

ENGINEERING MATERIALS OFFICE
PAVEMENT & FOUNDATION DESIGN SECTION

WO 82-26025

DIST 4

HWY GO-ALRT

STR SITE 10

GO-ALRT, West Extension, Oakville Project

- Fourth Line CNR Subway
- Fourth Line GO-ALRT Subway
- Associated Retaining Walls

DISTRIBUTION

K. Pask (5)
G.C.E. Burkhardt (3)
R.D. Gunter
A. Wittenberg
J. Smrcka (2)
K. Bassi
B.J. Giroux
R. Hore
R. Fitzgibbon (Cover Only)
T.J. Kovich (Cover Only)
Files

FOUNDATION INVESTIGATION REPORT

FOR

W.O. 82-26025, Site 10

District 4, Hamilton

GO-ALRT, West Extension, Oakville Project

- Fourth Line CNR Subway
- Fourth Line GO-ALRT Subway
- Associated Retaining Walls

INTRODUCTION

This report summarizes the results of the foundation investigations required for the proposed structures.

The fieldwork was conducted during the period from 83 10 25 to 83 11 17 utilizing continuous flight auger machines equipped with hollow-stem and solid-stem augers, BX casing and BXL core barrels.

This work consisted of:

- 9 dynamic cone penetration tests/sampled boreholes/rock cores,
- 2 boreholes/rock cores
- 2 dynamic cone penetration tests/sampled boreholes,
- 3 dynamic cone penetration tests.

SITE DESCRIPTION

This site is located at the Fourth Line in the Town of Oakville, approximately 650 m south of the QEW. The GO-ALRT alignment is on the existing Ontario Hydro right-of-way, with the CNR to the south.

The area is described physiographically by Chapman and Putnam (1969) as the South Slope, which, in the vicinity of the site, consists generally of a shale plain overlain by a veneer of glacial drift. These soils have originated, to a large extent, from the underlying bedrock, although some imported glacial material is also present.

The topography at this site is flat.

The land use in the area is light industrial/commercial.

SUBSURFACE CONDITIONS

General

The Record of Borehole Sheets, (Appendix) illustrate the conditions at the borehole locations. The locations and elevations of the boreholes, and stratigraphical profiles based on the borehole data, are shown on the Borehole Locations & Soil Strata Drawing for Fourth Line.

The overburden generally consists of 1 to 3 metres of stiff to hard silty clay overlying the Queenston Formation shale bedrock. The elevation of the bedrock surface at this site is in the order of 101.0 m - the upper 1± m being weathered. Below the weathered zone, the bedrock is generally sound and intact.

It was necessary to interpolate the subsurface conditions for the footing locations on the CNR right-of-way because of property and utility constraints. However, due to the generally uniform nature of the bedrock topography in this area, interpolation can be made with a reasonable amount of confidence.

Overburden

SILTY SAND

This loose to compact material is non-cohesive.

It contains traces to some sand, and traces of gravel.

Up to 0.9 m of this material was encountered beneath the asphalt pavement of Fourth Line. At BH #19 and BH #23, silty sand extends from the surface to a depth of 2 ± m. At BH #1 and BH #10, up to 1 m of silty sand was encountered below a 1 m covering of silty clay. Seams of silty sand, up to 0.3 m thick were encountered at BH #21 and BH #22, under 2.3 to 3.4 m of silty clay.

Figure 1 illustrates a typical grain size distribution for this material.

SILTY CLAY (CL to CI)

This soft to hard (generally firm to very stiff) material is cohesive with low to intermediate plasticity.

It contains occasional shaly layers, traces to some sand, and traces of gravel.

Generally, this material overlies the bedrock and ranges in thickness from 0.3 to 2.6 m.

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

	<u>Range</u>	<u>Average</u>	<u>Median</u>
Natural Moisture Content (w)	9.0 - 22.5 %	16.3 %	16.5 %
Liquid Limit (W_L)	31.0 - 50.0 %	35.8 %	33.0 %
Plastic Limit (W_p)	14.0 - 18.0 %	16.4 %	16.5 %

Figure 2 illustrates a typical grain size distribution for this material.

Bedrock

The site is underlain by shale of the Queenston Formation. The shale is predominantly red containing occasional (approximately 5 - 10%) green shale and siltstone layers and stronger limestone layers from approximately 10 to 100 mm. The upper bedrock is weathered to varying degrees (see borehole logs), and becomes sound with depth. The sound bedrock is generally massive (i.e. it is not intersected by natural discontinuities) and is estimated to be of low unconfined compressive strength (i.e. 4 - 15 MPa). Refer to Table 1 (Appendix) for descriptions of the rock core that was recovered at this site.

Groundwater

Stabilized groundwater conditions were difficult to establish because of the impermeable nature of the overburden and the generally intact nature of the bedrock. At the time of the field investigation the groundwater elevation was estimated at 102.5± m at this site. Slight fluctuations in this level are expected to occur seasonally.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct two subways to carry the proposed GO-ALRT and the existing CNR over Fourth Line at a grade of 104± m.

This project will involve the following proposed structures:

- 1) GO-ALRT 2-span subway and associated retaining walls. Refer to Figure A and Figure B-1 (Section T-T).
- 2) CNR 2-span subway and associated retaining walls. Refer to Figure A and Figure B-2 (Section S-S).

The following general recommendations and design details refer to all structures.

General Recommendations

- Earth pressure acting on abutments and retaining walls should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a non-yielding foundation with $K_0 = 0.43$ and $\gamma = 22.0 \text{ kN/m}^3$ for Granular A backfill; $K_0 = 0.5$ and $\gamma = 21.2 \text{ kN/m}^3$ for Granular C backfill.
- For frost protection, cover should be greater than 1.2 m.
- No stability problems are anticipated for embankments or cuts with slopes of 2:1 or flatter. If steeper slopes are required please contact this section for recommended slope angles and erosion protection.
- Differential settlements in the structures will be negligible.
- Dewatering is not anticipated to be a major problem because of the impermeable nature of the overburden and the generally intact nature of the bedrock. It is believed that groundwater entering the excavations can be controlled by conventional pumping techniques.
- Excavations in bedrock may be accomplished without blasting techniques.

Design Details

Two alternatives are recommended.

All structures may be founded on spread footings (Refer to Figs. A & B);

- i) within Zone 2 (weathered bedrock),
- or ii) within Zone 3 (sound bedrock).

For these alternatives, all soft or loose material at the proposed footing locations should be removed, and the foundation surface should be covered within 12 hours of exposure with a 15 cm pad of mass concrete.

Where trenches (e.g. underground utilities) are encountered they should be excavated to sound bedrock and backfilled (within 12 hours of exposure) with mass concrete.

For resistance to lateral forces,

- a) key footing into bedrock a minimum of 0.5 m and use a friction coefficient of ~~0.25~~ ^{tan 25 (0.47)} between the bedrock and the footing, or
- b) dowel into bedrock a minimum of 1.5 m (as a design example a 5 cm diameter dowel installed as recommended will provide a safe shear-ing resistance of approximately 20 kN per dowel).

The following design values are recommended for footings within the indicated foundation zones:

- net safe bearing pressure
 - for Zone 2 = 670 kPa
 - for Zone 3 = 1000 kPa

and for the purposes of the O.H.B.D.C.:

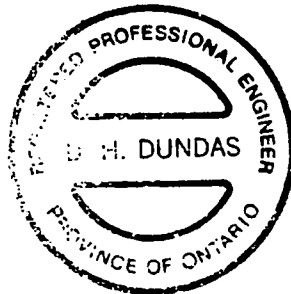
- Factored Bearing Capacity at U.L.S.
 - for Zone 2 = 1000 kPa
 - for Zone 3 = 1500 kPa
- Bearing Capacity at S.L.S. Type II will not govern design.

