

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-205

DIST. 6 REGION

W.P. No. 54-82-15/16

CONT. No. 91-45

W. O. No.

STR. SITE No. 24-493

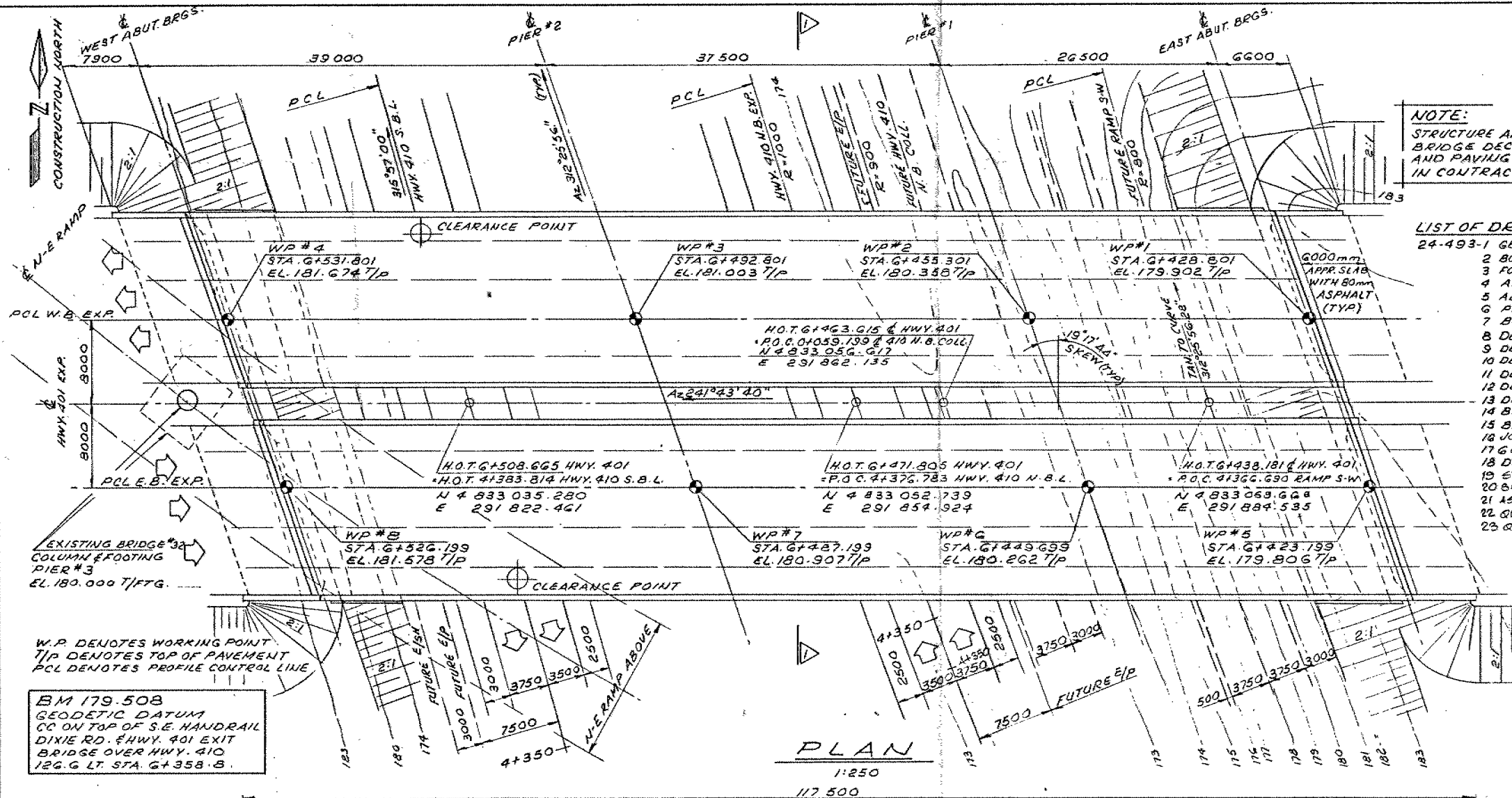
HWY. No. 401/410

LOCATION Hwy 401/410 E.B. Core lanes
W.B. Core lanes

No. of PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



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

DIST. 6
CONT No
WP No 54-82-15
54-82-16



NOTE:
STRUCTURE APPROACH SLABS AND
BRIDGE DECK WATERPROOFING
AND PAVING ARE NOT INCLUDED
IN CONTRACT.

Fenco
FENCO ENGINEERS INC.

- LIST OF DRAWINGS**
- 24-493-1 GENERAL ARRANGEMENT
 - 2 BOREHOLE LOCATION & SOIL STRATA
 - 3 FOUNDATION LAYOUT & REINF.
 - 4 ABUTMENTS - I
 - 5 ABUTMENTS - II
 - 6 PIERS
 - 7 BEARINGS
 - 8 DECK LAYOUT & DETAILS
 - 9 DECK PRESTRESSING I
 - 10 DECK PRESTRESSING II
 - 11 DECK PRESTRESSING III
 - 12 DECK REINFORCEMENT I
 - 13 DECK REINFORCEMENT II
 - 14 BARRIER WALLS I
 - 15 BARRIER WALLS II
 - 16 JOINT ANCHORAGE AND ARMOURING
 - 17 6000 mm APPROACH SLAB
 - 18 DETAILS OF CONC. SLOPE PAVING
 - 19 STANDARD DETAILS
 - 20 BRIDGE DATE & SITE NUMBER DATA
 - 21 AS CONSTRUCTED ELEV. & DIMENSIONS
 - 22 QUANTITIES
 - 23 QUANTITIES

GENERAL NOTES:

CLASS OF CONCRETE

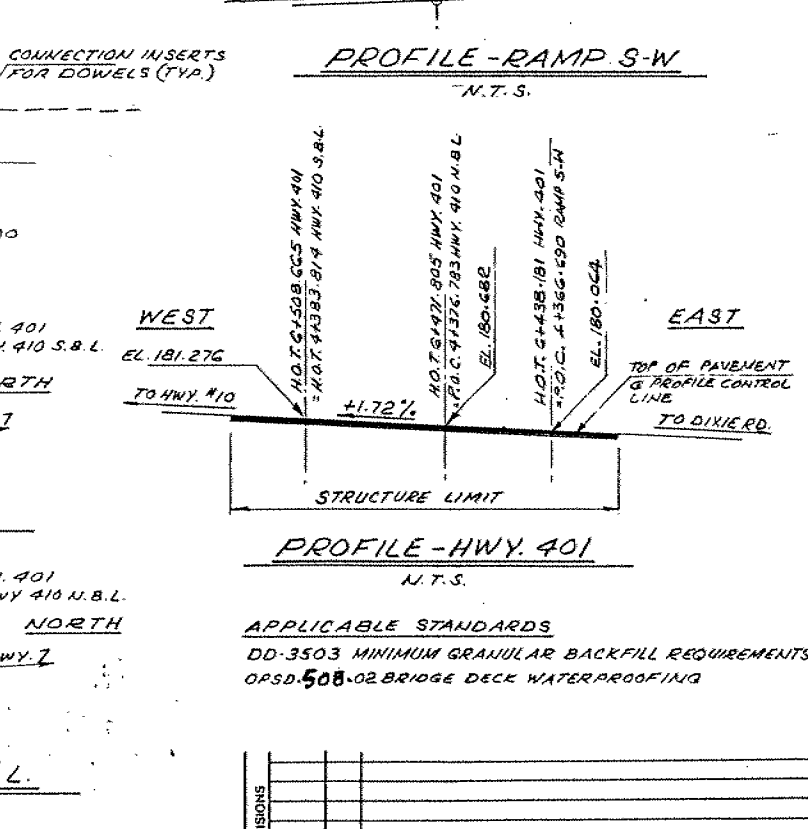
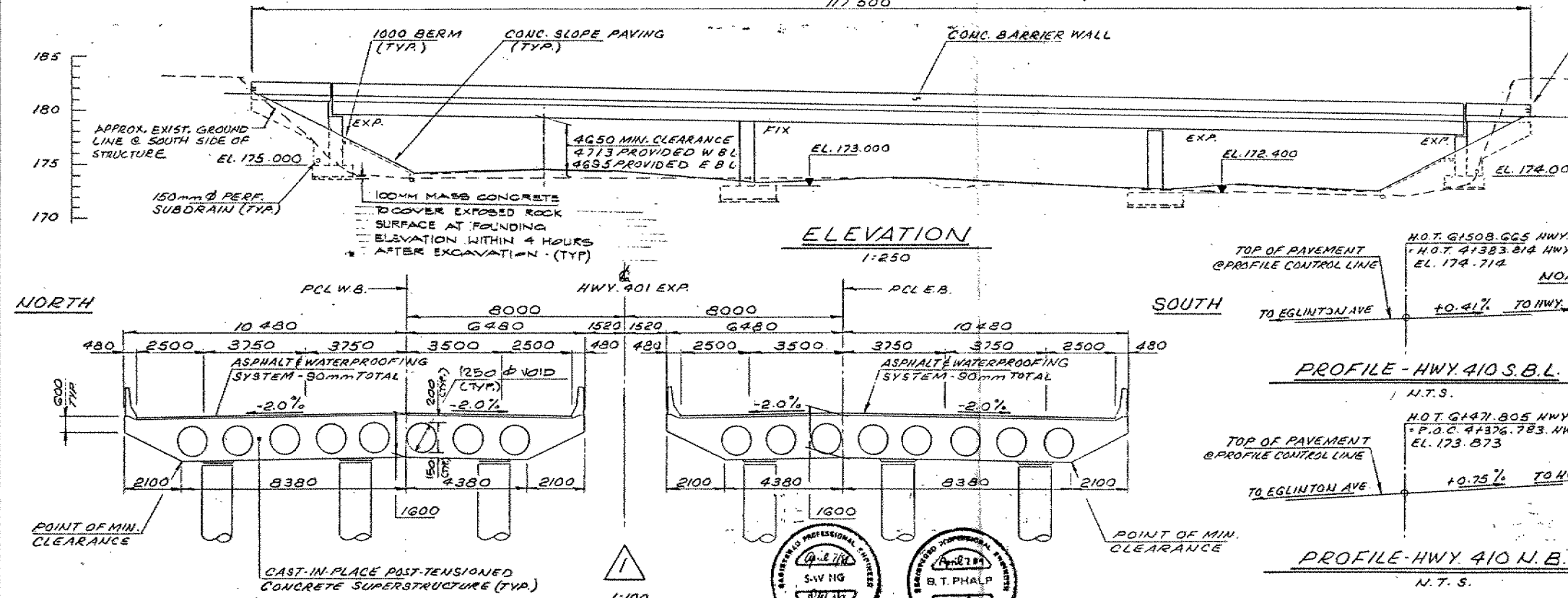
SLOPE PAVING & MASS CONCRETE 20 MPa
PIERS & DECK 35 MPa
REMAINDER 30 MPa

REINFORCING STEEL

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

CLEAR COVER TO REINFORCING STEEL

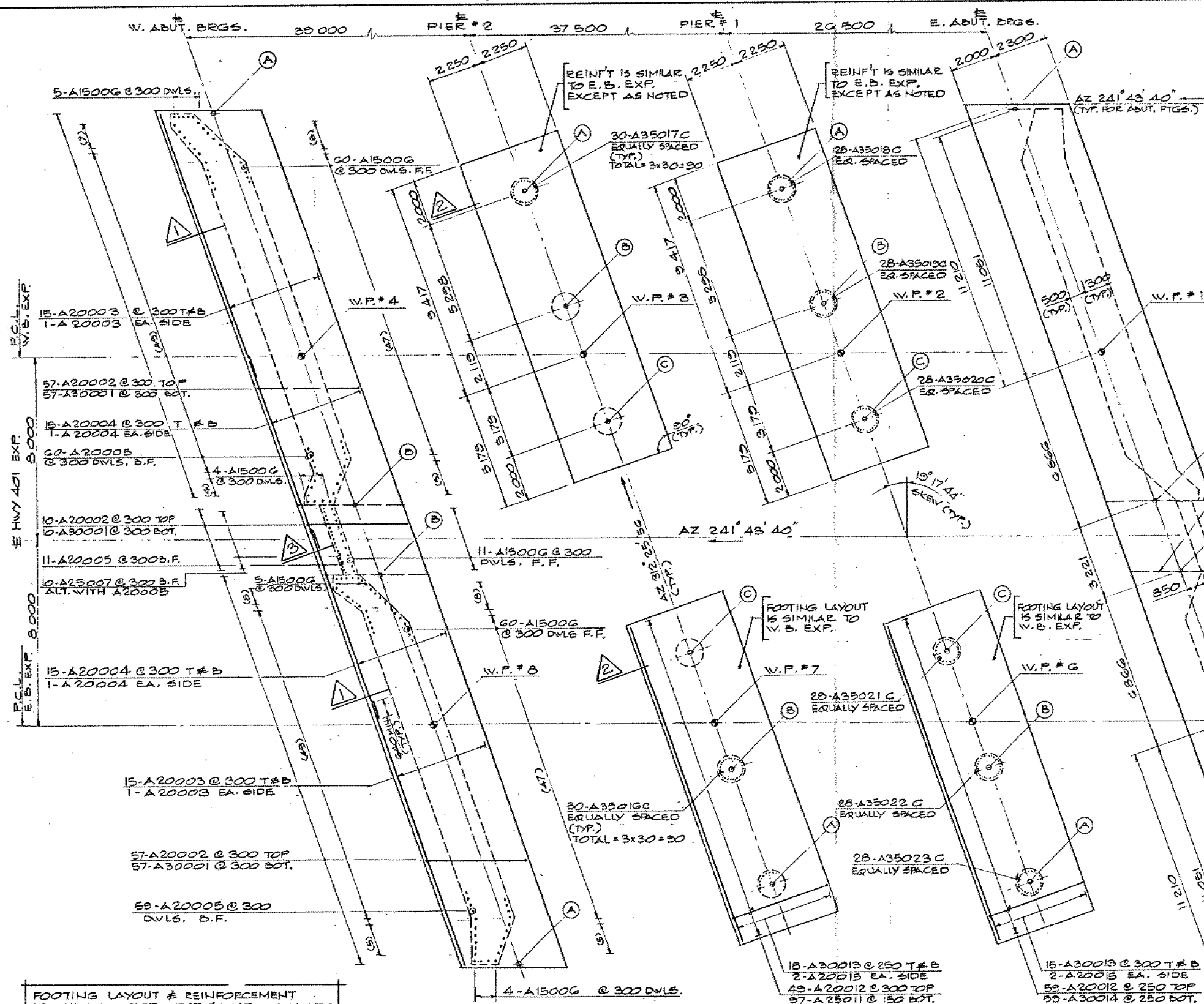
FOOTINGS 100 ± 25
ABUTMENTS & WING WALLS
FRONT FACE 80 ± 20
BACK FACE 70 ± 20
PIERS 80 ± 20
DECK TOP 70 ± 20
DECK BOTTOM 50 ± 10
REMAINDER UNLESS OTHERWISE NOTED 70 ± 20



