GEOCRES No.
31F-150

FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH EMBANKMENTS
WHITE LAKE ROAD INTERCHANGE
MADAWASKA RIVER, CPR OVERHEAD
AND DIVISION STREET BRIDGE APPROACHES
HIGHWAY 17 – 417 FOUR LANING
ARNPRIOR, ONTARIO
G.W.P. 647-92-00

GEOCRES Number: 31F-150

Report to

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October 17, 2005
File: 19-1351-82
C:\Thurber Projects 2005\19-1351-82\ High Fills (White Lake Madawaska CPR Overhead) FINAL Fdn Inv Des Rep Oct16 05.doc

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the high embankment locations at the proposed White Lake Road interchange including bridge approaches and ramps, and along sections of the proposed alignments of the Highway 17-417 mainline near the Madawaska River, the CPR Overhead and at the Division Street Underpass approaches. This report addresses all identified high embankments of 6 m or greater in height, beyond the 20 m zone immediately behind the bridge abutments. Foundation recommendations applicable to the 20 m zone are contained in References 1 to 3 noted below.

The purpose of the investigation was to explore the subsurface conditions at the sites and, based on the data obtained, to provide borehole location plans and soil strata drawings of stratigraphic profiles along the proposed centrelines of the road embankments and selected cross-sections, records of boreholes, laboratory test results and a generalized description of the subsurface conditions.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to McCormick Rankin Corporation (MRC), under the Ministry of Transportation Ontario (MTO) Agreement Number 4005-A-000349.

Reference is made to the following document during the preparation of this report.

- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, White Lake Road Underpass, Highway 17 Twinning, Arnprior to Renfrew, Ontario", G.W.P. 647-92-00, Site No. 29-421, GEOCRES No. 31F-132, File No. 19-3745-0, September 30, 2004 (Reference 1).

- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, Madawaska River Bridge, Highway 17 Twinning, Arnprior to Renfrew, Ontario", G.W.P. 647-92-00, Site No. 29-191/1, GEOCRES No. 31F-130, File No. 19-3745-0, August 13, 2004 (Reference 2).

- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, C.P.R. Overhead (Arnprior), Highway 17 Twinning, Arnprior to Renfrew, Ontario", G.W.P. 647-92-00, Site No. 29-200, GEOCRES No. 31F-131, File No. 19-3745-0, August 20, 2004 (Reference 3).

- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, Division Street Underpass, Highway 17 Twinning, Arnprior to Renfrew, Ontario", G.W.P. 647-92-00, Site No. 29-417, GEOCRES No. 31F-127, File No. 19-3745-0, August 27, 2004 (Reference 4).

2 SITE DESCRIPTION

All three sites are located in the Township of McNab, County of Renfrew, Ontario. The general site locations are shown on the Borehole Locations and Soil Strata drawings in Appendices A, B and C.

White Lake Road Interchange

The site is located to the south of the Town of Arnprior in the area surrounding the at-grade intersection of Highway 17 Twinning and White Lake Road (approximate Mainline Station 29+150).

The site is situated in an area of relatively flat terrain characterized by shallow bedrock underlying glacio-lacustrine clays. Vegetation is light and mainly consists of grass and occasional small trees and shrubs. Regional drainage in the area is largely governed by the Madawaska River to the east.

Madawaska River Bridge

The site is located immediately to the north of the existing Madawaska River Bridge between approximate mainline Stations 30+625 and 31+225 on the existing Highway 17. This project area is located just downstream (north) of the existing Hydro Dam of the Arnprior Generating Station.

At the bridge crossing, the Madawaska River, which flows from south to north, is in the order of 100 m wide and is deeply incised into the surrounding lands. Available information indicates that the river is approximately 14 m deep at this location. Within the river valley, the terrain is fairly rugged with bedrock outcrops, moderately to steeply sloping rockfaces and bedrock underlying thin veneer of soils. The east bank is lightly vegetated, whereas the west bank is heavily vegetated with large deciduous and coniferous trees.

CPR Overhead (Arnprior) Bridge

The site is located about 165 m east of the existing at grade intersection of Highway 17 and Upper Access Road (approximate mainline Station 31+400 on the existing Highway 17). This location is south of the Town of Arnprior and east of the Madawaska River. At this site, the existing Highway 17 crosses over the present C.P.R. track, which is oriented northwest to southeast relative to the highway. The site is located immediately to the north of the existing bridge.

The terrain at the site is fairly rugged with bedrock outcrops and rock faces. The railway runs in a cut in the bedrock that is now spanned by Highway 17. Vegetation is light and consists mainly of grass and shrubs growing in the shallow pockets of overburden across the site. Further away clumps of larger trees are evident.

Division Street Underpass Bridge

The site is located about 50 m east of the existing at grade intersection of Highway 17 and Division Street/Pine Grove Road, Township of McNab, County of Renfrew (approximate mainline Station 27+705 on existing Highway 17). This location is to the southwest of the Town of Arnprior.

The site is flat and there are private dwellings on large open fields to the north and south of the existing Highway. Vegetation is light and consists mainly of grass, some small trees and shrubs.

General Geology

In general, the three project areas are located within a physiographic region known as the Ottawa Valley Clay Plains. This area is located between the Laurentian upland to the north and west, and the Ottawa lowland to the south and east. Native soil deposits typically consist of glacio-lacustrine clayey silts to silty clays that were deposited when the Champlain Sea inundated the Ottawa – St. Lawrence lowland. In Renfrew County, there are prominent east-west trending scarps (fault zones), including a major depression geologically known as the "Ottawa-Bonnechere" graben. Bedrock in the site area consists of crystalline limestone of the Ordovician Period that had been subjected to faulting, weathering and erosion.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out during the period of May 10 to June 1, 2005, and consisted of drilling and sampling 33 boreholes at the White Lake Road Interchange, 9 boreholes at the Madawaska River Bridge approaches, 2 boreholes at the CPR Overhead (Arnprior) bridge approaches, and 6 boreholes at the Division Street Underpass approaches, for a total of 50 boreholes. The depths of the boreholes ranged from approximately 0.2 m (bedrock at surface) to 22 m depths below existing ground surface. All boreholes advanced for the embankments are identified by stations and offsets from the respective centrelines of the mainline Highway 17, road approaches or the interchange ramps, except for Borehole WLR05-1 located at the south approach to the White Lake Road Bridge. In the vicinities of the proposed bridge sites, selected boreholes drilled for the structures (previously reported under separate covers) are also included as appropriate. The identification of these explorations and their approximate locations are shown on the Borehole Locations and Soil Strata Drawings in Appendices A to C.

The centrelines of the proposed Highway 17, road approaches and interchange ramps, were staked/marked in the field by surveyors from J.D. Barnes Ltd (Barnes). The boreholes were then located in the field by our staff with reference to the median centreline or approach/ramp centrelines.

Minor relocation of some holes from the originally intended locations was necessary mainly due to reasons related to drill rig access and conflict with buried utilities. Utility clearances at the hole locations were obtained by Thurber prior to drilling. Site plans, ground surface and top of embankment profile base drawings were provided by MRC.

Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario supplied track and truck mounted drill rigs, and conducted the drilling, sampling and in-situ testing operations. The sampled boreholes were advanced by continuous flight hollow stem, or occasionally solid stem, augering. Soil samples were obtained at selected depths using a 50 mm outside diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). Thin walled Shelby tubes of 73 mm inside diameter were used to retrieve relatively undisturbed cohesive samples. Field vane shear testing was carried out at selected depths within the cohesive deposits.

Groundwater conditions were observed in the open boreholes throughout the drilling operations and upon completion. All groundwater observations at this site are short term and the water levels are expected to fluctuate seasonally and after weather events such as spring snowmelt and heavy rainfall.

Standpipe piezometers were installed in selected boreholes for monitoring the groundwater levels. The installation details are presented on the Records of Boreholes in Appendices A to C. For a typical installation, a 19 mm diameter Schedule 40 PVC pipes with a typical 1.5 m long slotted screen were installed near the bottom of the open boreholes. The sand screens surrounding the pipes were generally in the order of 2 m in length. Bentonite holeplug seals were placed above the sand screen and just below the ground surface in each installation. The remaining space in the boreholes was grouted with a cement / bentonite mix. All other holes were similarly grouted from bottom to ground surface upon completion.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, secured the soil samples in labelled and sealed containers which were then transported to Thurber's laboratory for testing. Particular attention was paid to waxing and sealing Shelby tube samples prior to transportation.

4 LABORATORY TESTING

The recovered soil samples were subjected to visual identification and to natural moisture content determination. Selected cohesive soil samples were subjected to grain size distribution analysis and Atterberg limits tests. The results of this testing are shown on the Record of Borehole sheets in Appendices A to D. Laboratory oedometer (consolidation) testing was carried out on specimens obtained from three relatively undisturbed, cohesive Shelby tube samples from the White Lake Road interchange area. The results of this testing program are reported on the accompanying figures in Appendix A.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Details of the encountered subsurface stratigraphy are presented on the Records of Boreholes, and on the "Borehole Locations and Soil Strata" drawings in Appendices A to D of this report. Summarized descriptions of the subsurface stratigraphy at each site are given in the following paragraphs. The factual information at the borehole locations governs any interpretation of site conditions.

For the purpose of reporting, the high embankment areas covered in this report are grouped into several sections as follows:

- White Lake Road Interchange (including White Lake Road, W-N/S Ramp, N-E Ramp, S-E Ramp, E-N/S Ramp, S-W Ramp and N-W Ramp).
- Madawaska River Bridge Approaches.
- CPR Overhead Bridge Approaches.
- Division Street Underpass Approaches.

5.2 White Lake Road Interchange

In general, the subsurface conditions in the vicinity of the White Lake Road Interchange consist of surficial fill overlying a deposit of silty clay which is underlain by bedrock. The groundwater level is at shallow depth, near the surface of the silty clay deposit.

5.2.1 Topsoil and Asphalt

Topsoil ranging between 50 mm and 180 mm, but typically between 50 mm and 100 mm, in thickness was encountered in Boreholes S-E Ramp 29+175, 29+225, 29+275, 29+325, 29+350; N-E Ramp 28+800, 28+850, 28+900; W-N/S Ramp 29+085, 29+125; S-W Ramp 29+390, 29+475, 29+430; N-W Ramp 29+020, 29+070, 29+120, 29+170, 29+220, 29+240, and E-N/S Ramp 29+280. Topsoil thicknesses may vary between and beyond the borehole locations.

Asphalt was encountered in the vicinity of the existing intersection between White Lake Road and Highway 17 (Boreholes WLR-4, WLR-5 and 10+050) ranging in thickness from 25 mm to 50 mm.

5.2.2 Sand to Sand and Gravel Fill

Sand to sand and gravel fill was found at the surface or beneath the asphalt in Boreholes WLR 05-1, WLR 10+050, 10+100, 10+150, 10+200, 9+825, 9+850, 9+900 and 9+950, E-N/S Ramp 29+230 and W-N/S Ramp 29+165, WLR-4, WLR-5, WLR-6 and WLR-7.

At these borehole locations, the thickness of the fill varied typically from 0.2 m to 2.2 m. The several SPT values ranging from 8 blows to 49 blows per 0.3 m penetration indicate a loose to dense condition. The measured moisture contents of samples of the cohesionless fill ranged typically between 2% and 15%.

5.2.3 Silty Clay

A deposit of silty clay was encountered below the fill or at ground surface across the site, between approximate Elevations 108 m to 94 m. The thickness of this deposit ranges from about 1.3 m on the east side up to 14 m on the west side.

The upper "crust" of the clay is generally brown to greyish-brown in colour and extends to about 4 m to 5 m depth below existing ground surface, at approximate Elevation 103 m. The SPT 'N' values generally range from 18 blows to 8 blows for 0.3 m penetration. Field vane shear values obtained within the crust vary from about 100 kPa to the order of 60 kPa. These correlations indicate a typically stiff consistency.

Atterberg Limit tests conducted on selected samples of this crust are presented in Figures A1 to A6. The results indicated that the liquid limits vary between 62% and 39%, and corresponding plasticity indices between 38% and 20%. These values indicate that the crust is typically of medium to high plasticity (CI-CH). Figures A10 to A14 show the grain size distributions of selected samples of this crust. The clay content of these samples varied between 34% and 70%. The measured moisture content varied from about 20% to 40%.

Below a depth of about 4 m to 5 m, the clay gradually changes in colour to grey and becomes firm to soft as indicated by the SPT 'N' values ranging from 6 blows to 1 blow per 0.3 m penetration. Field vane shear tests conducted at selected depths gave typical values ranging from about 60 kPa to 35 kPa. These correlations indicate a decrease of consistency from stiff to firm with depth.

Atterberg Limit tests conducted on selected samples of this lower portion of the silty clay to clay are presented in Figure A7 and A9. The results indicated that the liquid limits vary typically between 50% and 28%, and corresponding plasticity indices between 29% and 16%. These values indicate typically intermediate plasticity (CI) with occasional low plasticity zones (CL). Figures A15 and A16 show the grain size distributions of selected samples of this silty clay. The clay content of these samples varied between 40% and 64%. The moisture content varied from about 40% to 60%.

Based on field vane test results, the sensitivity of this silty clay ranges from 2 to 5.

Four laboratory consolidation (oedometer) tests (3 from the current investigation and 1 from a previous investigation) were carried out on undisturbed specimen prepared from Shelby tube samples obtained in Boreholes WLR-5A, WLR05-1 and W-N/S 29+125. Inferred parameters from the test are summarized in the following table.

Borehole and Sample Number	Existing Overburden Pressure p'_0 (kPa)	Pre-consolidation Pressure p'_c (kPa)	Compression Index $C_c / (1 + e_0)$	Recompression Index $C_r / (1 + e_0)$	Initial Void Ratio, e_0	Over-consolidation Ratio (OCR)
W-N/S Ramp 29+125 TW 2	45	260	0.43	0.024	1.47	5.8
WLR-051 TW 2	60	180	0.22	0.041	1.05	3
WLR-051 TW 3	70	170	0.37	0.048	1.29	2.4
WLR-5A TW 2	100	180	0.37	0.018	1.48	1.8

For the over-consolidated zones with OCR values greater than 1.8, the coefficient of consolidation, C_v, value (vertical drainage) is estimated to be in the order of 10 to 30 m^2/yr, within the range of stresses anticipated to be acting on the foundation soils. For the lightly over-consolidated zones with OCR values of 1.8 or less, the coefficient of consolidation, C_v, value is estimated to be in the order of 100 m^2/yr within the range of stresses anticipated to be acting on the foundation soils.

The parameters obtained from these tests are considered representative of the zones in the clay deposit with varying degrees of over-consolidation.

Specific gravity values ranging between 2.78 and 2.80 were measured for the tested specimens. These values correspond to a unit weight of approximately 17 kN/m^3.

Detailed results of this oedometer test are included in Appendix A.

5.2.4 Bedrock

The soils described above are underlain by crystalline limestone bedrock of the Ordovician Period. The bedrock was proven by coring in some boreholes drilled during a previous

investigation. The bedrock surface was inferred from refusal to auger penetration in boreholes drilled during this investigation. Inferred bedrock surface depths and elevations at the borehole locations are summarized in the following table.

Borehole Number	Inferred Depth to Bedrock (m)	Inferred Top of Bedrock Elevation (m)
White Lake Road		
WLR 9+825	9.7	98.7
WLR 9+850	6.3	102.0
WLR 9+950	4.7	102.7
WLR-5	10.7	97.9
WLR 05-1	7.6	100.7
WLR 10+050 LT	12.1	96.3
WLR 10+100 RT	7.1	100.6
WLR 10+150 2m LT	8.2	99.6
WLR 10+200 RT	14.5	93.3
W-N/S Ramp		
W-N/S Ramp 29+085 CL	13.4	93.7
W-N/S Ramp 29+125 CL	11.0	96.1
W-N/S Ramp 29+165 CL	11.3	96.5
NW Ramp		
NW Ramp 29+020 CL	6.7	99.4
NW Ramp 29+070 CL	5.8	101.2
NW Ramp 29+170 CL	1.4	105.8
NW Ramp 29+220 CL	5.2	102.2
NW Ramp 29+240 CL	6.4	100.9
NE Ramp		
NE Ramp 28+800 CL	6.2	100.9
NE Ramp 28+850 CL	6.4	100.8
SE Ramp		
SE Ramp 29+074 5m RT	5.6	101.2
SE Ramp 29+125 6m RT	> 5.8	< 100.4
SE Ramp 29+325 CL	5.3	101.9
SE Ramp 29+350 CL	4.7**	102.6**
E-N/S Ramp		
E-N/S Ramp 29+230 CL	9.4**	99.0
SW Ramp		
SW Ramp 29+390 CL	2.4	104.8

Notes : * Inferred by auger refusal except otherwise noted.
** Inferred by split spoon sampler refusal.

The top of bedrock undulates across the site with depths below existing ground surface varying from 1.4 m to 14.5 m, or approximate Elevations 105.8 m to 93.3 m. Based on the borehole information, it appears that the bedrock surface dips in a northeasterly to southwesterly direction. Given that the ground surface is relatively flat across the site, the depth to bedrock increases in a similar orientation.

5.2.5 Groundwater

Free water was noted to be present in many boreholes upon completion of drilling. Where encountered, the water levels in open boreholes were noted to range typically from 0.3 m to 2m depths below existing ground surface, except for a 5.2 m depth reading in Borehole WLR 10+200 RT. Standpipe piezometers were installed in six selected boreholes and the measured water levels are presented below.

Borehole (screen location)	Date of Reading	Water Level Depth (m)	Water Level Elevation (m)
WLR 9+850 (silty clay)	June 1, 2005	2.0	106.3
WLR 10+200 (silty clay)	June 1, 2005	5.2	102.6
NW Ramp 29+070 (silty clay)	June 1, 2005	1.3	105.7
SW Ramp 29+475 (silty clay)	June 1, 2005	1.3	106.3
SE Ramp 29+125 (silty clay)	June 1, 2005	0.3	105.9
SE Ramp 29+350 (silty clay)	June 1, 2005	0.9	106.4

Based on these water level readings and general site observations, the groundwater level is anticipated to be at approximate Elevation 106 m. At locations such as in the vicinity of Borehole WLR 10+200, the piezometric reading appears to suggest the presence of a downward hydraulic gradient.

5.3 Mainline Stations 30+625 to 31+225 (Madawaska River Bridge Approaches)

In general, the bedrock in the immediate vicinity behind the abutments is either exposed at surface or covered by relatively shallow deposits of overburden. The overburden soils consist of topsoil, silty clay, sand and silt, cobbles and boulders and rockfill. Beyond the abutment areas, a deep deposit of silty clay is present below the slopes rising from the river floodplain.

5.3.1 Topsoil

Topsoil was encountered across the site in most boreholes drilled at the approaches during the present investigation. Topsoil thickness encountered at all boreholes drilled at the approaches during the present investigation and at selected boreholes drilled in a previous investigation are listed in the table below.

Borehole	Topsoil Thickness (mm)
West Approach	
30+640 Cl	125
30+700 Cl	75
30+760 12.5 Lt	100
30+865 Cl	150
30+915 5 Rt	150
30+965 15 Lt	125
East Approach	
31+180 Cl	150
31+215 Cl	150

Topsoil thicknesses may vary between and beyond borehole locations.

5.3.2 Silty Clay

In several of the boreholes along the west and east approach, and at the top of the river floodplain slopes (30+965 15Lt, 30+760 12.5Lt, 30+700 CL, 30+640 CL and 31+180 CL), a silty clay deposit underlies topsoil. At locations close to the abutments, the silty clay thickness ranges from 1 m to 5 m. At west floodplain slope, Boreholes 30+640 and 30+700 indicate that the silty clay ranges from 16 m to 21 m in thickness, and extends from Elevations 97 m to 73 m. At the east floodplain slope, the silty clay is about 10 m thick, and extends from Elevations 102 m to 92m. The silty clay is typically brown in colour becoming grey below a depth of 7 m to 8 m.

Atterberg Limit tests were conducted on selected samples from this deposit and the results are illustrated on the plasticity charts in Figure B1 and B2. The silty clay samples had measured plasticity indices ranging between 12% and 25%, and corresponding liquid limits ranging from 28% and 44%, respectively, indicating clayey soils of low to medium plasticity (group symbols of CL to CI). Grain size analyses conducted on selected silty clay samples are presented in Figure B3.

Standard Penetration Tests conducted within this deposit gave 'N' values ranging typically between 23 blows and 2 blows per 0.3 m penetration. Field vane shear strengths ranged from the order of 110 kPa near the surface to the order of 45 kPa to 50 kPa at depth. Based on these results, the consistency of the deposit is considered to be generally stiff to very stiff

becoming firm at depth. The measured moisture contents of samples recovered from this unit ranged from 15% to 35%.

5.3.3 Sandy Silt to Silty Sand

A layer of sandy silt was found underlying the silty clay deposit in Borehole 30+640 Cl. This soil contains some gravel and trace to some clay. It has a thickness of about 1.2 m, and was in a loose state as indicated by an SPT 'N' value of 9 blows per 0.3 m penetration. Figure B4 shows a grain size distribution of a sample of this sandy silt. A layer of silty sand was encountered between the silty clay and auger refusal in Borehole 31+180. An 'N' value of 18 blows indicates that this soil is compact. Figure B5 shows a grain size distribution of a sample of this silty sand.

5.3.4 Bedrock

The soils described above are underlain by crystalline limestone bedrock of the Ordovician Period. The bedrock along the approaches was inferred by auger refusal or exposure at ground surface at some locations. Inferred bedrock surface depths and elevations at the borehole locations are summarized in the following table.

Borehole Number	Inferred Depth to Bedrock (m)	Inferred Top of Bedrock Elevation (m)
West Approach		
30+640 Cl	21.9	75.1
30+700 Cl	16.2	72.6
30+760 12.5 Lt	6.1	81.6
30+815 Cl	0.0	87.7
30+865 Cl	0.2	86.2
MRB-3	0.1	87.7
MRB-4	0.0	88.0
30+915 5.0 Rt	0.3	87.4
30+965 15 Lt	5.5	76.3
MRB-10	2.9	79.0
MRB-1	0.4	87.6
East Approach		
MRB-16	0.0	79.1
MRB-17	0.1	79.7
31+180 Cl	2.2	81.2
31+215 Cl	1.0	85.8

The top of bedrock undulates across the site and is close to the ground surface adjacent to the flow channel where outcrop is common. Along the west approach between Stations 30+750 and 31+000 (west bank of river), bedrock is present at shallow depths ranging from 5 m to exposure at ground surface, or Elevations 88 m to 76 m. From Stations 31+650 (crest of floodplain slope) to 31+750 within which the surface topography rises in a westerly direction, the bedrock dips to about Elevations 73 m to 75 m. Along the east approach between Stations 31+100 (east bank of river) to 31+250, the bedrock surface rises in an easterly direction and is present at within 2 m depth of the floodplain surface. Beyond Station 31+250, the surface topography gradually rises resulting in a bedrock depth of about 12 m near Station 31+350.

5.3.5 Groundwater

Most boreholes were noted to be dry upon completion of drilling. A standpipe piezometer was installed in a selected borehole (some 300 m west of the river banks) and the measured water level is presented below.

Borehole (screen location)	Date of Reading	Water Level Depth (m)	Water Level Elevation (m)
30+640 CI (silty clay)	June 1, 2005	6.5	90.5

Further east towards the river channel, water levels measured during previous investigations ranged between Elevations 78.1 m and 78.6 m.

Based on these observations, the local groundwater level near the river banks appear to exist at about Elevation 78 m and is influenced by the water level in the Madawaska River. The groundwater level rises with increasing distance from the river. According to a previous MTO report, the river water level at this site is controlled by the hydro dam and generally fluctuates between Elevations 77.4 m and 78.6 m. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.4 Mainline Stations 31+325 to 31+475 (CPR Overhead Bridge Approaches)

5.4.1 Topsoil

Topsoil was encountered at Boreholes 31+347 2.5 Rt and 31+470 with measured thickness of of 150 mm to 200 mm. Topsoil thickness may vary between and beyond the boreholes.

5.4.2 Silty Clay

In Boreholes 31+347 2.5 Rt and 31+470, the topsoil is underlain by a silty clay layer encountered at depths ranging from 0.2 to 1.3 m below ground surface. This deposit extends to a depth of about 12 m or Elevation 92 m at the west approach, and to a depth of about 7.5m or Elevation 96.5 m at the east approach. Sand seams were noted below Elevation 96 m.

The plasticity chart in Figure C1 shows that the silty clay samples had measured plasticity indices of ranging from 18% to 21% indicating a medium plasticity (group symbol CI). Grain size analyses conducted on two samples retrieved from this unit are presented in Figure C2. These results show that the clay content of this soil ranges between 38% and 47%.

Standard Penetration Tests conducted within this deposit gave 'N' values ranging from 12 blows to 1 blow per 0.3 m penetration, but typically between 7 and 4 blows. Field vane shear tests were attempted at three elevations. The vane could not be turned at Elevations 98 m (probably due to clay stiffness) and 93.5 m (probably due to sand seams), whereas a vane strength of 92 kPa was obtained at Elevation 96.5 m. Based on these results, the deposit is considered to be generally very stiff becoming stiff to firm with depth. The measured moisture contents of samples recovered from this unit ranged from 5% to 50%.

5.4.3 Bedrock

The soils described above are underlain by crystalline limestone bedrock of the Ordovician Period. The bedrock along the approaches was inferred by auger refusal. Inferred bedrock surface depths and elevations at the borehole locations are summarized in the following table.

Borehole Number	Inferred Depth to Bedrock (m)	Inferred Top of Bedrock Elevation (m)
West Approach		
31+347 2.5 Rt	11.6	91.9
OVR-6	0.0	96.7
OVR-7	0.0	95.5
East Approach		
OVR-8	2.2	95.1
OVR-9	2.3	95.7
31+470 CI	7.5	96.5

In the vicinity of the CPR Overhead structure, the top of bedrock varies from Elevations 92 m at the west approach, to about 95 m to 97 m at the cut and the east approach. These elevations correspond to bedrock depths of 11 m and 7 m at the west and east approaches, respectively.

5.4.4 Groundwater

All boreholes drilled at the approaches were noted to be dry upon completion of drilling.

Based on observations at previously installed piezometers in the area, the local groundwater level is anticipated to be at approximate Elevations 93 m to 94 m. It is anticipated that the local groundwater level at this site is influenced by the nearby Madawaska River valley. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe climatic events.

5.5 Mainline Stations 27+700 (Division Street Underpass)

5.5.1 Topsoil

Topsoil was encountered in Boreholes DIV 9+780 Cl, 8+830 6m Rt and 9+930 5m Rt drilled during the current investigation. Its thickness ranges between 100 mm and 150 mm which is consistent with the range determined in a previous investigation. Topsoil thickness may vary between and beyond the boreholes.

5.5.2 Fill

A sand and gravel fill was encountered either at ground surface or below topsoil in Boreholes DIV 9+872 3m Lt, 9+930 5m Rt, 10+100 Rt and 10+145 Rt shoulder drilled during the current investigation. Its thickness ranges between 0.3 m and 1.3 m. In Borehole 9+930 5m Rt, an SPT 'N' value of 7 blows per 0.3 m penetration indicates a loose condition. A moisture content of about 17% was measured for this sample.

In Borehole DIV 10+100 Rt, silty sand fill underlies the sand and gravel fill to about 1.5 m depth. A moisture content of about 15% was measured for this sample.

5.5.3 Silty Clay

In Boreholes DIV 9+780 Cl, 9+830 6m Rt and 9+872 3m Lt, the topsoil or fill is underlain by a silty clay layer. This deposit extends to depths of 1.1 m to 2.7 m, or Elevations 109.5 m to 106.4 m.

The plasticity chart in Figure G1 shows that a silty clay sample from Borehole DIV 9+780 Cl had a measured plasticity index of 30% and a liquid limit of about 53%, indicating a high plasticity (group symbol CH). Grain size analysis conducted on a sample retrieved from this unit is presented in Figure G2. These results show that the clay content of this soil is approximately 47%.

Standard Penetration Tests conducted within this deposit gave 'N' values ranging from 11 blows to 5 blows per 0.3 m penetration indicating a typically stiff becoming firm consistency

with depth. The measured moisture contents of samples recovered from this unit ranged from 20% to 30%.

5.5.4 Clayey Silt Till

In Boreholes DIV 9+780 Cl, 9+830 6m Rt, 9+930 5m Rt and 10+145 Rt Shoulder, the silty clay or fill is underlain by a clayey silt till deposit. This deposit extends to auger refusal at depths of 3.3 m to 5.8 m, or Elevations 107.0 m to 103.9 m.

Grain size analyses conducted on three samples retrieved from this unit are presented in Figure G3. These results show that the clay content of this soil ranges between 12% and 15%.

Standard Penetration Tests conducted within this deposit gave 'N' values ranging from 23 blows to 8 blows per 0.3 m penetration, indicating a typically very stiff becoming stiff consistency with depth. Occasional higher 'N' values of 50 blows for less than 0.3 m penetration encountered immediately above auger refusal may be attributed to the presence of bedrock or boulders. The measured moisture contents of samples recovered from this unit ranged between 8% and 10%.

5.5.5 Bedrock

The soils described above are underlain by crystalline limestone bedrock of the Ordovician Period. The bedrock along the approaches was inferred by auger refusal. Inferred bedrock surface depths and elevations at the borehole locations are summarized in the following table.

Borehole Number	Inferred Depth to Bedrock (m)	Inferred Top of Bedrock Elevation (m)
East Approach		
DIV 9+780 Cl	5.1	103.9
DIV 9+830 6m Rt	3.3	107.0
DIV 9+872 3m Lt	1.1	109.5
DIV 9+930 5m Rt	4.1	106.3
West Approach		
10+100 Rt	1.5	111.0
10+145 Rt	5.8	106.7

Along the alignment of the Division Street Underpass structure, the top of bedrock varies between 1.1 m and 5.8 m depths, or Elevations 111.0 m and 103.9 m.

5.5.6 Groundwater

All boreholes drilled during the current investigation were noted to be dry upon completion of drilling.

Based on observations at standpipe piezometers installed during the previous investigation, the local groundwater levels exist between approximate Elevations 108.8 m and 110.5 m, or about 1 m to 2.5 m depths. All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

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**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH EMBANKMENTS
WHITE LAKE ROAD INTERCHANGE
MADAWASKA RIVER, CPR OVERHEAD
AND DIVISION STREET BRIDGE APPROACHES
HIGHWAY 17 – 417 FOUR LANING
ARNPRIOR, ONTARIO
G.W.P. 647-92-00**

GEOCRES Number: 31F-150

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

6 GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents foundation recommendations for the design of embankments 6 m or greater in height at the White Lake Road Interchange, and approaches to the Madawaska River Bridge, CPR Overhead (Arnprior) Bridge and Division Street Underpass.

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

The project information, including plans and profiles, was provided in digital files to Thurber in May 2005, and was utilized for the preparation of this report.

7 ENGINEERING AND ANALYSIS METHODOLOGY

7.1 General

Major factors governing high embankment design at these sites include the following:

- material type and geometry of the embankment fills,
- characteristics of foundation soils,
- immediate and post construction settlements,
- means of minimizing post construction settlement and maintaining stability during all stages of construction and in the long term.

7.2 Available Alternatives

This section outlines alternatives for the design and construction of highway embankments equal and greater than 6 m in height at the above noted interchange and bridge approaches. Analyses and comparisons of alternatives, their relative cost effectiveness, and the recommended/preferred alternative(s) are presented in subsequent sections of this report.

The foundation soils are predominantly cohesive at the embankment locations, and will undergo settlement under the weight of the embankment fills. Conventional means of modifying the slope geometry such as provision of berms, ground improvement techniques such as preloading/surcharging and use of wick drains, and alternate construction materials such as lightweight fill have been considered, where appropriate, to minimize post-construction, time dependent settlements as well as to maintain global embankment stability at all times.

7.3 Methods of Stability and Settlement Analyses

For the purpose of embankment stability analyses, the commercially available slope stability program GSLOPE developed by Mitre Software Inc. was used.

Immediate foundation settlements due to elastic compression of any sands and silts have been estimated based on the methods described in the CHBDC, 2000 Commentary Section C6.6.3.6. Settlements due to recompression and primary consolidation of foundation clays have been estimated based on conventional one-dimensional consolidation theory, also outlined in the CHBDC.

The global stability of the embankment fill depends on the slope geometry, foundation conditions and on the fill material used to construct the embankment. Based on consideration of the risks involved, past experience of highway embankment performance and site specific conditions, a minimum Factor of Safety (F.S.) of 1.3 is considered appropriate to achieve global embankment stability for cohesive foundation soils.

The global stability of embankment fills due to seismic loading has been assessed based on a pseudo-static approach. In this approach, the horizontal acceleration associated with a F.S. of 1.0, referred to as the "yield acceleration", is compared with 67% of the peak horizontal acceleration (0.67 x PHA) based on seismic parameters applicable to the site location. The potential for embankment instability and lateral spreading is considered low if the yield acceleration is higher than 0.67 x PHA.

Seismic Considerations

The following seismic parameters have been used for design:

- Velocity Related Seismic Zone: 2

- Zonal Velocity Ratio: 0.1
- Acceleration Related Seismic Zone: 4
- Zonal Acceleration Ratio: 0.2

The Soil Profile Type at these locations is classified as Type 1, which, according to Table 4.4.6.1 of the CHBDC, is associated with a Site Coefficient (also referred to as the ground motion amplification factor) of 1.0. A value of 67% of the Peak Horizontal Ground Acceleration (0.67 x PHA) at ground surface of 0.134g (0.67 x 0.2 g), where g is the acceleration due to gravity, has been used in the analysis. This PHA value corresponds to a probability of exceedance of 10% in 50 years.

8 EMBANKMENT DESIGN AND CONSTRUCTION

8.1 General

Table 8.1 presents a summary of the embankment heights and simplified subsurface conditions encountered along the proposed alignments of the White Lake Road interchange, mainline embankments at the approaches to the Madawaska River Bridge, the CPR Overhead (Arnprior) Bridge, and the approaches to the Division Street Underpass.

The subsurface information indicates that the foundation soils consist of surficial fill or topsoil overlying a silty clay deposit that is underlain by bedrock at various depths.

The stability and settlement analyses presented below have been carried out assuming the removal of topsoil, loose/soft fill or other deleterious materials and placement of embankment materials on stiff competent subgrade. Analysis and design recommendations for the approach embankments within 20 m of the abutments are covered in References 1 to 4.

8.2 Stability Analysis – White Lake Road Interchange

8.2.1 General

The subsurface conditions, soil properties, groundwater table and embankment geometry assumed in the stability analysis are shown on Figures D1 to D13A. It is noted that at locations such as those along the White Lake Road south approach, SE Ramp and NE Ramp, a combination of the height of proposed fill, depth to bedrock and silty clay deposits will result in development of excess pore water pressures and subsequent consolidation settlement (see later sections) of the firm and lightly over-consolidated portion of the silty clay.

With the exception of the compacted Granular A or other engineered fill core at locations immediately behind the abutments, the remainder of the embankments may consist of rockfill or Select Subgrade Material (SSM). The slope of the core may be formed not steeper than 1H : 1V for Granular A, and 1.5H : 1V for other types of cohesionless fill (the core should

extend at least 1.5 m beyond the footing perimeter). Design of side slopes for rock fill and SSM fill have been assumed equal to 1.25H : 1V and 2H : 1V, respectively.

8.2.2 Static Analysis

Results of static stability analyses carried out for the proposed embankments at this site indicate that adequate Factors of Safety (F.S.) can be maintained for global stability. Figures E1 to E6 present selected stability analysis results for the south approach, Figures E7 to E10A for the NE Ramp, and Figures E11 to E13A for the SE Ramp.

The range of F.S. for selected critical locations are summarized as follows:

White Lake Road Bridge South Approach

- Side Slopes - F.S. $\geq$ 1.5
- Preload/surcharge stages - F.S. $\geq$ 1.3

NE Ramp

- Side Slopes - F.S. $\geq$ 1.3
- Preload/surcharge stages - F.S. $\approx$ 1.3

SE Ramp

- Side Slopes - F.S. $\geq$ 1.4
- Preload/surcharge stages - F.S. > 1.3

8.2.3 Seismic Analysis

Liquefaction Potential

In general, the interchange embankments may consist of rock fill, granular or SSM fill founded on native silty clay overlying bedrock. The groundwater level is below the base of the embankments. Based on the CHBDC, the foundation materials have negligible potential for liquefaction.

Consequently, the approach embankments will be stable against seismic activities at this site. Some toe failure may occur due to seismic loading, but this is expected to be minor in nature and readily repairable.

Limit Equilibrium

Results of pseudo-static analysis indicate that the yield acceleration is higher than 67% of the peak horizontal ground acceleration (0.67 x PHA) in all critical cases.

Figures ES1 to ES3 in Appendix E present selected results of pseudo-static analyses carried out to estimate the dynamic stability of the earth embankments subject to seismic loading.

Based on these results, it is considered that there is low potential for embankment foundation failure to occur upon seismic loading at this interchange.

8.3 Settlement Analysis – White Lake Road Interchange

8.3.1 General

Total settlement at the top of the embankment is a result of settlement of the foundation soils and settlement due to compression of the embankment material.

8.3.2 Foundation Settlement

Table 8.2 presents a summary of the anticipated foundation settlements.

Settlement of the cohesive foundation soils consists of recompression and primary consolidation. Recompression is anticipated to occur during construction, whereas settlement due to primary consolidation is time dependent and will not be complete until 9 to 12 months after the end of construction.

The foundation silty clay deposit at this site is heavily over-consolidated within the upper portion, i.e. above approximately Elevations 102 m to 103 m, changing with depth to lightly over-consolidated above bedrock. As such, a significant proportion of the total settlement is attributed to the elastic recompression of the clay.

White Lake Road South Approach, SE Ramp, NE Ramp

A combination of high fills and relatively deep cohesive deposits exist at White Lake Road South Approach, and adjacent sections of the SE and NE Ramps.

Based on a 7.5 m to 8 m high fill placed in a single stage, the analysis results indicate that immediate foundation soil settlement could be in the order of 150 to 200 mm and is anticipated to be complete by the end of fill placement. Subsequent settlement due to primary consolidation of the lower, lightly over-consolidated, clay is estimated to be in the order of 200 to 250 mm, which is expected to take place from the end of fill placement until after the end of construction. Settlement due to primary consolidation is estimated to be complete within 9 to 12 months after completion of fill placement.

If this magnitude of settlement and time frame are unacceptable, consideration can be given to preloading and surcharging. For preloading/surcharging, assuming that rock fill is placed to the assumed pavement subgrade level (7.5 m in height) and granular fill is placed to the top of surcharge (2 m above proposed final grade), the analysis results show that removal of the surcharge (regrading to the proposed final grade) in 3 to 4 months would result in over-consolidation of the clay and negligible post construction settlement due to primary consolidation. Under such loading conditions, it is estimated that immediate settlement of the foundation soils could be in the order of 150 to 200 mm and is anticipated to be complete by

the end of fill placement. Settlement due to primary consolidation is anticipated to be completed before surcharge removal and is estimated to be in the order of 250 to 350 mm.

Provided that the preloading/surcharging and surcharge removal is carried out as recommended in this report, settlement due to secondary compression is anticipated to be less than 25 mm in 10 years after construction.

8.3.3 Embankment Compression

Table 8.2 also summarizes the anticipated settlement due to embankment compression.

Embankments constructed with rock fill and compacted SSM fill are anticipated to settle due to compression of the fill materials. For SSM fill, this settlement can be up to 0.5% of the embankment height, which is anticipated to be complete within one to two years after the end of embankment construction. For rock fill, settlement is anticipated to occur due to rock particle reorientation and particle deterioration due to high contact stresses. Such settlement is time dependent and is expected to take place throughout the years after construction. For planning and design purposes, it is assumed that the magnitude of rock fill settlement will be up to 0.5% of the embankment height.

It is recommended that all new embankments be over-built (wider platform) in accordance with the latest MTO practice in order to accommodate the effects of embankment compression.

8.4 Embankment Design – White Lake Road Interchange

Beyond the immediate approach areas, embankments constructed using granular material and SSM will have stable side slopes at inclinations not steeper than 2H : 1V. Berms will not be required to satisfy global stability requirements.

