

GEOCRES No. 30M13-86DIST. 6 REGION W.P. No. 88-78-01CONT. No. 89-62W. O. No. STR. SITE No. HWY. No. 407LOCATION from E of 407/427 ICTo W of 407 / Kipling ICNo of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WP 88-78-01 DIST 6

HWY 407 STR SITE N/A

East of 407/427 Interchange to
West of 407/Kipling Interchange

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FOUNDATION INVESTIGATION REPORT

For

Highway 407

East of 407/427 Interchange to
West of 407/Kipling Interchange

W.P. 88-78-01, Site N/A

District 6, Toronto

INTRODUCTION

This report contains the results of a foundation investigation carried out at the above mentioned site for the following:

1. eleven proposed culvert locations,
2. the stability of a deep cut (up to 9.5 m) along the east diversion channel north of Highway 407, and
3. the stability of a cut proposed along the backslope, east of Highway 27 and south of Highway 407.

The fieldwork was conducted during the period from 88 09 19 to 88 10 04 utilizing a 5.3 (i) auger machine equipped with continuous flight augers. A total of 32 boreholes were advanced, 21 of which were drilled at the culvert locations. Eleven borings were advanced for the proposed cuts along Highway 407 between Sta. 12 ± 500 and Sta. 13 ± 750. Piezometers were installed in three of these boreholes.

In addition to the results of the field investigation, this report contains recommendations for the proposed culverts and deep cut sections.

SITE DESCRIPTION

The proposed stretch of Highway 407 extends from east of Highway 427 to just west of Kipling Avenue, and runs parallel to and approximately 350 m north of Steeles Avenue. It is located in the Township of Vaughan.

The topography across the whole area is fairly flat to gently undulating. At the east end the ground dips, steeply in some areas, down to a creek and adjacent flood plain.

Land use in the area is largely agricultural at present although urban development is beginning to take over these lands.

Physiographically, the site is located in the Peel Plain characterized by cohesive soils overlying a glacial till deposit.

SUBSURFACE CONDITIONS

The subsurface material was found to be relatively consistent across the site. It consists primarily of cohesive clayey silt containing varying proportions of sand and gravel. The material is a till of glacial origin. Layers of granular material are present intermittently across the site and are often water-bearing. These layers, composed of sand to silt, are more prevalent at the west end of the site and by the creek at the east end of the site.

From the information obtained from the field investigation, the clayey silt deposit ranges from less than 1.0 m to greater than 14.0 m in thickness. The N values vary from 8 to in excess of 120 per 30 cm, but are generally greater than 30. The material exhibits low to medium plasticity and a consistency of stiff to hard.

Detailed descriptions of the subsurface material are provided for each of the culvert locations in the tables containing the culvert foundation recommendations.

The boundaries of the different strata, together with the field and laboratory test results are presented on the Record of Borehole sheets found in the Appendix of this report. Refer to these sheets for the locations and elevations of the boreholes. Stratigraphic sections at the proposed culvert locations are shown on Drawing No's. 887801-A and 887801-B.

GROUNDWATER CONDITIONS

The water levels shown on the appended borehole log sheets are the levels measured immediately following the completion of each borehole. The differences in the recordings are evidence that, in many cases, the groundwater readings do not reflect the true stabilized groundwater conditions. The boreholes in which piezometers were installed (D3, D6 and D10) are stabilized and provide a better indication of the general groundwater conditions across the area.

DISCUSSION AND RECOMMENDATIONS

I Culvert Foundations

It is proposed to construct eleven concrete box culverts across the site. The subsurface material encountered below the invert elevations at each of the culvert locations is suitable for spread footing foundations. The allowable bearing capacities as per the O.H.B.D.C. and the footing elevations for each of the culverts are presented in tabular form in the pages that follow the General Recommendations.

General Recommendations

The culvert footings should be constructed in the 'dry'. Although some dewatering problems may occur where granular seams intersect the excavation below the water table, it is anticipated that dewatering may be achieved by using sump pumping techniques, incorporating perimeter ditches to prevent disturbance of the foundation soil (Figure 1, appended). If the footing base, upon excavation, is to remain uncovered for a long period of time or softens with exposure, a 15 cm concrete working slab should be poured within six hours of exposure.

Temporary excavation for the construction of the culvert footings should be maintained at a slope of 1H:1V to a maximum height of 6.0 m. Temporary excavations exceeding 6.0 m should be inclined at 1.5H:1V or flatter. Water-bearing granular seams may occur just beneath the level of excavation at some of the culvert locations and, as a result, boiling may occur. In this event, our office should be contacted.

At Culvert 5 (Hwy. 27) and Culvert 9 (Martingrove), care should be taken, when constructing the culvert footings, that the excavation does not interfere with the proposed bridge foundations. Excavations should not encroach on the critical zone beneath the proposed bridge footings defined by a plane extending 1H:1V from a point 3 m from the base of the bridge footing. Refer to Figure 2 appended to this report.

Culvert 8 is proposed to cross beneath the Ontario Hydro rail spur line. It is assumed that the existing track will be removed prior to the construction of the culvert. If this is not the case, then tunnelling may be required and details should be obtained from this office.

Backfill to the culverts should proceed as per OPSD-803.01 and OPSD-803.06 using Granular 'A' or Granular 'B'.

The culvert outlets should be treated with rock protection as per OPSD-810-01 Type A.

It is recommended that a seal be placed at the inlets to the culverts. The seal should comply with the requirements outlined in Form 1205 'Material Specification for Clay Seal'. It should have a minimum thickness of 0.6 m. The seal should extend over the backfill to the culvert from the high water level down to the channel bed and 1.0 m along the channel.

The embankment slope around the culvert entrances should be protected against erosion by laying a 0.6 m minimum thickness of rock protection over the above mentioned seal.

CULVERT	SUBSURFACE CONDITIONS	G.W.L.	INV.EL.	SPREAD FOOTING RECOMMENDATIONS (kPa) (within 1.0 m of inv. el.)	
				Factored B.C. @U.L.S.	B.C. @S.L.S. Type II
1	BH 1				
	El. 175.0-172.9 Clayey Silt Very Stiff	169.0	172.2		
	El. 172.9-169.5 Silt to Sandy Silt Very Dense			450	300
	El. 169.5-166.9 Sand Dense				
	BH 2				
	El. 172.7-165.1 Clayey Silt Hard	166.8	171.8		
	El. 165.1-164.7 Sand Very Dense				
2	BH 2	166.8	171.8		
	As above				
	BH 3				
	El. 173.3-167.2 Clayey Silt Hard	167.2			
	El. 167.2-165.2 Sand to Sandy Silt Dense to Very Dense			375	250
	BH 4				
	El. 172.2-164.1 Clayey Silt Hard	167.6	171.4		

CULVERT	SUBSURFACE CONDITIONS	G.W.L.	INV.EL.	SPREAD FOOTING RECOMMENDATIONS (kPa) (within 1.0 m of inv. el.)	
				Factored B.C. @U.L.S.	B.C. @S.L.S. Type II
3	BH 4 El. 172.2-164.1 Clayey Silt Hard	167.6	171.4	450	300
	BH 5 El. 171.7-163.6 Silty Clay to Clayey Silt Occasional Sandy Silt Zones Very Stiff to Hard	167.7	171.1		
4	BH 6 El. 171.9-162.4 Silty Clay to Clayey Silt Occasional Sandy Silt Zones Hard	167.1	169.4	600	400
	BH 7 El. 172.0-159.4 Clayey Silt Occasional Sandy Silt Zones Very Stiff to Hard	Dry	167.1		

CULVERT	SUBSURFACE CONDITIONS	G.W.L.	INV.EL.	SPREAD FOOTING RECOMMENDATIONS (kPa) (within 1.0 m of inv. el.)	
				Factored B.C. @U.L.S.	B.C. @S.L.S. Type II
5	BH 8 El. 172.4-159.8 Silty Clay to Clayey Silt Occasional Sandy Silt Zones Hard	Dry	166.9	525	350
	BH 9 El. 172.4-160.5 Silty Clay to Clayey Silt Occasional Sand Seams Very Stiff to Hard	Dry	166.7		
6	BH 10 El. 171.1-160.0 Clayey Silt Occasional Sand Seams Very Stiff to Hard	161.0	166.5	450	300
	BH 11 El. 170.6-162.1 Clayey Silt Very Stiff to Hard	Dry	166.4		
	El. 162.1-159.9 Sand Very Dense				
	El. 159.9-159.5 Clayey Silt Hard				

CULVERT	SUBSURFACE CONDITIONS	G.W.L.	INV.EL.	SPREAD FOOTING RECOMMENDATIONS (kPa) (within 1.0 m of inv. el.)	
				Factored B.C. @U.L.S.	B.C. @S.L.S. Type II
7	BH 12 El. 170.7-162.2 Clayey Silt Very Stiff to Hard El. 162.2-159.1 Sandy Silt to Silt Very Dense El. 159.1-158.3 Clayey Silt Hard	Dry	165.9	450	300
	BH 13 El. 171.1-161.0 Clayey Silt Very Stiff to Hard El. 161.0-159.5 Sandy Silt to Silt Very Dense El. 159.5-157.5 Clayey Silt Hard	Dry	164.4		
8	BH 14 El. 171.4-158.3 Clayey Silt Occasional Sand Seams Hard El. 158.3-156.2 Silty Clay Hard El. 156.2-155.9 Sand Very Dense	157.4	162.6	450	300
	BH 15 El. 171.7-162.4 Clayey Silt Very Stiff to Hard El. 162.4-161.0 Sandy Silt to Silt Very Dense El. 161.0-157.5 Clayey Silt Hard	166.1	162.4		

CULVERT	SUBSURFACE CONDITIONS	G.W.L.	INV.EL.	SPREAD FOOTING RECOMMENDATIONS (kPa) (within 1.0 m of inv. el.)	
				Factored B.C. @U.L.S.	B.C. @S.L.S. Type II
9	BH 16 El. 170.4-156.2 Clayey Silt to Silt Occasional Sandy Silt Zones Hard	Dry	161.3	375	250
	BH 17 El. 170.4-156.2 Clayey Silt Sandy Silt Zones Stiff to Hard	166.0	161.2		
10	BH 18 El. 155.5-153.4 Sand and Gravel Dense to Very Dense	154.7	154.3	600	400
	El. 153.4-150.0 Clayey Silt to Silt Hard				
	El. 150.0-147.5 Sand and Gravel Very Dense				
	BH 19 El. 155.0-151.0 Silty Clay Very Stiff to Hard	152.6	153.6		
	El. 151.0-147.1 Sandy Silt to Silt Very Dense				

CULVERT	SUBSURFACE CONDITIONS	G.W.L.	INV.EL.	SPREAD FOOTING RECOMMENDATIONS (kPa) (within 1.0 m of inv. el.)	
				Factored B.C. @U.L.S.	B.C. @S.L.S. Type II
11	BH 20				
	El. 154.0-152.9 Gravel, Sand, Silt Mixture Compact	153.1	152.8		
	El. 152.9-150.7 Silty Clay to Clayey Silt Hard				
	El. 150.7-146.3 Silty Sand Very Dense				
	BH 21				
	El. 152.0-145.0 Clayey Silt Sand and Gravel Seam Very Stiff to Hard	149.7	149.9	450	300
	El. 145.0-144.2 Sandy Silt Very Dense				

II RECOMMENDATIONS FOR THE DEEP CUT NORTH OF HIGHWAY 407

A diversion channel is proposed to run parallel to and approximately 50.0 m north of Highway 407 centreline between Sta. 12+100 ± Sta. 13+780 ±. The cut required to achieve the channel elevation extends to a maximum depth of 9.5 m.

Piezometers installed across the area of the deep cut indicate a high groundwater table. The main concerns, then, are surficial and long term internal slope stability. A series of slope stability analyses was conducted for various cross sections using Bishop's effective stress analysis. Based on the results of the analyses two alternatives are proposed for the final slope configuration and treatment requirements.

Alternative #1

The slopes to the diversion channel may be maintained at an incline of 2H:1V or flatter, to a maximum height of 6.0 m. The cut should be treated with a 0.6 m thick granular blanket that extends across the channel bottom and halfway up the channel slopes. This treatment is recommended for cuts of 4.5 m to 6.0 m.

Where the cut exceeds 6.0 m in depth, slopes should remain at 2H:1V and incorporate a 2.0 m to 3.0 m wide bench at approximately mid-height. The lower slope should be treated with a 0.6 m thick granular blanket, the treatment extending across the channel bottom and halfway up the adjacent slope. A 1.2 m deep sub-drain is required along the toe of the uppermost slope.

To prevent erosion of the diversion channel bottom, the granular blanket should be overlain by a 250 mm± thickness of rock protection or gabion mats. The protection should be placed along the channel bed and up the slopes to the high water level or alternatively to the level of the granular blankets.

The slope geometry and recommended slope treatment are sketched in Figure 3, appended.

The granular blanket should consist of Granular 'A'. Granular 'B' may be used provided that it has a suitable gradation. In this case, typical gradation curves should be submitted to this office for assessment.

The treatments described should be applied for the length of the diversion channel (east of Highway 27 to Rainbow Creek) where the cut is 4.5 m or deeper.

It is recommended that the sub-drain trench be lined with geotextile filter fabric. Suitable fabrics include Class 1 non-woven geotextile with EOS of 75 to 150 um. The pipe laid should be perforated and have a minimum diameter of 150 mm. Granular backfill (pit Granular 'A') should surround the pipe to a minimum thickness of 150 mm. The sub-drain should connect with the diversion channel. The link should take into consideration the effects of erosion and freezing. This may be achieved by extending a channel lined with rock protection from the sub-drain outlets to the diversion channel. Alternatively and preferably, the sub-drain at the outlets, should extend downslope to the diversion channel, remaining below the frost penetration zone for the entire distance.

Alternative #2

The deep cut to the diversion channel may be maintained at an uninterrupted 3H:1V slope for the entire length of the cut. The channel bottom and the channel slopes to mid-height should be treated with a 0.6 m thick granular blanket. The erosion protection of the channel bottom described in Alternative #1 applies in this situation. The materials for the blanket and erosion protection are as specified in Alternative #1.

General Recommendation (Alternatives #1 and #2)

An interceptor ditch is recommended at the top of the slope and should run for the entire length of the cut. Vegetation should be placed on the slopes, not covered with rock protection or gabion mats, as soon as possible after completion of the cut to minimize and control surficial erosion.

If external erosion is not a concern, then the rock protection or gabion mat treatment may be eliminated.

III Recommendations for the Cut Slope South of Highway 407

To the south, the cut for Highway 407 runs from approximately Sta. 12+650 to Sta. 13+540. The alternatives recommended for the cut slope to the north are applicable to the south slope, minus the requirements for the diversion channel erosion protection, i.e. gabion mats or rock protection.

