

G.I.-30 SEPT. 1976

GEOCRES No. 31E-88DIST. 11 REGION W.P. No. CONT. No. 79-108W. O. No. 94-11005STR. SITE No. HWY. No. 121LOCATION Hwy 121 & Haliburton
Rd. #1No of PAGES - =====
OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT. REMARKS:

ENGINEERING MATERIALS OFFICE
FOUNDATION DESIGN SECTION

WO 94-11005 DIST 52
HWY Local Road STR SITE -

Haliburton County Road 1

DISTRIBUTION

J. McDougall (2)
R. Mantha
S. Wilson (2)
M. Holowka
J. Robinson
E.A. Joseph
O. Ramakko (Cover Only)
F. Bacchus (Cover Only)
File ✓

GEOCRES ~~31E-115~~
31E-88

DATE FEB 10 1995

FOUNDATION INVESTIGATION REPORT

For

Haliburton County Road 1

W.O. 94-11005

District 52, Huntsville

INTRODUCTION

This report summarizes the results of the foundation investigation conducted at Haliburton County Road 1, near Hwy. 121. The investigation was carried out upon the request of the Northern Region Geotechnical Section for the proposed reconstruction of a swamp crossing prior to acceptance and take over by the County of Haliburton. The field work for the investigation was carried out between 94 08 03 and 94 08 10 and consisted of ten (10) sampled boreholes.

SITE DESCRIPTION

The site is located on Haliburton County Road 1 (formerly Hwy. 519), in the Town of Haliburton, Municipality of Dysart et al. It is situated just south of the intersection with Hwy. 121 as illustrated in Drawing No. 9411005A.

Physiographically, the site lies in a region known as the Algonquin Highlands (after Chapman and Putnam, 1984). This region is basically an area of rock outcrops with thin stony, sandy soils. There are also frequent swamps and bogs in this region.

The existing County Road 1 traverses a swamp at this location. The roadway surface was approximately 0.6 meters above the water level of the swamp at the time of investigation. The pavement surface is comprised of hot mix asphalt overlain with single surface treatment. It contains many distortions and settlements and over 10 % of the area has been hand patched.

This road provides transportation to Hwy. 35 to the south. Locally, access is gained to a public school and local hospital for the town of Haliburton.

INVESTIGATION PROCEDURES

Soil data and inherent properties were obtained by in situ and laboratory testing. The procedures employed are discussed below.

Field

The field work for the investigation was carried out between 94 08 03 and 94 08 10 and consisted of ten (10) sampled boreholes which were advanced to depths of 6.6 to 13.0 m.

The boreholes were advanced using conventional hollow stem augering techniques. Boreholes were sunk by a truck mounted continuous flight auger drill rig. The sampling program consisted of split spoon samples collected in the pavement structure and supporting strata. Disturbed subsoil samples were retrieved by a split spoon sampler in accordance with the Standard Penetration Test (ASTM D1586). They provided Standard Penetration Resistance ('N') values for assessment of the denseness of the non-cohesive material. Relatively undisturbed samples were retrieved using thin walled Shelby tube samplers in accordance with ASTM D1587. All the samples collected were used for identification and laboratory testing purposes. Dynamic cone penetration tests were carried out adjacent to BH's 1, 5, 8 and 10. In situ vane tests were carried out in the cohesive stratum in BH's 1 and 8 to determine the undrained shear strength of the soil. The test was conducted employing the Standard MTO 'N' vane.

All subsoil samples were identified in the field and returned to the laboratory for further examination and appropriate testing.

The groundwater was monitored in all open boreholes. All the boreholes were backfilled upon completion of the fieldwork.

Survey information related to the location and elevation of the boreholes was provided by Huntsville District, Engineering Services.

Laboratory

The laboratory testing program for selected soil samples consisted of:

- Atterburg Limit Test
- Grain Size Distribution
- Unit Weight Determinations
- Natural Moisture Content Determinations
- Organic Content Determinations

Laboratory test results are given in the following section of this report and are illustrated on Record of Borehole sheets included in the Appendix.

SUBSURFACE CONDITIONS

General

The Record of Borehole sheets in the Appendix illustrate the subsurface conditions at the borehole locations. The locations and elevations of the boreholes are shown on Drawing No. 9411005A.

