DOCUMENT MICROFILMING IDENTIFICATION

G.I.-30 SEPT. 1976

GEOCRES No. 30M12-221

DIST. 6 REGION

W.P. No. 194-94-01

CONT. No.

W. O. No.

STR. SITE No. 24-680 RW

HWY. No. 401

LOCATION Hwy 401 Retaining Wall Adjacent to Ramp E-N/S to Hwy 10

No OF PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

FILE COPY

Ministry of
Transportation and
Communications
Ontario

FOUNDATION DESIGN SECTION

foundation investigation and design report

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP	194-94-01	DIST	6
HWY	401	STR SITE	24-680 RW

Retaining Wall
Adjacent to Hwy. 401 Ramp E-N/S to Hwy. 10

DISTRIBUTION

V.F. Boehnke (3)
D. Billings
W. Peck (2)
B. Peltier (3)
M. Holowka
J. Robinson
E.A. Joseph
F. Bacchus (Cover Only)
File

GEOCRES 30M12-221

DATE DEC 0 1 1994

FOUNDATION INVESTIGATION REPORT
For
Retaining Wall, Adjacent to Hwy 401 Ramp E-N/S to Hwy 10
W.P. 194-94-01, Site: 24-680 RW
Hwy. 401, District 6, Toronto

INTRODUCTION

This report summarizes the results of a foundation investigation at the above mentioned site. The investigation was carried out for a proposed Hwy 401 ramp E-N/S to Hwy 10. The request for investigation was made by the Central Region Structural Section.

SITE DESCRIPTION

The site is located beside Hwy 401 westbound collector and westbound transfer lanes, between Kennedy Road and Hurontario St (Hwy 10) between stations 5+230 and 5+590. The area is situated in the City of Mississauga, Region of Peel. The site is located within MTO right of way.

The topography across the site is undulating. The ground elevation at the proposed ramp profile control ranges from 192.4m to 202.3m.

The site lies within the physiographic region known as "Peel Plain". This region is characterized by a level to undulating "Till or Boulder Clay" plain underlain by shale or limestone bedrock (after Chapman and Putnam, 1984).

INVESTIGATION PROCEDURES

The fieldwork for the investigation was carried out on 94 06 24 and 94 06 27 and consisted of 7 sampled boreholes (BH 1 through BH 7) advanced to depths ranging from 3.9 to 6.2m below ground surface.

The boreholes were advanced using a CME 55 track-mounted auger machine equipped with solid stem augers.

Sampling was carried out at each borehole location by means of a 50mm O.D. split spoon sampler driven into the soil according to the specifications of the Standard Penetration Test (ASTM D 1586).

In all boreholes, samples were retrieved at 0.7m intervals.

Groundwater levels were obtained by monitoring the levels in the open boreholes. All boreholes were backfilled at the completion of the fieldwork.

The laboratory testing for representative samples consisted of:

- Grain Size Analyses
- Natural Moisture Content Determination
- Atterberg Limit Tests, and
- Unit Weights Determinations

The results of the laboratory tests are plotted on the Record of Borehole sheets (Appendix).

SUBSURFACE CONDITIONS

General

The record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations of boreholes (BH 1 through BH 7) along with the stratigraphical profiles based on the borehole data are shown on the attached drawing Dwg. No. 1949401-A.

All boreholes encountered glacial till as a native soil. The glacial till was overlain by fill at only BH 1,2 and 3 locations. The native soil consisted of clayey silt to silty clay glacial till underlain by Queenston shale bedrock. The glacial deposit contained layers of silty sand, some sand and some gravel. The deposits occasionally contain cobbles and boulders. Detailed descriptions of the soil strata are as follows:

Clayey Silt (Fill)

This cohesive material was encountered only in BH 1, 2 and 3. The top elevation of this deposit ranged from 195.5m to 196.0m. The thickness of the fill was about 1.4m. The Standard Penetration test 'N' values ranged from 12 to 27 blows which suggested that the deposit is stiff to very stiff. Typical properties of the material, based on one laboratory test are as follows:

Natural Moisture Content (w)	11 %
Plastic Limit (w_L)	12 %
Liquid Limit (w_P)	22 %
Unit Weight (kN/m^3)	21.7

Clayey Silt to Silty Clay (Glacial Till)

This cohesive deposit was underlying the fill at BH 1,2 and 3 and constituted the surficial deposit elsewhere. The top elevation of this deposit ranged from 191.9m to 194.6m. The thickness ranged from 1.2m to 2.7m. The Standard Penetration Test 'N' values ranged from 10 blows to 87 blows with average 'N' value of 25. This suggested that the deposit in general is stiff to hard but on average it is very stiff.