APPLICABLE STANDARDS
DD-3503 MINIMUM GRANULAR BACKFILL REQUIREMENTS
OPSD-508-02 BRIDGE DECK WATERPROOFING

REVISIONS	DATE	BY	DESCRIPTION
1	APR 1989	CHK & YJC	DESIGN LAYOUT
2	APR 1989	CHK & T.P.	CONSTRUCTION
3	APR 1989	CHK & T.P.	SCHEME
4	APR 1989	CHK & T.P.	SCHEME

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



FOOTING LAYOUT & REINFORCEMENT
IS SIMILAR FOR WEST & EAST ABUTMENTS

FOUNDATION LAYOUT 1:100

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

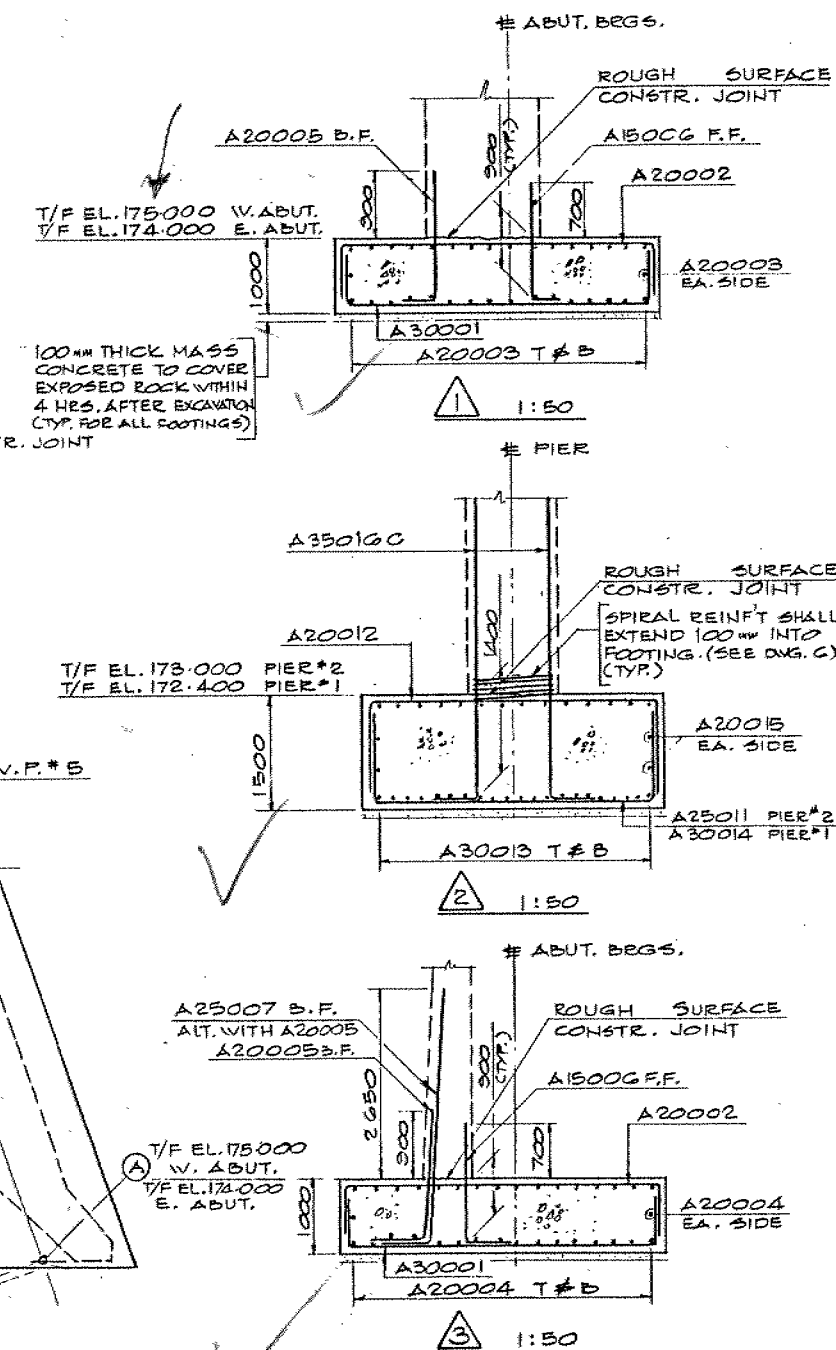
DIST.
CONT No
WP No 54-82-15
54-82-16
HWY. 401/HWY. 410 INTERCH
HWY. 401 CORE LANE STRUCT
(BRIDGE No. 30)
FOUNDATION LAYOUT & REIN

Fenco

FENCO ENGINEERS INC.

LEGEND:

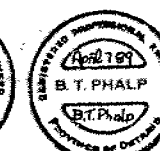
F.F. DENOTES FRONT FACE
B.F. DENOTES BACK FACE -
T & B DENOTES TOP & BOT.
T/F DENOTES TOP OF FOOTING



NOTES:

THIS DRAWING TO BE READ IN
CONJUNCTION WITH DWG. 4, 5 & 6

POINTS LOCATION	COORDINATES							
	W.B. EXP.				E.B. EXP.			
	W. ADUT.	PIER #2	PIER #1	E. ADUT.	W. ADUT.	PIER #2	PIER #1	E. ADUT.
W.F.	N 4 833 021.367 E 2 21 728.220	N 4 833 045.840 E 2 21 832.644	N 4 833 067.602 E 2 21 863.970	N 4 833 080.154 E 2 21 885.009	N 4 833 019.829 E 2 21 810.809	N 4 833 038.402 E 2 21 845.156	N 4 833 056.164 E 2 21 878.182	N 4 833 088.716 E 2 21 901.521
A	N 4 833 038.828 E 2 21 720.140	N 4 833 054.844 E 2 21 827.165	N 4 833 072.606 E 2 21 860.156	N 4 833 087.610 E 2 21 880.852	N 4 833 012.473 E 2 21 818.024	N 4 833 033.358 E 2 21 850.430	N 4 833 051.160 E 2 21 883.656	N 4 833 061.260 E 2 21 909.477
B	N 4 833 020.735 E 2 21 803.328	N 4 833 051.829 E 2 21 831.080	N 4 833 069.032 E 2 21 864.108	N 4 833 075.922 E 2 21 834.070	N 4 833 024.561 E 2 21 805.741	N 4 833 036.872 E 2 21 846.720	N 4 833 054.734 E 2 21 875.748	N 4 833 073.345 E 2 21 896.453
C	—	N 4 833 047.925 E 2 21 834.950	N 4 833 068.487 E 2 21 868.019	—	—	N 4 833 040.546 E 2 21 842.810	N 4 833 058.305 E 2 21 875.836	—



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REV							
	DATE	BY	DESCRIPTION				
	DESIGN J.K.	CHKL NG	CODE 214DC-83	LOAD CLASS A	DATE APR 1, 1983		
	DRAWN D.M.G.	CHKL NG	SITE 24-483	STRUCT	SCHEME	DWG 3	

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 91-45



Ministry of
Transportation

INDEX

<u>Page No.</u>	<u>DESCRIPTION</u>
1	Index
2	Abbreviations & Symbols
3 - 26	Foundation Investigation Report for Hwy. 401/410 E.B. & W.B. Core Lanes W.P. 54-82-15/16, Site 24-493 Hwy. 401/410, District 6, Toronto

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

EXPLANATION OF TERMS USED IN REPORT

2

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS

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

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

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

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

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

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

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

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'_{v0}	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
T_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

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

PHYSICAL PROPERTIES OF SOIL

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

FOUNDATION INVESTIGATION REPORT

For

Hwy. 401 - Hwy. 410

Overpass Eastbound Core Lanes/Westbound Core Lanes

WP 54-82-15&16; Site No. 24-493

District #6, TorontoINTRODUCTION

This report summarizes the results of a foundation investigation carried out at the aforementioned site. The proposed structure is a twin, three span cast-in-place post-tensioned voided concrete slab carrying Highway 401 core lanes over Highway 410 and associated ramps.

SITE DESCRIPTION

The site is located between the existing Hwy. 401 E.B. and W.B. Collector and Sub-Collector structures over Hwy. 410 in the City of Mississauga, Regional Municipality of Peel.

The terrain surrounding the site is generally flat and tends to slope downward gently to the east. Excavation cuts approximately 10 metres in depth in the shale bedrock required to advance the existing Hwy. 410 southbound have resulted in sloped 2H:1V embankments on either side of Hwy. 410. However, excavation of the western embankment is in progress in preparation of the planned Hwy. 410 widening.

The site is located in the physiographic region known as the "Peel Plain". This region is characterized by a level to gently undulating "till or boulder clay" plain underlain by shale or limestone bedrock. In the vicinity of this site the overburden is very shallow with shale bedrock very close to the surface.

FIELD INVESTIGATION

A total of eleven sampled boreholes were advanced at locations spread across the site in the interim between 88 02 17 and 88 03 23. The boreholes were located in the vicinity of the twin structure abutments and piers.

At the eastern and western limits of the site, continuous flight augers were used to advance the boreholes until bedrock was encountered. Subsoil samples were retrieved by a split spoon sampler in accordance with the standard penetration test (ASTM D1586). Dynamic cone penetration tests accompanied the sampled boreholes. Advancement of the borehole continued with N or B rock coring. Within the extreme limits, borehole advancement was strictly by rock coring. Field RQD's and core recoveries were determined to evaluate the competence of the bedrock.

All samples were identified in the field and then transported to the laboratory for further examination and evaluation.

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

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

SUBSURFACE CONDITIONS

The western and eastern limits of the site revealed a heterogeneous mixture of clayey silt, sand and gravel (glacial till) overlying shale bedrock. The thickness of the overburden was found to be in the order of 2.0 to 3.0 metres. The bedrock is predominately shale with interbedded calcareous siltstone. The condition of the rock varies from weathered to unweathered. Within these extreme limits, bedrock is exposed at the existing ground surface since extensive excavation in the bedrock had been carried out previously.

Factual data on the subsurface conditions is contained on the Record of Borehole Sheets. A plan of the site illustrating the locations and elevations of the

boreholes and subsurface stratigraphical sections of the borings are provided on Dwg. 54821516-A.*

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

Clayey silt, some/with sand, trace gravel (Glacial Till)

A heterogeneous unstratified mixture of clayey silt, sand and gravel (glacial till) up to 3.0 metres in thickness constituted the overburden at the western and eastern extremes of the site. Typical grain size distribution curves shown in an envelope form as determined by mechanical analyses is provided in Figure 1. Atterberg Limits were also obtained to evaluate the behaviour of the fine grain portion of the deposit. These results are plotted in Figure 2. A summary of the indices are provided below.

Table 1

	<u>Range</u>
Natural Moisture Content (w%)	11-15.5
Liquid Limit (w_L %)	29-40.5
Plastic Limit (w_p %)	15-18
'N' values (blows/0.3 m)	27-120

It can be concluded from the results that the matrix is cohesive and generally of low plasticity with occasional zones of intermediate plasticity.

The consistency of the deposit as determined by 'N' values obtained from the Standard Penetration Test is predominately hard.