The subsurface stratigraphy consists of granular fill overlying peat and organic subsoils. Below the organic layers is a silt stratum which extends to EL. $308 \pm$ m. The silt stratum is underlain by a deposit of sand which extends below $301 \pm$ m. Local deposits of clayey silt material (1-2 m) are encountered in BH 1, between the organic layers and the silt stratum. Bedrock was not encountered at the termination depths of the boreholes.

Following are the specific descriptions of the material encountered in the investigation:

Silty Sand, trace of Gravel and Organics, (Fill)

This non-cohesive stratum is contacted at the surface in all boreholes with thickness ranging from 1.7 to 4.0 m. The material has been placed as fill for the pavement structure through the swamp crossing. Laboratory testing was not carried out on samples from this strata.

Based on Standard Penetration Resistance 'N' values which ranged from 2 to 21 blows/0.3 m, the denseness of this stratum is very loose to compact.

Peat

This organic layer was encountered at all boreholes with the exception of BH 1. It is 0.1 to 2.1 m in thickness. Laboratory testing for moisture content was completed on one sample with results of 163.5 %. Organic content testing was completed on two samples with results of 10.4% and 62.4 %. Based on Standard Penetration Resistance 'N' values which ranged from 2 to 6 blows/0.3 m, the material is in a loose to very loose state.

Organic Silty Clay/Clay

This organic layer is encountered in BH 3 to BH 10 underlying the peat stratum. It is 0.7 to 3.5 m in thickness. In BH 8, a pocket of organic silt was found within this layer. Typical properties of the material, as determined by laboratory tests on representative samples

are summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Tests</u>
Natural Moisture Content (w)	46.5-220%	5
Liquid Limit (w_L)	32-59%	5
Plastic Limit (w_p)	27-52%	5
Grain Size Distribution (%)		1
- Gravel	0	
- Sand	0	
- Silt	72	
- Clay	28	

Based on the undrained shear strength values determined by insitu vane tests which range from 30 to 48 \pm kPa, the consistency of the material is soft to firm. A consolidation test was carried out on the organic silt material encountered in BH 8. The results indicate a preconsolidation pressure of 65 kPa (which is close to the existing overburden pressure) and a compression index of 0.3. Based on this, the material is considered normally consolidated.

Silty Sand with Organics

This organic layer was only contacted in BH 2 underlying the peat stratum. It is only 1.1 m thick. Based on the SPT 'N' value of 2, the material is considered very loose. Laboratory tests carried out on this sample indicate a moisture content of 226.5% and grain size distribution of 0% gravel, 77% sand, 16% silt and 7% clay.

Clayey Silt, Occasional Sand Layers

This cohesive layer was encountered in BH 1. It is approximately 1.7 m in thickness. Laboratory tests were carried out on a representative sample with results of 35% natural moisture content, 31% liquid limit and 22% plastic limit. Based on an undrained shear strength of 35 \pm kPa from insitu vane test, the consistency of this material is firm.

Silt, Occasional Clay Pockets

This non-cohesive layer is encountered in all boreholes. It is 2.0 to 6.4 m in thickness. Typical properties of the material, as determined by laboratory tests on representative

samples are summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Tests</u>
Natural Moisture Content (w)	29-46%	15
Liquid Limit (w_L)	22-30%	14
Plastic Limit (w_p)	20-25%	14
Grain Size Distribution (%)		12
- Gravel	0-1	
- Sand	0-7	
- Silt	70-88	
- Clay	10-29	

Based on Standard Penetration Resistance 'N' values which range from 0 to 11 blows/0.3 m, the denseness of this layer varies from very loose to compact, but typically very loose to loose.

Sand, trace Gravel, trace Silt

Underlying all the above layers is a deposit of non-cohesive sand. This deposit was not fully penetrated at the maximum termination depth of the boreholes (13.0 m depth, El. 306.1 m). Typical properties of the material, as described by laboratory tests on representative samples are summarized as follows:

<u>Property</u>	<u>Range</u>	<u>No. of Tests</u>
Natural Moisture Content (w)	16.5-20%	3
Grain Size Distribution (%)		3
- Gravel	3-4	
- Sand	77-90	
- Silt and Clay	7-9	

Based on Standard Resistance 'N' values which range from 0 to 12, the denseness of this stratum is very loose to compact.

