



Foundation Investigation Report
Non-Structural Culvert Replacement
Township of Conmee, Station 10+780
Lat: 48.5197429, Lon: -89.65540958
District of Thunder Bay
Highway 11/17

Assignment No.: 14 6022-E-0044
GWP No.: 6920-17-00
GeoCres 52A12-003

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Part A - FOUNDATION INVESTIGATION REPORT

1 Introduction

TBT Engineering Limited (TBTE) has been retained by the Ontario Ministry of Transportation Northwest Region (MTO) to provide foundation investigation and design services for the replacement of a non-structural existing twin 1220 mm diameter CSPs culverts intersecting Highway 11/17, 1.7 km south of the intersection of HWY 11/17 and Hwy 102, between Kakabeka and Shabaqua. Foundation investigation and design were provided under the Northwest Region (NWR) Geotechnical Retainer Assignment. The foundation investigation was conducted to provide subsurface data for the design of the culvert replacement.

The existing twin culverts have approximately 5.5 m of cover. The site coordinates are as follows:

- Conmee Township, Station 10+780, Latitude: 48.5197429°, Longitude: -89.65540958°

A Google image illustrating the site location has been provided as Figure 1.1.

The investigation consisted of a total of four boreholes; one borehole was advanced at each of the culvert's inlet and outlet to a maximum depth of 6.9 m, and two through the embankment on either side of the twin culverts to a maximum depth of 22.6 m. This report (Part A) describes the subsurface conditions encountered during the investigation.

The MTO Foundations Section has assigned Geocres No. 52A12-003 to this site.



Figure 1.1: A Google Earth Image Illustrating the Site Location.

2 Site Description

The existing embankment is within the MTO Right-of-Way but are within the tree line. The photos below were taken by TBTE during site recognisance. An embankment height of 6.7 m with embankment side slopes estimated ranging from 1.7H:1V to 1.9H:1V for both sides of the embankment

The culvert at station 10+777 has an inlet obvert elevation of 391.3 m and invert elevation of 390.1 m; and an outlet obvert elevation of 391.0 m and invert elevation of 389.8 m. The culvert at station 10+781 has an inlet obvert elevation of 391.5 m and invert elevation of 390.3 m; and an outlet obvert elevation of 391.0 m and invert elevation of 389.8 m. Water levels measured at the inlet and outlet of the culverts were both 391.0 m and was measured at 390.3 m on May 16, 2018 as per MTO provided drawing.



**Figure 2.1: East side Embankment
Looking South, June 7, 2024.**



**Figure 2.2: East side Embankment
Looking West, June 7, 2024.**



**Figure 2.3: Westside Embankment
Looking West, June 7, 2024.**

2.1 Surficial Geology

As defined by the Ontario Ministry of Natural Resources' Northern Ontario Engineering Geology Terrain Study (NOEGTS), 1979, Map No. 52A/NW, the site is in an area which primarily consists of a clay/clayey glaciolacustrine plain. The area has low to moderate local relief and is generally dry.

Glaciolacustrine Plains are described in the NOEGTS as deposits with fine grained materials varying in clay, silt and sand content based on depth of water and distance from the shoreline of former glacial lakes. Clay deposits vary from varved to massive and often have minor inclusions of till and scattered dropstones. The presence of the above soils was confirmed from the field investigation.

3 Investigation Procedures

A site visit was conducted on June 7, 2024 prior to geotechnical investigations in order to assess drill access in ditch lines and assess traffic control requirements for on road drilling.

A geotechnical site investigation was undertaken from June 25, 2024 to July 9, 2024. The field investigation consisted of advancing a total of four boreholes. Borehole locations are illustrated on the Borehole Location and Soil Strat Drawings (Appendix C). Boreholes 3 and 4 were advanced near either culvert end, where Boreholes 5 and 6 were advanced through the road surface. Due to traffic concerns Boreholes 5 and 6 were drilled on either side of the culverts but within the same lane.

The borehole locations were identified in the field by TBTE personnel and service clearances were completed prior to mobilizing the drill rig to site. The boreholes were advanced using a drill rig mounted on an all-terrain carrier equipped with a casing advancement apparatus used to carry out Standard Penetration Testing as per ASTM D1586.

During the drilling operations for the boreholes, soil samples were obtained from the auger flights and using the techniques of the Standard Penetration Test (SPT). The SPT involves driving a thick walled sampler into the soils under a standardized energy (63.5 kg, falling 760 mm). The number of blows required to drive the sampler 0.3 m is known as the SPT blow count (N). Following completion of the test, a representative soil sample is obtained from within the sampler. SPTs are typically taken at a frequency of every 0.75 m for the first 3 m of the

borehole, and every 1.5 m afterwards, to the termination depth of the borehole. Sample frequency may vary due to circumstances experienced in the field.

In addition, thin-walled tube samples were taken within the cohesive materials, alternating with SPT samples. In-situ field vane testing was completed at select depths within the cohesive materials to obtain an indication of the material's undrained shear strength. In-situ field vane testing was completed as per ASTM D2573 with a tapered vane.

DCP Testing was completed at Borehole 5 at a depth of 19.2 m (elev. 377.8 m) and extended to a depth of 22.6 m (elev. 374.4 m). The dynamic cone penetrometer test is a continuous test, driving a 51 mm diameter cone with an energy of a 63.5 kg weight falling through 760 mm. The number of blows required to drive the cone 300 mm is recorded which provides an indication of the condition of the soil.

Borehole locations were surveyed by TBTE with a level and rod and referenced to a temporary benchmark at the centreline of the highway. A hand-held Garmin GPS device was used in the field to record coordinates of the borehole locations, based on North American Data 1983 NAD83 (CSRS) v6 (2010 epoch).

A summary of the borehole location data is provided on the enclosed Borehole Location and Soil Strata Drawings in Appendix C.

Table 3.1: Summary of Borehole Information.

| Test Hole Number | Co-ordinates | Surface Elevation (m) | Depth of Exploration (m) |
|------------------|-------------------------------------|-----------------------|--------------------------|
| 1 | Lat 48.51980567 Lon -89.65531403 | 392.0 | 6.7 |
| 2 | Lat 48.51969297 Lon -89.65473929 | 391.4 | 6.9 |
| 3 | Lat 48.51978683 Lon -89.6549609 | 397.0 | 22.6 |
| 4 | Lat 48.51967524 Lon -89.65511759 | 397.1 | 18.8 |

All boreholes and the temporary standpipe piezometers have been backfilled and/or decommissioned with auger cuttings and bentonite in accordance with the Ontario Ministry of the

Environment's Regulation 903, as amended by Regulation 128/03 (water well regulation under the Ontario Water Resource Act).

4 Laboratory Testing

Soil samples obtained during the field investigation were subjected to routine laboratory testing. The routine testing included moisture content, Atterberg limit tests and grain size analysis. Typically, 100% of the recovered soil samples are tested for natural moisture content determination, and 25% of the recovered soil samples are chosen for grain size analysis and/or Atterberg limits testing, as applicable. The following test methods/standards are followed for the above testing: LS 602 (sieve analysis for aggregates), LS 701 (moisture content of soils), ASTM C136 (standard test method for sieve analysis of fine and coarse aggregates), ASTM D4318 (standard test for liquid, plastic, and plasticity index of soils), ASTM D2216 (standard test method for laboratory determination of water (moisture) content of soil and rock by mass). The results of this testing are shown on the borehole logs (Appendix A) and on the laboratory data reports (Appendix B).

One soil sample was submitted to the ALS Canada Ltd. laboratory in Thunder Bay, Ontario which was subjected to corrosivity and conductivity testing. Results of this testing have been provided below and in Appendix B.

5 Subsurface Conditions

Details of the subsurface conditions are provided on the borehole logs (Appendix A), laboratory reports (Appendix B) and on the Soil Strata Drawing (Appendix C).

The subsurface soils at this site typically consist of fills through the embankment overlying clay. Silts and sands overlying clay was encountered outside the embankment fills.

5.1 Asphalt

130 mm of asphalt was identified at the surface of Borehole 3 (397.0 m). 110 mm of asphalt was identified at the surface of Borehole 4 (397.1 m).

5.2 Fill

Embankment fill was encountered below asphalt surface at Boreholes 5 and 6 and extended to depths of 7.4 and 7.2 m respectively (elev. 389.6 and 389.9 m) was comprised of various fill materials. The fill typically consisted of sand with varying amounts of gravel and silt. The results

of three grain size analysis indicates that this material can consist of 5 to 44 % gravel 36 to 53% sand and 7 to 59 % silt/clay sized particles. The condition of this material is loose to dense based on SPT N-values of 7 to 35 blows per 0.3 m.

Clay fill was encountered at two depths 1.4 m (elev. 395.6 m) at Borehole 3, and 2.9 m (elev. 394.2 m) at Borehole 4. The Borehole 3 sample's Atterberg limit test indicates a silty clay, with the natural moisture content exceeding the liquid limit. The Borehole 4 sample's Atterberg limit test indicates that this material is a clay of high plasticity with the natural moisture content between the plastic and liquid limits.

5.2.1 Rockfill

Rockfill was encountered from surface of Borehole 1 (elev. 392.2 m) and extended to a depth of 0.7 m depth (elev. 391.5 m).

5.3 Clay

Clay and sand to clay with trace sand and trace gravel was present underlying the fill at Boreholes 1, 3 and 4 and at the surface of Borehole 2 (elev. 389.1 to 391.3 m) and extended to depths ranging from 6.7 to 19.2 m (elev. 377.8 to 385.5 m) where the boreholes were terminated. Trace organics was noted at the surface of this material. Occasional to numerous sand and silt varves were noted within this material.

Atterberg limits testing indicates that this material is generally medium to high plasticity, with the natural moisture content in between the plastic and liquid limits to above the liquid limit. An area of low plasticity was encountered at a depth of 18.2 m (elev. 378.5 m) within Borehole 3. Grain size analysis indicates that this material can consist of 0 - 10 % gravel, 9 - 39 % sand, 60 - 91 % silt/clay sized particles. This material has a very soft to stiff consistency based on SPT N-values of 1 to 12 blows per 0.3 m generally decreasing with depth, a firm to very stiff consistency based on field vane tests ranging from 33 kPa to over 100 kPa, firm to stiff consistency based on lab vanes ranging from 28 to 85 kPa, and soft consistency based on pocket penetrometer ranging from 0.5 to 1.5 kg/cm². Field vane test results may be inflated due to intersecting gravel and/or sand particles and/or varves within the clay.

Undrained direct shear testing was conducted on a sample of the clay from Borehole 2 at a depth of 1.5 m (elev. 389.9 m). The result of this testing is provided in Appendix B.

