



THURBER ENGINEERING LTD.

FINAL
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
CULVERT 10+890 WBL, MCNAB/BRAESIDE
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009

Geocres No.: 31F-217

Report to:

Ministry of Transportation Ontario

Latitude: 45.446998°
Longitude: -76.597665°

July 2021
Thurber File No.: 24726



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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

Thurber Engineering Ltd. (Thurber) has been engaged by the Ministry of Transportation Ontario (MTO) under Assignment No. 4018-E-0009 to carry out Foundation Investigations to support the design of the Highway 17 Twinning Project which extends from Scheel Drive westerly to 3 km west of Bruce Street in the Renfrew area.

This report addresses the proposed culvert located at Station 10+890 McNab/Braeside Township near Renfrew, Ontario. The existing Highway 17 alignment will become the future Highway 17 eastbound lanes and new westbound lanes will be constructed. This new culvert is required to convey an unnamed tributary of Bonnechere River below an embankment supporting the proposed Highway 17 westbound lanes.

This section of the report presents the factual findings obtained from a foundation investigation completed at the future culvert structure at Station 10+890. Thurber carried out the investigation under Ministry of Transportation (MTO) Assignment No. 4018-E-0009.

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. A model of the subsurface conditions influencing design and construction was developed in the course of the investigation.

No previous foundation investigation information for the subject culvert was available within the online Geocres Library.

2 SITE DESCRIPTION

2.1 General

The site is currently undeveloped and located approximately 80 m north of the existing Highway 17 alignment and 800 m west of Goshen Road. For project purposes, Highway 17 is herein described as oriented east-west.



The land use adjacent to the site generally consists of undeveloped, forested and marshy areas with nearby agriculture. The terrain is relatively flat with a minimal downward slope towards the small, unnamed tributary of the Bonnechere River. The ground surface at the proposed culvert location was wet and covered with tall grass. At the time of the field investigation, the creek was within a channel with a width of approximately 1.5 to 2.0 m and a water depth of approximately 0.3 to 0.4 m. The topography suggests flow through the new culvert would be from south to north.

The existing Highway 17 south of the site consists of a two-lane undivided highway with gravel shoulders and a posted speed limit of 90 km/hr. The AADT for this existing section of Highway 17 near the site had a reported AADT of 13,200 in 2012.

Photographs showing the existing conditions in the area of the site at the time of the field investigation are included in Appendix D for reference.

2.2 Site Geology

Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies within the physiographic region known as the Ottawa Valley Shallow Till and Rock Ridges. Surficial mapping by Ontario Geological Survey (OGS) indicates the site to be comprised of either coarse-textured glaciomarine deposits, organic deposits or Precambrian bedrock. Base mapping by the OGS indicates the bedrock in the area is early felsic plutonic rock consisting of granodiorite, tonalite, monzogranite, syenogranite, derived gneisses and migmatites.

3 SITE INVESTIGATION AND FIELD TESTING

The current site investigation and field-testing program was carried out between October 2nd to 7th, 2019. The field investigation consisted of advancing 3 boreholes identified as Boreholes CV-16 through CV-18. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

The locations of the boreholes were surveyed by Thurber for both location and elevation with a Trimble Catalyst DA1 antenna with centimeter accuracy. The northing, easting and elevation of the boreholes are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A, the individual Record of Borehole sheets in Appendix B, and in Table 3-1 below. The site is located within MTM Zone 9.

The current investigation was carried out using a track-mounted CME 45 drill rig equipped with hollow-stem augers and rotary diamond drilling equipment.

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In situ vane shear testing was completed in cohesive soils with an MTO 'N' sized vane. Bedrock was cored following ASTM Standard D6032-08 in all boreholes with NQ size coring equipment. Bedrock core samples were stored in core boxes for transport.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
CV-16	Proposed Culvert Inlet	5 034 110.1 (45.446883)	297 393.7 (-76.594681)	157.4	5.6
CV-17	Proposed HWY17 WBL C/L	5 034 122.9 (45.446998)	297 395.0 (-76.594665)	157.3	5.8
CV-18	Proposed Culvert Outlet	5 034 137.4 (45.447128)	297 409.1 (-76.594485)	157.3	5.1

A standpipe piezometer, 19 mm in diameter, was installed in Boreholes CV-16. The installation details are illustrated on the respective Record of Borehole sheets provided in Appendix B. The boreholes were backfilled in accordance with MOE requirements (O.Reg 903, as amended). The piezometer will be decommissioned by Thurber following its use as part of a hydrogeological study.

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

4 LABORATORY TESTING

Laboratory testing was selected in accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. At least 25% of the recovered soil samples were subjected to grain size distribution analysis and Atterberg limits tests, where appropriate. The testing was carried out to MTO and ASTM standards. Chemical analysis for determination of pH, conductivity, resistivity, sulphide, sulphate and chloride was carried out on one soil sample from Borehole CV-16. All cored bedrock was logged and total core recovery (TCR), solid core recovery (SCR) and rock quality designation (RQD) was measured on each core.

The results of the geotechnical tests are summarized on the Record of Borehole sheets included in Appendix B and all laboratory results are presented on the figures included in Appendix C.

