

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M5-148

DIST. 4 REGION

W.P. No. 199-77-13

CONT. No. 91-22

W. O. No.

STR. SITE No. 10-1337-340

HWY. No. 403

LOCATION Brant St. Underpass

No. of PAGES -

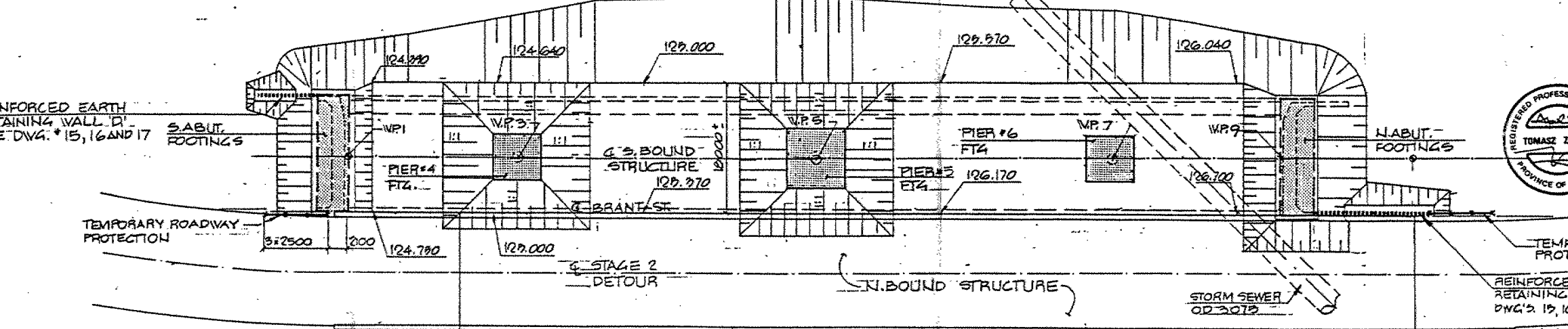
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

- ## 2) STAGE 2

- ## NOTES

1. MATERIAL SPECIFICATIONS:
  - STRUCTURAL STEEL TO CSA CAN 640.21M 300W.
  - SOLDIER PILES TO CAN3-640.21M-WITH 300 MPa YIELD STRENGTH, TYPE W.
  - CONCRETE IN ENCASEMENT OF SOLDIER PILES 30 MPa.
  - TIMBER LAGGING SHALL BE NEW, DOUGLAS FIR CONSTRUCTION GRADE, DIMENSION GIVEN IS ACTUAL SIZE REQUIRED.
2. NO WALERS SHALL BE REMOVED UNTIL EXCAVATION IS BACKFILLED 2.2 m OVER THE TOP OF FOOTINGS.
3. MACHINE EXCAVATION SHALL NOT BE CARRIED OUT CLOSER THAN 300 m FROM THE FACE OF SOLDIER PILES.
4. WELDING IS TO BE CARRIED OUT IN ACCORDANCE WITH CSA W59-M1984.
5. ALL DIMENSIONS MUST BE VERIFIED BY THE CONTRACTOR BEFORE PROCEEDING WITH THE WORK.
6. ALL MATERIALS FOR ROADWAY PROTECTION TO BE SUPPLIED, PLACED, FABRICATED AND REMOVED BY THE CONTRACTOR.
7. REMOVE WALERS. CUT SOLDIER PILES MINIMUM 700 mm BELOW THE TOP OF PAVEMENT AND MINIMUM 500 mm BELOW FINISH GRADE. REMOVE TIMBER LAGGING AS DEEP AS POSSIBLE. (SUBJECT TO APPROVAL BY THE ENGINEER).
8. EMPLOY ALL NECESSARY PROTECTION SCHEMES FOR ENSURING INTEGRITY AND STABILITY OF EMBANKMENTS AND STRUCTURES IN THE VICINITY.
9. SOLDIER PILE LOADING - AFTER CONCRETE STRENGTH IN ENCASEMENT HAS REACHED 20 MPa.
10. MAINTAIN SOIL STABILITY IN THE PIERS 3,6 AND NORTH ABUTMENTS AREA DURING STORM SEWER INSTALLATION.



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	4 MAR 91 J.J. SOLDIER PILES FOR PIER #6 (CHANGES IN STORM SEWER)					
	DATE	BY	DESCRIPTION			
DESIGN	J.J.	CHK	T.Z.	CODE	LOAD C. A	DATE APR 1990
DRAWN	C.G.	CHK	J.J.	SITE 10-1337-340	STRUCT	SCHEME DWG. 3

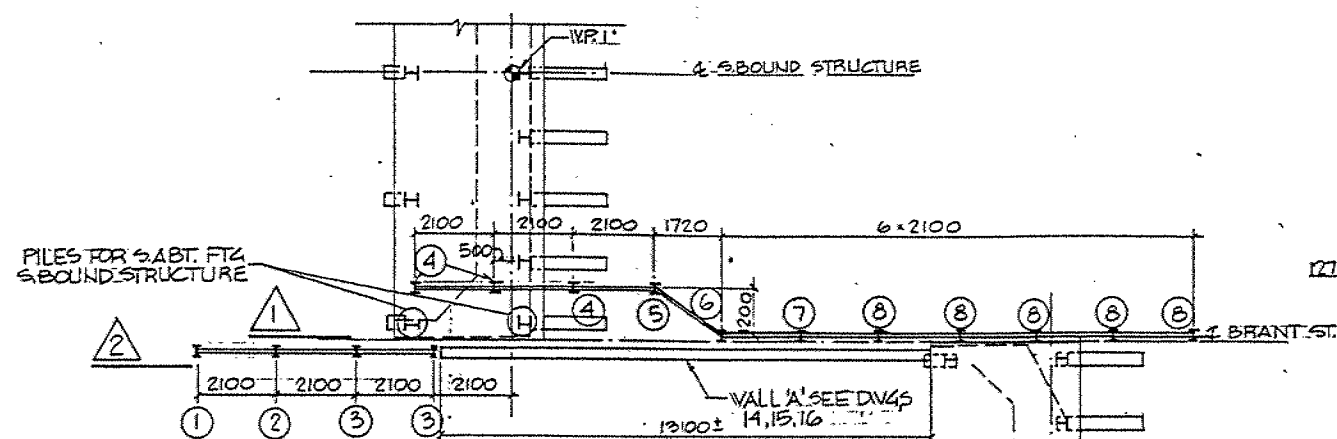
# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

