



**FOUNDATION INVESTIGATION AND DESIGN REPORT
PINEIMUTA RIVER BRIDGE REPLACEMENT
DISTRICT OF KENORA, ONTARIO
AGREEMENT NO.: 6021-E-0011
GWP 6046-21-00**

GEOCRES NO.: 53B01-001

Location: Lat: 52.214011°, Long: -90.438015°

Client Name: HATCH

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PART 1. FACTUAL INFORMATION

1. INTRODUCTION

Thurber Engineering Ltd. (Thurber) has been retained by Hatch to carry out a foundation investigation for the replacement of a modular bridge on Highway 599/808 (Nort Road), approximately 135 km north of the Highway 599 / Pickle Lake Road Junction in the District of Kenora, Ontario.

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

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

2.1 General

The existing Pineimuta River Modular Bridge (Site No. 41X-0108/B0) is located on Highway 599/808 (Nort Road), approximately 135 km north of the Highway 599 / Pickle Lake Road Junction in the District of Kenora, Ontario.

The existing modular structure carries a single lane of traffic over the Pineimuta River. The existing structure is single span and the foundation element of the abutments were unknown. A demolished bridge footprint (1969) is present west of the existing modular bridge, and the abutments are rock-filled timber cribs.

For project purposes, Highway 599/808 (Nort Road) is considered to be oriented north-south, and the river is described as oriented east-west at the bridge location.

The bridge is generally surrounded by a forested area.

Photographs showing the existing conditions at the project site at the time of the field investigation are included in Appendix F.

2.2 Regional Geology

Surficial geological mapping indicates that the site is characterized by glaciofluvial ice-contact deposits, comprising gravel and sand, minor till; includes esker, kame, end moraine, ice-marginal delta and subaqueous fan deposits (Barnett, P.J., Henry, A.P. and Babuin, D. 1991. Quaternary geology of Ontario, west-central sheet; Ontario Geological Survey, Map 2553, scale 1:1,000,000).

Bedrock geology mapping indicates that the site is underlain by igneous and metamorphic rocks, comprised of granitic gneiss (Ontario Geological Survey 1991. Bedrock geology of Ontario, west-central sheet; Ontario Geological Survey, Map 2542, scale 1:1,000,000).

3. INVESTIGATION PROCEDURES

Borehole drilling was carried out between June 11 and June 15, 2024. The field program consisted of advancing six boreholes to sampling depths ranging from 12.8 to 17.8 m below the existing ground surface. Two probe boreholes were also advanced to confirm bedrock depths.

The borehole locations were marked in the field by Thurber staff. Public utility locates were obtained in the vicinity of the borehole locations before commencing the drilling.

The boreholes were drilled using a track-mounted CME-55 drill rig equipped with hollow stem augers, NW casing and NQ coring equipment.

Soil samples were obtained at selected intervals using a 50 mm nominal diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT) in general accordance with ASTM D1586.

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

One 50 mm diameter standpipe piezometer was installed in each of Borehole 25-01 and 25-05 to allow for measurements of the groundwater level after drilling. The details of the standpipe piezometers are illustrated on the respective Record of Borehole sheets provided in Appendix

B.

Upon completion of drilling, all boreholes were backfilled in general accordance with O. Reg. 903, as amended. The standpipe piezometers were decommissioned in general accordance with O. Reg. 903, as amended, on the last day of drilling.

The borehole locations and elevations were referenced to the base plan mapping provided by Hatch. The borehole coordinates are referenced to MTM NAD83 Zone 15. The borehole coordinates and elevations are shown on the Borehole Locations and Soil Strata Drawing included in Appendix A and on the individual Record of Borehole sheets included in Appendix B. A summary of the borehole locations and termination depths is provided in the table below.

Table 3-1 Borehole Summary

Borehole	Northing (m)	Easting (m)	Ground Surface Elevation (m)	Termination Depth Below Ground Surface (m)
25-01	5,786,694.0	274,848.4	351.9	16.8
25-02	5,786,681.6	274,842.6	352.2	16.6
25-02B*	5,786,681.2	274,842.6	352.1	13.6
25-03	5,786,691.4	274,825.5	353.0	12.8
25-04	5,786,666.1	274,887.1	352.1	17.8
25-05	5,786,658.7	274,881.0	352.1	16.6
25-05B*	5,786,658.8	274,878.0	352.0	13.2
25-05MW**	5,786,659.4	274,880.2	352.1	7.8
25-06	5,786,647.8	274,894.9	352.1	13.0

* Probe borehole drilled (not sampled) to confirm bedrock depths

** Separate borehole drilled (not sampled) to install shallow monitoring well at 25-05 location

3.1 Single Well Response Test

Single well response tests (slug tests) were carried out in both monitoring wells (25-01 and 25-05). The results of the slug tests are included in Appendix E.

4. LABORATORY TESTING

Laboratory testing was selected in general accordance with Section 5 of the MTO Guideline for Foundation Engineering Services, Version 3.0, dated April 2022. Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all recovered soil samples. Selected soil samples were subjected to grain size distribution and Atterberg Limits testing; point load test (PLT) and unconfined compressive strength (UCS) testing were carried out on selected rock cores in accordance with MTO and ASTM standards. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B.

Two soil samples were submitted for analytical testing of corrosivity parameters and sulphate content. Four soil samples were collected and submitted to a certified and accredited laboratory to be tested analytically for petroleum hydrocarbons BTEX, F1 to F4, metals and some inorganic parameters.

All laboratory test results from the field investigation are provided in Appendix C.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered subsurface conditions are presented on the Record of Borehole sheets included in Appendix B and on the Borehole Locations and Soil Strata Drawing included in Appendix A. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following sections. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil, bedrock, and groundwater conditions will vary between and beyond the borehole locations.

The subsurface conditions encountered in the boreholes generally consisted of cohesionless sand to sand and gravel fill overlying a sand deposit, which is underlain by layers of silty clay and clayey silt to silt. A layer of silty sand to sand and gravel till underlies the cohesive deposits. Cobbles and boulders were encountered within the fill and lower cohesionless tills just above bedrock. The overburden soil was underlain by granitic gneiss bedrock.

5.1 Topsoil

A 200 to 250 mm thick layer of topsoil was encountered at the ground surface in Boreholes 25-02 and 25-03.

5.2 Sand to Sandy Gravel Fill

Cohesionless fill material consisting of sand to sandy gravel was encountered at ground surface or below the topsoil in all boreholes. The fill had a thickness ranging from 2.2 to 3.7 m (base Elev. 348.4 m to 350.0 m).

SPT N-values in the fill ranged from 4 to 72 blows per 0.3 m, indicating a loose to very dense condition. The moisture content varied from 3 percent to 22 percent.

Frequent auger grinding and spoon refusal were encountered in the fill material during investigation indicating presence of cobbles and boulders.

Four grain size distribution analyses were completed on the fill, and a summary of the results is presented in the table below and Figure C1 in Appendix C.

Table 5-1 Grain Size – Sand Fill

Grain Size Distribution		
Gravel (%)	Sand (%)	Silt and Clay
3 to 26	66 to 86	8 to 13

5.3 Sand to Sand and Gravel

A native deposit of sand to sand and gravel was encountered below the sand fill in all boreholes. The deposit had a thickness ranging from 4.1 to 5.0 m and extended to depths of 6.4 m to 7.9 m (base elev. 344.0 m to 345.8 m) in all boreholes.

SPT N-values in the sand to sand and gravel ranged from 2 per 0.3 m to over 50 blows per 0.125 m, indicating a very loose to very dense condition. The moisture content varied from 4 to 23 percent.

Frequent auger grinding/refusal was encountered in the material during investigation.

Six grain size distribution analyses were completed on the sand, and a summary of the results is presented in the table below and Figure C2 in Appendix C.

Table 5-2 Grain Size Tests – Sand, and Sand and Gravel

Soil Material	Grain Size Distribution				
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Silt and Clay (%)
Sand	0 to 3	92 to 96	--	--	3 to 7
	9	76	13	2	15
Sand and Gravel	37	59	--	--	4

5.4 Silty Clay, Clayey Silt to Silt

Cohesive material consisting of silty clay, clayey silt to silt was encountered below the sand to sand and gravel deposit in all boreholes. The deposit had a thickness ranging from 3.8 to 4.7 m and extended to depths of 11.0 m to 12.5 m (base elev. 339.6 m to 341.1 m) in all boreholes, except Borehole 25-03. The deposit extended to the maximum investigated depth in Boreholes 25-03.

SPT N-values in the cohesive deposits ranged from 7 to 57 blows per 0.3 m, indicating a firm to hard consistency. The moisture content varied from 10 to 31 percent.

Eight grain size distribution analyses and six Atterberg Limits tests were completed on the deposit, and a summary of the results is presented in the table below and Figure C3, C4, C6 and C7 in Appendix C. The results of Atterberg Limits testing carried out on selected samples indicate that the clayey silt to silt has negligible to slight plasticity (ML, CL-ML) and the silty clay has low plasticity (CL).

Table 5-3 Grain Size and Atterberg Limits Tests – Silty Clay, Clayey Silt to Silt

Soil Material	Grain Size Distribution				Atterberg Limits		
	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Clayey Silt to Silt	0 to 1	0 to 4	77 to 92	7 to 23	18 to 21	17 to 18	1 to 4
Silty Clay	0	0 to 3	73 to 67	27 to 30	25 to 26	17	8 to 9

5.5 Silty Sand Till

A deposit of silty sand till was encountered at a deeper depth below the cohesive soils in Boreholes 25-02, 25-04, 25-05 and 25-06. The deposit had a thickness of 1.0 to 2.0 m and extended to a depth of 13.6 to 13.7 m (base elev. 338.4 m to 339.1 m).

SPT N-values in the sand till ranged from 13 to 21 blows per 0.3 m indicating a compact condition. The moisture content varied from 4 to 8 percent.

Frequent auger grinding/refusal was encountered in the till during investigation indicating the presence of cobbles and boulders. Glacial tills inherently contain cobbles and boulders.

One grain size distribution analysis was completed on the deposit, and a summary of the results is presented in the table below and Figure C5 in Appendix C.

Table 5-4 Grain Size Tests – Lower Silty Sand Till

Grain Size Distribution			
Gravel (%)	Sand (%)	Silt (%)	Clay (%)
0	55	38	7

5.6 Sand and Gravel Till

Sand and gravel till was encountered at a deeper depth below the cohesive deposit in Borehole 25-01. The deposit had a thickness of 2.0 m and extended to a depth of 13.7 m (base elev. 338.2m).

Frequent auger grinding/refusal was encountered in the sand and gravel material during investigation, indicating the presence of cobbles and boulders. Glacial tills inherently contain cobbles and boulders.

An SPT N-value in the sand and gravel was recorded as 9 blows per 0.3 m indicating a loose condition. The moisture content was 15 percent.

One grain size distribution analysis was completed on the sand and gravel, and a summary of the results is presented in the table below and Figure C5 in Appendix C.

Table 5-5 Grain Size Tests – Lower Sand and Gravel

Grain Size Distribution		
Gravel (%)	Sand (%)	Silt and Clay (%)
37	36	27

5.7 Cobbles and Boulders

Cobbles and boulders were inferred at several depths and confirmed by coring through the cobbles and boulder in Boreholes 25-01, 25-04, 25-05.

A 150 mm thick cobble was recovered in Boreholes 25-01 at a depth of 2.3 m (elev. 349.6).

The boulder fragments recovered from Boreholes 25-01 and 25-04 had a thickness ranging from approximately 375 mm to 450 mm and were encountered at depths ranging from 12.8 m to 13.7 (elev. 339.1 m to 338.4 m).

An approximately 450 mm thick, localized boulder within the sand deposit was encountered in Borehole 25-05 at a depth of 5.1 (elev. 347 m).

The cobbles and boulders were mainly encountered within the cohesionless soils at shallower depths and in the tills immediately above bedrock.

5.8 Bedrock

Bedrock was proven by rock core recovery underlying the lower silty sand to sand and gravel till (and boulders) at depths ranging between 13.0 and 14.6 m (elev. 337.5 m to 339.1 m) in all boreholes, except Boreholes 25-03 and 25-06 where casing refusal was encountered on probable boulders or bedrock.

Two probe boreholes (25-02B and 25-05B) were completed to further confirm the depth/elevation of the bedrock within the abutment foundation location.

Upon contact with bedrock in Boreholes 25-01, 25-02, 25-04 and 25-05, the bedrock was cored using HQ sized diamond rock coring equipment to the termination depths in the boreholes.

The table below summarizes the depths and elevations of the top of bedrock:

Table 5-6 Depths and Elevation of top of bedrock

Bridge	Location	Borehole	Top of Bedrock	
			Depth (m)	Elevation (m)
Existing Bridge Replacement	North Abutment	25-01	13.8	338.1
		25-02	13.6	338.6
	South Abutment	25-04	14.6	337.5
		25-05	13.0	339.1
Detour Bridge	North Abutment	25-02B*	13.6	338.5
	South Abutment	25-05B*	13.2	338.8

*Probe borehole to confirm bedrock depths

The bedrock encountered consisted of slightly weathered to fresh, grey and dark grey, very strong granitic gneiss. Photographs of the bedrock cores are provided in Appendix G.

The rock core recovery measurements, rock quality designation and rock core laboratory testing results are summarized in Table 5-8 below.

Table 5-7 Bedrock Details

Parameter	Range
Total Core Recovery (TCR), %	98 – 100
Solid Core Recovery (SCR), %	73 – 100
Rock Quality Designation (RQD), %	73 – 100
Unconfined Compressive Strength from UCS Tests (MPa)	124 – 222
Unconfined Compressive Strength Estimated from Point Load Tests (MPa)	154 – 236

Based on the RQD, the bedrock quality is described as good to excellent (CFEM 5th Edition, 2023). The results of UCS and point load testing indicate that the tested samples of the bedrock are very strong (CFEM 5th Edition, 2023). The results of the UCS and point load testing are included in Appendix C.

5.9 Groundwater Conditions

The measured groundwater levels from the standpipe piezometers are summarized in the table below.

Table 5-8 Groundwater Level Measurements

Well ID	Ground Surface Elevation (m)	Depth of Screened Interval (m)	Screened Material	Groundwater Level		Date of Reading
				Depth (m)	Elevation (m)	
25-01	351.9	10.7 – 13.7	Silt, sand, boulders	1.9	350.0	June 17, 2025
25-05	352.1	4.6 – 7.6	Sand / boulders	4.6	347.5	

It should be noted that the above values are considered short-term readings and may not reflect the stabilized groundwater level during investigation and at the time of construction. It is anticipated that the groundwater levels are governed by the river level at this site. 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 events.

5.10 Analytical Testing

Two soil samples were submitted for analytical testing of corrosivity parameters and sulphate content. The analytical results are included in Appendix D and are summarized in the table below.

Table 5-9 Analytical Test Results

Borehole	Sample	Sample Depth (m)	Conductivity (mS/cm)	pH	Resistivity (ohm-cm)	Chloride (mg/kg)	Sulphate (mg/kg)	Sulphide (%)
25-02	SS4	2.3 – 2.9	53	8.15	18900	2.8	1.4	< 0.01
25-04	SS4	2.3 – 2.9	132	8.00	7580	2.8	3.6	< 0.01

Four soil samples were also submitted for analytical testing of petroleum hydrocarbons BTEX, F1 to F4, metals, Electrical Conductivity (EC), and Sodium Adsorption Ratio (SAR). The analytical results are included in Appendix D.

6. MISCELLANEOUS

The borehole locations reflect existing site features and access constraints. The as-drilled borehole locations and ground surface elevation were estimated by Thurber based on physical landmarks and site features. The boreholes were drilled by Downing Drilling of Hawkesbury, Ontario. Traffic control was carried out in accordance with Ontario Traffic Manual Book 7 by Downing Drilling of Hawkesbury, Ontario.

Routine geotechnical laboratory testing of soil samples and point load testing of rock core samples was completed by Thurber's laboratory in Oakville, Ontario. Uniaxial compressive strength tests were carried out by Geomechanica Inc. in Oakville, Ontario. Analytical testing was completed by ALS Canada Ltd. in Waterloo, Ontario, and SGS in Mississauga, Ontario.

The field investigation was observed on a full-time basis by Mr. Smit Patel. Overall supervision of the field investigation program was provided by Mr. Yamlak Aragaw, P.Eng. and Mr. Rod de Castro, P.Eng.

This report was prepared by Mr. Yamlak Aragaw, P.Eng. and Mr. Rod de Castro, P.Eng. The report was reviewed by Messrs. Sydney Pang, P.Eng. and Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

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PART 2. ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. ENGINEERING DISCUSSIONS AND DESIGN RECOMMENDATIONS

7.1 General

This section of the report provides an interpretation of the factual data from Part 1 of this report and presents foundation design recommendations for the replacement of a modular bridge on Highway 599/808 (Nort Road), approximately 135 km north of Highway 599 / Pickle Lake Road Junction in the District of Kenora, Ontario. The discussion and recommendations presented in this report are based on information provided by Hatch and the factual data obtained during the current field investigation.

The foundation design recommendations presented in this section of the report (Part 2) are intended for the use of MTO, and shall not be used or relied upon for any other purpose or by any other parties, including the construction or design-build contractor. Contractors must make their own interpretation based on the factual data in Part 1 of this report. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction must make their own interpretation of the factual data provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

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.

7.2 Background

The existing modular structure carries a single lane of traffic over the Pineimuta River. The existing structure is single span and the foundation elements of the abutments were unknown. A demolished bridge footprint (1969) is present west of the existing modular bridge, and the remaining abutments are rock-filled timber cribs.

7.3 Proposed Replacement Structure

It is understood from a preliminary General Arrangement (GA) drawing dated August 2025 provided by Hatch that the existing bridge is to be replaced and that the replacement bridge will consist of a new, approximately 39.5 m long single-span (two lane) steel girder bridge. It is understood that consideration is being given to supporting the new bridge on deep foundation (piles), with Retained Soil System (RSS) walls utilized to retain the abutment fill. The new bridge will have a deck width of 10.0 m. A grade raise of approximately 1 to 2.5 m at both approach embankments is anticipated. It is understood that the new bridge abutments will be constructed at the existing abutment locations.

Depending on the selected replacement bridge arrangement and the construction schedule, construction staging may include a temporary detour with a temporary modular bridge to cross the river. The detour bridge is anticipated to be located approximately 13.3 m west of the proposed Nort Road (centreline to centreline), with detour approach embankments located to the south and north of the modular bridge. It is understood that the existing modular bridge is to be shifted and used as a detour bridge.

Detailed design information for the proposed and temporary bridges was not available at the time of preparation of this report.

7.4 Applicable Codes and Design Considerations

The foundation design recommendations presented in this section of the report are based on the Canadian Highway Bridge Design Code (CHBDC), Version CSA S6-19, 2019.

It is understood that the proposed replacement bridge will have a “Typical” consequence level based on Clause 6.5.1 of the CHBDC 2019 with a corresponding consequence factor (Ψ) of 1.0 as per Table 6.1 of the CHBDC 2019.

The degree of site and prediction model understanding for this site has been assessed to be “Typical understanding” based on the current information as per Clause 6.5.3 of the CHBDC 2019.

7.5 Seismic Design

The subsurface conditions for seismic site characterization were assessed based on the results of the energy-corrected average standard penetration resistance, \bar{N}_{60} , within the upper 30 m of the overburden. Based on the above assessment, and presence of sand deposits underlain by bedrock, the site may be classified as Site Class D in accordance with Table 4.1 of the CHBDC (2019), in the absence of direct measurements of the shear wave velocities at the site.

As indicated in Section C4.4.3.2 of the Commentary to the CHBDC, the determination of representative site properties described in Section 4.4.3.2 of the CHBDC are based on the 2015 National Building Code of Canada (NBCC) which was in effect at the time of publication of the current CHBDC. Since the current seismic assessment is to be based on the *sixth*-generation seismic model associated with the 2020 NBCC, the determination of the Site Designation provided below has considered the guidance provided in Section 4.1.8.4 of the 2020 NBCC.

Site specific (Site Class D) peak seismic hazard values are provided in Appendix H. As per Table 4.1, Clause 4.4.3.2 of the CHBDC (2019), the site may be classified as Seismic Site Class D.

The site-specific seismic hazard values obtained from the 2020 National Building Code of Canada Seismic Hazard tool considering a Site Designation of X_D are presented below in table below.

Table 7-1 Recommended Ground Motion Parameters for Design (Site Class D)

PARAMETER	PROBABILITY OF EXCEEDANCE IN 50 YEARS (RETURN PERIOD)		
	2% (2,475-year)	5% (975-year)	10% (475-year)
Sa(0.2) [g]	0.123	0.0646	0.0367
Sa(0.5) [g]	0.106	0.0569	0.0324
Sa(1.0) [g]	0.0535	0.0278	0.0152
Sa(2.0) [g]	0.021	0.0105	0.00537
Sa(5.0) [g]	0.00426	0.00197	0.000933
Sa(10.0) [g]	0.00126	0.00058	0.000267
PGA [g]	0.0746	0.0373	0.0203
PGV [m/s]	0.0552	0.0278	0.0149

The new structure is classified to have a Seismic Performance Category of 1 based on Table 4.10 of the CHBDC (2019).

8. STRUCTURE FOUNDATION ALTERNATIVES

This section presents discussions on the proposed foundation alternatives for the proposed temporary detour bridge and replacement bridge.

The subsurface conditions encountered in the boreholes generally consisted of cohesionless sand to sand and gravel fill overlying a sand deposit, which is underlain by layers of silty clay and clayey silt to silt. A layer of silty sand to sand and gravel till underlies the cohesive deposits. Cobbles and boulders were encountered within the fill and lower cohesionless tills just above bedrock. The overburden soil was underlain by granitic gneiss bedrock.

Based on the subsurface conditions encountered and project requirements, shallow and deep foundation options have initially been considered to support the replacement bridge and temporary detour modular bridge as discussed in the following:

- Spread footings placed on compact sand fill and/or engineered fill pads
- Driven piles to bedrock and/or on boulders just above bedrock
- Drilled in pipe piles socketted into bedrock
- Micropiles

Given the frequent and random presence of very loose to loose sands and some firm zones within the stiff to very stiff silty clay to clayey silt deposits, the granitic gneiss bedrock appears to be the only reliable bearing stratum at this site. However, the random presence of cobbles within the soil deposits and the presence of boulders above bedrock are likely to pose difficulties and increase risks for micropile installation, which would anticipate to have a negative impact on the cost effectiveness of this option. As such, micropiles are not considered to be a cost-effective option at this site and no further discussion will be presented herein.

Discussions on feasible foundation options are provided in the following sections. A comparison of the foundation alternatives based on their advantages, disadvantages, risks/consequences and relative costs is provided in Appendix I.

8.1 Temporary Detour Bridge

Spread footings for supporting the temporary detour bridge could be founded within the sand to sandy gravel fill, which will require less excavation through the detour embankment fill and avoid excavation below the groundwater level, comparing with footings founded on native soils.

Although deep foundations are technically feasible to support the temporary detour bridge, this is not considered a cost-effective foundation option, unless bearing resistances provided by the existing fill, and founded on engineered fill pads if required, are insufficient to support the structure.

Since loose fills are present at the south abutment and fill materials are inherently variable, compounded by the fact that no borehole information is available at the proposed detour bridge abutments, spread footings founded on an engineered fill pad resting on the existing fill is the preferred foundation alternative for support of the modular detour bridge.

8.2 Replacement Bridge

Due to the expected higher load demands, the foundation soils do not have the capacity to provide support to the abutments of the permanent replacement bridge. In addition, a footing option would

require deeper excavation through the cohesionless fill and native soils to below the groundwater level, which requires additional costs for dewatering. Spread footings are not considered feasible for supporting the replacement bridge.

Driven piles are considered a feasible foundation alternative to meet the foundation load demands. Both steel H-piles and pipe piles driven to refusal on bedrock or boulders can be considered at this site. Consideration could also be given to using drilled-in pipe piles to enhance the chance of penetrating the boulders and socketted into bedrock, should this be required. The cost-effectiveness of the drilled-in pipe pile option should be assessed for this remote site.

From a foundation/geotechnical and cost-effectiveness perspective, driven steel H-piles seated into bedrock are feasible to support the new permanent bridge. Driven steel pipe piles may be used as an alternative. The higher risk of encountering difficulties due to obstructions during installation may result in lower cost effectiveness. Some piles may not be able to penetrate the boulders immediately above bedrock. However, given that this is a lightly loaded structure, the relatively flat bedrock surface and the good quality of the rock (minimal fractures), lower geotechnical resistances may be used for designing the driven piles to practical refusal.

9. TEMPORARY DETOUR BRIDGE FOUNDATION

9.1 Timber Footings on Compacted Granular Pad

9.1.1 Founding Level

Based on the preliminary drawings and discussions with Hatch, it is understood that timber footings (3.5 m wide and 200 mm thick) are proposed to support the temporary detour bridge. The use of timber footings placed on a minimum of 1 m thick compacted granular pads are considered feasible from a foundation/geotechnical perspective to support the temporary detour bridge.

The founding elevation and the site grading at the proposed abutment footings were not available at the time of this report preparation. Where possible, the underside of the pad may be placed at a nominal 0.5 m below the final grade on the existing sand to sandy gravel fill.

For a minimum 3.5 m wide timber footing placed on a 1 m thick compacted Granular A pad (following subgrade approval), the design can be based on a factored geotechnical resistance at ULS of 240 kPa and at SLS of 120 kPa. The factored geotechnical resistances include a geotechnical resistance factor of 0.5 (ϕ_{gu}) and 0.8 (ϕ_{gs}), as per Table 6.2 of the CHBDC 2019 (static analysis – typical understanding). See the section below for subgrade preparation and engineered fill pad construction.

The geotechnical resistances above are for vertical concentric loading. In the case of eccentric or inclined loading, the geotechnical resistances must be adjusted in accordance with Clause 6.10.2 of the CHBDC 2019. The SLS resistances given above are for foundation settlement up to 25 mm.

Resistance against sliding between the base of timber footing and the underlying compacted Granular A should be assessed in accordance with Clause 6.10.4 of the CHBDC, assuming an unfactored friction coefficient of 0.2. It is noted that a lower value is provided since the friction coefficient is a function of wood type and quality, moisture content and surface finish, none of which is known to us at this time. A geotechnical resistance factor of 0.8 (ϕ_{gu}) for non-cohesive soil as per Table 6.2 of the CHBDC 2019 (static analysis – typical understanding) should be applied to this value. It is understood that a shear key to be located at the heel of the footing will be used to enhance lateral resistance.

9.1.2 Engineered Fill Pad Construction

Since the footing founding level is near the surface of the detour embankment fill and therefore above the anticipated groundwater level, dewatering will not be required during construction of the engineered fill pads. All existing surficial topsoil and existing fill material within the footprint of the detour bridge abutment footing locations must be stripped prior to placing fill for the embankment. Proof-rolling with suitable equipment should be carried out on the exposed subgrade and any loose/soft materials delineated should be removed prior to placing the granular materials.

If sufficient clearance is unavailable between the proposed edge of granular pad and the existing modular bridge abutment, a Temporary Protection System (TPS) may be utilized during the construction of the granular pad. TPS recommendations are provided in Section 17.2 and may be considered for the granular pad construction and protection of the existing abutment.

The engineered fill pads should consist of OPSS Granular A placed in 150 mm loose lifts and compacted to 100 percent of its Standard Proctor Maximum Dry Density (SPMDD) at ± 2 percent of the Optimum Moisture Content (OMC). Where the subgrade is below the water level, a graded aggregate such as the 19 mm Clear Stone stipulated in OPSS.PROV 1004 may be used to raise the grade to above the water level, prior to placing and compacting the first lift of granular materials.

Due to the close proximity of the demolished bridge (1969), rock fill should be anticipated at the detour abutment foundation locations. Where the underlying embankment fill consists of rockfill (cobbles and/or boulders), the surface of the rockfill should be chinked with finer material before constructing the engineered fill pads to prevent loss of granular materials into the rockfill. The minimum depth of excavation should accommodate the footprint of the engineered fill pad below the footing.

The dimensions of the base of the excavation should be determined by assuming a granular pad at least 1.0 m wider than the spread footing at the level of the footing base and projecting outward and downward at 1H : 1V.

If the engineered fill pads are located close to the river channel, the forward slope of the foundation pads should be embedded at least 0.5 m below the face of the forward slope, with the edge of footing at a minimum of 2 m behind the crest of the forward slope at no steeper than 1.5H : 1V. Provision of properly designed erosion protection works will be critical to ensure adequate performance of the foundations/engineered fill pads.

10. REPLACEMENT BRIDGE FOUNDATION

10.1 Driven Piles

The site is underlain by an extensive cohesionless deposit ranging in composition from sand, silty sand to sand and gravel till, interlayered with a deposit of cohesive soils. Cobbles and occasional boulders were encountered within the sand above the cohesive deposit. Boulders were also present immediately above bedrock. The locations where cobbles and boulders were sampled or were inferred from the drilling operation are indicated on the Record of Borehole sheets in Appendix B.

It is possible that penetration of some driven steel piles may be impeded by the shallower boulders. To enhance pile penetration through the upper soils to reach bedrock or the boulders immediately above bedrock, it is recommended that pre-augering equipment be available on site to create pilot holes where required.

10.1.1 Driven Pile Geotechnical Resistance

Due to the requirement to penetrate potential obstructions and properly seat the piles onto bedrock or boulders immediately above bedrock, heavier steel pile sections should be used. Accordingly, it is recommended that HP 360 x 132 be used as an H-pile, or alternatively 356 mm outside diameter pipe pile with a 12.7 mm wall thickness, be used at this site.

The factored axial geotechnical resistances and the estimated tip elevations recommended for the two pile sections driven to *bedrock or lower* boulders are provided in the table below.

Table 10-1 Recommended Axial Geotechnical Resistance of Driven Piles

Foundation Location	Approximate Pile Tip Elevation (m)	Driven Pile Type	Pile Size/Dimensions	Factored Geotechnical Resistance at ULS, kN
North Abutment (Borehole 25-01 and 25-02/25-02B)	338.1 to 338.6	H-Pile	HP 360 x 132	1,800
		Pipe Pile	356 OD (12.7 mm wall thickness)	1,800
South Abutment (Borehole 25-04 and 25-05/25-05B)	339.1 to 337.5	H-Pile	HP 360 x 132	1,800
		Pipe Pile	356 OD (12.7 mm wall thickness)	1,800

In order to account for some piles achieving refusal on the boulders immediately above bedrock, it is noted that the above ULS capacity is lower than the typical value recommended for such piles driven to refusal on bedrock or unyielding material.

The SLS condition will not govern the design of piles driven to bedrock or unyielding material.

The actual refusal pile tip elevations may vary during installation due to the boulders and uneven bedrock elevations.

Downdrag on the piles is not anticipated to be a design issue at this site.

In view of the MTO Memo: SCB-SO-2025-02 titled “Steel Sourcing for MTO Structures and Guide Rail”, the designers are encouraged to utilize steel products available from Canadian mills. Given the advantage of using a H-pile section at this site, it is recommended that preference be given to using pre-fabricated steel sections, in this case HP 360 x 132, as shown on MTOD 3000.160 Fabricated Equivalent, Steel H-Piles.

10.1.2 Driven Pile Installation

All pile installation/driving should be carried out in accordance with OPSS.PROV 903 (Deep Foundations) as amended by Special Provision 109F57. The piles are to be driven to bedrock and adequately seated without damaging the pile.

Due to the presence of cobbles and occasional boulders noted in the fill and the underlying native sand deposit, pre-augering through these upper layers (without removing cuttings from the hole by reverse augering) may be necessary for piles to reach their design depths at some locations. Pre-augering equipment should therefore be available on site in case it is needed. Statements regarding this requirement will be provided in an NSSP.

The tips of all driven piles shall be protected using Titus Rock Injector Points for H-piles or pipe piles. This is to prevent the pile tip from sliding along slightly sloping bedrock (or boulder) surfaces and to enhance proper seating of the piles.

Since the piles are designed to be driven to refusal in the bedrock or boulders (above the bedrock), the pile driving and seating on bedrock at both abutments should be controlled in accordance with the procedures stipulated in OPSS.PROV 903. The appropriate pile driving note is “Piles to be driven to bedrock”.

From a foundation engineering perspective, the conditions at this site are considered suitable for integral abutments. For a typical integral abutment design, the flexibility of the upper portion of the pile may be provided by a single corrugated steel pipe (CSP) system. A typical single CSP system involves installing a pile through a 600 mm diameter, 3 m long, CSP with the void between the pile and the CSP backfilled with uncompacted uniformly graded sand after driving the piles. At this site, the embankment fill is typically compact to loose and sloping towards the river and, as such, a CSP setup may not even be required. Note that MTO has suggested and approved the omission of the CSP at other sites. It is recommended that the structural designers take this into consideration by enquiring MTO regarding this scenario.

The above CSP arrangement is typically used within the context of driven steel H-piles. Due to its higher bending stiffness, the use of steel pipe piles for integral abutments may require specific design considerations. However, similar CSP arrangements may still be applicable.

10.2 Drilled-In Steel Pipe Piles Socketted into Bedrock

Alternatively, the permanent replacement bridge may be supported on drilled-in steel pipe piles socketted into the bedrock and filled with concrete. It is recommended that the pipe piles be advanced to penetrate any boulders, if encountered, to a minimum 1 m into the underlying bedrock.

The drilled-in piles option typically carries a higher cost than driven piles. It also requires specialized installation techniques that limit the number of qualified contractors with suitable equipment and experienced crews, especially for a remote site like this one.

It is understood that the design of this replacement bridge has employed driven H-piles as foundation support. Further design recommendations for drilled-in pipe piles are therefore not provided.

11. PILE LATERAL RESISTANCE

The geotechnical lateral resistance acting on a pile in cohesive soils can be calculated using coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$k_s = 67 * S_u / D \quad (\text{kPa/m})$$

$$p_{ult} = 9 * S_u \quad (\text{kPa})$$

where:

$$S_u = \text{undrained shear strength (kPa), see table below}$$

$$D = \text{pile width or diameter (m)}$$

The geotechnical lateral resistance acting on a pile in cohesionless soil may be calculated using a value for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$$k_s = n_h z / D \quad (\text{kPa/m})$$

$$p_{ult} = 3 \gamma' z K_p \quad (\text{kPa})$$

Where

- z = depth of embedment of pile (m)
- D = pile width or diameter (m)
- n_h = coefficient related to soil relative density (kN/m^3)
- γ' = effective unit weight (kN/m^3)
- K_p = passive earth pressure coefficient

For analysis of the interaction between a pile and the surrounding soil, the above equations and parameters recommended in Table below, may be used. The lateral pressures obtained from the analysis should not exceed the ultimate lateral resistance.

