

**FOUNDATION INVESTIGATION REPORT
EAGLE LAKE ROAD UNDERPASS
HIGHWAY 11, BURK'S FALLS TO SOUTH RIVER
ONTARIO
G.W.P. 759-93-00, W.P. 5040-03-01, SITE 44-413
Geocres Number: 31E-197**

Report to

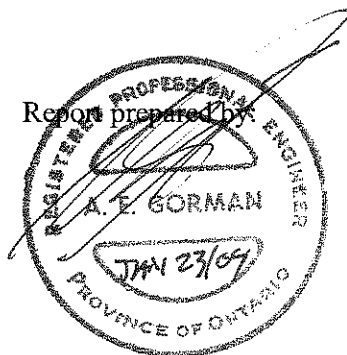
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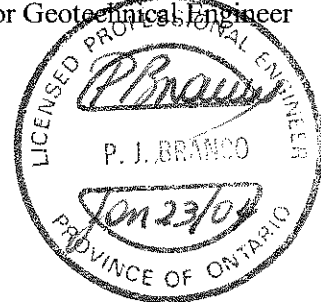
January 23, 2004

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AEG\CA\19\1423\12 Hwy 11\Bridges\413 Eagle Lake Rd\NEW EAGLE FNDN
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**FOUNDATION INVESTIGATION REPORT
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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation at the Eagle Road Underpass (Site 44-413) on Highway 11, near South River, in the Township of Machar, Ontario. The proposed underpass structure is expected to consist of a two-span structure with a total of three foundation elements: two abutments and one centre pier. The centreline of the proposed structure will lie approximately 30m north of the existing Eagle Lake Road centreline.

Golder Associates Ltd. (Golder) carried out an investigation in February of 2000 at the site and the factual data from that investigation was available to be used in the current assignment.

The purpose of the present investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile and cross-sections and a written description of the subsurface conditions. A model of the subsurface conditions was developed through considering a combination of the data from the previous Golder report and the data obtained in the course of the present investigation.

Thurber carried out the investigation as a sub-consultant to Marshall Macklin Monaghan, under the Ministry of Transportation Ontario (MTO) Agreement Number 6005-A-000188.

2 SITE DESCRIPTION

The bridge site is located approximately 30m north of Eagle Lake Road, a short distance outside the boundary of South River in Machar Township.

The general site area is located within the physiographic region known as the Canadian Shield, characterized by Pre-Cambrian bedrock typically occurring as rounded knobs and ridges where exposed. The ground is locally undulating with local relief of 1m to 2m, rising to the east and to the north. The bridge site is well drained with drainage to the southeast into a swampy area and a creek approximately 400m southwest of the proposed structure.

The land is wooded with typically second growth softwoods, mostly spruce and cedar.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between April 23 and April 28, 2003. The site investigation consisted of drilling and sampling four boreholes (Boreholes 413-1 through 413-4) to depths ranging from 6.7 to 37.2m. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing.

Surveyors from Marshall Macklin Monaghan Ltd. marked the borehole locations in the field and utility clearances were obtained by Thurber prior to any drilling being carried out.

All-Terrain Drilling supplied and operated the drilling and sampling equipment, mobilizing from Waterloo, Ontario. A combination of hollow stem auger and rotary drilling techniques were used to advance the boreholes and samples were obtained using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

Borehole 413-1 was drilled to 6.7m depth to provide information for the design of the West approach embankment to the underpass structure. Borehole 15-1 by Golder was used to provide subsurface conditions for the design of the East approach embankment.

Boreholes 413-2, 413-3 and 413-4 were drilled to 37.2m, 29.1m and 18.3m depth at the West abutment, central pier and south abutment locations, respectively. These boreholes were advanced to obtain information relating to the subsurface conditions for the design of the underpass structure foundation elements.

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full time basis. The inspector logged the boreholes and the recovered samples and processed them for transport to Thurber's Oakville office.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in Appendix A.

Selected samples were subjected to gradation analysis (sieve and hydrometer) and the results are shown on the Record of Borehole sheets in Appendix A and on the charts in Appendix B. A total of eighteen samples were selected for this testing

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A and to the Record of Borehole sheets prepared by Golder included in Appendix C. Details of the encountered soil stratigraphy are presented in these appendices and on the attached Borehole Locations and Soil Strata Drawings. A description of the stratigraphy is given in the following paragraphs.

In general terms, the site was found to be underlain by compact to very dense granular soils. The granular soils consist of mostly fine-grained sand to 10m to 15m. Below these depths the sand becomes coarser, gravelly, with occasional cobbles and boulders. Fill, topsoil and sand with organics were present at or near the ground surface, as described in the following paragraphs.

5.2 Topsoil and Fill

Topsoil in depths ranging from 150 to 200 mm was encountered in Boreholes 413-2, 413-3, 413-4, G-3 and G-4. The topsoil was sandy with a comparatively low organic content and was generally dry.

Fill to 0.76m depth, consisting of sand and gravel was encountered in Borehole 15-1 by Golder.

No topsoil or fill was encountered at the remaining boreholes.

5.3 Sandy Silt/Silty Sand

The near-surface soils were found to be somewhat variable in composition, ranging from sandy silt to silty sand.

At the West approach and West abutment, the soil is described as sandy silt, moist and brown. Based on SPT values ranging from 8 to 22, the sandy silt is described as loose to compact. The thickness of the sandy silt ranged from 2.2 to 2.3 m.

At the east approach and east abutment, the soil is described as silty sand, dry to moist and brown. Based on SPT values ranging from 7 to 22, the sandy silt is described as loose to compact. The thickness of the sandy silt ranged from 2.2 to 3.7 m.

At the middle of the site (Borehole 413-3) and sandy silt and silty sand were not encountered.

5.4 Sand

The material underlying the surficial soils consisted of an extensive deposit of fine-grained sand, with variable amount of silt and gravel size particles, possibly with occasional cobbles and boulders at depth. Gradation tests indicated that this material consists typically of 90% to 98% sand and 2% to 10% fines (silt and clay size particles). Increased gravel content was detected from visual observation and monitoring of the drill performance generally between Elev. 323 and Elev. 327. A silt lens was encountered in Golder Borehole 15-3 between Elev. 328.8 and Elev. 330.4.

The thickness of the sand layer increases in a northerly direction from 12.5 m at BH 413-4 to a maximum encountered thickness of 29.9 m at BH 413-2 at the West abutment. The top of the sand layer lies at elevations ranging from Elev. 338.4 at the West abutment (Borehole 413-2) to Elev. 337.7 at the east abutment (Borehole 413-4). The underside of

the sand layer lies at elevations ranging from Elev. 325.2 at the east abutment (Borehole 413-4) to Elev. 308.5 at the West abutment (Borehole 413-2).

Based on SPT values generally ranging from 10 to 30 blows for 0.3 m of penetration, the sand is described as compact. Occasional lower SPT values are attributed to silt lenses or sample disturbance. Below Elev. 320 at the West abutment (Borehole 413-2), the SPT values increase to the range of 25 to 58 blows for 0.3 m of penetration, indicating that the sand layer becomes compact to very dense below that elevation.

Borehole 413-1 and Golder's Boreholes 15-1, 15-3 and 15-4 terminated in this sand layer.

5.5 Gravelly Sand With Cobbles and Boulders

The sand layer was found to be underlain by a layer of gravelly sand with cobbles and boulders. Gradation tests indicated that this material consists typically of 9% to 45% gravel, 41% to 78% sand and 13% to 18% fines (silt and clay size particles). Gradation tests are carried out on the gravel size and finer material recovered in the split spoon sample and therefore represent the matrix between the cobbles and boulders. The presence of cobbles and boulders was inferred from the behaviour of the drilling and sampling tools.

This layer was not fully penetrated in any of the boreholes, but was proved to a thickness of 2.2 m at Golder Borehole 15-2 and 6.6 m at Borehole 413-2. The elevation of the top of this layer coincides with the underside of the sand layer described above. The underside of the layer was not established, but Boreholes 413-2, 413-3, 413-4 and Golder Borehole 15-2 terminated in the layer at elevations ranging from Elevation 321.6 at the east abutment (Borehole 413-4) to Elevation 301.9 at the West abutment (Borehole 413-2).

Based on SPT values generally ranging from 48 to more than 100 blows for 0.3 m of penetration, this layer is described as very dense.

Sampling in the current investigation was continued to prove 3 m of material with SPT values of at least 100 blows for 0.3 m of penetration, defined as "refusal". Table 1 below summarizes the approximate elevations at which "refusal" was encountered.

