



**THURBER** ENGINEERING LTD.

**FINAL  
FOUNDATION INVESTIGATION REPORT  
CULVERT 27-362/C REHABILITATION  
HWY 417 COUNTY ROAD 7 UNDERPASS, CASSELMAN ON**

**G.W.P. 451-98-00**

Geocres No.: 31G-271

Report to:

**Ainley Group**

Latitude: 45.302267°  
Longitude: -75.079573°

November 2018  
Thurber File: 18310

## TABLE OF CONTENTS

### PART 1. FACTUAL INFORMATION

1	INTRODUCTION .....	1
2	SITE DESCRIPTION .....	1
3	SITE INVESTIGATION AND FIELD TESTING.....	2
4	LABORATORY TESTING.....	3
5	GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS.....	3
5.1	Embankment Fill .....	3
5.1.1	Asphalt .....	3
5.1.2	Fill: Silty Sand with gravel .....	3
5.1.3	Fill: Silty Sand trace gravel.....	4
5.1.4	Fill: Interlayered Clay, Silt, Silty Sand and Gravel.....	4
5.2	Clay (Cl to CH).....	4
5.3	Silty Sand to Sandy Silt (Glacial Till).....	5
5.4	Bedrock.....	5
5.5	Groundwater .....	6
5.6	Analytical Testing.....	6
6	MISCELLANEOUS .....	8

### APPENDICES

Appendix A.	Borehole Location Plan and Stratigraphic Drawings
Appendix B.	Record of Borehole Sheets
Appendix C.	Laboratory Testing
Appendix D.	Site Photographs

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**PART 1. FACTUAL INFORMATION**

**1 INTRODUCTION**

This section of the report presents the factual findings obtained from a foundation investigation completed for Culvert 27-362/C crossing of County Road 7 near the underpass of the Highway 417 Interchange. The culvert is located approximately 400 m north of Aurele Road on County Road 7 East within the Township of Cambridge. Thurber Engineering Limited (Thurber) carried out the current investigation as a sub-consultant to Ainley Graham & Associates Limited (Ainley) under Agreement No. 4016-E-0036.

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 current investigation. The following historical foundation investigation report was obtained from the online Geocres library and reviewed in preparation of this report.

Foundation Investigation Report for Proposed Crossing, New Hwy. #417 and County Road #7, Twp. of Cambridge, Co. of Russell, Lot 9 Conc. 7, District No. 9 (Ottawa), W.J.70-F-3 – W.P. 35-66-16 [Geocres 31G-47]

**2 SITE DESCRIPTION**

The existing culvert is a corrugated steel sectional plate arch culvert servicing the Leo Denis Municipal Drain and is noted to have been constructed in 1971. The culvert is reported to be 3.5 m wide by 2.2 m high and approximately 37 m long with a generally east to west alignment. The flow through the culvert is to the west.

At the location of the culvert, County Road 7 is a two-lane road with narrow paved shoulders and steel beam guiderails on both sides. The underpass embankment fill height is approximately 6.6 m over the culvert with the road surface at approximate elevation of 69.9 m. The existing embankment side slopes are inclined at approximately 2H:1V. Adjacent to the highway right-of-way, are commercial properties and agriculture land. No signs of erosion or slope instability were noted on the existing highway embankments during the field investigation. The roadway surface over the culvert was generally in good condition with no dips or bumps noted during the field investigation. The existing culvert, however, did show minimal signs of corrosion. Traffic volumes are understood to be 1812 AADT (2014). County Road 7 is also known as Rue Principale.

**FINAL**

Photographs showing the existing conditions in the area of the culvert are included in Appendix D for reference.

### 3 SITE INVESTIGATION AND FIELD TESTING

The current site investigation and field testing program was carried out between June 19<sup>th</sup> and June 26<sup>th</sup>, 2018. Drilling consisted of advancing four boreholes identified as 17-9 through 17-12. The drilling was carried out using truck and track mounted CME 55 drill rigs equipped with hollow stem augers. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

The northing, easting, and elevation of the boreholes from the current investigation are shown on the Borehole Location and Soil Strata Drawing No. 1 in Appendix A. The individual Record of Borehole sheets are provided in Appendix B and summarized in Table 3-1. The termination depth of each of the boreholes is also provided, below. The borehole elevations were surveyed using geodetic benchmark GBM 00819758419 (elev. 71.241 m) and a Trimble Catalyst with centimetre precision in conjunction with a Nikon-AP-8 with an accuracy of +/- 1.5 mm. Borehole locations were measured off existing site features and translated to northings and eastings based on the available base plans. The site is within MTM Zone 8.

**Table 3-1: Borehole Summary**

<b>Borehole No.</b>	<b>Drilled Location</b>	<b>Northing (m)</b>	<b>Easting (m)</b>	<b>Ground Surface Elevation (m)</b>	<b>Termination Depth (m)</b>
17-9	Near Culvert inlet	5 019 259.2	180 937.0	63.9	10.0
17-10	County Road 7 NB lane	5 019 243.3	180 926.6	69.7	17.0
17-11	Country Road 7 SB lane	5 019 248.9	180 918.2	70.1	16.4
17-12	Near Culvert outlet	5 019 243.7	180 898.9	63.3	11.1

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). In-situ shear vane testing was carried out within the cohesive strata using an N-vane. Bedrock was cored with NQ size coring equipment.

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

A 19 mm diameter standpipe piezometer was installed in Borehole 17-9 to allow for measurements of the groundwater level after completion of drilling. The piezometer installation details are illustrated on the Record of Borehole sheet for Borehole 17-9, provided in Appendix B. Following completion of the field investigation the remaining

boreholes were backfilled in accordance with MOE requirements (O.Reg. 903, as amended).

The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawing included in Appendix A. The coordinates and elevation of the boreholes are provided on this drawing and on the individual Record of Borehole sheets.

#### **4 LABORATORY TESTING**

The recovered soil samples were subjected to visual identification and to natural moisture content determination. Selected samples were also subjected to gradation analysis (hydrometer and/or sieve) and Atterberg Limit testing. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B. One sample of soil recovered from within the boreholes was selected and submitted for analytical testing of corrosivity parameters and sulphate content. All laboratory test results from the field investigation are provided 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 Locations 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 paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over the Soil Strata Drawing and the general description. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations.

In general terms, the site was found to be underlain by a granular embankment fill overlying a thin deposit of native clay over glacial till. Bedrock was encountered within the depth of investigation in all boreholes.

The conditions reported in Geocres Report 31G-47 indicate a similar stratigraphy. The borehole records have not been included in this report due to the significant grade modifications which occurred during construction of the Highway 417 Underpass.

##### **5.1 Embankment Fill**

###### **5.1.1 Asphalt**

Boreholes 17-10 and 17-11 were drilled through the existing County Road 7 pavement and encountered a layer of asphalt at the surface with a thickness of 100 mm.

###### **5.1.2 Fill: Silty Sand with gravel**

At surface in the on-road boreholes was a layer of silty sand fill with gravel. The underside of the fill was 0.5 to 0.6 m below the existing pavement surface (elev. 69.1 to 69.6 m).

The moisture content was measured to be 2% on one sample.

Gradation analysis was completed on one sample of this granular fill layer. The grain size distribution curve for this sample is included in Figure C1 of Appendix C. The results of the test indicated the material consisted of 39% gravel, 41% sand and 20% fines.

### 5.1.3 Fill: Silty Sand trace gravel

At surface in Borehole 17-9 and below the pavement structure in Boreholes 17-10 and 17-11 was a layer of silty sand fill with trace amounts of gravel. The underside of the layer was 1.7 to 5.7 m below the existing ground / pavement surface (elev. 62.2 to 64.4 m).

The SPT tests conducted in this layer typically gave N-values ranging from 6 to 49 blows indicating a relative density of loose to dense. Recorded moisture contents ranged from 2 to 25%.

Gradation analyses were completed on two samples of this granular fill layer. The grain size distribution curves for these samples are included in Figure C1 of Appendix C. The results of the tests are summarized in Table 5-1 and are presented on the corresponding Record of Borehole sheets in Appendix B.

**Table 5-1: Gradation Results for Silty Sand trace Gravel Fill**

Soil Particle	Percentage (%)
Gravel	6 – 7
Sand	70 – 74
Silt and Clay	19 – 24

### 5.1.4 Fill: Interlayered Clay, Silt, Silty Sand and Gravel

Below the silty sand fill in the on-road boreholes was a fill material composed of an interlayered mixture of clay, silty clay, silty sand, silt and gravel. The underside of this fill was 6.9 to 7.6 m below the existing pavement surface (elev. 62.5 to 62.8 m).

The SPT tests conducted in this fill layer typically gave N-values ranging from 6 to 12 blows indicating a relative density of loose to compact and a firm to stiff consistency. Recorded moisture contents ranged from 13 to 42%.

## 5.2 Clay (CI to CH)

Below the fill materials in Boreholes 17-9 through 17-11 and at surface at Borehole 17-12 was a clay deposit. The thickness of this layer ranged from 0.9 to 1.2 m with a base elevation ranging from 61.2 to 62.1 m.