Bedrock

Underlying the shallow deposits of overburden at the western and eastern limits of the site, and present at the existing ground surfaces within these limits, bedrock was proven by obtaining BQ and NQ size rock core samples. The bedrock surface varies from elevation 179.4 m to 182.6 m at the site extremes and from 172.9 m to 174.7 m within these extreme limits. The weathered layer varies from

* DWG NO 2 OF THE CONTRACT DWG'S

a penetration depth of 0.0 m to 2.7 m in the rock formation.

Core recoveries and rock quality designations (RQD) were determined in situ to evaluate the competence and integrity of the rock. Excavated rock cuts were also examined. The rock core samples were then returned to the laboratory for further identification and analysis.

The bedrock is a grey shale with interbedded calcareous siltstone, limestone and occasional clay seams. Detailed descriptions of the bedrock are attached in the appendix, entitled "Description of Rock Core". The bedrock is of the Georgian Bay Formation. The Record of Borehole Sheets provides the bedrock elevations and also the boundaries between weathered and unweathered layers.

The bedrock formation is composed primarily of weak to extremely weak greyish-black shales. The shales are extremely friable and slake readily upon exposure to cyclic wetting and drying and freeze-thaw. The shales are interbedded with the siltstone-limestone layers both in the weathered and unweathered zones.

Calcareous siltstone and limestone layers ranging in thickness from 0.5 cm to 45 cm were clearly evident both in the recovered core and also in the excavated cut face exposed during the investigation at the western limits of the site. These layers were found to be both in the weathered and unweathered zones and are of equal strength (strong to very strong) in both zones. The presence of these strong layers in the weathered zone explains the higher RQD than at locations in the unweathered zones. The calcareous siltstone and limestone layers comprise approximately 30% of the recovered core.

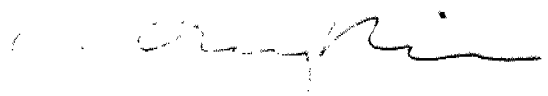
The occasional clay seams encountered at the site were of moisture content ranging from 19 to 34 percent. The seams range in thickness from 1 cm to 3 cm and occur both in the weathered and unweathered zones. The seams are cohesive and generally of stiff to very stiff consistency.

Groundwater Conditions

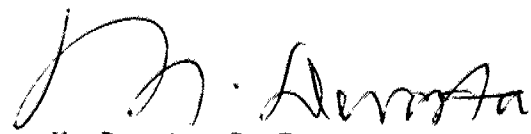
Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Measurements revealed stabilized levels ranging from elevations 172.5 m to 173.0 m.

MISCELLANEOUS

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


T. Sangiuliano, P. Eng.
Foundation Engineer




M. Devata, P. Eng.
Chief Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 086.6; E 291 881.2 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE Cone Test, S-S Auger, N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 19, 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
183.0	Ground Surface													
0.0	Clayey Silt With/Some Sand Trace Gravel Brown		1	SS	27		182							8 19 43 30
180.6	Very Stiff to Hard (Glacial Till)		2	SS	120	5 cm							21.4	29 12 36 23
2.4			3	SS	120	8 cm								
	Bedrock Weathered Unweathered		4	RC	REC 67%		180							RQD = 0%
	Shale		5	RC	REC 79%		178							RQD = 9%
	With Interbedded Siltstone Layers and Occasional Clay Seams		6	RC	REC 98%		176							RQD = 29%
			7	RC	REC 93%		174							RQD = 0
			8	RC	REC 97%		172							RQD = 0
170.8			9	RC	REC 100%									RQD = 57%
12.2	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 1A

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 080.1; E 291 905.5 ORIGINATED BY TS
DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
DATUM Geodetic DATE 88 03 23 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
182.5	Ground Surface													GR SA 51 CL
0.0	Clayey Silt With/Some Sand Trace Gravel Brown, Hard (Glacial Till)		1	SS	38	*	182							
			2	SS	100	15 cm								
			3	SS	60	15 cm	180							
179.4			4	SS	100	15 cm								
3.1	Bedrock Shale With Interbedded Siltstone Weathered Layers Unweathered and Occasional Clay Seams		5	RC	REC 38%		178							RQD = 8%
			6	RC	REC 43%									RQD = 0%
175.5			7	RC	REC 86%		176							RQD = 26%
7.0	End of Borehole * Dry Hole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 062.0; E 291 908.6 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE Cone Test, S-S Auger, N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 23-25 CHECKED BY _____

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH σ_p ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W_p NATURAL MOISTURE CONTENT W LIQUID LIMIT W_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES						
182.5	Ground Surface										
0.0	Clayey Silt With/Some Sand Trace Gravel Brown, Hard (Glacial Till)		1	SS	35		182				2 23 44 31
180.3			2	SS	100	15 cm	180	120/25 cm		22.2	19 5 43 33
2.2	Bedrock		3	RC	REC 74%		178				RQD = 0%
	Shale Weathered Unweathered With Interbedded Siltstone Layers and Occasional Clay Seams		4	RC	REC 81%		176				RQD = 8%
			5	RC	REC 64%		174				RQD = 0%
			6	RC	REC 100%		172				RQD = 16%
			7	RC	REC 84%						RQD = 0%
			8	RC	REC 84%						RQD = 10%
			9	RC	REC 87%						RQD = 58%
171.1	End of Borehole										
11.4											

RECORD OF BOREHOLE No 3

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 075.6; E 291 858.4 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 18 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100						SHEAR STRENGTH kPa
173.3	Ground Surface													
0.0	Bedrock		1	RC	REC									
	Shale Weathered Unweathered With Interbedded Siltstone Layers and Occasional Clay Seams													
170.3			2	RC	REC									
3.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 049.4; E 291 887.1 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 18 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
172.9	Ground Surface																GR SA SI CL
0.0	Bedrock Shale <u>Weathered</u> with <u>Unweathered</u>		1	RC	REC 27%		172										RQD = 11%
171.2	Interbedded Siltstone																
171.7	Layers and Occasional Clay Seams																
	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833.056.7; E 291 824.2 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 26 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES								
174.1	Ground Surface												
0.0	Bedrock Weathered Shale Unweathered With Interbedded Siltstone Layers and Occasional Clay Seams		1	RC	REC 17%		174						RQD = 0 %
171.4			2	RC	REC 65%		172						RQD = 17%
2.7	End of Borehole												

OFFICE REPORT ON SOIL EXPLORATION

METRIC

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 7

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 038.1; E 291 790.0 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 17 - 18 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	N' VALUES			20	40					
174.5	Ground Surface													
0.0	Bedrock Shale With Interbedded Siltstone Unweathered		1	RC	REC 100%		174							RQD = 62%
			2	RC	REC 74%									RQD = 21%
			3	RC	REC 72%		172							RQD = 0%
170.8			4	RC	REC 95%									RQD = 10%
3.7	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7A										METRIC					
W P 54-82-15 & 16			LOCATION Co-ords. N 4 833 035.0; E 291 786.4			ORIGINATED BY TS									
DIST 6 HWY 410/401			BOREHOLE TYPE B-Core			COMPILED BY TS									
DATUM Geodetic			DATE 88 03 21			CHECKED BY									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60					
180.6	Ground Surface														
0.0	Bedrock - Weathered Shale Unweathered		1	RC	REC 73%	*	180								RQD = 7%
	With Interbedded Siltstone Layers and Occasional Clay Seams		2	RC	REC 98%		178								RQD = 13%
			3	RC	REC 95%										RQD = 0%
175.1			4	RC	REC 91%		176								RQD = 0%
5.5	End of Borehole * Dry Hole														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 012.9; E 291 817.8 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	VALUES			20	40	60	80	100					
174.7	Ground Surface																
0.0	Bedrock Shale With Interbedded Siltstone Unweathered		1	RC	REC 62%		174										RQD = 11%
171.7			2	RC	REC 83%		172										RQD = 13%
3.0	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

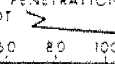

*3, *5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 8A

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 010.0; E 291 813.0 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
 DATUM Geodetic DATE 88 03 22 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		
180.7	Ground Surface													
0.0	Weathered Bedrock Unweathered Shale With Interbedded Siltstone Layers and Occasional Clay Seams		1	RC	REC 50%	*	180							RQD = 9%
			2	RC	REC 95%		178							RQD = 28%
			3	RC	REC 100%		176							RQD = 23%
			4	RC	REC 70%		174							RQD = 8%
173.7			5	RC	REC 64%		174							RQD = 35%
7.0	End of Borehole * Dry Hole													

OFFICE REPORT ON SOIL EXPLORATION

+3, x5 : Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 021.5; E 291 796.4 ORIGINATED BY DT
 DIST 6 HWY 410/401 BOREHOLE TYPE Solid Stem Auger, BQ Rock Core COMPILED BY HS
 DATUM Geodetic DATE 1984 10 05 CHECKED BY

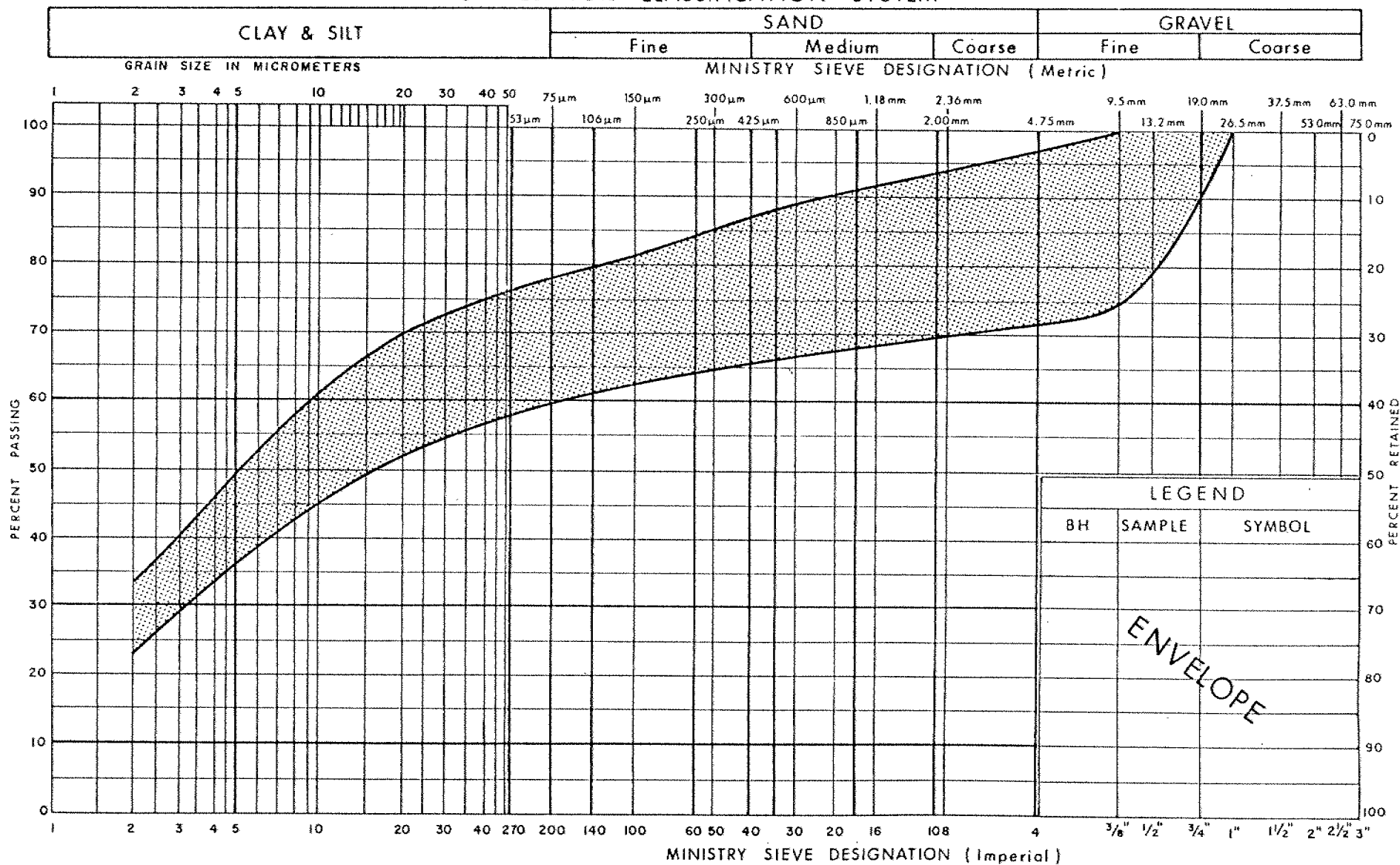
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
183.9	Ground Surface																GR SA SI CL
0.0	Clayey Silt with Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	14	8 cm Spoon Bouncing	182										
1.3	Bedrock Shale With Interbedded Siltstone Layers Weathered		2	RC	REC 61%												RQD = 0%
180.9			3	RC	REC 83%												RQD = 0%
3.0	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5; Numbers refer to Sensitivity