5.4 DCPT

DCPT test was completed measuring DCPT-N blows per 0.3 m. The DCPT was advanced within the clay material at BH3 starting at a depth of 19.2 m (elev. 377.8 m) and extended to a depth of 22.6 m (elev. 374.4 m). DCPT N-values ranged from 7 to 30 blows per 0.3 m increasing with depth.

5.5 Corrosivity and Conductivity Testing

One soil sample from fill at approximate elevation 397.3 m was submitted for corrosivity and conductivity testing, results of which are summarized in the table below. Detailed results are provided in Appendix B.

Table 5.1: Analytical Testing Results.

| Test | Unit | Result |
|------------------|--------|--------|
| Conductivity | mS/cm | 366 |
| Moisture | % | 39.7 |
| Acidity/Basicity | pH | 7.76 |
| Redox Potential | mV | 292 |
| Resistivity | ohm-cm | 2730 |
| Chloride | mg/kg | 111 |
| Sulphide (as S) | mg/kg | <0.33 |
| Sulphate | mg/kg | <20 |

5.5.1 Groundwater

The groundwater levels were read upon completion of drilling and within the temporary standpipe piezometer installed to a depth of 2.9 m at Boreholes 2 and 3 as shown below. Groundwater levels will vary from season to season and from the effects of heavy precipitation events.

Table 5.2: Observed Groundwater Levels.

| Location | Surface Elevation (m) | Groundwater Level on Completion of Drilling | | Groundwater Level After Completion | | |
|------------|-----------------------|---|-----------|------------------------------------|-----------|-----------------|
| | | Depth (m) | Elev. (m) | Depth (m) | Elev. (m) | Time After Comp |
| Borehole 1 | 392.2 | - | - | 1.2 | 391.0 | 16 days |
| Borehole 2 | 391.5 | 0.3 | 391.2 | 0.3 | 391.2 | 15 days |
| Borehole 3 | 397.0 | - | - | 5.3 | 391.7 | 5 Hrs |

6 Miscellaneous

Laboratory testing was carried out at the TBT Engineering laboratory in Thunder Bay. The drill equipment for this investigation was operated by TBT Engineering Limited. The field operations

were supervised by Alan Finke. Laboratory testing was supervised by Forch Valela, C.E.T. This report was prepared and reviewed by Dean Vale, P.Eng., and Steven Seller, P.Eng. (TBTE's designated principal contact identified for MTO Foundation Engineering).

7 Limitations

Conclusions and recommendations presented in this report are based on the information determined at a limited number of test hole locations. Subsurface and groundwater conditions between and beyond these locations may differ from those encountered. Conditions may become apparent during construction that were not detected and could not be anticipated at the time of the site investigation.

Groundwater levels indicated are based on the information described within the report. The presence of all conditions that could affect the type and scope of the dewatering procedures which may be considered during construction cannot readily be determined from site investigation or boreholes. These conditions include local and seasonal fluctuations of the groundwater level, changes in soil conditions between borehole locations, thin and/or discontinuous layers of highly permeable soils, etc.

In no way does the information contained within this report reflect any environmental aspect of the site or soil.

8 Closure

We trust the above addresses your project requirements at this time. Should you have any questions or comments, please do not hesitate to contact us at your convenience.

Yours truly,

For TBT ENGINEERING



Dean Vale, P.Eng.
Project Engineer



Steven Seller, P.Eng.
Senior Engineer
Principal Contact for MTO Foundations

APPENDIX A

Borehole Logs

EXPLANATION OF TERMS

N Value: The Standard Penetration Test (SPT) N value is the number of blows required to cause a standard 51mm O.D. split barrel sampler to penetrate 0.3m into undisturbed ground in a borehole when driven by a hammer with a mass of 63.5 kg, falling freely a distance of 0.76m. For penetrations of less than 0.3m N values are indicated as the number of blows for the penetration achieved. Average N value is denoted thus \bar{N} .

Dynamic Cone Penetration Test: Continuous penetration of a conical steel point (51mm O.D. 60° cone angle) driven by 475 J impact energy on 'A' size drill rods. The resistance to cone penetration is measured as the number of blows for each 0.3m advance of the conical point into the undisturbed ground.

Soils are described by their composition and consistency/condition.

Consistency: Cohesive soils are described on the basis of their undrained shear strength (c_u) as follows:

| C_u (kPa) | 0-12 | 12-25 | 25-50 | 50-100 | 100-200 | >200 |
|-------------|-----------|-------|-------|--------|------------|------|
| | Very Soft | Soft | Firm | Stiff | Very Stiff | Hard |

Condition: Cohesionless soils are described on the basis of denseness as indicated by SPT N values as follows:

| N (Blows/0.3m) | 0-4 | 4-10 | 10-30 | 30-50 | >50 |
|----------------|------------|-------|---------|-------|------------|
| | Very Loose | Loose | Compact | Dense | Very Dense |

Minor Soil Components: Terminology used to represent the amount of minor components based on their percent of the sample by weight as follows:

| % by weight | 0-10 | 10-20 | 20-35 | 35-50 |
|-------------|-------|-------|-------------|-------|
| | Trace | Some | "ey" or "y" | And |

ABBREVIATIONS AND SYMBOLS

Field Sampling, Insitu Testing, Laboratory Testing

| | | | |
|-----|-----------------------|-----|---|
| S S | Split Spoon | T P | Thin Wall Piston |
| A S | Auger | O S | Osterberg |
| W S | Wash | R C | Rock Core |
| S T | Slotted Tube | P H | T W Advanced Hydraulically |
| B S | Block | P M | T W Advanced Manually |
| C S | Chunk | F S | Foil |
| V T | Vane Test (kPa) | P P | Pocket Penetrometer (kg/cm ²) |
| T W | Thin Wall Shelby Tube | | |

EXPLANATION OF TERMS Cont'd.

| Stress and Strain | | | | Mechanical Properties of Soil | | | |
|--------------------------------------|-----|------------------------------|--|-------------------------------|-----------------------|--------------------------------------|--|
| u_w | kPa | Pore Water Pressure | | m_v | kPa^{-1} | Coefficient of Volume Change | |
| u | | Pore Pressure Ratio | | C_c | | Compression Index | |
| σ | | Total Normal Stress | | C_s | | Swelling Index | |
| σ' | kPa | Effective Normal Stress | | C_a | | Rate of Secondary Consolidation | |
| τ | kPa | Shear Stress | | c_v | m^2/s | Coefficient of Consolidation | |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | Principal Stress | | H | m | Drainage Path | |
| ϵ | % | Linear Strain | | T_v | | Time Factor | |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | % | Principal Strains | | U | % | Degree of Consolidation | |
| E | MPa | Young's Modulus | | P'_o | kPa | Effective Overburden Pressure | |
| G | kPa | Modulus of Shear Deformation | | P'_c | kPa | Preconsolidation Pressure | |
| m | MPa | Constrained Modulus | | τ_f | kPa | Shear Strength | |
| μ | | Coefficient of Friction | | c' | kPa | Effective Cohesion Intercept | |
| | | | | ϕ' | $^\circ$ | Effective Angle of Internal Friction | |
| | | | | c_u | kPa | Undrained Shear Strength | |
| | | | | s | | Sensitivity | |

| Physical Properties of Soil | | | | | | | | |
|-----------------------------|------------------------|--------------------------------|------------|---|---|------------|------------------------|---|
| ρ_s | kg/m^3 | Density of Solid Particles | e | % | Void Ratio | e_{\min} | % | Void Ratio in Densest State |
| γ_s | kN/m^3 | Unit Weight of Solid Particles | n | % | Porosity | I_D | | Density Index $= \frac{e_{\max} - e}{e_{\max} - e_{\min}}$ |
| ρ_w | kg/m^3 | Density of Water | w | % | Water Content | D | mm | Grain Diameter |
| γ_w | kN/m^3 | Unit Weight of Water | s_r | % | Degree of Saturation | D_n | mm | n Percent Diameter |
| ρ | kg/m^3 | Density of Soil | w_L | % | Liquid Limit | C_U | | Uniformity Coefficient |
| γ | kN/m^3 | Unit Weight of Soil | w_P | % | Plastic Limit | h | m | Hydraulic Head or Potential |
| ρ_d | kg/m^3 | Density of Dry Soil | w_S | % | Shrinkage Limit | q | m^3/s | Rate of Discharge |
| γ_d | kN/m^3 | Unit Weight of Dry Soil | I_P | % | Plasticity Index = $w_L - w_P$ | v | m/s | Discharge Velocity |
| ρ_{sat} | kg/m^3 | Density of Saturated Soil | I_L | | Liquidity Index = $\frac{w - w_P}{I_P}$ | i | | Hydraulic Gradient |
| γ_{sat} | kN/m^3 | Unit Weight of Saturated Soil | I_C | | Consistency Index = $\frac{w_L - w}{I_P}$ | k | m/s | Hydraulic Conductivity |
| ρ' | kg/m^3 | Density of Submerged Soil | e_{\max} | % | Void Ratio in Loosest State | j | kN/m^3 | Seepage Force |
| γ' | kN/m^3 | Unit Weight of Submerged Soil | | | | | | |

| RECORD OF BOREHOLE No 1 | | | | | | | | | | 1 OF 1 | | METRIC | | | | | |
|----------------------------|---|------------|--|------|----------------------|-------------------------|------------------------|--|---------------|--------|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|-------------------|--|
| W.P. _____ | | | LOCATION Station 10+777 o/s 24.1m RT of C/L N:5375747.334; E:330260.29 MTM Zone:15 | | | | | ORIGINATED BY IB | | | | | | | | | |
| DIST Thunder Bay HWY 11&17 | | | BOREHOLE TYPE Casing Advancer | | | | | COMPILED BY TG | | | | | | | | | |
| DATUM Geodetic | | | DATE 2024.06.25 - 2024.06.25 | | LATITUDE 48.51980567 | | LONGITUDE -89.65531403 | | CHECKED BY SS | | | | | | | | |
| 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 | REMARKS & GRAIN SIZE DISTRIBUTION (%) | | |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | | WATER CONTENT (%) | |
| | | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | |
| 392.2 | | | | | | | | | | | | | | | | | |
| 0.0 | ROCKFILL | | | | | | 392 | | | | | | | | | | Water level @ 1.2 m on July 10, 2024. |
| 391.5 | | | | | | | | | | | | | | | | | |
| 0.7 | CLAY - Sandy, trace gravel, trace organics to 1.4 m, brown, firm to stiff | | 1 | SS | 9 | | 391 | | | | | | | | | | 3 35 (62) |
| | | | 2 | SS | 5 | | | | | | | | | | | | |
| | | | 3 | SS | 12 | | 390 | | | | | | | | | | |
| | | | 4 | SS | 6 | | 389 | | | | | | | | | | 5 31 (64) Temporary Standpipe installed to 2.9 m. |
| | ----- - occasional grey sand varves to 4.5 m | | | | | | 388 | | | | | | | | | | |
| | | | 5 | TW | | | 387 | | | | | | | | | | |
| | ----- - very soft | | | | | | | | | | | | | | | | |
| 385.5 | | | 6 | SS | 1 | | 386 | | | | | | | | | | |
| 6.7 | End of Borehole @ 6.7 m. | | | | | | | | | | | | | | | | |

