REVISED PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
LITTLE WHITE RIVER II BRIDGE REPLACEMENT
HIGHWAY 546, DISTRICT OF ALGOMA
G.W.P.512-00-00, W.P. 513-00-01, SITE: 38S-056

Geocres Number: 41J-73

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of the proposed replacement bridge to carry Highway 546 over the Little White River in Algoma, Ontario.

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, records of boreholes, stratigraphic profile and cross-sections, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

A previous investigation was reported in 2004 by Golder Associates Ltd. related to the replacement of the existing temporary modular bridge (TMB). The factual data from that investigation is included in Appendix C and has been considered in the analysis and preparation of recommendations contained in this report.

Thurber carried out the investigation as a sub-consultant to Marshall Macklin Monaghan, under the Ministry of Transportation Ontario (MTO) Agreement Number 5005-E-0042.

2 SITE DESCRIPTION

At the site, the Little White River flows towards the southwest in a channel that parallels Highway 546. Little White River joins the Mississagai River near Wharncliffe, approximately 10 km north of Highway 17. The river level was recorded as Elevation 297.2 in October 2006.

The river flows on a relatively gentle gradient at the site, with poorly developed meanders. The channel is approximately 21 m wide and 3 m deep (in the middle of the channel). The river banks are approximately 2 m high at the site, though higher, actively eroding banks were observed approximately 200 m upstream from the existing crossing, as can be seen in the background of Photo 4 in Appendix E, just below the "Little White River" sign.

Geologically, the site lies within the Canadian Shield, which is characterized by Pre-Cambrian bedrock. Locally, however, the Little White River flow across post-glacial deposits of sand and gravel and the area is comparatively flat and well treed. There are no buildings or other developments in the immediate vicinity of the site. The junction of Highway 546 with Highway 639 lies approximately 1.4 km north of the site.

Photographs of the site are included in Appendix E and show the existing bridge, the approaches and the soil exposure north of the bridge site.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field-testing for this project was carried out during February 19 to March 17, 2007. Six boreholes numbered 07-LW1 to 07-LW6 were drilled at the north and south abutments of possible single-span structures on three alternative alignments. The depths of the boreholes ranged from 23.2 m to 32.3 m. 8 boreholes (07-LW7 to 07-LW14) were drilled along the existing road for the proposed embankment and ranged in depth from 2.9 m to 3.7 m. The Record of Borehole sheets for the boreholes are included in Appendix A. The approximate locations of the 14 boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix F.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area.

A combination of hollow-stem auger drilling and diamond coring techniques were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Dynamic Cone Penetration Testing (DCPT) was undertaken in boreholes LW1, LW2, LW5 & LW6 from a depth of 1.5 m to refusal, and from 25.5 m to refusal in borehole LW3.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. At each abutment one or more standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed and enclosed in filter sand to permit longer term groundwater level monitoring. The locations and completion details of the piezometers are shown in Table 3.1. Boreholes without piezometer installations were grouted with bentonite upon completion. The borehole completion details are shown in Table 3.1.

A member of Thurber's technical staff supervised drilling and sampling operations on a full time basis. The supervisor logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing.

Table 3.1 – Borehole Completion Details

Borehole Location	Piezometer Tip Depth/ Elevation (m)	Completion Details
07-LW1 South Abutment	29.9 / 270.0	Piezometer with 1.5 m slotted screen installed with sand filter to 27.8 m, bentonite seal from 27.8 m to ground surface.
07-LW2 North Abutment	22.8 / 275.8	Piezometer with 1.5 m slotted screen installed with sand filter to 21.0 m, bentonite seal from 21.0 m to ground surface.
07-LW3 South Abutment	No Installation	Bentonite grout to ground surface.
07-LW4 North Abutment	No Installation	Bentonite grout to ground surface.
07-LW5 South Abutment	30.5 / 270.2	Piezometer with 1.5 m slotted screen installed with sand filter to 28.4 m, bentonite seal from 28.4 m to ground surface.
07-LW6 North Abutment	24.4 / 273.3	Piezometer with 1.5 m slotted screen installed with sand filter to 22.9 m, bentonite seal from 22.9 m to ground surface.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) 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 also subjected to gradation analysis and the results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy along the three alternative alignments are presented in this appendix and on the "Borehole Locations and Soil Strata" drawings in Appendix F. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by granular fill overlying cohesionless deposits of sand and gravel with cobbles and boulders.

5.1 Topsoil

Topsoil was encountered at two abutment borehole locations (LW3 & LW6) ranging from 75 mm to 200 mm in thickness. The topsoil ranged from peaty deposits near the river to sandy topsoil above the riverbank. Topsoil was encountered in Boreholes LW 7 to LW11 inclusively, ranging in thickness from 50 to 100 mm.

5.2 Fill

Boreholes LW4 & LW5, located on the north and south abutments respectively, encountered granular fill consisting of reworked native sand and gravel with cobbles and boulders. The thickness of the fill ranged from 2.4 to 3.0 m and the underside of the fill layer was recorded at elevations between 298.3 m and 297.4 m.

'N' values ranging from 11 to greater than 100, derived from Standard Penetration Tests conducted in the sand and gravel fill, indicate a compact to very dense relative density. In some cases, the high SPT values may reflect the presence of cobbles or boulders.

Natural moisture content of samples from the granular fill ranged from approximately 4 to 16 %. A gradation of a sample of the fill is shown in Figure B1 in Appendix B.

Fill material was not encountered in the embankment boreholes.

5.3 Sand and Gravel

The soils encountered in the boreholes drilled for the investigation consisted predominantly of layered sand and gravel deposits. These deposits extended to the depth of exploration, ranging from 23.2 to 32.3 m at the river crossing and 2.9 m to 3.7 m for the embankment boreholes. The soils were generally encountered in a compact state, becoming very dense toward the bottom of the exploratory boreholes. Cobbles and boulders were inferred at depth from SPT refusal. SPT 'N' values generally ranged between 17 and greater than 100 blows per 300mm penetration were recorded in this stratum, indicating compact to very dense relative density.

Gravel was encountered more frequently at the south abutment than at the north abutment where sand was the predominant soil type, with sand and gravel occurring at depths of greater than 17 m below ground level. Gravel was not encountered in boreholes LW4 and LW5.

The structural boreholes, with the exception of LW3, terminated in 2 m to greater than 3 m of dense or very dense sand.

The embankment boreholes encountered layers of sand and sand and gravel and predominantly exhibited compact to very dense relative density.

Selected samples from this deposit were subjected to grain size distribution tests and the results are presented in Figures B2 to B9 in Appendix B. Natural moisture content of this material ranged from approximately 4 to 35%.

5.4 Silt

A layer of silt, 0.8 m to 3.7 m thick, was encountered at depths of 4 to 7 m on the north bank (LW2, LW4 & LW6) of the river and also a 0.7 m thick layer at a depth of 0.8 m in LW 2. SPT 'N' values between 16 and 45 were recorded in the main stratum, indicating

compact to dense relative density. The upper stratum in LW 2 is loose, based on a SPT 'N' value of 8.

Loose sandy silt was encountered at embankment borehole LW11 from ground level to 2.2 m, coinciding with a high water table of 0.8 m below ground level. Compact silt was also encountered in embankment borehole LW12 from 3 to 3.7 m.

The results of gradation testing undertaken on this deposit are presented in Figures B10 to B12 in Appendix B. Natural moisture content of this material ranged from approximately 16 to 28 %.

5.5 Groundwater Conditions

Standpipe piezometers were installed in selected boreholes and water levels were measured after completion of drilling and prior to demobilization from the site. The water level readings are presented in Tables 5.2 and 5.3.

Based on short-term readings in piezometers installed at the site, the groundwater level ranges from Elevation 295.0 close to the river to Elevation 302.4 in borehole LW13 further from the river. The water table will fluctuate seasonally and will be strongly influenced by the level of the river.

Table 5.2: Water Level Measurements at Bridge Abutments

	BH 07-LW1		BH 07-LW2		BH 07-LW3		BH 07-LW4		BH 07-LW5		BH 07-LW6	
Date (2007)	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.
March 8	-		-		-		-		-		0.8	296.9
March 9	-		-		-		3.7	296.8	-		-	
March 13	4.9	295.0	-		-		-		-		-	
March 15	-		-		-		-		3.7	297.0	-	
March 16	-		1.8	296.8	-		-		-		-	
March 29	-		-		3.1	297.2	-		-		-	

Table 5.3: Water Level Measurements along Embankment Alignment

	BH 07-LW7, LW8, LW9, LW10, LW14		BH 07-LW11		BH 07-LW12		BH 07-LW13	
Date (2007)	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.	Depth (m)	Elev.
March 10	Dry Upon Completion		-		2.1	299.9	2.9	302.4
March 17			0.8	299.8	-		-	

Boreholes LW7, LW8, LW9, LW10, and LW14 did not encounter groundwater at the time of investigation. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

6 MISCELLANEOUS

Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario supplied a track mounted CME 75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger and Mr. George Azzopardi of Thurber, under the direction of Mr. Alastair E. Gorman, P.Eng.

The coordinates for the boreholes and the ground surface elevations were provided by Marshall Macklin Monaghan.

Mr. Tony Harte, M.Sc., FGS and Mr. Alastair E. Gorman, P.Eng prepared the Foundation Investigation Report.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

Thurber Engineering Ltd.

Alastair E. Gorman, P.Eng.,
Senior Foundations Engineer

Report Reviewed by:
P.K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents preliminary geotechnical design recommendations to assist the design team to select and design a suitable foundation system and approach embankments for the new structure.

It is understood that Highway 546 will cross the Little White River on a single-span temporary modular bridge (TMB) that will lie on a new alignment approximately 8.5 m east of the existing.

It is anticipated that the grade of the highway as it crosses the new structure will be approximately Elevation 300.0. The resulting approach embankments will be approximately 2 m above the original ground level at the south and up to 3.5 m above original ground at the north.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of this investigation.

8 STRUCTURE FOUNDATIONS

The stratigraphy identified in the preliminary investigation consisted primarily of a deep deposit of sands and gravels, with some silt layers, extending to depths greater than the maximum depth of exploration of 32 m. On and adjacent to the existing highway alignment, the native soil was overlain by generally dense to very dense cohesionless fill, presumably placed during past road construction activities.

The existing temporary modular bridge (TMB) is supported on timber cribs as shown in Photo 4 in Appendix E. These crib foundations appear to be performing satisfactorily. The approach spans from the ends of the TMB to the river bank are assumed to be supported on shallow footings or sleepers that are not readily visible.

In the preparation of the preliminary geotechnical design recommendations, consideration has been given to the following foundation types:

- Spread footings bearing on native soil
- Spread footings on engineered fill
- Steel H-piles driven into the very dense soil
- Drilled shafts founded in the very dense soil

A comparison of the foundation alternatives based on advantages and disadvantages of each is included in Appendix D. While deep foundations are a viable alternative at this site, it is recognized that spread footings may provide the more cost effective solution for support of a TMB.

8.1 Spread Footings on Native Soil

Spread footings founded on native soil are generally the most cost effective form of foundation for the support of a TMB. However, in the vicinity of the north abutment (Borehole 07-LW6), the upper 2 m of native soil is in a very loose state, with SPT values of 1 blow for 0.3 m of penetration being recorded. The near surface soil near the south abutment (Borehole 07-LW5) consists of existing cohesionless fill, generally in a very dense state.

In view of these conditions and the proximity of the river, spread footings on the existing native ground are not recommended.

8.2 Spread Footings on Engineered Fill

Spread footings bearing on engineered fill are considered to be a viable form of construction for a TMB and these footings may be perched in the approach fill.

However, based on the findings in the two boreholes drilled in the vicinity of the TMB foundations, a number of issues must be addressed if spread footings are to be considered for support of the TMB. These issues are discussed separately for each foundation.

8.2.1 South Foundation

Based on the findings in Borehole 07-LW5, the top 2.4 m of soil (to Elevation 298.3) consists of very dense sand and gravel fill. Below the fill and within the depth of interest for spread footing design, the soil consists of compact sand. The groundwater level for design is assumed to be equal to the design elevation of the river, i.e. Elevation 298.8.

Based on the preliminary GA and profile, it is assumed that a spread footing for the south foundation can be founded approximately at Elevation 299. At that elevation, the footing will be underlain by approximately 1 m of very dense fill followed by compact, saturated sand. The design of the footing must also take account of the slope of the river channel in front of the foundation.

It is recommended that the south foundation footing be designed on the basis of the following geotechnical resistances:

Factored ULS	270 kPa
SLS	180 kPa

8.2.2 North Foundation

At the north foundation (BH 07-LW6), the upper 2 m of soil was very loose, with an SPT value of 1 blow for 0.3 m of penetration, based on the borehole for the preliminary investigation for deep foundations. Below that, compact conditions prevailed.

It is recommended that the spread footing to support the TMB not be placed directly on the very loose soil but the final recommendations will depend on the results of boreholes to be drilled for the detail investigation.

However, for preliminary design, it is recommended that:

1. The north foundation area be stripped to the groundwater level prevailing at the time of construction, expected to be approximately Elevation 297
2. The lowest elevation at which a footing may be placed is Elevation 299
3. Free draining Granular B fill be placed in a thickness of 1 m before attempting compaction
4. Continue placing compacted granular fill to an Elevation of 302
5. Allow the full height of fill to remain in place for at least 2 weeks
6. Excavate to founding elevation of 299 and construct the footing.

It is recommended that the footing be designed on the basis of the following geotechnical resistances:

Factored ULS	270 kPa
SLS	180 kPa

8.2.3 Future Investigation and Recommendations

It is noted that at the time the preliminary investigation was carried out, the proposed structure was a two-lane, single span, concrete bridge and previous investigations concluded that deep foundations would be required. The preliminary investigation was targeted at that concept rather than a TMB.

Further investigation is being carried out during the detail design phase and it is possible that the geotechnical recommendations will be revised in light of the new findings.

8.3 Steel H-Piles

The soil stratigraphy encountered at this site is considered to be suitable for the support of foundations on driven steel piles.

It is recommended that the H-piles be driven to sufficient depth to embed the pile tips in the very dense sand and gravel soils encountered at the site.