Groundwater

Groundwater was measured in the open boreholes during the investigation was generally

within 1 m depth. The level of the free surface of the adjacent swamp was El. $318.6 \pm m$, about 0.4 m below the existing road surface.

Groundwater level is subject to seasonal fluctuations and may vary from the values given in this report.

DISCUSSION AND RECOMMENDATION

General

This project comprises the remedial measures required to alleviate the poor performance of Haliburton County Road No. 1, formerly Secondary Highway 519. The concerned section of roadway at the swamp crossing has not been accepted by Haliburton county due to severe settlements and distortions. The county is requesting that the Ministry complete remedial measures necessary to improve the performance of this swamp crossing prior to acceptance.

Discussion

In general, the subsurface stratigraphy consists of granular fill overlying some organic layers. Below the organic layers is a silt stratum which extends to El. 308 \pm m. The silt stratum is underlain by a deposit of sand which extends below El. 301 \pm m. Local deposits of clayey silt material (1 - 2 m) are encountered in BH 1 between the organic layers and the silt stratum.

Based on the borehole information, this swamp crossing was apparently constructed by direct placement of granular fill over the organic materials. Sampling indicated that the organics were trapped underneath the fill. As a result, the organic layers have undergone extensive consolidation. Within the central portion of the concerned area, the organic layers extend to El. 313 \pm m. The thickness of this layer varies from 2 to 4 \pm m. The organic layers are underlain by native, generally incompressible layers of silts and sands.

Due to the nature of the materials, it is envisaged that the organic layers will continue to consolidate. Settlements and distortions of the road surface will continue. Surface treatment or hot mix patching repairs will be short lived due the high compressibility of the underlying organic layers and the added weight of such repairs.

Recommendations

The organic layers within the central portion of the swamp is underlain by generally incompressible layers of silt and sand. Complete removal of the organics would involve excavation of up to 5-7 \pm m and appears to be impractical. This method would require the roadway to be closed and traffic detoured as well as disposal of a large quantity of

material.

In our opinion, the conditions of the road can be greatly improved by replacing a portion of the existing granular fill with a light weight fill material, thereby reducing the overburden loads on the organics. Various light weight fill materials can be considered. It appears that sawdust is an appropriate choice in this area, provided that it is environmentally acceptable. Blast Furnace Slag can be obtained from Hamilton area. Another light weight fill material called Elastizell E.F. (which is basically a cement/foam mix) has also been employed before on a project in Northwestern region (Pinewood River Bridge, Contract 93-211, Hwy 619). Typical unit weights for design are as follows:

<u>Material</u>	<u>Bulk Unit Weight (kN/m³)</u>
Fill	20
Peat	11
Saw-dust	6
Blast Furnace Slag	12
Elastizell E.F.	5

(Note: submerged unit weights should be used below water table)

Various light weight fill materials can be used and various thicknesses of different layers can be designed for, based on the pavement design requirements. The design philosophy is to replace the existing material with light weight fill so that the overall weight on the compressible organic layer can be reduced. Grade raise may also be carried out to bring the pavement further above the swamp. The more the existing material is replaced, the lighter the overall load is. However, as the depth of excavation increases, various construction problems such as roadway protection and shoring requirements may arise. The following illustrates a design example for your reference.

Assuming the required raise in grade is 1.0 m and sawdust is to be used as the light weight fill. The procedures are as follows:

- 1) Excavate and remove existing fill material to a depth of 2 m (total pressure relieved is 40 kPa).
- 2) Place geotextile (Terrafix non-woven 360R or equivalent) at the base of the excavation.
- 3) Backfill with 2.5 m thick light weight fill material (pressure added = 15.0 kPa).
- 4) Place a second sheet of geotextile over the light weight fill (including side slopes).
- 5) Side slopes to be constructed at 4H:1V.
- 6) Place 0.5 m thick granular fill and pavement structure over the light weight fill (pressure added = 10.0 kPa). Side slopes shall be protected with 0.3 m thick

granular blanket. Note that the total reduction in weight is 15 kPa.

