

**FOUNDATION INVESTIGATION REPORT  
SOUTH RIVER BRIDGE, SBL  
HIGHWAY 11, BURK'S FALLS TO SOUTH RIVER  
G.W.P. 759-93-00, W.P. 5037-03-01, SITE 44-373**

**Geocres Number: 31E-199**

**Report to**

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NBL\South Riv NBL FNDN DRAFT.doc

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## **1 INTRODUCTION**

This report presents the factual findings obtained from a foundation investigation conducted at the site of a proposed bridge to carry realigned Highway 11 over the South River near the village of South River, Ontario. A previous, preliminary investigation had been carried out at the site by Golder Associates Ltd. (Golder) and the factual data from that investigation has been incorporated in the current assignment.

The purpose of the 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 investigation and the data obtained in the course of the present investigation. This model describes the geotechnical conditions influencing design and construction of the foundations and approach embankments for the bridge and the stability of the north bank of the river.

Thurber carried out the investigation as a sub-consultant to Marshall Macklin Monaghan, under the Ministry of Transportation Ontario (MTO) Agreement Number 5005-A-000188.

## **2 SITE DESCRIPTION**

The site lies across the valley of the South River at a location where it is proposed that Highway 11 will cross the river. The site lies in Machar Township, 200 to 300 m west of existing Highway 11 and immediately north of the South River village limits.

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. Locally, however, the site lies in the valley of the South River. The present valley appears to occupy a much deeper valley incised into the bedrock and later filled to the present ground surface elevation with glacial and post glacial soil deposits and recent river alluvium.

The flood plain of the river occupies the entire valley floor, which is approximately 170 m wide, while the normal river channel is approximately 20 m wide and flows at the base of the north valley slope. The maximum river depth at normal water conditions is approximately 3 m.

The south valley wall is approximately 30 m high and sloped at 3.5H:1V while the north valley wall is approximately 30 m high and sloped at 5.5H:1V, above the eroded face of the river bank.

The valley slopes are treed with mixed second growth conifers and hardwoods. The valley floor is more sparsely treed but is largely occupied by willow and alder scrub. The site is drained by the South River, which locally flows westward. The local groundwater level is at or slightly above the river level and wet surface conditions are encountered across the portion of the site lying south of the river.

There are no buildings in the immediate site vicinity and the closest development is in the village of South River a short distance to the south of the site.

### 3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for the current project were carried out in two phases between October 7 and October 17, 2003, and between January 12 and January 22, 2004. The current site investigation consisted of drilling and sampling six boreholes (Boreholes 373-6 through 373-11) to depths ranging from 5.8 m at the north approach to 32.9 m at south abutment. The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix G.

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.

DBW Drilling Limited supplied and operated the drilling and sampling equipment used on the north side of the river and for one of the boreholes to the south of the river. All-Terrain Drilling and George Downing Estate Drilling supplied and operated the drilling and sampling equipment used for the remaining foundation boreholes and the approach fill boreholes at the south of the valley. 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). Where bedrock was encountered, it was proved by coring into it for a distance of approximately 3 m.

The positions of the principal boreholes considered in the preparation of this report, relative to the structure site are as shown in Table 3.1.

**Table 3.1 – Borehole Locations Relative to Structure**

<b>Location on Structure</b>	<b>Boreholes Considered in Design</b>
North Approach	BH 373-9, BH 373-10, BH 373-11A/B, BH 16-6*
North Abutment	BH 373-9, BH 373-11A/B, BH 16-6*
Pier	BH 373-8, BH 16-7*
South Abutment	BH 373-7
South Approach	BH 373-6, BH 373-7

\* Boreholes drilled by Golder in 2000

The coordinates and elevations of the boreholes are given on the Borehole Locations and Soil Strata Drawing in Appendix G and on the individual Record of Borehole Sheets in Appendix A.

Standpipe piezometers, consisting of 19 mm PVC pipe with slotted tips, were installed in selected boreholes to monitor the groundwater levels. The locations and completion details for the piezometers are shown in Table 3.2.

**Table 3.2 – Piezometer Details**

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation	Completion Details
BH 373-7	33.8/296.3	Piezometer with 1.5 m tip installed at bottom of borehole. Filter sand from 33.8 to 31.4, bentonite seal to 30.8, hole collapsed to surface, bentonite seal installed at 0.3 to surface.
BH 373-8	22.2/307.9	Borehole completed to 22.5 m depth, piezometer with 1.5 m tip installed at 22.2 m. Sand backfill from 22.2 to 5.8 m, bentonite and sand mix to the surface.
BH 373-9	9.6/329.6	Borehole completed to 9.7 m depth, piezometer with 1.5 m tip installed at 9.6 m. Sand backfill from 9.6 to 1.5 m, bentonite seal to the surface.

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 nineteen samples were selected for this testing.

The rock cores were logged visually and measurements carried out to determine the total core recovery, solid core recovery, RQD and fracture index. Point load tests were conducted on selected portions of core to provide estimates of the unconfined compressive strength of the rock.

## 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 in Appendix G. An overall description of the stratigraphy is given in the following paragraphs however the factual data presented in the borehole logs governs any interpretation of the site conditions.

The south abutment and pier lie south of the river and in the flood plain with original ground elevations ranging from 329.2 to 330.2. The north abutment lies north of the river on the north valley slope with an original ground approximately at Elevation 339.2.

The subsoil stratigraphy at the site is governed by the physiography and glacial history of the area. The recent geological history of the site is interpreted to consist of:

- Glaciation and scouring of a valley into the bedrock
- Deposition of a layer of gravelly sand, possibly as moraine material
- Deposition of a layer of fine sands and sandy silts, possibly in a glacial lake environment
- Subsequent erosion and local re-deposition by the South River

In general terms, the site was found to be underlain a layer of very loose to compact sand and sandy silt. The layer was found to be approximately 2 m thick (base Elevation 343) at the north approach, 2 to 3 m thick (base Elevation 336 to 337) at the north abutment, increasing in thickness to 15 m (base Elevation 315) at the pier. It was found to be 28 m thick (base Elevation 302) at the south abutment and at least 16 m thick at the south approach where the borehole was terminated at Elevation 313.4. This layer is underlain by a dense to very dense gravelly sand with cobbles and boulders found to be 3 to 5 m thick at the north abutment (base Elevation 333 to 334), at least 8 m thick at the pier (end of hole Elevation 307.6) and approximately 5 m (end of hole Elevation 297.4) at the south abutment.

As a comparison, the stratigraphy at the NBL structure is similar, except that bedrock was encountered at the south abutment but not at the north abutment.

More detailed descriptions of the individual strata are presented below.

## 5.2 Topsoil

At the north approach and north abutment, topsoil was encountered in thicknesses ranging from 25 to 150 mm. At the pier, only a negligible thickness of topsoil was encountered, while at the south abutment 600 mm of organic topsoil was encountered. At the south approach, a 1.2 m thick layer of peat was encountered.

Topsoil and peat thicknesses were established only at borehole locations. The thickness may vary between and beyond the borehole locations and the data is not intended for the purpose of estimating quantities.

## 5.3 Sand (Upper Sand)

The upper sand layer lies immediately below the topsoil layer and was identified across the entire site. This stratum is described as sand, trace to some silt to silty.

At the south abutment, the sand stratum extends from the underside of the organic soil (Elevation 329.7) to a depth of 6.9 m (Elevation 323.4). At the pier, it extends to a depth of 5.5 m (Elevation 324.6) and at the north abutment it extends to a depth of 2.2 to 3 m (Elevation 336.3 to 337.0).

The upper 2 m depth at the pier appear to be recently reworked as river alluvium and traces of peat and wood have been incorporated in the soil.

At the south abutment and pier and based on SPT values ranging generally from 1 to 11 blows for 0.3 m of penetration, the soil is classified as very loose to compact. In this area, the sand is brown at the top, becoming grey below a depth of 4 to 4.5 m. The groundwater is near the surface, controlled by the South River, and the sand is generally saturated and described as wet with moisture contents ranging from 18 to 43%.