Table 11-1 Soil Parameters for Lateral Pile Resistance

Parameter	Foundation Design Parameters			
	Existing Fill	Sand	Silty Clay / Clayey Silt to Silt	Silty Sand / Sand & Gravel Till
Unit Weight (kN/m^3)	19	20	20	21
Friction Angle	29	30	29	30
Passive Pressure Coefficient, K_p	2.9	3.0	2.9	3.0
S_u (kPa)	--	--	90	--
n_h (kN/m^3)	2,000	2,000	---	2,000

The spring constant, K_s , for analysis may be obtained by the expression, $K_s = k_s L D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kPa/m), D is the pile width or diameter (m) and L is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance, P_{ult} , may be obtained from the expression, $P_{ult} = p_{ult} L D$. This represents the ultimate load at which the pile fails and will not support any additional load at greater displacements.

The modulus of subgrade reaction and ultimate lateral resistance may have to be reduced, based on the pile spacing. The reduction factors to be used for a pile group oriented perpendicular or parallel to the direction of loading are provided in Section C.6.11.3.4 of CHBDC 2019.

Where applicable, horizontal loads may be resisted by means of battered piles if load requirements exceed the available lateral pile resistances.

12. FROST COVER

The depth of frost penetration at this site is approximately 2.8 m, as per OPSD 3090.100. Typically, the base of all footings, concrete pile caps and concrete abutment stems, if employed, must be provided with a minimum of 2.8 m of earth cover as protection against frost action. For the permanent bridge and where applicable, thermal insulation materials may be used instead of earth cover.

For the detour bridge, timber footings founded on granular engineered fill pads, provided they consist of non-frost susceptible, free draining engineered fill, above the river water level may be provided with a minimum embedment of 0.5 m. These footings for the temporary detour bridge do not need to be placed below the depth of frost, particularly since a modular bridge can accommodate some movement. The designer should confirm that this is the case.

13. CEMENT TYPE AND CORROSION POTENTIAL

Two soil samples were submitted for chemical analysis related to potential corrosion of exposed buried steel and potential sulphate attack on buried concrete elements. The analytical results are summarized in Section 5.10 and included in Appendix D.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the sub-surface environment. The resistivity results were compared to Table 3.2 in the MTO Gravity Pipe Design Guidelines (2014) and generally indicate a very low corrosiveness potential. The corrosive effects of road de-icing salts should also be considered.

The concentration of soluble sulphate provides an indication of the degree of sulphate attack on concrete. The sulphate results were compared to Table 3 in CSA A23-1 and generally indicate a low degree of sulphate attack (less than the moderate range of 0.1 to 0.2%). The selection for exposure class of concrete should include consideration of the effects of road de-icing salts.

14. ABUTMENT WALLS

Given the land terrain, proximity to the river, subsurface conditions, remnants of the original bridge abutments amongst other reasons, the design and construction of the abutment walls require careful consideration of available options and their feasibility at this site. The following presents discussions of several options that are being considered.

14.1 Retained Soil System (RSS) Walls

Information provided by Hatch indicates that one the alternatives is to utilize RSS wingwalls for the abutments of the replacement bridge. As per MTO policy, the use of RSS walls adjacent to a watercourse must be subject to approval by the MTO RSS Committee for use at this site, if RSS walls are the chosen alternative.

If RSS is adopted, the contract drawings should include information on the longitudinal alignment of the RSS walls in plan, the top and base elevations of the walls in profile, cross-sectional space constraints and an NSSP for the RSS walls.

The performance of an RSS is dependent on, among other factors, the characteristics of its foundation. Failure to provide an adequate foundation may lead to excessive settlements and distortion of the RSS and, in severe cases, to possible failure of the system, especially when performing in the proximity to the watercourse (and above the 100-year groundwater level). The foundation of the entire RSS mass should be considered, i.e. from the face of the wall to the furthest extent of the reinforcement.

The borehole information indicates that the soil conditions at and below the proposed wall base levels generally consist of loose to compact sand fill, and/or compact sand above the groundwater level. To provide a uniformly competent subgrade, the RSS mass should be founded on an engineered granular fill pad. The fill pad should be a minimum of 500 mm thick for portions of the wall that are less than 4 m in height. The top of the engineered fill pad should be embedded a minimum of 1 m below the final ground surface at the wall location, and the base of the fill pads should be kept above a groundwater level of Elev. 350 m (river level was at about Elev. 349 m in June 2022) to avoid the need for dewatering excavations that extend below the water table, and avoid potential wash out of fine materials within the fill pad.

If the underside of the pad is below the groundwater level and subject to MTO approval, a graded aggregate such as the 19 mm Clear Stone stipulated in OPSS.PROV 1004 may be placed up to just above the water level. The granular pad may then be constructed on top of the clear stones. A layer of geosynthetics may be required as a separator to minimize loss of fines into the clear stones.

If clear stones are not acceptable as a substitute, then dewatering possibly in the form of a cofferdam may be required to facilitate construction in the dry. The cost effectiveness of this undertaking is to be assessed by the designers.

Any topsoil, organics, loose fill, and any soft/wet material should be stripped from the footprint of the RSS. The subgrade under the RSS foundation should be proof-rolled or inspected and any loose or soft areas sub-excavated and replaced with well compacted granular materials prior to placing the wall.

The engineered fill pad material placed under the RSS mass should consist of OPSS Granular A or Granular B Type II and should be placed and compacted in accordance with OPSS.PROV 501. The bedding should extend at least 500 mm beyond the limits of the entire RSS mass.

RSS walls founded on this material may be designed using the following geotechnical resistances:

Table 14-1 Geotechnical Resistances for RSS Walls

Geotechnical Resistance	RSS Wall (0.5 m Granular Pad)
Factored Geotechnical Resistance at ULS (kPa)	200
Factored Geotechnical Reaction at SLS (kPa)	140

The geotechnical resistances at SLS correspond to settlement up to 25 mm at the base of the RSS wall. The geotechnical resistance is for vertical, concentric loads. Where eccentric or inclined loads are applied, the resistance used in design should be reduced in accordance with the CHBDC 2019, Clause 6.10.5.3.

The entire block of reinforced earth should be designed against various modes of failure including sliding and overturning. Sliding resistance along the base of the wall may be estimated using an ultimate friction coefficient of 0.5 for an engineered granular fill subgrade.

The proprietary RSS system should meet the Ministry's specifications for performance and appearance. The RSS supplier/designer may specify more stringent criteria or other requirements related to the particular design. The internal stability of the RSS wall should be analysed by the supplier/designer of the proprietary product selected for this site.

14.2 Bin Walls

Bin walls may be considered as an alternative to RSS walls. Based on a founding elevation of 349 m to 351.2 m, geotechnical resistances provided in Table 14-1 in Section 14.1 may be used for the design of bin walls. If founding of parts of the wall below the water level is unavoidable, then dewatering possibly in the form of a cofferdam may be required to facilitate construction in the dry. The cost effectiveness of this undertaking is to be assessed by the designers.

A bin wall typically consists of prefabricated metal containers with compacted earth backfill. Galvanized containers should be considered to enhance corrosion protection. Consideration may also be given to using graded aggregates such as clear stones as backfill instead of granular materials, which can be subject to washing out of fines within a watercourse.

Design of the bin walls including corrosivity assessment is the responsibility of the designers. The design must ensure that it can carry the eccentric loads imposed by the bridge abutment footings without distortion or lateral movement. The lateral stability of the bin walls must be checked for overturning and sliding.

The bin walls must be backfilled as per the manufacturer's requirements. Excavation and backfilling for the bin walls must be in accordance with OPSS 206 and 902.

14.3 Sheet Pile Walls

The use of sheet pile walls for the permanent abutments is technically feasible for the permanent replacement bridge. However, there are notable concerns related to potential obstructions during installation, corrosion, long-term durability, aesthetics. Sheet piles may be considered as an option, provided these issues can be resolved and associated risks are properly managed.

It is anticipated that the sheet piles are anticipated to retain between 2.7 m to 2.9 m of approach fill at the south and north abutments of the replacement bridge, respectively. Soil parameters and recommendations provided in Section 17.2 of this report may be used for the design and installation of sheet piles.

The native sand deposit at shallow depths contains loose zones and may not be sufficient to provide adequate lateral geotechnical resistance to limit deflection. As such, consideration may be given to stiffening the sheetpile wall by a combination of walers, corner and cross bracings. A soil anchoring system may be considered, if required, during detail design. Corrosion protection in terms of coatings and/or sacrificial steel thickness should be addressed.

Installation of sheetpiles may encounter obstructions from cobbles and occasionally boulders within the soils. Pre-augering equipment should be available on site, or be made available to site on short notice, during construction. Should large boulders be encountered, local minor wall alignment adjustment, e.g. a jog, may be required. An NSSP has been prepared and included in Appendix K.

15. BACKFILL AND LATERAL EARTH PRESSURES

Where appropriate, backfill behind the new abutments should consist of Granular A or Granular B Type II meeting the requirements of OPSS.PROV 1010. Reference should also be made to OPSD 3101.150 where applicable. The backfill must be in accordance with OPSS.PROV 902 and placed to the extents shown on OPSD 3121.150. The backfill should be compacted in accordance with OPSS.PROV 501 and compaction equipment to be used adjacent to the structure must be restricted in accordance with OPSS.PROV 501.07.02.

The lateral earth pressure provided in the equation below assumes that the backfill is fully drained so that there are no unbalanced hydrostatic pressures. If adequate drainage cannot be confirmed, the potential for buildup of hydrostatic pressures should be considered in design. A lateral earth pressure due to backfill compaction should be added to the calculated lateral earth pressure in accordance with Clause 6.12.3 of the CHBDC.

Lateral earth pressures should be computed in accordance Clause 6.12 of the CHBDC 2019, but under fully drained conditions acting on vertical structures, the lateral pressures are generally given by the following expression:

$$\sigma_h = K * (\gamma * d + q)$$

where:

σ_h = static lateral earth pressure on the wall at depth d (kPa)

K = static earth pressure coefficient (see table below)

γ = unit weight of retained soil (see table below)
adjust to submerged unit weights below water level

d = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

Static Lateral Earth Pressure Coefficients

Typical lateral earth pressure coefficients for vertical walls for backfill material with a horizontal surface behind the wall are shown in the table below.

Table 15-1 Static Lateral Earth Pressure Coefficients

Material	Friction Angle (deg.)	Unit Weight (kN/m ³)	Static Earth Pressure Coefficients		
			Active (K _A)	At-Rest (K _O)	Passive (K _P)
OPSS Granular A	35	22.8	0.27	0.43	3.7
OPSS Granular B Type II	35	22.0	0.27	0.43	3.7

The parameters in the above table correspond to full mobilization of active and passive earth pressures and require certain relative movements between the wall and adjacent soil to produce these conditions. The movement required can be assessed from Table C6.12 of the Commentary to the CHBDC 2019. Active earth pressures should be used for unrestrained walls. At-rest earth pressures should be used for restrained structures.

A geotechnical resistance factor of 0.5 (ϕ_{gu}) should be applied in static design to the passive earth pressure resistance in accordance with Table 6.2 of the CHBDC (static analysis – typical understanding). The soils within the depth of frost should be ignored from providing passive lateral resistance; however, the equivalent surcharge loading from the weight of the soils above the frost depth should be incorporated into the lower layers.

Seismic Lateral Earth Pressure Coefficients

Seismically induced lateral soil pressures may be calculated using the Mononobe-Okabe Method with:

$$k_h = \frac{1}{2} * F(\text{PGA}) * \text{PGA}, \text{ for structures that allow 25 to 50 mm of movement}$$

$$k_h = F(\text{PGA}) * \text{PGA}, \text{ for non-yielding walls}$$

The lateral earth pressure coefficients for seismic loading presented in the table below may be used for vertical walls. The provided earth pressure coefficients are based on a 1 in 2475yr seismic event and a Seismic Site Class D.

Table 15-2 Seismic Lateral Earth Pressure Coefficients

Material	Friction Angle (deg.)	Unit Weight (kN/m ³)	K _{AE} (Yielding Wall)	K _{AE} (Non-Yielding Wall)
OPSS Granular A	35	22.8	0.29	0.31
OPSS Granular B Type II	35	22.0	0.29	0.31

16. APPROACH EMBANKMENTS AND FORWARD SLOPES

16.1 Embankment Design and Reinstatement

Embankment reinstatement after construction of the replacement bridge should be carried out in accordance with OPSS.PROV 206. If constructed using Select Subgrade Material (SSM) or Granular B Type I, the embankment should be reconstructed with side slopes of 2H : 1V, or flatter. The fill should be placed and compacted in accordance with OPSS.PROV 501.

Prior to placement of fill, topsoil, organic, loose/soft or otherwise deleterious soils should be removed. Where newly placed embankment fill is placed against existing embankment slopes or on a sloping ground surface steeper than 3H : 1V, benching of the existing slope should be carried out in accordance with OPSD 208.010.

16.2 Embankment Settlement

The proposed embankment geometry had been presented in cross-sections and profiles provided by Hatch. It has been indicated that grades could be raised by as much as 2.5 m at the replacement bridge location.

An assessment of the estimated settlement from the proposed grade raise was carried out. The modeling parameters have been derived from empirical relationships with index properties.

The settlement analysis indicates that the approach embankments behind the abutments could settle up to 25 to 30 mm, with 15 to 20 mm being immediate settlement, as a result of the proposed grade raise. The immediate settlement is anticipated to occur as new fill is placed during construction. This settlement is within MTO's criteria (2010 Embankment Settlement Criteria For Design).

The grade raise at the replacement bridge location will induce up to 20 mm of settlement at the edge of the sleeper slab foundation of the TMB in addition to the foundation settlements under the TMB load.

16.3 Embankment Stability

Slope stability analyses were carried out using the commercially available computer program SLOPE/W of the GeoStudio software package with the option of Morgenstern-Price method of slices for limit equilibrium.

The input parameters used in the stability analysis, including soil stratigraphy, material properties, groundwater conditions and modeled geometry are shown in Appendix J. The material properties used in the analyses were determined from in-situ and laboratory testing and soil index correlations.

The geotechnical resistance factors provided in Table 6.2 within Clause 6.9.1 of the CHBDC for typical degree of understanding are $\phi_{gu} = 0.75$ for temporary condition and $\phi_{gu} = 0.65$ for permanent condition. This results in a target Factor of Safety (FoS) of 1.33 and 1.53 for temporary and permanent conditions, respectively.

16.3.1 Embankment Reinstatement

The stability analysis plots for the reinstated embankment are presented in Appendix J and the results are summarized in the table below.

Table 16-1 Slope Stability Analysis Results for Permanent Bridge Replacement

Location	Condition	Factor of Safety	Figure
South Abutment (Forward Slope)	Short Term	1.8	J1
	Long Term	1.8	J2
	Pseudo-Static (Seismic Loading)	1.5	J3
North Abutment (Forward Slope)	Short Term	1.9	J4
	Long Term	1.9	J5
	Pseudo-Static (Seismic Loading)	1.6	J6

The results of the stability analysis indicate that embankment reinstatement with OPSS Granular A or Granular B Type II material with a side slope inclination of 2H : 1V meets the minimum target Factor of Safety of 1.1, 1.3 and 1.5 for pseudo-static, short term and long term conditions, respectively.

17. CONSTRUCTION CONSIDERATIONS

17.1 Excavation and Dewatering

All excavations must be carried out in accordance with the requirements of the Occupational Health & Safety Act & Regulations (OHSA) for Construction Projects. The fill and native soils above the groundwater table may be classified as Type 3 soils and excavations should be made with side slopes no steeper than 1H : 1V to the base of excavation. Soils below the water table may be classified as Type 4 soils and excavations should be made with side slopes no steeper than 3H : 1V to the base of excavation.

Excavations must be planned and carried out in a manner in order not to impact the stability of the existing roadway. No stockpiling of the excavated materials should be permitted on the existing embankment. The duration of temporary open excavations and cut slopes should be minimized to reduce the likelihood of causing instability concerns. Temporary embankment and cut slope stability is the responsibility of the Contractor.

The excavation for foundation construction at the abutments is anticipated to extend through the existing fill and into the native sand to gravelly sand (and possibly cobbles and boulders). It must be emphasized that cobbles and boulders and other potential obstructions will likely be encountered during excavation in the fill and native soils. Suggested wording for an NSSP on obstructions is included in Appendix K. Any excavations below the groundwater or river water level will require dewatering to lower the water level below the base of the excavation and permit construction in the dry and facilitate compaction of the backfill materials. Therefore, it is recommended that all excavations be kept above the river level to avoid the need for extensive dewatering, base boiling and sloughing of the excavations.

The subgrade should be inspected and approved prior to placing a lean concrete mud slab for subgrade protection prior to footing construction. Any loose fill, topsoil, organics, loose/soft or otherwise deleterious materials at the subgrade level should be removed and replaced with lean concrete. Temporary excavation for the new bridge foundation must remain above the creek water level, since dewatering at this site is difficult and therefore should be avoided.

The design of dewatering systems, if required, is the responsibility of the Contractor. Dewatering of all excavations, as required, and the design, construction, and removal of any cofferdams must be carried out in accordance with OPSS.PROV 517 as modified by SP517F01.

17.2 Temporary Protection Systems (Sheet Pile Walls)

At locations where there are space restrictions or where a slope must be retained, the excavations will need to be carried out within a protection system.

Temporary Protection Systems (TPS) could be used for excavation support or groundwater control, they must be implemented in accordance with OPSS.PROV 539 and designed for Performance Level 2. The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. The protection system should be installed at a suitable distance away from the new structures to limit the disturbance to subgrade associated with removal of the protection system following completing of construction. Alternatively, the protection system near the structures could be left in place and cut off in accordance with OPSS.PROV 903 to limit the disturbance of subgrade during removal of the TPS.

Lateral earth pressure coefficients, under fully mobilized conditions, that can be used in design for the structural backfill are provided in Table 17.1. The lateral earth pressure coefficients for the underlying native soils are given below for a vertical wall and a horizontal backslope.

Table 17-1 Static Earth Pressure Coefficients for Existing Soils

Material	Friction Angle (deg.)	Unit Weight (kN/m ³) (*)	K _A	K _P	Ground Surface Behind Structure
Existing Fill	29	19	0.35	2.9	Horizontal
Native sand	30	20	0.33	3.0	Horizontal
Silty Clay / Clayey Silt to Silt	29	20	0.35	2.9	Horizontal
Silty Sand / Sand and Gravel Till	30	21	0.33	3.0	Horizontal

Note: (*) To be adjusted when below water level

If the backslope behind, or if the ground surface in front of the temporary protection systems is not horizontal, the lateral earth pressure parameters provided above do not apply and recalculation of the earth pressure parameters will be required.

Based on the anticipated depth of excavation and subsurface conditions at the site, it is anticipated that a TPS consisting of steel sheet piles installed to depth within the native silty clay / clayey silt to silt deposit are feasible. However, cobbles and boulders should be expected during sheet pile installation.

The design of roadway protection is the responsibility of the Contractor. All protection systems should be designed by a licensed Professional Engineer experienced in such designs and retained by the Contractor. The design of the roadway protection system must incorporate traffic loading and surcharge loading due to construction equipment and operations.

17.3 Obstructions

The random presence of cobbles and occasional boulders is to be expected throughout the soil deposits. As such, pre-augering should be made available to facilitate driven pile and sheetpile installation through the soil deposits, if and when required. Suggested wordings for an NSSP on pre-augering during foundation installation are included in Appendix K.

Boulders are also present immediately above bedrock. Driven pile installation involving boulders have been addressed elsewhere in this report.

17.4 Scour and Erosion Protection

The Contractor should provide silt fences and erosion control blankets as per OPSS.PROV 805 and OPSD 219.110 throughout the duration of construction to prevent transport of silt/sediment.

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the embankment slopes. A vegetation cover should be established on all exposed earth

surfaces to protect against surficial erosion in general accordance with OPSS.PROV 803 and OPSS.PROV 804. Slope vegetation should be established as soon as possible after completion of construction to limit surficial erosion, and water should be prevented from running down unprotected earth and granular slopes.

Scour and erosion protection must be provided along the waterline to protect the abutments. The design of erosion protection measures must consider hydrologic and hydraulic factors and must be carried out by specialists experienced in this field. Typically, rock protection should be provided over all earth surfaces subjected to flowing water in accordance with OPSS.PROV 511.

18. CONSTRUCTION CONCERNS

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

- Cobbles and boulders were encountered within the fills and native sand to sand and gravel at this site. The cobbles and boulders may interfere with foundation construction. The Contractor shall have appropriate equipment available on site capable of penetrating, handling or removing cobbles and boulders.
- Boulders are also present within the lower silty sand to sand and gravel till. Pre-augering equipment should be available during driven pile installation to confirm that all piles can reach bedrock or the boulders immediately above bedrock.
- If sub-excavation is required below the proposed foundation base elevation due to the presence of organics, disturbed materials, excessively soft soil, and/or cobbles and boulders, the sub-excavated area should be backfilled with granular material (after the final subgrade approval).
- If possible, it is recommended that excavations take place during the dry summer months, when groundwater and surface creek levels are typically at the lowest to reduce the volume of water entering the excavations.
- If groundwater and surface water levels are high during construction, cofferdam installation in conjunction with dewatering may be required for footing excavation and construction to permit construction in the dry. The dewatering equipment may need to handle significant flow volumes in view of the permeable nature of the cohesionless deposits. It is envisaged that high volume sumps and pumps may not be adequate, and a more robust dewatering system may be required. Cofferdam installation may be problematic due to the frequency of cobbles and/or boulders, as well as the locally very dense conditions. The design of an effective cofferdam and dewatering system is the responsibility of the Contractor. The Contractor's dewatering plan must be in place prior to commencing excavation.

- The removal/demolition of the existing bridge and timber crib abutment should not destabilize the existing slopes or otherwise negatively impact the new foundations. The existing foundation elements should remain in place and the existing riverbank soils should not be disturbed.
- The Contractor's selection of construction equipment and methodology must include assessment of the capability of the existing soils to support the proposed construction equipment and supplies.

The successful performance of the project will depend largely upon good workmanship and quality control during construction. Subgrade examination and field density testing should be carried out by qualified personnel during construction to confirm that foundation recommendations are correctly implemented and material specifications are met.

19. CLOSURE

This report was prepared by Mr. Yamlak Aragaw, P.Eng. and Mr. Rod de Castro, P.Eng. The report was reviewed by Messrs. Sydney Pang, P.Eng. and Jason Lee, P.Eng., a Designated Principal Contact for MTO Foundation Projects.

Thurber Engineering Ltd.
Report Prepared By:



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STATEMENT OF LIMITATIONS AND CONDITIONS

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.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

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.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

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

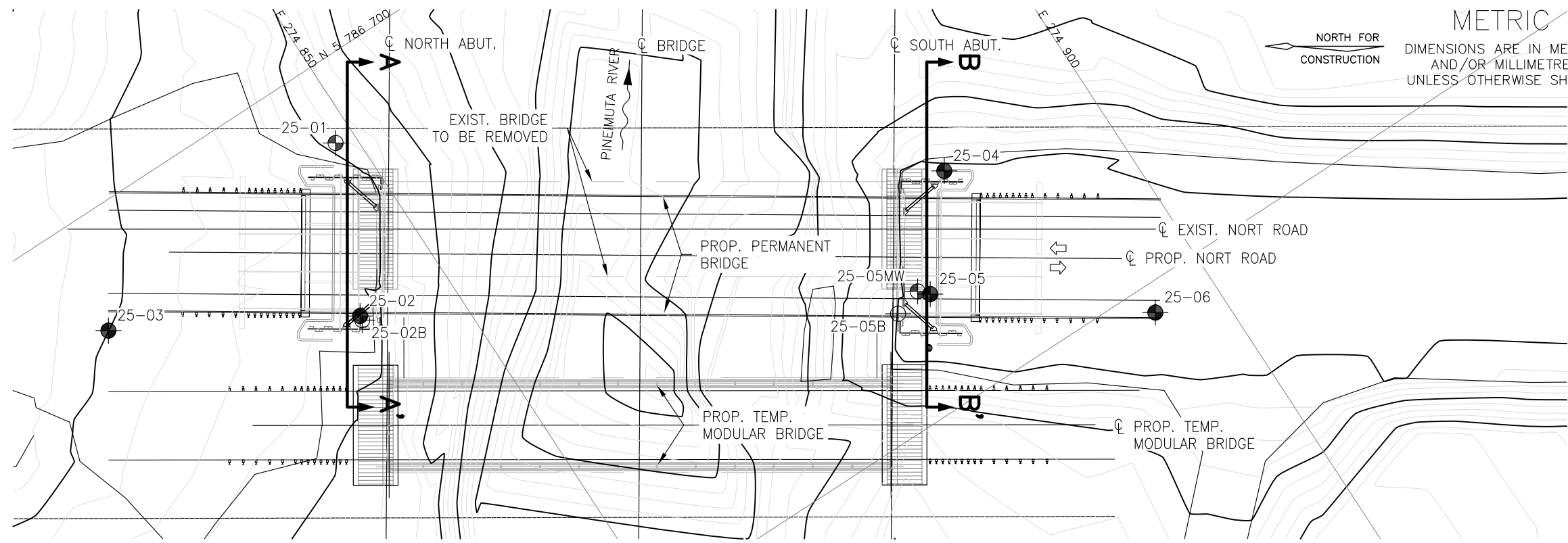
The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or 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.



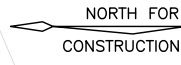
APPENDIX A

Borehole Locations and Soil Strata Drawing

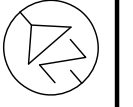
MINISTRY OF TRANSPORTATION, ONTARIO



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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



CONT No
GWP No 6046-21-00



BRIDGE REPLACEMENT AT
PINEIMUTA RIVER AND
NORT ROAD
BOREHOLE LOCATIONS PLAN AND SOIL STRATA

SHEET



KEYPLAN

LEGEND

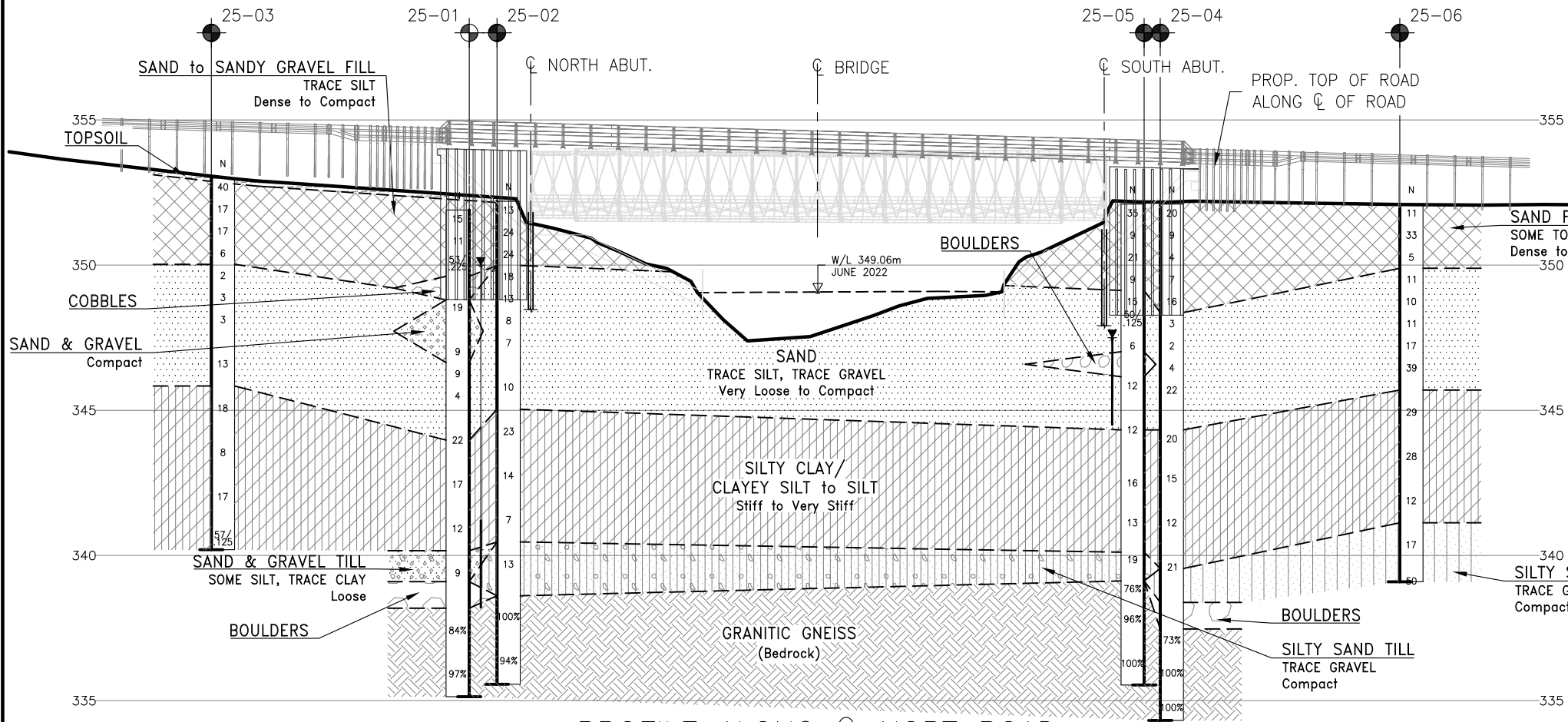
- Borehole
- ⊕ Borehole with Monitoring Well
- ⊕ Probe Borehole
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- ∇ Water Level Upon Completion of Drilling
- ∇ Water Level in Monitoring Well/Piezometer
- ⊕ Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
25-01	351.9	5 786 694.0	274 848.4
25-02	352.2	5 786 681.6	274 842.6
25-02B	352.1	5 786 681.2	274 842.6
25-03	353.0	5 786 691.4	274 825.5
25-04	352.1	5 786 666.1	274 887.1
25-05	352.1	5 786 658.7	274 881.0
25-05B	352.0	5 786 658.8	274 878.0
25-05MW	352.1	5 786 659.4	274 880.2
25-06	352.1	5 786 647.8	274 894.9

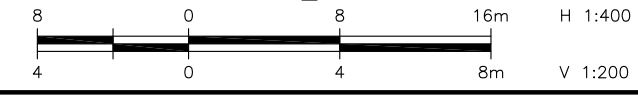
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 15.

