

DOCUMENT MICROFILMING IDENTIFICATION

GEOCRES No. 30M3-167

DIST. 4 REGION

W.P. No. 46-74-16

CONT. No. 82-33

W. O. No.

STR. SITE No. 18-248

HWY. No. 406

LOCATION St. Catharines

No of PAGES -

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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

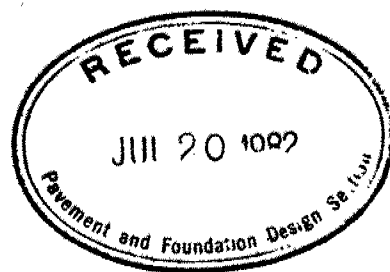
REMARKS:

FOUNDATION INVESTIGATION REPORT

CONTRACT NO 82-33



Ministry of
Transportation and
Communications



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NOTE: For purposes of the contract these reports supercede all other foundation reports prepared by or for the Ministry in connection with the above-mentioned projects.

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON "A" SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. CIU = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_a COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_p COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_p PLASTIC LIMIT
 w_s SHRINKAGE LIMIT
 I_p PLASTICITY INDEX = $w_L - w_p$
 I_L LIQUIDITY INDEX = $\frac{w - w_p}{w_L - w_p}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w_p}{w_L - w_p}$
 A_c ACTIVITY = $\frac{I_p \text{ of soil}}{2 \mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

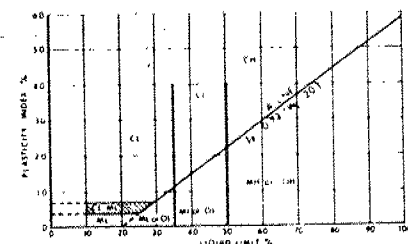
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
A, B PORE PRESSURE COEFFICIENTS
NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_c OVERCONSOLIDATION RATIO (OCR)

EXTENDED CASAGRANDE SOIL CLASSIFICATION SYSTEM											
FIELD IDENTIFICATION PROCEDURES (EXCLUDING PARTICLES LARGER THAN 75 mm AND BASING FRACTIONS ON ESTIMATED MASS)					GRP. SYMB.	TYPICAL NAMES	INFORMATION REQUIRED FOR DESCRIBING SOILS	LABORATORY CLASSIFICATION CRITERIA			
COARSE GRAINED SOILS MORE THAN HALF OF MATERIAL IS LARGER THAN 75 μ m (TO THE NAKED EYE)	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN 4.75 mm	CLEAN GRAVELS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZE & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES			GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES	GIVE TYPE, NAME, IF NECESSARY, INDICATE APPROX % OF SAND & GRAVEL; MAX. SIZE, ANGULARITY, SURFACE CONDITION, & HARDNESS OF THE COARSE GRAINS; LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION, & SYMBOL IN PARENTHESES. FOR UNDISTURBED SOILS ADD INFORMATION ON STRATIFICATION, DEGREE OF COMPACTNESS, CEMENTATION, MOISTURE CONDITIONS & DRAINAGE CHARACTERISTICS.	DETERMINE PERCENTAGES OF GRAVEL & SAND FROM GRAIN SIZE CURVE DEPENDING ON PERCENTAGE OF FINES (FRACTION SMALLER THAN 75 μ m) COARSE GRAINED SOILS ARE CLASSIFIED AS FOLLOWS: LESS THAN 5% GW, GP, SW, SP MORE THAN 12% GW, GC, SM, SC 5% TO 12% BORDERLINE CASES REQ. USE OF DUAL SYMBOLS		
		GRAVEL WITH FINES (APPRECIABLE AMOUNT OF FINES)	PREDOMINANTLY ONE SIZE OF A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES; LITTLE OR NO FINES		$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 4 $C_c = \frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR GW		
			NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE NL BELOW)			GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES		ATTERBERG LIMITS BELOW A-LINE, OR I_p LESS THAN 4 ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS		
		PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES	ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7				
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN 4.75 mm	CLEAN SANDS (LITTLE OR NO FINES)	WIDE RANGE IN GRAIN SIZES & SUBSTANTIAL AMOUNTS OF ALL INTERMEDIATE PARTICLE SIZES			SW	WELL GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES		$C_u = \frac{D_{60}}{D_{10}}$ GREATER THAN 6 $C_c = \frac{(D_{30})^2}{D_{10} \cdot D_{60}}$ BETWEEN ONE AND 3 NOT MEETING ALL GRADATION REQUIREMENTS FOR SW		
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	PREDOMINANTLY ONE SIZE OR A RANGE OF SIZES WITH SOME INTERMEDIATE SIZES MISSING			SP	POORLY GRADED SANDS, GRAVELLY SANDS; LITTLE OR NO FINES		ATTERBERG LIMITS BELOW A-LINE OR I_p LESS THAN 4 ABOVE A-LINE WITH I_p BETWEEN 4 AND 7 ARE BORDERLINE CASES REQUIRING USE OF DUAL SYMBOLS		
			NON-PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE NL BELOW)			SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES		ATTERBERG LIMITS ABOVE A-LINE WITH I_p GREATER THAN 7		
		PLASTIC FINES (FOR IDENTIFICATION PROCEDURES SEE CL BELOW)			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES					
		IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN 425 μ m									
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN 75 μ m (1.75 mm IS ABOUT THE SMALLEST PARTICLE VISIBLE TO THE NAKED EYE)	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 35%	DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)			GIVE TYPE, NAME, IF NECESSARY, INDICATE DEGREE & CHARACTER OF PLASTICITY, AMOUNT & MAXIMUM SIZE OF COARSE GRAINS, COLOUR (1% WET CONDITION), ODOUR, IF ANY, LOCAL OR GEOLOGIC NAME & OTHER PERTINENT DESCRIPTIVE INFORMATION & SYMBOL IN PARENTHESES. FOR UNDISTURBED SOILS AND INFORMATION ON STRUCTURE, STRATIFICATION, CONSISTENCY IN UNDISTURBED & REMOLDED STATES, MOISTURE & DRAINAGE CONDITIONS			



BOUNDARY CLASSIFICATIONS. SOILS POSSESSING CHARACTERISTICS OF TWO GROUPS ARE DESIGNATED BY COMBINATION OF GROUP SYMBOLS. FOR EXAMPLE GM-GC.
WELL GRADED GRAVEL-SAND MIXTURE WITH CLAY BINDER

FOUNDATION INVESTIGATION REPORT

For

Three Cell Culvert Extension at Lock 3
W.P. 46-74-16, Site 18-248
Hwy. 406, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out for the above project. Fieldwork consists of seven sampled boreholes and three dynamic cone penetration tests. As part of preliminary investigations for route alignment, boreholes were advanced at this site by Golder Associates in 1963 and by MTC personnel in 1971. Following the finalization of the route a detailed investigation consisting of a further five boreholes was undertaken in February, 1979. Hollow stem augers powered by a track mounted CME 55 were employed for this latter investigation.

SITE DESCRIPTION

The site is situated on the floor of a broad valley in central St. Catharines approximately 600 feet south and east of the intersection of St. Paul and Ontario Streets. In this area the Old Welland Canal channel has been replaced by a three cell culvert which passes under the Glenridge Fill. Concrete retaining walls line the channel between the end of the culvert and a stone lock located approximately 100 feet downstream. The valley slopes are about 70 feet in height and are $2\frac{1}{2}$ horizontal to 1 vertical or flatter. They are lightly tree covered and act as an informal park and recreation area.

SUBSURFACE CONDITIONS

General

From the ground surface downward subsoil consists of 35 feet of stiff clayey silt to silty clay (the upper half of which is contaminated by organics) followed by 20 feet of hard silt to

clayey silt of glacial origin. This layer is underlain by 45 feet of compact silty sand to sandy silt which in turn is underlain by 5 feet of very dense sandy gravel. The sandy gravel overlies Queenston Shale bedrock which is 103 feet below the ground surface.

Reference should be made to the Record of Borehole Sheets which are contained in the Report Appendix. They show a summary of the results of all field and laboratory tests performed. Reference should also be made to Sheet No. 121 of the contract drawings which shows the location and elevation of all borings, as well as an inferred subsoil stratigraphy.

Clayey Silt to Silty Clay

This layer extends from the surface to a depth of 34 feet with the upper 17 feet contaminated by organic material. The deposit has an undrained shear strength ranging from about 1000 to in excess of 2000 psf. Moisture content of the layer ranges from 20 percent to about 35 percent.

Silt to Clayey Silt

This layer underlies the clayey silt to silty clay and has a thickness of about 20 feet. It is reddish brown in colour and contains some sand and gravel. Standard Penetration 'N' values which range from 25 to 75 indicate a hard consistency and reflect the glacial origin of the layer. Moisture content of samples tested was approximately 10 percent.

Silty Sand to Sandy Silt

The silt to clayey silt is underlain by 45 feet of compact silty sand to sandy silt. Standard Penetration 'N' values for this layer range from 17 to 20. The moisture content is approximately 20 percent.

Sandy Gravel

This layer is only 5 feet in thickness and directly overlies bedrock. It is very dense as indicated by the Standard Penetration tests. The moisture content is approximately 5 percent.

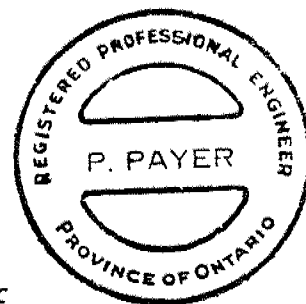
Queenston Shale

Sound Queenston Shale bedrock was encountered at elevation 178, 103 feet below the ground surface.

Groundwater

Groundwater was encountered at approximate elevation 272 which was slightly above the water level in the adjoining open channel at the time of the field investigations.

P. Payer, P. Eng.
Foundations Engineer



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

APPENDIX



RECORD OF BOREHOLE No 11

8

W P 46-74-16 LOCATION Coords. N 15 679 894; E 1 068 447 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY PJS
DATUM Geodetic DATE January 30 & 31, 1979 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF							WATER CONTENT (%)			
								20 40 60 80 100										
281.9	Ground Level																	
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	8													
			2	SS	11													
			3	SS	7													
			4	SS	6													
264.9			5	SS	5													
17.0	Clayey Silt to Silty Clay Stiff		6	SS	10													
			7	SS	6													
			8	SS	4													
247.9			9	SS	32													
34.0	Silt to Clayey Silt Some Sand and Gravel Hard Reddish Brown (Glacial Till)		10	SS	37									3 20 64 13				
			11	SS	34													
			12	SS	40													
228.9			13	SS	19													
53.0	Silty Sand to Sandy Silt Compact		14	SS	20									0 80 (20)				
			15	SS	17													
			16	SS	21													
			17	SS	20													
			18	SS	100/8"									53 29 13 5				
183.9			19	SS	100/1"													
98.0	Sandy Gravel, Some Silt (Glacial Till) Very Dense		20	BXL RC	80% Rec.									RQD 20 %				
178.9	Queenston Shale																	
103.0																		
171.8																		
110.1	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 12

9

W P 46-74-16 LOCATION Coords. N 15 679 789; E 1 068 505 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY PJS
DATUM Geodetic DATE February 1, 1979 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20	40	60	80	100		
282.5	Ground Level												
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	7								
			2	SS	3								
			3	TW	PH							118	
			4	TW	PH							Om 1.5%	
264.5												127	
18.0	Clayey Silt to Silty Clay Stiff		5	TW	PH								
			6	TW	PH							132	
			7	TW	PH							105	
244.5			8	SS	3								
38.0	Silt to Clayey Silt												
241.0	Hard (Glacial Till)		9	SS	28								13 21 55 11
41.5	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 13

10

W P 46-74-16 LOCATION Coords. N 15 679 785; E 1 068 438 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE February 2, 1979 CHECKED BY *CP*

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 PSF			WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE							● QUICK TRIAXIAL x LAB VANE								
281.3	Ground Level																						
0.0	Fill Clayey Silt to Silty Clay Stiff to Very Stiff		1	SS	11		280																
			2	SS	9																		
271.3			3	SS	5		270		+ 2														
10.0	Organically Contaminated Clayey Silt Stiff		4	SS	4					+ 4													
264.3			5	SS	6		260		+ 6														
17.0	Clayey Silt to Silty Clay Stiff		6	SS	6				+ 2														
			7	SS	4		250																
247.3			8	SS	25					+ 2													
34.0	Silt to Clayey Silt																						
244.8	Hard (Glacial Till)																						
36.5	End of Borehole																						
	Note: Water Level Not Established																						

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 14

11

W P 46-74-16 LOCATION Coords. N 15 679 842; E 1 068 336 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE February 2 & 5, 1979 CHECKED BY ef

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
284.0	Ground Level							20	40	60	80	100								
0.0	Fill Clayey Silt to Silty Clay Stiff		1	SS	5		280							○						
275.0			2	SS	4															
9.0	Organically Contaminated Clayey		3	SS	5			+ 2						○						
270.0	Silt to Silty Cl.Stiff						270	+ 3												
14.0			4	SS	14									○						
	Clayey Silt to Silty Clay Stiff		5	SS	27		260							○						
			6	SS	11									○						
			7	SS	6		250	+ 3						○						
			8	SS	6															
245.0																				
39.0	Silt to Clayey Silt																			
242.5	Hard (Glacial Till)		9	SS	26			+ 2						○						
41.5	End of Borehole																			
	Note: Water Level Not Established																			

+3, x5 : Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 15

12

W P 46-74-16 LOCATION Coords. N 15 679 748; E 1 068 355 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE February 5, 1979 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
282.7	Ground Level													
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	9		280							
			2	SS	5									
270.7			3	SS	4		270							
12.0	Clayey Silt to Silty Clay Stiff		4	SS	13									
			5	SS	8									
			6	SS	7		260							
			7	SS	7									
			8	SS	5		250							
243.7			9	SS	36									
39.0	Silt to Clayey Silt													
241.2	Hard (Glacial Till)													
41.5	End of Borehole													
	Note: Water Level Not Established													

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 123

13

W P 46-74-16 LOCATION Coords. N 15 679 978; E 1 068 451 ORIGINATED BY PK
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY A.K.B.
DATUM Geodetic DATE November 24, 1971 CHECKED BY P.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
303.0	Ground Level																
0.0	Fill, Clayey Silt to Silty Clay Trace of Sand and Gravel Stiff to Very Stiff		1	SS	8		300										
			2	TW	PH		290										
			3	SS	20												
281.0			4	TW	PH		280										
22.0	Clayey Silt to Silty Clay Trace of Sand and Gravel Hard to Stiff		5	SS	29		270										
			6	SS	57												
			7	SS	30		260										
			8	SS	28												
			9	TW	PH		250										
			10	TW	PH												
			11	TP	PH												
245.0																	
58.0	Silt to Clayey Silt Some Sand and Gravel Hard and Reddish Brown (Glacial Till)		12	SS	59		240										
236.5			13	SS	94												
66.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 307

14

W P 46-74-16 LOCATION Coords. N 15 679 847; E 1 068 315 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Power Auger Boring COMPILED BY M.W.
DATUM Geodetic DATE September 24, 1963 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y pcf	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40					
286.5	Ground Level													
0.0	Fill, Clayey Silt Some Sand and Gravel		1	SS	9									
281.3	Stiff													
5.2	Organically Contaminated Clayey Silt to Silty Clay		2	SS	5									
273.3	Stiff													
13.2	Clayey Silt to Silty Clay, Trace of Sand and Gravel		3	TW	PH									
	Very Stiff		4	SS	17									
			5	TW	PH								131	
			6	SS	22									
			7	TW	PH								132	
248.0			8	SS	52									
38.5	Silt to Clayey Silt Some Sand and Gravel Reddish Brown Hard (Glacial Till)		9	SS	59									
			10	SS	58									
231.5			11	SS	56									
55.0	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

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

FOUNDATION INVESTIGATION REPORT

FOR

Pedestrian Crossing Underpass
850 Feet East of the Burgoine Bridge
W.P. 46-74-35, Site 18-268
Hwy. 406, District 4, Hamilton

INTRODUCTION

This report contains the results of the foundation investigations carried out at the aforementioned site on September 25-26, 1963, June 23-24, 1971 and Feb. 5, 1979. The fieldwork consisted of three sampled boreholes.

SITE DESCRIPTION

The site is located in central St. Catharines approximately 800 feet southeast of the intersection of Ontario and St. Pauls Streets. It is on the side of a valley with overall slopes of three horizontal to one vertical but which has areas with local slopes much steeper. A stone lock and open channel located in the valley floor below remain from an early Welland Canal which followed this route. Parts of the valley slopes are covered with brush and occasional trees.

SUBSOIL

The upper layer of subsoil consists of clayey silt to silty clay which extends to elevation 245. This layer varies from 40 to 80 feet in thickness within the length of the proposed structure.

A brown desiccated crust up to 25 feet in thickness has developed. Undrained shear strength in this crust varies from 2000 to 5000 psf. Beneath the crust the soil is grey with an undrained shear strength ranging from 1500 to 2500 psf.

The clayey silt to silty clay layer is underlain by silt to clayey silt containing some sand and a trace of gravel. Its glacial origin is reflected in its very dense to hard consistency with Standard Penetration 'N' values ranging from 35 to in excess of 100 blows per foot.

In the area bordering the open channel there is a deposit of organically contaminated clayey silt to silty clay. Its moisture content ranges from 25 to 35 percent and it has an underdrained shear strength ranging from 800 to 2000 psf.