DIST No 4  
CONT No 91-22  
WP No 199-77-13

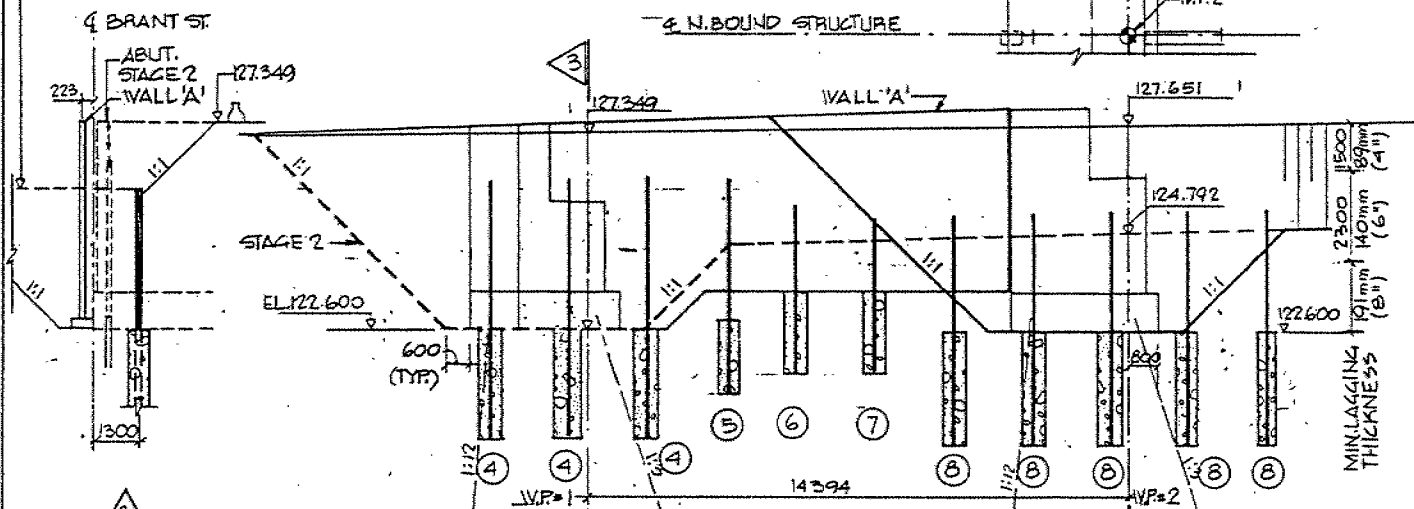
HWY 403 - BRANT STREET  
UNDERPASS  
TEMPORARY ROADWAY  
PROTECTION II

SHEET  
227

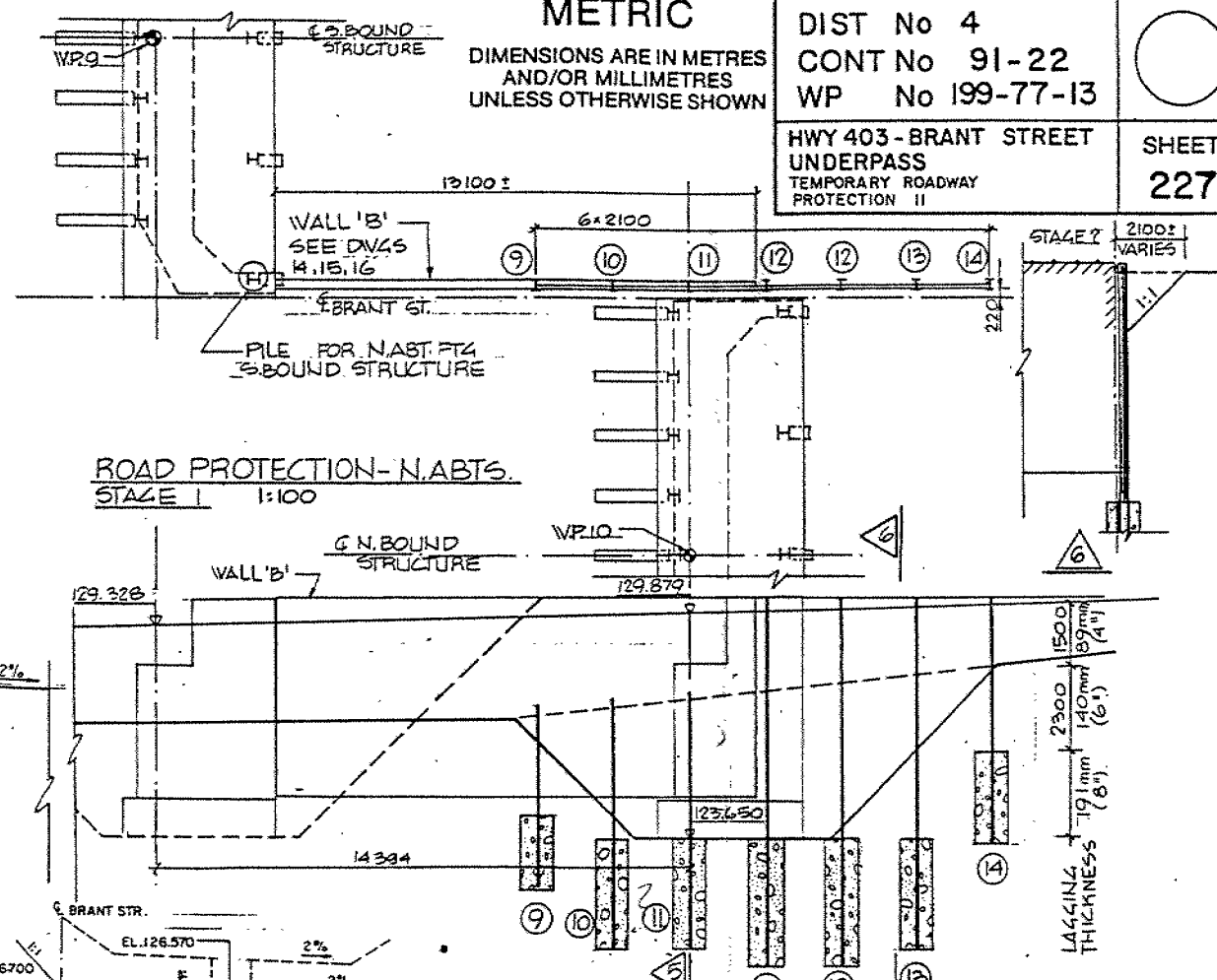


## ROAD PROTECTION - S.ABTS. STAGE 1 1:100

126.300±  
PILE DRIVING ELEV.  
FOR S.B. STRUCT. - STAGE 1



## ROAD PROTECTION - N.ABTS. STAGE 1 1:100



NOTE:  
THIS DWG. TO BE READ IN  
CONJUNCTION WITH DWG'S 14, 15, 16.

**Wyllie & Ufnal**  
consulting engineers

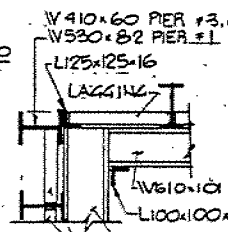
## SOLDIER PILES INFORMATION

PILE NO.	LOCATION	TYPE	RCE	LENGTH (mm)	ENCASEMENT DIA (mm)	ENCASEMENT HEIGHT (mm)	PILE CUT OF ELEV. (m)	PILE TIP ELEV. (m)
1	S.ABUT.	W410x85	1	5000	750	2200	128.000	123.000
2		W410x85	1	8300	750	3000	128.000	119.700
3		W610x155	2	9000	900	3500	128.000	119.000
4		W610x155	3	7300	750	3000	126.300	119.000
5		W410x85	1	5900	750	2200	126.300	120.400
6		W410x85	1	4900	750	2200	126.000	121.100
7		W410x85	1	4500	750	2200	125.450	120.950
8		W610x155	5	6700	900	3000	125.700	119.000
9	N.ABUT.	W410x85	1	5300	900	2000	127.500	122.200
10		W610x155	1	7400	900	3000	127.700	120.300
11		W610x155	1	7400	900	3000	127.900	120.500
12		W610x155	2	10200	900	3500	130.500	120.300
13		W610x155	1	9300	900	3000	130.600	121.300
14		W410x85	1	7500	750	2500	130.700	123.700
15	PIER 2	W530x82	6	9700	900	1800	126.600	116.900
16		W530x82	14	9400	750	1500	126.400	117.000
17	PIER 1 & 3	W530x82	5	8800	750	1800	125.600	116.800
18		W410x60	14	8700	750	1200	126.800	118.100
17	PIER 5	W410x60	5	9000	750	1200	126.300	117.300
18		W410x60	14	9000	750	1200	126.300	117.300

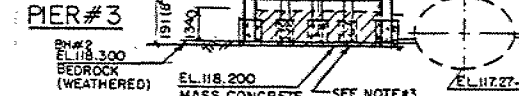
- NOTES:
1. INSTALL WALLS WHEN EXCAVATION IS 300mm BELOW ITS INSTALLATION LEVEL.
  2. REMOVE WALLER WHEN MASS CONCRETE STRENGTH IS MINIMUM 15 MPa.
  3. REMOVE PART OF CONCRETE ENCASMENT TO INSTALL LAGGING (TYR).