In-situ shear vane test results near the base of the layer indicated an undrained shear strength ranging from 25 to 55 kPa indicating a firm to stiff consistency. The results of the in-situ shear vane tests indicate that the clay exhibits some sensitivity. SPT tests gave N-values ranging from Weight of Rods (WR) for 300 mm penetration to 100 blows for 75 mm. The high blow count indicated the start of the glacial till beneath the clay deposit.

Recorded moisture contents ranged from 20 to 82%. The results of grain size analyses conducted on four samples of the clay are summarized in Table 5-2 and illustrated on Figure C2 in Appendix C.

**Table 5-2: Gradation Results for Clay**

Soil Particle	Percentage (%)
Gravel	0 – 3
Sand	2 – 10
Silt	23 – 54
Clay	36 – 75

The results of Atterberg Limits testing completed on three samples of this material indicated a liquid limit ranging from 40 to 72, a plastic limit ranging from 20 to 26, and a plasticity index of 20 to 46. The laboratory results indicate that the clay has intermediate to high plasticity (CI to CH). The results are summarized on the Record of Borehole sheets in Appendix B and the Atterberg Limits graph is included as Figure C4 of Appendix C.

### 5.3 Silty Sand to Sandy Silt (Glacial Till)

A native deposit of glacial till consisting of silty sand to sandy silt with varying amounts of gravel was observed underlying the clay deposit in all boreholes. Occasional to frequent cobbles and boulders were encountered within this deposit at Borehole 17-10 and 17-12. A 0.6 m thick silt bed was encountered at a depth of 11.4 m below existing pavement surface within the glacial till deposit in Borehole 17-10. The thickness of the till ranged from 3.7 to 6.6 m with a base elevation ranging from 55.5 to 57.5 m.

SPT tests gave N-values ranging from 4 for 300 mm penetration to 100 blows for 75 mm, indicating a relative density of loose to very dense. The recorded moisture contents ranged from 2 to 25%.

Gradation analyses was completed on six samples of the glacial till. The grain size distribution curves are included in Figure C3 of Appendix C. The results of the tests are summarized in Table 5-3 and are presented on the corresponding Record of Borehole sheets in Appendix B and indicate an SM to ML material.

**Table 5-3: Gradation Results for Glacial Till**

Soil Particle	Percentage (%)	
Gravel	4 – 36	
Sand	24 – 51	
Silt	39 – 69	13 – 43
Clay	3 – 10	

### 5.4 Bedrock

Bedrock was proven by coring in all four boreholes. Information on the bedrock surface from the current investigation is summarized in the Table 5-4.

**Table 5-4: Summary of Bedrock Elevations**

Borehole No.	Depth to Bedrock (m)	Bedrock Elevation (m)
17-9	6.4	57.5
17-10	13.8	55.9
17-11	13.2	56.9
17-12	7.8	55.5

The bedrock encountered within Boreholes 17-9 through 17-12 consisted of slightly weathered to fresh limestone with shale partings. The Total Core Recovery (TCR) measured on the recovered bedrock core ranged from 78 to 100%, the Solid Core Recovery (SCR) ranged from 78 to 100% and the Rock Quality Designation (RQD) ranged from 65 to 100%. It should be noted that a possible void (lost core) with an approximate thickness of 20 cm was encountered in Borehole 17-9 at a depth of 9.2 m below existing ground surface (elev. 54.7 m). Based on the measured RQD values, the bedrock is classified as fair to excellent quality, but predominantly ranges from good to excellent quality.

Unconfined Compressive Strength (UCS) testing was carried out on the bedrock. The results of UCS testing carried out on two samples of the rock core ranged from 98 to 127 MPa, indicating the intact bedrock to be strong to very strong. Photographs of the bedrock core are provided in Appendix C.

## **5.5 Groundwater**

The groundwater level measured in the standpipe piezometer installed in Borehole 17-9 was recorded at a depth of 0.8 m below the ground surface (elev. 63.1m) on August 3, 2018.

The water level of the Leo Denis Municipal Drain was also surveyed during the field investigation and measured to be at an elevation of 62.0 and 62.1 m on June 20 and June 21, 2018, respectively. It is expected that the groundwater level will likely reflect the water level in the creek.

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 soil was submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, sulphides, resistivity and conductivity. The analysis results are summarized in the Table 5-5.



**Table 5-5: Summary of Analytical Testing**

Borehole (Sample)	Depth (mbgs)	Sulphate (µg/g)	pH ( - )	Resistivity (Ohm-cm)	Conductivity (uS/cm)	Chloride (µg/g)	Sulphide (%)
17-12 (SS4)	2.3 – 2.9	69	7.91	1,600	326	91	0.17

## 6 MISCELLANEOUS

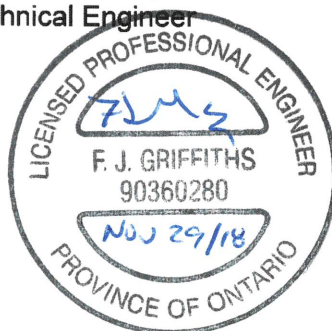
Borehole locations were selected by Thurber relative to existing site features. The as-drilled locations and ground surface elevations were surveyed by Thurber following completion of the field program.

George Downing Estate Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling equipment to conduct the drilling, soil sampling, in-situ testing and borehole decommissioning. Beacon Lite of Ottawa, Ontario supplied the traffic control equipment and personnel for TL-20A lane closures required for the on-road boreholes in conformance with Ontario Book 7 requirements. The field investigation was supervised on a full time basis by Miss Katya Edney, P.Eng. of Thurber. Overall supervision of the investigation program was conducted by Dr. Fred Griffiths, P.Eng.

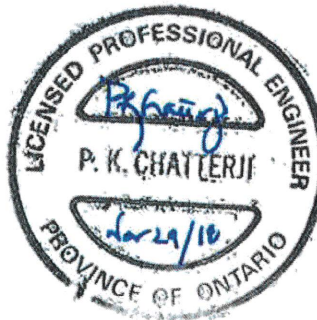
Routine geotechnical laboratory testing was completed by Thurber's laboratory in Ottawa, Ontario. Analytical testing was completed by Paracel Laboratories in Ottawa, Ontario. Rock testing was completed by Stantec in Ottawa, Ontario. Interpretation of the factual data and preparation of this report were carried out by Miss Katya Edney, P.Eng. and Dr. Fred Griffiths, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng. a Designated Principal Contact for MTO Foundation Projects.