GENERAL COMMENTS

Of the two alternatives proposed, Alternative #1 is preferred since it requires less grading and provides a more effective drainage scheme.

The cut proposed for Highway 407 through this area is extensive and in order to facilitate the excavation, construction should proceed in an upstream direction.

MISCELLANEOUS

The fieldwork for this investigation was carried out by B. Bennett, Jr. Foundation Engineer. The equipment was owned and operated by Master Soil Investigation Limited. The report was written by Ms. B. Bennett under the guidance of Mr. D. Dundas, and reviewed by Mr. M. Devata.



B. Bennett

B. Bennett, P.Eng.

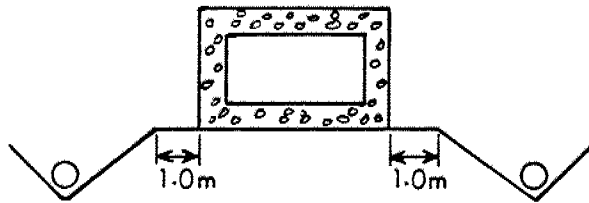
Jr. Foundation Engineer

M. Devata

M. Devata, P.Eng.

Chief Foundation Engineer

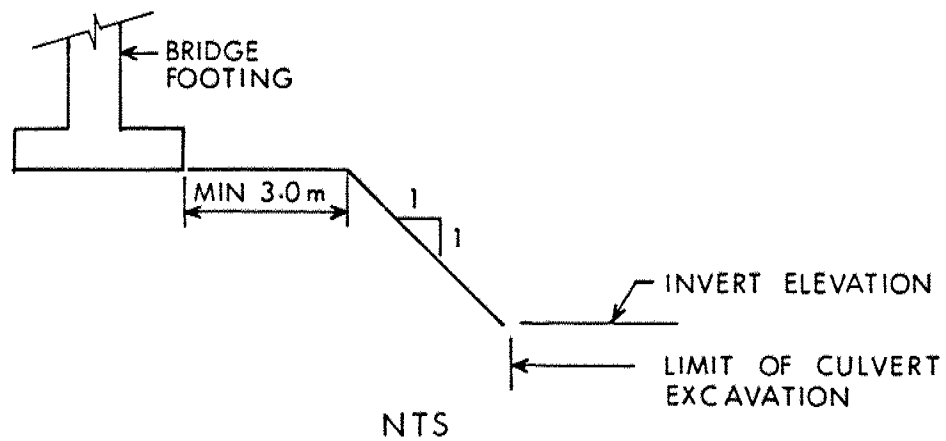
APPENDIX



NTS

DEWATERING SCHEME AT CULVERT FOOTINGS

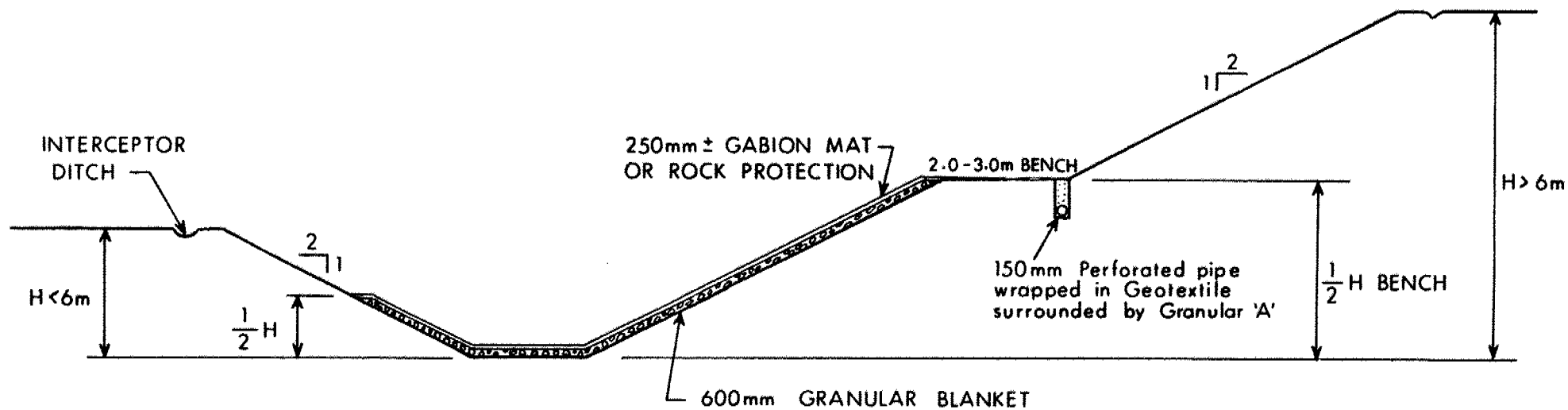
Figure -1



RECOMMENDED MINIMUM DISTANCE TO EXISTING BRIDGE FOOTING

Figure -2

WP 88 -78-01



RECOMMENDED DIVERSION CHANNEL SLOPE GEOMETRY AND TREATMENT

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						

RECORD OF BOREHOLE No 1 (CULVERT 1) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 129.0; E 294 570.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 19 CHECKED BY _____

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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
175.0	Ground Level										
0.0	Clayey Silt Trace/Some Sand Trace Gravel (Glacial Till) Very Stiff		1	SS	9		174				
172.9			2	SS	11						
2.1	Silt to Sandy Silt Some Gravel Trace Clay Very Dense		3	SS	60	15cm	172				
			4	SS	60	15cm					
169.5			5	SS	60	13cm	170				
5.5	Sand Some Silt Trace Gravel Dense		6	SS	40		168				
166.9			7	SS	43						
8.1	End of Borehole										

RECORD OF BOREHOLE No 2 (Culvert 1) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 080, E 294 670.5 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 19 CHECKED BY

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	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
172.7	Ground Level										
0.0											
	Trace Organics		1	SS	33		172				
	Clayey Silt		2	SS	86					22.8	6 31 (63)
	Some/With Sand		3	SS	60/	15cm	170				
	Trace Gravel		4	SS	60/	13cm					
	Brown Grey										
	Hard		5	SS	31		168				
	(Glacial Till)		6	SS	59		166				
165.1											
7.6	Sand										
164.7	Grey Very Dense		7	SS	98						0 81 (19)
8.0	End of Borehole										

RECORD OF BOREHOLE No 3 (Culvert 2) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 043.0; E 294 742.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 19 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	20 40 60 80 100					
173.3	Ground Level												
0.0													
	Trace Organics		1	SS	8								
			2	SS	51								7 36 (57)
	Brown Grey		3	SS	70								
	Clayey Silt Some/With Sand Trace Gravel Stiff to Hard		4	SS	72								
			5	SS	21								
167.2	(Glacial Till)												
6.1	Sand to Silty Sand Trace Gravel Dense to Very Dense		6	SS	34								0 39 (61)
165.2													
			7	SS	89								
8.1	End of Borehole												

RECORD OF BOREHOLE No 4 (Culvert 2) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 002.5, E 294 811.5 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 20 CHECKED BY

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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE							
172.2 0.0	Ground Level					172					
	Trace Organics		1	SS	56						10 30 (60)
	Brown Grey		2	SS	67						
	Clayey Silt		3	SS	64						
	Trace/With Sand										
	Trace Gravel		4	SS	36						0 1 (99)
	Sand and Gravel		5	SS	39						
	Hard										
164.1	(Glacial Till)		6	SS	50						
8.1	End of Borehole										

RECORD OF BOREHOLE No 5 (Culvert 3) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 968.0, E 294 895.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 19 CHECKED BY _____

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 (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
171.7	Ground Level										
0.0	Trace Organics		1	SS	11						
	Silty Clay to Clayey Silt		2	SS	30						
	Some/With Sand		3	SS	60/15cm						
	Trace Gravel										
	Very Stiff to Hard		4	SS	58						
	Occasional Sand Zones										
			5	SS	45						
163.6	(Clacial Till)		6	SS	69						
8.1	End of Borehole										

RECORD OF BOREHOLE No 6 (Culvert 4) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 317.0, E 295 294.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 20 CHECKED BY

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	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER						
171.9	Ground Level								
0.0	Trace Organics		1	SS	43				
			2	SS	40				
			3	SS	38				
			4	SS	41				
	Brown Grey		5	SS	50				
	Silty Clay to Clayey Silt		6	SS	48				
	Some/With Sand Trace Gravel		7	SS	60	11cm			
	Hard		8	SS	79	23cm			
162.4	(Glacial Till)								
	Occasional Sandy Silt Zones								
9.5	End of Borehole								

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 7 (Culvert 4) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 305.0; E 295 321.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 20-21 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
171.9	Ground Level												GR SA SI CL
0.0						*							
	Trace Organics		1	SS	23		170						
			2	SS	31								
			3	SS	41								
			4	SS	59								
	Brown Grey						168						
	Clayey Silt Some Sand Trace Gravel Very Stiff to Hard		5	SS	43		166						3 21 (76)
			6	SS	65								
	Sandy Silt Brown		7	SS	60/	14cm	164		O	H			7 48 (45)
			8	SS	60								
	(Glacial Till)		9	SS	100/	25cm	162						
							160						
159.4			10	SS	81								
12.5	End of Borehole												
	*Borehole Dry												

RECORD OF BOREHOLE No 8 (Culvert 5) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 328.0, E 295 385.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 21 CHECKED BY

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 (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100		SHEAR STRENGTH kPa					W _p W W _L
								O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE		WATER CONTENT (%) 10 20 30					
172.4	Ground Level														
0.0						*	172								
	Trace Organics		1	SS	25										
			2	SS	46										
			3	SS	33		170								
			4	SS	41										
	Brown Grey		5	SS	39		168								
	Silty Clay to Clayey Silt Some Sand		6	SS	38		166					22.1	3 13 (84)		
	Trace Gravel Hard		7	SS	60		164								
			8	SS	60/	8cm									
	(Glacial Till)						162								
			9	SS	116/	25cm									
	Occasional Zones of Sandy Silt						160								
159.8	Sandy Silt		10	SS	84/	28cm									
12.6	End of Borehole														
	*Borehole Dry														

RECORD OF BOREHOLE No 9 (Culvert 5) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 356.0 E 295 455.0 ORIGINATED BY T.S.
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 09 23 CHECKED BY

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			
172.4	Ground Level													
0.0						*	172							
	Trace Organics		1	SS	25									
			2	SS	40									
			3	SS	60		170							
			4	SS	60									
	Brown Grey Silty Clay to Clayey Silt		5	SS	30		168							
	Trace/Some Sand													
	Trace Gravel		6	SS	45		166							
	Very Stiff to Hard		7	SS	35		164							
			8	SS	51									
	Occasional Sand Seams													
	(Glacial Till)		9	SS	60/	30cm	162							
160.5	Auger Refusal		10	SS	60/	0cm								
11.9	End of Borehole													
	*Borehole Dry													

+3, x⁵: Numbers refer to
Sensitivity

20
15 \diamond 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 10 (Culvert 6) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 379.0; E 295 506.0 ORIGINATED BY T.S.
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 09 23 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
								SHEAR STRENGTH kPo						
171.1	Ground Level													
0.0														
	Trace Organics		1	SS	27		170							
			2	SS	12									
			3	SS	50									
	Brown Grey		4	SS	27		168							
	Clayey Silt		5	SS	47		166							
	Some/With Sand													
	Trace Gravel		6	SS	44		164							
	Very Stiff to Hard		7	SS	40									
	Occasional Sand Seams		8	SS	100	20cm	162							
160.0	(Glacial Till)													
11.1	End of Borehole		9	SS	70									

RECORD OF BOREHOLE No 11 (Culvert 6) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 392.0; E 295 534.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 09 26 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.6	Ground Level																
0.0						*	170										
	Trace Organics		1	SS	43												
	Brown Grey		2	SS	32												
			3	SS	26		168										
			4	SS	31												
	Clayey Silt																
	Some Sand		5	SS	41		166										
	Trace Gravel																
	Very Stiff to Hard		6	SS	34		164										
162.1	(Glacial Till)		7	SS	29												
8.5	Sand, Some Gravel		8	SS	60	8cm	162										
	Some Silt																
	Very Dense																
159.9	Clayey Silt Some Sand						160										
159.5	Trace Gravel Hard		9	SS	57												
11.1	End of Borehole																
	*Borehole Dry																

RECORD OF BOREHOLE No 12 (Culvert 7) METRIC

W P 88-78-01 LOCATION Co-ords N 4 846 413.0; E 295 733.5 ORIGINATED BY JP
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100	WATER CONTENT (%)
								SHEAR STRENGTH kPa										
							○ UNCONFINED + FIELD VANE											
							● QUICK TRIAXIAL x LAB VANE											
170.7	Ground Level													GR SA SI CL				
0.0						*	170											
	Trace Organics		1	SS	32													
			2	SS	40													
	Brown Grey		3	SS	47													
			4	SS	40													
	Clayey Silt																	
	Some Sand		5	SS	27									2 23 (75)				
	Trace Gravel																	
	Very Stiff to Hard		6	SS	32													
	(Glacial Till)																	
162.2			7	SS	48													
8.5	Sandy Silt to Silt		8	SS	110/	25cm												
	Trace Gravel																	
	Very Dense		9	SS	100									1 9 (90)				
159.1																		
11.6	Clayey Silt, Some Sand																	
158.3	Trace Gravel Hard		10	SS	65/	8cm												
12.4	End of Borehole																	
	*Borehole Dry																	

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

RECORD OF BOREHOLE No 13 (Culvert 7) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 443.0; E 295 755.0 ORIGINATED BY J.P.
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40						60	80	100
								SHEAR STRENGTH kPa									

RECORD OF BOREHOLE No 14 (Culvert 8) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 498.0; E 295 970.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 21 to 22 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
171.4	Ground Level													
0.0														
	Trace Organics		1	SS	34									
			2	SS	30									
			3	SS	43									
			4	SS	48									
	Brown Grey													
	Clayey Silt		5	SS	36									1 20 (79)
	Some Sand													
	Trace Gravel		6	SS	33									12 19 (69)
	Hard		7	SS	50									
			8	SS	60									
	Occasional Sand Seams		9	SS	32									
			10	SS	62									
158.3	(Glacial Till)													
13.1	Silty Clay													
	Trace Sand		11	SS	36									
	Hard													
156.2	Sand Some Gravel													
155.9	Trace Silt Very Dense		12	SS	100/	10cm								
15.5	End of Borehole													

