

DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 40PI-76

DIST. 4 REGION

W.P. No. 66-67-04

CONT. No.

W. O. No.

STR. SITE No. 1-191

HWY. No. 403

LOCATION T.H. & B. SUBWAY

No. of PAGES -

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

REMARKS:



METRIC

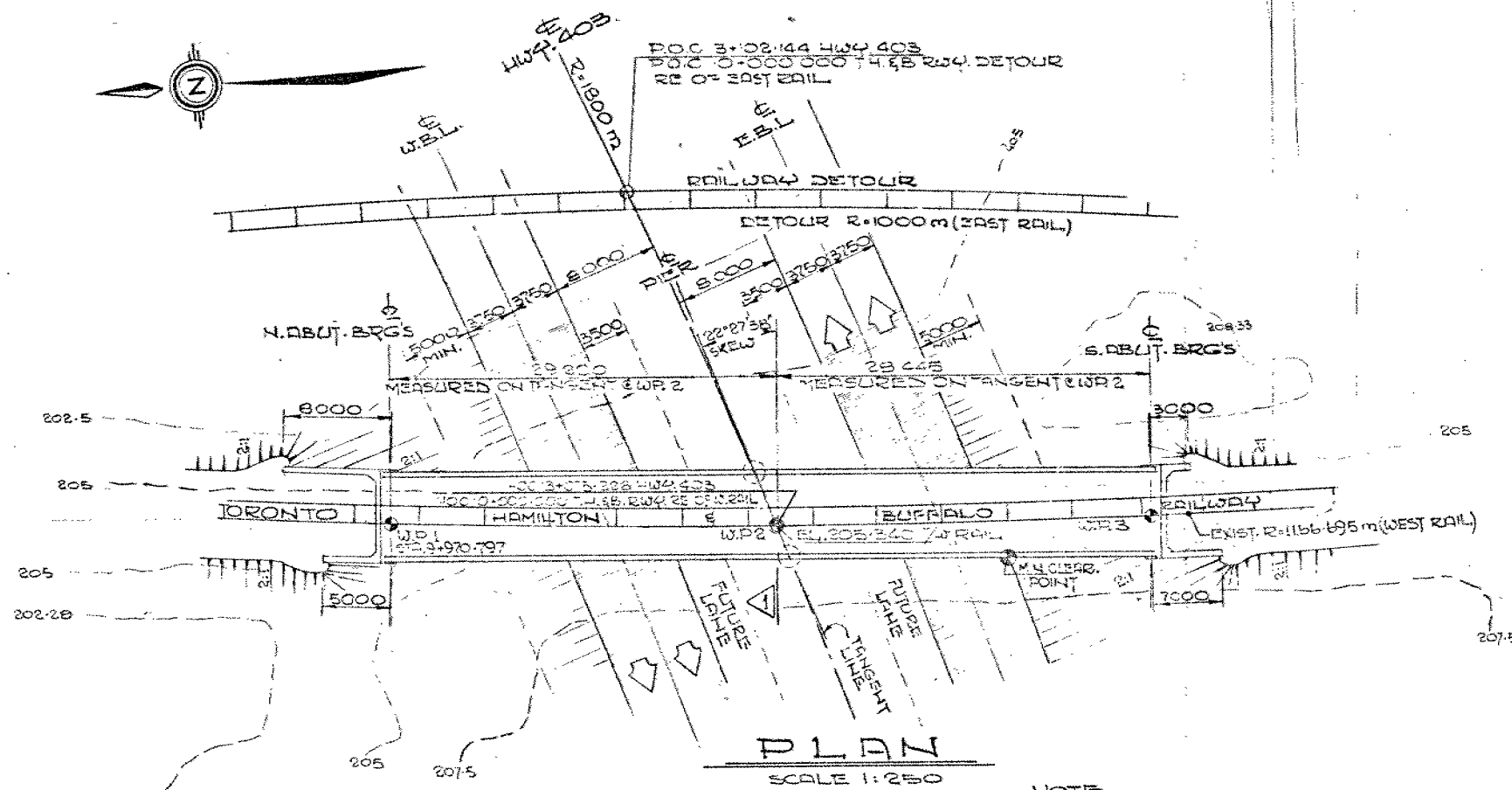
DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

DIST 4
CONT No
WP No 66-67-04

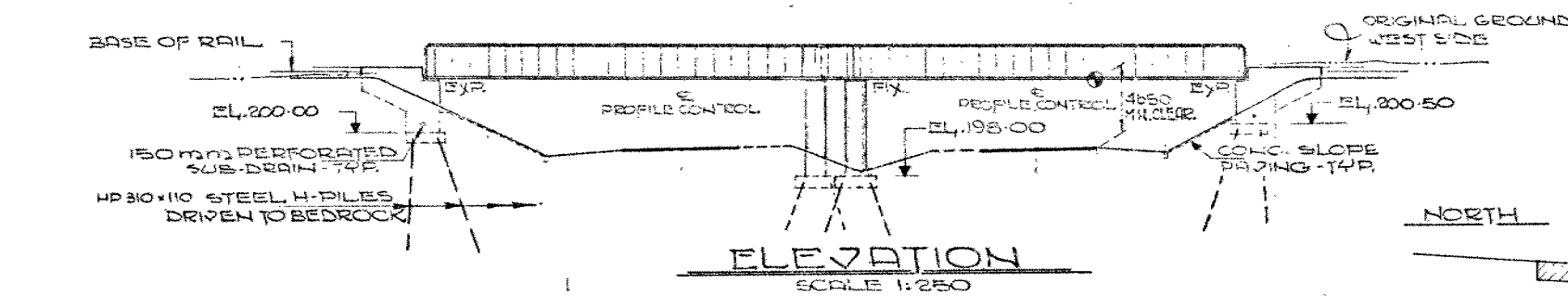
T.H. & B. RWY. SUBWAY

GENERAL LAYOUT

SHEET

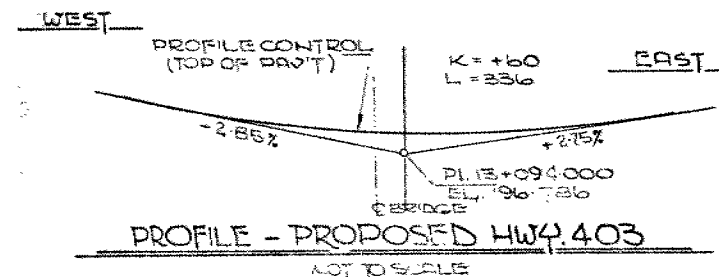


NOTE
C.E. DENOTES RUNNING EDGE
W.P. WORKING POINT



PROFILE - T.H. & B. RAILWAY

NOT TO SCALE



GENERAL NOTES

REINFORCING STEEL

GRADE 400

CLASS OF CONCRETE

FOOTINGS & ABUTMENTS — 20 MPa
PIER COLUMNS — 30 MPa

CLEAR COVER ON REINFORCING STEEL

FOOTINGS, ABUTMENTS & COLUMNS — 75

CONSTRUCTION NOTES

THE CONTRACTOR IS RESPONSIBLE FOR
FINISHING THE BEARING SEATS DEAD LEVEL
TO THE SPECIFIED ELEVATIONS WITH
A TOLERANCE OF ± 8