Katya Edney, P.Eng.  
Geotechnical Engineer



Dr. Fred Griffiths, P.Eng.  
Senior Associate  
Senior Geotechnical Engineer

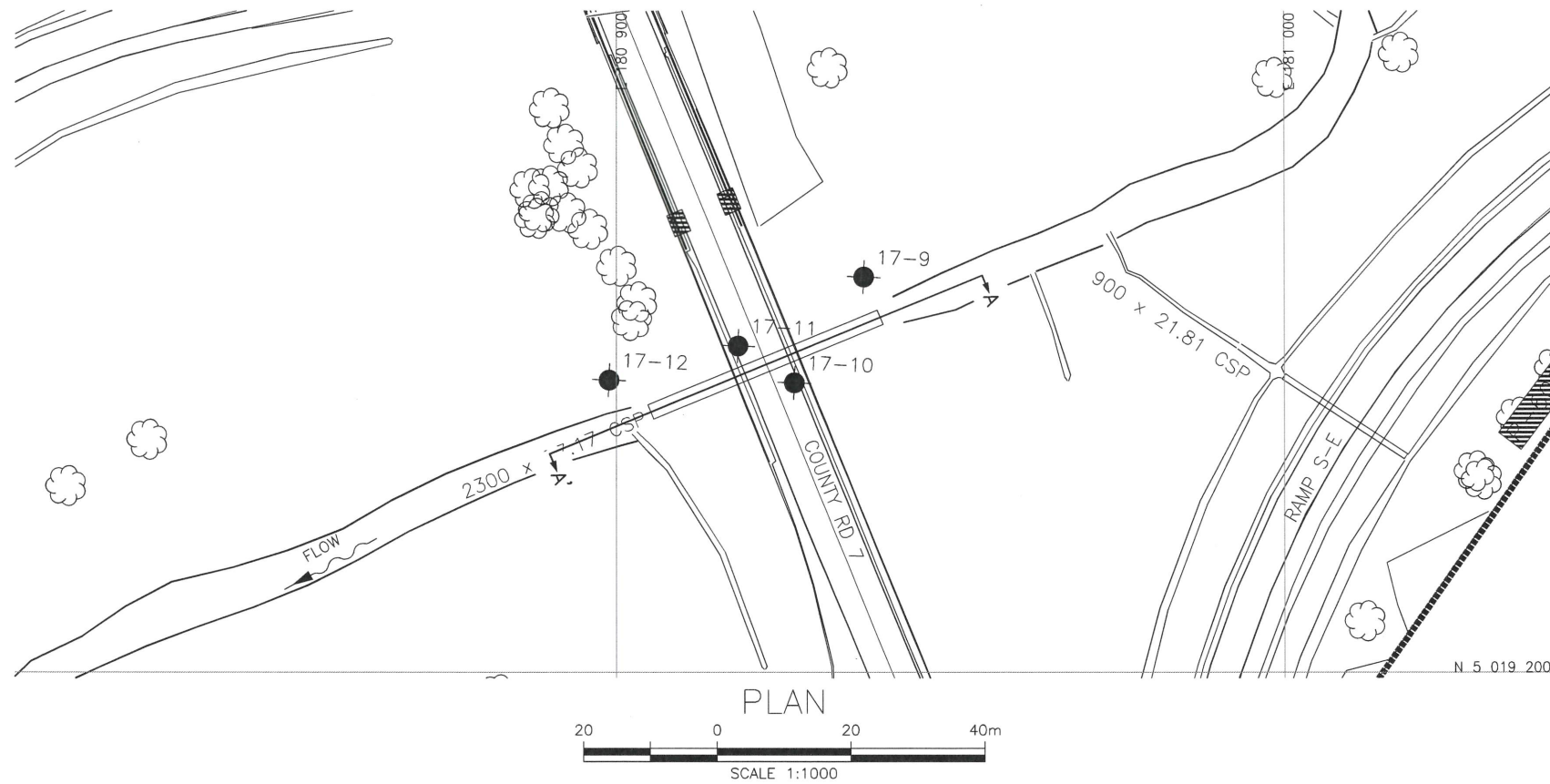


Dr. P.K. Chatterji, P.Eng.  
Review Principal  
Senior Geotechnical Engineer

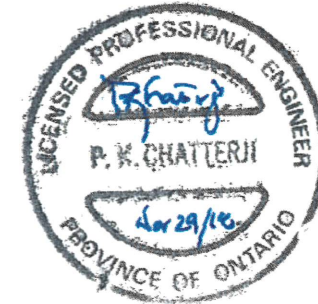
FINAL

**Appendix A.**

**Borehole Location Plan and Stratigraphic Drawings**



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



CONT No  
GWP No 451-98-00

HIGHWAY 417  
CULVERT 27-362/C  
REHABILITATION  
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



KEYPLAN

LEGEND

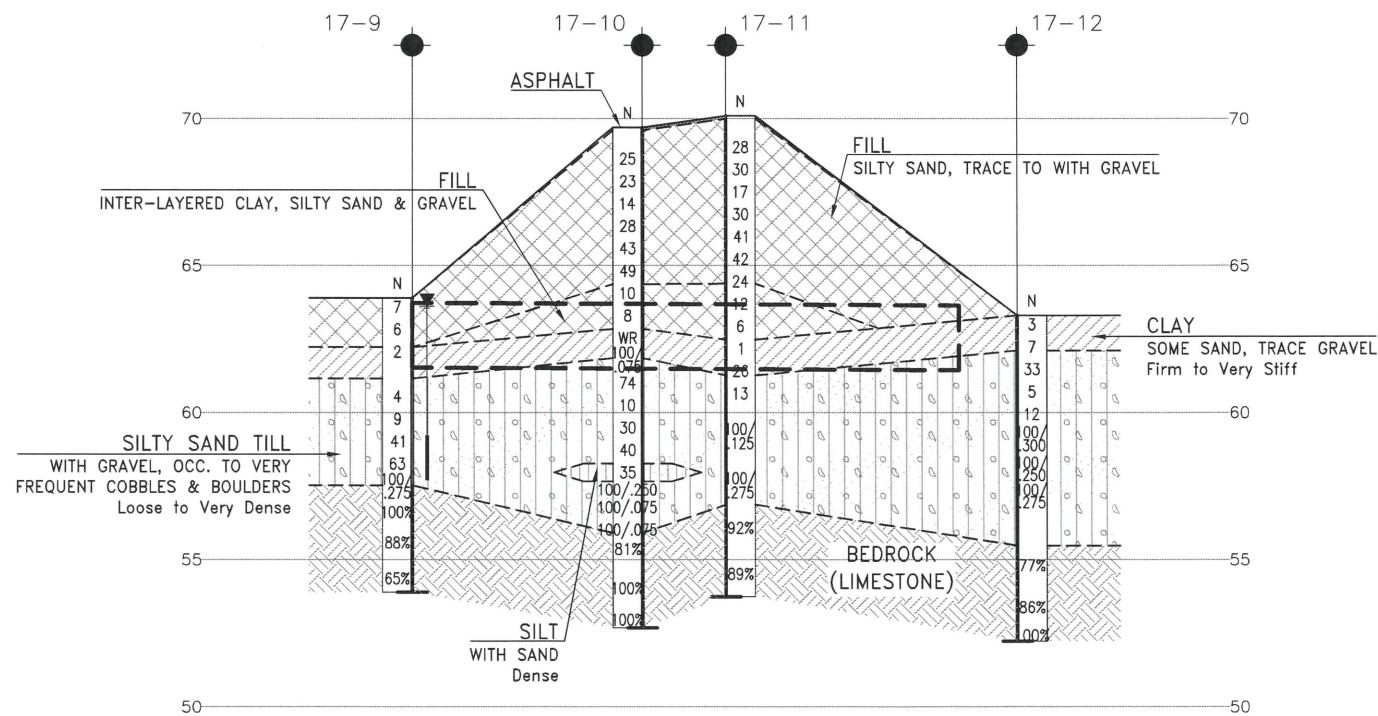
	Borehole
	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17-9	63.9	5 019 259.2	180 937.0
17-10	69.7	5 019 243.3	180 926.6
17-11	70.1	5 019 248.9	180 918.2
17-12	63.3	5 019 243.7	180 898.9

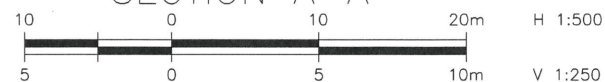
-NOTES-

- 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) Coordinate system is MTM NAD 83 Zone 8.