5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in the following sections. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and the general description. It must be



recognized that the soil, rock and groundwater conditions may vary between and beyond borehole locations. Soil classification is in accordance with ASTM D2487. Cohesive soils are described per current MTO protocols.

In general terms, the site was found to consist of a thin veneer of organics at surface over deposits consisting of sand to silty sand and clayey silt over gneiss bedrock.

5.1 Organic Silt

A thin veneer of organic material consisting of an organic silt with varying amounts of gravel was encountered at surface in Boreholes CV-16 and CV-18 with a thickness of 25 mm and 0.8 m, respectively.

One SPT test conducted within the organic unit gave an N-value of 6 indicating a loose relative density. The moisture content of one sample tested was 95%.

5.2 Sand to Silty Sand (SM) with gravel

A native deposit of sand to silty sand with varying amounts of gravel was encountered below the organic material in Boreholes CV-16 and CV-18 and at surface in Borehole CV-17. Wood fragments were observed in the upper portion of the sand unit in Borehole CV-17. Frequent cobbles and boulders were noted below a depth of 0.8 m (elev. 156.6 and 156.5 m) in Boreholes CV-16 and CV-17, respectively, and throughout the deposit in Borehole CV-18. The layer ranged in thickness from 0.7 to 2.5 m and extended to a base elevation ranging from 154.8 to 155.8.

SPT tests conducted in this layer gave N-values ranging from 3 to greater than 100 blows for 178 mm of penetration indicating a relative density ranging from very loose to very dense, however, this refusal represents the bedrock surface rather than the relative density of the soil deposit. The soil generally ranges from very loose to dense in relative density.

The moisture content of this unit generally ranged from 14 to 55% with one test reading of 1% from a sample consisting of primarily broken boulder fragments. The results of grain size distribution testing carried out on one sample of this material indicate the material consists of approximately 33% gravel, 45% sand and 22% fines, as illustrated on Figure C1 in Appendix C.

5.3 Clayey Silt (CL)

A glaciomarine native deposit of clayey silt was encountered below the sand deposit in Borehole CV-16. The deposit extended to a depth of 2.8 m with an underside elevation of 154.6 m.

SPT tests conducted within this cohesive unit gave N-values of weight of hammer and 35. An in situ shear vane test in the clayey silt indicated an undrained shear strength of approximately 21 kPa indicating a soft consistency. Sensitivity was measured to be 3.3.

The moisture content of the clayey silt samples tested were 28 and 33%. The results of one grain size analysis tests conducted on a sample of this material indicated the material to consist of



approximately 0% gravel, 3% sand, 63% silt and 34% clay, as illustrated on Figures C2 in Appendix C.

The results of Atterberg Limits testing carried out on one sample of this material indicate the material to have a liquid Limit of 26, Plasticity Limit of 15 and a Plasticity Index of 11, as illustrated on Figure C3 in Appendix C. The laboratory results indicate that the material to have low plasticity (CL). It should be noted in accordance with the MTO Guideline for Foundation Engineering Services (May 2019) the cohesive deposit could be described as a “clayey silt”.

5.4 Bedrock

Bedrock was proven by coring in all boreholes. The bedrock encountered consisted of slightly weathered to fresh, strong, foliated gneiss to granitic gneiss ranging in colours of red, pink, grey and black. Clay infilled fractures were noted in Run 2 and 3 between a depth of approximately 3.0 to 4.7 m (elev. 154.4 to 15.27 m) in Borehole CV-16. Photographs of the bedrock cores are provided in Appendix C. The following table summarizes the rock core quality:

Summary of Rock Core Quality

Parameter	Range	Average
Total Core Recovery (TCR), %	43 – 100	87
Solid Core Recovery (SCR), %	15 – 100	68
Rock Quality Designation (RQD), %	0 – 100	45
Fracture Index	1 to >10	-

Based on the RQD value range, the bedrock is classified as poor to excellent quality. Based on field observations, the bedrock is strong.

A summary of the bedrock surface information is provided in Table 5-1 below:

Table 5-1: Summary of Bedrock Depth/Elevation

Borehole No.	Depth to Bedrock Surface (mbgs)	Bedrock Surface Elevation (m)
CV-16	2.8	154.6
CV-17	2.5	154.8
CV-18	1.5	155.8

5.5 Groundwater

One standpipe piezometer with a diameter of 19 mm was installed in Borehole CV-16. Groundwater levels recorded in the piezometer are presented in Table 5-2 below:

Table 5-2: Summary of Groundwater Levels

Borehole No.	Bottom of Screen Elevation (m)	Depth (m)	Groundwater Elevation (m)	Date of Measurement
CV-16	154.8	0.1 above g.s.*	157.5	2019.11.26
		0.2 above g.s.*	157.6	2020.04.21

*g.s. = ground surface

Due to the relatively thin soil strata encountered at the site, the piezometer screen was installed across the interface between the sand and underlying clayey silt and therefore represents a generalized indication of the groundwater level in the subsoils at the site.

At the time of the field investigation, the creek water level was measured at an approximate elevation of 157.0 m.

