

G.I.-30 SEPT. 1976

GEOCRES No. 30M4-67DIST. 4 REGION W.P. No. 54-88-00 (A)CONT. No. W. O. No. STR. SITE No. HWY. No. Q' E. W.LOCATION N-S Transportation
CorridorNo of PAGES - =====OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

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Ministry
of
Transportation

FOUNDATION DESIGN SECTION

**foundation
investigation and
design report**

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 54-88-00 (A) DIST 4

HWY Q.E.W. STR SITE N/A

N/S Transportation Corridor Interchange

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PRELIMINARY FOUNDATION INVESTIGATION REPORT

For

N/S Transportation Corridor Interchange

W.P. 54-88-00 (A), Site N/A

Highway Q.E.W., District 4, Burlington

INTRODUCTION

This report contains the results of a preliminary foundation investigation carried out for planning the proposed structures in the Q.E.W. N/S Transportation corridor interchange. The fieldwork was carried out during the period from 89 04 03 to 89 04 24 and consisted of fifteen sampled boreholes accompanied by dynamic cone penetration tests. The borings were advanced by hollow stem auger (84 mm I.D.), using machines mounted on muskeg vehicles. Boreholes were advanced to a maximum depth of 19.9 m below the ground surface. Bedrock was encountered and proven in ten boreholes by obtaining BQ size rock cores cored to a depth of 1.5 to 3 m. An additional 2 boreholes, carried out for previous jobs in the area, have also been incorporated into this report.

SITE DESCRIPTION

The site is located in the City of Hamilton, (Municipality of Hamilton Wenworth) in the vicinity of the Q.E.W.. It extends from Woodward Avenue in the West, to Hwy. 20 in the East, and from the south side of the Q.E.W., north to Van Wagner's Beach Road. The physiographic region has been described by Chapman and Putnam (1973) as the Iroquois Plain. The topography is fairly flat and low lying with the exception of fill which has been placed at various locations along the corridor for roads, railways, and other land uses. The railway has been abandoned. The existing roads along the corridor include the Q.E.W., which is a major divided highway, Burlington Street, which is 4 lanes, Nash Road, Van Wagner's Beach Road, Woodward Avenue and their respective ramps. The land use within the corridor is mixed and includes transportation, conservation, fields, wetlands (Van Wagner's Marsh), and a pump house. The drainage is towards Lake Ontario on the north side of the existing Q.E.W., and towards Redhill Creek, which in turn drains out into Hamilton Harbour, on the south side of Q.E.W.

SUBSURFACE CONDITIONS

General

The subsoil typically consists of varying thicknesses of fill overlying a 2.1 to 6.8 m thick deposit of clay silt till which in turn overlies a 2 to 4.5 m thick layer of sandy silt till, then shale bedrock. Although cobbles and boulders were not encountered within the till, it should be noted that they are usually found in the till deposit and the Contractor should be made aware of the possibility. Bedrock was encountered at elevation 69.7 m at the southeast extent and 59.2 m at the northwest extent of the site. The bedrock surface was mildly undulating with the upper 2 m frequently weathered. Since the typical surface elevation (disregarding fills) ranged from 76 to 81 m, the overburden thickness can be assumed to be in the order of 9 to 17 m for planning purposes.

Some variations from the typical stratigraphy were encountered along the abandoned railway line just south of Van Wagner's Beach Road where a 5.3 to 10.9 m thick lacustrine deposit of silty sand was found under the fill and overlying the glacial till.

For a more detailed description of the subsurface and groundwater conditions encountered, reference should be made to the Record of Borehole Log sheets contained in the Appendix of this report (Boreholes #1-1, 1-3, 3-1, 3-5, 5-1, 5-2, 5-3, 6-3, 6-4, 7-1, 7-2, 9-1, 9-2, 11-4, 12-5, 13-2, 13-3). The plan locations of the borings are shown on Drawing 548800-A.

DISCUSSION

It is proposed to reconstruct the Q.E.W. between Kirk Avenue and Centennial Parkway (Hwy. 20), to provide for the interchange at Burlington Street and the Hamilton N-S Transportation corridor. This will involve the widening, construction or reconstruction of nine structures.

Our recommendations, and comments on the design and construction of the various structures are provided below and in Table 1 (Data sheet) included in the attached Appendix. The text provides design recommendations applicable to all sites. The table provides specific information for each proposed structure location including the existing elevations, proposed grade raises, applicable boreholes, and estimated pile tip elevations are noted in this table.

Although recommendations have only been given for deep foundations, it should be noted that there is a possibility that shallow foundations may be feasible at certain sites. During the final investigation the feasibility of both alternatives will be considered and detailed design recommendations provided.

RECOMMENDATIONS

Structure Foundations

The proposed structures may be founded on steel H-piles driven to bedrock. The estimated pile tip elevation is given for each structure location on Table 1 (data sheet) included in the attached Appendix. For the purposes of the O.H.B.D.C. the following design values are recommended.

	<u>HP 310 x 110</u>	<u>HP 310 x 79</u>
Factored Capacity at U.L.S.	1600 kN	1150 kN
Capacity at S.L.S. Type II	1150 kN	825 kN

All piles should be reinforced with pile tips. The pile caps should have a minimum of 1.2 m of earth cover for frost protection.

Earth pressure should be computed as per Subsection 6.6.1.2.2. of the Code. A yielding foundation condition may be assumed. Backfill to the structures should

consist of granular material in accordance with MTO SP 109F03 (March, 1988), for which the following properties may be assumed:

Granular 'A' $\gamma = 22.8 \text{ kN/m}^3$, $\phi = 35^\circ$, $K_a = 0.271$

Granular 'B' $\gamma = 21.3 \text{ kN/m}^3$, $\phi = 30^\circ$, $k_a = 0.333$

Approaches

Topsoil and surficial material should be removed prior to placing any fill. The fill should consist of well compacted acceptable material. Care should be taken to ensure that no bouldery fill is placed within the approaches at locations through which piles have to be driven, and it is recommended that this portion of the fill contain grain sizes no larger than 75 mm.

Subexcavation of unsuitable material for depths of up to 3 m below the surface may be required before placing any fill. The actual depth will be determined during the final investigation. Also, consideration may be given to preloading the approaches for a period of approximately 6 months. These measures will minimize settlements of the completed approaches.

Stability analyses in terms of total stresses have been carried out for two typical sections with embankment heights of 6 and 13.5 m respectively. These analyses were conducted with the aid of Bishop's simplified slope stability program assuming conditions typical of the general area.