8.3.1 Axial Resistance

For preliminary design, the following geotechnical resistances can be used for piles founded in the very dense native soils:

Pile Section	Geotechnical Resistance (kPa)	
	Factored ULS	SLS (25 mm)
HP 310 X 110	1 600	1 400
HP 360 X 132	1 800	1 600

The structural resistance of the pile must be checked by the structural designer.

The highest recommended tip elevations for the H-piles are as follows:

	Highest Pile Tip Elevation		
	West Alignment	Existing Alignment	East Alignment
North Abutment	278	273	275
South Abutment	271	274	270

These are preliminary recommendations and may change during detail design based on the final alignment, final bridge arrangement and the results of the site investigation and field testing to be completed at that time.

8.3.2 Pile Installation

Pile installation should be in accordance with Special Provision No. 903S01.

The soils encountered consist of sand and gravel that is generally compact in the upper 20 m, becoming very dense at greater depths. The presence of cobbles and boulders has been inferred at depth across the site.

8.4 Drilled Shafts

Initial consideration was given to the use of drilled shafts to support the structure. However, the use of drilled shafts is not recommended for the following reasons:

1. Based on the available information from the investigation, the drilled shaft piles would be founded in cohesionless soils below the water table. Drilling with mud and/or the simultaneous advance of a steel liner would be required in order to maintain stable sides.
2. It would not be possible to unwater the shaft, necessitating placement of concrete by tremie methods, and preferably by pumping.
3. There is a high risk that the geotechnical resistance of the soil would be compromised due to disturbance of the founding soil caused by drilling below the groundwater level.

8.5 Downdrag

Downdrag on the piles is not an issue at this site.

8.6 Abutment Design Considerations

From a geotechnical perspective, the conditions at this site are considered to be suitable for the design of conventional, semi-integral or integral abutments.

Design of the abutment must take account of the CHBDC requirements for scour protection.

8.7 Recommended Foundation

For the purpose of supporting a TMB, and on the assumption that jacking and levelling are acceptable, the recommended foundation for the abutments is a spread footing on engineered fill or other form of ground improvement that will be determined in the course of the detail investigation.

9 BRIDGE APPROACHES AND EMBANKMENTS

Based on the two foundation boreholes drilled on the alignment of the TMB and eight boreholes drilled along potential realignments, the soils at the site are almost entirely non-cohesive sand and gravel. In general, the soils are described as compact to very dense sand and gravel with cobbles and boulders.

No long term settlement problems are anticipated for approach embankments built at this site. Similarly, the 2 to 3 m high embankments likely to be constructed will be stable at side slopes of 2H:1V and no global stability problems are expected provided the new embankments are adequately protected from erosion and scour. Recommendations in this regard should be obtained from a river hydrologist.

10 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

1. Pile Installation

The presence of cobbles and boulders in a very dense matrix of sand and gravel may present difficulties in installing the piles to the specified depth and to the specified tolerances for location and verticality.

2. Excavation

Hydraulic equipment is expected to be capable of excavating to the depths required for abutments on piles. If excavations advance below the existing groundwater level, groundwater control measures may have to be implemented in order to maintain stables sides and base in the excavation.

3. Unwatering

The pervious nature of the soils encountered at this site and the proximity to the river will make unwatering of excavations difficult. Depending on the locations of the abutments, steps may have to be taken to control the river and exclude it from the excavations. Typically, a combination of a sheet pile cutoff and vacuum well-points may be required.

11 INVESTIGATION FOR DETAIL DESIGN

During the detail design phase of the project, additional site investigation and field testing will be required. The following minimum program is recommended:

1. Boreholes for structure foundations and approaches.

Two sampled boreholes must be drilled at each foundation element of the new TMB structure and three in each approach embankment.

At each foundation element, the borehole must be sampled to sufficient depth to provide data on which to base recommendations for spread footings for the TMB. It is recommended that boreholes be drilled to depths of 10 m. The approach boreholes must be sampled to depths equal to the height of the embankment at the location of investigation or to refusal if refusal is encountered at lesser depth.

2. Reporting.

A Foundation Investigation and Foundation Investigation and Design Report must be prepared in accordance with the Ministry's standards. The topics addressed in the design portion must include:

- Structure foundation design (shallow or deep)

- Associated axial, lateral and sliding resistances
- Founding elevations for the potential foundation options
- Suitability for integral or semi-integral abutment design
- Requirements for pile driving shoes/rock points
- Assumptions for earth pressure diagrams and conceptual shoring alternatives, if required
- Stability analysis and recommendations for slope geometry
- Settlement (preloading/surcharging, soil improvement, wick drains, lightweight fill)
- Frost protection
- Drainage, run-off, erosion protection
- Unwatering
- Staged construction
- Geosynthetic reinforcement and Retained Soil Systems (RSS)
- Seismic considerations

12 CLOSURE

Engineering analysis and preparation of the Foundation Design Report were carried out by Mr. Alastair E. Gorman, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Alastair E. Gorman, P.Eng.,
Senior Foundations Engineer

P. K. Chatterji, P.Eng.,
Review Principal

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

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

$\overline{\blacktriangledown}$ Water Level

C_{pen} 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

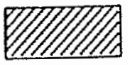
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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			

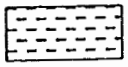
EXPLANATION OF ROCK LOGGING TERMS

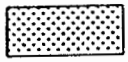
ROCK WEATHERING CLASSIFICATION

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

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	**Bedding Plane Spacing**
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
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.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	**Approximate Uniaxial Compressive Strength (MPa)**	**(psi)**	**Field Estimation of Hardness***
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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Ontario

THURBER

RECORD OF BOREHOLE No 07-LW1 1 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA

HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA

DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
299.9									
0.0	**SAND AND GRAVEL**, trace silt, occasional rootlets Very Dense Brown (SP)		1	SS	59				31 52 17 (SI+CL)
			2	SS	74		299		
298.4									
1.5	**SAND**, trace gravel Dense Brown (SP)		3	SS	37		298		
297.6									
2.4	**SAND AND GRAVEL** Compact to Dense Brown (SP)		4	SS	45				28 68 4 (SI+CL)
			5	SS	16		297		
295.3							296		
4.6	**SAND**, trace gravel Compact to Dense Brown Wet (SP)		6	SS	15	▼	295		0 97 3 (SI+CL)
			7	SS	31		294		8 81 11 (SI+CL)
			8	SS	19		293		
			9	SS	17		292		0 96 4 (SI+CL)
							291		
							290		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

GR SA SI CL

Continued Next Page

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

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

ONTMT4S 2333.GPJ 17/05/07

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THURBER

RECORD OF BOREHOLE No 07-LW1 2 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace gravel Compact to Dense Brown Wet (SP)										
289.3 10.7	**SAND AND GRAVEL** Compact to Dense Brown Wet (SP)		10	SS	21		289		○		43 53 4 (SI+CL)
			11	SS	27		288		○		
			12	SS	30		287		○		43 54 3 (SI+CL)
			13	SS	27		286		○		
			14	SS	17		285		○		
			15	SS	30		284		○		29 62 9 (SI+CL)
							283				
							282				
							281				
							280				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW1 3 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND AND GRAVEL, occasional cobbles Compact to Dense Brown Wet (SP)		16	SS	43		279 278 277		○		70 29 1 (SI+CL)
274.0			17	SS	19		276 275		○		52 46 2 (SI+CL)
25.9	**SAND**, some gravel Dense to Very Dense Brown Wet (SP)		18	SS	40		274 273 272		○		
			19	SS	112		271 270		○		13 85 2 (SI+CL)

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

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THURBER

RECORD OF BOREHOLE No 07-LW1 4 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 794.62 E 394 842.35 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.10 - 2007.03.13 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
269.1	**SAND**, some gravel Very Dense Brown Wet (SP)		20	SS	101						
30.8	END OF BOREHOLE AT 30.78m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 13/03/07 4.88 295.02						269				

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 07-LW2 1 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 821.99 E 394 861.84 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.16 - 2007.03.17 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
298.6							
0.0	**SAND**, trace silt, trace to some gravel, occasional cobbles Very Dense Brown (SP)		1	SS	50/.150		
297.8							298
0.8	**SILT**, trace clay, trace sand, occasional cobbles Firm Brown		2	SS	8		
297.1							
1.5	**SAND AND GRAVEL** Dense Brown Wet (GP)		3	SS	32	▼	297
296.3							
2.3	**SAND**, trace to some gravel Very Dense Brown (SP)		4	SS	55		296
			5	SS	50/.075		295
294.5							
4.1	Sandy **SILT**, trace clay, trace gravel Compact Grey (SM-NP)		6	SS	16		294
292.9							
5.6	**SAND** Compact to Dense Brown (SP)		7	SS	30		293
							292
			8	SS	27		291
							290
			9	SS	29		289

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

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

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
	61	38	1	(SI+CL)
	5	27	63	5
	0	100	0	(SI+CL)

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

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Ontario

THURBER

RECORD OF BOREHOLE No 07-LW2 2 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 821.99 E 394 861.84 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.16 - 2007.03.17 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND Compact to Dense Brown (SP)						288				
	Very Dense		10	SS	84				○		
							287				
			11	SS	26				○		1 96 3 (SI+CL)
							286				
							285				
			12	SS	27				○		0 93 7 (SI+CL)
							284				
			13	SS	23				○		0 100 0 (SI+CL)
	occasional gravel seam 15.85 to 16.46m.						283				
			14	SS	22		282		○		
280.7							281				
17.8	**SAND AND GRAVEL**, occasional cobbles Very Dense Grey (SP)		15	SS	82		280		○		
							279				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2333.GPJ 17/05/07

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THURBER

RECORD OF BOREHOLE No 07-LW2 3 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 821.99 E 394 861.84 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.16 - 2007.03.17 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%) (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
	Continued From Previous Page										
	SAND AND GRAVEL, occasional cobbles Very Dense Grey (SP)		16	SS	102		278				
277.2											
21.3	**SAND**, some gravel Very Dense Grey (SP)		17	SS	103		277				17 78 5 (SI+CL)
275.4			18	SS	108		276				
23.2	END OF BOREHOLE AT 23.16m. BOREHOLE OPEN TO 22.86m IN CASING. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 16/03/07 1.83 296.77										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
WATER CONTENT (%): 20 40 60

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

$15 \overset{20}{\oplus} 5$ $\overset{10}{}$ (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

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Ontario

THURBER

RECORD OF BOREHOLE No 07-LW3 1 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 786.98 E 394 843.37 ORIGINATED BY SLL
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY JHL
DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
300.3											
0.0	TOPSOIL: (75 mm)										
0.1	SAND AND GRAVEL, occasional cobbles, Very Dense, Brown		1	SS	50/.125		300				
299.2											
1.1	SAND, trace gravel, Compact, Brown, Moist		2	SS	21		299		○ ○		
			3	SS	15		298		○		1 94 5 (SI+CL)
			4	SS	7	▼	297		○		
			5	SS	17		296		○		
294.8											
5.5	SAND AND GRAVEL, occasional cobbles, Compact, Grey, Wet		6	SS	17		295				
			7	SS	20		294		○		
			8	SS	17		293				
							292				
							291		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW3 2 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 786.98 E 394 843.37 ORIGINATED BY SLL
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY JHL
DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
289.8	**SAND AND GRAVEL**, occasional cobbles Compact						290				
10.5	**SAND**, trace to some silt, trace gravel Compact Grey Wet		9	SS	17				○		2 94 4 (SI+CL)
							289				
			10	SS	23		288		○		
	some gravel, trace silt		11	SS	21		287		○		
							286				
	occasional cobbles		12	SS	21		285				
							284				
			13	SS	12				○		
							283				
							282				
			14	SS	20						
							281				

Continued Next Page

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

$15 \overset{20}{\oplus} 5$ $_{10}$ (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

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Ontario

THURBER

RECORD OF BOREHOLE No 07-LW3 3 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 786.98 E 394 843.37 ORIGINATED BY SLL
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY JHL
DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace to some silt, trace gravel Compact Grey Wet		15	SS	20		280		○		1 97 2 (SI+CL)
	occasion gravel seams loss of water in between 22.86m and 25.91 m						279				
							278				
			16	SS	15		277		○		
							276				
275.0											
25.3	AUGER REFUSAL AT 25.3m. DCPT REFUSAL AT 27.41m. BOREHOLE BACKFILLED WITH BENTONITE GROUT. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 29/03/07 3.05 297.25										

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

15^{20}_{10} 5 (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW4 1 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 821.16 E 394 872.30 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA
DATUM Geodetic DATE 2007.03.08 - 2007.03.09 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
300.5											
0.0	**SAND AND GRAVEL**, occasional cobbles Compact to Very Dense Brown (FILL)(SP)		1	SS	84		300	○			
			2	SS	78			○			67 28 5 (SI+CL)
			3	SS	100/ .075		299	○			
			4	SS	11		298	○			
297.4											
3.0	**SAND**, trace gravel, trace clay Loose to Very Dense Grey to Brown (SP)		5	SS	5	▼	297		○		
			6	SS	12		296	○			1 97 2 (SI+CL)
			7	SS	50/ .150		295	○			
293.5							294				
7.0	**SILT**, some clay, trace gravel, trace sand Hard (ML)		8	SS	41		293		○		3 9 69 19
			9	SS	45		292				
							291		○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No 07-LW4 2 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 821.16 E 394 872.30 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA
DATUM Geodetic DATE 2007.03.08 - 2007.03.09 CHECKED BY AEG

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
289.8	SILT, trace clay, trace gravel Hard (ML)						290				
10.7	SAND, trace silt, compact to dense Grey (SP)		10	SS	37		289	○			
			11	SS	35		288	○			
			12	SS	15		287	○			
			13	SS	35		286	○			27 70 3 (SI+CL)
			14	SS	30		285	○			
			15	SS	17		284	○			0 98 2 (SI+CL)
							283				
							282				
							281				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW4 3 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 821.16 E 394 872.30 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA
DATUM Geodetic DATE 2007.03.08 - 2007.03.09 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace silt, compact to dense Grey (SP)		16	SS	15		280		○		
	becoming gravelly		17	SS	29		279 278 277		○		
			18	SS	17		276 275		○		
			19	SS	101/.275		274 273		○		
271.2			20	SS	122/.300		272		○		
29.3	END OF BOREHOLE AT 29.26m. BOREHOLE BACKFILLED WITH BENTONITE GROUT.										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW4 4 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 821.16 E 394 872.30 ORIGINATED BY GA

HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 2007.03.08 - 2007.03.09 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 09/03/07 3.66 296.84										