20
15 - 5 (%) STRAIN AT FAILURE
10

UNIFIED SOIL CLASSIFICATION SYSTEM

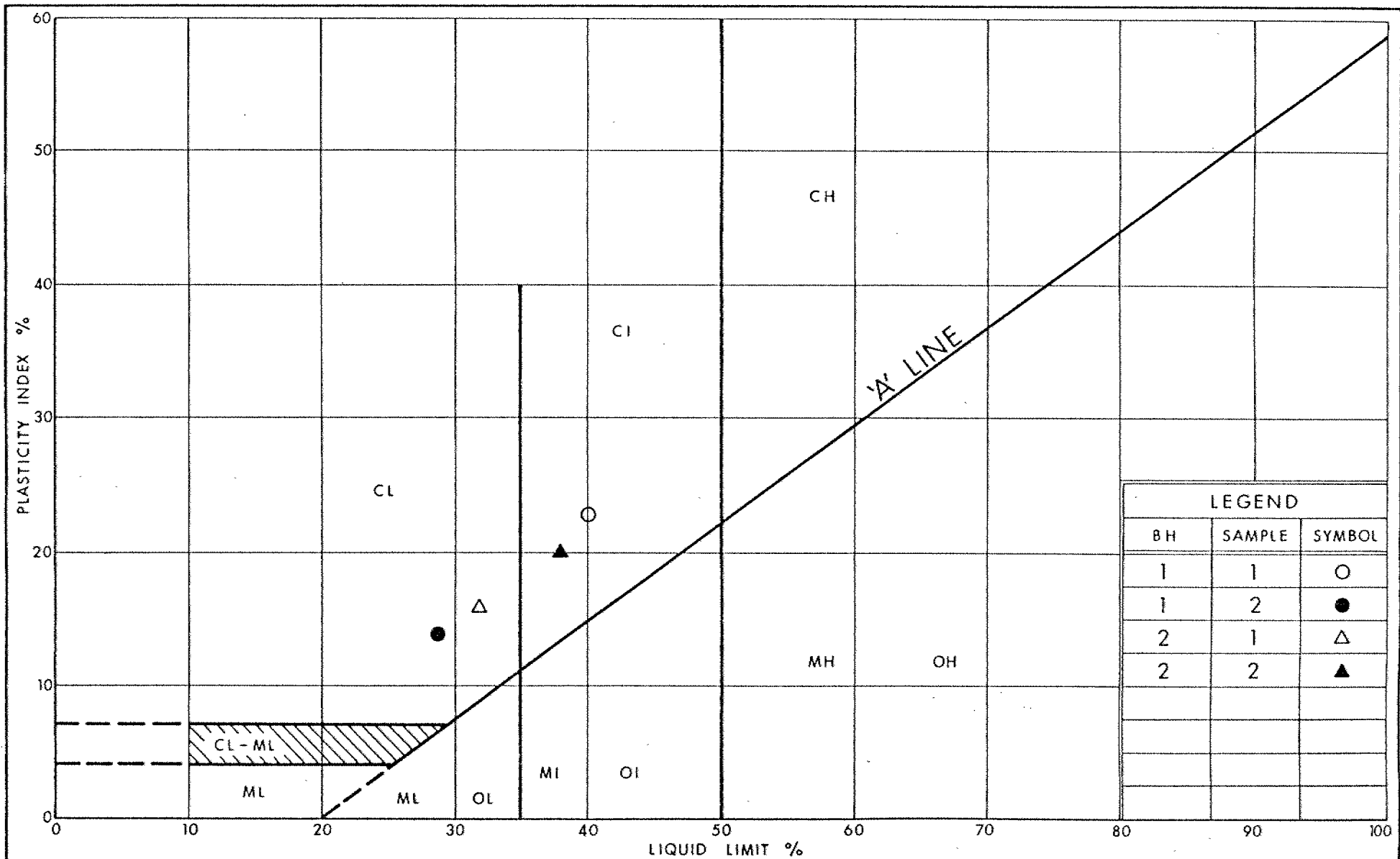


Ministry of
Transportation

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

FIG No 1

W P 54-82-15 & 16



Ministry of
Transportation

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

FIG No 2

W P 54-82-15 & 16

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
1	2.36- 4.19	67	0	2.36-12.19	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderate to slightly weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (30%); very thinly to medium bedded (0.5-30.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; close to very closely spaced fractures. CLAY SEAMS (1-3 cm) at 3.5, 4, 5.5, 6.5, 8.5, and 9 m.
	4.19- 6.10	79	9		
	6.10- 7.62	98	29		
	7.62- 9.14	93	0		
	9.14-10.67	97	0		
	10.67-12.19	100	57		
2	2.18- 3.66	74	0	2.18-11.40	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately to slightly weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (24%), thinly to medium bedded (1.0-22.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; very closely spaced fractures. CLAY SEAMS (1-3 cm) at 4, 4.5, 4.8, 5.5, 6, 6.2, 6.5, and 10.5 m.
	3.66- 5.80	81	8		
	5.80- 6.50	64	0		
	6.50- 7.90	100	16		
	7.90- 9.40	84	0		
	9.40-10.50	84	10		
	10.50-11.4	87	58		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

1../4

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
3	0.00- 2.45	44	12	0.00- 3.00	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (28%), thin to medium bedded (1.0-30.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures. CLAY SEAM (3 cm) at 1.5 m.
	2.45- 3.00	93	60		
4	0.00- 1.70	27	11	0.00- 1.70	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (14%), thin to medium bedded (1.0-20.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; closely spaced fractures. CLAY SEAMS (1-3 cm) present.
5	0.00- 1.00	17	0	0.00- 2.70	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (35%), thin to medium bedded (1.0-30.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures. CLAY SEAMS (1-3 cm) present.
	1.00- 2.70	65	17		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

2../4

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

HOLE #	CORE RECOVERY			CORE DESCRIPTION	
	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
6	0.00- 1.52	50	0	0.00- 3.05	SHALE, grey to black; very fine grained; weak to extremely weak rock; moderately weathered, medium weathered zone from 1.10-3.05 m; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (25%), thin bedded (1.0-9.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; closely spaced fractures.
	1.52- 3.05	88	0		
7	0.00- 0.45	100	62	0.00- 3.70	SHALE, grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (37%), thin to medium bedded (1.0-25.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures.
	0.45- 2.00	74	21		
	2.00- 2.60	72	0		
	2.60- 3.70	95	10		
8	0.00- 1.52	62	11	0.00- 3.05	SHALE, grey to black; very fine grained; weak to extremely weak rock; slight to moderately weathered; very close to extremely close spaced fractures, intensely fractured zone from 2.5-3.0; interbedded with CALCAREOUS SILTSTONE (36%), thin to medium bedded (1.0-38.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures.
	1.52- 3.05	83	13		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

3../4

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

HOLE #	CORE RECOVERY			CORE DESCRIPTION	
	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
1A	3.05- 4.57	38	8	3.05- 7.01	SHALE, grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with CALCAREOUS SILTSTONE (33%), thin to medium bedded (to 35 cm); fine grained; strong to very strong rock; slightly weathered; moderately close spaced horizontal fractures. Rust stained vertical fractures, 1-2 cm in length. CLAY SEAM (3 cm) at 3.50-4.00 m.
	4.57- 6.10	43	0		
	6.10- 7.01	86	26		
7A	0.00- 1.52	73	7	0.00- 5.49	SHALE, grey to black; very fine grained; weak to extremely weak rock; moderately weathered, highly weathered zone from 1.0-1.5 m; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (33%), slightly argillaceous; thin to medium bedded (1-30 cm); fine grained; strong to very strong rock; slightly weathered; close to very close spaced horizontal fractures. Occasional rust stained vertical fractures, 1-2 cm in length.
	1.52- 3.05	98	13		
	3.05- 4.57	95	0		
	4.57- 5.49	81	0		
8A	0.00- 1.52	50	9	0.00- 7.01	SHALE, grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE and ARGILLACEOUS LIMESTONE (34%); thin to thick bedded (to 45 cm); fine grained; strong to very strong rock; slightly weathered; medium to very close spaced horizontal fractures.
	6.10- 7.01	64	35		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION



Ministry of
Transportation and
Communications

FILE COPY

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 54-82-15 & 16

DIST 6

HWY 401/410

STR SITE 24-493

Overpass Eastbound Core Lanes/Westbound Core Lanes

CONT 91-45

DISTRIBUTION

G.C.E. Burkhardt (3)

R.D. Gunter

A. Wittenberg

J. Smrcka (2)

K. Bassi

J.H. Peer

T. Yakutchuk

G. Szekreny

B. Steeves (Cover Only)

M. MacLean (Cover Only)

File

FOUNDATION INVESTIGATION REPORT

For

Hwy. 401 - Hwy. 410

Overpass Eastbound Core Lanes/Westbound Core Lanes

WP 54-82-15&16; Site No. 24-493

District #6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation carried out at the aforementioned site. The proposed structure is a twin, three span cast-in-place post-tensioned voided concrete slab carrying Highway 401 core lanes over Highway 410 and associated ramps. The purpose of the investigation was to:

- 1) Determine the subsurface conditions at the site.
- 2) Provide pertinent geotechnical recommendations regarding structure foundations and related earth/rock works.

SITE DESCRIPTION

The site is located between the existing Hwy. 401 E.B. and W.B. Collector and Sub-Collector structures over Hwy. 410 in the City of Mississauga, Regional Municipality of Peel.

The terrain surrounding the site is generally flat and tends to slope downward gently to the east. Excavation cuts approximately 10 metres in depth in the shale bedrock required to advance the existing Hwy. 410 southbound have resulted in sloped 2H:1V embankments on either side of Hwy. 410. However, excavation of the western embankment is in progress in preparation of the planned Hwy. 410 widening.

The site is located in the physiographic region known as the "Peel Plain". This region is characterized by a level to gently undulating "till or boulder clay" plain underlain by shale or limestone bedrock. In the vicinity of this site the overburden is very shallow with shale bedrock very close to the surface.

FIELD INVESTIGATION

A total of eleven sampled boreholes were advanced at locations spread across the site in the interim between 88 02 17 and 88 03 23. The boreholes were located in the vicinity of the twin structure abutments and piers.

At the eastern and western limits of the site, continuous flight augers were used to advance the boreholes until bedrock was encountered. Subsoil samples were retrieved by a split spoon sampler in accordance with the standard penetration test (ASTM D1586). Dynamic cone penetration tests accompanied the sampled boreholes. Advancement of the borehole continued with N or B rock coring. Within the extreme limits, borehole advancement was strictly by rock coring. Field RQD's and core recoveries were determined to evaluate the competence of the bedrock.

All samples were identified in the field and then transported to the laboratory for further examination and evaluation.

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

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

SUBSURFACE CONDITIONS

The western and eastern limits of the site revealed a heterogeneous mixture of clayey silt, sand and gravel (glacial till) overlying shale bedrock. The thickness of the overburden was found to be in the order of 2.0 to 3.0 metres. The bedrock is predominately shale with interbedded calcareous siltstone. The condition of the rock varies from weathered to unweathered. Within these extreme limits, bedrock is exposed at the existing ground surface since extensive excavation in the bedrock had been carried out previously.

Factual data on the subsurface conditions is contained on the Record of Borehole Sheets. A plan of the site illustrating the locations and elevations of the

boreholes and subsurface stratigraphical sections of the borings are provided on Dwg. 54821516-A.

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

Clayey silt, some/with sand, trace gravel (Glacial Till)

A heterogeneous unstratified mixture of clayey silt, sand and gravel (glacial till) up to 3.0 metres in thickness constituted the overburden at the western and eastern extremes of the site. Typical grain size distribution curves shown in an envelope form as determined by mechanical analyses is provided in Figure 1. Atterberg Limits were also obtained to evaluate the behaviour of the fine grain portion of the deposit. These results are plotted in Figure 2. A summary of the indices are provided below.

Table 1

	<u>Range</u>
Natural Moisture Content (w%)	11-15.5
Liquid Limit (w _L %)	29-40.5
Plastic Limit (w _p %)	15-18
'N' values (blows/0.3 m)	27-120

It can be concluded from the results that the matrix is cohesive and generally of low plasticity with occasional zones of intermediate plasticity.

The consistency of the deposit as determined by 'N' values obtained from the Standard Penetration Test is predominately hard.

Bedrock

Underlying the shallow deposits of overburden at the western and eastern limits of the site, and present at the existing ground surfaces within these limits, bedrock was proven by obtaining BQ and NQ size rock core samples. The bedrock surface varies from elevation 179.4 m to 182.6 m at the site extremes and from 172.9 m to 174.7 m within these extreme limits. The weathered layer varies from

a penetration depth of 0.0 m to 2.7 m in the rock formation.

Core recoveries and rock quality designations (RQD) were determined in situ to evaluate the competence and integrity of the rock. Excavated rock cuts were also examined. The rock core samples were then returned to the laboratory for further identification and analysis.

The bedrock is a grey shale with interbedded calcareous siltstone, limestone and occasional clay seams. Detailed descriptions of the bedrock are attached in the appendix, entitled "Description of Rock Core". The bedrock is of the Georgian Bay Formation. The Record of Borehole Sheets provides the bedrock elevations and also the boundaries between weathered and unweathered layers.