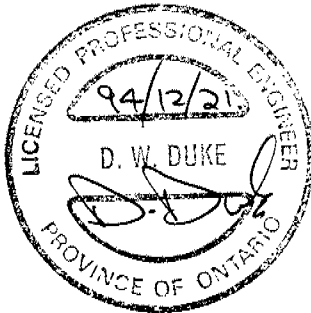
No stability problem is envisaged using 4H:1V side slopes. The slope surface should be protected from erosion by means of vegetation cover.

It should be noted that the above measures are designed to improve the conditions of the existing road. The compressible deposits will be left in place and there will still be long term settlements due to the overburden weight. Routine maintenance of this section of the road may still be required.

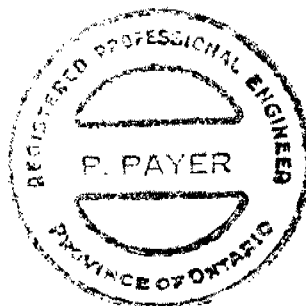
MISCELLANEOUS

The field work for this investigation was carried out under the joint supervision of D. Kwok, Project Foundation Engineer, and D. Duke, Pavement Design and Evaluation Engineer. The equipment was owned and operated by Master Soil Investigations Ltd.

The report was co-written by D. Kwok and D. Duke, reviewed and approved by P. Payer, Senior Foundation Engineer.



D. Duke, P. Eng.
Pavement Design and Evaluation Engineer



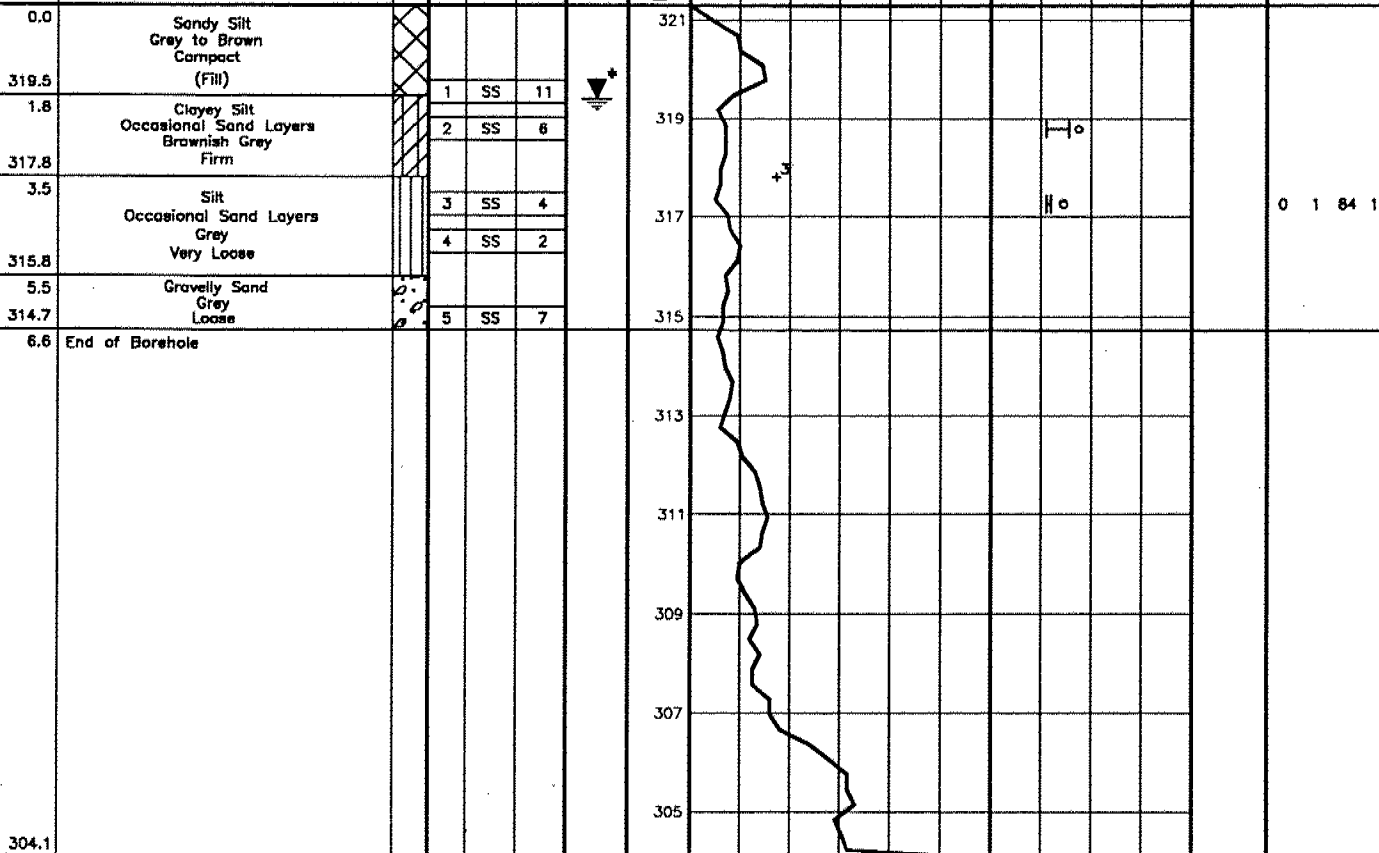
P. Payer
P. Payer, P. Eng.
Senior Foundation Engineer

