

GEOCRES No:

30M3-150A

ENGINEERING MATERIALS OFFICE
SOIL MECHANICS SECTION

WP 46-74-13/40/39

DIST 4

HWY 406

STR SITE 18-233A/B

Twelve Mile Creek Bridges
and Retaining Walls

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FOUNDATION INVESTIGATION REPORT

For

Twelve Mile Creek Bridges and Retaining Walls
W.P. 46-74-13/40/39, Site 18-233A/B
Hwy. 406, District 4, Hamilton

INTRODUCTION

This report contains the results of a foundation investigation for the above crossing including subsoil conditions and detailed recommendations for the design and construction of the 2 bridges and associated retaining walls to carry Hwy. 406 across Twelve Mile Creek. Fieldwork consisted of 53 boreholes in the general area carried out over the 15 year period 1963 to 1978. A number of the boreholes were related to proposals other than the one finally adopted and are presented only to indicate general subsoil conditions in the area.

SITE DESCRIPTION

The site is located in the valley of Twelve Mile Creek in the western part of the City of St. Catharines. The valley is from 1/4 to 1/2 mile in width with its floor 70 to 80 feet below the surrounding tableland. The natural slopes are gentle ranging from 2.5:1 to 3:1 and are mostly tree covered.

In 1829 man started his modification of the valley by raising the water level of Twelve Mile Creek to construct the first Welland Canal. Its use as a route for water transport continued for approximately 100 years. Gradually the canal's use switched to that of a disposal channel for water used for hydraulic power generation at the escarpment. In the late 1940's a hydraulic dredge was used to widen the old canal so that today it is a fast flowing channel 180 to 200 feet in width carrying approximately 7000 cfs diverted from the Niagara River.

SUBSURFACE CONDITIONS

General

Subsoil consists of a deposit of silty clay to clayey silt varying in thickness from zero in the vicinity of the stream to 70 feet at the crest of the valley slope. This deposit is underlain by red silt to clayey silt of glacial origin. It forms the stream bed for Twelve Mile Creek and varies in thickness from about 10 feet under the channel to 25 to 30 feet where no erosion has taken place. This layer is in turn underlain by Queenston Shale bedrock which varies in surface elevation from 240 to 245. In the vicinity of the stream there are local deposits of up to 15 feet of organic silt and sand.

Reference should be made to the Record of Borehole Sheets which are contained in the report Appendix. They show the boundaries between different soil types, as well as a summary of the results of all field and laboratory tests performed. Reference should also be made to drawings 18-233-2X/2Y/2Z which show location and elevation of the borings, together with profiles and sections showing inferred subsoil stratigraphy. More detailed descriptions of the major soil types encountered are given below.

Clayey Silt to Silty Clay

This stratum extends from approximate elevation 270 to 340 and is, therefore, exposed in the valley slopes. The upper 15 to 20 feet of material forms a desiccated crust. It is brown in colour with a moisture content of about 20 percent. The undrained shear strength which ranges from 2000 to 5000 psf is deceptive in that the material is highly fissured. Beneath the crust there is a transition in colour from brown to grey and an increase in moisture content to about 30 percent. The undrained shear strength decreases and varies from 1000 to 2500 psf. Atterberg Limit Tests as shown in Figure 1 of the Appendix show the deposit to be of low to medium plasticity.

Silt to Clayey Silt

This deposit lies between the silty clay to clayey silt deposit and the underlying bedrock. In thickness it varies from 10 feet under the stream channel to from 25 to 30 feet where no removal by erosion has taken place. It is of glacial origin and consists of

silt with lesser quantities of sand, clay and gravel. The origin of the material is primarily the underlying Queenston Shale which gives it a characteristic red colour. The lower portion of the deposit is composed almost entirely of shale fragments which have been compressed together to form a breccia or shale till. As shown on the log sheets, this shale till was on occasion cored and partially recovered employing both NXL and NV3 corebarrels. The deposit is hard to very dense with Standard Penetration 'N' values generally in excess of 100 blows per foot. Atterberg Limit Tests as shown in Figure 2 indicate a low plasticity generally in the silt to clayey silt transition zone. The natural moisture content is below the plastic limit and ranges from 8 to 12 percent.

Organic Silt and Sand

This deposit is found between the toe of the valley slope and the stream channel. It has built up outside the channel by a combination of natural deposition in areas flooded to construct the original Welland Canal and through filling both by dredging from the channel and as a dumping area for surplus material from construction projects in the area. The single largest source of material was Ontario Hydro's use of a hydraulic dredge to widen and deepen the channel in the late 1940's. This has led to a highly variable deposit with some layers being sandy enough to be non-plastic while other layers show considerable plasticity. The undrained shear strength is judged to vary from 500 psf to in excess of 1000 psf. Moisture contents vary from 20 to 40 percent.

Queenston Shale

Queenston shale bedrock was encountered under the till layer between elevations 240 and 245. It is red in colour and dips gently toward the south. The shale is generally sound but in places the upper 2 or 3 feet shows some weathering. Periodic limestone beds generally having a thickness of less than 3 inches but occasionally reaching a foot were encountered.

Groundwater

Groundwater levels were observed and recorded in the open boreholes during periods of fieldwork. In the area of organic silt and sand adjacent to the channel, water levels were equal to or slightly above the water level in the channel. Water levels recorded in

boreholes on the valley slopes are less reliable due to the relatively imperviousness of the silty clay to clayey silt. However, based on this information, combined with groundwater records from the area of the Burgoine Bridge, it is assumed that the groundwater surface is 15 to 20 feet below ground surface at the crest of the valley with drainage toward Twelve Mile Creek following the general topography of the slope.

Design Considerations

In passing through St. Catharines, Hwy. 406 follows the valley of Twelve Mile Creek for some distance before crossing the channel and climbing out of the valley. A crossing scheme is required which avoids fill encroaching on the channel while also minimizing cuts on the valley slopes for stability and property reasons. Because of the narrowness of the valley in the area of the crossing it is necessary for the SBL's to stay on structure and run up the valley some 800 feet while projecting over the water. This leads to the SBS having 6 spans while the NBS has only 3 spans and an associated retaining wall paralleling the shore. A further requirement is that all pier footings be buried in the channel bed to minimize restrictions to the capacity of the channel.

RECOMMENDATIONS

Bridge Foundations

Concrete Caissons: Any or all of the pier footings may be supported on concrete caissons socketed into the bedrock with a design load of 70 tons per square foot. The base elevation of the caissons will be 232 for Piers 1 and 2 of the SBS; 238 for Pier 3 of the SBS; and 240 for the remainder of the piers. A tremie design will be employed in all cases. This will require that the caisson excavations be examined by means of an underwater camera. A consultant specialist should be employed to carry out this assignment.

Steel H Piles: The abutments may be supported on steel H piles driven into the hard to very dense silt to clayey silt layer. A design load of 100 tons per pile should be used for a 74 pound section with driving controlled by SS3-11. Estimated tip elevations are as follows:

NBS	North Abutment - 245
	South Abutment - 245
SBS	North Abutment - 245
	South Abutment - 240

Piers 1, 2 and 3 of the SBS may be supported on steel H piles driven to bedrock. In this case the design load may be increased to 120 tons for a 74 pound section. Estimated tip elevations are as follows:

	Elevation
SBS Pier 1 -	238
2 -	238
3 -	244

In all cases the pile tips should be reinforced by standard flange plates to protect against damage by limestone boulders in the till layer, as well as to increase the contact area between the pile and the bearing stratum.

Spread Footings: Spread footings founded on the hard silt to clayey silt till may be loaded to 6 tons per square foot. Resistance to sliding may be calculated using 0.45 as a coefficient

of friction. Listed below are the highest elevations at which footings may be founded:

NBS	North Abutment	- 265
	South Abutment	- 262
SBS	North Abutment	- 265
	Pier 1	- 252
	2	- 252
	3	- 254

The base of the footing should be covered by 6 inches of mass concrete within 4 hours of the footing being dug to grade to prevent softening of the base due to exposure to seepage water.

Spread footings on the sound shale bedrock may be designed for a load of 10 tons per square foot. Resistance to sliding may be calculated employing a coefficient of friction of .45. Elevations at which footings may be constructed are listed below:

Elevation		
NBS	Pier 1	- 245
	2	- 245
SBS	Pier 2	- 237
	3	- 244
	4	- 245
	5	- 245

After dewatering the footing excavation and cleaning the rock surface, 12 inches of mass concrete should be placed to protect the rock from deterioration. As a precaution against uplift 2 inch diameter pipes should be placed through the slab of 6 foot centers to act as relief wells.

Dewatering

Where the footings are located completely within the channel of 12 Mile Creek, dewatering to construct the footings in the dry may be accomplished either within prefabricated steel boxes or interlocking sheet piling.

If steel boxes are employed the following procedure should be adopted. Excavate underwater to the footing formation level and place within this excavated hole a suitable sized prefabricated steel box. Seal around the outside of the box and backfill to a convenient level prior to unwatering.

If interlocking steel piling is employed to construct cofferdams the driving of the sheeting through the overburden and weathered shale is likely to be very difficult because of the hardness of the strata. In such a case it is likely that driving the sheeting and excavating the material within will have to be done simultaneously.

Where piers are located partly within 12 Mile Creek and partly on land, dewatering can be achieved by the construction of cofferdams either of earth or interlocking steel piling. As noted previously, driving of the sheeting through the very hard till strata will be difficult and may require simultaneous excavation within the sheeting.

Retaining Wall Alternatives

(formerly 3, 5 & 6)

Reinforced Earth: Retaining walls 12, 13 and 15 may be constructed of reinforced earth with the design based on the following criteria.

