FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH EMBANKMENTS AND SWAMPS
STRONG TOWNSHIP, MAINLINE STA 16+450 TO 17+350
HIGHWAY 11 FOUR LANING
BURK'S FALLS TO SOUTH RIVER, ONTARIO
G.W.P. 759-93-00

Geocres Number: 31E-235

Report to

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual information obtained from a foundation investigation at the proposed locations of high embankments along the proposed Highway 11 mainline alignment extending from Sta. 16+450 to Sta. 17+350 in Strong Township.

The purpose of the investigation was to explore the subsurface conditions at sites where embankments higher than 6 m or swamp crossings are proposed, and based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile and cross-sections and a written description of the subsurface conditions. Assessment of embankments less than 6 m in height is not included in this assignment.

Thurber carried out the investigation as a sub-consultant to Marshall Macklin Monaghan (MMM), under the Ministry of Transportation Ontario (MTO) Agreement Number 5005-A-000188.

2 SITE DESCRIPTION

This report addresses the portion of the proposed Highway 11 Mainline extending from about 200 m south of the existing intersection of Highway 11 and Valley View Drive to about 700 m north of this intersection for a total distance of approximately 900 m. The proposed mainline alignment is located in Strong Township and generally runs parallel to the existing Highway 11 alignment. The new alignment will incorporate parts of the existing highway into the NBL. New embankment will be constructed to support the South Bound Lanes (SBL).

The site is located in the physiographic area known as the Laurentian Highlands of the Canadian Shield which generally consists of undulating terrain with uplands areas comprised of bedrock outcrop or overburden soils comprised of granular outwash or basal till of variable thickness. Swamps or lakes are commonly present in the low-lying areas. The proposed alignment is located on undulating terrain which rises gently to the north end of the alignment. The vertical relief over

the assessed portion of the alignment is less than 35 m. The regional terrain morphology generally slopes gently from the upland areas east of the alignment downwards towards the Stirling Creek valley located west of the alignment.

Drainage in the surrounding areas is typically moderately well developed and is comprised of small streams which flow generally westwards into Stirling Creek.

The majority of the land along this section of the proposed alignment is undeveloped forested land with some localized residential and commercial development near the intersection of Highway 11 and Valley View Drive Road.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this portion of the project were carried out between July 26, 2002 and September 30, 2003. The site investigation for this area consisted of drilling and sampling a total of 16 boreholes and 4 Dynamic Cone Penetration Tests (DCPT) to depths ranging from 0 to 6.9 m.

The median centreline location and stations were surveyed and staked in the field by Marshall Macklin Monaghan (MMM) prior to commencing drilling operations. The borehole and DCPT locations were established in the field by Thurber personnel based on the staked median centreline or ramp centreline as applicable. The boreholes are labelled based on the individual station and offset for each alignment. Property access, site preparation and utility clearances were carried out by Thurber prior to any drilling being carried out. The locations of the boreholes are shown on the attached "Borehole Locations and Soil Strata Drawings" found in Appendices A through C. The site plans, topography and proposed height of embankments shown on the drawings were provided by MMM, dated May 2004.

The drilling, sampling and in-situ testing operations were carried out by All-Terrain Drilling of Waterloo, Ontario and George Downing Estate Drilling of Port Hawkesbury, Ontario. The boreholes were advanced by CME 75 drill rigs mounted on Nodwell tracked carriers using hollow stem and solid stem auger techniques. Disturbed samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in most overburden soils. Where cohesive layers exhibiting lower strength were encountered, in-situ vane shear tests and thin-walled tube samples were collected.

Dynamic Cone Penetration Tests (DCPT) were carried out at the toe of fill locations (alternating intermediate stations) to obtain a continuous profile in the upper portion of the deposit. The DCPT tests were carried out by continuous penetration of a 50 mm diameter steel cone (60 degree) driven by a standard SPT hammer. The DCPT profiles are shown on the borehole logs in the Appendices A through C.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and the recovered disturbed and undisturbed samples and processed the samples for transport back to Thurber's Oakville laboratory.

Upon completion of drilling and sampling, standpipe piezometers were installed in select boreholes. Piezometer construction generally utilized 19 mm diameter Schedule 40 PVC pipe with 1.5 m long slotted tips installed near the bottom of the boreholes. The piezometers installations were backfilled with a sand filter pack extending from the bottom of the hole to at least 0.3 m above the top of the screen and bentonite clay seal (holeplug) was placed above the filter sand. A second bentonite seal was placed just beneath the ground surface. The interval between the bentonite seals was backfilled with cuttings and bentonite. Boreholes without piezometers were backfilled using bentonite and drill cuttings.

The Record of Borehole logs, "Borehole Locations and Soil Strata" drawings, and laboratory test result summaries are included in each of the separate appendices as shown below:

- Appendix A Hwy 11 Mainline, Strong Township, Sta. 16+450 to 16+600
- Appendix B Hwy 11 Mainline, Strong Township, Sta. 16+700 to 16+850
- Appendix C Hwy 11 Mainline, Strong Township, Sta. 17+250 to 17+350

4 LABORATORY TESTING

All recovered soil samples were returned to Thurber's laboratory where they were subjected to visual identification and to natural moisture content determination. The results of this testing are shown on the Record of Borehole sheets in the Appendices as described in the preceding section.

Selected samples were subjected to gradation analysis (sieve tests) and Atterberg Limit testing. These test results are included on the borehole logs and plots in the Appendices.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

A general description of the stratigraphy for each of the locations where high fills are proposed is given in the following sections and summarized in Table 8.1. Details of the soil stratigraphy encountered are included in the Record of Boreholes sheets in Appendices A through D. Where specific information is required reference should be made to the Record of Borehole sheets in the Appendices.

5.1 Highway 11 Mainline Embankment, Strong Sta. 16+450 to 16+600

The SBL of Highway11 Mainline in Strong Township between Sta. 16+450 and 16+600 will be supported by an embankment which is generally 5 to 7 m in height, crossing a low-

lying area. The NBL will be located on a widened embankment placed over the existing Highway 11 embankment.

The soils encountered in the boreholes drilled along this portion of the alignment generally consist of a topsoil layer overlying discontinuous sandy silt to sand, which in turn rests on a extensive deposit of Silty clay to silt which extends to the maximum depth of investigation.

Topsoil

A layer of topsoil was encountered at the ground surface in most of the boreholes. The thickness of topsoil encountered at the boreholes varied from 0 to 200 mm. The average thickness was 85 mm.

Sand

A 1.4 m thick layer of sand was encountered extending from the ground surface in Borehole No. 16+575, R5. The sand is described as fine-grained sand, trace to some silt. The colour is reddish brown with oxide stain becoming brown below 0.6 m depth. The SPT N-value in this deposit was 19 indicating compact conditions. The moisture content was 13%.

Sandy Silt

At two borehole locations a local deposit comprised primarily of sandy silt was encountered. The composition of this unit was variable ranging from sand silt trace clay; to silt with some sand. The sand fraction was typically fine to medium grained. The thickness of this deposit, where present, varies from 0.5 to 1.5 m.

The deposit was typically brown to grey in colour.

The SPT N-values in this deposit were 16 indicating a compact condition. The moisture content of a disturbed sample collected from this unit was 18%.

Silty Clay

An extensive deposit of silty clay was encountered beneath the surficial topsoil, sand and sandy silt layers described above. The deposit is described as silty clay, trace sand with occasional sand seams and laminations. The colour is brown to grey with mottling noted at shallow depths. This deposit extended to 8.8 m to 13.6 m depth at the borehole locations. The silty clay is underlain by a sand layer, except near Sta. 16+575 R5 where a silt unit was encountered beneath the clay at 4.6 m depth. The maximum thickness of the silty clay encountered was 13.5 m.

The SPT N-values ranged from 23 to 2, generally decreasing with depth, and indicate stiff conditions above 4 to 6 m depth and firm to soft below this depth. Field vane shear tests

indicate undrained shear strengths varying from 88 kPa to 44 kPa, indicating stiff to firm consistency, typically decreasing with greater depth.

The particle-size and Atterberg Limit analyses, summarized in Figures A1, A2, A4 and A5 in Appendix A, are summarized below, and indicate low to medium plasticity (CL to CI).

% clay particles	31-46 %
Liquid Limit	28-42 %
Plastic Index	10-18 %
Water Content	23-67 %

Sand

A layer of sand was encountered beneath the silty clay unit noted above. The sand is described as sand, trace gravel trace silt. The SPT N-values varied from 5 to 27. The moisture content of the recovered samples varied from 12 to 18%. The two deeper boreholes terminated in this unit indicating a minimum thickness greater than 1.6 m.

The results of the gradation analyses for this deposit are summarized in Figure A3 in Appendix A.

Silt

At Borehole No. 16+575 R5 a layer of silt was encountered beneath the silty clay. The silt extended to the maximum depth of the investigation. This unit is described as silt, some clay, trace sand. The deposit is grey in colour. SPT N-values of 6 to 7 were encountered indicating a firm consistency. The moisture content of disturbed samples varied from 31 to 32%.

The results of the gradation analyses for this deposit are summarized in Figure A2 in Appendix A.

Groundwater

Observations of groundwater conditions during drilling and measurements of water levels in the standpipe piezometer indicate that at the time of investigation, the depth to the groundwater table was at Elev 320.1 m or about 2.6 m below the ground surface. The groundwater levels are expected to vary seasonally and with heavy precipitation events.

5.2 Hwy 11 Mainline Embankment, Strong Township, Sta. 16+700 to 16+850

The SBL of the proposed Highway 11 alignment will be supported by new embankment of 5 to 10 m in height. The NBL will be founded over the existing Highway 11 embankment.

The soils encountered in the boreholes drilled in this area generally consist of topsoil overlying a thin layer of sand. In the low-lying areas, peat was encountered overlying silty sand fill or silty clay. The various soil units are described below:

Topsoil and Peat

A layer of topsoil or peat was encountered at most boreholes. The topsoil is described as sandy topsoil and the peat is described as fibrous peat. Occasional rootlets were also noted. The colour varies from reddish brown to dark brown to black. The thickness of topsoil encountered in the boreholes varied from 0 to 300 mm, and averaged 225 mm.

Fill

A layer of silty sand fill was encountered beneath the peat at Borehole No. 16+769 L17. The deposit is described as silty sand, trace gravel, trace organics. The sand is fine-grained. SPT N-values in this deposit varied from 3 to 10 indicating loose to compact conditions. The moisture content of the recovered samples varied from 24 to 35 %. The thickness of the deposit was 2.1 m, and was underlain by auger refusal conditions indicating an underlying boulder layer or bedrock.

Silty Clay

A deposit of silty clay was encountered beneath the peat at Borehole No. 16+725 L18.75. This unit is described as silty clay, trace sand, trace gravel. The soil is grey in colour. SPT N-values decrease with increasing depth, varying from 36 to 4, indicating a hard to firm consistency. The moisture content of samples recovered in this unit varied from 40 to 43%. The thickness of the deposit was 2.5 m, beneath which auger refusal conditions were encountered indicating an underlying boulder layer or bedrock.

The particle-size and Atterberg Limit analyses, summarized below and shown in Figures B1 and B2 in Appendix B, indicate intermediate plasticity (CI).

% clay particles	32 %
Liquid Limit	34 %
Plastic Index	12 %

Sand

A sand layer was encountered beneath the topsoil in the upland areas. The sand is described in the borehole logs as fine to medium grained sand, trace gravel. Occasional gravel layers, cobbles and boulders were also noted. The deposit is reddish brown to brown in colour. An SPT N-value of > 100 was encountered indicating very dense conditions or the presence of cobbles and boulders. The moisture content of disturbed samples recovered from this unit varied from 7% to 27%. Auger refusal conditions, indicating the presence of boulders or bedrock, were encountered at the lower boundary of the sand. The thickness of the sand layer encountered in the boreholes varied from 0.3 to 1.2 m.

