

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M12-170

DIST. 4 REGION

W.P. No. 197-77-17
(see 197-77-02)

CONT. No. 84-78

W. O. No.

STR. SITE No. 10-82-328

HWY. No. 407

LOCATION Hwy 407 & Ramp S/E-W

No. of PAGES -

=====
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

17
WP 197-77-02 DIST 4
HWY 407 STR SITE 10-82-326
Hwy. #403 & 407 Interchange Complex

CONT 84-78

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
F. Norman
J. Smrcka (2)
K. Bassi
B.J. Giroux
R. Hore

R. Fitzgibbon (Cover Only)
T.J. Kovich (Cover Only)

Files

FOUNDATION INVESTIGATION REPORT

For

Hwy. 407 Underpass Structures
Hwy. #403 & 407 Interchange Complex
W.P. 197-77-02; Site 10-82-326
District #4 (Hamilton)

17

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on 82 11 02 - 82 11 08. The fieldwork consisted of four sampled boreholes and one dynamic cone penetration test adjacent to each boring. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped with solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, approximately 1.0 km north of Burnhamthorpe Rd. in the towns of Milton and Oakville. The surrounding terrain is relatively flat. Physiographically, the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by a sandy silt to silty sand deposit, followed by shale bedrock. In one of the borings a silty clay stratum was encountered within the sandy silt to silty sand deposit. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 1977702-A. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below the ground surface, a till-like zone was encountered at every boring location. The thickness varies from 6 m to 11 m. This material is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 16 to over 95 blows per 30 cm. In all four boreholes the material has a very stiff to hard consistency.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>	<u>Avg.</u>
Natural Moisture Content (%)	8.0 - 12.5	10.5
Liquid Limit (%)	18.5 - 23.0	21.7
Plastic Limit (%)	13.0 - 16.0	14.3

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

Sandy Silt to Silty Sand, Some Gravel, Trace of Clay

This stratum was encountered in all four borings below the above described glacial till. The thickness varies from 9 m to 13 m. The material in the deposit consists mainly of sands and silts with traces of clay and varying amounts of gravel. A layer of silty clay was found within the deposit at the location of B.H. #7.

Standard Penetration Tests, carried out within the deposit, gave 'N' values from 27 to over 120 blows per 30 cm. These values indicate that the deposit is in a dense to very dense condition. The natural moisture content ranges from 7.5% to 10%. The results of the grain-size analyses performed on selected samples are plotted in envelope form on Figure #2 of the Appendix.

Silty Clay, With Sand, Trace of Gravel

A layer of silty clay approximately 7 m thick was found within the silty sand to sandy silt layer at B.H. #7.

The deposit has a hard consistency, as indicated by 'N' values of 60 blows per 15 cm. The natural moisture content is in the order of 9%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits at all four boreholes. The shale is badly weathered and was penetrated by approximately 3 m, using augers.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

B.H. #	6	7	9
El.	181.6	180.9	180.1

No groundwater level measurements were carried out at Borehole #8.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct two new highways (Hwy. #403 and Hwy. #407) in the vicinity of the existing Ninth Line, about 1.0 km north of Burnhamthorpe Rd., in the towns of Milton and Oakville. In the above-mentioned area, an interchange complex consisting of several bridge structures will be required. Two of these structures, designated as the Hwy. 407 Southbound and Northbound Underpasses, are the subjects of this report.

The Hwy. 407 Underpass structures are identical in geometry and are centred approximately 23.5 m apart. They are two-span structures of 36.50 m per span, and are symmetrically located about the intersections of the centrelines of Hwy. #403 and Hwy. #407.

The profile grade of the Hwy. 403 W.B.L. and E.B.L. is approximately El. 177.5 m at the centreline of the Hwy. 407 underpass structures. The profile grade of the underpass at the corresponding point is approximately El. 185.0 m. To accomplish the proposed grades as described above, the following earthworks will be performed.

<u>Location</u> (Hwy. 407 Chainage)	<u>Cut</u>	<u>Fill</u>
South Abutment, Sta. 26 + 306±	5.0 m±	3.6 m±
North Abutment, Sta. 26 + 376±	4.0 m±	4.6 m±

The vertical clearance is 5.00 m at the crossing of the Hwy. #403 E.B.L. and the Hwy. #407 N.B. underpass structure.

STRUCTURE FOUNDATIONS

The following foundation design alternatives are recommended:

1) Spread Footings Within Original Ground

The entire structure (abutments and piers) may be supported on spread footing type foundations at or below the following elevations:

<u>Footing Location</u>	<u>Recommended Footing Level</u> <u>(At or Below)</u>
S.B.L. Underpass, South Abutment	El. 179.0 m
S.B.L. Underpass, Pier	El. 175.0 m
S.B.L. Underpass, North Abutment	El. 179.0 m
N.B.L. Underpass, South Abutment	El. 179.0 m
N.B.L. Underpass, Pier	El. 175.0 m
N.B.L. Underpass, North Abutment	El. 178.0 m

It should be noted, however, that 1.4 m of earth cover should be provided to the underside of the footings for frost protection purposes.

For footings founded at or below the above quoted elevations, an allowable bearing value of 300 kPa may be used in design.

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

Factored Bearing Capacity at U.L.S.: 460 kPa

Bearing Capacity at S.L.S. Type II: 300 kPa

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the code. For the granular backfill, a non-yielding foundation condition should be assumed, in which case a value of $K_o=0.43$ is recommended. The base of the footing excavations should be protected by 15 cm of mass concrete within 8 hours of exposure.

Settlements of the foundation subsoil, due to the surcharge loading of the footings will be negligible (approx. 25 mm) in magnitude.

No dewatering problems are anticipated during excavation and construction of the abutment footings, founded in the relatively impervious glacial till layer. *Although it is reasonable to assume that excavation for the pier footings will lead to a hydrostatic imbalance within the soil, "boiling" of the exposed, non-cohesive sandy silt layer is not expected to occur to a significant extent.

2) Pile Foundations

As a second alternative, any one or all of the abutments and piers may be supported on piles driven to refusal. In the case of steel 'H' piles (310 HP 110 or 310 HP 79) two approaches may be used.

- 1) Drive piles to bedrock at El. 159 m \pm , assuming design loads of up to 1160 kN. For the purpose of O.H.B.D.C., the following design values are recommended:

Factored Capacity at U.L.S.: 1500 kN

Capacity at S.L.S. Type II: 1160 kN

- 2) Drive piles to El. 168.0 m \pm , assuming design loads of up to 890 kN. For the purpose of O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S.: 1160 kN

Capacity at S.L.S. Type II: 890 kN

Piles should be driven in accordance with M.T.C. Standards SS103-10 or SS103-11.

The pile caps should have a minimum of 1.4 earth cover for frost protection requirements. The driving energy should not be less than 50 kJ.

APPROACH EMBANKMENTS

Fills up to 5 m in height above the existing ground surface will be required at this location. No stability problems are anticipated for the approaches of this height constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. It is estimated that the total settlement will be in the order of 25 mm.

In the vicinity of Sta. 26 + 450, Hwy. 407, a low wet area exists, at the proposed north approach embankment location. Any soft material in this area must be removed. The exact dimensions and location of this area will be carried out by the Regional Geotechnical Section.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. J. Hayward, Student Field Technician. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was written by Mr. Hayward and reviewed by Mr. P. Payer and Mr. K.G. Selby.