Typical properties of the material, based on laboratory and field testings, are as follows:

	Range (%)	Average (%)	Tests
Natural Moisture Content (w)	9 - 20	12	9
Plastic Limit (w_L)	12 - 20	15	9
Liquid Limit (w_P)	21 - 35	25	9
Unit Weight (kN/m^3)	21.9, 22.8	22.2	2

Queenston Shale Bedrock

Underlying the clayey silt to silty clay deposit all boreholes encountered shale bedrock. The top elevation of the bedrock ranged from 189.5m to 193.4m. The boreholes were advanced to a maximum depth of 3.9m into the bedrock. The shale bedrock was highly weathered within the zone explored. The Standard Penetration Test 'N' values within the weathered shale ranged from 77 to more than 100.

Laboratory tests were conducted on two samples from weathered shale. The results are as follows:

	Range (%)	Average (%)	Tests
Natural Moisture Content (w)	8 - 9	9	2
Plastic Limit (w_L)	19 - 20	20	2
Liquid Limit (w_P)	28 - 31	30	2
Unit Weight (kN/m^3)	22.8, 22.9	22.8	2

Groundwater Conditions

Groundwater was encountered in all boreholes. The groundwater stabilized at depths ranging from 0.3m (BH 5) to 1.5m (BH 2) below ground surface. The groundwater elevation ranged from 191.0m (BH 7) to 194.8m (BH 3).

DISCUSSION AND RECOMMENDATIONS

General

It is proposed to construct a new Hwy 401 ramp E-N/S to Highway 10. Within a 360 m length (station 5+230 to 5+590) of the ramp the side slopes on the north side will be steeper than the normal 2H:1V slope. It is proposed to construct either a retaining wall to accommodate the steeper slope or to reinforce the steep slope. The proposed retaining wall will be 2.0 m to 6.2 m high. Recommendations are provided for a gravity wall, for a retained soil system with a wall facing and for a reinforced slope.

RCC Retaining Wall

A gravity retaining wall can be founded on spread footing constructed on very stiff to hard cohesive glacial till deposit. The recommended highest footing elevations are as follows:

Limits of stations	Highest Footing Elevations
5+230 to 5+330	191.0m
5+330 to 5+445	193.0m
5+445 to 5+555	194.5m
5+555 to 5+590	194.0m

The following values can be utilized for the design of retaining wall foundation for the purposes of the O.H.B.D.C.

Factored Bearing Capacity at U.L.S. = 300 kPa
Bearing Capacity at S.L.S. = 200 kPa

The retaining wall footings should have at least 1.2m earth cover or equivalent for frost protection.

Backfilling to the retaining wall should consist of suitable material compacted in accordance with MTO Standards. Provision should be made to ensure free drainage behind the wall. The following properties are recommended for the calculation of lateral pressure:

Granular 'A'	$\Upsilon = 22.8\ kN/m^3$, $\phi = 35°$, Ko = 0.43, Ka = 0.27
Granular 'B'	$\Upsilon = 21.2\ kN/m^3$, $\phi = 30°$, Ko = 0.50, Ka = 0.33

Active condition (Ka) should be used to calculate the lateral pressure.

Sliding resistance for retaining wall footings should be calculated in accordance with the O.H.B.D.C. assuming unfactored angle of friction, $\phi = 26°$ between concrete and glacial till.

No deep seated stability problems are anticipated for the proposed height of permanent embankment. Total and differential settlement will be negligible if the foundation is constructed in accordance with the recommendations.

Retained Soil System Walls

Proprietary walls (such as RECO walls) may be considered for the entire length of the retaining wall. If retained soil systems are used, the proposal should be forwarded to the MTO RSS Committee c/o George Al-Bazi, Structural Office.

Design considerations for construction excavations and dewatering are the responsibility of the proprietary RSS company and shall be in accordance with the requirements of the Occupational Health and Safety Act. Fully detailed proposals should be submitted to the Foundation Design Section for review a minimum of 10 working days prior to construction.

Reinforced Soil Slope

Similarly, a reinforced steep slope may be considered at this location where the embankment slope does not exceed 1H:1V. It was identified that between Sta 5+490 and 5+590 the slope becomes as steep as 0.3H:1V. Between these stations, a gravity wall or a retained soil system with a wall facing should be considered. This alternative is also considered within the RSS process.

Global stability for a reinforced slope has been analyzed and factors of safety of 1.3 or higher was achieved. The design and internal stability of the reinforced slope would be the responsibility of the proprietary owner.

Construction Consideration

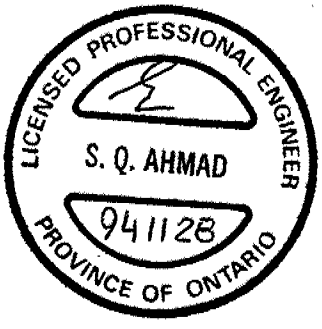
No dewatering concerns are anticipated for the footing excavations. It is expected that any seepage into the excavation can be relieved by sump pumping techniques.

Temporary excavations within the overburden may be carried out at 1.5H:1V slopes or flatter to a maximum depth of 6.0 m before incorporating a 2.0 m wide mid-height berm.

The Contractor should be made aware that cobbles/boulders may be encountered during excavation for foundation construction. In addition, it is likely that cobble and boulder sized fragments of bedrock will be encountered during excavations within the weathered shale.