Reference should be made to the Record of Borehole Sheets. They show the boundaries between different soil types, as well as a summary of all field and laboratory tests performed. Reference should also be made to sheet no. 130 of the contract drawings which shows the location and elevation of the borings, as well as an inferred subsoil stratigraphy and the observed groundwater levels.

Groundwater

The following groundwater levels were observed during the field investigation:

- B.H. # 15: No waterlevel was established in this boring
(Feb. 1979)
- B.H. #204: El. 291.8 (June 1971)
- B.H. #308: Stand Pipe 'B' (Tip at El. 230)
W.L. El. 273.8
Stand Pipe 'A' (Tip at El. 268)
W.L. El. 285.8



P. Payer, P. Eng.
Foundations Engineer

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

APPENDIX



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 15

18

W P 46-74-35 LOCATION Coords. N 15 679 748; E 1 068 355 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE February 5, 1979 CHECKED BY ep

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					
282.7	Ground Level																
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	9		280										
			2	SS	5												
270.7			3	SS	4		270										
12.0	Clayey Silt to Silty Clay Stiff		4	SS	13												
			5	SS	8												
			6	SS	7		260										
			7	SS	7												
			8	SS	5		250										
243.7			9	SS	36												
39.0	Silt to Clayey Silt																
241.2	Hard (Glacial Till)																
41.5	End of Borehole Note: Water Level Not Established																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 204

19

W P 46-74-35 LOCATION Coords. N 15 679 550; E 1 068 105 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill COMPILED BY A.K.B.
DATUM Geodetic DATE June 23-24, 1971 CHECKED BY RS

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
315.6	Ground Level							20	40	60	80	100	20	40	60		GW SA SI CL			
0.0	Clayey Silt to Silty Clay, Traces of Sand and Gravel Random Pockets of Sand Hard to Stiff Brown Becoming Grey		1	SS	21															
			2	SS	38															
			3	SS	37															
			4	SS	36															
			5	SS	32															
			6	SS	31												6 26 49 19			
			7	SS	13															
			8	TW	PH											122				
			9	TW	PM											122				
			10	SS	13												0 5 48 47			
			11	TW	PM											129				
			12	SS	19											130				
			13	SS	26															
			14	SS	31												8 44 25 23			
			15	SS	17															
245.6			16	TW	PH															
70.0	Silt to Clayey Silt Some Sand, Trace of Gravel, Very Dense to Hard (Glacial Till) Reddish Brown		17	SS	102											124				
			18	SS	118															
			19	SS	158															
235.6			20	SS	1507 5"												4 21 61 14			
80.0	End of Borehole																			

+3, x5: Numbers refer to
Sensitivity

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

RECORD OF BOREHOLE No 308

20

W P 46-74-35 LOCATION Coords. N 15 679 590; E 1 068 190 ORIGINATED BY Colder
DIST 4 HWY 406 BOREHOLE TYPE Power Auger Boring COMPILED BY M.W.
DATUM Geodetic DATE September 25-26, 1963 CHECKED BY RS

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 pcf	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
317.7	Ground Level																
315.2	Heterog. Fill Compr. of Br. Sa. Si. Brick and Concret. Fragments to 3 inch size		1	SS	16												
2.5			2	SS	21												
			3	SS	19												
			4	TW	PH												
	Silty Clay to Clayey Silt		5	SS	25												
	Trace of Sand and Gravel		6	TW	PH												
	Stiff to Very Stiff		7	SS	8												
			8	TW	PH												
			9	SS	9												
			10	TW	PH												
			11	SS	14												
			12	SS	18												
			13	SS	16												
			14	TW	PM												
			15	SS	11												
			16	SS	11												
245.7			17	SS	96												
72.0			18	SS	87												
	Silt to Clayey Silt		19	SS	93												
	Some Sand, Trace of Gravel, Very Dense to Hard (Glacial Till) Reddish Brown		20	SS	66												
227.7																	
90.0	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

FOUNDATION INVESTIGATION REPORT

For

Retaining Wall No. 17
W.P. 46-74-38, Site 18-RW
Hwy. 406, District 4, Hamilton

INTRODUCTION

This report contains the results of the foundation investigations carried out at this site. Field investigations have been carried out in this area during the 15 year period 1963 to 1978. They provided geotechnical information for a series of proposals, some of which differed considerably from the one finally adopted. For this reason much of the factual data presented does not relate directly to the scheme adopted but it is included to provide general subsoil information in this area.

SITE DESCRIPTION

The site is located in central St. Catharines on the east bank of Twelve Mile Creek. The creek valley is from $\frac{1}{4}$ to $\frac{1}{2}$ mile in width with its floor 70 to 80 feet below the surrounding tableland. The natural slopes are gentle with overall slopes of 3 horizontal to 1 vertical or flatter. A little used roadway parallels Twelve Mile Creek on the narrow strip of level ground bordering the water. The Burgoine Bridge is a high level structure crossing the valley at this point.

SUBSOIL CONDITIONS

The valley of Twelve Mile Creek has been eroded in a deep deposit of clayey silt to silty clay which is up to 100 feet

in thickness at the valley crest. It has developed a desiccated crust from 10 to 20 feet in thickness which is brown in colour and has an undrained shear strength ranging from 2000 to 10,000 psf. The moisture content in the crust ranges from 20 to 25 percent. Beneath the crust there is a transition from brown to grey with the moisture content increasing to as much as 35 percent. The undrained shear strength decreases varying from 1000 to 3000 psf.

The clayey silt to silty clay layer is underlain by a glacial fluvial deposit up to 70 feet in thickness. It consists of discontinuous layers of irregular thickness which range from clayey silt to fine sand. The till portion of the deposit consists of a hard reddish brown silt to clayey silt containing some sand and a trace of gravel. Standard Penetration 'N' values for this material range from 30 to in excess of 100 blows per foot. The layers of fluvial origin vary from clayey silt and silty sand but consist primarily of silt and silty sand. Standard Penetration 'N' values in these soils are generally between 10 to 50 indicating they are compact to very dense.

Between the toe of the valley slope and the stream channel there is a deposit of up to 25 feet of organically contaminated soil. It was built up by natural deposition in areas flooded to construct the original Welland Canal and through filling of these areas both by dredging from the channel and as a dumping area for surplus material from construction projects in the area. Much of the material was then repositioned when Ontario Hydro employed a hydraulic dredge to widen and deepen the channel in the late 1940's. As a result this deposit is highly variable with some areas being sandy enough to be non-plastic while others show considerable plasticity. The undrained shear strength of the cohesive portion is judged

to vary from 500 to in excess of 1000 psf. The granular portion varies from very loose to compact.

Reference should be made to the Record of Boreholes Sheets. They show the boundaries between different soil types, as well as a summary of the results of all field and laboratory tests performed and the observed groundwater levels.

Reference should also be made to Sheets No. 149, 149-1 and 149-2 of the Contract Drawings which show the location and elevation of the borings, together with profiles and sections showing inferred subsoil stratigraphy.

GROUNDWATER

Groundwater levels were recorded in the open boreholes during field investigations with readings in standpipes taken over more extended periods. Based on these observations it is estimated the groundwater is from 15 to 20 feet below the surface at the top of slope but decreased in depth until it is at or near the surface at the toe of slope. Water levels in the organically contaminated deposit bordering the stream channel varied from being at the surface to being 5 feet below it. An artesian head of up to 11 feet was encountered in the underlying sands and silts in the vicinity of Station 299 + 00.

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Foundations Engineer



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Senior Foundations Engineer

APPENDIX



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 38 S

25

W P 46-74-38 LOCATION Coords. N 15 679 653; E 1 066 107 ORIGINATED BY PS
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY JA
DATUM Geodetic DATE June 8, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
276.2	Ground Level											
0.0						270						
264.2												
12.0	End of Cone Test											

*³, x⁵: Numbers refer to
Sensitivity

20
15
10
5
0
5
10
15
20
(%) STRAIN AT FAILURE



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 395

26

W P 46-74-38 LOCATION Coords. N 15 679 684; E 1 066 065 ORIGINATED BY PS
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY JA
DATUM Geodetic DATE June 8, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
274.2	Ground Level									
0.0						270				
258.3						260	110/10"			
15.9	End of Cone Test									

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 405

27

W P 46-74-38 LOCATION Coords. N 15 679 432; E 1 066 790 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY JA
DATUM Geodetic DATE June 20, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	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								
271.8	Ground Level												
0.0	Gray Organic Silt and Sand Soft to Stiff		1	SS	7		270						
			2	SS	2								
			3	SS	5		260						
			4	SS	3								
			5	SS	9								
251.8			6	TW	PH		250						
20.0	Sandy Silt to Silty Sand Compact		7	SS	30								
			8	SS	11								
			9	SS	11		240						
			10	SS	11								
229.8			11	SS	23		230						
42.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		12	SS	60								
218.6			13	SS	1047	8"	220						
53.2	End of Borehole												

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

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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 455

28

W P 46-74-38 LOCATION Coords. N 15 679 488; E 1 066 805 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY JA
DATUM Geodetic DATE June 21, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
271.6	Ground Level									
0.0	Grey Organic Silt and Sand		1	SS	4					
	Soft to Stiff		2	TW	PH					
			3	SS	6					
			4	TW	PH					
			5	SS	1					
254.6			6	SS	6					
17.0	Clayey Silt									
250.1	Very Stiff		7	SS	25					
21.5	End of Borehole									
246.6										
25.0	End of Cone Test									

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 46 S

29

W P 46-74-38 LOCATION Coords. N 15 679 390; E 1 066 775 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger, Cone Test COMPILED BY JA
DATUM Geodetic DATE June 21, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
271.6	Ground Level												
0.0	Rock Rip Rap						270						
267.6			1	SS	33								
4.0	Organic Silt and Sand		2	SS	4								
263.6	Soft to Firm							+4.5					
8.0	End of Borehole Probable Organic Silt and Sand						260						Borehole ended because rocks forced boulders off line
254.6													
17.0							250						
							240						
236.6													
35.0	End of Cone Test Note: Water Level Not Established												



RECORD OF BOREHOLE No 47 S

30

W P 46-74-38 LOCATION Coords. N 15 679 462; E 1 066 691 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY JA
DATUM Geodetic DATE June 21, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	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								
270.0	Ground Level												
0.0			1	SS	2		260	6.4				110 Om	
	Grey Organic Silt and Sand, Soft to Stiff		2	SS	2			+ 2.3				2.31%	
254.5			3	TW	PH								
15.5	Clayey Silt to Silt Hard to Dense		4	SS	37								
248.5			5	SS	44		250						
21.5	End of Borehole Note: Water Level Not Established												

+3, x5: Numbers refer to Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 48 S

31

W P 46-74-38 LOCATION Coords. N 15 679 407; E 1 066 672 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY JA
DATUM Geodetic DATE June 22, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
270.5	Ground Level						270							
0.0	Probable Organic Silt and Sand						260							
255.5														
15.0														
248.5							250							
22.0	End of Cone Test													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 49S

32

W P 46-74-38 LOCATION Coords. N 15 679 528; E 1 066 711 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY JA
DATUM Geodetic DATE June 22, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
271.4	Ground Level												
0.0	Probable Organic Silt and Sand						270						
							260						
254.4													
17.0													
251.4													
20.0	End of Cone Test												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 50 S

33

W P 46-74-38 LOCATION Coords. N 15 679 502; E 1 066 592 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY JA
DATUM Geodetic DATE June 22, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	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								
270.4	Ground Level												
0.0	Grey Organic Silt and Sand Soft to Stiff		1	SS	4								
			2	TW	PH								
			3	TW	PM								
			4	SS	2								
255.4			5	TW	PH								
15.0	Clayey Silt to Silt Dense to Very Dense		6	SS	14								
			7	SS	36								
246.4			8	SS	57								
24.0	End of Borehole												

+³, x⁵: Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 515

34

W P 46-74-38 LOCATION Coords. N 15 679 553; E 1 066 615 ORIGINATED BY JA
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger, Cone Test COMPILED BY JA
DATUM Geodetic DATE June 27, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
270.9	Ground Level									
0.0	Grey Organic Silt and Sand, Soft to Stiff		1	SS	4					
			2	TW	PH					
			3	SS	3					
			4	SS	2					
			5	SS	2					
			6	SS	2					
249.9			7	SS	1					
21.0			8	SS	4					
246.9	Silt, Very Dense		9	SS	52					
24.0	End of Borehole									

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 52 S

35

W P 46-74-38 LOCATION Coords. N 15 679 446; E 1 066 580 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 27, 1978 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
271.5	Ground Level										
0.0	Rock Rip Rap										
266.5											
5.0	Grey Organic Silt and Sand		1	SS	2						
			2	SS	2						
	Soft to Stiff		3	TW	PH						
			4	SS	4						
253.0			5	SS	22						
18.5			6	SS	27						
250.0	Silt, Compact										
21.5	End of Borehole										
246.5											
25.0	End of Cone										

+3, x5: Numbers refer to Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 53 S

36

W P 46-74-38 LOCATION Coords. N 15 679 531; E 1 066 502 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 22, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%) GP SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE						
270.3	Ground Level									
0.0	Grey Organic Silt and Sand Soft to Stiff		1	SS	3		+7		Om 1.67%	0 31 58 11
			2	SS	1					
			3	SS	1					
			4	TW	PH		+8.5			14 39 34 13
			5	SS	1					
254.3			6	SS	2		+4.3			
16.0	Silt, Dense to Very Dense		7	SS	54					
243.8			8	SS	48					
26.5	End of Borehole									

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 54 S

37

W P 46-74-38 LOCATION Coords. N 15 679 473; E 1 066 492 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 23, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) Gr SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
269.0	Ground Level										
0.0	Probable Organic Silt and Sand										
253.0											
16.0											
248.0											
21.0	End of Cone Test										

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 55S

38

W P 46-74-38 LOCATION Coords. N 15 679 585; E 1 066 528 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 23, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES									
270.7	Ground Level						270							
0.0	Probable Organic Silt													
263.7														
7.0	Probable Clayey Silt						260							
254.7														
16.0	End of Cone Test													



RECORD OF BOREHOLE No 56 S

39

W P 46-74-38 LOCATION Coords. N 15 679 568; E 1 066 408 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 26, 1978 CHECKED BY R

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ pcf	REMARKS & GRAIN SIZE DISTRIBUTION (%) CR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
270.0	Ground Level										
0.0	Grey Organic Silt and Sand, Soft to Stiff		1	SS	6						
			2	SS	2						
			3	SS	2						
258.0			4	TW	PH						
12.0	Silty Clay, Stiff		5	SS	9						
255.0			6	SS	34						
15.0	Silt, Dense to Very Dense		7	SS	85						
248.5											
21.5	End of Borehole										

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 57 S

40

W P 46-74-38 LOCATION Coords. N 15 679 590; E 1 066 408 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 26, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
270.2	Ground Level												
0.0	Probable												
226.2	Organic Silt												
4.0	Probable Clayey Silt												
256.2													
14.0	End of Cone Test												

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 58 S

41

W P 46-74-38 LOCATION Coords. N 15 679 512; E 1 066 390 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger, Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 26, 1978 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				
267.7	Ground Level															
0.0	Organic Silt and Sand Soft to Stiff		1	TW	PM		260	3.3							104	Om=4.55%
			2	TW	PM										117	Om=2.11%
			3	TW	PM										124	Om=0.99%
			4	TW	PM			5.3							127	Om=0.73%
252.7								9.6								
251.2	Silt, Dense		5	SS	41		250									
16.5	End of Borehole															
18.0	Note: Water Level Not Established															

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5
(%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 59 S

42

W P 46-74-38 LOCATION Coords. N 15 679 588; E 1 066 310 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
270.7	Ground Level												
0.0	Clayey Silt Stiff to Very Stiff		1	SS	7		270						
			2	SS	8								
			3	SS	5								
			4	SS	7		260						
256.2			5	SS	62								
14.5	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



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RECORD OF BOREHOLE No 605

43

W P 46-74-38 LOCATION Coords. N 15 679 550; E 1 066 292 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 26, 1978 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 (%) OR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
269.2	Ground Level																
0.0	Grey Organic Silt and Sand, Soft to Stiff		1	SS	3											Om=2.13%	
			2	SS	1												
			3	TW	PH											0 84 13 3	
255.2			4	TW	PH											Om=2.39%	
14.0	Sand and Gravel		5	SS	11												
252.2	Compact																
250.9	Red Silt, Very Dense		6	SS	56												
19.0	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 61S

44

W P 46-74-38 LOCATION Coords. N 15 679 569; E 1 066 302 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 26, 1978 CHECKED BY RS

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 (%) CR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			'N' VALUES	20					
269.9	Ground Level												
0.0	Probable Organic Silt												
262.9													
7.0													
255.9													
14.0	End of Cone Test												

+3, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 62 S

45

W P 46-74-38 LOCATION Coords. N 15 679 559; E 1 066 297 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 26, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) R SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
269.6	Ground Level											
0.0	Probable Organic Silt and Sand						260					
253.6												
16.9												
251.6												
18.0	End of Cone Test											

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 63 S

46

W P 46-74-38 LOCATION Coords. N 15 679 593; E 1 066 193 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 27, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
287.7	Ground Level											
0.0	Organic Silt and Sand Soft to Firm		1	SS	2							
			2	TW	PH							
258.9			3	SS	3							
256.2	Silt, Compact		4	SS	13							
11.5	End of Borehole											
13.0	End of Cone Test											

