FOUNDATION DESIGN REPORT
CULVERTS, SUPPLEMENTARY EMBANKMENTS AND CUT SLOPES
HIGHWAY 11/17 RED ROCK TO NIPIGON
FROM 4.8 KM WEST OF HWY 628 TO 1.5KM WEST OF HWY 585
G.W.P. 647-89-00

Geocres Number: 52A-184

VOLUME 1 / 2

Report to

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ENGINEERING DISCUSSION AND RECOMMENDATIONS

1 INTRODUCTION

This report presents interpretation of the geotechnical data provided in the Foundation Investigation Report[1] and presents foundation design recommendations for culverts, supplementary embankments and cut slopes for the proposed four-laning of Highway 11/17 between Red Rock and Nipigon, Ontario.

The overall project consists of widening the existing Highway 11/17 from a two-lane undivided roadway to a four-lane divided highway. The current section to be widened or realigned extends from 4.8 km west of Highway 628 to 1.5 km west of Highway 585 in the Township of Thunder Bay District, Ontario.

Forty one areas of culverts, supplementary embankments and cut slopes are addressed in this report. A summary of each embankment and cut section, including: location, length of section, maximum fill height or cut depth and generalized stratigraphy, are presented in Table A1 provided in Appendix B through AM. For each section the factual data, including borehole logs, laboratory testing results and stratigraphy drawings have been presented in the Foundation Investigation Report[1]. A summary is also provided in Table A5 for each investigated culvert, including: location, culvert number, type, size and approximate length.

The project information used for the preparation of this report was provided by MMM Group Limited (MMM) which included plans and profile drawings of the proposed Highway 11/17 alignment as of June 2013. The discussion and recommendations presented in this report are based on the information provided by MMM and the factual data obtained during the course of the investigation.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to MMM under the Ministry of Transportation Ontario (MTO) Agreement Number 6009-E-0019.

[1] Foundation Investigation Report, Culverts, Supplementary Embankments and Cuts, Highway 11/17 Red Rock to Nipigon, From 4.8 kM West of Highway 628 to 1.5 kM West of Highway 585, GWP 647-89-00, Geocres 52A-184

2 ENGINEERING ANALYSIS METHODOLOGY

2.1 General

The subsurface conditions were investigated to assess the stability of the proposed embankment foundations, culvert foundations and cut slopes, potential settlement issues under embankment and culverts as well as anticipated construction concerns. Analyses carried out were based on soil profiles and soil design parameters, selected for critical and unfavorable foundation soil conditions. Geotechnical factors to be addressed for design of embankments, cut slopes and culverts on this project include:

- The thickness, extent and engineering properties of the foundation soils, with consideration to the extent and thickness of peat, topsoil, organic deposits, compressible and/or excessively soft/loose soils.
- The depth of bedrock or refusal materials.
- Embankment material type (rock fill, granular fill or earth fill).
- Embankment geometry including height, side slope angle and requirements for stabilizing berms.
- Construction and post-construction settlement of embankments and culverts.
- Interaction between embankment and culvert construction.
- Cut slope geometry including slope angle and requirement for benches
- Temporary and long-term drainage requirement and erosion control for cut slopes
- Construction procedures.

For the purpose of preparing geotechnical design recommendations, a number of assumptions have been made that are consistent with MTO's standard highway design practices:

- Peat, topsoil, organic deposits and other deleterious material will be stripped prior to constructing embankments (OPSS.PROV 206).
- Where new fill is placed against an existing embankment slope or on a sloping ground surface steeper than 3H:1V, the existing slope will be benched (OPSD 208.010).
- The embankments will be constructed using rock fill (sources of earth fill are not expected to be available or suitable for reuse on this project). Granular fill may be used for low fill embankments (< 1.5 m) and surcharge construction (if applicable).
- Embankments will be constructed as outlined in Section 5.6 with side slopes not steeper than:
  - 1.25H:1V for rock fill,
  - 2H:1V for granular fill, and
  - 1.5H:1V for temporary surcharge

- A transition treatment will be provided between adjoining rock fill and granular fill embankment materials (OPSD 205.040).
- Stabilizing berms will be constructed using rock fill. No further material or stockpiling will be allowed above the berm and embankment design grades without further analysis.
- Rock cuts with depths of 10 m or greater will be constructed with side slopes not steeper than 0.25H:1V (OPSD 209.020) and all earth cuts will not be steeper than 2H:1V, unless otherwise stated.
- Earth cuts with depths of 6 m or greater will be provided with a 2 m wide mid-height bench.
- A transition will be provided between rock cuts and earth cuts (OPSD 205.050), rock cuts and earth fills (OPSD 205.030) and rock cuts and rock fills (OPSD 205.020).
- Permanent drainage and erosion protection will be provided for all earth cuts and granular embankment slopes.

2.2 Stability Analysis

Stability analyses were carried out for embankments not founded on bedrock and earth cuts under both static and seismic loading conditions. Based on consideration of the risk involved and past experience with highway embankment design/monitoring, the following factors of safety are considered appropriate:

Foundation Soil Type	Minimum Recommended Factor of Safety		
	Short Term	Long Term	Seismic
Cohesionless	1.3	1.3	>1.0
Cohesive	1.3	1.5	>1.0

Stability analyses were carried out utilizing the commercially available slope stability program Slope/W (Version 7) of the GeoStudio software package developed by Geo-Slope International with the option for Morgenstern-Price method of slices for the limit equilibrium analyses.

The results of stability analysis are summarized in Table A2 of Appendix A and the input parameters and soil model used in the stability analyses, including soil stratigraphy, engineering properties, groundwater conditions, and embankment geometry for selected analysis are shown in their respective Appendix.

2.3 Settlement Analysis

2.3.1 Foundation Settlement

Settlement analyses for embankments not founded on bedrock, were carried out to assess the immediate (elastic) settlement, magnitude and rate of primary consolidation settlement of

fine grained foundation soils occurring during construction and post-construction (long-term) settlements of the foundation soils under the self-weight of the imposed new embankment fill materials. The culvert crossings addressed in this report are located within the proposed Highway 11/17 embankments and will undergo similar foundation settlement as a result of the embankment loadings.

In accordance with MTO's document "Embankment Settlement Criteria for Design" (March 2, 2010), one of the criteria adopted for embankment design is to limit the post-construction settlement to the maximum permissible settlement of 100 mm or less, within 20 years following paving, with a differential settlement allowance of 200:1.

Immediate settlements due to compression of the embankment foundation soils have been estimated based on elastic theory as described in CHBDC Commentary Section C6.6.

Settlement analyses were carried out utilizing the commercially available settlement program Settle^{3D} (Version 3) developed by Rocscience Inc. with the option of Terzaghi's one-dimensional consolidation theory and three dimensional Boussinesq stress computation.

The engineering parameters used in the analyses were determined by in situ field vane tests conducted during the current study and soil index correlations developed during current and past projects.

The results of the settlement analyses of the embankment foundation soils and along the proposed culvert alignments are summarized in Table A3 in Appendix A and provided in their respective Appendices. The estimated magnitudes and rates of settlement are considered approximate and may vary along and across the highway alignment subject to the thickness of compressible layers at a particular location, variations in the consolidation characteristics of the cohesive deposits with depth and location, layer boundary conditions, variations in the relative density of cohesionless soils, the presence of organics or silt/sand/clay partings within the various strata, the depth to bedrock, the height of embankment, and degree of compaction achieved in the fill.

Differential primary consolidation settlements are anticipated across and along the embankments and along the proposed culvert alignments. The installation of permanent culverts should be carefully planned such that the foundation settlements of the permanent culvert are within the tolerable limits of the culvert.

2.3.2 Embankment Compression

An assessment of the short and long-term compression of fill materials under self-weight was also completed. Settlement of the road grade on rock fill, due to particle re-orientation and degradation of the interparticle contacts, is expected to continue at a decreasing rate with time. In accordance with the MTO document "Post-Construction Rock Fill Settlement and Guidelines for Estimating Rock Fill Quantity" (April 12, 2010), the magnitude of this settlement in compacted rock fill is expected to range from 0.5 to 1.0% of the embankment height within 1 year of embankment construction (90% in the first 6 months), and a further

0.1% of the embankment height after the 1 year period. For dumped rock fill (placed under the water level), these settlement values would be approximately doubled. The estimated settlement of granular fill embankments due to compression of the compacted fill is 0.5% of the embankment height and is expected to occur after fill placement.

The estimated settlements due to embankment compression at the maximum height of embankment in each section are included in Table A3 of Appendix A. Embankment platform width must be overbuilt to allow for the anticipated foundation settlements and embankment compression.

2.4 Seismic Assessment

The stability analyses were checked assuming a horizontal peak ground acceleration (PGA) of 0.01g, where g is the acceleration due to gravity. The PGA has been obtained from the CHBDC. The PGA value corresponds to a 10% probability of exceedance in 50 years.

2.5 Design Alternatives

Where standard embankment construction is not feasible, supplementary analyses were carried out to assess design alternatives. An iterative approach was applied for embankment design to produce a practical and cost-effective solution achieving acceptable factors of safety against slope instability and limiting post-construction settlement to meet MTO's guidelines.

2.5.1 Embankment Design

Design alternatives considered during analysis of the embankments typically included the following:

- Full and/or partial sub-excavation of soft cohesive foundation soils in addition to stripping of the peat, topsoil and organic deposits to improve foundation stability and reduce settlement.
- Provision of stabilizing berms to improve global stability.
- Ground improvement techniques such as providing a waiting period to allow for foundation preloading, surcharging and geosynthetic basal reinforcement.
- Construction techniques such as wick drain installation to accelerate settlement and staged construction to maintain stability.

The analyses carried out for this project have indicated that, in addition to stripping peat, topsoil and organic deposits, a combination of the foundation treatment measures listed above may be required at several sites to address stability and/or settlement issues.

2.5.2 Cut Slope Design

Design alternatives considered during analysis of the cut slopes typically included the following:

- Provisions for benching and/or slope flattening of cut slopes to improve global stability.
- Cut slope stabilizing improvement techniques such as dewatering and/or provision for permanent drainage utilizing interceptor ditches and sub-drains.
- Provisions for cut slope protection treatment such as granular sheeting and erosion protection.

The analyses carried out for this project have indicated that a combination of the cut slope treatment measures listed above may be required at several sites to address stability issues.

2.5.3 Culvert Design

Design alternatives considered to accommodate culvert settlement would typically include one or more of the following:

- Oversize the permanent culvert to accommodate the expected foundation settlement
- Install the permanent culvert with a camber to accommodate the expected foundation settlement
- At the locations where drainage or creek flow is required to be maintained along the proposed culvert alignment where large foundation settlements are expected, a temporary sacrificial culvert will be required prior to the installation of the permanent culvert. The permanent culvert should be installed after sufficient primary consolidation settlement of the foundation soil has occurred to reduce the magnitude of remaining settlement to be within settlement tolerance limits of the permanent culvert.

The culverts and associated wing walls (if applicable) must be designed to resist loadings including frost forces, lateral earth pressures, hydrostatic pressure, weight of embankment fill, traffic loading and any surcharge due to construction equipment and activities under static and seismic conditions.

2.6 Frost Protection

The design depth of frost penetration at this project is 2.3 m. Accordingly a minimum of 2.3 m of earth cover must be provided to serve as frost protection (where required).

3 EMBANKMENT DESIGN

3.1 Site Specific Discussion and Recommended Treatment

Results of the stability and settlement analyses carried out at selected critical locations are summarized in Table A2 and A3, respectively, in Appendix A. The soil properties used for engineering analysis for each section are summarized in Table A4.

Discussions regarding the design alternatives for each specific embankment section are provided below. To mitigate the effects of the settlement for long-term performance of new embankments and culverts, it is recommended that in a number of cases, there should be an allowance for a waiting period(s) between embankment construction stages and in advance of pavement construction. Medium to high fills, fills crossing swamps and multi-stage embankment construction should be scheduled to commence as early as practical (i.e. at the beginning of the contract period) to allow for the required waiting period(s).

3.1.1 Highway 11/17 EBL, Sta. 10+500 to 10+940 and Highway 11/17 WBL, Sta. 10+600 to 10+940

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the EBL embankment between station 10+500 and 10+940 and WBL embankment between station 10+600 to 10+940 for the maximum proposed embankment height of up to 2.1 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlement and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, the embankments can be constructed directly over the inorganic foundation soils without a waiting period between completion of fill placement and paving. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.2 Off Highway 11/17, Sta. 10+965 (Red Rock Road #9)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankment at station 10+965 along Red Rock Road #9 for the maximum proposed embankment height of up to 2.1 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for an embankment constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.3 Highway 11/17 EBL and WBL, Sta. 10+940 to 11+170

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments between station 10+940 and 11+170. For the maximum proposed embankment height of up to 2.6 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against

slope instability are greater than 1.3 for short-term (undrained) conditions and greater than 1.5 for long-term (drained) conditions (Figures D1 and D2).

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.4 Highway 11/17 EBL, Sta. 11+170 to 11+770

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the EBL embankment between station 11+200 and 11+700 for the proposed maximum embankment height of up to 3.0 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for the EBL embankment constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.5 Off Highway 11/17, Sta. 11+410 (Landfill Road)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankment at station 11+410 along Landfill Road for the maximum proposed embankment height of up to 1.5 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for an embankment constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.6 Highway 11/17 EBL, Sta. 12+100 to 12+170

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the EBL embankment between station 12+100 and 12+170. For the maximum proposed embankment height of up to 3.0 m above the existing ground

surface constructed as outlined in Section 2.1 and 5.6 the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and greater than 1.5 for long-term (drained) conditions (Figures G1 and G2).

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for the EBL embankment constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.7 Highway 11/17 EBL, Sta. 12+270 to 12+420

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the EBL embankments between station 12+270 and 12+420 for the maximum proposed embankment fill height of up to 2.0 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for the EBL embankment constructed directly over the inorganic foundation soils, a 2 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.8 Highway 11/17 EBL, Sta. 12+540 to 12+590

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the EBL embankment between station 12+540 and 12+590 for the maximum proposed embankment fill height of up to 3.0 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for an embankment constructed directly over the inorganic foundation soils, a 2 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.9 Highway 11/17 WBL, Sta. 12+730 to 12+900

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the WBL embankment between station 12+730 and 12+900.

For the maximum proposed embankment height of up to 2.9 m above the existing ground surface construction as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) and long-term (drained) conditions (Figures J1 and J2).

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are summarized in Table A3. Based on the analysis results, for an embankment constructed directly over the inorganic foundation soils, a 5 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur and to limit post construction (long-term) settlement. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.10 Off Highway 11/17, Sta. 13+100 (Red Rock Road #8)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the embankment at station 13+100 along Red Rock Road #8 for the maximum proposed embankment height of up to 2.1 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure K1) and embankment fill compression are summarized in Table A3. Based on the analysis results, for an embankment constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of embankment fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.11 Highway 11/17 EBL and WBL, Sta. 13+100 to 13+300

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the embankments between station 13+100 and 13+300 for the maximum proposed embankment height of up to 1.6 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of embankment fill placement and paving to allow a portion of the time dependent foundation settlement to occur. It should be noted that the adjacent embankments will require up to an estimated 5 month waiting periods for foundation settlement to occur. Therefore, it is recommended that the embankment in this section also have an allowance for a 5 month waiting period prior to paving. The embankment in this section may be overbuilt to

accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.12 Highway 11/17 EBL, Sta. 13+590 to 13+660 and Highway 11/17 WBL, Sta. 13+590 to 13+640

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the EBL embankment between station 13+590 to 13+660 and WBL embankment between station 13+590 to 13+640 for the maximum proposed embankment height of up to 3.5 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 2 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.13 Highway 11/17 EBL, Sta. 13+875 to 14+100 and Highway 11/17 WBL, Sta. 13+875 to 14+190

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipate for the EBL embankment between station 13+875 to 14+100 and WBL embankment between station 13+875 to 14+190 for the maximum proposed embankment height of up to 3.3 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure N1) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over this inorganic foundation soils, a 3 and 2 month waiting period is recommended for the EBL and WBL, respectively, between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section must be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.14 Highway 11/17 WBL, Sta. 14+190 to 14+290

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the WBL embankment between station 14+190 and 14+290 for the maximum proposed embankment height of up to 4.9 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for an embankment constructed directly over the inorganic foundation soils, a 2 and 3 month waiting period is recommended for the EBL an WBL, respectively, between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.15 Off Highway 11/17, Sta. 14+800 (Highway 628)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankment at station 14+800 along Highway 628 for maximum proposed embankment height of up to 4.6 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure P3) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 6 month waiting period is recommended between completion of embankment fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section must be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.16 Highway 11/17 EBL, Sta. 14+900 to 14+930

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the EBL embankment between station 14+900 and 14+930 for the maximum proposed embankment height of up to 1.6 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, the embankment ca be constructed directly over the inorganic foundation soils without a waiting period between completion of fill placement and paving. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.17 Highway 11/17 EBL, Sta. 15+730 to 16+250 and Off Highway 11/17, Sta. 16+200 (Median Connector)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the EBL embankment between station 15+730 and 16+250

for the maximum proposed embankment height of up to 4.8 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AQ1) and embankment fill compression are summarized in Table A3. Based on the analysis results, for an embankment constructed directly over the inorganic foundation soils, a 4 one month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.18 Highway 11/17 EBL and WBL, Sta. 17+250 to 17+400

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments between station 17+250 and 17+400 for the maximum proposed embankment height of up to 3.7 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.19 Highway 11/17 EBL and WBL, Sta. 17+550 to 17+675

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments between station 17+550 and 17+675 for the maximum proposed embankment height of up to 4.4 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of embankment fill placement and paving to allow a portion of the time dependent foundation settlement to occur. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

3.1.20 Highway 11/17 EBL, Sta. 19+190 to 19+330

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the EBL embankment between station 19+190 and 19+330

for the maximum proposed embankment height of up to 2.2 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, the embankment constructed directly over the inorganic foundation soils without a waiting period between completion of embankment fill placement and paving. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4 EMBANKMENT DESIGN IN VICINITY OF CULVERT

4.1 Site Specific Discussions and Recommended Treatment

Results of the stability and settlement analyses carried out at selected critical locations are summarized in Table A2 and A3, respectively, in Appendix A. The soil properties used for engineering analysis for each culvert section are included in their respective appendices.

Discussions regarding the design alternatives for each specific embankment section in the vicinity of a culvert are provided below. To mitigate the effects of the settlement for long-term performance of new embankments and culverts, it is recommended that in a number of cases, a waiting period should be allowed between completion of fill placement and pavement construction. Embankment construction in the vicinity of culverts should be scheduled to commence as early as practical (i.e. at the beginning of the contract period) to allow for the required waiting period(s).

4.1.1 Highway 11/17 EBL and WBL, Sta. 10+940 to 10+950 (Culvert 2 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 2A and 2B. For the maximum proposed embankment height of up to 2.3 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and greater than 1.5 for long-term (drained) conditions (Figures V1 and V2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure V3) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of the embankment fill placement and paving to allow a portion of the time dependent foundation settlement to occur. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.2 Highway 11/17 EBL and WBL, Sta. 11+160 to 11+170 (Culvert 3 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 3A and 3B. For the maximum proposed embankment height of up to 2.6 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and greater than 1.5 for long-term (drained) conditions (Figures W1 and W2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure W3) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.3 Highway 11/17 EBL and WBL, Sta. 11+770 to 11+800 (Culvert 4 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 4A and 4B. For the maximum proposed embankment height of up to 4.6 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and greater than 1.5 for long-term (drained) conditions (Figures X1 and X2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figures X3 and X4) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.4 Highway 11/17 EBL and WBL, Sta. 11+900 to 11+950 (Culvert 5 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 5A and 5B. For the maximum proposed embankment height of up to 3.3 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures Y1 and Y2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure Y3) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.5 Highway 11/17 EBL and WBL, Sta. 12+070 to 12+080 (Culvert 6 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 6A and 6B. For the maximum proposed embankment height of up to 5.4 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures Z1 and Z2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figures Z3 and Z4) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 3 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. It should be noted that the EBL embankment adjacent to the culvert will require an estimated 5 month waiting period for foundation settlement to occur. Therefore, it is recommended that the culvert embankment also have an allowance for a 5 month waiting period prior to paving. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements.

The embankment in this section must be overbuilt to accommodate the predicted settlement. Geotechnical instrumentation monitoring will be required at this site to confirm the waiting period after fill placement and the magnitude and time rate of settlement. Further recommendations and a suggested NSSP for geotechnical instrumentation monitoring have been prepared in Appendix AQ.

4.1.6 Highway 11/17 EBL and WBL, Sta. 12+230 to 12+250 (Culvert 7 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 7A and 7B. For the maximum proposed embankment height of up to 5.3 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures AA1 and AA2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AA3 and AA4) and embankment fill compression are

summarized in Table A3. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 2 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. It should be noted that the WBL and EBL embankments adjacent to the culvert will require an estimated 3 and 10 month waiting periods, respectively, for foundation settlement to occur. Therefore, it is recommended that the culvert embankment also have an allowance for a 10 month waiting period prior to paving. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements.

The embankment in this section must be overbuilt to accommodate the predicted settlement. Geotechnical instrumentation monitoring will be required at this site to confirm the waiting period after fill placement and the magnitude and time rate of settlement. Further recommendations and a suggested NSSP for geotechnical instrumentation monitoring have been prepared in Appendix AQ.

4.1.7 Highway 11/17 EBL and WBL, Sta. 14+190 to 14+210 (Culvert 13 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 13A and 13B. For the maximum proposed embankment height of up to 6.0 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures AB1 and AB2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AB3) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 1 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. It should be noted that the WBL and EBL embankments adjacent to the culvert will require an estimated 2 and 3 month waiting periods, respectively, for foundation settlement to occur. Therefore, it is recommended that the culvert embankment also have an allowance for a 3 month waiting period prior to paving. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.8 Highway 11/17 EBL and WBL, Sta. 14+720 to 14+760 (Culvert 14 A/B)

For the maximum proposed embankment height of up to 4.1 m plus 2 m of surcharge in the vicinity of Culvert 14A and 14B, the long-term foundation settlement (within 20 years after completion of construction) is expected to be greater than MTO's guideline of 100 mm. Several ground improvement techniques have been considered to address the foundation soil settlement while maintaining embankment stability at the culvert location. The feasible

design option incorporates the design requirements of the embankment adjacent to Culverts 14 A/B and is discussed in a separate report[2].

The proposed construction sequence includes removal of peat, topsoil and organic deposits as outlined in Section 5.1, installation of a drainage blanket to an elevation of 1 m above the existing ground surface or 1 m above the water level, whichever is higher, installation of wick drains in a 1.2 m centre-to-centre triangular spacing, installation of geotechnical monitoring instrumentation followed by preparation of the culvert subgrade and installation of a temporary or permanent culvert.

To reduce the post construction foundation settlement below MTO's guideline, inclusion of a 2 m surcharge is required following embankment construction. To maintain stability, a stabilizing berm is required and must be constructed simultaneously with the embankment fill. Based on the proposed embankment height and surcharge requirement, a two stage construction is required for the proposed construction sequence. The embankment fill placement must be constructed with the total height of the first stage of fill placement restricted to a maximum of 5 m above existing ground level. The second stage of fill will be to full height of 6.1 m above the exiting ground level. A 6 month waiting period is required following each stage of embankment construction.

For an embankment constructed as outlined above and in Section 2.1 and 5.6 the computed factors of safety against slope instability are greater than 1.3 for short-term conditions at the completion of each stage of fill placement (Figures AC1 and AC2) and greater than 1.5 for long-term (drained) conditions (Figures AC3 and AC4).

The combined estimated foundation settlement during construction, post-construction foundation settlement (Figures AC5 to AC7) and embankment fill compression for an embankment construction method as outlined above is summarized in Table A3. Geotechnical instrumentation monitoring will be required at this site to confirm the waiting period after each stage of embankment construction and the magnitude and time rate of settlement.

Embankment construction should be scheduled to commence as early as practical (i.e. at the beginning of the contract period) to allow for the required waiting periods. The embankment in this section must be overbuilt to accommodate the large predicted settlement. The rate of fill placement and actual time for waiting between stages of fill placement and prior to paving will be governed by results from the instrumentation monitoring program and may be longer than provided herein. Further recommendations and a suggested NSSP for geotechnical instrumentation monitoring have been prepared in Appendix AQ.

It is anticipated that the total foundation settlement may be greater than the tolerable limits of a permanent culvert therefore a temporary (sacrificial) culvert may need to be incorporated

[2] Foundation Design Report, High Embankments and Deep Cuts, Highway 11/17 Red Rock to Nipigon, From 4.8 km West of Highway 628 to 1.5 km West of Highway 585, GWP 647-89-00, Geocres 52A-180

into the design. The temporary culvert should be designed (i.e. articulation and camber) to accommodate the differential foundation settlements along the culvert as provided in Figure AC5 in Appendix A.

The timing of permanent culvert installation must be determined by the culvert designer and must take into consideration the amount of remaining foundation settlement (Figure AC7). The permanent culvert should be designed to withstand the differential settlement remaining after installation.

4.1.9 Highway 11/17 EBL and WBL, Sta. 15+190 to 15+220 (Culvert 18 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 18A and 18B. For the maximum proposed embankment height of up to 3.2 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures AD1 and AD2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AD3 and AD4) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over this inorganic foundation soils, a 2 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.10 Highway 11/17 EBL, Sta. 16+390 to 16+410 and Highway 11/17 WBL, Sta. 16+430 to 16+470 (Culvert 24 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 24A and 24B. For the maximum proposed embankment height of up to 3.6 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures AE1 and AE2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AE3, AE4, AE5 and AE6)) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over this inorganic foundation soils, a 4 and 6 month waiting period is recommended for the EBL and WBL, respectively, between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements.

The embankment in this section must be overbuilt to accommodate the predicted settlement. Geotechnical instrumentation monitoring will be required for the WBL embankment at this site to confirm the waiting period after fill placement and the magnitude and time rate of settlement. Further recommendations and a suggested NSSP for geotechnical instrumentation monitoring have been prepared in Appendix AQ.

4.1.11 Highway 11/17 EBL and WBL, Sta. 16+820 to 16+900 (Culvert 25 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 25A and 25B. For the maximum proposed embankments height of up to 3.9 m above the existing ground surface constructed as outlined in Section 2.1 and 5.6, the computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures AF1 and AF2).

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AF3 and AF4) and embankment fill compression are summarized in Table A3. Based on the analysis results, for embankments constructed directly over this inorganic foundation soils, a 12 month waiting period is recommended between completion of the fill placement and paving to allow a portion of the time dependent foundation settlement to occur and to limit post construction (long-term) settlement. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlements.

The embankment in this section must be overbuilt to accommodate the predicted settlement. Geotechnical instrumentation monitoring will be required at this site to confirm the waiting period after fill placement and the magnitude and time rate of settlement. Further recommendations and a suggested NSSP for geotechnical instrumentation monitoring have been prepared in Appendix AQ.

4.1.12 Highway 11/17 WBL, Sta. 17+720 to 17+750 (Culvert 28)

For the maximum proposed embankment height of up to 9.0 m above the existing ground surface in the vicinity of Culvert 28, the long-term foundation settlement (within 20 years after completion of construction) is expected to be greater than MTO's guideline of 100 mm. Several ground improvement techniques have been considered to address the foundation soil settlement while maintaining embankment stability at the culvert location. The feasible design option incorporating the design requirements of the embankment in the vicinity of Culverts 28 is discussed in a separate report[3].

The proposed construction sequence includes removal of peat, topsoil and organic deposits as outlined in Section 5.1, installation of geotechnical monitoring instrumentation followed by preparation of the culvert subgrade and installation of a temporary or permanent culvert. Removal of the silty clay is not recommended due to the presence of artesian pressures

[3] Foundation Design Report, High Fill Embankments and Deep Cuts, Highway 11/17 Red Rock to Nipigon, From 4.8 km West of Highway 628 to 1.5 km West of Highway 585, GWP 647-89-00, Geocres 52A-180

recorded in the underlying stratum and the potential to affect the stability of the existing lanes (future EBL) directly adjacent to the new alignment.

To maintain stability, a stabilizing berm is required and must be constructed simultaneously with the embankment fill. Based on the proposed embankment height, a two stage construction is required for the proposed construction sequence. The embankment fill placement must be constructed with the total height of the first stage of fill placement restricted to a maximum of 6 m above existing ground level. The second stage of fill will be to full height of 9.0 m above the exiting ground level. A 5 month waiting period for the WBL is required following each stage of embankment construction. A 3 month waiting period is required for the EBL following the completion of embankment construction.

For an embankment constructed as outlined in Section 2.1 and 5.6 the computed factors of safety against slope instability are greater than 1.3 for short-term conditions at the completion of each stage of fill placement (Figures AG1 and AG2) and greater than 1.5 for long-term (drained) conditions (Figures AG3 and AG4).

The combined estimated foundation settlement during construction, post-construction foundation settlement (Figures AG5 and AG6) and embankment fill compression for an embankment construction method as outlined above is summarized in Table A3. Geotechnical instrumentation monitoring will be required at this site to confirm the waiting period after each stage of embankment construction and the magnitude and time rate of settlement.

Embankment construction should be scheduled to commence as early as practical (i.e. at the beginning of the contract period) to allow for the required waiting periods. The embankment in this section must be overbuilt to accommodate the large predicted settlement. The rate of fill placement and actual time for waiting between stages of fill placement and prior to paving will be governed by results from the instrumentation monitoring program and may be longer than provided herein. Further recommendations and a suggested NSSP for geotechnical instrumentation monitoring have been prepared in Appendix AQ.

It is anticipated that the total foundation settlement is within the tolerable limits of a permanent culvert therefore a temporary (sacrificial) culvert may not need to be incorporated into the design. The permanent culvert should be designed to withstand the differential settlement remaining after installation and a camber of over-sized culvert should be considered.

4.1.13 Highway 11/17 EBL and WBL, Sta. 17+900 to 17+910 (Culvert 29 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 29A and 29B for the maximum proposed embankment height of up to 8.3 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AH1) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, for embankments constructed directly over the inorganic foundation soils, a 3 and 5 month waiting period is recommended for the EBL and WBL, respectively, between completion of fill placement and paving. The embankment in this section may be overbuilt to accommodate the predicted settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.14 Highway 11/17 EBL and WBL, Sta. 18+740 to 18+790 (Culvert 32 A/B)

For the maximum proposed embankment height of up to 5.5 m plus 2 m of surcharge in the vicinity of Culvert 32A and 32B, the long-term foundation settlement (within 20 years after completion of construction) is expected to be greater than MTO's guideline of 100 mm. Several ground improvement techniques have been considered to address the foundation soil settlement while maintaining embankment stability at the culvert location. The feasible design option incorporates the design requirements of the embankment adjacent to Culverts 32 A/B ad is discussed in a separate report[4].

The proposed construction sequence includes removal of peat, topsoil and organic deposits as outlined in Section 5.1, installation of a drainage blanket to an elevation of 1 m above the water level, installation of wick drains in a 1.5 m centre-to-centre triangular spacing, installation of geotechnical monitoring instrumentation followed by preparation of the culvert subgrade and installation of a temporary or permanent culvert.

To reduce the post construction foundation settlement below MTO's guideline, inclusion of a 2 m surcharge is required following embankment construction. To maintain stability, a stabilizing berm is required and must be constructed simultaneously with the embankment fill. Based on the proposed embankment height and surcharge requirement, a three stage construction is required for the proposed construction sequence. The embankment fill placement must be constructed with the total height of the first stage of fill placement restricted to a maximum of 4.5 m above existing ground level and the second stage restricted to 2.5 m above stage two design level. The second stage of fill will be to 6.5 m and the final third stage will be to the full 7.5 m above the existing ground surface. A 6 month waiting period is required following each stage of embankment construction.

For an embankment constructed as outlined above and in Section 2.1 and 5.6 the computed factors of safety against slope instability are greater than 1.3 for short-term conditions at the completion of each stage of fill placement (Figures AI1 to AI2) and greater than 1.5 for long-term (drained) conditions (Figures AI3 and AI4).

[4] Foundation Design Report, High Fill Embankments and Deep Cuts, Highway 11/17 Red Rock to Nipigon, From 4.8 km West of Highway 628 to 1.5 km West of Highway 585, GWP 647-89-00, Geocres 52A-180

The combined estimated foundation settlement during construction, post-construction foundation settlement (Figures AI5 to AI7) and embankment fill compression for an embankment construction method as outlined above is summarized Table A3. Geotechnical instrumentation monitoring will be required at this site to confirm the waiting period after each stage of embankment construction and the magnitude and time rate of settlement.

Embankment construction should be scheduled to commence as early as practical (i.e. at the beginning of the contract period) to allow for the required waiting periods. The embankment in this section must be overbuild to accommodate the large predicted settlement. The rate of fill placement and actual time for waiting between stages of fill placement and prior to paving will be governed by results from the instrumentation monitoring program and may be longer than provided herein. Further recommendations and a suggested NSSP for geotechnical instrumentation monitoring have been prepared in Appendix AQ.

It is anticipated that the total foundation settlement may be greater than the tolerable limits of a permanent culvert therefore a temporary (sacrificial) culvert may need to be incorporated into the design. The temporary culvert should be designed (i.e. articulation and camber) to accommodate the differential foundation settlements along the culvert as provided in Figure AI7 in Appendix A.

The timing of permanent culvert installation must be determined by the culvert designer and must take into consideration the amount of remaining foundation settlement (Figure AI7). The permanent culvert should be designed to withstand the differential settlement remaining after installation.

4.1.15 Highway 11/17 EBL and WBL, Sta. 19+110 to 19+120 (Culvert 34 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 34A and 34B for the maximum proposed embankment height of up to 1.6 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction post-construction foundation settlements (Figure AJ1) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, the embankments can be constructed directly over the inorganic foundation soils without a waiting period between completion of fill placement and paving. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.16 Highway 11/17 EBL and WBL, Sta. 19+670 to 19+690 (Culvert 35 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 35A and 35B for the maximum proposed embankment height of up to 4.7 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AK1) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, the embankments can be constructed directly over the inorganic foundation soils without a waiting period between completion of fill placement and paving. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.17 Highway 11/17 EBL and WBL, Sta. 19+730 to 19+770 (Culvert 36 A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 36A and 36B for the maximum proposed embankment height of up to 4.7 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AL1) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, the embankments can be constructed directly over the inorganic foundation soils without a waiting period between completion of fill placement and paving. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

4.1.18 Highway 11/17 EBL and WBL, Sta. 20+860 to 20+880 (Culvert 37A/B)

After removal of peat, topsoil and organic deposits as outlined in Section 5.1, no global stability issues are anticipated for the embankments in the vicinity of Culvert 37 A and 37B for the maximum proposed embankment height of up to 2.1 m above the existing ground surface provided proper construction methods are used as outlined in Section 2.1 and 5.6.

The combined estimated foundation settlement during construction, post-construction foundation settlements (Figure AM1) and embankment fill compression are less than MTO's guideline of 100 mm. Based on the analysis results, the embankments can be constructed directly over the inorganic foundation soils without a waiting period between completion of fill placement and paving. Consideration should be given to installing the culvert with a camber or to oversize the culvert to accommodate the expected settlement. Due to the magnitude and duration of the predicted settlement, geotechnical instrumentation monitoring is not considered a requirement for this site.

5 EMBANKMENT AND CULVERT CONSTRUCTION

5.1 Subexcavation of Peat, Topsoil and Organic Deposits

It is standard procedure on MTO projects to sub-excavate all peat deposits not exceeding 6 m in depth from within the footprint of the embankment, and backfill the resulting excavation with rock or granular fill. Since the depth of peat soils within the investigated

areas in this report are less than 6.0 m, it is recommended that all peat soils be sub-excavated from within the proposed footprint of all embankments and any associated stabilization berms. All topsoil and organic deposits should also be stripped from under the proposed footprint of the embankment and berms (where applicable).

The anticipated and/or recommended depth of peat, topsoil and organic deposits to be removed along the proposed alignments is also summarized in Table A1 of Appendix A and are based on the thickness noted at the borehole locations. Subexcavation depths may vary at locations between and away from the boreholes. The subexcavated foundation area should be backfilled with rock or granular material as described later in this report.

Removal of peat, topsoil and organic deposits may be carried out below the surface water and groundwater levels. Construction operations should include measures such as temporary dewatering and drainage/lowering of ponded water wherever practical (for example, where excavation depths are small), and provision of equipment suitable for excavation below the water level where dewatering is not practical. The surface water depths and depths to groundwater at the time of construction will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions that may be impacted by beaver dams. Placement of rock fill is recommended where standing water is encountered and wick drain installation is not required.

In the stability and settlement analyses, it has been assumed that the peat, topsoil and organic deposits have been removed and replaced with rock or granular material as appropriate prior to culvert construction and embankment fill placement.

5.2 Subgrade Preparation and Embankment Construction Restrictions

It should be noted that where fine-grained silt and clay soils are exposed following clearing, grubbing and stripping activities under the proposed embankment and stabilization berms (where required), these native soils are soft and moisture sensitive and may become heavily disturbed when subjected to construction traffic. Site and subgrade drainage will be critical to maintain good trafficability of the subgrade for construction equipment. The contractor must be advised of the issue in the tender documents so that he may adjust his operations to suit the difficult subgrade conditions.

A number of embankment construction restrictions are noted in the Operational Constraints (General) – Construction Staging which will be included in the tender documents. These include construction of temporary haul roads, not allowing storing or stockpiling material and/or equipment on the stabilization berms or the main embankment. Operational Constraints (Foundations) – Surcharge and Waiting Periods are included in Appendix AQ.

5.3 Wick Drains and Granular Drainage Blanket

Wick drain installation is required at two sites (Section 4.1.8 and 4.1.14) to increase the rate of foundation settlement during construction and reduce the post construction (long-term)

foundation settlement. The lateral extents of wick drain installation and anticipated tip elevation, based on interpretation of available borehole data, are shown on the Wick Drain Plan drawings included in Appendix AQ. The wick drain tip elevation should extend at least 0.5 m into the cohesionless silt and sand below the compressible clay or to refusal if encountered immediately below the clay. It should be noted that the tip elevations between and beyond borehole locations were estimated by interpolation and extrapolation of the data, respectively. Therefore the actual tip elevations may vary during wick drain installation.

Pre-augering and/or suitable equipment should be used to facilitate wick drain installation if obstructions are encountered during installation. Care must be exercised to avoid construction equipment travelling over and damaging wick drains.

Wick drains must not be installed in frozen ground due to the potential of the drains freezing within the frost depth and the resultant impeded drainage until the soils thaw. If no or insufficient fill cover (less than 2.0 m of soil or less than 4.0 m of rock fill) is placed before the onset of freezing, placement of embankment fill on frozen soils and frozen wicks will delay dissipation of excess pore pressure in the foundation soils which may significantly delay the construction schedule.

The granular drainage blanket through which the wicks will be installed should be placed to 1.0 m above the original ground surface or 1 m above the surface water level, whichever is higher, and 1 m past the lateral extent of the wick drain layout. The granular drainage blanket shall be Granular B Type II or Type III, according to OPSS 1010 except that:

- 100% shall pass 37.5 mm sieve, and
- No more than 5% shall pass the 0.075 mm sieve

Non-Standard Specifications (NSSP) for wick drain and granular drainage blanket have been included in Appendix AQ.

5.4 Geogrid

Geogrid basal reinforcement is required at two site (Section 4.1.8 and 4.1.14) to maintain embankment stability. The installation details and lateral extents of the geogrid are shown on the Geogrid Plan drawing included in Appendix AQ. Each layer of geogrid shall be Tencate Miragrid 22XT, or equivalent, with a minimum long term design strength of 150 kN/m placed with the machine direction of the geogrid perpendicular to the embankment centreline. Adjoining geogrid joints shall be overlapped a minimum of 900 mm with a staggered arrangement between layers. No joints shall be allowed in the machine direction. A minimum thickness of 300 mm of Granular B Type II shall be placed above and below each layer of geogrid. Care must be exercised to avoid construction equipment travelling over and damaging the geogrid.

5.5 Accuracy of Settlement Calculations and Geotechnical Instrumentation and Monitoring Program

The settlement predictions in this report have been carried out based on a comprehensive field and laboratory program and on assumptions based on our experience with other embankments founded on compressible soils. Notwithstanding the care taken in predicting the embankment performance, the settlement values observed in the field could vary significantly from the predictions. This is due to the high degree of variability of the soil properties along the embankment alignment. The presence of locally sensitive deposits adds uncertainty to the prediction of the performance of the embankment proposed in this project. Therefore the results of the settlement analysis should be used to compare design alternative and to assess the most likely performance of the embankments.

Geotechnical instrumentation and monitoring, to control construction of embankments, is recommended at seven sites (Section 4.1.5, 4.1.6, 4.1.8, 4.1.10, 4.1.11, 4.1.12 and 4.1.14). The geotechnical instrumentation will consist of a combination of slope inclinometers, vibrating wire piezometers, settlement rods and settlement pins. The instrumentation locations, types of instrumentation, installation details and monitoring frequency are provided in Appendix AQ.

The results of the geotechnical instrumentation monitoring program will control the rate of the embankment construction and consequently the construction schedule. Although not anticipated, there is a risk that the pore pressure dissipation in the foundation clay will be slower than anticipated. If this situation occurs, the embankment construction may have to be slowed down which may delay the overall construction schedule. It is considered important that the construction contract includes clauses that allow for a flexible construction schedule to allow for delays associated with dissipation of excess pore pressures in the foundation soils slower than anticipated. In addition, a detailed and regular analysis of the results of the geotechnical instrumentation monitoring program during construction is considered critical to:

- Reduce the potential of an embankment failure
- Reduce the risk of a premature removal of the surcharge
- Reduce the risk of installing the permanent culverts too early

During construction, the Contract Administrator should employ experienced high complexity geotechnical staff to implement the geotechnical instrumentation monitoring program and to observe foundation performance related to construction activities.

5.6 Embankment Construction

Embankment construction should be carried out in accordance with OPSS.PROV 206. Rock size should be controlled in accordance with OPSS.PROV 206. Embankment fill may consist of granular

materials and Select Subgrade Material (SSM) in compliance with OPSS.PROV 1010. Granular fill embankment slopes must be provided with erosion protection in accordance with OPSS 804.

Rock fill placed above the water table should be placed in a controlled manner (not end dumped) including blading, dozing and chinking of the rock to minimize voids and bridging. Rock fill must be compacted as per OPSS.PROV 206. Rock fill used to backfill subexcavated areas below the water table may be placed by end dumping. Granular fill must not be used to backfill excavations below the water table.

At the pavement subgrade level or where granular fill is to be placed over rock fill, the rock fill subgrade must be blinded with spall material and rock fill chinking shall be in accordance with OPSS.PROV 206. All granular fill must be compacted as per OPSS 501.

Mid-height berms comprising 2 m wide benches should be incorporated along the length of embankments with heights at or exceeding 8 m in granular fill and 10 m in rock fill. Where new embankment fill is placed against existing embankment slopes or on a sloping ground surface steeper than 3H:1V, the existing earth or fill slope must be benched in accordance with OPSD 208.010.

Construction of new embankments over compressible soils should be carried out in accordance with OPSS 209 "Construction Specification for Embankments Over Swamps and Compressible Soils", April 2009, with specific reference to OPSD 203.010 "Embankments Over Swamp, New Construction".

5.7 Culvert Construction

Temporary and permanent culverts should be designed to accommodate the settlements expected to occur along the culvert alignment following the culvert installation. It is understood that the proposed permanent culverts will consist of either a pre-cast segmental closed box culvert or pipe culvert.

It is very important to found the culvert on uniform and competent foundation soil conditions to minimize the differential settlement of the structure. The Quality Verification Engineer (QVE) should therefore be directed to inspect the subgrade of the excavation to confirm that the subgrade is suitable and uniformly competent and draw to the attention of the Contract Administrator (CA) any remaining topsoil, peat, organics or deleterious conditions that are encountered. Construction equipment should not be permitted to travel on the subgrade.

5.7.1 Excavation, Bedding and Backfill

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the granular fill around the culvert and the shallow native soils may be classified as Type 3 soil above the water level. If excavation is carried out below the water table, these soils must be treated as Type 4.

Excavation, bedding, backfilling, and compaction for culverts must be carried out in accordance with OPSS 401, OPSD 803.010 and Canadian Highway Bridge Design Code

Section 7. It should be noted that backfill should be placed and compacted in simultaneous equal lifts on both sides of the culvert and the top of backfill elevation should be within 400 mm on both sides of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and roof of the culvert and compaction should be in accordance with OPSS 501.

Any fill, peat, topsoil, organic deposits, loose streambed deposits or deleterious soils should be subexcavated to the competent native subgrade. Any soft areas should be subexcavated and replaced with well compacted granular fill. This work should be carried out in accordance with OPSS 902.

In order to provide a more uniform foundation subgrade condition, a minimum of 300 mm thick layer of bedding material conforming to OPSS Granular A or Granular B Type II material requirements should be provided under the base of the culverts as per OPSD 803.010. The bedding material should be placed and compacted as soon as practical following inspection and approval of the final subgrade. Compaction of the granular bedding may cause disturbance of the clay subgrade and lighter compaction equipment should be used.

Protection systems may be required to facilitate the proposed construction. Protection systems should be designed by a licensed Professional Engineer experienced in such designs. OPSS 539 "Construction Specifications for Protection Systems" must be referenced in the contract documents and designed to Performance Level 2.

5.7.2 Groundwater and Surface Water Control

Surface water control and effective lowering of the groundwater level are important aspects of culvert construction. Failure to carry out either or both of these requirements could have serious detrimental impact on the construction and the future performance of the proposed culvert.

The design of the unwatering system, selection of equipment and methodology is the responsibility of the Contractor. Prior to any unwatering activity, erosion control measures should be implemented to prevent loss of sediments into the existing water course. Any accumulation of water from the base of the excavation must be removed prior to compacting granular fill. Culvert subgrade preparation, placing of bedding and compacting fill must be done in the dry. Dewatering and surface water diversion must remain operational and effective until the culvert is constructed and backfilled.

5.7.3 Erosion Protection

All culverts should be provided with erosion and scour protection. Erosion control should be provided at the culvert inlet and outlet areas as applicable. Design of the scour and erosion protection measures must consider hydrologic and hydraulic concerns and should be carried out by a specialist experienced in this field.

Typically rock protection should be provided over all surfaces which water flow is likely to be in contact. Treatment at the outlets should be in accordance with OPSD 801.010. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS 804.

It is recommended that a clay seal or a concrete cut-off wall be used to minimize the potential for erosion near the inlet area. The clay seal should extend a minimum of 0.3 m above the high water level and laterally for the width of the granular material, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS 1205.

6 CUT SLOPE DESIGN AND CONSTRUCTION

6.1 Site Specific Discussions and Recommended Treatment

The results of the stability analysis carried out at selected critical locations are summarized in Table 2 in Appendix A. The soil parameters used for engineering analysis for each section are summarized in Table A4 of Appendix A.

Discussion regarding the design alternatives for each specific cut slope section are provided below.

6.1.1 Highway 11/17 WBL, Sta. 13+450 to 13+550

Bedrock was inferred by split spoon refusal at depths up to 13.8 m below the existing ground surface. For the proposed road profile cut depth of up to 1.9 m, 2H:1V earth cut and standard rock cut side slopes will apply at this site. The computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures AN1 and AN2). Construction of cuts through earth and rock should be carried out in accordance with OPSD 209.020 “Widening Rock Cut with Grade Raise”.

6.1.2 Highway 11/17 WBL, Sta. 13+640 to 13+660

Bedrock was inferred by split spoon refusal at a depth of 6.4 m below the existing ground surface. For the proposed road profile cut depth up to 1.5 m, 2H:1V earth cut and standard rock cut side slopes will apply at this site. The computed factors of safety against slope instability are greater than 1.3 for short-term (undrained) conditions and 1.5 for long-term (drained) conditions (Figures AO1 and AO2). Construction of cuts through earth and rock should be carried out in accordance with OPSD 209.020 “Widening Rock Cut with Grade Raise”.

6.1.3 Highway 11/17 WBL, Sta. 14+290 to 14+410

Bedrock was inferred by auger refusal at depths up to 3.7 m below the existing ground surface. For the proposed road profile cut depth up to 6.0 m, 2H:1V earth cut and standard rock cut side slopes will apply and stability is not considered a concern at this site.

Construction of cuts through earth and rock should be carried out in accordance with OPSD 209.020 "Widening Rock Cut with Grade Raise".

Rock cuts should be designed in conformity with the Northwestern Region Rock Cut Design Guidelines.

6.1.4 Highway 11/17 WBL, Sta. 15+880 to 16+090

Bedrock was either exposed at the ground surface or inferred by auger refusal at depths up to 0.7 m below the existing ground surface. For the proposed road profile cut depth up to 3.0 m, 2H:1V earth cut and standard rock cut side slopes will apply and stability is not considered a concern at this site. Construction of cuts through earth and rock should be carried out in accordance with OPSD 209.020 "Widening Rock Cut with Grade Raise".

Rock cuts should be designed in conformity with the Northwestern Region Rock Cut Design Guidelines.

6.2 Cut Slope Construction

Excavation for cut slope construction should be carried out in accordance with OPSS.PROV 206.

Slope inclination in earth cuts should not be steeper than 2H:1V for cuts less than 4.5 m depth and not steeper than 3H:1V for cuts deeper than 4.5 m. Mid-height berms comprising 2 m wide benches should be incorporated along the length of earth cuts with depths exceeding 6 m. The bench should maintain a 2% slope to shed surface run-off.

During construction of earth cuts some areas may reveal a final subgrade to be soft and moisture sensitive. Subexcavation of the exposed soft and weak subgrade soils may be required in these areas. The subexcavation should be backfilled with well compacted granular fill. In some areas geogrid and/or geotextile may be required to allow placement of granular or rock fill above the soft subgrade. It is important that the CA have access to a geotechnical specialist to inspect such areas and provide site specific recommendations.

Rock cuts should be designed in conformity with the Northwestern Region Rock Cut Design Guidelines. Rock cuts at or greater than over 10 m in height are to be constructed at 0.25H:1V.

Rock excavation utilizing blasting should be carried out in accordance with OPSS 120, including blast design by a qualified Engineer/firm, explosive use by a competent blasting contractor, monitoring by a blast monitoring consultant, preparation of a pre-blast survey, and notification of any nearby utility authorities.

Rock mapping should be carried out prior to blast design to determine pertinent conditions such as the locations and orientation of joints and fractures in the rock mass. After blasting, the rock cuts should be examined by a rock slope specialist to identify any areas of unstable rock requiring removal or stabilization.

Temporary drainage of the cuts should be provided to maintain a relatively dry, stable excavation. Permanent drainage of the cuts must also be provided. Roadside ditches are expected to provide an adequate level of surface drainage in most areas. An interceptor ditch should be provided at the top of the earth cuts as per OPSD 200.020 and 201.020.

Where fine-grained silt and clay soils are exposed on a cut slope, the native soils are soft and moisture sensitive and may become negatively impacted after spring thaw and/or ingress of surface water and/or changes in the water table. The properties of the soils are such that the fluctuation in moisture content is likely to soften the soils and to result in erosion and/or sloughing of the soils and resulting in instability of the cut slopes. Such areas must be protected from erosion both on a temporary and permanent basis.

Temporary and/or permanent erosion and sedimentation control measures must be in place and maintained at all times so as to prevent any deleterious materials or fines from entering into any drainage feature or watercourse.

7 SUMMARY OF SITE SPECIFIC RECOMMENDATIONS

A summary of the primary recommendations for each specific area of embankment and culvert is presented on Table 1 in Appendix B through AM. The summary is based on the discussions presented above, and these discussions should be referenced for further detail.

The anticipated and/or recommended depth of subexcavation of peat, topsoil and organic deposits at all sites is summarized in Table A1 in Appendix A.

8 SEISMIC CONSIDERATIONS

Provided construction of embankments and cut slopes are carried out in accordance with the site-specific recommendations provided above, the minimum factor of safety, as outlined in Section 8.2, will be maintained for seismic loading conditions.

Based on the subsurface conditions encountered at the drilled locations, the potential for liquefaction of the foundation soils during a seismic event is considered to be low in accordance with CHBDC Section C4.6. Some local liquefaction and resulting toe failure may occur during a seismic event, but this is expected to be readily repaired.

9 CONSTRUCTION CONCERNS

During construction, qualified geotechnical staff should be retained to observe activities related to embankment construction and advise the Contract Administrator on construction concerns or issues related to embankment slope stability or settlement.

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

- The thickness and presence of organic deposits were investigated at the borehole locations only. Organic deposits may extend to greater depths between boreholes or be encountered at other locations.

- Geotechnical confirmation is required that all peat, topsoil and organic deposits within the proposed embankment footprint are stripped and replaced with approved backfill.
- Trafficability of construction equipment may be difficult in areas of organic deposits or excessively soft, loose/unstable and/or saturated subgrade. Disturbance of the subgrade by construction traffic must be minimized and the Contractor may have to adjust his operations in soft subgrade areas. Provisions of adequate site drainage is critical to maintain stable subgrade.
- Bedrock elevations may vary between and beyond the borehole locations. The limits of sub-excavation and ground treatment may require modification during construction based on the conditions encountered in the field.
- In the vicinity of Culvert 14 A/B and 32 A/B, pre-augering and/or suitable equipment should be used to facilitate wick drain installation if obstructions are encountered during installation. If no or insufficient fill cover (less than 2.0 m of soil or less than 4.0 m of rock fill) is placed before the onset of freezing, placement of embankment fill on frozen soils and frozen wicks will delay dissipation of excess pore pressure in the foundation soils which may significantly delay the construction schedule.
- Although not anticipated, there is a risk that the pore pressure dissipation and foundation soil settlement will be slower than anticipated. If this situation occurs, the embankment construction may have to be slowed down which may impact the overall construction schedule. It is considered important that the construction contract includes clauses that allow for a flexible construction schedule to allow for delays associated with dissipation of excess pore pressures in the foundation soils slower than anticipated
- In areas with culvert construction, care must be exercised during excavation to avoid disturbing the founding subgrade. When the excavation reaches the required elevation, the subgrade should be inspected and approved by qualified geotechnical personnel employed by the Contractor.
- For existing culverts that are to remain operational within the new embankment footprint for temporary drainage purposes only during construction, consideration should be given to grout the annulus the existing culvert to decommission the culvert after the new drainage culvert or creek crossing has been constructed.
- Areas of ongoing seepage emerging from cut slopes may require gravel sheeting or rock protection to provide drainage of the seepage and prevent erosion of the slope face. Control of groundwater seepage is the responsibility of the Contractor.
- Where new embankments are constructed directly adjacent to existing embankments, settlement of the existing embankment may occur. Maintenance measures such as placement of asphalt overlay may be required to compensate the settlement.