APPENDIX

1 OF 1

METRIC

SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER			TYPE	'N' VALUES	20 40 60 80 100	W _p		
321.3	Ground Surface					SHEAR STRENGTH kPa • UNCONFINED + FIELD VANE • QUICK TRIAXIAL * LAB VANE 20 40 60 80 100					

[illegible]

RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 94-11005 LOCATION Sta. 9+964.7 o/s 3.9 Lt. ORIGINATED BY DK
DIST 11 HWY 519 BOREHOLE TYPE H.S. Auger COMPILED BY DD
DATUM Geodetic DATE 94 08 09 CHECKED BY PP

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					
320.0	Ground Surface																
0.0	Sand with Gravel Trace of Silt Grey/Brown Compact to Loose (Fill)		2	SS	4		318										
317.9	Organics, Dark Brown, Very Loose (Peat)		3	SS	2												
317.1			4	SS	2												
2.9	Silty Sand with Organics Dark to Light Brown, Very Loose																
316.0			5	SS	3		316										
4.0	Silt Occasional Clay Pockets Grey Loose Occasional Sand Seams		6	SS	4												
			7	SS	5		314										
			8	SS	0		312										
309.9			9	SS	4												
10.1	Sand Grey		10	SS	**		310										
308.9																	
11.1	End of Borehole • 94 08 09 ** Sampled from sand blowback in auger casing																
320.0																	

0.0 End of Borehole

+3, x5: Numbers refer to
Sensitivity

20
15-5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.O. 94-11005 LOCATION Sta. 9+998.0 o/s 4.9 Rt. ORIGINATED BY DK
DIST 11 HWY 519 BOREHOLE TYPE H.S. Auger COMPILED BY DD
DATUM Geodetic DATE 94 08 09 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ KN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	20 40 60		
319.3	Ground Surface													
0.0	Silty Sand with Gravel and Organics Brown Compact (Fill)		1	SS	16		319							
317.6			2	SS	2									
1.7	Organics Dark Brown Very Loose (Peat)		3	SS	2		317							
315.6			4	SS	1									
3.7	Organic Silty Clay Greyish Brown Very Soft		5	SS	0		315							
313.8			6	SS	1									0 0 75 25
5.5	Silt with Clay Pockets Grey Very Loose		7	SS	4		313							
			8	SS	5		311							
309.1			9	SS	1									
10.2	Sand, trace Silt, Very Loose Grey		10	SS	1		309							0 81 (19)
308.2														
11.1	End of Borehole • 94 08 09													

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

W.O. 94-11005 LOCATION Sta. 10+025 o/s 5.3 Lt. ORIGINATED BY DK
DIST 11 HWY 519 BOREHOLE TYPE H.S. Auger COMPILED BY DP
DATUM Geodetic DATE 94 08 08 CHECKED BY PP