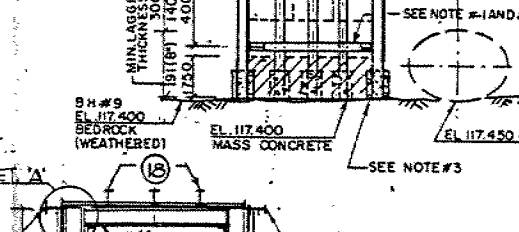
## SECTION 9



DET. 'A' (NTS)  
PIER #1  
PIER #3  
PIER #6  
SECTION 10  
1:100



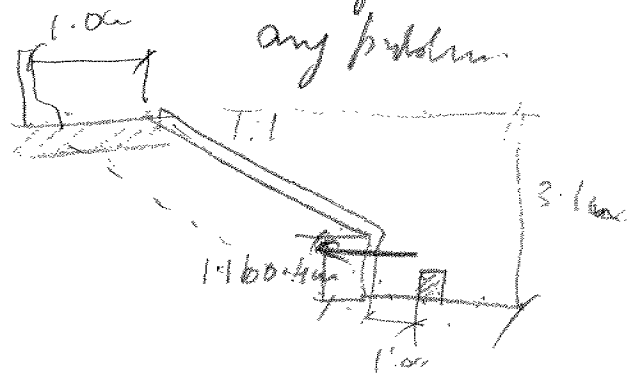
## PIER #6



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

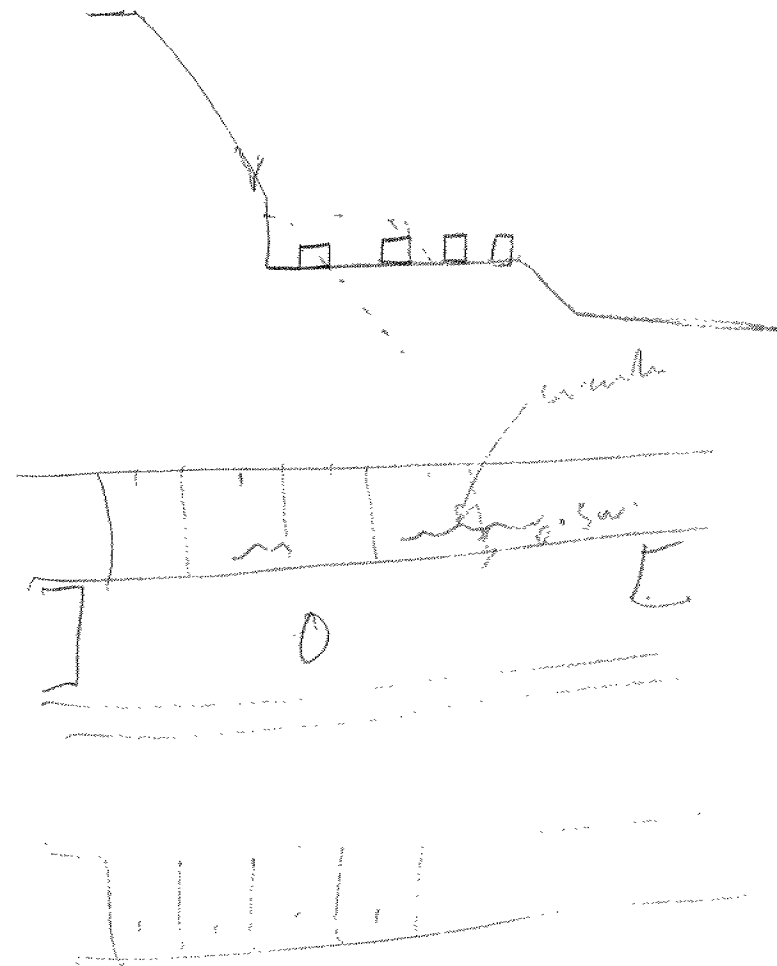
REVISIONS	DATE	BY	DESCRIPTION
1	APR 1990	J.J. MARCHI	SOLDIER PILES FOR PIER #6 (CHANGES IN STORM SEWER)
2		J.J. MARCHI	CHK T.2. CODE OHBDC-83. LOAD CL. 'A'
3		D.G. DRAWN	CHK J.J. SITE 10-1337-3405 STRUCT. SCHEME DWG. 4

This cut 1:1 slope is  
 there for last 3 m but without  
 any problem



Dong feels this  
 arrangement is better.

There are few cracks  
 close to the center line  
 at a distance of  
 about 0.5m from the  
 vertical face.



# METRIC

DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

DIST No 4  
CONT No 91-22  
WP No 199-77-13

HWY 403-BRANT STREET  
UNDERPASS  
GENERAL ARRANGEMENT

SHEET  
224

**Wyllie & Ufnal**  
consulting engineers

## GENERAL NOTES:

### 1. CLASS OF CONCRETE

.PRESTRESSED DECKS AND PIERS - 35 MPa.  
.REMAINDER - 30 MPa.

### 2. CLASS COVER TO REINFORCING STEEL

.FOOTINGS 100 ± 25 mm.  
.PIERS, ABUTMENTS AND WINGWALLS FRONT SURFACES 80 ± 20 mm.  
.ABUTMENTS AND WINGWALLS BACK SURFACES 70 ± 20 mm.  
.DECK TOP 70 ± 20 mm.  
.DECK BOTTOM 50 ± 10 mm.  
.REMAINDER, UNLESS OTHERWISE NOTED 70 ± 20 mm.

### 3. REINFORCING STEEL

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

### 4. CONSTRUCTION NOTES

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

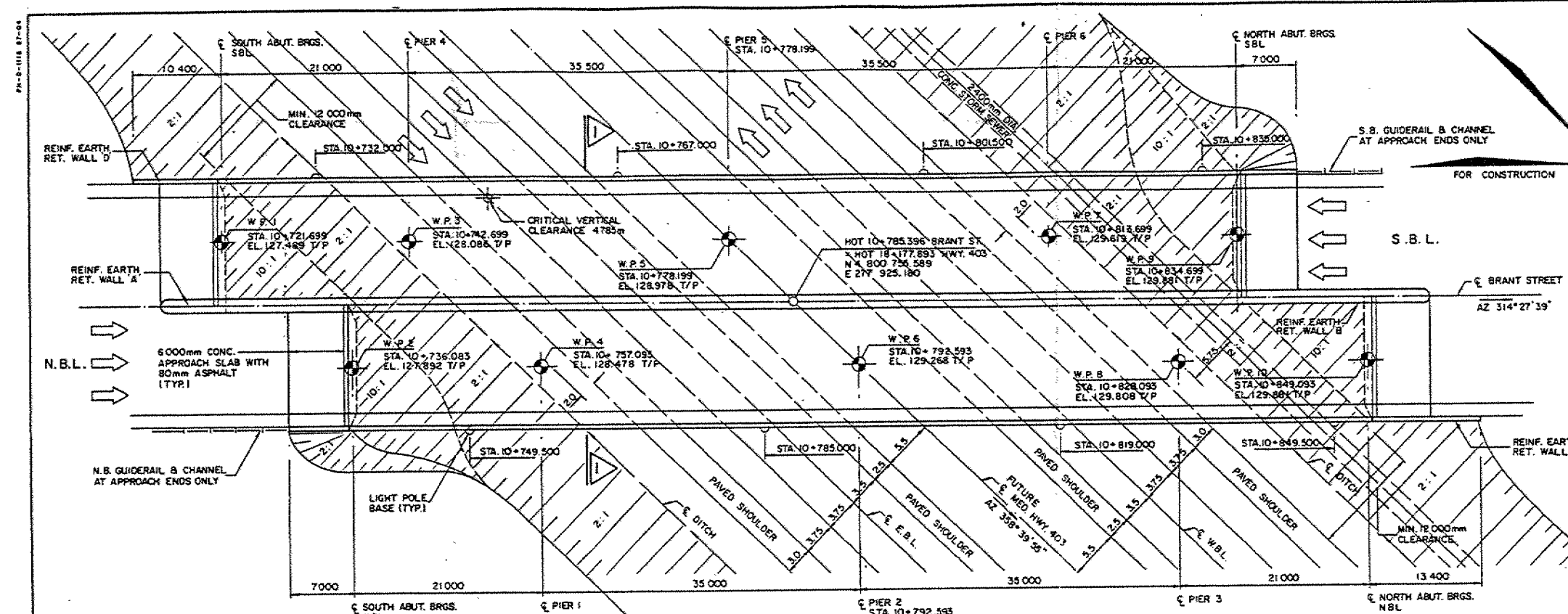
### LIST OF DRAWINGS

1. GENERAL ARRANGEMENT
2. BORE HOLE LOCATIONS AND SOIL STRATA
3. TEMPORARY ROADWAY PROTECTION - I
4. TEMPORARY ROADWAY PROTECTION - II
5. FOOTING LAYOUT
6. ABUTMENT FOOTING DETAILS
7. PIER FOOTING DETAILS
8. NORTH ABUTMENT - NBL
9. SOUTH ABUTMENT - NBL
10. NORTH ABUTMENT - SBL
11. SOUTH ABUTMENT - SBL
12. WINGWALL DETAILS - I
13. WINGWALL DETAILS - II
14. WINGWALL DETAILS - III
15. REINFORCED EARTH RETAINING WALLS - PLAN, SECTIONS & DETAILS
16. REINFORCED EARTH RETAINING WALLS - ELEVATIONS & DETAILS
17. REINFORCED EARTH RETAINING WALLS - TYPICAL DETAILS
18. PIER DETAILS
19. DECK LAYOUT
20. LONGITUDINAL TENDON DETAILS - I
21. TRANSVERSE TENDON DETAILS - I
22. TRANSVERSE TENDON DETAILS - II
23. DECK REINFORCING - I
24. DECK REINFORCING - II
25. DECK REINFORCING - III
26. REINFORCING DETAILS
27. BEARING DETAILS
28. 6000 mm APPROACH SLABS - NBL
29. 6000 mm APPROACH SLABS - SBL
30. NBL BARRIER WALL ON SIDEWALK
31. SBL BARRIER WALL ON SIDEWALK
32. BARRIER WALLS ON REINFORCED EARTH PANELS
33. MEDIAN CURB ON REINFORCED EARTH PANELS
34. RAILING FOR BARRIER WALL - NBL
35. RAILING FOR BARRIER WALL - SBL
36. JOINT ANCHORAGE AND ARMOURING - NBL
37. JOINT ANCHORAGE AND ARMOURING - SBL
38. AS CONSTRUCTED ELEVATIONS AND DIMENSIONS
39. DETAILS OF CONC. SLOPE PAVING
40. STANDARD DETAILS I
41. STANDARD DETAILS II
42. ELECTRICAL EMBEDDED WORK
43. QUANTITIES
44. QUANTITIES