MISCELLANEOUS

The fieldwork for this project was carried out under the supervision of Mr. P. Dempsey, Student Specialist, and Mr. D. H. Dundas, Foundations Engineer. The description and evaluation of the bedrock was carried out by Mr. E. Magni, Geologist.

The report was written by Mr. Dundas, and reviewed by Mr. K. G. Selby, Senior Foundations, Engineer.

The equipment used was owned and operated by Atcost Soil Drilling Inc.



D. H. Dundas
D. H. Dundas, P.Eng.
Foundations Engineer

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

APPENDIX

Fourth Line Subways										RECORD OF BOREHOLE No 1										METRIC									
WO 82-25026										LOCATION Co-ords N 4 810 314.5 E 288 249.5										ORIGINATED BY DD									
DIST 4 HWY GO-ALRT										BOREHOLE TYPE Cone Test, H-S Auger, BXL Core										COMPILED BY DD									
DATUM Geodetic										DATE 83 10 25										CHECKED BY SO									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)															
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp	W	WL	WATER CONTENT (%)																	
102.9	Ground Surface																												
0.0	Silty Clay (CL) trace/some sand trace gravel Stiff																												
102.1																													
0.8	Silty Sand trace clay compact to loose		1	SS	10									0 81 11 8															
101.1			2	SS	4									1 69 15 15															
1.8	* Silty Clay (CL)		3	SS	60/									5 18 62 15															
100.8			4	RC	71%																								
2.1			5	RC	100%																								
	weathered sound		6	RC	97%																								
	Bedrock Queenston Formation Shale		7	RC	67%																								
97.9				BXL																									
5.0	End of Borehole																												
	* occ. shaly layers trace/some sand trace gravel soft to very stiff																												

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RECORD OF BOREHOLE No 2										METRIC			
Fourth Line Subways										ORIGINATED BY PD			
WO 82-26025 LOCATION Co-ords N 4 810 330.5 E 288 262.0										COMPILED BY DD			
DIST 4 HWY GO-ALRT BOREHOLE TYPE Cone Test, Hollow Stem Auger										CHECKED BY SO			
DATUM Geodetic DATE 83 10 26													
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100		W _p	W		
102.7	Ground Surface												
0.0	Silty Clay (CL) occ. shaly layers trace/some sand trace gravel Stiff to Very Stiff		1	SS	17	**							
101.0			2	SS	22								
1.7	*Bedrock												
100.5	Weathered		3	SS	60								
2.2	End of Borehole												
	* Queenston Formation Shale												
	** water level not observed												

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Fourth Line Subways										RECORD OF BOREHOLE No 3										METRIC	
WO 82-26025					LOCATION Co-ords N 4 810 338.5 E 288 255.0					ORIGINATED BY DD											
DIST 4 HWY GO-ALRT					BOREHOLE TYPE Cone Test, H.S. Auger, BXL Core					COMPILED BY DD											
DATUM Geodetic					DATE 83 10 25					CHECKED BY SO											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	WATER CONTENT (%) 10 20 30												
102.8	Ground Surface																				
0.0	Silty Clay (CL to CI) occ. shaly layers trace/some sand trace gravel Stiff to Very Stiff		1	SS	18									0 19 35 46							
101.4			2	SS	97									23 16 44 17							
1.4			3	RC BXL	89%																
	Weathered Sound																				
	Bedrock Queenston Formation Shale		4	RC BXL	100%																
98.3																					
4.5	End of Borehole																				

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
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Fourth Line Subways										RECORD OF BOREHOLE No 4										METRIC	
WO 82-26025		LOCATION Co-ords N 4 810 345.5 E 288 247.5								ORIGINATED BY DD											
DIST 4 HWY GO-ALRT		BOREHOLE TYPE Cone Test								COMPILED BY DD											
DATUM Geodetic		DATE 83 10 26								CHECKED BY SO											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60						80	100				
102.7	Ground Surface																				
0.0	Probable Silty Clay (CL) occ. shaly layers trace/some sand trace gravel					**															
101.2																					
101.0	*																				
1.7	End of Cone Test																				
	* Probable Bedrock Weathered Queenston Formation Shale																				
	** water level not observed																				

+³, x⁵: Numbers refer to Sensitivity

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5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 6

METRIC

Fourth Line Subways

WO 82-26025

LOCATION Co-ords N 4 810 386.0 E 288 278.5

ORIGINATED BY PD

DIST 4 HWY GO-ALRT

BOREHOLE TYPE Cone Test

COMPILED BY DD

DATUM Geodetic

DATE 83 10 26

CHECKED BY SO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
102.5	Ground Surface										
0.0	Probable Silty Clay (CL) occ. shaly layers trace/some sand trace gravel					**	102				
101.3											
101.1	*										
1.4	End of Cone Test * Probable Bedrock Weathered Queenston Formation Shale ** water level not observed										

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+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
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RECORD OF BOREHOLE No 7										METRIC			
Fourth Line Subways													
WO 82-26025		LOCATION Co-ords N 4 810 378.0 E 288 285.5						ORIGINATED BY PD					
DIST 4 HWY GO-ALRT		BOREHOLE TYPE Cone Test, H-S Auger, BXL Core						COMPILED BY DD					
DATUM Geodetic		DATE 83 10 25						CHECKED BY SO					
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100	Wp	W	Wl		
102.3	Ground Surface												
0.0	Silty Clay (CL) occ. shaly layers trace/some sand trace gravel Stiff to Hard		1	SS	37								6 8 63 23
100.9			2	RC BXL	61%								
1.4	Weathered Sound		3	RC BXL	98%								
	Bedrock Queenston Formation Shale		4	RC BXL	92%								
97.9													
4.4	End of Borehole												

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+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
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Fourth Line Subways										RECORD OF BOREHOLE No 8										METRIC	
WO 82-26025					LOCATION Co-ords N 4 810 371.0 E 288 292.5					ORIGINATED BY PD											
DIST 4 HWY GO-ALRT					BOREHOLE TYPE Cone Test					COMPILED BY DD											
DATUM Geodetic					DATE 83 10 26					CHECKED BY SO											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W			W _L				
102.2	Ground Surface																				
0.0	Probable Silty Clay (CL) occ. shaly layers trace/some sand trace gravel					**	102														
101.0							101														
1.2	Probable Bedrock																				
100.4	*Weathered																				
1.8	End of Cone Test																				
	* Queenston Formation Shale																				
	** water level not observed																				

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
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Fourth Line Subways										RECORD OF BOREHOLE No 9										METRIC	
WO		82-26025		LOCATION		Co-ords N 4 810 387.0 E 288 305.5				ORIGINATED BY		PD									
DIST		4 HWY GO-ALRT		BOREHOLE TYPE		Cone Test, H-S Auger, BXL Core				COMPILED BY		DD									
DATUM		Geodetic		DATE		83 10 25				CHECKED BY		SO									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)											
102.2	Ground Surface																				
0.0	Silty Clay (CL) occ. shaly layers trace/some sand trace gravel Stiff to Hard		1	SS	115									3 13 62 22							
101.1	Weathered Sound		2	RC BXL	98%																
1.1	Bedrock Queenston Formation Shale		3	RC BXL	100%																
97.9	End of Borehole																				
4.3																					

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Fourth Line Subways										RECORD OF BOREHOLE No 10										METRIC	
WO 82-26025					LOCATION Co-ords N 4 810 323.0 E 288 256.0					ORIGINATED BY DD											
DIST 4 HWY GO-ALRT					BOREHOLE TYPE Cone Test, H-S Auger					COMPILED BY DD											
DATUM Geodetic					DATE 83 10 26					CHECKED BY SO											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60						80	100				
102.9	Ground Surface					**															
0.0	Silty Clay (CL) trace/some sand trace gravel Stiff																				
102.1																					
0.8	Silty Sand trace clay Compact to Loose		1	SS	9																
101.2																					
1.7	* Silty Clay (CL)		2	SS	5																
100.9																					
2.0	* Bedrock																				
100.5	Weathered		3	SS	100																
2.4	End of Borehole																				
	* occ. shaly layers trace/some sand trace gravel Firm to Very Stiff																				
	** water level not observed																				