10 CLOSURE

Engineering analysis and preparation of the foundation design report were carried out by Mr. Jason Lee, P.Eng., Mr. Michael Eastman, E.I.T. and Mr. Stephen Peters, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A

Tables

Table A1-1
Summary of Peat and Organic Soil Thickness

Appendix	Borehole / BH+DCPT (*)	Description	Depth of Investigation (m)	Depth of Peat, Topsoil and Organics Deposit (m)
B	Highway 11/17 EBL, Sta. 10+500 to 10+940			
	10+580 05R	Left toe of EBL	14.3	0.0 to 1.2
	10+750 19R	CL of EBL	14.3	
	10+850 13R	CL of EBL	11.3	
	Highway 11/17 WBL, Sta. 10+600 to 10+940			
	10+805 22L	CL of WBL	10.7	0.1
C	Off Highway 11/17, Sta. 10+965, Red Rock Road #9			
	10+020 CL	Median centreline	14.3	0.3
D	Highway 11/17 EBL and WBL, Sta. 10+940 to 11+170			
	11+050 17R	CL of EBL	14.3	1.6
	11+050 28L	Left toe of WBL	8.5	0.0
E	Highway 11/17 EBL, Sta. 11+170 to 11+770			
	11+250 19R	CL of EBL	14.3	0.1 to 0.3
	11+405 19R	CL of EBL	14.3	
	11+450 22R	CL of EBL	14.3	
	11+550 24R	CL of EBL	14.3	
	11+700 19R	CL of EBL	14	
F	Off Highway 11/17, Sta. 11+410, Landfill Road			
	9+965 CL	Median centreline	14.3	0.1 to 0.2
	10+010 CL	Median centreline	14.3	
G	Highway 11/17 EBL, Sta. 12+100 to 12+170			
	12+130 15R	CL of EBL	14.3	0.8
H	Highway 11/17 EBL, Sta. 12+270 to 12+420			
	12+350 19R	CL of EBL	12.2	0.0
I	Highway 11/17 EBL, Sta. 12+540 to 12+590			
	12+540 21R	CL of EBL	3.7	0.8
J	Highway 11/17 WBL, Sta. 12+730 to 12+900			
	12+770 23L	CL of WBL	5.4	0.0 to 0.5
	12+845 20L	CL of WBL	14.3	
K	Off Highway 11/17, Sta. 13+100, Red Rock Road #8			
	9+965 CL	Median centreline	14.1	0.4
L	Highway 11/17 EBL and WBL, Sta. 13+100 to 13+300			
	13+150 20R	CL of EBL	13.8	0.1 to 0.5
	13+250 20R	CL of EBL	14.3	
	13+205 19L	CL of WBL	13.4	0.2
M	Highway 11/17 EBL, Sta. 13+590 to 13+660 and WBL, Sta. 13+590 to 13+640			
	13+660 15R	CL of EBL	6.5	0.1
N	Highway 11/17 EBL, Sta. 13+875 to 14+100 and WBL, Sta. 13+875 to 14+190			
	13+955 19R	CL of EBL	2.7	0.4 to 0.9
	14+050 20R	CL of EBL	5.3	
	13+925 19L	CL of WBL	6.3	0.2 to 0.8
	14+000 19L	CL of WBL	9.2	
	14+105 19L	CL of WBL	3.9	
O	Highway 11/17 WBL, Sta. 14+190 to 14+290			
	14+255 19L	CL of WBL	1.4	0.0 to 0.1

Table A1-2
Summary of Peat and Organic Soil Thickness

Appendix	Borehole / BH+DCPT (*)	Description	Depth of Investigation (m)	Depth of Peat, Topsoil and Organics Deposit (m)
P	Off Highway 11/17, Sta. 14+800, Highway 628			
	10+160 CL	Median centreline	2.4	0.8
	10+160 16R*	Median centreline	14.9	
	10+160 18L	Median centreline	1.8	0.6 to 0.8
	10+210 05L	Median centreline	5.8	
	10+260 05L	Median centreline	5.2	
Q	Highway 11/17 EBL, Sta. 14+900 to 14+930			
	14+910 19R	CL of EBL	2.7	0.76
R	Highway 11/17 EBL and WBL, Sta. 15+730 to 16+250 and Off Highway 11/17, Sta. 16+200, Median Connect			
	15+740 24R	CL of EBL	4.3	0.8 to 1.7
	15+850 23R	CL of EBL	3.8	
	15+950 23R	CL of EBL	2.5	
	16+050 23R	CL of EBL	5.5	
	16+150 20R	CL of EBL	11.4	
	15+890 45L	Left toe of WBL	0.1	0.0 to 0.6
	15+940 19L	CL of WBL	0.2	
	15+940 49L	Left toe of WBL	0	
	15+990 45L	Left toe of WBL	0.1	
	16+040 19L	CL of WBL	1.9	
	16+040 49L	Left toe of WBL	0.7	
	16+090 35L	Left toe of WBL	2.8	
	16+175 34L	Left toe of WBL	5.6	
	10+020 CL	Median centreline	6	0.8
S	Highway 11/17 EBL and WBL, Sta. 17+250 to 17+400			
	17+330 24R	Right toe of EBL	4.3	0.0
	17+380 19L	CL of WBL	6.1	0.3
T	Highway 11/17 WBL, Sta. 17+550 to 17+675			
	17+600 19L	CL of WBL	4.9	0.0
	17+600 29R	Right toe of EBL	1.7	0.0
U	Highway 11/17 EBL, Sta. 19+190 to 19+330			
	19+200 23R	CL of EBL	2.3	0.0 to 0.8
	19+315 19R	CL of EBL	5.2	
V	Highway 11/17 EBL and WBL, Sta. 10+940 to 10+950			
	10+945 07R	Left toe of EBL	14.3	1.1 to 1.4
	10+945 15R	CL of EBL	14.3	
	10+945 27R*	Right toe of EBL	21.2	
	10+945 18L	CL of WBL	14.3	0.0 to 0.8
	10+945 27L	Left toe of WBL	6.7	
W	Highway 11/17 EBL and WBL, Sta. 11+160 to 11+170			
	11+165 05R*	Left toe of EBL	21	0.6 to 1.0
	11+165 19R	CL of EBL	14.3	
	11+165 31R	Right toe of EBL	14.3	
	11+165 14L	CL of WBL	14.3	0.0 to 0.6
	11+165 31L	Left toe of WBL	14.3	

Table A1-3
Summary of Peat and Organic Soil Thickness

Appendix	Borehole / BH+DCPT (*)	Description	Depth of Investigation (m)	Depth of Peat, Topsoil and Organics Deposit (m)
X	Highway 11/17 EBL and WBL, Sta. 11+770 to 11+800			
	11+785 08R	Left toe of EBL	13.6	0.8 to 0.9
	11+790 20R*	CL of EBL	15.2	
	11+795 35R	Right toe of EBL	14.3	
	11+775 35L	Left toe of WBL	12.1	0.6 to 1.4
	11+780 17L	CL of WBL	14	
Y	Highway 11/17 EBL and WBL, Sta. 11+900 to 11+950			
	11+923 02R	Left toe of EBL	14.2	0.8 to 1.5
	11+930 19R	CL of EBL	14.3	
	11+940 33R*	Right toe of EBL	15.5	
	11+905 32L	Left toe of WBL	14.3	0.0 to 1.5
	11+912 19L	CL of WBL	14.3	
Z	Highway 11/17 EBL and WBL, Sta. 12+070 to 12+080			
	12+075 05R	Left toe of EBL	14.1	0.8 to 2.1
Z	Highway 11/17 EBL and WBL, Sta. 12+070 to 12+080			
	12+075 35R*	Right toe of EBL	15.7	0.8 to 2.1
	12+075 06L	Right toe of WBL	13.4	1.2 to 1.5
	12+075 33L	Left toe of WBL	11.3	
AA	Highway 11/17 EBL and WBL, Sta. 12+230 to 12+250			
	12+230 43R	Right toe of EBL	10.1	1.5 to 1.7
	12+235 CL	Median centreline	8.6	
	12+240 42L	Left toe of WBL	4.7	1.5
AB	Highway 11/17 EBL and WBL, Sta. 14+190 to 14+210			
	14+201 37R	Right toe of EBL	2.2	0.2
	14+201 CL	Median centreline	0.5	0.2 to 0.5
AB	Highway 11/17 EBL and WBL, Sta. 14+190 to 14+210			
	14+201 19L	CL of WBL	0.3	0.2 to 0.5
	14+201 35L	Left toe of WBL	1.6	
AC	Highway 11/17 EBL and WBL, Sta. 14+720 to 14+760			
	14+739 58R	Right toe of EBL	0.5	0.5
	14+741 43L	Left toe of WBL	12.5	0.2
AD	Highway 11/17 EBL and WBL, Sta. 15+190 to 15+220			
	15+196 42R	Right toe of EBL	14.8	0.6 to 0.8
	15+203 21R*	CL of EBL	16.8	
	15+210 01R	Left toe of EBL	14.8	
	15+213 21L	CL of WBL	13.1	0.6
	15+218 35L	Left toe of WBL	11.9	
AE	Highway 11/17 EBL, Sta. 16+390 to 16+410 and WBL, Sta. 16+430 to 16+470			
	16+400 02R	Left toe of EBL	6.6	0.6
	16+404 13R	CL of EBL	6.7	
	16+440 01L	Right toe of WBL	7	1.5
	16+450 17L	CL of WBL	8.1	
	16+460 34L	Left toe of WBL	8.7	

Table A1-4
Summary of Peat and Organic Soil Thickness

Appendix	Borehole / BH+DCPT (*)	Description	Depth of Investigation (m)	Depth of Peat, Topsoil and Organics Deposit (m)
AF	Highway 11/17 EBL and WBL, Sta. 16+820 to 16+900			
	16+825 33R	Right toe of EBL	6.3	1.5
	16+857 CL	Median centreline	11.7	
	16+875 23L	Left toe of WBL	5.9	2.1
AG	Highway 11/17 EBL and WBL, Sta. 17+720 to 17+750			
	17+720 22R	CL of EBL	1.8	0.0
	17+736 CL	Median centreline	5.2	0.8
	17+750 34L	Left toe of WBL	8.5	
AH	Highway 11/17 EBL and WBL, Sta. 17+900 to 17+910			
	17+905 29R	Right toe of EBL	1.2	0.0
	17+905 02L	Right toe of WBL	4.3	0.0 to 0.2
	17+905 16L	CL of WBL	6.7	
	17+905 34L	Left toe of WBL	4	
AI	Highway 11/17 EBL and WBL, Sta. 18+740 to 18+790			
	18+755 CL	Median centreline	13.8	1.5
AJ	Highway 11/17 EBL, Sta. 19+110 to 19+120			
	19+115 03R	Left toe of EBL	2.3	0.0 to 1.2
	19+115 32R	Right toe of EBL	2.3	
	19+116 22R	CL of EBL	0.8	
AK	Highway 11/17 EBL and WBL, Sta. 19+670 to 19+690			
	19+678 19R	CL of EBL	10.1	0.0 to 0.8
	19+683 01R	Left toe of EBL	9.1	
	19+683 35R	Right toe of EBL	10.1	
	19+672 32L	Left toe of WBL	11.3	0.0 to 0.8
	19+683 15L	CL of WBL	9.1	
AL	Highway 11/17 EBL and WBL, Sta. 19+730 to 19+770			
	19+736 34R	Right toe of EBL	11.3	0.0 to 0.1
	19+748 19R	CL of EBL	14.3	
AL	Highway 11/17 EBL and WBL, Sta. 19+730 to 19+770			
	19+755 05L	Right toe of WBL	9.1	0.1 to 0.8
	19+759 17L	CL of WBL	14.3	
	19+760 33L*	Left toe of WBL	17.7	
AM	Highway 11/17 EBL and WBL, Sta. 20+860 to 20+880			
	20+855 16R	CL of EBL	14.3	1.1
	20+865 24L	Left toe of WBL	14.3	0.1
AN	Highway 11/17 WBL, Sta. 13+450 to 13+550			
	13+455 39L	Left toe of WBL	5.6	0.1 to 0.9
	13+505 40L	Left toe of WBL	8.7	
	13+520 19L	CL of WBL	13.8	
AO	Highway 11/17 WBL, Sta. 13+640 to 13+660			
	13+650 40L	Left toe of WBL	6.4	0.0
AP	Highway 11/17 WBL, Sta. 14+290 to 14+410			
	14+300 49L	Left toe of WBL	3.7	0.0 to 0.1
	14+350 48L	Left toe of WBL	2.1	
	14+375 23L	CL of WBL	2.3	
	14+400 33L	Left toe of WBL	1.5	

Table A2-1
Summary of Slope Stability Analyses

Appendix	Station	Embankment Hight/Cut Depth (m)	Condition	Computed Factor of Safety	Figure
D	10+940 to 11+170	2.3	Short-term (undrained analysis)	2.84	D1
			Long-term (drained analysis)	2.84	D2
G	12+100 to 12+170	2.3	Short-term (undrained analysis)	1.63	G1
			Long-term (drained analysis)	1.63	G2
J	12+730 to 12+900	2.4	Short-term (undrained analysis)	1.41	J1
			Long-term (drained analysis)	1.41	J2
P	14+800	4.6	Short-term (undrained analysis)	2.04	P1
			Long-term (drained analysis)	1.62	P2
V	10+940 to 10+950	2.2	Short-term (undrained analysis)	1.92	V1
			Long-term (drained analysis)	1.92	V2
W	11+160 to 11+170	2.3	Short-term (undrained analysis)	1.78	W1
			Long-term (drained analysis)	1.78	W2
X	11+770 to 11+800	4.4	Short-term (undrained analysis)	1.46	X1
			Long-term (drained analysis)	1.67	X2
Y	11+900 to 11+950	3.2	Short-term (undrained analysis)	1.54	Y1
			Long-term (drained analysis)	1.54	Y2
Z	12+070 to 12+080	4.7	Short-term (undrained analysis)	1.56	Z1
			Long-term (drained analysis)	1.52	Z2
AA	12+230 to 12+250	5.2	Short-term (undrained analysis)	1.45	AA1
			Long-term (drained analysis)	1.45	AA2
AB	14+190 to 14+210	6.0	Short-term (undrained analysis)	1.76	AB1
			Long-term (drained analysis)	1.49	AB2
AC	14+720 to 14+760	3.5	Stage 1 - short-term (undrained analysis) with 1.5 m surcharge and stabilizing berm	1.90	AC1
			Stage 2 - short-term (undrained analysis) with 2 m surcharge and stabilizing berm	1.75	AC2
			Long-term (drained analysis) with stabilizing berm	2.07	AC3
			Long-term (drained analysis) with horizontal seismic load of 0.01 and stabilizing berm	2.02	AC4
AD	15+190 to 15+220	2.7	Short-term (undrained analysis)	1.81	AD1
			Long-term (drained analysis)	1.81	AD2
AE	16+390 to 16+470	3.6	Short-term (undrained analysis)	2.27	AE1
			Long-term (drained analysis)	2.27	AE2
AF	16+820 to 16+900	3.5	Short-term (undrained analysis)	1.56	AF1
			Long-term (drained analysis)	1.56	AF2
AG	17+720 to 17+750	7.2	Stage 1 - short-term (undrained analysis) with stabilizing berm	1.94	AG1
			Stage 2 - short-term (undrained analysis) with stabilizing berm	1.94	AG2
			Long-term (drained analysis) with stabilizing berm	1.94	AG3
			Long-term (drained analysis) horizontal seismic load of 0.01 and stabilizing berm	1.90	AG4
AI	18+740 to 18+790	5.5	Stage 1 - short-term (undrained analysis) with stabilizing berm	1.92	AI1
			Stage 3 - short-term (undrained analysis) with 2 m surcharge and stabilizing berm	1.56	AI3
			Long-term (drained analysis) with stabilizing berm	1.92	AI4

Table A2-2
Summary of Slope Stability Analyses

Appendix	Station	Embankment Hight/Cut Depth (m)	Condition	Computed Factor of Safety	Figure
AI	18+740 to 18+790	5.5	Long-term (drained analysis) with horizontal seismic load of 0.01 and stabilizing berm	1.88	AI5
AN	13+450 to 13+550	-4.5	Short-term (undrained analysis)	2.98	AN1
			Long-term (drained analysis)	1.91	AN2
AO	13+640 to 13+660	-4.0	Short-term (undrained analysis)	2.93	AO1
			Long-term (drained analysis)	1.65	AO2

Table A3-1
Summary of Settlement Analyses

Note: (*) occurring within 1 year following placement, (**) occurring within 20 years following paving

Location			Design Option	Estimated Settlement (mm)						
				Foundation Settlement			Rock Fill Compression		Settl. During Constr.	Post Constr. Settl.(**)
				Immed.	Primary Consol.	Long Term	Short Term(*)	Long term		
11+770 to 11+800	11+785	EBL	Construction with 1 month waiting period	35	30	5	25	5	55	45
11+900 to 11+950	11+922	EBL	Construction with 1 month waiting period	20	35	10	20	5	45	45
12+070 to 12+080	12+075	EBL	Construction with a 3 month waiting period	35	55	15	25	5	90	45
		WBL	Construction with a 3 month waiting period	30	45	15	20	5	75	45
12+230 to 12+250	12+235	EBL	Construction with a 2 month waiting period	5	55	5	40	5	40	70
12+730 to 12+900	12+845	WBL	Construction with a 5 month waiting period	20	45	5	15	5	45	45
13+100	13+100	-	Construction with a 1 month waiting period	-	80	5	15	5	40	65
13+100 to 13+300	13+250	EBL	Construction with a 1 month waiting period	-	70	5	10	5	40	50
13+875 to 14+105	14+050	EBL	Construction with a 2 month waiting period	5	75	15	15	5	60	55
	14+105	WBL	Construction with a 2 month waiting period	5	75	20	20	5	55	70
14+720 to 14+760	14+740	EBL	Stage 1 construction with 6 month waiting period	5	125	-	20	5	250	30
			Stage 2 construction with a minimum of 6 month waiting period		100	25				
		WBL	Stage 1 construction with 6 month waiting period	10	350	-	20	5	465	30
			Stage 2 construction with a minimum of 6 month waiting period		85	25				

Table A3-2
Summary of Settlement Analyses

Note: (*) occurring within 1 year following placement, (**) occurring within 20 years following paving

Location			Design Option	Estimated Settlement (mm)						
				Foundation Settlement			Rock Fill Compression		Settl. During Constr.	Post Constr. Settl.(**)
				Immed.	Primary Consol.	Long Term	Short Term(*)	Long term		
14+800	14+800	-	Construction with a 6 month waiting period	5	160	20	25	5	135	80
15+190 to 15+220	15+206	EBL	Construction with a 2 month waiting period	-	85	15	15	5	45	75
		WBL	Construction with a 2 month waiting period	-	85	15	10	5	45	70
15+730 to 16+250	16+150	EBL	Construction with a 1 month waiting period	5	40	35	10	5	20	75
16+200	16+200	-	Construction with a 1 month waiting period	5	70	10	10	5	25	75
16+390 to 16+470	16+400	EBL	Construction with a 4 month waiting period	-	65	15	15	5	45	55
	16+440	WBL	Construction with a 6 month waiting period	-	110	10	20	5	50	95
16+820 to 16+900	16+857	EBL	Construction with a 12 month waiting period	5	105	25	20	5	65	95
		WBL	Construction with a 12 month waiting period	5	85	20	15	5	60	70
17+720 to 17+750	17+735	WBL	Stage 1 construction with 5 month waiting period	30	55	-	75	10	185	20
			Stage 2 construction with 5 month waiting period		25	10				
		EBL	Construction with a 3 month waiting period	10	40	5	40	5	60	40

Table A3-3
Summary of Settlement Analyses

Note: (*) occurring within 1 year following placement, (**) occurring within 20 years following paving

Location			Design Option	Estimated Settlement (mm)						
				Foundation Settlement			Rock Fill Compression		Settl. During Constr.	Post Constr. Settl.(**)
				Immed.	Primary Consol.	Long Term	Short Term(*)	Long term		
18+740 to 18+790	18+755	EBL	Stage 1 construction with 6 month waiting period	10	260	-	40	5	520	25
			Stage 2 construction with 6 month waiting period		120	-				
			Stage 3 construction with 6 month waiting period		65	45				
		WBL	Stage 1 construction with 6 month waiting period	10	260	-	40	5	525	25
			Stage 2 construction with 6 month waiting period		160	-				
			Stage 3 construction with 6 month waiting period		30	45				

Table A4-1
Summary of Modeling Parameters

Location	Soil Layer	Thick-ness	Unit Weight	Undrained Shear Strength	Drained Shear Strength		Young's Modulus	Primary Compression Ratio				Secondary Compression Ratio		Over-Consolidation Ratio		Coefficient of Consolidation (m^2/yr)			
			γ	c_u	c'	ϕ'	E	$Cc/(1+e_0)$		$Cr/(1+e_0)$		$C\alpha/(1+e_0)$		(OCR)		c_v (vertical)		c_h (horizontal)	
		(m)	(kN/m^3)	(kPa)	(kPa)	(^{o})	(MPa)	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
Hwy 11/17, EBL Sta. 10+580	Sand (Fill)	1.4	21.0	N/A	N/A	N/A	60	---	---	---	---	---	---	---	---	---	---	---	---
	Sand	7.7	20.0	N/A	N/A	N/A	25	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	5.2	19.0	N/A	N/A	N/A	15	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 10+805	Topsoil/Peat	0.1	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Clayey Silt	0.8	19.0	N/A	N/A	N/A	5	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	9.9	19.5	N/A	N/A	N/A	15	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 10+945	Sand (Fill)	1.4	20.0	---	---	34	30	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	3.0	19.0	35	7	23	---	0.090	0.100	0.006	0.007	0.003	0.003	6.0	5.0	2	2	5	5
	Sand	9.9	20.0	---	---	30	24	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 10+945	Sand (Fill)	0.8	20.0	---	---	34	30	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	3.2	19.0	35	7	23	---	0.090	0.100	0.006	0.007	0.003	0.003	6.0	5.0	2	2	5	5
	Sand	8.4	20.0	---	---	30	24	---	---	---	---	---	---	---	---	---	---	---	---
Red Rock Road #9 Sta. 10+965	Sand (Fill)	0.4	21.0	N/A	N/A	N/A	50	---	---	---	---	---	---	---	---	---	---	---	---
	Topsoil/Peat	0.2	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sand	2.4	20.0	N/A	N/A	N/A	35	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	2.5	18.0	N/A	N/A	N/A	---	0.110	0.200	0.008	0.014	0.003	0.006	3.0	1.8	2	2	5	5
	Silty Sand	8.8	19.5	N/A	N/A	N/A	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 11+050	Topsoil/Peat	1.5	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	2.7	18.0	50	7	23	---	0.120	0.160	0.008	0.008	0.004	0.004	10.0	4.0	2	2	5	5
	Silty Sand	10.0	19.5	---	---	32	25	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 11+165	Topsoil/Peat	0.6	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sand and Silt	2.2	19.0	---	---	29	19	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	3.2	19.0	30	7	23	---	0.090	0.100	0.006	0.007	0.003	0.003	5.0	2.0	2	2	5	5
	Sand and Silt	8.2	19.0	---	---	29	19	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 11+165	Sand (Fill)	2.2	22.0	---	---	34	22	---	---	---	---	---	---	---	---	---	---	---	---
	Sand and Silt	1.9	19.0	---	---	29	19	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	2.0	19.0	30	7	23	---	0.090	0.100	0.006	0.007	0.003	0.003	5.0	2.0	2	2	5	5
	Silty Sand	8.2	20.0	---	---	32	20	---	---	---	---	---	---	---	---	---	---	---	---
Landfill Road Sta. 11+410	Topsoil/Peat	0.2	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sandy Silt	4.7	19.5	N/A	N/A	N/A	10	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	2.6	18.0	N/A	N/A	N/A	---	0.080	0.080	0.006	0.006	0.002	0.002	4.0	1.8	2	2	5	5
	Silty Sand	6.8	20.0	N/A	N/A	N/A	15	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 11+450	Topsoil/Peat	0.2	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Sand	4.7	19.5	N/A	N/A	N/A	10	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	4.6	18.0	N/A	N/A	N/A	---	0.100	0.120	0.007	0.008	0.003	0.004	3.0	4.0	2	2	5	5
	Sand and Silt	4.8	20.0	N/A	N/A	N/A	15	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 11+785	Topsoil/Peat	0.9	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.0	19.0	40	7	23	---	0.090	0.160	0.006	0.011	0.003	0.005	12.0	7.0	2	2	5	5
	Silty Clay (Bot.)	2.0	19.0	60	7	23	---	0.160	0.110	0.011	0.008	0.005	0.003	7.0	6.0	2	2	5	5
	Silt	10.3	20.0	---	---	35	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 11+785	Sand (Fill)	2.9	22.0	---	---	34	21	---	---	---	---	---	---	---	---	---	---	---	---
	Topsoil/Peat	0.7	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	1.9	19.0	40	7	23	---	0.090	0.160	0.006	0.011	0.003	0.005	12.0	7.0	2	2	5	5
	Silty Clay (Bot.)	1.9	19.0	60	7	23	---	0.160	0.110	0.011	0.008	0.005	0.003	7.0	6.0	2	2	5	5
	Silt	6.7	20.0	---	---	35	20	---	---	---	---	---	---	---	---	---	---	---	---

THURBER

Table A4-2
Summary of Modeling Parameters

Location	Soil Layer	Thick-ness	Unit Weight	Undrained Shear Strength	Drained Shear Strength		Young's Modulus	Primary Compression Ratio				Secondary Compression Ratio		Over-Consolidation Ratio		Coefficient of Consolidation (m^2/yr)			
			γ	c_u	c'	ϕ'	E	$Cc/(1+e_0)$		$Cr/(1+e_0)$		$C\alpha/(1+e_0)$		(OCR)		c_v (vertical)		c_h (horizontal)	
		(m)	(kN/m^3)	(kPa)	(kPa)	(^{o})	(MPa)	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
Hwy 11/17, EBL Sta. 11+922	Topsoil/Peat	0.6	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.6	19.0	35	7	23	---	0.100	0.150	0.007	0.011	0.003	0.005	10.0	5.0	2	2	5	5
	Silty Clay (Bot.)	2.6	19.0	55	7	23	---	0.150	0.100	0.011	0.007	0.005	0.003	5.0	2.5	2	2	5	5
	Silt	7.6	20.0	---	---	35	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 11+922	Topsoil/Peat	0.6	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.4	19.0	35	7	23	---	0.100	0.150	0.007	0.011	0.003	0.005	10.0	5.0	2	2	5	5
	Silty Clay (Bot.)	2.4	19.0	55	7	23	---	0.150	0.100	0.011	0.007	0.005	0.003	5.0	2.5	2	2	5	5
	Silt	8.1	20.0	---	---	35	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 12+075	Topsoil/Peat	1.4	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	3.1	19.0	40	7	23	---	0.230	0.090	0.016	0.006	0.007	0.003	10.0	4.0	2	2	5	5
	Silt	9.4	20.0	---	---	33	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 12+075	Topsoil/Peat	1.4	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	3.4	19.0	40	7	23	---	0.230	0.090	0.016	0.006	0.007	0.003	10.0	4.0	2	2	5	5
	Silt	7.0	20.0	---	---	33	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 12+130	Topsoil/Peat	0.8	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	1.5	19.0	---	---	31	15	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	5.3	18.0	40	7	23	---	0.180	0.120	0.013	0.008	0.005	0.004	8.0	7.0	2	2	5	5
	Sandy Silt	6.7	19.5	---	---	31	30	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 12+235	Topsoil/Peat	1.5	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	1.9	18.5	50	7	23	---	0.120	0.080	0.009	0.005	0.004	0.002	10.0	8.0	2	2	5	5
	Silty Clay (Bot.)	5.7	18.5	50	7	23	---	0.080	0.100	0.005	0.007	0.002	0.003	8.0	3.0	2	2	5	5
	Silty Sand	1.0	20.0	---	---	40	---	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 12+235	Topsoil/Peat	1.5	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	0.8	19.5	---	---	28	10	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	0.6	18.5	50	7	23	---	0.120	0.080	0.009	0.005	0.004	0.002	10.0	8.0	2	2	5	5
	Silty Clay (Bot.)	1.8	18.5	50	7	23	---	0.080	0.100	0.005	0.007	0.002	0.003	8.0	3.0	2	2	5	5
Hwy 11/17, EBL Sta. 12+350	Sandy Silt (Fill)	2.3	18.0	---	---	34	10	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.8	18.0	50	7	23	---	0.150	0.150	0.010	0.010	0.005	0.005	7.3	4.0	2	2	5	5
	Silty Clay (Bot.)	5.6	18.0	50	7	23	---	0.150	0.150	0.010	0.010	0.005	0.005	4.0	2.0	2	2	5	5
	Sand	1.5	20.0	---	---	40	80	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 12+540	Topsoil/Peat	0.8	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	2.9	18.0	N/A	N/A	N/A	---	0.080	0.250	0.006	0.020	0.002	0.009	10.0	2.5	2	2	5	5
Hwy 11/17, WBL Sta. 12+845	Topsoil/Peat	0.8	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sandy Silt	2.2	19.0	---	---	28	10	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	7.0	18.0	40	7	23	---	0.180	0.200	0.008	0.014	0.003	0.006	3.0	1.5	2	2	5	5
	Silty Clay (Bot.)	18.0	18.0	40	7	23	---	0.200	0.230	0.014	0.014	0.006	0.006	1.5	1.2	2	2	5	5
Red Rock Road #8 Sta. 13+100	Topsoil/Peat	0.4	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	3.9	17.0	N/A	N/A	N/A	---	0.100	0.200	0.007	0.014	0.003	0.006	9.0	5.0	2	2	5	5
	Silty Clay (Bot.)	7.9	16.5	N/A	N/A	N/A	---	0.200	0.250	0.014	0.018	0.006	0.008	5.0	3.0	2	2	5	5
	Sand	1.9	20.0	N/A	N/A	N/A	60	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 13+205	Topsoil/Peat	0.2	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Clayey Silt	2.8	18.5	N/A	N/A	N/A	6	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.6	18.0	N/A	N/A	N/A	---	0.220	0.210	0.015	0.015	0.007	0.006	5.0	2.5	2	2	5	5
	Silty Clay (Bot.)	6.1	18.0	N/A	N/A	N/A	---	0.210	0.210	0.015	0.015	0.006	0.006	2.5	3.0	2	2	5	5
	Sand and Silt	1.7	20.0	N/A	N/A	N/A	10	---	---	---	---	---	---	---	---	---	---	---	---

Table A4-3
Summary of Modeling Parameters

Location	Soil Layer	Thick-ness	Unit Weight	Undrained Shear Strength	Drained Shear Strength		Young's Modulus	Primary Compression Ratio				Secondary Compression Ratio		Over-Consolidation Ratio		Coefficient of Consolidation (m^2/yr)			
			γ	c_u	c'	ϕ'	E	$Cc/(1+e_0)$		$Cr/(1+e_0)$		$C\alpha/(1+e_0)$		(OCR)		c_v (vertical)		c_h (horizontal)	
		(m)	(kN/m^3)	(kPa)	(kPa)	(^{o})	(MPa)	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
Hwy 11/17, EBL Sta. 13+250	Topsoil/Peat	0.1	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	4.6	18.0	40	7	23	---	0.150	0.200	0.011	0.015	0.005	0.006	8.5	3.0	2	2	5	5
	Silty Clay (Bot.)	9.3	18.0	20	7	23	---	0.200	0.230	0.015	0.016	0.006	0.007	3.0	2.0	2	2	5	5
	Sand	0.3	20.0	---	---	---	30	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 14+050	Topsoil/Peat	0.4	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	3.2	18.0	N/A	N/A	N/A	---	0.150	0.130	0.011	0.009	0.005	0.004	9.5	3.5	2	2	5	5
	Silty Sand	1.7	19.5	N/A	N/A	N/A	50	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 14+105	Topsoil/Peat	0.2	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	3.3	18.0	N/A	N/A	N/A	---	0.110	0.150	0.008	0.011	0.003	0.005	9.5	2.5	2	2	5	5
	Sand	0.4	20.0	N/A	N/A	N/A	13	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 14+201	Topsoil/Peat	0.2	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	0.7	18.0	40	7	23	---	0.090	0.060	0.006	0.004	0.003	0.002	15.0	10.0	2	2	5	5
	Silty Sand	1.2	19.5	---	---	35	70	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 14+201	Topsoil/Peat	0.2	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 14+740	Topsoil/Peat	0.2	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.5	18.0	20	7	23	---	0.100	0.220	0.007	0.015	0.003	0.007	7.0	3.0	2	2	5	5
	Silty Clay (Bot.)	10.0	18.0	40	7	23	---	0.220	0.240	0.015	0.017	0.007	0.007	3.0	1.3	2	2	5	5
	Sand	1.8	30.0	---	---	32	30	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 14+740	Topsoil/Peat	0.2	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.5	18.0	20	7	23	---	0.100	0.220	0.007	0.015	0.003	0.007	7.0	3.0	2	2	5	5
	Silty Clay (Bot.)	10.0	18.0	40	7	23	---	0.220	0.240	0.015	0.017	0.007	0.007	3.0	1.3	2	2	5	5
	Sand	1.8	30.0	---	---	32	30	---	---	---	---	---	---	---	---	---	---	---	---
Highway 628 Sta. 14+800	Topsoil/Peat	0.8	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	4.2	17.5	50	7	23	---	0.250	0.200	0.018	0.014	0.008	0.006	9.0	5.0	2	2	5	5
	Silty Clay (Bot.)	8.6	17.5	30	7	23	---	0.200	0.150	0.014	0.011	0.006	0.005	5.0	2.5	2	2	5	5
	Gravelly Sand	1.3	20.0	---	---	32	50	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 14+910	Topsoil/Peat	0.8	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	1.9	18.0	N/A	N/A	N/A	---	0.100	0.190	0.007	0.013	0.003	0.006	9.0	6.0	2	2	5	5
Hwy 11/17, EBL Sta. 15+206	Topsoil/Peat	0.7	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	3.6	18.0	35	7	23	---	0.130	0.160	0.009	0.011	0.004	0.005	6.0	4.0	2	2	5	5
	Silty Clay (Bot.)	9.3	17.5	50	7	23	---	0.160	0.260	0.011	0.018	0.005	0.008	4.0	1.5	2	2	5	5
Hwy 11/17, WBL Sta. 15+206	Topsoil/Peat	0.7	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	3.4	18.0	35	7	23	---	0.130	0.160	0.009	0.011	0.004	0.005	6.0	4.0	2	2	5	5
	Silty Clay (Bot.)	8.8	17.5	50	7	23	---	0.160	0.260	0.011	0.018	0.005	0.008	4.0	1.5	2	2	5	5
	Sandy Silt	0.3	19.0	---	---	27.5	30	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 16+150	Topsoil/Peat	1.5	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	3.0	18.0	N/A	N/A	N/A	---	0.100	0.150	0.007	0.011	0.003	0.005	8.0	4.0	2	2	5	5
	Silty Clay (Bot.)	6.0	18.0	N/A	N/A	N/A	---	0.150	0.310	0.011	0.022	0.005	0.009	4.0	2.0	2	2	5	5
	Clayey Silt	0.7	19.0	N/A	N/A	N/A	15	---	---	---	---	---	---	---	---	---	---	---	---
Median Connector Sta. 16+200	Topsoil/Peat	0.8	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	5.2	18.0	N/A	N/A	N/A	---	0.110	0.300	0.008	0.021	0.003	0.009	4.0	2.0	2	2	5	5
Hwy 11/17, EBL Sta. 16+400	Topsoil/Peat	0.5	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.0	17.5	40	7	23	---	0.120	0.280	0.008	0.020	0.004	0.008	10.0	3.0	2	2	5	5
	Silty Clay (Bot.)	4.1	18.0	40	7	23	---	0.280	0.150	0.020	0.010	0.008	0.005	3.0	1.4	2	2	5	5

Table A4-4
Summary of Modeling Parameters

Location	Soil Layer	Thick-ness	Unit Weight	Undrained Shear Strength	Drained Shear Strength		Young's Modulus	Primary Compression Ratio				Secondary Compression Ratio		Over-Consolidation Ratio		Coefficient of Consolidation (m^2/yr)			
			γ	c_u	c'	ϕ'	E	$Cc/(1+e_0)$		$Cr/(1+e_0)$		$C\alpha/(1+e_0)$		(OCR)		c_v (vertical)		c_h (horizontal)	
		(m)	(kN/m^3)	(kPa)	(kPa)	(^{o})	(MPa)	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
Hwy 11/17, WBL Sta. 16+440	Topsoil/Peat	1.5	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	2.2	17.5	50	7	23	---	0.120	0.280	0.008	0.020	0.004	0.008	10.0	3.0	2	2	5	5
	Silty Clay (Bot.)	4.4	18.0	50	7	23	---	0.280	0.150	0.020	0.010	0.008	0.005	3.0	1.4	2	2	5	5
Hwy 11/17, EBL Sta. 16+857	Topsoil/Peat	0.7	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	1.5	18.0	50	7	23	---	0.150	0.160	0.011	0.011	0.005	0.005	10.0	3.0	2	2	5	5
	Silty Clay (Bot.)	8.6	18.0	50	7	23	---	0.160	0.220	0.011	0.015	0.005	0.007	3.0	1.2	2	2	5	5
	Sand	2.3	20.0	---	---	35	50	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 16+857	Topsoil/Peat	0.7	13.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	1.0	18.0	50	7	23	---	0.150	0.160	0.011	0.011	0.005	0.005	10.0	3.0	2	2	5	5
	Silty Clay (Bot.)	5.4	18.0	50	7	23	---	0.160	0.220	0.011	0.015	0.005	0.007	3.0	1.2	2	2	5	5
	Sand	3.6	20.0	---	---	35	50	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 17+330	Silty Clay (Top)	0.6	18.0	N/A	N/A	N/A	---	0.200	0.200	0.014	0.014	0.006	0.006	10.0	10.0	2	2	5	5
	Sand	0.6	20.0	N/A	N/A	N/A	20	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Bot.)	3.1	18.0	N/A	N/A	N/A	---	0.060	0.080	0.004	0.006	0.002	0.002	9.5	4.0	2	2	5	5
Hwy 11/17, WBL Sta. 17+380	Topsoil/Peat	0.3	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sand (Top)	1.2	20.0	N/A	N/A	N/A	9	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	0.8	19.0	N/A	N/A	N/A	13	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	1.7	18.0	N/A	N/A	N/A	---	0.100	0.140	0.007	0.010	0.003	0.004	4.5	2.5	2	2	5	5
	Sand (Bot.)	2.1	21.0	N/A	N/A	N/A	37	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 17+600	Gravelly Sand	0.6	19.0	N/A	N/A	N/A	50	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	1.5	18.0	N/A	N/A	N/A	---	0.200	0.050	0.014	0.004	0.006	0.002	4.8	3.0	2	2	5	5
	Silt	2.8	19.0	N/A	N/A	N/A	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 17+736	Topsoil/Peat	0.5	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	0.5	19.0	40	7	23	---	0.100	0.090	0.007	0.006	0.003	0.003	10.0	5.0	2	2	5	5
	Sandy Silt	1.5	21.0	---	---	31	16.5	---	---	---	---	---	---	---	---	---	---	---	---
	Sand	0.9	22.0	---	---	31	27	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 17+736	Topsoil/Peat	0.5	13.0	---	2	28	---	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay	2.7	19.0	40	7	23	---	0.100	0.090	0.007	0.006	0.003	0.003	10.0	5.0	2	2	5	5
	Sandy Silt	5.0	21.0	---	---	31	16.5	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 17+905	Sand to Sand and Gravel	2.7	20.0	N/A	N/A	N/A	50	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 17+905	Sand to Sand and Gravel	6.7	20.0	N/A	N/A	N/A	50	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 18+755	Rock (Fill)	0.9	19.0	---	---	42	50	---	---	---	---	---	---	---	---	---	---	---	---
	Sand (Top)	0.4	22.0	---	---	31	29	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	1.1	18.0	20	7	23	---	0.100	0.150	0.007	0.011	0.003	0.005	5.5	2.4	2	2	5	5
	Silty Clay (Bot.)	6.1	18.0	40	7	23	---	0.150	0.200	0.011	0.014	0.005	0.006	2.4	1.0	2	2	5	5
	Sand (Bot.)	0.7	22.0	---	---	31	29	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 18+755	Rock (Fill)	0.9	19.0	---	---	42	50	---	---	---	---	---	---	---	---	---	---	---	---
	Sand (Top)	0.4	22.0	---	---	31	29	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Clay (Top)	1.1	18.0	20	7	23	---	0.100	0.150	0.007	0.011	0.003	0.005	5.5	2.4	2	2	5	5
	Silty Clay (Bot.)	6.1	18.0	40	7	23	---	0.150	0.200	0.011	0.014	0.005	0.006	2.4	1.0	2	2	5	5
	Sand (Bot.)	0.7	22.0	---	---	31	29	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 19+115	Silty Sand	0.8	19.5	N/A	N/A	N/A	30	---	---	---	---	---	---	---	---	---	---	---	---

Table A4-5
Summary of Modeling Parameters

Location	Soil Layer	Thick-ness	Unit Weight	Undrained Shear Strength	Drained Shear Strength		Young's Modulus	Primary Compression Ratio				Secondary Compression Ratio		Over-Consolidation Ratio		Coefficient of Consolidation (m^2/yr)			
			γ	c_u	c'	ϕ'	E	$Cc/(1+e_0)$		$Cr/(1+e_0)$		$C\alpha/(1+e_0)$		(OCR)		c_v (vertical)		c_h (horizontal)	
		(m)	(kN/m^3)	(kPa)	(kPa)	(^{o})	(MPa)	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.	Top	Bot.
Hwy 11/17, EBL Sta. 19+315	Topsoil/Peat	0.8	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sand	1.5	20.0	N/A	N/A	N/A	20	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	2.9	19.0	N/A	N/A	N/A	20	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 19+685	Topsoil/Peat	0.8	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sand	4.8	20.0	N/A	N/A	N/A	30	---	---	---	---	---	---	---	---	---	---	---	---
	Silty Sand	4.5	19.5	N/A	N/A	N/A	25	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 19+685	(Fill)	3.8	21.0	N/A	N/A	N/A	30	---	---	---	---	---	---	---	---	---	---	---	---
	Sand	5.3	20.0	N/A	N/A	N/A	30	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, EBL Sta. 19+755	Sand	10.7	20.0	N/A	N/A	N/A	25	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	3.6	19.0	N/A	N/A	N/A	25	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 19+755	Topsoil/Peat	0.6	13.0	N/A	N/A	N/A	---	---	---	---	---	---	---	---	---	---	---	---	---
	Sand	10.2	20.0	N/A	N/A	N/A	25	---	---	---	---	---	---	---	---	---	---	---	---
	Silt and Sand	4.1	19.5	N/A	N/A	N/A	35	---	---	---	---	---	---	---	---	---	---	---	---
Hwy 11/17, WBL Sta. 20+865	Silty Sand	8.7	19.5	N/A	N/A	N/A	25	---	---	---	---	---	---	---	---	---	---	---	---
	Silt	5.6	19.0	N/A	N/A	N/A	25	---	---	---	---	---	---	---	---	---	---	---	---

Table A5
Culvert Summary

Proposed Culvert Number	Chainage	Proposed Culvert		
		Size (mm) Span x Height	Length	Type
2a	10+945	900	30.2	Concrete
2b	10+945	900	31.5	Concrete
3a	11+165	750	31.9	Concrete
3b	11+165	750	33	Concrete
4a	11+784	900	33	Rough wall
4b	11+784	900	28	Concrete
5a	11+922	750	37.6	Concrete
5b	11+922	750	29.6	Concrete
6a	12+075	750	38.1	Rough wall
6b	12+075	750	28.3	Concrete
7a	12+235	900	41.3	Rough wall
7b	12+235	900	32.3	Concrete
13a	14+201	900	27.1	Concrete
13b	14+201	900	30.1	Concrete
14a	14+740	750	48.9	Concrete
14b	14+740	750	57.8	Rough wall
18a	15+206	1050	36.8	Concrete
18b	15+206	1050	44.2	Rough wall
24a	16+440	750	43.2	Rough wall
24b	16+399	750	58.1	Concrete
25a	16+858	2400 x 1200	33.1	Concrete
25b	16+858	2400 x 1200	36	Concrete
28	17+730	750	92.6	Concrete
29a	17+905	900	33.8	Concrete
29b	17+905	900	35.9	Concrete
32a	18+765	2400 x 1200	53.3	Concrete
32b	18+765	2400 x 1200	52.9	Concrete
35a	19+685	2400 x 1200	34.8	Concrete
35b	19+685	2400 x 1200	32.3	Concrete
36a	19+755	2400 x 1200	31.9	Concrete
36b	19+755	2400 x 1200	32.2	Concrete
37	20+865	1050	48.2	Rough wall

Appendix B

Highway 11/17 EBL

Sta. 10+500 to 10+940

Highway 11/17 WBL

Sta. 10+600 to 10+940

Recommendation Summary Table

Table B1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
10+500	10+600	10+580												0.0	0.0	233.3	235.2 (1.9)	-	-	-	-	-	0	10	5	25	15	40
10+600	10+900	10+805		0.1	0.1	235.2	235.8 (0.6)	-	-	-	-	-	0	1.2	1.2	233.8	235.8 (2.0)	-	-	-	-	-	0	5	5	15	10	25
		All		-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment and complete paving.										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment and complete paving.														

Appendix C

Off Highway 11/17 Red Rock Road #9

Sta. 10+965

Recommendation Summary Table

Table C1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
Red Rock Road #9		10+965												0.2	5.5	234.0	235.7 (1.7)	-	-	-	-	-	1	10	5	25	20	45
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																									

Appendix D

Highway 11/17 EBL and WBL

Sta. 10+940 to 11+170

Recommendation Summary Table

Selected Slope Stability Analysis Figures

Summary of Subsurface Conditions

Table D1
Recommendation Summary Table

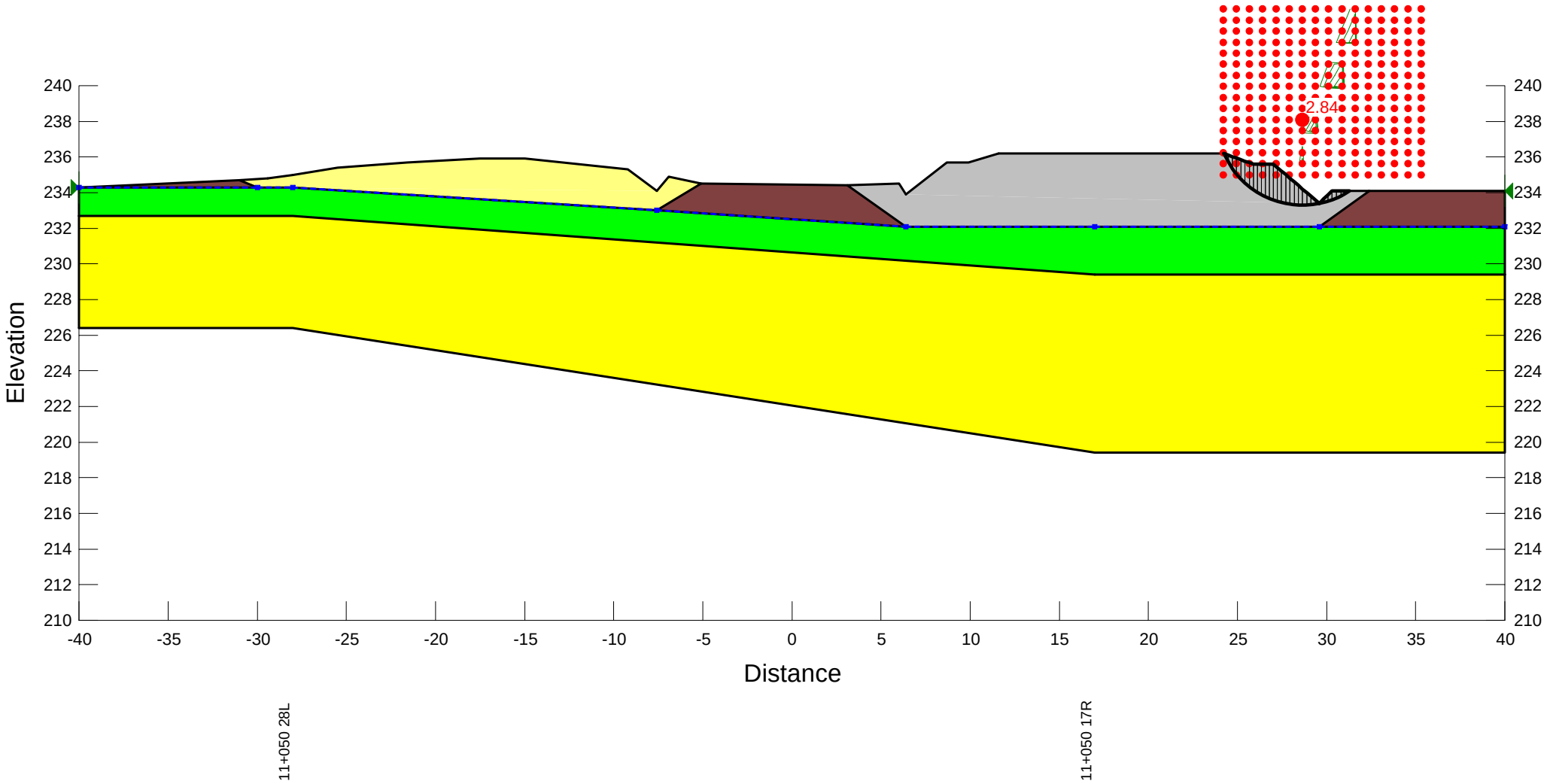
Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
10+950	11+160	11+050		0.0	2.3	235.6	236.5 (0.9)	-	-	-	-	-	1	1.6	4.3	234.1	236.4 (2.3)	-	-	-	-	-	1	15	5	40	25	65
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: EBL LT
Description: STA: 11+050 (11+000 to 11+100)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 8:27:42 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Silty Sand	19.5 kN/m³	0 kPa	32 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Embankments\11+000-11+100 (EBL,WBL)\Stability\

Figure D1

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: EBL ST
Description: STA: 11+050 (11+000 to 11+100)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 8:27:50 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay TSA	18 kN/m³	50 kPa	0 °	1
Silty Sand	19.5 kN/m³	0 kPa	32 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

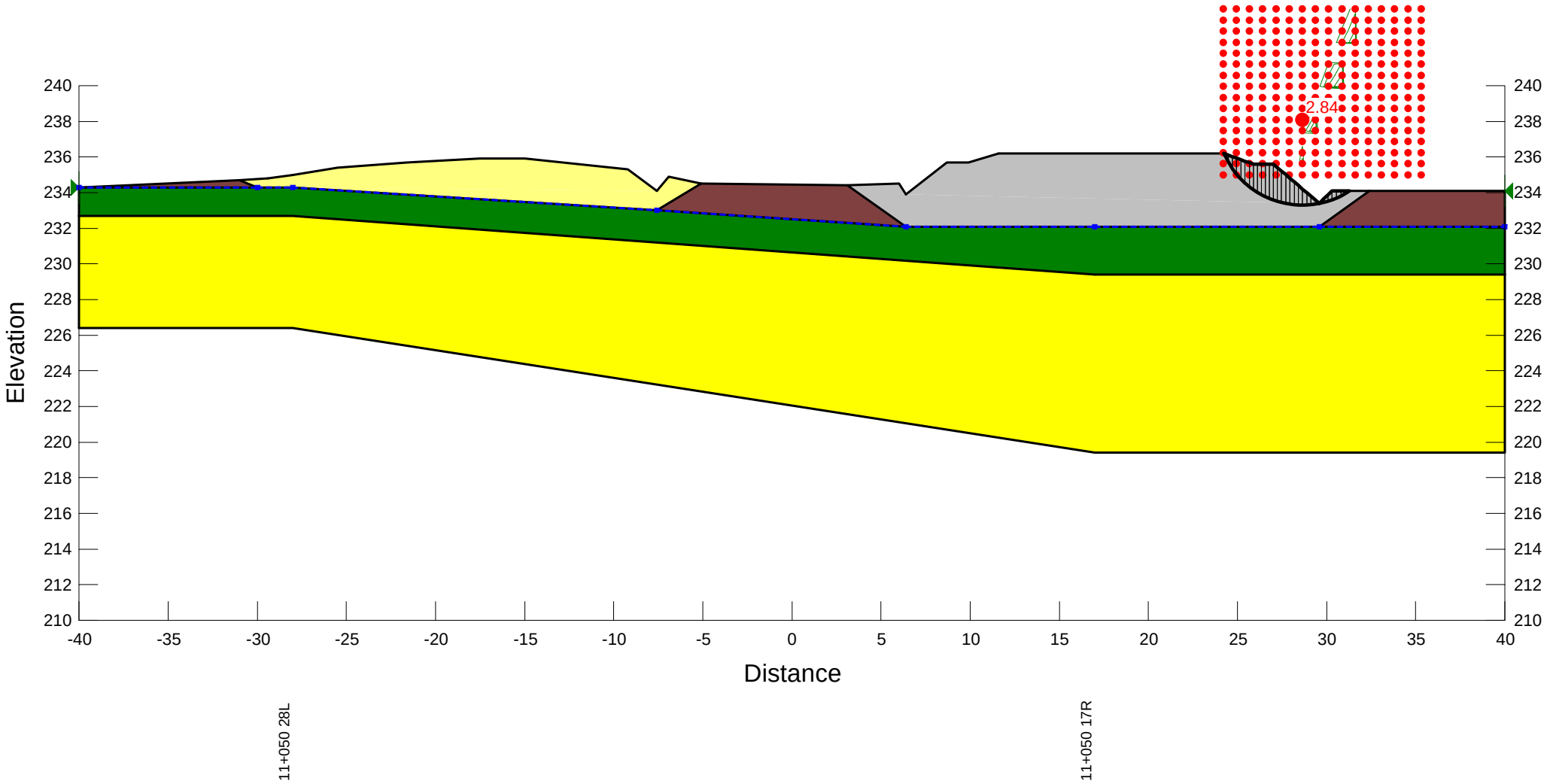


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Figure D2

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 10+940 to 10+170

Summary of Subsurface Conditions (Cohesive Soils)

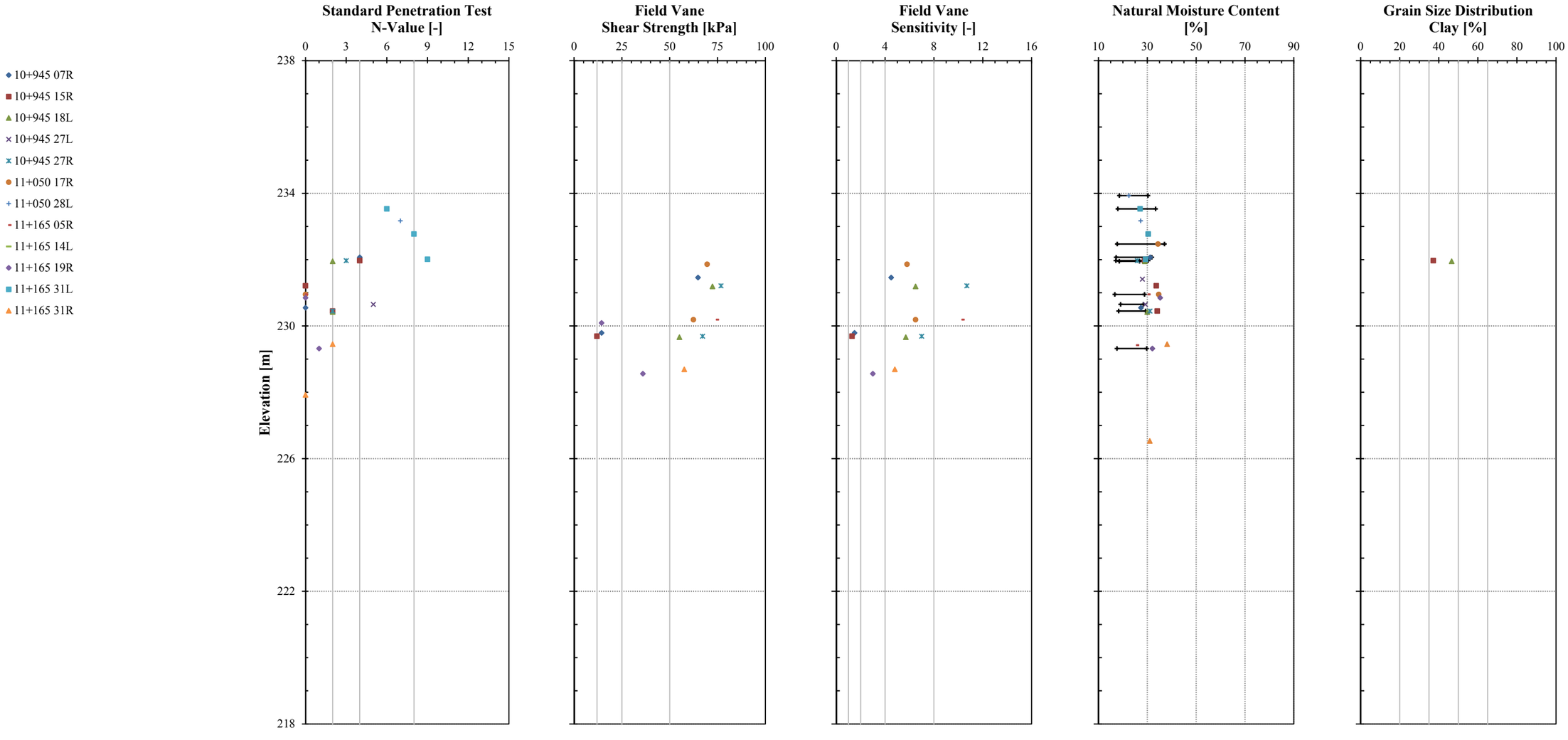


Figure D3

THURBER

Appendix E

Highway 11/17 EBL

Sta. 11+170 to 11+770

Recommendation Summary Table

Summary of Subsurface Conditions

Table E1
Recommendation Summary Table

Notes: (01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7, 8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7, 8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
														0.2	0.2	233.5	236.2 (2.7)	-	-	-	-	-	1	15	5	50	25	75
11+170	11+770	11+450												-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Highway 11/17 - Red Rock to Nipigon

EBL - Sta. 11+170 to 11+770

Summary of Subsurface Conditions (Cohesive Soils)

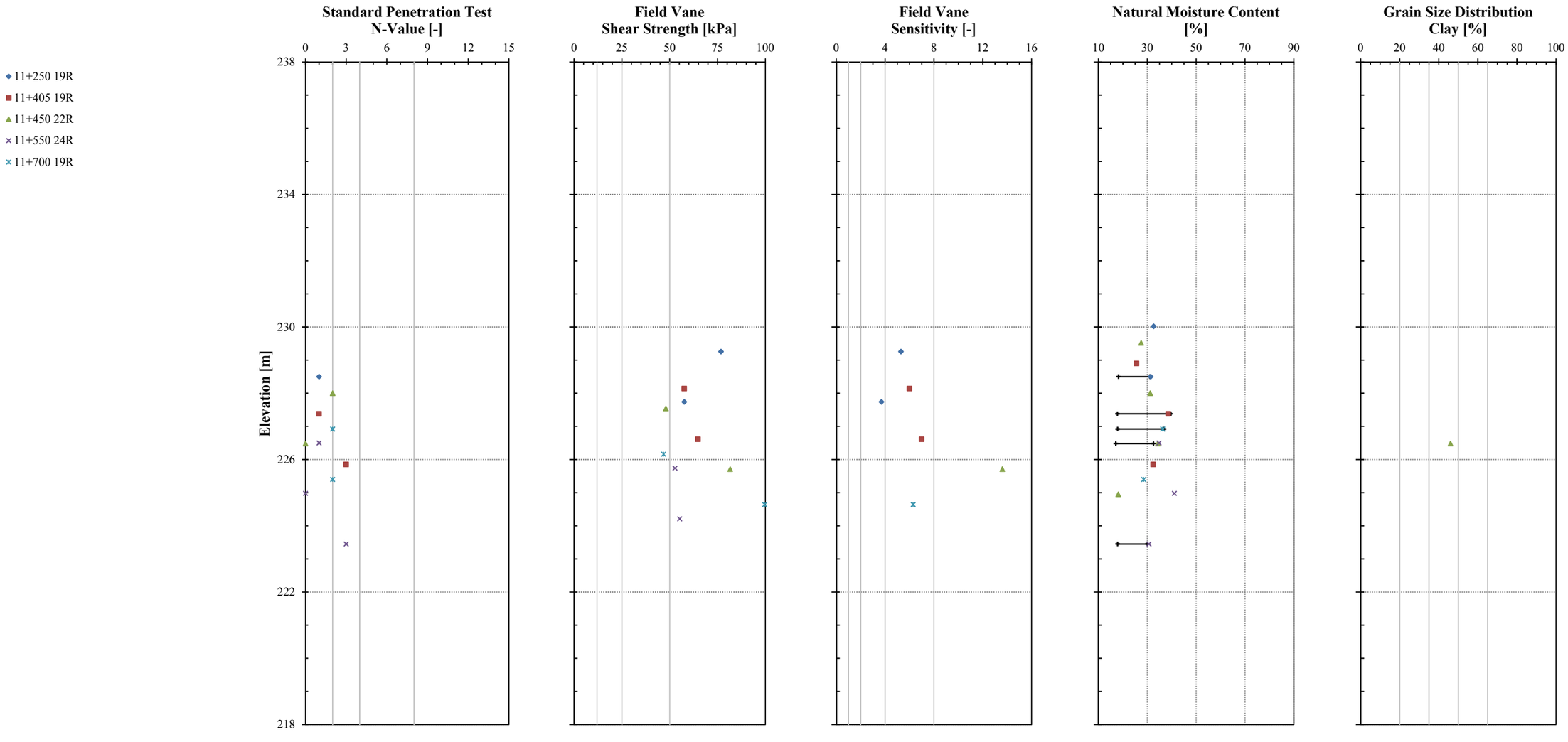


Figure E1

THURBER

Appendix F

Off Highway 11/17 Landfill Road

Sta. 11+410

Recommendation Summary Table

Summary of Subsurface Conditions

Table F1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
Landfill Road		11+410		0.2	7.5	235.2	236.7 (1.5)	-	-	-	-	-	1											10	5	30	20	50
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																								

Off Highway 11/17 - Red Rock to Nipigon

Land Fill Road

Summary of Subsurface Conditions (Cohesive Soils)