Details of the assumptions and results of the stability analyses are provided in Figure 1. Based on these analyses, fill heights up to 6 m should be stable with forward and side slopes of 2H:1V. Computer analyses based on the subsurface properties indicate that fill heights over 6 m may require mid height berms 2 m wide. Further analyses will be required to calculate specific safe heights, and necessary berm designs following the final foundation investigation for each proposed structure.

Dewatering


Concrete for pile caps or retraining walls should be placed in the 'dry'. Since

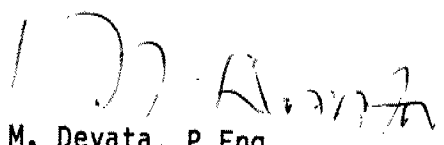
the groundwater level in the area is high, a dewatering scheme may be required for excavations extending below the prevailing groundwater elevation. To the north of the Q.E.W. where excavations below the water level extend into the silty sand deposit, dewatering schemes may require sheet-piling, well points or over-sized ditching and sump-pumping. At other locations sump-pumping may be adequate. However, the design of the dewatering scheme would be the responsibility of the Contractor and would be required to be submitted to the Engineer for review.

MISCELLANEOUS

The fieldwork for this preliminary investigation was carried out under the supervision of F. Pinder, Engineering Trainee, B. Bennett, Foundation Engineer and P. Marks, Foundation Engineer. The equipment was owned and operated by Master Soil Investigation Limited. The entire project was carried out under the general supervision of Mr. D. Dundas, Senior Foundation Engineer. The report was prepared by P. Marks, reviewed by D. Dundas and approved by M. Devata, Chief Foundation Engineer.




P. Marks, P.Eng.
Foundation Engineer


M. Devata, P.Eng.
Chief Foundation Engineer

APPENDIX

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ³ /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

TABLE 1: Data Sheet

W.P. 54-88-00(A)

Location: N-S Transportation Corridor

Site Number	Existing Ground Elevation (m±)	Proposed Grade Raises (m±)	Reference Boreholes for Subsurface Conditions	Estimated Pile Tip Elevations (m±)
1	81.2	6	1-1, 1-3	64.4
3	75.3 to 78.9	7	3-1, 3-5	68
5	76 to 77.2	5 to 13.5	5-1, 5-2, 5-3, 7-1	West Abutment 61.7 Centre Piers 59.5 Southeast Abutment 63.2
6	77.5 to 79.5	3	6-3, 6-4	62.5
7	76 to 77	6.5	7-1, 7-2	North Abutment 59.2 South Abutment 62.5
8	76.3	8	5-1, 6-3, 9-2	North Abutment 61.7 South Abutment 62.5
9	75.7 to 76.2	2.5	9-1, 9-2	North Abutment 60.9 South Abutment 62.9
11	77.6	4.5	11-5	54
12	77.5 to 78	4.5	12-4	53.7
13	76.7 to 80	6.5	13-2, 13-3	North Abutment 61.8 South Abutment 63.1

