THURBER ENGINEERING LTD.

FOUNDATION INVESTIGATION REPORT
REHABILITATION OF STRUCTURAL CULVERT No. 29-155/C
HIGHWAY 60 DOUGLAS CREEK CULVERT
TOWNSHIP OF ADMASTON, ON
G.W.P. 4076-13-00
AGREEMENT NUMBER: 4016-E-0014

GEOCRES NUMBER: 31F-203

SUBMITTED TO

McINTOSH PERRY CONSULTING ENGINEERS

LOCATION:
LATITUDE: 45.52117°
LONGITUDE: -76.86081°

AUGUST 2018
20479

104, 2460 Lancaster Road, Ottawa ON K1B 4S5 T. 613 247 2121 F. 613 247 2185
thurber.ca

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual data obtained from a foundation investigation conducted by Thurber Engineering Ltd. (Thurber) at the Douglas Creek Culvert located on Highway 60, within the Township of Admaston, Ontario. Thurber carried out the investigation as a subconsultant to McIntosh Perry Consulting Engineers (MPCE) under Agreement No. 4016-E-0014.

A base plan and a General Arrangement (GA) Drawing were provided by MPCE for the preparation of this report.

The purpose of this investigation was to explore the subsurface conditions at the Douglas Creek Culvert and based on this data, provide a borehole location plan, record of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions.

2 BACKGROUND

At the time of Thurber's investigation, the northwest wingwall was noted as having rotated significantly from the culvert (see Photographs 3 and 4 provided in Appendix D) and some rotation of the northeast wingwall was also noted (see Photograph 5).

The results of the Ministry's 2011 and 2015 inspection reports indicate that both the northeast and northwest wingwalls at the Douglas Creek Culvert inlet have rotated away from the culvert and should be replaced.

The GEOCRES library includes a Memorandum (31F-172) for the Douglas Creek Culvert dated December 20, 1988, that indicates that the culvert had similar deficiencies as noted in the more recent inspection reports (i.e. rotation of inlet wingwalls). It also indicates that further investigation was required to determine the cause, however, no additional documentation was available to indicate whether further investigation or remedial work had been completed.

Based on historical construction drawings from 1963, bedrock along the culvert alignment varies from bedrock outcropping at approximate Elevation 115.2 m within the culvert near the south end (outlet), to below Elevation 113.0 m at the north end of the culvert (inlet); see Appendix A. The drawings indicate that the wingwall foundations at the inlet were designed to be founded on bedrock at elevations of 113.7 m and 114.1 m at the northwest and northeast sides of the culvert respectively.

It is noted that the culvert depicted in the 1963 construction drawings replaced an earlier structure which was located to the west of the new alignment.

3 SITE DESCRIPTION

Culvert 29-155/C is located at approximate Station 11+200 on Highway 60, approximately 200 m east of the Highway 60 / Barr Line intersection in Renfrew County, Ontario. The location of the culvert is shown on the inset Key Plan on Drawing No. 1 in Appendix A.

It is noted that for project orientation purposes, Highway 60 within the project limits, will be assumed to run west-east. Flow through the culvert is from north to south.

At the project site Highway 60 is undivided with one through lane in each direction. Based on the drawings provided, the roadway cross-section at the culvert location consists of two, 3.7 m wide lanes and narrow gravel shoulders. Steel cable guiderails are present along both side of the highway in the vicinity of the culvert.

The existing 34.5 m long concrete, open footing culvert has an internal span of 6.1 m and an internal height of 3.0 m. The culvert includes concrete headwalls and wingwalls at both the inlet and outlet. The June 2018 GA Drawing, see Appendix A, indicates that the asphalt surface of the highway is at elevation 122.9 m and the cover over the culvert from shoulder to the top of the culvert is approximately 4.0 m. The creek bed is at approximate elevation 114.5 m upstream of the inlet based on the section drawings provided.

Based on the 1963 construction drawings the inlet wingwalls were to be constructed as outlined in Table 3-1.

Table 3-1: Design dimensions of Existing Inlet Wingwalls

Location	Exposed Height (m)		Length (m)	Underside of Footing Elevation (m)
	Top	Toe		
Northwest wingwall	4.5	2	8.3	113.7
Northeast wingwall	4.0	2	5.1	114.1

No settlement or stability or scour/erosion of the culvert foundations at the inlet were noted at the time of Thurber's field investigation. Scour/erosion was also not observed at the inlet wingwall foundations.

The culvert is located within a high fill section. The existing north embankment is sloped at approximately 2H:1V (Horizontal:Vertical) and is grass and brush covered; some trees are also present. No signs of settlement or erosion of the embankment slopes were noted at the time of the investigation. Boulders were present in front of the inlet and along the ditchline/toe of slope to the east of the culvert. A post and wire fence and overhead utility lines are present along the ditchline to the north of the culvert inlet.

Storm water drainage in the area is to ditches and the creek. It should be noted that the creek overtopped its banks and entered the investigation area to the north of the inlet during the field work.

Site photographs showing the general conditions at the site, and that of the inlet wingwalls are presented in Appendix D.

4 SITE INVESTIGATION

4.1 Field Investigation

The field investigation was carried out between February 6th and 18th, 2018, and included advancing four boreholes. The approximate MTM Zone 9 locations and ground surface elevations of the boreholes are shown on Drawing No. 1, provided in Appendix A and are summarized in Table 4-1. The structural inspection reports only noted rotational deformations at the north end (inlet) of the culvert hence, all boreholes were located at the culvert inlet.

Table 4-1: Borehole Summary

Borehole	Location	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Borehole Termination Elevation (m)
18-1	Behind NW wingwall	5042427.0	276601.0	118.4	109.8
18-2	Toe of NW wingwall	5042431.9	276598.6	116.1	110.5
18-3	Behind NE wingwall	5042425.2	276615.1	118.3	110.5
18-4	Toe of NE wingwall	5042429.3	276614.6	116.0	112.4

As a component of our standard procedures and due diligence, Thurber contacted Ontario One Call to provide utility locates/clearances for the intended borehole locations.

The boreholes were advanced with a portable drill rig with a half-weight hammer, equipped with NQ size coring equipment. Split spoon samples were collected at regular depth intervals in all boreholes during the completion of Standard Penetration Tests (SPT), following the methods described in ASTM Standard D1586-11. The SPT N values presented on the Record of Boreholes and summarised in the following sections have been corrected to provide an estimate of the SPT N value that would have been obtained with a standard weight hammer. The subsurface stratigraphy encountered in the boreholes was recorded in the field by Thurber personnel. All soil samples recovered from the boreholes were placed in moisture-proof containers and the samples were transported to Thurber's Ottawa geotechnical laboratory for further examination and testing.

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.

The boreholes were backfilled with low-permeability bentonite pellets in accordance with Ontario MOE Regulation 903, as amended.

The as-drilled locations of the boreholes and ground surface elevations at the borehole locations were surveyed by Thurber. The vertical datum used was the top of footing elevation of the northeast footing line at the culvert inlet. The location of the TBM is indicated on Drawing No. 1 in Appendix A. The geodetic elevation of 115.210 m was used for the TBM as indicated on the 1963 construction drawings for the culvert.

4.2 Laboratory Testing

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples. Grain size distribution analyses and Atterberg Limits testing were carried out on selected samples to MTO and ASTM standards. All recovered bedrock core was logged and core recoveries and Rock Quality Designation (RQD) values were determined.

Unconfined compressive strength testing was carried out on select samples of the recovered bedrock.

The geotechnical laboratory test results are presented on the Record of Borehole sheets in Appendix B and are illustrated on the figures in Appendix C.

Chemical analysis for determination of pH, resistivity, soluble sulphate and chloride concentrations was carried out on two soil samples. A copy of the chemical analysis results is provided in Appendix C.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 Overview / General

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. Stratigraphic profiles for the inlet wingwalls are presented on Drawing No. 1 in Appendix A for illustrative purposes. An overall description of the stratigraphy is given in the following paragraphs; however, the factual data presented in the Record of Boreholes governs any interpretation of the site conditions.

In general, the stratigraphy in the area of the boreholes is characterized by granular embankment fill, over clay fill, overlying till overlying granite bedrock. A buried concrete layer was noted in Borehole 18-2. Cobbles and boulders were noted at the surface of Borehole 18-4 and cobbles were noted within the till stratum.

More detailed descriptions of the individual strata are presented below.

5.2 Boulders and Cobbles

A 600 mm thick layer of boulders and cobbles was present at the ground surface of Borehole 18-4. The base of this layer was at Elevation 115.4 m. Cobbles and boulders were present in front of the inlet and along the ditchline/toe of slope to the east of the culvert.

5.3 Fill

Sand with Silt some Gravel to Silty Sand some Gravel Fill

A fill layer consisting predominantly of sand with varying amounts of gravel and silt was encountered at the ground surface in all boreholes except Borehole 18-4. The top of this layer was encountered at elevations ranging from 116.1 m to 118.4 m. The thickness of the layer ranged from 0.7 m to 3.7 m. The SPT N values ranged from 5 to greater than 100; indicating a loose to very dense condition however, the ground was frozen at the time of the investigation which may have increased the values.

The moisture content of the samples tested ranged from 5% to 51%. The results of grain size analysis tests on three samples of the sand fill material indicated a gravel content ranging from 7% to 10%, a sand content ranging from 78% to 86%, and a fines content (combined silt and clay size particles) ranging from 5% to 15%. Grain size analysis results are illustrated on Figure 1 in Appendix C.

Clay with Sand and Silt to Clay with Silt some Gravel Fill

A fill layer consisting predominantly of clay and silt with varying amounts of sand and gravel was encountered below the sand fill layer in Boreholes 18-2 and 18-3, and below the cobble and boulder layer in Borehole 18-4. The top of the clay fill layer was encountered at elevations ranging from 115.4 m to 116.5 m. The thickness of the layer ranged from 1.2 m to 2.1 m. The SPT N values ranged from 4 to 48; indicating a firm to very stiff consistency but typically stiff. Cobbles were noted at the base of this layer and coring techniques were required to penetrate the layer.

The moisture content of the samples tested ranged from 21% to 39%. The results of grain size analysis tests on samples of the clay fill material indicated a gravel content ranging from 1% to 14%, a sand content ranging from 13% to 35%, a silt content ranging from 29% to 39% and a clay content ranging from 22% to 47%. Grain size analysis results are illustrated on Figure 2 in Appendix C.

The results of Atterberg Limits testing completed on samples of the clay fill material indicated a liquid limit ranging from 34 to 47, a plastic limit ranging from 19 to 22, and a plasticity index ranging from 15 to 25. Atterberg Limits analysis results are illustrated on Figure 3 in Appendix C and indicate a clay with a low to intermediate plasticity.

5.4 Concrete

Buried concrete with a thickness of 700 mm was encountered in Borehole 18-2 underlying the clay fill layer at Elevation 113.3 m. Coring techniques were required to penetrate the concrete. A photograph of the recovered material is provided in Appendix B.

5.5 Till

Silty Sand with Gravel Till

A grey silty sand with gravel till deposit was encountered beneath the fill layer in Borehole 18-1. The top of this layer was encountered at Elevation 114.7 m and the layer had a thickness of 2.5 m. The SPT N values ranged from 13 to greater than 100; indicating a compact to very dense condition. Cobbles were noted in this layer.

The moisture content of the samples tested ranged from 14% to 23%. The results of a grain size analysis test indicated a gravel content of 18%, a sand content of 46%, a silt content of 28% and a clay content of 8%. Grain size analysis results are illustrated on Figure 4 in Appendix C.

The results of Atterberg Limits testing completed on a sample of this material indicated the fines were non-plastic.

Sandy Clay with Gravel to Gravely Clay with Sand Till

A clay till layer with sand and gravel was encountered below the fill and the buried concrete in Borehole 18-2 and beneath the fill layers in Boreholes 18-3 and 18-4. The top of this layer was encountered at elevations ranging from 112.5 m to 114.6 m. The thickness of the layer ranged from 0.4 m to 0.6 m. The SPT N values ranged from 4 to greater than 100; indicating a firm to very stiff consistency. Cobbles were noted at the base of this layer and coring techniques were required to penetrate the layer.

The moisture content of the samples tested ranged from 25% to 35%. The results of grain size analysis tests conducted on two samples of the clay till material indicated a gravel content ranging from 18% and 27%, a sand content ranging from 21 and 27%, a silt content ranging from 29% and 30% and a clay content ranging from 23% and 25%. Grain size analysis results are illustrated on Figure 5 in Appendix C.

The results of Atterberg Limits testing completed on two samples of the clay till material indicated a liquid limit of 31 and 35, a plastic limit of 17, and a plasticity index of 14 and 18. Atterberg Limits analysis results are illustrated on Figure 6 in Appendix C, and indicate a clay with a low to intermediate plasticity.

5.6 Granite Bedrock

The overburden materials were underlain by a grey granite bedrock. All four boreholes were advanced into bedrock by coring with NQ-size coring equipment. Photographs of the bedrock core are provided in Appendix B.

A summary of the bedrock surface elevation is provided in Table 5-1.

Table 5-1: Bedrock Summary

Borehole	Location	Ground Surface Elevation at Borehole Location (m)	Depth Below Existing Grade (m)	Top of Bedrock Elevation (m)
18-1	Behind NW wingwall	118.4	6.3	112.1
18-2	Toe of NW wingwall	116.1	4.2	111.9
18-3	Behind NE wingwall	118.3	4.3	114.0
18-4	Toe of NE wingwall	116.0	2.2	113.8

The total core recovery ranged from 65% to 100%, the solid core recovery ranged from 65% to 100% and the RQD ranged from 42% to 100%. Unconfined compressive strength testing was carried out on five samples of the bedrock; (see results in Appendix C). The results ranged from 85.7 MPa to 217.7 MPa.

Based on the RQD value the bedrock is classified as poor to excellent quality. Based on unconfined compressive strength testing the bedrock is strong to very strong.

5.7 Groundwater Conditions

Groundwater levels measured in the open boreholes were not considered representative due to the introduction of water into the boreholes during coring operations.

The water level in the Douglas Creek Culvert was surveyed on February 16, 2018, at Elevation 114.9 m.

Seasonal fluctuations of the water level in the culvert is to be expected. In particular, the water level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall. It should be noted that the creek overtopped its banks and entered the area to the north of the inlet during the investigation.

5.8 Analytic Test Results

Two samples of the soils encountered at the site were submitted to Paracel Laboratories in Ottawa, Ontario for analysis of pH, water soluble sulphate and chloride concentrations, and resistivity. The analysis results are summarized in the Table 5-2. A copy of the test results is provided in Appendix C.

Table 5-2: Results of Chemical Analysis

Borehole	Sample	Depth (m)	pH	Resistivity (Ohm-cm)	Chloride (µg/g)	Sulphate (µg/g)
18-1	SS3	1.5	8.5	10500	19	<5
18-3	SS4	2.1	8.3	3170	61	14

6 MISCELLANEOUS

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Thurber surveyed the borehole locations and determined the ground surface elevations based on construction drawings provided by McIntosh Perry Consulting Engineers. Forage M3 Drilling Services Inc. of Hawkesbury, Ontario supplied and operated the drilling equipment to carry out the drilling, sampling, and in-situ testing. Beacon Lite Ltd. of Ottawa provided traffic control services for lane closures during set-up and tear down of the drilling equipment. The drilling, and sampling operations in the field were supervised on a full-time basis by Nick Weil and Katya Edney, P.Eng. of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory in Ottawa. Unconfined Compressive Strength Testing of the bedrock was carried out by Stantec Consulting Ltd. in its MTO-approved laboratory in Ottawa.

Overall project management and direction of the field program was provided by Paul Carnaffan, P.Eng. Interpretation of the field data and preparation of this report was completed by Kenton Power, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng. and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations.

Kenton C. Power, P.Eng.
Geotechnical Engineer

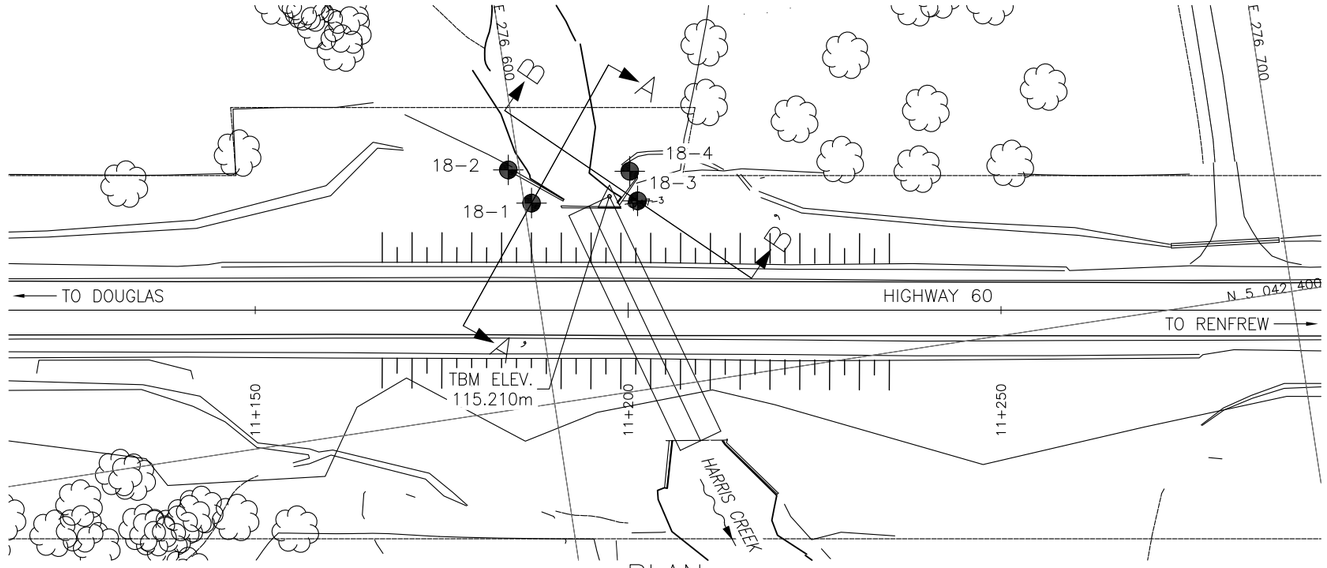
Fred J. Griffiths, Ph.D., P.Eng.
Senior Associate, Senior Geotechnical Engineer

P.K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

APPENDIX A

BOREHOLE LOCATIONS AND SOIL STRATA DRAWING
PRELIMINARY GENERAL ARRANGEMENT DRAWING
1963 CONSTRUCTION DRAWINGS FOR EXISTING CULVERT

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

16 0 16 32m

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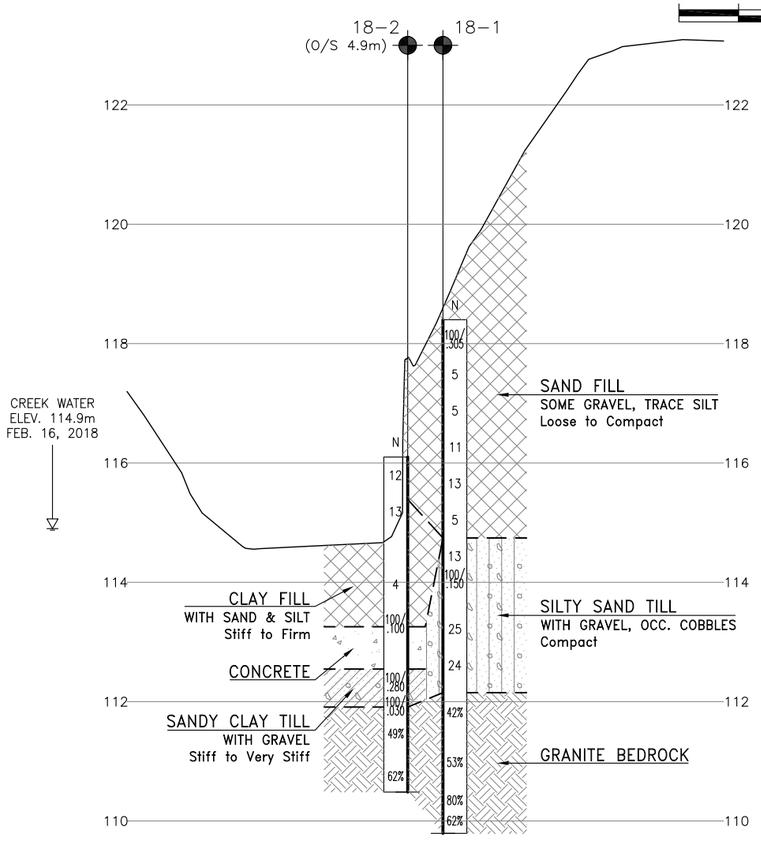

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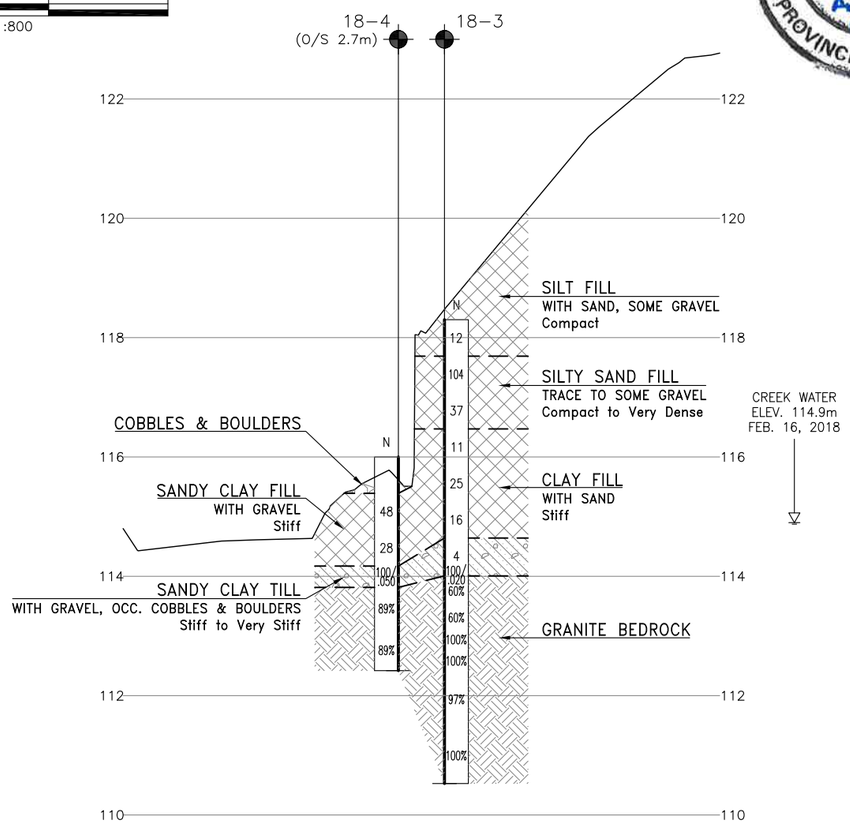


SECTION B–B'

8 0 8 16m H 1:400

2 0 2 4m V 1:100

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
K. T. C. POWER
100130652
2018/07/09
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 2/18
PROVINCE OF ONTARIO

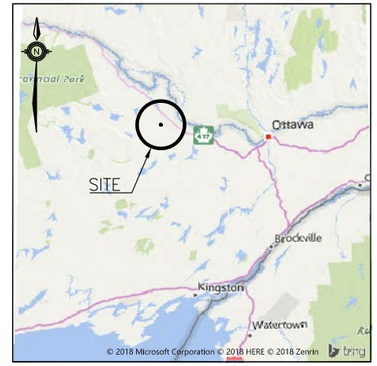
CONT No
GWP No 4076–13–00

SHEET

HIGHWAY 60
DOUGLAS CREEK
CULVERT REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

McINTOSH PERRY

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
▼	Head Artesian Water
┃	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
18–1	118.4	5 042 427.0	276 601.0
18–2	116.1	5 042 431.9	276 598.6
18–3	118.3	5 042 425.2	276 615.1
18–4	116.0	5 042 429.3	276 614.6

-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 9.

GEOCRES No. 31F-203

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN KP	CHK –	CODE	LOAD DATE JUL 2018
DRAWN MFA	CHK KP	SITE 29–155/C	STRUCT DWG 1

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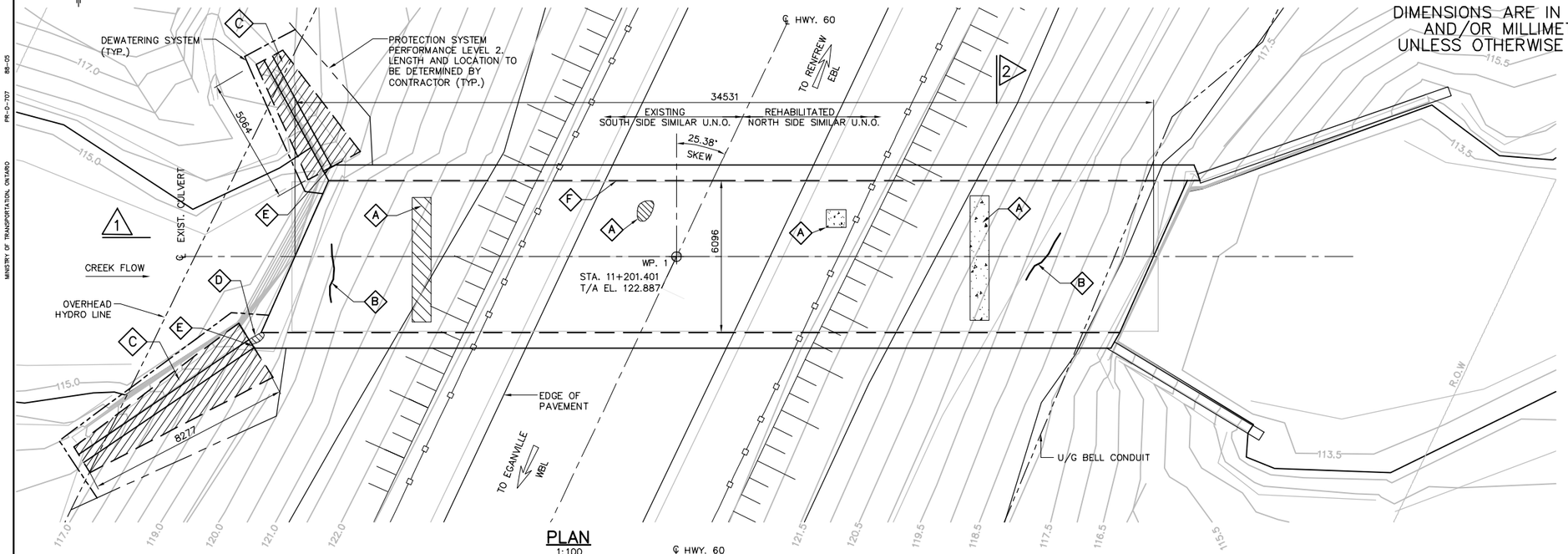
CONSTRUCTION NORTH

METRIC

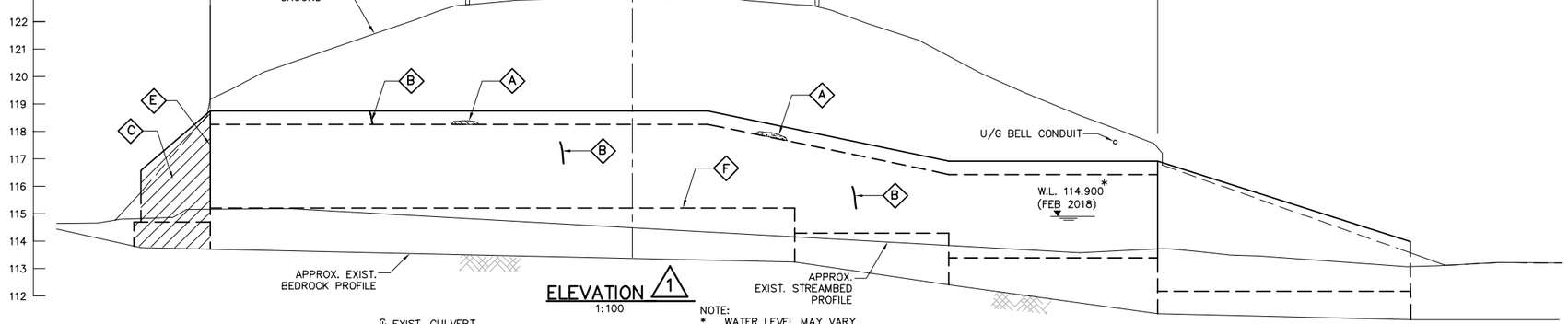
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

HWY. 60	
CONT No	
WP No 4115-13-01	
HIGHWAY 60	SHEET
DOUGLAS CREEK CULVERT REHABILITATION	
GENERAL ARRANGEMENT	

LEA Joint Venture — McINTOSH PERRY



PLAN
1:100



ELEVATION 1
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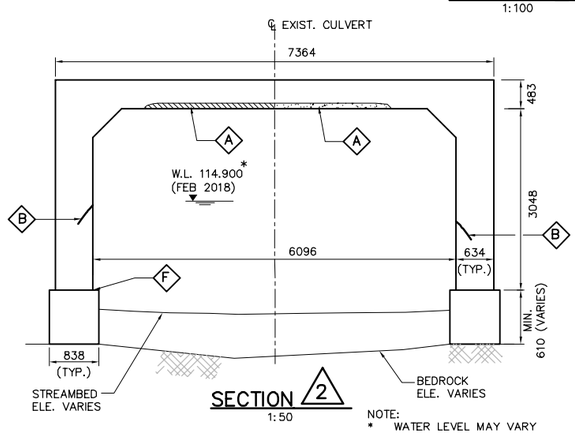
NOTE:
* WATER LEVEL MAY VARY



SECTION 2
1:50

NOTE:
* WATER LEVEL MAY VARY

GENERAL NOTES:

1. CLASS OF CONCRETE 30 MPa
2. CLEAR COVER TO REINFORCING STEEL

   SOFFIT 40±10
   REMAINDER (U.N.O) 70±20
3. REINFORCING STEEL

   REINFORCING STEEL SHALL BE DEFORMED BARS CONFORMING TO CSA STANDARD G30.18M GRADE 400.

CONSTRUCTION NOTES:

1. CONTRACTOR SHALL VERIFY ALL DIMENSIONS OF THE EXISTING WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
2. SAWCUTS IN CONC. WHERE DESIGNATED SHALL BE 25mm DEEP OR TO THE FIRST LEVEL OF REINFORCING STEEL, WHICHEVER IS LESS, UNLESS OTHERWISE NOTED.
3. DETERIORATED, SPALLED AND DELAMINATED AREAS SHOWN ON THE DRAWINGS ARE APPROXIMATE AND DO NOT REFLECT THE FULL EXTENT OR LOCATION OF THE PARTIAL DEPTH CONCRETE REMOVALS AND REPAIRS THAT SHALL BE DETERMINED ON SITE BY THE CONTRACT ADMINISTRATOR.
4. THE CONTRACTOR SHALL ENSURE THAT DUST & DEBRIS DOES NOT ENTER THE WATERCOURSE.
5. ALL SERVICES ARE TO ACCURATELY LOCATED PRIOR TO CONSTRUCTION AND ADEQUATE PROTECTION PROVIDED AT ALL THE TIME. ANY INTERFERENCE OF EXISTING SERVICES OR UTILITIES WITH PROPOSED STRUCTURE OR CONSTRUCTION OPERATIONS IS TO BE REPORTED TO THE CONTRACT ADMINISTRATOR PRIOR TO THE CONTINUATION OF CONSTRUCTION.
6. PROTECTION SYSTEM AROUND THE FOOTPRINT OF THE EXISTING RETAINING WALL SHALL BE INSTALLED BEFORE EXCAVATION TO PROTECT THE EXISTING CULVERT FOUNDATION.

SCOPE OF WORK

- (A) REMOVE ALL LOOSE AND DELAMINATED CONCRETE FROM UNDERSIDE OF ROOF SLAB AND REPAIR WITH FORMED AND PUMP CONCRETE.
- (B) REPAIR CRACKS WITH POLYURETHANE CRACK INJECTION.
- (C) REMOVE AND REPLACE NORTHEAST AND NORTHWEST RETAINING WALLS.
- (D) RECONSTRUCT CULVERT INLET AT NORTHWEST RETAINING WALL.
- (E) REMOVE AND REPLACE JOINT SEAL.
- (F) REPAIR CONCRETE VOIDS WITH GROUT.

LEGEND:

- FULL DEPTH CONCRETE REMOVAL
- PARTIAL DEPTH CONCRETE REMOVAL
- NEW CONCRETE
- MEDIUM CONCRETE CRACK

COORDINATES OF WORK POINTS

WP #	STATION	NORTH COORDINATE	EAST COORDINATE
1	11+201.401	5042410.687	276613.008

LIST OF ABBREVIATIONS:

C.J.	CONSTRUCTION JOINT
℄	CENTRE LINE
CONC.	CONCRETE
EL.	ELEVATION
STA.	STATION
T/	TOP OF
T/A	TOP OF ASPHALT (FINISHED ELEV.)
TYP.	TYPICAL
WP	WORKING POINT
W.L.	WATER LEVEL

LIST OF DRAWINGS:

1. GENERAL ARRANGEMENT
2. BOREHOLE SOIL STRATA
3. TYPICAL REPAIR DETAILS AND DEWATERING SYSTEM
4. RETAINING WALL DETAIL I
5. RETAINING WALL DETAIL II

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION

DESIGN FS	CHK RTK	CODE CHBDC 14	LOAD ONT CL-625	DATE JUNE 2018			
DRAWN RM	CHK FS	SITE 29-155/C	STRUCT –	SCHEME –	DWG 1		

MINISTRY OF TRANSPORTATION, ONTARIO
FR-D-707 88-05

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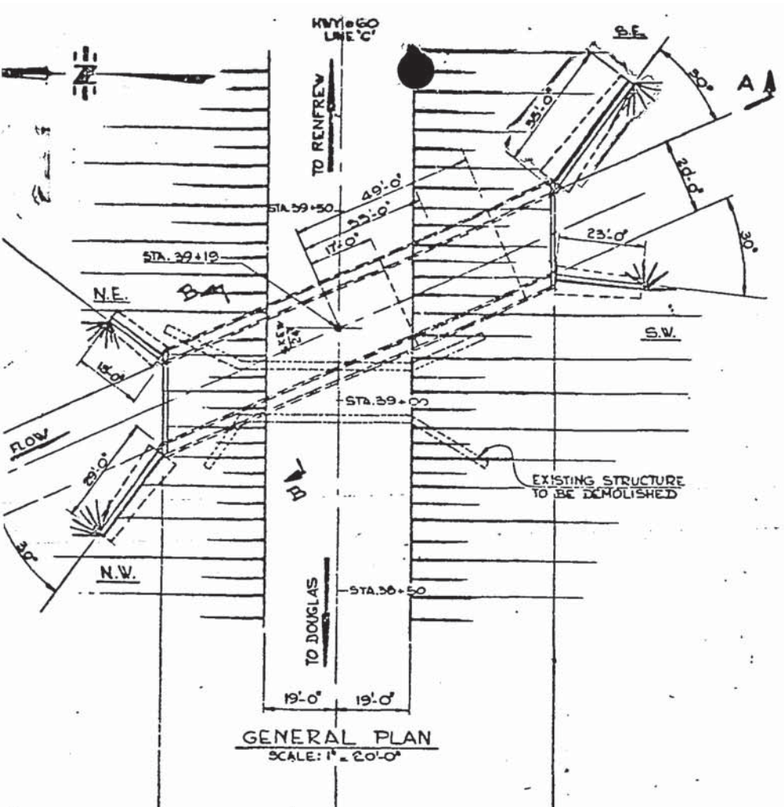
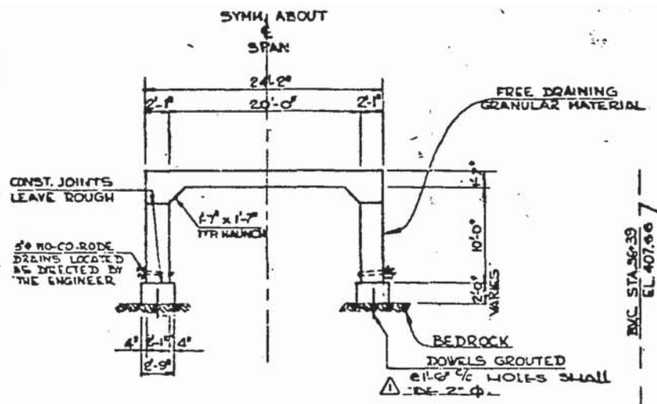


GENERAL PLAN
SCALE: 1" = 20'-0"



SECTION B-B
SCALE: 1/8" = 1'-0"

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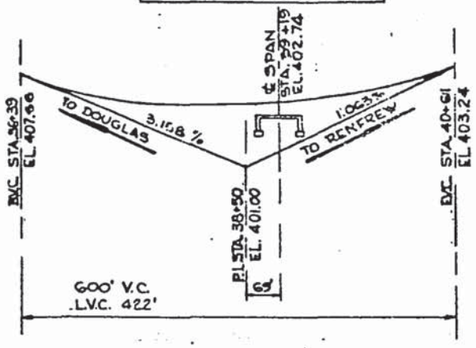
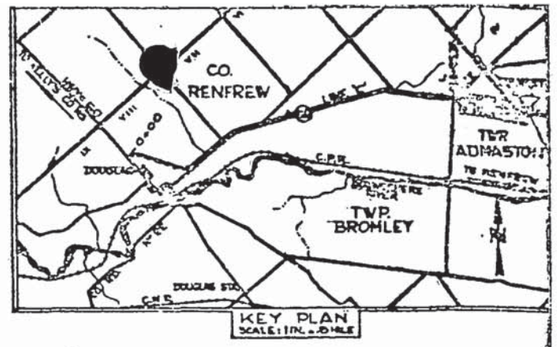
COS. .91355
TAN. .44523
SEC. 1.09464

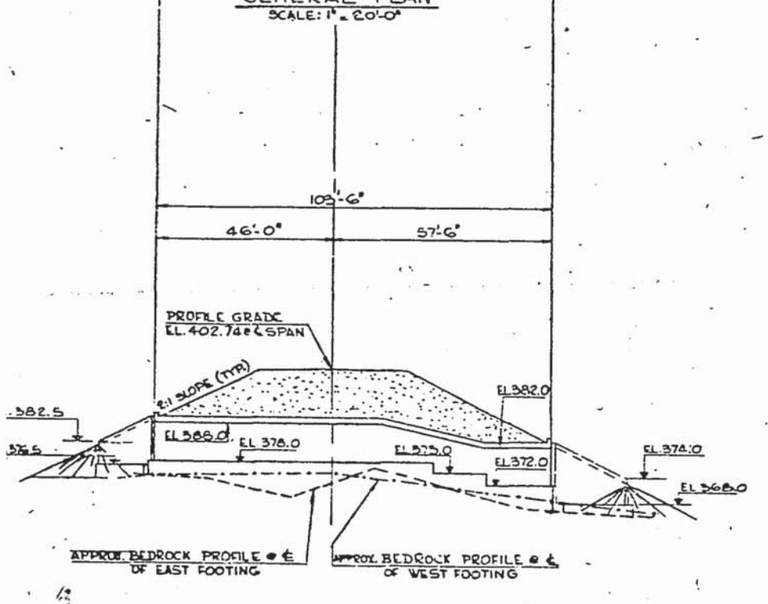


PROFILE GRADE
℄ ROADWAY
N.T.S.

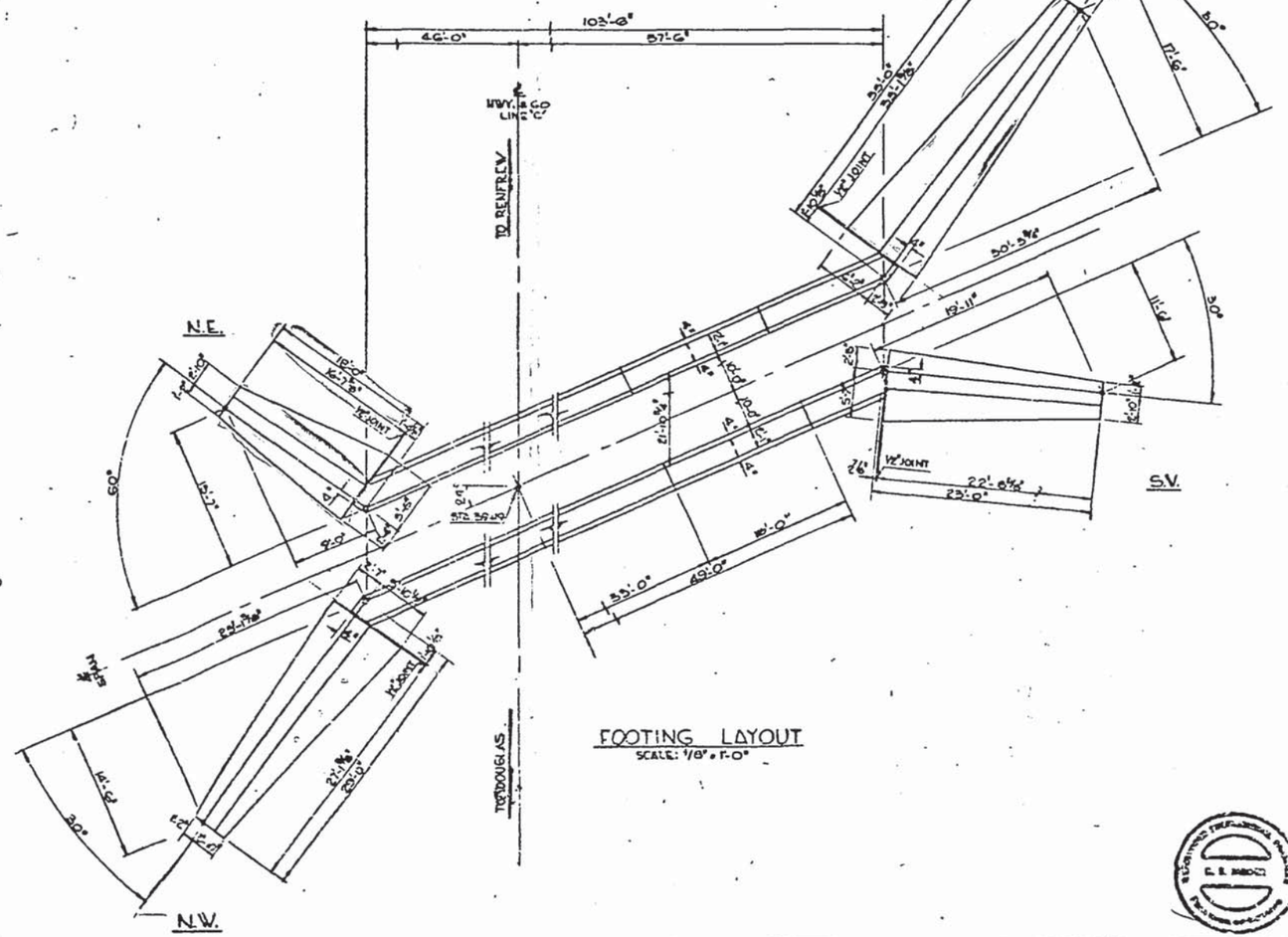


LIST OF DRAWINGS	
D-5305-1	GENERAL PLAN & FOOTING LAYOUT
2	DETAILS OF CULVERT
3	RETAINING WALLS
4	REINFORCING STEEL SCHEDULE
5	DO

NOTES
TO THE ENGINEER
CONCRETE WORK ON THIS STRUCTURE MUST NOT BE COMMENCED UNTIL MONUMENTS TO FIX CONTROL POINTS HAVE BEEN ERECTED AND CHECKED BY THE ENGINEER.
TO CONTRACTOR
STRUCTURE TO BE BUILT IN ACCORDANCE WITH FORM No 9 AND THE SPECIAL PROVISIONS EXTRA COPIES OF WHICH MAY BE OBTAINED FROM THE ENGINEER.
CONCRETE MIX:
MIN. STRENGTH OF CONCRETE @ 28 DAYS : 3000 P.S.I. APPROVED ADMIXTURES SUPPLIED BY THE CONTRACTOR WILL BE ADDED TO ALL CONCRETE, AS SPECIFIED BY THE ENGINEER.
CLEAR COVER ON REINFORCING STEEL.
1½" BOTTOM OF SLAB 3" ELSEWHERE
CONSTRUCTION NOTES
ALL EXPOSED EDGES TO BE CHAMFERED 1" x 1", EXCEPT AS NOTED.
ALL CONSTRUCTION JOINTS MUST BE APPROVED BY THE ENGINEER.
BORING DATA
NO SOIL INVESTIGATION REPORT FOR THIS STRUCTURE EXISTS. BEDROCK PROFILES SHOWN ON THESE PLANS ARE BASED ON FIELD INVESTIGATIONS THE ACCURACY OF WHICH IS NOT GUARANTEED BY THE D.H.O.



SECTION A-A
SCALE: 1" = 20'-0"



FOOTING LAYOUT
SCALE: 1/8" = 1'-0"

REVISIONS			
DATE	BY	DESCRIPTION	
3-11-63	JGC	SIZE OF 1 FOOTING ADDED.	

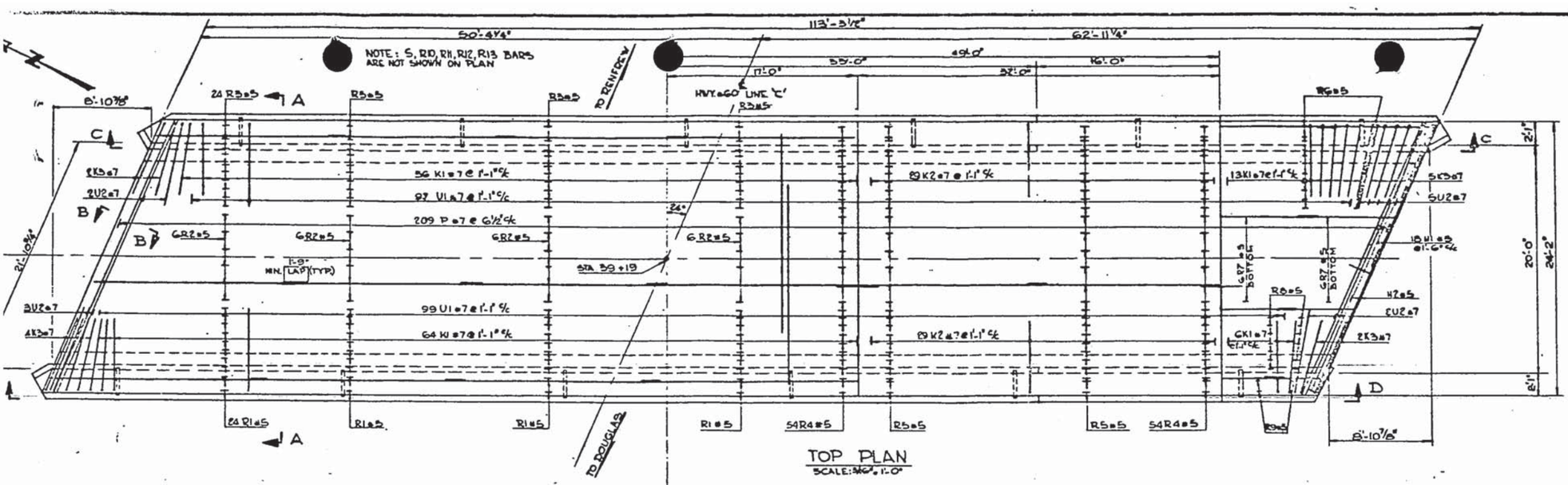
DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE ENGINEER

DOUGLAS CREEK CULVERT
4 MILES WEST OF HIGHWAY 17

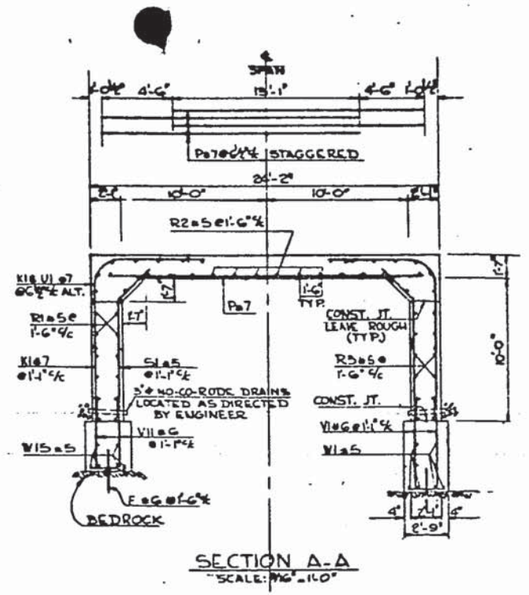
KING'S HIGHWAY No. 60 DIST. No. 10
CO. RENFREW STR. 39+19
TWP. ADMASTON LOT 29 & 36 CON. IV

GENERAL PLAN & FOOTING LAYOUT

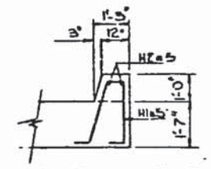
APPROVED				STR. No. 30-155	W.P. No. 35-61
DESIGN	G.D.	CHKD	SCALE	CONTRACT No.	65-122
DRAWING	G.D.	CHKD	N.T.S.		
DATE	OCT. 1962	LOADING	M.S.H.D.-S.16	DRAWING No.	D-5305-1



TOP PLAN
SCALE: 3/16" = 1'-0"

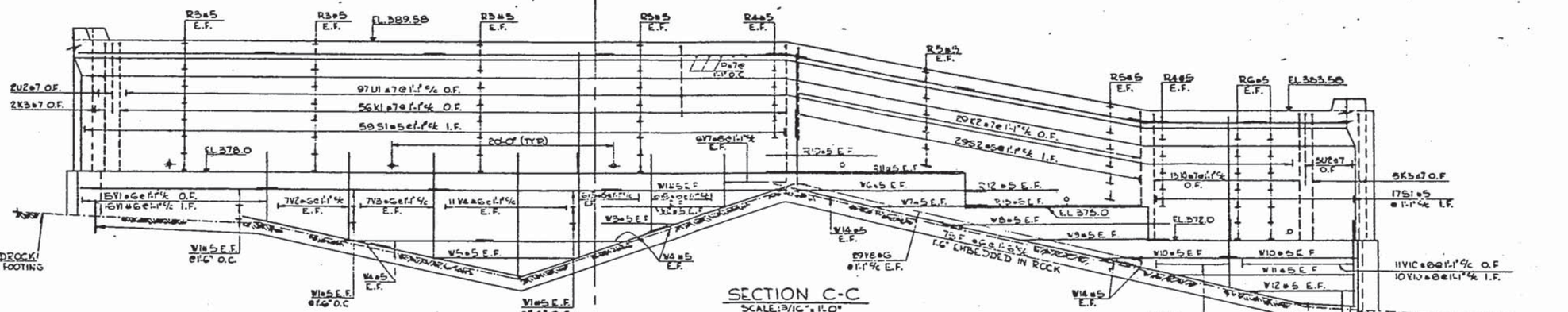


SECTION A-A
SCALE: 3/16" = 1'-0"

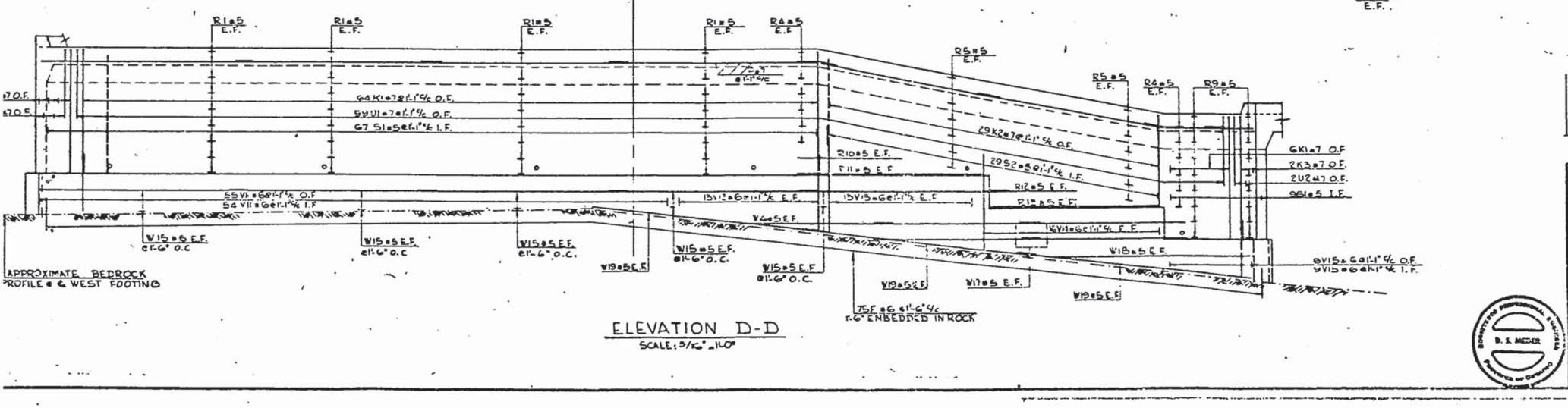


SECTION B-B
SCALE: 3/8" = 1'-0"

NOTE: THIS SECTION IS TYP FOR N & S. HEADWALLS.



SECTION C-C
SCALE: 3/16" = 1'-0"



ELEVATION D-D
SCALE: 3/16" = 1'-0"

LEGEND:
O.F. = OUTER FACE
I.F. = INNER FACE
E.F. = EACH FACE

REVISIONS		
DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
BRIDGE DIVISION

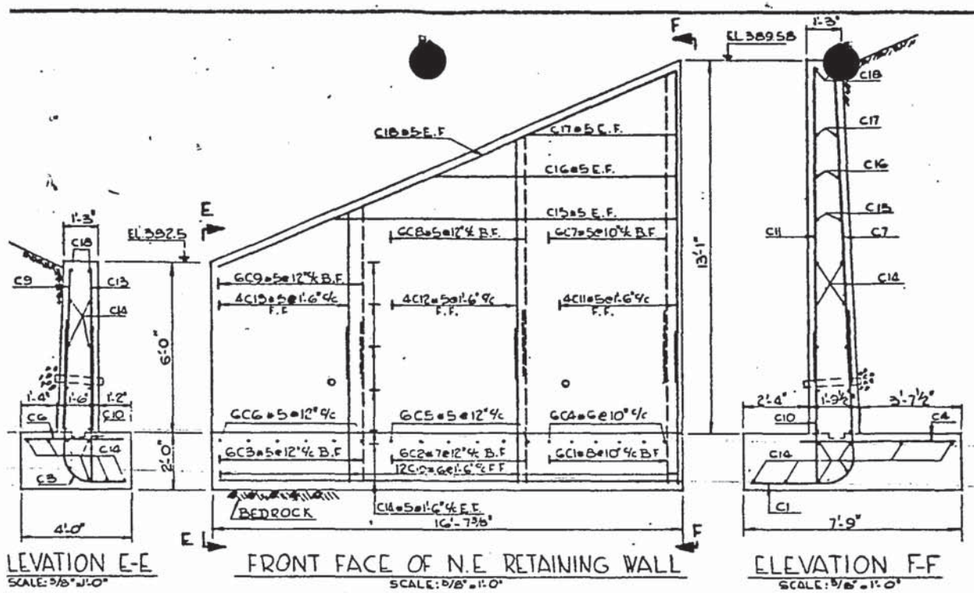
DOUGLAS CREEK CULVERT
4 MILES WEST OF HWY. 17

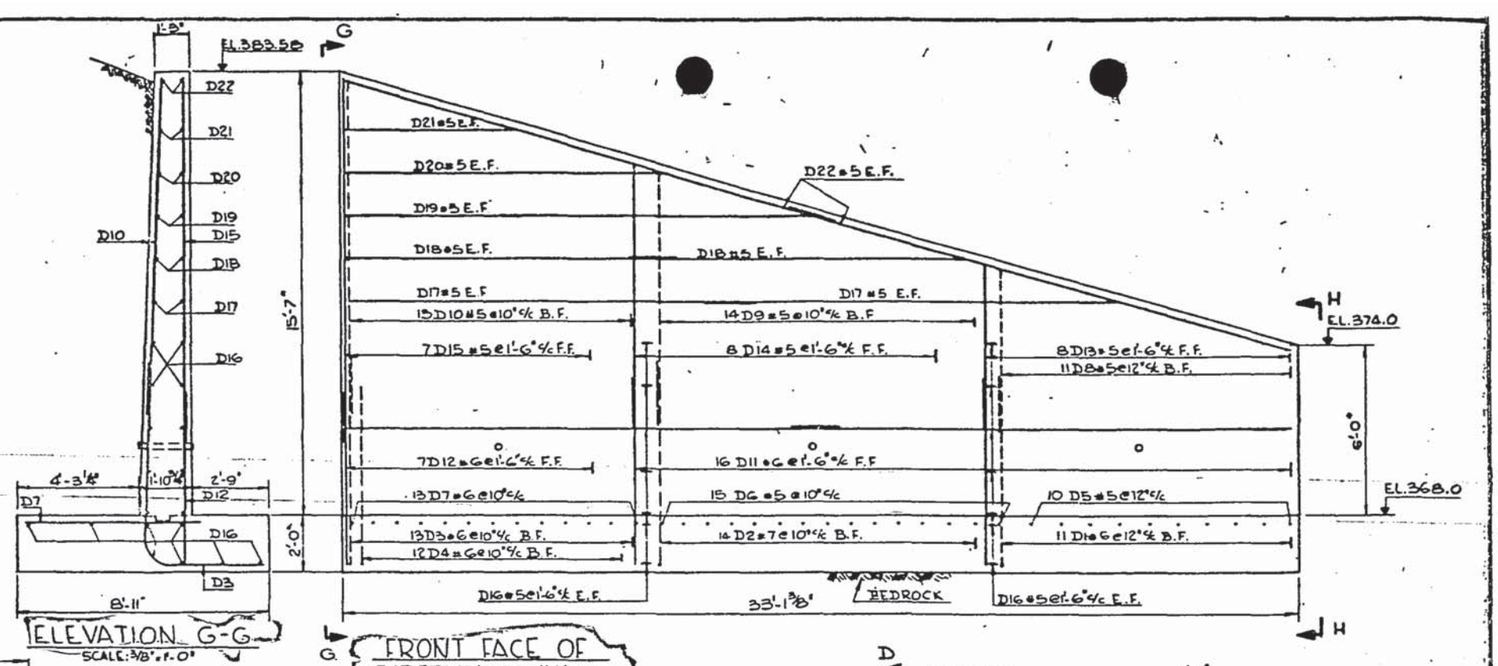
KING'S HIGHWAY No. 60 — DIST. No. 10
CO. RENFREW
TWP. ADMASTON — LOT 29 & 30 CON. IV

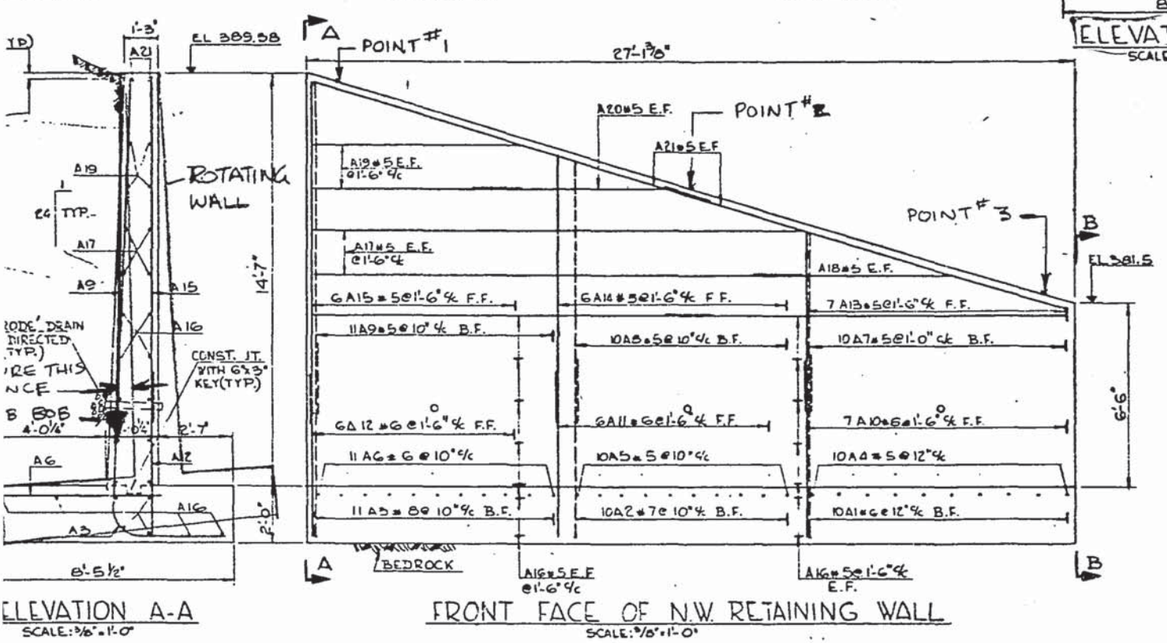
DETAILS OF CULVERT

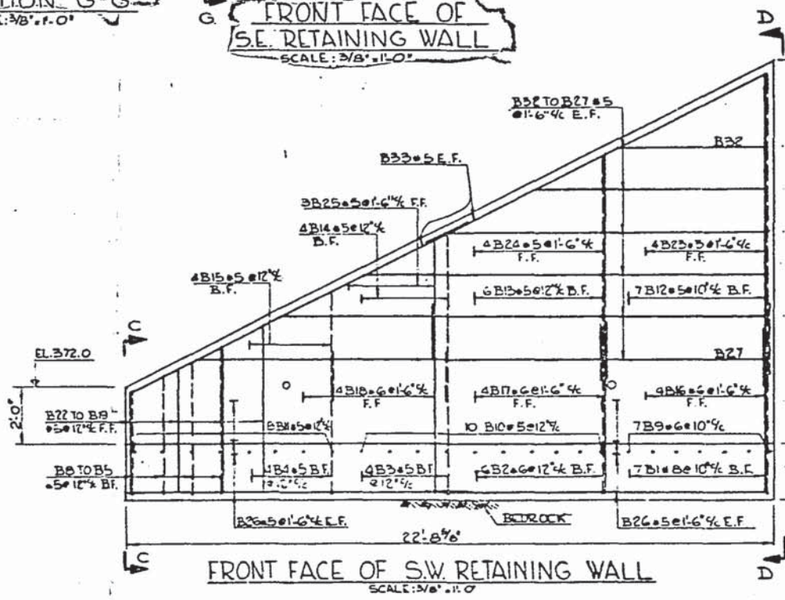
APPROVED				STR. No. 30-155	W.P. No. 35-61
DESIGN	G.D.	CHKD	DEM.	CONTRACT No.	65-235
DRAWING	G.D.	CHKD	H.S.B.		
DATE	OCT. 1963	LOADING	H20-S16	DRAWING No.	D-5305-2

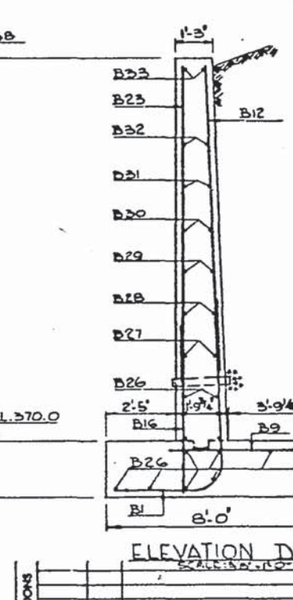
D. S. MEDER — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO



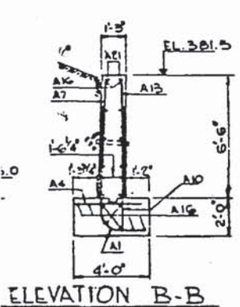




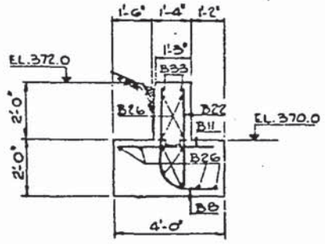




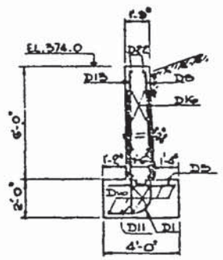
ELEVATION D-D
SCALE: 3/8" = 1'-0"



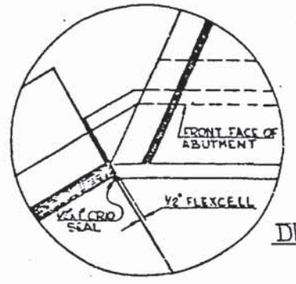
ELEVATION B-B
SCALE: 3/8" = 1'-0"



ELEVATION C-C
SCALE: 3/8" = 1'-0"



ELEVATION H-H
SCALE: 1/4" = 1'-0"



DETAIL OF JOINT
SCALE: 3/8" = 1'-0"

LEGEND
F.F. = FRONT FACE
B.F. = BACK FACE
E.F. = EACH FACE

REVISIONS

DATE	BY	DESCRIPTION

DEPARTMENT OF HIGHWAYS ONTARIO
EDGE DIVISION

DOUGLAS CREEK CULVERT
4 MILES WEST OF HWY 17

KING'S HIGHWAY No. 60 — DIST. No. 10
CO. RENFREW
TWP. ADMASTON — LOT 29 & 36 CON. IV

RETAINING WALLS

APPROVED _____ DATE _____ — CTR No. 30-155 — W.P. No. 35-61

DESIGN	GP	CHKD	DSM	CONTRACT No.		45-225
QUANTITIES	GP	CHKD	HSB			
DATE	OCT. 1963	LOADING	H20-S16	DRAWING No.	D-5305-3	

REGISTERED PROFESSIONAL ENGINEER — D. S. REEDER — PROVINCE OF ONTARIO

APPENDIX B

RECORD OF BOREHOLE SHEETS
BEDROCK CORE PHOTOGRAPHS

THURBER

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:

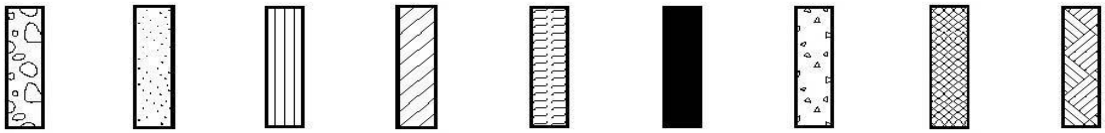
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented,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

THURBER

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

THURBER

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

THURBER

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-1

1 OF 1

METRIC

GWP# 4076-13-00 LOCATION Lat: 45.521191°, Long: -76.860966° MTM Zone 9: N 5 042 427.0 E 276 601.0 ORIGINATED BY NW

HWY 60 BOREHOLE TYPE Portable Drill NW Casing / NTW Coring COMPILED BY KE

DATUM Geodetic DATE 2018.02.06 - 2018.02.09 CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
118.4											
0.0	Sand with silt some gravel - frost to 0.75 m Loose to compact Brown **FILL**		1	SS	100/ 305mm		118		○		
			2	SS	5				○		9 86 5 (SI+CL)
			3	SS	5		117		○		
			4	SS	11				○		
			5	SS	13		116		○		
114.7			6	SS	5		115		○		
3.7	**SILTY SAND (SM) with gravel TILL** - occasional cobbles Compact Grey		7	SS	13				○		
			8	SS	100/ 150mm		114		○		
			9	SS	25				○		18 46 28 8 Non-plastic
			10	SS	24		113		○		
112.1	- cobble at 6.0 m										
6.3	**GRANITE BEDROCK** Slightly weathered to fresh Close joint spacing Very strong strength Poor to good quality Grey to black		1	RUN			112				RUN #1 TCR=96% SCR=100% RQD=42% UCS=107MPa
			2	RUN			111				RUN #2 TCR=100% SCR=93% RQD=53%
			3	RUN							RUN #3 TCR=90% SCR=90% RQD=80%
109.8	- 100 mm silt filled fracture at 8.3 m		4	RUN			110				RUN #4 TCR=88% SCR=71% RQD=62%
8.6	End of Borehole Note: A 50% (32 kg) drop hammer was used to advance the splitspoon sampler. The SPT N values presented above have been corrected to provide an estimate of the SPT N value that would have been obtained with a standard full weight hammer.										

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

(%) STRAIN AT FAILURE

DOUBLE_LINE 20479 DOUGLAS CREEK CULVERT.GPJ 2012TEMPLATE(MTO).GDT 2/8/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-2 1 OF 1 METRIC

GWP# 4076-13-00 LOCATION Lat: 45.521235°, Long: -76.860998° MTM Zone 9: N 5 042 431.9 E 276 598.6 ORIGINATED BY NW

HWY 60 BOREHOLE TYPE Portable Drill NW Casing / NTW Coring COMPILED BY KE

DATUM Geodetic DATE 2018.02.13 - 2018.02.13 CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
116.1											
0.0	Sand with silt some gravel Compact Brown **FILL**		1	SS	12		116				10 84 6 (SI+CL)
115.4											
0.7	Clay with sand and silt Stiff to firm Grey **FILL**		2	SS	13		115	1.0 3.8			
			3	SS	4		114				1 13 39 47
113.3	- becoming clayey silt below 2.7 m - cored 150 mm cobble at 2.8 m		4	SS	100/ 100mm						
2.8	**700 mm CONCRETE**		1	RUN			113				
112.5											
3.6	**SANDY CLAY (CL) with gravel TILL** Stiff to very stiff grey		5	SS	100/ 280mm						18 27 30 25
111.9	- Cored 100 mm cobble at 4.0 m		6	SS	100/ 30mm		112				
4.2	**GRANITE BEDROCK** Slightly weathered to fresh Close joint spacing Strong strength Poor to fair quality Grey to black		2	RUN							RUN #2 TCR=71% SCR=66% RQD=49%
			3	RUN			111				RUN #3 TCR=100% SCR=95% RQD=62% UCS=85MPa
110.5											
5.6	End of Borehole Note: A 50% (32 kg) drop hammer was used to advance the splitspoon sampler. The SPT N values presented above have been corrected to provide an estimate of the SPT N value that would have been obtained with a standard full weight hammer.										

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

(%) STRAIN AT FAILURE

DOUBLE_LINE 20479 DOUGLAS CREEK CULVERT.GPJ 2012TEMPLATE(MTO).GDT 2/8/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-3

1 OF 1

METRIC

GWP# 4076-13-00 LOCATION Lat: 45.521175°, Long: -76.860786° MTM Zone 9: N 5 042 425.2 E 276 615.1 ORIGINATED BY NW/KE

HWY 60 BOREHOLE TYPE Portable Drill NW Casing / NTW Coring COMPILED BY KE

DATUM Geodetic DATE 2018.02.15 - 2018.02.16 CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
118.3								20 40 60 80 100	20 40 60		
0.0	Sand with silt some gravel - grass and roots at surface Compact Brown		1	SS	12		118				
117.7											
0.6	**FILL**		2	SS	104						
	Silty sand some gravel - frost to 1.2 m Dense to very dense brown **FILL**		3	SS	37		117				7 78 15 (SI+CL)
116.5											
1.8	Clay with sand and silt some gravel Stiff Grey **FILL**		4	SS	11		116				
			5	SS	25						8 15 36 41
			6	SS	16		115				
114.6											
3.7	**SANDY CLAY (CL) with gravel TILL** - occasional cobbles and boulders Stiff Grey		7	SS	4						
114.0			8	SS	100/ 20 mm		114				
4.3	**GRANITE BEDROCK** Slightly weathered to fresh Close joint spacing Very strong strength Fair to excellent quality Grey to black - 150 mm silt filled fracture at 4.6 m		1	RUN							RUN #1 TCR=65% SCR=65% RQD=60% UCS=217MPa
			2	RUN							RUN #2 TCR=100% SCR=100% RQD=60%
			3	RUN			113				RUN #3 TCR=100% SCR=100% RQD=100% UCS=189MPa
			4	RUN							RUN #4 TCR=100% SCR=100% RQD=100%
			5	RUN			112				RUN #5 TCR=100% SCR=97% RQD=97%
			6	RUN			111				RUN #6 TCR=100% SCR=100% RQD=100%
110.5											
7.8	End of Borehole Note: A 50% (32 kg) drop hammer was used to advance the splitspoon sampler. The SPT N values presented above have been corrected to provide an estimate of the SPT N value that would have been obtained with a standard full weight hammer.										

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

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

DOUBLE_LINE 20479 DOUGLAS CREEK CULVERT.GPJ 2012TEMPLATE(MTO).GDT 2/8/18

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 18-4

1 OF 1

METRIC

GWP# 4076-13-00 LOCATION Lat: 45.521212°, Long: -76.860792° MTM Zone 9: N 5 042 429.3 E 276 614.6 ORIGINATED BY NW

HWY 60 BOREHOLE TYPE Portable Drill NW Casing / NTW Coring COMPILED BY KE

DATUM Geodetic DATE 2018.02.18 - 2018.02.18 CHECKED BY KP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
116.0											
0.0 115.4	**COBBLES / BOULDERS**										
0.6	Sandy clay with silt some gravel Stiff Grey **FILL**		1	SS	48		115				14 35 29 22
114.2			2	SS	28						
1.8 113.8	**GRAVELY CLAY (CL) with sand TILL** Very stiff		3	SS	100/ 50mm		114				27 21 29 23
2.2	Grey **GRANITE BEDROCK** Slightly weathered to fresh Close joint spacing Very strong strength Good quality Grey to black		1	RUN							RUN #1 TCR=100% SCR=100% RQD=89% UCS=110MPa
							113				
112.4			2	RUN							RUN #2 TCR=100% SCR=100% RQD=89%
3.6	End of Borehole Note: A 50% (32 kg) drop hammer was used to advance the splitspoon sampler. The SPT N values presented above have been corrected to provide an estimate of the SPT N value that would have been obtained with a standard full weight hammer.										

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

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

DOUBLE_LINE 20479 DOUGLAS CREEK CULVERT.GPJ 2012TEMPLATE(MTO).GDT 2/8/18

Borehole 18-1

Box 1 (of 2)

Elevation 112.1 m to 110.7 m

THURBER ENGINEERING LTD.

Foundation Investigation
Site 29-155/C Douglas Creek Culvert
Highway 60
Renfrew County, Ontario

G.W.P. 4076-13-00

Project No.: 20479

Borehole 18-1

Box 2 (of 2)

Elevation 110.7 m to 109.8 m

THURBER ENGINEERING LTD.

Foundation Investigation
Site 29-155/C Douglas Creek Culvert
Highway 60
Renfrew County, Ontario

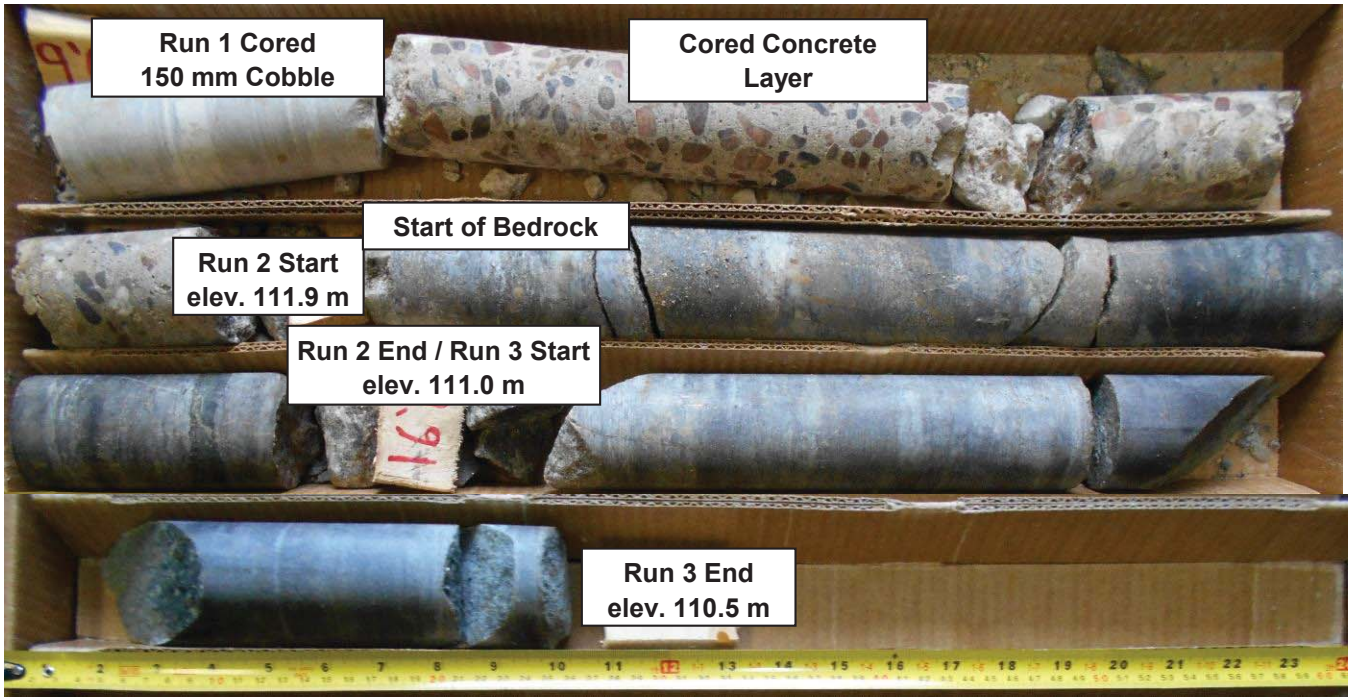
G.W.P. 4076-13-00

Project No.: 20479

Borehole 18-2

Run 1 and 2 (of 2)

Elevation 111.9 m to 110.5 m



THURBER ENGINEERING LTD.

Foundation Investigation
Site 29-155/C Douglas Creek Culvert
Highway 60
Renfrew County, Ontario

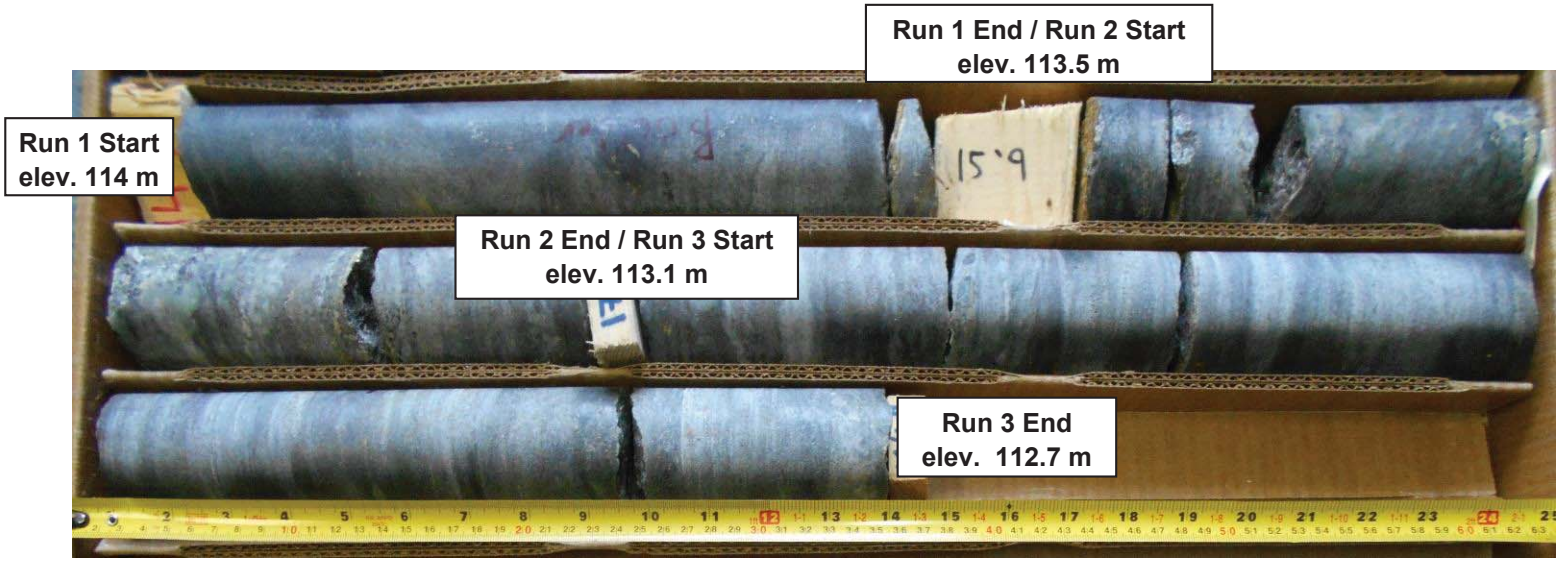
G.W.P. 4076-13-00

Project No.: 20479

Borehole 18-3

Box 1 (of 2)

Elevation 114.0 m to 112.7 m



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Renfrew County, Ontario

G.W.P. 4076-13-00

Project No.: 20479

Borehole 18-3

Box 2 (of 2)

Elevation 112.7 m to 110.5 m

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Foundation Investigation
Site 29-155/C Douglas Creek Culvert
Highway 60
Renfrew County, Ontario

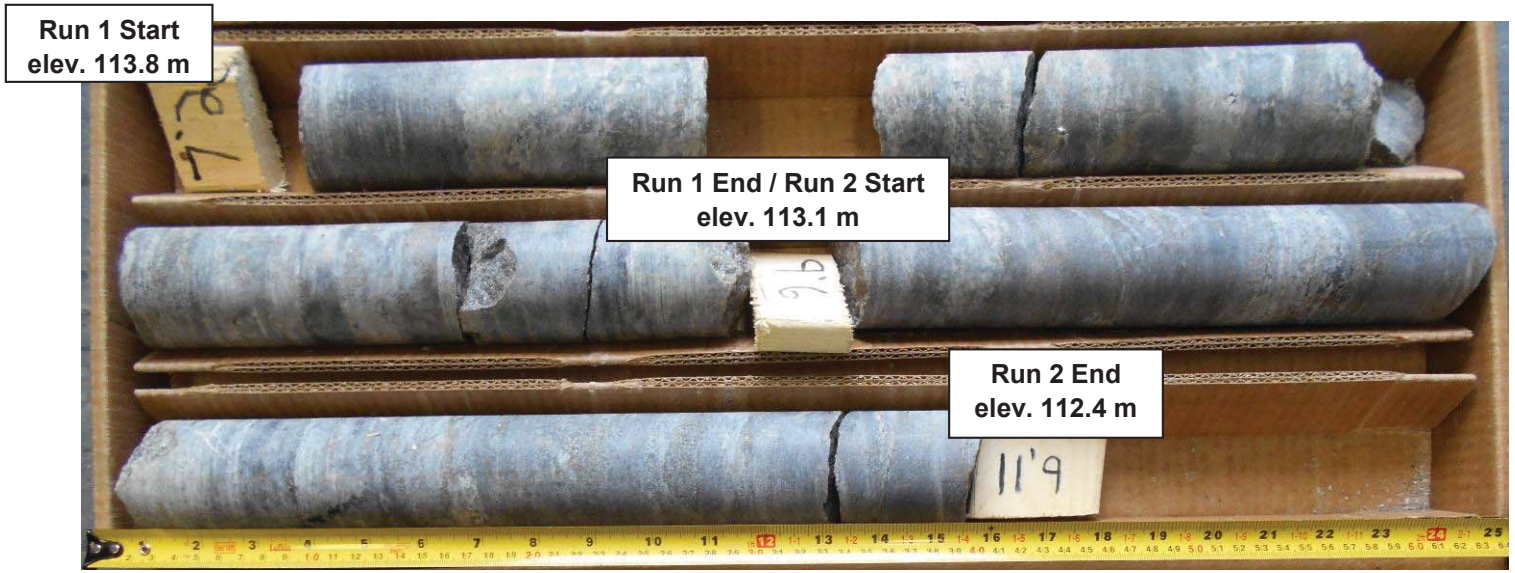
G.W.P. 4076-13-00

Project No.: 20479

Borehole 18-4

Box 1 (of 1)

Elevation 113.8 m to 112.4 m



THURBER ENGINEERING LTD.

Foundation Investigation
Site 29-155/C Douglas Creek Culvert
Highway 60
Renfrew County, Ontario

G.W.P. 4076-13-00

Project No.: 20479

APPENDIX C

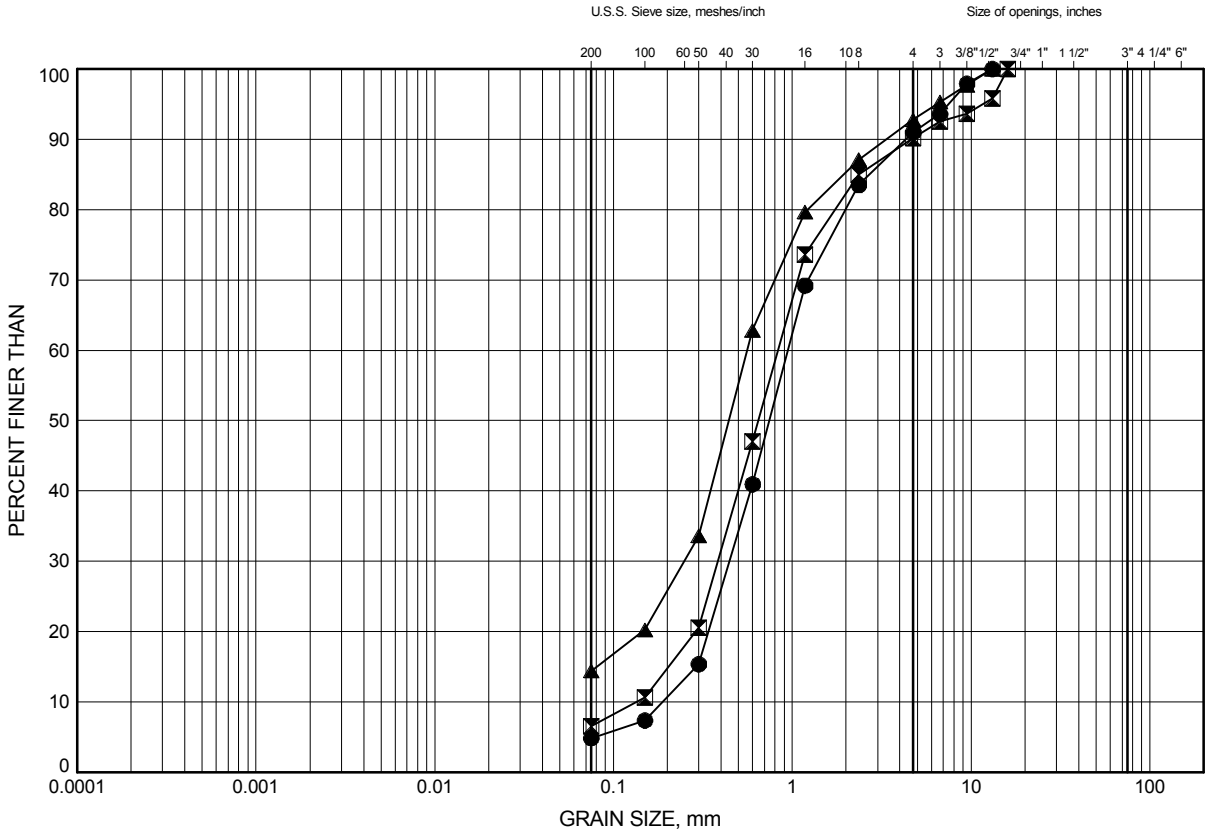
LABORATORY TEST RESULTS

Site 29-155/C Douglas Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE 1

Fill: Sand with Silt some Gravel to Silty Sand some Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	0.91	117.49
⊠	18-2	0.30	115.79
▲	18-3	1.52	116.78

Date July 2018

GWP# 4076-13-00

THURBER

Prep'd KCP

Chkd. FG

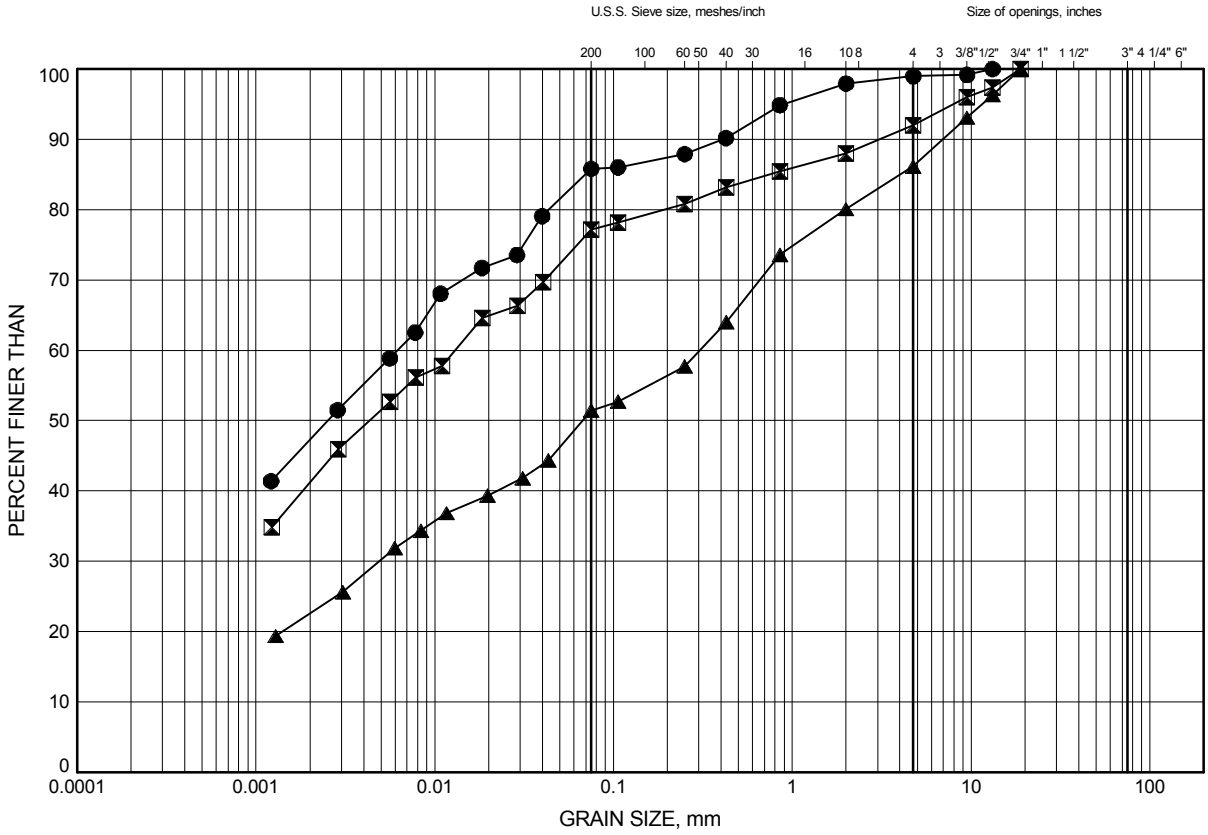
GRAIN SIZE DISTRIBUTION - THURBER 20479 DOUGLAS CREEK CULVERT.GPJ 30/7/18

Site 29-155/C Douglas Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE 2

Fill: Clay with Sand and Silt to Sandy Clay with Silt some Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-2	2.13	113.96
⊠	18-3	2.74	115.56
▲	18-4	0.91	115.09

Date July 2018

GWP# 4076-13-00

THURBER

Prep'd KCP

Chkd. FG

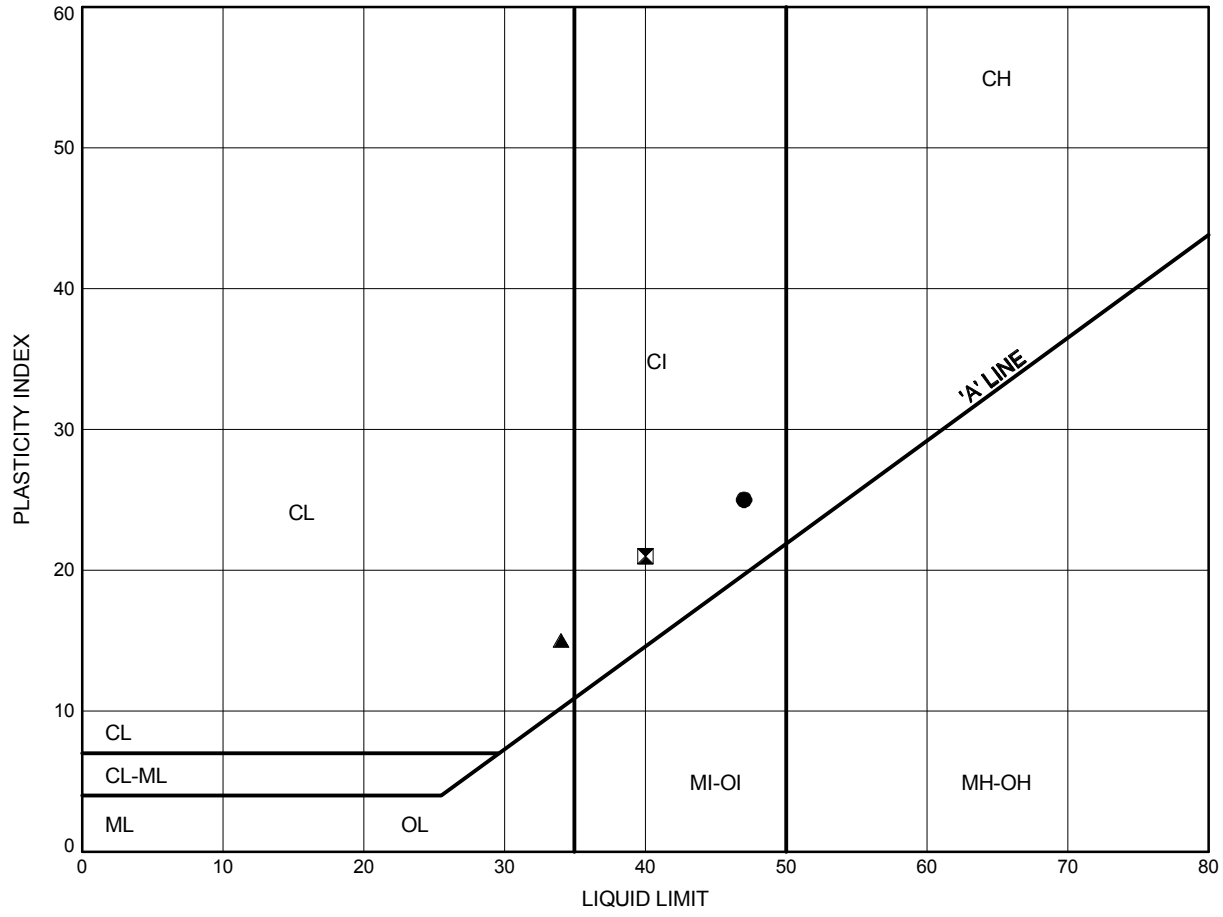
GRAIN SIZE DISTRIBUTION - THURBER 20479 DOUGLAS CREEK CULVERT.GPJ 30/7/18

Site 29-155/C Douglas Creek Culvert

ATTERBERG LIMITS TEST RESULTS

FIGURE 3

Fill: Clay with Sand and Silt to Sandy Clay with Silt some Gravel



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-2	2.13	113.96
⊠	18-3	2.74	115.56
▲	18-4	0.91	115.09

Date July 2018

GWP# 4076-13-00

THURBER

Prep'd KCP

Chkd. FG

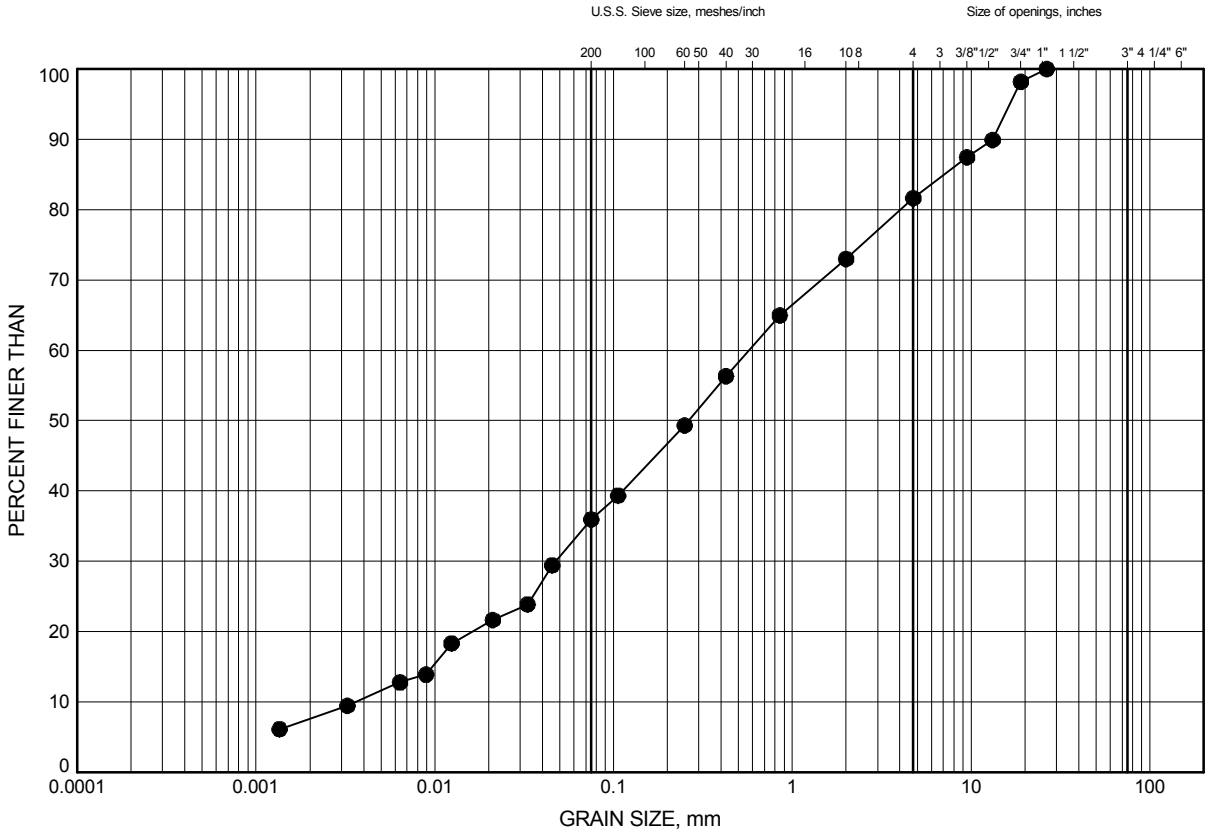
THURBALT 20479 DOUGLAS CREEK CULVERT.GPJ 31/7/18

Site 29-155/C Douglas Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE 4

Silty Sand with Gravel Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-1	5.18	113.22

Date July 2018

GWP# 4076-13-00

THURBER

Prep'd KCP

Chkd. FG

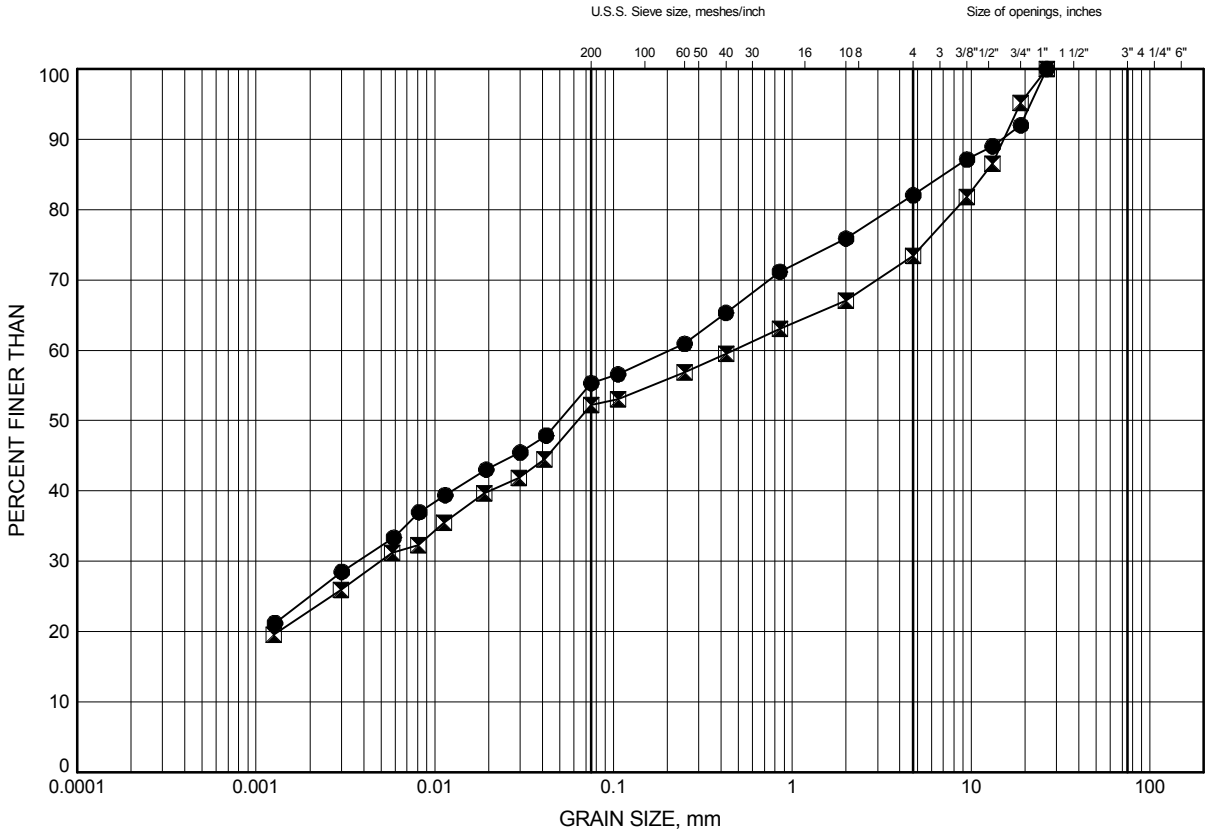
GRAIN SIZE DISTRIBUTION - THURBER 20479 DOUGLAS CREEK CULVERT.GPJ 30/7/18

Site 29-155/C Douglas Creek Culvert

GRAIN SIZE DISTRIBUTION

FIGURE 5

Sandy Clay with Gravel to Gravely Clay with Sand Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-2	3.76	112.34
⊠	18-4	2.01	114.00

Date July 2018

GWP# 4076-13-00

THURBER

Prep'd KCP

Chkd. FG

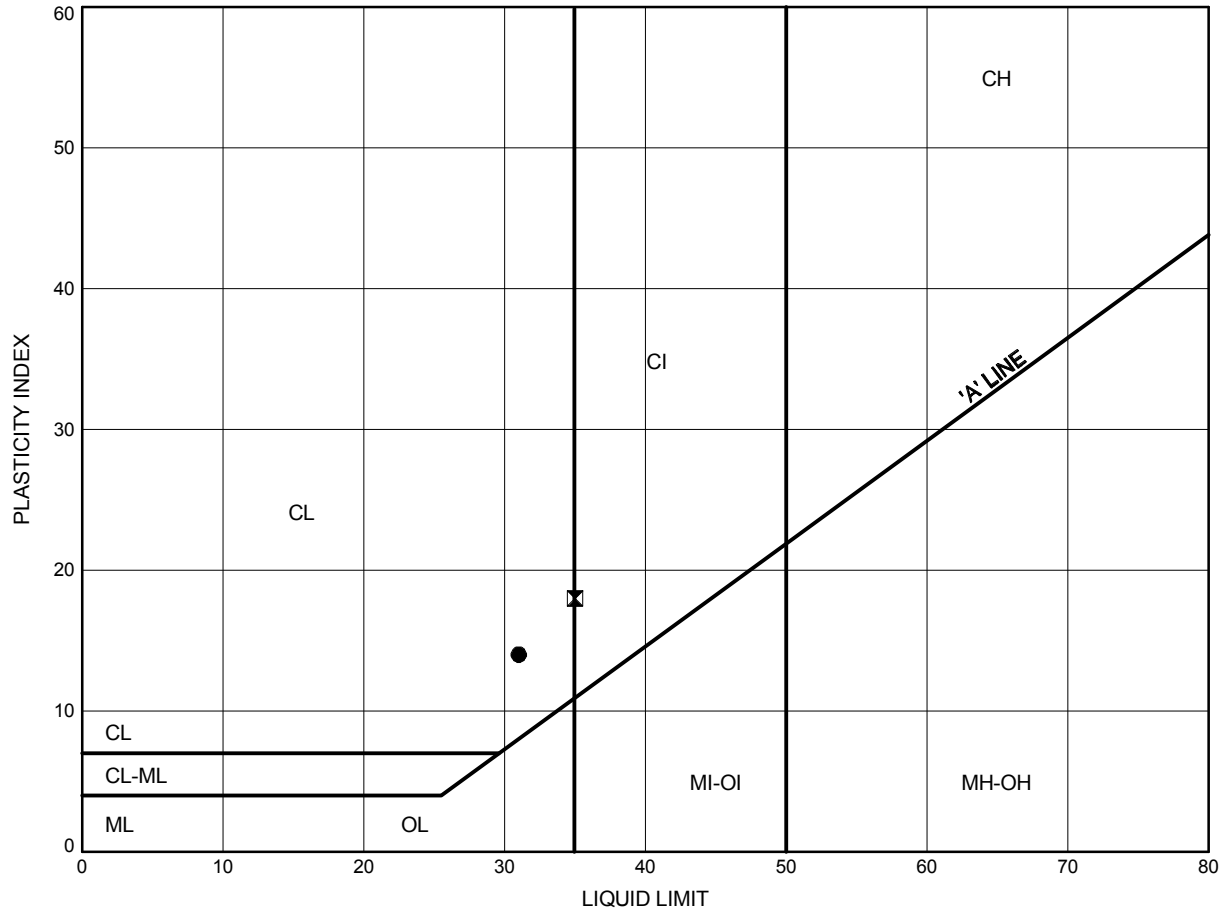
GRAIN SIZE DISTRIBUTION - THURBER 20479 DOUGLAS CREEK CULVERT.GPJ 30/7/18

Site 29-155/C Douglas Creek Culvert

ATTERBERG LIMITS TEST RESULTS

FIGURE 6

Sandy Clay with Gravel to Gravely Clay with Sand Till



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18-2	3.76	112.34
⊠	18-4	2.01	114.00

Date July 2018

GWP# 4076-13-00

THURBER

Prep'd KCP

Chkd. FG

THURBALT 20479 DOUGLAS CREEK CULVERT.GPJ 30/7/18

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

March 28, 2018
File: 122410864

Attention: **Thurber Engineering Ltd., File #20479**

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
18-1 (Run 1)	21'11"-22'4"	107.4	Two well formed cones on either end
18-2 (Run 2)	14'2"-14'9"	85.7	Well formed cone on bottom, diagonal cracks through top
18-3 (Run 1)	14'1"-15'1"	217.7	Two well formed cones on either end
18-3 (Run 3)	17'-17'5"	189.1	Well formed cone on bottom, cracks through rest of core
18-4 (Run 1)	7'2"-7'9"	110.2	Two well formed cones on either end

Sincerely,

Stantec Consulting Ltd

Brian Prevost

Brian Prevost
Laboratory Supervisor
Tel: 613-738-6075
brian.prevost@stantec.com

v:\01216\active\laboratory_standing_offers\2018 laboratory standing offers\122410864 thurber engineering ltd\rock cores\march 27, 2018 - douglas creek #20479\march 27, 2018 - rock core summary letter - #20479.doc

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Certificate of Analysis

Thurber Engineering Ltd.

2460 Lancaster Rd, Unit 107
Ottawa, ON K1B4S5
Attn: Kenton Power

Client PO:
Project: 20479 Douglas
Custody: 39591

Report Date: 27-Feb-2018
Order Date: 22-Feb-2018

Order #: 1808293

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

Paracel ID	Client ID
1808293-01	SS3 4'-6' BH18-1
1808293-02	SS4 6'-8' BH18-3

Approved By:

Mark Foto, M.Sc.
Lab Supervisor

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

Report Date: 27-Feb-2018
Order Date: 22-Feb-2018
Project Description: 20479 Douglas

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	23-Feb-18	24-Feb-18
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	23-Feb-18	23-Feb-18
Resistivity	EPA 120.1 - probe, water extraction	27-Feb-18	27-Feb-18
Solids, %	Gravimetric, calculation	23-Feb-18	23-Feb-18

Certificate of Analysis

Client: Thurber Engineering Ltd.

Client PO:

Report Date: 27-Feb-2018

Order Date: 22-Feb-2018

Project Description: 20479 Douglas

	Client ID:	SS3 4'-6' BH18-1	SS4 6'-8' BH18-3	-	-
	Sample Date:	08-Feb-18	15-Feb-18	-	-
	Sample ID:	1808293-01	1808293-02	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	95.6	79.5	-	-
General Inorganics					
pH	0.05 pH Units	8.46	8.34	-	-
Resistivity	0.10 Ohm.m	105	31.7	-	-
Anions					
Chloride	5 ug/g dry	19	61	-	-
Sulphate	5 ug/g dry	<5	14	-	-

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

Report Date: 27-Feb-2018
Order Date: 22-Feb-2018
Project Description: 20479 Douglas

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									
Resistivity	ND	0.10	Ohm.m						

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

Report Date: 27-Feb-2018
Order Date: 22-Feb-2018
Project Description: 20479 Douglas

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	8.3	5	ug/g dry	8.6			3.7	20	
Sulphate	6.88	5	ug/g dry	7.50			8.5	20	
General Inorganics									
pH	8.05	0.05	pH Units	8.07			0.2	10	
Resistivity	11.5	0.10	Ohm.m	11.5			0.5	20	
Physical Characteristics									
% Solids	86.1	0.1	% by Wt.	88.3			2.6	25	

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

Report Date: 27-Feb-2018
Order Date: 22-Feb-2018
Project Description: 20479 Douglas

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	100	5	ug/g	8.6	91.5	78-113			
Sulphate	112	5	ug/g	7.50	104	78-111			

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.

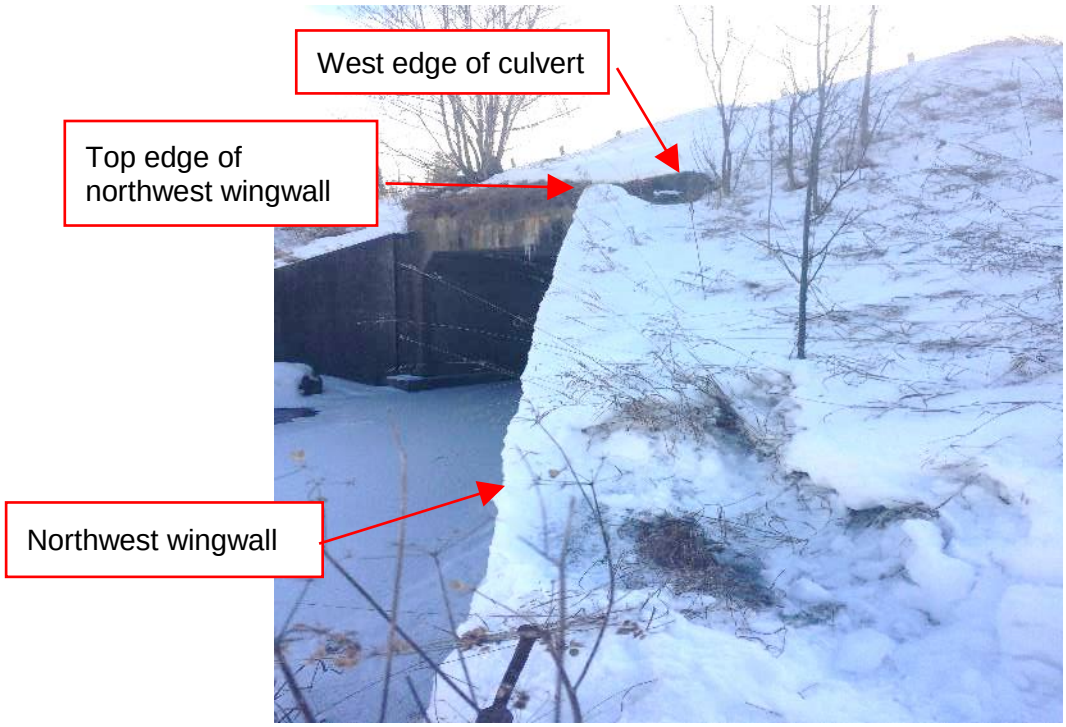
Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

APPENDIX D

SITE PHOTOGRAPHS

Photograph 1: Looking east along the north embankment towards the culvert inlet (2017/12/20)

Photograph 2: Looking downstream towards the culvert inlet (2017/12/20)



Photograph 3: Looking southeast along existing the northwest wingwall (2017/12/20)

Photograph 4: Rotation of northwest wingwall (2018/02/16)

Photograph 5: Rotation of northeast wingwall (2017/01/17)

Photograph 6: Looking west along embankment behind northwest wingwall (2017/12/20)

Photograph 7: Looking east along embankment behind northeast wingwall (2017/12/20)

Photograph 8: Looking upstream north of the inlet (2018/01/15)