Based on the stability analyses results in Section 8.2 Stability Analysis, all embankments may be constructed by placing rock, granular or SSM fill to the final grade without the need of any ground improvement or the use of lightweight fill.

At the critical locations of White Lake Road South Approach, and adjacent sections of the SE and NE Ramps, however, in order to limit post construction settlements, several embankment design alternatives are considered and discussed in the following.

Preloading/Surcharging

The settlement analysis results in Section 8.3 Settlement indicate it is possible to reduce post construction settlements to within tolerable limits by conventional preloading/surcharging, provided that a waiting time of up to 4 months is available between completion of surcharge placement and removal of surcharge.

Wick Drains

Wick drains increase the rate of foundation pore water pressure dissipation and reduce the time required for primary consolidation to be completed. The application of wick drains must be accompanied by geotechnical instrumentation and monitoring. In view of the scope of work anticipated at this site (White Lake Road south approach and its immediate surrounding areas) and the feasibility of preloading/surcharging, the use of wick drains may not be cost-effective at this site. If there is insufficient time available (e.g. less than 4 months) for preloading the foundation soils, consideration may then be given to using wick drains immediately behind the south abutment, in order not to jeopardize the bridge construction schedule. Detailed design and preparation of specifications for wick drains, if used, is beyond the scope of this assignment.

Lightweight Fill

Lightweight fill commonly used on MTO projects include blast furnace slag and expanded polystyrene (EPS).

At this site, the use of the Type II ultra lightweight slag (bulk unit weight of about 12 kN/m^3) is not considered feasible due to the following reasons; (1) some preloading will still be required at the high fill locations to limit post construction settlement and (2) the Type II slag is only available from a plant in Hamilton, which renders this option less cost-effective due to the large hauling distance.

EPS is a technically feasible option for embankment construction due to its extreme light weight (saturated unit weight of less than 1 kN/m^3). If used at this site, the resulting stress acting on the subgrade due to the weight of EPS plus the earth cover/pavement structure will be less than the preconsolidation pressure of the foundation clay. As such, the resulting settlement will be limited to elastic recompression of the over-consolidated clay. All settlements will be complete during construction. Since the unit cost for constructing EPS is relatively high, it is not cost effective for this site.

Based on the above, it is considered that conventional preloading/surcharging is the most cost effective means of constructing the embankments at critical locations at the White Lake Road south approach, and adjacent embankments associated with the SE and NE Ramps.

The recommended procedures and extent for carrying out the preloading/surcharging scheme is outlined as follows:

- Place fill consisting of rock, granular or SSM up to the design pavement subgrade level at all ramps and approaches.
- Place Granular B Type II fill to top of surcharge level at 2 m above final road grade along ramp and approach sections where the proposed final embankment height is

6m or higher above the existing ground surface. The top of surcharge level should then be tapered downwards, away from the high fill areas, at an inclination of 20 H to 1 V to intersect the final road grade.

- Leave all fill including the surcharge in place for four months (waiting period) after the completion of fill placement.
- Remove the surcharge to pavement subgrade level and commence other phases of construction.
- It is recommended that a geotechnical instrumentation and monitoring program be implemented to monitor the progress of settlement, generation and dissipation of pore water pressures in the foundation soils due to fill placement. This program should include settlement plates, settlement pins and vibrating wire piezometers. The monitoring readings will assist in determining the timing for removal of the surcharge. The design and preparation of specifications for instrumentation are beyond the scope of the present assignment.

8.5 Embankment Construction – White Lake Road Interchange

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 should consist of granular materials or Select Subgrade Material (SSM) in compliance with Special Provision 110F13, "Amendment to OPSS 1010, March 1993". It is recommended that preference be given to using granular materials over cohesive materials, as it is anticipated that the latter could sustain larger magnitudes of settlement.

All new embankment earth fill should be placed in regular lifts and be compacted in accordance with OPSS 501 and SP 105S10.

Vegetation cover should be established on all exposed earth slopes to protect against surficial erosion. Reference may be made to SP 572S01 (supersedes OPSS 572) for more detailed requirements.

8.6 Stability Analysis – Madawaska River Bridge Approaches

8.6.1 General

The subsurface conditions, soil properties, groundwater table and approach embankment geometry assumed in the stability analysis described below are summarized in Figures F1 through F7. Rock fill and SSM fill side slopes have been assumed equal to 1.25H : 1V and 2H : 1V, respectively. In view of the sloping site topography, space restrictions, and the availability of rock fill along the Highway 17 alignment, it is likely that the new embankments will be constructed with rock fill.

8.6.2 Static Analysis

Results of static stability analyses carried out for this site indicate that adequate Factors of Safety (F.S.) can be maintained for global stability. Figures F1 to F7 in Appendix F present selected stability analysis results for the east and west approaches.

The estimated F.S. for selected critical locations are summarized as follows:

Madawaska River Bridge West Approach

- Side slopes (Stations 750 to 975) - F.S. $\geq$ 1.4
- Side Slopes (Stations 650 to 750) - F.S. $\geq$ 1.5

Madawaska River Bridge East Approach

- Side Slopes - F.S. $\approx$ 1.4

8.6.3 Seismic Analysis

Liquefaction Potential

In general, the approaches will likely consist of rock fill (with a granular core immediately behind the abutments) or possibly SSM fill founded on native silty clay overlying bedrock. The groundwater level is below the base of the embankments. Based on the CHBDC, the foundation materials have low potential for liquefaction.

Consequently, the approach embankments will be stable against seismic activities at this site. Some toe failure may occur due to seismic loading, but this is expected to be minor in nature and readily repairable.

Limit Equilibrium

Results of pseudo-static analysis indicate that the yield acceleration is equal to or higher than 67% of the peak horizontal ground acceleration (0.67 x PHA). Based on these results, it is considered that there is low potential for embankment foundation failure to occur upon seismic loading at the bridge approaches.

Figure FS1 in Appendix F presents selected results of pseudo-static analyses carried out to estimate the dynamic stability of the earth embankments subject to seismic loading.

8.7 Settlement Analysis – Madawaska River Bridge Approaches

8.7.1 General

Total settlement at the top of the embankment is a result of settlement of the foundation soils and settlement due to compression of the embankment material.

8.7.2 Foundation Settlement

Table 8.2 presents a summary of the anticipated foundation settlements.

Settlement of the cohesive silty clay foundation soils consists of recompression and primary consolidation. Settlement due to recompression of the clay is anticipated to occur during construction.

At this site, the new embankment is to be constructed directly on bedrock or on over-consolidated silty clay overlying bedrock. The foundation silty clay deposit at this site is very stiff within the upper portion, i.e. above approximate Elevation 80 m, becoming stiff with depth until bedrock.

Stations 30+750 to 30+975

The total foundation settlement within this section is attributed to elastic recompression of the clay. The estimated magnitude of elastic foundation settlement is in the order of 100 mm, which is anticipated to be completed by the end of fill placement.

Stations 30+650 to 30+750

The total foundation settlement within this section consists of elastic recompression and primary consolidation of the clay. The estimated magnitude of elastic foundation settlement is in the order of 150 mm to 225 mm, which is anticipated to take place during fill placement. Primary consolidation settlement of the clay is estimated to be in the order of 100 mm which is anticipated to be completed by the end of construction. It is anticipated that post construction foundation settlement will not exceed 25 mm.

8.7.3 Embankment Compression

Table 8.2 also summarizes the anticipated settlement due to embankment compression.

Embankments constructed with rock fill and compacted earth fill are anticipated to settle due to compression of the fill materials. For earth fill, this settlement can be up to 0.5% of the embankment height, which is anticipated to be completed within one to two years after the end of embankment construction. For rock fill, settlement is anticipated to occur due to rock particle reorientation and particle deterioration due to high contact stresses. Such settlement is time dependent and is expected to take place throughout the years after construction. For planning and design purposes, it is assumed that the magnitude of rock fill settlement will be up to 0.5% of the embankment height.

8.8 Embankment Construction – Madawaska River Bridge Approaches

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. Rock fill is likely to be the material used to construct the approach embankments. Earth fill

may be used at this site and should consist of granular materials or Select Subgrade Material (SSM) in compliance with Special Provision 110F13, "Amendment to OPSS 1010, March 1993". It is recommended that preference be given to using granular or SSM materials over cohesive materials, as it is anticipated that the latter could sustain larger magnitudes of settlement.

Where rock fill embankments are 10 m or higher, berms should be incorporated at mid-height and should be 2 m wide and extend for the length through which the embankment height exceeds 10 m. Where earth fill embankments are higher than 8 m, berms should be incorporated at mid-height and should be 2 m wide and extend for the length through which the embankment height exceeds 8 m; and the berms should maintain a 2% positive drainage grade to shed surface run-off. It is noted that the requirements for a 2 m wide berm for a 10m high rock fill embankment, and 8 m high earth embankment, are in place to address surficial stability and to provide access for post construction maintenance.

Prior to placing new fill, the existing slope surfaces should be appropriately benched, as per OPSD 208.010, after stripping of topsoil, organics or otherwise unsuitable overburden materials.

All new embankment earth fill should be placed in regular lifts and be compacted in accordance with OPSS 501 and SP 105S10.

Earth fill embankment slopes must be provided with erosion protection in accordance with OPSS 572 and related special provision(s).

8.9 Stability Analysis – CPR Overhead (Arnprior) Bridge

8.9.1 General

The subsurface conditions, soil properties, groundwater table and approach embankment geometry assumed in the stability analysis described below are summarized in Figures G1 and G2. Design rock fill and SSM fill side slopes have been assumed equal to 1.25H : 1V and 2H : 1V, respectively.

8.9.2 Static Analysis

Results of static stability analyses carried out for this site indicate that adequate Factors of Safety (F.S.) can be maintained for global stability. Figures G1 and G2 present selected stability analysis results for the west approach.

The estimated F.S. for selected critical locations are summarized as follows:

CPR Overhead Bridge West Approach

- Side slopes (Stations 350 to 375) - F.S. $\geq$ 1.5

CPR Overhead Bridge East Approach

- Side Slopes (Stations 450 to 475) - F.S. ≥ 1.5

8.9.3 Seismic Analysis

Liquefaction Potential

In general, the approaches may consist of rock fill or SSM fill founded on native silty clay overlying bedrock. The groundwater level is below the base of the embankments. Based on the CHBDC, the foundation materials have negligible to no potential for liquefaction.

Consequently, the approach embankments will be stable against seismic activities at this site. Some toe failure may occur due to seismic loading, but this is expected to be minor in nature and readily repairable.

Limit Equilibrium

Results of pseudo-static analysis indicate that the yield acceleration is higher than 67% of the peak horizontal ground acceleration (0.67 x PHA). It is considered that there is low potential for instability and lateral spreading of the embankments to occur upon seismic loading at these approaches.

8.10 Settlement Analysis – CPR Overhead (Arnprior) Bridge

8.10.1 General

Total settlement at the top of the embankment is a result of settlement of the foundation soils and settlement due to compression of the embankment material.

8.10.2 Foundation Settlement

Table 8.2 presents a summary of the anticipated foundation settlements.

Settlement of the cohesive silty clay foundation soils is comprised of recompression and primary consolidation. Settlement due to recompression of the clay is anticipated to occur during construction.

At this site, the new embankment is to be constructed on 4 m to 5 m of over-consolidated silty clay overlying bedrock. The foundation silty clay deposit at this site is stiff to very stiff. As such, the total foundation settlement is attributed to elastic recompression of the clay. It is anticipated that all foundation settlements will be completed by the end of construction and that post construction settlement will be negligible.

8.10.3 Embankment Compression

Table 8.2 summarizes the anticipated settlement due to embankment compression.

Embankments constructed with rock fill and compacted earth fill are anticipated to settle due to compression of the fill materials. For earth fill, this settlement can be up to 0.5% of the embankment height, which is anticipated to be complete within one to two years after the end of embankment construction. For rock fill, settlement is anticipated to occur due to rock particle reorientation and particle deterioration due to high contact stresses. Such settlement is time dependent and is expected to take place throughout the years after construction. For planning and design purposes, it is assumed that the magnitude of rock fill settlement will be up to 0.5% of the embankment height.

8.11 Embankment Construction – CPR Overhead (Arnprior) Bridge

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. Rock fill or earth fill may be used at this site. Earth fill should consist of granular materials or Select Subgrade Material (SSM) in compliance with Special Provision 110F13, "Amendment to OPSS 1010, March 1993". It is recommended that preference be given to using granular or SSM materials over cohesive materials, as it is anticipated that the latter could sustain larger magnitudes of settlement.

Prior to placing new fill, the existing slope surfaces should be appropriately benched, as per OPSD 208.010, after stripping of topsoil, organics or otherwise unsuitable overburden materials.

Berms are not required at this site to maintain stability, nor to address surficial stability and post construction maintenance.

All new embankment earth fill should be placed in regular lifts and be compacted in accordance with OPSS 501 and SP 105S10.

Earth fill embankment slopes must be provided with erosion protection in accordance with OPSS 572 and related special provision(s).

8.12 Stability Analysis – Division Street Underpass Approaches

8.12.1 General

The subsurface conditions, soil properties, groundwater table and approach embankment geometry assumed in the stability analysis described below are shown on Figures H1 and H2. Rock fill and earth fill side slopes have been assumed equal to 1.25H : 1V and 2H : 1V, respectively. Analysis and design recommendations for the approach embankments within 20 m of the abutments are covered in Reference 4.

8.12.2 Static Analysis

Results of static stability analyses carried out for this site indicate that adequate Factors of Safety (F.S.) can be maintained for global stability. Figures G1 and G2 present selected stability analysis results for the east approach.

The estimated F.S. for selected critical locations are summarized as follows:

Division Street Underpass East Approach

- Side slopes - F.S. $\geq$ 1.4

Division Street Underpass West Approach

- Side Slopes - F.S. > 1.5

8.12.3 Seismic Analysis

Liquefaction Potential

In general, the approaches may consist of rock fill or SSM fill founded on native silty clay and clayey silt till overlying bedrock. The groundwater level is below the base of the embankments. Based on the CHBDC, the foundation materials have negligible potential for liquefaction.

Consequently, the approach embankments will be stable against seismic activities at this site. Some toe failure may occur due to seismic loading, but this is expected to be minor in nature and readily repairable.

Limit Equilibrium

Results of pseudo-static analysis indicate that the yield acceleration is higher than 67% of the peak horizontal ground acceleration (0.67 x PHA). It is considered that there is low potential for instability and lateral spreading of the embankments to occur upon seismic loading at these approaches.

Figure HS1 in Appendix H presents selected results of pseudo-static analyses carried out to estimate the dynamic stability of the earth embankments subject to seismic loading.

8.13 Settlement Analysis - Division Street Underpass Approaches

8.13.1 General

Total settlement at the top of the embankment is a result of settlement of the foundation soils and settlement due to compression of the embankment material.

8.13.2 Foundation Settlement

Table 8.2 presents a summary of the anticipated foundation settlements.

At this site, the new embankment is to be constructed on 1 m to 6 m of over-consolidated, stiff to very stiff silty clay and clayey silt till overlying bedrock. As such, the total foundation settlement is attributed to elastic recompression of the clayey deposits, and is estimated to be in the order of 25 mm to 50 mm. It is anticipated that all foundation settlements will be completed by the end of construction and that post construction settlement will be negligible.

8.13.3 Embankment Compression

Table 8.2 summarizes the anticipated settlement due to embankment compression.

Embankments constructed with rock fill and compacted earth fill are anticipated to settle due to compression of the fill materials. For earth fill, this settlement can be up to 0.5% of the embankment height, which is anticipated to be complete within one to two years after the end of embankment construction. For rock fill, settlement is anticipated to occur due to rock particle reorientation and particle deterioration due to high contact stresses. Such settlement is time dependent and is expected to take place throughout the years after construction. For planning and design purposes, it is assumed that the magnitude of rock fill settlement will be up to 0.5% of the embankment height.

8.14 Embankment Construction - Division Street Underpass Approaches

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. Rock fill or earth fill may be used at this site. Earth fill should consist of granular materials or Select Subgrade Material (SSM) in compliance with Special Provision 110F13, "Amendment to OPSS 1010, March 1993". It is recommended that preference be given to using granular or SSM materials over cohesive materials, as it is anticipated that the latter could sustain larger magnitudes of settlement.

Berms are not required at this site to maintain stability, nor to address surficial stability and post construction maintenance.

All new embankment earth fill should be placed in regular lifts and be compacted in accordance with OPSS 501 and SP 105S10.

Earth fill embankment slopes must be provided with erosion protection in accordance with OPSS 572 and related special provision(s).

8.15 Construction Concerns

During construction, the Contract Administrator should employ experienced geotechnical staff to observe activities related to embankment construction.

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

- maintaining stability of all embankments, including preloading and surcharge fills, at all times (with the assistance of geotechnical monitoring data from settlement plates and piezometers where applicable).

- confirming that settlement has stabilized at critical locations, such as at the south approach of the White Lake Road Bridge, NE and SE Ramps, before removing the surcharge fill and commencement of foundation construction.

Engineering Analysis and Report Preparation by:
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Report Reviewed by:
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Review Principal, Designated MTO Contact

TABLE 8.1 SUMMARY OF EMBANKMENT HEIGHTS AND SUBSURFACE CONDITIONS

Township	Alignment	Stations	Embankment Height	Groundwater Depth	Soil Stratigraphy	Depth to Bedrock
	White Lake Road Interchange					
McNab	White Lake Road North Approach	9+860 to 9+960	Up to 9 m	1 m to 2 m	Up to 1 m fill Up to 4 m Silty Clay	2 m to 4 m
		9+750 to 9+860	< 6 m	1 m to 2 m	Up to 8 m	4 m to 8 m
	White Lake Road South Approach	10+040 to 10+140	Up to 8 m	1 m to 2 m	< 1 m fill Up to 9 m Silty Clay	6 m to 10 m
		10+140 to 10+260	< 5 m	1 m to 2 m	< 1 m fill Up to 13 m Silty Clay	7 m to 14 m
	NW Ramp	29+120 to 29+220	Up to 7 m	Within 1 m	1 m to 5 m Silty Clay	2 m to 5 m
		28+960 to 29+120	< 6 m	1 m to 2 m	Up to 6 m	5 m to 6 m
	S-W Ramp	29+350 to 29+500	Up to 7 m	1 m to 2 m	Up to 4 m Silty Clay	2 m to 4 m
	E-N/S Ramp	29+220 to 29+350	< 4 m	Within 1 m	1 m fill Up to 8 m Silty Clay	5 m to 9 m
	S-E Ramp	29+000 to 29+400	Up to 7.5 m	Within 1 m	Up to 7 m Silty Clay	5 m to 10 m
	W-N/S Ramp	29+050 to 29+150	< 3 m	Within 1 m	Up to 13 m Silty Clay	10 m to 13 m
	NE Ramp	28+750 to 28+850	Up to 8 m	Within 1 m	Up to 6 m Silty Clay	6 m to 11 m
	NE Ramp	28+850 to 28+950	< 5 m	Within 1 m	Up to 11 m Silty Clay	6 m to 11 m
	Madawaska River Bridge Approaches					
	West Approach	30+650 to 30+750	7 m to 8 m	Within 2 m	Up to 15 m Silty Clay	15 m
	West Approach (beyond 20 m of west abutment)	30+750 to 30+975	10 m to 15 m	Within 2 m	Up to 5 m Silty Clay	5 m
	East Approach (beyond 20 m of east abutment)	31+100 to 31+300	Up to 18 m	Within 2 m	Up to 5 m Silty Clay	2 m

	CPR Overhead (Arnprior) Bridge Approaches					
	West Approach (beyond 20 m of west abutment)	31+350 to 31+375	Up to 5 m	> 4 m	5 m to 10 m Silty Clay	5 m to 10 m
	East Approach (beyond 20 m of east abutment)	31+450 to 31+475	Up to 5 m	> 4 m	3 m to 8 m Silty Clay	3 m to 8 m
	Division Street Underpass Approaches					
	West Approach (beyond 20 m of west abutment)	9+750 to 9+950	Up to 8 m	Within 2 m	Up to 6 m Clay / Clay Till	1 m to 5 m
	East Approach (beyond 20 m of east abutment)	10+050 to 10+200	Up to 10 m	Within 2 m	Up to 5 m Clay / Clay Till	1 m to 6 m

TABLE 8.2 FOUNDATION SETTLEMENT AND EMBANKMENT COMPRESSION

Township	Alignment	Stations	Embankment Height	Foundation Settlement		Embankment Compression (mm)
				During fill placement (mm)	Post fill placement (mm)	
	White Lake Road Interchange					
McNab	White Lake Road North Approach	9+860 to 9+960	Up to 9 m	50 to 75	Negligible	45 (earth fill) 45 (rock fill)
		9+750 to 9+860	< 6 m	50 to 100	Negligible	< 30 (earth fill) < 30 (rock fill)
	White Lake Road South Approach	10+040 to 10+140	Up to 8 m	150 to 200	<u>No surcharging</u> 250 - 300 (during construction) > 30 (post construction) <u>With surcharging</u> 300 - 350 (during construction) negligible (post construction)	40 (earth fill) 40 (rock fill)
		10+140 to 10+260	< 5 m	100 to 150	Negligible	< 25 (earth fill) < 25 (rock fill)
	NW Ramp	29+120 to 29+220	Up to 7 m	50 to 75	Negligible	35 (earth fill) 35 (rock fill)
		28+960 to 29+120	< 6 m	50 to 75	Negligible	< 30 (earth fill) < 30 (rock fill)
	S-W Ramp	29+350 to 29+500	Up to 7 m	50 to 75	Negligible	35 (earth fill) 35 (rock fill)
	E-N/S Ramp	29+220 to 29+350	< 4 m	50 to 100	Negligible	< 20 (earth fill) < 20 (rock fill)
	S-E Ramp	29+000 to 29+400	Up to 7.5 m	100 to 150	<u>No surcharging</u> 250 - 300 (during construction) > 30 (post construction) <u>With surcharging</u> 300 - 350 (during construction) negligible (post construction)	40 (earth fill) 40 (rock fill)

	W-N/S Ramp	29+050 to 29+150	< 3 m	75 to 100	Negligible	< 15 (earth fill) < 15 (rock fill)
	NE Ramp	28+750 to 28+850	Up to 8 m	150 to 200	<u>No surcharging</u> 250 - 300 (during construction) > 30 (post construction) <u>With surcharging</u> 350 - 400 (during construction) negligible (post construction)	40 (earth fill) 40 (rock fill)
McNab	NE Ramp	28+850 to 28+950	< 5 m	100 to 150	Negligible	< 25 (earth fill) < 25 (rock fill)
	Madawaska River Bridge Approaches					
	West Approach	30+650 to 30+750	7 m to 8 m	150 to 225	end of construction - 100 post construction - < 25	40 (earth fill) < 40 (rock fill)
	West Approach (beyond 20 m of west abutment)	30+750 to 30+975	10 m to 15 m	75 to 100	Negligible	< 75 (earth fill) < 75 (rock fill)
	East Approach (beyond 20 m of east abutment)	31+100 to 31+300	Up to 18 m	Up to 25	Negligible	< 90 (earth fill) < 90 (rock fill)
	CPR Overhead (Arnprior) Bridge					
	West Approach (beyond 20 m of west abutment)	31+350 to 31+375	Up to 5 m	75 to 100	Negligible	25 (earth fill) 25 (rock fill)
	East Approach (beyond 20 m of east abutment)	31+450 to 31+475	Up to 5 m	50 to 75	Negligible	25 (earth fill) 25 (rock fill)
	Division Street Underpass Approaches					
	West Approach (beyond 20 m of west abutment)	9+750 to 9+950	Up to 8 m	25 to 50	Negligible	Up to 40 (earth fill) Up to 40 (rock fill)
	East Approach (beyond 20 m of east abutment)	10+050 to 10+200	Up to 10 m	25 to 50	Negligible	Up to 50 (earth fill) Up to 50 (rock fill)

THURBER

Appendix A

White Lake Road Interchange
Records of Boreholes, Laboratory Test Results, Drawings

Figure A1 Summary of Soil Properties

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[1] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample WS Wash Sample AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight RC Rock Core SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

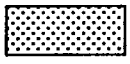
ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 05-1 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.10.05 - 05.10.05 CHECKED BY SKP

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, ● QUICK TRIAXIAL, + FIELD VANE, × 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
108.3											
0.0	SAND, occasional gravel, occasional rootlets, Loose, Brown (FILL)										
0.2	Silty CLAY, trace sand Stiff to Very Stiff Grey Moist		1	SS	9		108				
			2	SS	18						
							107				
			3	SS	11						0 1 45 54
							106	2.6			
			1	TW	PH		105				0 1 57 42
								4.5			
							104				
			2	TW	PH						0 6 49 45
							103	2.9			
			3	TW	PH		102				0 5 39 56
								3			
100.7							101				
7.6	END OF BOREHOLE AT 7.62m. AUGER REFUSAL AT 7.62m ON PROBABLE BEDROCK. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 6.4m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No WLR 9+825 RT 1 OF 2 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
108.4											
0.0	**SAND**, some gravel, trace silt Compact Brown Moist (FILL)										
			1	SS	23						
107.2											
1.2	Silty **CLAY**, some sand seams Stiff Brown										
			2	SS	11						
106.2											
2.2	Clayey **SILT**, some sand seams Stiff to Firm Brown										
			3	SS	9						
			4	SS	7						
			5	SS	5						
102.3											
6.1	Silty **CLAY**, trace sand, trace gravel Soft to Very Stiff Grey		6	SS	1						
								3.1			
			7	SS	1						
98.8			8	SS	50/.075						
9.7	END OF BOREHOLE AT 9.65 m. AUGER REFUSAL AT 9.65m.										

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No WLR 9+825 RT 2 OF 2 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

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
	BOREHOLE OPEN TO 8.08 m AND WATER LEVEL AT 3.81 m UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 9+850 RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
108.3							
0.0	**SAND and GRAVEL**, trace silt Brown Moist (FILL)						108
107.3			1	SS	8		107
1.1	Silty **CLAY**, some sand seams, trace gravel Stiff to Soft Brown		2	SS	10		
			3	SS	10		106
			4	SS	7		105
			5	SS	3		104
102.5							103
5.9	**SAND and GRAVEL**, trace silt Very Dense						
102.0	Brown		6	SS	50/		
6.3	Wet END OF BOREHOLE AT 6.30 m. AUGER REFUSAL AT 6.30 m ON PROBABLE BEDROCK. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05 2.0				.100		

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

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

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

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Ontario

THUNDER

RECORD OF BOREHOLE No WLR 9+900 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

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 108.1	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
0.0 / 107.4	**SAND and GRAVEL**, trace silt Brown Moist (FILL)						108				
0.7	Silty **CLAY**, some sand seams Soft to Stiff Brown		1	SS	3		107		○		
			2	SS	10				○		
105.9							106				
2.2	END OF BOREHOLE AT 2.21 m. BOREHOLE OPEN TO 1.96 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

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

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THURBER

RECORD OF BOREHOLE No WLR 9+950 RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	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
107.4											
0.0	**SAND and GRAVEL**, trace silt Brown Moist						107				
106.8	(FILL)										
0.6	Silty **CLAY**, some sand seams Soft to Firm Brown		1	SS	4		106		○		
			2	SS	7		105		○		
			3	SS	4						0 2 51 47
			4	SS	5		104		○		
103.1											
4.3	**SAND**, some gravel, some clay Very Dense						103				
102.7	Brown		5	SS	50/				○		
4.7	Wet				.025						
	END OF BOREHOLE AT 4.75 m. AUGER REFUSAL AT 4.75 m ON PROBABLE BEDROCK. BOREHOLE GROUTED TO SURFACE.										

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

$\oplus^{20}_{10}$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 10+050 LT 1 OF 2 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
108.4											
0.0 / 0.1	**ASPHALT** (50mm)										
	SAND and GRAVEL, trace silt Dense Brown Moist (FILL)						108				
107.4			1	SS	44						
1.1 / 107.0	**SAND**, trace gravel Dense Brown						107				
1.4	Moist (FILL)		2	SS	17						
	Silty **CLAY**, trace sand seams Very Stiff to Firm Brown						106				
			3	SS	6						
			4	SS	9		105				
							104				
			5	SS	4						
							103				
	Becoming Soft		6	SS	1		102	+ 4.0			
							101				
	Becoming Grey		7	SS	1						
							100				
			8	SS	1	▽	99				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 10+050 LT 2 OF 2 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100; ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE; 20 40 60 80 100	w_P w w_L; 20 40 60	γ kN/m^3	GR SA SI CL
97.2			1	TW	PH		98	+ 7.0			
11.2 / 96.3	Silty **CLAY**, some sand seams, trace gravel Grey						97				
12.1	END OF BOREHOLE AT 12.09 m. AUGER REFUSAL AT 12.09 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 10.16 m AND WATER LEVEL AT 9.30 m UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 10+100 RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 19.05.05 - 19.05.05 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L	γ kN/m^3	GR SA SI CL
107.7								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60		
0.0	SAND, some gravel, trace silt Brown Moist (FILL)										
107.0											
0.7	Silty CLAY, trace sand seams Stiff to Firm Brown		1	SS	9		107		○		
			2	SS	13		106		○		
			3	SS	6		105		⊢○⊣		
			4	SS	3		104		○		
			5	SS	2		103		⊢○⊣		
								3.5 +			
			6	SS	1	▽	102		○		
100.6							101				
7.1	END OF BOREHOLE AT 7.09 m. AUGER REFUSAL AT 7.09 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 6.40 m AND WATER LEVEL AT 6.25 m UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 10+100 RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 19.05.05 - 19.05.05 CHECKED BY SKP

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 ● QUICK TRIAXIAL + FIELD VANE × 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
107.7											
0.0	**SAND**, some gravel, trace silt Brown Moist (FILL)										
107.0											
0.7	Silty **CLAY**, trace sand seams Stiff to Firm Brown		1	SS	9		107	○			
			2	SS	13		106	○			
			3	SS	6		105	○			
			4	SS	3		104	○			
			5	SS	2		103	○			
							102	+ 3.5			
			6	SS	1	▽	101	○			
100.6											
7.1	END OF BOREHOLE AT 7.09 m. AUGER REFUSAL AT 7.09 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 6.40 m AND WATER LEVEL AT 6.25 m UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 10+150 2 m LT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 06.01.05 - 06.01.05 CHECKED BY SKP

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
107.8											
0.0	**SAND and GRAVEL**, trace silt Brown Moist (FILL)										
107.1											
0.7	Silty **CLAY**, trace sand Stiff to Firm Brown		1	SS	12		107				
			2	SS	8		106				
			3	SS	7		105				0 2 64 34
							104				
	Becoming Grey		4	SS	4		103				
							102				
			5	SS	1		101	3.3 +			
			6	SS	50/.100		100				
99.6											
8.2	END OF BOREHOLE AT 8.23 m. AUGER REFUSAL AT 8.23 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 7.47 m AND WATER LEVEL AT 3.20 m UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 10+200 RT 1 OF 2 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 20.05.05 - 20.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
107.8								20 40 60 80 100	20 40 60		
0.0	**SAND**, trace gravel, trace silt Brown Moist (FILL)										
107.2											
0.6	Silty **CLAY**, occasional sand seams Stiff to Firm Brown		1	SS	11		107				
			2	SS	13		106				
			3	SS	7		105				0 1 40 59
			4	SS	4		104				
			5	SS	1		103	4.7			
	Grey		6	SS	WH		102				
			7	SS	WH		101				
							100	3.6			
			1	TW	PH		99				
							98				

Continued Next Page

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

20
15-⊕-5
10
(%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No WLR 10+200 RT 2 OF 2 METRIC

W.P. 19-1351-82 LOCATION White Lake Road ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 20.05.05 - 20.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			8	SS	1		97		○		
							96	+			
			9	SS	1				○		0 4 48 48
94.1							95				
13.7	Silty CLAY, some sand, trace gravel Stiff Grey (TILL)		10	SS	14		94		○		
93.3											
14.5	END OF BOREHOLE AT 14.48 m. AUGER REFUSAL AT 14.48m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05 5.2										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/05/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-E Ramp 28+800 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION N-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.10.05 - 05.10.05 CHECKED BY SKP

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
107.1											
0.0	TOPSOIL (100mm)						107				
0.1	Silty CLAY, trace sand, occasional rootlets Stiff Brown to Grey/ Brown Moist to Wet Becoming Very Stiff, Grey		1	SS	9						
			2	SS	15		106				
	Becoming Firm		3	SS	7		105	3.8			
			4	SS	6		104				0 3 43 54
							103	3 3			
			5	SS	3		102				
								4			
100.8	Becoming Hard		6	SS	60/		101				
6.2	END OF BOREHOLE AT 6.25m. AUGER REFUSAL AT 6.25m ON PROBABLE BEDROCK. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.				.152						

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

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

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-E Ramp 28+850 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION N-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.10.05 - 05.10.05 CHECKED BY SKP

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 ● QUICK TRIAXIAL + FIELD VANE × 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
107.2											
0.0	TOPSOIL (50mm)										
0.1	Silty CLAY, trace sand, occasional rootlets Stiff to Very Stiff Grey to Brown Moist to Wet		1	SS	8		107				
	Becoming Very Stiff, Grey		2	SS	17		106				0 1 42 57
			3	SS	13		105	3.6			
	Becoming Firm		4	SS	6		104				
							103	3.5			
			5	SS	3		102				0 2 34 64
								4.8			
100.8	Becoming Hard		6	SS	53		101				
6.4	END OF BOREHOLE AT 6.40m. AUGER REFUSAL AT 6.40m ON PROBABLE BEDROCK. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 5.2m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

15 ⊕ 5 (20, 10) (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-E Ramp 28+900 CL 1 OF 2 METRIC

W.P. 19-1351-82 LOCATION N-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.11.05 - 05.11.05 CHECKED BY SKP

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 ● QUICK TRIAXIAL + FIELD VANE × 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
107.1											
0.0	TOPSOIL (50mm)						107				
0.1	Silty CLAY, trace sand, occasional rootlets Firm Brown Moist to Wet Becoming Very Stiff		1	SS	6						
			2	SS	15		106				
	Becoming Stiff		3	SS	12		105	3.2			
			4	SS	4		104				
							103	3.4			
			5	SS	4		102				
			6	SS	2		101				
							100	4			
			7	SS	2		99				0 1 58 40
								4			
	Becoming Firm		8	SS	2		98				

Continued Next Page

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

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

ONTMT4S 5182EMBANKMENT.GPJ 29/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-E Ramp 28+900 CL 2 OF 2 METRIC

W.P. 19-1351-82 LOCATION N-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.11.05 - 05.11.05 CHECKED BY SKP

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						
							97				
96.1			9	SS	2						
11.0	END OF BOREHOLE AT 10.97m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-E Ramp 29+074 5R 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.12.05 - 05.12.05 CHECKED BY SKP

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
106.8											
0.0	Silty **CLAY**, trace sand, occasional rootlets Stiff to Very Stiff Brown Moist		1	SS	12				○		
			2	SS	15		106		○		
			3	SS	17		105		○		
	Becoming Stiff occasional iron oxide staining		4	SS	8		104		⊢●⊣		0 7 39 53
			1	TW			103	1.9 +			
101.2							102				
5.6	END OF BOREHOLE AT 5.61m. AUGER REFUSAL AT 5.61m ON PROBABLE BEDROCK. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 1.5m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-E Ramp 29+125 6.1R 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.12.05 - 05.12.05 CHECKED BY SKP

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 ● QUICK TRIAXIAL + FIELD VANE × 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
106.2											
0.0	Silty **CLAY**, trace sand, occasional wood fibres, trace rootlets, organic staining to 0.76m		1	SS	10		106		○		
	Stiff Grey Moist Becoming Very Stiff, Brown		2	SS	16		105		○		
	Becoming Grey		3	SS	16		104		○		
	Becoming Firm		4	SS	4		103		○		
							102	3.4 +			
			5	SS	2		101		○		
100.4								2.8 +			
5.8	END OF BOREHOLE AT 5.79m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 0.9m DEPTH UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05 0.3										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-E Ramp 29+175 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.12.05 - 05.12.05 CHECKED BY SKP

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
106.4											
0.0 / 0.1	TOPSOIL (50mm)										
	Silty CLAY, trace sand, occasional rootlets Stiff Grey to Dark Grey Moist to Wet		1	SS	9		106				
			2	SS	14						0 1 41 58
			3	SS	10		105				
							104	3.3			
	Becoming Firm, Grey		4	SS	6		103				
								4.2			
			5	SS	4		102				
							101	3.8			
			6	SS	2		100				
								4			
98.5			7	SS	2		99				
7.9	END OF BOREHOLE AT 7.92m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 7.3m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-E Ramp 29+225 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.12.05 - 05.12.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
106.8								20 40 60 80 100	20 40 60		
0.0	TOPSOIL (50mm)										
0.1	Silty CLAY, trace sand, occasional rootlets Stiff Brown Moist		1	SS	10				○		
	Becoming Very Stiff, Mottled Brown and Grey		2	SS	15		106		○		
	Becoming Stiff, Brown		3	SS	11		105		○		0 1 47 52
								5.3			
	Becoming Firm		4	SS	5		104		○		
							103	4			
101.6			5	SS	2	▽	102		○		
5.2	END OF BOREHOLE AT 5.18m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 4.9m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-E Ramp 29+275 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.12.05 - 05.12.05 CHECKED BY SKP

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
107.2											
0.0	TOPSOIL (80mm)										
0.1	Silty **CLAY**, trace sand, occasional rootlets Firm Dark Brown to Brown Moist Reworked above 0.76m Becoming Very Stiff		1	SS	6		107	○	○		
			2	SS	17		106		○		
			3	SS	15		105		○		
	Becoming Firm		4	SS	7	▽	104	3.6 +	⊢○⊣		0 3 44 54
102.6							103				
4.6	Silty **CLAY**, some sand, trace gravel Very Stiff Brown Wet (TILL)		5	SS	20				○		
102.2											
5.0	END OF BOREHOLE AT 5.03m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 4.0m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-E Ramp 29+325 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.12.05 - 05.12.05 CHECKED BY SKP

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
107.3											
0.0	**TOPSOIL** (80mm)										
0.1	Silty **CLAY**, trace sand, occasional rootlets Stiff Brown Moist Reworked above 0.76m		1	SS	8		107				
			2	SS	15		106				
			3	SS	10		105	3.2			
			4	SS	9		104	3.3			0 4 51 45
	Becoming Soft		5	SS	4	▽	103				
101.9							102				
5.3	END OF BOREHOLE AT 5.33m. AUGER REFUSAL AT 5.33m ON PROBABLE BEDROCK . BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 4.6m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-E Ramp 29+350 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-E Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.12.05 - 05.12.05 CHECKED BY SKP

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
107.3											
0.0	TOPSOIL (80mm)										
0.1	Silty **CLAY**, trace sand, occasional rootlets Firm Brown Moist Reworked above 0.76m Becoming Stiff		1	SS	7		107				
			2	SS	14		106				
			3	SS	10		105	+3.3			
	Becoming Very Stiff		4	SS	15		104				0 2 46 52
102.5			5	SS	50/		103				
4.7	END OF BOREHOLE AT 4.72m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05 0.9				.000						

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-N/S Ramp 29+085CL1 OF 2 METRIC

W.P. 19-1351-82 LOCATION W-N/S Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.11.05 - 05.11.05 CHECKED BY SKP

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
107.1											
0.0 / 0.1	TOPSOIL (50mm)										
	Silty CLAY, trace sand, occasional rootlets Firm Brown Moist to Wet Becoming Stiff		1	SS	7		107				
			2	SS	13		106				0 0 30 70
			3	SS	13		105				
			4	SS	7		104				
			5	SS	2		103	3.5			0 2 49 49
			6	SS	2	▽	102	4			
	Becoming Firm		7	SS	2		101				
			8	SS	2		100	4.4			
							99				
							98				

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

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+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-N/S Ramp 29+085CL2 OF 2 METRIC

W.P. 19-1351-82 LOCATION W-N/S Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.11.05 - 05.11.05 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100; ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	w_P w w_L; 20 40 60	γ kN/m^3	GR SA SI CL
							97	4 (+)			
			9	SS	2				○		
							96	3.7 (+)			
			10	SS	2		95		○		
93.7							94				
13.4	END OF BOREHOLE AT 13.41m. AUGER REFUSAL AT 13.41m ON PROBABLE BEDROCK. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 6.1m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-N/S Ramp 29+125CL1 OF 2 METRIC

W.P. 19-1351-82 LOCATION W-N/S Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.11.05 - 05.11.05 CHECKED BY SKP

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
107.1											
0.0	TOPSOIL (80mm)										
0.1	Silty CLAY, trace sand, occasional rootlets Stiff to Very Stiff Brown Moist to Wet		1	SS	8		107				
			2	SS	17		106				0 1 32 67
			3	SS	12		105				
			4	SS	6		104				
							103	3.7			
	Becoming Firm		1	TW			102				0 5 45 50
								3.4			
			5	SS	4		101				
							100	4.4			
			6	SS	4		99				
			7	SS	2	▽	98				0 5 55 40

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-N/S Ramp 29+125CL2 OF 2 METRIC

W.P. 19-1351-82 LOCATION W-N/S Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 05.11.05 - 05.11.05 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100; ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	w_P w w_L; 20 40 60	γ kN/m^3	GR SA SI CL
							97	2.8 +			
96.1			8	SS	2				○		
11.0	END OF BOREHOLE AT 10.97m. AUGER REFUSAL AT 10.97m ON PROBABLE BEDROCK. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. WATER LEVEL IN OPEN BOREHOLE AT 9.4m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-N/S Ramp 29+165CL1 OF 2 METRIC

W.P. 19-1351-82 LOCATION W-N/S Ramp ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 20.05.05 - 20.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (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
107.7											
0.0	**SAND**, trace gravel Brown Moist (FILL)										
107.1											
0.7	Silty **CLAY**, occasional sand seams Stiff to Soft Brown		1	SS	9		107				
			2	SS	13		106				
			3	SS	8		105				
			4	SS	4		104				0 1 45 55
			5	SS	0		103				
	becoming Grey		6	SS	WH	▽	102				
			7	SS	WH		101	5.0			
			8	SS	WH		100				0 4 55 42
							99				
							98				

Continued Next Page

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No W-N/S Ramp 29+165CL2 OF 2 METRIC

W.P. 19-1351-82 LOCATION W-N/S Ramp ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 20.05.05 - 20.05.05 CHECKED BY SKP

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						
								5.6 +			
			9	SS	15		97		○		
96.5											
11.3	END OF BOREHOLE AT 11.25 m. BOREHOLE OPEN TO 10.37 m. WATER LEVEL AT 6.55 m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG.										