RECORD OF BOREHOLE No 15 (Culvert 8) METRIC

W P 88-78-01 LOCATION Co-ords N 4 846 504.0; E 295 990.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) and Cone Test COMPILED BY BB
 DATUM Geodetic DATE 88 09 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100						
171.7 0.0	Ground Surface													GR SA SI CL
	Trace Organics		1	SS	46									
			2	SS	36		170							7 18 (75)
	Clayey Silt													
			3	SS	40		168							
	Brown Grey		4	SS	23									
	Some Sand						166							
	Trace Gravel		5	SS	33									
	Very Stiff to Hard		6	SS	80		164							
162.4	(Glacial Till)													
9.3	Sandy Silt to Silt		7	SS	71		162							2 58 (40)
	Trace Gravel													
161.0	Very Dense													
10.7	Clayey Silt		8	SS	67		160							
	With Sand													
	Trace Gravel													
	Occasional Sandy Silt		9	SS	45									
	Zones													
	Hard													11 33 (56)
157.5	(Glacial Till)		10	SS	39		158							
14.2	End of Borehole													

RECORD OF BOREHOLE No 16 (Culvert 9) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 603.0; E 296 250.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 09 28 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.4	Ground Surface																
0.0						*	170										
	Trace Organics		1	SS	38												
			2	SS	33												
	Brown Grey		3	SS	46		168										
	Clayey Silt to Silt		4	SS	19		166										2 19 (79)
	Some/With Sand		5	SS	16		164										
	Trace Gravel		6	SS	28		162										6 32 (62)
	Hard		7	SS	49												
			8	SS	42		160										
	Occasional Sandy Silt Zones		9	SS	32												
	(Glacial Till)						158										
156.2			10	SS	31												
14.2	End of Borehole																
	*Borehole Dry																

RECORD OF BOREHOLE No 17 (Culvert 9) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 614.0; E 296 306.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 09 29 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100								SHEAR STRENGTH kPa			WATER CONTENT (%)				
																○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			10 20 30				
170.4	Ground Level																						
0.0																							
			1	SS	37		170																
			2	SS	34																		
			3	SS	48		168																
			4	SS	19		166																
			5	SS	10		164																
			6	SS	24		162																
			7	SS	87		160																
			8	SS	86/28cm		158																
			9	SS	22																		
			10	SS	52																		
156.2																							
14.2	End of Borehole																						

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 18 (Culvert 10) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 931.0; E 296 800.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 10 03 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
155.5	Ground Level																
0.0	Trace Organics																
	Sand and Gravel		1	SS	36		154										50 41 (9)
	Trace/Some Silt		2	SS	60												
153.4	Dense to Very Dense																
2.1	Clayey Silt to Silt		3	SS	74		152										8 44 (48)
	Some/With Sand																
	Trace Gravel		4	SS	43												
	Hard																
150.0	(Glacial Till)						150										
5.5	Sand and Gravel		5	SS	60												
	Some Silt																
	Very Dense																
	Occ. Clayey Silt Zones																
147.5	Trace Organics		6	SS	96		148										
8.0	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 19 (Culvert 10) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 907.0; E 296 850.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 10 04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
155.0	Ground Level													
0.0	Trace Organics		1	SS	18		154							2 11 (87)
	Silty Clay Brown		2	SS	36									
	Some Sand Grey													
	Trace Gravel		3	SS	51		152							0 19 (81)
151.0	(Glacial Till)													
4.0	Sandy Silt to Silt		4	SS	96		150							
	Trace Gravel													
	Pockets of Clayey Silt		5	SS	79									
	Trace Organics													
	Very Dense		6	SS	60		148							
147.1														
7.9	End of Borehole													

RECORD OF BOREHOLE No 20 (Culvert 11) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 884.0; E 296 903.5 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 10 04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100									
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE									
							WATER CONTENT (%) 10 20 30										
154.1	Ground Level						154										
0.0	Gravel, Sand, Silt Mixture																
152.9	Brown Compact		1	SS	19												
1.2	Clayey Silt to Silty Clay		2	SS	41		152							0 6 (94)			
	Trace/Some Sand																
150.7	Trace Gravel Hard Grey (Glacial Till)		3	SS	80									0 14 (86)			
3.4	Silty Sand						150										
	Trace Organics		4	SS	72												
	Trace Gravel																
	Pockets of Clayey Silt		5	SS	93	23cm	148										
146.3	Very Dense		6	SS	70	15cm											
7.8	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 21 (Culvert 11) METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 835.0; E 296 993.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 10 04 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
152.0	Ground Level																GR SA SI CL
0.0	Trace Organics		1	SS	18												
	Clayey Silt		2	SS	35												0 5 (95)
	Trace/Some Sand																
	Trace Gravel		3	SS	48												33 49 (18)
	Sand and Gravel																
	Trace Organics		4	SS	33												
	Very Stiff to Hard																
	(Glacial Till)		5	SS	96	20cm											
145.0	Sandy Silt, Trace																
7.0																	
144.2	Gravel, Very Dense		6	SS	60	15cm											3 50 (47)
7.8	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No D1

METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 383.5; E 295 693.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY BB
 DATUM Geodetic DATE 88 09 26 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.5	Ground Level																
0.0						*	170										
	Trace Organics		1	SS	31												
			2	SS	49												
	Brown Grey		3	SS	25		168										
	Silty Clay to Clayey Silt		4	SS	35		166										
	Trace/Some Sand																
	Trace Gravel		5	SS	26		164										
	Very Stiff to Hard																
162.4	(Glacial Till)		6	SS	27												
8.1	End of Borehole																
	*Borehole Dry																

+³, x⁵: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D2

METRIC

W P BB-78-01 LOCATION Co-ords: N 4 846 386.5; E 295 797.5 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY FP
 DATUM Geodetic DATE 88 09 26 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
171.0	Ground Surface																GR SA SI CL
0.0						*											
	Trace Organics		1	SS	32		170										
			2	SS	39												
			3	SS	41												
			4	SS	33		168										
	Brown Grey																
	Silty Clay to Clayey Silt Some/With Sand		5	SS	19		166										
	Trace Gravel		6	SS	26												
	Very Stiff to Hard		7	SS	14		164										
	(Glacial Till)		8	SS	56		162										
160.6	**																
10.4	End of Borehole																
	*Borehole Dry																
	**Auger refusal Probable Boulder																

RECORD OF BOREHOLE No D3

METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 388.5; E 295 902.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY F.P.
 DATUM Geodetic DATE 88 09 26 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.5	Ground Surface																
0.0			1	SS	27		170										
			2	SS	28		168										
	Brown Grey		3	SS	32	Seal	168										
	Silty Clay to Clayey Silt		4	SS	26	Seal	166										
	Some Sand		5	SS	41		164										
	Trace Gravel		6	SS	21		162										
	Very Stiff to Hard		7	SS	34		160										
	(Glacial Till)		8	SS	46	Seal	158										
158.8			9	SS	83	Piezometer Dry	158										
11.7	Silt to Sandy Silt		10	SS	60		156										
156.6	Trace Gravel																
13.9	Occ. Clayey Silt Zones																
	Very Dense																
	End of Borehole																
	* WL in Open Borehole																

RECORD OF BOREHOLE No D4

METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 441.5; E 296 096.5 ORIGINATED BY RR
DIST 6 HWY 407 BOREHOLE TYPE S.S. Auger COMPILED BY P.P.
DATUM Geodetic DATE 88 09 28 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
171.0	Ground Surface																
0.0																	
	Trace Organics		1	SS	47		170										
			2	SS	37												
			3	SS	36		168										
	Brown Grey		4	SS	17		166										
	Clayey Silt		5	SS	26		164										
	Some Sand		6	SS	29		162										
	Trace Gravel		7	SS	32												
	Very Stiff to Hard		8	SS	120		160										
	(Glacial Till)		9	SS	55												
158.4																	
12.6	End of Borehole																

RECORD OF BOREHOLE No D5

METRIC

W P BB-78-01 LOCATION Co-ords: N 4 846 555.0; E 296 157.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY F.P.
 DATUM Geodetic DATE 88 09 28 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	SHEAR STRENGTH kPa					
170.5	Ground Surface							○ UNCONFINED + FIELD VANE						
0.0						*	170	● QUICK TRIAXIAL x LAB VANE						
	Trace Organics		1	SS	38									
			2	SS	43									
							168							
	Brown Grey		3	SS	41									
							166							
	Clayey Silt		4	SS	21									
	Trace/Some Sand													
	Trace Gravel		5	SS	41		164							
	Very Stiff to Hard													
			6	SS	23		162							
	(Glacial Till)		7	SS	79		160							
158.9			8	SS	57									
11.6	Sandy Silt													
157.9	Grey V. Dense		9	SS	73		158							
12.6	End of Borehole													
	* Borehole Dry													

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No D6

METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 628.0; E 296 400.0 ORIGINATED BY BB
DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY F.P.
DATUM Geodetic DATE 88 09 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
170.0	Ground Surface																
0.0																	
	Trace Organics		1	SS	50												
			2	SS	47												
			3	SS	40												
	Brown Grey		4	SS	19												
	Clayey Silt																
	Some Sand		5	SS	13												
	Trace Gravel																
	Very Stiff to Hard		6	SS	16												
	(Glacial Till)																
160.4			7	SS	45												
9.6	Silt																
	Some Sand		8	SS	60												
	Trace Gravel																
	Occ. Clayey Silt Seams																
157.7	Very Dense		9	SS	58												
12.3	Sandy Silt to Silty Sand																
	Trace Gravel																
155.8	Grey Very Dense		10	SS	80												
14.2	End of Borehole																

RECORD OF BOREHOLE No D7

METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 648.0; E 296 501.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY LNS
 DATUM Geodetic DATE 88 09 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
166.7	Ground Level																GR SA SI CL
0.0	Sandy Silt to Silt					*	166										
	Occasional Clayey Silt		1	SS	10												
	Trace Gravel		2	SS	11												
164.3	Compact																
2.4	Silty Clay		3	SS	8		164										1 5 (94)
	Trace Sand																
	Trace Gravel		4	SS	9		162										
	Stiff																
161.2																	
5.5	Clayey Silt to Silt		5	SS	26		160										
	Some Sand																
	Trace Gravel		6	SS	88												5 25 (70)
	Occasional Sand Seams																
	Very Stiff to Hard						158										
156.9	(Glacial Till)		7	SS	32												
9.8	Sandy Silt																
	Some Gravel		8	SS	60/	8cm	156										
	Very Dense																
154.2			9	SS	60/	15cm											
12.5	End of Borehole																
	*Borehole Dry																

RECORD OF BOREHOLE No D8

METRIC

W P 88-78-01 LOCATION Co-ords N 4 846 661.0; E 296 604.5 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY LNS
 DATUM Geodetic DATE 88 09 30 CHECKED BY DD

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		
								SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
166.5	Ground Level											10 20 30		
0.0	Clayey Silt to Silt Some Sand Trace Gravel Very Stiff to Hard (Glacial Till)		1	SS	44	*	166						9 23 (68)	
			2	SS	29		164							
			3	SS	39		162							
			4	SS	29		160							
			5	SS	83		158							
			6	SS	35		156							
			7	SS	60									
			8	SS	104									
155.4	End of Borehole													
11.1	*Borehole Dry													

RECORD OF BOREHOLE No D9

METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 730.0; E 296 683.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY F.P.
 DATUM Geodetic DATE 88 09 30 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
165.3	Ground Level													
0.0			1	SS	43		164							
	Clayey Silt		2	SS	41									
	Trace/Some Sand													
	Trace Gravel		3	SS	42		162							7 20 (73)
	Hard													
	(Glacial Till)		4	SS	86		160							
159.1			5	SS	83									
6.2	Silt						158							
	Trace Sand		6	SS	86									
156.8	Trace Clay													
	Very Dense													
8.5	Sand to Silty Sand		7	SS	45		156							16 62 (22)
	Trace Organics													
	Some Gravel													
154.3	Dense to Very Dense		8	SS	87									
11.0	End of Borehole													

RECORD OF BOREHOLE No D10

METRIC

W P 88-78-01 LOCATION Co-ords: N 4 846 743.5, E 296 781.5 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY F.P.
 DATUM Geodetic DATE 88 10 04 CHECKED BY _____

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
163.3	Ground Level																GR SA SI CL
0.0	Clayey Silt																
	Trace Sand																
	Trace Gravel																
160.9	Stiff (Glacial Till)		1	SS	11		162										
2.4	Silt		2	SS	8	Seal	160										0 2 (98)
	Trace/Some Sand					Piezometer											
	Trace Gravel		3	SS	86	Dry											
	Dense to Very Dense		4	SS	45	Seal	158										
			5	SS	31	W.L. in Piezometer	156										0 10 (90)
153.2	Sand and Gravel		6	SS	60	8 cm	154										
10.1	Clayey Silt					Seal											
152.2	Trace Sand																
	Hard (Glacial Till)		7	SS	80	Piezometer											
11.1	End of Borehole																

RECORD OF BOREHOLE No D 11

METRIC

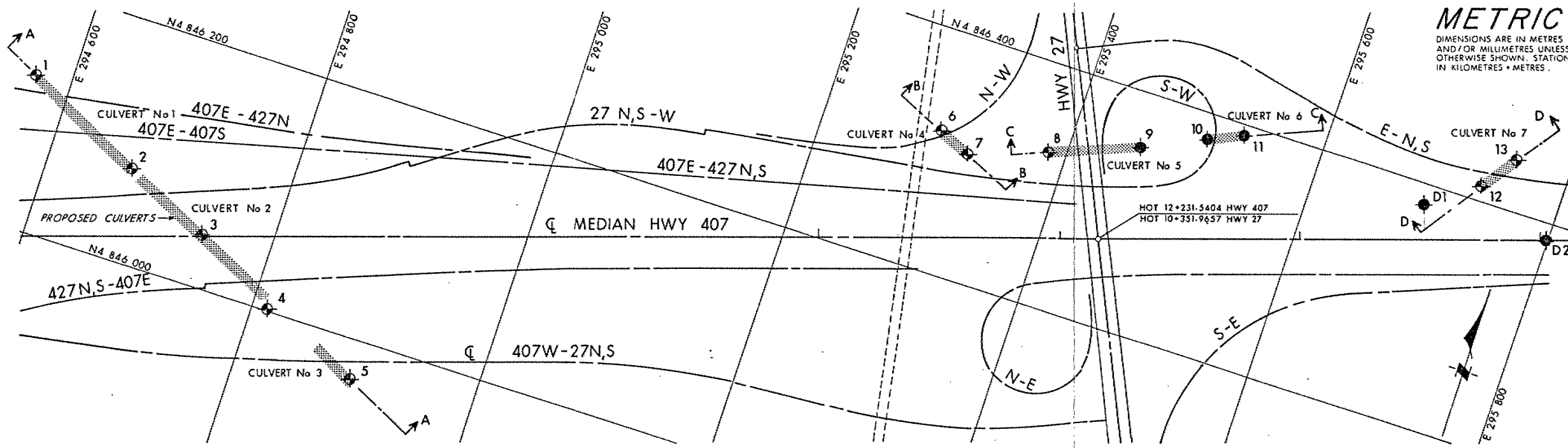
W P 88-78-01 LOCATION Co-ords: N 4 846 816.0; E 296 863.0 ORIGINATED BY BB
 DIST 6 HWY 407 BOREHOLE TYPE Cont. Flight Auger (S.S.) COMPILED BY F.P.
 DATUM Geodetic DATE 88 10 04 CHECKED BY