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Fourth Line Subways										RECORD OF BOREHOLE No 19										METRIC									
WO 82-26025										LOCATION Co-ords N 4 810 302.5 E 288 306.5										ORIGINATED BY DD									
DIST 4 HWY GO-ALRT										BOREHOLE TYPE Cone, S-S Auger, BXL Core										COMPILED BY DD									
DATUM Geodetic										DATE 83 10 27										CHECKED BY SO									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)														
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	WATER CONTENT (%)	10 20 30																
102.8	Ground Surface														GR SA SI CL														
0.0	Silty Sand trace clay Compact		1	SS	13										0 82 14 4														
101.0			2	SS	10										0 68 20 12														
100.7	*Silty Clay (CL)		3	SS	60/	15 cm																							
2.1	Weathered Sound		4	RC BXL	78%																								
	Bedrock Queenston Formation Shale		5	RC BXL	78%																								
98.1	Weathered Zone																												
4.7	End of Borehole																												
	* occ. shaly layers trace/some sand trace gravel stiff																												

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+3, x5 : Numbers refer to Sensitivity

20
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5 (%) STRAIN AT FAILURE



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Fourth Line Subways										RECORD OF BOREHOLE No 20										METRIC									
WO 82-26025										LOCATION Co-ords N 4 810 355.5 E 288 268.5										ORIGINATED BY PD									
DIST 4 HWY GO-ALRT										BOREHOLE TYPE Cone Test, S-S Auger, BXL Core										COMPILED BY DD									
DATUM Geodetic										DATE 83 10 27										CHECKED BY SO									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)																
ELEV. DEPTH	DESCRIPTION	STRAT. PLT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp W WL	WATER CONTENT (%)	10 20 30																		
103.5	Ground Surface																												
0.0	Asphalt, Hard																												
102.6	Silty Sand some grave, trace clay Compact		1	SS	13																								
0.9	and sand Silty Clay (CL to CI) occ. shaly layers trace/some sand trace gravel		2	SS	8																								
101.4	Firm to Stiff		3	SS	92/23	cm																							
2.1	Weathered Sound		4	RC BXL	93%																								
	Bedrock Queenston Formation Shale		5	RC BXL	95%																								
97.9	End of Borehole																												
5.6																													

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+3, x5: Numbers refer to Sensitivity

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15 \pm 5 (%) STRAIN AT FAILURE
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Fourth Line Subways										RECORD OF BOREHOLE No 21										METRIC	
WO 82-26025					LOCATION Co-ords N 4 810 323.0 E 288 324.5					ORIGINATED BY PD											
DIST 4 HWY GO-ALRT					BOREHOLE TYPE Cone Test, S-S Auger, BXL Core					COMPILED BY DD											
DATUM Geodetic					DATE 83 10 27					CHECKED BY SO											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)											
102.4	Ground Surface																				
0.0	Silty Clay (CL to CI) occ. shaly layers trace/some sand trace gravel Very Stiff to Stiff		1	SS	17									0 10 63 27							
	Silty Sand		2	SS	11									0 73 17 10 0 17 59 28							
100.3			3	SS	60	15 cm															
2.1	Weathered Sound		4	RC BXL	92%																
	Bedrock Queenston Formation Shale		5	RC BXL	97%																
96.9																					
5.5	End of Borehole																				

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Fourth Line Subways

RECORD OF BOREHOLE No 22

METRIC

WO 82-26025

LOCATION Co-ords N 4 810 335.0 E 288 334.5

ORIGINATED BY PD

DIST 4 HWY GO-ALRT

BOREHOLE TYPE Cone Test, S-S Auger, BXL Core

COMPILED BY DD

DATUM Geodetic

DATE 83 10 28

CHECKED BY SO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
103.0	Ground Surface												
0.0	Silty Clay (CL) occ. shaly layers trace/some sand trace gravel Stiff to Very Stiff		1	SS	10								
			2	SS	20								
100.4	Silty Sand		3	SS	26								
2.6			4	SS	92								
	Weathered Sound		5	RC BXL	100%								
	Bedrock Queenston Formation Shale		6	RC BXL	100%								
96.5													
6.5													

+3, x5: Numbers refer to
Sensitivity

20
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(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 23

METRIC

Fourth Line Subways

WO 82-26025

LOCATION Co-ords N 4 810 285.0 E 288 292.5

ORIGINATED BY PD

DIST 4 HWY GO-ALRT

BOREHOLE TYPE Cone Test, S-S Auger, BXL Core

COMPILED BY DD

DATUM Geodetic

DATE 83 10 28

CHECKED BY SO

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SH CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
102.6	Ground Surface											
0.0	Silty Sand trace clay Compact to Loose		1	SS	11							
			2	SS	5							
100.5			3	SS	60/							
2.1	Weathered Sound		4	RC BXL	97%	15 cm						
98.6	Bedrock Queenston Formation Shale											
4.0	End of Borehole											

+3, x5 : Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation and
Communications
Ontario

Fourth Line Subways										RECORD OF BOREHOLE No 44										METRIC	
WO 82-25026					LOCATION Co-ords. N 4 810 321 E 288 327					ORIGINATED BY DD											
DIST 4 HWY GO-ALRT					BOREHOLE TYPE S-S Auger, BXL Core					COMPILED BY DD											
DATUM Geodetic					DATE 83 11 14-15					CHECKED BY SO											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	Wp	W	W _L	WATER CONTENT (%)									
102.4	Ground Surface																				
100.3	Probable Silty Clay (CL) occ. shaly layers trace/some sand trace gravel																				
2.1	Weathered Sound		1	RC BXL	63%																
	Bedrock Queenston Formation Shale		2	RC BXL	100%																
			3	RC BXL	100%																
95.4	End of Borehole																				
7.0																					

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
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Ontario

Fourth Line Subways		RECORD OF BOREHOLE No 45										METRIC				
WO 82-26025		LOCATION Co-ords N 4 810 337 E 288 257										ORIGINATED BY PD				
DIST 4 HWY GO-ALRT		BOREHOLE TYPE S-S Auger, BXL Core										COMPILED BY DD				
DATUM Geodetic		DATE 83 11 17										CHECKED BY SO				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p W W _L	WATER CONTENT (%)						
102.8	Ground Surface															
0.0	Probable Silty Clay (CL) occ. shaly layers trace/some sand trace gravel															
101.4																
1.4																
	Weathered Sound		1	RC BXL	58%											
			2	RC BXL	100%											
	Bedrock															
	Queenston Formation Shale		3	RC BXL	88%											
			4	RC BXL	100%											
			5	RC BXL	75%											
95.2	End of Borehole															
7.6																