J. Hayward

J. Hayward
Student Field Technician

P. Payer

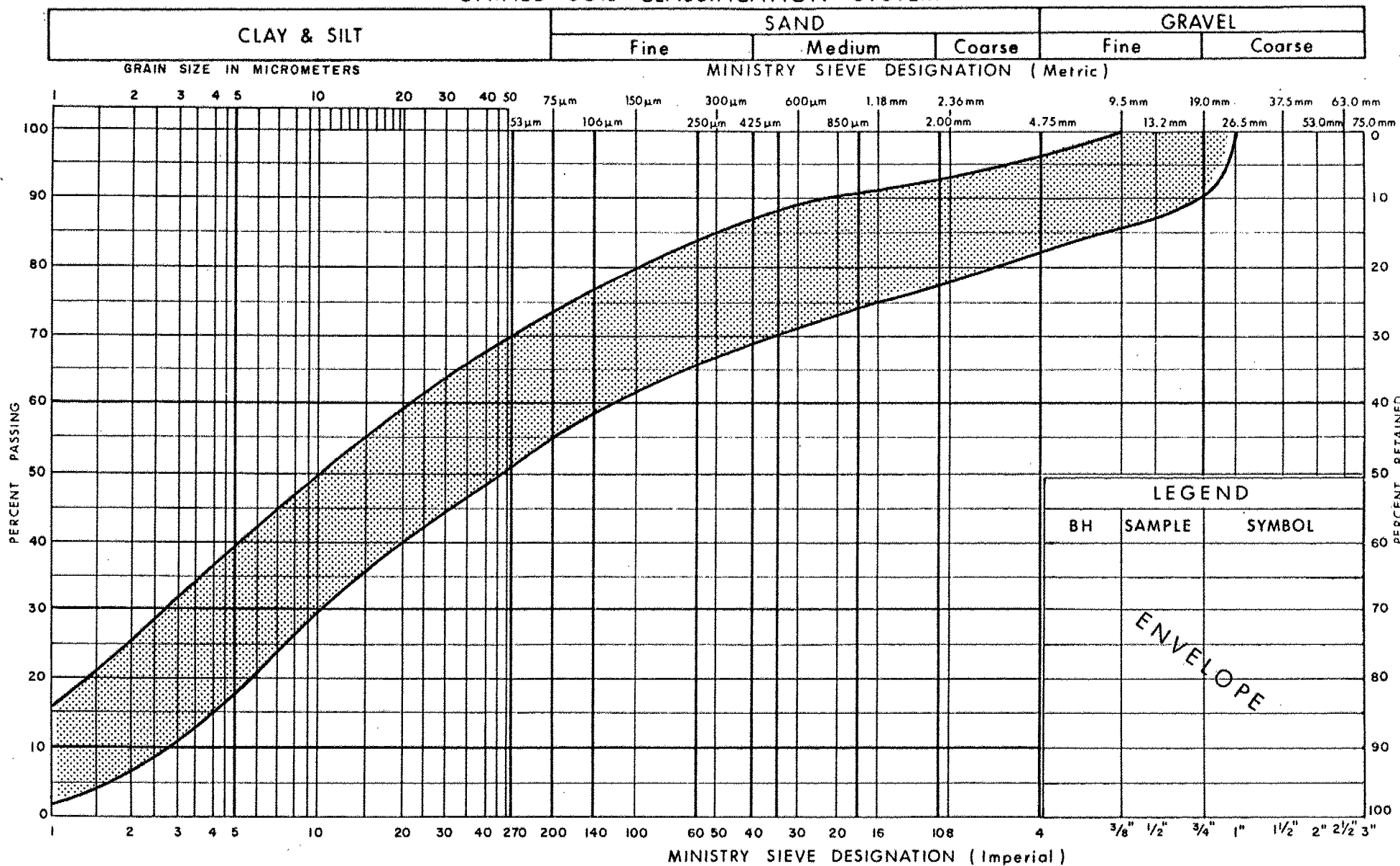
P. Payer, P. Eng.
Foundations Engineer

K. G. Selby

K.G. Selby, P. Eng.
Senior Foundations Engineer

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



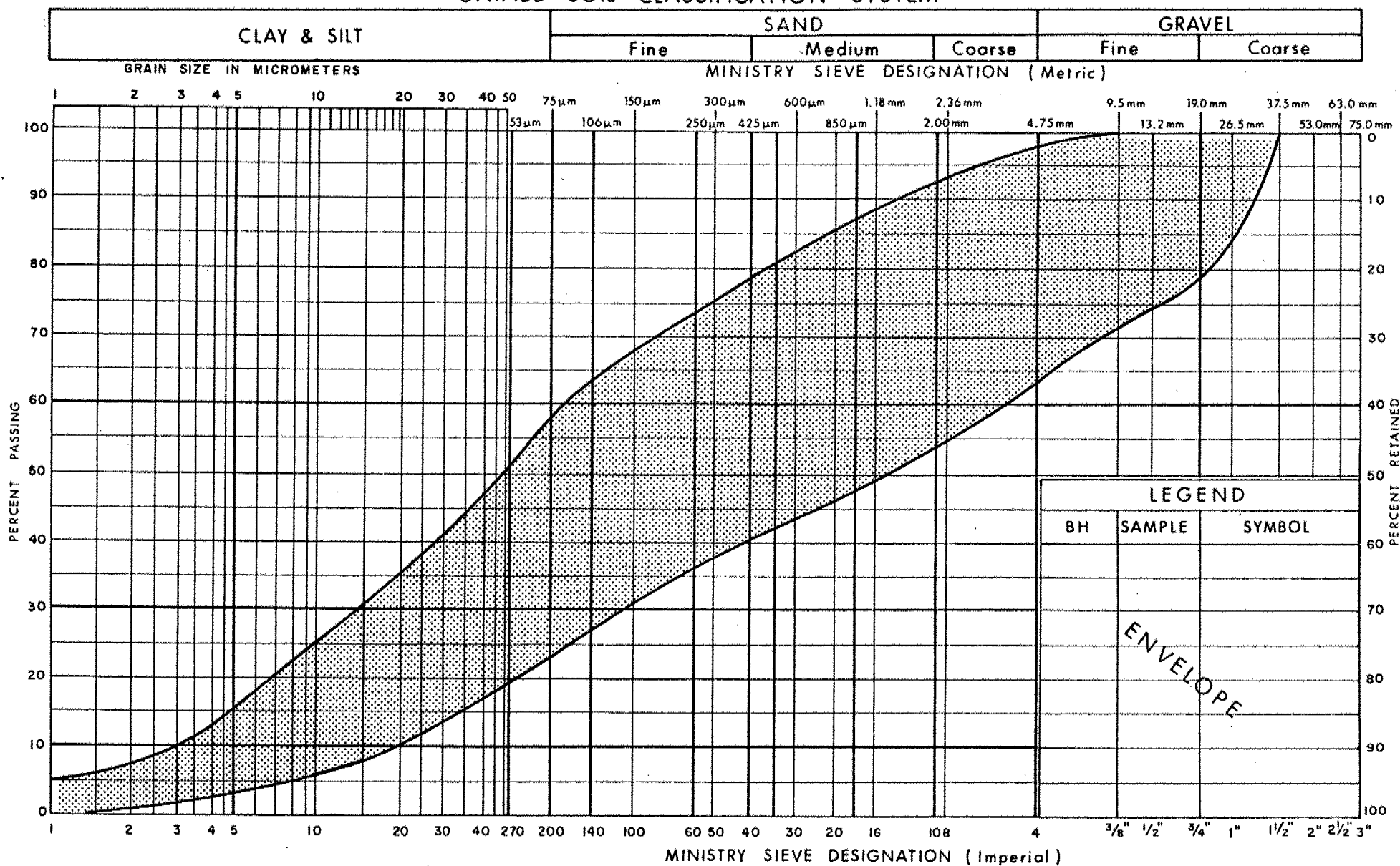
Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
HET MIXTURE OF
SILTY CLAY SAND & GRAVEL
(GLACIAL TILL)

FIG No 1

W P 197-77-17

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND
SOME GRAVEL TRACE CLAY

FIG No 2

W P 197 - 77 - 17

RECORD OF BOREHOLE No 6

METRIC

W P 197-77-17

LOCATION Co-ords. N 4 820 651.8; E 286 577.9

ORIGINATED BY JH

DIST 4 HWY 403

BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test

COMPILED BY JH

DATUM Geodetic

DATE 1982 11 02 and 03

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 _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									
181.6	Ground Level													
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	22								8 23 49 20	
			2	SS	42									
			3	SS	67									
			4	SS	86									5 21 52 22
175.3	Some Gravel Sandy Silt to Silty Sand Trace Clay Very Dense with Gravel Trace Gravel		5	SS	75	23 cm							13 23 44 20	
6.3			6	SS	82									10 40 43 7
			7	SS	40	8 cm								
			8	SS	78									37 37 24 2
			9	SS	72	15 cm								
			10	SS	100	8 cm								7 43 44 6
161.8	Weathered Red Shale													
19.8														
158.7	End of Borehole													
22.9														

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 695.2; E 286 518.5 ORIGINATED BY JH
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
 DATUM Geodetic DATE 1982 11 05 and 08 CHECKED BY LB

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				
180.9	Ground Level														GR SA SI CL
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	19										
			2	SS	35										
			3	SS	51										
			4	SS	43										
			5	SS	20										
			6	SS	16										
175.0			7	SS	24										
5.9	Sandy Silt to Silty Sand, Some Gravel, Trace Clay Dense to Very Dense		8	SS	27										
			9	SS	43										
			10	SS	62										
			11	SS	60/	15 cm									
170.6	Silty Clay with Sand Trace Gravel Hard		12	SS	60/	15 cm									
10.3			13	SS	80/	10 cm									
167.2	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense		14	SS	60/	15 cm									
13.7															
			15	SS	60/	8 cm									
161.4	Weathered Red Shale		16	SS	80/	8 cm									
159.5															
21.4	End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 8

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 692.5; E 286 607.3 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 1982 11 03 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 Level															
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	23		180									
			2	SS	36											3 27 50 20
			3	SS	66		178									
			4	SS	64		176									
			5	SS	42		174									8 25 44 23
173.4	Sandy Silt to Silty Sand, Some Gravel Trace Clay Very Dense		6	SS	70		172									2 74 20 4
7.2			7	SS	94		170									18 48 28 5
			8	SS	60/	8 cm	168									
			9	SS	70/	15 cm	166									
			10	SS	90/	10 cm	164									12 46 37 5
			11	SS	100/	15 cm	162									
160.8	Weathered Red Shale						160									
19.8			12	SS	100/	8 cm										10 15 52 23
159.2	End of Borehole															
21.4																
	Note: No Groundwater Level Measurements Were Carried Out.															

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 735.6; E 286 548.0 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 1982 11 04 and 05 CHECKED BY *so*

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						W _p W W _L
180.1	Ground Level												GR SA SI CL	
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	26									
			2	SS	70									5 27 46 22
			3	SS	36									8 30 43 19
			4	SS	41									17 22 45 16
			5	SS	46									
			6	SS	97									17 26 43 14
169.1	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense		7	SS	60/	15 cm							3 27 64 6	
11.0			8	SS	71/	15 cm								10 48 37 5
			9	SS	62/	15 cm								
160.3	Weathered Red Shale													
19.8														
158.7			10	SS	60/	3 cm								
21.4	End of Borehole													

+3, x5: Numbers refer to
Sensitivity


20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 692 E 286 564 ORIGINATED BY SO
 DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger COMPILED BY SO
 DATUM Geodetic DATE 83 02 16 CHECKED BY SO

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
180.8	Ground Level															
0.0	Heterogeneous Mixture of Silty Clay, Sand and Gravel (glacial till) Very Stiff to Hard		1	SS	31		180									
			2	SS	36											
			3	SS	56		178									
			4	SS	94											
			5	SS	64											
			6	SS	54		176									
			7	SS	62											
			8	SS	120/		25 cm									
			9	SS	130/		25 cm	174								
			10	SS	63											
172.8	End of Borehole															
8.0																

OFFICE REPORT ON SOIL EXPLORATION

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
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						

METRIC

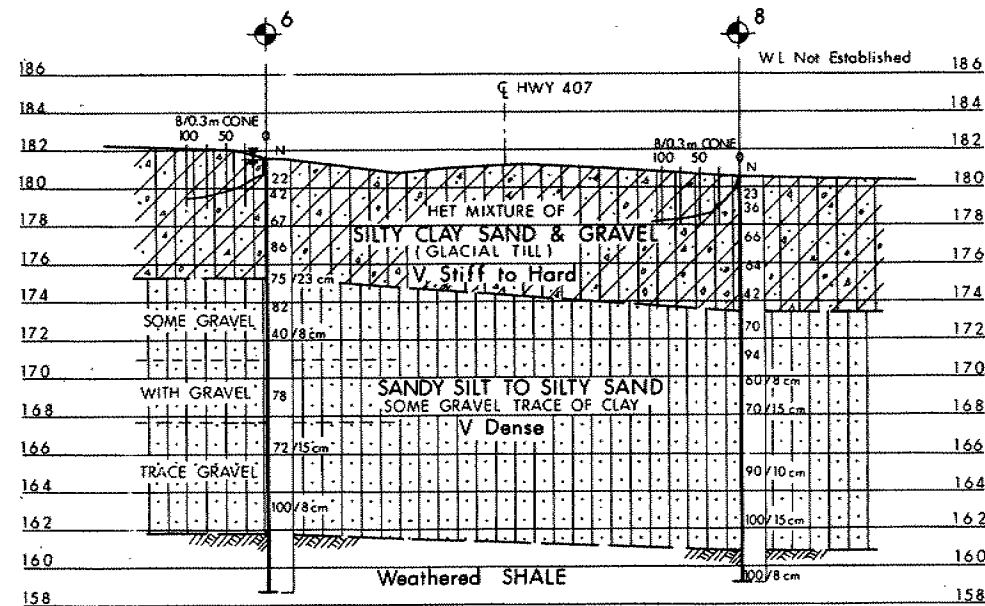
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 197-77-17