1. The thickness of the reinforced zone may be assumed to be 80% of the wall height with the minimum thickness being 14 feet.
2. The backfill material in the reinforced zone should be granular C which may be assumed to have the following properties:

$$\gamma = 135 \text{ pcf}$$

$$\phi = 30^\circ$$

3. Backfill behind the reinforced zone may be any acceptable earth fill. For design purposes the following properties should be assumed:

$$\text{Cohesive Soil } \gamma = 130 \text{ pcf}$$

$$C = 500 \text{ psf}$$

$$\phi' = 25$$

$$c' = \text{zero}$$

Non-Cohesive Soil $\gamma = 135$
 $\phi = 30$

Bin Wall: Retaining walls 12, 13 and 15 may also be constructed as bin walls. If this alternative is chosen the following design parameters apply:

1. Backfill within the bins is to be granular A
2. Backfill to the bin wall should be as per SD-4-58.
3. To calculate resistance to sliding the wall must be considered in 2 parts. In areas where the wall will rest on select subgrade material used to backfill organic excavations, a coefficient of friction of 0.5 will apply. Where the wall rests on original ground which is primarily clayey silt, resistance to sliding will be the lesser of a coefficient of friction of 0.4 or adhesion of 2000 psf. The wall should be designed with a minimum safety factor against sliding of 1.5.

Reinforced Concrete Walls

Spread Footings: Retaining wall 14 may be supported on spread footings on the clayey silt to silty clay with a design load of up to 2 tons per square foot. Resistance to sliding may be calculated using an adhesion value of 1500 psf between the footing and the underlying soil. (formed, S)

Retaining wall 15 may be supported on spread footings founded in the hard silt to clayey silt till with a design load of up to 6 tons per square foot. Resistance to sliding may be calculated using a coefficient of friction of 0.45. The base of the footing should be covered with 6 inches of mass concrete within 4 hours of the footing being dug to grade to prevent softening of the underlying soil.

Steel H Piles: All of the retaining walls have the alternative of being founded on steel H piles driven into the hard silt to clayey silt till layer. Piles with a 74 pound section will support a design load of up to 100 tons with driving controlled by SS-3-11. The pile tips should be reinforced by standard flange plates to prevent damage on boulders in the till layer and to increase contact area between the pile tip and the bearing stratum. It

is estimated the design loads will be achieved at the following elevations:

	Elevation
Retaining Wall #12	245
13	245
14	250
15	245

Organic Excavation

Retaining walls 12 and 13, as well as the south abutment of the SBS, will be constructed partly in an area of organic silt and sand. To ensure the stability of these structures it will be necessary to excavate this deposit for its full depth from the toe of the valley slope to 10 feet in front of the structure involved. This excavation will be backfilled to elevation 270 with select subgrade material. The quantities involved may be estimated from profiles shown on Drawing 18-233-2Z, as well as the typical section shown in Figure 3 of the Appendix. To minimize differential settlement of the walls between excavated and non-excavated areas, the ends of the excavation should be tapered over the final 50 feet.

Settlements

Settlements of footings founded on caissons, piles or as spread footings on rock or hard silt to clayey silt till will be less than 1 inch. What settlement does take place will be elastic in nature taking place during the loading process.

Settlement of retaining wall 14 if founded on spread footings on the silty clay to clayey silt will not exceed 2 inches.

If retaining walls 12, 13 and 15 are built employing reinforced earth or bin wall construction, the settlement will be greater. Where the walls are on original ground they will settle up to 3 inches during and following construction. Where the walls are founded on granular backfill to organic excavation the settlement will take place during construction. It will be proportional to the depth of excavation and may amount to as much as 15 inches where

the depth of excavations is a maximum. The amount of settlement will decrease to zero as the depth of excavation decreases.

Earth Pressure

The following design parameters for granular backfill to walls and abutments should be used for calculating earth pressure.

Granular A

$$\gamma = 145$$

$$K_a = 0.25$$

$$K_o = 0.36$$

Granular B and C

$$\gamma = 135$$

$$K_a = 0.33$$

$$K_o = 0.50$$

Walls and abutments founded on end bearing piles should be considered rigid and K_o values employed. Some movement may be expected with spread footings so K_a values may be used.

The use of heavy vibratory rollers will be restricted behind conventional concrete walls and abutments as outlined in CR-78-22. Compaction behind reinforced earth walls will be as specified by the Reinforced Earth Company Ltd.

Frost Protection

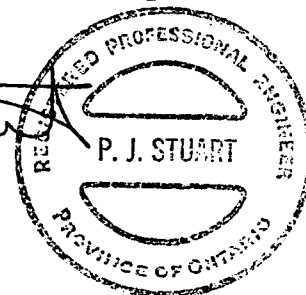
All footings or pile caps including the base of the reinforced earth or bin walls should be protected by a minimum of 4 feet of cover.

Channel Widening

If the proposed channel widening in the area of the north abutments is constructed with slopes of 2.5 horizontal to 1 vertical, no slope instability will result. These new cut slopes along with 5 feet of the channel bottom should immediately be protected by rip-rap to prevent any undercutting of the slope.

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

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



December, 1978

APPENDIX



RECORD OF BOREHOLE No 12 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,467; E 1,065,438 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger COMPILED BY P.S.
DATUM Geodetic DATE August 31, 1977 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					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE					20 40 60				
270.4	Ground Level						270										
0.0	Rock Rip-Rap																
267.4																	
3.0	Grey Clayey Silt		1	SS	10												
	Stiff		2	SS	14												
260.4			3	SS	100/	11"	260									8 30 52 10	
10.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		4	SS	100/	7"											
			5	SS	138/	10"	250										
			6	SS	100/	9"											
245.4			7	SS	100/	9"											
25.0	Queenston Shale		8	SS	100/	6"											
			9	SS	100/	1"	240										
237.8			10	SS	50/	1"											
32.6	End of Borehole Note: Water Level Not Established																

RECORD OF BOREHOLE No 13 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,472; E 1,065,438 ORIGINATED BY P.S.
 DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers and NV3 Core COMPILED BY P.S.
 DATUM Geodetic DATE September 1 & 2, 1977 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										WATER CONTENT (%)		
								SHEAR STRENGTH ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE												
270.4	Ground Level						270													
0.0	Rock Rip-Rap																			
267.4																				
3.0	Grey Clayey Silt																			
	Stiff																			
260.4							260													
10.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard Glacial Till																			
			1	SS	100% Rec															
			2	NV3	95% Rec															
			3	RC NV3	75% Rec		250													
245.4																				
25.0	Queenston Shale		4	RC NV3	90% Rec															
			5	RC NV3	100% Rec		240													
			6	RC NV3	100% Rec															
			7	RC NV3	95% Rec		230													
225.3																				
45.1	End of Borehole																			
	Note: Water Level Not Established																			

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 14 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,607; E 1,065,149 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and NV3 Core COMPILED BY P.S.
DATUM Geodetic DATE September 6, 1977 CHECKED BY dp.

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					20 40 60				
								○ UNCONFINED	+ FIELD VANE								
								● QUICK TRIAXIAL	x LAB VANE								
272.6	Ground Level																
0.0	Rock Rip-Rap						270										
268.6																	
4.0	Grey Organic Silt and Sand		1	SS	5										Om		
			2	SS	10										2.8%		
260.6	Firm		3	SS	14		260										
12.0	Clayey Silt to Silty Clay, Stiff to Very Stiff		4	SS	8										Om		
			5	SS	9										0.15%		
254.1			6	SS	13										Om		
18.5	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		7	SS	100/ 6"		250								3.4%	0 23 64 13	
			8	SS	100/ 8"												
			9	SS	100/ 10"												
244.2			10	RC	65% NV3 Rec												
28.4	Queenston Shale		11	RC	92% NV3 Rec		240										
			12	RC	90% NV3 Rec												
			13	RC	92% NV3 Rec												
230.1																	
42.5	End of Borehole																
	Note: Water Level Not Established																



RECORD OF BOREHOLE No 15 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,738; E 1,065,995 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE May 29, 1978 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			20 40 60 80 100						
271.4	Ground Level												
0.0	Rock Rip-Rap					270	Auger Through Rip-Rap						
267.9													
3.5	Grey Organic Silt and Sand		1	SS	4								
			2	SS	2								
			3	SS	1								
	Soft to Firm		4	SS	3								
256.4						260							
15.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		5	SS	40								
			6	SS	109								
			7	SS	124/ 8"								
			8	SS	125/ 9"								
236.9			9	SS	105/ 7"	240							
34.5	End of Borehole Note: Water Level Not Established												

RECORD OF BOREHOLE No 16 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,760; E 1,066,005 ORIGINATED BY J.A.
 DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
 DATUM Geodetic DATE May 30, 1978 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									
							20	40	60	80	100						
269.9	Ground Level																
0.0	Clayey Silt		1	SS	7												
	Stiff																
260.9			2	SS	23												
9.0	Sandy Silt		3	SS	28												
	Compact to Very Dense																
253.5			4	SS	104/	10"											
16.4	End of Borehole																

+³, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 17 S

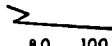
W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,864; E 1,065,899 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Augers BXL Core and Cone Test COMPILED BY P.S.
DATUM Geodetic DATE May 30, 1978 CHECKED BY [Signature]

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 (%)		
								20 40 60 80 100										20 40 60		
							O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000													
270.8	Ground Level						270	Auger Through Rip-Rap												
0.0	Rock Rip-Rap																			
266.3																				
4.5	Grey Organic Silt and Sand Soft to Firm		1	SS	3															
			2	SS	2															
			3	SS	3															
255.3			4	SS	42															
15.5	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		5	SS	110															
			6	SS	110/12"															
			7	SS	104/10"															
239.8			8	SS	100/6"															
31.0	Weathered Queenston Shale Limestone Beds 42'5" to 43'7"		9	BXL Core	25% Rec															
			10	BXL Core	100% Rec															
226.8			11	BXL Core	100% Rec															
44.0	End of Borehole																			



RECORD OF BOREHOLE No 18 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,057; E 1,065,737 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE N Casing and BXL Core COMPILED BY P.S.
DATUM Geodetic DATE May 31, 1978 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			20	40	60	80	100					
265.6	Water Level															
0.0	Water															
261.6	Channel Bottom															
4.0	Grey Organic Silt and Sand Soft to Firm		1	SS	3	260										
			2	SS	4											
			3	SS	3											
253.6			4	SS	18											
12.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		5	SS	100/8"	250										
			6	BXL Core	40% Rec											
			7	BXL Core	17% Rec											
240.6			8	BXL Core	45% Rec	240										
25.0	Weathered Queenston Shale Limestone Beds 36'5" to 37'9"		9	BXL Core	95% Rec											
			10	BXL Core	88% Rec	230										
227.9																
37.7	End of Borehole															

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 195

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,889; E 1,065,923 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE May 31, 1978 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			20	40	60	80	100					
270.8	Ground Level																
0.0	Grey Organic Silt and Sand Soft to Firm		1	SS	5		270										
			2	SS	1												
			3	SS	2												
			4	SS	5		260										
257.2			5	SS	19												
255.7	Silt, Compact to V.Dense		6	SS	100/1"												
15.1	End of Borehole Note: Water Level Not Established																



RECORD OF BOREHOLE No 20S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,856; E 1,065,951 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE May 31, 1978 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					
269.6	Ground Level													
0.0	Grey Organic Silt and Sand Soft to Firm		1	SS	5									
262.6			2	SS	3									
7.0	Brown Clayey Silt		3	SS	11									
257.6	Stiff													
12.0	Red Sandy Silt		4	SS	106									
254.0	Very Dense		5	SS	100/7"									
15.6	End of Borehole													



RECORD OF BOREHOLE No 215

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,975; E 1,065,849 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE May 31, 1978 CHECKED BY JP.

