# Foundation Investigation and Design 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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## APPENDICIES

# 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 asses drill access in ditch lines and asses 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<br>Lon -89.65531403 | 392.0 | 6.7 |
| 2 | Lat 48.51969297<br>Lon -89.65473929 | 391.4 | 6.9 |
| 3 | Lat 48.51978683<br>Lon -89.6549609 | 397.0 | 22.6 |
| 4 | Lat 48.51967524<br>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 wat 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/cm$^2$. 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.**

<table>
<tr><th rowspan="2">Location</th><th rowspan="2">Surface Elevation (m)</th><th colspan="2">Groundwater Level on Completion of Drilling</th><th colspan="3">Groundwater Level After Completion</th></tr>
<tr><th>Depth (m)</th><th>Elev. (m)</th><th>Depth (m)</th><th>Elev. (m)</th><th>Time After Comp</th></tr>
<tr><td>Borehole 1</td><td>392.2</td><td>-</td><td>-</td><td>1.2</td><td>391.0</td><td>16 days</td></tr>
<tr><td>Borehole 2</td><td>391.5</td><td>0.3</td><td>391.2</td><td>0.3</td><td>391.2</td><td>15 days</td></tr>
<tr><td>Borehole 3</td><td>397.0</td><td>-</td><td>-</td><td>5.3</td><td>391.7</td><td>5 Hrs</td></tr>
</table>

## 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).

# Part B - FOUNDATION DESIGN REPORT

## 7 Introduction

TBT Engineering Limited (TBTE) has been retained by NWR Ministry of Transportation (MTO) to provide foundation investigation and design services for the proposed replacement and rehabilitation to the existing non-structural twin 1200 mm culverts intersecting Highway 11/17, 1.7 km south of the intersection of HWY 11/17 and Hwy 102, in the Township of Conmee Ontario. The foundation investigation was conducted to provide subsurface data for the design of the culvert extensions.

The foundation investigations, as described in Part A, were completed to investigate the subsurface conditions at this site. Part A describes the subsurface conditions encountered during the investigation. The investigation consisted of 4 boreholes. The subsurface soils at this site consist of embankment fills overlying clay. Clay was observed outside the embankment.

The purpose of this section of the report (Part B) is to provide embankment design recommendations for culvert replacement. It is understood the existing culvert will be replaced with the same size CSP and no change in vertical alignment, or slope flattening will be required. Staged construction with the use of temporary protection, temporary embankment widening and/or the use of a coffer dam will be required.

## 8 Foundation Recommendations

Recommendations and analysis for construction of a new embankment are not provided. These are based on the conditions encountered at the borehole locations, TBTE's interpretation of the subsurface conditions at the site and analyses of embankment stability. All design recommendations presented in this report assume that an adequate level of construction monitoring during excavation and construction will be provided. An adequate level of construction monitoring is examination of all excavation surfaces prior to fill and/or concrete placement to ensure the integrity of the subgrade. Full-time monitoring, materials testing, and compaction testing should be provided.

The strength properties of the native materials have been estimated based on published correlations with index tests, shear testing. Typical strength properties have been selected for granular materials. Determination of the effective strength properties of the native clay material relied upon both published correlations and observations made by completing a back analysis of the existing embankment configuration.

**Table 8.1: Soil Properties for Geotechnical Analyses.**

| Soil | Effective Shear Strength Properties | | Total Stress Strength Properties | Unit Weight, γ (kN/m$^3$) |
|---|---|---|---|---|
| | Angle of Internal Friction, $\phi$' (degrees) | Cohesion Intercept, c' (kPa) | Undrained Shear Strength, Cu (kPa) | |
| Compacted Granular B, Type II | 35 | 0 | N/A | 21 |
| Existing Upper Embankment Sand and Gravel Fill | 35 | 0 | N/A | 20 |
| Existing Clay and Sand Fill | 29 | 0 | N/A | 20 |
| Existing Lower Embankment Sand and Gravel Fill | 29 | 0 | N/A | 20 |
| Upper Clay (above elev. 379 m) | 25 | 0 | N/A | 17 |
| Lower Clay (below elev. 379 m)) | 30 | 0 | N/A | 17 |
| Upper Clay Underlying the Embankment (above elev. 387 m) | N/A | N/A | 32 | 17 |
| Lower Clay Underlying the Embankment (Below elev. 387 m) | N/A | N/A | 32 kPa with an increase of 2.88 kPa/m | 17 |
| Upper Clay Outside the Embankment (above elev. 387 m) | N/A | N/A | 32 | 17 |
| Lower Clay Outside the Embankment (Below elev. 387 m) | N/A | N/A | 25 kPa with an increase of 1.65 kPa/m | 17 |

For the following sections, where applicable, the following parameters apply, as per the 2019 version of the Canadian Highway Bridge Design Code (CHBDC):

- Resistance factors of 0.65 (permanent conditions) and 0.75 (temporary conditions) for analyses of global stability based on a typical site understanding have been applied.

# 9 Staged Construction

## 9.1 Embankment Analyses - General

The foundation soils consist of moderate strength and highly compressible clays.

Stability modeling was completed using Slope/W software and limit equilibrium analysis using the Morgenstern-Price method. Stability modelling was carried out for global stability of the foundations and the approach embankments. The slope stability models have been included in Appendix D.

The soil properties established for the embankment and foundation materials are presented above in Table 8.1.

Stability analyses have been completed to investigate excavation slopes and to assess the global stability of the final configuration. The designs are based on providing a minimum calculated factor of safety (FoS) against global instability for slip surfaces extending into the foundation soils as stated in Section 8. The resistance factors have been referenced from the CHBDC, as stated in Section 8. A uniformly distributed traffic load of 12 kPa over the traversable lanes was applied.

The foundation embankment recommendations provided below are based on the following design/construction criteria:

- Surface water drainage measures will be incorporated into the design of the embankment to prevent ponding of water adjacent to the embankment.
- Dewatering may be required to facilitate construction.
- Only one lane of traffic will be open during construction.
- No surface surcharges should be placed in close proximity to the edge of embankment or along the slope of the embankment unless the stability of the slope has been assessed.
- Retaining systems must be in place prior to excavation of any embankment toe material.
- Limits of excavation are based on the drawings provided by the MTO B-600-1117-6

### 9.1.1 Design Section

The design section was selected in the vicinity of Borehole 4 as it is the section with the thickest embankment fill height (approximately 7.2 m). It should be noted that based on the provided survey, the existing embankment slopes for the design section range from 1.8H:1V for the right-hand embankment and 1.9H:1V for the left-hand embankment. Back analysis of the existing embankment configuration provided a factor of safety above unity. The foundation soil stratigraphy was developed based on the findings at Station 10+790.00, near where the culvert is located.

## 9.2 Embankment Slope Stability Analyses

### 9.2.1 Stage 1 - Excavation and Widening to Facilitate Culvert Replacement

The following recommendations have been derived based on minimum requirements for excavation and widening to support a 50/50 culvert replacement methodology:

- Excavation cut slopes shall be no steeper than 1.7H:1V inside slope and 1.5H:1V outside slope.
- A small widening is required to maintain a 5 m wide lane, there by steepening the exterior slope from the original 2H:1V.
- The existing grade is to be cut at least 2 m from existing grade.
- Groundwater must be no higher than 391.0 m.
- All new fill materials will be compacted.
- The base of the excavation shall extend the base of the existing culvert.
- A 5 m wide temporary roadway to be constructed 2 m below existing roadway.

A factor of safety of 1.7 and 1.4 were achieved for total stress analysis of excavation slopes (see Figure D.1 and D.2 in Appendix D).

### 9.2.2 Stage 2 - Excavation and Widening to Facilitate Culvert Replacement

The following recommendations have been derived based on minimum requirements for the lane shift to support the 50/50 culvert replacement methodology:

- Inside Excavation slope no steeper than 1.5H:1V, with outside embankment slope no steeper than 2H:1V.
- The existing grade is to be cut at least 2 m
- All new fill materials will be compacted.
- The base of the excavation shall extend to the base of the existing culvert.
- A 5 m wide temporary roadway to be constructed 2 m below the existing roadway.

A factor of safety of 1.7 and 1.9 were achieved for total stress analysis of excavation slopes (see Figure D.3 and D.4 in Appendix D).

### 9.2.3 Stage 3 - Global Stability for Embankment Slopes

The following recommendations have been derived based on minimum requirements for general embankment slopes adjacent to the proposed culvert:

- Embankment slopes shall be no steeper than 2H:1V.

- Ditching shall be a minimum of 6.7 m on the lefthand side, and 7.5 on the righthand side from the toe of the embankment slope.

A minimum factor of safety of 1.5 was achieved for effective stress analysis (see Figure D.5 and D.6 in Appendix D).

#### 9.2.3.1 Slope Stability Modelling Summary and Construction Recommendations

The table below shows a summary of the slope stability analyses completed, results of those analyses, and any relevant comments regarding the analyses.

**Table 9.2: Summary of Slope Stability Analyses**

| Configuration | Figure # | Analysis Type | FOS | Comments |
|---|---|---|---|---|
| Stage 1: 5 m Wide Lane with 1.7H:1V Slopes RHS – Inside Slope | D.1 | Total Stress | 1.7 | Existing Grade is Lowered 2 m with a 5.0 m Wide Driving Lane and a 12 Kpa Road Load. Water Table is at Measured Levels (391.0 m). Additional Granular B Type II is Utilized to Construct Driving Lane. |
| Stage 1: 5 m Wide Lane with 1.5H:1V Slopes RHS – Outside Slope | D.2 | Total Stress | 1.4 | Existing Grade is Lowered 2 m with a 5.0 m Wide Driving Lane and a 12 Kpa Road Load. Water Table is at Measured Level (391.0 m). Additional Granular B Type II is Utilized to Construct Driving Lane. |
| Stage 2: 5 m Wide Lane with 1.5H:1V Slopes LHS - Inside Slope | D.3 | Total Stress | 1.7 | Rebuild embankment to 2 m lower than previous grade with a 5.0 m Wide Driving Lane and a 12 Kpa Road Load. Water Table is at Measured Level (391.0 m). Granular B Type II is Utilized for the embankment construction. |
| Stage 2: 5 m Wide Lane with 2H:1V Slopes LHS– Outside Slope | D.4 | Total Stress | 1.9 | Rebuild embankment to 2 m lower than previous grade with a 5.0 m Wide Driving Lane and a 12 Kpa Road Load. Water Table is at Measured Level (391.0 m). Granular B Type II is Utilized for the embankment construction. |
| Final Stage: Existing Slope LHS | D.5 | Effective Stress | 1.5 | Rebuilt embankment constructed with compacted Granular B Type II material with 2H:1V slope to match adjacent grade. Ditching shall be located a |

| | | | | |
|---|---|---|---|---|
| | | | | minimum of 6.7 m from the embankment toe. |
| Final Stage: Existing Slope RHS | D.6 | Effective Stress | 1.5 | Rebuilt embankment constructed with compacted Granular material with 2H:1V slope B Type II to match adjacent grade. Ditching shall be located a minimum of 7.5 m from the embankment toe. |

To achieve the minimum FOS, the requirements shown above must be followed. All slope stability models are provided in Appendix D.

## 10 Embankment Settlement

It is understood that the existing embankment will not be raised, and no appreciable settlements are expected. Culverts will not require camber.

## 11 Subgrade Preparation

All existing fills from previous highway embankment construction and all organic soils (if encountered) must be stripped from the proposed culvert footprint to expose a non-disturbed, native, inorganic subgrade prior to embankment fill placement. If organics are encountered and the depth of organics exceeds stripping depths (300 mm), the organics shall be removed in accordance with OPSD 203.010 Nov. 2017 with fill slopes constructed as discussed below. The exposed subgrade may be sensitive to disturbance and worker traffic should be minimized prior to fill placement.

## 12 Considerations for Temporary Roadway Protection

The potential use of temporary roadway protection during construction to aid in excavation and/or aid in dewatering measures may be considered at this location. Refusal was not encountered at any of the borehole locations

The overall embankment fill thickness is in the order of 6.0 m above the culvert. The use of roadway protection during construction may be required depending on final culvert configuration and construction staging requirements. Systems including, but not limited to, soldier pile with lagging or sheet pile walls can be considered. Temporary roadway protection systems should be designed and constructed in accordance with OPSS 539 November 2014 for a minimum Performance Level 2, by engineers with a minimum of five years of experience designing similar systems. Design should also consider the global stability of the chosen traffic protection system. Design of roadway protection systems is the responsibility of the contractor. Where possible all temporary roadway protection measures should be fully removed.