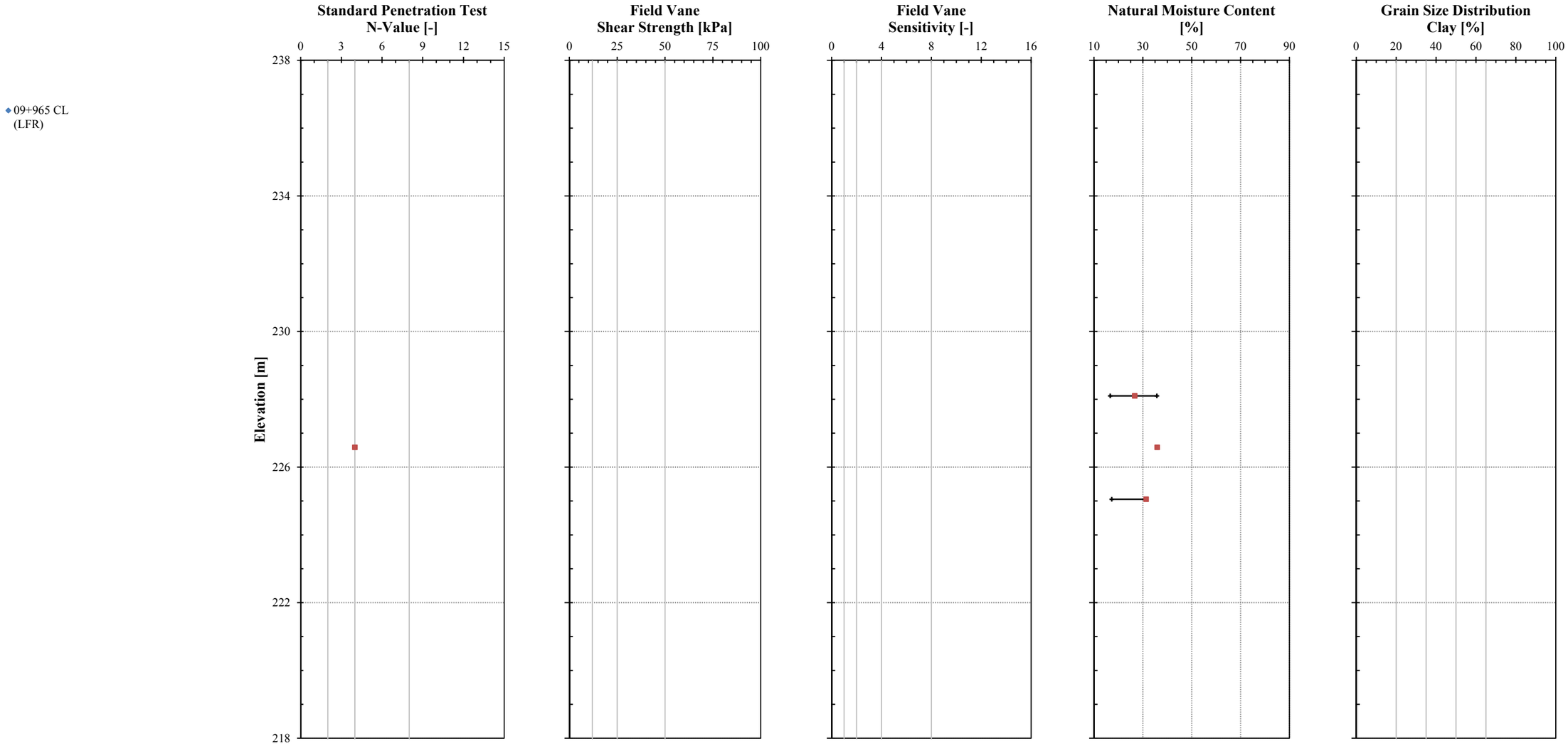


Figure F1

Appendix G

Highway 11/17 EBL

Sta. 12+100 to 12+170

Recommendation Summary Table

Selected Slope Stability Analysis Figures

Table G1
Recommendation Summary Table

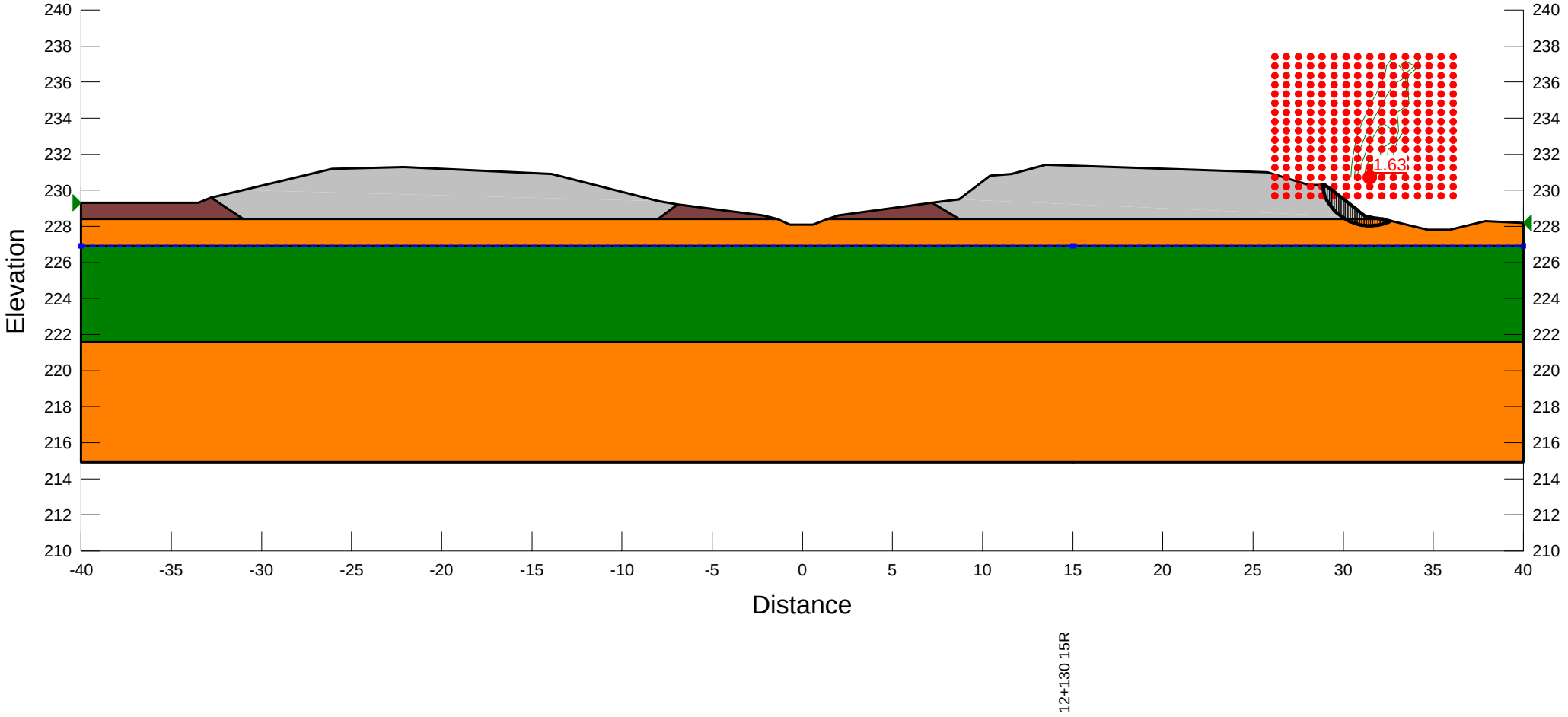
Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
12+100	12+170	12+130												0.8	7.6	228.9	231.2 (2.3)	-	-	-	-	-	1	15	5	30	35	65
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																									

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: EBL ST
Description: STA: 12+130 (12+100 to 12+170)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 1:51:28 PM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay TSA	18 kN/m³	40 kPa	0 °	1
Silt	19.5 kN/m³	0 kPa	31 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



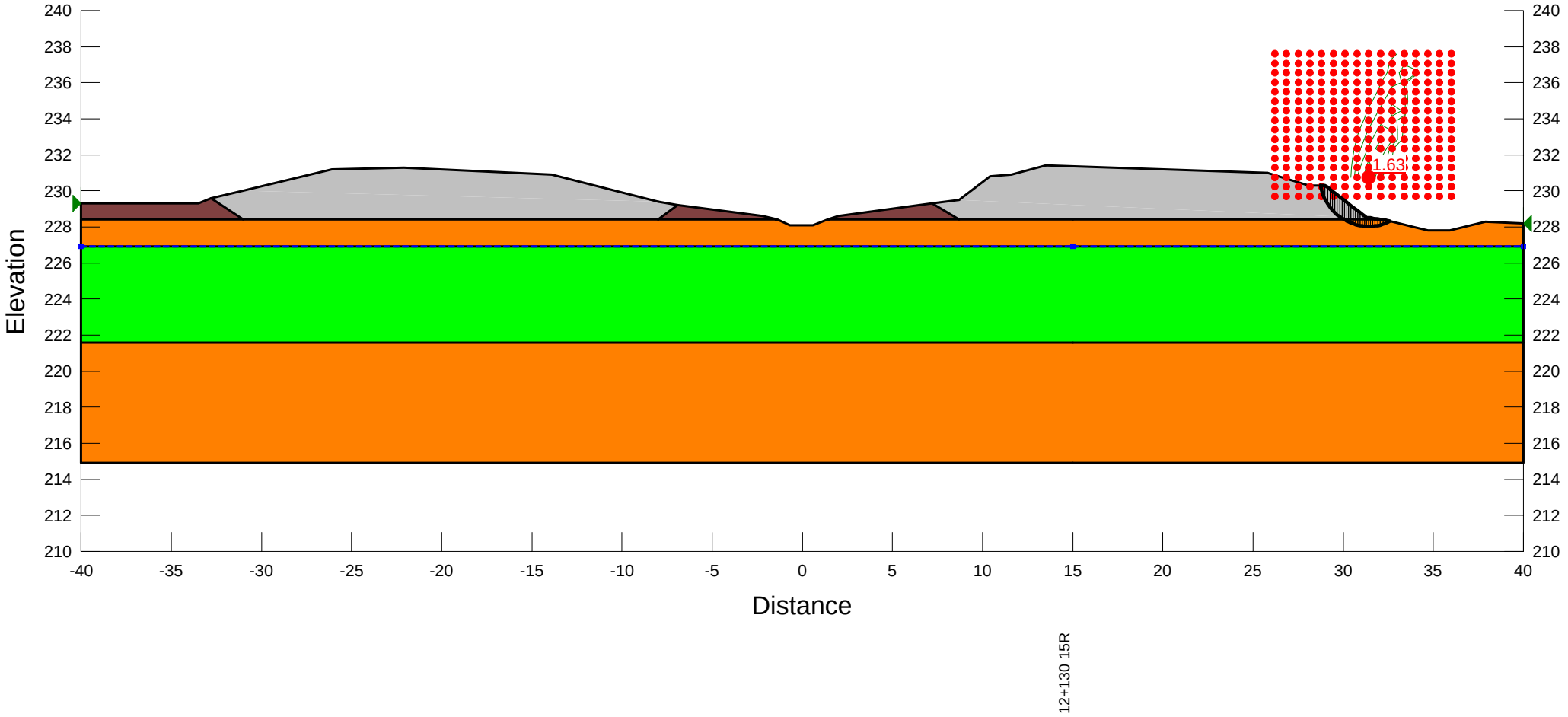
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Embankments\12+100-12+170 (EBL)\Stability\

Figure G1

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: EBL LT
Description: STA: 12+130 (12+100 to 12+170)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 1:51:20 PM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Silt	19.5 kN/m³	0 kPa	31 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Embankments\12+100-12+170 (EBL)\Stability\

Figure G2

Appendix H

Highway 11/17 EBL

Sta. 12+270 to 12+420

Recommendation Summary Table

Table H1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
														0.0	10.7	227.5	229 (1.5)	-	-	-	-	-	1	10	5	15	30	45
12+270	12+420	12+350												-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving															

Appendix I

Highway 11/17 EBL

Sta. 12+540 to 12+590

Recommendation Summary Table

Table I1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
12+540	12+590	12+540												0.8	3.7	224.1	227.1 (3.0)	-	-	-	-	-	2	15	5	25	50	75
														-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 2 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																

Appendix J

Highway 11/17 WBL

Sta. 12+730 to 12+900

Recommendation Summary Table

Selected Slope Stability Analysis Figures

Summary of Subsurface Conditions

Table J1
Recommendation Summary Table

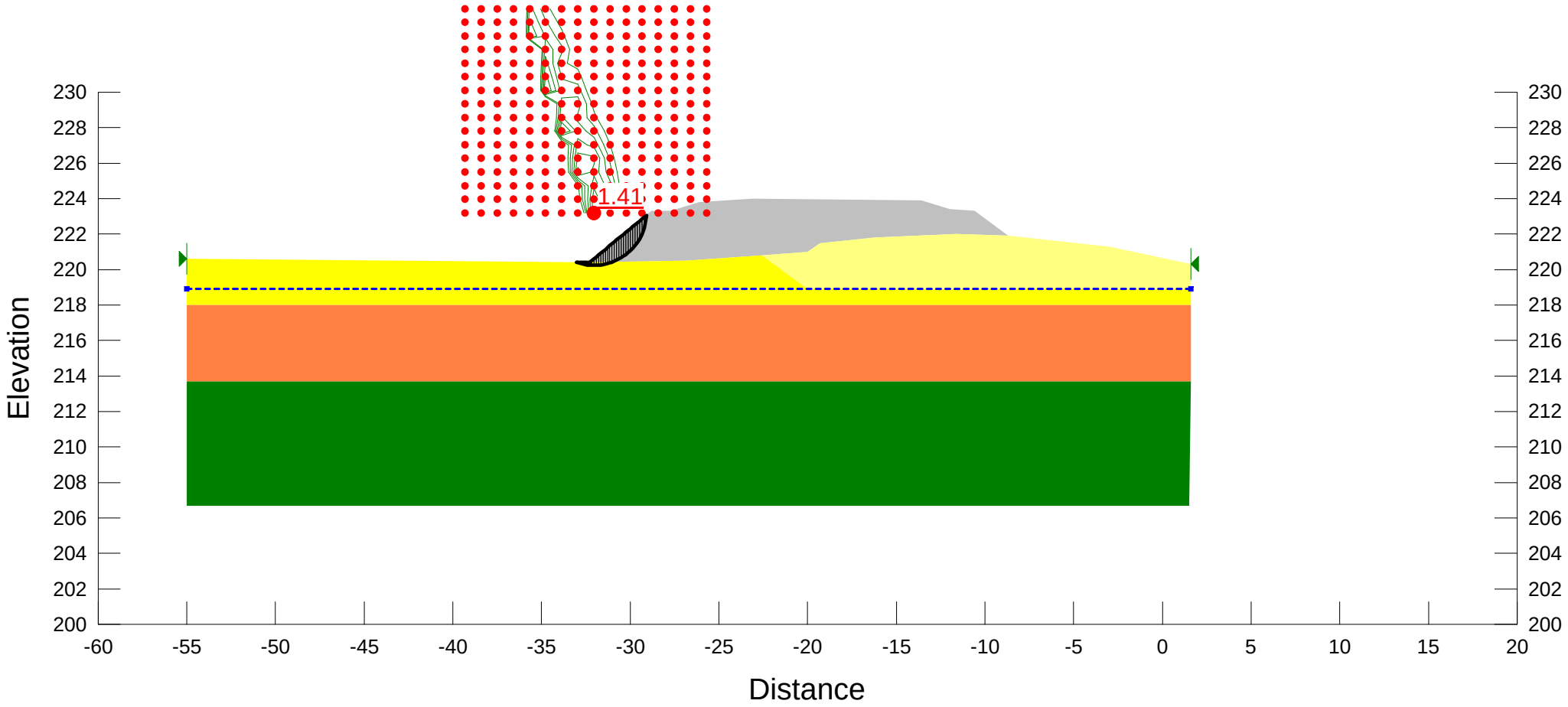
Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
12+730	12+900	12+845		0.0	23.8	221.0	223.4 (2.4)	-	-	-	-	-	5											15	5	45	45	90
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 5 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																								

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: WBL ST
Description: STA: 12+845 (12+730 to 12+900)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, Last Solved Time: 9:24:50 AM

Method: GLE, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Sand	20 kN/m³	0 kPa	30 °	1
Silt	19 kN/m³	0 kPa	28 °	1
Silty Clay (TSA)	18 kN/m³	40 kPa	0 °	1



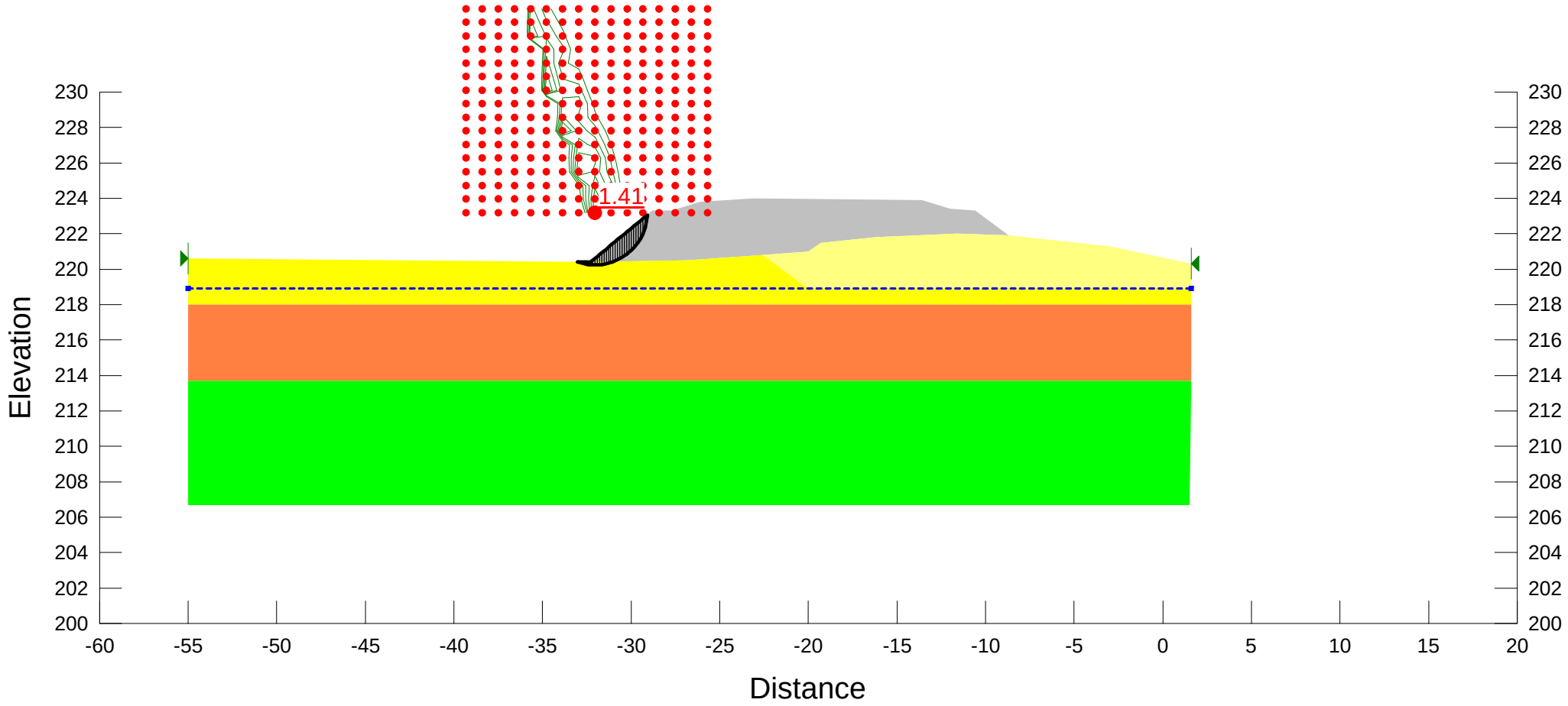
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Embankments\12+730-12+900 WBL)\Stability\

Figure J1

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: WBL LT
Description: STA: 12+845 (12+730 to 12+900)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, Last Solved Time: 9:24:36 AM

Method: GLE, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Sand	20 kN/m³	0 kPa	30 °	1
Silt	19 kN/m³	0 kPa	28 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Embankments\12+730-12+900 WBL)\Stability\

Figure J2

Highway 11/17 - Red Rock to Nipigon

WBL - Sta. 12+730 to 12+900

Summary of Subsurface Conditions (Cohesive Soils)

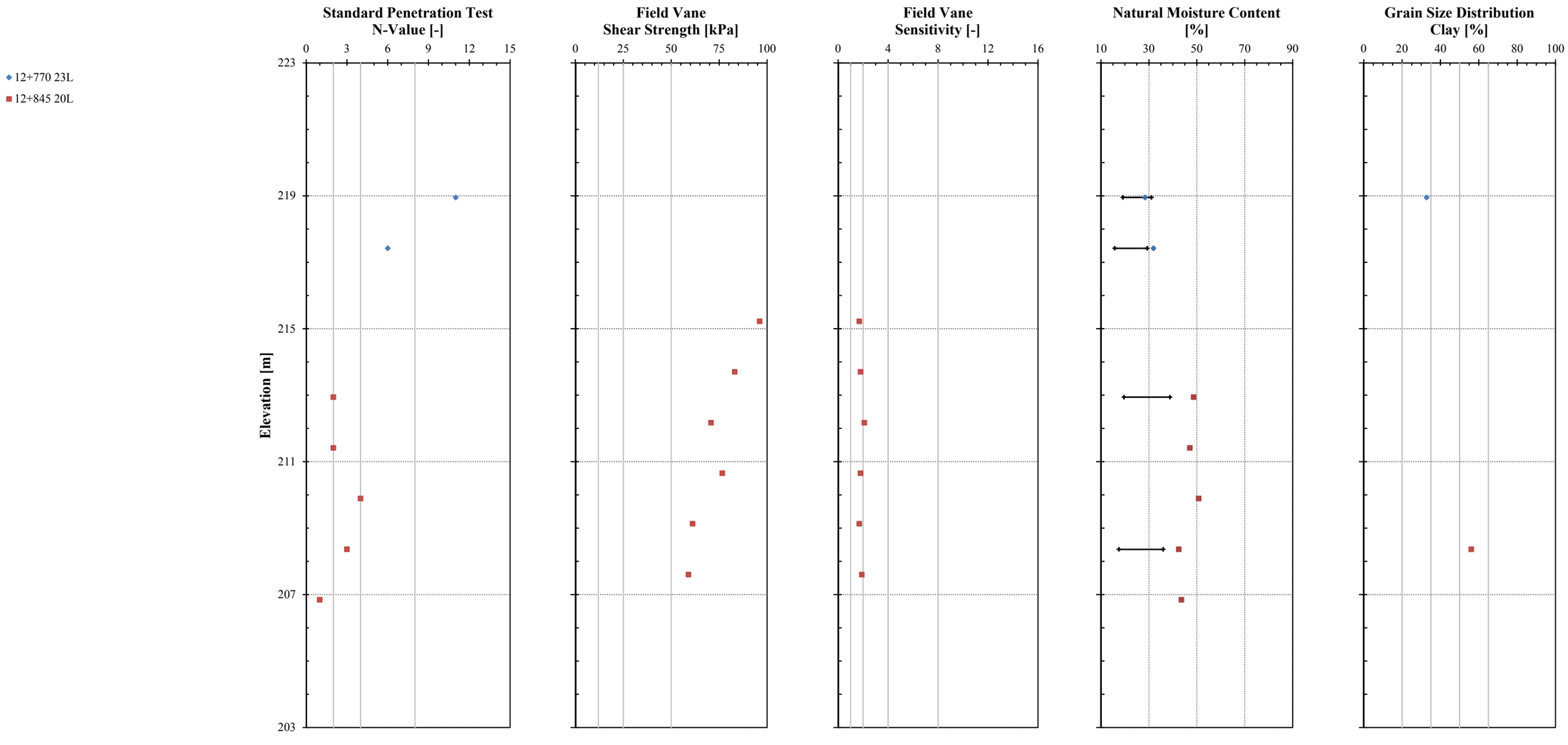


Figure J3

THURBER

Appendix K

Off Highway 11/17 Red Rock Road #8

Sta. 13+100

Recommendation Summary Table

Selected Settlement Analysis Figures

Table K1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
Red Rock Road #8		13+100		0.4	3.0	219.5	221.6 (2.1)	-	-	-	-	-	1											15	5	40	65	115
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

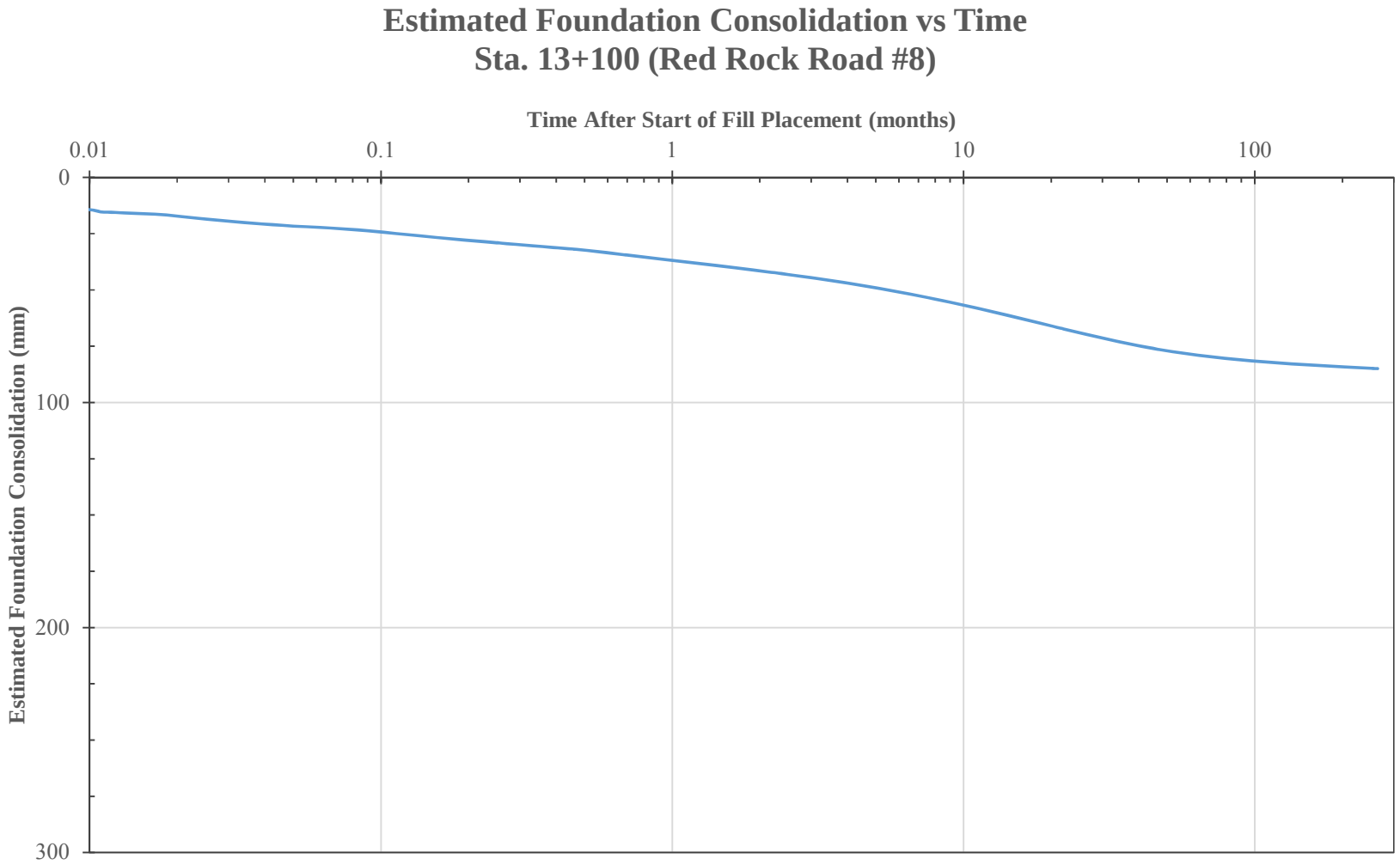


Figure K1

THURBER

Appendix L

Highway 11/17 EBL and WBL

Sta. 13+100 to 13+300

Recommendation Summary Table

Summary of Subsurface Conditions

Table L1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
13+100	13+300	13+250		0.2	11.7	219.2	220.5 (1.3)	-	-	-	-	-	1	0.1	14.0	218.9	220.5 (1.6)	-	-	-	-	-	1	10	5	40	50	90
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 13+100 to 13+300

Summary of Subsurface Conditions (Cohesive Soils)

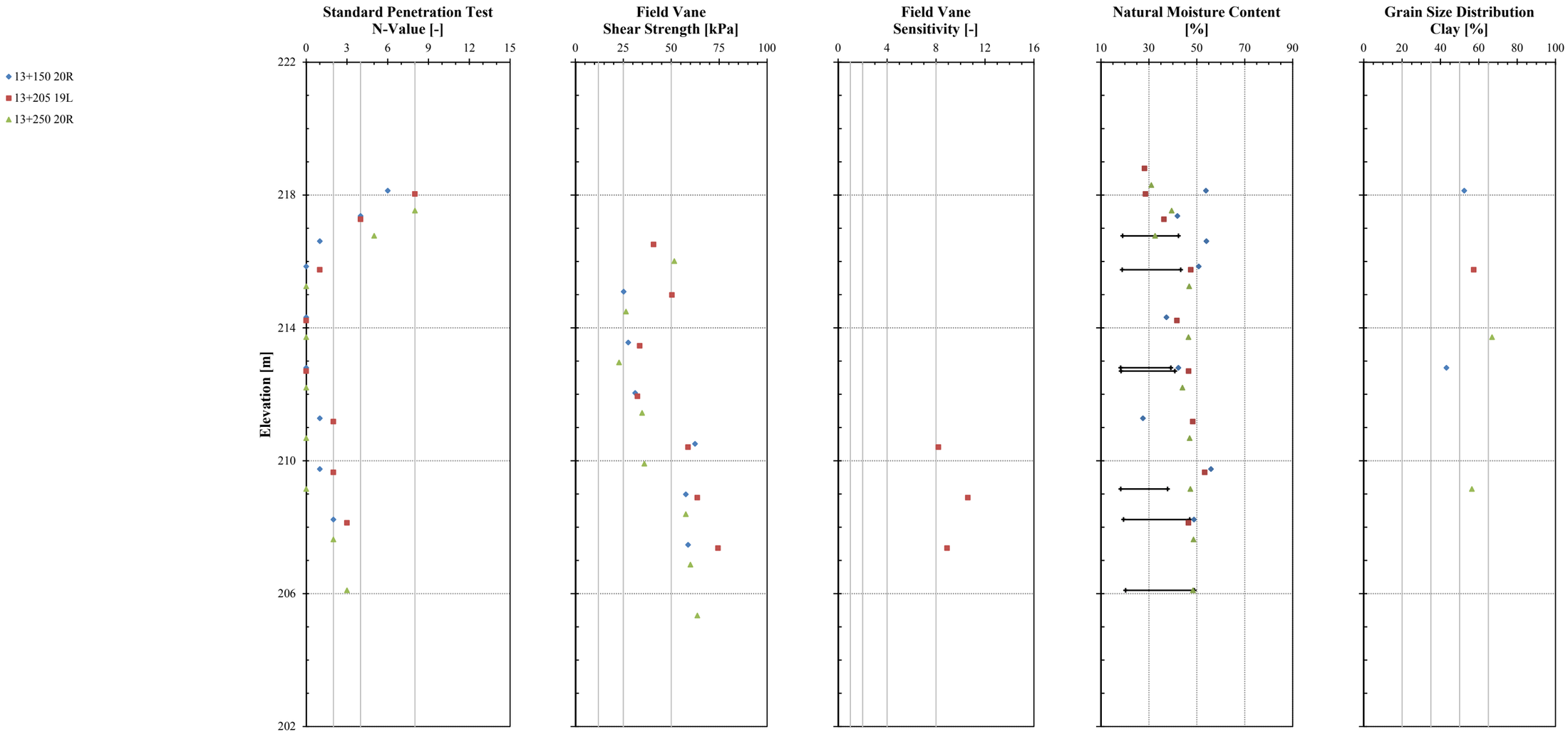


Figure L1

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Appendix M

Highway 11/17 EBL

Sta. 13+590 to 13+660

Highway 11/17 WBL

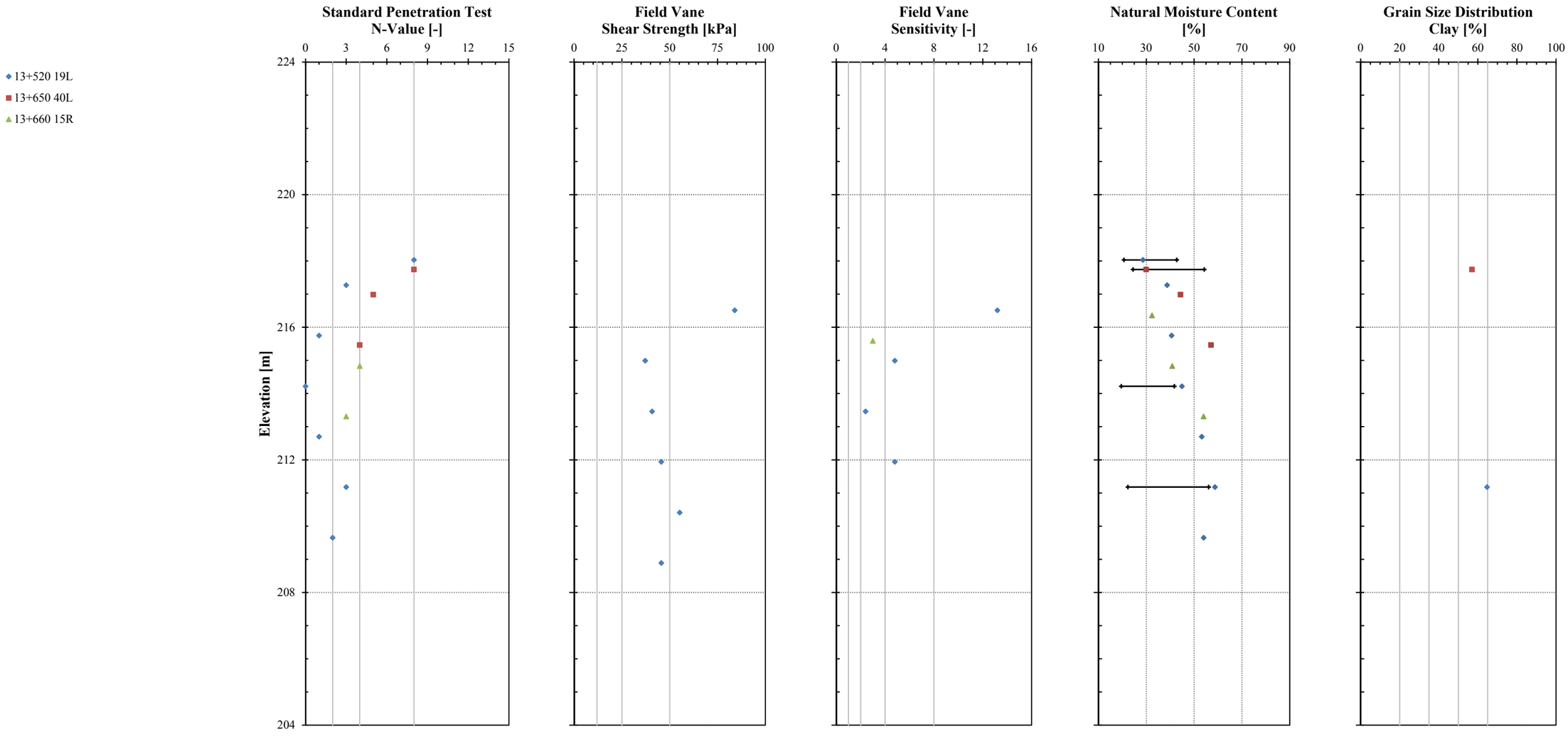
Sta. 13+590 to 13+640

Summary of Subsurface Conditions

Highway 11/17 - Red Rock to Nipigon

EBL - Sta 13+590 to 13+660 and WBL - Sta. 13+590 to 13+640

Summary of Subsurface Conditions (Cohesive Soils)



Appendix N

Highway 11/17 EBL

Sta. 13+875 to 14+100

Highway 11/17 WBL

Sta. 13+875 to 14+190

Recommendation Summary Table
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table N1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.(6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
13+875	14+105	14+105		0.2	3.5	220.0	222.5 (2.6)	-	-	-	-	-	2	0.4	3.6	219.5	222.5 (3.0)	-	-	-	-	-	2	20	5	55	70	125
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 2 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 2 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

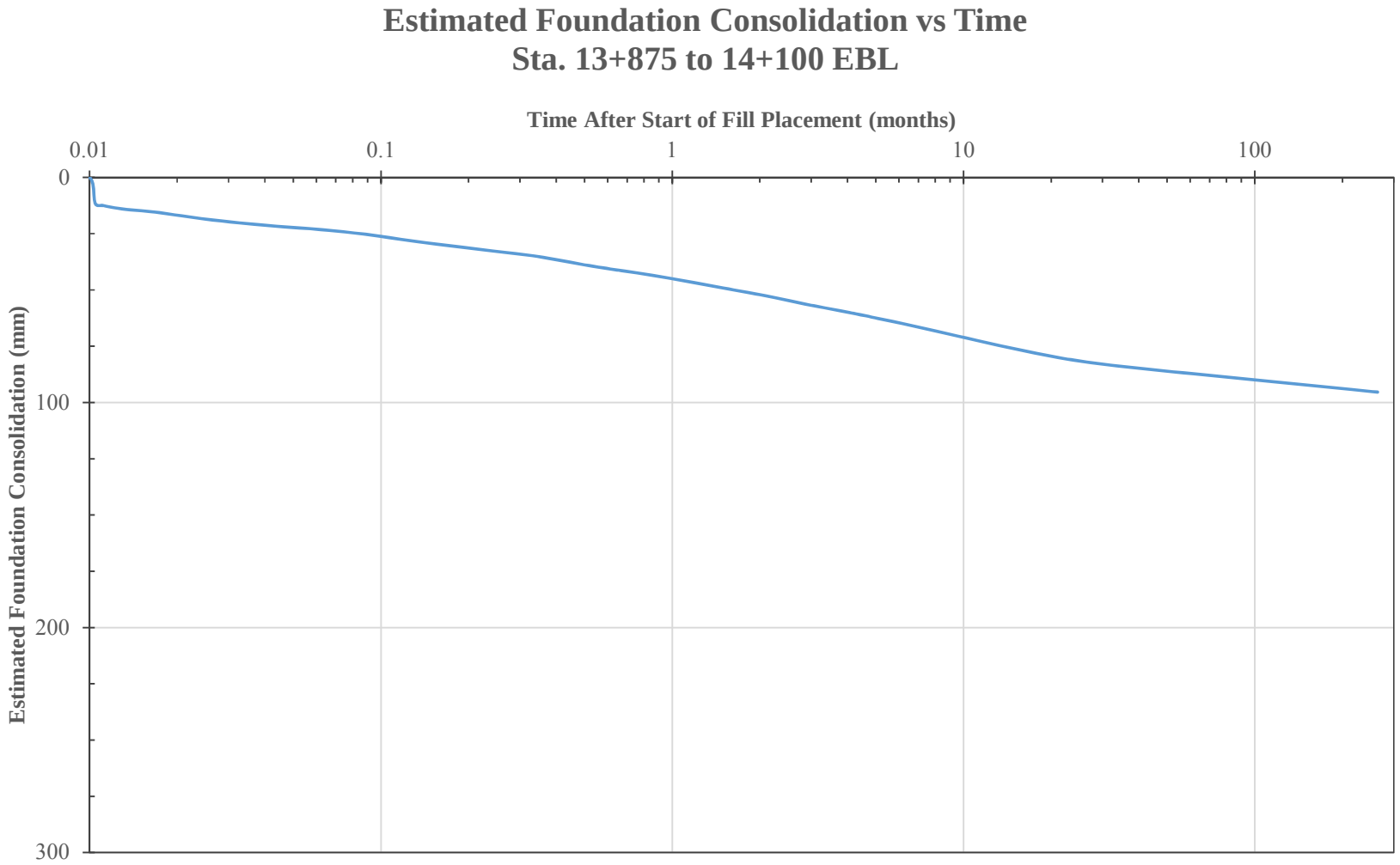


Figure N1

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Highway 11/17 - Red Rock to Nipigon

EBL Sta. 13+875 to 14+100 and WBL - Sta. 13+875 to 14+190

Summary of Subsurface Conditions (Cohesive Soils)

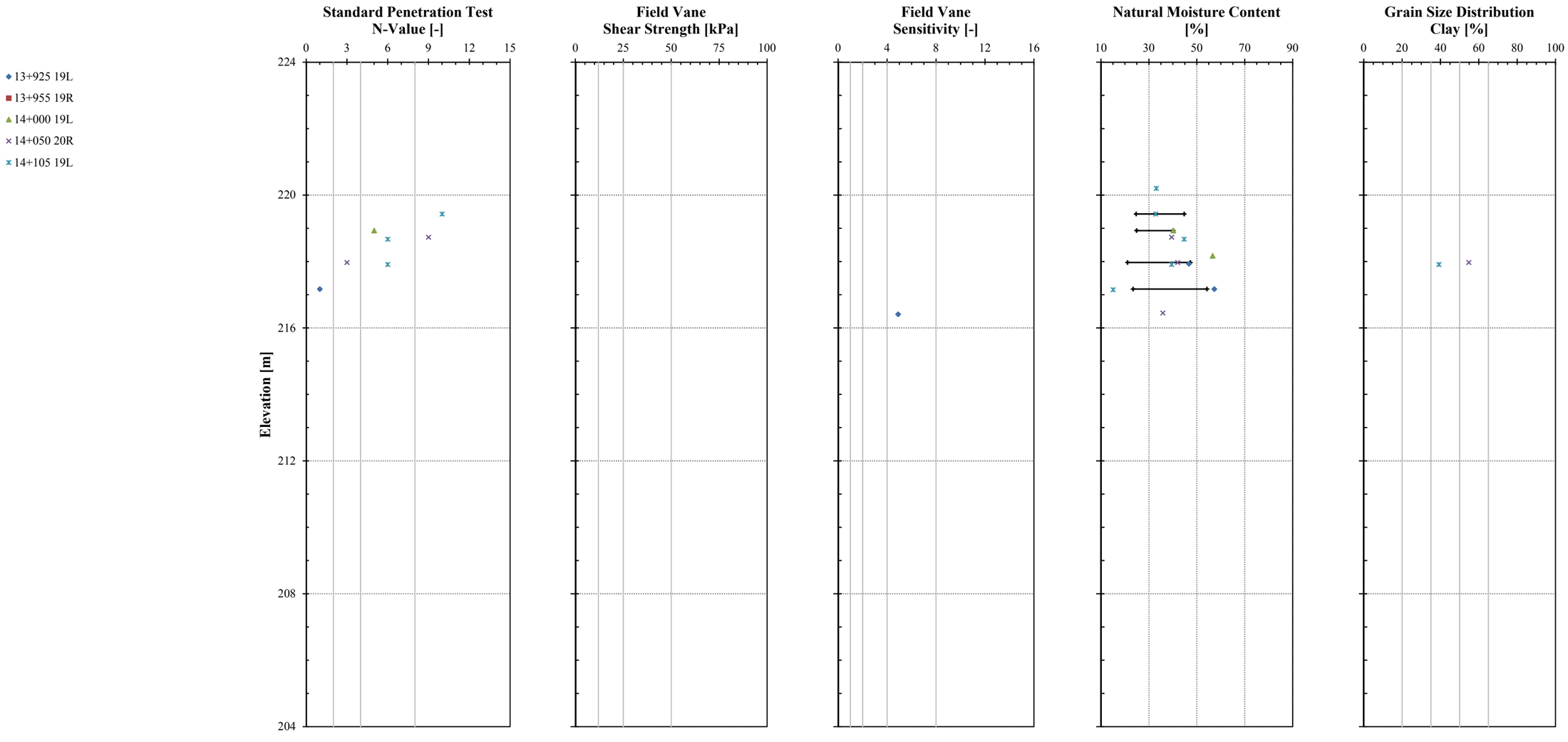

Figure N2

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Appendix O

Highway 11/17 WBL

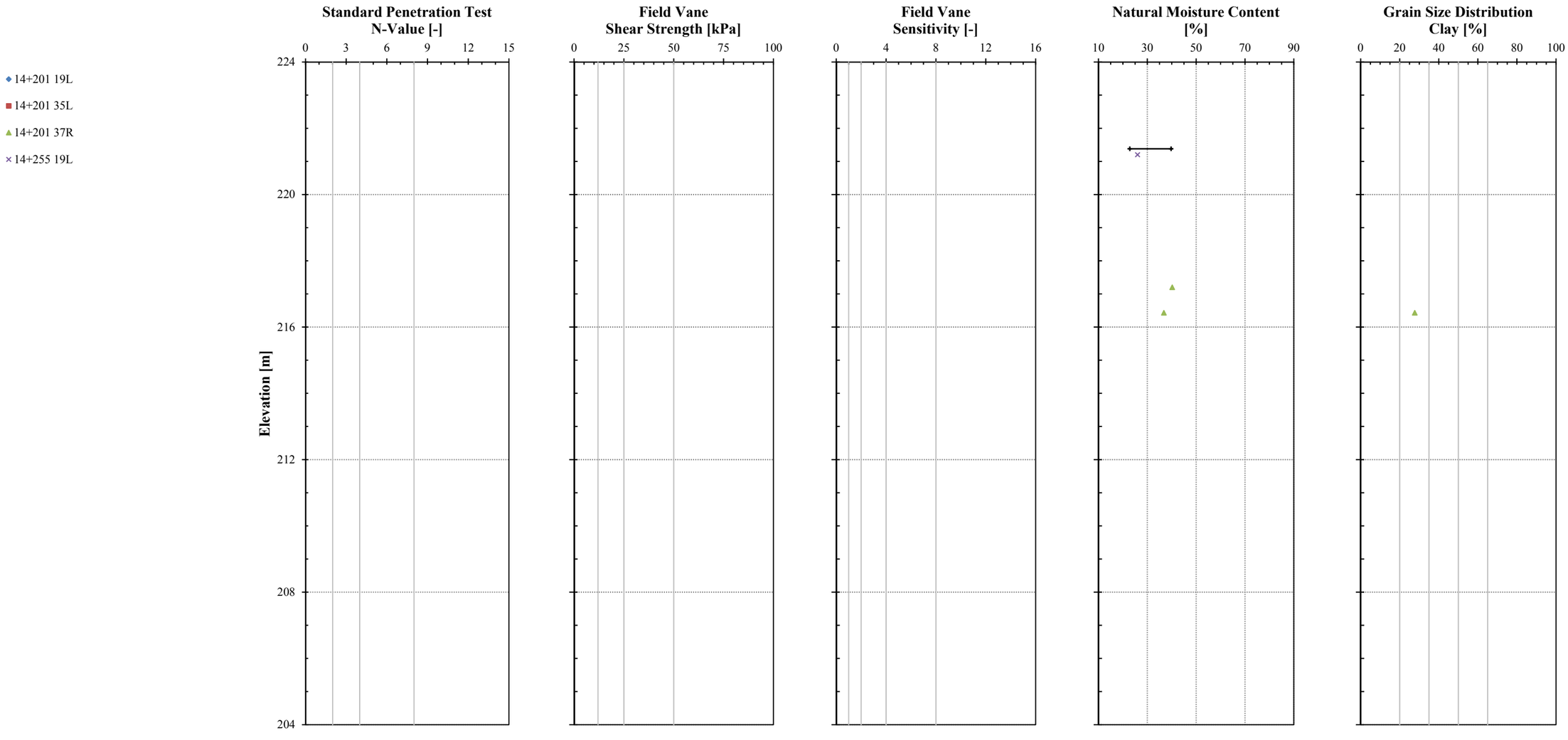
Sta. 14+190 to 14+290

Summary of Subsurface Conditions

Highway 11/17 - Red Rock to Nipigon

WBL - Sta. 14+190 to 14+290

Summary of Subsurface Conditions (Cohesive Soils)



Appendix P

Off Highway 11/17 Highway 628

Sta. 14+800

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table P1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
Highway 628		14+800												0.8	13.6	214.3	219.0 (4.6)	-	-	-	-	-	6	25	5	135	80	215
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 6 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																									

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: ST
Description: STA: 10+160
Last Edited By: Michael Eastman
Last Solved Date: 9/29/2014, 11:03:05 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay TSA 1	18 kN/m³	50 kPa	0 °	1
Gravelly Sand	19.5 kN/m³	0 kPa	32 °	1
Silty Clay TSA 2	18 kN/m³	30 kPa	0 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

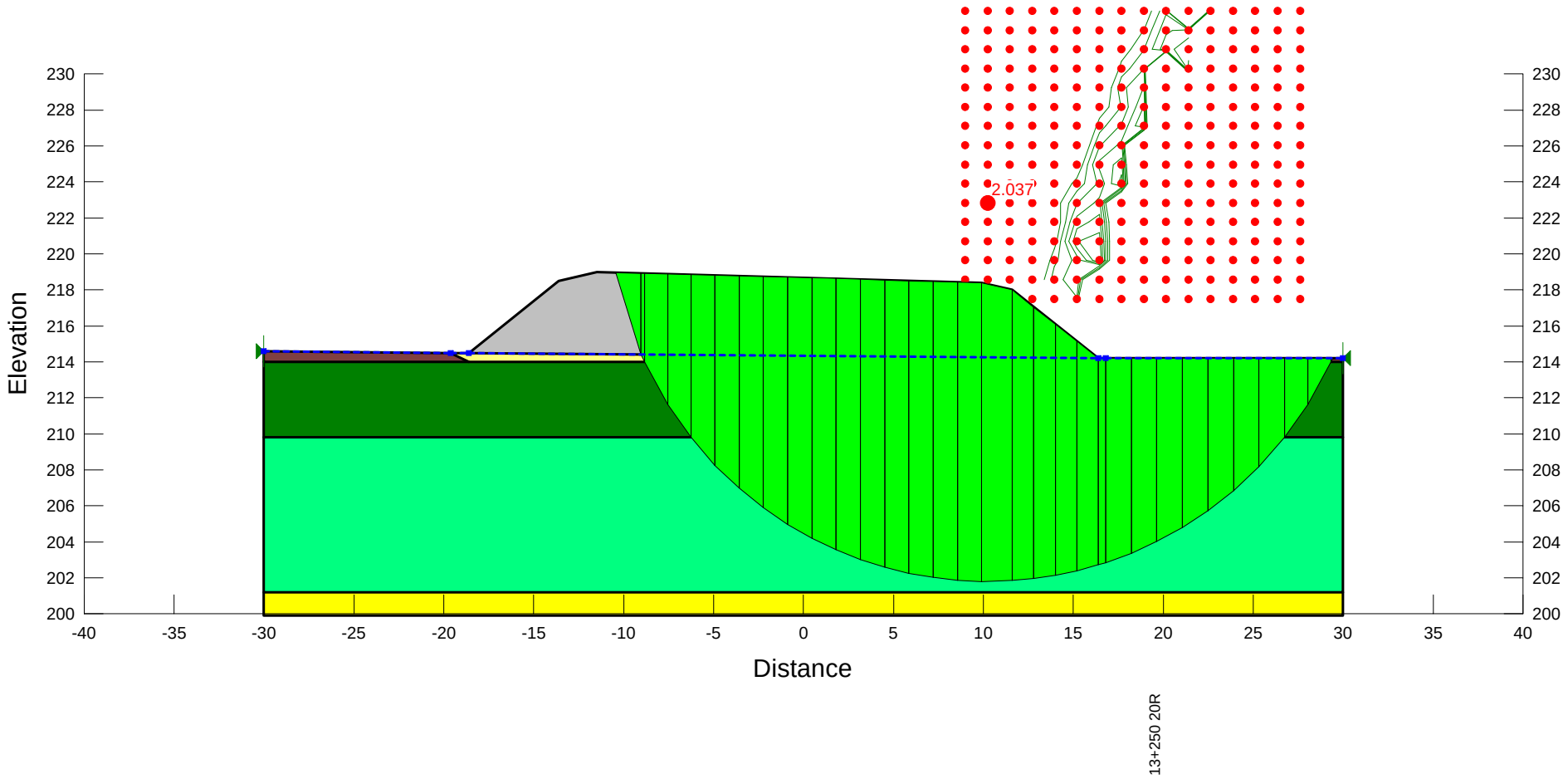


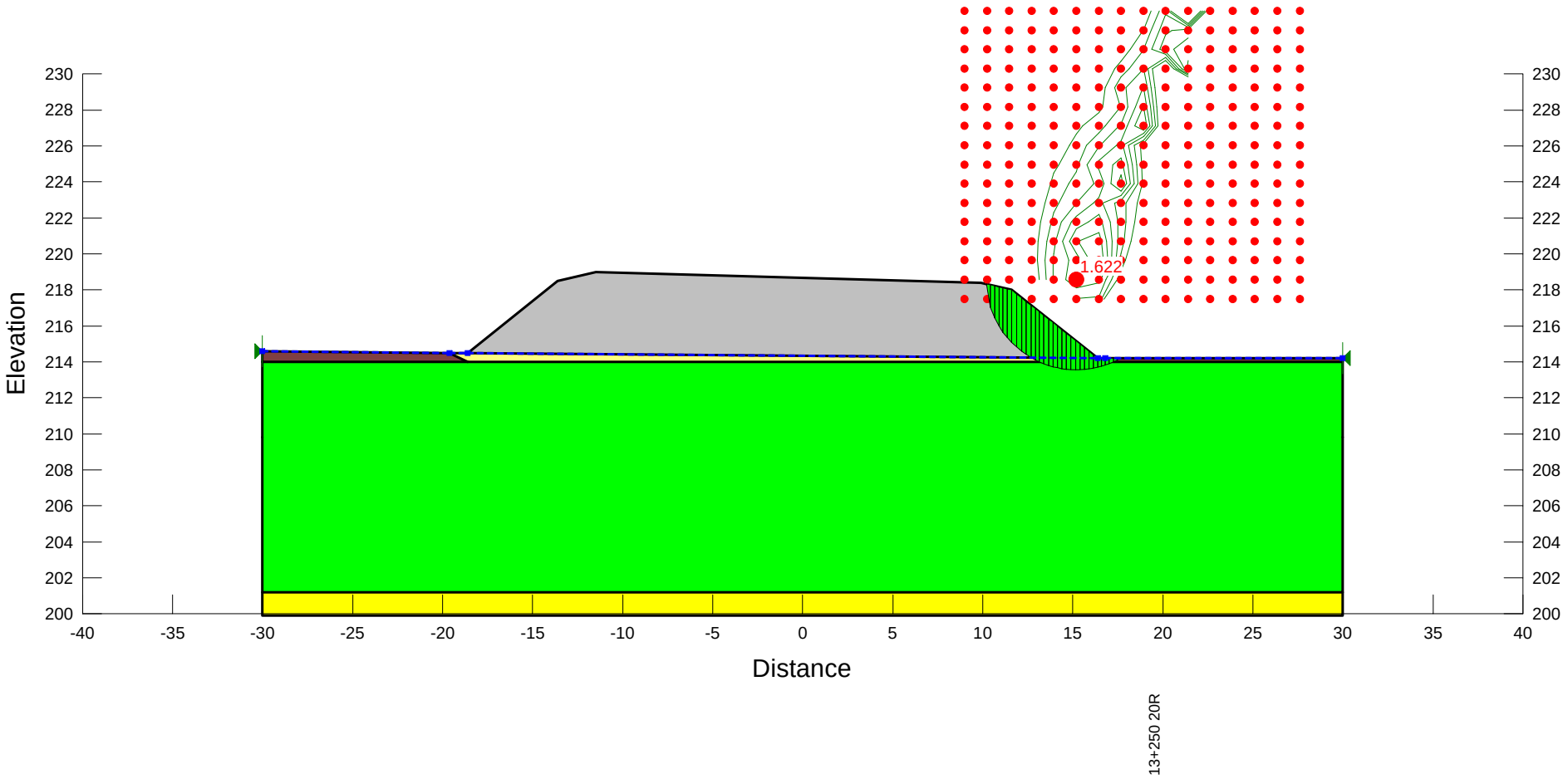
Figure P1

Directory: H:\19\1351\237 Hwy 11-17 Nipigon\Analysis\Culverts, Additional Embankments and Cut Slopes\Embankments\14+800 (Hwy 628)\Stability\

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: LT
Description: STA: 10+160
Last Edited By: Michael Eastman
Last Solved Date: 9/29/2014, 11:02:57 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Gravelly Sand	19.5 kN/m³	0 kPa	32 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



13+250 20R

Figure P2

Directory: H:\19\1351\237 Hwy 11-17 Nipigon\Analysis\Culverts, Additional Embankments and Cut Slopes\Embankments\14+800 (Hwy 628)\Stability\

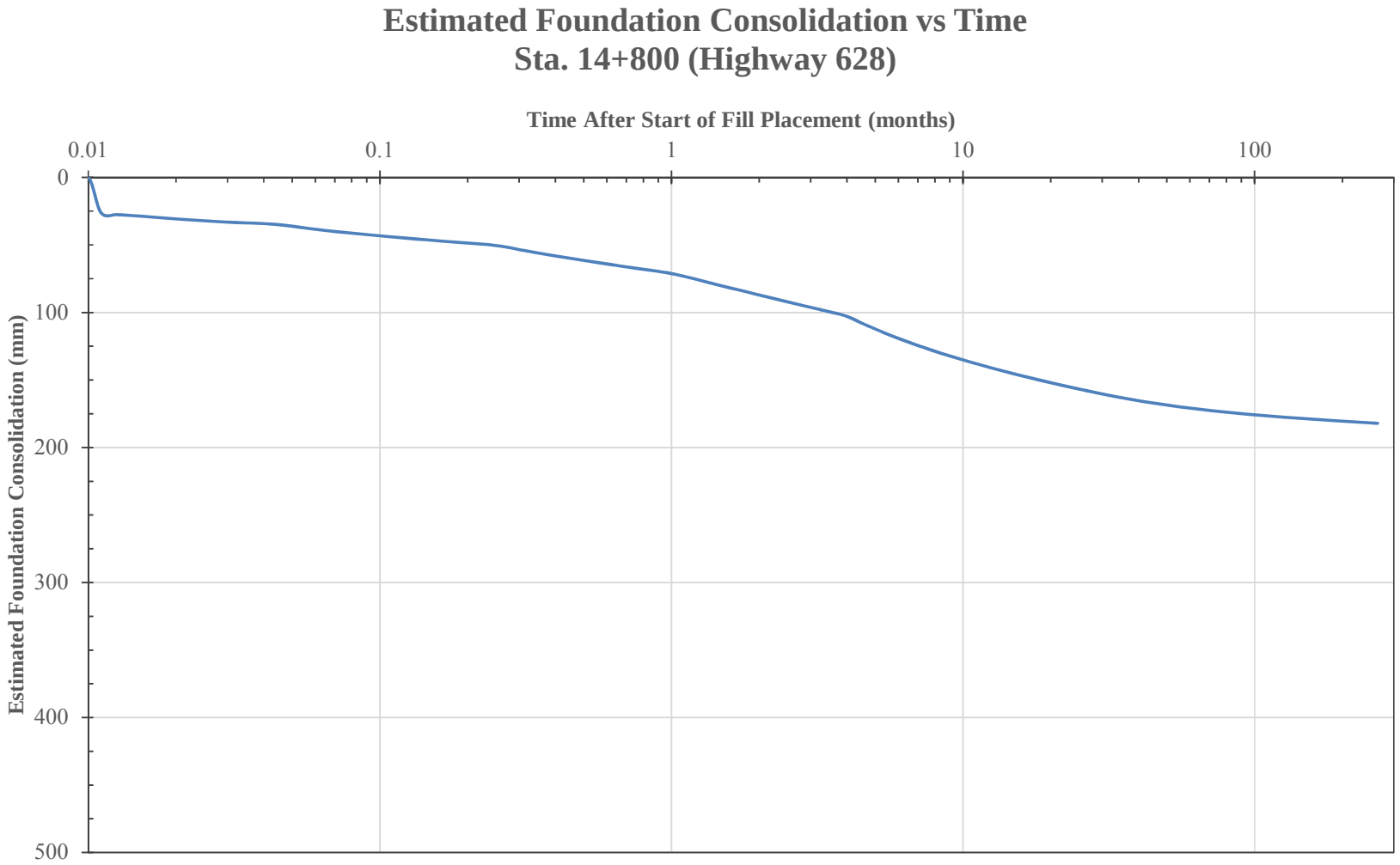


Figure P3

THURBER

Off Highway 11/17 - Red Rock to Nipigon

Highway 628

Summary of Subsurface Conditions (Cohesive Soils)

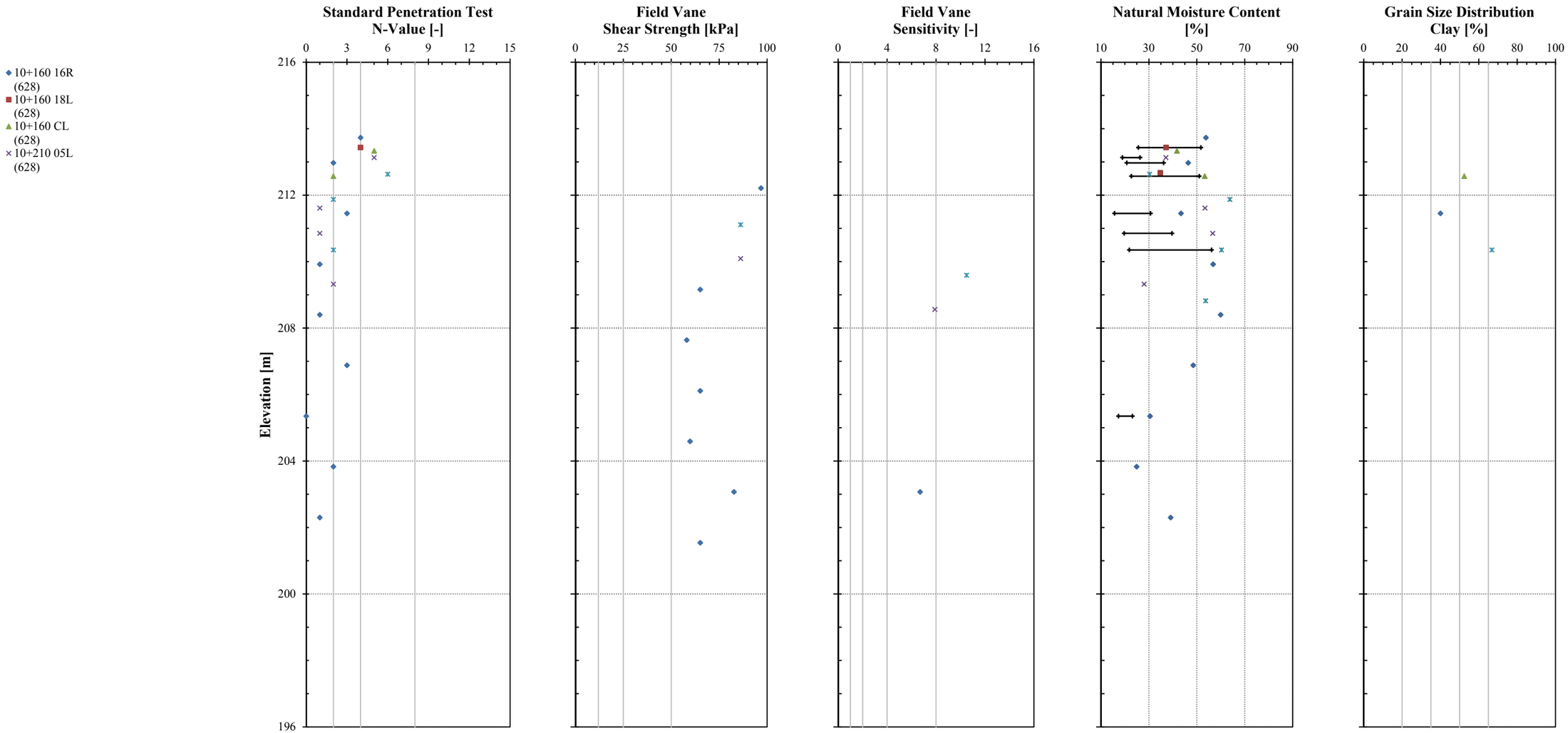


Figure P4

THURBER

Appendix Q

Highway 11/17 EBL

Sta. 14+900 to 14+930

Recommendation Summary Table

Table Q1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
14+900	14+930	14+910												0.8	2.7	219.0	217.4 (1.6)	-	-	-	-	-	1	10	5	20	25	45
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																									