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



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RECORD OF BOREHOLE No 64 S

47

W P 46-74-38 LOCATION Coords. N 15 679 612; E 1 066 205 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 27, 1978 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
270.4	Ground Level												
0.0	Probable Clayey Silt						270						
260.4													
10.0	End of Cone Test												

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (% STRAIN AT FAILURE)



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RECORD OF BOREHOLE No 65S

48

W P 46-74-3A LOCATION Coords. N 15 679 580; E 1 066 377 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 27, 1978 CHECKED BY RS

SOIL PROFILE		STRAT. PLOT	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		NUMBER	TYPE			'N' VALUES	20					
270.2	Ground Level												
0.0	Probable Organic Silt					270							
264.2													
6.0	Probable Clayey Silt					260							
255.2													
15.0	End of Cone Test												

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 66S

49

W P 46-74-38 LOCATION Coords. N 15 679 416; E 1 067 008 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger COMPILED BY J.A.
DATUM Geodetic DATE June 27, 1978 CHECKED BY RS

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					
271.9	Ground Level																
0.0	Organic Silt and Sand, Soft to Stiff		1	SS	4		270									118	Om=1.26%
264.9			2	TW	PH												
7.0	Clayey Silt With Layers of Organic Silt		3	SS	7												
			4	SS	3		260			+ 2.9							
			5	SS	1												
253.9	Soft to Firm		6	SS	5					+ 1.8							Om=0.85%
18.0	Silty Sand to Sandy Silt		7	SS	37		250										
	Compact to Dense																
			8	SS	47		240										
			9	SS	19		230										0 78 15 7
			10	SS	13		220										
			11	SS	17		210										0 0 91 9
206.9																	
65.0	Queenston Shale																Harder at 65'
202.7																	
69.2	End of Borehole		12	SS	100/2"												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 675

50

W P 46-74-38 LOCATION Coords. N 15 679 315; E 1 067 744 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 28, 1978 CHECKED BY

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	SHEAR STRENGTH PSF UNCONFINED + FIELD VANE QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 200	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									
275.7	Ground Level											
0.0	Organically Contaminated Clayey Silt With Sandy Layers Firm to Stiff		1	SS	17							
			2	SS	6							
			3	TW	PH							
			3A	SS	5							
			4	SS	3							
			5	TW	PH							
			6	SS	2							
254.7			7	SS	9							
21.0	Silty Clay Stiff		8	SS	6							
245.7												
244.2	Silt, Compact		9	SS	25							
31.5	End of Borehole											
33.0	End of Cone Test											



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RECORD OF BOREHOLE No 68 S

51

W P 46-74-38 LOCATION Coords. N 15 679 215; E 1 067 770 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 28, 1978 CHECKED BY RS

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			SHEAR STRENGTH PSP							WATER CONTENT (%)
							20 40 60 80 100							
							○ UNCONFINED + FIELD VANE							
							● QUICK TRIAXIAL × LAB VANE							
							400 800 1200 1600 2000							
273.8	Ground Level												Gr SA Si CL	
0.0	Organically Contaminated Clayey Silt With Sandy Layers		1	SS	3									
	Soft to Firm		2	SS	4									
			3	TW	PH									
			4	SS	2									
			5	SS	4									
			6	TW	PH									
255.8			7	SS	3									
18.0	Silty Clay		8	SS	3									
	Firm													
247.3			9	SS	7									
26.5	End of Borehole													
242.8														
31.0	End of Cone Test													

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 69 S

52

W P 46-74-38 LOCATION Coords. N 15 679 242; E 1 067 568 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 29, 1978 CHECKED BY RS

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			SHEAR STRENGTH PSF							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
								400	800 1200 1600 2000						
276.6	Ground Level														
0.0	Silt to Clayey Silt Some Sand		1	SS	8										
270.6	Loose		2	SS	2										
6.0	Organically Contaminated Clayey Silt With Sandy Layers Soft to Firm Black and Grey		3	TW	PH		270	+5.6	+4.8				124	0 67 25 8	
			4	SS	6										
			5	TW	PH										
260.6			6	SS	9		260						Om=2.42	14 38 32 16	
16.6	Silty Clay		7	SS	8										
	Firm		8	SS	3										
250.1			9	SS	14										
26.5	End of Borehole														
245.6															
31.5	End of Cone Test														
	Note: Water Level Not Established														

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 70 S

53

W P 46-74-38 LOCATION Coords. N 15 679 242; E 1 067 456 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 29, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
274.8	Ground Level											
0.0	Pavement and Gravel											
1.0	Clayey Silt With Sand, Some Gravel		1	SS	9							
267.8	Stiff		2	SS	6							
7.0	Silty Clay Very Stiff		3	SS	10							
			4	SS	19							
258.3			5	SS	11							
16.5	End of Borehole											
244.8												
30.0	End of Cone Test											

+3, x5 : Numbers refer to
Sensitivity

20
15
10

5 (%) STRAIN AT FAILURE



Ministry of
Transportation and
Communications

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 715

54

W P 46-74-38 LOCATION Coords. N 15 679 265; E 1 067 367 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger COMPILED BY J.A.
DATUM Geodetic DATE July 6, 1978 CHECKED BY RS

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					
274.3	Ground Level															
0.0	Pavement, Gravel															
1.0	Sand, Some Gravel and Silt Trace of Clay Loose		1	SS	8	270 260 250										24 56 14 6
			2	SS	3											
			3	SS	6											
264.3			4	SS	11											
10.0	Clayey Silt to Silty Clay Firm to Stiff		5	SS	3											
			6	SS	4											
			7	TW	PH											
			8	SS	4											
245.3						250										
29.0	Red Silt to Clayey Silt		9	SS	38											
242.8																
31.5	End of Borehole															

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



Ministry of
Transportation and
Communications
Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 72 S

55

W P 46-74-38 LOCATION Coords. N 15 679 362; E 1 067 182 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 29, 1978 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
274.3	Ground Level											
0.0	Silty Clay Very Stiff		1	SS	16							
			2	SS	15							
			3	SS	17							
			4	SS	20							
257.8			5	SS	9							
16.5	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



Ministry of
Transportation and
Communications

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 73 S

56

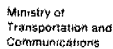
W P 46-74-38 LOCATION Coords. N 15 679 318; E 1 067 170 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE July 4, 1978 CHECKED BY

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						
273.4	Ground Level													
0.0	Organically Contaminated Silt and Sand		1	SS	4		270						104	
	Soft to Firm		2	TW	PH			+2.0					Om=7.7%	
			3	SS	3			+2.5	+4.4				125	Om=1.86%
258.4			4	TW	PM									
256.4	Sand & Gravel, Compact		5	SS	2		260						Om=2.6%	8 66 20 6
17.0	Silt to Clayey Silt, Stiff to Very Stiff (Layered)		6	SS	10									
			7	SS	2									
			8	SS	14									
			9	SS	22		250							
			10	SS	14									
238.4			11	SS	23		240							
35.0	Fine Sand Some Silt													
	Compact		12	SS	10		230							3 83 11 3
222.4														
51.0	Gravel Some Sand, Trace of Silt		13	SS	100/9"		220							71 18 9 2
	Very Dense		14	SS	100		210							
203.9			15	SS	-									
69.5	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 74 S

57

W P 46-74-38 LOCATION Coords. N 15 679 300; E 1 067 260 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger COMPILED BY J.A.
DATUM Geodetic DATE July 6, 1978 CHECKED BY BS

[illegible]

+3, x5: Numbers refer to Sensitivity

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 201

58

W P 46-74-38 LOCATION Coords. N 15 679 347; E 1 067 522 ORIGINATED BY WA
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY ABK
DATUM Geodetic DATE June 21-22, 1971 CHECKED BY RS

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			SHEAR STRENGTH PSF							WATER CONTENT (%)			
								○ UNCONFINED	+ FIELD VANE							● QUICK TRIAXIAL	× LAB VANE	400
306.2	Ground Level																	
0.0	Silty Clay to Clayey Silt Some Organics		1	SS	8								125.5	0 6 66 28				
296.7	Stiff - Brown		2	TW	PH				4800									
9.5	Silty Sand With Some Gravel		3	SS	25													
	Dense		4	TW	PH									8 76 (16)				
288.2			5	SS	35													
18.0	Clayey Silt to Silty Clay Traces of Sand and Gravel		6	SS	47								115					
	Stiff to Very Stiff		7	TW	PM				+s=2.8				119					
	Grey		8	SS	5				+s=3.5									
			9	TW	PM				+s=2.0									
			10	SS	19				+s=2.0									
			11	SS	21				+s=1.5									
			12	SS	12				+s=2.6									
253.2			13	G										9 35 46 10				
53.0	Silt to Clayey Silt Some Sand and Gravel Very Dense to Hard (Glacial Till) Brown		14	TW	PM													
			15	SS	110													
			16	SS	74													
			17	SS	88													
230.2																		
76.0	Silty Sand Dense to Very Dense Brown		18	SS	28									0 70 (30)				
			19	SS	58													
208.2																		
98.0	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

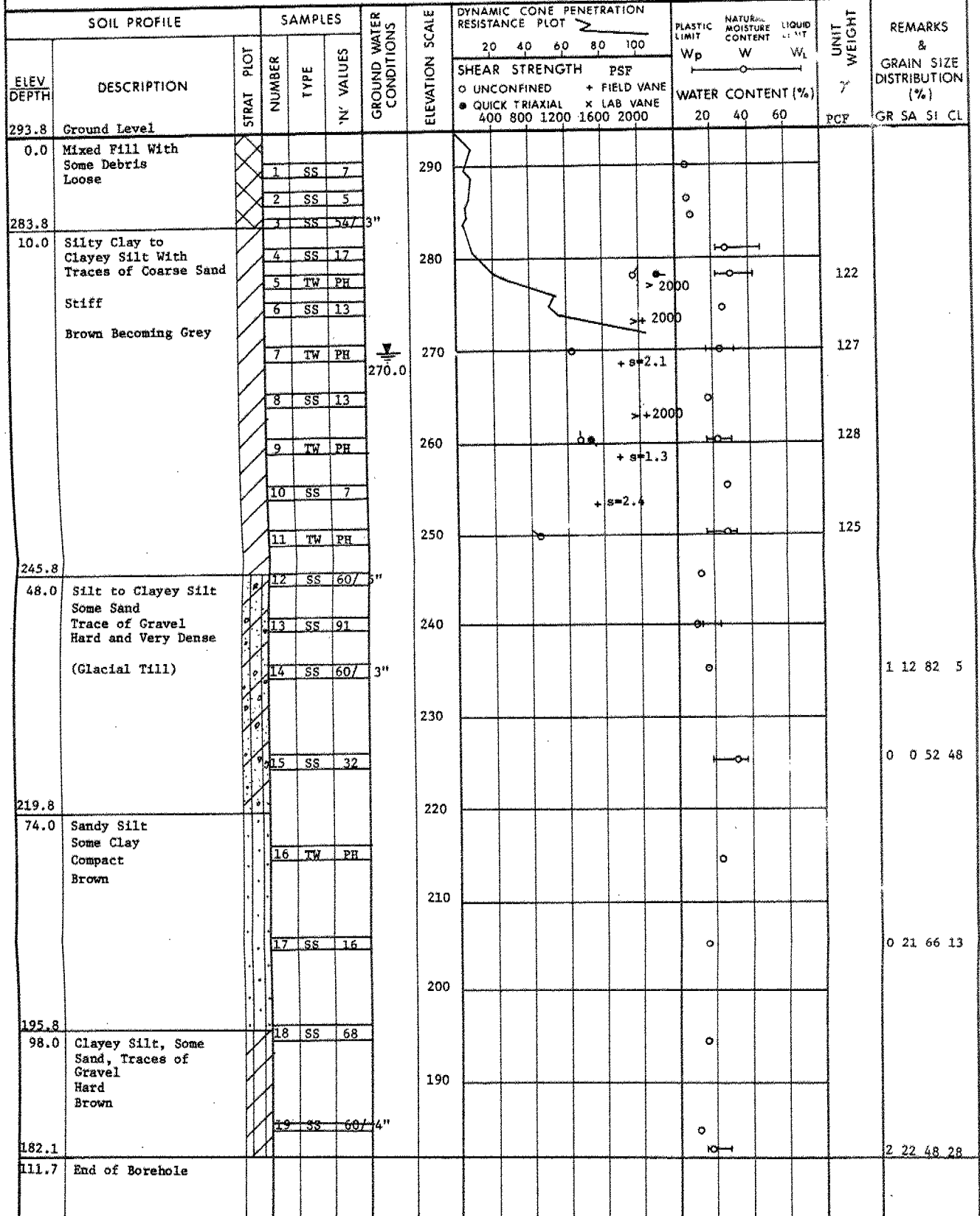
20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 202

59

W P 46-74-38 LOCATION Coords. N 15 679 472; E 1 067 921 ORIGINATED BY W.A.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY A.B.K.
DATUM Geodetic DATE June 23, 1971 CHECKED BY



+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 203

60

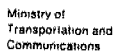
W P 46-74-38 LOCATION Coords. N 15 679 543; E 1 067 714 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY A.K.B.
DATUM Geodetic DATE June 24-29, 1971 CHECKED BY R.S.

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60					
328.5	Ground Level													
0.0	Silty Sand Traces of Gravel (Fill)		1	SS	14									
320.5	Compact, Brown		2	SS	15									5 54 37 4
8.0	Clayey Silt to Silty Clay, Traces of Coarse Sand		3	SS	22									
	Firm to Very Stiff		4	SS	36									
	Brown Becoming Grey		5	SS	30									
			6	SS	22									
			7	SS	18									
			8	SS	17									
			9	SS	10									
			10	TW	PM									
			11	SS	11									
			12	TW	PM									
			13	TW	PM									
270.5														
58.0	Clayey Silt With Sand and Gravel		14	SS	27									
	Very Stiff		15	SS	28									
			16	SS	31									
			17	SS	16									
247.5			18	TW	PM									
81.0	Silt to Clayey Silt Some Sand, Traces of Gravel		19	SS	113									
	Very Dense to Hard (Glacial Till) Brown		20	SS	121									
			21	SS	82									
			22	SS	93									
			23	SS	148									
225.5														
103.0	Silty Sand, Traces of Gravel		24	SS	14									
	Very Dense													
213.5														
115.0	Silt to Clayey Silt		25	SS	120/7"									
210.0	Hard													
118.5														

Continued

+3, x⁵: Numbers refer to
Sensitivity

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



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 203 Continued

61

W P 46-74-38 LOCATION Coords. N 15 679 543; E 1 067 714 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill COMPILED BY A.K.B.
DATUM Geodetic DATE June 24-29, 1971 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	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		
210.0												
118.5												
202.8												
125.7	End of Borehole		26	SS	100/8"							

+3, x5: Numbers refer to Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 204

62

W P 46-74-38 LOCATION Coords. N 15 679 550; E 1 068 105 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill COMPILED BY A.K.B.
DATUM Geodetic DATE June 23-24, 1971 CHECKED BY RS

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			SHEAR STRENGTH PSF							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
315.6	Ground Level							20 40 60 80 100	400 800 1200 1600 2000	20 40 60	PCF	CR SA SI CL			
0.0	Clayey Silt to Silty Clay, Traces of Sand and Gravel Random Pockets of Sand Hard to Stiff Brown Becoming Grey		1	SS	21										
			2	SS	38										
			3	SS	37										
			4	SS	36										
			5	SS	32										
			6	SS	31									6 26 49 19	
			7	SS	13										
			8	TW	PH								122		
			9	TW	PM								122		
			10	SS	13									0 5 48 47	
			11	TW	PM								129		
			12	SS	19								130		
			13	SS	26										
			14	SS	31									8 44 25 23	
			15	SS	17										
245.6			16	TW	PH										
70.0	Silt to Clayey Silt Some Sand, Trace of Gravel, Very Dense to Hard (Glacial Till) Reddish Brown		17	SS	102								124		
			18	SS	118										
			19	SS	168										
235.6			20	SS	150/5"									4 21 61 14	
80.0	End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 205

63

W P 46-74-38 LOCATION Coords. N 15 679 284; E 1 067 778 ORIGINATED BY W.A.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY A.K.B.
DATUM Geodetic DATE June 24-28, 1971 CHECKED BY RS

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					
274.3	Ground Level																
0.0	Clayey Silt With Traces of Sand, Seams of Sand and Gravel Organic Contamination Firm to Stiff		1	SS	4		270										
			2	SS	14												
			3	SS	11												
			4	TW	PH												
			5	TW	PH												
			6	SS	5												
			7	TW	PH												
248.3			8	SS	73												
26.0			9	SS	89												
	Clayey Silt to Silt Some Sand, Trace of Gravel, Very Stiff to Hard or Dense (Glacial Till) Reddish Brown		10	SS	86/11"												
			11	SS	22												
			12	SS	16												
			13	TW	PH												
			14	SS	14												
			15	SS	43												
			16	SS	46												
			17	SS	43												
180.6			18	SS	60/2"												
93.7	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 206