Groundwater

Groundwater conditions noted during drilling and in the open boreholes following completion of drilling indicate a depth to water-table of 2.1 m (Elev 324 m). The groundwater levels are expected to vary seasonally and with heavy precipitation events.

5.3 Hwy 11 Mainline Embankment, Strong Township, Sta. 17+250 to 17+350

The Highway11 Mainline in Strong Township between Sta. 17+250 and 17+350 will consist of new embankment supporting the proposed SBL. The NBL will be supported by widening the existing Highway 11 embankment. The proposed height of fill at the SBL varies from 3 to 4.5 m in height.

The soils encountered in the boreholes drilled along this portion of the alignment generally consist of a surficial topsoil or peat layer overlying a discontinuous layer of sand to silty sand. Beneath the sand in the low-lying area, a layer of silty clay to silt was present. At one location, Borehole No. 17+298.5 L18.75, a layer of gravelly sand was encountered underlying the sequence described above. All boreholes encountered auger refusal conditions suggesting the presence of boulders or bedrock. The maximum depth of investigation was 5.5 m.

Topsoil and Peat

A layer of topsoil or peat was encountered at all boreholes. The topsoil was present in the upland areas and the peat was encountered at lower elevations. The peat was fibrous and the colour was black. The thickness of topsoil encountered in the boreholes varied from 100 to 300 mm.

Sand to Silty Sand

A layer of sand to silty sand was encountered beneath the topsoil and peat at the boreholes located near the SBL centreline. The deposit is described as fine-grained sand, some silt to silty, with trace to some gravel. The colour is brown. An SPT-N-value in this deposit of 61 was obtained indicating very dense conditions. The sample water content was 18%. The thickness of the deposit measured in the boreholes varied from 0.6 to 1.1 m.

Silty Clay to Silt

A silty clay to silt deposit was encountered underlying the deposits described above within two boreholes advanced in the low-lying area. This composition of the deposit is variable and is described as silty clay to silt, some sand to sandy. Occasional sand pockets and sandy silt layers were also noted. The unit is grey in colour. The SPT N-values varied from 6 to 30 indicating stiff to very stiff consistency. The moisture content of disturbed samples from this unit is 25 to 32 %. Particle size analysis and Atterberg limit tests indicate the following properties indicating low plasticity (CL).

% clay-sized particles	11 - 23
Liquid Limit	25 %.
Plastic Limit	8 %

The thickness measured in the boreholes varied from 2.2 m to 2.8 m.

The results of the laboratory testing for the units above are summarized in Figures C1 to C2, in Appendix C.

Gravelly Sand

At one location (Borehole 17+298.5 L18.75) a deposit of gravelly sand was encountered beneath the soil strata described above. This unit is described as well graded, gravelly sand, some silt. The soil is brown in colour. The SPT N-value of 17 indicates a compact condition, and the sample moisture content was 12%. The thickness of this deposit was 1.8 m.

Groundwater

Observations of groundwater and soil moisture conditions during drilling indicate that the groundwater table in this area is generally 1.2 m to 1.5 m below the ground surface., indicating that the water-table surface varies at the borehole locations from Elev 346.2 m to Elev 346.9 m. The groundwater levels are expected to vary seasonally and with heavy precipitation events.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents preliminary foundation design recommendations where embankment heights exceed 6 m or swamp crossings have been proposed.

The discussion and preliminary recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigation.

7 ENGINEERING ANALYSIS METHODOLOGY

7.1 General

The project information, including plan and profile of the proposed alignments dated May 2004, utilized in the engineering analysis was provided by MMM. For the purpose of analysis and reporting the proposed embankments and swamp crossings along the proposed Highway 11 alignment, interchange ramps and other highway alignments have been treated separately. A summary of the various segments is provided below:

- Hwy 11 Mainline, Strong Township, Sta. 16+450 to 16+600
- Hwy 11 Mainline, Strong Township, Sta. 16+700 to 16+850
- Hwy 11 Mainline, Strong Township, Sta. 17+250 to 17+350

The major factors governing foundation design of the proposed embankments include:

- Proposed embankment geometry (height, slope angle, footprint, etc)
- Embankment material type (earthfill, Select Subgrade Material -SSM or rockfill)
- Extent and thickness of surficial organic soils
- Thickness and engineering properties of underlying mineral soils

- Depth to competent layer (bedrock or dense sand or gravel)
- Groundwater conditions

The geotechnical analysis summarized in this report includes assessment of the global stability of different embankment geometries and material types for both short and long term conditions. Assessment of immediate elastic and long term foundation settlement was also carried out.

7.2 Design Options

Several design options are available for reducing settlement and improving stability during embankment construction on soft soils including peat removal, staged construction, surcharging, wick drains and lightweight fill. Soft cohesive soils were encountered in the lower portion of the boreholes between Sta. 16+450 and 16+600. The relatively good subsurface conditions encountered during the site investigation along the assessed portion of Highway 11 mainline from Sta.16+450 to 17+350 allows conventional embankment design methods to be utilized where embankments greater than 6 m in height are proposed. The estimated stability and settlements associated with conventional embankment construction are presented in the following section.

7.3 Stability and Settlement Analyses

The stability analyses were carried out using limit equilibrium methods by the commercially available slope stability program "GSLOPE" developed by Mitre Software Inc. Bishop's modified method of slices was used in the analyses. Based on consideration of the risk involved and past experience with highway embankment design and monitoring of embankment performance, a Factor of Safety (FS) of 1.3 is considered appropriate to maintain embankment stability and control deformations during construction. A FS of 1.3 is considered acceptable for assessment of global embankment stability on granular soils for long and short term conditions. For embankments founded on cohesive soils, in additional to a minimum FS of 1.3 for short term conditions, a FS of 1.5 for long term conditions is recommended in order to reduce the potential for creep-induced settlements of the fill. The results of the stability analysis are included in Appendix D.

Immediate foundation settlements due to compression of the non-cohesive soils have been estimated based on the methods described in the CHBDC, 2000 Commentary Section C6.6.3.6. Long term settlements were estimated for cohesive soils based on methods described by Mesri (1973). The use of surcharge to increase the rate of primary settlements was also assessed.

7.4 Seismic Considerations

The following seismic parameters have been used in design

- Velocity Related Seismic Zone 1
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 2
- Zonal Acceleration Ratio 0.1

In accordance with the CHBDC, the soil profile type at this site is classified as Type I (less than 60 m of stable sand, gravel or stiff clay), which according to Table 4.4.6.1 of the CHBDC is associated with a Site Coefficient of 1.0. A peak horizontal ground acceleration (PHA) of 0.11g, where g is the acceleration due to gravity, has therefore been used in this analysis. This PHA value corresponds to a probability of exceedance of 10% in 50 years.

7.4.1 Stability

Stability of the embankments under seismic loading was assessed by carrying out a pseudo-static analysis using the parameters above. The pseudo-static analysis considers the application of the PHA to the soil mass on a non-softening foundation to assess the embankment stability. Where the results of the analysis indicate a FS greater than 1.0 under seismic loading, large scale movements of the embankment are not considered likely to occur. Small movements or local toe failure may be associated with these conditions, but are expected to be easily repairable.

7.4.2 Liquefaction Potential

Several of the proposed embankments will be constructed on loose to compact cohesionless soils overlying bedrock. A review of the subsurface conditions at each site, including presence of cohesionless deposits, the depth to water-table, SPT values and fines content at each site was carried out to provide a cursory assessment of the likelihood of liquefaction. Soils that are not subject to liquefaction during seismic events include: dense granular deposits (N>30), stiff cohesive soils, unsaturated deposits, or soft cohesive deposits that do not meet the 'Chinese Criteria', presented by Seed et al (1983) as shown below:

-Percent finer than 0.005 mm size	< 15%
-Liquid Limit	< 35%
-water content	>0.9 LL

Where the data collected in the boreholes did not meet the criteria above, the foundation area was assigned low liquefaction potential, indicating that a significant volume of the foundation soils would not be not subject to liquefaction during a seismic event.

8 EMBANKMENT DESIGN

8.1 General

Representative sections were selected for stability and settlement analysis based on the soil information with preference given to areas exhibiting low shear strength and high compressibility.

Assessment of stability and settlement for embankments lower than 6 m height is beyond the scope of this report and is therefore not included in this assessment.

The subsurface conditions encountered at the various embankment locations generally consist of loose to compact, cohesionless deposits or deposits of stiff to firm silty clay. A summary of general soil and groundwater conditions is included in Table 8.1.

8.2 Peat and Topsoil Removal

Within the project limits addressed in this report, the depth of peat and organic soils encountered at the boreholes is generally less than 300 mm thick. It is recommended that all peat and topsoil be subexcavated from within the proposed fill footprint. The foundation area should be backfilled with rock or granular backfill as described in the following section. Placement of coarse rockfill material is recommended where surface water is encountered.

It is anticipated that standing water or swamp may be encountered in low-lying areas. For the shallow depth of peat encountered in the boreholes, special measures to dewater the site will not be necessary. Embankment construction using s

Table 8.2 provides a summary of the anticipated average depth of stripping for peat and topsoil removal along the proposed alignments. The depth of stripping is based on the average thickness of organics noted at the borehole locations. Stripping depths may vary from that noted in the table at locations between the boreholes.

In the stability and settlement analyses summarized below it has been assumed that the organic and peat layers have been removed and replaced with granular backfill as appropriate.

8.3 Stability Analysis

Separate analyses were carried out for both short term (undrained) and long term (effective stress) and seismic conditions using the following variables:

- Earth fill embankment slopes 2H:1V
- Rock fill embankment slopes 1.25H:1V

The stability analyses indicate that short and long term stability will be adequate for all sites where high fills are proposed. The analyses indicate a FS greater than 1.3 for short term conditions. For long term conditions, a FS greater than 1.5 was obtained where cohesive soils are present and greater than 1.3 where cohesion-less soils are present.

8.4 Settlement Analysis

8.4.1 Foundation Settlements

A settlement analysis was carried out using stresses calculated for two-dimensional embankment loading configurations on an elastic foundation. Input parameters were developed based on correlations between SPT N-values measured at the site. Consolidation settlement analysis was also carried out using Terzaghi's one-dimensional method where soft, cohesive deposits were encountered at Mainline, Sta. 16+450 to 16+600 and near Sta. 16+725.

The result of the settlement analyses are summarized in Table 8.3 following the text of the report.

Hwy 11 Mainline, Strong Sta. 16+450 to 16+600

The portion of the Hwy 11 mainline from Sta. 16+450 to 16+600 is located on cohesive deposits which are stiff to very stiff within about 5 m of the surface, but become softer with increasing depth. The maximum settlement beneath the Hwy 11 SBL in this area is estimated as about 330 mm, with the majority of this occurring within 1 year of embankment construction. Design options for reducing the short term and long term settlements are summarized in Table 8.4 following the text of the report. A discussion of theses options is given below.

Design Options

Several options for reducing the post-construction settlements and increasing the rate of consolidation are presented in Table 8.4. The preferred option will depend on the selected design constraints relating to schedule, cost and risk.

The cost estimates included in the table are based on assumed design parameters (wick drain spacing, surcharge height and volume of lightweight fill), and are for initial comparison of design options only. Detailed design will be required to determine the final values for these parameters.