Miscellaneous

The fieldwork for this project was carried out under the supervision of Lori O'Malley Engineering student, using equipment owned and operated by Canadian Soil Drilling. The report was prepared by B. Bennett and K. Ahmad, Foundation Engineers, reviewed and approved by D. Dundas, Senior Foundation Engineer.



K.S.Q. Ahmad, P. Eng.
Foundation Engineer

D.H. Dundas, P. Eng.
Senior Foundation Engineer

APPENDIX

RECORD OF BOREHOLE No 1 — 1 OF 1 — METRIC

W.P. 194-94-01 LOCATION Coords.: N 4 832 424, E 290 454 ORIGINATED BY L.O.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY L.O.

DATUM Geodetic DATE 1994 06 27 CHECKED BY B.B.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.5	Ground Surface										
0.0	CLAYEY SILT Trace to Some Gravel Some Sand Trace Organics Very Stiff		1	SS	27	▼				21.7	4 37 40 19
194.1	(Fill Material)						194				
1.4	CLAYEY SILT TO SILTY CLAY Silty Sand Zone Some Gravel and Sand Hard		2	SS	46						
192.8	(Glacial Till)		3	SS	60						0 1 (99)
2.7			4	SS	86	/15cm	192				
	BEDROCK Queenston Shale Highly Weathered		5	SS	85	/15cm					
			6	SS	85	/15cm					
			7	SS	85	/10cm	190				
189.3			8	SS	85	/8cm					
6.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 (20/10) 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 2 — 1 OF 1 — METRIC

W.P. 194-94-01 LOCATION Coords.: N 4 832 466, E 290 498 ORIGINATED BY L.O.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY L.O.

DATUM Geodetic DATE 1994 06 27 CHECKED BY B.B.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.0	Ground Surface										
0.0	CLAYEY SILT Some Gravel Some Sand Trace Organics Stiff		1	SS	12						
194.6	(Fill Material)										
1.4	CLAYEY SILT TO SILTY CLAY Some Gravel, Some Sand Occ. Silty Sand Zones Very Stiff to Hard		2	SS	24	▼	194		○ ⊢ ⊣	22.8	8 35 (57)
193.4	(Glacial Till)		3	SS	52				○ ⊢ ⊣		12 30 (58)
2.6			4	SS	77						
	BEDROCK Queenston Shale Highly Weathered		5	SS	126		192				
			6	SS	90	/15cm					
			7	SS	90	/10cm					
189.8			8	SS	90	/8cm	190				
6.2	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

15 20/10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3 1 OF 1 METRIC

W.P. 194-94-01 LOCATION Coords.: N 4 832 508, E 290 541 ORIGINATED BY L.O.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY L.O.

DATUM Geodetic DATE 1994 06 27 CHECKED BY B.B.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
196.0 Ground Surface											
0.0	CLAYEY SILT Some Gravel Some Sand Trace Organics Very Stiff (Fill Material)		1	SS	21	▼					
194.6											
1.4	CLAYEY SILT TO SILTY CLAY Trace to Some Gravel Some Sand Brown / Red Occ. Sandy Silt zones Very Stiff to Hard (Glacial Till)		2	SS	31		194				
			3	SS	41						3 7 68 22
193.0											
3.0	BEDROCK Queenston Shale Highly Weathered		4	SS	120 /19cm					22.9	4 2 (94)
			5	SS	100 /18cm		192			22.8	0 0 (100)
			6	SS	85 /13cm						
			7	SS	90 /10cm						
189.8			8	SS	90 /10cm		190				
6.2	End of Borehole										

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 194-94-01 LOCATION Coords.: N 4 832 543, E 290 590 ORIGINATED BY L.O.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY L.O.

DATUM Geodetic DATE 1994 06 24 CHECKED BY B.B.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
194.1	Ground Surface										
0.0	CLAYEY SILT TO SILTY CLAY Trace to Some Gravel Some Sand Trace Organics Stiff to Hard (Glacial Till) Brown / Red		1	SS	10	▼	194				5 15 (80)
191.8			2	SS	33						
2.3			3	SS	84		192				
			4	SS	90	/13cm					
	BEDROCK Queenston Shale Highly Weathered		5	SS	80	/9cm	190				
			6	SS	87	/10cm					
			7	SS	85	/13cm					
187.9			8	SS	85	/10cm	188				
6.2	End of Borehole										

$+^{3}$, $\times^{5}$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
$\frac{}{10}$

RECORD OF BOREHOLE No 5 1 OF 1 METRIC

W.P. 194-94-01 LOCATION Coords.: N 4 832 570, E 290 645 ORIGINATED BY L.O.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY L.O.