These observations are considered short term and it should be noted that the groundwater level at the time of construction may be different and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation.

5.6 Analytical Testing

One sample of the native sand was submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate, sulphide and chloride concentrations, resistivity and conductivity. The analysis results are summarized in Table 5-3. Copies of the test results are provided in Appendix C.

Table 5-3: Results of Chemical Analysis

Borehole	CV-16
Sample	SS1
Depth (m)	0 – 0.6
Chloride (µg/g)	24
Sulphate (µg/g)	6
Sulphide (%)	< 0.02
pH (-)	7.55
Resistivity (Ohm-cm)	8,320
Conductivity (µS/cm)	120



6 MISCELLANEOUS

Borehole locations were selected by Thurber relative to existing site features. The as-drilled locations and ground surface elevation of the boreholes were surveyed by Thurber following completion of the field program. The elevation survey was carried out with reference to geodetic elevation benchmarks provided by the MTO.

Eastern Ontario Diamond Drilling of Hawkesbury, Ontario supplied and operated the drilling equipment and carried out the drilling, soil sampling, in-situ testing, piezometer installation and borehole decommissioning. The field investigation was supervised on a full-time basis by Michel Johnston of Thurber. Overall supervision of the investigation program was provided by Justin Gray, P.Eng.

Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa.

Overall project management and direction of the field program was provided by Fred Griffiths, P.Eng. Interpretation of the factual data and preparation of this report were carried out by Katya Edney, P.Eng., Matt Kennedy, P.Eng., and Fred Griffiths, P.Eng. The report was reviewed by P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

 for:

Katya Edney, M.Eng., P.Eng.
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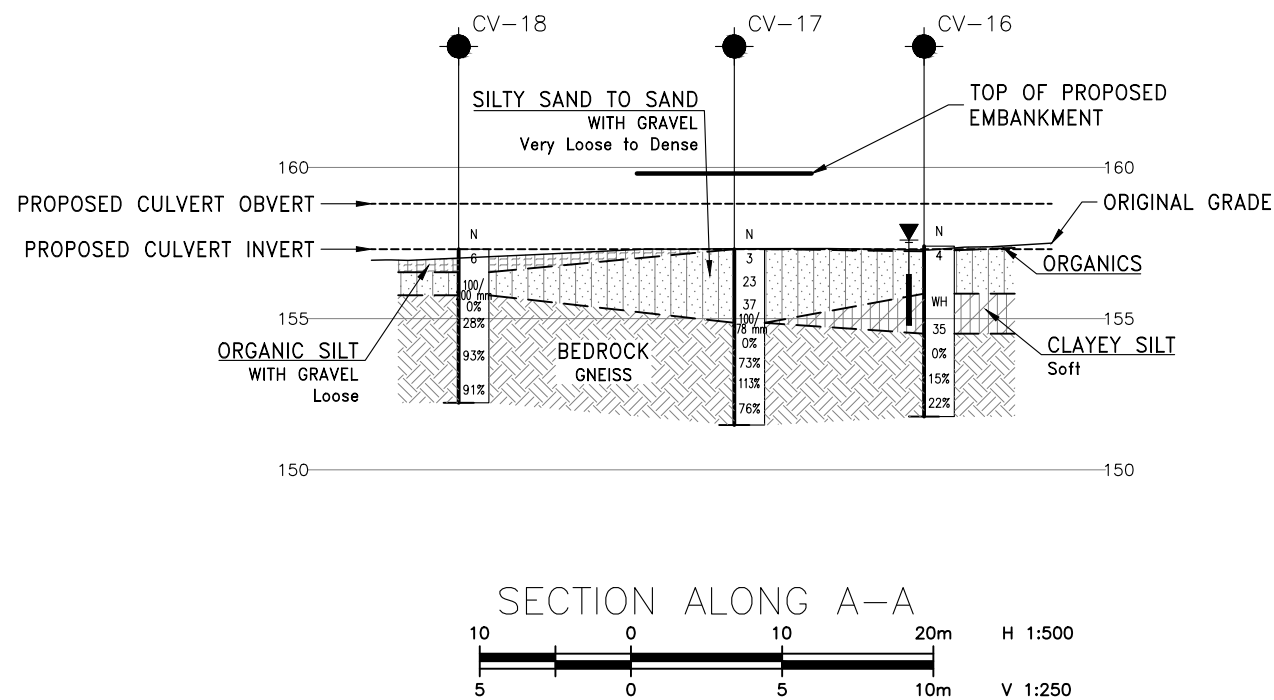
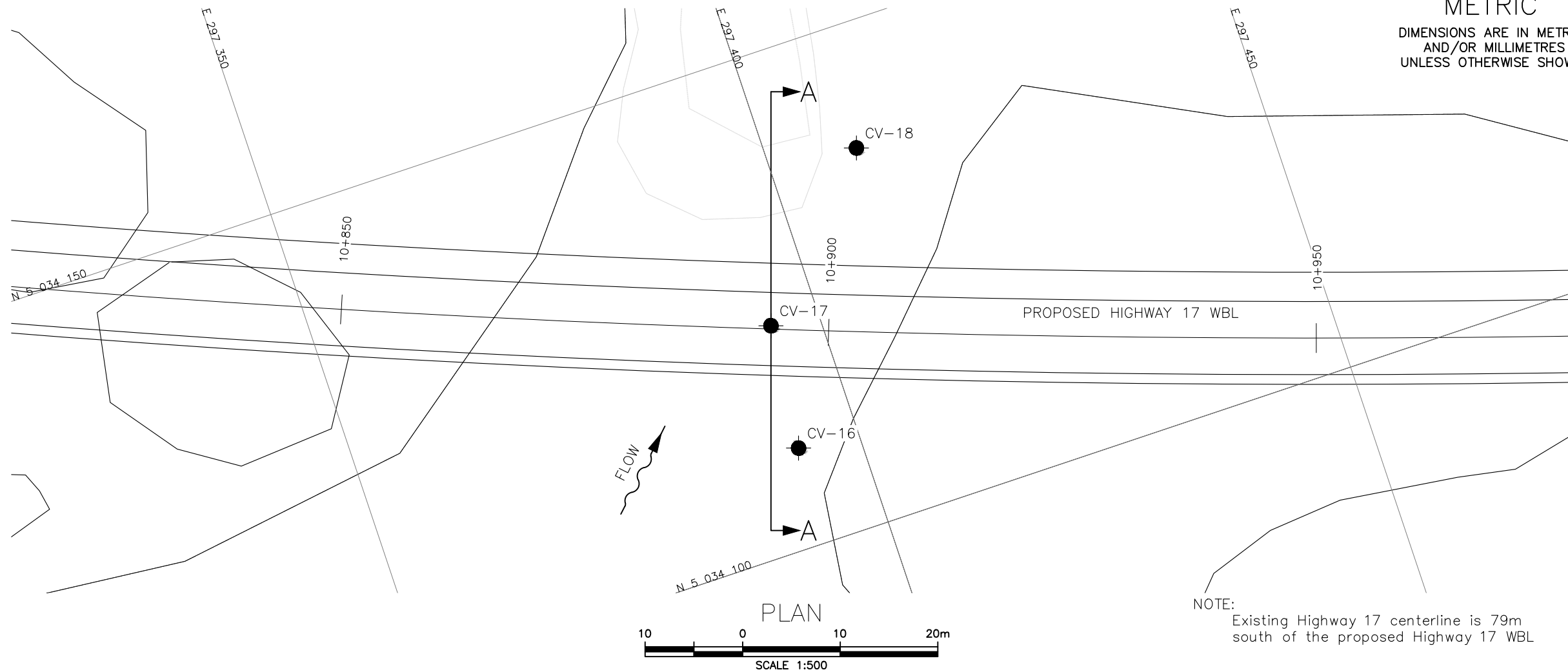
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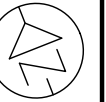
Appendix A.