OFFICE REPORT ON SOIL EXPLORATION

+³, x⁵: Numbers refer to
Sensitivity

20
15 → 5 (%) STRAIN AT FAILURE
10

TABLE 1

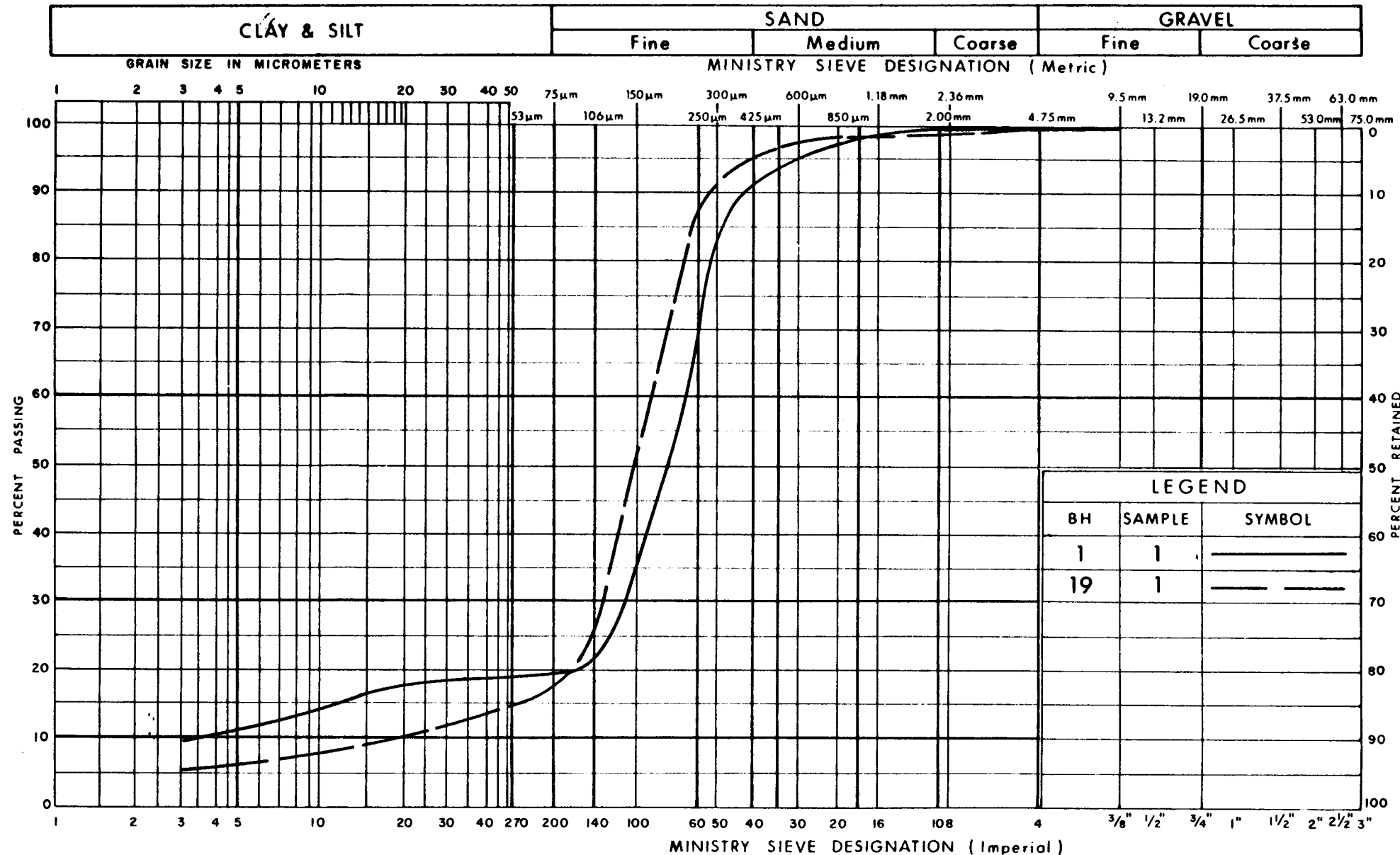
DESCRIPTION OF ROCK CORE - FOURTH LINE

BOREHOLE NUMBER	CORE RECOVERY		CORE DESCRIPTION	
	DEPTH (m)	%	DEPTH (m)	DESCRIPTION
1	2.3 - 2.8	71	2.3 - 2.8	Shale, red (Queenston Fm), highly to slightly weathered
	- 3.1	100		
	- 4.2	97	2.8 - 5.0	Shale, red, occasional green (Queenston Fm), sound; high core loss 4.2 - 5.0 m, apparently due to drilling
	- 5.0	67		
3	1.8 - 3.2	89	1.8 - 2.4	Shale, red (Queenston Fm), highly weathered
	- 4.5	100	2.4 - 3.0	Shale, red (Queenston Fm), slightly to moderately weathered, contain- ing approximately 20% limestone layers
			3.0 - 4.5	Shale, red (Queenston Fm), sound, containing approximately 10% lime- stone layers
7	1.4 - 2.4	61	1.4 - 2.3	Shale, red (Queenston Fm), moderately weathered
	- 3.8	98	2.3 - 4.4	Shale, red (Queenston Fm), sound, containing approximately 10% silt- stone layers
	- 4.4	92		
9	1.2 - 2.4	98	1.2 - 1.4	Shale, red (Queenston Fm), moderately weathered
	- 4.3	100	1.4 - 4.3	Shale, red (Queenston Fm), sound, containing approximately 5% lime- stone and siltstone layers
19	2.4 - 3.8	78	2.4 - 2.8	Presumed zone of core loss
	- 4.7	78	2.8 - 4.2	Shale, red (Queenston Fm), sound
			4.2 - 4.7	Shale, red (Queenston Fm), highly weathered
20	2.7 - 4.2	93	2.7 - 2.9	Shale, red (Queenston Fm), slightly to moderately weathered
	- 5.7	95	2.9 - 5.7	Shale, red (Queenston Fm), sound

TABLE 1
DESCRIPTION OF ROCK CORE - FOURTH LINE - continued

BOREHOLE NUMBER	CORE RECOVERY		CORE DESCRIPTION	
	DEPTH (m)	%	DEPTH (m)	DESCRIPTION
21	2.4 - 4.0	92	2.4 - 2.5	Shale, red (Queenston Fm), slightly weathered
	- 5.5	97	2.5 - 3.7	Shale, red (Queenston Fm), sound
22	3.5 - 5.0	100	3.5 - 3.8	Shale, red (Queenston Fm), slightly weathered
	- 6.5	100	3.8 - 6.5	Shale, red (Queenston Fm), sound
23	2.5 - 4.0	97	2.5 - 2.8	Shale, red (Queenston Fm), moderately weathered
			2.8 - 4.0	Shale, red (Queenston Fm), sound
44	2.4 - 4.0	63	2.4 - 4.0	Shale, red (Queenston Fm), moderately weathered
	- 5.5	100		
	- 7.0	100	4.0 - 7.0	Shale, red (Queenston Fm), sound, containing occasional limestone layers
45	1.8 - 2.1	58	1.8 - 2.4	Shale, red (Queenston Fm), moderately weathered
	- 3.7	100		
	- 5.4	88	2.4 - 7.6	Shale, red (Queenston Fm), sound, containing occasional limestone layers
	- 7.0	100		
	- 7.6	75		