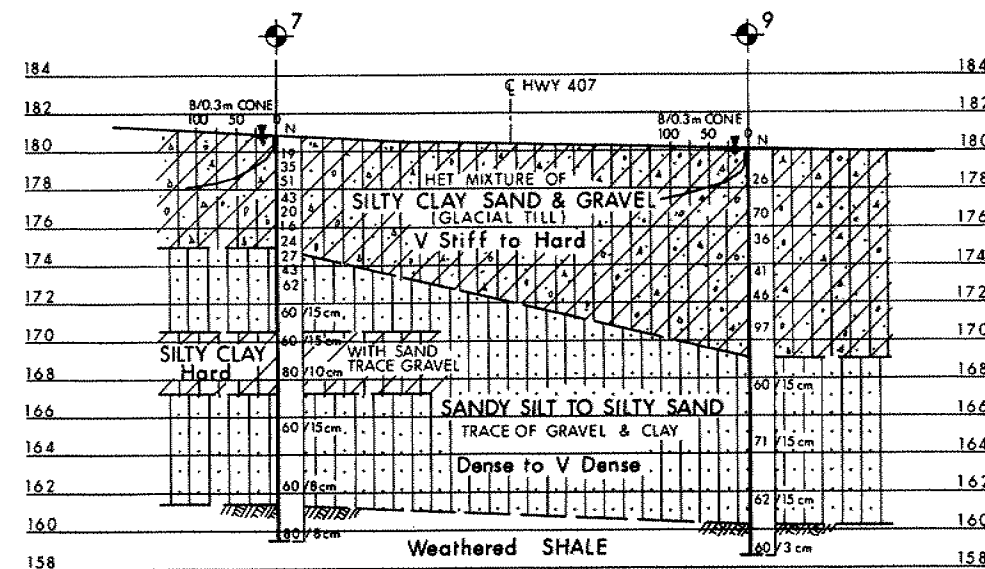


SHEET

BORE HOLE LOCATIONS & SOIL STRATA



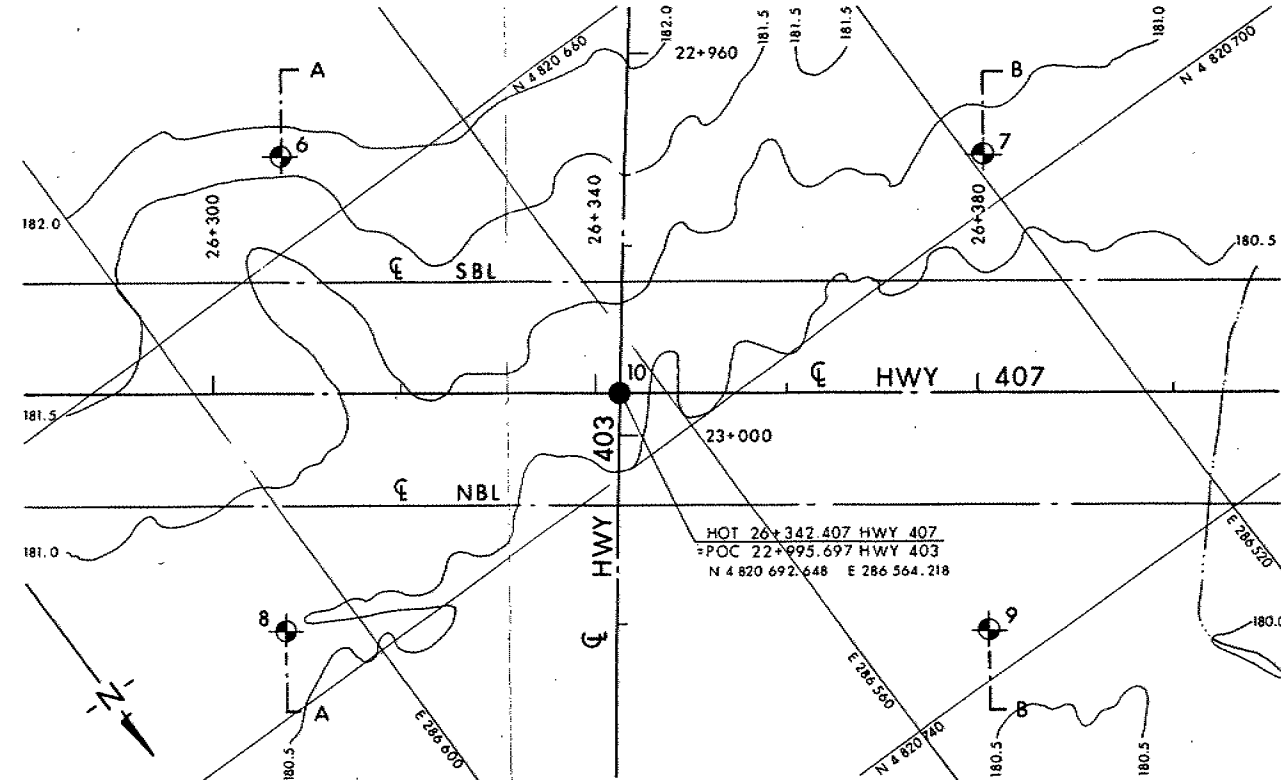
A-A



B-B

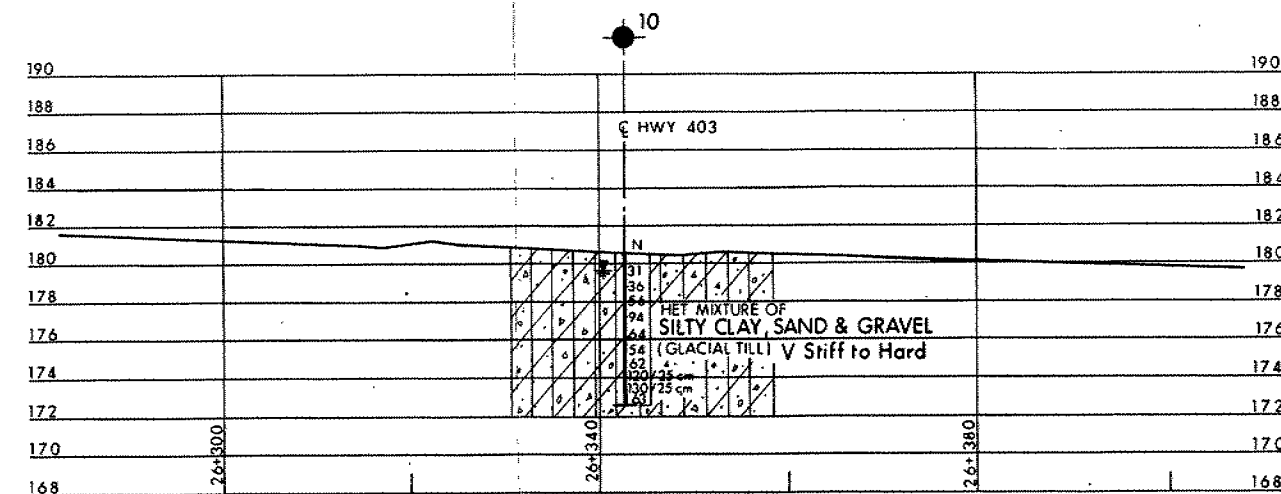
SECTIONS

SCALE
HORIZONTAL 8m 4m 0 8m
VERTICAL 4m 2m 0 4m



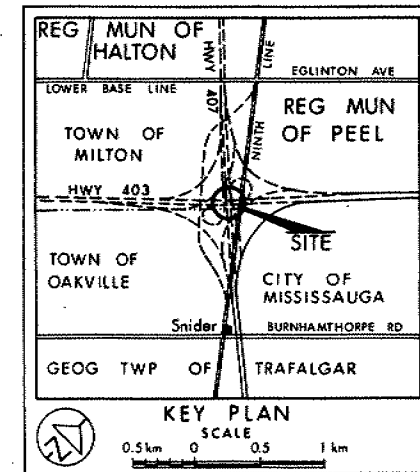
PLAN

SCALE
8m 4m 0 8m



PROFILE HWY 407

SCALE
HORIZONTAL 8m 4m 0 8m
VERTICAL 4m 2m 0 4m



LEGEND

- ◆ Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- ⬇ WL at time of investigation 82118302
- WL Not Established in BH 8

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
6	181.6	4 820 651.8	286 577.9
7	180.9	4 820 695.2	286 518.5
8	180.6	4 820 692.5	286 607.3
9	180.1	4 820 735.6	286 548.0
10	180.8	4 820 692.0	286 564.0

NOTE

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

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

REV.	DATE	BY	DESCRIPTION
83 10	50		BORE HOLE TO BE ADDED

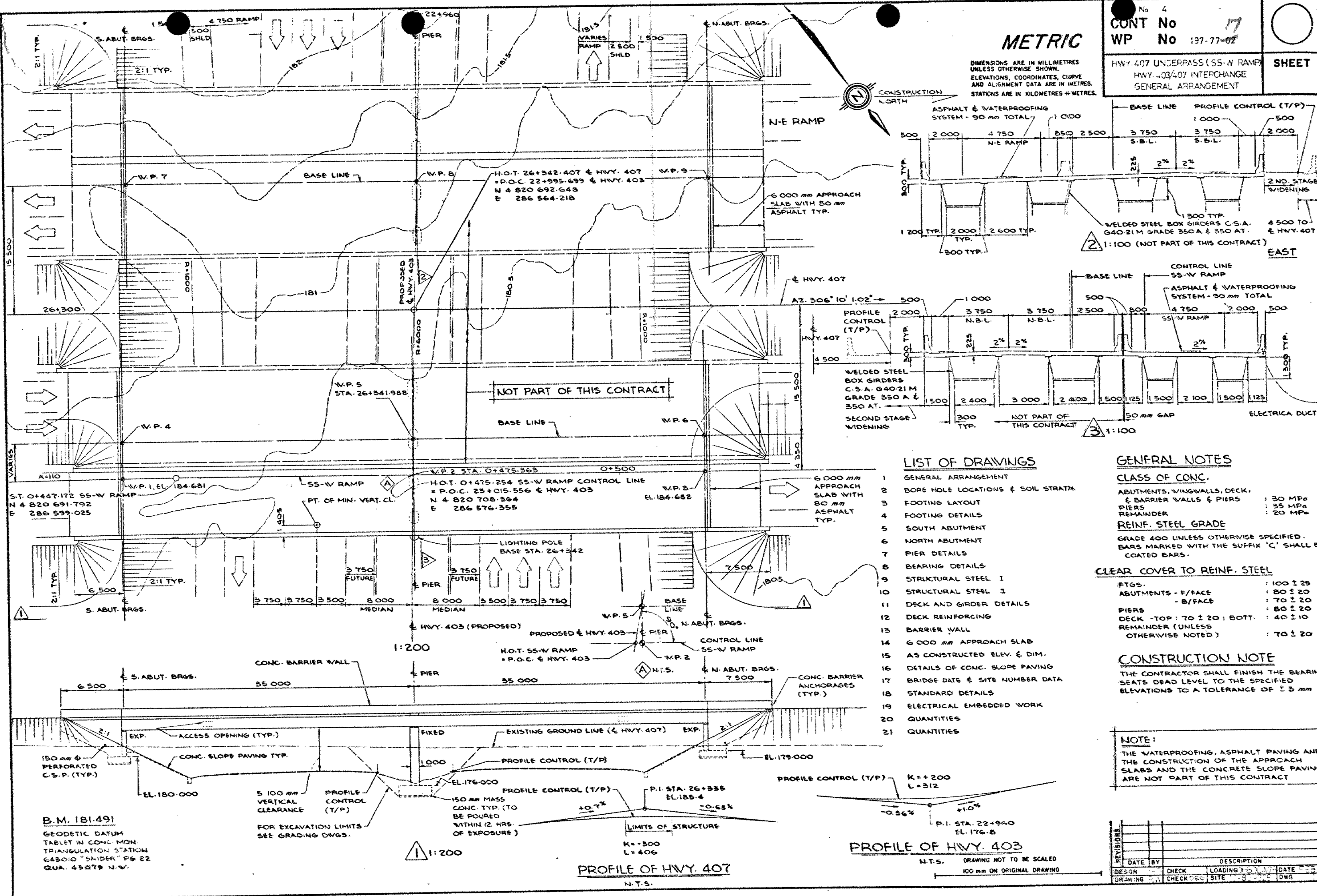
Geacres No 30M12-170			
HWY No 407 & 403			DIST 4
SUBMIT PP CHECKED	DATE 82 12 14		SITE 10-82-326
DRAWN SO CHECKED			DWG