ONTARIO MTO MOD 23-318-14 MTO.GPJ ONTARIO MTO.GDT 9-19-24

METRIC

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE PP=Pocket Penetrometer (Kg/cm²)

RECORD OF BOREHOLE No 3

1 OF 2

METRIC

W.P. _____ LOCATION Station 10+775 o/s 6.9 m LT of C/L N:5375745.597; E:330277.581 MTM Zone:15 ORIGINATED BY AF
DIST Thunder Bay HWY 11&17 BOREHOLE TYPE Casing Advancer COMPILED BY TG
DATUM Geodetic DATE 2024.07.08 - 2024.07.09 LATITUDE 48.51978934 LONGITUDE -89.65508005 CHECKED BY SS

| 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 | | | SHEAR STRENGTH kPa | | | | | | | | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | | |
| 397.0 | | | | | | | 20 | 40 | 60 | 80 | 100 | | | | | | | |
| 396.9 | ASPHALT - 130 mm | | | | | | | | | | | | | | | | | |
| 0.1 | FILL - SAND - some gravel, trace silt, brown | | 1 | AS | | | | | | | | | | | | | | |
| | - GRAVEL - some sand, trace silt, grey, dense | | 2 | SS | 35 | | | | | | | | | | | | | |
| | - SAND - Gravelly, some clay, brown, loose | | 3 | SS | 9 | | | | | | | | | | | | | |
| | - CLAY & SAND - trace gravel, brown, firm | | 4 | SS | 7 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | 5 | SS | 8 | | | | | | | | | | | | | |
| | - SAND & GRAVEL - some rock fill, trace silt/clay, grey, compact | | | | | | | | | | | | | | | | | |
| | | | 6 | SS | 15 | | | | | | | | | | | | | |
| | | | 7 | SS | 13 | | | | | | | | | | | | | |
| 389.6 | CLAY - grey sand varves to 8.7 m, trace to some sand, brown, very soft to firm | | 8 | SS | 5 | | | | | | | | | | | | | |
| 7.4 | | | | | | | | | | | | | | | | | | |
| | | | 9 | TW | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | 10 | SS | 1 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | 11 | TW | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |
| | | | 12 | SS | 1 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | |

Continued Next Page

RECORD OF BOREHOLE No 3

2 OF 2

METRIC

W.P. _____ LOCATION Station 10+775 o/s 6.9 m LT of C/L N:5375745.597; E:330277.581 MTM Zone:15 ORIGINATED BY AF
DIST Thunder Bay HWY 11&17 BOREHOLE TYPE Casing Advancer COMPILED BY TG
DATUM Geodetic DATE 2024.07.08 - 2024.07.09 LATITUDE 48.51978934 LONGITUDE -89.65508005 CHECKED BY SS

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC LIMIT NATURAL MOISTURE CONTENT | | | 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 | | | WATER CONTENT (%) | | | | |
| | | | | | | | | <div><div></div><div>○ UNCONFINED</div></div> | <div><div></div><div>● QUICK TRIAXIAL</div></div> | <div><div></div><div>+ FIELD VANE</div></div> | <div><div></div><div>× LAB VANE</div></div> | <div><div></div><div>W_p</div></div> | <div><div></div><div>W</div></div> | | |
| | | | | | | <div><div></div><div>20</div></div> | <div><div></div><div>40</div></div> | <div><div></div><div>60</div></div> | <div><div></div><div>80</div></div> | <div><div></div><div>100</div></div> | <div><div></div><div>20</div></div> | <div><div></div><div>40</div></div> | <div><div></div><div>60</div></div> | | |

| | | |
|--|--|---|
| | CLAY - grey sand varves to 8.7 m, trace to some sand, brown, very soft to firm (continued) | <div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><div></div><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|
|--|--|---|

ONTARIO MTO MOD 23-318-14 MTO.GPJ ONTARIO MTO.GDT 9-19-24

RECORD OF BOREHOLE No 4

1 OF 2

METRIC

W.P. _____ LOCATION Station 10+785 o/s 6.9 m LT of C/L N:5375735.606; E:330275.374 MTM Zone:15 ORIGINATED BY AF
DIST Thunder Bay HWY 11&17 BOREHOLE TYPE Casing Advancer COMPILED BY TG
DATUM Geodetic DATE 2024.07.09 - 2024.07.09 LATITUDE 48.51969958 LONGITUDE -89.65511054 CHECKED BY SS

| 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 (%) GR SA SI CL | | | | |
|-----------------------|---|------------|---------|------|------------|----------------------------|-----------------|--|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|---------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | | WATER CONTENT (%) | | | |
| | | | | | | | | ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE | | | | | | | | | | |
| 397.1 396.0 0.1 | ASPHALT - 110 mm FILL - SAND - some gravel, trace silt, grey, compact to dense ----- - some silt, trace gravel, brown ----- - Gravelly, some clay ----- - CLAY & SAND - brown, stiff ----- - trace gravel | | | | | | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | | | | |
| | | | 1 | SS | 34 | | | | | | | | | | | | | |
| | | | 2 | SS | 11 | | | | | | | | | | | | | |
| | | | 3 | SS | 9 | | | | | | | | | | | 5 36 (59) | | |
| | | | 4 | SS | 9 | | | | | | | | | | | | | |
| | | | 5 | SS | 11 | | | | | | | | | | | | | |
| | | | 6 | SS | 3 | | | | | | | | | | | 0 39 (61) | | |
| | | | 7 | TW | | | | | | | | | | | | | | |
| | | | 8 | TW | | | | | | | | | | | | 10 30 (60) | | |
| | | | 9 | SS | 1 | | | | | | | | | | | PP = 0.5 kg/cm ² | | |
| | | | 10 | TW | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | PP = <0.5 kg/cm ² | | |

Continued Next Page

+³, X³: Numbers refer to
Sensitivity

O 3% STRAIN AT FAILURE

PP=Pocket Penetrometer (Kg/cm²)

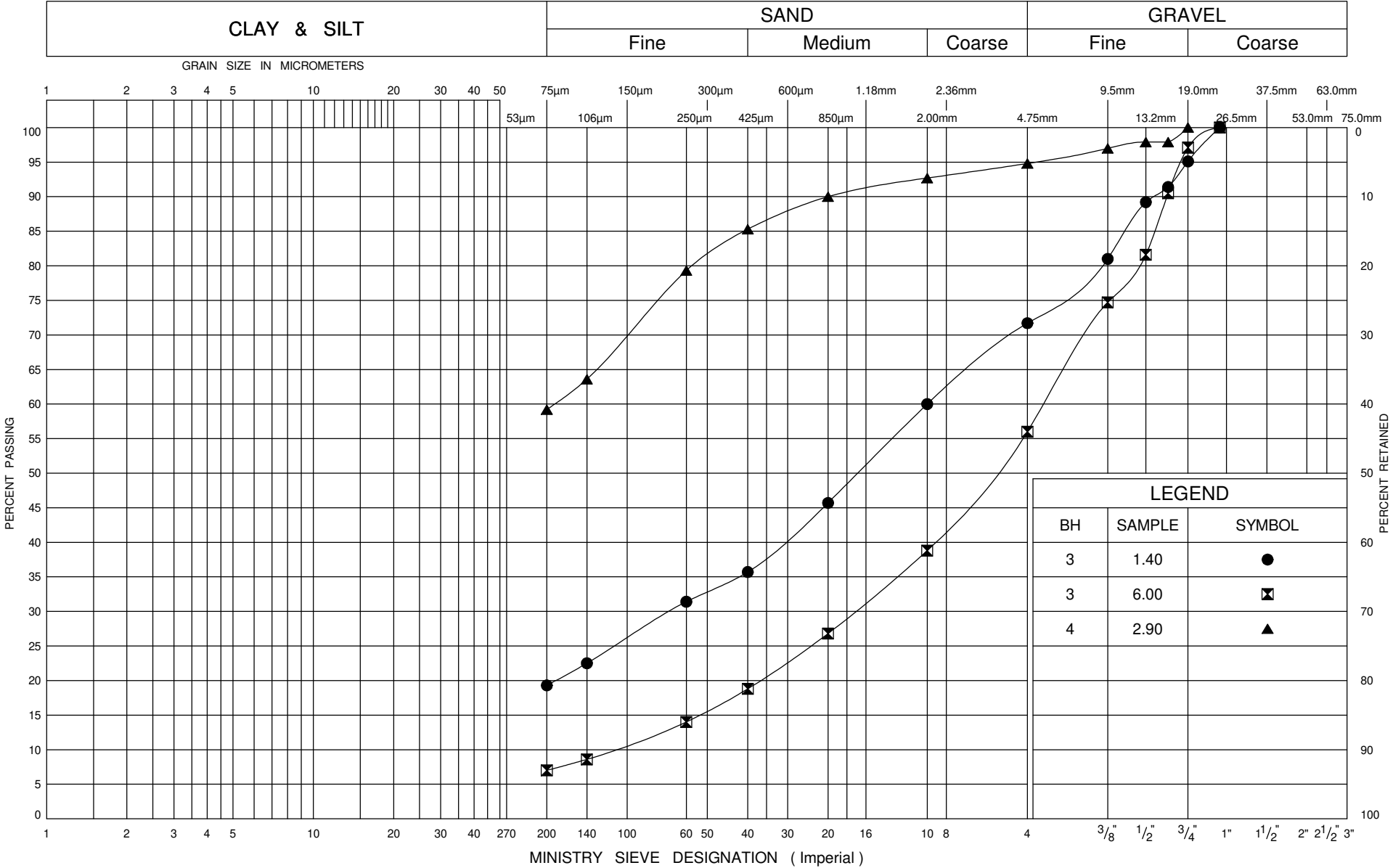
METRIC

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE PP=Pocket Penetrometer (Kg/cm²)

