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DETAILED FOUNDATION INVESTIGATION AND DESIGN REPORT

Omer Lake Culvert Replacement

Highway 11, District of Thunder Bay, Ontario
Agreement No.: 6021-E-0007, Work Order 3
G.W.P. 6911-12-00, Site No. 48C-0181/C0
Latitude: 49.377205°, Longitude: -88.133495°
GEOCRES No.: 52H08-004

Client Name: HATCH
Date: January 30, 2025
File: 47632

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LATITUDE: 49.377205°, LONGITUDE: -88.133495°

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PART 1. FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual data obtained from a supplemental foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for detailed design of the proposed Omer Lake Culvert replacement. The Omer Lake Culvert is located on Highway 11, south of Macdiarmid, in the Unsurveyed Territory, District of Thunder Bay, Ontario.

A preliminary foundation investigation was previously completed by Thurber for this culvert replacement. The preliminary foundation investigation report for this site is available within the online Geocres Library (Geocres No. 52H-051) and is entitled:

"Foundation Investigation and Design Report, Omer Lake Culvert Replacement, Highway 11, District of Thunder Bay, Ontario, Agreement 6019-E-0009, Work Order 16, G.W.P. 6911-12-00, Site No. 48C-0181/C0", File: 31344, Dated: January 6, 2023.

The purpose of this supplemental investigation was to advance additional deeper boreholes along the proposed replacement culvert sheet pile foundation alignments and in embankment widening areas, and based on the data obtained, to provide a borehole location plan, stratigraphic profile, records of boreholes, laboratory test results and a written description of the subsurface conditions, incorporating the factual data obtained from both investigations.

Thurber carried out the investigation as a sub-consultant to Hatch Corporation (Hatch), under the Ministry of Transportation Ontario (MTO) Retainer Agreement Number 6021-E-0007, Work Order 3.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SITE DESCRIPTION

The site is located on Highway 11, approximately 32 km south of Highway 580, in the Unsurveyed Territory, District of Thunder Bay, Ontario. The existing culvert allows a tributary of Omer Lake to flow in an east to west direction under Highway 11. Highway 11 generally runs in a north-south direction at the culvert site. The watercourse connects Omer Lake on the east side of Highway 11 to Lake Nipigon on the west site.

The available base plan drawing provided by Hatch indicates that the existing structure is an open bottom, concrete box culvert. The base plan indicates that the span of the structure is 3.1 m, the height is 1.5 m and the length is 32.8 m. The estimated culvert invert is at approximate Elevation 259.1 m at both the inlet (east) and the outlet (west). The existing road grade at the culvert location is at approximate Elev. 264.7 m, which indicates approximately 4.1 m of fill above the culvert. The local creek water level was reportedly measured at Elev. 259.9 m in November 2018. The site topography within the culvert area is generally sloped down from north to south, with low lying grassy/marshy land and treed areas surrounding the culvert site.

The highway embankment side slopes near the existing culvert appear to be performing satisfactorily and range in inclination from approximately 1.3H:1V to 2H:1V or flatter. No significant evidence of instability, settlement or erosion was observed. Trees were observed to be growing above the inlet of the existing culvert structure.

Photographs in Appendix E show the general nature of the site and the existing culvert.

Based on published geological mapping, the quaternary geology in the area of the culvert site consists of undifferentiated till with predominantly sand to silty sand matrix. The bedrock in the area is described as metasedimentary rocks with mafic dikes and related intrusive rocks.

3. INVESTIGATION PROCEDURE

Two site investigations were carried out in support of the Omer Lake Culvert design. The preliminary site investigation and field-testing program was carried out in two phases from April 20 to 25, 2021 and from May 6 to 8, 2021. The field program consisted of drilling and sampling nine (9) boreholes (21-01, 21-02, 21-03A, 21-03B, and 21-04 to 21-08) to depths from 2.7 to 17.4 m below the ground surface (Elevation 253.2 to 246.2 m). Dynamic Cone Penetration Tests (DCPTs) were advanced from the base of Boreholes 21-01, 21-03A, 21-03B, 21-07 and 21-08 to depths from 8.8 to 24.4 m below the ground surface (Elevation 251.0 to 239.5 m). Boreholes 21-01, 21-02 and 21-05 to 21-08 were drilled through the paved portion of Highway 11. Boreholes 21-03A, 21-03B and 21-04 were drilled off-road near the inlet and outlet of the existing culvert.

The supplemental detailed design investigation was carried out in two phases from June 17 to 20, 2024 and from August 8 to 13, 2024. The field program consisted of drilling and sampling six (6) boreholes (24-01 to 24-06) to depths from 4.4 to 23.5 m below ground surface (Elevation 241.0 to 255.9 m). DCPTs were advanced from the base of Boreholes 24-03, 24-04, and 24-05 to depths of 6.6 to 11.7 m below ground surface (Elevation 248.3 to 253.3). DCPTs (24-03A, 24-04A and 24-05A) were also advanced from ground surface adjacent to Boreholes 24-03, 24-04, and 24-05 to depths of 4.7 to 9.9 m below ground surface (Elevation 250.5 to 255.3 m). The boreholes were drilled along the approximate locations of the proposed sheet pile foundations for the replacement culvert, with Boreholes 24-01 and 24-02 drilled through the paved portion of Highway 11 and Boreholes 24-03 to 24-06 drilled off-road near the inlet and outlet of the existing culvert.

The approximate locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix A. The Record of Borehole sheets for the preliminary and detailed investigations are included in Appendix B.

Utility clearances were obtained prior to the start of drilling. The ground surface elevations for the boreholes were estimated from field measurements and the topographic drawings provided to Thurber by Hatch. The coordinate system MTM NAD 83, Zone 14 was used for the boreholes.

The boreholes through the road surface were advanced using a rubber track-mounted CME55 drill rig, using solid stem auger and/or wash boring techniques, as well as Dynamic Cone Penetration Tests (DCPTs). The off-road boreholes were advanced using a portable Hilti drill and tripod equipment using wash boring techniques, as well as DCPTs. In all boreholes, soil samples were obtained at selected intervals with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT).

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

Monitoring wells were installed in Boreholes 21-01 and 21-02. Both wells consisted of 50 mm Schedule 40 PVC pipe with a 3.0 m long slotted screen, enclosed in a column of filter sand to permit groundwater level monitoring. Monitoring well installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets. A sample of the groundwater was obtained from the well at Borehole 21-01 and submitted to a specialist analytical laboratory under chain of custody procedures for testing for a suite of water quality parameters. Single well response tests ("slug") tests were carried out in the wells installed in both Boreholes 21-01 and 21-02. Upon collection of the final water level readings on April 25, 2021, the wells were decommissioned in accordance with MOECP O.Reg. 903.

Details of the drilling program, including drilling depths, monitoring well installation and completion details are summarized in Table 3.1 below.

Table 3.1: Borehole Completion Details

Borehole Number	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
21-01	17.4 / 247.1	13.7 / 250.8	Borehole caved to 13.7 m, filter sand from 13.7 m to 10.4 m, bentonite holeplug from 10.4 m to 0.6 m, concrete from 0.6 m to 0.2 m, and cold patch asphalt to ground surface.
21-02	17.4 / 247.6	10.7 / 254.3	Borehole caved to 10.7 m, filter sand from 10.7 m to 7.3 m, bentonite holeplug from 7.3 m to 0.6 m, concrete from 0.6 m to 0.2 m, and cold patch asphalt to ground surface.
21-03A	6.7 / 253.2	None installed	Borehole caved to 2.3 m and was backfilled with bentonite holeplug from 2.3 m to ground surface.
21-03B	2.7 / 257.1	None installed	Borehole backfilled with bentonite holeplug from 2.7 m to ground surface.
21-04	14.0 / 246.2	None installed	Borehole caved to 10.0 m and was backfilled with bentonite holeplug from 10.0 m to ground surface.
21-05	17.4 / 246.9	None installed	Borehole caved to 11.4 m and was backfilled with bentonite holeplug from 11.4 m to 0.6 m, concrete from 0.6 m to 0.2 m, and cold patch asphalt to ground surface.
21-06	17.4 / 247.8	None installed	Borehole caved to 5.3 m and was backfilled with bentonite holeplug from 5.3 m to 0.6 m, concrete from 0.6 m to 0.2 m, and cold patch asphalt to ground surface.
21-07	17.4 / 248.3	None installed	Borehole caved to 6.1 m and was backfilled with bentonite holeplug from 6.1 m to 0.6 m, concrete from 0.6 m to 0.2 m, and cold patch asphalt to ground surface.
21-08	17.4 / 246.5	None installed	Borehole caved to 5.9 m and was backfilled with bentonite holeplug from 5.9 m to 0.6 m, concrete from 0.6 m to 0.2 m, and cold patch asphalt to ground surface.

Borehole Number	Borehole Depth / Base Elevation (m)	Monitoring Well Tip Depth / Elevation (m)	Completion Details
24-01	23.5 / 241.0	None installed	Borehole caved to 7.7 m and was backfilled with bentonite holeplug to 0.6 m, gravel from 0.6 m to 0.1 m, and cold patch asphalt to ground surface.
24-02	23.5 / 241.4	None installed	Borehole caved to 18.0 m and was backfilled with bentonite holeplug to 0.6 m, gravel from 0.6 m to 0.1 m, and cold patch asphalt to ground surface.
24-03	8.2 / 252.2	None installed	Borehole caved to 2.3 m and was backfilled with bentonite holeplug to ground surface.
24-04	6.6 / 253.3	None installed	Borehole caved to 2.3 m and was backfilled with bentonite holeplug to ground surface.
24-05	9.1 / 250.9	None installed	Borehole caved to 2.4 m and was backfilled with bentonite holeplug to ground surface.
24-06	5.5 / 255.9	None installed	Borehole caved to 4.3 m and was backfilled with bentonite holeplug to ground surface.

4. LABORATORY TESTING

All recovered soil samples were subjected to visual identification and natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and hydrometer), and the results of this testing program are summarized on the Record of Borehole sheets in Appendix B and are shown on the figures included in Appendix C.

In order to assess the potential for sulphate attack on concrete foundations, as well as the potential for corrosion associated with the structure, two samples of the soil and a sample of the creek water were collected during the investigation and submitted to SGS Canada Inc., a CALA accredited analytical laboratory in Lakefield, Ontario, for analytical testing of soil corrosivity parameters. In order to assess the quality of the groundwater for disposal purposes, a water sample was collected from the well installed in Borehole 21-01. The results of the analytical testing are summarized in this report and presented in Appendix D.

In order to assess the organic content of the buried peat to sand and silt mixed with peat on site, six (6) soil samples collected in the detailed design investigation were submitted to ALS Canada Inc., a CALA accredited analytical laboratory in Waterloo, Ontario, for analytical testing (loss on

ignition at 440°C). The results of the analytical testing are summarized in this report and presented in Appendix D.

An environmental soil sampling program was completed concurrently with the foundation investigation to collect four soil samples for excess soil analysis, with the sample locations and depths selected by Hatch. The results of this sampling program were reported separately to Hatch by email on July 18, 2024.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix B. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the Borehole Locations and Soil Strata drawings in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes from the preliminary and detailed investigations, is given in the following paragraphs. However, the factual data presented in the Record of Borehole sheets governs any interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface stratigraphy below the asphalt typically consists of sand to silty sand fill underlain by a layer of peat to sand and silt mixed with peat. Underlying the peat, the native soils consisted of sand to silt and sand, with lower deposits of silt. More detailed descriptions of individual strata are presented below.

5.1 Asphalt

Boreholes 21-01, 21-02, 21-05 to 21-08, 24-01 and 24-02 were drilled through the paved portion of Highway 11. The asphalt ranged in thickness from 50 to 225 mm at these locations. A 250 to 305 mm thick layer of granular fill was encountered below the asphalt in Boreholes 24-01 and 24-02.

A thin layer of asphalt (approximately 25 mm thick) was also encountered at a depth of 0.6 m in Boreholes 21-02 and 21-08 within the fill.

5.2 Silty Sand Fill

Silty sand fill ranging to granular fill was encountered below the asphalt and granular fill in Boreholes 21-01, 21-02, 21-05 to 21-08 and 24-01. The fill generally consisted of silty sand with some gravel, and ranged to sand, some gravel to gravelly with some silt in Boreholes 21-07 and 24-01.

The silty sand fill ranged in thickness from 0.4 m to 1.2 m, with an underside depth ranging from 0.8 m to 1.4 m below ground surface (Elevation 264.4 to 263.1 m).

SPT ‘N’ values in the silty sand fill generally ranged from 28 to 100 blows per 0.3 m penetration, indicating a compact to very dense relative density; typically very dense.

The measured moisture contents generally ranged from 2 to 7%.

The results of grain size analyses conducted on selected samples of silty sand to gravelly sand fill are provided on the Record of Borehole sheets in Appendix B and plotted on Figure C1 in Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	12 to 27
Sand	60 to 73
Silt & Clay	13 to 23

5.3 Sand and Silt Fill

Sand and silt embankment fill was encountered below the silty sand fill in Boreholes 21-01, 21-02, 21-05 to 21-08, 24-01 and 24-02. The fill ranged in composition from sand with some silt to sand and silt and contained trace gravel and trace clay.

The sand and silt fill ranged in thickness from 3.3 m to 4.8 m, with an underside depth ranging from 4.1 m to 6.1 m below ground surface (Elevation 261.6 to 259.4 m).

SPT ‘N’ values in the fill ranged from 4 to 43 blows per 0.3 m penetration, indicating a very loose to dense relative density; typically compact.

The measured moisture contents generally ranged from 4 to 23%.

The results of grain size analyses conducted on selected samples of the sand and silt fill are provided on the Record of Borehole sheets in Appendix B and plotted on Figure C2 in Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 5
Sand	37 to 84
Silt	23 to 62
Clay	0 to 6
Silt & Clay	11

5.4 Peat to Sand and Silt mixed with Peat

A surficial layer of peat was encountered at the ground surface in Boreholes 21-03A, 21-04, 24-03, 24-04 and 24-05, and a buried layer of peat ranging to sand and silt mixed with peat was

encountered below the sand and silt fill in Boreholes 21-01, 21-02, 21-05 to 21-08, 24-01 and 24-02. The peat generally contained sand and silt, as well as wood fragments and some clay lenses. A thin layer of topsoil (75 mm) was encountered at the ground surface at Borehole 24-06.

In Boreholes 21-03A, 21-04, 24-03, 24-04, and 24-05, the depth and thickness of the surficial peat ranged from 150 mm to 1.8 m (Elevation 260.0 to 258.1 m). In Boreholes 21-01, 21-02, 21-05 to 21-08, 24-01 and 24-02, the thickness of the buried peat ranged from 1.1 m to 3.1 m, with an underside depth ranging from 5.6 m to 7.7 m below ground surface (Elevation 258.5 to 257.1 m).

SPT ‘N’ values in the peat to sand and silt mixed with peat ranged from 1 to 13 blows per 0.3 m penetration, indicating a very loose to compact density; typically loose. Borehole 24-01 encountered a single SPT ‘N’ Value of 50 blows per 125 mm, most likely due to the presence of the wood fragments encountered in the sample.

Measured moisture contents ranged from 24 to 186%.

The results of a grain size analysis conducted on samples of sand and silt mixed with peat are provided on the Record of Borehole sheets in Appendix B and plotted on Figure C3 in Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	38 to 73
Silt	26 to 59
Clay	0 to 5

Based on visual laboratory assessment of selected samples, the peat to sand and silt mixed with peat is considered to be non-plastic.

The organic content of selected peat samples was estimated to range from approximately 2 to 10%, based on the results of analytical testing for the percent loss on ignition at 440 degrees Celsius and the remaining ash content. The laboratory certificates of analysis are presented in Appendix D and summarized in Table 5.1 below:

Table 5.1: Organic Content Test Results

Sample ID	Depth Range (m)	Loss on Ignition at 440°C	Ash Content at 440°C
24-01 SS8	5.3 – 5.5	7.0%	93.0%
24-02 SS7	4.6 – 5.2	4.1%	95.9%
24-03 SS-1 (0'-2') & SS-3 (4'-6')	0 – 1.8	6.4%	93.6%
24-04 SS-1 (0'-2') & SS-4 (6'-8')	0 – 2.4	4.2%	95.8%
24-05 SS-2B (2'7"-4') & SS-3A (4'-5'1")	0.8 – 1.5	9.8%	90.2%
24-06 SS-1 (0'-2') & SS-2A (2'-3'5")	0 – 1.0	2.2%	97.8%

5.5 Sand to Silt and Sand

A deposit ranging in composition from sand with trace to some silt, to silty sand, to silt and sand was encountered below the peat or topsoil in all of the boreholes. The deposit also generally contained trace gravel and trace clay. A lower deposit of sand to silt and sand was also encountered below the silt layer in Boreholes 24-01 and 24-02.

Boreholes 21-02 and 21-06 were terminated in the upper sand to silt and sand deposit at a depth of 17.4 m (Elevation 247.8 to 247.6 m). Boreholes 24-01 and 24-02 were terminated in the lower sand to silt and sand deposit at a depth of 23.5 m below ground surface (Elevation 241.4 to 241.0 m). The thickness of the upper sand to silt and sand deposit, where fully penetrated in Boreholes 21-01, 21-04, 21-05, 21-07, 24-01 and 24-02, ranged from 5.4 to 9.1 m, with an underside depth ranging from 5.6 to 16.3 m (Elevation 254.6 to 248.2 m).

SPT 'N' values in the sand to silt and sand ranged from 2 blow to 54 blows, indicating a very loose to very dense relative density; typically compact.

Measured moisture contents generally ranged from 11 to 59%. The results of grain size analyses conducted on samples of the sand to silt and sand deposit are provided on the Record of Borehole sheets in Appendix B, and plotted on Figures C4 to C6 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 4
Sand	35 to 92
Silt	4 to 64
Clay	0 to 7

5.6 Silt

A silt deposit was encountered below the sand to silt and sand layer in Boreholes 21-01, 21-04, 21-05, 21-07, 24-01 and 24-02. The silt contained trace to some sand, trace to some clay, and trace gravel.

A 1.4 m thick upper layer of silt was also encountered in Borehole 21-04 within the sand to silt and sand deposit at a depth of 3.2 m (Elevation 257.0 m).

The thickness of the silt layer, where fully penetrated in Boreholes 24-01 and 24-02, ranged from 6.1 to 7.2 m with an underside depth of 22.0 to 22.4 m below ground surface (Elevation 242.9 to 242.1 m) Sampling was terminated in Boreholes 21-01, 21-04, 21-05 and 21-07 within the silt deposit at depths ranging from 14.0 to 17.4 m below ground surface (Elevation 248.3 to 246.2 m). Dynamic Cone Penetration Tests (DCPTs) were conducted at the base of the sampled portions of Boreholes 21-01, 21-03A, 21-03B, 21-07, 21-08, 24-03, 24-04, 24-05, and from the ground surface of Boreholes 24-03A, 24-04A and 24-05A. The DCPTs were terminated at depths ranging from 4.7 to 24.4 m below the ground surface (Elevation 255.3 to 239.5 m). The DCPTs at Boreholes 21-03B, 24-03, 24-03A, 24-04, 24-04A, 24-05, and 24-05A encountered refusal of 100 blows per 0.3 m penetration. The DCPT termination depths are estimated to mainly correspond to the silt deposit, with some DCPTs ended within the overlying or underlying sand to silt and sand deposits.

SPT ‘N’ values in the silt deposit ranged from 11 to 38 blows, indicating a compact to dense relative density.

Recorded moisture contents in the silt ranged from 12 to 23%. The results of grain size analyses conducted on samples of the silt deposit are provided on the Record of Borehole sheets in Appendix B and plotted on Figure C7 of Appendix C. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	0 to 18
Silt	72 to 96
Clay	2 to 20

The results of the Atterberg Limits tests conducted on samples of the silt are provided on the Record of Borehole sheets in Appendix B and illustrated on Figure C8 of Appendix C. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	17 to 21
Plasticity Index	2 to 4

The results of the Atterberg Limits tests indicate that the silt has low plasticity (ML).

5.7 Groundwater Conditions

Groundwater conditions were observed during drilling operations and groundwater levels were measured in the open boreholes upon completion of drilling, and in the monitoring wells installed in Boreholes 21-01 and 21-02. The measured groundwater levels are summarized in Table 5.2 below. The monitoring wells were decommissioned on April 25, 2021 following final water level readings and slug testing.

Table 5.2: Groundwater Measurements

Borehole	Date	Water Level (m)		Remark
		Depth	Elevation	
21-01	April 22, 2021 April 23, 2021 April 25, 2021	5.5 4.7 4.7	259.0 259.8 259.8	In monitoring well
21-02	April 23, 2021 April 25, 2021	5.2 5.2	259.8 259.8	In monitoring well
21-03A	May 8, 2021	0.1	259.3	Open Borehole
21-04	May 6, 2021	0.9	260.3	Open Borehole
21-05	April 22, 2021	*	-	Open Borehole
21-06	April 23, 2021	*	-	Open Borehole
21-07	April 23, 2021	*	-	Open Borehole
21-08	April 25, 2021	*	-	Open Borehole
24-01	June 18, 2024	4.9	259.6	Open Borehole
24-02	June 20, 2024	5.0	259.9	Open Borehole
24-03	August 11, 2024	*	-	Open Borehole
24-04	August 12, 2024	*	-	Open Borehole
24-05	August 13, 2024	*	-	Open Borehole
24-06	Augst 8, 2024	*	-	Open Borehole

*Water level not recorded due to residual drilling water in the borehole.

The groundwater level is likely to reflect the local creek water level. The local creek water level was measured at Elevation 259.9 m in November 2018.

It should also be noted that groundwater levels are short term observations and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant and/or prolonged precipitation and spring snow melts.

6. CORROSIVITY AND SULPHATE TEST RESULTS

Samples of the sand and silt mixed with peat and the native sand from Boreholes 21-01 and 21-02 respectively, and a sample of surface water collected from the watercourse were submitted for analytical testing of corrosivity parameters and sulphate. The laboratory certificates of analysis are presented in Appendix D. The results of the analytical tests are summarized below in Table 6.1.

Table 6.1: Analytical Test Results

Parameter	Units (Soil)	Units (Water)	Test Results		
			21-01, SS6B (16'-17') (4.9 – 5.2 m)	21-02, SS8 (25" – 27') (7.6 – 8.2 m)	Omer Lake Watercourse
			(Native Sand and Silt mixed with Peat)	(Native Sand)	(Surface Water)
Redox Potential	mV	mV	210	199	243
Sulphide	%	µg/L	<0.04	<0.04	8
pH	-	-	7.52	8.74	7.65
Chloride	µg/g	mg/L	4700	190	39
Sulphate	µg/g	mg/L	51	5.2	2.1
Conductivity	µS/cm	µS/cm	4230	436	210
Resistivity	ohm-cm	ohm-cm	236	2290	4762*

* Calculated based on conductivity result

7. WATER QUALITY

For assessment of the general groundwater quality in the project area, a sample of the groundwater from the monitoring well at Borehole 21-01 was collected on April 25, 2021. The water sample was analyzed for selected inorganic parameters included in the Ontario Provincial Water Quality Objectives (PWQO). A filtered sub-sample was also tested for dissolved metal parameters for comparison purposes. The analytical test results are presented in Appendix D.

The analytical results of the water testing were compared to limits for the PWQO for surface water discharge. The concentrations of all parameters tested that did not meet the criteria established in the PWQO are listed below in Table 7.1.

Table 7.1: Water Parameters Exceeding PWQO Criteria

Sample ID	Parameter	Criteria	Parameter Limit (µg/L)	Result (µg/L)
BH21-01	Total Cobalt	PWQO	0.9	2.51
	Total Phosphorus	PWQO	10	121
	Total Copper	PWQO	1	12.2
	Total Aluminum	PWQO	15	1470
	Total Iron	PWQO	300	3120
	Total Phenols	PWQO	1	<2*
BH21-01 (Filtered sub-sample)	Dissolved Phosphorus	PWQO	10	16
	Dissolved Copper	PWQO	1	3.4
	Dissolved Aluminum	PWQO	15	31

*Note: The laboratory detection limit is higher than the PWQO criteria for this parameter and therefore this test result may not be indicative of an actual parameter exceeding the criteria.

8. SINGLE WELL RESPONSE TEST RESULTS

8.1 Test Procedure

Single well response tests (SWRT) (“slug” tests) were carried out on the 50 mm diameter wells installed in Boreholes 21-01 and 21-02. The well installed in Borehole 21-01 was screened across sand and silt to silty sand. The well installed in Borehole 21-02 was screened across sand, some silt. The tests were completed using the following method:

- The static water level was measured and recorded, and a datalogger was inserted into the well below the water level. The datalogger was set to record water levels every 0.125 to 0.5 seconds, based on the anticipated rate of recovery of the wells.
- A slug of groundwater was removed from the well with a dedicated bailer to induce a change in hydraulic head (rising head test).
- Manual and electronic measurements were recorded until the water level in the well recovered sufficiently.
- Manual measurements were compared to electronic measurements for quality control of the data.

8.2 Hydraulic Conductivity

The slug tests were completed and analyzed using the Hvorslev method. The plots of the slug test results are included in Appendix C. The hydraulic conductivity values calculated from the in-situ slug tests are summarized in the following table.

Table 8.1: Single Well Response Test Results

Monitoring Well	Hydraulic Conductivity (m/s)	Screened Formation
21-01	6.1 x 10-5	Sand and silt to silty sand
21-02	4.7 x 10-5	Sand, some silt

9. MISCELLANEOUS

Thurber obtained utility clearances for the borehole locations prior to drilling. Borehole locations were selected and established in the field by Thurber Engineering Ltd.

RPM Drilling of Thunder Bay, Ontario supplied a rubber track-mounted CME55 drill rig and Ohlmann Geotechnical Services (OGS) Inc. of Almonte, Ontario supplied a portable Hilti drill, to conduct the drilling, sampling and in-situ testing operations for the boreholes in both the preliminary and detailed design investigations. Traffic control services conforming to Ontario Traffic Manual (Book 7) were provided by Men at Worx Ltd. of Thunder Bay, Ontario.

Geotechnical laboratory testing was carried out in Thurber's geotechnical laboratory. Analytical testing was carried out by SGS Canada Inc. for the preliminary investigation and ALS Canada Ltd. for the detailed design investigation.

The preliminary field investigation was supervised on a full-time basis by Ms. Rachel Bourassa, and Mr. Greg Stanhope of Thurber. Overall supervision of the field program was provided by Mr. Joshua Alexander and Mr. Mark Farrant, P. Eng. of Thurber.

The detailed design field investigation was supervised on a full-time basis by Mr. Greg Stanhope and Mr. Jaimin Patel of Thurber. Overall supervision of the field program was provided by Ms. Madisan Chiarotto, P.Eng. and Mr. Mark Farrant, P.Eng. of Thurber.

The report was prepared by Ms. Madisan Chiarotto, P.Eng. and Mr. Mark Farrant, P.Eng., and reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Date: January 30, 2025
File: 47632

DETAILED FOUNDATION INVESTIGATION AND DESIGN REPORT
OMER LAKE CULVERT REPLACEMENT
HIGHWAY 11, DISTRICT OF THUNDER BAY, ONTARIO
AGREEMENT NO.: 6021-E-0007, WORK ORDER 3
G.W.P. 6911-12-00, SITE NO. 48C-0181/C0
LATITUDE: 49.377205°, LONGITUDE: -88.133495°

GEOCRES No.: 52H08-004

PART 2. ENGINEERING DISCUSSION AND RECOMMENDATIONS

10. GENERAL

This report provides an interpretation of the factual data from Part 1 of the report and presents geotechnical recommendations for detailed design of the proposed replacement of the Omer Lake culvert crossing Highway 11. The discussion and recommendations presented in this report are based on the information provided by Hatch and on the factual data obtained during the course of the preliminary and detailed design investigations by Thurber.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The construction or design-build contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The available base plan drawing provided by Hatch indicates that the existing structure is an open bottom, concrete box culvert. The base plan indicates that the span of the structure is 3.1 m, the height is 1.5 m and the length is 32.8 m. The estimated culvert invert is at approximate Elevation 259.1 m at both the inlet (east) and the outlet (west). The existing road grade at the culvert location is at approximate Elev. 264.7 m, which indicates approximately 4.1 m of fill above the culvert. The local creek water level was reportedly measured at Elev. 259.9 m in November 2018. The site topography within the culvert area is generally sloped down from north to south, with low lying grassy/marshy land and treed areas surrounding the culvert site.

The highway embankment side slopes near the existing culvert appear to be performing satisfactorily and range in inclination from approximately 1.3H:1V to 2H:1V or flatter. No significant

evidence of instability, settlement or erosion was observed. Trees were observed to be growing above the inlet of the existing culvert structure.

This report refers to the following applicable codes:

- Canadian Highway Bridge Design Code (CHBDC), 2019
- National Building Code of Canada (NBCC), 2020

11. CULVERT DESIGN

11.1 Culvert Alternatives

This section presents discussions on various types of replacement culverts and foundation alternatives and provides recommendations for the preferred culvert option.

Several culvert options that were considered during the preliminary design stage included:

- Corrugated steel pipe (CSP), structural plate corrugated steel pipe (SPCSP) or twin pipes
- Concrete box (closed) culvert composed of pre-cast segments
- Concrete box, open footing culvert
- Structural plate corrugated steel pipe arch, supported on sheet piles

Foundation recommendations and comparison of the above alternatives was provided in the preliminary FIDR by Thurber. Ultimately, an arch culvert supported on sheet piles was selected as the preferred option as it reduces the need for removal of buried peat below the groundwater table at this site. This report provides foundation recommendations for detailed design of the arch culvert supported on sheet piles.

A draft General Arrangement (GA) drawing was provided by Hatch for the arch culvert option, which is attached in Appendix H. The culvert replacement includes lengthening of the culvert and widening of the approach embankment by up to approximately 2 m on the west side of Highway 11. Foundation recommendations for the design and installation of the culvert and the embankment widening are presented below.

11.2 Summary of Subsurface Conditions

In general, the subsurface conditions encountered in the boreholes consisted of asphalt and sand to silty sand fill underlain by a layer of peat to sand and silt mixed with peat. Underlying the peat, the native soils consisted of sand to silt and sand, with lower deposits of silt. Underlying the lower silt layer was a lower deposit of sand to silt and sand.

The groundwater level in the open boreholes and monitoring wells ranged from approximate Elevation 259.0 to 260.3 m. The local creek surface water level was measured at an Elevation of 259.9 m in November 2018. The culvert site is located in a low lying grassy/marshy area, with generally high surface water levels.

11.3 Foundation Design for SPCSP Arch Culvert Supported on Sheet Piles

The invert level of the existing culvert is at approximate Elevation 259.1 m.

Foundation design aspects for the replacement culvert include subgrade conditions and preparation, geotechnical capacities, settlement of foundation soils, lateral earth pressures, groundwater control, cofferdams, temporary roadway protection system design, temporary modular bridge foundations, and restoration and widening of the roadway embankment.