## 13 Backfill and Lateral Earth Pressures

The existing site materials are not suitable for use as structural backfill. Structural backfill should consist of Granular A, Granular B, Type I or Granular B, Type II. Backfill materials shall be supplied, placed and compacted in accordance with OPSS.PROV 1010 Apr. 2013, OPSS.PROV 206 Nov. 2014, OPSS 902 Nov. 2023 and OPSS.PROV 501 Nov. 2014.

Lateral earth pressure coefficients for potential granular backfill for sloping and level ground conditions have been provided in the tables below.

**Table 13.1: Lateral Earth Pressure Coefficients for Non-Sloping Ground**

| Compacted Granular Backfill | $\phi'$ (°) | Bulk Unit Weight of Soil, γ (kN/m$^3$) | Lateral Earth Pressure Coefficients, K | | |
|---|---|---|---|---|---|
| | | | Active $K_a$ | At Rest $K_0$ | Passive $K_p$ |
| Granular A | 35 | 21 | 0.27 | 0.43 | 3.69 |
| Granular B, Type II | 35 | 21 | 0.27 | 0.43 | 3.69 |
| Granular B, Type I | 32 | 20 | 0.31 | 0.47 | 3.25 |
| Existing Upper Sand and Gravel Fill | 35 | 20 | 0.27 | 0.43 | 3.69 |
| Existing Clay and Sand Fill | 29 | 20 | 0.35 | 0.52 | 2.88 |
| Existing Lower Sand and Gravel Fill | 29 | 20 | 0.35 | 0.52 | 2.88 |
| Upper Native Clay (Above 379.0 m) | 25 | 17 | 0.41 | 0.58 | 2.46 |
| Lower Native Clay (Below 379.0 m) | 30 | 17 | 0.33 | 0.50 | 3.00 |

No factor of safety has been included in the above coefficients. A compaction surcharge should be added in accordance with Section 6.12.3 of the CHBDC. The effects of groundwater should be considered by the designer.

## 14 Dewatering for Temporary Conditions

Dewatering of groundwater below the base of excavation will be required to facilitate dry and stable excavations for construction. Dewatering systems should be designed in accordance with OPSS.PROV 517 Nov. 2023 and SP 517F01 (Nov. 2023). It is recommended that any dewatering system be designed and checked by engineers with a minimum of five years of experience designing similar systems. The need for a permit to take water or the registration of the project on the MOECC's Environmental Activity and Sector Registry should be determined by the contractor.

To facilitate construction in the dry, control of surface water will also be required given the proposed excavations will be carried out below the water level. The use of sheet piles/coffer dams to restrict surface flow into open excavations may be warranted, especially where excavations are in close proximity to the water. Diversion of the water surface water from entering the excavation may be required

The complexity of the dewatering system will be governed by the depth of the excavation and any requirements for working in the dry.

Channel diversion options are limited without the construction of a diversion and subsequent temporary culvert to allow construction traffic to both sides of the creek. The use of temporary cofferdams utilizing either controlled flow or pumping should be considered the best option for channel diversion.

### 14.1 Preliminary Considerations for Cofferdams

The potential use of cofferdams/sheet piles during construction to control water conditions, aid in excavation and/or aid in placement of structures may be considered at this location. A cofferdam system can range from earthen structures to sheet piles installed on or within low permeable soils.

Based on the subsurface conditions at the borehole locations, relatively low permeable soils are encountered beneath the creek.

Cofferdam design should be completed by the contractor's designer and consider, but not limited to, the following potential issues:

- Requirement for bracing and/or tie backs.
- Global and internal stability.
- Sufficient seepage cut off measures be employed to avoid piping of the soil.
- Potential loss of soil adjacent to the cofferdam.
- Bedrock was not encountered.

### 14.2 Channel Diversion

Channel diversion options are limited without the construction of a diversion and subsequent temporary culvert. The use of temporary cofferdams utilizing either controlled flow or pumping should be considered the best option for channel diversion.

## 15 Temporary Excavations

Excavations should be constructed in accordance with the requirements of the Occupational Health and Safety act. The soil through the embankment and the native clay and sands can be preliminarily classified as Type 3 soils, as defined by the Occupational Health and Safety Act and Regulations for Construction Projects. The soil types must be reassessed as excavations proceed and adjustments to construction methodologies should be taken as required. Cut slopes for unsupported temporary excavations shall be no steeper than those provided in previous sections of this report.

Surface surcharge loads should not be placed in close proximity to the edge of an excavation unless the stability of the excavation slope has been assessed. An operational constraint should be included within the contract documents to inform the contractor of the requirement to assess the slope where surcharges are placed in close proximity to the edge of an excavation. If a geotechnical assessment is found necessary, a Non-Standard Special Provision should be included within the contract documents to inform the contractor of the requirement that a RAQS qualified Foundation Engineering Service Provider shall be retained to conduct the analyses. Examples of the wording for these has been included in Appendix E.

## 16 Frost Penetration Depth

Based on OPSD 3090.100 November 2010 Foundation Frost Penetration Depths for Northern Ontario, the estimated frost depth penetration within the expected embankment fill is 2.2 m. The embankment soils anticipated within the frost depth are considered to be of low frost susceptibility (MTO Pavement Design and Rehabilitation Manual).

## 17 Scour Protection

Where appropriate, foundation elements should be provided with sufficient scour protection in the event of elevated creek water levels. The ultimate design of scour protection measures should be provided by engineers with sufficient experience. Scour protection should be designed in accordance with Section 1.9.5 of the CHBDC. Scour protection measures should also consider OPSS.PROV 511 Nov. 2018 and OPSS.PROV 1004 Nov. 2014. Where clay seals are considered, OPSS.PROV 1205 Apr. 2015 should be reviewed, and OPSD 810.010 Nov. 2018 for rip rap placement.

## 18 Erosion Protection

Exposed granular fill and native soils may be subject to erosion from surface water runoff. At areas where runoff is expected or observed during construction, the granular surface shall be provided with suitable erosion protection. Embankment slopes beyond specific erosion treatment locations (e.g. Granular Sheeting or Rock Protection) should be treated as per the construction specification for temporary erosion control, OPSS.PROV 804 April 2021 and/or the construction specification for vegetative cover, OPSS.PROV 803 Nov. 2020. Available organic material meeting the construction specification for topsoil, OPSS 802 Nov. 2019, should be applied to the embankment slopes in accordance with OPSS 802 prior to the application of temporary erosion control and/or vegetative cover. Erosion control blankets (ECB) may be utilized in conjunction with vegetative cover operations. Bonded Fibre Matrix (BFM) application may also warrant consideration as an alternative treatment. These treatments should be applied at the discretion of the designer.

## 19 Potential Construction Issues

Issues which may require consideration include, but are not limited to:

- The depth of organics may exceed stripping depths of 300 mm outside the Borehole locations, the organics shall be removed in accordance with OPSD 203.010 Nov. 2017.
- Dewatering systems should be designed in accordance with OPSS.PROV 517 Nov. 2016 and SP 517F01 (Jul. 2017). It is recommended that any dewatering system be designed and checked by engineers with a minimum of five years of experience designing similar systems.

## 20 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.

The comments given in this report on potential construction problems and possible methods of construction are intended only for the guidance of the designer.

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.

## 21 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

TBT ENGINEERING
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# EXPLANAITION 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 Shellby Tube | | |

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# EXPLANAITION OF TERMS Cont'd.

## Stress and Strain

| | | |
|---|---|---|
| $u_w$ | kPa | Pore Water Pressure |
| $_u$ | | Pore Pressure Ratio |
| $\sigma$ | kPa | Total Normal Stress |
| $\sigma'$ | kPa | Effective Normal Stress |
| $\tau$ | kPa | Shear Stress |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | Principal Stress |
| $\varepsilon$ | % | Linear Strain |
| $\varepsilon_1, \varepsilon_2, \varepsilon_3$ | % | Principal Strains |
| E | MPa | Young's Modulus |
| G | kPa | Modulus of Shear Deformation |
| m | MPa | Constrained Modulus |
| $\mu$ | | Coefficient of Friction |

## Mechanical Properties of Soil

| | | |
|---|---|---|
| $m_v$ | $kPa^{-1}$ | Coefficient of Volume Change |
| $C_c$ | | Compression Index |
| $C_s$ | | Swelling Index |
| $C_a$ | | Rate of Secondary Consolidation |
| $c_v$ | $m^2/s$ | Coefficient of Consolidation |
| H | m | Drainage Path |
| $T_v$ | | Time Factor |
| U | % | Degree of Consolidation |
| $P'_o$ | kPa | Effective Overburden Pressure |
| $P'_c$ | kPa | Preconsolidation Pressure |
| $\tau_f$ | kPa | Shear Strength |
| c' | kPa | Effective Cohesion Intercept |
| $\phi'$ | ° | Effective Angle of Internal Friction |
| $c_u$ | kPa | Undrained Shear Strength |
| s | | Sensitivity |

## Physical Properties of Soil

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $\rho_s$ | $kg/m^3$ | Density of Solid Particles | e | % | Void Ratio | $e_{min}$ | % | Void Ratio in Densest State |
| $\gamma_s$ | $kN/m^3$ | Unit Weight of Solid Particles | n | % | Porosity | $I_D$ | | Density Index $= \frac{e_{max}-e}{e_{max}-e_{min}}$ |
| $\rho_w$ | $kg/m^3$ | Density of Water | w | % | Water Content | D | mm | Grain Diameter |
| $\gamma_w$ | $kN/m^3$ | Unit Weight of Water | $s_r$ | % | Degree of Saturation | $D_n$ | mm | n Percent Diameter |
| $\rho$ | $kg/m^3$ | Density of Soil | $w_L$ | % | Liquid Limit | $C_U$ | | Uniformity Coefficient |
| $\gamma$ | $kN/m^3$ | Unit Weight of Soil | $w_P$ | % | Plastic Limit | h | m | Hydraulic Head or Potential |
| $\rho_d$ | $kg/m^3$ | Density of Dry Soil | $w_S$ | % | Shrinkage Limit | q | $m\ ^3/_5$ | Rate of Discharge |
| $\gamma_d$ | $kN/m^3$ | Unit Weight of Dry Soil | $I_P$ | % | Plasticity Index = $w_L - w_P$ | v | m/s | Discharge Velocity |
| $\rho_{sat}$ | $kg/m^3$ | Density of Saturated Soil | $I_L$ | | Liquidity Index = $\frac{w-w_P}{I_P}$ | i | | Hydraulic Gradient |
| $\gamma_{sat}$ | $kN/m^3$ | Unit Weight of Saturated Soil | $I_C$ | | Consistency Index = $\frac{w_L-w}{I_P}$ | k | m/s | Hydraulic Conductivity |
| $\rho'$ | $kg/m^3$ | Density of Submerged Soil | $e_{max}$ | % | Void Ratio in Loosest State | j | $kN/m^3$ | Seepage Force |
| $\gamma'$ | $kN/m^3$ | Unit Weight of Submerged Soil | | | | | | |

# RECORD OF BOREHOLE No 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

| ELEV / DEPTH | DESCRIPTION | SAMPLE NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | SHEAR STRENGTH kPa | WATER CONTENT (%) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | ▼ (water level) | 391 | | ○ | | |
| | | 2 | SS | 5 | | | | ○ | | 3 35 (62) |
| | | 3 | SS | 12 | | 390 | | ○ | | |
| | - - - - - <br>- occasional grey sand varves to 4.5 m | 4 | SS | 6 | | 389 | | ├○┤ | | 5 31 (64)<br>Temporary Standpipe installed to 2.9 m. |
| | | 5 | TW | | | 388 / 387 | + (field vane) | ○ | | |
| | - - - - - <br>- very soft | 6 | SS | 1 | | 386 | | ○ | | |
| 385.5 / 6.7 | End of Borehole @ 6.7 m. | | | | | | | | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

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

# RECORD OF BOREHOLE No 2



**METRIC**

W.P. ____ LOCATION Station 10+780 o/s 20.0m LT of C/L N:5375734.995; E:330302.8 MTM Zone:15 ORIGINATED BY IB

DIST Thunder Bay HWY 11&17 BOREHOLE TYPE Casing Advancer COMPILED BY TG

DATUM Geodetic DATE 2024.06.26 - 2024.06.26 LATITUDE 48.51969297 LONGITUDE -89.65473929 CHECKED BY SS

| ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | "N" VALUES | ELEVATION SCALE | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|
| 391.4 | | | | | | |
| 0.0 | CLAY & SAND - brown, firm to stiff | | | | 391 | Water level @ 0.3 m on completion. |
| | | 1 | SS | 7 | | 0 35 (65) |
| | | | | | 390 | Water level @ 0.3 m on July 10, 2024. |
| | - occasional sand seams | 2 | TW | | | PP = 1.0 - 1.25 kg/cm² |
| | - some sand, very soft | | | | 389 | |
| | | 3 | SS | 1 | 388 | Standpipe installed to 2.9 m. Cave @ 2.9 m. |
| | | | | | 387 | |
| | | 4 | SS | 1 | | 0 15 (85) |
| | | | | | 386 | |
| | - firm | 5 | TW | | 385 | |
| 384.5 | | | | | | PP = <0.25 kg/cm² |
| 6.9 | End of Borehole @ 6.9 m. | | | | | PP = Pocket Penetrometer |