Borehole Location Plan and Stratigraphic Drawings



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

CONT No
WP No 4068-09-00



HIGHWAY 17 TWINNING
CULVERT STA. 10+890 WBL

BOREHOLE LOCATIONS AND SOIL STRATA







THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
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
CV-16	157.4	5 034 110.1	297 393.7
CV-17	157.3	5 034 122.9	297 395.0
CV-18	157.3	5 034 137.4	297 409.1

-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. Structural elements, surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 9.

GEOCRES No. 31F-217

[illegible]

Appendix B.

Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

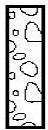
DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

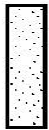


STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel



Sand



Silt



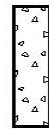
Clay



Organics



Asphalt



Concrete



Fill



Bedrock

TEXTURING CLASSIFICATION OF SOILS

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

SAMPLE TYPES

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

Descriptive Term	SPT "N" Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clayey silts of low plasticity, gravelly clays, sandy clays.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials.
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 structures are preserved.

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 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

DISCONTINUITY SPACING

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

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

RECORD OF BOREHOLE No CV-16

1 OF 1

METRIC

WP# 4068-09-00 LOCATION Lat: 45.446883°, Long: -76.594681°
Culvert 10+890 MTM z9: N 5 034 110.1 E 297 393.7 ORIGINATED BY MJJ
HWY 17 BOREHOLE TYPE CME 45 Trackmount, HSA/NW/NQ Coring COMPILED BY JP
DATUM Geodetic DATE 2019.10.04 - 2019.10.04 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
157.4	Ground Surface															
0.0 0.1	Organics (25 mm)															
	SAND Very Loose to Loose Brown to Grey - frequent cobbles/boulders from 0.8 m to 1.5 m		1	SS	4											
155.8																
1.6	CLAYEY SILT (CL) Soft Grey		2	SS	WH											0 3 63 34
154.6			3	SS	35											
2.8	GNEISS BEDROCK Slightly weathered, red and black, strong, moderately to highly fractured - clay infilled fractures from elev. 154.4 to 152.7 m		1	RUN												RUN #1 TCR=43% SCR=34% RQD=0%
			2	RUN												RUN #2 TCR=100% SCR=52% RQD=15%
			3	RUN												RUN #3 TCR=67% SCR=92% RQD=22%
151.8																
5.6	End of Borehole Monitoring well consists of 19 mm diameter Schedule 40 PVC pipe with a 1.5 m slotted screen WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2019.11.26 0.1 above g.s. 157.5 2020.04.21 0.2 above g.s. 157.6															