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Appendix R

Highway 11/17 EBL

Sta. 15+730 to 16+250

Off Highway 11/17 Median Connector

Sta. 16+200

Recommendation Summary Table

Summary of Subsurface Conditions

Table R1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
15+730	16+250	16+150												1.7	10.7	231.6	233.0 (1.4)	-	-	-	-	-	1	10	5	20	75	95
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																								
Median Connector	16+200													0.8	6.0	232.1	233.3 (1.2)	-	-	-	-	-	1	10	5	25	75	100
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																								

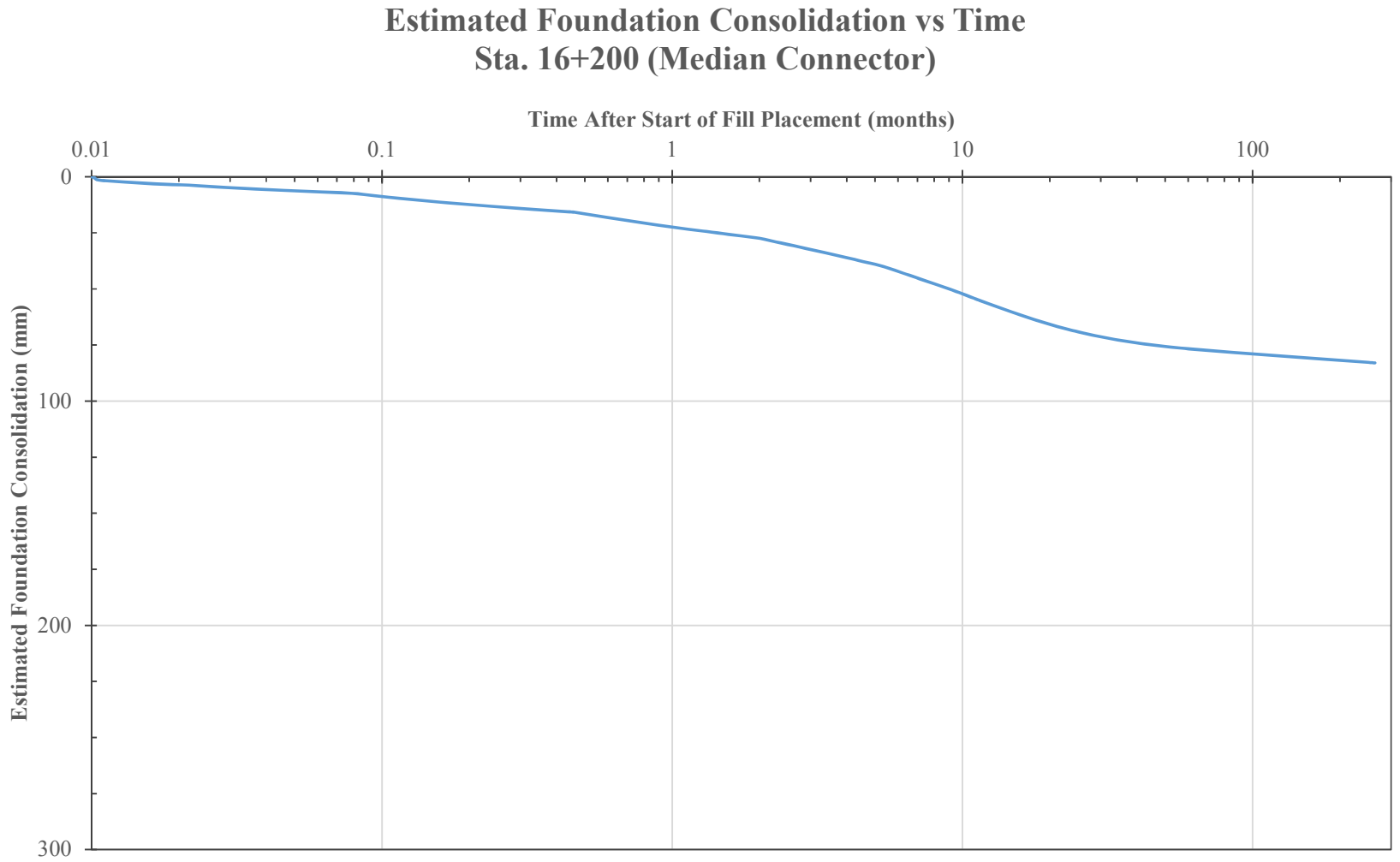

Figure R1

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL Sta. 15+730 to 16+250 and Median Connector

Summary of Subsurface Conditions (Cohesive Soils)

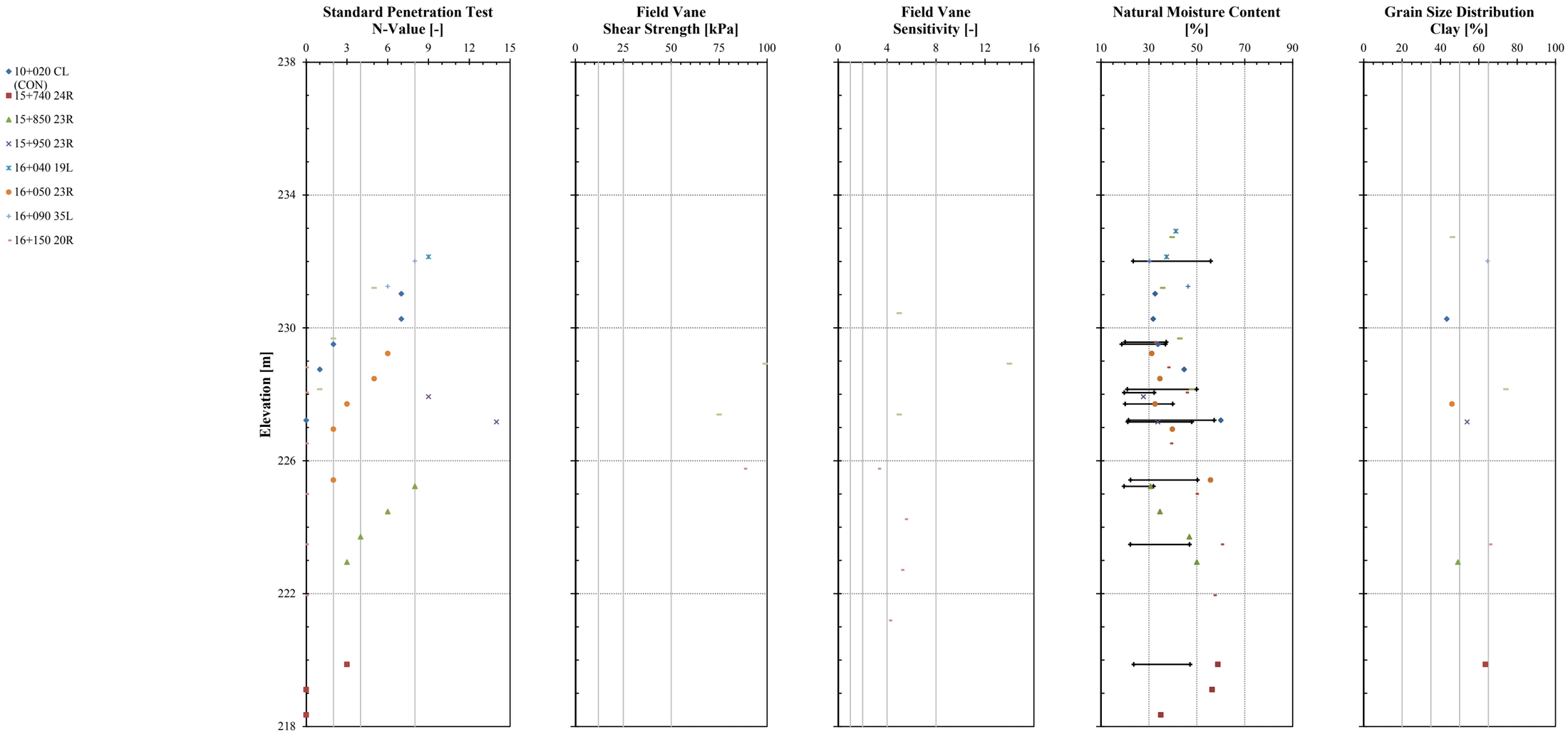

Figure R1

Appendix S

Highway 11/17 EBL and WBL

Sta. 17+250 to 17+400

Recommendation Summary Table

Table S1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
17+250	17+400	17+330		0.3	4.0	255.3	257.7 (2.4)	-	-	-	-	-	1	0.0	3.2	254.1	255.6 (1.5)	-	-	-	-	-	1	10	5	50	25	75
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Appendix T

Highway 11/17 EBL and WBL

Sta. 17+550 to 17+675

Recommendation Summary Table

Table T1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
17+550	17+675	17+600		0.0	2.1	260.7	262.8 (2.1)	-	-	-	-	-	1	0.0	0.0	261.5	261.6 (0.1)	-	-	-	-	-	1	10	5	25	40	65
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Appendix U

Highway 11/17 EBL

Sta. 19+190 to 19+1330

Recommendation Summary Table

Table U1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
19+190	19+330	19+315												0.8	0.8	271.0	273.2 (2.2)	-	-	-	-	-	1	15	5	15	20	35
														-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving															

Appendix V

Highway 11/17 EBL and WBL

Sta. 10+940 to 10+950

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table V1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.(6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
10+940	10+950	10+945	X	0.0 to 1.4	3.7 to 5.9	235.3	236.1 (0.8)	-	-	-	-	-	1	1.1 to 1.4	4.3 to 4.4	233.8	236.0 (2.2)	-	-	-	-	-	1	15	5	35	35	70
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 10+940 to10+950
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 8:17:04 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silt	19 kN/m³	0 kPa	29 °	1
Silty Clay TSA	18 kN/m³	35 kPa	0 °	1
Sand	20 kN/m³	0 kPa	30 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

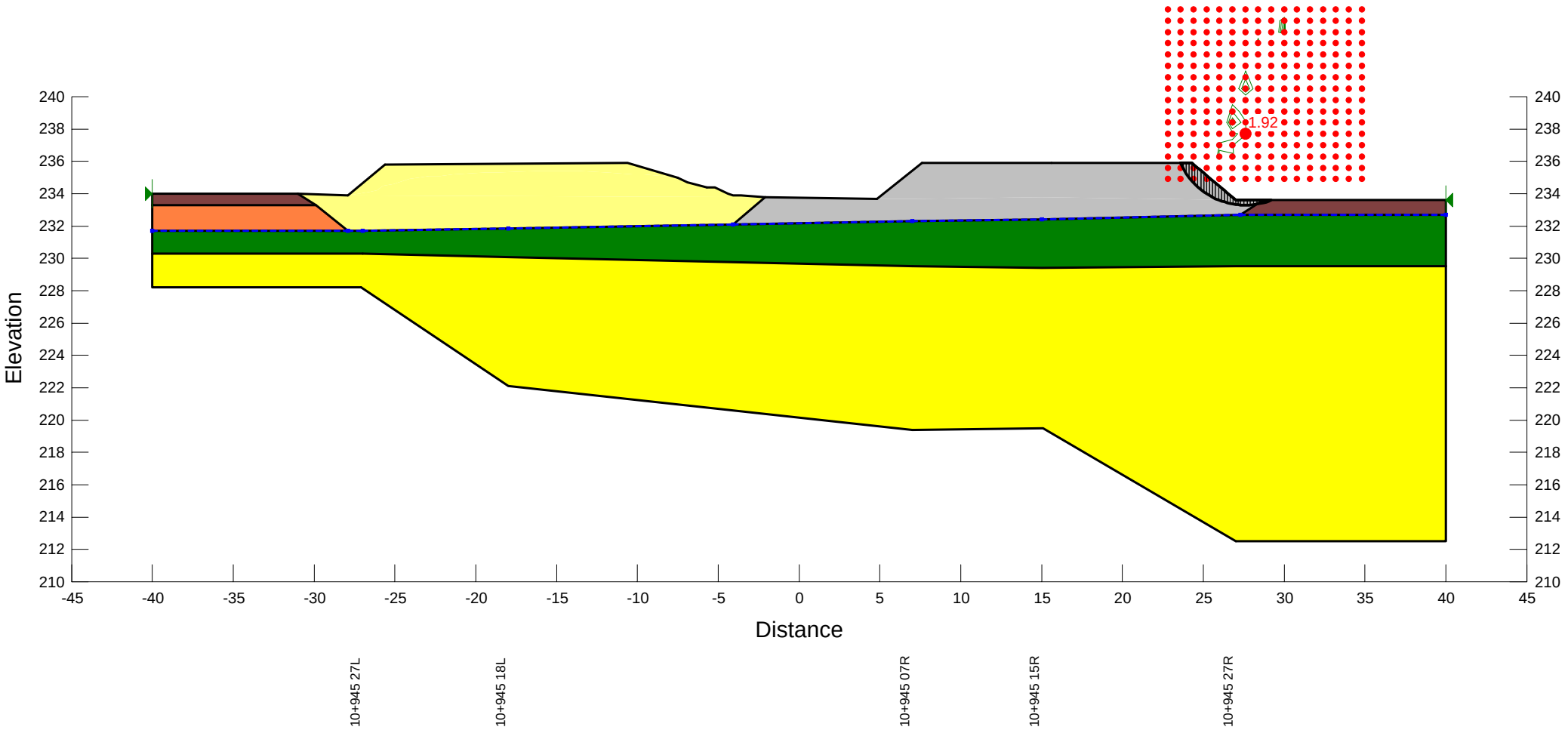

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Figure V1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 10+940 to 10+950
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 4:09:22 PM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silt	19 kN/m³	0 kPa	29 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sand	20 kN/m³	0 kPa	30 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

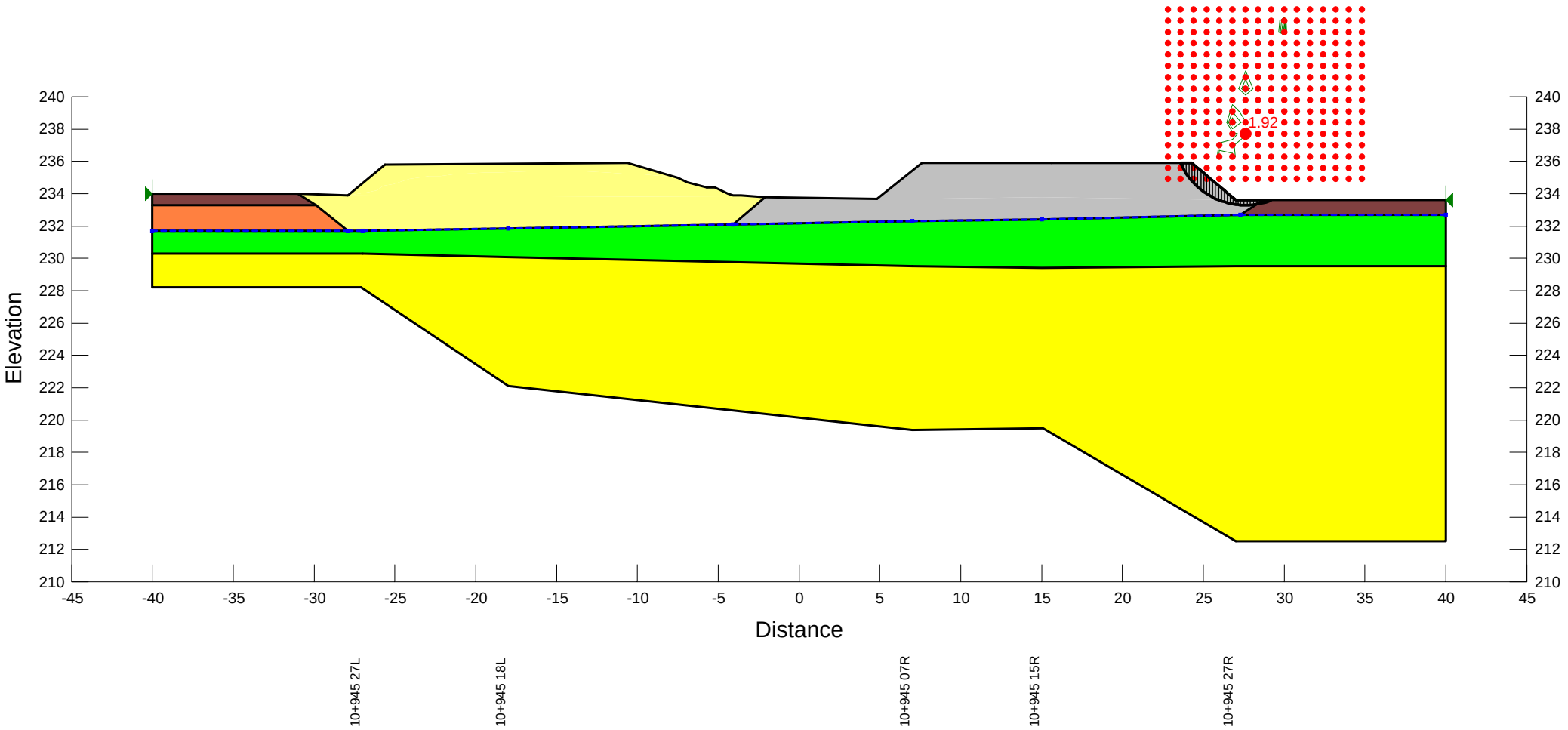

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Figure V2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-50	0	0	12
	-48	0	2	13
	-46	0	4	17
	-44	0	6	25
	-42	0	8	37
	-40	0	10	44
	-38	1	12	46
	-36	1	14	47
	-34	2	16	48
	-32	3	18	47
	-30	5	20	46
	-28	10	22	43
	-26	14	24	37
	-24	15	26	24
	-22	15	28	14
	-20	17	30	8
	-18	18	32	5
	-16	17	34	4
	-14	16	36	2
	-12	16	38	1
	-10	14	40	1
	-8	12	42	1
	-6	10	44	1
	-4	10	46	0
	-2	10	48	0
	0	12	50	0

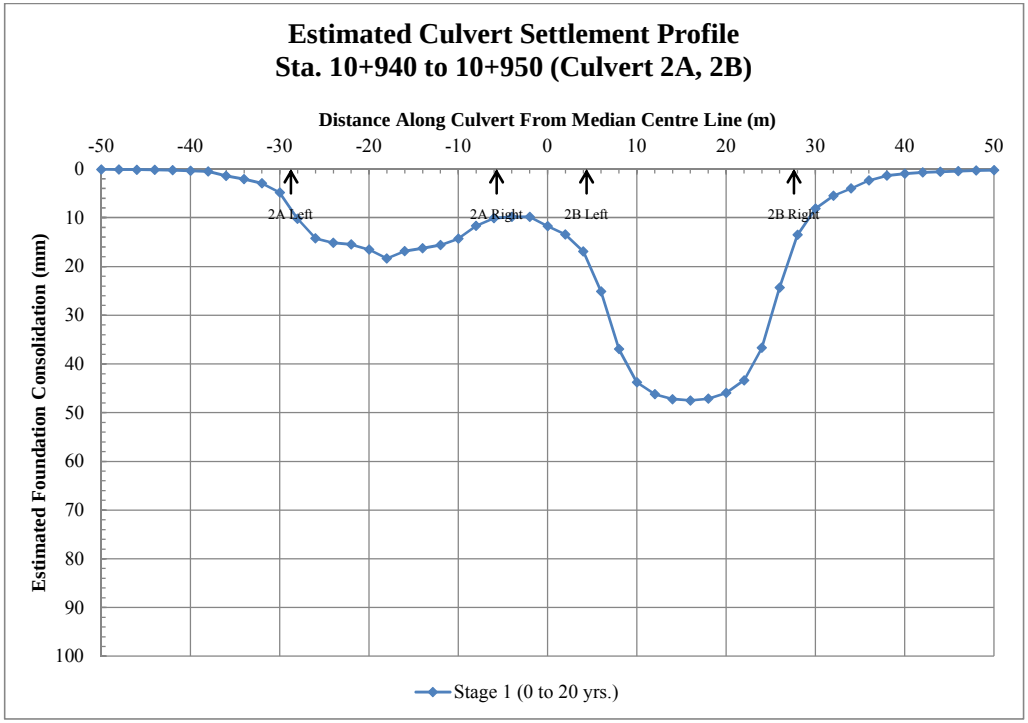

Figure V3

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 10+940 to 10+950

Summary of Subsurface Conditions (Cohesive Soils)

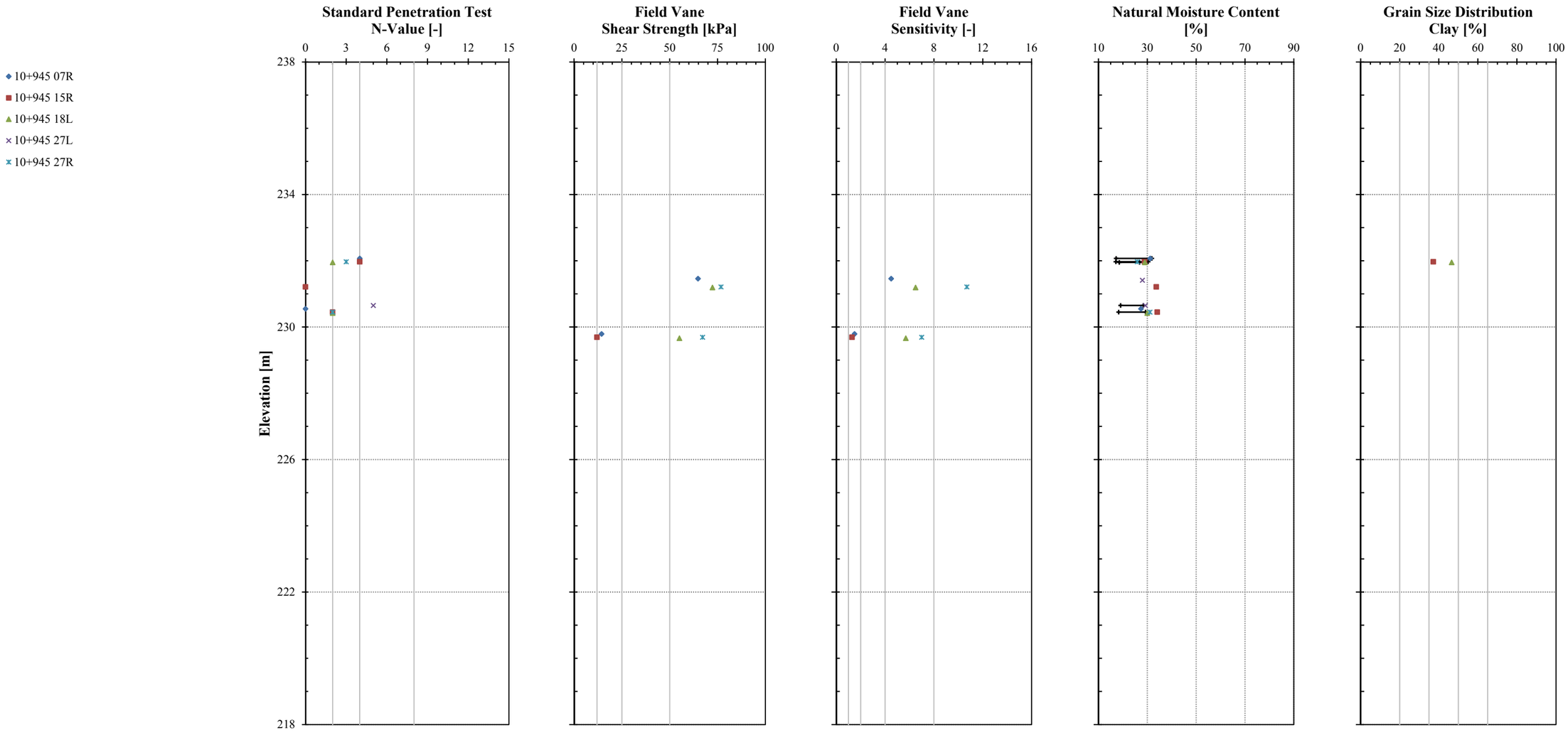

Figure V4

THURBER

Appendix W

Highway 11/17 EBL and WBL

Sta. 11+160 to 11+170

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table W1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.(6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
11+160	11+170	11+165	X	0.6 to 1.0	3.4 to 5.0	236.0	236.7 (0.7)	-	-	-	-	-	1	0.6 to 1.0	5.0 to 6.5	234.3	236.6 (2.3)	-	-	-	-	-	1	15	5	25	25	50
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: 11+160 to 11+170
Last Edited By: Michael Eastman

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Sand & Silt	19.5 kN/m³	0 kPa	29 °	1
Silty Clay TSA	18 kN/m³	30 kPa	0 °	1
Silt & Sand	20 kN/m³	0 kPa	32 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

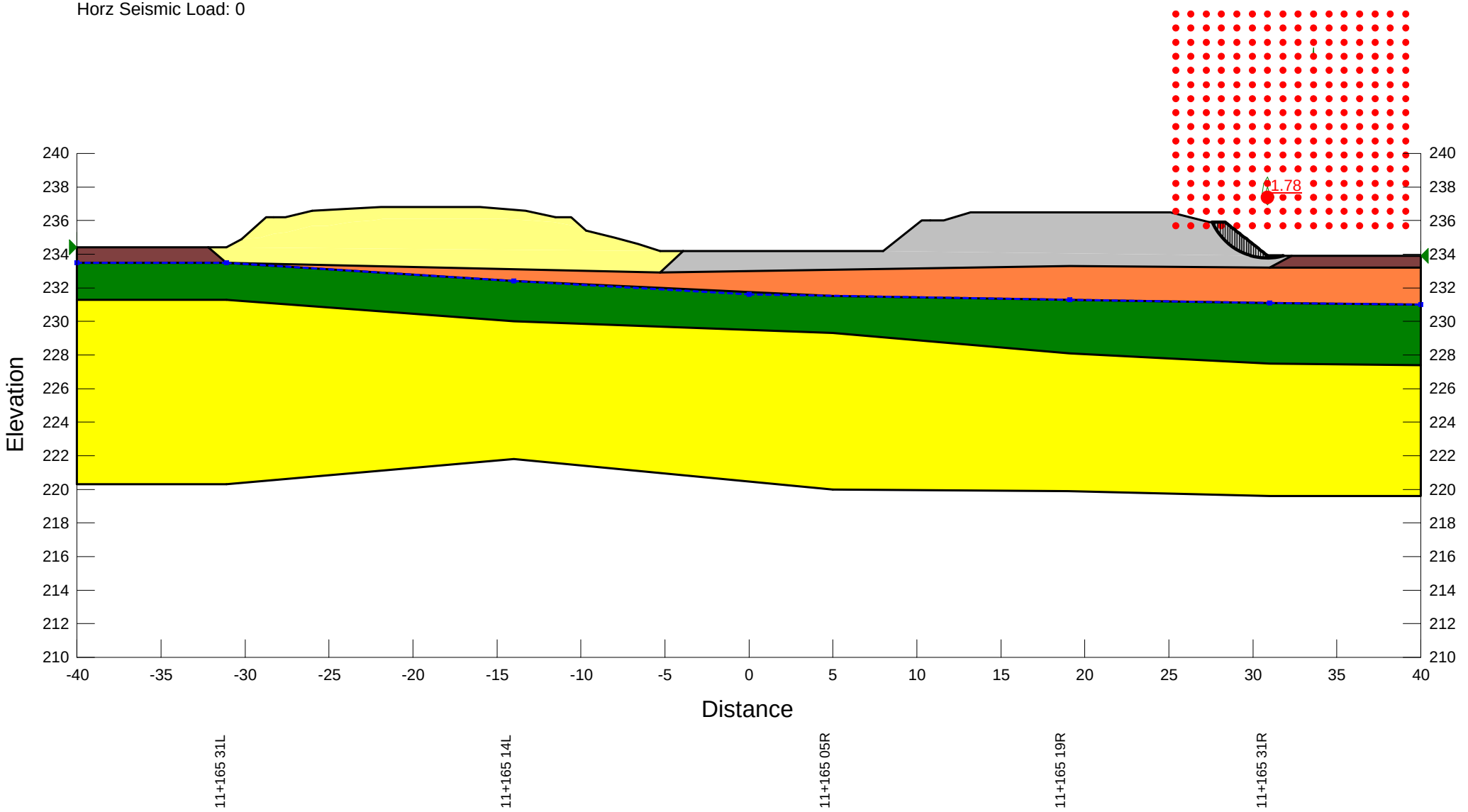

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Figure W1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: 11+160 to 11+170
Last Edited By: Michael Eastman

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Sand & Silt	19.5 kN/m³	0 kPa	29 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Silt & Sand	20 kN/m³	0 kPa	32 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

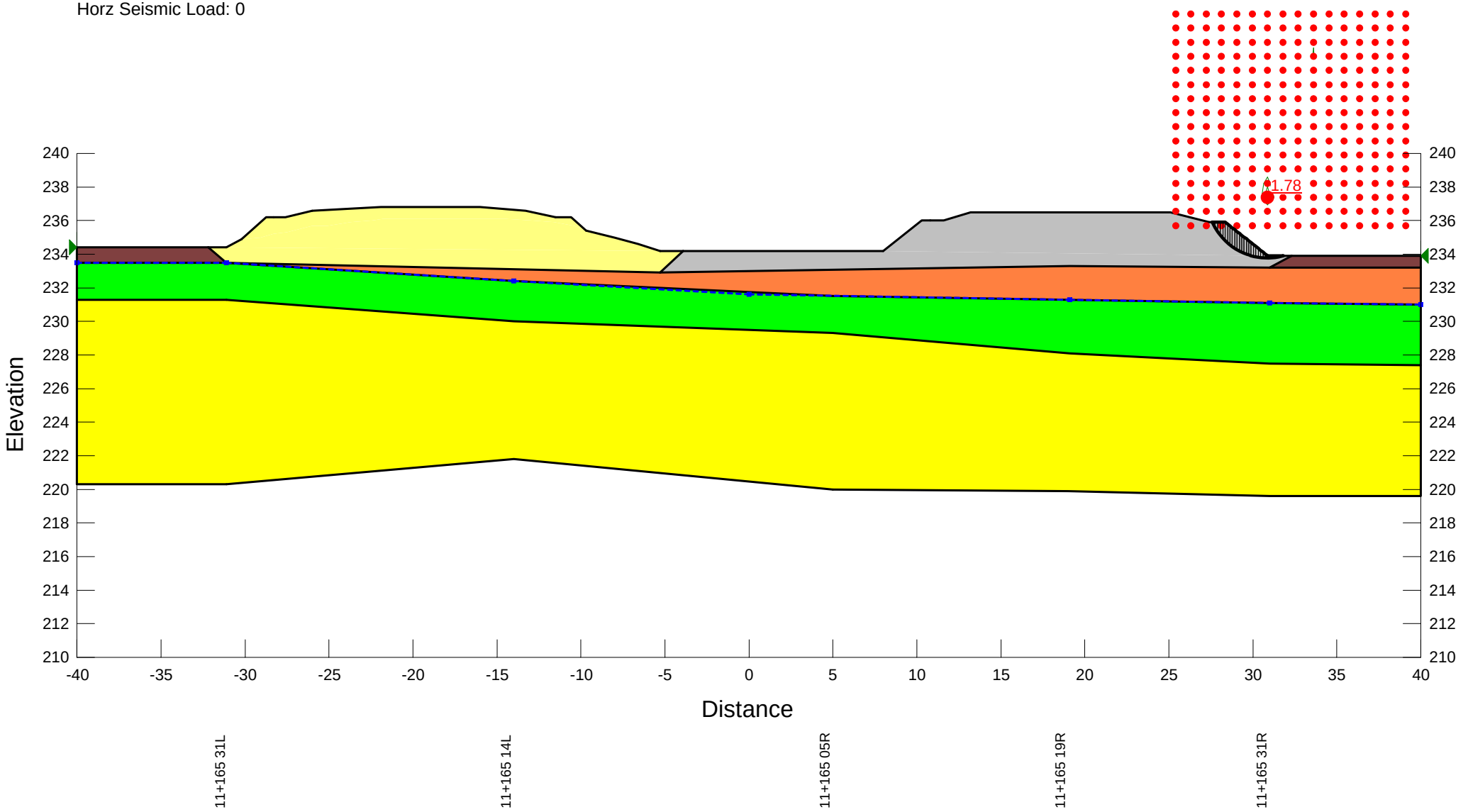

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Figure W2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-50	0	0	5
	-48	0	2	5
	-46	0	4	6
	-44	0	6	8
	-42	0	8	11
	-40	1	10	17
	-38	1	12	21
	-36	2	14	23
	-34	3	16	25
	-32	4	18	25
	-30	8	20	25
	-28	12	22	25
	-26	12	24	24
	-24	11	26	22
	-22	10	28	19
	-20	10	30	14
	-18	10	32	9
	-16	10	34	6
	-14	10	36	4
	-12	9	38	3
	-10	7	40	2
	-8	6	42	1
	-6	5	44	1
	-4	5	46	0
	-2	4	48	0
	0	5	50	0

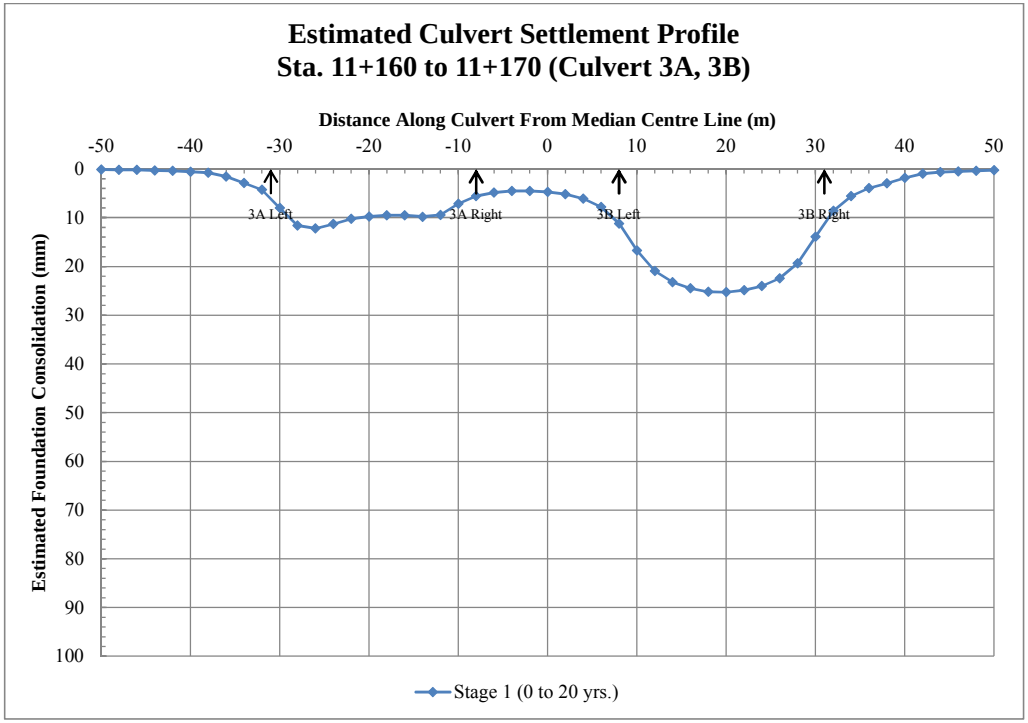


Figure W3

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 11+160 to 11+170

Summary of Subsurface Conditions (Cohesive Soils)

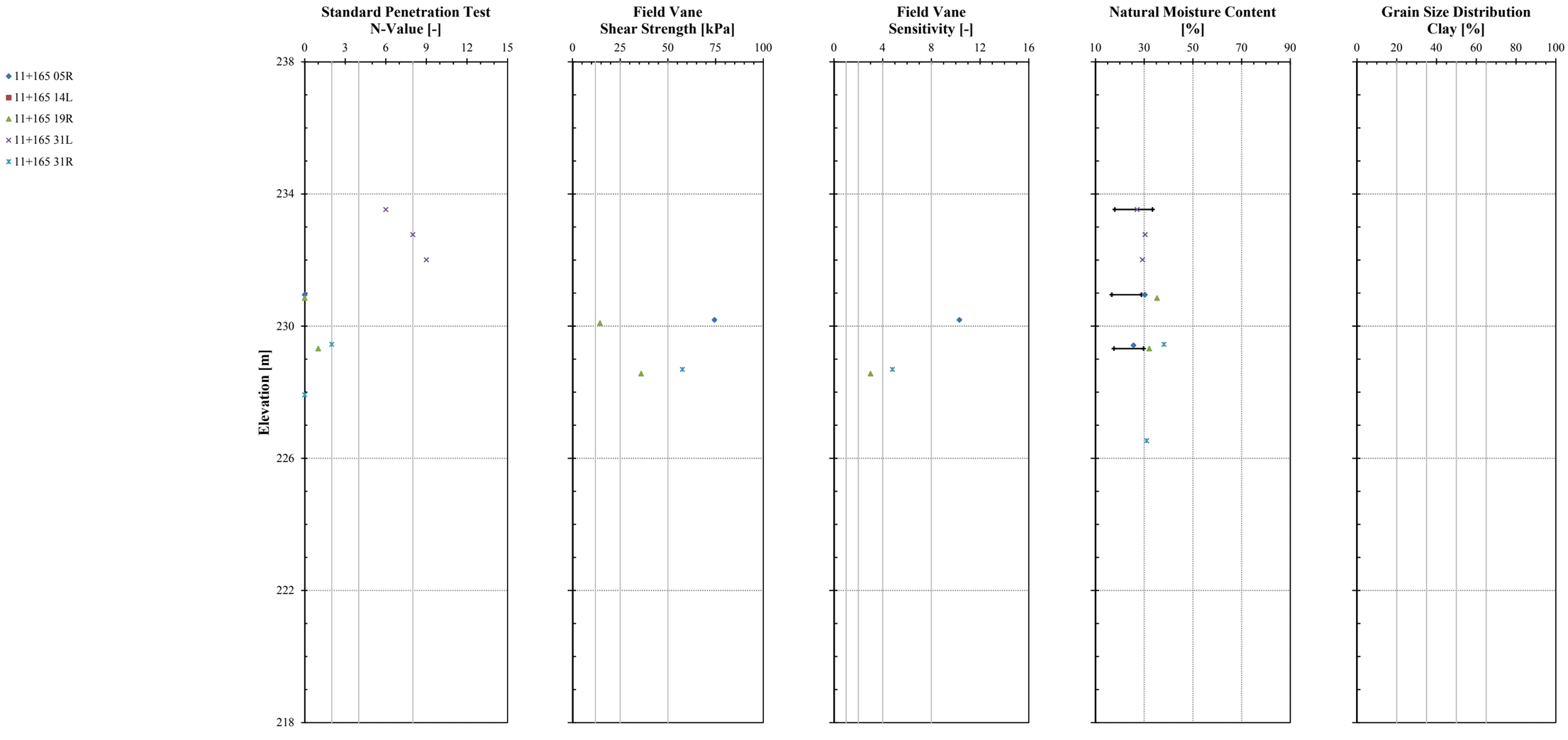


Figure W4

THURBER

Appendix X

Highway 11/17 EBL and WBL

Sta. 11+770 to 11+800

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table X1
Recommendation Summary Table

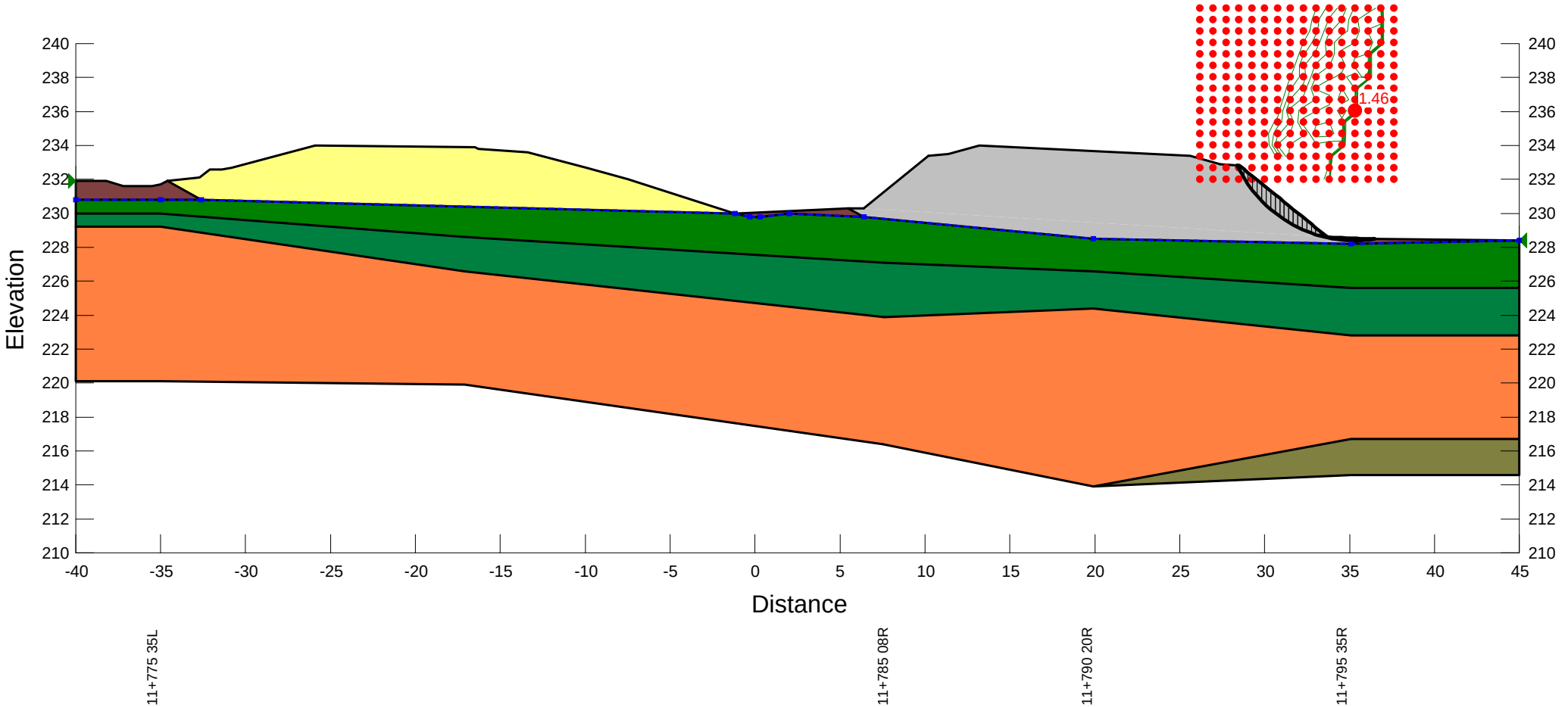
Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
11+770	11+800	11+785	X	0.0 to 1.4	3.0 to 7.3	233.9	233.9 (0.0)	-	-	-	-	-	1	0.8 to 0.9	4.9 to 6.1	229.3	233.7 (4.4)	-	-	-	-	-	1	25	5	55	45	100
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 11+770 to 11+800
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:07:31 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay Top (TSA)	18 kN/m³	40 kPa	0 °	1
Silty Clay Bottom (TSA)	18 kN/m³	60 kPa	0 °	1
Silt	19.5 kN/m³	0 kPa	35 °	1
Clayey Silt	19 kN/m³	0 kPa	33 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1



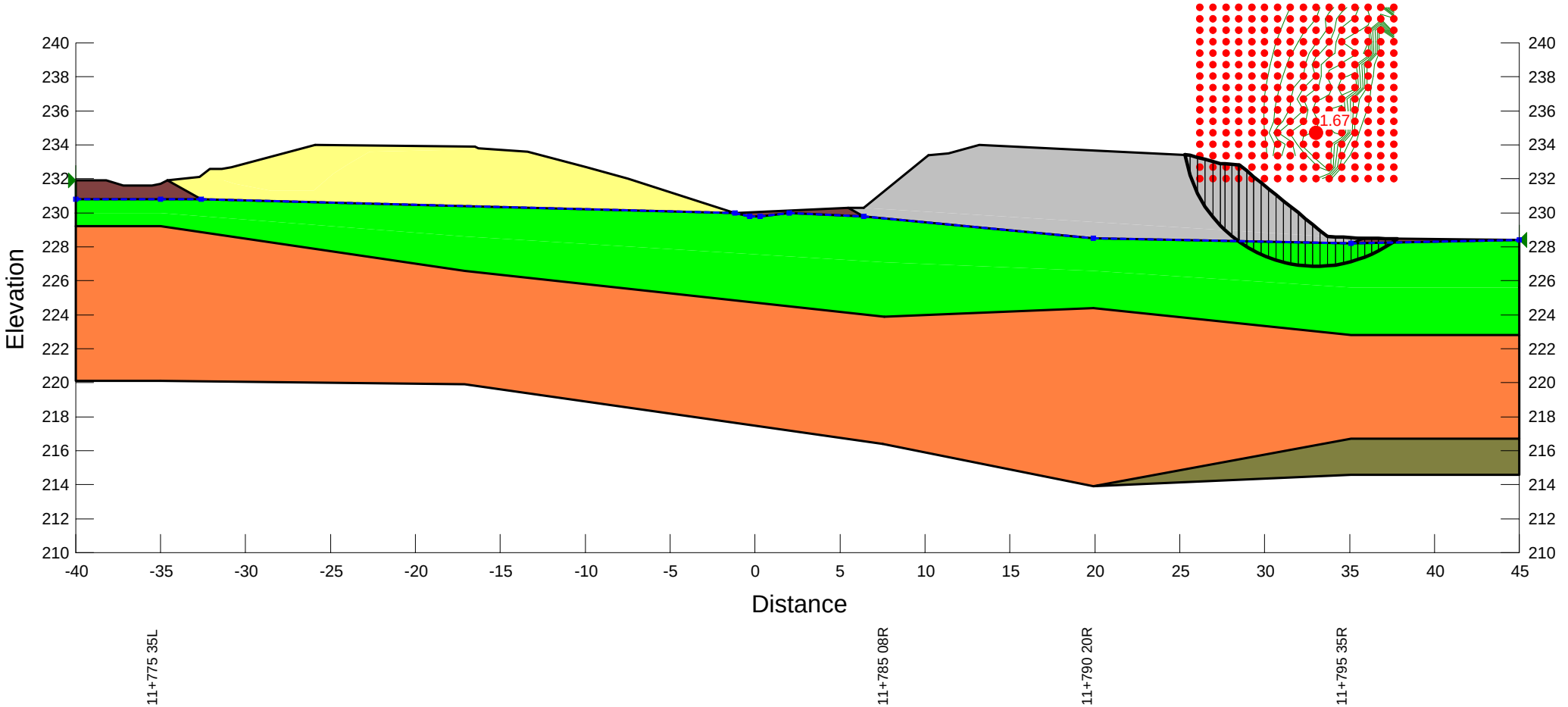
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\11+770-11+800\Stability\

Figure X1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 11+770 to 11+800
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:07:22 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silt	19.5 kN/m³	0 kPa	35 °	1
Clayey Silt	19 kN/m³	0 kPa	33 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\11+770-11+800\Stability\

Figure X2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-51	0	0	12
	-49	0	2	15
	-47	0	4	17
	-45	1	6	22
	-43	1	8	30
	-41	1	10	43
	-39	2	12	53
	-37	4	14	58
	-35	5	16	61
	-33	9	18	63
	-31	18	20	65
	-29	25	22	64
	-27	26	25	62
	-25	22	27	59
	-22	15	29	54
	-20	12	31	45
	-18	11	33	33
	-16	10	35	20
	-14	10	37	13
	-12	10	39	9
	-10	9	41	7
	-8	10	43	5
	-6	11	45	3
	-4	11	47	2
	-2	10	49	1
	0	12	51	1

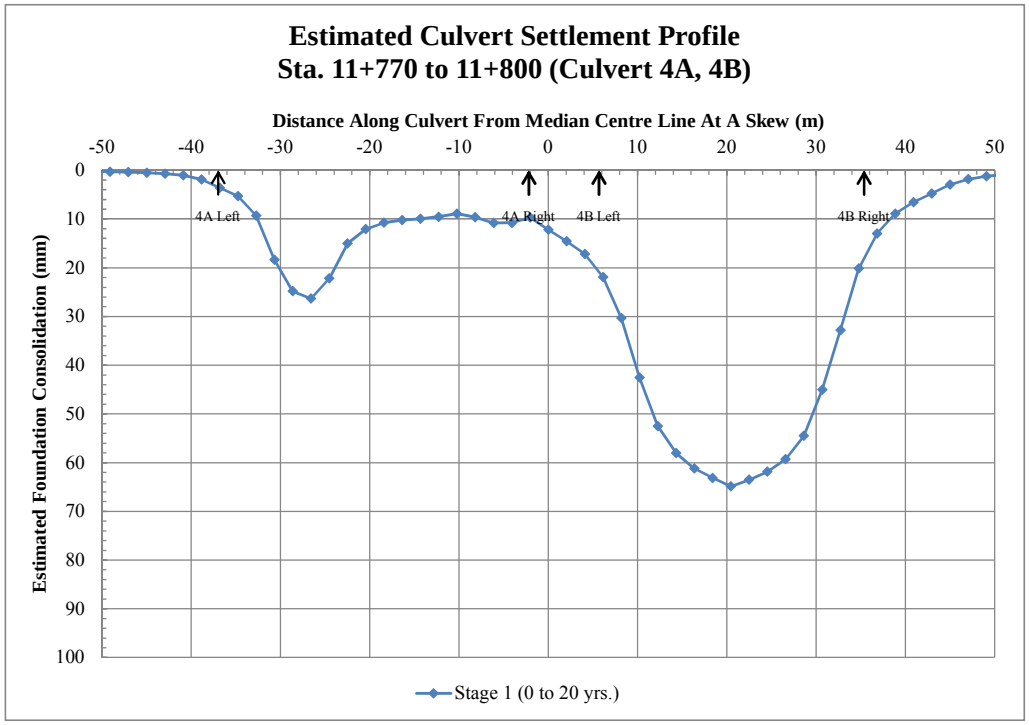


Figure X3

THURBER

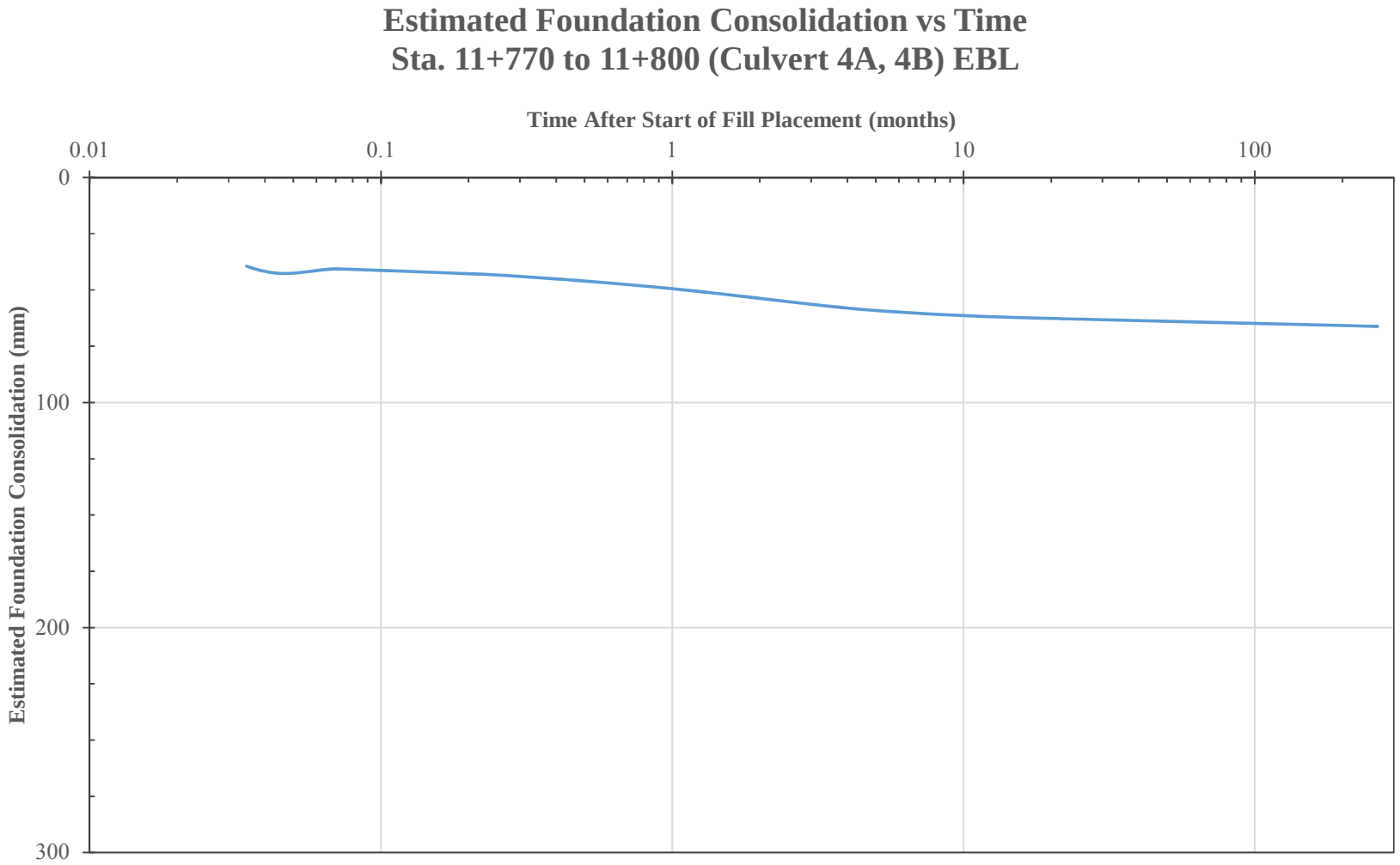


Figure X4

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 11+770 to 11+800

Summary of Subsurface Conditions (Cohesive Soils)

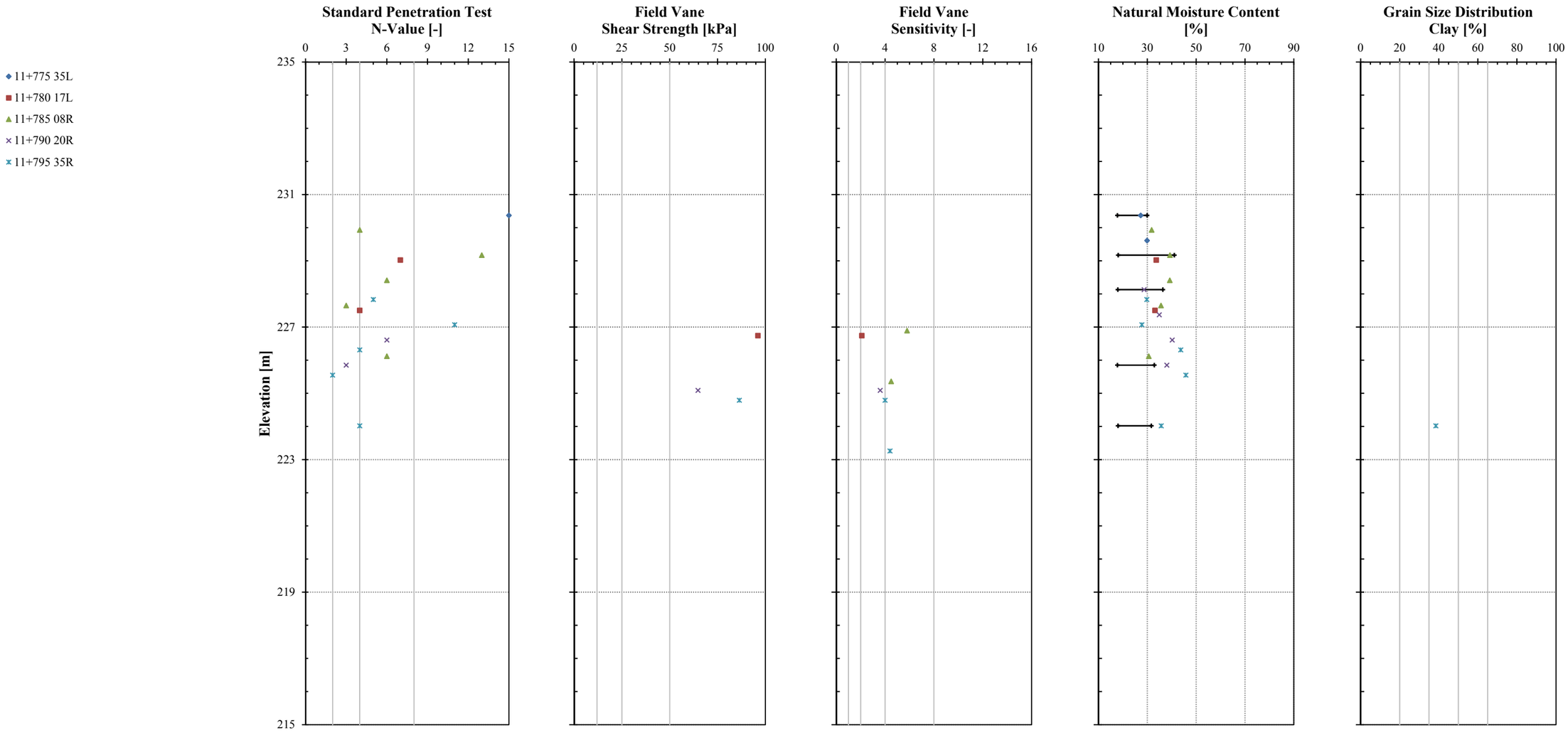


Figure X5

THURBER

Appendix Y

Highway 11/17 EBL and WBL

Sta. 11+900 to 11+950

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table Y1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
11+900	11+950	11+922	X	0.0 to 1.5	0.0 to 6.2	231.2	232.7 (1.5)	-	-	-	-	-	1	0.8 to 1.5	5.0 to 8.5	229.6	232.8 (3.2)	-	-	-	-	-	1	20	5	45	45	90
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 11+900 to 11+950
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:16:28 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay Top (TSA)	18 kN/m³	35 kPa	0 °	1
Silty Clay Bottom (TSA)	18 kN/m³	55 kPa	0 °	1
Silt	19.5 kN/m³	0 kPa	35 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1