The bedrock formation is composed primarily of weak to extremely weak greyish-black shales. The shales are extremely friable and slake readily upon exposure to cyclic wetting and drying and freeze-thaw. The shales are interbedded with the siltstone-limestone layers both in the weathered and unweathered zones.

Calcareous siltstone and limestone layers ranging in thickness from 0.5 cm to 45 cm were clearly evident both in the recovered core and also in the excavated cut face exposed during the investigation at the western limits of the site. These layers were found to be both in the weathered and unweathered zones and are of equal strength (strong to very strong) in both zones. The presence of these strong layers in the weathered zone explains the higher RQD than at locations in the unweathered zones. The calcareous siltstone and limestone layers comprise approximately 30% of the recovered core.

The occasional clay seams encountered at the site were of moisture content ranging from 19 to 34 percent. The seams range in thickness from 1 cm to 3 cm and occur both in the weathered and unweathered zones. The seams are cohesive and generally of stiff to very stiff consistency.

Photos of the rock formation taken at the time of investigation and during excavation of the proposed widened Hwy. 410 are attached in the Appendix. The photos illustrate the constituents of the formation mentioned.

Groundwater Conditions

Observation of the groundwater level was carried out by measuring the water level in the open boreholes. Measurements revealed stabilized levels ranging from elevations 172.5 m to 173.0 m.

DISCUSSION AND RECOMMENDATIONS

A twin three-span structure (34 m - 39 m - 25 m) is proposed to carry Highway 401 core lanes over Highway 410 and associated ramps. The cast in place post-tensioned voided concrete slab decks will each accommodate two 3.75 m lanes and one 3.5 m passing lane with 2.5 m shoulders on each side. This project is one of the components of the planned extensive Hwy. 401/410/403 interchange. The profile grade of the Hwy. 401 twin bridge has been set at elevation 180.642 m over Hwy. 410 N.B. and elevation 181.276 m over Hwy. 410 S.B. Cuts in the order of 3.0 to 4.0 metres will be required for the approaches. Elevations for Hwy. 410 N.B. and 410 S.B. are 174.714 m and 173.873 m respectively.

The following provides recommendations regarding:

- 1) structure foundations and related earth/rock works
- 2) approach cuts
- 3) granular backfill to structures

Structure Foundations and Related Earth/Rock Works

Structure foundations may be founded on one or a combination of the following alternatives:

- 1) Spread Footings on Unweathered Rock
- 2) Perched Abutments on Spread Footings on Weathered Rock
- 3) Perched Abutments on Spread Footings on Unweathered Rock

The alternative, or combination that proves to be most economical is recommended. The alternatives are described below.

Alternative 1 - Spread Footings on Unweathered Rock

The structure abutments and piers may be supported on spread footings founded on unweathered bedrock at or below the elevations indicated in Table A.

This alternative is applicable to a closed-type abutment design. For purposes of the O.H.B.D.C., the following design values are recommended.

Factored Bearing Capacity at U.L.S. = 1000 kPa

The Bearing Capacity at S.L.S. Type II will not govern design as the unweathered bedrock is considered to be unyielding.

Alternative 2 - Perch Abutments on Spread Footings on Weathered Rock

Spread footings on weathered rock at an elevation equal or higher than as indicated in Table A can be used to support perched abutments. For purposes of the O.H.B.D.C., the following design values are recommend.

Factored Bearing Capacity at U.L.S. = 750 kPa

Bearing Capacity at S.L.S. Type II = 500 kPa

The reduced capacities account for the degree of weathering of the bedrock and the presence of clay seams.

All footings on or above a slope must be located at a minimum horizontal distance of 2.0 m from the edge of the footing base to the slope.

Alternative 3 - Perched Abutments on Spread Footings on Unweathered Rock

Perched abutments may be supported on spread footings founded on unweathered rock at or below the elevations indicated in Table A. For purposes of the O.H.B.D.C., the following design values are recommended.

Factored Bearing Capacity at U.L.S. = 1000 kPa

The Bearing Capacity at S.L.S. Type II will not govern design as the unweathered bedrock is considered to be unyielding.

Footings on or above a slope must comply to the condition outlined in Alternative 2.

TABLE A


	ELEVATION		
FOUNDATION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
West Abutments	173.5	180	179.0
West Piers	173.0	-	-
East Piers	172.0	-	-
East Abutments	175.0	178.0	175.0

Settlement

Total and differential settlements of the structures for the foundation alternatives provided will be negligible.

Resistance to Lateral Forces

For design purposes, the following unfactored friction coefficients can be used between the bases of footings and the indicated founding stratum.

Weathered Shale Bedrock $\tan 24^\circ$  D.D. 88 11 14
Unweathered Shale Bedrock $\tan 20^\circ$

If additional resistance to lateral forces is required, please contact this office. Keys, dowels and rock anchors may be used to increase resistance.

Footing Excavation and Cover

The founding footing elevations should be void of any soft or loose material, and should be covered, within 4 hours of exposure, with a working slab of concrete to protect against the effects of weathering. No de-watering difficulties are anticipated for the footing excavations. It is expected that any groundwater entering excavations can be controlled by conventional pumping techniques.

Due to the friable nature of the shale formation and the presence of clay seams in the formation, all footings must have a minimum earth cover of 1.2 m to protect the footing base against the effects of weathering and frost penetration.

Approach Cuts

Highway 401

The approach cuts for Hwy. 401, up to 4.0 metres, will be made through the cohesive clayey silt deposit and partially into the upper weathered shale bedrock. No stability problems are anticipated for this portion of the cuts provided standard 2H:1V slopes are used. In view of the slaking nature of the shale bedrock and its disintegration upon exposure to cyclic freeze-thaw and wetting-drying, the 2H:1V recommendation applies to the rock cut as well as the earth cut.

Highway 410

Excavation cuts amounting to a further 6 metres beneath the Hwy. 401 cut will be required in the widening of Hwy. 410. Due to the rapid disintegration of the bedrock upon exposure to cyclic freeze-thaw and wetting-drying it is recommended that the permanent cuts be excavated at 2H:1V slopes to ensure adequate stability. It is further recommended that the cut slopes be protected with an adequate cover of topsoil and sodded. Temporary cut slopes in weathered shale bedrock should not be steeper than 1.5 horizontal to 1 vertical and in sound shale bedrock should not be steeper than 1 horizontal to 3 vertical.

The groundwater level established during the period of field investigation, is at or below the bottom of the proposed cut. Consequently, no dewatering difficulties are anticipated during excavation.

Granular Backfill to Structures

Free draining material such as Granular 'A' or Granular 'B' is recommended as appropriate backfill to the abutments to prevent hydrostatic pressure build-up.

Computation of earth pressures should be in accordance with Section 6.6.1.2. of O.H.B.D.C. Design parameters of the soil are given below:

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

MISCELLANEOUS

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



A handwritten signature in cursive script, appearing to read "T. Sangiuliano".

Tony Sangiuliano, P.Eng.
Foundation Engineer

A handwritten signature in cursive script, appearing to read "M. Devata".

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

APPENDIX

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
1	2.36- 4.19	67	0	2.36-12.19	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderate to slightly weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (30%); very thinly to medium bedded (0.5-30.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; close to very closely spaced fractures. CLAY SEAMS (1-3 cm) at 3.5, 4, 5.5, 6.5, 8.5, and 9 m.
	4.19- 6.10	79	9		
	6.10- 7.62	98	29		
	7.62- 9.14	93	0		
	9.14-10.67	97	0		
	10.67-12.19	100	57		
2	2.18- 3.66	74	0	2.18-11.40	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately to slightly weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (24%), thinly to medium bedded (1.0-22.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; very closely spaced fractures. CLAY SEAMS (1-3 cm) at 4, 4.5, 4.8, 5.5, 6, 6.2, 6.5, and 10.5 m.
	3.66- 5.80	81	8		
	5.80- 6.50	64	0		
	6.50- 7.90	100	16		
	7.90- 9.40	84	0		
	9.40-10.50	84	10		
	10.50-11.4	87	58		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
3	0.00- 2.45	44	12	0.00- 3.00	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (28%), thin to medium bedded (1.0-30.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures. CLAY SEAM (3 cm) at 1.5 m.
	2.45- 3.00	93	60		
4	0.00- 1.70	27	11	0.00- 1.70	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (14%), thin to medium bedded (1.0-20.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; closely spaced fractures. CLAY SEAMS (1-3 cm) present.
5	0.00- 1.00	17	0	0.00- 2.70	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (35%), thin to medium bedded (1.0-30.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures. CLAY SEAMS (1-3 cm) present.
	1.00- 2.70	65	17		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
6	0.00- 1.52	50	0	0.00- 3.05	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered, medium weathered zone from 1.10-3.05 m; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (25%), thin bedded (1.0-9.0 cm); fine grained; strong to very strong rock; slightly weathered to unweathered; closely spaced fractures.
	1.52- 3.05	88	0		
7	0.00- 0.45	100	62	0.00- 3.70	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (37%), thin to medium bedded (1.0-25.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures.
	0.45- 2.00	74	21		
	2.00- 2.60	72	0		
	2.60- 3.70	95	10		
8	0.00- 1.52	62	11	0.00- 3.05	SHALE , grey to black; very fine grained; weak to extremely weak rock; slight to moderately weathered; very close to extremely close spaced fractures, intensely fractured zone from 2.5-3.0; interbedded with CALCAREOUS SILTSTONE (36%), thin to medium bedded (1.0-38.0 cm); fine grained; strong to very strong rock slightly weathered to unweathered; closely spaced fractures.
	1.52- 3.05	83	13		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION

DESCRIPTION OF ROCK CORE - WP 54-82-15,16

CORE RECOVERY				CORE DESCRIPTION	
HOLE #	DEPTH (m)	%CR*	%RQD*	DEPTH (m)	DESCRIPTION
1A	3.05- 4.57	38	8	3.05- 7.01	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with CALCAREOUS SILTSTONE (33%), thin to medium bedded (to 35 cm); fine grained; strong to very strong rock; slightly weathered; moderately close spaced horizontal fractures. Rust stained vertical fractures, 1-2 cm in length. CLAY SEAM (3 cm) at 3.50-4.00 m.
	4.57- 6.10	43	0		
	6.10- 7.01	86	26		
7A	0.00- 1.52	73	7	0.00- 5.49	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered, highly weathered zone from 1.0-1.5 m; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE (33%), slightly argillaceous; thin to medium bedded (1-30 cm); fine grained; strong to very strong rock; slightly weathered; close to very close spaced horizontal fractures. Occasional rust stained vertical fractures, 1-2 cm in length.
	1.52- 3.05	98	13		
	3.05- 4.57	95	0		
	4.57- 5.49	81	0		
8A	0.00- 1.52	50	9	0.00- 7.01	SHALE , grey to black; very fine grained; weak to extremely weak rock; moderately weathered; very close to extremely close spaced fractures; interbedded with: CALCAREOUS SILTSTONE and ARGILLACEOUS LIMESTONE (34%); thin to thick bedded (to 45 cm); fine grained; strong to very strong rock; slightly weathered; medium to very close spaced horizontal fractures.
	6.10- 7.01	64	35		

*CR = CORE RECOVERY

*RQD = ROCK QUALITY DESIGNATION



1. Section view of rock formation illustrating the lighter bands of calcareous siltstone - limestone interbedded in the shale. Surface elevations are:

- | | |
|---------------------------------------|----------------|
| a) Top Elevation (Top of Photo) | - 180 m |
| b) Bottom Elevation (Bottom of Photo) | - 174 m |
| c) Depth to Unweathered Rock | - 0.4 to 1.0 m |