GEOCREs No. 53B01-001



PROFILE ALONG Q NORTH ROAD



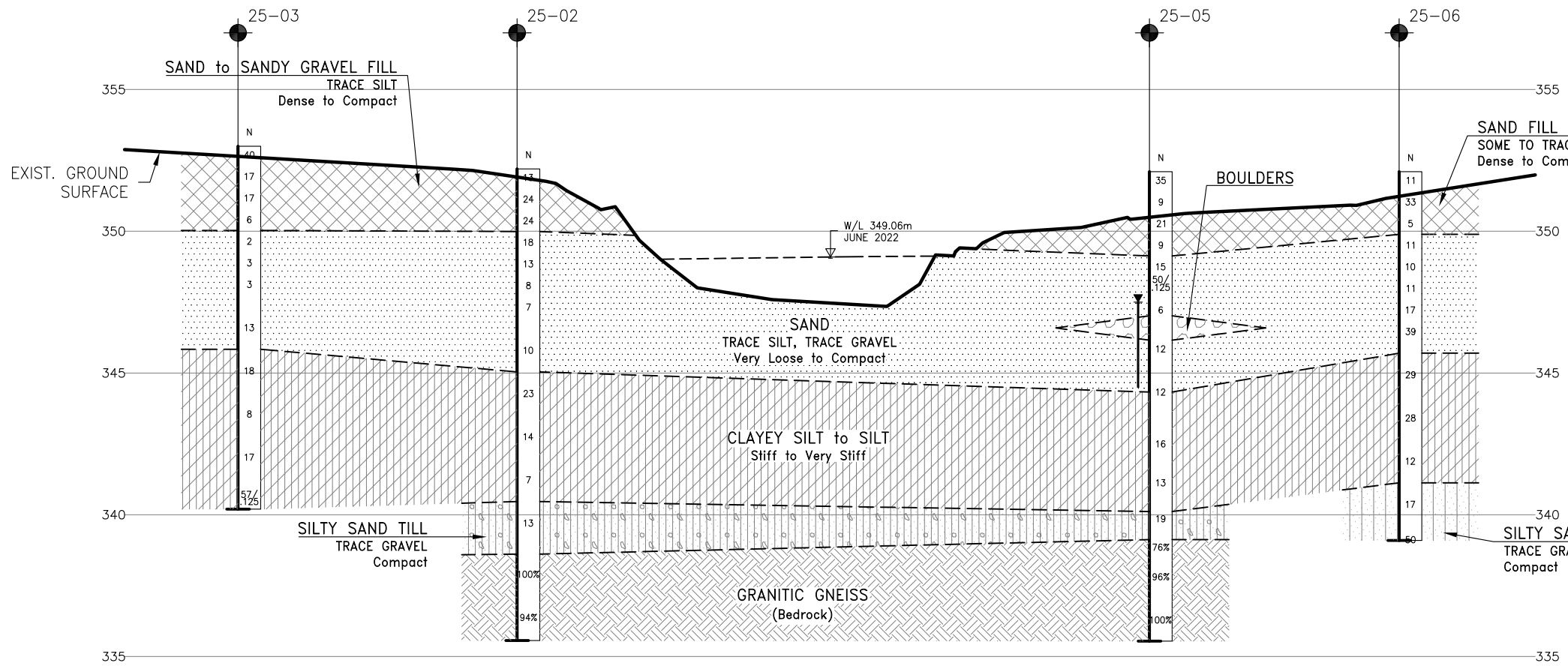
REVISIONS	DATE	BY	DESCRIPTION

DESIGN	CHK Rdc	CODE	LOAD	DATE
YA				MAR 2026

DRAWN	CHK YA	SITE	STRUCT	DWG
AN				1

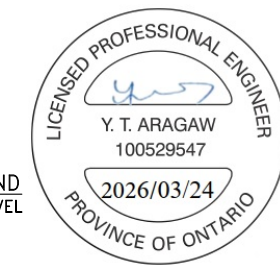
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MINISTRY OF TRANSPORTATION, ONTARIO



PROFILE ALONG C PROP. TEMP. MODULAR BRIDGE

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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



CONT No
GWP No 6046-21-00

BRIDGE REPLACEMENT AT
PINEMUTA RIVER AND
NORT ROAD
BOREHOLE SOIL STRATA

SHEET



KEYPLAN

LEGEND

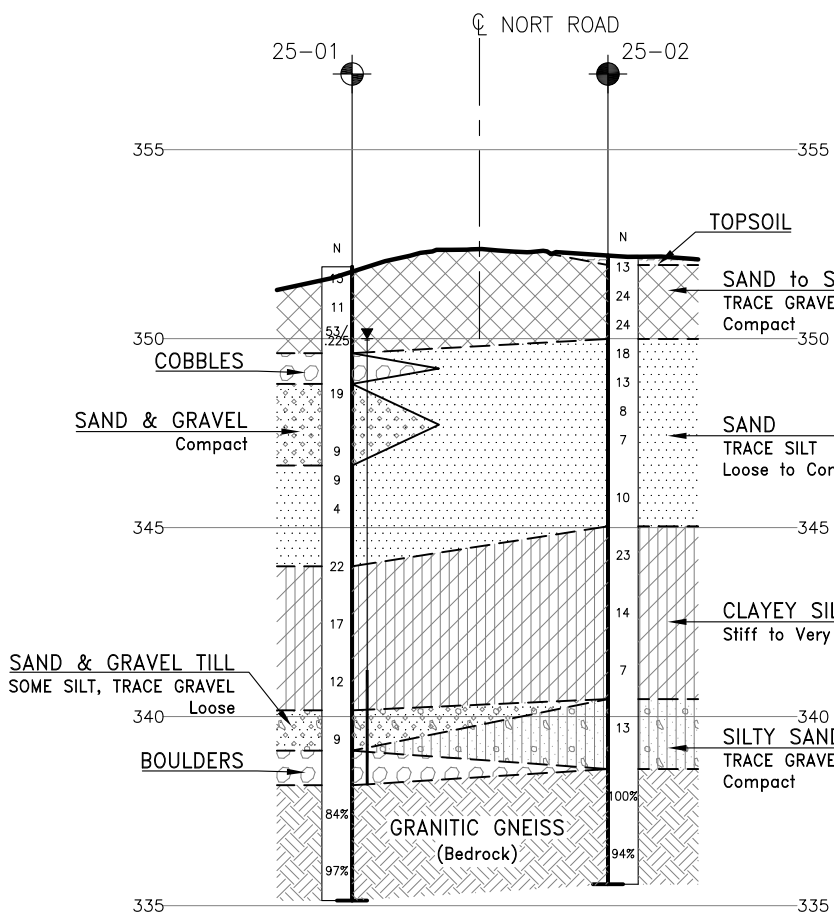
- Borehole
- Borehole with Monitoring Well
- Probe Borehole
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level Upon Completion of Drilling
- Water Level in Monitoring Well/Piezometer
- Monitoring Well/Piezometer Screen
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
25-01	351.9	5 786 694.0	274 848.4
25-02	352.2	5 786 681.6	274 842.6
25-02B	352.1	5 786 681.2	274 842.6
25-03	353.0	5 786 691.4	274 825.5
25-04	352.1	5 786 666.1	274 887.1
25-05	352.1	5 786 658.7	274 881.0
25-05B	352.0	5 786 658.8	274 878.0
25-05MW	352.1	5 786 659.4	274 880.2
25-06	352.1	5 786 647.8	274 894.9

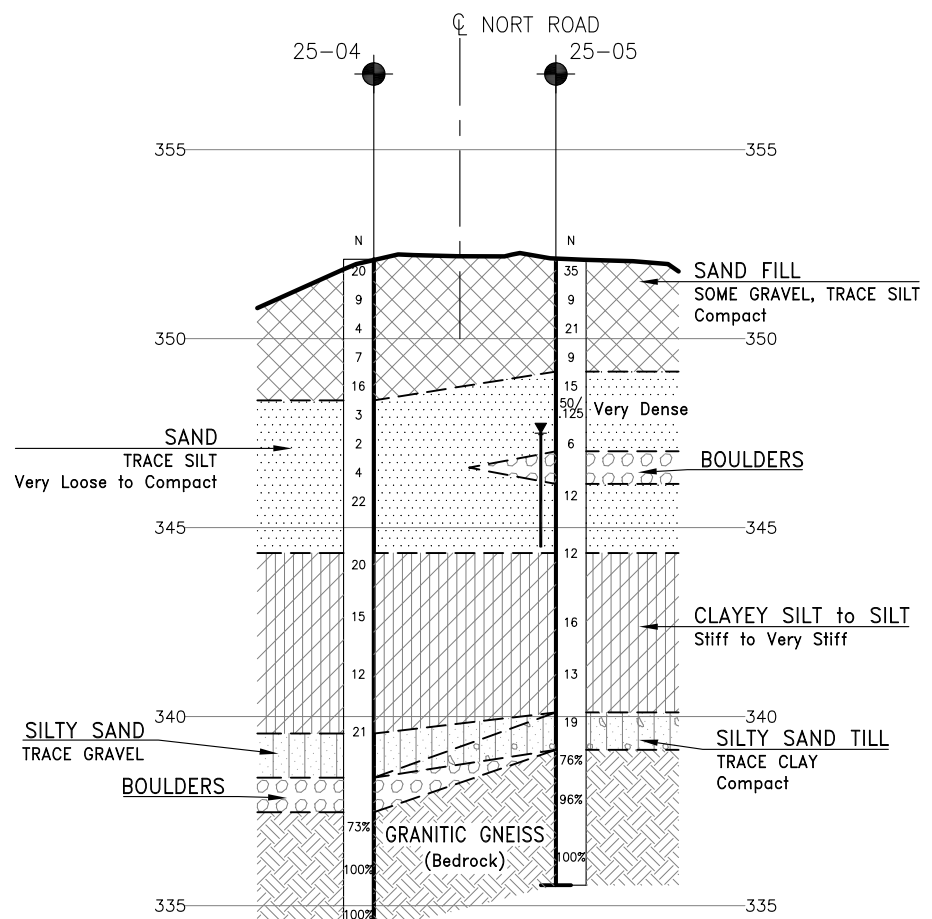
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 15.

GEORES No. 53B01-001



SECTION ALONG A-A'



SECTION ALONG B-B'

REVISIONS	DATE	BY	DESCRIPTION

DESIGN	YA	CHK	Rdc	CODE	LOAD	DATE	MAR 2026
DRAWN	AN	CHK	YA	SITE	STRUCT	DWG	2

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PLOT DATE: 3/25/2026 12:21 PM



APPENDIX B

Record of Borehole Sheets

RECORD OF BOREHOLE No 25-01

1 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 694.0 E 274 848.4 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.13 - 2025.06.13 LATITUDE 52.214242 LONGITUDE -90.438256 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60			80	100
351.9	GROUND SURFACE													
0.0	SAND , trace gravel, trace silt Compact Brown Moist (FILL)		1	SS	15									
			2	SS	11									
			3	SS	53/ 0.225									
349.6	COBBLES ~150mm thick cobble recovered		4	RC										
348.8	SAND and GRAVEL , trace silt Compact Brown Wet		5	SS	19									37 59 4 (SI+CL)
			6	SS	9									No recovery
346.6	SAND , trace gravel Loose Brown Wet		7	SS	9									
			8	SS	4									
344.0	Silty CLAY , trace sand Very Stiff Grey Moist		9	SS	22									
			10	SS	17									0 3 67 30

ONTMT452, 2020LIBRARY(MTO),GLB MTO-68438.GPJ 3-11-26

Continued Next Page

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

RECORD OF BOREHOLE No 25-01

2 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 694.0 E 274 848.4 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.13 - 2025.06.13 LATITUDE 52.214242 LONGITUDE -90.438256 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
340.2	Silty CLAY , trace sand Very Stiff Grey Moist Stiff		11	SS	12									
11.7	SAND and GRAVEL , some silt, trace clay Grey Moist (TILL)		12	SS	9									
12.8	BOULDERS ~375mm thick boulder recovered, Low recovery sand and gravel material below 13.3m		13	GS										
13.8	GRANITIC GNEISS fresh to slightly weathered, very strong, light to medium grey		14	SS										
16.8	END OF BOREHOLE AT A DEPTH OF 16.8 m. Notes: 1. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2025.06.17 1.9 350.0		1	RUN										
			2	RUN										

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+³, ×³: Numbers refer to Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 25-02

2 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 681.6 E 274 842.6 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.13 - 2025.06.13 LATITUDE 52.214131 LONGITUDE -90.438339 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
342	Clayey SILT to SILT Stiff to Very Stiff Grey Moist		11	SS	7									
341	Wet sand													
340.5														
11.7	Silty SAND , trace gravel Compact Grey Wet (TILL)		12	SS	13									
338.6														
13.6	GRANITIC GNEISS fresh, very strong, dark grey		1	RUN										RUN #1 TCR=100% SCR=100% RQD=100%
335.6			2	RUN										
16.6	END OF BOREHOLE AT A DEPTH OF 16.6 m.													

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

RECORD OF BOREHOLE No 25-03

1 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 691.4 E 274 825.5 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing with water and drilling mud COMPILED BY MC
 DATUM Geodetic DATE 2025.06.14 - 2025.06.14 LATITUDE 52.214218 LONGITUDE -90.438591 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
353.0	GROUND SURFACE					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
0.0	TOPSOIL: (200mm)					20 40 60 80 100 W P W W L WATER CONTENT (%)								
0.2	Gravelly SAND, trace silt Compact to Dense Light Brown Moist (FILL)	[Cross-hatched pattern]	1	SS	40									
			2	SS	17	352								
			3	SS	17	351								26 66 8 (SI+CL)
	Loose		4	SS	6									
350.0	SAND, trace silt Very Loose Brown Wet	[Dotted pattern]	5	SS	2	350								
			6	SS	3	349								
			7	SS	3	348								
	Compact		8	SS	13	347								
345.8	Clayey SILT to SILT, trace sand Stiff to Very Stiff Grey Moist	[Diagonal hatched pattern]	9	SS	18	345							0 1 91 8	
7.2			10	SS	8	344								

ONTMT452_2020LIBRARY(MTO),GLB_MTO-68438.GPJ_3-11-26

Continued Next Page

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

RECORD OF BOREHOLE No 25-03

2 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 691.4 E 274 825.5 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing with water and drilling mud COMPILED BY MC
 DATUM Geodetic DATE 2025.06.14 - 2025.06.14 LATITUDE 52.214218 LONGITUDE -90.438591 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
							20	40	60	80	100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L		
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)				
							20	40	60			20	40	60		
	Continued From Previous Page															
	Clayey SILT to SILT , trace sand Stiff to Very Stiff Grey Moist															
	trace gravel		11	SS	17		342									1 4 81 14
	Hard		12	SS	57/ 0.125		341									
340.2 12.8	END OF BOREHOLE AT A DEPTH OF 12.8 m UPON CASING REFUSAL ON PROBABLE BOULDERS OR BEDROCK.															

ONTMT452_2020LIBRARY(MTO).GLB_MTO-68438.GPJ_3-11-26

+³, ×³: Numbers refer to Sensitivity 20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 25-04

1 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 666.1 E 274 887.1 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.15 - 2025.06.15 LATITUDE 52.213994 LONGITUDE -90.437687 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80			100
352.1	GROUND SURFACE													
0.0	SAND , some gravel, trace silt Loose to Compact Brown Moist (FILL)		1	SS	20									
			2	SS	9									
			3	SS	4									10 81 9 (SI+CL)
			4	SS	7									
			5	SS	16									
348.4	SAND , trace silt Very Loose Brown Wet		6	SS	3									
			7	SS	2									1 93 6 (SI+CL)
			8	SS	4									
	Compact		9	SS	22									
			10	GS										
344.3	Clayey SILT to SILT Very Stiff Grey Moist		11	SS	20									0 1 92 7
343.3	Silty CLAY Very Stiff Grey Moist		12	SS	15									0 0 73 27

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Continued Next Page

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

RECORD OF BOREHOLE No 25-04

2 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 666.1 E 274 887.1 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.15 - 2025.06.15 LATITUDE 52.213994 LONGITUDE -90.437687 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page					20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60									
339.6	Silty CLAY Very Stiff Grey Moist		13	SS	12										
	Stiff														
12.5	Silty SAND , trace gravel Grey Moist to Wet		14	SS	21										
338.4															
13.7	BOULDERS ~450mm thick cobbles/boulder recovered		15	RC											
337.5															
14.6	GRANITIC GNEISS fresh to slightly weathered, very strong, light to medium grey		1	RUN										RUN #1 TCR=97% SCR=73% RQD=73%	
			2	RUN											RUN #2 TCR=100% SCR=100% RQD=100%
			3	RUN											RUN #3 TCR=100% SCR=100% RQD=100%
334.3	END OF BOREHOLE AT A DEPTH OF 17.8 m.														

ONTMT452_2020LIBRARY(MTO),GLB_MTO-68438.GPJ 3-11-26

RECORD OF BOREHOLE No 25-05

1 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 658.7 E 274 881.0 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.11 - 2025.06.12 LATITUDE 52.213927 LONGITUDE -90.437777 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
352.1	GROUND SURFACE													
0.0	SAND , some silt, trace gravel Loose to Compact Moist (FILL)		1	SS	35									
			2	SS	9									
			3	SS	21									
			4	SS	9									
349.1	SAND , trace silt Loose to Compact Brown Wet		5	SS	15									
			6	SS	50/ 0.125									
			7	SS	6									
347.0	BOULDERS ~450mm thick boulder recovered		8	RC										
346.2	SAND , trace silt, trace gravel Compact Brown Wet		9	SS	12									
344.3	Clayey SILT to SILT Stiff to Very Stiff Grey Moist		10	SS	12									
			11	SS	16									

ONTMT452_2020LIBRARY(MTO).GLB_MTO-68438.GPJ_3-11-26

Continued Next Page

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

RECORD OF BOREHOLE No 25-05 2 OF 2 METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 658.7 E 274 881.0 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.11 - 2025.06.12 LATITUDE 52.213927 LONGITUDE -90.437777 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
	Continued From Previous Page													
340.1	Clayey SILT to SILT Stiff to Very Stiff Grey Moist		12	SS	13							○		
12.0	Silty SAND , trace clay Compact Grey Moist (TILL)		13	SS	19							○		0 55 38 7
339.1	GRANITIC GNEISS fresh to slightly weathered, very strong, grey		1	RUN										RUN #1 TCR=95% SCR=76% RQD=76% UCS=154-194MPa
338			2	RUN										RUN #2 TCR=100% SCR=82% RQD=96%
337			3	RUN										RUN #3 TCR=100% SCR=100% RQD=100%
335.5	16.6	END OF BOREHOLE AT A DEPTH OF 16.6 m.												
	Notes: 1. Well installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2025.06.17 4.6 347.5													

ONTMT452_2020LIBRARY(MTO).GLB_MTO-68438.GPJ_3-11-26

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

RECORD OF BOREHOLE No 25-06

1 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 647.8 E 274 894.9 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.15 - 2025.06.15 LATITUDE 52.213830 LONGITUDE -90.437571 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE WATER CONTENT (%) 20 40 60								
352.1	GROUND SURFACE													
0.0	SAND , some to trace gravel, trace silt Compact to Dense Brown Moist (FILL)		1	SS	11									
			2	SS	33									
	Loose		3	SS	5									
349.9														
2.2	SAND , trace to some silt Compact Brown Moist		4	SS	11								0 93 7 (SI+CL)	
			5	SS	10									
			6	SS	11									
			7	SS	17									
	trace clay Dense		8	SS	39								9 76 13 2	
345.7														
6.4	Clayey SILT to SILT Very Stiff Grey Moist		9	SS	29									
			10	SS	28									

ONTMT452_2020LIBRARY(MTO).GLB_MTO-68438.GPJ_3-11-26

Continued Next Page

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

RECORD OF BOREHOLE No 25-06

2 OF 2

METRIC

GWP# 6046-21-00 LOCATION Pineimuta River Bridge Replacement N 5 786 647.8 E 274 894.9 ORIGINATED BY SP
 DIST Northwest Region HWY 599/808 BOREHOLE TYPE CME 55 Track-Mount / Hollow Stem Augers / NW Casing / NQ Coring COMPILED BY MC
 DATUM Geodetic DATE 2025.06.15 - 2025.06.15 LATITUDE 52.213830 LONGITUDE -90.437571 CHECKED BY JA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
	Continued From Previous Page																	
341.1	Clayey SILT to SILT Stiff Grey Moist		11	SS	12													0 1 77 22
11.0	Silty SAND , trace gravel Compact Grey Moist		12	SS	17													
339.1	END OF BOREHOLE AT A DEPTH OF 13.0 m. UPON CASING REFUSAL ON PROBABLE BOULDERS OR BEDROCK.		13	SS	50													

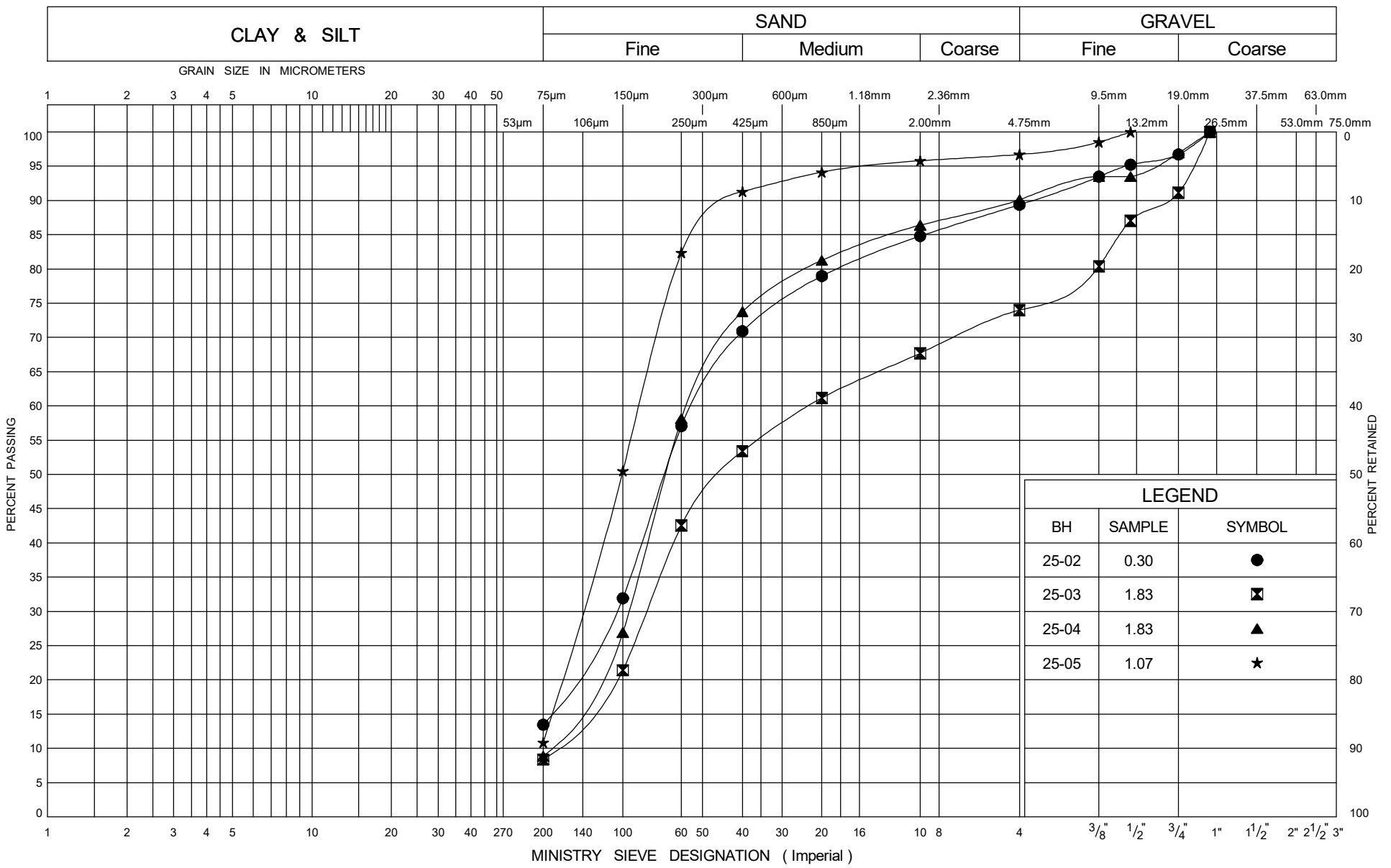
ONTMT452_2020LIBRARY(MTO).GLB_MTO-68438.GPJ_3-11-26

+³, ×³: Numbers refer to Sensitivity 20 15 10 (5) STRAIN AT FAILURE



APPENDIX C

Laboratory Test Results



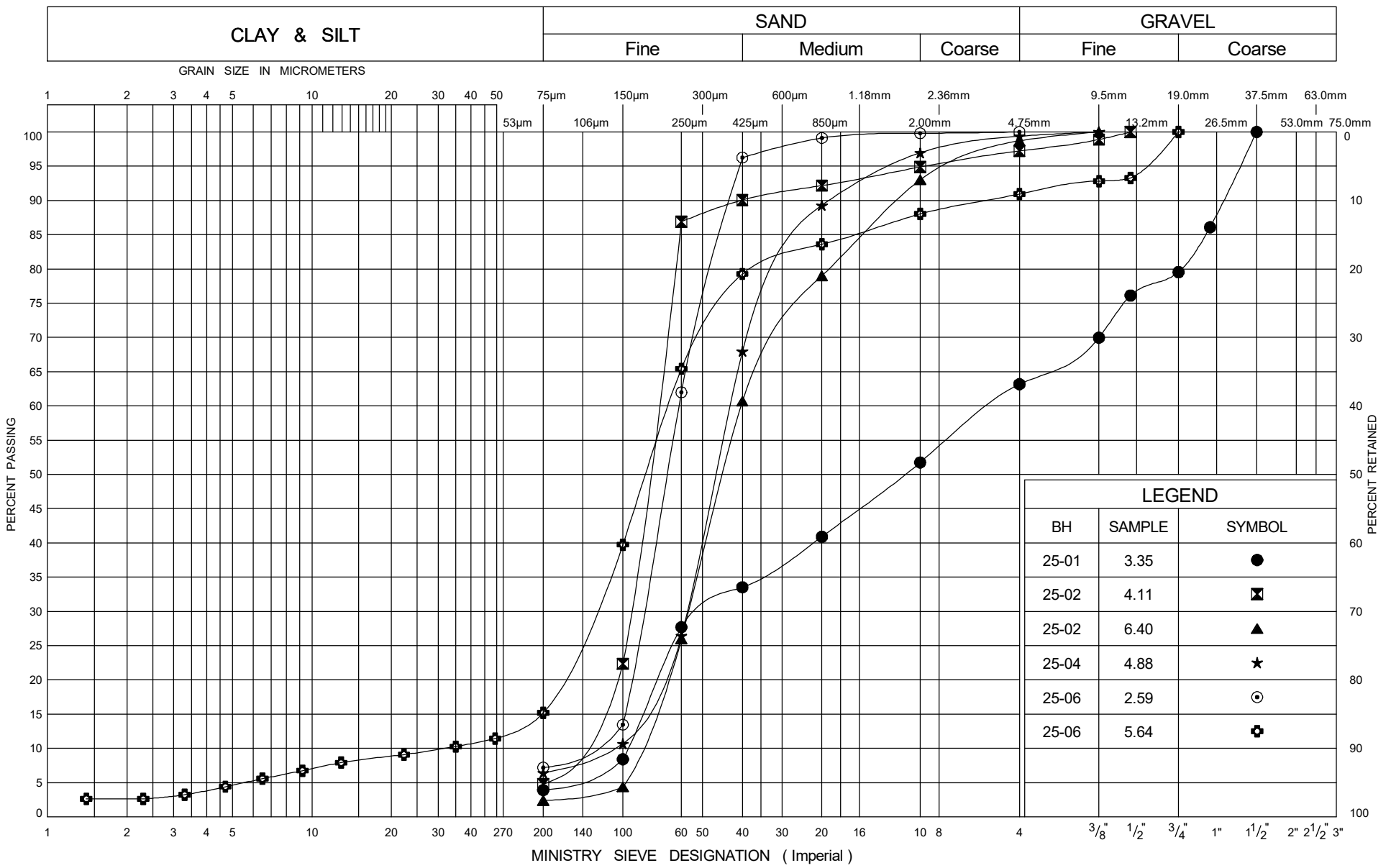
ONTARIO MOT GRAIN SIZE 2 MTO-68438.GPJ ONTARIO MOT.GDT 11/20/25



GRAIN SIZE DISTRIBUTION

Sand/Gravel FILL

FIG No C1
 GWP# 6046-21-00
 Pineimuta River Bridge

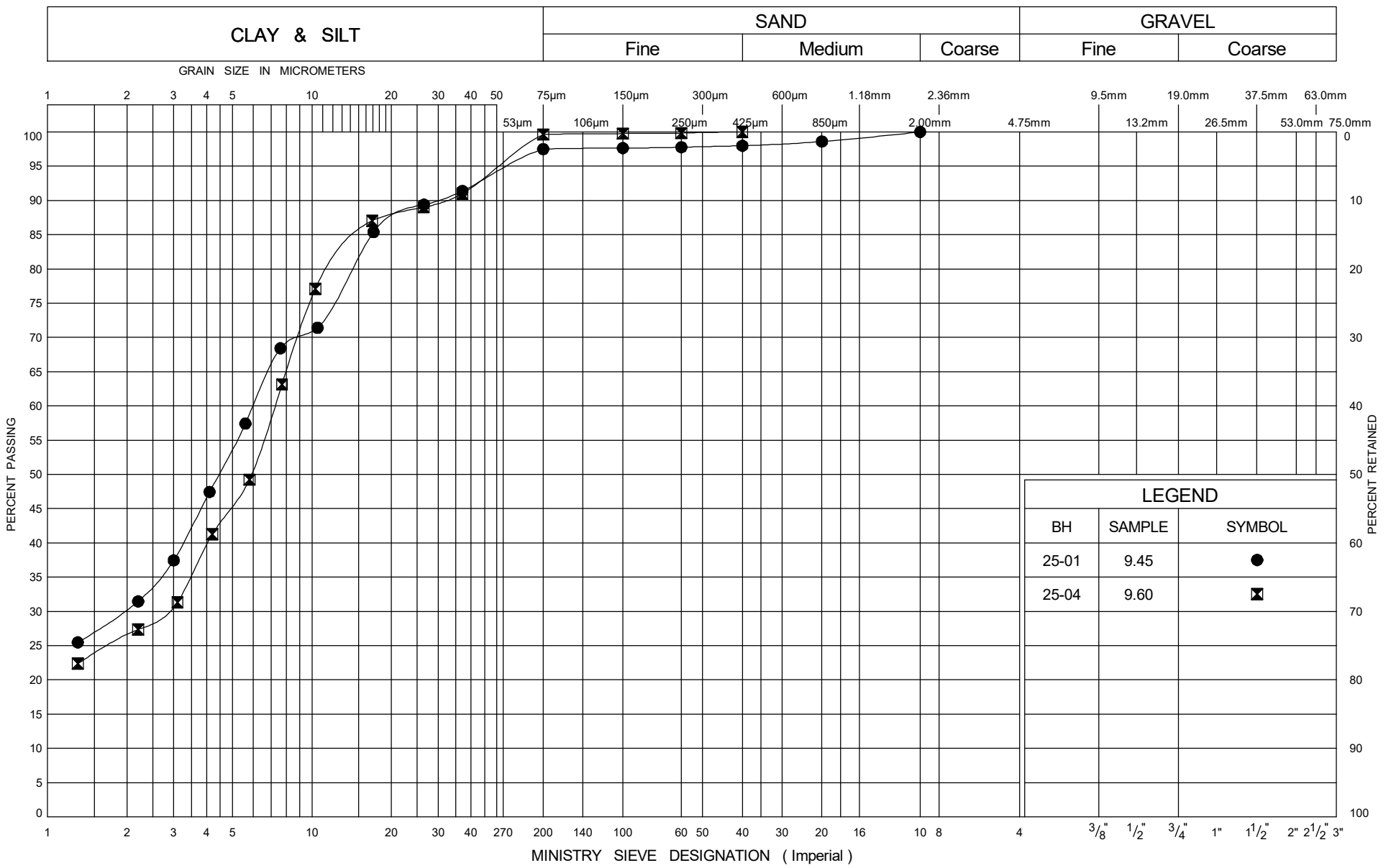


ONTARIO MOT GRAIN SIZE 2 MTO-68438.GPJ ONTARIO MOT.GDT 11/20/25



GRAIN SIZE DISTRIBUTION
SAND to SAND and GRAVEL

FIG No C2
 GWP# 6046-21-00
 Pineimuta River Bridge



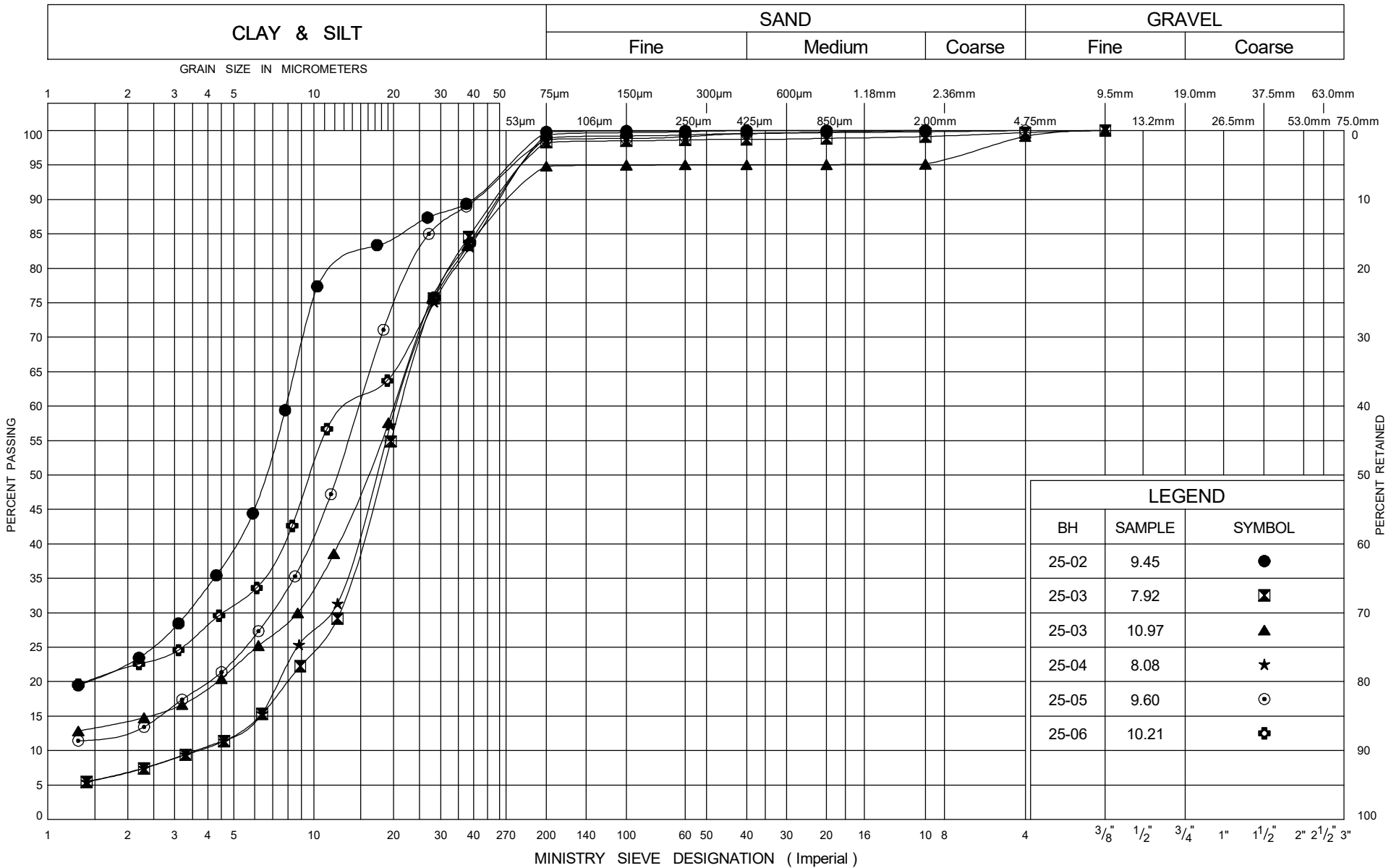
ONTARIO MOT GRAIN SIZE 2 MTO-68438.GPJ ONTARIO MOT.GDT 11/20/25



GRAIN SIZE DISTRIBUTION

Silty CLAY

FIG No C3
 GWP# 6046-21-00
 Pineimuta River Bridge



LEGEND		
BH	SAMPLE	SYMBOL
25-02	9.45	●
25-03	7.92	⊠
25-03	10.97	▲
25-04	8.08	★
25-05	9.60	⊙
25-06	10.21	⊕

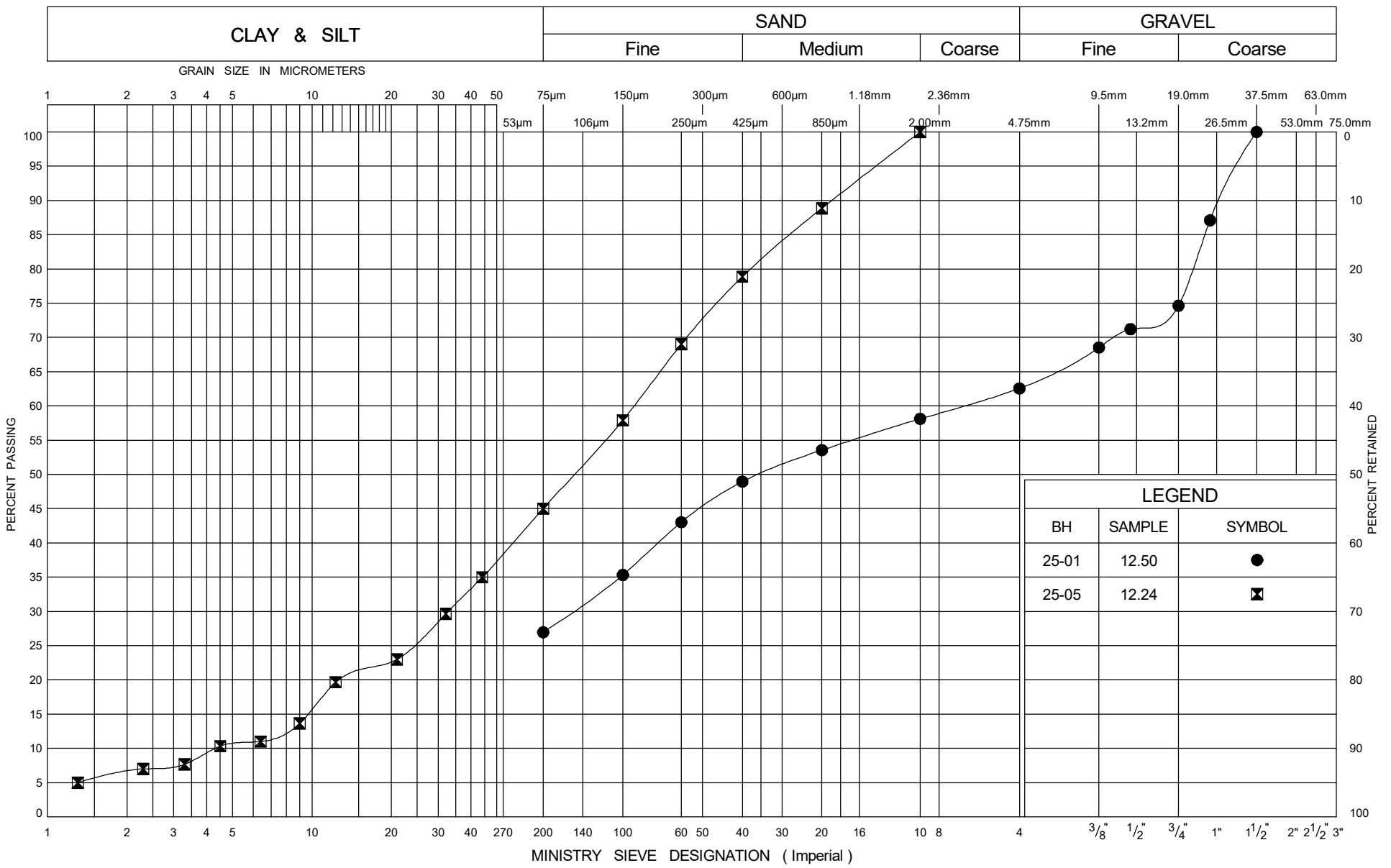
ONTARIO MOT GRAIN SIZE 2 MTO-68438.GPJ ONTARIO MOT.GDT 11/20/25