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation and
Communications

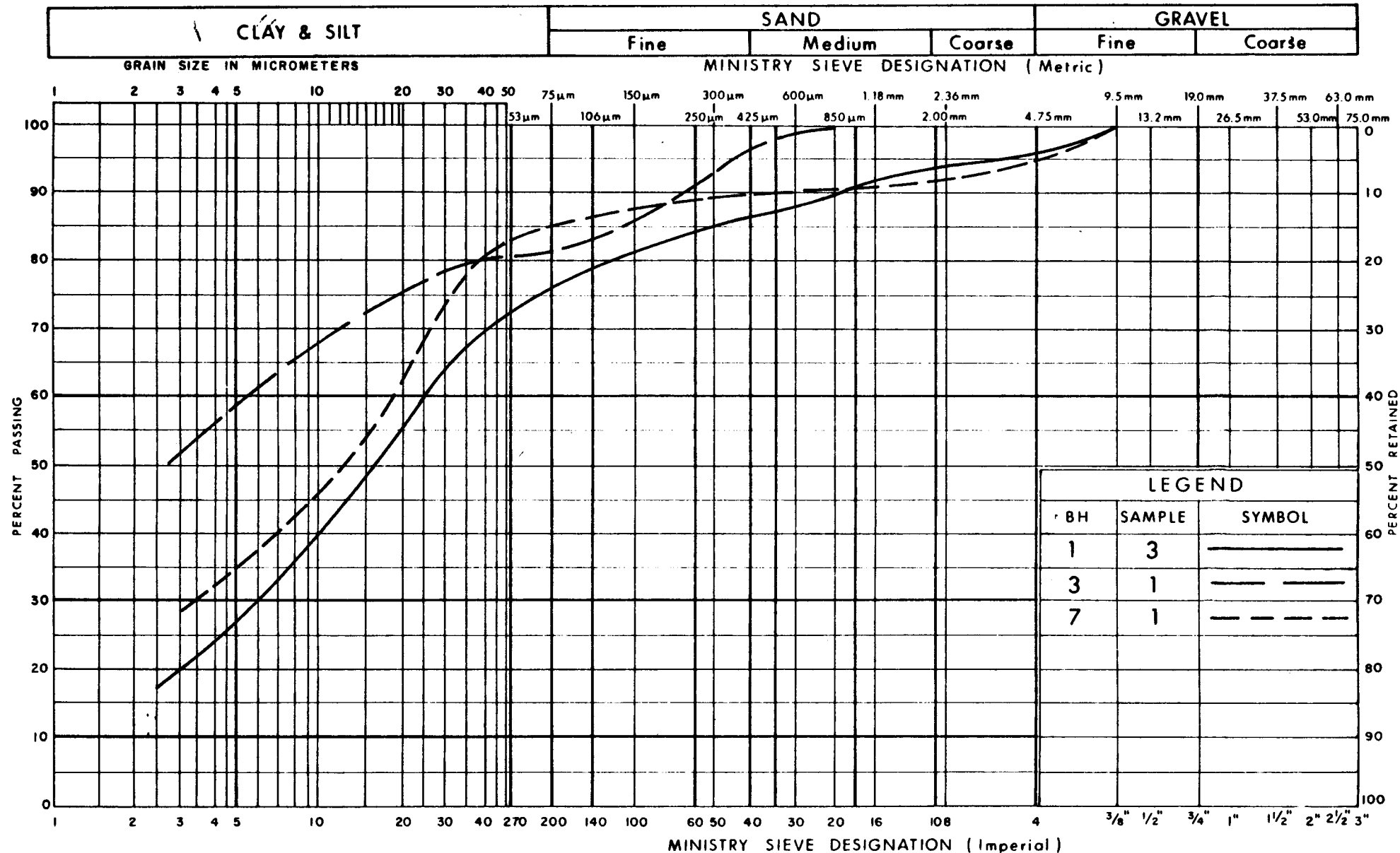
GRAIN SIZE DISTRIBUTION
SILTY SAND
TRACE CLAY

FIG No 1

GO - ALRT

FOURTH LINE SUBWAYS

UNIFIED SOIL CLASSIFICATION SYSTEM



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Communications

GRAIN SIZE DISTRIBUTION SILTY CLAY

OCC SHALY LAYERS, TRACE / SOME SAND, TRACE OF GRAVEL

FIG No 2

GO-ALRT

FOURTH LINE SUBWAYS

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

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						

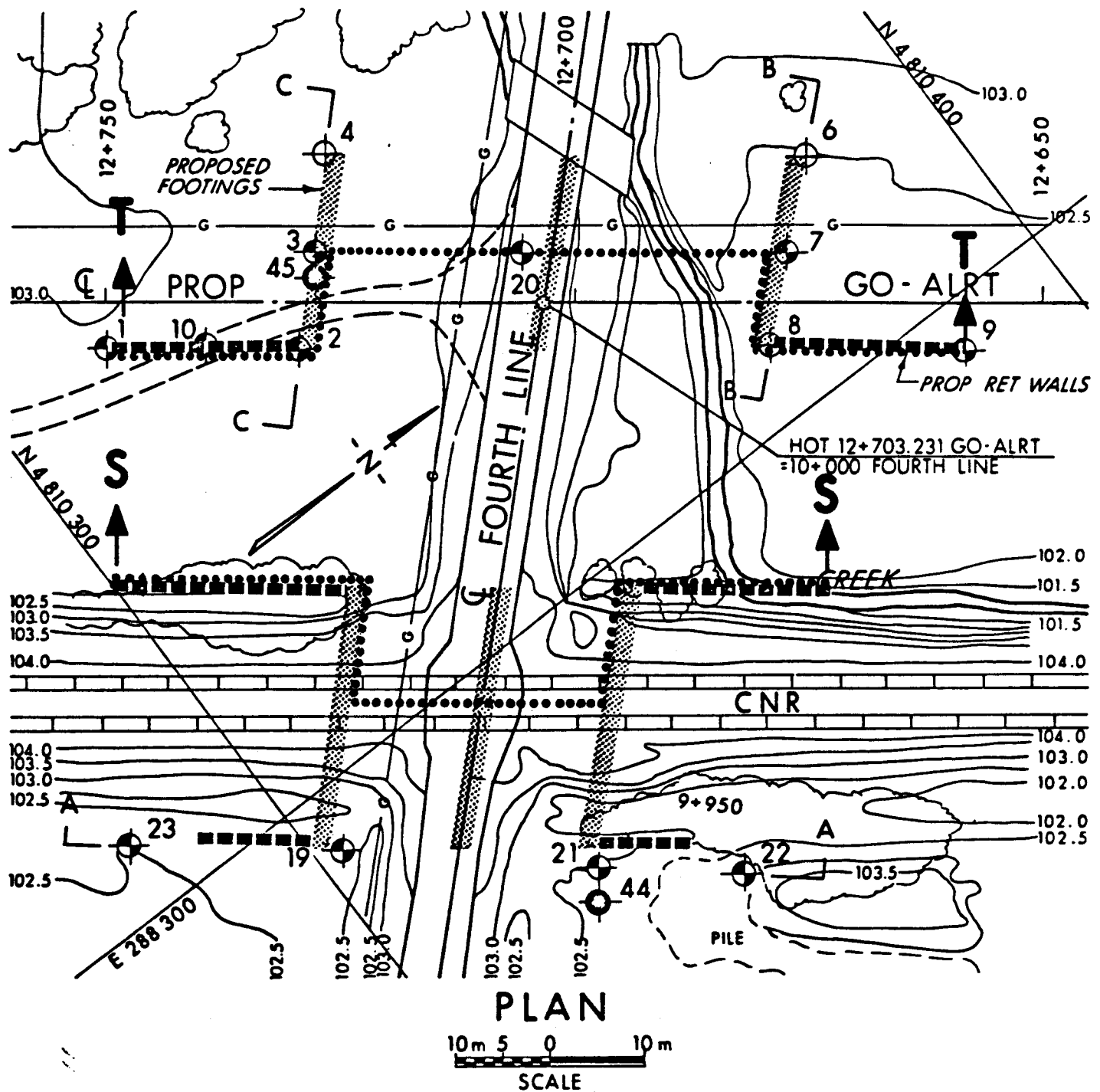


FIGURE A

PLAN SHOWING RECOMMENDATIONS SECTIONS

GO-ALRT - FOURTH LINE SUBWAYS



Ontario

Ministry of
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Communications

Tel: (416) 248-3282

Foundation Design Section
Engineering Materials Office
Room 315, Central Building
1201 Wilson Avenue
Downsview, Ontario
M3M 1J8

1984 10 23

M.M. Dillon Ltd.
Consulting Engineers
and Planners
1425 Bishop Street
Cambridge, Ontario
N1R 6J9

Attention: D. McKinnon

RE: 4th Line/CNR Subway
4th Line/GO-ALRT Subway
Associated Retaining Walls

Dear Sir,

This letter contains recommendations given to you previously by telephone which relate to various aspects of the design and construction of the above-mentioned project.

- (1) Based on the results of laboratory tests carried out on rock samples, we recommend that you assume for design purposes a friction coefficient of $\tan 25^\circ$ to apply between the essentially horizontal bedding planes of material described in our report as 'sound shale' and $\tan 22^\circ$ for material described as 'weathered shale'.