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-W Ramp 29+020 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION N-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 17.05.05 - 17.05.05 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L 20 40 60	γ kN/m^3	GR SA SI CL
106.1											
0.0	TOPSOIL (80mm)										
0.1	Silty CLAY, occasional sand lenses Stiff to Firm Brown		1	SS	4		106				
			2	SS	12		105				
			3	SS	11						0 0 35 65
							104	3.6			
			4	SS	4		103				
	becoming Grey							4.4			
			1	TW	PH		102				
							101	3.2			
	Soft		5	SS	2	▽	100				
99.4											
6.7	END OF BOREHOLE AT 6.71 m. AUGER REFUSAL AT 6.71 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 6.71 m. WATER LEVEL AT 6.10 m UPON COMPLETION OF DRILLING. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-W Ramp 29+070 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION N-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 17.05.05 - 17.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
107.0								20 40 60 80 100	20 40 60		
0.0	TOPSOIL (50mm)						107				
0.1	Silty CLAY, occasional sand seams, trace sand Very Stiff to Firm Brown		1	SS	3				○		
			2	SS	15		106		○		
			3	SS	14		105		○		
			4	SS	4		104		⊖		0 4 40 56
	becoming Grey		5	SS		▽	103	3.5	○		
101.2							102	5.1			
5.8	END OF BOREHOLE AT 5.79 m. AUGER REFUSAL AT 5.79 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 5.79 m AND WATER LEVEL AT 4.88 m UPON COMPLETION. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05 1.3										

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-W Ramp 29+120 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION N-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 17.05.05 - 17.05.05 CHECKED BY SKP

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
105.9											
0.0 / 0.0	**TOPSOIL** (25mm)										
	Silty **CLAY**, trace sand, occasional iron oxide staining Firm to Very Stiff Brown		1	SS	7						
			2	SS	15		105				
			3	SS	50/ .150	▽					
103.9							104				
2.0	END OF BOREHOLE AT 1.98 m. AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE OPEN TO 1.98 m AND WATER LEVEL AT 1.68 m UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-W Ramp 29+170 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION N-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 16.05.05 - 16.05.05 CHECKED BY SKP

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						
107.2											
0.0	TOPSOIL (80mm)										
0.1	Silty CLAY, trace sand Stiff to Very Stiff Brown		1	SS	8		107				
			2	SS	15		106				
105.8											
1.4	END OF BOREHOLE AT 1.37 m. AUGER REFUSAL AT 1.37 m. BOREHOLE OPEN TO 1.37 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-W Ramp 29+220 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION N-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 16.05.05 - 16.05.05 CHECKED BY SKP

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
107.3											
0.0	**TOPSOIL** (100 mm)										
0.1	Silty **CLAY**, trace sand Very Stiff to Stiff Brown		1	SS	6		107		○		
			2	SS	18		106		○		
			3	SS	14				○		0 2 40 59
			4	SS	10		105		○		
			5	SS	9		104	3.1	○		
102.2							103				
5.2	END OF BOREHOLE AT 5.18 m. AUGER REFUSAL AT 5.18 m. BOREHOLE OPEN TO 5.18 m AND DRY UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No N-W Ramp 29+240 2.0RT OF 1 METRIC

W.P. 19-1351-82 LOCATION N-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 16.05.05 - 16.05.05 CHECKED BY SKP

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
107.3											
0.0	TOPSOIL (80mm)										
0.1	Silty CLAY, trace sand Very Stiff to Firm Brown		1	SS	7		107				
			2	SS	18		106				
			3	SS	15		105				
			4	SS	7		104	2.8			0 8 40 52
	Becoming Grey		5	SS	4		103				
101.2						▽	102	3.1			
6.1	Silty CLAY, some sand, trace gravel		6	SS	50/		101				
100.9	Hard Grey				.150						
6.4	END OF BOREHOLE AT 6.40 m. AUGER REFUSAL AT 6.40 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 6.40 m AND WATER LEVEL AT 5.79 m UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

+ 3, × 3: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-W Ramp 29+390 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 13.05.05 - 13.05.05 CHECKED BY SKP

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
107.2											
0.0	TOPSOIL (100mm)										
0.1	Silty CLAY, trace sand, occasional rootlets Soft Brown Moist Reworked above 1.91m Becoming Stiff		1	SS	4		107				
			2	SS	12		106				0 8 41 51
			3	SS	8		105				
104.8											
2.4	END OF BOREHOLE AT 2.44m. AUGER REFUSAL AT 2.44m ON PROBABLE BEDROCK . BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-W Ramp 29+430 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 13.05.05 - 13.05.05 CHECKED BY SKP

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
107.3											
0.0	**TOPSOIL** (180mm)										
0.2	Silty **CLAY**, trace sand, occasional rootlets Stiff to Very Stiff Brown Moist		1	SS	11		107				
			2	SS	14		106				
			3	SS	16						0 1 52 46
			4	SS	9		105				
	Becoming sandy from 3.96m						104				
102.9							103				
4.4	END OF BOREHOLE AT 4.42m. BOREHOLE OPEN TO 4.42m. BOREHOLE GROUTED TO SURFACE WITH BENTONITE GROUT.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No S-W Ramp 29+475 4L 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION S-W Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 13.05.05 - 13.05.05 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100; ○ UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100	w_P w w_L; 20 40 60	γ kN/m^3	GR SA SI CL
107.5											
0.0	TOPSOIL (100mm)										
0.1	Silty CLAY, trace sand, occasional rootlets Firm Brown Moist Becoming Stiff		1	SS	7		107				
			2	SS	11						
			3	SS	12		106				0 3 45 52
							105	3.4			
	Becoming Sandy, Hard, Wet from 2.97m,		4	SS	64/280						
104.1											
3.5	END OF BOREHOLE AT 3.48m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05 1.3										

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

15 $\oplus$ 5 (20, 10) (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No E-N/S Ramp 29+230 CL1 OF 2 METRIC

W.P. 19-1351-82 LOCATION E-N/S Ramp ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
108.4											
0.0	**SAND and GRAVEL**, trace silt Dense Brown Moist		1	SS	49		108		○		
107.0											
1.4	Silty **CLAY**, occasional topsoil staining Stiff Dark Brown		2	SS	10		107		○		
106.2											
2.2	Silty **CLAY**, some sand seams Stiff to Soft Brown		3	SS	11		106		○		
			4	SS	8		105		○		
			5	SS	4		104		○		
	Becoming Grey		1	TW	PH		103				
							102	7.7 +			
			6	SS	0		101		○		
99.6							100	4.4 +			
8.8	Silty **CLAY**, some sand seams, trace gravel Grey		7	SS	50/ .075						
99.1											
9.4	END OF BOREHOLE AT 9.37 m. BOREHOLE OPEN TO 8.38 m AND WATER LEVEL AT 4.39 m. BOREHOLE GROUTED TO										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No E-N/S Ramp 29+230 CL2 OF 2 METRIC

W.P. 19-1351-82 LOCATION E-N/S Ramp ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 18.05.05 CHECKED BY SKP

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
	SURFACE.										

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

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

ONTM4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No E-N/S Ramp 29+280 CL1 OF 1 METRIC

W.P. 19-1351-82 LOCATION E-N/S Ramp ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 13.05.05 - 13.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
106.9								20 40 60 80 100	20 40 60		
0.0	TOPSOIL (50mm)										
0.1	Silty CLAY, trace sand, occasional rootlets Firm Brown Moist Becoming Stiff		1	SS	6				○		
			2	SS	14		106		○		
			3	SS	9		105	2.9	○		
	Becoming Very Stiff		4	SS	16		104		⊢○⊣		0 2 48 50
	Becoming Firm, Grey, Wet		5	SS	6		103 102	4	○		
101.1											
5.8	END OF BOREHOLE AT 5.79m. BOREHOLE OPEN TO 5.79m. WATER LEVEL IN OPEN BOREHOLE AT 4.3m DEPTH UPON COMPLETION. BOREHOLE GROUTED TO SURFACE WITH BENTONITE GROUT.										

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

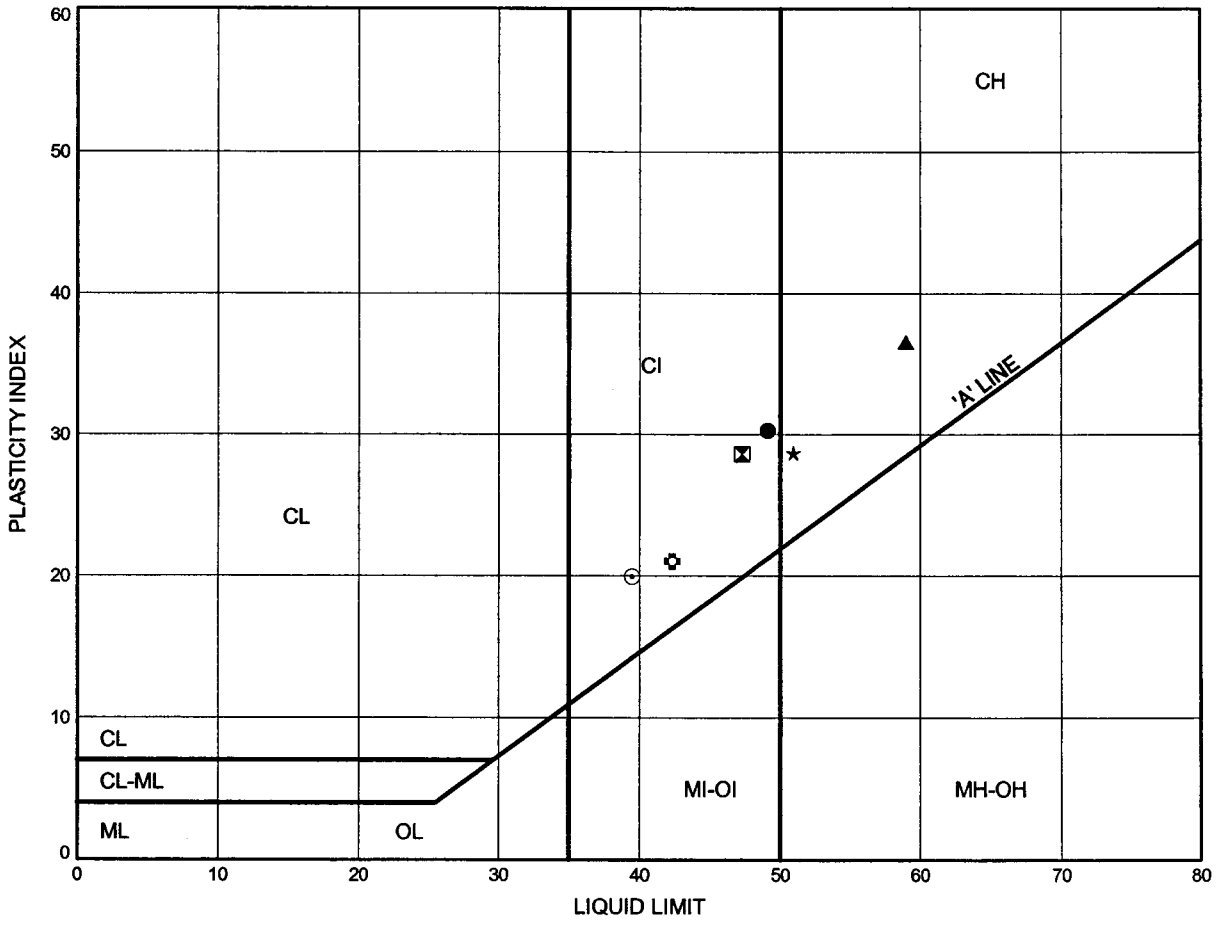
ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A1

SILTY CLAY (CRUST)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	E-N/S Ramp 29+280 CL	3.35	103.50
⊠	N-E Ramp 28+800 CL	3.35	103.73
▲	N-E Ramp 28+850 CL	1.07	106.13
★	NW Ramp 29+020 CL	1.83	104.26
⊙	NW Ramp 29+070 CL	3.35	103.65
✿	NW Ramp 29+120 CL	1.07	104.78

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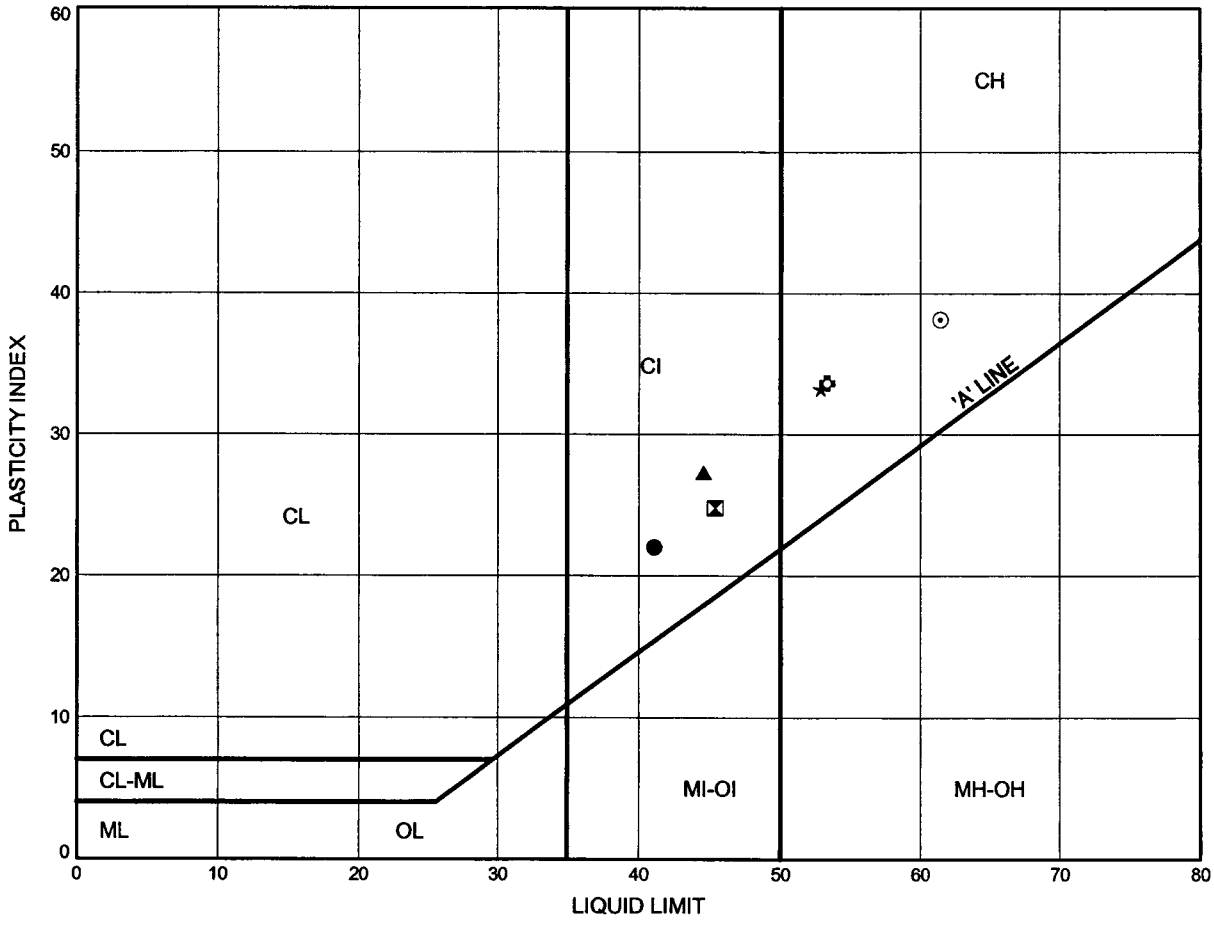
THURBALT 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A2

SILTY CLAY (CRUST)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	N-W Ramp 29+170 CL	1.07	106.10
⊠	N-W Ramp 29+220 CL	1.83	105.52
▲	N-W Ramp 29+240 2.0RT	3.35	103.91
★	S-E Ramp 29+074 5R	3.35	103.43
⊙	S-E Ramp 29+175 CL	1.07	105.37
✿	S-E Ramp 29+225 CL	1.83	105.00

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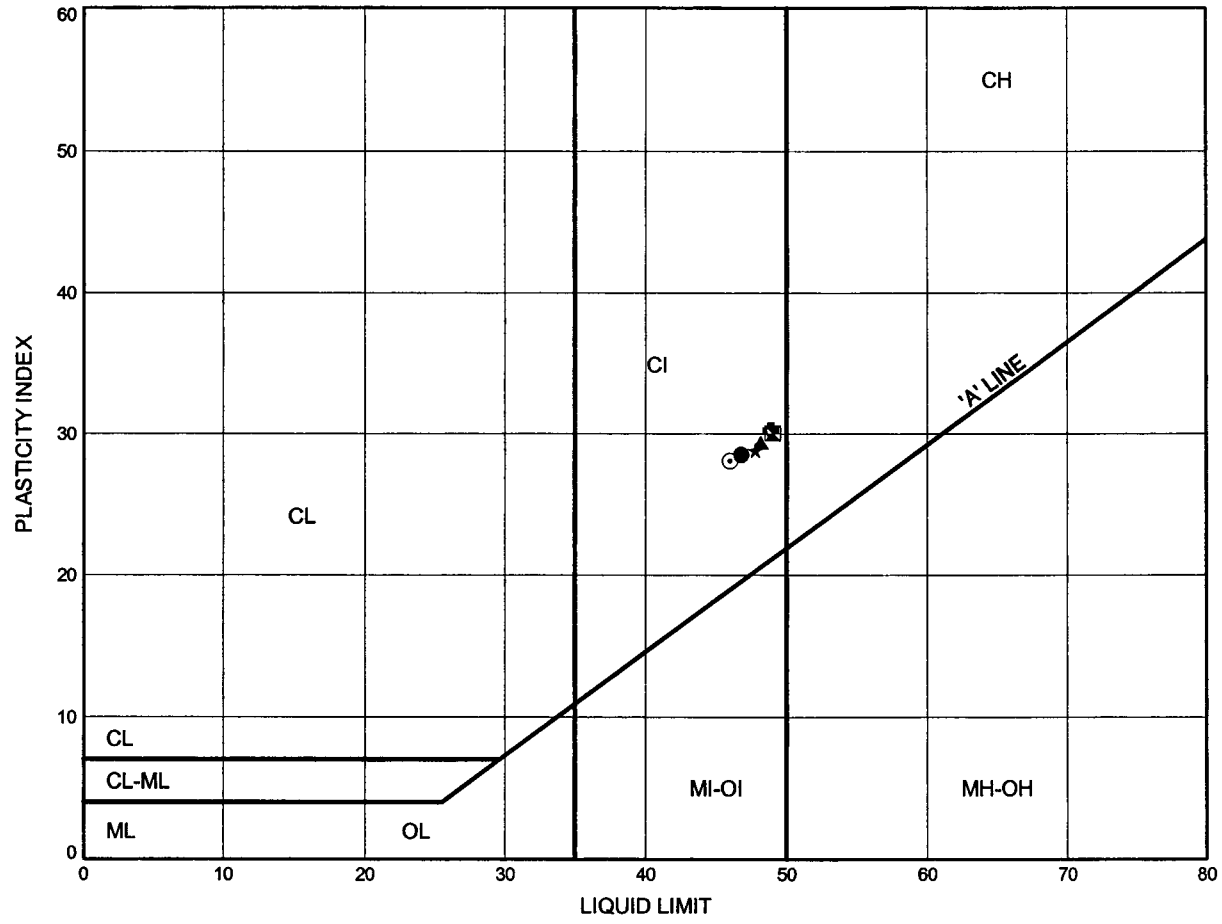
HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A3

SILTY CLAY (CRUST)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S-E Ramp 29+275 CL	3.35	103.84
⊠	S-E Ramp 29+325 CL	3.35	103.92
▲	S-E Ramp 29+350 CL	3.35	103.92
★	SW Ramp 29+390 CL	1.07	106.18
⊙	SW Ramp 29+430 CL	1.83	105.49
✿	SW Ramp 29+475 4L	1.83	105.72

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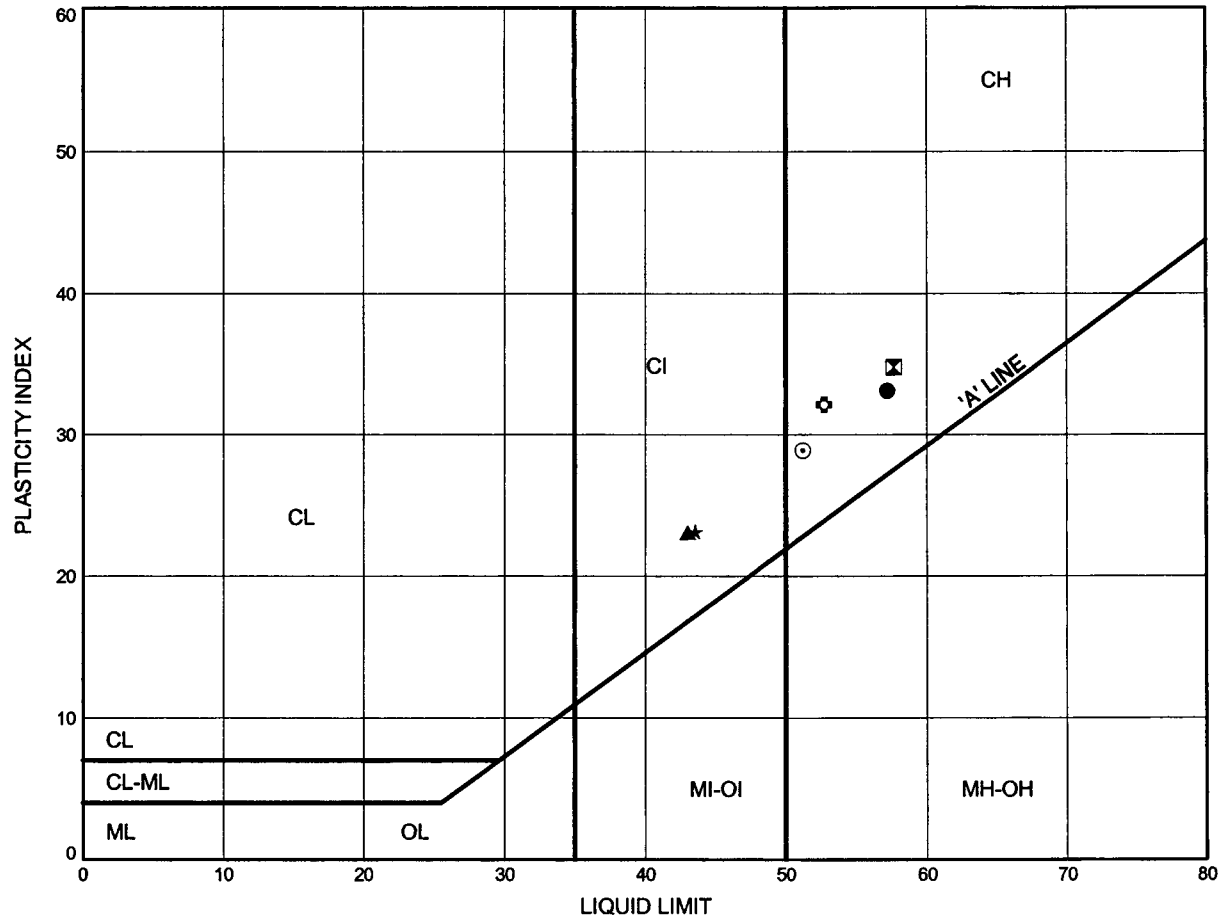
HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A4

SILTY CLAY (CRUST)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	WLR 05-1	1.07	107.28
⊠	WLR 05-1	1.83	106.52
▲	WLR 05-1	3.58	104.76
★	WLR 05-1	5.11	103.24
⊙	WLR 10+100 RT	2.59	105.12
✿	WLR 10+150 2 m LT	3.35	104.43

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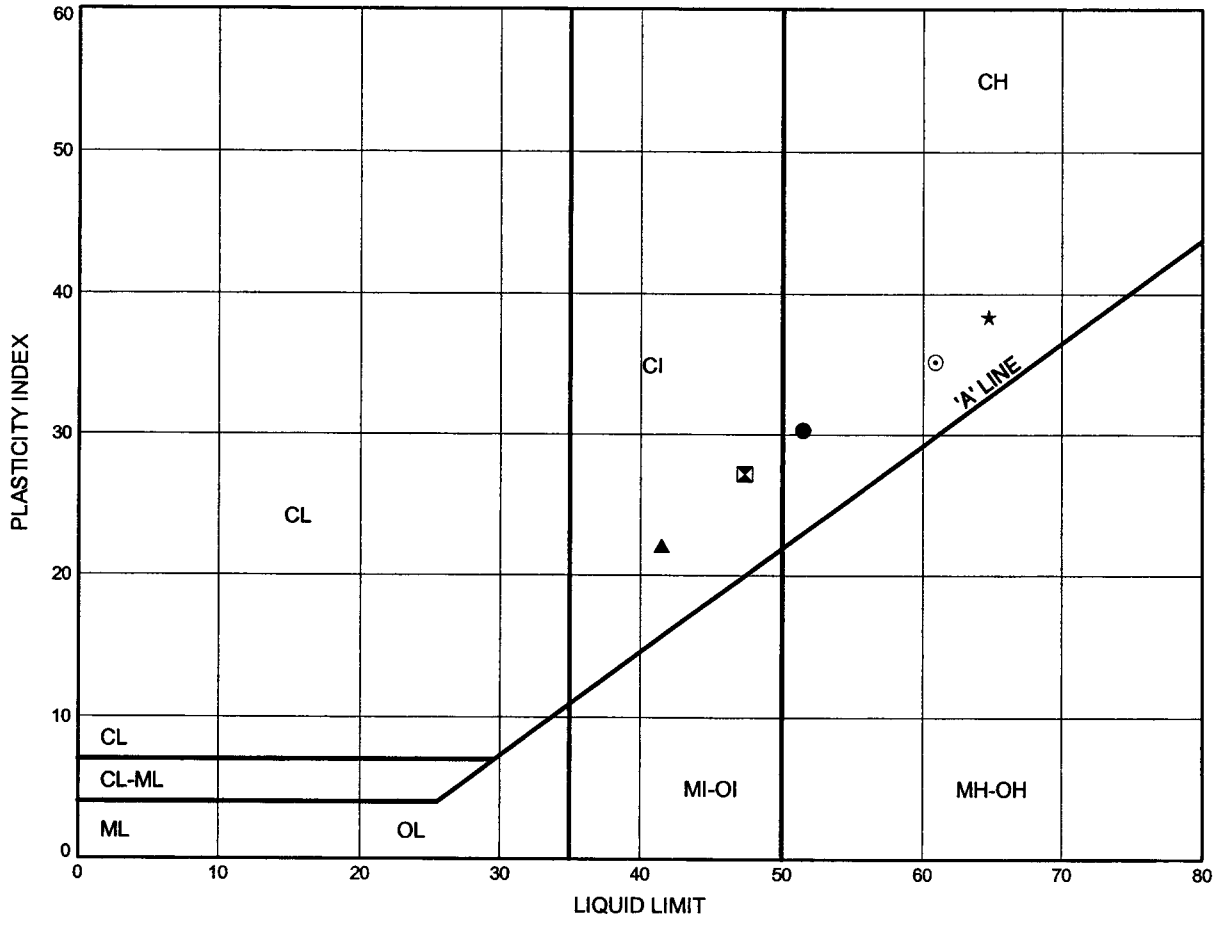
HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A5

SILTY CLAY (CRUST)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	WLR 10+200 RT	2.59	105.21
⊠	WLR 9+825 RT	3.35	105.09
▲	WLR 9+950 RT	2.59	104.82
★	W-N/S Ramp 29+085CL	1.07	106.07
⊙	W-N/S Ramp 29+125CL	1.07	106.05

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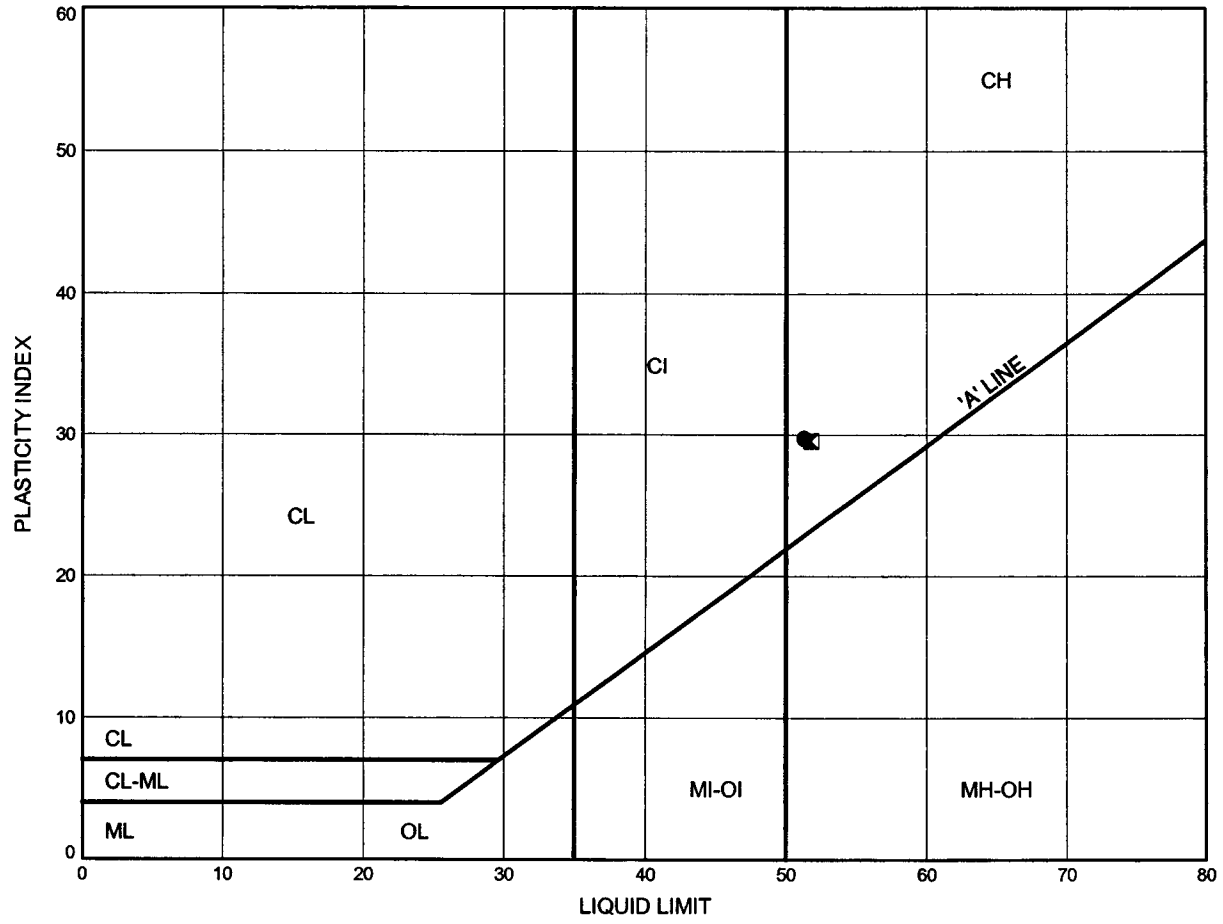
HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A6

SILTY CLAY (CRUST)



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	W-N/S Ramp 29+125	CL 3.35	103.77
⊠	W-N/S Ramp 29+165	CL 3.35	104.39

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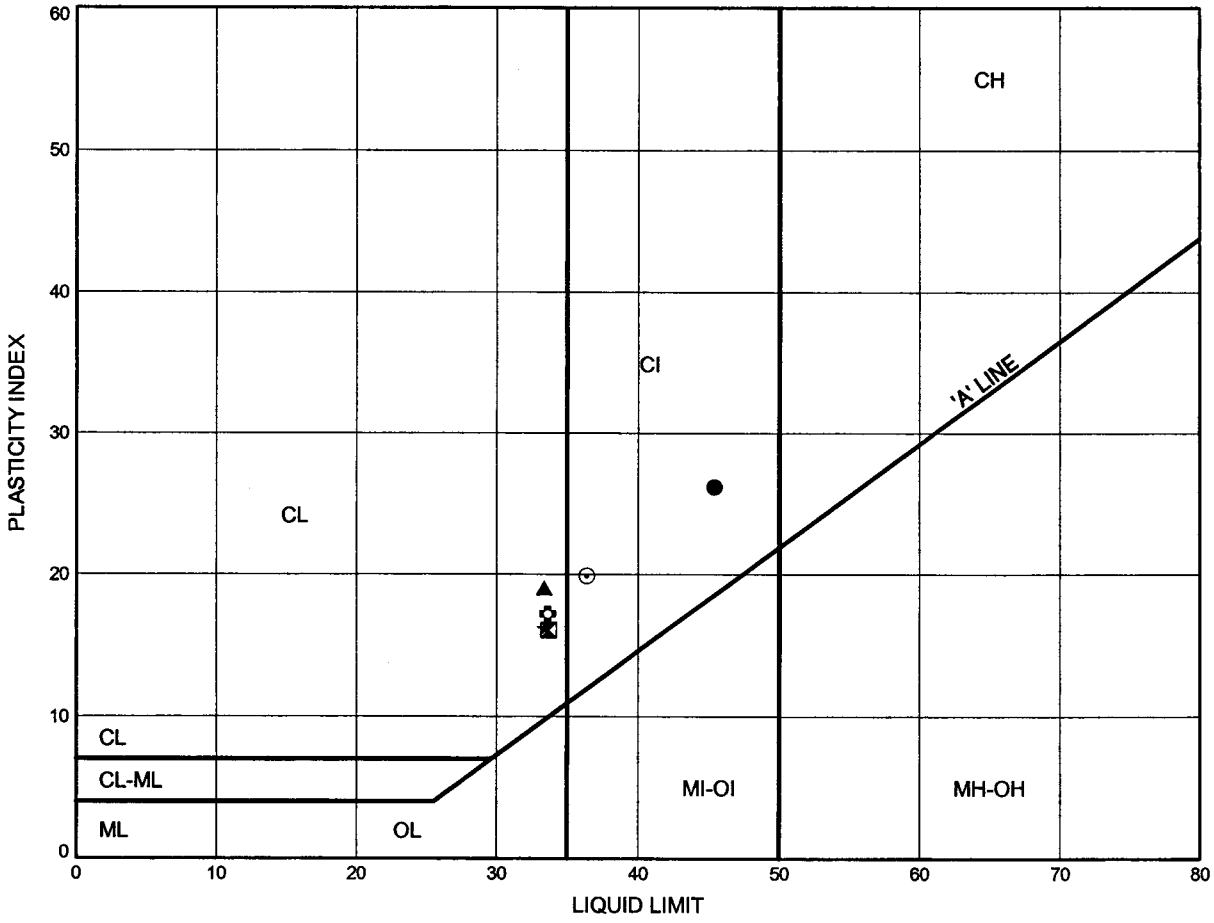
HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A7

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	N-E Ramp 28+850 CL	4.88	102.32
⊠	N-E Ramp 28+900 CL	7.92	99.13
▲	S-E Ramp 29+175 CL	4.88	101.56
★	WLR 05-1	6.55	101.79
⊙	WLR 10+100 RT	4.88	102.83
✿	WLR 10+150 2 m LT	7.77	100.01

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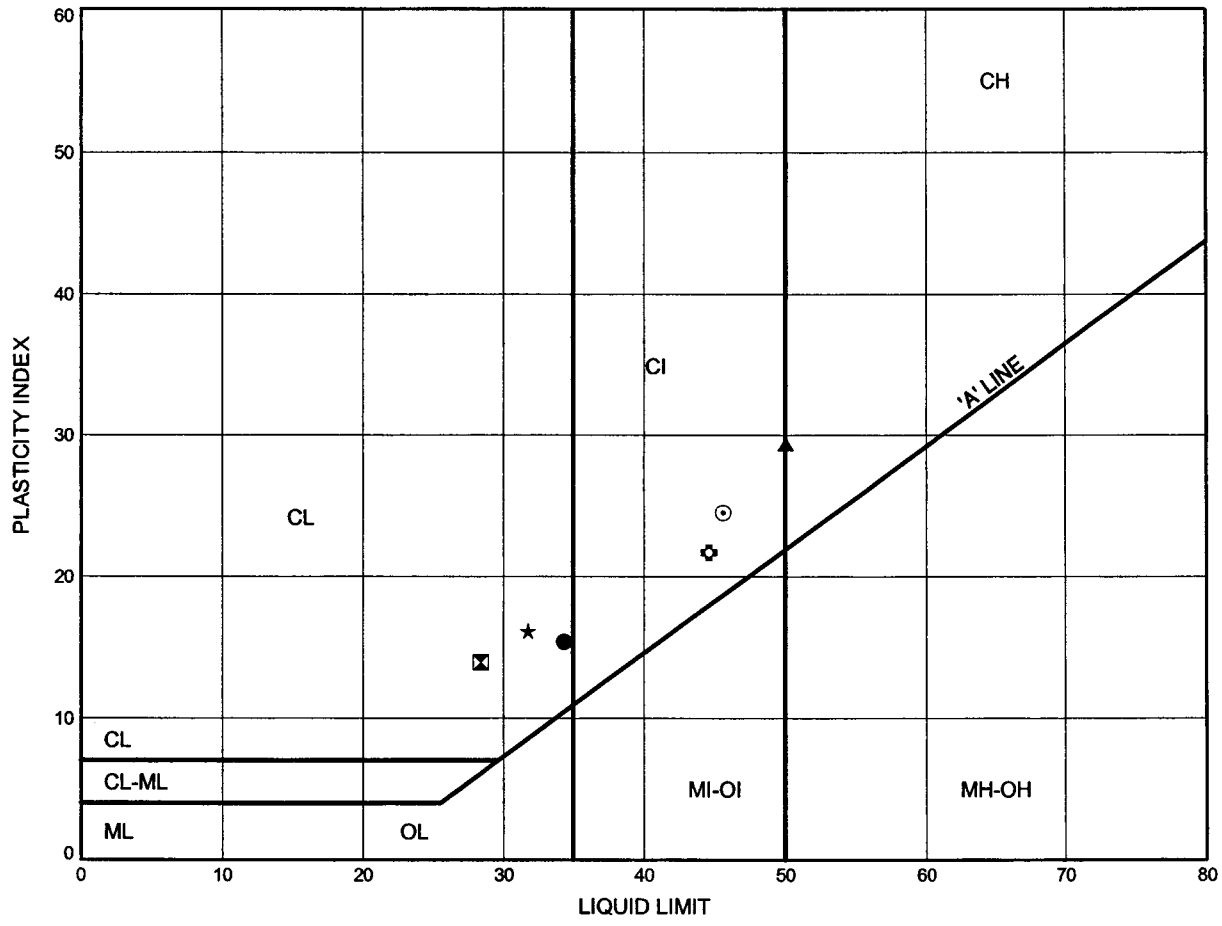
HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A8