2. Close-up view of interbedded shale-siltstone formation revealing the distinctive bedding planes.
-

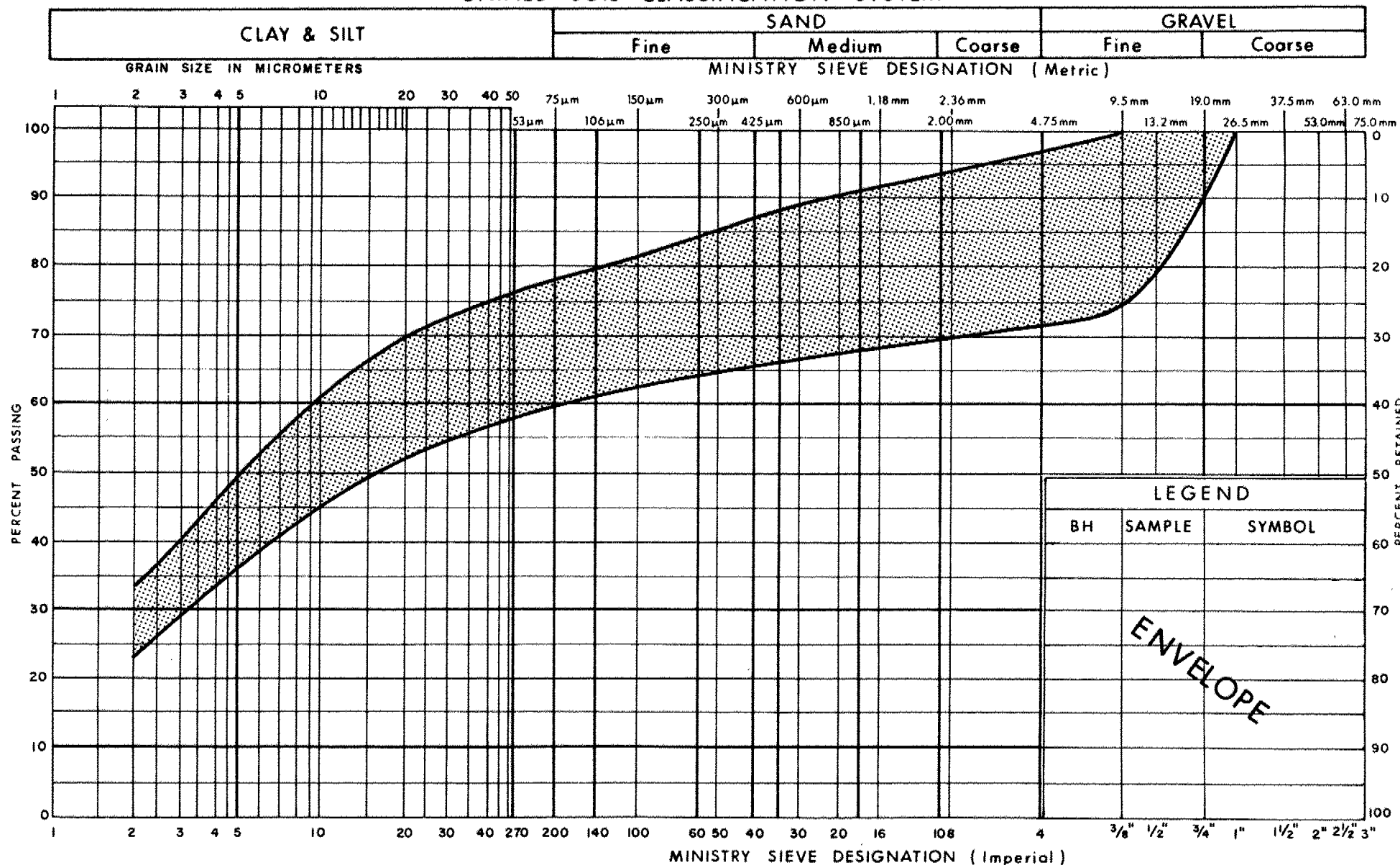


3. Photo illustrating the effects on the shale as a result of exposure to cyclic wetting and drying. The shale is very friable and has a low slaking durability index.
-



4. Vertical fractures in the bedrock were evident throughout the formation.

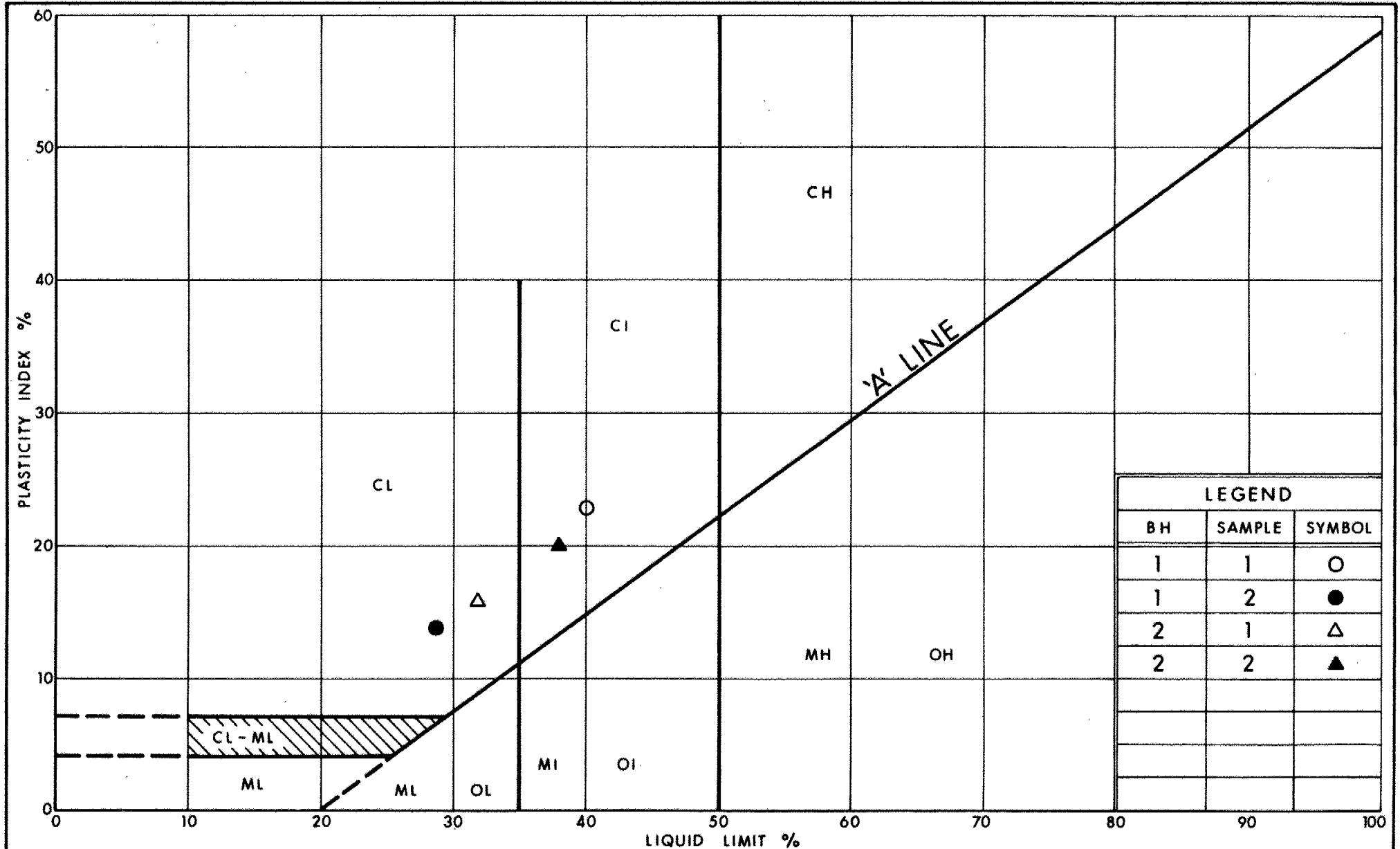
UNIFIED SOIL CLASSIFICATION SYSTEM


 Ministry of
Transportation

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

FIG No 1

W P 54-82-15 & 16



Ministry of
Transportation

Ontario

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

FIG No 2

W P 54-82-15 & 16

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

RECORD OF BOREHOLE No 1

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 086.6; E 291 881.2 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE Cone Test, S-S Auger, N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 19, 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
183.0	Ground Surface											
0.0	Clayey Silt With/Some Sand Trace Gravel Brown Very Stiff to Hard (Glacial Till)		1	SS	27		182					8 19 43 30
180.6			2	SS	120	5 cm						29 12 36 23
2.4			3	SS	120	8 cm		120/3 cm				
	Bedrock Weathered Unweathered Shale		4	RC	REC 67%		180					RQD = 0%
	With Interbedded Siltstone Layers and Occasional Clay Seams		5	RC	REC 79%		178					RQD = 9%
			6	RC	REC 98%		176					RQD = 29%
			7	RC	REC 93%		174					RQD = 0
			8	RC	REC 97%		172					RQD = 0
170.8			9	RC	REC 100%							RQD = 57%
12.2	End of Borehole											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 1A

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 080.1; E 291 905.5 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
 DATUM Geodetic DATE 88 03 23 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			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 _p	W	W _L																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
								SHEAR STRENGTH kPo																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										</

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 2

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 062.0; E 291 908.6 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE Cone Test, S-S Auger, N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 23-25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						WATER CONTENT (%)
								10 20 30						
								SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL x LAB VANE						
182.5	Ground Surface					15 cm	182					22.2	GR SA SI CL	
0.0	Clayey Silt With/Some Sand Trace Gravel Brown, Hard (Glacial Till)		1	SS	35									2 23 44 31
180.3			2	SS	100									19 5 43 33
2.2	Bedrock		3	RC	REC 74%									RQD = 0%
	Shale Weathered Unweathered		4	RC	REC 81%									RQD = 8%
	With Interbedded		5	RC	REC 64%									RQD = 0%
	Siltstone Layers and		6	RC	REC 100%									RQD = 16%
	Occasional Clay		7	RC	REC 84%									RQD = 0%
	Seams		8	RC	REC 84%									RQD = 10%
171.1			9	RC	REC 87%							RQD = 58%		
11.4	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

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



RECORD OF BOREHOLE No 3

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 075.6; E 291 858.4 ORIGINATED BY TS
DIST 6 HWY 410/401 BOREHOLE TYPE N-Core COMPILED BY TS
DATUM Geodetic DATE 88 02 18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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						
173.3	Ground Surface													
0.0	Bedrock		1	RC	REC 44%		172							RQD = 12%
170.3	Weathered Shale Unweathered With Interbedded Siltstone Layers and Occasional Clay Seams		2	RC	REC 93%									RQD = 60%
3.0	End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 4

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 049.4; E 291 887.1 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 18 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
172.9	Ground Surface																GR SA SI CL
0.0	Bedrock Shale Weathered with Unweathered		1	RC	REC 27%		172										RQD = 11%
171.2	Interbedded Siltstone Layers and Occasional Clay Seams																
1.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 056.7; E 291 824.2 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 26 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
174.1	Ground Surface																
0.0	Bedrock Weathered Shale Unweathered With Interbedded Siltstone Layers and Occasional Clay Seams		1	RC	REC 17%											RQD = 0 %	
171.4			2	RC	REC 65%											RQD = 17%	
2.7	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 6

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 031.1; E 291 852.6 ORIGINATED BY TS
DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
DATUM Geodetic DATE 88 02 26 CHECKED BY _____



SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE 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 _p	W	W _L	WATER CONTENT (%)					
174.1	Ground Surface																
0.0	Bedrock Weathered Unweathered		1	RC	REC 50%		174									RQD = 0%	
	Shale With Interbedded Siltstone		2	RC	REC 88%		172										RQD = 0%
171.1	End of Borehole																
3.0																	

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 038.1; E 291 790.0 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE N-Core COMPILED BY TS
 DATUM Geodetic DATE 88 02 17 - 18 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
174.5	Ground Surface																
0.0	Bedrock Shale With Interbedded Siltstone Unweathered		1	RC	REC 100%		174										
			2	RC	REC 74%												
			3	RC	REC 72%		172										
			4	RC	REC 95%												
170.8	End of Borehole																
3.7																	

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7A

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 035.0; E 291 786.4 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
 DATUM Geodetic DATE 88 03 21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
180.6	Ground Surface																GR SA SI CL
0.0	Bedrock <u>Weathered</u> Shale <u>Unweathered</u> With Interbedded Siltstone Layers and Occasional Clay Seams		1	RC	REC 73%	*	180										RQD = 7%
			2	RC	REC 98%		178										RQD = 13%
			3	RC	REC 95%												RQD = 0%
175.1			4	RC	REC 91%		176										RQD = 0%
5.5	End of Borehole * Dry Hole																

OFFICE REPORT ON SOIL EXPLORATION



METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 012.9; E 291 817.8 ORIGINATED BY TS
DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
DATUM Geodetic DATE 88 02 25 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
174.7	Ground Surface												
0.0	Bedrock Shale With Interbedded Siltstone Unweathered		1	RC	REC 62%		174						RQD = 11%
171.7			2	RC	REC 83%		172						RQD = 13%
3.0	End of Borehole												


+3, x⁵: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8A

METRIC

W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 010.0; E 291 813.0 ORIGINATED BY TS
 DIST 6 HWY 410/401 BOREHOLE TYPE B-Core COMPILED BY TS
 DATUM Geodetic DATE 88 03 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
180.7	Ground Surface														GR SA SI CL		
0.0	Weathered Unweathered Bedrock Shale With Interbedded Siltstone Layers and Occasional Clay Seams		1	RC	REC 50%	*	180								RQD = 9%		
			2	RC	REC 95%		178									RQD = 28%	
			3	RC	REC 100%		176									RQD = 23%	
			4	RC	REC 70%											RQD = 8%	
173.7			5	RC	REC 64%		174									RQD = 35%	
7.0	End of Borehole																
	* Dry Hole																