- (2) For computation of earth/rock pressures the following physical properties should be assumed:-

Overburden & upper 1 m of weathered shale bedrock

Unit Weight	- 24 kN/m ³
Friction Angle	- 30°

Sound shale bedrock and weathered shale
bedrock below 1 m

Unit Weight	- 26 kN/m ³
-------------	------------------------

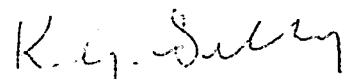
- (3) For resistance to lateral forces to supplement frictional resistance along the footing base a key cut into the sound shale bedrock below the footing should be constructed. The minimum depth should be 0.5 m. Provided that concrete is placed against the 'undisturbed' rock face the key should provide a resisting pressure of 1 MPa against lateral forces.

- (4) Passive resistance in front of footings should be discounted except for that portion below the frost penetration zone (1.2 m depth). If necessary we will provide recommendations for specific cases.
- (5) Temporary cut slopes in the overburden and the upper 1 m of weathered shale bedrock should not be steeper than 1.5 horizontal to 1 vertical.
- (6) Temporary cut slopes in the sound shale bedrock and the weathered shale bedrock below 1 m depth, may be constructed with slopes of 1 horizontal to 3 vertical.
- (7) For rock anchors installed in the shale bedrock an ultimate bond stress of 600 kPa should be assumed to apply at the shale/grout interface. This value is derived from pulling tests in Queenston shale carried out in the past by this Section.
- (8) Backfill to structures should consist of Granular 'A' or 'B' in accordance with Standard Special Provision No. 121 dated October, 1983. Earth pressures acting on the wall may be computed in accordance with Section 6.6.1.1.1 of the O.H.B.D.C. assuming a non yielding foundation in which case the 'at rest' condition applies. The physical properties to be assumed for the backfill are as follows:
$$\begin{aligned} \text{Granular 'A' - } \phi &= 35^\circ, & &= 22.0 \text{ kN/m}^3 \\ \text{Granular 'B' - } \phi &= 30^\circ, & &= 21.2 \text{ kN/m}^3 \end{aligned}$$

Values of K_o therefore are 0.43 for Granular 'A' and 0.50 for Granular 'B'.
- (9) The pumping station to be constructed in the bedrock should be filled around with a minimum of 1 m width of Granular 'A' and a suitable drain provided. For pressures on the walls use the parameters in (8) above.

I believe the foregoing answers all of the queries contained in your letters. If further information or advice is required please contact the undersigned.

Yours truly,



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

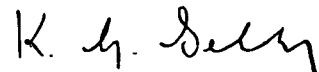
KGS/mmj

c.c. - K. Pask
G. Burkhardt
W. Lin

- (11) With regard to the proposal contained in your letter of 84 02 16 to eliminate shoring for the first stage construction of the C.N. subway along the north side we do not feel that this would provide adequate safety. The shale bedrock deteriorates rapidly on exposure to weather and will also expand laterally towards the cut face due to release of lateral pressure. Vertical tension cracks parallel to the face will develop as a consequence since the tensile strength of the shale is small compared to its compressive strength. In our view shoring is necessary.

I believe the foregoing answers all of the queries contained in your letters. If further information or advice is required please contact the undersigned.

Yours truly,



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

KGS/mmj

c.c. - K. Pask
G. Burkhardt
W. Lin



Ontario

Ministry of
Transportation and
Communications

Tel: (416) 248-3282

Foundation Design Section
Engineering Materials Office
1201 Wilson Avenue
Room 315, Central Building
Downsview, Ontario
M3M 1J8

1984 03 27

Mr. R. Temple, P. Eng.
Chief Bridge Engineer
Fenco Engineers Inc.
33 Yonge Street
Toronto, Ontario
M5E 1E7

RE: 3rd Line/CNR Subway
3rd Line/GO-ALRT Subway
Associated retaining walls

Dear Sir:

This letter contains recommendations given to you previously by telephone which relate to various aspects of the design and construction at the above-mentioned projects some of which were discussed during our meeting of 84 02 07 and others which are referred to in your letters dated 84 02 09 and 84 02 16.

- (1) Based on the results of laboratory tests carried out on rock samples we recommend that you assume for design purposes a friction coefficient of $\tan 25^\circ$ to apply between the essentially horizontal bedding planes of material described in our report as 'sound shale' and $\tan 22^\circ$ for material described as 'weathered shale'.

- (2) For computation of earth/rock pressures the following physical properties should be assumed:-

Overburden & upper 1 m of weathered shale bedrock

Unit Weight $\gamma - 24 \text{ kN/m}^3$

Friction Angle $\phi - 30^\circ$

Sound shale bedrock and weathered shale
bedrock below 1 m

Unit Weight $\gamma - 26 \text{ kN/m}^3$

- (3) For resistance to lateral forces to supplement frictional resistance along the footing base a key cut into the sound shale bedrock below the footing should be constructed. The minimum depth should be 0.5 m. Provided that concrete is placed against the 'undisturbed' rock face the key should provide a resisting pressure of 1 MPa against lateral forces.

- (4) Passive resistance in front of footings should be discounted except for that portion below the frost penetration zone (1.2 m depth). If necessary we will provide recommendations for specific cases.
- (5) Temporary cut slopes in the overburden and the upper 1 m of weathered shale bedrock should not be steeper than 1.5 horizontal to 1 vertical.
- (6) Temporary cut slopes in the sound shale bedrock and the weathered shale bedrock below 1 m depth, may be constructed with slopes of 1 horizontal to 3 vertical.
- (7) For rock anchors installed in the sound shale bedrock at an approximate angle of 45° to the vertical an ultimate bond stress of 600 kPa should be assumed to apply. This value is derived from pulling tests in Queenstone shale carried out in the past by this Section.
- (8) The bonded portions of rock anchors should be located so as to ensure a safety factor of at least 1.5 for sliding and 2.0 for overturning for the shoring system including the rectangular prism of shale bedrock between the shoring and the back of the bonded zone.
- (9) Solder piles to be used in the shoring system should be socketed into the bedrock a minimum of 2 m and concreted. Such a socket should provide a resisting pressure of 1 MPa against lateral forces.
- (10) Backfill to structures should consist of Granular 'A' or 'B' in accordance with Standard Special Provision No. 121 dated October, 1983. Earth pressures acting on the wall may be computed in accordance with Section 6.6.1.2.1 of the O.H.B.D.C. assuming a non yielding foundation in which case the 'at rest' condition applies. The physical properties to be assumed for the backfill are as follows:

Granular 'A' - $\phi = 35^\circ$, $\gamma = 22.0 \text{ kN/m}^3$
Granular 'B' - $\phi = 30^\circ$, $\gamma = 21.2 \text{ kN/m}^3$
Values of K_0 therefore are 0.43 for Granular 'A' and 0.50 for Granular 'B'.