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	WLR 10+200 RT	12.50	95.30
⊠	WLR 9+825 RT	7.92	100.52
▲	W-N/S Ramp 29+085CL	4.88	102.26
★	W-N/S Ramp 29+085CL	9.45	97.69
⊙	W-N/S Ramp 29+125CL	5.06	102.06
✿	W-N/S Ramp 29+125CL	6.40	100.72

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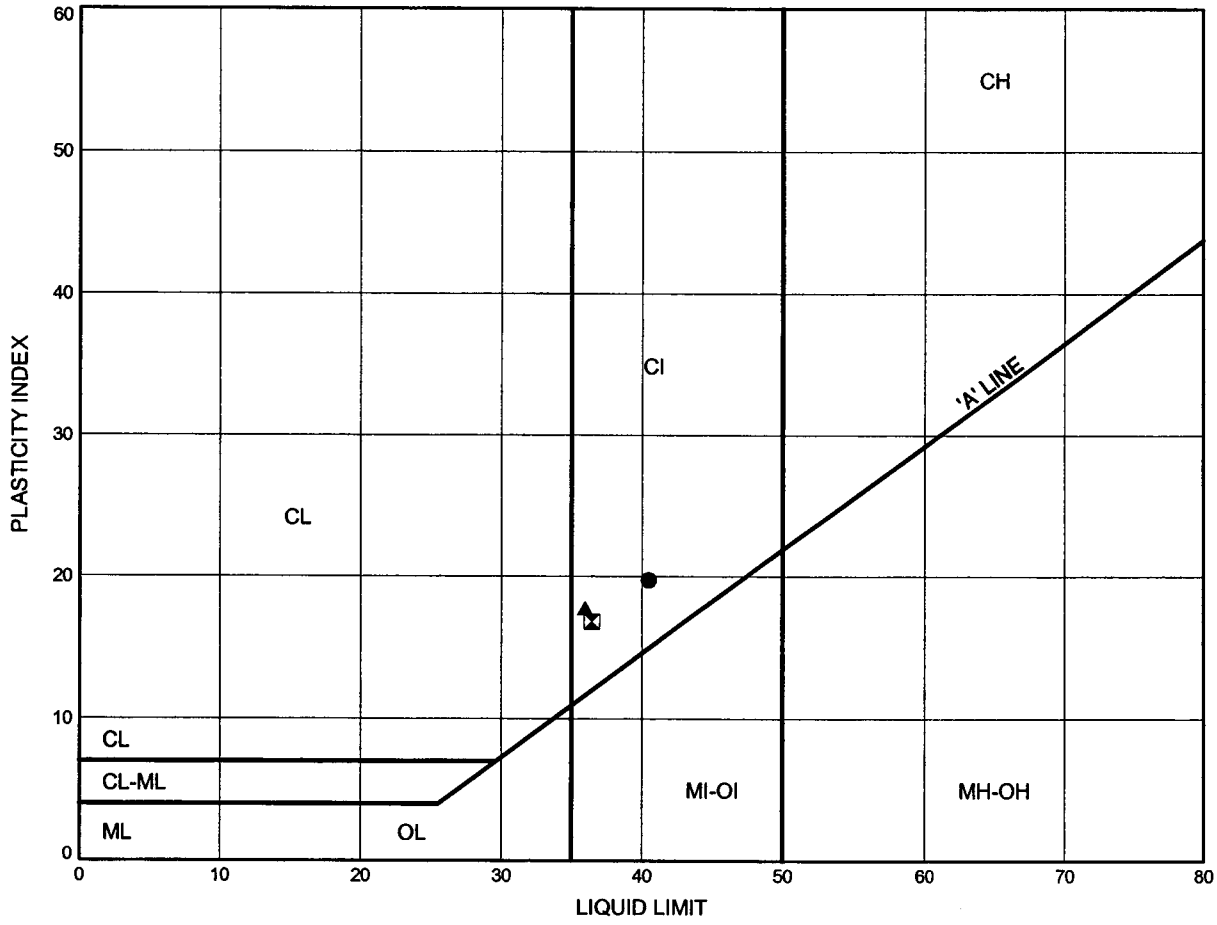
HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE A9

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	W-N/S Ramp 29+125CL	7.92	99.20
⊠	W-N/S Ramp 29+125CL	9.45	97.67
▲	W-N/S Ramp 29+165CL	9.45	98.29

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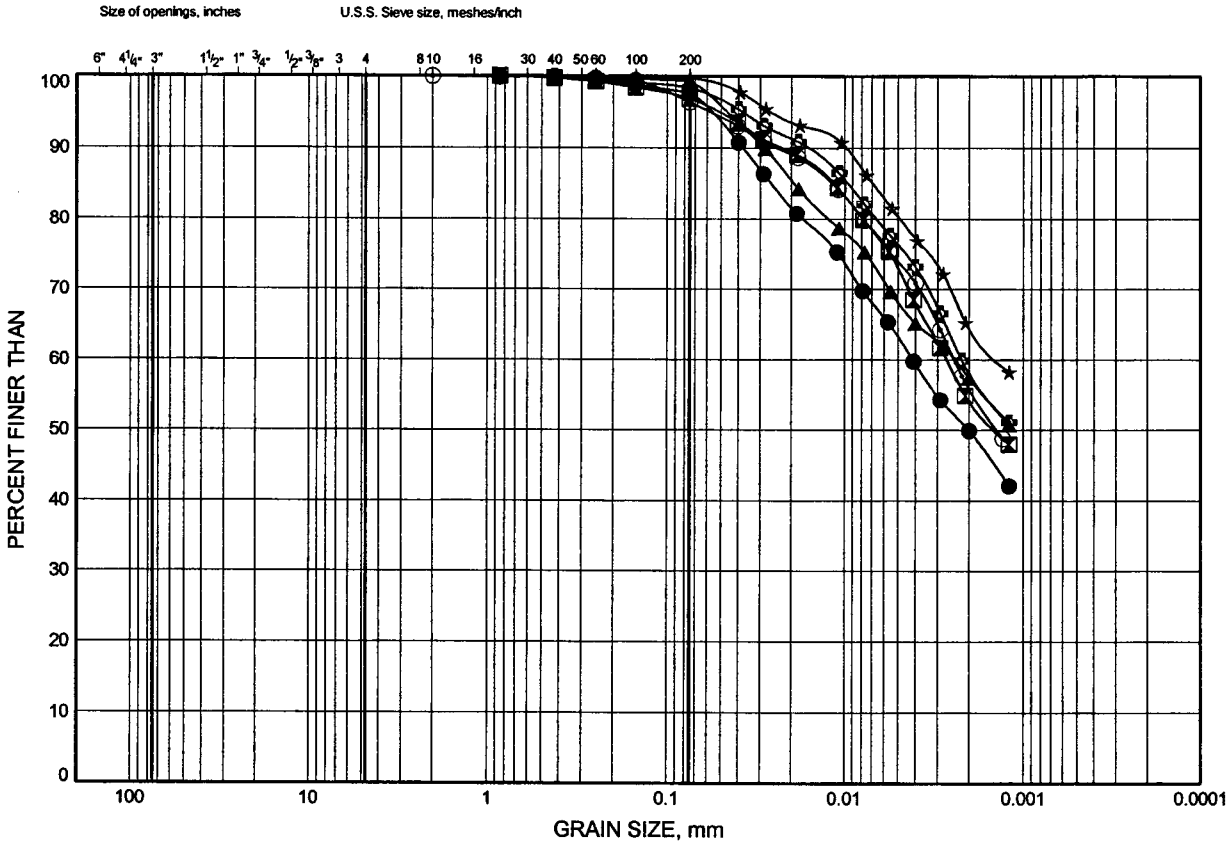
HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE A10

SILTY CLAY (CRUST)



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	E-N/S Ramp 29+280 CL	3.35	103.50
⊠	N-E Ramp 28+800 CL	3.35	103.73
▲	N-E Ramp 28+850 CL	1.07	106.13
★	NW Ramp 29+020 CL	1.83	104.26
⊙	NW Ramp 29+070 CL	3.35	103.65
✿	NW Ramp 29+220 CL	1.83	105.52

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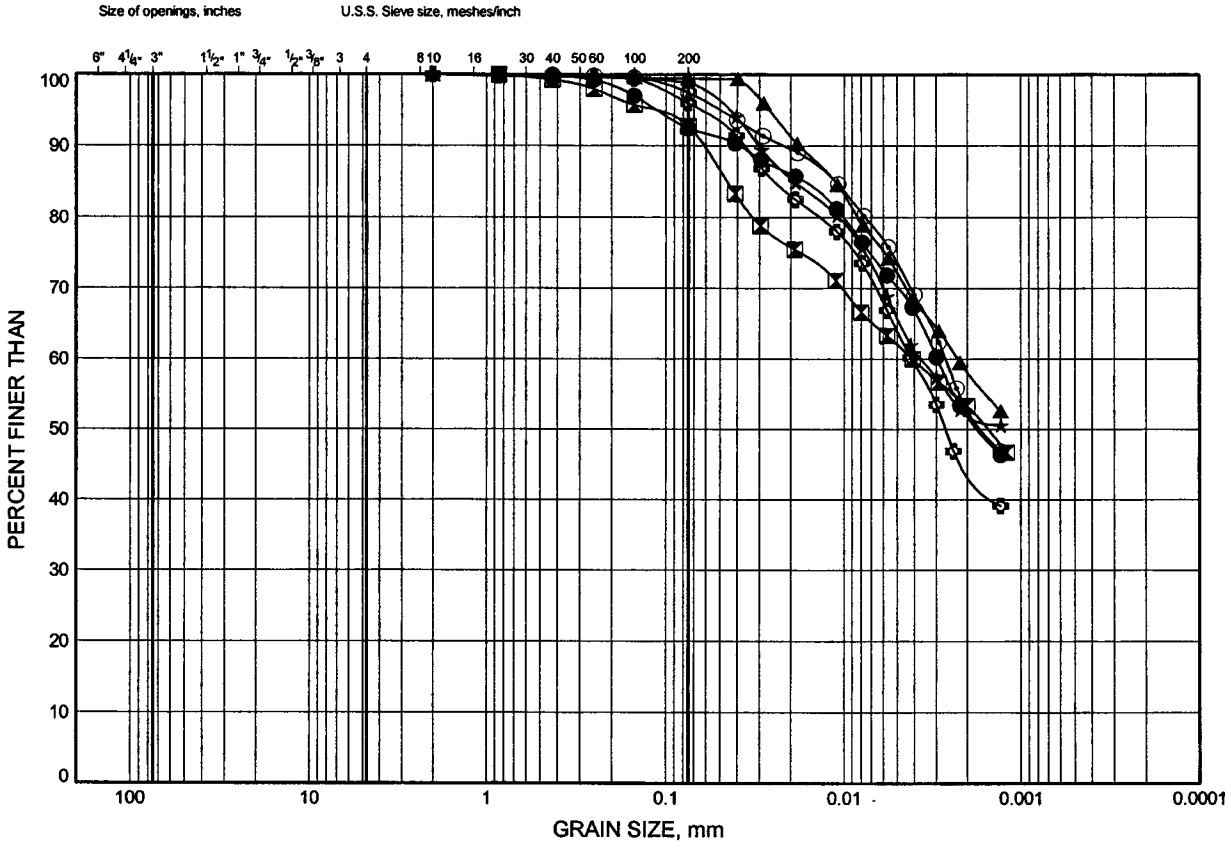
HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE A11

SILTY CLAY (CRUST)



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	NW Ramp 29+240 2.0RT	3.35	103.91
⊠	S-E Ramp 29+074 5R	3.35	103.43
▲	S-E Ramp 29+175 CL	1.07	105.37
★	S-E Ramp 29+225 CL	1.83	105.00
⊙	S-E Ramp 29+275 CL	3.35	103.84
✿	S-E Ramp 29+325 CL	3.35	103.92

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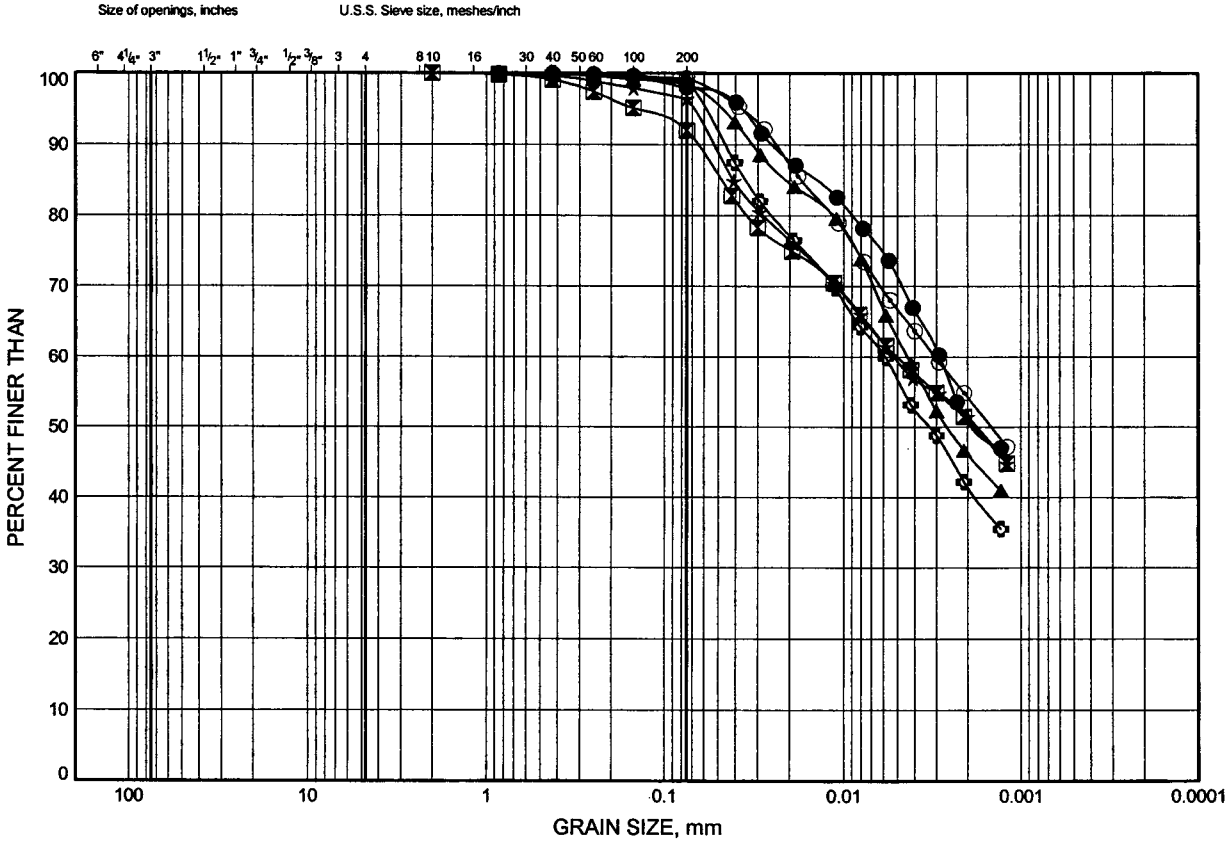
HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE A12

SILTY CLAY (CRUST)



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	S-E Ramp 29+350 CL	3.35	103.92
⊠	SW Ramp 29+390 CL	1.07	106.18
▲	SW Ramp 29+430 CL	1.83	105.49
★	SW Ramp 29+475 4L	1.83	105.72
⊙	WLR 05-1	1.83	106.52
✿	WLR 05-1	3.58	104.76

Date June 2005

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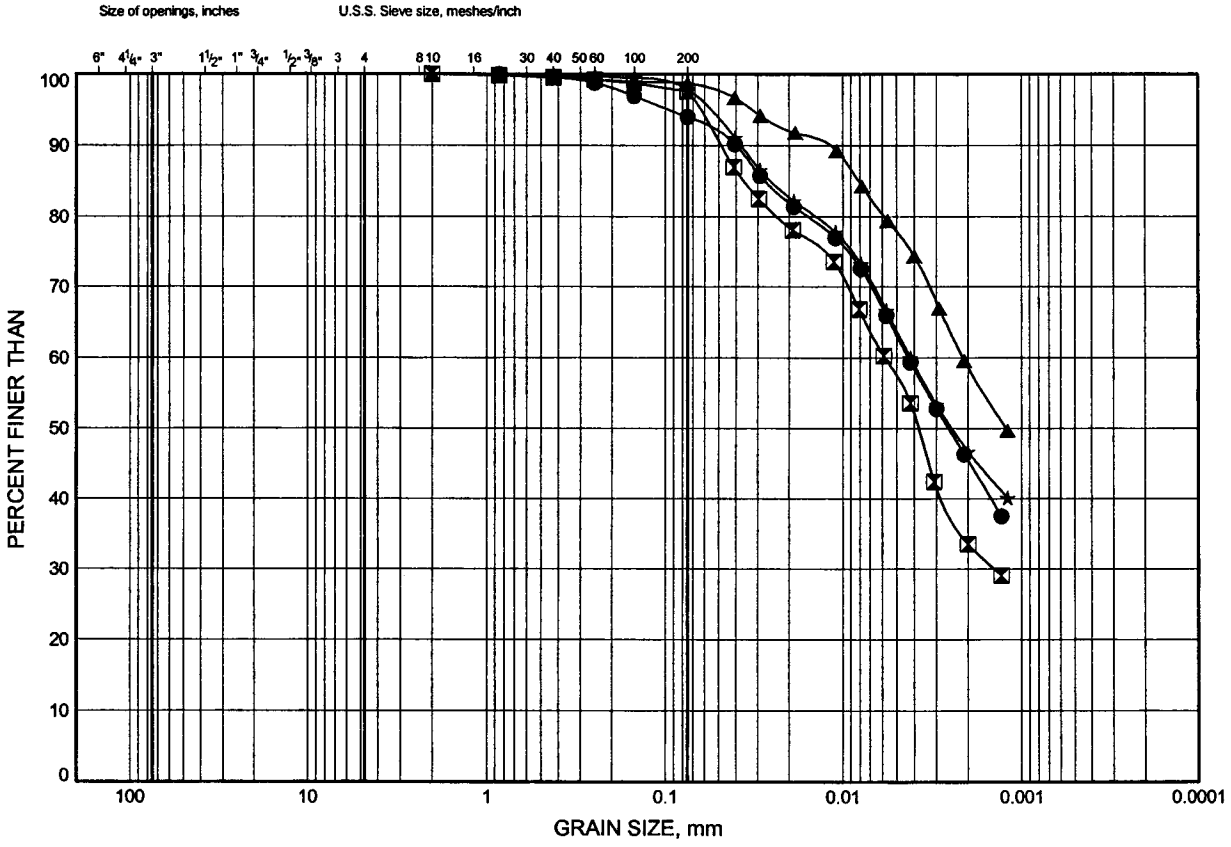
THURBGSD 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE A13

SILTY CLAY (CRUST)



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	WLR 05-1	5.11	103.24
⊠	WLR 10+150 2 m LT	3.35	104.43
▲	WLR 10+200 RT	2.59	105.21
★	WLR 9+950 RT	2.59	104.82

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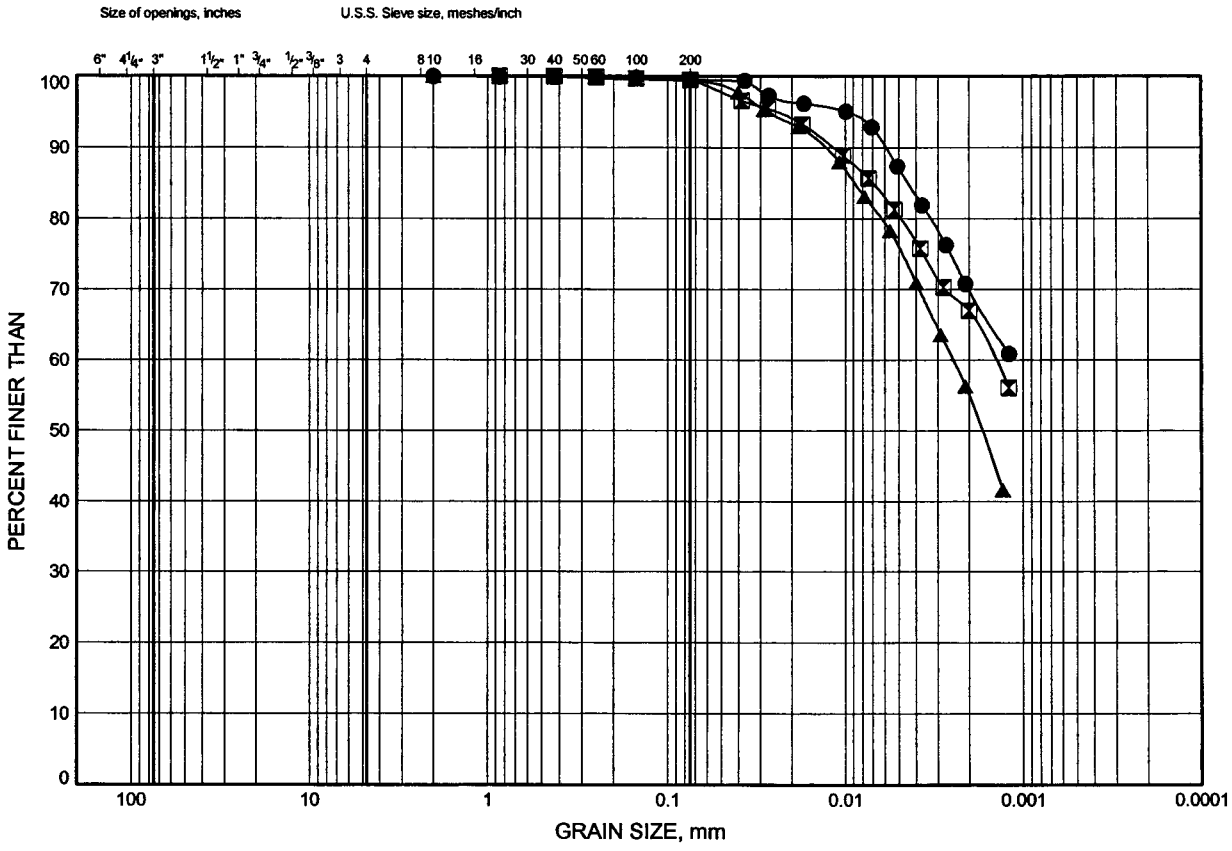
HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE A14

SILTY CLAY (CRUST)



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	W-N/S Ramp 29+085CL	1.07	106.07
⊠	W-N/S Ramp 29+125CL	1.07	106.05
▲	W-N/S Ramp 29+165CL	3.35	104.39

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

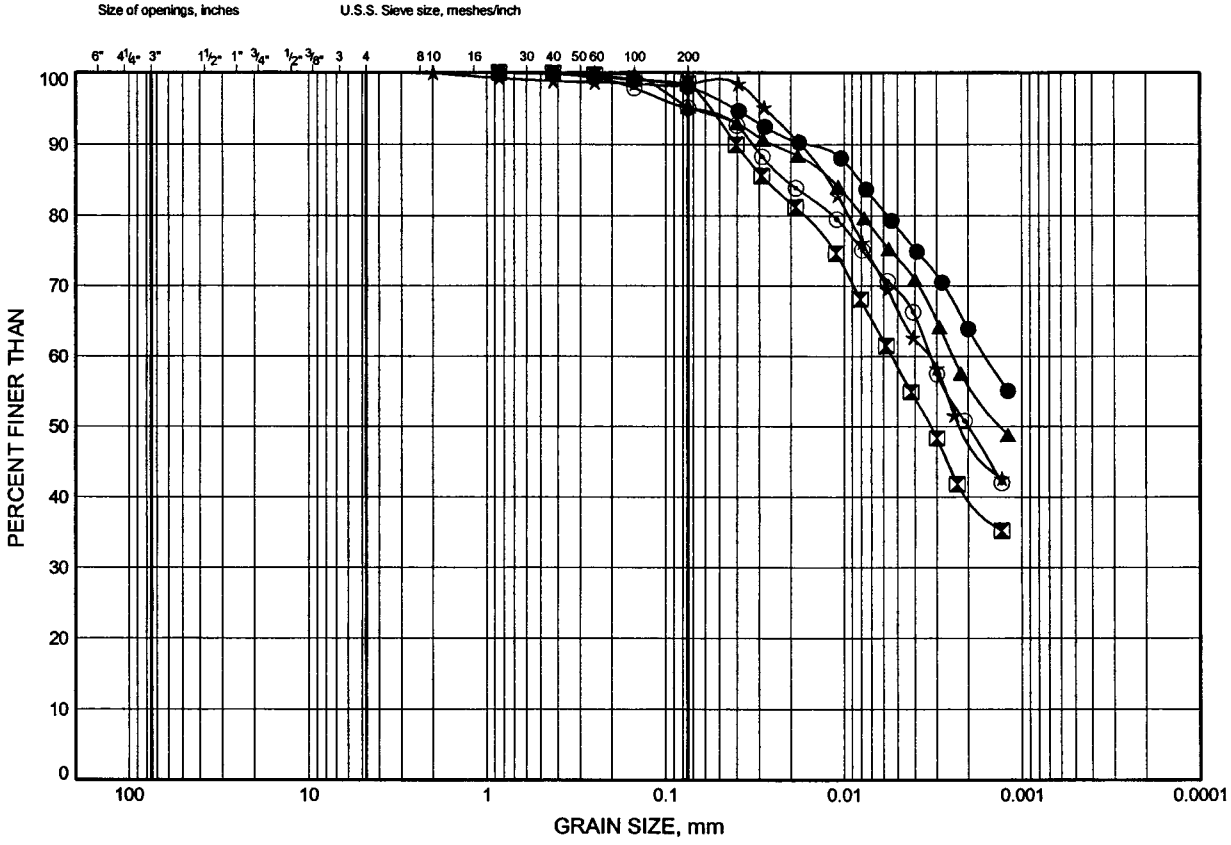
THURBGSD 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE A15

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	N-E Ramp 28+850 CL	4.88	102.32
⊠	N-E Ramp 28+900 CL	7.92	99.13
▲	WLR 05-1	6.40	101.95
★	W-N/S Ramp 29+085CL	4.88	102.26
⊙	W-N/S Ramp 29+125CL	5.06	102.06

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

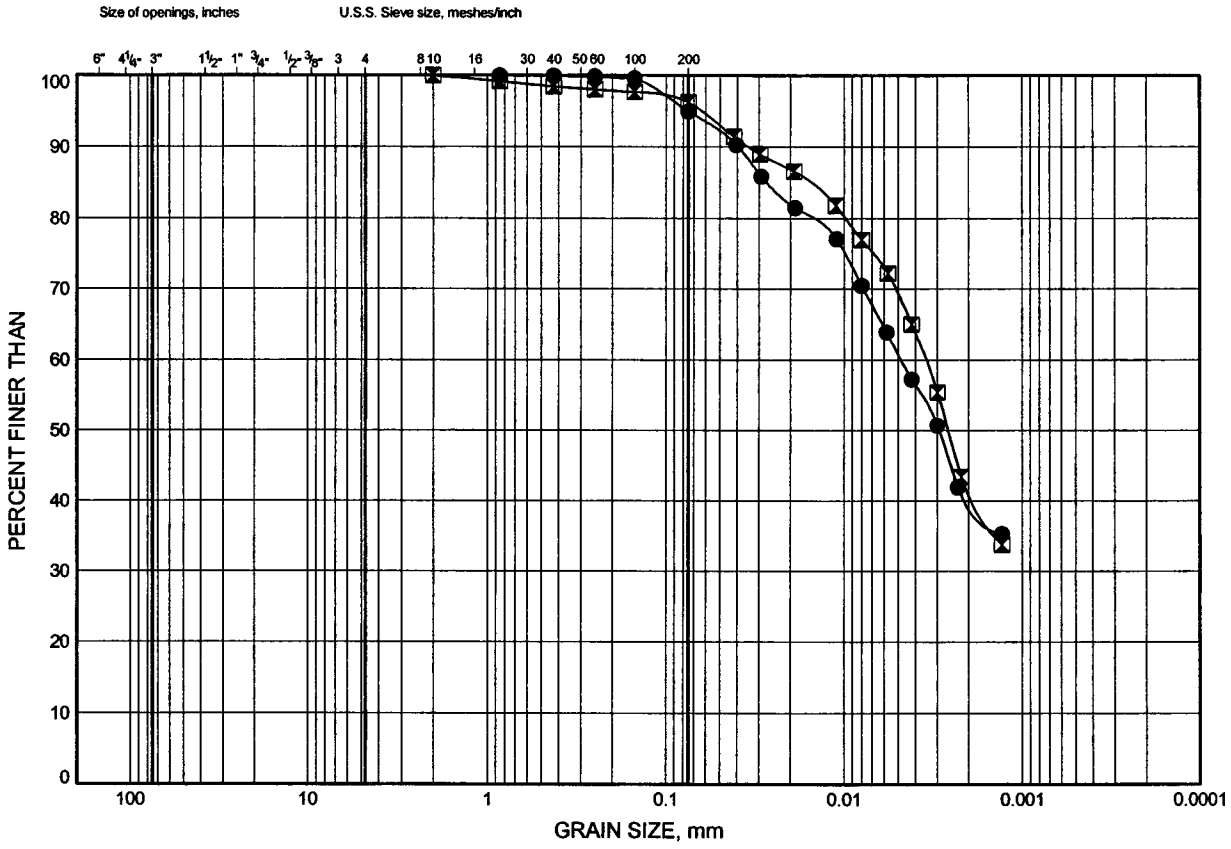
THURBGSD 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE A16

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	W-N/S Ramp 29+125CL	9.45	97.67
⊠	W-N/S Ramp 29+165CL	9.45	98.29

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

THURBGSD 5182EMBANKMENT.GPJ 24/06/05

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

Consolidation Test Report

CLIENT: **McCormick Rankin Corporation** FILE NUMBER: 19-1351-82

PROJECT: Highway 17-417, Arnprior (White Lake Road) REPORT DATE: 23-Jun-05

TEST DATES: May 16, 2005 - May 31, 2005

SAMPLE: WLR05-1, ST3, 21'-22'
Silty Clay, trace sand, grey, uniform, plastic, (CL-CI)

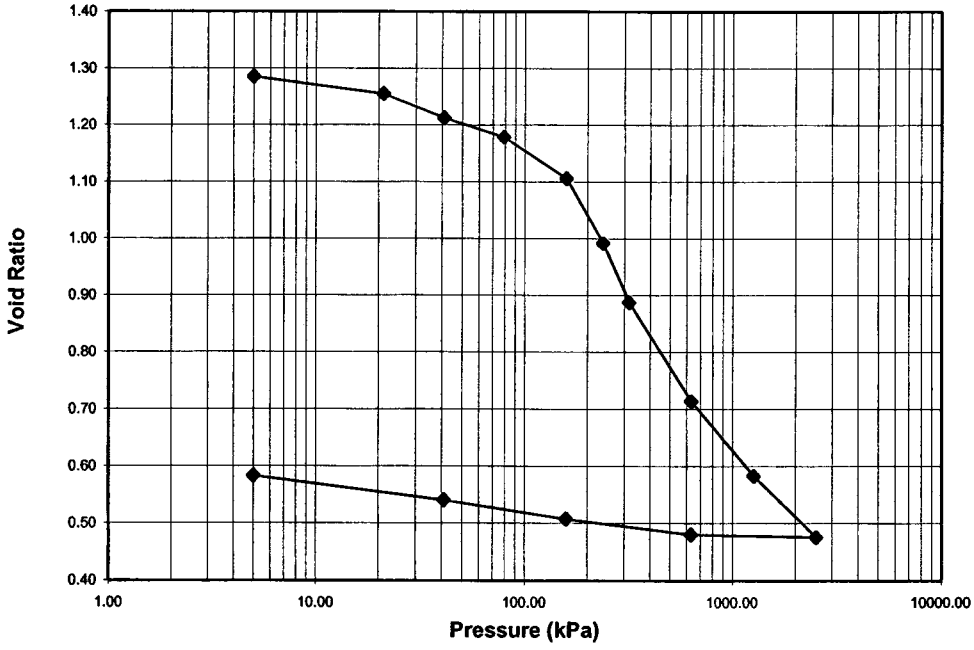
PROCEDURE: Tested in accordance with Standard Test Method for One-Dimensional Consolidation Properties of Soils, ASTM D 2435-04, method B

	Start of Test	End of Test
Wet Dens. (kg/m^3)	1804.7	2249.8
Dry Dens. (kg/m^3)	1194.1	1736.5
Moisture Cont. (%)	47.3	25.8
Void Ratio	1.303	0.584
Saturation(%)	99.8	

Note: A Specific Gravity of 2.75 was measured for the void ratio and saturation calculations

Void Ratio vs Presuure

19-1351-82 (McCormick Rankin Corporation)
HWY 17-417, Arnprior (White Lake Road)
WLR05-1, ST3, 21'-22'
Oedometer Consolidation Test



TEST DONE BY: JL
REVIEWED BY: JL

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS

Consolidation Test Report

Highway 17-417, Arnprior (White Lake Road)
19-1351-82 WLR05-1, ST3, 21'-22'

TRIMMING: The Specimen was manually trimmed to the size of consolidation ring, then mounted in a fixed ring consolidometer

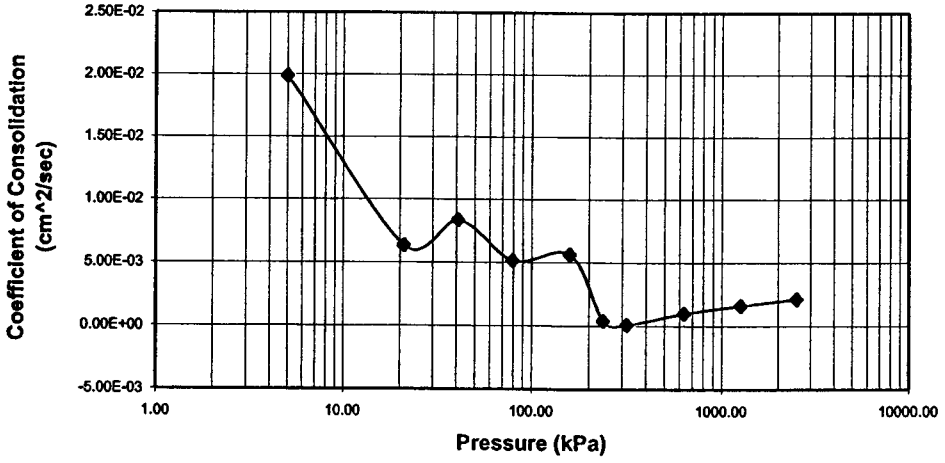
LOADING: A seating load of 5 kPa was applied and the consolidometer was flooded with distilled water. Sample was monitored to ensure no swelling effect occurred before the start of the test. Subsequent loads were applied and the duration of each load step was 24 hours

CALCULATIONS: Coefficients of Consolidation were calculated by the square root time method.