Table 1 – Refusal Elevations

Borehole	Location	Refusal Elevation (m)
413-2	West Abutment	307.0
413-3	Centre pier	312.5
413-4	East Abutment	324.5

5.6 Water Levels

Groundwater levels at this site measured within standpipe piezometers in the spring of 2000 and summer of 2003 were encountered between EL. 329.6m and EL. 330.7m as shown in Table 2, below.

Table 2 – Groundwater Depths (in metres) and Elevations

Date	BH 413-2		BH 413-3		BH 413-4		G 15-2	
	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.
Feb. 12, 2000	-	-	-	-	-	-	12.3	327.5
March 8, 2000	-	-	-	-	-	-	9.1	330.7
March 25, 2000	-	-	-	-	-	-	10.5	329.3
June 20, 2003	9.4	329.6	8.7	329.8	10.3	329.6	-	-

The above values are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after the spring snow melt or after periods of heavy rainfall.

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

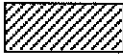
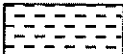
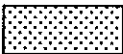


 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

<u>ROCK WEATHERING CLASSIFICATION</u>		<u>SYMBOLS</u>
Fresh (FR)	No visible signs of weathering.	
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.	 CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.	 SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.	 SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.	 COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.	 BENTONITE

<u>DISCONTINUITY SPACING</u>		<u>STRENGTH CLASSIFICATION</u>			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 200	Greater than 29,200	Requires many blows of geological hammer to break.
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-200	14,600 to 29,200	Requires a few blows of geological hammer to break.
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,300 to 14,600	Breaks under single blow of geological hammer.
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Moderately Strong	12.5 to 50.0	1,825 to 7,300	¼" indentations with sharp end of geological pick.
<u>TERMS</u>		Moderately Weak	5.0 to 12.5	730 to 1,825	Too hard to cut by hand into triaxial specimen.
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Weak	1.25 to 5.0	182 to 730	Crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.				
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.	Very Weak (Rock)	0.60 to 1.25	85 to 182	May be broken in the hand with difficulty.
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No BH 413-1

1 OF 1

METRIC

W.P. 5040-03-1 LOCATION N 5 079 147.5 E 313 277.7 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
 DATUM Geodetic DATE 25.04.03 - 25.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					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 (%)
								20 40 60 80 100							
339.6															
0.0	Sandy SILT, trace clay Compact Grey Moist (non-plastic)														
			1	SS	22										
			2	SS	17										
337.4															
2.2	SAND, fine grained, some silt Compact Brown Dry														
			3	SS	15										
			4	SS	14										
			5	SS	13										
			6	SS	15										
332.9															
6.7	END OF BOREHOLE AT 6.71m.														

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 413-2

2 OF 4

METRIC

W.P. 5040-03-1 LOCATION N 5 079 128.5 E 313 286.5 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
DATUM Geodetic DATE 28.04.03 - 29.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
	Trace to some gravel between elevation 326m and elevation 327		9	SS	15										
				10	SS	15									
				11	SS	20									
	Becoming fine grained, trace to some silt Compact to very dense		12	SS	15										
				13	SS	3/ 102									
			14	SS	27										

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Sensitivity 20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 413-2

3 OF 4

METRIC

W.P. 5040-03-1 LOCATION N 5 079 128.5 E 313 286.5 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
DATUM Geodetic DATE 28.04.03 - 29.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
			15	SS	30		319					
							318					
			16	SS	25		317					
							316					
			17	SS	58		315					
							314					
			18	SS	45		313					
							312					
			19	SS	48		311					
							310					
			20	SS	34							
			21	SS	12							
	Compact to very dense Grey Wet											

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+³, ×³: Numbers refer to
Sensitivity

20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 413-2

4 OF 4

METRIC

W.P. 5040-03-1 LOCATION N 5 079 128.5 E 313 286.5 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
 DATUM Geodetic DATE 28.04.03 - 29.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								○ UNCONFINED + FIELD VANE				
								● QUICK TRIAXIAL × LAB VANE				
						WATER CONTENT (%)						
						20 40 60 80 100			20 40 60			
309.0												
30.1	Gravelly SAND , trace to some silt, occ. cobbles and boulders Very dense		22	SS	68							
			23	SS	100/ 140							
			24	SS	91							
			25	SS	100/ 127							
			26	SS	50/ 250							
301.9												
37.2	END OF BOREHOLE AT 37.19m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEVATION(m) 20/06/03 9.44 329.61											

ONTMT4 413EAGLE.GPJ 02/02/04

RECORD OF BOREHOLE No BH 413-3

1 OF 4

METRIC

W.P. 5040-03-1 LOCATION N 5 079 083.5 E 313 288.1 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
 DATUM Geodetic DATE 24.04.03 - 24.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80		
338.5													
0.0	TOPSOIL, some roots												
338.2	Brown												
0.2	SAND, fine grained, trace to some silt												
	Compact												
	Brown												
	Dry												
			1	SS	21		338						0 80 20 (SI+CL)
			2	SS	11		337						
			3	SS	18		336						
			4	SS	14		335						
							334						
			5	SS	16		333						0 96 4 (SI+CL)
							332						
			6	SS	29		331						
			7	SS	29		330						
							329						
			8	SS	14								

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+ ³ x ³ : Numbers refer to
Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 413-3

2 OF 4

METRIC

W.P. 5040-03.1 LOCATION N 5 079 083.5 E 313 288.1 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
 DATUM Geodetic DATE 24.04.03 - 24.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				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	20 40 60 80 100	20 40 60 80 100		
	Becoming fine to medium grained, trace silt Wet		9	SS	24		328						0 92 8 (SI+CL)
							327						
	Trace to some gravel between elevation 327m and elevation 323m		10	SS	24		326						
							325						
			11	SS	22		324						
							323						
			12	SS	22		322						
							321						
	Becoming fine grained, trace silt		13	SS	26		320						0 98 2 (SI+CL)
			14	SS	21		319						

Continued Next Page

+ 3 . x 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 413-3

3 OF 4

METRIC

W.P. 5040-03-1 LOCATION N 5 079 083.5 E 313 288.1 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
DATUM Geodetic DATE 24.04.03 - 24.04.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT Y 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 + FIELD VANE										
								● QUICK TRIAXIAL × LAB VANE										
						20	40	60	80	100	20	40	60					
			15	SS	18													
			16	SS	25													
			17	SS	40													
			18	SS	48													
313.0																		
25.5	Gravelly SAND, trace to some silt, occ. cobbles and boulders Wet		19	SS	153													
			20	SS	100/ .114													
309.4			21	SS	100/ .15													
29.1	END OF BOREHOLE AT 29.11m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.																	

Continued Next Page

+ 3 × 3 : Numbers refer to
Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No BH 413-3

4 OF 4

METRIC

W.P. 5040-03-1 LOCATION N 5 079 083.5 E 313 288.1 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
 DATUM Geodetic DATE 24.04.03 - 24.04.03 CHECKED BY AEG

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					
	WATER LEVEL READINGS DATE DEPTH(m) ELEVATION(m) 20/06/03 8.66 329.8													

ONTMT4 413EAGLE.GPJ 02/02/04

RECORD OF BOREHOLE No BH 413-4

1 OF 2

METRIC

W.P. 5040-03-1 LOCATION N 5 079 045.1 E 313 298.4 (Eagle Lake Road) SITE 44-413 ORIGINATED BY DP
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS
 DATUM Geodetic DATE 23.04.03 - 23.04.03 CHECKED BY AEG

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								WATER CONTENT (%)				
								○ UNCONFINED	+ FIELD VANE											
								● QUICK TRIAXIAL	× LAB VANE											
339.9								20	40	60	80	100	20	40	60					
339.9	TOPSOIL																			
0.2	Brown																			
	Silty SAND, fine grained																			
	Loose to compact																			
	Brown																			
	Dry		1	SS	8		339						○							
			2	SS	15		338						○							
337.7	Silt seam												○							
2.2	SAND, fine to medium grained, trace silt																			
	Compact to dense		3	SS	47		337						○				0 94 6 (SI+CL)			
	Brown																			
			4	SS	30								○							
							336													
			5	SS	18		335						○							
							334													
			6	SS	15								○				0 97 3 (SI+CL)			
							333													
			7	SS	16		332						○							
							331						○							
			8	SS	28								○							
							330													
	Wet																			

Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

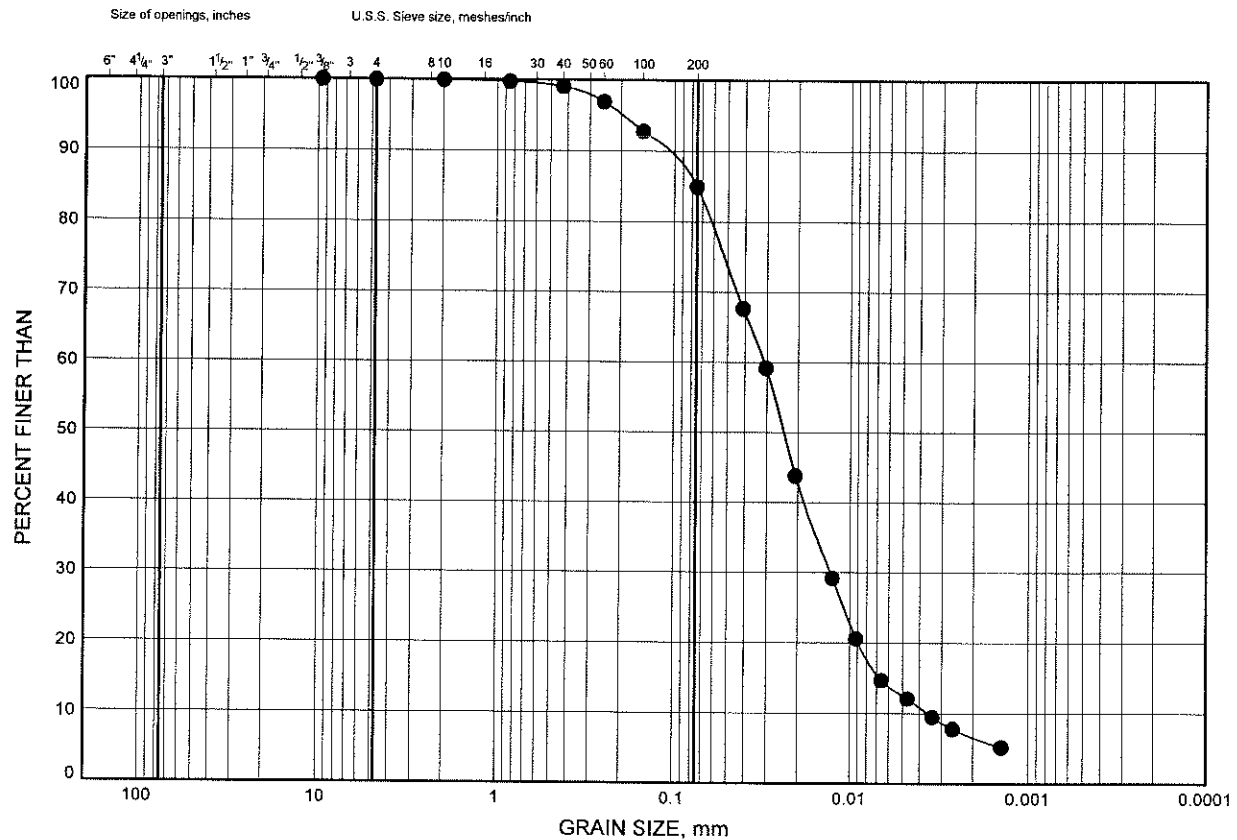
Appendix B

Laboratory Test Results

Hwy 11 Four Laning GRAIN SIZE DISTRIBUTION

FIGURE B1

SILT, some sand

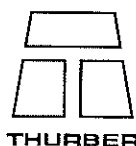


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 413-1	1.83	337.79

Date January 2004

Project 759-93-00



Prep'd SS

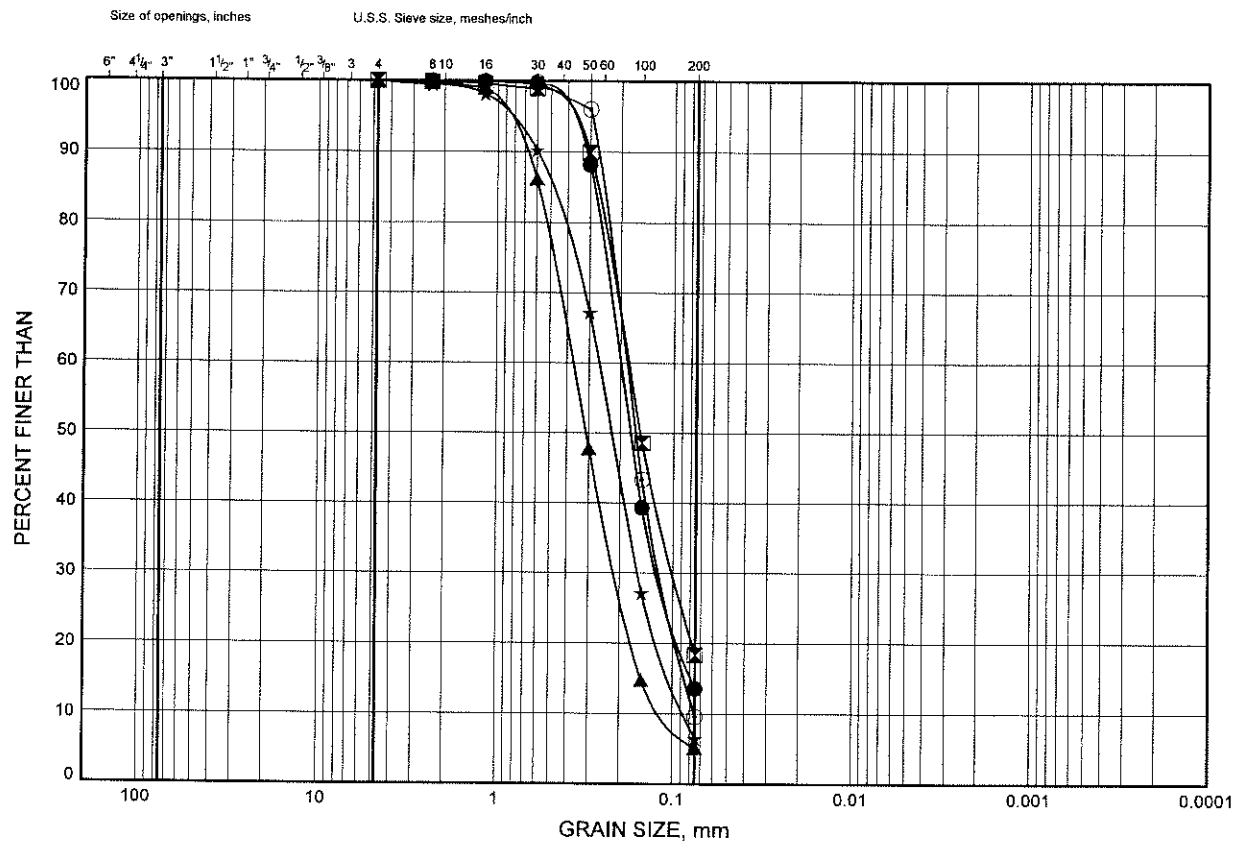
Chkd. AEG

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND, trace to some silt

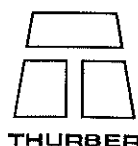


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 413-1	3.35	336.27
⊠	BH 413-2	3.35	335.70
▲	BH 413-2	9.45	329.60
★	BH 413-2	18.59	320.46
⊙	BH 413-2	26.21	312.84