LIST OF DRAWINGS

1. GENERAL LAYOUT
2. BOREHOLE LOCATIONS & SOIL STRATA
3. FOOTING & PILE LAYOUT
4. FOOTING REINFORCEMENT
5. NORTH ABUTMENT
6. SOUTH ABUTMENT
7. PIER COLUMNS
8. BEARINGS
9. FRAMING PLAN
10. GIRDERS & FLOOR BEAMS
11. STRUCTURAL DETAILS
12. WALKWAY & DETAILS
13. CONC. SLOPE PAVING
14. BRIDGE DATA & SITE NUMBER DATA

CONCRETE QUANTITIES

(FOR LUMP SUM TENDER ITEMS)

CONCRETE IN PIER, ABUTMENTS
AND WING WALLS — 154 (m³)
CONCRETE IN SLOPE PAVING — 18 (m³)

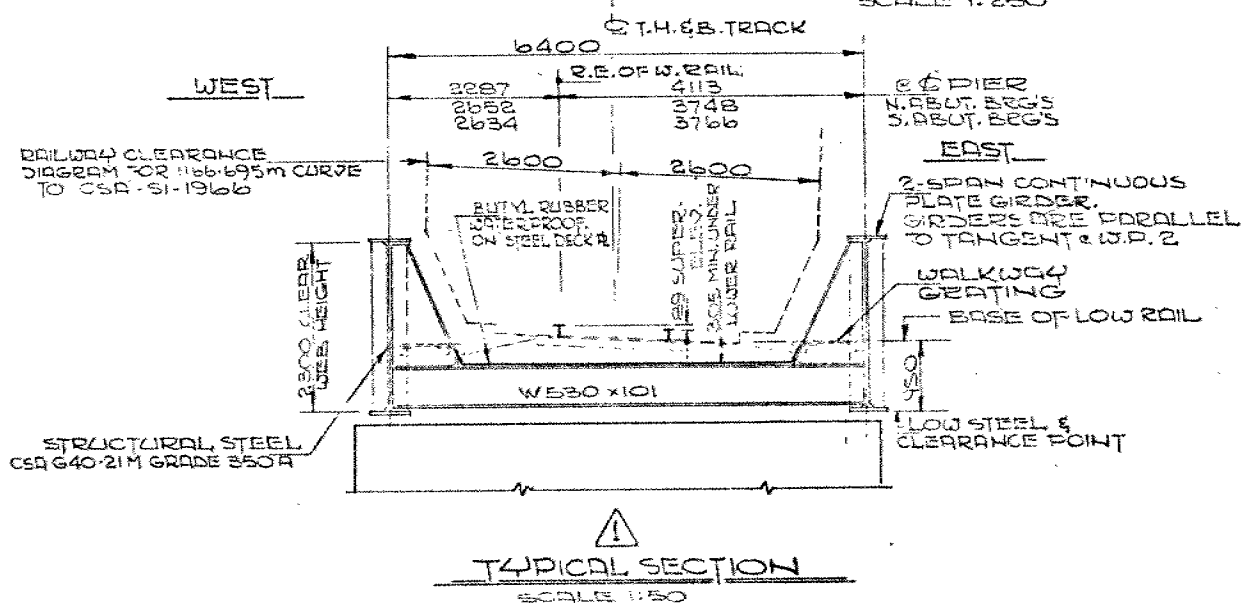
STRUCTURAL STEEL WEIGHT — 212 TONNES

DESIGN LOADING
COOPER'S E75 WITH DIESEL IMPACT FOR FLOOR SYSTEM
COOPER'S E70 WITH DIESEL IMPACT FOR MAIN GIRDERS



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
1			PROFILE OF HW4.403 REVISED
2			
3			
4			
5			
6			
7			
8			
9			
10			



METRIC

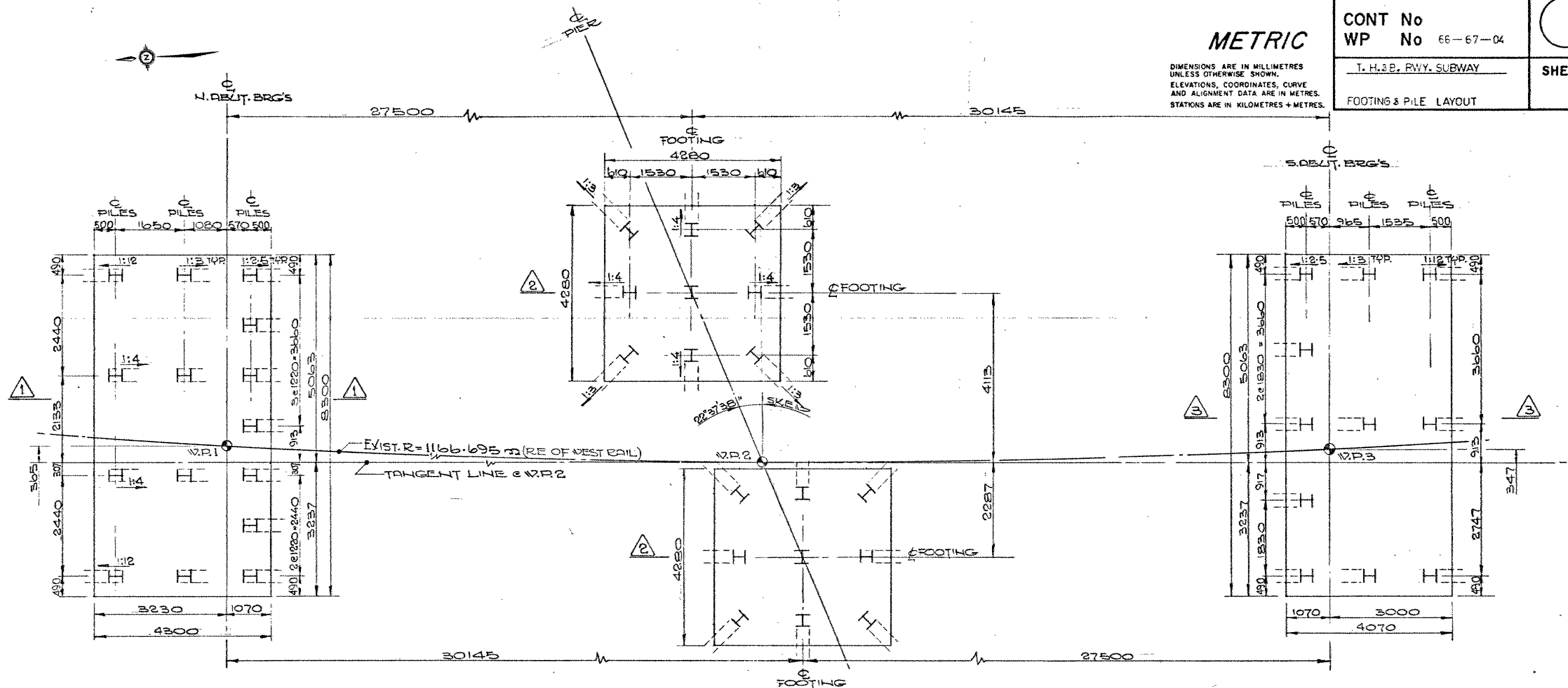
DIMENSIONS ARE IN MILLIMETRES
UNLESS OTHERWISE SHOWN.
ELEVATIONS, COORDINATES, CURVE
AND ALIGNMENT DATA ARE IN METRES.
STATIONS ARE IN KILOMETRES + METRES.