In particular, construction of the replacement culvert requires the removal of the peat layer in areas where new embankment fill is required for widening.

The preferred culvert replacement option at this site is a structural plate corrugated steel pipe (SPCSP) arch, located along the same alignment as the existing culvert. The draft GA drawing provided by Hatch indicates that the SPCSP arch would have a span of 5.8 m and would be supported on sheet pile walls. Both standard sheet piles walls and sheet pile combination walls are considered. Sheet pile combination walls consist of a combination of conventional sheet piles and H-piles to form the walls, which allow for higher lateral and axial capacities to be achieved over conventional sheet piles alone. Combination walls are expected to provide additional rigidity for lateral loading.

The GA drawing shows a sheet pile cut-off elevation of 260.4 m, and a base of excavation for backfill around the arch culvert of approximate Elevation 259.7 m. The base of the creek channel between the sheet pile walls is shown at approximate Elevation 258 m.

The arch culvert supported on sheet piles at this site reduces the need for removal of buried peat under the existing embankment since the replacement culvert would not be founded directly on the subgrade soils (i.e. no excavation for bedding placement required) and the excavation to install the arch culvert would only extend up to approximately 0.5 m below the top of the peat layer, to approximate Elevation 259.7 m.

Although removal of peat will not be required below the culvert for subgrade preparation for the arch option, all peat encountered beyond the existing embankment where the culvert will be lengthened and the embankment widened must be removed and replaced, as described in Section 11.3.5. The peat must be removed for a width of 1.5 m beyond the outside of the arch culvert, and extend for 1.5 m beyond the toe of slope of the final embankment.

The sheet pile installation will likely require partial depth excavation of the embankment to allow for pile installation before removal of the existing box culvert or installation of the temporary stream diversion pipe.

11.3.1 Axial Resistance of Sheet Piles

Driven steel sheet piles will develop resistance to vertical loads through frictional resistance along the sides of the sheet piles within the native compact sand and silt. The upper 2 to 3 m of the sheet piles will be embedded in the peat and therefore will provide very little axial or lateral resistance.

Based on discussions with Hatch, we understand that AZ 44-700N standard sheet pile sections or HZ 880M C-12 / AZ 25-800 sheet pile combination walls sections are proposed. Based on this information, the following table provides the recommended geotechnical axial resistances for driven sheet pile walls and sheet pile combination walls, for the application sections and minimum pile lengths below the sheet pile cut-off elevation of 260.4 m:

Sheet Pile Wall Type and Section	Minimum Sheet Pile Tip Elevation (m)	Approximate Total Sheet Pile Length (m)	Factored ULS Capacity (per m of wall) (kN/m)	SLS Capacity (per m of wall) (kN/m)
Standard Sheet Pile Wall Section AZ 44-700N	246	14.4	380	315
Combination Wall Section HZ 880M C-12 / AZ 25-800	247	13.4	400	330

The SLS values are based on a vertical pile settlement of 25 mm at the base of the embankment fill. Elastic compression of the sheet pile will be in addition to this settlement.

A consequence factor of 1.0 was utilized in this design adopting the typical consequence level. The geotechnical resistance factor of 0.4 for compression and 0.8 for settlement, both adopted for typical degree of understanding, were used to obtain the above values, as per Canadian Highway Bridge Design Code (CHBDC) 2019, Section 6.9.

11.3.2 Sheet Pile Installation

Sheet pile installation should be in accordance with OPSS.PROV 903.

Sheet piles should be driven to the specified elevation noted above for the selected sheet pile length. The appropriate pile driving note is “Sheet piles to be driven to Elevation XXX m” (to be completed by designer).

Tip protection should not be used for sheet piles at this site as the load bearing sheet piles will derive vertical resistance mostly from shaft friction.

Design of the sheet pile foundations must consider environmental conditions such as road salts

or fluctuating water levels that may cause long term corrosion and reduce the service life of the structure.

Depending on the depth of excavation for positioning of the pile-driving equipment, the sheet piles will be partially driven through the embankment fill prior to excavation and removal of the existing culvert. It should be recognized that fill materials including embankment fills are heterogeneous in nature and may contain obstructions such as wood, boulders or rock fill. If such obstructions are encountered at the proposed location of the sheet pile walls, they will have to be removed to facilitate sheet pile installation.

Advancement of the sheet piles to the design depths may be impeded by the build-up of friction on the piles during driving. The Contractor should be prepared to drive the piles to the full design depths using the appropriate means, including vibration if necessary, and that no piles may be left overnight at partial depth.

If any sheet piles cannot be advanced to the full depth to reach the design tip elevations, the Contractor must immediately notify the Contract Administrator (CA), who should contact the designer for review. The Contractor must not be permitted to proceed with installation of the next sheet pile until the designer has checked whether sufficient capacity is achieved, and the CA has given approval to proceed.

Horizontal alignment of the sheet piles should be maintained within the required tolerances using a stable and secure template.

It is recommended that the Contractor should submit a work plan for sheet pile installation to the CA in advance of construction. The work plan should be submitted to the designer for review.

During installation, the CA should provide daily sheet pile driving records to the designer and be prepared to contact the designer and the foundation engineer if the sheet piles cannot be driven to the full design depths, if specified tolerances cannot be maintained, or if other problems arise.

Suggested text for an NSSP on sheet pile installation is included in Appendix F.

11.3.3 Lateral Resistance of Sheet Piles

The depth of penetration of the sheet piles will be governed not only by the axial resistance/capacity, but also by the lateral pressure imposed by the soils retained behind the sheet piles. The sheet pile design must satisfy the lateral stability requirement.

The recommended soil parameters for lateral sheet pile design are given in the table below. These parameters should be used in conjunction with the equations provided below the table. The lateral resistance in the peat should be ignored.

Soil Unit	Approximate Elevation (m)	Effective Unit Weight γ' (kN/m^3)	N_h (kN/m3)	K_p
Peat	260 – 257.5	5	-	-
Sand and Silt	Below 257.5	10	2,500	3.1

The coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) for sheet pile design can be calculated as follows:

$k_s = n_h * z$ (kN/m^2/m)

$p_{ult} = \gamma' * z * K_p$ (kPa)

where z = depth of embedment of sheet pile (m)

n_h = coefficient related to soil relative density (kN/m^3)

γ' = effective unit weight of soil (kN/m^3)

K_p = coefficient of passive earth pressure

The spring constant, K_s, and ultimate lateral resistance, P_{ult}, can be obtained from the following expressions:

$K_s = k_s * L$ (kN/m per metre wall)

$P_{ult} = p_{ult} * L$ (kN per metre wall)

where L = length (m) of the pile segment/element along depth of embedment

To maintain the computed passive resistance, protection must be provided in front of the sheet piles to prevent material loss due to creek erosion.

11.3.4 Frost Cover

The depth of frost penetration at this site is approximately 2.4 m based on OPSD 3090.100. The base of any permanent concrete footings if employed should be provided with a minimum of 2.4 m of earth cover as protection against frost action. The frost cover requirement does not apply to the SPCSP arch culvert.

Spread footings founded on granular engineered fill pads for the temporary modular bridge, provided the fill pads consist of non-frost susceptible, free draining engineered fill and are above the water level, should be provided with a minimum embedment of 0.5 m. These footings do not need to be placed below the depth of frost.

11.3.5 Peat Replacement

The borehole information indicates a variable thickness of peat below the existing embankment fill and near the culvert footprint area. Approximately 1.1 to 3.1 m of peat to sand and silt mixed

with peat was encountered below the embankment fill at an approximate elevation of 260.4 to 259.6 m, with peat also encountered beyond the existing inlet and outlet. The base elevation of the peat deposit ranges from 258.5 to 257.1 m.

For the chosen SPCSP arch culvert option, where new embankment fill is required for highway widening, the peat deposit must be removed prior to fill placement. The extent of peat removal must be a minimum width of 1.5 m beyond the outside of the arch culvert, and must extend from the existing embankment toe for a minimum of 1.5 m beyond the toe of slope of the final embankment.

The excavation should be carried out in accordance with OPSS.PROV 209 (Embankments over Swamps and Compressible Soils) and OPSD 203.030 (Embankments Over Swamp - Existing Slopes Maintained). Care must be exercised not to destabilize the existing highway embankment while excavating the peat near the toe of the embankment. Further discussion on embankment stability is provided in Section 21.

The sub-excavated area should then be backfilled with granular material meeting OPSS.PROV 1010 Granular A or Granular B Type II requirements and be compacted as per OPSS.PROV 501, provided that the peat sub-excavation and compaction and placement of the replacement granular fill is carried out in the dry as per OPSS.PROV 902 and SP 109S61. If full dewatering is not possible, the peat sub-excavation should be backfilled with rock fill or clear stone as described in Section 11.3.6.

Construction equipment should not be allowed to travel on the prepared subgrade, which must be protected from disturbance during construction.

11.3.6 Construction in Wet Conditions

Given that removal and replacement of peat below the water table may be required, and that seepage of groundwater through the foundation sand to silt and sand and of surface water through the embankment fill is expected, backfilling in the wet conditions (below water level) could be considered. This approach will still require diversion of the stream flow and surface water so that the excavations can be done within stagnant water. When backfilling is conducted in the wet, select rock fill should be used below the water table after removal of the peat. The recommended gradation of the rock fill is as follows:

Sieve Size	Percent Passing (%)
150 mm	100
106 mm	50 – 100
75 mm	15 – 80
26.5 mm	0 – 15
0.075 mm	0 – 2

The rock fill shall be well graded with the gradation determined as provided in Note 2 of Table 8 within OPSS.PROV 1004 (November 2012). The rock fill must be derived from crushed rock and the rock fill particles shall be durable and have a minimum unconfined compressive strength (UCS) of 100 MPa and meet the physical property requirements of “Rock Protection” as provided in Table 7 within OPSS.PROV 1004 (November 2012). Weak rocks such as Shales and Sandstones, or cobbles and boulders are not acceptable as rock fill.

Care must be exercised not to destabilize the existing highway embankment while excavating the peat near the toe of the embankment.

Following peat removal, a separation layer consisting of a non-woven geotextile should be placed between the native sand to silt and sand and the rock fill. The geotextile should meet the specifications for OPSS.PROV 1860 Class II, and have a fabric opening size (FOS) not greater than 212 micro millimetres. The rock fill should be completely wrapped with the geotextile to minimize migration of fines into the rock fill.

Rock fill used to backfill sub-excavated areas below the water table may be placed by end dumping. Granular fill must not be used to backfill excavations below the water table. The rock fill placement below the water level should follow OPSS.PROV 206 and OPSS.PROV 209 (Embankments over Swamps and Compressible Soils).

Rock fill placed above the water level should be placed in a controlled manner (not end dumped) including blading, dozing and chinking of the rock to minimize voids and bridging. Rock fill above the water level must be compacted as per OPSS.PROV 206. Where granular fill is to be placed over rock fill, the rock fill subgrade must be blinded with spall material and rock fill chinking shall be in accordance with OPSS.PROV 206. All granular fill must be compacted as per OPSS.PROV 501.

Other options would be to use a coarse 53 mm clear stone, fully wrapped in geotextile, for backfilling in the wet below the culvert or for embankment widening. Once the clear stone backfill is above the water level, granular fill for the culvert backfill or embankment widening may be placed in the dry and compacted as per OPSS.PROV 501.

For this backfilling option under water, if the peat is not completely removed or the rock fill traps peat, there is a risk of additional settlement of the embankment.

11.3.7 Settlement

The replacement culvert will be constructed approximately on the same alignment and with a larger opening size as the existing culvert with no grade raise on the overlying embankment. As the replacement culvert will be longer than the existing culvert, some placement of additional fill will be required to widen the embankment slopes. The anticipated additional fill height ranges from approximately 1 to 2.5 m. Due to the presence of native peat in the widened areas, foundation settlement under this fill in the order of 40 to 65 mm near the highway shoulders and 300 to 400 mm near the toes of the slopes are anticipated if the peat remains in place. However, provided that all peat is removed from the widened embankment areas, the foundation settlement would be reduced to less than 25 mm, which would be completed by the end of construction.

12. EXCAVATION AND GROUNDWATER CONTROL

All excavations should be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the silty sand and sand and silt fills at this site are classified as a Type 3 soil above the water table. Below the water table (i.e., if the groundwater flow is not controlled), the fill soils would be classified as Type 4 soils. The native peat to sand and silt mixed with peat and other surficial alluvial deposits that are anticipated in the inlet and outlet areas should be classified as Type 4 soils. The native sand and silt deposits underlying the peat and below the water table are also classified as Type 4 soils.

Excavations for culvert replacement and embankment widening will be carried out through the existing fill and up to the base of the native peat layer. Excavation for culvert construction should be carried out in accordance with OPSS.PROV 902 and SP 109S61. Excavations for embankment widening with peat removal should follow OPSS.PROV 206, OPSS.PROV 209 and OPSD 203.030.

As the excavations will be carried out below the creek water level, diversion of the surface water flow will be required. Furthermore, groundwater and surface runoff will tend to seep into and accumulate in the excavations.

For the arch culvert installation, excavations to below the sheet pile cut-off Elevation of 260.4 m will be required, which may potentially extend into the top of the native peat layer. It is recommended that the excavations be kept above the groundwater level to allow for a dry working area. If excavation below the groundwater level is required, the base of the excavation (likely native peat) should be covered with geotextile and a sufficient thickness of clear stone backfill to create a working platform. Constructing in this manner should minimize the need for dewatering of the temporary excavations. Further discussion on dewatering is included in Section 14 below.

When backfilling adjacent to the arch culvert, it is recommended that the temporary excavations to the top of the sheet piles should be backfilled with clear stone, fully wrapped in geotextile. This

will facilitate compaction of the overlying granular culvert backfill above the groundwater level and the native peat layer.

13. STREAM DIVERSION PIPE

A temporary stream diversion pipe may be required to accommodate tributary water flow during culvert replacement. It is anticipated that the invert level of the diversion pipe will be at or below Elevation 259.5 m, which corresponds to the base of the sand and silt fill, or within the buried peat deposit. If peat is encountered at the invert level of the stream diversion pipe trench, it may be left in place, provided some settlement of the stream diversion pipe is acceptable. If the settlement is not acceptable, the underlying peat should be removed and replaced with well compacted granular material.

The temporary diversion pipe should be placed on a minimum 300 mm thick layer of bedding material conforming to OPSS.PROV 1010 Granular A or Granular B Type II requirements as per OPSD 802.010. The bedding material should be placed on the prepared subgrade as soon as practical, following its inspection and approval. The subgrade preparation should be carried out in the dry unless measures are taken to work in the wet as described in Section 11.3.6. The prepared subgrade should be protected from disturbance during construction.

The stream diversion pipe could be installed within the temporary open cut excavations, or within a shored excavation using a trench box.

14. DEWATERING ASSESSMENT

Groundwater taking for construction dewatering is governed by the Ontario Water Resources Act (OWRA), Environmental Protection Act (EPA) and the Water Taking and Transfer Regulation 387/04, a regulation under the OWRA.

If the water taking rate will be greater than 50,000 L/day and less than 400,000 L/day then registration on the Environmental Activity and Sector Registry (EASR) will be required. If the water taking rate will be greater than 400,000 L/day, then a Category 3 Permit To Take Water (PTTW) will be required.

Should the arch culvert installation be carried out in the wet, as described in Section 12, then the need for significant dewatering is not anticipated. However, for comparison purposes an assessment was carried out for dewatering temporary excavations to below the sheet pile cut-off level, which may extend to approximate Elevation 259.7 m. Based on the preliminary GA drawings attached in Appendix H, the dimensions and conditions that were assumed for the preliminary dewatering assessment are provided in Table 14.1 below. It is assumed that construction will be staged, whereby one half of the culvert will be placed at a time. The geologic units that are anticipated to supply water to this excavation are sand and silt fill, native peat to sand and silt

mixed with peat, and native sand to silt and sand. It is assumed that the groundwater would be lowered in advance of the excavation such that the groundwater can be drawn down sufficiently.

Table 14.1: Assumed Excavation Dimensions and Ground Conditions

Structure	Assumed Excavation Footprint (m)	Lowest Assumed Elevation of Excavation (m)	Assumed Dewatering Target Elevation (m)	Assumed Groundwater Elevation (m)	Geologic Units to Dewater
Culvert Installation at Sheet Pile Cut-Off Level (Half Culvert Length)	25 x 12	259.7	259.2	259.76	Fill, peat, sand to sand and silt

For the purpose of estimating water taking flow rates it was assumed that surface water flow would be directed around the excavation such that surface water will not enter the excavation at a significant rate.

The water taking will be temporary in nature for the purpose of construction dewatering for installation of the infrastructure. Dewatering rates were estimated using the Dupuit analytical solution. The radius of influence was calculated using the Sichardt equation. It is assumed the water level will be required to be lowered to about 0.5 m below the proposed excavation, or to Elevation 259.2 m, in order to facilitate a dry, stable work area.

The preliminary peak water taking rate was estimated to be approximately 300,000 litres per day including a safety factor and rainfall allowance. The preliminary radius of influence was estimated to be approximately 20 m from the edge of the excavation.

Considering the estimated peak water taking rate is greater than 50,000 L/day and less than 400,000 L/day, registration on the EASR would be required to dewater the temporary culvert excavations. A Water Taking Report and Discharge Report would be required for EASR registration to provide the necessary data and analysis to meet O.Reg. 63/16. The study would need to include an impact assessment as well as mitigation measures, a monitoring plan, and a contingency plan.

Based on the above factors, it is recommended that the temporary excavations be kept above the groundwater level if practical, with temporary excavations carried out in the wet where required, as described in Sections 11.3.6 and 12. In this case, the Contractor should be allowed to dewater up to 50,000 litres per day. Above this quantity of dewatering, the Contractor should take appropriate measures for working in the wet.

However, if dewatering will be used for constructing in the dry, EASR registration would be required as described above. The selection and design of any dewatering systems is the responsibility of the Contractor. The Contract Documents must alert the Contractor to this

responsibility and to design the system in accordance with OPSS.PROV 517 and SP 517F01. For constructing in the dry, an appropriate dewatering system must be designed and be effective to maintain the water level at a minimum depth of 0.5 m below the base of the excavations. A preconstruction survey is not required at this site. Considering the conditions on site, it is recommended that a dewatering engineer with a minimum of 5 years of experience in designing dewatering systems should be retained by the Contractor for design of an effective dewatering system. Suggested wording for an NSSP on Dewatering is included in Appendix F.

15. WATER QUALITY

For assessment of the general groundwater quality in the project area, a sample of the groundwater from the monitoring well at Borehole 21-01 was collected. As noted in Section 7, the water sample was tested and the results were compared to the Ontario Provincial Water Quality Objectives (PWQO). A filtered sub-sample was also tested for dissolved metal parameters for comparison purposes. The water sample test results are summarized in Table 7.1.

The test results indicate that five of the metals parameters tested exceeded the PWQO criteria for total concentrations. However, testing of a filtered sample to remove the high Total Suspended Solids, indicated considerably reduced metals concentrations, with only three parameters exceeding the PWQO criteria. If dewatering is used at this site, it is likely that treatment of the discharge water through the use of filtering, settling tanks or other methods may be required to reduce the amount of suspended solids and the metals concentrations prior to discharge into local surface water bodies such as creeks.

16. CULVERT BACKFILL AND LATERAL EARTH PRESSURES

Backfill to the culvert should consist of free-draining, non-frost susceptible granular materials such as Granular A or B Type II conforming to the requirements of OPSS.PROV 1010. Reference should be made to the backfill arrangements stipulated in OPSD 802.020, as appropriate. All fills should be placed in regular lifts and be compacted in accordance with OPSS.PROV 501 and OPSS.PROV 206. The backfill should be placed and compacted in simultaneous lifts on both sides of the culvert, and the top of backfill elevation should not differ more than 500 mm on both sides of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and on the roof of the culvert. Compaction equipment to be used adjacent to the culvert should be restricted in accordance with OPSS.PROV 501.

To facilitate compaction of the granular backfill where excavations extend below the groundwater level and/or into the native peat layer, the base should be backfilled with clear stone, fully wrapped in geotextile, until the backfill is above the water level, as described in Sections 11.3.6 and 12.

Lateral earth pressures acting on the culvert walls may be assumed to be a triangular distribution. For a fully drained backfill, the pressures should be computed in accordance with the CHBDC 2019, but are generally given by the expression:

$$p_h = K(\gamma h + q)$$

where
- p_h = horizontal pressure on the wall at depth h (kPa)
- K = earth pressure coefficient (see table below)
- γ = bulk unit weight of retained soil (see table below)
- h = depth below top of fill where pressure is computed (m)
- q = value of any surcharge (kPa)

Earth pressure coefficients for backfill to the culvert walls are dependent on the material used as backfill. Recommended unfactored values are shown in Table 16.1 below.

Table 16.1: Lateral Earth Pressure Coefficients (K)

Loading Condition	OPSS Granular A or Granular B Type II ϕ = 35°; γ = 22.8 kN/m3		OPSS Granular B Type I (modified) or Type III ϕ = 32°; γ = 21.2 kN/m3	
	Horizontal Backfill	Sloping Backfill (2H:1V)	Horizontal Backfill	Sloping Backfill (2H:1V)
Active (Unrestrained Wall)	0.27	0.40	0.31	0.48
At-rest (Restrained Wall)	0.43	0.62	0.47	0.70
Passive	3.7	-	3.2	-

Note: Submerged unit weight should be used below the groundwater level/high tributary level.

Active earth pressures should be used for any unrestrained wall.

The use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) is preferred as it results in lower earth pressures acting on the culvert.

In accordance with Clause 6.12.3 of the CHBDC 2019, a compaction surcharge should be added. The magnitude of the surcharge should be 12 kPa at the top of fill and decrease to 0 kPa at a depth of 1.7 m for Granular B Type I, or at a depth of 2.0 m for Granular A or B Type II.

17. SEISMIC CONSIDERATIONS

In accordance with the CHBDC 2019, the selection of the seismic site classification is based on the soil conditions encountered in the upper 30 m of the stratigraphy. Based on the presence of generally compact fill and native soils, as well as the presence of a buried peat layer, the site is

classified as Seismic Site Class D in accordance with Table 4.1, Clause 4.4.3.2 of the CHBDC. The peak ground acceleration, PGA, for a 2,475-year return period seismic event (2% probability of being exceeded in 50 years) for Site Class D at this site is 0.0668 g as per the National Building Codes of Canada (NBCC 2020).

The coefficients of horizontal earth pressures for seismic loading on walls assuming a level backfill, a Site Class D, and a reference PGA of 0.0668 g are presented in Table 17.1 below. The vertical acceleration coefficient has been ignored ($k_v = 0$).

Table 17.1: Earth Pressure Coefficients for Earthquake Loading

Loading Condition	Horizontal Acceleration Coefficient, k_h	Seismic Earth Pressure Coefficients (K_{AE})			
		OPSS Granular A or Granular B Type II $\phi = 35°$, $\gamma = 22.8$ kN/m^3	OPSS Granular B Type I (modified) or Type III $\phi = 32°$, $\gamma = 21.2$ kN/m^3	Existing Silt and Sand to Sandy Silt Fill $\phi = 31°$, $\gamma = 21$ kN/m^3	Existing Peat to Sand and Silt mixed with Peat $\phi = 29°$, $\gamma = 16$ kN/m^3
Active (Unrestrained Wall)	0.033	0.29	0.33	0.34	0.37
Active (Restrained Wall)	0.067	0.31	0.35	0.36	0.39

Note 1: Mononobe and Okabe, 1929, World Engineering Congress 9: 179-187
Note 2: Wood, J. H. 1973, earthquake induced soil pressures on structures, PhD Thesis, California Institute of Technology, Pasadena, CA.

In view of the low potential for seismic activity in the area, liquefaction is not considered to be a concern at this site.

18. COFFERDAMS

Construction of cofferdams will be required for stream diversion. Options for cofferdams include interlocking sheet piles or sandbags. Sheet pile cofferdams are anticipated to be feasible at this site as they can be driven into the native sands and silts. The recommendations provided in Section 19 below for Temporary Protection Systems are also applicable to sheet pile cofferdams.

19. TEMPORARY PROTECTION SYSTEM

A temporary roadway protection system, if utilized, should be implemented in accordance with OPSS.PROV 539 and designed for Performance Level 2. Options for roadway protection are a

soldier pile and lagging system or interlocking sheet piles. The soil parameters in Table 19.1 may apply for the design of the temporary roadway protection system with horizontal backfill.

Table 19.1: Soil Parameters for Temporary Protection System Design

Soil Parameter	Existing Silt and Sand to Sandy Silt Fill	Native Peat to Peat Mixed with Sand and Silt	Native Silt and Sand
Φ (angle of internal friction)	31˚	29˚	30˚
γ (total unit weight)	21 kN/m^3	16 kN/m^3	20 kN/m^3
γ_w (submerged unit weight)	11 kN/m^3	6 kN/m^3	10 kN/m^3
K_a	0.32	0.35	0.33
K_p	3.1	2.9	3.0

Full hydrostatic pressure should be considered assuming a water level at least equal to the design creek water level.

The temporary protection system may be removed or partially removed upon completion of the work. Care must be taken when removing the soldier piles as to not incur damage to the subgrade of the newly installed culvert.

The design of the temporary protection system is the responsibility of the Contractor. The actual pressure distribution acting on the protection/shoring system is a function of the construction sequence and the relative flexibility of the wall, and these factors have to be considered when designing the shoring system. All protection systems should be designed by a Professional Engineer experienced in such designs, who will determine an appropriate support system.

20. TEMPORARY MODULAR BRIDGE

An inline temporary modular bridge is planned at this site for traffic staging purposes during construction of the replacement culvert. The design of the temporary bridge is the responsibility of the contractor. The contractor must retain a Professional Engineer, experienced in bridge design, to design the temporary bridge.

Based on discussions with Hatch, it is understood that the modular bridge would be located at the west lane (outlet end of the culvert), and would be installed after the foundation sheet pile walls have been installed for the outlet half of the culvert.

The modular bridge may be supported on precast concrete bearing pads founded on 1 m thick engineered granular fill pads. The base of the concrete pads may be placed at approximate

Elevations of 262.5 to 264.5 m. The base of the underlying engineered fill pads may be placed on the existing embankment fill (typically dense silty sand to sand and silt fill) at approximate Elevations of 262.5 to 263.5 m at the south and north abutments respectively.

The granular fill pads should be a minimum of 1 m thick and consist of OPSS Granular A or Granular B Type II, placed in 150 mm thick lifts and compacted to 100% of the SPMDD at ±2% of Optimum Moisture Content (OMC).

The minimum footing width should be 2 m and the footing should be embedded a minimum of 0.5 m below the face of the forward excavation slope. The front edge of the footing should be set back a minimum of 2 m behind from the crest of the temporary excavation slope at the top of the footing level. The dimensions of the base of the fill pad excavations should be determined by assuming a granular fill pad that is 1.0 m wider than the spread footing at the level of the footing base and projecting outward and downward at 1H:1V for the side slopes of the pad.

The forward slopes of the temporary excavation in front of the modular bridge footings following the culvert foundation sheet pile installations should be inclined at no steeper than 2H:1V above the water level and 3H:1V below the water level. Stability of the forward slopes is described in Section 21 below. The temporary excavation slopes for the modular bridge must be protected from erosion by covering the slopes with tarp.

The following geotechnical resistances are recommended for design of 2 to 3 m wide (minimum 2 m wide) concrete spread footings placed on minimum 1 m thick engineered granular fill pads prepared as outlined above with the underside of the fill pads at approximate Elevations of 262.5 to 263.5 m:

Geotechnical Resistance	Temporary Modular Bridge with Spread Footings on 1.0 m Thick Engineered Fill Pads		
	2.0 m Wide Footings	2.5 m Wide Footings	3.0 m Wide Footings
Factored Geotechnical Resistance at ULS	210	180	150
Geotechnical Resistance at SLS (for up to 25 mm settlement)	135	120	100

Resistance to lateral forces/sliding resistance between the concrete pad and the underlying Granular A or B Type II engineered fill should be calculated assuming and ultimate coefficient of friction of 0.55. This is an “ultimate” value and requires a degree of sliding movement to occur to fully mobilize the resistance. A resistance factor of 0.8 should be applied to this ultimate value.

The above Geotechnical Resistances assume the footings are embedded a minimum of 0.5 m below the ground surface surrounding the footings.

It is recommended that the contractor retain a geotechnical consultant who is RAQs qualified at the medium complexity level (RAQs Category – Geotechnical Structures and Embankment – Medium Complexity) to design the footings and stable slopes in front of the footings for the temporary modular bridge. All final reports and drawings must be sealed and signed by a Professional Engineer, who shall also be a RAQs Designated Contact. An NSSP for this effect is attached in Appendix F.

21. SLOPE STABILITY

Some placement of additional fill (ranging from approximately 1 to 2.5 m in height) will be required for widening of the highway embankment by up to 2 m. Based on draft highway cross-sections provided by Hatch, the embankment widening is only on the west side of Highway 11, between approximate Sta. 28+215 and 28+325, for a total length of approximately 110 m.

Slope stability analyses were conducted for the widened embankment side slope of Highway 11 to assess the stability if the native peat layer is left in place or removed and replaced with granular material. A critical section at Sta. 28+241 just beyond the south side of the replacement culvert was selected for analysis due to the presence of peat along the existing embankment toe of slope. The stability assessments assume the embankment fill will consist of Granular B Type I, constructed at a 2H:1V slope. Figure 1 in Appendix G indicates that the safety factor of the widened embankment slope will not be acceptable if the peat is left in place (Factor of Safety of approximately 1.4). If the peat is removed to a minimum of 1.5 m beyond the toe of slope of the final embankment and replaced with 53 mm clear stone below the water table, (fully wrapped in geotextile as described in Section 11.3.6), and well-compacted Granular B Type I, Type II or Type III above the water table, then the stability of the permanent widened slopes will be acceptable, with a Factor of Safety of approximately 1.5 (Figure 2). It will be necessary to remove the peat in short sections (up to 3 m long) and backfill immediately to maintain stability of the embankment slope. The peat should be removed in this manner wherever it is encountered along the 110 m length of widened embankment. Only a thin layer of peat or topsoil (75 to 150 mm) above the water level was encountered in Boreholes 21-04 and 24-06 to the north of the culvert on the west side of the highway embankment. Therefore, it is anticipated that peat replacement with clear stone below the water level for embankment widening will mainly be required to the south of the culvert.

For the temporary excavation slopes in front of the temporary modular bridge footings, as described in Section 20, in order to achieve a stability safety factor of 1.3, the footings should be embedded a minimum of 0.5 m below the forward face of the excavation, and set back a minimum of 2 m from the crest of the forward slope. Following the culvert foundation sheet pile installations, the temporary excavation slopes must be inclined at no steeper than 2H:1V above the groundwater level and 3H:1V below the groundwater level. Figures 3 to 5 in Appendix G depict

the forward slope stability for 2, 2.5 and 3 m wide footings for temporary slopes inclined at 2H:1V, with sheet piles installed along the culvert foundation alignment near the base of the excavation. The temporary excavation slopes for the modular bridge must be protected from erosion by covering the slopes with tarp.