DATUM Geodetic DATE 1994 06 24 CHECKED BY B.B.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.7	Ground Surface										
0.0	CLAYEY SILT TO SILTY CLAY Trace to Some Gravel Some Sand Very Stiff to Hard (Glacial Till) Trace Organics Brown Red		1	SS	19		192		○		12 28 (60)
			2	SS	67				○		4 32 (64)
190.0			3	SS	123	/28cm	190				
2.7	BEDROCK Queenston Shale Highly Weathered		4	SS	87	/10cm					
			5	SS	84	/9cm					
188.0			6	SS	85	/10cm	188				
4.7	End of Borehole										

$+^{3}$, $\times^{5}$: Numbers refer to Sensitivity

$\frac{20}{15}\diamond^{5}_{10}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6 1 OF 1 METRIC

W.P. 194-94-01 LOCATION Coords.: N 4 832 588, E 290 707 ORIGINATED BY L.O.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY L.O.

DATUM Geodetic DATE 1994 06 24 CHECKED BY B.B.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%) (w_P PLASTIC LIMIT, w NATURAL MOISTURE CONTENT, w_L LIQUID LIMIT)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.5	Ground Surface										
0.0	CLAYEY SILT TO SILTY CLAY Trace to Some Gravel Some Sand Occ. Silty Sand Zones Stiff to Hard Trace Organics (Glacial Till)		1	SS	10	▼	192				
			2	SS	22				o	21.9	2 21 (77)
189.9			3	SS	80	/15cm	190				
2.6	BEDROCK Queenston Shale Highly Weathered		4	SS	85	/5cm					
			5	SS	85	/10cm					
			6	SS	95	/13cm	188				
187.1			7	SS	100	/10cm					
5.4	End of Borehole										

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7 1 OF 1 METRIC

W.P. 194-94-01 LOCATION Coords.: N 4 832 606, E 290 769 ORIGINATED BY L.O.

DIST 6 HWY 401 BOREHOLE TYPE Solid Stem Auger COMPILED BY L.O.

DATUM Geodetic DATE 1994 06 24 CHECKED BY B.B.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
191.9	Ground Surface										
0.0	CLAYEY SILT TO SILTY CLAY Some Gravel Some Sand Red and Grey Trace Organics Hard (Glacial Till)		1	SS	87	▼	191				
			2	SS	69						
189.5			3	SS	81	/10cm					
2.4	BEDROCK Queenston Shale Highly Weathered		4	SS	84	/10cm	189				
188.0			5	SS	85	/8cm					
3.9	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-207 88 10