CONT No
WP No 66-67-04

T. H. B. R.WY. SUBWAY

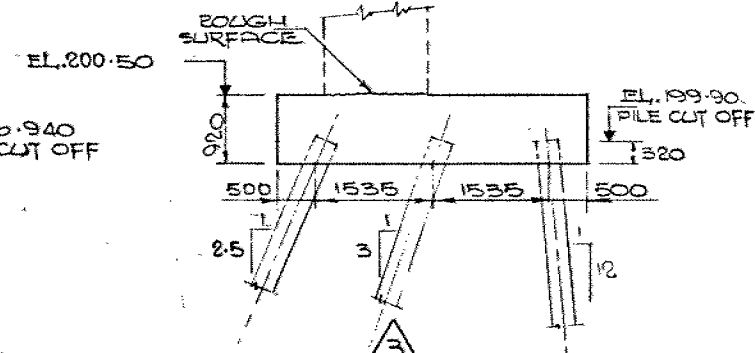
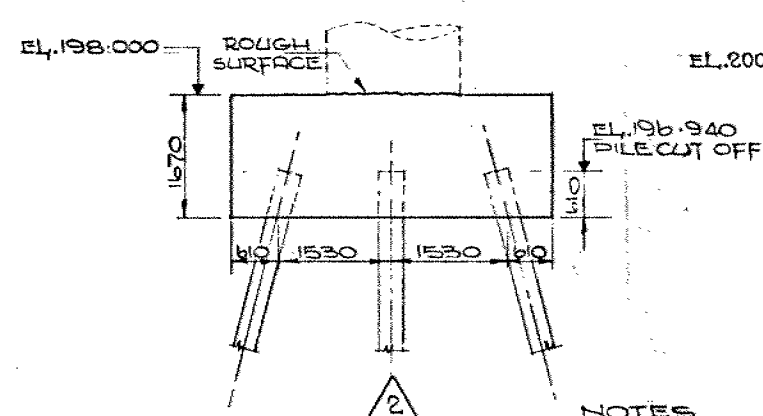
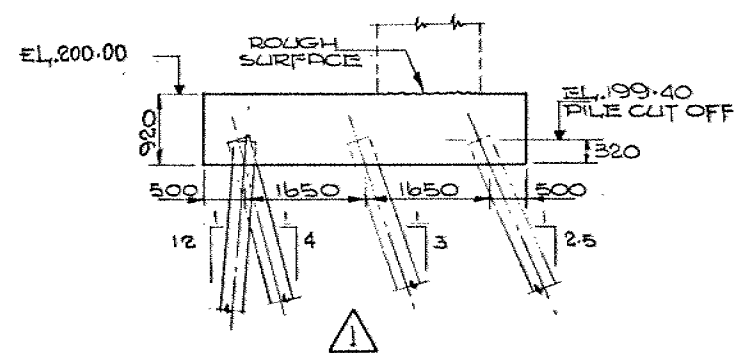
FOOTING & PILE LAYOUT

SHEET



FOOTING & PILE LAYOUT

SCALE 1:50



NOTES

- PILE LENGTH SHOWN ON THE DRAWING IS THE THEORETICAL LENGTH BELOW CUT OFF.
- PILE SPACING TO BE MEASURED AT UNDERSIDE OF FOOTING.



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

HP 310x110 H-PILES			
LOCATION	NO	LENGTH	BATTER
N. ABUT.	7	17.750	1:2.5
	4	17.500	1:3
	2	17.000	1:4
	2	16.500	1:12
PIER	8	14.750	1:3
	8	14.500	1:4
	2	14.000	0
	5	18.250	1:2.5
S. ABUT.	3	18.000	1:3
	3	17.000	1:12