Temporary excavations of approximately 2 to 2.5 m deep into the existing embankment fill will also be required to allow for installation of the temporary modular bridge footings and underlying engineered fill pads. Where there is insufficient space for widening the adjacent lane, short-term excavation slopes of steeper than 2H:1V may be required until the footings are installed and backfilled. The Contractor is responsible for maintaining stability of the temporary excavation slopes. While the adjacent lane is utilized for live traffic, the short-term excavation slopes must be monitored for signs of instability, and it may be necessary to make contingency repairs or modifications. Full-time traffic control would be required to accommodate the contingency measures. It is recommended that a visual monitoring plan be in place prior to excavation and during construction of the modular bridge footings. Some contingency measures that could be implemented to address signs of instability include:

- Monitor and repair the temporary slopes if they begin to ravel.
- Reduce the width of the travelled lane to allow the temporary slope to be flattened.
- Temporarily lower the grade of the travelled lane to apply less load on the embankment beside the footing excavation.
- Install short-term roadway protection until the footings are installed and backfilled.

22. EMBANKMENT RESTORATION

Embankment restoration after completion of the culvert replacement should be carried out in accordance with OPSS.PROV 206 and OPSS.PROV 209. The embankment reconstruction material should consist of imported Granular A, Granular B Type II, or Granular B Type III material. The restored embankment beyond the culvert should be reinstated at the existing slope inclination, but no steeper than 2H:1V. Soils generated from the culvert excavation should not be used for reinstatement of the embankment.

In general, surface vegetation, peat, topsoil, organic deposits, disturbed material or otherwise loose/soft soils should be stripped from the areas around the culvert inlet and outlet, and within the embankment footprints. Inspection and approval of the foundation surfaces by qualified geotechnical personnel should be conducted.

23. SCOUR AND EROSION PROTECTION

Erosion protection should be provided at the culvert inlet and outlet. Design of the erosion protection measures should consider hydrologic and hydraulic factors and should be carried out by specialists experienced in this field in accordance with OPSD 810.010, OPSS.PROV 511 and OPSS.PROV 1004.

Typically, rock protection should be provided over all surfaces with which tributary water is likely to be in contact. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS.PROV 804.

A concrete cut-off wall and a clay seal (only at the inlet) should be used to minimize the potential for erosion or piping around the culvert. The clay seal should extend to approximately 0.3 m above the high water level and laterally for the width of the granular material, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS.PROV 1205. A geosynthetic clay liner may be used in place of a compacted clay seal.

Selection of streambed material should be in accordance with OPSS.PROV 1005.

Liaison between the Foundations Consultant, Structural Engineer and Hydraulic / Drainage Engineer will be required in design to ensure that scour protection is adequately addressed.

24. CORROSION AND SULPHATE ATTACK POTENTIAL

The results of the corrosivity and sulphate content analytical tests conducted on the soil and surface water samples indicate the following conditions at the locations tested:

- The potential for corrosion on metal or concrete foundations from the surrounding native sand or surface water is considered to be mild to moderate due to the low concentrations of sulphate and chloride in the samples tested. The effect of road deicing salt should be considering while selecting the class of concrete.
- The potential for corrosion on metal and concrete from the peat to peat mixed with silt and sand is considered to be high, due to the high concentration of chloride and the low resistivity.
- The potential for sulphate attack on concrete from the surrounding soil or surface water is considered to be negligible due to the low sulphate concentration in the samples tested.
- Appropriate protection measures are recommended for metal or concrete structural elements. The effect of road deicing salt should be considered while selecting the corrosion protection measures. Consideration should also be given to removing the buried peat below and in the vicinity of the replacement culvert.

25. CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- For stability purposes and to avoid settlement under the widened embankment slopes, the peat layer must be fully removed to the limits discussed in Sections 11.3 and 21.

- Full dewatering to below the base of the culvert excavations may not be practical at this site and would also require EASR registration. Accordingly, appropriate methods for constructing in the wet should be developed. An NSSP on dewatering is attached in Appendix F.

- The water level in the watercourse may fluctuate and be at a higher elevation at the time of construction than indicated in the report.

- Temporary modular bridge (TMB) footings must be setback a minimum of 2 m behind the crest of the forward slopes, with the footing bases embedded a minimum of 0.5 m below the ground surface (as described in Sections 20 and 21) in order to maintain stable temporary excavation slopes in front of the TMB foundations. An NSSP on the TMB is attached in Appendix F.

- Obstructions may be present within the existing embankment fill, which may impede the driving of sheet piles for the SPCSP arch culvert foundations. Build-up of friction on the sheet piles may also impede driving to the full design depths. An NSSP on sheet pile installation is provided in Appendix F.

26. CLOSURE

Engineering analysis and preparation of the design report was carried out by Ms. Madisan Chiarotto and Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.

Madisan Chiarotto, P.Eng.
Geotechnical Engineer

Mark Farrant, P.Eng.
Associate, Senior Geotechnical Engineer

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

Date: January 30, 2025
File: 47632

THURBER

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1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

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3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

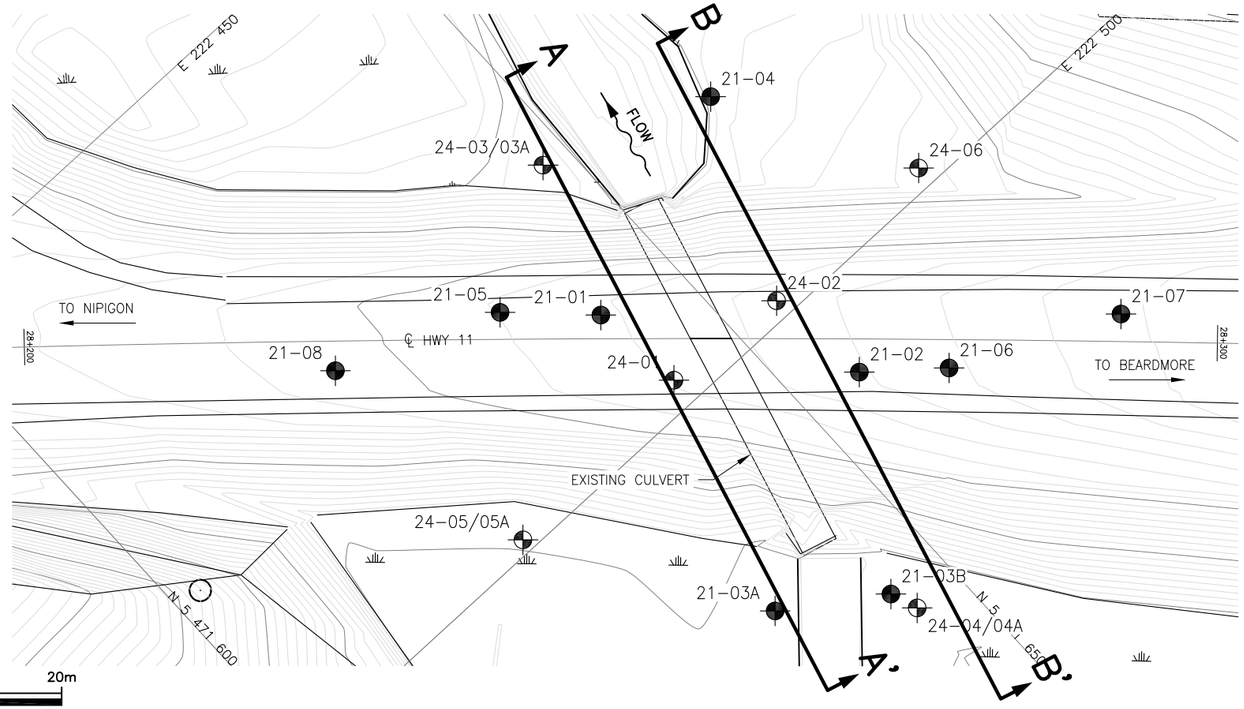
7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

APPENDIX A

Borehole Locations and Soil Strata Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

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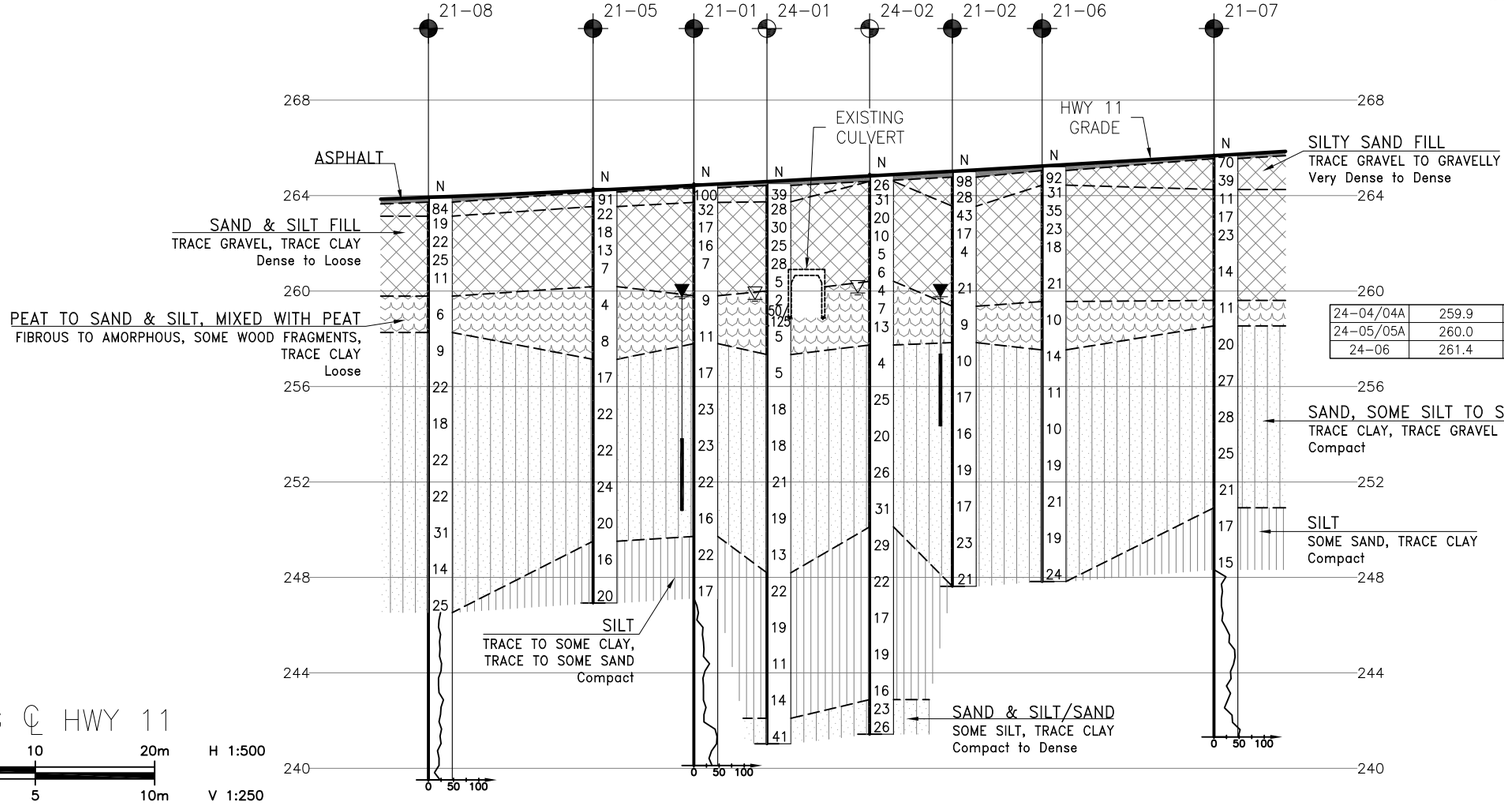


PROFILE ALONG ℄ HWY 11

10 0 10 20m H 1:500

5 0 5 10m V 1:250

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
JAN 28, 2025
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
JAN 28, 2025
PROVINCE OF ONTARIO

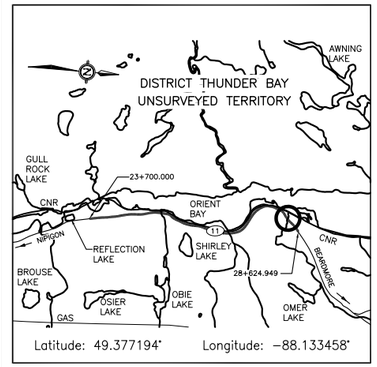
CONT No
GWP No 6911-12-00

OMER LAKE CULVERT
ON HIGHWAY 11
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

HATCH

THURBER



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
21-01	264.5	5 471 642.7	222 489.4
21-02	265.0	5 471 655.5	222 507.6
21-03A	259.9	5 471 636.7	222 517.6
21-03B	259.8	5 471 644.9	222 523.1
21-04	260.2	5 471 661.8	222 482.1
21-05	264.3	5 471 636.6	222 483.6
21-06	265.2	5 471 661.2	222 512.4
21-07	265.7	5 471 674.9	222 518.8
21-08	263.9	5 471 623.1	222 477.9
24-01	264.5	5 471 643.5	222 497.6
24-02	264.9	5 471 654.4	222 498.5
24-03/03A	260.4	5 471 647.6	222 476.9
24-04/04A	259.9	5 471 645.7	222 525.4
24-05/05A	260.0	5 471 625.2	222 498.9
24-06	261.4	5 471 670.7	222 498.3

-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 14.

GEOCRES No. 52H08-004

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MC	CHK	MEF	CODE	LOAD
DRAWN	AN	CHK	MC	SITE 48C-0181/C0	STRUCT

DATE JAN 2025
DWG 1

FILENAME: H:\Drafting\47000\47632\TED-47632 (31344)-PLPR-GL.dwg
PLOTDATE: 1/30/2025 11:11 AM

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

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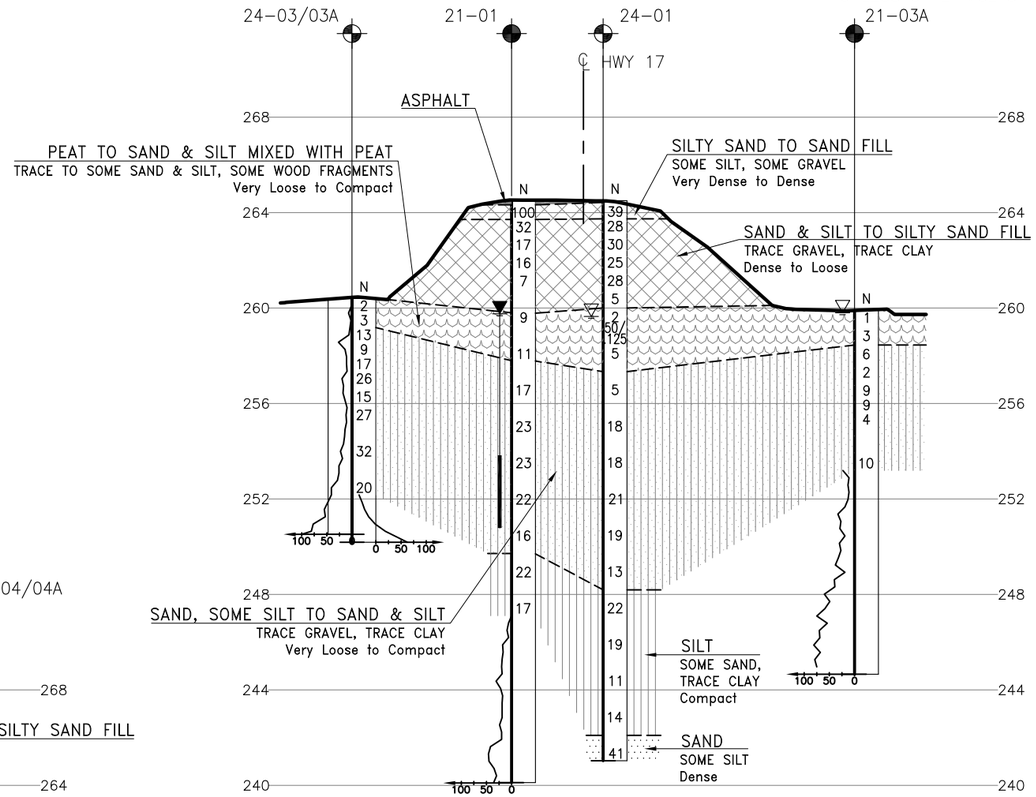
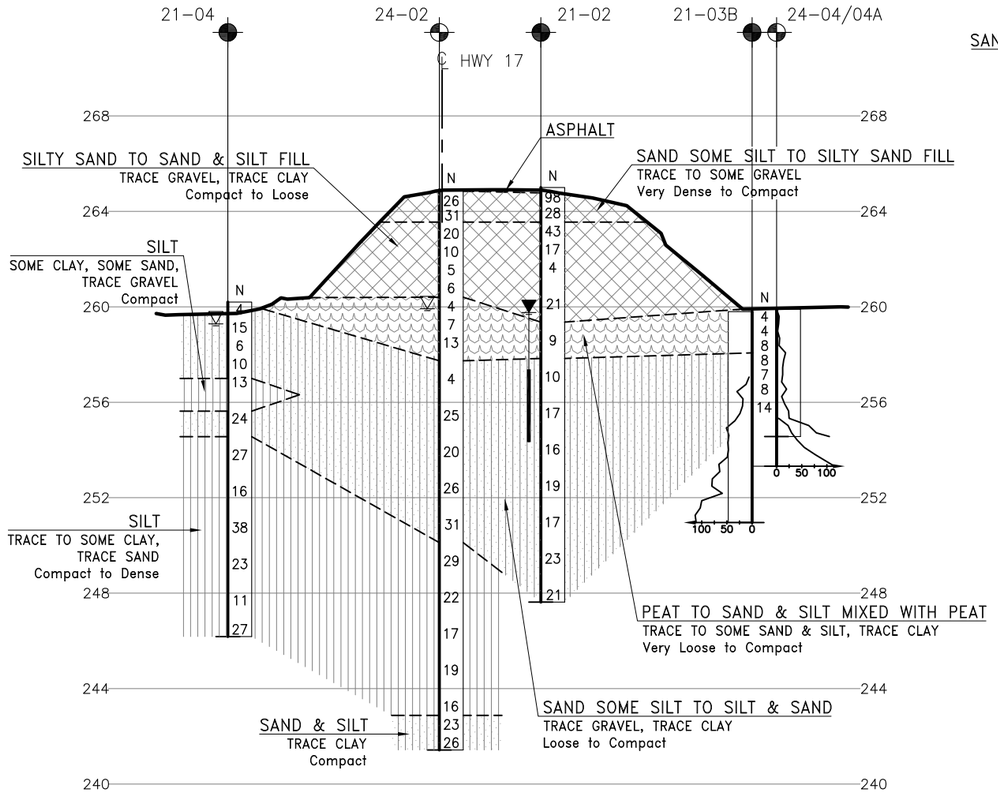


SECTION ALONG A–A'



SECTION ALONG B–B'

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24-05/05A	260.0	5 471 625.2	222 498.9
24-06	261.4	5 471 670.7	222 498.3

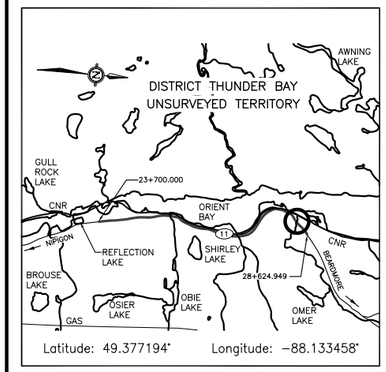
CONT No
GWP No 6911-12-00

OMER LAKE CULVERT
ON HIGHWAY 11
REPLACEMENT
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

HATCH

THURBER



KEYPLAN

LEGEND

●	Borehole
⊕	Borehole and Cone
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▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

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21-03B	259.8	5 471 644.9	222 523.1
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21-05	264.3	5 471 636.6	222 483.6
21-06	265.2	5 471 661.2	222 512.4
21-07	265.7	5 471 674.9	222 518.8
21-08	263.9	5 471 623.1	222 477.9
24-01	264.5	5 471 643.5	222 497.6
24-02	264.9	5 471 654.4	222 498.5
24-03/03A	260.4	5 471 647.6	222 476.9

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2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 14.

GEOCRES No. 52H08-004

LICENSED PROFESSIONAL ENGINEER
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JAN 28, 2025
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
JAN 28, 2025
PROVINCE OF ONTARIO

10 0 10 20m H 1:500
5 0 5 10m V 1:250

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	MC	CHK	MEF	CODE	LOAD
DRAWN	AN	CHK	MC	SITE 48C-0181/C0	STRUCT

DATE JAN 2025
DWG 2

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APPENDIX B

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

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THURBER

RECORD OF BOREHOLE No 21-01 1 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 642.7 E 222 489.4 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.20 - 2021.04.21 LATITUDE 49.377150 LONGITUDE -88.133602 CHECKED BY MEF

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
264.5	GROUND SURFACE										
0.0	**ASPHALT:** (175mm)										
0.2	Silty **SAND**, some gravel Very Dense Brown Moist (FILL)		1	SS	100		264				
263.7											
0.8	**SAND** and **SILT**, trace clay Dense to Loose Brown Moist (FILL)		2	SS	32		263				
			3	SS	17						0 37 62 1
			4	SS	16		262				
			5	SS	7		261				
259.8						▼					
4.7	**SAND** and **SILT** mixed with **PEAT**, some clay lenses, wood fragments Loose to Compact Brown to Black Wet		6	SS	9		260				
			7	SS	11		259				
257.8							258				
6.7	**SAND** and **SILT**, trace clay Compact Grey Wet		8	SS	17		257				0 62 38 0
			9	SS	23		256				
							255				

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No 21-01 2 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 642.7 E 222 489.4 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.20 - 2021.04.21 LATITUDE 49.377150 LONGITUDE -88.133602 CHECKED BY MEF

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **SILT**, trace clay Compact Grey Wet						254				
			10	SS	23				○		0 35 64 1
252.8							253				
11.7	Silty **SAND** Compact Brown Wet										
			11	SS	22		252		○		
			12	SS	16		251		○		
249.7							250				
14.8	**SILT**, trace clay, trace sand Compact Grey Wet										
			13	SS	22		249		○		
			14	SS	17		248		○		0 4 86 10
247.1											
17.4	End of sampling at 17.4m and start DCPT						247				
							246				
							245				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

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THURBER

RECORD OF BOREHOLE No 21-01 3 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 642.7 E 222 489.4 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.20 - 2021.04.21 LATITUDE 49.377150 LONGITUDE -88.133602 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						244	20 40 60 80 100	20 40 60		
							243				
							242				
240.1							241				
24.4	END OF DCPT AT 24.4m. BOREHOLE CAVED TO 12.5m BEFORE MONITORING WELL INSTALLATION. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2021.04.22 5.5 259.0 2021.04.23 4.7 259.8 2021.04.25 4.7 259.8										

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

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

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

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THURBER

RECORD OF BOREHOLE No 21-02 1 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 655.5 E 222 507.6 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2021.04.22 - 2021.04.22 LATITUDE 49.377267 LONGITUDE -88.133355 CHECKED BY MEF

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
265.0	GROUND SURFACE										
0.0	**ASPHALT:** (225mm)										
0.2	Silty **SAND**, some to trace gravel Very Dense to Compact Brown Moist (FILL) 25mm thick layer of asphalt at 0.6m		1	SS	98				○		13 64 23 (SI+CL)
263.6			2	SS	28		264		○		
1.4	**SAND** and **SILT**, trace clay, trace gravel Dense to Loose Brown Moist (FILL)		3	SS	43		263		○		
			4	SS	17				○		
			5	SS	4		262		○		1 43 55 1
	Trace organics, rootlets and wood fragments		6	SS	21	▼	261 260		○		
259.4											
5.6	**PEAT**, fibrous, trace sand, trace silt Loose Brown to Black Wet		7	SS	9		259		○		
257.8							258				
7.2	**SAND**, some silt Compact Grey Wet		8	SS	10		257		○		0 88 12 0
			9	SS	17		256		○		

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 21-02 2 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 655.5 E 222 507.6 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2021.04.22 - 2021.04.22 LATITUDE 49.377267 LONGITUDE -88.133355 CHECKED BY MEF

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt Compact Grey Wet										
			10	SS	16		254				
			11	SS	19		253				
251.7							252				
13.3	Silty **SAND** Compact Grey Wet		12	SS	17		251				
			13	SS	23		250				0 64 36 0
							249				
247.6			14	SS	21		248				
17.4	END OF BOREHOLE AT 17.4m. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2021.04.23 5.2 259.8 2021.04.25 5.2 259.8										

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No 21-03A 1 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 636.7 E 222 517.6 ORIGINATED BY GS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Casing/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.05.08 - 2021.05.08 LATITUDE 49.377100 LONGITUDE -88.133213 CHECKED BY MEF

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
259.9	GROUND SURFACE										
0.0	**PEAT**, some silt and sand Very Loose Brown to Black Wet		1	SS	1	▽					
			2	SS	3		259				
258.5											
1.4	**SAND**, some silt, trace gravel, some organics in upper 1.0m Loose to Very Loose Grey Wet		3	SS	6		258				
			4	SS	2						1 87 12 0
			5	SS	9		257				
			6	SS	9		256				
			7	SS	4						4 85 11 0
							255				
							254				
253.2			8	SS	10						
6.7	End of sampling and start DCPT due to refusal (wet sand conditions) with advancing the casing further.						253				
							252				
							251				
							250				

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-03A 2 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 636.7 E 222 517.6 ORIGINATED BY GS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Casing/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.05.08 - 2021.05.08 LATITUDE 49.377100 LONGITUDE -88.133213 CHECKED BY MEF

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page						249 248 247 246 245				
244.7											
15.2	END OF BOREHOLE AT 15.2m. BOREHOLE CAVED TO 2.3m AND WATER LEVEL AT 0.1m. BOREHOLE BACKFILLED WITH BENOTNITE HOLEPLUG TO SURFACE.										

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No 21-03B 1 OF 1 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 644.9 E 222 523.1 ORIGINATED BY GS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Casing/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.05.08 - 2021.05.08 LATITUDE 49.377174 LONGITUDE -88.133139 CHECKED BY MEF

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
259.8	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Casing advanced to 2.7m depth below ground surface and started DCPT due to refusal (wet sand conditions) with advancing the casing further. No soil samples were collected.						259				
257.1							258				
2.7	Start DCPT at 2.7m						257				
							256				
							255				
							254				
							253				
							252				
251.0							251				
8.8	END OF DCPT AT 8.8m UPON REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-04 1 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 661.8 E 222 482.1 ORIGINATED BY GS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Casing/Tripod COMPILED BY AN

DATUM Geodetic DATE 2021.05.06 - 2021.05.06 LATITUDE 49.377321 LONGITUDE -88.133706 CHECKED BY MEF

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.2	GROUND SURFACE										
0.0	**PEAT:** (150mm)						260				
0.2	Sandy **SILT**, some roots, organics Loose to Compact Brown to Grey Moist		1	SS	4	▽			○		
			2	SS	15		259		○		
258.8											
1.4	**SILT** and **SAND**, trace clay, trace gravel Loose to Compact Grey Wet		3	SS	6				○		0 53 46 1
			4	SS	10		258		○		
257.0											
3.2	**SILT**, some clay, some sand, trace gravel Compact Grey Moist		5	SS	13		257		○		
255.6											
4.6	Silty **SAND** Compact Brown Moist		6	SS	24		256		○		
254.6									○		
5.6	**SILT**, some to trace clay, trace sand Compact to Dense Grey Moist		7	SS	27		255				
							254		○		
			8	SS	16		253		○		
							252				
			9	SS	38		251		⊟		0 0 80 20

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-04 2 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 661.8 E 222 482.1 ORIGINATED BY GS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Casing/Tripod COMPILED BY AN

DATUM Geodetic DATE 2021.05.06 - 2021.05.06 LATITUDE 49.377321 LONGITUDE -88.133706 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100)	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
	Continued From Previous Page										
	SILT, some to trace clay, trace sand Compact Grey Moist						250				
			10	SS	23						
							249				
							248				
			11	SS	11						
							247				
246.2			12	SS	27						0 2 96 2
14.0	END OF BOREHOLE AT 14.0m. BOREHOLE CAVED TO 10.0m AND WATER LEVEL AT 0.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-05 1 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 636.6 E 222 483.6 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Wash Boring COMPILED BY AN

DATUM Geodetic DATE 2021.04.22 - 2021.04.22 LATITUDE 49.377095 LONGITUDE -88.133682 CHECKED BY MEF

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
264.3	GROUND SURFACE						264				
0.0	**ASPHALT:** (150mm)										
0.2	Silty **SAND**, some gravel Very Dense Brown Moist (FILL)		1	SS	91				○		
263.5							263				
0.8	**SAND** and **SILT**, trace gravel Compact to Loose Brown Moist (FILL)		2	SS	22				○		
			3	SS	18				○		
			4	SS	13		262		○		0 56 44 0
			5	SS	7		261		○		
260.2											
4.1	Silty **SAND** mixed with **PEAT**, some wood fragments Loose Brown to Black Wet (FILL)		6	SS	4		260		○		
			7	SS	8		259		○		0 73 26 1
257.1							258				
7.2	Silty **SAND** Compact Brown Wet		8	SS	17		257		○		
			9	SS	22		256				
							255		○		

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-05 2 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 636.6 E 222 483.6 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Wash Boring COMPILED BY AN

DATUM Geodetic DATE 2021.04.22 - 2021.04.22 LATITUDE 49.377095 LONGITUDE -88.133682 CHECKED BY MEF

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
	Continued From Previous Page										
	Silty **SAND** Compact Brown Wet						254				
			10	SS	22		253		○		
			11	SS	24		252		○		
			12	SS	20		251		○		
249.5							250				
14.8	**SILT**, some sand, some clay Compact Grey Wet		13	SS	16		249		○		
			14	SS	20		248		○		0 17 72 11
246.9							247				
17.4	END OF BOREHOLE AT 17.4M. BOREHOLE CAVED TO 11.2m. NO WATER LEVEL MEASUREMENT DUE TO RESIDUAL DRILLING WATER IN BOREHOLE. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, DRY CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE UPON COMPLETION.										