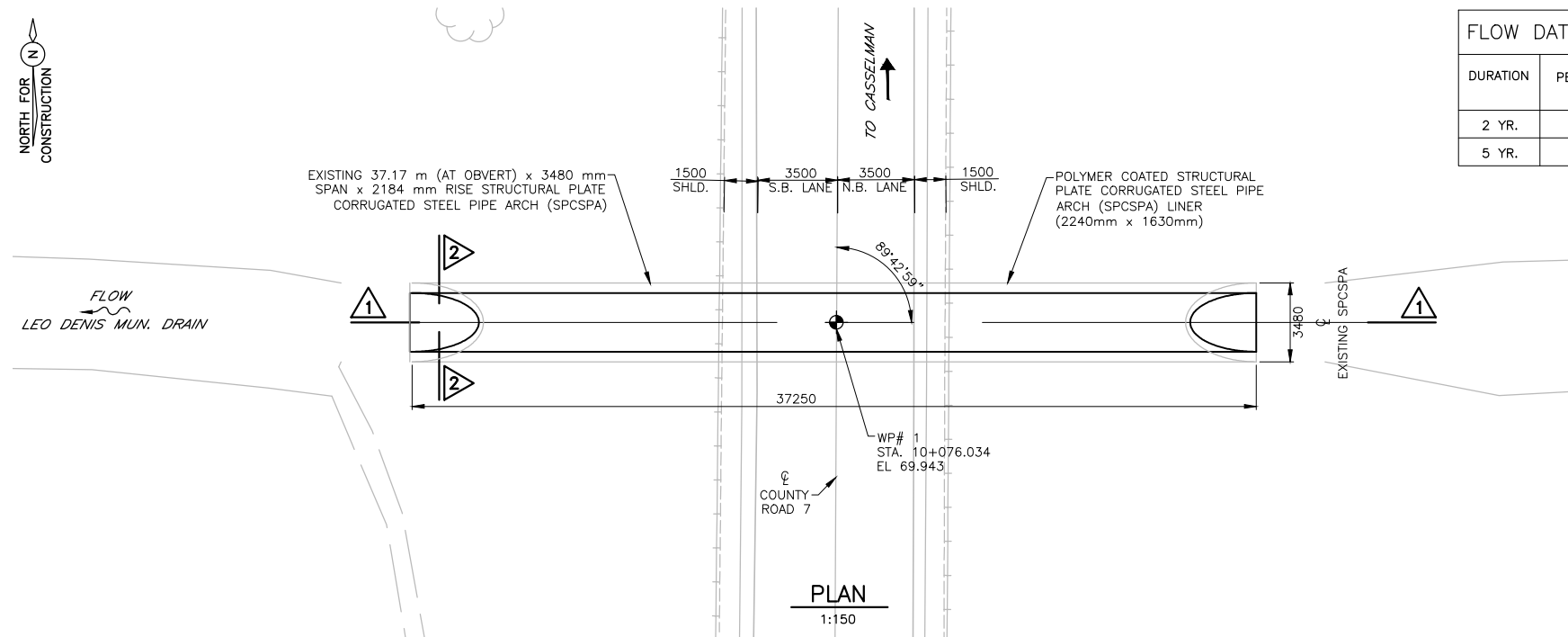
GEOCRES No. 31G-271



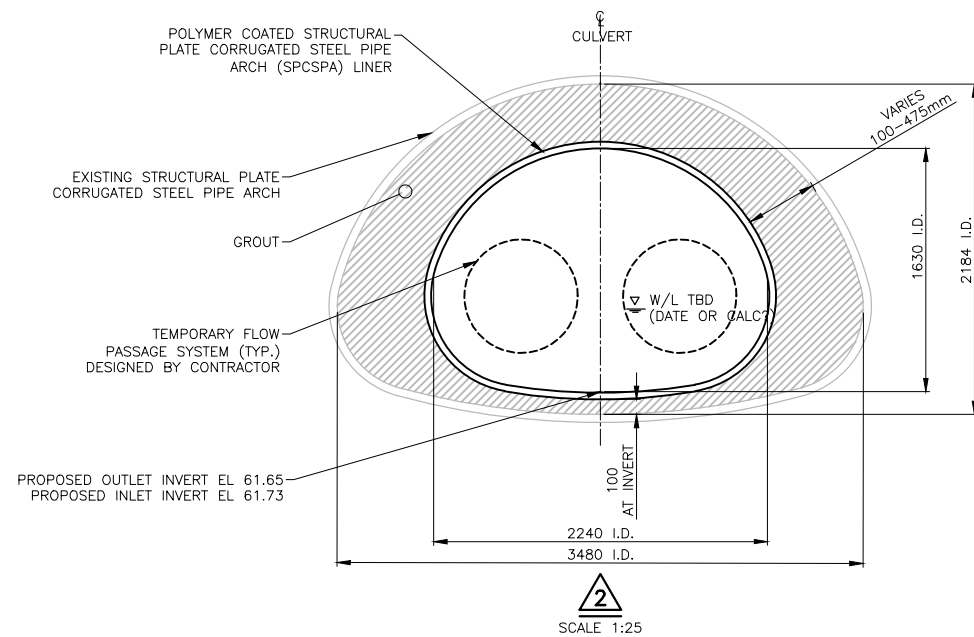
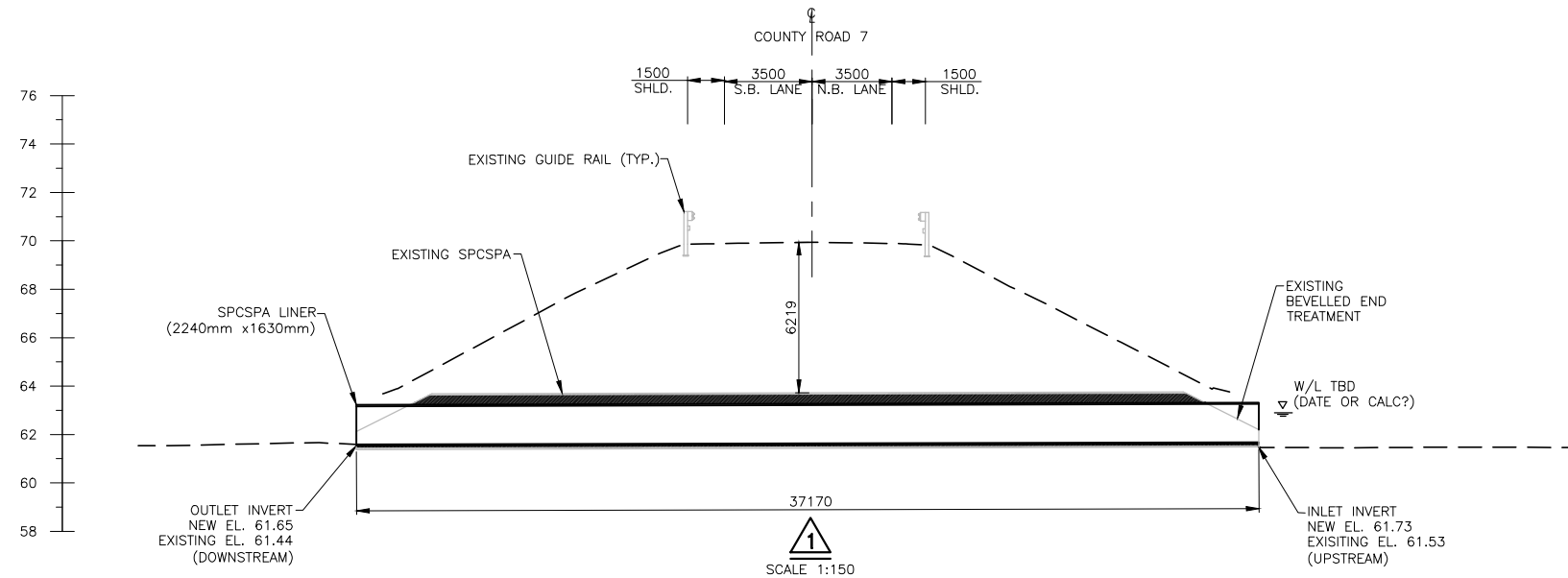
SECTION A-A'





REVISIONS	DATE	BY	DESCRIPTION
DESIGN	KE	CHK	PC
DRAWN	MFA	CHK	KE
CODE	LOAD	DATE	NOV 2018
SITE	STRUCT	DWG	1



FLOW DATA: EXISTING CULVERT		
DURATION	PEAK FLOW "Q" (m <sup>3</sup> /S)	WATER LEVEL (m)
2 YR.	1.386	-
5 YR.	2.329	-



DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING

<p><b>METRIC</b></p> <p>DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN</p>		<p>CONT WP</p> <p>#### 451-98-00</p>	
		<p>SITE No. 27-362/C</p>	<p>SHEET  1</p>
		<p>PRELIMINARY GENERAL ARRANGEMENT</p>	
			

GENERAL NOTES

1. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND ELEVATION OF THE EXISTING WORK AND ALL DETAILS ON SITE AGAINST THE PROPOSED WORK AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
2. THE CONTRACTOR SHALL CONTROL OPERATIONS TO PREVENT ENTRY OF DELETERIOUS MATERIAL INTO WATERCOURSES.
3. THE CONTRACTOR SHALL COMPLY WITH THE REQUIREMENTS OF THE ONTARIO OCCUPATIONAL HEALTH AND SAFETY ACT AND REGULATIONS FOR CONSTRUCTION PROJECTS O.REG. 213/91 AND CONFINED SPACES O.REG. 632/05.
4. GROUT NEW SPCSA LINER COMMENCING FROM DOWNSTREAM END AND PROGRESSING TOWARDS UPSTREAM END. GROUTING TO BE COMPLETED IN LIFTS AND STAGES IN ACCORDANCE WITH CONTRACTOR'S SUBMITTED METHODOLOGY.

### CONSTRUCTION NOTES

1. DESIGN, INSTALL AND CONTINUOUSLY MONITOR TEMPORARY FLOW PASSAGE SYSTEM. TEMPORARY FLOW PASSAGE SYSTEM SHALL PERMIT FLOW OF WATER COURSES THROUGH THE WORK ZONE SUCH THAT WORK IS EXECUTED IN THE DRY AND SHALL PERMIT STAGING OF THE WORK.
2. CLEAN EXISTING CULVERTS OF ALL SEDIMENT AND DEBRIS.
3. IN ADVANCE OF INSTALLATION OF THE NEW STEEL LINER, THE CONTRACTOR SHALL COMPLETE PRECONSTRUCTION SURVEY TO CONFIRM CROSS SECTION DIMENSIONS OF EXISTING CULVERT, ANY OBSTRUCTIONS AND/OR DAMAGE AND CONFIRM CROSS SECTION DIMENSIONS TO ACCOMMODATE NEW STEEL LINER.
4. THE NEW STEEL LINER SHALL BE MONITORED FOR DEFLECTIONS AND/OR DISTORTION DURING THE GROUTING OPERATION. THE CONTRACTOR SHALL NOTIFY THE CONTRACT ADMINISTRATOR AND CEASE ALL GROUTING IF DEFLECTION AND/OR DISTORTION IS OBSERVED.
5. DAMAGE TO POLYMER COATING SYSTEM IS TO BE REPAIRED IN ACCORDANCE WITH SUBMITTED METHODOLOGY.

SCOPE OF WORK \*

1. INSTALL AND CONTINUOUSLY MONITOR TEMPORARY FLOW PASSAGE SYSTEM AND MANAGE FLOW OF WATER FOR DURATION OF THE WORK.
2. COMPLETE PRECONSTRUCTION SURVEY.
3. REMOVE DEBRIS AND CLEAN CULVERT SURFACES.
4. SUPPLY AND INSTALL POLYMER COATED STRUCTURAL PLATE CORRUGATED STEEL PIPE ARCH (SPCSPA) LINER.

\* NOT INTENDED TO SHOW SEQUENCE OF WORK

MATERIALS:

1. CEMENTITIOUS GROUT FOR BACKGROUTING STEEL LINER SHALL BE 20 MPa COMPRESSIVE STRENGTH AT 28 DAYS.
2. LINER END TREATMENT TO MATCH BEVELLED ENDS OF EXISTING CULVERT.
3. STEEL LINER SHALL BE 2240 x 1630mm POLYMER COATED STRUCTURAL PLATE CORRUGATED STEEL PIPE ARCH (SPCSPA), 152 X 51mm CORRUGATIONS, MINIMUM 3.0mm THICK,  $F_y = 230\text{MPa}$ .