Legend: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20, 40, 60, 80, 100); PLASTIC LIMIT $w_P$, NATURAL MOISTURE CONTENT $w$, LIQUID LIMIT $w_L$; WATER CONTENT (%) (20, 40, 60); UNIT WEIGHT γ kN/m³

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

# RECORD OF BOREHOLE No 3



**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

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

UNIT WEIGHT $\gamma$ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%): GR SA SI CL

| ELEV / DEPTH | DESCRIPTION | SAMPLE NUMBER | TYPE | "N" VALUES | ELEVATION SCALE | REMARKS (GR SA SI CL) |
|---|---|---|---|---|---|---|
| 397.0 | | | | | | |
| 396.9 / 0.0 / 0.1 | ASPHALT - 130 mm | | | | | Water level @ 5.3 m 5 hours after completion. |
| | FILL - SAND - some gravel, trace silt, brown | 1 | AS | | | |
| | - - - - - - GRAVEL - some sand, trace silt, grey, dense | 2 | SS | 35 | 396 | |
| | - - - - - - SAND - Gravelly, some clay, brown, loose | 3 | SS | 9 | 395 | 28 53 (19) |
| | - - - - - - CLAY & SAND - trace gravel, brown, firm | 4 | SS | 7 | 394 | |
| | | | | | 393 | |
| | - - - - - - SAND & GRAVEL - some rock fill, trace silt/clay, grey, compact | 5 | SS | 8 | 392 | |
| | | 6 | SS | 15 | 391 | 44 49 (7) |
| | | 7 | SS | 13 | 390 | Wood in tip. |
| 389.6 / 7.4 | CLAY - grey sand varves to 8.7 m, trace to some sand, brown, very soft to firm | 8 | SS | 5 | 389 | |
| | | 9 | TW | | 388 | |
| | | | | | 387 | |
| | | 10 | SS | 1 | 386 | |
| | | | | | 385 | Cave @ 11.4 m. |
| | | 11 | TW | | 384 | |
| | | 12 | SS | 1 | 383 | 0 9 (91) |

Continued Next Page

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

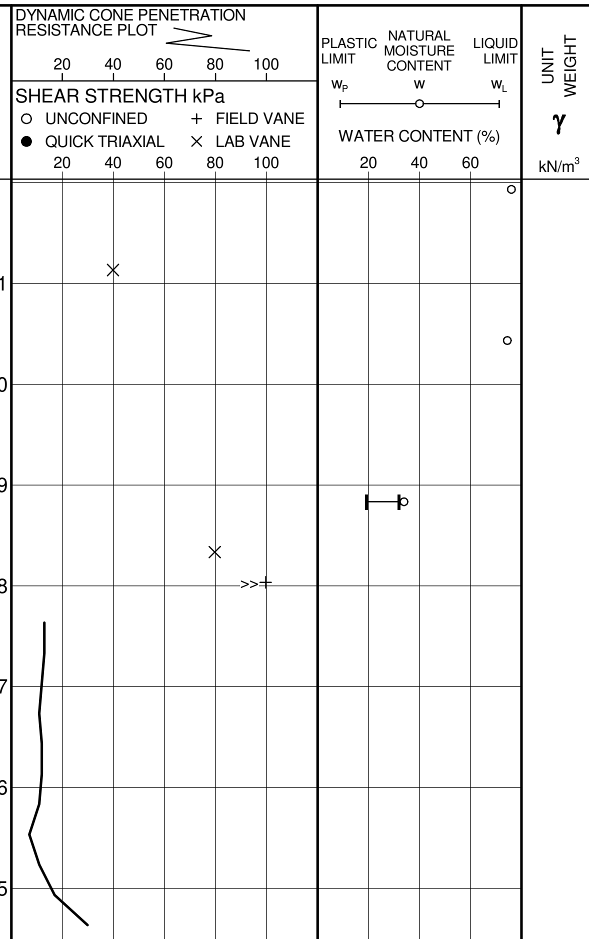
# RECORD OF BOREHOLE No 3



**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 |

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| | CLAY - grey sand varves to 8.7 m, trace to some sand, brown, very soft to firm *(continued)* | | 13 | TW | | | | |
| | | | | | | | 381 | |
| | | | 14 | SS | 1 | | 380 | |
| | | | | | | | 379 | |
| | - - - - -<br>- some sand varves, occasional sand seam, grey, stiff to very stiff | | 15 | TW | | | | 0 13 (87)<br>PP = 1.5 kg/cm²<br>PP = Pocket Penetrometer |
| 377.8 / 19.2 | DCPT Testing | | | | | | 378 | |
| | | | | | | | 377 | |
| | | | | | | | 376 | |
| | | | | | | | 375 | |
| 374.4 / 22.6 | End of Borehole @ 22.6 m. | | | | | | | |




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

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# RECORD OF BOREHOLE No 4



**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 |
| DIST | Thunder Bay HWY 11&17 | BOREHOLE TYPE | Casing Advancer |
| DATUM | Geodetic | DATE | 2024.07.09 - 2024.07.09 LATITUDE 48.51969958 LONGITUDE -89.65511054 |

ORIGINATED BY AF
COMPILED BY TG
CHECKED BY SS

Column headings: SOIL PROFILE (ELEV / DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20, 40, 60, 80, 100); PLASTIC LIMIT $w_P$, NATURAL MOISTURE CONTENT w, LIQUID LIMIT $w_L$, WATER CONTENT (%) (20, 40, 60); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

| ELEV / DEPTH | DESCRIPTION |
|---|---|
| 397.1 | |
| 397.0 / 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 |
| | - - - - - |
| | - SAND & GRAVEL - trace silt, grey, compact |
| 389.9 / 7.2 | CLAY & SAND - occasional varves, brown, soft to firm |
| | - - - - - |
| | - Sandy, trace gravel, firm |
| | - - - - - |
| | - brown, very soft to firm |

| NUMBER | TYPE | "N" VALUES |
|---|---|---|
| 1 | SS | 34 |
| 2 | SS | 11 |
| 3 | SS | 9 |
| 4 | SS | 9 |
| 5 | SS | 11 |
| 6 | SS | 3 |
| 7 | TW | |
| 8 | TW | |
| 9 | SS | 1 |
| 10 | TW | |

Elevation scale: 396, 395, 394, 393, 392, 391, 390, 389, 388, 387, 386, 385, 384, 383

Remarks & grain size distribution:

| Elevation (approx.) | GR | SA | SI | CL | Remarks |
|---|---|---|---|---|---|
| 394 | 5 | 36 | (59) | | |
| 392 | | | | | Cave @ 5.3 m. |
| 389.5 | 0 | 39 | (61) | | |
| 386.5 | 10 | 30 | (60) | | |
| 386 | | | | | PP = 0.5 kg/cm² |
| 383 | | | | | PP = <0.5 kg/cm² |

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Continued Next Page

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

# RECORD OF BOREHOLE No 4



**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

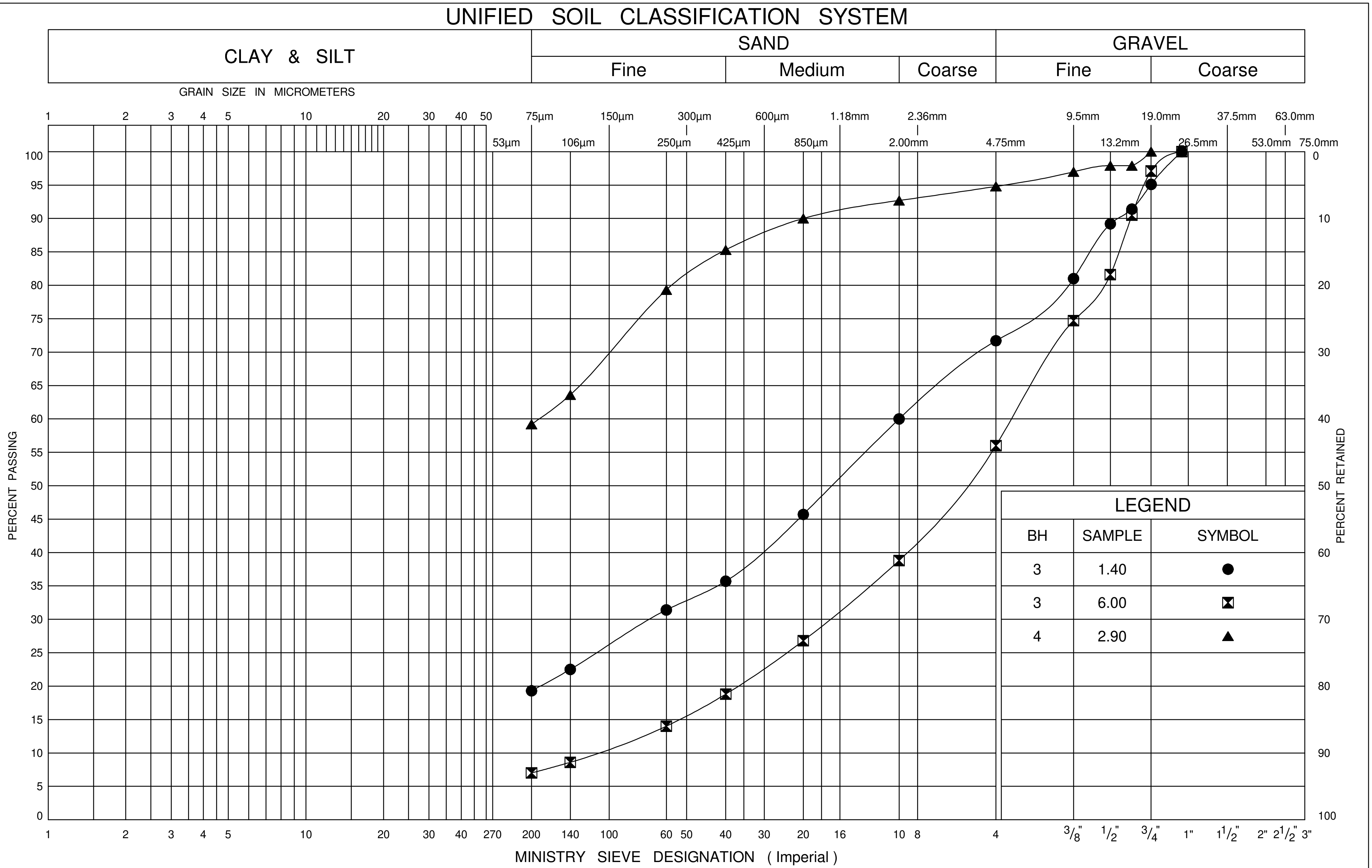
DIST Thunder Bay HWY 11&17 BOREHOLE TYPE Casing Advancer COMPILED BY TG

DATUM Geodetic DATE 2024.07.09 - 2024.07.09 LATITUDE 48.51969958 LONGITUDE -89.65511054 CHECKED BY SS

| ELEV DEPTH | SOIL PROFILE DESCRIPTION | STRAT PLOT | SAMPLES NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT w / LIQUID LIMIT $w_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CLAY & SAND - occasional varves, brown, soft to firm *(continued)*<br>- - - - -<br>- some sand | | 11 | SS | 1 | | | | | | 0 20 (80) |
| | | | | | | | 381 | | | | |
| | - - - - -<br>- very soft to stiff | | 12 | SS | 1 | | | | | | |
| | | | | | | | 380 | | | | PP = Pocket Penetrometer |
| | | | | | | | 379 | | | | |
| 378.3 | | | 13 | SS | 1 | | | | | | |
| 18.8 | End of Borehole @ 18.8 m. | | | | | | | | | | |