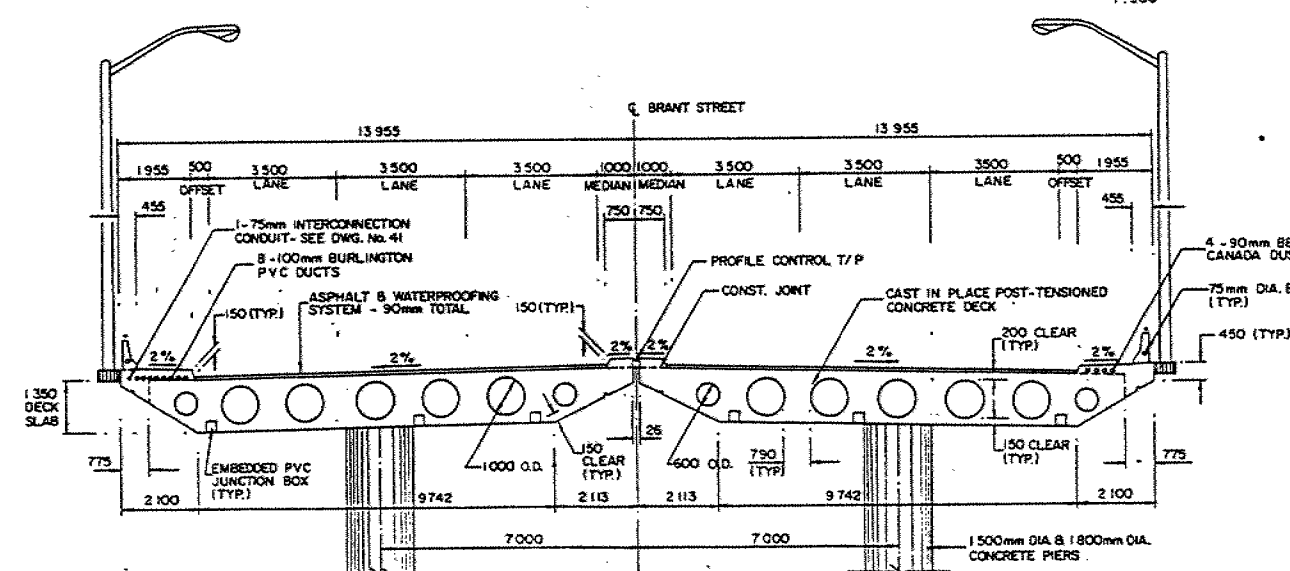
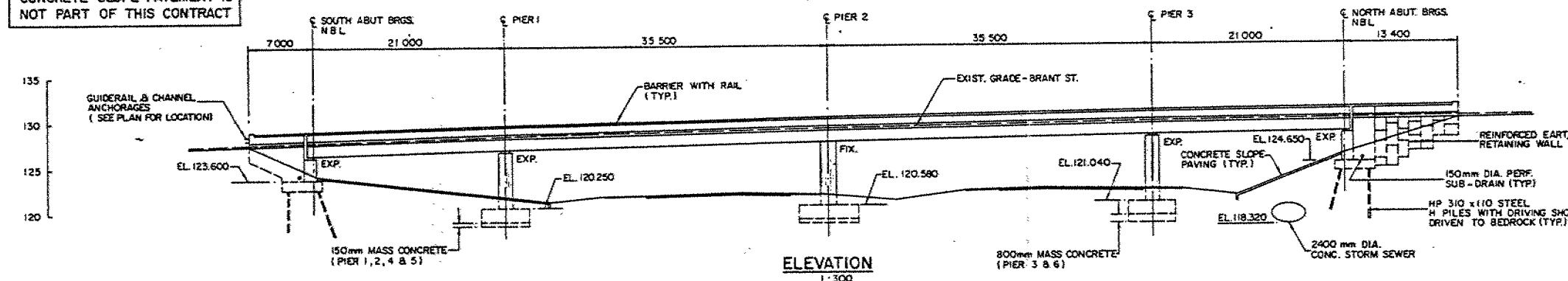


APPLICABLE STANDARD DRAWINGS:  
00-3502 MINIMUM GRANULAR BACKFILL REQUIREMENTS

REVISIONS	DATE	BY	DESCRIPTION



NOTE:  
CONCRETE SLOPE PAVEMENT IS NOT PART OF THIS CONTRACT



BENCH MARK:  
GBM 65U126 EL. 132.945  
PUMPING STA. RES. BLDG. No. 1458 TAB IN N.W. FACE OF RET. WALL 24.4 LT. JO. 964.8 QUA 430795 W LINE 331

SECTION  
1:100

PROFILE OF HWY. 403  
N.T.S.

PROFILE OF BRANT STREET  
N.T.S.

DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

ENGINEERING MATERIALS OFFICE  
FOUNDATION DESIGN SECTION

*CONT 91-22*

WP 199-77-13

DIST 4

HWY 403

STR SITE 10-1337-340

Hwy. 403 - Brant St. Underpass

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T.J. Kovich (Cover Only)

Files

# FOUNDATION INVESTIGATION REPORT

For

Hwy. 403 - Brant St. Underpass

W.P. 199-77-13, Site 10-1337-340

District 4, Burlington

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## INTRODUCTION

This report summarizes the factual information obtained from a foundation investigation performed at the above-mentioned site. Fieldwork consisted of ten sampled boreholes and four dynamic cone penetration tests advanced during the period 85 01 17 to 85 01 28. Bedrock was proven by obtaining up to 3.1 m of rock core in BXL size. Boring depths ranged from 11.6 m to 16.8 m and all borings were advanced utilizing track mounted auger machines.

## SITE DESCRIPTION

The site is located on existing Brant St., in the City of Burlington, Regional Municipality of Halton.

At the future crossing of Hwy. 403 at Brant St. it is proposed to construct a twin cast-in-place 4-span concrete structure which will carry Brant St. over new Hwy. 403.

Brant St. is presently a four-lane urban roadway.

At the proposed crossing, preliminary grading has been carried out along the Hwy. 403 right-of-way both to the east and west of Brant St., with the most significant cut being immediately to the west of the proposed structure.

The site is located in the physiographic region known as the South Slope which is characterized in this area by a ground moraine of limited relief.

The bedrock underlying the site is a red shale with siltstone of the Queenston Formation.

## SUBSURFACE CONDITIONS

### General

The boundaries of the various subsoil types are shown on the Record of Borehole Sheets located in the Appendix. The locations and elevations of the borings, along with an estimated stratigraphic profile based on the borehole data, are shown on Drawing Number 1997713-A. This report must be read in conjunction with the above-noted items.

The subsoil conditions are fairly uniform across the site. Underlying up to 2.7 m of silty clay, some gravel and sand fill, is a heterogeneous mixture of silty clay with varying proportions of sand and gravel, and occasional cobbles and boulders. The site is underlain by a red shale with siltstone of the Queenston Formation.

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

FILL - Silty Clay, some Gravel and Sand

This material was encountered at all borehole locations except numbers 7 and 8. It ranged in thickness from 1.3 m at borehole 9 to 2.7 m at borehole 1. The consistency of this deposit, as determined by Standard Penetration Test 'N' values ranged from firm to very stiff.

Heterogeneous mixture of Silty Clay, Sand and Gravel (Glacial Till)

This is the predominant soil type at the site and was encountered at all borehole locations. It consists of a heterogeneous mixture of silty clay with varying proportions of sand and gravel.

The results of Atterberg Limit and water content testing are plotted on the Plasticity Chart, Figure No. 1, and are summarized as follows:

		Range	Average
Water Content	(W )%	7-23	13
Liquid Limit	(W <sub>L</sub> )%	20-36	26
Plastic Limit	(W <sub>p</sub> )%	13-19	16
Plasticity Index	(I <sub>p</sub> )%	3-18	12

The results of grain size distribution tests are plotted in envelope form on Figure 2 of the Appendix.

Standard Penetration 'N' values ranged from 16 to over 100 blows per 0.3 m penetration which indicates that the consistency of this deposit ranges from very stiff to hard. Occasional cobbles and boulders were encountered throughout the deposit.

Bedrock

Bedrock was proven by obtaining up to 3.1 m of rock core in BXL size. The bedrock was encountered at depths ranging from 11.5 m to 13.8 m.



The bedrock at this site is from the Queenston Formation and consists of red shales with interbedded siltstone. The upper 1 m to 2 m of the shale is in a highly weathered condition with alternating layers of broken rock and a red silty clay material.

A detailed description of the rock cores was prepared by Mr. E. Magni, Ministry of Transportation and Communications, Geologist and his report is located in the Appendix.

#### Groundwater

The groundwater was found at various elevations across the site. However, the true groundwater elevation is believed to be controlled by the Highway 403 advance cut just to the southwest of the site and is assumed to be at or below elevation 122 ± m.

## DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a twin cast-in-place 4-span concrete structure to carry existing Brant St. over the proposed Highway 403 in the City of Burlington. It is understood that the abutments will be built square because of the extreme skew, thereby necessitating offsets between the north bound and south bound structures.