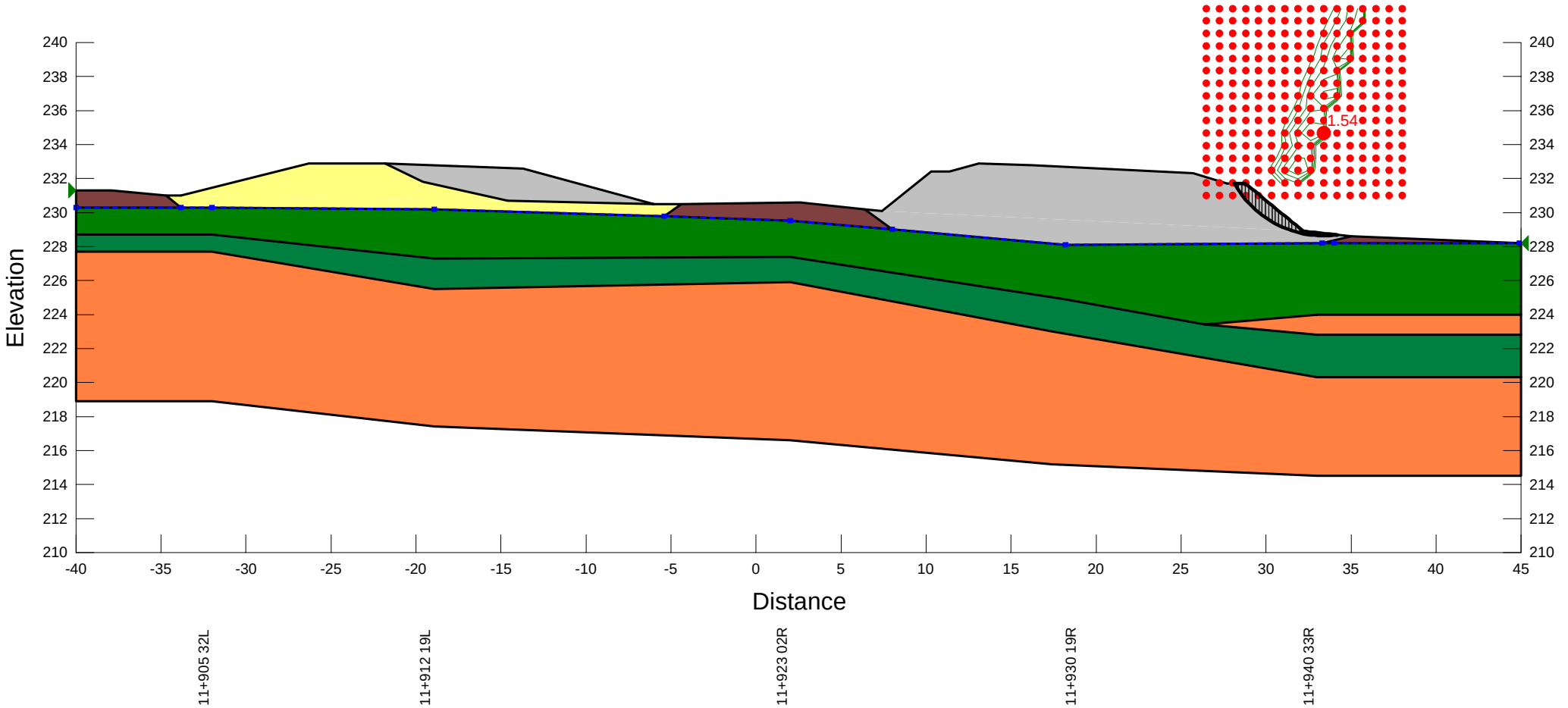


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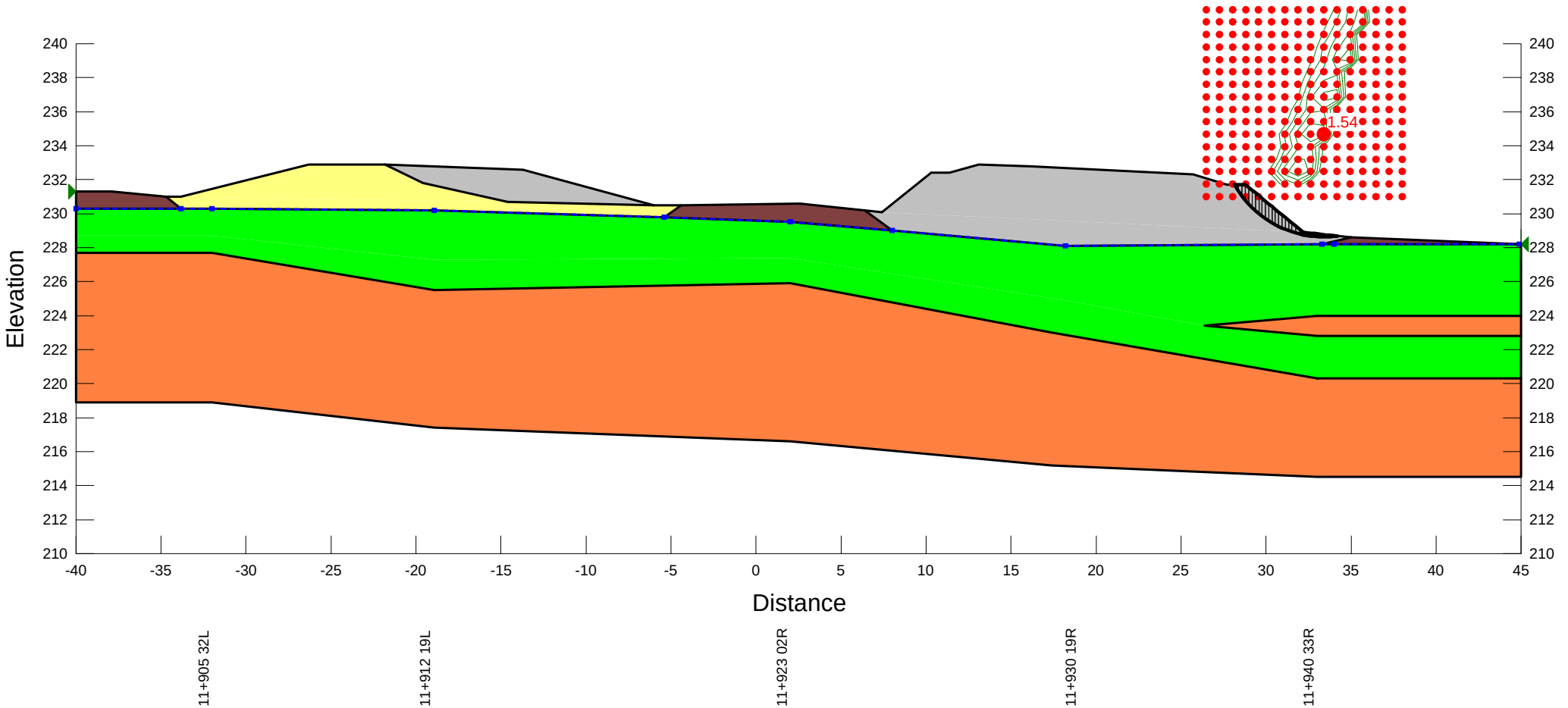
Figure Y1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 11+900 to 11+950
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:16:20 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silt	19.5 kN/m³	0 kPa	35 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\11+900-11+950\Stability\

Figure Y2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-59	0	0	12
	-56	0	2	12
	-54	0	5	14
	-52	0	7	18
	-49	0	9	27
	-47	1	12	43
	-45	1	14	52
	-42	2	16	60
	-40	3	19	62
	-38	3	21	63
	-35	4	23	63
	-33	5	26	64
	-30	4	28	61
	-28	6	30	59
	-26	12	33	52
	-23	25	35	37
	-21	37	38	22
	-19	45	40	13
	-16	49	42	9
	-14	45	45	6
	-12	37	47	4
	-9	27	49	3
	-7	19	52	2
	-5	14	54	1
	-2	12	56	1
	0	12	59	1

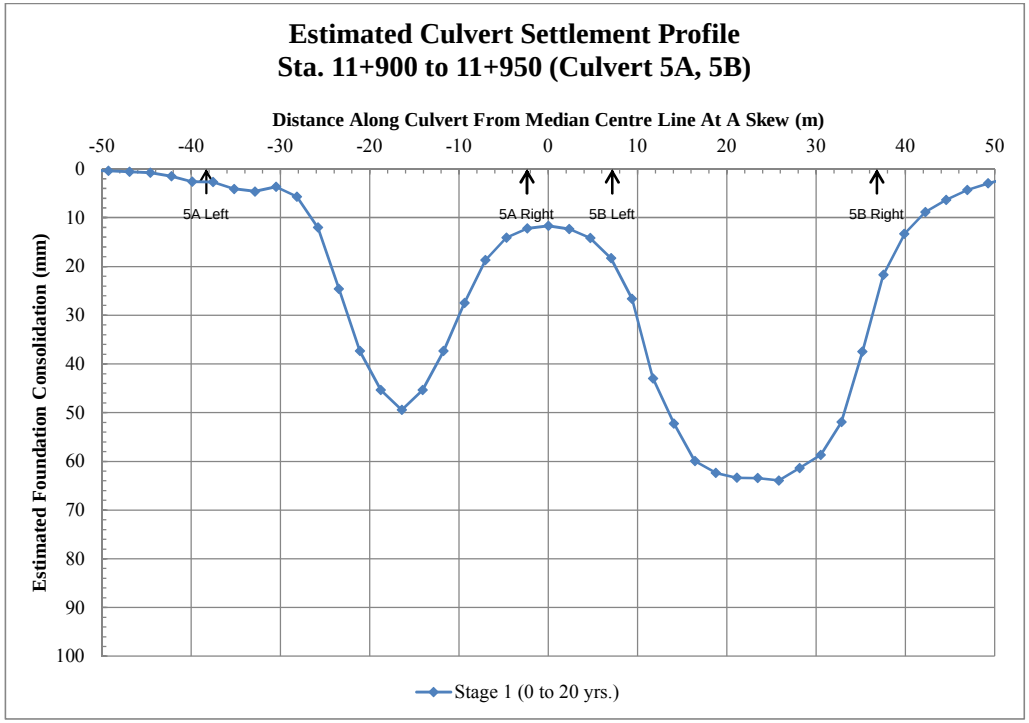


Figure Y3

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 11+900 to 11+950

Summary of Subsurface Conditions (Cohesive Soils)

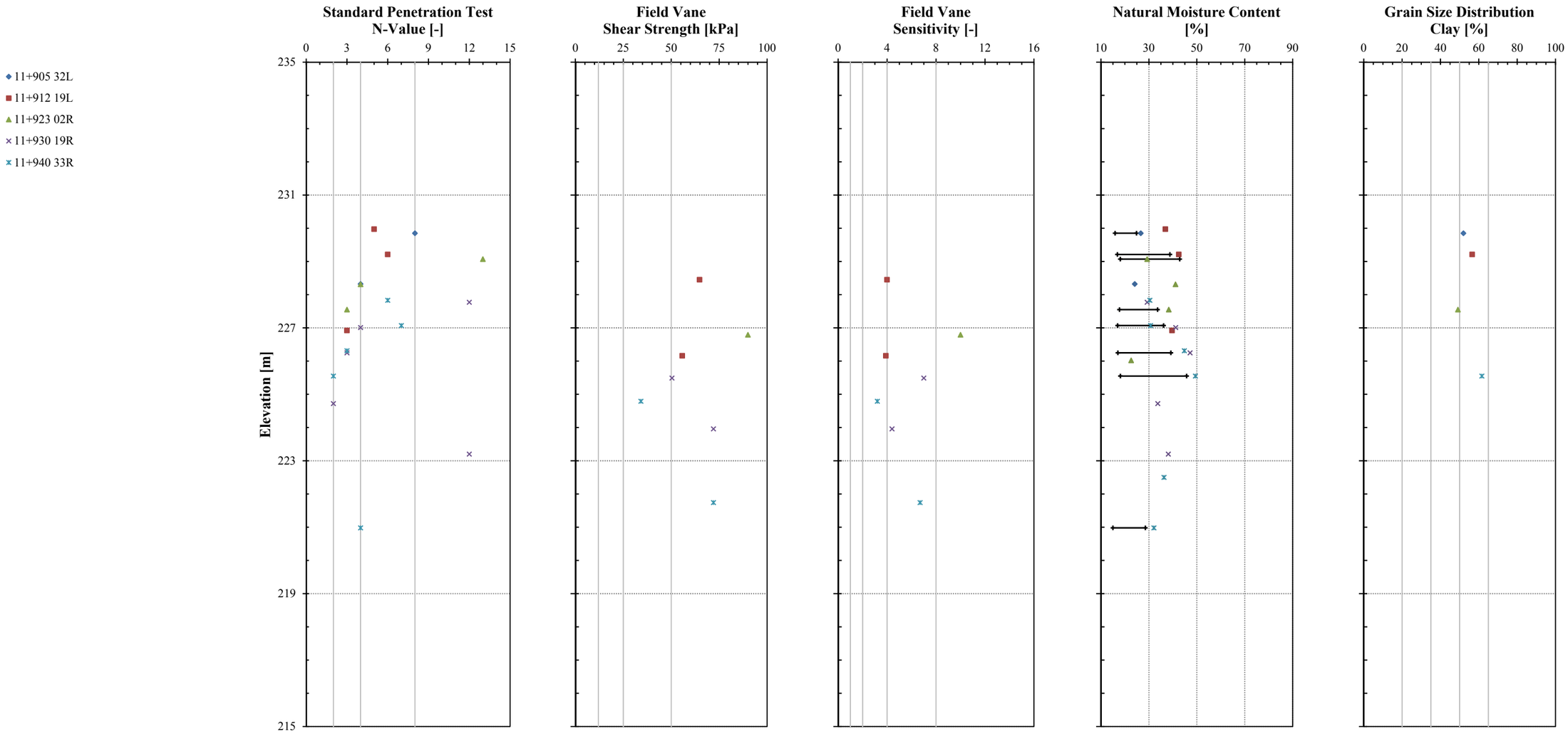


Figure Y4

THURBER

Appendix Z

Highway 11/17 EBL and WBL

Sta. 12+070 to 12+080

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table Z1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
12+070	12+080	12+075	X	0.9 to 1.5	3.0 to 4.6	228.0	231.6 (3.6)	-	-	-	-	-	3	1.2 to 2.1	4.3 to 7.6	226.8	231.5 (4.7)	-	-	-	-	-	3	25	5	90	45	135
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 3 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 3 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 12+070 to 12+080
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:28:07 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay (TSA)	18 kN/m³	40 kPa	0 °	1
Silt	19.5 kN/m³	0 kPa	33 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1

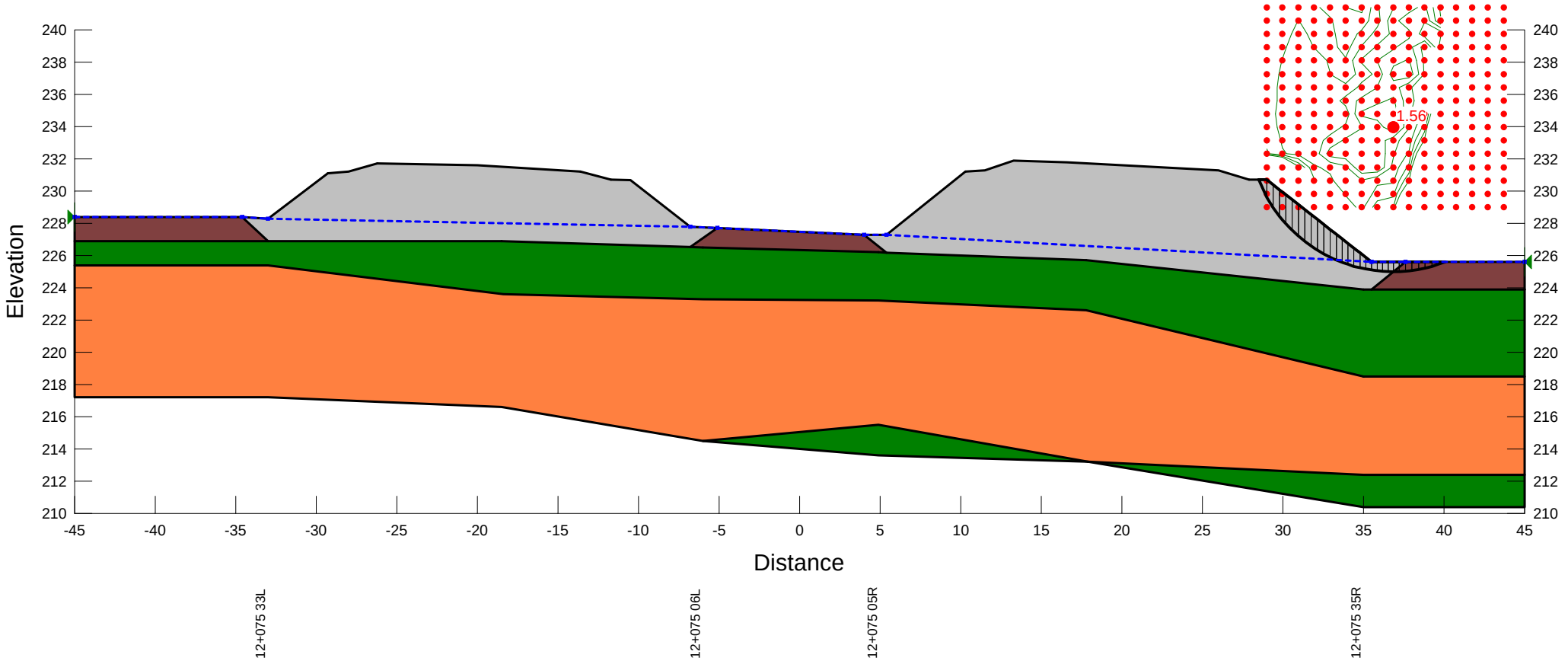


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Figure Z1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 12+070 to 12+080
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:28:00 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silt	19.5 kN/m³	0 kPa	33 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1

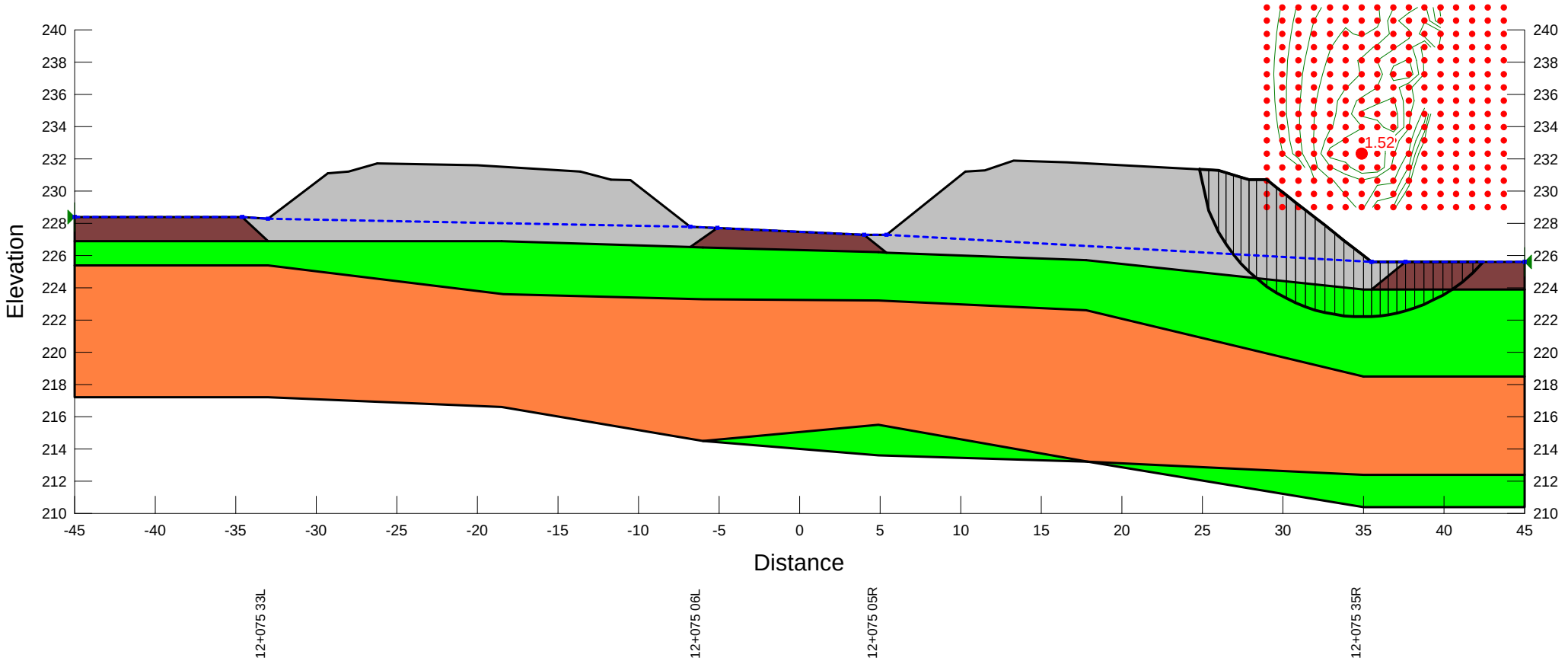

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Figure Z2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-50	1	0	24
	-48	1	2	26
	-46	2	4	31
	-44	3	6	41
	-42	4	8	59
	-40	5	10	77
	-38	8	12	87
	-36	12	14	97
	-34	19	16	102
	-32	31	18	104
	-30	48	20	104
	-28	59	22	103
	-26	72	24	99
	-24	76	26	96
	-22	75	28	91
	-20	76	30	79
	-18	76	32	63
	-16	76	34	45
	-14	74	36	29
	-12	69	38	18
	-10	58	40	12
	-8	43	42	8
	-6	33	44	6
	-4	27	46	5
	-2	24	48	4
	0	24	50	3

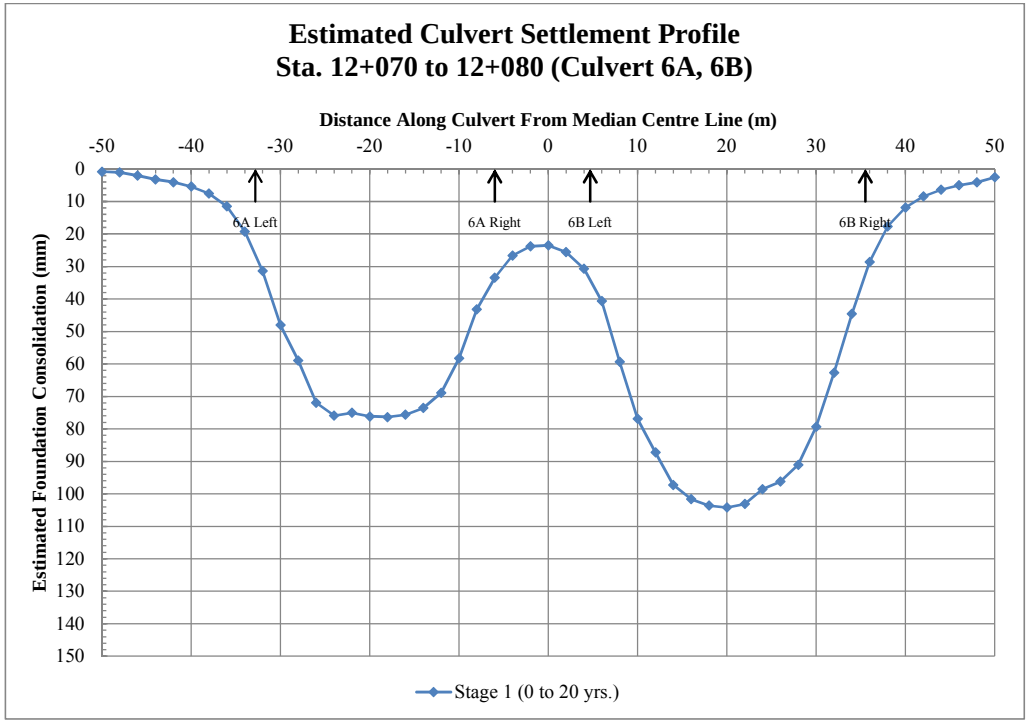


Figure Z3

THURBER

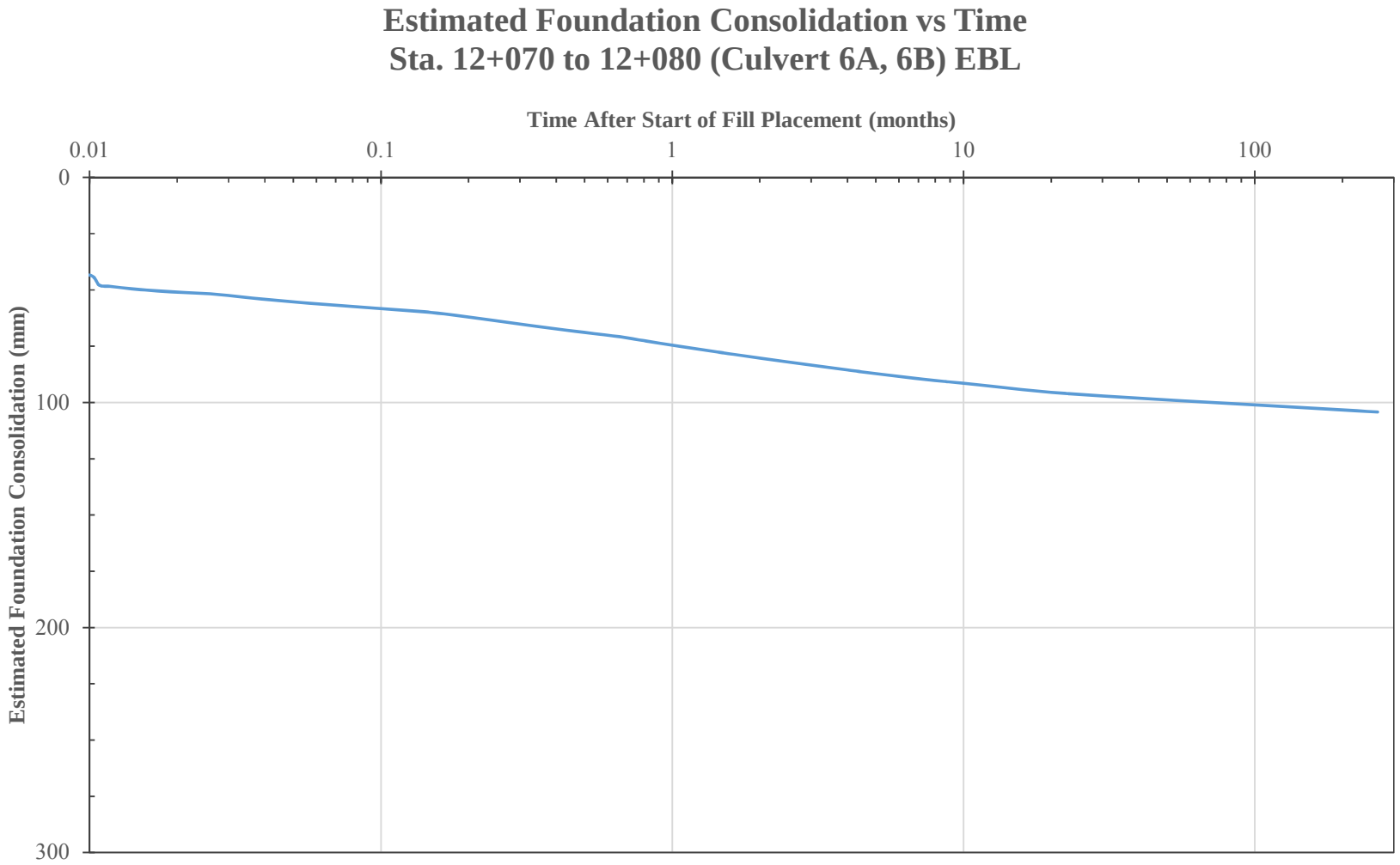


Figure Z4

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 12+070 to 12+080

Summary of Subsurface Conditions (Cohesive Soils)

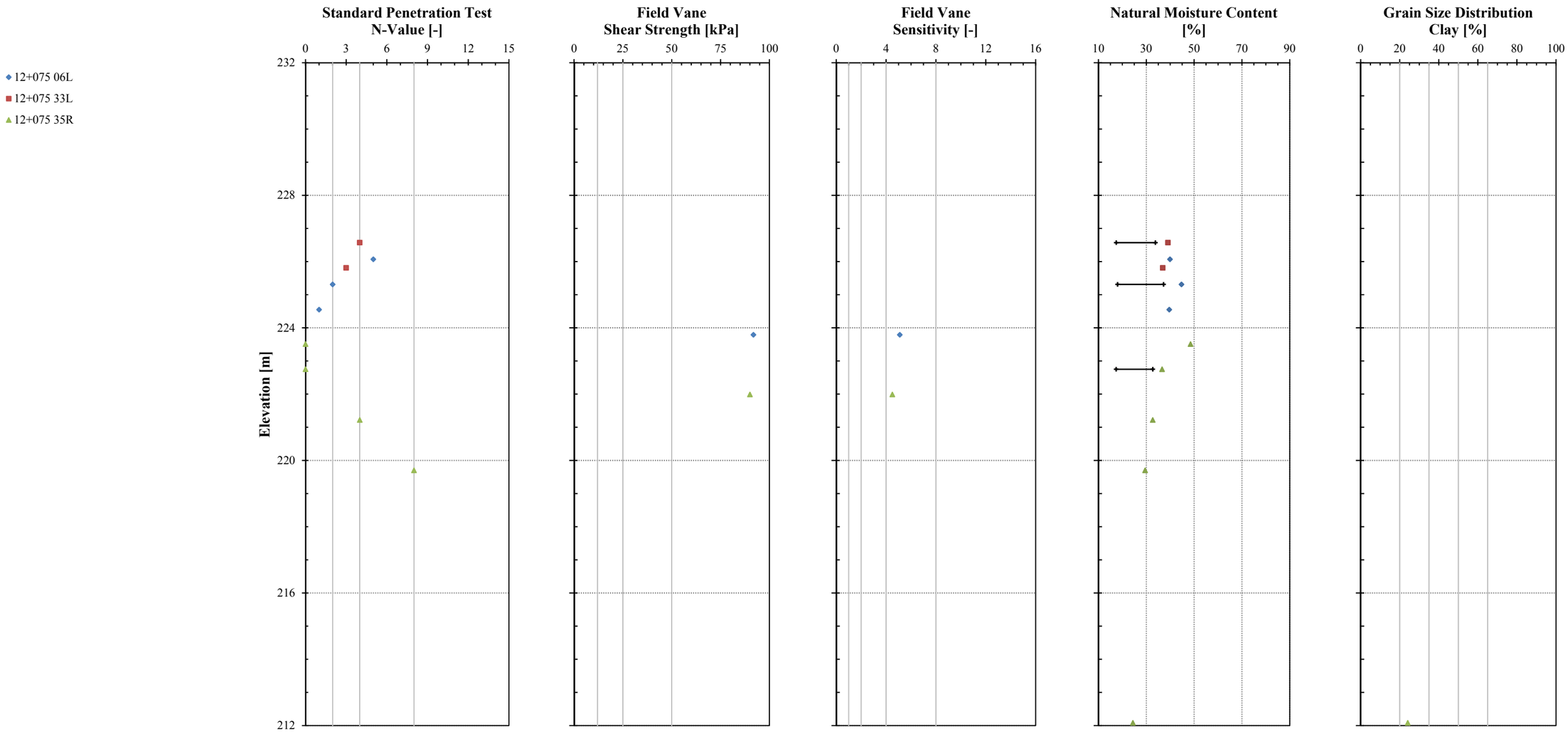


Figure Z5

Appendix AA

Highway 11/17 EBL and WBL

Sta. 12+230 to 12+250

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table AA1
Recommendation Summary Table

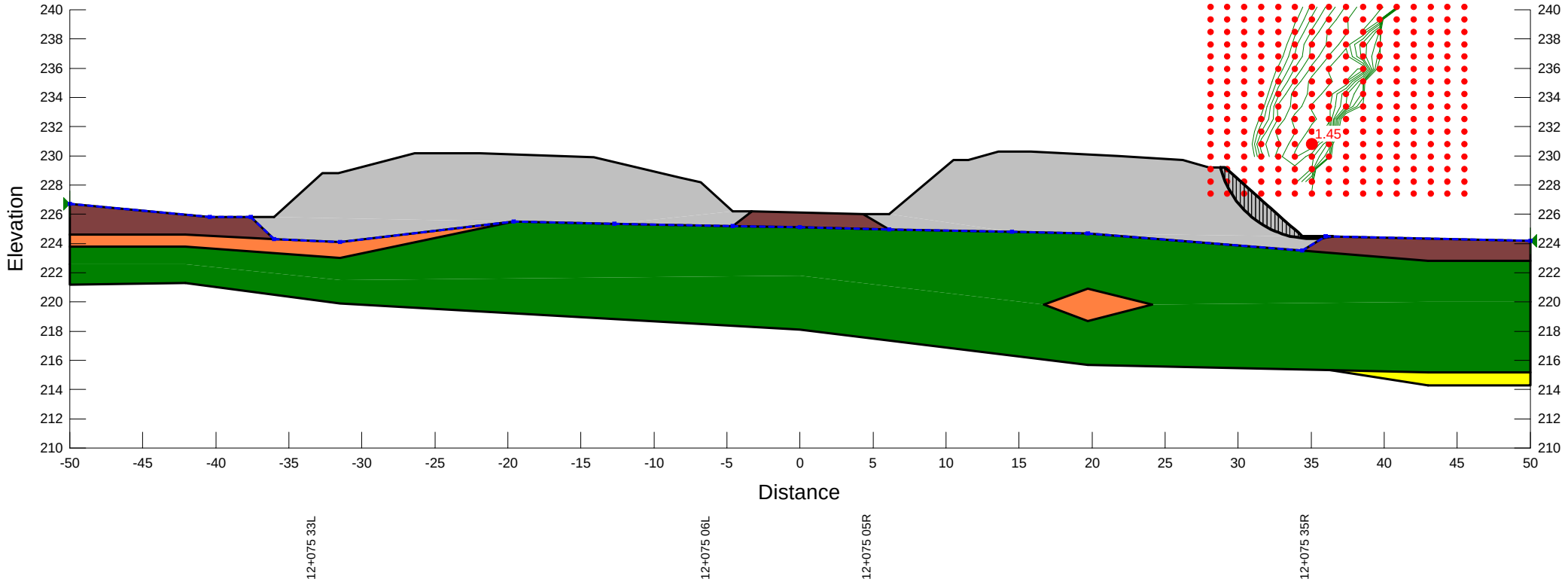
Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
12+230	12+250	12+235	X	1.5 to 1.7	4.7 to 8.6	225.6	230.0 (4.4)	-	-	-	-	-	2	0.2 to 1.7	8.6 to 9.1	224.8	230.0 (5.2)	-	-	-	-	-	2	40	5	40	70	110
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 2 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 2 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 12+230 to 12+250
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:52:23 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay (TSA)	18 kN/m³	50 kPa	0 °	1
Silt	19 kN/m³	0 kPa	28 °	1
Rock Fill	19 kN/m³	0 kPa	42 °	1
Silty Sand	20 kN/m³	0 kPa	40 °	1



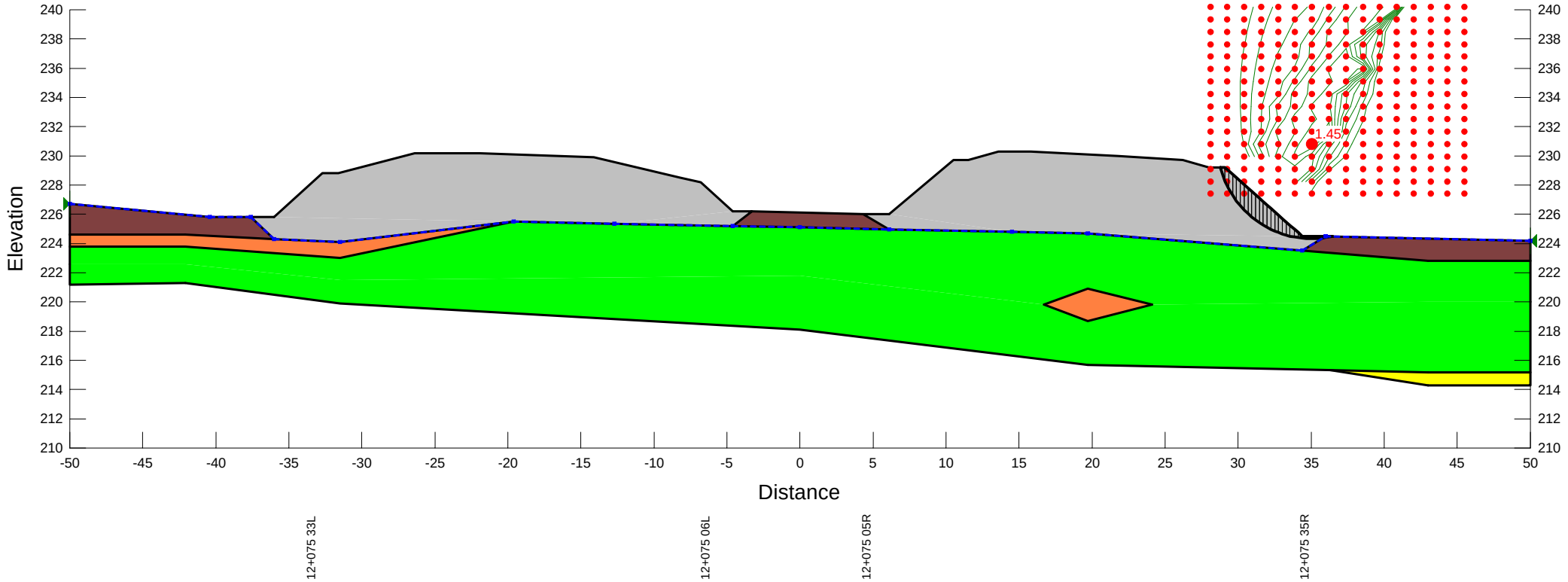
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\12+230-12+250\Stability\

Figure AA1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 12+230 to 12+250
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 9:52:14 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silt	19 kN/m³	0 kPa	28 °	1
Rock Fill	19 kN/m³	0 kPa	42 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1
Silty Sand	20 kN/m³	0 kPa	40 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\12+230-12+250\Stability\

Figure AA2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-51	0	0	9
	-49	0	2	9
	-47	1	4	12
	-45	1	6	17
	-43	1	8	26
	-41	2	10	37
	-39	3	12	46
	-37	6	14	53
	-35	12	16	57
	-32	19	18	59
	-30	23	20	59
	-28	25	22	57
	-26	26	24	53
	-24	26	26	48
	-22	26	28	42
	-20	26	30	33
	-18	26	32	21
	-16	26	35	13
	-14	26	37	7
	-12	26	39	5
	-10	25	41	3
	-8	23	43	2
	-6	19	45	2
	-4	13	47	2
	-2	10	49	1
	0	9	51	1

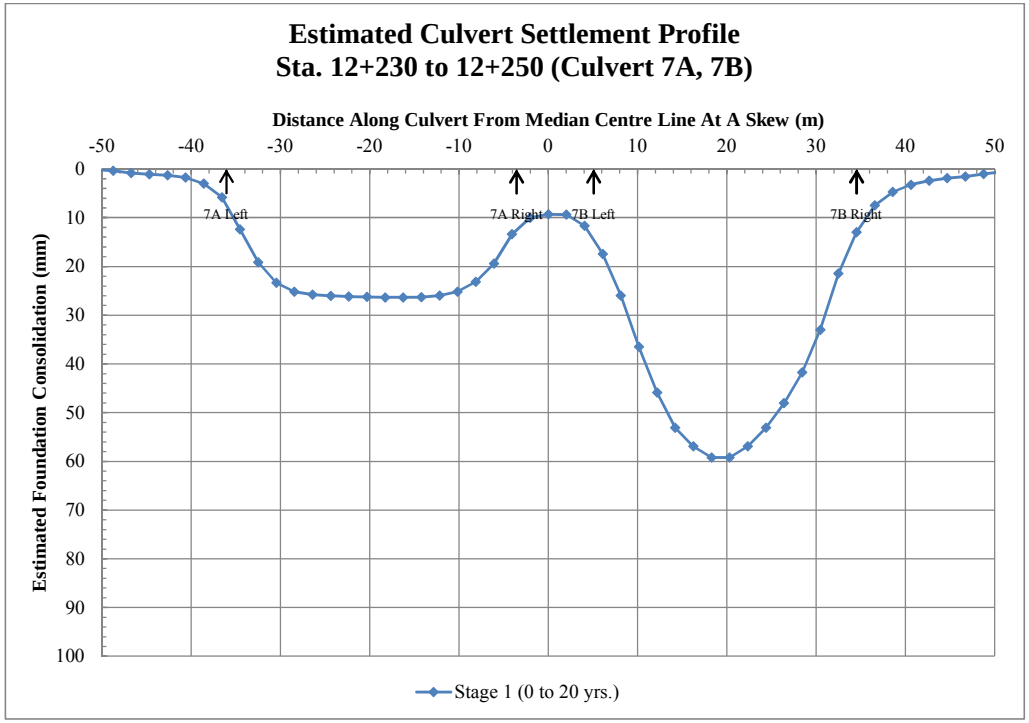


Figure AA3

THURBER

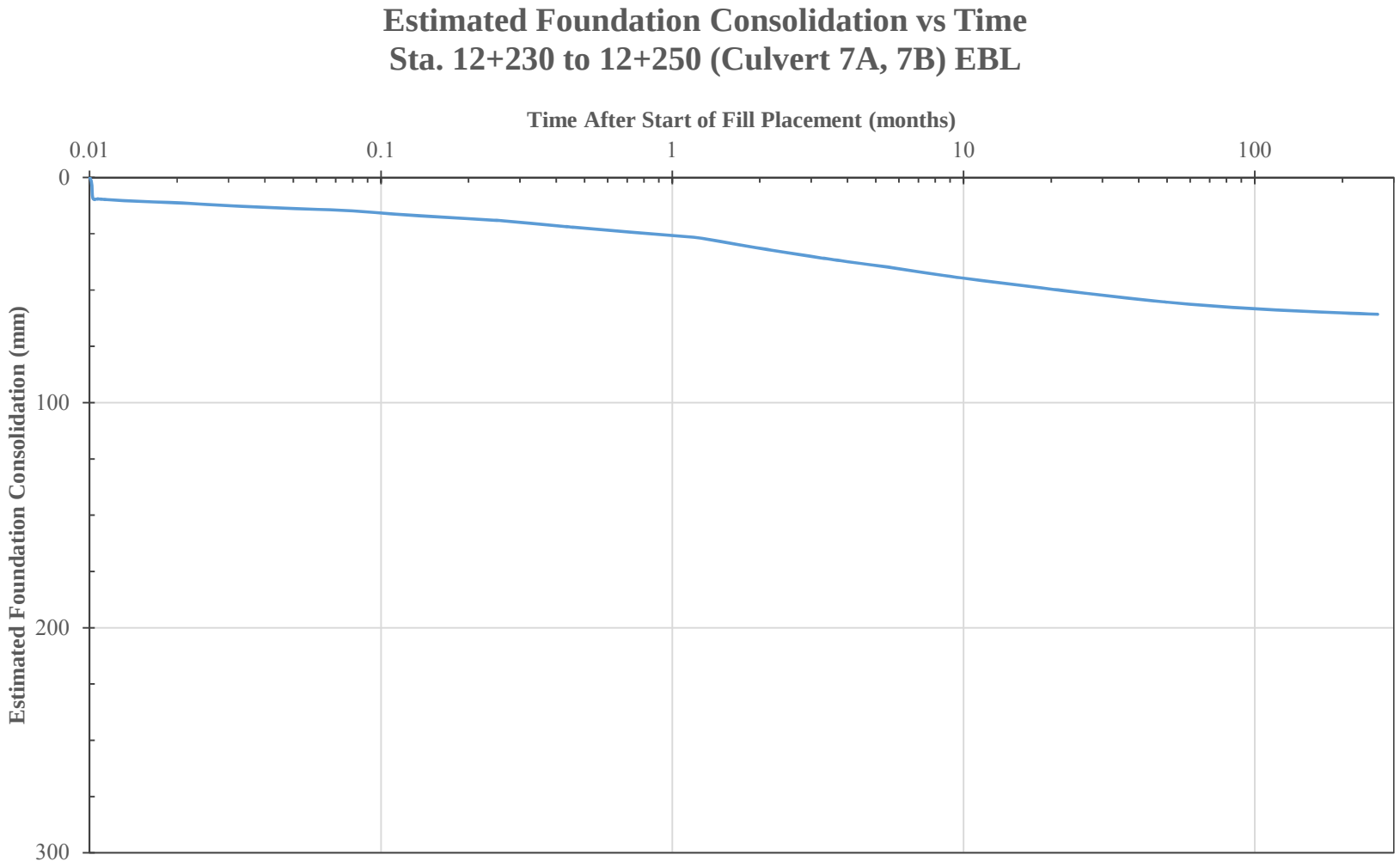

Estimated Foundation Consolidation vs Time
Sta. 12+230 to 12+250 (Culvert 7A, 7B) EBL
Time After Start of Fill Placement (months)
0.01
0.1
1
10
100
0
100
200
300
Estimated Foundation Consolidation (mm)

Figure AA4

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 12+230 to 12+250

Summary of Subsurface Conditions (Cohesive Soils)

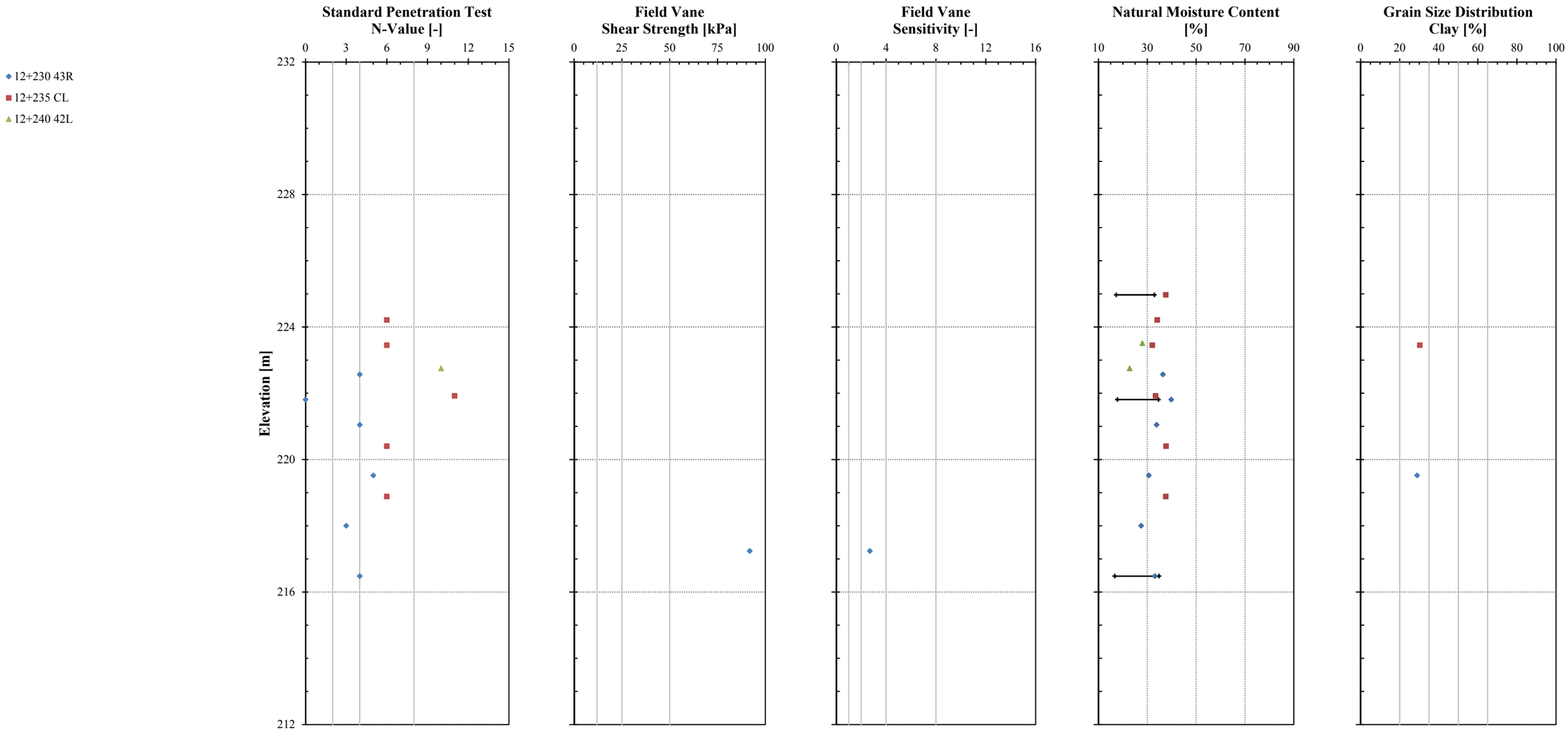


Figure AA5

Appendix AB

Highway 11/17 EBL and WBL

Sta. 14+720 to 14+760

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures

Table AB1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.(6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
14+190	14+210	14+201	X	0.2 to 0.5	0.3 to 0.9	220.7	225.1 (4.4)	-	-	-	-	-	1	0.0 to 0.5	0.5 to 1.3	218.4	224.4 (6.0)	-	-	-	-	-	1	45	10	25	55	80
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 14+200 to 14+210
Last Edited By: Michael Eastman
Last Solved Date: 8/8/2014, 8:22:14 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Silty Clay Top (TSA)	18 kN/m³	40 kPa	0 °	1
Silty Sand	19.5 kN/m³	0 kPa	35 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1

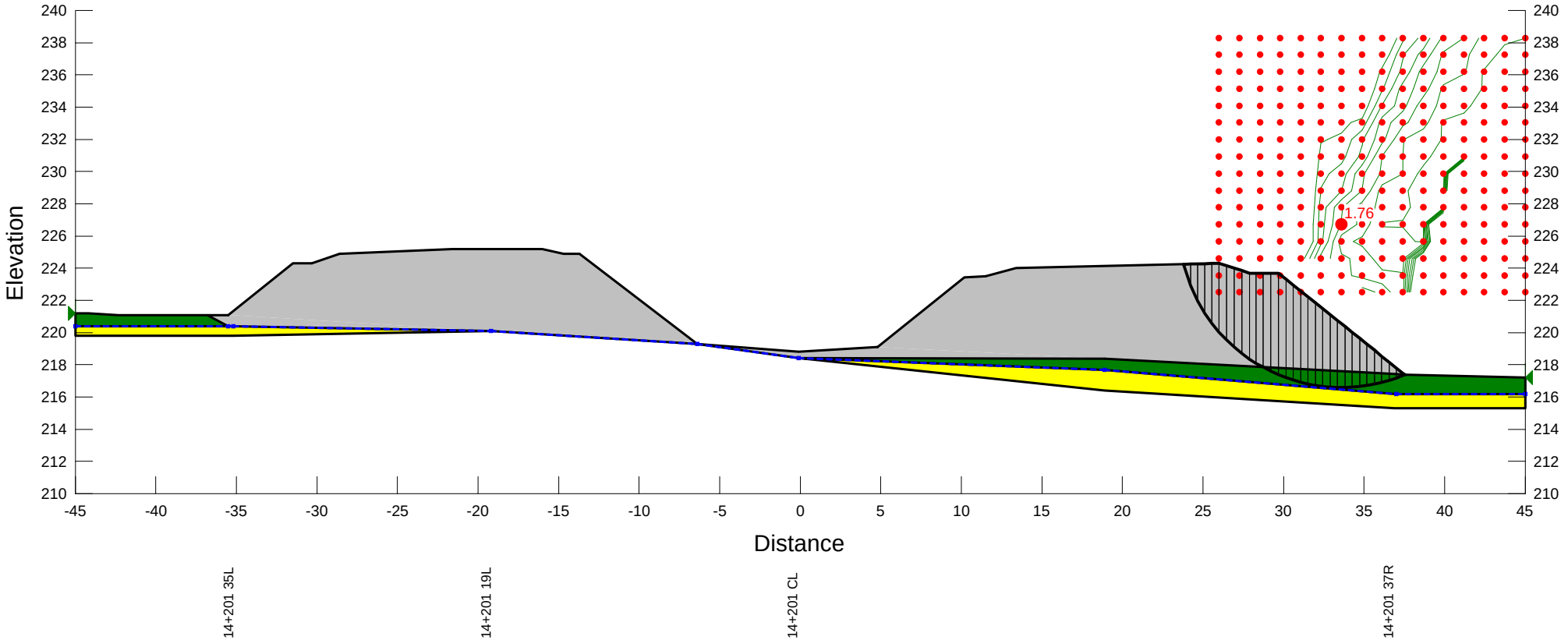


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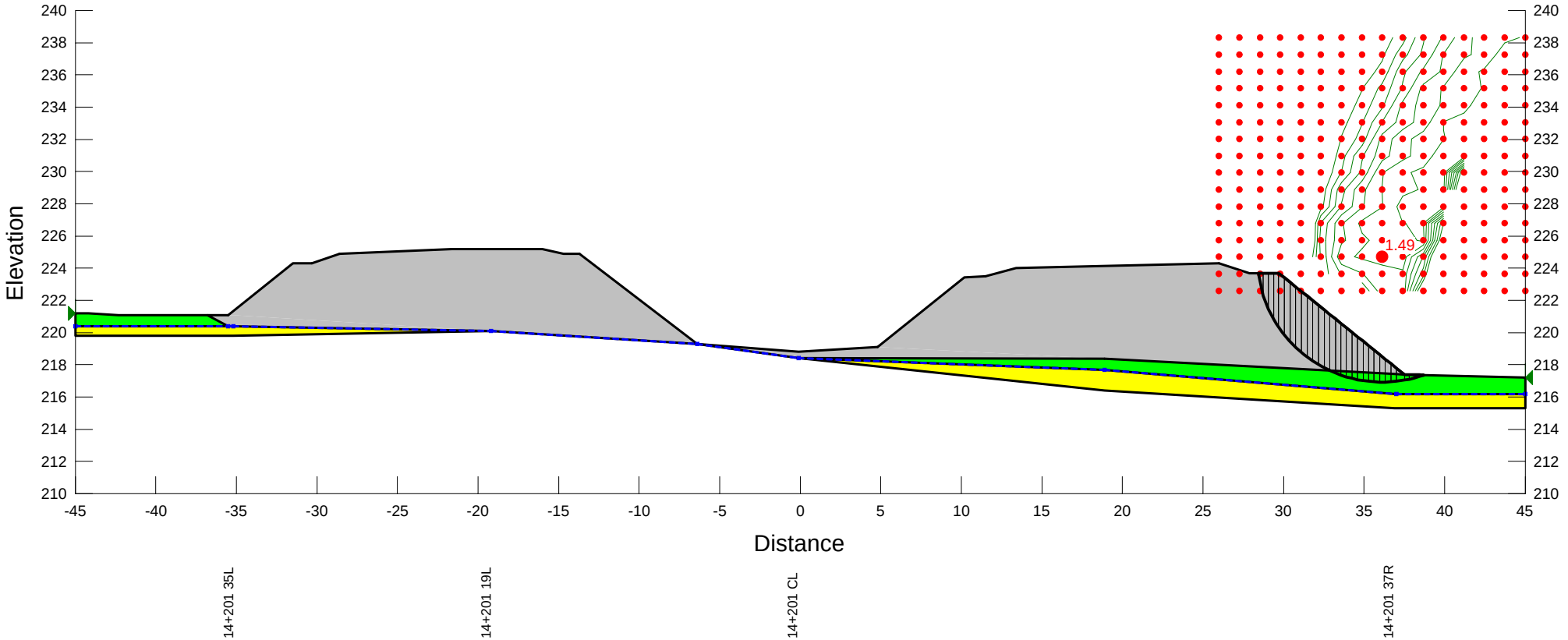
Figure AB1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 14+200 to 14+210
Last Edited By: Michael Eastman
Last Solved Date: 8/8/2014, 8:22:05 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Silty Sand	19.5 kN/m³	0 kPa	35 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\14+200-14+210\Stability\

Figure AB2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-50	0	0	0
	-48	0	2	1
	-46	0	4	1
	-44	1	6	7
	-42	1	8	13
	-40	1	10	17
	-38	1	12	20
	-36	2	14	22
	-34	5	16	23
	-32	8	18	24
	-30	12	20	24
	-28	13	22	24
	-26	12	24	24
	-24	11	26	23
	-22	8	28	23
	-20	4	30	20
	-18	4	32	17
	-16	7	34	12
	-14	9	36	6
	-12	9	38	3
	-10	7	40	2
	-8	3	42	1
	-6	1	44	1
	-4	1	46	1
	-2	0	48	1
	0	0	50	0

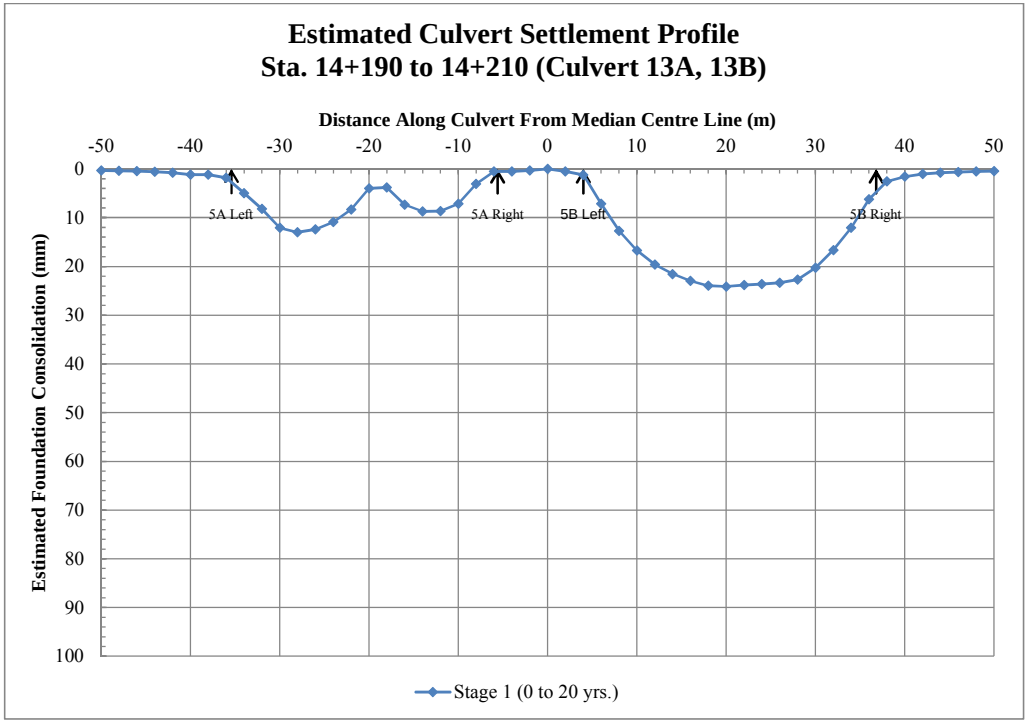


Figure AB3

THURBER

Appendix AC

Highway 11/17 EBL and WBL

Sta. 14+720 to 14+760

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table AC1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
			X	0.2 to 0.6	9.1 to 13.1	217.8	220.6 (2.5)	2.0	12.5	219.3 (1.5)	-	1.2	Stage 1: 6 Stage 2: 12 (18 total)	0.5 to 0.6	0.5 to 4.3	216.8	220.6 (3.5)	2.0	9.5	219.3 (2.5)	-	-	Stage 1: 6 Stage 2: 12 (18 total)	20	5	470	25	495
14+720	14+760	14+740		-Pre Construction: Remove organics/peat and replace with drainage blanket to 1.0 m above water level for wick drain installation. Install wick drains. Install monitoring instrumentation. Record monitoring instrumentation baseline readings. -Sacrificial culvert will need to be installed (details to be provided) -Fill Placement Stage 1: Simultaneously construct berm (to dimensions shown) and embankments to maximum total height of 5.0 m above existing ground elevation (or embankment + surcharge, if total height is less then 5.0 m). Wait 6 months. -Fill Placement Stage 2: Reconstruct embankment to Stage 1 elevation (replace grade due to settlement) + 0.5 m. Wait 12 months. -Excavate sacrificial culvert and replace with permanent culvert. -Post Construction: After wait period, remove excess surcharge to design road grade elevation and complete paving. Estimated settlement: -Stage 1: 365 mm -Stage 2: 115 mm Height of surcharge, berm extents and wick drain spacing provided previously																										

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL ST Stage 1
Description: STA: 14+720 to 14+760
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 9:51:54 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Silt	19.5 kN/m³	0 kPa	34 °	1
Silty Clay TSA 1	18 kN/m³	20 kPa	0 °	1
Sand	20 kN/m³	0 kPa	32 °	1
Silty Clay TSA 2	18 kN/m³	40 kPa	0 °	1
Sitly Clay TSA 3	18 kN/m³	60 kPa	0 °	1
Surcharge	21 kN/m³	0 kPa	32 °	1