## LIST OF ABBREVIATIONS

TYP.	TYPICAL
DIA	DIAMETER
STA	STATION
W/L	WATER LEVEL
I.D.	INNER DIAMETER
N.B.	NORTHTBOUND
S.B.	SOUTHBOUND

## LIST OF DRAWINGS

GENERAL ARRANGEMENT											
1	REVISIONS										
		DATE	BY	DESCRIPTION							
		DESIGN	###	CHK	###	CODE	CSA-S6-14	LOAD	CL-625-ONT	DATE	###
		DRAWN	MRF	CHK	ECL	SITE	27-362/C		DWG	P1	



**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

### 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.

### 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 (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 clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean 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 17-9

1 OF 2

METRIC

GWP# 451-98-00 LOCATION Lat: 45.302363°, Long: -75.079421° Site 27-362/C Culvert MTM z8: N 5 019 259.2 E 180 937.0 ORIGINATED BY KE  
HWY 417 BOREHOLE TYPE HSA/NQ coring COMPILED BY AC  
DATUM Geodetic DATE 2018.06.21 - 2018.06.21 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W P      W      W L				
63.9							20 40 60 80 100	20 40 60 80 100						
0.0	SILTY SAND trace gravel, trace organics loose to very loose brown FILL		1	SS	7									
			2	SS	6									
62.2														
1.7	CLAY (CH) some sand firm to stiff grey		3	SS	2									
61.2														
2.7	SILTY SAND (SM) to SANDY SILT (ML) TILL trace to with gravel loose to very dense grey		4	SS	4									
			5	SS	9									
			6	SS	41									
			7	SS	63									
57.5			8	SS	100/									
6.4	BEDROCK LIMESTONE with shale partings slightly weathered to fresh thinly bedded fine grained strong grey		1	NQ										
			2	NQ										
			3	NQ										
53.9														

Continued Next Page

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

DOUBLE LINE SITE 27-362C.GPJ 2012TEMPLATE(MTO).GDT 14/11/18

# RECORD OF BOREHOLE No 17-9

2 OF 2

METRIC

GWP# 451-98-00 LOCATION Lat: 45.302363°, Long: -75.079421° Site 27-362/C Culvert MTM z8: N 5 019 259.2 E 180 937.0 ORIGINATED BY KE  
 HWY 417 BOREHOLE TYPE HSA/NQ coring COMPILED BY AC  
 DATUM Geodetic DATE 2018.06.21 - 2018.06.21 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT      NATURAL MOISTURE      LIQUID CONTENT      LIMIT			UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			W P	W	W L		
								20   40   60   80   100	WATER CONTENT (%) 20   40   60						
	Continued From Previous Page							<div><div></div><div></div><div></div><div></div><div></div></div> <div><div>○ UNCONFINED</div><div>● QUICK TRIAXIAL</div><div>+ FIELD VANE</div><div>× LAB VANE</div></div>							
10.0	End of Borehole Water level in well: 2018.06.25   0.6 mbgs (elev. 63.3 m) 2018.08.03   0.8 mbgs (elev. 63.1 m)														

DOUBLE LINE SITE 27-362C.GPJ 2012TEMPLATE(MTO).GDT 14/11/18

# RECORD OF BOREHOLE No 17-10

1 OF 2

METRIC

GWP# 451-98-00 LOCATION Lat: 45.302218°, Long: -75.079548° Site 27-362/C Culvert MTM z8: N 5 019 243.3 E 180 926.6 ORIGINATED BY KE/AC  
 HWY 417 BOREHOLE TYPE HSA/NQ coring COMPILED BY AC  
 DATUM Geodetic DATE 2018.06.25 - 2018.06.25 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
69.7													
0.0	ASPHALT (100 mm)												
0.1	SILTY SAND with gravel												
69.1	very dense												
0.6	grey												
	FILL												
	SILTY SAND		1	SS	25		69						
	trace gravel												
	compact to dense												
	brown												
	FILL												
			2	SS	23		68						
			3	SS	14		67						
			4	SS	28		66						
			5	SS	43		65						
			6	SS	49		64						6 70 24 (SI+CL)
64.4													
5.3	Interlayered SILTY SAND, CLAY and GRAVEL		7	SS	10		63						
	trace wood												
	loose to compact / stiff to very stiff		8	SS	8		62						
	brown												
	FILL												
62.8													
6.9	CLAY (CH)		9	SS	WR		61						1 8 23 68
	trace gravel												
	firm to very stiff		10	SS	100/		60						
	grey-brown												
61.9													
7.8	SILTY SAND (SM) with gravel TILL				75 mm								
	compact to very dense												
	grey												
			11	SS	74		61						
			12	SS	10		60						

Continued Next Page

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





DOUBLE LINE SITE 27-362C.GPJ 2012TEMPLATE(MTO).GDT 14/11/18

# RECORD OF BOREHOLE No 17-10

2 OF 2

METRIC

GWP# 451-98-00 LOCATION Lat: 45.302218°, Long: -75.079548° Site 27-362/C Culvert MTM z8: N 5 019 243.3 E 180 926.6 ORIGINATED BY KE/AC  
 HWY 417 BOREHOLE TYPE HSA/NQ coring COMPILED BY AC  
 DATUM Geodetic DATE 2018.06.25 - 2018.06.25 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
								20 40 60 80 100								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
							WATER CONTENT (%)									
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> W W <sub>L</sub> 20 40 60									
Continued From Previous Page																
58.3	SILTY SAND (SM) with gravel TILL dense grey -occasional cobbles and boulders		13	SS	30		59								28 38 34 (SI+CL)	
11.4	SILT (ML) with sand dense grey		14	SS	40											
57.7																
12.0	SILTY SAND (SM) with gravel TILL very dense grey -occasional to frequent cobbles and boulders		15	SS	35		58								4 24 69 3 Non plastic	
			16	SS	100/ 250 mm		57									
			17	SS	100/ 75 mm											
55.9			18	SS	100/ 75 mm		56									
13.8	BEDROCK LIMESTONE with shale partings slightly weathered to fresh thinly bedded fine grained strong grey		1	NQ			55								RUN #1 TCR=100% SCR=90% RQD=81%	
																RUN #2 TCR=100% SCR=100% RQD=100% UCS=98MPa
																RUN #3 TCR=100% SCR=100% RQD=100%
			2	NQ			54									
			3	NQ			53									
52.7																
17.0	End of Borehole															

DOUBLE LINE SITE 27-362C.GPJ 2012TEMPLATE(MTO).GDT 14/11/18

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 17-11

1 OF 2

METRIC

GWP# 451-98-00 LOCATION Lat: 45.302267°, Long: -75.079657° Site 27-362/C Culvert MTM z8: N 5 019 248.9 E 180 918.2 ORIGINATED BY KE/AC  
 HWY 417 BOREHOLE TYPE HSA/NQ coring COMPILED BY AC  
 DATUM Geodetic DATE 2018.06.26 - 2018.06.26 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
70.1													
0.0	ASPHALT (100 mm)												
0.1	SILTY SAND with gravel		1	GS									39 41 20 (SI+CL)
69.6	brown												
0.5	FILL												
	SILTY SAND												
	trace gravel		2	SS	28								
	compact to dense												
	brown												
	FILL												
			3	SS	30								
			4	SS	17								7 74 19 (SI+CL)
			5	SS	30								
			6	SS	41								
			7	SS	42								
64.4			8	SS	24								
5.7	Interlayered SILT, SILTY CLAY and CLAY												
	loose to compact / stiff to very stiff												
	grey to grey-brown		9	SS	12								
	FILL												
			10	SS	6								
62.5													
7.6	CLAY (CH)												
	very stiff		11	SS	1								0 2 23 75
	grey												
			12	SS	26								
61.3													
8.8	SILTY SAND (SM) with gravel												
	TILL												
	compact												
	grey		13	SS	13								

Continued Next Page

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

DOUBLE LINE SITE 27-362C.GPJ 2012TEMPLATE(MTO).GDT 14/11/18

## METRIC

[illegible]

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



# RECORD OF BOREHOLE No 17-12

1 OF 2

METRIC

GWP# 451-98-00 LOCATION Lat: 45.302217°, Long: -75.079902° Site 27-362/C Culvert MTM z8: N 5 019 243.7 E 180 898.9 ORIGINATED BY KE  
 HWY 417 BOREHOLE TYPE HSA/NQ coring COMPILED BY AC  
 DATUM Geodetic DATE 2018.06.19 - 2018.06.19 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				
								WATER CONTENT (%)				
63.3							20 40 60 80 100	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT		
0.0	<b>CLAY (CI)</b> trace sand, trace organics Stiff to firm Grey-brown		1	SS	3		63					
62.1			2	SS	7		62					3 7 54 36
1.2	<b>SILTY SAND (SM)</b> with gravel <b>TILL</b> occasional to frequent cobbles and boulders loose to very dense grey		3	SS	33		61					
			4	SS	5		60					
			5	SS	12		59					
			6	SS	100/ 300 mm		58					
			7	SS	100/ 250 mm		57					
			8	SS	100/ 275 mm		56					
	- very frequent cobbles and boulders below 5.9 m		9	NQ			55					
55.5							54					
7.8	<b>BEDROCK</b> LIMESTONE with shale partings slightly weathered to fresh thinly bedded fine grained strong grey		1	NQ			53					
			2	NQ			52					

DOUBLE LINE SITE 27-362C.GPJ 2012TEMPLATE(MTO).GDT 14/11/18

Continued Next Page

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

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 17-12

2 OF 2

METRIC

GWP# 451-98-00 LOCATION Lat: 45.302217°, Long: -75.079902° Site 27-362/C Culvert MTM z8: N 5 019 243.7 E 180 898.9 ORIGINATED BY KE  
 HWY 417 BOREHOLE TYPE HSA/NQ coring COMPILED BY AC  
 DATUM Geodetic DATE 2018.06.19 - 2018.06.19 CHECKED BY FG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
							20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>			
	Continued From Previous Page																
52.2	<b>BEDROCK</b> LIMESTONE with shale partings slightly weathered to fresh thinly bedded fine grained strong grey		3	NQ			53										
11.1	End of Borehole																