No 4
CONT No 17
WP No 197-77-02
HWY. 407 UNDERPASS (SS-W RAMP)
HWY. 403/407 INTERCHANGE
GENERAL ARRANGEMENT

SHEET

METRIC

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



LIST OF DRAWINGS

- 1 GENERAL ARRANGEMENT
- 2 BORE HOLE LOCATIONS & SOIL STRATA
- 3 FOOTING LAYOUT
- 4 FOOTING DETAILS
- 5 SOUTH ABUTMENT
- 6 NORTH ABUTMENT
- 7 PIER DETAILS
- 8 BEARING DETAILS
- 9 STRUCTURAL STEEL 1
- 10 STRUCTURAL STEEL 3
- 11 DECK AND GIRDER DETAILS
- 12 DECK REINFORCING
- 13 BARRIER WALL
- 14 6 000 mm APPROACH SLAB
- 15 AS CONSTRUCTED ELEV. & DIM.
- 16 DETAILS OF CONC. SLOPE PAVING
- 17 BRIDGE DATE & SITE NUMBER DATA
- 18 STANDARD DETAILS
- 19 ELECTRICAL EMBEDDED WORK
- 20 QUANTITIES
- 21 QUANTITIES

GENERAL NOTES

CLASS OF CONC.

ABUTMENTS, VINGWALLS, DECK,
& BARRIER WALLS & PIERS : 30 MPa
PIERS : 35 MPa
REMAINDER : 20 MPa

REINF. STEEL GRADE

GRADE 400 UNLESS OTHERWISE SPECIFIED.
BARS MARKED WITH THE SUFFIX 'C' SHALL BE
COATED BARS.

CLEAR COVER TO REINF. STEEL

FTGS. : 100 ± 25
ABUTMENTS - F/FACE : 80 ± 20
- B/FACE : 70 ± 20
PIERS : 80 ± 20
DECK - TOP : 70 ± 20; BOTT. : 40 ± 10
REMAINDER (UNLESS
OTHERWISE NOTED) : 70 ± 20

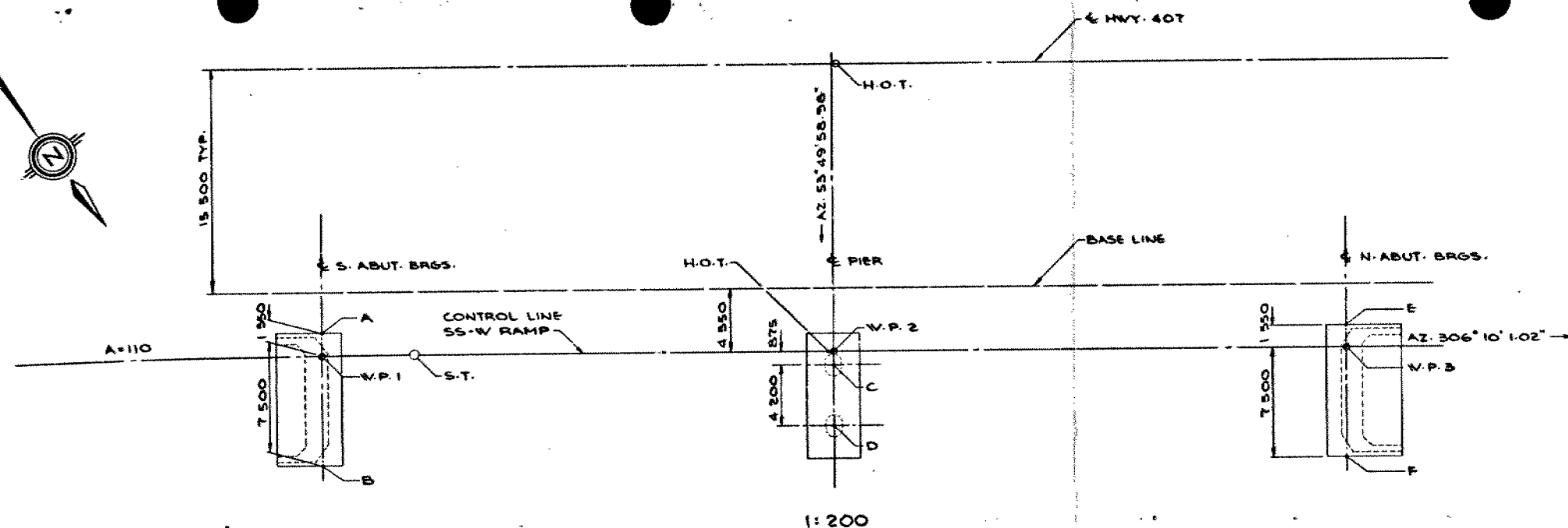
CONSTRUCTION NOTE

THE CONTRACTOR SHALL FINISH THE BEARING
SEATS DEAD LEVEL TO THE SPECIFIED
ELEVATIONS TO A TOLERANCE OF ± 3 mm

NOTE:

THE WATERPROOFING, ASPHALT PAVING AND
THE CONSTRUCTION OF THE APPROACH
SLABS AND THE CONCRETE SLOPE PAVINGS
ARE NOT PART OF THIS CONTRACT

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CHECK	LOADING	DATE
DRAWING	CHECK	SITE	DWG



NOTE: ALL ϵ ARE PARALLEL

		CO-ORDINATES	
POINT	STATION	N	E
A	O+440.366	4 820 686.524	286 603.615
W.P. 1	O+440.363	4 820 687.775	286 604.530
B	O+440.347	4 820 693.830	286 608.956
S.T.	O+447.172	4 820 691.792	286 599.025
H.O.T.	O+475.254	4 820 708.364	286 576.355
W.P. 2	O+475.363	4 820 708.425	286 576.271
C	O+475.363	4 820 703.134	286 576.789
D	O+475.363	4 820 712.525	286 579.267
H.O.T.	26+342.407	4 820 692.648	286 564.218
E	O+510.363	4 820 727.827	286 547.099
W.P. 3	O+510.363	4 820 729.079	286 548.014
F	O+510.363	4 820 735.133	286 552.440

METRIC

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

CONT No
WP No 197-77-92

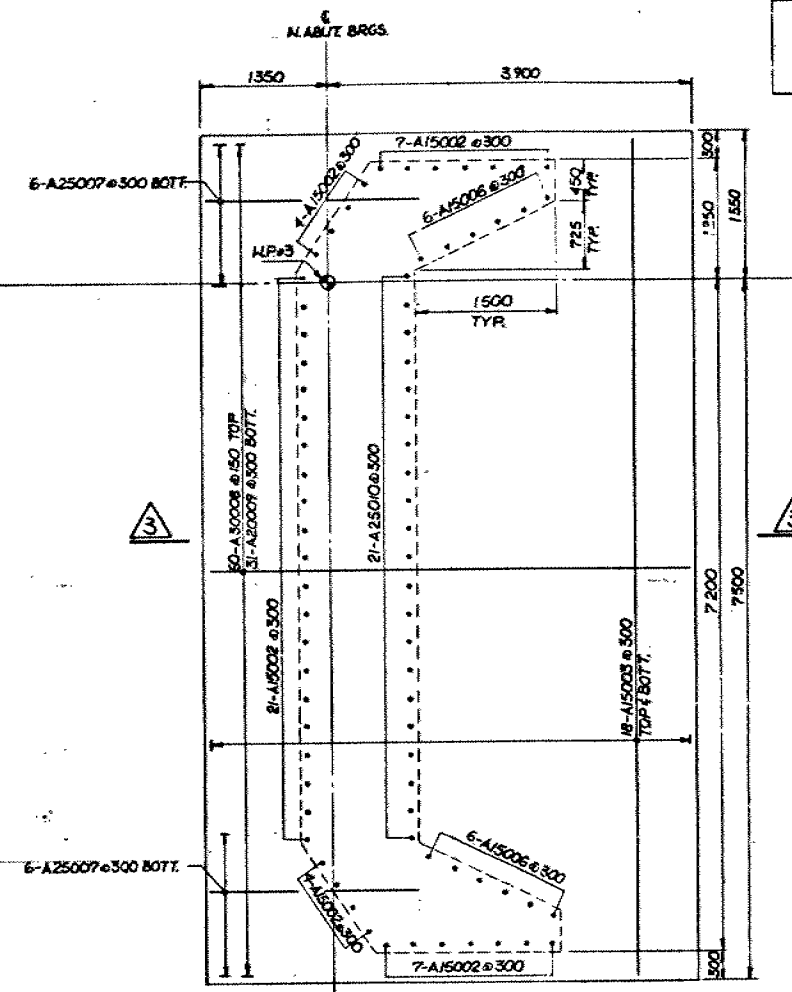
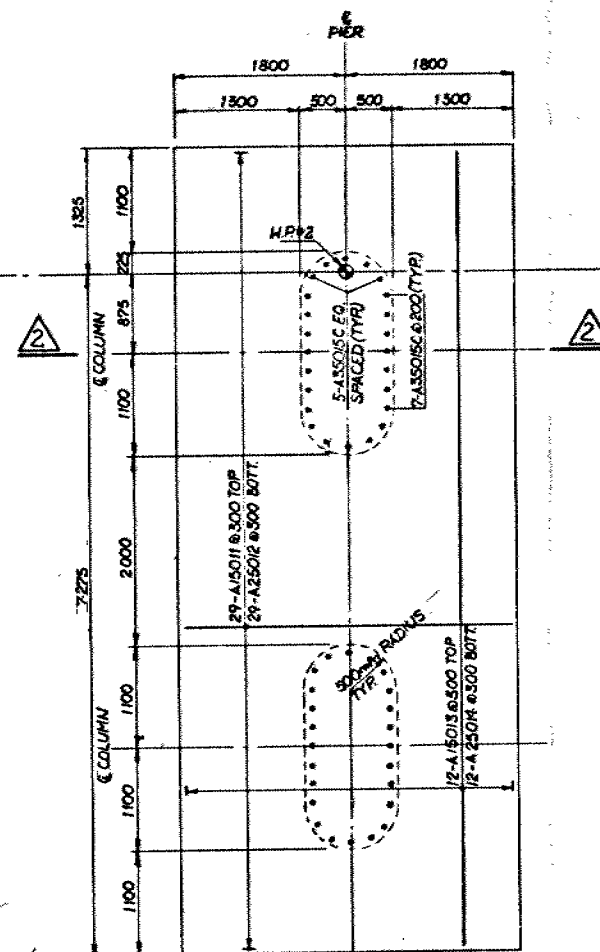
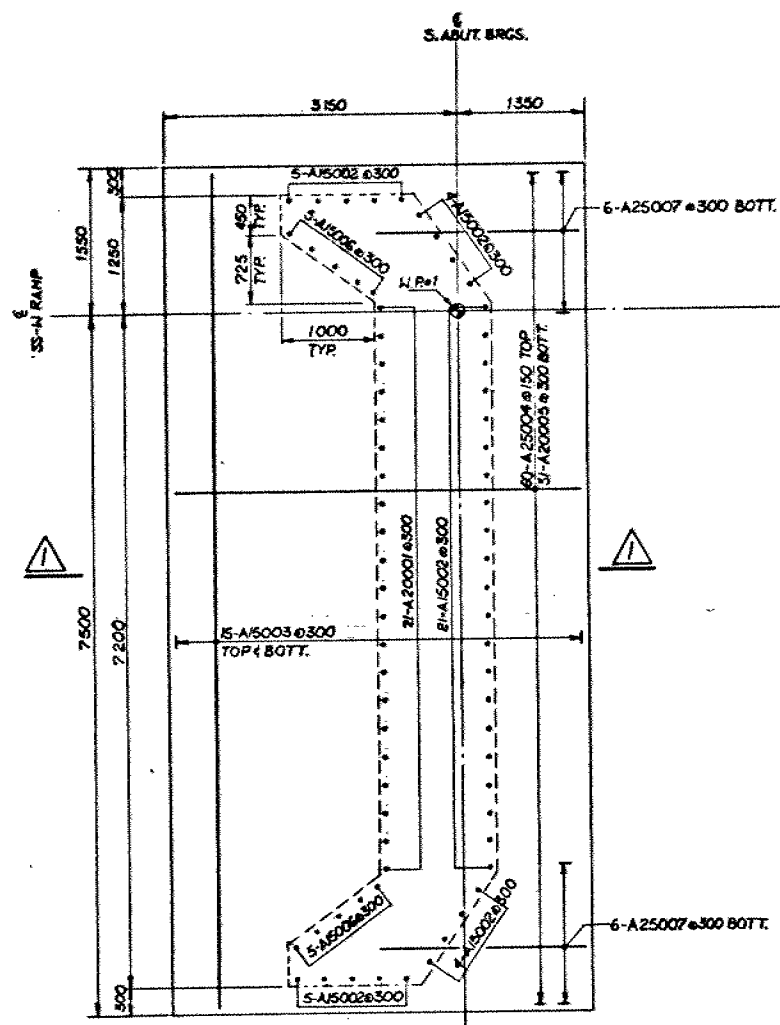
HWY. 407 UNDERPASS (SS-W RAMP)
HWY. 403/407 INTERCHANGE
FOOTING LAYOUT