64

W P 46-74-38 LOCATION Coords. N 15 679 659; E 1 067 524 ORIGINATED BY W.A.
DIST 4 HWY 406 BOREHOLE TYPE Washboring BX Casing COMPILED BY A.K.B.
DATUM Geodetic DATE July 8-12, 1971 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100				
356.5	Ground Level														
0.0	Gravelly Sand to Sandy Gravel Traces of Silt Compact to Dense Brown		1	SS	51										41 51 (8)
			2	SS	18										
			3	SS	25										
			4	SS	10										68 26 (6)
			5	SS	42										33 53 (14)
335.5															
21.0	Clayey Silt to Silty Clay Traces of Sand and Gravel Occasionally Laminated Firm to Stiff Grey		6	SS	14										
			7	TW	PH										123
			8	TW	PH										129
			9	TW	PH										127
			10	TW	PH										119
			11	TW	PH										118.5
			12	TW	PH										
			13	TW	PM										
			14	TW	PH										117
			15	TW	PH										120
			16	TW	PH										119
			17	TW	PH										120
	Gravelly Sand Beams		18	SS	18										
			19	SS	9										
250.8															
105.7	Silt to Clayey Silt Some Sand & Gravel (Till), Very Dense to Hard, Red		20	SS	60/5"										
245.8			21	SS	60/2"										
110.7	End of Borehole														

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 207

65

W P 46-74-38 LOCATION Coords. N 15 679 212; E 1 067 400 ORIGINATED BY WA
DIST 4 HWY 406 BOREHOLE TYPE Pennndrill and Cone Test COMPILED BY AKB
DATUM Geodetic DATE July 14-15, 1971 CHECKED BY RS

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	400 800 1200 1600 2000					
273.0	Ground Level												PCF	GR SA SI CL
0.0	Mixed Fill						270							
268.5			1	SS	2		270.9							
4.5	Clayey Silt to Silty Clay Layers of Sand and Gravel		2	SS	6									1 55 34 10
	Traces of Organics		3	SS	3									
	Soft to Firm		4	SS	2		260							
	Brown and Grey		5	SS	5									
			6	TW	PH		250							
			7	TW	PH									
245.0			8	SS	19									
28.0	Clayey Silt Some Sand and Gravel		9	SS	30		240							
	Hard		10	SS	37									
	Red-Brown		11	SS	59		230							0 70 (30)
229.0			12	SS	20									
44.0	Silty Sand Compact		13	SS	16		220							
	Grey-Brown		14	SS	43									
214.2			15	SS	46		210							
58.8	Clayey Silt Traces of Sand		16	SS	34		200							
	Hard													
190.0														
83.0	Weathered Shale		17	SS	60/2"		190							
187.9			18	SS	60/2"									18 42 30 10
85.1	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 208

66

W P 46-74-38 LOCATION Coords. N 15 679 496; E 1 067 346 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY A.K.B.
DATUM Geodetic DATE July 1-7, 1971 CHECKED BY RS

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				
324.7	Ground Level															
0.0	Silty Sand Traces of Gravel Loose		1	SS	7		320									9 39 26 6
318.2			2	SS	4											
6.5	Clayey Silt to Silty Clay With Traces of Sand and Gravel, Occ. Laminated Firm to Very Stiff Grey		3	SS	4											
			4&5	TW	PM											
			6&7	TW	PM											
			8	SS	PM											
			9	SS	8											
			10	TW	PM											
			11	SS	7											
			12	SS	7											
			13	TW	PM											
			14	SS	8											
			15	TW	PM											
			16	SS	24											
			17	SS	21											
			18	SS	31											
254.7			19	SS	101											
70.0	Silt to Silty Clay Some Sand and Gravel Very Dense to Hard (Glacial Till) Red		20	SS	100/10"											30 42 24 4
			21	SS	100/9"											
239.7																1 18 60 21
85.0	Silty Sand Very Dense		22	SS	9											
232.2			23	SS	79											0 77 (23)
92.5	End of Borehole															

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 209

67

W P 46-74-38 LOCATION Coords. N 15 679 479; E 1 067 187 ORIGINATED BY WA
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY AKB
DATUM Geodetic DATE July 5, 6, 1971 CHECKED BY RS

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 P _u	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
302.7	Ground Level													
0.0	Clayey Silt to Silty Clay With Traces of Sand and Gravel		1	SS	10		300							
			2	SS	16									
	Occasionally Laminated		3	SS	29									
	Stiff to Hard		4	SS	45		290							
	Grey		5	SS	43									
			6	SS	21									
			7	TW	PH		280						117	
			8	SS	9								120	
			9	TW	PM		270						130	
			10	SS	24									1 9 54 36
			11	TW	PH		260						128	
			12	SS	31									
			13	SS	100/ 10"		250							
244.7			14	SS	60/ 4"									1 10 73 16
58.0	Silt With Pockets of Clayey Silt		15	SS	55		240							
	Hard													
229.7							230							0 76 (24)
228.2	Silty Sand		16	SS	41									
74.5	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10
S (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 210

68

W P 46-74-38 LOCATION Coords. N 15 679 575; E 1 066 964 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY K.W.
DATUM Geodetic DATE June 30 and July 1, 1971 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	PSF					
286.5	Ground Level													
0.0	Clayey Silt With Traces of Sand and Gravel						284.9							
	Stiff to Very Stiff		1	SS	5	P5	283.0							
	Grey and Brown		2	SS	13		280						131.5	
			3	TW	PM									
			4	SS	9		270						130	
			5	TW	PM									
			6	SS	10		260							
			7	TW	PM								135.5	
			8	SS	79		250							
248.5			9	SS	4/6		P4							0 53 (47)
38.0	Silty Sand to Sandy Silt		10	SS	33		240							
	Dense		11	SS	21									
231.5			12	SS	113		230							8 28 54 10
55.0	Silt to Clayey Silt Some Sand and Gravel Hard to Very Dense Red (Glacial Till)		13	SS	100/5"		220							
			14	SS	71/6"									
211.9			15	SS	50/1"									
74.6	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 211

69

W P 46-74-38 LOCATION Coords. N 15 679 672; E 1 066 665 ORIGINATED BY W.A.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY K.W.
DATUM Geodetic DATE July 7, 8, 1971 CHECKED BY RS

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	400 800 1200 1600 2000						20 40 60
300.8	Ground Level														
0.0	Clayey Silt to Silty Clay With Traces of Sand and Gravel Firm to Stiff Brown and Grey		1	SS	16										
			2	SS	6										
			3	SS	11										
			4	SS	9										
			5	TW	PH										
			6	SS	8										
			7	TW	PM										
			8	SS	13										
			9	SS	18										
			10	TW	PH										
			11	SS	17										
252.8			12	SS	70/4 1/2"										
48.0	Silt to Clayey Silt														
	Trace of Sand and Gravel (Glacial Till)														
247.3	Very Dense to Hard		13	SS	60/6"									1 6 75 18	
53.5	End of Borehole														

+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 212

70

W P 46-74-38 LOCATION Coords. N 15 679 348; E 1 066 916 ORIGINATED BY WA
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and BX Washbore COMPILED BY KW
DATUM Geodetic DATE June 30, July 1 & 5, 1971 CHECKED BY RS

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		20 40 60 80 100	PSF	W _p	W	W _L		
271.7	Ground Level											
0.0	Organically Contaminated		1	SS	4							
	Clayey Silt		2	SS	3							
	Firm		3	TW	PM							
			4	SS	4							
			5	SS	3							
			6	TW	PM							
			7	SS	6							
			8	TW	PH							
237.7			9	SS	8							
34.0	Silty Sand		10	SS	21							
	Compact to Dense		11	SS	27							
	Greyish-Brown		12	SS	31							
			13	SS	39							
216.5			14	SS	33							
55.2	Silt to Clayey Silt		15	SS	60/5"							
	Some Sand and Gravel		16	RC	1% Rec.							
204.2												
67.5	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 213

71

W P 46-74-38 LOCATION Coords. N 15 679 403; E 1 066 715 ORIGINATED BY W.A.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill, BX and AXT Washboring and Cone Test COMPILED BY K.W.
DATUM Geodetic DATE June 28, 29, 30, 1971 CHECKED BY R.S.

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
271.7	Ground Level																
0.0	Grey Organic Silt and Sand		1	SS	9		271.7									0m	
	Soft to Stiff		2	SS	3											3.7%	
			3	SS	3												
			4	SS	2												
253.7			5	SS	12												
18.0	Silt to Silty Sand		6	SS	30												
	Seams of Gravel		7	SS	24												
	Traces of Clay		8	SS	21												0 58 (47)
	Compact		9	SS	21												
	Brown		10	SS	64												7 53 30 10
232.7			11	SS	60/ 3"												
39.0	Clayey Silt to Silt		12	SS	60/ 2"												
	Some Sand and Gravel		13	SS	60/ 2 1/2"												
	Very Dense to Hard																
	(Glacial Till)																
	Red-Brown																
209.2			14	SC	50%		210										
62.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 214

72

W P 46-74-38 LOCATION Coords. N 15 679 467; E 1 066 514 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY K.W.
DATUM Geodetic DATE June 29, 1971 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	20 40 60					
270.0	Ground Level													
0.0	Organic Silt With Some Sand Traces of Vegetable Matter		1	SS	2	269.2								
	Very Loose		2	SS	4									
	Dark Brown and Black		3	SS	3	260								
255.0			4	SS	4									
15.0	Silt to Sandy Silt		5	SS	42									
	Traces of Clay and Gravel		6	SS	121	250								
	Very Dense		7	SS	57									5 7 78 10
	Grey		8	SS	70	240								
235.0			9&10	SS	91									
35.0	Clayey Silt to Silt Some Sand, Trace of Gravel (Glacial Till)		11	SS	93/5"	230								
	Very Dense to Hard		12	SS	100/6"									7 26 53 14
	Red-Brown		13	SS	101/7"	220								
215.4			14	SS	507 1/2"									
54.6	End of Borehole													

+³, x⁵: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 215

73

W P 46-74-38 LOCATION Coords. N 15 679 710; E 1 066 436 ORIGINATED BY W.A.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY K.W.
DATUM Geodetic DATE July 13, 14, 1971 CHECKED BY R.S.

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	PSF					
305.6	Ground Level													
0.0	Silty Sand With Some Gravel (Fill?) Very Loose Brown		1	SS	5		300							1 80 (19)
296.6			2	SS	3									
9.0	Clayey Silt to Silty Clay Traces of Sand and Gravel		3	SS	10		290						119	
			4	SS	8									
			5	TW	PM									
			6	SS	15									
	Stiff to Very Stiff		7	TW	PM		280						124	
	Grey		8	SS	19								127	
			9	TW	PM/ PH/	15" 3"	270						133	
			10	SS	24									
			11	TW	PH		260						137	
257.6			12	SS	73								122	
48.0	Clayey Silt to Silt		13	SS	100/11"		250							
	Traces of Sand and Gravel		14	SS	88									
	Very Dense to Hard Red-Brown		15	SS	105/11"		240							0 8 75 17
	(Glacial Till)													
236.7			16	SS	60/4"									
68.9	End of Borehole													

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 216

74

W P 46-74-38 LOCATION Coords. N 15,679,834, E 1,066,169 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY K.W.
DATUM Geodetic DATE July 8 & 9, 1971 CHECKED BY [Signature]

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					
324.7	Ground Level																
0.0	Clayey Silt With Organics Firm		1	SS	6		323.2										
317.2	Dark Grey		2&3	SS	5												
7.5	Clayey Silt to Silty Clay, Traces of Sand and Gravel		4	SS	16												
			5	SS	25												
			6	SS	31												
	Occasionally Laminated		7	SS	34												
			8	SS	24												
	Stiff to Hard		9	SS	27												
			10	SS	17												
	Grey and Brown		11	SS	13												
			12	TV	PM												
			13	SS	29												
			14	SS	32												
264.7			15	SS	100/ 11"												
60.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		16	SS	100/ 11"												
			17	SS	70/ 6"												
250.1			18	SS	50/ 11"												
74.6	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

+3, x5: Numbers refer to
Sensitivity

20
15 ÷ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 219

75

W P 46-74-38 LOCATION Coords. N 15 680 043; E 1 066 283 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill COMPILED BY K.W.
DATUM Geodetic DATE July 13, 14, 15, 1971 CHECKED BY RS

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					
348.5	Ground Level																
0.0	Silty Sand With Gravel. Fill, Loose		1	SS	9												4-74 (22)
342.0			2	SS	25												
6.5	Clayey Silt to Silty Clay		3	SS	43		340										
	Traces of Sand and Gravel		4	SS	29												0 4 41 55
	Hard, Becoming Stiff		5	SS	21		330										
			6	SS	14												
	Grey and Brown		7	TW	PM											118	
			8	SS	9		320										
			9	TW	PM												119
			10	SS	11		310										
			11	TW	PM												100
			12	SS	8		300										
			13	TW	PM/	13"											120
			14	SS	12		290										
			15	TW	PM/	12"											114
			16	SS	20		280										121
272.0			17	SS	48												
76.5	Clayey Silt to Silt Some Sand and Gravel Very Dense to Hard (Glacial Till) Red-Brown		18	SS	73		273.4										
			19	SS	507	3"											
			20	SS	537	6"	260										
253.7			21	SS	507	4"											
94.8	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 + 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 220

W P 46-74-38 LOCATION Coords. N 15,679,705; E 1,066,028 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY K.W.
DATUM Geodetic DATE July 12, 1971 CHECKED BY *EP*

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			20	40	60	80	100					
273.5	Ground Level															
0.0	Clayey Silt															
268.5	Very Stiff		1	SS	22											
5.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		3	SS	67											
			4	SS	62											
			5	SS	57											
			6	SS	76											
			7	SS	60/ 3"											
			8	SS	75/ 6"											
243.7			9	SS	50/ 3"											4 31 49 16
29.8	End of Borehole Note: Water Level Not Established															

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 221

77

W P 46-74-38 LOCATION Coords. N 15 679 127; E 1 067 734 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY A.K.B.
DATUM Geodetic DATE August 6-9, 1971 CHECKED BY RS

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
									SHEAR STRENGTH PSF						
									○ UNCONFINED + FIELD VANE						
									● QUICK TRIAXIAL x LAB VANE						
									400 800 1200 1600 2000			20 40 60			
273.4	Ground Level													PCF	GR SA SI CL
0.0	Organically Contaminated Clayey Silt, Seams of Silt and Sand Occasional Gravel		1	SS	3		270.7								
			2	SS	3										
			3	SS	3										
	Soft to Firm Black and Grey		4	SS	4										0 52 38 10
			5	SS	10										
			6	SS	3										
			7	TW	PH										
			8	TW	PH										
246.9			9	SS	31										
26.5			10	SS	75										
	Clayey Silt to Silt Trace of Sand and Gravel		11	SS	70										
	Very Stiff to Hard (Glacial Till)		12	SS	56										
	Reddish Brown		13	SS	18										
			14	SS	22										
			15	SS	17										
			16	SS	33										
			17	SS	40										
			18	SS	50										
			19	SS	27										
			20	SS	23										
			21	SS	33										0 6 79 15
181.4			22	SS	25										
92.0	End of Borehole														

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 222

78

W P 46-74-38 LOCATION Coords. N 15 679 208; E 1 067 946 ORIGINATED BY KW
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY AKB
DATUM Geodetic DATE August 10-11, 1971 CHECKED BY RS

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	100					
272.9	Ground Level													
0.0	Layers of Clayey Silt to Silt, Sand and Gravel, Heavily Contaminated With Organics. Black and Grey Soft to Firm		1	SS	28		270							
			1A	SS	3									
			2	SS	20		260							
			3	SS	3									
			4	SS	38									
			5	SS	11									
			6	SS	4		250							
244.9			7	SS	8									
28.0	Clayey Silt to Silt Trace of Sand and Gravel Hard Reddish Brown (Glacial Till)		8	SS	36		240							
			9	SS	75									
			10	SS	60		230							
			11	SS	58									
			12	SS	69		220							
			13	SS	54									
			14	SS	45		210							
207.4			15	SS	92									
65.5	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 223

79

W P 46-74-38 LOCATION Coords. N 15 679 379; E 1 067 881 ORIGINATED BY KW
DIST 4 HWY 406 BOREHOLE TYPE Penndrill & Washboring, BX Casing & Cone Test COMPILED BY AKB
DATUM Geodetic DATE August 13-17, 1971 CHECKED BY RS

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	PSF					
274.8	Ground Level					277.0								
0.0	Clayey Silt to Silty Clay		1	SS	18	271.5	270		100/3"					
	Layers of Sand		2	SS	5									
	Heavily Contaminated With Organics		3	SS	9									
	Soft to Firm		4	TW	PH		260		+ s=18.0				123	
			5	TW	PH				+ s=3.5				128	
254.8			6	SS	16									
20.0	Clayey Silt Some Sand and Gravel		7	SS	21		250							
247.8	Very Stiff		8	SS	27									37 19 34 10
27.0	Clayey Silt to Silt Some Sand		9	SS	39									
	Very Dense to Hard (Glacial Till)		10	SS	95		240							
	Reddish Brown		11	SS	98									
			12	SS	95		230							
226.8			13	SS	17									
48.0	Clayey Silt to Silt		14	SS	19		220							
	Very Stiff		15	SS	17									
	Grey													
210.8			16	SS	63		210							
64.0	Clayey Silt		17	SS	51									
	Traces of Sand and Gravel (Glacial Till)		18	SS	64		200							
	Hard		19	SS	57									
	Brown		20	SS	42		190							
			21	SS	38									
180.1			22	SS	75/3"									
94.7	End of Borehole					180.5								

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

RECORD OF BOREHOLE No 224

80

W P 46-74-38 LOCATION Coords. N 15 679 265; E 1 067 685 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY A.R.B.
DATUM Geodetic DATE August 11-12, 1971 CHECKED BY RS