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						
270.9	Ground Level							20 40 60 80 100							
0.0	Rock Rip-Rap						270								
265.4															
5.5	Grey Organic Silt and Sand Soft to Firm		1	SS	1										
			2	SS	2		260								
			3	SS	2										
252.9															
18.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel, Very Dense to Hard (Glacial Till)		4	SS	120		250								
244.9			5	SS	105	5"									
26.0	End of Borehole Note: Water Level Not Established														



RECORD OF BOREHOLE No 22 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,797; E 1,065,991 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 8, 1978 CHECKED BY [Signature]

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 (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
270.4	Ground Level						270					
0.0	Clayey Silt		1	SS	9							
	Stiff		2	SS	11							
261.4			3	SS	68		260					
9.0	Sandy Silt											
257.4	Very Dense											
13.0	Red Silt to Clayey											
254.4	Silt, Very Dense to Hard		4	SS	107							
16.0	End of Borehole											

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 23 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,027; E 1,065,800 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 1, 1978 CHECKED BY [Signature]

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								
270.3	Ground Level												
0.0	Rock Rip-Rap						270	Auger Through Rip-Rap					
265.3													
5.0	Probable Organic Silt and Sand						260						
257.3													
13.0													
253.3													
17.0	End of Cone Test												

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 24 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,075; E 1,065,769 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 1, 1978 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					
270.4	Ground Level																
0.0	Rock Rip-Rap						270										
266.4																	
4.0	Grey Organic Silt and Sand Soft to Firm		1	SS	4												
			2	SS	2												
			3	SS	2												
256.9			4	SS	100/10"												
17.2			5	SS	100/9"												
254.7	Red Silt to Clayey Silt																
15.7	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

15 \diamond 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 255

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,067; E 1,065,749 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger COMPILED BY J.A.
DATUM Geodetic DATE June 1, 1978 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			SHEAR STRENGTH PSF										WATER CONTENT (%)		
								20 40 60 80 100										20 40 60		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE													
269.6	Ground Level																GR SA SI CL			
0.0	Rock Rip-Rap																			
265.6																				
4.0	Grey Organic Silt and Sand Soft to Firm		1	SS	3		260	+5.3									0 55 31 14			
			2	SS	1			+3.0												
			3	SS	3			+1.7												
253.6																				
16.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		4	SS	100/ 11"		250													
			5	SS	100/ 9"															
			6	SS	108															
			7	SS	100/ 10"															
			8	SS	105/ 9"															
240.6																				
29.0	Queenston Shale		9	SS	100/ 6"		240													
			10	SS	100/ 4"															
234.4																				
			11	SS	75/ 2"															
35.2	End of Borehole																			

+3, x⁵ : Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 26 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,244; E 1,065,560 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE N Casing and BXL Core COMPILED BY P.S.
DATUM Geodetic DATE June 1 & 2, 1978 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			20	40	60	80	100					
265.6	Water Level																
0.0	Water																
258.8	Channel Bottom						260										11 32 50 7
6.8	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		1	SS	44	6"											
			2	SS	75/												
			3	SS	100/	5"											
			4	SS	100/	7"	250										
			5	SS	100/	6"											
243.6			6	SS	100/	4"											
22.0	Queenston Shale Limestone Bed 25'4" to 26'0"		7	SS	100/	1"	240	Corebarrel Blocked									
			8	BXL	100%												
			9	BXL Core	95% Rec												RQD = 77%
			10	BXL Core	88% Rec												RQD = 100%
230.6																	
35.0	End of Borehole																

RECORD OF BOREHOLE No 27 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,988; E 1,065,874 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 5, 1978 CHECKED BY CP

[illegible]

+3, x5 : Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 28 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,045; E 1,065,825 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 5, 1978 CHECKED BY [Signature]

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							
272.3	Ground Level											
0.0	Probable Organic Silt and Sand						270					
262.3												
10.0							260					
258.4									100/11"			
13.9	End of Cone Test											



RECORD OF BOREHOLE No 29S

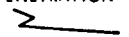



W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,172; E 1,065,675 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 5, 1978 CHECKED BY JP

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	Rock Rip-Rap													
267.5														
2.5	Grey Organic Silt and Sand		1	SS	7									
			2	SS	6									
261.0	Firm		3	SS	3									
9.0	Red Silt to Clayey Silt, Very Dense to Hard (Glacial Till)		4	SS	85									
256.4			5	SS	105/7"									
13.6	End of Borehole													



RECORD OF BOREHOLE No 30 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,249; E 1,065,583 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and NV3 Core COMPILED BY P.S.
DATUM Geodetic DATE June 5 & 6, 1978 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										20 40 60		
272.2	Ground Level																			
0.0	Rock Rip-Rap						270													
268.7																				
3.5	Silt to Clayey Silt Some Sand		1	SS	12															
263.2	Compact		2	SS	13															
9.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard		3	SS	100/	8"										2 41 46 11				
			4	SS	100/	8"										3 21 66 10				
			5	SS	100/	6"														
	(Glacial Till)		6	NV3	0% Rec															
			7	NV3	30% Core Rec		250													
244.2			8	NV3	90% Core Rec															
28.0	Queenston Shale		9	NV3	95% Core Rec		240									RQD = 33%				
238.2																				
34.0	End of Borehole Note: Water Level Not Established																			



RECORD OF BOREHOLE No 315

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,427; E 1,065,410 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE N Casing and NXL Core COMPILED BY P.S.
DATUM Geodetic DATE June 5 & 6, 1978 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					
265.6	Water Level																GR SA SI CL
0.0	Water																
259.9	Channel Bottom						260										18 26 49 7
5.7	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		1	SS	50								o				3 26 63 8
			2	SS	100/	5"							o				
			3	SS	100/	5"											
			4	SS	100/	5"											
246.6			5	NXL RC	65% Rec		250										RQD = 13%
19.0	Queenston Shale		6	NXL RC	100% Rec												RQD = 48%
			7	NXL RC	100% Rec		240										RQD = 81%
			8	NXL RC	85% Rec												RQD = 48%
230.0																	
35.6	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 32 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,398; E 1,065,497 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 6, 1978 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					
270.9	Ground Level																
0.0	Clayey Silt Some Sand Trace of Organics Stiff		1	SS	8		270										
263.9			2	SS	9												
7.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel, Very Dense to Hard (Glacial Till)		3	SS	106												
			4	SS	1007	11"	260										6 26 62 6
255.0			5	SS	1007	10"											22 26 42 10
15.9	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 33 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,212; E 1,065,644 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 7, 1978 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			20	40	60	80	100					
271.6	Ground Level																
0.0	Silt With Fine Sand						270										
	Compact		1	SS	17												
262.6			2	SS	28												
9.0	Red Silt To Clayey Silt, Some Sand		3	SS	100/	11"	260										
256.1	Trace of Gravel Very Dense to Hard		4	SS	100/	5"											
15.5	End of Borehole																



RECORD OF BOREHOLE No 34 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,421; E 1,065,522 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 6, 1978 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			20 40 60 80 100							
								SHEAR STRENGTH							

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 35 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,389; E 1,065,488 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 6, 1978 CHECKED BY *JP*

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					NATURAL MOISTURE CONTENT			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	PLASTIC LIMIT W _p	W	LIQUID LIMIT W _L		
271.7	Ground Level																
0.0	Rock Rip-Rap																
267.7																	
4.0	Probable Clayey Silt																
261.7																	
10.0	End of Cone Test																



RECORD OF BOREHOLE No 36 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,352; E 1,065,524 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Hollow Stem Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 6, 1978 CHECKED BY CP

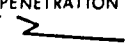


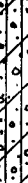

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH PSF O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
273.7	Ground Level												
0.0	Rip-Rap												
270.2													
3.5	Silt to Clayey Silt Some Sand Loose to Compact		1	SS	7		270						
			2	SS	11								
262.7			3	SS	15/	3"							
11.0	Red Silt to Clayey Silt, Very Dense to Hard (Glacial Till)		4	SS	100/	11"							
258.2			5	SS	100/	5"	260						
15.5	End of Borehole												

3.3
100/9"
Splitspoon bouncing on stone



RECORD OF BOREHOLE No 37 S

W P 46-74-13, 40 & 39 LOCATION Coor'ds. N 15,680,520; E 1,065,382 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE N Casing and NXL Rockcore COMPILED BY P.S.
DATUM Geodetic DATE June 8 & 9, 1978 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										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										20 40 60		
265.6	Water Level																			
0.0	Water																			
260.1	Channel Bottom						260													
5.5	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		1	SS	51															
			2	SS	100/	7"														
			3	SS	100/	5"														
			4	SS	100/	4"														
			5	SS	78/	6"														
245.6																				
20.0	Queenston Shale Limestone Beds 31'6" to 31'8" 32'5" to 32'10" 34'0" to 34'2" 35'5" to 36'2"		6	NXL RC	90% Rec															
			7	NXL	100%															
			8	NXL RC	88% Rec															
			9	NXL RC	100% Rec															
			10	NXL RC	94% Rec															
225.0																				
40.6	End of Borehole																			



RECORD OF BOREHOLE No 38 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,653; E 1,066,107 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 8, 1978 CHECKED BY [Signature]

[illegible]

+3, x5: Numbers refer to Sensitivity

15 ϕ 5 (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 395

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,684; E 1,066,065 ORIGINATED BY P.S.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 8, 1978 CHECKED BY [Signature]