SHEET

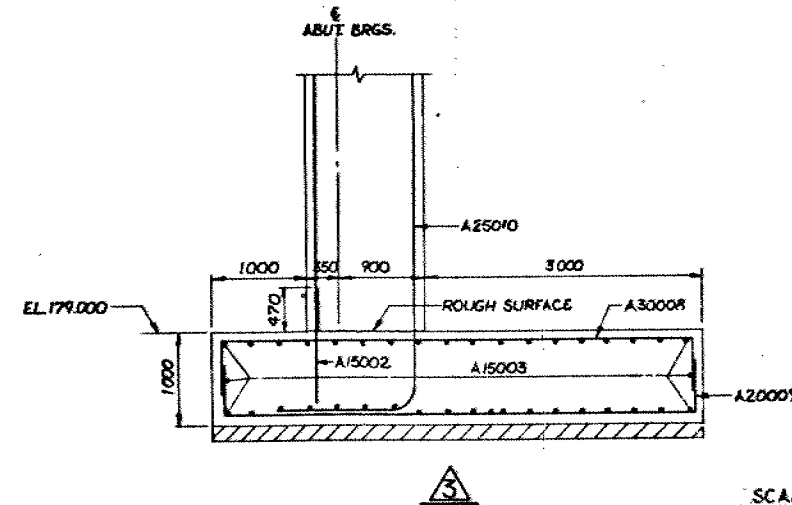
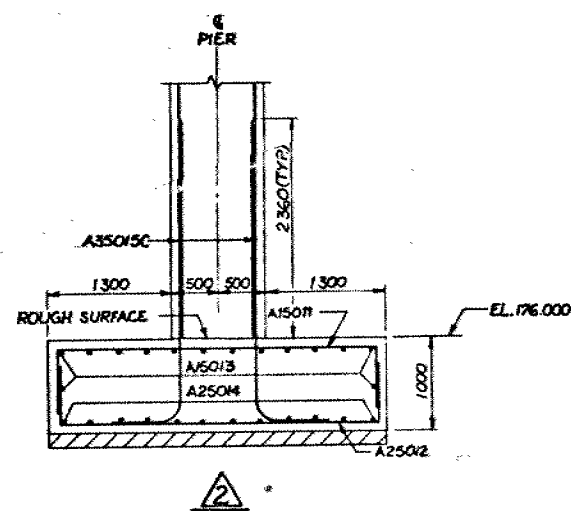
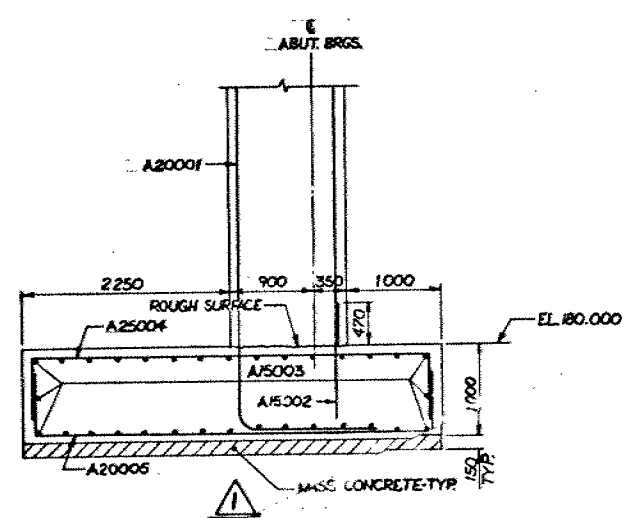
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

DATE		BY	DESCRIPTION	
DESIGN	RG	CHECK	LOADING	8
DRAWING	RW	CHECK	SITE No	OWG

HWY. 407 UNDERPASS (SS-W RAMP)
HWY. 403 INTERCHANGE
FOOTING DETAILS



PLAN



NOTES:

- DRWG. TO BE READ IN CONJUNCTION WITH DRWG. NO.3
- 150 mm OF MASS CONCRETE TO BE CAST AT BASE OF ALL FOOTINGS EXCAVATION WITHIN 12 HOURS OF EXPOSURE.

SCALE 1:40

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DESCRIPTION			
	DATE	BY		
	DESIGN	CHECK	LOADING	DATE
	DRAWING	CHECK	SITE No	DWG

GEOCRES No. 30M12-170

DIST. 4 REGION

W.P. No. 197-77-02

CONT. No.

W. O. No.

STR. SITE No. 10-82-326

HWY. No. 407

LOCATION Hwy 403 & Hwy 407
INTERCHANGE Complex

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Ministry
of
Transportation

FILE COPY

30M12-170

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WP 197-77-02 DIST 4
HWY 407 STR SITE 10-82-326
Hwy. #403 & 407 Interchange Complex

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
F. Norman
J. Smrcka (2)
K. Bassi
B.J. Giroux
R. Hore

R. Fitzgibbon (Cover Only)
T.J. Kovich (Cover Only)

Files ✓

FOUNDATION INVESTIGATION REPORT

For

Hwy. 407 Underpass Structures
Hwy. #403 & 407 Interchange Complex
W.P. 197-77-02; Site 10-82-326
District #4 (Hamilton)

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on 82 11 02 - 82 11 08. The fieldwork consisted of four sampled boreholes and one dynamic cone penetration test adjacent to each boring. The borings were advanced by continuous flight auger machines mounted on muskeg vehicles and equipped with solid stem augers.

SITE DESCRIPTION

The site is located in the vicinity of the existing Ninth Line Road, approximately 1.0 km north of Burnhamthorpe Rd. in the towns of Milton and Oakville. The surrounding terrain is relatively flat. Physiographically, the site is located in the region referred to as the Peel Plain. The deposits in the vicinity of the area under investigation are composed of cohesive glacial till and granular deposits. The overburden is underlain by shale bedrock.

SUBSURFACE CONDITIONS

General

The subsoil at this location was found to consist of cohesive type glacial till, followed by a sandy silt to silty sand deposit, followed by shale bedrock. In one of the borings a silty clay stratum was encountered within the sandy silt to silty sand deposit. The boundaries of the different strata, together with the obtained field and laboratory test results are shown on the Record of Borehole Sheets contained in the Appendix of this report. A stratigraphical profile is shown on Drawing No. 1977702-A. A description of the different strata encountered is given below.

Heterogeneous Mixture of Silty Clay, Sand & Gravel (Glacial Till)

Immediately below the ground surface, a till-like zone was encountered at every boring location. The thickness varies from 6 m to 11 m. This material is basically cohesive in nature - i.e., silty clay binding coarser particles. Standard Penetration Tests carried out within the deposit gave 'N' values to range from 16 to over 95 blows per 30 cm. In all four boreholes the material has a very stiff to hard consistency.

Physical properties of the material as determined from laboratory tests are summarized as follows:

	<u>Range</u>	<u>Avg.</u>
Natural Moisture Content (%)	8.0 - 12.5	10.5
Liquid Limit (%)	18.5 - 23.0	21.7
Plastic Limit (%)	13.0 - 16.0	14.3

The results of the grain-size distribution tests are shown in an envelope form on Figure #1 of the Appendix.

Sandy Silt to Silty Sand, Some Gravel, Trace of Clay

This stratum was encountered in all four borings below the above described glacial till. The thickness varies from 9 m to 13 m. The material in the deposit consists mainly of sands and silts with traces of clay and varying amounts of gravel. A layer of silty clay was found within the deposit at the location of B.H. #7.

Standard Penetration Tests, carried out within the deposit, gave 'N' values from 27 to over 120 blows per 30 cm. These values indicate that the deposit is in a dense to very dense condition. The natural moisture content ranges from 7.5% to 10%. The results of the grain-size analyses performed on selected samples are plotted in envelope form on Figure #2 of the Appendix.

Silty Clay, With Sand, Trace of Gravel

A layer of silty clay approximately 7 m thick was found within the silty sand to sandy silt layer at B.H. #7.

The deposit has a hard consistency, as indicated by 'N' values of 60 blows per 15 cm. The natural moisture content is in the order of 9%.

Shale Bedrock

Shale-type bedrock was encountered below the sandy silt to silty sand deposits at all four boreholes. The shale is badly weathered and was penetrated by approximately 3 m, using augers.

GROUNDWATER CONDITIONS

The following groundwater levels were observed during the field investigation:

B.H. #	6	7	9
El.	181.6	180.9	180.1

No groundwater level measurements were carried out at Borehole #8.

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct two new highways (Hwy. #403 and Hwy. #407) in the vicinity of the existing Ninth Line, about 1.0 km north of Burnhamthorpe Rd., in the towns of Milton and Oakville. In the above-mentioned area, an interchange complex consisting of several bridge structures will be required. Two of these structures, designated as the Hwy. 407 Southbound and Northbound Underpasses, are the subjects of this report.