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 PSF										
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE											
							400 800 1200 1600 2000					20 40 60						
277.7	Ground Level													GR SA SI CL				
0.0	Organically Contaminated Clayey Silt to Silty Clay Traces of Sand		1	SS	16	*												
			2	SS	6													
			3	SS	24													
			4	SS	8													
	Firm to Very Stiff		5	TW	PH													
	Grey and Brown		6	SS	18													
			7	SS	15													
			8	SS	7													
248.7			9	SS	80													
29.0	Clayey Silt Traces of Sand and Gravel		10	SS	92													
	Reddish Brown		11	SS	74													
	Hard		12	SS	62													
	(Glacial Till)		13	SS	31													
225.7																		
52.0	Clayey Silt to Silt Some Sand		14	SS	16													
			15	SS	62													
213.2	Hard and Very Dense		16	SS	72													
64.5	Clayey Silt Traces of Sand																	
	Hard		17	SS	29													
	(Glacial Till)		18	SS	34													
			19	SS	37													
189.7			20	SS	50/7													
88.0	End of Borehole																	
	*Note: Water Level Not Established																	

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

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 225

81

W P 46-74-38 LOCATION Coords. N 15 679 508; E 1 067 820 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Washboring BX Casing and Cone Test COMPILED BY A.K.B.
DATUM Geodetic DATE August 17-19, 1971 CHECKED BY RS

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 P.C.	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			20 40 60 80 100						
300.4	Ground Level												
0.0	Silty Clay to Clayey Silt Traces of Sand and Gravel Stiff		1	SS	39								
			2	SS	22								
			3	SS	20								
			4	SS	9								
			5	TW	PH								
			6	TW	PH								
			7	SS	13								
			8	TW	PH								
			9	SS	16								
			10	TW	PH								
			11	SS	14								
			12	TW	PH								
			13	SS	10								
			14	TW	PH								
248.4	Clayey Silt to Silt Trace of Sand and Gravel Hard to Very Dense (Glacial Till) Brown		15	SS	28								
52.0			16	SS	75								
			17	SS	73								
			18	SS	58								
			19	SS	66								
227.4	Silty Sand to Sand Dense		20	SS	3								
73.0			21	SS	36								
217.4	Clayey Silt Some Sand and Gravel (Glacial Till) Hard		22	SS	66								
83.0			23	SS	95								
208.9	End of Borehole Note: Water Level Not Established												
91.5													

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 226

82

W P 46-74-38 LOCATION Coords. N 15 679 605; E 1 067 657 ORIGINATED BY B.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger and Washboring COMPILED BY P.K.
DATUM Geodetic DATE December 13-15, 1971 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF				WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	W _p	W	W _L		
355.5	Ground Level															
0.0	Fill Silty Sand Some Gravel Some Roots Dense		1	SS	5											
			2	SS	4											
			3	SS	6											
342.5			4	SS	10											
13.0			5	SS	17											
			6	SS	13											
			7	SS	41	336.3										
			8	SS	36											
			9	SS	17											
			10	TW	PH											
			11	SS	--											
			12	TW	PH											
			13	TW	PH											
			14	TW	PH											
			15	TW	PH											
			16	TW	PH											
			17	TW	PH											
			18	TW	PH											
			19	TW	PH											
			20	TW	PH											
			21	TW	PH											
			22	TW	PH											
			23	TW	PH											
			24	TW	PH											
			25	SS	--											
270.5			26	SS	--											
85.0	Clayey Silt With Some Sand and Gravel (Glacial Till) Very Stiff to Hard		27	SS	22											
			28	SS	34											
			29	SS	30											
			30	SS	55											
			31	SS	20											
248.5			32	SS	29											
107.0	Silty Fine Sand Very Dense Red		33	SS	53											
			34	SS	193											
239.0			35	SS	95											
116.5	End of Borehole															

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications
Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 227

83

W P 46-74-38 LOCATION Coords. N 15 679 454; E 1 067 628 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Penndrill and Cone Test COMPILED BY P.K.
DATUM Geodetic DATE November 29-30, 1971 CHECKED BY RS

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					
314.8	Ground Level																
0.0	Sand With Some Silt and Gravel		1	SS	4												14 71 (15)
	Loose		2	SS	9												
306.3			3	SS	26												
8.5	Silty Clay to Clayey Silt Traces of Sand Random Pockets of Silt Occasionally Laminated Very Stiff to Stiff Greyish Brown		4	TW	PH												121
			5	TW	PM												121
			6	TW	PH												122
			7	TW	PM												120
			8	TW	PM												121
			9	SS	7												117
			10	TW	PM												134.5
			11	TW	PM												128.5
			12	SS	14												2 8 52 38
			13	SS	27												130
			14	TW	PM												128.5
			15	SS	20												125
			16	TW	PM												121
250.2			17	TW	PM												
64.0	Silt to Clayey Silt Some Sand, Trace of Gravel, Very Dense to Hard (Glacial Till)		18	SS	81												2 19 63 16
214.3			19	SS	74												
71.5	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 228

84

W P 46-74-38 LOCATION Coords. N 15 679 176; E 1 067 619 ORIGINATED BY PK
DIST 4 HWY 406 BOREHOLE TYPE Auger and Cone Test COMPILED BY PK
DATUM Geodetic DATE November 29, 1971 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ pcf	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100		
275.4	Ground Level													
0.0	Organically Contaminated Silty Clay to Clayey Silt, With Sandy Layers		1	TW	PH								123	
			2	TW	PH								115	1 49 40 10
	Soft to Firm		3	TW	PH									1 86 (13)
	Black and Grey		4	TW	PH									
			5	TW	PH									
			6	TW	PH								110	
256.4														
19.0	Silty Sand to Sandy Silt, Traces of Clay Compact to Very Dense		7	SS	26									30 49 19 2
			8	SS	11									0 10 72 18
			9	SS	44									8 24 58 10
243.9														
			10	SS	75									
31.5	End of Borehole													

+3, x5: Numbers refer to
Sensitivity


20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 229

85

W P 46-74-38 LOCATION Coords. N 15 679 153; E 1 067 506 ORIGINATED BY PK
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY PK
DATUM Geodetic DATE November 29, 1971 CHECKED BY RS

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 PSF									20 40 60			
							○ UNCONFINED + FIELD VANE													
							● QUICK TRIAXIAL x LAB VANE													
							400 800 1200 1600 2000				20 40 60									
274.5	Ground Level															GR SA SI CL				
0.0	Layers of Silty Clay Silty Sand and Silt. Organic Matters Throughout Soft to Stiff		1	TW	PH		270.2								120	11 54 28 7				
		2	SS	18													123			
		3	TW	PH													116.5			
		4	TW	PH													124			
		5	TW	PH													109			
		6	TW	PH													113			
		7	SS	41																
		8	SS	6																
246.5																				0 7 75 18
28.0		Sandy Silt, Traces		9	SS			84												5 23 60 12
242.5	of Clay, Very Dense		10	SS	83															
32.0	End of Borehole																			

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 230

86

W P 46-74-38 LOCATION Coords. N 15 679 277; E 1 067 458 ORIGINATED BY PK
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY PK
DATUM Geodetic DATE November 30, 1971 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			20 40 60 80 100	PSF					
280.5	Ground Level												
0.0	Gravelly Sand With Organics		1	TW	PH	280							40 48 (12)
274.7	Compact		2	SS	32								
5.8	Clayey Silt to Silty Clay		3	SS	26	277.0							
	Traces of Sand Becoming Stratified		4	SS	27								
	Clayey Silt and Silty Clay Pockets of Silt		5	TW	PH	270						128	
	Stiff		6	TW	PH							121	
			7	TW	PH	260						125	3 11 51 35
			8	TW	PH							128	
			9	TW	PH	250						124	
			10	TW	PH							119	
			11	TW	PH							118	
245.5			12	TW	PH							107	
35.0	Sandy Silt, Trace of		13	SS	70							112	0 2 49 50
242.0	Clay, Very Dense		14	SS	55								6 21 65 8
38.5	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 231

87

W P 46-74-38 LOCATION Coords. N 15 679 337; E 1 067 471 ORIGINATED BY DM
DIST 4 HWY 406 BOREHOLE TYPE Auger and Cone Test COMPILED BY PK
DATUM Geodetic DATE November 30, 1971 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
304.8	Ground Level										
0.0	Clayey Silt		1	SS	24		200		○		1 5 64 30
	Traces of Sand		2	SS	32				○		
			3	SS	33				○		
292.8			4	SS	42				○		1 5 67 27
12.0	Gravelly Sand		5	SS	33		290		○		16 67 (17)
	Some Silt		6	SS	32						
	Dense		7	SS	33				○		35 40 20 5
285.8			8	TW	PM		288.9				
19.0	Silty Clay		9	AS							
	Traces of Sand						280				
278.8											
26.0	End of Borehole										

+³, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 231A

88

W P 46-74-38 LOCATION Coords. N 15 679 339; E 1 067 475 ORIGINATED BY DM
DIST 4 HWY 406 BOREHOLE TYPE Auger and Washboring COMPILED BY PK
DATUM Geodetic DATE November 30-December 3, 1971 CHECKED BY RS

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					
304.8	Ground Level													
0.0	Layers of Gravelly Sand Some Silt and Clayey Silt		1	SS	19		300							35 46 (19)
			2	SS	9									0 2 67 31
			3	SS	25		290							27 45 22 6
285.8														
19.0	Silty Clay Some Sand Traces of Gravel Occasional Silt Pockets Stiff Greyish Brown		4	TW	PM		280						114	0 1 55 44
			5	TW	PM								118	
			6	TW	PM									
			7	SS	7		270							
			8	TW	PM								126	
			9	TW	PM								129	8 12 47 33
			10	SS	14		260							2 12 53 33
			11	TW	PM								128	1 6 53 40
			12	TW	PM								118	
250.8			13	SS	16		250							2 22 62 14
54.0	Silt to Clayey Silt Some Sand, Trace of Gravel, Hard to Dense (Glacial Till)		14	SS	34									9 30 51 10
			15	SS	31									
241.3			16	SS	68									3 23 55 19
63.5	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 232

89

W P 46-74-38 LOCATION Coords. N 15 679 420; E 1 067 484 ORIGINATED BY PK
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY PK
DATUM Geodetic DATE November 30 to December 2, 1971 CHECKED BY RS

[illegible]

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 233

90

W P 46-74-38 LOCATION Coords. N 15 679 522; E 1 067 477 ORIGINATED BY P.K.
DIST 4 HWY 406 BOREHOLE TYPE Auger and Washboring COMPILED BY P.K.
DATUM Geodetic DATE December 2-7, 1971 CHECKED BY RS

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 PSF									
								○ UNCONFINED	+ FIELD VANE								
								● QUICK TRIAXIAL	x LAB VANE								
								400 800 1200 1600 2000									
356.1	Ground Level																
0.0	Gravelly Sand Traces of Silt Dense to Very Dense Brown		1	SS	43		350									37 55 (8)	
			2	SS	54											4 89 (7)	
			3	SS	29											46 45 (9)	
			4	SS	56												
			5	SS	30												
338.1			6	AS			340										
18.0	Clayey Silt Seams of Sandy Silt Stiff		7	SS	10												
			8	N/R			330										
			9	SS	7												
325.1			10	TW	PH		328.0										
31.0	Gravelly Sand Traces of Silt Compact		11	SS	27												
			12	SS	22												
317.6			13	SS	159/ 8"												
38.5	Silty Clay Pockets of Sand and Gravel Stiff to Very Stiff		14	SS	48												
			15	SS	11												
			16	TW	PH												
303.6			17	TW	PH												
52.5	Sandy Silt With Some Gravel		18	SS	71		300										
296.1	Very Dense		19	SS	73												
60.0	Clayey Silt to Silty Clay Stiff		20	SS	10												
			21	TW	PH												
			22	SS	7												
			23	TW	PH												
			24	TW	PH												
			25	SS	10												
			26	TP	PH												
			27	SS	25												
			28	SS	27												
			29	TW	PH												
257.1			30	SS	37												
99.0	Silt to Clayey Silt Some Sand and Gravel (Glacial Till) Reddish Brown		31	SS	24												
			32	SS	100/ 5"		250										
245.6			33	SS	111												
110.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

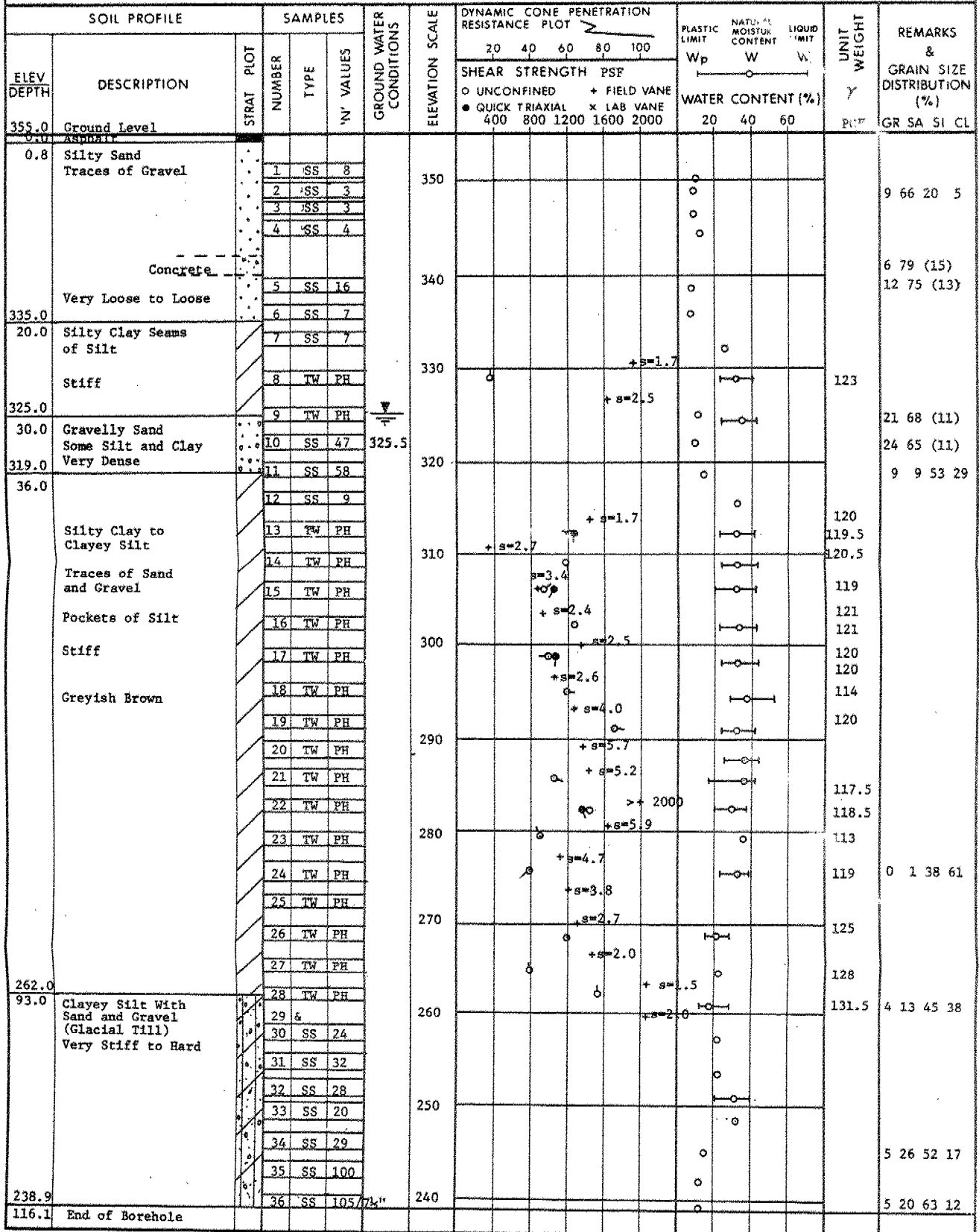
20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 234

91

W P 46-74-38 LOCATION Coords. N 15 679 530; E 1 067 557 ORIGINATED BY PK & BM
DIST 4 HWY 406 BOREHOLE TYPE Auger and Washboring COMPILED BY P.K.
DATUM Geodetic DATE December 8-10, 1971 CHECKED BY RS



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

RECORD OF BOREHOLE No 235

92

W P 46-74-38 LOCATION Coords. N 15 679 734; E 1 066 257 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger and Cone Test COMPILED BY P.K.
DATUM Geodetic DATE December 6-7, 1971 CHECKED BY RS

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE						
310.6	Ground Level							20 40 60 80 100	400 800 1200 1600 2000	20 40 60				GR SA SI CL	
0.0	Silty Clay to Clayey Silt		1	SS	40		310								
	Traces of Sand and Gravel		2	SS	38									0 3 39 58	
	Pockets of Silt		3	SS	42		300								
	Hard to Stiff		4	SS	27										
	Greyish Brown		5	SS	33										
			6	TW	PM		290						120	1 2 32 65	
			7	TW	PM								125		
			8	TW	PM		280						119		
			9	SS	11									2 16 56 26	
			10	TW	PM		270						127		
			11	TW	PM		269.0						126		
262.6															
48.0	Silt to Clayey Silt		12	SS	63		260							8 22 56 14	
	Some Sand														
	Trace of Gravel														
	(Glacial Till)														
	Very Dense to Hard		13	SS	168/10"										
249.6														0 30 66 4	
61.0	End of Borehole						250								

+3, x5: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



Ministry of
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HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 236