+ ³, × ³: Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW5 1 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 778.62 E 394 853.61 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.14 - 2007.03.15 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
300.7						
0.0	**SAND AND GRAVEL**, trace silt, occasional cobbles Very Dense Brown (FILL)(SP)		1	SS	106	
			2	SS	90	
299.2						
1.5	**SAND**, trace silt, occasional gravel Very Dense Brown (FILL)(SP)		3	SS	78	
298.3						
2.4	**SAND**, trace gravel, trace to some silt Compact Brown (SP)		4	SS	22	
			5	SS	11	▼
			6	SS	15	
			7	SS	33	
	Occasional dense or very dense seams		8	SS	51	
	cobbles at 8.99 to 9.14m.		9	SS	17	

ELEVATION SCALE: 300, 299, 298, 297, 296, 295, 294, 293, 292, 291

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

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

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL	
0	98	2		(SI+CL)
0	96	4		(SI+CL)
5	92	3		(SI+CL)

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW5 2 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 778.62 E 394 853.61 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.14 - 2007.03.15 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt, trace gravel Compact Brown (SP)										
			10	SS	38		290		○		
							289				
	becoming Grey		11	SS	21		288		○		
			12	SS	26		287		○		7 75 18 (SI+CL)
			13	SS	16		286		○		
			14	SS	17		285		○		
			15	SS	20		284		○		
							283				
							282				
							281				

Continued Next Page

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

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

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW5 3 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 778.62 E 394 853.61 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.14 - 2007.03.15 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt, trace gravel Compact to Very Dense Brown (SP)		16	SS	20		280 279 278		○		7 91 2 (SI+CL)
	Silty **SAND**		17	SS	18		277 276 275		○		1 61 38 (SI+CL)
			18	SS	29		274 273		○		
	Becoming very dense below elevation 272		19	SS	51		272 271		○		

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW5 4 OF 4 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 778.62 E 394 853.61 ORIGINATED BY GA

HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA

DATUM Geodetic DATE 2007.03.14 - 2007.03.15 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND, trace silt, trace gravel Very Dense										
			20	SS	104						5 91 4 (SI+CL)
							270				
							269				
268.4											
32.3	END OF BOREHOLE AT 32.31m. BOREHOLE OPEN TO 32.00m IN CASING Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 15/03/07 3.66 297.04										

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

$15 \overset{20}{\underset{10}{\oplus}} 5$ (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW6 1 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 811.91 E 394 880.99 ORIGINATED BY SLL/GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.07 - 2007.03.07 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
297.7									
0.0	**ORGANICS**, with roots and rootlets								
0.2	**SAND**, trace gravel, with wood fragments Loose to Dense Brown Wet		1	SS	1		297		
			2	SS	1		296		
			3	SS	15		295		
			4	SS	36		294		
			5	SS	26		293		1 97 2 (SI+CL)
	trace gravel Very Dense Brown/Grey		6	SS	70		292		
291.0									
6.7	**SILT**, some clay Hard Grey Moist						291		
290.2									
7.5	**SAND**, trace silt, trace to some gravel Loose to Compact Grey Wet (SP)		7	SS	10		290		
			8	SS	23		289		
	becoming brown						288		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW6 2 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 811.91 E 394 880.99 ORIGINATED BY SLL/GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.07 - 2007.03.07 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace silt, some gravel Loose to Compact Brown Wet										
			9	SS	20		287		○		20 80 0 (SI+CL)
							286				
			10	SS	30		285		○		
			11	SS	22		284		○		
			12	SS	27		283		○		0 92 8 (SI+CL)
			13	SS	20		282		○		
279.4							281		○		
18.3	**SAND AND GRAVEL** Compact Grey (SP)		14	SS	23		280		○		
277.9							279				
19.8	**SAND**, occasional gravel						278				

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+ ³, × ³: Numbers refer to Sensitivity

15 20 5 10 (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW6 3 OF 3 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 811.91 E 394 880.99 ORIGINATED BY SLL/GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger / NW Casing COMPILED BY MFA
DATUM Geodetic DATE 2007.03.07 - 2007.03.07 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Dense to Very Dense Grey (SP)		15	SS	45				○		
							277				
	gravel layer at 21.3m						276				
							275				
	some gravel, frequent cobbles, occasional boulders		16	SS	100/.150		274				
273.1											
24.6	END OF BOREHOLE AT 24.6m. BOREHOLE OPEN TO 24.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 08/03/07 0.76 296.94								○		

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 17/05/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW7 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 596.63 E 394 857.60 ORIGINATED BY SLL

HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL

DATUM Geodetic DATE 2007.02.19 - 2007.02.19 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
301.8											
0.0	TOPSOIL: (50 mm)										
0.0	**SAND**, trace gravel, occasional cobbles Very Dense Brown Moist		1	AS					○		
			1	SS	50/.125		301		○		
			2	SS	23		300		○		5 92 3 (SI+CL)
			3	SS	50/.150				○ ○		
298.7			4	SS	50/.025		299				
3.1	END OF BOREHOLE AT 3.08 m. BOREHOLE OPEN TO 0.84 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2333.GPJ 23/04/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW8 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 645.13 E 394 850.56 ORIGINATED BY SLL

HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL

DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
301.3											
0.0 / 0.0	**TOPSOIL**: (50 mm)										
	SAND AND GRAVEL, occasional cobbles Compact Brown Moist Cobble		1	SS	50/.100		301				
			2	SS	25		300				
299.1											
2.2	**SAND**, some silt Dense Brown Moist		3	SS	40		299				0 97 3 (SI+CL)
			4	SS	30		298				
297.6											
3.7	END OF BOREHOLE AT 3.66 m. BOREHOLE OPEN TO 1.83 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2333.GPJ 23/04/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW9 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 696.02 E 394 848.00 ORIGINATED BY SLL

HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL

DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ 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 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
301.0											
0.0	TOPSOIL: (50 mm)						301				
0.0	**SAND AND GRAVEL**, occasional cobbles Loose to Dense Brown Moist		1	AS					○		
	Cobble		1	SS	50/.100		300		○		
			2	SS	8				○		
							299				
			3	SS	19				○		22 76 2 (SI+CL)
							298				
297.3			4	SS	36				○		
3.7	END OF BOREHOLE AT 3.66 m. BOREHOLE OPEN TO 1.60 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.										

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

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

ONTMT4S 2333.GPJ 23/04/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW10 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 744.62 E 394 829.68 ORIGINATED BY SLL
HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JHL
DATUM Geodetic DATE 2007.02.20 - 2007.02.20 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
301.2											
0.0	**TOPSOIL**: (75 mm)										
0.1	**SAND**, trace silt, trace gravel Very Loose to Compact Brown Moist						301				
			1	SS	1				○		
							300				
			2	SS	6				○		2 94 4 (SI+CL)
							299				
			3	SS	20				○		
			4	SS	23		298		○		0 97 3 (SI+CL)
297.5											
3.7	END OF BOREHOLE AT 3.66 m. BOREHOLE OPEN TO 3.05 m AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.										

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

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

ONTMT4S 2333.GPJ 23/04/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW11 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 838.20 E 394 892.09 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA
DATUM Geodetic DATE 2007.03.17 - 2007.03.17 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
300.6											
0.0	**TOPSOIL**										
0.1	Sandy **SILT**, trace clay, occasional rootlets and wood fibres Loose Brown (SM)		1	SS	6	▼	300		○		
			2	SS	5				○		0 29 66 5
			3	SS	6		299		○		
298.4											
2.2	**SAND AND GRAVEL** Compact Grey Wet (SP)		4	SS	11		298		○		
296.9			5	SS	28				○		
3.7	END OF BOREHOLE AT 3.7m. BOREHOLE OPEN TO 1.2m AND BACKFILLED WITH BENTONITE GROUT TO SURFACE. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 17/03/07 0.76 299.84										

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

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

ONTMT4S 2333.GPJ 23/04/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW12 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 854.29 E 394 930.36 ORIGINATED BY GA

HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA

DATUM Geodetic DATE 2007.03.10 - 2007.03.10 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
302.0											
0.0	**SAND**, some gravel, occasional rootlets, occasional wood fibers Compact to Dense Brown Dry (SP)		1	SS	50/.125		302		○		
			2	SS	21		301		○		
	Wet		3	SS	25	▼	300		○		
299.0			4	SS	43				○		
3.0	**SILT**, trace sand, trace clay Compact Grey		5	SS	27		299		○		0 2 90 8
298.3	(ML)										
3.7	END OF BOREHOLE AT 3.66m. BOREHOLE OPEN TO 3.0m, BACKFILLED WITH BENTONITE GROUT TO SURFACE. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10/03/07 2.13 299.87										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 2333.GPJ 23/04/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW13 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 889.58 E 394 967.43 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA
DATUM Geodetic DATE 2007.03.10 - 2007.03.10 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
305.3											
0.0	**SAND,** trace to some gravel, occasional rootlets Very Dense Brown (SP)		1	SS	50/ .125		305		○		
304.5											
0.8	**SAND AND GRAVEL,** Very Dense Brown (SP)		2	SS	50/ .150		304		○		
			3	SS	50/ .150				○		
302.4			4	SS	50/ .150	▼	303		○		
2.9	END OF BOREHOLE AT 2.9m. BOREHOLE OPEN TO 2.9m AND BACKFILLED WITH BENTONITE GROUT TO SURFACE. WATER LEVEL READINGS: DATE DEPTH(m) ELEV.(m) 10/03/07 2.90 302.40										

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

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

ONTMT4S 2333.GPJ 23/04/07

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 07-LW14 1 OF 1 METRIC

G.W.P. 5321-04-00 LOCATION Little White River N 5 167 913.38 E 395 012.85 ORIGINATED BY GA
HWY 129 BOREHOLE TYPE Hollow Stem Auger COMPILED BY MFA
DATUM Geodetic DATE 2007.03.10 - 2007.03.10 CHECKED BY AEG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.3											
0.0	**SAND AND GRAVEL**, occasional cobbles Very Dense Brown (SP)		1	SS	50/ .150		307	○	○		
			2	SS	50/ .100		306		○		
			3	SS	51		305		○		
	Wet		4	SS	50/ .150				○		
304.3											
3.0	**SAND**, trace gravel Very Dense Brown (SP)		5	SS	78		304		○		
303.8											
3.5	END OF BOREHOLE AT 3.5m. BOREHOLE OPEN AND DRY TO 2.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE GROUT TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 2333.GPJ 23/04/07