DOUBLE LINE SITE 27-362C.GPJ 2012TEMPLATE(MTO).GDT 14/11/18

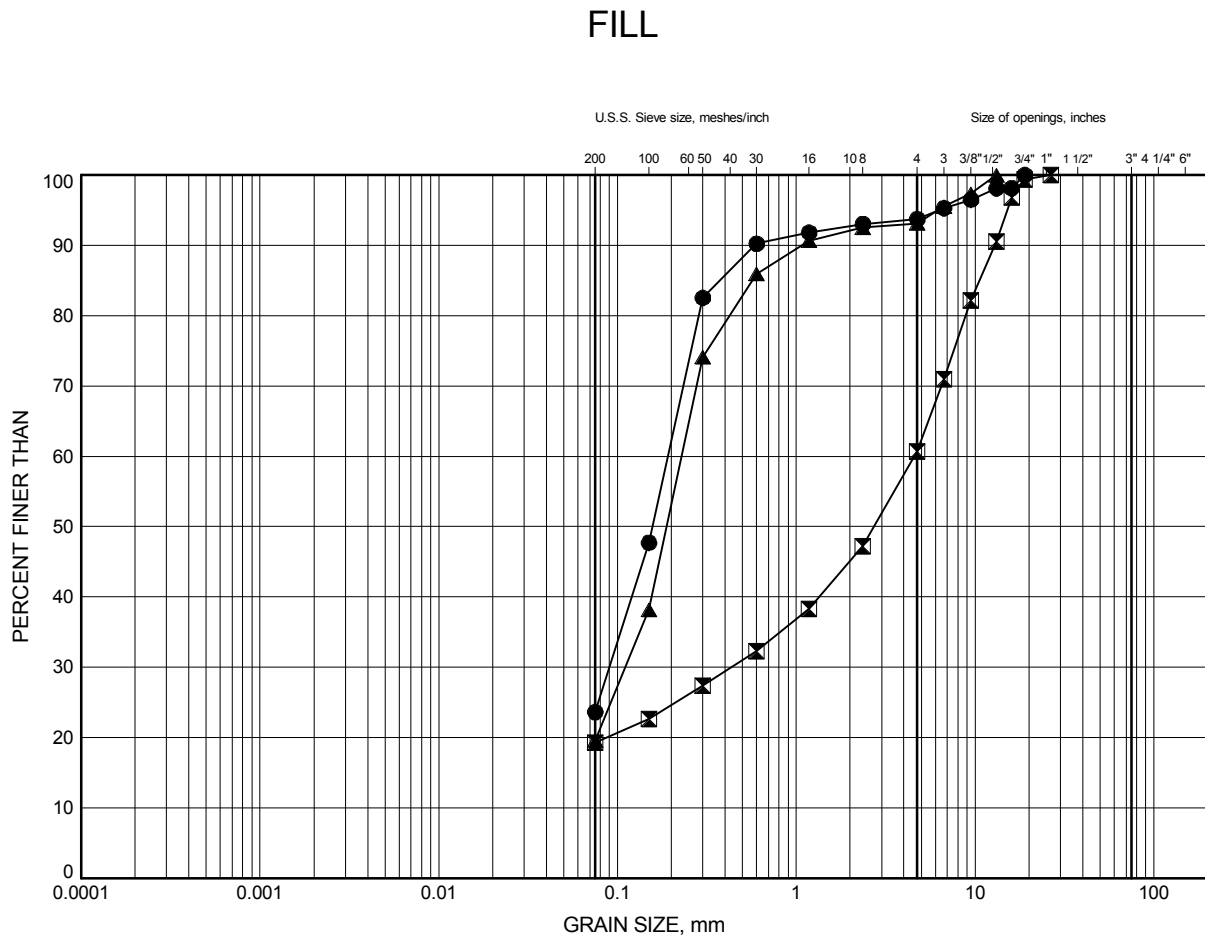
**Appendix C.**  
**Laboratory Testing**

**Appendix C.1**  
**Particle Size Analysis Figures**

Site 27-362/C

# GRAIN SIZE DISTRIBUTION

FIGURE C1



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

## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-10	4.9	64.8
⊠	17-11	0.3	69.8
▲	17-11	2.6	67.5

Date November 2018  
GWP# 451-98-00

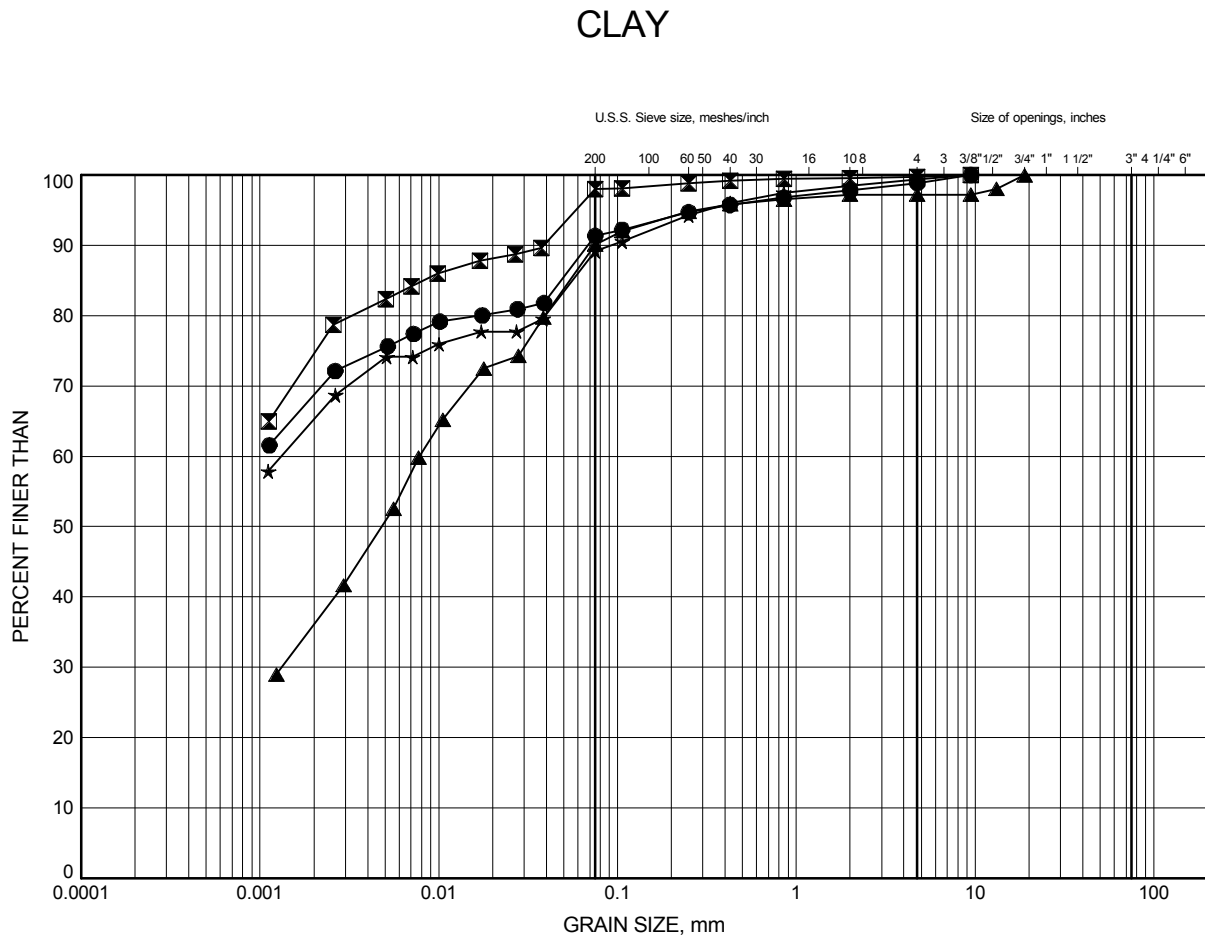


Prep'd KE  
Chkd. FG

# Site 27-362/C

## GRAIN SIZE DISTRIBUTION

FIGURE C2



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-10	7.2	62.5
⊠	17-11	7.9	62.2
▲	17-12	1.0	62.3
★	17-9	1.9	62.0

