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FOUNDATION INVESTIGATION REPORT
PIKE RIVER BRIDGE REPLACEMENT
HIGHWAY 572
NEW LISKEARD DISTRICT, ONTARIO
G.W.P 5196-13-00, W.P. 417-91-01, SITE NO. 39-152

GEOCRES No. 42A-116

Report

to

WSP

Date: June 9, 2017
File: 19-5161-251

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60 YEARS

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the existing Pike River Bridge along Highway 572, in the District of New Liskeard, Ontario. The investigation was carried out for three alignment alternatives for a replacement structure, namely, for the structure to be located along the existing bridge alignment (Alternative 1), a minor shift of 9 to 14 m to the east (Alternative 2) and a major shift of 70 to 80 m to the east (Alternative 3).

The purpose of this 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, laboratory test results and a written description of the subsurface conditions for the preferred alignment. A model of the subsurface conditions was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited, under the Ministry of Transportation Ontario (MTO) Agreement Number 5014-E-0019.

2. SITE DESCRIPTION

The existing Pike River Bridge is located on Highway 572, approximately 4.5 km south of Highway 101, in the Township of Guibord, New Liskeard District. Pike River flows from northwest to southeast in the general area and approaches a north-south flow direction at the bridge site. In the vicinity of the existing bridge, the river valley is relatively steep on the south side, and the land on the north side is relatively flat within approximately 140 m distance from the bridge. The river valley is densely vegetated with trees, shrubs and grass.

Highway 572 is carried over the Pike River by a single-span bailey bridge with a grated steel deck. The structure was constructed in 1975 and upgraded in 2008. The bridge has a span of

approximately 37 m and a width of 3.4 m, and is supported on timber crib abutments. Deterioration of the timber forming the cribs and adjacent gabion baskets are evident, especially at the north abutment. Erosion of the river banks at the bridge location, including steepening of the river valley slopes in front of the abutments and erosion/scour below the timber cribs can be observed on the photographs enclosed in Appendix C.

Based on the published geological information, the general area of the project is covered by glaciolacustrine sediments of clays and silts deposited during the Pleistocene period. These deposits are mostly varved clays, but massive clays are also present in some areas. Underlying the clays are glacial outwash deposits of silts, sands and gravels extending to Precambrian mafic to intermediate meta-volcanic bedrock.

3. INVESTIGATION PROCEDURES

The field investigation program for this project was conducted in two phases. The first phase of the investigation was carried out between March 5 and March 8, 2016 and consisted of drilling and sampling four boreholes, identified as Boreholes PR-01 to PR-04, for the two proposed bridge alignments referred to as Alternatives 2 and 3. Boreholes PR-01 and PR-02 were advanced at the respective south and north abutments of the Alternative 2 alignment, and Boreholes PR-03 and PR-04 were advanced at the respective south and north abutments of the Alternative 3 alignment. Dynamic Cone Penetration Tests (DCPTs) were conducted from the ground surface adjacent to each of the four sampled boreholes. The boreholes extended to depths ranging from 10.8 to 14.0 m and the DCPTs were conducted to depths ranging from 5.5 to 8.8 m.

The second phase of the investigation was conducted on July 13 and July 14, 2016, following selection of the alignment of the replacement bridge. The field investigation program consisted of drilling and sampling of two boreholes designated as Boreholes PR-05 and PR-06 to depths of 18.3 and 16.8 m, respectively, along the existing Highway 572 alignment (referred to as Alternative 1), and near the south and north abutments of the existing bridge.

The approximate locations of all completed boreholes are shown on the attached Borehole Locations and Soil Strata Drawing enclosed in Appendix D.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling operations. The coordinates and ground surface elevations for the boreholes were derived from topographic plans provided to Thurber by MMM Group Limited.

Track-mounted CME-45 and CME-55 drill rigs were used to advance the boreholes during the first phase and second phase of the investigation, respectively. The first-phase boreholes were advanced using NW casing and wash boring techniques. The second-phase boreholes were

advanced using hollow stem augers. NQ coring equipment was used to penetrate through cobble and boulder layers and to obtain core samples of the bedrock in Boreholes PR-05 and PR-06. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) procedures, as per ASTM D-1586-99.

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

Groundwater conditions in the open boreholes were observed throughout the drilling operations and in open boreholes after completion of drilling. These groundwater level observations may not be representative of the site conditions as water was used during wash boring operations. Standpipe piezometers were installed in Boreholes PR-02, PR-04, PR-05 and PR-06 to monitor the groundwater level after drilling. The piezometers were subsequently decommissioned following the final water level readings. The boreholes were backfilled in general accordance with MOE Regulation 903 (amended by Ontario Reg. 331). Completion details of the piezometers and boreholes are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole	Borehole Depth/Elev. (m)	Piezometer Installations		Completion Details
			Sand Screen Depth (m)	Sand Screen Elev. (m)	
Alternative 1					
South Abutment	PR-05	18.3/264.5	12.8 - 15.2	270.0 - 267.6	Sand from 12.8 m to 15.2 m and bentonite holeplug to surface.
North Abutment	PR-06	16.8/267.3	11.7 - 13.9	272.4 - 270.2	Sand from 11.7 m to 13.9 m and bentonite holeplug to surface.
Alternative 2					
South Abutment	PR-01	10.8/270.7	None Installed		Bentonite holeplug from 10.8 m to surface.
North Abutment	PR-02	14.0/268.6	12.2 - 14.0	270.4 - 268.6	Sand from 12.2 m to 14.0 m and bentonite holeplug to surface.
Alternative 3					
South Abutment	PR-03	12.3/267.5	None Installed		Bentonite holeplug from 12.3 m to surface.

Foundation Unit	Borehole	Borehole Depth/Elev. (m)	Piezometer Installations		Completion Details
			Sand Screen Depth (m)	Sand Screen Elev. (m)	
North Abutment	PR-04	13.9/266.5	11.9 - 13.9	268.5 - 266.5	Sand from 11.9 m to 13.9 m and bentonite holeplug to surface

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification (VI) and natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (sieve and hydrometer) and plasticity testing (Atterberg Limits). The results of the geotechnical laboratory program are summarized on the Record of Borehole sheets included in Appendix A and on figures presented in Appendix B.

Point load tests (PLT) were performed on selected intact rock core samples. The test results are included in Appendix B. Average unconfined compressive strengths (UCS) of the rock cores correlated from the PLT results for each run are shown on the Record of Borehole sheets in Appendix A.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, a sample of the native silty clay to clayey silt, and a sample of surface water from the creek upstream of the bridge were collected. The samples were submitted to AGAT Laboratories in Mississauga, Ontario for analytical testing of corrosivity parameters and sulphate contents. The results of the analytical testing are summarized in this report and are enclosed in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A and on the Borehole Locations and Soil Strata drawing included in Appendix D.

A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. The factual data presented on the Record of Borehole sheets take precedence over this general description and should be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

As noted above, the replacement bridge is proposed to be located on the existing Highway 572 alignment or Alternative 1. Given the distance of Boreholes PR-03 and PR-04 from the existing Highway 572, the two boreholes were not considered in the descriptions of individual soil strata. However, the Record of Borehole sheets of the completed boreholes are enclosed in Appendix A for reference.

The subsurface information in the area of Pike River Bridge was also available in the MTO Foundation Investigation and Design Report dated September 30, 1983 (Geocres No. 42A-36), which was prepared for the-then proposed replacement of the Pike River Bridge on Line “B”. The locations of the boreholes and the Line “B” from the 1983 report cannot be determined with sufficient accuracy for reference in the subsurface stratigraphy described in this report. The Record of Borehole sheets and the Foundation Drawing from the 1983 Report are enclosed in Appendix E for information.

In general, the soil stratigraphy beneath the existing embankment fill comprises a silty clay layer underlain by a silty sand to sand till with trace to some clay and gravel and occasional cobbles and boulders. The silty sand to sand till was underlain by basaltic bedrock as encountered in Boreholes PR-05 and PR-06. Descriptions of the individual strata are presented below.

5.1 Embankment Fill

Embankment fill was encountered at the ground surface in Boreholes PR-05 and PR-06. The embankment fill comprised a layer of sand with some gravel, some silt and trace clay overlain by a silty clay with trace sand, trace gravel and occasional wood fragments and organics. The thickness of the cohesionless fill ranged from 0.2 to 0.3 m. The cohesive fill extended to depths ranging from 0.8 to 0.9 m below the ground surface (Elev. 281.9 to 283.3).

The results of a grain size analysis conducted on a sample of the sand fill is provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B1 of Appendix B. The results indicate that the fill contains 14% gravel, 68% sand, 12% silt and 6% clay.

5.2 Silty Clay

A silty clay deposit was encountered below the silty clay fill in Boreholes PR-05 and PR-06 and at the ground surface in Boreholes PR-01 and PR-02. The deposit was brown to grey in colour and contained occasional rootlets and wood fibres near the ground surface. The thickness of the deposit ranged from 1.4 to 5.3 m with the bottom at depth between 1.4 m and 6.1 m (Elevation 280.4 to 278.0). The silty clay was also encountered in Boreholes PR-03 and PR-04 at surface drilled for an alternative alignment during preliminary design phase. However, the soil conditions

encountered in these two boreholes are not included in the current description as they were located approximately 150 m away from the proposed final alignment.

SPT N values measured in the deposit ranged between 4 and 21 blows per 0.3 m penetration, with most values between 4 and 12 blows, indicating firm to stiff consistency. The measured water contents ranged from 21% to 64% with typical values between 21% and 44%.