93

W P 46-74-38 LOCATION Coords. N 15,679,666; E 1,066,129 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger and Cone Test COMPILED BY P.K.
DATUM Geodetic DATE December 13, 1971 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
278.7	Ground Level											
0.0	Silty Clay Some Sand Hard		1	SS	39							
270.7			2	SS	45							
8.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		3	SS	40							
			4	SS	55							0 15 80 5
			5	SS	49							3 23 60 14
			6	SS	116							
			7	SS	100/4"							9 10 66 15
248.2	Boulders		8	SS	100/6"							
30.5	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 237

94

W P 46-74-38 LOCATION Coords. N 15,679,597; E 1,066,076 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY P.K.
DATUM Geodetic DATE December 17, 1971 CHECKED BY [Signature]

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					
272.2	Ground Level															
0.0	Rock Rip-Rap					270										
268.2			1	SS	17	268.2										3 18 67 12
4.0	Grey Organic Silt & Sand, Firm to Stiff		2	TW	PH											
264.2			3	SS	8											
8.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel		4	SS	74											
			5	SS	148	260										1 7 85 7
	Very Dense to Hard (Glacial Till)		6	SS	1027	6"										
253.2																
19.0	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No. 238

95

W P 46-74-38 LOCATION Coords. N 15,679,825; E 1,066,126 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger and Cone Test COMPILED BY P.K.
DATUM Geodetic DATE December 8, 1971 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 PSF										
								○ UNCONFINED	+ FIELD VANE									
								● QUICK TRIAXIAL	x LAB VANE									
								400 800 1200 1600 2000										
311.6	Ground Level												PCF	GR SA SI CL				
0.0	Fill Sandy Silt, Silty Clay, Some Brick Fragments		1	AS			310							2 39 40 19				
			2	SS	15										0 4 47 49			
			3	SS	42													
			4	SS	36													
297.6			5	SS	32			300										
14.0	Clayey Silt to Silty Clay Traces of Sand Pockets of Silt Stiff to Very Stiff		6	TW	PH								127					
			7	TW	PH			290						123				
			8	SS	15										0 3 52 45			
			9	AS														
			10	TW	PH			280						120				
			11	TW	PM									134.5				
			12	SS	16			270						136	3 12 54 31			
268.6	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		13	SS	28		269.0											
43.0			14	SS	47													
			15	SS	105/6"										5 16 69 10			
251.1			16	SS	100/6"													
60.5	End of Borehole																	

+3, x5: Numbers refer to
Sensitivity

20
15 x 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 239

96

W P 46-74-38 LOCATION Coords. N 15,679,783; E 1,066,089 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger and Cone Test COMPILED BY P.K.
DATUM Geodetic DATE December 9 & 10, 1971 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	100					
300.2	Ground Level													
0.0	Clayey Silt to Silty Clay		1	SS	31		300							
	Trace of Sand and Gravel		2	SS	39									0 3 40 57
	Very Stiff to Hard		3	SS	34		290						125	
			4	TW	PH								127.5	
			5	TW	PH								118	
			6	TW	PM		280						136	
			7	SS	22									2 17 50 31
267.2			8	TW	PM		270						130	
33.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		9	SS	43	266	260						128	
	Boulders		10	SS	85									2 18 66 14
			11	SS	100/6"									
250.7														
49.5	End of Borehole													

+³, x⁵; Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 240

97

W P 46-74-38 LOCATION Coords. N 15,679,683; E 1,066,015 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY P.K.
DATUM Geodetic DATE December 16 & 17, 1971 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					
271.7	Ground Level																
0.0	Rock Rip-Rap						270										
267.7																	
4.0	Grey Organic Silt and Sand, Firm to Stiff		162	AS	6		267.2										
261.9			3	TW	PM												
9.8	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		4	SS	45		260										0 4 90 6
253.2			5	SS	98												2 20 68 10
18.5	End of Borehole		6	SS	128	6"											

+3, x5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 308

98

W P 46-74-38 LOCATION Coords. N 15 679 590; E 1 068 190 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Power Auger Boring COMPILED BY M.W.
DATUM Geodetic DATE September 25-26, 1963 CHECKED BY RS

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					
317.7	Ground Level																
0.0	Heterog. Fill Compr. of																
315.2	Br. Sa. Si. Brick and																
2.5	Concret. Fragments to 3 inch size		1	SS	16												
			2	SS	21												
			3	SS	19												
			4	TW	PH												
	Silty Clay to Clayey Silt		5	SS	25												
	Trace of Sand and Gravel		6	TW	PH												
	Stiff to Very Stiff		7	SS	8												
			8	TW	PH												
			9	SS	9												
			10	TW	PH												
			11	SS	14												
			12	SS	18												
			13	SS	16												
			14	TW	PM												
			15	SS	11												
			16	SS	11												
245.7			17	SS	96												
72.0	Silt to Clayey Silt Some Sand, Trace of Gravel, Very Dense to Hard (Glacial Till) Reddish Brown		18	SS	87												
			19	SS	93												
227.7			20	SS	66												
90.0	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 309

99

W P 46-74-38 LOCATION Coords. N 15 679 430; E 1 067 822 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Power Auger Boring COMPILED BY MW
DATUM Geodetic DATE September 27, 1963 CHECKED BY RS

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			SHEAR STRENGTH PSF						
294.0	Ground Level							20 40 60 80 100						
0.0	Loose Heterogeneous Mixture of Brick and Concrete Fragments Brown Silty Sand and Gravel (Fill)		1	AS	--		290							
			2	SS	8									
280.8			3	SS	14		280							
13.2	Silty Clay to Clayey Silt, Trace of Sand and Gravel, Very Stiff, Brown Desiccated		4	TW	17	W.L. in pipe @ elev. 270.6 Oct. 25/63								
269.5			5	SS	15		270							
24.5	Silty Clay to Clayey Silt, Trace of Sand and Gravel Stiff to Very Stiff Grey Dense Silty Sand Layers at 34.5 to 35.2 and 44.7 to 46.0 Foot Depth		6	SS	12									
			7	TW	PM		260							
			8	SS	8									
			9	TW	PM		250							
246.5			10	SS	14									
47.5	Silt to Clayey Silt Some Sand, Trace of Gravel Very Dense to Hard (Glacial Till) Reddish Brown		11	SS	59		240							
			12	SS	61									
			13	SS	69									
229.5			14	SS	84		230							
64.5	End of Borehole													

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5
0
(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 310

100

W P 46-74-38 LOCATION Coords. N 15 679 258; E 1 067 625 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Washboring COMPILED BY MW
DATUM Geodetic DATE September 20-23, 1963 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					
277.1	Ground Level																
0.0	Loose Brown Silty Sand, Some Brick Fragments (Fill)		1	SS	5		W.L. @ elev. 277.0 Oct. 25/63										
271.8			2	SS	16												
5.3	Stiff Grey (Brown Coloured & Desiccated Down to 10 Ft. Depth) Silty Clay With a Few Scattered Sand and Gravel Size Particles		3	SS	19		270									132	
			4	TW	PM												
			5	TP	PM		260										
			6	TP	PM												
			7	TW	PM		250									133	
248.1			8	SS	43												
29.0	Dense to Very Dense Grey Sandy & Clayey Silt With Some Gravel Size Particles Scattered Throughout Few Sand Lenses		9	SS	67		240										
236.6			10	SS	64												
40.5	Very Dense Stratified Sandy Silts Becoming Stiff Layered Silty Clay and Clayey Silt With Some Layers of Fine Sandy Silt Below About 44 Ft. Depth		11	SS	33		230										
225.6			12	SS	16												
51.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 313

101

W P 46-74-38 LOCATION Coords. N 15 679 290; E 1 067 170 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Washboring HX and BX Casing COMPILED BY MW
DATUM Geodetic DATE September 23-25, 1963 CHECKED BY RS

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					
273.2	Ground Level																
0.0	Loose Brown Sand		1	SS	6		270										
269.3	Stiff Brown Si.Cl. Fill		2	SS	2												
3.9	Organically Contaminated Clayey Silt and Silty Sand Soft to Firm		3	SS	1												
			4	SS	3												
258.0							260										
15.2	Soft Grey Brown Silty Clay		5	SS	3												
255.2																	
18.0	Silt to Clayey Silt Firm to Very Stiff (Layered)		6	TW	PM												
			7	SS	4		250										
			8	SS	23												
			9	SS	13												
240.0							240										
33.2	Sand and Silt Loose to Very Dense		10	SS	46												
			11	SS	7												
221.7							230										
			12	SS	67												
51.5	End of Borehole																
	Note: Artesian Water Pressure First Noticed During Drilling When Casing Was at 35 Foot Depth																

+3, x5: Numbers refer to
Sensitivity

20
15 ± 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 314

102

W P 46-74-38 LOCATION Coords. N 15 679 456; E 1 066 720 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Washboring HX and BX Casing COMPILED BY M.W.
DATUM Geodetic DATE September 25-27, 1963 CHECKED BY RS

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100	Wp	W		
270.9	Ground Level														
0.0	Grey Organic Silt and Sand Firm to Stiff		1	SS	10										
			2	SS	6										
			3	SS	4										
			4	SS	3										
			5	SS	PM										
255.9			6	SS	23										
15.0	Silt to Sandy Silt Layers of Clayey Silt Dense to Very Dense		7	SS	33										
			8	SS	57										
			9	SS	28										
			10	SS	WH										
			11	SS	35										
			12	SS	95										
			13	SS	87										
218.9	Silt to Clayey Silt		14	SS	100										
52.0	Red-Brown (Glacial Till)														
215.6															
55.3	End of Borehole														

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 315

103

W P 46-74-38 LOCATION Coords. N 15 679 572; E 1 066 212 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Power Auger, Washboring and BX Casing COMPILED BY M.W.
DATUM Geodetic DATE September 28-October 8, 1963 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
270.6	Ground Level												
0.0	Br. Cl. Sl. With Sa. Gr. & Boulders (Fill)												
268.1													
2.5	Organic Silt and Sand Firm to Stiff		1	SS	4								
			2	TW	PM								
261.3			3	SS	16								
9.3	Reddish Brown Silt to Clayey Silt Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		4	SS	26								
			5	SS	>100								
			6	SS	>100								
			7	SS	>100								
234.8			8	SS	>100								
35.8	End of Borehole												

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



Ministry of
Transportation and
Communications
Ontario

HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

RECORD OF BOREHOLE No 316

104

W P 46-74-38 LOCATION Coords. N 15 679 095; E 1 066 908 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Washboring HX and BX Casing and Cone Test COMPILED BY M.W.
DATUM Geodetic DATE September 27-October 1, 1963 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQ. ID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
270.0	Ground Level																
0.0	Grey Organic Silt and Sand Pieces of Wood Soft to Firm		1	SS	7												
			2	SS	4												
			3	SS	3												
			4	SS	1												
			5	TW	5												
249.2			6	SS	18												
20.8	Silt to Sandy Silt Occasional Clayey Silt Layers Compact to Dense		7	SS	43												
			8	SS	36												
			9	TW	PM												
			10	SS	25												
			11	SS	15												
			12	SS	27												
			13	SS	28												
			14	SS	33												
204.5			15	SS	46												
65.5	Silt to Clay Silt, Some Sand & Gravel, Hard to Very Dense, Reddish- Brown (Triaxial Silt)		16	SS	100												
200.0																	
70.0	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 338

105

W P 46-74-38 LOCATION Coords. N 15 679 145; E 1 066 693 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Power Auger COMPILED BY M.W.
DATUM Geodetic DATE September 30, 1963 CHECKED BY

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

+3, x5: Numbers refer to Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 349

106

W P 46-74-38 LOCATION Coords. N 15 679 246; E 1 066 163 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Washboring HX and BX Casing COMPILED BY M.W.
DATUM Geodetic DATE October 28-30, 1963 CHECKED BY RS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQ. LD 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 PSF									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					WATER CONTENT (%)				
								400 800 1200 1600 2000					20 40 60			PCF	GR SA SI CL
270.1	Ground Level		1	SS	10												
0.0	Organically Contaminated Clayey Silt		2	SS	7												
			3	SS	3												
	Firm to Stiff		4	TW	PM												
			5	SS	2												
			6	SS	24												
251.1			7	SS	100												
19.0	Silt to Clayey Silt Some Sand and Gravel Hard to Very Dense Red-Brown (Glacial Till)		8	SS	100												
			9	SS	74												
238.6																	
31.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 46-74-16

DIST 4

HWY 406

STR SITE 18-248

Three Cell Culvert
Extension at Lock 3

DISTRIBUTION

G.C.E. Burkhardt (3)

R.D. Gunter

M.R. Ernesaks

D.E. Thrasher (2)

C. Grebski

G.A. Wong

B.J. Giroux

SAMPLE DISPOSITION NOTICE

TYPE	DISCARD AFTER	RECOMM. BY
JARS	79-07-04	PP
TUBES	79-07-04	PP
SOCK DOES	AFTER CONSTRUCTION	PP

R. Hore (Ministry of the Environment)

J. Patkowski (Proctor and Redfern)

R. Fitzgibbon)

J. Anderson) cover only

G. Sloan)

Files ↓

FOUNDATION INVESTIGATION REPORT

For

Three Cell Culvert Extension at Lock 3

W.P. 46-74-16, Site 18-248

Hwy. 406, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation carried out for the above project. Fieldwork consists of seven sampled boreholes and three dynamic cone penetration tests. As part of preliminary investigations for route alignment, boreholes were advanced at this site by Golder Associates in 1963 and by MTC personnel in 1971. Following the finalization of the route a detailed investigation consisting of a further five boreholes was undertaken in February, 1979. Hollow stem augers powered by a track mounted CME55 were employed for this latter investigation.

SITE DESCRIPTION

The site is situated on the floor of a broad valley in central St. Catharines approximately 600 feet south and east of the intersection of St. Paul and Ontario Streets. In this area the Old Welland Canal channel has been replaced by a three cell culvert which passes under the Glenridge Fill. Concrete retaining walls line the channel between the end of the culvert and a stone lock located approximately 100 feet downstream. The valley slopes are about 70 feet in height and are $2\frac{1}{2}$ horizontal to 1 vertical or flatter. They are lightly tree covered and act as an informal park and recreation area.

SUBSURFACE CONDITIONS

General

From the ground surface downward subsoil consists of 35 feet of stiff clayey silt to silty clay (the upper half of which is contaminated by organics) followed by 20 feet of hard silt to clayey silt of glacial origin. This layer is underlain by 45 feet of

compact silty sand to sandy silt which in turn is underlain by 5 feet of very dense sandy gravel. The sandy gravel overlies Queenston Shale bedrock which is 103 feet below the ground surface.

Reference should be made to the Record of Borehole Sheets which are contained in the Report Appendix. They show a summary of the results of all field and laboratory tests performed. Reference should also be made to Drawing 467416-A which shows the location and elevation of all borings, as well as an inferred subsoil stratigraphy.

Clayey Silt to Silty Clay

This layer extends from the surface to a depth of 34 feet with the upper 17 feet contaminated by organic material. The deposit has an undrained shear strength ranging from about 1000 to in excess of 2000 psf. Moisture content of the layer ranges from 20 percent to about 35 percent.

Silt to Clayey Silt

This layer underlies the clayey silt to silty clay and has a thickness of about 20 feet. It is reddish brown in colour and contains some sand and gravel. Standard Penetration 'N' values which range from 25 to 75 indicate a hard consistency and reflect the glacial origin of the layer. Moisture content of samples tested was approximately 10 percent.

Silty Sand to Sandy Silt

The silt to clayey silt is underlain by 45 feet of compact silty sand to sandy silt. Standard Penetration 'N' values for this layer range from 17 to 20. The moisture content is approximately 20 percent.

Sandy Gravel

This layer is only 5 feet in thickness and directly overlies bedrock. It is very dense as indicated by a Standard Penetration result of in excess of 100 blows per foot. The moisture content is approximately 5 percent.

Queenston Shale

Sound Queenston Shale bedrock was encountered at elevation 178, 103 feet below the ground surface.

Groundwater

Groundwater was encountered at approximate elevation 272 which was slightly above the water level in the adjoining open channel.

DESIGN CONSIDERATIONS

Proposal

To allow for the construction of the Hwy. 406 embankment it is proposed that the 3 cell culvert be extended on a line 28 degrees to the east of the alignment of the existing portion.

Recommendations

The culvert extension should be placed on a pad of granular A with a minimum thickness of 12 inches. The following parameters should be used to compute earth pressure for the culvert design which should make allowance for any surcharge loading.

Earth Fill
= 130 lb/ft³

Granular Backfill₃
= 145 lb/ft³

Coefficient of Earth Pressure
K_o = 0.5

Modulus of Vertical Subgrade Reaction
K_s = 10 kips/ft³

Modulus of Horizontal Subgrade Reaction
K_h = 2.5 kips/ft³

Settlement

Settlement of the culvert of up to 5 inches may be anticipated due to the embankment loading. The exposed end of the existing culvert will also settle due to an increase in loading. There will, however, be differential movement between the old and new culvert sections of several inches requiring a flexible joint at this location.

Slope Design

The embankment should be designed with a slope of 2 horizontal to 1 vertical and having a bench with a minimum width of 10 feet at approximate elevation 282. The channel slopes should be rip-rapped to design high water level to prevent erosion on the slope.

Subexcavation

Where the existing channel extends under the road bed of Hwy. 406 all soft alluvial deposits should be excavated and the channel backfilled with compacted select subgrade material. This granular

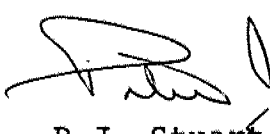
material should be placed to an elevation equal to the top of the channel walls to avoid poor compaction in this confined area. Excavation quantities should be estimated on the basis of removing a 5 foot layer of material.