The use of surcharge, wick drains or other measures to reduce the time for primary consolidation will typically increase the post-construction settlements by 20 to 40%. The post-construction settlement can be reduced by leaving the surcharge in place for longer

period of time or using higher surcharge level. Higher surcharge levels will decrease the factor of safety for instability and may require the use of berms or staged construction to complete the embankment.

If detailed design of wick drains or surcharge measures is required to meet the project schedule or control post construction settlement, we recommend that additional investigation and detailed analysis for these options be carried out.

8.4.2 Embankment Compression

The estimated foundation settlements provided in the preceding section do not include compression of fill material itself. Embankment compression of the embankment material is expected to occur because of rearrangement of particles associated with traffic loading and changes in moisture conditions. The magnitude and rate of fill compression are dependant on numerous factors and are difficult to predict. For design purposes, fill compression values of 0.2% for rock fill and 0.5% for SSM fill should be used.

8.5 Liquefaction Analysis

The results of the assessment of embankment foundations liquefaction are summarized in Table 8.3. Significant movements or deformation of the high embankments during seismic events are not likely to occur in these areas.

8.6 Embankment Construction

8.6.1 Embankment Construction Over Swamps

Where appropriate, construction of new embankments over swamp or standing water should be carried out in accordance with OPSS 209, "Construction Specification for Embankments Over Swamps", dated March 1998, and with specific reference to OPSD 203.010, "Embankments Over Swamps, New Construction".

For backfilling of subexcavation below the water-table or in swamps where surface water may be seasonally present above the ground surface, it is recommended that rock fill or coarse granular materials (OPSS Granular B Type II), be used as backfill. Where rockfill is placed in these areas, the embankment should be completed up to subgrade level using rockfill. Voids on top of the embankment shall be chinked with rock fragments and spalls prior to placing granular materials.

8.6.2 Embankments

Embankment construction should be carried out in accordance with OPSS 206, as amended by Special Provision "Amendment to OPSS 206, December 1993", dated November 2002. Earth fill may consist of granular materials and Select Subgrade Material (SSM) in compliance with Special Provision 110F13, "Amendment to OPSS 1010, March 1993".

Earth fill used for construction of embankments should be placed in regular lifts and compacted in accordance with Special Provision NO. 105S10. Benches, 2 m minimum in width, are required along embankment slopes at 8 m maximum vertical intervals in earth and 10 m maximum vertical intervals in rock.

Earth fill embankments slopes must be provided with erosion protection in accordance with Special Provision SP572SO1.

8.6.3 Tie-in to Existing Embankments

The proposed embankments will incorporate the existing 2-lane Highway 11 embankment at some locations. The depth of stripping and subexcavation based on information encountered in the boreholes is generally expected to be less than 300 mm. However, deeper deposits of organic or loose fill may be encountered in the region between boreholes.

For excavations at the base of the existing embankment deeper than 1 m, shoring may be required. Shoring will be required for any excavation encroaching towards the existing embankment and within a 2H:1V imaginary line extending down from the crest of an existing embankment to the base of the excavation. A schematic of this requirement is included in Figure 1.

9 CONSTRUCTION CONCERNS

During construction, a 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 stability or settlement.

Potential construction concerns to be highlighted are shown below, but the concerns are not necessarily limited to this list:

- Inspection and confirmation that all organics and peat materials within the proposed embankment footprints are sub-excavated and replaced with approved backfill.
- Inspection where subexcavation deeper than 1 m is carried out at the toe of existing highway embankments.

- Monitoring of embankment settlement during construction is recommended in areas where preload has been recommended at Hwy 11 Mainline Sta. 16+450 to 16+600 and from Sta. 16+700 to 16+800.

10 CLOSURE

Depending on the design requirements, specialized geotechnical design of surcharge, wick drains, or monitoring programs may be required. While these items are not part of the current scope of work, we would be pleased to assist in preparation of these design options if required.

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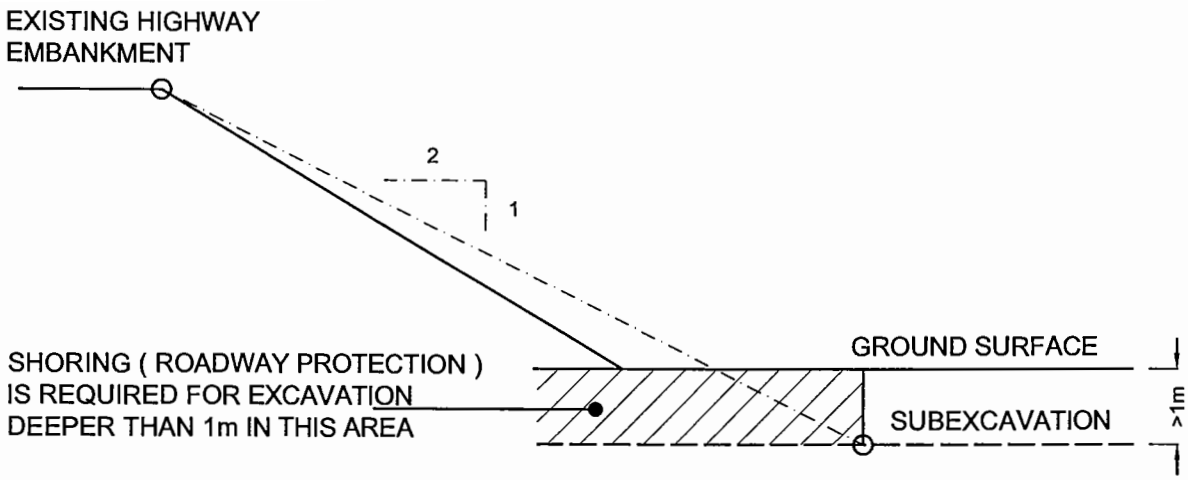


SCHEMATIC FOR EXCAVATION AT BASE OF EXISTING EMBANKMENTS

NOT TO SCALE

FIGURE 1

THURBER

HWY 11 FOUR LANING
EMBANKMENTS AND SWAMPS
Strong Tp, Mainline, Sta 16+450 to 17+350

ALIGNMENT		Offset	Embankment Height (m)	Peat/ topsoil thickness (m)	Depth to Firm Bottom (m)	Predominant Soil Type (m)	Depth to Groundwater (m)
Hwy/Ramp	Station						
Hwy 11 - Strong Tp	16+450 to 16+600	SBL	7.0 ~ 10.0	0 ~0.3	>6 m	Silty Clay to Silt	2.6
Hwy 11 - Strong Tp	16+700 to16+850	SBL	6.0 ~ 7.0	0 ~0.2	0.2	Sand with localized silty clay	2.1
Hwy 11 - Strong Tp	17+250 to 17+350	SBL	3.0 ~ 4.5	0.1 ~ 0.3	1.2 - 5.5	Sand/Silt	1.2 - 1.5

SBL = South Bound Lane
NBL = North Bound Lane
CL = Median

TABLE 8.1
SUMMARY OF EMBANKMENT AND SITE CONDITIONS

HWY 11 - Four Laning
Embankments and Swamps
Strong Tp, Mainline, Sta. 16+450 to 17+350

ALIGNMENT		Offset	Embankment Height (m)	Average Stripping Depth (mm)
Hwy/Ramp	Station			
HWY 11 - Strong Tp	16+450 to 16+600	SBL	7 ~ 10	225
HWY 11 - Strong Tp	16+725 to16+875	SBL	6.0 - 7.0	100
HWY 11 - Strong Tp	17+250 to 17+350	SBL	3.0 ~ 4.5	300

TABLE 8.2
ESTIMATED STRIPPING DEPTH

HWY 11 - Four Laning
Embankments and Swamps
Strong TP, Mainline Sta. 16+450 to 17+350

ALIGNMENT		Site Factor	Embankment Height (m)	Factor of Safety	Embankment settlement (mm)	Foundation Settlement (mm)	Time to Reach 90% of settlement	Liquefaction Potential
Hwy/Ramp	Station							
HWY 11 - Strong Tp	16+450 to16+600	1.0	7	>1.3 short term >1.5 long term	14-35 mm	elastic: 130 mm consolidation: 350 mm long term: 60 mm	90 days 365 days 30 years	low
HWY 11 - Strong Tp	16+700 to 16+850	1.0	10	>1.3 short term >1.5 long term	20-50 mm	elastic: 35 mm consolidation: 50 mm long term: 20 mm	30 days 60 days 30 years	low
Stirling Bridge - west approach	17+250 to 17+350	1.0	4.5	>1.3 short term >1.5 long term	9-23 mm	40 mm	90 days	low

Notes: Factor of Safety are minimum calculated for both short and long term conditions.
FS > 1.3 is required for embankments on cohesionless foundations
Long term settlement will occur post-construction

TABLE 8.3
GEOTECHNICAL EMBANKMENT DESIGN

Design Option	Estimated Time for 90 % consolidation	Approximate Cost	Advantages	Disadvantages	Risk
conventional embankment construction	365 days	$420,000	▪Relatively inexpensive	▪relatively long preload time required to complete primary consolidation settlement	▪Actual settlement rate may be lower than the estimated rate resulting in larger post-construction settlement
surcharge with berms	200-365 days	$440,000	▪Reduces preload time. ▪Decreased post-construction (long term) settlement	▪lower FS for short term stability berms will be required ▪higher cost	▪Actual settlement rate may be lower than the estimated rate resulting in larger post-construction settlement
wick drains	90-120 days	$290,000	▪Significantly reduced preload time ▪Settlement rate is more reliable	▪higher capital cost	▪Construction cost may increase if difficulty encountered during installation
light weight fill	120-350 days	$1,980,000	▪Improves effectiveness of surcharge ▪decreased post-construction settlement	▪higher capital cost ▪complex design and construction requirements	▪Construction cost may increaseif difficulty encountered during installation

Notes: 1. The cost estimates are based on assumed design parameters (wick drain spacing, surcharge height and thickness of lighweight fill) and are for initial comparison of design options only. Detailed design will be required to determine the final design values for these parameters.

2. The costs shown in the above table are unit costs for treatement of an area 60 m wide by 150 m long. Combining any of the options described in the table would require summation of the applicable unit costs.

TABLE 8.4
SUMMARY OF EMBANKMENT DESIGN OPTIONS

Appendix A
Hwy 11 Mainline, Strong Township, Sta. 16+450 to 16+600

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+450 L18.75 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+450, O/S 18.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 30.07.02 - 30.07.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	TOPSOIL										
0.1	Silty **CLAY**, trace sand Very Stiff to Stiff Brown Dry to Moist										
			1	SS	24				○		0 3 66 31
			2	SS	19				○		
			3	SS	14				○		
			4	SS	18				○		
	Increasing clay content Becoming firm		5	SS	5				⊢ ○		0 0 54 46
	Becoming soft		6	SS	3				○		
6.7	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S16+450 L18.75 1 OF 2 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+450, O/S 18.75L ORIGINATED BY SL

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 24.03.05 - 24.03.05 CHECKED BY SS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	Augered to 7.62 m.										
7.6	Silty **CLAY** Firm to Soft Grey		1	SS	5				○		
								+ 5			
			1	TW	PH						
								+ 3.3			
			2	SS	3				○	○	0 0 50 50
			3	SS	2				○		
								+ 3.3			
13.6	**SAND**, trace silt, occasional cobbles Compact Brown Wet		4	SS	27				○		9 86 5 (SI+CL)

Continued Next Page

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

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

ONTMT4S 2312STRONG(52).GPJ 04/07/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S16+450 L18.75 2 OF 2 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+450, O/S 18.75L ORIGINATED BY SL

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 24.03.05 - 24.03.05 CHECKED BY SS

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
15.2	END OF BOREHOLE AT 15.24 m. BOREHOLE OPEN TO 13.72 m. WATER LEVEL AT 2.59 m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE BENSEAL TO SURFACE.										