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100		
161.5	Ground Level												
0.0	Trace Organics		1	SS	51								
	Silt		2	SS	31								
	Trace/Some Sand												
	Trace Gravel		3	SS	38								
	Occasional Clayey Silt Zones												
156.0	Compact to Very Dense		4	SS	34								
5.5	Trace Organics		5	SS	86								
	Sand to												
	Sand and Gravel		6	SS	60								
	Trace/Some Silt												
	Very Dense												
151.9			7	SS	59								
9.6	Clayey Silt												
	Trace Sand Grey												
150.4	Hard (Glacial Till)		8	SS	66								
11.1	End of Borehole												

+³, x⁵: Numbers refer to
Sensitivity

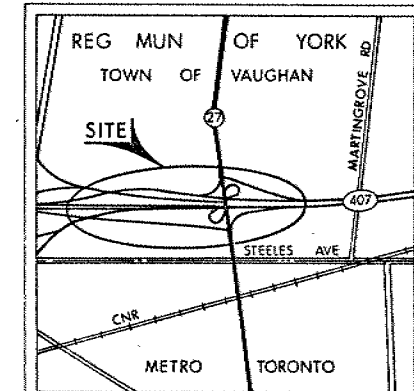
20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

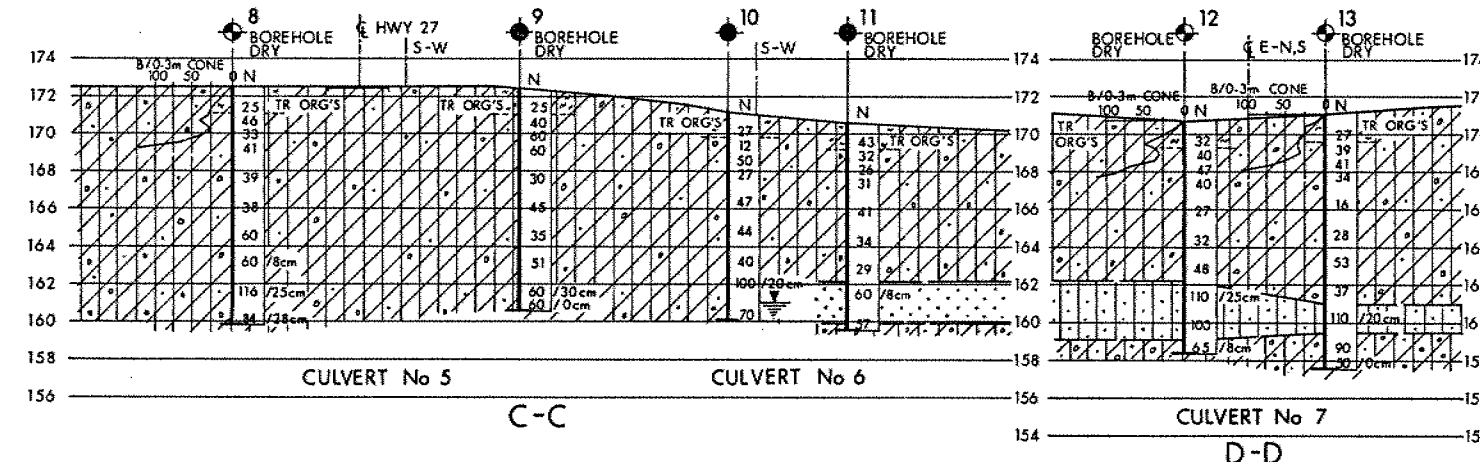
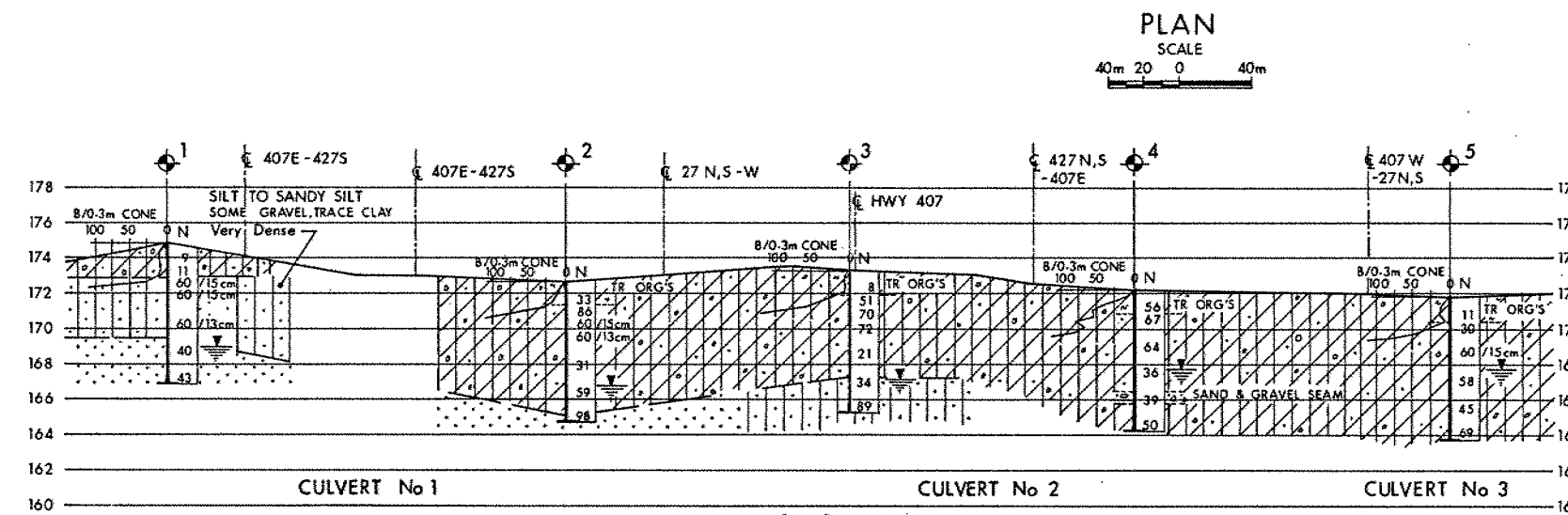


METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.

CONT No
WP No 88-78-01
HWY. 407
(EAST OF HWY 427 TO WEST OF KIPLING)
BORE HOLE LOCATIONS & SOIL STRATA
SHEET



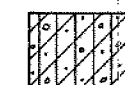
MATCH LINE 'A' SEE DWG 887801-B



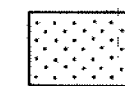
SECTIONS

SCALE
20m 10 0 20m Hor
4m 2 0 4m Vert

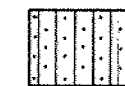
SOIL STRATIGRAPHY LEGEND



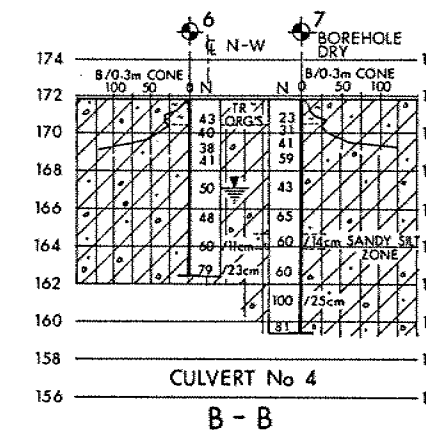
SILTY CLAY TO CLAYEY SILT
TRACE/SOME SAND, TRACE GRAVEL
OCCASIONAL SAND SEAMS
OCCASIONAL SANDY SILT ZONES
Stiff to Hard
(GLACIAL TILL)



SAND
SOME SILT
TRACE/SOME GRAVEL
Dense to Very Dense



SAND TO SILTY SAND
TRACE GRAVEL
Dense to Very Dense



- 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 88 09

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
1	175.0	4 846 129.0	294 570.0
2	172.7	4 846 080.0	294 670.5
3	173.3	4 846 043.0	294 742.0
4	172.2	4 846 002.5	294 811.5
5	171.7	4 845 968.0	294 895.0
6	171.9	4 846 317.0	295 294.0
7	171.9	4 846 305.0	295 321.0
8	172.4	4 846 328.0	295 385.0
9	172.4	4 846 356.0	295 455.0
10	171.1	4 846 379.0	295 506.0
11	170.6	4 846 392.0	295 534.0
12	170.7	4 846 413.0	295 733.5
13	171.1	4 846 443.0	295 755.0
D1	170.5	4 846 383.5	295 693.0
D2	171.0	4 846 386.5	295 797.5

NOTE

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

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

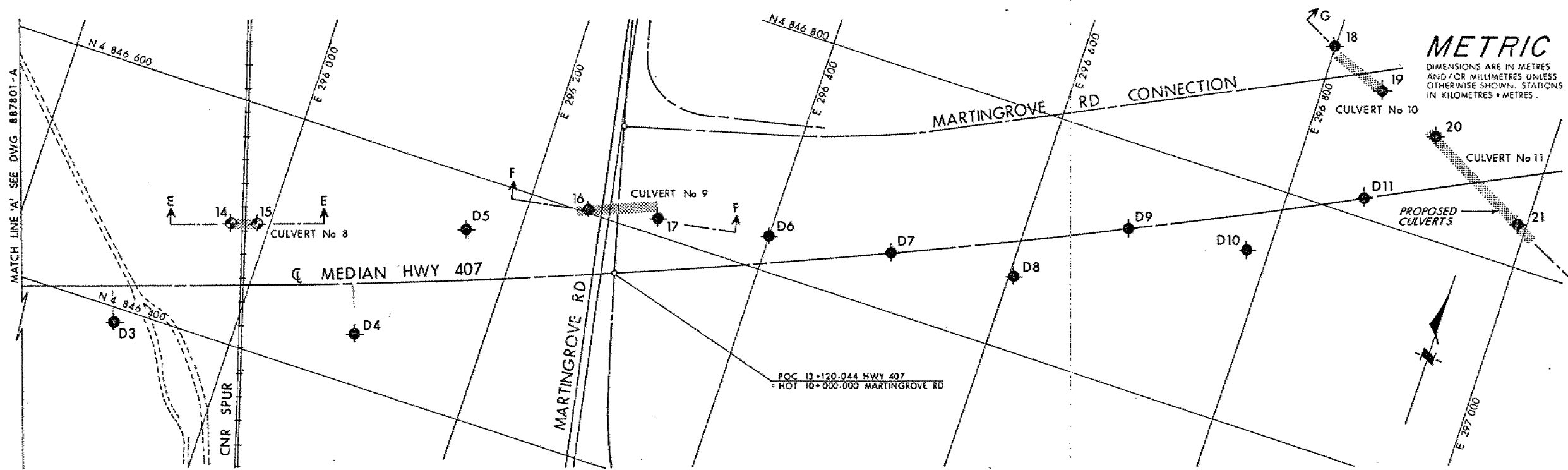
REV	DATE	BY	DESCRIPTION
1	89 01 20		SITE
2	89 01 20		APPROVED

Geacres No 30M13-86

HWY No 407	CHECKED	DATE 89 01 20	DIST 6
SUBMD BB	CHECKED		
DRAWN DT	CHECKED		DWG 887801-A

NOTES

- Subsoil information for BH D1 & D2 refer to Record of Borehole sheets
- For details of groundwater conditions at BH No 6 to BH No 17 refer to report



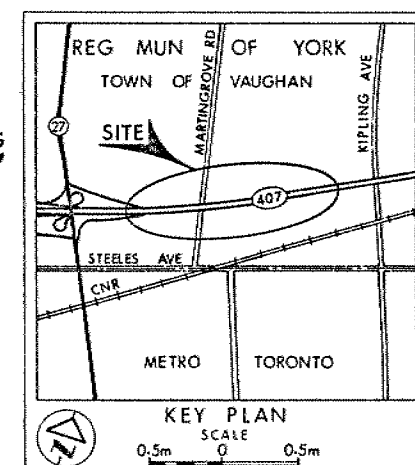
CONT No
WP No 88-78-01

HWY 407
(EAST OF HWY 427 TO WEST OF KIPLING)

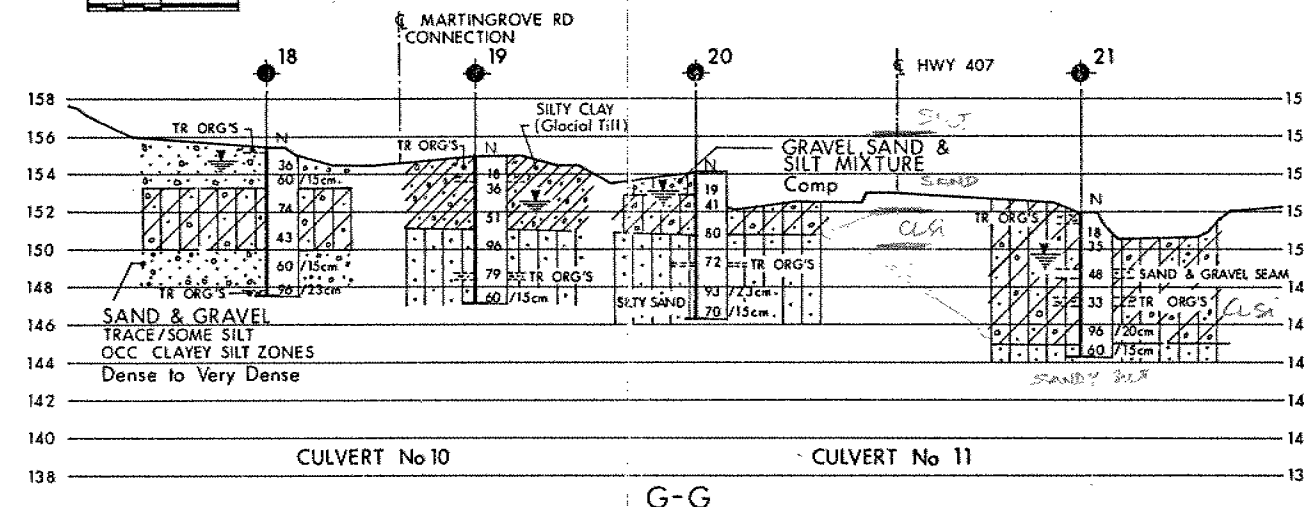
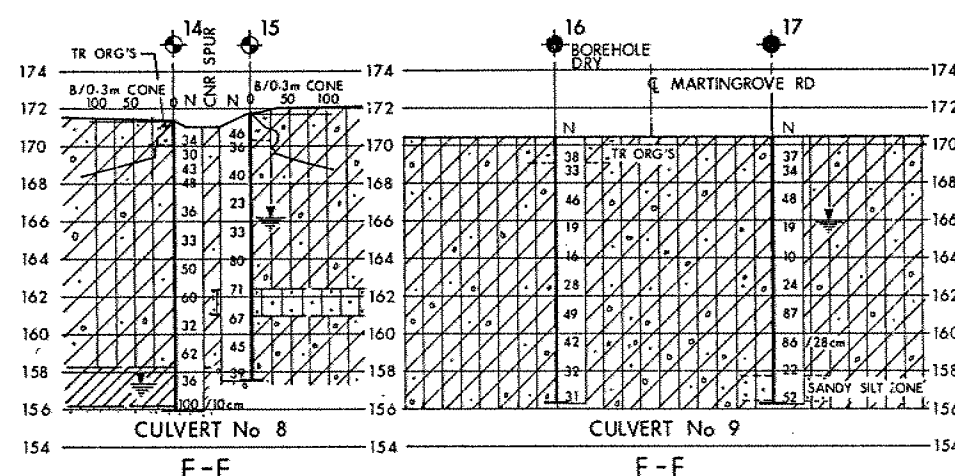
BORE HOLE LOCATIONS & SOIL STRATA