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								
274.2	Ground Level												
0.0							270						
258.3							260						
15.9	End of Cone Test												



RECORD OF BOREHOLE No 415

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,582; E 1,065,215 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE N Casing and NXL Core COMPILED BY P.S.
DATUM Geodetic DATE June 13, 1978 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					
265.6	Water Level																
0.0	Water																
254.6	Channel Bottom																
11.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		1	SS	27												
			2	SS	100/9"												
			3	NXL Core	85% Rec												
246.1	Queenston Shale Limestone Beds		4	NXL Core	97% Rec											RQD = 38%	
19.5	23'6" to 23'8" 24'7" to 24'10" 31'1" to 31'5" 33'4" to 34'0"		5	NXL Core	98% Rec											RQD = 63%	
			6	NXL Core	100% Rec											RQD = 87%	
231.6	End of Borehole																
34.0																	



RECORD OF BOREHOLE No 425

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,665; E 1,065,179 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE N Casing and NXL Core COMPILED BY P.S.
DATUM Geodetic DATE June 14, 1978 CHECKED BY CP.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%) 20 40 60
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
265.6	Water Level																	
0.0	Water						260											
257.3	Channel Bottom																	
8.3	Organic Silt and		1	SS	2													
254.6	Sand Soft																	
11.0	Red Silt to Clayey		2	SS	100%	5"												
	Silt, Some Sand																	
	Trace of Gravel		3	SS	100%	7"												
	Very Dense to Hard						250											
	(Glacial Till)		4	NXL	45%													
245.6				RC	Rec											RQD = 0%		
20.0	Queenston Shale		5	NXL	80%													
				RC	Rec											RQD = 57%		
	Limestone Beds		6	NXL	95%		240											
	31'5" to 31'9"																	
	33'0" to 34'2"		7	NXL	100%											RQD = 68%		
				RC	Rec											RQD = 93%		
			8	NXL	100%		230											
				RC	Rec											RQD = 93%		
225.4																		
40.2	End of Borehole																	



RECORD OF BOREHOLE No 43 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,654; E 1,065,104 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 19, 1978 CHECKED BY [Signature]

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 (%) 20 40 60	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
273.6	Ground Level										
0.0	Clayey Silt to Silty Clay, Stiff to Very Stiff		1	SS	10		270				
266.6			2	SS	28						
7.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		3	SS	100/7	5"					
			4	SS	100/7	8"					
			5	SS	100/7	5"					
			6	SS	100/7	5"					
253.1			7	SS	100/7	6"					
20.5	End of Borehole										



RECORD OF BOREHOLE No 44 S

W P 46-74-13, 40 & 39 LOCATION Coords. N. 15,680,756; E 1,065,079 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger and Cone Test COMPILED BY J.A.
DATUM Geodetic DATE June 20, 1978 CHECKED BY [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
275.7	Ground Level												
0.0	Clayey Silt to Silty Clay Very Stiff		1	SS	10		270	100/6"	o				0 21 68 11
269.7			2	SS	65								
6.0	Silt Some Sand		3	SS	44								
265.7	Dense		4	SS	100/	7"			o				
10.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		5	SS	100/	5"	260						
			6	SS	100/	5"							
254.9			7	SS	100/	9"			o				
20.8	End of Borehole												



RECORD OF BOREHOLE No 75S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,760; E 1,065,090 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger COMPILED BY J.A.
DATUM Geodetic DATE July 6, 1978 CHECKED BY JP.

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								
							20	40	60	80	100					
274.0	Ground Level															
0.0	Clayey Silt to Silty Clay Very Stiff															
267.0			1	SS	13											
7.0	Silt Some Sand		2	SS	46											
264.0	Dense		3	SS	100/	9"										
10.0	Red Silt to Clayey		4	SS	100/	7"										
261.0	Silt, Very Dense to Hard															
13.0	End of Borehole															
	Note: Water Level Not Established															

+3, x5: Numbers refer to
Sensitivity

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



RECORD OF BOREHOLE No 76 S

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,658; E 1,065,118 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Solid Auger COMPILED BY J.A.
DATUM Geodetic DATE July 6, 1978 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			20	40	60	80	100					
272.9	Ground Level																
0.0	Clayey Silt to Silty Clay Stiff to Very Stiff		1	SS	10		270										
			2	SS	10												
			3	SS	7												
			4	SS	9		260										
255.9	Organic Silt		5	SS	9												
17.0	Red Silt to Clayey		6	SS	100/ 8"												
252.4	Silt, Very Dense to Hard		7	SS	100/ 6"												
20.5	End of Borehole																
	Note: Water Level Not Established																

+3, x5 : Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,902; E 1,065,936 ORIGINATED BY J.A.
DIST 4 HWY 406 BOREHOLE TYPE Cone Test COMPILED BY J.A.
DATUM Geodetic DATE May 31, 1978 CHECKED BY [Signature]

10



RECORD OF BOREHOLE No 216

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,834 ; E 1,066,169 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Pendril 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	400 800 1200 1600 2000					
324.7	Ground Level													
0.0	Clayey Silt With Organics Firm		1	SS	6									
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	TW	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/	1 1/2"									
74.6	End of Borehole													

+3, x5: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 217

W P 46-74-13, 40 & 39 LOCATION Coords N 15,679,992; E 1,066,055 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Pendrill COMPILED BY K.W.
DATUM Geodetic DATE July 15 & 16, 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			SHEAR STRENGTH PSF										WATER CONTENT (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE													
325.2	Ground Level							20	40	60	80	100					GR SA SI CL				
0.0	Silty Sand, Some Organics		1	SS	7		320										1 3 45 51				
318.7	Loose		2	SS	12																
6.5	Clayey Silt to Silty Clay, Traces of Sand and Gravel		3	SS	17																
			4	SS	28																
			5	SS	30																
			6	SS	28																
			7	SS	26																
			8	SS	28																
			9	SS	17																
			10	SS	10																
			11	TW	PM																
			12	SS	45																
			272.2		13			SS	50/	3"	270										
			53.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)	14			SS	50/	4"											
			15		SS			50/	5"												
			254.7		16			SS	50/	4"											
70.5	End of Borehole																				
	Note: Hole Caved in to Elevation 267+ Immediately																				

+3, x²: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 218

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,963; E 1,065,885 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Pendrill COMPILED BY K.W.
DATUM Geodetic DATE July 12, 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					
273.0	Ground Level																
0.0	Silty Fine Sand						270										
267.5	Loose		162	SS	6												
5.5	Grey Organic Silt and Sand Soft to Firm		3	SS	3	267.9											
			4	SS	6												
			5	SS	4		260										
256.0			6	TW	PM												
17.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		7	SS	50/	3 1/2"											
			8	SS	50/	2 1/2"	250										
243.2			9	SS	50/	3"											0 38 44 18
29.8	End of Borehole																

+3, x⁵: Numbers refer to
Sensitivity

20
15 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 220

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,705; E 1,066,028 ORIGINATED BY K.W.
DIST 4 HWY 406 BOREHOLE TYPE Pendril COMPILED BY K.W.
DATUM Geodetic DATE July 12, 1971 CHECKED BY [Signature]

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 (%) 20 40 60	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
273.5	Ground Level										
0.0	Clayey Silt										
268.5	Very Stiff		1	SS	22		270				
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		260				
			6	SS	76						
			7	SS	60	3"					
			8	SS	75	6"	250				
243.7			9	SS	50	3"					4 31 49 16
29.8	End of Borehole Note: Water Level Not Established										



RECORD OF BOREHOLE No 236

W P 46-74-13, 40 & 39 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 P.

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								
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												



RECORD OF BOREHOLE No 237

W P 46-74-13, 40 & 39 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										WATER CONTENT (%)
								SHEAR STRENGTH PSF										
272.2	Ground Level																	
0.0	Rock Rip-Rap						270											
268.2			1	SS	17													
4.0	Grey Organic Silt & Sand, Firm to Stiff		2	TW	PH													
264.2			3	SS	8													
			4	SS	74													
8.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel						260											
	Very Dense to Hard		5	SS	148													
253.2	(Glacial Till)		6	SS	1027	6"												
19.0	End of Borehole																	

+3, x²: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 238

W P 46-74-13, 40 & 39 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 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			SHEAR STRENGTH PSF							WATER CONTENT (%)			
311.6	Ground Level							20	40	60	80	100						
0.0	Fill Sandy Silt, Silty Clay, Some Brick Fragments		1	AS			310							2 39 40 19				
			2	SS	15													
			3	SS	42									0 4 47 49				
			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 Spiff		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								136					
268.6	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		13	SS	28		270						3 12 54 31					
43.0			14	SS	47													
			15	SS	105/6"		260						5 16 69 10					
251.1			16	SS	100/6"													
60.5	End of Borehole																	



RECORD OF BOREHOLE No 239

W P 46-74-13, 40 & 39 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 P.