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

# APPENDIX B
# Laboratory Test Data

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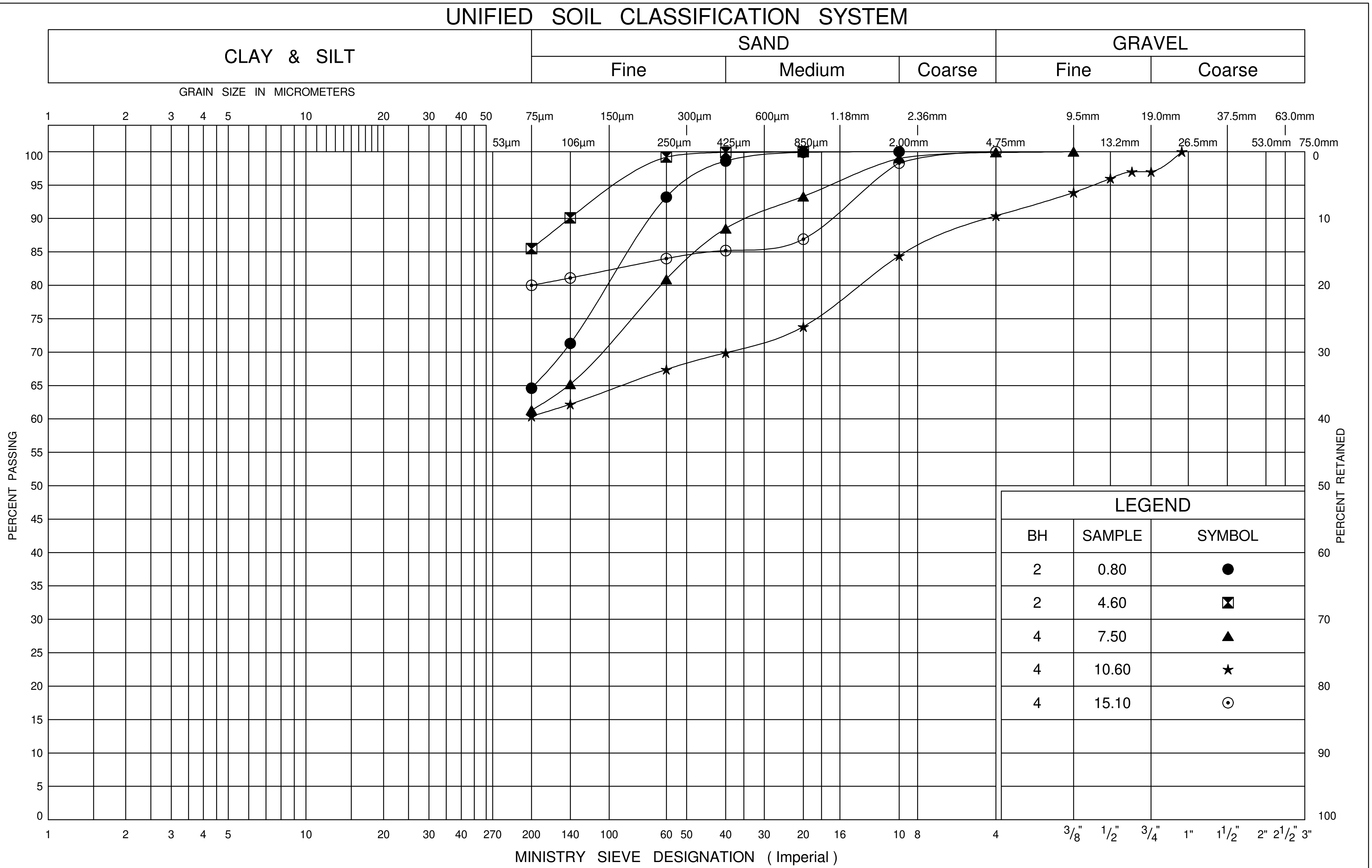
# GRAIN SIZE DISTRIBUTION
# FILL

FIG No 1

W P 6920-17-00

Culverts

78 12 M




GS CLAY & SAND 23-318-14 MTO.GPJ ONTARIO MOT.GDT 9-25-24

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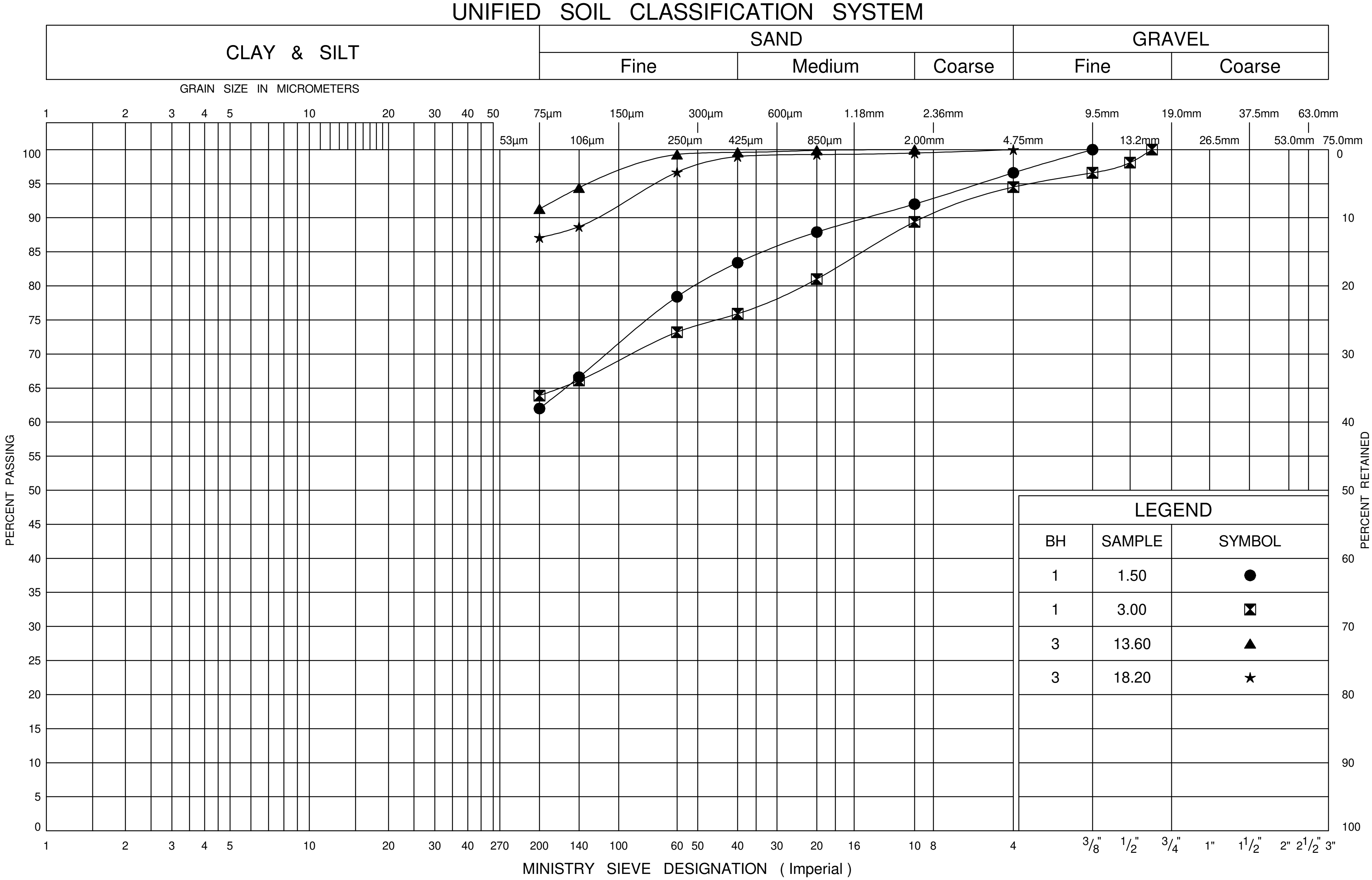
# GRAIN SIZE DISTRIBUTION
# CLAY & SAND

FIG No 2

W P 6920-17-00

Culverts

78 12 M




| LEGEND | | |
|---|---|---|
| BH | SAMPLE | SYMBOL |
| 1 | 1.50 | ● |
| 1 | 3.00 | ⊠ |
| 3 | 13.60 | ▲ |
| 3 | 18.20 | ★ |

GS CLAY 23-318-14 MTO.GPJ ONTARIO MOT.GDT 9-25-24

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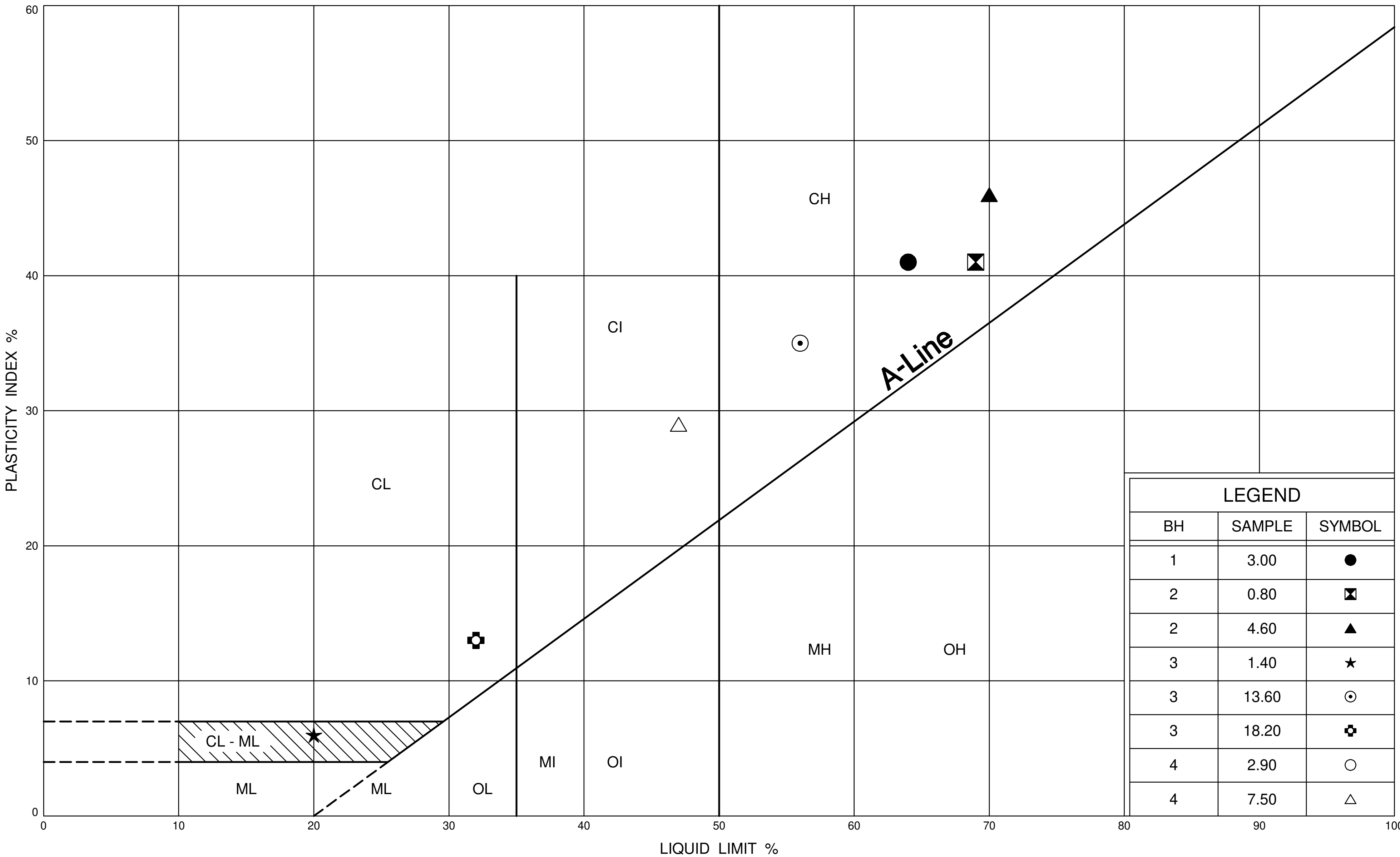
# GRAIN SIZE DISTRIBUTION
# CLAY

FIG No 3

W P 6920-17-00

Culverts

Oct 75, FF - S - 21




LEGEND

| BH | SAMPLE | SYMBOL |
|---|---|---|
| 1 | 3.00 | ● |
| 2 | 0.80 | ⧗ |
| 2 | 4.60 | ▲ |
| 3 | 1.40 | ★ |
| 3 | 13.60 | ⊙ |
| 3 | 18.20 | ✿ |
| 4 | 2.90 | ○ |
| 4 | 7.50 | △ |