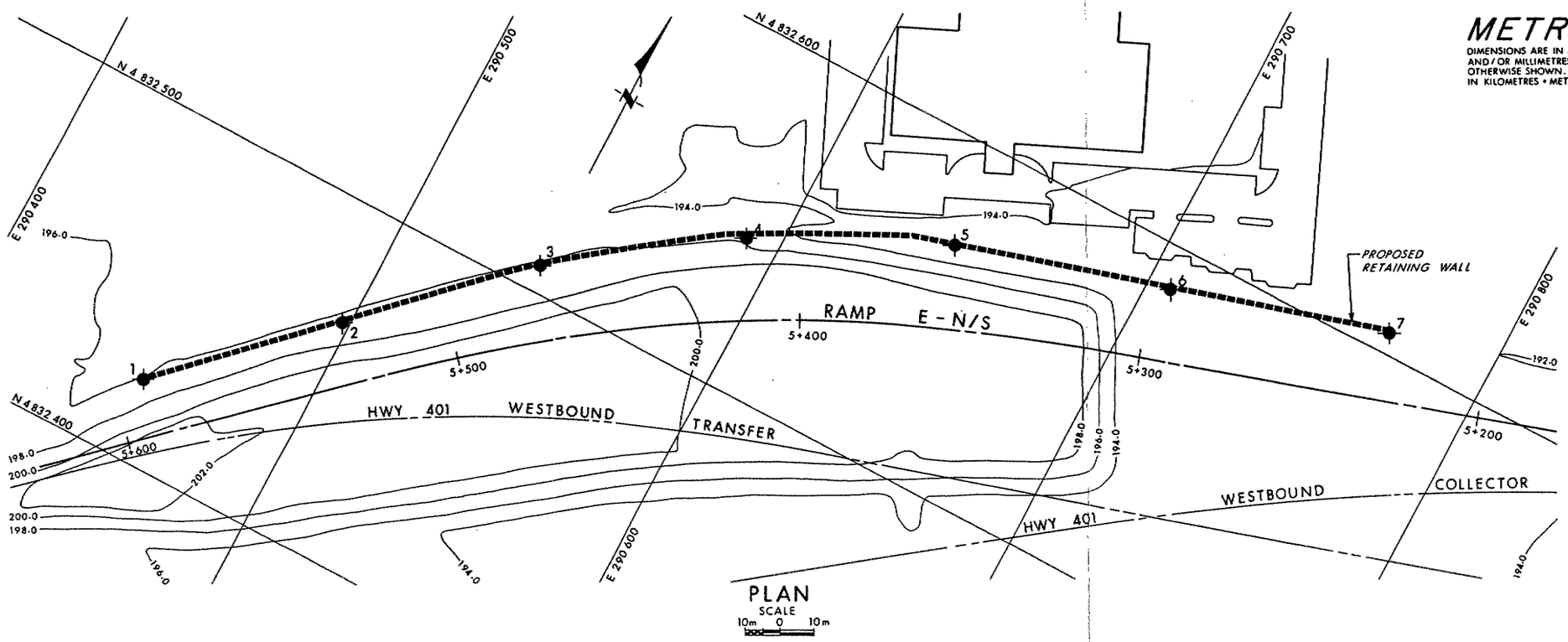
METRIC

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

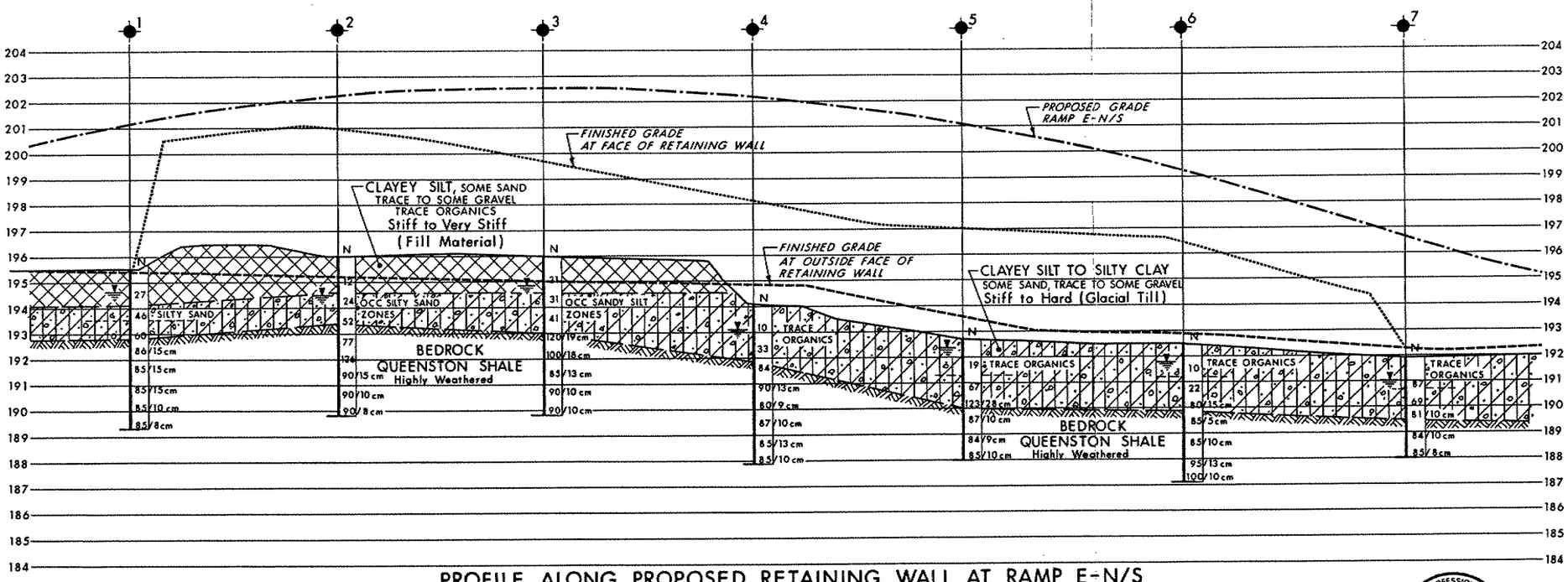
CONT No
WP No 194-94-01

PROP RETAINING WALL
HWY 401 RAMP E-N/S TO HWY 10
BORE HOLE LOCATIONS & SOIL STRATA

SHEET

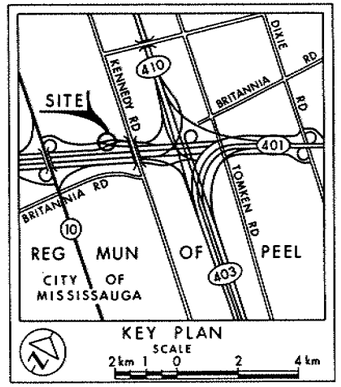


PLAN
SCALE
10m 0 10m



PROFILE ALONG PROPOSED RETAINING WALL AT RAMP E-N/S

SCALES
10m 0 10m HORIZONTAL
2m 1 0 2m VERTICAL



KEY PLAN
SCALE
2km 1 0 2 4km

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 1994 06

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	195.5	4 832 424	290 454
2	196.0	4 832 466	290 498
3	196.0	4 832 508	290 541
4	194.1	4 832 543	290 590
5	192.7	4 832 570	290 645
6	192.5	4 832 588	290 707
7	191.9	4 832 606	290 769

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 GC 2.01 of OPS Gen. Cond.