DOUBLE LINE 24726 CULVERT 10+890.GPJ 2012TEMPLATE(MTO).GDT 1/5/21

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No CV-17

1 OF 1

METRIC

WP# 4068-09-00 LOCATION Lat: 45.446998°, Long: -76.594665°
Culvert 10+890 MTM z9: N 5 034 122.9 E 297 395.0 ORIGINATED BY MJJ
HWY 17 BOREHOLE TYPE CME 45 Trackmount, HSA/NW/NQ Coring COMPILED BY JP
DATUM Geodetic DATE 2019.10.02 - 2019.10.03 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
157.3	Ground Surface							20	40	60	80	100			
0.0	SAND Very Loose Grey - wood fragments		1	SS	3		157								
156.5															
0.8	SILTY SAND (SM) with gravel Compact to Dense Brown to Grey - frequent cobbles		2	SS	23		156								33 45 22 (SI+CL)
			3	SS	37										
154.8			4	SS	100/		155								
2.5	GNEISS BEDROCK Slightly weathered to fresh, grey, foliated, strong		1	RUN	178 mm		154								RUN #1 TCR=53% SCR=18% RQD=0%
			2	RUN											RUN #2 TCR=100% SCR=96% RQD=73%
			3	RUN			153								RUN #3 TCR=100% SCR=100% RQD=100%
			4	RUN			152								RUN #4 TCR=97% SCR=93% RQD=76%
151.5															
5.8	End of Borehole														

DOUBLE LINE 24726 CULVERT 10+890.GPJ 2012TEMPLATE(MTO).GDT 1/5/21

RECORD OF BOREHOLE No CV-18

1 OF 1

METRIC

WP# 4068-09-00 LOCATION Lat: 45.447128°, Long: -76.594485°
Culvert 10+890 MTM z9: N 5 034 137.4 E 297 409.1 ORIGINATED BY MJJ
HWY 17 BOREHOLE TYPE CME 45 Trackmount, NW/NQ Coring COMPILED BY JP
DATUM Geodetic DATE 2019.10.07 - 2019.10.07 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100						
157.3	Ground Surface													
0.0	ORGANIC SILT with gravel Loose Black		1	SS	6		157							
156.5														
0.8	SILTY SAND (SM) with gravel - frequent cobbles and boulders		2	GS			156							
155.8			3	SS100/200 mm										
1.5	GRANITE/GNEISS BEDROCK Pink and grey, slightly weathered to fresh, strong, some foliation, highly to slightly fractured		1	RUN			155							
			2	RUN										
			3	RUN			154							
			4	RUN			153							
152.2														
5.1	End of Borehole													