GRAIN SIZE DISTRIBUTION

Clayey SILT to SILT

FIG No C4
 GWP# 6046-21-00
 Pineimuta River Bridge



LEGEND		
BH	SAMPLE	SYMBOL
25-01	12.50	●
25-05	12.24	⊠

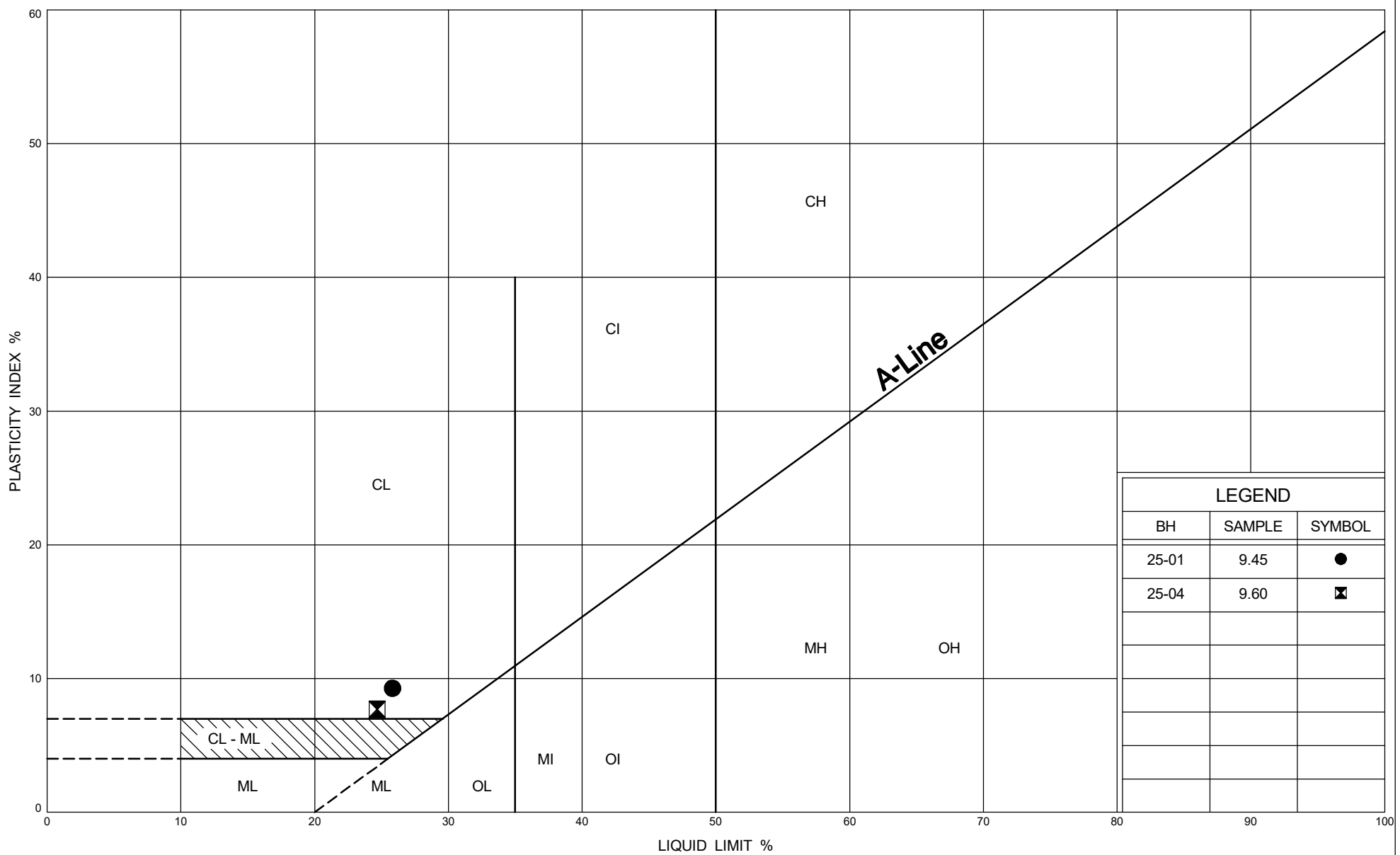
ONTARIO MOT GRAIN SIZE 2 MTO-68438.GPJ ONTARIO MOT.GDT 11/20/25



GRAIN SIZE DISTRIBUTION

Silty SAND to SAND and GRAVEL

FIG No C5
 GWP# 6046-21-00
 Pineimuta River Bridge



LEGEND		
BH	SAMPLE	SYMBOL
25-01	9.45	●
25-04	9.60	⊠

ONTARIO MOT PLASTICITY CHART MTO-68438.GPJ ONTARIO MOT.GDT 11/20/25

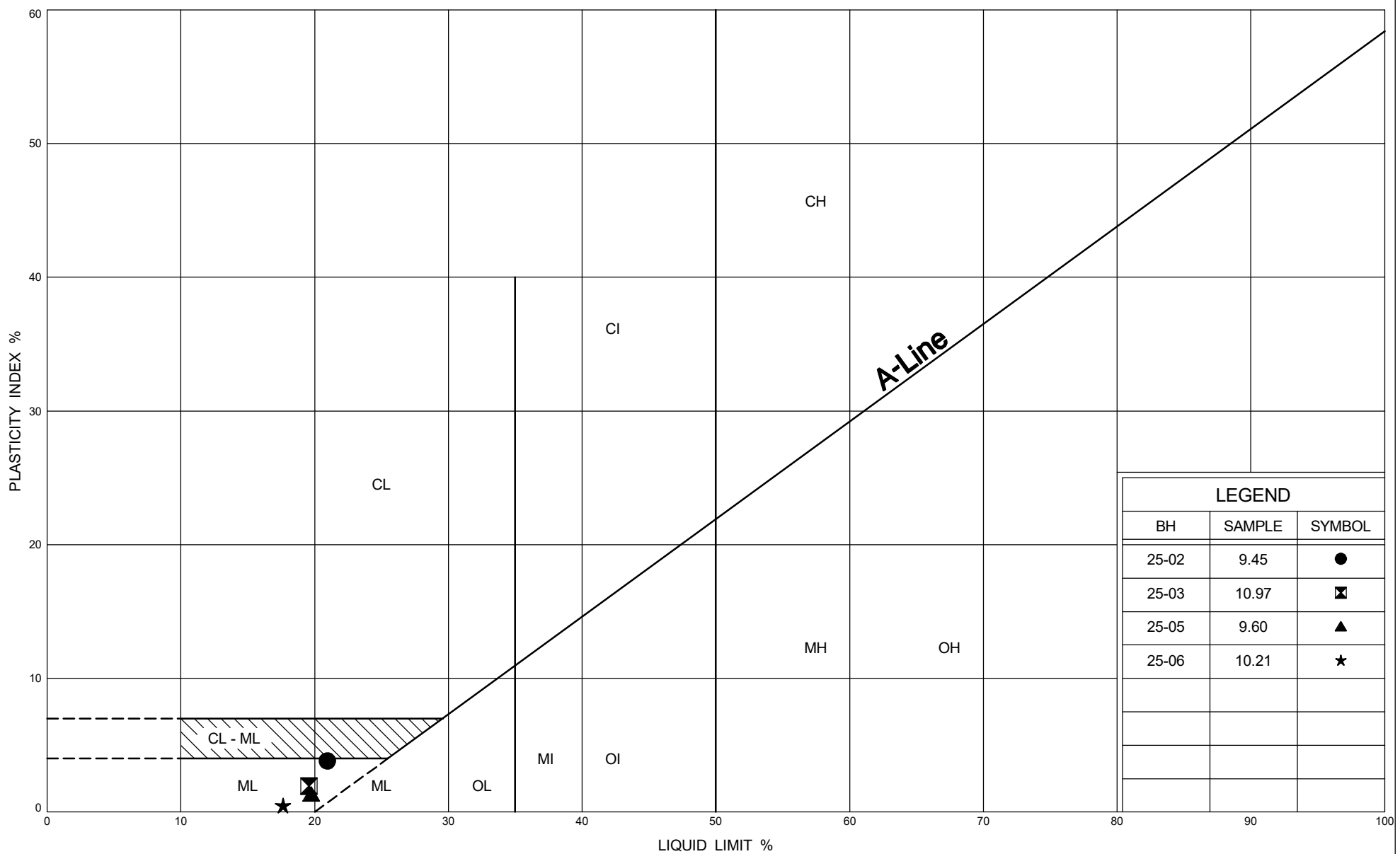


PLASTICITY CHART
Silty CLAY

FIG No C6

GWP# 6046-21-00

Pineimuta River Bridge



LEGEND		
BH	SAMPLE	SYMBOL
25-02	9.45	●
25-03	10.97	◩
25-05	9.60	▲
25-06	10.21	★

ONTARIO MOT PLASTICITY CHART MTO-68438.GPJ ONTARIO MOT.GDT 11/20/25



PLASTICITY CHART

Clayey SILT to SILT

FIG No C7

GWP# 6046-21-00

Pineimuta River Bridge

July 25, 2025

Joshua Alexander
Thurber Engineering Ltd.
202 – 1908 Ironoak Way
Oakville, Ontario
Canada, L6H 0N1

Re: UCS Testing
(Thurber Engineering Ltd. Project No. 68438)

Dear Joshua Alexander:

On July 11, 2025 a series of core samples (HQ-sized) were received by Geomechanica Inc. via drop-off by Thurber personnel. These samples were identified as being from Thurber Engineering Ltd. Project No. 68438. From these samples, 2 Uniaxial Compressive Strength (UCS) tests were completed.

Details regarding the steps of specimen preparation and testing along with the test results are presented in the accompanying laboratory report and summary spreadsheet.

Sincerely,



Bryan Tatone, PhD, PEng
Geomechanica Inc.
Tel: +1-647-478-9767
lab@geomechanica.com

Rock Laboratory Testing Results

A report submitted to:

Joshua Alexander
Thurber Engineering Ltd.
202 – 1908 Ironoak Way
Oakville, Ontario
Canada, L6H 0N1

Prepared by:

Bryan Tatone, PhD, PEng
Omid Mahabadi, PhD, PEng
Geomechanica Inc.
#14-1240 Speers Rd.
Oakville ON
L6L 2X4 Canada
Tel: +1-647-478-9767
lab@geomechanica.com

July 25, 2025
Project number: 68438

Abstract

This document summarizes the results of 2 Uniaxial Compressive Strength (UCS) tests. The UCS values along with photographs of specimens before and after testing are presented.

In this document:

1 Uniaxial Compressive Strength Tests	1
Appendices	3

1 Uniaxial Compressive Strength Tests

1.1 Overview

This section summarizes the results of uniaxial compressive strength (UCS) testing. The testing was performed in Geomechanica Inc.'s rock testing laboratory using a 150 ton (1.3 MN) Forney loading frame equipped with pressure-compensated control valve to maintain an axial strain rate of approximately 0.05 mm/min (Figure 1). The preparation and testing procedure for each specimen included the following:

1. Unwrapping the core sample and inspecting it for damage.
2. Diamond cutting the core sample to obtain a cylindrical specimen with an appropriate length (length:diameter = 2:1) and nearly parallel end faces.
3. Diamond grinding the specimen to obtain flat (within ± 0.025 mm) and parallel end faces (within 0.25°).
4. Placing the specimen into the loading frame, applying a 1 kN axial seating load.
5. Axially loading the specimens to rupture while continuously recording axial force to determine the peak strength (UCS).



Figure 1: Forney loading frame setup for UCS testing.

Using a precision V-block mounted on the magnetic chuck of the surface grinder, test specimens met the end flatness, end parallelism, and perpendicularity criteria set out in ASTM D4543-19. The side straightness criteria, as checked with a feeler gauge, and the minimum length:diameter criteria were met for all specimens unless noted otherwise in Table 1. Testing of the specimens followed ASTM D7012-14 Method C.

1.2 Results

The results of UCS testing are summarized in Table 1. Additional specimen and test details are provided on the summary spreadsheet that accompanies this report.

Table 1: Summary of Uniaxial Compression test results.

Sample	Depth (m)	Bulk density ρ (g/cm ³)	UCS (MPa)	Lithology	Failure description
BH25-01 R1	13.92 - 14.22	2.743	123.6	Gneiss	1, 2
BH25-02 R2	14.30 - 14.71	2.709	221.7	Gneiss	3

¹ Inclined shear failure

² Failure along pre-existing structure

³ Inclined shear fracture and axial splitting failure

1.3 Specimen photographs



Photographs of the specimens before and after testing are presented in the Appendix of this report.

Appendices



Specimen sheets

- BH25-01 R1
- BH25-02 R2

Uniaxial Compression Test

Client	Thurber Engineering Ltd.	Project	68438
Sample	BH25-01 R1	Depth	13.92 - 14.22
<u>Specimen parameters</u>		<u>Prior to testing</u>	<u>After testing</u>
Diameter (mm) ^a	62.91		
Length (mm) ^a	130.12		
Bulk density ρ (g/cm ³)	2.743		
UCS (MPa)	123.6		
Lithology	Gneiss		
Failure description ^b	1, 2		
^a Additional specimen measurement/details provided in accompanying summary spreadsheet. ^b Failure description: ¹ Inclined shear failure; ² Failure along pre-existing structure;			
Remarks: Displacement rate: 0.05 mm/min.			
Performed by	AA	Date	2025-07-14

Uniaxial Compression Test

Client	Thurber Engineering Ltd.	Project	68438
Sample	BH25-02 R2	Depth	14.30 - 14.71
<u>Specimen parameters</u>		Prior to testing	After testing
Diameter (mm) ^a	47.30		
Length (mm) ^a	105.25		
Bulk density ρ (g/cm ³)	2.709		
UCS (MPa)	221.7		
Lithology	Gneiss		
Failure description ^b	3		
^a Additional specimen measurement/details provided in accompanying summary spreadsheet. ^b Failure description: ³ Inclined shear fracture and axial splitting failure;			
Remarks: Displacement rate: 0.05 mm/min.			
Performed by	AA	Date	2025-07-14



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 68438
Client: Hatch
Project Name: 6021-E-0011-008 Pineimuta River Modular Bridge
Core Size: HQ BH No : 25-01

Date Drilled: 25-Jun-14
Date Tested: 25-Jul-08
Tester: GA
Reviewed by: GL

Table with 11 columns: Test No., Run No., Depth (m), Axial or Diametral, Gauge (MPa), Diameter (mm), Length (mm), Is(50) (MPa), UCS (MPa), Rock Type, Rock Strength (after Hoek & Brown, 1997). Rows 1-5 contain test data for Granite, showing UCS values >157.3 MPa and Rock Strength as Extremely Strong.

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 68438
Client: Hatch
Project Name: 6021-E-0011-008 Pineimuta River Modular Bridge
Core Size: NQ BH No : 25-02

Date Drilled: 25-Jun-13
Date Tested: 25-Jul-08
Tester: GA
Reviewed by: GL

Table with 11 columns: Test No., Run No., Depth (m), Axial or Diametral, Gauge (MPa), Diameter (mm), Length (mm), Is(50) (MPa), UCS (MPa), Rock Type, Rock Strength (after Hoek & Brown, 1997). Rows 1-7 contain test data for Granite, and rows 8-35 are empty.

- * It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 68438
 Client: Hatch
 Project Name: 6021-E-0011-008 Pineimuta River Modular Bridge
 Core Size: HQ BH No : 25-04

Date Drilled: 13-Jul-25
 Date Tested: 21-Jul-25
 Tester: AR
 Reviewed by: GL

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	15.0	D	>25	63.1	145.2				
2	2	15.7	D	>25	63.2	143.8				
3	2	16.5	D	>25	63.2	141.4				
4	3	17.0	D	>25	63.1	139.5				
5	3	17.1	D	>25	63.1	144.2				
6										
7										
8										
9										
10										
11										
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28										
29										
30										
31										
32										
33										
34										
35										

- * It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
- Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
- * Diametral Test should have $0.7 \times D$ on either side of test point.
- * Correlation factor to obtain UCS values is 24.



POINT LOAD TEST SHEET

ASTM D5731-08

Job No: 68438
Client: Hatch
Project Name: 6021-E-0011-008 Pineimuta River Modular Bridge
Core Size: NQ BH No : 25-05

Date Drilled: 25-Jun-12
Date Tested: 25-Jul-08
Tester: GA
Reviewed by: GL

Table with 11 columns: Test No., Run No., Depth (m), Axial or Diametral, Gauge (MPa), Diameter (mm), Length (mm), Is(50) (MPa), UCS (MPa), Rock Type, Rock Strength (after Hoek & Brown, 1997). Rows 1-7 contain test data for Granite, showing UCS values ranging from 193.9 to >234.4 MPa.

* It is ideal to perform axial test on core specimens with D/L ratio of 1.1 ± 0.1
Long pieces of core can be tested diametrically to produce suitable lengths for axial testing
* Diametral Test should have 0.7 x D on either side of test point.
* Correlation factor to obtain UCS values is 24.



APPENDIX D

Analytical Chemical Testing Results



FINAL REPORT

CA40248-JUL25 R1

68438

Prepared for

Thurber Engineering Ltd.

First Page

CLIENT DETAILS

Client **Thurber Engineering Ltd.**

Address **1908 Ironoak Way, Suite 202
Oakville, ON
L6H 0N1, Canada**

Contact **Joshua Alexander**

Telephone **613-606-7303**

Facsimile

Email **jalexander@thurber.ca**

Project **68438**

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 **CA40248-JUL25**

Received **07/24/2025**

Approved **07/31/2025**

Report Number **CA40248-JUL25 R1**

Date Reported **07/31/2025**

COMMENTS

Temperature of Sample upon Receipt: 4 degrees C
Cooling Agent Present:yes
Custody Seal Present:yes

Chain of Custody Number:N/A

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



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FINAL REPORT

CA40248-JUL25 R1

Client: Thurber Engineering Ltd.

Project: 68438

Project Manager: Joshua Alexander

Samplers: Lynda Dinh

MATRIX: SOIL

Sample Number	5	6
Sample Name	BH25-04 SS-4 7'6"-9'6"	BH25-02 SS-4 7'6"-9'6"
Sample Matrix	Soil	Soil
Sample Date	23/07/2025	23/07/2025

Parameter	Units	RL	Result	Result
Corrosivity Index				
Corrosivity Index	none	1	1	2
pH	pH Units	0.05	8.00	8.15
Soil Redox Potential	mV	no	262	219
Sulphide (Na ₂ CO ₃)	%	0.01	< 0.01	< 0.01
Resistivity (calculated)	ohms.cm	-9999	7580	18900
General Chemistry				
Conductivity	uS/cm	2	132	53
Metals and Inorganics				
Sulphate	µg/g	0.4	3.6	1.4
Other (ORP)				
Chloride	µg/g	0.4	2.8	2.8

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
Chloride	DIO0671-JUL25	µg/g	0.4	<0.4	2	35	100	80	120	103	75	125
Sulphate	DIO0671-JUL25	µg/g	0.4	<0.4	4	35	106	80	120	93	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-IENVIARD-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)	ECS0097-JUL25	%	0.01	< 0.01								

Conductivity

Method: SM 2510 | 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	EWL0617-JUL25	uS/cm	2	< 2	1	20	99	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 | Internal ref.: ME-CA-ENVIEWL-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	EWL0617-JUL25	pH Units	0.05	NA	1		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

Results relate only to the sample tested.

Data reported represent the sample as submitted to SGS. 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 and Excess Soil Quality" 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.

SGS Canada Inc. statement of conformity decision rule does not consider uncertainty when analytical results are compared to a specified standard or regulation.

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This report supersedes all previous versions.

-- End of Analytical Report --

CERTIFICATE OF ANALYSIS (GUIDELINE EVALUATION)

Work Order	: TY2506918	Laboratory	: ALS Environmental - Thunder Bay
Client	: Thurber Engineering Ltd.	Account Manager	: Christine Paradis
Contact	: Donna Rein	Address	: 1081 Barton Street
Address	: 1908 Ironoak Way Suite 202 Oakville Ontario Canada L6H 0N1		: Thunder Bay ON Canada P7B 5N3
Telephone	: ----	Telephone	: +1 807 623 6463
Project	: Pineimuta Modular Bridge/ 68438	Date Samples Received	: 28-Jun-2025 09:01
PO	: ----	Date Analysis Commenced	: 02-Jul-2025
C-O-C number	: ----	Issue Date	: 08-Jul-2025 16:43
Sampler	: ----		
Site	: ----		
Quote number	: Standing Offer Price List - 2025		
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
- Guideline Comparison

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.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
David Tremblett		VOC, Waterloo, Ontario
Jeremy Gingras		Organics, Waterloo, Ontario
Josphin Masihi		Centralized Prep, Waterloo, Ontario
Nik Perkio		Metals, Waterloo, Ontario
Nik Perkio		Inorganics, Waterloo, Ontario





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.

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Application of guidelines is provided "as is" without warranty of any kind, either expressed or implied, including, but not limited to fitness for a particular purpose, or non-infringement. ALS assumes no responsibility for errors or omissions in the information. Guidelines are not adjusted for the hardness, pH or temperature of the sample (the most conservative values are used). Measurement uncertainty is not applied to test results prior to comparison with specified criteria values.

Key: CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances.

LOR: Limit of Reporting (detection limit).

<i>Unit</i>	<i>Description</i>
-	no units
%	percent
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
mS/cm	millisiemens per centimetre

>: greater than.

<: less than.

Red shading is applied where the result or the LOR is greater than the Guideline Upper Limit (or lower than the Guideline Lower Limit, if applicable).

For drinking water samples, Red shading is applied where the result for E.coli, fecal or total coliforms is greater than or equal to the Guideline Upper Limit.

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

SubMatrix: Soil
 (Matrix: Soil/Solid)

Client sample ID: 25-05 SS2
 Client sampling date / time: 11-Jun-2025 12:00

Analyte	CAS Number	Method/Lab	LOR	Unit	TY2506918-001						
Physical Tests											
Conductivity (1:2 leachate)	----	E100-LWT	0.00500	mS/cm	0.0681	----	----	----	----	----	----
Moisture	----	E144/WT	0.25	%	3.80	----	----	----	----	----	----
Metals											
Antimony	7440-36-0	E440C/WT	0.10	mg/kg	<0.10	----	----	----	----	----	----
Arsenic	7440-38-2	E440C/WT	0.10	mg/kg	0.91	----	----	----	----	----	----
Barium	7440-39-3	E440C/WT	0.50	mg/kg	13.3	----	----	----	----	----	----
Beryllium	7440-41-7	E440C/WT	0.10	mg/kg	0.10	----	----	----	----	----	----
Boron	7440-42-8	E440C/WT	5.0	mg/kg	<5.0	----	----	----	----	----	----
Cadmium	7440-43-9	E440C/WT	0.020	mg/kg	<0.020	----	----	----	----	----	----
Calcium, soluble ion content	7440-70-2	E484/WT	0.50	mg/L	1.83	----	----	----	----	----	----
Chromium	7440-47-3	E440C/WT	0.50	mg/kg	10.1	----	----	----	----	----	----
Cobalt	7440-48-4	E440C/WT	0.10	mg/kg	2.21	----	----	----	----	----	----
Copper	7440-50-8	E440C/WT	0.50	mg/kg	4.91	----	----	----	----	----	----
Lead	7439-92-1	E440C/WT	0.50	mg/kg	1.58	----	----	----	----	----	----
Magnesium, soluble ion content	7439-95-4	E484/WT	0.50	mg/L	0.77	----	----	----	----	----	----
Molybdenum	7439-98-7	E440C/WT	0.10	mg/kg	0.11	----	----	----	----	----	----
Nickel	7440-02-0	E440C/WT	0.50	mg/kg	6.48	----	----	----	----	----	----
Selenium	7782-49-2	E440C/WT	0.20	mg/kg	<0.20	----	----	----	----	----	----
Silver	7440-22-4	E440C/WT	0.10	mg/kg	<0.10	----	----	----	----	----	----
Sodium, soluble ion content	17341-25-2	E484/WT	0.50	mg/L	0.83	----	----	----	----	----	----
Thallium	7440-28-0	E440C/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Uranium	7440-61-1	E440C/WT	0.050	mg/kg	0.308	----	----	----	----	----	----
Vanadium	7440-62-2	E440C/WT	0.20	mg/kg	11.4	----	----	----	----	----	----
Zinc	7440-66-6	E440C/WT	2.0	mg/kg	10.0	----	----	----	----	----	----
Sodium adsorption ratio [SAR]	----	E484/WT	0.10	-	0.13	----	----	----	----	----	----
Volatile Organic Compounds											
Benzene	71-43-2	E611A/WT	0.0050	mg/kg	<0.0050	----	----	----	----	----	----
Ethylbenzene	100-41-4	E611A/WT	0.015	mg/kg	<0.015	----	----	----	----	----	----
Toluene	108-88-3	E611A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Xylene, m+p-	179601-23-1	E611A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Xylene, o-	95-47-6	E611A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Xylenes, total	1330-20-7	E611A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
BTEX, total	----	E611A/WT	0.10	mg/kg	<0.10	----	----	----	----	----	----
Hydrocarbons											
F1 (C6-C10)	----	E581.F1/WT	5.0	mg/kg	<5.0	----	----	----	----	----	----
F2 (C10-C16)	----	E601.SG-LWT	10	mg/kg	<10	----	----	----	----	----	----
F3 (C16-C34)	----	E601.SG-LWT	50	mg/kg	<50	----	----	----	----	----	----
F4 (C34-C50)	----	E601.SG-LWT	50	mg/kg	<50	----	----	----	----	----	----



Analyte	CAS Number	Method/Lab	LOR	Unit	Client sample ID							
					Client sampling date / time	25-05 SS2						
						11-Jun-2025 12:00						
						TY2506918-001	----	----	----	----	----	----
Hydrocarbons												
F1-BTEX	----	EC580/WT	5.0	mg/kg	<5.0	----	----	----	----	----	----	
Hydrocarbons, total (C6-C50)	n/a	EC581/WT	80	mg/kg	<80	----	----	----	----	----	----	
Chromatogram to baseline at nC50	n/a	E601.SG-L/WT	-	-	YES	----	----	----	----	----	----	
Hydrocarbons Surrogates												
Bromobenzotrifluoride, 2- (F2-F4 surrogate)	392-83-6	E601.SG-L/WT	1.0	%	93.7	----	----	----	----	----	----	
Dichlorotoluene, 3,4-	95-75-0	E581.F1/WT	1.0	%	90.0	----	----	----	----	----	----	
Volatile Organic Compounds Surrogates												
Bromofluorobenzene, 4-	460-00-4	E611A/WT	0.10	%	91.9	----	----	----	----	----	----	
Difluorobenzene, 1,4-	540-36-3	E611A/WT	0.10	%	83.8	----	----	----	----	----	----	
Polycyclic Aromatic Hydrocarbons												
Acenaphthene	83-32-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Acenaphthylene	208-96-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Anthracene	120-12-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Benzo(a)anthracene	56-55-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Benzo(a)pyrene	50-32-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Benzo(b+j)fluoranthene	n/a	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Benzo(g,h,i)perylene	191-24-2	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Benzo(k)fluoranthene	207-08-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Chrysene	218-01-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Dibenz(a,h)anthracene	53-70-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Fluoranthene	206-44-0	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Fluorene	86-73-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Indeno(1,2,3-c,d)pyrene	193-39-5	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Methylnaphthalene, 1-	90-12-0	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----	
Methylnaphthalene, 1+2-	----	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Methylnaphthalene, 2-	91-57-6	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----	
Naphthalene	91-20-3	E641A/WT	0.010	mg/kg	<0.010	----	----	----	----	----	----	
Phenanthrene	85-01-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Pyrene	129-00-0	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----	
Polycyclic Aromatic Hydrocarbons Surrogates												
Acridine-d9	34749-75-2	E641A/WT	0.1	%	85.0	----	----	----	----	----	----	
Chrysene-d12	1719-03-5	E641A/WT	0.1	%	93.4	----	----	----	----	----	----	
Naphthalene-d8	1146-65-2	E641A/WT	0.1	%	99.0	----	----	----	----	----	----	
Phenanthrene-d10	1517-22-2	E641A/WT	0.1	%	94.9	----	----	----	----	----	----	

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

No Breaches Found



SubMatrix: Soil (Matrix: Soil/Solid)		Client sample ID		25-02 SS3							
		Client sampling date / time		13-Jun-2025 12:00							
Analyte	CAS Number	Method/Lab	LOD	Unit	TY2506918-002						
Physical Tests											
Conductivity (1:2 leachate)	----	E100-LWT	0.00500	mS/cm	0.0410	----	----	----	----	----	----
Moisture	----	E144/WT	0.25	%	14.2	----	----	----	----	----	----
Metals											
Antimony	7440-36-0	E440C/WT	0.10	mg/kg	<0.10	----	----	----	----	----	----
Arsenic	7440-38-2	E440C/WT	0.10	mg/kg	1.72	----	----	----	----	----	----
Barium	7440-39-3	E440C/WT	0.50	mg/kg	27.2	----	----	----	----	----	----
Beryllium	7440-41-7	E440C/WT	0.10	mg/kg	0.16	----	----	----	----	----	----
Boron	7440-42-8	E440C/WT	5.0	mg/kg	<5.0	----	----	----	----	----	----
Cadmium	7440-43-9	E440C/WT	0.020	mg/kg	0.030	----	----	----	----	----	----
Calcium, soluble ion content	7440-70-2	E484/WT	0.50	mg/L	1.62	----	----	----	----	----	----
Chromium	7440-47-3	E440C/WT	0.50	mg/kg	17.3	----	----	----	----	----	----
Cobalt	7440-48-4	E440C/WT	0.10	mg/kg	4.59	----	----	----	----	----	----
Copper	7440-50-8	E440C/WT	0.50	mg/kg	8.62	----	----	----	----	----	----
Lead	7439-92-1	E440C/WT	0.50	mg/kg	5.68	----	----	----	----	----	----
Magnesium, soluble ion content	7439-95-4	E484/WT	0.50	mg/L	0.66	----	----	----	----	----	----
Molybdenum	7439-98-7	E440C/WT	0.10	mg/kg	0.43	----	----	----	----	----	----
Nickel	7440-02-0	E440C/WT	0.50	mg/kg	8.56	----	----	----	----	----	----
Selenium	7782-49-2	E440C/WT	0.20	mg/kg	<0.20	----	----	----	----	----	----
Silver	7440-22-4	E440C/WT	0.10	mg/kg	<0.10	----	----	----	----	----	----
Sodium, soluble ion content	17341-25-2	E484/WT	0.50	mg/L	0.56	----	----	----	----	----	----
Thallium	7440-28-0	E440C/WT	0.050	mg/kg	0.119	----	----	----	----	----	----
Uranium	7440-61-1	E440C/WT	0.050	mg/kg	0.673	----	----	----	----	----	----
Vanadium	7440-62-2	E440C/WT	0.20	mg/kg	26.9	----	----	----	----	----	----
Zinc	7440-66-6	E440C/WT	2.0	mg/kg	23.4	----	----	----	----	----	----
Sodium adsorption ratio [SAR]	----	E484/WT	0.10	-	<0.10	----	----	----	----	----	----
Volatile Organic Compounds											
Benzene	71-43-2	E611A/WT	0.0050	mg/kg	<0.0050	----	----	----	----	----	----
Ethylbenzene	100-41-4	E611A/WT	0.015	mg/kg	<0.015	----	----	----	----	----	----
Toluene	108-88-3	E611A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Xylene, m+p-	179601-23-1	E611A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Xylene, o-	95-47-6	E611A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Xylenes, total	1330-20-7	E611A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
BTEX, total	----	E611A/WT	0.10	mg/kg	<0.10	----	----	----	----	----	----
Hydrocarbons											
F1 (C6-C10)	----	E581.F1/WT	5.0	mg/kg	<5.0	----	----	----	----	----	----
F2 (C10-C16)	----	E601.SG-L/WT	10	mg/kg	<10	----	----	----	----	----	----
F3 (C16-C34)	----	E601.SG-L/WT	50	mg/kg	<50	----	----	----	----	----	----
F4 (C34-C50)	----	E601.SG-L/WT	50	mg/kg	<50	----	----	----	----	----	----
F1-BTEX	----	EC580/WT	5.0	mg/kg	<5.0	----	----	----	----	----	----



Analyte	CAS Number	Method/Lab	LOR	Unit	Client sample ID						
					25-02 SS3						
(Matrix: Soil/Solid)					Client sampling date / time						
					13-Jun-2025 12:00						
					TY2506918-002	----	----	----	----	----	----
Hydrocarbons											
Hydrocarbons, total (C6-C50)	n/a	EC581/WT	80	mg/kg	<80	----	----	----	----	----	----
Chromatogram to baseline at nC50	n/a	E601.SG-LWT	-	-	YES	----	----	----	----	----	----
Hydrocarbons Surrogates											
Bromobenzotrifluoride, 2- (F2-F4 surrogate)	392-83-6	E601.SG-LWT	1.0	%	92.8	----	----	----	----	----	----
Dichlorotoluene, 3,4-	95-75-0	E581.F1/WT	1.0	%	70.7	----	----	----	----	----	----
Volatile Organic Compounds Surrogates											
Bromofluorobenzene, 4-	460-00-4	E611A/WT	0.10	%	74.8	----	----	----	----	----	----
Difluorobenzene, 1,4-	540-36-3	E611A/WT	0.10	%	79.4	----	----	----	----	----	----
Polycyclic Aromatic Hydrocarbons											
Acenaphthene	83-32-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Acenaphthylene	208-96-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Anthracene	120-12-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benz(a)anthracene	56-55-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(a)pyrene	50-32-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(b+j)fluoranthene	n/a	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(g,h,i)perylene	191-24-2	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(k)fluoranthene	207-08-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Chrysene	218-01-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Dibenz(a,h)anthracene	53-70-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Fluoranthene	206-44-0	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Fluorene	86-73-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Indeno(1,2,3-c,d)pyrene	193-39-5	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Methylnaphthalene, 1-	90-12-0	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Methylnaphthalene, 1+2-	----	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Methylnaphthalene, 2-	91-57-6	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Naphthalene	91-20-3	E641A/WT	0.010	mg/kg	<0.010	----	----	----	----	----	----
Phenanthrene	85-01-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Pyrene	129-00-0	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Polycyclic Aromatic Hydrocarbons Surrogates											
Acridine-d9	34749-75-2	E641A/WT	0.1	%	78.4	----	----	----	----	----	----
Chrysene-d12	1719-03-5	E641A/WT	0.1	%	91.3	----	----	----	----	----	----
Naphthalene-d8	1146-65-2	E641A/WT	0.1	%	93.2	----	----	----	----	----	----
Phenanthrene-d10	1517-22-2	E641A/WT	0.1	%	90.8	----	----	----	----	----	----

