WEIGHT OF SOIL (DRY DENSITY)  
 $\gamma'$  UNIT WEIGHT OF SUBMERGED SOIL  
 $G_s$  SPECIFIC GRAVITY OF SOLIDS  
 $e$  VOIDS RATIO  
 $e_o$  INITIAL VOIDS RATIO  
 $e_{max}$   $e$  IN LOOSEST STATE  
 $e_{min}$   $e$  IN DENSEST STATE  
 $D_r$  RELATIVE DENSITY =  $\frac{e_{max} - e}{e_{max} - e_{min}}$   
 $n$  POROSITY  
 $w$  WATER CONTENT  
 $w_L$  LIQUID LIMIT  
 $w_p$  PLASTIC LIMIT  
 $w_s$  SHRINKAGE LIMIT  
 $I_p$  PLASTICITY INDEX =  $w_L - w_p$   
 $L_L$  LIQUIDITY INDEX =  $\frac{w - w_p}{w_L - w_p}$   
 $I_c$  CONSISTENCY INDEX =  $\frac{w_L - w}{w_L - w_p}$   
 $A_c$  ACTIVITY =  $\frac{I_p \text{ of soil}}{I_p \text{ of } \mu m \text{ Sed Fraction}}$   
 $O_m$  ORGANIC MATTER CONTENT  
 $S_r$  DEGREE OF SATURATION  
 $S$  SENSITIVITY =  $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

### STRENGTH PARAMETERS

$\phi$  ANGLE OF SHEARING RESISTANCE  
 $\tau_f$  PEAK SHEAR STRENGTH  
 $\tau_R$  RESIDUAL SHEAR STRENGTH  
 $c$  COHESION INTERCEPT  
 $\sigma_1, \sigma_2, \sigma_3$  NORMAL PRINCIPAL STRESSES  
 $u$  PORE WATER PRESSURE  
 $u_e$  EXCESS  $u$   
 $r_u$  PORE PRESSURE RATIO  
 $q_u$  UNCONFINED COMPRESSIVE STRENGTH  
 $s_u$  UNDRAINED SHEAR STRENGTH  
 $\epsilon$  LINEAR STRAIN  
 $\gamma$  SHEAR STRAIN  
 $\nu$  POISSON'S RATIO  
 $E$  MODULUS OF ELASTICITY  
 $G$  MODULUS OF SHEAR DEFORMATION  
 $k_s$  MODULUS OF SUBGRADE REACTION  
 $m, n$  STABILITY COEFFICIENTS  
 $A, B$  PORE PRESSURE COEFFICIENTS

### HYDRAULIC TERMS

$h$  HYDRAULIC HEAD OR POTENTIAL  
 $q$  RATE OF DISCHARGE  
 $v$  VELOCITY OF FLOW  
 $i$  HYDRAULIC GRADIENT  
 $j$  SEEPAGE FORCE PER UNIT VOLUME  
 $\eta$  COEFFICIENT OF VISCOSITY  
 $k$  COEFFICIENT OF HYDRAULIC CONDUCTIVITY  
 $k_h$   $k$  IN HORIZONTAL DIRECTION  
 $k_v$   $k$  IN VERTICAL DIRECTION  
 $\alpha_v$  COEFFICIENT OF VOLUME CHANGE  
 $c_v$  COEFFICIENT OF CONSOLIDATION  
 $C_c$  COMPRESSION INDEX  
 $C_r$  RECOMPRESSION INDEX  
 $d$  DRAINAGE PATH DISTANCE  
 $T_v$  TIME FACTOR  
 $U$  DEGREE OF CONSOLIDATION  
 $O_c$  OVERCONSOLIDATION RATIO (OCR)

**NOTE:** EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:  
 $\phi'$  = EFFECTIVE ANGLE OF SHEARING RESISTANCE;  
 $\sigma'$  = EFFECTIVE NORMAL STRESS