On the north side of the river, in the area of the north abutment and approach, the sand is classified as loose to dense, based on SPT values ranging from generally from 7 to 48 blows for 0.3 m of penetration. The sand in this location is brown and dry to moist, with measured natural moisture contents ranging from 8 to 11%.

Typical grain size distributions for this soil are shown in Figure B1 in Appendix B.

## 5.4 Sandy Silt

At the south abutment and pier, the upper sand is underlain by a layer of sandy silt. The silt stratum was not identified at the north abutment and is believed to be absent from there.

At the south abutment, the silt extended to a depth of 18.3 m (Elevation 312.0) and at the pier it extended to a depth of 11.6 m (Elevation 318.5).

The silt layer is classified as very loose to loose with occasional compact pockets, based on SPT values ranging from 1 to 11 blows for 0.3 m of penetration. Natural moisture contents ranged from 21 to 24% and the silt is described as wet and it is grey in colour.

Typical grain size distributions for this soil are shown in Figures B2 and B3 in Appendix B.

### **5.5 Sand to Silty Sand (Lower Sand)**

The sandy silt is underlain by a stratum that ranges from sand to silty sand that forms a fairly substantial thickness at the south abutment. However, it appears that the thickness of this layer diminishes northward across the site and that it is absent at the north abutment.

At the south abutment, the lower sand extends to a depth of 28.0 m (Elevation 302.3). At the pier it extends to a depth of 14.8 m (Elevation 315.3). The lower sand was not identified at the north abutment but was identified under the north approach fill.

Based on SPT values ranging from 2 to 48, the lower sand is described as very loose to dense.

The measured natural moisture contents ranged from 8 to 26%.

Typical grain size distributions for this soil are shown in Figure B4 in Appendix B.

### **5.6 Gravelly Sand With Cobbles and Boulders**

A layer of gravelly sand with cobbles and boulders underlies the lower sand at the south abutment, pier and north abutment. This layer is described as sand, gravelly, trace to some silt, occasional cobbles and boulders. The SPT values ranging from 54 to over 100 blows for 0.3 m of penetration indicate that this layer is very dense.

At the south abutment, the gravelly sand was found to at least a depth of 32.9 m (end of hole Elevation 297.4). At the pier, the gravelly sand was proved to be at least 7.7 m thick and to extend at least to a depth of 22.5 m (Elevation 307.6) where the borehole was terminated after establishing approximately 8 m of soil with an SPT value exceeding 100 blows for 0.3 m of penetration. At the north abutment, the gravelly sand was proved to extend to a depth of 4.9 to 5.8 m (Elevation 333.5 to 334.2).

The measured moisture contents ranged from 3 to 20%. Some values may have been influenced by sample disturbance and this soil can be assumed to be saturated.

Typical grain size distributions for this soil are shown in Figure B5 in Appendix B. This figure also includes the grading of a sample selected from a pocket of fine sand observed within the layer of gravelly sand.

### **5.7 Bedrock**

At the north abutment and north approach, the soils described above were found to be underlain by bedrock, which was proved by coring in BH 373-9, BH 373-10 and BH 373-11B. The lengths of core extracted were 4.3 m in BH 373-9, 2.8 m in BH 373-10 and 1.3 m in BH 373-11B.



The rock is described as gneiss, fresh to slightly weathered with colours ranging from pink through white.

Core recovery was 96 to 100% and RQD values ranged from 39 to 93%. Based on the RQD values, the rock mass is described as ranging from poor quality to excellent quality. The Fracture Index was generally 0 to 6.

Based on Point Load Testing, the unconfined shear strength of the bedrock was estimated to range from 135 MPa to over 220 MPa. Based on these strength values, the rock was classified as very strong to extremely strong.

### 5.8 Depths to Refusal

The depths at which effective refusal was first encountered, defined as an SPT value exceeding 100 blows for 0.3 m of penetration or bedrock, are shown in Table 5.1.

**Table 5.1 – Refusal Depths (Elevations)**

Location	Borehole	Refusal Depth (Elevation) (m)	Material
North Abutment	BH 373-9	5.4 (333.8)	Bedrock
	BH 373-11B	4.9 (334.2)	Bedrock
Pier	BH 373-8	15.2 (314.9)	Gravelly sand
South Abutment	BH 373-7	28.0 (302.3)	Gravelly sand

### 5.9 Water Levels

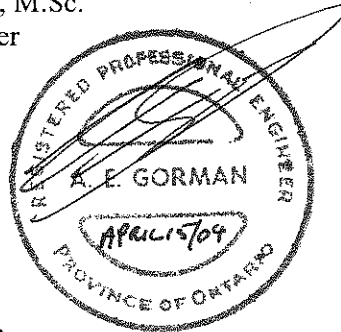
Groundwater levels at this site were measured within standpipe piezometers in the spring of 2000, and winter of 2003/2004. The measured depth and elevations are shown in Table 5.2.

**Table 5.2 – Groundwater Depths (in metres) and Elevations**

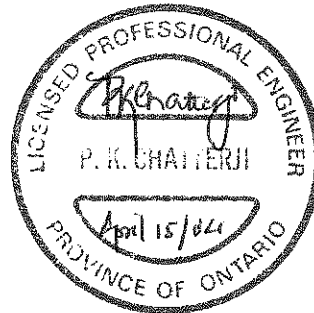
Date	BH 373-7		BH 373-8		BH 373-9		BH 16-6	
	Depth	Elev.	Depth	Elev.	Depth	Elev.	Depth	Elev.
Feb. 22, 2000	-	-	-	-	-	-	6.7	329.2
Mar. 8, 2000	-	-	-	-	-	-	6.6	329.3
Mar. 26, 2000	-	-	-	-	-	-	6.5	329.4
Jan. 29, 2004	1.7	328.6	0.7	329.4	-	-	-	-
Jan. 30, 2004	-	-	-	-	5.8	333.4	-	-

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 snowmelt or after periods of heavy rainfall.

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## **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 <sup>(1)</sup> '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

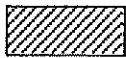
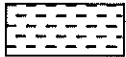



C<sub>pen</sub> Shear Strength Determination by Pocket Penetrometer

- (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>	
<b>Fresh (FR)</b>	No visible signs of weathering.		
<b>Fresh Jointed (FJ)</b>	Weathering limited to the surface of major discontinuities.		CLAYSTONE
<b>Slightly Weathered (SW)</b>	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
<b>Moderately Weathered (MW)</b>	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
<b>Highly Weathered (HW)</b>	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
<b>Completely Weathered (CW)</b>	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 373-6

1 OF 2

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 354.8 E 313 729.2) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/SS  
 DATUM Geodetic DATE 22.01.04 - 22.01.04 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	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	20 40 60 80 100		
329.2 0.0	PEAT Dark Brown						329							
328.0			1	SS	1		328							
1.2	SAND, some silt, fine to medium grained Loose Brown Moist		2	SS	6		327							
	Becoming Grey		3	SS	2		326							0 77 21 2
			4	SS	2		325							
			5	SS	4		324							
			6	SS	2		323							0 89 11 (SI+CL)
			7	SS	8		322							
			8	SS	11		321							
							320							

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

## METRIC

[illegible]



# RECORD OF BOREHOLE No 373-7

1 OF 4

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 358.1 E 313 753.8) South River Bridge SBL Site 44-373 ORIGINATED BY SL  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 22.01.04 - 22.01.04 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
330.3 0.0	ORGANICS Dark														
329.7 0.6	SAND, trace to some silt, trace organics, trace wood fragments Very Loose to Loose Brown Wet		1	SS	2										
			2	SS	1										
			3	SS	1										
	silty below 3m		4	SS	2										0 75 25 (SI+CL)
	becoming grey		5	SS	1										
			6	SS	2										0 54 46 (SI+CL)
323.4 6.9	Sandy SILT, trace clay Very Loose to Loose Grey Wet		7	SS	8										0 48 46 6
			8	SS	8										