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

No Breaches Found



SubMatrix: Soil (Matrix: Soil/Solid)		Client sample ID		25-04 SS3		Client sampling date / time		15-Jun-2025 12:00		TY2506918-003		---	---	---	---	---	---
Analyte	CAS Number	Method/Lab	LOD	Unit													
Physical Tests																	
Conductivity (1:2 leachate)	---	E100-LWT	0.00500	mS/cm	0.0805	---	---	---	---	---	---	---	---	---	---	---	---
Moisture	---	E144/WT	0.25	%	5.73	---	---	---	---	---	---	---	---	---	---	---	---
Metals																	
Antimony	7440-36-0	E440C/WT	0.10	mg/kg	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Arsenic	7440-38-2	E440C/WT	0.10	mg/kg	1.32	---	---	---	---	---	---	---	---	---	---	---	---
Barium	7440-39-3	E440C/WT	0.50	mg/kg	15.6	---	---	---	---	---	---	---	---	---	---	---	---
Beryllium	7440-41-7	E440C/WT	0.10	mg/kg	0.15	---	---	---	---	---	---	---	---	---	---	---	---
Boron	7440-42-8	E440C/WT	5.0	mg/kg	<5.0	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium	7440-43-9	E440C/WT	0.020	mg/kg	0.022	---	---	---	---	---	---	---	---	---	---	---	---
Calcium, soluble ion content	7440-70-2	E484/WT	0.50	mg/L	3.09	---	---	---	---	---	---	---	---	---	---	---	---
Chromium	7440-47-3	E440C/WT	0.50	mg/kg	13.8	---	---	---	---	---	---	---	---	---	---	---	---
Cobalt	7440-48-4	E440C/WT	0.10	mg/kg	2.90	---	---	---	---	---	---	---	---	---	---	---	---
Copper	7440-50-8	E440C/WT	0.50	mg/kg	4.84	---	---	---	---	---	---	---	---	---	---	---	---
Lead	7439-92-1	E440C/WT	0.50	mg/kg	2.85	---	---	---	---	---	---	---	---	---	---	---	---
Magnesium, soluble ion content	7439-95-4	E484/WT	0.50	mg/L	0.56	---	---	---	---	---	---	---	---	---	---	---	---
Molybdenum	7439-98-7	E440C/WT	0.10	mg/kg	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Nickel	7440-02-0	E440C/WT	0.50	mg/kg	8.59	---	---	---	---	---	---	---	---	---	---	---	---
Selenium	7782-49-2	E440C/WT	0.20	mg/kg	<0.20	---	---	---	---	---	---	---	---	---	---	---	---
Silver	7440-22-4	E440C/WT	0.10	mg/kg	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Sodium, soluble ion content	17341-25-2	E484/WT	0.50	mg/L	<0.50	---	---	---	---	---	---	---	---	---	---	---	---
Thallium	7440-28-0	E440C/WT	0.050	mg/kg	0.051	---	---	---	---	---	---	---	---	---	---	---	---
Uranium	7440-61-1	E440C/WT	0.050	mg/kg	0.328	---	---	---	---	---	---	---	---	---	---	---	---
Vanadium	7440-62-2	E440C/WT	0.20	mg/kg	16.6	---	---	---	---	---	---	---	---	---	---	---	---
Zinc	7440-66-6	E440C/WT	2.0	mg/kg	12.8	---	---	---	---	---	---	---	---	---	---	---	---
Sodium adsorption ratio [SAR]	---	E484/WT	0.10	-	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Volatile Organic Compounds																	
Benzene	71-43-2	E611A/WT	0.0050	mg/kg	<0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	100-41-4	E611A/WT	0.015	mg/kg	<0.015	---	---	---	---	---	---	---	---	---	---	---	---
Toluene	108-88-3	E611A/WT	0.050	mg/kg	<0.050	---	---	---	---	---	---	---	---	---	---	---	---
Xylene, m+p-	179601-23-1	E611A/WT	0.030	mg/kg	<0.030	---	---	---	---	---	---	---	---	---	---	---	---
Xylene, o-	95-47-6	E611A/WT	0.030	mg/kg	<0.030	---	---	---	---	---	---	---	---	---	---	---	---
Xylenes, total	1330-20-7	E611A/WT	0.050	mg/kg	<0.050	---	---	---	---	---	---	---	---	---	---	---	---
BTEX, total	---	E611A/WT	0.10	mg/kg	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Hydrocarbons																	
F1 (C6-C10)	---	E581.F1/WT	5.0	mg/kg	<5.0	---	---	---	---	---	---	---	---	---	---	---	---
F2 (C10-C16)	---	E601.SG-L/WT	10	mg/kg	<10	---	---	---	---	---	---	---	---	---	---	---	---
F3 (C16-C34)	---	E601.SG-L/WT	50	mg/kg	<50	---	---	---	---	---	---	---	---	---	---	---	---
F4 (C34-C50)	---	E601.SG-L/WT	50	mg/kg	<50	---	---	---	---	---	---	---	---	---	---	---	---
F1-BTEX	---	EC580/WT	5.0	mg/kg	<5.0	---	---	---	---	---	---	---	---	---	---	---	---



Analyte	CAS Number	Method/Lab	LOR	Unit	Client sample ID						
					25-04 SS3						
(Matrix: Soil/Solid)					Client sampling date / time						
					15-Jun-2025 12:00						
					TY2506918-003	----	----	----	----	----	----
Hydrocarbons											
Hydrocarbons, total (C6-C50)	n/a	EC581/WT	80	mg/kg	<80	----	----	----	----	----	----
Chromatogram to baseline at nC50	n/a	E601.SG-LWT	-	-	YES	----	----	----	----	----	----
Hydrocarbons Surrogates											
Bromobenzotrifluoride, 2- (F2-F4 surrogate)	392-83-6	E601.SG-LWT	1.0	%	97.4	----	----	----	----	----	----
Dichlorotoluene, 3,4-	95-75-0	E581.F1/WT	1.0	%	91.1	----	----	----	----	----	----
Volatile Organic Compounds Surrogates											
Bromofluorobenzene, 4-	460-00-4	E611A/WT	0.10	%	87.7	----	----	----	----	----	----
Difluorobenzene, 1,4-	540-36-3	E611A/WT	0.10	%	93.9	----	----	----	----	----	----
Polycyclic Aromatic Hydrocarbons											
Acenaphthene	83-32-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Acenaphthylene	208-96-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Anthracene	120-12-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benz(a)anthracene	56-55-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(a)pyrene	50-32-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(b+j)fluoranthene	n/a	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(g,h,i)perylene	191-24-2	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(k)fluoranthene	207-08-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Chrysene	218-01-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Dibenz(a,h)anthracene	53-70-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Fluoranthene	206-44-0	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Fluorene	86-73-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Indeno(1,2,3-c,d)pyrene	193-39-5	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Methylnaphthalene, 1-	90-12-0	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Methylnaphthalene, 1+2-	----	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Methylnaphthalene, 2-	91-57-6	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Naphthalene	91-20-3	E641A/WT	0.010	mg/kg	<0.010	----	----	----	----	----	----
Phenanthrene	85-01-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Pyrene	129-00-0	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Polycyclic Aromatic Hydrocarbons Surrogates											
Acridine-d9	34749-75-2	E641A/WT	0.1	%	74.7	----	----	----	----	----	----
Chrysene-d12	1719-03-5	E641A/WT	0.1	%	86.7	----	----	----	----	----	----
Naphthalene-d8	1146-65-2	E641A/WT	0.1	%	87.2	----	----	----	----	----	----
Phenanthrene-d10	1517-22-2	E641A/WT	0.1	%	85.0	----	----	----	----	----	----

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

No Breaches Found



SubMatrix: Soil (Matrix: Soil/Solid)		Client sample ID		25-01 SS2		Client sampling date / time		13-Jun-2025 12:00		TY2506918-004		---	---	---	---	---	---
Analyte	CAS Number	Method/Lab	LOR	Unit								---	---	---	---	---	---
Physical Tests																	
Conductivity (1:2 leachate)	---	E100-LWT	0.00500	mS/cm	0.0940	---	---	---	---	---	---	---	---	---	---	---	---
Moisture	---	E144/WT	0.25	%	4.86	---	---	---	---	---	---	---	---	---	---	---	---
Metals																	
Antimony	7440-36-0	E440C/WT	0.10	mg/kg	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Arsenic	7440-38-2	E440C/WT	0.10	mg/kg	1.58	---	---	---	---	---	---	---	---	---	---	---	---
Barium	7440-39-3	E440C/WT	0.50	mg/kg	17.8	---	---	---	---	---	---	---	---	---	---	---	---
Beryllium	7440-41-7	E440C/WT	0.10	mg/kg	0.13	---	---	---	---	---	---	---	---	---	---	---	---
Boron	7440-42-8	E440C/WT	5.0	mg/kg	<5.0	---	---	---	---	---	---	---	---	---	---	---	---
Cadmium	7440-43-9	E440C/WT	0.020	mg/kg	0.025	---	---	---	---	---	---	---	---	---	---	---	---
Calcium, soluble ion content	7440-70-2	E484/WT	0.50	mg/L	3.59	---	---	---	---	---	---	---	---	---	---	---	---
Chromium	7440-47-3	E440C/WT	0.50	mg/kg	14.4	---	---	---	---	---	---	---	---	---	---	---	---
Cobalt	7440-48-4	E440C/WT	0.10	mg/kg	3.08	---	---	---	---	---	---	---	---	---	---	---	---
Copper	7440-50-8	E440C/WT	0.50	mg/kg	7.49	---	---	---	---	---	---	---	---	---	---	---	---
Lead	7439-92-1	E440C/WT	0.50	mg/kg	3.45	---	---	---	---	---	---	---	---	---	---	---	---
Magnesium, soluble ion content	7439-95-4	E484/WT	0.50	mg/L	0.99	---	---	---	---	---	---	---	---	---	---	---	---
Molybdenum	7439-98-7	E440C/WT	0.10	mg/kg	0.21	---	---	---	---	---	---	---	---	---	---	---	---
Nickel	7440-02-0	E440C/WT	0.50	mg/kg	8.83	---	---	---	---	---	---	---	---	---	---	---	---
Selenium	7782-49-2	E440C/WT	0.20	mg/kg	<0.20	---	---	---	---	---	---	---	---	---	---	---	---
Silver	7440-22-4	E440C/WT	0.10	mg/kg	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Sodium, soluble ion content	17341-25-2	E484/WT	0.50	mg/L	0.67	---	---	---	---	---	---	---	---	---	---	---	---
Thallium	7440-28-0	E440C/WT	0.050	mg/kg	0.068	---	---	---	---	---	---	---	---	---	---	---	---
Uranium	7440-61-1	E440C/WT	0.050	mg/kg	0.471	---	---	---	---	---	---	---	---	---	---	---	---
Vanadium	7440-62-2	E440C/WT	0.20	mg/kg	16.7	---	---	---	---	---	---	---	---	---	---	---	---
Zinc	7440-66-6	E440C/WT	2.0	mg/kg	16.1	---	---	---	---	---	---	---	---	---	---	---	---
Sodium adsorption ratio [SAR]	---	E484/WT	0.10	-	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Volatile Organic Compounds																	
Benzene	71-43-2	E611A/WT	0.0050	mg/kg	<0.0050	---	---	---	---	---	---	---	---	---	---	---	---
Ethylbenzene	100-41-4	E611A/WT	0.015	mg/kg	<0.015	---	---	---	---	---	---	---	---	---	---	---	---
Toluene	108-88-3	E611A/WT	0.050	mg/kg	<0.050	---	---	---	---	---	---	---	---	---	---	---	---
Xylene, m+p-	179601-23-1	E611A/WT	0.030	mg/kg	<0.030	---	---	---	---	---	---	---	---	---	---	---	---
Xylene, o-	95-47-6	E611A/WT	0.030	mg/kg	<0.030	---	---	---	---	---	---	---	---	---	---	---	---
Xylenes, total	1330-20-7	E611A/WT	0.050	mg/kg	<0.050	---	---	---	---	---	---	---	---	---	---	---	---
BTEX, total	---	E611A/WT	0.10	mg/kg	<0.10	---	---	---	---	---	---	---	---	---	---	---	---
Hydrocarbons																	
F1 (C6-C10)	---	E581.F1/WT	5.0	mg/kg	<5.0	---	---	---	---	---	---	---	---	---	---	---	---
F2 (C10-C16)	---	E601.SG-L/WT	10	mg/kg	<10	---	---	---	---	---	---	---	---	---	---	---	---
F3 (C16-C34)	---	E601.SG-L/WT	50	mg/kg	<50	---	---	---	---	---	---	---	---	---	---	---	---
F4 (C34-C50)	---	E601.SG-L/WT	50	mg/kg	<50	---	---	---	---	---	---	---	---	---	---	---	---
F1-BTEX	---	EC580/WT	5.0	mg/kg	<5.0	---	---	---	---	---	---	---	---	---	---	---	---



Analyte	CAS Number	Method/Lab	LOR	Unit	Client sample ID						
					25-01 SS2						
(Matrix: Soil/Solid)					Client sampling date / time						
					13-Jun-2025 12:00						
					TY2506918-004	----	----	----	----	----	----
Hydrocarbons											
Hydrocarbons, total (C6-C50)	n/a	EC581/WT	80	mg/kg	<80	----	----	----	----	----	----
Chromatogram to baseline at nC50	n/a	E601.SG-LWT	-	-	YES	----	----	----	----	----	----
Hydrocarbons Surrogates											
Bromobenzotrifluoride, 2- (F2-F4 surrogate)	392-83-6	E601.SG-LWT	1.0	%	91.8	----	----	----	----	----	----
Dichlorotoluene, 3,4-	95-75-0	E581.F1/WT	1.0	%	84.0	----	----	----	----	----	----
Volatile Organic Compounds Surrogates											
Bromofluorobenzene, 4-	460-00-4	E611A/WT	0.10	%	89.4	----	----	----	----	----	----
Difluorobenzene, 1,4-	540-36-3	E611A/WT	0.10	%	91.0	----	----	----	----	----	----
Polycyclic Aromatic Hydrocarbons											
Acenaphthene	83-32-9	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Acenaphthylene	208-96-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Anthracene	120-12-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benz(a)anthracene	56-55-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Benzo(a)pyrene	50-32-8	E641A/WT	0.050	mg/kg	0.088	----	----	----	----	----	----
Benzo(b+j)fluoranthene	n/a	E641A/WT	0.050	mg/kg	0.216	----	----	----	----	----	----
Benzo(g,h,i)perylene	191-24-2	E641A/WT	0.050	mg/kg	0.118	----	----	----	----	----	----
Benzo(k)fluoranthene	207-08-9	E641A/WT	0.050	mg/kg	0.077	----	----	----	----	----	----
Chrysene	218-01-9	E641A/WT	0.050	mg/kg	0.090	----	----	----	----	----	----
Dibenz(a,h)anthracene	53-70-3	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Fluoranthene	206-44-0	E641A/WT	0.050	mg/kg	0.069	----	----	----	----	----	----
Fluorene	86-73-7	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Indeno(1,2,3-c,d)pyrene	193-39-5	E641A/WT	0.050	mg/kg	0.118	----	----	----	----	----	----
Methylnaphthalene, 1-	90-12-0	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Methylnaphthalene, 1+2-	----	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Methylnaphthalene, 2-	91-57-6	E641A/WT	0.030	mg/kg	<0.030	----	----	----	----	----	----
Naphthalene	91-20-3	E641A/WT	0.010	mg/kg	<0.010	----	----	----	----	----	----
Phenanthrene	85-01-8	E641A/WT	0.050	mg/kg	<0.050	----	----	----	----	----	----
Pyrene	129-00-0	E641A/WT	0.050	mg/kg	0.072	----	----	----	----	----	----
Polycyclic Aromatic Hydrocarbons Surrogates											
Acridine-d9	34749-75-2	E641A/WT	0.1	%	82.6	----	----	----	----	----	----
Chrysene-d12	1719-03-5	E641A/WT	0.1	%	91.9	----	----	----	----	----	----
Naphthalene-d8	1146-65-2	E641A/WT	0.1	%	95.3	----	----	----	----	----	----
Phenanthrene-d10	1517-22-2	E641A/WT	0.1	%	93.4	----	----	----	----	----	----

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

No Breaches Found



QUALITY CONTROL INTERPRETIVE REPORT

<p>Work Order : TY2506918</p> <p>Client : Thurber Engineering Ltd.</p> <p>Contact : Donna Rein</p> <p>Address : 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1</p> <p>Telephone : ----</p> <p>Project : Pineimuta Modular Bridge/ 68438</p> <p>PO : ----</p> <p>C-O-C number : ----</p> <p>Sampler : ----</p> <p>Site :</p> <p>Quote number : Standing Offer Price List - 2025</p> <p>No. of samples received : 4</p> <p>No. of samples analysed : 4</p>	<p>Page : 1 of 9</p> <p>Laboratory : ALS Environmental - Thunder Bay</p> <p>Account Manager : Christine Paradis</p> <p>Address : 1081 Barton Street Thunder Bay, Ontario Canada P7B 5N3</p> <p>Telephone : +1 807 623 6463</p> <p>Date Samples Received : 28-Jun-2025 09:01</p> <p>Issue Date : 08-Jul-2025 16:44</p>
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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 Laboratory Control Sample (LCS) outliers occur
- No Matrix Spike 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)

- Analysis Holding Time Outliers exist - please see following pages for full details.

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	
Hydrocarbons : CCME PHC - F1 by Headspace GC-FID										
Glass soil methanol vial [ON MECP] 25-04 SS3	E581.F1	15-Jun-2025	02-Jul-2025	14 days	17 days	* EHT	02-Jul-2025	40 days	0 days	✓
Hydrocarbons : CCME PHC - F1 by Headspace GC-FID										
Glass soil methanol vial [ON MECP] 25-01 SS2	E581.F1	13-Jun-2025	02-Jul-2025	14 days	19 days	* EHTR	02-Jul-2025	40 days	0 days	✓
Hydrocarbons : CCME PHC - F1 by Headspace GC-FID										
Glass soil methanol vial [ON MECP] 25-02 SS3	E581.F1	13-Jun-2025	02-Jul-2025	14 days	19 days	* EHTR	02-Jul-2025	40 days	0 days	✓
Hydrocarbons : CCME PHC - F1 by Headspace GC-FID										
Glass soil methanol vial [ON MECP] 25-05 SS2	E581.F1	11-Jun-2025	02-Jul-2025	14 days	21 days	* EHTR	02-Jul-2025	40 days	0 days	✓
Hydrocarbons : CCME PHCs - F2-F4 by GC-FID (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-04 SS3	E601.SG-L	15-Jun-2025	02-Jul-2025	14 days	17 days	* EHT	03-Jul-2025	40 days	1 days	✓
Hydrocarbons : CCME PHCs - F2-F4 by GC-FID (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-01 SS2	E601.SG-L	13-Jun-2025	02-Jul-2025	14 days	19 days	* EHTR	03-Jul-2025	40 days	1 days	✓
Hydrocarbons : CCME PHCs - F2-F4 by GC-FID (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-02 SS3	E601.SG-L	13-Jun-2025	02-Jul-2025	14 days	19 days	* EHTR	03-Jul-2025	40 days	1 days	✓



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	
Hydrocarbons : CCME PHCs - F2-F4 by GC-FID (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-05 SS2	E601.SG-L	11-Jun-2025	02-Jul-2025	14 days	21 days	* EHTR	03-Jul-2025	40 days	1 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS (<355 µm)										
Glass soil jar/Teflon lined cap [ON MECP] 25-04 SS3	E440C	15-Jun-2025	07-Jul-2025	180 days	22 days	✓	07-Jul-2025	180 days	22 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS (<355 µm)										
Glass soil jar/Teflon lined cap [ON MECP] 25-01 SS2	E440C	13-Jun-2025	07-Jul-2025	180 days	24 days	✓	07-Jul-2025	180 days	24 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS (<355 µm)										
Glass soil jar/Teflon lined cap [ON MECP] 25-02 SS3	E440C	13-Jun-2025	07-Jul-2025	180 days	24 days	✓	07-Jul-2025	180 days	24 days	✓
Metals : Metals in Soil/Solid by CRC ICPMS (<355 µm)										
Glass soil jar/Teflon lined cap [ON MECP] 25-05 SS2	E440C	11-Jun-2025	07-Jul-2025	180 days	26 days	✓	07-Jul-2025	180 days	26 days	✓
Metals : Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)										
Glass soil jar/Teflon lined cap [ON MECP] 25-04 SS3	E484	15-Jun-2025	07-Jul-2025	180 days	22 days	✓	07-Jul-2025	180 days	0 days	✓
Metals : Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)										
Glass soil jar/Teflon lined cap [ON MECP] 25-01 SS2	E484	13-Jun-2025	07-Jul-2025	180 days	24 days	✓	07-Jul-2025	180 days	0 days	✓
Metals : Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)										
Glass soil jar/Teflon lined cap [ON MECP] 25-02 SS3	E484	13-Jun-2025	07-Jul-2025	180 days	24 days	✓	07-Jul-2025	180 days	0 days	✓
Metals : Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)										
Glass soil jar/Teflon lined cap [ON MECP] 25-05 SS2	E484	11-Jun-2025	07-Jul-2025	180 days	26 days	✓	07-Jul-2025	180 days	0 days	✓



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 : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-04 SS3	E100-L	15-Jun-2025	07-Jul-2025	30 days	22 days	✓	08-Jul-2025	30 days	22 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-01 SS2	E100-L	13-Jun-2025	07-Jul-2025	30 days	24 days	✓	08-Jul-2025	30 days	24 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-02 SS3	E100-L	13-Jun-2025	07-Jul-2025	30 days	24 days	✓	08-Jul-2025	30 days	24 days	✓
Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)										
Glass soil jar/Teflon lined cap [ON MECP] 25-05 SS2	E100-L	11-Jun-2025	07-Jul-2025	30 days	26 days	✓	08-Jul-2025	30 days	26 days	✓
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] 25-01 SS2	E144	13-Jun-2025	----	----	----		07-Jul-2025	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] 25-02 SS3	E144	13-Jun-2025	----	----	----		07-Jul-2025	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] 25-04 SS3	E144	15-Jun-2025	----	----	----		07-Jul-2025	----	----	
Physical Tests : Moisture Content by Gravimetry										
Glass soil jar/Teflon lined cap [ON MECP] 25-05 SS2	E144	11-Jun-2025	----	----	----		07-Jul-2025	----	----	
Polycyclic Aromatic Hydrocarbons : PAHs in Soil/solid by Hex: Ace GC-MS										
Glass soil jar/Teflon lined cap [ON MECP] 25-04 SS3	E641A	15-Jun-2025	02-Jul-2025	60 days	17 days	✓	03-Jul-2025	40 days	0 days	✓



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	
Polycyclic Aromatic Hydrocarbons : PAHs in Soil/solid by Hex:Ace GC-MS										
Glass soil jar/Teflon lined cap [ON MECP] 25-01 SS2	E641A	13-Jun-2025	02-Jul-2025	60 days	19 days	✓	03-Jul-2025	40 days	0 days	✓
Polycyclic Aromatic Hydrocarbons : PAHs in Soil/solid by Hex:Ace GC-MS										
Glass soil jar/Teflon lined cap [ON MECP] 25-02 SS3	E641A	13-Jun-2025	02-Jul-2025	60 days	19 days	✓	03-Jul-2025	40 days	0 days	✓
Polycyclic Aromatic Hydrocarbons : PAHs in Soil/solid by Hex:Ace GC-MS										
Glass soil jar/Teflon lined cap [ON MECP] 25-05 SS2	E641A	11-Jun-2025	02-Jul-2025	60 days	21 days	✓	03-Jul-2025	40 days	0 days	✓
Volatile Organic Compounds : BTEX by Headspace GC-MS										
Glass soil methanol vial [ON MECP] 25-04 SS3	E611A	15-Jun-2025	02-Jul-2025	14 days	17 days	* EHT	02-Jul-2025	40 days	0 days	✓
Volatile Organic Compounds : BTEX by Headspace GC-MS										
Glass soil methanol vial [ON MECP] 25-01 SS2	E611A	13-Jun-2025	02-Jul-2025	14 days	19 days	* EHTR	02-Jul-2025	40 days	0 days	✓
Volatile Organic Compounds : BTEX by Headspace GC-MS										
Glass soil methanol vial [ON MECP] 25-02 SS3	E611A	13-Jun-2025	02-Jul-2025	14 days	19 days	* EHTR	02-Jul-2025	40 days	0 days	✓
Volatile Organic Compounds : BTEX by Headspace GC-MS										
Glass soil methanol vial [ON MECP] 25-05 SS2	E611A	11-Jun-2025	02-Jul-2025	14 days	21 days	* EHTR	02-Jul-2025	40 days	0 days	✓

Legend & Qualifier Definitions

EHTR: Exceeded ALS recommended hold time prior to sample receipt.
 EHT: Exceeded ALS recommended hold time prior to analysis.
 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	Method	QC Lot #	Count		Frequency (%)		
			QC	Regular	Actual	Expected	Evaluation
Analytical Methods							
Laboratory Duplicates (DUP)							
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	2088837	1	16	6.2	5.0	✓
Moisture Content by Gravimetry	E144	2092349	1	20	5.0	5.0	✓
Metals in Soil/Solid by CRC ICPMS (<355 µm)	E440C	2088835	1	20	5.0	5.0	✓
Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)	E484	2088838	1	16	6.2	5.0	✓
CCME PHC - F1 by Headspace GC-FID	E581.F1	2085840	1	20	5.0	5.0	✓
CCME PHCs - F2-F4 by GC-FID (Low Level)	E601.SG-L	2086214	1	4	25.0	5.0	✓
BTEX by Headspace GC-MS	E611A	2085839	1	20	5.0	5.0	✓
PAHs in Soil/solid by Hex:Ace GC-MS	E641A	2086215	1	4	25.0	5.0	✓
Laboratory Control Samples (LCS)							
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	2088837	2	16	12.5	10.0	✓
Moisture Content by Gravimetry	E144	2092349	1	20	5.0	5.0	✓
Metals in Soil/Solid by CRC ICPMS (<355 µm)	E440C	2088835	2	20	10.0	10.0	✓
Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)	E484	2088838	2	16	12.5	10.0	✓
CCME PHC - F1 by Headspace GC-FID	E581.F1	2085840	1	20	5.0	5.0	✓
CCME PHCs - F2-F4 by GC-FID (Low Level)	E601.SG-L	2086214	1	4	25.0	5.0	✓
BTEX by Headspace GC-MS	E611A	2085839	1	20	5.0	5.0	✓
PAHs in Soil/solid by Hex:Ace GC-MS	E641A	2086215	1	4	25.0	5.0	✓
Method Blanks (MB)							
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L	2088837	1	16	6.2	5.0	✓
Moisture Content by Gravimetry	E144	2092349	1	20	5.0	5.0	✓
Metals in Soil/Solid by CRC ICPMS (<355 µm)	E440C	2088835	1	20	5.0	5.0	✓
Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)	E484	2088838	1	16	6.2	5.0	✓
CCME PHC - F1 by Headspace GC-FID	E581.F1	2085840	1	20	5.0	5.0	✓
CCME PHCs - F2-F4 by GC-FID (Low Level)	E601.SG-L	2086214	1	4	25.0	5.0	✓
BTEX by Headspace GC-MS	E611A	2085839	1	20	5.0	5.0	✓
PAHs in Soil/solid by Hex:Ace GC-MS	E641A	2086215	1	4	25.0	5.0	✓
Matrix Spikes (MS)							
CCME PHC - F1 by Headspace GC-FID	E581.F1	2085840	1	20	5.0	5.0	✓
CCME PHCs - F2-F4 by GC-FID (Low Level)	E601.SG-L	2086214	1	4	25.0	5.0	✓
BTEX by Headspace GC-MS	E611A	2085839	1	20	5.0	5.0	✓
PAHs in Soil/solid by Hex:Ace GC-MS	E641A	2086215	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
Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level)	E100-L ALS Environmental - Waterloo	Soil/Solid	CSSS Ch. 15 (mod)/APHA 2510 (mod)	Conductivity, also known as Electrical Conductivity (EC) or Specific Conductance, is measured by immersion of a conductivity cell with platinum electrodes into a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Conductance is measured in the fluid that is observed in the upper layer.
Moisture Content by Gravimetry	E144 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	Moisture is measured gravimetrically by drying the sample at 105°C. Moisture content is calculated as the weight loss (due to water) divided by the wet weight of the sample, expressed as a percentage.
Metals in Soil/Solid by CRC ICPMS (<355 µm)	E440C ALS Environmental - Waterloo	Soil/Solid	EPA 6020B (mod)	<p>This method is intended to liberate metals that may be environmentally available. Samples are dried, then sieved through a 355 µm sieve, and digested with HNO₃ and HCl.</p> <p>Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Silicate minerals are not solubilized. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. This method does not adequately recover elemental sulfur, and is unsuitable for assessment of elemental sulfur standards or guidelines.</p> <p>Analysis is by Collision/Reaction Cell ICPMS.</p>
Sodium Adsorption Ratio (SAR) - 1:2 Soil:Water (Dry)	E484 ALS Environmental - Waterloo	Soil/Solid	SW846 6010C	A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES. The concentrations of Na, Ca and Mg are reported as per CALA requirements for calculated parameters. These individual parameters are not for comparison to any guideline.
CCME PHC - F1 by Headspace GC-FID	E581.F1 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	<p>CCME Fraction 1 (F1) is analyzed by static headspace GC-FID. Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.</p> <p>Analytical methods for CCME Petroleum Hydrocarbons (PHCs) are validated to comply fully with the Reference Method for the Canada-Wide Standard for PHC. Test results are expressed on a dry weight basis. Unless qualified, all required quality control criteria of the CCME PHC method have been met, including response factor and linearity requirements.</p>



Analytical Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
CCME PHCs - F2-F4 by GC-FID (Low Level)	E601.SG-L ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	Sample extracts are subjected to in-situ silica gel treatment prior to analysis by GC-FID for CCME hydrocarbon fractions (F2-F4). Analytical methods for CCME Petroleum Hydrocarbons (PHCs) are validated to comply fully with the Reference Method for the Canada-Wide Standard for PHC. Test results are expressed on a dry weight basis. Unless qualified, all required quality control criteria of the CCME PHC method have been met, including response factor and linearity requirements.
BTEX by Headspace GC-MS	E611A ALS Environmental - Waterloo	Soil/Solid	EPA 8260D (mod)	Volatile Organic Compounds (VOCs) are analyzed by static headspace GC-MS. Samples are prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.
PAHs in Soil/solid by Hex:Acetone GC-MS	E641A ALS Environmental - Waterloo	Soil/Solid	EPA 8270E (mod)	Polycyclic Aromatic Hydrocarbons (PAHs) are extracted with hexane/acetone and analyzed by GC-MS. If reported, IACR (index of additive cancer risk, unitless) and B(a)P toxic potency equivalent (in soil concentration units) are calculated as per CCME PAH Soil Quality Guidelines fact sheet (2010) or ABT1.
F1-BTEX	EC580 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	F1-BTEX is calculated as follows: F1-BTEX = F1 (C6-C10) minus benzene, toluene, ethylbenzene and xylenes (BTEX).
Sum F1 to F4 (C6-C50)	EC581 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1	Hydrocarbons, total (C6-C50) is the sum of CCME Fractions F1(C6-C10), F2(C10-C16), F3(C16-C34), and F4(C34-C50). F4G-sg is not used within this calculation due to overlap with other fractions.

Preparation Methods	Method / Lab	Matrix	Method Reference	Method Descriptions
Leach 1:2 Soil:Water for pH/EC	EP108 ALS Environmental - Waterloo	Soil/Solid	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL	The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water.
Digestion for Metals and Mercury (355 µm Sieve)	EP440C ALS Environmental - Waterloo	Soil/Solid	EPA 200.2 (mod)	Samples are sieved through a 355 µm sieve, and digested with HNO ₃ and HCl. This method is intended to liberate metals that may be environmentally available.
VOCs Methanol Extraction for Headspace Analysis	EP581 ALS Environmental - Waterloo	Soil/Solid	EPA 5035A (mod)	VOCs in samples are extracted with methanol. Extracts are then prepared in headspace vials and are heated and agitated on the headspace autosampler, causing VOCs to partition between the aqueous phase and the headspace in accordance with Henry's law.
PHCs and PAHs Hexane-Acetone Tumbler Extraction	EP601 ALS Environmental - Waterloo	Soil/Solid	CCME PHC in Soil - Tier 1 (mod)	Samples are subsampled and Petroleum Hydrocarbons (PHC) and PAHs are extracted with 1:1 hexane:acetone using a rotary extractor.

QUALITY CONTROL REPORT

Work Order	: TY2506918	Page	: 1 of 10
Client	: Thurber Engineering Ltd.	Laboratory	: ALS Environmental - Thunder Bay
Contact	: Donna Rein	Account Manager	: Christine Paradis
Address	: 1908 Ironoak Way Suite 202 Oakville ON Canada L6H 0N1	Address	: 1081 Barton Street Thunder Bay, Ontario Canada P7B 5N3
Telephone	: ----	Telephone	: +1 807 623 6463
Project	: Pineimuta Modular Bridge/ 68438	Date Samples Received	: 28-Jun-2025 09:01
PO	: ----	Date Analysis Commenced	: 02-Jul-2025
C-O-C number	: ----	Issue Date	: 08-Jul-2025 16:45
Sampler	: ----		
Site	:		
Quote number	: Standing Offer Price List - 2025		
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
- Matrix Spike (MS) Report; Recovery and Data Quality Objectives
- Reference Material (RM) Report; Recovery and Data Quality Objectives
- Method Blank (MB) Report; Recovery and Data Quality Objectives
- Laboratory Control Sample (LCS) 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.