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-06 1 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 661.2 E 222 512.4 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY AN

DATUM Geodetic DATE 2021.04.23 - 2021.04.23 LATITUDE 49.377320 LONGITUDE -88.133290 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
265.2	GROUND SURFACE							
0.0	**ASPHALT:** (150mm)							
0.2	Silty **SAND**, some gravel Very Dense Brown Moist (FILL)	1	SS	92				
264.4								
0.8	**SAND** and **SILT** Dense to Compact Brown Moist (FILL)	2	SS	31				
		3	SS	35				
		4	SS	23				
		5	SS	18	0	47	52	1
	Trace organics	6	SS	21				
259.6								
5.6	**PEAT**, fibrous, silty sand layers Compact Brown to Black Wet	7	SS	10				
257.5								
7.7	**SAND**, some silt Compact Brown to Grey Wet	8	SS	14				
		9	SS	11	0	88	12	0

ELEVATION SCALE: 265, 264, 263, 262, 261, 260, 259, 258, 257, 256

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

1221

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-06 2 OF 2 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 661.2 E 222 512.4 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY AN

DATUM Geodetic DATE 2021.04.23 - 2021.04.23 LATITUDE 49.377320 LONGITUDE -88.133290 CHECKED BY MEF

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) 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
	Continued From Previous Page										
	SAND, some silt Compact Grey Wet						255				
			10	SS	10		254		○		
			11	SS	19		253		○		
251.9							252				
13.3	Silty **SAND** Compact Grey Wet		12	SS	21		251		○		0 71 29 0
			13	SS	19		250		○		
			14	SS	24		249		○		
247.8							248				
17.4	END OF BOREHOLE AT 17.4m. BOREHOLE CAVED TO 5.3m. NO WATER MEASUREMENT DUE TO RESIDUAL DRILLING WATER IN BOREHOLE. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, DRY CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE UPON COMPLETION.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-07 1 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 674.9 E 222 518.8 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.23 - 2021.04.23 LATITUDE 49.377444 LONGITUDE -88.133205 CHECKED BY MEF

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
265.7	GROUND SURFACE										
0.0	**ASPHALT:** (150mm)										
0.2	Gravelly **SAND**, some silt Very Dense to Dense Brown Moist (FILL)		1	SS	70		265				
			2	SS	39						27 60 13 (SI+CL)
264.3							264				
1.4	**SAND** and **SILT**, trace clay Compact Brown Moist (FILL)		3	SS	11						
			4	SS	17		263				0 48 50 2
			5	SS	23		262				
261.6											
4.1	Silty **SAND**, trace oxidation Compact Brown Moist (FILL)		6	SS	14		261				
259.6							260				
6.1	Low recovery due to wood fragments, Anticipated **PEAT**, mixed with silty sand		7	SS	11		259				
258.5											
7.2	**SAND**, some silt Compact Brown Moist		8	SS	20		258				
			9	SS	27		257				
							256				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-07 2 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 674.9 E 222 518.8 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.23 - 2021.04.23 LATITUDE 49.377444 LONGITUDE -88.133205 CHECKED BY MEF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt Compact Brown Moist										
			10	SS	28		255		○		0 86 14 0
							254				
			11	SS	25		253		○		
							252				
			12	SS	21				○		
250.9							251				
14.8	**SILT**, some sand, trace clay Compact Grey Wet		13	SS	17		250		○		
			14	SS	15		249		○		0 15 80 5
248.3											
17.4	End of sampling at 17.4m and start DCPT						248				
							247				
							246				

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-07 3 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 674.9 E 222 518.8 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.23 - 2021.04.23 LATITUDE 49.377444 LONGITUDE -88.133205 CHECKED BY MEF

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
							245				
							244				
							243				
							242				
241.3											
24.4	END OF DCPT AT 24.4m. BOREHOLE CAVED TO 6.1m. NO WATER MEASUREMENT DUE TO RESIDUAL DRILLING WATER IN BOREHOLE. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, DRY CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE UPON COMPLETION.										

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

20
15 5
10
(%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-08 1 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 623.1 E 222 477.9 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.25 - 2021.04.25 LATITUDE 49.376973 LONGITUDE -88.133757 CHECKED BY MEF

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	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
263.9	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100			
0.0	**ASPHALT:** (175mm)										
0.2	Silty **SAND**, some gravel Very Dense Brown Moist		1	SS	84				○		
263.1							263				
0.8	(FILL) Layer of asphalt at 0.6m		2	SS	19				○		
	SAND and **SILT**, trace gravel, trace clay Compact Brown Moist (FILL)		3	SS	22		262		○		
	Trace oxidation		4	SS	25				○		0 37 57 6
							261				
	Trace organics		5	SS	11				○		
259.8							260				
4.1	**PEAT**, fibrous to amorphous, interbedded with sandy silt, trace clay Loose Brown to Black Wet		6	SS	6		259		109 ○		
258.3							258				
5.6	**SAND**, some silt, trace clay Loose to Compact Grey Wet		7	SS	9				○		
	Trace wood fragments						257				
			8	SS	22		256		○		0 88 11 1
							255				
			9	SS	18				○		
							254				

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-08 2 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 623.1 E 222 477.9 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.25 - 2021.04.25 LATITUDE 49.376973 LONGITUDE -88.133757 CHECKED BY MEF

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt, trace clay Compact to Dense Grey Wet										
			10	SS	22		253		○		
							252				
			11	SS	22				○		0 85 14 1
							251				
			12	SS	31		250		○		
249.0											
14.9	Sandy **SILT**, trace clay Compact Grey Wet		13	SS	14		249		○		0 38 60 2
							248				
			14	SS	25		247		○		
246.5											
17.4	End of sampling at 17.4m and start DCPT						246				
							245				
							244				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 21-08 3 OF 3 METRIC

GWP# 6118-17-01 LOCATION Omer Lake Tributary Culvert; MTM NAD83-14 N 5 471 623.1 E 222 477.9 ORIGINATED BY RB

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring/DCPT COMPILED BY AN

DATUM Geodetic DATE 2021.04.25 - 2021.04.25 LATITUDE 49.376973 LONGITUDE -88.133757 CHECKED BY MEF

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
							243				
							242				
							241				
							240				
239.5											
24.4	END OF DCPT AT 24.4m. BOREHOLE CAVED TO 5.9m. NO WATER MEASUREMENT DUE TO RESIDUAL DRILLING WATER IN BOREHOLE. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.6m, DRY CONCRETE TO 0.2m, THEN ASPHALT TO SURFACE UPON COMPLETION.										

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-01 1 OF 3 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 643.5 E 222 497.6 ORIGINATED BY GAS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY MC

DATUM Geodetic DATE 2024.06.17 - 2024.06.18 LATITUDE 49.377159 LONGITUDE -88.133490 CHECKED BY MF

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)	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
264.5	GROUND SURFACE										
0.0	**ASPHALT:** (75mm)										
0.1											
264.1	**GRANULAR:** (305mm)										
0.4	**SAND**, some gravel, some silt Dense Brown Moist (FILL)		1	SS	39		264	○			12 73 15 (SI+CL)
263.7											
0.8	Silty **SAND** to **SAND** and **SILT**, trace gravel, trace clay Compact to Loose Brown Moist (FILL)		2	SS	28			○			
							263				
			3	SS	30			○ ○			
			4	SS	25		262	○			
			5	SS	28			○			
							261				
			6	SS	5				○		
260.0											
4.5	Silty **SAND**, mixed with **PEAT**, some wood fragments Loose Grey to Dark Brown Wet		7	SS	2	▽	260			○	
			8	SS	50/ 0.125		259			○	
			9	SS	5		258			○	
257.3											
7.2	**SAND**, some silt, trace gravel Loose to Compact Brown Wet		10	SS	5		257		○		
							256				
			11	SS	18		255		○		2 86 12 0

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-01 2 OF 3 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 643.5 E 222 497.6 ORIGINATED BY GAS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY MC

DATUM Geodetic DATE 2024.06.17 - 2024.06.18 LATITUDE 49.377159 LONGITUDE -88.133490 CHECKED BY MF

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, some silt, trace gravel Loose to Compact Brown Wet						254				
			12	SS	18				○		
252.8							253				
11.7	**SILT** and **SAND**, trace clay, trace gravel Compact Grey Wet										
			13	SS	21		252		○		
			14	SS	19		251		○		1 51 47 1
			15	SS	13		250				
248.2							249		○		
16.3	**SILT**, some sand, trace clay Compact Grey Moist to Wet						248				
			16	SS	22		247		○		0 14 82 4 Non-Plastic
			17	SS	19		246		○		
							245				

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-01 3 OF 3 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 643.5 E 222 497.6 ORIGINATED BY GAS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY MC

DATUM Geodetic DATE 2024.06.17 - 2024.06.18 LATITUDE 49.377159 LONGITUDE -88.133490 CHECKED BY MF

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
	Continued From Previous Page										
	SILT, some sand, trace clay Compact Grey Moist to Wet		18	SS	11		244		○		
							243				
			19	SS	14				○		0 18 77 5
242.1											
22.4	**SAND**, some silt Dense Grey Wet						242				
241.0			20	SS	41				○		
23.5	END OF BOREHOLE AT 23.5m. BOREHOLE OPEN AND CAVED INTO 7.7m AND WATER LEVEL AT 4.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS TO 0.6m, GRAVEL TO 0.1m, THEN ASPHALT TO SURFACE.										

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

20 15 5 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-02 1 OF 3 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 654.4 E 222 498.5 ORIGINATED BY GAS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY MC

DATUM Geodetic DATE 2024.06.19 - 2024.06.20 LATITUDE 49.377256 LONGITUDE -88.133480 CHECKED BY MF

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
264.9	GROUND SURFACE										
0.0 / 0.1	**ASPHALT:** (50mm)										
264.6 / 0.3	**GRANULAR:** (250mm)										
	SAND, some silt to silty, trace gravel Compact to Loose Brown Moist (FILL)		1	SS	26						5 84 11 (SI+CL)
			2	SS	31		264				
			3	SS	20		263				
			4	SS	10						4 73 23 0
			5	SS	5		262				
260.4			6	SS	6		261				
4.5	**SAND** and **SILT**, mixed with **PEAT** Loose to Compact Brown to Black Wet		7	SS	4	▽	260				
			8	SS	7		259				0 55 45 0
			9	SS	13		258				
257.7											
7.2	Silty **SAND** Loose to Compact Brown to Grey Wet		10	SS	4		257				
			11	SS	25		256				
							255				

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-02 2 OF 3 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 654.4 E 222 498.5 ORIGINATED BY GAS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY MC

DATUM Geodetic DATE 2024.06.19 - 2024.06.20 LATITUDE 49.377256 LONGITUDE -88.133480 CHECKED BY MF

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
	Continued From Previous Page										
	Silty **SAND** Loose to Compact Brown to Grey Wet										
			12	SS	20		254				
							253				
			13	SS	26						0 79 21 0
							252				
			14	SS	31		251				
250.1											
14.8	**SILT**, trace to some sand Compact Grey Wet (ML)		15	SS	29		250				
							249				
			16	SS	22		248				
							247				
			17	SS	17						0 5 90 5
							246				
							245				

Continued Next Page

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

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

ONTMT4S2 2020LIBRARY(MTO).GLB OMER LAKE CULVERTS.GPJ 1/30/25

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-02 3 OF 3 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 654.4 E 222 498.5 ORIGINATED BY GAS

DIST Thunder Bay HWY 11 BOREHOLE TYPE Solid Stem Augers/Wash Boring COMPILED BY MC

DATUM Geodetic DATE 2024.06.19 - 2024.06.20 LATITUDE 49.377256 LONGITUDE -88.133480 CHECKED BY MF

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										
	SILT, trace to some sand Compact Grey Wet (ML)		18	SS	19						
			19	SS	16		244				
242.9							243				
22.0	**SILT** and **SAND**, trace clay Compact Grey Wet		20	SS	23						
241.4			21	SS	26		242				
23.5	END OF BOREHOLE AT 23.5m. BOREHOLE OPEN AND CAVED INTO 18.0m AND WATER LEVEL AT 5.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE AND CUTTINGS TO 0.6m, GRAVEL TO 0.1m, THEN ASPHALT TO SURFACE.										

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

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-03 1 OF 2 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 647.6 E 222 476.9 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Tripod/Casing/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2024.08.10 - 2024.08.11 LATITUDE 49.377193 LONGITUDE -88.133776 CHECKED BY MF

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/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.4	GROUND SURFACE										
0.0	**PEAT**, trace silt, some roots Very Loose Dark Brown to Black Wet		1	SS	2		260		188		
259.2			2	SS	3						
1.2	Sandy **SILT**, trace clay, trace peat Compact Dark Brown Moist to Wet		3	SS	13		259				
258.6											
1.8	**SAND**, trace to some silt, trace clay, trace gravel Loose to Compact Brown to Grey Moist to Wet		4	SS	9		258				1 78 18 3
			5	SS	17						
			6	SS	26		257				
			7	SS	15		256				
			8	SS	27						2 91 4 3
							255				
			9	SS	32		254				
							253				
			10	SS	20						0 90 8 2
252.2											
8.2	End of sampling and start of DCPT due to refusal (wet sand conditions) with advancing the casing further						252				
							251				

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-03 2 OF 2 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 647.6 E 222 476.9 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Tripod/Casing/Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2024.08.10 - 2024.08.11 LATITUDE 49.377193 LONGITUDE -88.133776 CHECKED BY MF

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
250.2											
10.2	END OF BOREHOLE AT 10.2m UPON DCPT REFUSAL. BOREHOLE OPEN AND CAVED TO 2.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-03A 1 OF 2 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 647.6 E 222 476.9 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2024.08.11 - 2024.08.11 LATITUDE 49.377193 LONGITUDE -88.133776 CHECKED BY MF

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
260.4	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Start of DCPT from surface						260				
							259				
							258				
							257				
							256				
							255				
							254				
							253				
							252				
							251				
250.5											
9.9											

Continued Next Page

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-03A 2 OF 2 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 647.6 E 222 476.9 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM Geodetic DATE 2024.08.11 - 2024.08.11 LATITUDE 49.377193 LONGITUDE -88.133776 CHECKED BY MF

SOIL PROFILE			SAMPLES			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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	END OF DCPT AT 9.9m UPON REFUSAL.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-04 1 OF 1 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 645.7 E 222 525.5 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Tripod/Casing/Dynamic Cone Penetration Test COMPILED BY MC

DATUM Geodetic DATE 2024.08.12 - 2024.08.12 LATITUDE 49.377182 LONGITUDE -88.133107 CHECKED BY MF

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
259.9	GROUND SURFACE										
0.0	**PEAT**, some sand and silt, trace clay, some roots Loose Brown to Dark Brown Wet		1	SS	4						
			2	SS	4		259				
258.1			3	SS	8						0 58 38 4 Non-Plastic
1.8	**SAND**, some silt, trace clay, trace gravel Loose to Compact Brown to Grey Moist to Wet		4	SS	8		258				
			5	SS	7		257				4 78 16 2
			6	SS	8						
255.5			7	SS	14		256				0 88 10 2
4.4	End of sampling and start of DCPT due to refusal (wet sand conditions) with advancing the casing further						255				
253.3							254				
6.6	END OF BOREHOLE AT 6.6m UPON DCPT REFUSAL. BOREHOLE OPEN AND CAVED TO 2.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

(%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-04A 1 OF 1 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 645.7 E 222 525.5 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY MC

DATUM Geodetic DATE 2024.08.12 - 2024.08.12 LATITUDE 49.377182 LONGITUDE -88.133107 CHECKED BY MF

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
259.9	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Start of DCPT from surface						259				
							258				
							257				
							256				
							255				
254.6											
5.3	END OF DCPT AT 5.3m UPON REFUSAL.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-05 1 OF 2 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 625.2 E 222 498.9 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Tripod/Casing/Dynamic Cone Penetration Test COMPILED BY MC

DATUM Geodetic DATE 2024.08.13 - 2024.08.13 LATITUDE 49.376994 LONGITUDE -88.133468 CHECKED BY MF

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
260.0	GROUND SURFACE										
0.0	**PEAT**, some silt and sand, trace clay, trace roots and wood fragments Very Loose to Loose Grey to Dark Brown Wet		1	SS	6						0 38 59 3 Non-Plastic
			2	SS	3		259				
258.5			3	SS	9						0 39 56 5
1.5	Silty **SAND** Loose Brown Moist		4	SS	8		258				
257.6											
2.4	**SAND**, trace to some silt, trace clay Compact Brown Moist		5	SS	24						
			6	SS	24		257				
			7	SS	23		256				0 92 6 2
			8	SS	19		255				
252.8											
7.2	Silty **SAND**, trace clay Compact Grey Moist		9	SS	18		254				
			10	SS	24		253				
							252				0 67 31 2
250.9											
9.1	End of sampling and start of DCPT due to refusal (wet sand conditions) with advancing the casing further						251				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-05 2 OF 2 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 625.2 E 222 498.9 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Tripod/Casing/Dynamic Cone Penetration Test COMPILED BY MC

DATUM Geodetic DATE 2024.08.13 - 2024.08.13 LATITUDE 49.376994 LONGITUDE -88.133468 CHECKED BY MF

SOIL PROFILE			SAMPLES			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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
							249				
248.3											
11.7	END OF BOREHOLE AT 11.7m UPON DCPT REFUSAL. BOREHOLE OPEN AND CAVED TO 2.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

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

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Ontario

THURBER

RECORD OF BOREHOLE No 24-05A 1 OF 1 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 625.2 E 222 498.9 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY MC

DATUM Geodetic DATE 2024.08.13 - 2024.08.13 LATITUDE 49.376994 LONGITUDE -88.133468 CHECKED BY MF

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	WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
260.0	GROUND SURFACE										
0.0	Start of DCPT from surface										
255.3											
4.7	END OF DCPT AT 4.7m UPON REFUSAL.										

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

ELEVATION SCALE: 259, 258, 257, 256

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 24-06 1 OF 1 METRIC

GWP# 6911-12-00 LOCATION Omer Lake Culvert N 5 471 670.7 E 222 498.3 ORIGINATED BY JP

DIST Thunder Bay HWY 11 BOREHOLE TYPE Tripod/Casing COMPILED BY AN

DATUM Geodetic DATE 2024.08.08 - 2024.08.08 LATITUDE 49.377403 LONGITUDE -88.133486 CHECKED BY MF

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
261.4	GROUND SURFACE										
0.0	**TOPSOIL:** (75mm)										
0.1	**SAND** and **SILT**, some roots Very Loose Brown to Dark Brown Moist		1	SS	2		261				
260.4			2	SS	4						0 36 64 (SI+CL) Non-Plastic
1.0	Silty **SAND**, trace clay Loose to Compact Brown Moist		3	SS	18		260				
			4	SS	11						0 66 27 7
			5	SS	7		259				
			6	SS	21		258				
	Becoming dense		7	SS	49						
257.1											
4.3	**SAND** and **SILT**, trace clay Dense to Very Dense Brown to Grey Moist		8	SS	54		257				0 53 45 2
			9	SS	35						
255.9							256				
5.5	END OF BOREHOLE AT 5.5m. BOREHOLE CAVED-IN TO 4.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.										

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

(%) STRAIN AT FAILURE

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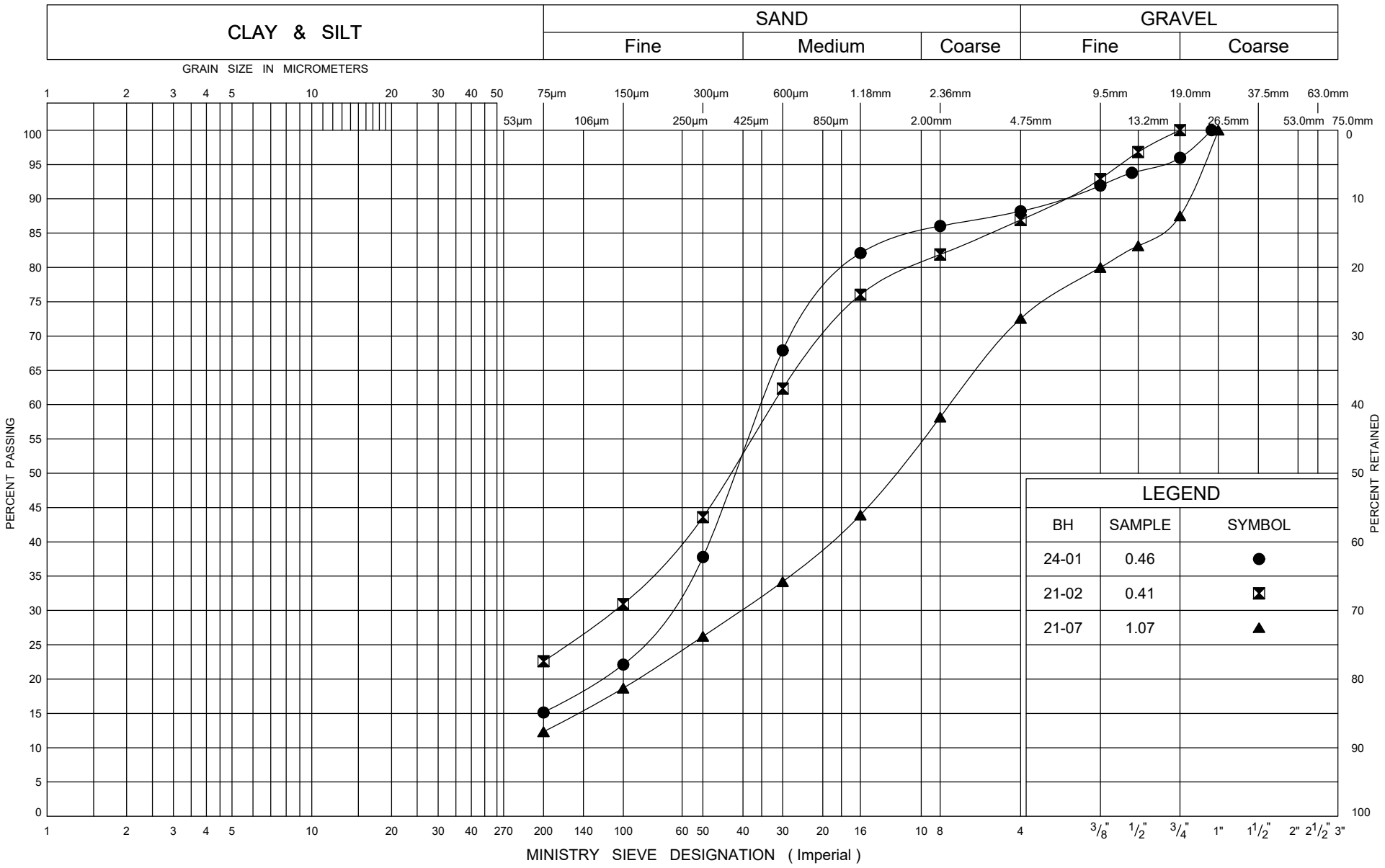
APPENDIX C

Geotechnical Laboratory and Well Test Results



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Ontario

GRAIN SIZE DISTRIBUTION

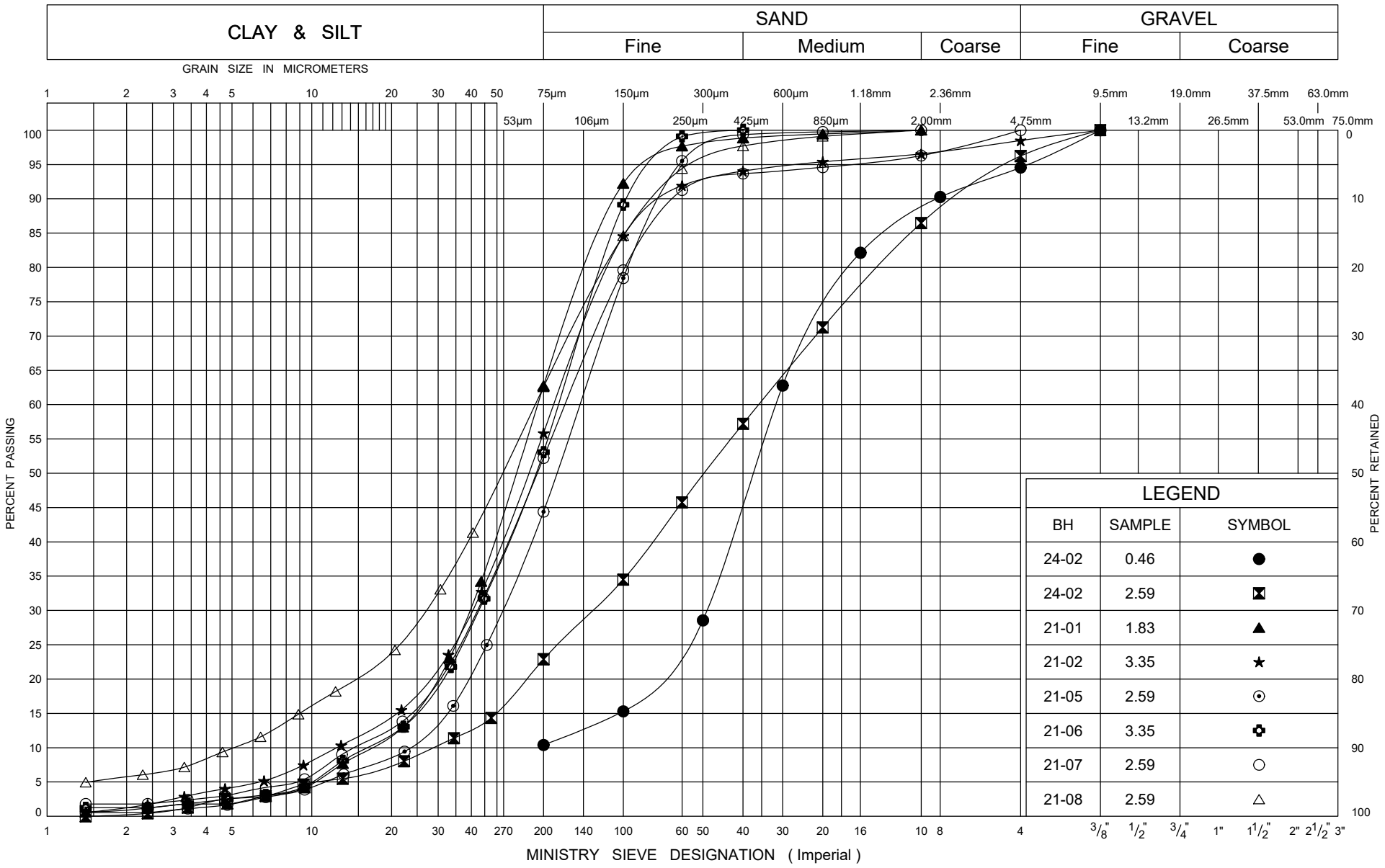
Silty SAND to Gravelly SAND FILL

FIG No C1

GWP# 6911-12-00

Omer Lake Culvert

ONTARIO MOT GRAIN SIZE 2 MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24



ONTARIO MOT GRAIN SIZE 2 MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24

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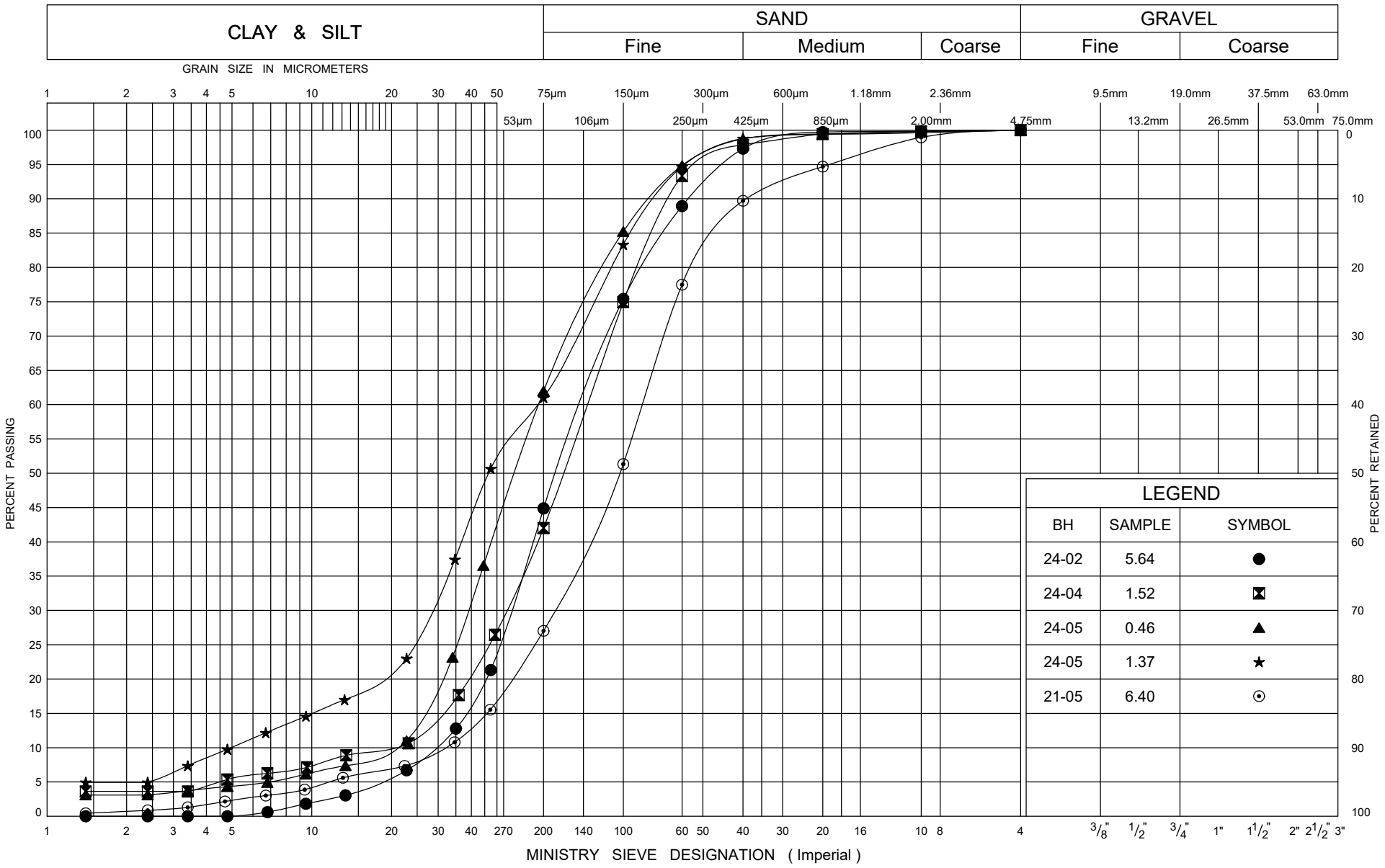
GRAIN SIZE DISTRIBUTION