General recommendations which are applicable to all foundations for these structures are given below. The recommendations which lead to the most economical design should be adopted.

### GENERAL RECOMMENDATIONS

#### Earth Pressure Calculations

Backfill to structures should consist of Granular 'A' or 'B' in accordance with Standard Special Provision No. 121 dated October, 1983. Earth pressures should be computed in accordance with Section 6.6.1.2.1 of the O.H.B.D.C. The recommended foundations for the abutments are considered to be non-yielding and the at rest condition ( $K_0$ ) applies. For design purposes, the physical properties of the backfill material are as follows:

MATERIAL	$\theta$	UNIT WEIGHT ( $\gamma$ )
Granular 'A'	35	22.8 kN/m <sup>3</sup>
Granular 'B'	30	21.2 kN/m <sup>3</sup>

#### Settlements

Total and differential settlements should not exceed 25 mm for footings designed in accordance with the recommendations given in this report.

#### Slope Stability

The construction of Highway 403 will necessitate cuts of up to 10 m. No stability problems are anticipated for cuts of this depth with slopes of 2 horizontal to 1 vertical.

#### Frost Protection

The minimum cover requirement for frost protection is 1.2 m.

#### Dewatering

Dewatering is not anticipated to be a major problem. It is expected that water entering into footing excavations can be controlled by pumping from corner sumps.

### Footing Excavations

Excavations in bedrock may be accomplished without blasting techniques.

All soft or loose material at the base of the proposed footing locations should be removed and the base of the excavation should be covered with a 15 cm pad of mass concrete within 12 hours of exposure.

### Resistance to Lateral Forces

For design purposes, the following unfactored friction coefficients may be assumed to apply between the base of the footing and the founding stratum.

Overburden	$\tan 22^\circ$
Weathered Shale Bedrock	$\tan 22^\circ$
Sound Shale Bedrock	$\tan 25^\circ$

If lateral resistance in addition to that provided by friction is required, a key should be cut into the sound shale bedrock below the footing. The minimum depth should be 0.5 m. Provided that concrete is placed against the "undisturbed" rock face, then the key should provide a resisting pressure of 1.0 MPa.

## STRUCTURE FOUNDATIONS

### ABUTMENTS

All abutments for this structure should be supported on steel H-piles driven to shale bedrock. The following O.H.B.D.C. parameters are recommended:

	Factored Capacity at U.L.S. (kN)	Capacity at S.L.S. Type II (kN)
HP 310 x 110	1600	1150

The piles should be equipped with standard tip reinforcement. To facilitate pile driving, the fill material through which piles will be driven should be restricted to a maximum size of 75 mm.

The hammer should be capable of providing a minimum driving energy of 50,000 J/blow.

For design purposes, it is estimated that the piles will attain their recommended design capacities at the following elevations:

UNIT	ELEVATION (m)
NB North Abutment	116
NB South Abutment	114
SB North Abutment	116
SB South Abutment	115

### PIERS

#### Alternative 1 - Spread Footings on Hard Silty Clay

All of the piers may be supported on spread footings placed on the hard silty clay overburden. In this case a value of 750 kPa may be used for the factored bearing capacity at U.L.S. The bearing capacity at S.L.S. Type II will not govern the design. The following founding elevations are recommended:

UNIT	APPLICABLE BOREHOLE	ELEVATION (m)
3 NB North Pier	2	120.5
2 NB Centre Pier	3	120.0
1 NB South Pier	4	119.0
6 SB North Pier	9	120.0
5 SB Centre Pier	8	119.0
4 SB South Pier	7	119.8

#### Alternative 2 - Spread Footings on Weathered Shale

As an alternative, the piers may be founded on spread footings placed on weathered shale bedrock. In this case a value of 1000 kPa may be used for the factored bearing capacity at U.L.S. The bearing capacity at S.L.S. Type II will not govern the design. The following founding elevations are recommended:

UNIT	APPLICABLE BOREHOLE	ELEVATION (m)
NB North Pier	2	118.3
NB Centre Pier	3	117.8
NB South Pier	4	116.5
SB North Pier	9	117.4
SB Centre Pier	8	117.6
SB South Pier	7	116.5

Alternative 3 - Spread Footings on Sound Shale Bedrock

All of the piers may be founded on spread footings placed on sound shale bedrock. In this case, a value of 1500 kPa may be used for the factored bearing capacity at U.L.S. The bearing capacity at S.L.S. Type II will not govern the design. The following founding elevations are recommended:

UNIT	APPLICABLE BOREHOLE	ELEVATION (m)
NB North Pier	2	117.1
NB Centre Pier	3	116.0
NB South Pier	4	114.7
SB North Pier	9	115.3
SB Centre Pier	8	116.3
SB South Pier	7	115.4

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Messrs. R. Thomas and D. Graham, Student Specialist Engineers utilizing equipment owned and operated by Atcost Soil Drilling, Concord and Dominion Soil Investigation Ltd., Scarborough. This report was written by Mr. B. Ruck, Project Foundations Engineer and reviewed by Mr. K. Selby, Chief Foundations Engineer, (West).



*Brian Ruck*

B. E. Ruck, P. Eng.  
Project Foundations Engineer

*K. G. Selby*

K. G. Selby, P. Eng.  
Chief Foundations Engineer  
( West )

## APPENDIX

## 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
$u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	kPa <sup>-1</sup>	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	m <sup>2</sup> /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_f$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

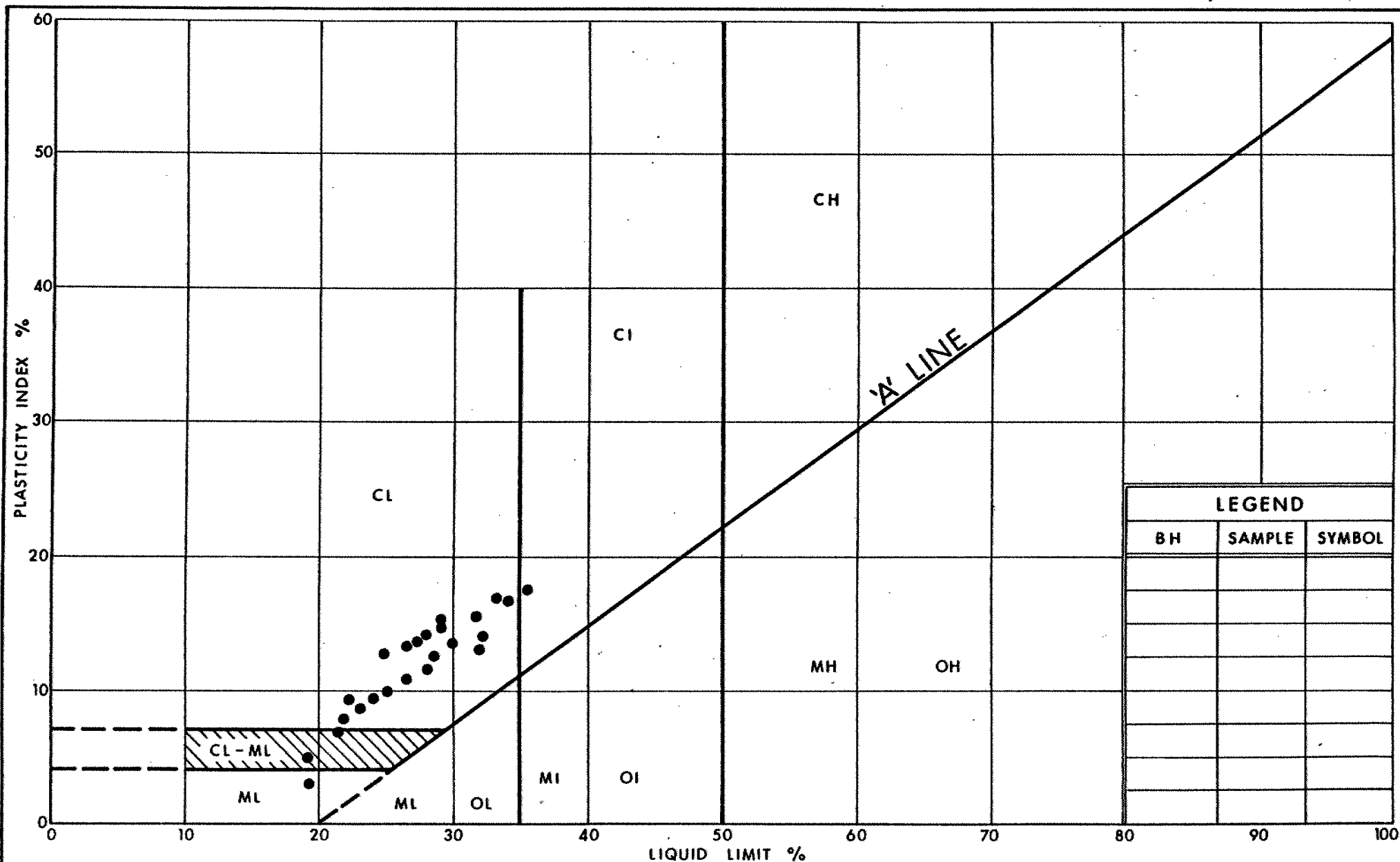
$\rho_s$	kg/m <sup>3</sup>	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	kN/m <sup>3</sup>	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	kg/m <sup>3</sup>	DENSITY OF WATER	w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