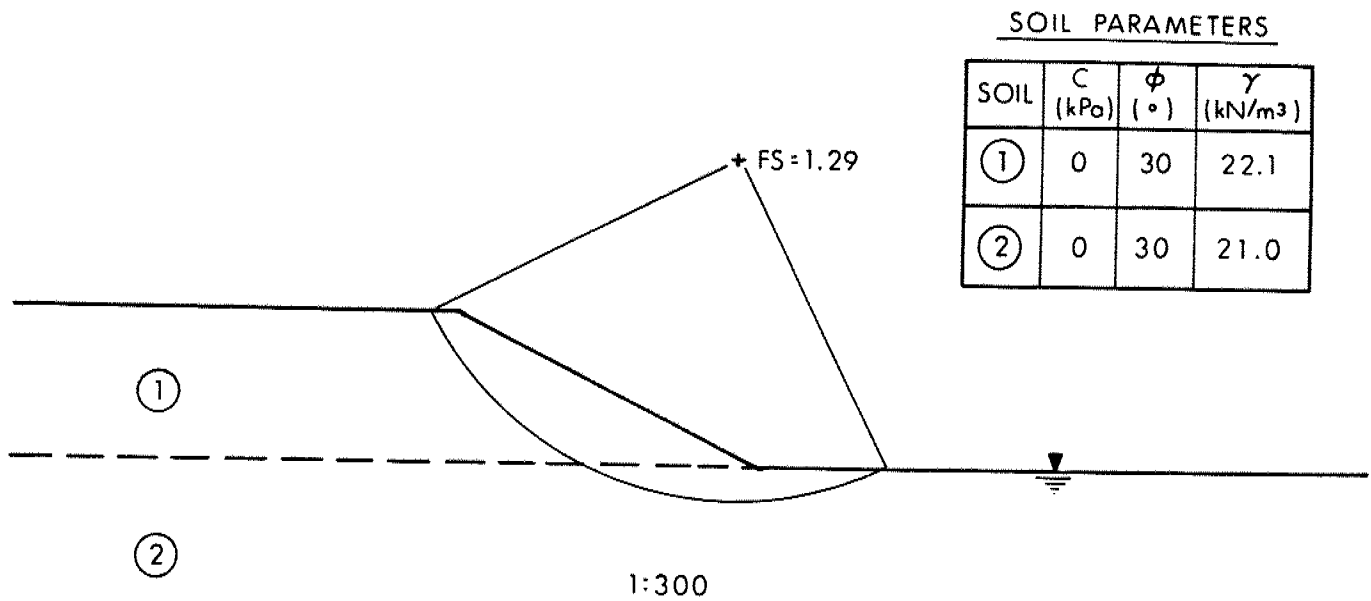


FIG 1A - 6m EMBANKMENT - SHALLOW SEALED STABILITY-TOTAL STRESS

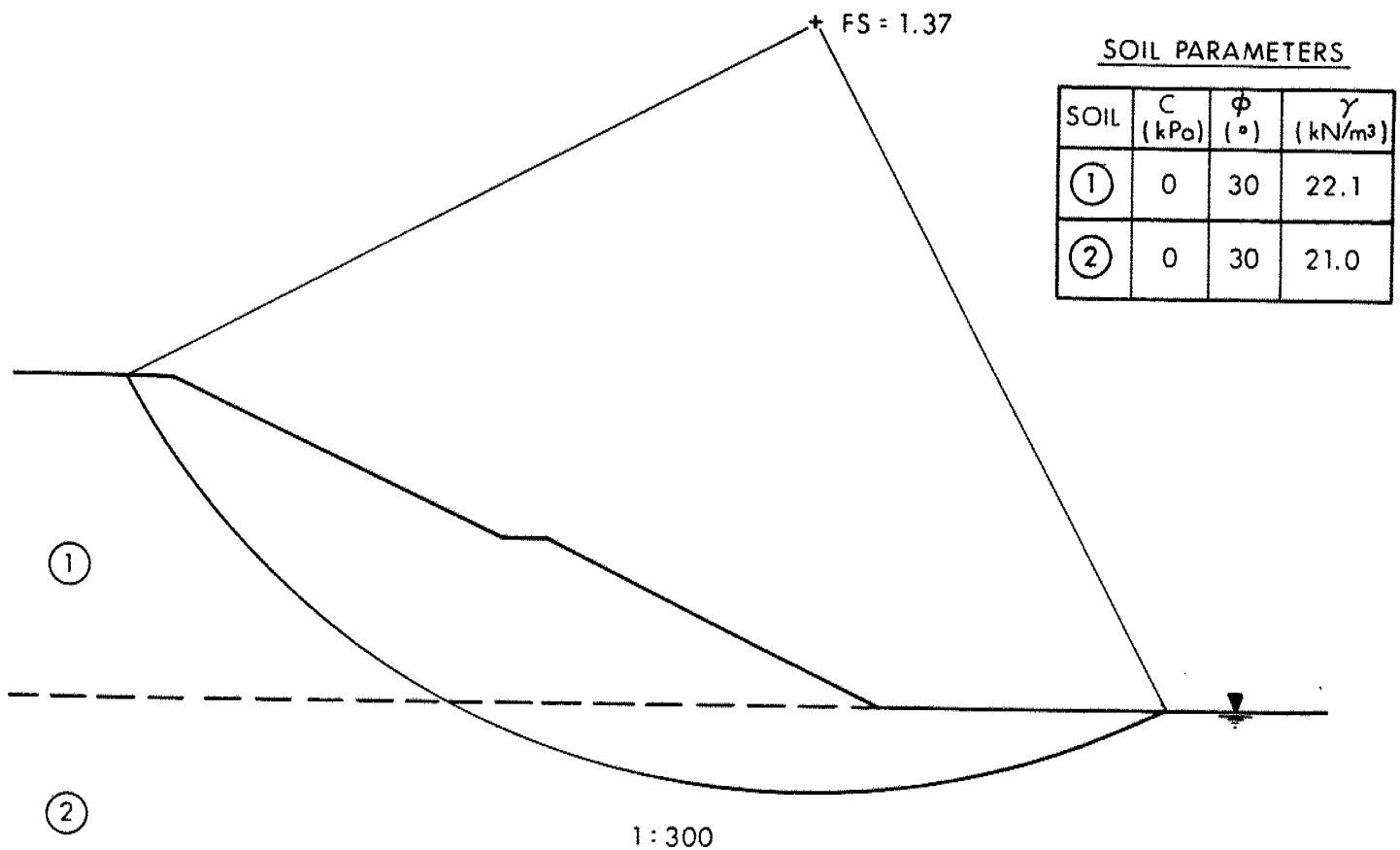


FIG 1B - 13.5m EMBANKMENT WITH 2m WIDE HALF HEIGHT BERM
SHALLOW SEALED STABILITY-TOTAL STRESS

RECORD OF BOREHOLE No 1-1

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 789 730; E 283 445 ORIGINATED BY PM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 14 CHECKED BY DD

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH kPa 20 40 60 80 100	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									
81.2 0.0	Ground Level													
	Clayey Silt		1	SS	13								21.1	1 17 (82)
	Some Sand		2	SS	36									
	Trace Gravel		3	SS	32									
	Stiff to Hard		4	SS	25									
	(Glacial Till)		5	SS	25									
			6	SS	18									
	Sandy Silt		7	SS	23									
			8	SS	15									0 49 (51)
			9	TW	PH									
			10	SS	26									
			11	SS	120/13cm									
69.0	Shaly Zones		12	SS	30/0cm									5 16 (79)
12.2	End of Borehole													
	* Water Level not Established													

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

RECORD OF BOREHOLE No 1-3

METRIC

W P 54-88-00A

LOCATION Co-ords: N 4 789 672; E 283 496

ORIGINATED BY PM

DIST 4 HWY Q.E.W.

BOREHOLE TYPE Continuous Flight Auger (H.S.)

COMPILED BY PM

DATUM Geodetic

DATE 89 04 14

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	W _p	W	W _L	W _p	W	W _L		
81.2 0.0	Ground Level															GR SA SI CL
	Clayey Silt		1	SS	23		80								20.1	0 3 (97)
			2	SS	27											
			3	SS	24											
	Some Sand		4	SS	20		78									
	Trace of Gravel		5	SS	16											0 4 (96)
			6	SS	8											
			7	TW	PH		76									
	Stiff		8	SS	14											
			9	SS	24		74									
	(Glacial Till)		10	SS	28		72									2 13 (85)
			11	SS	133											
			12	SS	120/17cm		70								22.7	2 13 (85)
	Shaly Zones		13	SS	120/15cm											
			14	RC BQ	--		68									
			15	RC BQ	--		66									
64.4	Hard															
16.8	Shale		16	SS	120/10cm		64									
	Bedrock															
	Weathered Sound		17	SS	60/10cm											
61.3			18	RC BQ	77		62									
19.9	End of Borehole															

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3-1

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 789 965; E 283 460 ORIGINATED BY BB
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 10 to 89 04 11 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60	W _p W W _L				
78.8	Road Level													
0.0	Sand and Gravel, Traces Asphalt, Clay, Pipe, Organics, Loose (Fill)		1	SS	7									
77.4			2	SS	5									
1.4			3	SS	4									
	Trace of Organics		4	SS	6									
	Clayey Silt		5	SS	13									
	Some Sand		6	SS	13									
	Trace of Gravel		7	SS	18									
	Firm to Very Stiff		8	SS	10									
			9	SS	26									
69.7	(Glacial Till)		10	SS	60/	0cm								
9.1	Shale		11	SS	60/	0cm								
	Bedrock		12	SS	60/	0cm								
			13	RC BQ	93									
65.1	Wearhered Sound													
13.7	End of Borehole													

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

RECORD OF BOREHOLE No 3-5

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 789.907; E 283.397 ORIGINATED BY FP
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 14 to 89 04 17 CHECKED BY 10