REVISIONS			
DATE	BY	DESCRIPTION	DATE
DESIGN	GP	CHECK	GP
DRAWING	GP	CHECK	GP

METRIC

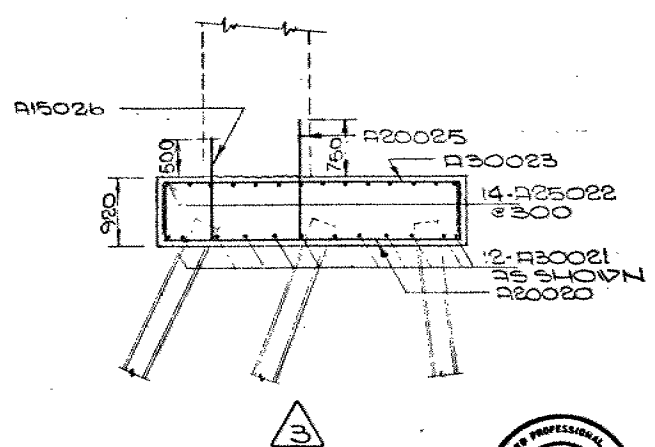
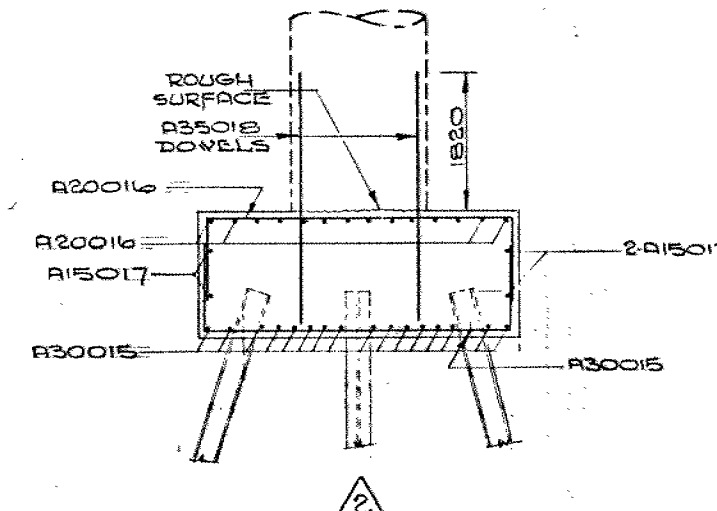
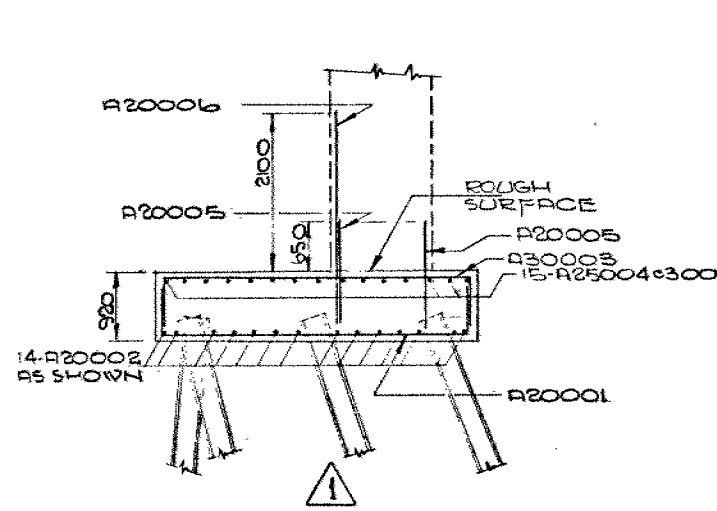
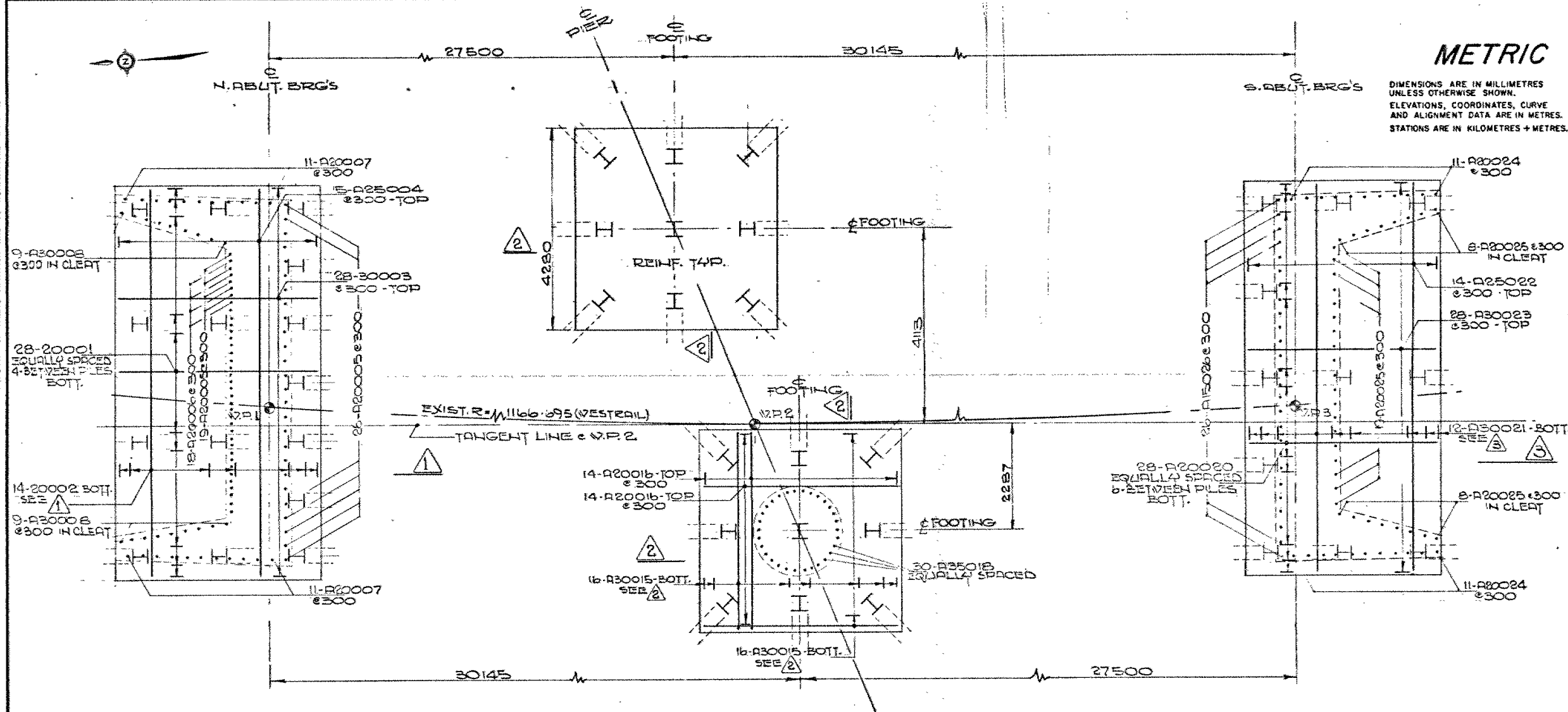
CONT No
WP No 66-67-04

T.H. & B. RWY. SUBWAY

SHEET

FOOTING REINFORCEMENT

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



SCALE 1:50



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 66-67-04

DIST 4

HWY 403

STR SITE 1-191

TH & B Railway Subway
14.7 km West of Hwy. 2

DISTRIBUTION

G.C.E. Burkhardt (3)
R.D. Gunter
M.R. Ernesaks
D.E. Thrasher (2)

C. Grebski
G.A. Wrong
B.J. Giroux
R.S. Pillar

R. Hore

R. Fitzgibbon)
J. Anderson) cover only
G. Sloan)

J.D. Elliott (McCormick Rankin)

Files J

SAMPLE DISPOSITION NOTICE

TYPE	DISCARD AFTER	RECOMM. BY
JARS	79-04-18	1288
TUBES	79-04-18	1288
ROCK CORES	79-04-18	1288

FOUNDATION INVESTIGATION REPORT

For

TH & B Railway Subway
14.7 km West of Hwy. 2
W.P. 66-67-04, Site 1-191
Hwy. 403, District 4, Hamilton

INTRODUCTION

This report contains the results of the foundation investigation carried out at the above mentioned site. The fieldwork which consisted of four sampled boreholes was carried out during the two periods of March 16 and 17, 1976 and January 30 to February 2, 1979. The boreholes were advanced using auger machines equipped with hollow stem augers and BXL rock coring techniques to depths of up to 23.1 metres below the ground surface.

SITE DESCRIPTION

The site is located at the crossing of the proposed Hwy. 403 and the T.H. & B Railway in the Township of Brantford, Brant County. At this location the railway is situated in a cut up to 4.5 metres in depth constructed with slopes of about 1.6:1. No slope failures were evident.

The land is gentle to moderately rolling and used for agricultural purposes.

The site lies in the physiographic region known as the Haldimand Clay Plain. This extensive plain consists of stratified clay, silts and sands deposited by glacial lakes Whittlesey and Warren.

SUBSURFACE CONDITIONS

Generally, the subsurface conditions consist of an extensive cohesive deposit overlaying dolomite bedrock at elevation 183.1 to 183.9. The cohesive deposit is composed of alternating layers of clayey silt and silty clay with occasional layers of clay and seams of silt and sand.

For a detailed description of the various soil and rock types encountered in each borehole refer to the Record of Borehole Sheets. The estimated stratigraphical profile and section shown on Drawing #666704-A are based upon this information. The following paragraphs summarize the various soil and rock types encountered from ground level downwards.

Fill Material - Clayey Silt

In borehole #27 a fill deposit composed of clayey silt containing traces of organics and occasional cobbles was encountered immediately below the ground surface. The thickness of this deposit is 1.5 metres.

The one Standard Penetration Test carried out within this deposit yielded an N value of 14 blows/0.30 m indicating a stiff consistency.

Alternating Layers of Clayey Silt and Silty Clay

Below the ground surface and the fill material a stratified deposit consisting of alternating layers of clayey silt and silty clay with occasional layers of clay and seams of silt and sand was encountered. The upper 2.1 to 3.5 metres of this deposit have been modified by weathering. Within this weathered zone the individual clayey silt and silty clay layers are not as distinguishable as in the lower portion of the stratum. The thickness of the clayey silt and silty clay layers varied from 2 to 120 mm. Overall the deposit extends to bedrock located at elevation 183.1 to 183.9.

Field vanes carried out within this deposit yielded undrained shear strengths ranging from 38 to over 107 kPa with a sensitivity of 2 to 5. These results, along with six laboratory unconfined and quick triaxial test results, are plotted with respect to depth on Figure 1. The consistency of the upper weathered portion of the stratum is uniform whereas at depth the clayey silt and silty clay layers were observed to be of different consistencies.