# DESCRIPTION OF ROCK CORE - W.P. 199-77-13

BOREHOLE NUMBER				CORE DESCRIPTION	
	DEPTH (m)	% CR*	% RQD*	DEPTH (m)	DESCRIPTION
2	12.31-13.90	85	66	12.31-12.80	Shale (100%), red, moderately weathered, very closely spaced joints
				12.80-12.90	Shale (75%), red, unweathered, medium spaced joints, with siltstone (25%), green, unweathered
4	13.59-15.19 15.19-16.71	97 100	57 100	13.59-13.74	Shale (100%), red, moderately weathered, very closely spaced joints
				13.74-16.71	Shale (80%), red, unweathered, medium spaced joints, with siltstone (20%), green, unweathered, with moderately weathered layer of red shale from 14.05 m - 14.20 m
7	13.64-15.19 15.19-16.71	92 100	73 58	13.64-15.19	Shale (90%), red, unweathered, medium spaced joints, with siltstone (10%), green, unweathered
8	13.56-15.18	100	79	13.64-15.19	Shale (75%), red, unweathered, medium spaced joints, with siltstone (25%), green, unweathered
9	15.19-16.76	90	48	15.19-16.76	Shale (90%), red, unweathered, medium spaced joints, with siltstone (10%), green, unweathered

\* CR= CORE RECOVERY ; RQD = ROCK QUALITY DESIGNATION





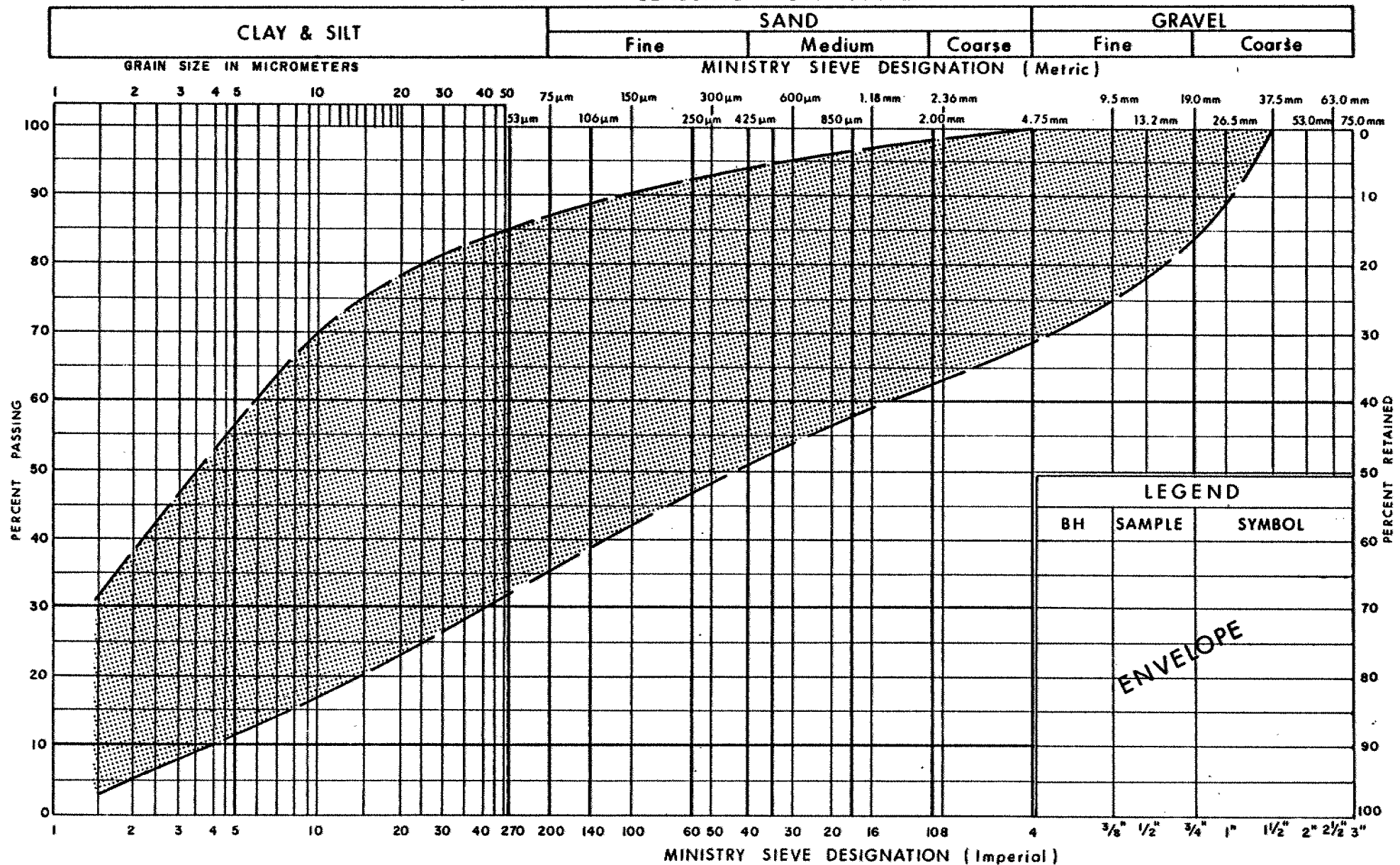
Ministry of  
Transportation and  
Communications

# PLASTICITY CHART HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL (Glacial Till)

FIG No 1

W P 199 - 77 - 13

# UNIFIED SOIL CLASSIFICATION SYSTEM

Ministry of  
Transportation and  
Communications

### GRAIN SIZE DISTRIBUTION

HETEROGENEOUS MIXTURE OF SILTY CLAY, SAND & GRAVEL  
(Glacial Till)

FIG No 2

W P 199-77-13



# RECORD OF BOREHOLE No 1

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 814.5; E 277 884.0 ORIGINATED BY BR  
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY BR  
DATUM Geodetic DATE 85 01 17 CHECKED BY 10

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>		
130.2	Ground Surface												
0.0	Silty Clay Some Gravel and Sand Fill Stiff		1	SS	11		130						21 41 26 11
			2	SS	15		128						
127.5			3	SS	15								
2.7			4	SS	34								
	Heterogeneous Mixture of Silty Clay, Sand and Gravel Hard Glacial Till occasional cobbles and boulders		5	SS	40		126						
			6	SS	70								
			7	SS	33		124						
			8	SS	49		122						
			9	SS	99		120						
			10	SS	100								
118.3			11	SS	100/6 cm		118						
11.9			12	SS	100/5 cm								
116.7	Bedrock Weathered Queenston Shale												25 26 38 11
13.5	End of Borehole						116						

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

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

# RECORD OF BOREHOLE No 2

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 795.0; E 277 903.0 ORIGINATED BY BR  
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger - BXL Rock Coring COMPILED BY BR  
DATUM Geodetic DATE 85 01 18 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
129.9	Ground Surface																
0.0	Silty Clay some sand and gravel Fill Stiff		1	SS	11	*	128										
121.5			2	SS	72		126										
2.4	Heterogeneous Mixture of Silty Clay Sand and Gravel  Hard  Glacial Till  Occasional cobbles and boulders		3	SS	69		124										
			4	SS	35		122										
			5	SS	44		120										
			6	SS	100	28 cm											
			7	SS	100	25 cm											
118.3			8	SS	100	10 cm	118										
11.6	Bedrock  Weathered Sound Queenston Shale		9	BXL RC	REC 85%		116										RQD = 66%
116.0																	
13.9	End of Borehole  * Water Level Not Observed																



# RECORD OF BOREHOLE No 3

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 770.0; E 277 927.5 ORIGINATED BY RT  
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger COMPILED BY BR  
DATUM Geodetic DATE 85 01 21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
129.3	Ground Surface																
0.0	Silty Clay some sand and gravel Fill					*											
126.9	Stiff to Very Stiff		1	SS	16		128										
2.4	Heterogeneous Mixture of Silty Clay Sand and Gravel		2	SS	38		126										
	Hard		3	SS	70		124										
	Glacial Till		4	SS	45		122										
	Occasional cobbles and boulders		5	SS	44		120										
			6	SS	100/23 cm												
117.8			7	SS	100/30 cm		118										
11.5	Bedrock																
117.1	Weathered		8	SS	100/0 cm												
12.2	End of Borehole																
	* Water Level Not Observed						116										