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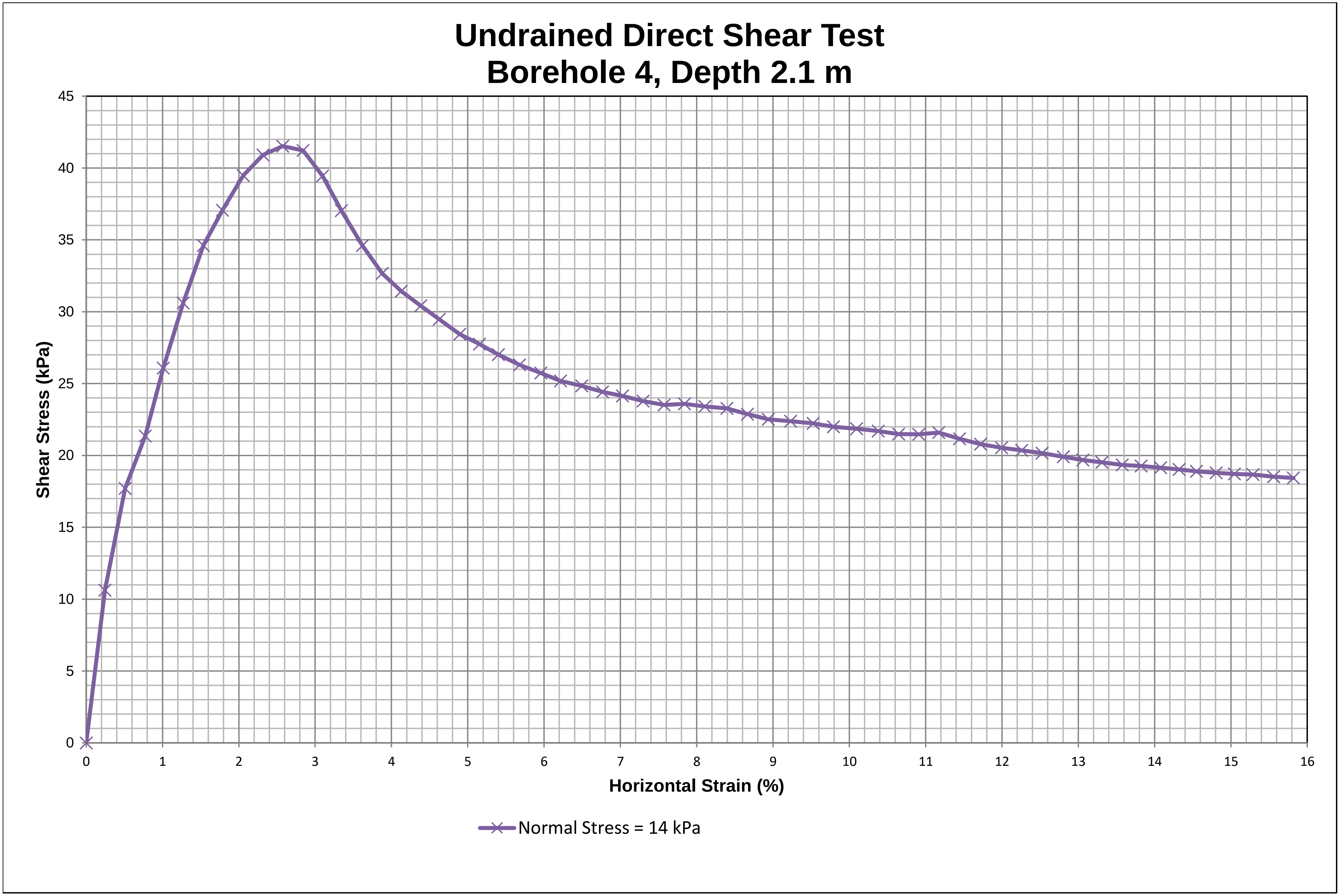
# PLASTICITY CHART

.

FIG No 4

W P 6920-17-00

Culverts


Undrained Direct Shear Test
Borehole 4, Depth 2.1 m
Shear Stress (kPa)
0
5
10
15
20
25
30
35
40
45
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Horizontal Strain (%)
Normal Stress = 14 kPa

ALS Canada Ltd.

# 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<br>Thunder Bay Ontario Canada P7E 6T9 | Address | : 60 Northland Road, Unit 1<br>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 Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

## *Signatories*

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

| *Signatories* | *Position* | *Laboratory Department* |
|---|---|---|
| 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)**

| Analyte | CAS Number | Method/Lab | LOR | Unit | Client sample ID: BH6-SS6 | ---- | ---- | ---- | ---- |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Client sampling date / time | 09-Jul-2024 12:00 | ---- | ---- | ---- | ---- |
| | | | | | 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.

# ALS Canada Ltd.

right solutions.
right partner.

# 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<br>Thunder Bay ON Canada P7E 6T9 | Address | : 1081 Barton Street<br>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<br>Container / Client Sample ID(s) | Method | Sampling Date | Extraction / Preparation | | | | Analysis | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Preparation Date | Holding Times Rec | Holding Times Actual | Eval | Analysis Date | Holding Times Rec | Holding Times Actual | Eval |
| **Inorganics : Acid Volatile Sulfide in Soil by Colourimetry (0.2 mg/kg)** | | | | | | | | | | |
| **Glass soil jar/Teflon lined cap [ON MECP]**<br>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]**<br>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]**<br>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]**<br>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]**<br>BH6-SS6 | E144 | 09-Jul-2024 | ---- | ---- | ---- | | 22-Jul-2024 | ---- | 13 days | |
| **Physical Tests : ORP by Electrode** | | | | | | | | | | |
| **Glass soil jar/Teflon lined cap [ON MECP]**<br>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]**<br>BH6-SS6 | E108A | 09-Jul-2024 | 20-Jul-2024 | 30 days | 11 days | ✓ | 22-Jul-2024 | 30 days | 13 days | ✓ |

**Legend & Qualifier Definitions**

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

## Quality Control Parameter Frequency Compliance

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

Matrix: **Soil/Solid**

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

| Quality Control Sample Type | | | Count | | Frequency (%) | | |
|---|---|---|---|---|---|---|---|
| *Analytical Methods* | *Method* | *QC Lot #* | *QC* | *Regular* | *Actual* | *Expected* | *Evaluation* |
| **Laboratory Duplicates (DUP)** | | | | | | | |
| 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<br><br>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 CaCl2 Extraction) - As Received | E108A<br><br>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.<br>This method is equivalent to ASTM D4972 and is acceptable for topsoil analysis. |
| ORP by Electrode | E125<br><br>ALS Environmental - Waterloo | Soil/Solid | APHA 2580 (mod) | Oxidation Redution 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<br><br>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<br><br>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.SO4<br><br>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<br><br>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<br><br>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<br><br>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 : 0.01CaCl2 - As Received for pH | EP108A<br><br>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<br><br>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<br><br>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<br><br>ALS Environmental - Waterloo | Soil/Solid | APHA 4500S2J | 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. |

ALS Canada Ltd.

# 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<br>Thunder Bay ON Canada P7E 6T9 | Address | : 1081 Barton Street<br>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 | ---- |

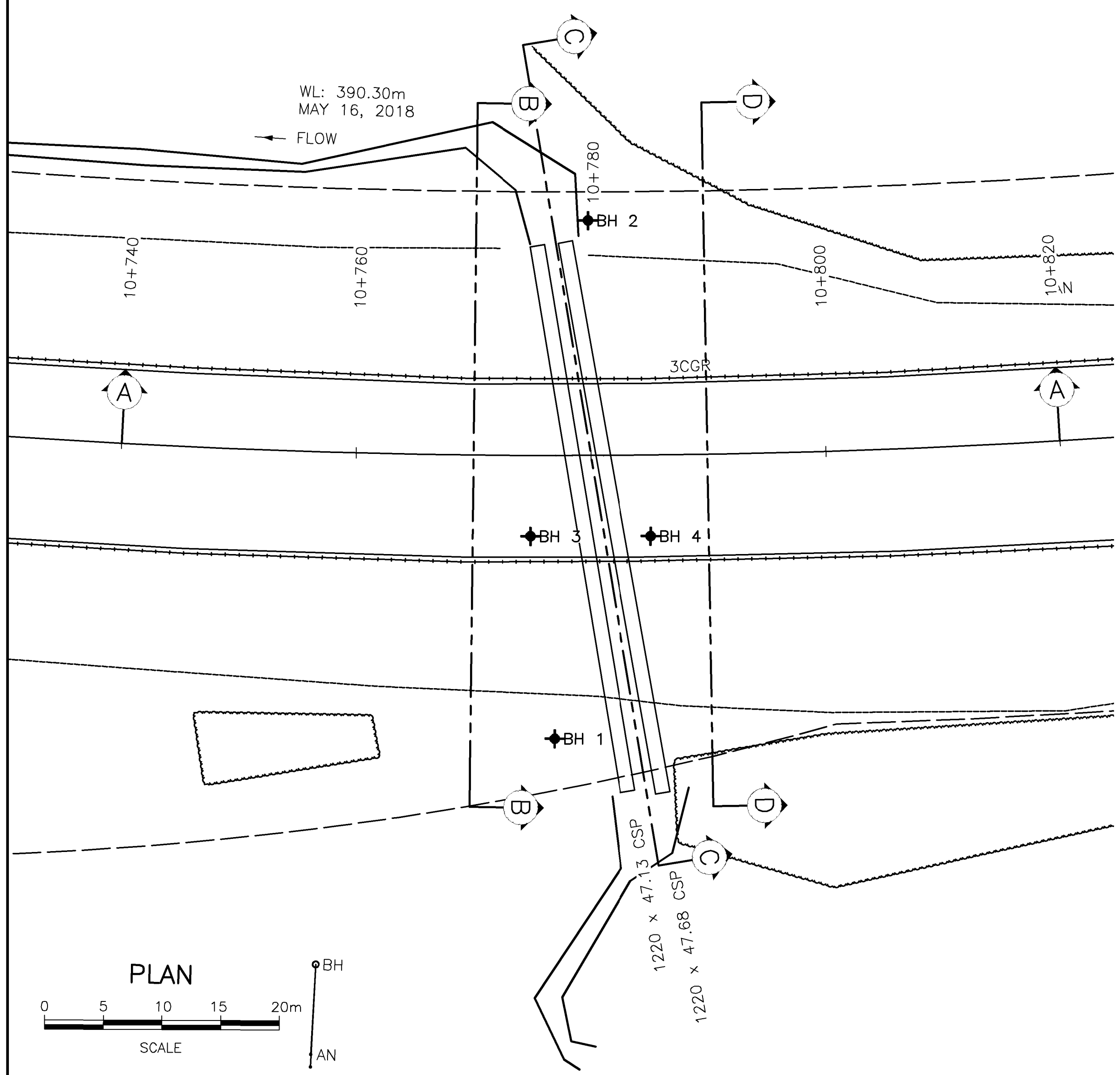
## Reference Material (RM) Report

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 | Recovery (%) | Recovery Limits (%) | | |
| Laboratory sample ID | Reference Material ID | Analyte | CAS Number | Method | Concentration | RM | 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 | ---- |

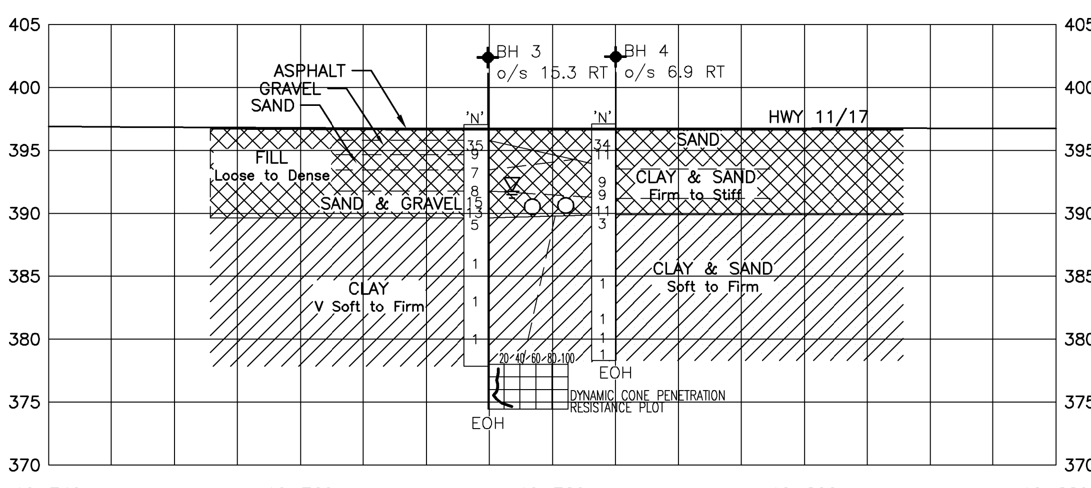
# APPENDIX C
# Borehole Locations and Soil Strata Drawings