SAND and SILT FILL

FIG No C2

GWP# 6911-12-00

Omer Lake Culvert



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GRAIN SIZE DISTRIBUTION

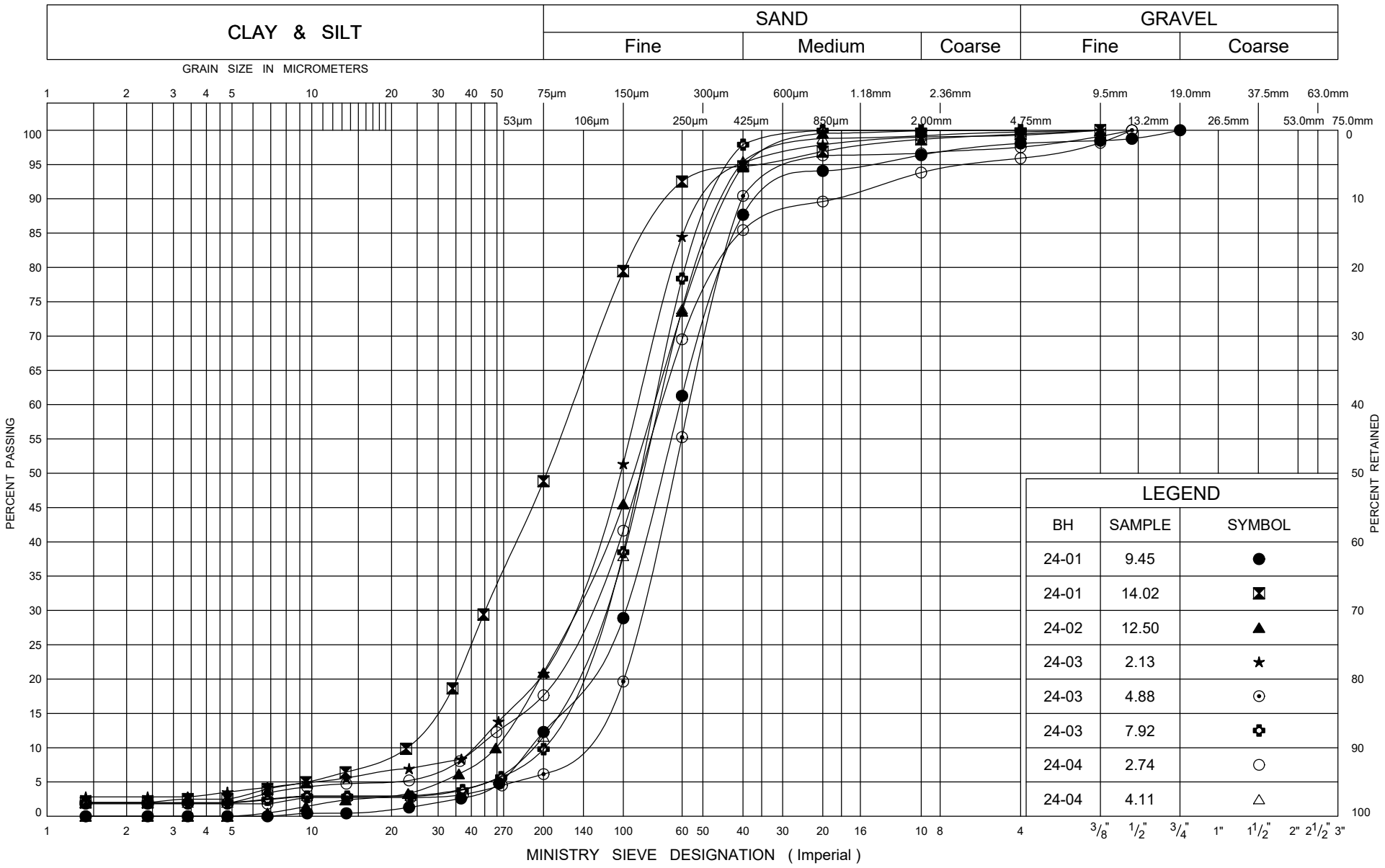
SAND and SILT, mixed with Peat

FIG No C3

GWP# 6911-12-00

Omer Lake Culvert

ONTARIO MOT GRAIN SIZE 2 MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24



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GRAIN SIZE DISTRIBUTION

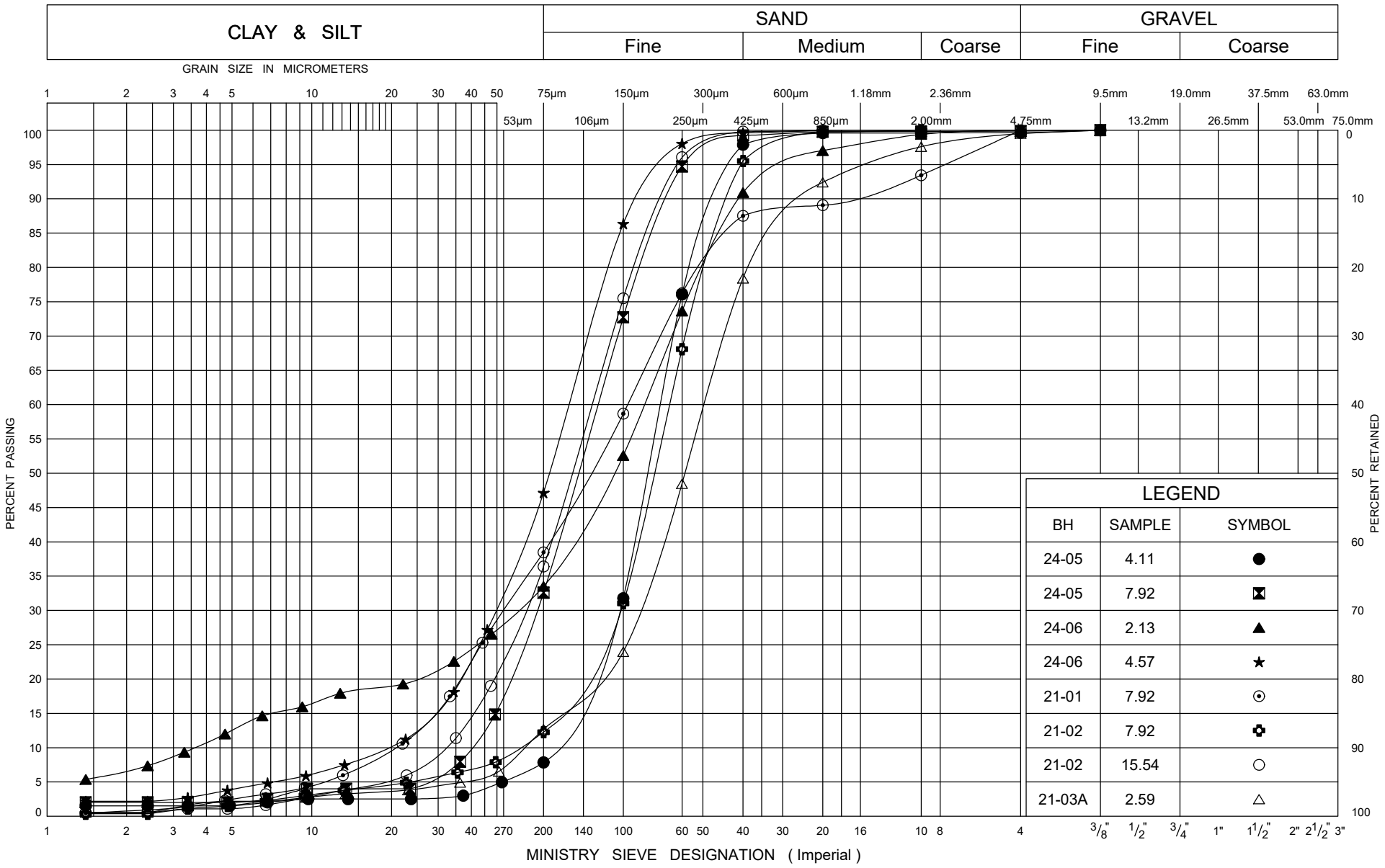
SAND to SILT and SAND

FIG No C4

GWP# 6911-12-00

Omer Lake Culvert

ONTARIO MOT GRAIN SIZE 2 MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24



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GRAIN SIZE DISTRIBUTION

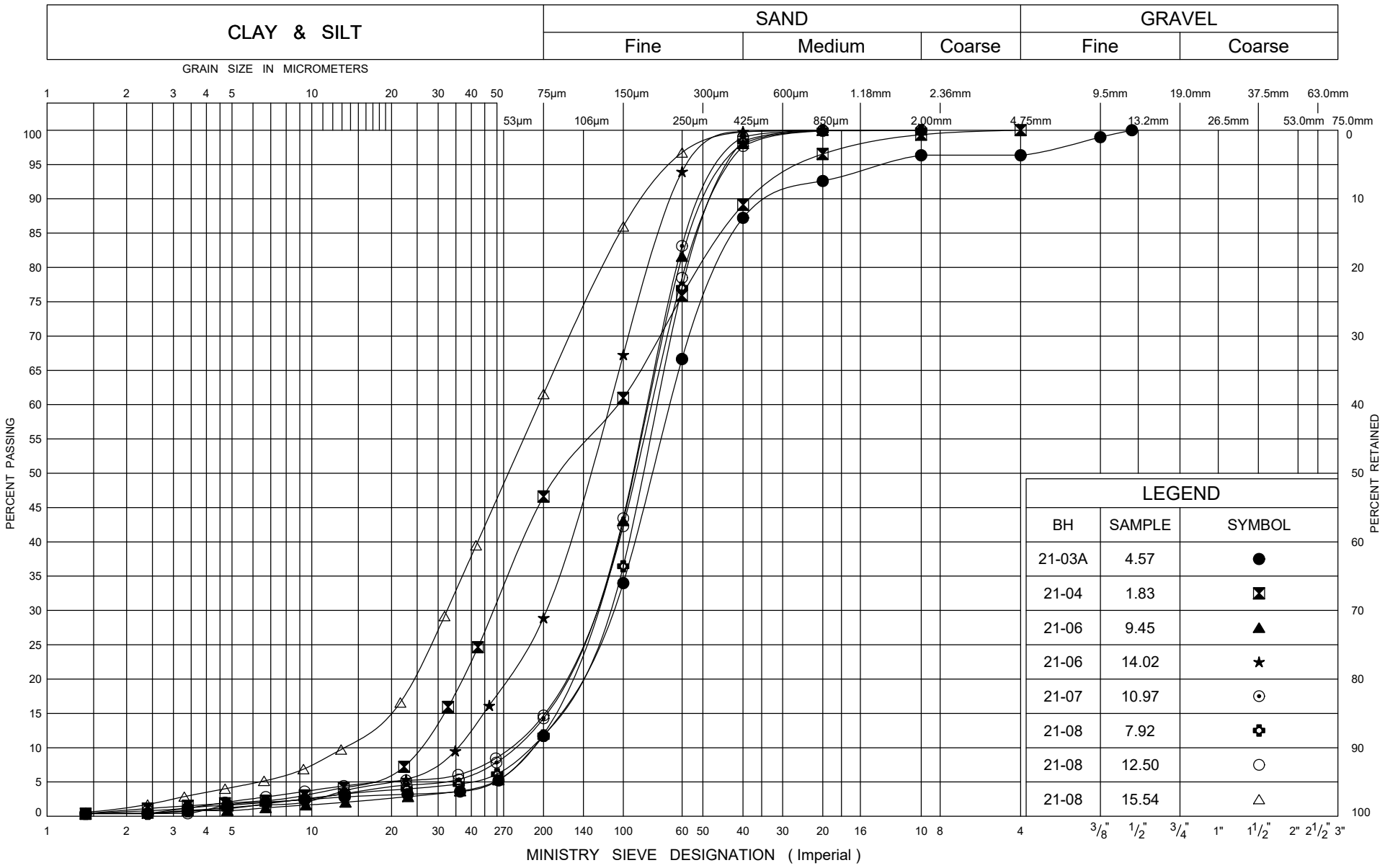
SAND to SILT and SAND

FIG No C5

GWP# 6911-12-00

Omer Lake Culvert

ONTARIO MOT GRAIN SIZE 2 MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24



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Ontario

GRAIN SIZE DISTRIBUTION

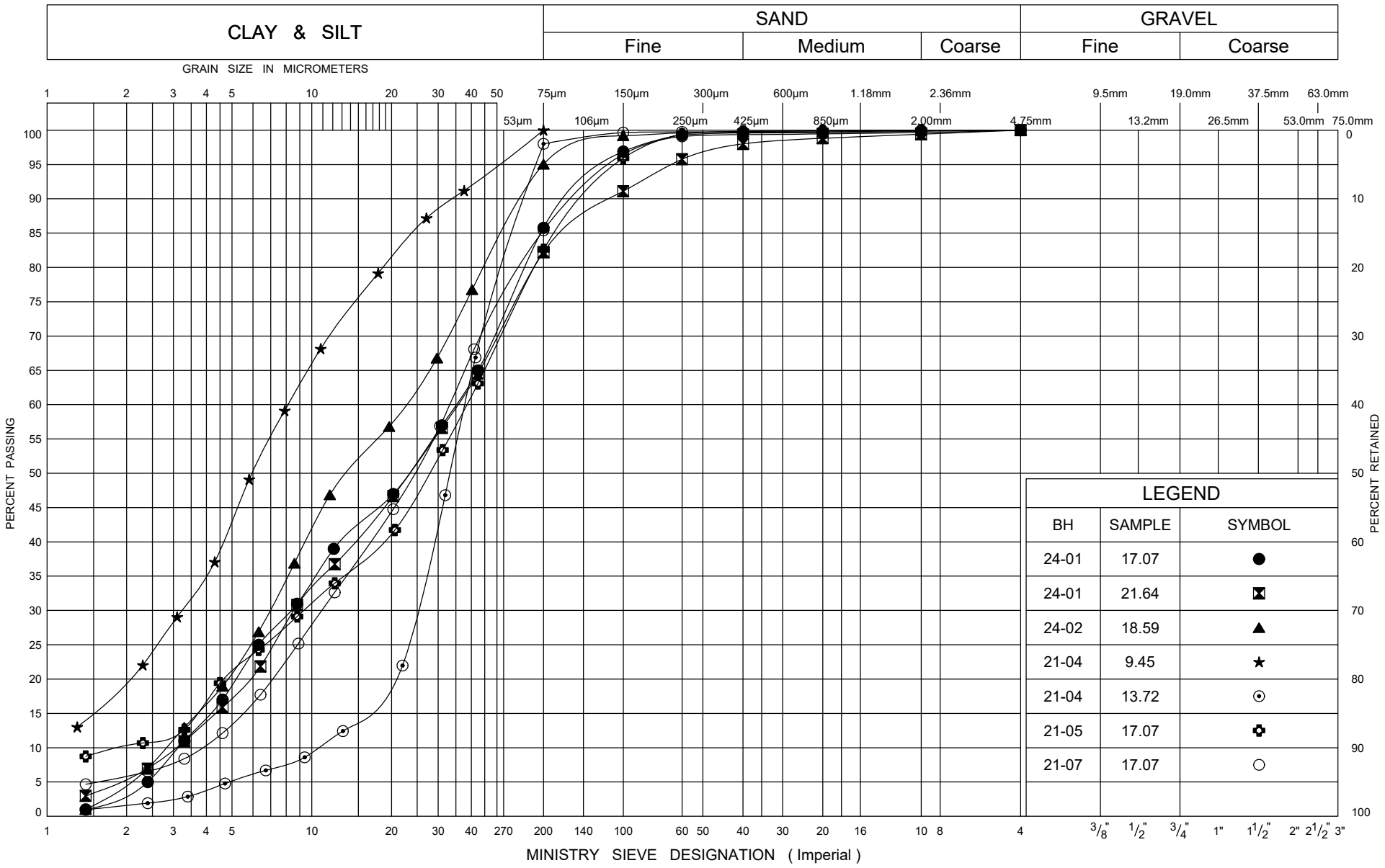
SAND to SILT and SAND

FIG No C6

GWP# 6911-12-00

Omer Lake Culvert

ONTARIO MOT GRAIN SIZE 2 MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24



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Ontario

GRAIN SIZE DISTRIBUTION

SILT

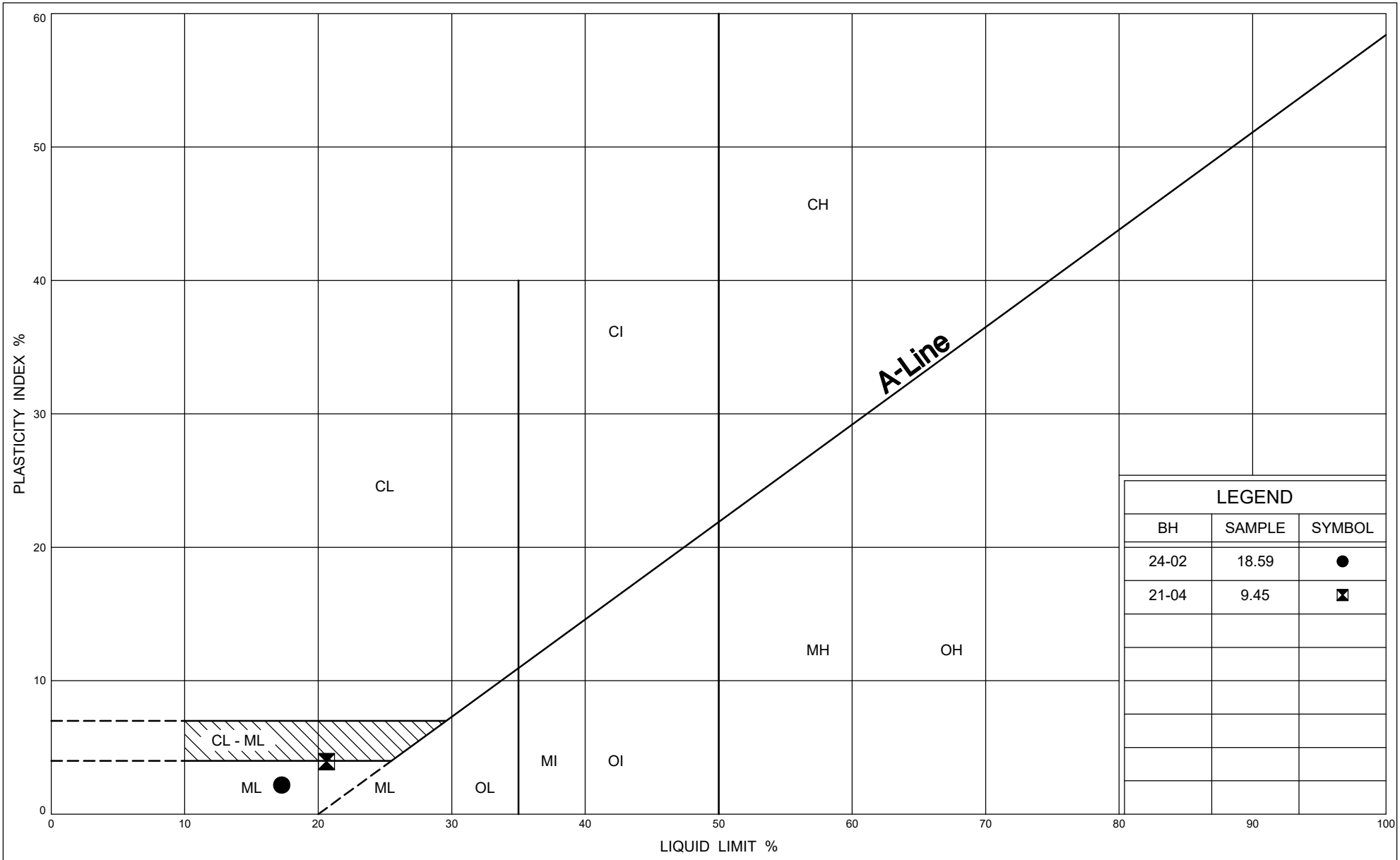
FIG No C7

GWP# 6911-12-00

Omer Lake Culvert

ONTARIO MOT GRAIN SIZE 2 MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART MTO-47632.GPJ ONTARIO MOT.GDT 11/29/24

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Ontario

PLASTICITY CHART

SILT

FIG No C8

GWP# 6911-12-00

Omer Lake Culvert

THURBER ENGINEERING LTD.

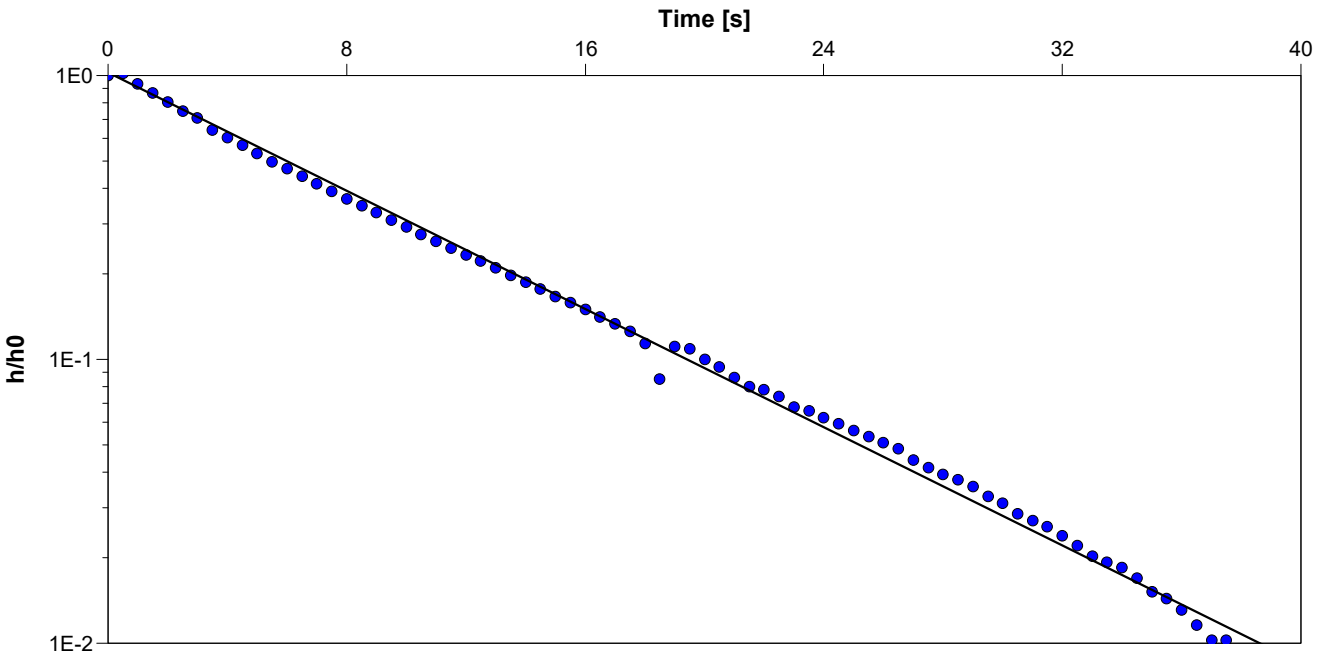
Slug Test Analysis Report

Project: Omer Lake Tributary Culvert

Number: 31344

Client: Hatch

Location: District of Thunder Bay	Slug Test: 21-01	Test Well: 21-01
Test Conducted by: RB		Test Date: 2021-04-23
Analysis Performed by: PC	21-01 SWRT Analysis	Analysis Date: 2021-10-12
Aquifer Thickness:		
Checked by: DH		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
21-01	6.1×10^{-5}	

THURBER ENGINEERING LTD.

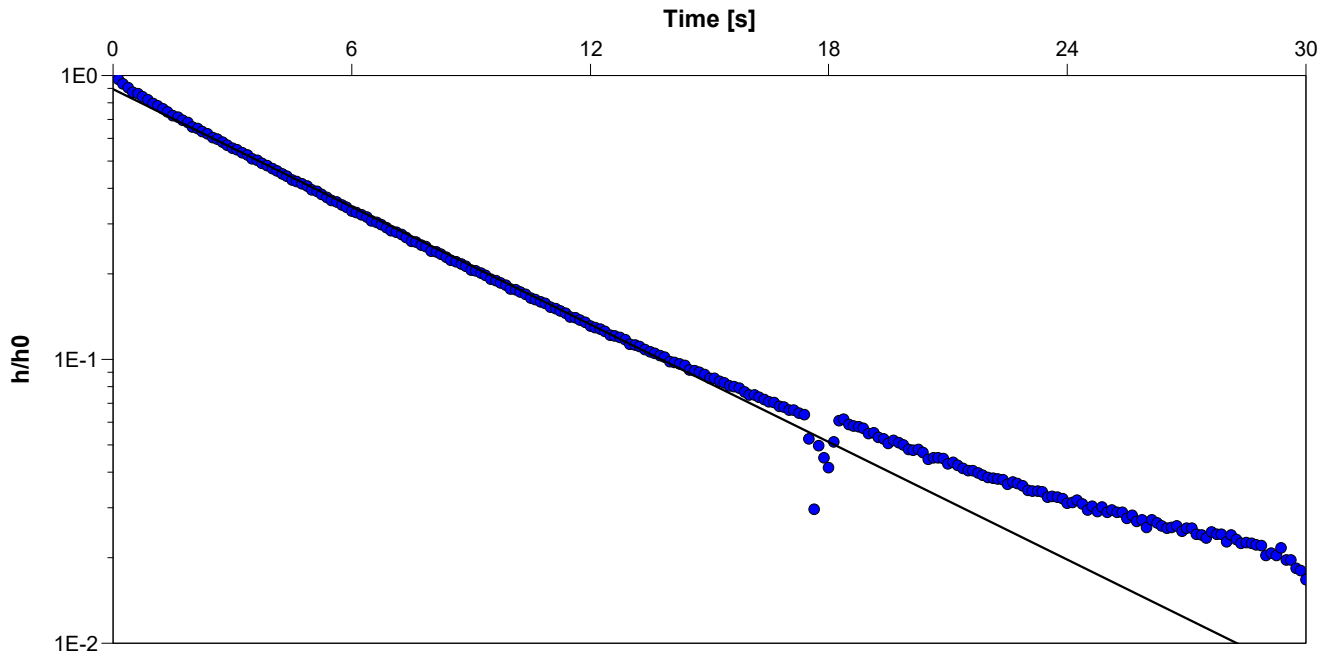
Slug Test Analysis Report

Project: Omer Lake Tributary Culvert

Number: 31344

Client: Hatch

Location: District of Thunder Bay	Slug Test: 21-02	Test Well: 21-02
Test Conducted by: RB		Test Date: 2021-04-25
Analysis Performed by: PC	21-02 SWRT Analysis	Analysis Date: 2021-10-12
Aquifer Thickness:		
Checked by: DH		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]	
21-02	4.7×10^{-5}	

THURBER

APPENDIX D

Analytical Laboratory Test Results

CERTIFICATE OF ANALYSIS

Work Order	: **WT2419203**	Page	: 1 of 3
Client	: **Thurber Engineering Ltd.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Madison Chiarotto	Account Manager	: Amanda Overholster
Address	: 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 47632 - Omer Lake Culvert	Date Samples Received	: 10-Jul-2024 18:00
PO	: ----	Date Analysis Commenced	: 12-Jul-2024
C-O-C number	: ----	Issue Date	: 16-Jul-2024 15:55
Sampler	: Client		
Site	: ----		
Quote number	: 2024 SOA		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Colby Bingham	Laboratory Supervisor	Sask Soils, Saskatoon, Saskatchewan

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.
Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
%	percent

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Workorder Comments

Sample(s) 1,2: Samples Received with temperature >10 °C

Analytical Results

Sub-Matrix: Soil/Solid (Matrix: Soil/Solid)				Client sample ID	24-01 SS8	24-02 SS7	----	----	----
				Client sampling date / time	12-Jun-2024 00:00	12-Jun-2024 00:00	----	----	----
Analyte	CAS Number	Method/Lab	LOR	Unit	WT2419203-001	WT2419203-002	--------	--------	--------
					Result	Result	----	----	----
Physical Tests									
Loss on ignition @ 440°C	----	E205E/SK	1.0	%	7.0	4.1	----	----	----
Ash content @ 440°C	----	E205E/SK	1.0	%	93.0	95.9	----	----	----

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Please refer to the Accreditation section for an explanation of analyte accreditations.

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QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WT2419203**	Page	: 1 of 5
Client	: **Thurber Engineering Ltd.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Madison Chiarotto	Account Manager	: Amanda Overholster
Address	: 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 47632 - Omer Lake Culvert	Date Samples Received	: 10-Jul-2024 18:00
PO	: ----	Issue Date	: 16-Jul-2024 15:56
C-O-C number	: ----		
Sampler	: Client		
Site	: ----		
Quote number	: 2024 SOA		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	*Method*	*Sampling Date*	*Extraction / Preparation*				*Analysis*			
			Preparation Date	*Holding Times*		*Eval*	*Analysis Date*	*Holding Times*		*Eval*
				Rec	*Actual*			*Rec*	*Actual*	
Physical Tests : Loss On Ignition (440°C)										
Glass soil jar/Teflon lined cap [ON MECP]										
24-01 SS8	E205E	12-Jun-2024	----	----	----		13-Jul-2024	365 days	32 days	✓
Physical Tests : Loss On Ignition (440°C)										
Glass soil jar/Teflon lined cap [ON MECP]										
24-02 SS7	E205E	12-Jun-2024	----	----	----		13-Jul-2024	365 days	32 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Loss On Ignition (440°C)	E205E	1543724	1	2	50.0	5.0	✓
Laboratory Control Samples (LCS)							
Loss On Ignition (440°C)	E205E	1543724	1	2	50.0	5.0	✓
Method Blanks (MB)							
Loss On Ignition (440°C)	E205E	1543724	1	2	50.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Loss On Ignition (440°C)	E205E ALS Environmental - Saskatoon	Soil/Solid	ASTM D2974 Method A	Loss On Ignition (LOI) is determined by drying a portion of an air dried and ground sample at 105°C overnight, then igniting at 440°C for 16-20 hours. The weight loss after ignition is reported as % loss on ignition. LOI is reported on a dry weight basis. LOI at 440°C can be used as an estimation of Organic Matter (ASTM D2974 Method A).

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dry and Grind in Soil/Solid <60°C	EPP442 ALS Environmental - Saskatoon	Soil/Solid	Soil Sampling and Methods of Analysis, Carter 2008	After removal of any coarse fragments and reservation of wet subsamples a portion of homogenized sample is set in a tray and dried at less than 60°C until dry. The sample is then particle size reduced with an automated crusher or mortar and pestle, typically to <2 mm. Further size reduction may be needed for particular tests.