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

SHEET

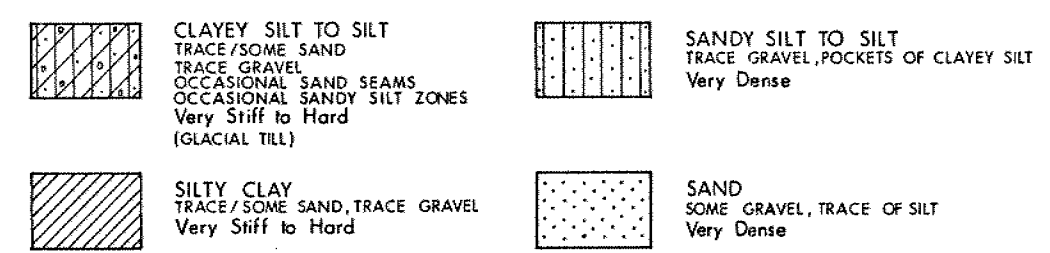


PLAN
SCALE
40m 20 0 40m



SECTIONS
SCALE
20m 10 0 20m Hor
4m 2 0 4m Vert

SOIL STRATIGRAPHY LEGEND



NOTES

- Subsoil information for BH D3 to D11 refer to Record of Borehole sheets
- For details of groundwater conditions at BH No 6 to BH No 17 refer to report

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 88 09 and 88 10

No	ELEVATION	CO-ORDINATES NORTH	EAST
14	171.4	4 846 498.0	295 970.0
15	171.7	4 846 504.0	295 990.0
16	170.4	4 846 603.0	296 250.0
17	170.4	4 846 614.0	296 306.0
18	155.5	4 846 931.0	296 800.0
19	155.0	4 846 907.0	296 850.0
20	154.1	4 846 884.0	296 903.5
21	152.0	4 846 835.0	296 993.0
D3	170.5	4 846 388.5	295 902.0
D4	171.0	4 846 441.5	296 096.5
D5	170.5	4 846 555.0	296 157.0
D6	170.0	4 846 628.0	296 400.0
D7	166.7	4 846 648.0	296 501.0
D8	166.5	4 846 661.0	296 604.5
D9	165.3	4 846 730.0	296 683.0
D10	163.3	4 846 743.5	296 781.5
D11	161.5	4 846 816.0	296 863.0

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

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REV	DATE	BY	DESCRIPTION

Geocres No 30M13-86

HWY No 407	DIST 6
SUBMD BB [CHECKED]	DATE 89 01 25
DRAWN DT [CHECKED]	APPROVED
	OWG 887801-B

MEMORANDUM

To: J. Cullen
Manager
Construction Office
Central Region

Date: 90 07 06

Attn: D. Lang

From: Foundation Design Section
Room 315, Central Building

Re: Contract 89-62
WP 88-78-01
Slope Treatment near Martingrove
Hwy. 407, District 6, Toronto

Further to my site visit with K. Ganesh of June 20/90, and your subsequent memo of June 22/90, we have reviewed the requirements for a 600 mm granular blanket at the locations specified in your memo (Hwy. 407 east at Martingrove).

As you have indicated, the cut slopes are dry with no evidence of silt seams. Due to the distance to the Hwy. 407 lanes, the consequences of any long term instabilities, that may develop in cut slopes when pore pressures fully dissipate, are minor and could be handled by routine maintenance. Consequently, since we understand that this change will result in a substantial savings for the Ministry, we agree that the granular blanket should be deleted.

If there are any questions, please advise.

D. Dundas
D. Dundas, P. Eng.
Sr. Foundation Engineer

SEND TO Mr. Dave Dundas - Sr. Foundation Engineer
 Foundations Design Section
 3rd Floor, Central Bldg. 1201 Wilson Ave

FROM Don Long Contract 89-62 Construction 90-06-22

SUBJECT Granular "A" Blanket Hwy 407 slopes.

We request a review for the necessity of the 600 mm granular blanket for the slopes on Hwy 407 advanced cut area sta 12+870 to 13+040, sta 13+185 to 13+475 on the south slope and sta 13+185 to 13+675 on the north slope - ref. contract drawings sheets 23 to 26.

The slopes have been cut during last fall and this spring operations. They are completely dry with no leaching of water and show no water seams. Therefore we feel there is no need for the granular blanket.

REPLY

Yours truly
 D.K. Long
 Sr. Proj. Supd.

cc - K. Ganesh
 T. Zander
 R. Kent



REPLY FROM

REPLY DATE

memo

To: File

June 22/90

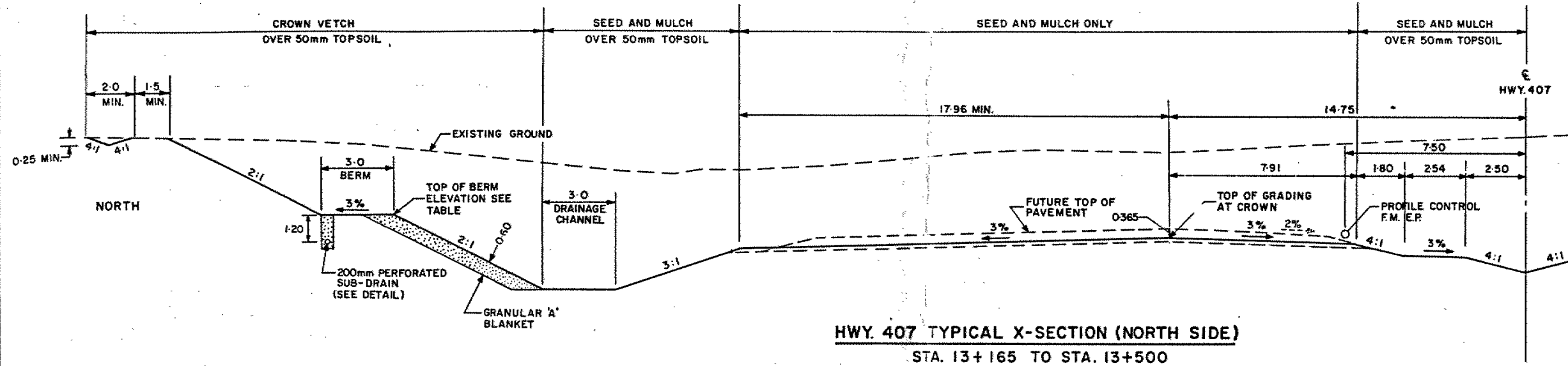
Re: Contract ⁸⁹⁻⁶² ~~MAAZ~~
 Hwy 407 / Markingrove
 Slope Treatment
 WP 88-78-01

On June 20, Keran Gonsalves and
Geotech advised that the construction supervisor
felt that no granular blanket was required
on cut slopes.

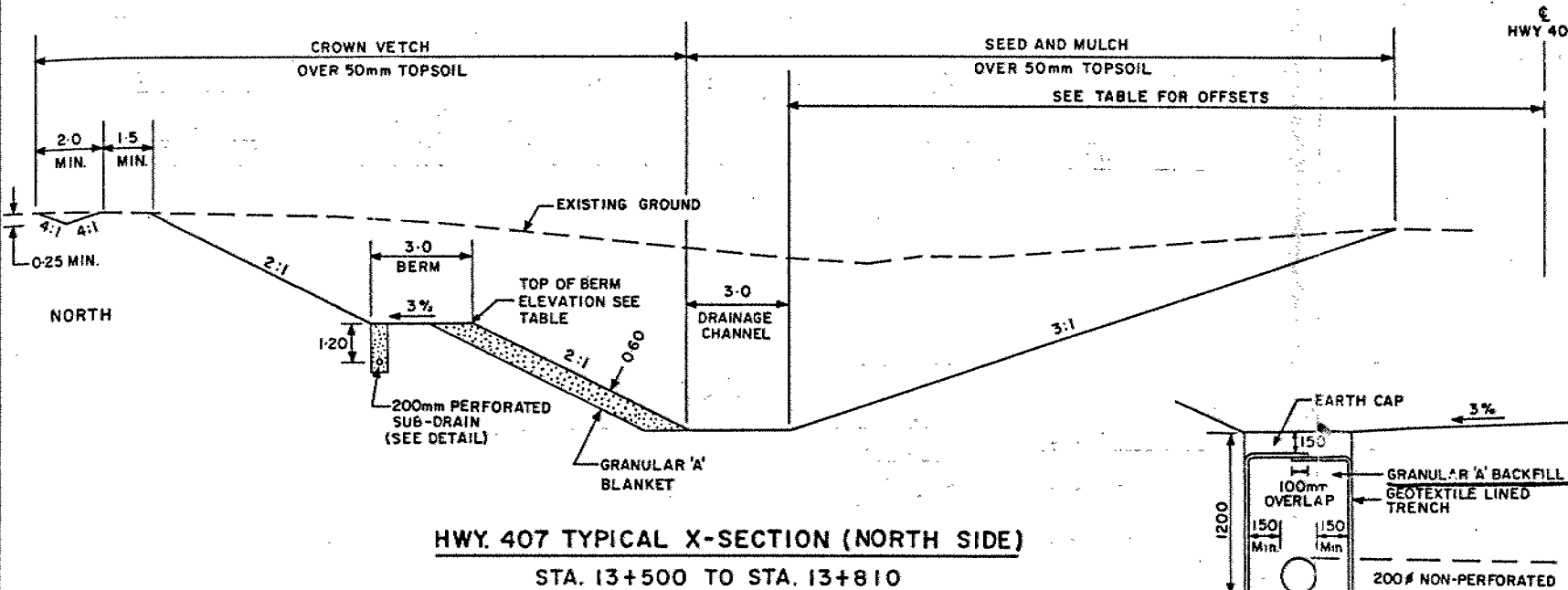
Keran and I inspected the site
and since the slopes are clay & the water
table is below and there would be
little consequence if there were small
instabilities I concurred. I discussed with
Munty and he agreed.

We will note that vegetation is
required and that long term stability may
still pose some concern.

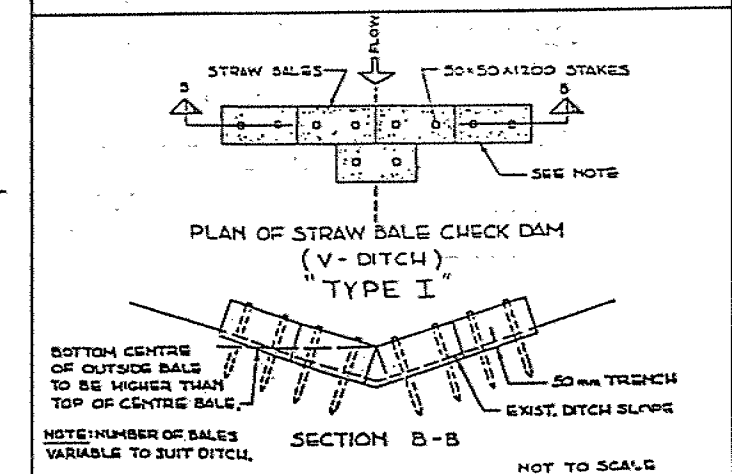
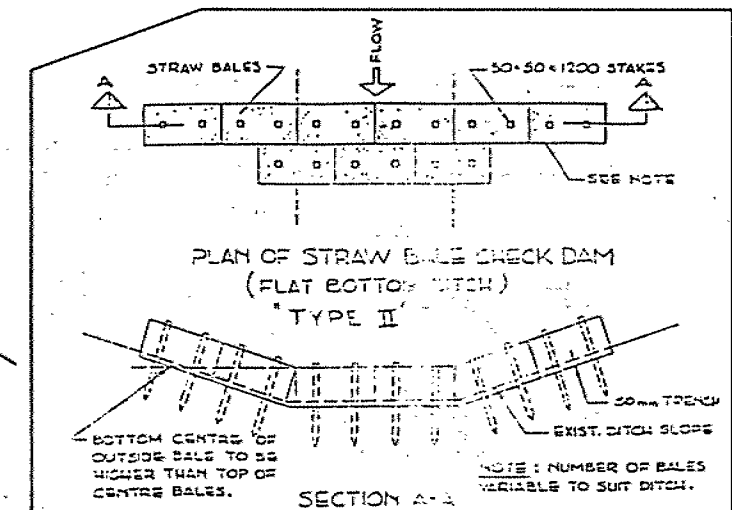
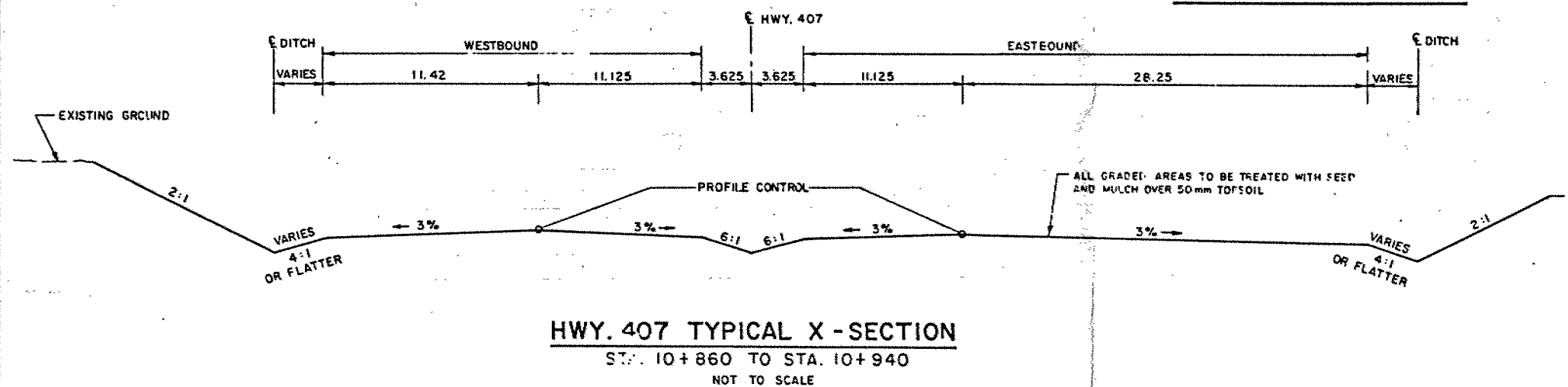
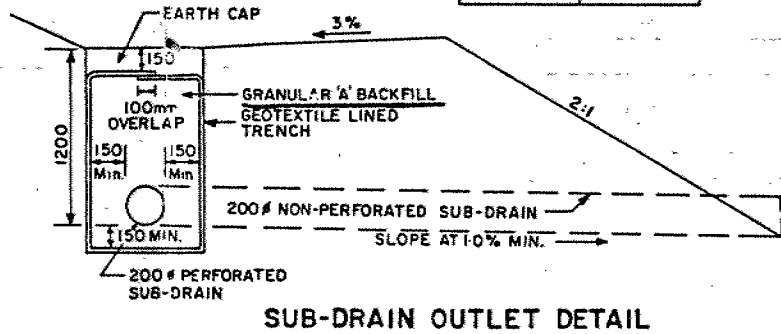
J. Dando
S. J. Ety.