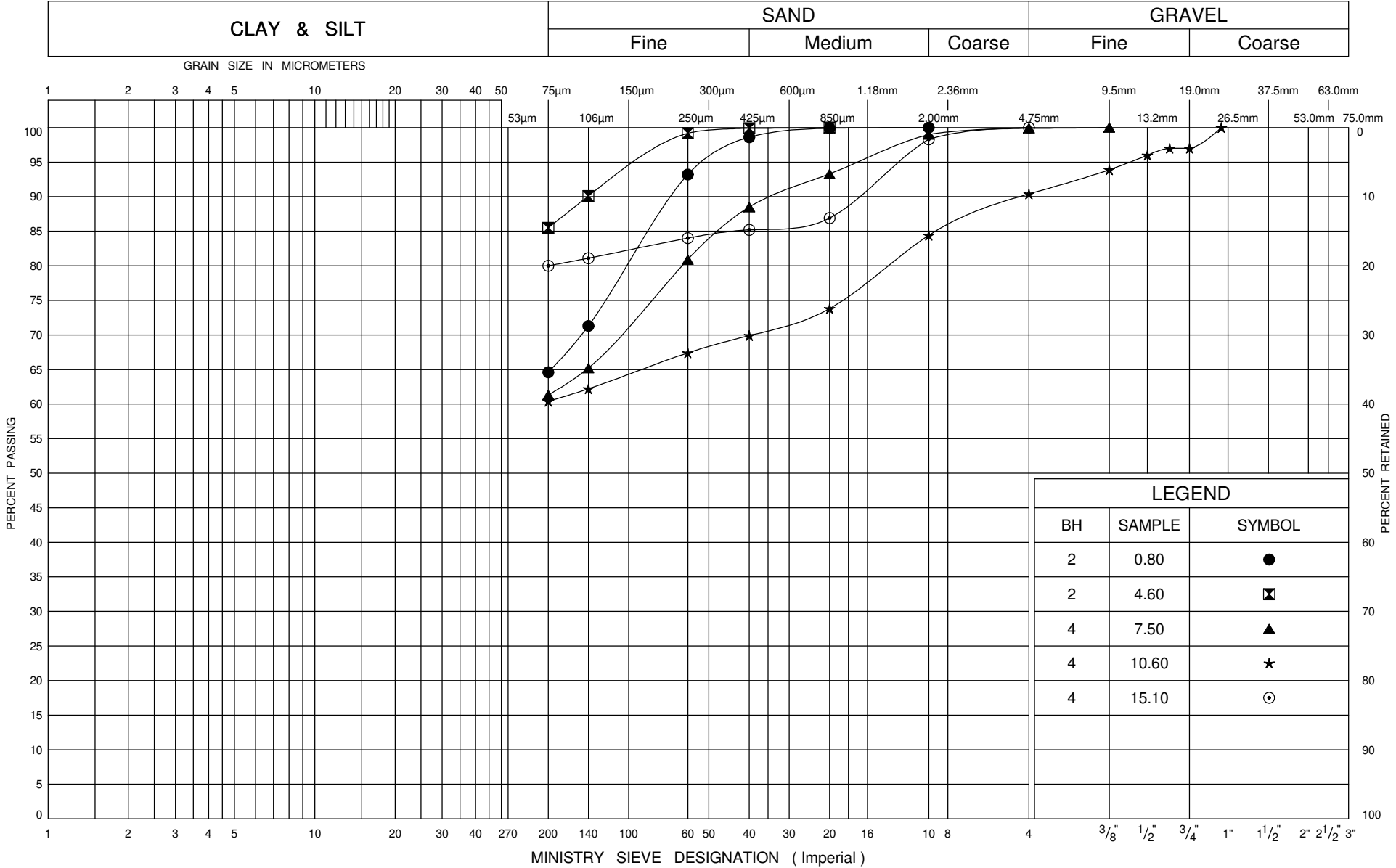
APPENDIX B

Laboratory Test Data

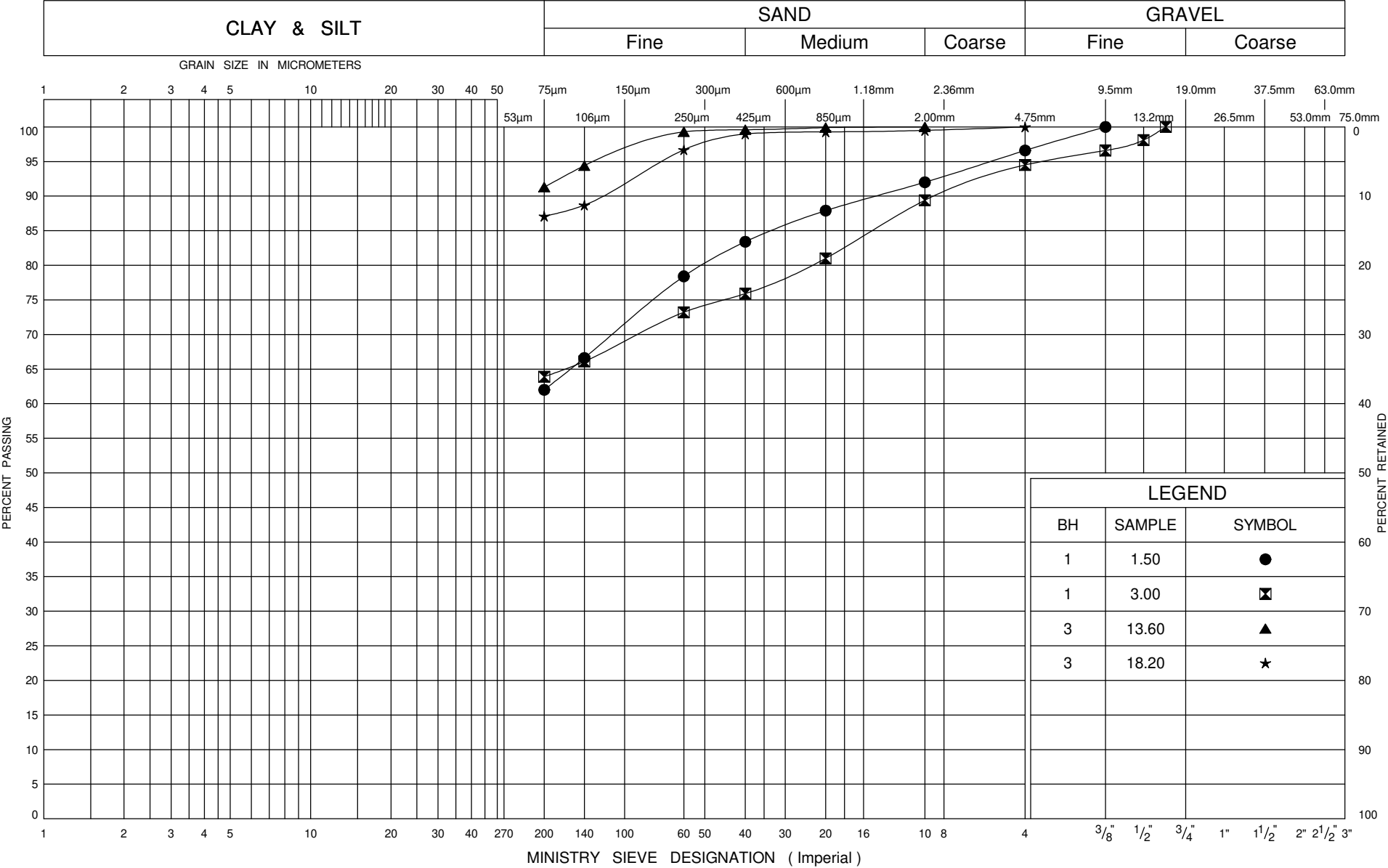
UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM

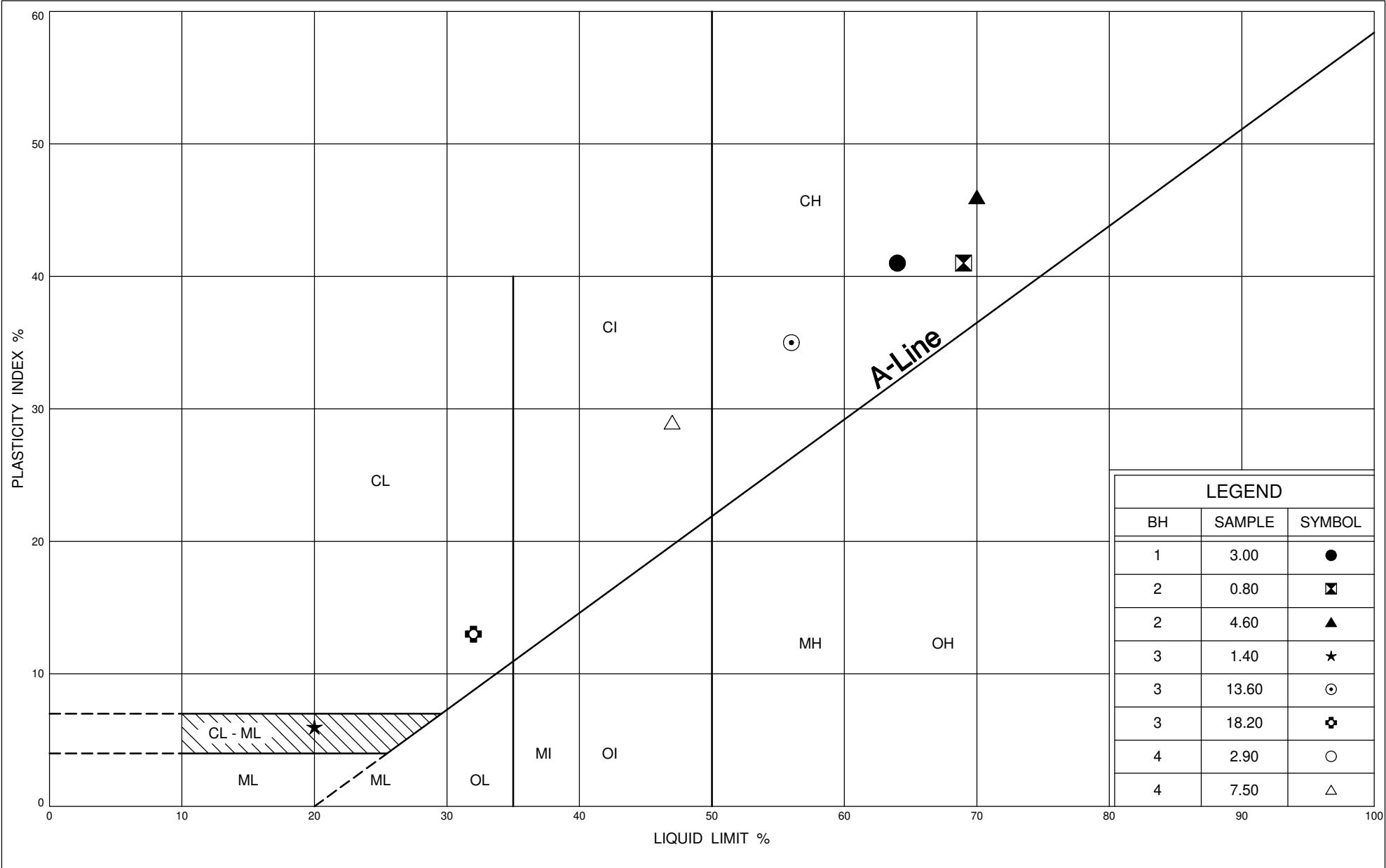


GRAIN SIZE DISTRIBUTION
CLAY

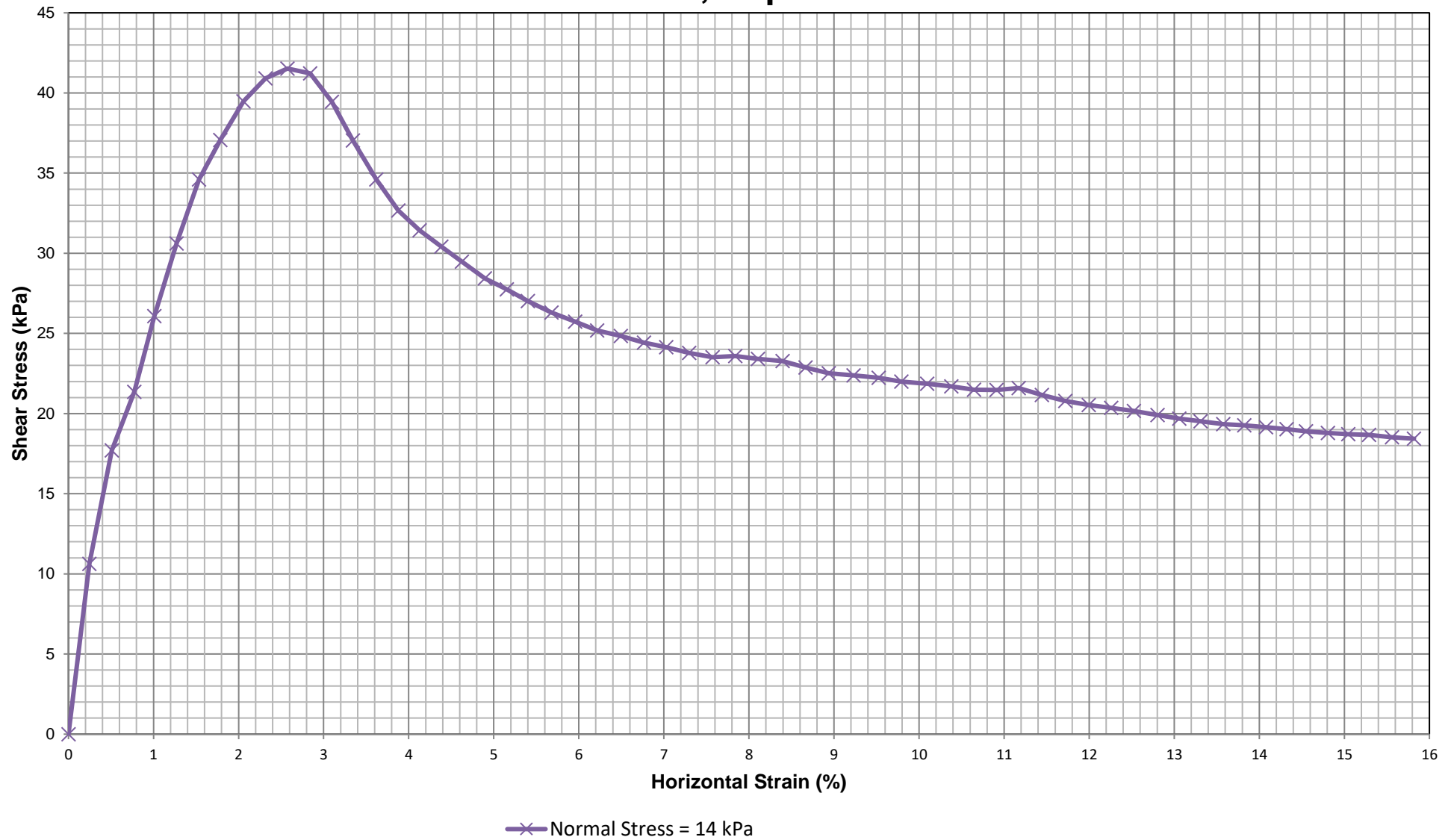
FIG No 3

W P 6920-17-00

Culverts



Undrained Direct Shear Test Borehole 4, Depth 2.1 m



CERTIFICATE OF ANALYSIS

| | | | |
|--------------------------------|--|--------------------------------|---|
| Work Order | : TY2407728 | | |
| Client | : TBT Engineering Group | Laboratory | : ALS Environmental - Waterloo |
| Contact | : Doug Steele | Account Manager | : Cassidy Young |
| Address | : 1918 Younge Street Thunder Bay Ontario Canada P7E 6T9 | Address | : 60 Northland Road, Unit 1 Waterloo ON Canada N2V 2B8 |
| Telephone | : (807)624-5160 | Telephone | : +1 519 886 6910 |
| Project | : 23-318-14 | Date Samples Received | : 18-Jul-2024 09:45 |
| PO | : 2407-5133 | Date Analysis Commenced | : 20-Jul-2024 |
| C-O-C number | : ---- | Issue Date | : 25-Jul-2024 09:15 |
| Sampler | : LF | | |
| Site | : ---- | | |
| Quote number | : Standing Offer - Soil - 2024 | | |
| No. of samples received | : 1 | | |
| No. of samples analysed | : 1 | | |

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatories

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

| <i>Signatories</i> | <i>Position</i> | <i>Laboratory Department</i> |
|--------------------|-----------------|-------------------------------------|
| Josphin Masihi | Analyst | Centralized Prep, Waterloo, Ontario |
| Nik Perkio | Senior Analyst | 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.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

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

| Unit | Description |
|----------|-------------------------------|
| ohm cm | ohm centimetres (resistivity) |
| % | percent |
| mV | millivolts |
| pH units | pH units |
| µS/cm | microsiemens per centimetre |
| mg/kg | milligrams per kilogram |

<: less than.

>: greater than.

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

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

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





Analytical Results

| | | | | | | | | | | |
|--|------------|-------------|------|----------|------------------|-------------------|------|------|------|------|
| Sub-Matrix: Soil (Matrix: Soil/Solid) | | | | | Client sample ID | BH6-SS6 | ---- | ---- | ---- | ---- |
| Client sampling date / time | | | | | | 09-Jul-2024 12:00 | ---- | ---- | ---- | ---- |
| Analyte | CAS Number | Method/Lab | LOR | Unit | | TY2407728-001 | ---- | ---- | ---- | ---- |
| Result | | | | | | | ---- | ---- | ---- | ---- |
| Physical Tests | | | | | | | | | | |
| Conductivity (1:2 leachate) | ---- | E100-L/WT | 5.00 | µS/cm | 366 | | ---- | ---- | ---- | ---- |
| Moisture | ---- | E144/WT | 0.25 | % | 39.7 | | ---- | ---- | ---- | ---- |
| Oxidation-reduction potential [ORP] | ---- | E125/WT | 0.10 | mV | 292 | | ---- | ---- | ---- | ---- |
| pH (1:2 soil:CaCl2-aq) | ---- | E108A/WT | 0.10 | pH units | 7.76 | | ---- | ---- | ---- | ---- |
| Resistivity | ---- | EC100R/WT | 100 | ohm cm | 2730 | | ---- | ---- | ---- | ---- |
| Inorganics | | | | | | | | | | |
| Sulfides, acid volatile | ---- | E396-L/WT | 0.33 | mg/kg | <0.33 | | ---- | ---- | ---- | ---- |
| Leachable Anions & Nutrients | | | | | | | | | | |
| Chloride, soluble ion content | 16887-00-6 | E236.Cl/WT | 5.0 | mg/kg | 111 | | ---- | ---- | ---- | ---- |
| Sulfate, soluble ion content | 14808-79-8 | E236.SO4/WT | 20 | mg/kg | <20 | | ---- | ---- | ---- | ---- |

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

QUALITY CONTROL INTERPRETIVE REPORT

| | | | |
|-------------------------|---|-----------------------|---|
| Work Order | : TY2407728 | Page | : 1 of 7 |
| Client | : TBT Engineering Group | Laboratory | : ALS Environmental - Thunder Bay |
| Contact | : Doug Steele | Account Manager | : Cassidy Young |
| Address | : 1918 Younge Street Thunder Bay ON Canada P7E 6T9 | Address | : 1081 Barton Street Thunder Bay, Ontario Canada P7B 5N3 |
| Telephone | : (807)624-5160 | Telephone | : +1 807 623 6463 |
| Project | : 23-318-14 | Date Samples Received | : 18-Jul-2024 09:45 |
| PO | : 2407-5133 | Issue Date | : 25-Jul-2024 09:15 |
| C-O-C number | : ---- | | |
| Sampler | : LF | | |
| Site | : | | |
| Quote number | : Standing Offer - Soil - 2024 | | |
| No. of samples received | : 1 | | |
| No. of samples analysed | : 1 | | |

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 Test sample Surrogate recovery outliers exist.

Outliers: Reference Material (RM) Samples

- No Reference Material (RM) Sample outliers occur.

Outliers : Analysis Holding Time Compliance (Breaches)

- No Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- No Quality Control Sample Frequency Outliers occur.