QUALITY CONTROL REPORT

Work Order	: **WT2419203**	Page	: 1 of 3
Client	: Thurber Engineering Ltd.	Laboratory	: ALS Environmental - Waterloo
Contact	: Madison Chiarotto	Account Manager	: Amanda Overholster
Address	: 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 47632 - Omer Lake Culvert	Date Samples Received	: 10-Jul-2024 18:00
PO	: ----	Date Analysis Commenced	: 12-Jul-2024
C-O-C number	: ----	Issue Date	: 16-Jul-2024 15:59
Sampler	: Client		
Site	: ----		
Quote number	: 2024 SOA		
No. of samples received	: 2		
No. of samples analysed	: 2		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Colby Bingham	Laboratory Supervisor	Saskatoon Sask Soils, Saskatoon, Saskatchewan

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Physical Tests (QC Lot: 1543724)											
WT2419203-001	24-01 SS8	Loss on ignition @ 440°C	----	E205E	1.0	%	7.0	7.0	0.02	Diff <2x LOR	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

Reference Material (RM) Report									
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 1543724)									
QC-1543724-002	RM	Loss on ignition @ 440°C	----	E205E	8.78 %	94.3	80.0	120	----

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 -

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Environmental Division
Waterloo
Work Order Reference
WT2419203

Telephone : +1 519 886 6910

Report To	Contact and company name below will appear on the final report
Company:	Thurber Engineering Limited
Contact:	Madisan Chiarotto
Phone:	647-548-8390
	Company address below will appear on the final report
Street:	202-1908 Ironoak Way
City/Province:	Oakville/ON
Postal Code:	L6H 0N1
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Thurber Engineering Limited
Contact:	Madisan Chiarotto

Project Information	
ALS Account # / Quote #:	
Job #:	47632 - Omer Lake Culvert
PO / AFE:	
LSD:	
ALS Lab Work Order # (ALS use only):	

Reports / Recipients

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)
Merge QC/QCI Reports with COA ☐ YES ☑ NO ☐ N/A
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: mchiarotto@thurber.ca
Email 2: mfarrant@thurber.ca
Email 3:

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: AccountiingON@thurber.ca
Email 2:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#:
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Contact: Sampler:

Turnaround Time (TAT) Requested

☑ Routine [R] if received by 3pm M-F - no surcharges apply
☐ 4 day [P4] if received by 3pm M-F - 20% rush surcharge minimum
☐ 3 day [P3] if received by 3pm M-F - 25% rush surcharge minimu
☐ 2 day [P2] if received by 3pm M-F - 50% rush surcharge minimu
☐ 1 day [E] if received by 3pm M-F - 100% rush surcharge minimu
Same day [E2] if received by 10am M-S - 200% rush surcharge. fees may apply to rush requests on weekends, statutory holidays a routine tests

Date and Time Required for all E&P TATs:

For all tests with rush TATs requested, please

Analysis R

Indicate Filtered (F), Preserved (P) or Filtered

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	ASTM D2974 (Method C (440C) - general purposes Organic testing	(Quantitation of asbestos by point coun	SAMPLES ON HOLD	EXTENDED STORAGE REQU	SUSPECTED HAZARD (see n
	24-01 SS8	12-Jun-23		Soil		R				
	24-02 SS7	12-Jun-23		Soil		R				

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human consumption/ use?
☐ YES ☑ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☐ ICE ☑ ICE PACKS ☐ FROZEN ☐ COOLING INITIATED
Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO
Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				7.4			

SHIPMENT RELEASE (client use)

Released by: Greg Stanhope Date: July 09 2024 Time:

INITIAL SHIPMENT RECEPTION (ALS use only)

Received by: Date: Time:

FINAL SHIPMENT RECEPTION (ALS use only)

Received by: Date: 10-July-24 Time: 18:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

AUG 2020 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

CERTIFICATE OF ANALYSIS

Work Order	: **WT2424358**	Page	: 1 of 2
Client	: **Thurber Engineering Ltd.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Madisan Chiarotto	Account Manager	: Amanda Overholster
Address	: 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1	Address	: 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 47632 - Omer Lake Culvert	Date Samples Received	: 21-Aug-2024 17:10
PO	: ----	Date Analysis Commenced	: 24-Aug-2024
C-O-C number	: ----	Issue Date	: 29-Aug-2024 22:27
Sampler	: CLIENT		
Site	: ----		
Quote number	: 2024 SOA		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Maria Painchaud	Laboratory Assistant	Sask Soils, Saskatoon, Saskatchewan

General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.
Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
%	percent

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical Results

Sub-Matrix: **Soil/Solid**
(Matrix: **Soil/Solid**)

Analyte	*CAS Number*	*Method/Lab*	*LOR*	*Unit*	*Client sample ID*	**24-03 SS-1 (0'-2') & SS-3 (4'-6')**	**24-04 SS-1 (0'-2') & SS-4 (6'-8')**	**24-05 SS-2B (2'7"-4') & SS-3A (4'-5'1")**	**24-06 SS-1 (0'-2') & SS-2A (2'-3'5")**	**----**
					Client sampling date / time	11-Aug-2024 00:00	12-Aug-2024 00:00	13-Aug-2024 00:00	08-Aug-2024 00:00	----
						WT2424358-001	**WT2424358-002**	**WT2424358-003**	**WT2424358-004**	**--------**
						Result	Result	Result	Result	----
Physical Tests										
Loss on ignition @ 440°C	----	E205E/SK	1.0	%		6.4	4.2	9.8	2.2	----
Ash content @ 440°C	----	E205E/SK	1.0	%		93.6	95.8	90.2	97.8	----

Please refer to the General Comments section for an explanation of any result qualifiers detected.

Please refer to the Accreditation section for an explanation of analyte accreditations.

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QUALITY CONTROL INTERPRETIVE REPORT

Work Order	: **WT2424358**	Page	: 1 of 5
Client	: **Thurber Engineering Ltd.**	Laboratory	: ALS Environmental - Waterloo
Contact	: Madisan Chiarotto	Account Manager	: Amanda Overholster
Address	: 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 47632 - Omer Lake Culvert	Date Samples Received	: 21-Aug-2024 17:10
PO	: ----	Issue Date	: 29-Aug-2024 23:15
C-O-C number	: ----		
Sampler	: CLIENT		
Site	: ----		
Quote number	: 2024 SOA		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report is automatically generated by the ALS LIMS (Laboratory Information Management System) through evaluation of Quality Control (QC) results and other QA parameters associated with this submission, and is intended to facilitate rapid data validation by auditors or reviewers. The report highlights any exceptions and outliers to ALS Data Quality Objectives, provides holding time details and exceptions, summarizes QC sample frequencies, and lists applicable methodology references and summaries.

Key

Anonymous: Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number: Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO: Data Quality Objective.
LOR: Limit of Reporting (detection limit).
RPD: Relative Percent Difference.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Summary of Outliers

Outliers : Quality Control Samples

- No Method Blank value outliers occur.
- No Duplicate outliers occur.
- No Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times, which are selected to meet known provincial and /or federal requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by organizations such as CCME, US EPA, APHA Standard Methods, ASTM, or Environment Canada (where available). Dates and holding times reported below represent the first dates of extraction or analysis. If subsequent tests or dilutions exceeded holding times, qualifiers are added (refer to COA).

If samples are identified below as having been analyzed or extracted outside of recommended holding times, measurement uncertainties may be increased, and this should be taken into consideration when interpreting results.

Where actual sampling date is not provided on the chain of custody, the date of receipt with time at 00:00 is used for calculation purposes.

Where only the sample date without time is provided on the chain of custody, the sampling date at 00:00 is used for calculation purposes.

Matrix: **Soil/Solid**

Evaluation: × = Holding time exceedance ; ✓ = Within Holding Time

Analyte Group : Analytical Method / Container / Client Sample ID(s)	Method	Sampling Date	Extraction / Preparation				Analysis			
			Preparation Date	Holding Times Rec	Holding Times Actual	Eval	Analysis Date	Holding Times Rec	Holding Times Actual	Eval
Physical Tests : Loss On Ignition (440°C)										
Glass soil jar/Teflon lined cap [ON MECP] 24-05 SS-2B (2'7"-4') & SS-3A (4'-5'1")	E205E	13-Aug-2024	----	----	----		28-Aug-2024	365 days	16 days	✓
Physical Tests : Loss On Ignition (440°C)										
Glass soil jar/Teflon lined cap [ON MECP] 24-04 SS-1 (0'-2') & SS-4 (6'-8')	E205E	12-Aug-2024	----	----	----		28-Aug-2024	365 days	17 days	✓
Physical Tests : Loss On Ignition (440°C)										
Glass soil jar/Teflon lined cap [ON MECP] 24-03 SS-1 (0'-2') & SS-3 (4'-6')	E205E	11-Aug-2024	----	----	----		28-Aug-2024	365 days	18 days	✓
Physical Tests : Loss On Ignition (440°C)										
Glass soil jar/Teflon lined cap [ON MECP] 24-06 SS-1 (0'-2') & SS-2A (2'-3'5")	E205E	08-Aug-2024	----	----	----		28-Aug-2024	365 days	21 days	✓

Legend & Qualifier Definitions

Rec. HT: ALS recommended hold time (see units).

Quality Control Parameter Frequency Compliance

The following report summarizes the frequency of laboratory QC samples analyzed within the analytical batches (QC lots) in which the submitted samples were processed. The actual frequency should be greater than or equal to the expected frequency.

Matrix: **Soil/Solid**

Evaluation: × = *QC frequency outside specification*; ✓ = *QC frequency within specification.*

Quality Control Sample Type			Count		Frequency (%)		
Analytical Methods	*Method*	*QC Lot #*	*QC*	*Regular*	*Actual*	*Expected*	*Evaluation*
Laboratory Duplicates (DUP)							
Loss On Ignition (440°C)	E205E	1621023	1	4	25.0	5.0	✓
Laboratory Control Samples (LCS)							
Loss On Ignition (440°C)	E205E	1621023	1	4	25.0	5.0	✓
Method Blanks (MB)							
Loss On Ignition (440°C)	E205E	1621023	1	4	25.0	5.0	✓

Methodology References and Summaries

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Reference methods may incorporate modifications to improve performance (indicated by "mod").

Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Loss On Ignition (440°C)	E205E ALS Environmental - Saskatoon	Soil/Solid	ASTM D2974 Method A	Loss On Ignition (LOI) is determined by drying a portion of an air dried and ground sample at 105°C overnight, then igniting at 440°C for 16-20 hours. The weight loss after ignition is reported as % loss on ignition. LOI is reported on a dry weight basis. LOI at 440°C can be used as an estimation of Organic Matter (ASTM D2974 Method A).

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Dry and Grind in Soil/Solid <60°C	EPP442 ALS Environmental - Saskatoon	Soil/Solid	Soil Sampling and Methods of Analysis, Carter 2008	After removal of any coarse fragments and reservation of wet subsamples a portion of homogenized sample is set in a tray and dried at less than 60°C until dry. The sample is then particle size reduced with an automated crusher or mortar and pestle, typically to <2 mm. Further size reduction may be needed for particular tests.

QUALITY CONTROL REPORT

Work Order	: **WT2424358**	Page	: 1 of 3
Client	: Thurber Engineering Ltd.	Laboratory	: ALS Environmental - Waterloo
Contact	: Madisan Chiarotto	Account Manager	: Amanda Overholster
Address	: 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1	Address	: 60 Northland Road, Unit 1 Waterloo, Ontario Canada N2V 2B8
Telephone	: ----	Telephone	: 1 416 817 2944
Project	: 47632 - Omer Lake Culvert	Date Samples Received	: 21-Aug-2024 17:10
PO	: ----	Date Analysis Commenced	: 24-Aug-2024
C-O-C number	: ----	Issue Date	: 29-Aug-2024 19:32
Sampler	: CLIENT		
Site	: ----		
Quote number	: 2024 SOA		
No. of samples received	: 4		
No. of samples analysed	: 4		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percent Difference (RPD) and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Maria Painchaud	Laboratory Assistant	Saskatoon Sask Soils, Saskatoon, Saskatchewan

General Comments

The ALS Quality Control (QC) report is optionally provided to ALS clients upon request. ALS test methods include comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against predetermined Data Quality Objectives (DQOs) to provide confidence in the accuracy of associated test results. This report contains detailed results for all QC results applicable to this sample submission. Please refer to the ALS Quality Control Interpretation report (QCI) for applicable method references and methodology summaries.

Key :

Anonymous = Refers to samples which are not part of this work order, but which formed part of the QC process lot.
CAS Number = Chemical Abstracts Service number is a unique identifier assigned to discrete substances.
DQO = Data Quality Objective.
LOR = Limit of Reporting (detection limit).
RPD = Relative Percent Difference
# = Indicates a QC result that did not meet the ALS DQO.

Workorder Comments

Holding times are displayed as "---" if no guidance exists from CCME, Canadian provinces, or broadly recognized international references.

Laboratory Duplicate (DUP) Report

A Laboratory Duplicate (DUP) is a randomly selected intralaboratory replicate sample. Laboratory Duplicates provide information regarding method precision and sample heterogeneity. ALS DQOs for Laboratory Duplicates are expressed as test-specific limits for Relative Percent Difference (RPD), or as an absolute difference limit of 2 times the LOR for low concentration duplicates within ~ 4-10 times the LOR (cut-off is test-specific).

Sub-Matrix: **Soil/Solid**

					Laboratory Duplicate (DUP) Report						
Laboratory sample ID	*Client sample ID*	*Analyte*	*CAS Number*	*Method*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD(%) or Difference*	*Duplicate Limits*	*Qualifier*
Physical Tests (QC Lot: 1621023)											
WT2424358-001	24-03 SS-1 (0'-2') & SS-3 (4'-6')	Loss on ignition @ 440°C	----	E205E	1.0	%	6.4	6.9	0.5	Diff <2x LOR	----

Reference Material (RM) Report

A Reference Material (RM) is a homogenous material with known and well-established analyte concentrations. RMs are processed in an identical manner to test samples, and are used to monitor and control the accuracy and precision of a test method for a typical sample matrix. RM results are expressed as percent recovery of the target analyte concentration. RM targets may be certified target concentrations provided by the RM supplier, or may be ALS long-term mean values (for empirical test methods).

Sub-Matrix:

					Reference Material (RM) Report				
					RM Target	Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Concentration	RM	Low	High	Qualifier
Physical Tests (QCLot: 1621023)									
QC-1621023-002	RM	Loss on ignition @ 440°C	----	E205E	8.78 %	98.6	80.0	120	----

SOL-733

Chain of Custody (COC) / Analytical Request Form

COC Number: 20 -

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Environmental Division Waterloo

Work Order Reference WT2424358

Telephone : +1 519 886 6910

Report To	Contact and company name below will appear on the final report
Company:	Thurber Engineering Limited
Contact:	Madisan Chiarotto
Phone:	647-548-8390
	Company address below will appear on the final report
Street:	202-1908 Ironoak Way
City/Province:	Oakville/ON
Postal Code:	L6H 0N1
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Thurber Engineering Limited
Contact:	Madisan Chiarotto

Reports / Recipients

Select Report Format: ☑ PDF ☐ EXCEL ☐ EDD (DIGITAL)

Merge QC/QCI Reports with COA ☐ YES ☑ NO ☐ N/A

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax mchiarotto@thurber.ca

Email 2 mfarrant@thurber.ca

Email 3

Invoice Recipients

Select Invoice Distribution: ☑ EMAIL MAIL ☐ FAX

Email 1 or Fax AccountingON@thurber.ca

Email 2

Turnaround Time (TAT)

☐ Routine [R] if received by 3pm M-F - no st

☐ 4 day [P4] if received by 3pm M-F - 20% r

☐ 3 day [P3] if received by 3pm M-F - 25%

☐ 2 day [P2] if received by 3pm M-F - 50%

☐ 1 day [E] if received by 3pm M-F - 100%

Same day [E2] if received by 10am M-S - fees may apply to rush requests on weeke routine tests

Date and Time Required for all E&P

For all tests with rus

E LABEL HERE only)

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:	47632 - Omer Lake Culvert	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (ALS use only):		ALS Contact:	Sampler:

ALS Sample # (ALS use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	NUMBER OF CONTAINERS	ASTM D2974 (Method C (440C) - general purposes Organic testing	(Quantitation of asbestos by point coun	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below												SAMPLES ON HOLD	EXTENDED STORAGE REQUIRED	SUSPECTED HAZARD (see notes)
	24-03 SS-1 (0'-2') & SS-3 (4'-6')	11-Aug-23		Soil		R																
	24-04 SS-1 (0'-2') & SS-4 (6'-8')	12-Aug-23		Soil		R																
	24-05 SS-2B (2'7"-4') & SS-3A (4'-5'1")	13-Aug-23		Soil		R																
	24-06 SS-1 (0'-2') & SS-2A (2'-3'5")	08-Aug-23		Soil		R																

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human consumption/ use?

☐ YES ☑ NO

Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only)

SAMPLE RECEIPT DETAILS (ALS use only)

Cooling Method: ☐ NONE ☑ ICE ☐ ICE PACKS FROZEN ☐ COOLING INITIATED

Submission Comments identified on Sample Receipt Notification: ☐ YES ☐ NO

Cooler Custody Seals Intact: ☐ YES ☐ N/A Sample Custody Seals Intact: ☐ YES ☐ N/A

INITIAL COOLER TEMPERATURES °C				FINAL COOLER TEMPERATURES °C			
				6.1			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (ALS use only)			FINAL SHIPMENT RECEPTION (ALS use only)		
Released by: Jaimin Patel	Date: 2024-08-20	Time:	Received by:	Date:	Time:	Received by:	Date: 8-21-24	Time: 11:15

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY AUG 2020 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

FINAL REPORT

CA15887-APR21 R1

31344, Omer Lake Culvert

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada
Contact	Joshua Alexander
Telephone	613-606-7303
Facsimile	
Email	jalexander@thurber.ca
Project	31344, Omer Lake Culvert
Order Number	
Samples	Soil (2)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA15887-APR21
Received	04/28/2021
Approved	05/05/2021
Report Number	CA15887-APR21 R1
Date Reported	05/05/2021

COMMENTS

Temperature of Sample upon Receipt: 7 degrees C
Cooling Agent Present: yes
Custody Seal Present: yes

Chain of Custody Number: 019461

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **- Corrosivity Index** (SOIL)

Sample Number	5	6
Sample Name	BH21-01, SS6B	BH21-02, SS8
Sample Matrix	Soil	Soil
Sample Date	20/04/2021	22/04/2021

Parameter	Units	RL		Result	Result
Corrosivity Index					
Corrosivity Index	none	1		11	6
Soil Redox Potential	mV	-		210	199
Sulphide (Na2CO3)	%	0.04		< 0.04	< 0.04
pH	pH Units	0.05		7.52	8.74
Resistivity (calculated)	ohms.cm	-9999		236	2290

PACKAGE: **- General Chemistry** (SOIL)

Sample Number	5	6
Sample Name	BH21-01, SS6B	BH21-02, SS8
Sample Matrix	Soil	Soil
Sample Date	20/04/2021	22/04/2021

Parameter	Units	RL		Result	Result
General Chemistry					
Conductivity	uS/cm	2		4230	436

PACKAGE: **- Metals and Inorganics** (SOIL)

Sample Number	5	6
Sample Name	BH21-01, SS6B	BH21-02, SS8
Sample Matrix	Soil	Soil
Sample Date	20/04/2021	22/04/2021

Parameter	Units	RL		Result	Result
Metals and Inorganics					
Moisture Content	%	0.1		29.2	18.9
Sulphate	µg/g	0.4		51	5.2

FINAL REPORT

CA15887-APR21 R1

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **- Other (ORP)** (SOIL)

Sample Number	5	6
Sample Name	BH21-01, SS6B	BH21-02, SS8
Sample Matrix	Soil	Soil
Sample Date	20/04/2021	22/04/2021

Parameter	Units	RL		Result	Result
Other (ORP)					
Chloride	µg/g	0.4		4700	190

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0520-APR21	µg/g	0.4	<0.4	3	20	99	80	120	113	75	125
Sulphate	DIO0520-APR21	µg/g	0.4	<0.4	6	20	97	80	120	85	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0001-MAY21	%	0.04	< 0.04	ND	20	105	80	120			

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0541-APR21	uS/cm	2	< 2	3	20	101	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0541-APR21	pH Units	0.05	NA	0		100			NA		

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No: 019461 Page _____ of _____

Laboratory Information Section - Lab use only

Received By: Oleg Mozhar
Received Date: 04/28/21 (mm/dd/yy)
Received Time: 11:00 (hr : min)
Received By (signature):
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: Ice
Temperature Upon Receipt (°C) 7.7
LAB LIMS #: CA15885-87 Apr21

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber	☐ (same as Report Information)
Contact: Josh Alexander	Company:
Address: 2010 ~~133~~ Winston Park Dr. unit 103	Contact:
Phone: 613 606-7303	Address:
Fax:	Phone:
Email: jalexander@thurber.ca	Email: accountingONE@thurber.ca

Quotation #: P.O. #:
Project #: 31344 Site Location/ID: Over Lake Culvert

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days) — TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: *NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture: ☐ Coarse
☐ Table 2 ☐ Ind/Com ☐ Medium/Fine
☐ Table 3 ☐ Agri/Other
☐ Table ____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations: ☐ Reg 347/558 (3 Day min TAT) ☒ PWQO ☐ MMER ☐ CCME ☐ Other: ☐ MISA ☐ ODWS Not Reportable *See note

Sewer By-Law: ☐ Sanitary ☐ Storm Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M&I: Metals & Inorganics (incl CrVI, CN, Hg pH (B(HWS),EC,SAR-soil) (Cl, Na-water)	M&I: Full Metals Suite (ICP metals plus B(HWS-soil only) Hg, CrVI	M&I: ICP Metals only (Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni,	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs ☐ Total ☐ Aroclor	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other: Corrosivity Pkg	Other: TBSS	Other: CrVI	Other: Hg	Other: Appendix 2: 406/19 Leachate Screening Levels Table :	Other: Sewer Use: Specify pkg:	Other: Water Characterization Pkg ☒ Extended ☐ General	TCLP: Specify TCLP tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.	COMMENTS:
1	BH 21-01	04/25/21	3:00PM	13	water	N		X											X	X	X			X		
2	Over Lake Tank@HWY11	"	1:00PM	1	water	N												X								
3	BH 21-01, SS6B	04/20/21	2:00PM	1	Soil	N												X								
4	BH 21-02, SS8	04/22/21	4:00PM	1	Soil	N												X								
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										

Observations/Comments/Special Instructions: Please only test parameters within hold time

Sampled By (NAME): Signature: Date: ____/____/____ (mm/dd/yy)

Relinquished by (NAME): Josh Alexander Signature: Date: 04/28/21 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

FINAL REPORT

CA15886-APR21 R

31344, Omer Lake Culvert

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

CA15886-APR21 R

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	103, 2010 Winston Park Drive Oakville, ON L6H 5R7. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Joshua Alexander	Telephone	2165
Telephone	613-606-7303	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	jalexander@thurber.ca	SGS Reference	CA15886-APR21
Project	31344, Omer Lake Culvert	Received	04/28/2021
Order Number		Approved	05/05/2021
Samples	Solution (1)	Report Number	CA15886-APR21 R
		Date Reported	05/05/2021

COMMENTS

Temperature of Sample upon Receipt: 7 degrees C
Cooling Agent Present:Yes
Custody Seal Present:Yes

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **- General Chemistry** (WATER)

Sample Number	6
Sample Name	Omer Lake Trit@Hwy 11
Sample Matrix	Solution
Sample Date	25/04/2021

Parameter	Units	RL		Result
General Chemistry				
Conductivity	uS/cm	2		210
Redox Potential	mV	-		243
Sulphide	µg/L	6		8

PACKAGE: **- Metals and Inorganics** (WATER)

Sample Number	6
Sample Name	Omer Lake Trit@Hwy 11
Sample Matrix	Solution
Sample Date	25/04/2021

Parameter	Units	RL		Result
Metals and Inorganics				
Sulphate	mg/L	0.04		2.1

PACKAGE: **- Other (ORP)** (WATER)

Sample Number	6
Sample Name	Omer Lake Trit@Hwy 11
Sample Matrix	Solution
Sample Date	25/04/2021

Parameter	Units	RL		Result
Other (ORP)				
pH	No unit	0.05		7.65
Chloride	mg/L	0.04		39

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphate	DIO0053-MAY21	mg/L	0.04	<0.04	ND	20	96	80	120	90	75	125
Chloride	DIO0524-APR21	mg/L	0.04	<0.04	0	20	101	80	120	101	75	125

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0547-APR21	uS/cm	2	< 2	1	20	97	90	110	NA		

pH

Method: SM 4500 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0547-APR21	No unit	0.05	NA	0		100			NA		

QC SUMMARY

Redox Potential

Method: SM 2580 I

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Redox Potential	EWL0502-APR21	mV	no	NA	1	20	104	80	120	NA		

Sulphide by SFA

Method: SM 4500 I Internal ref.: ME-CA-IENVISFA-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	SKA0022-MAY21	ug/L	6	<0.006	ND	20	102	80	120	NA	75	125

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No: 019461 Page ____ of ____

Laboratory Information Section - Lab use only

Received By: Olcay Mozhan
Received Date: 04/28/21 (mm/dd/yy)
Received Time: 11:00 (hr : min)
Received By (signature):
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: Ice
Temperature Upon Receipt (°C) 7.7
LAB LIMS #: CA15885-87 Apr21

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber	☐ (same as Report Information)
Contact: Josh Alexander	Company:
Address: 2010 ~~133~~ Winston Park Dr. unit 103	Contact:
Phone: 613-606-7303	Address:
Fax:	Phone:
Email: jalexander@thurber.ca	Email: accountingONE@thurber.ca

Quotation #: P.O. #:
Project #: 31344 Site Location/ID: Over Lake Culvert

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days) — TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐1 Day ☐2 Days ☐3 Days ☐4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date: *NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture:
☐ Table 2 ☐ Ind/Com ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ Medium/Fine
☐ Table ____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☒ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M&I: Metals & Inorganics incl CrVI, CN, Hg pH (B(HWS),EC,SAR-soil) (Cl, Na-water)	M&I: Full Metals Suite ICP metals plus B(HWS-soil only) Hg, CrVI	M&I: ICP Metals only Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni,	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs ☐ Total ☐ Aroclor	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other: Corrosivity Pkg	Other: TRSS	Other: CrVI+	Other: Hg+	Other: Appendix 2: 406/19 Leachate Screening Levels Table :	Other: Sewer Use: Specify pkg:	Other: Water Characterization Pkg Extended ☐ General	TCLP: Specify TCLP tests ☐M&I ☐VOC ☐PCB ☐B(a)P ☐ABN ☐Ignit.	COMMENTS:
1	BH 21-01	04/25/21	3:00PM	13	water	N		X										X	X	X	X		X			
2	Over Lake Tank@HWY11	"	1:00PM	1	water	N												X								
3	BH 21-01, SS 6B	04/26/21	2:00PM	1	Soil	N												X								
4	BH 21-02, SS 8	04/22/21	4:00PM	1	Soil	N												X								
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										

Observations/Comments/Special Instructions: Please only test parameters within hold time

Sampled By (NAME): Signature: Date: ____/____/____ (mm/dd/yy)

Relinquished by (NAME): Josh Alexander Signature: Date: 04/28/21 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

FINAL REPORT

CA15885-APR21 R1

31344, Omer Lake Culvert

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	103, 2010 Winston Park Drive, Oakville Canada, L6H 5R7 Phone: 613-606-7303. Fax:
Contact	Joshua Alexander
Telephone	613-606-7303
Facsimile	
Email	jalexander@thurber.ca
Project	31344, Omer Lake Culvert
Order Number	
Samples	Ground Water (1)

LABORATORY DETAILS

Project Specialist	Jill Campbell, B.Sc.,GISAS
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	2165
Facsimile	705-652-6365
Email	jill.campbell@sgs.com
SGS Reference	CA15885-APR21
Received	04/28/2021
Approved	05/04/2021
Report Number	CA15885-APR21 R1
Date Reported	05/04/2021

COMMENTS

MAC - Maximum Acceptable Concentration
AO/OG - Aesthetic Objective / Operational Guideline
NR - Not reportable under applicable Provincial drinking water regulations as per client.