PLAN

0 5 10 15 20m

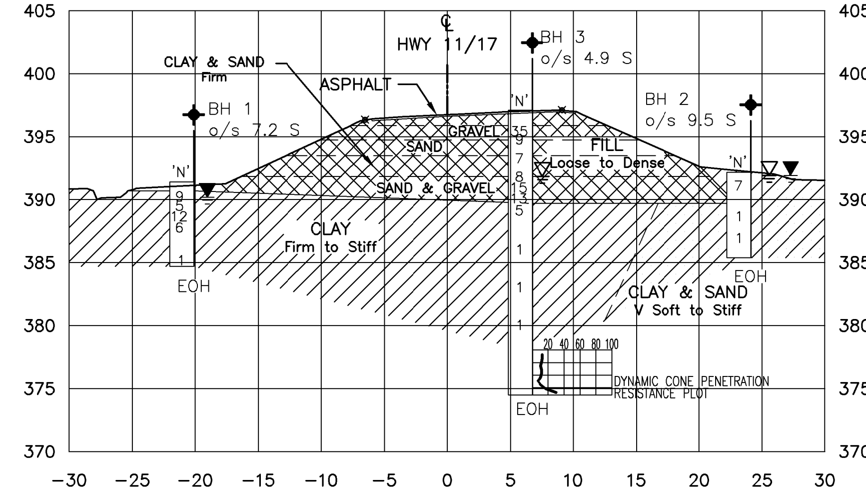
SCALE




PROFILE A–A

0 5 10 15 20m

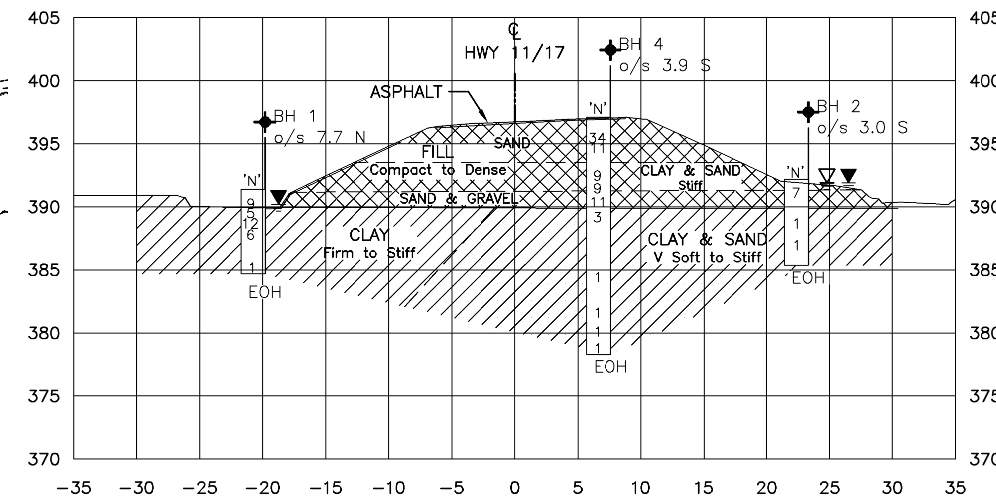
SCALE




SECTION B–B

0 5 10 15 20m

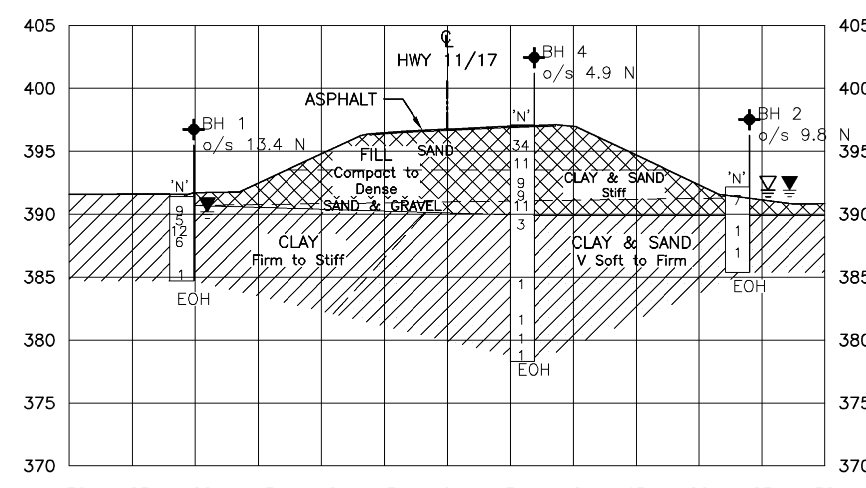
SCALE




SECTION C–C

0 5 10 15 20m

SCALE




SECTION D–D

0 5 10 15 20m

SCALE

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

Ontario Ministry of Transportation

| | |
|---|---|
| GEOCRES | 52A12–003 |
| CONT | 2025–6021 |
| GWP | 6920–17–00 |

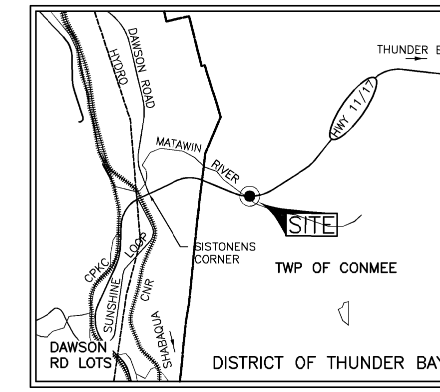
SOIL STRATA
HWY 11/17 CULVERT 10+780
TOWNSHIP OF CONMEE

SHEET
–

TBT ENGINEERING CONSULTING GROUP

LICENSED PROFESSIONAL ENGINEER
D. VALE
100117156
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S.W.S. SELLER
100043505
PROVINCE OF ONTARIO




KEY PLAN

2.0 km 0 2.0 km

## SOIL STRATA SYMBOLS

- ASPAHLT
- CLAY
- FILL
- CLAY & SAND

## LEGEND

| Symbol | Description |
|---|---|
| ✦ | Borehole |
| 'N' | Std Pen Test (Blows/0.3m) |
| ▽ | Water Level on Completion |
| ▼ | Water Level after Completion |
| EOH | End of Borehole |
| AR | Auger Refusal |

| No | ELEVATION | CO–ORDINATES (MTM) NORTH | EAST |
|---|---|---|---|
| BH 1 | 392.2 | 15 5 37 5747 | 330 260 |
| 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 |

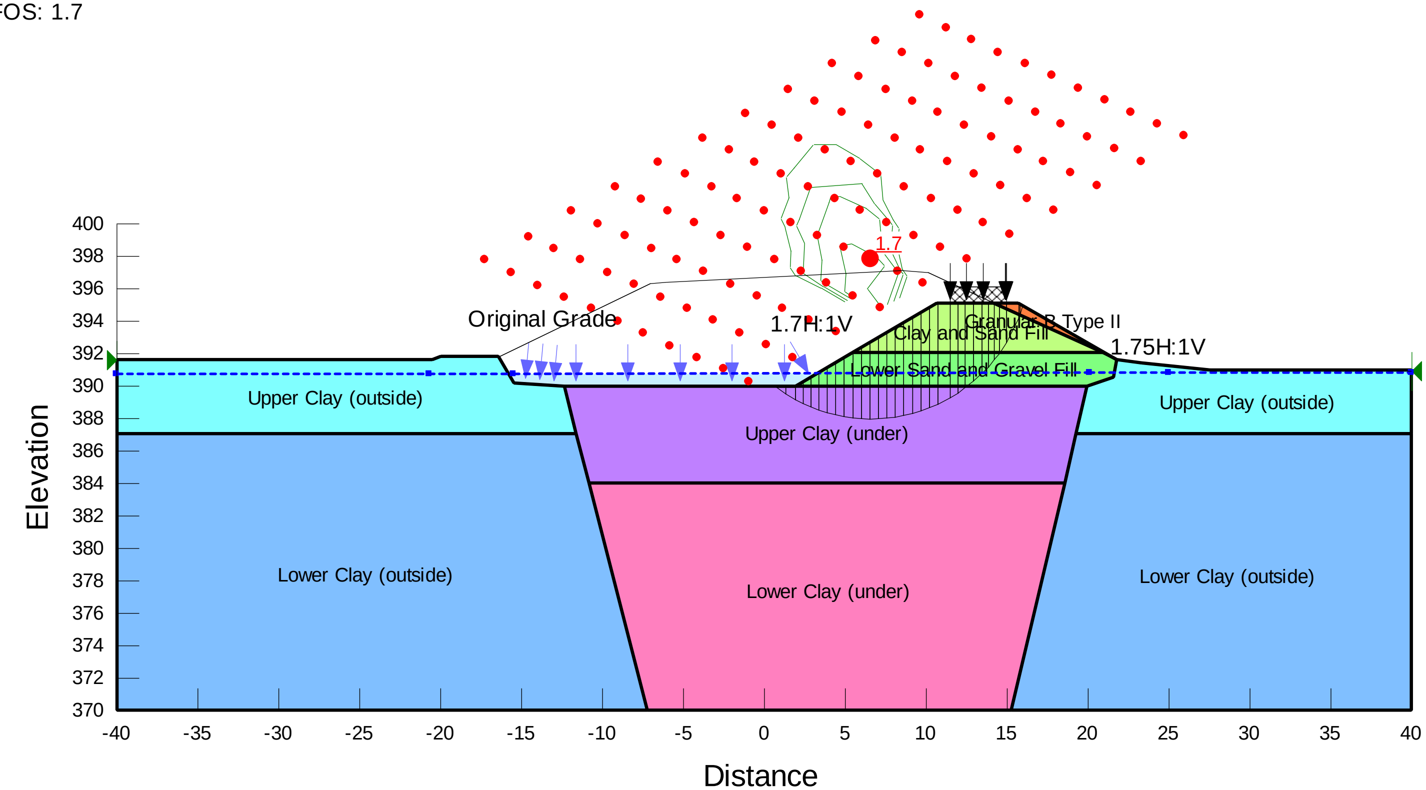
| | | | | |
|---|---|---|---|---|
| DESIGN XX | CHK SS | CODE XXXXXX | LOAD XXXX | DATE 20/09/24 |
| DRAWN TG | CHK DV | SITE XXXXX | | DWG 1 |

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

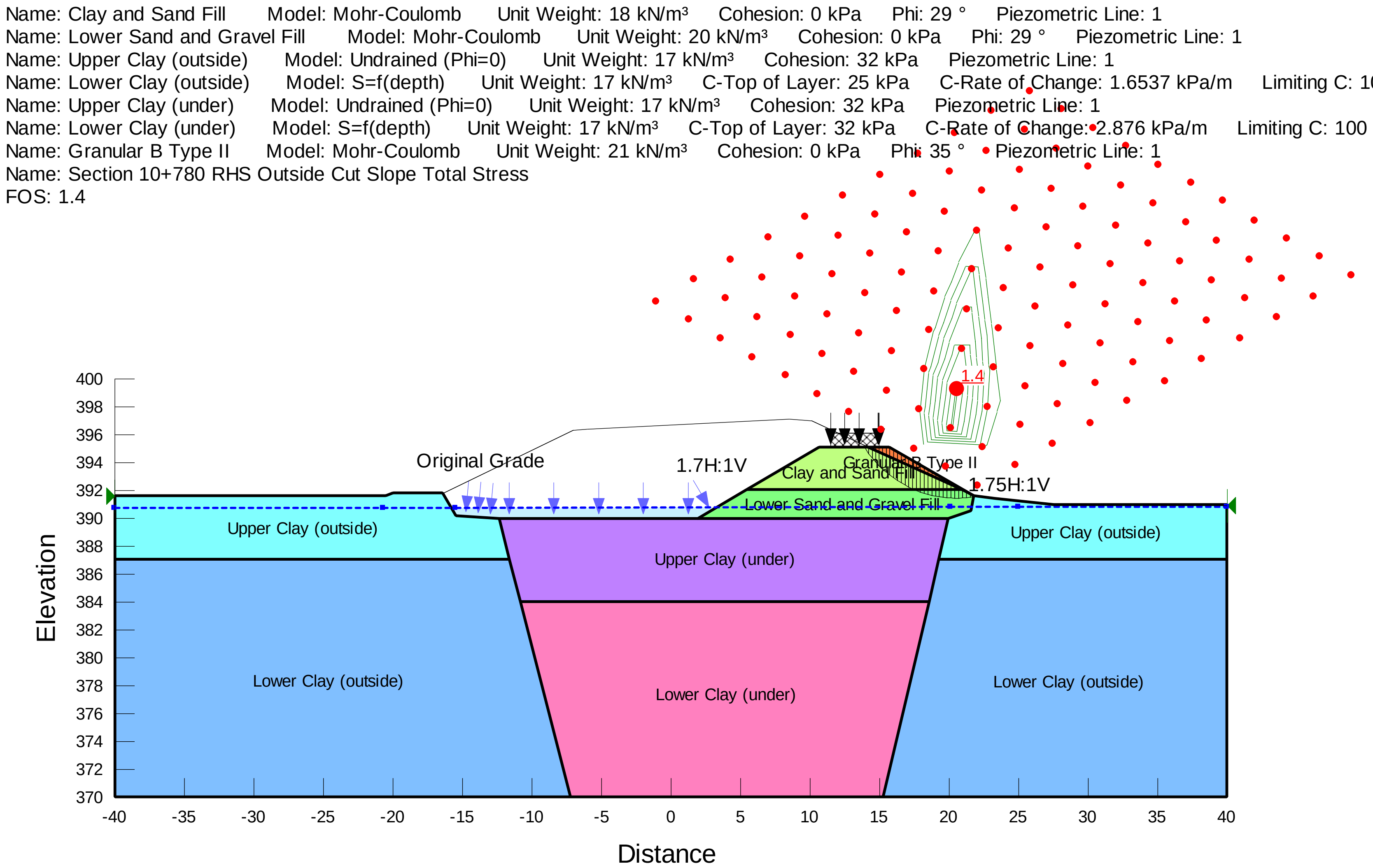
MINISTRY OF TRANSPORTATION, ONTARIO ANSI-D 2016