Appendix B

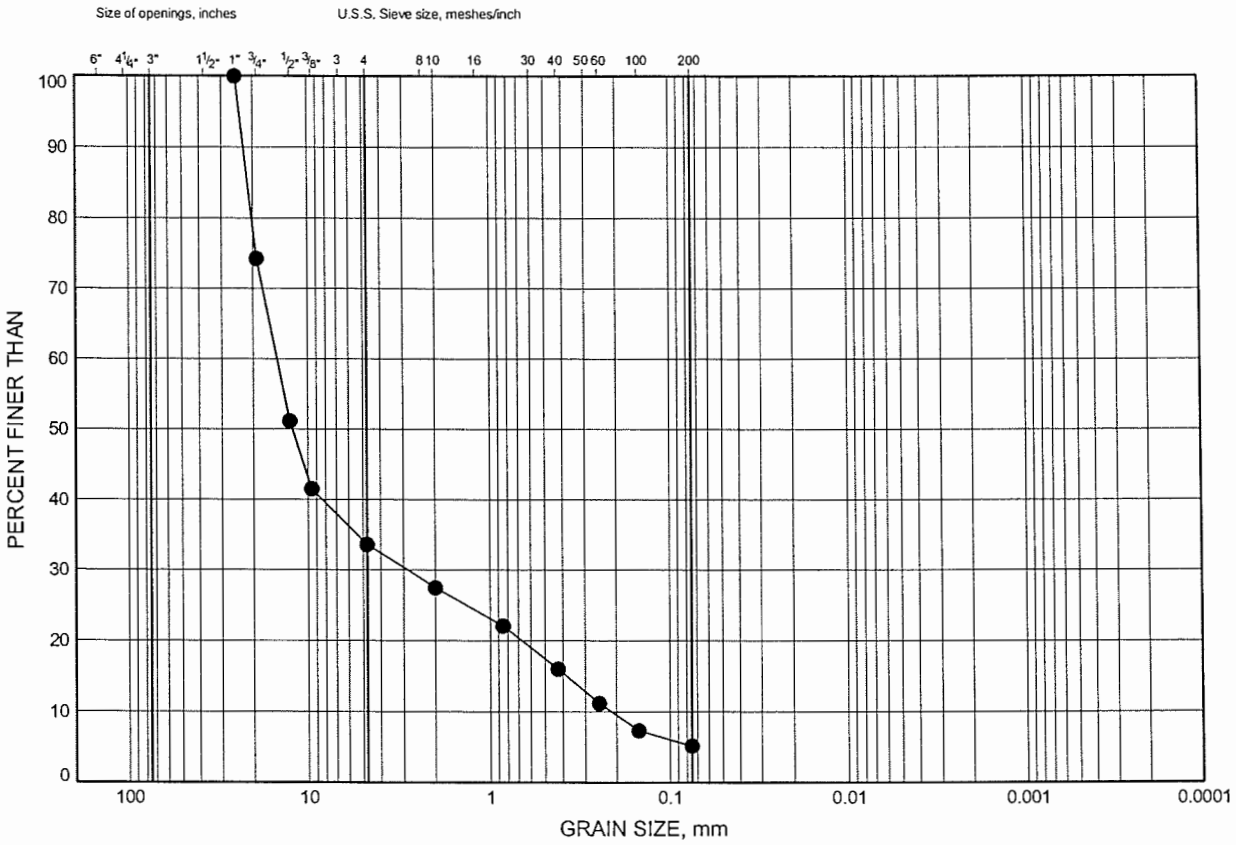
Laboratory Test Results

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B1

FILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW4	1.07	297.01

Date April 2007

Project 5321-04-00

THURBER

Prep'd MFA

Chkd. TJH

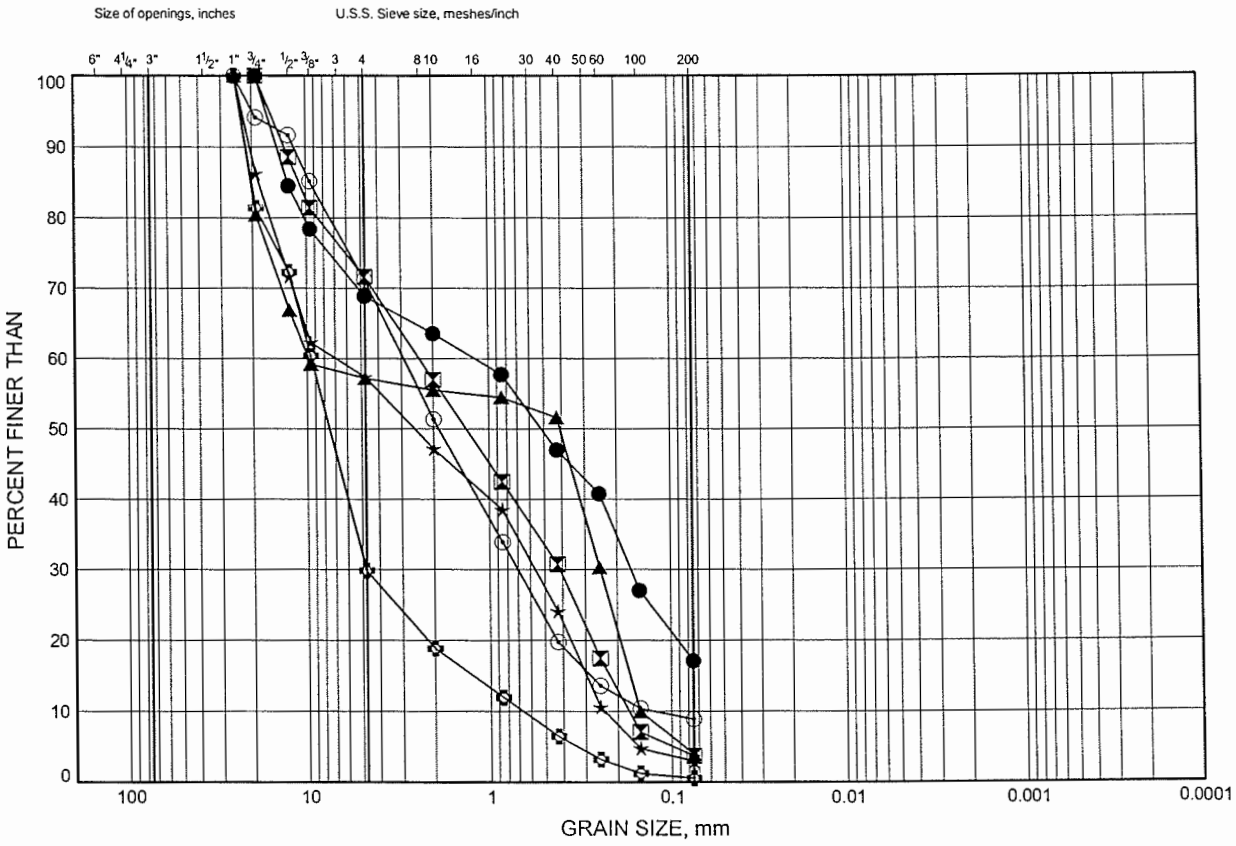
THURBGSD 2333.GPJ 20/04/07

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND AND GRAVEL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW1	0.30	299.07
⊠	07-LW1	2.59	296.78
▲	07-LW1	10.97	288.40
★	07-LW1	14.02	285.35
⊙	07-LW1	18.59	280.78
✿	07-LW1	20.12	279.25

Date April 2007

Project 5321-04-00

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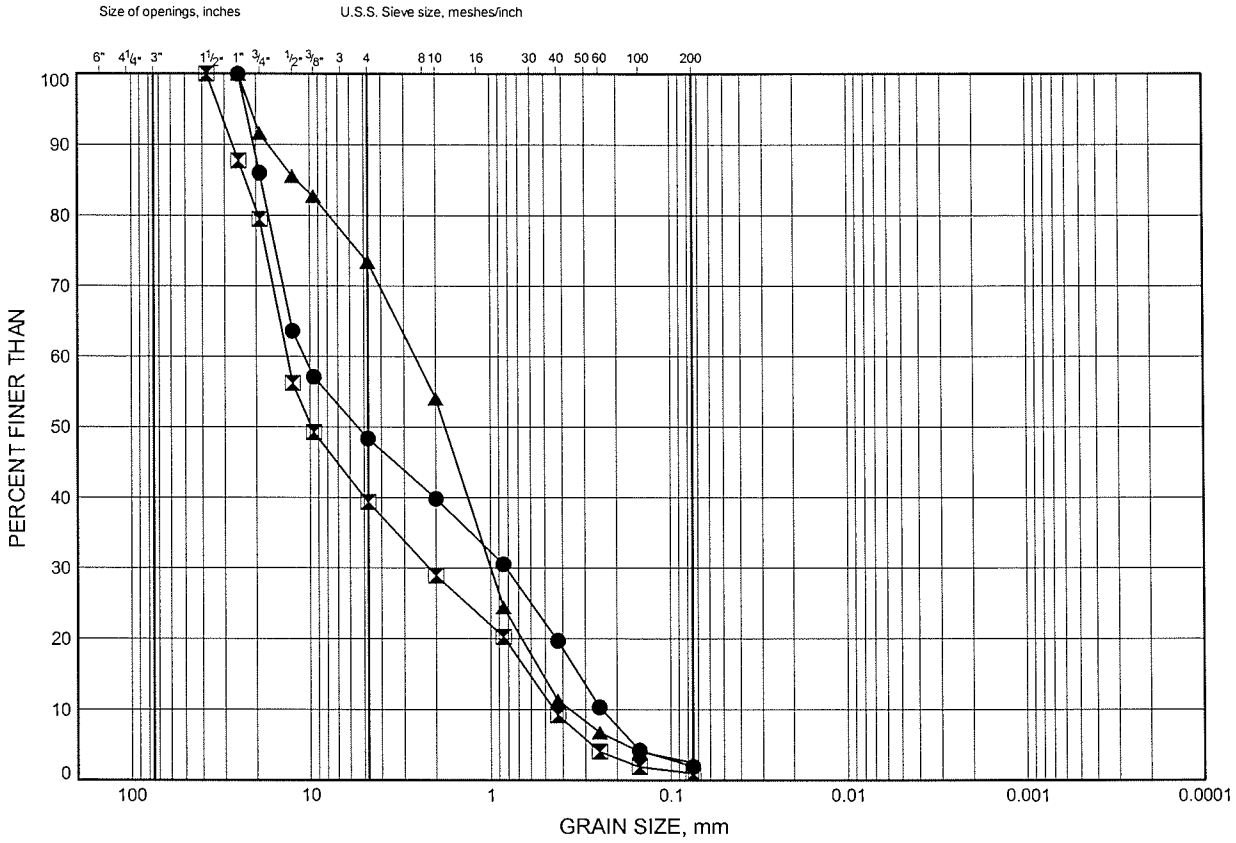
THURBGSD 2333.GPJ 20/04/07

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND AND GRAVEL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW1	23.16	276.76
⊠	07-LW2	1.83	296.75
▲	07-LW4	15.54	284.94

Date May 2007

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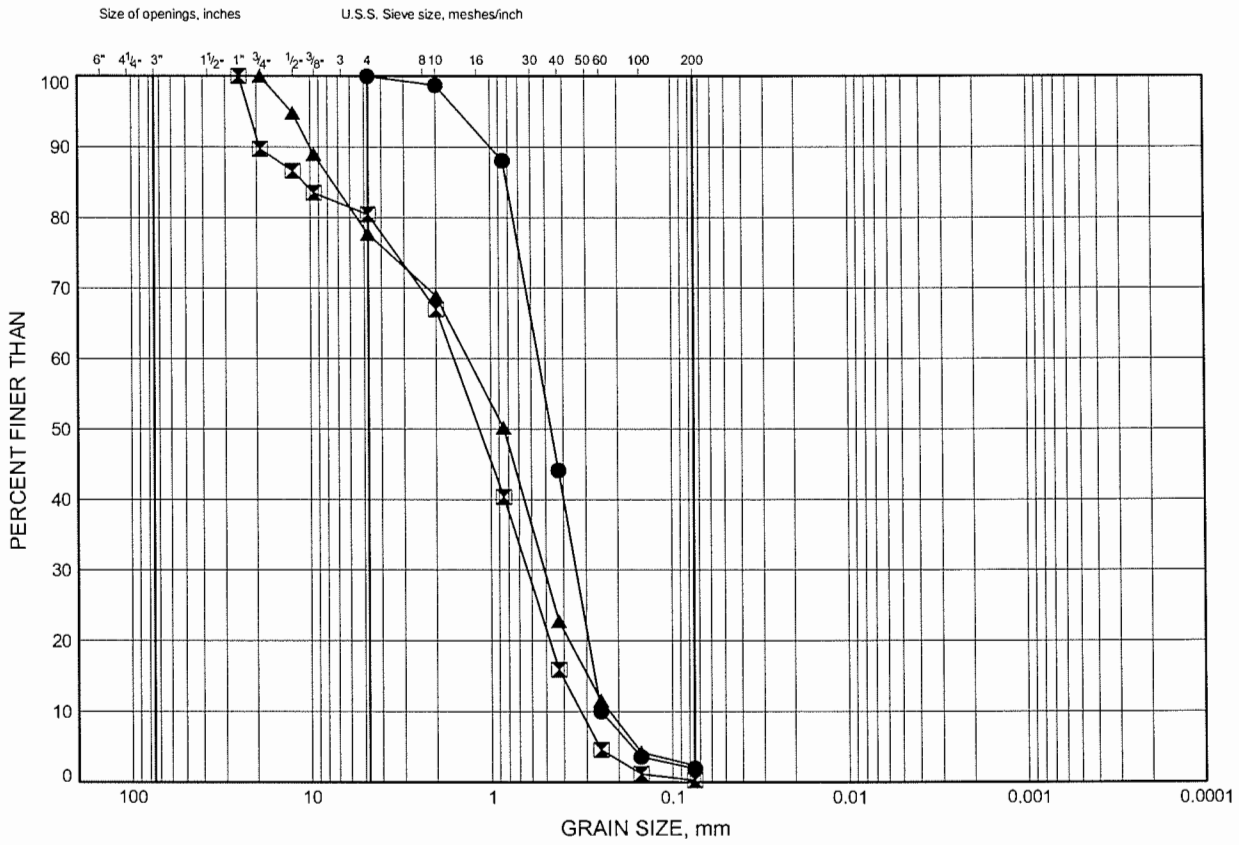
THURBGSD 2333.GPJ 17/05/07

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW4	18.59	281.89
⊠	07-LW6	10.97	286.70
▲	07-LW9	2.59	298.41

Date May 2007

Project 5321-04-00

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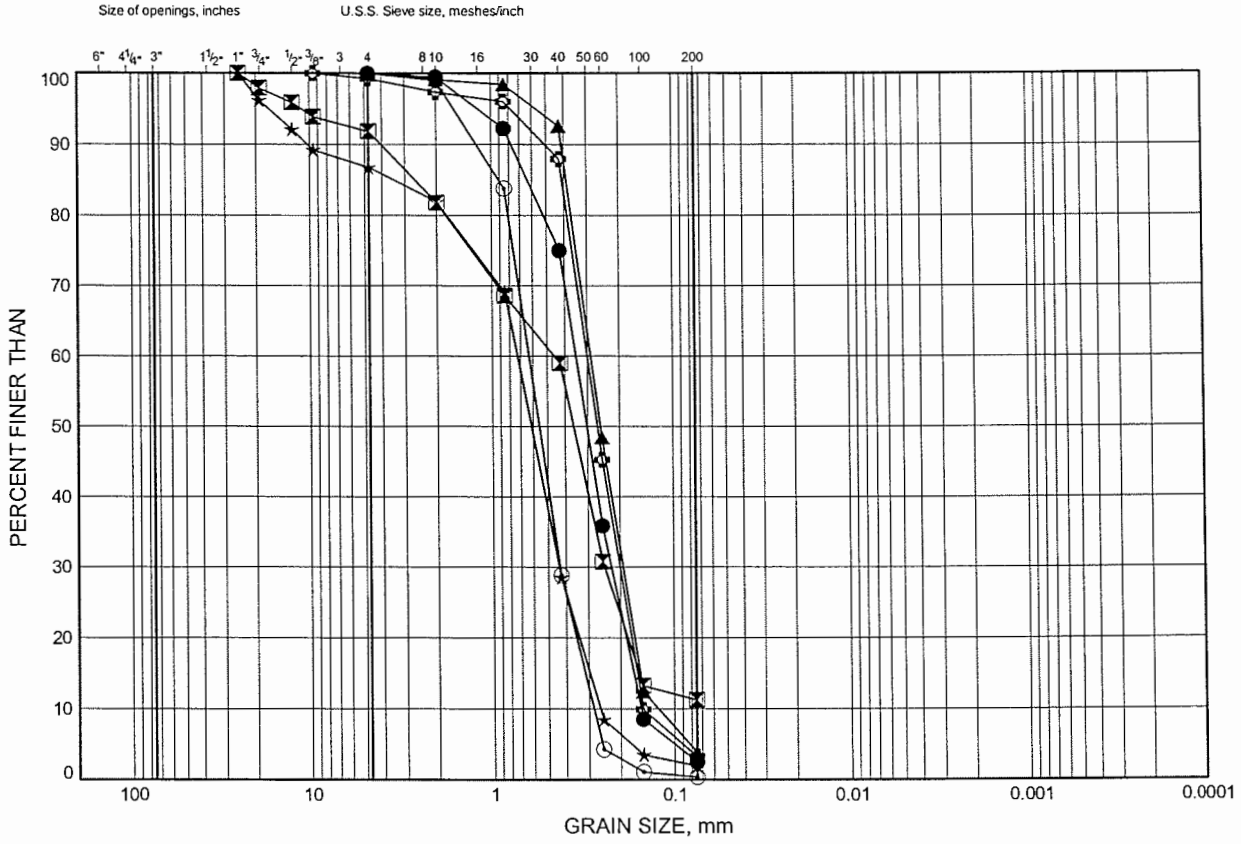
THURBGSD 2333.GPJ 17/05/07

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW1	4.88	294.49
⊠	07-LW1	6.40	292.97
▲	07-LW1	9.45	289.92
★	07-LW1	29.26	270.11
⊙	07-LW2	9.45	287.24
✿	07-LW2	12.50	284.19