STATION	ELEVATION
13+175	166.00
13+200	165.80
13+225	165.50
13+250	165.25
13+275	165.00
13+300	164.70
13+325	164.20
13+350	163.78
13+375	163.40
13+400	163.00
13+425	162.65
13+450	162.20
13+475	162.00
13+500	161.40
13+525	161.00
13+550	160.70
13+575	160.20
13+600	159.80
13+625	159.10
13+650	158.20



STATION	LEFT OF C
13+500	39.40
13+525	40.20
13+550	41.00
13+575	41.70
13+600	42.40
13+625	42.40
13+650	43.20
13+675	44.00
13+700	44.80
13+725	45.70
13+750	45.10
13+775	44.30



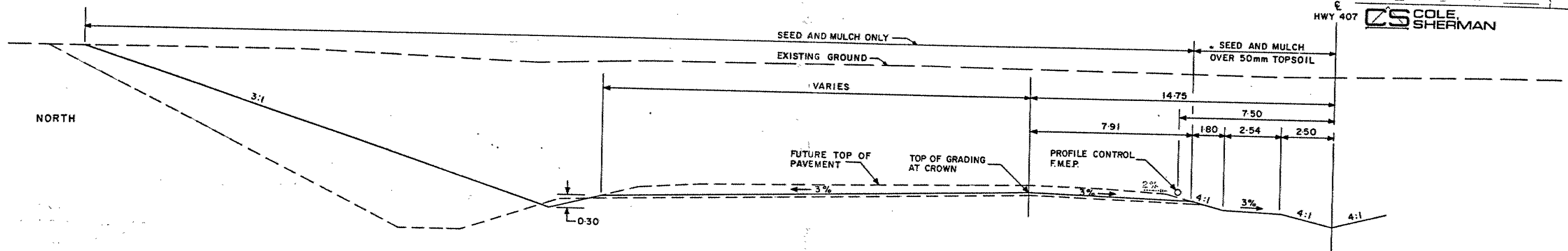
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

PLAT No 89-62
CONT No 88-78-25
WP No 88-78-25

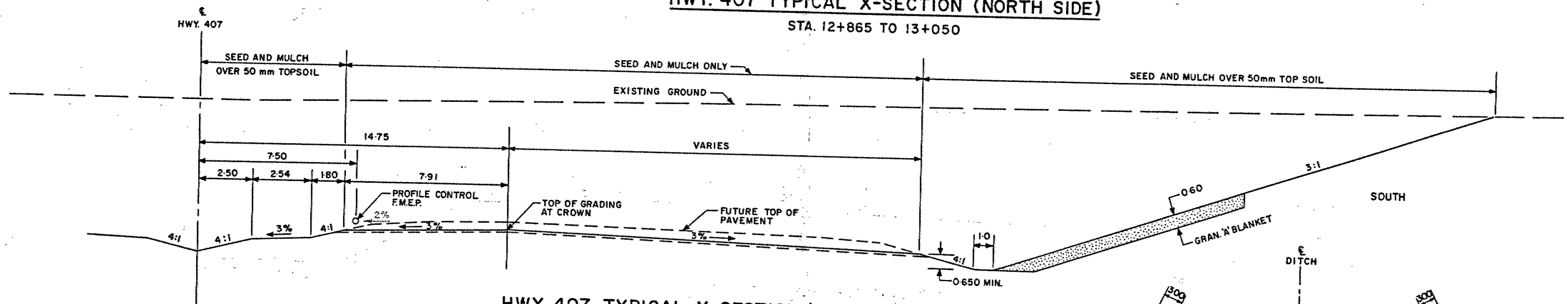
TYPICAL X-SECTION
HWY. 407
STA TO STA
Survey Revised

SHEET
52

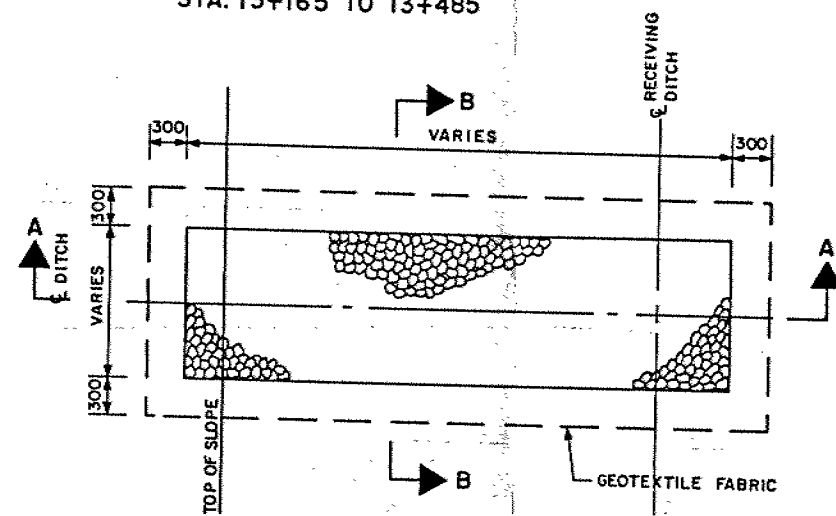
CS COLE
SHERMAN



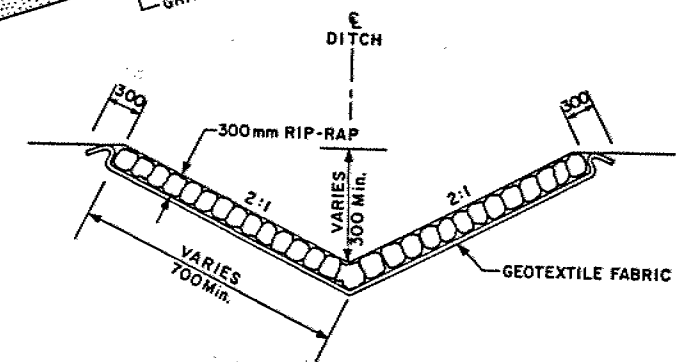
HWY. 407 TYPICAL X-SECTION (NORTH SIDE)
STA. 12+865 TO 13+050



HWY. 407 TYPICAL X-SECTION (SOUTH SIDE)
STA. 12+865 TO 13+050
STA. 13+165 TO 13+485

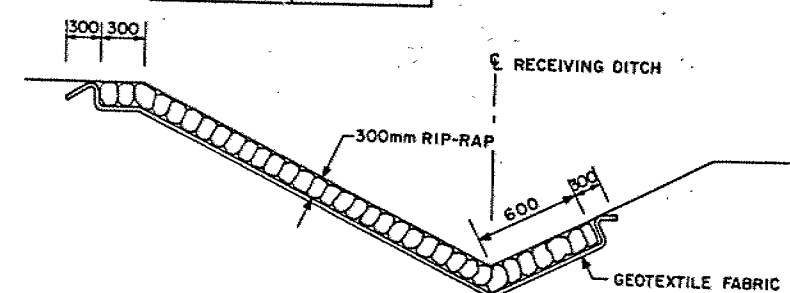


PLAN
RIP-RAP DETAIL



SECTION B-B

DEPTH OF DITCH	WIDTH OF SLOPE
300mm	700mm
650mm	1500mm



SECTION A-A

SCALE
M.T.S.

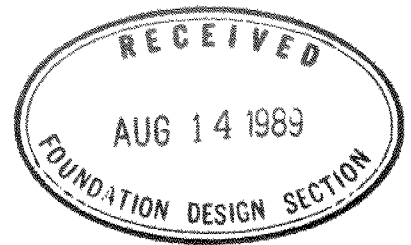
0.25 MIN.

2.0
MIN.

0.25 MIN.

NORTH

EX



M E M O R A N D U M

Geotechnical Section, Central Region

Telephone: 224-7408

To: M. Devata
Head, Foundation Section
Engineering Materials Office
3rd Floor, Central Building

Date: 89 08 10

Attention: Balu Iyer

Re: WP 88-78-01
Hwy. 407, Diversion Channel, North Side
From Hwy. 27 to Rainbow Creek
District 6


This memo will advise you of the treatment method of the side slope and channel protection for the above diversion channel, adopted by the Geotechnical Section and Planning and Design Section.

Refer to the following memos and report by Betty Bennett of your section for background information.

- 1) Memo, W.P. 88-78-01, Preliminary Foundation Recommendation issued 88-12-06.
- 2) Speedy memo, W.P. 88-78-00, 407 Diversion channel, issued 89-03-29.
- 3) Memo. W.P. 88-78-01/25, Hwy. 407 Diversion channel, issued 89-04-17.
- 4) Final Foundation Report W.P. 88-78-01, Hwy. 407 From east of 407/427 Interchange to west of 407/Kipling Ave. Interchange, issued 89-05-17

The 250mm thick Gabion mat along the channel bed and up the side slope as shown in the attached x-section Hwy. 407, is set into the 600mm Granular blanket so that the channel bed remains 3.0m wide as required.

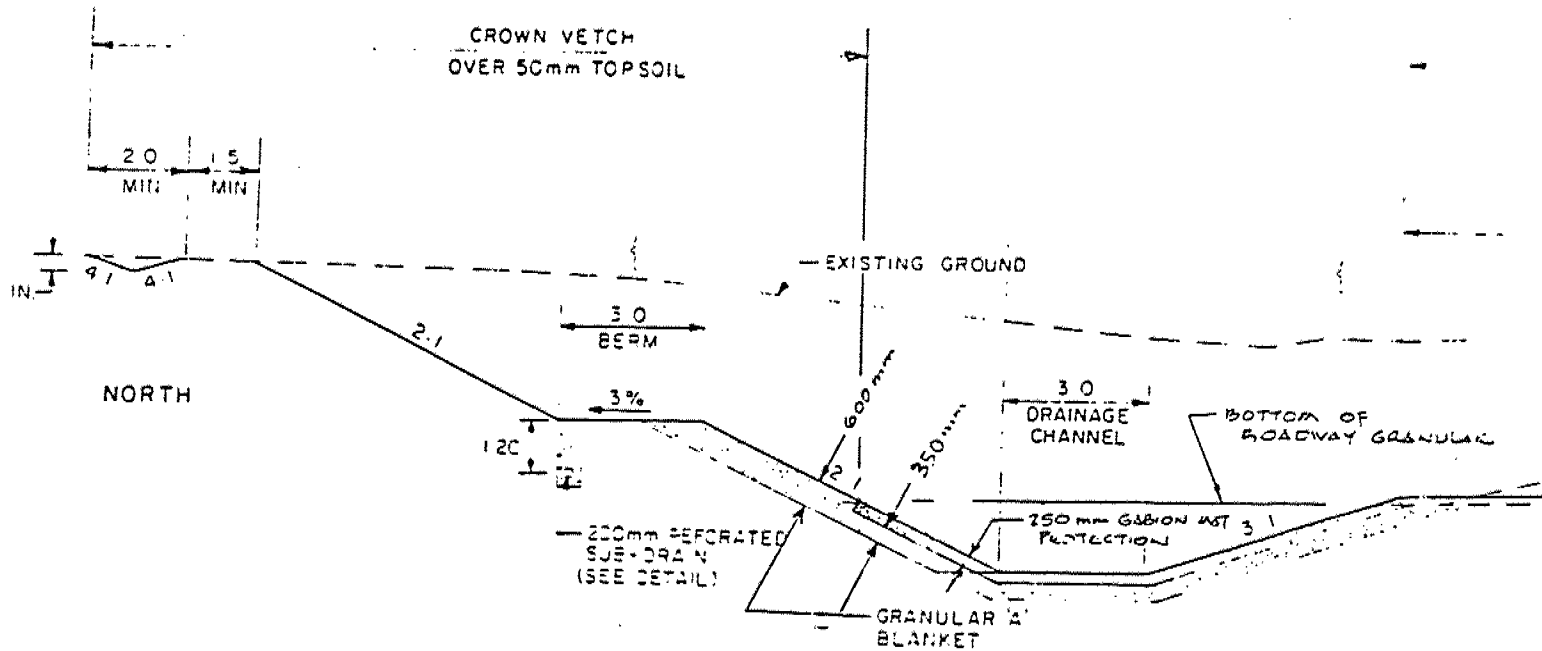
KG/GC/fd
Attach.


K. Ganesh
P.D.E.O.
For:
G. Cautillo
Head, Geotechnical Section

c.c. J. Klowak
B. Hurd (Cole, Sherman & Ass. Ltd.)

Disk File: Devata

To File



HWY. 407 TYPICAL X-SECTION (NORTH SIDE)

March 31, 1989

Call from K. Ganesh, Geotechnical Section
Consultants enquiring about minimum
depth of cut for which granular
blanket to half-height is required.
Since the original investigation request
from the geotechnical section was made
for cuts deeper than 4.5m. I
suggested to him that 4.5m be
the minimum height for which ~~the~~
our recommendations apply. For cuts
less than that, he and the
consultants can decide on whether
or not to apply the blanket at all.

FOB.

memorandum



To: Mr. G. Cautillo
Head, Geotechnical Section
Central Region

Date: 1989 04 17

Attn: Mr. K. Ganesh

From: Foundation Design Section
Room 315, Central Building

RE: W.P. 88-78-01/25
Highway 407, Diversion Channel
From Highway 27 to Rainbow Creek

In response to your request of 89 04 14 and to the concerns addressed in J. Klowak's memo dated 89 04 05, the following memorandum is intended to clarify the recommendations made for the diversion channel running alongside and north of Highway 407 between Highway 27 and Rainbow Creek.