Pressure (kPa)	Corr. Hgt (mm)	Avg. Hgt. (mm)	D90 (mm)	T90 (min)	Cv (cm^2/sec)	Void Ratio	mv (m^2/kN)	k (cm/s)
0.00	19.050	19.050				1.303		
5.00	18.899	18.975	-0.14	0.64	1.99E-02	1.285	8.094E-04	1.58E-06
21.11	18.644	18.771	-0.313	1.96	6.35E-03	1.255	9.325E-04	5.8E-07
40.95	18.281	18.462	-0.125	1.44	8.36E-03	1.213	3.830E-04	3.14E-07
79.32	17.993	18.137	-0.18	2.25	5.17E-03	1.179	3.964E-04	2.01E-07
158.55	17.378	17.685	-0.27	1.96	5.64E-03	1.106	6.311E-04	3.49E-07
237.23	16.405	16.891	-0.38	25	4.03E-04	0.992	5.716E-04	2.26E-08
316.46	15.517	15.961	-0.545	94.09	9.57E-05	0.888	2.386E-04	2.24E-09
632.19	14.041	14.779	-0.95	7.84	9.84E-04	0.714	9.019E-05	8.7E-09
1263.90	12.925	13.483	-0.65	4	1.61E-03	0.583	3.680E-05	5.79E-09
2527.73	12.013	12.469	-0.53	2.56	2.15E-03	0.476	1.063E-06	2.24E-10
632.19	12.053	12.033				0.481		
158.55	12.282	12.167				0.508		
40.95	12.564	12.423				0.541		
5.00	12.925	12.744				0.583		

Coefficient of Consoildation vs Pressure

19-1351-82 (McCormick Rankin Corporation)
HWY 17-417, Amprior (White Lake Road)
WLR05-1, ST3, 21'-22'
Oedometer Consolidation Test



Notes: Cv and k calculated using t_{90} values

TEST DONE BY: JL
REVIEWED BY: JL

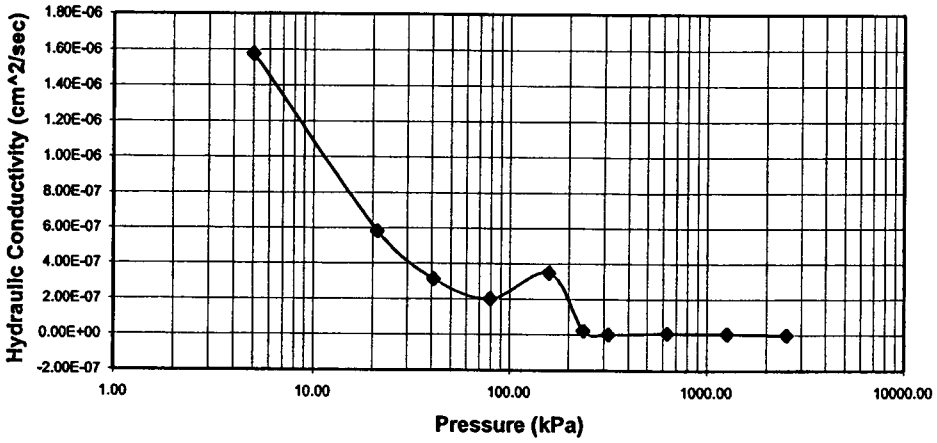
Consolidation Test Report

Highway 17-417, Arnprior (White Lake Road)
19-1351-82

WLR05-1, ST3, 21'-22'

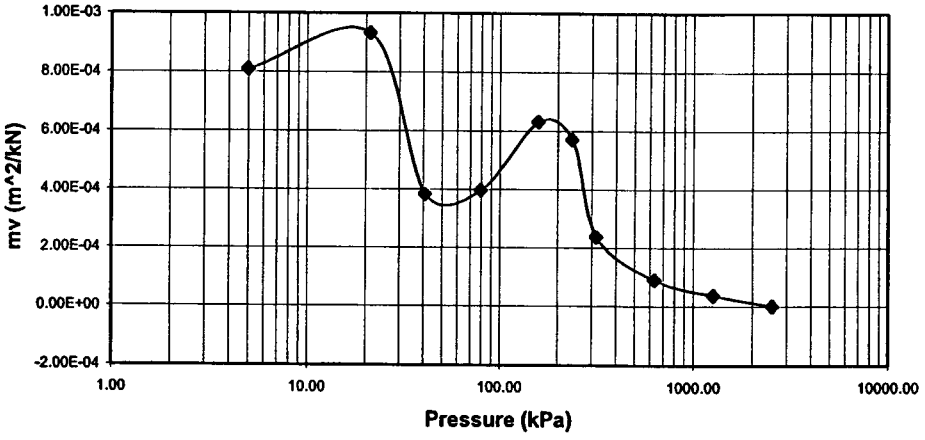
Hydraulic Conductivity vs Pressure

19-1351-82 (McCormick Rankin Corporation)
HWY 17-417, Arnprior (White Lake Road)
WLR05-1, ST3, 21'-22'
Oedometer Consolidation Test



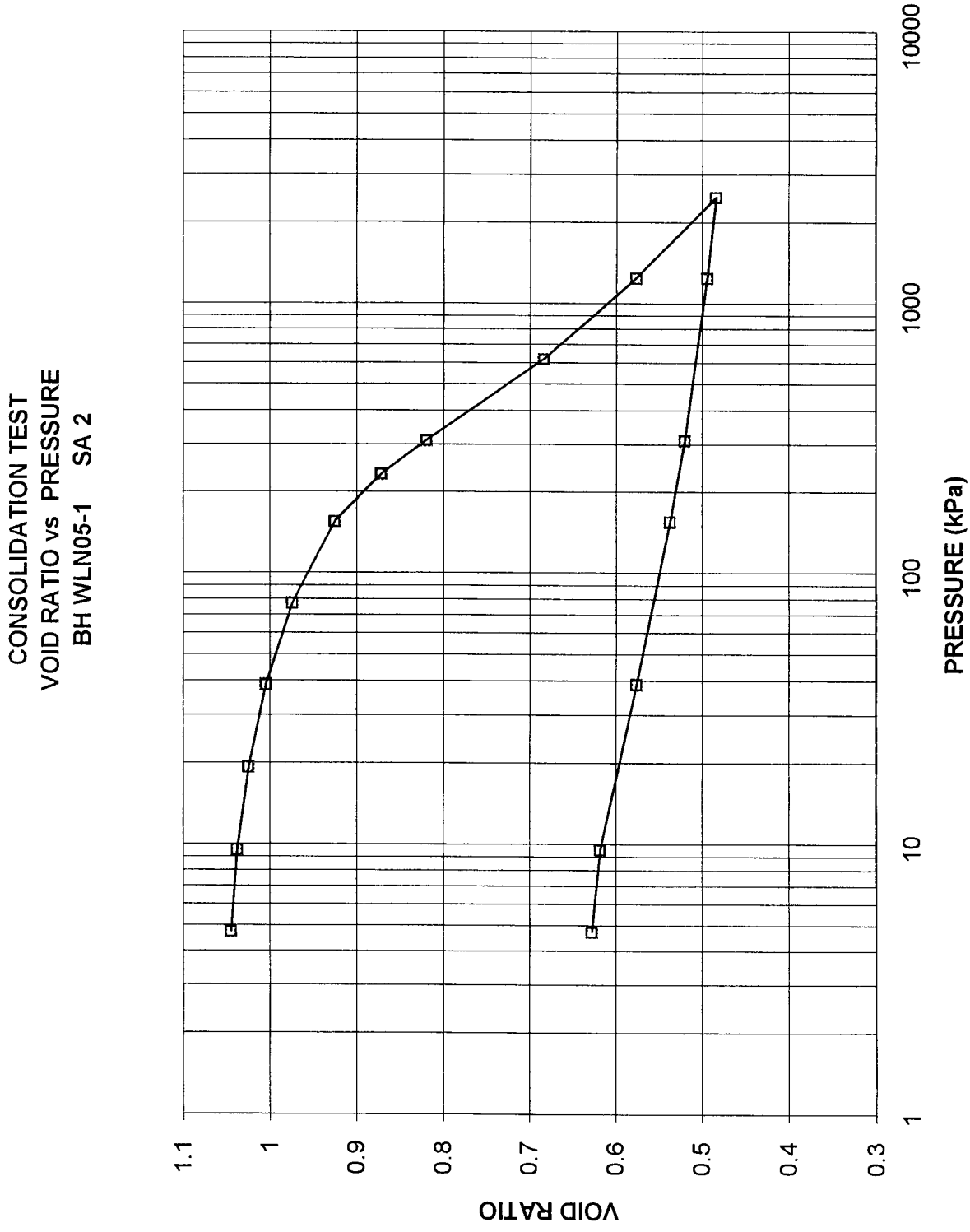
mv vs Pressure

19-1351-82 (McCormick Rankin Corporation)
HWY 17-417, Arnprior (White Lake Road)
WLR05-1, ST3, 21'-22'
Oedometer Consolidation Test



TEST DONE BY: JL
REVIEWED BY: JL

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 05-1116-029
Prepared By: LFG

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	05-1116-029	Sample Number	2
Borehole Number	WLN05-1	Sample Depth, m	4.6-5.2

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	9		
Date Started	5/17/2005		
Date Completed	6/01/2005		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.92	Unit Weight, kN/m^3	18.36
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	13.33
Area, cm^2	31.52	Specific Gravity, measured	2.79
Volume, cm^3	60.36	Solids Height, cm	0.933
Water Content, %	37.72	Volume of Solids, cm^3	29.41
Wet Mass, g	113.01	Volume of Voids, cm^3	30.95
Dry Mass, g	82.06	Degree of Saturation, %	100.0

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.915	1.052	1.915				
4.72	1.908	1.045	1.912	49	1.58E-02	7.74E-04	1.20E-06
9.58	1.901	1.037	1.905	60	1.28E-02	7.52E-04	9.45E-07
19.37	1.889	1.024	1.895	177	4.30E-03	6.40E-04	2.70E-07
38.87	1.870	1.004	1.880	240	3.12E-03	5.09E-04	1.56E-07
77.76	1.842	0.974	1.856	240	3.04E-03	3.76E-04	1.12E-07
155.30	1.796	0.925	1.819	165	4.25E-03	3.10E-04	1.29E-07
233.06	1.746	0.871	1.771	356	1.87E-03	3.36E-04	6.15E-08
310.60	1.698	0.820	1.722	540	1.16E-03	3.23E-04	3.69E-08
621.23	1.571	0.684	1.635	540	1.05E-03	2.13E-04	2.19E-08
1242.49	1.471	0.576	1.521	338	1.45E-03	8.41E-05	1.20E-08
2485.17	1.384	0.483	1.428	204	2.12E-03	3.66E-05	7.59E-09
1242.49	1.394	0.494	1.389				
310.60	1.418	0.520	1.406				
155.30	1.434	0.537	1.426				
38.87	1.470	0.575	1.452				
9.58	1.510	0.618	1.490				
4.72	1.519	0.628	1.515				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.52	Unit Weight, kN/m^3	21.30
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m^3	16.81
Area, cm^2	31.52	Specific Gravity, measured	2.79
Volume, cm^3	47.88	Solids Height, cm	0.933
Water Content, %	26.75	Volume of Solids, cm^3	29.41
Wet Mass, g	104.01	Volume of Voids, cm^3	18.47
Dry Mass, g	82.06		

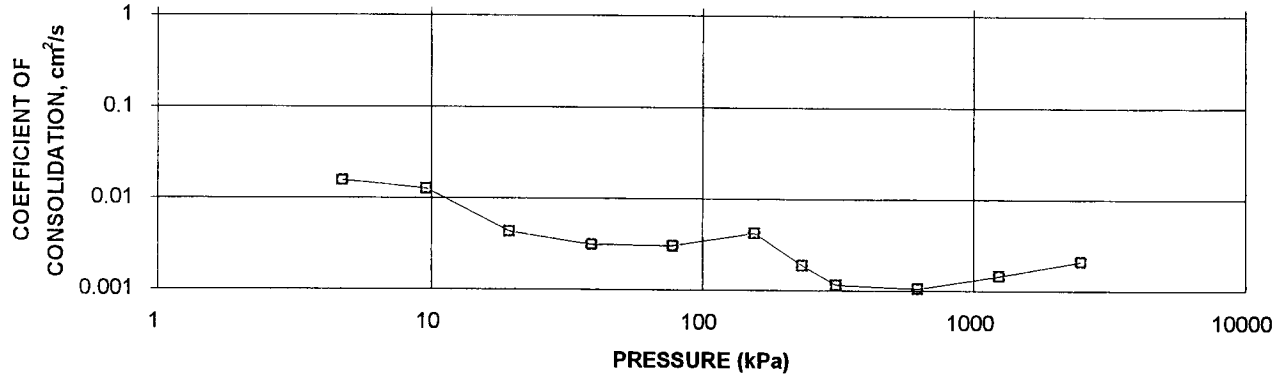
Prepared By: LFG

Golder Associates

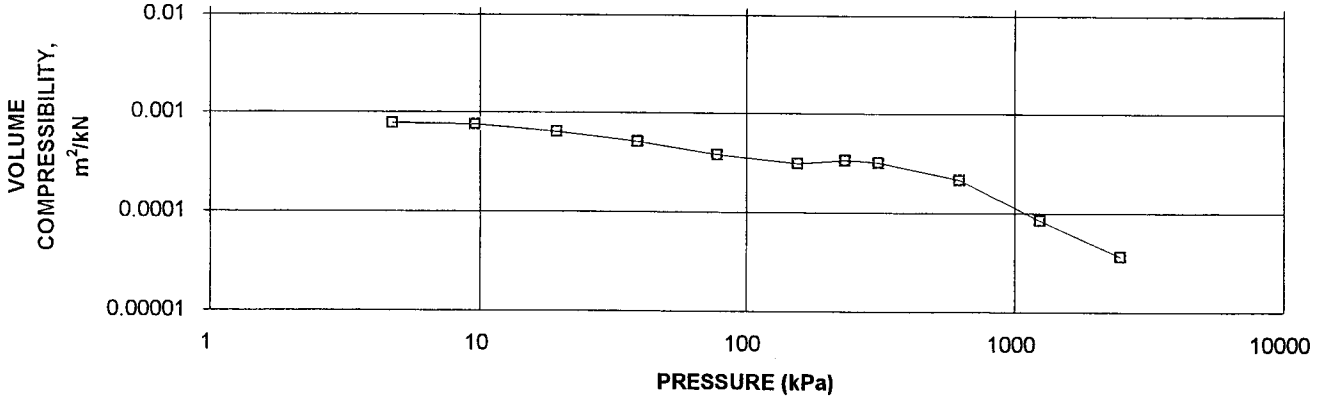
Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

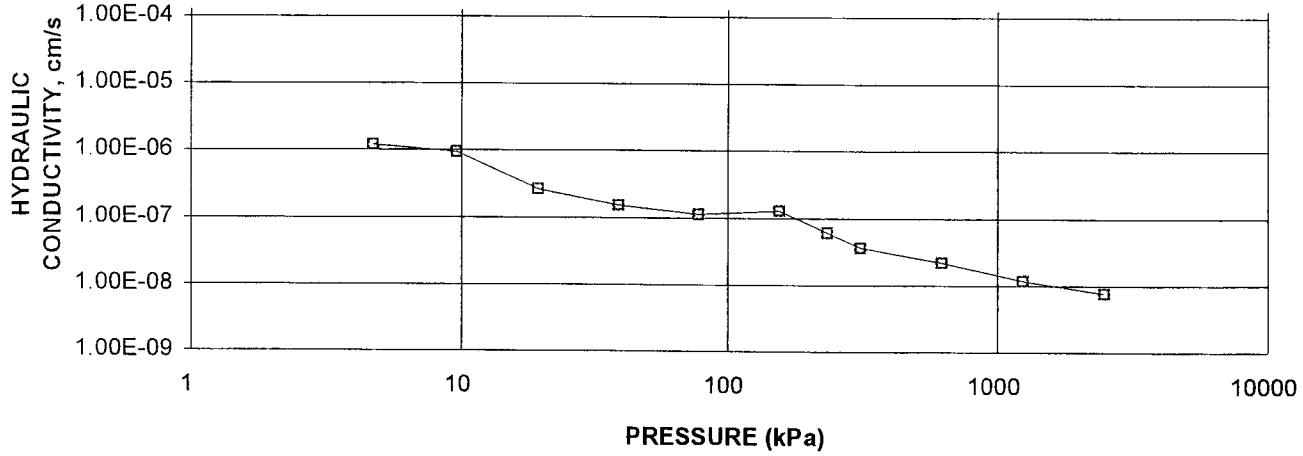
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH WLN05-1 SA 2



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH WLN05-1 SA 2



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH WLN05-1 SA 2

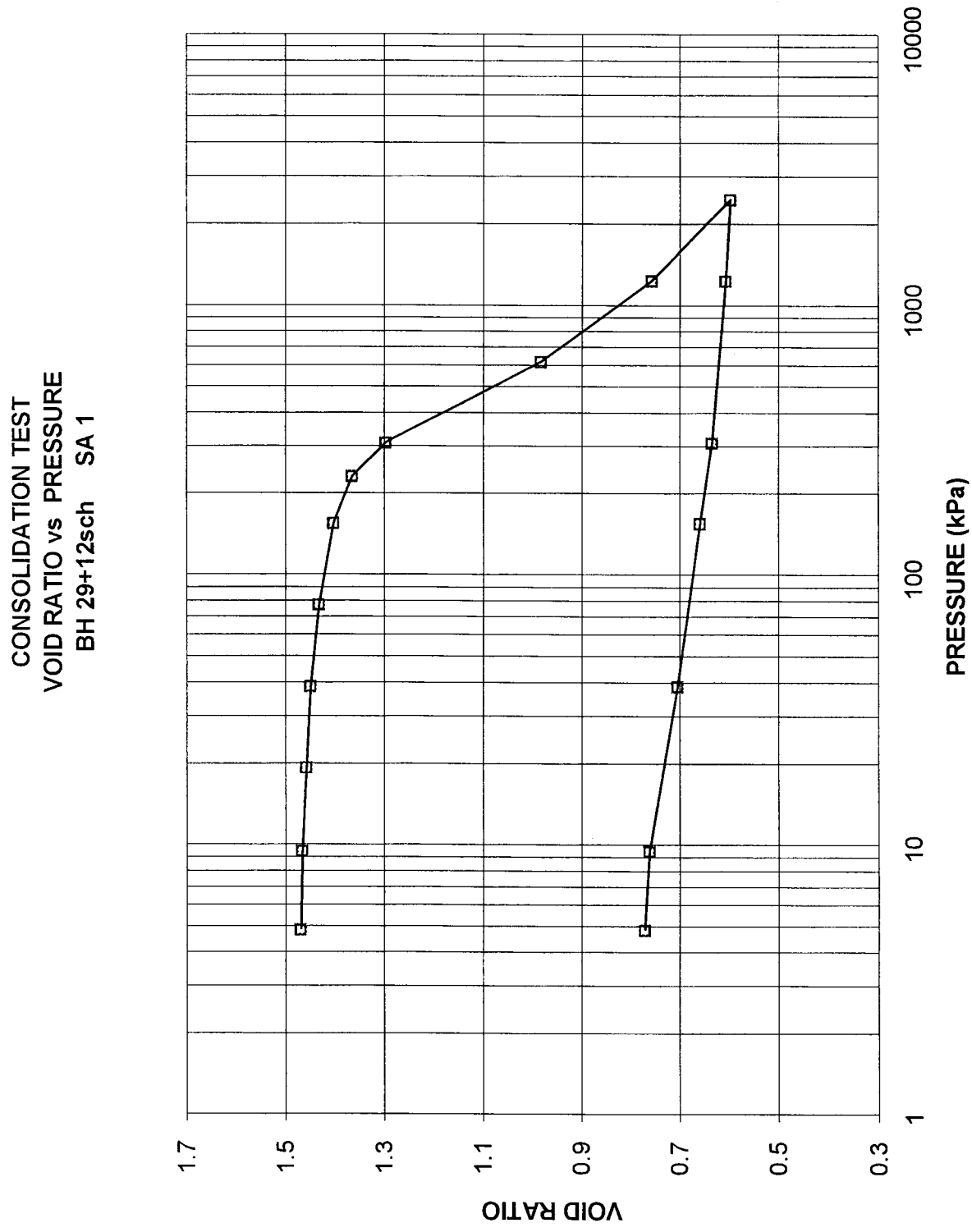


Project No. 05-1116-029
Prepared By: LFG

Golder Associates

Checkey By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 05-1116-029
Prepared By: LFG

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	05-1116-029	Sample Number	1
Borehole Number	29+12sch	Sample Depth, m	4.6-5.2

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	8		
Date Started	5/17/2005		
Date Completed	6/01/2005		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.92	Unit Weight, kN/m^3	16.84
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	11.02
Area, cm^2	31.67	Specific Gravity, measured	2.78
Volume, cm^3	60.65	Solids Height, cm	0.774
Water Content, %	52.89	Volume of Solids, cm^3	24.50
Wet Mass, g	104.15	Volume of Voids, cm^3	36.14
Dry Mass, g	68.12	Degree of Saturation, %	99.7

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.915	1.475	1.915				
4.85	1.911	1.470	1.913	8	9.70E-02	4.31E-04	4.09E-06
9.50	1.908	1.466	1.910	34	2.27E-02	3.37E-04	7.51E-07
19.40	1.902	1.458	1.905	19	4.05E-02	3.16E-04	1.26E-06
38.64	1.895	1.449	1.899	53	1.44E-02	1.90E-04	2.68E-07
77.43	1.882	1.432	1.889	43	1.76E-02	1.75E-04	3.02E-07
154.66	1.859	1.403	1.871	43	1.72E-02	1.56E-04	2.63E-07
232.09	1.829	1.364	1.844	124	5.81E-03	2.02E-04	1.15E-07
309.67	1.777	1.297	1.803	287	2.40E-03	3.50E-04	8.24E-08
618.79	1.534	0.983	1.656	287	2.02E-03	4.10E-04	8.14E-08
1237.65	1.360	0.758	1.447	540	8.22E-04	1.47E-04	1.18E-08
2475.12	1.236	0.597	1.298	433	8.25E-04	5.23E-05	4.23E-09
1237.65	1.243	0.606	1.240				
309.67	1.265	0.635	1.254				
154.66	1.284	0.659	1.275				
38.64	1.319	0.705	1.302				
9.50	1.363	0.762	1.341				
4.85	1.371	0.772	1.367				

Note:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

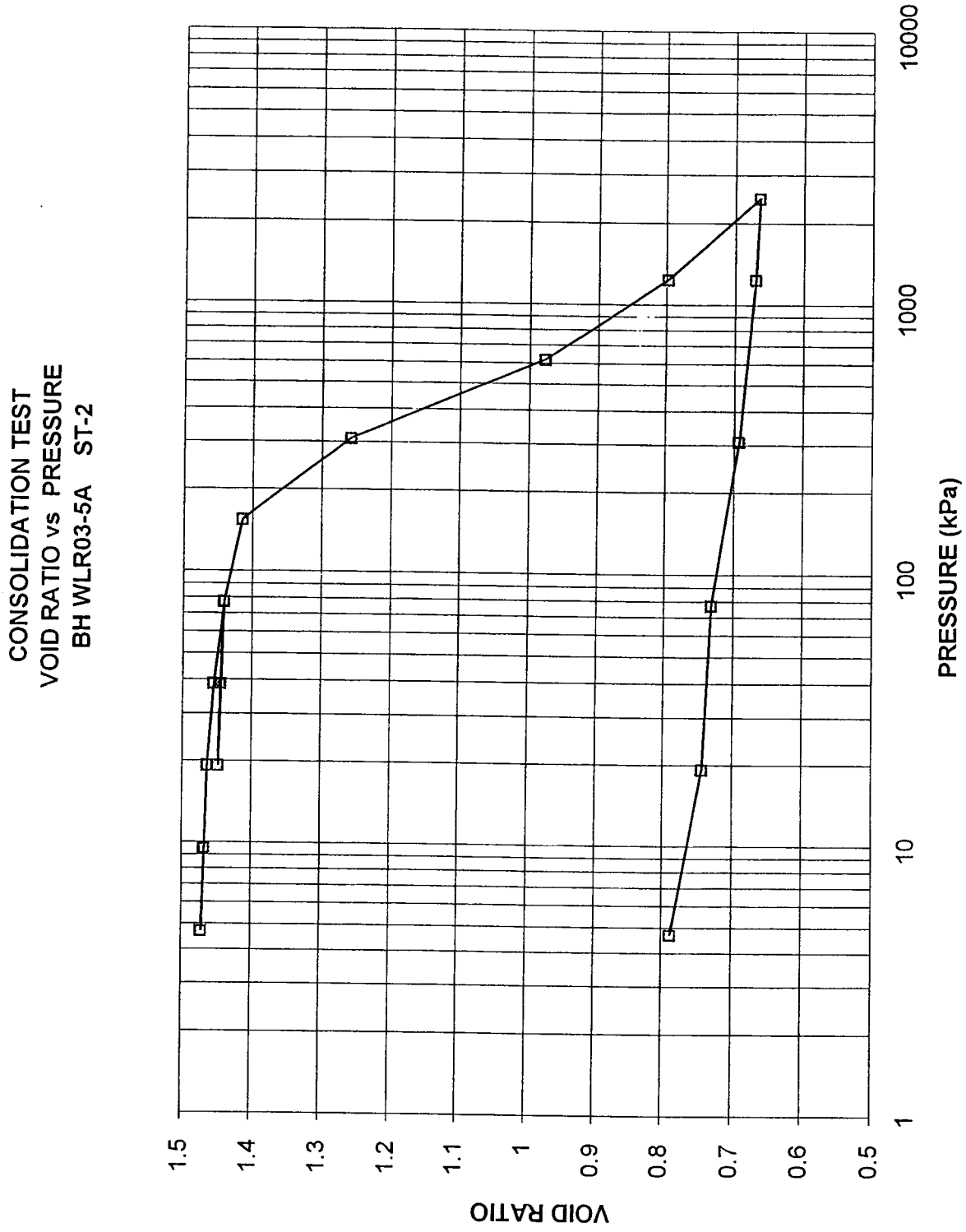
Sample Height, cm	1.37	Unit Weight, kN/m^3	20.18
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	15.39
Area, cm^2	31.67	Specific Gravity, measured	2.78
Volume, cm^3	43.42	Solids Height, cm	0.774
Water Content, %	31.18	Volume of Solids, cm^3	24.50
Wet Mass, g	89.36	Volume of Voids, cm^3	18.91
Dry Mass, g	68.12		

Prepared By: LFG

Golder Associates

Checked By: MM

CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE	FIGURE



Project No. 04-1116-026
Prepared By: LFG

Golder Associates

Checked By: MM

OEDOMETER CONSOLIDATION SUMMARY

SAMPLE IDENTIFICATION

Project Number	04-1116-026	Sample Number	ST-2
Borehole Number	WLR03-5A	Sample Depth, m	8.5-9.1

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	5		
Date Started	03/18/2004		
Date Completed	03/29/2004		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.91	Unit Weight, kN/m^3	16.84
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	11.09
Area, cm^2	31.65	Specific Gravity, measured	2.80
Volume, cm^3	60.45	Solids Height, cm	0.772
Water Content, %	51.76	Volume of Solids, cm^3	24.43
Wet Mass, g	103.79	Volume of Voids, cm^3	36.03
Dry Mass, g	68.39	Degree of Saturation, %	98.3

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.910	1.475	1.910				
4.70	1.907	1.471	1.909	15	5.15E-02	3.34E-04	1.69E-06
9.54	1.904	1.467	1.906	15	5.13E-02	3.25E-04	1.63E-06
19.29	1.901	1.463	1.903	5	1.53E-01	1.61E-04	2.42E-06
38.71	1.894	1.454	1.898	8	9.54E-02	1.89E-04	1.76E-06
77.44	1.883	1.440	1.889	15	5.04E-02	1.49E-04	7.35E-07
38.71	1.886	1.444	1.885				
19.29	1.889	1.448	1.888				
38.71	1.887	1.445	1.894	15	5.07E-02	5.39E-05	2.68E-07
77.44	1.883	1.440	1.889	10	7.56E-02	1.49E-04	4.01E-07
154.67	1.863	1.414	1.873	15	4.96E-02	1.36E-04	6.59E-07
309.92	1.742	1.257	1.803	21	3.28E-02	4.08E-04	1.31E-06
619.04	1.526	0.977	1.634	375	1.51E-03	3.66E-04	5.41E-08
1236.79	1.387	0.797	1.457	94	4.78E-03	1.18E-04	5.52E-08
2474.94	1.284	0.664	1.336	171	2.21E-03	4.36E-05	9.44E-09
1236.79	1.289	0.670	1.287				
309.92	1.306	0.692	1.298				
77.44	1.336	0.731	1.321				
19.29	1.345	0.743	1.341				
4.70	1.379	0.787	1.362				

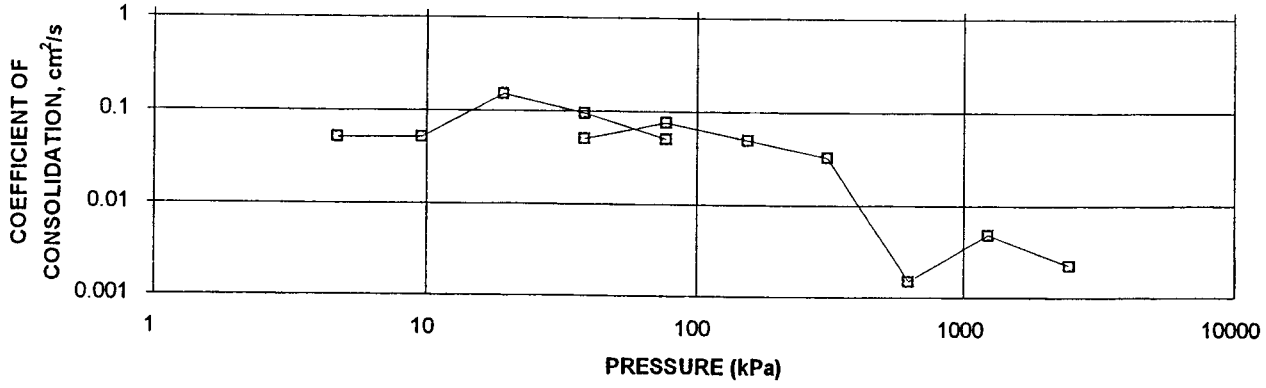
Notes:
k calculated using cv based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

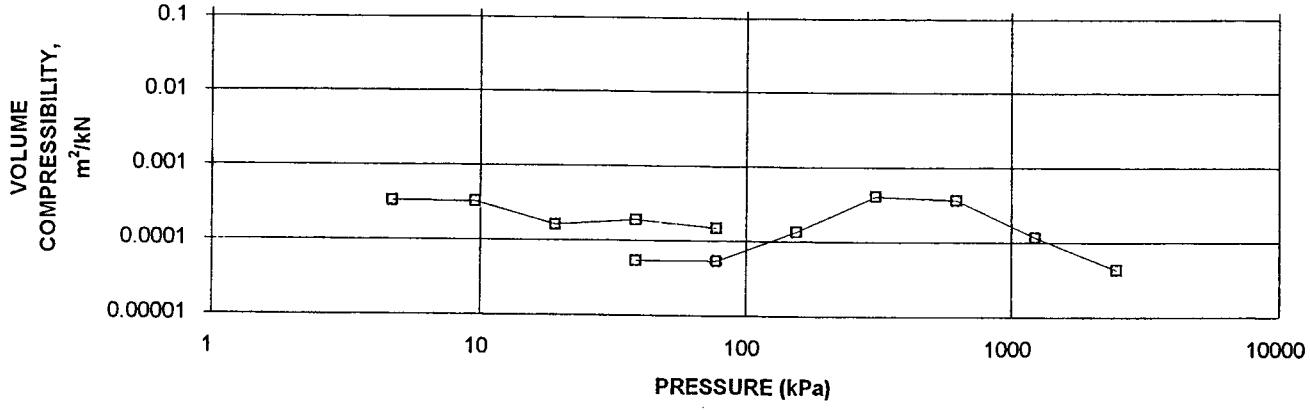
Sample Height, cm	1.38	Unit Weight, kN/m^3	19.86
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	15.37
Area, cm^2	31.65	Specific Gravity, measured	2.80
Volume, cm^3	43.64	Solids Height, cm	0.772
Water Content, %	29.26	Volume of Solids, cm^3	24.43
Wet Mass, g	88.40	Volume of Voids, cm^3	19.22
Dry Mass, g	68.39		

OEDOMETER CONSOLIDATION SUMMARY

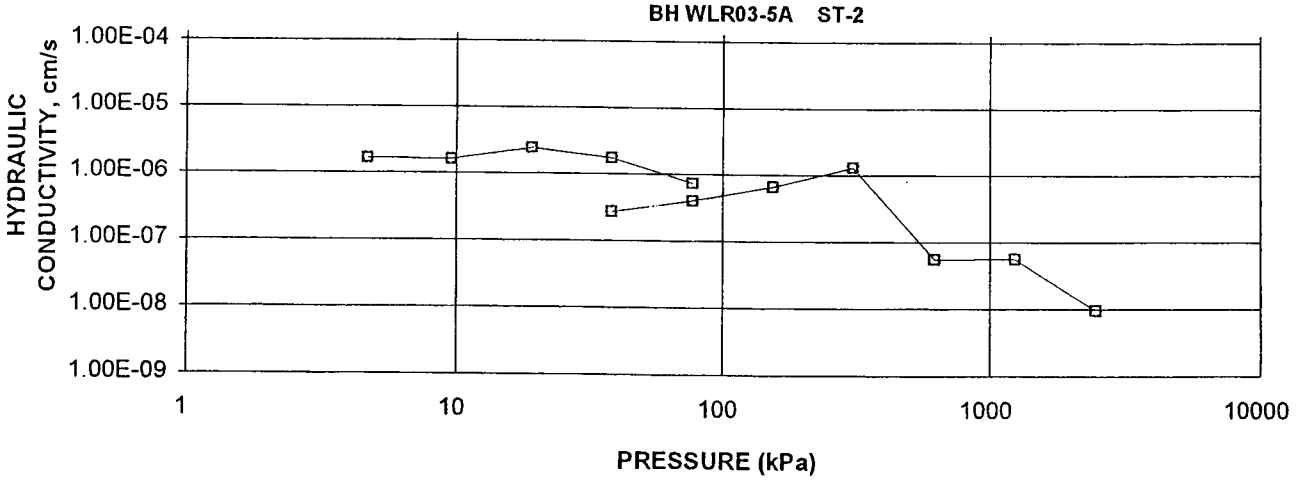
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH WLR03-5A ST-2



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH WLR03-5A ST-2



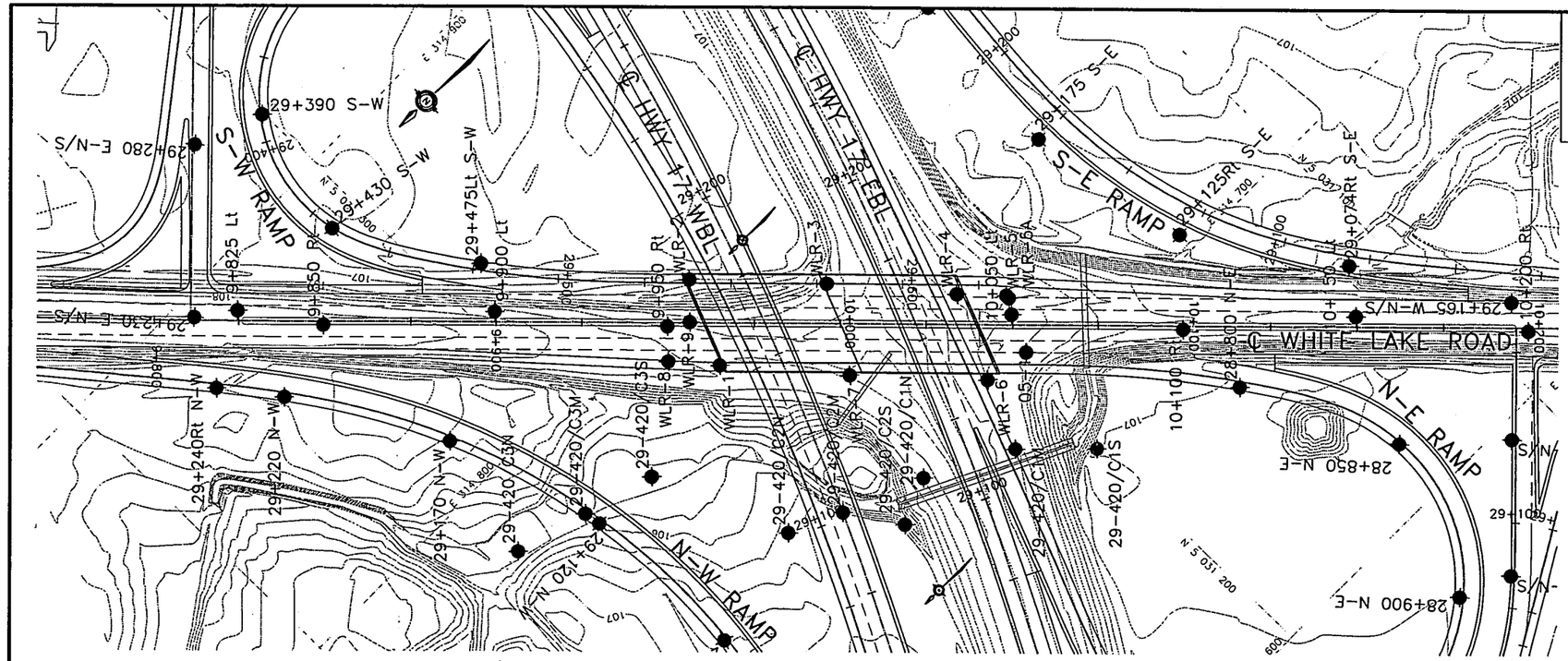
CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH WLR03-5A ST-2



Project No. 04-1116-026
Prepared By: LFG

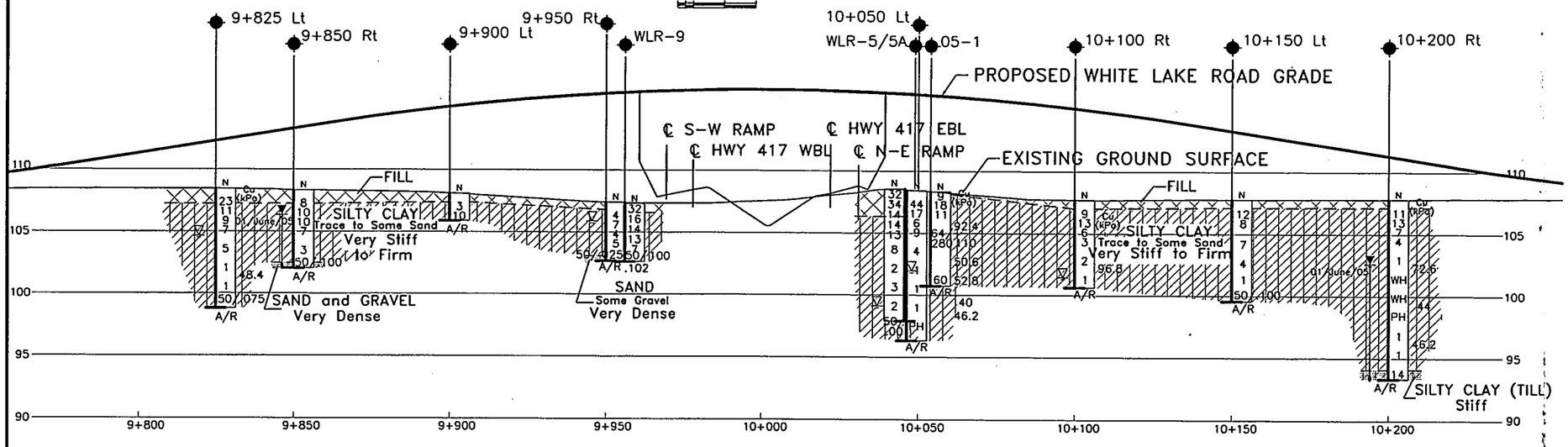
Golder Associates

Checkey By: MM



PLAN

5 0 10 20m



PROFILE ℄ WHITE LAKE ROAD

5 0 10 20m HOR
1.250 2.5 5m VERT

NO	ELEVATION	NORTH	EAST
WLR-5	108.6	5 031 186.8	314 728.2
WLR-5A	108.6	5 031 186.8	314 729.2
WLR-9	107.3	5 031 256.7	314 789.6

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

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

HWY.17
GWP NO. 647-92-00

HIGHWAY 17 TWINNING
WHITE LAKE ROAD INTERCHANGE
WHITE LAKE ROAD
BOREHOLE LOCATIONS AND SOIL STRATA

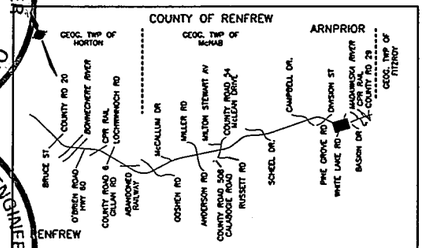
SHEET

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.