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

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

ONTMT4S 2312STRONG(52).GPJ 04/07/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+475 L42 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+475, O/S 42L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 30.07.02 - 30.07.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	TOPSOIL										
0.1	Sandy SILT, trace clay Compact Grey Dry to Moist		1	SS	16				○		
1.5	Silty Clay, trace sand Very Stiff to Stiff Grey Moist to Wet		2	SS	24				○		
			3	SS	13				○		
			4	SS	10				⊢●		0 1 63 37
			1	TW	PH				+3		
	Becoming Firm		5	SS	7				○		
6.7	END OF BOREHOLE AT 6.71 m. BOREHOLE OPEN TO 6.71 m and DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+476 R2 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+476, O/S 2R ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY MF/SS

DATUM Geodetic DATE 29.07.02 - 29.07.02 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
0.0	DCPT from surface.										
6.9	END OF DCPT AT 6.86 m.										

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+502.5 L16.75 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+502.5, O/S 16.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 29.07.02 - 29.07.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL**										
0.1	**SILT**, some fine grained sand Brown										
0.8	Silty **CLAY**, occasional sand seams Very Stiff to Stiff Mottled Grey/Brown Moist to Wet		1	SS	22				e		0 9 63 28
			2	SS	13				○		
	Becoming Grey		3	SS	12				○		
			4	SS	12				○		
	Becoming Firm		5	SS	6				e ○		0 0 55 45
			1	TW	PH			+2			
6.6	END OF BOREHOLE AT 6.55m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH (m)
30/07/02	2.58

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+551 L18.75 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+551, O/S 18.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 29.07.02 - 29.07.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL**										
0.2	Silty **CLAY**, trace sand Very Stiff to Firm Mottled Brown / Grey										
			1	SS	18				○		
	fine grained sand laminations from 1.5 m to 3.0 m		2	SS	15				○		0 5 67 29
			3	SS	15				○		
			4	SS	17				○		
			5	SS	12				⊢●⊣		0 2 69 29
			6	SS	6				○		
6.7	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

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

ONTMT4 2312STRONG(52).GPJ 14/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S16+551 L18.75 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+551, O/S 18.75L ORIGINATED BY SL

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM

DATUM Geodetic DATE 24.03.05 - 24.03.05 CHECKED BY SS

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	Augered to 7.62 m.										
7.6	Silty **CLAY** Soft Grey		1	SS	2				○		
8.8	**SAND**, trace gravel, trace silt Loose to Compact Brown Wet		2	SS	5				○		13 80 7 (SI+CL)
			3	SS	24						
11.3	END OF BOREHOLE AT 11.28 m. BOREHOLE OPEN TO 9.60 m. WATER LEVEL AT 3.43 m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE BENSEAL TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTMT4S 2312STRONG(52).GPJ 04/07/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+572 L43 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+572, O/S 43L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY MF/SS

DATUM Geodetic DATE 26.07.02 - 26.07.02 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
0.0	DCPT from surface.										
6.1	END OF DCPT AT 6.10m.										

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+575 R5 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+575, O/S 5R ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 26.07.02 - 26.07.02 CHECKED BY JL

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**SAND**, fine grained, trace silt, occasional iron oxide staining Reddish Brown										
0.6	**SAND**, fine grained, some silt Compact Brown Dry to Moist		1	SS	19				○		
1.4	Silty **CLAY**, some sand Stiff Mottled Brown / Grey		2	SS	12				○		
	thin sand laminations at 2.29m		3	SS	11				○		0 17 59 24
			1	TW	PH						
4.6	**SILT**, some clay, trace sand Firm Grey Wet		4	SS	6				○		
			5	SS	7				○		0 2 82 16
6.7	END OF BOREHOLE AT 6.71m. BOREHOLE OPEN TO 6.71 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4 2312STRONG(52).GPJ 14/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+600 L18.75 1 OF 1 METRIC

G.W.P. 742-93-00 LOCATION Strong Township, ST. 16+600, O/S 18.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 30.07.02 - 30.07.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL**										
0.1	Silty **CLAY**, trace sand laminations Very Stiff to Soft Mottled Brown / Grey Dry to Wet										
			1	SS	19				○		0 5 66 29
	Becoming Grey		2	SS	11				○		
			3	SS	18				○		
			4	SS	8				○		
	Becoming Wet, Soft										
			5	SS	3				⊢ ○		0 0 47 52
			6	SS	2				○		
6.7	END OF BOREHOLE AT 6.71 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH (m)
30/07/02	Dry

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

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

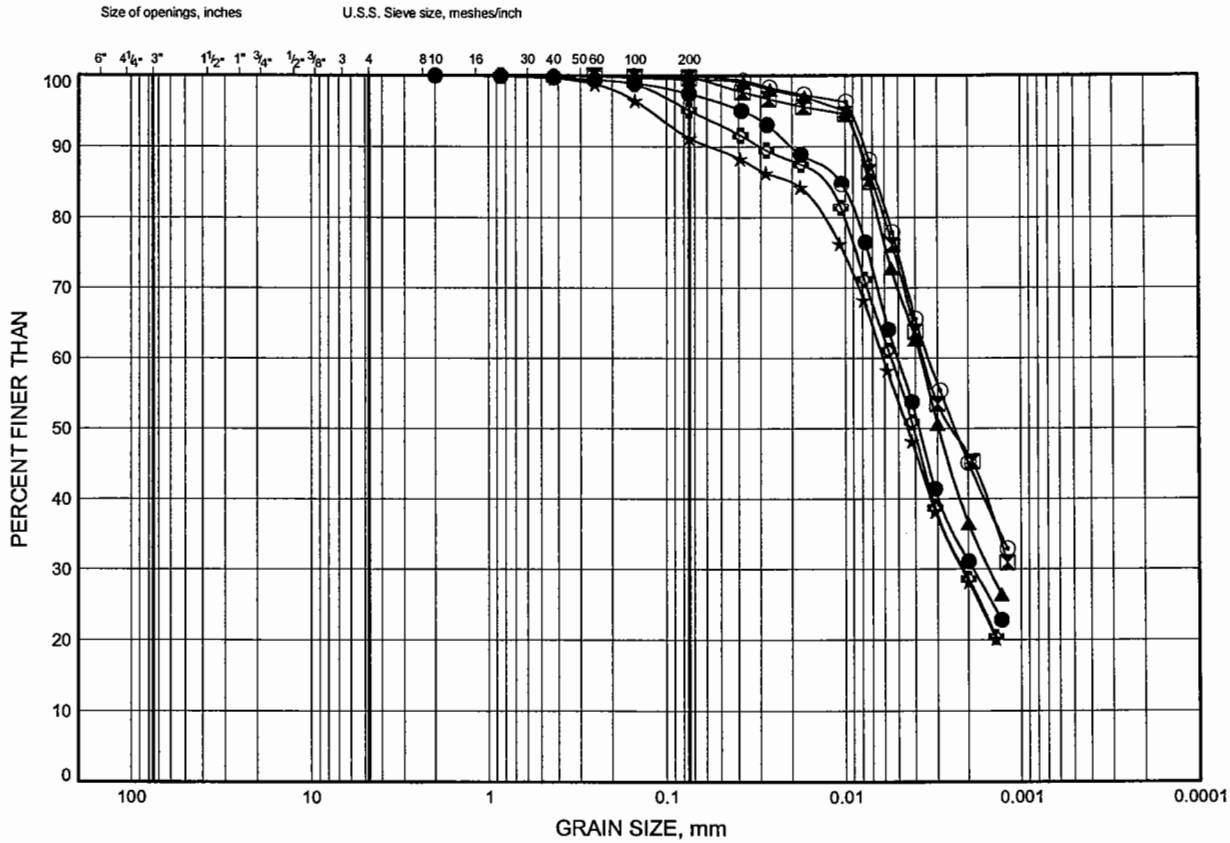
UNIMI4 2312S1RUNG(52).GPJ 18/02/05

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE A1

Silty Clay



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S 16+450 L18.75	1.07	
⊠	S 16+450 L18.75	4.87	
▲	S 16+475 L42	3.35	
★	S 16+502.5 L16.75	1.07	
⊙	S 16+502.5 L16.75	4.87	
✿	S 16+551 L18.75	1.82	

Date July 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

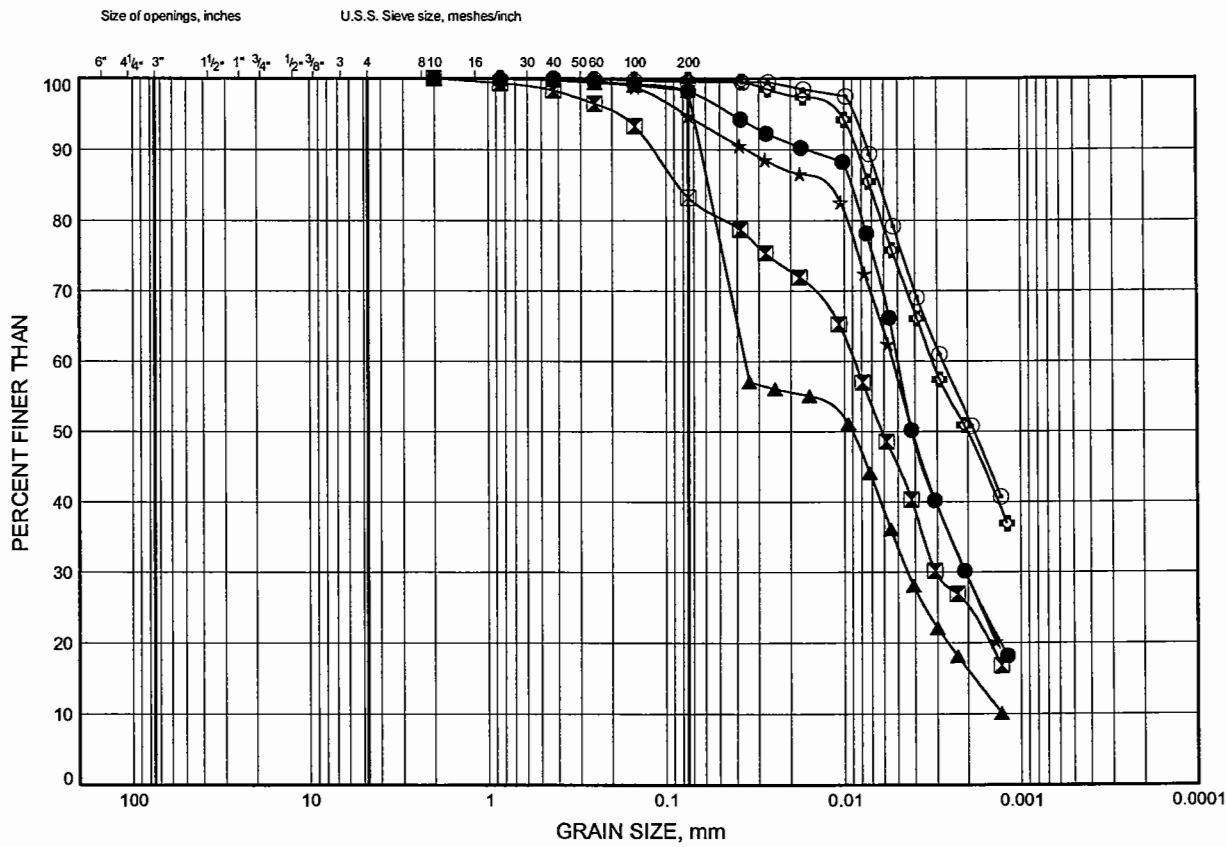
THURBGSD 2312STRONG(62).GPJ 04/07/05

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE A2

Silty Clay to Silt



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S 16+551 L18.75	4.87	
⊠	S 16+575 R5	2.59	
▲	S 16+575 R5	6.40	
★	S 16+600 L18.75	1.07	
⊙	S 16+600 L18.75	4.87	
✿	S16+450 L18.75	10.98	