The effective strength parameters of this stratum were obtained by conducting two consolidated isotropic undrained triaxial tests with pore pressure measurements. The tests yielded an effective angle

of internal friction, ϕ' , of 29.4 and 18.6 with corresponding effective cohesion intercepts, c' , of 17.9 and 22.1 kPa respectively.

Laboratory testing was performed to determine the natural water content and Atterberg Limits of the individual soil layers wherever possible. These soil properties are listed below. The Atterberg Limit results are also plotted on the Plasticity Chart, Figure 2.

i) Clayey Silt Layers			Range	Average
Natural Water Content	(W) %		24-33	27
Liquid Limit	(W_L) %		23-30	29
Plastic Limit	(W_P) %		16-22	19
Plasticity Index	(I_P) %		7-16	10
ii) Silty Clay Layers				
Natural Water Content	(W) %		23-35	28
Liquid Limit	(W_L) %		37-40	38
Plastic Limit	(W_P) %		17-22	19
Plasticity Index	(I_P) %		17-21	19
iii) Clay Layers				
Natural Water Content	(W) %		39-49	44
Liquid Limit	(W_L) %		52-63	58
Plastic Limit	(W_P) %		19-31	25
Plasticity Index	(I_P) %		21-42	34

Bedrock

Immediately below the layered stratum moderately fractured dolomite bedrock is present. The bedrock was proven by obtaining 1.5 metres of BXL rock core from B.H. #4. The bedrock surface is relatively level and is situated between elevation 183.1 and 183.9. Refer to the Diamond Drill Sheet for a description of the rock core obtained.

Groundwater Level

The groundwater level was observed during the field investigation by measuring in the open boreholes. The groundwater level ranged from 0.6 to 6.4 metres below the ground surface in B.H. #4 and 25 respectively. This corresponds to elevations 202.5 and 199.9. It should be noted that B.H. #4 was augered in the spring of 1976, thus the high groundwater level. Boreholes #24, 25 and 27 were

completed in the winter of 1979. B.H. #24 was dry at completion of augering, however, the borehole was not left open a sufficient amount of time to allow the groundwater to be established. The groundwater levels are shown on the Record of Borehole Sheets and Drawing No. 666704-A.

DISCUSSION AND RECOMMENDATIONS

General

In order to carry the T.H. & B Railway over Hwy. 403 a structure composed of two 22.2 metre spans is presently proposed. At this crossing Hwy. 403 is to be situated at profile grade 199.2 and the railway is to be raised 0.2 metres to elevation 205.4. This scheme will necessitate an excavation about 6 metres in depth below the existing track elevation. Adjacent to the railway a cut of up to 10.6 metres will be required to attain the profile grade of Hwy. 403. During construction of the structure the railway is to be detoured to the east.

Structure Foundation

It is recommended that the proposed structure be founded on end bearing piles driven to the bedrock. The estimated tip elevation is 183.0+. The piles may be steel 'H', closed end steel tubes filled with concrete or reinforced concrete piles, depending on economics. Properly seated piles on the bedrock may be designed to carry the full allowable structural capacity of the particular pile section chosen.

If steel 'H' piles are employed the pile tips should be fitted with flange plates to ensure proper seating on the bedrock and to prevent damage during driving when the bedrock is contacted. HP 310X110 steel piles so fitted may be designed for a load per pile of up to 1.1 MN.

Alternatively, closed end steel tubes may be employed if the wall thickness is 6.3 mm or greater. A 324 0.0 x 6.3 mm closed end tube pile filled with concrete may be designed for a load per pile of up to 1.1 MN. During the driving operation there is the possibility of buckling the steel tube pile when contact is made with the bedrock if too high a driving energy is being utilized. To prevent pile damage the driving energy should be reduced to less than 40 kilojoules/blow for the final two metres of driving.

The structure may also be supported on end bearing reinforced concrete piles. The allowable load per pile will depend on the manufacturer's specifications for the particular pile section chosen.

Excavation

Immediately west of the structure a cut up to 10.6 metres will be required to achieve the proposed Hwy. 403 profile grade. The stability of this cut if constructed with 2:1 slopes, was checked and found to have a satisfactory factor of safety against base failure. The analysis was based on effective stress parameters $c' = 11 \text{ kPa}$, $\phi' = 18.5^\circ$ and assumed tension crack of three metres and a groundwater level between elevation 200 and 198.

Excavation of the cut will be carried out below the groundwater level prevailing at the time of construction. The cohesive deposit is relatively impermeable, therefore, water seepage into excavations should be minimal.

The slopes should be seeded according to current M.T.C. standards.

Railway Detour

In order to construct the subway the T.H. & B. Railway is to be detoured approximately 25 metres to the east. Construction of the detour will require fills up to 4.5 metres in height. No stability problems are anticipated for fills constructed at 2 horizontal to 1 vertical based on the soil conditions encountered at the structure site. The horizontal distance between the easterly most extent of the structure excavation at base level and the top west edge of the railway embankment should be 13 metres or greater. If this scheme is followed no railway protection is required.

Other Considerations

The subway will be drained by means of a permanent sewer discharging into Fairchild Creek. The sewer should be installed before or in conjunction with construction of the structure foundation.

For frost protection purposes the base of all pier caps should be provided with a minimum earth cover of 1.3 metres.

For estimating the earth pressure on the abutment walls due to a granular backfill having a unit weight of 21.2 kN/m^3 , a coefficient of active earth pressure (K_A) of 0.33 may be used if some movement at the top of the wall is permitted. However, if no movement at the top is allowed, a coefficient of earth pressure at rest (K_0) of 0.5 should be used for design purposes.

In order to relieve the build-up of excess hydrostatic pressure behind the abutment walls suitable drainage measures should be provided.

MISCELLANEOUS

The fieldwork for this investigation was carried out under the supervision of Mr. R. Van Veen and Mr. C.T. Johnson. The rock core obtained was examined by Mrs. Z. Koniuszy, Geologist. This report was written by Mr. C.T. Johnson and reviewed by Mr. K.G. Selby.

The equipment used was owned and operated by Atcost Soil Drilling Inc., Concord and D.S.I.L. Drilling Inc., Scarborough.