Continued Next Page

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

## METRIC

[illegible]

+ 3, × 3: Numbers refer to Sensitivity

ONTMT4 373SOUTH RIVER BRIDGES.GPJ 11/02/04

# RECORD OF BOREHOLE No 373-7

3 OF 4

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 358.1 E 313 753.8) South River Bridge SBL Site 44-373 ORIGINATED BY SL  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 22.01.04 - 22.01.04 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Silty SAND Loose to Compact Grey Wet		16	16	11		310							
							309							
			17	SS	14		308							
							307							
			18	SS	19		306							
							305							
			19	SS	14		304							
							303							
			20	SS	15		302							
302.3							301							
28.0	Gravelly SAND, fine grained, with cobbles/ boulders, trace to some silt Very Dense Brown to Grey Wet		21	SS	50/ .076									

ONTMT4 373SOUTH RIVER BRIDGES.GPJ 11/02/04

Continued Next Page


+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity  
20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 373-7

4 OF 4

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 358.1 E 313 753.8) South River Bridge SBL Site 44-373 ORIGINATED BY SL  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 22.01.04 - 22.01.04 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Gravelly SAND, fine grained, with cobbles/ boulders, trace to some silt Very Dense Brown to Grey Wet		23	SS	50/ .05		300							
297.4							299							
32.9	END OF BOREHOLE AT 32.9m.		24	SS	50/ .03		298							

+<sup>3</sup> ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 373-8

1 OF 3

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 391.7 E 313 794.5) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/SS  
 DATUM Geodetic DATE 12.01.04 - 12.01.04 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
330.1 0.0	Silty <b>SAND</b> , organic, some wood fragments, trace peat and topsoil Loose Dark Brown Wet														GR SA SI CL			
			1	SS	2													
			2	SS	4													
328.0	<b>SAND</b> , fine grained, trace silt Loose Brown Moist to Wet																	
2.1			3	SS	9													
			4	SS	2													
			5	SS	4													
324.6	Sandy <b>SILT</b> , trace clay Compact to Loose Brown Wet																	
5.1			6	SS	11													
			7	SS	5													
			8	SS	6													

Continued Next Page

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

## METRIC

SOIL PROFILE			SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ kN/m <sup>3</sup>	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 (%) w
318.5	Silty SAND, fine to medium grained, trace gravel, occasional cobbles Loose to Dense Moist to Wet Brown		9	SS	10							0 45 55 (SI+CL)	
11.6			10	SS	5							0 61 39 (SI+CL)	
			11	SS	48								3 65 32 (SI+CL)
315.3	Gravelly SAND, fine to medium grained, trace silt Very Dense Brown Moist		12	SS	100/ .175								
14.8			13	SS	100/ .200								
			14	SS	73								0 94 6 (SI+CL)
			15	SS	100/ .150								

+ 3, x 3: Numbers refer to Sensitivity

ONTMT4 373SOUTH RIVER BRIDGES.GPJ 11/02/04

# RECORD OF BOREHOLE No 373-8

3 OF 3

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 391.7 E 313 794 5) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/SS  
 DATUM Geodetic DATE 12.01.04 - 12.01.04 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 Y kN/m <sup>3</sup>	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 <sub>P</sub> W W <sub>L</sub>				
			16	SS	100/									
					125									
307.6			17	SS	100/									
22.5	END OF BOREHOLE AT 22.50 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted Screen.  WATER LEVEL READINGS: DATE DEPTH (m) 29/01/04 0.7				100									

# RECORD OF BOREHOLE No 373-9

1 OF 2

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 424.9 E 313 844.5) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 07.10.03 - 09.10.03 CHECKED BY AEG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT Y kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
339.2													
338.6													
0.1	TOPSOIL, some rootlets (50mm) Dark Brown Silty SAND, very fine grained, some rootlets, trace gravel Very Loose to Compact Light Brown to Brown Dry to Moist	1	SS	3		339							
		2	SS	28		338							3 66 31 (SI+CL)
		3	SS	26									
337.0						337							
2.2	SAND, fine grained, some silt, some gravel Very Dense Brown Dry to Moist occasional silt pockets	4	SS	70									
		5	SS	60		336							13 67 20 (SI+CL)
	pink black granite boulder from 3.71m to 4.04m												
	granite boulder from 4.44m to 4.62m	6	SS	54		335							
						334							
333.8													
5.4	BEDROCK, GNEISS Fresh to slightly weathered, pink, white and black, very strong	1	RUN			333							RUN 1# TCR=100%, SCR=86%, RQD=39%, UCS=178.6MPa
		2	RUN			332							RUN 2# TCR=100%, SCR=100%, RQD=55%, UCS=193.9MPa
		3	RUN			331							RUN 3# TCR=97%, SCR=87%, RQD=82%, UCS=137.78MPa
						330							
329.6													
9.7	END OF BOREHOLE AT 9.65m. Piezometer installation consists of												

Continued Next Page

+ 3, x 3: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE



# RECORD OF BOREHOLE No 373-9

2 OF 2

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 424.9 E 313 644.5) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 07.10.03 - 09.10.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.																
						</											

ONTMT4 373SOUTH RIVER BRIDGES.GPJ 05/02/04

# RECORD OF BOREHOLE No 373-10

1 OF 1

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 432.7 E 313 864.0) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 16.10.03 - 17.10.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	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							
344.7 0.0	TOPSOIL, some rootlets (25mm) Dark Brown Moist to Wet		1	SS	3										
344.0 0.7	SAND, very fine grained, some silt Very Loose Reddish Brown Moist to Wet Silty SAND, trace gravel Compact Grey		2	SS	21										
343.1 1.6	Moist boulder from 1.40m to 1.57m. Gravelly SAND, some silt, occasional cobbles Very Dense Grey Moist		3	SS	40/ .050										
			4	SS	100/ .150										
341.8 3.0			5	SS	100/ .150										
	BEDROCK, GNEISS Fresh to slightly weathered, pink, white and black, very strong to extremely strong.		1	RUN											
			2	RUN											
338.9 5.8	END OF BOREHOLE AT 5.84m.														

# RECORD OF BOREHOLE No 373-11A

1 OF 1

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 417.2 E 313 850.7) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 10.10.03 - 14.10.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
339.3														
339.2	TOPSOIL, some rootlets (150mm) Dark Brown Moist		1	SS	3		339							
338.7	SAND, very fine grained, some silt Very Loose Reddish Brown Dry		2	SS	7		338							
0.6	Silty SAND, fine grained, trace to some gravel, occasional cobbles Loose to Very Dense Brown Dry to Moist		3	SS	20		337							
			4	SS	48		336							
336.3	Gravelly SAND Very Dense Brown		5	SS	70		335							
3.0	boulder from 3.99m to 4.17m		6	SS	78		334							
333.5	cobble from 5.7m to 5.8m													
5.8	NW CASING NOT STRAIGHT DOWN IN THE BOREHOLE. END OF BOREHOLE AT 5.82m. DRILL EXTRA BOREHOLE 373-11B.													