# APPENDIX D
# Slope Stability Models

Name: Clay and Sand Fill     Model: Mohr-Coulomb     Unit Weight: 18 kN/m³     Cohesion: 0 kPa     Phi: 29 °     Piezometric Line: 1
Name: Lower Sand and Gravel Fill     Model: Mohr-Coulomb     Unit Weight: 20 kN/m³     Cohesion: 0 kPa     Phi: 29 °     Piezometric Line: 1
Name: Upper Clay (outside)     Model: Undrained (Phi=0)     Unit Weight: 17 kN/m³     Cohesion: 32 kPa     Piezometric Line: 1
Name: Lower Clay (outside)     Model: S=f(depth)     Unit Weight: 17 kN/m³     C-Top of Layer: 25 kPa     C-Rate of Change: 1.6537 kPa/m     Limiting C: 100 kPa     Piezometric
Name: Upper Clay (under)     Model: Undrained (Phi=0)     Unit Weight: 17 kN/m³     Cohesion: 32 kPa     Piezometric Line: 1
Name: Lower Clay (under)     Model: S=f(depth)     Unit Weight: 17 kN/m³     C-Top of Layer: 32 kPa     C-Rate of Change: 2.876 kPa/m     Limiting C: 100 kPa     Piezometric Lin
Name: Granular B Type II     Model: Mohr-Coulomb     Unit Weight: 21 kN/m³     Cohesion: 0 kPa     Phi: 35 °     Piezometric Line: 1
Name: Section 10+780 RHS Inside Cut Slope Total Stress
FOS: 1.7

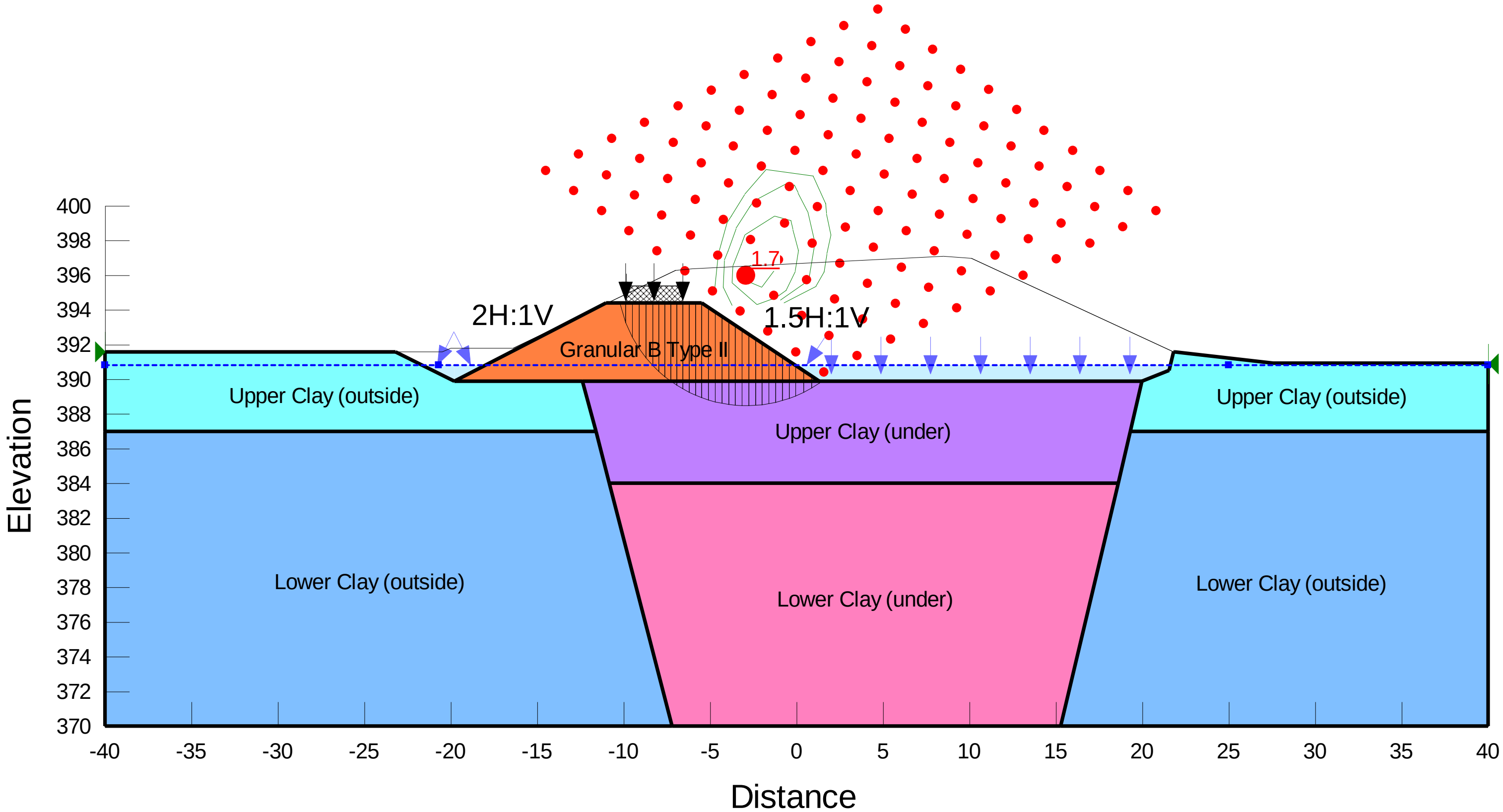



**D1 - Stage 1: 5 m Wide Lane with 1.7H:1V Slopes RHS – Inside Slope Total Stress Analysis**



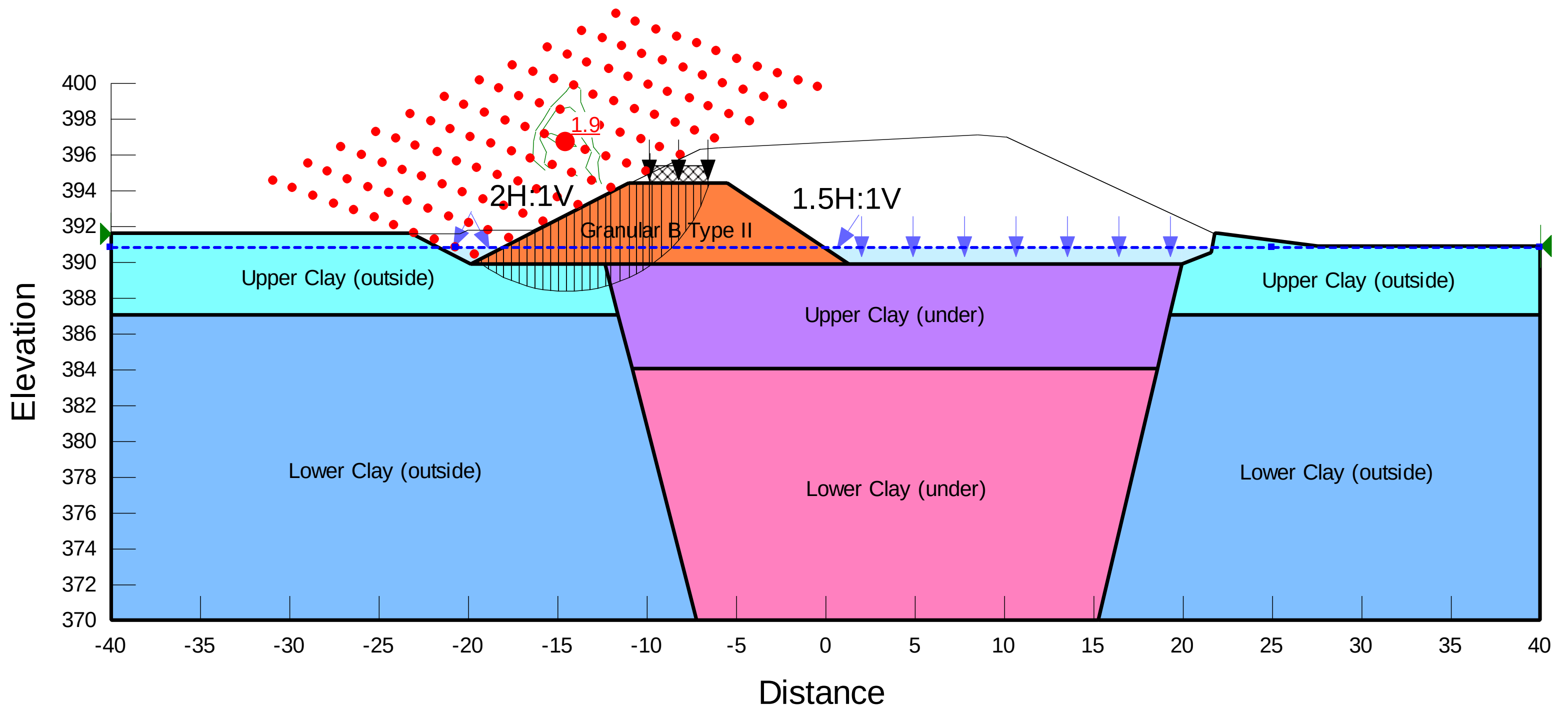

**D2 - Stage 1: 5 m Wide Lane with 1.75H:1V Slopes RHS – Outside Slope Total Stress Analysis**

Name: Upper Clay (outside) Model: Undrained (Phi=0) Unit Weight: 17 kN/m³ Cohesion: 32 kPa Piezometric Line: 1
Name: Lower Clay (outside) Model: S=f(depth) Unit Weight: 17 kN/m³ C-Top of Layer: 25 kPa C-Rate of Change: 1.6537 kPa/m Limiting C: 100 kPa Piezometric Line: 1
Name: Upper Clay (under) Model: Undrained (Phi=0) Unit Weight: 17 kN/m³ Cohesion: 32 kPa Piezometric Line: 1
Name: Lower Clay (under) Model: S=f(depth) Unit Weight: 17 kN/m³ C-Top of Layer: 32 kPa C-Rate of Change: 2.876 kPa/m Limiting C: 100 kPa Piezometric Line: 1
Name: Granular B Type II Model: Mohr-Coulomb Unit Weight: 21 kN/m³ Cohesion: 0 kPa Phi: 32 ° Piezometric Line: 1
Name: Section 10+780 LHS Inside Cut Slope Total Stress
FOS: 1.7