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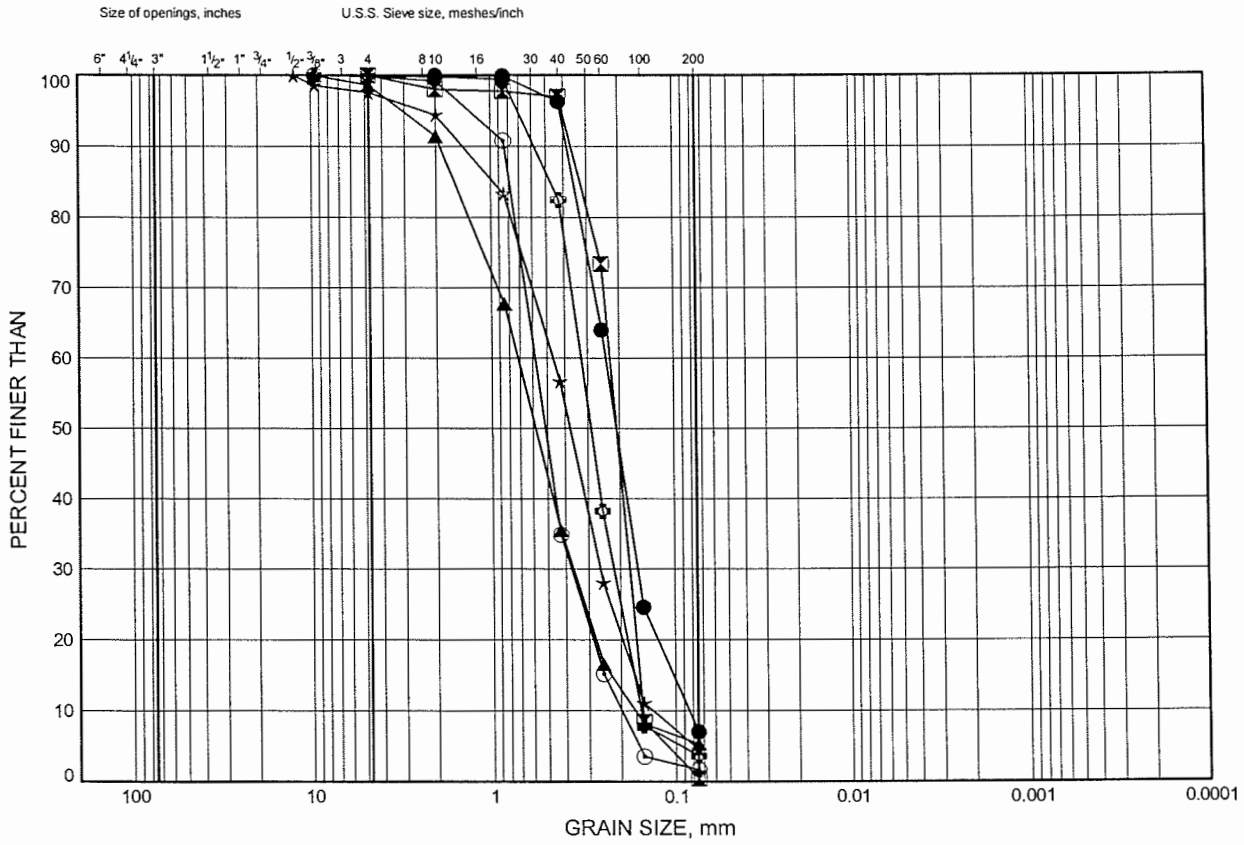
THURBGSD 2333.GPJ 20/04/07

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW2	14.02	282.67
⊠	07-LW2	15.54	281.15
▲	07-LW3	2.59	297.00
★	07-LW3	10.97	288.62
⊙	07-LW5	2.59	298.08
✿	07-LW5	6.40	294.27

Date April 2007

Project 5321-04-00

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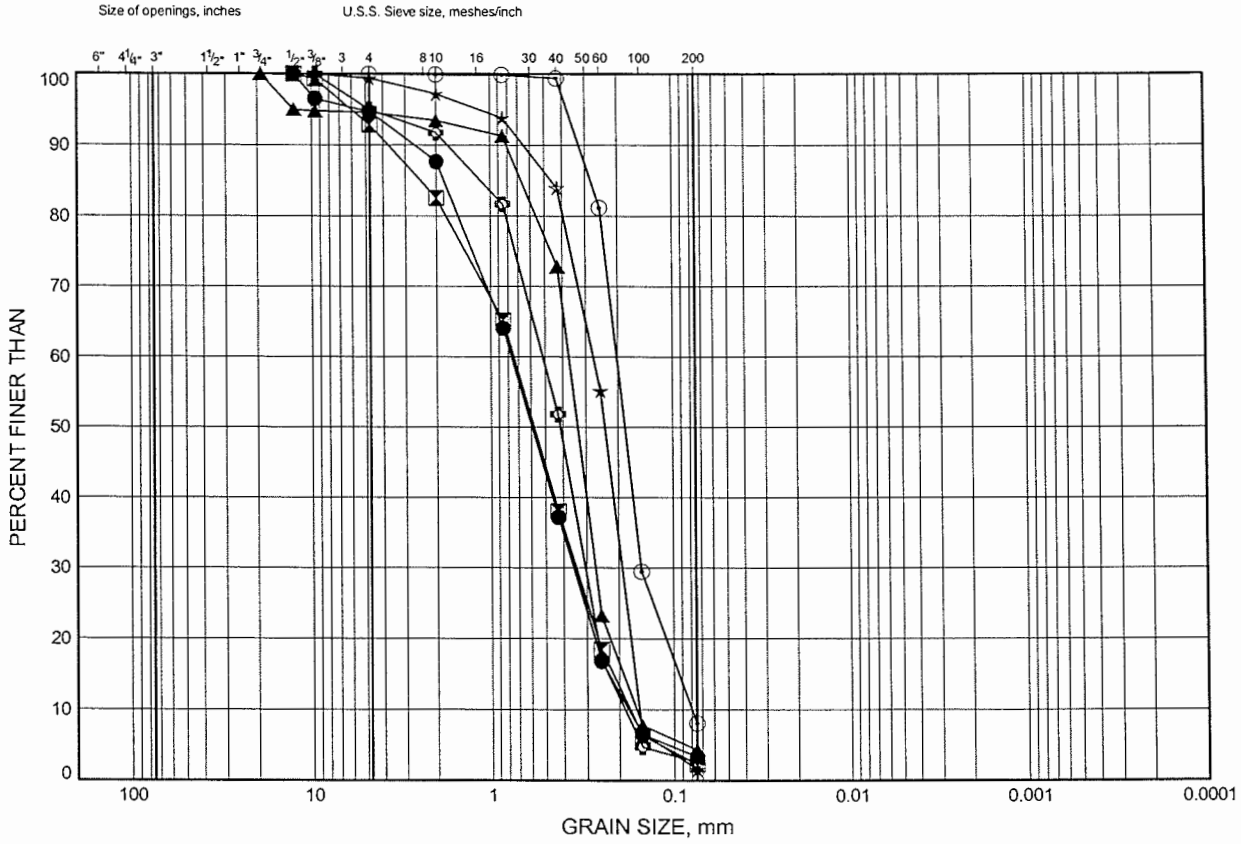
Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B7

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW5	9.45	291.22
⧓	07-LW5	20.12	280.55
▲	07-LW5	30.63	270.04
★	07-LW6	4.88	295.59
⊙	07-LW6	15.54	284.93
✿	07-LW7	1.83	299.97

Date April 2007

Project 5321-04-00

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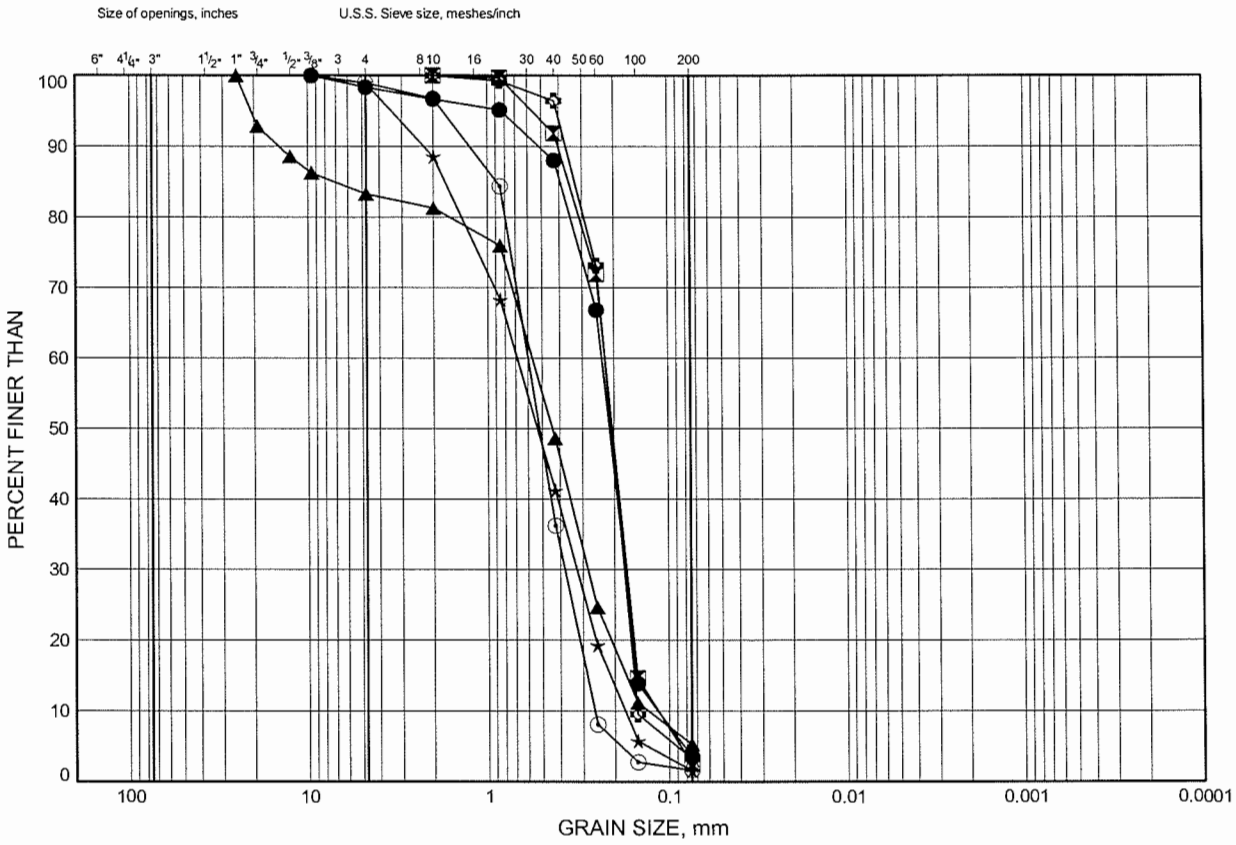
THURBGSD 2333.GPJ 20/04/07

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B8

SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
▲	07-LW2	21.64	276.94
★	07-LW3	20.12	280.21
⊙	07-LW4	4.88	295.60
✿	07-LW8	2.59	298.71
●	07-LW10	1.83	299.37
⧓	07-LW10	3.35	297.85

Date May 2007

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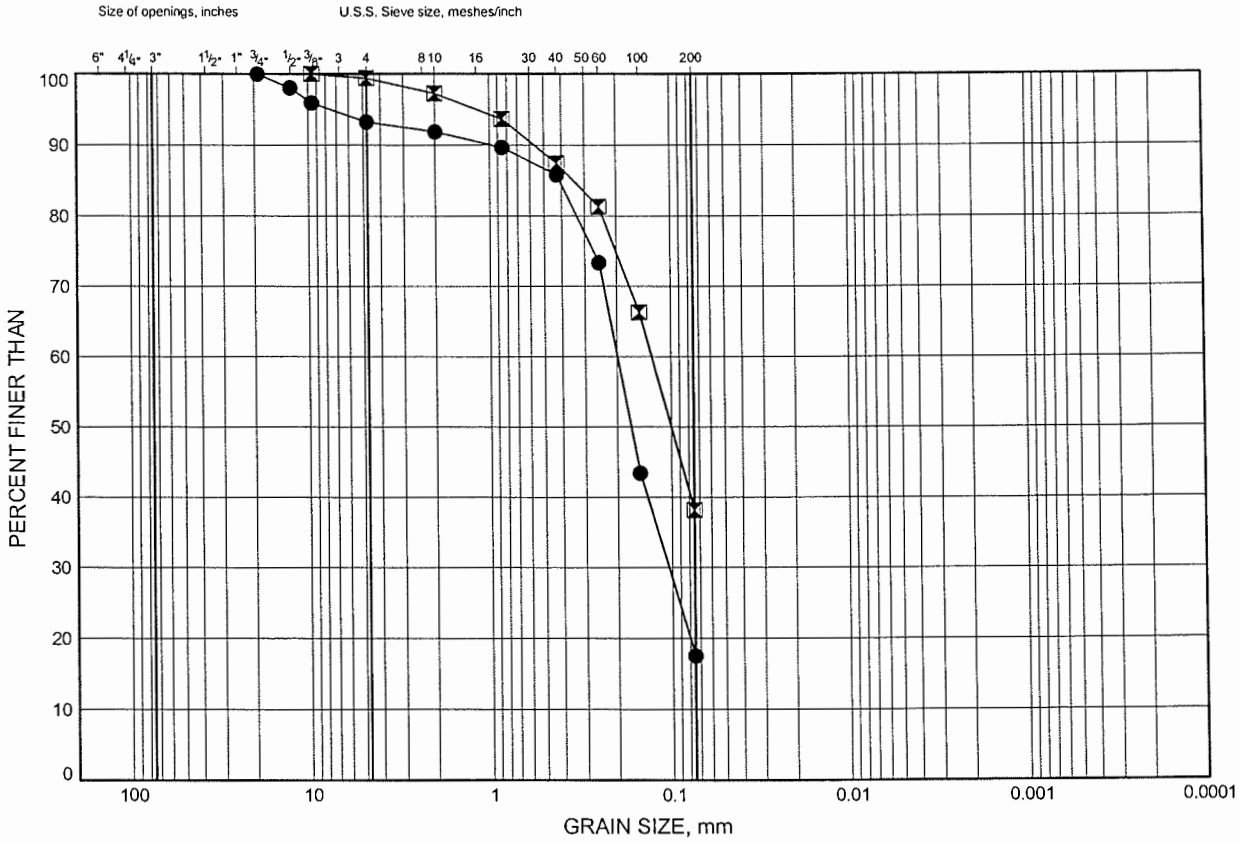
Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B9