C.T. Johnson, P. Eng.
Project Engineer



K.G. Selby, P. Eng.
Supervising Engineer

April, 1979

APPENDIX



RECORD OF BOREHOLE No 4

METRIC

W P 66-67-04 LOCATION Coords. N 4 780 946.5; E 249 236.3 ORIGINATED BY BVV
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger, Cone Test & BXL Rock Core COMPILED BY BVV
DATUM Geodetic DATE 1976 03 16 & 17 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	100					
203.1	Ground Level													
0.0	Traces of Organics and Coarse Sand Weathered		1	SS	10		202						Org. 0.46	0 0 73 27
	Brown		2	SS	11									
	Brown & Grey		3	SS	9									
	Alternating Layers of Clayey Silt and Silty Clay		4	SS	7		200							
			5	SS	5									
	Occasional Layers of Clay and Seams of Silt		6	TW	PH		198	+ 2						
	Firm to Stiff													
			7	SS	7		196							
			8	SS	6		194							
			9	TW	PH		192	+ 2						
			10	SS	8		190	+ 2						
			11	TW	PH		188	+ 3						
			12	SS	11		186							
183.9			13	TW	PH								17.9	0 0 62 38
19.1	Dolomite Bedrock Moderately Fractured		14	RC BXL	Rec. 91%		184							
182.4														
20.6	End of Borehole													

RECORD OF BOREHOLE No 24

METRIC

W P 66-67-04 LOCATION Coords. N 4 780 925.0; E 249 199.0 ORIGINATED BY CTJ
 DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger COMPILED BY CTJ
 DATUM Geodetic DATE 1979 02 02 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT Σ					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					
209.1	Ground Level																
0.0	Very Stiff Occasional Seams of Fine Sand					*	208										
			1	SS	28												
	Weathered Brown		2	SS	14		206										0 1 84 15
	Brown & Grey									+4							c'=17.9 kPa φ=29.4°
	Alternating Layers of Clayey Silt and Silty Clay		3	TW	PH		204			+3							0 0 68 32
	Layers Vary From 3 to 90 mm in Thickness		4	SS	8		202			+3							
	Occasional Seams of Silt		5	TW	PH		200			+4							0 0 55 45 0 0 15 85
	Stiff																c'=22.1 kPa φ'=18.6°
	Occasional Layers of Clay up to 20 mm		6	TW	PH		198			+5							
			7	TW	PH												
196.0			8	TW	PH		196			+5							
13.1	End of Borehole																
	* Water Level Not Established Borehole Dry at Completion of Augering																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 25

METRIC

W P 66-67-04 LOCATION Coords. N 4 780 931.5; E 249 241.0 ORIGINATED BY CTJ
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY CTJ
DATUM Geodetic DATE 1979 01 30 and 1979 01 31 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 (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)				
								20 40 60 80 100							15 30 45				
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE													
206.3	Ground Level																		
0.0							206												
	Occasional Seams of Fine Sand		1	SS	9		204												
	Weathered Brown		2	SS	9		202	+3											
	Brown & Grey						202						18.7						
	Alternating Layers of Clayey Silt and Silty Clay Layers Vary From 2 mm to 120 mm in Thickness		3	TW	PH		200	+3						0 0 76 24					
	Occasional Layers of Clay and Seams of Silt		4	SS	5		200	+2											
	Firm to Stiff		5	TW	PH		198	+3					18.8						
			6	SS	7		196	+4					18.8						
			7	TW	PH		194	+3											
			8	SS	7		192	+3											
			9	SS	5		190	+2											
			10	TW	PH		188	+3											
			11	SS	16		186												
184.5	End of Borehole		12	SS	17		184												
21.8	End of Cone Test																		
183.2	Probable Bedrock																		
23.1																			



RECORD OF BOREHOLE No 27

METRIC

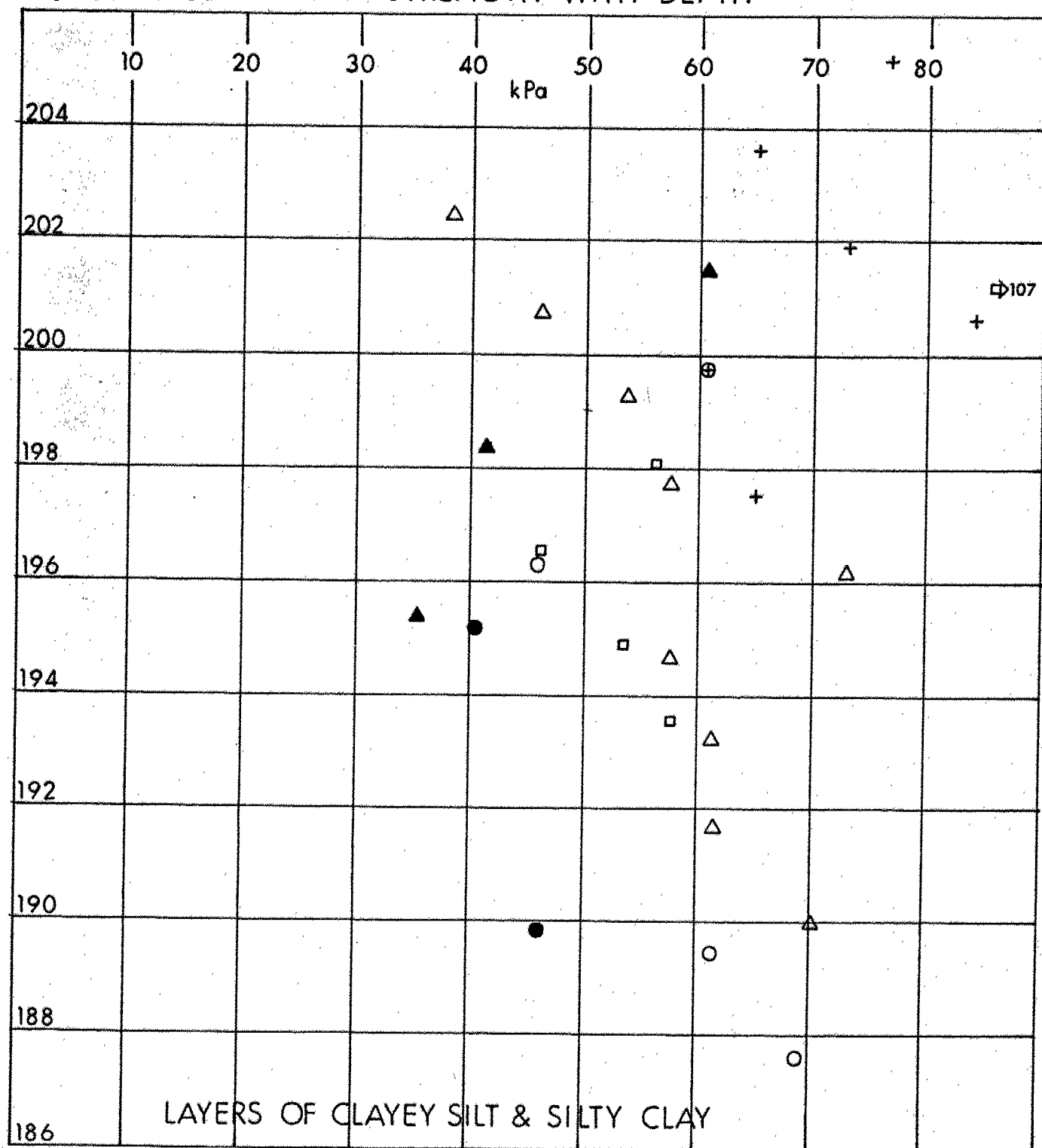
W P 66-67-04 LOCATION Coords. N 780 967.5; E 249 251.0 ORIGINATED BY CTJ
DIST 4 HWY 403 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY CTJ
DATUM Geodetic DATE 1979 02 01 CHECKED BY

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					
205.1	Ground Level																
0.0	Fill Material Clayey Silt Traces of Organics Occasional Cobbles Stiff		1	SS	14		204							o			Org. 1.06
203.6			2	SS	9		202							o			
1.5	Weathered Brown Brown & Grey Alternating Layers of Clayey Silt and Silty Clay Occasional Layers of Clay and Seams of Silt Firm to Stiff		3	SS	10		200							o			0 1 63 36
			4	SS	12												
			5	SS	6		198							o			
			6	SS	6									o			
			7	SS	9		196							o			
			8	SS	7		194										
192.5			9	SS	8									o			
12.6	End of Borehole						192										
							190										
							188										
							186										
							184										
183.1																	
22.0	End of Cone Test Probable Bedrock																