The results of grain size analyses conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A, and are illustrated in Figure B2 of Appendix B. The results are summarized in the following table.

Soil Particle	Percentage (%)
Gravel	0
Sand	0
Silt	21 to 70
Clay	30 to 79

The results of the Atterberg Limits tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B4 of Appendix B. The test results are summarized below.

Atterberg Limits	Percentage (%)
Liquid Limit	24 to 62
Plasticity Index	7 to 40

The results of the Atterberg Limits tests indicate that the silty clay varies from low plasticity (CL) to high plasticity (CH). The high plastic zone was encountered in the upper 2 m of the deposit in Borehole PR-06.

5.3 Sand to Silty Sand Till

A layer of sand to silty sand till was encountered underlying the silty clay in all boreholes. The brown to grey till contained trace to some clay and gravel, and occasional cobbles and boulders. The thickness of the till, where fully penetrated in Boreholes PR-05 and PR-06, varied between 7.8 m and 12.8 m with the bottom at Elevation 267.6 and 270.2, respectively. Boreholes PR-01 and PR-02 were terminated in the till at depths of 10.8 m and 14.0 m (Elevation 270.7 and 268.6).

SPT N values measured in the till ranged from 3 blows per 0.3 m penetration to greater than 100 blows per 0.15 m penetration, indicating a very loose to very dense relative density. Low SPT N values of 3 and 6 blows per 0.3 m penetration were obtained at 3.6 m and 12.2 m depth in Borehole PR-05. The measured water contents of till samples ranged from 7% to 19%.

The results of grain size analyses conducted on selected till samples are provided on the Record of Borehole sheets in Appendix A, and illustrated in Figure B3 of Appendix B. The results are summarized in the following table.

Soil Particle	Percentage (%)
Gravel	0 to 13
Sand	40 to 63
Silt	18 to 33
Clay	5 to 21

Glacial till inherently contains cobbles and boulders.

5.4 Bedrock

Basaltic meta-volcanic bedrock was encountered in Boreholes PR-05 and PR-06 below the sand to silty sand till. Table 5.1 summarizes the depth to bedrock and the bedrock surface elevations determined by coring in the boreholes.

Table 5.1: Depth to Bedrock at Borehole Locations

Location	Borehole	Depth to Bedrock (m)	Bedrock Surface Elevation (m)	Comment
South Abutment	PR-05	15.2	267.6	Cored 3 m
North Abutment	PR-06	13.9	270.2	Cored 3 m

The bedrock is generally described as slightly weathered to fresh, dark grey in colour with occasional pink and white veins ranging between 1 mm and 10 mm in width. Total Core Recovery (TCR) in the bedrock was 100% with solid core recovery (SCR) ranging from 67% to 89%. The Rock Quality Designation (RQD) determined from the recovered cores ranged from 48% to 82%, indicating poor to good rock quality. The Fracture Index (FI) of the rock, expressed as number of fractures per 0.3 m of core, varied from 0 to 6.

The unconfined compressive strength (UCS) of the rock interpreted from point load tests conducted on core samples ranged from 60 to 275 MPa, indicating a strong to extremely strong rock. The UCS values of individual tested cores interpreted from point load tests are presented on the Point Load Test Sheet enclosed in Appendix B.

5.5 Groundwater Conditions

Where possible, water levels were monitored in the open boreholes during drilling operation. Wash boring and/or coring methods were used to advance all boreholes and therefore water levels recorded during or upon completion of drilling may not reflect natural groundwater levels.

The water levels measured in the piezometers installed in Boreholes PR-02, PR-05 and PR-06 and upon completion of drilling are summarized in Table 5.2.

Table 5.2 – Water Level Measurements

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
PR-01	March 5, 2016	1.4	280.1	Open Borehole
PR-02	March 8, 2016 March 9, 2016 June 20, 2016	3.1 2.5 2.7	279.5 280.1 279.9	Open Borehole Piezometer Piezometer
PR-05	July 17, 2016	3.7	279.1	Piezometer
PR-06	July 14, 2016 July 17, 2016	3.5 3.6	280.6 280.5	Piezometer Piezometer

The recorded levels are short-term readings and seasonal fluctuations of the groundwater and river level are to be expected. In particular, the water level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

The water level in Pike River was shown on the archive drawing (Geocres No. 42A-36) at Elevation 279.5 on November 17, 1982. The Preliminary General Arrangement drawing prepared by MMM Group also indicated the water level in Pike River at Elev. 279.54 in June 2015 and a 2-year high water level at Elev. 280.23.

6. CORROSIVITY AND SULPHATE TEST RESULTS

A sample of the native silty clay and a sample of surface water from the Pike River were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are summarized in Table 6.1. The laboratory certificates of analysis are presented in Appendix B.

Table 6.1 – Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results	
			PR-02 SS#4, 7.5' – 9.5'	Pike River Water
			(Soil 2.3 – 2.9 m)	(Creek Water)
Sulphide	%	mg/L	0.1	< 0.05
Chloride	µg/g	mg/L	2	2.6
Sulphate	µg/g	mg/L	70	4.64
pH	pH Units	pH Units	8.07	7.62
Electrical Conductivity	mS/cm	µS/cm	0.159	158
Resistivity	ohm.cm	ohm.cm	6290	6330
Redox Potential	mV	mV	348	368

7. MISCELLANEOUS

Borehole locations were selected and established in the field by Thurber Engineering Ltd. The coordinates and the ground surface elevations for the boreholes were established based on topographic survey information provided by MMM Group Limited.

Thurber obtained utility clearances for the borehole locations prior to drilling. Overall supervision of the field program was carried out by Mr. Stephane Loranger, CET.

The drilling operations carried out in March 2016 were supervised by Mr. George Azzopardi of Thurber. Eastern Ontario Diamond Drilling of Hawkesbury, Ontario, supplied a track-mounted CME-55 drill rig and conducted the drilling, sampling and in-situ testing operations. The drilling operations conducted in July 2016 were supervised by Mr. Zane Bourk of Thurber, and Eastern Ontario Diamond Drilling of Hawkesbury, Ontario, supplied a track-mounted CME-55 drill rig and conducted the drilling, sampling and in-situ testing operations.

Routine laboratory testing was carried out at Thurber's geotechnical laboratory.

Interpretation of the field data and preparation of this report were carried out by Ms. Anna Piascik, P.Eng. and Mr. Keli Shi, P.Eng. The report was reviewed by Mr. Alastair Gorman, M.Sc., P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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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[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

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.

EXPLANATION OF ROCK LOGGING TERMS

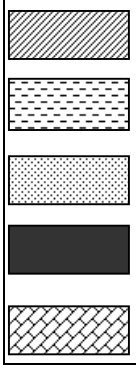
ROCK WEATHERING CLASSIFICATION

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.

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

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

BEDROCK

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

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 % 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.

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			

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-01 1 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 529.9 E 358 355.2 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.05 - 2016.03.05 CHECKED BY AMP

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	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
281.5	GROUND SURFACE										
0.0	Silty **CLAY**, occasional rootlets Stiff Brown Moist to Wet		1	SS	12		281				
			2	SS	11						0 0 53 47
280.1						▽	280				
1.4	Silty **SAND**, trace to some clay, trace gravel, occasional cobbles and boulders Compact to Very Dense Brown to Grey Moist (TILL)		3	SS	16						
			4	SS	18		279				
			5	SS	21						2 56 32 10
	150mm boulder at 4.3m		6	SS	112/0.150		278				
			7	SS	109/0.150		277				
			8	SS	106/0.150		276				
			9	SS	102/0.150		275				0 51 33 16
							274				
							273				
							272				

Continued Next Page

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

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-01 2 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 529.9 E 358 355.2 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.05 - 2016.03.05 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m^3	GR SA SI CL
	Continued From Previous Page										
270.7			10	SS	116/		271		○		
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE OPEN TO 10.8m AND WATER LEVEL AT 1.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.150						

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

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-02 1 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 589.3 E 358 371.8 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.08 - 2016.03.08 CHECKED BY AMP

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
282.6	GROUND SURFACE										
0.0	Silty **CLAY**, occasional rootlets Firm to Very Stiff Brown Wet		1	SS	21		282				
			2	SS	7						
			3	SS	12		281				0 0 70 30
			4	SS	16	▼	280				
	Becoming Grey		5	SS	6		279				
278.5											
4.1	Silty **SAND**, trace to some clay, trace gravel, occasional cobbles and boulders Compact to Very Dense Grey Moist (TILL)		6	SS	13		278				3 59 33 5
	Cobbles from 5.5m to 6.1m		7	SS	24		277				
			8	SS	100/0.150		276				
			9	SS	111/0.150		275				
							274				
							273				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-02 2 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 589.3 E 358 371.8 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.08 - 2016.03.08 CHECKED BY AMP

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 (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	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										
			10	SS	102/ 0.150		272		○		
	225mm boulder at 11.0m						271				
			11	SS	119/ 0.150		270		○		
268.6							269				
			12	SS	138				○		7 40 32 21
14.0	END OF BOREHOLE AT 14.0m. BOREHOLE OPEN TO 14.0m AND WATER LEVEL AT 3.1m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2016.03.09	2.5	280.1
2016.06.20	2.7	279.9

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

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-03 1 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 427.0 E 358 409.2 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.06 - 2016.03.06 CHECKED BY AMP