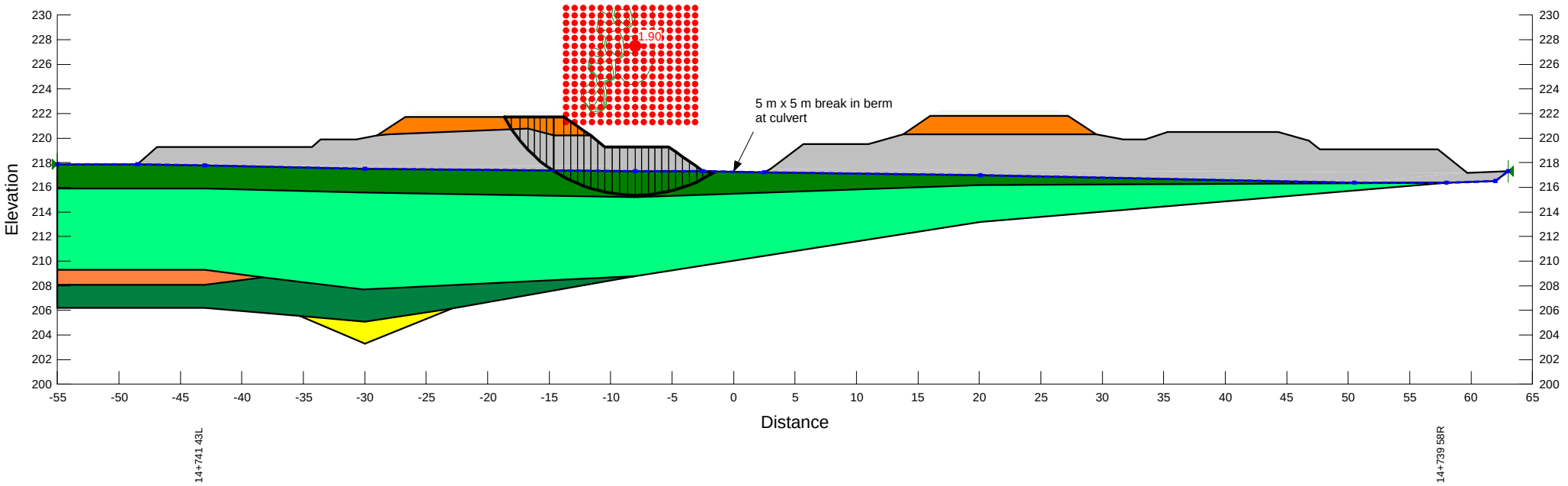


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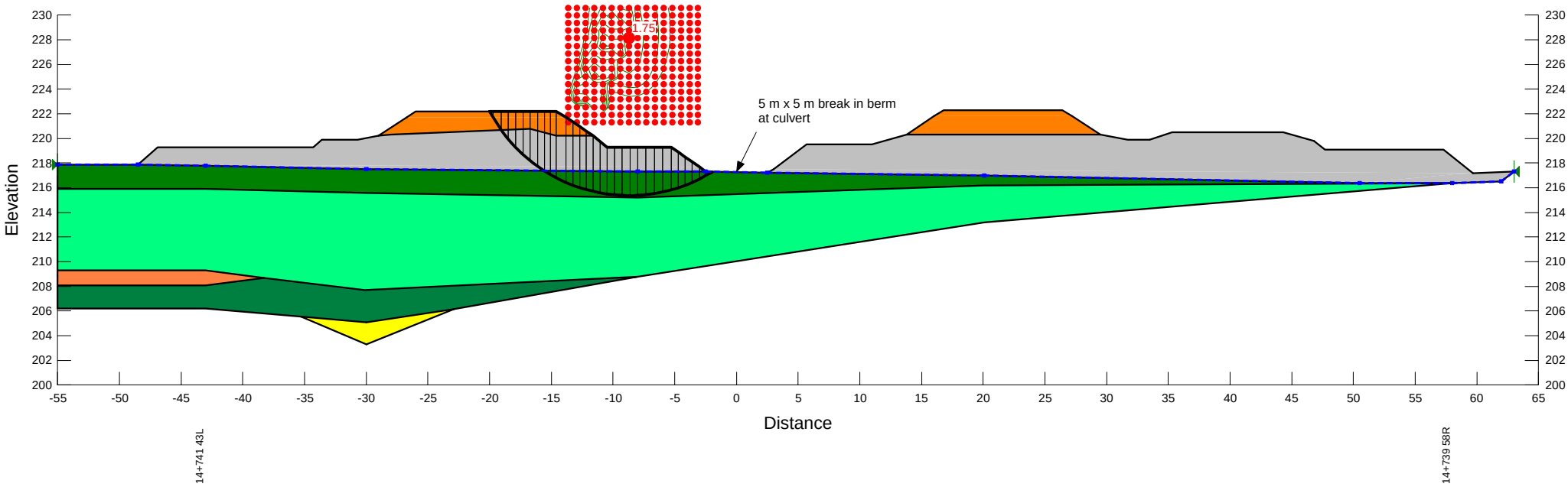
Figure AC1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL ST Stage 2
Description: STA: 14+720 to 14+760
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 9:52:04 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Silt	19.5 kN/m³	0 kPa	34 °	1
Silty Clay TSA 1	18 kN/m³	20 kPa	0 °	1
Sand	20 kN/m³	0 kPa	32 °	1
Silty Clay TSA 2	18 kN/m³	40 kPa	0 °	1
Sitly Clay TSA 3	18 kN/m³	60 kPa	0 °	1
Surcharge	21 kN/m³	0 kPa	32 °	1



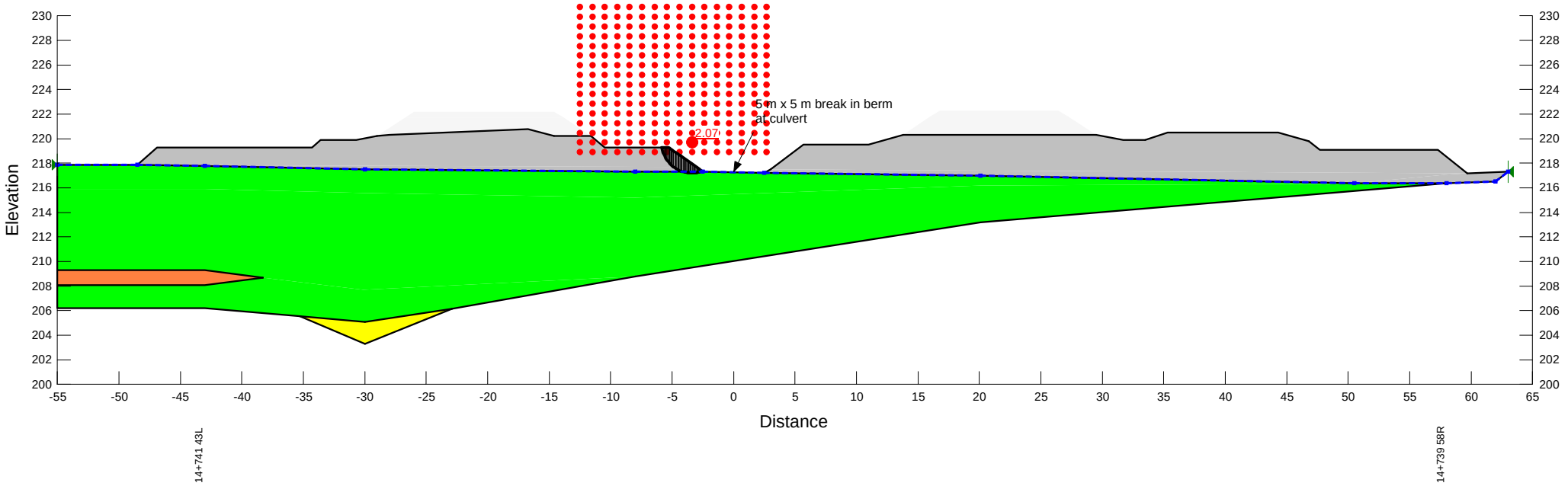
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\14+720-14+760\Stability\

Figure AC2

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL LT
Description: STA: 14+720 to 14+760
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 9:57:08 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Silt	19.5 kN/m³	0 kPa	34 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sand	20 kN/m³	0 kPa	32 °	1



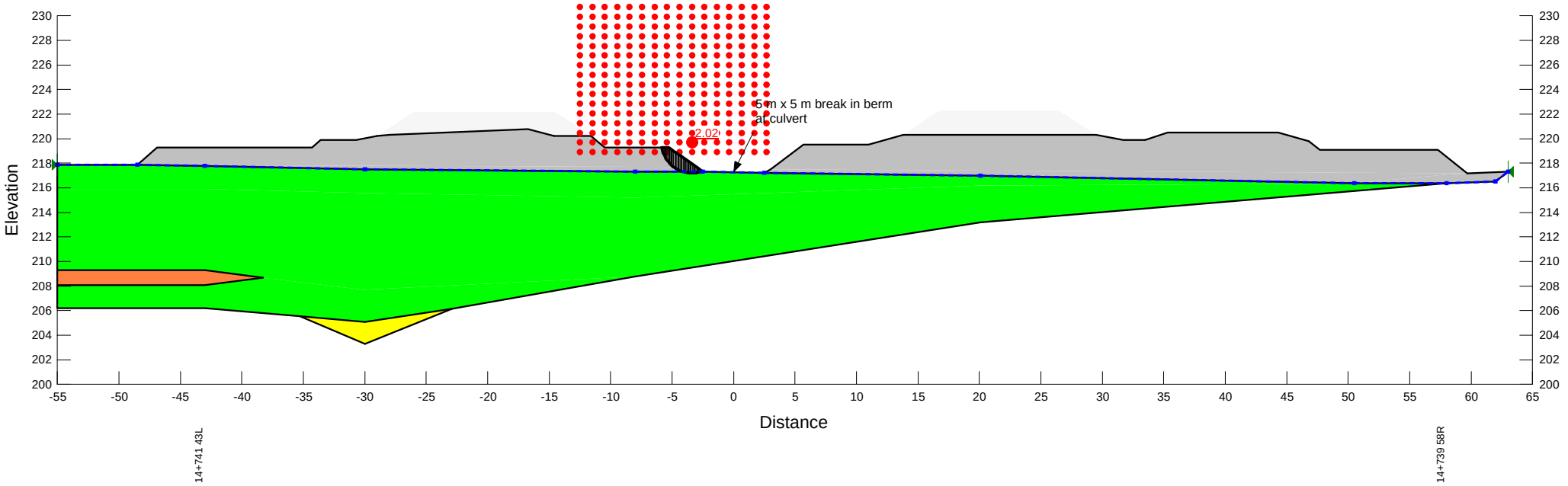
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\14+720-14+760\Stability\

Figure AC3

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL LT Seismic
Description: STA: 14+720 to 14+760
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 9:58:31 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0.01

Rock Fill	20 kN/m³	0 kPa	42 °	1
Silt	19.5 kN/m³	0 kPa	34 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sand	20 kN/m³	0 kPa	32 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\14+720-14+760\Stability\

Figure AC4

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-60	1	0	86
	-58	2	2	53
	-55	3	5	55
	-53	4	7	57
	-50	7	10	59
	-48	36	12	73
	-46	64	14	95
	-43	76	17	109
	-41	83	19	116
	-38	93	22	120
	-36	106	24	122
	-34	151	26	123
	-31	226	29	123
	-29	286	31	123
	-26	332	34	122
	-24	354	36	120
	-22	359	38	117
	-19	348	41	112
	-17	316	43	103
	-14	262	46	85
	-12	195	48	62
	-10	128	50	55
	-7	107	53	52
	-5	98	55	47
	-2	95	58	35
	0	86	60	11

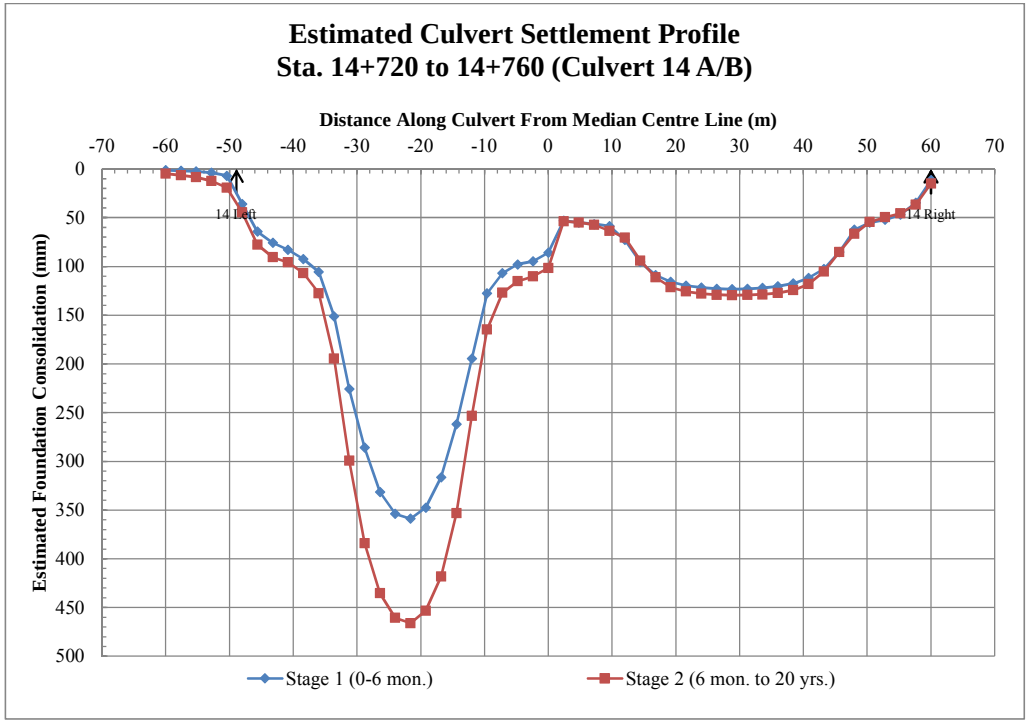


Figure AC5

THURBER

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 2	-60	5	0	50
	-58	6	2	54
	-55	8	5	55
	-53	12	7	57
	-50	19	10	64
	-48	45	12	71
	-46	78	14	94
	-43	91	17	111
	-41	96	19	121
	-38	107	22	126
	-36	128	24	128
	-34	195	26	129
	-31	299	29	130
	-29	384	31	129
	-26	436	34	129
	-24	461	36	127
	-22	466	38	124
	-19	453	41	118
	-17	418	43	105
	-14	353	46	85
	-12	254	48	66
	-10	165	50	55
	-7	127	53	50
	-5	115	55	46
	-2	110	58	37
	0	102	60	15

THURBER

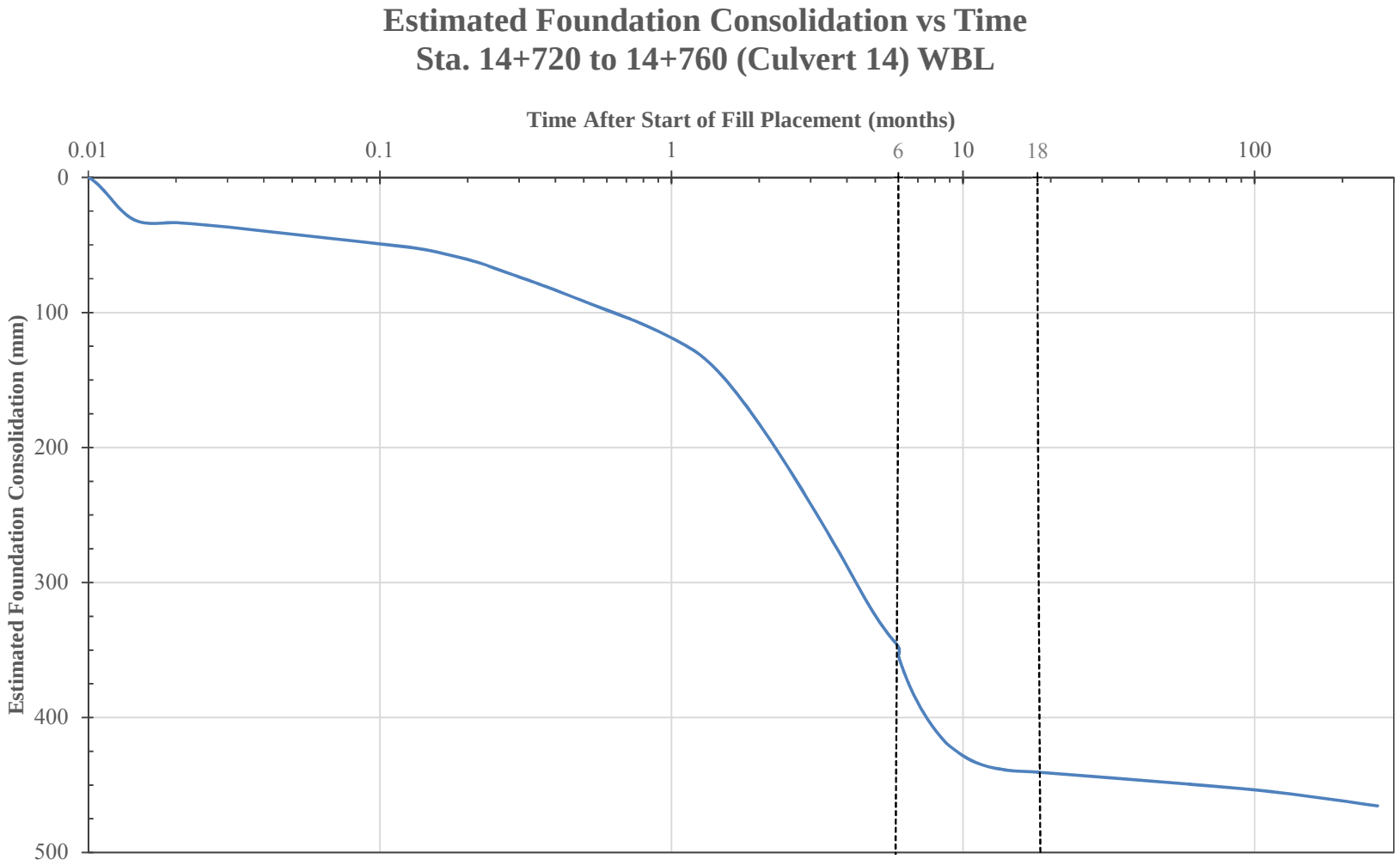


Figure AC7

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 14+720 to 14+760

Summary of Subsurface Conditions (Cohesive Soils)

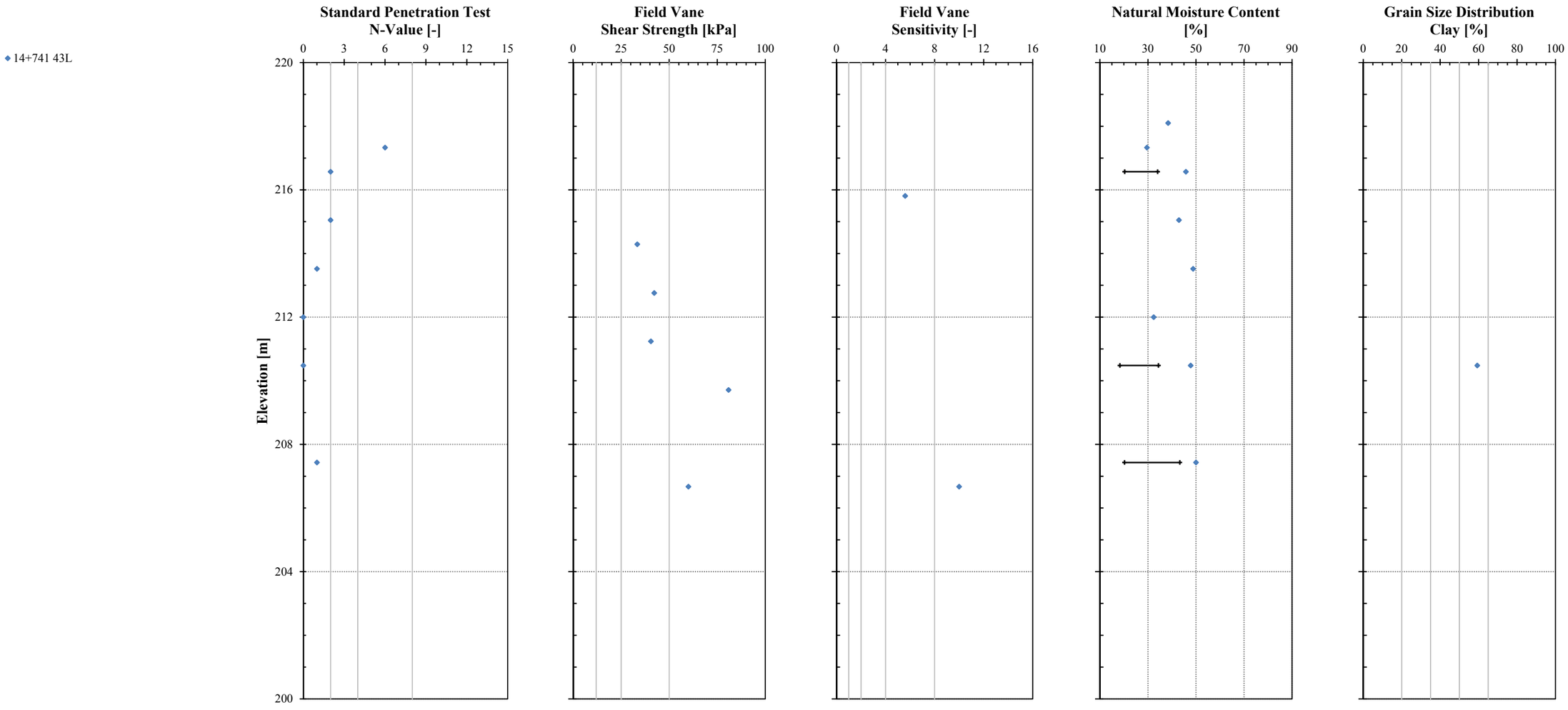


Figure AC8

Appendix AD

Highway 11/17 EBL and WBL

Sta. 15+190 to 15+220

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table AD1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
15+190	15+220	15+206	X	0.6	9.1 to 12.8	213.8	216.0 (2.1)	-	-	-	-	-	2	0.6 to 0.8	9.1 to 14.8	212.7	215.4 (2.7)	-	-	-	-	-	2	15	5	45	75	120
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 2 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving											-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 2 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

THURBER

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 15+190 to 15+220
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 9:49:22 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay Top (TSA)	18 kN/m³	35 kPa	0 °	1
Sandy Silt	19.5 kN/m³	0 kPa	27.5 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Silty Clay Bottom (TSA)	18 kN/m³	50 kPa	0 °	1

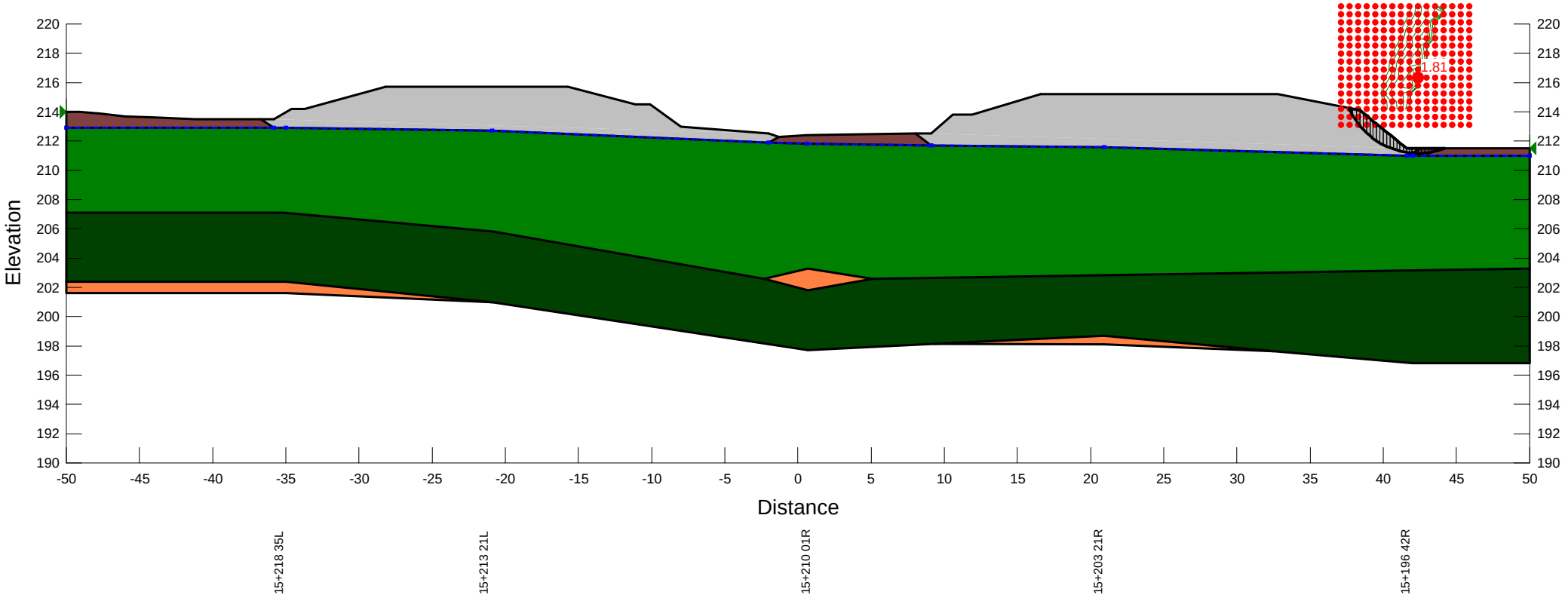


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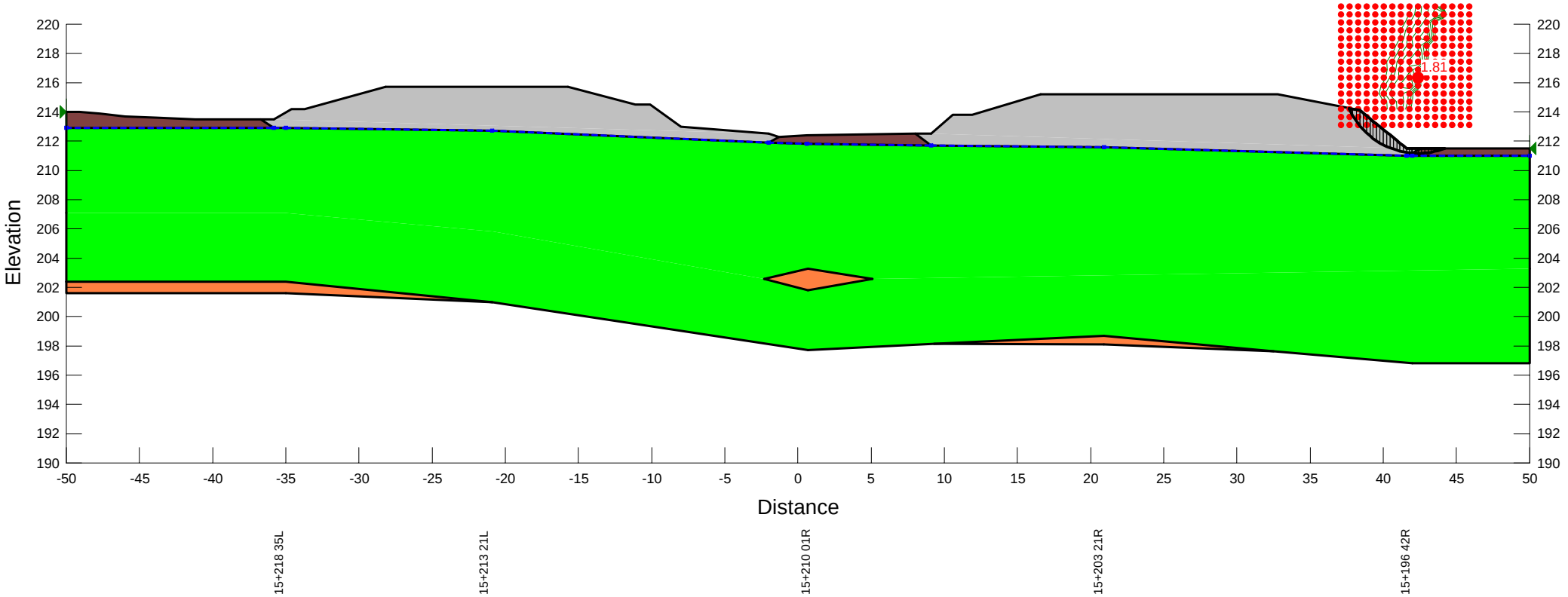
Figure AD1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 15+190 to 15+220
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 9:49:12 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Sandy Silt	19.5 kN/m³	0 kPa	27.5 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\15+190-15+220\Stability\

Figure AD2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-51	3.0	0	17
	-49	4.7	2	18
	-47	6.0	4	20
	-45	7.1	6	24
	-43	8.4	8	29
	-41	10.4	10	46
	-39	13.5	12	62
	-37	18.9	14	77
	-35	30.4	16	89
	-33	43.7	18	95
	-31	59.5	20	97
	-29	75.3	22	98
	-27	85.5	25	98
	-25	89.1	27	98
	-22	90.3	29	97
	-20	89.9	31	95
	-18	87.8	33	90
	-16	81.4	35	78
	-14	65.8	37	63
	-12	51.7	39	46
	-10	37.6	41	28
	-8	26.3	43	19
	-6	21.9	45	14
	-4	19.0	47	11
	-2	17.6	49	9
	0	17.2	51	8

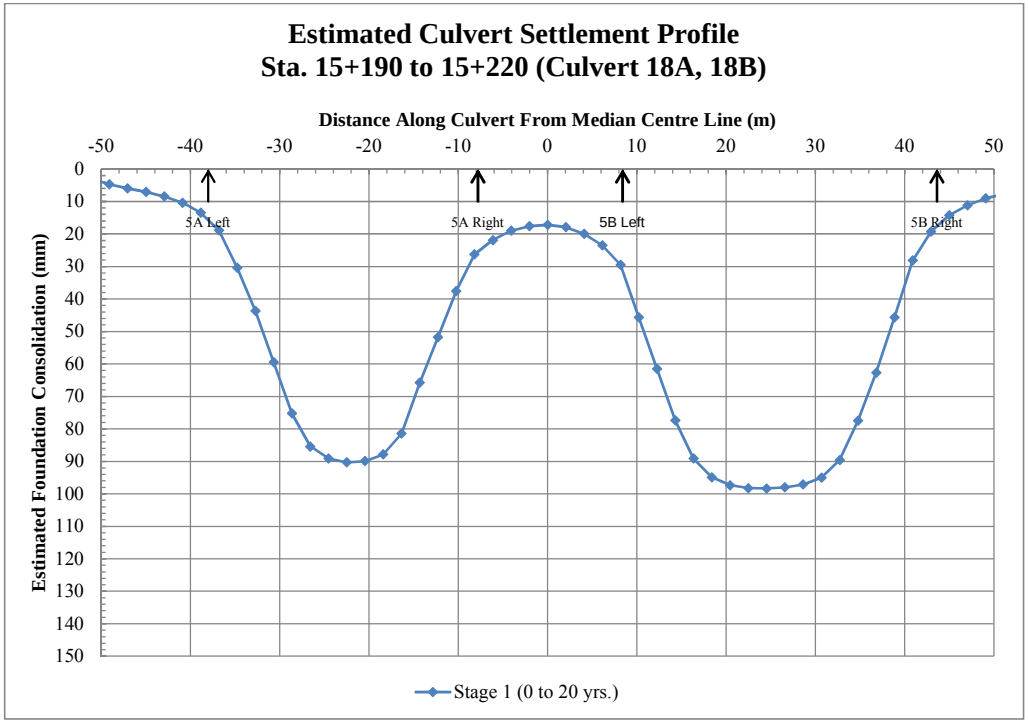


Figure AD3

THURBER

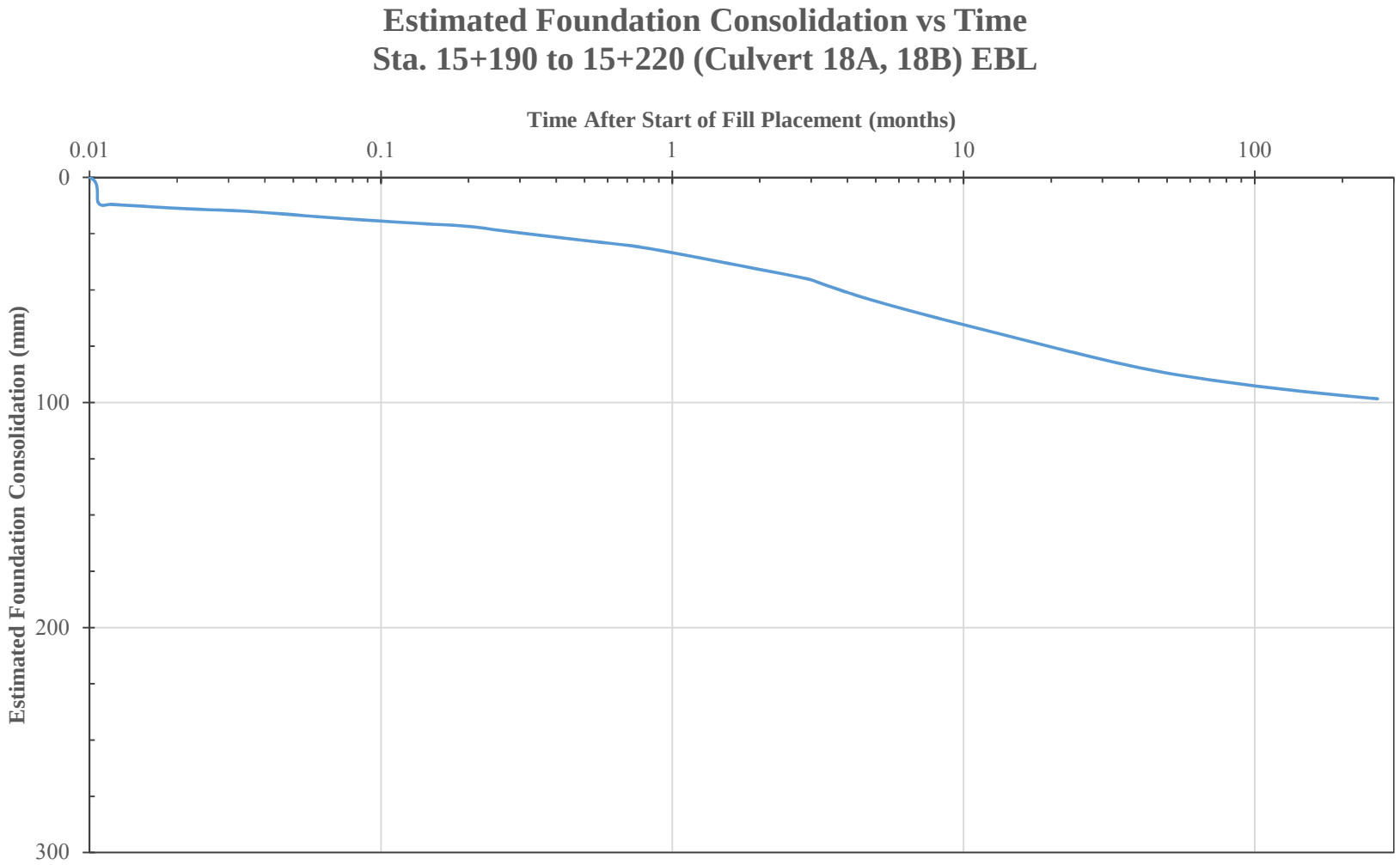

Estimated Foundation Consolidation vs Time
Sta. 15+190 to 15+220 (Culvert 18A, 18B) EBL
Time After Start of Fill Placement (months)
0.01
0.1
1
10
100
0
100
200
300
Estimated Foundation Consolidation (mm)

Figure AD4

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 15+190 to 15+220

Summary of Subsurface Conditions (Cohesive Soils)

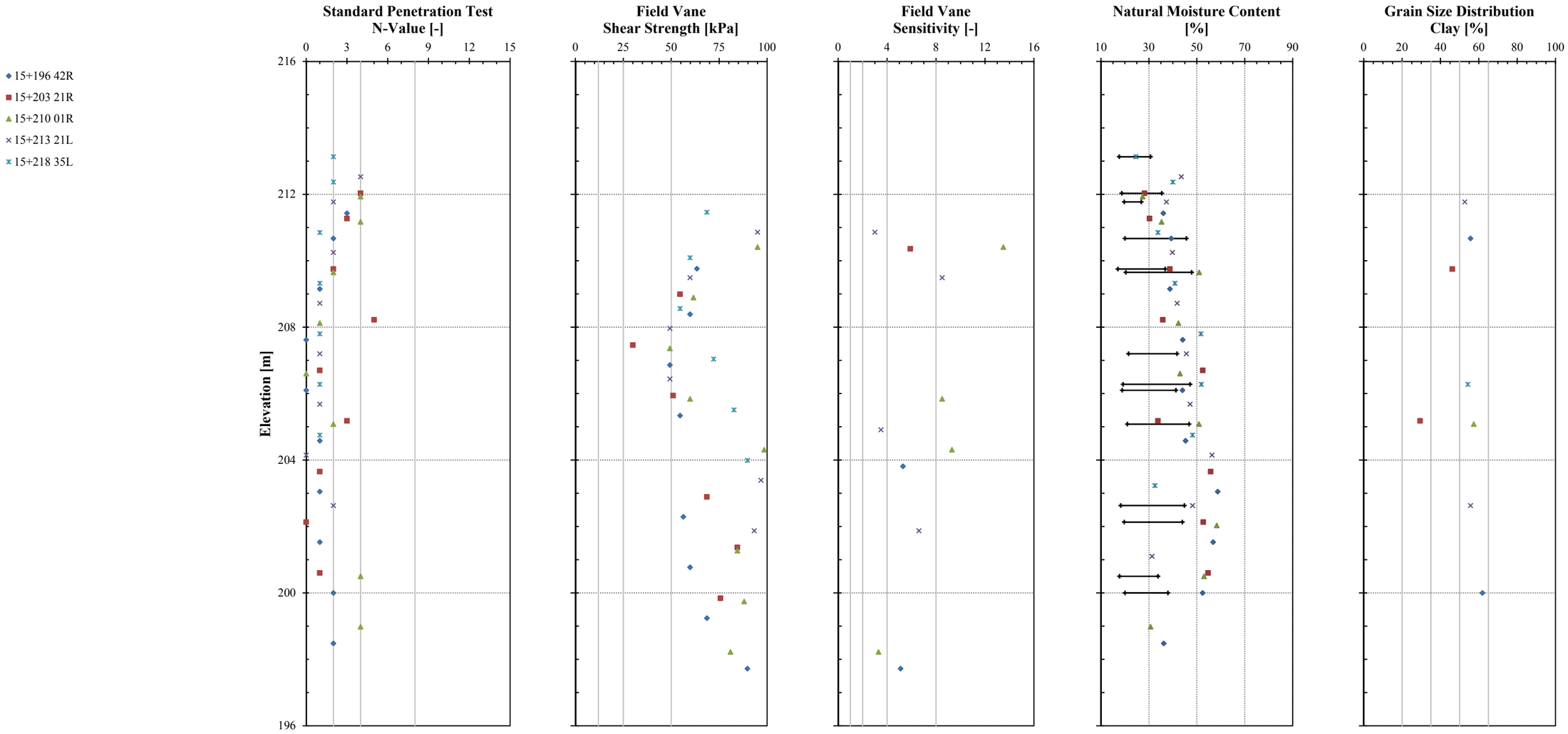


Figure AD5

THURBER

Appendix AE

Highway 11/17 EBL

Sta. 16+390 to 16+410

Highway 11/17 WBL

Sta. 16+430 to 16+470

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table AE1
Recommendation Summary Table

Notes: (01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
16+390	16+410	16+400	X											0.2 to 0.6	6.4 to 6.7	232.5	235.3 (2.8)	-	-	-	-	-	4	15	5	45	55	100
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 4 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																									
16+430	16+470	16+440	X	0.2 to 1.5	7.0 to 11.9	233.0	236.6 (3.6)	-	-	-	-	-	6											20	5	50	95	145
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 6 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving																									

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL ST
Description: STA: 16+440 (16+390 to 16+470)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 9:58:32 AM

Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay (TSA)	18 kN/m³	50 kPa	0 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

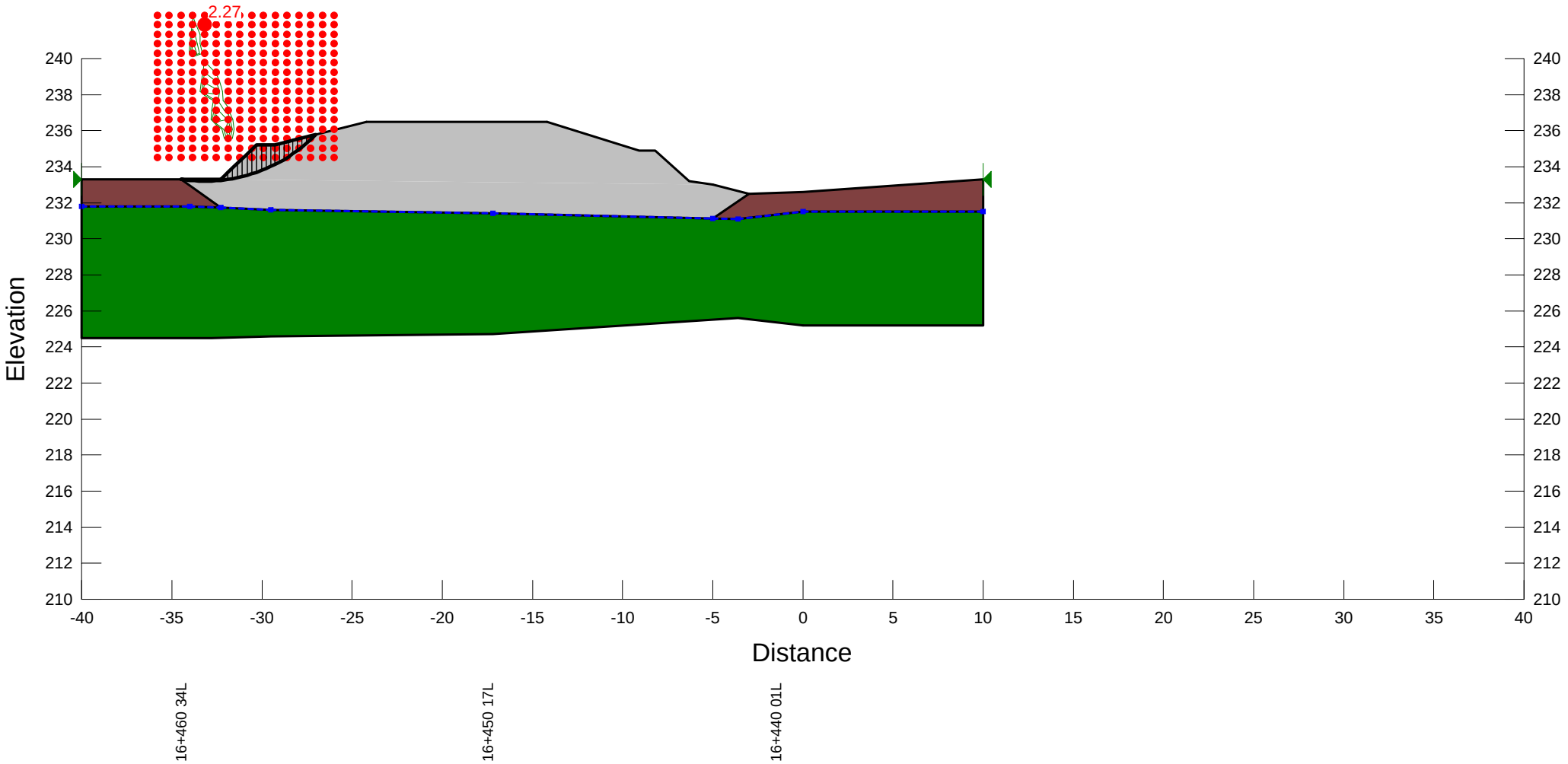


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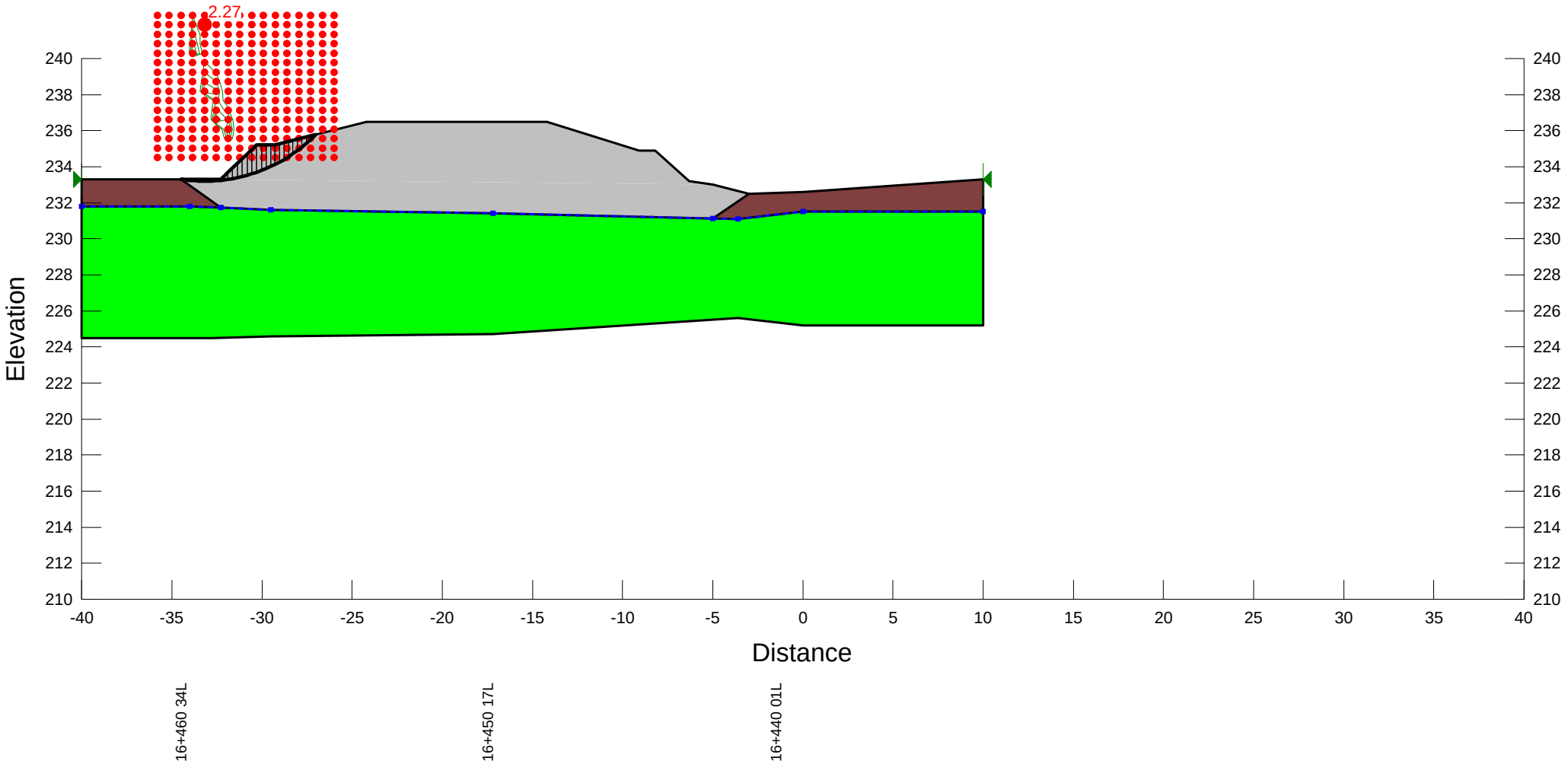
Figure AE1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL LT
Description: STA: 16+440 (16+390 to 16+470)
Last Edited By: Michael Eastman
Last Solved Date: 7/9/2014, 9:58:24 AM

Peat	13 kN/m³	2 kPa	28 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\16+390-16+470\Stability\

Figure AE2

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1			0	9
			2	3
			4	2
			6	5
			8	11
			10	13
			12	20
			14	25
			16	31
			18	39
			20	50
			22	59
			24	72
			26	78
			28	70
			30	49
			32	27
			34	14
			36	8
			38	6
			40	5
			42	3
			44	1
			46	0
			48	0
			50	0

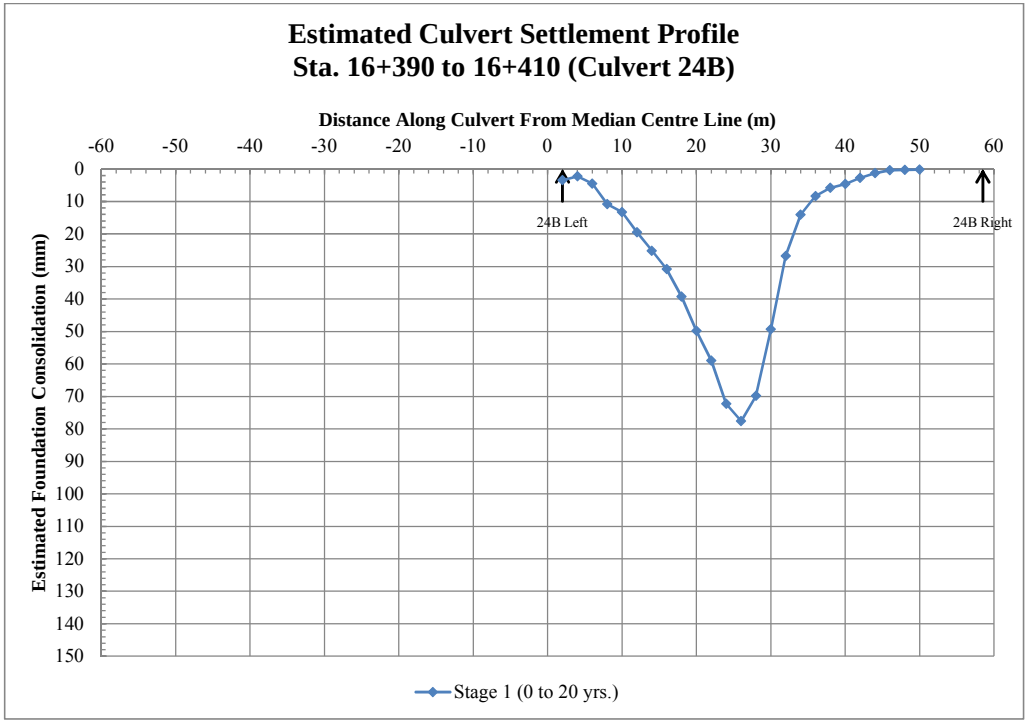


Figure AE3

THURBER

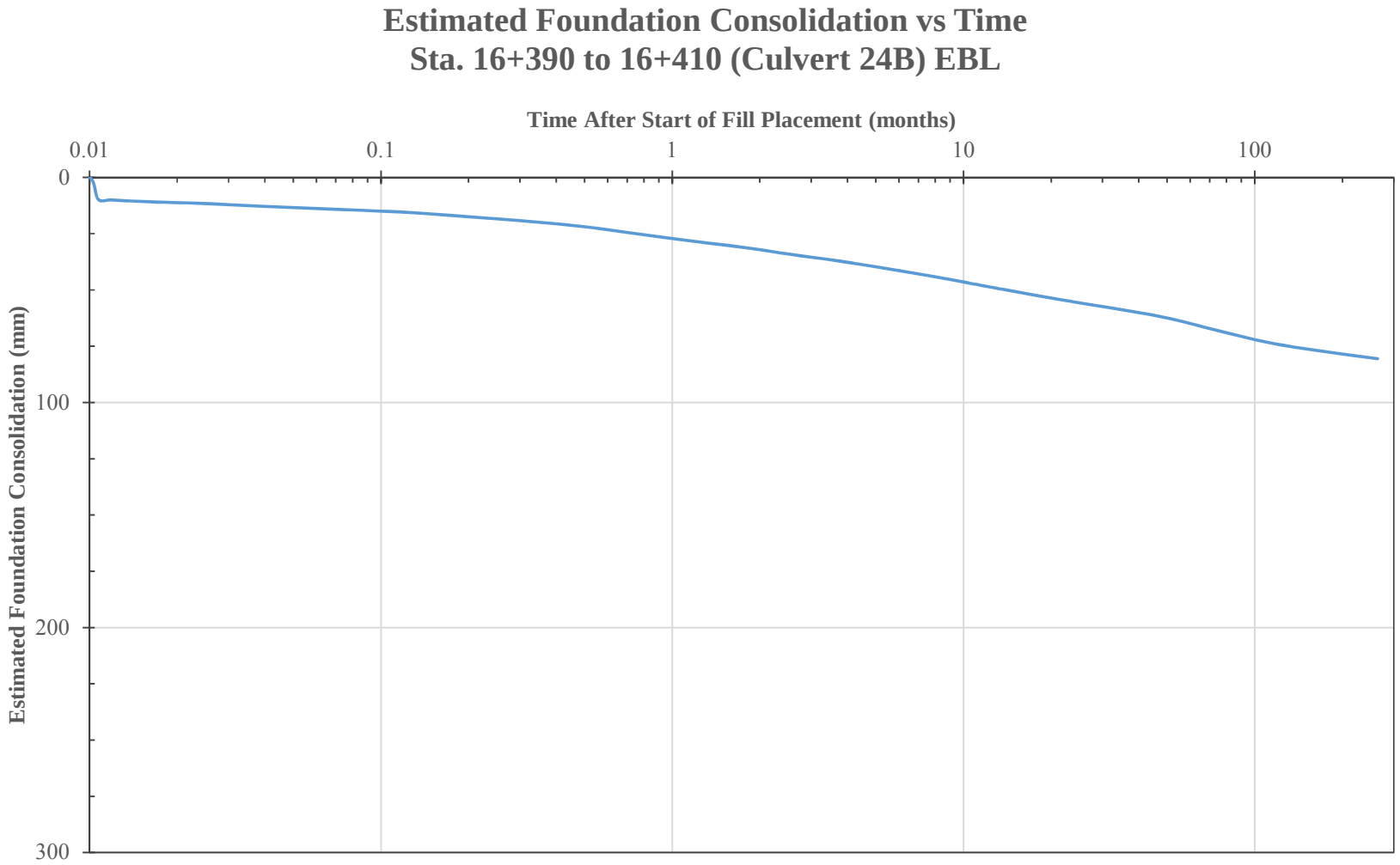


Figure AE4

THURBER

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	0	10		
	-2	12		
	-4	16		
	-5	24		
	-7	38		
	-9	52		
	-11	67		
	-12	83		
	-14	99		
	-16	110		
	-18	117		
	-19	120		
	-21	119		
	-23	117		
	-25	111		
	-26	103		
	-28	92		
	-30	83		
	-32	71		
	-33	59		
	-35	47		
	-37	35		
	-39	23		
	-40	15		
	-42	11		
	-44	8		

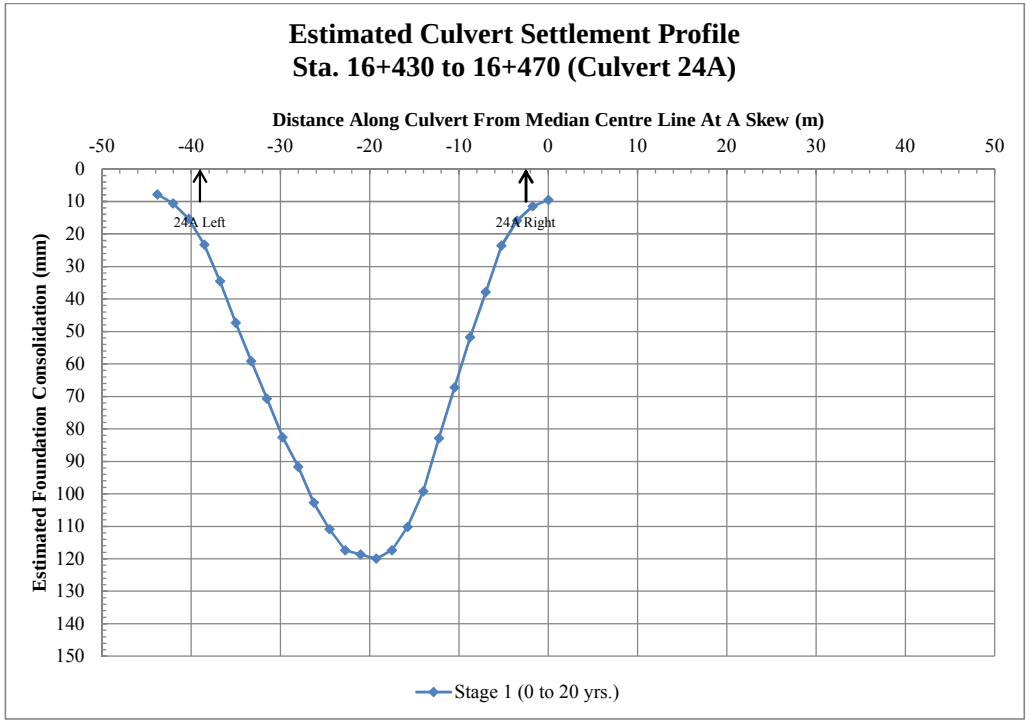


Figure AE5

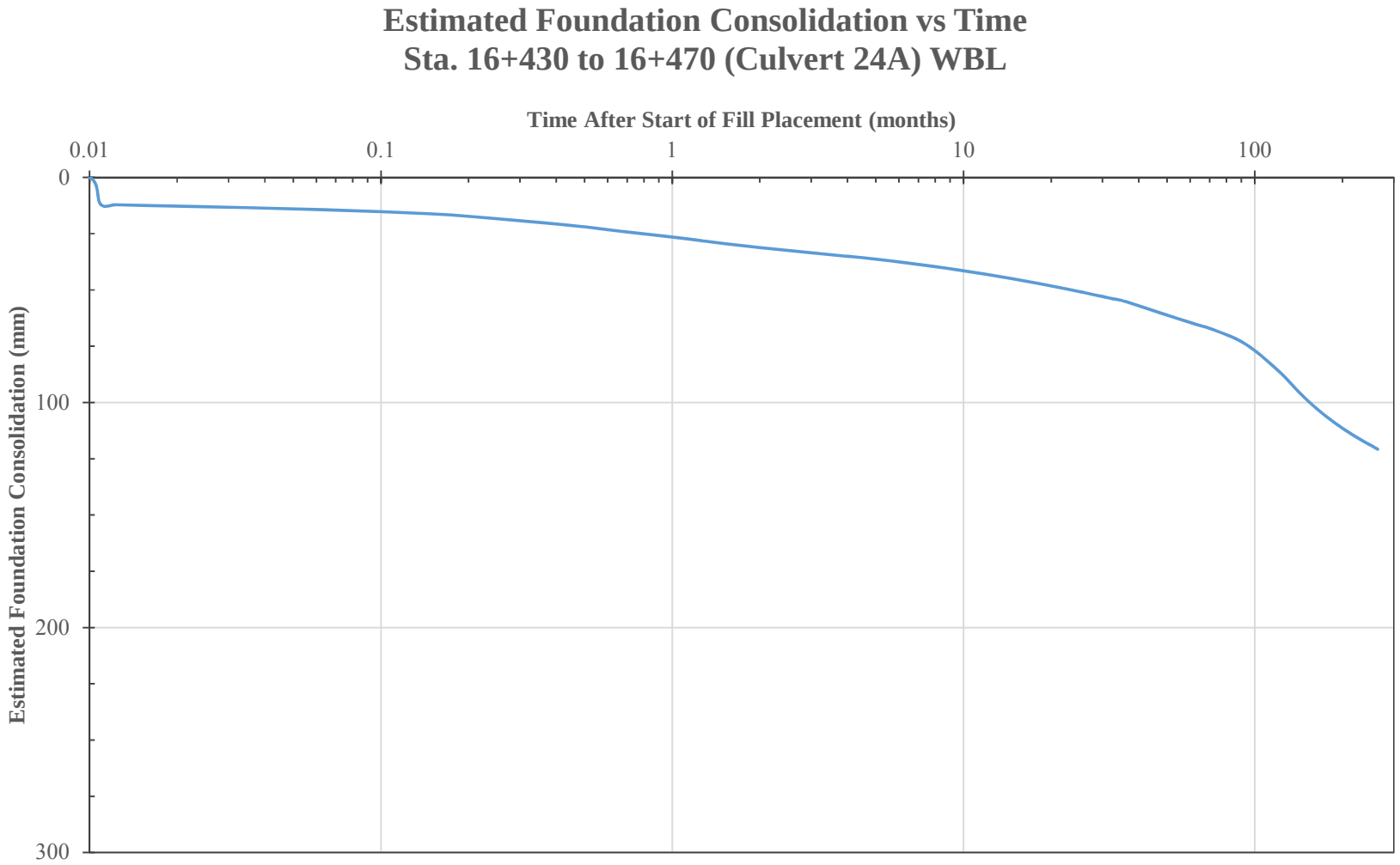


Figure AE6

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL 16+390 to 16+410 and WBL - Sta. 16+430 to 16+470