The Hwy. 407 Underpass structures are identical in geometry and are centred approximately 23.5 m apart. They are two-span structures of 36.50 m per span, and are symmetrically located about the intersections of the centrelines of Hwy. #403 and Hwy. #407.

The profile grade of the Hwy. 403 W.B.L. and E.B.L. is approximately El. 177.5 m at the centreline of the Hwy. 407 underpass structures. The profile grade of the underpass at the corresponding point is approximately El. 185.0 m. To accomplish the proposed grades as described above, the following earthworks will be performed.

<u>Location</u> (Hwy. 407 Chainage)	<u>Cut</u>	<u>Fill</u>
South Abutment, Sta. 26 + 306 \pm	5.0 m \pm	3.6 m \pm
North Abutment, Sta. 26 + 376 \pm	4.0 m \pm	4.6 m \pm

The vertical clearance is 5.00 m at the crossing of the Hwy. #403 E.B.L. and the Hwy. #407 N.B. underpass structure.

STRUCTURE FOUNDATIONS

The following foundation design alternatives are recommended:

1) Spread Footings Within Original Ground

The entire structure (abutments and piers) may be supported on spread footing type foundations at or below the following elevations:

<u>Footing Location</u>	<u>Recommended Footing Level</u> <u>(At or Below)</u>
S.B.L. Underpass, South Abutment	El. 179.0 m
S.B.L. Underpass, Pier	El. 175.0 m
S.B.L. Underpass, North Abutment	El. 179.0 m
N.B.L. Underpass, South Abutment	El. 179.0 m
N.B.L. Underpass, Pier	El. 175.0 m
N.B.L. Underpass, North Abutment	El. 178.0 m

It should be noted, however, that 1.4 m of earth cover should be provided to the underside of the footings for frost protection purposes.

For footings founded at or below the above quoted elevations, an allowable bearing value of 300 kPa may be used in design.

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

Factored Bearing Capacity at U.L.S.: 460 kPa

Bearing Capacity at S.L.S. Type II: 300 kPa

Earth pressures should be computed as per Subsection 6.6.1.2.2 of the code. For the granular backfill, a non-yielding foundation condition should be assumed, in which case a value of $K_o=0.43$ is recommended. The base of the footing excavations should be protected by 15 cm of mass concrete within 8 hours of exposure.

Settlements of the foundation subsoil, due to the surcharge loading of the footings will be negligible (approx. 25 mm) in magnitude.

No dewatering problems are anticipated during excavation and construction of the abutment footings, founded in the relatively impervious glacial till layer. *Although it is reasonable to assume that excavation for the pier footings will lead to a hydrostatic imbalance within the soil, "boiling" of the exposed, non-cohesive sandy silt layer is not expected to occur to a significant extent.

2) Pile Foundations

As a second alternative, any one or all of the abutments and piers may be supported on piles driven to refusal. In the case of steel 'H' piles (310 HP 110 or 310 HP 79) two approaches may be used.

- 1) Drive piles to bedrock at El. 159 m \pm , assuming design loads of up to 1160 kN. For the purpose of O.H.B.D.C., the following design values are recommended:

Factored Capacity at U.L.S.: 1500 kN

Capacity at S.L.S. Type II: 1160 kN

- 2) Drive piles to El. 168.0 m \pm , assuming design loads of up to 890 kN. For the purpose of O.H.B.D.C. the following design values are recommended:

Factored Capacity at U.L.S.: 1160 kN

Capacity at S.L.S. Type II: 890 kN

Piles should be driven in accordance with M.T.C. Standards SS103-10 or SS103-11.

The pile caps should have a minimum of 1.4 earth cover for frost protection requirements. The driving energy should not be less than 50 kJ.

APPROACH EMBANKMENTS

Fills up to 5 m in height above the existing ground surface will be required at this location. No stability problems are anticipated for the approaches of this height constructed with 2:1 slopes. The fill should consist of well compacted acceptable material. It is estimated that the total settlement will be in the order of 25 mm.

In the vicinity of Sta. 26 + 450, Hwy. 407, a low wet area exists, at the proposed north approach embankment location. Any soft material in this area must be removed. The exact dimensions and location of this area will be carried out by the Regional Geotechnical Section.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. J. Hayward, Student Field Technician. The equipment used was owned and operated by Master Soil Investigation Ltd. This report was written by Mr. Hayward and reviewed by Mr. P. Payer and Mr. K.G. Selby.



J. Hayward

J. Hayward
Student Field Technician

P. Payer

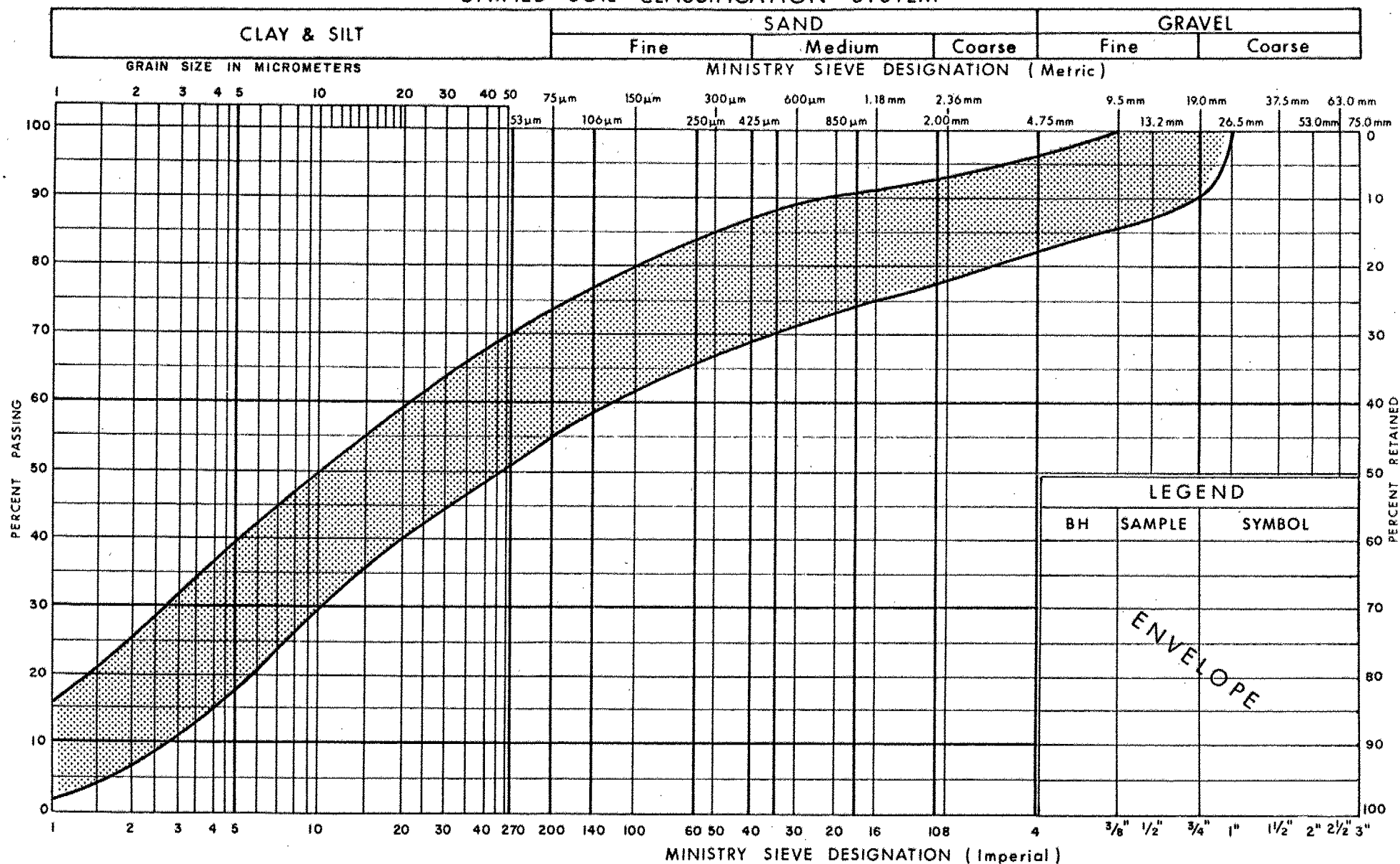
P. Payer, P. Eng.
Foundations Engineer

K. G. Selby

K.G. Selby, P. Eng.
Senior Foundations Engineer

A P P E N D I X

UNIFIED SOIL CLASSIFICATION SYSTEM



**Ministry of
Transportation and
Communications**

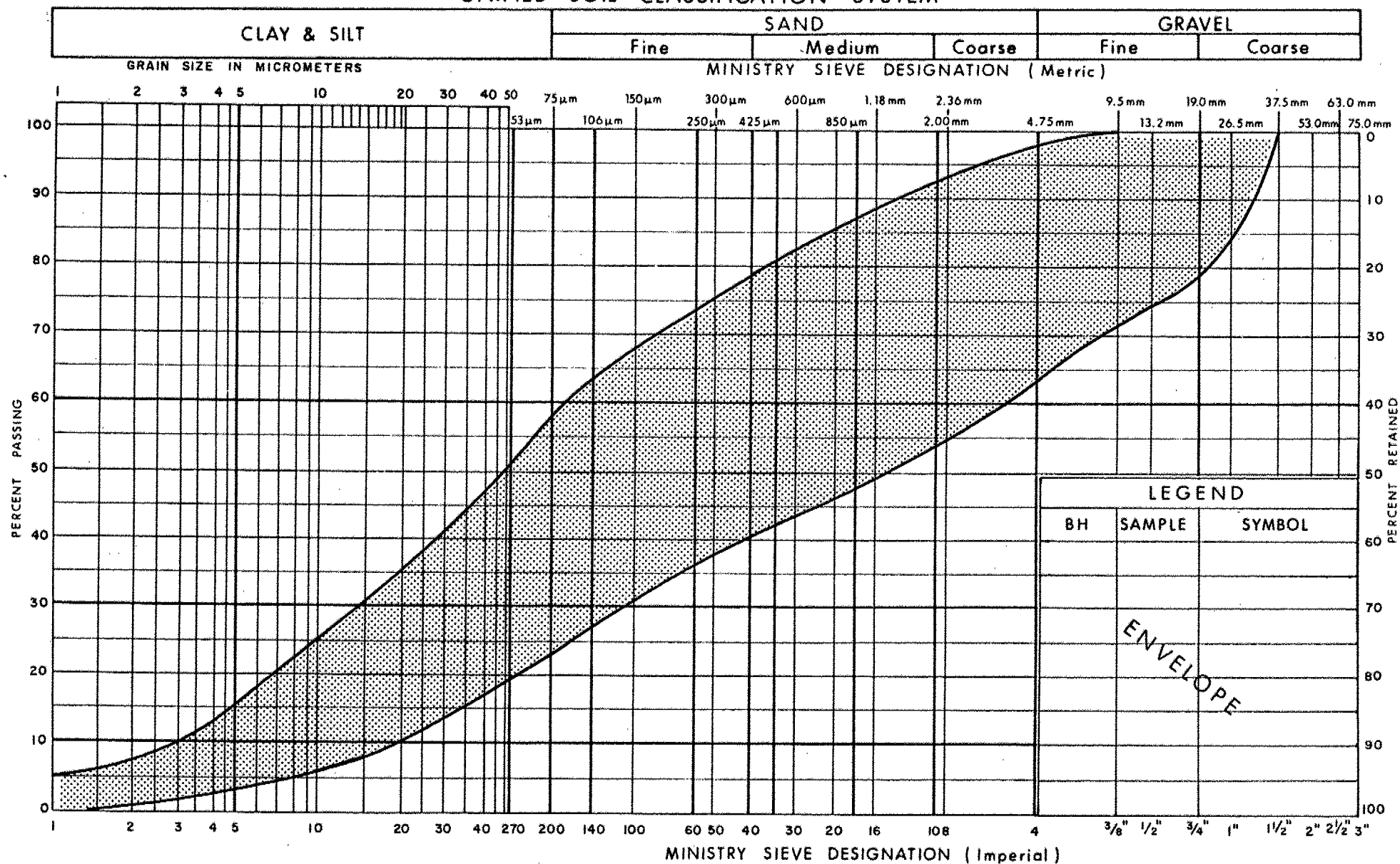
GRAIN SIZE DISTRIBUTION

HET MIXTURE OF SILTY CLAY SAND & GRAVEL (GLACIAL TILL)