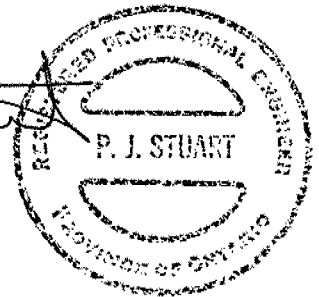
Dewatering


It will be necessary to employ sheeting to control water flow from the culvert during construction staging. There will not, however, be any further dewatering problem due to the relatively impervious nature of the subsoil. Seepage into the excavation may be controlled by pumping from sumps.

Water Quality

Water samples taken from the channel indicated the water was mildly corrosive. It is slightly acid and contains chloride and sulphate ions. It is not, however, considered to be necessary to use sulphate resistant cement.


P.J. Stuart, P. Eng.
Project Engineer




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

APPENDIX



RECORD OF BOREHOLE No 11

W P 46-74-16 LOCATION Coords. N 15 679 894; E 1 068 447 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY PJS
DATUM Geodetic DATE January 30 & 31, 1979 CHECKED BY GP

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		
281.9	Ground Level													
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	8		280							
			2	SS	11									
			3	SS	7									
			4	SS	6									
264.9			5	SS	5		270							
17.0	Clayey Silt to Silty Clay Stiff		6	SS	10									
			7	SS	6									
			8	SS	4									
247.9			9	SS	32		250							
34.0	Silt to Clayey Silt Some Sand and Gravel Hard Reddish Brown (Glacial Till)		10	SS	37									
			11	SS	34									
			12	SS	40									
228.9			13	SS	19		230							
53.0	Silty Sand to Sandy Silt Compact		14	SS	20									
			15	SS	17									
			16	SS	21									
			17	SS	20									
183.9			18	SS	100/8"		200							
98.0	Sandy Gravel, Some Silt (Glacial Till) Very Dense		19	SS	100/1"									
178.9			20	BXL RC	80% Rec.									
103.0	Queenston Shale													
171.8														
110.1	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 12

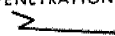











W P 46-74-16 LOCATION Coords. N 15 679 789; E 1 068 505 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers and Cone Test COMPILED BY PJS
DATUM Geodetic DATE February 1, 1979 CHECKED BY CP

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
282.5	Ground Level																
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	7		280										
			2	SS	3												
			3	TW	PH		270										
			4	TW	PH												
264.5																	
18.0	Clayey Silt to Silty Clay Stiff		5	TW	PH		260										
			6	TW	PH												
			7	TW	PH		250										
			8	SS	3												
244.5																	
38.0	Silt to Clayey Silt																
241.0	Hard (Glacial Till)		9	SS	28												
41.5	End of Borehole																



RECORD OF BOREHOLE No 13

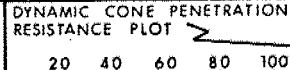
W P 46-74-16 LOCATION Coords. N 15 679 785; E 1 068 438 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE February 2, 1979 CHECKED BY CP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000										20 40 60		
281.3	Ground Level							20	40	60	80	100								
0.0	Fill Clayey Silt to Silty Clay Stiff to Very Stiff						280													
			1	SS	11															
			2	SS	9															
271.3			3	SS	5															
10.0	Organically Contaminated Clayey Silt Stiff		4	SS	4															
264.3																				
17.0	Clayey Silt to Silty Clay Stiff		5	SS	6															
			6	SS	6															
			7	SS	4															
247.3																				
34.0 244.8	Silt to Clayey Silt Hard (Glacial Till)		8	SS	25															
36.5	End of Borehole Note: Water Level Not Established																			



RECORD OF BOREHOLE No 14

W P 46-74-16 LOCATION Coords. N 15 679 842; E 1 068 336 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE February 2 & 5, 1979 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF					WATER CONTENT (%)				
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE x LAB VANE	400	800	1200	1600	2000	20		
284.0	Ground Level																
0.0	Fill Clayey Silt to Silty Clay Stiff		1	SS	5		280										
275.0			2	SS	4												
9.0	Organically Contaminated Clayey Silt to Silty Cl. Stiff		3	SS	5			+ 2									
270.0								+ 3									
14.0	Clayey Silt to Silty Clay Stiff		4	SS	14		270										
			5	SS	27												
			6	SS	11		260										
			7	SS	6												
			8	SS	6		250		+ 3								
245.0								+ 2									
39.0	Silt to Clayey Silt																
242.5	Hard (Glacial Till)		9	SS	26												
41.5	End of Borehole																
	Note: Water Level Not Established																



RECORD OF BOREHOLE No 15

W P 46-74-16 LOCATION Coords. N 15 679 748; E 1 068 355 ORIGINATED BY PJS
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY PJS
DATUM Geodetic DATE February 5, 1979 CHECKED BY EP.

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					
282.7	Ground Level																
0.0	Organically Contaminated Clayey Silt to Silty Clay Stiff		1	SS	9		280										
			2	SS	5												
270.7			3	SS	4		270										
12.0	Clayey Silt to Silty Clay Stiff		4	SS	13												
			5	SS	8		260										
			6	SS	7												
			7	SS	7		250										
			8	SS	5												
243.7																	
39.0	Silt to Clayey Silt																
241.2	Hard (Glacial Till)		9	SS	36												
41.5	End of Borehole Note: Water Level Not Established																

+3, x5: Numbers refer to
Sensitivity

20
15
10
5
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 123

W P 46-74-16 LOCATION Coords. N 15 679 978; E 1 068 451 ORIGINATED BY PK
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY AKB
DATUM Geodetic DATE November 24, 1971 CHECKED BY CP

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES		20	40	60	80	100					
303.0	Ground Level															
0.0	Fill, Clayey Silt to Silty Clay Trace of Sand and Gravel Stiff to Very Stiff		1	SS	8											
			2	TW	PH											
			3	SS	20											
281.0			4	TW	PH											
22.0	Clayey Silt to Silty Clay Trace of Sand and Gravel Hard to Stiff		5	SS	29											
			6	SS	57											
			7	SS	30											
			8	SS	28											
			9	TW	PH											
			10	TW	PH											
			11	TP	PH											
245.0			12	SS	59											
58.0	Silt to Clayey Silt Some Sand and Gravel Hard and Reddish Brown (Glacial Till)		13	SS	94											
236.5																
66.5	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 307

W P 46-74-16 LOCATION Coords. N 15 679 847; E 1 068 315 ORIGINATED BY Golder
 DIST 4 HWY 406 BOREHOLE TYPE Power Auger Boring COMPILED BY M.W.
 DATUM Geodetic DATE September 24, 1963 CHECKED BY CP

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
286.5	Ground Level																
0.0	Fill, Clayey Silt Some Sand and Gravel Stiff		1	SS	9	W.L. in standpipe @ elev. 278.5 Oct. 25/63 	280										
281.3			2	SS	5												
5.2	Organically Contaminated Clayey Silt to Silty Clay Stiff		3	TW	PH												
273.3			4	SS	17		270										
13.2	Clayey Silt to Silty Clay, Trace of Sand and Gravel Very Stiff		5	TW	PH												
			6	SS	22		260										
			7	TW	PH												
			8	SS	52		250										
248.0			9	SS	59												
38.5	Silt to Clayey Silt Some Sand and Gravel Reddish Brown Hard (Glacial Till)		10	SS	58		240										
			11	SS	56												
231.5							232										
55.0	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION

EXPLANATION OF TERMS USED IN REPORT

'N' VALUE: AN INDICATOR OF SUBSOIL QUALITY. IT IS OBTAINED FROM THE STANDARD PENETRATION TEST (CSA STD. A119.1). SPT 'N' VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 2 INCH O.D. SPLIT-BARREL SAMPLER TO PENETRATE 12 INCHES INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WEIGHING 140 POUNDS, FALLING FREELY A DISTANCE OF 30 INCHES. FOR PENETRATIONS OF LESS THAN 12 INCHES 'N' VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. 'N' VALUES CORRECTED FOR OVERBURDEN PRESSURE ARE DENOTED THUS N_c .

DYNAMIC CONE PENETRATION TEST (CSA STD. A119.3): CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (2" O.D. 60 CONE ANGLE) DRIVEN BY 350 FT-LB IMPACTS ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 12 INCH ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOIL QUALITY: SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSITY.

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

S_u (PSF)	0 - 250	250 - 500	500 - 1000	1000 - 2000	2000 - 4000	> 4000
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

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

'N' (BLOW/FT)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCK QUALITY: 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 DRILLED IN THAT CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE NATURALLY FRACTURED CORE PIECES, 4" 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	2"	2" - 12"	1' - 3'	3' - 10'	> 10'
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS & SYMBOLS

LABORATORY TESTING

TRIAXIAL TESTS ARE DESCRIBED IN TERMS OF WHETHER THEY ARE CONSOLIDATED (C) OR NOT (U) ISOTROPICALLY (I) OR NOT (A) AND SHEARED DRAINED (D) OR UNDRAINED (U) WITH PORE PRESSURE MEASUREMENTS (BAR OVER SYMBOLS) EG. C_{IU} = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

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

EARTH PRESSURE TERMS

μ COEFFICIENT OF FRICTION
 δ ANGLE OF WALL FRICTION
 k_o COEFFICIENT OF EARTH PRESSURE AT REST
 k_A COEFFICIENT OF ACTIVE EARTH PRESSURE
 k_P COEFFICIENT OF PASSIVE EARTH PRESSURE
 i ANGLE OF INCLINATION OF SURCHARGE
 w SLOPE ANGLE-BACKFACE OF WALL
 β ANGLE OF SLOPE
 N, N_q, N_c BEARING CAPACITY FACTORS
 D_f DEPTH OF FOOTING
 B, L FOOTING DIMENSIONS

INDEX PROPERTIES

γ UNIT WEIGHT OF SOIL (BULK DENSITY)
 γ_w UNIT WEIGHT OF WATER
 γ_d UNIT DRY WEIGHT OF SOIL (DRY DENSITY)
 γ' UNIT WEIGHT OF SUBMERGED SOIL
 G_s SPECIFIC GRAVITY OF SOLIDS
 e VOIDS RATIO
 e_o INITIAL VOIDS RATIO
 e_{max} e IN LOOSEST STATE
 e_{min} e IN DENSEST STATE
 D_r RELATIVE DENSITY = $\frac{e_{max} - e}{e_{max} - e_{min}}$
 n POROSITY
 w WATER CONTENT
 w_L LIQUID LIMIT
 w_P PLASTIC LIMIT
 w_S SHRINKAGE LIMIT
 I_P PLASTICITY INDEX = $w_L - w_P$
 I_L LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
 I_c CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
 A_c ACTIVITY = $\frac{I_P \text{ of soil}}{w_L - 2 \mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u \text{ (undisturbed)}}{S_u \text{ (remoulded)}}$

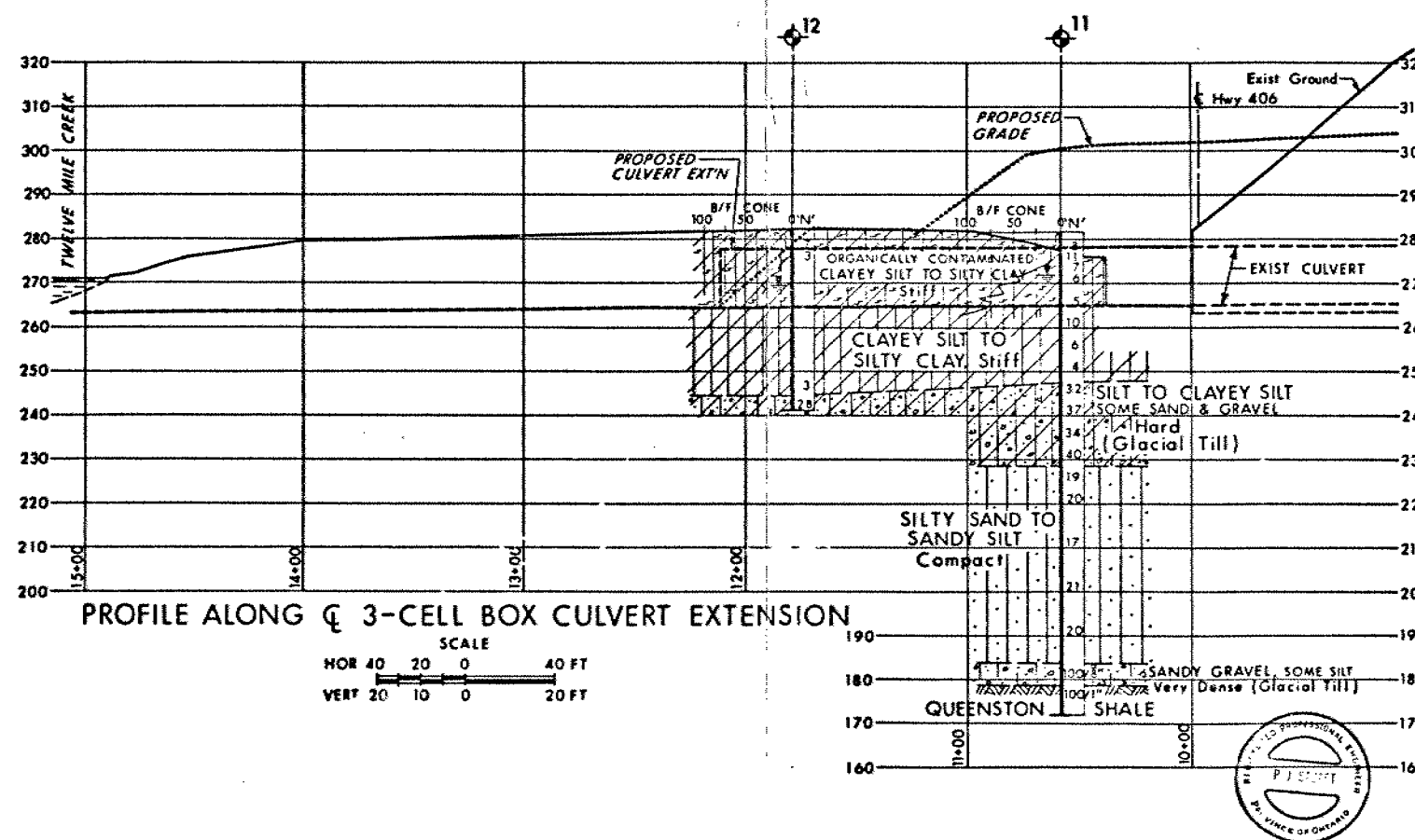
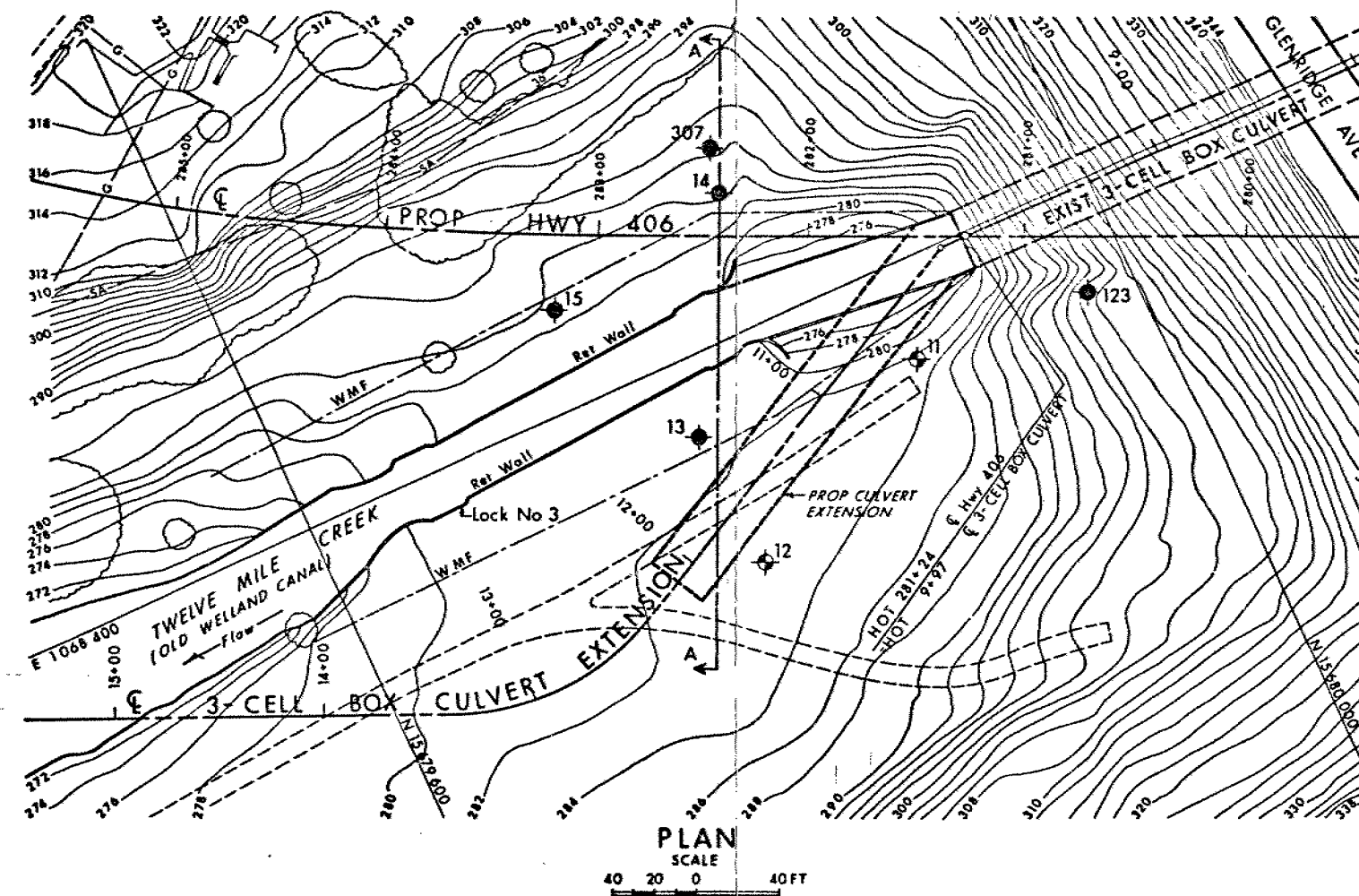
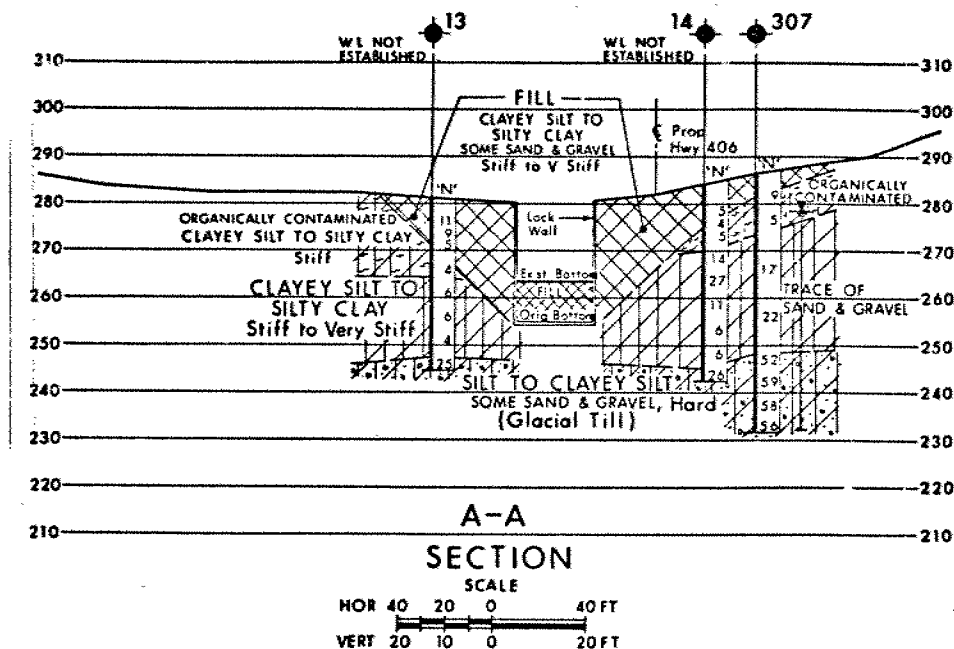
STRENGTH PARAMETERS