Date July 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

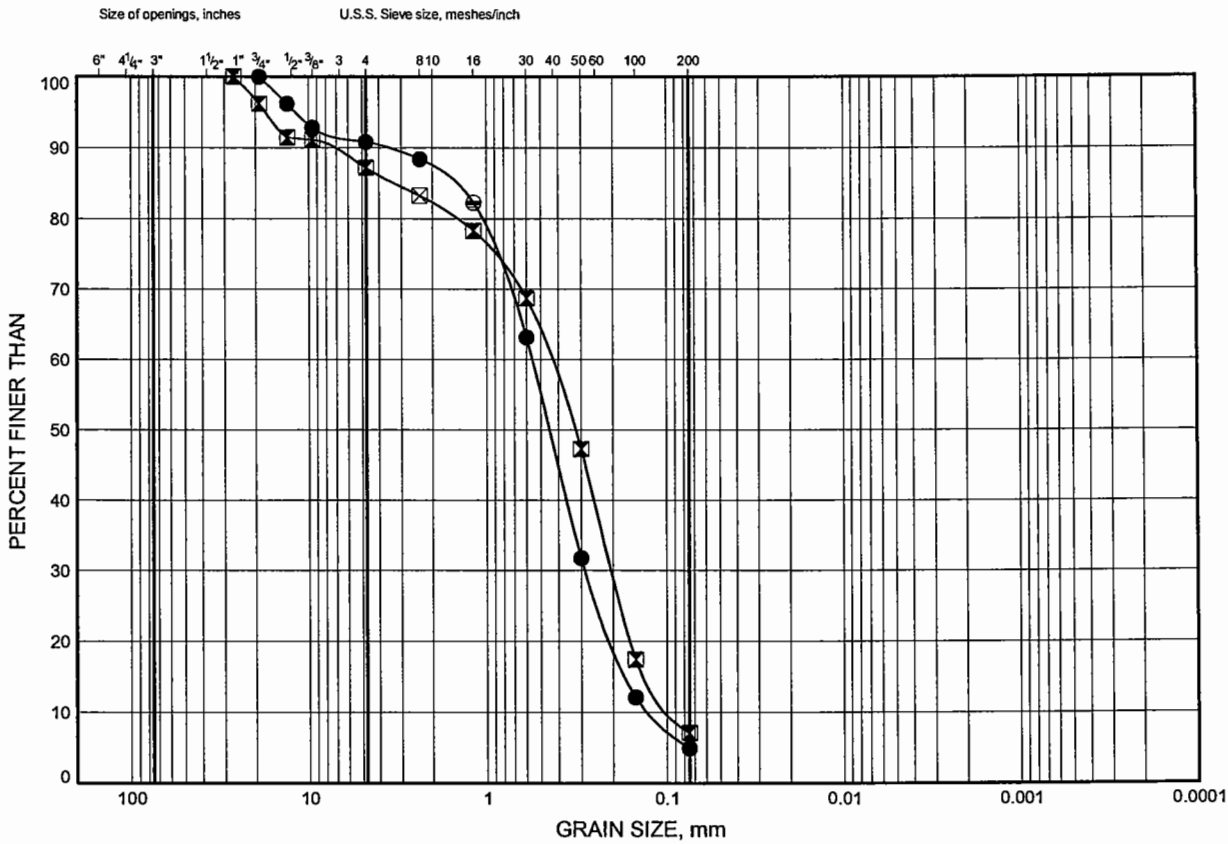
THURBGSD 2312STRONG(52).GPJ 04/07/05

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE A3

Sand



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S16+450 L18.75	14.02	
⊠	S16+551 L18.75	9.45	

Date July 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

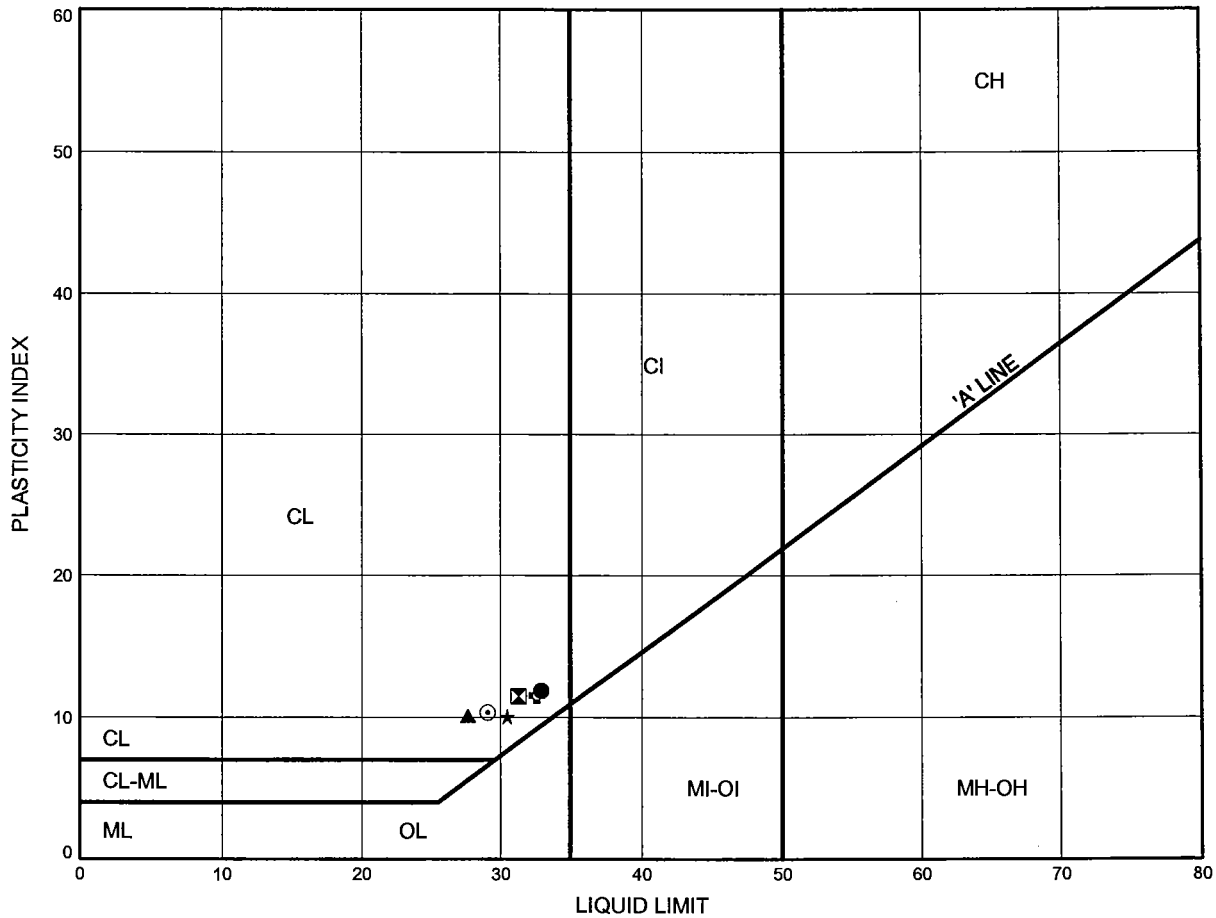
THURBGSD 2312STRONG(52).GPJ 04/07/05

Hwy 11 Four Laning

ATTERBERG LIMITS TEST RESULTS

FIGURE A4

Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S 16+450 L18.75	4.87	
⊠	S 16+475 L42	3.35	
▲	S 16+502.5 L16.75	1.07	
★	S 16+502.5 L16.75	4.87	
⊙	S 16+551 L18.75	4.87	
✿	S 16+600 L18.75	4.87	

Date July 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

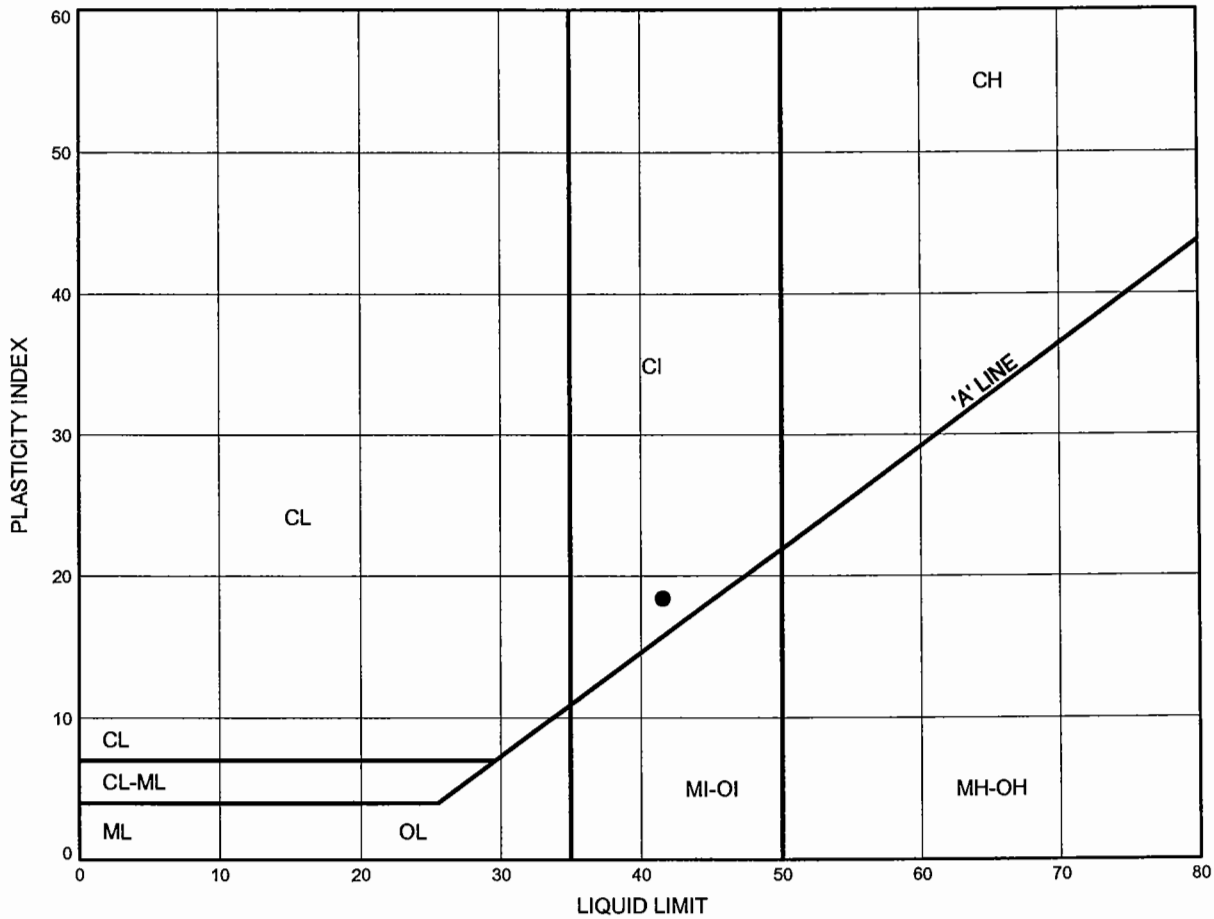
THURBALT 2312STRONG(52).GPJ 04/07/05

Hwy 11 Four Laning

ATTERBERG LIMITS TEST RESULTS

FIGURE A5

Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S16+450 L18.75	10.98	

Date July 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

THURBALT 2312STRONG(52).GPJ 04/07/05

Appendix B
Hwy 11 Mainline, Strong Township, Sta. 16+700 to 16+850

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+725 L18.75 1 OF 1 METRIC

G.W.P. 742-93-00 LOCATION Strong Township, ST. 16+725, O/S 18.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 30.09.03 - 30.09.03 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**PEAT**, fibrous, some rootlets Dark Brown to Black										
0.3	Wet Silty **CLAY**, trace sand, trace gravel Hard to Firm Grey Wet		1	SS	36						
			1	GS							
			2	SS	10						
			3	SS	4						1 4 63 32
2.8	END OF BOREHOLE AT 2.84 m. AUGER REFUSAL AT 2.84 m ON PROBABLE BEDROCK OR BOULDER.. BOREHOLE OPEN TO 2.84 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