SILTY SAND



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW5	14.02	286.65
⊠	07-LW5	23.16	277.51

Date April 2007

Project 5321-04-00

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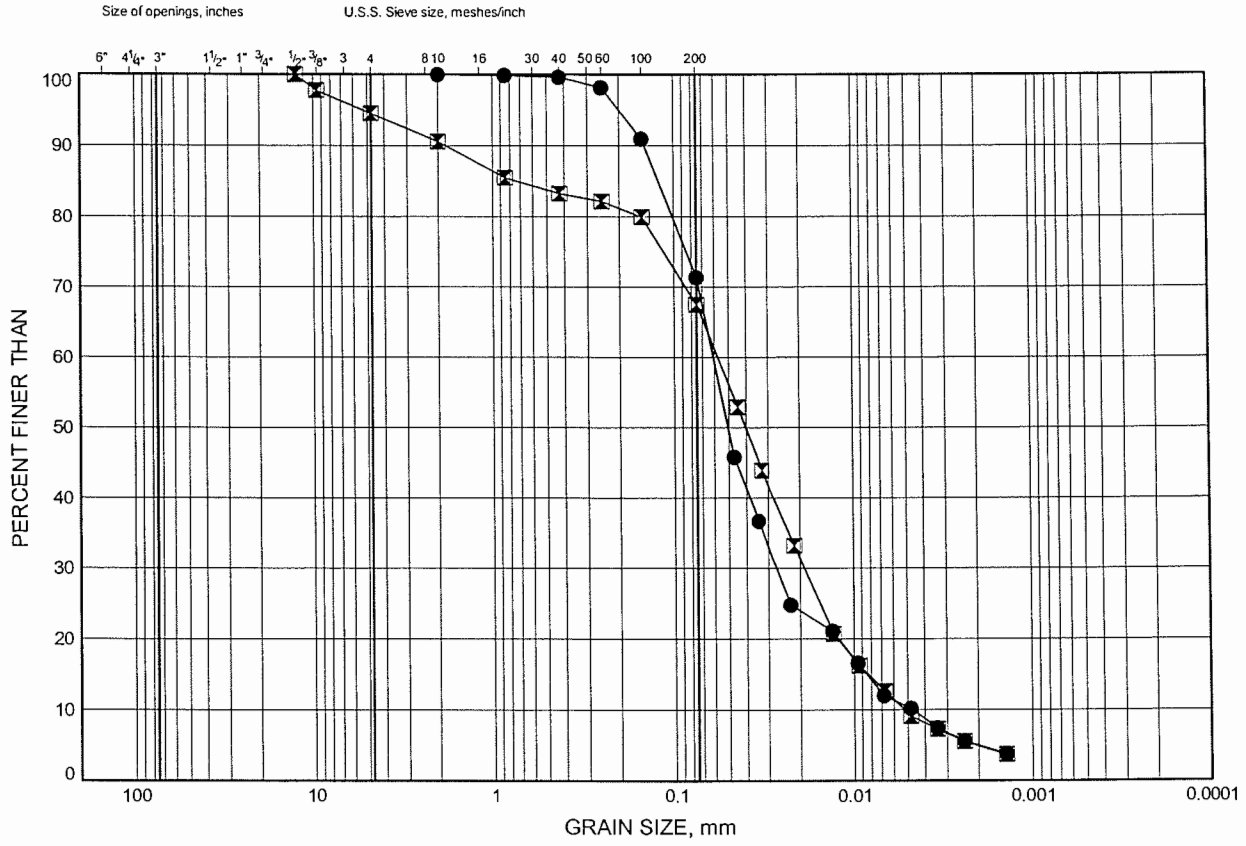
THURBGSD 2333.GPJ 20/04/07

Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B10

SANDY SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
⊠	07-LW2	4.88	291.81
●	07-LW11	1.07	299.53

Date April 2007

Project 5321-04-00

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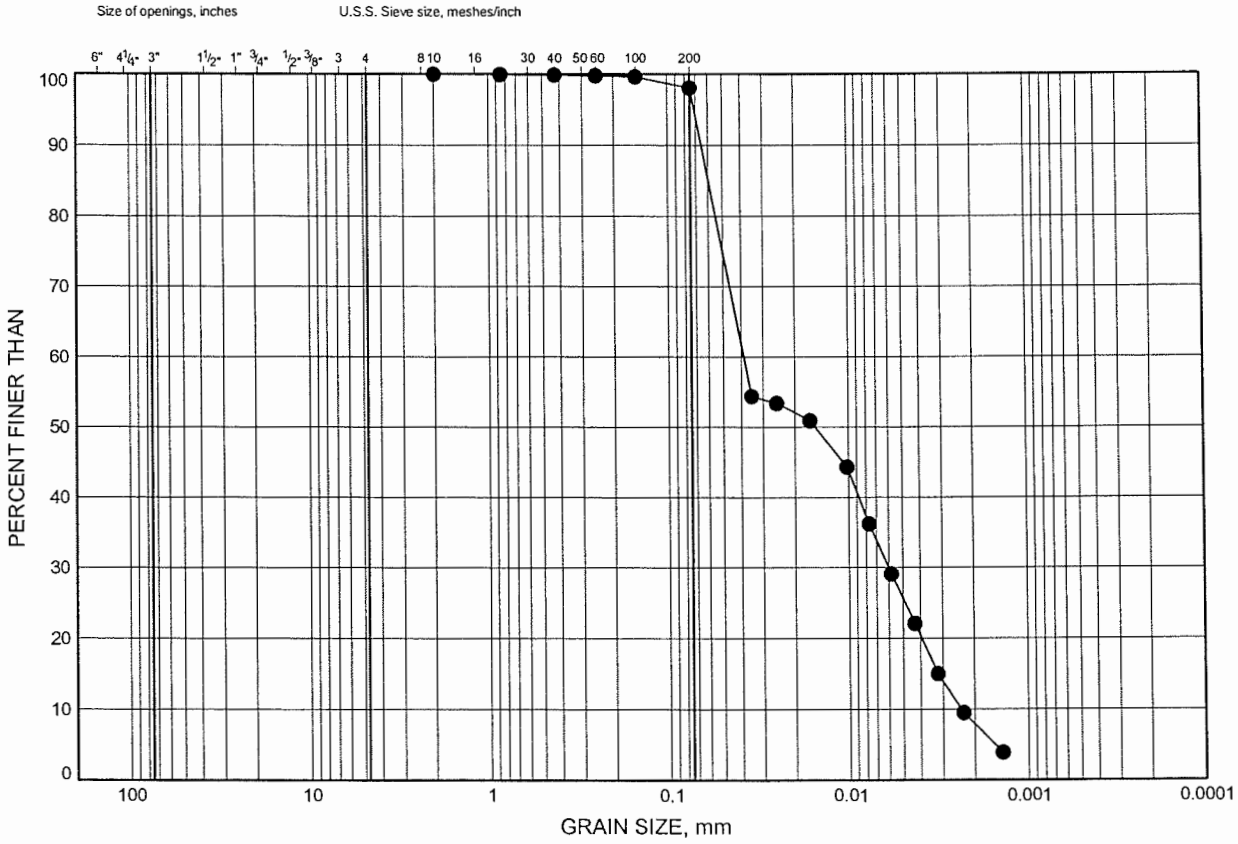
Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B11

SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW12	3.35	298.65

Date April 2007

Project 5321-04-00

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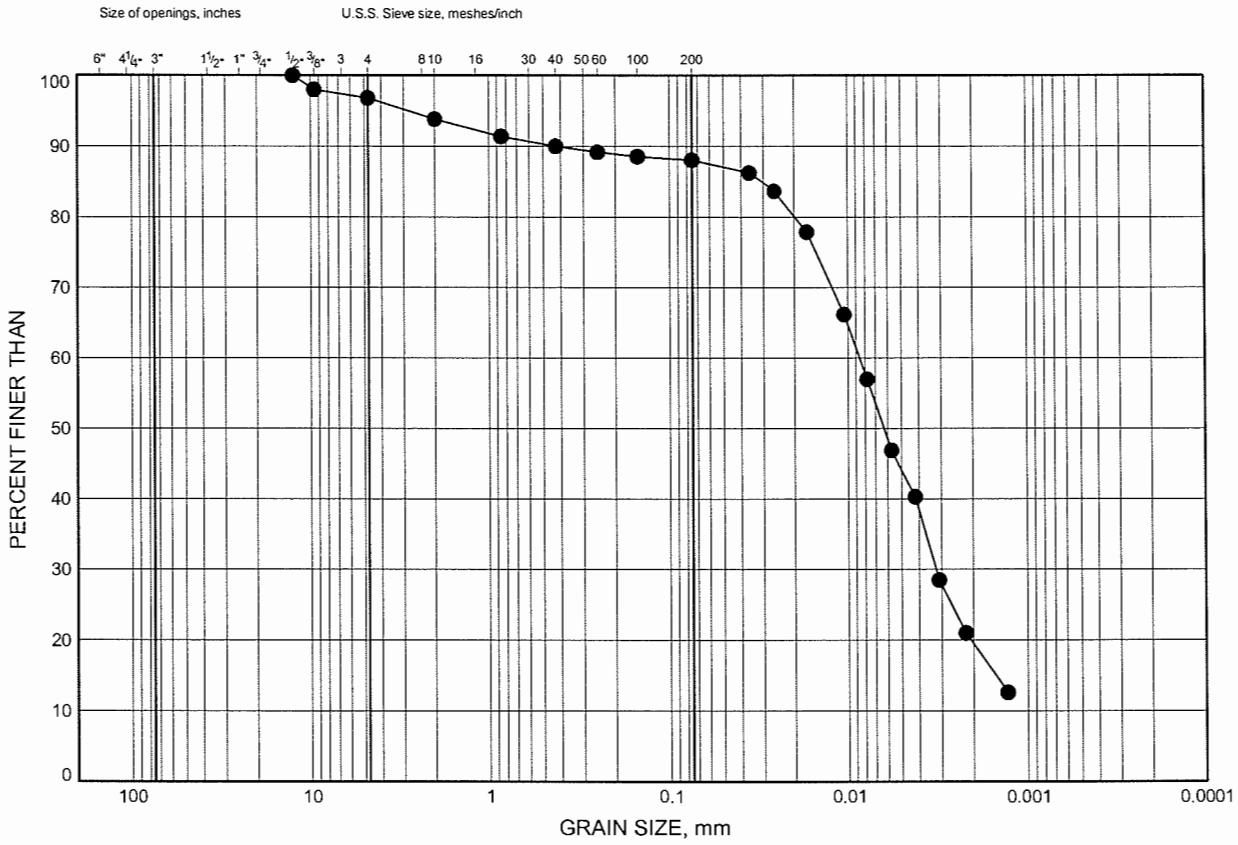
Little White River

GRAIN SIZE DISTRIBUTION

FIGURE B12

SILT, SOME CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	07-LW4	7.92	292.56

Date May 2007

Project 5321-04-00

THURBER

Prep'd MFA

Chkd. TJH

THURBGSD 2333.GPJ 17/05/07

Appendix C

Factual Information from the Golder Report

PROJECT 03-1111-029 | **RECORD OF BOREHOLE No LW2-1** | 1 OF 3 | **METRIC**

W.P. 513-00-01 | LOCATION N 199995.9 ;E 100009.8 | ORIGINATED BY GB

DIST 62 HWY 546 | BOREHOLE TYPE CME 55 POWER AUGER AND WET ROTARY WITH NQ CORE BARREL | COMPILED BY KG

DATUM Local | DATE October 31, 2003 | CHECKED BY JPD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS
100.7	GROUND SURFACE					
0.0	Silty Sand, some gravel and rootlets, occasional cobbles Loose Brown Moist (Fill)		1	SS	5	
			2	SS	7	
99.3						
1.4	Sand and Gravel, trace silt, occasional cobbles Compact Brown Moist (Fill)		3	SS	19	
97.7						
3.0	Sand and Gravel, trace silt, occasional cobbles Loose to compact Brown Wet		4	SS	11	
			5	SS	7	
			6	SS	12	
			7	SS	22	
91.0						
9.8	End of Borehole					

Notes:

1. Borehole was advanced to a depth of 1.8 m using 108 mm I.D. hollow stem augers, beyond which, further boring to 9.75 m depth was carried out using 'N' size casing and 'NQ' size core barrel.