OFFICE REPORT ON SOIL EXPLORATION



# RECORD OF BOREHOLE No 4

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 744.5; E 277 955.0 ORIGINATED BY RT  
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger & BXL Rock Coring COMPILED BY BR  
DATUM Geodetic DATE 85 01 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										WATER CONTENT (%)		
								SHEAR STRENGTH										10 20 30		
128.4	Ground Surface																			
0.0	Silty Clay some sand and gravel Fill Firm		1	SS	8		128													
126.1			2	SS	45		126													
2.3	Heterogeneous Mixture of Silty Clay Sand, and Gravel Very Stiff to Hard Glacial Till		3	SS	62		124													
			4	SS	27		122													
			5	SS	44		120													
			6	SS	100	10 cm	118													
			7	SS	100	13 cm	116									32 26 37 5				
116.5	Bedrock		8	SS	hammer bounding		116													
11.9	Weathered Sound		9	AS			114									RQD = 57%				
	Queenston Shale		10	BXL RC	REC 97%		112									RQD = 100%				
111.7			11	BXL RC	REC 100%		110													
16.7	End of Borehole																			

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

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 5

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 720.0; E 277 977.0 ORIGINATED BY RT  
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger COMPILED BY BR  
DATUM Geodetic DATE 85 01 21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
127.6	Ground Surface																
0.0	Silty Clay some sand and gravel Fill		1	SS	16												
125.4	Very Stiff		2	SS	27												
2.2	Heterogeneous Mixture of Silty Clay Sand and Gravel  Very Stiff to Hard  Glacial Till  Occasional cobbles and boulders		3	SS	34												
			4	SS	55												
			5	SS	61												
			6	SS	41												
			7	SS	19												
			8	SS	43												
			9	SS	1007	18 cm											
			10	SS	1007	23 cm											
115.8			11	SS	1007	0 cm											
11.8			12	AS													
113.9	Bedrock Weathered Queenston Shale																
13.7	End of Borehole																
	* Water Level Observed 2 hours after completion																



# RECORD OF BOREHOLE No 6

METRIC

W P 199-77-13 LOCATION Co-ords. N 4800 693.0; E 277 963.5 ORIGINATED BY DG  
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger COMPILED BY BR  
DATUM Geodetic DATE 85 01 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	100	100	100					
128.1	Ground Surface															
0.0	Silty Clay some sand and gravel Fill		1	SS	16	*	128									
126.4	Very Stiff		2	SS	37		126									
1.7			3	SS	44		126									
			4	SS	25		126									
	Heterogeneous Mixture of Silty Clay Sand and Gravel		5	SS	30		124									
			6	SS	16		124									
	Very Stiff to Hard Glacial Till		7	SS	19		122									
			8	SS	33		120									
			9	SS	100/30 cm		118									
116.4			10	SS	79/23 cm		116									
115.9	Bedrock - Weathered		11	SS	100/5 cm		116									
12.2	End of Borehole						114									
	* Water Level Not Observed															

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10





## METRIC

W P	199-77-13	LOCATION	Co-ords. N 4 800 708.5; E 277 941.5	ORIGINATED BY	RT
DIST	4 HWY 403	BOREHOLE TYPE	Solid Stem Auger & BXL Rock Coring	COMPILED BY	BR
DATUM	Geodetic	DATE	85 01 28	CHECKED BY	CS

[illegible]

+3, x5 : Numbers refer to Sensitivity

15  $\phi$  5 (%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 8

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 735.5; E 277 916.0 ORIGINATED BY RT  
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger & BXL Rock Coring COMPILED BY BR  
DATUM Geodetic DATE 85 01 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
129.9	Ground Surface																
0.0																	
	Heterogeneous Mixture of Silty Clay Sand and Gravel  Very Stiff to Hard  Glacial Till  Occasional cobbles and boulders		1	SS	52		128										
			2	SS	73		126										
			3	SS	36		124										
			4	SS	29		122										
			5	SS	31		120										
			6	SS	75		118										
			7	SS	1007	23 cm	116										
117.6			8	SS	1007	13 cm	114										
12.3	Bedrock																
	Weathered Sound																
114.7	Queenston Shale		9	BXL RC	REC 100%												RQD = 79%
15.2	End of Borehole																
	* Water Level at Completion																

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 9

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 759.0; E 277 892.0 ORIGINATED BY RT  
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger & BXL Rock Coring COMPILED BY BR  
DATUM Geodetic DATE 85 01 24 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH					
130.4	Ground Surface													
0.0	Silty Clay some sand and gravel Fill - Very Stiff		1	SS	21		130							
129.1			2	SS	47									
1.3			3	SS	66		128							
	Heterogeneous Mixture of Silty Clay Sand and Gravel		4	SS	27		126							
	Very Stiff to Hard		5	SS	37		124							
	Glacial Till		6	SS	37		122							
	Occasional cobbles and boulders		7	SS	65		120							
			8	SS	100		118							
117.4			9	SS	100	28 cm	116							
13.0	Bedrock		10	SS	100	8 cm	114							
	Weathered Sound													
113.6	Queenston Shale		11	BXL RC	REC 90%		112							
16.8	End of Borehole													
	* Water Level Upon Completion													

+3, x5 : Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10



# RECORD OF BOREHOLE No 10

METRIC

W P 199-77-13 LOCATION Co-ords. N 4 800 780.5; E 277 871.5 ORIGINATED BY RT  
DIST 4 HWY 403 BOREHOLE TYPE Solid Stem Auger COMPILED BY BR  
DATUM Geodetic DATE 85 01 23 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH									