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	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
279.8	GROUND SURFACE										
0.0	Silty **CLAY** to Clayey **SILT**, trace sand, occasional wood fibres Very Stiff to Stiff Grey Wet to Moist		1	SS	18						
			2	SS	9						
			3	SS	10						0 6 63 31
277.6											
2.2	Silty **SAND**, trace to some clay, trace to some gravel, occasional cobbles Loose to Very Dense Grey Moist (TILL)		4	SS	50/ 0.150						
	100mm cobble at 2.4m		5	SS	7						
			6	SS	41						1 75 24 (SI+CL)
	Cobbles from 5.5m to 6.1m		7	SS	107						
			8	SS	103/ 0.150						
			9	SS	112/ 0.150						

ELEVATION SCALE: 279, 278, 277, 276, 275, 274, 273, 272, 271, 270

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

Continued Next Page

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

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-03 2 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 427.0 E 358 409.2 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.06 - 2016.03.06 CHECKED BY AMP

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										
	300mm boulder at 10.4m										
			10	SS	111/ 0.150		269		○		0 52 34 14
							268				
267.5			11	SS	119/				○		
12.3	END OF BOREHOLE AT 12.3m BOREHOLE OPEN TO 12.3m AND ARTESIAN PRESSURE AT 1.0m ABOVE GROUND SURFACE IN NW CASING UPON COMPLETION OF BOREHOLE. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.150						

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

(%) STRAIN AT FAILURE

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-04 1 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 461.4 E 358 415.3 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.07 - 2016.03.07 CHECKED BY AMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
280.4	GROUND SURFACE						
0.0	**TOPSOIL:** (150mm)						
0.2	Silty **CLAY**, some sand, trace gravel in upper zone, occasional rootlets and wood fibres Stiff to Soft Grey Moist		1	SS	14		
			2	SS	6		
			3	SS	4		
			4	SS	3		
277.4							
3.0	**PEAT**, fibrous, trace to some silt, trace sand, trace clay Loose Dark Brown Wet		5	SS	4		
276.6							
3.8	Silty **SAND**, trace gravel, trace to some clay, occasional cobbles and boulders Compact to Very Dense Grey Moist (TILL) 125mm cobbles at 5.3m		6	SS	20		
			7	SS	20		
			8	SS	103		
			9	SS	105/ 0.150		

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

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

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

WATER CONTENT (%) (20 40 60)

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
	0	18	38	44
	5	62	28	5

Continued Next Page

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-04 2 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 461.4 E 358 415.3 ORIGINATED BY GA

HWY 572 BOREHOLE TYPE NW Casing/NQ Coring/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2016.03.07 - 2016.03.07 CHECKED BY AMP

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										
							270				
			10	SS	111/ 0.150				○		3 42 39 16
							269				
			11	SS	106/ 0.150		268		○		
							267				
266.5			12	SS	116/ 0.150				○		
13.9	END OF BOREHOLE AT 13.9m. BOREHOLE OPEN TO 13.9m AND WATER LEVEL AT 1.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2016.03.08	0.9	279.5
2016.03.09	0.8	279.6

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

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-05 1 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 546.7 E 358 341.8 ORIGINATED BY ZRB

HWY 572 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2016.07.14 - 2016.07.14 CHECKED BY AMP

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
282.8	GROUND SURFACE										
0.0	**SAND**, some gravel, some silt, trace clay Brown Moist (FILL)		1	GS							14 68 12 6
0.2											
281.9	Silty **CLAY**, occasional rootlets and wood fragments Firm Brown Moist (FILL)		1	SS	7		282				0 0 62 38
0.9											
	Silty **CLAY** Firm Grey Moist		2	SS	4		281				
280.4											
2.4	**SAND** to Silty **SAND**, trace to some clay, trace to some gravel, occasional cobbles and boulders Very Loose to Very Dense Brown to Grey Moist (TILL)		3	SS	8		280				13 63 18 6
			4	SS	13						
						▼	279				
			5	SS	3						
	Occasional cobbles and boulders from 4.9m to 12.2m						278				
			6	SS	18		277				
			7	SS	43		276				
							275				
			8	SS	108/ 0.150		274				
							273				8 49 30 13

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-05 2 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 546.7 E 358 341.8 ORIGINATED BY ZRB

HWY 572 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2016.07.14 - 2016.07.14 CHECKED BY AMP

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										
	Occasional cobbles and boulders from 10.5m to 12.2m		9	SS	130		272		○		
			10	SS	6		271		○		
			11	SS	36		270		○		
267.6							269				
15.2	**BASALTIC METAVOLCANIC BEDROCK**, slightly weathered to fresh, dark grey, joints dipping 40' to 160' to vertical, occasional white and pink veins 2.0 to 10.0mm thick		1	RUN			268		○		FI 4 4 4 1 RUN #1 TCR=100% SCR=71% RQD=48% UCS=132MPa (Average)
			2	RUN			267				2 5 6 1 RUN #2 TCR=100% SCR=83% RQD=58% UCS=218MPa (Average)
264.5							266				3
18.3	END OF BOREHOLE AT 18.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2016.07.17 3.7 279.1						265				2

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

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-06 1 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 609.7 E 358 364.4 ORIGINATED BY ZRB

HWY 572 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2016.07.13 - 2016.07.13 CHECKED BY AMP

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 ● 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
284.1	GROUND SURFACE										
0.0 / 283.8	**SAND**, some gravel, some silt, trace clay		1	GS			284				
0.3 / 283.3	Brown Moist (FILL)		2	GS							
0.8	Silty **CLAY**, occasional wood fragments and rootlets Firm Dark Grey Moist (FILL)		1	SS	11		283				0 0 31 69
	Silty **CLAY** Firm to Stiff Grey Moist		2	SS	10						0 0 21 79
			3	SS	4		282				
			4	SS	5		281				0 0 59 41
			5	SS	5		280				
278.0							279				
6.1	Silty **SAND**, trace to some gravel, trace clay, occasional cobbles and boulders Compact to Very Dense Grey Moist (TILL)		6	SS	13		278				
			7	SS	30		277				
	Occasional cobbles and boulders present		8	SS	108		276				
							275				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No PR-06 2 OF 2 METRIC

GWP# 5196-13-00 LOCATION Pike River Bridge N 5 373 609.7 E 358 364.4 ORIGINATED BY ZRB

HWY 572 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2016.07.13 - 2016.07.13 CHECKED BY AMP

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						274				
			9	SS	112/ 0.150		273		○		
			10	SS	108/ 0.150		272		○		
	Zone of rock fragments from 13.7m to 13.9m						271			FI	
270.2										2	RUN #1 TCR=100% SCR=67% RQD=48% UCS=153MPa (Average)
13.9	**BASALTIC METAVOLCANIC BEDROCK**, slightly weathered to fresh, dark grey, joints dipping 45' to 160' to vertical, occasional white and pink veins 1.0 to 4.0mm thick		1	RUN			270			3 2 1	
							269			3 1	
			2	RUN			268			1 2 1	RUN #2 TCR=100% SCR=89% RQD=82% UCS=145MPa (Average)
267.3										1 0	
16.8	END OF BOREHOLE AT 16.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.										

WATER LEVEL READINGS:

DATE	DEPTH (m)	ELEV. (m)
2016.07.14	3.5	280.6
2016.07.17	3.6	280.5

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

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

ONTMT4S 19-5161-251.GPJ 2015TEMPLATE(MTO).GDT 11/2/16

THURBER

60 YEARS

Appendix B

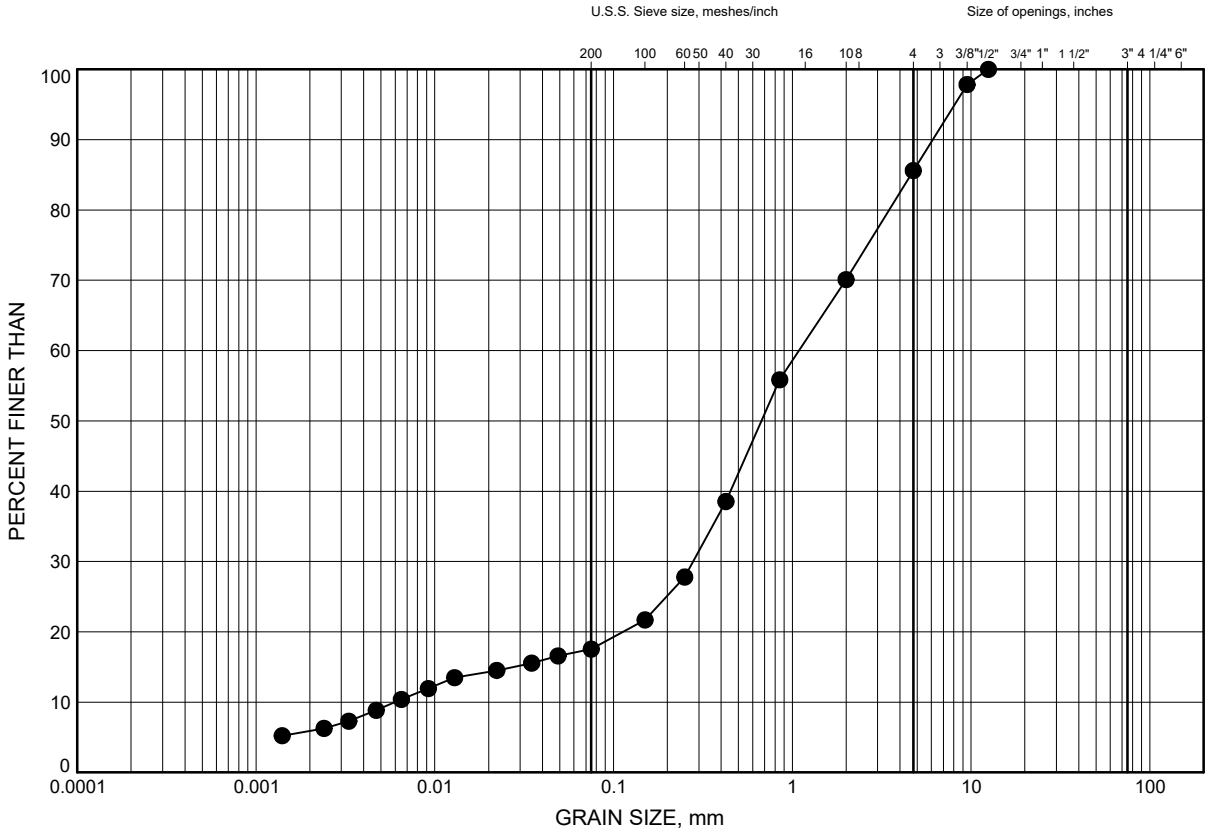
Geotechnical and Analytical Laboratory Test Results