The original foundation investigation request made by the Geotechnical Section included a request to provide recommendations to ensure the stability of the deep cut (>4.5m) and diversion channel bottom.

The recommendations made by this office were based on soils investigations and stability analyses. They provide one method of protecting the slope and channel bed. The granular blanket is intended to protect the slope from internal seepage zones intersecting the cut. The rock protection or gabion mat placed along the channel bottom is intended to protect the channel from external erosion.

Our recommendations for the final slope geometry and treatment (both granular blanket and rock protection/gabion), remain as outlined in our memos dated 88 12 06 and 89 03 29. The 600 mm thick granular blanket, placed to mid-height on slopes where the cut is less than 6.0 m deep, and on the lower slope where the cut exceeds 6.0 m in depth, should extend across the channel bed. The granular blanket should be overlain by a 250 mm± thickness of rock protection or gabion mats that extend across the channel bottom and up the slopes to the high water level or alternatively to the level of the granular blankets. The treatment should be applied for the length of the diversion channel (east of Hwy. 27 to Rainbow Creek) where the cut is 4.5 m or deeper.

If external erosion is not a concern, then the rock protection or gabion mat treatment may be eliminated at your discretion. However, protecting the slopes and granular blanket with vegetation is desirable.

The slopes of temporary excavations near existing roadways should be fully protected and maintained as described above. Stability of temporary excavations away from the roadway is not as critical and the slopes may be maintained at 2H:1V without blankets or rock protection.

If there are any questions regarding the above, please contact this office.

B. Bennett

B. Bennett, P. Eng.
Foundation Engineer

BB/jb

SEND
TOK. GIANESH
GEOTECHNICAL SECTION, CENTRAL REGION

FROM

B. BENNETT

DEPT

FOUNDATION DESIGN SECTION

DATE

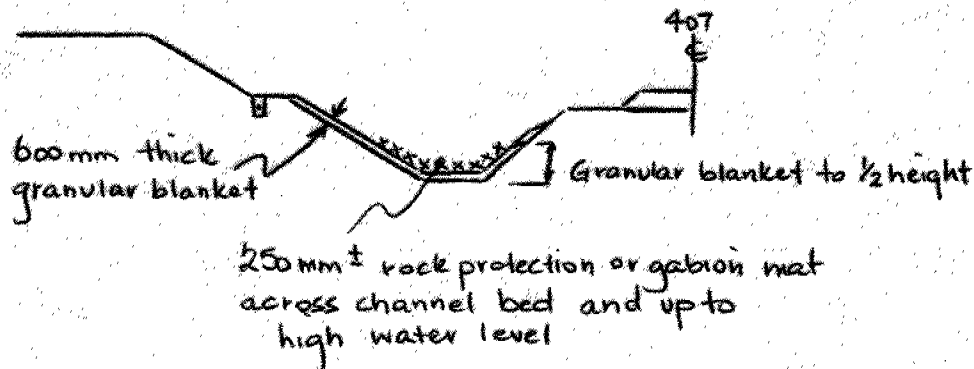
89 03 29

SUBJECT

WP 88-78-00 HWY 407 / FROM HWY 427 TO W. OF KIPLING AVE., DIVERSION CHANNEL

As requested in our discussion on 89.03.28, the following are recommendations for the diversion channel in conjunction with those made in our memo dated 881206. The 600 mm thick granular blanket recommended on the side slopes of the cut for the diversion channel should extend from the toe of slope across the channel bed and to mid-height of the adjacent slope. The granular blanket should be overlain by a $250\text{ mm} \pm$ thickness of rock protection or gabion mats along the channel bed and to a height equal to the anticipated high water level on both sides.

REPLY



REPLY FROM

REPLY DATE

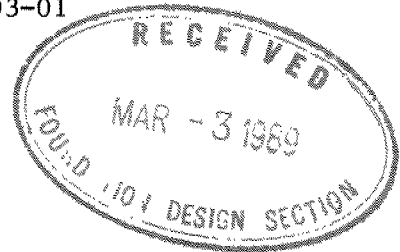
M E M O R A N D U M

Geotechnical Section, Central Region

Telephone: 224-7410

To: B. Bennett
Foundation Engineer
Engineering Materials Office
Central Building
1201 Wilson Ave.
Downsview

Date: 89-03-01



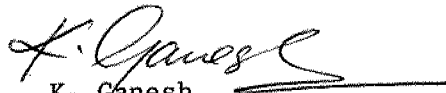
Re: W.P. 88-78-01/25: Hwy. 407
From Hwy. 427 to West of Kipling Ave.
Foundation Recommendations for Hwy. 407 Cut slopes

This memo will inform you of the decision taken by the Geotechnical and Planning and Design Sections as per your recommendations in your memo dated 1988-12-06 regarding the above subject matter.

Design alternative 1 was selected for the cut of the diversion channel on the north side with a slight modification. A 3 m wide berm instead of the recommended 2 m wide berm was used.

Design alternative 2 was selected for the cut on the south side.

These alternatives were respectively selected to minimize revision to the contract package which was undergoing Document review in early January 1989.


K. Ganesh
For: Guy Cautillo
Head, Geotechnical Section

GC/SZ

c.c. J. Klowak
D. Dundas
P. Jefford
B. Hurd (Cole, Sherman)

File: WP-88-78

memorandum



235-3731

To: Mr. G. Cautillo
Head, Geotechnical Section
Central Region

Date: 1988 12 06

From: Foundation Design Section
Room 315, Central Building

Subject: W.P. 88-78-01
From East of 407/427 I.C. to
West of 407/Kipling I.C.
Preliminary Foundation Recommendations

As requested in your memo dated 88 08 12, a foundation investigation was carried out at the above mentioned site.

The investigation was conducted to provide recommendations for

1. eleven proposed culvert locations;
2. the stability of a deep cut (up to 9.5 m) along the east diversion channel north of Highway 407; and
3. the stability of a cut proposed along the backslope, east of Highway 27 and south of Highway 407.

The fieldwork was conducted during the period from 88 09 19 to 88 10 04 utilizing an auger machine. A total of 32 boreholes were advanced, 21 of which were drilled at the culvert locations. Eleven borings were advanced between Sta. 12±500 and 13±750 for the proposed cuts along Highway 407. Piezometers were installed in three of these boreholes.

This memo contains a summary of the general subsurface conditions encountered across the area and the foundation recommendations for the proposed culverts and deep cuts. The final report, complete with borehole log sheets, will be forwarded in the near future.

General Subsurface Conditions

The subsurface material encountered across the area consists largely of cohesive clayey silt containing varying proportions of sand and gravel. The material is a till of glacial origin. Layers of granular material are present intermittently across the site and are often water-bearing. These layers, composed of sand to silt, are more prevalent at the west end of the site and by the creek at the east end of the site.

.../2

From the information obtained from the field investigation, the clayey silt deposit ranges from less than 1.0 m to greater than 14.0 m in thickness. The N values vary from 8 to in excess of 120 per 30 cm, but are generally greater than 30. The material exhibits low plasticity and a consistency of stiff to hard.

A more detailed description of the subsurface material will be included in the final foundation investigation report.

Recommendations

I Culvert Foundations

It is proposed to construct eleven concrete box culverts across the site. The subsurface material encountered below the invert elevations at each of the culvert locations is suitable for spread footing foundations. The allowable bearing capacities as per the O.H.B.D.C. and the minimum footing elevations for each of the culverts are shown in Table I.

The footings should be constructed in the 'dry'. Although some dewatering problems may occur where granular seams intersect the excavation below the water table, it is anticipated that dewatering may be achieved by using sump pumping techniques, incorporating perimeter ditches to prevent disturbance of the foundation soil (Fig. 1). If the footing base, upon excavation, is to remain uncovered for a long period of time or softens with exposure, a 15 cm concrete working slab should be poured within six hours of exposure.

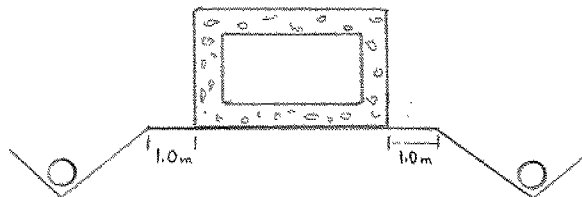


FIG. 1

Temporary excavation for the construction of the culvert footings should be maintained at a slope of 1H:1V to a maximum height of 6.0 m. Temporary excavations exceeding 6.0 m should be inclined at 1.5H:1V or flatter. Water-bearing granular seams may occur just beneath the level of excavation at some of the culvert locations and, as a result, basal heave may occur. In this event, our office should be contacted.

At Culvert 5 (Hwy. 27) and Culvert 9 (Martingrove), care should be taken, when constructing the culvert footings, that the excavation does not interfere with the proposed bridge foundations. Excavations should not encroach on the critical zone beneath the proposed bridge footings defined by a plane extending 1H:1V from a point 3 m from the base of the bridge footing.

Culvert 8 is proposed to cross beneath the Ontario Hydro rail spur line. It is assumed that the existing track will be removed prior to the construction of the culvert. If this is not the case, then tunnelling may be required and details should be obtained from this office.

Backfill to the culverts should proceed as per OPSD-803.01 and OPSD-803.06 using Granular 'A' or Granular 'B'.

The culvert outlets should be treated with rock protection as per OPSD-810.01 Type A.

It is recommended that a seal be placed at the inlets to the culverts. The seal should comply with the requirements outlined in Form 1205 'Material Specification for Clay Seal'. It should have a minimum thickness of 0.6 m. The seal should extend over the backfill to the culvert from the high water level down to the channel bed and 1.0 m along the channel.

The embankment slope around the culvert entrances should be protected against erosion by laying a 0.6 m minimum thickness of rock protection over the above-mentioned seal.

II Recommendations for the Deep Cut North of Highway 407

A diversion channel is proposed to run parallel to and approximately 50.0 m north of Highway 407 centreline between Sta. 12+100 +/- Sta. 13+780 +/- . The cut required to achieve the channel elevation extends to a maximum depth of 9.5 m.

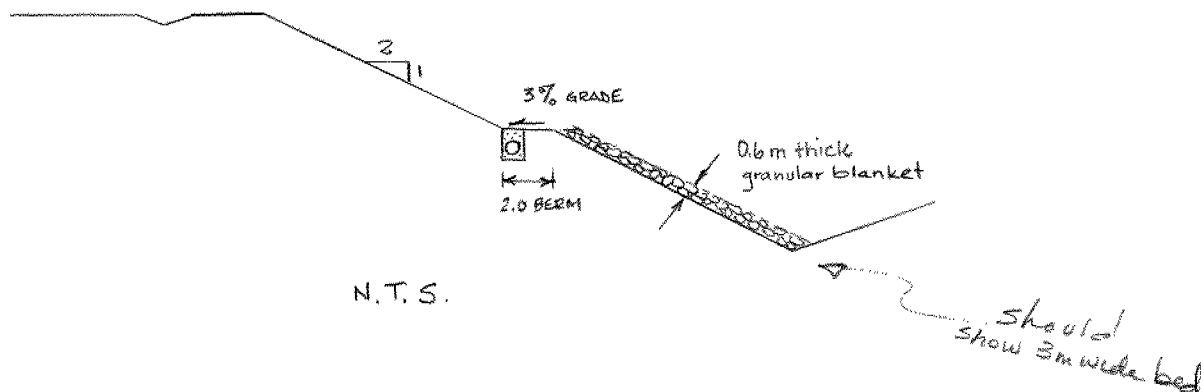
Piezometers installed across the area of the deep cut indicate a high groundwater table. The main concerns, then, are surficial and long term internal slope stability. A series of slope stability analyses was conducted for various cross sections using Bishop's effective stress analysis. Based on the results of the analyses two alternatives are proposed.

Alternative #1

The deep cut may be maintained at a slope of 2H:1V, to a maximum height of 6.0 m, and treated with a 0.6 m thick granular blanket on the lower half of the slope. Where the cut exceeds 6.0 m in depth,

.../4

slopes should remain at 2H:1V and incorporate a 2.0 m wide berm at approximately mid-height. The lower slope should be treated with a 0.6 m thick granular blanket. A 1.2 m deep sub-drain is required along the toe of the uppermost slope as shown on the sketch below:



The granular blanket recommended along the lower slope should consist of Granular 'A'. Granular 'B' may be used provided that it has a suitable gradation. In this case, typical gradation curves should be submitted to this office for assessment.

It is recommended that the sub-drain trench be lined with geotextile filter fabric. Suitable fabrics include Class 1 non-woven geotextile with EOS of 75 to 150 μ m. The pipe laid should be perforated and have a minimum diameter of 150 mm. Granular backfill should surround the pipe to a minimum thickness of 150 mm. The sub-drain should connect with the diversion channel. The link should take into consideration the effects of erosion and freezing. This may be achieved by extending a channel lined with rock protection from the sub-drain outlets to the diversion channel. Alternatively and preferably, the sub-drain at the outlets, should extend downslope to the diversion channel, remaining below the frost penetration zone for the entire distance.

Alternative #2

The deep cut to the diversion channel may be maintained at an uninterrupted 3H:1V slope for the entire length of the cut. The slope should be treated to mid-height with a 0.6 m thick granular blanket. The appropriate materials for the blanket are described in Alternative #1.

General Recommendations

An interceptor ditch is recommended at the top of the slope and should run for the entire length of the cut. Vegetation should be

placed on the slope as soon as possible after completion of the cut to minimize and control surficial erosion.

III Recommendations for the Cut Slope South of Highway 407

To the south, the cut for Highway 407 runs from approximately Sta. 12+650 to Sta. 13+540. The alternatives recommended for the cut slope to the north are applicable to the south slope.

Of the two alternatives proposed, Alternative #1 is preferred since it requires less grading and provides a more effective drainage scheme.

In general, the cut for Highway 407 through this area is extensive and in order to facilitate the excavation, construction should proceed in an upstream direction.

If there are any questions regarding the above recommendations, do not hesitate to call this office.