Temperature of Sample upon Receipt:7
Cooling Agent Present:Yes
Custody Seal Present:Yes

Chain of Custody Number:019461

SIGNATORIES

Jill Campbell, B.Sc.,GISAS

TABLE OF CONTENTS

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **General Chemistry** (WATER)

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	BH21-01
Sample Matrix	Ground Water
Sample Date	25/04/2021

General Chemistry

Parameter	Units	RL	L1	Result
UV Transmittance	%T			72.9
Alkalinity	mg/L as CaCO3	2		116
Bicarbonate	mg/L as CaCO3	2		116
Carbonate	mg/L as CaCO3	2		< 2
OH	mg/L as CaCO3	2		< 2
Colour	TCU	3		11
Conductivity	uS/cm	2		638
Total Suspended Solids	mg/L	2		121
Organic Nitrogen	mg/L	0.05		0.43
Total Kjeldahl Nitrogen (N)	as N mg/L	0.05		1.58
Ammonia+Ammonium (N)	as N mg/L	0.04		1.15
Dissolved Organic Carbon	mg/L	1		7
Total Organic Carbon	mg/L	1		8
Sulphide	µg/L	6		< 6

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **Metals and Inorganics** (WATER)

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	BH21-01
Sample Matrix	Ground Water
Sample Date	25/04/2021

Metals and Inorganics

Parameter	Units	RL	L1	Result
Fluoride	mg/L	0.06		0.12
Bromide	mg/L	0.05		0.05#<MDL
Nitrite (as N)	as N mg/L	0.003		0.003#<MDL
Nitrate (as N)	as N mg/L	0.006		0.102
Sulphate	mg/L	0.04		8.8
Mercury	µg/L	0.01	0.2	0.01
Hardness	mg/L as CaCO3	0.05		107
Aluminum	µg/L	1	15	1470
Arsenic	µg/L	0.2	5	3.1
Boron	µg/L	2	200	8
Barium	µg/L	0.02		20.4
Beryllium	µg/L	0.007	11	0.091
Bismuth	µg/L	0.01		0.01
Cobalt	µg/L	0.004	0.9	2.51
Calcium	mg/L	0.01		32.1
Cadmium	µg/L	0.003	0.1	0.044
Copper	µg/L	0.2	1	12.2
Chromium	µg/L	0.08	100	4.35
Iron	ug/L	7	300	3120
Potassium	mg/L	0.009		2.30
Magnesium	mg/L	0.001		6.46
Manganese	µg/L	0.01		95.5
Molybdenum	µg/L	0.04	40	3.61

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **Metals and Inorganics** (WATER)

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	BH21-01
Sample Matrix	Ground Water
Sample Date	25/04/2021

Metals and Inorganics (continued)

Parameter	Units	RL	L1	Result
Nickel	µg/L	0.1	25	6.2
Sodium	mg/L	0.01		93.8
Phosphorus	mg/L	0.003	0.01	0.121
Lead	µg/L	0.01	11	1.83
Silicon	ug/L	20		4400
Silver	µg/L	0.05	0.1	< 0.05
Strontium	µg/L	0.02		71.5
Thallium	µg/L	0.005	0.3	0.038
Tin	µg/L	0.06		1.54
Titanium	ug/L	0.05		44.7
Antimony	µg/L	0.9	20	1.6
Selenium	µg/L	0.04	100	0.21
Uranium	µg/L	0.002	5	4.94
Vanadium	µg/L	0.01	6	4.58
Zinc	µg/L	2	20	13

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **Other (ORP)** (WATER)

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	BH21-01
Sample Matrix	Ground Water
Sample Date	25/04/2021

Parameter	Units	RL	L1	Result
Other (ORP)				
pH	No unit	5	0.1	8.21
Chloride	mg/L	0.04		130
Chromium VI	µg/L	0.2	1	< 0.2
Phenols				
4AAP-Phenolics	mg/L	0.002	0.001	< 0.002

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E L1
BH21-01				
Aluminum	SM 3030/EPA 200.8	µg/L	1470	15
Cobalt	SM 3030/EPA 200.8	µg/L	2.51	0.9
Copper	SM 3030/EPA 200.8	µg/L	12.2	1
Iron	SM 3030/EPA 200.8	ug/L	3120	300
Phosphorus	SM 3030/EPA 200.8	mg/L	0.121	0.01
pH	SM 4500	No unit	8.21	0.1
4AAP-Phenolics	SM 5530B-D	mg/L	< 0.002	0.001

QC SUMMARY

Alkalinity

Method: SM 2320 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Alkalinity	EWL0547-APR21	mg/L as CaCO3	2	< 2	0	20	100	80	120	NA		

Ammonia by SFA

Method: SM 4500 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-007

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Ammonia+Ammonium (N)	SKA0276-APR21	mg/L	0.04	<0.04	4	10	101	90	110	101	75	125

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-IENVIIC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Bromide	DIO0523-APR21	mg/L	0.05	<0.05	1	20	99	80	120	99	75	125
Nitrite (as N)	DIO0523-APR21	mg/L	0.003	<0.003	ND	20	95	80	120	98	75	125
Nitrate (as N)	DIO0523-APR21	mg/L	0.006	<0.006	0	20	102	80	120	92	75	125
Chloride	DIO0525-APR21	mg/L	0.04	<0.04	NV	20	100	80	120	NV	75	125
Sulphate	DIO0525-APR21	mg/L	0.04	<0.04	0	20	96	80	120	90	75	125

Carbon by SFA

Method: SM 5310 | Internal ref.: ME-CA-IENVISFA-LAK-AN-009

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Dissolved Organic Carbon	SKA0010-MAY21	mg/L	1	<1	1	10	103	90	110	102	75	125
Total Organic Carbon	SKA0010-MAY21	mg/L	1	<1	1	10	103	90	110	102	75	125

QC SUMMARY

Carbonate/Bicarbonate

Method: SM 2320 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Carbonate	EWL0547-APR21	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		
Bicarbonate	EWL0547-APR21	mg/L as CaCO3	2	< 2	0	10	NA	90	110	NA		
OH	EWL0547-APR21	mg/L as CaCO3	2	< 2	ND	10	NA	90	110	NA		

Colour

Method: SM 2120 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-002

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Colour	EWL0518-APR21	TCU	3	< 3	ND	10	105	80	120	NA		

QC SUMMARY

Conductivity

Method: SM 2510 I Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0547-APR21	uS/cm	2	< 2	1	20	97	90	110	NA		

Fluoride by Specific Ion Electrode

Method: SM 4500 I Internal ref.: ME-CA-IENVIEWL-LAK-AN-014

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Fluoride	EWL0520-APR21	mg/L	0.06	<0.06	ND	10	107	90	110	106	75	125

Hexavalent Chromium by SFA

Method: EPA218.6/EPA3060A I Internal ref.: ME-CA-IENVISKA-LAK-AN-012

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chromium VI	SKA0265-APR21	ug/L	0.2	<0.2	6	20	104	80	120	NV	75	125

QC SUMMARY

Mercury by CVAAS

Method: SM3112/EPA 245 | Internal ref.: ME-CA-IENVISPE-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Mercury	EHG0027-APR21	ug/L	0.01	<0.01	ND	20	108	80	120	115	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-IENVISPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Silver	EMS0161-APR21	ug/L	0.05	< 0.05	ND	20	99	90	110	105	70	130
Aluminum	EMS0161-APR21	ug/L	1	< 1	ND	20	106	90	110	130	70	130
Arsenic	EMS0161-APR21	ug/L	0.2	< 0.2	1	20	102	90	110	114	70	130
Barium	EMS0161-APR21	ug/L	0.02	< 0.02	3	20	99	90	110	101	70	130
Beryllium	EMS0161-APR21	ug/L	0.007	< 0.07	ND	20	110	90	110	111	70	130
Boron	EMS0161-APR21	ug/L	2	< 2	1	20	94	90	110	NV	70	130
Bismuth	EMS0161-APR21	ug/L	0.01	< 0.01	ND	20	93	90	110	97	70	130
Calcium	EMS0161-APR21	mg/L	0.01	< 0.02	4	20	95	90	110	91	70	130
Cadmium	EMS0161-APR21	ug/L	0.003	< 0.003	18	20	96	90	110	117	70	130
Cobalt	EMS0161-APR21	ug/L	0.004	< 0.004	18	20	101	90	110	109	70	130
Chromium	EMS0161-APR21	ug/L	0.08	< 0.08	ND	20	101	90	110	100	70	130
Copper	EMS0161-APR21	ug/L	0.2	< 0.2	2	20	99	90	110	95	70	130
Iron	EMS0161-APR21	ug/L	7	< 7	2	20	99	90	110	100	70	130
Potassium	EMS0161-APR21	mg/L	0.009	< 0.009	2	20	99	90	110	NV	70	130
Magnesium	EMS0161-APR21	mg/L	0.001	< 0.001	0	20	99	90	110	91	70	130
Manganese	EMS0161-APR21	ug/L	0.01	< 0.01	1	20	100	90	110	99	70	130
Molybdenum	EMS0161-APR21	ug/L	0.04	< 0.04	7	20	99	90	110	110	70	130
Sodium	EMS0161-APR21	mg/L	0.01	< 0.01	0	20	99	90	110	96	70	130
Nickel	EMS0161-APR21	ug/L	0.1	< 0.1	2	20	98	90	110	130	70	130
Lead	EMS0161-APR21	ug/L	0.01	< 0.01	ND	20	108	90	110	118	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS (continued)

Method: SM 3030/EPA 200.8 I Internal ref.: ME-CA-IENVISPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Phosphorus	EMS0161-APR21	mg/L	0.003	< 0.003	ND	20	98	90	110	NV	70	130
Antimony	EMS0161-APR21	ug/L	0.9	< 0.09	ND	20	100	90	110	125	70	130
Selenium	EMS0161-APR21	ug/L	0.04	< 0.04	ND	20	99	90	110	111	70	130
Silicon	EMS0161-APR21	ug/L	20	< 0.02	6	20	97	90	110	NV	70	130
Tin	EMS0161-APR21	ug/L	0.06	< 0.06	ND	20	95	90	110	NV	70	130
Strontium	EMS0161-APR21	ug/L	0.02	< 0.02	1	20	96	90	110	94	70	130
Titanium	EMS0161-APR21	ug/L	0.05	< 0.05	10	20	96	90	110	NV	70	130
Thallium	EMS0161-APR21	ug/L	0.005	< 0.005	ND	20	100	90	110	108	70	130
Uranium	EMS0161-APR21	ug/L	0.002	< 0.002	3	20	99	90	110	109	70	130
Vanadium	EMS0161-APR21	ug/L	0.01	< 0.01	ND	20	103	90	110	110	70	130
Zinc	EMS0161-APR21	ug/L	2	< 2	0	20	99	90	110	105	70	130

pH

Method: SM 4500 I Internal ref.: ME-CA-IENVIEWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0547-APR21	No unit	5	NA	0		100			NA		

QC SUMMARY

Phenols by SFA

Method: SM 5530B-D | Internal ref.: ME-CA-IENVISFA-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
4AAP-Phenolics	SKA0021-MAY21	mg/L	0.002	<0.002	ND	10	100	80	120	86	75	125

Sulphide by SFA

Method: SM 4500 | Internal ref.: ME-CA-IENVISFA-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide	SKA0022-MAY21	ug/L	6	<0.006	ND	20	102	80	120	NA	75	125

Suspended Solids

Method: SM 2540D | Internal ref.: ME-CA-IENVIEWL-LAK-AN-004

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Total Suspended Solids	EWL0558-APR21	mg/L	2	< 2	1	10	99	90	110	NA		

QC SUMMARY

Total Nitrogen

Method: SM 4500-N C/4500-NO3- F | Internal ref.: ME-CA-[ENV]SFA-LAK-AN-002

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Total Kjeldahl Nitrogen (N)	SKA0272-APR21	mg/L	0.05	<0.05	0	10	102	90	110	85	75	125

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS	Insufficient sample for analysis.
RL	Reporting Limit.
↑	Reporting limit raised.
↓	Reporting limit lowered.
NA	The sample was not analysed for this analyte
ND	Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. “Temperature Upon Receipt” is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act” published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated. This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/terms_and_conditions.htm. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any other holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of Client's instructions, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents.

-- End of Analytical Report --

SGS

Request for Laboratory Services and CHAIN OF CUSTODY

No: 019461

Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Page _____ of _____

Laboratory Information Section - Lab use only

Received By: Oleg Mozhin
Received By (signature):
Received Date: 04/28/21 (mm/dd/yy)
Received Time: 11:00 (hr : min)
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: ice
Temperature Upon Receipt (°C) 7.7
LAB LIMS #: CA15885-87 Apr21

REPORT INFORMATION

Company: Thurber
Contact: Josh Alexander
Address: 2010 ~~133~~ Winston Park Dr. unit 103
Phone: 613 606-7303
Fax:
Email: jalexander@thurber.ca

INVOICE INFORMATION

☐ (same as Report Information)
Company:
Contact:
Address:
Phone:
Email: accounting ONE@thurber.ca

Quotation #:
P.O. #:
Project #: 31344
Site Location/ID: Over Lake Culvert

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐1 Day ☐2 Days ☐3 Days ☐4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

*NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture:
☐ Table 2 ☐ Ind/Com ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ Medium/Fine
☐ Table _____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☒ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M&I: Metals & Inorganics (incl CrVI, CN, Hg pH, B(HWS), EC, SAR – soil) (Cl, Na – water)	M&I: Full Metals Suite (ICP metals plus B(HWS)-soil only) Hg, CrVI	M&I: ICP Metals only (Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni,	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs ☐ Total ☐ Aroclor	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other: Corrosivity Pkg	Other: TSS	Other: CrVI	Other: Hg	Other: Appendix 2: 406/19 Leachate Screening Levels Table :	Other: Sewer Use: Specify pkg:	Other: Water Characterization Pkg ☒ Extended ☐ General	TCLP: Specify TCLP tests ☐M&I ☐VOC ☐PCB ☐B(a)P ☐ABN ☐Ignit.	COMMENTS:
1	BH 21-01	04/25/21	3:00PM	13	water	N		X											X	X	X				
2	Over Lake Trk @ HWY11	"	1:00PM	1	water	N												X							
3	BH 21-01, SS6B	04/26/21	2:00PM	1	Soil	N												X							
4	BH 21-02, SS8	04/22/21	4:00PM	1	Soil	N												X							
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									

Observations/Comments/Special Instructions: Please only test parameters within hold time

Sampled By (NAME):
Signature:
Date: ___/___/___ (mm/dd/yy)

Relinquished by (NAME): Josh Alexander
Signature:
Date: 04/28/21 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

Revision #: 1.4
Date of Issue: 22 May 2020

FINAL REPORT

CA15271-MAY21 R1

31344, Omer Lake Culvert

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

CA15271-MAY21 R1

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	103, 2010 Winston Park Drive, Oakville Canada, L6H 5R7 Phone: 613-606-7303. Fax:
Contact	Joshua Alexander
Telephone	613-606-7303
Facsimile	
Email	jalexander@thurber.ca
Project	31344, Omer Lake Culvert
Order Number	
Samples	Ground Water (1)

LABORATORY DETAILS

Project Specialist	Brad Moore Hon. B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2143
Facsimile	705-652-6365
Email	brad.moore@sgs.com
SGS Reference	CA15271-MAY21
Received	05/18/2021
Approved	05/27/2021
Report Number	CA15271-MAY21 R1
Date Reported	05/27/2021

COMMENTS

SIGNATORIES

Brad Moore Hon. B.Sc

TABLE OF CONTENTS

FINAL REPORT

CA15271-MAY21 R1

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **Metals and Inorganics** (WATER)

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	BH21-01
Sample Matrix	Ground Water
Sample Date	25/04/2021

Metals and Inorganics

Parameter	Units	RL	L1	Result
Hardness (dissolved)	mg/L as CaCO3	0.05		77.7
Aluminum (dissolved)	mg/L	0.001	0.015	0.031
Arsenic (dissolved)	mg/L	0.0002		0.0017
Boron (dissolved)	mg/L	0.002		0.009
Barium (dissolved)	mg/L	0.00002		0.00923
Beryllium (dissolved)	mg/L	0.000007		< 0.000007
Bismuth (dissolved)	mg/L	0.00001		< 0.00001
Cobalt (dissolved)	mg/L	0.000004		0.000091
Calcium (dissolved)	mg/L	0.01		23.4
Cadmium (dissolved)	mg/L	0.000003		0.000012
Copper (dissolved)	mg/L	0.0002		0.0034
Chromium (dissolved)	mg/L	0.00008		0.00026
Iron (dissolved)	mg/L	0.007		0.042
Potassium (dissolved)	mg/L	0.009		2.18
Magnesium (dissolved)	mg/L	0.001		4.66
Manganese (dissolved)	mg/L	0.00001		0.00049
Molybdenum (dissolved)	mg/L	0.00004		0.00453
Nickel (dissolved)	mg/L	0.0001		0.0010
Sodium (dissolved)	mg/L	0.01		94.7
Phosphorus (dissolved)	mg/L	0.003		0.016

Client: Thurber Engineering Ltd.
Project: 31344, Omer Lake Culvert
Project Manager: Joshua Alexander
Samplers: NA

PACKAGE: **Metals and Inorganics** (WATER)

L1 = PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E

Sample Number	7
Sample Name	BH21-01
Sample Matrix	Ground Water
Sample Date	25/04/2021

Metals and Inorganics (continued)

Parameter	Units	RL	L1	Result
Lead (dissolved)	mg/L	0.00009		< 0.00009
Silicon (dissolved)	mg/L	0.02		2.89
Silver (dissolved)	mg/L	0.00005		< 0.00005
Strontium (dissolved)	mg/L	0.00002		0.0596
Thallium (dissolved)	mg/L	0.000005		0.000013
Tin (dissolved)	mg/L	0.00006		0.00071
Titanium (dissolved)	mg/L	0.00005		0.00049
Antimony (dissolved)	mg/L	0.0009		0.0022
Selenium (dissolved)	mg/L	0.00004		0.00015
Uranium (dissolved)	mg/L	0.000002		0.00410
Vanadium (dissolved)	mg/L	0.00001		0.00090
Zinc (dissolved)	mg/L	0.002		< 0.002

EXCEEDANCE SUMMARY

Parameter	Method	Units	Result	PWQO_L / WATER / - - Table 2 - General - July 1999 PIBS 3303E L1
BH21-01				
Aluminum (dissolved)	SM 3030/EPA 200.8	mg/L	0.031	0.015

QC SUMMARY

Metals in aqueous samples - ICP-MS

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-IENVISPE-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Silver (dissolved)	EMS0103-MAY21	mg/L	0.00005	<0.00005	ND	20	100	90	110	99	70	130
Aluminum (dissolved)	EMS0103-MAY21	mg/L	0.001	<0.001	1	20	94	90	110	106	70	130
Arsenic (dissolved)	EMS0103-MAY21	mg/L	0.0002	<0.0002	11	20	102	90	110	100	70	130
Barium (dissolved)	EMS0103-MAY21	mg/L	0.00002	<0.00002	1	20	100	90	110	100	70	130
Beryllium (dissolved)	EMS0103-MAY21	mg/L	0.000007	<0.00007	ND	20	93	90	110	88	70	130
Boron (dissolved)	EMS0103-MAY21	mg/L	0.002	<0.002	5	20	96	90	110	99	70	130
Bismuth (dissolved)	EMS0103-MAY21	mg/L	0.00001	<0.00001	5	20	90	90	110	81	70	130
Calcium (dissolved)	EMS0103-MAY21	mg/L	0.01	<0.01	2	20	102	90	110	102	70	130
Cadmium (dissolved)	EMS0103-MAY21	mg/L	0.000003	<0.000003	2	20	101	90	110	108	70	130
Cobalt (dissolved)	EMS0103-MAY21	mg/L	0.000004	<0.000004	1	20	99	90	110	98	70	130
Chromium (dissolved)	EMS0103-MAY21	mg/L	0.00008	<0.00008	5	20	100	90	110	101	70	130
Copper (dissolved)	EMS0103-MAY21	mg/L	0.0002	<0.0002	4	20	100	90	110	94	70	130
Iron (dissolved)	EMS0103-MAY21	mg/L	0.007	<0.007	0	20	102	90	110	100	70	130
Potassium (dissolved)	EMS0103-MAY21	mg/L	0.009	<0.009	1	20	104	90	110	100	70	130
Magnesium (dissolved)	EMS0103-MAY21	mg/L	0.001	<0.001	2	20	110	90	110	100	70	130
Manganese (dissolved)	EMS0103-MAY21	mg/L	0.00001	<0.00001	1	20	101	90	110	106	70	130
Molybdenum (dissolved)	EMS0103-MAY21	mg/L	0.00004	<0.00004	7	20	95	90	110	108	70	130
Sodium (dissolved)	EMS0103-MAY21	mg/L	0.01	<0.01	2	20	107	90	110	99	70	130
Nickel (dissolved)	EMS0103-MAY21	mg/L	0.0001	<0.0001	2	20	103	90	110	102	70	130
Lead (dissolved)	EMS0103-MAY21	mg/L	0.00009	<0.00001	3	20	109	90	110	104	70	130

QC SUMMARY

Metals in aqueous samples - ICP-MS (continued)

Method: SM 3030/EPA 200.8 | Internal ref.: ME-CA-IENVISPE-LAK-AN-003

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Phosphorus (dissolved)	EMS0103-MAY21	mg/L	0.003	<0.003	6	20	99	90	110	NV	70	130
Antimony (dissolved)	EMS0103-MAY21	mg/L	0.0009	<0.0009	2	20	100	90	110	120	70	130
Selenium (dissolved)	EMS0103-MAY21	mg/L	0.00004	<0.00004	12	20	101	90	110	105	70	130
Silicon (dissolved)	EMS0103-MAY21	mg/L	0.02	<0.02	4	20	109	90	110	NV	70	130
Tin (dissolved)	EMS0103-MAY21	mg/L	0.00006	<0.00006	2	20	98	90	110	NV	70	130
Strontium (dissolved)	EMS0103-MAY21	mg/L	0.00002	<0.00002	2	20	98	90	110	101	70	130
Titanium (dissolved)	EMS0103-MAY21	mg/L	0.00005	<0.00005	5	20	104	90	110	NV	70	130
Thallium (dissolved)	EMS0103-MAY21	mg/L	0.000005	<0.000005	ND	20	104	90	110	100	70	130
Uranium (dissolved)	EMS0103-MAY21	mg/L	0.000002	<0.000002	2	20	102	90	110	96	70	130
Vanadium (dissolved)	EMS0103-MAY21	mg/L	0.00001	<0.00001	0	20	99	90	110	102	70	130
Zinc (dissolved)	EMS0103-MAY21	mg/L	0.002	<0.002	3	20	99	90	110	108	70	130

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.

Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.

LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.

Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Samples analysed as received. Solid samples expressed on a dry weight basis. "Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.

Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act" published by the Ministry and dated March 9, 2004 as amended.

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-- End of Analytical Report --

APPENDIX E

Site Photographs

Figure 1: Looking north at north approach on Highway 11 (June 2024)

Figure 2: Looking south at south approach on Highway 11 (June 2024)

Figure 3: Looking southwest at culvert inlet (August 2024)

Figure 4: Looking east towards marshy conditions near culvert inlet (August 2024)

Figure 5: Looking north towards culvert outlet (August 2024)

Figure 6: Looking southwest towards marshy conditions south of culvert outlet (August 2024)

THURBER

APPENDIX F

List of OPSS and OPSD Documents and Suggested Wording for NSSPs

1. The following Special Provisions and OPSS Documents are referenced in this report:

OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 209	Embankments over Swamps and Compressible Soils
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 511	Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting
OPSS.PROV 517	Construction Specification for Dewatering and Temporary Flow Passage Systems
SP 517F01	Dewatering System – Temporary Flow Passage System
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS.PROV 902	Construction Specification for Excavating and Backfilling Structures
SP 109S61	Dewatering and Protection Systems
OPSS.PROV 903	Construction Specification for Deep Foundations
OPSS.PROV 1005	Material Specification for Aggregates – Streambed Material
OPSS.PROV 1004	Material Specification for Aggregates - Miscellaneous
OPSS.PROV 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
OPSS.PROV 1205	Material Specification for Clay Seal
OPSS.PROV 1860	Material Specification for Geotextiles
OPSD 203.030	Embankments Over Swamp - Existing Slopes Maintained
OPSD 802.010	Flexible Pipe Embedment and Backfill Earth Excavation
OPSD 802.020	Flexible Pipe Arch – Embedment and Backfill, Earth Excavation
OPSD 810.010	General Rip-Rap Layout for Sewer and Culvert Outlets
OPSD 3090.100	Foundation Frost Penetration Depths for Northern Ontario

2. Suggested Wording for NSSPs

- **Suggested Text for NSSP on Dewatering**

The Contractor is notified that full dewatering to below the base of the relatively small temporary excavations adjacent to the arch culvert and foundation sheet piles are anticipated to produce discharges of approximately 300,000 litres of water per day (for half of the culvert length) due to the peat and underlying cohesionless native soils at this site. It is therefore anticipated that any construction in the temporary excavations below the groundwater level will likely be carried out in the wet.

The Contractor is permitted to dewater a maximum of 50,000 L/day in order to remove as much of the standing water in the temporary excavations as possible. Above this quantity of dewatering, it is assumed that the Contractor shall work in the wet and take all appropriate measures to create a safe, working platform for installation of the arch culvert at the sheet pile cut-off elevation.

- **Suggested Text for NSSP on Installation of Steel Sheet Piles**

Obstructions such as wood, boulders or rock fill may be present within the existing embankment fill. These obstructions may impede the driving of sheet piles and at some locations the sheet piles may not be able to penetrate these materials to reach the design depth of installation. The Contractor shall be prepared to remove, drill through and/or penetrate these obstructions and extend the piles to the design depths. Tip protection shall not be used for the sheet piles at this site.

Advancement of sheet piles to the design depths may be impeded by the build-up of friction on the piles during driving. The Contractor shall be prepared to drive the piles to the full design depths using the appropriate means, including vibration if necessary. No piles shall be left overnight at partial depth.

If any sheet piles cannot be advanced to the full depth to reach the specified tip elevations, the Contractor shall immediately notify the Contract Administrator (CA). The Contractor shall not proceed to install the next sheet pile until given approval to do so by the CA.

Horizontal alignment of the sheet piles shall be maintained within the required tolerances using a stable and secure template.

The Contractor shall submit a Work Plan for installation of the arch culvert foundation sheet piles to the Contract Administrator (CA) at least 14 Days prior to construction for information

purposes. The Work Plan shall include the information specified in Section 903.04.02.04.01 of OPSS.PROV 903 (April 2016), as well as the following:

- The procedure for how horizontal alignment of the sheet piles will be maintained within the required tolerances, including details on the sheet pile driving template.
- The procedure for how the sheet piles will be advanced to the full design depths, including the measures to be taken if the full depths cannot be achieved.

- **Suggested Text for NSSP on Temporary Modular Bridge**

The Contractor is responsible for the detailed design of the Temporary Modular Bridge (TMB) including, but not limited to, slope stability of the temporary excavation slope in front of the TMB abutment footings, determination of bearing capacity for the abutment footings and safe footing set back distance from the open excavation, as well as the performance of the temporary footings throughout construction. As a minimum, modular bridge footings shall be set back a minimum two (2) metres from the top of the temporary excavation. The temporary excavation slope shall be no steeper than two (2) horizontal to one (1) vertical above the groundwater level and three (3) horizontal to one (1) vertical below the groundwater level. The Contractor is responsible for retaining a RAQS approved Licensed Geotechnical Engineer with a medium-complexity rating (RAQs Category – Geotechnical Structures and Embankment – Medium Complexity) to confirm all aspects of the modular bridge slope stability and foundation design. All final reports and drawings must be sealed and signed by a Professional Engineer, who shall also be a RAQs Designated Contact. The Contractor shall submit to the Contract Administrator shop drawings for the TMB and footings and geotechnical report of the footing details at least 3 weeks in advance of proceeding with the work.

The Contractor shall also determine and report to the Contract Administrator the vertical displacement of a fixed point at each of the four corners of each TMB footing by surveying on a weekly basis for the duration of operation of the TMB. The precision of the vertical displacement survey should be +/- 2 mm. If any tilting of the footings are noted, the Contractor shall take appropriate measures to shim the footings to their original position.

APPENDIX G

Slope Stability Analysis Figures

FIGURE 1
SIDE SLOPE, STA. 28+241
EMBANKMENT WIDENING
NO PEAT REMOVAL

OMER LAKE CULVERT

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Gran B Type I	Mohr-Coulomb	21	0	32
	Peat to Sand and Silt with Peat - Loose	Mohr-Coulomb	16	2	29
	Sand and Silt Fill - Loose to Compact	Mohr-Coulomb	21	0	31
	Silt and Sand - Compact	Mohr-Coulomb	20	0	30
	Silty Sand to Sand Fill - Dense	Mohr-Coulomb	21	0	32

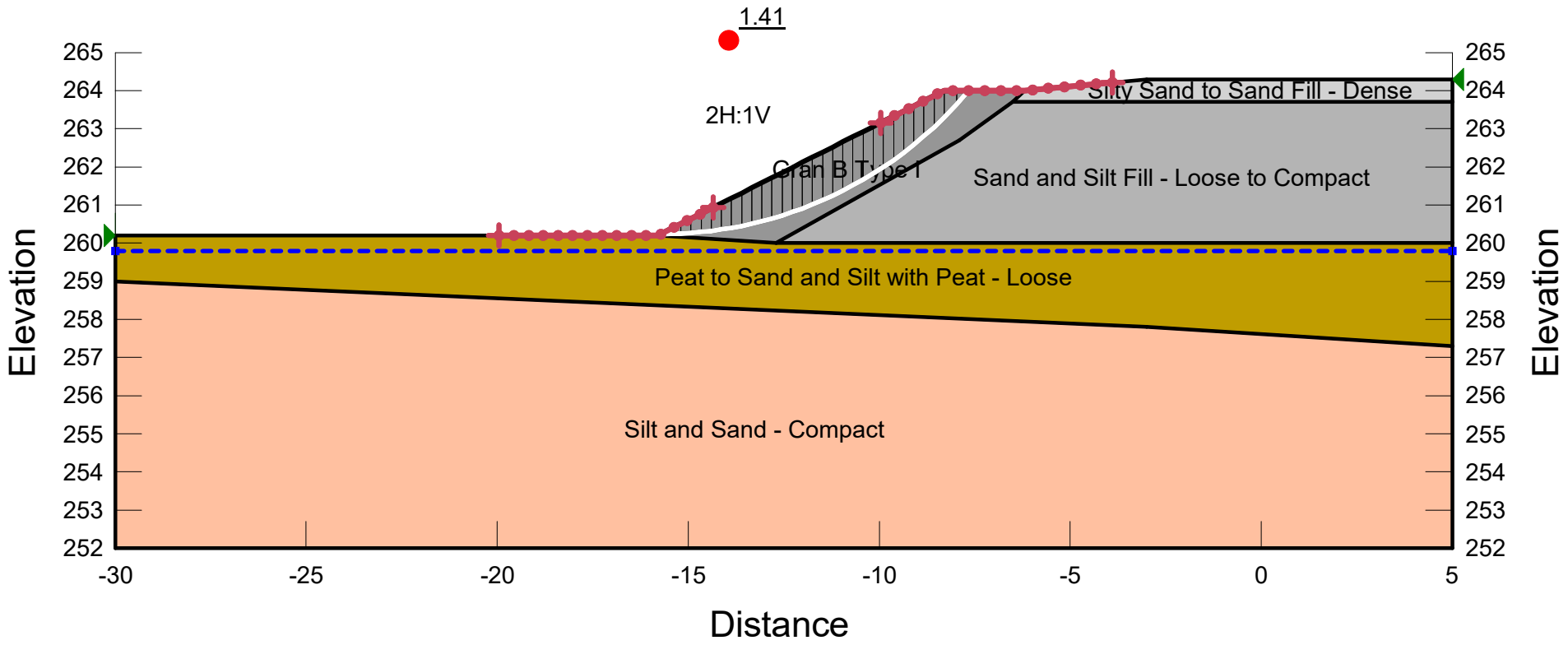


FIGURE 2
SIDE SLOPE, STA. 28+241
EMBANKMENT WIDENING
PEAT REPLACEMENT

OMER LAKE CULVERT

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Clear Stone	Mohr-Coulomb	19	0	32
	Gran B Type I	Mohr-Coulomb	21	0	32
	Peat to Sand and Silt with Peat - Loose	Mohr-Coulomb	16	2	29
	Sand and Silt Fill - Loose to Compact	Mohr-Coulomb	21	0	31
	Silt and Sand - Compact	Mohr-Coulomb	20	0	30
	Silty Sand to Sand Fill - Dense	Mohr-Coulomb	21	0	32