FOURTH LINE SUBWAYS - SUBSURFACE CONDITIONS

CONSTRUCTION EAST →

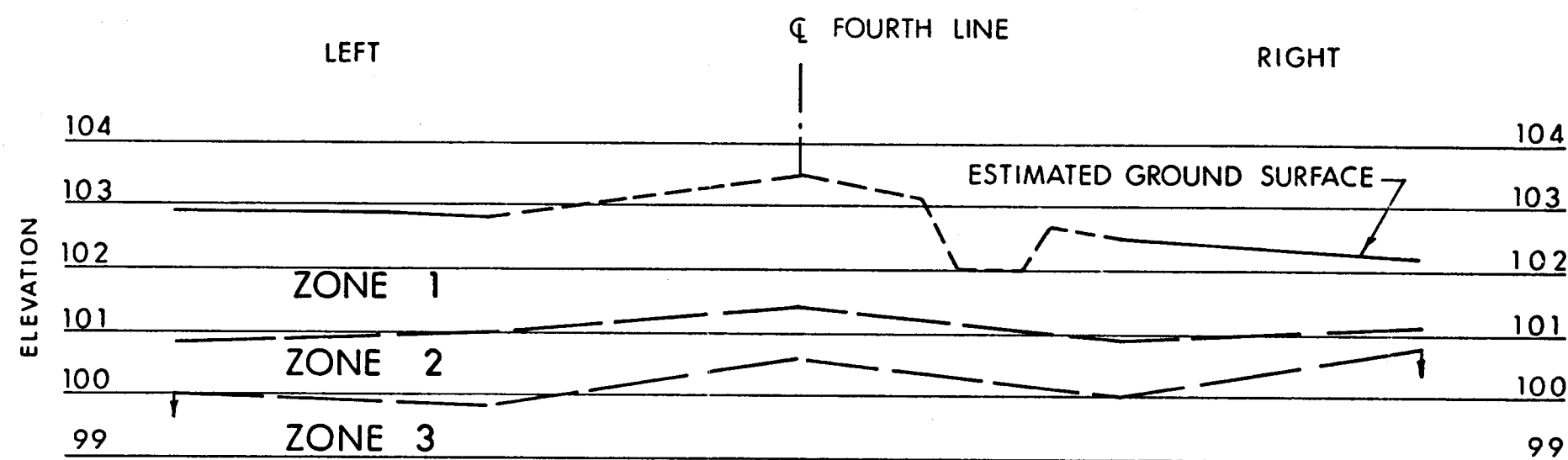


FIG B-1 - LONGITUDINAL SECTION T-T
GO-ALRT SUBWAY & RETAINING WALLS

SCALE HOR 1:500
VERT 1:100

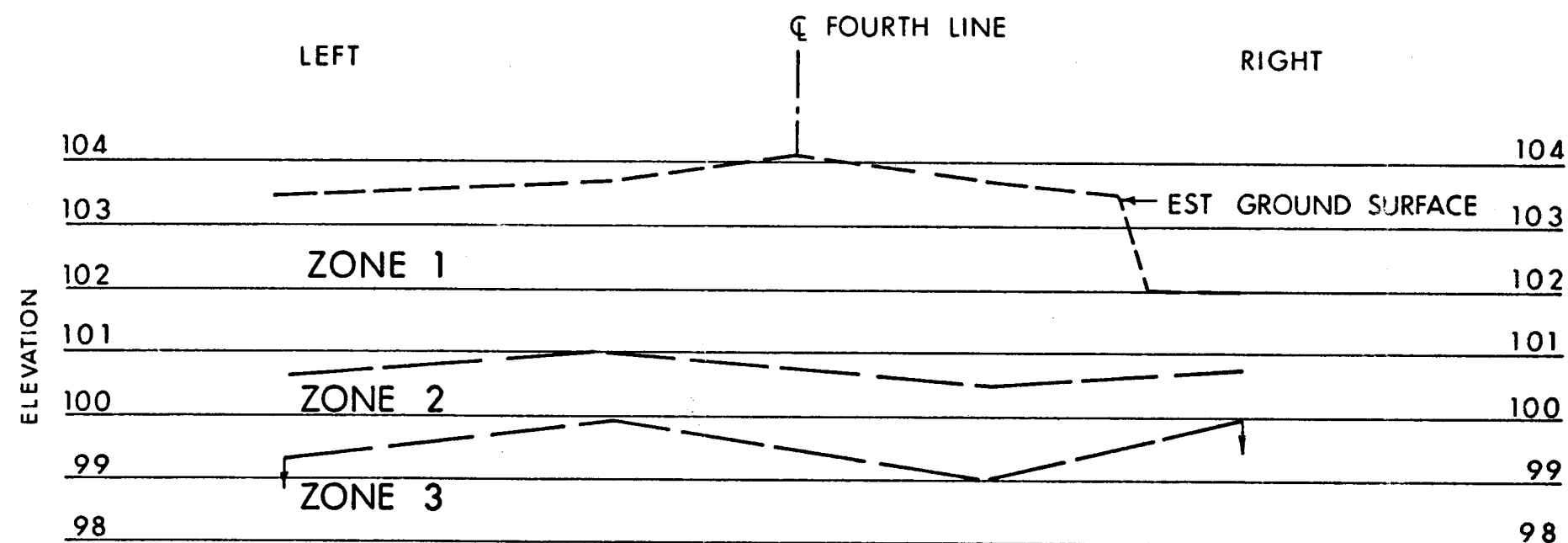


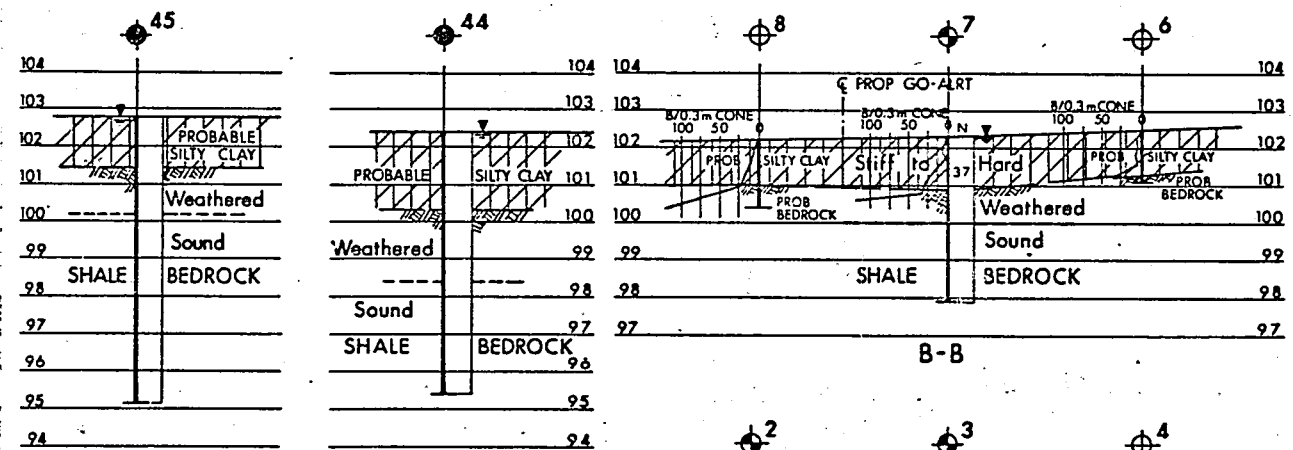
FIG B-2 - LONGITUDINAL SECTION S-S
CNR SUBWAY & RETAINING WALLS

SCALE HOR 1:500
VERT 1:100

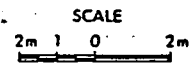
CONSTRUCTION EAST →

FIGURE B

GO-ALRT WEST EXTENSION-OAKVILLE PROJECT

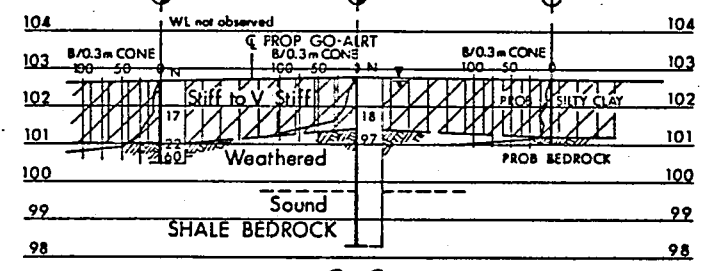


BOREHOLES 44 & 45

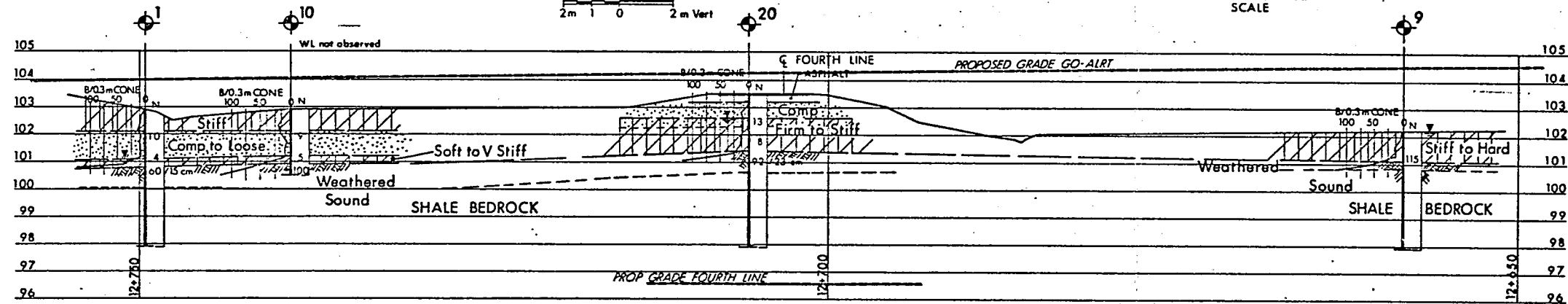
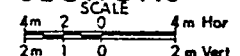