+3, x5: Numbers refer to  
Sensitivity

20  
15 5 (%) STRAIN AT FAILURE  
10

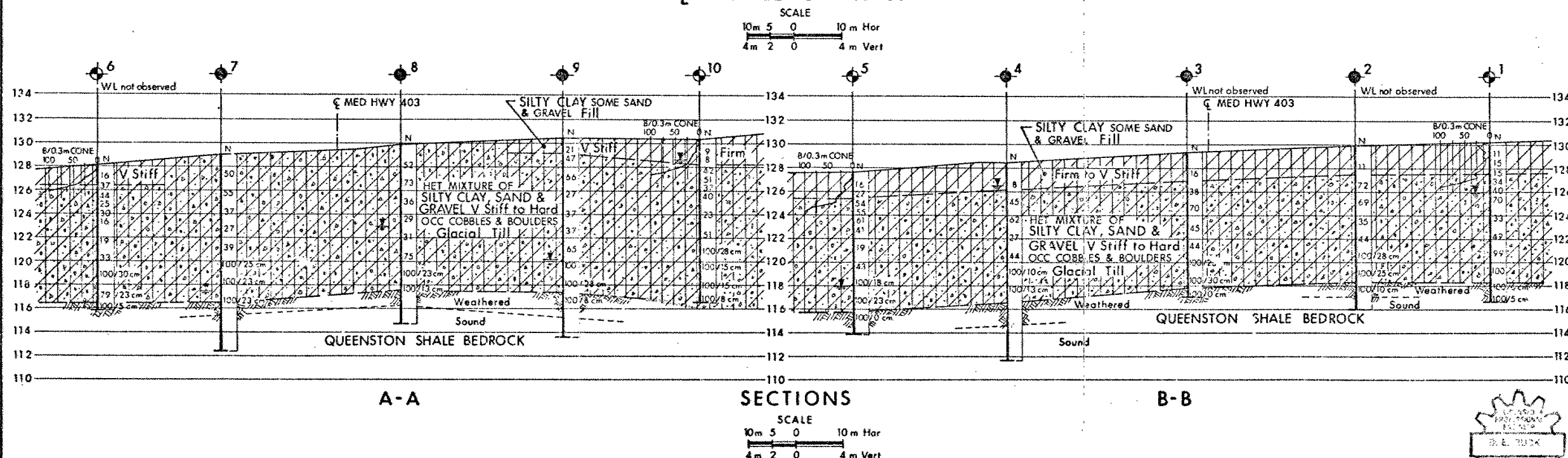
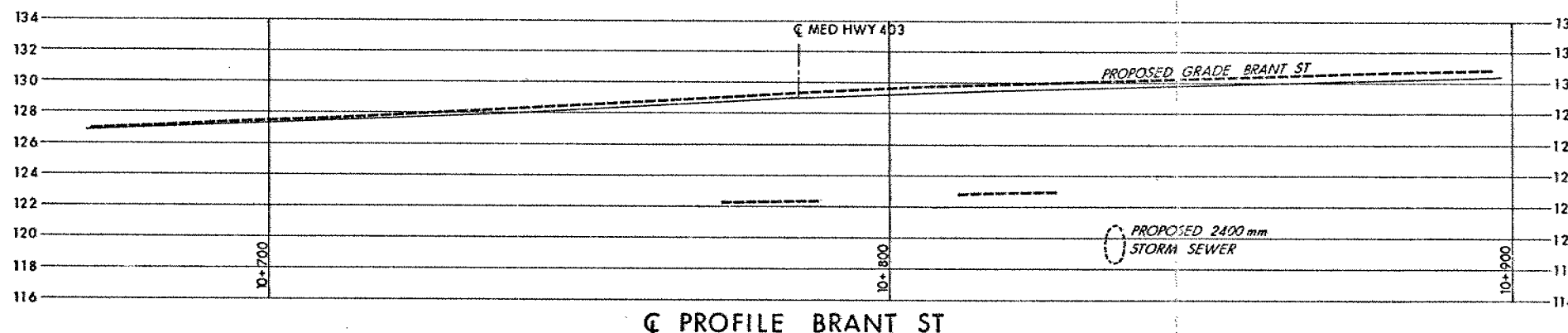
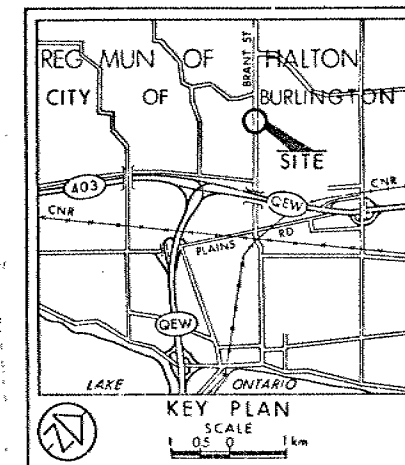
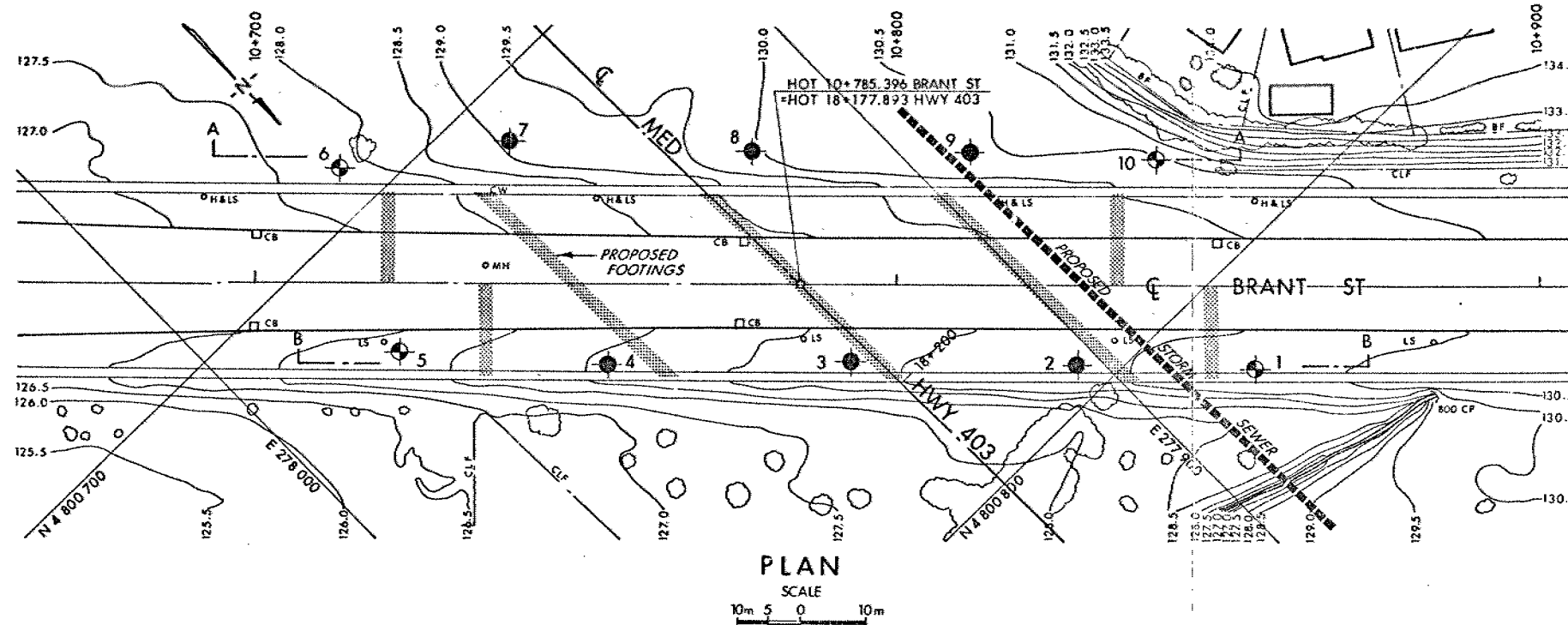
**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES.

CONT No  
WP No 199-77-13

BRANT ST

SHEET

BORE HOLE LOCATIONS & SOIL STRATA



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 85 01
- WL not observed in bore holes 2, 3 & 6

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	130.2	4800814.5	277884.0
2	129.9	4800795.0	277903.0
3	129.3	4800770.0	277927.5
4	128.4	4800744.5	277955.0
5	127.6	4800720.0	277977.0
6	128.1	4800693.0	277963.5
7	129.0	4800708.5	277941.5
8	129.9	4800735.5	277916.0
9	130.4	4800759.0	277892.0
10	130.3	4800780.5	277871.5

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 12.2 of Form 100.

DATE	BY	DESCRIPTION
1985 02 26	DATE	1985 02 26
1985 02 26	DATE	1985 02 26

Geocres No 30M5-148

HWY No 403  
SUBMD BR [CHECKED] DATE 1985 02 26 SITE 10-1337-340  
DRAWN SO [CHECKED] APPROVE DWG 1997713-A

## PIERS

### Alternative 1 - Spread Footings on Hard Silty Clay

All of the piers may be supported on spread footings placed on the hard silty clay overburden. In this case a value of 750 kPa may be used for the factored bearing capacity at U.L.S. The bearing capacity at S.L.S. Type II will not govern the design. The following founding elevations are recommended:

UNIT	APPLICABLE BOREHOLE	ELEVATION (m)
NB North Pier	2	120.5
NB Centre Pier	3	120.0
NB South Pier	4	119.0
SB North Pier	9	120.0
SB Centre Pier	8	119.0
SB South Pier	7	119.8

### Alternative 2 - Spread Footings on Weathered Shale

As an alternative, the piers may be founded on spread footings placed on weathered shale bedrock. In this case a value of 1000 kPa may be used for the factored bearing capacity at U.L.S. The bearing capacity at S.L.S. Type II will not govern the design. The following founding elevations are recommended:

UNIT	APPLICABLE BOREHOLE	ELEVATION (m)
NB North Pier	2	118.3
NB Centre Pier	3	117.8
NB South Pier	4	116.5
SB North Pier	9	117.4
SB Centre Pier	8	117.6
SB South Pier	7	116.5

### Alternative 3 - Spread Footings on Sound Shale Bedrock

All of the piers may be founded on spread footings placed on sound shale bedrock. In this case, a value of 1500 kPa may be used for the factored bearing capacity at U.L.S. The bearing capacity at S.L.S. Type II will not govern the design. The following founding elevations are recommended:

UNIT	APPLICABLE BOREHOLE	ELEVATION (m)
NB North Pier	2	117.1
NB Centre Pier	3	116.0
NB South Pier	4	114.7
SB North Pier	9	115.3
SB Centre Pier	8	116.3
SB South Pier	7	115.4

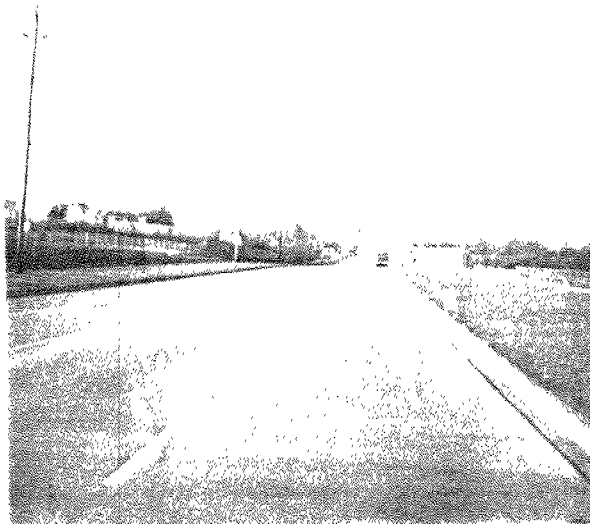
*Brian Ruck*

B. E. Ruck, P.Eng.  
Project Foundations Engineer

c.c. - K. Bassi

HWY. 403 - BRANT ST. UNDERPASS  
SITE 10-1337-340, W.P. 199-77-13  
DISTRICT 4, HAMILTON

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LOOKING NORTH ALONG BRANT ST. AT PROPOSED HWY. 403  
ALIGNMENT.

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