METRIC

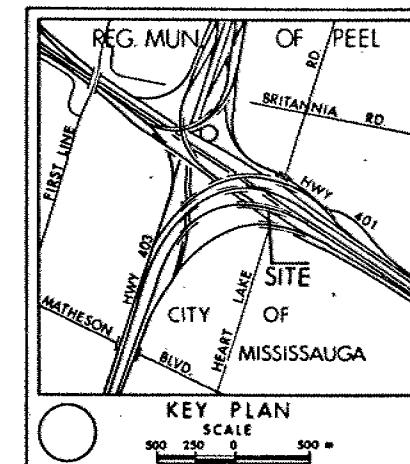
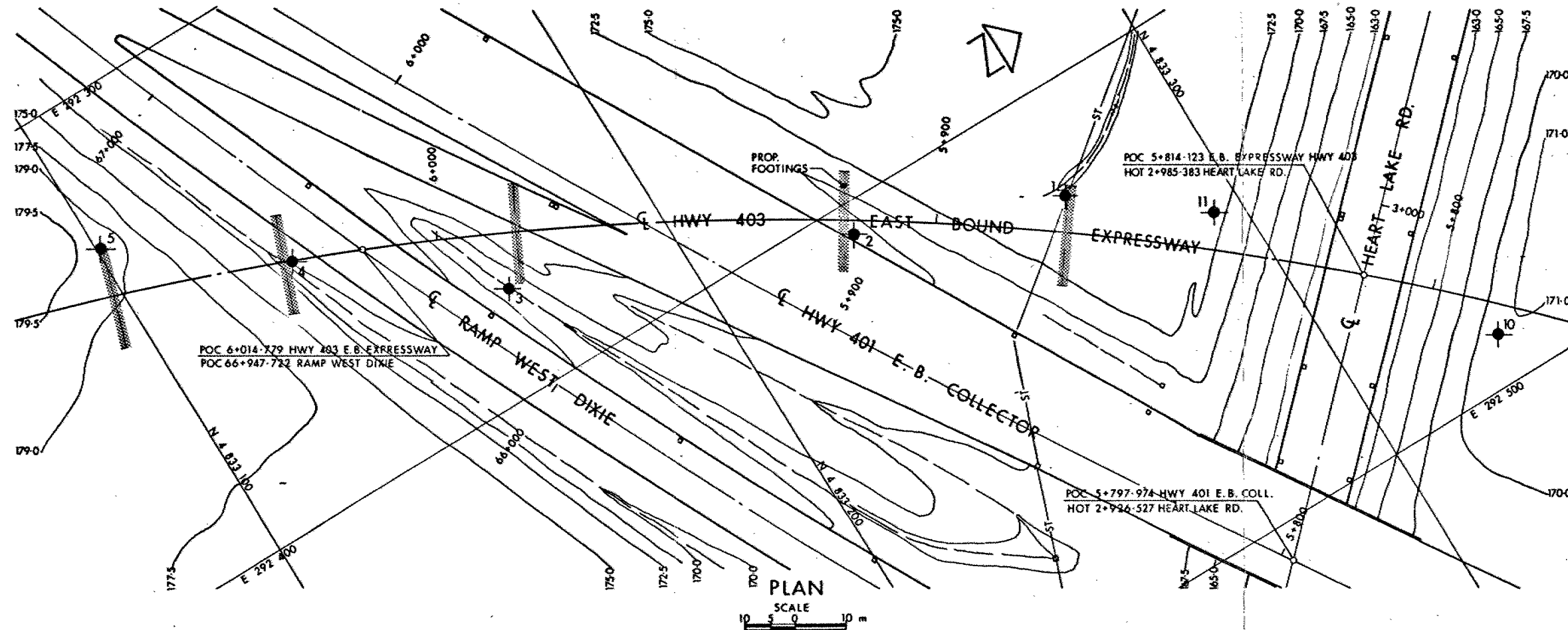
NOTE: DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN STATIONS IN KILOMETRES + METRES

CONT No  
WP No 127-66-71

HWY 403 E.B. EXPRESSWAY CROSSING  
RAMP WEST & HWY 401 E.B. COLLECTOR  
(BRIDGE No 23)  
BORE HOLE LOCATIONS & SOIL STRATA