LICENSED PROFESSIONAL ENGINEER
S. PANG
Oct. 17/05
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 17/05
PROVINCE OF ONTARIO



KEYPLAN

LEGEND

●	Bore Hole
⊕	Dynamic Cone Penetration Test (cone) or Probe Hole
◈	Bore Hole & Cone
N	Blows/0.3m (Std pen Test, 475J/blow)
CONE	Blows/0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	WL in Piezometer at Time of Investigation (Date)
▼	Head Artesian Water Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
90%	Rock Quality Designation (ROD)
A/R	Auger Refusal
C/R	Cone Refusal

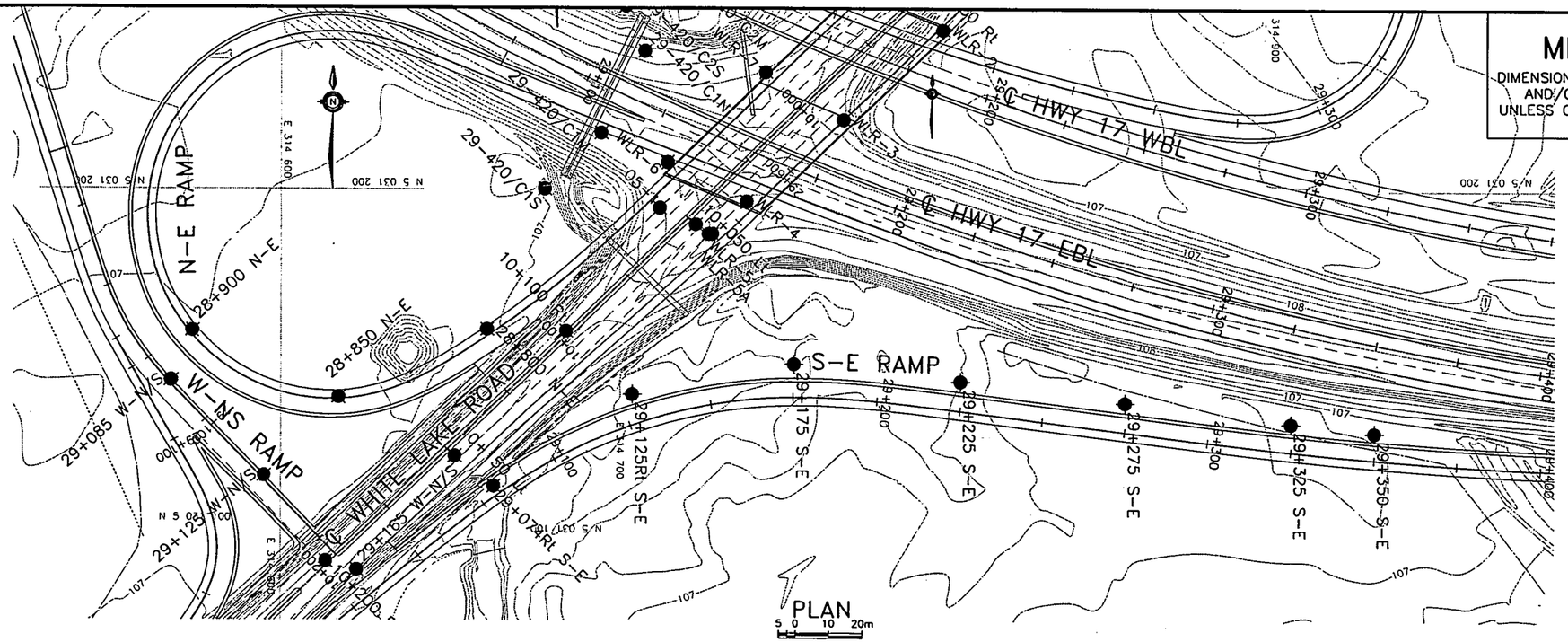
NO	STATION	OFFSET FROM CL (m)
05-1	10+054	8.0Rt
10+050 LT	10+050	2.0Lt
10+100 RT	10+100	2.0Rt
10+150 LT	10+150	2.0Lt
10+200 RT	10+200	2.0Rt
9+825 RT	9+825	2.0Rt
9+850 RT	9+850	2.0Rt
9+900 LT	9+900	2.0Lt
9+950 RT	9+950	2.0Rt

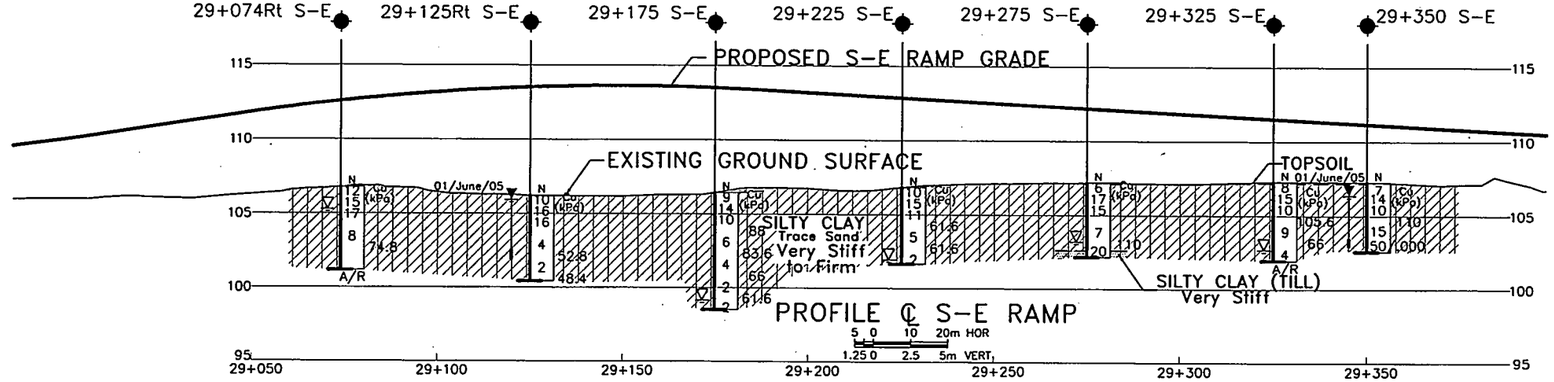
— NOTE —

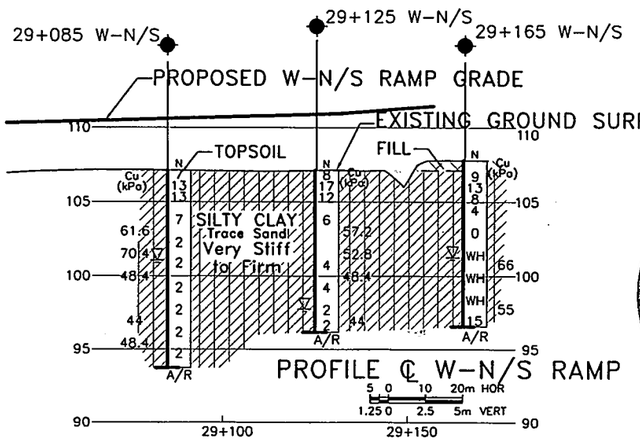
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

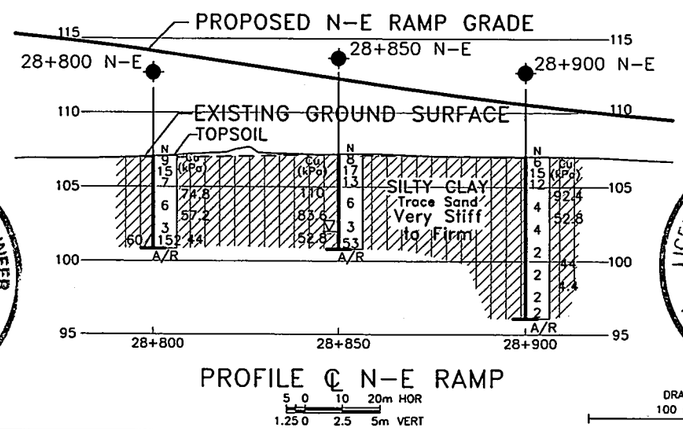
REVISIONS		
OCT, 05	SP	FINAL
JUN, 05	SP	ISSUED AS DRAFT FOR REVIEW
DATE	BY	DESCRIPTION

DESIGN SP	CHK AEG	CODE CHBDC	LOAD		DATE JUN, 2005
DRAWN HS	CHK SP	SITE	STRUCT	SCHEME	DWG W1









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HWY.17

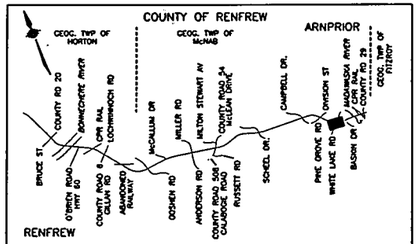
GWP NO. 647-92-00

HIGHWAY 17 TWINNING
WHITE LAKE ROAD INTERCHANGE
S-E, W-N/S & N-E RAMPS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



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CONE	Blows/0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	WL in Piezometer at Time of Investigation (Date)
▼	Head Artesian Water Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal
C/R	Cone Refusal

NO	STATION	OFFSET FROM CL (m)
28+800 N-E	28+800	0
28+850 N-E	28+850	0
28+900 N-E	28+900	0
29+074 Rt S-E	29+074	5.0 Rt
29+125 Rt S-E	29+125	6.1 Rt
29+175 S-E	29+175	0
29+225 S-E	29+225	0
29+275 S-E	29+275	0
29+325 S-E	29+325	0
29+350 S-E	29+350	0
29+085 W-N/S	29+085	0
29+125 W-N/S	29+125	0
29+165 W-N/S	29+165	0

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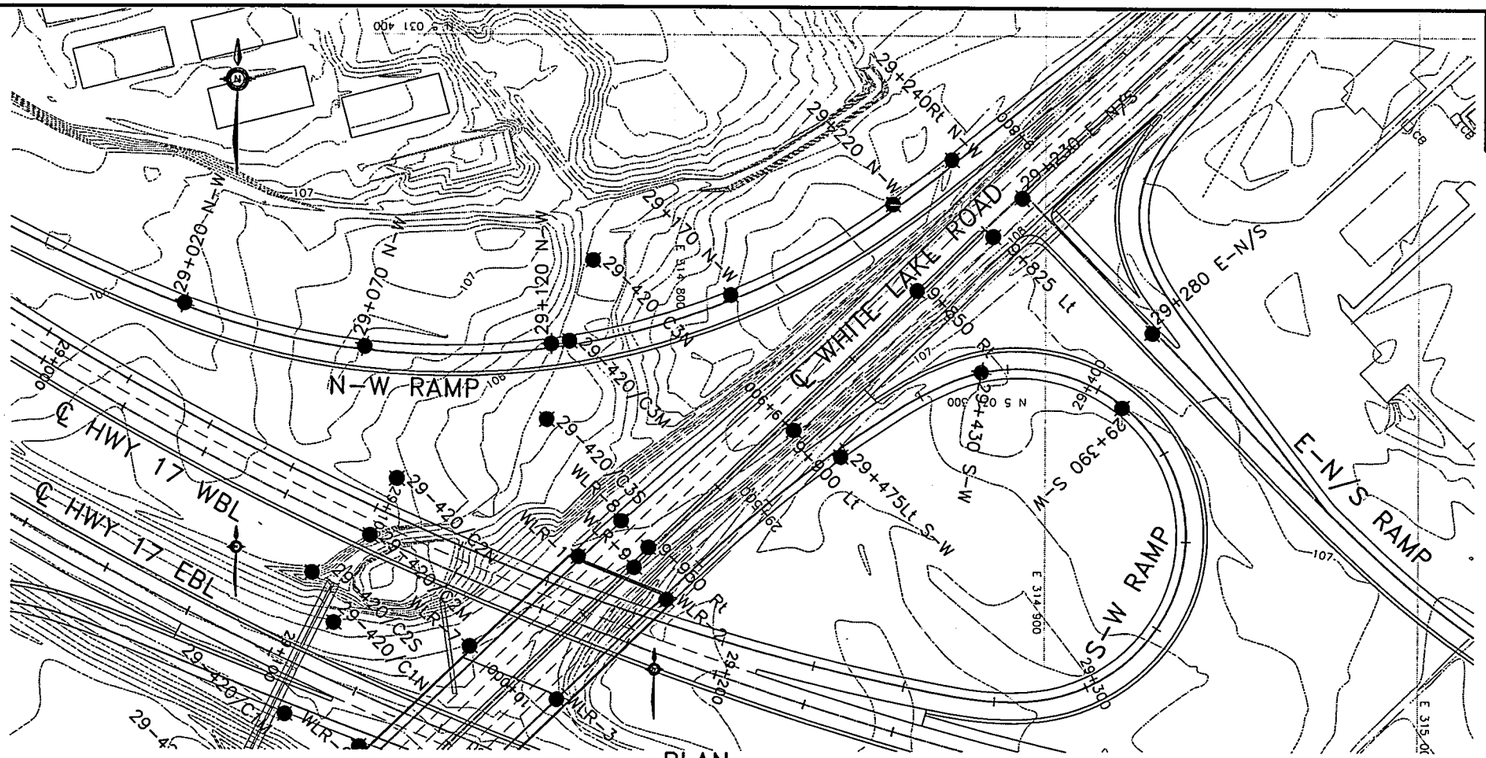
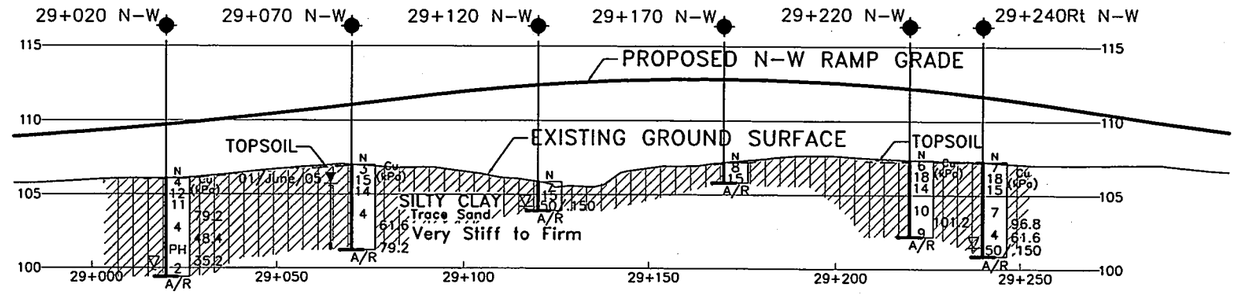
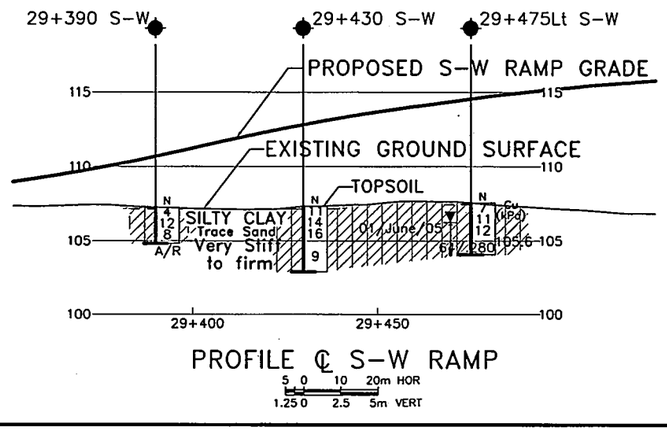
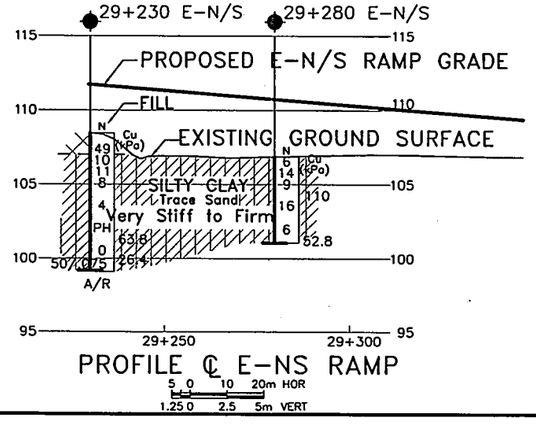
JUN, 05	SP	ISSUED AS DRAFT FOR REVIEW
DATE	BY	DESCRIPTION

DESIGN SP	CHK AEG	CODE CHBDC	LOAD		DATE JUN, 2005
DRAWN HS	CHK SP	SITE	STRUCT	SCHEME	DWG W2









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HWY.17

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WHITE LAKE ROAD INTERCHANGE
N-W, S-W & E-N/S RAMPS
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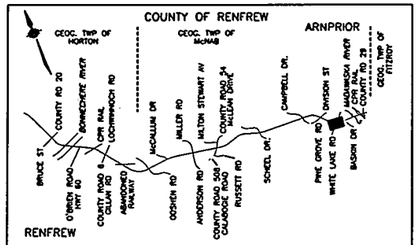

KEYPLAN

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PH	Pressure, Hydraulic
▼	WL in Piezometer at Time of Investigation (Date)
▼	Head Artesian Water Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal
C/R	Cone Refusal

NO	STATION	OFFSET FROM CL (m)
29+230 E-N/S	29+230	0
29+280 E-N/S	29+280	0
29+020 N-W	29+020	0
29+070 N-W	29+070	0
29+120 N-W	29+120	0
29+170 N-W	29+170	0
29+220 N-W	29+220	0
29+240Rt N-W	29+240	2.0 Rt
29+390 S-W	29+390	0
29+430 S-W	29+430	0
29+475Lt S-W	29+475	4.0 Lt

— NOTE —

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DATE	BY	DESCRIPTION

DESIGN SP	CHK AEG	CODE CHBDC	LOAD	DATE JUN. 2005	
DRAWN HS	CHK SP	SITE	STRUCT	SCHEME	DWG W3

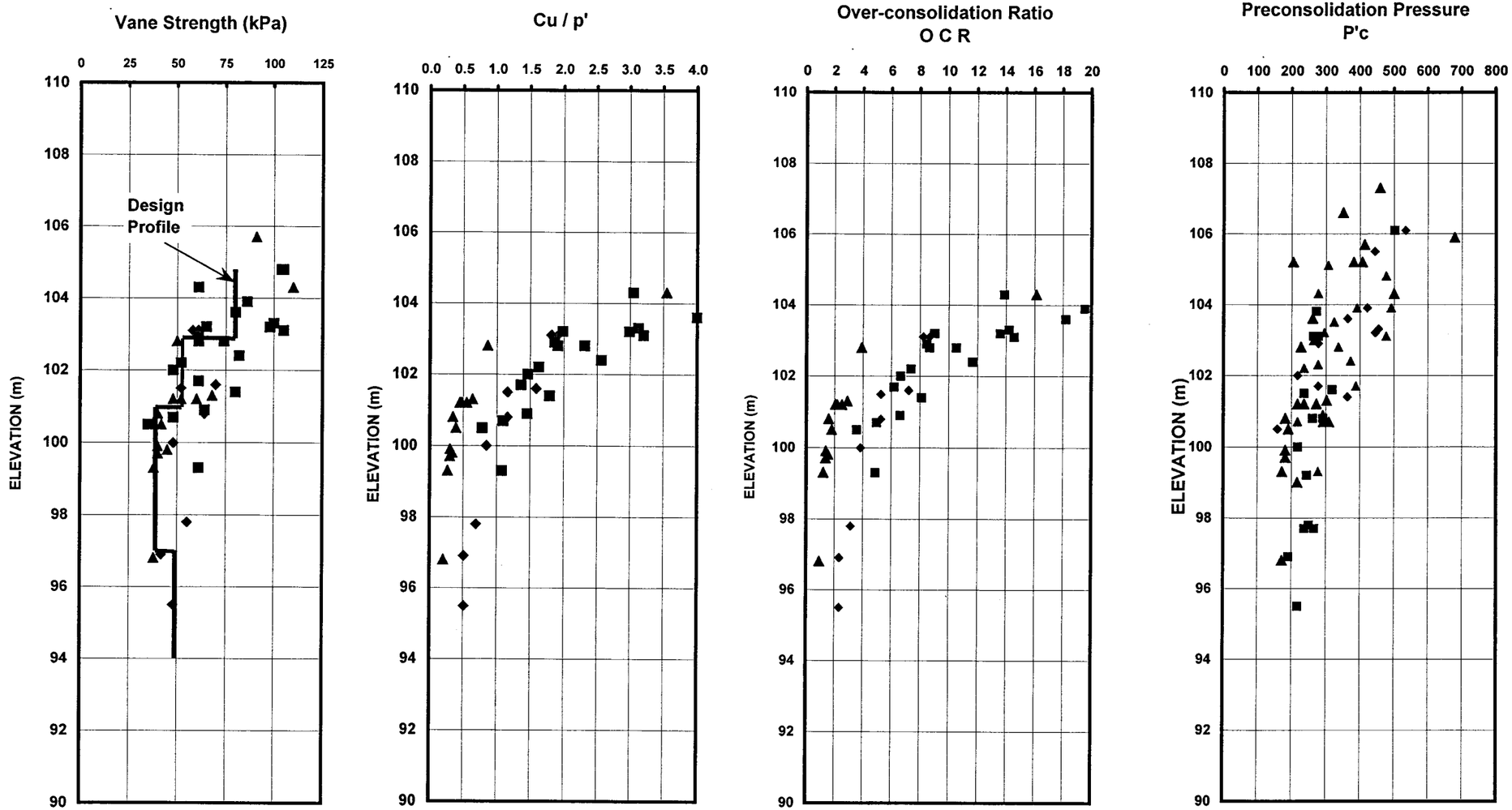
Figure A1 Summary of Soil Properties - White Lake Road Interchange

FILL — variable

SILTY CLAY

variable depth

BEDROCK



THURBER

Appendix B

Madawaska River Bridge Approaches
Records of Boreholes, Laboratory Test Results, Drawings

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\blacktriangledown$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

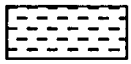
EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

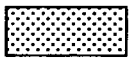
Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS

CLAYSTONE



SILTSTONE



SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+640 CL 1 OF 3 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 19.05.05 CHECKED BY SKP

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
97.0							97				
0.0	TOPSOIL (125mm)										
0.1	Silty **CLAY**, trace sand Stiff Brown		1	SS	8						
			2	SS	19		96				
95.6											
1.4	Silty **CLAY**, trace sand Very Stiff Brown		3	SS	16						
			4	SS	20		95				
			5	SS	17		94				
			6	SS	17		93				
			7	SS	15		92				
			8	SS	4		91				0 1 60 39
	Becoming Grey						90				
							89				
							88				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+640 CL 2 OF 3 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 19.05.05 CHECKED BY SKP

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						
	Firm						87	4.3			
			1	TW	PH		86				
								5.0			
							85				
			9	SS	2						
83.6							84				
13.4	Stiff										
			10	SS	4		83				
								3.6			
							82				
			11	SS	4						
							81				
			12	SS	6		80				
							79	3.3			
			13	SS	6						
							78				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+640 CL 3 OF 3 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 18.05.05 - 19.05.05 CHECKED BY SKP

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
76.3			14	SS	7		77		○		
20.7	Sandy **SILT**, some gravel, trace to some clay Loose Grey Wet						76				
75.1			15	SS	9				○		13 39 38 11
21.9	END OF BOREHOLE AT 21.95 m. AUGER REFUSAL AT 21.95 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 21.95 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) June 1/ 05 6.5										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+700 CL 1 OF 2 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 20.05.05 - 20.05.05 CHECKED BY SKP

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 ● QUICK TRIAXIAL + FIELD VANE × 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
88.8											
0.0	TOPSOIL (75mm)										
0.1	Silty CLAY, trace sand, trace crobbles Stiff Brown		1	SS	11			○	○		
88.0											
0.8	Silty CLAY, trace sand Stiff Brown		2	SS	14		88		○		
			3	SS	13		87		○		
			4	SS	10		86		○		
							85	3.3 +			
			5	SS	6		84		○		
							83	4.2 +			
			6	SS	4						0 3 61 36
							82	4.2 +			
			1	TW	PH		81				
	Becoming Firm, Grey		7	SS	2		80				
							79				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 29/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+700 CL 2 OF 2 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 20.05.05 - 20.05.05 CHECKED BY SKP

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
								4.8 +			
			8	SS	2		78		○		
							77				
			9	SS	5				○		
							76	4.0 +			
			10	SS	4		75		⊢○		
							74				
			11	SS	3				○		
72.6							73				
16.2	END OF BOREHOLE AT 16.15 m. AUGER REFUSAL AT 16.15 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 16.15 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+760 12.5LT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 19.05.05 - 19.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (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
87.7											
0.0	**TOPSOIL** (100mm)										
0.1	Silty **CLAY**, trace sand, trace crobbles Firm Brown		1	SS	6						
87.0							87				
0.8	Silty **CLAY**, trace sand Very Stiff to Stiff Brown		2	SS	16						
			3	SS	7		86				
								3.3			
							85				
			4	SS	5						0 4 50 46
							84	3.0			
			5	SS	6		83				
								2.8			
81.6							82				
6.1	END OF BOREHOLE AT 6.10 m. AUGER REFUSAL AT 6.10 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 6.10 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

$15 \overset{20}{\underset{10}{\diamond}} 5$ (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+815 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 19.05.05 - 19.05.05 CHECKED BY SKP

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
87.7											
0.0	**BEDROCK** at surface.						87				

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+865 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 19.05.05 - 19.05.05 CHECKED BY SKP

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 86.4	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
0.0	**TOPSOIL** (150mm)		1	SS	50/						
0.2	END OF BOREHOLE AT 0.15 m. AUGER REFUSAL AT 0.15 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 0.15 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.				.150		86				

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+915 5.0RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 19.05.05 - 19.05.05 CHECKED BY SKP

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
87.7											
0.0	TOPSOIL (150mm)		1	SS	50/.150				○		
87.4 / 0.2	SAND, trace gravel Brown										
0.3	END OF BOREHOLE AT 0.30 m. AUGER REFUSAL AT 0.30 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 0.30 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.						87				

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 30+965 15LT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge West Approach ORIGINATED BY GA

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 19.05.05 - 19.05.05 CHECKED BY SKP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
81.8								20 40 60 80 100	20 40 60		
0.0	TOPSOIL (125mm)										
0.2	Silty CLAY, trace cobbles Loose Brown		1	SS	8			○	○		
81.0							81				
0.8	Silty CLAY, trace sand Very Stiff to Stiff Brown		2	SS	17				○		
			3	SS	15		80		⊖		0 8 52 40
			4	SS	5		79		○		
							78	3.6			
	Becoming Stiff, Grey		5	SS	11		77		○		
76.3											
5.5	END OF BOREHOLE AT 5.49 m. AUGER REFUSAL AT 5.49 m ON PROBABLE BEDROCK. Piezometer installation consists of 25 mm diameter Schedule 40 PVC pipe with a 1.52 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m)										

+³, ×³: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 5182EMBANKMENT.GPJ 28/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 31+180 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge East Approach ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 31.05.05 - 31.05.05 CHECKED BY SKP

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
83.4											
0.0	**TOPSOIL** (150mm)										
0.2	Silty **CLAY** Very Stiff Brown						83				
82.0			1	SS	16				○		
1.3	**SAND**, some silt, trace gravel and cobbles Compact Brown Wet						82				
81.2			2	SS	18				○		22 52 19 7
2.2	END OF BOREHOLE AT 2.21 m. AUGER REFUSAL AT 2.21 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 2.21 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 31+215 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Madawaska Bridge East Approach ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 31.05.05 - 31.05.05 CHECKED BY SKP

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
86.8											
0.0	TOPSOIL (150mm)										
0.2	SAND, trace gravel Compact Brown Moist										
85.8			1	AS			86		○		
1.0	END OF BOREHOLE AT 0.99 m. AUGER REFUSAL AT 0.99 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 0.99 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

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

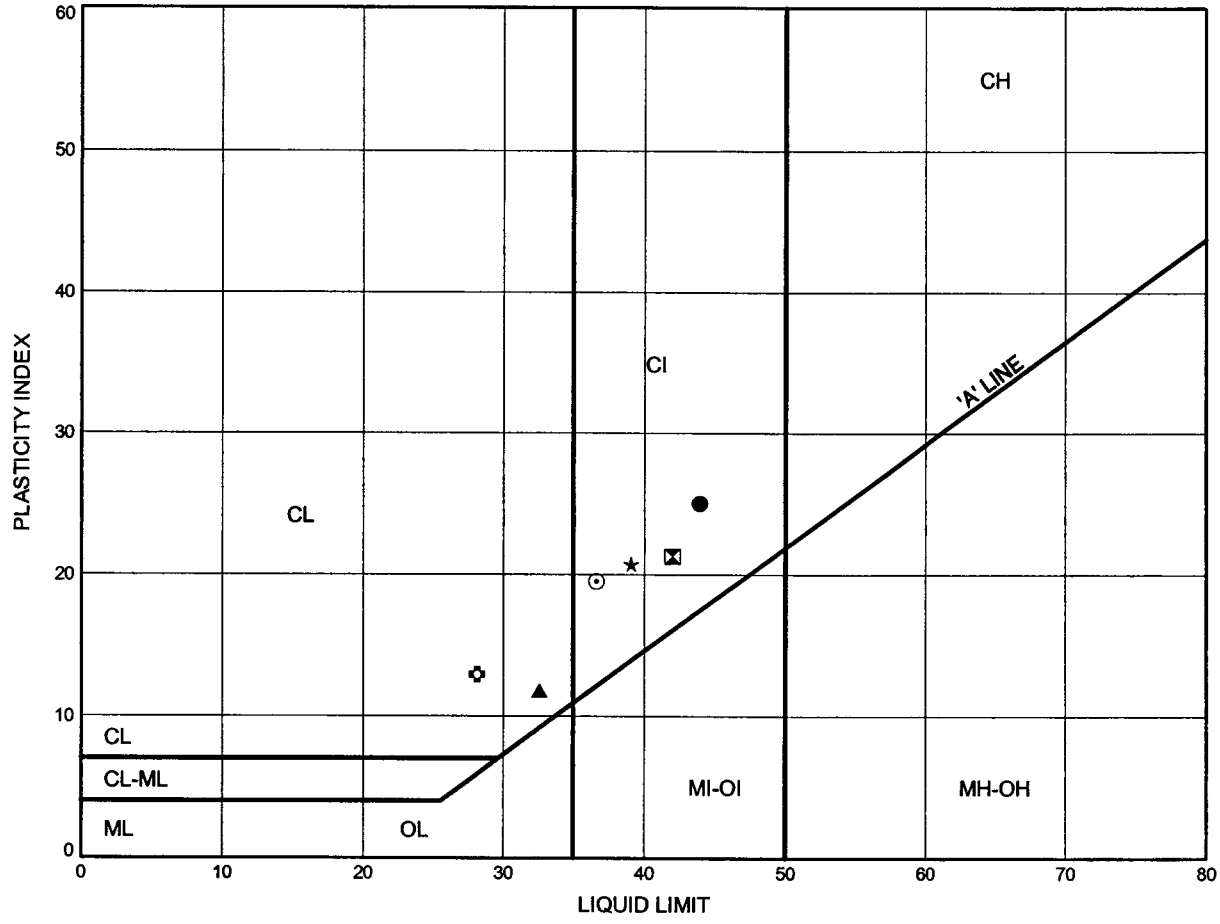
ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE B1

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	30+640 CL	4.88	92.12
⊠	30+640 CL	9.45	87.55
▲	30+640 CL	17.07	79.93
★	30+700 CL	1.83	86.97
⊙	30+700 CL	6.40	82.40
✿	30+700 CL	14.02	74.78

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

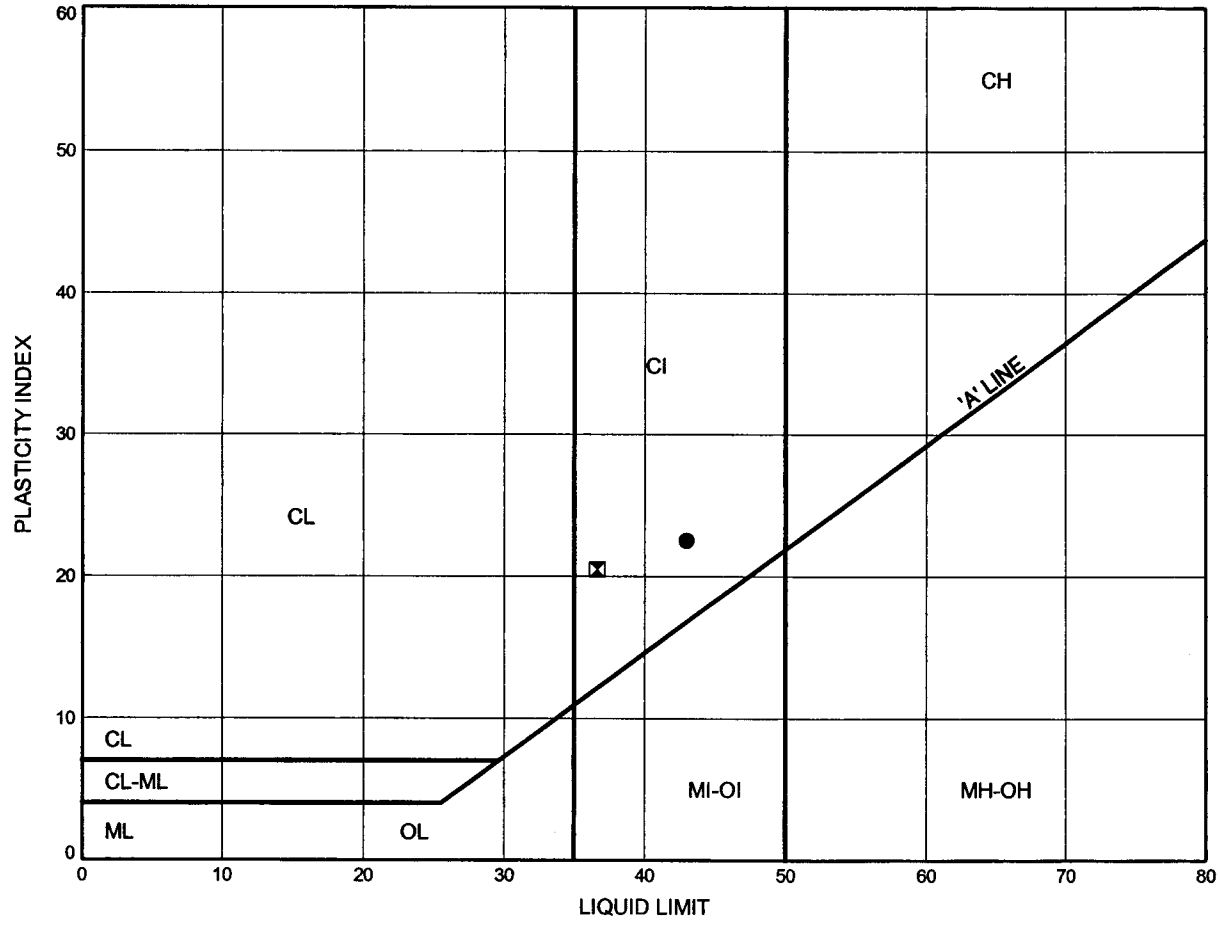
THURBALT 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE B2

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	30+760 12.5LT	3.35	84.39
⊠	30+965 15LT	1.83	79.95

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

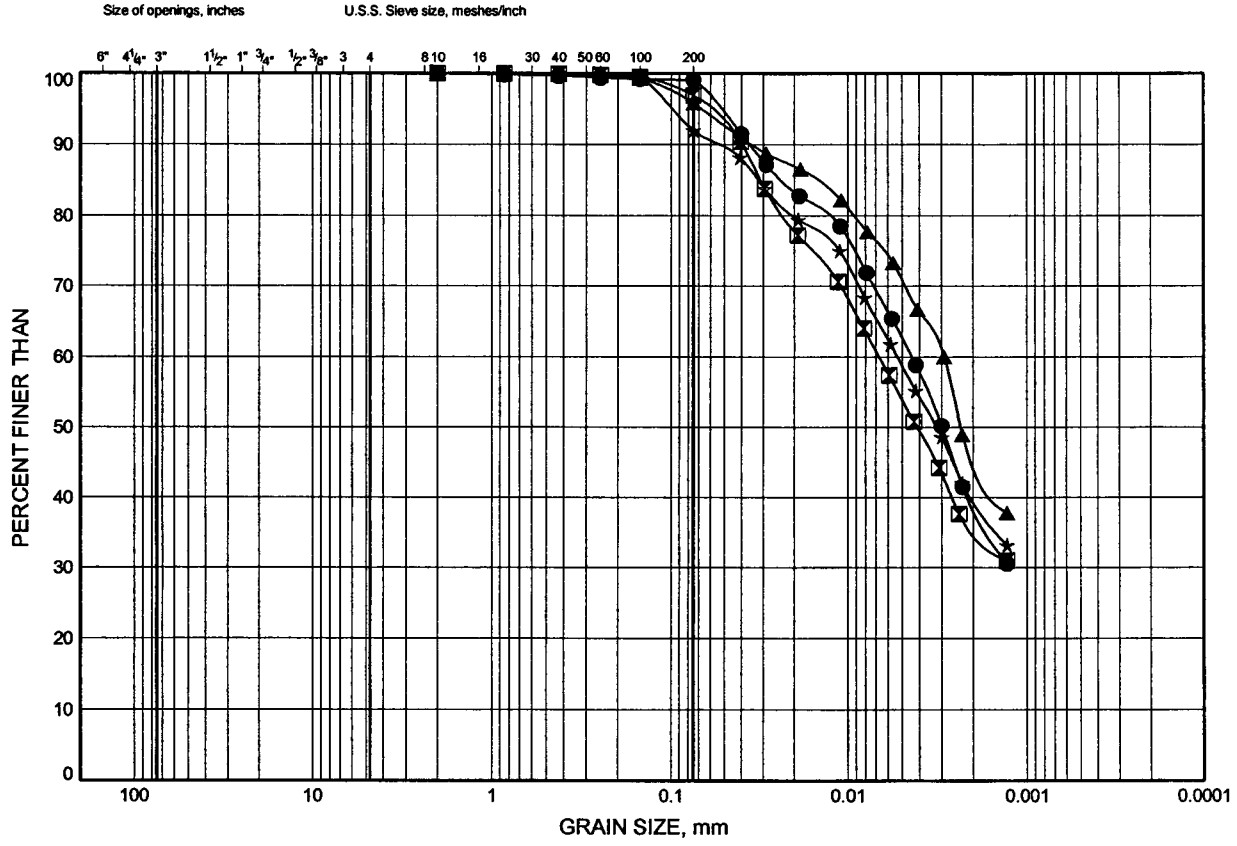
THURBALT 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	30+640 CL	9.45	87.55
⊠	30+700 CL	6.40	82.40
▲	30+760 12.5LT	3.35	84.39
★	30+965 15LT	1.83	79.95

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

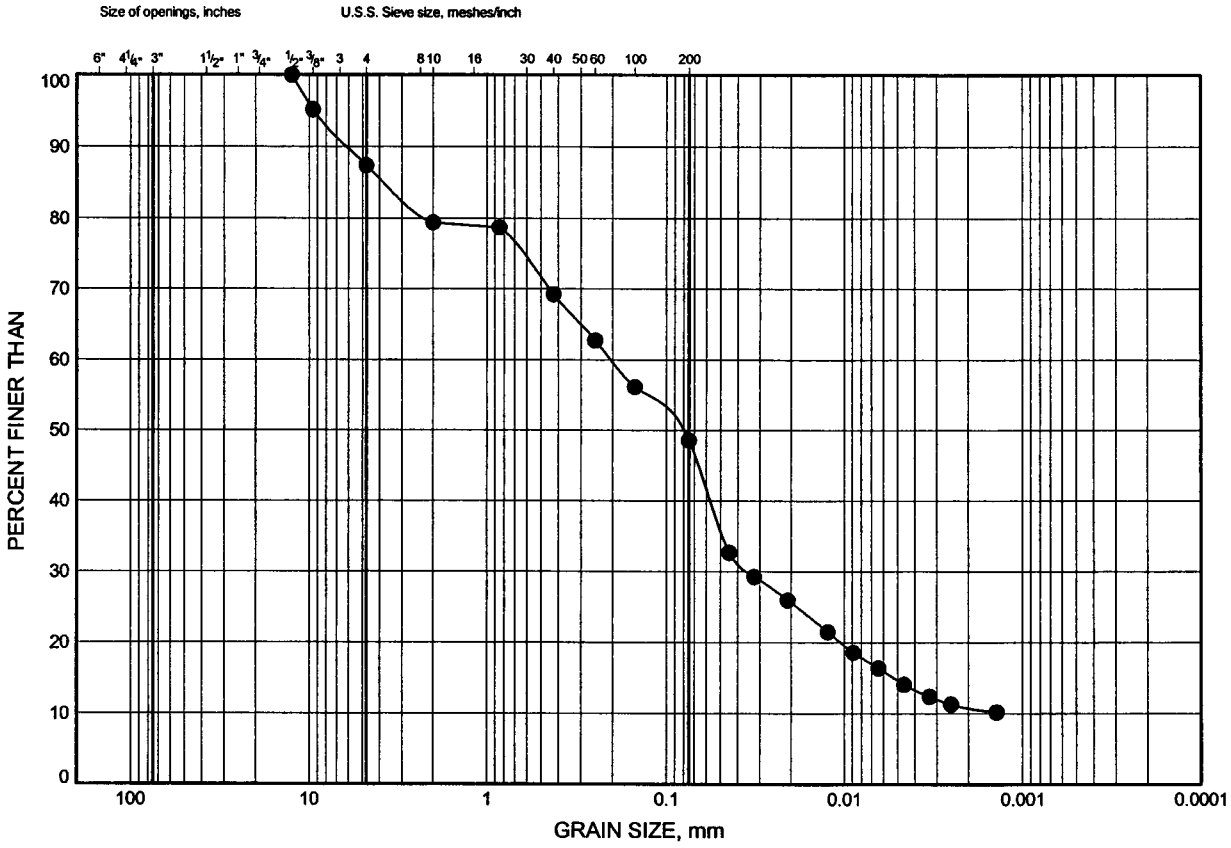
THURBGSD 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE B4