Analysis Holding Time Compliance

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

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

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

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

Matrix: **Soil/Solid**

Evaluation: ✖ = Holding time exceedance ; ✔ = Within Holding Time

| Analyte Group : Analytical Method Container / Client Sample ID(s) | Method | Sampling Date | Extraction / Preparation | | | | Analysis | | | |
|---|----------|---------------|--------------------------|---------------|---------|------|---------------|---------------|---------|------|
| | | | Preparation Date | Holding Times | | Eval | Analysis Date | Holding Times | | Eval |
| | | | | Rec | Actual | | | Rec | Actual | |
| Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg) | | | | | | | | | | |
| Glass soil jar/Teflon lined cap [ON MECP] BH6-SS6 | E396-L | 09-Jul-2024 | 22-Jul-2024 | 14 days | 13 days | ✓ | 22-Jul-2024 | 7 days | 0 days | ✓ |
| Leachable Anions & Nutrients : Water Extractable Chloride by IC | | | | | | | | | | |
| Glass soil jar/Teflon lined cap [ON MECP] BH6-SS6 | E236.Cl | 09-Jul-2024 | 23-Jul-2024 | 30 days | 14 days | ✓ | 23-Jul-2024 | 28 days | 0 days | ✓ |
| Leachable Anions & Nutrients : Water Extractable Sulfate by IC | | | | | | | | | | |
| Glass soil jar/Teflon lined cap [ON MECP] BH6-SS6 | E236.SO4 | 09-Jul-2024 | 23-Jul-2024 | 30 days | 14 days | ✓ | 23-Jul-2024 | 28 days | 0 days | ✓ |
| Physical Tests : Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level) | | | | | | | | | | |
| Glass soil jar/Teflon lined cap [ON MECP] BH6-SS6 | E100-L | 09-Jul-2024 | 23-Jul-2024 | 30 days | 14 days | ✓ | 23-Jul-2024 | 30 days | 14 days | ✓ |
| Physical Tests : Moisture Content by Gravimetry | | | | | | | | | | |
| Glass soil jar/Teflon lined cap [ON MECP] BH6-SS6 | E144 | 09-Jul-2024 | ---- | ---- | ---- | | 22-Jul-2024 | ---- | 13 days | |
| Physical Tests : ORP by Electrode | | | | | | | | | | |
| Glass soil jar/Teflon lined cap [ON MECP] BH6-SS6 | E125 | 09-Jul-2024 | 23-Jul-2024 | 180 days | 14 days | ✓ | 24-Jul-2024 | 180 days | 15 days | ✓ |
| Physical Tests : pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received | | | | | | | | | | |
| Glass soil jar/Teflon lined cap [ON MECP] BH6-SS6 | E108A | 09-Jul-2024 | 20-Jul-2024 | 30 days | 11 days | ✓ | 22-Jul-2024 | 30 days | 13 days | ✓ |

Page : 4 of 7
Work Order : TY2407728
Client : TBT Engineering Group
Project : 23-318-14



Legend & Qualifier Definitions

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



Quality Control Parameter Frequency Compliance

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

Matrix: **Soil/Solid**

Evaluation: ✖ = QC frequency outside specification; ✔ = QC frequency within specification.

| Quality Control Sample Type | | | Count | | Frequency (%) | | |
|--|----------|----------|-------|---------|---------------|----------|------------|
| Analytical Methods | Method | QC Lot # | QC | Regular | Actual | Expected | Evaluation |
| Laboratory Duplicates (DUP) | | | | | | | |
| Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg) | E396-L | 1558163 | 1 | 11 | 9.0 | 4.7 | ✓ |
| Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level) | E100-L | 1554472 | 1 | 8 | 12.5 | 5.0 | ✓ |
| Moisture Content by Gravimetry | E144 | 1558683 | 1 | 20 | 5.0 | 5.0 | ✓ |
| ORP by Electrode | E125 | 1558925 | 1 | 17 | 5.8 | 5.0 | ✓ |
| pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received | E108A | 1555648 | 1 | 19 | 5.2 | 5.0 | ✓ |
| Water Extractable Chloride by IC | E236.Cl | 1559110 | 1 | 18 | 5.5 | 5.0 | ✓ |
| Water Extractable Sulfate by IC | E236.SO4 | 1559111 | 1 | 10 | 10.0 | 5.0 | ✓ |
| Laboratory Control Samples (LCS) | | | | | | | |
| Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg) | E396-L | 1558163 | 1 | 11 | 9.0 | 4.7 | ✓ |
| Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level) | E100-L | 1554472 | 2 | 8 | 25.0 | 10.0 | ✓ |
| Moisture Content by Gravimetry | E144 | 1558683 | 1 | 20 | 5.0 | 5.0 | ✓ |
| ORP by Electrode | E125 | 1558925 | 1 | 17 | 5.8 | 5.0 | ✓ |
| pH by Meter (1:2 Soil:0.01M CaCl2 Extraction) - As Received | E108A | 1555648 | 1 | 19 | 5.2 | 5.0 | ✓ |
| Water Extractable Chloride by IC | E236.Cl | 1559110 | 2 | 18 | 11.1 | 10.0 | ✓ |
| Water Extractable Sulfate by IC | E236.SO4 | 1559111 | 2 | 10 | 20.0 | 10.0 | ✓ |
| Method Blanks (MB) | | | | | | | |
| Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg) | E396-L | 1558163 | 1 | 11 | 9.0 | 4.7 | ✓ |
| Conductivity in Soil (1:2 Soil:Water Extraction) (Low Level) | E100-L | 1554472 | 1 | 8 | 12.5 | 5.0 | ✓ |
| Moisture Content by Gravimetry | E144 | 1558683 | 1 | 20 | 5.0 | 5.0 | ✓ |
| Water Extractable Chloride by IC | E236.Cl | 1559110 | 1 | 18 | 5.5 | 5.0 | ✓ |
| Water Extractable Sulfate by IC | E236.SO4 | 1559111 | 1 | 10 | 10.0 | 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. |
| pH by Meter (1:2 Soil:0.01M CaCl ₂ Extraction) - As Received | E108A ALS Environmental - Waterloo | Soil/Solid | MECP E3530 | pH is determined by potentiometric measurement with a pH electrode, and is conducted at ambient laboratory temperature (normally 20 ± 5°C) and is carried out in accordance with procedures described in the Analytical Protocol (prescriptive method). A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling, or decanting and then analyzed using a pH meter and electrode. This method is equivalent to ASTM D4972 and is acceptable for topsoil analysis. |
| ORP by Electrode | E125 ALS Environmental - Waterloo | Soil/Solid | APHA 2580 (mod) | Oxidation Reduction Potential (ORP) is reported as the oxidation-reduction potential of the platinum metal-reference electrode employed in the analysis, measured in mV. |
| 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. |
| Water Extractable Chloride by IC | E236.Cl ALS Environmental - Waterloo | Soil/Solid | EPA 300.1 | Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer. |
| Water Extractable Sulfate by IC | E236.SO ₄ ALS Environmental - Waterloo | Soil/Solid | EPA 300.1 | Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection using a soil sample that has been added in a defined ratio of soil to deionized water, then shaken well and allowed to settle. Anions are measured in the fluid that is observed in the upper layer. |
| Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg) | E396-L ALS Environmental - Waterloo | Soil/Solid | APHA 4500S2J | This analysis is carried out in accordance with the method described in APHA 4500 S2-J. After extraction the Acid Volatile Sulphide is determined colourimetrically. |
| Resistivity Calculation for Soil Using E100-L | EC100R ALS Environmental - Waterloo | Soil/Solid | APHA 2510 B | Soil Resistivity (calculated) is determined as the inverse of the conductivity of a 2:1 water:soil leachate (dry weight). This method is intended as a rapid approximation for Soil Resistivity. Where high accuracy results are required, direct measurement of Soil Resistivity by the Wenner Four-Electrode Method (ASTM G57) is recommended. |
| Preparation Methods | Method / Lab | Matrix | Method Reference | Method Descriptions |



| 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. |
| Leach 1:2 Soil : 0.01CaCl ₂ - As Received for pH | EP108A ALS Environmental - Waterloo | Soil/Solid | MOEE E3137A | A minimum 10g portion of the sample, as received, is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil by centrifuging, settling or decanting and then analyzed using a pH meter and electrode. |
| Preparation of ORP by Electrode | EP125 ALS Environmental - Waterloo | Soil/Solid | APHA 2580 (mod) | Field-moist sample is extracted in a 1:2 ratio with DI water and then analyzed by ORP meter. |
| Anions Leach 1:10 Soil:Water (Dry) | EP236 ALS Environmental - Waterloo | Soil/Solid | EPA 300.1 | 5 grams of dried soil is mixed with 50 grams of distilled water for a minimum of 30 minutes. The extract is filtered and analyzed by ion chromatography. |
| Distillation for Acid Volatile Sulfide in Soil | EP396-L ALS Environmental - Waterloo | Soil/Solid | APHA 4500S ₂ J | Acid Volatile Sulfide is determined by colourimetric measurement on a sediment sample that has been treated with hydrochloric acid within a purge and trap system, where the evolved hydrogen sulfide gas is carried into a basic solution by argon gas for analysis. |

QUALITY CONTROL REPORT

| | | | |
|-------------------------|---|-------------------------|---|
| Work Order | : TY2407728 | Page | : 1 of 5 |
| Client | : TBT Engineering Group | Laboratory | : ALS Environmental - Thunder Bay |
| Contact | : Doug Steele | Account Manager | : Cassidy Young |
| Address | : 1918 Younge Street Thunder Bay ON Canada P7E 6T9 | Address | : 1081 Barton Street Thunder Bay, Ontario Canada P7B 5N3 |
| Telephone | : (807)624-5160 | Telephone | : +1 807 623 6463 |
| Project | : 23-318-14 | Date Samples Received | : 18-Jul-2024 09:45 |
| PO | : 2407-5133 | Date Analysis Commenced | : 20-Jul-2024 |
| C-O-C number | : ---- | Issue Date | : 25-Jul-2024 09:14 |
| Sampler | : LF | | |
| Site | : | | |
| Quote number | : Standing Offer - Soil - 2024 | | |
| No. of samples received | : 1 | | |
| No. of samples analysed | : 1 | | |

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

This Quality Control Report contains the following information:

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

| Signatories | Position | Laboratory Department |
|----------------|----------------|--|
| Josphin Masihi | Analyst | Waterloo Centralized Prep, Waterloo, Ontario |
| Nik Perkio | Senior Analyst | Waterloo Inorganics, Waterloo, Ontario |