Date January 2004

Project 759-93-00



Prep'd SS

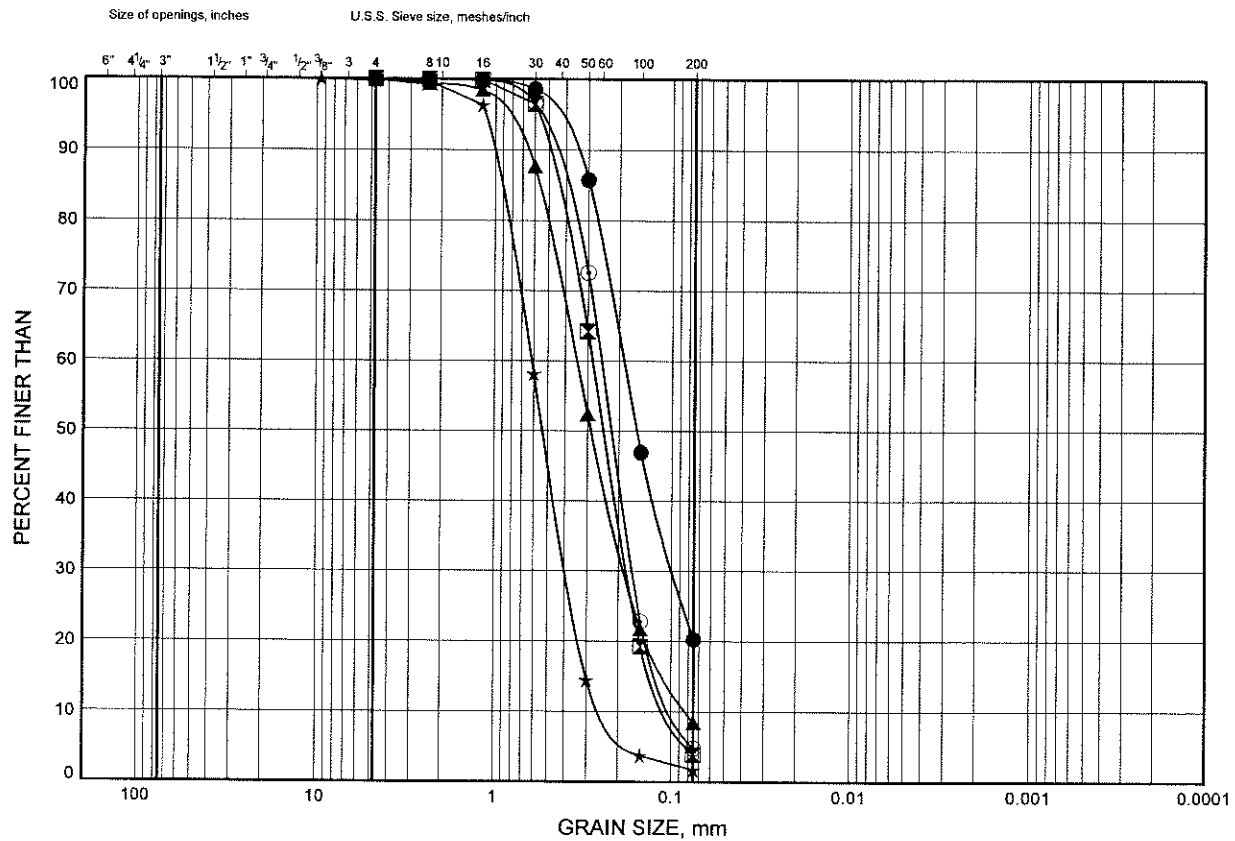
Chkd. AEG

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B3

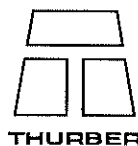
FINE SAND, trace to some silt



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 413-3	1.07	337.39
⊠	BH 413-3	4.88	333.58
▲	BH 413-3	10.97	327.49
★	BH 413-3	18.59	319.87
⊙	BH 413-3	21.64	316.82

Date January 2004
Project 759-93-00



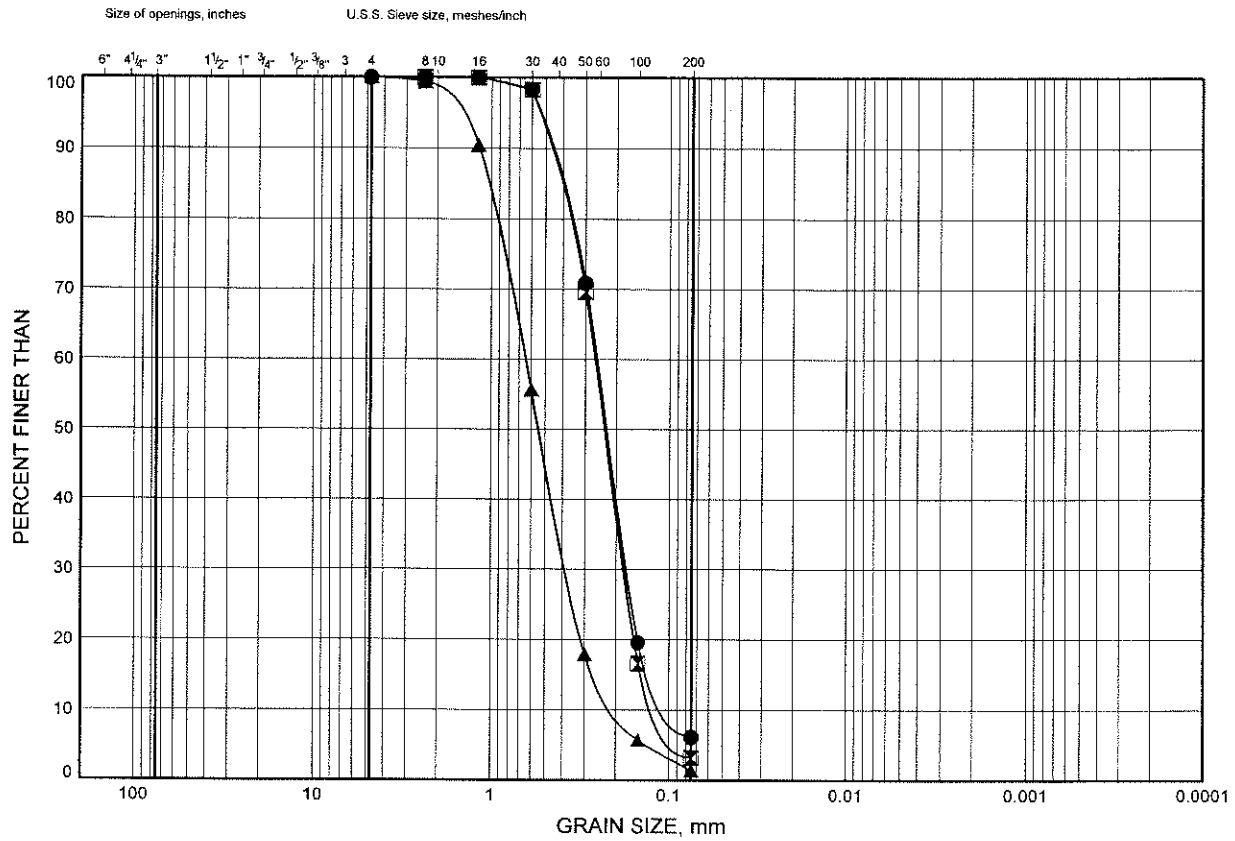
Prep'd SS
Chkd. AEG

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND, trace to some silt

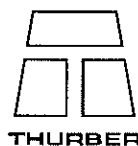


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 413-4	2.59	337.32
⊠	BH 413-4	6.40	333.51
▲	BH 413-4	10.97	328.94