OFFICE REPORT ON SOIL EXPLORATION

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 (%)				
78.3	Ground Level													
0.0	Silty Clay to Clayey Silt Some to Trace of Sand, Gravel Stiff to Firm		1	SS	13									25 14 (61)
			2	SS	13									
			3	SS	7									
			4	SS	5									
73.9	(Fill)		5	SS	9									8 2 76 14
4.4	Organic Clay to Organic Silt		6	SS	47									
	Peat		7	SS	5									*10.95%
	Traces of Sand, Gravel													
71.0	Hard to Firm		8	TW	PH									
7.3	Clayey Silt Some Sand Trace of Gravel		9	SS	11									10 8 69 23
	Shaly Zones		10	SS	32									
68.1	(Glacial Till)													
10.2	Weathered Shale		11	SS	120	11cm								
66.7	Bedrock		12	SS	120	18cm								0 14 (86)
11.6	End of Borehole													
	* Organic Content by Weight													

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

RECORD OF BOREHOLE No 5-1

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 790 923; E 282 893 ORIGINATED BY BB
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger COMPILED BY PM
 DATUM Geodetic DATE 89 04 12 CHECKED BY AB

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE					
76.3	Ground Level													GR SA SI CL
0.0	Clayey Silt with Sand		1	SS	11	Refusal	76						21.6	0 32 (68)
	Traces of Organics		2	SS	21		74							
	Stiff to Soft		3	SS	2									
72.9	(Fill)		4	TW	PH								21.3	2 21 (77)
3.4	Clayey Silt		5	SS	16									
	Some Sand		6	SS	64									
	Trace of Gravel		7	SS	44									
	Very Stiff to Hard		8	SS	32									
	(Glacial Till)		9	SS	29									
			10	SS	23									
			11	SS	22									
63.5			12	SS	63/13cm									
12.8	Sandy Silt		13	SS	65/5cm									
	Trace of Gravel													
	Trace of Clay													
61.7	Very Dense (Glacial Till)													
14.6	Weathered													
60.8	Shale Bedrock		14	SS	60/3cm									
15.5	End of Borehole													
	*Water Level not Established													

+³, x⁵: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 5-2

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 790 925.0; E 283 046.0 ORIGINATED BY PM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 03 to 89 04 05 CHECKED BY PM

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ 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						
76.6	Ground Level										
0.0	Clayey Silt, with Sand Trace of Gravel Very Stiff (Fill)										
75.6			1	SS	17						1 26 (73)
1.0			2	SS	10						15 74 9 2
	Silty Sand		3	SS	19						
	Trace of Clay		4	SS	13						
	With Gravel and Gravel		5	SS	59						18 68 10 4
			6	SS	42						
			7	SS	60/10cm						
			8	SS							
	Compact to Very Dense		9	SS	147/20cm						
			10	SS	40						69 27 (4)
			11	SS	30						
64.7	(Lacustrine)										
11.9	Clayey Silt Some Sand Trace of Gravel		12	SS	63						6 21 (73)
	Hard (Glacial Till)		13	SS	120/13cm						
59.8	Probable Weathered Bedrock		14	SS	60/2cm						
16.8	Sound Shale Bedrock		15	RC BQ	92						
58.3											
18.3	End of Borehole										

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

RECORD OF BOREHOLE No 5-3

METRIC

W P 54-88-00A

LOCATION Co-ords: N 4 790.814; E 283 136

ORIGINATED BY PM

DIST 4 HWY Q.E.W.

BOREHOLE TYPE Continuous Flight Auger (H.S.)

COMPILED BY PM

DATUM Geodetic

DATE 89 04 07 to 89 04 10

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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 (%)		
76.0	Ground Level													
0.0	Gravelly Sand with Clayey Silt Firm (Fill) Trace of Organics		1	SS	6									12 54 (34)
74.8	Silty Sand Trace of Clay		2	SS	11									14 71 13 2
1.2	Compact to Very Dense		3	SS	13									
	Some Gravel and Gravel		4	SS	36									
			5	SS	30									61 30 8 1
	(Lacustrine)		6	SS	41									
			7	SS	60/15cm									
			8	SS	110/22cm									
67.9			9	SS	92/28cm									53 36 (11)
8.1	Clayey Silt Some Sand Trace of Gravel Very Stiff (Glacial Till)		10	SS	30									11 23 (66)
65.8														
10.2	Sandy Silt Trace of Clay Trace of Gravel Shaly Zones Very Dense (Glacial Till)		11	SS	60/10cm									16 17 (67)
63.2			12	SS	100/8cm									
12.8	Weathered Shale Bedrock													
61.9														
14.1	End of Borehole													

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6-3

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 790 829; E 282 806 ORIGINATED BY PM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 12 to 89 04 13 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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				
76.3	Ground Level															
0.0	Sand and Gravel Traces of Clay, Pipe, Organics															
74.9	Stiff to Very Stiff (Fill)		1	SS	13		76									
1.4			2	SS	24											
	Clayey Silt		3	SS	57	*	74									
	Some Sand		4	SS	53											
	Trace of Gravel		5	SS	48											
			6	SS	20		72								21.4	3 20 (77)
			7	SS	20										20.9	2 16 (82)
			8	SS	19		70									
	Very Stiff to Hard		9	SS	24		68									1 14 (85)
			10	SS	21											
64.7	(Glacial Till)		11	SS	120/15cm		66									
11.6	Sandy Silt with Gravel		12	SS	120/18cm		64									36 25 (39)
62.6	Trace of Clay															
13.7	Very Dense (Glacial Till)		13	SS	120/5cm		62									
	Weathered															
	Shale		14	SS	120/5cm		60									
	Bedrock Sound		15	RC BQ	100											
			16	RC BQ	100											
57.9							58									
18.4	End of Borehole															
	*Water Level not Established															

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 6-4

METRIC

W P 54-88-00A

LOCATION Co-ords: N4 790 787; E 282 808

ORIGINATED BY FP

DIST 4 HWY Q.E.W.

BOREHOLE TYPE Continuous Flight Auger (H.S.)