Summary of Subsurface Conditions (Cohesive Soils)

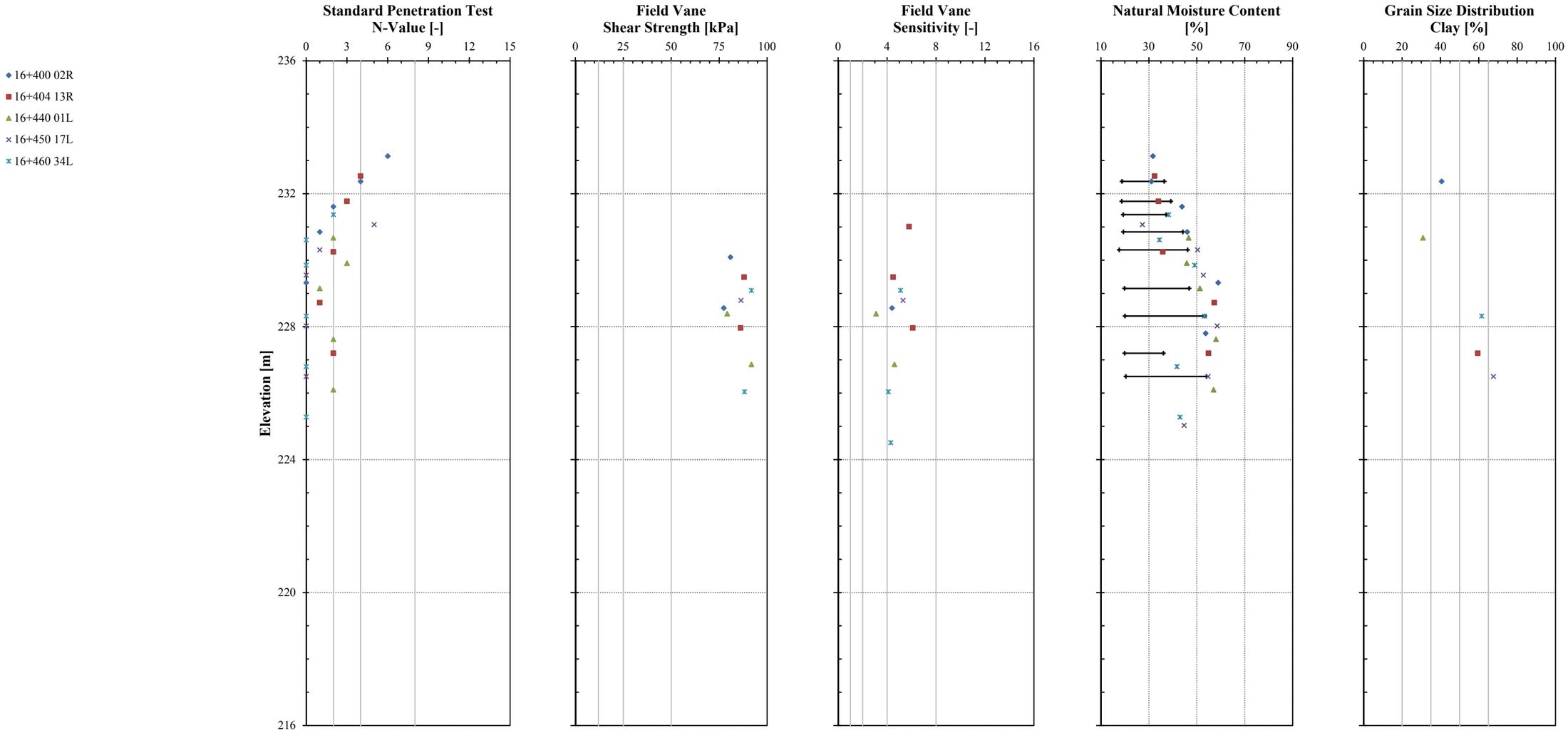


Figure AE7

Appendix AF

Highway 11/17 EBL and WBL

Sta. 16+820 to 16+900

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table AF1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
16+820	16+900	16+857	X	0.2 to 2.1	5.9 to 9.1	243.0	245.4 (2.4)	-	-	-	-	-	12	0.3 to 1.5	6.3 to 10.1	242.3	245.8 (3.5)	-	-	-	-	-	12	20	5	65	95	160
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 12 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 12 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL ST
Description: STA: 16+820 to 16+900
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 11:05:47 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Peat	13 kN/m³	2 kPa	28 °	1
Silty Clay (TSA)	18 kN/m³	50 kPa	0 °	1
Sand	20 kN/m³	0 kPa	35 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1

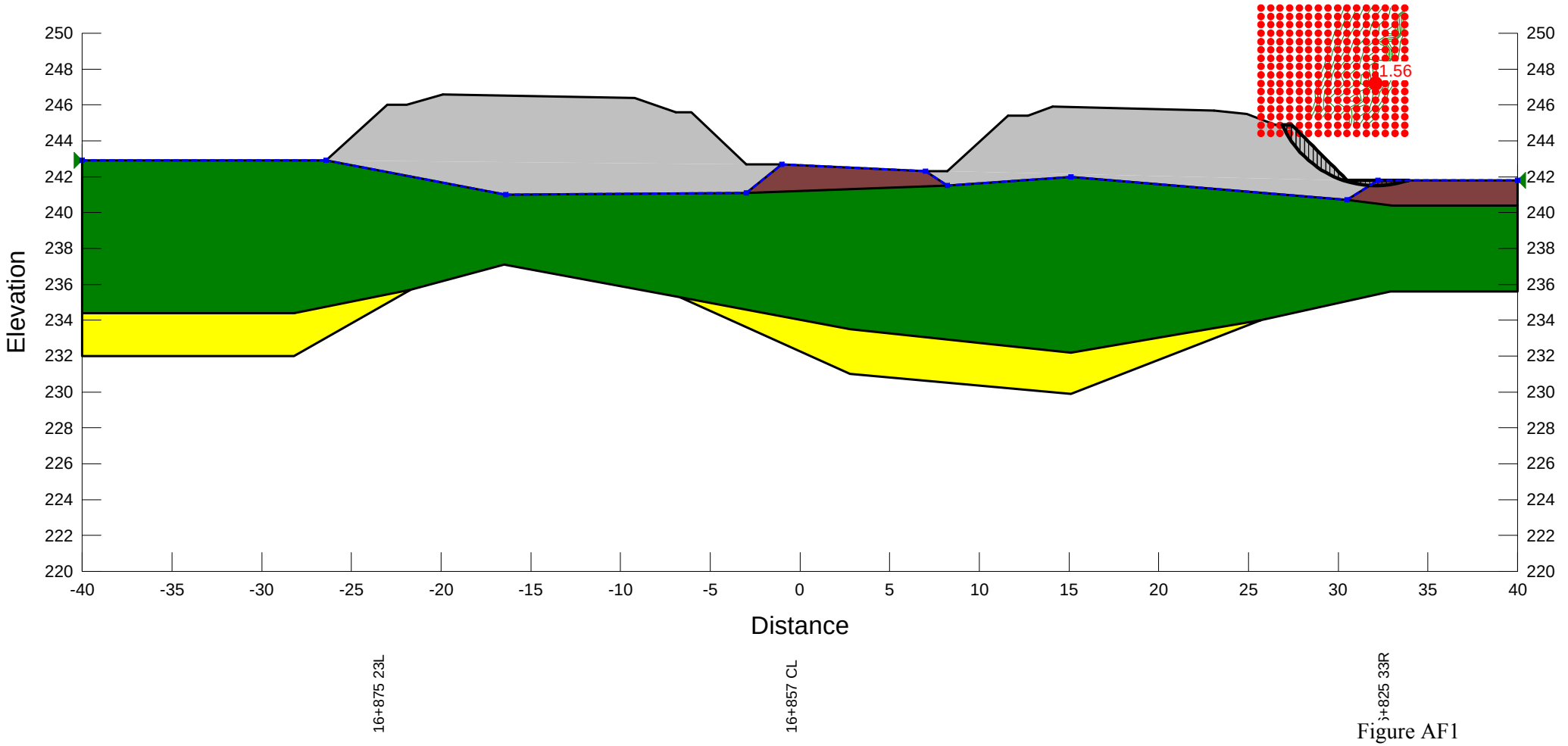


Figure AF1

Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\16+820-16+900\Stability\

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: EBL LT
Description: STA: 16+820 to 16+900
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 11:05:32 AM

Peat	13 kN/m³	2 kPa	28 °	1
Sand	20 kN/m³	0 kPa	35 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Silty Clay (ESA)	18 kN/m³	7 kPa	23 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

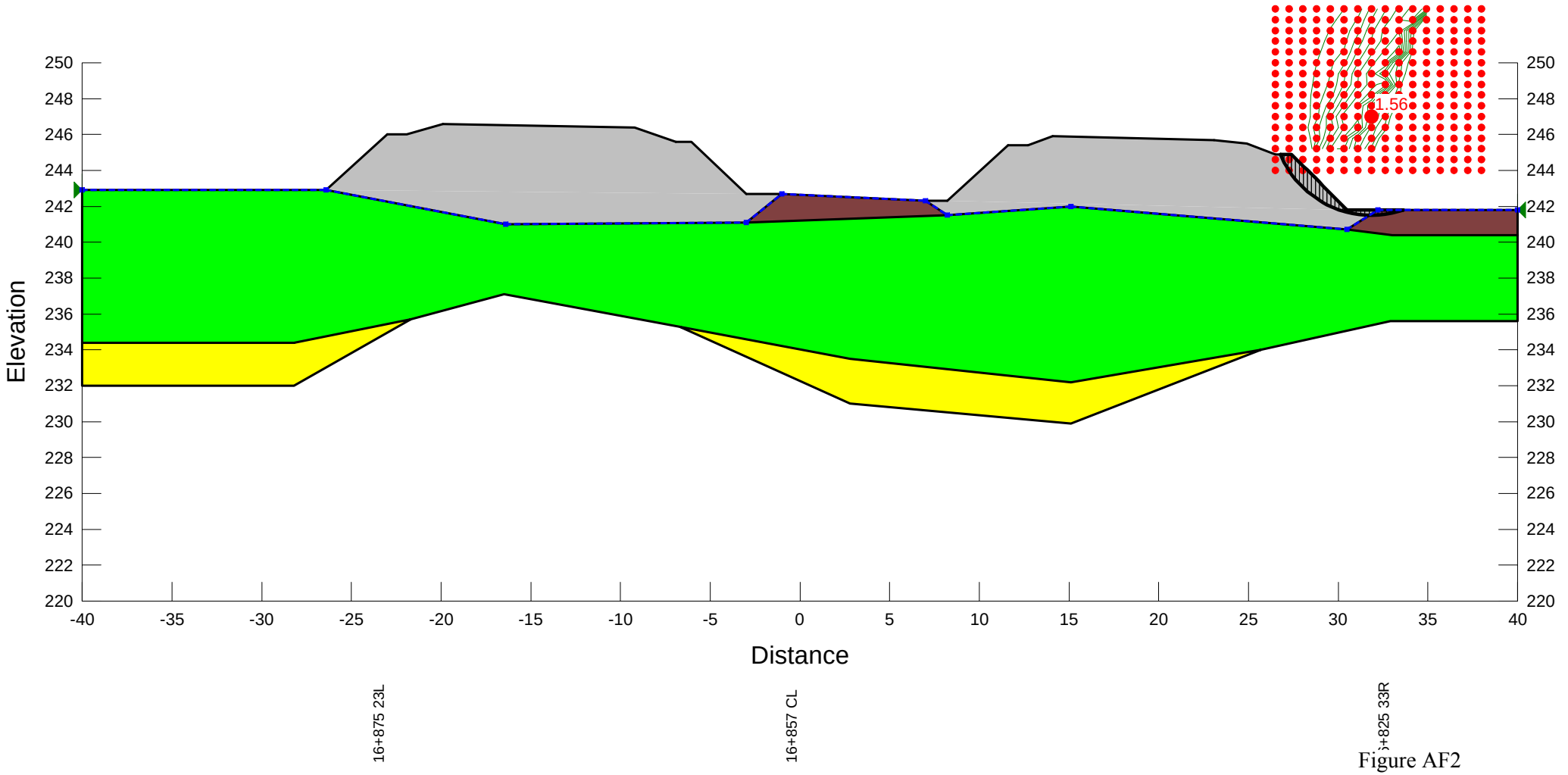


Figure AF2

Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\16+820-16+900\Stability\

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-78	0	0	15
	-75	0	3	16
	-72	0	6	20
	-68	0	9	27
	-65	1	12	37
	-62	3	16	55
	-59	5	19	79
	-56	7	22	93
	-53	10	25	105
	-50	17	28	114
	-47	30	31	125
	-44	51	34	129
	-40	74	37	127
	-37	88	40	115
	-34	98	44	76
	-31	103	47	39
	-28	105	50	18
	-25	101	53	9
	-22	90	56	6
	-19	75	59	4
	-16	50	62	2
	-12	30	65	1
	-9	26	68	0
	-6	19	72	0
	-3	16	75	0
	0	15	78	0

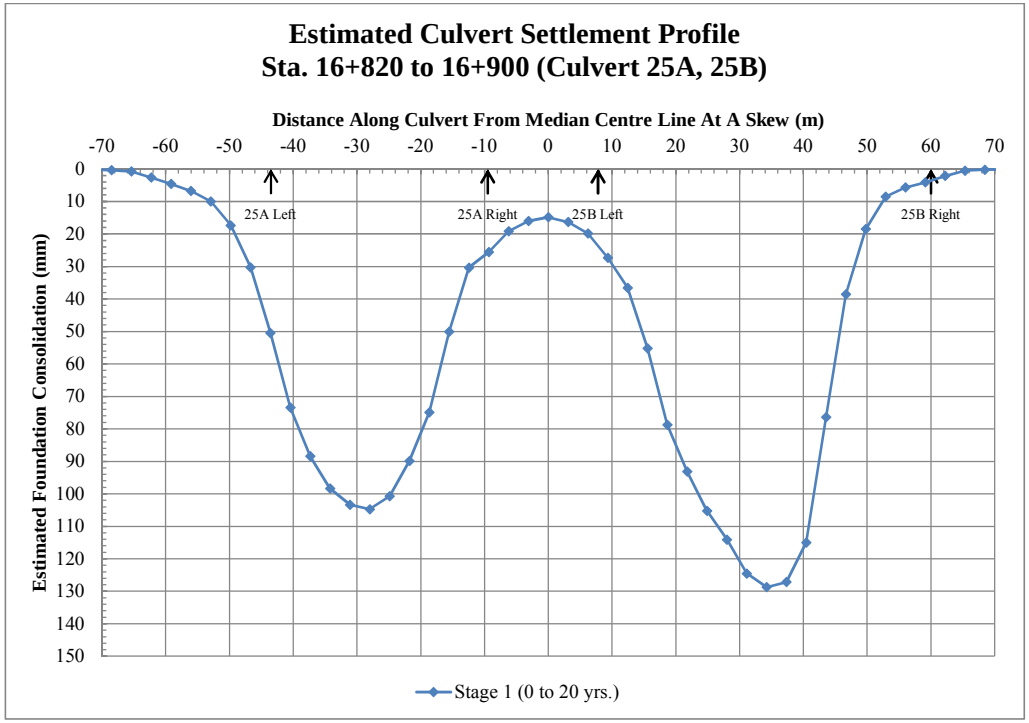


Figure AF3

THURBER

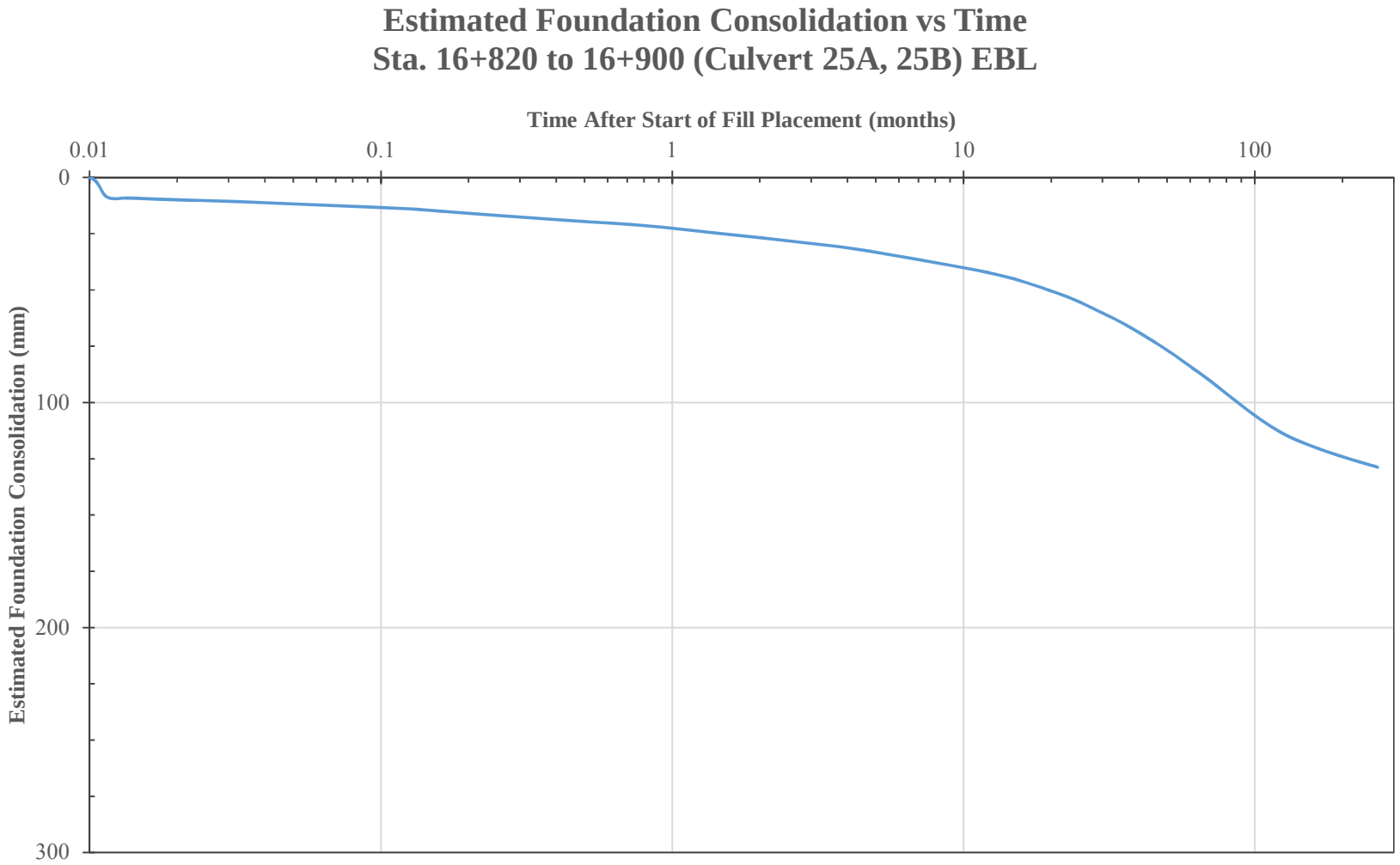

Estimated Foundation Consolidation vs Time
Sta. 16+820 to 16+900 (Culvert 25A, 25B) EBL
Time After Start of Fill Placement (months)
0.01
0.1
1
10
100
0
100
200
300
Estimated Foundation Consolidation (mm)

Figure AF4

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 16+820 to 16+900

Summary of Subsurface Conditions (Cohesive Soils)

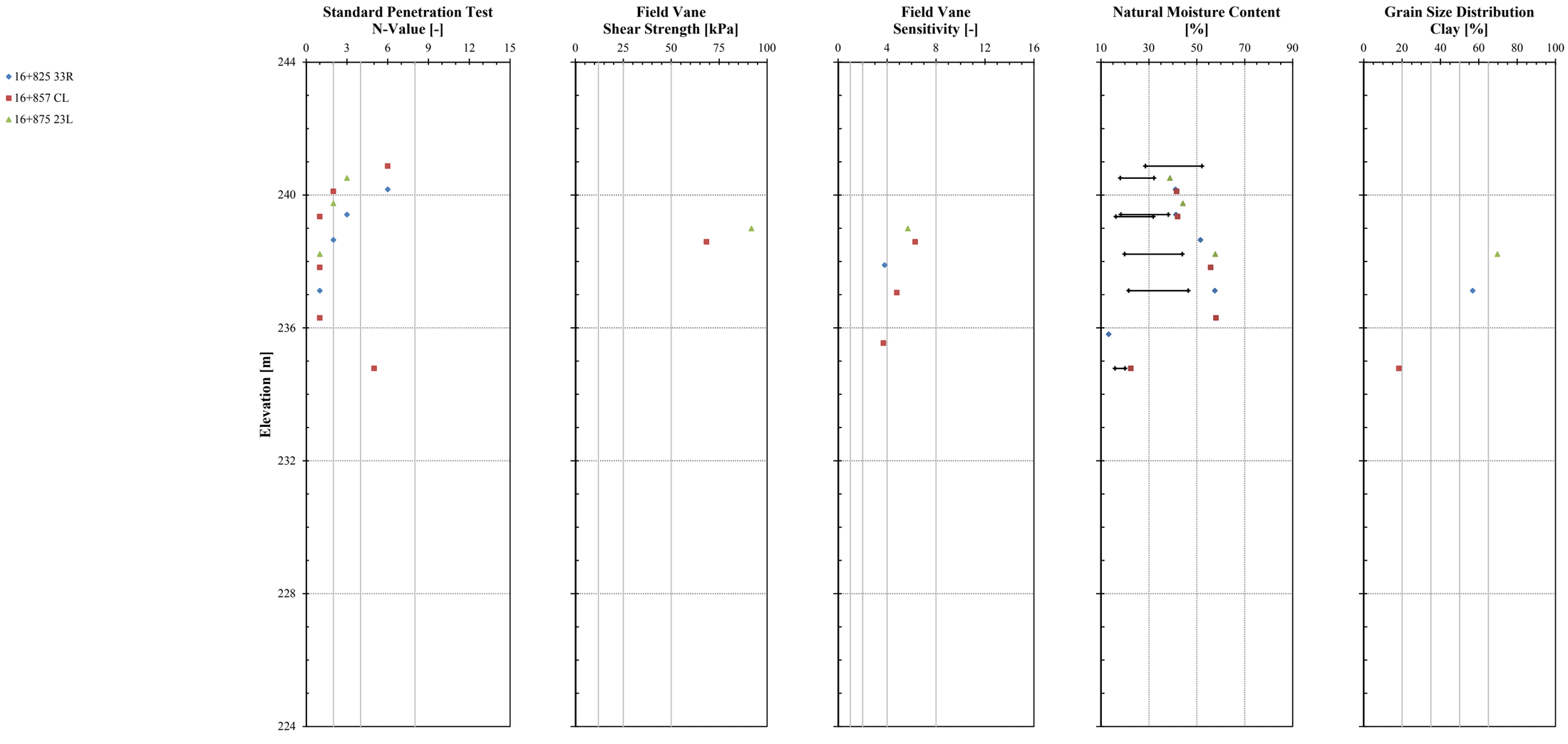


Figure AF5

Appendix AG

Highway 11/17 WBL

Sta. 17+720 to 17+750

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table AG1
Recommendation Summary Table

Notes: (01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

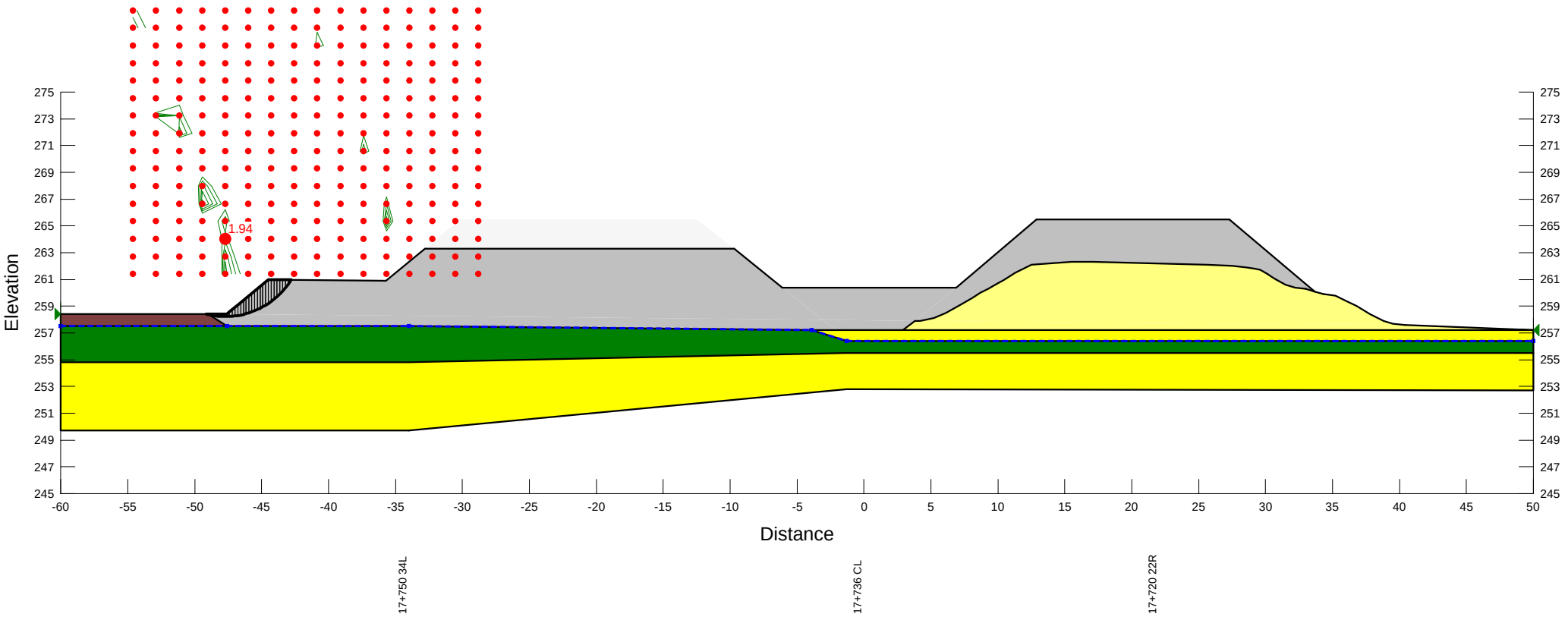
Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
			X	0.8	2.4 to 3.5	258.1	267.5 (7.2)	-	9.5	261 (2.5)	-	-	Stage 1: 5 Stage 2: 5 (10 total)	0.0 to 0.8	0.0 to 2.4	262.2	267.2 (5.0)	-	-	-	-	-	3	75	10	185	20	205
17+720	17+750	17+736		-Pre Construction: Remove organics/peat ONLY (do not excavate clay due to artesian conditions and to not adversely affect the stability of the existing roadway along the EBL alignment). Option 1 -Fill Placement Stage 1: Simultaneously construct berm (to dimensions shown) and embankments to maximum total height of 5.0 m above existing ground elevation. Wait 5 months. -Fill Placement Stage 2: Reconstruct embankment to Stage 1 elevation (replace grade due to settlement) + remaining embankment. Wait 5 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving. Estimated settlement: -Stage 1: 135 mm -Stage 2: 50 mm Berm extents provided previously											-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 3 months. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										

THURBER

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL ST Stage 1
Description: STA: 17+720 to 17+750
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 11:15:58 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay TSA	18 kN/m³	40 kPa	0 °	1
Sand	20 kN/m³	0 kPa	31 °	1
Peat	13 kN/m³	2 kPa	28 °	1



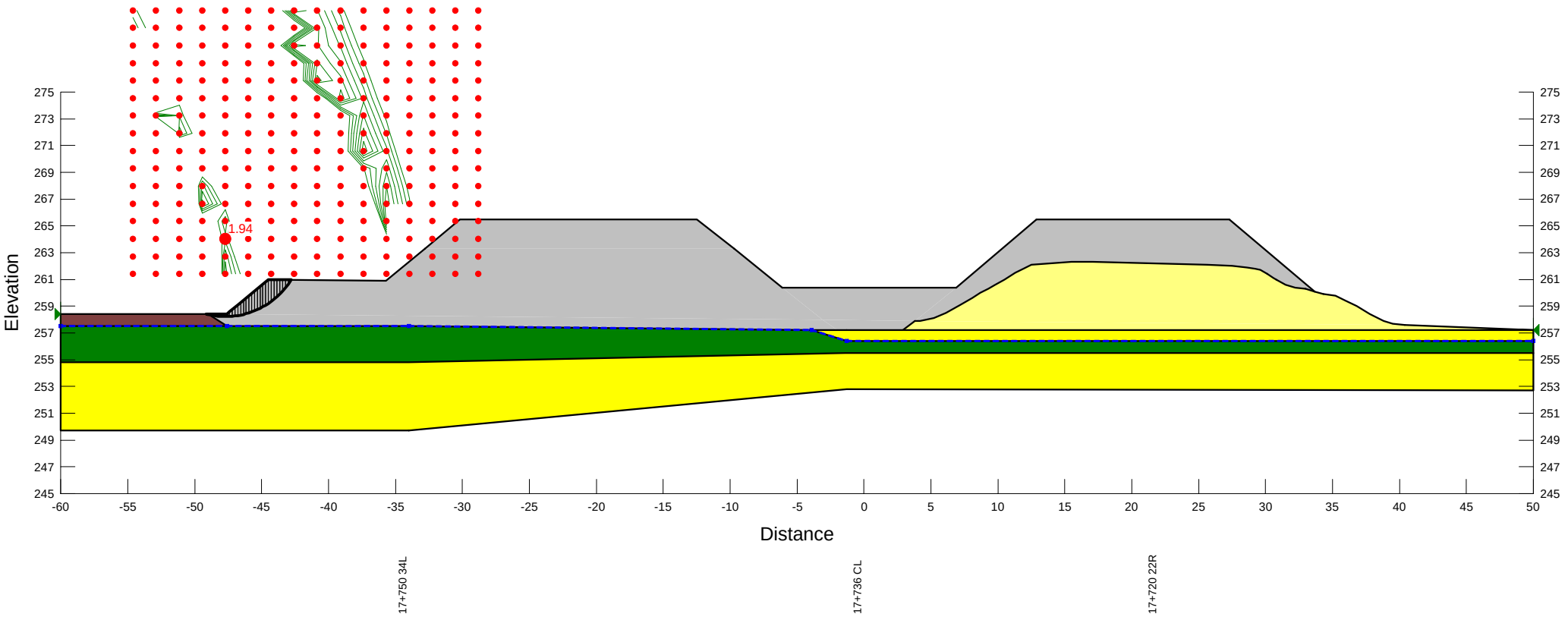
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\17+720-17+750\Stability\

Figure AG1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL ST Stage 2
Description: STA: 17+720 to 17+750
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 11:16:08 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay TSA	18 kN/m³	40 kPa	0 °	1
Sand	20 kN/m³	0 kPa	31 °	1
Peat	13 kN/m³	2 kPa	28 °	1



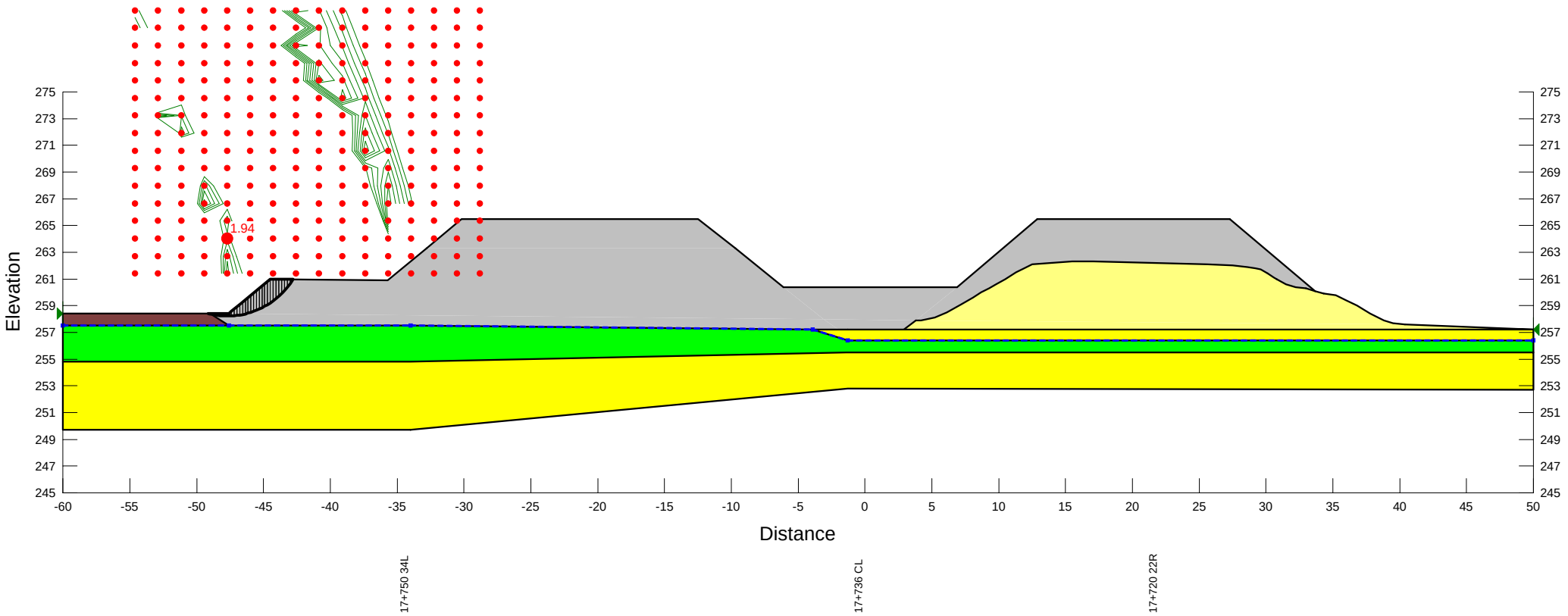
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\17+720-17+750\Stability\

Figure AG2

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL LT
Description: STA: 17+720 to 17+750
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 10:07:14 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sand	20 kN/m³	0 kPa	31 °	1
Peat	13 kN/m³	2 kPa	28 °	1



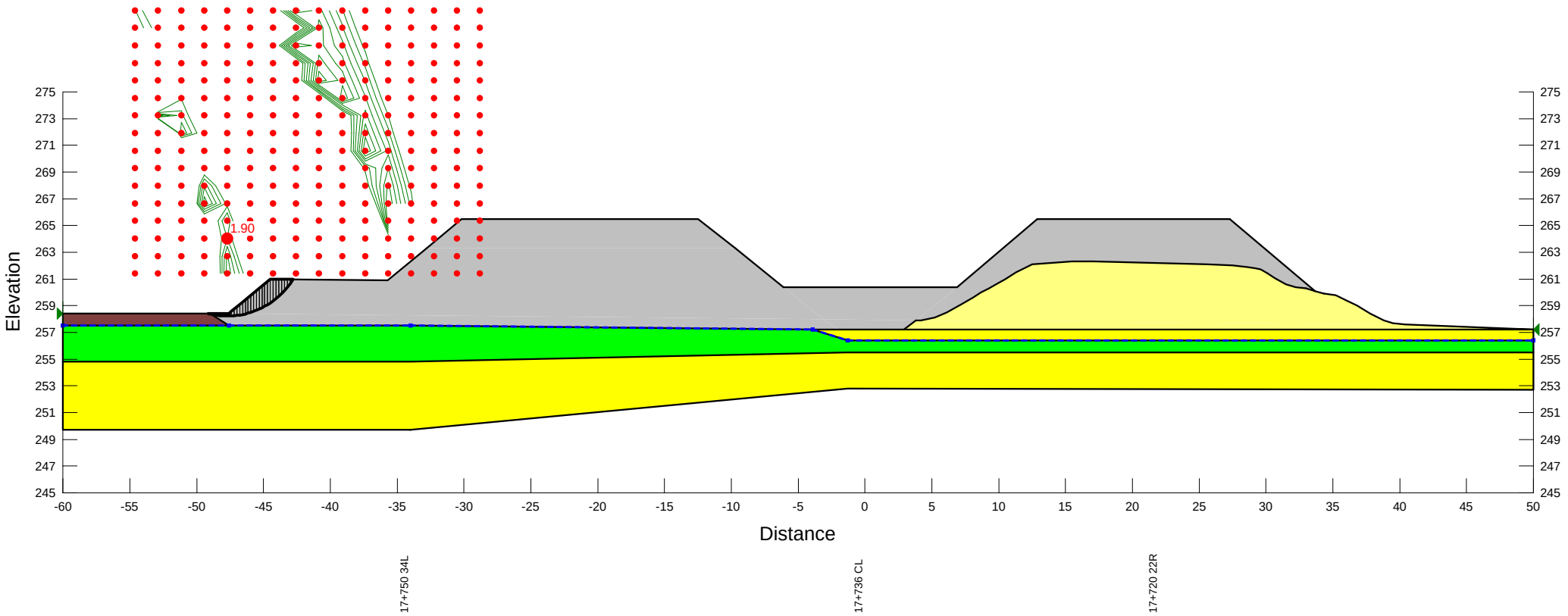
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\17+720-17+750\Stability\

Figure AG3

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL LT Seismic
Description: STA: 17+720 to 17+750
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 10:07:22 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0.01

Rock Fill	20 kN/m³	0 kPa	42 °	1
Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sand	20 kN/m³	0 kPa	31 °	1
Peat	13 kN/m³	2 kPa	28 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\17+720-17+750\Stability\

Figure AG4

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-64	1	0	38
	-61	1	3	42
	-59	1	5	40
	-56	2	8	37
	-54	4	10	36
	-51	10	13	39
	-49	27	15	44
	-46	44	18	46
	-44	52	20	47
	-41	58	23	48
	-38	63	26	47
	-36	68	28	45
	-33	69	31	41
	-31	74	33	34
	-28	78	36	29
	-26	81	38	25
	-23	82	41	18
	-20	82	44	5
	-18	82	46	2
	-15	80	49	1
	-13	77	51	1
	-10	72	54	1
	-8	65	56	1
	-5	57	59	0
	-3	50	61	0
	0	38	64	0

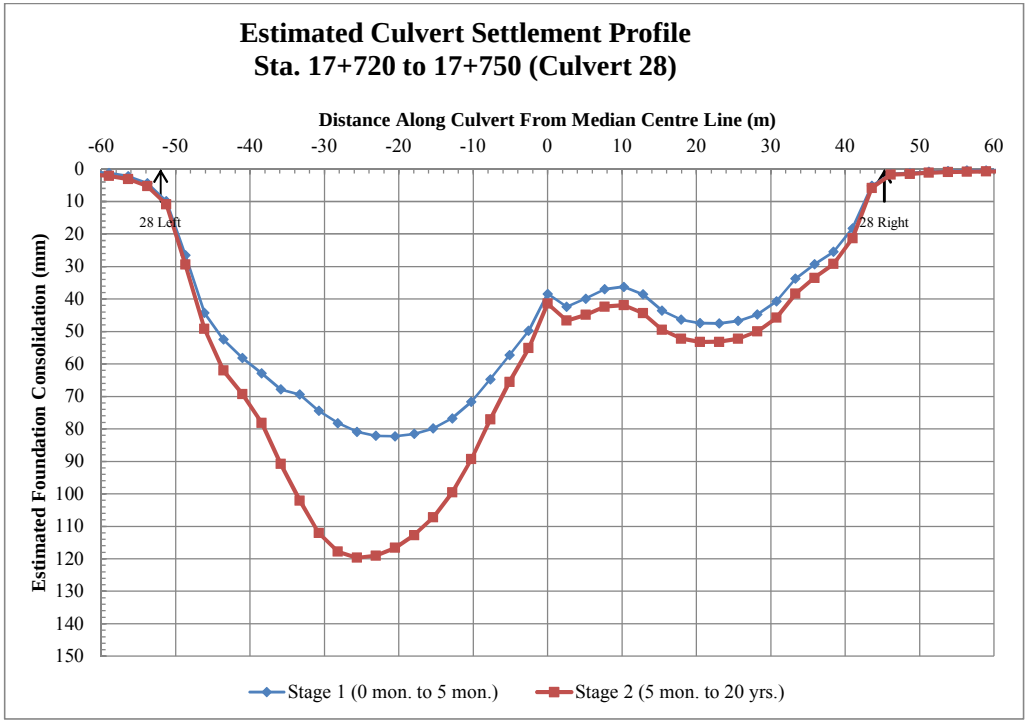


Figure AG5

THURBER

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 2	-64	1	0	41
	-61	2	3	47
	-59	2	5	45
	-56	3	8	42
	-54	5	10	42
	-51	11	13	44
	-49	29	15	50
	-46	49	18	52
	-44	62	20	53
	-41	69	23	53
	-38	78	26	52
	-36	91	28	50
	-33	102	31	46
	-31	112	33	38
	-28	118	36	34
	-26	120	38	29
	-23	119	41	21
	-20	117	44	6
	-18	113	46	2
	-15	107	49	2
	-13	100	51	1
	-10	89	54	1
	-8	77	56	1
	-5	66	59	1
	-3	55	61	1
	0	41	64	0

THURBER

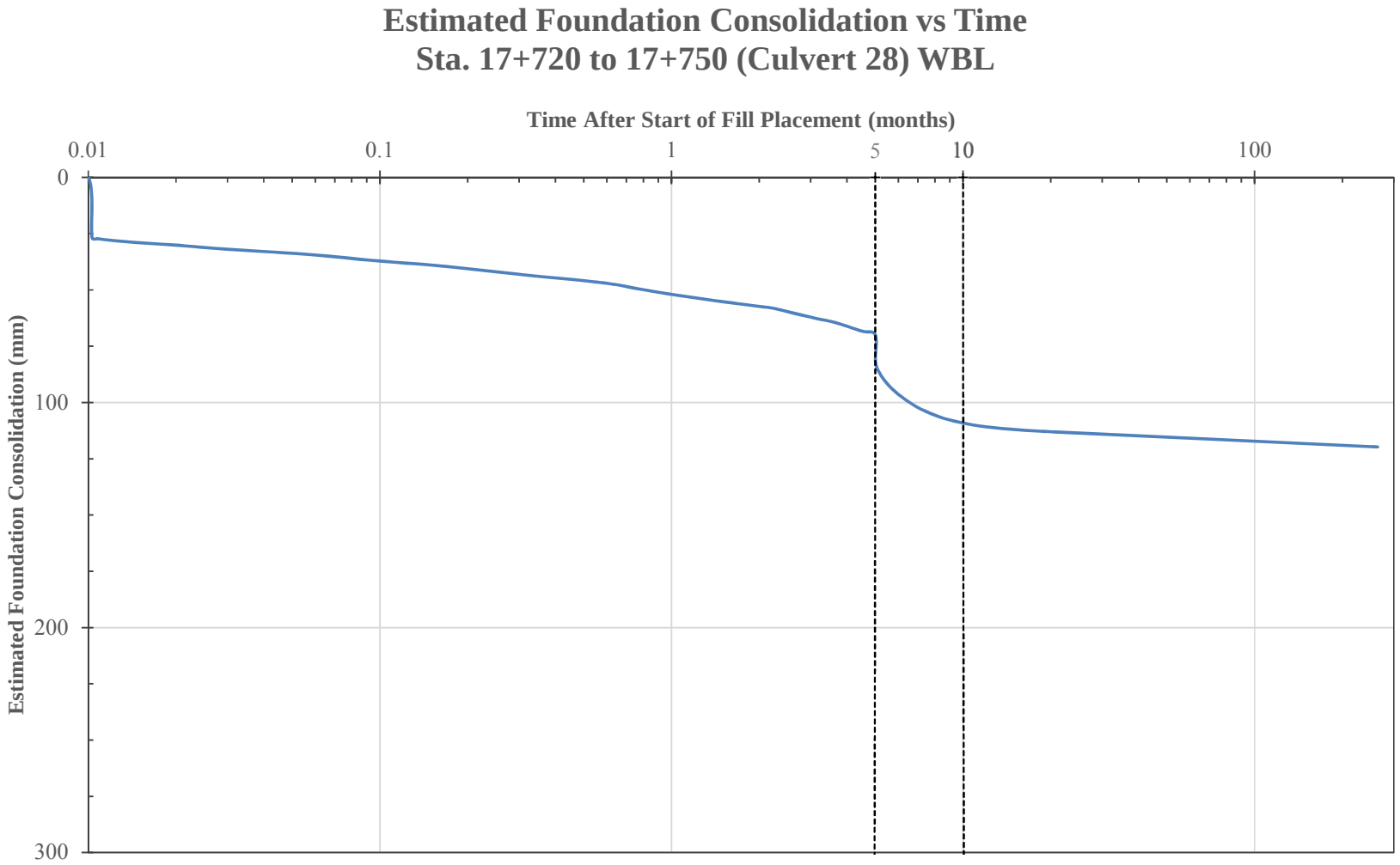


Figure AG6

THURBER

Highway 11/17 - Red Rock to Nipigon

WBL - Sta. 17+720 to 17+750

Summary of Subsurface Conditions (Cohesive Soils)

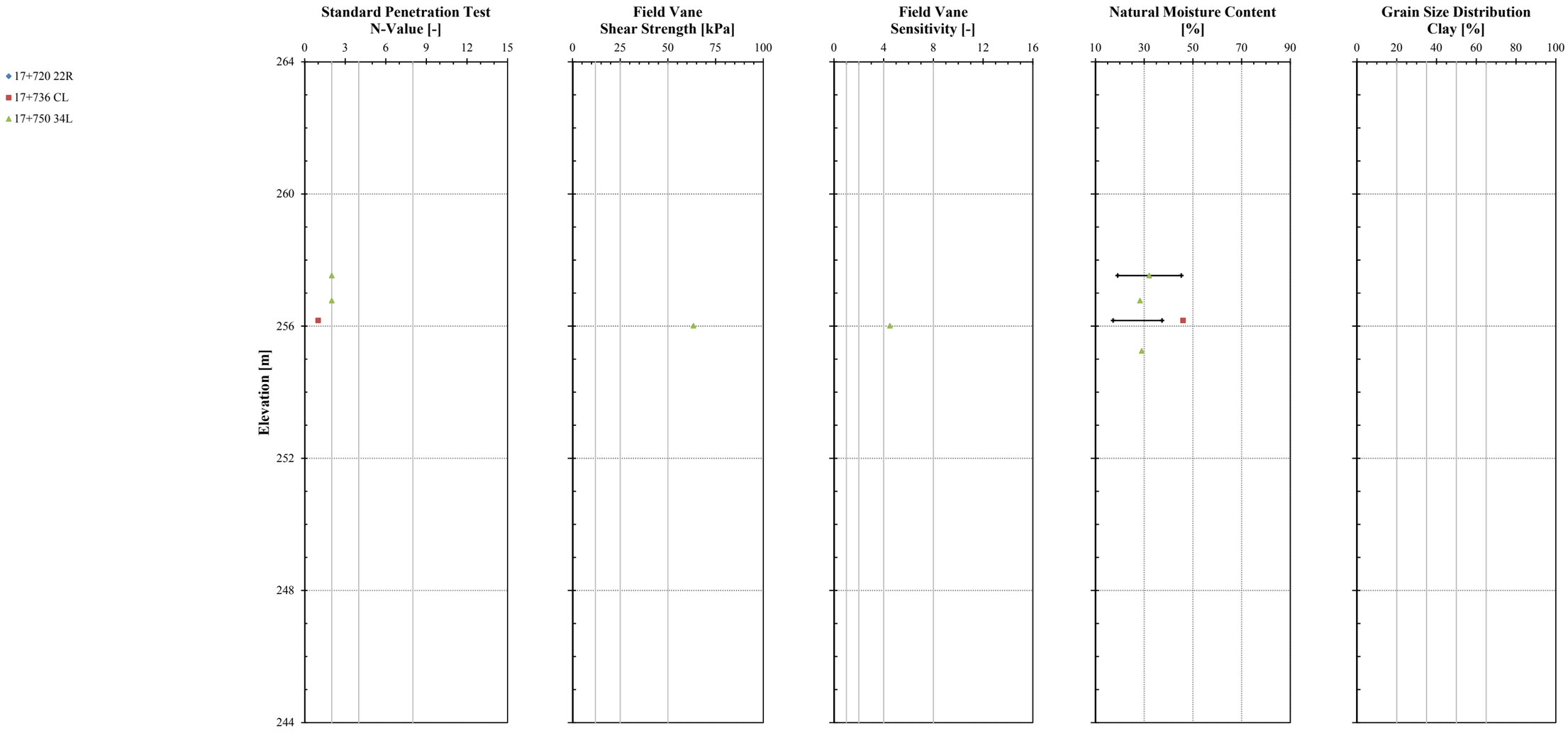


Figure AG7

Appendix AH

Highway 11/17 EBL and WBL

Sta. 17+900 to 17+910

Recommendation Summary Table

Selected Settlement Analysis Figures

Table AH1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
17+900	17+910	17+905	X	0	0.0	263.3	269.8 (6.5)	-	-	-	-	-	0	0.0 to 0.2	0.0	263.0	269.3 (6.3)	-	-	-	-	-	0	50	10	60	10	70
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment and complete paving.										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment and complete paving.														

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-50	0	0	1
	-48	0	2	1
	-46	0	4	2
	-44	0	6	4
	-42	0	8	4
	-40	0	10	4
	-38	0	12	3
	-36	0	14	2
	-34	1	16	1
	-32	3	18	1
	-30	5	20	1
	-28	6	22	1
	-26	8	24	1
	-24	8	26	1
	-22	9	28	0
	-20	10	30	0
	-18	10	32	0
	-16	11	34	0
	-14	10	36	0
	-12	8	38	0
	-10	7	40	0
	-8	5	42	0
	-6	3	44	0
	-4	1	46	0
	-2	1	48	0
	0	1	50	0

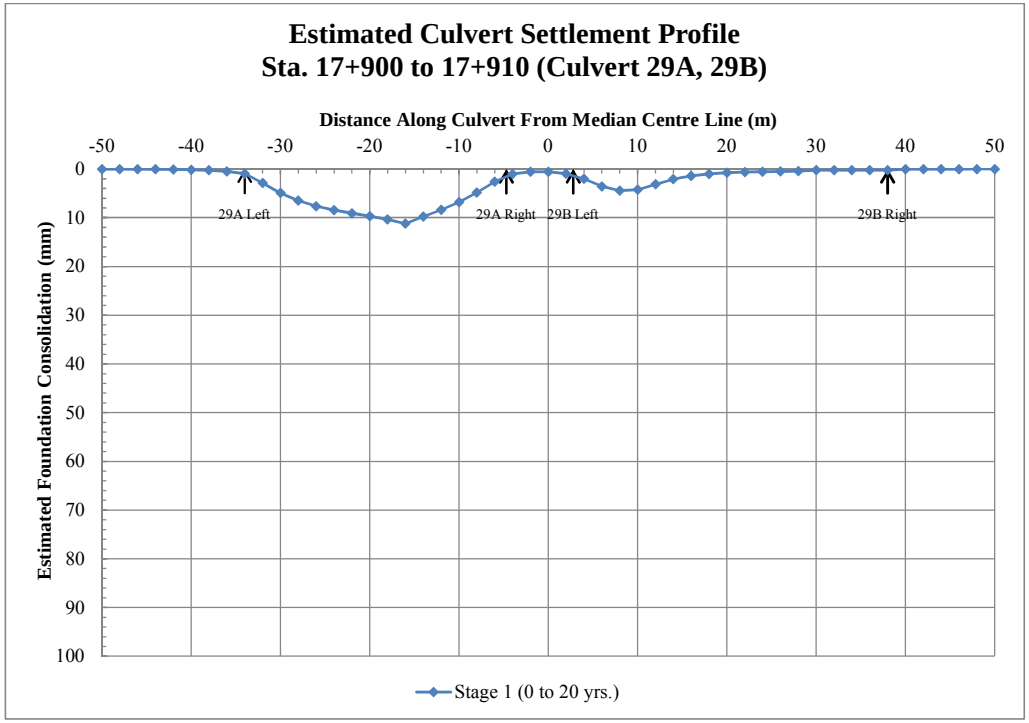


Figure AH1

THURBER

Appendix AI

Highway 11/17 EBL and WBL

Sta. 18+740 to 18+790

Recommendation Summary Table
Selected Slope Stability Analysis Figures
Selected Settlement Analysis Figures
Summary of Subsurface Conditions

Table AI1
Recommendation Summary Table

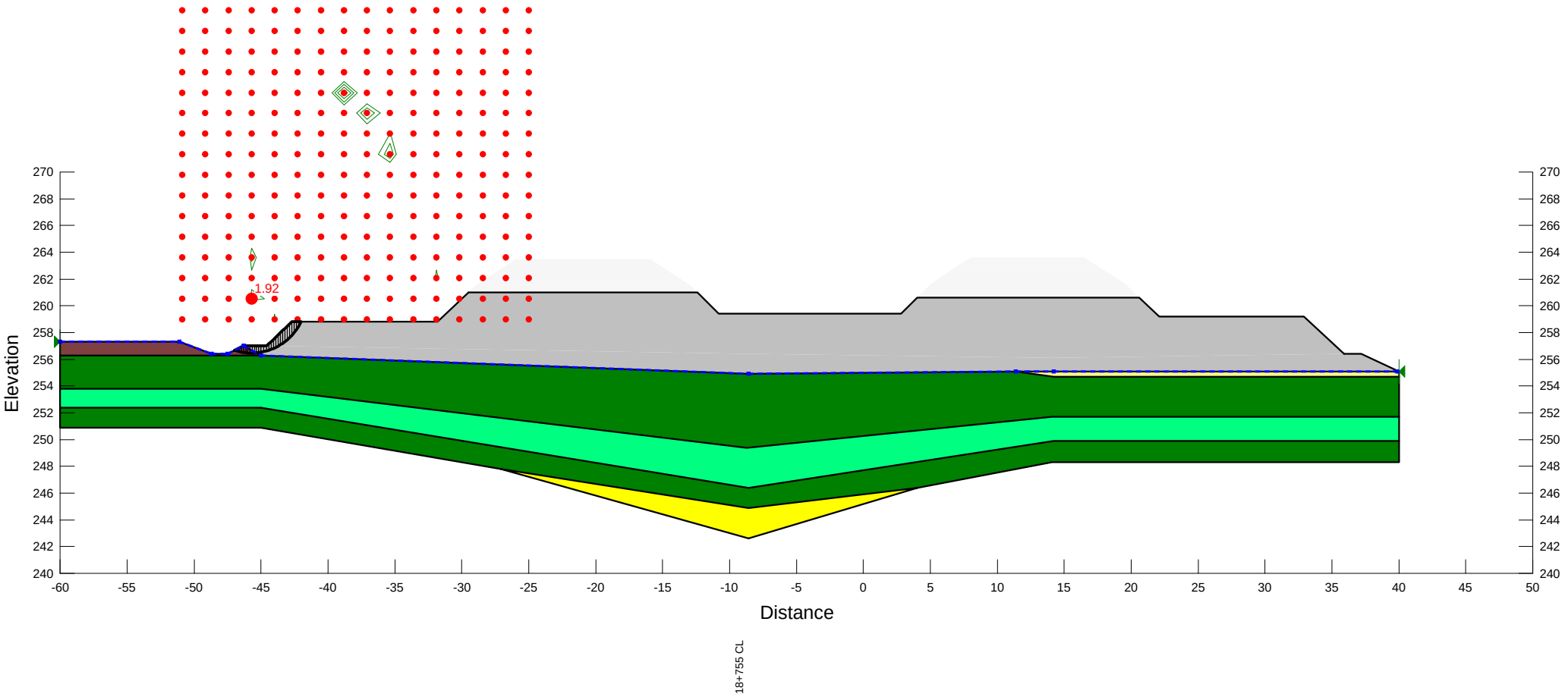
Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.(6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
			X	0.6 to 1.5	6.1 to 11.6	256.6	261.7 (5.1)	2.0	12.5	258.8 (2.5)	-	1.5	Stage 1: 6 Stage 2: 6 Stage 3: 6 (18 total)	0.9 to 1.5	7.6 to 11.6	256.2	261.7 (5.5)	2.0	12.5	259.2 (3.0)	-	1.5	Stage 1: 6 Stage 2: 6 Stage 3: 6 (18 total)	40	5	525	25	550
18+740	18+790	18+755		-Pre Construction: Remove organics/peat and replace with drainage blanket to 1.0 m above water level for wick drain installation. Install wick drains. Install monitoring instrumentation. Record monitoring instrumentation baseline readings. -Sacrificial culvert will need to be installed (details to be provided) -Install geosynthetic -Fill Placement Stage 1: Simultaneously construct berm (to dimensions shown) and embankments to maximum total height of 4.5 m above existing ground elevation (or embankment + surcharge, if total height is less then 4.5 m). Wait 6 months. -Fill Placement Stage 2: Reconstruct embankment to Stage 1 elevation (replace grade due to settlement) + 2.5 m. Wait 6 months. -Fill Placement Stage 3: Reconstruct embankment to Stage 2 elevation (replace grade due to settlement) + 0.5 m. Wait 6 months. -Excavate sacrificial culvert and replace with permanent culvert. -Post Construction: After wait period, remove excess surcharge to design road grade elevation and complete paving Estimated settlement: -Stage 1: 330 -Stage 2: 160 -Stage 3: 35 Height of surcharge, berm extents and wick drain spacing provided previously																											

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL ST Stage 1
Description: STA: 18+740 to 18+790
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 11:26:26 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Sand	20 kN/m³	0 kPa	32 °	1
Silty Clay TSA 1	18 kN/m³	20 kPa	0 °	1
Silty Clay TSA 2	18 kN/m³	40 kPa	0 °	1
Sand	20 kN/m³	0 kPa	31 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



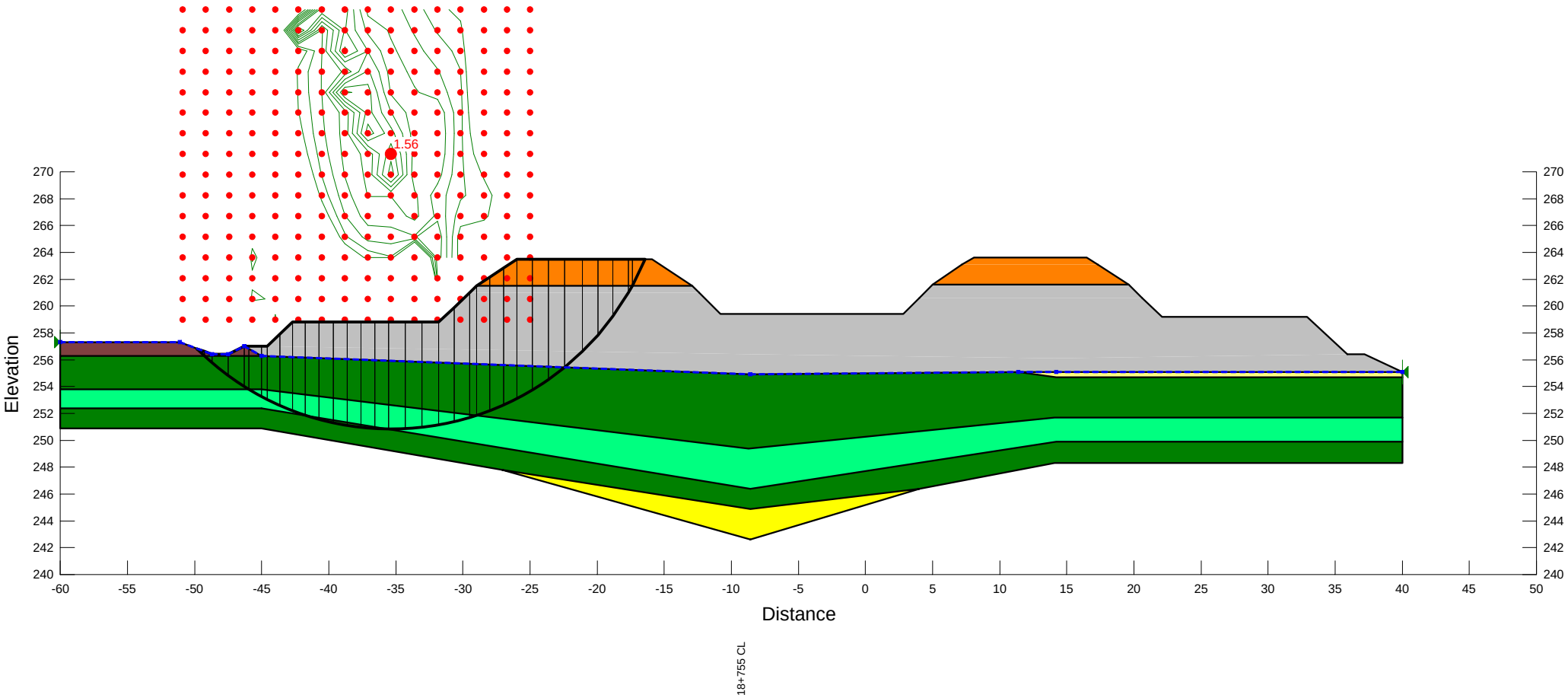
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\18+740-18+790\Stability\