<i>Signatories</i>	<i>Position</i>	<i>Laboratory Department</i>
David Tremblett	VOC Section Supervisor	Waterloo VOC, Waterloo, Ontario
Jeremy Gingras	Supervisor - Semi-Volatile Instrumentation	Waterloo Organics, Waterloo, Ontario
Josphin Masihi	Supervisor I	Waterloo Centralized Prep, Waterloo, Ontario
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Nik Perkio	Senior Analyst	Waterloo Metals, Waterloo, Ontario

Page : 2 of 10
Work Order : TY2506918
Client : Thurber Engineering Ltd.
Project : Pineimuta Modular Bridge/ 68438



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: 2088837)											
TY2506918-001	25-05 SS2	Conductivity (1:2 leachate)	----	E100-L	5.00	µS/cm	0.0681 mS/cm	63.8	6.52%	20%	----
Physical Tests (QC Lot: 2092349)											
TY2506918-003	25-04 SS3	Moisture	----	E144	0.25	%	5.73	5.46	4.83%	20%	----
Metals (QC Lot: 2088835)											
WT2517070-006	Anonymous	Antimony	7440-36-0	E440C	0.10	mg/kg	<0.10	<0.10	0	Diff <2x LOR	----
		Arsenic	7440-38-2	E440C	0.10	mg/kg	2.03	1.96	3.48%	30%	----
		Barium	7440-39-3	E440C	0.50	mg/kg	11.2	11.1	1.03%	40%	----
		Beryllium	7440-41-7	E440C	0.10	mg/kg	0.15	0.14	0.006	Diff <2x LOR	----
		Boron	7440-42-8	E440C	5.0	mg/kg	5.5	5.4	0.05	Diff <2x LOR	----
		Cadmium	7440-43-9	E440C	0.020	mg/kg	0.033	0.033	0.0006	Diff <2x LOR	----
		Chromium	7440-47-3	E440C	0.50	mg/kg	8.71	8.97	3.00%	30%	----
		Cobalt	7440-48-4	E440C	0.10	mg/kg	2.52	2.57	1.99%	30%	----
		Copper	7440-50-8	E440C	0.50	mg/kg	11.1	11.1	0.418%	30%	----
		Lead	7439-92-1	E440C	0.50	mg/kg	4.21	4.00	5.14%	40%	----
		Molybdenum	7439-98-7	E440C	0.10	mg/kg	0.27	0.27	0.004	Diff <2x LOR	----
		Nickel	7440-02-0	E440C	0.50	mg/kg	4.30	4.25	1.11%	30%	----
		Selenium	7782-49-2	E440C	0.20	mg/kg	<0.20	<0.20	0	Diff <2x LOR	----
		Silver	7440-22-4	E440C	0.10	mg/kg	<0.10	<0.10	0	Diff <2x LOR	----
		Thallium	7440-28-0	E440C	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Uranium	7440-61-1	E440C	0.050	mg/kg	0.406	0.386	5.09%	30%	----
		Vanadium	7440-62-2	E440C	0.20	mg/kg	25.2	27.3	8.04%	30%	----
		Zinc	7440-66-6	E440C	2.0	mg/kg	16.1	16.1	0.0944%	30%	----
Metals (QC Lot: 2088838)											
TY2506918-001	25-05 SS2	Calcium, soluble ion content	7440-70-2	E484	0.50	mg/L	1.83	1.85	0.02	Diff <2x LOR	----
		Magnesium, soluble ion content	7439-95-4	E484	0.50	mg/L	0.77	0.96	0.19	Diff <2x LOR	----
		Sodium, soluble ion content	17341-25-2	E484	0.50	mg/L	0.83	0.84	0.01	Diff <2x LOR	----
Volatile Organic Compounds (QC Lot: 2085839)											
TY2506918-001	25-05 SS2	Benzene	71-43-2	E611A	0.0050	mg/kg	<0.0050	<0.0050	0	Diff <2x LOR	----
		Ethylbenzene	100-41-4	E611A	0.015	mg/kg	<0.015	<0.015	0	Diff <2x LOR	----
		Toluene	108-88-3	E611A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----



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
Volatile Organic Compounds (QC Lot: 2085839) - continued											
TY2506918-001	25-05 SS2	Xylene, m+p-	179601-23-1	E611A	0.030	mg/kg	<0.030	<0.030	0	Diff <2x LOR	----
		Xylene, o-	95-47-6	E611A	0.030	mg/kg	<0.030	<0.030	0	Diff <2x LOR	----
Hydrocarbons (QC Lot: 2085840)											
TY2506918-001	25-05 SS2	F1 (C6-C10)	----	E581.F1	5.0	mg/kg	<5.0	<5.0	0	Diff <2x LOR	----
Hydrocarbons (QC Lot: 2086214)											
TY2506918-001	25-05 SS2	F2 (C10-C16)	----	E601.SG-L	10	mg/kg	<10	<10	0	Diff <2x LOR	----
		F3 (C16-C34)	----	E601.SG-L	50	mg/kg	<50	53	3	Diff <2x LOR	----
		F4 (C34-C50)	----	E601.SG-L	50	mg/kg	<50	<50	0	Diff <2x LOR	----
Polycyclic Aromatic Hydrocarbons (QC Lot: 2086215)											
TY2506918-001	25-05 SS2	Acenaphthene	83-32-9	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Acenaphthylene	208-96-8	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Anthracene	120-12-7	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Benz(a)anthracene	56-55-3	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Benzo(a)pyrene	50-32-8	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Benzo(b+j)fluoranthene	n/a	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Benzo(g,h,i)perylene	191-24-2	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Benzo(k)fluoranthene	207-08-9	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Chrysene	218-01-9	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Dibenz(a,h)anthracene	53-70-3	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Fluoranthene	206-44-0	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Fluorene	86-73-7	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Indeno(1,2,3-c,d)pyrene	193-39-5	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----
		Methylnaphthalene, 1-	90-12-0	E641A	0.030	mg/kg	<0.030	<0.030	0	Diff <2x LOR	----
		Methylnaphthalene, 2-	91-57-6	E641A	0.030	mg/kg	<0.030	<0.030	0	Diff <2x LOR	----
		Naphthalene	91-20-3	E641A	0.010	mg/kg	<0.010	<0.010	0	Diff <2x LOR	----
Phenanthrene	85-01-8	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----		
Pyrene	129-00-0	E641A	0.050	mg/kg	<0.050	<0.050	0	Diff <2x LOR	----		



Method Blank (MB) Report

A Method Blank is an analyte-free matrix that undergoes sample processing identical to that carried out for test samples. Method Blank results are used to monitor and control for potential contamination from the laboratory environment and reagents. For most tests, the DQO for Method Blanks is for the result to be < LOR.

Sub-Matrix: Soil/Solid

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Physical Tests (QCLot: 2088837)						
Conductivity (1:2 leachate)	---	E100-L	5	µS/cm	<5.00	---
Physical Tests (QCLot: 2092349)						
Moisture	---	E144	0.25	%	<0.25	---
Metals (QCLot: 2088835)						
Antimony	7440-36-0	E440C	0.1	mg/kg	<0.10	---
Arsenic	7440-38-2	E440C	0.1	mg/kg	<0.10	---
Barium	7440-39-3	E440C	0.5	mg/kg	<0.50	---
Beryllium	7440-41-7	E440C	0.1	mg/kg	<0.10	---
Boron	7440-42-8	E440C	5	mg/kg	<5.0	---
Cadmium	7440-43-9	E440C	0.02	mg/kg	<0.020	---
Chromium	7440-47-3	E440C	0.5	mg/kg	<0.50	---
Cobalt	7440-48-4	E440C	0.1	mg/kg	<0.10	---
Copper	7440-50-8	E440C	0.5	mg/kg	<0.50	---
Lead	7439-92-1	E440C	0.5	mg/kg	<0.50	---
Molybdenum	7439-98-7	E440C	0.1	mg/kg	<0.10	---
Nickel	7440-02-0	E440C	0.5	mg/kg	<0.50	---
Selenium	7782-49-2	E440C	0.2	mg/kg	<0.20	---
Silver	7440-22-4	E440C	0.1	mg/kg	<0.10	---
Thallium	7440-28-0	E440C	0.05	mg/kg	<0.050	---
Uranium	7440-61-1	E440C	0.05	mg/kg	<0.050	---
Vanadium	7440-62-2	E440C	0.2	mg/kg	<0.20	---
Zinc	7440-66-6	E440C	2	mg/kg	<2.0	---
Metals (QCLot: 2088838)						
Calcium, soluble ion content	7440-70-2	E484	0.5	mg/L	<0.50	---
Magnesium, soluble ion content	7439-95-4	E484	0.5	mg/L	<0.50	---
Sodium, soluble ion content	17341-25-2	E484	0.5	mg/L	<0.50	---
Volatile Organic Compounds (QCLot: 2085839)						
Benzene	71-43-2	E611A	0.005	mg/kg	<0.0050	---
Ethylbenzene	100-41-4	E611A	0.015	mg/kg	<0.015	---
Toluene	108-88-3	E611A	0.05	mg/kg	<0.050	---
Xylene, m+p-	179601-23-1	E611A	0.03	mg/kg	<0.030	---
Xylene, o-	95-47-6	E611A	0.03	mg/kg	<0.030	---



Sub-Matrix: **Soil/Solid**

Analyte	CAS Number	Method	LOR	Unit	Result	Qualifier
Hydrocarbons (QCLot: 2085840)						
F1 (C6-C10)	---	E581.F1	5	mg/kg	<5.0	---
Hydrocarbons (QCLot: 2086214)						
F2 (C10-C16)	---	E601.SG-L	10	mg/kg	<10	---
F3 (C16-C34)	---	E601.SG-L	50	mg/kg	<50	---
F4 (C34-C50)	---	E601.SG-L	50	mg/kg	<50	---
Polycyclic Aromatic Hydrocarbons (QCLot: 2086215)						
Acenaphthene	83-32-9	E641A	0.05	mg/kg	<0.050	---
Acenaphthylene	208-96-8	E641A	0.05	mg/kg	<0.050	---
Anthracene	120-12-7	E641A	0.05	mg/kg	<0.050	---
Benzo(a)anthracene	56-55-3	E641A	0.05	mg/kg	<0.050	---
Benzo(a)pyrene	50-32-8	E641A	0.05	mg/kg	<0.050	---
Benzo(b+j)fluoranthene	n/a	E641A	0.05	mg/kg	<0.050	---
Benzo(g,h,i)perylene	191-24-2	E641A	0.05	mg/kg	<0.050	---
Benzo(k)fluoranthene	207-08-9	E641A	0.05	mg/kg	<0.050	---
Chrysene	218-01-9	E641A	0.05	mg/kg	<0.050	---
Dibenz(a,h)anthracene	53-70-3	E641A	0.05	mg/kg	<0.050	---
Fluoranthene	206-44-0	E641A	0.05	mg/kg	<0.050	---
Fluorene	86-73-7	E641A	0.05	mg/kg	<0.050	---
Indeno(1,2,3-c,d)pyrene	193-39-5	E641A	0.05	mg/kg	<0.050	---
Methylnaphthalene, 1-	90-12-0	E641A	0.03	mg/kg	<0.030	---
Methylnaphthalene, 2-	91-57-6	E641A	0.03	mg/kg	<0.030	---
Naphthalene	91-20-3	E641A	0.01	mg/kg	<0.010	---
Phenanthrene	85-01-8	E641A	0.05	mg/kg	<0.050	---
Pyrene	129-00-0	E641A	0.05	mg/kg	<0.050	---



Laboratory Control Sample (LCS) Report

A Laboratory Control Sample (LCS) is an analyte-free matrix that has been fortified (spiked) with test analytes at known concentration and processed in an identical manner to test samples. LCS results are expressed as percent recovery, and are used to monitor and control test method accuracy and precision, independent of test sample matrix.

Sub-Matrix: Soil/Solid

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Physical Tests (QCLot: 2088837)									
Conductivity (1:2 leachate)	---	E100-L	5	µS/cm	1410 µS/cm	91.1	90.0	110	---
Physical Tests (QCLot: 2092349)									
Moisture	---	E144	0.25	%	50 %	99.6	90.0	110	---
Metals (QCLot: 2088835)									
Antimony	7440-36-0	E440C	0.1	mg/kg	100 mg/kg	103	80.0	120	---
Arsenic	7440-38-2	E440C	0.1	mg/kg	100 mg/kg	106	80.0	120	---
Barium	7440-39-3	E440C	0.5	mg/kg	25 mg/kg	102	80.0	120	---
Beryllium	7440-41-7	E440C	0.1	mg/kg	10 mg/kg	94.6	80.0	120	---
Boron	7440-42-8	E440C	5	mg/kg	100 mg/kg	98.8	80.0	120	---
Cadmium	7440-43-9	E440C	0.02	mg/kg	10 mg/kg	96.3	80.0	120	---
Chromium	7440-47-3	E440C	0.5	mg/kg	25 mg/kg	99.1	80.0	120	---
Cobalt	7440-48-4	E440C	0.1	mg/kg	25 mg/kg	97.3	80.0	120	---
Copper	7440-50-8	E440C	0.5	mg/kg	25 mg/kg	96.4	80.0	120	---
Lead	7439-92-1	E440C	0.5	mg/kg	50 mg/kg	95.5	80.0	120	---
Molybdenum	7439-98-7	E440C	0.1	mg/kg	25 mg/kg	101	80.0	120	---
Nickel	7440-02-0	E440C	0.5	mg/kg	50 mg/kg	96.0	80.0	120	---
Selenium	7782-49-2	E440C	0.2	mg/kg	100 mg/kg	102	80.0	120	---
Silver	7440-22-4	E440C	0.1	mg/kg	10 mg/kg	82.6	80.0	120	---
Thallium	7440-28-0	E440C	0.05	mg/kg	100 mg/kg	95.1	80.0	120	---
Uranium	7440-61-1	E440C	0.05	mg/kg	0.5 mg/kg	97.4	80.0	120	---
Vanadium	7440-62-2	E440C	0.2	mg/kg	50 mg/kg	102	80.0	120	---
Zinc	7440-66-6	E440C	2	mg/kg	50 mg/kg	93.6	80.0	120	---
Metals (QCLot: 2088838)									
Calcium, soluble ion content	7440-70-2	E484	0.5	mg/L	300 mg/L	113	80.0	120	---
Magnesium, soluble ion content	7439-95-4	E484	0.5	mg/L	50 mg/L	107	80.0	120	---
Sodium, soluble ion content	17341-25-2	E484	0.5	mg/L	50 mg/L	105	80.0	120	---
Volatile Organic Compounds (QCLot: 2085839)									
Benzene	71-43-2	E611A	0.005	mg/kg	3.48 mg/kg	84.9	70.0	130	---
Ethylbenzene	100-41-4	E611A	0.015	mg/kg	3.48 mg/kg	80.1	70.0	130	---
Toluene	108-88-3	E611A	0.05	mg/kg	3.48 mg/kg	85.0	70.0	130	---
Xylene, m+p-	179601-23-1	E611A	0.03	mg/kg	6.95 mg/kg	76.1	70.0	130	---



Sub-Matrix: Soil/Solid

					Laboratory Control Sample (LCS) Report				
					Spike	Recovery (%)	Recovery Limits (%)		
Analyte	CAS Number	Method	LOR	Unit	Target Concentration	LCS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 2085839) - continued									
Xylene, o-	95-47-6	E611A	0.03	mg/kg	3.48 mg/kg	80.9	70.0	130	----
Hydrocarbons (QCLot: 2085840)									
F1 (C6-C10)	---	E581.F1	5	mg/kg	69.2 mg/kg	103	80.0	120	----
Hydrocarbons (QCLot: 2086214)									
F2 (C10-C16)	---	E601.SG-L	10	mg/kg	671 mg/kg	104	70.0	130	----
F3 (C16-C34)	---	E601.SG-L	50	mg/kg	1380 mg/kg	108	70.0	130	----
F4 (C34-C50)	---	E601.SG-L	50	mg/kg	748 mg/kg	109	70.0	130	----
Polycyclic Aromatic Hydrocarbons (QCLot: 2086215)									
Acenaphthene	83-32-9	E641A	0.05	mg/kg	0.5 mg/kg	92.0	60.0	130	----
Acenaphthylene	208-96-8	E641A	0.05	mg/kg	0.5 mg/kg	90.7	60.0	130	----
Anthracene	120-12-7	E641A	0.05	mg/kg	0.5 mg/kg	87.6	60.0	130	----
Benz(a)anthracene	56-55-3	E641A	0.05	mg/kg	0.5 mg/kg	87.4	60.0	130	----
Benzo(a)pyrene	50-32-8	E641A	0.05	mg/kg	0.5 mg/kg	90.8	60.0	130	----
Benzo(b+)fluoranthene	n/a	E641A	0.05	mg/kg	0.5 mg/kg	92.2	60.0	130	----
Benzo(g,h,i)perylene	191-24-2	E641A	0.05	mg/kg	0.5 mg/kg	95.1	60.0	130	----
Benzo(k)fluoranthene	207-08-9	E641A	0.05	mg/kg	0.5 mg/kg	96.7	60.0	130	----
Chrysene	218-01-9	E641A	0.05	mg/kg	0.5 mg/kg	94.2	60.0	130	----
Dibenz(a,h)anthracene	53-70-3	E641A	0.05	mg/kg	0.5 mg/kg	93.9	60.0	130	----
Fluoranthene	206-44-0	E641A	0.05	mg/kg	0.5 mg/kg	93.7	60.0	130	----
Fluorene	86-73-7	E641A	0.05	mg/kg	0.5 mg/kg	92.1	60.0	130	----
Indeno(1,2,3-c,d)pyrene	193-39-5	E641A	0.05	mg/kg	0.5 mg/kg	92.6	60.0	130	----
Methylnaphthalene, 1-	90-12-0	E641A	0.03	mg/kg	0.5 mg/kg	84.0	60.0	130	----
Methylnaphthalene, 2-	91-57-6	E641A	0.03	mg/kg	0.5 mg/kg	89.0	60.0	130	----
Naphthalene	91-20-3	E641A	0.01	mg/kg	0.5 mg/kg	80.3	60.0	130	----
Phenanthrene	85-01-8	E641A	0.05	mg/kg	0.5 mg/kg	87.5	60.0	130	----
Pyrene	129-00-0	E641A	0.05	mg/kg	0.5 mg/kg	92.1	60.0	130	----



Matrix Spike (MS) Report

A Matrix Spike (MS) is a randomly selected intra-laboratory replicate sample that has been fortified (spiked) with test analytes at known concentration, and processed in an identical manner to test samples. Matrix Spikes provide information regarding analyte recovery and potential matrix effects. MS DQO exceedances due to sample matrix may sometimes be unavoidable; in such cases, test results for the associated sample (or similar samples) may be subject to bias. ND – Recovery not determined, background level >= 1x spike level.

Sub-Matrix: Soil/Solid

					Matrix Spike (MS) Report					
					Spike		Recovery (%)	Recovery Limits (%)		
Laboratory sample ID	Client sample ID	Analyte	CAS Number	Method	Concentration	Target	MS	Low	High	Qualifier
Volatile Organic Compounds (QCLot: 2085839)										
TY2506918-001	25-05 SS2	Benzene	71-43-2	E611A	1.93 mg/kg	2.11 mg/kg	91.2	60.0	140	----
		Ethylbenzene	100-41-4	E611A	1.83 mg/kg	2.11 mg/kg	86.4	60.0	140	----
		Toluene	108-88-3	E611A	1.98 mg/kg	2.11 mg/kg	93.6	60.0	140	----
		Xylene, m+p-	179601-23-1	E611A	3.49 mg/kg	4.23 mg/kg	82.5	60.0	140	----
		Xylene, o-	95-47-6	E611A	1.84 mg/kg	2.11 mg/kg	86.8	60.0	140	----
Hydrocarbons (QCLot: 2085840)										
TY2506918-001	25-05 SS2	F1 (C6-C10)	----	E581.F1	39.6 mg/kg	42.3 mg/kg	93.8	60.0	140	----
Hydrocarbons (QCLot: 2086214)										
TY2506918-001	25-05 SS2	F2 (C10-C16)	----	E601.SG-L	500 mg/kg	521 mg/kg	96.1	60.0	140	----
		F3 (C16-C34)	----	E601.SG-L	1160 mg/kg	1070 mg/kg	108	60.0	140	----
		F4 (C34-C50)	----	E601.SG-L	643 mg/kg	581 mg/kg	111	60.0	140	----
Polycyclic Aromatic Hydrocarbons (QCLot: 2086215)										
TY2506918-001	25-05 SS2	Acenaphthene	83-32-9	E641A	0.390 mg/kg	0.388 mg/kg	100	50.0	140	----
		Acenaphthylene	208-96-8	E641A	0.385 mg/kg	0.388 mg/kg	99.2	50.0	140	----
		Anthracene	120-12-7	E641A	0.369 mg/kg	0.388 mg/kg	95.0	50.0	140	----
		Benz(a)anthracene	56-55-3	E641A	0.350 mg/kg	0.388 mg/kg	90.2	50.0	140	----
		Benzo(a)pyrene	50-32-8	E641A	0.388 mg/kg	0.388 mg/kg	100.0	50.0	140	----
		Benzo(b+j)fluoranthene	n/a	E641A	0.376 mg/kg	0.388 mg/kg	96.9	50.0	140	----
		Benzo(g,h,i)perylene	191-24-2	E641A	0.374 mg/kg	0.388 mg/kg	96.4	50.0	140	----
		Benzo(k)fluoranthene	207-08-9	E641A	0.399 mg/kg	0.388 mg/kg	103	50.0	140	----
		Chrysene	218-01-9	E641A	0.389 mg/kg	0.388 mg/kg	100	50.0	140	----
		Dibenz(a,h)anthracene	53-70-3	E641A	0.375 mg/kg	0.388 mg/kg	96.7	50.0	140	----
		Fluoranthene	206-44-0	E641A	0.379 mg/kg	0.388 mg/kg	97.7	50.0	140	----
		Fluorene	86-73-7	E641A	0.381 mg/kg	0.388 mg/kg	98.0	50.0	140	----
		Indeno(1,2,3-c,d)pyrene	193-39-5	E641A	0.375 mg/kg	0.388 mg/kg	96.5	50.0	140	----
		Methylnaphthalene, 1-	90-12-0	E641A	0.371 mg/kg	0.388 mg/kg	95.5	50.0	140	----
		Methylnaphthalene, 2-	91-57-6	E641A	0.398 mg/kg	0.388 mg/kg	102	50.0	140	----
		Naphthalene	91-20-3	E641A	0.382 mg/kg	0.388 mg/kg	98.4	50.0	140	----
		Phenanthrene	85-01-8	E641A	0.370 mg/kg	0.388 mg/kg	95.3	50.0	140	----
		Pyrene	129-00-0	E641A	0.374 mg/kg	0.388 mg/kg	96.4	50.0	140	----



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).

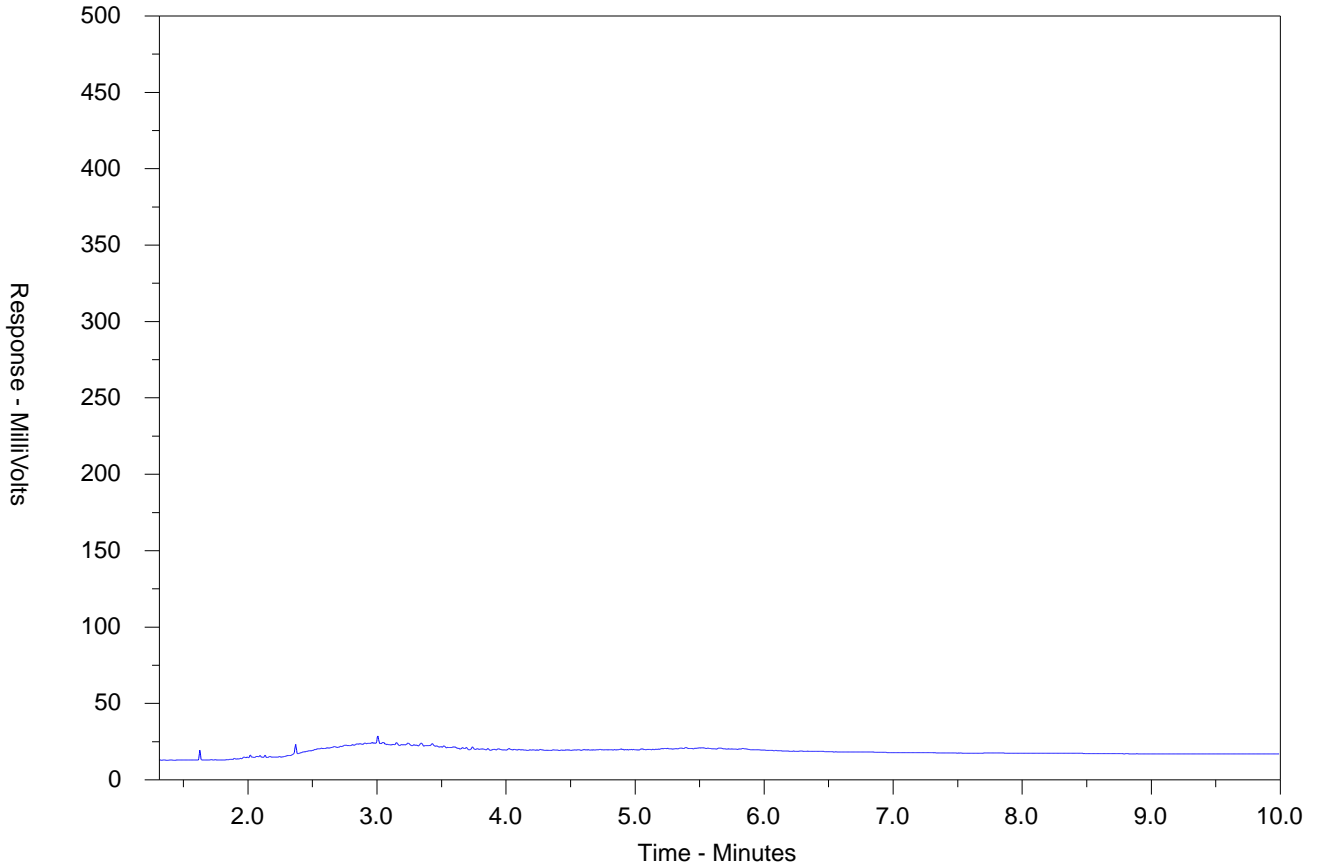
Sub-Matrix:

Laboratory sample ID	Reference Material ID	Analyte	CAS Number	Method	Reference Material (RM) Report				
					RM Target Concentration	Recovery (%) RM	Recovery Limits (%)		Qualifier
							Low	High	
Physical Tests (QCLot: 2088837)									
QC-2088837-003	RM	Conductivity (1:2 leachate)	----	E100-L	3130 µS/cm	101	70.0	130	----
Metals (QCLot: 2088835)									
QC-2088835-003	RM	Antimony	7440-36-0	E440C	24.8 mg/kg	96.2	70.0	130	----
QC-2088835-003	RM	Arsenic	7440-38-2	E440C	21.2 mg/kg	89.2	70.0	130	----
QC-2088835-003	RM	Barium	7440-39-3	E440C	788 mg/kg	97.6	70.0	130	----
QC-2088835-003	RM	Beryllium	7440-41-7	E440C	1.82 mg/kg	94.6	70.0	130	----
QC-2088835-003	RM	Cadmium	7440-43-9	E440C	2.15 mg/kg	93.9	70.0	130	----
QC-2088835-003	RM	Chromium	7440-47-3	E440C	56.9 mg/kg	94.8	70.0	130	----
QC-2088835-003	RM	Cobalt	7440-48-4	E440C	32 mg/kg	92.4	70.0	130	----
QC-2088835-003	RM	Copper	7440-50-8	E440C	969 mg/kg	93.9	70.0	130	----
QC-2088835-003	RM	Lead	7439-92-1	E440C	919 mg/kg	91.6	70.0	130	----
QC-2088835-003	RM	Molybdenum	7439-98-7	E440C	25.1 mg/kg	95.3	70.0	130	----
QC-2088835-003	RM	Nickel	7440-02-0	E440C	1000 mg/kg	95.8	70.0	130	----
QC-2088835-003	RM	Selenium	7782-49-2	E440C	1.04 mg/kg	97.2	60.0	140	----
QC-2088835-003	RM	Silver	7440-22-4	E440C	8.98 mg/kg	89.3	70.0	130	----
QC-2088835-003	RM	Thallium	7440-28-0	E440C	0.907 mg/kg	93.6	70.0	130	----
QC-2088835-003	RM	Uranium	7440-61-1	E440C	3.97 mg/kg	83.5	70.0	130	----
QC-2088835-003	RM	Vanadium	7440-62-2	E440C	66.2 mg/kg	94.6	70.0	130	----
QC-2088835-003	RM	Zinc	7440-66-6	E440C	828 mg/kg	91.0	70.0	130	----
Metals (QCLot: 2088838)									
QC-2088838-003	RM	Calcium, soluble ion content	7440-70-2	E484	169 mg/L	105	70.0	130	----
QC-2088838-003	RM	Magnesium, soluble ion content	7439-95-4	E484	60.4 mg/L	103	70.0	130	----
QC-2088838-003	RM	Sodium, soluble ion content	17341-25-2	E484	107 mg/L	110	70.0	130	----

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: TY2506918-001-E601.SG-L
 Client Sample ID: 25-05 SS2



← F2 →		← F3 →		← F4 →	
nC10	nC16	nC34	nC50		
174°C	287°C	481°C	575°C		
346°F	549°F	898°F	1067°F		
Gasoline →			← Motor Oils/Lube Oils/Grease		
← Diesel/Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

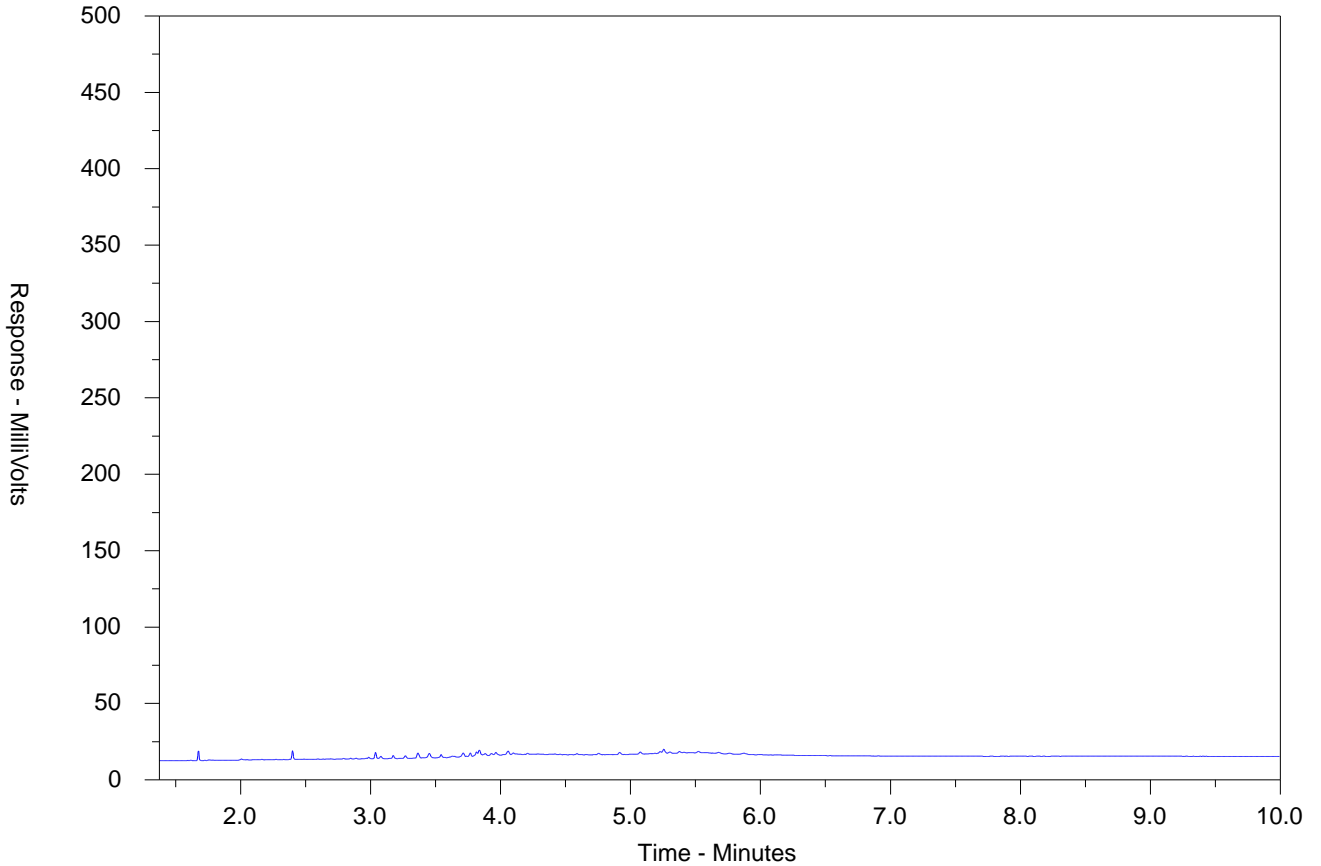
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor and the scale at the left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR Library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: TY2506918-002-E601.SG-L
 Client Sample ID: 25-02 SS3



← F2 →		← F3 →		← F4 →	
nC10	nC16		nC34		nC50
174°C	287°C		481°C		575°C
346°F	549°F		898°F		1067°F
Gasoline →			← Motor Oils/Lube Oils/Grease		
← Diesel/Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