DOUBLE LINE 24726 CULVERT 10+890.GPJ 2012TEMPLATE(MTO).GDT 1/5/21

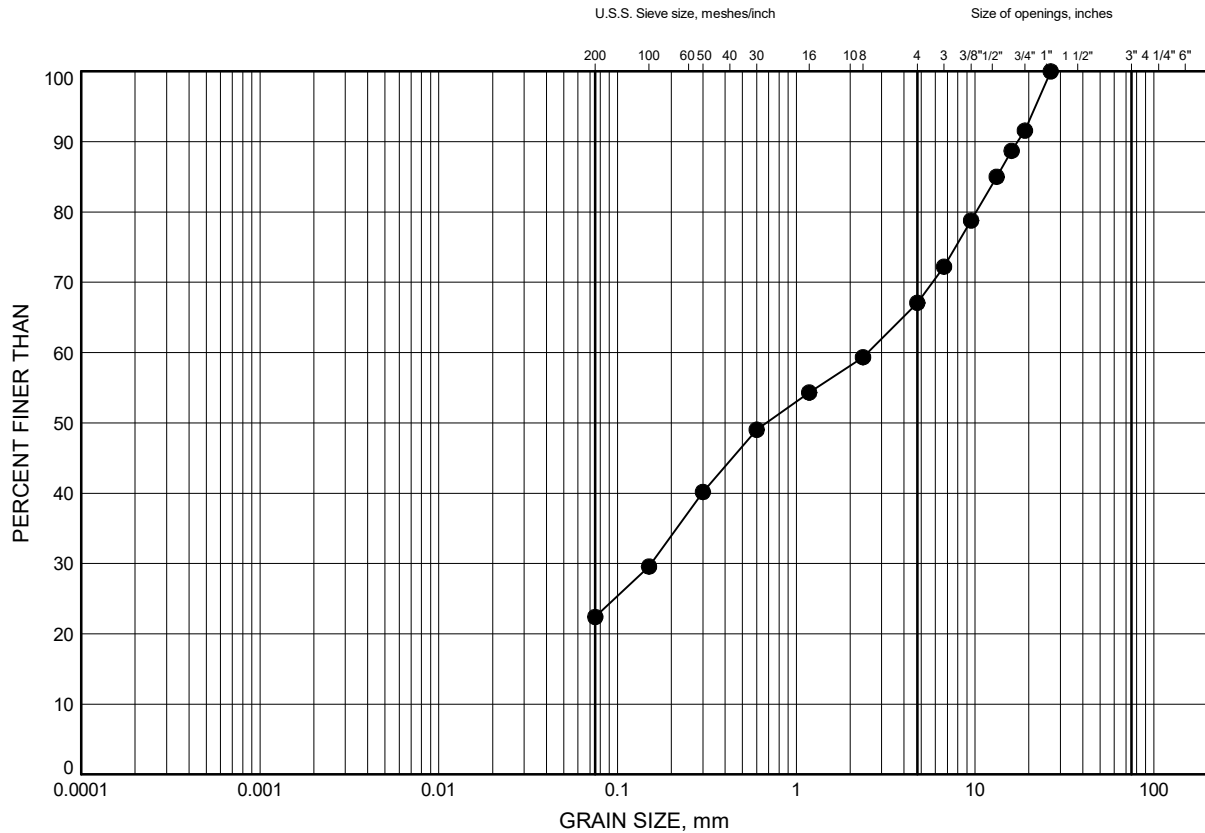
Appendix C.
Laboratory Testing

Appendix C.1
Particle Size Analysis Figures
Atterberg Limit Test Results

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C1

SILTY SAND (SM) with gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-17	1.1	156.2

Date June 2020
WP# 4068-09-00

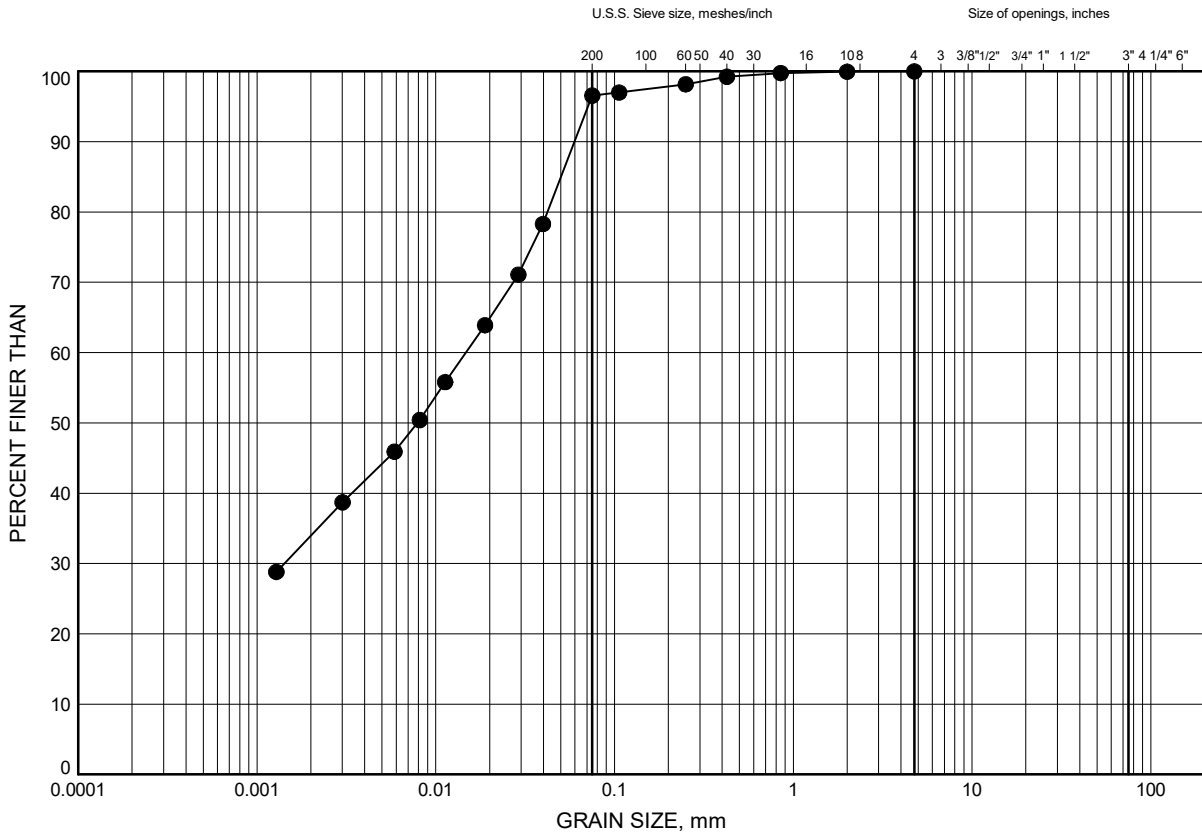


Prep'd KE
Chkd. FG

Highway 17 Twinning GRAIN SIZE DISTRIBUTION

FIGURE C2

CLAYEY SILT (CL)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-16	1.8	155.6