Date January 2004

Project 759-93-00



Prep'd SS

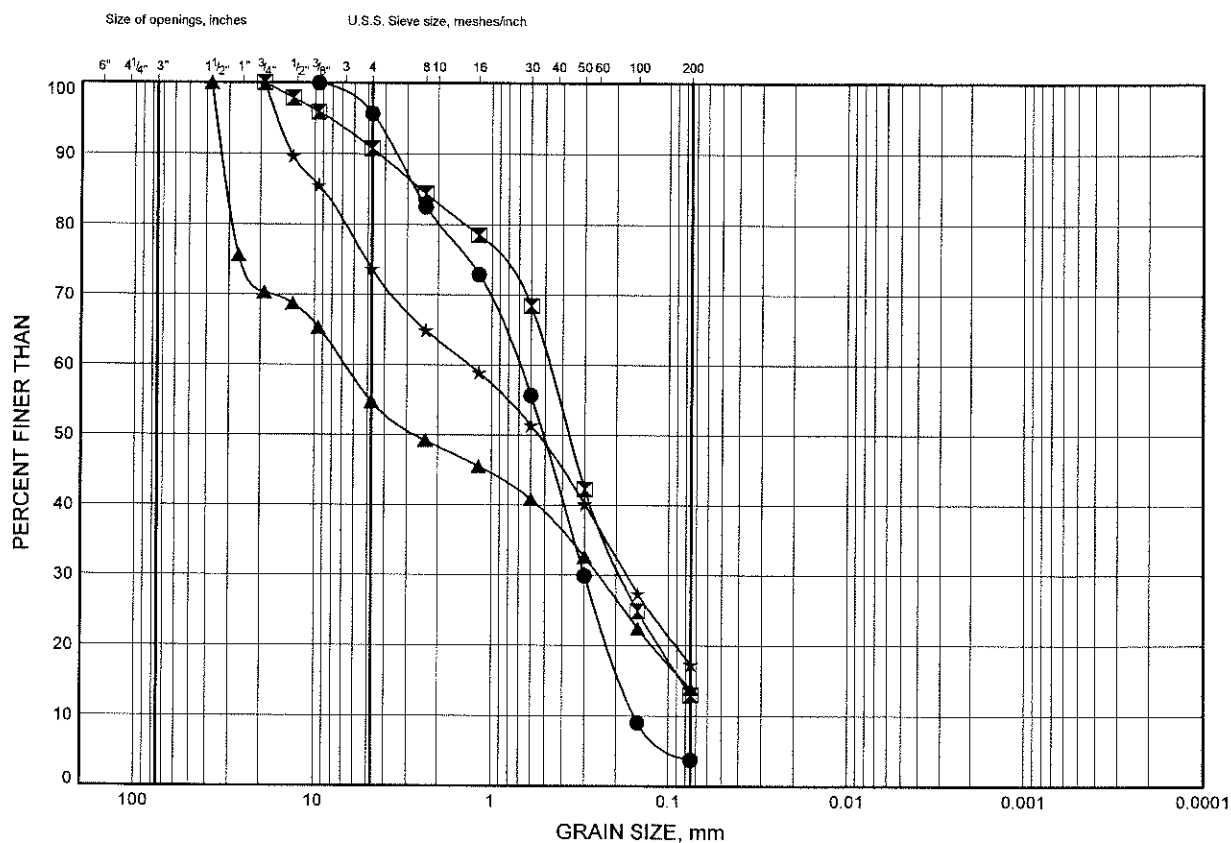
Chkd. AEG

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND AND GRAVEL, some silt

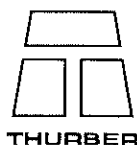


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 413-2	14.02	325.03
⊠	BH 413-2	33.83	305.22
▲	BH 413-3	26.21	312.25
★	BH 413-4	15.54	324.37

Date January 2004

Project 759-93-00



Prep'd SS

Chkd. AEG

Appendix C

Data From Golder Report

PROJECT 991-1193			RECORD OF BOREHOLE No 15-1			1 OF 1			METRIC				
W.P. 335-98-00			LOCATION N 5079031.29; E 313304.69			ORIGINATED BY SB							
DIST 54 HWY 11			BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS			COMPILED BY DKB							
DATUM GEODETTIC			DATE Feb 13/00			CHECKED BY ASP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID UNIT WEIGHT REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	Y	GR SA SI CL
340.50	GROUND SURFACE												
0.00	Sand and Gravel, trace silt Brown Moist (Fill)						340						
339.74							339						
0.76	Silty Sand Loose to compact Brown Moist		1	SS	7								
			2	SS	19								
			3	SS	22		338						
337.53													
2.97	Silt, some sand, little clay Compact Brown Moist		4	SS	19		337						
336.80	non-plastic Atterberg limits test result for Sample 4.												
3.70	Sand, trace silt Compact Brown Moist		5	SS	24		336						
			6	SS	16								
335.32													
5.18	END OF BOREHOLE												
	Note: Open borehole dry upon completion of drilling.												

ON MOT 991-1193 GPJ ON MOT.GDT 24/4/00

ON MOT 991-1193.GPJ ON MOT.GDT 24/4/00

+3, X3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 991-1193			RECORD OF BOREHOLE No 15-2			2 OF 2			METRIC				
W.P. 335-98-00			LOCATION N 5079051.29, E 313301.86			ORIGINATED BY SB							
DIST 54 HWY 11			BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS			COMPILED BY DKB							
DATUM GEODETIC			DATE Feb. 12/00			CHECKED BY ASP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
	— CONTINUED FROM PREVIOUS PAGE —												
323.45	Sand, trace silt Compact Brown Moist to wet		13	SS	16		324						
16.31	Gravelly Sand, some silt, occ. cobbles and/or boulders Very dense Brown Wet		14	SS	10/9/11		323						30 52 18 0
321.22	Boulder cored from 18.0m to 18.4m depth		15	SS	10/9/11		322						
18.54	END OF BOREHOLE						321						
320.38	END OF CONE HOLE Refusal to further cone penetration; probable boulder												
19.38	Note: 1. Water level measured in piezometer at 12.3m depth (El. 327.5m) upon completion of installation. 2. Water level measured in piezometer at 9.1m depth (El. 330.7m) on March 8, 2000. 3. Water level measured in piezometer at 10.5m depth (El. 329.3m) on March 26, 2000.												

ON MOT 991-1193 GPJ ON MOT GDT 26/4/00

PROJECT 991-1193		RECORD OF BOREHOLE No 15-3		1 OF 2 METRIC	
W.P. 335-98-00		LOCATION N 5079108 32; E 313282		ORIGINATED BY SB	
DIST 54 HWY 11		BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS		COMPILED BY DKB	
DATUM GEODETIC		DATE Feb. 13/00		CHECKED BY ASP	

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						
								○ UNCONFINED 20 40 60 80 100	+ FIELD VANE 20 40 60 80 100					
336.00	GROUND SURFACE													
0.00	Topsoil													
0.15	Silty Sand, trace wood fragments and roots													
335.24	Brown Moist													
0.76	Sand, trace silt		1	SS	8									
	Loose to compact													
	Brown Moist		2	SS	15									
			3	SS	15									
			4	SS	13									0 90 10 0
			5	SS	11									
			6	SS	13									
330.36	Silt, some sand, little clay													
5.64	Compact		7	SS	15									
	Brown Wet													
328.84	Sand, trace silt													
7.16	Loose to compact		8	SS	7									
	Brown Wet													
326.40	Gravelly Sand, trace to some silt													
9.60	Dense to compact		9	SS	11									
	Brown Wet		10	SS	31									20 78 2 0
			11	SS	16									
322.74	Sand, trace silt													
13.26	Compact to loose		12	SS	10									
	Brown Wet													

Continued Next Page

+ 3 . X 3. Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON MOT 991-1193.GPJ ON MOT.GDT 24/4/00

PROJECT 991-1193			RECORD OF BOREHOLE No 15-3			2 OF 2		METRIC					
W.P. 335-98-00			LOCATION N 5079108.32; E 313282			ORIGINATED BY SB							
DIST 54 HWY 11			BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS			COMPILED BY DKB							
DATUM GEODETTIC			DATE Feb. 13/00			CHECKED BY ASP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	GR SA SI CL
— CONTINUED FROM PREVIOUS PAGE —													
	Sand, trace silt Compact to loose Brown Wet	[Pattern]	13	SS	11		320						
							319						0 95 5 0
							318						
				14	SS	17		317					
				15	SS	4		316					
315.68 20.42	END OF BOREHOLE			16	SS	5		315					
308.87 27.13	END OF CONE HOLE						314						
	Note: Water level measured in open borehole at 9m depth (El. 327m) upon completion of drilling. Easting co-ordinate and elevation accurate to nearest metre.						313						
							312						
							311						
							310						
							309						