ONTMT4 373SOUTH RIVER BRIDGES.GPJ 05/02/04

# RECORD OF BOREHOLE No 373-11B

1 OF 1

METRIC

W.P. 5041-03-01 LOCATION (N 5 079 413.4 E 313 854.3) South River Bridge SBL Site 44-373 ORIGINATED BY MF  
 HWY 11 BOREHOLE TYPE Hollow Stem Augers, NW Casing, NQ Core COMPILED BY SS  
 DATUM Geodetic DATE 14.10.03 - 15.10.03 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	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	20 40 60 80 100					
339.1 0.0	Auger and advance NW casing to 4.9m.						339							kn/m <sup>3</sup>	GR SA SI CL
							338								
							337								
	cobbles and boulders from 2.49m to 3.15m						336								
	cobbles from 3.53m to 3.66m						335								
334.2 4.9	<b>BEDROCK, GNEISS</b> Slightly weathered, pink, white and black, extremely strong		1	RUN			334							FI	RUN 1# TCR=100%, SCR=89%, RQD=62%, UCS=219.4MPa
332.9 6.2	END OF BOREHOLE AT 6.22m.						333							1	

ONTMT4 373SOUTH RIVER BRIDGES.CPJ 05/02/04

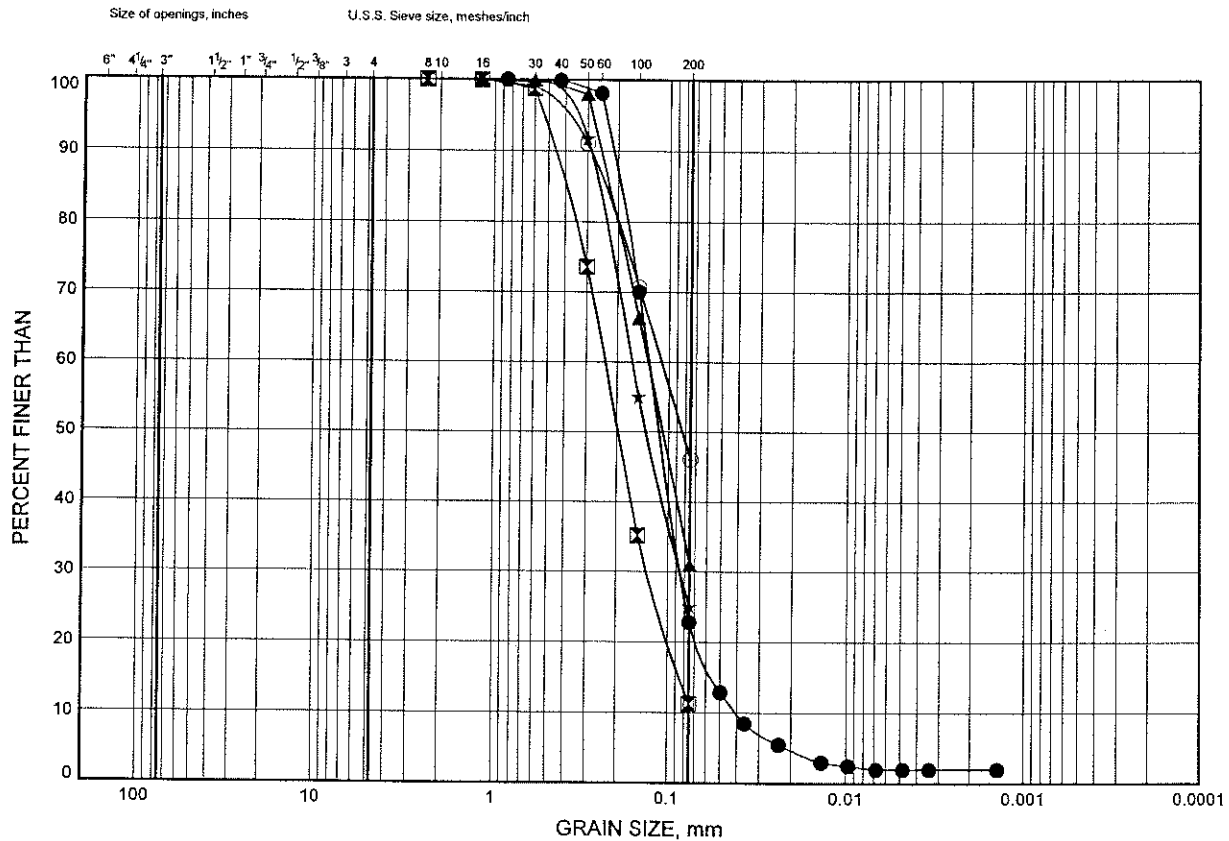
## **Appendix B**

### **Laboratory Test Results**

# Hwy 11 Four Laning GRAIN SIZE DISTRIBUTION

FIGURE B1

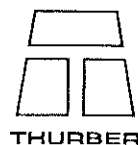
## SILTY SAND (UPPER SAND)



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	373-6	3.35	325.85
⊠	373-6	6.40	322.80
▲	373-6	10.97	318.23
★	373-7	3.35	326.85
⊙	373-7	6.40	323.80

Date February 2004  
Project 5041-03-01

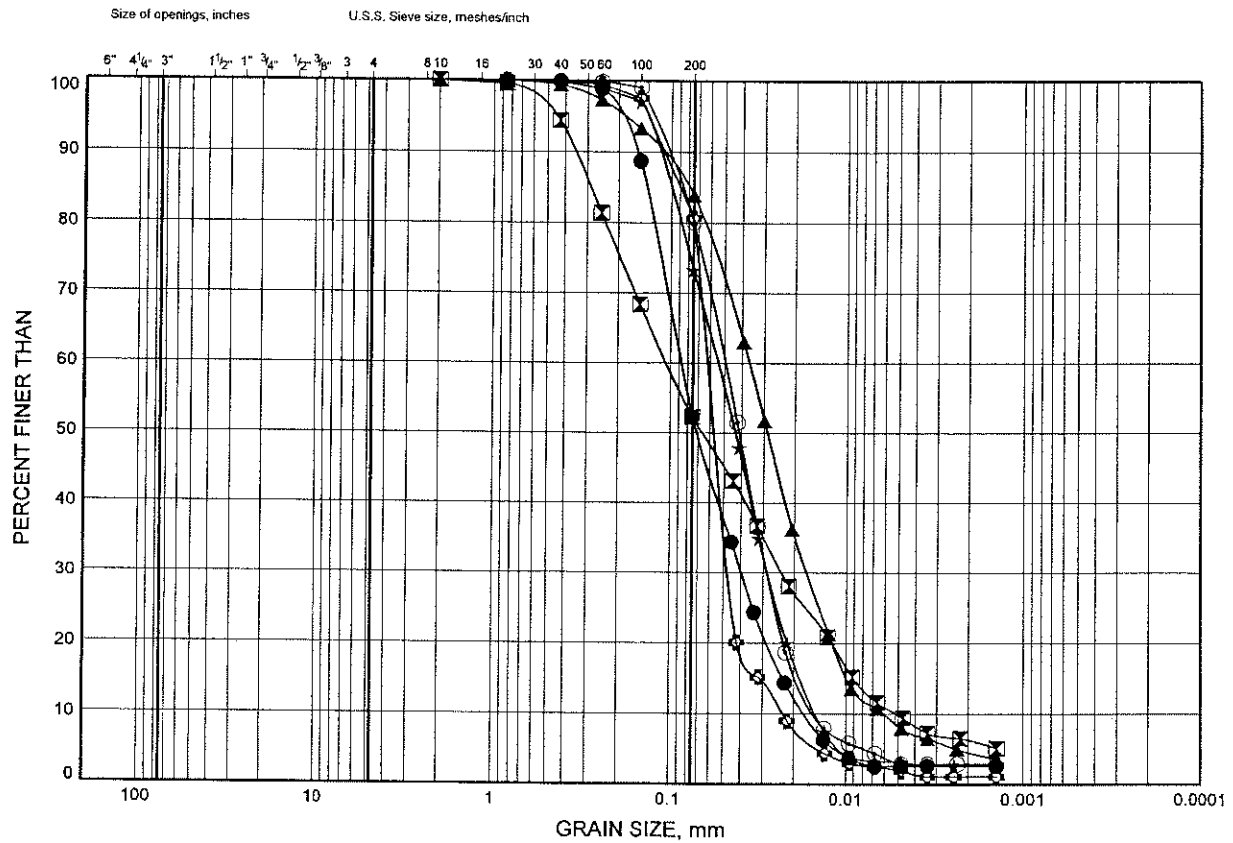


Prep'd SS  
Chkd. AEG

# Hwy 11 Four Laning GRAIN SIZE DISTRIBUTION

FIGURE B2

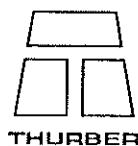
## SANDY SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	373-6	14.02	315.18
⊠	373-7	7.32	322.88
▲	373-7	11.89	318.31
★	373-7	13.41	316.79
⊙	373-7	17.98	312.22
⊛	373-7	17.99	312.21