REV	DATE	BY	DESCRIPTION

LICENSED PROFESSIONAL ENGINEER S. Q. AHMAD PROVINCE OF ONTARIO

Geocres No 30M12-221

HWY No 401 (RAMP E-N/S)			DIST 6
SUBM'D KA	CHECKED	DATE 1994 10 24	SITE 24-680-RW
DRAWN	CHECKED	APPROVED	DWG 1949401-A

MEMORANDUM

Ontario

To: V. Boehnke, P.Eng.
Head, Structural Section
Central Region

Date: September 7, 1994

Attn: N. Potak, P.Eng
Sr. Structural Engineer

From: Foundation Design Section
Room 315, Central Bldg.

Tel: (416) 235-3731
Fax: (416) 235-5240

Re: Preliminary Foundation Recommendations for
Hwy 401 Retaining Wall adj. Ramp E-N/S to Hwy 10
Hwy 401 Widening betw'n Hwys 401/403 and First Line West
W.P. 194-94-01, Site 24-680RW, District 6

A foundation investigation has been completed at the above-mentioned location. This memo outlines the general subsurface conditions encountered at the site and the preliminary foundation recommendations for both retaining wall and reinforced steep slope alternatives.

General Site and Subsurface Conditions

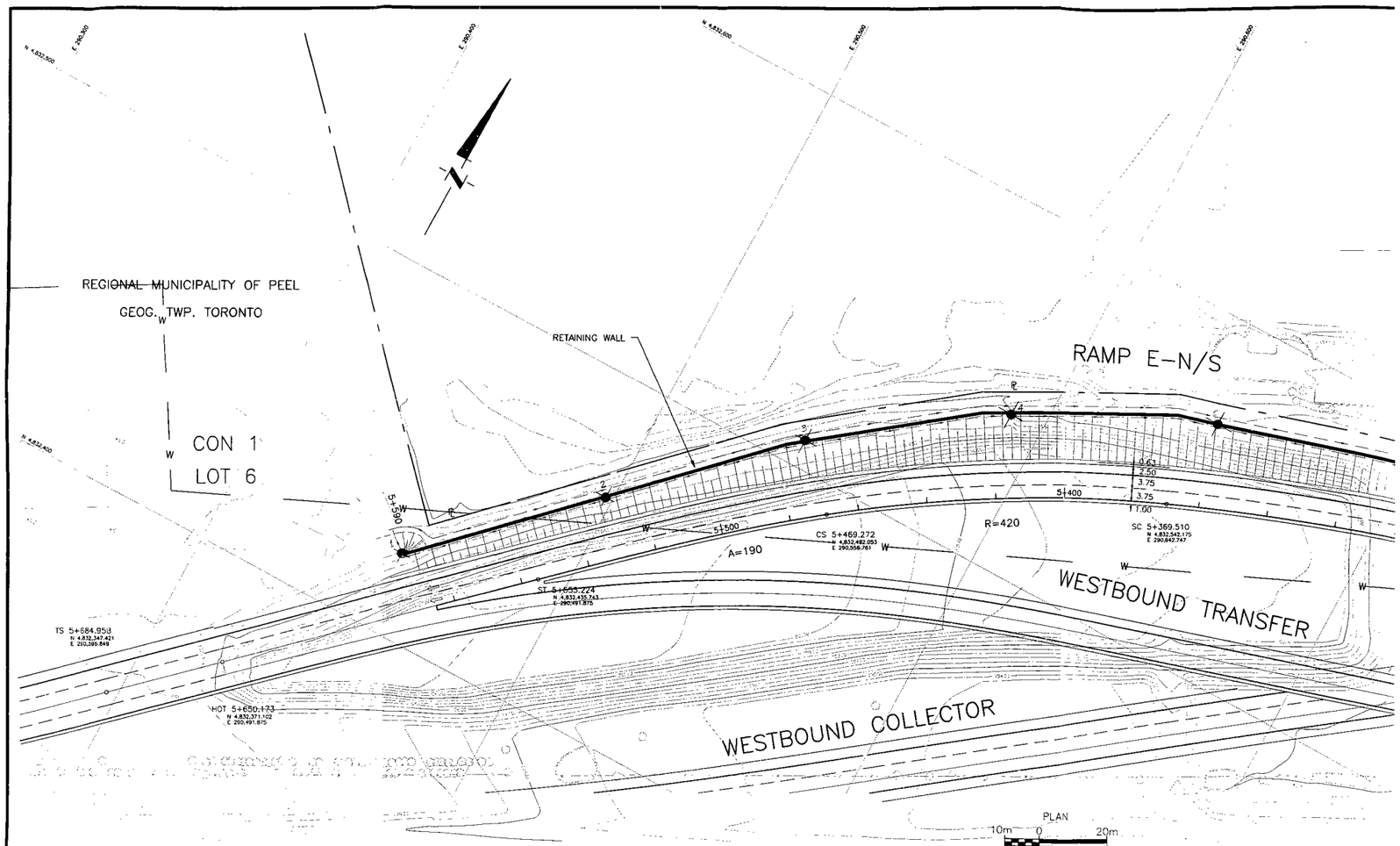
The fieldwork was carried out to the north of the present westbound lanes of Highway 401, approximately 500 m east of the Highway 10 underpass structure. The site is located in the City of Mississauga. Physiographically, it is located in the Peel Plain that is characterized by glacial overburden overlying bedrock.