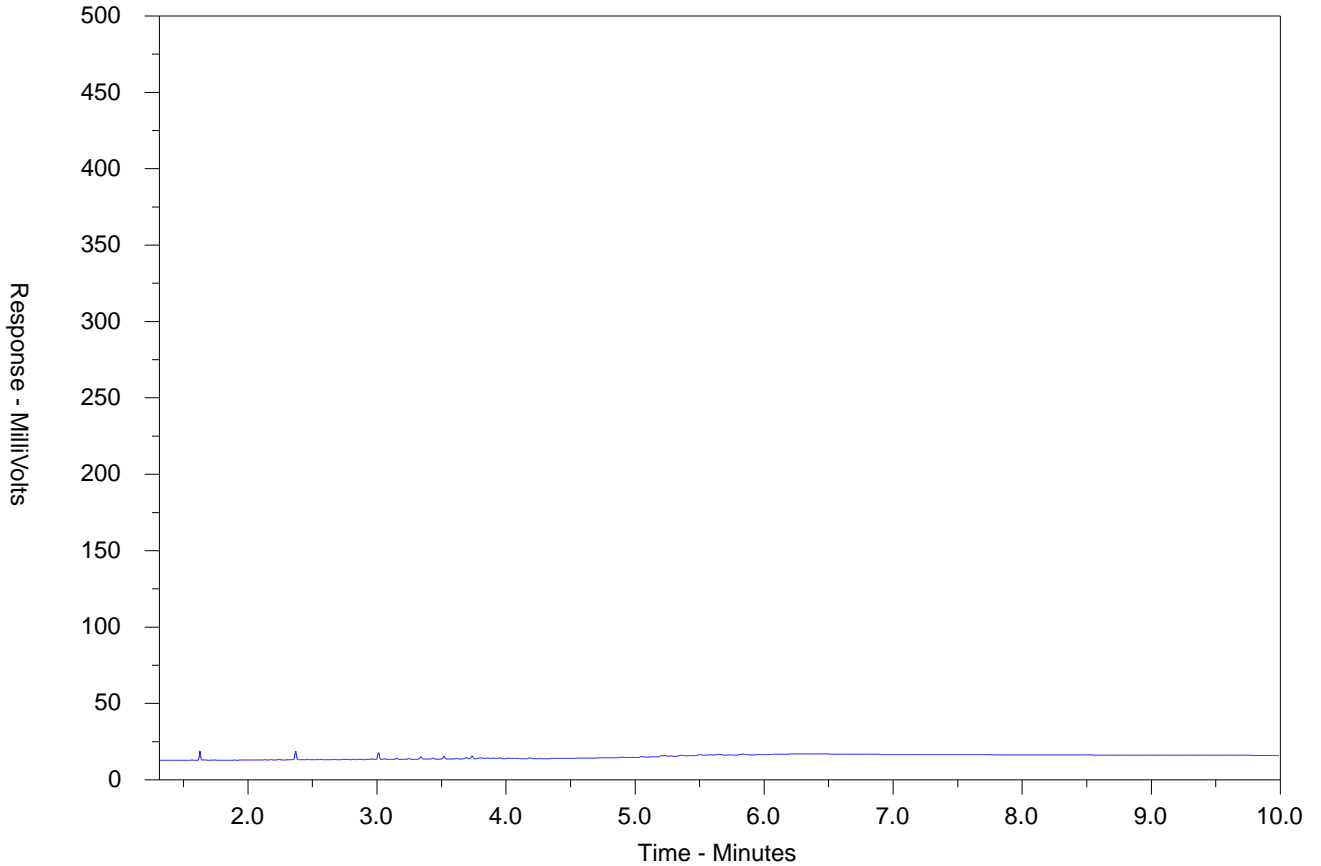
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor and the scale at the left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR Library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: TY2506918-003-E601.SG-L
 Client Sample ID: 25-04 SS3



← F2 →		← F3 →		← F4 →	
nC10	nC16		nC34		nC50
174°C	287°C		481°C		575°C
346°F	549°F		898°F		1067°F
← Gasoline →			← Motor Oils/Lube Oils/Grease →		
← Diesel/Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

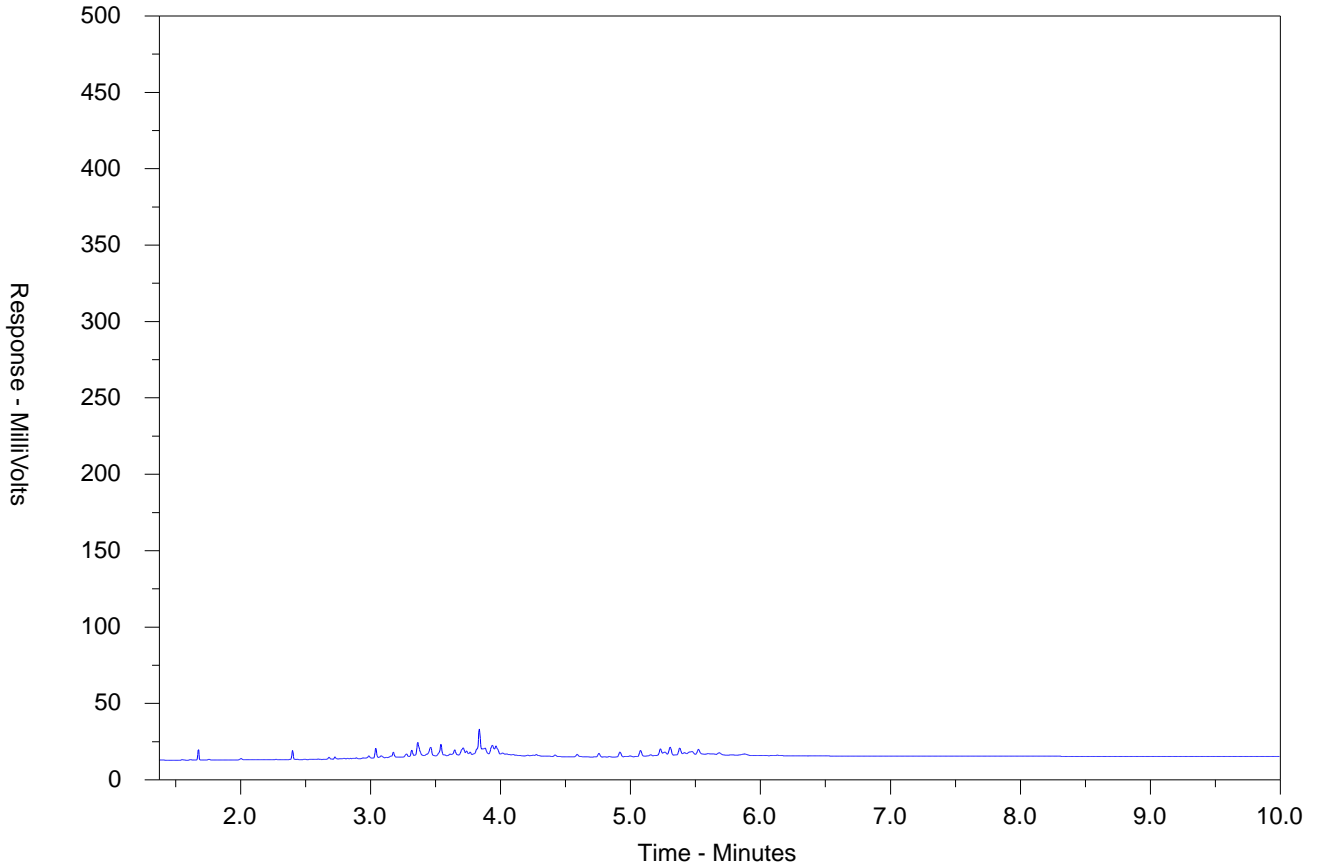
Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor and the scale at the left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR Library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT



ALS Sample ID: TY2506918-004-E601.SG-L
 Client Sample ID: 25-01 SS2



← F2 →		← F3 →		← F4 →	
nC10	nC16		nC34		nC50
174°C	287°C		481°C		575°C
346°F	549°F		898°F		1067°F
Gasoline →			← Motor Oils/Lube Oils/Grease		
← Diesel/Jet Fuels →					

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor and the scale at the left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR Library can be found at www.alsglobal.com.



www.alsglobal.com

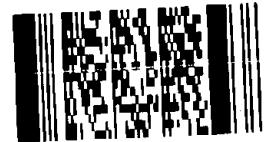
Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

COC Number: 23 - 1098

Page of

Environmental Division
Thunder Bay
Work Order Reference
TY2506918



Telephone: +1 807 623 6463

Report To: Thurber Eng Ltd.
Company: Thurber Eng Ltd.
Contact: Yamilah Aragon
Phone: 316473605744
Street: 1909 Ironoak Way Suite 202
City/Province: Oakville, ON
Postal Code: L6L 0N1
Invoice To: Same as Report To
Copy of Invoice with Report: YES
Company: Thurber Engineering Ltd.
Contact: Yamilah Aragon
Project Information: Pineimata Modular Bridge / 68438
ALS Client Code / QUOTE #:
Job / Project #:
PO / AFE:
LSD:
ALS Lab Work Order # (ALS use only): 6918
ALS Sample # (ALS use only):
Sample Identification and/or Coordinates:
Date:
Time:
Sample Type:
NUMBER OF CONTAINERS:
Analysis Request:
Drinking Water (DW) Samples (client use):
Notes / Specify Limits for result evaluation by selecting from drop-down below (Excel COC only):
SAMPLE RECEIPT DETAILS (ALS use only):
SHIPMENT RELEASE (client use):
INITIAL SHIPMENT RECEPTION (ALS use only):
FINAL SHIPMENT RECEPTION (ALS use only):

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

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.

Original IX

Intake and Login Verification Form

SAMPLE INTAKE						ACCOUNT INFO VERIFICATION					
Priority/Emergency Service Requested		YES	NO			Priority/Emergency Service Requested		YES	NO		
Time Sensitive Hold Time		YES	NO			Confirmed all as accurate as per COC, Sample Remarks or PM					
Client:						Client		Work Contact		Quote	
SAMPLE RECEIPT INFORMATION						RECEIPT DETAIL					
Mode of Delivery:		Courier		Drop Off		Project		PO		Site/LSD	
Courier						Overall Description Entered		Yes	NA		
Waybill Number						Received date/time as per COC					
Temperature			Cooler Count			Recipients match CoC or Sample Remarks		Yes	No		
Cooling Method		None	Ice	Ice Packs		Billing Instruction added to remarks		Yes	NA		
SAMPLE MATRIX/BOTTLE INFORMATION						VERIFICATION CHECKLIST					
Matrix:	Water	Soil	Air	Biota	Other	Planned Event Submission		Yes	No		
DW Schedule 24 Bottles Correct?				Yes	No	Sample Name entered as per CoC					
DW Metals pH Check <2				Yes	No	Sampling Date and time entered as per CoC					
Regulation Circled, Works # present		Yes	No - Reject?			Containers selected in layout order					
# of Bottles:		Sample Count				Sales items entered from QUOTE ONLY (and/or verified as correct)					
Green/white						Field Data/EC298A removed if not on COC		Yes	NA		
Purple/white						Bottle Allocation Verified					
Warm red/white						Guideline added or auto-allocated					
Yellow/black						Due dates updated					
Light blue/white						VALIDATION					
Orange/black						Validation errors resolved?		Yes	No		
Others (detail)						Internal Sublet CoC created		Yes	NA		
- 4 small jars.						Login Comments:					
- 4x2 vials.											
Comments on Samples and Bottles:											
- No time on COC or on bottles.											
Samples Requiring Preservation or Filtering:											
Layout Staff Initials		GS 28-June-25 9:17				Login Staff Initials:		SS			
Date and Time of Layout											



APPENDIX E

Single Well Response Test Results



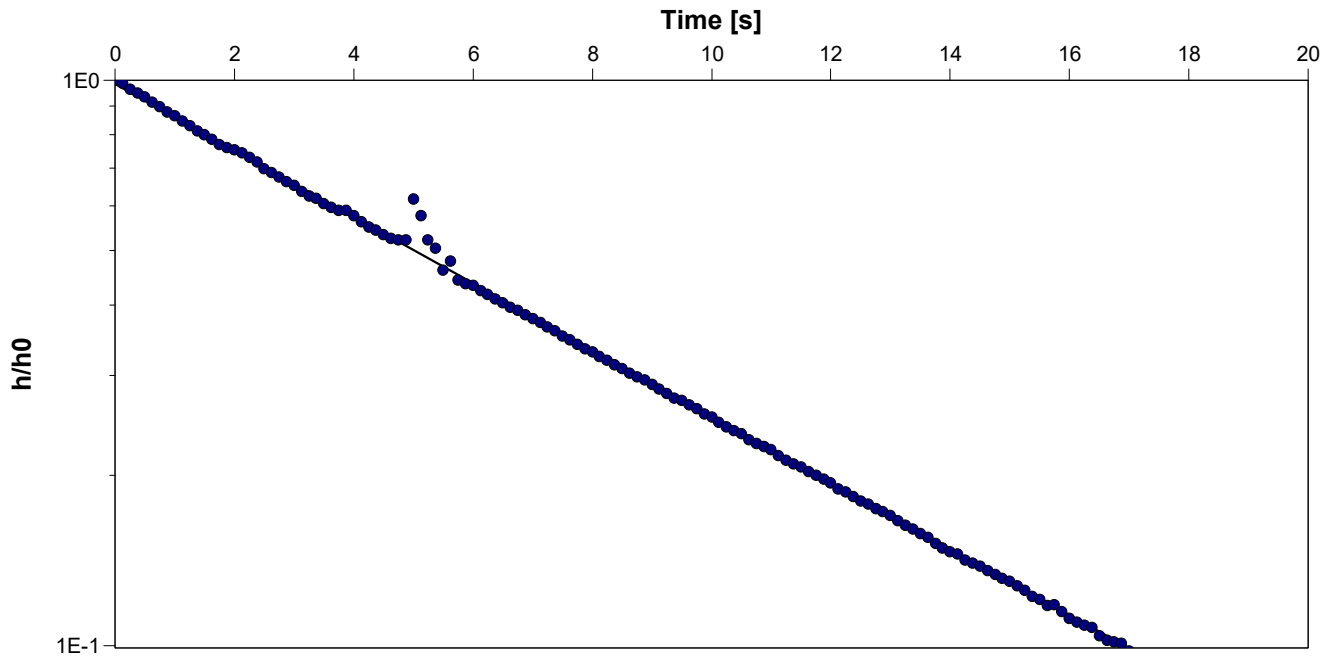
Slug Test Analysis Report

Project: Pinemuta River Modular Bridge Replacement

Number: 68438

Client: HATCH

Location: Kenora, ON	Slug Test: 25-05 SWRT Test 1	Test Well: 25-05
Test Conducted by: SP		Test Date: 2025-06-26
Analysis Performed by: JM	25-05 SWRT Analysis	Analysis Date: 2025-06-26
Aquifer Thickness:		
Checked By: AH		



Calculation using Hvorslev		
Observation Well	Hydraulic Conductivity [m/s]	
25-05	6.8×10^{-5}	



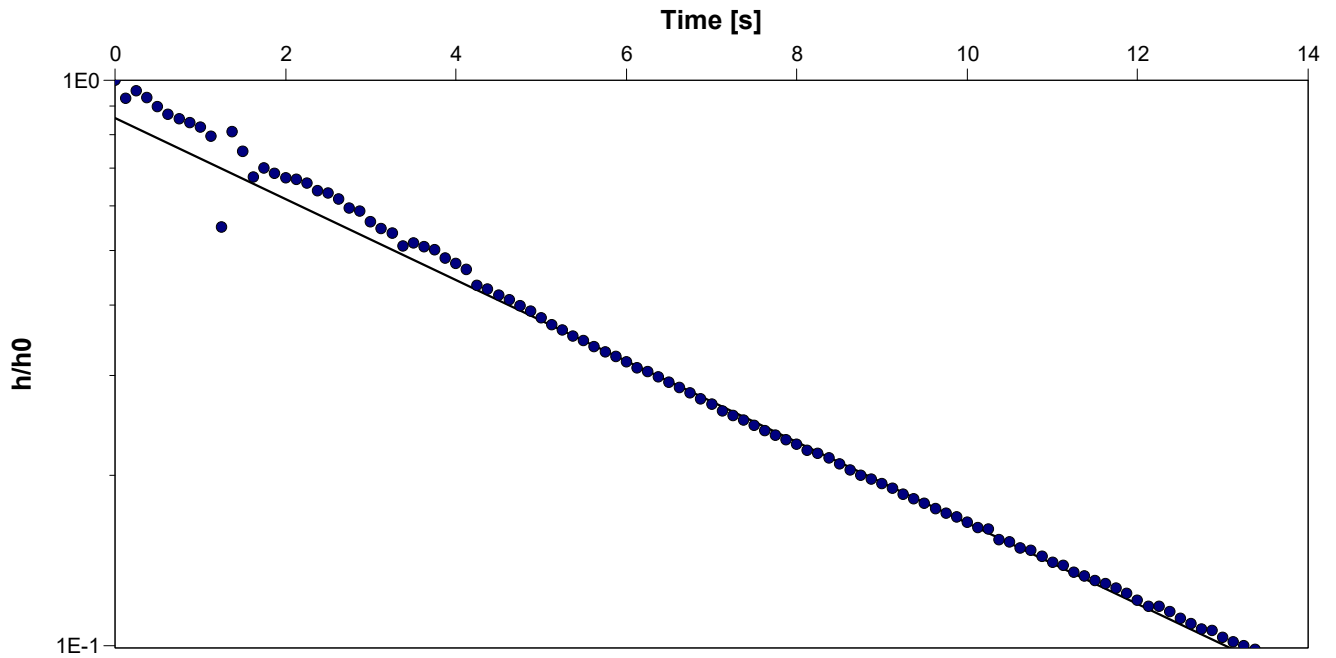
Slug Test Analysis Report

Project: Pinemuta River Modular Bridge Replacement

Number: 68438

Client: HATCH

Location: Kenora, ON	Slug Test: 25-05 SWRT Test 2	Test Well: 25-05
Test Conducted by: SP		Test Date: 2025-06-17
Analysis Performed by: JM	25-05 SWRT Analysis	Analysis Date: 2025-06-20
Aquifer Thickness:		
Checked By: AH		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]
25-05	8.3×10^{-5}



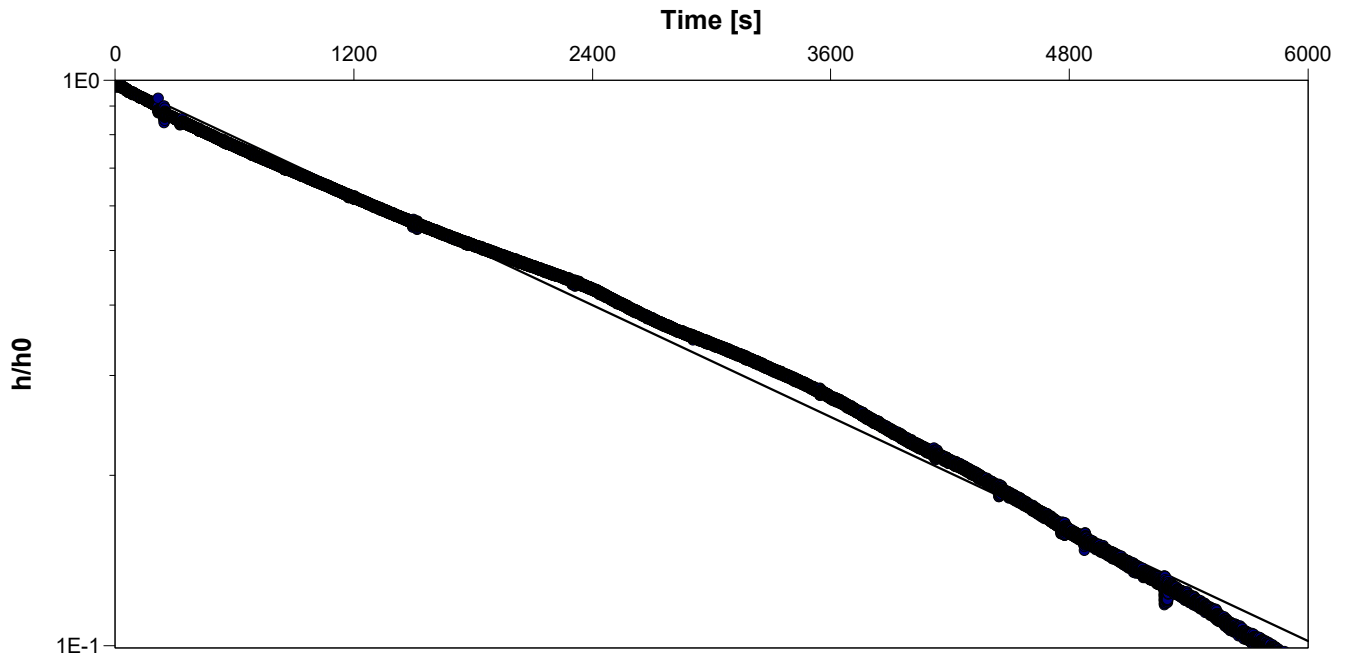
Slug Test Analysis Report

Project: Pinemuta River Modular Bridge Replacement

Number: 68438

Client: HATCH

Location: Kenora, ON	Slug Test: 25-01 SWRT	Test Well: 25-01
Test Conducted by: SP		Test Date: 2025-06-17
Analysis Performed by: JM	25-05 SWRT Analysis	Analysis Date: 2025-06-20
Aquifer Thickness:		
Checked By: AH		



Calculation using Hvorslev

Observation Well	Hydraulic Conductivity [m/s]
25-01	1.9×10^{-7}



APPENDIX F

Site Pictures



Photo 1: Looking northwest at existing bridge structure (June 11, 2025).



Photo 2: Looking southeast at existing east structure (June 11, 2025).



Photo 3: Looking southwest at Pineimuta River from modular bridge (June 11, 2025).



Photo 4: Looking west at Pineimuta River from modular bridge (June 11, 2025).



Photo 5: Looking north at Pineimuta River and modular bridge (June 11, 2025).



Photo 6: Looking north at Pineimuta River modular bridge (June 11, 2025).



Photo 7: Looking north at Pineimuta River from under the bridge (June 11, 2025).



Photo 8: Looking east below the bridge (June 11, 2025).



Photo 9: Looking northwest at the bridge embankment fill (June 11, 2025).



Photo 10: Looking northwest at the bridge embankment fill (June 11, 2025).

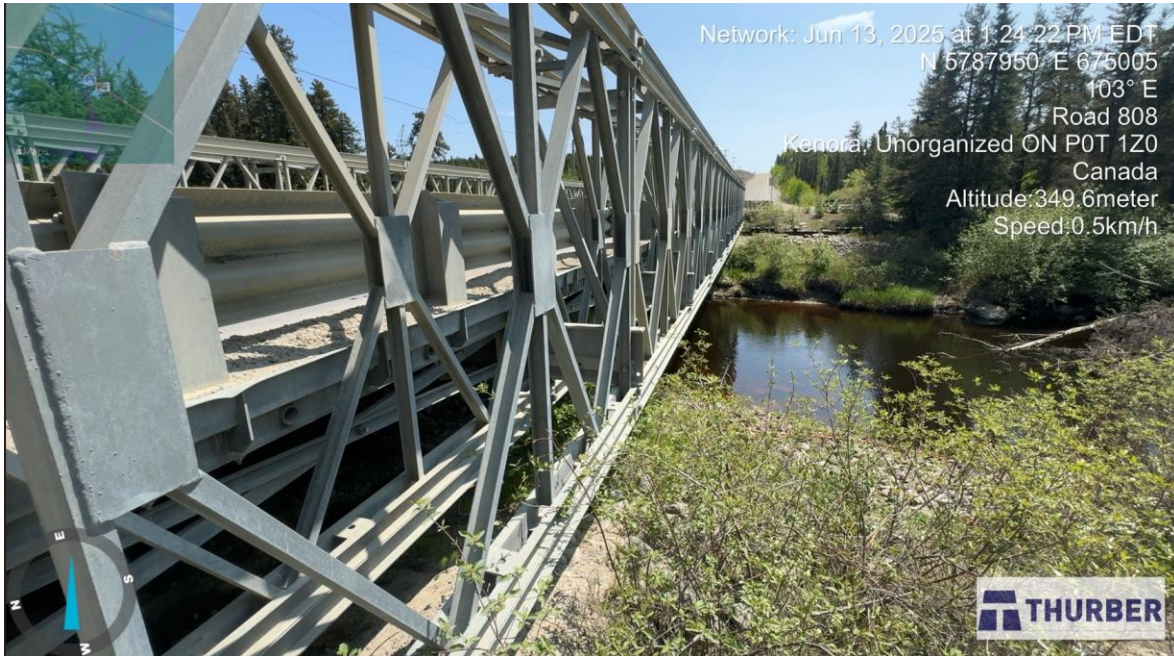


Photo 11: Looking east at the bridge from the embankment fill (June 13, 2025).



Photo 12: Looking southeast at the bridge and the embankment fill (June 13, 2025).

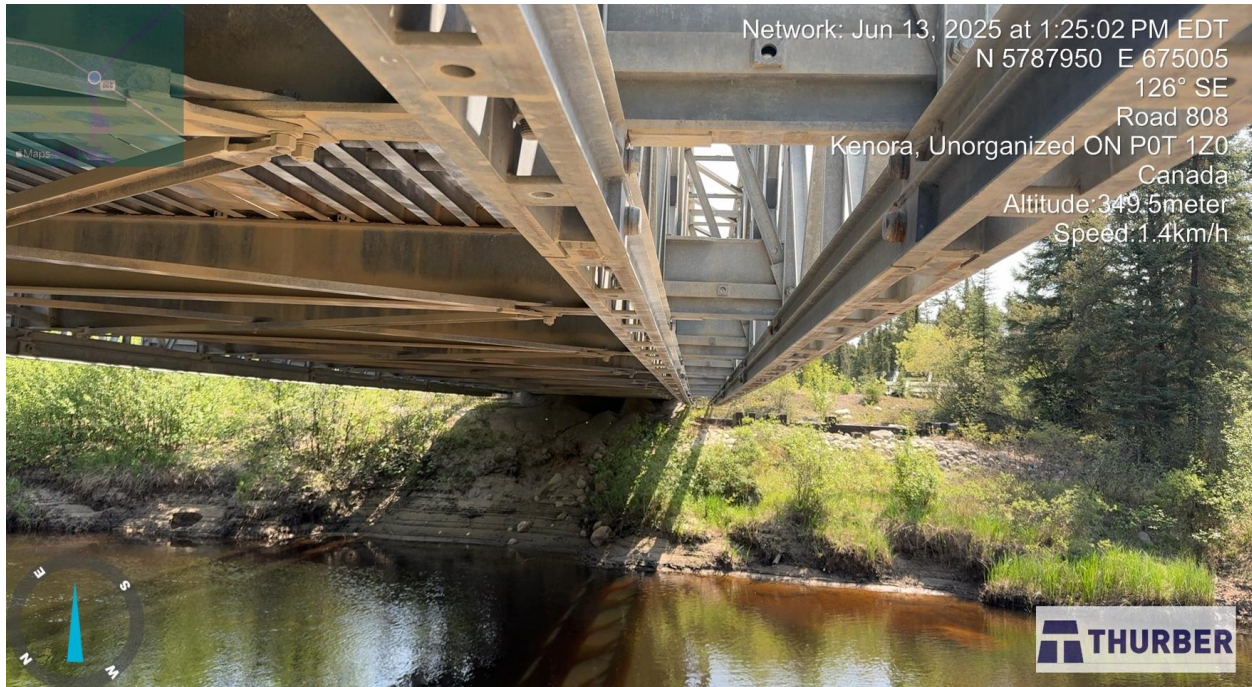


Photo 13: Looking southeast below the bridge and the embankment fill (June 13, 2025).



Photo 14: Looking west below the bridge (June 13, 2025).



Photo 15: Looking north at the bridge approach (June 13, 2025).



Photo 16: Looking south at the river, below the bridge (June 13, 2025).

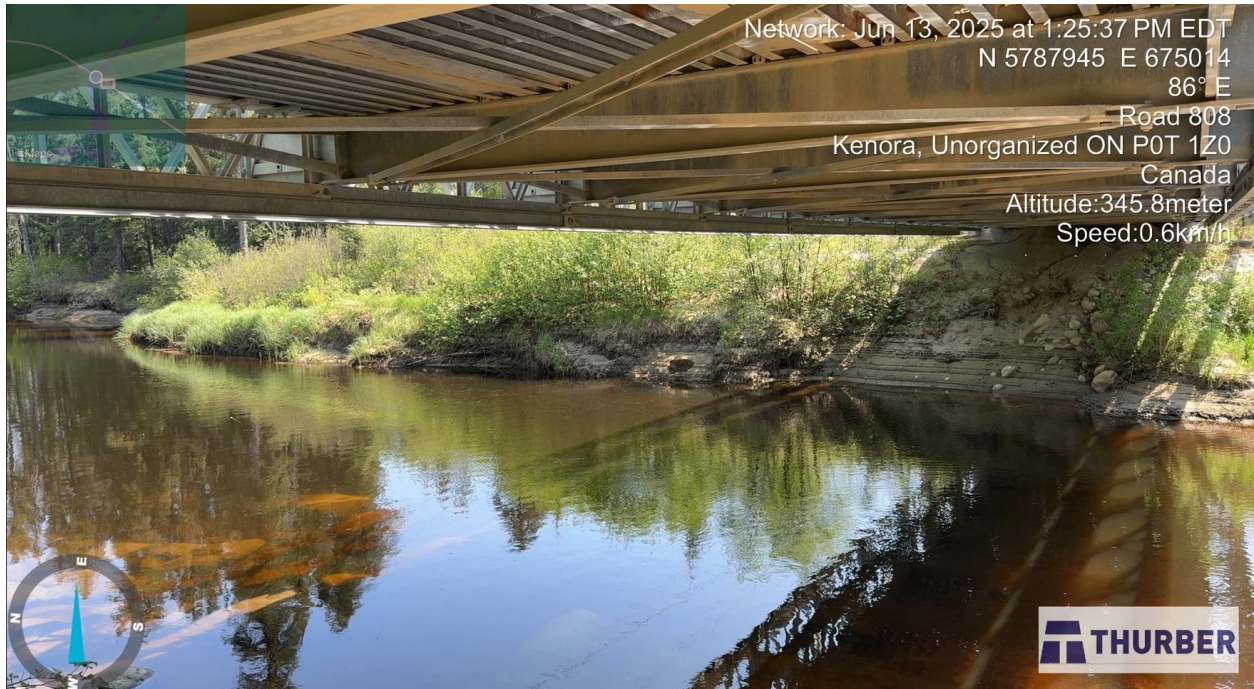


Photo 17: Looking at the river, below the bridge (June 13, 2025).

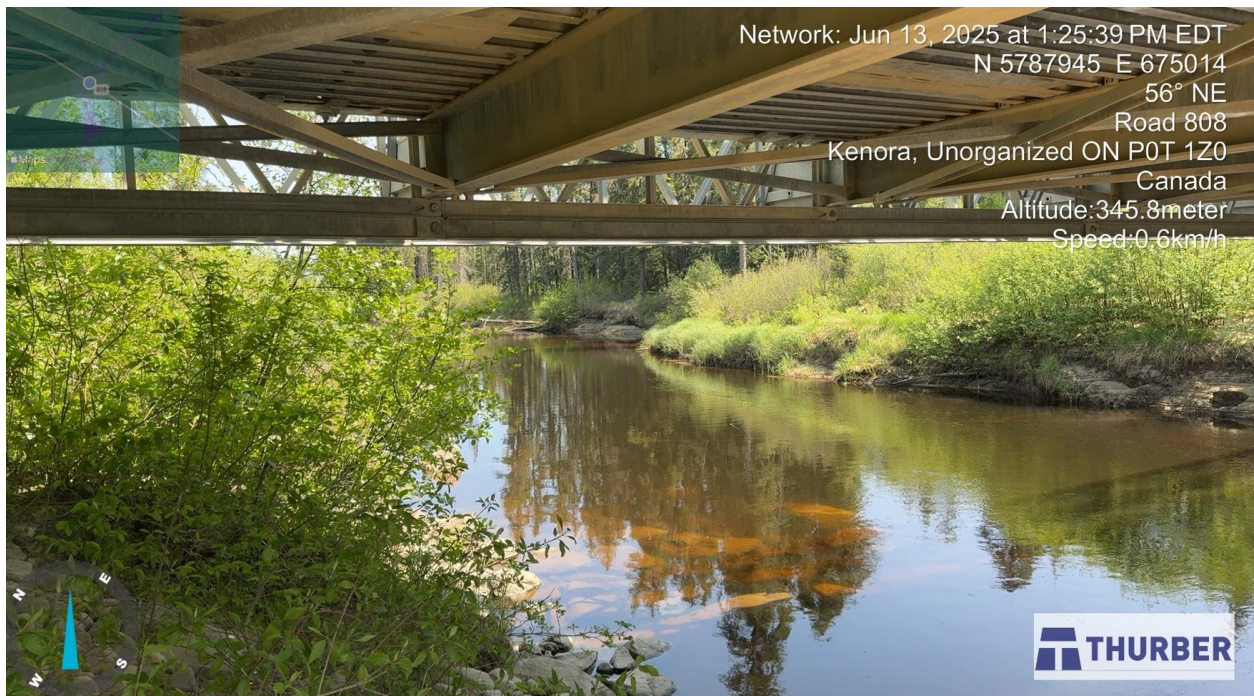


Photo 18: Looking northeast at the river, below the bridge (June 13, 2025)



APPENDIX G

Bedrock Core Pictures

PINEIMUTA RIVER MODULAR BRIDGE
Photographs of Rock Core

Borehole 25-01 - Run 1 and 2 - 13.7 m to 16.8 m



Borehole 25-02 - Run 1 - 13.6 m to 15 m



Borehole 25-02 - Run 2 - 15 m to 16.6 m

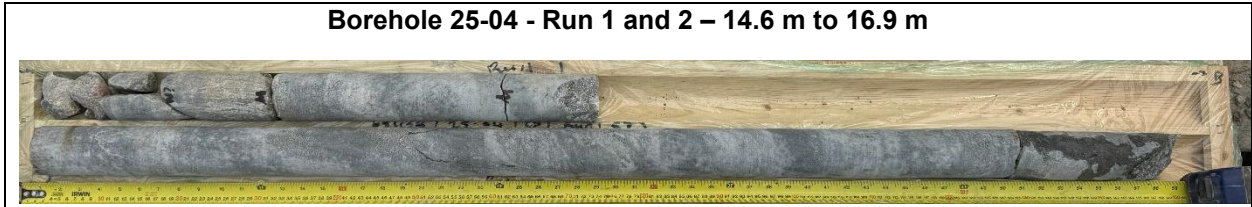


PINEIMUTA RIVER MODULAR BRIDGE
Photographs of Rock Core

Borehole 25-02B - Run 1 – 13.3 m to 15.3 m



Borehole 25-04 - Run 1 and 2 – 14.6 m to 16.9 m



Borehole 25-04 - Run 3 – 16.9 m to 17.8 m



PINEIMUTA RIVER MODULAR BRIDGE
Photographs of Rock Core

Borehole 25-05 - Run 1 and 2 – 13 m to 15 m



Borehole 25-05 - Run 3 – 15 m to 16.6 m



PINEIMUTA RIVER MODULAR BRIDGE
Photographs of Rock Core

Borehole 25-05B - Run 1 – 13.2 m to 14.35 m



Borehole 25-05B - Run 3 – 14.35 m to 14.8 m





APPENDIX H

NBCC 2020 Seismic Hazard Values



Government
of Canada

Gouvernement
du Canada

[Canada.ca](#) › [Natural Resources Canada](#) › [Earthquakes Canada](#)

2020 National Building Code of Canada Seismic Hazard Tool

i This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_S	X_D
Latitude (°)	52.214
Longitude (°)	-90.438

Please select one of the tabs below.