Date February 2004  
Project 5041-03-01

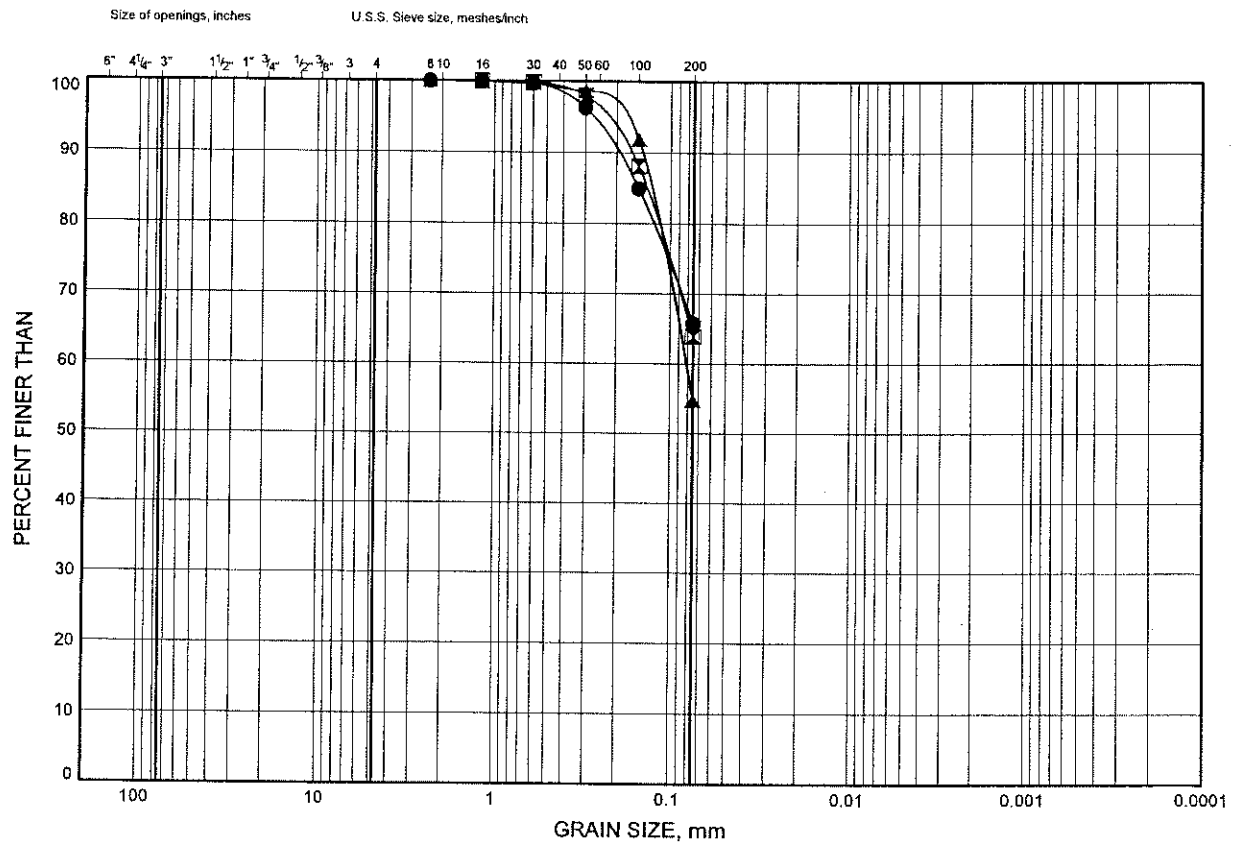


Prep'd SS  
Chkd. AEG

# Hwy 11 Four Laning GRAIN SIZE DISTRIBUTION

FIGURE B3

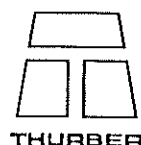
## SANDY SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	373-8	6.40	323.70
⊠	373-8	7.92	322.18
▲	373-8	10.97	319.13

Date February 2004  
Project 5041-03-01



Prep'd SS  
Chkd. AEG



## FIGURE B4

Size of openings, inches

U.S.S. Sieve size, meshes/inch

PERCENT FINER THAN

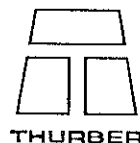
GRAIN SIZE, mm

Grain Size (mm)	Sieve Size (U.S.S.)	Percent Finer Than (Solid Circles)	Percent Finer Than (Open Squares)
100	6"	100	100
4.75	No. 40	100	100
2.5	No. 60	100	100
1.18	No. 125	100	100
0.85	No. 16	100	100
0.6	No. 30	95	95
0.425	No. 40	82	76
0.3	No. 60	70	60
0.25	No. 60	60	50
0.15	No. 100	38	32
0.075	No. 200	32	32

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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	373-8	12.50	317.60
⊠	373-8	14.02	316.08

Date February 2004.....  
Project 5041-03-01.....

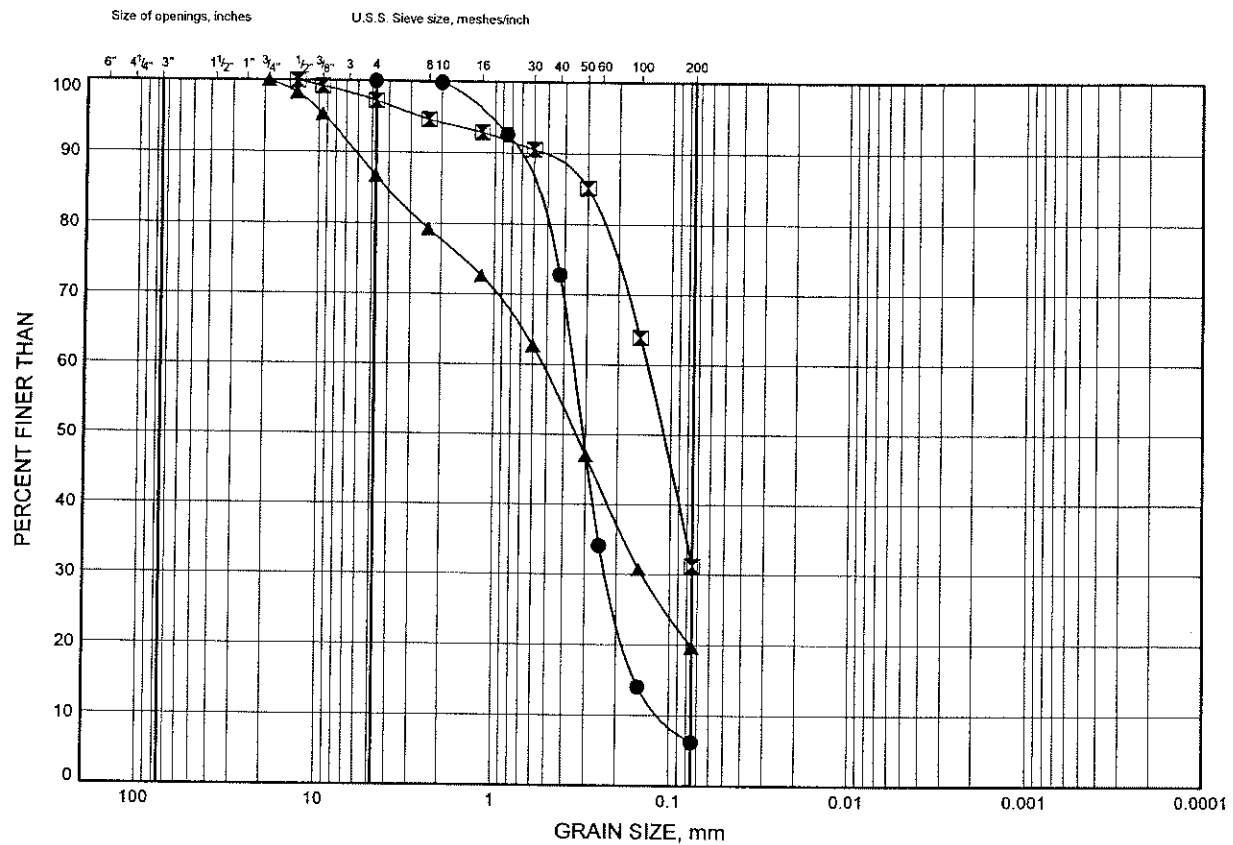


Prep'd ..... SS .....  
Chkd. .... AEG .....