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									
								SHEAR STRENGTH PSF									
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE 400 800 1200 1600 2000									
							WATER CONTENT (%) 20 40 60										
300.2	Ground Level						300										
0.0	Clayey Silt to Silty Clay Trace of Sand and Gravel Very Stiff to Hard		1	SS	31		300										
			2	SS	39		290										
			3	SS	34		290										
			4	TW	PH		290										
			5	TW	PH		290										
			6	TW	PM		280										
			7	SS	22		270										
			8	TW	PM		270										
267.2																	
33.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till) Boulders		9	SS	43		266										
			10	SS	85		260										
			11	SS	100/6"		260										
250.7																	
49.5	End of Borehole																

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



RECORD OF BOREHOLE No 240

W P 46-74-13, 40 & 39 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 [Signature]

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ PCF	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										
271.7	Ground Level																	
0.0	Rock Rip-Rap						270											
267.7																		
4.0	Grey Organic Silt and Sand, Firm to Stiff		1&2	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	178/ 6"													



RECORD OF BOREHOLE No 241

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,834; E 1,066,009 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger and Cone Test COMPILED BY P.K.
DATUM Geodetic DATE December 16, 1971 CHECKED BY SP

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES							
275.8	Ground Level											
0.0	Silty Clay											
270.8	Hard		1	SS	37							0 6 48 46
5.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		2	SS	29							
			3	SS	57							6 23 56 15
			4	SS	69							
			5	SS	53							
			6	SS	145							
250.0			7	SS	1007	5"						9 23 53 15
25.8	End of Borehole											

+3, x5: Numbers refer to Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 242 A

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,767; E 1,065,960 ORIGINATED BY D.M.
DIST 4 HWY 406 BOREHOLE TYPE Auger COMPILED BY P.K.
DATUM Geodetic DATE December 17, 1971 CHECKED BY JP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT Wp	NATURAL MOISTURE CONTENT W	LIQUID LIMIT Wl	UNIT WEIGHT γ PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										20 40 60		
271.2	Ground Level																			
0.0	Rock Rip-Rap						270													
267.7																				
3.5	Organic Silt and Sand, Trace of Gravel		1	SS	61	267.2										8 9 41 42				
			2	SS	5												3 17 57 23			
			3	SS	2															
			4	SS	2															
	Soft to Firm		5	TW	N/R		260													
256.2			6	SS	145/											34 46 18 2				
15.0	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		7	SS	130/	11"										7 33 50 10				
							3"	250												
245.7			8	SS	140/	6"														
25.5	End of Borehole																			

RECORD OF BOREHOLE No 317

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,015; E 1,065,805 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Wash Boring BX Casing COMPILED BY M.W.
DATUM Geodetic DATE October 8 & 9, 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100					
270.6	Ground Level																
0.0	Rock Rip-Rap		1	SS	13		270									135	
266.6																	
4.0	Grey Organic Silt and Sand Soft to Very Stiff		2	TW	PM		265									126	
			3	TW	PM												
			4	TW	PM		260									130	
257.6																	
13.0	Silty Clay																
254.1	Firm		5	SS	14		250									125	
16.5	Red Silt to Clayey Silt, Some Sand Trace of Gravel		6	SS	> 100												
	Very Dense to Hard (Glacial Till)		7	SS	> 100		246										
245.1																	
25.5	End of Borehole																

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 318

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,436; E 1,065,496 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Wash Boring HX & BX Casing COMPILED BY M.W.
DATUM Geodetic DATE October 10 & 11, 1963 CHECKED BY JP

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					
272.5	Ground Level																
0.0	Clayey Silt Some Sand Trace of Organics Stiff		1	SS	15		270										
			2	SS	14		268.5										
264.0			3	TW	12		W.L. in pipe Oct. 25, 1963										
8.5	Red Silt to Clayey Silt, Some Sand Trace of Gr.V. Dense to Hard (Glacial Till)		4	SS	>100		260										
257.0			5	SS	>100												
15.5	End of Borehole																

OFFICE REPORT ON SOIL EXPLORATION



RECORD OF BOREHOLE No 319

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,638; E 1,065,365 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Wash Boring HX & BX Casing, BX Core COMPILED BY M.W.
DATUM Geodetic DATE October 10 & 11, 1963 CHECKED BY GP

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					
270.9	Ground Level																
0.0	Very Stiff Mottled Brown Silty Clay Containing a Few Rock Fragments (Fill)		1	SS	13		270										
263.1			2	SS	16												
7.8			3	SS	PM		265.5										
260.7	Sandy Silt, Compact		4	SS	70		W.L. in pipe									130	
10.2	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		5	SS	>100		260										
			6	BX Core	-												
250.6			7	SS	>100		25										
20.3	End of Borehole																

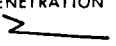



+3, x⁵: Numbers refer to
Sensitivity

20
15
10
5 (%) STRAIN AT FAILURE



RECORD OF BOREHOLE No 350

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,605; E 1,065,816 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Wash Boring HX & BX Casing COMPILED BY M.W.
DATUM Geodetic DATE October 28-30, 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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH										WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE										
275.9	Ground Level																	
0.0	Stiff to Very Stiff Mottled Grey & Brown Silty Clay		1	SS	9	W.L. in pipe @ Elev. 275.7 Nov. 1, 1963 270												
			2	SS	16													
			3	SS	14													
267.8			4	SS	13													
	8.1 Silty Fine Sand Compact		5	SS	17													
261.9																		
14.0	Red Silt to Clayey Silt, Some Sand, Tr. of Gravel, V. Dense to Hard (Glacial Till)		6	SS	46	260												
255.3			7	SS	>100	255.5												
20.6	End of Borehole																	

*3, *5: Numbers refer to
Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10



RECORD OF BOREHOLE No 351

W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,440; E 1,065,206 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Wash Boring BX Casing COMPILED BY M.W.
DATUM Geodetic DATE October 29, 1963 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					
268.8	Ground Level		1	CS	-												
0.0	Stiff Becoming Soft to Firm Below About 4' Depth, Silty Clay to Clayey Silt		2	SS	9												
			3	SS	4												
259.3																	
9.5	Red Silt to Clayey Silt, Some Sand Trace of Gravel Very Dense to Hard (Glacial Till)		4	SS	>100												
			5	SS	>100												
248.8			6	RC	-												
20.0	End of Borehole																

RECORD OF BOREHOLE No 352




W P 46-74-13, 40 & 39 LOCATION Coords. N 15,680,580; E 1,064,945 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Wash Boring HX & BX Casing COMPILED BY M.W.
DATUM Geodetic DATE October 30-31, 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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH PSF							WATER CONTENT (%)
								20 40 60 80 100							
333.0	Ground Level													GR SA SI CL	
0.0	Hard to Very Stiff Brown-Grey Silty Clay With Some Fissures, Some Scattered Sand and Gravel Size Particles (Desiccated Zone)		1	CS	-										
			2	SS	26										
			3	CS	-										
			4	SS	27										
			5	SS	26										
			6	SS	25										
			7	TW	21										
			8	SS	23										
311.0			9	SS	33								132		
22.0	Very Stiff to Firm Grey Silty Clay With a Few Grey Silt Pockets (Generally Less Than 1/2 Inch in Size) and Some Scattered Sand and Gravel Size Particles		10	SS	26										
			11	TW	20										
			12	SS	11										
			13	TW	PM										
			14	SS	6										
			15	TW	PM										
			16	SS	12										
273.5															
59.5	Red Silt to Clayey Silt, Some Sand Trace of Gravel, V. Dense to Hard (Glacial Till)		17	TW	31										
265.2			18	SS	>100										
67.8	End of Borehole		19	SS	>100										



HIGHWAY ENGINEERING DIVISION-ENGINEERING MATERIALS OFFICE-SOIL MECHANICS SECTION

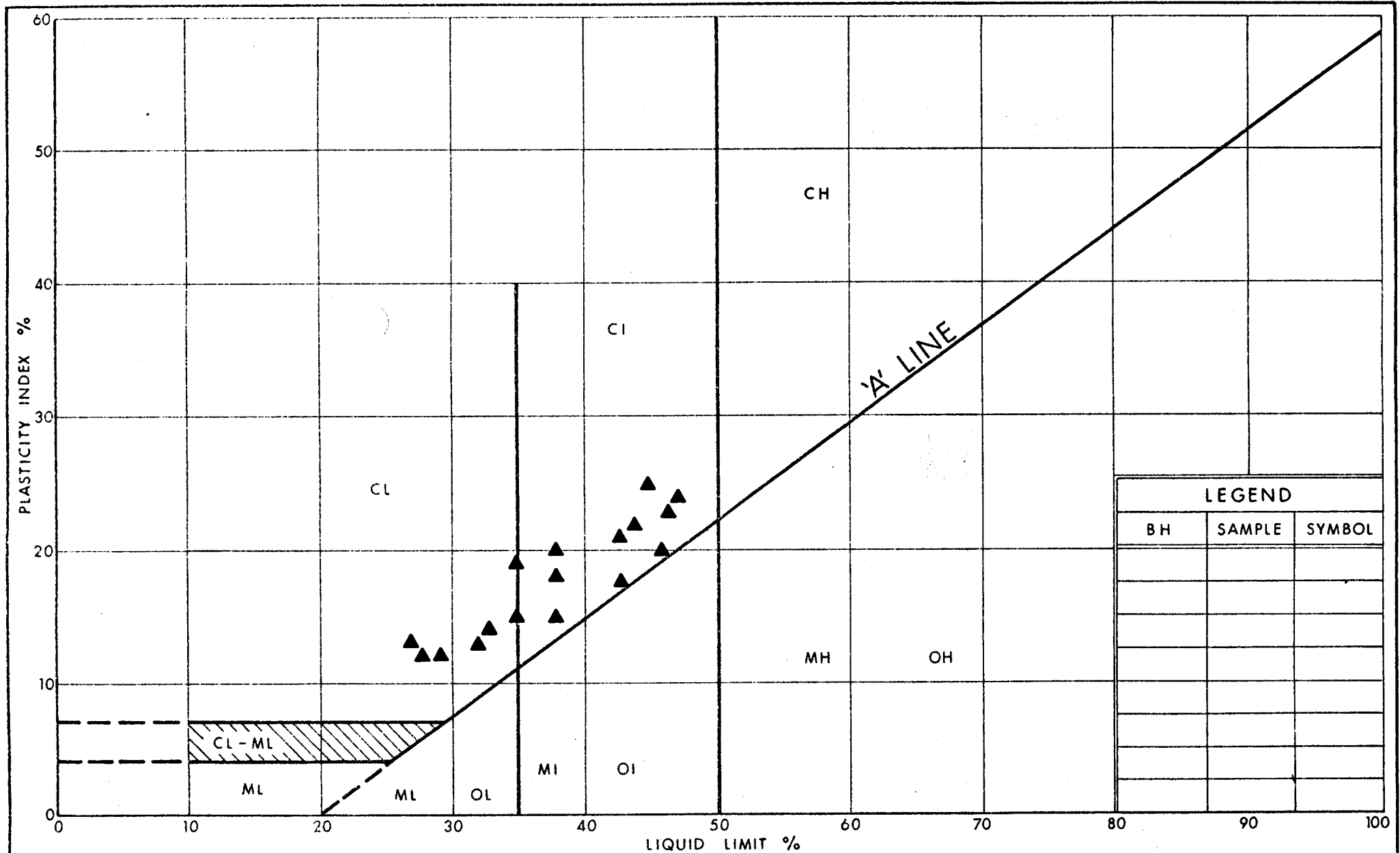
W P 46-74-13, 40 & 39 LOCATION Coords. N 15,679,605; E 1,065,817 ORIGINATED BY Golder
DIST 4 HWY 406 BOREHOLE TYPE Wash Boring HX & BX Casing COMPILED BY M.W.
DATUM Geodetic DATE November 5, 1963 CHECKED BY [Signature]