Date June 2020
WP# 4068-09-00

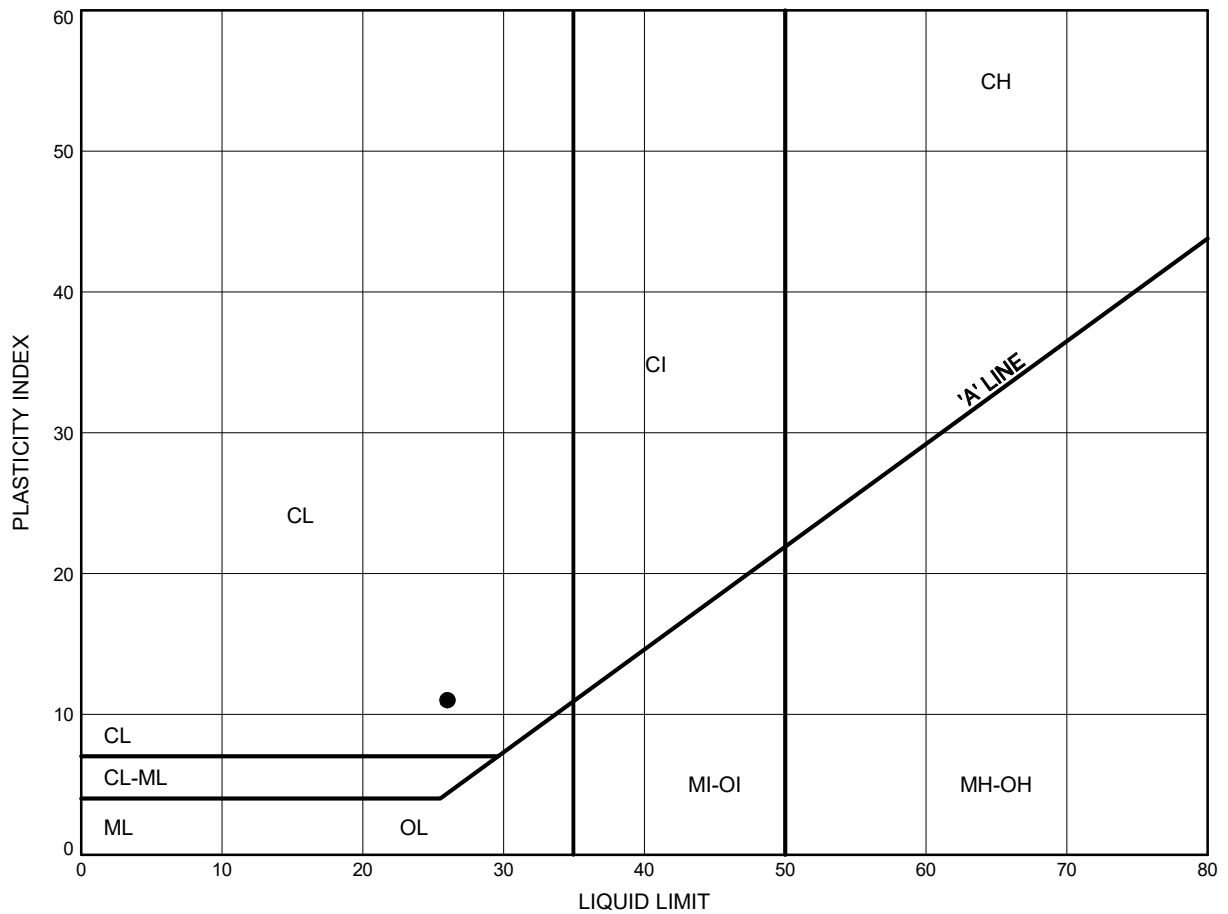


Prep'd KE
Chkd. FG

Highway 17 Twinning ATTERBERG LIMITS TEST RESULTS

FIGURE C3

CLAYEY SILT (CL)



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	CV-16	1.8	155.6

Date June 2020
 WP# 4068-09-00



Prep'd KE
 Chkd. FG

Appendix C.2
Analytical Testing Results

Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Justin Gray

Client PO: 24726
Project: Hwy 17, Culvert 10+890
Custody: 49176

Report Date: 20-Oct-2019
Order Date: 16-Oct-2019

Order #: 1942186

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID

1942186-01

Client ID

CV-16, SS1, 0'-2'

Approved By:



Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019

Order Date: 16-Oct-2019

Project Description: Hwy 17, Culvert 10+890

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	17-Oct-19	17-Oct-19
Conductivity	MOE E3138 - probe @25 °C, water ext	17-Oct-19	18-Oct-19
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	18-Oct-19	19-Oct-19
Resistivity	EPA 120.1 - probe, water extraction	17-Oct-19	18-Oct-19
Solids, %	Gravimetric, calculation	17-Oct-19	17-Oct-19

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019

Order Date: 16-Oct-2019

Project Description: Hwy 17, Culvert 10+890

Client ID:	CV-16, SS1, 0'-2'	-	-	-
Sample Date:	04-Oct-19 09:00	-	-	-
Sample ID:	1942186-01	-	-	-
MDL/Units	Soil	-	-	-

Physical Characteristics

% Solids	0.1 % by Wt.	79.0	-	-	-
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General Inorganics

Conductivity	5 uS/cm	120	-	-	-
pH	0.05 pH Units	7.55	-	-	-
Resistivity	0.10 Ohm.m	83.2	-	-	-