Pike River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR-05	0.08	282.72

Date September 2016

GWP# 5196-13-00

THURBER

Prep'd AN

Chkd. AMP

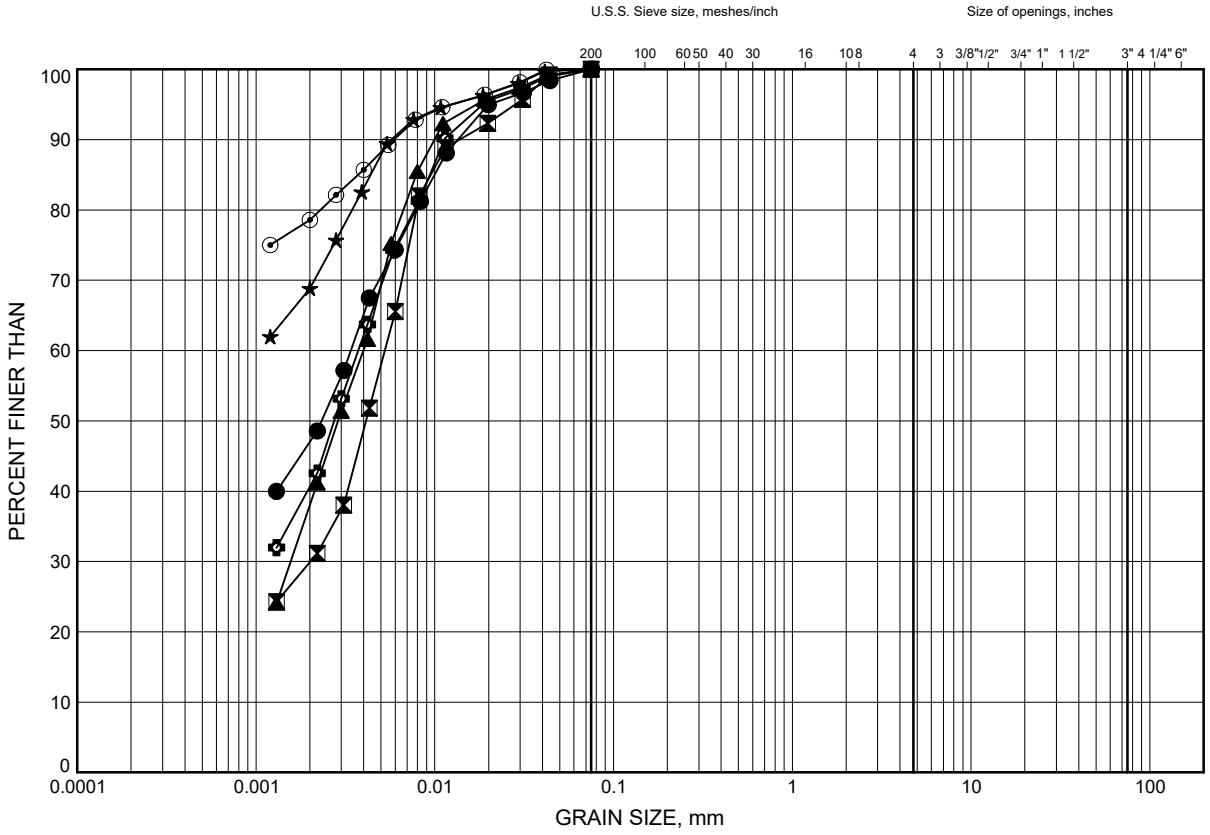
GRAIN SIZE DISTRIBUTION - THURBER 19-5161-251.GPJ 9/26/16

Pike River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR-01	1.07	280.43
⊠	PR-02	1.83	280.77
▲	PR-05	1.14	281.66
★	PR-06	1.07	283.03
⊙	PR-06	1.83	282.27
✿	PR-06	3.35	280.75

Date October 2016

GWP# 5196-13-00

THURBER

Prep'd AN

Chkd. AMP

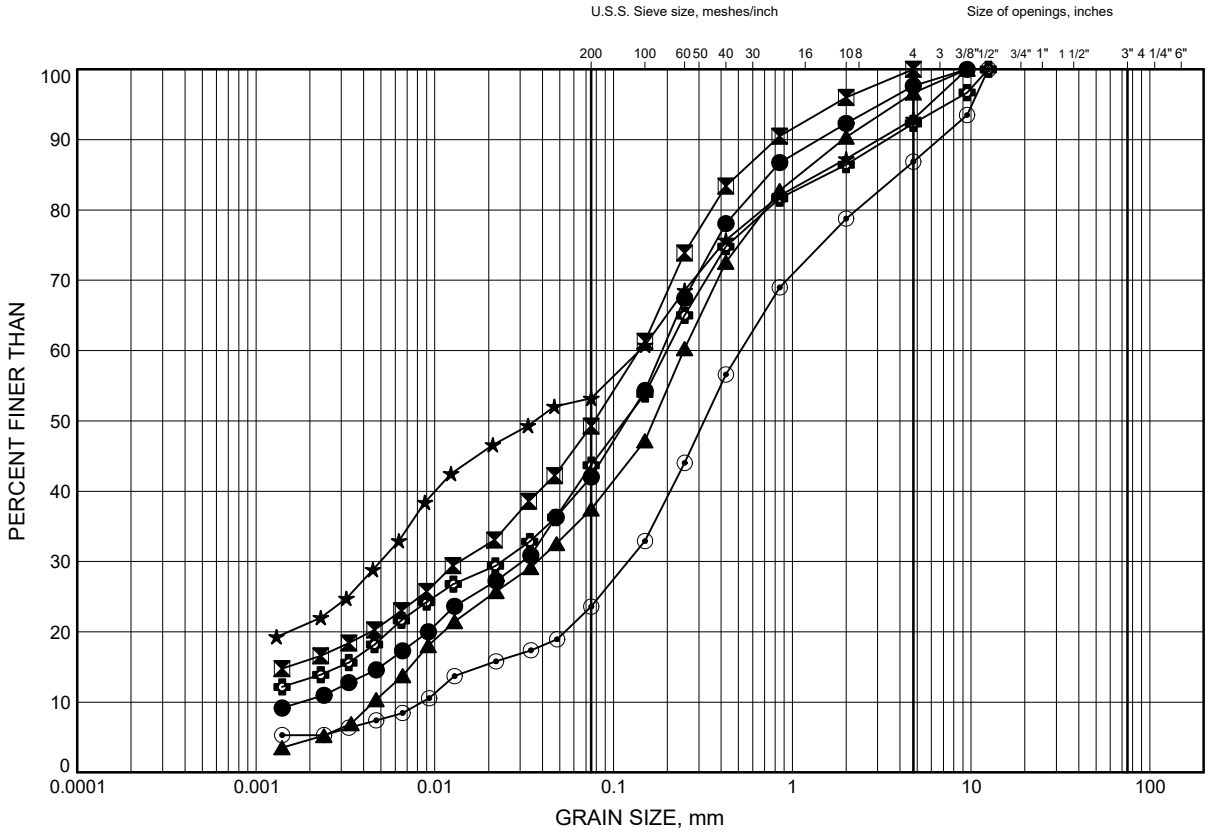
GRAIN SIZE DISTRIBUTION - THURBER 19-5161-251.GPJ 10/5/16

Pike River Bridge

GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty SAND TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR-01	3.35	278.15
⊠	PR-01	7.70	273.80
▲	PR-02	4.88	277.72
★	PR-02	13.87	268.73
⊙	PR-05	2.67	280.13
✿	PR-05	9.75	273.05