COMPILED BY PM

DATUM Geodetic

DATE 89 04 18

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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	20 40 60 80 100	W _p	W	W _L		
76.2	Ground Level													
0.0	Clayey Silt and Sand		1	SS	25		76							1 49 (50)
74.1	Trace of Gravel		2	SS	28		74							
2.1	(Fill)		3	SS	36									
	Clayey Silt		4	SS	29								21.8	1 6 (93)
	Some Sand		5	SS	28									
	Trace of Gravel		6	SS	22									
	Very Stiff to Hard		7	SS	12									
	(Glacial Till)		8	SS	20									6 16 (78)
			9	SS	23									
	Sand		10	SS	26									
66.0														
10.2	Sandy Silt		11	SS	120/18cm		66							9 40 (51)
63.9	Trace of Gravel		12	SS	120/13cm		64							
12.3	Trace of Clay													
62.5	Very Dense (Glacial Till)													10 38 (52)
13.7	Weathered Shale Bedrock		13	SS	120/0cm									
	End of Borehole													

+³, x⁵: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7-1

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 790 943; E 282 981
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.)
 DATUM Geodetic DATE 89 04 05
 ORIGINATED BY PM
 COMPILED BY PM
 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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	WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100						
76.0	Ground Level																	
0.0	Clayey Silt with Sand Trace of Gravel Pockets of Sandy Silt Stiff to Firm		1	SS	12													
			2	SS	7													
73.4	(Fill)		3	SS	4													
2.6	Silty Sand Trace of Clay		4	SS	9													
	Trace of Gravel		5	SS	29													
			6	SS	41													
	Loose to very Dense		7	SS	72													
			8	SS	73													
68.1	(Lacustrine)		9	SS	21													
7.9	Clayey Silt Some Sand Trace of Gravel		10	SS	19													
	Very Stiff to Hard		11	SS	24													
			12	SS	66													
62.9	(Glacial Till)		13	SS	120	20cm												
13.1	Sandy Silt Trace of Gravel Trace of Clay		14	SS	50	5cm												
	Very Dense Shaly Zones		15	SS	60	0cm												
59.2	(Glacial Till)		16	RC	40													
16.8	Shale Bedrock		17	RC	45													
	Weathered Sound		18	RC	100													
			19	RC	100													
56.8				BQ														
19.2	End of Borehole																	

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

RECORD OF BOREHOLE No 7-2

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 790 847; E 282 929 ORIGINATED BY BB
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 13 to 89 04 14 CHECKED BY [Signature]

OFFICE REPORT ON SOIL EXPLORATION

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				
76.2	Ground Level															
0.0	Clayey Silt, with Sand															
	Trace of Gravel															
	Stiff (Fill)		1	SS	19											
74.5			2	SS	11											
1.7	Trace of Organics		3	SS	34											
			4	SS	37											
	Clayey Silt		5	SS	31											
	Some Sand		6	SS	25											
	Trace of Gravel		7	SS	28											
			8	SS	24											
			9	SS	22											
	Very Stiff to Hard		10	SS	27											
			11	SS	25											
64.5	(Glacial Till)															
11.7	Sandy Silt		12	SS	60/	5cm										
	Trace of Gravel															
	Trace of Clay															
	Very Dense															
62.5	(Glacial Till)															
13.7	Weathered		13	SS	120/	10cm										
			14	SS	120/	3cm										
	Shale															
	Bedrock	Sound	15	RC BQ	80											
59.3																
16.9	End of Borehole															

+³, x⁵: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 9-1

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 790 971; E 282 840 ORIGINATED BY BB
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (H.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 11 to 89 04 12 CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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				
75.7	Ground Level															
0.0	Clayey Silt		1	SS	10											
	Some Sand		2	SS	9											
	Trace of Gravel		3	SS	21											
73.3	Stiff (Fill)		4	SS	50											
2.4	Organic Clay		5	SS	32											
			6	SS	30											
	Clayey Silt		7	SS	29											
	Some Sand		8	SS	18											
	Trace of Gravel		9	SS	12											
			10	SS	15											
	Stiff to Hard		11	SS	26											
			12	SS	52											
	Shaly Zones		13	SS	60/5cm											
60.9	(Glacial Till)		14	SS	60/10cm											
14.8	Weathered Sand		15	RC BQ	54											
	Shale Bedrock		16	RC BQ	77											
57.4																
18.3	End of Borehole															
	* Organic Content by Weight															

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

RECORD OF BOREHOLE No 9-2

METRIC

W P 54-88-00A LOCATION Co-ords: N 4 790.880; E 282 794.0 ORIGINATED BY PM
 DIST 4 HWY Q.E.W. BOREHOLE TYPE Continuous Flight Auger (R.S.) COMPILED BY PM
 DATUM Geodetic DATE 89 04 11 to 89 11 12 CHECKED BY PM

OFFICE REPORT ON SOIL EXPLORATION

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	20 40 60					
76.2	Ground Level													
0.0	Clayey Silt		1	SS	10		76							
74.9	Trace of Sand		2	SS	11									
1.3	Stiff (Fill)		3	SS	10									
	Trace of Organics		4	TW	PH									
	Clayey Silt		5	SS	34									
	Some Sand		6	SS	32									
	Trace of Gravel		7	SS	33									
			8	SS	17									
			9	SS	15									
	Stiff to Hard		10	SS	17									
			11	SS	17									
			12	SS	27									
	Shaly Zones		13	SS	120	19cm								
62.4	(Glacial Till)		14	SS	120	9cm								
13.8	Shale		15	SS	120	3cm								
	Weathered Bedrock		16	RC BQ	95									
59.3	End of Borehole													
16.9														
	* Organic Content by Weight													

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 11-4 (FORMERLY METRIC BH 4

W P 54-88-00A LOCATION Co-ords. N 4 791 312.0; E 282 678.0 ORIGINATED BY DP
 DIST 4 HWY QEW BOREHOLE TYPE H-S Auger, Cone Test COMPILED BY TM
 DATUM Geodetic DATE 84 05 09 - 10 CHECKED BY JSO

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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60					
77.6	Ground Surface													
0.0	Silty Sand trace/some gravel trace clay occ. boulders Very Loose to Compact		1	SS	11									
			2	SS	6									
			3	SS	5									
	occ. Zones of organics		4	SS	3									
			5	SS	2									
72.7			6	SS	7									
4.9	Silty Sand to Sand trace/some gravel occ. traces of clay Compact to Very Dense		7	SS	21									
			8	SS	7									
			9	SS	24									
			10	SS	29									
	occ. gravelly zones		11	SS	124									
			12	SS	38									
			13	SS	40									
62.7			14	SS	23									
14.9	Silty Clay (CL) some sand trace/some gravel Very Stiff to Hard		15	SS	120									
			16	SS	77									
53.9														
23.7	Probable Bedrock Shale End of Borehole													

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 12-5 (FORMERLY BH 5) METRIC

W P 54-88-00A LOCATION Co-ords. N 4 791 332.5; E 282 719.0 (FORMERLY BH 5) WP 83-74-20
 DIST 6 HWY QEW BOREHOLE TYPE H-S Auger, Cone Test ORIGINATED BY TM
 DATUM Geodetic DATE 84 05 09-10 COMPILED BY TM
 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	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER									
77.5	Ground Surface											
0.0	Silty Clay (CL) some/with sand trace/some gravel occ. boulders Soft to Stiff		1	SS	6							13 13 50 24
			2	SS	2							
			3	SS	2							
74.1			4	SS	20							
3.4			5	SS	28							
			6	SS	41							
			7	SS	86							
			8	SS	71							
	Silty Sand to Sand trace/some gravel occ. traces of clay Compact to Very Dense		9	SS	87							
			10	SS	121							
			11	SS	101/25 cm							
			12	SS	80							
			13	SS	24							
62.0			14	SS	72							
15.3												
	Silty Clay (CL) some sand trace/some gravel Very Stiff to Hard											
53.7												
23.8	Probable Bedrock Shale End of Bedrock											

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 13-2

METRIC

W P 54-88-00A

LOCATION Co-ords: N 4 790 709; E 283 149

ORIGINATED BY FP

DIST 4 HWY Q.E.W.