OFFICE REPORT ON SOIL EXPLORATION

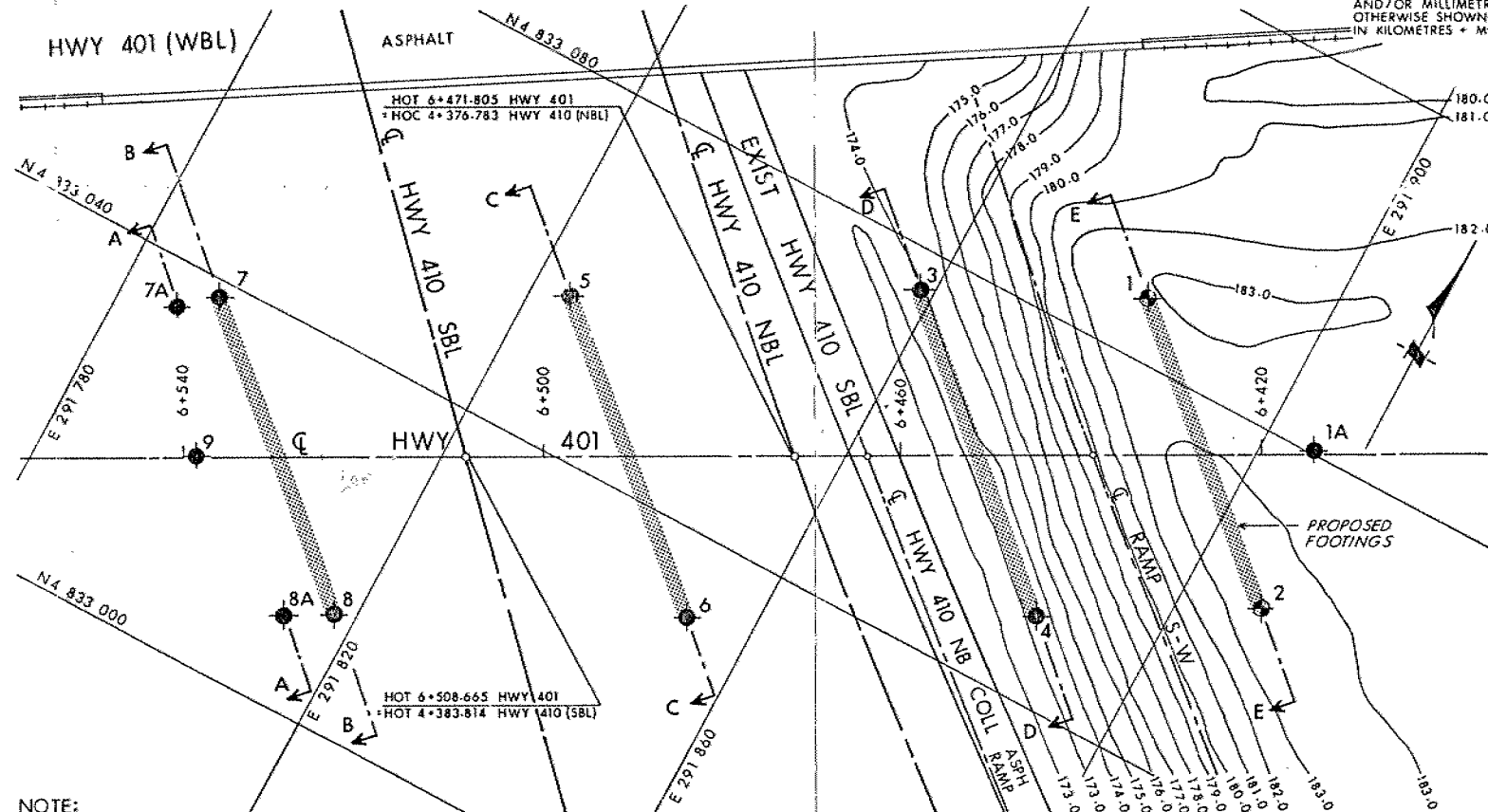
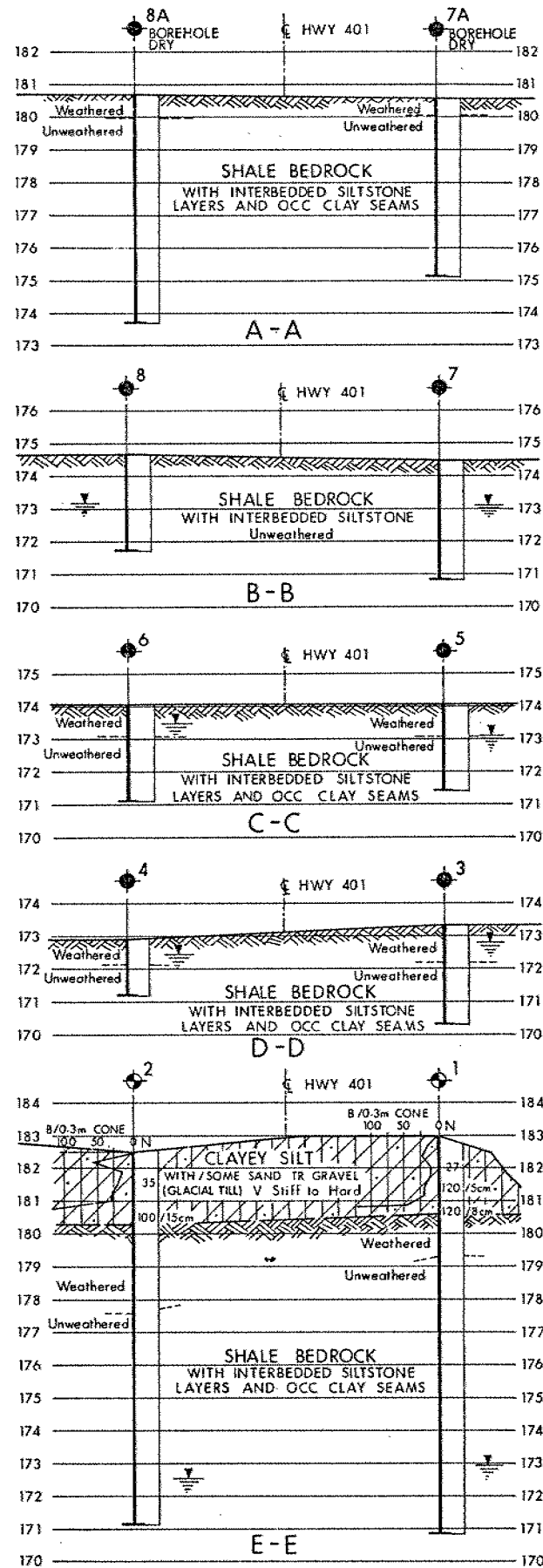
RECORD OF BOREHOLE No 9

METRIC

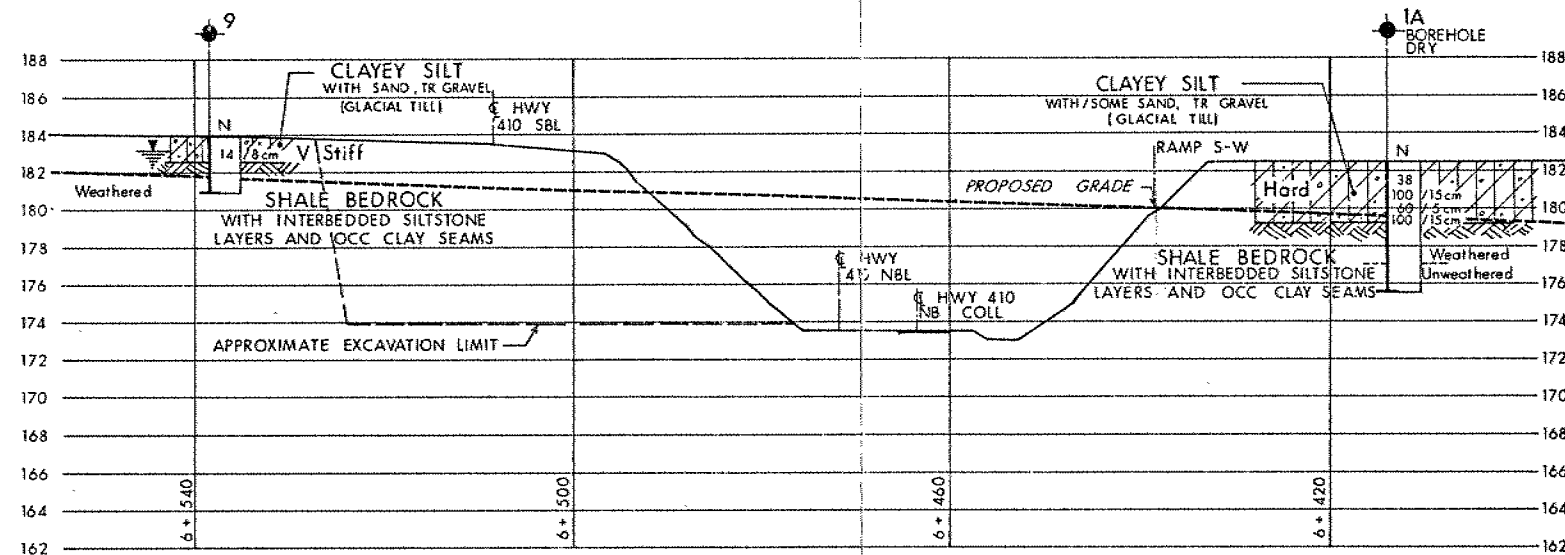
W P 54-82-15 & 16 LOCATION Co-ords. N 4 833 021.5; E 291 796.4 ORIGINATED BY DT
 DIST 6 HWY 410/401 BOREHOLE TYPE Solid Stem Auger, BQ Rock Core COMPILED BY HS
 DATUM Geodetic DATE 1984 10 05 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
183.9	Ground Surface												
0.0	Clayey Silt with Sand Trace Gravel Very Stiff (Glacial Till)		1	SS	14	8 cm Spoon Bouncing							
182.6													
1.3	Bedrock Shale With Interbedded Siltstone Layers Weathered		2	RC	REC 61%								RQD = 0%
180.9			3	RC	REC 83%								RQD = 0%
3.0	End of Borehole												

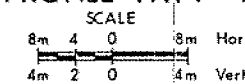
OFFICE REPORT ON SOIL EXPLORATION



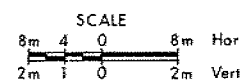
NOTE:
CONTOUR LINES HAVE BEEN OMITTED
AT WESTERN EXTREME OF SITE IN VIEW
OF THE EXCAVATION IN THAT AREA AT
TIME OF FIELD INVESTIGATION
(SEE EXCAVATION LIMIT BELOW)



Q PROFILE HWY 401



SECTIONS



METRIC

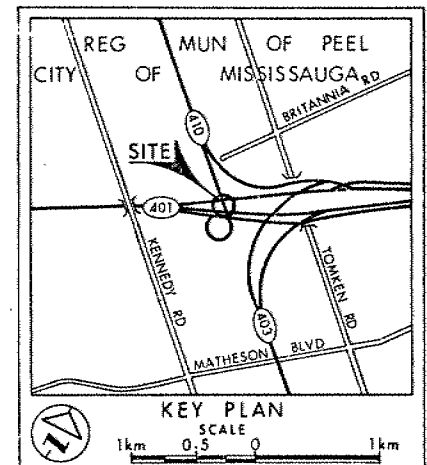
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 54-82-15&16





HWY 401 / 410
EB CORF LANES & WB CORE LANES
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
 84 10, 88 02 & 88 03

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	183.0	4 833 086.6	291 881.2
1A	182.5	4 833 080.1	291 905.5
2	182.5	4 833 062.0	291 908.6
3	173.3	4 833 075.6	291 858.4
4	172.9	4 833 049.4	291 887.1
5	174.1	4 833 056.7	291 824.2
6	174.1	4 833 031.1	291 852.6
7	174.5	4 833 038.1	291 790.0
7A	180.6	4 833 035.0	291 786.4
8	174.7	4 833 012.9	291 817.8
8A	180.7	4 833 010.0	291 813.0
9	183.9	4 833 021.5	291 796.4

NOTE

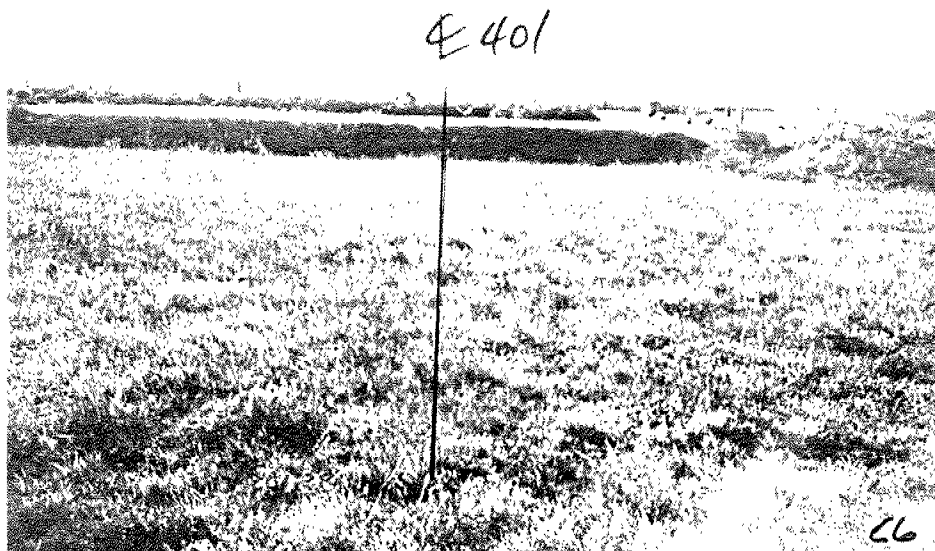
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

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.