Anions

Chloride	5 ug/g dry	24	-	-	-
Sulphate	5 ug/g dry	6	-	-	-

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019

Order Date: 16-Oct-2019

Project Description: Hwy 17, Culvert 10+890

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Conductivity	ND	5	uS/cm						
Resistivity	ND	0.10	Ohm.m						

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019

Order Date: 16-Oct-2019

Project Description: Hwy 17, Culvert 10+890

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	120	5	ug/g dry	123			3.1	20	
Sulphate	323	5	ug/g dry	332			2.8	20	
General Inorganics									
Conductivity	114	5	uS/cm	117			2.6	5	
pH	7.30	0.05	pH Units	7.33			0.4	2.3	
Resistivity	87.7	0.10	Ohm.m	85.5			2.6	20	
Physical Characteristics									
% Solids	87.2	0.1	% by Wt.	87.5			0.4	25	

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019

Order Date: 16-Oct-2019

Project Description: Hwy 17, Culvert 10+890

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	215	5	ug/g	123	91.2	82-118			
Sulphate	421	5	ug/g	332	88.8	80-120			

Certificate of Analysis
Client: Thurber Engineering Ltd.
Client PO: 24726

Report Date: 20-Oct-2019

Order Date: 16-Oct-2019

Project Description: Hwy 17, Culvert 10+890

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

Subcontracted Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Suite 104
Ottawa, ON K1B 4S5
Attn: Justin Gray

Tel: (613) 408-6795
Fax: (613) 247-2185

Paracel Report No: **1942186**
Client Project(s): **Hwy 17, Culvert 10+890**
Client PO: **24726**
Reference: **Standing Offer**
CoC Number: **49176**

Order Date: 16-Oct-19
Report Date: 20-Oct-19

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
1942186-01	CV-16, SS1, 0'-2'	Sulphide, solid

**SGS Canada Inc.**

P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - K0L 2H0
Phone: 705-652-2000 FAX: 705-652-6365

Paracel Laboratories

Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6, Canada

Phone: 613-731-9577
Fax:613-731-9064

23-October-2019

Date Rec. : 17 October 2019
LR Report: CA15379-OCT19
Reference: Project#: 1942186

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		23-Oct-19
2: Analysis Start Time		14:17
3: Analysis Completed Date		23-Oct-19
4: Analysis Completed Time		14:33
5: QC - Blank		< 0.02
6: QC - STD % Recovery		113%
7: QC - DUP % RPD		4%
8: RL		0.02
9: CV-16, SS1, 0'-2'	04-Oct-19	< 0.02

RL - SGS Reporting Limit

Note: Sample was received on last day of 14 day holding time; result may be unreliable.

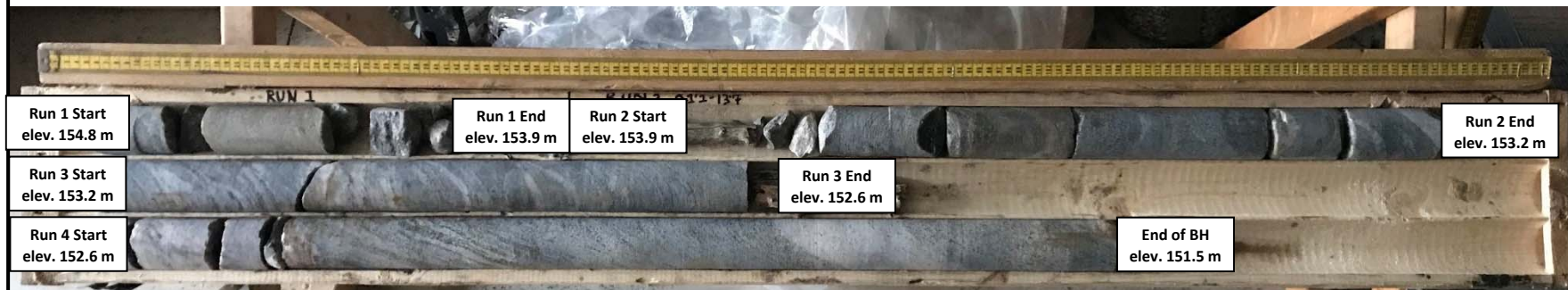
Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

Appendix C.3
Bedrock Photos

Borehole CV-16
Run 1 to 4 (of 4)
Elevation 154.6 m to 151.8 m



Borehole CV-17
Run 1 to 4 (of 4)
Elevation 154.8 m to 151.5 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
HWY 17 Twinning
Renfrew, Ontario

BH CV-17
Project No.: 24726

Borehole CV-18
Run 1 to 3 (of 3)
Elevation 155.8 m to 152.2 m



THURBER ENGINEERING LTD.

Geotechnical Investigation
HWY 17 Twinning
Renfrew, Ontario

BH CV-18
Project No.: 24726

Appendix D.
Site Photographs



Photo 1. Looking southwest on Highway 17 at Station 10+890 (2019/10/02)



Photo 2. Looking south towards existing Highway 17 at Station 10+890 (2019/10/02)