BOREHOLE TYPE Continuous Flight Auger (H.S.)

COMPILED BY PM

DATUM Geodetic

DATE 89 04 19 to 89 04 20

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE						
76.7	Ground Level														
0.0	Clayey Silt Trace to of Silty Clay Organics		1	SS	14		76								
	Some Sand		2	SS	9									10 16 (74)	
	Trace of Gravel		3	SS	8		74								
	Stiff		4	SS	10										
72.7	(Fill)		5	SS	6									0 28 (72)	
4.0	Layer of Silty Sand		6	SS	17		72							1 85 11 3	
	Clayey Silt		7	SS	35									2 12 (86)	
	Some Sand		8	SS	22		70								
	Trace of Gravel		9	SS	20										
	Very Stiff to Hard		10	SS	60		68								
66.3	(Glacial Till)														
10.4	Sandy Silt		11	SS	120	18cm	66							21 26 47 6	
	Some Gravel														
	Trace of Clay		12	SS	120	15cm	64								
	Very Dense														
	Shaly Zones		13	SS	120	5cm									
61.8	(Glacial Till)		14	SS	120	5cm	62								
14.9	Weathered Shale		15	RC	18										
	Bedrock			RC	63										
60.0			16	BQ											
16.7	End of Borehole						60								

+³, x⁵: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 13-3

METRIC

W P 54-88-00A

LOCATION Co-ords: N 4 790 645; E 283 194

ORIGINATED BY FP

DIST 4 HWY Q.E.W.

BOREHOLE TYPE Continuous Flight Auger (H.S.)

COMPILED BY PM

DATUM Geodetic

DATE 89 04 21 to 89 04 24

CHECKED BY

OFFICE REPORT ON SOIL EXPLORATION

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			SHEAR STRENGTH kPa							WATER CONTENT (%)					
								20 40 60 80 100							20 40 60					
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE													
76.9	Ground Level																			
0.0	Clayey Silt to Silty Clay																			
	Some Sand		1	SS	8		76							3 17 (80)						
	Trace of Gravel		2	SS	8															
	Trace of Organics		3	SS	8															
	Firm to Stiff																			
73.5	(Fill)		4	SS	23		74							0 53 43 4						
3.4	Layer of Silty Sand		5	SS	28									0 16 (94)						
	Clayey Silt		6	SS	12		72													
	Some Sand		7	SS	10									2 13 (85)						
	Trace of Gravel		8	SS	9		70													
	Stiff to Very Stiff																			
	(Glacial Till)		9	SS	17															
67.5			10	SS	99/	23cm	68													
9.4	Sandy Silt													10 25 59 6						
	Some Gravel		11	SS	120/	20cm	66													
	Trace of Clay																			
	Shaly Zones		12	SS	120/	18cm	64													
	Very Dense																			
63.1	(Glacial Till)		13	SS	120/	15cm	62													
13.8	Shale		14	SS	Refusal															
	Bedrock		15	RC	100															
				BQ																
59.5	Weathered Sound		16	RC	100		60													
				BQ																
17.4	End of Borehole																			

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

METRIC

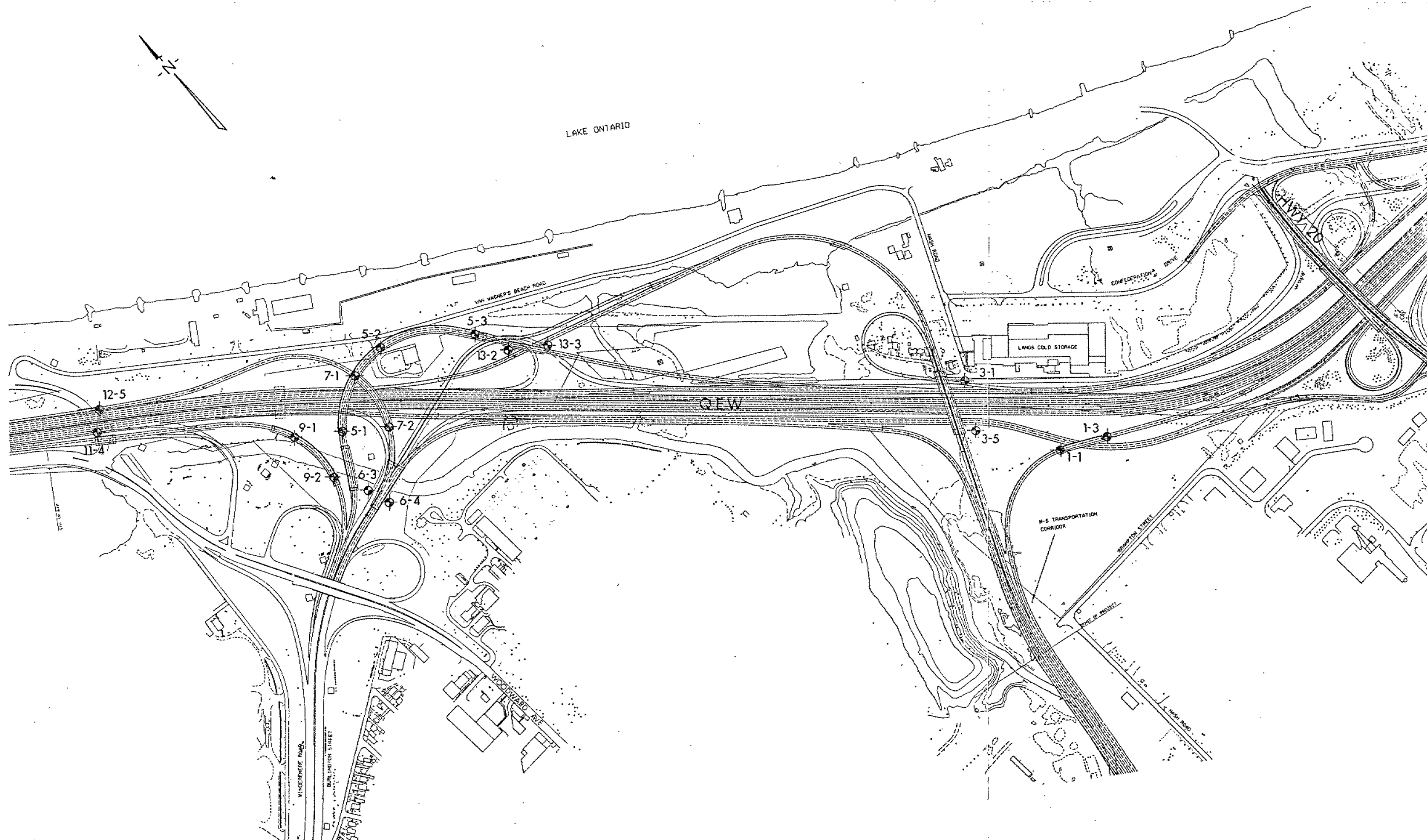
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 54-88-00A