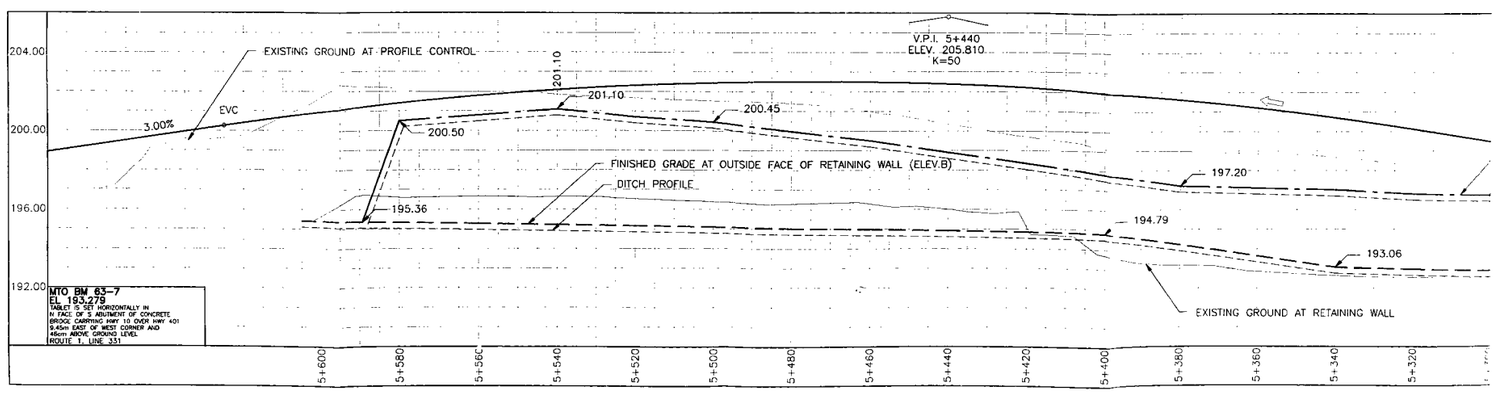
The borings carried out revealed a 1.4 m thick blanket of fill to the west end of the site composed of stiff to very stiff clayey silt with some sand and trace gravel. Elsewhere, the surficial deposit consisted of relatively shallow overburden composed of stiff to hard clayey silt to silty clay glacial till. It was also encountered below the fill material and varied in thickness from 1.2 m to 3.0 m across the site. Weathered shale bedrock of the Queenston Formation was identified in all the borings. The glacial till/weathered bedrock interface ranges in elevation from 189.7 to 191.4 across the site.

Discussion and Recommendations

It is proposed to construct a 360 m retaining wall to accommodate the E-N/S ramp to Highway 401. The retaining wall extends from Ramp E-N/S Sta 5 + 230 to Sta 5 + 590 and ranges in height from 2.0 m to 6.2 m. Recommendations are provided for a gravity wall, for a reinforced steep slope and for a retained soil system with a wall facing.

\..2





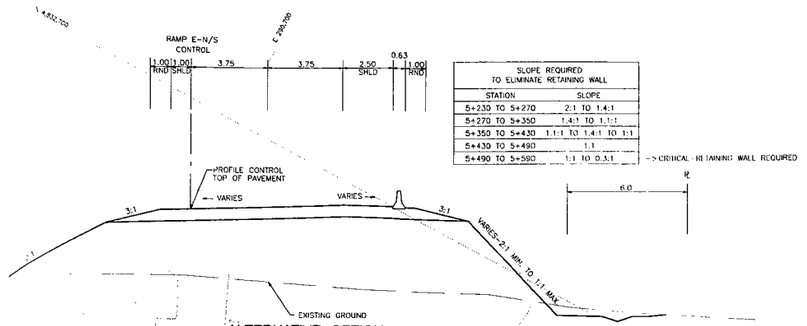
PROFILE OF RETAINING WALL AT RAMP

20m 0 20m 2m 0 4m

1:500 HORIZONTAL 1:200 VERTICAL

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



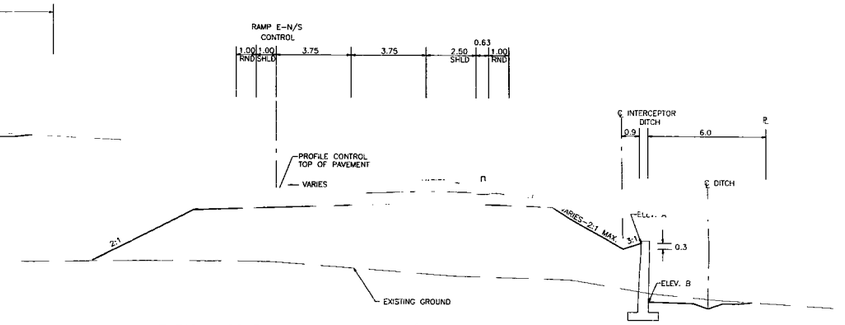
SLOPE REQUIRED TO ELIMINATE RETAINING WALL	
STATION	SLOPE
5+230 TO 5+270	2:1 TO 1.4:1
5+270 TO 5+350	1.4:1 TO 1.1:1
5+350 TO 5+430	1.1:1 TO 1.4:1 TO 1:1
5+430 TO 5+490	1:1
5+490 TO 5+590	1:1 TO 0.3:1