+3, x5: Numbers refer to
Sensitivity

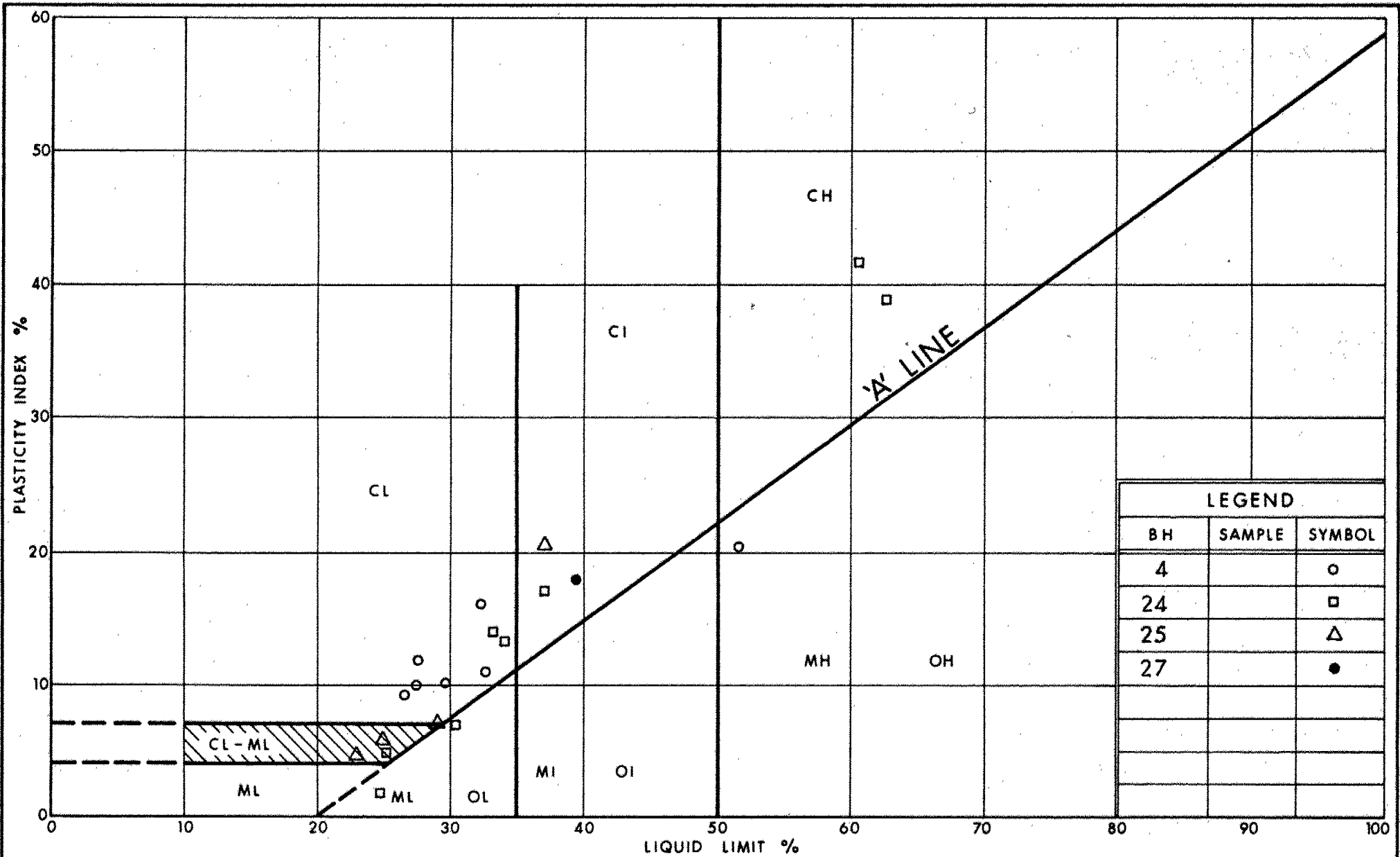
20
15 5 (%) STRAIN AT FAILURE
10

UNDRAINED SHEAR STRENGTH WITH DEPTH



BH	SYMBOLS	
	FIELD VANES	LAB TESTS
4	○	●
24	+	⊕
25	△	▲
27	◻	

FIG 1



Ontario

 Ministry of
Transportation and
Communications

ENGINEERING SERVICES BRANCH

PLASTICITY CHART ALTERNATING LAYERS OF CLAYEY SILT & SILTY CLAY OCCASIONAL LAYERS OF CLAY

FIG No. 2

W P 66-67-04

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'_{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
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

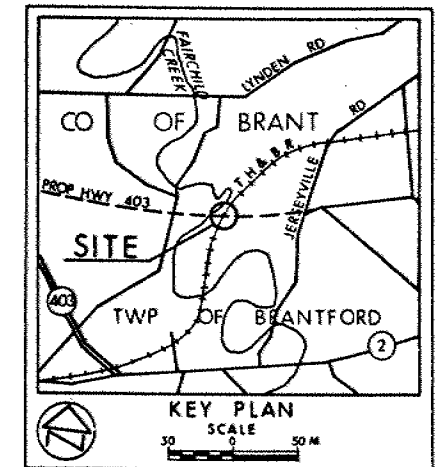
CONT No
WP No 66-67-04

T.H. & B. SUBWAY AT HWY 403

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)
- ✚ WL at time of investigation
- NO WL established BH No 24

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
4	203.1	4 780 946.5	249 256.3
24	209.1	4 780 925.0	249 199.0
25	206.3	4 780 931.5	249 241.0
27	205.1	4 780 967.5	249 251.0