# Hwy 11 Four Laning GRAIN SIZE DISTRIBUTION

FIGURE B5

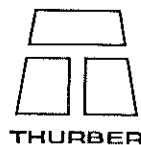
## GRAVELLY SAND (SAND SEAM)



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	373-8	17.98	312.12
□	373-9	1.07	338.63
▲	373-9	3.35	336.35

Date February 2004  
Project 5041-03-01



Prep'd SS  
Chkd. AEG

## **Appendix C**

### **Data From Golder Report**

PROJECT <u>991-1193</u>		<b>RECORD OF BOREHOLE No 16-6</b>		1 OF 2 <b>METRIC</b>	
W.P. <u>335-98-00</u>		LOCATION <u>N 5079413.37; E 313846.67</u>		ORIGINATED BY <u>SE</u>	
DIST <u>54</u> HWY <u>11</u>		BOREHOLE TYPE <u>108mm I.D. HOLLOW STEM AUGERS</u>		COMPILED BY <u>DKB</u>	
DATUM <u>GEODETIC</u>		DATE <u>Feb. 22/00</u>		CHECKED BY <u>ASP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100				
								SHEAR STRENGTH kPa							WATER CONTENT (%)						
								○ UNCONFINED	+ FIELD VANE						● QUICK TRIAXIAL	× REMOULDED	20	40	60	80	100
335.90	GROUND SURFACE																				
0.00	Topsoil																				
0.15	Silty Sand																				
	Brown																				
335.14	Moist																				
0.76	Sand, trace to some silt		1	SS	8																
	Loose to compact																				
	Brown		2	SS	11																
	Moist																				
			3	SS	13																
332.93																					
2.97	Silty Sand, trace gravel		4	SS	15																
	Compact																				
	Brown		5	SS	15.05																
	Moist																				
	-boulder cored from about 4m to 4.6m depth																				
331.33																					
4.57	Gravelly Sand, trace to some silt, occ. cobbles and/or boulders		6	SS	70																
	Compact to very dense																				
	Brown																				
	Wet																				
			7	SS	32																
			8	SS	31																
			9	SS	17																
			10	SS	40																
			11	SS	119.15																
322.34																					
13.56	Slightly weathered, pinkish grey-white with black blotches, moderately jointed, lightly foliated, coarse to very coarse grained, strong GRANITIC GNEISS.																				

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity  
O 3% STRAIN AT FAILURE

ON MOT 991-1193 GPJ ON MOT GDT 2/14/00

+ 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 DRILLHOLE: 16-6

SHEET 1 OF 1

LOCATION: N 5079413.37; E 313846.67

DRILLING DATE: Feb.23/00

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (mm/min)	FLUSH	FR-FRACTURE CL-CLEAVAGE SH-SHEAR VN-VEIN	F-FAULT J-JOINT P-POLISHED S-SUCKENSIDED	SM-SMOOTH R-ROUGH ST-STEPPED PL-PLANAR	FL-FLEXURED UE-UNEVEN W-WAVY C-CURVED	BC-BROKEN CORE MB-MECH. BREAK B-BEDDING	DIAMETRAL INDEX (MP)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE												
14		Slightly weathered, pinkish grey-white with black blotches, moderately jointed, lightly foliated, coarse to very coarse grained, strong GRANITIC GNEISS.		13.56	1									
15														
16					2									
17		END OF HOLE		16.61										
18														
19														
20														
21														
22														
23														

DEPTH SCALE

1:50



LOGGED: SB

CHECKED: PD

DRILLHOLE 1193 ROCK GPJ GLDR CAN.GDT 24/100 PS

PROJECT 991-1193 RECORD OF BOREHOLE No 16-7 1 OF 2 METRIC  
W.P. 335-98-00 LOCATION N 5079385 79, E 313795.95 ORIGINATED BY SB  
DIST 54 HWY 11 BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS COMPILED BY DKB  
DATUM GEODETIC DATE Feb 20/00 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
329.77	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100					
0.00 329.47	Topsoil													
0.30	Sand, trace to some silt, trace gravel; organics/decaying wood matter noted throughout Very loose to compact Brown to black Moist to wet		1	SS	2		329							
			2	SS	11		328							
			3	SS	7		327							
			4	SS	2		326							2 83 15 0
			5	SS	2		325							
			6	SS	2		324							
324.14	Sandy Silt, trace clay; organic matter noted in samples to 7.2m depth Very loose to loose Brown Wet		7	SS	2		323							
5.63			8	SS	6		322							
			9	SS	6		321							
			10	SS	6		320						0 19 73 8	
			11	SS	2		319							
			12	SS	3		318							
318.04	Silty Sand Very loose Brown Wet						317							
11.73							316							
							315							

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

Continued Next Page

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

PROJECT <u>991-1193</u>		<b>RECORD OF BOREHOLE No 16-7</b>		2 OF 2 <b>METRIC</b>	
W.P. <u>335-98-00</u>		LOCATION <u>N 5079385.79, E 313795.95</u>		ORIGINATED BY <u>SB</u>	
DIST <u>54</u> HWY <u>11</u>		BOREHOLE TYPE <u>108mm I.D. HOLLOW STEM AUGERS</u>		COMPILED BY <u>DKS</u>	
DATUM <u>GEODETIC</u>		DATE <u>Feb. 20/00</u>		CHECKED BY <u>ASP</u>	

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 $\gamma$  kN/m <sup>3</sup>	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	20 40 60 80 100						10 20 30	
— CONTINUED FROM PREVIOUS PAGE —																
314.50																
15.27	Boulder (cored between 15.3m and 15.9m depth)		13	SS	100/00											
313.92																
15.85	Sand and Gravel, trace silt Very loose Brown Wet						314									
312.85			14	SS	3		313									
16.92	END OF BOREHOLE						312									
311.18																
18.59	END OF CONE HOLE Refusal to further cone penetration; probable bedrock															

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



PROJECT <u>991-1193</u>		<b>RECORD OF BOREHOLE No 16-8</b>		1 OF 1 <b>METRIC</b>	
W.P. <u>335-98-00</u>		LOCATION <u>N 5079381.25; E 313776.32</u>		ORIGINATED BY <u>SB</u>	
DIST <u>54</u> HWY <u>11</u>		BOREHOLE TYPE <u>108mm I.D. HOLLOW STEM AUGERS</u>		COMPILED BY <u>DKS</u>	
DATUM <u>GEODETIC</u>		DATE <u>Feb 20/00</u>		CHECKED BY <u>ASP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	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							w <sub>p</sub> w w <sub>L</sub>		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED									
330.75	GROUND SURFACE																
0.00 330.45	Topsoil																
0.30	Sand, some silt to silt and sand, organics/decaying wood matter noted throughout Very loose Brown to black Moist to wet		1	SS	2												
			2	SS	1												
			3	SS	1												
			4	SS	2												
			5	SS	2												
	non-plastic Atterberg Limit test result for Sample 6		6	SS	1									0 53 47 0			
			7	SS	1												
323.59																	
7.16	Sandy Silt, trace clay, organics/decaying wood matter noted throughout Very loose to loose Brown Wet		8	SS	5												
	non-plastic Atterberg Limit test for Sample 9		9	SS	8									0 30 64 6			
321.00	organic content of Sample 9 = 19%																
9.75	END OF BOREHOLE																