2. Difficulties were experienced with sand blowing into the casing during drilling and sampling operations.

3. Dynamic Cone Penetration Test (DCPT) was carried out between depths of 9.75 m to 30.2 m.

ELEVATION SCALE: 100, 99, 98, 97, 96, 95, 94, 93, 92, 91, 90, 89, 88, 87, 86

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
- O UNCONFINED
- + FIELD VANE
- ● QUICK TRIAXIAL
- × REMOULDED

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

WATER CONTENT (%) (10 20 30)

UNIT WEIGHT γ kN/m³

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

+ ³, × ³: Numbers refer to Sensitivity

O ³% STRAIN AT FAILURE

Continued Next Page

PROJECT 03-1111-029 | RECORD OF BOREHOLE No LW2-1 | 2 OF 3 | METRIC

W.P. 513-00-01 | LOCATION N 199995.9 ;E 100009.8 | ORIGINATED BY GB

DIST 62 | HWY 546 | BOREHOLE TYPE CME 55 POWER AUGER AND WET ROTARY WITH NQ CORE BARREL | COMPILED BY KG

DATUM Local | DATE October 31, 2003 | CHECKED BY JPD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)		
	— CONTINUED FROM PREVIOUS PAGE —									kN/m³	GR SA SI CL

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100

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

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

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

ELEVATION SCALE: 85 84 83 82 81 80 79 78 77 76 75 74 73 72 71

Continued Next Page

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

PROJECT 03-1111-029

RECORD OF BOREHOLE No LW2-1 3 OF 3 **METRIC**

W.P. 513-00-01 LOCATION N 199995.9 ;E 100009.8 ORIGINATED BY GB

DIST 62 HWY 546 BOREHOLE TYPE CME 55 POWER AUGER AND WET ROTARY WITH NQ CORE BARREL COMPILED BY KG

DATUM Local DATE October 31, 2003 CHECKED BY JPD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	— CONTINUED FROM PREVIOUS PAGE —						70				

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

PROJECT 03-1111-029 | **RECORD OF PENETRATION TEST No LW2-2** | 1 OF 1 | **METRIC**

W.P. 513-00-01 | LOCATION N 200022.7 ;E 100037.1 | ORIGINATED BY CS

DIST 62 HWY 546 | BOREHOLE TYPE DYNAMIC CONE PENETRATION TEST | COMPILED BY KG

DATUM Local | DATE November 1, 2003 | CHECKED BY JPD

SOIL PROFILE			SAMPLES										
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
100.6 / 0.0	GROUND SURFACE						100 99 98 97 96 95				

Note:

1. Dynamic Cone Penetration Test (DCPT) was carried out between depths of 0 m to 6.4 m.

+ UNCONFINED, × FIELD VANE, ● QUICK TRIAXIAL, ○ REMOULDED

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

$O^{3\%}$ STRAIN AT FAILURE

DIST. 62 HWY. 546
CONT No.
WP No.513-00-01

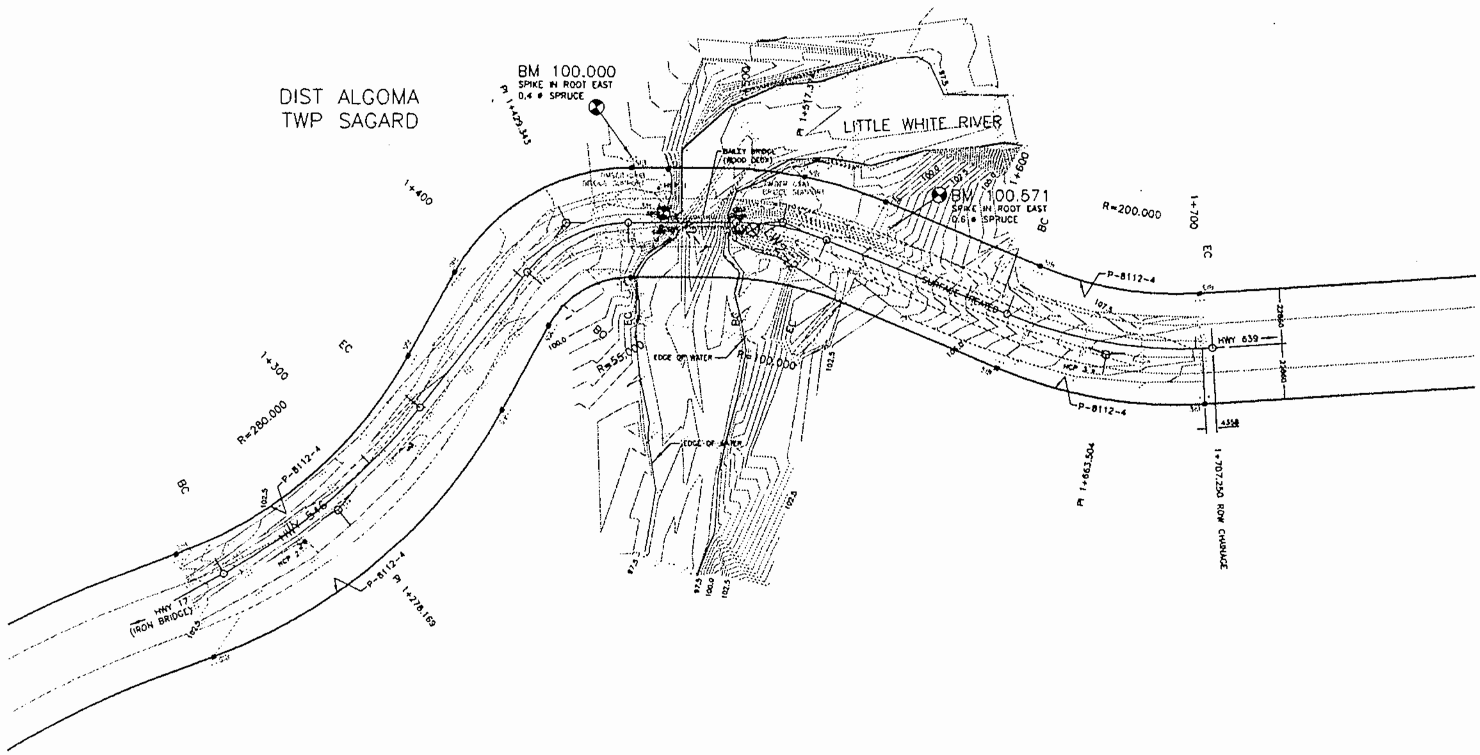
LITTLE WHITE RIVER#2
AND HWY 546
BOREHOLE LOCATIONS

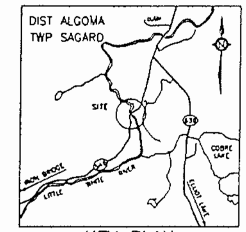
SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN





KEY PLAN

LEGEND

- Borehole – Current Investigation
- Dynamic Cone Penetration Test
- Borehole and Cone

No.	ELEVATION	CO-ORDINATES NORTHING[1]	CO-ORDINATES EASTING[1]
LW2-1	100.7	199995.9	100009.8
LW2-2	100.6	200022.7	100037.1

SCALE 20 0 20 40 METRES

PLAN

NOTE

1. Northings and Eastings presented on this drawing are as presented by Northland Engineering and are not in UTM coordinate system, but are based on a local metric grid.

REFERENCE

Base plans provided in digitial format by Northland Engineering (1987) limited, drawing file nos. LWR # 2 E-Plan.dwg, received November 25, 2003.

NO.	DATE	BY	REVISION

Geocres No.			
HWY. 546		PROJECT NO. 03-1111-029	DIST. 62
SUBM'D.	CHKD. JPD	DATE: JAN. 2004	SITE: 38S-56
DRAWN: JDR	CHKD. FJH	APPD.	DWG. 1

MINISTRY OF TRANSPORTATION, ONTARIO

Appendix D

Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Foundation Element	Spread Footings	Spread Footings on Engineered Fill	Driven Piles	Drilled Shafts
Abutments	*Advantages:* i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Low geotechnical resistance available due to variable and very loose soils at the surface. ii. Shallow foundations near the edge of the river may be subject to scour. iii. Deeper excavations required as a result of scour protection will be difficult to dewater and maintain in an undisturbed condition. **NOT RECOMMENDED**	*Advantages:* i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Better geotechnical resistance than spread footings on native, but still influenced by the variable and very loose soils at the surface. ii. Shallow foundations or engineered fill pads near the edge of the river may be subject to scour. iii. Deeper excavations required as a result of scour protection will be difficult to dewater and maintain in an undisturbed condition. **NOT RECOMMENDED**	*Advantages:* i. High geotechnical resistance may be developed by driving the piles into very dense soil. ii. Comparatively short abutment stem possible iii. Permits integral abutment design iv. Readily permits founding below the scour depth *Disadvantages:* i. Higher unit cost compared to footings. **RECOMMENDED**	*Advantages:* i. High geotechnical resistance is potentially available using deep shafts *Disadvantages:* i.Higher costs compared to spread footings. Probably higher costs compared to driven piles. ii. Difficulties advancing through very dense sand and gravel containing cobbles and boulders. iii. High risk of not being able to maintain undisturbed shaft walls and base below the groundwater level. iv. An integral abutment design is not an available option v. It may be necessary to place concrete by tremie methods. **NOT RECOMMENDED**

Appendix E

Site Photographs

Photo 1. Looking south along Little White River Bridge

Photo 2. North approach to the Little White River II Bridge

Photo 3. South approach to the Little White River II Bridge.

Photo 4. Little White River II Bridge from the southeast showing timber cribs.

Appendix F

Drawings

MINISTRY OF TRANSPORTATION, ONTARIO PR-D-707 88-05 PLOT SCALE 1:1

Twp SAGARD
Dist ALGOMA

LITTLE WHITE RIVER

BM El. 301.847m

BM El. 304.861m

07-LW1
07-LW2
07-LW3
07-LW4
07-LW5
07-LW6
07-LW7
07-LW8
07-LW9
07-LW10
07-LW11
07-LW12
07-LW13
07-LW14

R=55
R=100
R=200

EC
BC

P-8112-4

9+900
9+800
10+000
10+100
10+200

E 394 800
E 394 900
E 395 000
N 5 167 600
N 5 167 700
N 5 167 800

PLAN

20 0 25 50m

SCALE 1:1200

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REGISTERED PROFESSIONAL ENGINEER
A. E. GORMAN
May 17/07
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
May 15/07
PROVINCE OF ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

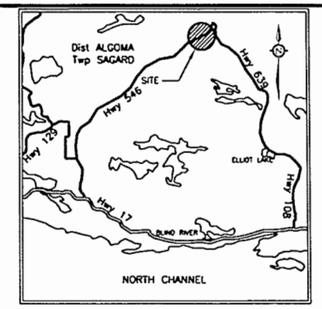
CONT No 512-00-00
GWP No

LITTLE WHITE RIVER II
BRIDGE REPLACEMENT
BOREHOLE LOCATION PLAN

SHEET

Marshall Macklin Monaghan
PROJECT MANAGERS • ENGINEERS • SURVEYORS • PLANNERS

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	Water Level
▼ |	Head Artesian Water
|	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
07-LW1	299.92	5 167 794.62	394 842.35
07-LW2	298.58	5 167 821.99	394 861.84
07-LW3	300.33	5 167 786.98	394 843.37
07-LW4	300.48	5 167 821.16	394 872.30
07-LW5	300.70	5 167 778.62	394 853.61
07-LW6	297.67	5 167 811.91	394 880.99
07-LW7	301.80	5 167 596.63	394 857.60
07-LW8	301.30	5 167 645.13	394 850.56
07-LW9	301.00	5 167 696.02	394 848.00
07-LW10	301.20	5 167 744.62	394 829.68
07-LW11	300.60	5 167 838.20	394 892.09
07-LW12	302.00	5 167 854.29	394 930.36
07-LW13	305.30	5 167 889.58	394 967.43
07-LW14	307.30	5 167 913.38	395 012.85

-NOTES-

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GEOCRES No. 41J73

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	AEG	CHK	PKC	CODE		LOAD	DATE MAY 2007
DRAWN	MFA	CHK	PKC	SITE		STRUCT	DWG

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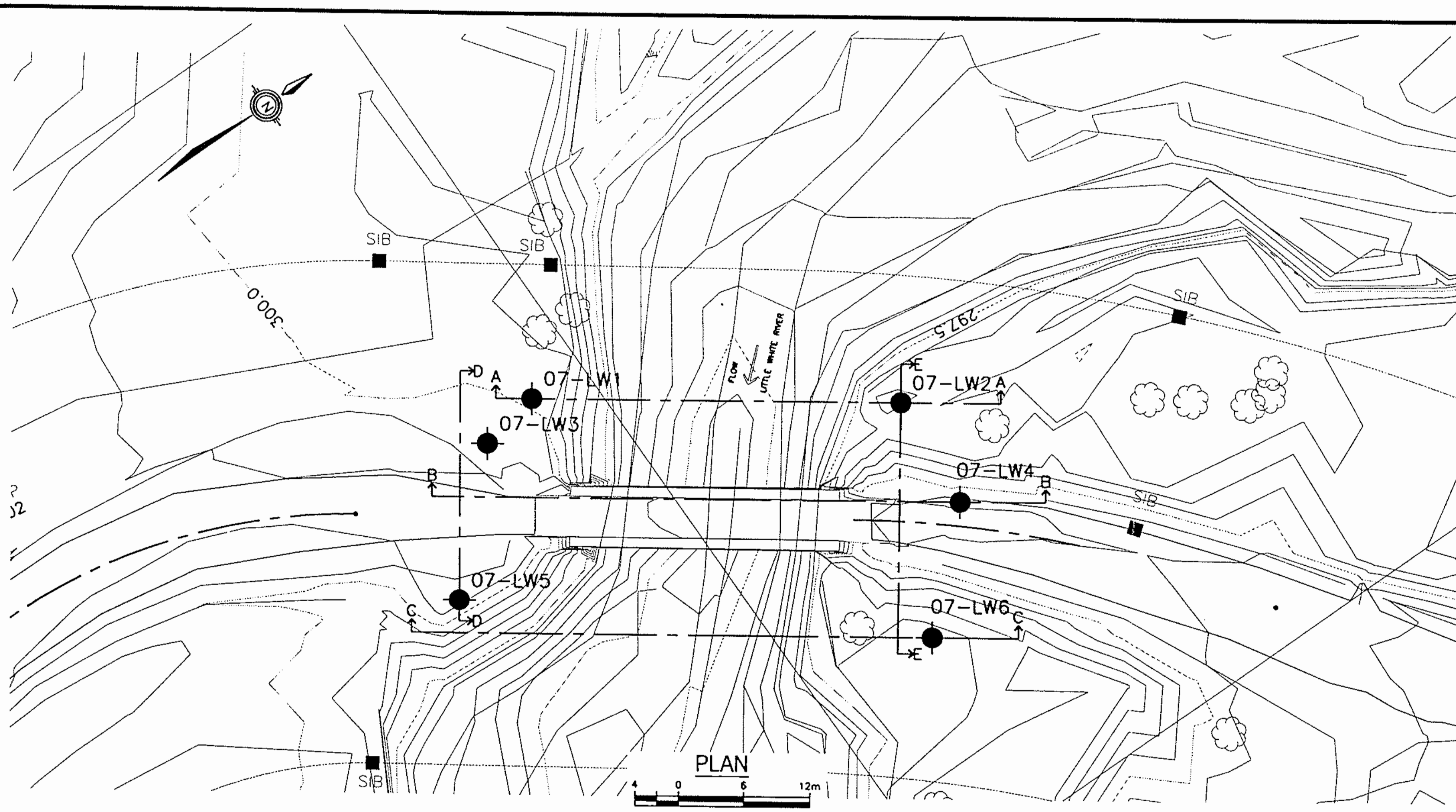
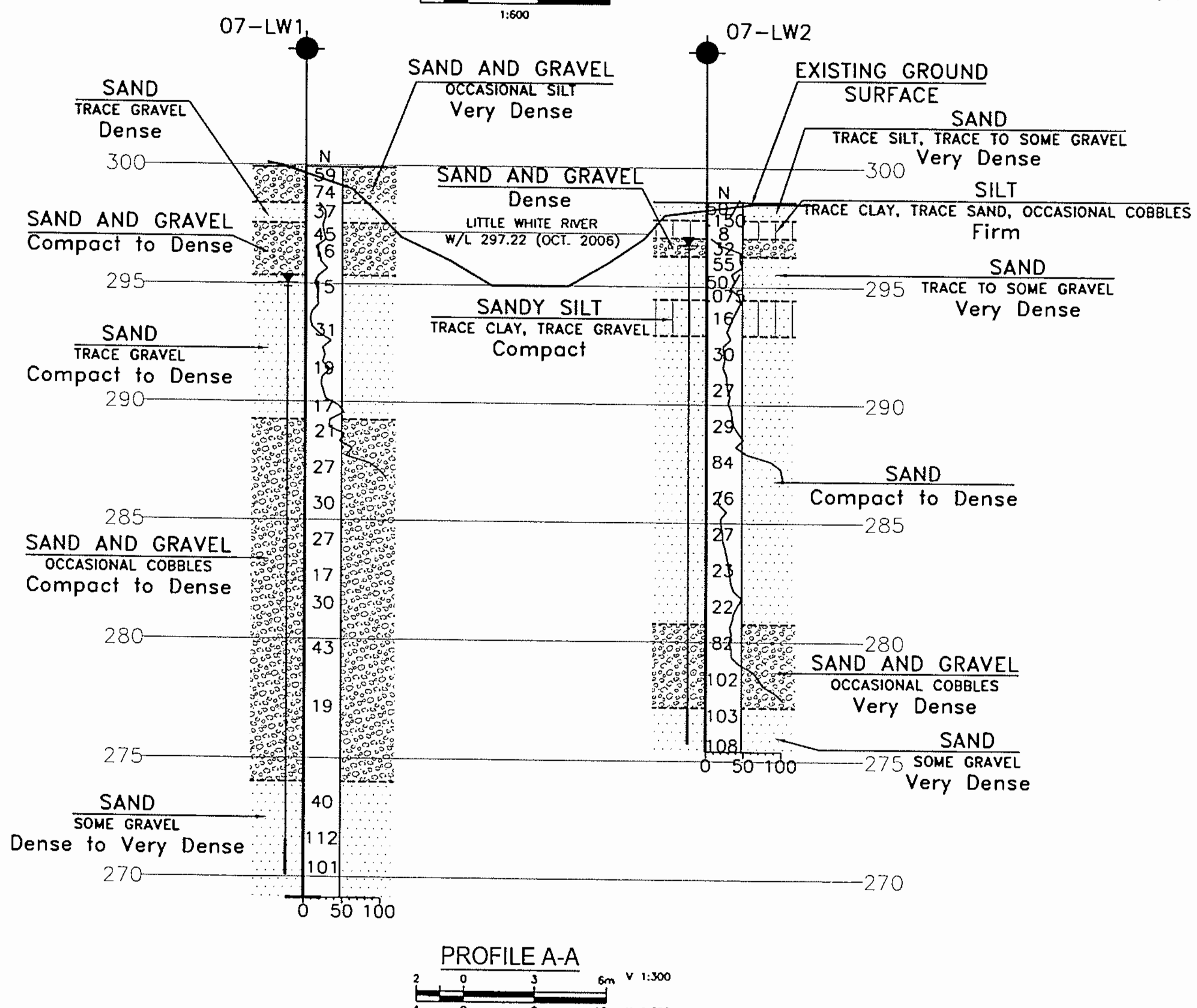
PLOTDATE: May 18, 2007 - 4:44pm