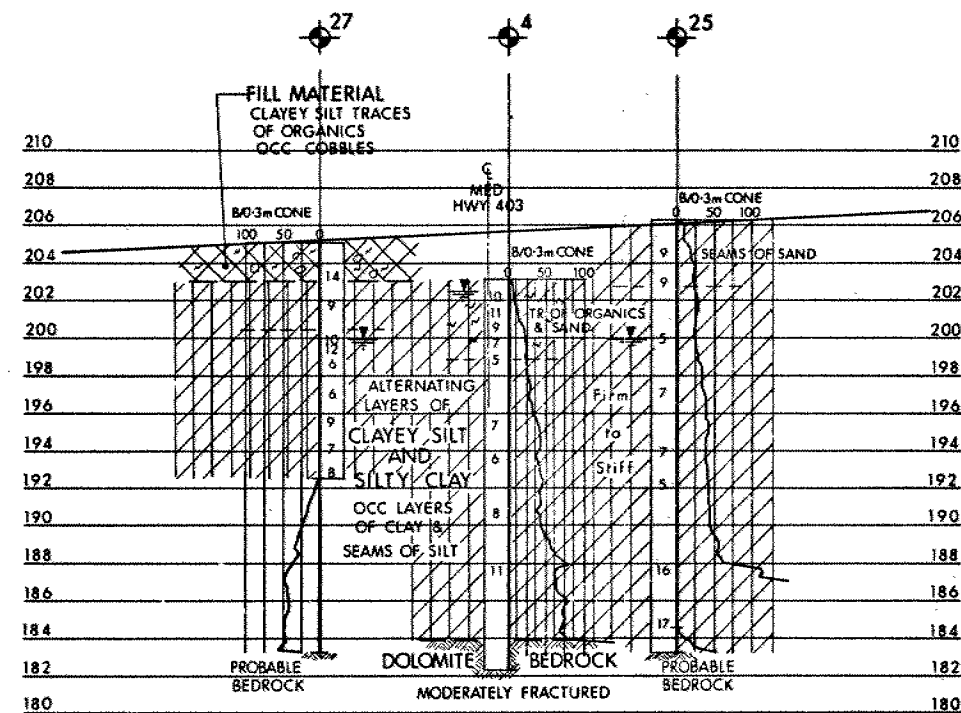
NOTE

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

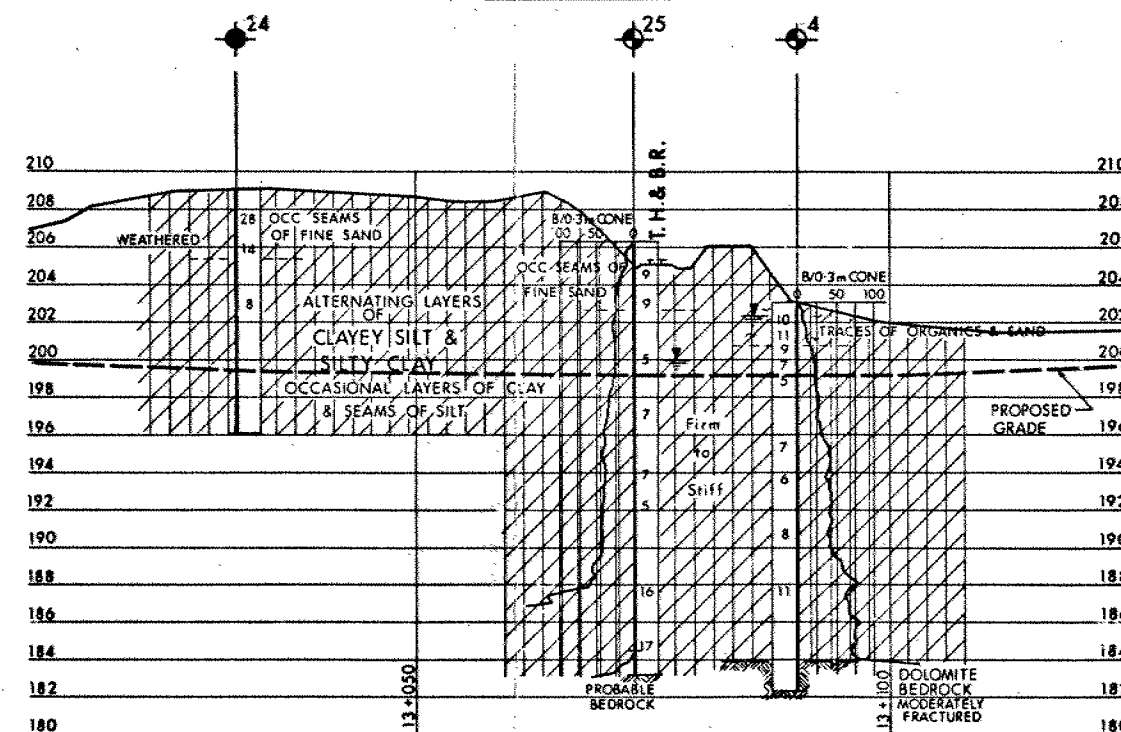
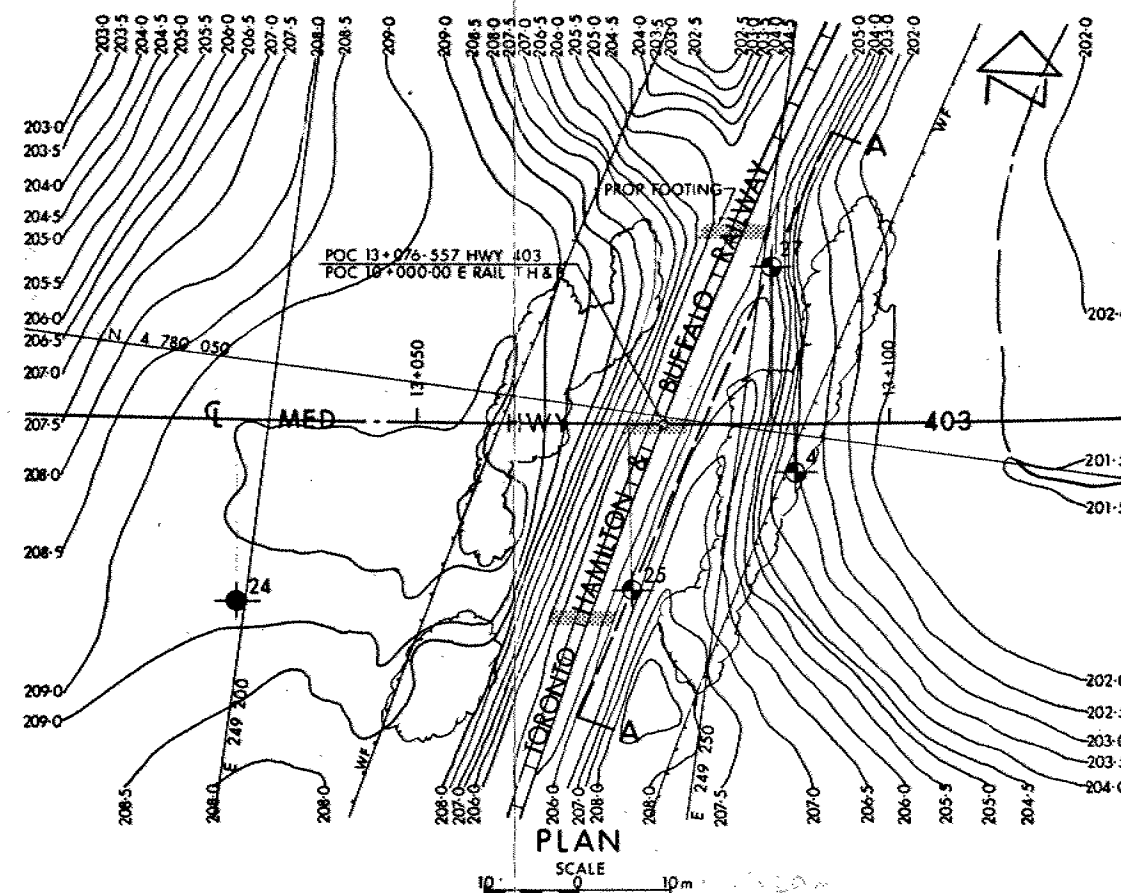
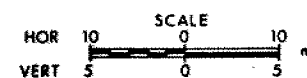
REVISIONS	DATE	BY	DESCRIPTION

Geocres No

HWY No	403	DIST	4
SUBMIT C J	CHECKED C J	DATE	79 03 09
DRAWN O J	CHECKED	APPROVED	SITE 1-191
			DWG 666704-A



SECTION A-A



PROFILE MED HWY 403