B. Bennett

B. Bennett
Jr. Foundation Engineer

BB/ms

				FAC B.C. @ ULS	B.C. @ SLS II
CULVERT	BH	LOCATION	INV EL (m)	(within 1.0 m of inv el)	
1	1	Sta 11+354, 135m Lt	172.2	450	300
	2	Sta 11+434, 57m Rt	171.8		
2	2	Sta 11+434, 57m Rt	171.8	375	250
	4	Sta 11+544, 60m Lt	171.4		
3	4	Sta 11+544, 60m Lt	171.4	450	300
	5	Sta 11+612, 118m Rt	171.1		
4	6	Sta 12+100, 90m Lt	169.4	600	400
	7	Sta 12+121, 70m Lt	167.1		
5	8	Sta 12+189, 72m Lt	166.9	525	350
	9	Sta 12+265, 77m Lt	166.7		
6	10	Sta 12+319, 83m Lt	166.5	450	300
	11	Sta 12+351, 87m Lt	166.4		
7	12	Sta 12+547, 45m Lt	165.9	450	300
	13	Sta 12+577, 67m Lt	164.4		
8	14	Sta 12+799, 52m Lt	162.6	450	300
	15	Sta 12+820, 51m Lt	162.4		
9	16	Sta 13+100, 54m Lt	161.3	375	250
	17	Sta 13+157, 43m Lt	161.2		
10	18	Sta 13+743, 130m Lt	154.3	600	400
	19	Sta 13+778, 87m Lt	153.6		
11	20	Sta 13+816, 43m Lt	152.8	450	300
	21	Sta 13+875, 40m Rt	149.9		

TABLE 1

memorandum



Tel #235-3731

To: Mr. G. Cautillo
Head,
Geotechnical Section
Central Region

Date: 1988 11 29

Attention: Mr. K. Ganesh

From: Foundation Design Section
Room #315, Central Building

Re: Temporary Culvert
Martingrove Rd. N of Hwy 407
WP 88-78-01
Hwy 407, District 6, Toronto

Further to your request of 88 11 25, we have reviewed the proposal to construct 6.6±m temporary cut with $\frac{1}{2}$:1 slopes for the installation of the culvert. This proposal is not in accordance with the Occupational Health and Safety Act, and in our opinion it is not acceptable.

If there are any questions, please advise.

D. H. Dundas

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

DHD:st

SEND
TODane Dundas
Sr. Foundation Eng.
Foundation Section.

FROM

Karan GAWESH

DEPT.

Geotechnical Section

DATE

25/Nov/88

SUBJECT

Temporary Crossing of Martin Grove Road

NP. 88-78-01 Hwy 407

It is proposed to install a temporary 600 mm diam C.S.P. across Martin Grove Road just north of the proposed Hwy 407 alignment. See attached cross-section for details.

The purpose of this C.S.P. is to drain the excavated area after borrow material is removed from the R.O.W of Hwy 407.

Could you please comment on the stability of the temporary (4-5 days) $1/4:1$ slope

REPLY

created during the installation of the C.S.P.

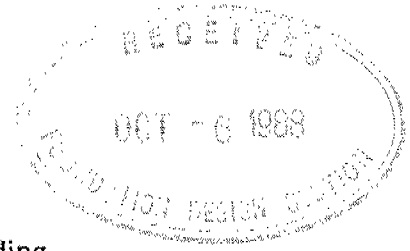
The installation is ~~proposed~~ to be carried out in two stages.

Attached are plans and profile for your assistance.

Karan

REPLY FROM

REPLY DATE

CONSULTING ENGINEERS AND ARCHITECTS**MINUTES OF MEETING****W.P. 88-78-01 - Highway 407
Slope Stability in Deep Cut Sections**

DATE: September 26, 1988 @ 1000 hours

PLACE: M.T.O. Keele Street Offices, Room 131, Central Building

PRESENT: M.T.O.

J. Klowak	- Planning & Design Section
P. Jefford	- Planning & Design Section
D. Dundas	- Foundation Section
P. Ksenych	- Geotechnical Section
K. Ganesh	- Geotechnical Section

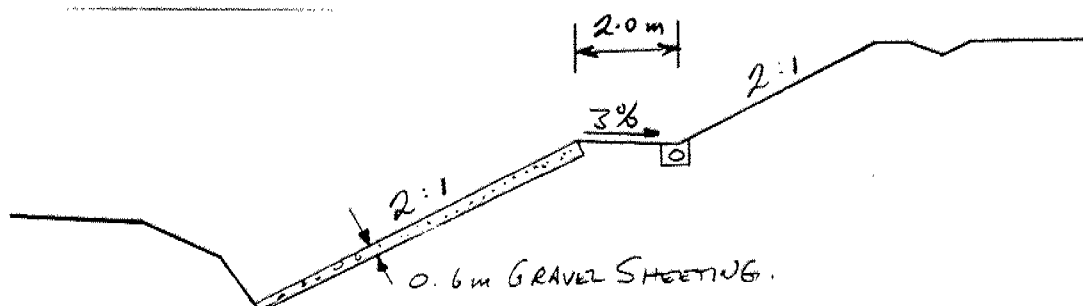
C.S.A.

R. Thompson
B.H. Hurd

A meeting was called on the above date by Geotechnical Section to review preliminary recommendations by Foundation Section for slope treatments in deep cut sections.

D. Dundas advised that his current recommendation is preliminary in that field investigation and subsequent soil testing are not yet completed. The recommendation covers a "worst case" scenario of high water table and seepage zone problems. This treatment includes a 2.0 m mid-height berm on 2:1 side slopes greater than 6.0 m in height, with sub-drain installed at the back edge of the berm and a 0.6 m layer of gravel sheeting on the portion of the 2:1 side slope below the berm. A sub-drain may also be used at the toe of the slope.

This treatment would apply to the cut slope adjacent to Diversion No. 2 channelization as well.



The current (Sept. 19/88) design package has utilized uninterrupted 3:1 side slopes along the south side of 407. Along the north side adjacent to the drainage channel, 2:1 slopes with a 2.0 m mid-height berm were used with no sub-drains and no gravel sheeting.

Following general discussion, it was agreed:

- Foundation Section will issue final recommendations, including the feasibility of using 3:1 side slopes, by the end of November (approx.).
- Current design package to remain as is. Any revisions to cut section grading to be carried out following the November 22/88 Technical Review Meeting in light of final recommendations by Foundation Section.

Submitted by:



Bram Hurd

BHH:jt

cc: All attendees

Sept. 26/88

WP 88-78-2501 & 25-

- meeting with Colo Sherman

- 3:1 vs. 2:1 was discussed
- Colo Sherman preferred 3:1 slope due to maintenance concerns.
- I stated that 2:1 treatment was based on worst case scenario & could be more for design in all probability.
- I agreed that we would consider 3:1 slopes
- my impression is that Colo Sherman completed plans without authorization & therefore has vested interest in them remaining the same.
- I advised John Klawns that we could not make any more technical recs until the field work was completed.

88 07 21

WP 88-78-01

WP 88-78-25

Hwy 407 from Hwy 427 E to E of Meekingrove Rd.

Meeting @ Cole Sherman

1) In response to P. Ksanych memo dated 88 07 13, I addressed

a) for fill heights less than 8 m
2H:1V slopes are OK

b) for fill heights greater than 8 m
2 m wide berms. No uninterrupted
slopes greater than 8 m high.
Berms to slope to down slope

2) Discussion re: Reinforced Earth wall
I advised Wade Young that since (Struct. Sect.)
they have retained Reinforced Earth
we (FDS) ^{assume} they have checked and taken
responsibility for overall stability of the wall.
If not they should formally request our
review. Furthermore in the future Structure Section
should consult FDS before contracting R.E. as
it is geotech. concept.

- 3) For cuts, no uninterrupted slope greater than 6 m high, the 2 m berm.
If seepage or drainage problems exist, more extravagant drainage measures such as sand & toe drains and gravel blankets may be required.
The concept of flatter slopes was discussed (3:1) and I advised there was more than one way to solve problems depending on drainage, seepage & soil conditions.

There is no property problem at present time.
The minutes of meeting will serve as preliminary recs. Gertsch will make formal request for mid August 88

- ④ WP 88-78-24, Bridge over Steeles
Design is nearly complete so that introducing berms at this stage would require redesign.
Hence reinforced 2:1 slopes may be considered.

- ⑤ Discussion re: future high mast lighting.
I advised that this can be collocated after construction^{but} that they should attempt to locate on flat land, or berms if necessary, & they should avoid boulders beneath pole sections in fill.
The depth of embankment may be greater than normal due to fill.

D.H. Dundas Sr. P.E. Eng.

memorandum



To: G. Cautillo
Head
Geotechnical Section
Central Region

Date: 1988 09 01

Attn: P. Ksenych

From: Foundation Design Section
Room 315, Central Building

RE: W.P. 88-78-01, Highway 407
Subsurface Investigation along Cut Section
Sta 12+500 to Sta 13+750

This letter is a request for additional fieldwork to be conducted in conjunction with your geotechnical investigation along the proposed Highway 407 alignment east of the 407/427 Interchange and west of the 407/Kipling Interchange.

As discussed during our meeting of 88 08 26, the following is an outline of the information required by our office in order to determine the overall slope stability of the deep cut section and diversion channel between Sta 12+500 and Sta 13+780 of Highway 407.

1. Borehole Locations

Please advance the following boreholes a minimum of 5.0 m below subgrade profile:

BH 1	Sta 12+500	o/s 30 m North
BH 2	Sta 12+600	o/s 30 m North
BH 3	Sta 12+650	o/s 30 m South
BH 4	Sta 12+700	o/s 30 m North
BH 5	Sta 12+750	o/s 30 m South
BH 6	Sta 12+850	o/s 30 m South
BH 7	Sta 12+900	o/s 30 m North
BH 8	Sta 12+950	o/s 30 m South
BH 9	Sta 13+000	o/s 30 m North
BH 10	Sta 13+050	o/s 30 m South
BH 11	Sta 13+200	o/s 30 m North
BH 12	Sta 13+250	o/s 30 m South
BH 13	Sta 13+300	o/s 30 m North

W of RR track

W of Martingrove

BH 14	Sta 13+350	o/s 30 m South
BH 15	Sta 13+400	o/s 30 m North
BH 16	Sta 13+450	o/s 30 m South
BH 17	Sta 13+500	o/s 30 m North
BH 18	Sta 13+550	o/s 30 m South
BH 19	Sta 13+600	o/s 30 m North
BH 20	Sta 13+650	⊕
BH 21	Sta 13+700	o/s 30 m North
BH 22	Sta 13+750	⊕

2. Sampling Procedures

Samples are to be taken every 1.5 m (5') for the entire length of the borehole using a split spoon sampler. Where cohesive material with N of less than 15 blows is encountered, field vane tests should be conducted and undisturbed samples taken. Laboratory testing should provide sufficient information such that the soil properties, shear strength and angle of internal friction, can be deduced.

3. Groundwater

Groundwater levels should be provided for each borehole location. Any artesian conditions or seepage zones should be recorded.

4. Piezometer Installation

Piezometers are to be installed at the following borehole locations:

BH 5	Sta 12+750	o/s 30 m South
BH 13	Sta 13+300	o/s 30 m North
BH 22	Sta 13+750	⊕

Two piezometers are required in each borehole. One piezometer is to be placed at the bottom of the borehole and the second is to be installed at the elevation of the proposed cut. The installation should resemble that shown on the attached figure. Should there be some difficulty with the location of the piezometers with respect to crop harvesting, please notify our office and the changes will be made accordingly.

If there are any questions regarding our request, do not hesitate to call this office. We would appreciate it if the consultant would contact our office if additional information is required.

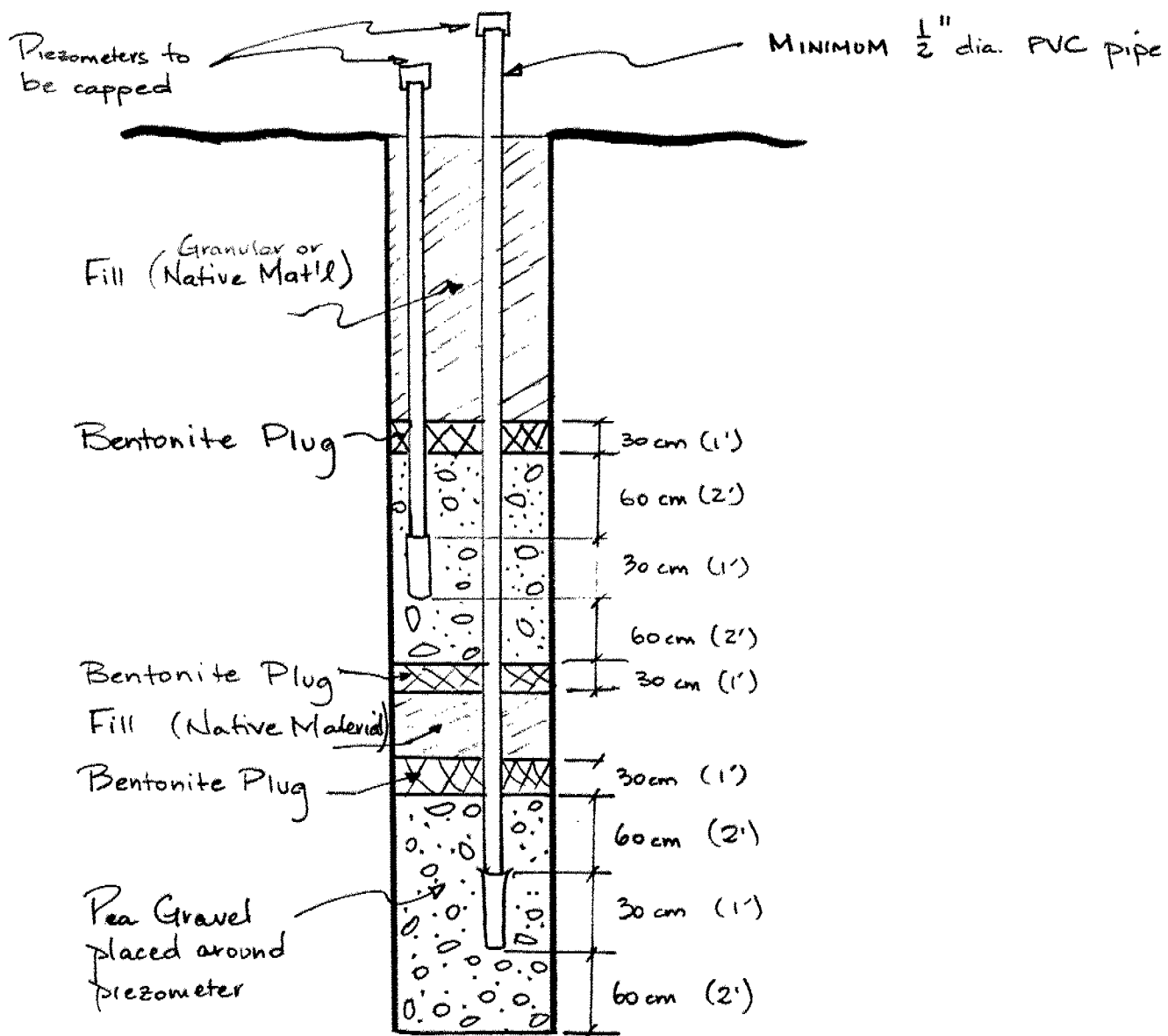
B. Bennett

B. Bennett, P. Eng.
Jr. Foundations Engineer

BB/mj.

Attach.

PIEZOMETER INSTALLATION



N.T.S.