SOIL STRATIGRAPHY LEGEND

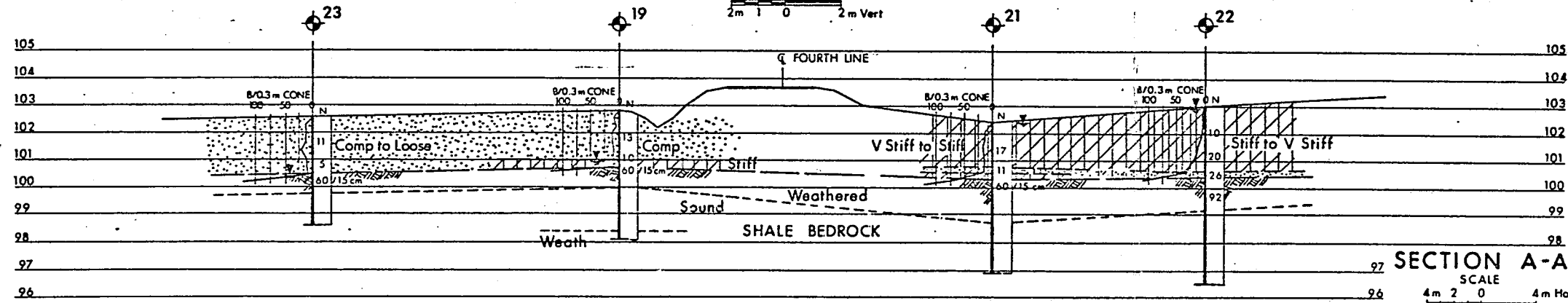
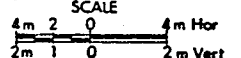
- SILTY SAND TRACE OF CLAY
- SILTY CLAY OCC SHALY LAYERS, TRACE / SOME SAND, TRACE OF GRAVEL



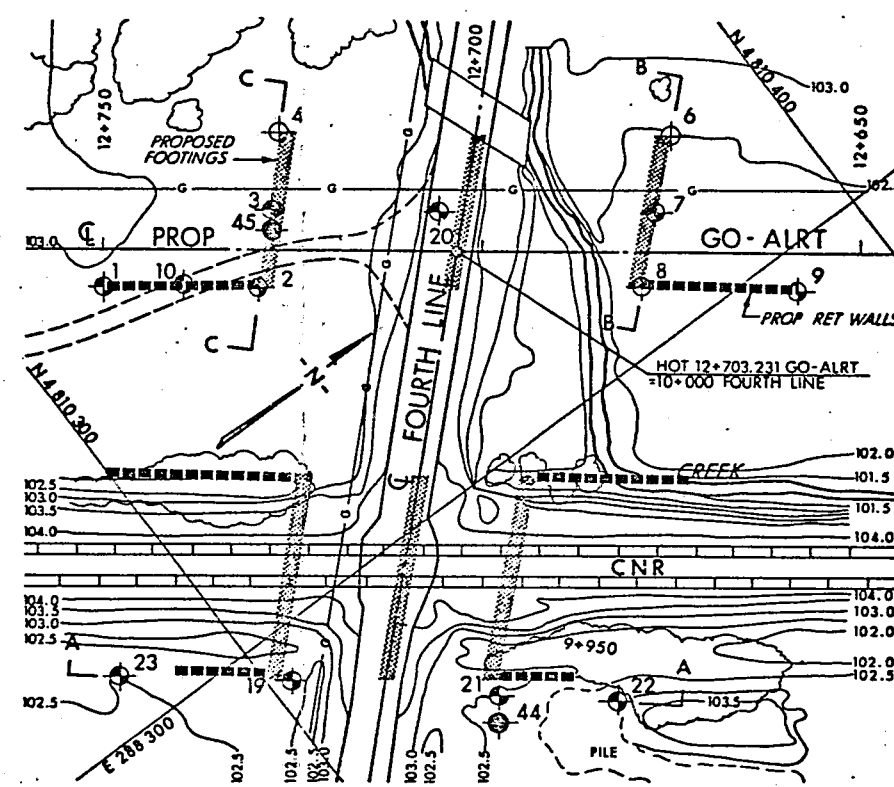
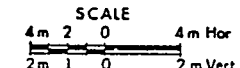
C-C SECTIONS



PROFILE PROP GO-ALRT



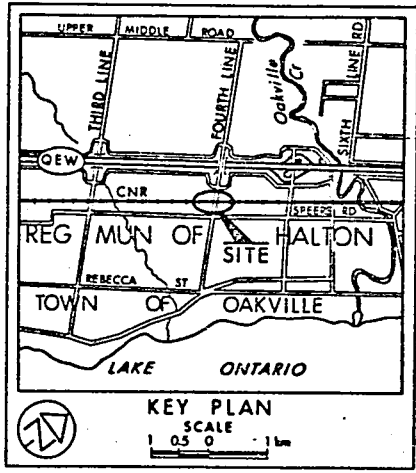
SECTION A-A



PLAN



METRIC
ALL DIMENSIONS SHOWN ARE IN METRES AND/OR MILLI-METRES UNLESS OTHERWISE NOTED.



- 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 8310&11
 - WL not observed in Bore Holes 2 & 10

No	ELEVATION	CO-ORDINATES NORTH	EAST
1	102.9	4810 314.5	288 249.5
2	102.7	4810 330.5	288 262.0
3	102.8	4810 338.5	288 255.0
4	102.7	4810 345.5	288 247.5
6	102.5	4810 386.0	288 278.5
7	102.3	4810 378.0	288 285.5
8	102.2	4810 371.0	288 292.5
9	102.2	4810 387.0	288 305.5
10	102.9	4810 323.0	288 256.0
19	102.8	4810 302.5	288 306.5
20	103.5	4810 355.5	288 268.5
21	102.4	4810 323.0	288 324.5
22	103.0	4810 335.0	288 334.5
23	102.6	4810 285.0	288 292.5
44	102.4	4810 321.0	288 327.0
45	102.8	4810 337.0	288 257.0

Geocres No 30M5-137

NOTE

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

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

GO-ALRT REF PD2-300-



REFERENCE DRAWINGS		REVISIONS		DRAWN BY: SO 1984 01 03 CHK'D BY: [Signature]		DESIGNED BY: [Signature] APPROVED BY: K. A. B.		ENGINEERING MATERIALS OFFICE FOUNDATION DESIGN SECTION		 Ministry of Transportation and Communications OAKVILLE PROJECT - WEST EXTENSION		HALTON REGION FOURTH LINE SUBWAYS BORE HOLE LOCATIONS & SOIL STRATA STA 12+703.231	
				SCALE: FULL SIZE ONLY		AS SHOWN				PROJECT MANAGER		CONTRACT NO DWG NO REV SHEET	