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DIST. 18 REGION

W.P. No. 195-87-01(B)

CONT. No.

W. O. No.

STR. SITE No. 48E-46

HWY. No. 17

LOCATION Hwy 17 & McKellar Creek (Approaches)

No OF PAGES -

OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

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foundation investigation and design report

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FOUNDATION DESIGN SECTION

WP 195-87-01 (B) DIST 18

HWY 17 STR SITE 48 E - 46

McKellar Creek Culvert at Highway 17

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GEOCRES 42D-16

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FOUNDATION INVESTIGATION REPORT
For
McKellar Creek Culvert at Highway 17
W.P. 195-87-01 (B), Site 48 E - 46
District 18, Sault Ste. Marie

INTRODUCTION

This report summarizes the results of a foundation investigation conducted near McKellar Creek, just north of Highway 17. The investigation was carried out upon the request of the Northwestern Region Geotechnical Section. A previous investigation carried out for the Structural Section on the proposed McKellar Creek culvert structure has revealed potential stability and settlement problems on the approaches. The current investigation intends to address these concerns. This report should therefore be read in conjunction with the Foundation Investigation Report W.P. 195-87-01 dated 91 04 25 on the McKellar Creek Culvert.

SITE DESCRIPTION

The site is located along the proposed new Highway 17 alignment at the approaches to the McKellar Creek crossing, approximately 34.5 km east of Terrace Bay in the Township of Walsh, District of Sault Ste. Marie. The area is undulating and heavily vegetated with trees.

According to the Geological Map S265 in Ontario Geological Survey Report GR 164, the site consists largely of deposits of varved or massive clay and silt and bare bedrock.

INVESTIGATION PROCEDURES

The field investigation for this project was conducted between 91 04 09 and 91 04 12 and consisted of fourteen (14) sampled boreholes generally accompanied by dynamic cone penetration tests. BH 10 was located on exposed bedrock and no drilling was carried out at this location. The grade elevation was noted. The boreholes are generally staggered evenly along the centreline and 30 m offset lines on both sides. Due to the existing terrain, some hole locations had to be adjusted from this pattern.

Trailer mounted and muskeg vehicle mounted continuous flight drilling machines equipped with hollow stem augers were used to advance the boreholes. A bulldozer was also employed to remove surficial obstructions, and to move the trailer mounted machine around the site.

The locations of the boreholes are shown on Drawing No. 1958701(B)-A. A total of 59 split spoon samples and 13 shelby tube samples were collected. The shelby tube samples provided generally undisturbed samples for detailed laboratory evaluation of the relatively soft cohesive overburden. The split spoon samples provided material for visual classification purposes and Standard Penetration Tests values for assessment of the strength of the subsoil. In addition, 18 field vane tests were carried out to determine the in situ shear strengths and sensitivity values of the cohesive material. Groundwater elevations were determined by measuring in the open boreholes.

The following laboratory tests were carried out on representative samples to identify and determine the physical properties and strength of the overburden.

- Natural Moisture Content Determinations
- Atterberg Limits
- Consolidation Tests
- Unit Weight Tests
- Unconfined Compressive Tests

SUBSURFACE CONDITIONS

The Record of Borehole sheets in the Appendix illustrates the subsurface conditions at the borehole locations. The locations and elevations of the boreholes, along with stratigraphical profiles based on the borehole data are shown on Drawing No. 1958701(B)-A.

The subsurface stratigraphy typically comprises a layer (up to 3 m) of organic material overlying silty clay to a maximum depth of 9.9 m, which is in turn underlain by a major silty sand deposit.

Organics

Organic material was contacted in most of the boreholes at the ground surface. The thickness of the material is very variable across the site. It was an organic silty sand with rootlets or woodchips in BH 5, BH 7, BH 9, BH 12 and BH 14, and an organic silty clay in BH 1, BH 3, BH 8, BH 11 and BH 13. The thickness of this organic layer is 0.8 to 3.0 m.

Silty Clay

This cohesive deposit was encountered at the ground surface or below the organic layer in the boreholes between Sta. 14+600 to 14+750 approximately, as shown in Drawing No. 1958701(B)-A. It is described as silty clay to clay. It extended to a maximum depth of 9.9 m (elevation 185.3 m) in BH 7.

The results of the laboratory testing carried out on the soil samples are as follows:

Property	Range
Natural Moisture Content (%)	27-54
Liquid Limit (%)	35-57
Plastic Limit (%)	16-28
Unit Weight (kN/cu.m)	15.9-18.5

Two consolidation tests were carried out and they indicated an average void ratio of 1.485 and an average compression index of 0.663.

An unconfined compressive test was carried out on a silty clay sample and the unconfined shear strength obtained was 20 kPa.

Field vane tests carried out on the material indicated undrained shear strengths of 19 to 39 kPa, but typically between 20 and 25 kPa. Based on this information, the consistency of the material can be described as soft to firm.

Silty Sand

This non-cohesive deposit was contacted in all boreholes underlying the organic or silty clay stratum except in BH 10 where the overburden was absent. The material was described as a fine to coarse sand with trace of gravel. It was generally in a loose to compact state, as determined by the Standard Penetration Tests and Dynamic Cone Tests. The deposit was not penetrated at the termination depths in BH 3, BH 6, BH 9 and BH 13.