SANDY SILT



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	30+640 CL	21.64	75.36

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

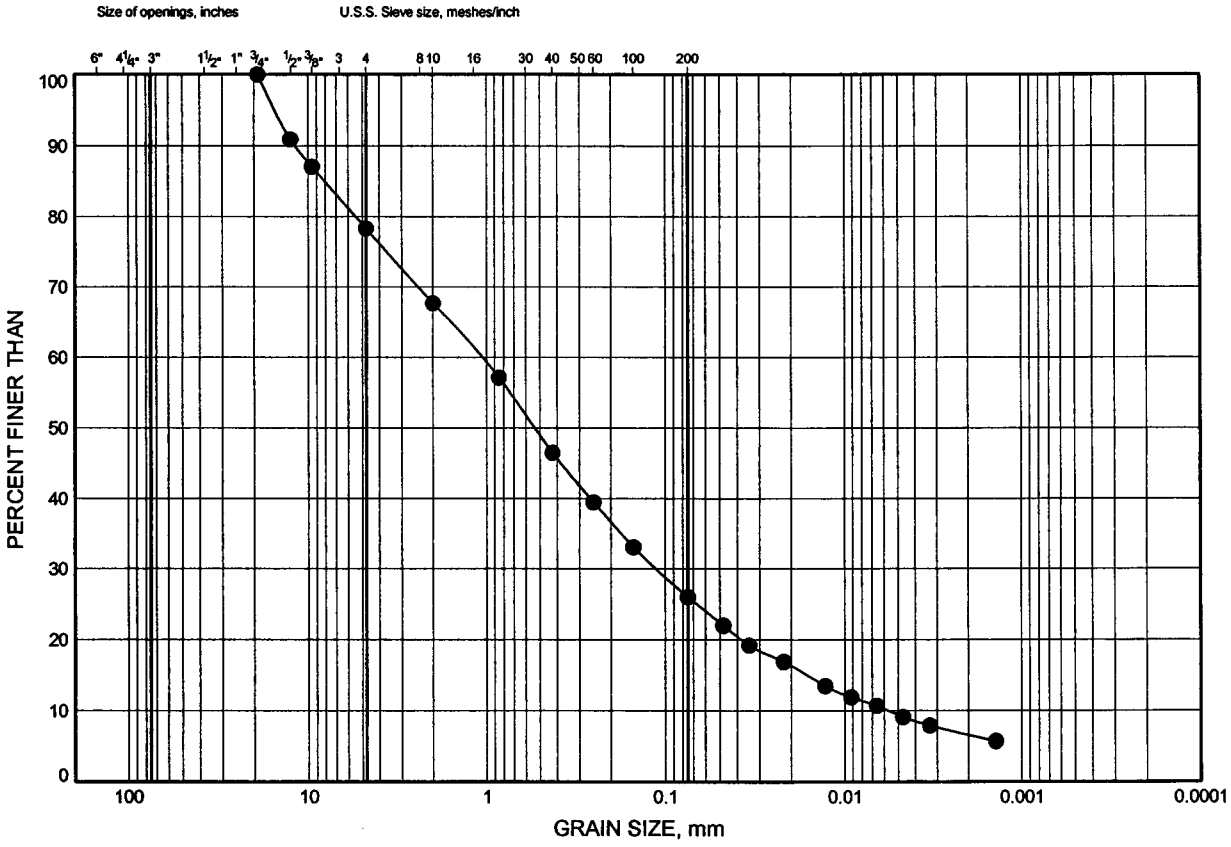
THURBGSD 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY SAND, some gravel



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	31+180 CL	1.83	81.56

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

THURBGSD 5182EMBANKMENT.GPJ 24/06/05

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

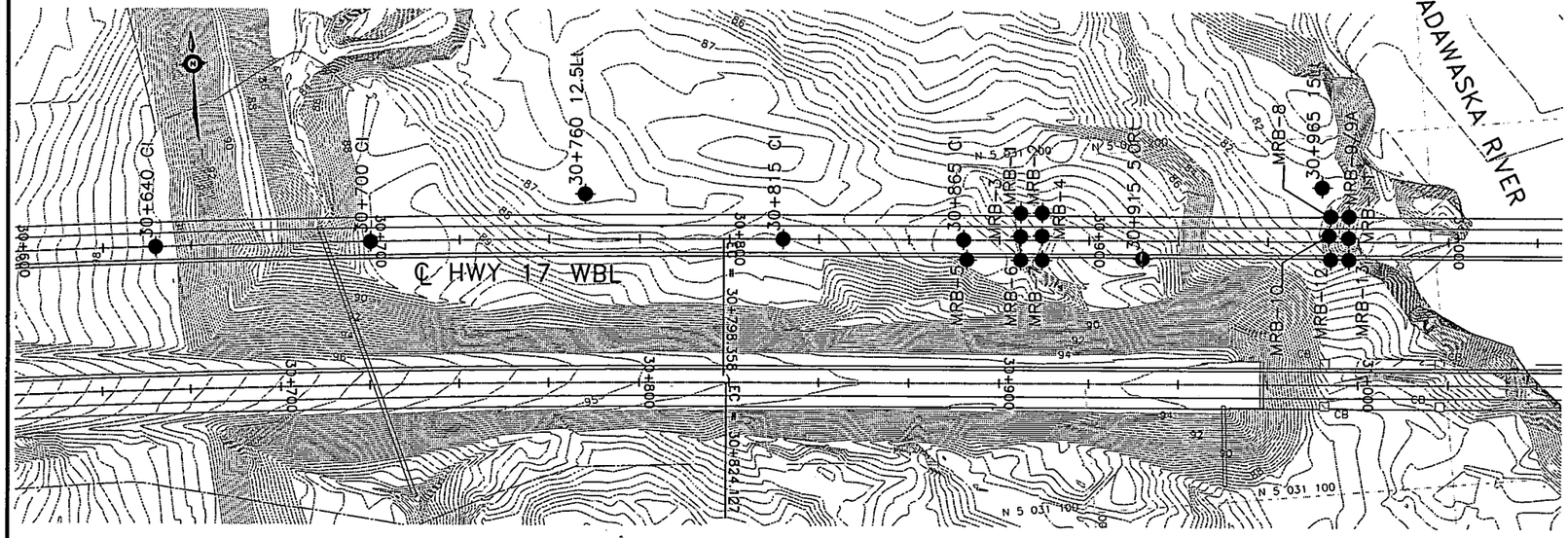
HWY.17
GWP NO. 647-92-00

HIGHWAY 17 TWINNING
MADAWASKA RIVER BRIDGE
WEST APPROACH
BOREHOLE LOCATIONS AND SOIL STRATA

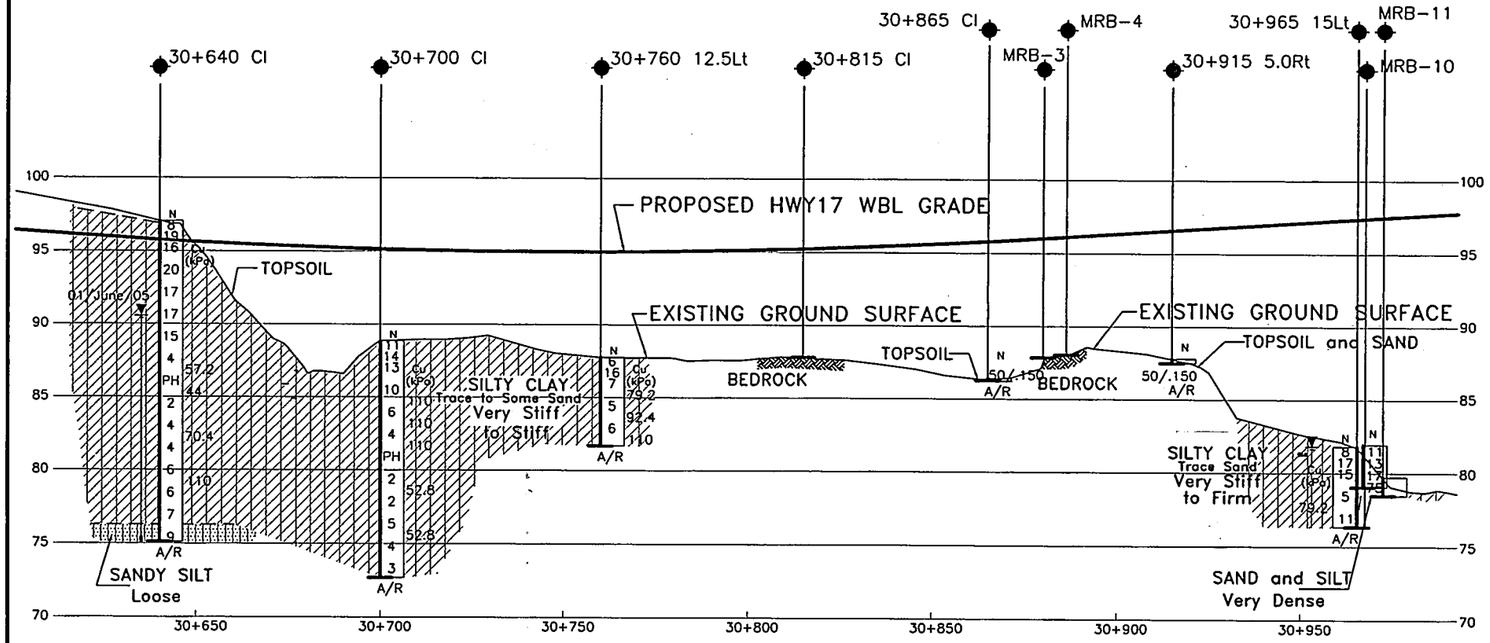
SHEET

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



PLAN
5 0 10 20m

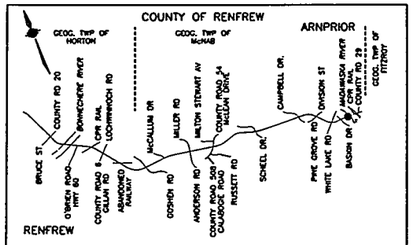


PROFILE ℄ HWY 17 WBL
5 0 10 20m HOR
1.25 0 2.5 5m VERT

NO	ELEVATION	NORTHING	EASTING
MRB-1	88.0	5 031 185.2	316 485.8
MRB-2	88.2	5 031 184.9	316 491.8
MRB-3	87.8	5 031 178.8	316 485.3
MRB-4	88.0	5 031 178.5	316 491.3
MRB-5	86.4	5 031 173.5	316 469.8
MRB-6	87.4	5 031 172.2	316 484.8
MRB-7	88.3	5 031 171.8	316 490.8
MRB-8	81.6	5 031 177.7	316 572.0
MRB-9	80.0	5 031 177.3	316 577.0
MRB-9A	80.0	5 031 177.3	316 577.0
MRB-10	81.9	5 031 172.4	316 571.1
MRB-11	79.7	5 031 171.3	316 576.5
MRB-12	82.1	5 031 165.7	316 571.0

LICENSED PROFESSIONAL ENGINEER
S. PANG
Oct. 17/05
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 17/05
PROVINCE OF ONTARIO



KEYPLAN

	LEGEND
●	Bore Hole
⊕	Dynamic Cone Penetration Test (cone) or Probe Hole
⊕	Bore Hole & Cone
N	Blows/0.3m (Std pen Test, 475J/blow)
CONE	Blows/0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	WL in Piezometer at Time of Investigation (Date)
▼	Head Artesian Water Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal
C/R	Cone Refusal

NO	STATION	OFFSET FROM CL (m)
30+640 CL	30+640	0
30+700 CL	30+700	0
30+760 12.5LT	30+760	12.5 Lt
30+815 CL	30+815	0
30+865 CL	30+865	0
30+915 5.0RT	30+915	5.0 Rt
30+965 15LT	30+965	15 Lt

— NOTE —
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

REVISIONS		
OCT, 05	SP	FINAL
JUN, 05	SP	ISSUED AS DRAFT FOR REVIEW
DATE	BY	DESCRIPTION

DESIGN SP	CHK AEG	CODE CHBDC	LOAD	DATE JUN. 2005	
DRAWN HS	CHK SP	SITE	STRUCT	SCHEME	DWG M1

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

HWY.17

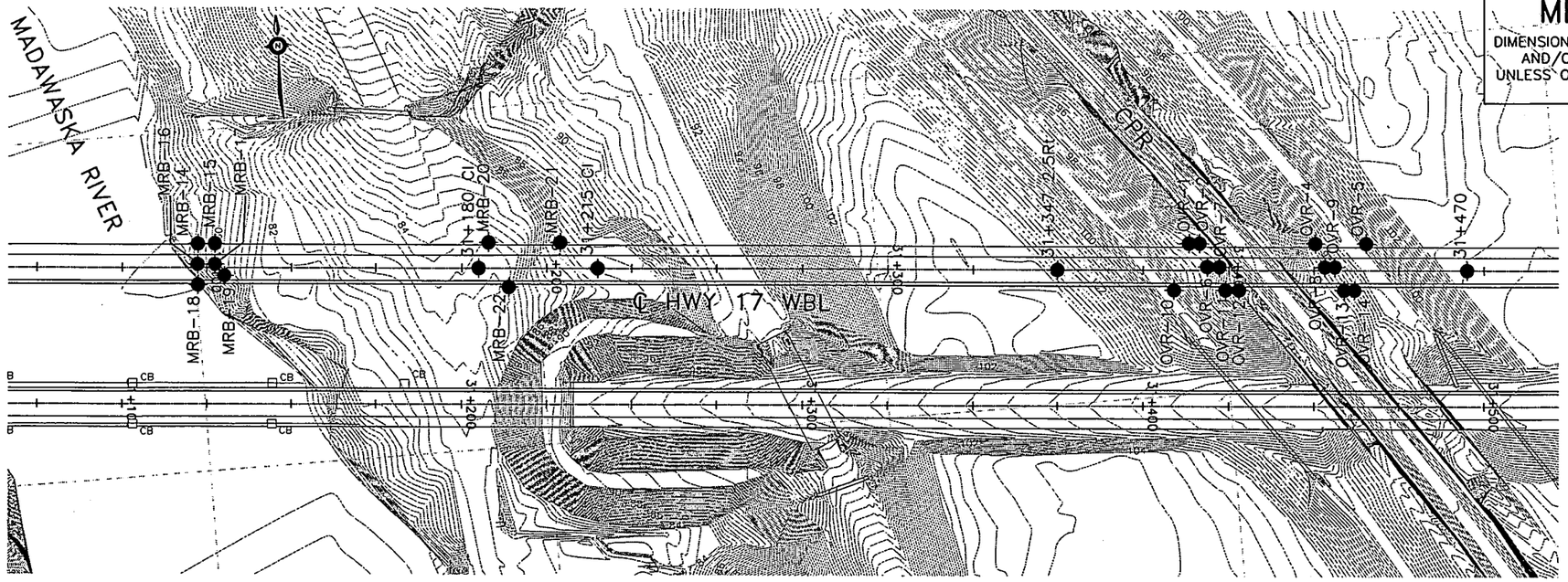
GWP NO. 647-92-00

SHEET

HIGHWAY 17 TWINNING
MADAWASKA RIVER BRIDGE EAST APPROACH
CPR OVERHEAD WEST & EAST APPROACHES
BOREHOLE LOCATIONS AND SOIL STRATA

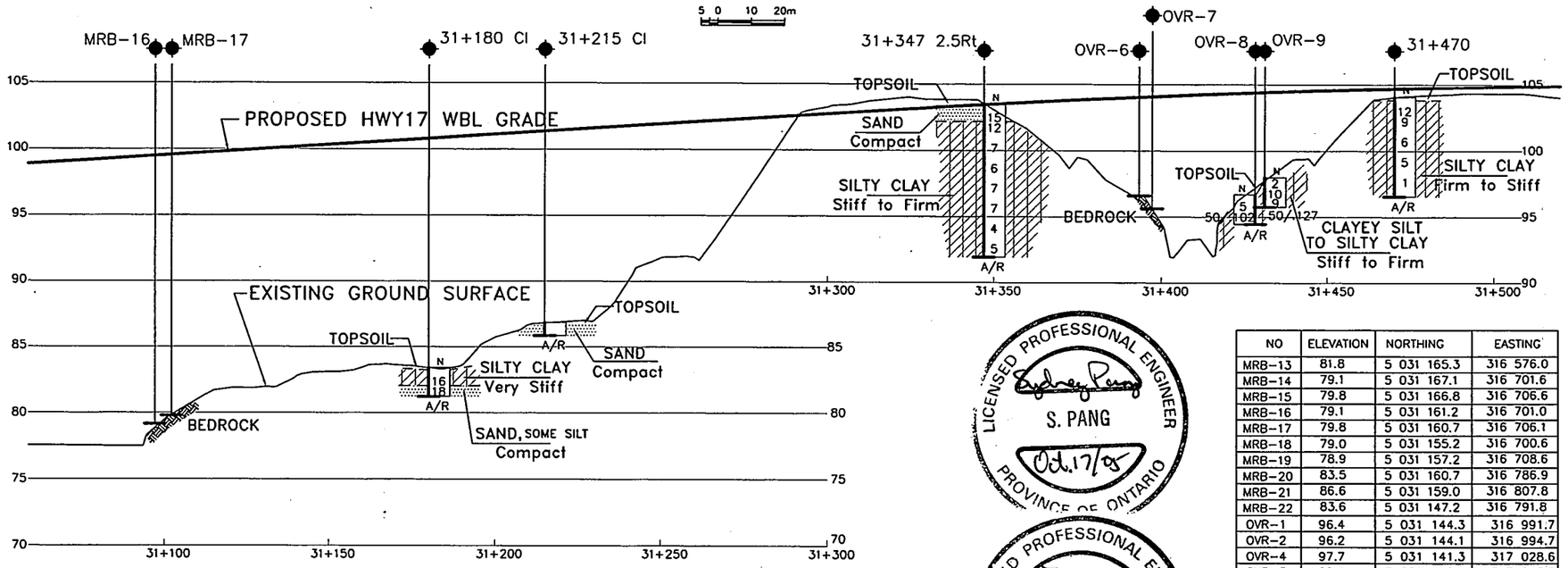
McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



PLAN

5 0 10 20m

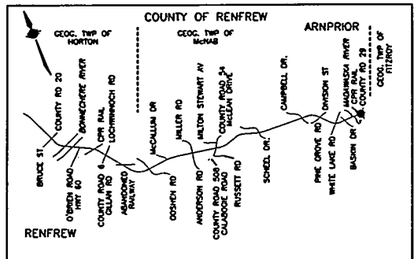


PROFILE ℄ HWY 17 WBL

5 0 10 20m HOR
1.25 0 2.5 5m VERT

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

NO	ELEVATION	NORTHING	EASTING
MRB-13	81.8	5 031 165.3	316 576.0
MRB-14	79.1	5 031 167.1	316 701.6
MRB-15	79.8	5 031 166.8	316 706.6
MRB-16	79.1	5 031 161.2	316 701.0
MRB-17	79.8	5 031 160.7	316 706.1
MRB-18	79.0	5 031 155.2	316 700.6
MRB-19	78.9	5 031 157.2	316 708.6
MRB-20	83.5	5 031 160.7	316 786.9
MRB-21	86.6	5 031 159.0	316 807.8
MRB-22	83.6	5 031 147.2	316 791.8
OVR-1	96.4	5 031 144.3	316 991.7
OVR-2	96.2	5 031 144.1	316 994.7
OVR-4	97.7	5 031 141.3	317 028.6
OVR-5	99.1	5 031 140.1	317 043.5
OVR-6	96.7	5 031 137.1	316 996.4
OVR-7	95.5	5 031 136.8	316 999.8
OVR-8	97.3	5 031 134.2	317 030.8
OVR-9	98.0	5 031 134.0	317 033.8
OVR-10	98.9	5 031 131.1	316 986.2
OVR-11	95.1	5 031 129.8	317 001.2
OVR-12	94.1	5 031 129.5	317 005.1
OVR-13	97.5	5 031 127.0	317 036.0
OVR-14	98.3	5 031 126.8	317 039.0



KEYPLAN

LEGEND

●	Bore Hole
⊕	Dynamic Cone Penetration Test (cone) or Probe Hole
◈	Bore Hole & Cone
N	Blows/0.3m (Std pen Test, 475J/blow)
CONE	Blows/0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	WL in Piezometer at Time of Investigation (Date)
▼	Head Artesian Water Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal
C/R	Cone Refusal

NO	STATION	OFFSET FROM CL (m)
31+180 CL	31+180	0
31+215 CL	31+215	0
31+347 2.5m RT	31+347	2.5 Rt
31+470 CL	31+470	0

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS

DATE	BY	DESCRIPTION
OCT. 05	SP	FINAL
JUN. 05	SP	ISSUED AS DRAFT FOR REVIEW

DESIGN SP	CHK AEG	CODE CHBDC	LOAD	DATE JUN. 2005	
DRAWN HS	CHK SP	SITE	STRUCT	SCHEME	DWG C1

Appendix C

CPR Overhead Arnprior Bridge Approaches
Records of Boreholes, Laboratory Test Results, Drawings

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

SS Split Spoon Sample WS Wash Sample AS Auger (Grab) Sample
TW Thin Wall Shelby Tube Sample TP Thin Wall Piston Sample
PH Sampler Advanced by Hydraulic Pressure PM Sampler Advanced by Manual Pressure
WH Sampler Advanced by Self Static Weight RC Rock Core SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

$\overline{\blacktriangledown}$ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
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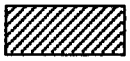
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

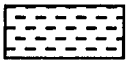
EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 31+347 2.5m RT 1 OF 2 METRIC

W.P. 19-1351-82 LOCATION CPR Overhead (Amprior) ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 31.05.05 - 31.05.05 CHECKED BY SKP

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
103.5											
0.0	**TOPSOIL** (150mm)										
0.2	**SAND**, fine grained, trace silt Compact Brown Moist		1	SS	15		103		○		
102.2											
1.3	Silty **CLAY**, some seashell Stiff to Firm Brown		2	SS	12		102		○		
			3	SS	7		101		⊢●○		0 0 53 47
			4	SS	6		100		○		
	Becoming Grey		5	SS	7		99	3.5	○		
	some sand seams		6	SS	7		98		○		
			7	SS	4		97		⊢●○		
							96				
							95				
							94				

Continued Next Page

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

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

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 31+347 2.5m RT 2 OF 2 METRIC

W.P. 19-1351-82 LOCATION CPR Overhead (Amprior) ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 31.05.05 - 31.05.05 CHECKED BY SKP

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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
							93				
			8	SS	5				○		
91.9							92				
11.6	END OF BOREHOLE AT 11.60 m. AUGER REFUSAL AT 11.60 m ON PROBABLE BEDROCK. BOREHOLE GROUTED TO SURFACE.										

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

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

ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 31+470 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION CPR Overhead (Amprior) ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 31.05.05 - 31.05.05 CHECKED BY SKP

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
104.0											
0.0	**TOPSOIL** (200mm)						104				
0.2	Silty **CLAY**, trace sand Stiff to Firm Brown										
			1	SS	12		103		○		
			2	SS	9		102		○		
			3	SS	6		101		○		
			4	SS	5		100		⊢●		0 3 59 38
	Becoming Grey, Soft		5	SS	1		99		○		
96.5							98				
7.5	END OF BOREHOLE AT 7.52 m. AUGER REFUSAL AT 7.52m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 7.01 m AND DRY UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.						97				

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

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

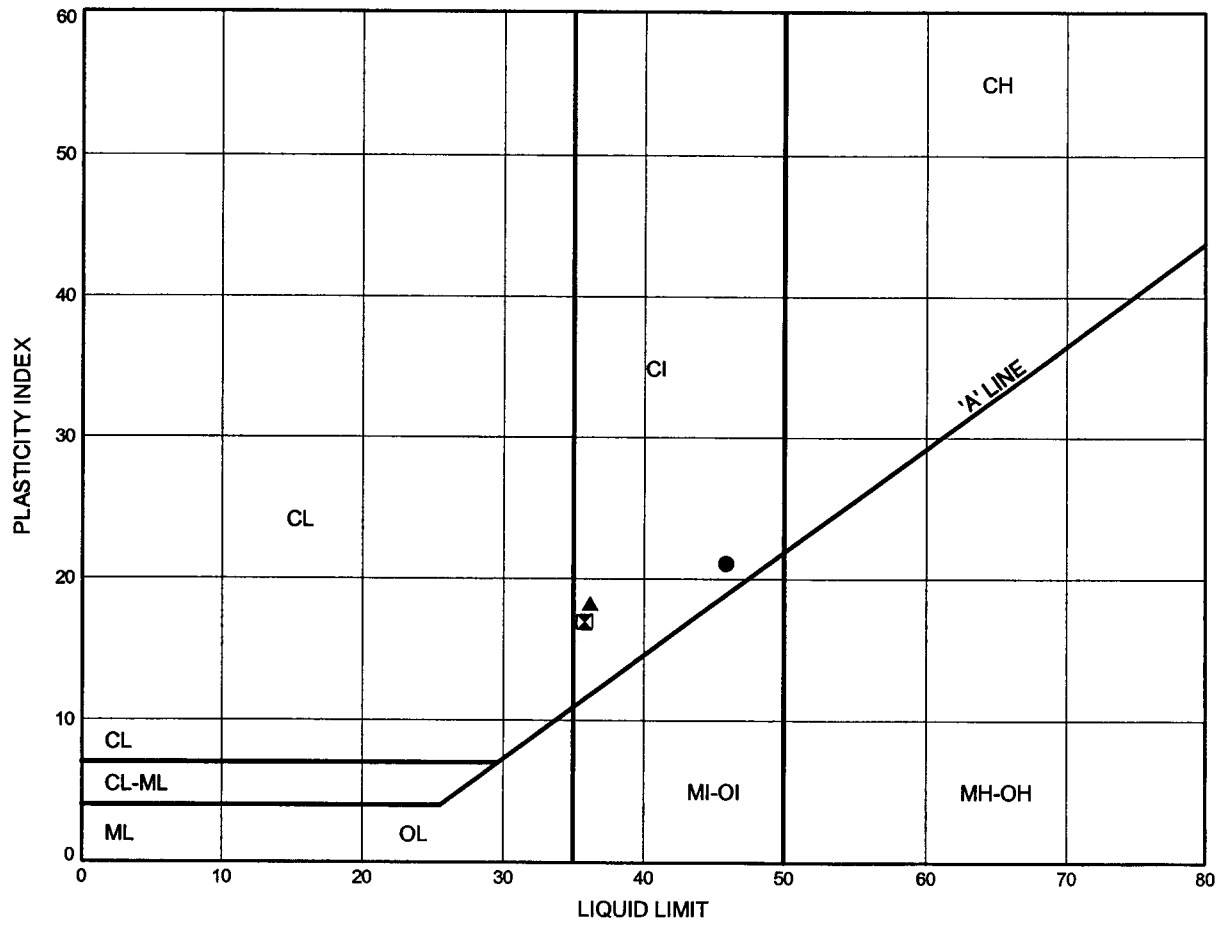
ONTMT4S 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE C1

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	31+347 2.5m RT	3.35	100.15
⊠	31+347 2.5m RT	9.45	94.05
▲	31+470 CL	4.88	99.14

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

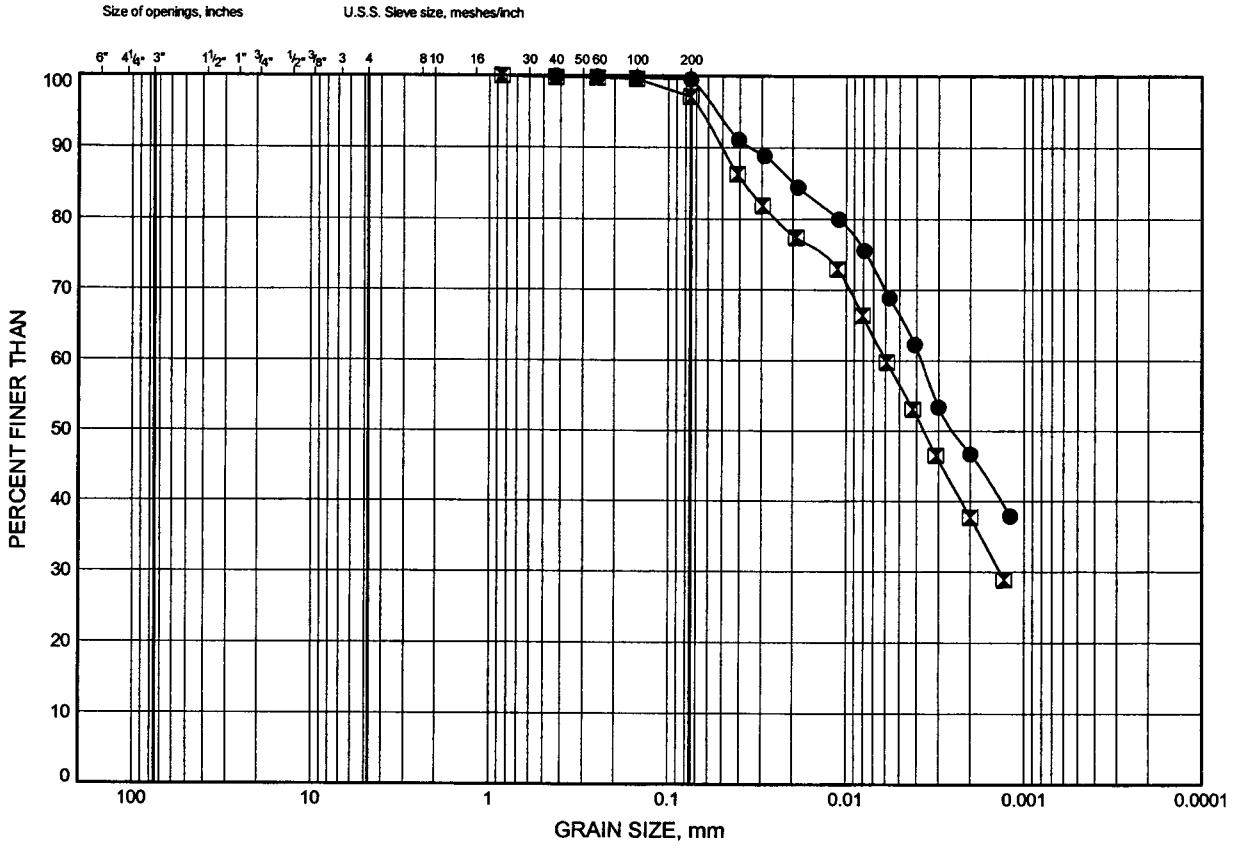
THURBALT 5182EMBANKMENT.GPJ 24/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE C2

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	31+347 2.5m RT	3.35	100.15
⊠	31+470 CL	4.88	99.14

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

THURBGSD 5182EMBANKMENT.GPJ 24/06/05

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

HWY.17

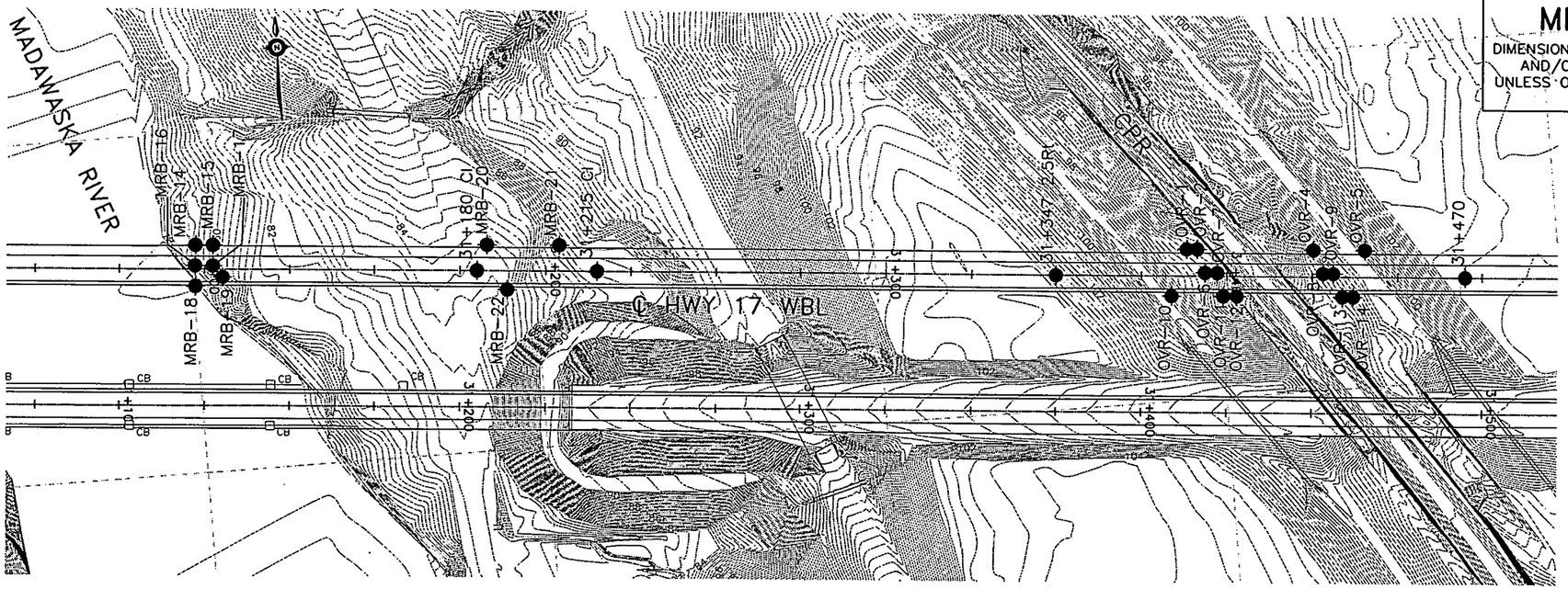
GWP NO. 647-92-00

HIGHWAY 17 TWINNING
MADAWASKA RIVER BRIDGE EAST APPROACH
CPR OVERHEAD WEST & EAST APPROACHES
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

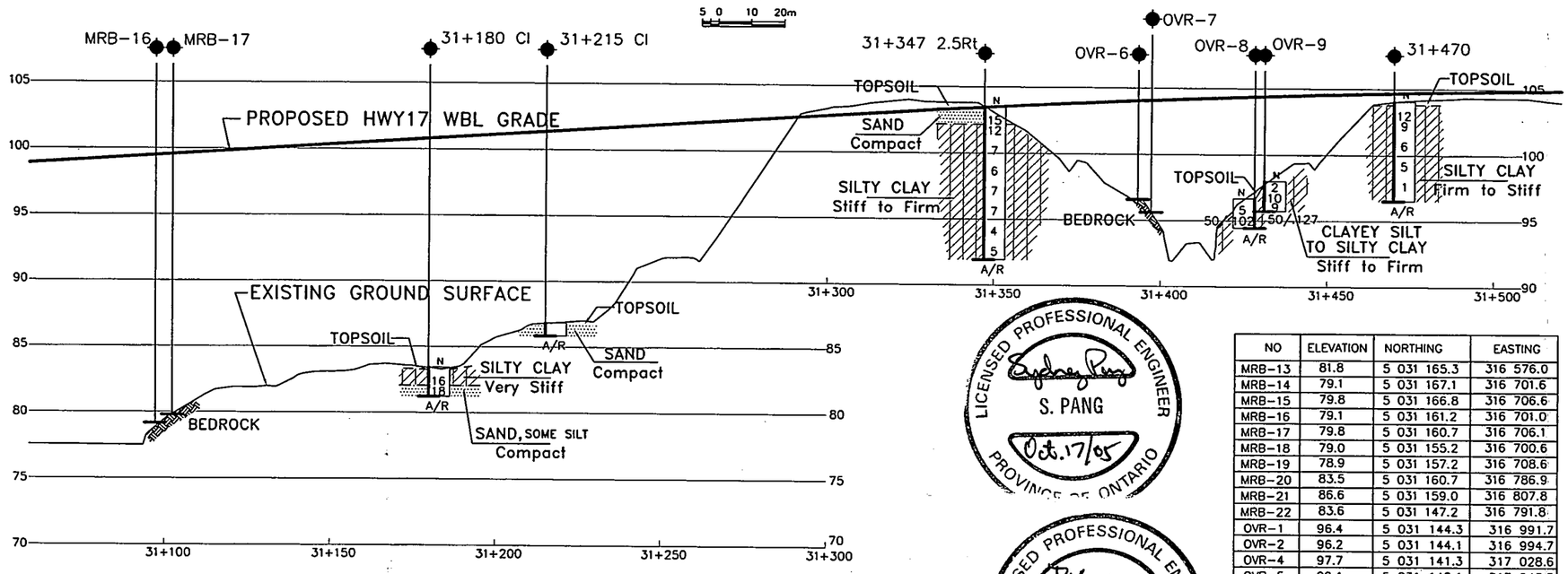
McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



PLAN

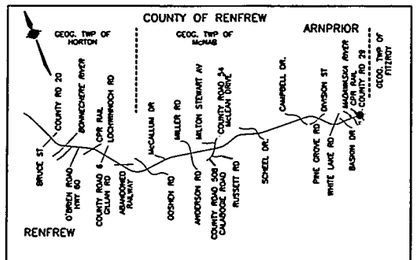
5 0 10 20m



PROFILE ℄ HWY 17 WBL

5 0 10 20m HOR
1.25 0 2.5 5m VERT

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



KEYPLAN

LEGEND

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CONE	Blows/0.3m (60° Cone, 475J/blow)
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▼	Head Artesian Water Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
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31+180 CL	31+180	0
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NOTE

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LICENSED PROFESSIONAL ENGINEER
S. PANG
Oct. 17/05
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Oct 17/05
PROVINCE OF ONTARIO

NO	ELEVATION	NORTHING	EASTING
MRB-13	81.8	5 031 165.3	316 576.0
MRB-14	79.1	5 031 167.1	316 701.6
MRB-15	79.8	5 031 166.8	316 706.6
MRB-16	79.1	5 031 161.2	316 701.0
MRB-17	79.8	5 031 160.7	316 706.1
MRB-18	79.0	5 031 155.2	316 700.6
MRB-19	78.9	5 031 157.2	316 708.6
MRB-20	83.5	5 031 160.7	316 786.9
MRB-21	86.6	5 031 159.0	316 807.8
MRB-22	83.6	5 031 147.2	316 791.8
OVR-1	96.4	5 031 144.3	316 991.7
OVR-2	96.2	5 031 144.1	316 994.7
OVR-4	97.7	5 031 141.3	317 028.6
OVR-5	99.1	5 031 140.1	317 043.5
OVR-6	96.7	5 031 137.1	316 996.4
OVR-7	95.5	5 031 136.8	316 999.8
OVR-8	97.3	5 031 134.2	317 030.8
OVR-9	98.0	5 031 134.0	317 033.8
OVR-10	98.9	5 031 131.1	316 986.2
OVR-11	95.1	5 031 129.8	317 001.2
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Division Street Underpass Approaches
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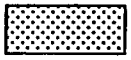
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS


CLAYSTONE


SILTSTONE


SANDSTONE


COAL


Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

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THURBER

RECORD OF BOREHOLE No DIV 9+780 CL 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Division Street ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 26.05.05 - 26.05.05 CHECKED BY SKP

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
109.1											
0.0	**TOPSOIL** (150mm)						109				
0.2	Silty **CLAY** Stiff to Firm Brown		1	SS	11		108				
			2	SS	6		107				0 4 49 47
106.4											
2.7	Clayey **SILT**, some sand, trace gravel, occasional cobbles Stiff to Very Stiff Grey Moist to Wet (TILL)		3	SS	14		106				
			4	SS	50/100		105				
103.9							104				
5.1	END OF BOREHOLE AT 5.13 m. AUGER REFUSAL AT 5.13 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 5.13 m AND DRY UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

ONTMT4S 5182EMBANKMENT.GPJ 27/06/05

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

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

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THURBER

RECORD OF BOREHOLE No DIV 9+830 6m RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Division Street ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 26.05.05 - 26.05.05 CHECKED BY SKP

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 110.3	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
0.0	**TOPSOIL** (150mm)										
0.2	Silty **CLAY** Firm Brown		1	SS	5		110		○		
108.8							109				
1.4	Clayey **SILT**, some sand, trace gravel Stiff to Very Stiff Brown Moist to Wet (TILL)		2	SS	15		108		○		1 57 30 12
107.0			3	SS	50/.125						
3.3	END OF BOREHOLE AT 3.25 m. AUGER REFUSAL AT 3.25 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 2.90 m AND DRY UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No DIV 9+872 3m LT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Division Street ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 26.05.05 - 26.05.05 CHECKED BY SKP

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
110.6											
0.0	**SAND and GRAVEL**, trace silt Brown Moist (FILL)						110				
109.7											
0.8	Silty **CLAY**		1	SS	50/						
109.5	Brown				075						
1.1	Moist END OF BOREHOLE AT 1.09 m. AUGER REFUSAL AT 1.09 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 1.09 m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.										