Date November 2018  
GWP# 451-98-00



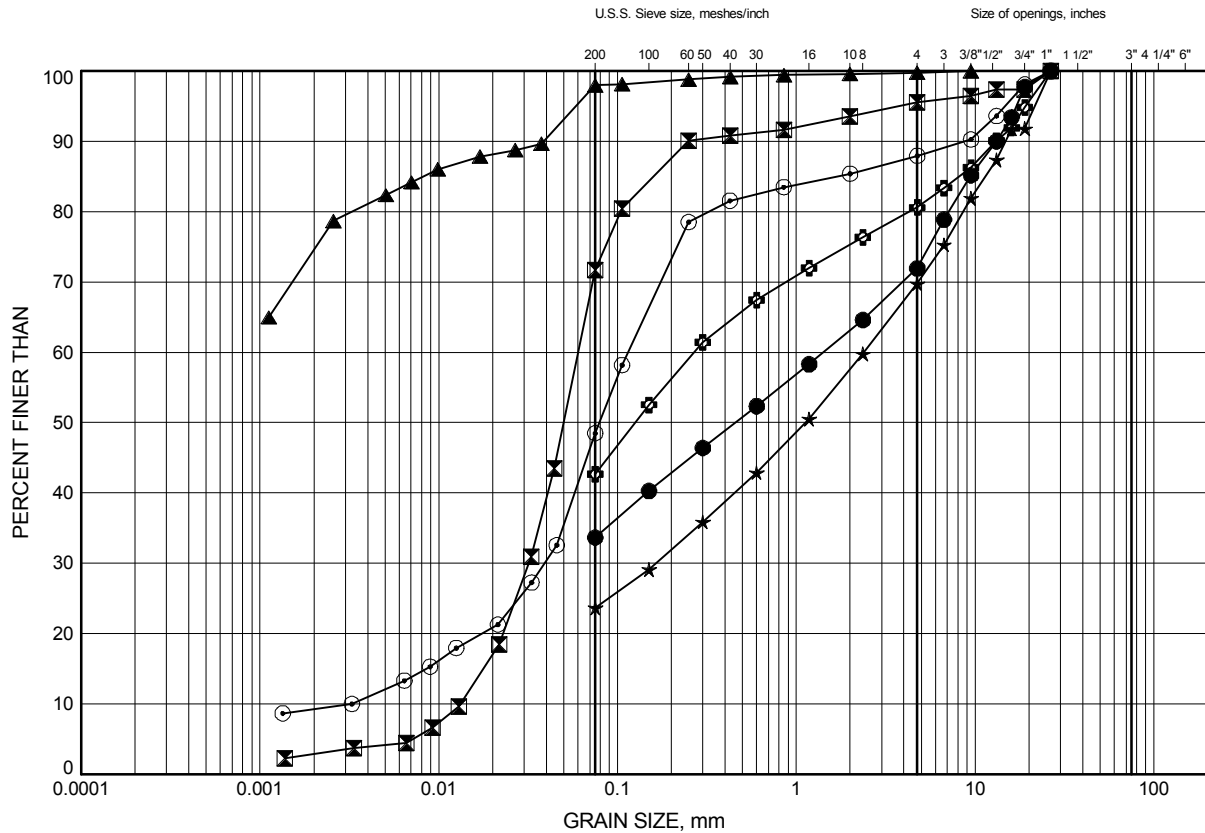
Prep'd KE  
Chkd. FG

Site 27-362/C

# GRAIN SIZE DISTRIBUTION

FIGURE C3

## Silty Sand to Sandy Silt (GLACIAL TILL)



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-10	10.2	59.5
⊠	17-10	11.7	58.0
▲	17-11	7.9	62.2
★	17-12	4.8	58.5
⊙	17-9	4.1	59.8
⊕	17-9	5.6	58.3

Date November 2018

GWP# 451-98-00



Prep'd KE

Chkd. FG

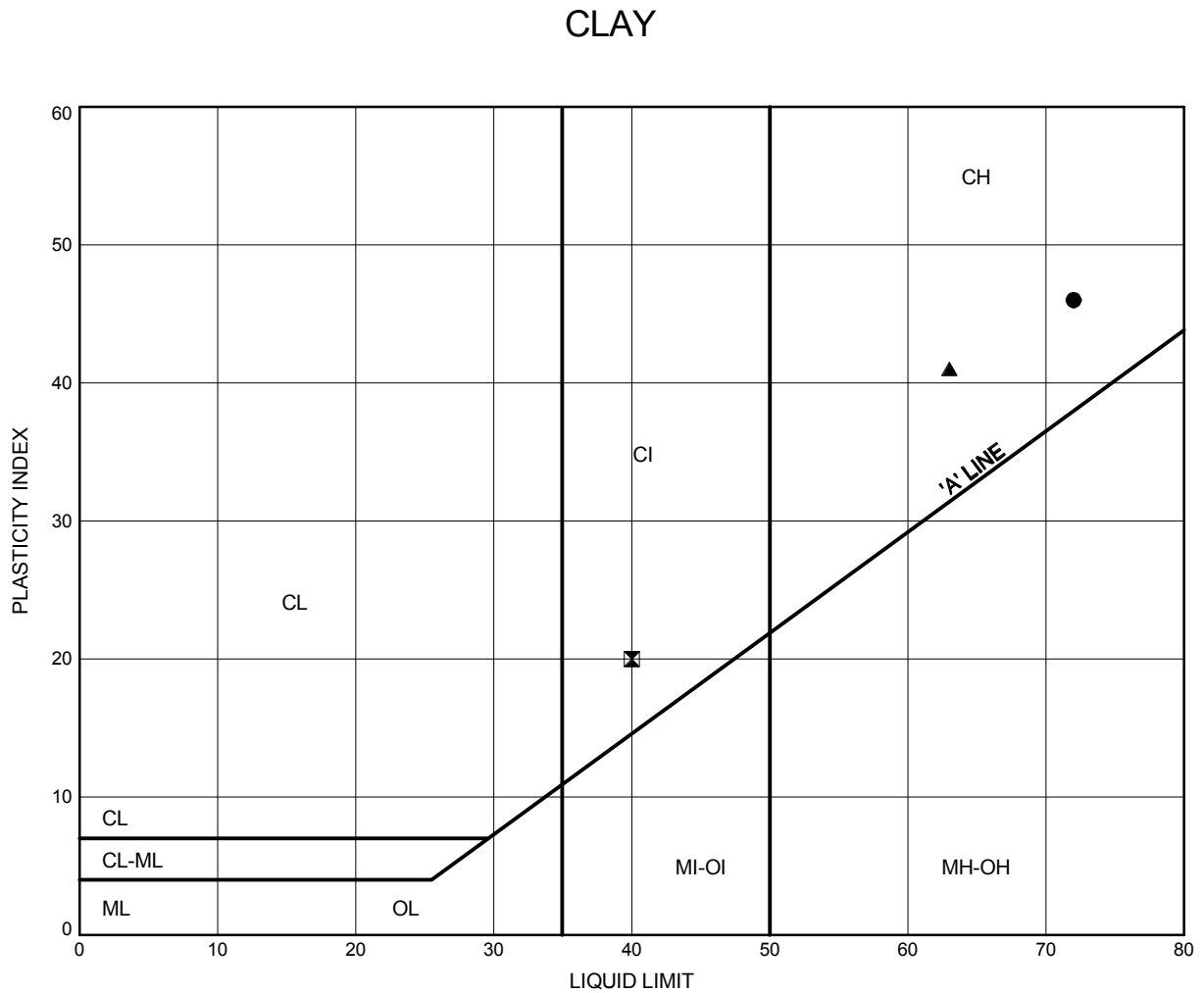
**Appendix C.2**  
**Atterberg Limits Analysis Figure**