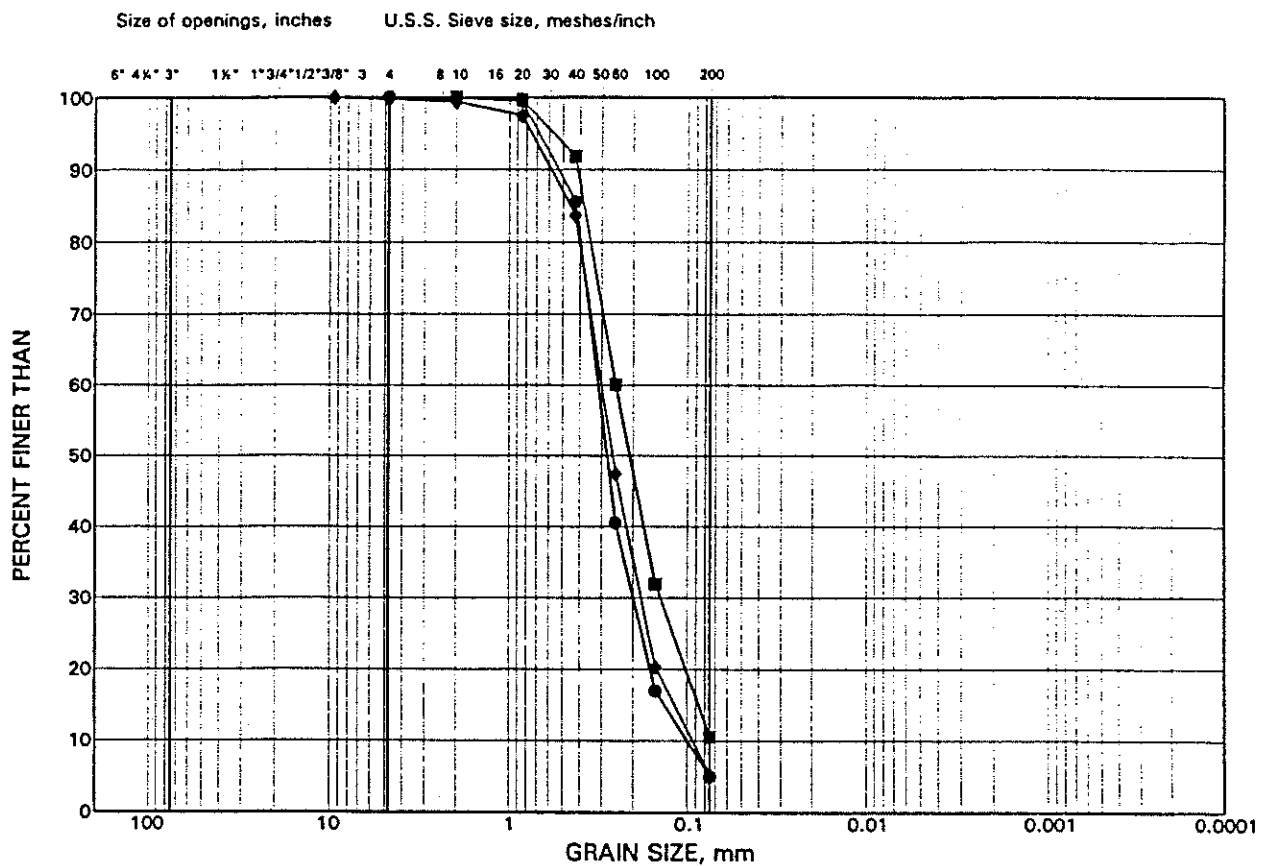
PROJECT 991-1193			RECORD OF BOREHOLE No 15-4			1 OF 1			METRIC				
W.P. 335-98-00			LOCATION N 5079131.23, E 313279			ORIGINATED BY SB							
DIST 54 HWY 11			BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS			COMPILED BY DKB							
DATUM GEODETTIC			DATE Feb. 13/00			CHECKED BY ASP							
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC NATURAL LIQUID UNIT WEIGHT REMARKS & GRAIN SIZE DISTRIBUTION				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p W W _L	WATER CONTENT (%)	γ	GR SA SI CL
336.00	GROUND SURFACE												
0.00	Topsoil												
0.15	Silty Sand, trace wood fragments/roots												
335.24	Brown Moist												
0.76	Silt, some sand, trace gravel		1	SS	8		335						
	Loose to compact												
	Brown Moist		2	SS	14		334						
333.79													
2.21	Sand, trace silt		3	SS	17		333						
	Compact												
	Brown Moist		4	SS	14		332						
			5	SS	13								
			6	SS	11		331						
330.82													
5.18	END OF BOREHOLE												
	Note: Open borehole dry upon completion of drilling.												
	Easting co-ordinate and elevation accurate to nearest metre.												

ON MOT 991-1193 GPJ ON MOT.GDT 24/4/00

GRAIN SIZE DISTRIBUTION

Sand, trace to some silt

FIGURE 21



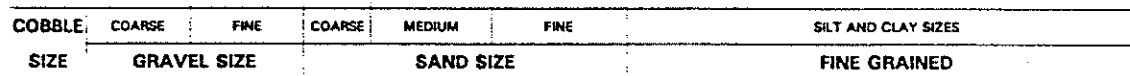
COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL BOREHOLE SAMPLE ELEVATION(m)

●	15-2	8	331.6
■	15-3	4	332.3
◆	15-3	14	318.6

FIGURE 23



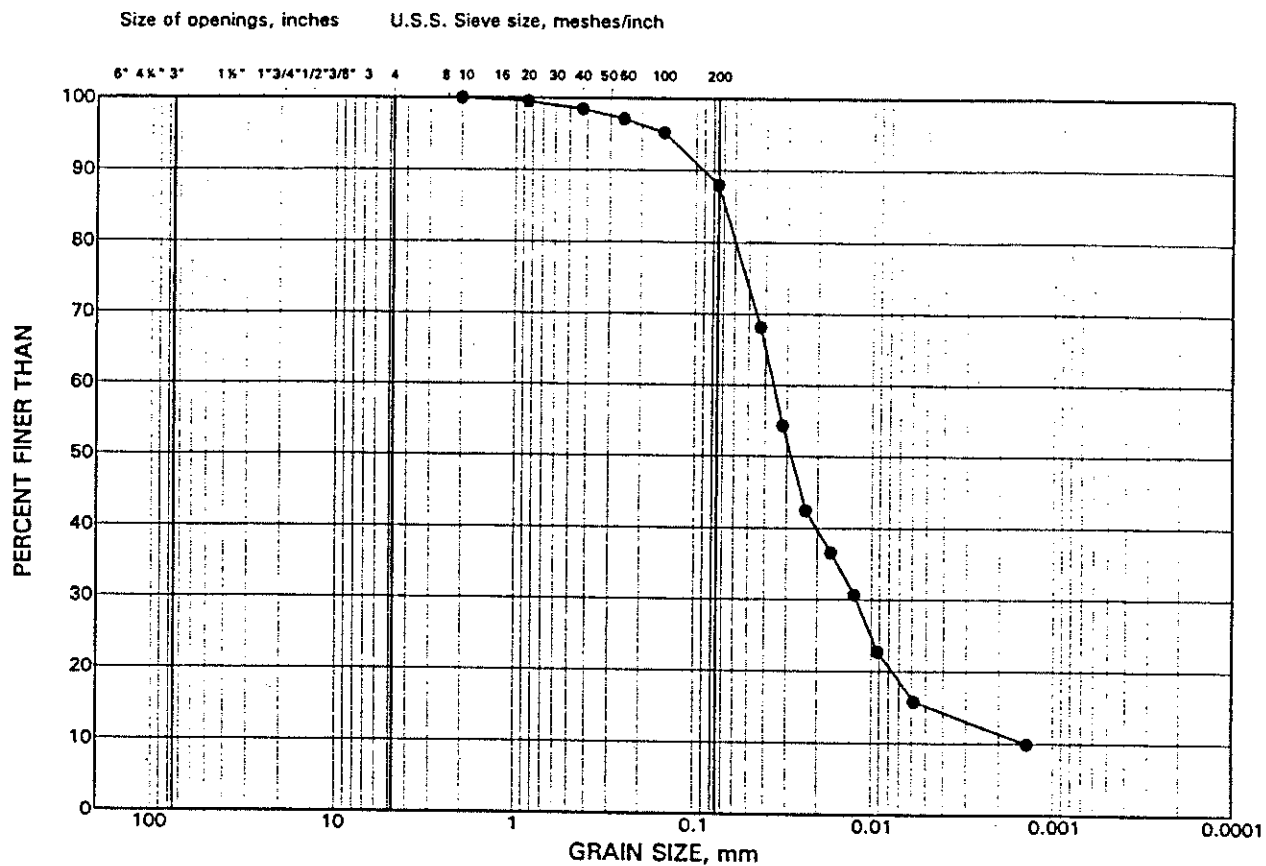
SYMBOL	BOREHOLE	SAMPLE ELEVATION(m)
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16
17	17	17
18	18	18
19	19	19
20	20	20
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89	89	89
90	90	90
91	91	91
92	92	92
93	93	93
94	94	94
95	95	95
96	96	96
97	97	97
98	98	98
99	99	99
100	100	100