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 kPa							WATER CONTENT (%)			
								• UNCONFINED								+ FIELD VANE		• QUICK TRIAXIAL
318.8	Ground Surface							20 40 60 80 100										
0.0	Silty Sand with Gravel Greyish Brown Loose (Fill)		1	SS	9		318											
316.9			2	SS	4													
1.9	Organics Dark Brown Very Loose (Peat)		3	SS	1		316											
314.8																		
4.0	Organic Clay Grey, Very Soft		4	SS	0		314											
313.8			5	SS	0													
5.2	Silt Occasional Clay Pockets Grey Very Loose to Loose ----- Sand Seams		6	SS	0		312											
			7	SS	4													
			8	SS	1		310											
			9	SS	6		308											
307.2																		
11.8	Gravelly Sand Grey																	
306.2			10	SS	**													
12.6	End of Borehole * 94 08 08 ** Sampled from sand blowback in augers																	

1 OF 1

METRIC

[illegible]

+3, x5: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 6

1 OF 1

METRIC

W.O. 94-11005 LOCATION Sta. 10+091.3 c/s 4.0 Lt. ORIGINATED BY DK
DIST 11 HWY 519 BOREHOLE TYPE H.S. Auger COMPILED BY DD
DATUM Geodetic DATE 94 08 05 CHECKED BY PP

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					
319.0	Ground Surface																
0.0	Silty Sand Trace of Gravel Grey and Brown Compact to Very Loose (Fill)		1	SS	15		318										
			2	SS	4		316										
315.8			3	SS	14												
3.4	Organics, Brown, Very Loose, (Peat)		4	SS	4												
4.0	Organic Silty Clay Dark Brown Soft		5	SS	4		314										
313.8			6	SS	0												
5.2	Silt Trace of Clay Grey Very Loose to Loose Sand Seams		7	TW	PH		312										1 7 81 11
			8	SS	7												0 0 88 12
308.9			9	SS	2		310										
10.1	Sand with Gravel Grey		10	SS	**		308										
307.8																	
11.1	End of Borehole • 94 08 08 ** Sampled from sand blowback in augers																

RECORD OF BOREHOLE No 7

1 OF 1

METRIC

W.O. 94-11005 LOCATION Sta. 10+130.1 o/s 3.9 Rt. ORIGINATED BY DK
DIST 11 HWY 519 BOREHOLE TYPE H.S. Auger COMPILED BY DD
DATUM Geodetic DATE 94 08 10 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20	40	60	80	100	W _p	W	W _L		
319.0	Ground Surface																
0.0	Silty Sand some Gravel and Organics Grey To Black Compact to Loose (Fill)		1	SS	15												
			2	SS	7												
			3	SS	7												
			4	SS	5												
315.0			5	SS	5												
4.0	Organics, Brown, Loose, (Peat)																
4.6	Organic Silty Clay																
313.2	Greenish Grey, Soft		6	SS	3												
5.8	Silt Occasional Clay Pockets Grey Very Loose to Loose		7	SS	0												
			8	SS	3												
			9	SS	8												
			10	SS	1												
307.3																	
11.7	Sand Grey Compact		11	SS	12												
308.4																	
12.6	End of Borehole • 94 08 10																

RECORD OF BOREHOLE No 8

1 OF 1

METRIC

W.O. 94-11005 LOCATION Sta. 10+162.8 a/s 4.3 Lt. ORIGINATED BY DK
DIST 11 HWY 519 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DD
DATUM Geodetic DATE 94 08 04 CHECKED BY PP

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 80 100					
319.1	Ground Surface													
0.0	Silty Sand with Gravel and Organics Grey to Brown Compact (Fill)		1	SS	16		318							
			2	SS	12									
			3	SS	10									
315.4			4	SS	13		316							
3.7	Organics Dark Brown Loose (Peat)		5	SS	6									
313.5			6	SS	5		314							
5.6	Organic Silty Clay Grey, Firm		7	SS	2		312							
	organic silt		8	TW	PH									
310.0							310							
9.1	Silt Grey, Loose to Compact		9	SS	11									
	trace sand		10	SS	8		308							
307.4														
11.7	Sand Trace Gravel and Silt Grey, Very Loose		11	SS	0									
306.1														
13.0	End of Borehole													
301.4														
17.7	End of Cone Test													
	+ 94 08 04													