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

ONTMT4 2312STRONG(52).GPJ 18/02/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+769 L17 1 OF 1 METRIC

G.W.P. 742-93-00 LOCATION Strong Township, ST. 16+769, O/S 17L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 30.09.03 - 30.09.03 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**PEAT**, fibrous, some rootlets Dark Brown to Black Wet										
0.2	Silty **SAND**, fine grained, trace gravel, trace organics Very Loose to Loose Dark Brown Wet (FILL)		1	SS	3				○ at 40		
			2	SS	10				○ at 40		
2.3	END OF BOREHOLE AT 2.29 m. AUGER REFUSAL AT 2.29 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN TO 2.29 m AND WATER LEVEL AT 2.13 m UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4 2312STRONG(52).GPJ 18/02/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+800 R4 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+800, O/S 4R ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 31.07.02 - 31.07.02 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
0.0	Sandy **TOPSOIL**, some rootlets										
0.3	**SAND**, fine to medium grained, trace gravel Reddish brown Moist		1	GS					○		
0.8	END OF BOREHOLE AT 0.76 m. AUGER REFUSAL AT 0.76 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+802 L41.8 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+802, O/S 41.8L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 31.07.02 - 31.07.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	Sandy **TOPSOIL** Reddish Brown										
0.3	**SAND,** fine grained, trace gravel, occasional boulders Reddish Brown Dry to Moist		1	GS					○		
1.5	END OF BOREHOLE AT 1.52 m. AUGER REFUSAL AT 1.52 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+823 L18.75 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+823, O/S 18.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 31.07.02 - 31.07.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	Sandy **TOPSOIL**										
0.2	Reddish Brown **SAND**, fine grained, occasional boulders Brown Dry to Moist		1	GS					○		
0.9	END OF BOREHOLE AT 0.91 m. AUGER REFUSAL AT 0.91 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN TO 0.46 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+850 R2 1 OF 1 METRIC

G.W.P. 742-93-00 LOCATION Strong Township, ST. 16+850, O/S 2R ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 31.07.02 - 31.07.02 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60		GR SA SI CL
0.0	Sandy **TOPSOIL**										
0.3	**SAND**, some gravel and boulders Brown Dry to Moist										
0.6	END OF BOREHOLE AT 0.61 m. AUGER REFUSAL AT 0.61 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN TO 0.30 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

15 ⊕ 5 (20, 10) (%) STRAIN AT FAILURE

ONTMT4 2312STRONG(52).GPJ 18/02/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+850 L47 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+850, O/S 47L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT)/Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 31.07.02 - 31.07.02 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
0.0	DCPT from surface.										
0.6	END OF DCPT AT 0.61 m. CONE REFUSAL AT 0.61 m ON PROBABLE BEDROCK OR BOULDER.										
0.9	AT S 16+850 L44, AUGER REFUSAL AT 0.91 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN TO 0.61 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

ONTM4T4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 16+874 L23.75 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 16+874, O/S 23.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 30.07.02 - 30.07.02 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
0.0	**SAND**, some gravel, some rootlets Reddish Brown Dry to Moist		1	SS	50/				○		
0.9	END OF BOREHOLE AT 0.91 m. AUGER REFUSAL AT 0.91 m ON PROBABLE BEDROCK OR BOULDER.				.025						

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

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

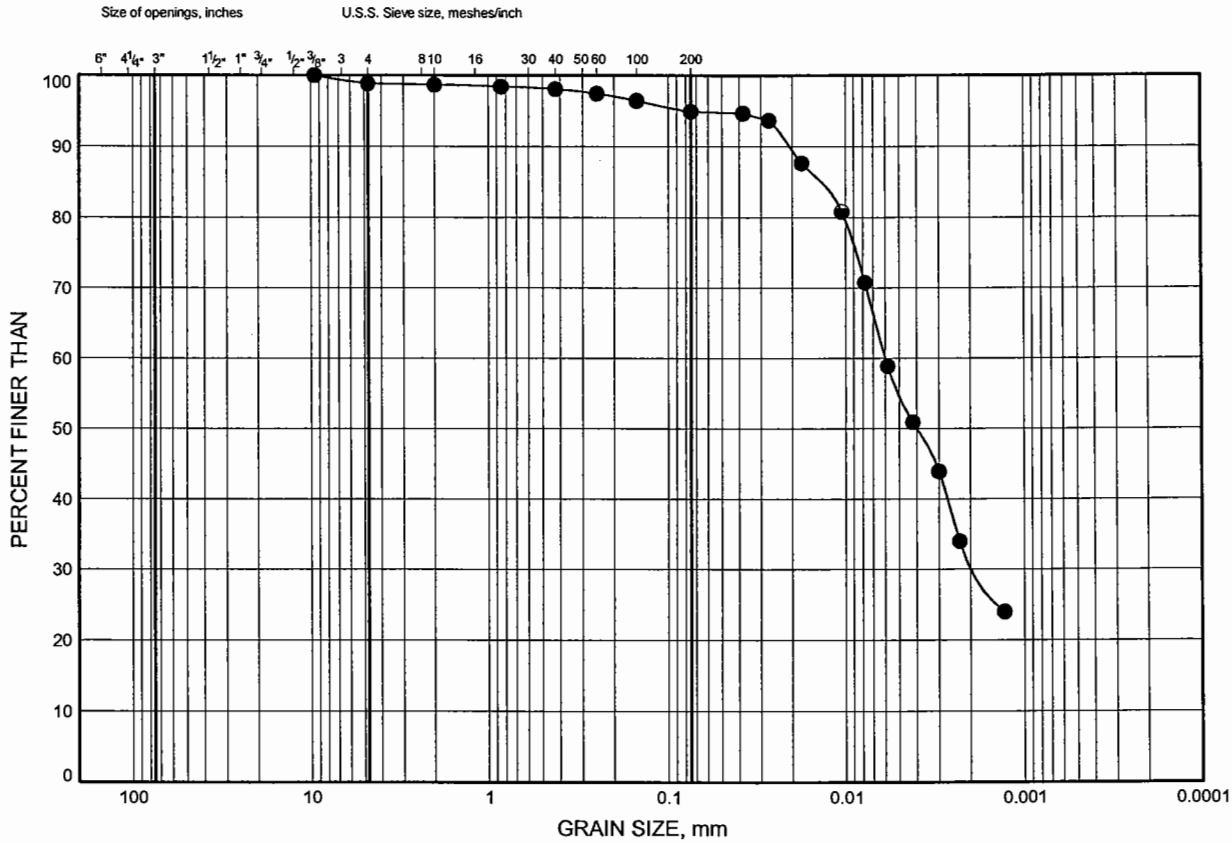
ONTMT4 2312STRONG(52).GPJ 11/09/04

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty Clay



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S 16+725 L18.75	2.59	

Date February 2005

Project 742-93-00

THURBER

Prep'd WM

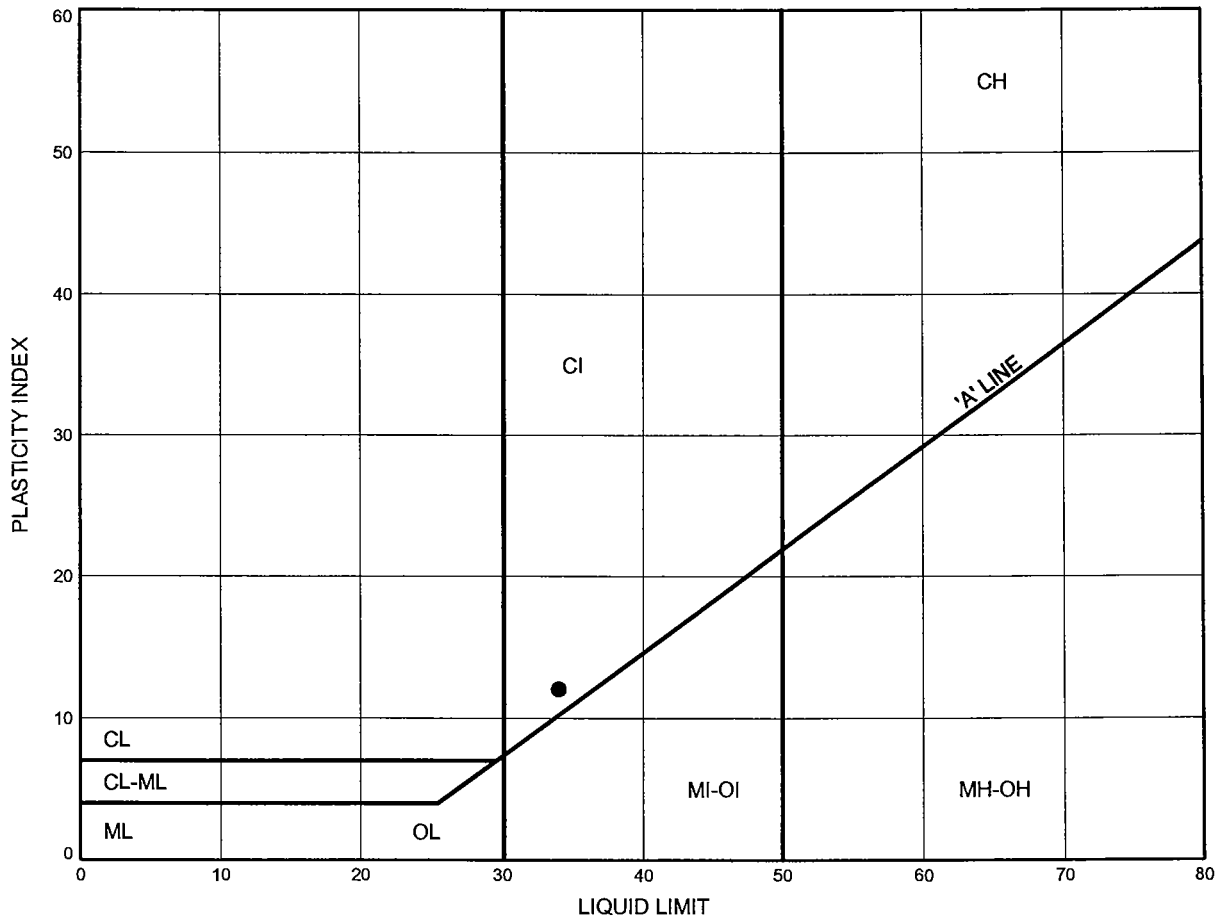
Chkd. SS

THURBGSD 2312STRONG(52).GPJ 18/02/05

Hwy 11 Four Laning

ATTERBERG LIMITS TEST RESULTS

FIGURE B2



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S 16+725 L18.75	2.59	

Date February 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

TTCALTR 2312STRONG(52).GPJ 18/02/05

Appendix C
Hwy 11 Mainline, Strong Township, Sta. 17+250 to 17+350

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 17+298.5 L18.75 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 17+298.5, O/S 18.75L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 01.08.02 - 01.08.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**PEAT**, fibrous Black										
0.3	Wet **SAND**, fine grained, some silt Brown Wet										
0.9	Silty **CLAY**, some sand Stiff to Firm Grey Wet		1	SS	13	▽			○		
			2	SS	8				○		0 18 59 23
	Occasional sand pockets		3	SS	6				○		
3.1	**SILT**, some clay, some sand Compact Grey Wet		4	SS	10				○		0 12 77 11
3.7	Gravelly **SAND**, well graded, some silt Compact Brown Wet		5	SS	17				○		
5.5	END OF BOREHOLE AT 5.49 m. AUGER REFUSAL AT 5.49 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN TO 3.51 m AND WATER LEVEL AT 1.52 m UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 17+324.5 R1.5 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 17+324.5, O/S 1.5R ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Dynamic Cone Penetration Test (DCPT) COMPILED BY MF/SS

DATUM Geodetic DATE 31.07.02 - 31.07.02 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
0.0	DCPT from surface.										
6.9	END OF DCPT AT 6.91m. CONE REFUSAL AT 6.91 m ON PROBABLE BEDROCK OR BOULDER.										