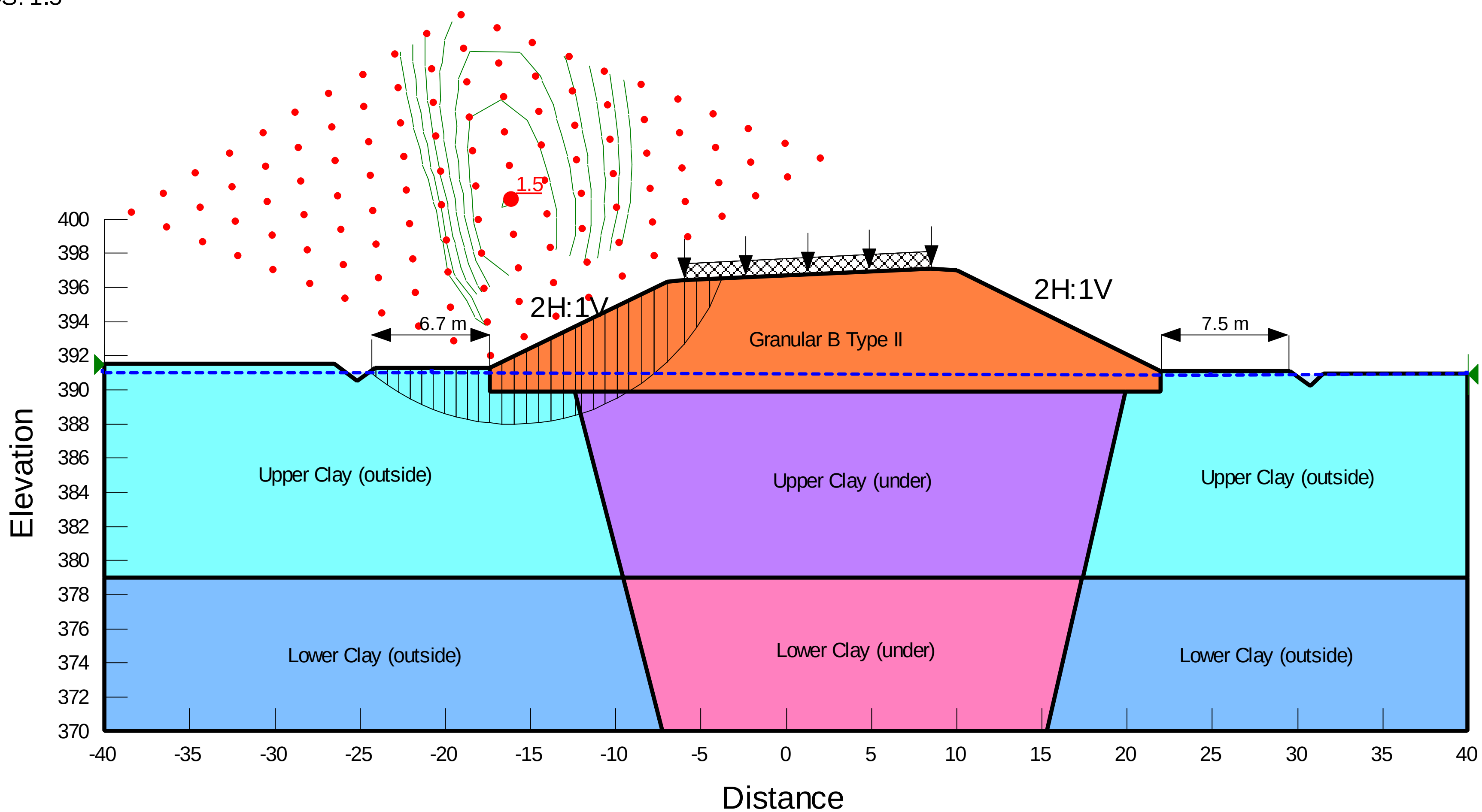

**D3 - Stage 2: 5 m Wide Lane with 2H:1V Outside Slope and 1.5H:1V Inside Slope LHS – Inside Slope Total Stress Analysis**

Name: Upper Clay (outside)   Model: Undrained (Phi=0)   Unit Weight: 17 kN/m³   Cohesion: 32 kPa   Piezometric Line: 1
Name: Lower Clay (outside)   Model: S=f(depth)   Unit Weight: 17 kN/m³   C-Top of Layer: 25 kPa   C-Rate of Change: 1.6537 kPa/m   Limiting C: 100 kPa   Piezometric
Name: Upper Clay (under)   Model: Undrained (Phi=0)   Unit Weight: 17 kN/m³   Cohesion: 32 kPa   Piezometric Line: 1
Name: Lower Clay (under)   Model: S=f(depth)   Unit Weight: 17 kN/m³   C-Top of Layer: 32 kPa   C-Rate of Change: 2.876 kPa/m   Limiting C: 100 kPa   Piezometric Lin
Name: Granular B Type II   Model: Mohr-Coulomb   Unit Weight: 21 kN/m³   Cohesion: 0 kPa   Phi: 32 °   Piezometric Line: 1
Name: Section 10+780 LHS Outside Cut Slope Total Stress
FOS: 1.9



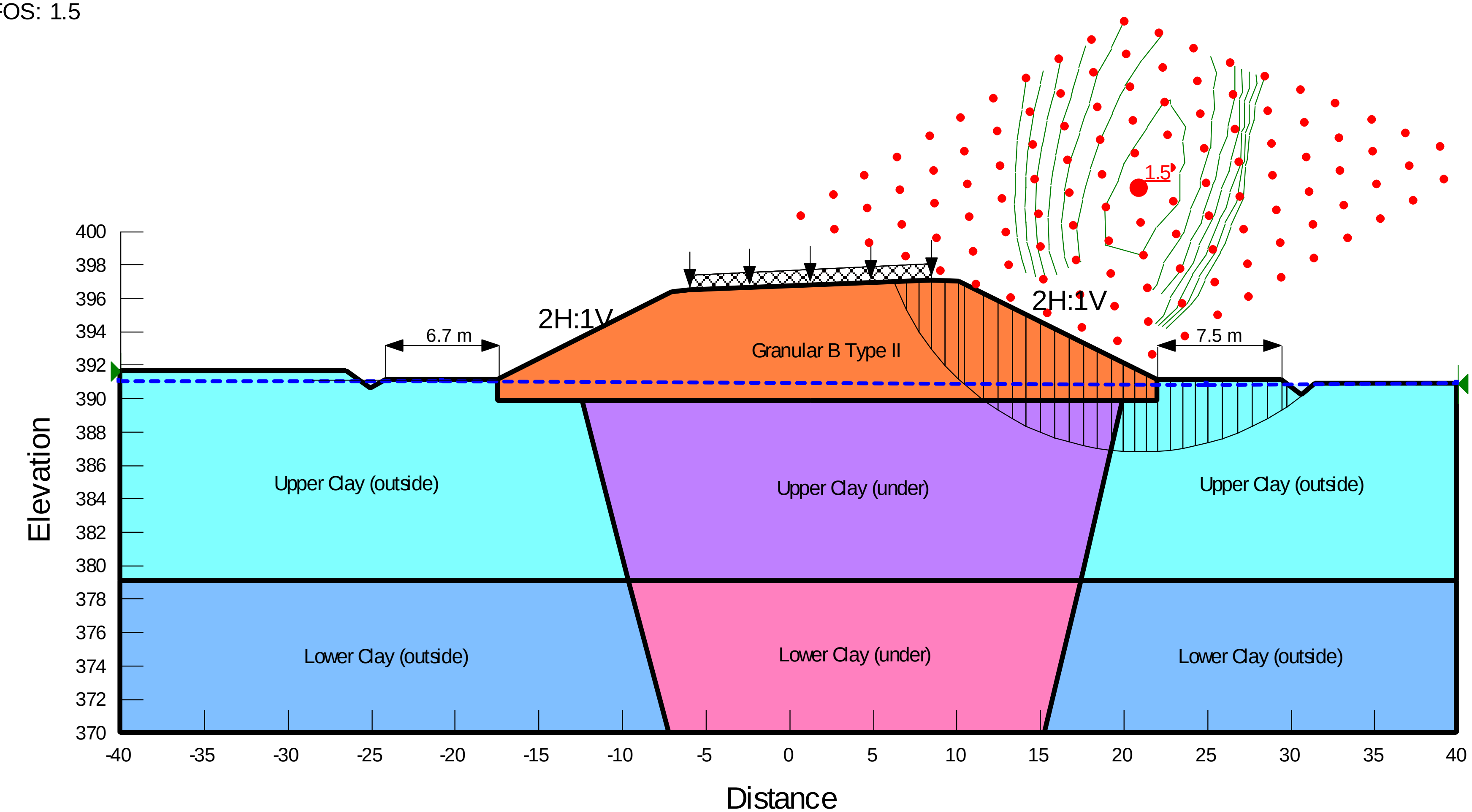

**D4 - Stage 2: 5 m Wide Lane with 2H:1V Outside Slope and 1.5H:1V Inside Slope LHS – Inside Slope Total Stress Analysis**

Name: Upper Clay (outside) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 25 ° Piezometric Line: 1
Name: Lower Clay (outside) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 30 ° Piezometric Line: 1
Name: Upper Clay (under) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 25 ° Piezometric Line: 1
Name: Lower Clay (under) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 30 ° Piezometric Line: 1
Name: Granular B Type II Model: Mohr-Coulomb Unit Weight: 21 kN/m³ Cohesion: 0 kPa Phi: 35 ° Piezometric Line: 1
Name: Section 10+780 LHS Rebuilt Drained
FOS: 1.5




**D5 - Final Stage: Rebuilt Slope LHS**
**Effective Stress Analysis**

Name: Upper Clay (outside) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 25 ° Piezometric Line: 1
Name: Lower Clay (outside) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 30 ° Piezometric Line: 1
Name: Upper Clay (under) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 25 ° Piezometric Line: 1
Name: Lower Clay (under) Model: Mohr-Coulomb Unit Weight: 17 kN/m³ Cohesion: 0 kPa Phi: 30 ° Piezometric Line: 1
Name: Granular B Type II Model: Mohr-Coulomb Unit Weight: 21 kN/m³ Cohesion: 0 kPa Phi: 35 ° Piezometric Line: 1
Name: Section 10+780 RHS Rebuilt Drained
FOS: 1.5




**D6 - Final Stage: Rebuilt Slope RHS**
**Effective Stress Analysis**

# APPENDIX E
# NSSP and Operational Constraint

**GEOTECHNICAL ASSESSMENT** - Item No.

Special Provision

## 1.0 SCOPE

The use of heavy construction equipment and material stockpiling may be required during construction of the culvert. The global stability impact of the surface surcharge loads on the excavation slopes must be considered during selection of the methodology and equipment employed for construction. Tentatively, for bidding purposes:

- Any material stockpiles, including excavated soils, construction materials and/or demolition debris, shall not be permitted within 6.5 m of the crest of excavation slopes;
- No heavy equipment shall be permitted within 6.5 m of the crest of excavation slopes;
- To maintain stability of the excavation slopes, the ground pressures applied by all construction equipment and any material stockpiles must be placed beyond the 5 m offset and shall not exceed 20 kPa;

The Contractor shall engage a Geotechnical Consultant to carry out a geotechnical assessment to assess an excavation slope where surcharges are placed in close proximity to the edge of an excavation and to aid in the selection of construction equipment and methodology.

## 2.0 REFERENCES

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.: 16 6022-E-0044 GWP No.: 6920-17-00 GEOCRES No. XXXXX, dated XXX, XX, 2024.

## 3.0 DEFINITIONS – Not Used

## 4.0 DESIGN AND SUBMISSION REQUIREMENTS

### 4.1 Design Requirements

Prior to commencement of construction, the Contractor shall retain a Geotechnical Consultant to assess the stability impacts of the proposed equipment loads and methodology, and to determine requirements and/or restrictions necessary to safely support the loads without a foundation or slope failure. All Foundation Engineering services required for this project shall be performed by consultant(s) listed as accepted under the MTO's RAQS for providing services under the specialty of Geotechnical (Structures and Embankments), of the medium complexity rating.

The geotechnical assessment carried out by the Contractor's Geotechnical Consultant shall include, but not be limited to, the following:

- Review of available geotechnical information and supplementing with additional subsurface information, as required.
- Determination of appropriate setbacks for heavy equipment and material stockpiles from the crest of slopes;
- Determination of the permissible ground pressure that may be applied by the equipment and material stockpiles; and

- Provision of recommendations for the support of all heavy equipment and material stockpile loads to prevent foundation failure at any location within the project limits based on the proposed equipment and methodology of the Contractor.

**4.2 Submission Requirements**

The Contractor shall submit the geotechnical assessment report containing details of the proposed construction equipment and methodology and the geotechnical assessment to the Contract Administrator for information purposes a minimum of two weeks prior to the mobilization of heavy equipment.

The report shall be signed and sealed by two (2) Professional Engineers licensed by the Professional Engineers of Ontario, one (1) of whom shall be the RAQS Approved Key Personnel and provide the following, as a minimum:

- Appropriate set back distances for heavy equipment and material stockpiles from excavation slopes;
- Permissible ground pressures which may be applied adjacent to excavation slopes by heavy equipment and material stockpiles;
- Recommendations for the support of all heavy equipment and material stockpile loads to prevent foundation failure.

**5.0 MATERIALS – Not Used**

**6.0 EQUIPMENT – Not Used**

**7.0 CONSTRUCTION – Not Used**

**8.0 QUALITY ASSURANCE – Not Used**

**9.0 MEASUREMENT FOR PAYMENT – Not Used**

**10.0 BASIS OF PAYMENT**

Payment at the Contract price for the above tender item shall be full compensation for all labour to do the work.

Payment for costs associated with heavy construction equipment necessary to complete the work, such as design and construction of temporary works, supply, mobilization/de-mobilization, and operation shall be made under the associated items.

**OPERATIONAL CONSTRAINT – USE OF HEAVY EQUIPMENT AND SURCHAGES NEAR EXCAVATION**

The Contractor is notified that the placement of surcharges, (eg. stockpiles, equipment, building materials) near the edge of excavations at the site of 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, should be assessed. Assessment can include, but not be limited to, slope stability analysis, monitoring, and delineation of safe offset limits. The assessment should be completed by a RAQS qualified Foundation Engineering Service Provider.

Tentatively, surcharges should not be placed within 5 m of the crest, and surcharges outside of 5 m should not exceed 20 kPa.

End of Section



TBT Engineering 1918 Yonge Street, Thunder Bay, ON P7E 6T9 807-624-5160

# APPENDIX F
# 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.**