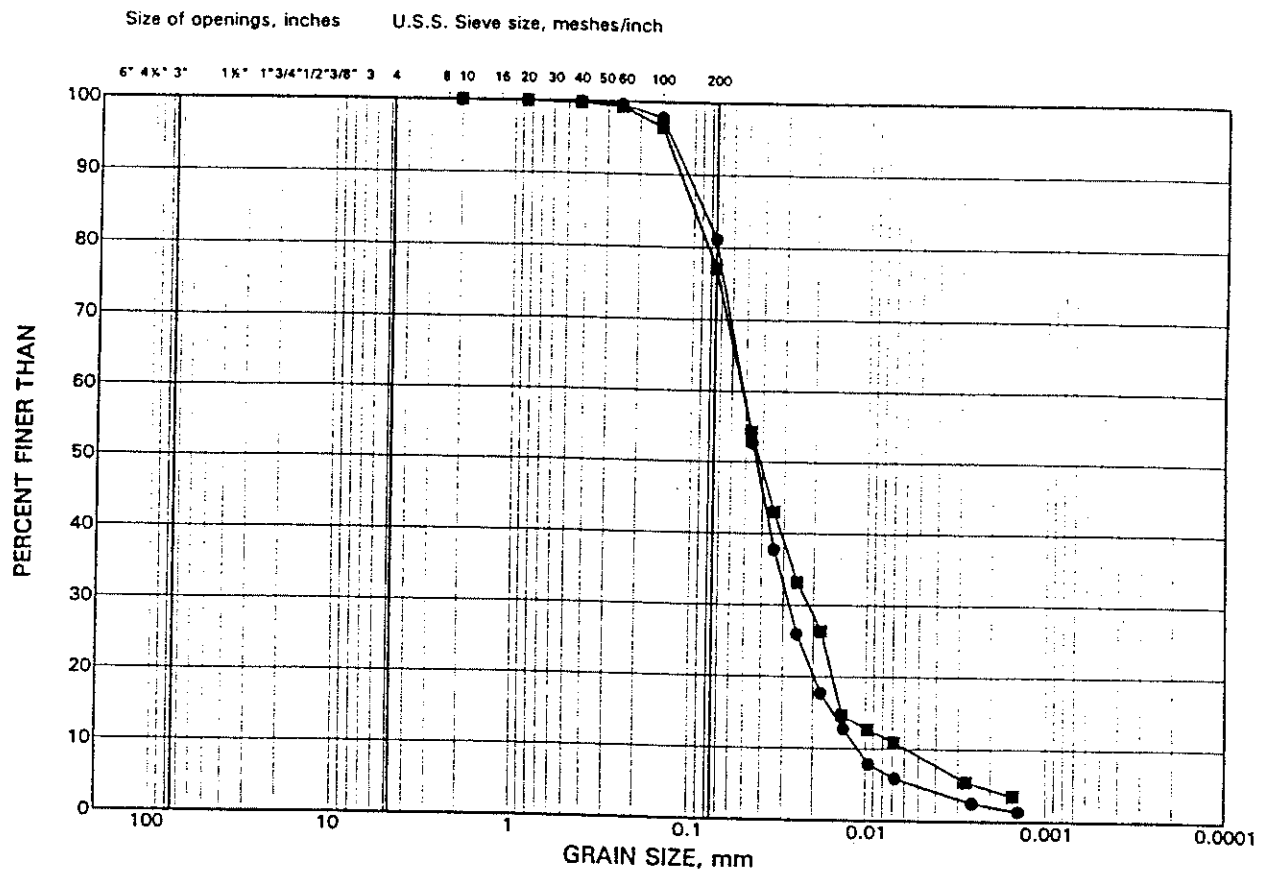
ON MOT 991-1193 GPJ ON MOT.GDT 24/4/00

+3, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# GRAIN SIZE DISTRIBUTION

Silt, some sand

FIGURE 18



## LEGEND

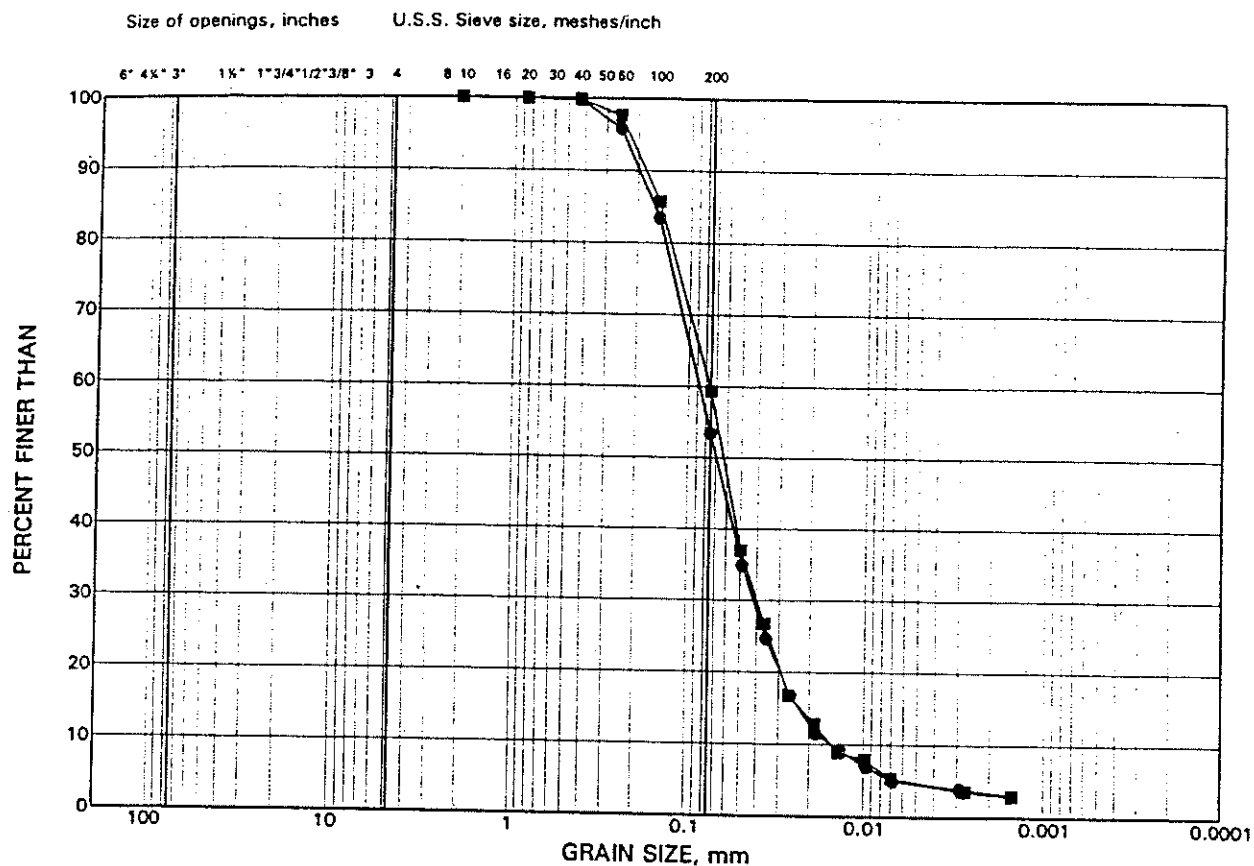
SYMBOL      BOREHOLE      SAMPLE ELEVATION(m)