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

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

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 17+327 L42.3 1 OF 1 METRIC

W.P. 742-93-00 LOCATION Strong Township, ST. 17+327, O/S 42.3L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MF/SS

DATUM Geodetic DATE 01.08.02 - 01.08.02 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**PEAT**, fibrous Black Wet										
0.3	**SILT**, some clay, trace sand, trace gravel Hard Mottled Brown / Grey Wet		1	SS	30	▽			o		
1.5	**SILT**, trace clay Compact Grey Wet		2	SS	12				o		
2.2	Sandy **SILT** Compact Grey Wet		3	SS	15				o		
3.1	END OF BOREHOLE AT 3.05 m. AUGER REFUSAL AT 3.05 m ON PROBABLE BEDROCK OR BOULDER. BOREHOLE OPEN TO 3.05 m AND WATER LEVEL AT 1.22 m UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

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

15 ⊕ 5 (20, 10) (%) STRAIN AT FAILURE

ONTMT4 2312STRONG(52).GPJ 11/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S 17+350 L7 1 OF 1 METRIC

G.W.P. 742-93-00 LOCATION Strong Township, ST. 17+350, O/S 7L ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 30.09.03 - 30.09.03 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	**TOPSOIL**										
0.1	Dry Silty **SAND**, fine grained, trace to some gravel Very Dense Brown Moist to Wet		1	SS	61/ 254				○		
1.2	END OF BOREHOLE AT 1.22 m. AUGER REFUSAL AT 1.22 m ON PROBABLE BEDROCK OR BOULDER..										

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

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

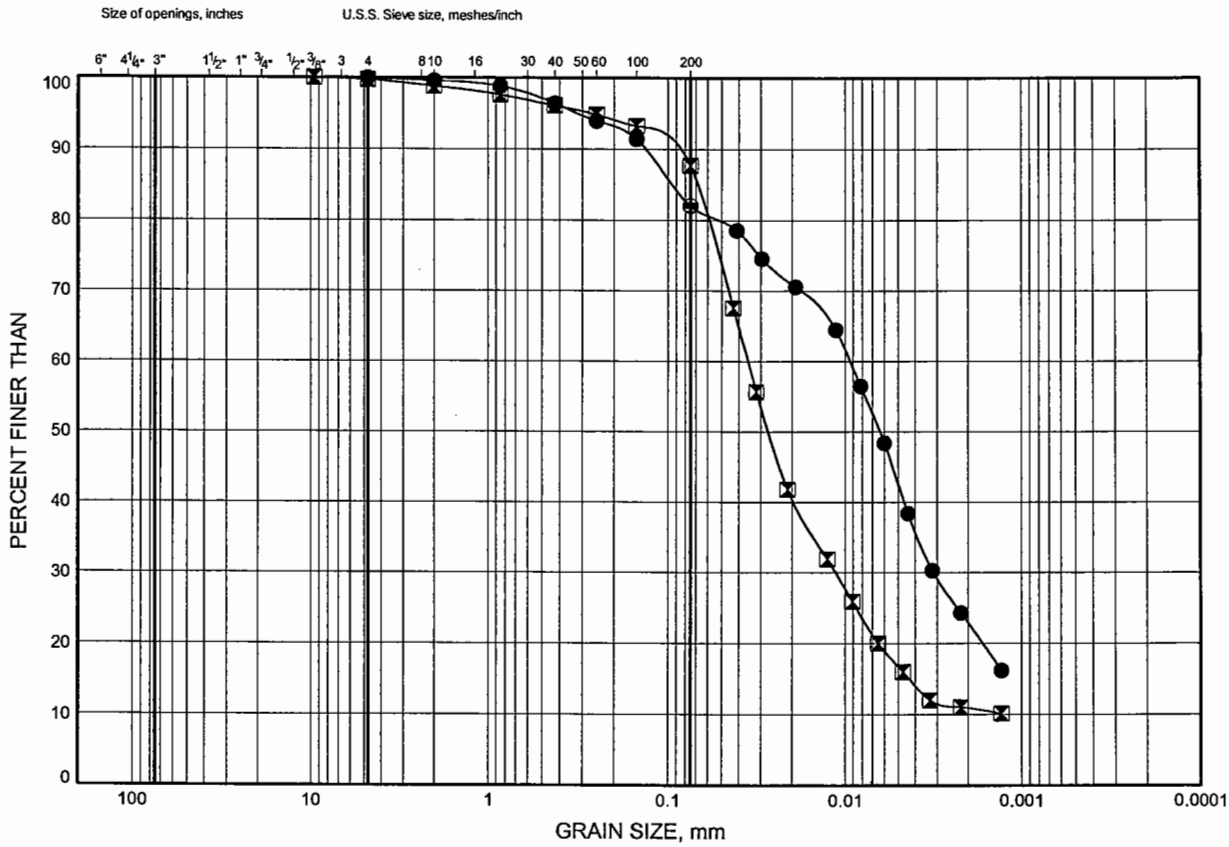
ONTMT4 2312STRONG(52).GPJ 18/02/05

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE C1

Silty Clay



COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S 17+298.5 L18.75	1.82	
⊠	S 17+298.5 L18.75	3.35	