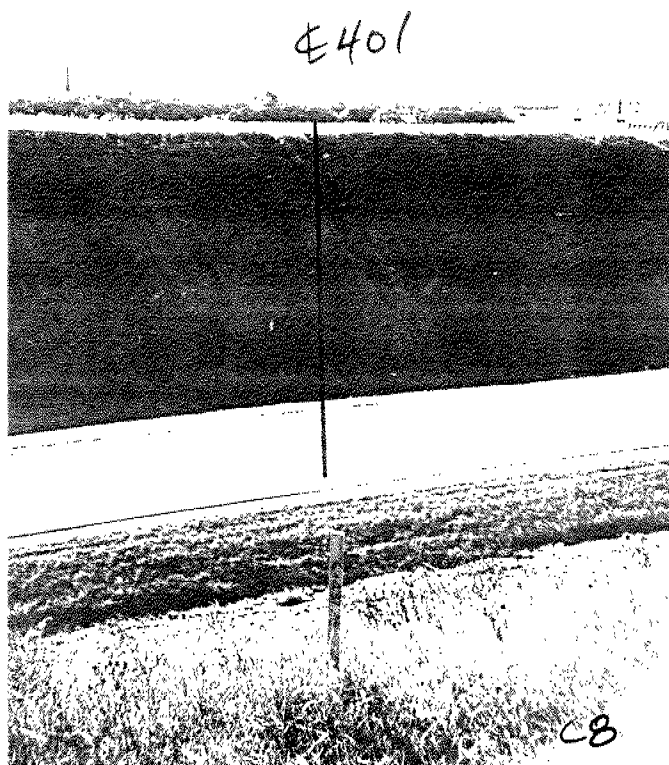
REV			
	DATE	BY	DESCRIPTION

Geocres No 30M12-205

HWY No	401	DIST	6
SUBMIT TS	CHECKED	DATE	88 05 16
DRAWN DT	CHECKED	APPROVED	SITE 24-493
			DWG 54821516-A



#1 401 Facing West @ Sta 6+400 ±



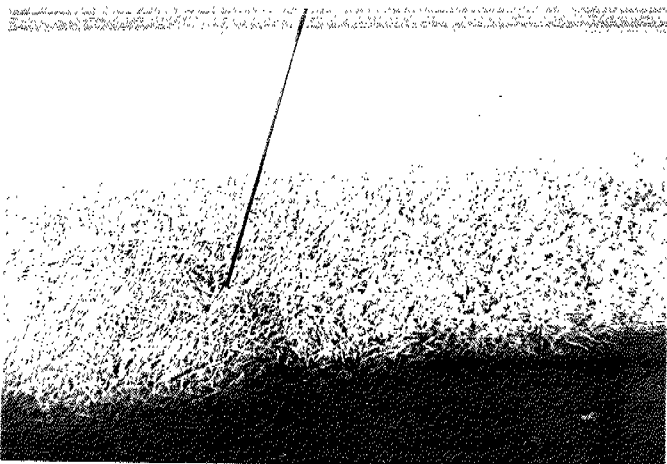
#2 401 Facing West
@ Sta 6+428±

E 401



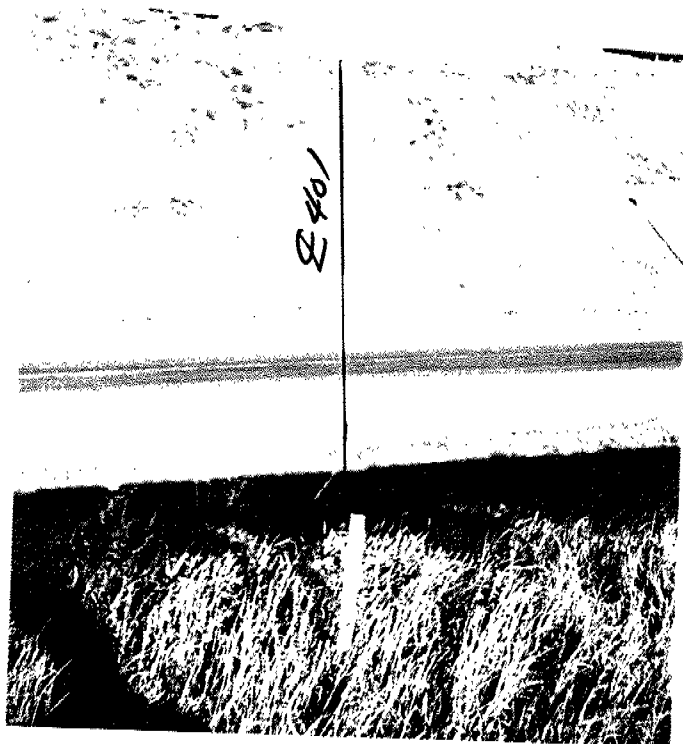
#3 E 401 Facing
West @ Sta 6+454±

C10



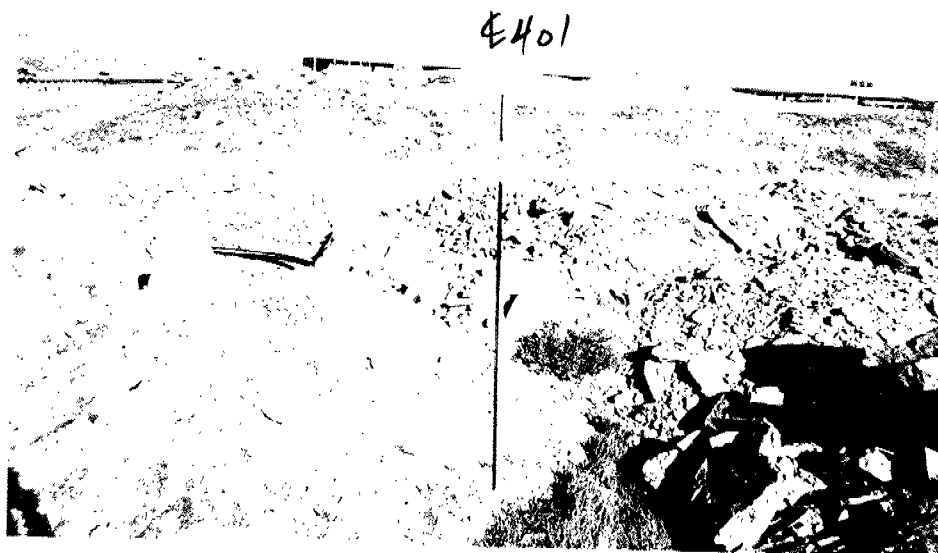
#4 E 401 Facing East
@ Sta 4+379±

C11



#5 \leftarrow 401 Facing East
@ Sta 6+500±

C21



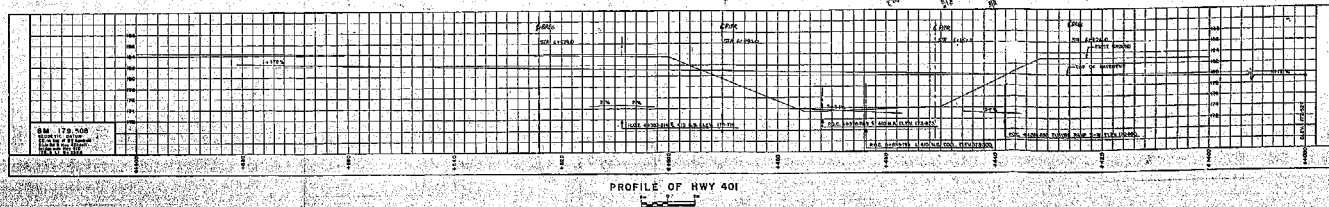
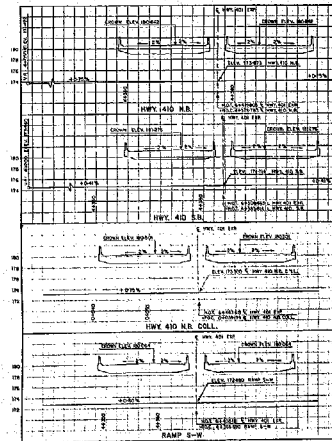
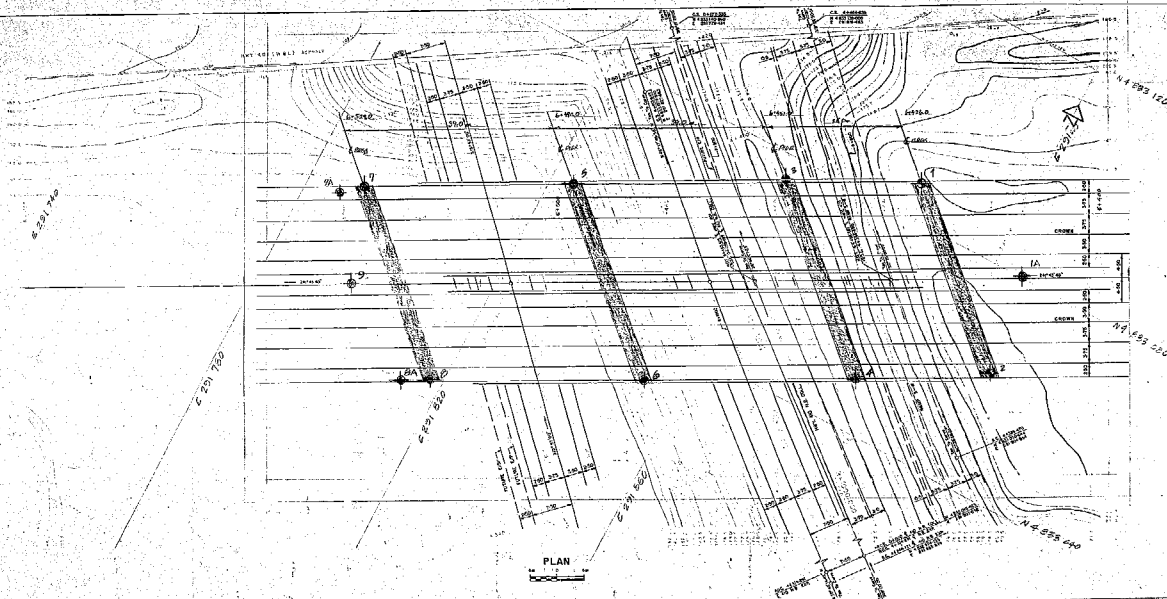
#6 \leftarrow 401 Facing East @ Sta 6+509± (Intersection of Hwy
410 SBI

C24



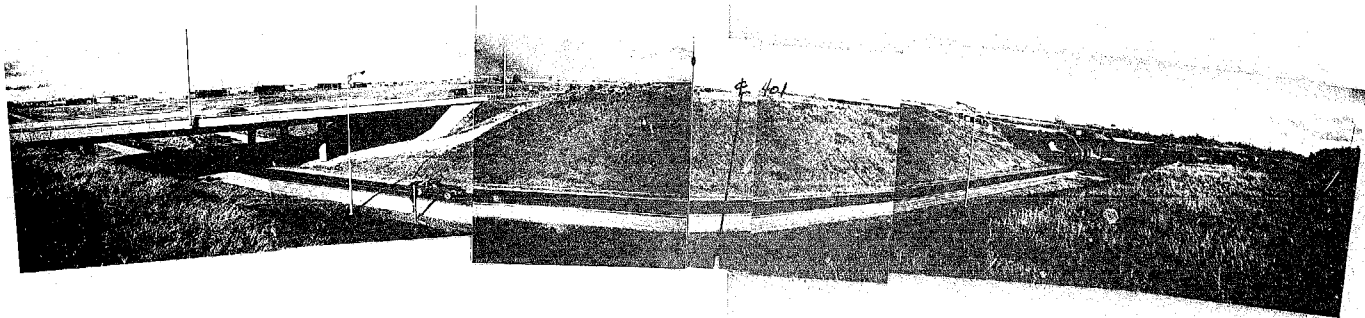
#7 \angle 401 Facing East @ Sta. 6+530±

METRIC
DIMENSIONS ARE IN METERS
EXCEPT MILLIMETERS
UNLESS OTHERWISE SHOWN



DATE	REVISED AND AMENDMENTS		
MINISTRY OF TRANSPORTATION AND COMMUNICATIONS ENGINEERING AND RIGHT OF WAY OFFICE SURVEY AND PLANNING SECTION			
BRIDGE SITE PLAN			
PROPOSED CROSSING			
KING'S HIGHWAY 410			
AND			
KING'S HIGHWAY 401			
LOC. FROM TORONTO		LOC. FROM K. H. HWY.	
DISTANCE		DISTANCE	
SCALE	DISTRICT	REGION	
A8 1:10,000	E. TORONTO	CENTRAL	
WP/NO	PROFILE	PLAN 252	
A4-62-62		B-61-200-20	
SURVEY BY DT		PLAN BY DT	
SITE		PLAN E-6072-1	

WP 64-82-15/16 Foundation Investigation Request Photo Survey



Panoramic View of Interchange site @ Sta. 6+500 facing East