FIG No 1

W P 197-77-17

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

GRAIN SIZE DISTRIBUTION
SANDY SILT TO SILTY SAND
SOME GRAVEL TRACE CLAY

FIG No 2

W P 197 - 77 - 17

RECORD OF BOREHOLE No 6

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 651.8; E 286 577.9 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 1982 11 02 and 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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			
								SHEAR STRENGTH							WATER CONTENT (%)
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE								
181.6	Ground Level														
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	22		180							8 23 49 20	
			2	SS	42										
			3	SS	67										
			4	SS	86										5 21 52 22
175.3			5	SS	75	23 cm	176							13 23 44 20	
6.3	Some Gravel Sandy Silt to Silty Sand Trace Clay Very Dense		6	SS	82		174							10 40 43 7	
			7	SS	40	8 cm	172								
			8	SS	78		170								37 37 24 2
			9	SS	72	15 cm	166								
	with Gravel		10	SS	100	8 cm	164							7 43 44 6	
161.8							162								
19.8	Weathered Red Shale						160								
158.7															
22.9	End of Borehole														

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 695.2; E 286 518.5; ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 1982 11 05 and 08 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				
180.9	Ground Level															GR SA SI CL
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	19		180									
			2	SS	35											
			3	SS	51											6 25 50 19
			4	SS	43											
			5	SS	20											10 26 48 16
			6	SS	16											5 26 44 25
175.0			7	SS	24											9 25 42 24
5.9	Sandy Silt to Silty Sand, Some Gravel, Trace Clay Dense to Very Dense		8	SS	27											
			9	SS	43											
			10	SS	62											25 44 26 5
			11	SS	60/	15 cm										
170.6	Silty Clay with Sand Trace Gravel Hard		12	SS	60/	15 cm										
10.3			13	SS	80/	10 cm										9 30 42 19
																5 31 42 22
167.2	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense		14	SS	60/	15 cm										
13.7			15	SS	60/	8 cm										6 36 54 4
161.4	Weathered Red Shale															
19.5																
159.5			16	SS	80/	8 cm										
21.4	End of Borehole															

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 8

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 692.5; E 286 607.3
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test
DATUM Geodetic DATE 1982 11 03

ORIGINATED BY JH
COMPILED BY JH
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						WATER CONTENT (%)
180.6	Ground Level							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	10 20 30					GR SA SI CL	
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	23		180							3 27 50 20	
			2	SS	36		178								
			3	SS	66		176								
			4	SS	64		174								8 25 44 23
			5	SS	42		172								
173.4	Sandy Silt to Silty Sand, Some Gravel Trace Clay Very Dense		6	SS	70		170							2 74 20 4	
7.2			7	SS	94		168								
			8	SS	60/	8 cm	166								18 48 28 5
			9	SS	70/	15 cm	164								
			10	SS	90/	10 cm	162								12 46 37 5
			11	SS	100/	15 cm	160								
160.8	Weathered Red Shale														
19.8															
159.2			12	SS	100/	8 cm								10 15 52 23	
21.4	End of Borehole														
	Note: No Groundwater Level Measurements Were Carried Out.														

+³, ×⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 9

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 735.6; E 286 548.0 ORIGINATED BY JH
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger (S.A.) & Cone Test COMPILED BY JH
DATUM Geodetic DATE 1982 11 04 and 05 CHECKED BY *so*

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					
180.1	Ground Level						180							GR SA SI CL
0.0	Heterogeneous Mixture of Silty Clay, Sand, Gravel (Glacial Till) Very Stiff to Hard		1	SS	26		178							5 27 46 22
			2	SS	70		176							8 30 43 19
			3	SS	36		174							17 22 45 16
			4	SS	41		172							
			5	SS	46		170							17 26 43 14
			6	SS	97		168							3 27 64 6
169.1	Sandy Silt to Silty Sand, Trace Gravel, Clay Very Dense		7	SS	60/	15 cm	166							10 48 37 5
11.0			8	SS	71/	15 cm	164							
			9	SS	62/	15 cm	162							
160.3	Weathered Red Shale		10	SS	60/	3 cm	160							
19.8			11	SS	60/	3 cm								
158.7	End of Borehole		10	SS	60/	3 cm								
21.4			11	SS	60/	3 cm								

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 10

METRIC

W P 197-77-17 LOCATION Co-ords. N 4 820 692 E 286 564 ORIGINATED BY SO
DIST 4 HWY 403 BOREHOLE TYPE Cont. Flight Auger COMPILED BY SO
DATUM Geodetic DATE 83 02 16 CHECKED BY SO

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 (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	VALUES		20	40	60	80	100					
180.8	Ground Level															
0.0																
	Heterogeneous Mixture of Silty Clay, Sand and Gravel (glacial till)		1	SS	31											
			2	SS	36											
			3	SS	56											
			4	SS	94											
	Very Stiff to Hard		5	SS	64											
			6	SS	54											
			7	SS	62											
			8	SS	120/	25 cm										
			9	SS	130/	25 cm										
172.8			10	SS	63											
8.0	End of Borehole															

OFFICE REPORT ON SOIL EXPLORATION

METRIC

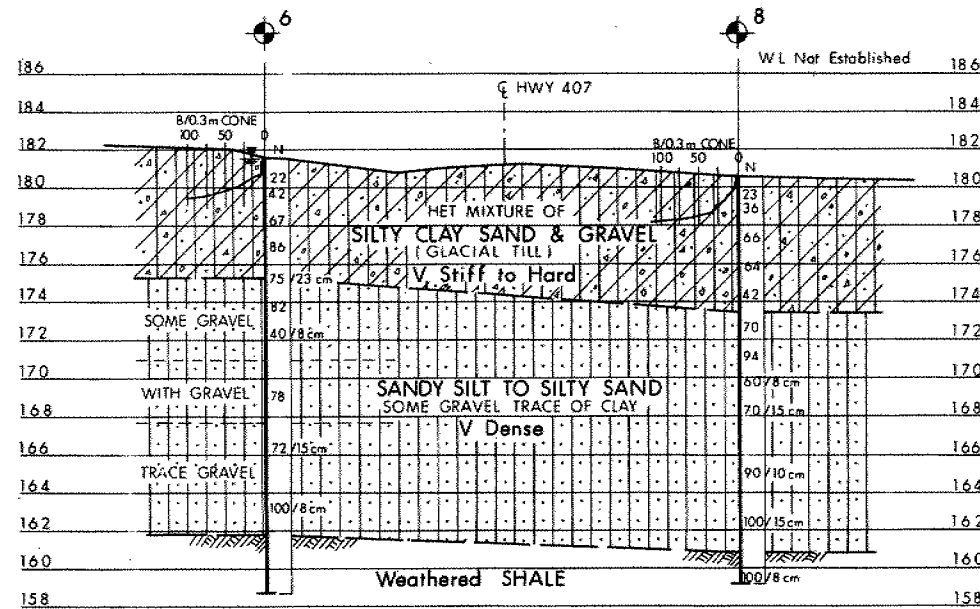
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 197-77-17