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: 1554472) | | | | | | | | | | | |
| WT2419473-003 | Anonymous | Conductivity (1:2 leachate) | ---- | E100-L | 5.00 | µS/cm | 0.267 mS/cm | 266 | 0.375% | 20% | ---- |
| Physical Tests (QC Lot: 1555648) | | | | | | | | | | | |
| WT2415870-001 | Anonymous | pH (1:2 soil:CaCl2-aq) | ---- | E108A | 0.10 | pH units | 7.85 | 7.85 | 0.00% | 5% | ---- |
| Physical Tests (QC Lot: 1558683) | | | | | | | | | | | |
| TY2407728-001 | BH6-SS6 | Moisture | ---- | E144 | 0.25 | % | 39.7 | 39.4 | 0.742% | 20% | ---- |
| Physical Tests (QC Lot: 1558925) | | | | | | | | | | | |
| TY2407728-001 | BH6-SS6 | Oxidation-reduction potential [ORP] | ---- | E125 | 0.10 | mV | 292 | 292 | 0.00% | 25% | ---- |
| Inorganics (QC Lot: 1558163) | | | | | | | | | | | |
| CG2409588-001 | Anonymous | Sulfides, acid volatile | ---- | E396-L | 0.24 | mg/kg | <0.24 | <0.24 | 0 | Diff <2x LOR | ---- |
| Leachable Anions & Nutrients (QC Lot: 1559110) | | | | | | | | | | | |
| TY2407728-001 | BH6-SS6 | Chloride, soluble ion content | 16887-00-6 | E236.Cl | 5.0 | mg/kg | 111 | 104 | 6.66% | 30% | ---- |
| Leachable Anions & Nutrients (QC Lot: 1559111) | | | | | | | | | | | |
| TY2407728-001 | BH6-SS6 | Sulfate, soluble ion content | 14808-79-8 | E236.SO4 | 20 | mg/kg | <20 | <20 | 0.008 | 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: 1554472) | | | | | | |
| Conductivity (1:2 leachate) | ---- | E100-L | 5 | µS/cm | <5.00 | ---- |
| Physical Tests (QCLot: 1558683) | | | | | | |
| Moisture | ---- | E144 | 0.25 | % | <0.25 | ---- |
| Inorganics (QCLot: 1558163) | | | | | | |
| Sulfides, acid volatile | ---- | E396-L | 0.2 | mg/kg | <0.20 | ---- |
| Leachable Anions & Nutrients (QCLot: 1559110) | | | | | | |
| Chloride, soluble ion content | 16887-00-6 | E236.Cl | 5 | mg/kg | <5.0 | ---- |
| Leachable Anions & Nutrients (QCLot: 1559111) | | | | | | |
| Sulfate, soluble ion content | 14808-79-8 | E236.SO4 | 20 | mg/kg | <20 | ---- |



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: 1554472) | | | | | | | | | |
| Conductivity (1:2 leachate) | ---- | E100-L | 5 | µS/cm | 1410 µS/cm | 98.2 | 90.0 | 110 | ---- |
| Physical Tests (QCLot: 1555648) | | | | | | | | | |
| pH (1:2 soil:CaCl2-aq) | ---- | E108A | ---- | pH units | 7 pH units | 100 | 98.0 | 102 | ---- |
| Physical Tests (QCLot: 1558683) | | | | | | | | | |
| Moisture | ---- | E144 | 0.25 | % | 50 % | 98.8 | 90.0 | 110 | ---- |
| Inorganics (QCLot: 1558163) | | | | | | | | | |
| Sulfides, acid volatile | ---- | E396-L | 0.2 | mg/kg | 100 mg/kg | 86.0 | 70.0 | 130 | ---- |
| Leachable Anions & Nutrients (QCLot: 1559110) | | | | | | | | | |
| Chloride, soluble ion content | 16887-00-6 | E236.Cl | 5 | mg/kg | 1000 mg/kg | 99.4 | 80.0 | 120 | ---- |
| Leachable Anions & Nutrients (QCLot: 1559111) | | | | | | | | | |
| Sulfate, soluble ion content | 14808-79-8 | E236.SO4 | 20 | mg/kg | 1000 mg/kg | 101 | 80.0 | 120 | ---- |

Reference Material (RM) Report

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

Sub-Matrix:

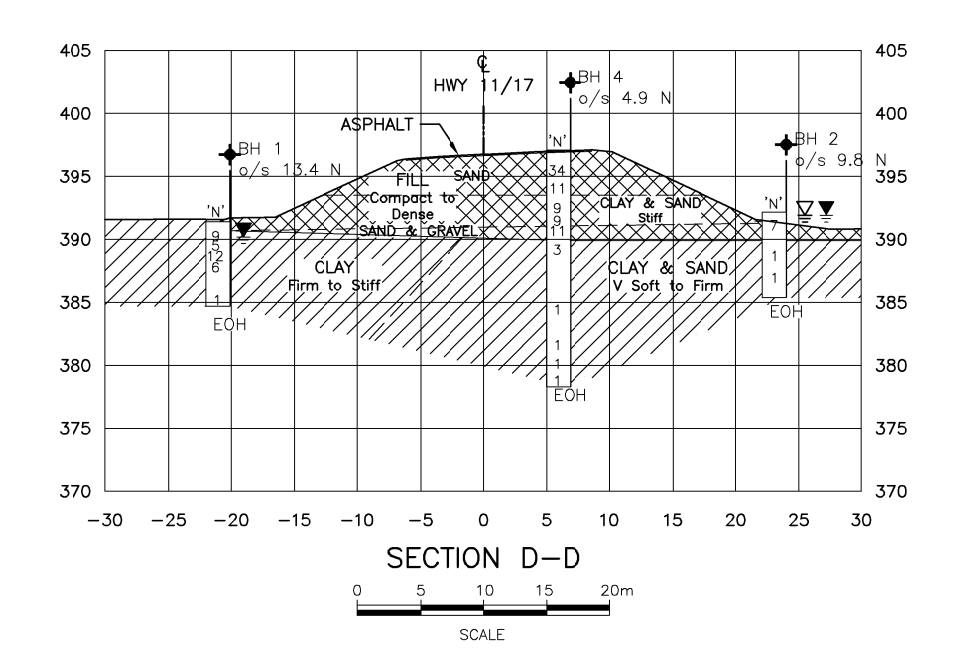
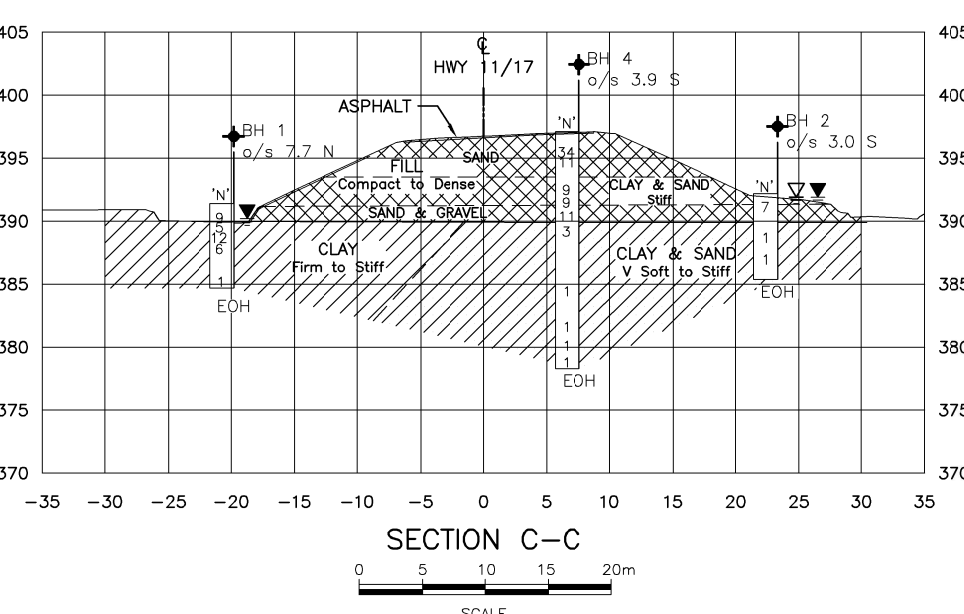
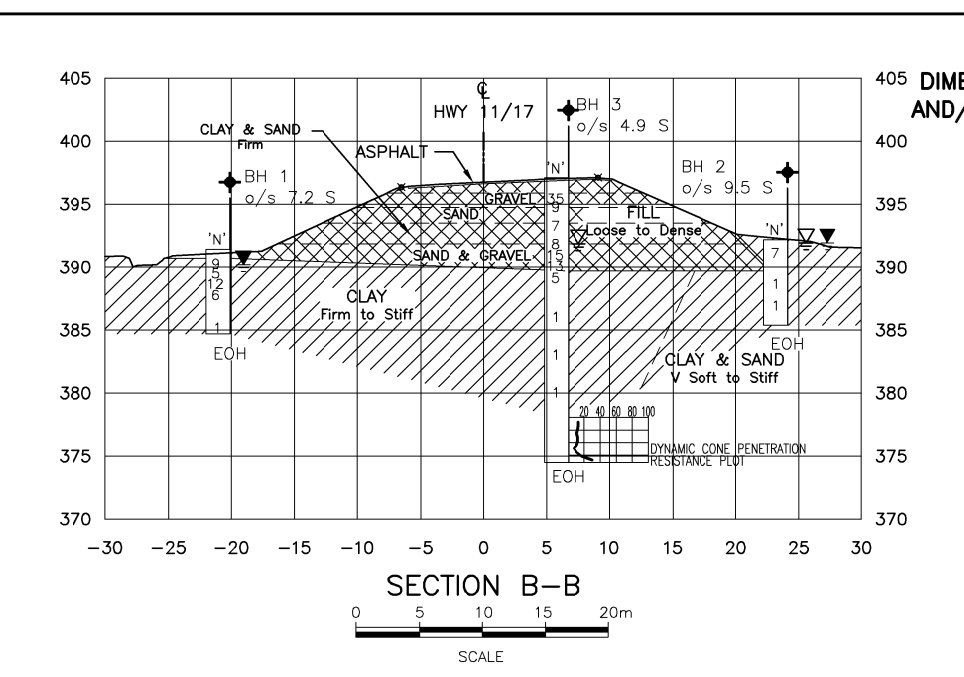
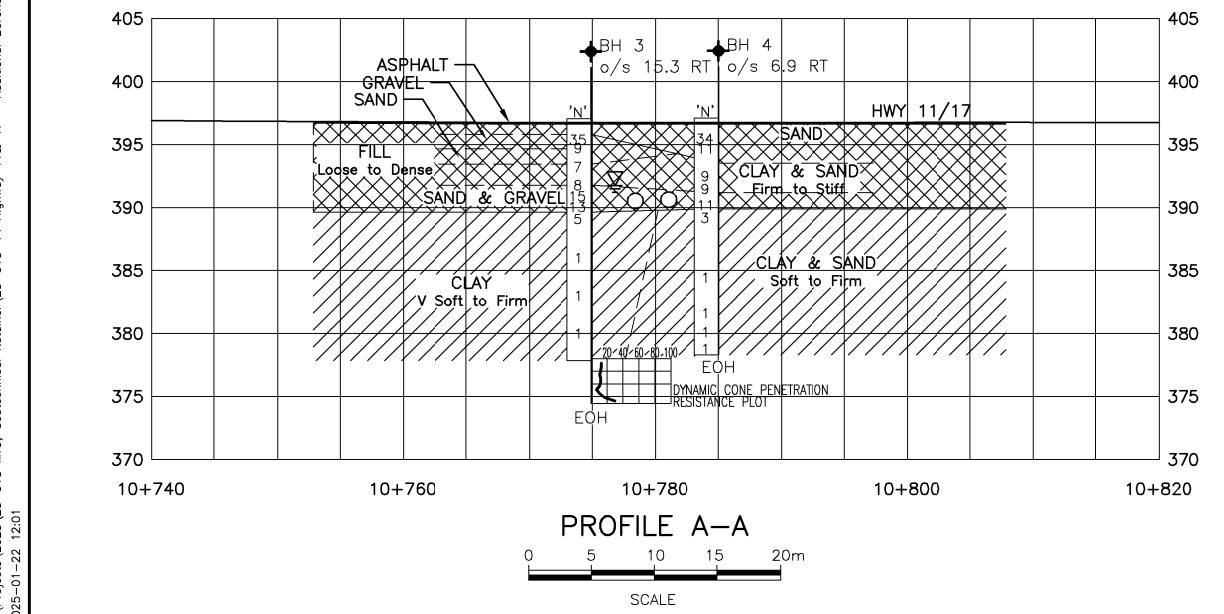
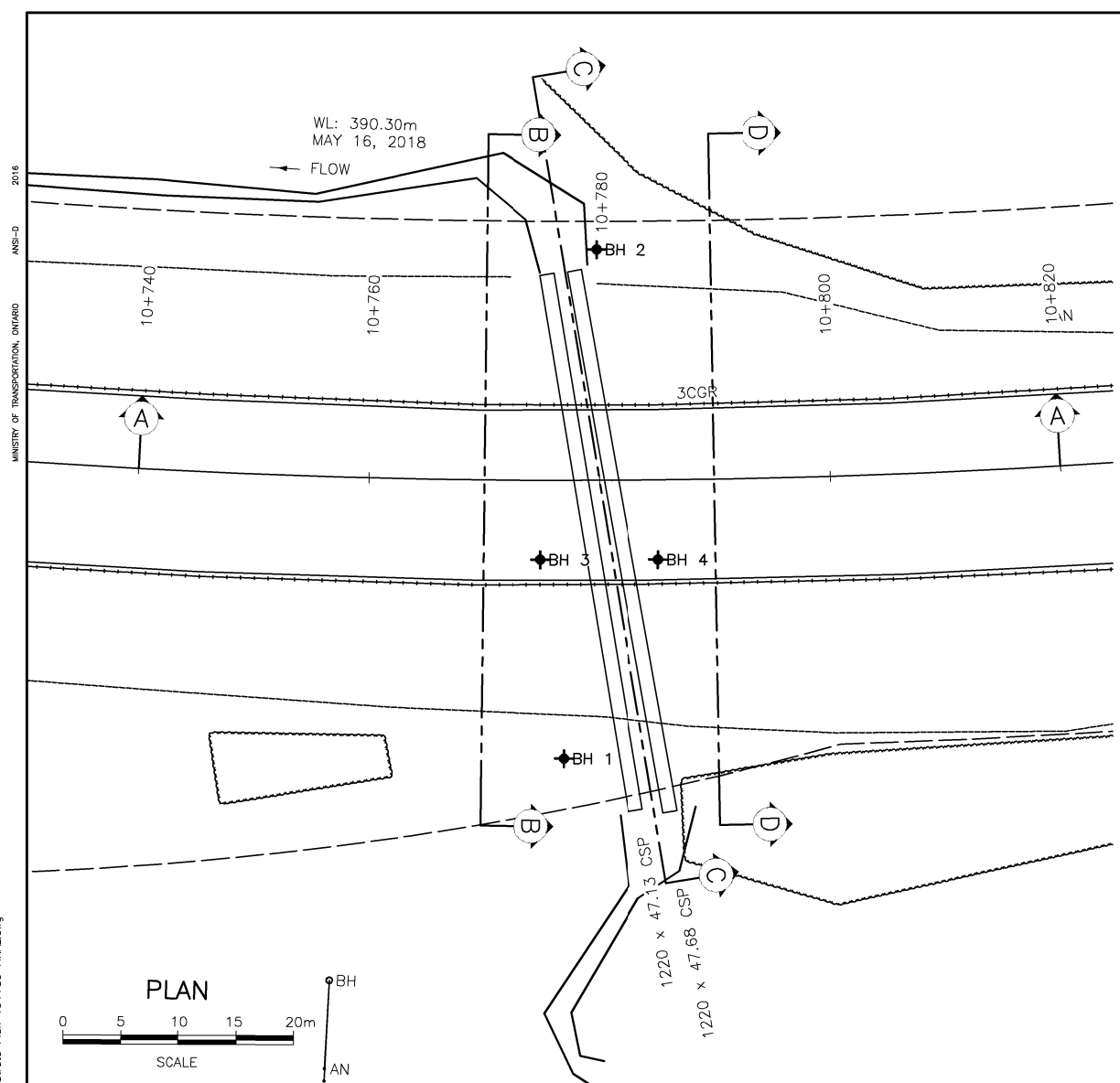
| | | | | | Reference Material (RM) Report | | | | |
|---|-----------------------|-------------------------------------|------------|----------|--------------------------------|-----------------|---------------------|------|-----------|
| | | | | | RM Target Concentration | Recovery (%) RM | Recovery Limits (%) | | |
| Laboratory sample ID | Reference Material ID | Analyte | CAS Number | Method | | | Low | High | Qualifier |
| Physical Tests (QCLot: 1554472) | | | | | | | | | |
| QC-1554472-003 | RM | Conductivity (1:2 leachate) | ---- | E100-L | 3270 µS/cm | 108 | 70.0 | 130 | ---- |
| Physical Tests (QCLot: 1558925) | | | | | | | | | |
| QC-1558925-001 | RM | Oxidation-reduction potential [ORP] | ---- | E125 | 475 mV | 91.4 | 90.0 | 110 | ---- |
| Leachable Anions & Nutrients (QCLot: 1559110) | | | | | | | | | |
| QC-1559110-003 | RM | Chloride, soluble ion content | 16887-00-6 | E236.Cl | 601 mg/kg | 87.2 | 70.0 | 130 | ---- |
| Leachable Anions & Nutrients (QCLot: 1559111) | | | | | | | | | |
| QC-1559111-003 | RM | Sulfate, soluble ion content | 14808-79-8 | E236.SO4 | 172 mg/kg | 94.4 | 70.0 | 130 | ---- |