Date September 2016

GWP# 5196-13-00

THURBER

Prep'd AN

Chkd. AMP

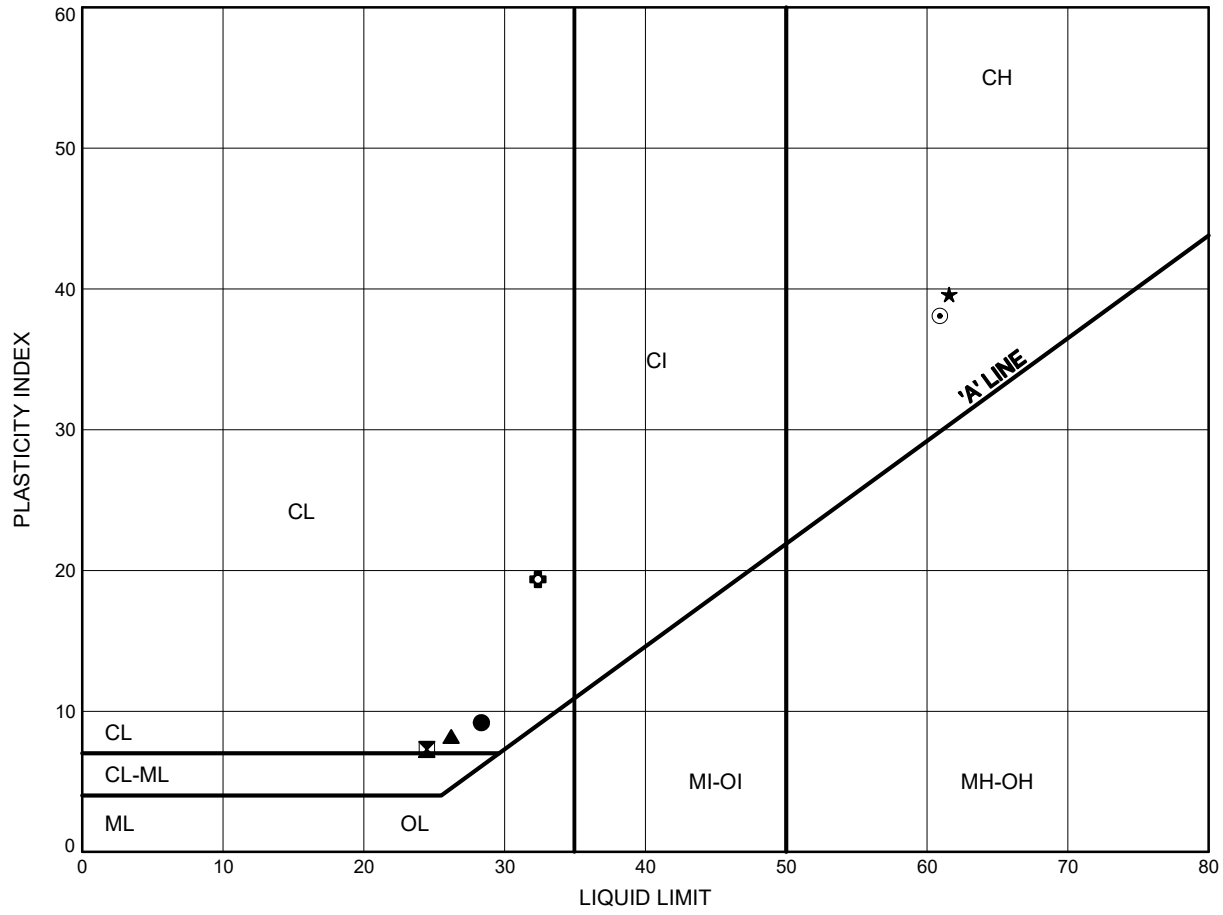
GRAIN SIZE DISTRIBUTION - THURBER 19-5161-251.GPJ 9/26/16

Pike River Bridge

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

Silty CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PR-02	1.83	280.77
⊠	PR-02	3.35	279.24
▲	PR-05	1.14	281.66
★	PR-06	1.07	283.03
⊙	PR-06	1.83	282.27
✿	PR-06	3.35	280.75

Date October 2016

GWP# 5196-13-00

THURBER

Prep'd AN

Chkd. AMP

THURBALT 19-5161-251.GPJ 10/5/16

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

Job No :	19-5161-251	**Client :**	MMM
		Date Drilled :	Jul-16
Project Name :	Pike River Bridge	**Date Tested :**	22-Aug-16
Core Size :	NQ **BH No :** PR-05	**Tester :**	RMT

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	15.6	D	7.3	47.5	117.8	60.1	Metamorphic	Strong
2	1	16.1	D	20.4	47.5	82.9	167.2	Metamorphic	Very Strong
3	1	16.4	D	10.3	47.5	150.0	84.7	Metamorphic	Strong
4	1	16.6	D	25.0	47.5	150.0	205.6	Metamorphic	Very Strong
5	1	16.7	D	17.1	47.5	150.0	140.6	Metamorphic	Very Strong
6	2	16.9	D	22.1	47.5	77.3	181.6	Metamorphic	Very Strong
7	2	17.4	D	23.4	47.5	88.4	192.0	Metamorphic	Very Strong
8	2	17.7	D	27.2	47.5	150.0	223.5	Metamorphic	Very Strong
9	2	18.1	D	33.6	47.5	150.0	275.9	Metamorphic	Extremely Strong
10									
11									
12									
13									
14									
15									
16									
17									
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28									
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33									
34									
35									

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

Job No :	19-5161-251	**Client :**	MMM
		Date Drilled :	Jul-16
Project Name :	Pike River Bridge	**Date Tested :**	22-Aug-16
Core Size :	NQ **BH No :** PR-06	**Tester :**	RMT

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	UCS (MPa)	Rock Type	Notes
1	1	13.9	D	16.4	47.5	150.0	135.0	Metamorphic	Very Strong
2	1	14.2	D	20.0	47.5	150.0	164.2	Metamorphic	Very Strong
3	1	14.5	D	22.0	47.5	118.2	180.7	Metamorphic	Very Strong
4	1	14.8	D	23.9	47.5	150.0	195.9	Metamorphic	Very Strong
5	1	15.1	D	16.7	47.5	150.0	137.1	Metamorphic	Very Strong
6	1	15.3	D	13.1	47.5	150.0	107.6	Metamorphic	Very Strong
7	2	15.5	D	13.2	47.5	150.0	108.6	Metamorphic	Very Strong
8	2	15.7	D	13.0	47.5	150.0	106.9	Metamorphic	Very Strong
9	2	16.1	D	22.0	47.5	150.0	180.7	Metamorphic	Very Strong
10	2	16.4	D	17.2	47.5	150.0	141.2	Metamorphic	Very Strong
11	2	16.7	D	22.9	47.5	150.0	188.2	Metamorphic	Very Strong
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
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27									
28									
29									
30									
31									
32									
33									
34									
35									

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing

* Diametral Test should have 0.7 x D on either side of test point.

AGAT Laboratories

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 16T078548

PROJECT: 19-5161-251

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:Temiskaming Structures

SAMPLED BY:

Corrosivity Package

DATE RECEIVED: 2016-03-18 **DATE REPORTED: 2016-03-30**

				SAMPLE DESCRIPTION:	PR-02 SS4 7.5'-9.5'
				SAMPLE TYPE:	Soil
				DATE SAMPLED:	3/8/2016
Parameter	Unit	G / S	RDL		7450204
Sulphide*	%		0.05		0.10
Chloride (2:1)	µg/g		2		2
Sulphate (2:1)	µg/g		2		70
pH (2:1)	pH Units		NA		8.07
Electrical Conductivity (2:1)	mS/cm		0.005		0.159
Resistivity (2:1)	ohm.cm		1		6290
Redox Potential (2:1)	mV		5		348

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

7450204 EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).

Certified By: Amanjot Bhela

AGAT Laboratories

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FAX (905)712-5122
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Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 16T078548

PROJECT: 19-5161-251

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:Temiskaming Structures

SAMPLED BY:

Soil Analysis

RPT Date: Mar 30, 2016			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Corrosivity Package															
Sulphide*	7444756		< 0.05	< 0.05	NA	< 0.05	95%	80%	120%	NA			NA		
Chloride (2:1)	7443948		70	69	1.4%	< 2	98%	80%	120%	100%	80%	120%	95%	70%	130%
Sulphate (2:1)	7443948		337	336	0.3%	< 2	97%	80%	120%	102%	80%	120%	96%	70%	130%
pH (2:1)	7449192		7.50	7.62	1.6%	NA	102%	90%	110%	NA			NA		
Electrical Conductivity (2:1)	7443948		0.531	0.536	0.9%	< 0.005	97%	90%	110%	NA			NA		
Redox Potential (2:1)	7449192		381	380	0.3%	< 5	109%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

AGAT Laboratories

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CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 16T078548

PROJECT: 19-5161-251

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:Temiskaming Structures

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
Sulphide*	MIN-200-12025	ASTM E1915-09	GRAVIMETRIC
Chloride (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH
pH (2:1)	INOR 93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Electrical Conductivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B	EC METER
Resistivity (2:1)	INOR-93-6036	McKeague 4.12, SM 2510 B,SSA #5 Part 3	CALCULATION
Redox Potential (2:1)		McKeague 4.12 & SM 2510 B	REDOX POTENTIAL ELECTRODE

AGAT Laboratories

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FAX (905)712-5122
http://www.agatlabs.com

Certificate of Analysis

AGAT WORK ORDER: 16T076149

PROJECT:

CLIENT NAME: THURBER ENGINEERING LTD

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:

SAMPLED BY:GA

Corrosivity Package (Water)

DATE RECEIVED: 2016-03-11

DATE REPORTED: 2016-03-18

		SAMPLE DESCRIPTION:		Pike River
		SAMPLE TYPE:		Water
		DATE SAMPLED:		3/9/2016
Parameter	Unit	G / S	RDL	7435575
Sulphide	mg/L		0.05	<0.05
Chloride	mg/L		0.10	2.60
Sulphate	mg/L		0.10	4.64
Electrical Conductivity	uS/cm		2	158
pH	pH Units		NA	7.62
Redox Potential	mV		5	368
Resistivity	ohms.cm			6330

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By: Amanjot Bhela

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CANADA L4Z 1Y2
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FAX (905)712-5122
http://www.agatlabs.com

Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 16T076149

PROJECT:

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:

SAMPLED BY:GA

Water Analysis

RPT Date: Mar 18, 2016			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Corrosivity Package (Water)															
Sulphide	7430656		<0.05	<0.05	NA	< 0.05	100%	80%	120%	102%	85%	115%	102%	70%	130%
Chloride	7435391		149	148	0.7%	< 0.10	108%	90%	110%	110%	90%	110%	114%	80%	120%
Sulphate	7435391		10.0	10.0	0.0%	< 0.10	107%	90%	110%	109%	90%	110%	108%	80%	120%
Electrical Conductivity	7436969		2740	2750	0.4%	< 2	104%	80%	120%	NA			NA		
pH	7436969		8.07	8.03	0.5%	NA	99%	90%	110%	NA			NA		
Redox Potential	7435580	7435580	395	395	0.0%	< 5	109%	70%	130%	NA			NA		

Comments: NA signifies Not Applicable.
Duplicate Qualifier: As the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Certified By: Amanjot Bhela

AGAT Laboratories

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FAX (905)712-5122
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Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 16T076149

PROJECT:

ATTENTION TO: Deanna Pizycki

SAMPLING SITE:

SAMPLED BY:GA

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Sulphide	INOR-93-6054	SM 4500 S2- D	SPECTROPHOTOMETER
Chloride	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Sulphate	INOR-93-6004	SM 4110 B	ION CHROMATOGRAPH
Electrical Conductivity	INOR-93-6000	SM 2510 B	PC TITRATE
pH	INOR-93-6000	SM 4500-H+ B	PC TITRATE
Redox Potential		SM 2510 B	REDOX POTENTIAL ELECTRODE
Resistivity		SM 2510 B	EC METER

Appendix C

Site Photographs

Photo 1 – South Approach Looking North

Photo 2 – North Approach Looking South

Photo 3 – South Abutment

Photo 4 – North Abutment

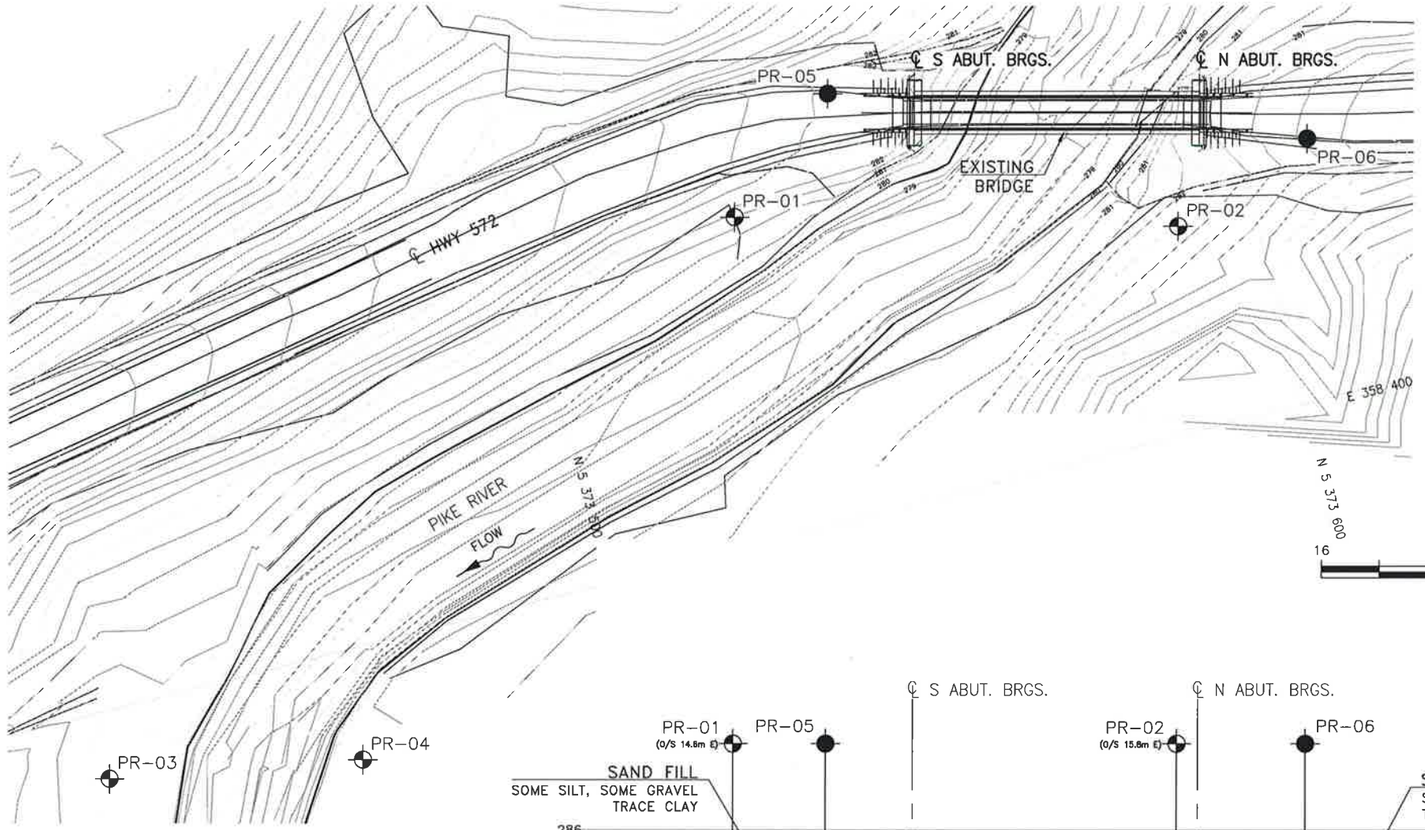
Photo 5 – East Elevation Looking South

Photo 6 – West Elevation Looking North

Appendix D

Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

16 0 16 32m

SCALE 1:800

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No

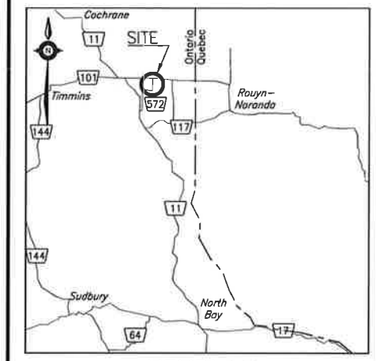
GWP No 5196-13-00

HIGHWAY 572
PIKE RIVER BRIDGE
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MMM GROUP

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

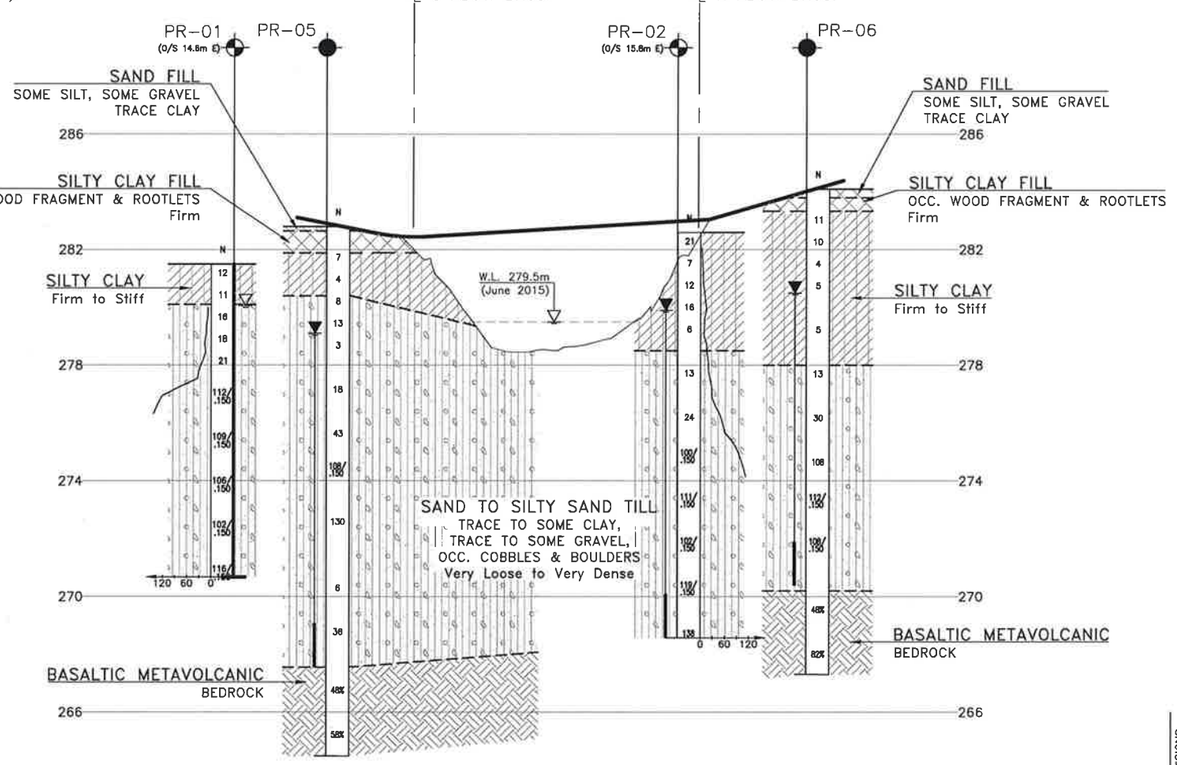
⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▽	Water Level in Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING (MTM)	EASTING (MTM)
PR-01	281.5	5 373 529.9	358 355.2
PR-02	282.6	5 373 589.3	358 371.8
PR-03	279.8	5 373 427.0	358 409.2
PR-04	280.4	5 373 461.4	358 415.3
PR-05	282.8	5 373 546.7	358 341.8
PR-06	284.1	5 373 609.7	358 364.4

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Survey data provided by MMM.
4) MTM 83, Zone 12 coordinate system was used to obtain boreholes Northings and Eastings.