GROUNDWATER CONDITIONS

Groundwater levels were measured in open boreholes after completion of the investigation. The groundwater table was typically found to be within 2 m below the ground surface, between elevations 190 to 194 m from Sta. 14+600 to 14+800 and 194 to 202 m from Sta. 14+500 to 14+600. Seasonal variation is expected.

DISCUSSIONS AND RECOMMENDATIONS

It is proposed to replace the existing timber box culvert at McKellar Creek with a concrete box culvert. The new culvert will be located under a new alignment of Highway 17 about 75 m maximum to the north of the existing alignment.

Recommendations for the construction of the structure were given in the Foundation Investigation Report W.P. 195-87-01 dated 91 04 25. A layer of soft silty clay of substantial thickness was revealed in the previous investigation. the design height of embankment is up to about 14 m as indicated in the E-plan. there are concerns on potential stability and settlement problems along the new alignment of Highway 17. In response to this, the Northwestern Region Geotechnical Section requested this office to carry out an investigation on the approaches between Sta. 14+500 to 14+800 to cover the fill portion of the new alignment. The profile of the new alignment in relation to the existing grades is shown in the longitudinal sections of Drawing No. 1958701(B)-A.

According to the field investigation data, the silty clay deposit exists approximately from Sta. 14+600 to Sta. 14+750 as indicated in Drawing No. 1958701(B)-A. It extends to depths of 3.7 to 9.9 m. A surficial layer of organic material was found over most of the site area. Based on the laboratory and in situ test results, the silty clay is soft to firm, highly compressible and in a normally consolidated state. Constructing the embankment over this material will create stability as well as settlement problems.

Excavation

All surficial organic material should be completely excavated. In addition, the silty clay should be removed as far as possible in order to minimize consolidation settlement. Excavation should be ideally carried down to the sand stratum, and be then brought up to the design grades with rockfill material. Considerations could be given to backfilling with free draining granular material if rockfill is not available. No dewatering is required during excavation and backfilling. For preliminary planning purposes, the estimated bottom of the soft clay stratum is given in Table 1.

Table 1

Highway 17 Centreline	Estimated Bottom of Excavation Elevation
14+500	202.5
14+550	197.0
14+600	192.5
14+650	187.5
14+700	186.5
14+750	189.0
14+800	190.0
Highway 17 Left 30 m	
14+500	not required
14+550	198.5
14+600	191.5
14+650	187.5
14+700	186.5
14+750	not required
14+800	not required
Highway 17 Right 30 m	
14+500	not required
14+550	not required
14+600	195.0
14+650	190.0
14+700	184.5
14+750	188.0
14+800	190.0

Excavation should be carried down to remove as much of the soft material as possible. The geometry of the excavation should be as shown in Figure 1. It is anticipated that the maximum depth of excavation is about 6 m to 7 m due to limitations in equipment. Based on the investigation results, the weak material between Sta. 14+600 and Sta. 14+710 approximately may extend beyond the excavation depth limits of a standard excavating machine. Any remaining soft material will have to be preloaded by the weight of the backfill and an additional surcharge to eliminate most of the consolidation settlement.

It is recommended that a 2 m rockfill surcharge be placed on top of the new embankment from Sta. 14+600 to 14+710 during the early stage of construction and be left there as long as possible. The surcharge should extend over the entire width of the roadway and this may necessitate minor steepening of the top portion of the embankment slope. The surcharge should taper off smoothly at a gradient of 5H:1V at both ends of the loaded area to minimize differential settlements. The preloading period should preferably be 3 months or longer. If not enough time is allowed for the preloading, excessive settlements would take place in the future and maintenance of the highway would be required.

Embankment Slopes

Following the removal of the soft clay and organic material to the sand stratum, the excavation should be backfilled and the embankment be constructed with rockfill or suitable fill material. If earth fill is used, the slopes should be formed at 2H:1V gradient with a 1 to 2 m wide berm incorporated at 9 m for embankment heights above 9 m to a maximum height of 18 m. In our opinion, 2 m wide berms may be more practical to construct. For rockfill slopes, they should be formed at 1.25H:1V up to 6 m and with a 2 m wide berm every 6 m up to a maximum height of 18 m so that no uninterrupted slope is greater than 6 m. Alternatively, rockfill slopes may be formed to 1.5H:1V gradients up to 10 m and with a 2 m wide berm every 10 m up to a maximum height of 18 m.

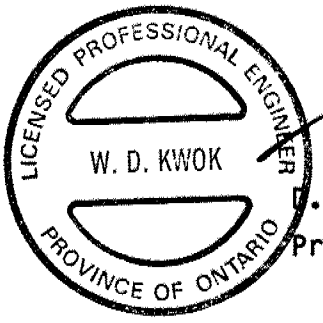
Foundation

Detailed recommendations for foundation construction are given in the Foundation Investigation Report W.P. 195-87-01 dated 91 04 25. As requested by the

Structural Section, deep foundation recommendations were also given in the report as an alternative to shallow footings. The current investigation has concluded that excavation for removal of soft clay is required in the approaches to the structure. It is therefore not recommended to employ deep foundations at this site due to concerns about possible differential settlements between the structure and the approaches.