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 PCF	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100										SHEAR STRENGTH			WATER CONTENT (%)		
																		○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE			20 40 60		
272.8	Ground Level																						
0.0	Hard to Firm, Brown Silty Clay, Some Gravel		1	HX	-		270																
266.8			2	SS	14																		
	3	SS	24																				
6.0	Sandy Silt Compact		4	SS	14																		
260.0			5	SS	30																		
12.8	Red Silt to Cl. Silt Some Sand, Tr. of Gr. V. Dense to Hard (Glacial Till)		6	SS	49		260																
254.3			7	SS	>100																		
18.5	End of Borehole																						
	Note: Water Level Not Established																						

+3, x5: Numbers refer to Sensitivity

20
15 ϕ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION



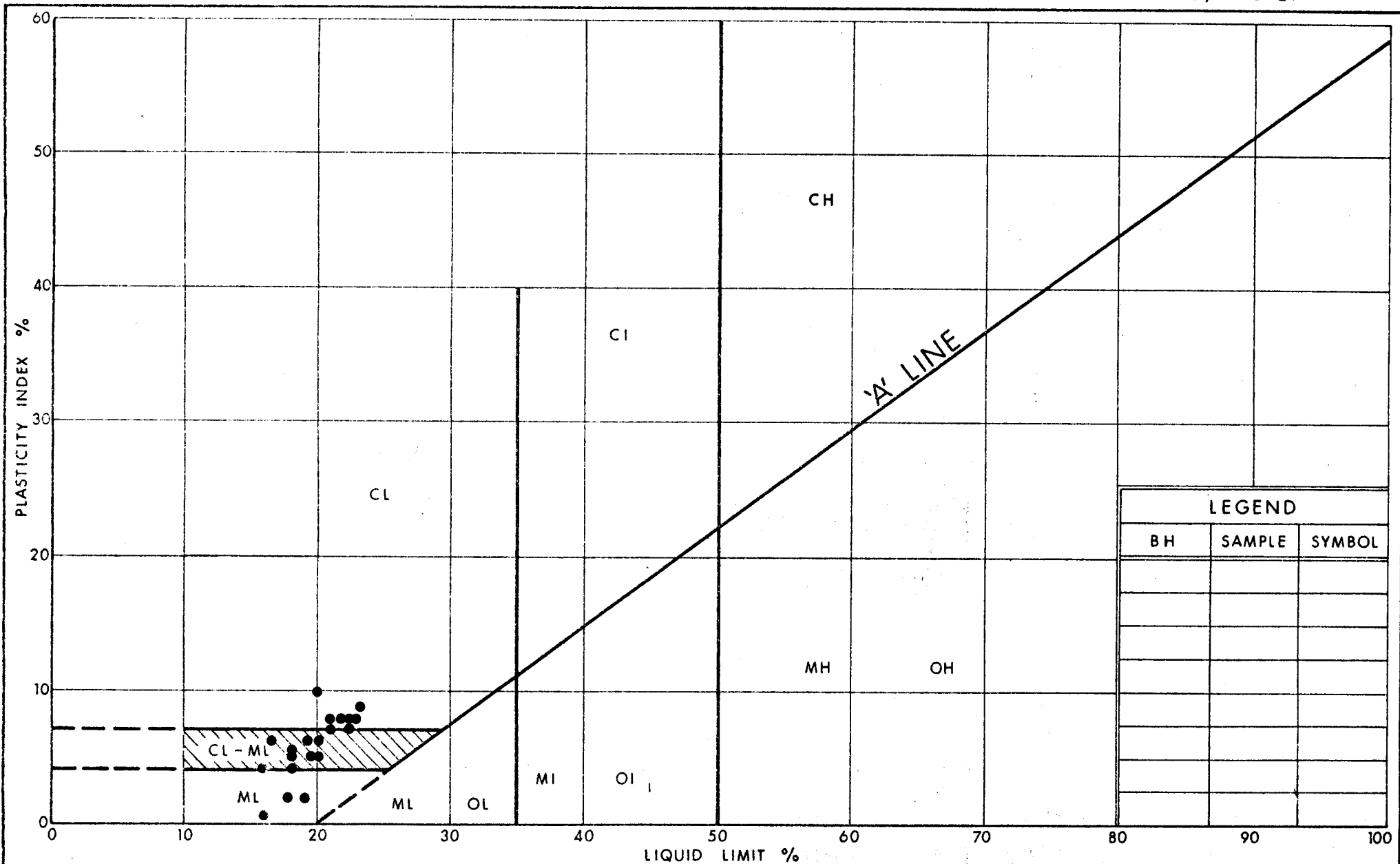
Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART
CLAYEY SILT TO SILTY CLAY
TRACE OF SAND & GRAVEL

FIG No 1

W P 46-74-13/40 & 39



Ontario

Ministry of
Transportation and
Communications

PLASTICITY CHART

SILT TO CLAYEY SILT, SOME SAND TRACE OF GRAVEL
(Glacial Till)

FIG No 2

W P 46-74-13/40 & 39

ORGANIC EXCAVATION (TYPICAL)

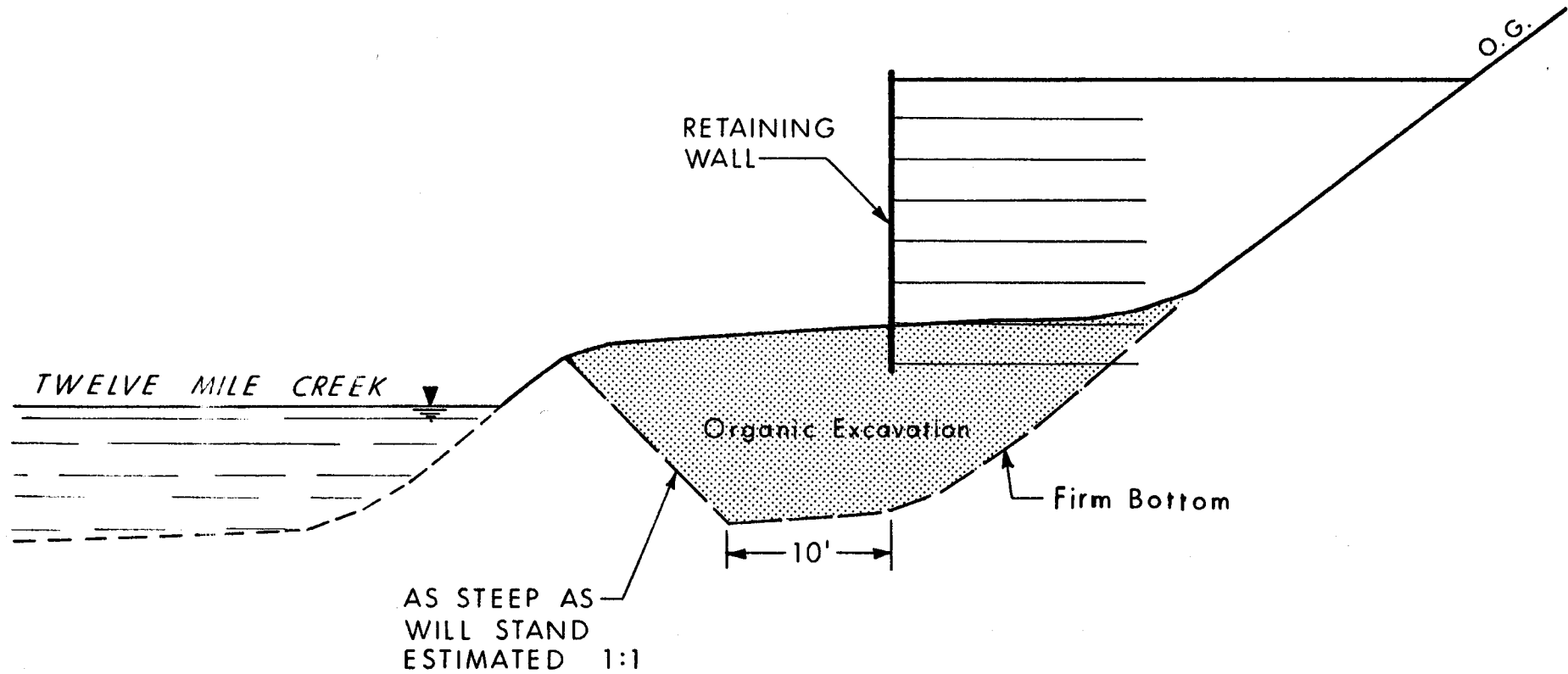


FIG No 3

WP 46-74-13/40 & 39

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. $\bar{C}IU$ = CONSOLIDATED ISOTROPIC UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENT UNLESS OTHERWISE SPECIFIED IN REPORT ALL TESTS ARE IN COMPRESSION

FIELD SAMPLING

SS SPLIT SPOON
WS WASH SAMPLE
ST SLOTTED TUBE SAMPLE
BS BLOCK SAMPLE
CS CHUNK SAMPLE
TW THINWALL OPEN
TP THINWALL PISTON
OS OSTERBERG SAMPLE
FS FOIL SAMPLE
RC ROCK CORE
PH T.W. ADVANCED HYDRAULICALLY
PM 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 = $\frac{I_p \text{ of soil}}{I_p \text{ of } 2\mu m \text{ Soil Fraction}}$
 Om ORGANIC MATTER CONTENT
 S_r DEGREE OF SATURATION
 S SENSITIVITY = $\frac{S_u(\text{undisturbed})}{S_u(\text{remoulded})}$