PROFILE A-A

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No 512-00-00
GWP No

SHEET

LITTLE WHITE RIVER II
BRIDGE REPLACEMENT
BOREHOLE LOCATION PLAN AND SOIL STRATA

Marshall Macklin Monaghan
PROJECT MANAGERS • ENGINEERS • SURVEYORS • PLANNERS

THURBER ENGINEERING LTD.
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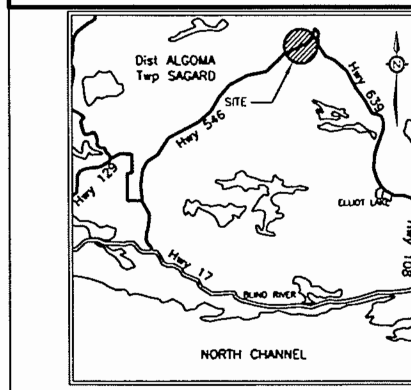

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REGISTERED PROFESSIONAL ENGINEER A. E. GORMAN MAY 15/07 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER P. K. CHATTERJI May 15/07 PROVINCE OF ONTARIO

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DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION		
DESIGN AEG	CHK PKC	CODE	LOAD	DATE	MAY 2007
DRAWN MFA	CHK PKC	SITE	STRUCT	DWG	

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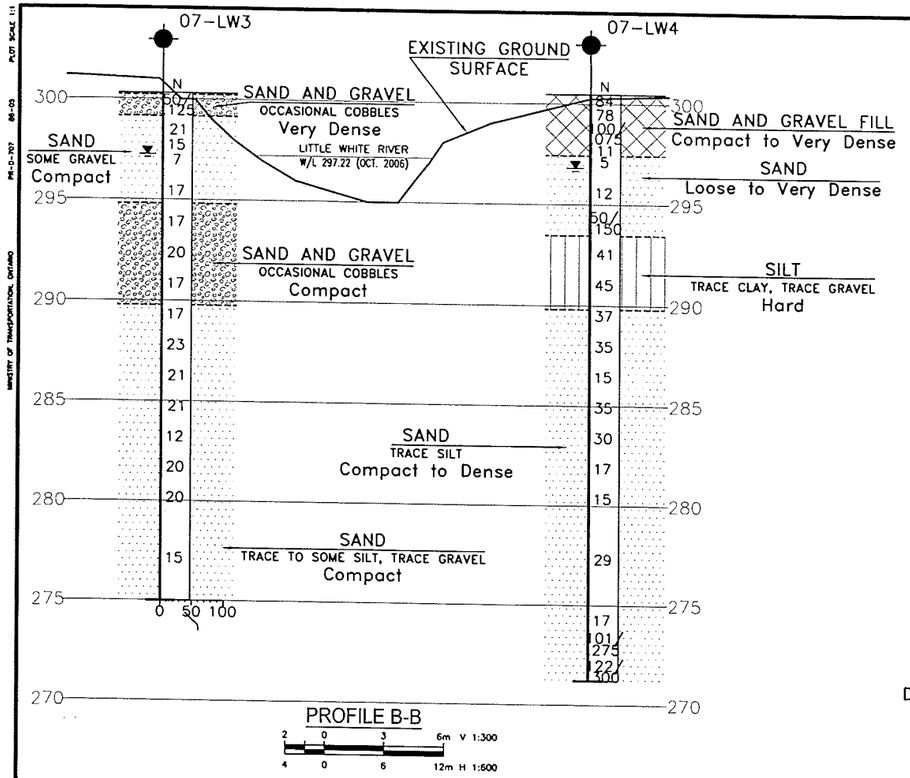
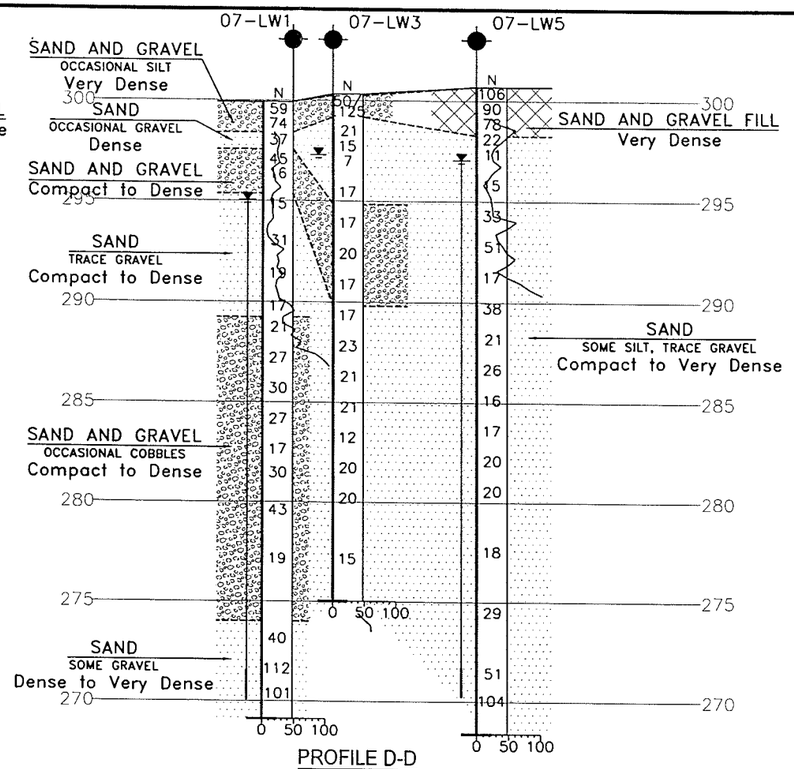
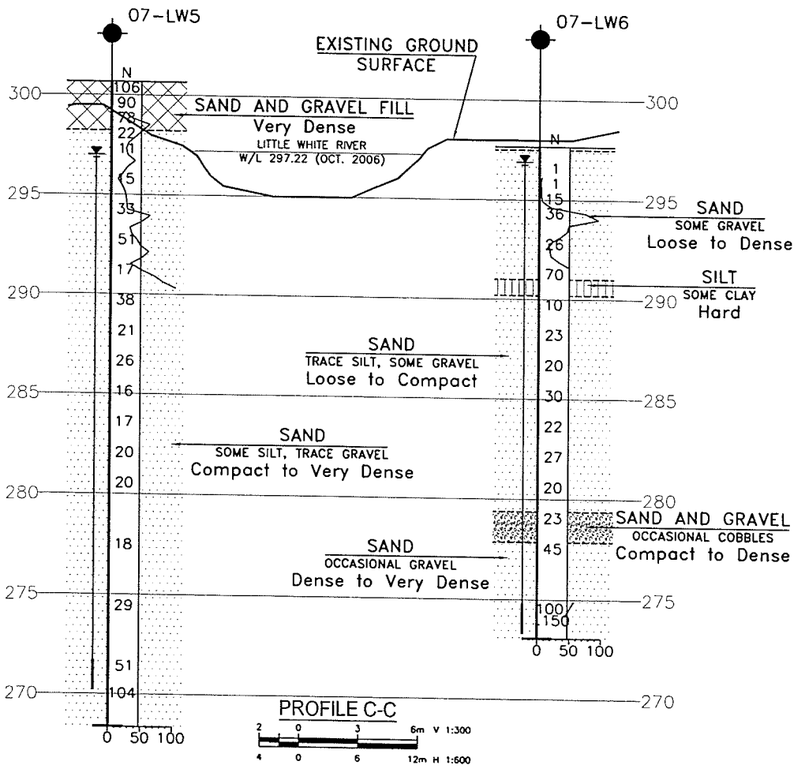
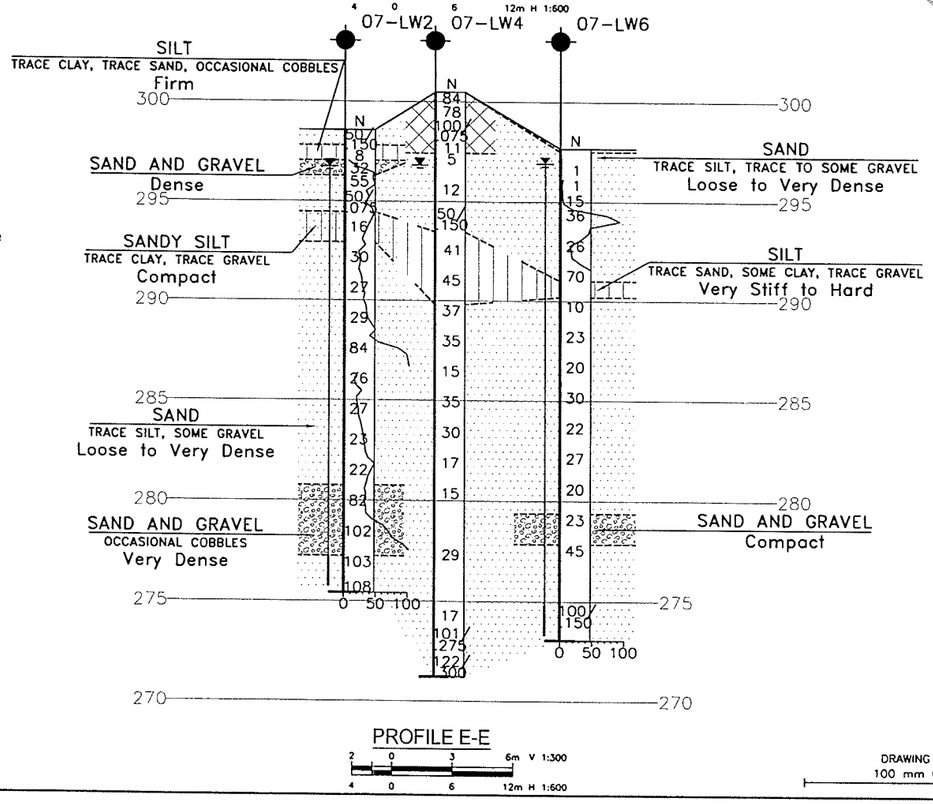
PLOTDATE: May 18, 2007 - 4:44pm

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-707 88-05 PLOT SCALE 1:1









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CONT No 512-00-00
GWP No

LITTLE WHITE RIVER II
BRIDGE REPLACEMENT
SOIL STRATA

SHEET

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May. 16/07
PROVINCE OF ONTARIO

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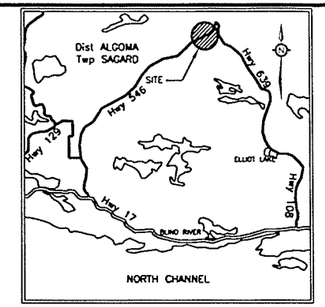

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DATE MAY 2007
DWG

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