APPENDIX C
Borehole Locations and Soil Strata Drawings

2016
ANSI-D
MINISTRY OF TRANSPORTATION, ONTARIO

FILE NAME: Y:\Projects\2023\23-318 MTO, Geotechnical Retainer\23-318-14 Highway 11& 17 - Additional Boreholes\Drawings\Strata Plan 10+780 FINAL.dwg
MODIFIED: 2025-01-22 12:01



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



Ontario
Ministry of Transportation

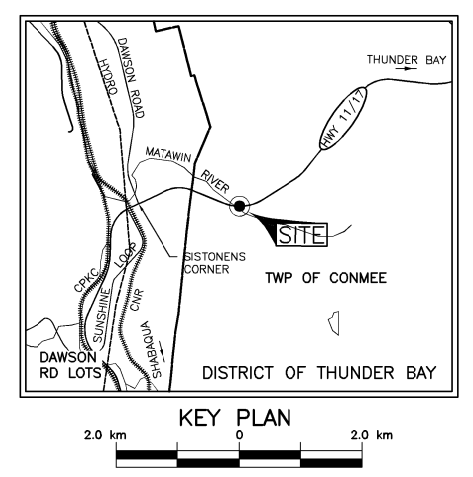
GEOCRE
CONT
GWP

52A12-003
2025-6021
6920-17-00

SOIL STRATA
HWY 11/17 CULVERT 10+780
TOWNSHIP OF CONMEE

SHEET
-

TBT ENGINEERING
CONSULTING GROUP



| SOIL STRATA SYMBOLS | |
|---------------------|-------------|
| | ASPAHLT |
| | CLAY |
| | FILL |
| | CLAY & SAND |

| LEGEND | | | |
|--------|------------------------------|--------------------|---------|
| | Borehole | | |
| | Std Pen Test (Blows/0.3m) | | |
| | Water Level on Completion | | |
| | Water Level after Completion | | |
| | End of Borehole | | |
| | Auger Refusal | | |
| No | ELEVATION | CO-ORDINATES (MTM) | |
| | | NORTH | EAST |
| BH 1 | 392.2 | 15 5 37 5747 | 330 280 |
| BH 2 | 391.4 | 15 5 375 735 | 330 303 |
| BH 3 | 397.0 | 15 5 375 746 | 330 278 |
| BH 4 | 397.1 | 15 5 375 736 | 330 275 |

-NOTE-
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

| REVISIONS | | | | |
|-----------|----|------------------|----------|---------------|
| 1 | SS | ISSUED FOR DRAFT | 27/09/24 | |
| DESIGN | XX | CHK | SS | CODE XXXXXX |
| DRAWN | TG | CHK | DV | SITE XXXXX |
| | | | | LOAD XXXX |
| | | | | DATE 20/09/24 |
| | | | | DWG |
| | | | | 1 |

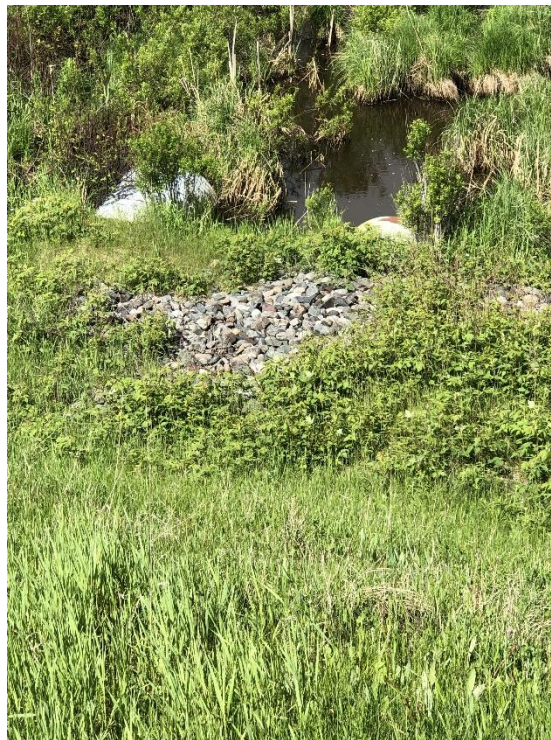
APPENDIX D
Site Photographs



**Figure 21.1: East side Embankment
Looking South, June 7, 2024.**



**Figure 2.2: East side Embankment
Looking West, June 7, 2024.**



**Figure 21.3: Westside Embankment
Looking West, June 7, 2024.**