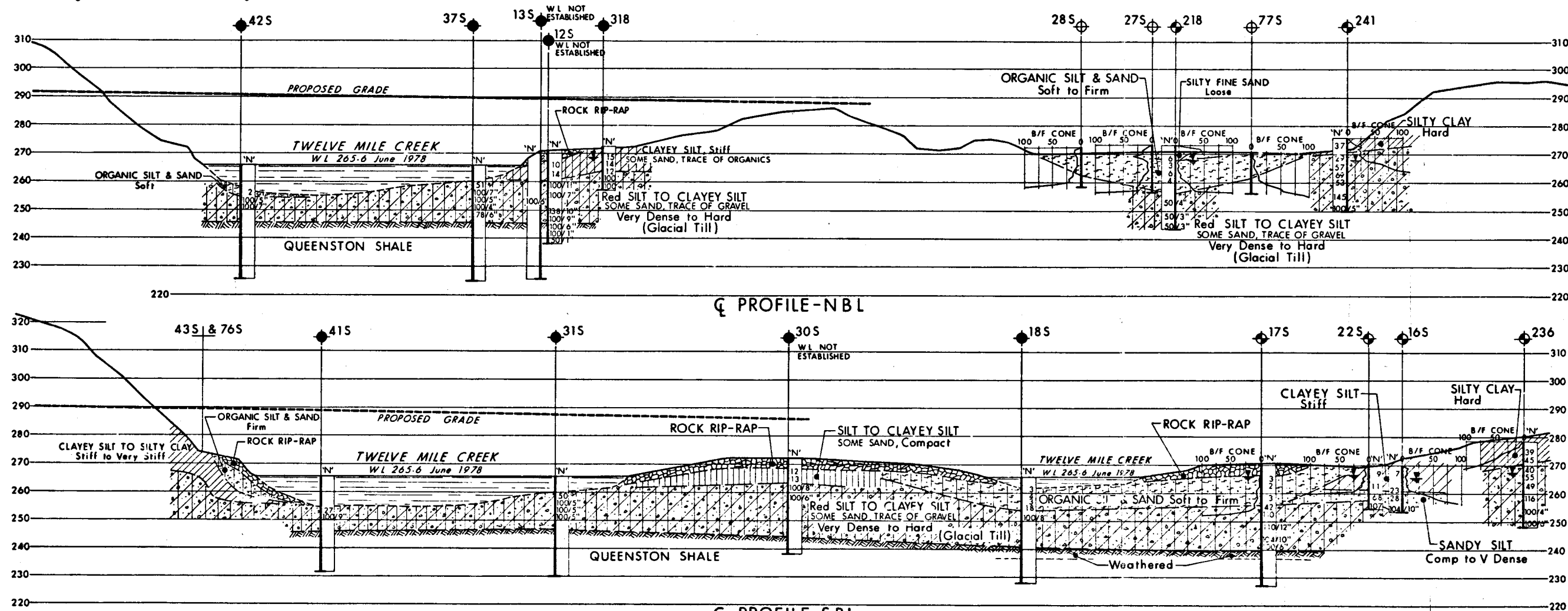
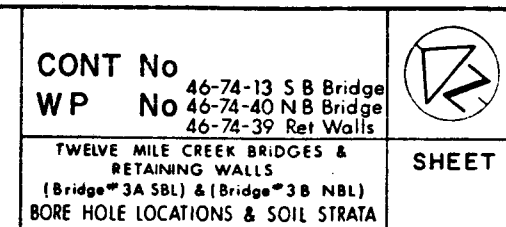
STRENGTH PARAMETERS

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_r OVERCONSOLIDATION RATIO (OCR)



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		
	May & June 1978		
	WL for BH 318, Oct 1963		
	WL for BH 218, July 1971		
	WL for BH 236 & 241, Dec 1971		
	WL Not Established in BH 125, 135 & 305		

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
125	270.4	15 680 467	1065 438
135	270.4	15 680 472	1065 438
145	272.6	15 680 607	1065 149
155	271.4	15 679 738	1065 995
165	269.9	15 679 760	1066 005
175	270.8	15 679 844	1065 899
185	265.6	15 680 057	1065 737
195	270.8	15 679 889	1065 923
205	269.6	15 679 856	1065 951
215	270.9	15 679 975	1065 849
225	270.4	15 679 797	1065 991
235	270.3	15 680 027	1065 800
245	270.4	15 680 075	1065 769
255	269.6	15 680 067	1065 749
265	265.6	15 680 084	1065 560
275	273.1	15 679 988	1065 574
285	272.3	15 680 045	1065 825
295	270.0	15 680 172	1065 675
305	272.2	15 680 249	1065 583
315	265.6	15 680 427	1065 410
325	270.9	15 680 398	1065 497
335	271.6	15 680 212	1065 644
345	273.6	15 680 421	1065 522
355	271.7	15 680 389	1065 488
365	273.7	15 680 352	1065 524
375	265.6	15 680 520	1065 382
385	276.2	15 679 653	1066 107
395	274.2	15 679 684	1066 065
415	265.6	15 680 582	1065 215
425	265.6	15 680 665	1065 179
435	273.6	15 680 654	1065 104
445	275.7	15 679 756	1065 079
755	274.0	15 680 760	1065 090
765	272.9	15 680 658	1065 118
775	270.9	15 679 902	1065 936
216	324.7	15 679 834	1066 169
217	325.2	15 679 992	1066 055
218	273.0	15 679 963	1065 885
220	273.5	15 679 705	1066 028
226	278.7	15 679 666	1066 129
237	272.2	15 679 597	1066 074
238	311.6	15 679 825	1066 126
239	300.2	15 679 783	1066 089
240	271.7	15 679 683	1066 015
241	275.8	15 679 834	1066 009
242A	271.2	15 679 767	1065 960
317	270.6	15 680 015	1065 805
318	272.5	15 680 436	1065 496
319	270.9	15 680 638	1065 655
350	275.9	15 679 850	1065 665
351	268.8	15 680 440	1065 206
352	333.0	15 680 580	1064 945
355	272.8	15 679 605	1065 817

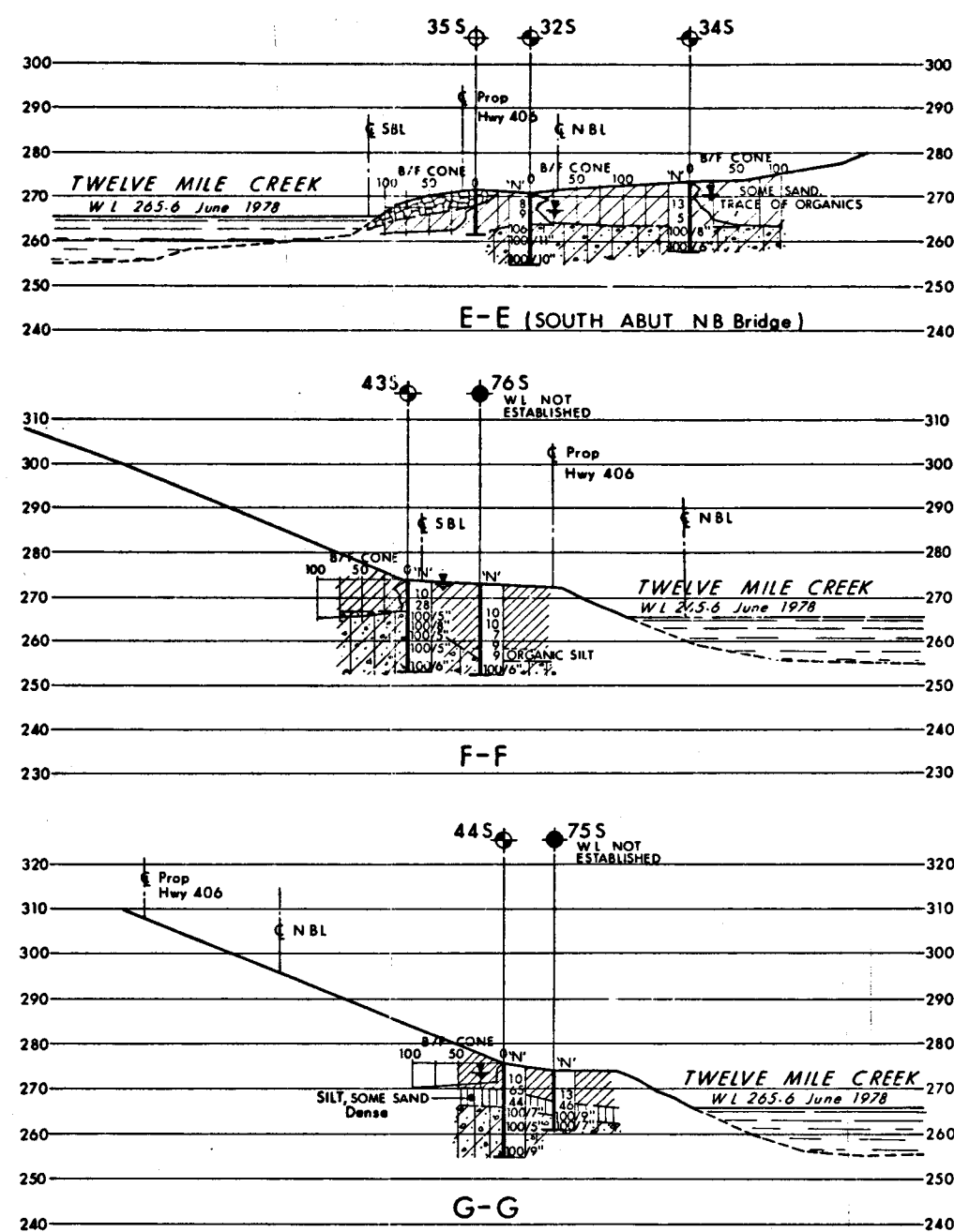
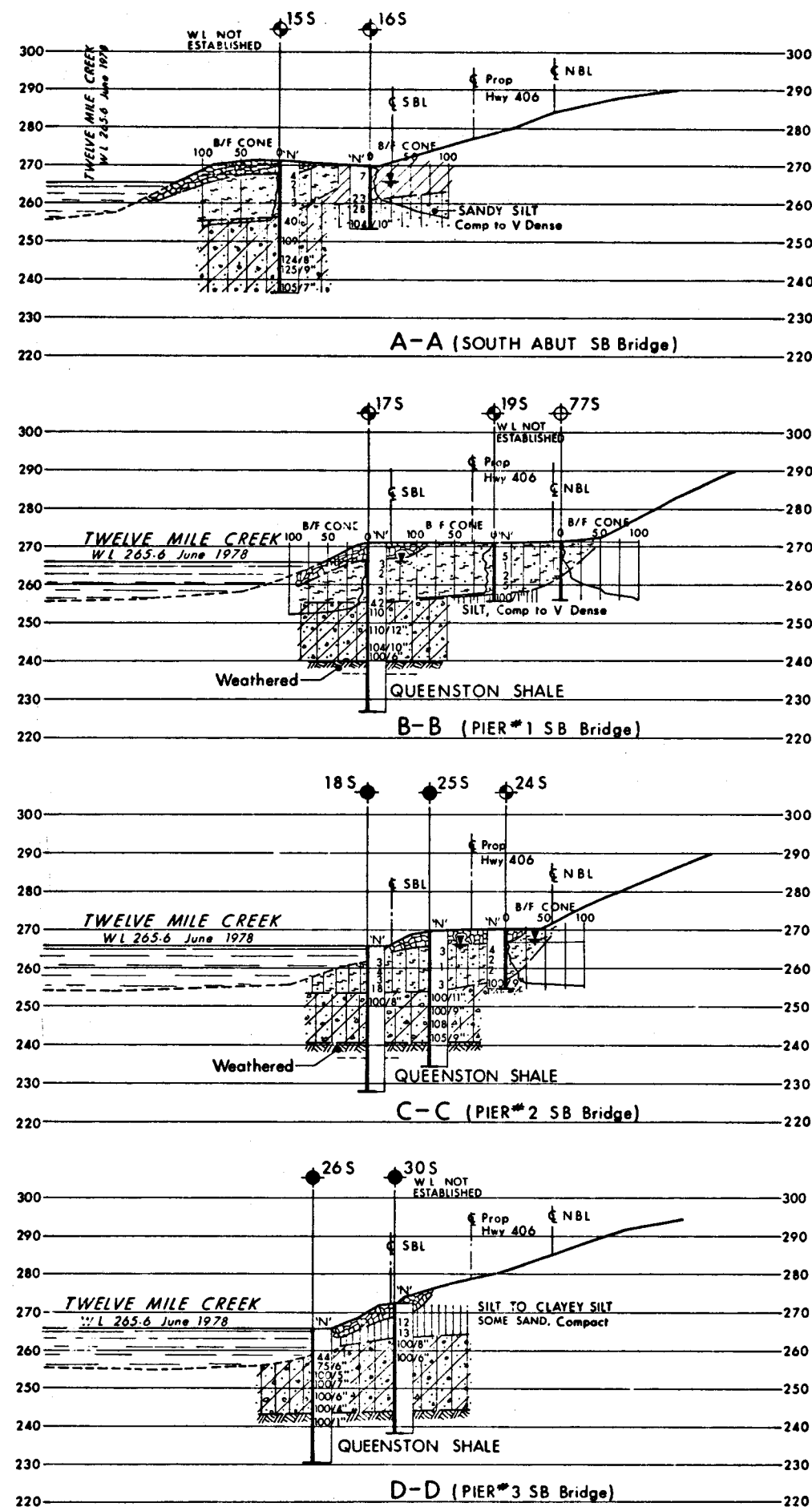
DATE	BY	DESCRIPTION