MISCELLANEOUS

The field work for this investigation was carried out by D. Kwok, Project Foundation Engineer, and G. Dare, Engineering Student. The drilling equipment was owned and operated by Dominion Soil Investigation Ltd. The report was prepared by D. Kwok. It was reviewed by Mr. D. Dundas, Senior Foundation Engineer, and approved by Mr. M. Devata, Chief Foundation Engineer.



D. Kwok, P.Eng.
Project Foundation Engineer

M. Devata, P.Eng.
Chief Foundation Engineer

RECORD OF BOREHOLE No 1 — 1 OF 1 — METRIC

W.P. 195-87-01B — LOCATION McKellar Creek, Sta 14+500 Centreline — ORIGINATED BY DK

DIST 18 — HWY 17 — BOREHOLE TYPE Hollow Stem Auger — COMPILED BY GD

DATUM Geodetic — DATE 1991 04 11 — CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100; o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE; 10 20 30 40 50	WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
203.6 Ground Surface											
0.0 / 202.2	Organic Clay and Silt, Trace of Gravel, Brown and Grey		1	SS	13	▼	202				
1.4 / 201.3	Fine Sand, Compact, Brown		2	SS	12						
2.3	End of Borehole — Probable Bedrock							100/ 25cm			

+³, ×⁵ : Numbers refer to Sensitivity

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

RECORD OF BOREHOLE No 2 1 OF 1 METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta 14+525 Lt. 30m ORIGINATED BY GD

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY GD

DATUM Geodetic DATE 1991 04 11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE * QUICK TRIAXIAL x LAB VANE 10 20 30 40 50	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
203.1	Ground Surface										
0.0	Fine to Medium Sand, Some Gravel Brown, Loose — Silt, Trace Sand and Clay, Compact		1	SS	17	▼	202				
200.7			2	SS	7						
2.4	End of Borehole — Probable Bedrock										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 3 — 1 OF 1 — METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta. 14+575 Centreline ORIGINATED BY GD

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DK

DATUM Geodetic DATE 1991 04 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
197.6	Ground Surface										
0.0	Silty Clay, Some Organics		1	SS	3		196				
	Soft, Brown										
194.9			2	TW	PH						
2.7	Fine to Medium Sand		3	SS	8		194				
	Brown, Loose										
192.9			4	SS	70						
4.7	End of Borehole										

* Silty Sand with Gravel

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 10 20 30 40 50

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 4 1 OF 1 METRIC

W.P. 195-87-01B LOCATION McKellar Creek, Sta 14+636.5 Rt 30 m ORIGINATED BY GD

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK

DATUM Geodetic DATE 91 04 11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL × LAB VANE 10 20 30 40 50	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
198.5	Ground Surface										
0.0			1	SS	7		198			18.5	
	Brown / Grey Silty Clay to Clay Soft to Firm		2	TW	PH		196			16.2	
			3	TW	PH		194			15.9	
191.6			4	SS	3						
6.9	Fine to Coarse Sand, Trace of Clay Very Loose to Compact		5	SS	2		192				
			6	SS	13		190				
188.6	Sandy Silt with Gravel some rock fragment		7	SS	80						
9.9	End of Borehole Probable Bedrock							120/2.5cm			

+³, ×³: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5 1 OF 1 METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta 14+637.5 Centreline ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem, Cone COMPILED BY DK

DATUM Geodetic DATE 91 04 09 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
195.3	Ground Surface						
0.0 / 194.3	Organic Silty Sand Some Rootlets, Black						
1.0	Brown Grey		1	SS	4	▼	194
	Silty Clay to Clay Soft to Firm		2	TW	PH		
			3	TW	PH		192
188.5			4	SS	2		190
6.9	Fine to Medium Sand Some Silt, Trace of Gravel Loose, Grey		5	SS	0		188
186.4			6	SS	44	/23cm	
9.0	End of Borehole Probable Bedrock						

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
10 20 30 40 50

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m³: 17.2

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

100/8cm

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 6 1 OF METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta 14+706.7 Lt 30 m ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY GD

DATUM Geodetic DATE 1991 04 10 CHECKED BY DD

SOIL PROFILE			SAMPLES								
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (10 20 30 40 50)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
194.5	Ground Surface										
0.0 / 193.0	Sandy Silt with Black Organic Trace Gravel and Cobble Brown										
1.5	Silty Clay to Clay, Grey, Firm		1	SS	2	▼					
			2	TW	PH						
186.9			3	TW	PH					18.5	
7.6	Fine to Coarse Sand, Trace of Gravel, Grey, Loose to Compact		4	SS	18						
			5	SS	24						
			6	SS	7						
			7	SS	13						
171.7											
22.9	End of Borehole										

+³, x³ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 7

1 OF 1 METRIC

W.P. 195-87-01B LOCATION McKellar Creek, Sta 14+675 Centreline ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY GD