QEW N/S TRANSPORTATION
CORRIDOR INTERCHANGE
BORE HOLE LOCATIONS & SOIL STRATA

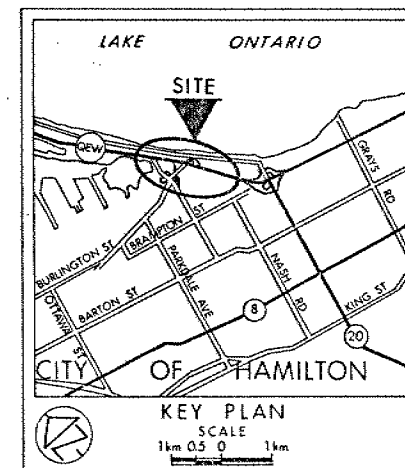


SHEET



PLAN
SCALE
100m 50 0 100m

NOTE: FOR SUBSOIL INFORMATION REFER TO
RECORD OF BORE HOLE



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

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1-1	81.2	4 789 730.0	283 445.0
1-3	81.2	4 789 672.0	283 496.0
3-1	78.8	4 789 965.0	283 460.0
3-5	78.3	4 789 907.0	283 397.0
5-1	76.3	4 790 923.0	282 893.0
5-2	76.6	4 790 925.0	283 046.0
5-3	76.0	4 790 814.0	283 136.0
6-3	76.3	4 790 829.0	282 806.0
6-4	76.2	4 790 787.0	282 808.0
7-1	76.0	4 790 943.0	282 981.0
7-2	76.2	4 790 847.0	282 929.0
9-1	75.7	4 790 971.0	282 840.0
9-2	76.2	4 790 880.0	282 794.0
13-2	76.7	4 790 709.0	283 149.0
13-3	76.9	4 790 645.0	283 194.0
11-4	77.6	4 791 312.0	282 678.0
12-5	77.5	4 791 332.5	282 719.0

NOTE

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

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

REV	DATE	BY	DESCRIPTION

Geocres No 30M4-67

HWY No QEW	DIST 4
SUBM'D PM	CHECKED DATE 1989 09 15 SITE
DRAWN SO	CHECKED APPROVED DWG 548800A-A

memorandum



To: M. S. Devata
Chief Foundation Engineer
Foundation Design Section
Room 315, Central Building

Date: May 31, 1989

Attn: P. Marks/ B. Bennett

File No: 3162-2-4-113

From: Soils and Aggregates Section
Engineering Materials Office
Room 311, Central Building

Re: Borehole Core Descriptions
QEW/ Burlington St.: N-S Transportation Corridor Interchange
Van Wagner's Beach, Ontario
WP 54-88-00

As requested by your section, core from ten (10) boreholes was logged, and a description is appended. Depth to bedrock and depth to top of unweathered rock in each borehole are tabulated below:

Borehole Number	Depth to Bedrock in meters below ground surface	Depth to Unweathered Rock ³ (including slightly weathered) in meters below ground surface
1) 3-1	9.14 ¹	12.98
2) 7-2	13.72 ¹	16.10
3) 9-1	15.80	15.80
4) 13	16.82 ¹	18.90
5) 13-2	14.86 ²	not confirmed
6) 13-3	13.82 ¹	17.25
7) 52	16.79	16.79
8) 63AA	13.72 ¹	15.39
9) 71	16.76 ²	17.81
10) 92	13.79 ¹	15.49

11) 64

13) 35

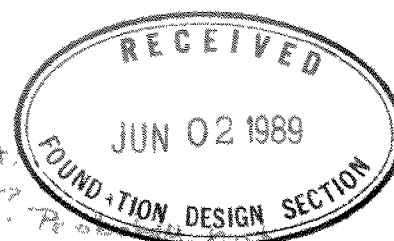
14) 51

15) 53

? but think not

? is SS/4 W.B.?

? SS/4 v. 12 No



.../2

Notes:

1. Estimated depth from split spoon samples.
2. Estimated depth from first retrieval of bedrock.
(insufficient split spoon sample)
3. For shale materials it is important that information on weathering and RQD be recorded at the drill site and that the core be stored under optimum conditions until further logging can be done. Drying-out of the shale results in additional weathering of the core and the formation of new fractures. This affects the description and measurement of engineering parameters. Depth to unweathered rock is also affected and therefore cannot be accurately determined.

The depths to unweathered rock, weathering descriptions, and RQD values given in this report are estimates based on the dried-out condition of the core received in the laboratory.

Bedrock is **SHALE** of the Queenston Formation.

If you have any questions, please contact me.

A handwritten signature in black ink, appearing to read 'S. A. Senior', written over a horizontal line.

S. A. Senior,
Geological Engineer

Attachment

ROCK CORE DESCRIPTION
WP 54-88-00

1../3

CORE DIAMETER: BX

CORE RECOVERY					CORE DESCRIPTION	
BH #	RC #	DEPTH (m)	CR* (%)	RQD* (%)	DEPTH (m)	DESCRIPTION
3-1	13	12.19-13.72	93	15	12.19-13.72	SHALE, reddish brown interbedded with greenish grey (32%); very fine grained; weak to very weak rock; slightly weathered to moderately weathered, completely weathered zone from 12.88-12.98m; extremely close to very close spaced fractures from 12.19-12.98m (<2cm spacing), close spaced fractures from 12.98-13.72m (3-11cm spacing).
7-2	15	15.37-16.89	80	0	15.37-16.89	SHALE, reddish brown interbedded with greenish grey (27%); very fine grained; weak to very weak rock; slightly weathered to moderately weathered; very close to extremely close spaced fractures (1-4cm spacing), extremely close spaced fractures (<0.5cm spacing) from 15.37-16.08m.
9-1	15 16	15.80-16.84 16.84-18.29	54 77	0 0	15.80-16.69 16.69-18.29	LIMESTONE/BOULDER(?), greenish grey, minor interbed of reddish brown SHALE (4%); medium to fine grained; medium strong rock; slightly weathered; very close spaced fractures (3-6cm spacing), intersected by near vertical, steeply dipping joint set. SHALE, reddish brown interbedded with greenish grey (30%); very fine grained; slightly to moderately weathered; very close to close spaced fractures (2-9cm spacing, avg.~6cm).