Site 27-362/C

# ATTERBERG LIMITS TEST RESULTS

FIGURE C4



## LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17-11	7.9	62.2
⊠	17-12	1.0	62.3
▲	17-9	1.9	62.0

Date November 2018  
GWP# 451-98-00

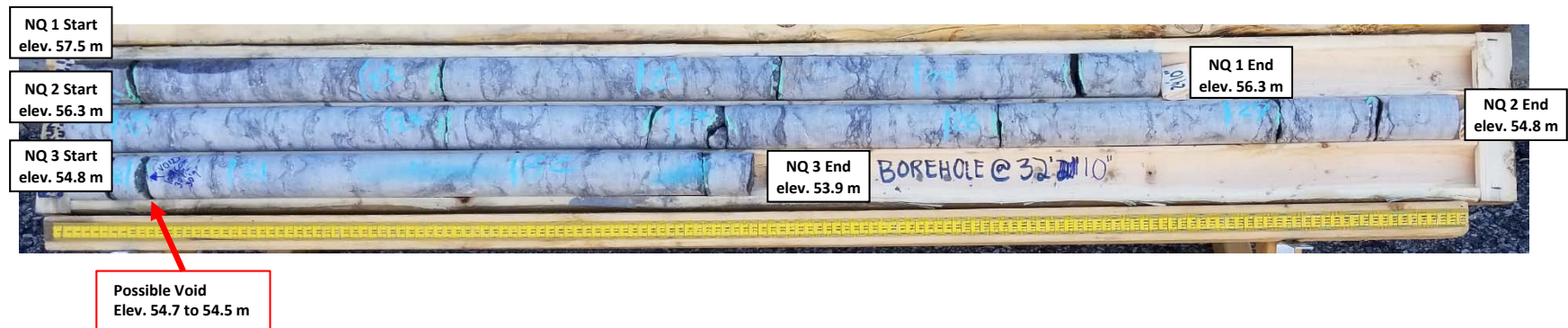


Prep'd KE  
Chkd. FG

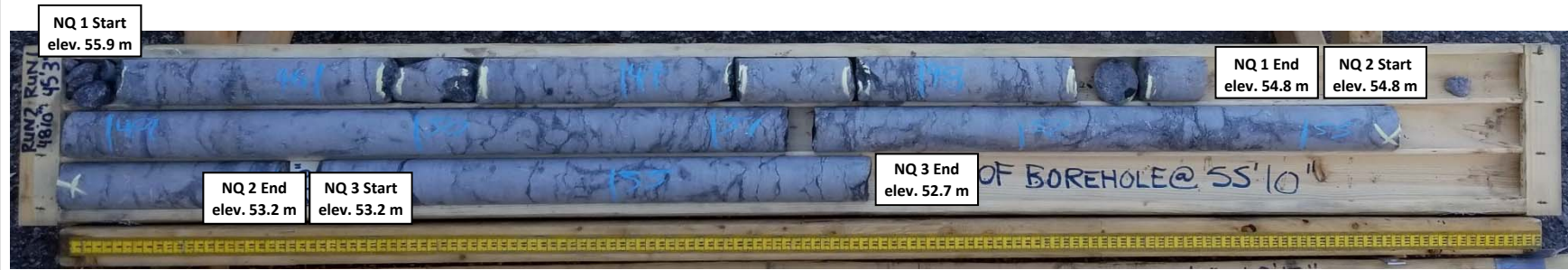
### **Appendix C.3**

#### **Rock Core Photos and Testing Results**

**Borehole 17-9**  
**Run 1 to 3 (of 3)**  
**Elevation 57.5 m to 53.9 m**



**Borehole 17-10**  
**Run 1 to 3 (of 3)**  
**Elevation 55.9 m to 52.7 m**



**Borehole 17-11**  
**Run 1 to 2 (of 2)**  
**Elevation 56.9 m to 53.7 m**



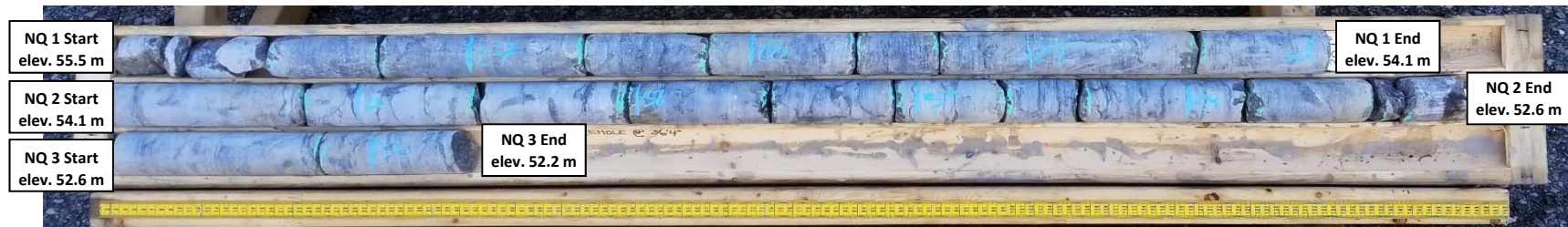
**THURBER** ENGINEERING LTD.

**Foundation Investigation**  
**Highway 417 – Site 27-362/C Culvert**  
**Foundations**

**GWP: 451-98-00**

**Project No.: 18310**

**Borehole 17-12**  
**Run 1 to 3 (of 3)**  
**Elevation 55.5 m to 52.2 m**



**THURBER** ENGINEERING LTD.

**Foundation Investigation**  
**Highway 417 – Site 27-362/C Culvert**  
**Foundations**

**GWP: 451-98-00**

**Project No.: 18310**



**Stantec**

**Stantec Consulting Ltd**  
2781 Lancaster Rd, Suite 100 A&B  
Ottawa, ON K1B 1A7  
Tel: (613) 738-6075  
Fax: (613) 722-2799

July 11, 2018  
File: 122410864

**Attention: Thurber Engineering Ltd., File #18310**

**Reference: ASTM D7012, Method C, Unconfined Compressive Strength of Intact Rock Core**

The table below summarizes five (5) rock core unconfined compressive strength results.

Location	Sample Depth	Compressive Strength (MPa)	Description of Break
17-1	Run 2 @ 22'4"	143.6	Well-formed cone on one end
17-5	Run 2 @ 36'4"	138.0	Well-formed cone on one end
17-10	Run 2 @ 53'7"	98.0	Reasonably well-formed cones on both ends
17-11	Run 3 @ 51'10"	127.4	Vertical cracking through both ends
17-13	Run 2 @ 23'10"	140.4	Specimen shattered

Sincerely,

**Stantec Consulting Ltd**

Denis Rodriguez  
Laboratory Technician  
Tel: 613-738-6075  
[denis.rodriguez@stantec.com](mailto:denis.rodriguez@stantec.com)

**Appendix C.4**  
**Analytical Testing Results**



## Certificate of Analysis

**Thurber Engineering Ltd.**

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

Client PO: 18310  
Project: Site 27-362/C  
Custody: 39854

Report Date: 28-Jun-2018  
Order Date: 25-Jun-2018

**Order #: 1826162**

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

Paracel ID	Client ID
1826162-01	17-12, SS4, 7'6"-9'6"

Approved By:



Dale Robertson, BSc  
Laboratory Director

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 18310

Report Date: 28-Jun-2018  
Order Date: 25-Jun-2018  
Project Description: Site 27-362/C

### Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	27-Jun-18	27-Jun-18
Conductivity	MOE E3138 - probe @25 °C, water ext	27-Jun-18	27-Jun-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	26-Jun-18	27-Jun-18
Resistivity	EPA 120.1 - probe, water extraction	27-Jun-18	27-Jun-18
Solids, %	Gravimetric, calculation	27-Jun-18	27-Jun-18

Certificate of Analysis  
**Client: Thurber Engineering Ltd.**  
**Client PO: 18310**

Report Date: 28-Jun-2018

Order Date: 25-Jun-2018

**Project Description: Site 27-362/C**

<b>Client ID:</b>	17-12, SS4, 7'6"-9'6"	-	-	-
<b>Sample Date:</b>	06/19/2018 09:00	-	-	-
<b>Sample ID:</b>	1826162-01	-	-	-
<b>MDL/Units</b>	Soil	-	-	-

**Physical Characteristics**

% Solids	0.1 % by Wt.	93.3	-	-	-
----------	--------------	------	---	---	---

**General Inorganics**

Conductivity	5 uS/cm	326	-	-	-
pH	0.05 pH Units	7.91	-	-	-
Resistivity	0.10 Ohm.m	16.0	-	-	-

**Anions**

Chloride	5 ug/g dry	91	-	-	-
Sulphate	5 ug/g dry	69	-	-	-

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 18310

Report Date: 28-Jun-2018  
Order Date: 25-Jun-2018  
Project Description: Site 27-362/C

### Method Quality Control: Blank

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

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 18310

Report Date: 28-Jun-2018  
Order Date: 25-Jun-2018  
Project Description: Site 27-362/C

**Method Quality Control: Duplicate**

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	265	5	ug/g dry	282			6.1	20	
Sulphate	146	5	ug/g dry	151			3.0	20	
<b>General Inorganics</b>									
Conductivity	293	5	uS/cm	290			1.1	6.2	
pH	7.89	0.05	pH Units	7.83			0.8	10	
Resistivity	34.1	0.10	Ohm.m	34.5			1.1	20	
<b>Physical Characteristics</b>									
% Solids	84.4	0.1	% by Wt.	85.3			1.0	25	

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 18310

Report Date: 28-Jun-2018  
Order Date: 25-Jun-2018  
Project Description: Site 27-362/C

### Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
<b>Anions</b>									
Chloride	374	5	ug/g	282	92.2	78-113			
Sulphate	254	5	ug/g	151	104	78-111			

Certificate of Analysis  
Client: Thurber Engineering Ltd.  
Client PO: 18310

Report Date: 28-Jun-2018  
Order Date: 25-Jun-2018  
Project Description: Site 27-362/C

**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 **1826162**  
Client Project(s): **Site 27-362/C**  
Client PO: **18310**  
Reference: **Standing Offer**  
CoC Number: **39854**

Order Date: 25-Jun-18  
Report Date: 05-Jul-18

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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
1826162-01	17-12, SS4, 7'6"-9'6"	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,

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

05-July-2018

**Date Rec. :** 27 June 2018  
**LR Report:** CA12933-JUN18  
**Reference:** Project#:1826162

**Copy:** #1

## CERTIFICATE OF ANALYSIS

### Final Report

Sample ID	Sample Date & Time	Sulphide %
1: Analysis Start Date		05-Jul-18
2: Analysis Start Time		10:43
3: Analysis Completed Date		05-Jul-18
4: Analysis Completed Time		13:07
5: QC - Blank		<0.02
6: QC - STD % Recovery		85%
7: QC - DUP % RPD		11%
8: RL		0.02
9: 17-12, SS4, 7'6"-9'6"	19-Jun-18	0.17

RL - SGS Reporting Limit

Kimberley Didsbury  
Project Specialist  
Environmental Services, Analytical

**Appendix D.**

**Site Photographs**



**Photo 1. Looking west along culvert alignment. (25/06/2018)**



**Photo 2. Looking east along culvert alignment. (26/06/2018)**



**Photo 3. Looking north along County Road 7 Underpass. (26/06/2018)**



**Photo 4. Looking south along County Road 7 Underpass. (26/06/2018)**





**Photo 5. Looking at culvert outlet. (19/06/2018)**



**Photo 6. Looking north at culvert inlet. (21/06/2018)**