Geocres No 30M3-150

HWY No Prop 406 DIST 4

SUBMIT PLS (CHECKED) DATE Sept 8, 1978 SITE# 233-A&B

DRAWN & CHECKED DWG# 18-233-2X



SECTIONS
SCALE FOR SECTIONS
20 10 0 20 FT

SOIL STRATIGRAPHY LEGEND

- ROCK RIP-RAP
- ORGANIC SILT & SAND
Soft to Firm
- CLAYEY SILT TO SILT; CLAY
Stiff to Very Stiff
- CLAYEY SILT
Firm to Stiff
- Red SILT TO CLAYEY SILT
SOME SAND, TRACE OF GRAVEL
Very Dense to Hard
(Glacial Till)

CONT No 46-74-13 SB Bridge
WP No 46-74-40 NB Bridge
46-74-39 Ret Walls
TWELVE MILE CREEK BRIDGES & RETAINING WALLS
(Bridge #3A SBL) & (Bridge #3B NBL)
SECTIONS & SOIL STRATA

SHEET

SEE DRWG 18-233-2X

KEY PLAN

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
May and June, 1978
WL Not Established in Bore Holes
155, 195, 305, 755 & 765

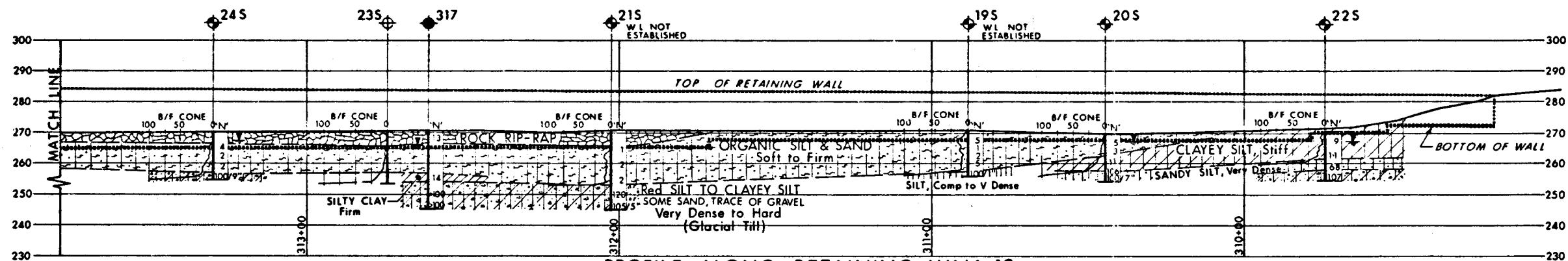
No	ELEVATION	

-NOTE-

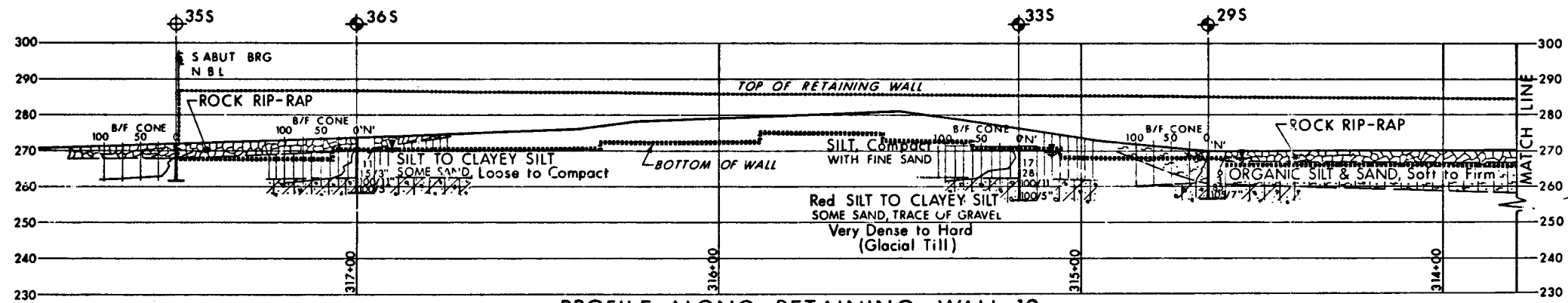
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS	DATE	BY	DESCRIPTION

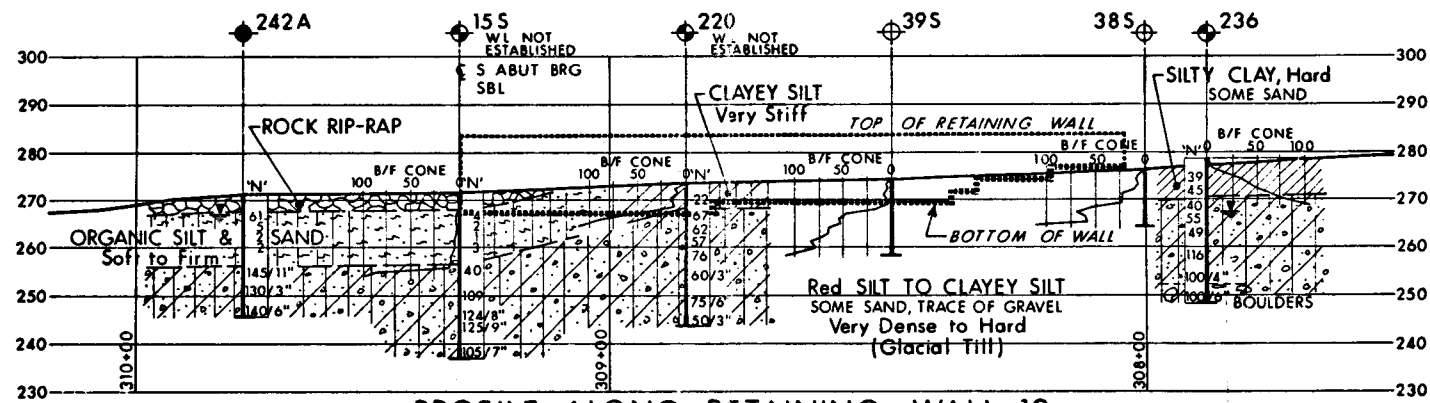
Geocres No 30M3-150
HWY No Prop 406
SUBMDP J S (CHECKED) DATE Sept 8, 1978 SITE 18-233-A & B
DRAWN G (CHECKED) DWG 18-233-2Y



PROFILE ALONG RETAINING WALL 12



PROFILE ALONG RETAINING WALL 12



PROFILE ALONG RETAINING WALL 13

SCALE FOR RETAINING WALLS
20 10 0 20 FT

CONT No 46-74-13 S B Bridge
WP No 46-74-40 NB Bridge
46-74-39 Ret Walls
TWELVE MILE CREEK BRIDGES & RETAINING WALLS
(Bridge 3A SBL) & (Bridge 3B NBL)
RET WALLS PROFILES & SOIL STRATA

SHEET

SEE DRWG 18-233-2X

KEY PLAN

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)
- ↓ W.L. at time of investigation June 1978
- W.L. for BH 317, Oct 1963
- W.L. for BH 236 & 242A, Dec 1971
- W.L. Not Established in Bore Holes 155, 195, 215 & 220

No	ELEVATION		

-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 30M3-150

HWY No Prop 406
SUBMITTALS CHECKED DATE Sept 7, 1978 SITE 18-233-A & B
DRAWN & CHECKED DATE 18-233-2Z