●	15-2	14	323.0
■	15-3	10	325.0

GRAIN SIZE DISTRIBUTION

Silt, trace to some sand and clay

FIGURE 22



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

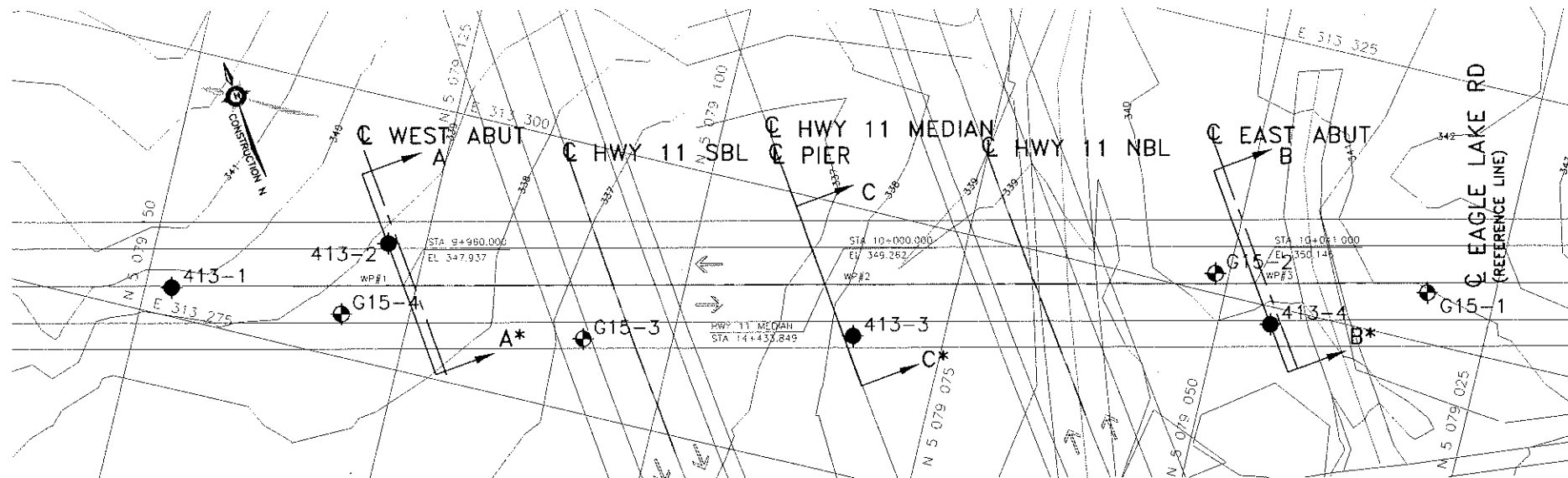
LEGEND

SYMBOL BOREHOLE SAMPLE ELEVATION(m)

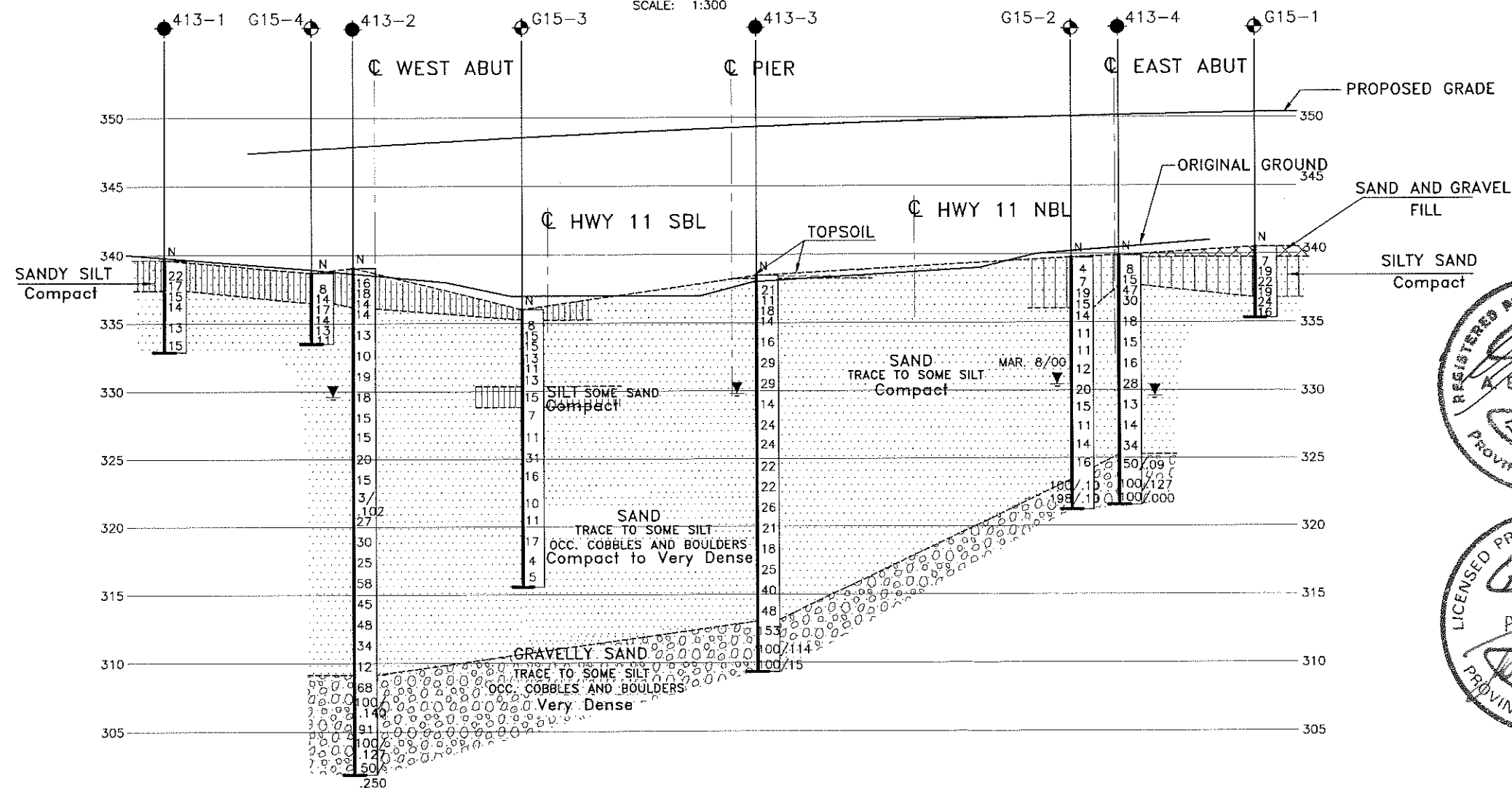
• 15-1 4 336.8

Appendix D

Drawings



PLAN
4 0 10 15m
SCALE: 1:300



PROFILE @ EAGLE LAKE RD

4 0 10 15m
2.7 0 6.7 10m
HOL: 1:300
VER: 1:200

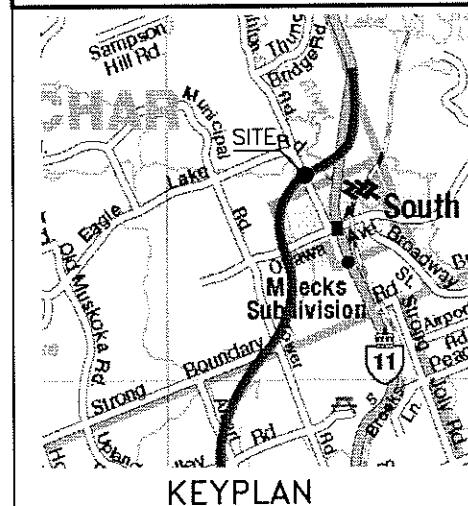
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

HWY 11
CONT No.
WP No.5040-03-01

EAGLE LAKE ROAD
UNDERPASS
BOREHOLE LOCATION AND SOIL STRATA

**Marshall
Macklin
Monaghan**
CONSULTING ENGINEERS • SURVEYORS • PLANNERS

THURBER ENGINEERING LTD.
THURBER



KEYPLAN

LEGEND

- BoreHole by THURBER
- ⊕ Dynamic Cone penetration Test (cone)
- ⊙ BoreHole by GOLDER
- N Blow/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- PH Pressure, Hydraulic
- WL on June 20, 2003
- ↑ Head Artesian Water
- Piezometer

NO	ELEVATION	NORTHING	EASTING
413-1	339.6	5079147.54	313277.70
413-2	339.1	5079128.46	313286.50
413-3	338.5	5079083.51	313288.14
413-4	339.9	5079045.12	313298.37
G15-1	340.5	5079031.29	313304.69
G15-2	339.8	5079051.29	313301.86
G15-3	336.0	5079108.32	313282.00
G15-4	336.0	5079131.23	313279.00