GEOCRES No. 42A-116



PROFILE ALONG ℄ HWY 572

16 0 16 32m H 1:800

4 0 4 8m V 1:200

LICENSED PROFESSIONAL ENGINEER
P. R. CHATTERJI
June 9/17
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
K. L. SHI
100141639
Jun 9/17
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	DJP	CHK DJP	CODE	LOAD	DATE JUN 2017
DRAWN	AN	CHK AMP	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\19\516\251\ted1251-Plan&Profile(Pike Culvert)_REVISE.dwg
PLOTDATE: 6/8/2017 3:40 PM

THURBER

60 YEARS

Appendix E

Subsurface Information from 1983 Foundation Report,
Geocres No 42A-36

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS, ONTARIO PH-D-207 82 04

METRIC

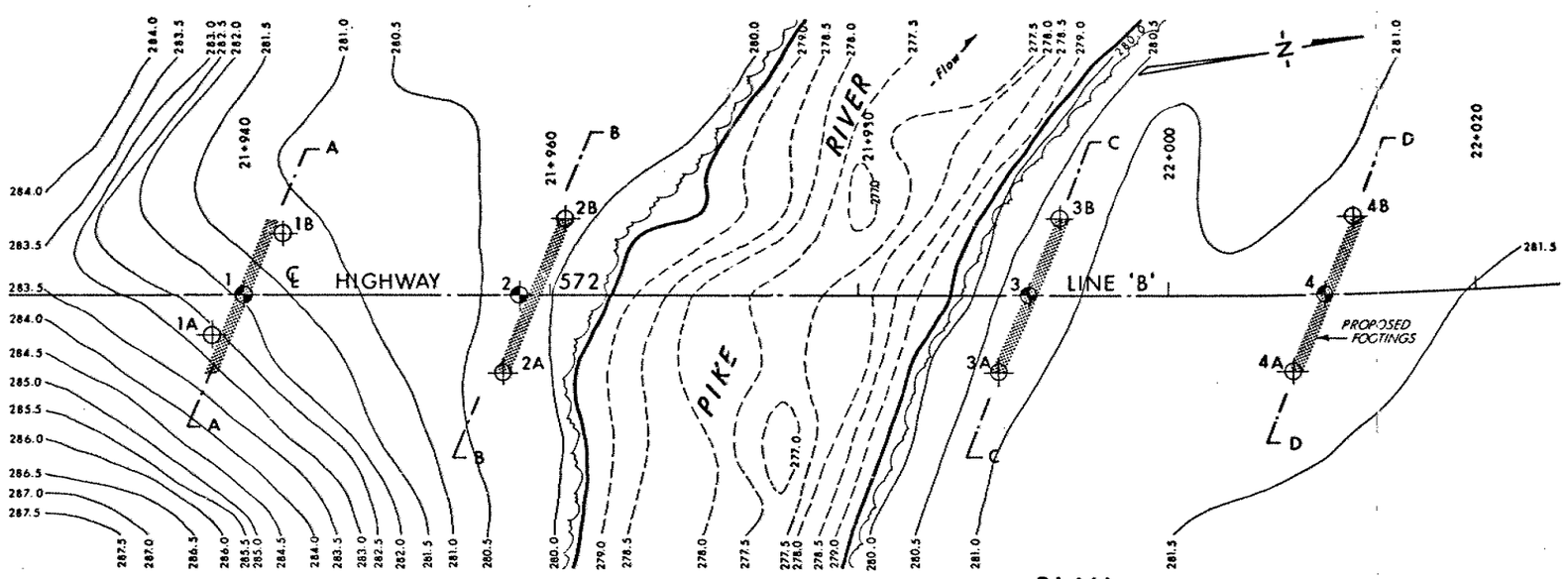
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN STATIONS IN KILOMETRES + METRES

CONT No
WP No 1-81-02

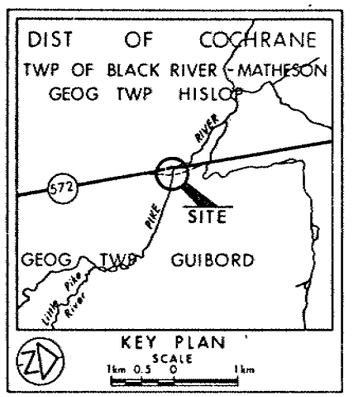
PIKE RIVER

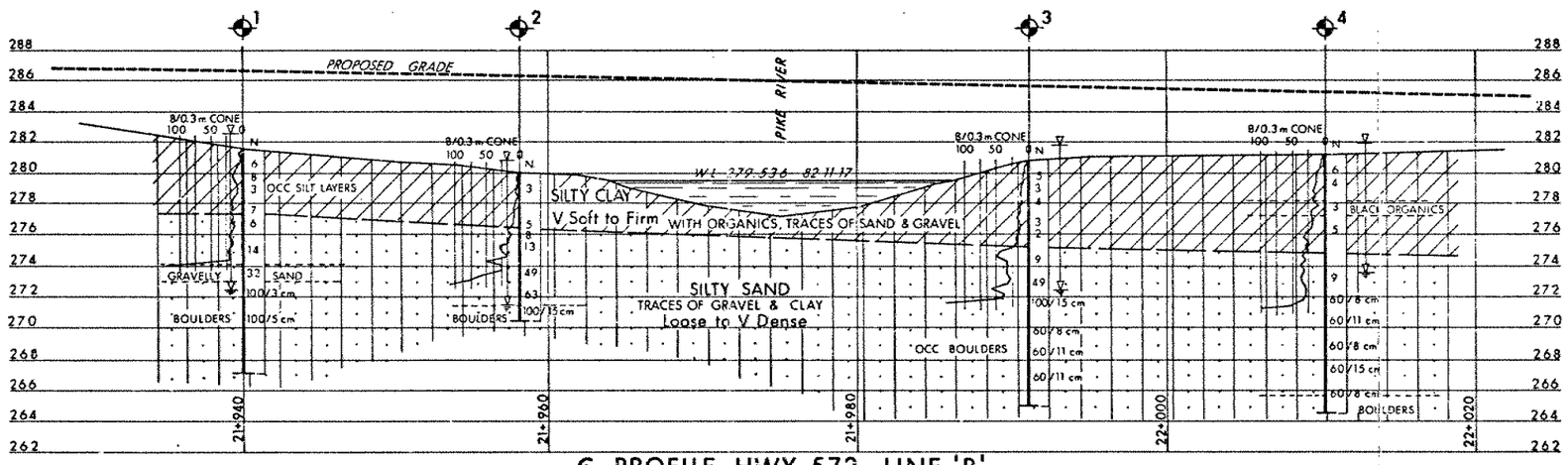
BORE HOLE LOCATIONS & SOIL STRATA

SHEET



PLAN
SCALE
4m 2 0 4m





℄ PROFILE HWY 572 LINE 'B'
SCALE
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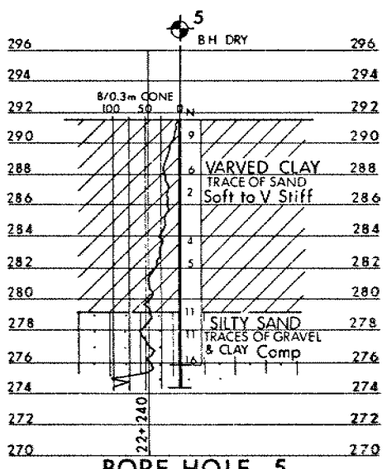
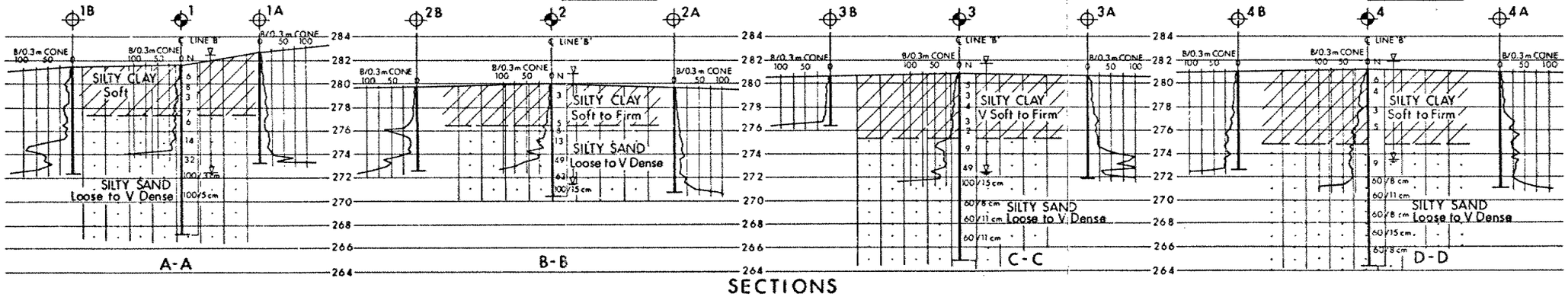


BORE HOLE 5
SCALE
4m 2 0 4m



SECTIONS
SCALE
4m 2 0 4m Ver
2m 1 0 2m Hor

REF NO E-9016-1 83 02

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation 83 06
- Head ARTESIAN WATER Encountered