RECORD OF BOREHOLE No 9

1 OF 1

METRIC

W.O. 94-11005 LOCATION Sta. 10+195.5 o/s 3.7 Rt. ORIGINATED BY DK
DIST 11 HWY 519 BOREHOLE TYPE H.S. Auger COMPILED BY DD
DATUM Geodetic DATE 94 08 10 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa											
								20 40 60 80 100											
319.6	Ground Surface																		
0.0	Silty Sand Trace of Gravel and Organics Brown to Grey Loose (Fill)		1	SS	9		319												
317.2			2	SS	10		317												
2.4	Organics, Brown, Loose, (Peat)		3	SS	2														
3.0	Organic Silty Clay		4	SS	2														
315.4	Dark Grey, Very Soft																		
4.2	Silt Trace Clay and Organics Grey to Dark Grey Very Loose		5	SS	5		315						H ^o			0 1 75 24			
			6	SS	3		313												
			7	SS	3								H	o					
310.9							311												
8.7	Sand, Trace of Silt																		
310.0	Grey and Brown, Very Loose		8	SS	0														
9.6	End of Borehole • 94 08 10																		

RECORD OF BOREHOLE No 10

1 OF 1

METRIC

W.O. 94-11005 LOCATION Sta. 10+229.2 o/s 5.1 Lt. ORIGINATED BY DK
 DIST 52 HWY 519 BOREHOLE TYPE H.S. Auger, Cone Test COMPILED BY DD
 DATUM Geodetic DATE 94 08 03 CHECKED BY PP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE * LAB VANE						
320.6	Ground Surface							20 40 60 80 100	20 40 60						
0.0	Silty Sand Some Gravel and Organics Loose (Fill)		1	SS	6								0 3 78 19 14 77 (9)		
317.7	Organics, Brown, Loose, (Peat)		2	SS	3										
317.2	Organic Silty Clay		3	SS	5										
316.0	Grey, Soft		4	SS	5										
4.6	trace organics		5	SS	6										
	Silt, trace Clay		6	SS	7										
	Grey		7	SS	2										
312.2	Loose to Very Loose		8	SS	12										
8.4	Sand Trace of Silt and Gravel Grey Compact		9	SS	**										
309.9	End of Borehole														
10.7															
308.1															
12.5	End of Cone Test * 94 08 03 ** Sampled from sand blowback in augers								120/5cm						