DATUM Geodetic DATE 1991 04 09 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
195.2	Ground Surface					
0.0	Organic Silty Sand Some Wood Fibres and Gravel Black		1	SS	7	
193.6						
1.5	Silty Clay to Clay Soft to Firm Grey		2	SS	1	
			3	TW	PH	
			4	TW	PH	
			5	SS	2	
185.3						
9.9	Fine Grained Fine to Medium Sand Grey, Loose		6	SS	2	
			7	SS	5	
			8	SS	1	
			9	SS	4	
			10	SS	3	
178.4						
16.8	End of Borehole Probable Bedrock				100/8cm	

ELEVATION SCALE: 194, 192, 190, 188, 186, 184, 182, 180

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: 10 20 30 40 50
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³: 17.3

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

$+^3$, $\times^5$: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 8 1 OF 1 METRIC

W.P. 195-87-01B LOCATION McKellar Creek, Sta 14+700 Rt 30 m ORIGINATED BY GD

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK

DATUM Geodetic DATE 1991 04 10 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS
190.8	Ground Surface					
0.0	Organic Clay with Rootlets		1	SS	15	
189.1	Grey					
1.5	Trace of Organic		2	SS	5	
	Silty Clay		3	TW	PH	
184.5	Grey, Firm					
6.1	Fine to Coarse Sand		4	SS	6	
	Brown and Grey					
	Loose to Compact		5	SS	8	
	with Gravel and Rock Fragment					
175.6			6	SS	65/8cm	
15.0	End of Borehole					

ELEVATION SCALE: 190, 188, 186, 184, 182, 180, 178, 176

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
10 20 30 40 50

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+5

120/23cm

+^{3}, x^5 : Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 9 1 OF 1 METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta 14+770.6 Rt 30 m ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK

DATUM Geodetic DATE 1991 04 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa o UNCONFINED + FIELD VANE • QUICK TRIAXIAL x LAB VANE 10 20 30 40 50	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
191.6	Ground Surface										
0.0 / 190.0	Organic Silty Sand Numerous Woodchips		1	SS	23						
1.5	Coarse Sand and Gravel Brown and Grey, Compact		2	SS	15		190				
			3	SS	15						
			4	SS	8		188				
	Some Silt, Grey		5	SS	19						
	Medium to Coarse Sand Grey and Brown						186				
			6	SS	14						
							184				
	with Cobbles and Boulders						182				
180.4											
11.1	End of Borehole							100/ 10cm			

+^{3}, x^5 : Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 10 1 OF 1 METRIC

W.P. 195-87-01B LOCATION McKellar Creek, Sta 14+800 Lt 30 m ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE – COMPILED BY DK

DATUM Geodetic DATE 1991 04 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 10 20 30 40 50	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
206.1											
206.0											
0.3	End of Borehole Probable Bedrock										
206.1											
0.0	End of Borehole										

+³, ×⁵: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 11 1 OF 1 METRIC

W.P. 195-87-01B LOCATION McKellar Creek, Sta 14+563.38 Rt 14.45 m ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK

DATUM Geodetic DATE 1991 04 11 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 10 20 30 40 50	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
197.9	Ground Surface										
0.0 / 197.1	Silty Clay with Organics Brown and Black					▼					
0.8	Sand and Silt Brown		1	SS	10						
195.8	Compact to Very Dense		2	SS	45	/26cm	196				
2.3	End of Borehole Probable Bedrock										

+³, ×³: Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 12 1 OF 1 METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta 14+600 Lt 30 m ORIGINATED BY GD

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK

DATUM Geodetic DATE 1991 04 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100; o UNCONFINED + FIELD VANE; • QUICK TRIAXIAL × LAB VANE; 10 20 30 40 50	WATER CONTENT (%) 20 40 60	γ kN/m^3	GR SA SI CL
198.0 Ground Surface											
0.0 / 197.1	Organic Sand										
0.9	Brown / Grey Silty Clay Soft to Firm		1	SS	8		196	+8			
			2	SS	2		194			18.1	
			3	TW	PH						
			4	SS	7		192				
191.0			5	SS	25/23cm						
190.4	Sandy Silt with Gravel, Grey										
7.6	End of Borehole Probable Bedrock							120/25cm			

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13 1 OF 1 METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta 14+865.8 Lt 30 m ORIGINATED BY GD

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Cone COMPILED BY DK

DATUM Geodetic DATE 1991 04 12 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
195.7	Ground Surface										
0.0	Silty Clay with Organics, Grey to Dark Grey, Soft		1	SS	3						
			2	SS	4		194				
192.7			3	SS	1						
3.0	Silty Clay to Clay, Soft to Firm, Grey		4	SS	1		192	+5			
			5	TW	PH		190	+3		16.7	
186.6	Clayey Silt, Trace Sand		6	SS	10		188				
9.1	Fine to Coarse Sand, Grey, Loose to Compact		7	SS	6		186				
184.6			8	SS	13						
11.1	End of Borehole										
	Probable Sand										
176.5											
19.2	End of Cone Test										

+³, ×⁵: Numbers refer to Sensitivity

15 ◇ 5 (%) STRAIN AT FAILURE (20 / 10)

RECORD OF BOREHOLE No 14 1 OF 1 METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Sta 14+778.18 Rt 5.4 m ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger, Conc COMPILED BY DK

DATUM Geodetic DATE 1991 04 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
191.6	Ground Surface							20 40 60 80 100	WATER CONTENT (%) 20 40 60	γ kN/m^3	GR SA SI CL
0.0	Organic Sand with Gravel and Numerous Woodchips Dark Brown		1	SS	43						
			2	SS	36		190				
189.4											
2.1	Coarse Sand and Gravel Brown and Grey Compact to Dense		3	SS	14						
			4	SS	41		188				
187.1											
4.4	End of Borehole Probable Bedrock							100/ 28cm			

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 10 20 30 40 50

$+^3$, $\times^3$; Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 15 1 OF 1 METRIC

W.P. 195-87-018 LOCATION McKellar Creek, Stg 14+725 Lt 30 m ORIGINATED BY DK

DIST 18 HWY 17 BOREHOLE TYPE Hollow Stem Auger COMPILED BY DK

DATUM Geodetic DATE 1991 04 12 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (10 20 30 40 50)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
194.5	Ground Surface										
0.0	Coarse Sand Cobble and Boulder						194				
			1	SS	7						
	Silty Clay Grey Firm					▼		+4			
							192				
190.8			2	TW	PH						
190.2	Medium to Coarse Sand		3	SS	1						
4.3	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 1A 1 OF 1 METRIC

W.P. 195-87-01 LOCATION Sta. 14 + 738.0, 24.4 LT. Line B ORIGINATED BY BL

DIST 18 HWY 17 BOREHOLE TYPE Cone Test, Hollow-Stem Auger, N Casing COMPILED BY BL

DATUM Geodetic DATE 90 08 21 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
193.0	Ground Surface						
0.0	Frequent Cobbles And Boulders Very Dense		1	CS	*	▼	
			2	CS	*		
			3	CS	*		
			4	SS	2		
			5	SS	2		9 71 15 5
			6	SS	2		
	Silty Sand		7	SS	2		0 88 9 3
	Very Loose		8	SS	2		
	Trace Clay Loose To Compact		9	SS	12		
			10	SS	9		
			11	SS	6		
			12	SS	4		0 92 (8)
			13	SS	25		
	Occ. Gravel Compact To Dense		14	SS	12		
177.9			15	SS	36		
15.1 176.8	End of Borehole						
16.2	End of Cone Test						

ELEVATION SCALE: 192, 190, 188, 186, 184, 182, 180, 178

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L

WATER CONTENT (%) 20 40 60

UNIT WEIGHT 7 kN/m³

120/ 30cm

• Grab sample taken by backhoe

$+^3$, $\times^5$: Numbers refer to Sensitivity

$\frac{20}{15 \diamond 5}$ (%) STRAIN AT FAILURE
10

RECORD OF BOREHOLE No 2A 1 OF 1 METRIC

W.P. 195-87-01 LOCATION Sta. 14 + 736.0, C/L Line B ORIGINATED BY BL

DIST 18 HWY 17 BOREHOLE TYPE Cone Test, Hollow-Stem Auger, N Casing COMPILED BY BL

DATUM Geodetic DATE 90 08 20 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (o UNCONFINED, + FIELD VANE, • QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
192.7	Ground Surface										
0.0	Occ. Cobbles And Boulders		1	CS	•		192			7	
	Silty Clay Trace Sand Soft To Firm		2	SS	9	▼					0 2 34 64
			3	SS	4			+3			
188.6			4	SS	2		190	+5			
4.1			5	SS	9		188				0 87 5 8
	Silty Sand Trace Clay Loose To Compact		6	SS	7						
			7	SS	7		186				0 81 15 4
			8	SS	17						
183.2	Occ. Gravel Very Dense		9	SS	63	/21cm	184				
9.5	End of Borehole										
181.9											
10.8	End of Cone Test Probable Bedrock							120/15cm			

• Grab sample taken by backhoe

+3, ×5 : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 3A 1 OF 1 METRIC

W.P. 195-87-01 LOCATION Sta. 14 + 720.0, 47.0 RT, Line 8 ORIGINATED BY BL

DIST 18 HWY 17 BOREHOLE TYPE Cone Test, Hollow-Stem Auger COMPILED BY BL

DATUM Geodetic DATE 90 08 22 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa: o UNCONFINED, • QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
190.7 Ground Surface								20 40 60 80 100	20 40 60		
0.0	Silty Sand, Occ. Organics, Compact		1	CS	•		190				
			2	SS	12						
			3	TW	PH						
			4	TW	PH		188				0 0 72 28
	Silty Clay, Trace Sand		5	TW	PH			+10, 2			
			6	SS	2						0 1 50 49
	Soft To Firm						186	6			
			7	SS	9						
			8	SS	2		184	2			
182.9											
7.8			9	SS	6				o		0 65 33 2
	Silty Sand, Trace Clay, Compact						182				
			10	SS	10						
			11	SS	6		180				
178.1			12	SS	10						3 79 12 6
12.6	End of Borehole										
172.1											
18.6	End of Cone Test										
	• Grab sample taken by backhoe										

+^{3}, ×^{5}: Numbers refer to Sensitivity

15 $\frac{20}{10}$ S (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 4A 1 OF 1 METRIC

W.P. 195-87-01 LOCATION Sta. 14 + 727.6, 23.6 RT. Line B ORIGINATED BY BL

DIST 18 HWY 17 BOREHOLE TYPE Cone Test COMPILED BY BL

DATUM Geodetic DATE 90 08 22 CHECKED BY DD

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)		GR SA SI CL
181.3 Ground Surface								20 40 60 80 100	20 40 60		
0.0	Probable Silty Clay Soft To Firm						190 188				
186.4							186				
4.9	Probable Silty Sand Loose To Compact						184 182 180 178				
176.4											
14.9	End of Cone Test							120/10cm			

+^{3}, ×^{5} : Numbers refer to Sensitivity

20 / 15 ◇ 5 / 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 5A 1 OF 1 METRIC

W.P. 195-87-01 LOCATION Sta. 14 + 740.0, 14.0 LT. Line B ORIGINATED BY BL

DIST 18 HWY 17 BOREHOLE TYPE Cone Test COMPILED BY BL

DATUM Geodetic DATE 90 08 22 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH kPa: o UNCONFINED, * QUICK TRIAXIAL, + FIELD VANE, x LAB VANE	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
193.3 Ground Surface								20 40 60 80 100	20 40 60		
0.0	Probable Occ. Cobbles And Boulders						192				
	Probable Silty Clay Soft To Firm						190				
189.2							188				
4.1	Probable Silty Sand Loose To Compact						186				
182.3							184				
11.0	End of Cone Test Probable Bedrock							120/25cm			

$+^3$, x^5 ; Numbers refer to Sensitivity

$\frac{20}{15}\diamond\frac{5}{10}$ (%) STRAIN AT FAILURE

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 (R Q D), 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
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX = $w_L - w_P$
I_L	1	LIQUIDITY INDEX = $\frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE
e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

APPENDIX

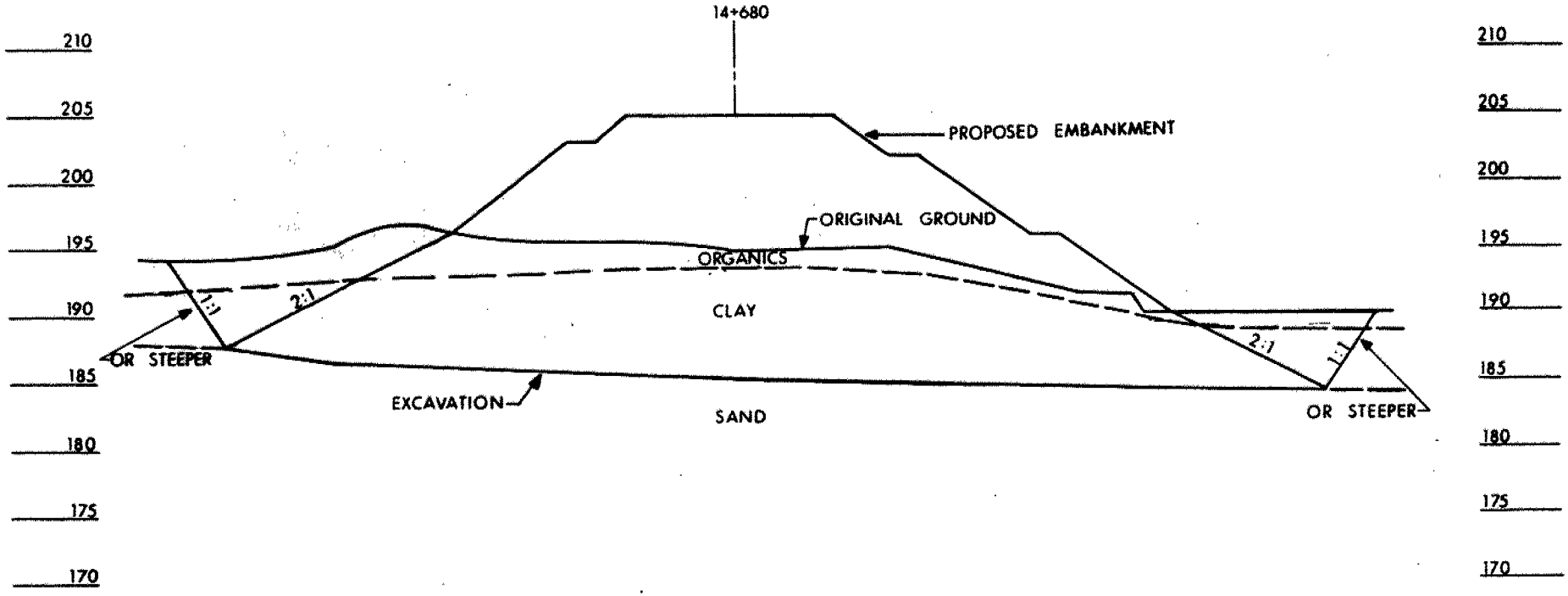
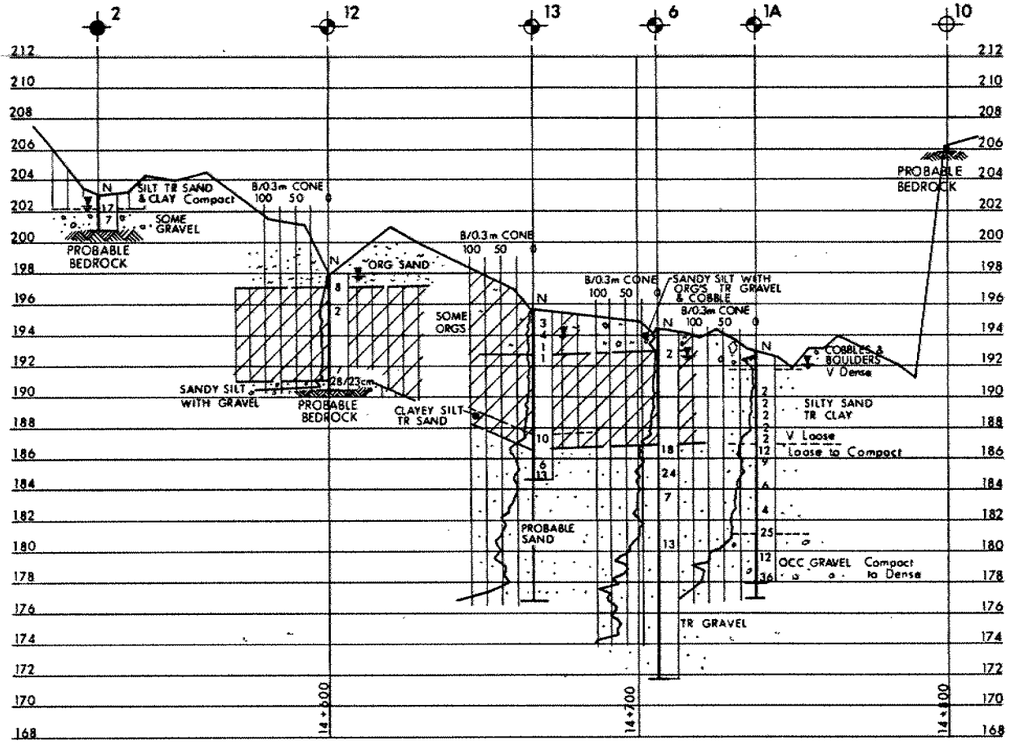
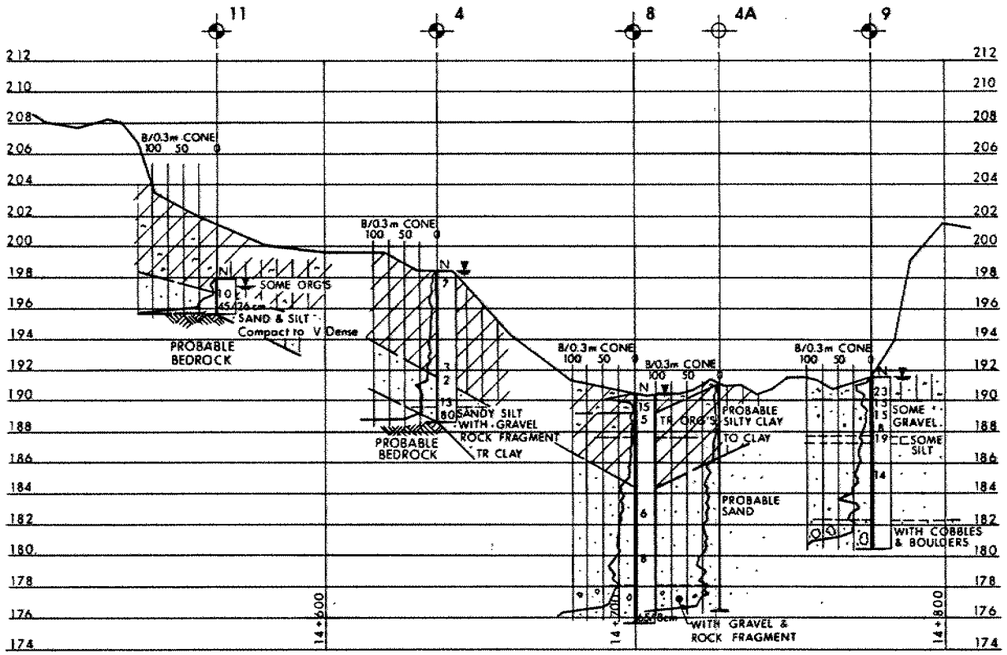


Fig 1 - EXCAVATION GEOMETRY



A-A



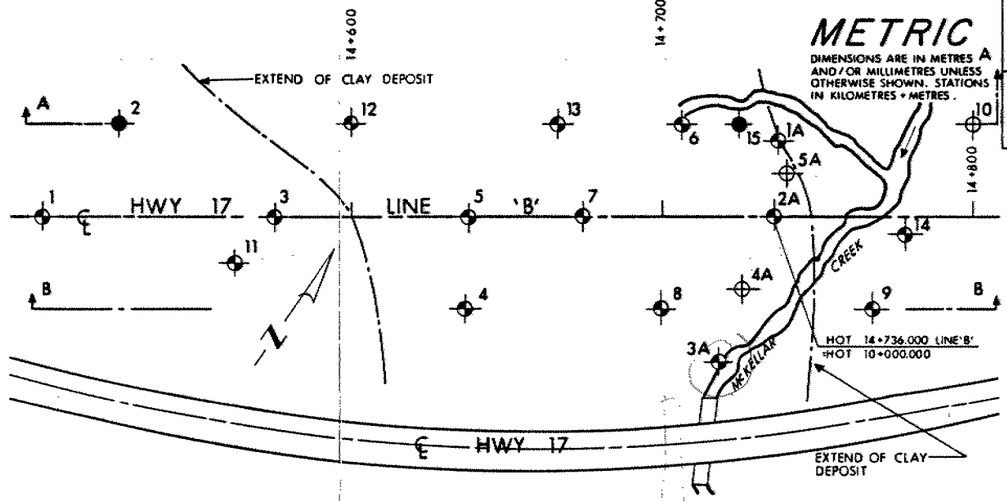
B-B

SECTIONS

SCALE

20m 10 0 20m Hor

4m 2 0 4m Vert

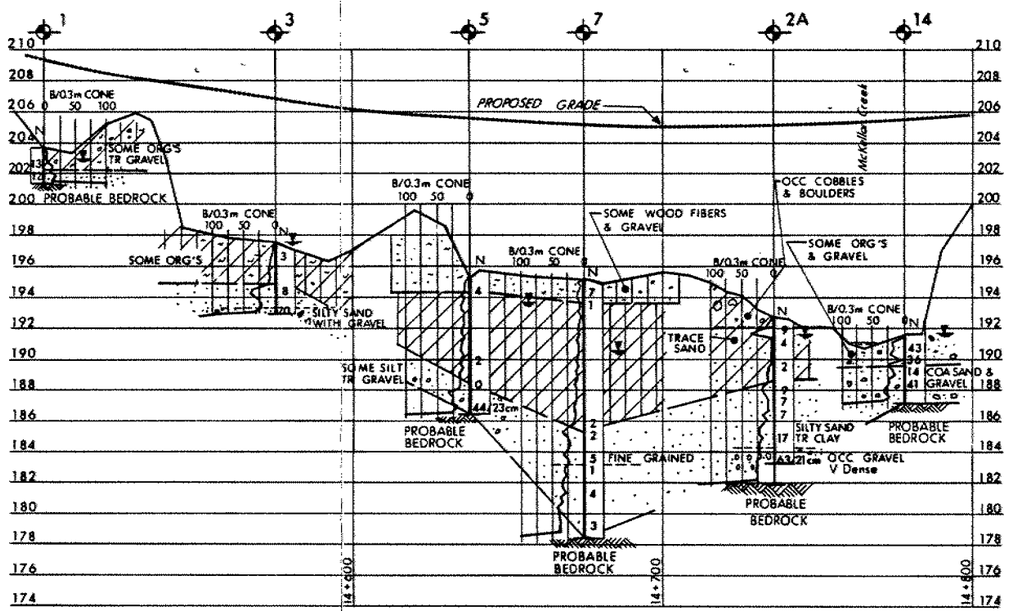


PLAN

SCALE

20m 0 20m

NOTE: FOR SUBSOIL INFORMATION FOR BH'S 3A, 5A, 10 & 15 SEE RECORD OF BOREHOLE.

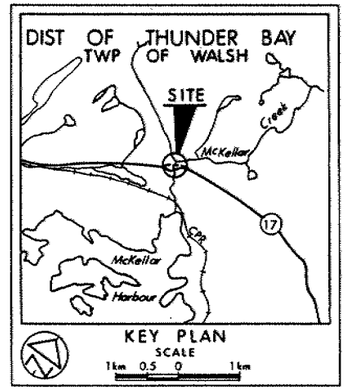


℄ PROFILE HWY 17 LINE 'B'

SCALE

20m 10 0 20m Hor

4m 2 0 4m Vert



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 1991 04, 1990 08

No	ELEVATION	STATION	OFFSET
1	203.6	14+500	℄
2	203.1	14+525	30m Lt
3	197.6	14+575	℄
4	198.5	14+636.5	30m Rt
5	195.3	14+637.5	℄
6	194.5	14+706.7	30m Lt
7	195.2	14+675	℄
8	190.6	14+700	30m Rt
9	191.6	14+770.6	30m Rt
10	206.1	14+800	30m Lt
11	197.9	14+563.3	14.45m Rt
12	198.0	14+600	30m Lt
13	195.7	14+665.8	30m Lt
14	191.6	14+778.1	5.4m Rt
15	194.5	14+725	30m Lt
1A	193.0	14+738	24.4m Lt
1990 08 2A	192.7	14+736	℄
3A	190.7	14+720	47m Rt
4A	191.3	14+727.6	23.6m Rt
5A	193.3	14+740	14m Lt

STRATIGRAPHY LEGEND

- ORGANIC CLAY
- SILTY CLAY TO CLAY Soft to Firm
- ORGANIC SILTY SAND
- SAND FINE TO COARSE Compact to V Loose

NOTE

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

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

REV.	DATE	BY	DESCRIPTION

Geocres No 42 D-16

HWY No 17			DIST 18
SUBMD DK	CHECKED	DATE 1991 08 01	SITE 48E-46
DRAWN KM	CHECKED	APPROVED	DWG 1958701 (B)

CONT No

WP No 195-87-01(B)

McKELLAR CREEK

BORE HOLE LOCATIONS & SOIL STRATA

SHEET