No	ELEVATION	STATION	OFFSET
1	281.6	21+940	℄
1A	282.7	21+938	2.5 m RT
1B	281.4	21+942.5	4.0 m LT
2	280.0	21+958	℄
2A	279.7	21+957	5.0 m RT
2B	279.8	21+961	5.0 m LT
3	280.9	21+991	℄
3A	280.6	21+989	5.0 m RT
3B	280.7	21+993	5.0 m LT
4	281.2	22+010	℄
4A	281.0	22+008	5.0 m RT
4B	281.0	22+012	5.0 m LT
5	291.6	22+242	17.0 m RT

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

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

REV	DATE	BY	DESCRIPTION

Geocres No 42A-36

HWY No 572 LINE 'B'			DIST 14
SUBMD PP	CHECKED	DATE 83 09 14	SITE 39E-152
DRAWN SO	CHECKED	APPROVED	DWG 18102-A

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1 METRIC

W P 1-81-02 LOCATION Sta: 21+940; o/s ℄, Line 'B' ORIGINATED BY CM
DIST 14 HWY 572 BOREHOLE TYPE Cont. Flight Auger COMPILED BY PP
DATUM Geodetic DATE 83 06 24-27 CHECKED BY

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 (o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
281.6	Ground Level										
0.0	Silty Clay Traces of Sand and Organics Occ. Silt Sand Soft		1	SS	6		280				0 2 45 53
			2	SS	8						
			3	SS	3						
277.4			4	TW	PM		278				0 1 83 16
4.2			5	SS	7						0 12 66 21
	Silty Sand Traces of Gravel and Clay Loose to Very Dense		6	SS	6						3 62 31 4
			7	SS	14		276				
	Gravelly Sand		8	SS	32		274	End of Cone Test			31 54 11 4
			9	SS	100/3cm		272				
	Boulders		10	SS	100/5cm						8 83 7 2
							270				
267.1							268				
14.5	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1A

METRIC

W P 1-81-02 LOCATION Sta: 21+938; 2.5 m RT, Line 'B' ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY JB

DATUM Geodetic DATE 83 06 24 CHECKED BY JB

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			20 40 60 80 100	Wp W WL	γ	GR SA SI CL
282.7	Ground Level							SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	WATER CONTENT (%)		
0.0							282				
							280				
							278				
							276				
							274				
273.3											
9.4	End of Cone Test										

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1B

METRIC

W P 1-81-02 LOCATION Sta: 21 + 942.5; o/s 4 m Lt. Line 'B' ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY JB

DATUM Geodetic DATE 83 06 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: o UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
281.4	Ground Level										
0.0							280, 278, 276, 274				
272.3											
9.1	End of Cone Test										

+3, ×5 : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 1-81-02 LOCATION Sta: 21 + 958; o/s ℄ , Line 'B' ORIGINATED BY CM
DIST 14 HWY 572 BOREHOLE TYPE Cont. Flight Auger and Washbore COMPILED BY PP
DATUM Geodetic DATE 83 06 21-23 CHECKED BY

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 kPo ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp / 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
280.0	Ground Level										
0.0	Silty Clay with organics trace of sand Soft to Firm		1	SS	3					om 6.1% 16.5	0 10 41 49
			2	TW	PH		278				
276.4			3	SS	5						4 10 64 22
3.6	Silty Sand traces of gravel and clay Loose to Very Dense		4	SS	8		276				8 62 27 3
			5	SS	13						
			6	SS	49		274				4 93 (3)
			7	SS	63		272				
	Boulders		8	SS	100/15 cm						14 84 (2)
270.4											
9.6											

+³, ×⁵ : Numbers refer to Sensitivity

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2A

METRIC

W P 1-81-02 LOCATION Sta: 21 + 957; o/s 5 m Rt.; Line 'B' ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY JB

DATUM Geodetic DATE 83 06 23 CHECKED BY

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			20 40 60 80 100	Wp W WL	γ	GR SA SI CL
279.7	Ground Level							SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)		
0.0							278				
							276				
							274				
							272				
270.7											
9.0	End of Cone Test										

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

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RECORD OF BOREHOLE No 2 B

METRIC

W P 1-81-02 LOCATION Sta: 21 + 961; o/s 5 m Lt. Line 'B' ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY JB

DATUM Geodetic DATE 83 06 23 CHECKED BY

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			20 40 60 80 100	Wp W W_L	γ	GR SA SI CL
279.8	Ground Level							SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)		
0.0							278				
							276				
							274				
272.6											
7.2	End of Cone Test							120/25cm			

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

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

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RECORD OF BOREHOLE No 3 — METRIC

W P 1-81-02 — LOCATION Sta: 21 + 991; o/s , Line 'B' — ORIGINATED BY CM
DIST 14 HWY 572 — BOREHOLE TYPE Cont. Flight Auger and Washboring — COMPILED BY PP
DATUM Geodetic — DATE 83 06 28-29 — CHECKED BY

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ KN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
280.9	Ground Level						
0.0	Silty Clay with organics some sand trace of gravel Very Soft to Firm	1	SS	5			
		2	SS	3		om 9.6%	
		3	SS	4		om 10.8% (103%)	
		4	TW	PM		15.5	0 14 58 28
		5	SS	3			3 33 26 38
275.3		6	SS	2			
5.6	Silty Sand some gravel trace of clay Occ. Boulders Loose to Very Dense	7	SS	9			7 78 14 1
		8	SS	49			
		9	SS	100 / 15 cm			18 73 8 1
		10	SS	60 / 8 cm			
		11	SS	60 / 11 cm			
		12	SS	60 / 11 cm			21 38 33 8
264.9							
16.0	End of Borehole						

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 Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L
WATER CONTENT (%) 20 40 60

ELEVATION SCALE: 280, 278, 276, 274, 272, 270, 268, 266

+³, ×⁵ : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 3 A

METRIC

W P 1-81-02 LOCATION Sta: 21 + 989; o/s 5 m RT ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PP

DATUM Geodetic DATE 83 06 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
280.6	Ground Level										
0.0							280				
							278				
							276				
							274				
271.9							272				
8.7	End of Cone Test							100/14 cm			

OFFICE REPORT ON SOIL EXPLORATION

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

20
15 ◇ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 3B

METRIC

W P 1-81-02 LOCATION Sta: 21 + 993; 5 m Lt. LINE 'B' ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PP

DATUM Geodetic DATE 83 06 29 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL; WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
280.7	Ground Level										
0.0							280				
							278				
276.4											
4.3	End of Cone Test										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 4 METRIC

W P 1-81-02 LOCATION Sta: 22 + 010; o/s ℄, Line 'B' ORIGINATED BY CM
DIST 14 HWY 572 BOREHOLE TYPE Cont. Flight Auger and Washbore COMPILED BY PP
DATUM Geodetic DATE 83 06 29 to 83 07 01 CHECKED BY [illegible]

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
281.2	Ground Level										
0.0	Silty Clay some sand traces of organics		1	SS	6		280	+10			0 16 61 23
			2	SS	4						
			3	TW	PH						
	Black Organics		4	SS	3		278	+6			
	Soft to Firm		5	SS	5		276	+6			
274.8			6	TW	PH						0 1 64 35
6.4	Silty Sand some gravel and clay Loose to Very Dense		7	SS	9	▽	274				16 61 21 2
			8	SS	60/8 cm		272	100/9 cm			
			9	SS	60/11 cm						2 46 36 16
			10	SS	60/8 cm		270				
			11	SS	60/15 cm		268				
			12	SS	60/8 cm		266				8 15 65 12
264.4	Boulders										
16.8	End of Borehole										

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 4A

METRIC

W P 1-81-02 LOCATION Sta: 22 + 008; o/s 5 m Rt LINE 'B' ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PP

DATUM Geodetic DATE 83 07 01 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT Wp — NATURAL MOISTURE CONTENT W — LIQUID LIMIT WL WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
281.0	Ground Level										
0.0							280				
							278				
							276				
							274				
							272				
271.1											
9.9	End of Cone Test							100/18 cm			

+3, ×5 : Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No 4B

METRIC

W P 1-81-02 LOCATION Sta: 22 + 012; o/s 5 m Lt. Line 'B' ORIGINATED BY CM

DIST 14 HWY 572 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY PP

DATUM Geodetic DATE 83 07 01 CHECKED BY

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			20 40 60 80 100	Wp W W_L	γ	GR SA SI CL
281.0	Ground Level							SHEAR STRENGTH: o UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	WATER CONTENT (%)		
0.0							280				
							278				
							276				
							274				
272.6											
8.4	End of Cone Test							100/21 cm			

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

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No 5 — METRIC

W P 1-81-02 LOCATION Sta: 22 + 242;o/s 17 m Rt. LINE 'B' ORIGINATED BY CM
DIST 14 HWY 572 BOREHOLE TYPE Cont. Flight Auger (H.S.) COMPILED BY PP
DATUM Geodetic DATE 83 07 01-02 CHECKED BY

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 ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ KN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
291.6	Ground Level										
0.0			1	SS	9		290				
	Varved Clay		2	TW	PH				17.9	0 1 27 72	
	trace of sand		3	SS	6		288				
			4	SS	2		286				
			5	TW	PH	Dry			17.0	0 0 16 84	
	Soft to Very Stiff		6	SS	4		284				
			7	SS	5		282				
			8	TW	PH				18.1		
279.1			9	SS	11		280				
12.5	Silty Sand traces of gravel and clay Compact		10	SS	11		278				
275.9			11	SS	16		276			6 80 12 2	
15.7	End of Borehole										
274.3											
17.3	End of Cone Test										

+³, ×⁵ : Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION