THURBER ENGINEERING LTD.

PRELIMINARY
FOUNDATION INVESTIGATION REPORT
HIGHWAY 17 TWINNING, RENFREW AREA
CULVERTS 26 AND 26N
STA. 13+227, MCNAB TOWNSHIP
WP 4068-09-00 / ASSIGNMENT NO. 4018-E-0009

Geocres No.: 31F07-007

Report to:

Ministry of Transportation Ontario

Latitude: 45.447032°
Longitude: -76.565280°

December 2024
Thurber File No.: 24726

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THURBER

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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

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

This report addresses the Highway 17 culvert crossing located near Station 13+227 in McNab-Braeside Township (McNab) within Renfrew County, Ontario. The existing Highway 17 alignment at this site will become the future Highway 17 eastbound lanes and new westbound lanes will be constructed to the north of the existing alignment at this location. The existing culvert (Culvert 26) will be replaced, and a new culvert (Culvert 26N) is required to convey Liffey Creek below the embankment supporting the proposed Highway 17 westbound lanes.

This section of the report presents the factual findings obtained from the foundation investigation conducted by Thurber as part of the current study.

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.

It should be noted that the use of and reliance on Part 1 of the Report is governed by and limited to the terms and conditions set out in the Report and a reliance letter. The Preferred Proponent remains responsible to assess the need for additional investigations and to complete that work.

2 SITE DESCRIPTION

2.1 General

For project purposes, Highway 17 is herein described as oriented east-west, and the culvert is described as oriented north-south. The culvert crosses Highway 17 at Sta. 13+227 McNab, which is approximately 260 m west of McCallum Drive.

In the area of the culvert, the existing Highway 17 is a three-lane highway including a westbound passing lane and has a posted speed limit of 90 km/h. The highway profile is inclined at about 3% down to the east towards McCallum Drive. To the west, the highway profile continues to rise at the same incline to approximately 800 m west of the culvert site. The shoulders have a total width of approximately 3.5 m and 1.5 m in the east- and westbound directions, respectively. Approximately 0.5 m of the shoulders are paved. Galvanized W beam guiderails on metal posts are present along both shoulders. The traffic volume for this section of Highway 17 is understood to have been 13,900 AADT in 2016.

The culvert under the existing Highway 17 was not visible during the field investigation. The existing culvert was assumed flooded. Water was ponding near the inlet and outlet with surface of the ponded water at approximate elevation 152.5 m on July 26, 2024. The existing culvert is reported to be a 1,000 mm diameter, corrugated steel pipe (CSP) culvert oriented approximately perpendicular to the highway alignment. At the time of the field investigation, no discernible creek flow was present, but it is assumed based on the site topography that the creek water flows under the highway embankment from south to north. Drawings provided by MTO indicate the existence of natural springs near Station 13+400 by the eastbound embankment toe.

Embankment side slopes, in the vicinity of the site, are inclined at approximately 1.9H:1V on the north side and 2.3H:1V on the south side. The existing embankment side slopes at the culvert site did not show any visible signs of global instability at the time of the investigation.

The site is in a rural setting and the area directly adjacent to the highway is undeveloped and densely vegetated with coniferous and deciduous trees. The terrain along the ditch line is relatively rugged in the vicinity of the culvert site. A low-lying marshy area with grasses and ponded water is located on both sides of the highway. Rockfill material is present immediately north of the highway westbound embankment toe. Rock outcrops are visible approximately 150 m east and west of the culvert site. Overhead utility lines are not present.

Photographs of the project area are included in Appendix D. These photographs show the existing condition of the highway embankment at the time of the field investigation.

2.2 Site Geology

Under the same MTO Assignment a Foundation investigation was conducted by Thurber in several high fill locations within the Highway 17 twinning project boundaries. The available information was reviewed prior to this investigation and can be found in the Geocres Library under Geocres Number 31F00-235. Borehole N-HF-02 from that investigation is relevant to the present report and has been included in Appendix B.

According to Crins et al. 2009[1] the project area is described as Ecoregion 6E (Lake Simcoe-Rideau Ecoregion) within the Mixedwood Plains Ecozone. According to Wester et al. 2018[2] the

[1] *https://files.ontario.ca/mnrf-ecosystemspart1-accessible-july2018-en-2020-01-16.pdf*
[2] *https://files.ontario.ca/ecosystems-ontario-part2-03262019.pdf*

ecoregion is subdivided into Ecodistrict 6E-16 (Pembroke Ecodistrict). The area is characterized by glaciolacustrine dominated landscape overlying a mix of Paleozoic to Precambrian bedrock.

Based on published geological information in *The Physiography of Southern Ontario* by Chapman and Putnam (1984), the site lies within the physiographic region known as the Ottawa Valley Clay Plains. The Ottawa Valley Clay Plains are characterized primarily by clay plains deposited by the Champlain Sea (Leda Clay) interrupted by ridges of rock or sand.

Ontario Geological Survey Map P.3784[3] suggests the bedrock in the project area comprises felsic intrusive rocks, such as monzogranites to syenogranites.

3 SITE INVESTIGATION AND FIELD TESTING

Borehole N-HF-02 was drilled off-road on November 17, 2020, using a CME 850 track mounted drill rig equipped with hollow stem augers.

The foundation investigation and field-testing program was augmented between February 20 and March 22, 2024, and consisted of one on-road borehole identified as SC26-2 and four off-road boreholes identified as SC26-1, SC26-3, SC-26-4, and SC26-5. The on-road borehole was advanced with a CME 75 truck mounted drill rig utilizing hollow stem augers, NW casing, and coring techniques in the cobbles and boulders and bedrock. The off-road Boreholes SC26-3, SC26-4, and SC26-5 were advanced with a CME 55 track mounted drill rig utilizing hollow stem augers, NW casing, and coring techniques in bedrock. Borehole SC26-1 was advanced with portable drilling equipment. Prior to commencement of drilling, utility clearances were obtained in the vicinity of the borehole locations.

A summary of the borehole coordinates, elevations, and termination depths is provided in Table 3-1. The locations and elevations of the boreholes were surveyed by Thurber with a Trimble Catalyst DA1 antenna with centimeter accuracy and were measured relative to BM HCP 102 (Elevation 129.023 m) and BM HCP 118 (Elevation 139.303 m). Horizontal locations were measured by Thurber relative to existing site features. The elevations and borehole coordinates were reviewed and referenced to the survey data provided by the MTO. The borehole coordinates and elevations are shown on the Borehole Location and Soil Strata drawing included in Appendix A and on the individual Record of Borehole sheets included in Appendix B. The borehole coordinates are referenced to MTM Zone 9.

Table 3-1: Borehole Summary

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
SC26-1	Near Culvert 26 Inlet	5 034 061.8 (45.446469)	299 720.0 (-76.564941)	152.7	4.1

[3] *http://www.geologyontario.mndm.gov.on.ca/mines/data/google/mrd126/doc.kml*

Borehole No.	Drilled Location	Northing (Latitude)	Easting (Longitude)	Ground Surface Elevation (m)	Termination Depth (m)
SC26-2	Existing Westbound Shoulder	5 034 094.3 (45.446761)	299 701.4 (-76.565181)	160.2	15.8
SC26-3	Near Culvert 26 Outlet	5 034 121.9 (45.447009)	299 715.5 (-76.565001)	154.0	13.8
SC26-4	Near Culvert 26N Inlet	5 034 124.4 (45.447032)	299 693.5 (-76.565281)	153.6	9.8
SC26-5	Near Culvert 26N Outlet	5 034 160.6 (45.447358)	299 676.1 (-76.565504)	151.0	8.5
N-HF-02	Near Proposed Eastbound Lanes	5 034 144.4 (45.447212)	299 663.0 (-76.565671)	151.6	7.2

Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D 1586. The portable drill used for Borehole SC26-1 was equipped with a full weight hammer, thus no adjustments were necessary for the SPT N values.

A 25 mm diameter piezometer was installed in each of Borehole SC26-1 and N-HF-02, and 50 mm diameter monitoring wells were installed in Boreholes SC26-3 and SC26-5 to allow for measurements of the groundwater level after drilling. The details for the piezometer and well installations are illustrated on the respective Record of Borehole sheets provided in Appendix B. The piezometers and monitoring wells installed as part of the current investigation will be decommissioned by Thurber, as outlined in the Hydrogeological Investigation and Design Report.

Boreholes SC26-2 and SC26-4 were backfilled in accordance with MOE requirements (O.Reg 903, as amended). Borehole SC26-2 was capped with cold patch asphalt to reinstate the pavement surface.

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 to Thurber's Ottawa laboratory for further examination and testing.

4 LABORATORY TESTING

Laboratory testing was selected in accordance with the current MTO Guideline for Foundation Engineering Services, Section 5. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all retained soil samples. At least 25% of the recovered soil samples were subjected to testing for grain size distribution analysis and, where

appropriate, Atterberg Limits in accordance with MTO and ASTM standards. Chemical analysis for determination of pH, conductivity, resistivity, sulphide, sulphate, and chloride was carried out on two soil samples.

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

5 GENERAL DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix B and the Borehole Location and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in the following sections. However, the factual data presented on the Borehole Records takes precedence over the Soil Strata Drawing and the general description. It must be recognized that the soil and groundwater conditions may vary between and beyond borehole locations. Soil descriptions are in accordance with the MTO Guideline for Foundation Engineering Services (GFES) Manual (April 2022) and the 4th Edition of the Canadian Foundation Engineering Manual.

In general, the encountered stratigraphy below the existing fills and surficial peat and topsoil consists of a native deposit silty sand to sandy silt underlain by glacial till over bedrock.

5.1 Embankment Fill

5.1.1 Asphalt

A 115 mm thick layer asphalt was encountered at the ground surface in Borehole SC26-2.

5.1.2 Sand to Sandy Silt Fill

A fill layer consisting of sand to silty sand to sandy silt with varying amounts of gravel and organics was encountered below the asphalt in Borehole SC26-2 and at the ground surface in Boreholes SC26-3 and SC26-4. The thickness of the layer ranged from 0.7 to 2.9 m (base elev. at 159.4 to 151.1 m). The SPT N values ranged from 4 to 53 blows, indicating a loose to very dense condition.

The moisture content of the samples tested ranged from 2 to 46%. The results of grain size analyses conducted on a sample of this fill material are summarized in the table below and are illustrated on Figure C1 in Appendix C.

Summary of Grain Size Distribution Testing – Sand to Sandy Silt Fill

Soil Particle	Percentage (%)
Gravel	38
Sand	53
Silt & Clay	9

5.1.3 Gravel to Cobbles and Boulders Rockfill

A rockfill layer consisting of gravel to cobbles and boulder sized particles was encountered below the silty sand to sandy silt fill in Boreholes SC26-2 and SC26-4. The thickness of the layer ranged from 2.2 to 7.6 m (base elev. at 151.8 and 150.6 m). The cobbles and boulders rockfill was interbedded with sand; voids were noted between boulders. Varying amounts of sand and silt were encountered throughout the layer. The SPT N values ranged from 5 to 41 blows but were typically greater than 11 blows, indicating a compact to dense condition. SPT refusal was encountered at several depths in Borehole SC26-2; coring techniques were required to advance the borehole. Rock particle sizes of 200 mm and 300 mm were noted in the recovered cores.

The moisture content of the samples tested ranged from 1 to 21% but were typically less than 10%. The results of grain size analyses conducted on a sample of the gravel with silt and sand fill material are summarized in the table below and are illustrated on Figure C2 in Appendix C. It is noted that the gradation test results may be biased to smaller particle sizes due to the physical limitations of the split spoon sampler.

Summary of Grain Size Distribution Testing – Gravel with Silt and Sand Fill

Soil Particle	Percentage (%)
Gravel	64
Sand	28
Silt & Clay	8

5.2 Topsoil

A 200 mm thick layer of topsoil was encountered at the ground surface in Borehole N-HF-02.

5.3 Peat

A native deposit of coarse fibrous peat was encountered at the ground surface in Borehole SC26-5. The thickness of the layer was 0.8 m (base elev. 150.2 m). The layer is described as very soft based on tactile evaluations of strength. The moisture content of a sample tested was 536%.

5.4 Silty Sand to Sandy Silt

A native deposit of silty sand to sandy silt was encountered at the ground surface in Borehole SC26-1, below the sand to silty sand fill in Borehole SC26-3, below the gravel rockfill in Borehole SC26-4, below the peat in Borehole SC26-5, and below the topsoil in Borehole N-HF-02. Varying amounts of organics were noted within the layer. The thickness of the layer ranged from 1.2 to 6.1 m (base elev. 151.5 to 144.1 m). The SPT N-values recorded were between 2 and 38 blows indicating a very loose to dense relative density.

The moisture content of the samples tested ranged from 11 to 35%. The results of grain size analyses conducted in seven samples of this layer are summarized in the table below and are illustrated on Figure C3 and C4 in Appendix C.

Summary of Grain Size Distribution Testing – Silty Sand to Sandy Silt

Soil Particle	Percentage (%)
Gravel	0 – 1
Sand	8 – 59
Silt	34 – 73
Clay	6 – 19

The results of Atterberg Limits testing carried out in the fines portion of one sample of this material are summarized below and are illustrated on Figure C5 in Appendix C. The laboratory results indicate that the fines are of low plasticity (ML). The results of Atterberg Limit testing conducted on the fines portion of five other samples of the deposit indicate a non-plastic material.

Summary of Atterberg Limit Testing – Silty Sand to Sandy Silt

Parameter	Value
Liquid Limit	21
Plastic Limit	17
Plasticity Index	4

5.5 Sand to Sandy Silt to Gravel with Sand & Silt (Glacial Till)

A layer of sand to sandy silt to gravel with sand and silt till was encountered below the cobbles and boulders rockfill in Borehole SC26-2 and below the silty sand to sandy silt in all the other boreholes. Varying amounts of gravel, cobbles, and boulders were encountered throughout the layer. Where fully penetrated, the thickness of the layer ranged from 0.3 to 2.7 m (base elev. 151.2 to 146.9 m). The layer was not fully penetrated in Boreholes SC26-3, SC26-5 and N-HF-02 but was proven to extend to a depth of as much as 13.8 m below ground surface (elev. 140.2 m). SPT N-values ranged from 5 blows to refusal but were typically greater than 11 blows, indicating a compact to very dense relative density.

The moisture content of the samples tested ranged from 3 to 27%. The results of gradation analyses completed on seven samples of the layer are illustrated in Figures C6 and C7 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

Summary of Grain Size Distribution Testing – Sand to Silty Sand (Glacial Till)

Soil Particle	Percentage (%)	
Gravel	4 – 23	
Sand	65 – 72	
Silt	22 – 28	11 – 14
Clay	1 – 7	

The results of Atterberg Limit testing conducted on the fines portion of four samples of the deposit indicate a non-plastic material.

The base of the glacial till in Borehole SC26-5 was observed to be coarser gravel with silt and sand. Cobbles were also noted. The results of gradation analyses completed on a sample of the coarse till are illustrated in Figure C8 of Appendix C. The results of the tests are summarized below and on the Record of Borehole sheets in Appendix B.

Summary of Grain Size Distribution Testing – Gravel with Silt and Sand Till

Soil Particle	Percentage (%)
Gravel	74
Sand	19
Silt & Clay	7

5.6 Bedrock

Boreholes SC26-3, SC26-5 and N-HF-02 were terminated on auger refusal at elevations ranging from 140.2 to 144.4. Refusal could be due to the presence of bedrock or cobbles and boulders.

Bedrock was proven by coring in Boreholes SC26-1, SC26-2, and SC26-4. The bedrock surface sloped downwards from south to north with depths ranging from 1.5 to 11.1 m (elevation 151.2 to 146.9 m).

The bedrock encountered consisted of slightly weathered to fresh jointed, coarse grained, reddish pink to grey monzogranite. Photographs of the bedrock cores are provided in Appendix C. The rock core quality measurements are summarized in the Table 5-1.

Table 5-1: Bedrock Details

Parameter	Range
Total Core Recovery (TCR), %	79 – 100
Solid Core Recovery (SCR), %	22 – 90
Rock Quality Designation (RQD), %	30 – 85
Fracture Index (fractures per 0.3 m)(1)	0 – >10
Unconfined Compressive Strength (MPa)	71 – 126

Note: (1) Indicated as "FI" on Borehole Logs

The RQD values ranged from 30 to 85% indicating a bedrock of poor to good quality (CFEM, 2023). The results of unconfined compressive strength tests (UCS) ranged from 71 to 126 MPa, indicating that the tested samples of the bedrock are strong to very strong (CFEM, 2023). The UCS test results are included in Appendix C.

5.7 Groundwater

Piezometers with a 25 mm diameter were installed in Boreholes SC26-1 and N-HF-02, and monitoring wells with a 50 mm diameter were installed in Boreholes SC26-3 and SC26-5. The recorded groundwater levels are presented in Table 5-2.

Table 5-2: Summary of Groundwater Levels

Borehole No.	Bottom of Screen Elevation (m)	Groundwater Depth(a) (m)	Groundwater Elevation (m)	Date of Measurement
SC26-1	148.6	-0.4	153.1	April 09, 2024
		-0.4	153.1	May 01, 2024
		-0.1	152.8	June 10, 2024
		-0.3	153.0	June 28, 2024
		0.0	152.7	August 28, 2024
SC26-3	144.9	2.1	151.9	March 12, 2024
		2.1	151.9	March 22, 2024
		2.1	151.9	April 09, 2024
		2.1	151.9	May 01, 2024
		2.2	151.8	June 07, 2024
		2.2	151.8	June 26, 2024
		2.2	151.8	June 28, 2024
		2.3	151.7	July 15, 2024
		2.4	151.6	August 28, 2024

Borehole No.	Bottom of Screen Elevation (m)	Groundwater Depth[a] (m)	Groundwater Elevation (m)	Date of Measurement
SC26-5	144.9	-0.1	151.1	March 12, 2024
		-0.2	151.2	March 22, 2024
		-0.2	151.2	April 09, 2024
		-0.2	151.2	May 01, 2024
		0.0	151.0	June 10, 2024
		-0.2	151.2	June 26, 2024
		0.1	150.9	August 28, 2024
N-HF-02	144.9	0.0[b]	151.6	December 12, 2020
		0.5	151.1	September 23, 2021
		0.5	151.1	November 11, 2021
		-0.1[b]	151.7	January 24, 2022
		-0.1[c]	151.7	May 01, 2024
		0.4[c]	151.2	August 28, 2024

Notes: (a) negative ground water depths indicate artesian conditions
(b) piezometer water was frozen at the time of measurements
(c) water level taken after borehole log was finalized

The surface of the ponded water in the creek was at approximately elevation 152.5 m near the north and south embankment toes on July 26, 2024.

These observations are considered short term as they were recorded at discrete times, 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 creek water and groundwater levels may be at a higher elevation after periods of significant and/or prolonged precipitation.

5.8 Analytical Testing

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

Table 5-3: Results of Chemical Analysis

Borehole	Sample	Depth (m)	Chloride (µg/g)	Sulphate (µg/g)	Sulphide (%)	pH (-)	Resistivity (Ohm-cm)
SC26-3	SS5	3.0 – 3.6	82	16	< 0.01	6.79	3,870
SC26-5	SS4	2.3 – 2.9	92	45	0.02	7.17	3,270

6 MISCELLANEOUS

The borehole locations reflect existing site features and access constraints. The as-drilled locations and ground surface elevation were measured by Thurber following completion of the field program. Limitless Drilling Ltd. Renfrew, Ontario, supplied and operated the portable equipment and George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, supplied and operated the drill rigs used to drill, test, sample, and decommission the boreholes. Traffic control was performed in accordance with Ontario Book 7 and was provided by T.G. Carroll Cartage Ltd. of Carp, Ontario. The field investigation was supervised on a full-time basis by Mr. I. Khan, EIT, and Mr. D. Amorim Pereira, Geotechnical Technician, and Mr. R. Howarth, Geotechnical Technician. Overall supervision of the field investigation program was provided by Mr. J. Gray, P.Eng.

Routine geotechnical laboratory testing were completed by Thurber's laboratory in Ottawa. UCS testing were completed by Thurber's laboratory in Oakville. Analytical testing was completed by Paracel Laboratories Ltd. in Ottawa.

Interpretation of the factual data and preparation of this report was completed by I. Khan, EIT, and A. de Oliveira, P.Eng. The report was reviewed by Dr. F. Griffiths, P.Eng., and Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

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Appendix A.

Borehole Location Plan and Stratigraphic Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 4068-09-00

HIGHWAY 17 TWINNING
STATION 13+227, MCNAB TWP.
CULVERT 26/26N
BOREHOLE LOCAITON PLAN AND SOIL STRATA

SHEET 1

Ontario

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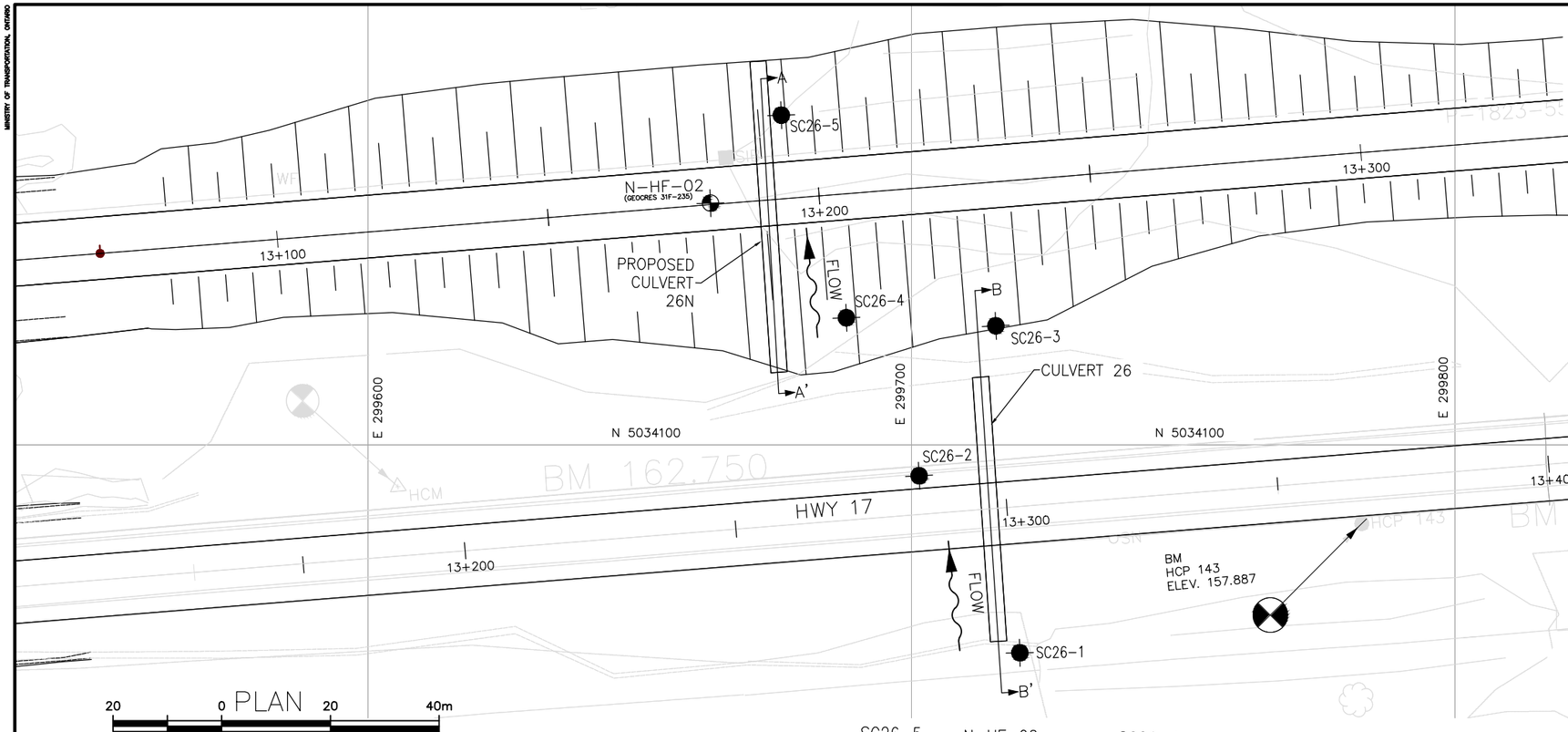

PLAN
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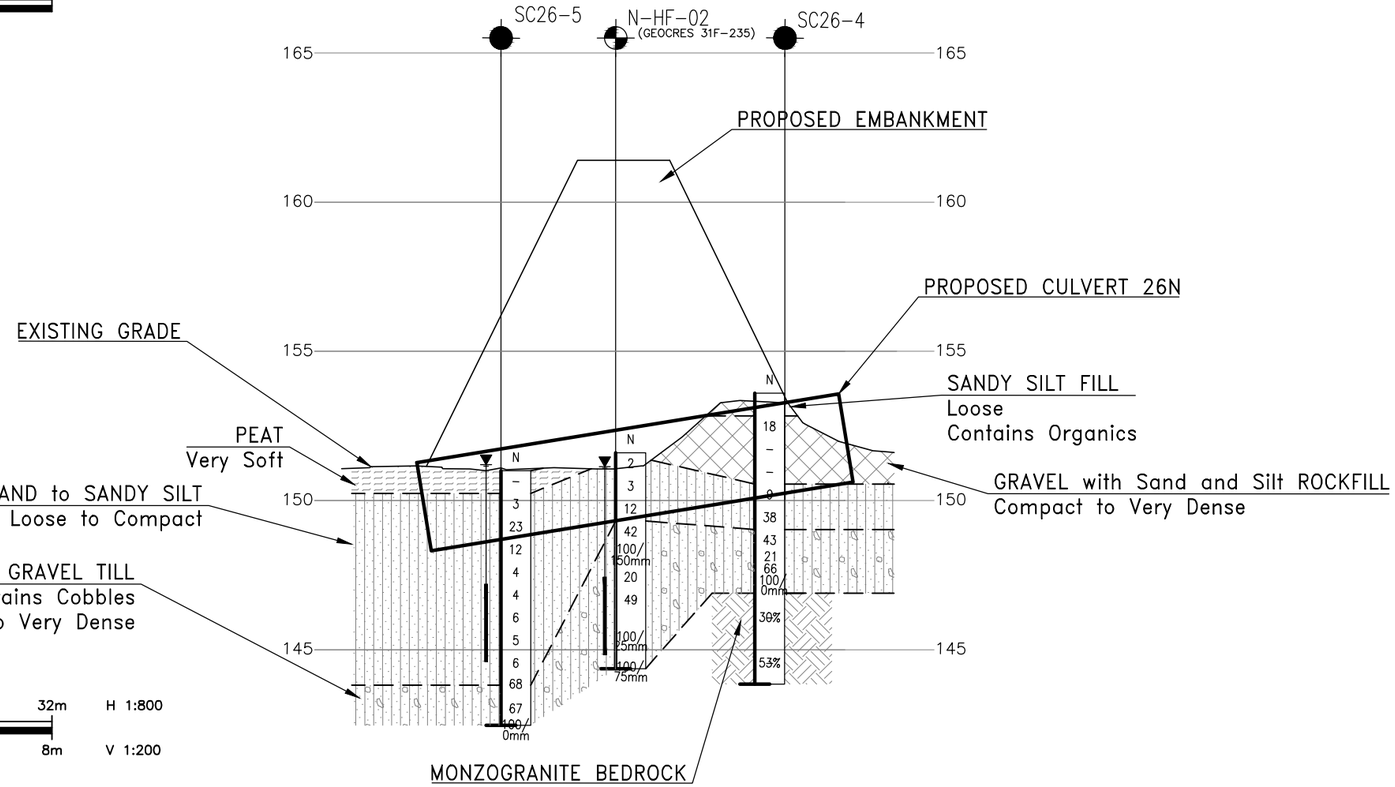

SECTION A-A'
16 0 16 32m H 1:800
4 0 4 8m V 1:200

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Dec 19, 2024
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Dec 19, 2024
PROVINCE OF ONTARIO

KEYPLAN

LEGEND

	Borehole
	Historic Borehole
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level Upon Completion of Drilling
	Water Level in Mointoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SC26-1	152.7	5 034 061.8	299 720.0
SC26-2	160.2	5 034 094.3	299 701.4
SC26-3	154.0	5 034 121.9	299 715.5
SC26-4	153.6	5 034 124.4	299 693.5
SC26-5	151.0	5 034 160.6	299 676.1
(GEOCRES 31F-235) N-HF-02	151.6	5 034 144.4	299 663.0

-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. 31F07-007

REVISIONS		
DATE	BY	DESCRIPTION

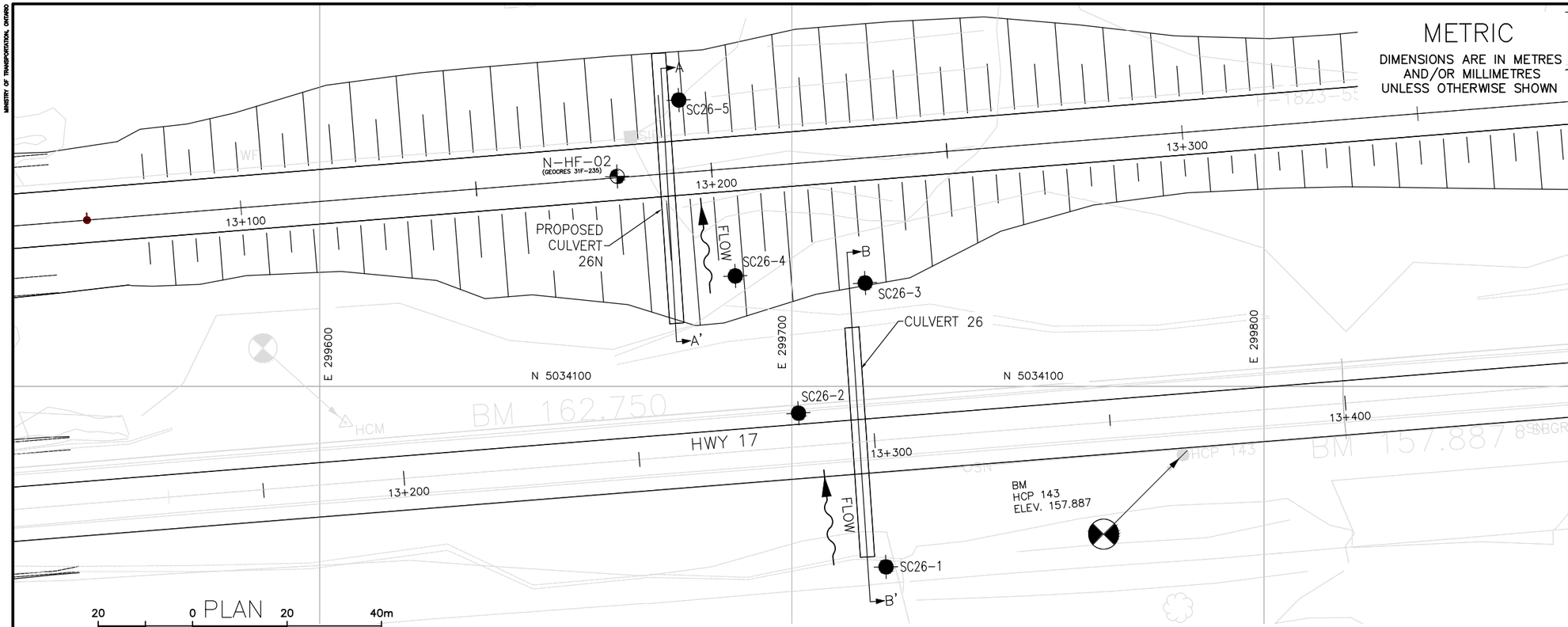
DESIGN	AO	CHK	–	CODE		LOAD	DATE NOV 2024
DRAWN	RH	CHK	FG	SITE		STRUCT	DWG 1

FILENAME: H:\Drafting\24000\24726\Culvert 26\TED-24726-BHPP-Culvert 26.dwg
PLOTDATE: 1/27/2024 5:05 PM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

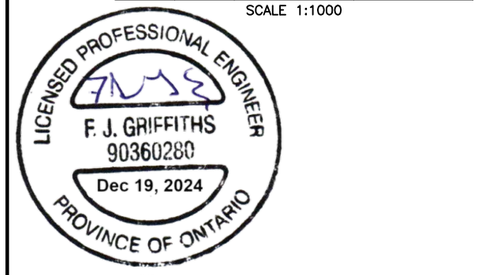
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

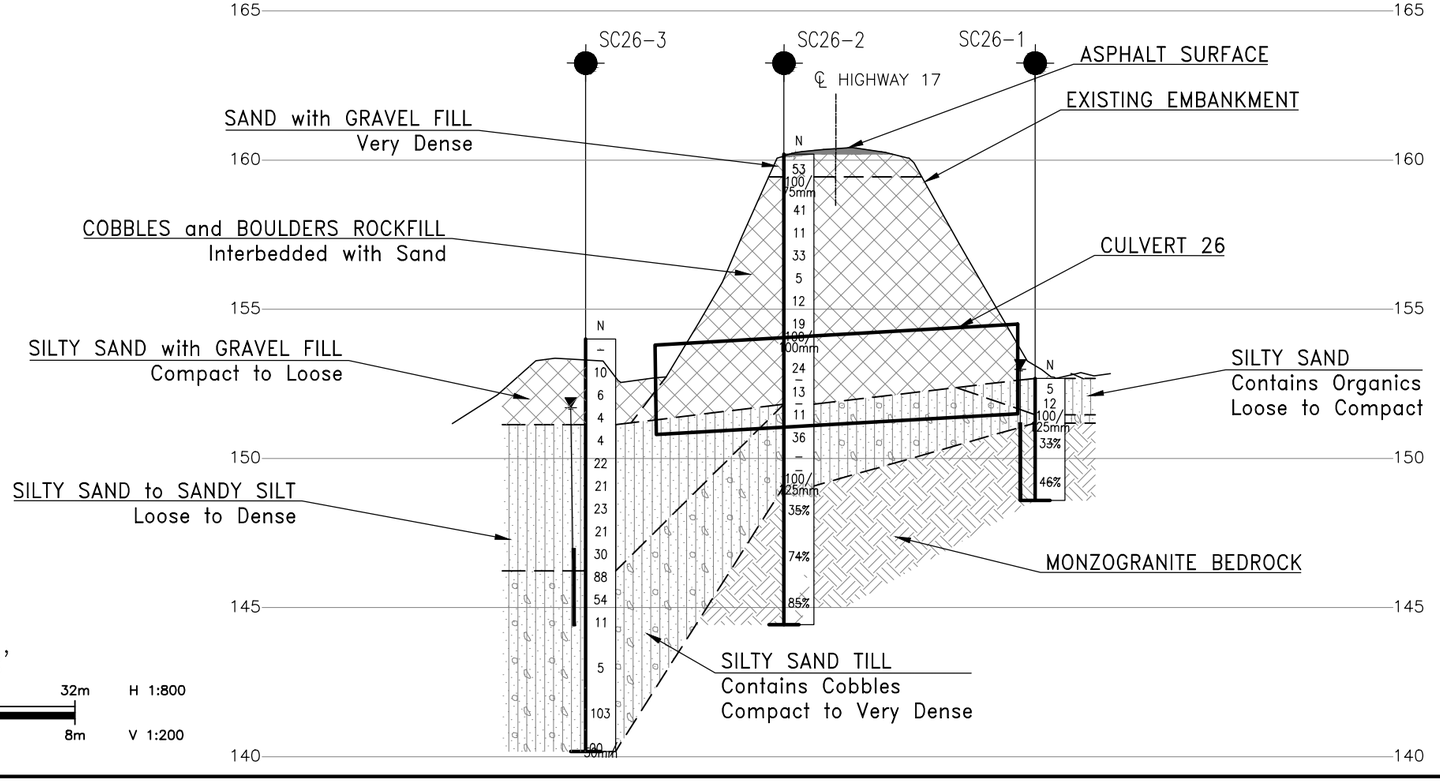


PLAN

20 0 20 40m

SCALE 1:1000





SECTION B–B'

16 0 16 32m H 1:800

4 0 4 8m V 1:200

CONT No

GWP No 4068-09-00

HIGHWAY 17 TWINNING
STATION 13+227, MCNAB TWP.
CULVERT 26/26N
BOREHOLE LOCATION PLAN AND SOIL STRATA

SHEET 1

Ontario

THURBER

KEYPLAN

LEGEND

●	Borehole
⊕	Historic Borehole
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Mointoring Well/Piezometer
┃	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
SC26-1	152.7	5 034 061.8	299 720.0
SC26-2	160.2	5 034 094.3	299 701.4
SC26-3	154.0	5 034 121.9	299 715.5
SC26-4	153.6	5 034 124.4	299 693.5
SC26-5	151.0	5 034 160.6	299 676.1
(GEOCRES 31F-235) N-HF-02	151.6	5 034 144.4	299 663.0

-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. 31F07-007

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	AO	CHK –	CODE	LOAD	DATE NOV 2024
DRAWN	RH	CHK FG	SITE	STRUCT	DWG 1

FILENAME: H:\Drafting\24000\24726\Culvert 26\TED-24726-BHPP-Culvert 26.dwg
PLOTDATE: 11/27/2024 5:06 PM

Appendix B.

Record of Borehole Sheets

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:

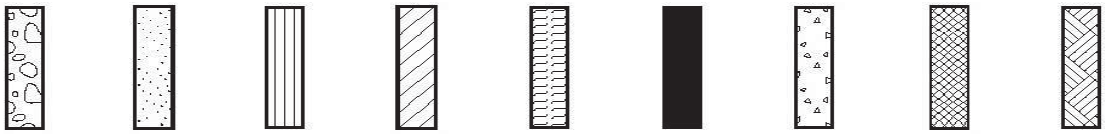
Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, 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 SC26-1 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.446469°, Long: -76.564941° Culvert 26/26N; McNab Township; MTM z9: N 5 034 061.8 E 299 720.0 ORIGINATED BY IK

HWY 17 BOREHOLE TYPE Portable / Tricone / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.03.22 - 2024.03.22 CHECKED BY JG

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 / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
152.7	**Ground Surface**										
0.0	**SILTY SAND** contains organics loose to compact dark brown to brown		1	SS	5						
			2	SS	12		152				
151.5											
1.2	**SILTY SAND (SM)**, trace gravel contains cobbles and boulders very dense brown **GLACIAL TILL**		3	SS	100/						14 72 14 (SI+CL)
151.2			4	NQ	125mm					FI	
1.5	**MONZOGRANITE BEDROCK** slightly weathered to fresh jointed reddish pink to grey coarse grained strong to very strong		1	RUN	-		151			>10	RUN #1 TCR=100% SCR=22% RQD=33%
										>10	
										10	
							150			4	
										1	
			2	RUN	-					1	RUN #2 TCR=79% SCR=63% RQD=46% UCS=126MPa
							149			3	
148.6										6	
4.1	**End of Borehole**										

Piezometer installed:
Schedule 40 PVC standpipe with 25-mm diameter and 1.5-m slotted screen. Stick-up cover installed at ground surface.

Water Level Readings:

DATE	DEPTH (m)	ELEV. (m)
2024/04/09	-0.4	153.1
2024/05/01	-0.4	153.1
2024/06/10	-0.1	152.8
2024/06/28	-0.3	153.0
2024/08/28	0.0	152.7

Note: Full-weight hammer was used to advance the split-spoons.

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC26-2 1 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.446761°, Long: -76.565181° Culvert 26/26N; McNab Township; MTM z9: N 5 034 094.3 E 299 701.4 ORIGINATED BY DAP

HWY 17 BOREHOLE TYPE CME 75 Truckmount / HSA / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.03.12 - 2024.03.12 CHECKED BY JG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
160.2	**Ground Surface**										
0.0	**ASPHALT (115 mm)**						160				
0.1	SAND with gravel very dense grey		1	SS	53						38 53 9 (SI+CL)
159.4	**FILL**										
0.8	COBBLES and BOULDERS interbedded with brown sand voids between larger boulders noted **ROCKFILL**		2	SS	100/ 75mm		159				
			3	SS	41						
			4	SS	11		158				
			5	SS	33		157				
			6	SS	5		156				
			7	SS	12		155				
			8	SS	19						
			9	SS	100/ 100mm		154				
	- 200 mm boulder at a depth of 6.2 m (elev. 154.0 m)		1	NQ	-						
			10	SS	24		153				
			2	NQ	-						
			11	SS	13						
	- 300 mm boulder at a depth of 8.0 m (elev. 152.2 m)		3	NQ	-		152				
151.8											
8.4	**SILTY SAND (SM)**, trace gravel contains cobbles compact to dense grey **GLACIAL TILL**		12	SS	11						4 67 22 7 Non-plastic
			13	SS	36		151				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC26-2 2 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.446761°, Long: -76.565181° Culvert 26/26N; McNab Township; MTM z9: N 5 034 094.3 E 299 701.4 ORIGINATED BY DAP

HWY 17 BOREHOLE TYPE CME 75 Truckmount / HSA / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.03.12 - 2024.03.12 CHECKED BY JG

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
	Continued From Previous Page										
	SILTY SAND (SM), trace gravel contains cobbles compact to dense grey **GLACIAL TILL**		1	GS	-		150				
			4	NQ	-						
149.1			14	SS	100/ 125mm					FI	
11.1	**MONZOGRANITE BEDROCK** slightly weathered to fresh jointed reddish pink to grey coarse grained strong to very strong						149			>10	
			1	RUN	-					>10	
										4	RUN #1 TCR=100% SCR=30% RQD=35%
							148			5	
										3	
										5	
										3	
							147			2	
			2	RUN	-					1	RUN #2 TCR=100% SCR=54% RQD=74%
										1	
							146			3	
										>10	
										2	
			3	RUN	-					2	RUN #3 TCR=100% SCR=90% RQD=85% UCS=73MPa
							145			0	
144.4											
15.8	**End of Borehole**										

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

15 20 10 5 (%) STRAIN AT FAILURE

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC26-3 1 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.447009°, Long: -76.565001° Culvert 26/26N; McNab Township; MTM z9: N 5 034 121.9 E 299 715.5 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.02.22 - 2024.02.22 CHECKED BY JG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
154.0	**Ground Surface**										
0.0	SILTY SAND with gravel compact to loose brown **FILL**		1	GS	-				○		
			2	SS	10		153		○		
			3	SS	6		152				
			4	SS	4	▽			○ ○		
151.1							151				
2.9	**SILTY SAND** to **SANDY SILT** loose to dense grey		5	SS	4				○		
			6	SS	22		150		○		0 32 55 13 Non-plastic
			7	SS	21		149		○		
			8	SS	23				○		
			9	SS	21		148		○		0 46 47 7 Non-plastic
			10	SS	30		147		○		
146.2											
7.8	**SILTY SAND (SM)**, trace gravel very dense to compact grey **GLACIAL TILL**		11	SS	88		146		○ ○		
			12	SS	54		145		○		7 68 23 2 Non-plastic
			13	SS	11				○		
							144				

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC26-3 2 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.447009°, Long: -76.565001° Culvert 26/26N; McNab Township; MTM z9: N 5 034 121.9 E 299 715.5 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.02.22 - 2024.02.22 CHECKED BY JG

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
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	SILTY SAND (SM), trace gravel loose to very dense grey **GLACIAL TILL**										
			14	SS	5		143		○		
							142				
			15	SS	103				○		7 70 22 1 Non-plastic
							141				
140.2			16	SS	100 / 50mm						
13.8	**End of Borehole** Borehole terminated upon Auger Refusal **Monitoring Well installed:** Schedule 40 PVC standpipe with 50-mm diameter and 3.0-m slotted screen. Stick-up cover installed at ground surface. **Water Level Readings:** **DATE DEPTH (m) ELEV. (m)** 2024/03/12 2.1 151.9 2024/03/22 2.1 151.9 2024/04/09 2.1 151.9 2024/05/01 2.1 151.9 2024/06/07 2.2 151.8 2024/06/26 2.2 151.8 2024/06/28 2.2 151.8 2024/07/15 2.3 151.7 2024/08/28 2.4 151.6										

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

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

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC26-4 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.447032°, Long: -76.565281° Culvert 26/26N; McNab Township; MTM z9: N 5 034 124.4 E 299 693.5 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.02.21 - 2024.02.21 CHECKED BY JG

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
153.6	**Ground Surface**										
0.0	SANDY SILT contains organics loose brown		1	GS	-		153				
152.8	**FILL**										
0.8	GRAVEL with sand and silt compact to dense brown **ROCKFILL**		2	SS	18		152				
			3	GS	-						
			4	GS	-		151				64 28 8 (SI+CL)
150.6											
3.0	**SILTY SAND** to **SANDY SILT** loose to dense brown to grey		5	SS	9		150				
			6	SS	38						0 42 50 8 Non-plastic
149.0											
4.6	**SILTY SAND (SM)**, trace gravel compact to very dense grey **GLACIAL TILL**		7	SS	43		149				
			8	SS	21		148				
			9	SS	66						4 66 28 2 Non-plastic
146.9			10	SS	100/0mm		147			FI	
6.7	**MONZOGRANITE BEDROCK** slightly weathered to fresh jointed reddish pink to grey coarse grained strong to very strong		1	RUN	-		146			7 9 3 6 10	RUN #1 TCR=96% SCR=51% RQD=30%
			2	RUN	-		145			6 5 2 3	RUN #2 TCR=100% SCR=70% RQD=53% UCS=71MPa
143.8							144			7	
9.8	**End of Borehole**										

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

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

(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC26-5 1 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.447358°, Long: -76.565504° Culvert 26/26N; McNab Township; MTM z9: N 5 034 160.6 E 299 676.1 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.02.20 - 2024.02.20 CHECKED BY JG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.0	**Ground Surface**								
0.0	**COARSE FIBROUS PEAT** very soft brown to black		1	GS	-				
150.2							150		
0.8	**SILTY SAND** to **SANDY SILT** very loose to compact brown to grey		2	SS	3				
			3	SS	23		149		0 59 34 7 Non-plastic
			4	SS	12		148		
			5	SS	4				
			6	SS	4		147		0 8 73 19
			7	SS	6		146		
			8	SS	5				
			9	SS	6		145		1 55 38 6 Non-plastic
144.1									
6.9	**SILTY SAND** to **GRAVEL** with sand and silt contains cobbles very dense grey **GLACIAL TILL**		10	SS	68		144		
			11	SS	67		143		74 19 7 (SI+CL)
142.5									
8.5	**End of Borehole** Borehole terminated upon Auger Refusal **Monitoring Well installed:** Schedule 40 PVC standpipe with 50-mm diameter and 3.0-m slotted screen. Stick-up cover installed at ground surface.		12	SS	100/0mm				

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

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

536

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No SC26-5 2 OF 2 METRIC

WP# 4068-09-00 LOCATION Lat: 45.447358°, Long: -76.565504° Culvert 26/26N; McNab Township; MTM z9: N 5 034 160.6 E 299 676.1 ORIGINATED BY RH

HWY 17 BOREHOLE TYPE CME 55 Trackmount / HSA / NW Casing / NQ Coring COMPILED BY AO

DATUM Geodetic DATE 2024.02.20 - 2024.02.20 CHECKED BY JG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	Water Level Readings:										
	DATE DEPTH (m) ELEV. (m)										
	2024/03/12 -0.1 151.1										
	2024/03/22 -0.2 151.2										
	2024/04/09 -0.2 151.2										
	2024/05/01 -0.2 151.2										
	2024/06/10 0 151.0										
	2024/06/26 -0.2 151.2										
	2024/08/28 0.1 150.9										

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

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

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 12-17-24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-HF-02 1 OF 1 METRIC

WP# 4068-09-00 LOCATION Lat: 45.447212°, Long: -76.565671° High Fills; MTM Zone 9: N 5 034 144.4 E 299 663.0 ORIGINATED BY AO

HWY 17 BOREHOLE TYPE CME 850 Trackmount / HSA COMPILED BY AO

DATUM Geodetic DATE 2020.11.17 - 2020.11.17 CHECKED BY JG

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
151.6	**Ground Surface**										
0.0	**TOPSOIL (200 mm)**										
0.2	**SANDY SILT (ML)** trace organics very loose to compact yellow-brown to grey-brown		1	SS	2		151				
			2	SS	3						
			3	SS	12		150				0 29 59 12
149.3											
2.3	**SAND (SW-SM)** with silt and gravel compact to very dense grey to black-brown **TILL**		4	SS	42		149				23 65 12 (SI+CL)
			5	SS	100/150mm		148				
			6	SS	20						
			7	SS	49		147				22 67 11 (SI+CL)
			8	SS	100/25mm		146				
							145				
144.4			9	SS	100/75mm						
7.2	**End of Borehole** Spoon and auger refusal on inferred bedrock. Piezometer installation consists of 25-mm diameter Schedule 40 PVC pipe with a 1.5-m slotted screen **Water Level Readings:** **DATE DEPTH (m) ELEV. (m)** 2020/12/16 0.0 (Frozen) 151.6 2021/09/23 0.5 151.1 2021/11/11 0.5 151.1 2022/01/24 -0.1 (Frozen) 151.7										

+ ³, × ³: Numbers refer to Sensitivity

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

DOUBLE LINE CULVERT 26 GINT LOGS.GPJ 2012TEMPLATE(MTO).GDT 11-21-24

Appendix C.

Laboratory Testing

THURBER

Appendix C.1

Particle Size Analysis Figures

Atterberg Limit Test Results

Unconfined Compressive Strength Testing Results

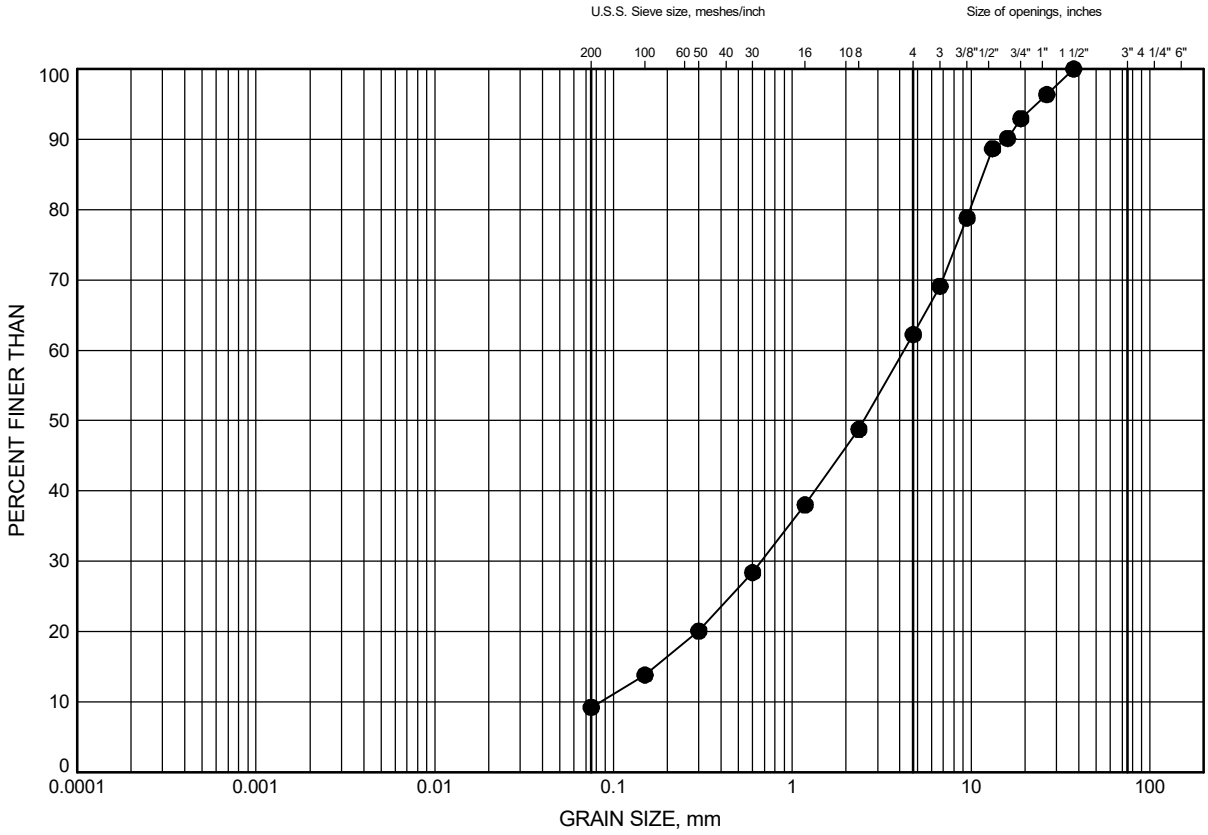
Rock Core Photos

Highway 17 Twinning, Culverts 26 and 26N

GRAIN SIZE DISTRIBUTION

FIGURE C1

FILL: Sand to Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC26-2	0.5	159.7

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

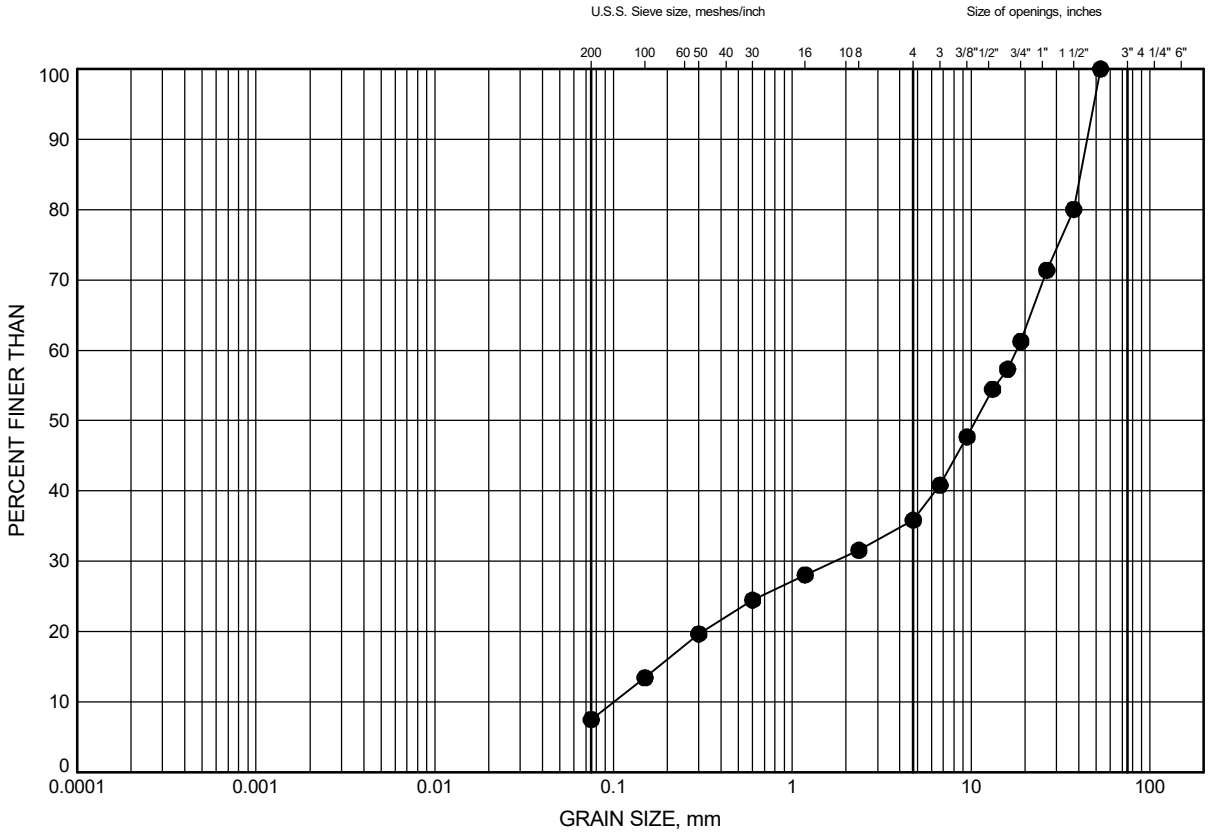
GRAIN SIZE DISTRIBUTION - THURBER CULVERT 26 GINT LOGS.GPJ 9-5-24

Highway 17 Twinning, Culverts 26 and 26N

GRAIN SIZE DISTRIBUTION

FIGURE C2

FILL: Gravel with Silt and Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC26-4	2.6	151.0

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

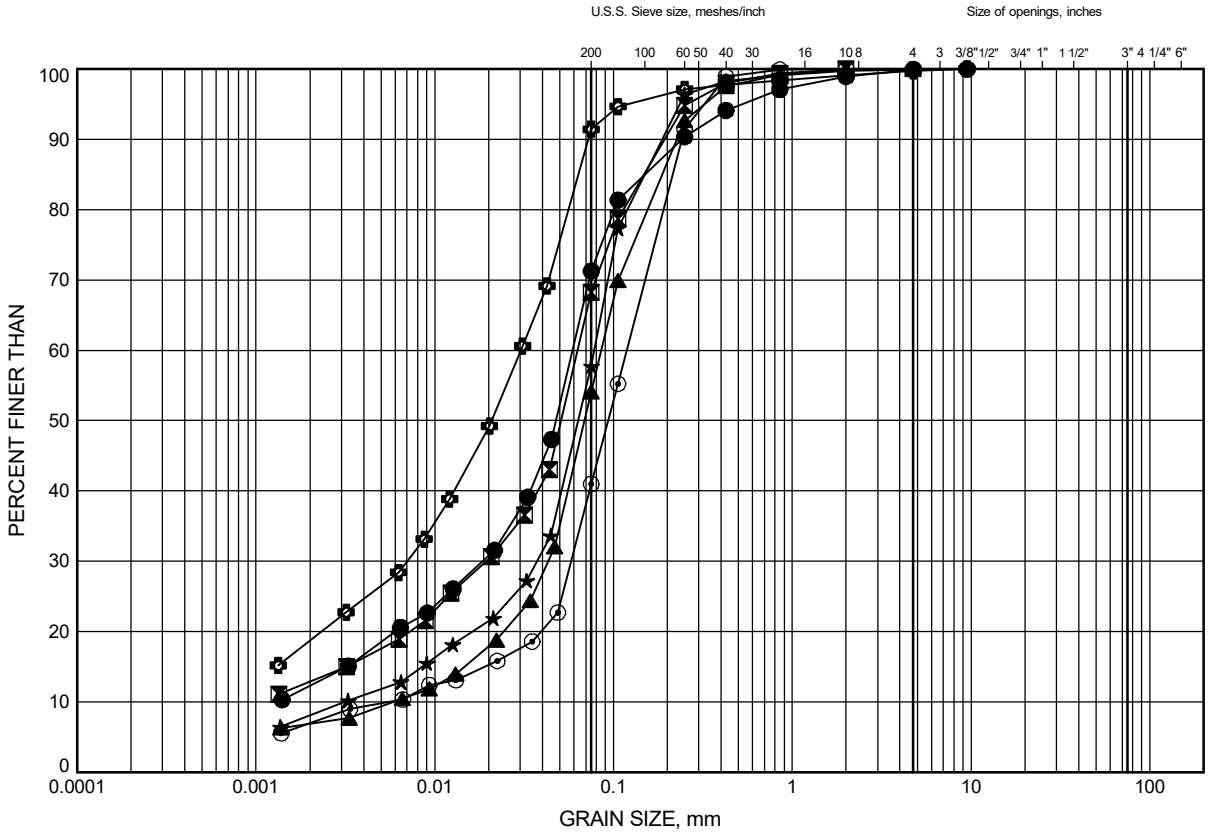
GRAIN SIZE DISTRIBUTION - THURBER CULVERT 26 GINT LOGS.GPJ 9-5-24

Highway 17 Twinning, Culverts 26 and 26N

GRAIN SIZE DISTRIBUTION

FIGURE C3

Silty Sand to Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	N-HF-02	1.8	149.8
⊠	SC26-3	4.1	149.9
▲	SC26-3	6.4	147.6
★	SC26-4	4.1	149.5
⊙	SC26-5	1.8	149.2
✿	SC26-5	4.1	146.9

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

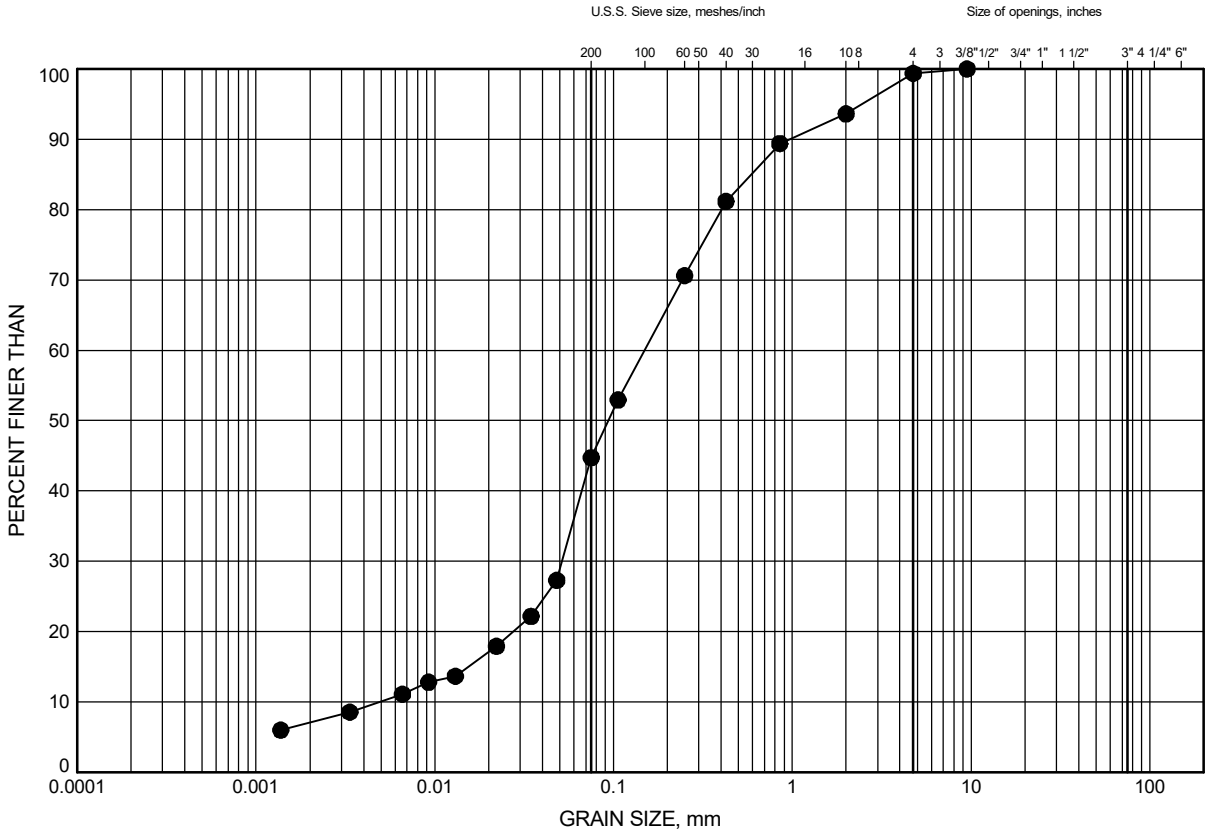
GRAIN SIZE DISTRIBUTION - THURBER CULVERT 26 GINT LOGS.GPJ 9-5-24

Highway 17 Twinning, Culverts 26 and 26N

GRAIN SIZE DISTRIBUTION

FIGURE C4

Silty Sand to Sandy Silt



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC26-5	6.4	144.6

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

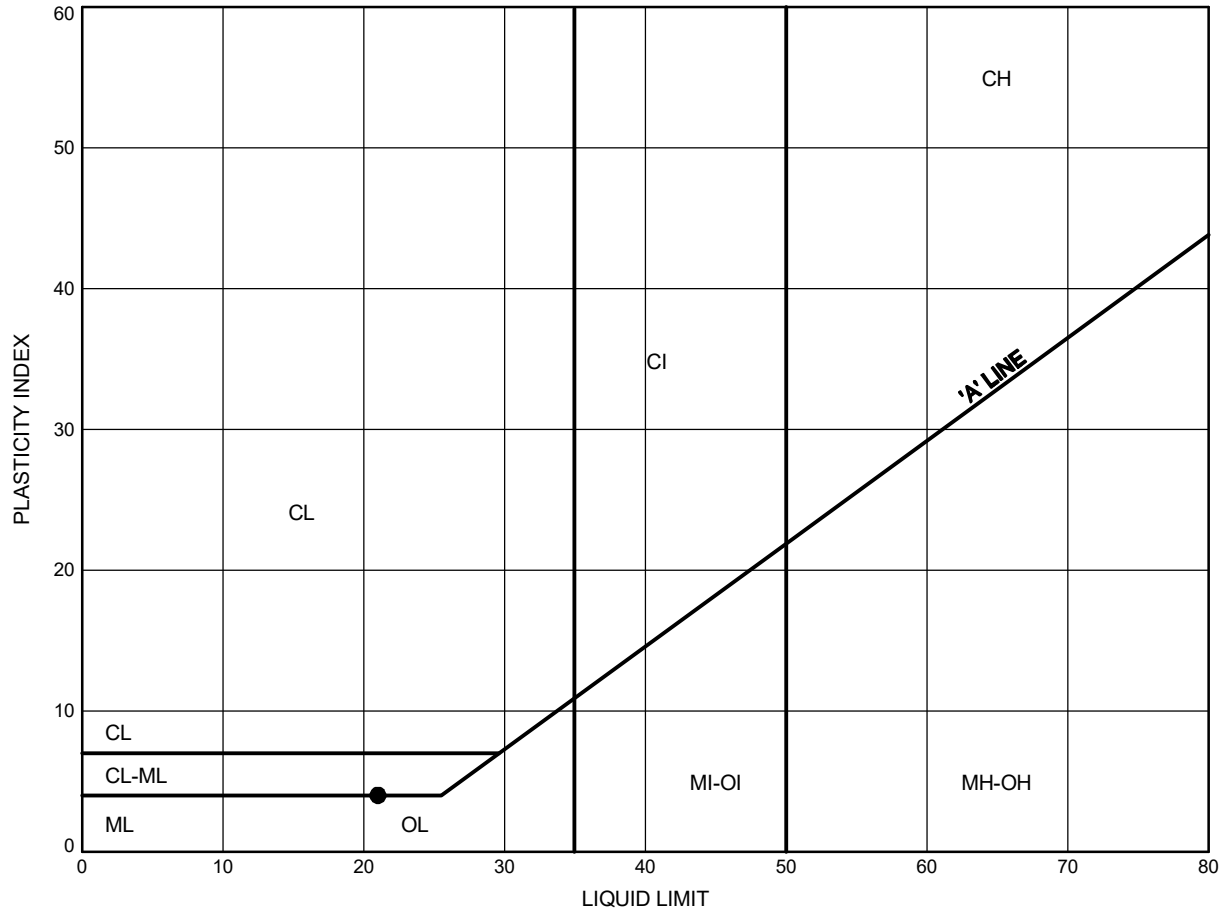
GRAIN SIZE DISTRIBUTION - THURBER CULVERT 26 GINT LOGS.GPJ 9-5-24

Highway 17 Twinning, Culverts 26 and 26N

ATTERBERG LIMITS TEST RESULTS

FIGURE C5

Silty Sand to Sandy Silt



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC26-5	4.1	146.9

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

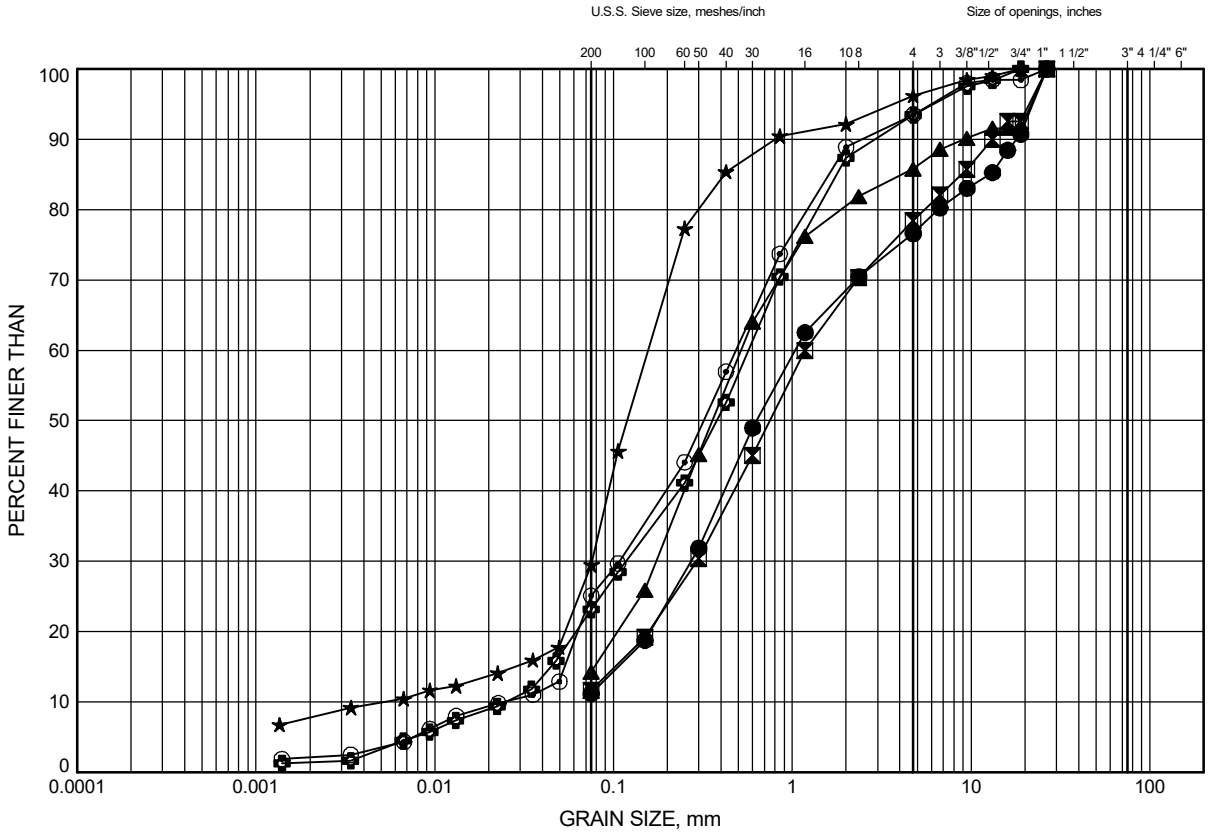
THURBALT CULVERT 26 GINT LOGS.GPJ 9-5-24

Highway 17 Twinning, Culverts 26 and 26N

GRAIN SIZE DISTRIBUTION

FIGURE C6

Sand to Silty Sand (Glacial Till)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	N-HF-02	2.6	149.0
⊠	N-HF-02	4.9	146.7
▲	SC26-1	1.3	151.4
★	SC26-2	8.7	151.5
⊙	SC26-3	8.7	145.3
✿	SC26-3	12.5	141.5

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

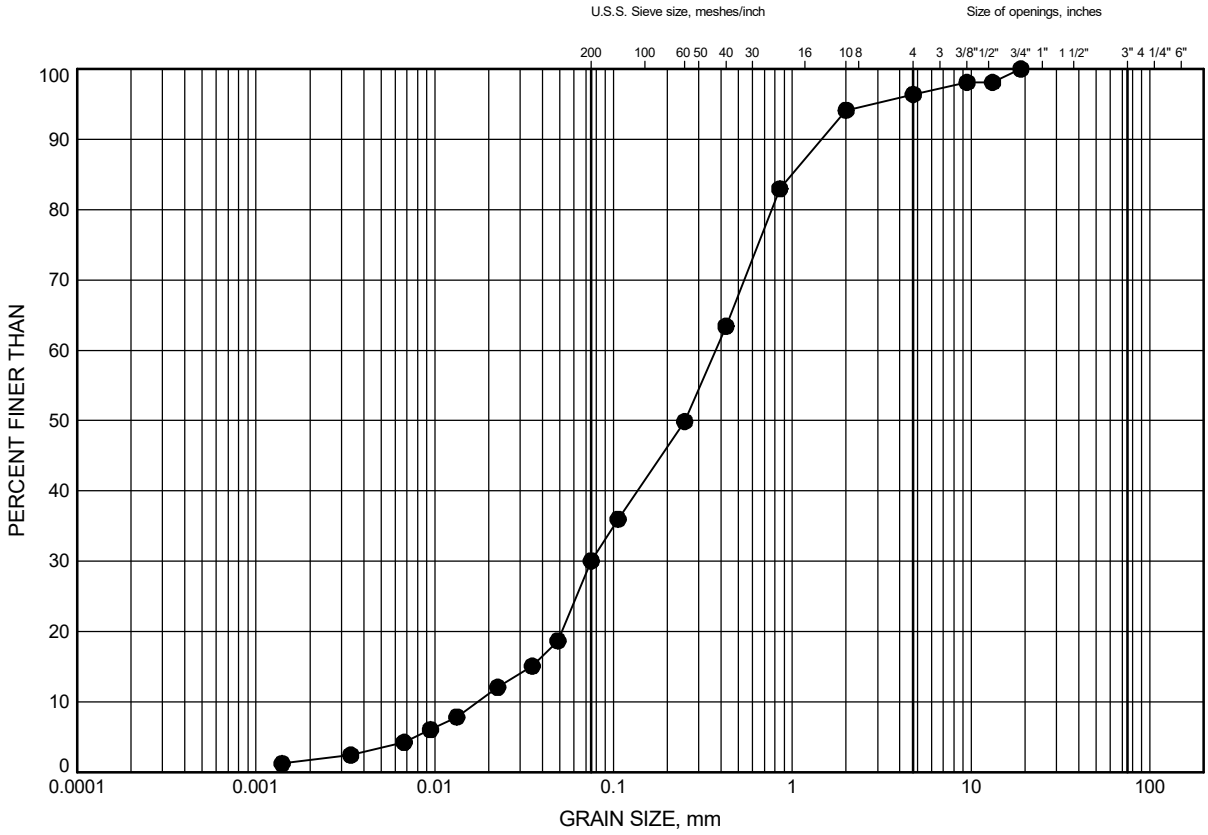
GRAIN SIZE DISTRIBUTION - THURBER CULVERT 26 GINT LOGS.GPJ 9-5-24

Highway 17 Twinning, Culverts 26 and 26N

GRAIN SIZE DISTRIBUTION

FIGURE C7

Sand to Silty Sand (Glacial Till)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC26-4	6.3	147.3

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

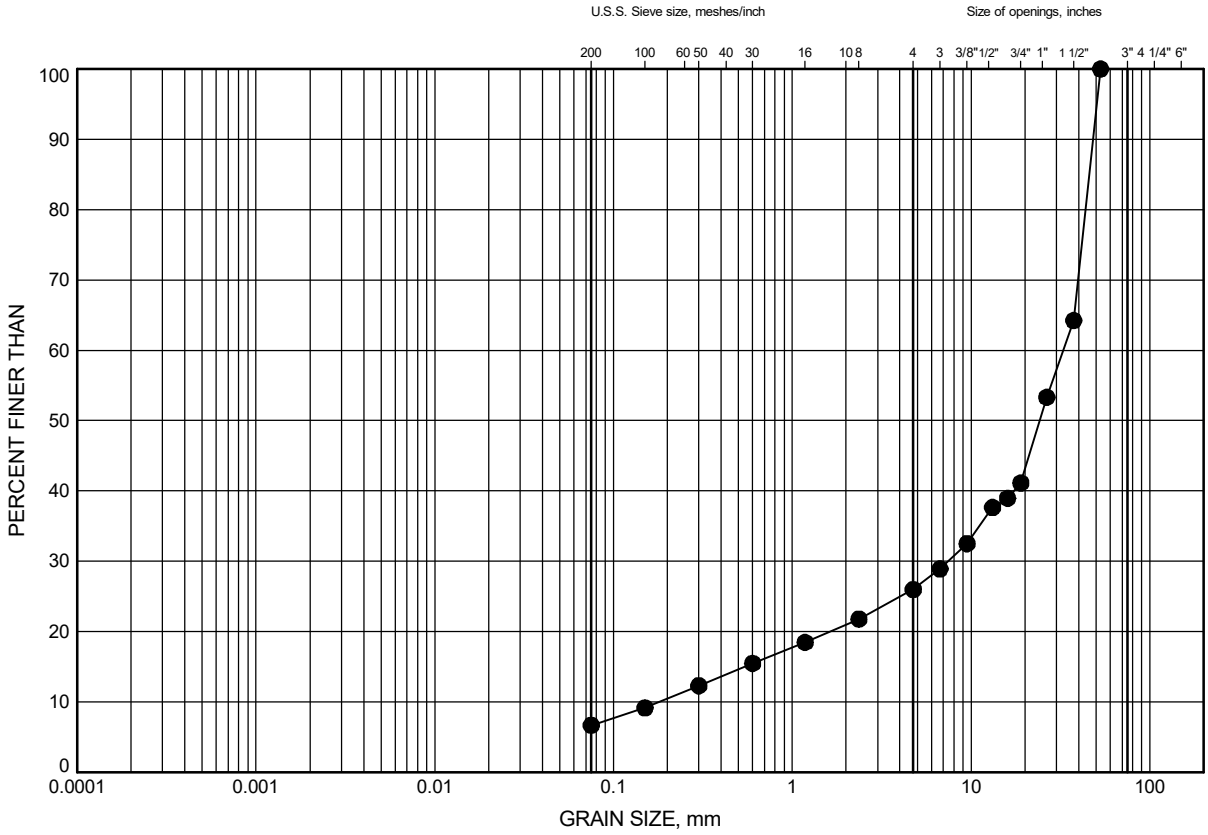
GRAIN SIZE DISTRIBUTION - THURBER CULVERT 26 GINT LOGS.GPJ 9-5-24

Highway 17 Twinning, Culverts 26 and 26N

GRAIN SIZE DISTRIBUTION

FIGURE C8

Gravel with Silt and Sand (Glacial Till)



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SC26-5	7.9	143.1

Date September 2024

GWP# 4018-E-0009

THURBER

Prep'd RH

Chkd. AO

GRAIN SIZE DISTRIBUTION - THURBER CULVERT 26 GINT LOGS.GPJ 9-5-24

THURBER ENGINEERING LTD.

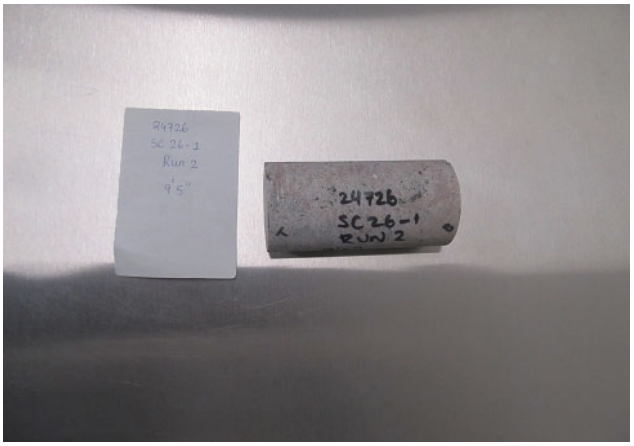
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

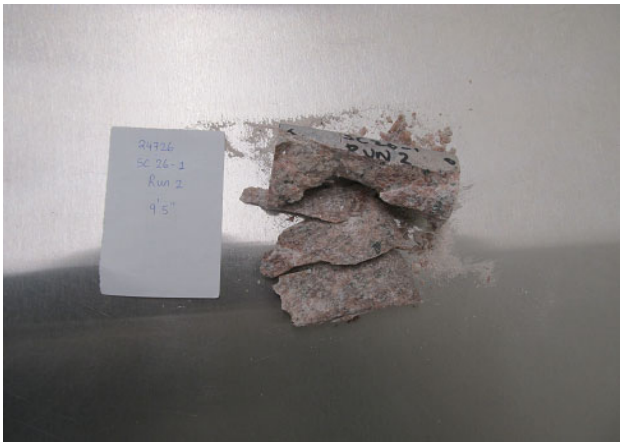
CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	2-Aug-24
BOREHOLE No.:	SC26-1	TEST DATE:	9-May-24
SAMPLE No.:	Run 2		
SAMPLE DEPTH:	2.87 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	10.0	Weight (g):	525.0
Avg. Diameter (cm):	5.0	Wet Density (kg/m^3):	2,674
H. to Dia. Ratio**:	2:1	Dry Density (kg/m^3):	2,674
Cross Sectional Area (cm^2):	19.63	Moisture Content* (%):	N/A
Sample Volume (cm^3):	196.35		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	248.3	kN
UNCONFINED COMPRESSIVE STRENGTH:	126.5	MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

THURBER ENGINEERING LTD.

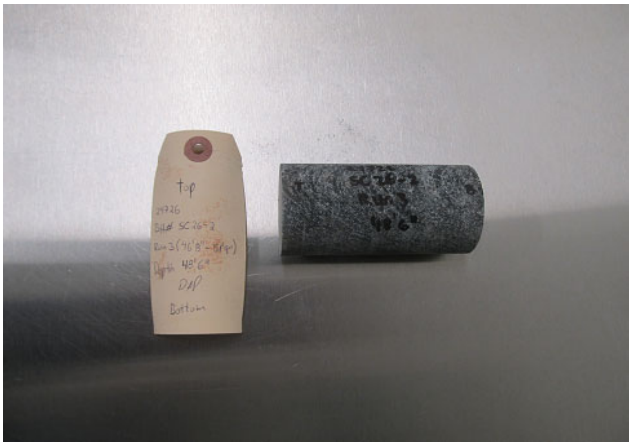
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

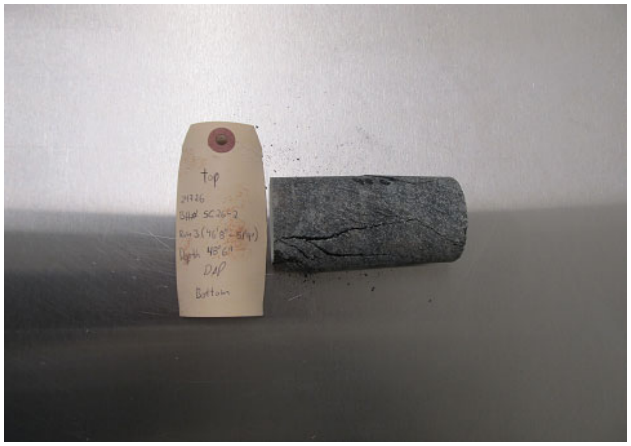
CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	2-Aug-24
BOREHOLE No.:	SC26-2	TEST DATE:	9-May-24
SAMPLE No.:	Run 3		
SAMPLE DEPTH:	14.78 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	9.5	Weight (g):	476.6
Avg. Diameter (cm):	4.7	Wet Density (kg/m^3):	2,892
H. to Dia. Ratio**:	2:1	Dry Density (kg/m^3):	2,892
Cross Sectional Area (cm^2):	17.35	Moisture Content* (%):	N/A
Sample Volume (cm^3):	164.82		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	126.6	kN
UNCONFINED COMPRESSIVE STRENGTH:	73.0	MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

THURBER ENGINEERING LTD.

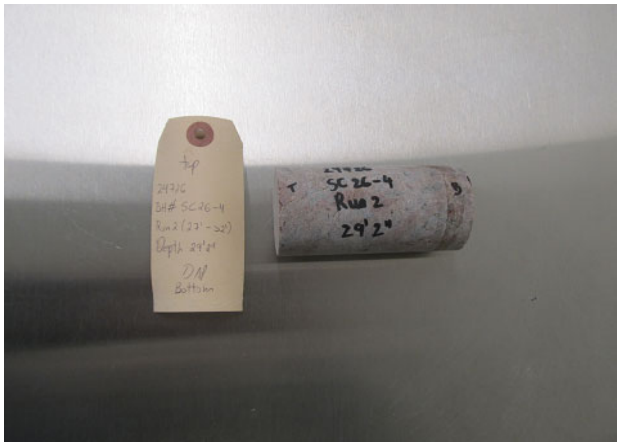
UNCONFINED COMPRESSION TEST REPORT

ASTM D7012-14

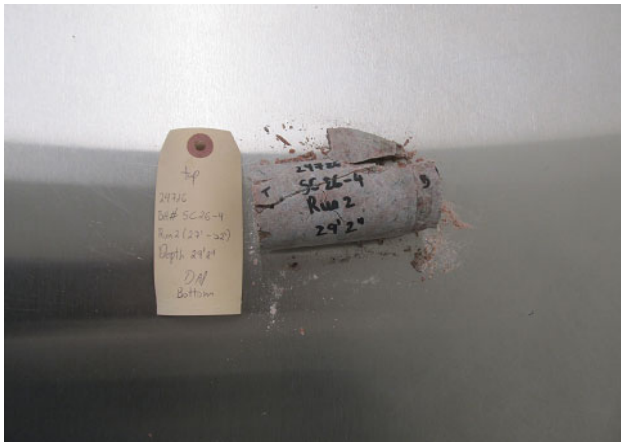
CLIENT:	Thurber Engineering (Ottawa)	FILE NUMBER:	24726
PROJECT NAME:	Highway 17 Twinning - Renfrew	REPORT DATE:	2-Aug-24
BOREHOLE No.:	SC26-4	TEST DATE:	9-May-24
SAMPLE No.:	Run 2		
SAMPLE DEPTH:	8.89 m		
DESCRIPTION:	Granite		

Avg. Height (cm):	9.6	Weight (g):	435.0
Avg. Diameter (cm):	4.7	Wet Density (kg/m^3):	2,612
H. to Dia. Ratio**:	2:1	Dry Density (kg/m^3):	2,612
Cross Sectional Area (cm^2):	17.35	Moisture Content* (%):	N/A
Sample Volume (cm^3):	166.55		

ORIGINAL SPECIMEN



FRACTURED SPECIMEN



AVG. RATE OF STRAIN TO FAILURE:	0.250	MPa/s
MAXIMUM COMPRESSIVE LOAD:	123.3	kN
UNCONFINED COMPRESSIVE STRENGTH:	71.1	MPa

Note: * The moisture content was obtained before the test.
** Dimensions of Specimen conform to ASTM D 4543-04.

TEST DONE BY: GF
REVIEWED BY: WM

Borehole SC26-1

Runs 1 and 2
Depth 1.5 to 4.1 m
Elevation 151.2 to 148.6 m
Dry Sample

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

W.P. 4068-09-00
Project No.: 24726

Borehole SC26-1

Runs 1 and 2
Depth 1.5 to 4.1 m
Elevation 151.2 to 148.6 m
Wet Sample

Cobbles and Boulders

Run 1 Start
elev. 151.2 m

Run 1 End
elev. 149.9 m

Run 2 Start
elev. 149.9 m

Run 2 End
elev. 148.6 m

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

W.P. 4068-09-00
Project No.: 24726

Borehole SC26-2

Run 1
Depth 11.1 to 12.6 m
Elevation 149.1 to 147.6 m
Dry Sample

Cobbles and Boulders (NQ 1, 2, 3, and 4)

Run 1 Start
elev. 149.1 m

Run 1 End
elev. 147.6 m

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

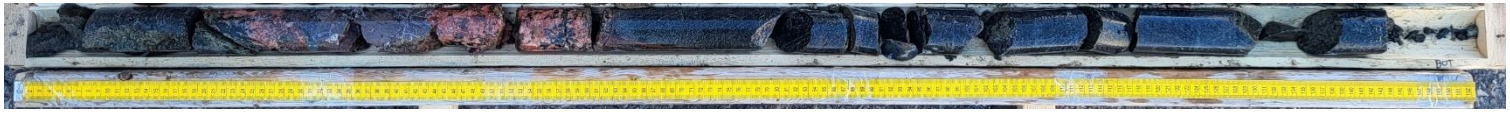
W.P. 4068-09-00
Project No.: 24726

Borehole SC26-2

Run 1
Depth 11.1 to 12.6 m
Elevation 149.1 to 147.6 m
Wet Sample

Cobbles and Boulders (NQ 1, 2, 3, and 4)

Run 1 Start
elev. 149.1 m



Run 1 End
elev. 147.6 m

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

W.P. 4068-09-00
Project No.: 24726

Borehole SC26-2

Runs 2 and 3
Depth 12.6 to 15.8 m
Elevation 147.6 to 144.4 m
Dry Sample

Run 2 Start
elev. 147.6 m

Run 2 End
elev. 146.0 m

Run 3 Start
elev. 146.0 m

Run 3 End
elev. 144.4 m

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

W.P. 4068-09-00
Project No.: 24726

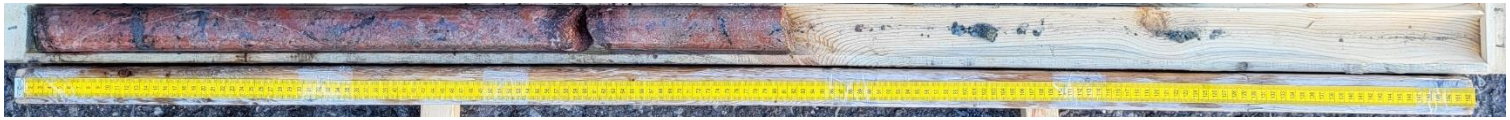
Borehole SC26-2

Runs 2 and 3
Depth 12.6 to 15.8 m
Elevation 147.6 to 144.4 m
Wet Sample

Run 2 Start
elev. 147.6 m

Run 2 End
elev. 146.0 m

Run 3 Start
elev. 146.0 m



Run 3 End
elev. 144.4 m

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

W.P. 4068-09-00
Project No.: 24726

Borehole SC26-4

Runs 1 and 2
Depth 6.7 to 9.8 m
Elevation 146.9 to 143.8 m
Dry Sample

Run 1 Start
elev. 146.9 m

Run 1 End
elev. 145.4 m

Run 2 Start
elev. 145.4 m

Run 2 End
elev. 143.8 m

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

W.P. 4068-09-00
Project No.: 24726

Borehole SC26-4

Runs 1 and 2
Depth 6.7 to 9.8 m
Elevation 146.9 to 143.8 m
Wet Sample

Run 1 Start
elev. 146.9 m

Run 1 End
elev. 145.4 m

Run 2 Start
elev. 145.4 m

Run 2 End
elev. 143.8 m

THURBER ENGINEERING LTD.

Foundation Investigation
Culverts 26 and 26N (McNab Township)
Renfrew, Ontario

W.P. 4068-09-00
Project No.: 24726

THURBER

Appendix C.2

Analytical Testing Results

	Client ID:	SC26-3 SS#5 10'-12'	SC26-5 SS#4 7'6"-9'6"	-	-		
	Sample Date:	22-Feb-24 13:00	20-Feb-24 10:30	-	-	-	-
	Sample ID:	2409075-01	2409075-02	-	-		
	Matrix:	Soil	Soil	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	78.7	84.8	-	-	-	-
General Inorganics							
Conductivity	5 uS/cm	259	306	-	-	-	-
pH	0.05 pH Units	6.79	7.17	-	-	-	-
Resistivity	0.1 Ohm.m	38.7	32.7	-	-	-	-
Anions							
Chloride	10 ug/g	82	92	-	-	-	-
Sulphate	10 ug/g	16	45	-	-	-	-

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

07-March-2024

Paracel Laboratories
Attn : Dale Robertson

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

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

Date Rec. : 28 February 2024
LR Report: **CA12795-FEB24**
Reference: Project#: 2409075

Copy: #2

CERTIFICATE OF ANALYSIS

Final Report - Revised

Sample ID	Sample Date & Time	Sulphide (Na2CO3) %
1: Analysis Start Date		06-Mar-24
2: Analysis Start Time		06:37
3: Analysis Completed Date		06-Mar-24
4: Analysis Completed Time		09:27
5: RL		0.01
6: SC26-3 SS#5 10'-12'	22-Feb-24 13:00	< 0.01
7: SC26-5 SS#4 7'6"-9'6"	20-Feb-24 10:30	0.02

RL - SGS Reporting Limit

Revised March 7, 2024 - Sample collection date for SC26-5 SS#4 7'6"-9'6" corrected.

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0003641695

THURBER

Appendix D.

Site Photographs

Photo 1. Looking east along existing eastbound embankment (March 22, 2024)

Photo 2. Looking east at ponded water near the EB embankment toe (April 9, 2024)

Photo 3. Looking southwest along eastbound embankment (July 26, 2024)

Photo 4. Looking west along Highway 17 (July 26, 2024)

Photo 5. Looking west along Highway 17 (July 26, 2024)

Photo 6. Looking east along Highway 17 and existing WB embankment (July 26, 2024)