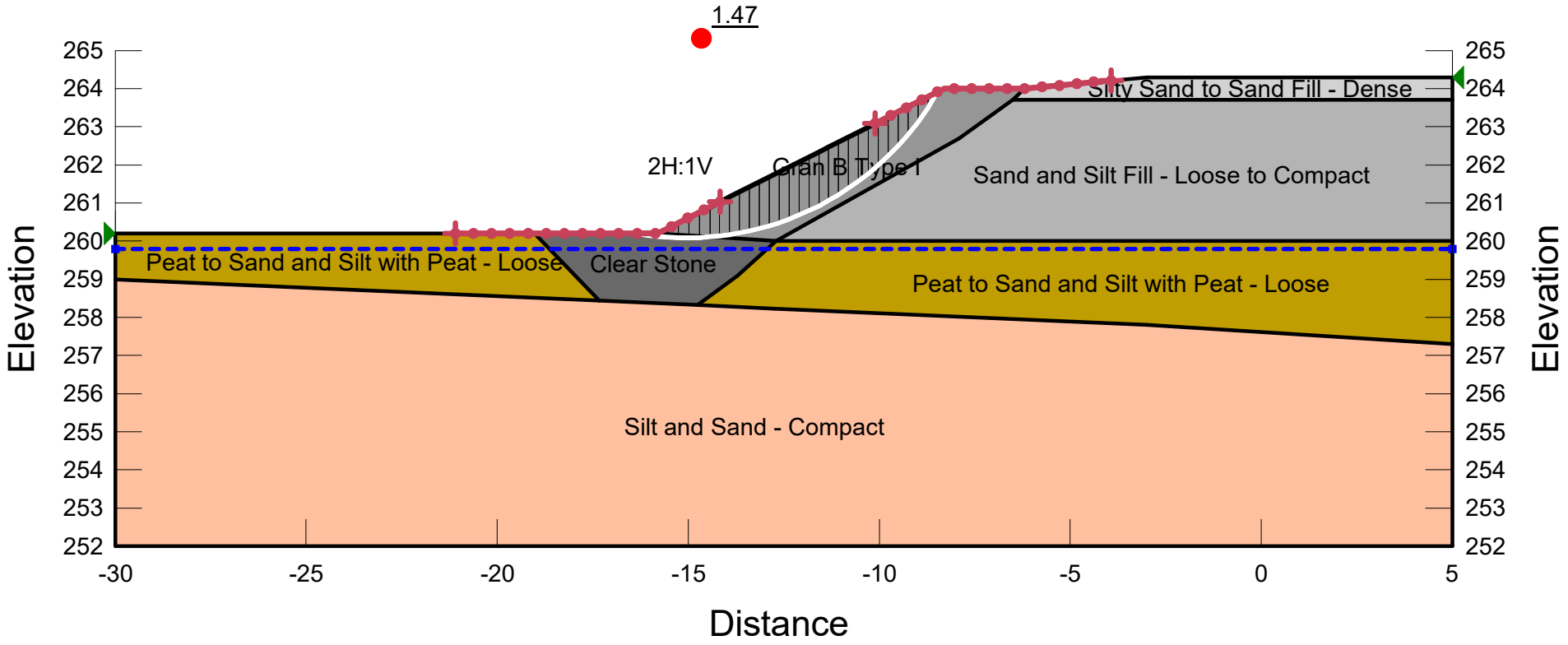


FIGURE 3
TEMPORARY MODULAR BRIDGE
EXCAVATION FORWARD SLOPE
2 m WIDE FOOTING - BASE AT 0.5 m DEPTH

OMER LAKE CULVERT

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular Fill	Mohr-Coulomb	22	0	35
	Peat to Sand and Silt with Peat - Loose	Mohr-Coulomb	16	2	29
	Sand and Silt Fill - Loose to Compact	Mohr-Coulomb	21	0	31
	Silt and Sand - Compact	Mohr-Coulomb	20	0	30
	Silty Sand to Sand Fill - Dense	Mohr-Coulomb	21	0	32

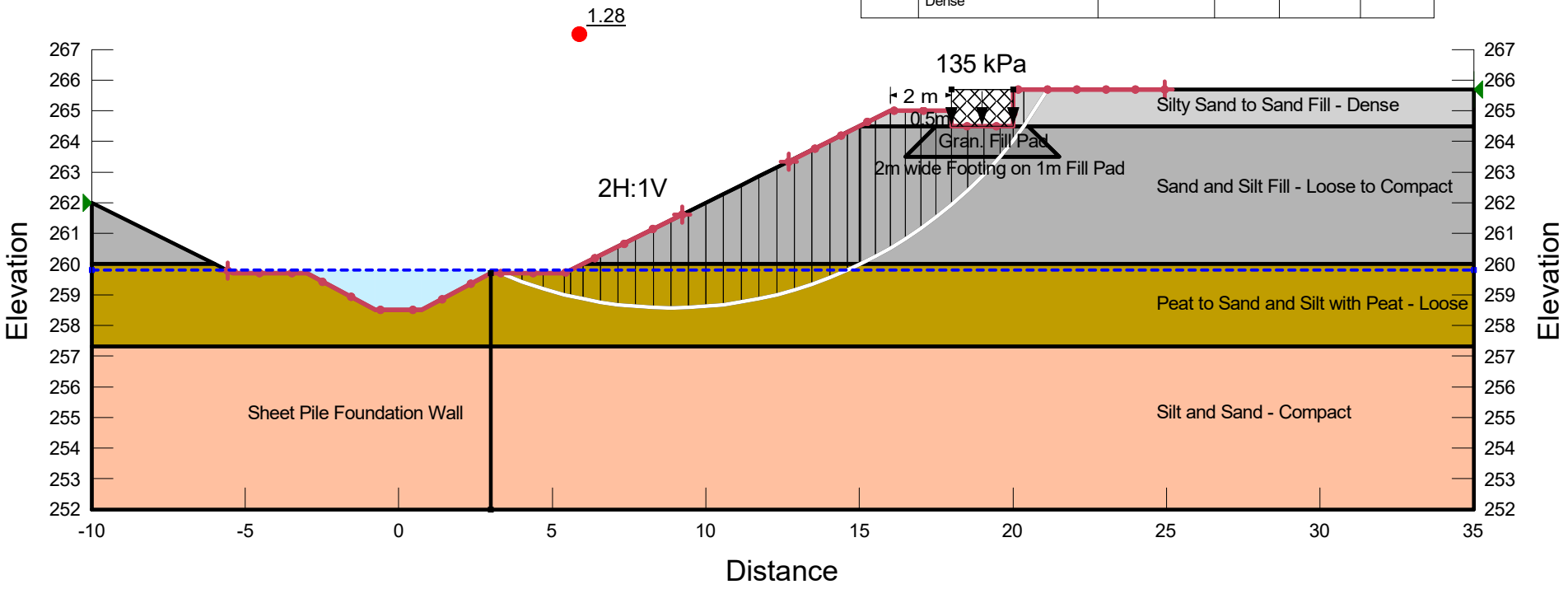


FIGURE 4
TEMPORARY MODULAR BRIDGE
EXCAVATION FORWARD SLOPE
2.5 m WIDE FOOTING - BASE AT 0.5 m DEPTH

OMER LAKE CULVERT

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular Fill	Mohr-Coulomb	22	0	35
	Peat to Sand and Silt with Peat - Loose	Mohr-Coulomb	16	2	29
	Sand and Silt Fill - Loose to Compact	Mohr-Coulomb	21	0	31
	Silt and Sand - Compact	Mohr-Coulomb	20	0	30
	Silty Sand to Sand Fill - Dense	Mohr-Coulomb	21	0	32

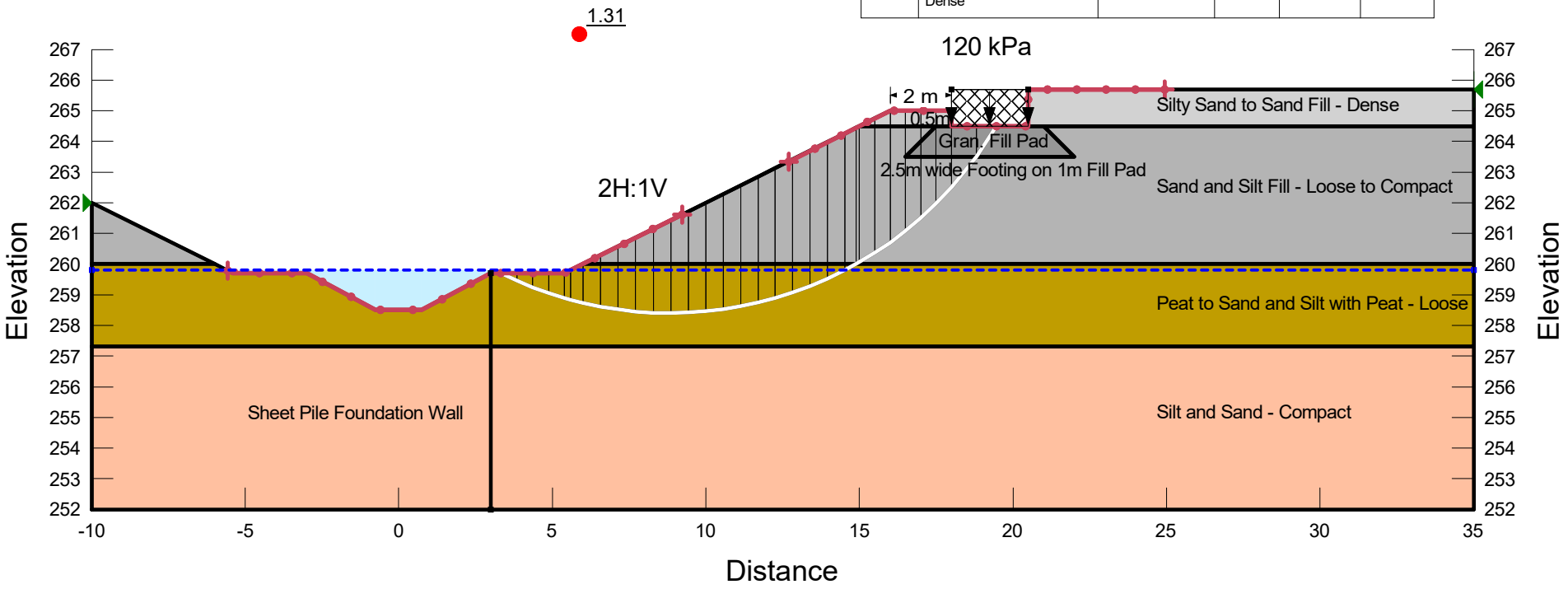
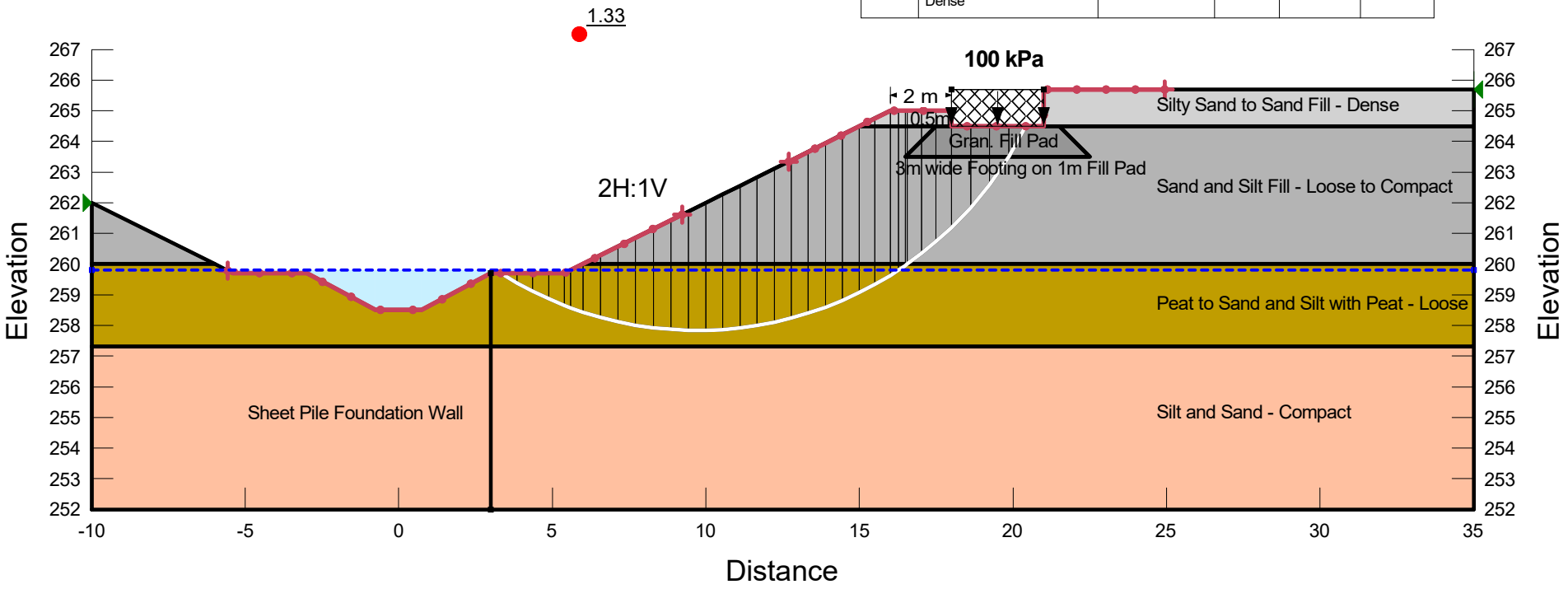


FIGURE 5
TEMPORARY MODULAR BRIDGE
EXCAVATION FORWARD SLOPE
3 m WIDE FOOTING - BASE AT 0.5 m DEPTH

OMER LAKE CULVERT

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Granular Fill	Mohr-Coulomb	22	0	35
	Peat to Sand and Silt with Peat - Loose	Mohr-Coulomb	16	2	29
	Sand and Silt Fill - Loose to Compact	Mohr-Coulomb	21	0	31
	Silt and Sand - Compact	Mohr-Coulomb	20	0	30
	Silty Sand to Sand Fill - Dense	Mohr-Coulomb	21	0	32



THURBER

APPENDIX H

Draft General Arrangement Drawing

WP	NORTHING	EASTING
#1	5 471 648.170	222 497.112

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

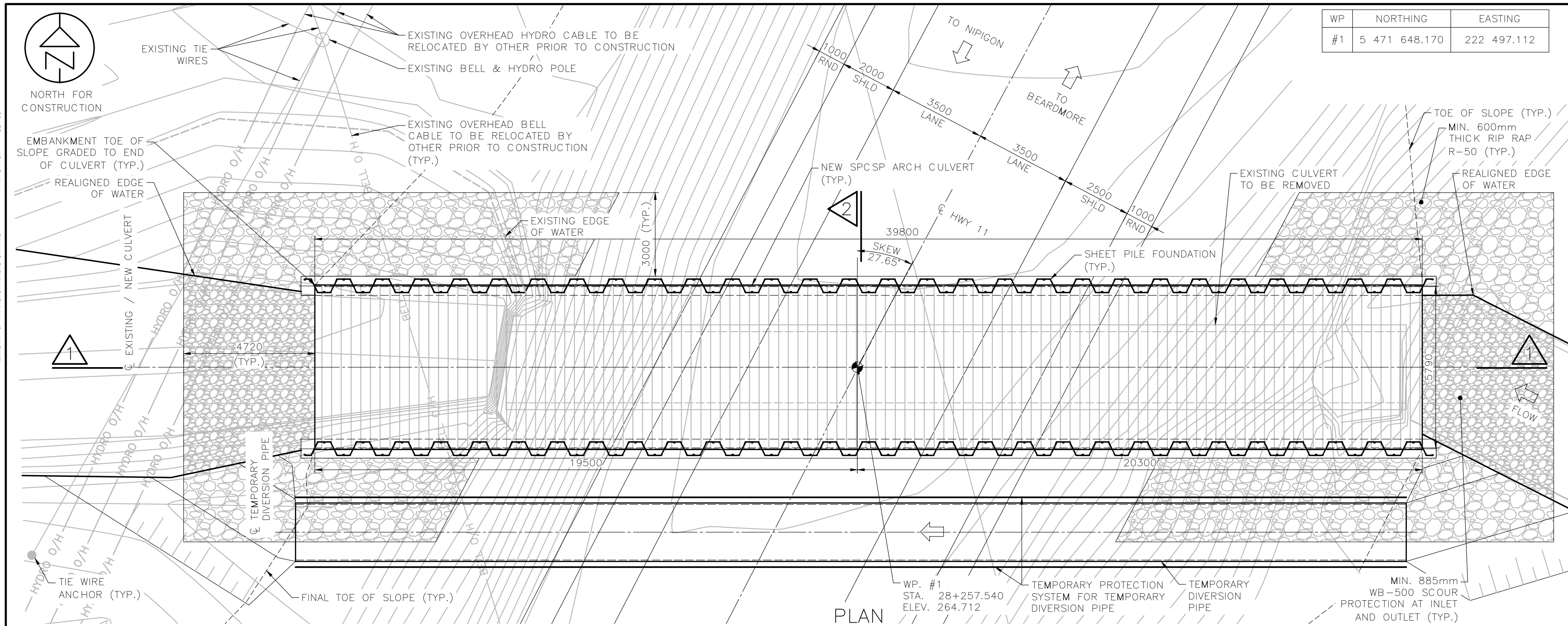
CONT No. 2025-6013
WP No. 6118-17-01

OMER LAKE CULVERT STRUCTURAL REPLACEMENT

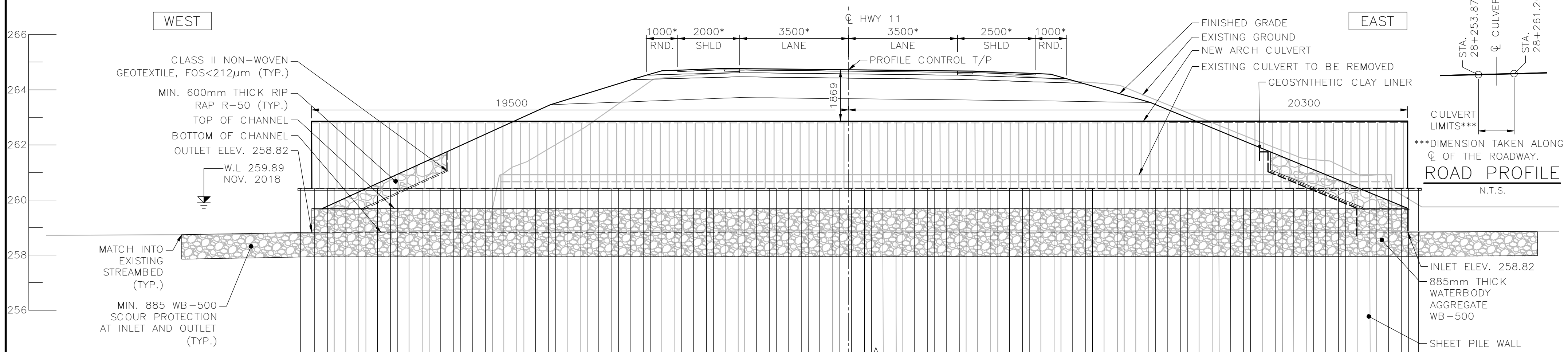
GENERAL ARRANGEMENT

SHEET 15

HATCH

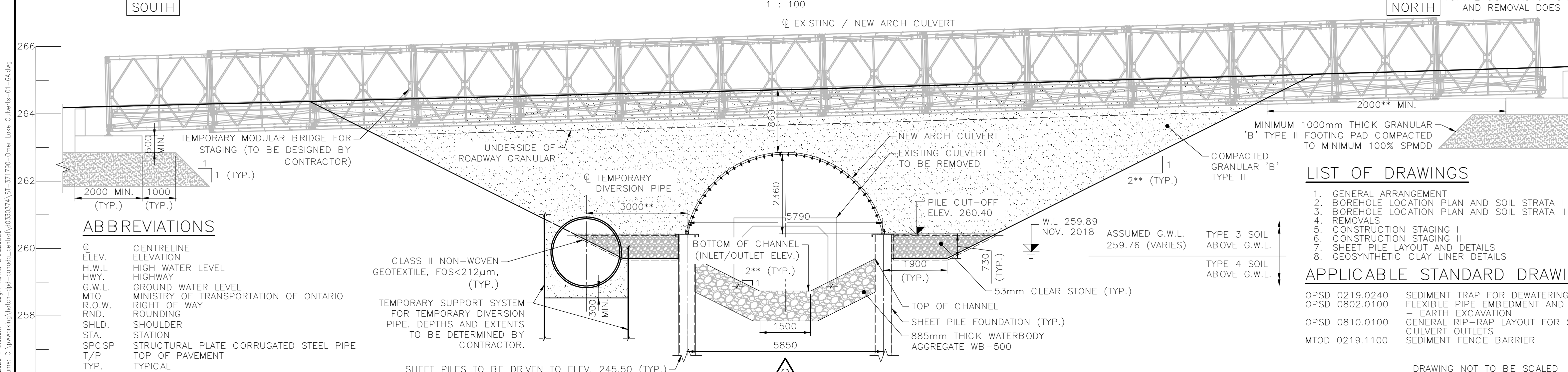


PLAN
1 : 100



ROAD PROFILE
N.T.S.

1 : 100
* DIMENSION TAKEN PERPENDICULAR TO ℄ OF THE ROADWAY.



1 : 75
** DIMENSION MEASURED PERPENDICULAR TO ℄ OF CULVERT.

ABBREVIATIONS

℄	CENTRELINE
ELEV.	ELEVATION
H.W.L	HIGH WATER LEVEL
HWY.	HIGHWAY
G.W.L.	GROUND WATER LEVEL
MTO	MINISTRY OF TRANSPORTATION OF ONTARIO
R.O.W.	RIGHT OF WAY
RND.	ROUNDING
SHLD.	SHOULDER
STA.	STATION
SPCSP	STRUCTURAL PLATE CORRUGATED STEEL PIPE
T/P	TOP OF PAVEMENT
TYP.	TYPICAL
W.L.	WATER LEVEL
WP	WORKING POINT (TOP OF PAVEMENT)

GENERAL NOTES:

1. SHEET PILES SHALL BE AZ 44-700N, ZZ44-700 OR APPROVED EQUIVALENT. MINIMUM ELASTIC SECTION MODULUS = 4400cm3/m, MINIMUM MOMENT OF INTERTIA= 110100cm4/m. MINIMUM FLANGE THICKNESS =19.0mm. MINIMUM WEB THICKNESS = 15.0mm. THE STRUCTURE GEOMETRY AND LAYOUT ARE SHOWN BASED ON AN AZ 44-700N SHEET PILE SECTION. USE OF AN ALTERNATE SECTION WILL RESULT IN CHANGES TO THE GEOMETRY AND LAYOUT. UPDATES TO DRAWINGS AS A RESULT OF THE USE OF AN ALTERNATE SHEET PILE SECTION ARE THE RESPONSIBILITY OF THE CONTRACTOR.
2. THIS CULVERT SHALL BE STRUCTURAL PLATE CORRUGATED STEEL ARCH CULVERT WITH 5790mm SPAN AND 2360mm RISE (MIN. WALL THICKNESS = 6mm, CORRUGATION PROFILE IS 152mm x 51mm). CONTRACTOR IS RESPONSIBLE TO DESIGN, SUPPLY, ASSEMBLE AND ERECT THE NEW CULVERT. CULVERT DESIGN SHALL BE IN ACCORDANCE WITH CHBDC S6-19, LIVE LOAD SHALL BE CL-625-ONT.
3. PERMANENT SPCSP ARCH CULVERT SHALL BE POLYMER LAMINATE COATED. CULVERTS TO BE DESIGNED FOR A 75 YEAR SERVICE LIFE. SOIL RESISTIVITY AT THIS SITE IS MEASURED TO BE 2290 ohm*cm, pH = 8.74. WATER RESISTIVITY AT THIS SITE IS MEASURED TO BE 4762 ohm*cm, pH = 7.65. REFER TO FOUNDATION INVESTIGATION REPORT FOR MORE INFORMATION ON CHEMICAL ANALYSIS.

CONSTRUCTION NOTES

1. BACKFILL AND BEDDING SHALL BE COMPACTED IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS OR OPSS 501 AND 206, WHICHEVER IS MORE STRINGENT.
2. BACKFILL SHALL BE PLACED SIMULTANEOUSLY BEHIND BOTH SIDES OF THE CULVERT WITH LIFT HEIGHTS NOT EXCEEDING 300mm AND KEEPING THE HEIGHT OF THE BACKFILL APPROXIMATELY THE SAME. AT NO TIME SHALL THE DIFFERENCE IN ELEVATION BE GREATER THAN 200mm.
3. THE LOCATION AND LENGTH OF DEWATERING EQUIPMENT IS THE RESPONSIBILITY OF THE CONTRACTOR.
4. THE CONTRACTOR IS RESPONSIBLE FOR TEMPORARY DIVERSION OF THE FLOW AROUND THE SITE DURING CONSTRUCTION AS PER THE CONTRACT DOCUMENTS. ALL DETAILS OF THE TEMPORARY FLOW DIVERSION, INCLUDING EXCAVATION LIMITS, ARE SHOWN FOR INFORMATION PURPOSES ONLY. BOTTOM OF TEMPORARY DIVERSION PIPE OR CHANNEL SHALL NOT HAVE ANY SUDDEN CHANGES IN ELEVATION OR SLOPE.
5. THE CONTRACTOR IS RESPONSIBLE FOR THE DESIGN OF COFFERDAMS. DIMENSIONS AND DETAILS OF COFFERDAMS ARE SHOWN FOR INFORMATION PURPOSES ONLY. ACTUAL DIMENSIONS AND DETAILS TO BE DETERMINED BY THE CONTRACTOR FOR A MINIMUM 2-YEAR STORM EVENT OF 2.81 m3/s WITH A MINIMUM 0.3m FREEBOARD. THE CONTRACTOR SHALL SUBMIT A DETAILED PLAN FOR THE ISOLATION AND DEWATERING WORKS IN ACCORDANCE WITH THE CONTRACT DOCUMENTS.
6. NO HIGHWAY TRAFFIC SHALL BE ALLOWED OVER CULVERT UNTIL THE MINIMUM DESIGN COVER IS ACHIEVED. THE CONTRACTOR SHALL COMPLY WITH THE MANUFACTURER'S SHOP DRAWINGS FOR OTHER RESTRICTIONS WITH REGARDS TO EQUIPMENT DURING CONSTRUCTION LOADING.
7. THE CONTRACTOR IS ADVISED NOT TO RELY ON THE WATER LEVEL OR EDGE OF WATER SHOWN ON DRAWINGS. THE WATER LEVEL IS SUBJECT TO VARIATION.
8. THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS OF THE PROPOSED WORK AND ALL DETAILS ON SITE AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.
9. THE CONTRACTOR IS RESPONSIBLE FOR STABILITY OF BOTH EXISTING AND NEW STRUCTURES AT ALL TIMES THROUGHOUT CONSTRUCTION INCLUDING EXCAVATION, BACKFILL, REMOVALS, INSTALLATIONS ETC. THE CONTRACTOR IS TO DESIGN AND PROVIDE ANY TEMPORARY SUPPORT SYSTEMS FOR EXISTING, TEMPORARY AND NEW STRUCTURES AT VARIOUS STAGES OF CONSTRUCTION AS REQUIRED TO SUIT THEIR METHOD OF CONSTRUCTION.
10. THE CONTRACTOR SHALL ADHERE TO IN-WATER WORK DATES SPECIFIED IN THE CONTRACT DOCUMENTS.
11. FOR AREAS OF WATERBODY AGGREGATE, GRANULAR 'A' SHALL BE WASHED INTO THE VOIDS. GRANULAR 'A' MATERIAL SHALL CONFORM TO THE REQUIREMENTS OF OPSS PROV 1010. THE CONTRACTOR IS TO ENSURE THAT VOIDS WITHIN THE ENTIRE DEPTH OF WATERBODY AGGREGATE ARE FILLED WITH GRANULAR 'A'.
12. THE CONTRACTOR IS FULLY RESPONSIBLE FOR THE DESIGN, CONSTRUCTION METHODS AND PERFORMANCE OF THE TEMPORARY SLOPES, PROTECTION SYSTEM AND ASSOCIATED WORKS.
13. THE CONTRACTOR SHALL DEWATER AS REQUIRED DURING CONSTRUCTION TO FACILITATE INSTALLATION OF THE SHEET PILES, PILE CAP, UNBALANCED CHANNEL, AND SPCSP ARCH CULVERT INSTALLATION. THE CONTRACTOR IS PROHIBITED FROM DEWATERING IN EXCESS OF 50,000 L/DAY. DEWATERING IS THE RESPONSIBILITY OF THE CONTRACTOR AND SHALL BE ADJUSTED ON SITE TO SUIT THE CONDITIONS PRESENT AT THE TIME OF CONSTRUCTION AND SUBMIT AS PER OPSS 517.
14. CULVERT ASSEMBLY SHALL BE CARRIED OUT IN ACCORDANCE WITH THE SUPPLIER'S RECOMMENDATIONS.
15. THE CONTRACTOR SHALL CONFIRM UTILITY LOCATIONS ON SITE. UTILITY PROTECTION, IF REQUIRED, IS THE RESPONSIBILITY OF THE CONTRACTOR.
16. THE CONTRACTOR SHALL HAND PLACE RIP-RAP AT CULVERT SIDES TO ENSURE NO DAMAGE OCCURS TO THE CULVERT COATING.
17. THE CONTRACTOR SHALL ENSURE THAT THE WATERBODY AGGREGATE AND STREAMBED MATERIAL AT THE INLET AND OUTLET PROVIDES A SMOOTH TRANSITION TO THE EXISTING STREAMBED, AS CONFIRMED ON SITE BY THE FISHERIES CONTRACT SPECIALIST.
18. THE CONTRACTOR SHALL ENSURE ANY METHODS FOR COFFERDAM OR TEMPORARY SUPPORT INSTALLATION AND REMOVAL DOES NOT IMPACT THE EXISTING STRUCTURE, NEW STRUCTURE OR FOUNDING SOILS.
19. THE CONTRACTOR SHALL TAKE EXTRA CARE TO ENSURE CONSTRUCTION EQUIPMENT DOES NOT DESTABILIZE NEW OR EXISTING EMBANKMENTS DURING ALL STAGES OF CONSTRUCTION.
20. FOR A TEMPORARY MODULAR BRIDGE FOOTING, THE FACTORED GEOTECHNIAL AXIAL RESISTANCE OF A MINIMUM 2.0 m WIDE FOOTING FOUNDED ON A MINIMUM OF 1m THICK GRANULAR 'A' PAD THAT IS 1m WIDER THAN THE FOOTING BASE AND PROJECTING DOWNWARD AND OUTWARD AT A 1H:1V SLOPE AND COMPACTED TO 100% SPMDD ON EXISTING SOIL, WITH A MINIMUM OF 0.5m EMBEDMENT AND MINIMUM 2.0m SETBACK FROM TOP OF 2H:1V SLOPE IS 210 kPa AT ULS AND 135 kPa AT SLS WITH LESS THAN 25mm OF SETTLEMENT. THE GEOTECHNICAL RESISTANCE PRESENTED ARE FOR VERTICAL CONCENTRIC LOADING ONLY AND WILL NEED TO BE ADJUSTED FOR THE EFFECTS OF INCLINED OR ECCENTRIC LOADING, WHERE APPLICABLE. THE CONTRACTOR SHALL RETAIN A GEOTECHNICAL ENGINEER TO COMPLETE THE DETAILED DESIGN OF THE TEMPORARY MODULAR BRIDGE FOOTINGS.

LIST OF DRAWINGS

APPLICABLE STANDARD DRAWINGS

OPSD 0219.0240	SEDIMENT TRAP FOR DEWATERING
OPSD 0802.0100	FLEXIBLE PIPE EMBEDMENT AND BACKFILL - EARTH EXCAVATION
OPSD 0810.0100	GENERAL RIP-RAP LAYOUT FOR SEWER AND CULVERT OUTLETS
MTOD 0219.1100	SEDIMENT FENCE BARRIER

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS DATE	REV.	DESCRIPTION
25/01/30	0	ISSUED FOR TENDER

DESIGN JG	CHK LB	CODE CAN/CSA S6-19	LOAD CL-625-ONT	DATE	JAN. 2025
DRAWN CR	CHK JG	SITE48C-0181/C0		DWG	1