●	14-1	6	341.8
■	14-7	4	337.0

# GRAIN SIZE DISTRIBUTION

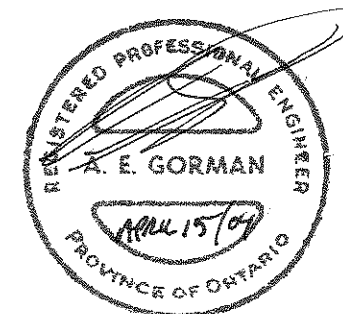
Silt and Sand

FIGURE 19



**Appendix D**

**Drawings**



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

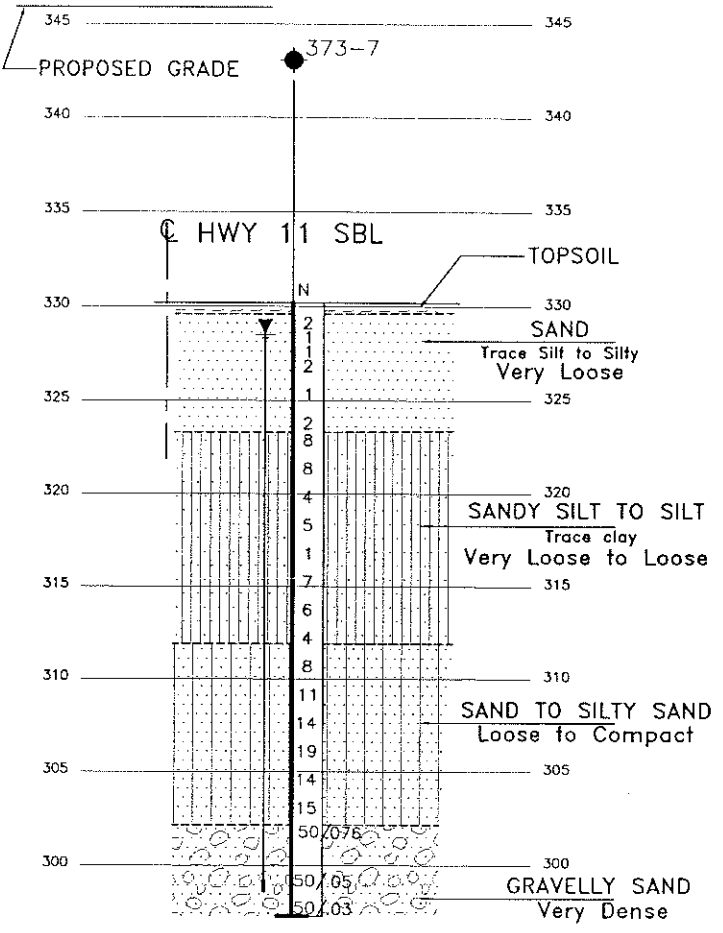
HWY 11  
CONT No  
WP No 5037-03-01

SOUTH RIVER BRIDGE  
(SBL)  
SOIL STRATA

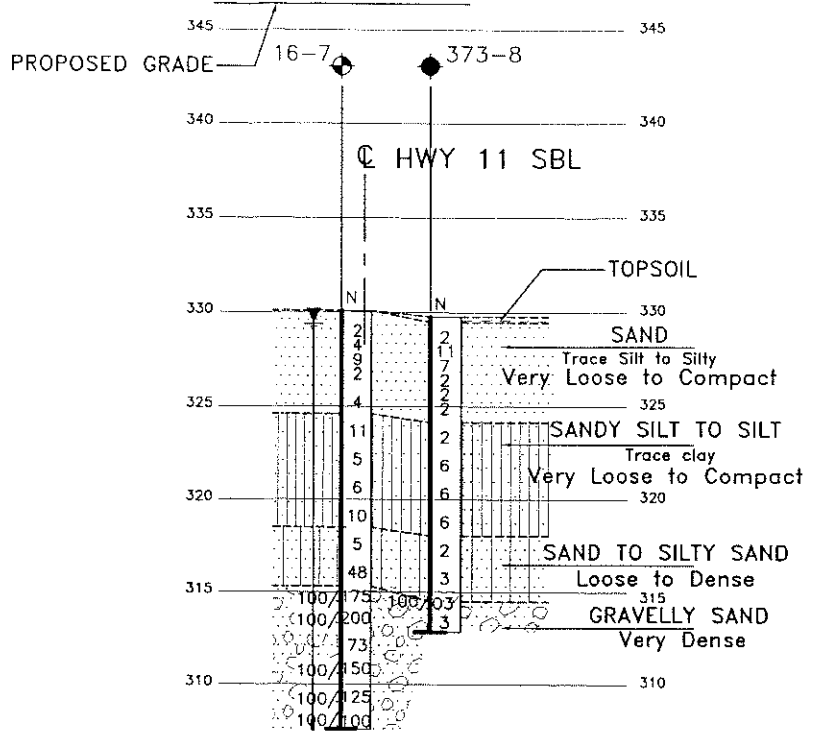
**Marshall  
Macklin  
Monaghan**  
PROJECT MANAGERS • ENGINEERS • SURVEYORS • PLANNERS

**THURBER ENGINEERING LTD.**  
THURBER

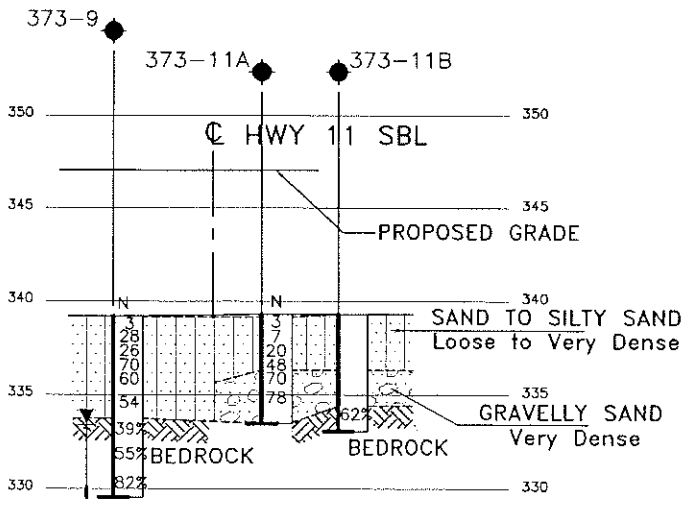
KEYPLAN



SECTION A-A



SECTION B-B



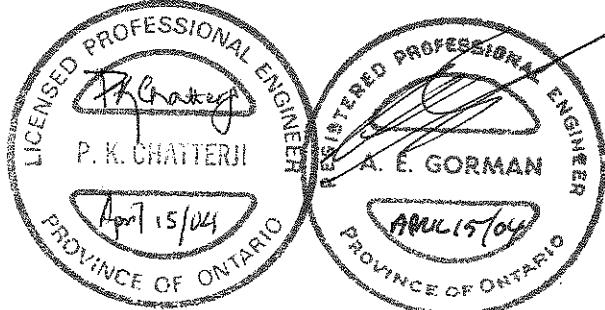
SECTION C-C

LEGEND			
	BoreHole by THURBER		
	Dynamic Cone Penetration Test (cone)		
	BoreHole by GOLDER		
N	Blows /0.3m (Std Pen Test, 475J/blow)		
CONE	Blows /0.3m (60° Cone, 475J/blow)		
PH	Pressure, Hydraulic		
WL	Head Artesian Water		
	Piezometer		
90%	Rock Quality Designation (RQD)		
NO	ELEVATION	NORTHING	EASTING
373-6	329.2	5 079 354.8	313 729.2
373-7	330.3	5 079 358.1	313 753.8
373-8	330.1	5 079 391.7	313 784.5
373-9	339.2	5 079 424.9	313 844.5
373-10	344.7	5 079 432.7	313 863.6
373-11A	339.3	5 079 417.2	313 850.7
373-11B	339.1	5 079 413.4	313 854.3
16-6	335.9	5 079 413.4	313 846.7
16-7	329.8	5 079 385.8	313 796.0
16-8	330.8	5 079 381.3	313 776.3

NOTE

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

BENCH MARK  
N&W IN NE ROOT OF 0.4  
SPRUCE 66.71 LT OF 14+975.0  
BM ELEV. : 330.612



DRAWING NOT TO BE SCALED  
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AEG	CHK	PK
DRAWN	SS	CHK	AEG
CODE CHBDC 2000/LOAD CL-625-INT/DATE FEB 2004			
SITE 44-373/STRUCT SCHEME DWG 3			