Figure AI1

Surcharge	21 kN/m³	0 kPa	32 °	1
Rock Fill	20 kN/m³	0 kPa	42 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Sand	20 kN/m³	0 kPa	32 °	1
Silty Clay TSA 1	18 kN/m³	20 kPa	0 °	1
Silty Clay TSA 2	18 kN/m³	40 kPa	0 °	1
Sand	20 kN/m³	0 kPa	31 °	1

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL ST Stage 3
Description: STA: 18+740 to 18+790
Last Edited By: Michael Eastman
Last Solved Date: 8/5/2014, 11:26:49 AM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



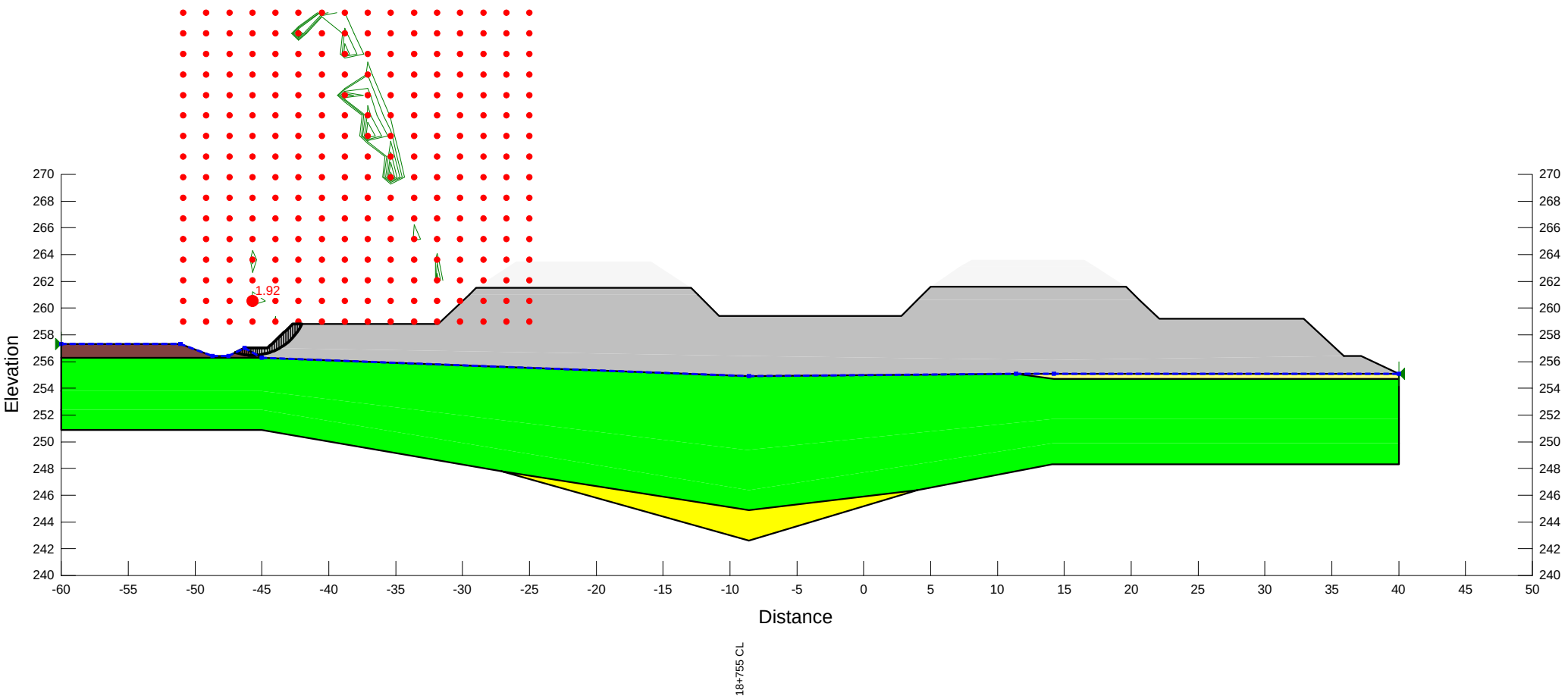
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\18+740-18+790\Stability\

Figure AI2

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL LT
Description: STA: 18+740 to 18+790
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 10:22:06 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Sand	20 kN/m³	0 kPa	32 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sand	20 kN/m³	0 kPa	31 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0



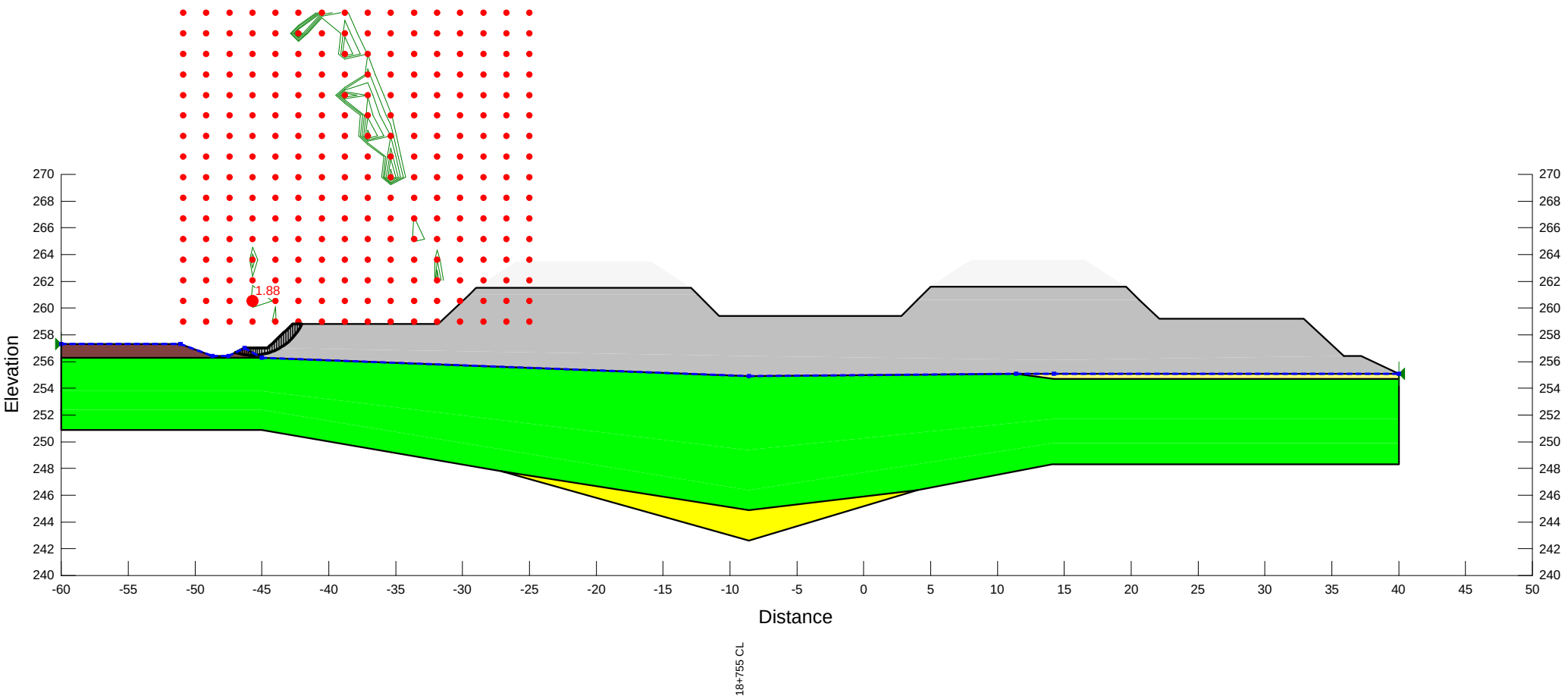
Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\18+740-18+790\Stability\

Figure AI3

Title: Highway 11/17, Nipigon, Ontario
Comments: Culvert Stability
Name: WBL LT Seismic
Description: STA: 18+740 to 18+790
Last Edited By: Michael Eastman
Last Solved Date: 8/7/2014, 10:22:17 AM

Rock Fill	20 kN/m³	0 kPa	42 °	1
Peat	13 kN/m³	2 kPa	28 °	1
Silty Sand	20 kN/m³	0 kPa	32 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sand	20 kN/m³	0 kPa	31 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0.01



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Culverts\18+740-18+790\Stability\

Figure AI4

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-68	1	0	76
	-65	2	3	79
	-62	4	5	120
	-60	8	8	193
	-57	16	11	235
	-54	36	14	257
	-51	85	16	265
	-49	139	19	264
	-46	160	22	259
	-43	171	24	263
	-41	182	27	263
	-38	198	30	256
	-35	225	32	239
	-32	265	35	211
	-30	288	38	182
	-27	301	41	162
	-24	308	43	148
	-22	312	46	135
	-19	313	49	116
	-16	310	51	78
	-14	302	54	47
	-11	284	57	23
	-8	247	60	12
	-5	184	62	7
	-3	95	65	3
	0	76	68	2

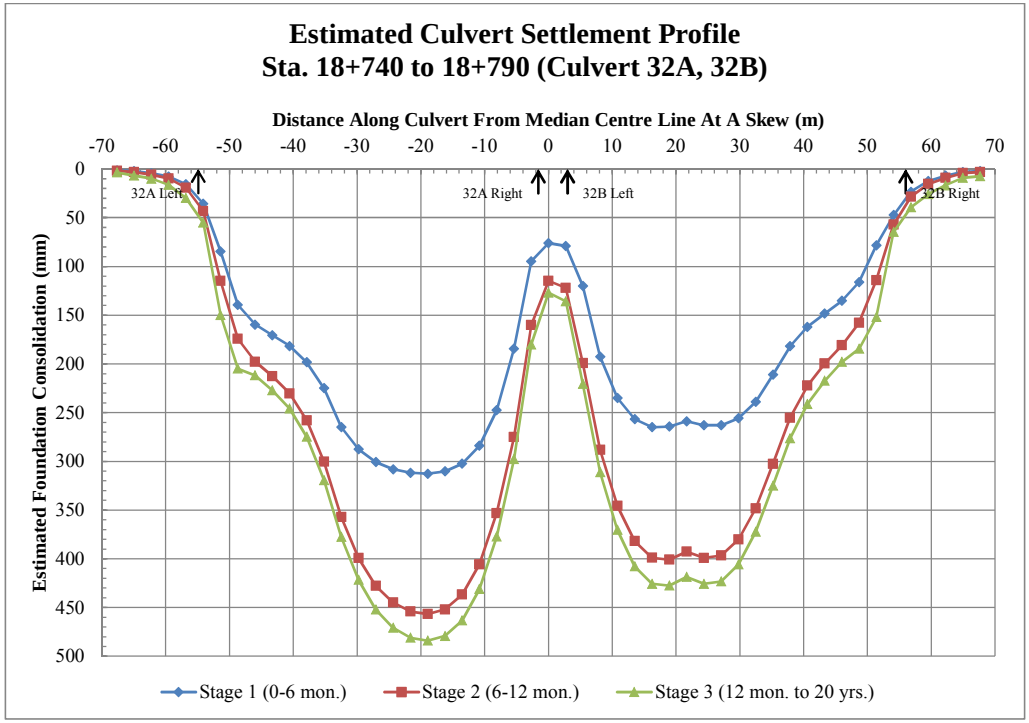


Figure AI5

THURBER

	WBL		EBL	
Stage 2	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
	-68	2	0	115
	-65	3	3	122
	-62	6	5	199
	-60	10	8	288
	-57	19	11	346
	-54	43	14	382
	-51	115	16	399
	-49	174	19	401
	-46	198	22	393
	-43	213	24	399
	-41	230	27	397
	-38	258	30	380
	-35	301	32	348
	-32	357	35	303
	-30	399	38	255
	-27	428	41	222
	-24	445	43	200
	-22	454	46	181
	-19	457	49	158
	-16	452	51	114
	-14	437	54	57
	-11	406	57	28
	-8	353	60	15
	-5	275	62	9
	-3	160	65	4
	0	115	68	3

	WBL		EBL	
Stage 3	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
	-68	4	0	127
	-65	7	3	136
	-62	10	5	221
	-60	16	8	311
	-57	30	11	370
	-54	55	14	408
	-51	150	16	426
	-49	205	19	428
	-46	212	22	419
	-43	227	24	426
	-41	246	27	423
	-38	275	30	406
	-35	319	32	372
	-32	378	35	325
	-30	422	38	276
	-27	452	41	241
	-24	471	43	217
	-22	481	46	198
	-19	484	49	184
	-16	479	51	152
	-14	463	54	65
	-11	431	57	39
	-8	377	60	26
	-5	298	62	17
	-3	180	65	9
	0	127	68	7

THURBER

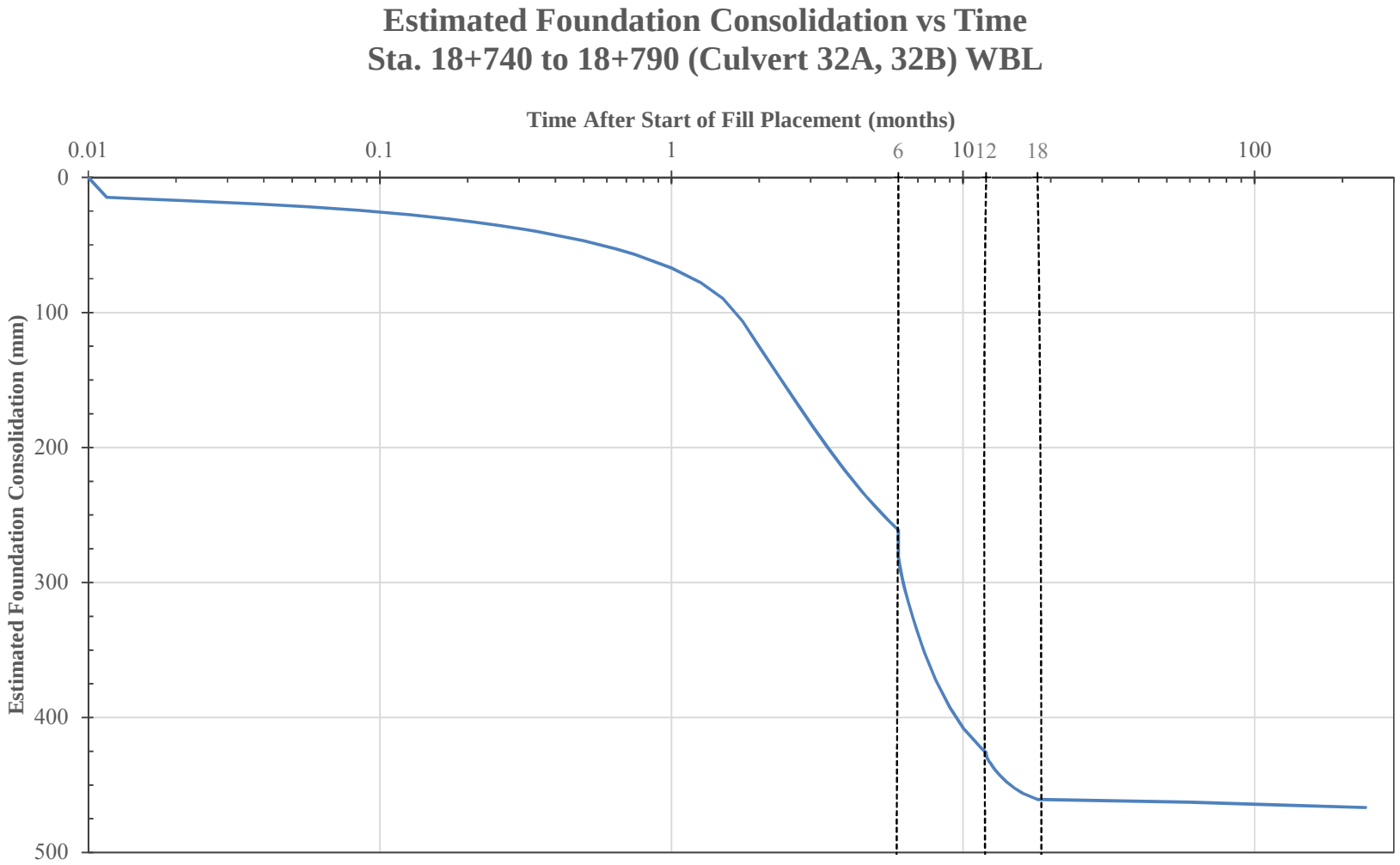


Figure AI7

THURBER

Highway 11/17 - Red Rock to Nipigon

EBL and WBL - Sta. 18+740 to 18+790

Summary of Subsurface Conditions (Cohesive Soils)

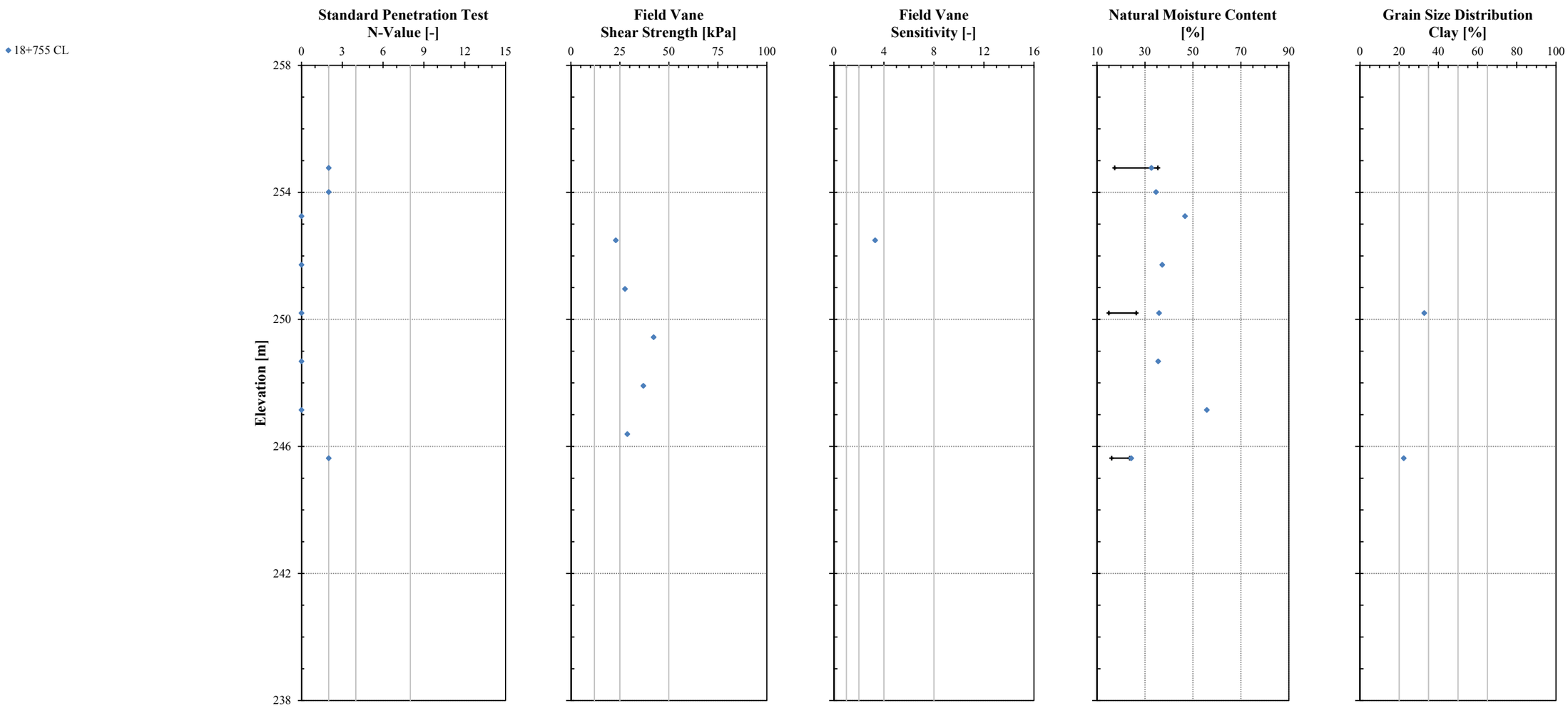


Figure AI8

Appendix AJ

Highway 11/17 EBL and WBL

Sta. 19+110 to 19+120

Recommendation Summary Table

Selected Settlement Analysis Figures

Table AJ1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
19+110	19+120	19+115	X	0.0	0.0	270.1	268.4 (*-1.7*)	-	-	-	-	-	1	0.0	0.0	267.0	268.6 (1.6)	-	-	-	-	-	1	10	5	5	15	20
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-50	0	0	0
	-48	0	2	0
	-46	0	4	0
	-44	0	6	0
	-42	0	8	0
	-40	0	10	0
	-38	0	12	0
	-36	0	14	0
	-34	0	16	0
	-32	0	18	0
	-30	0	20	0
	-28	0	22	1
	-26	0	24	1
	-24	0	26	1
	-22	0	28	2
	-20	0	30	1
	-18	0	32	0
	-16	0	34	0
	-14	0	36	0
	-12	0	38	0
	-10	0	40	0
	-8	0	42	0
	-6	0	44	0
	-4	0	46	0
	-2	0	48	0
	0	0	50	0

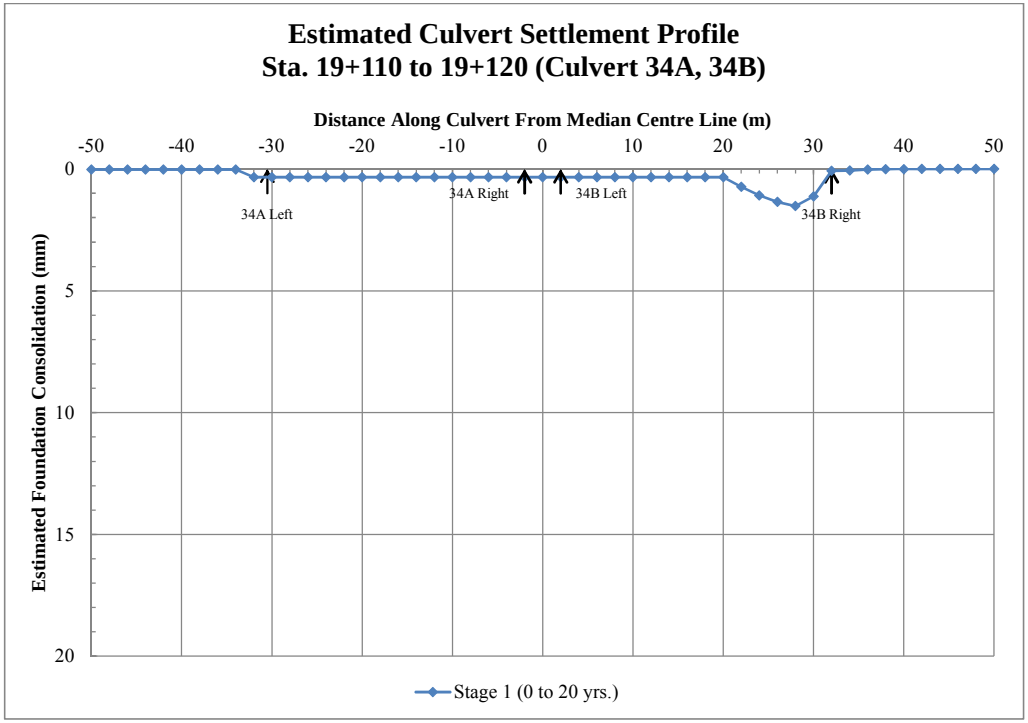


Figure AJ1

THURBER

Appendix AK

Highway 11/17 EBL and WBL

Sta. 19+670 to 19+690

Recommendation Summary Table

Selected Settlement Analysis Figures

Table AK1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
19+670	19+690	19+685	X	0.0 to 0.8	0.0 to 0.8	274.0	277.8 (3.8)	-	-	-	-	-	1	0.0 to 0.8	0.0 to 0.8	273.0	277.7 (4.7)	-	-	-	-	-	1	25	5	35	30	65
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving											-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-50	0	0	1
	-48	0	2	1
	-46	0	4	1
	-44	0	6	2
	-42	1	8	10
	-40	1	10	18
	-38	1	12	23
	-36	1	14	26
	-34	1	16	28
	-32	1	18	29
	-30	4	20	30
	-28	8	22	29
	-26	11	24	28
	-24	12	26	25
	-22	12	28	22
	-20	11	30	17
	-18	10	32	11
	-16	8	34	7
	-14	6	36	5
	-12	3	38	3
	-10	1	40	2
	-8	1	42	1
	-6	1	44	1
	-4	1	46	1
	-2	1	48	1
	0	1	50	0

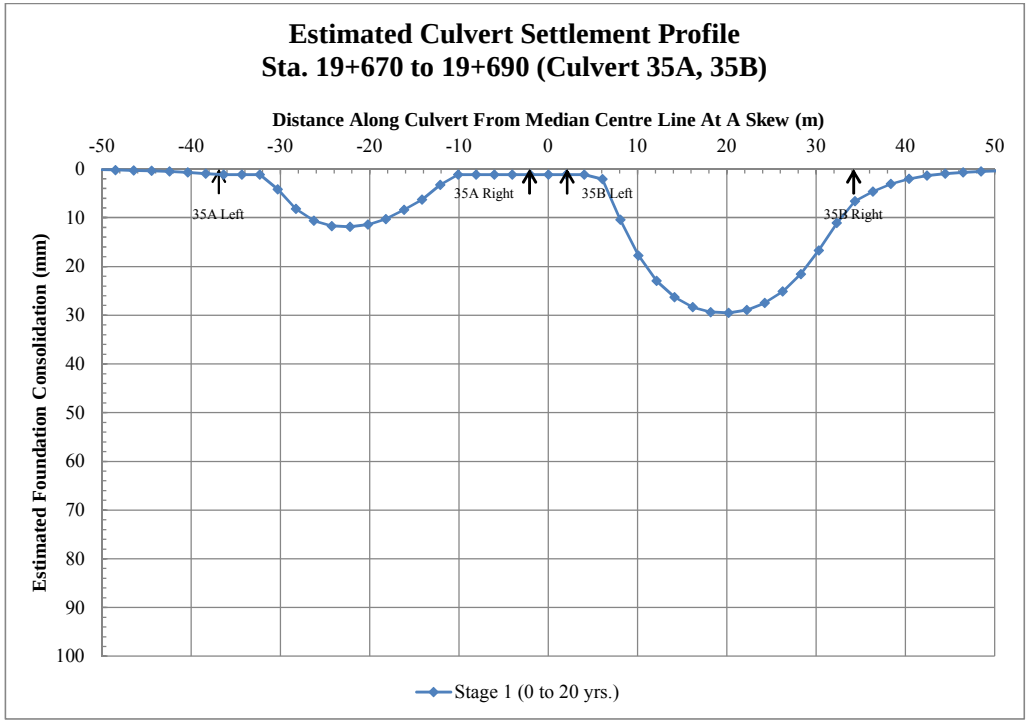


Figure AK1

THURBER

Appendix AL

Highway 11/17 EBL and WBL

Sta. 19+730 to 19+770

Recommendation Summary Table

Selected Settlement Analysis Figures

Table AL1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment[3,4,5]										Treatment[3,4,5]						Rockfill Comp.[10]				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.[1]	Depth to base of Peat/ Org./ Clay[1]	Approx. Elev. of Existing Ground[2]	Elev. of Design Grade[2] (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.[7,8]	Wick Drain Spacing (c-c)[9]	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr.[6]	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
19+730	19+770	19+755	X	0.0 to 0.8	0.0 to 0.8	273.8	278.4 (4.6)	-	-	-	-	-	1	0.0 to 0.1	0.0 to 0.1	274.2	278.4 (4.2)	-	-	-	-	-	1	25	5	50	30	80
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-51	1	0	1
	-49	1	2	2
	-47	2	4	3
	-45	2	6	5
	-43	3	8	6
	-40	5	10	14
	-38	7	12	22
	-36	11	14	29
	-34	16	16	34
	-32	24	18	36
	-30	31	20	37
	-28	36	22	37
	-26	40	24	35
	-24	42	26	32
	-22	44	28	28
	-20	44	30	22
	-18	45	32	16
	-16	42	34	9
	-14	35	36	6
	-12	26	38	4
	-10	16	40	3
	-8	11	43	2
	-6	5	45	1
	-4	3	47	1
	-2	2	49	1
	0	1	51	1

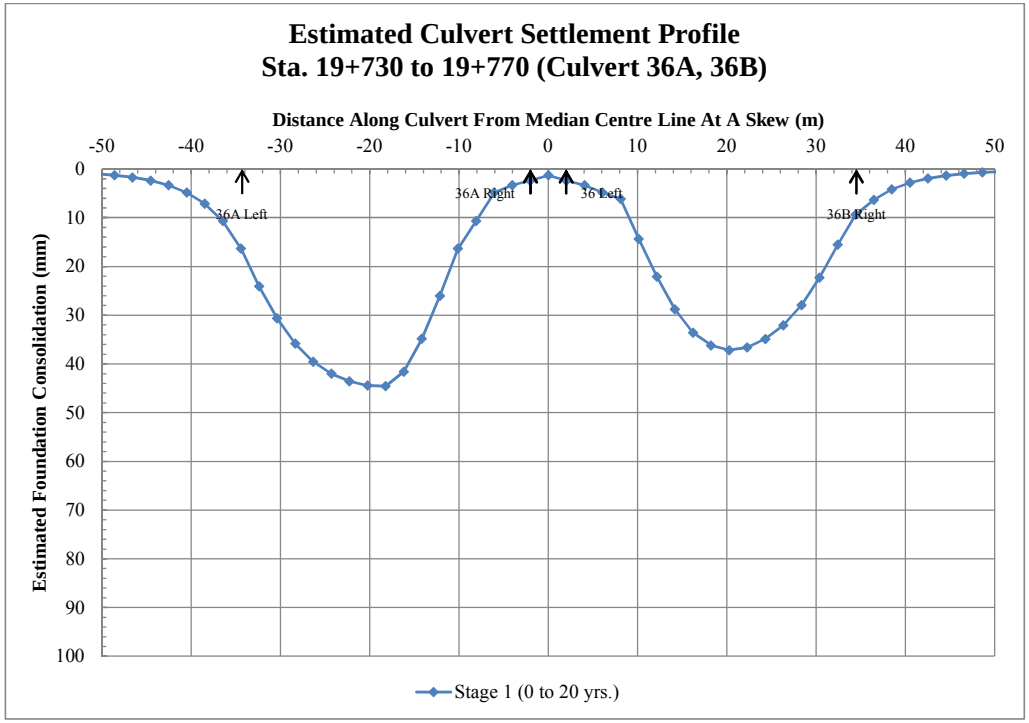


Figure AL1

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Appendix AM

Highway 11/17 EBL and WBL

Sta. 20+860 to 20+890

Recommendation Summary Table

Selected Settlement Analysis Figures

Table AM1
Recommendation Summary Table

Notes:
(01) Subsurface stratigraphy summary obtained from Borehole, DCPT and CPTu investigations. Ranges of values represent boreholes in vicinity of Stationing shown. Stratigraphy will vary between and beyond investigated locations.
(02) Based on AutoCAD profiles and cross sections received from MMM on June 18, 2013. Elevations are obtained within the width of roadway platform.
(03) Treatment for both sides of embankment slope, median treatment to correspond with the adjacent embankment treatment
(04) Minimum Target Factors of Safety of 1.3 (short term) and 1.5 (long term), were used during foundation stability analyses
(05) Embankments analyzed with rockfill at 1.25H:1V side slopes. Mid-height benching should be included in alignment with MTO's guidelines.
(06) Overbuild to compensate for foundation settlement occurring during wait period. An allowance should be included for loss of rockfill into soft subgrades.
(07) Reinforcement strength is Long Term Design Strength (LTDS), applicable reduction factors and suitable factor of safety should be applied. Example reinforcement: 2 layers of Tencate Mirafi 22XT (or equivalent) can provide 300 kN/m LTDS.
(08) Geosynthetic should be placed at the base of the main embankments and extend the width of embankment (not required under the berm) and requires granular material (300 mm in thicknesss) above and below each layer of geosynthetic.
(09) Wick drains installed in a triangular pattern and through a granular drainage blanket. The top of the granular drainage blanket should be at least 1.0 m above the water level. Wick drains installed below all fill placement areas (i.e. from toe of EBL berm to toe of WBL berm)
(10) Estimated rockfill compression based on MTO guidelines
(*) N/M = not measured

Stations				WBL (Left of Median)										EBL (Right of Median)										Settlement (refer to Table A3)				
								Treatment(3,4,5)										Treatment(3,4,5)						Rockfill Comp.(10)				
									Berm										Berm									
From	To	Station	Culvert	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	Thickn. of Peat/ Org.(1)	Depth to base of Peat/ Org./ Clay(1)	Approx. Elev. of Existing Ground(2)	Elev. of Design Grade(2) (Height)	Height of Surcharge	Width	Elev. (Height)	Geosyn.(7,8)	Wick Drain Spacing (c-c)(9)	Wait Time Between Fill Stages and Prior to Paving	0 - 1yr.	> 1yr.	Settle. During Constr. (6)	Post Constr. Settle.	Total Est. Settl.
[-]	[-]	[-]	[-]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[m]	[m]	[m]	[m]	[m]	[m]	[m]	[kN/m]	[m]	[mon.]	[mm]	[mm]	[mm]	[mm]	[mm]
20+860	20+880	20+865	X	0.1	0.1	268.5	270.6 (2.1)	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	10	5	25	15	40
				-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving										-Pre Construction: Remove organics/peat. Option 1 -Fill Placement Stage 1: Construct embankment with overbuild. Wait 1 month. -Post Construction: After wait period, remove excess overbuild to design road grade elevation and complete paving														

	WBL		EBL	
	Distance	Estimated Foundation Consolidation	Distance	Estimated Foundation Consolidation
	(m)	(mm)	(m)	(mm)
Stage 1	-37	0	13	7
	-35	0	15	4
	-33	0	17	1
	-31	0	19	0
	-29	0	21	0
	-27	0	23	0
	-25	1	25	0
	-23	1	27	0
	-21	1	29	0
	-19	1	31	0
	-17	2	33	0
	-15	3	35	0
	-13	4	37	1
	-11	6	39	1
	-9	9	41	1
	-7	14	43	0
	-5	18	45	0
	-3	20	47	0
	-1	22	49	0
	1	23	51	0
	3	23	53	0
	5	22	55	0
	7	21	57	0
	9	18	59	0
	11	13	61	0
	13	7	63	0

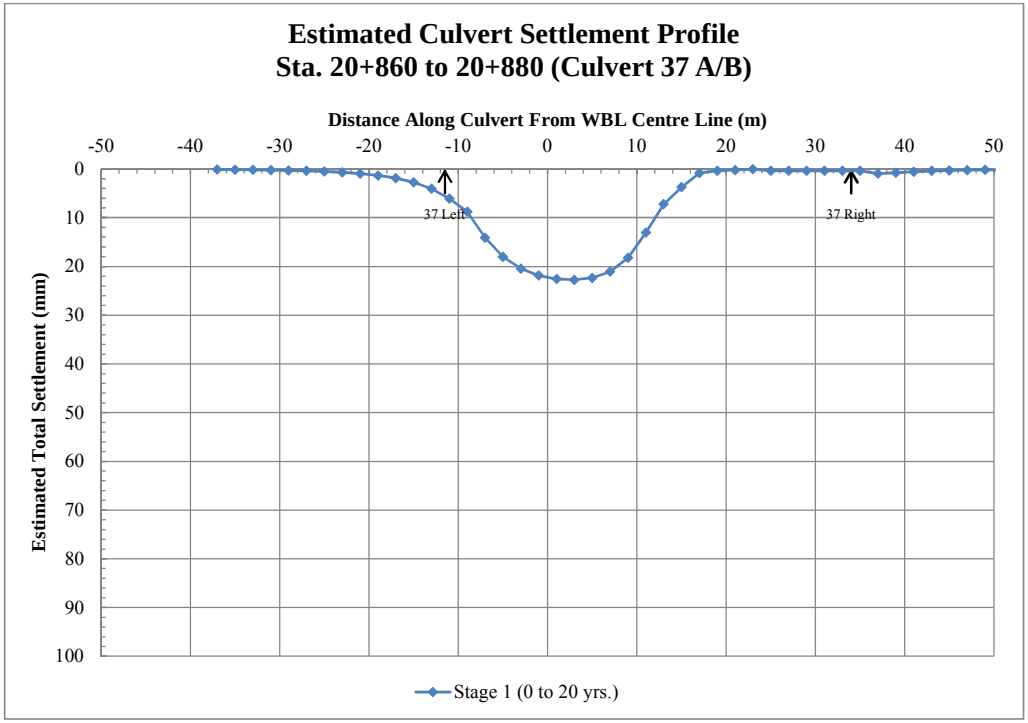

Figure AM1

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Appendix AN

Highway 11/17 WBL

Sta. 13+450 to 13+550

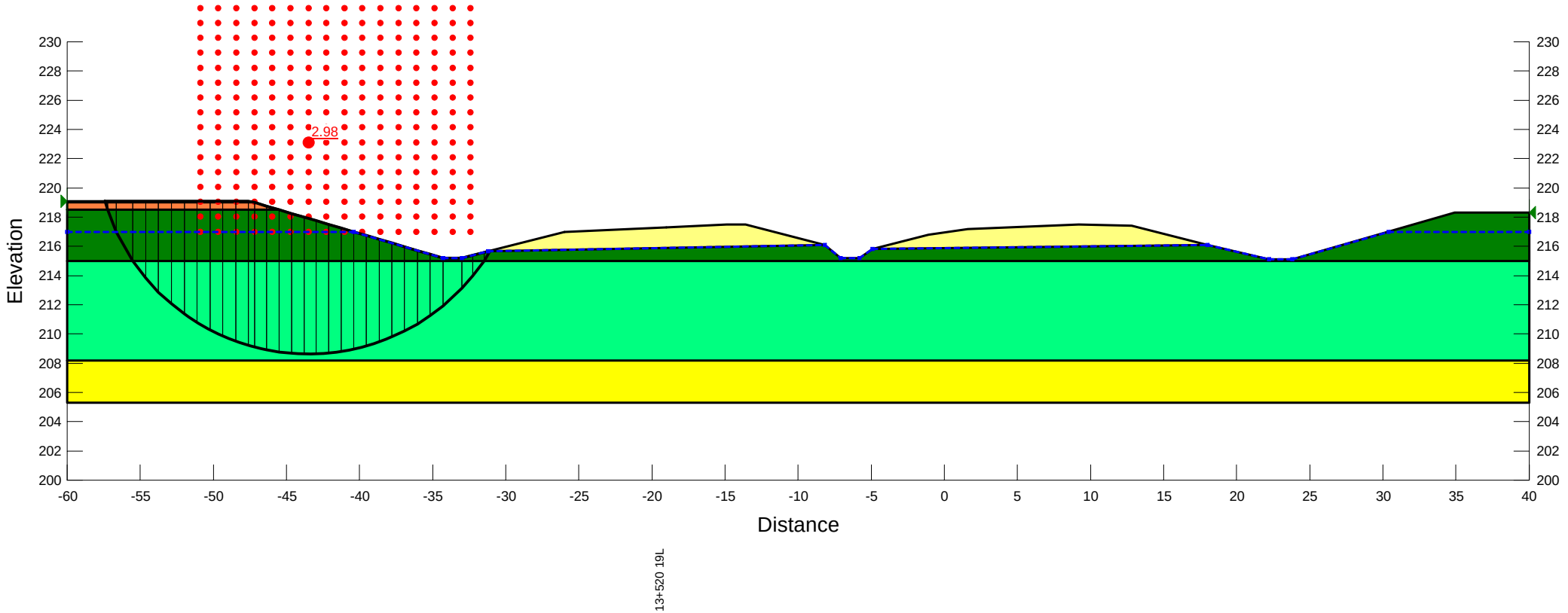
Selected Slope Stability Analysis Figures

Summary of Subsurface Conditions

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: WBL ST
Description: STA: 13+520 (13+450-13+550)
Last Edited By: Michael Eastman
Last Solved Date: 8/6/2014, 3:25:52 PM

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay TSA 1	18 kN/m³	50 kPa	0 °	1
Silty Clay TSA 2	18 kN/m³	30 kPa	0 °	1
Silty Sand 2	20 kN/m³	0 kPa	35 °	1
Silty Sand 1	20 kN/m³	0 kPa	30 °	1
Peat	13 kN/m³	2 kPa	28 °	1



Directory: H:\19\1351\237 Hwy 11-17 Nipigon Low Fills\Analysis\Cuts\13+450 to 13+550\Stability\

Figure AN1

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: WBL LT
Description: STA: 13+520 (13+450-13+550)
Last Edited By: Michael Eastman
Last Solved Date: 8/6/2014, 3:27:20 PM

Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Silty Sand 2	20 kN/m³	0 kPa	35 °	1
Silty Sand 1	20 kN/m³	0 kPa	30 °	1
Peat	13 kN/m³	2 kPa	28 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

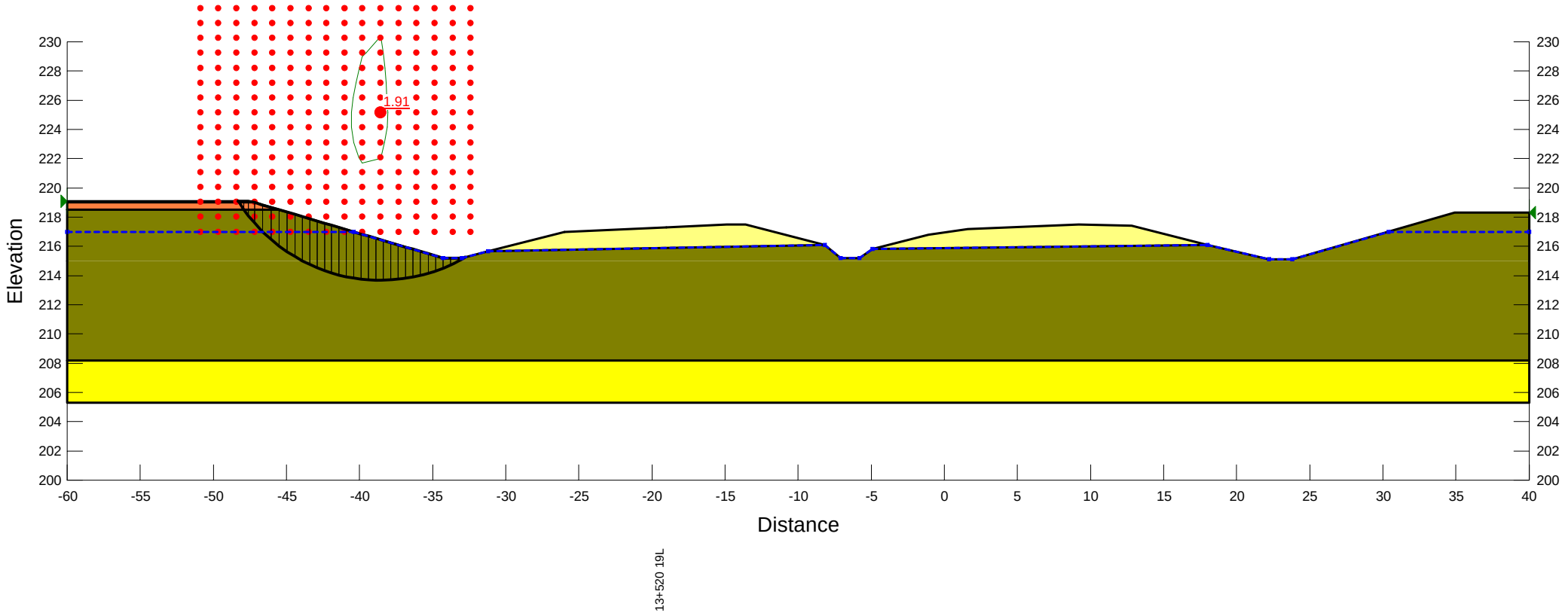


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Figure AN2

Highway 11/17 - Red Rock to Nipigon

WBL - Sta. 13+450 to 13+550

Summary of Subsurface Conditions (Cohesive Soils)

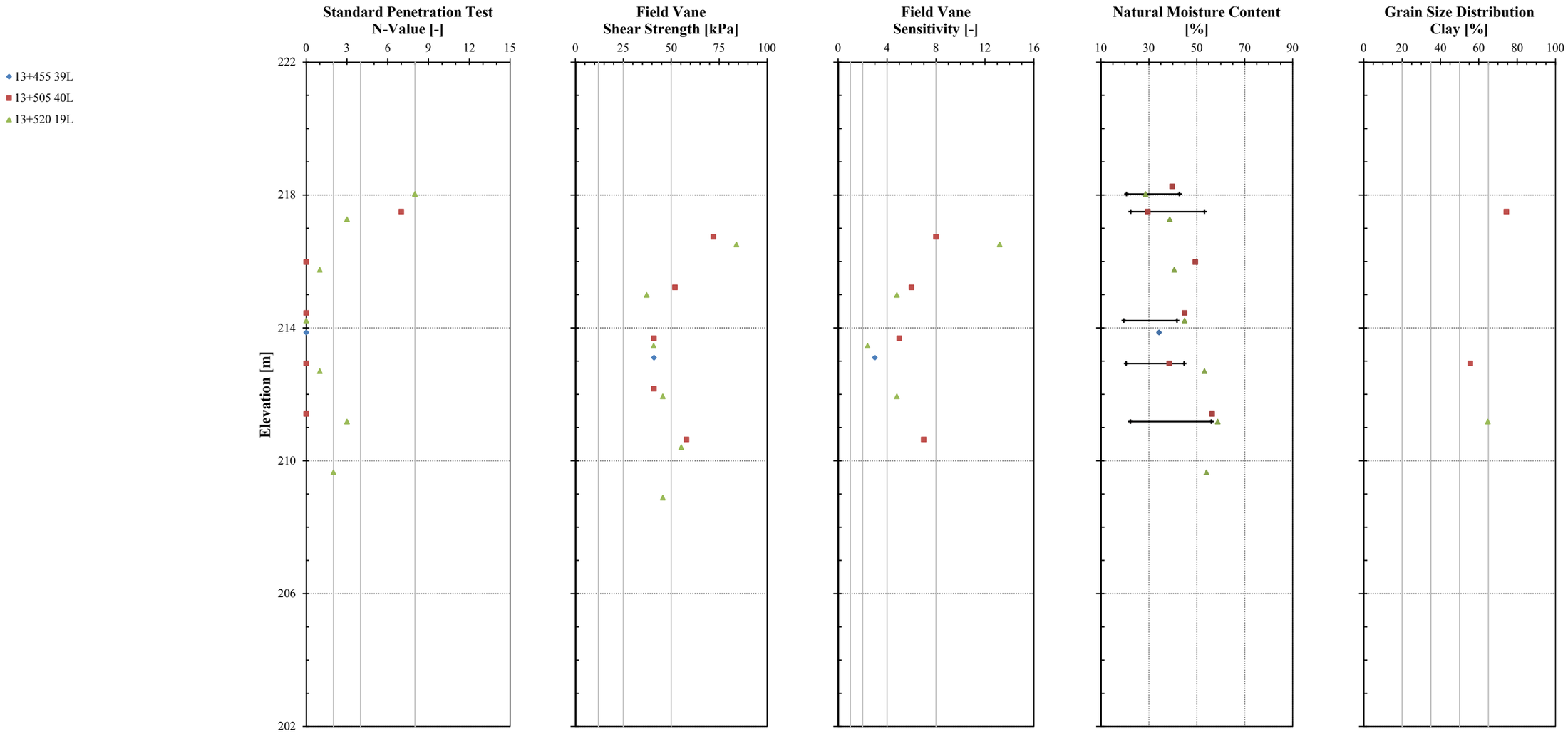

Figure AN3

Appendix AO

Highway 11/17 WBL

Sta. 13+640 to 13+660

Selected Slope Stability Analysis Figures

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: WBL ST
Description: STA: 13+650 (13+590 to 13+660)
Last Edited By: Michael Eastman
Last Solved Date: 8/6/2014, 4:30:32 PM

Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay TSA	18 kN/m³	50 kPa	0 °	1
Sandy Silt	20 kN/m³	0 kPa	28 °	1
Sand	20 kN/m³	0 kPa	35 °	1
Peat	13 kN/m³	2 kPa	28 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

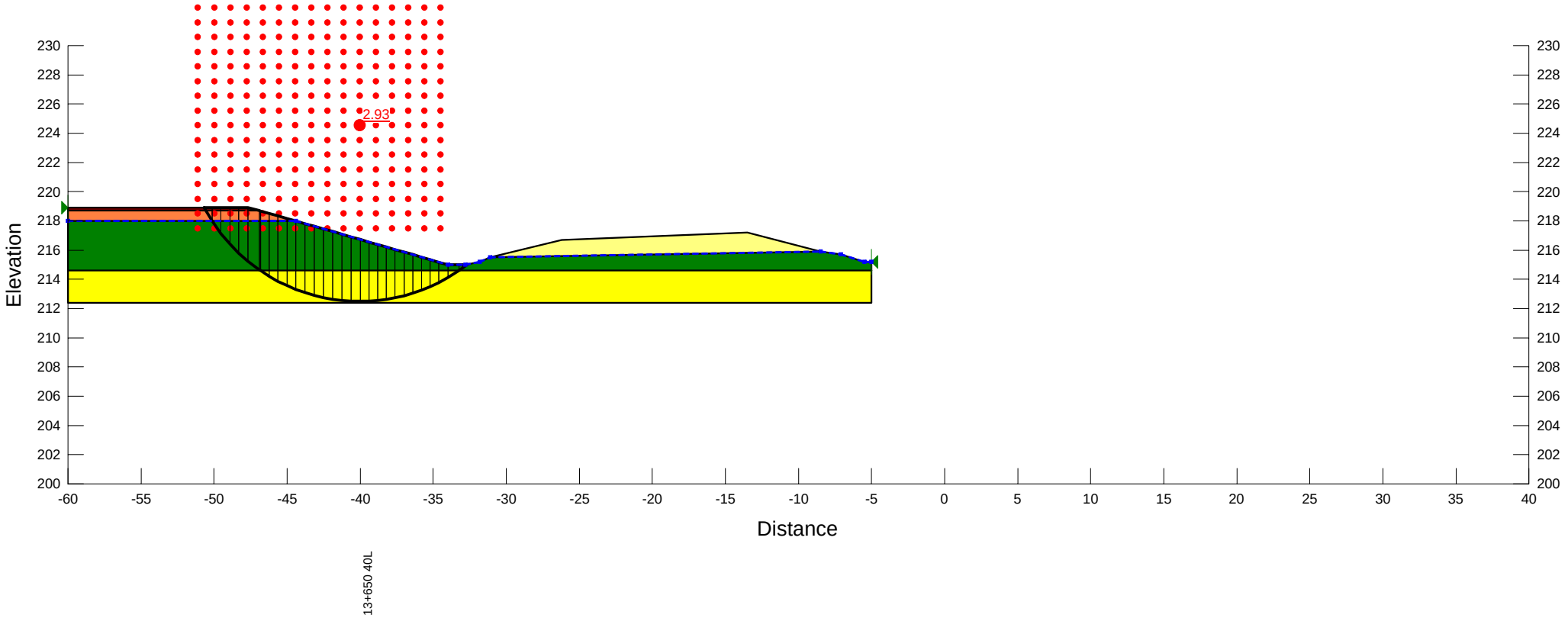

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Figure AO1

Title: Highway 11/17, Nipigon, Ontario
Comments: Embankment Stability
Name: WBL LT
Description: STA: 13+650 (13+590 to 13+660)
Last Edited By: Michael Eastman
Last Solved Date: 8/6/2014, 4:30:22 PM

Sand Fill	21 kN/m³	0 kPa	34 °	1
Silty Clay ESA	18 kN/m³	7 kPa	23 °	1
Sandy Silt	20 kN/m³	0 kPa	28 °	1
Sand	20 kN/m³	0 kPa	35 °	1
Peat	13 kN/m³	2 kPa	28 °	1

Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1 m
Horz Seismic Load: 0

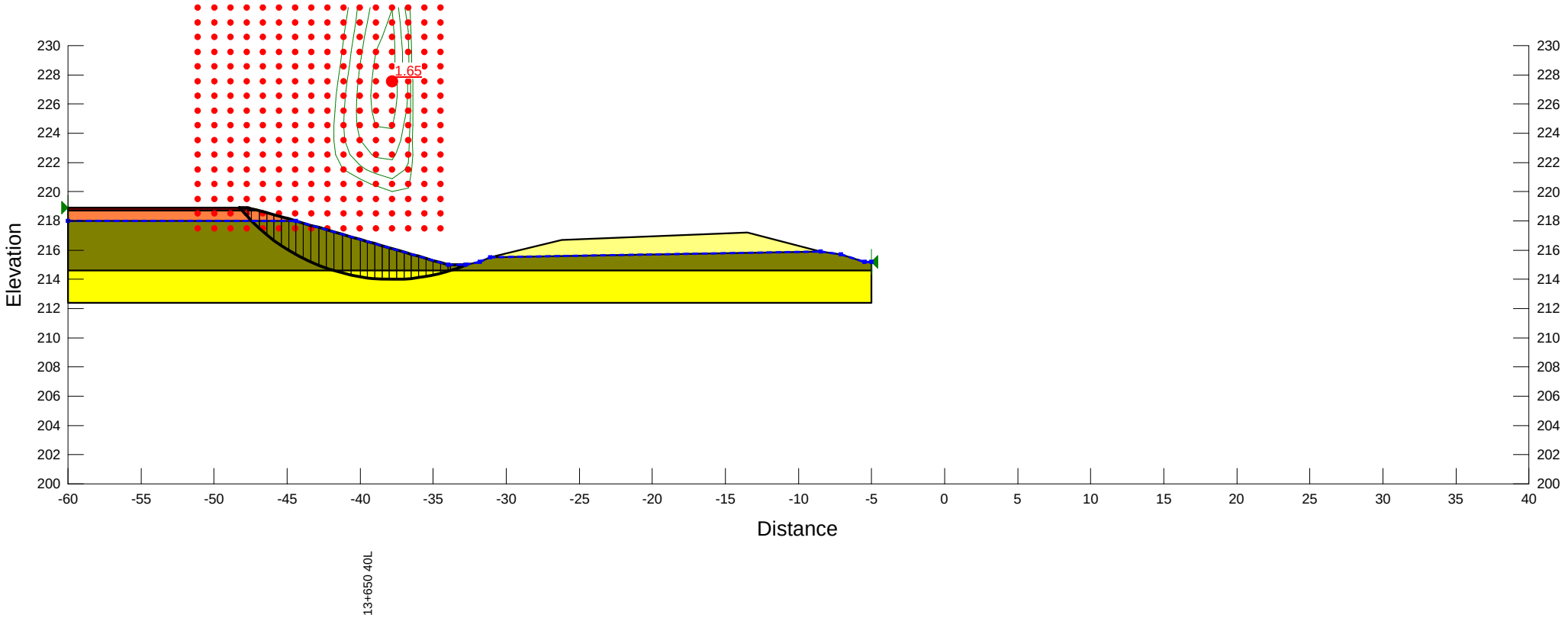

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Figure AO2

Appendix AP

Highway 11/17 WBL

Sta. 14+290 to 14+410

Summary of Subsurface Conditions

Highway 11/17 - Red Rock to Nipigon

WBL - Sta. 14+290 to 14+410

Summary of Subsurface Conditions (Cohesive Soils)

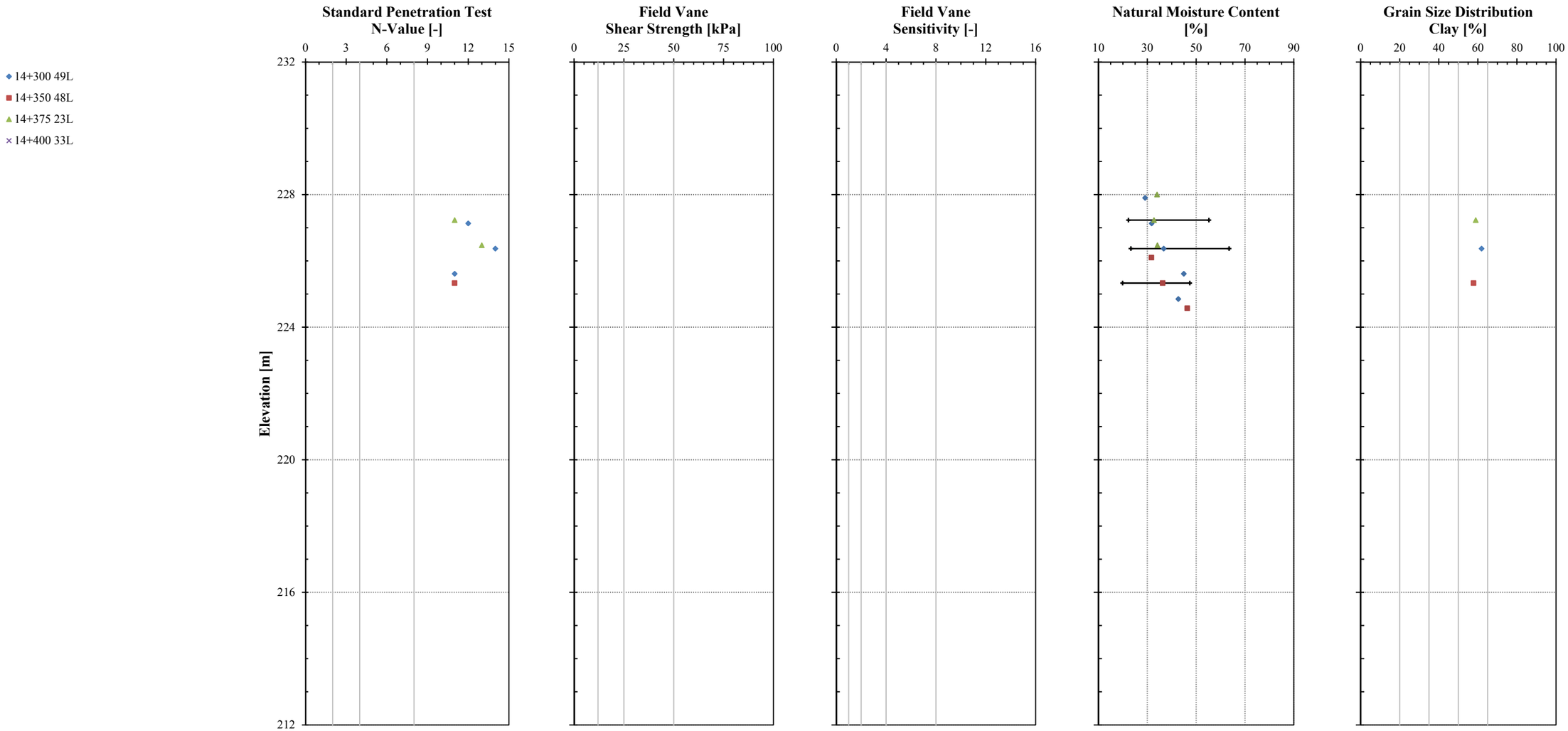

Figure AP1