→ CRITICAL - RETAINING WALL REQUIRED

ALTERNATIVE OPTION

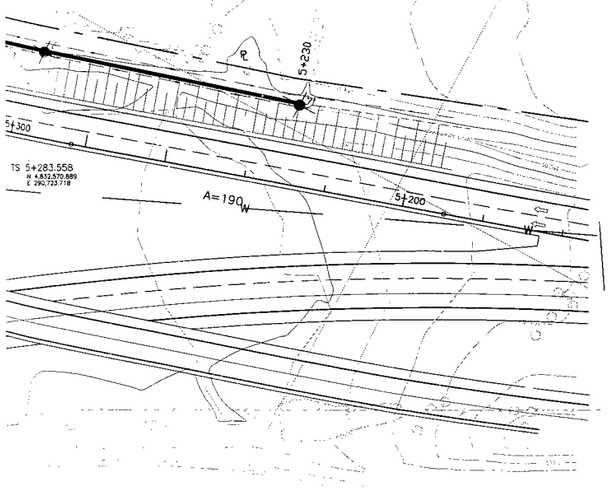
TYPICAL SECTION OF RAMP E-N/S WITHOUT RETAINING WALL
(SEE TABLE)

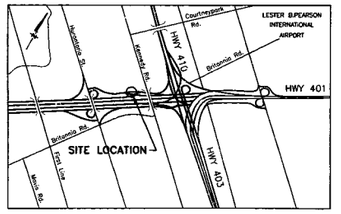
N.T.S.



TYPICAL SECTION OF RAMP E-N/S WITH RETAINING WALL

N.T.S.

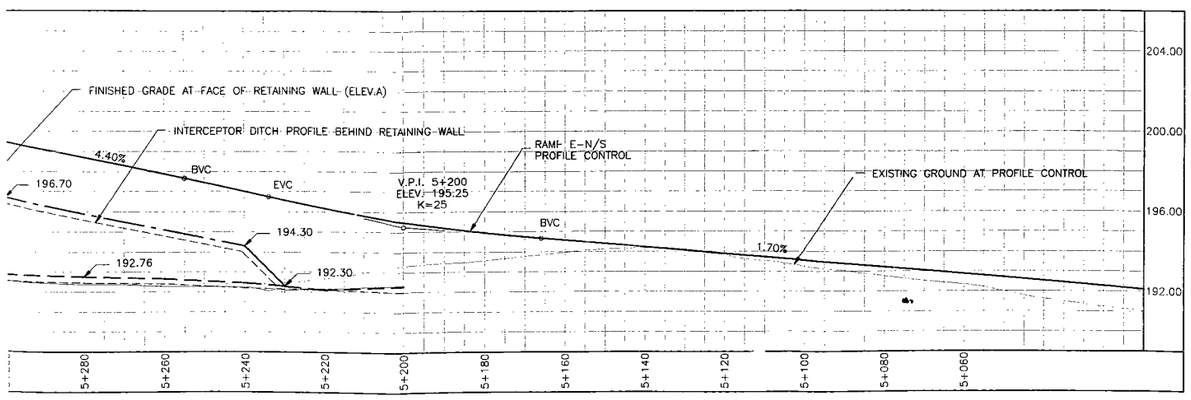




KEY PLAN

2.5km 0 5.0km

1:100,000



E-N/S

PROCTOR & REDFERN LIMITED
CONSULTING ENGINEERS, ARCHITECTS SCIENTISTS, AND PLANNERS
TORONTO, ONTARIO

DATE	REVISION
JUNE 30/94	RAMP E-N/S SHOULDER WIDTHS

MINISTRY OF TRANSPORTATION OF ONTARIO
ENGINEERING AND RIGHT OF WAY OFFICE
SURVEYS AND PLANS SECTION

RETAINING WALL SITE PLAN

PROPOSED RETAINING WALL ADJACENT TO HWY 401 RAMP E-N/S TO HWY 10

LOT 6	CITY OF	CON.1
TWP TORONTO	MISSISSAUGA	REG. MUN. PEEL

SCALE	DISTRICT	REGION
AS SHOWN	6 - TORONTO	CENTRAL
WP 194-94-01	PROFILE	PLAN B-81-401-6
SURVEY APR. 19, 1993	PLAN APR., 1994	
SITE 24-680-RW		