Date February 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

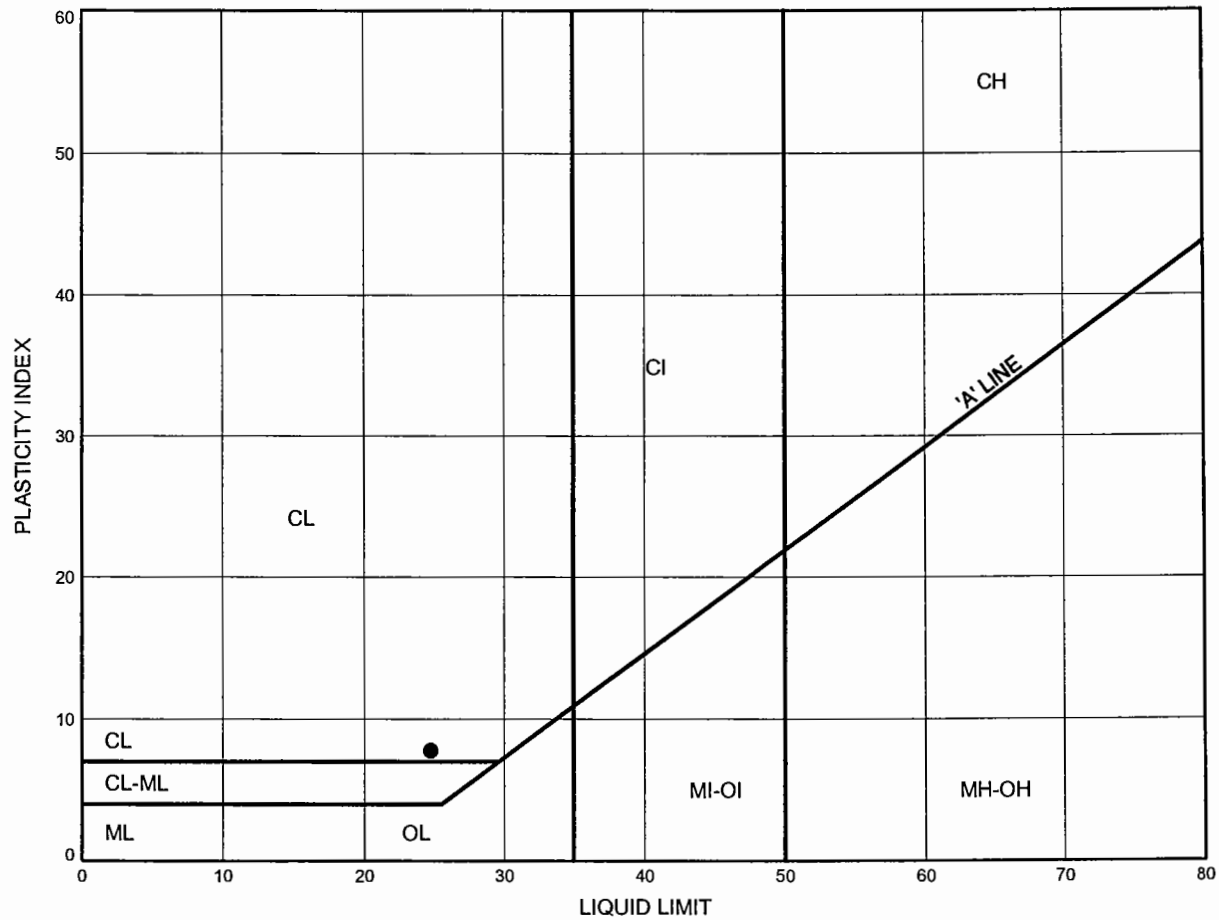
THURBGSD 2312STRONG(52).GPJ 18/02/05

Hwy 11 Four Laning

ATTERBERG LIMITS TEST RESULTS

FIGURE C2

Silty Clay



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S 17+298.5 L18.75	1.82	

Date February 2005

Project 742-93-00

THURBER

Prep'd WM

Chkd. SS

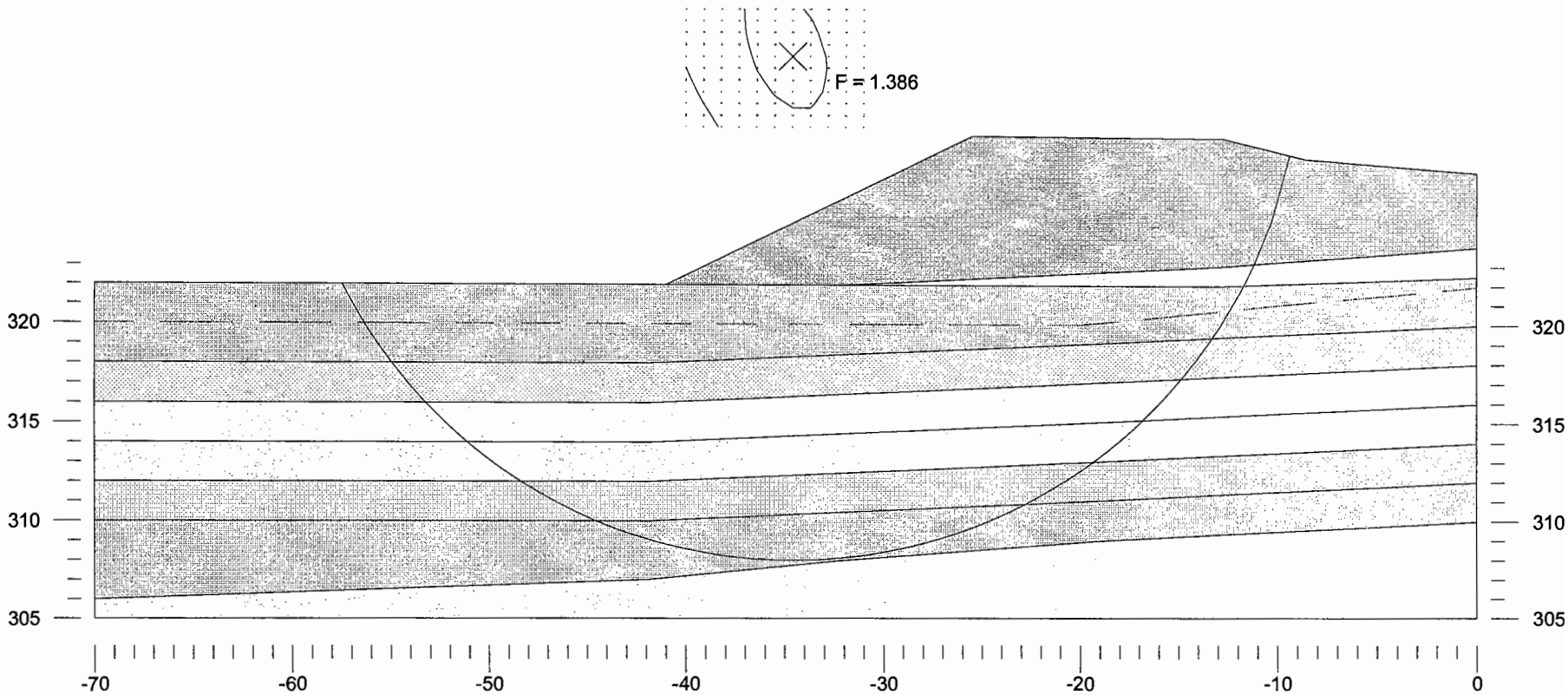
THURBALT 2312STRONG(52).GPJ 18/02/05

Appendix D
Stability Analysis Results
Settlement Analysis Results

THURBER

	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Fill (SSM)	22	2	30	0
sand SILT	20	1	30	1
silty Clay 1	19	80	0	1
silty Clay 2	18	50	0	1
Clay 1	17.6	25	0	1
Clay 2	17.8	30	0	1
Clay 3	17.9	34	0	1
Clay 4	18	36	0	1
Sand	21	0	32	1

Thurber Engineering Ltd. - Toronto
19-1423-12
HWY11- Burke's Falls
February 2005
HWY11 Embankment (km 16+500)
Short Term - SSM Fill- SBL slope

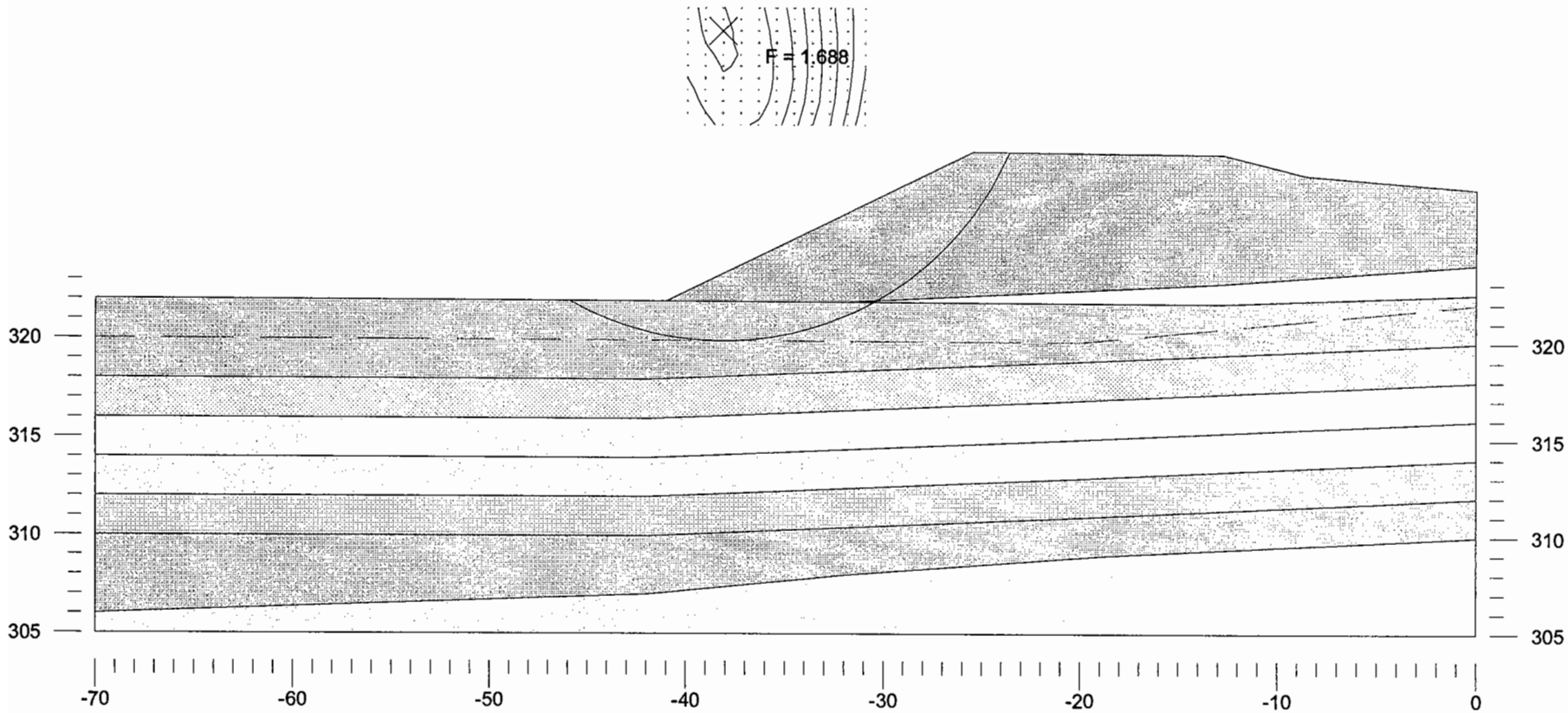


28/06/2005 10:35:19 AM C:\DATA\PROJEC~2\19\19-142~1\EMBANK~2\HWY11-20.GSL Thurber Engineering Ltd. - Toronto F = 1.386

FIGURE D1

	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Fill (SSM)	22	2	30	0
sand SILT	20	1	30	1
silty Clay 1	19	0	29	1
silty Clay 2	18	0	26	1
Clay 1	17.6	0	26	1
Clay 2	17.8	0	26	1
Clay 3	17.9	0	26	1
Clay 4	18	0	26	1
Sand	21	0	32	1

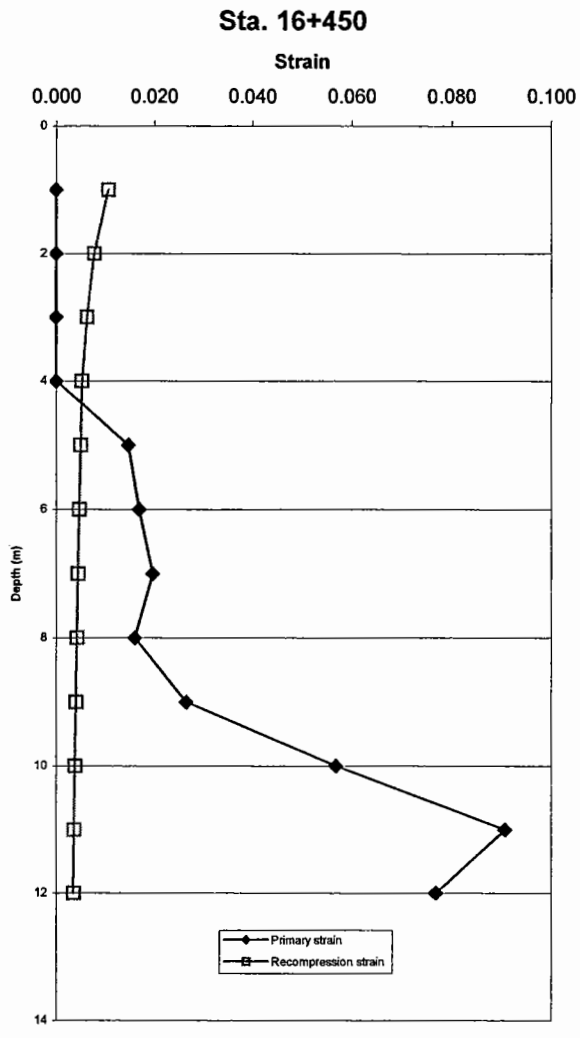
Thurber Engineering Ltd. - Toronto
19-1423-12
HWY11- Burke's Falls
February 2005
HWY11 Embankment (km 16+500)
Long Term - SSM Fill- SBL slope

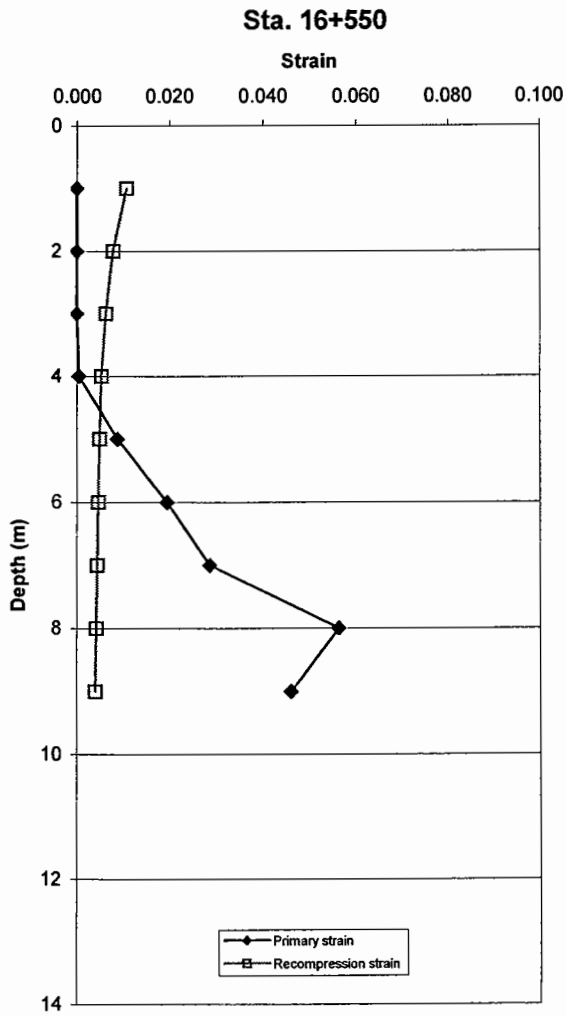


28/06/2005 10:48:36 AM C:\DATA\PROJEC~2\19\19-142~1\EMBANK~2\HWY11-21.GSL Thurber Engineering Ltd. - Toronto F = 1.688

FIGURE D2

HWY 11 - FOUR LANING
MAINLINE Sta. 16+450 to 16+600
SETTLEMENT ANALYSIS





Primary settlement	318 mm
Recompression settlement	63 mm

Primary settlement	160 mm
Recompression settlement	52 mm

FIGURE D3

19-1423-12