NOTE

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

*-SEE FOLLOWING SHEET
FOR CROSS-SECTIONS
A-A, B-B, C-C
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

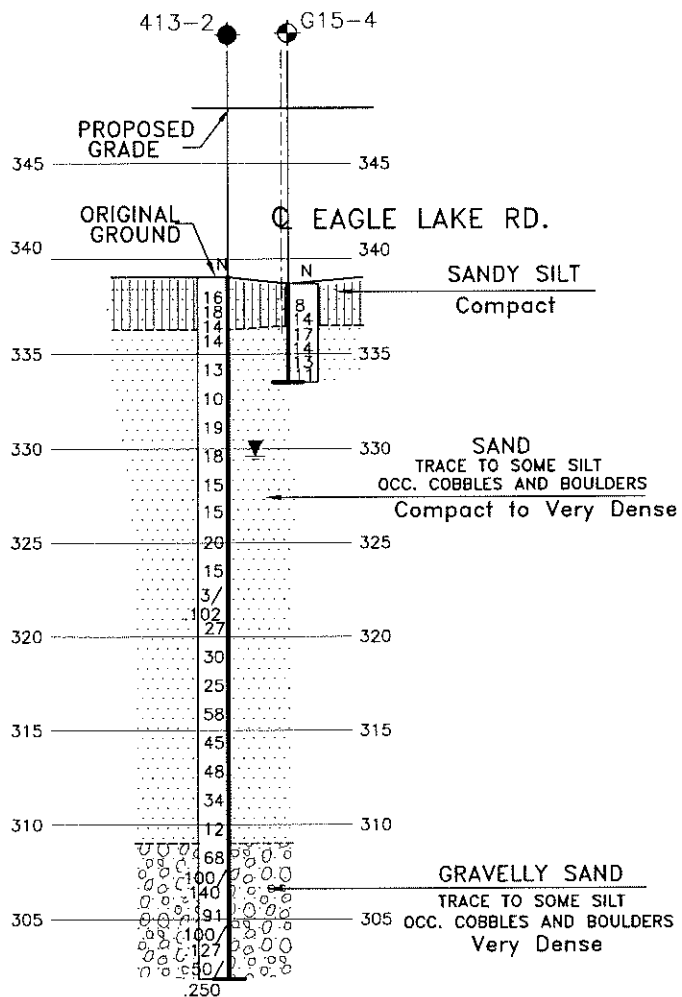
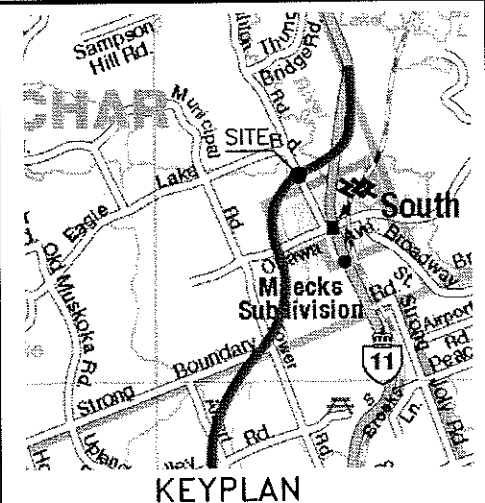
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CHK	CODE CHBDC 2000	LOAD CL-625-ONT
DRAWN	SS	CHK P.B.	SITE 44-413
			STRUCT
			SCHEME
			DWG 2

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

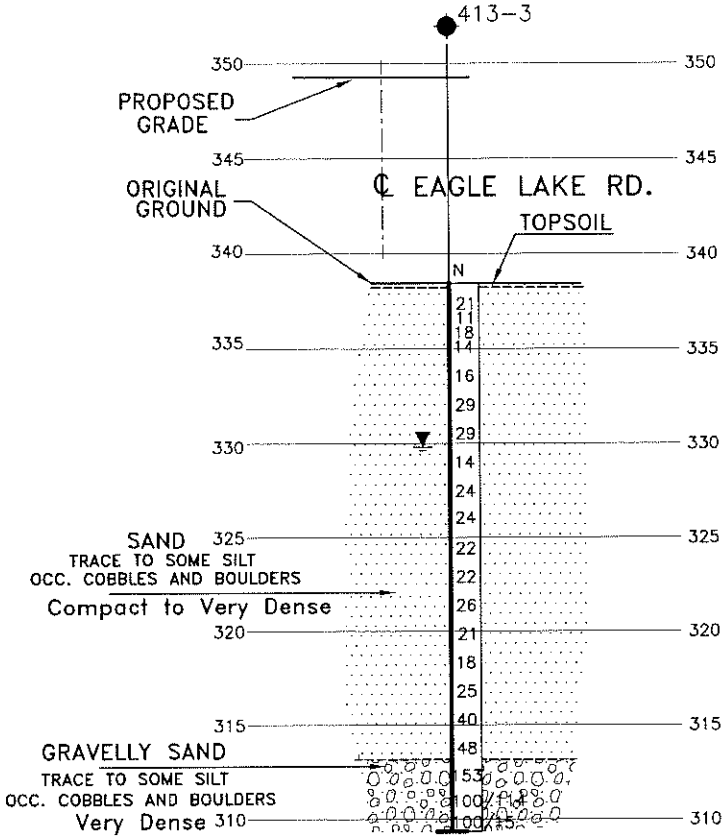
HWY 11
CONT No.
WP No.5040-03-01
EAGLE LAKE ROAD
UNDERPASS
SOIL STRATA



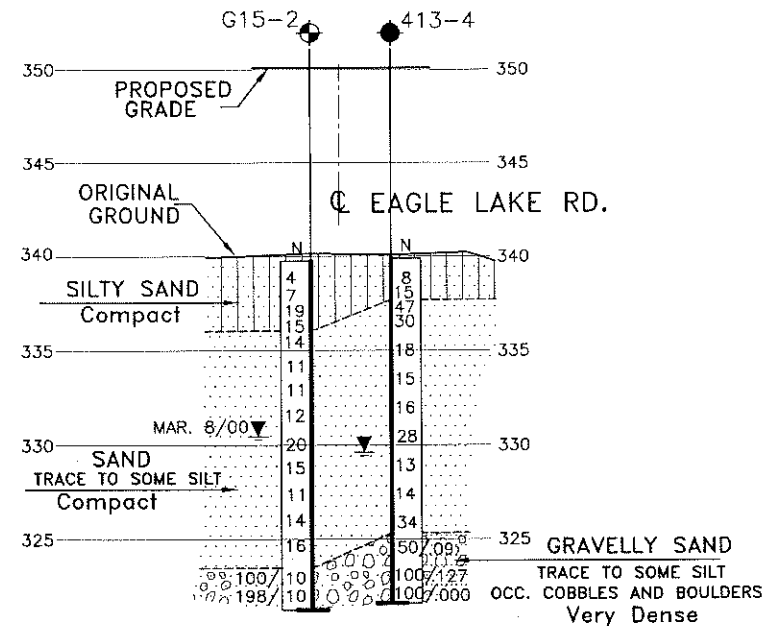
THURBER ENGINEERING LTD.



SECTION A-A*
HOL: 1:300
VER: 1:200



SECTION C-C*
HOL: 1:300
VER: 1:200



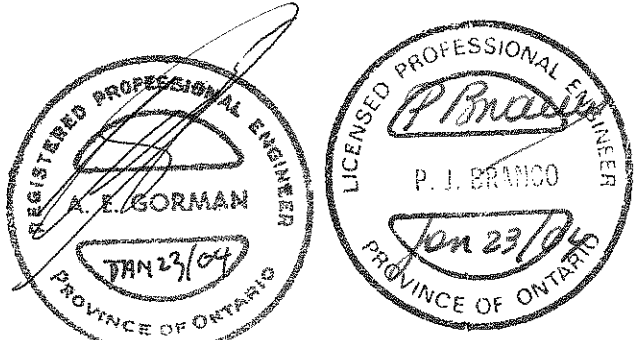
SECTION B-B*
HOL: 1:300
VER: 1:200

LEGEND

●	BoreHole by THURBER
⊕	Dynamic Cone penetration Test (cone)
⊗	BoreHole by GOLDER
N	Blow/0.3m (Std Pen Test, 475 J/blow)
CONE	Blows/0.3m (60° Cone, 475 J/blow)
PH	Pressure, Hydraulic
W	WL on June 20, 2003
+	Head Artesian Water
	Piezometer

NO	ELEVATION	NORTHING	EASTING
413-1	339.6	5079147.54	313277.70
413-2	339.1	5079128.46	313286.50
413-3	338.5	5079083.51	313288.14
413-4	339.9	5079045.12	313298.37
G15-1	340.5	5079031.29	313304.69
G15-2	339.8	5079051.29	313301.86
G15-3	336.0	5079108.32	313282.00
G15-4	336.0	5079131.23	313279.00

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



*-SEE PREVIOUS SHEET FOR
SECTION LOCATIONS
A-A, B-B, C-C
DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	CHK	CODE CHBDC 2000	LOAD CL-625-0MT
DRAWN	SS	CHK P.B	SITE 44-413
		STRUCT	ISCHIE
			LDWG 3