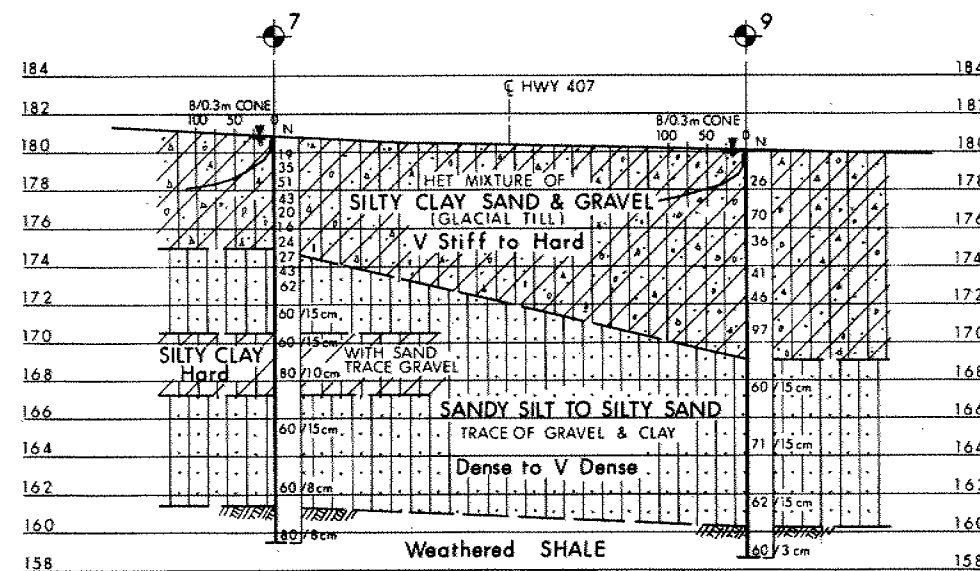


SHEET

BORE HOLE LOCATIONS & SOIL STRATA



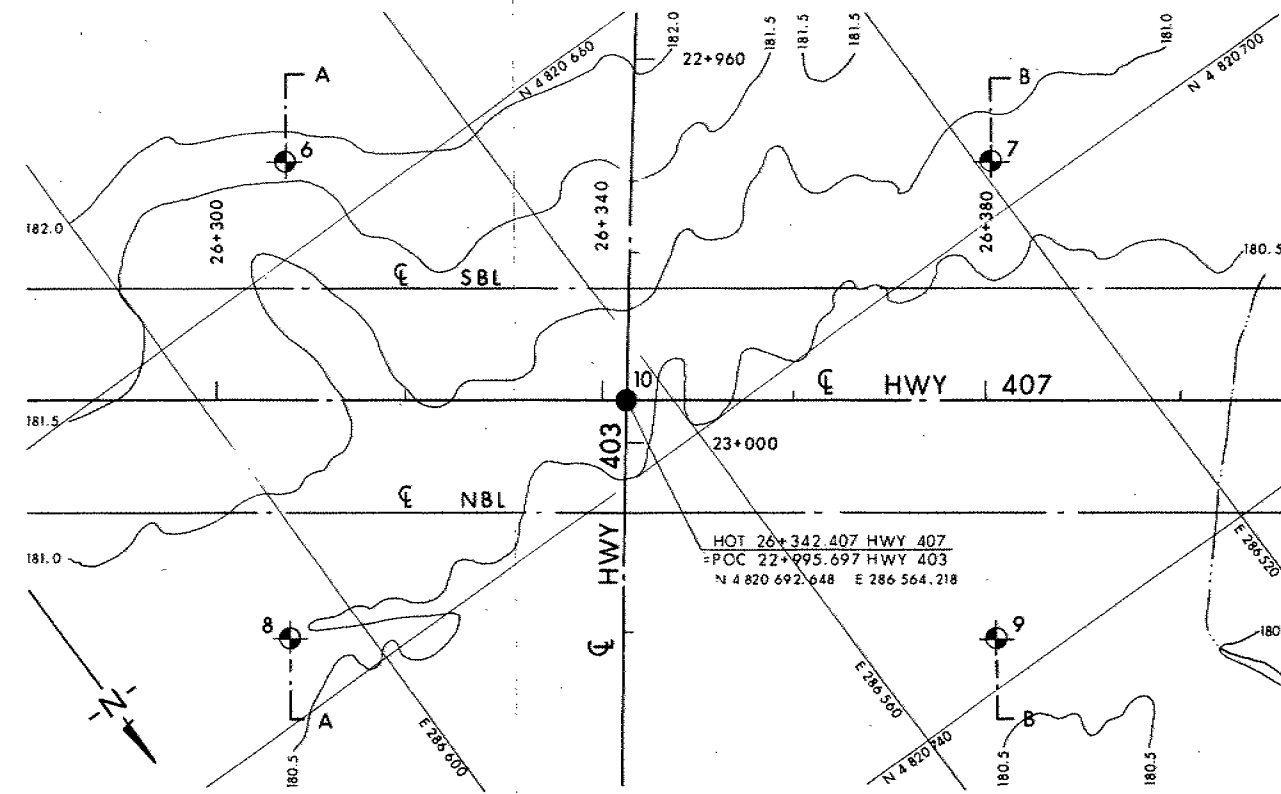
A-A



B-B

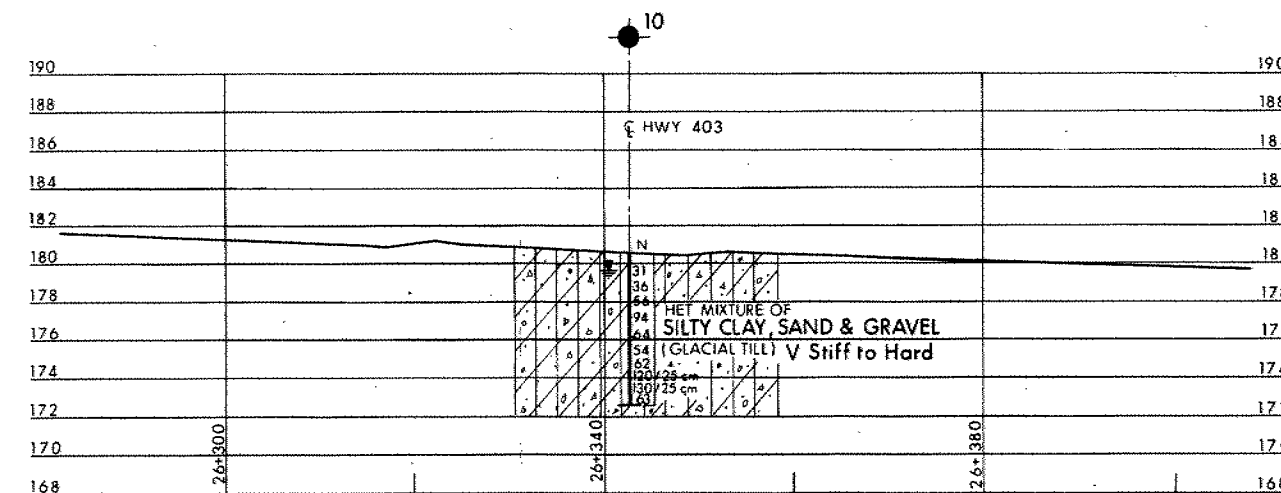
SECTIONS

SCALE
HORIZ: 8m 4 0 8m
VERT: 4m 2 0 4m



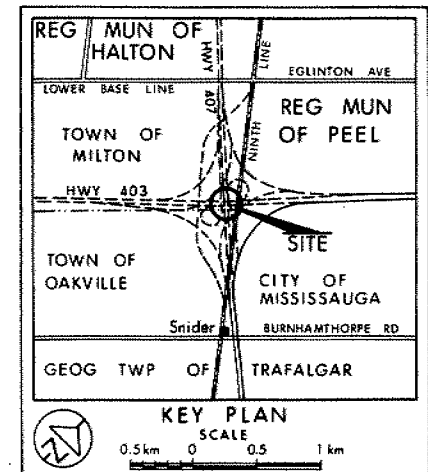
PLAN

SCALE
8m 4 0 8m



PROFILE HWY 407

SCALE
HORIZ: 8m 4 0 8m
VERT: 4m 2 0 4m



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 8211 & 8302
- WL Not Established in BH 8

No	ELEVATION	CO-ORDINATES NORTH	EAST
6	181.6	4 820 651.8	286 577.9
7	180.9	4 820 695.2	286 518.5
8	180.6	4 820 692.5	286 607.3
9	180.1	4 820 735.6	286 548.0
10	180.8	4 820 692.0	286 564.0

NOTE

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

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

REV	DATE	BY	DESCRIPTION
1	83 10	SO	BORE HOLE TO BE ADDED

Geocres No 30M12-170

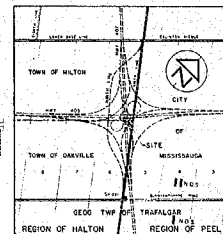
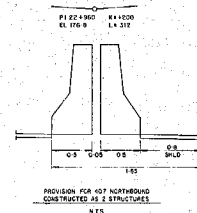
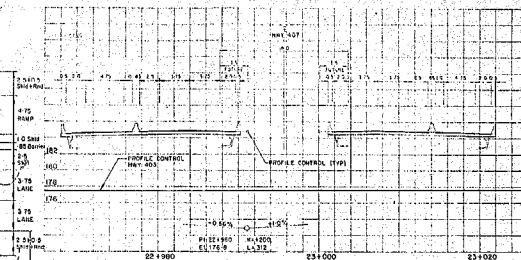
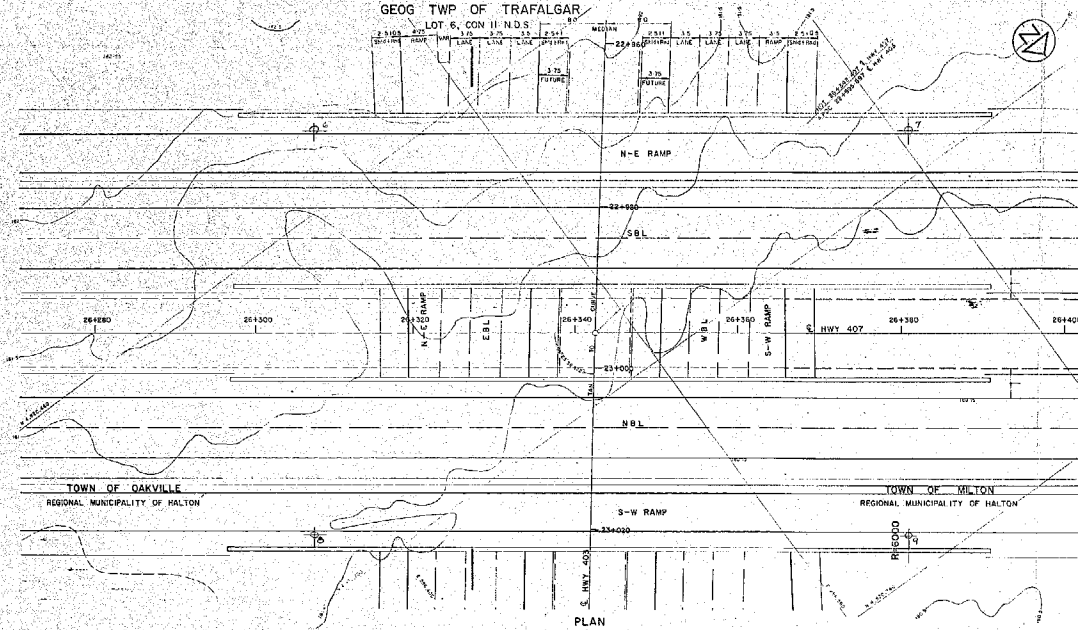
HWY No 407 & 403	CHECKED	DATE 82 12 14	DIST 4
SUBM'D PP	CHECKED	DATE 82 12 14	SITE 10-82-326
DRAWN SO	CHECKED	DATE 82 12 14	DWG

GEOG TWP OF TRAFALGAR

LOT 6, CON II N.D.S.

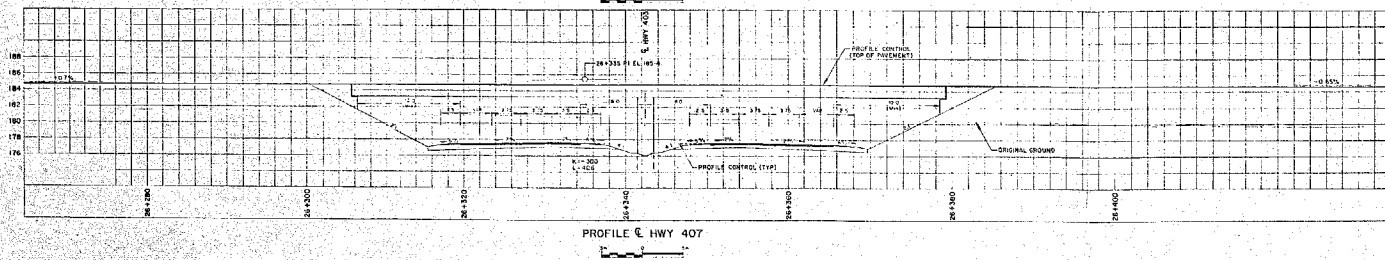
METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



KEY PLAN
SCALE 1:10,000

PRELIMINARY ONLY
Nov 30/82



PROFILE C HWY 407

DATE	REVISIONS AND ADDITIONS
BRIDGE SITE PLAN	
PROPOSED CROSSING	
KING'S HIGHWAY 407	
AND	
KING'S HIGHWAY 403	
LOT 6 GEORG TWP OF TRAFALGAR	CON 2 N.D.S. REGION OF HALTON
SCALE AS SHOWN	DISTRICT 4-HAMILTON
W.P.N.D. 197-77-02	REVISION CENTRAL
SURVEY JUNE 1981	PLAN B-62-403-12
SITE 10-62-326	PLAN E-