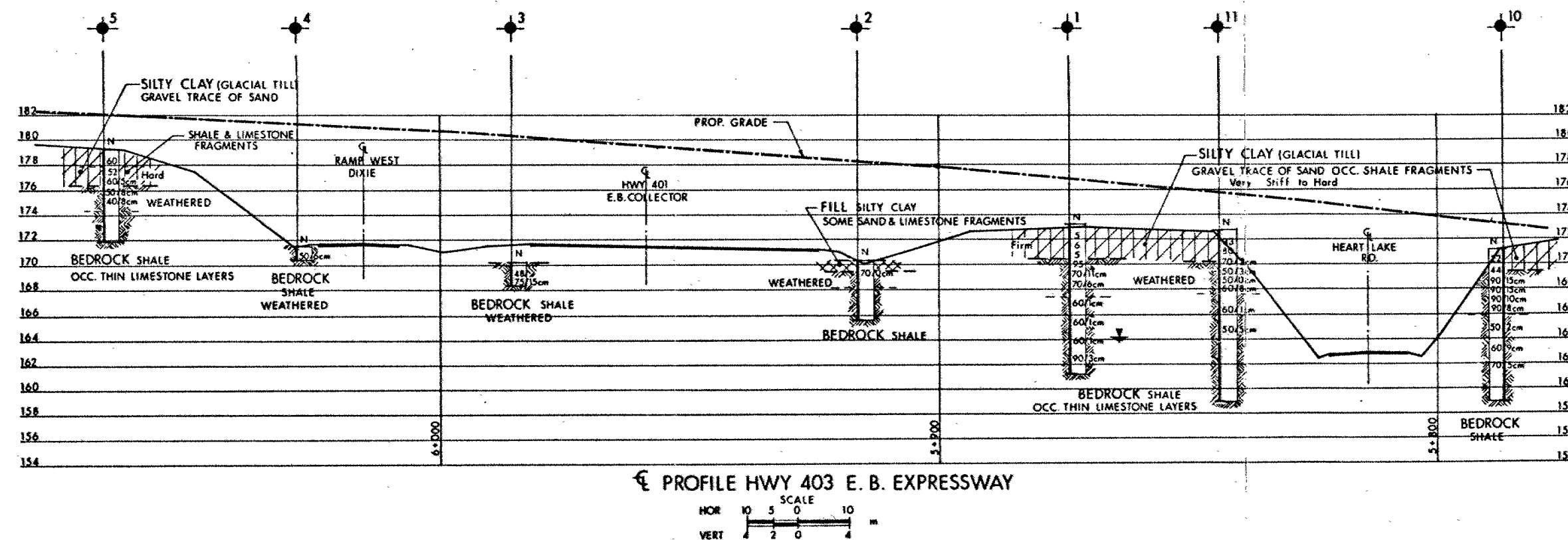


SHEET



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 B2 02 16



No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	173.2	4 833 271.0	292 421.5
2	170.3	4 833 230.5	297 406.0
3	170.2	4 833 166.0	292 379.0
4	171.5	4 833 132.5	292 351.5
5	179.3	4 833 101.0	292 329.0
10	171.1	4 833 330.0	292 490.0
11	172.8	4 833 294.0	292 440.0

NOTE

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

REVISIONS		DESCRIPTION	
DATE	BY		

Geocres No 30M12-156

HWY No	403	DIST	6
SUBMITT K. CHECKED	DATE 82 03 18	SITE 24-81-465	
DRAWNOL J. CHECKED	APPROVED	DWG 1276671-A	

# MEMORANDUM



To: Mr. K. Lutska  
— Inspection Engineer  
Structural Office  
3501 Dufferin St., 4th Floor

Date: 83 03 15

From: Pavement & Foundation Design Section  
Room 315, Central Bldg.  
Downsview

Re: Footing Pier #1 - Bridge No. 23  
Hwy. 403, E.B. Express Over Hwy. 401 E.B.  
Collector & Ramp - W Dixie

Further to our site meeting with yourself, Mr. Grenville Sholer (Project Supervisor) and Mr. Kelly Saarits (Area Construction Superintendant), we provide the following comments and the enclosed photographs as per your request.

Part of the footing for the north pier of bridge No. 23, is situated over top of an existing 381 mm Ø storm sewer. At the time of our visit, the storm sewer in the vicinity of the footing had been removed and the trench was left open for our inspection. Mr. Saarits suggested filling that part of the trench directly underneath the proposed footing with mass concrete and the remaining section of the trench was to be backfilled with shale backfill. We questioned the durability of shale backfill especially when exposed to water and mentioned the concern of possible differential settlement between the concrete and the shale backfill within the influence area of the pier footing. For this reason, we suggested filling the entire trench with mass concrete, to which you agreed.

Mr. Saarits estimated the additional cost for this treatment at approximately \$4,000.

*Brian Ruck*

Brian Ruck  
Trainee Engineer

For: M. Devata, P. Eng.  
Senior Foundations Engineer

BR:syc