NBC 2020

Additional Values

Plots

API

Background Information

The 5%-damped spectral acceleration ($S_a(T,X)$, where T is the period, in s , and X is the site designation) and peak ground acceleration ($PGA(X)$) values are given in units of acceleration due to gravity (g , 9.81 m/s^2). Peak

ground velocity. (PGV(X)) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

NBC 2020 - 2%/50 years (0.000404 per annum) probability

$S_a(0.2, X_D)$	$S_a(0.5, X_D)$	$S_a(1.0, X_D)$	$S_a(2.0, X_D)$	$S_a(5.0, X_D)$	$S_a(10.0, X_D)$	PGA(X_D)	PGV(X_D)
0.123	0.106	0.0535	0.021	0.00426	0.00126	0.0746	0.0552

The log-log interpolated 2%/50 year $S_a(4.0, X_D)$ value is : **0.0063**

► Tables for 5% and 10% in 50 year values

Download CSV

← Go back to the [seismic hazard calculator form](#)

Date modified: 2021-04-06



APPENDIX I

Foundation Comparison

TABLE 11: COMPARISON OF FOUNDATION ALTERNATIVES FOR PERMANENT REPLACEMENT BRIDGE

Spread Footings on Native Sand	Driven H-Piles on Bedrock	Driven Pipe Piles on Bedrock	Drilled in Pipe Piles Socketed into Bedrock	Micropiles Socketed into Bedrock
Advantages				
<ul style="list-style-type: none"> - Generally, less costly construction than deep foundations. - Requires less specialized construction equipment than deep foundations. 	<ul style="list-style-type: none"> - Higher geotechnical resistance than shallow foundations. - Construction could continue in winter weather conditions. - Requires less concrete than shallow foundations or caissons. - Pile capacity can be proven by dynamic testing. - Suitable for integral abutments. 	<ul style="list-style-type: none"> - Higher geotechnical resistance than driven H-Piles, if required. - Construction could continue in winter weather conditions. - Pile capacity can be proven by dynamic testing. - Pipe piles section should be readily available from local Canadian mills. - Higher lateral stiffness and lateral geotechnical resistance than H-piles, if required. 	<ul style="list-style-type: none"> - Generally higher geotechnical resistance than shallow foundations and H-Piles. - Pipe pile installation could continue in winter weather conditions. - Well suited for penetrating cobbles/boulders when used with down-the-hole hammer. - Higher lateral resistance is available due to larger pile diameter and in rock socket. 	<ul style="list-style-type: none"> - Smaller equipment enhancing easier access to a remote site location. - Generally lower noise and vibration than driven piles.
Disadvantages				
<ul style="list-style-type: none"> - Requires moderate to large excavations adjacent to the roadway/creek. - Lower geotechnical resistance than deep foundations per unit area. - Typically, does not allow for integral abutments. - Presence of cobbles and boulders may pose difficulty during excavation 	<ul style="list-style-type: none"> - Lower geotechnical resistance than pipe piles socketed into bedrock. - Presence of cobbles and boulders may pose difficulty during pile driving - Generates noise and vibration during pile driving 	<ul style="list-style-type: none"> - Presence of cobbles and boulders will pose difficulty during pile driving. - Generates higher noise and vibration during pile driving 	<ul style="list-style-type: none"> - Specialized installation – limited number of contractors with suitable equipment. - Generally, more expensive than driven piles. 	<ul style="list-style-type: none"> - Presence of cobbles and boulders will pose difficulty during installation and grouting (loss of grout). - Limited lateral capacity available due to site conditions and slenderness of micropiles cross section. - Suitability of micropiles design for integral abutments should be assessed by others. - Coring of hard bedrock to form bond zone can be difficult.
Risks/Consequences				
<ul style="list-style-type: none"> - Moderate to large excavations adjacent to the roadway/creek. 	<ul style="list-style-type: none"> - Potential for driven piles being damaged and not reaching design tip elevations due to presence of cobbles and boulders. - Cobbles and boulders potentially resulting into piles being terminated above the design tip elevations. 	<ul style="list-style-type: none"> - Higher potential for driven pipe piles being damaged and not reaching design tip elevations due to presence of cobbles and boulders. - Cobbles and boulders pose high risks of pipe piles being terminated above the design tip elevations. 	<ul style="list-style-type: none"> - Piles must be socketed into very strong bedrock - Difficulty in grouting the annular space between the pile and the socket 	<ul style="list-style-type: none"> - Potential for micro piles being damaged and not reaching design tip elevations due to presence of cobbles and boulders - Environmentally related risk of grout loss into the river during installation
Cost Effectiveness				
Moderate	High	Moderate	Low	Low to Moderate
Recommendation				
Not Recommended	Recommended	Technically Feasible	Not Recommended	Not Recommended

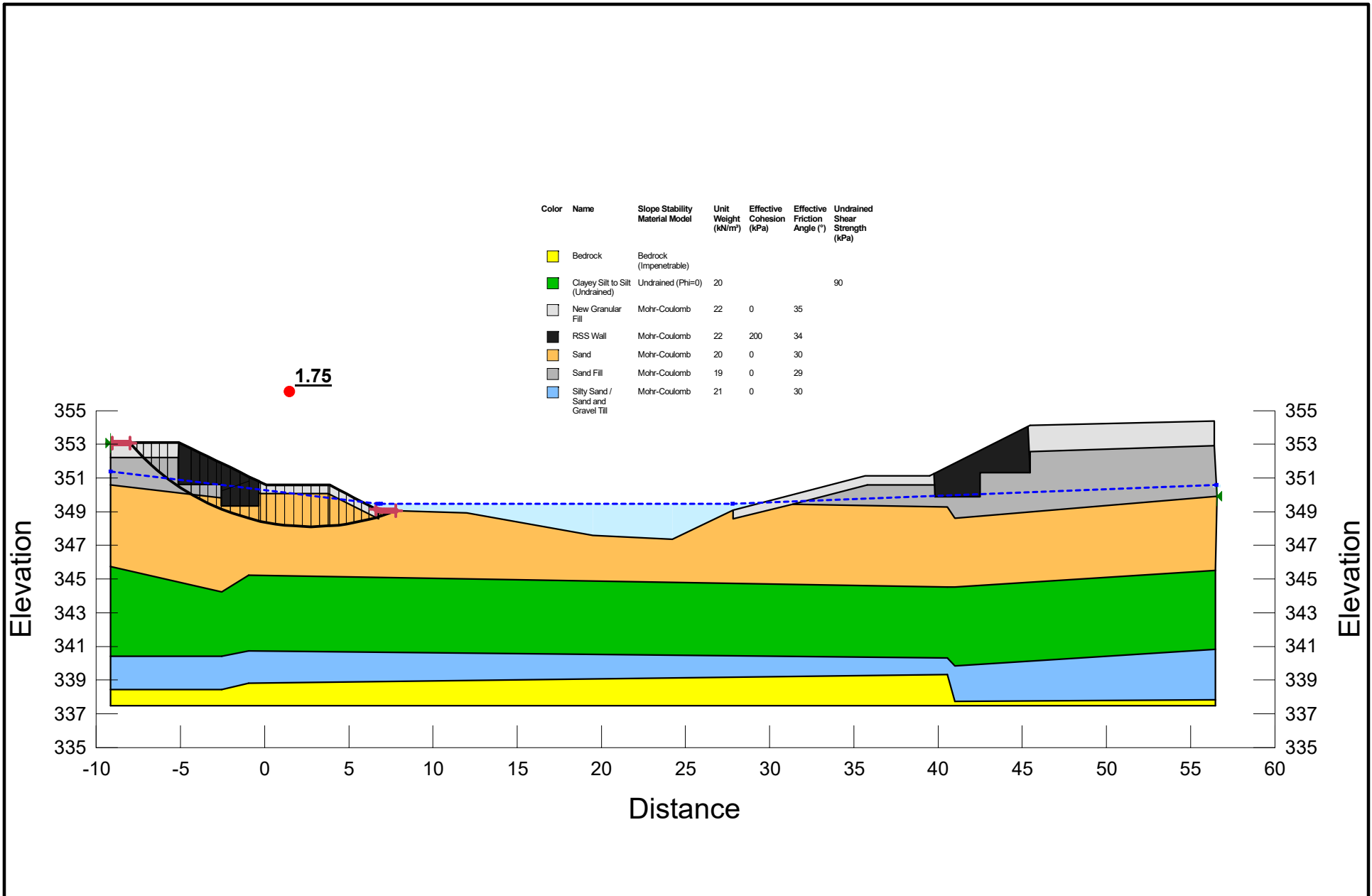
TABLE I2: COMPARISON OF FOUNDATION ALTERNATIVES FOR TEMPORARY DETOUR BRIDGE

Spread Footings on Engineered Fill Pads	Driven Piles on Bedrock
Advantages	
<ul style="list-style-type: none"> - Higher founding elevation requiring less excavation and minimal dewatering than footings on native soils. - An economical foundation alternative for the support of the temporary abutments. 	<ul style="list-style-type: none"> - Higher geotechnical resistance than shallow foundations. - Construction could continue in winter weather conditions. - Requires less concrete than shallow foundations.
Disadvantages	
<ul style="list-style-type: none"> - Lower geotechnical capacities than driven piles. - Granular fill pads may need to be protected from scour and erosion. 	<ul style="list-style-type: none"> - Presence of cobbles and boulders may pose difficulty during pile driving - Generates greater noise and vibration during pile driving
Risks/Consequences	
<ul style="list-style-type: none"> - Moderate sized excavations adjacent to the roadway/river. 	<ul style="list-style-type: none"> - Potential for driven piles being damaged and not reaching design tip elevations due to presence of cobbles and boulders -Cobbles and boulders potentially resulting into piles being terminated above the design tip elevations
Cost Effectiveness	
High	Low (for a temporary structure)
Recommendation	
Recommended	Not Recommended



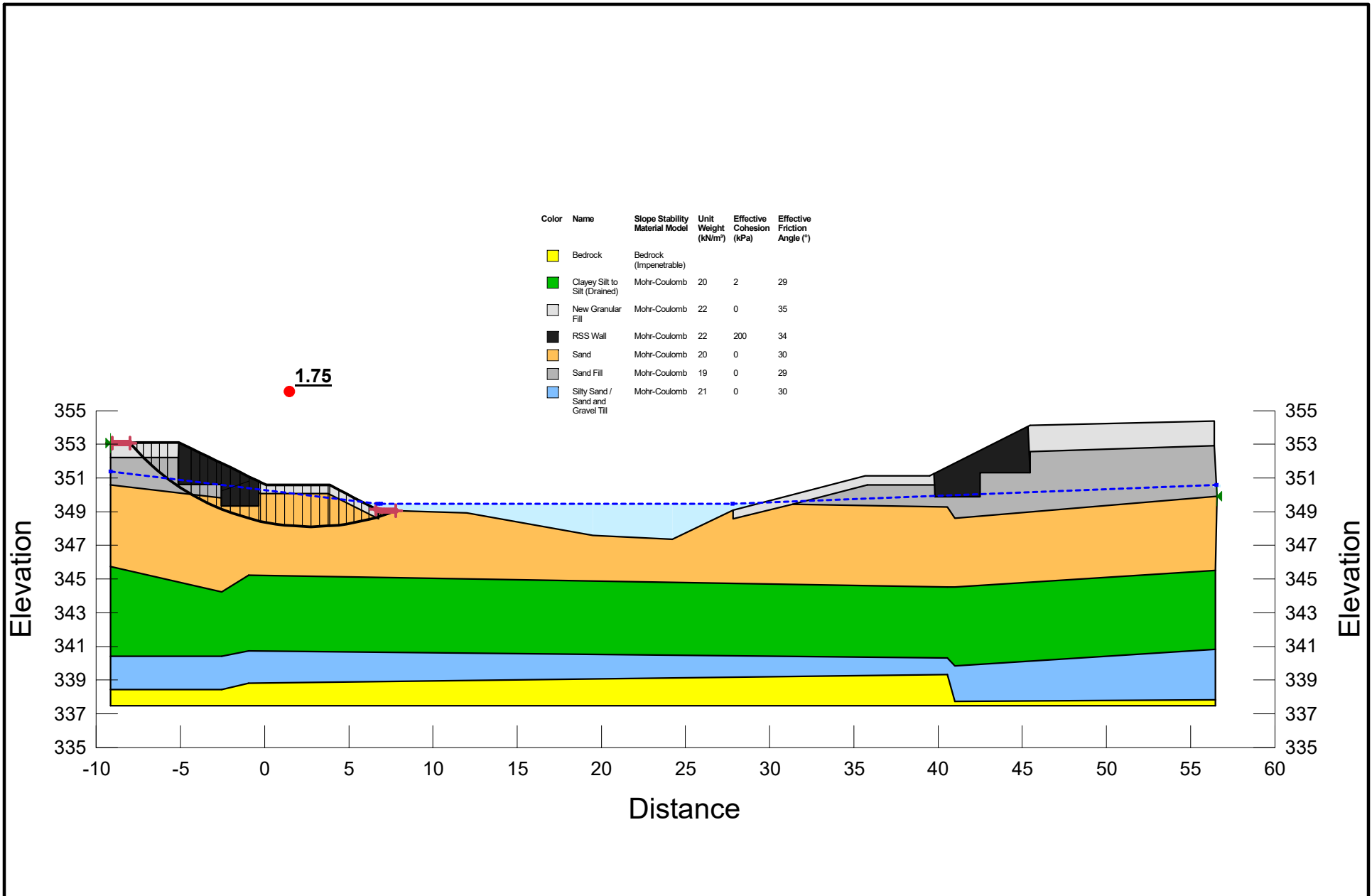
APPENDIX J

Slope Stability Results



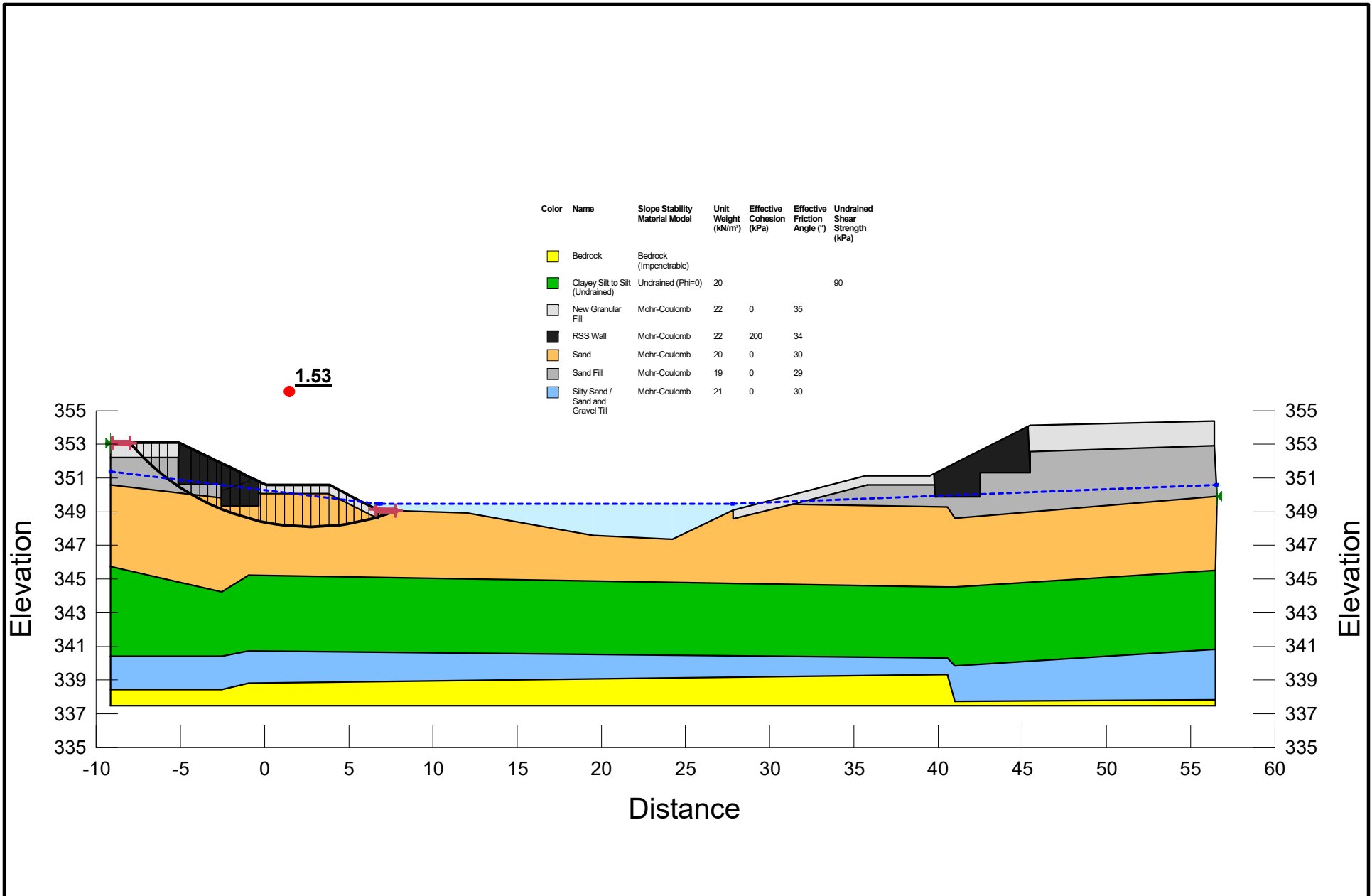
	Project 6021-E-0011-008 Pineimuta River Bridge Replacement		Additional Details Name: Permanent Bridge Profile (South Abutment) Comments: Sta. 24+600	
	Analysis 01 South Abutment (Short Term)		Method: Morgenstern-Price, Half-Sine Minimum Slip Surface Depth: Minimum Slip Surface Depth: 1.5 m	
	Seismic Coefficient H: 0g, V: 0g	Last Run 12/12/2025, 12:52:23 PM	Scale 1:319	Entry: (-8, 353.08677) m, Exit: (7.7999999, 349.04326) m Center: (2.7542511, 362.21798) m, Radius: 14.107897 m

Figure J1



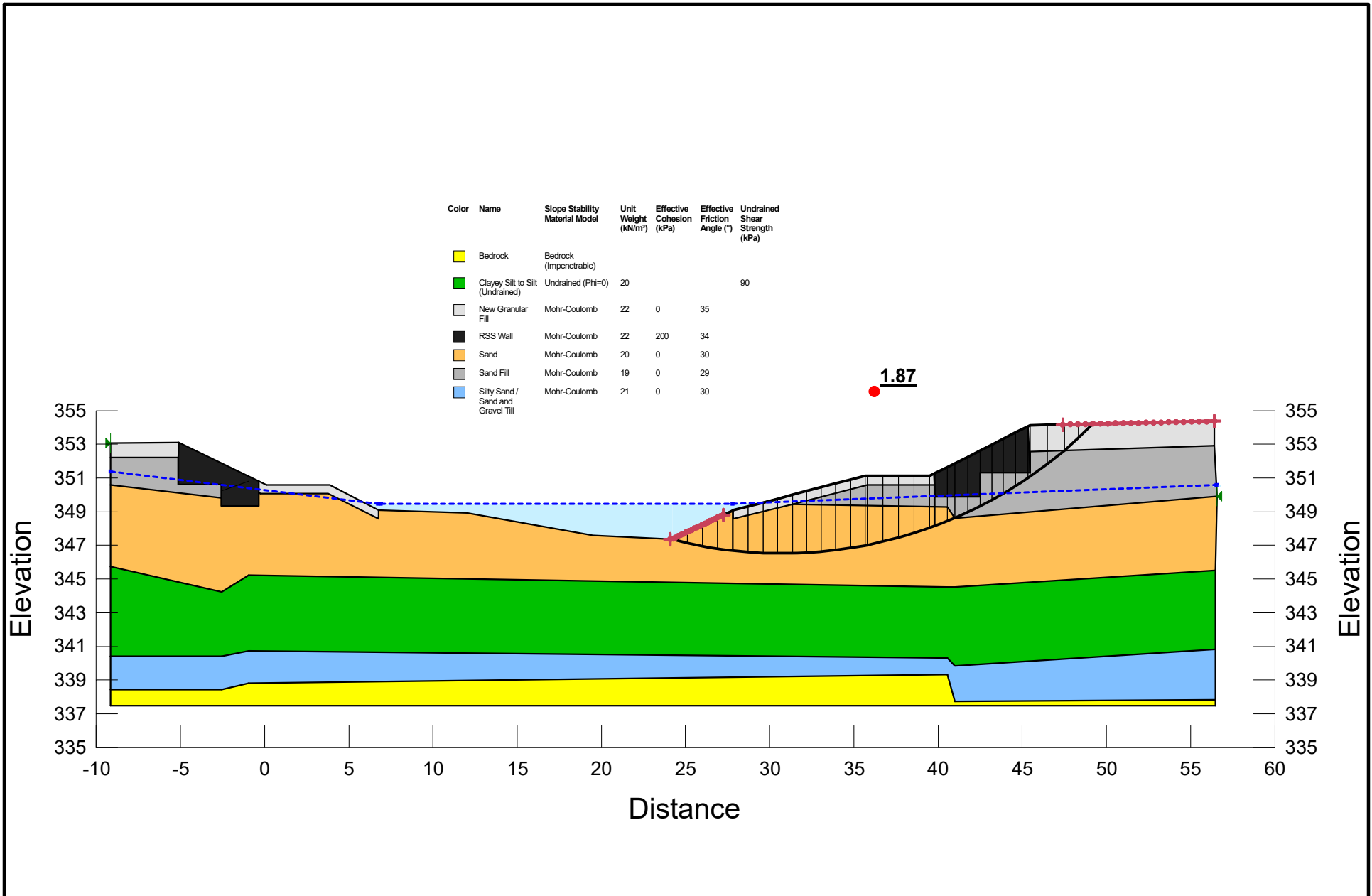
	Project 6021-E-0011-008 Pineimuta River Bridge Replacement		Additional Details Name: Permanent Bridge Profile (South Abutment) Comments: Sta. 24+600 Method: Morgenstern-Price, Half-Sine Minimum Slip Surface Depth: Minimum Slip Surface Depth: 1.5 m Entry: (-8, 353.08677) m, Exit: (7.7999999, 349.04326) m Center: (2.7542511, 362.21798) m, Radius: 14.107897 m	
	Analysis 02 South Abutment (Long Term)			
	Seismic Coefficient H: 0g, V: 0g	Last Run 12/12/2025, 12:52:26 PM	Scale 1:319	

Figure J2



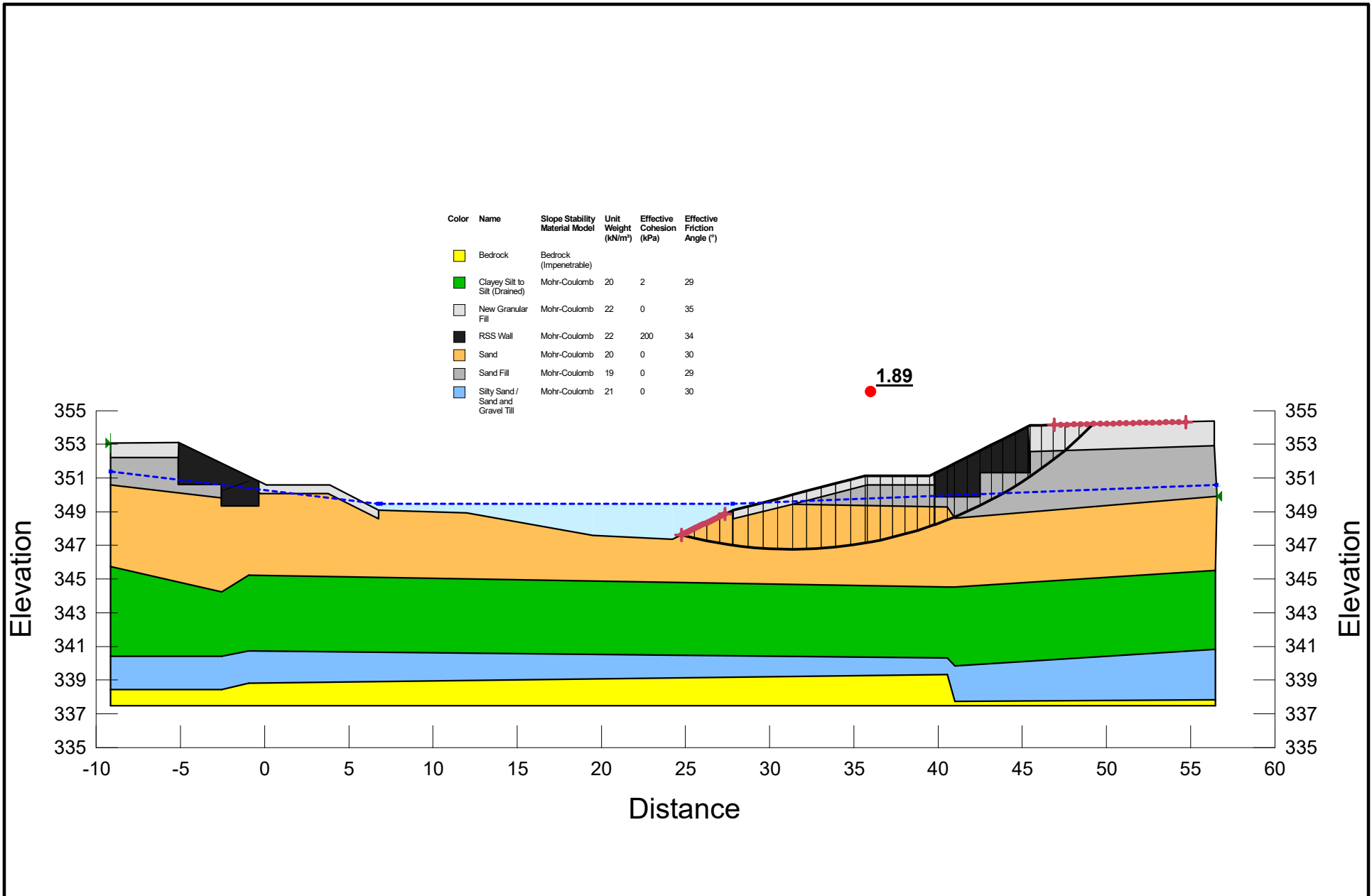
	Project		6021-E-0011-008 Pineimuta River Bridge Replacement		Additional Details Name: Permanent Bridge Profile (South Abutment) Comments: Sta. 24+600 Method: Morgenstern-Price, Half-Sine Minimum Slip Surface Depth: Minimum Slip Surface Depth: 1.5 m Entry: (-8, 353.08677) m, Exit: (7.7999999, 349.04326) m Center: (2.7542511, 362.21798) m, Radius: 14.107897 m
	Analysis		03 South Abutment (Sesimic)		
	Seismic Coefficient	Last Run	Scale		
	H: 0.0373g, V: 0g	12/12/2025, 12:52:29 PM	1:319		

Figure J3



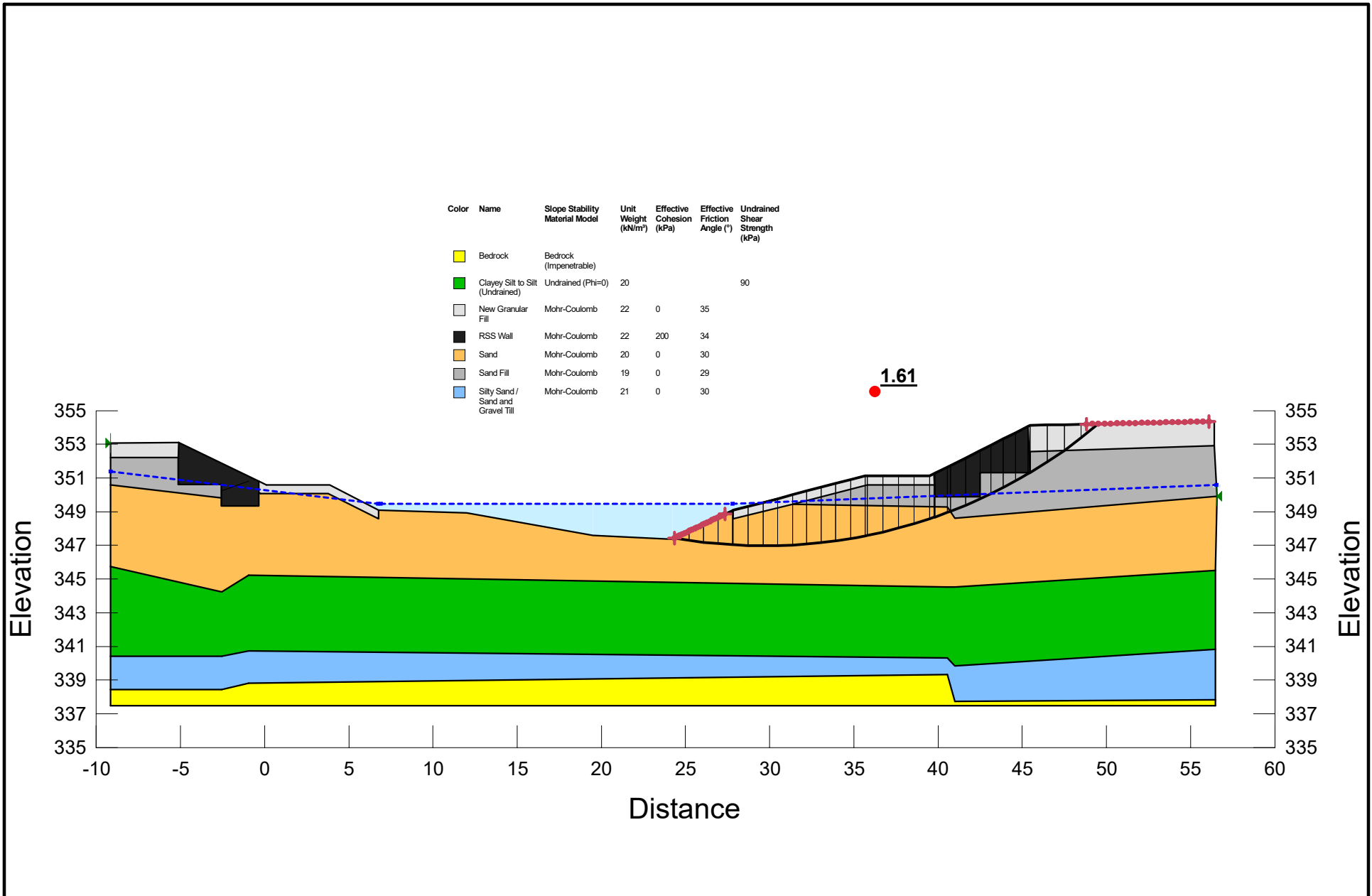
	Project		6021-E-0011-008 Pineimuta River Bridge Replacement		Additional Details Name: Permanent Bridge Profile (North Abutment) Comments: Sta. 24+600 Method: Morgenstern-Price, Half-Sine Minimum Slip Surface Depth: Minimum Slip Surface Depth: 1.5 m Entry: (24.1, 347.37763) m, Exit: (49.2, 354.20845) m Center: (30.722334, 372.57439) m, Radius: 26.052488 m
	Analysis		04 North Abutment (Short Term)		
	Seismic Coefficient	Last Run	Scale		
	H: 0g, V: 0g	12/12/2025, 12:52:32 PM	1:319		

Figure J4



	Project		6021-E-0011-008 Pineimuta River Bridge Replacement		Additional Details Name: Permanent Bridge Profile (North Abutment) Comments: Sta. 24+600 Method: Morgenstern-Price, Half-Sine Minimum Slip Surface Depth: Minimum Slip Surface Depth: 1.5 m Entry: (24.750004, 347.62881) m, Exit: (49.24, 354.20936) m Center: (31.306369, 372.08974) m, Radius: 25.324361 m
	Analysis		05 North Abutment (Long Term)		
	Seismic Coefficient	Last Run	Scale		
	H: 0g, V: 0g	12/12/2025, 12:52:36 PM	1:319		

Figure J5



	Project		6021-E-0011-008 Pineimuta River Bridge Replacement		Additional Details Name: Permanent Bridge Profile (North Abutment) Comments: Sta. 24+600 Method: Morgenstern-Price, Half-Sine Minimum Slip Surface Depth: Minimum Slip Surface Depth: 1.5 m Entry: (24.350001, 347.43992) m, Exit: (49.53, 354.21598) m Center: (29.695336, 377.74929) m, Radius: 30.77711 m
	Analysis		06 North Abutment (Sesimic)		
	Seismic Coefficient	Last Run	Scale		
	H: 0.0373g, V: 0g	12/12/2025, 12:52:39 PM	1:319		

Figure J6



APPENDIX K

Referenced OPSS Specifications and Wordings for NSSPs, Operational Constraints and Notice to Contractor

1. The following Special Provisions and OPS Documents are referenced in this report:

OPSS.PROV 206	Construction specification for grading
OPSS.PROV 212	Construction Specification for Earth Borrow
OPSS.PROV 501	Construction specification for compacting
OPSS.PROV 517	Construction specification for dewatering
OPSS.PROV 539	Construction specification for temporary protection systems
OPSS.PROV 803	Construction specification for Vegetative cover
OPSS.PROV 804	Construction specification for seed and cover
OPSS.PROV 805	Construction specification for Temporary Sediment Control
OPSS.PROV 902	Construction specification for excavating and backfilling – Structures
OPSS.PROV 903	Construction specification for deep foundations
OPSS.PROV 1004	Aggregates – Miscellaneous
OPSS.PROV 1010	Material specification for aggregates - base, subbase, select subgrade, and backfill material
OPSD 208.010	Benching of Earth Slopes
OPSD 3121.150	Walls, Retaining, Backfill, Minimum Granular Requirement
OPSD 3102.100	Wall Abutments, backfill drain
OPSD 3101.150	Wall Abutment, backfill, minimum granular requirement
SP109F57	Amendment to OPSS.PROV 903
SP 517F01	Amendment to OPSS.PROV 517
MTOD 3000.160	MTO Drawing: Fabricated Equivalent Steel H-Piles

2. Suggested Text for Obstructions During Driven Pile Installation

During pile installation, the Contractor is alerted that there are risks of encountering obstructions such as cobbles and occasional boulders within the foundation soils. Such obstructions can impede pile penetration to the design tip elevations. Pre-augering equipment shall be available on site during pile installation. Pre-augering shall be carried out where required to facilitate pile penetration. The diameter of the pre-augered hole depends on the size of the piles to be used. For a HP 360 x 132 pile section, each pre-augered hole shall not be greater than 250 mm in diameter. For each hole, reverse augering shall be carried out as the auger is retrieved to leave as much soil cuttings as possible inside the hole. The Contractor shall seek approval from the Contract Administrator (CA) including hole diameter and procedures prior to proceeding with pre-augering.



The piles are to be driven to bedrock. Boulders are present at some locations immediately above bedrock. Pile installation shall be in accordance with OPSS.PROV 903 as amended by SP 109F57. Should a pile reach practical refusal at an elevation higher than that indicated in the contract, the CA shall be informed immediately who should consult with the design team for confirmation. Over-driving must be avoided to minimize the risk of damaging the pile.

3. Suggested Text for Obstruction During Sheet Pile Installation

Installation of sheetpiles may encounter obstructions from cobbles and occasionally boulders within the soils. Pre-augering equipment should be available on site, or be made available to site on short notice, during construction. Should large boulders be encountered, local minor wall alignment adjustment, e.g. a jog, may be required. Pre-augering shall be carried out where required to facilitate sheet pile penetration. If pre-augering is carried out, reverse augering shall be carried out as the auger is retrieved to leave as much soil cuttings as possible inside the hole. The Contractor shall seek approval from the Contract Administrator (CA) including hole diameter and procedures prior to proceeding with pre-augering.