*CR = CORE RECOVERY (NOTE: Depths are approximated in zones of poor core recovery.)

*RQD = ROCK QUALITY DESIGNATION

Logged by: S. A. Senior, Soils and Aggregates Section.

ROCK CORE DESCRIPTION
WP 54-88-00

2../3

CORE DIAMETER: BX

CORE RECOVERY					CORE DESCRIPTION	
BH - RC # #	DEPTH (m)	CR* (%)	RQD* (%)	DEPTH (m)	DESCRIPTION	
13	14	12.32-13.77	-	-	12.32-15.28	TILL, BOULDER
	15	13.77-15.28	-	-	18.34-19.86	SHALE, reddish brown interbedded with greenish grey (37%); very fine grained; slightly to moderately weathered, completely weathered zone at 19.05m and 19.60m (approx.); extremely close to very close spaced fractures (<4cm spacing, avg.≈0.5cm) from 18.34-18.90m, very close to close spaced fractures (1-8cm, avg.≈5cm) from 18.90-19.86m.
	18	18.34-19.86	77	0		
13-2	15	14.86-15.29	18	0	14.86-16.71	SHALE, reddish brown interbedded with greenish grey (21%); very fine grained; very soft rock; highly to completely weathered; extremely close spaced fractures.
	16	15.29-16.71	63	0		
13-3	15	15.32-16.64	100	0	15.32-17.40	SHALE, reddish brown interbedded with greenish grey (18%); very fine grained; soft rock; moderately weathered, intensely weathered from 16.08-16.31m and from 16.76-17.25m; very close spaced fractures, extremely close spaced fractures (<2cm) from 15.49-15.82m.
	16	16.64-17.40	100	0		
52	15	16.79-18.30	92	7	16.79-18.30	SHALE, reddish brown interbedded with greenish grey (17%); very fine grained; weak to very weak rock; slightly to moderately weathered; very close spaced fractures (1-11cm, avg.≈6cm), extremely close spaced fractures from 17.55-17.68m.

*CR = CORE RECOVERY (NOTE: Depths are approximated in zones of poor core recovery.)

*RQD = ROCK QUALITY DESIGNATION

Logged by: S. A. Senior, Soils and Aggregates Section.

ROCK CORE DESCRIPTION
WP 54-88-00

3../3

CORE DIAMETER: BX

CORE RECOVERY					CORE DESCRIPTION	
BH #	RC #	DEPTH (m)	CR* (%)	RQD* (%)	DEPTH (m)	DESCRIPTION
63	15	15.39-16.92	100	0	15.39-18.44	SHALE, reddish brown interbedded with greenish grey (22%); very fine grained; weak to very weak rock; moderately weathered; extremely close to very close spaced fractures (2-6cm, avg.≈3cm).
AA	16	16.92-18.44	100	0		
71	16	17.02-17.27	40	0	17.02-19.18	SHALE, reddish brown interbedded with greenish grey (24%); very fine grained; weak to very weak rock; moderately weathered; very close to close spaced fractures, extremely close spaced fractures (2-10cm, avg.≈4cm) from 17.37-17.81m and from 18.06-18.29m.
	17	17.27-17.81	45	0		
	18	17.81-17.96	100	0		
	19	17.96-19.18	100	17		
92	16	15.49-16.94	95	8	15.49-16.94	SHALE, reddish brown interbedded with greenish grey (26%); very fine grained; weak to very weak rock; moderately weathered; very close spaced fractures (2-6cm, avg.≈3cm), extremely close spaced fractures from 15.80-15.93m.

*CR = CORE RECOVERY (NOTE: Depths are approximated in zones of poor core recovery.)

*RQD = ROCK QUALITY DESIGNATION

Logged by: S. A. Senior, Soils and Aggregates Section.

	<u>Pile Type</u>	
	<u>310 HP 110</u>	<u>310 HP 79</u>
Factored Capacity at U.L.S.	1600 kN	1150 kN
Bearing Capacity at S.L.S. Type II	1150 kN	830 kN

All piles should be reinforced with driving shoes.

The feasibility of spread footings will be considered during the detailed design phase for these projects.

All pile caps require a minimum of 1.2 m of earth cover for frost protection.

Approaches

In some areas unsuitable (soft organics or peat) material may exist at or below the surface requiring subexcavation.

Possible foundation problems anticipated are dewatering, slope stability and settlements due to the induced embankment loadings.

Detailed foundation investigations will be required at the design stage to complete and to verify the preliminary recommendations for the final foundation investigation report.

B. Bennett

B. Bennett, P.Eng.
Foundation Engineer

P. Marks

P. Marks, P.Eng.
Foundation Engineer

BB/PM/ms

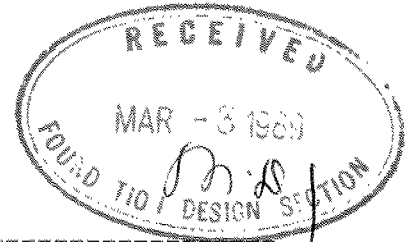
MINISTRY OF TRANSPORTATION

M E M O R A N D U M

TO: Mr. M. Devata ✓
Chief Foundation Engineer
Engineering Materials Office

DATE: 1989-03-01

FROM: Structural Section
Central Region



RE: QEW/N-S Transportation Corridor Interchange
W.P. 54-88-00

This is to confirm the conclusion of our discussion today regarding the dates for foundation recommendation as follows:

- 1) The Foundation Section shall provide general foundation recommendation by mid-March based on present available data in the vicinity.
- 2) The earliest time for field work to begin on this site is around mid-March.
- 3) The preliminary foundation report will be ready around middle to end of May after completing all necessary field work, testing and analysis.
- 4) Recommendations to Geotechnical Section shall be provided at the same time.

A handwritten signature in cursive script, appearing to read 'Dennis Wong'.

Dennis Wong
Structural Engineer
for:
G.C.E. Burkhardt
Head, Structural Section

DW/rb

c.c. Mr. H. Vander Kooji, P & D
Mr. B. Grundy (Via P & D)
Mr. R. MacLean (Geotechnical)