ϕ ANGLE OF SHEARING RESISTANCE
 τ_f PEAK SHEAR STRENGTH
 τ_R RESIDUAL SHEAR STRENGTH
 c COHESION INTERCEPT
 $\sigma_1, \sigma_2, \sigma_3$ NORMAL PRINCIPAL STRESSES
 u PORE WATER PRESSURE
 u_e EXCESS u
 r_u PORE PRESSURE RATIO
 q_u UNCONFINED COMPRESSIVE STRENGTH
 s_u UNDRAINED SHEAR STRENGTH
 ϵ LINEAR STRAIN
 γ SHEAR STRAIN
 ν POISSON'S RATIO
 E MODULUS OF ELASTICITY
 G MODULUS OF SHEAR DEFORMATION
 k_s MODULUS OF SUBGRADE REACTION
 m, n STABILITY COEFFICIENTS
 A, B PORE PRESSURE COEFFICIENTS

HYDRAULIC TERMS

h HYDRAULIC HEAD OR POTENTIAL
 q RATE OF DISCHARGE
 v VELOCITY OF FLOW
 i HYDRAULIC GRADIENT
 j SEEPAGE FORCE PER UNIT VOLUME
 η COEFFICIENT OF VISCOSITY
 k COEFFICIENT OF HYDRAULIC CONDUCTIVITY
 k_h k IN HORIZONTAL DIRECTION
 k_v k IN VERTICAL DIRECTION
 m_v COEFFICIENT OF VOLUME CHANGE
 c_v COEFFICIENT OF CONSOLIDATION
 C_c COMPRESSION INDEX
 C_r RECOMPRESSION INDEX
 d DRAINAGE PATH DISTANCE
 T_v TIME FACTOR
 U DEGREE OF CONSOLIDATION
 O_r OVERCONSOLIDATION RATIO (OCR)

NOTE: EFFECTIVE STRESS PARAMETERS ARE DENOTED BY USE OF APOSTROPHE ABOVE THE SYMBOL, THUS:
 ϕ' = EFFECTIVE ANGLE OF SHEARING RESISTANCE;
 σ' = EFFECTIVE NORMAL STRESS

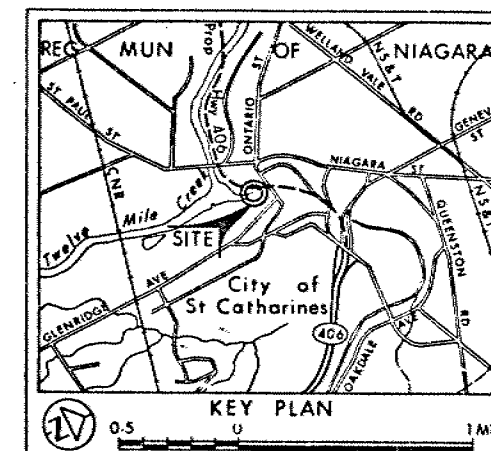


CONT No
WP No 46-74-16

3-CELL BOX CULVERT EXT'N
(AT LOCK No 3) (BRIDGE No 19)
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊙ Bore Hole & Cone
- N' Blows/ft (Std Pen Test 350ft lbs energy)
- CONE Blows/ft (60° Cone, 350ft lbs energy)
- ↓ WL at time of investigation Feb 1979
- ↓ WL for BH 307, Sept 1963
- ↓ WL Not Established in BH 13, 14 & 15
- ← WL in Standpipe shown thus

No	ELEVATION	CO-ORDINATES NORTH	EAST
11	281.9	15 679 894	1068 447
12	282.5	15 679 789	1068 505
13	281.3	15 679 785	1068 438
14	284.0	15 679 842	1068 336
15	282.7	15 679 748	1068 355
123	303.0	15 679 978	1068 451
307	286.5	15 679 847	1068 315

-NOTE-

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

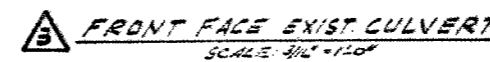
REVISIONS	DATE	BY	DESCRIPTION

Geocres No 30M3-167

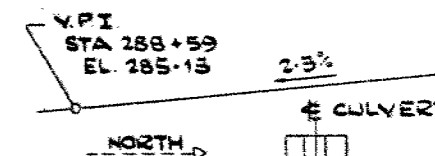
HWY No Prop 406
SUBMDP 15 CHECKED DATE June 27, 1979 SITE 18-248
DRAWN 15 CHECKED DATE 10-00 DWG 467416-A



BENCH MARK * 132 EL. 348.77

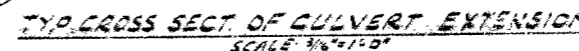


CLEAR COVER TO REINFORCING STEEL 3" AND/OR
 AS NOTED ON DRAWINGS.
 FILL SHALL BE PLACED ON BOTH SIDES OF THE
 CULVERT SIMULTANEOUSLY.



LIST OF DRAWINGS

- 4 GENERAL PLAN
5 BOREHOLE LOCATION
6 PROPOSED CONSTRUCTION STAGING
7 CULVERT REINFORCING I
8 CULVERT REINFORCING II
9 BRIDGE DATE & SITE NUMBER DATA
10 STANDARD DETAILS
8. Dwg 592-D-111
9. Dwg 592-D-112
10. Dwg 592-B-113
- EXISTING
CULVERT DETAILS



USE SCALE BELOW

10 1 12

3 INCHES ON ORIGINAL PLAN

REVISIONS				
DATE BY	DESCRIPTION			
DESIGN - J	CHECK	LOADING	DATE MAR	
DRAWING	CHECK	SITE No	DWG	



Memorandum

To: Mr. W. L. Lin,
Design Engineer/Central Section,
Structural Office,
2nd Floor, West Building.

From: Pav't. & Foundation Design Section,
Engineering Materials Office,
Room 315, Central Building.

Attention: Mr. A. J. Lee.

Date: 79 11 06

Our File Ref.

In Reply to

Subject:

Re: Three Cell Culvert Extension,
W.P. 46-74-16, Site 18-248,
Hwy. 406, District 4, Hamilton.

A review of the construction staging drawings for this project leads to the following comment. Due to the height of the temporary cut slope in the area of the existing culvert, the suggested temporary slope should be shown as 1.5 horizontal to 1 vertical rather than 1:1.

PJS/cy

P. J. Stuart,
Project Foundations Engineer.

c.c. Files ✓

Mr. G.C. Burkhardt
Head, Structural Section
Central Region
3501 Dufferin St., Downsview

Mr. M. Bendayan

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 05 10

Re: Retaining Wall, Three Cell Culvert Extension
W.P. 46-74-16, Site 18-248
Hwy. 406, District 4, Hamilton

Analysis of the preliminary plans for the retaining wall being considered to protect lock #3 shows the wall as proposed to be stable. Such a wall would require a piled foundation with the most likely alternative being H piles driven to bedrock at approximate elevation 180. Design loads could equal the structural capacity of the section chosen.



P.J. Stuart
Project Engineer

PJS/gs

cc: C. Rayman
Files /

memorandum



To: Mr. P.J. Stuart,
Project Engineer,
Soil Mechanics Section,
Central Building.

Date: 1979-04-06

Re: Three Cell Culvert Extension in St. Catharines
W.P. 46-74-16, Site 18-248
District 4, Hamilton

Pursuant to our telephone conversation of yesterday, attached please find a plan, a cross-section and elevation view of the high retaining wall proposed at subject site.

The purpose of this wall is to allow to expose part of the lock #3 of the former Welland Canal.

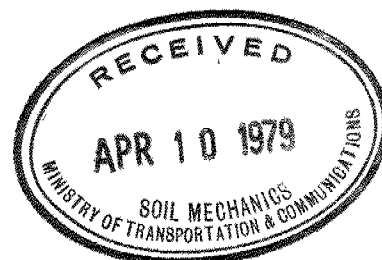
Would you please consider the feasibility of building such a structure and give us, accordingly, your recommendations.

A handwritten signature in cursive script, reading "M. D. Bendayan".

MDB:lc
Attach.

M. D. Bendayan,
Senior Structural Engineer,
for:
G.C.E. Burkhardt,
Head, Structural Section.

cc: C. Rayman
R. Fitzgibbon



Mr. G.C.E. Burkhardt
Head, Structural Section
Central Region
3501 Dufferin St., Downsview

Soil Mechanics Section
Engineering Materials Office
Room 315, Central Building

79 03 07

Mr. M.D. Bendayan

Re: Three Cell Culvert Extension
W.P. 46-74-16, Site 18-248
Hwy. 406, District 4, Hamilton

The field and a portion of the laboratory investigation for this site has been completed. Preliminary recommendations will be made in this memorandum to allow the design to proceed while a complete report is produced.

The Hwy. 406 embankment as shown in the attached figure should be constructed employing 2:1 slopes with a bench having a minimum width of 10 feet at the existing ground surface of approximately 282. The channel slopes should be rip-rapped to above high water level to prevent erosion. Where the existing channel extends under the road bed of Hwy. 406, all soft alluvial deposits should be excavated and the channel backfilled with compacted select subgrade material. This granular material should be placed to an elevation equal to the top of the channel walls to avoid poor compaction in this confined area.

The box culvert extension should be placed on a pad of granular 'A' of minimum thickness 12 inches and have a design loading not to exceed one ton per square foot above overburden pressure. Settlements of the culvert of up to five inches may be anticipated due to the embankment loading. The exposed end of the existing culvert will also settle due to the increase in loading. There will, however, be differential movement between the old and new culvert sections requiring a flexible joint at this point.

The following soil parameters should be used to compute earth pressures for the design of the culvert. The design should also take into account any surcharge loading.

Earth Fill

$$\gamma = 130 \text{ lb/ft}^3$$

Granular Backfill

$$\gamma = 145 \text{ lb/ft}^3$$

cont'd.....

Coefficient of Earth Pressure at Rest

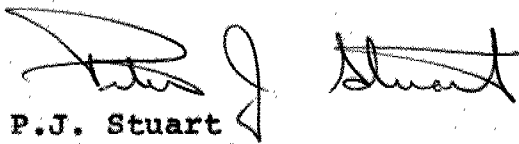
$$k_o = 0.5$$

Modulus of Vertical Subgrade Reaction

$$k_s = 10 \text{ kips/ft}^3$$

Modulus of Horizontal Subgrade Reaction

$$k_h = 2.5 \text{ kips/ft}^3$$



P.J. Stuart
Project Engineer

PJS/gs

Attach.

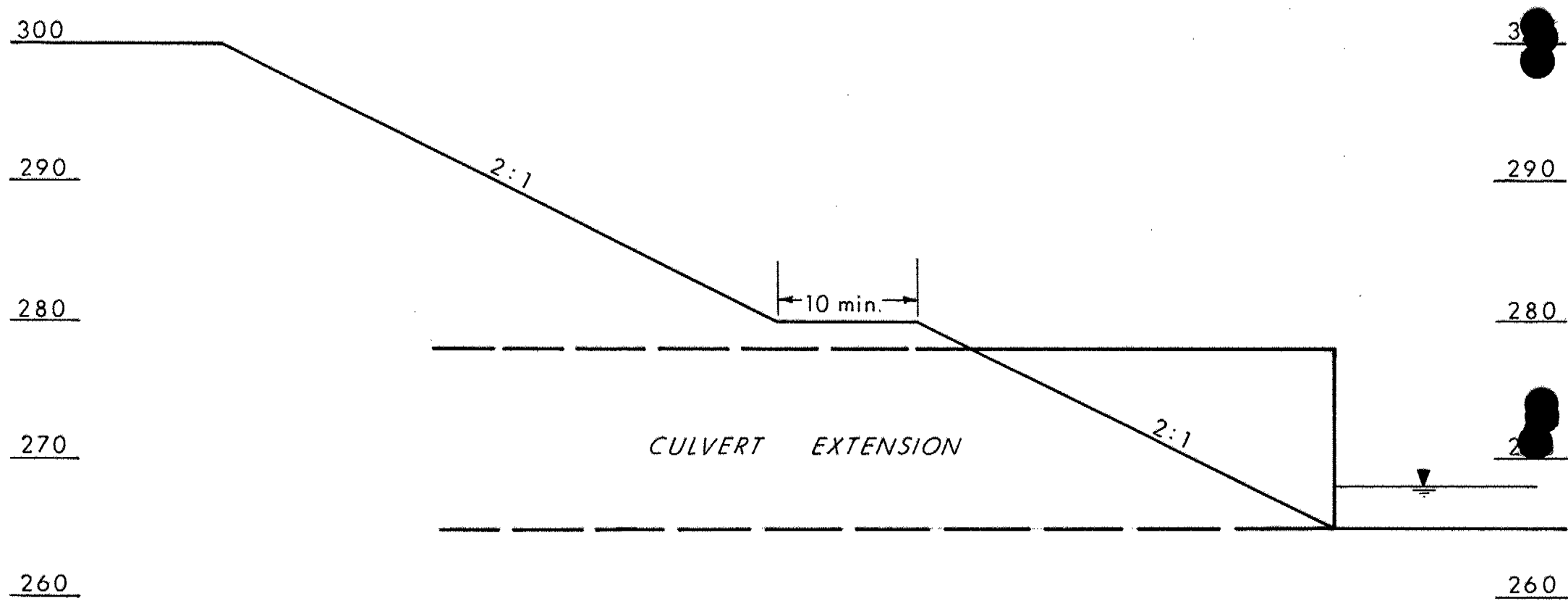
cc: Files ✓

W. Lin

J. Patkowski (Proctor & Redfern)

J. Anderson

D. Mullet



HIGHWAY 406, ST. CATHARINES
THREE CELL CULVERT EXTENSION
W.P. 46-74-16, SITE 18-248,
DISTRICT 4, HAMILTON

SUGGESTED SEQUENCE OF CONSTRUCTION

1. Place cofferdam on existing channel as shown in brown.
2. Divert water flow to west cell of existing culvert as shown in red arrows.
3. Construct stage 1 of new culvert and new channel as shown in red.
4. When stage 1 culvert and new channel are ready, dam the outlet of the west cell of new culvert and divert the water flow to centre cell and east cell of both the old and the new culvert as shown in blue arrows.
5. Remove piling in brown and place piling as shown in blue or use other temporary protection to serve as a dam to avoid the backflow from downstream.
6. Pump dry the area north of the new dam, so as to allow for construction of stage 2 of the new culvert as shown in blue, and start filling in the existing channel.
7. When stage 2 is ready, open all three cells and complete the filling.