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

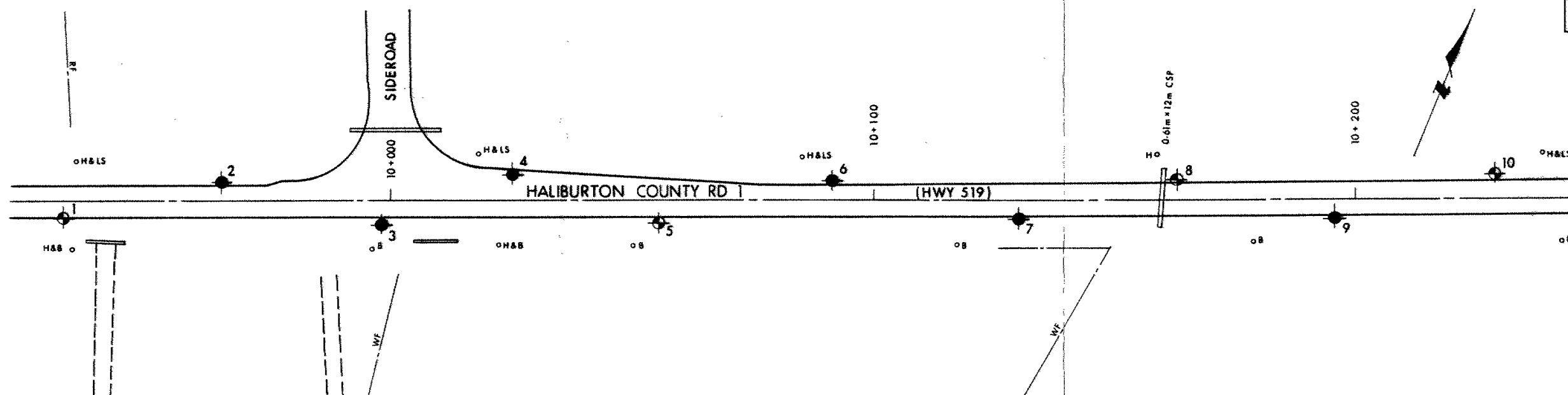
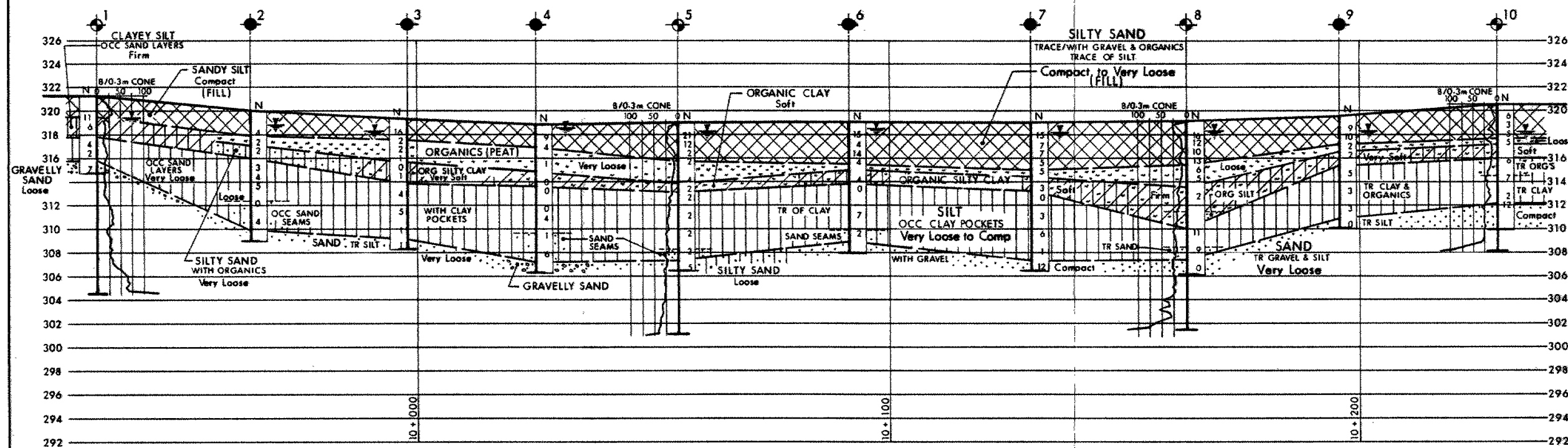
METRICDIMENSIONS ARE IN METRES
AND/OR MILLIMETRES UNLESS
OTHERWISE SHOWN. STATIONS
IN KILOMETRES + METRES.CONT No
WO No 94-11005

HALIBURTON COUNTY RD 1

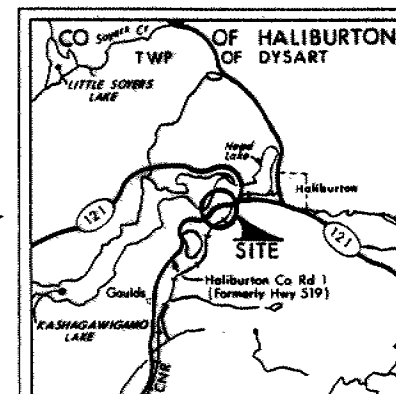
BORE HOLE LOCATIONS & SOIL STRATA



SHEET

PLAN
SCALE
10m 0 10m

C PROFILE HALIBURTON Co RD 1

SCALE
10m 0 10m Hor
2m 0 2m Vert

KEY PLAN

SCALE
1km 0 1km

LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 1994 08

No	ELEVATION	STATION	OFFSET
1	321.3	9+931.5	3.5 m Rt
2	320.0	9+964.7	3.9 m Lt
3	319.3	9+998.0	4.9 m Rt
4	318.8	10+025.0	5.3 m Lt
5	319.0	10+055.2	4.6 m Rt
6	319.0	10+091.3	4.0 m Lt
7	319.0	10+130.1	3.9 m Rt
8	319.1	10+162.8	4.3 m Lt
9	319.6	10+195.5	3.7 m Rt
10	320.6	10+229.2	5.1 m Lt

=NOTE=

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2-01 of OPS Gen Cond.

REV.	DATE	BY	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Geocres No 345-46-31E-88

HWY No HALIBURTON Co Rd 1 (Hwy 519) DIST 52

SUBMID DK / CHECKED / DATE 1995 01 19 SITE

DRAWN DT / CHECKED / APPROVED / DWG 9411005-A