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

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

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THURBER

RECORD OF BOREHOLE No DIV 9+930 5m RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Division Street ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 26.05.05 - 26.05.05 CHECKED BY SKP

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
110.3											
0.0	**TOPSOIL** (100mm)										
0.1	**SAND and GRAVEL**, trace silt Dark Brown Moist (FILL)		1	SS	7		110		○		
108.9							109				
1.4	Clayey **SILT**, some sand, trace gravel Very Stiff to Stiff Brown Moist (TILL)		2	SS	17				○		10 48 27 15
							108				
			3	SS	8		107		○		
106.3											
4.1	END OF BOREHOLE AT 4.09 m. AUGER REFUSAL AT 4.09 m ON PROBABLE BEDROCK. BOREHOLE OPEN TO 2.60 m AND DRY UPON COMPLETION. BOREHOLE GROUTED TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

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THURBER

RECORD OF BOREHOLE No DIV 10+100 RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Division Street ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 06.01.05 - 06.01.05 CHECKED BY SKP

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						
112.6											
0.0 / 112.3	**SAND and GRAVEL** (300mm)										
0.3	Silty **SAND**, trace gravel, trace clay Compact Brown Moist to Wet (FILL)						112		○		
111.0											
1.5	END OF BOREHOLE AT 1.52m. AUGER REFUSAL AT 1.52m ON PROBABLE BEDROCK OR BOULDERS. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION BOREHOLE GROUTED TO THE SURFACE.										

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

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

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No DIV 10+145 RT 1 OF 1 METRIC

W.P. 19-1351-82 LOCATION Division Street ORIGINATED BY SL

HWY HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY WM/HS

DATUM Geodetic DATE 06.01.05 - 06.01.05 CHECKED BY SKP

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
112.6											
0.0 / 112.3	**SAND and GRAVEL**, trace silt Brown (FILL)										
0.3	Clayey **SILT**, trace gravel, with sand seams Stiff to Very Stiff Brown (TILL)		1	SS	12		112		○		
	Becoming Grey		2	SS	23		111		○		
			3	SS	11		110		○		2 52 31 15
			4	SS	12		109		○		
106.7							108				
5.8	END OF THE BOREHOLE AT 5.84 m. AUGER REFUSAL AT 5.84 m ON PROBABLE BEDROCK. BOREHOLE GROUTED TO THE SURFACE.						107				

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

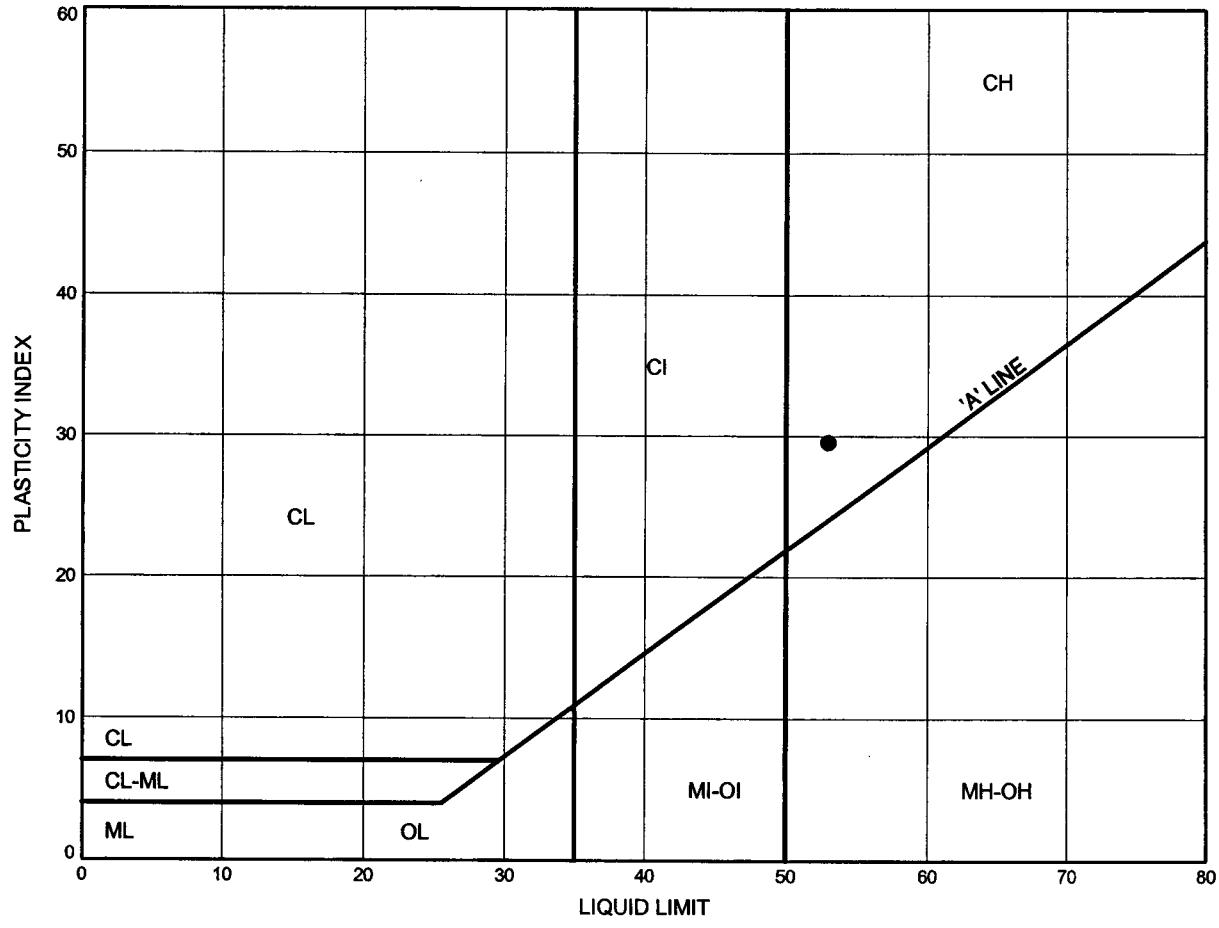
$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

HWY 17 Twinning, Arnprior to Renfrew

ATTERBERG LIMITS TEST RESULTS

FIGURE D1

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	DIV 9+780 CL	1.83	107.23

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

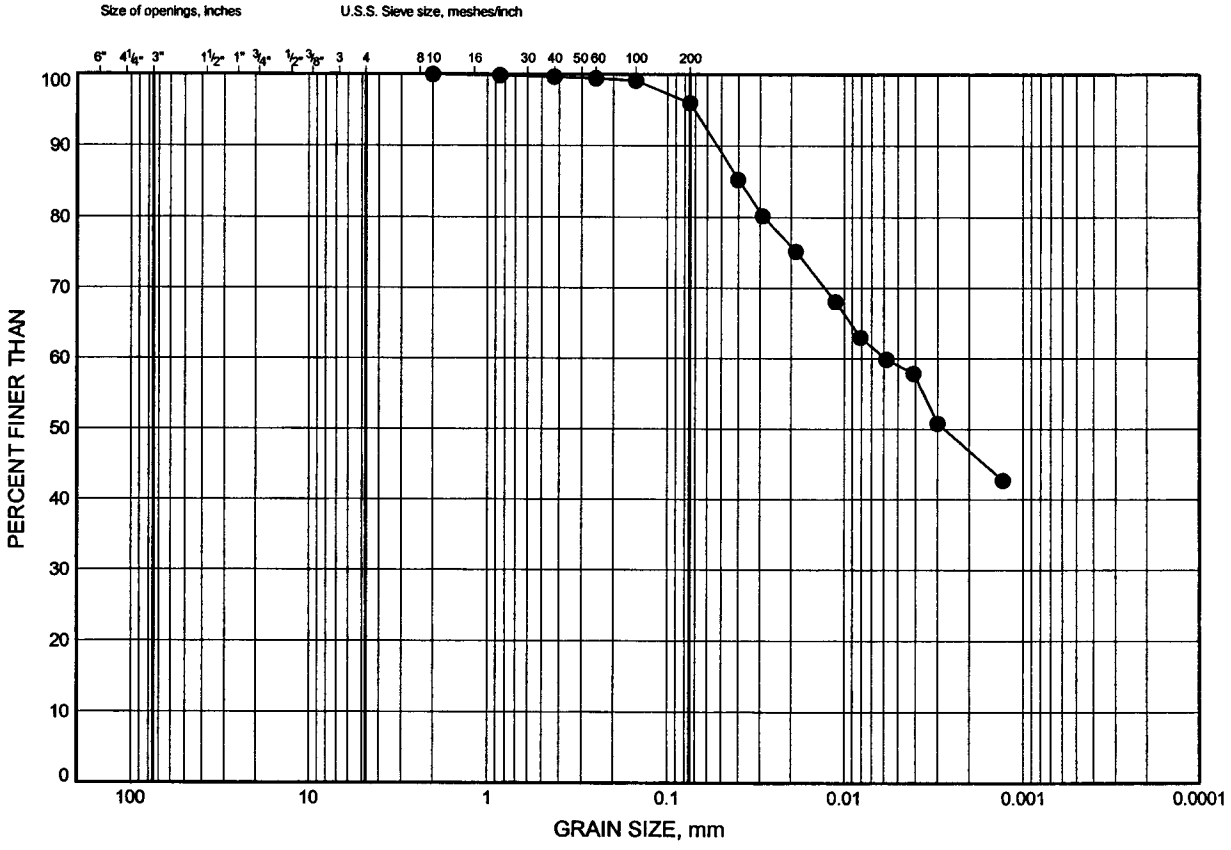
THURBALT 5182EMBANKMENT.GPJ 29/06/05

HWY 17 Twinning, Amprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE D2

SILTY CLAY



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	DIV 9+780 CL	1.83	107.23

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

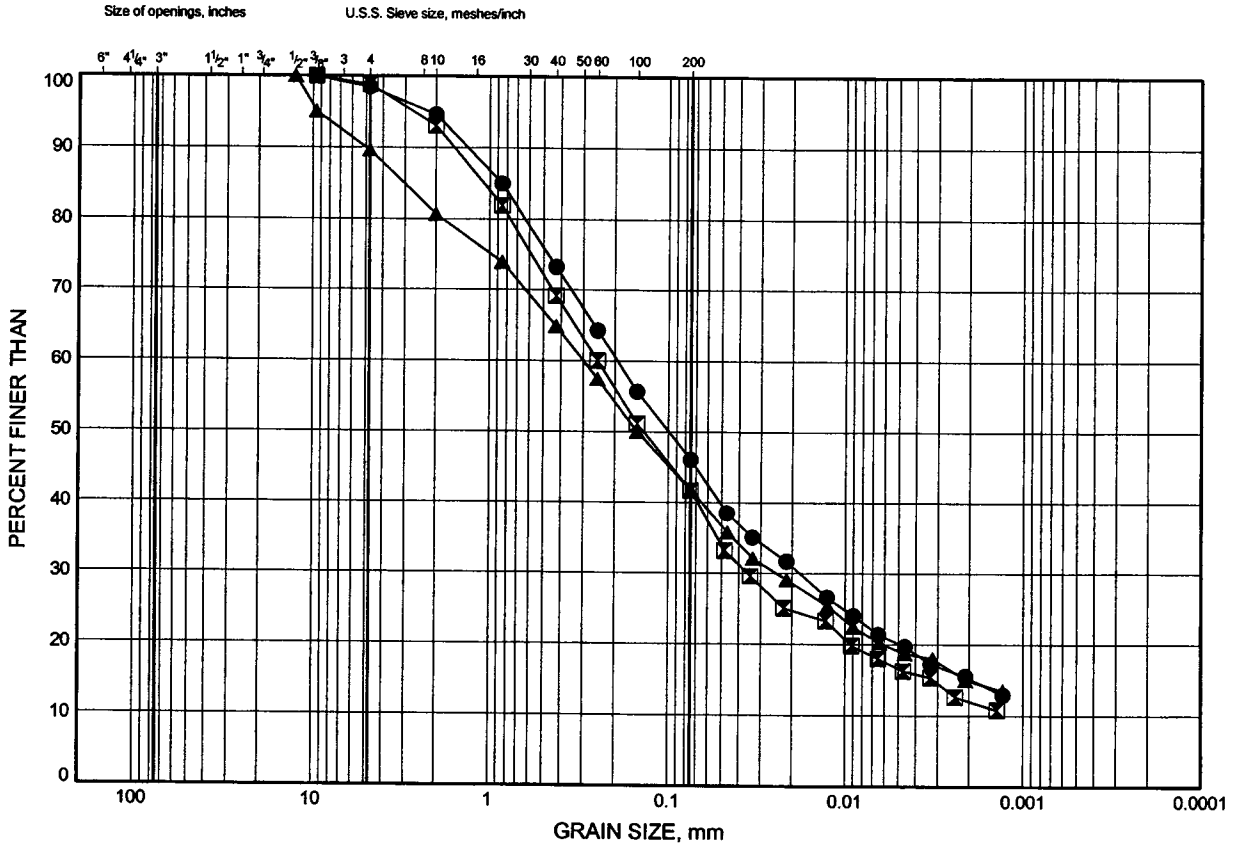
THURBGSD 5182EMBANKMENT.GPJ 27/06/05

HWY 17 Twinning, Arnprior to Renfrew

GRAIN SIZE DISTRIBUTION

FIGURE D3

CLAYEY SILT TILL



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

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	DIV 10+145 RT Shoulder	3.35	109.24
⊠	DIV 9+830 6m RT	1.83	108.46
▲	DIV 9+930 5m RT	1.83	108.52

Date June 2005

Project 19-1351-82

THURBER

Prep'd HS

Chkd. SP

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METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

HWY.17

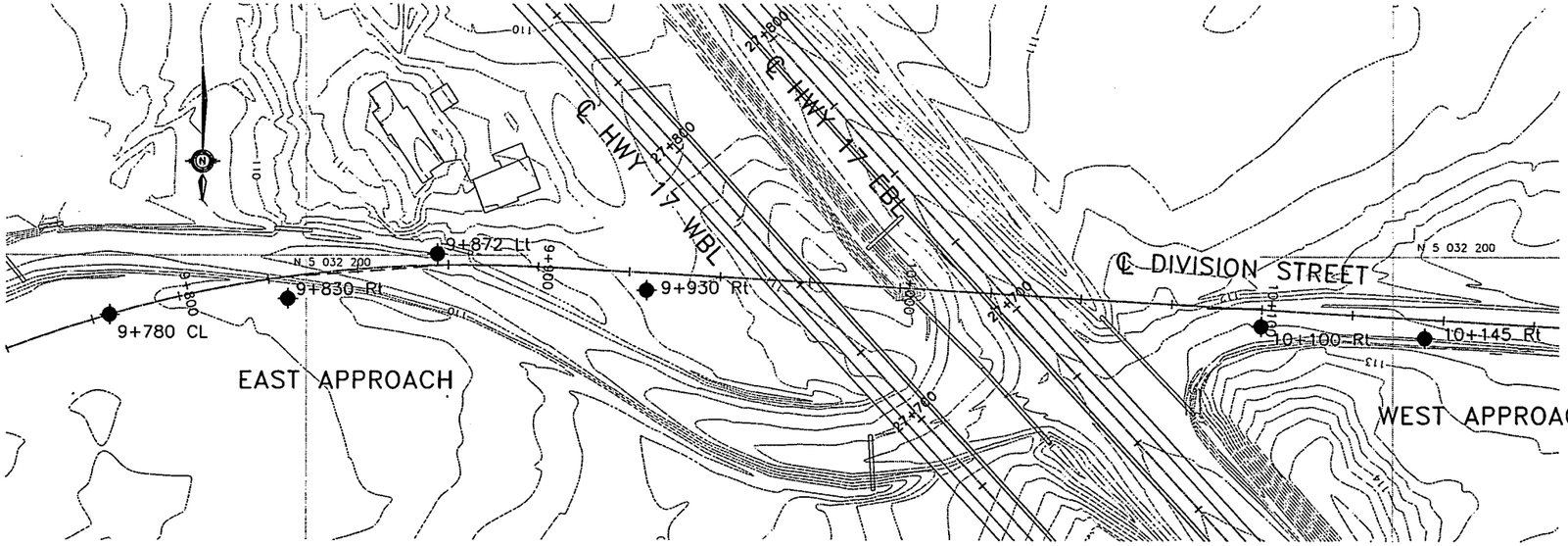
GWP NO. 647-92-00

HIGHWAY 17 TWINNING
DIVISION STREET
BOREHOLE LOCATIONS AND SOIL STRATA

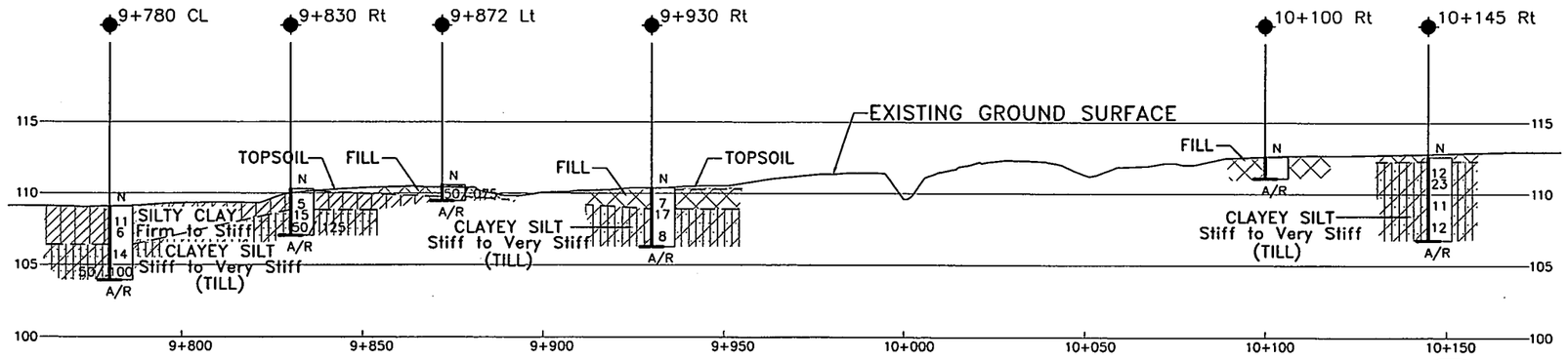
SHEET

McCORMICK RANKIN CORPORATION

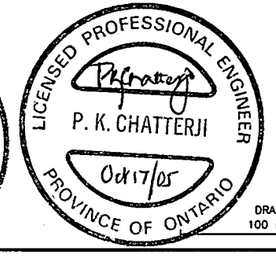
THURBER ENGINEERING LTD.



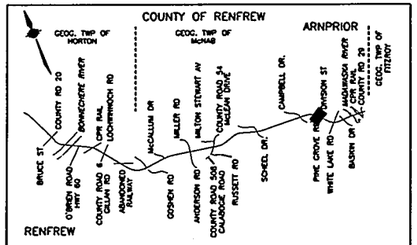
PLAN
5 0 10 20m



PROFILE ℄ DIVISION STREET
5 0 10 20m HOR
1.25 0 2.5 5m VERT



DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING



KEYPLAN

	LEGEND
◆	Bore Hole
⊕	Dynamic Cone Penetration Test (cone) or Probe Hole
◈	Bore Hole & Cone
N	Blows/0.3m (Std pen Test, 475J/blow)
CONE	Blows/0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▼	WL in Piezometer at Time of Investigation (Date)
▼	Head Artesian Water Piezometer
▼	WL in Open Borehole Upon Completion of Drilling
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal
C/R	Cone Refusal

NO	STATION	OFFSET FROM CL (m)
9+780 CL	9+780	0
9+830 Rt	9+830	R6
9+872 Lt	9+872	L3
9+930 Rt	9+930	R5
10+100 Rt	10+100	R5
10+145 Rt	10+145	R5

NOTE

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

REVISIONS		
OCT, 05	SP	FINAL
JUN, 05	SP	ISSUED AS DRAFT FOR REVIEW
DATE	BY	DESCRIPTION

DESIGN SP	CHK AEG	CODE CHBDC	LOAD	DATE JUN, 2005	
DRAWN HS	CHK SP	SITE	STRUCT	SCHEME	DWG 01

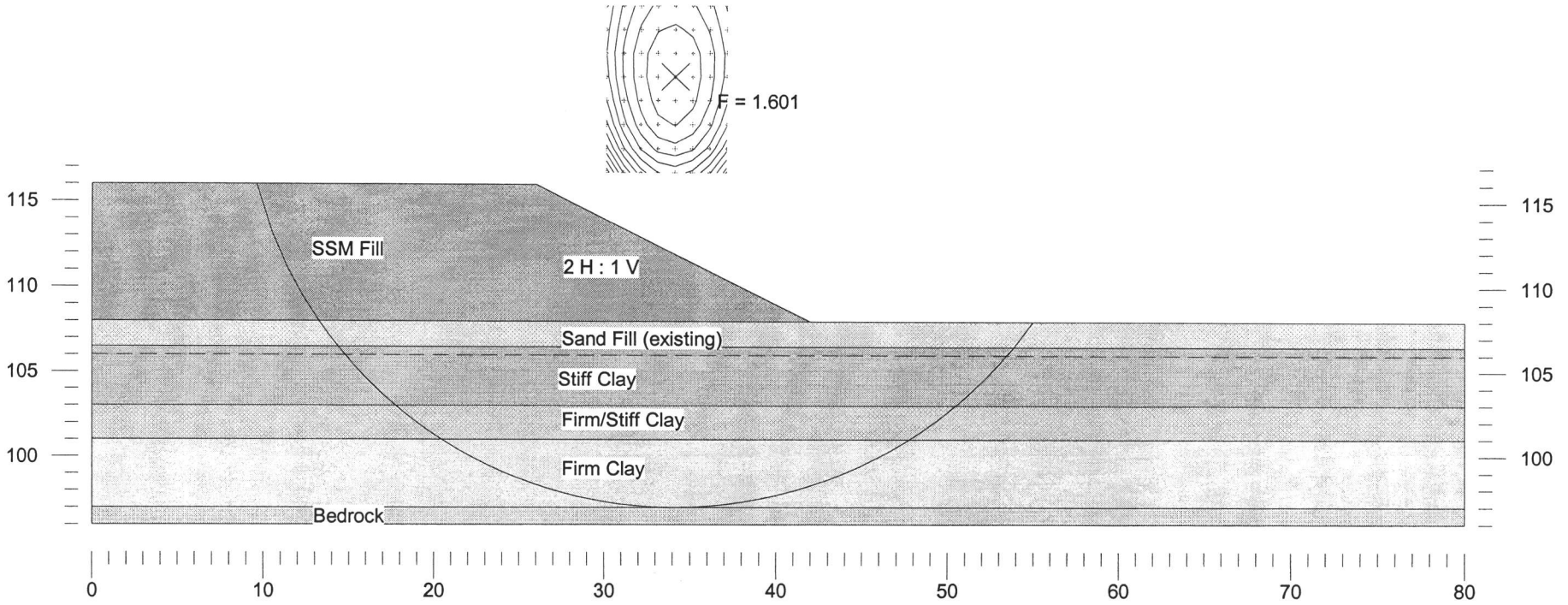
Appendix E

Selected Stability Analyses Results

White Lake Road Interchange

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Sand Fill	20	0	30	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	1
Firm Clay	17	40	0	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
19-3745-0
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - South Approach
Figure E1 Undrained Analysis - SSM Fill

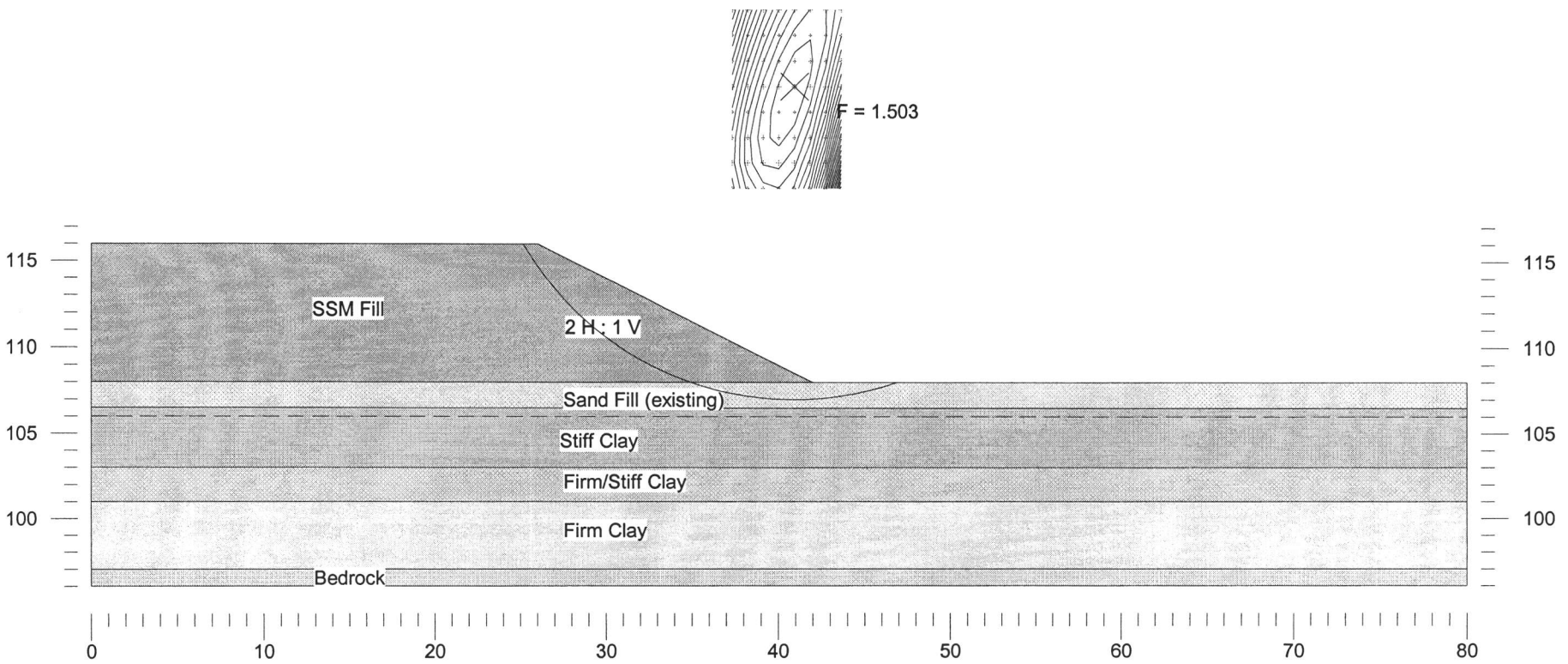


29/06/2005 10:33:32 AM C:\SPANG\THURB~12\19-135~4\FIGE1.GSL Thurber Engineering Ltd. - Toronto F = 1.601

FIGURE E1

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Sand Fill	20	0	30	0	0
StiffvStiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	1
Firm Clay	17	0	27	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
19-3745-0
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - South Approach
Figure E2 Drained Analysis - SSM Fill

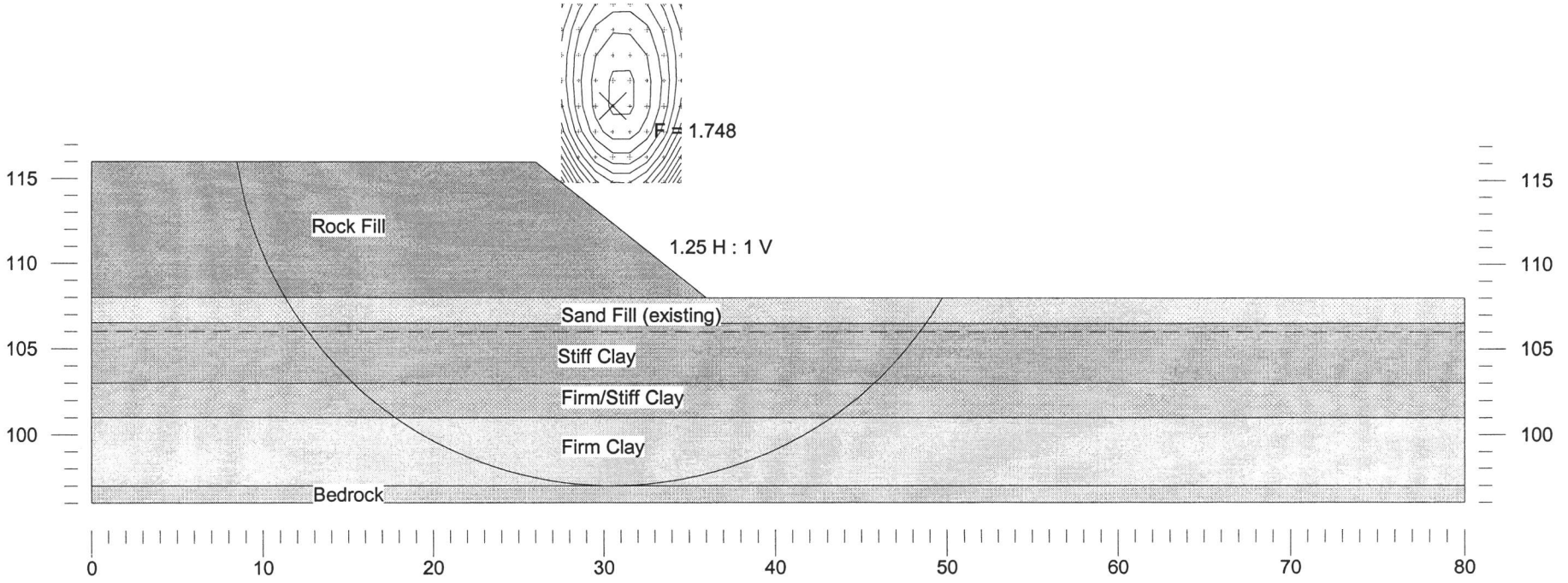


29/06/2005 10:34:35 AM C:\SPANG\THURB~12\19-135~4\FIGE2.GSL Thurber Engineering Ltd. - Toronto F = 1.503

FIGURE E2

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Rock Fill	19	0	42	0	0
Sand Fill	20	0	30	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	1
Firm Clay	17	40	0	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
19-3745-0
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - South Approach
Figure E3 Undrained Analysis - Rock Fill

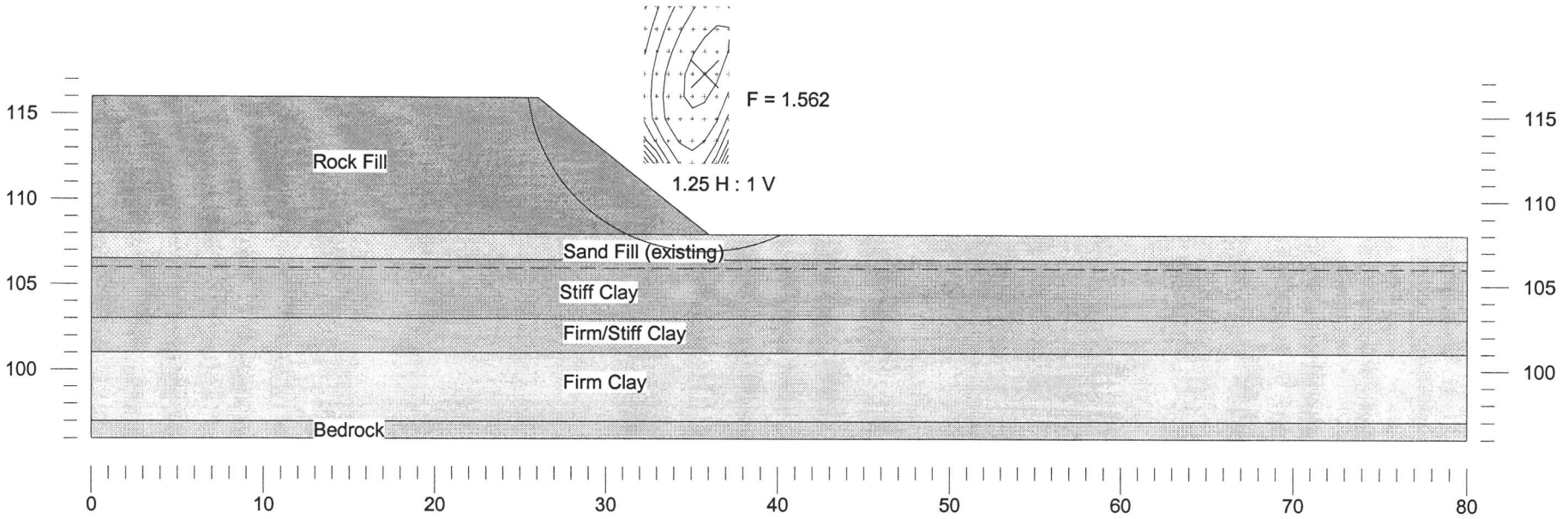


29/06/2005 10:35:32 AM C:\SPANG\THURB~12\19-135~4\FIGE3.GSL Thurber Engineering Ltd. - Toronto F = 1.748

FIGURE E3

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Rock Fill	19	0	42	0	0
Sand Fill	20	0	30	0	0
StiffvStiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	1
Firm Clay	17	0	27	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
19-3745-0
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - South Approach
Figure E4 Drained Analysis - Rock Fill

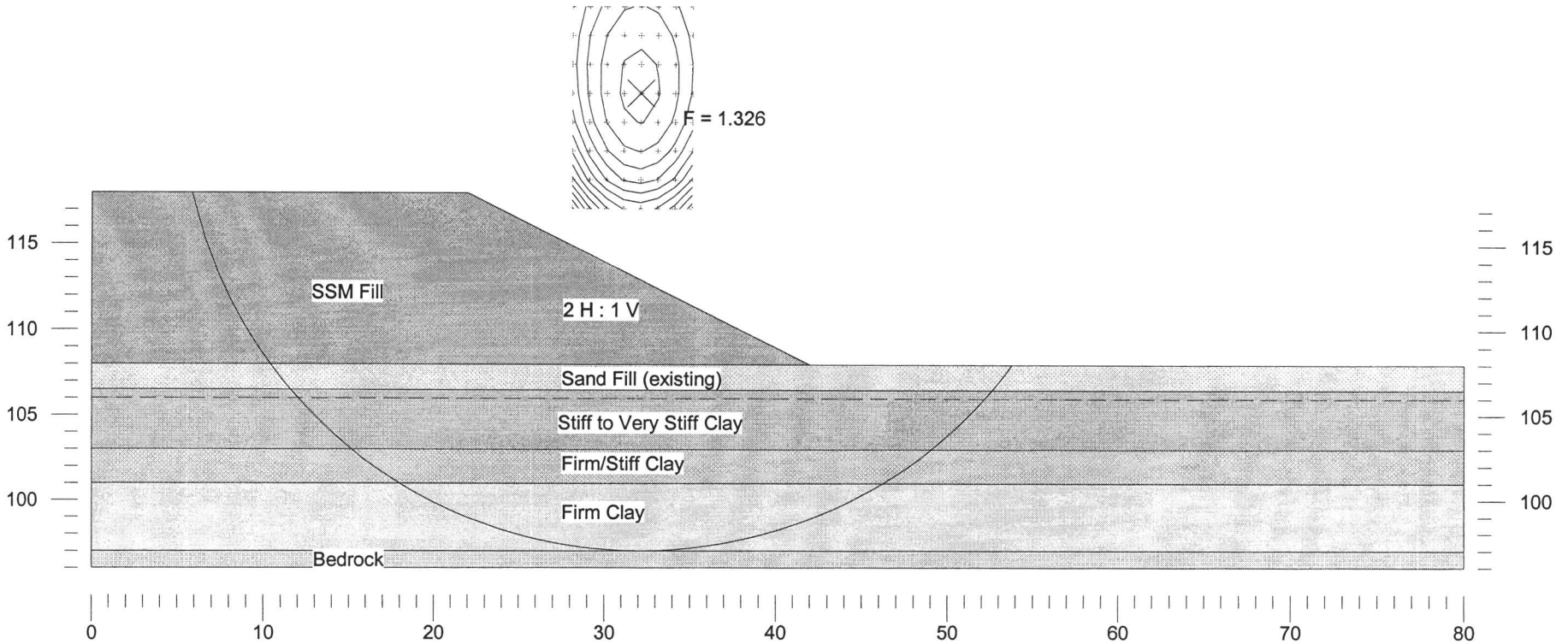


29/06/2005 10:36:54 AM C:\SPANG\THURB~12\19-135~4\FIGE4.GSL Thurber Engineering Ltd. - Toronto F = 1.562

FIGURE E4

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Sand Fill	20	0	30	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	4
Firm Clay	17	40	0	0	5
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
19-3745-0
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - South Approach (8 m + 2 m surcharge)
Figure E5 Undrained Analysis - SSM Fill



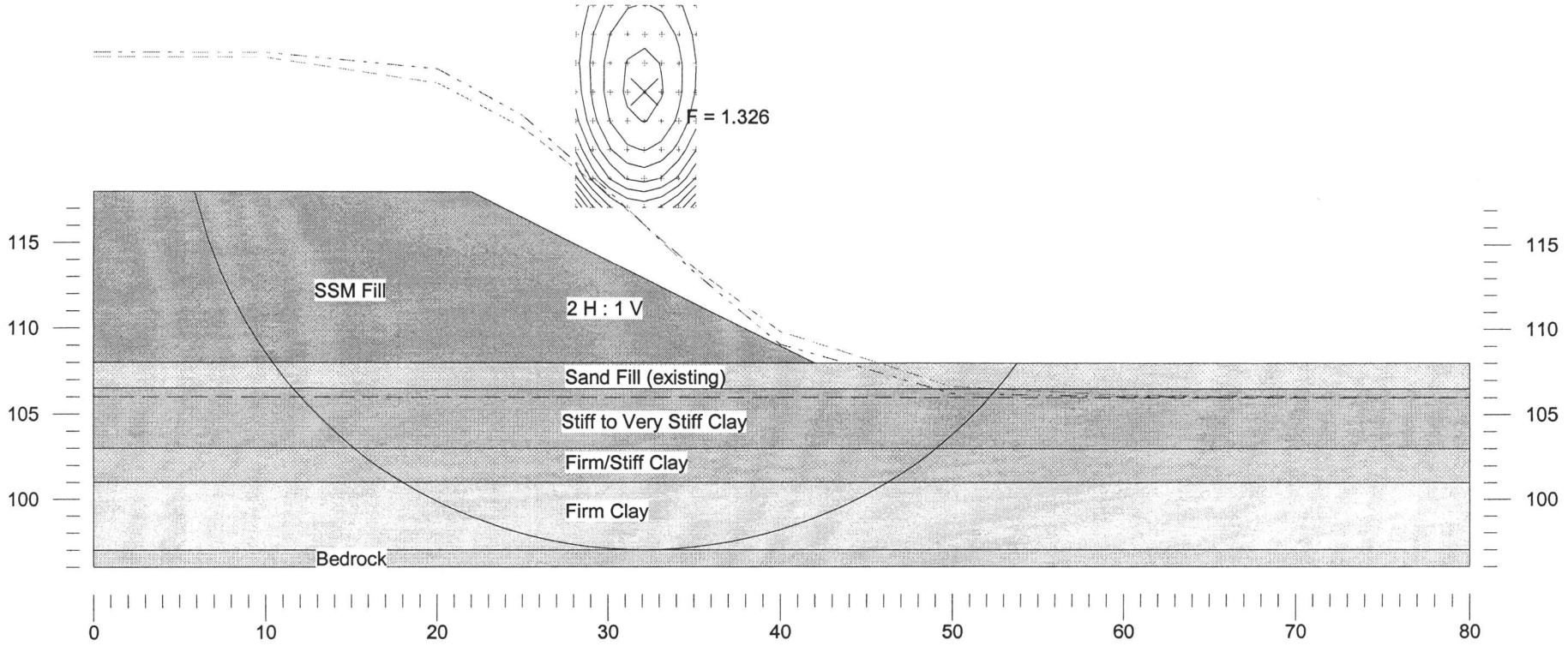
29/06/2005 10:37:41 AM C:\SPANG\THURB~12\19-135~4\FIGE5.GSL Thurber Engineering Ltd. - Toronto F = 1.326

FIGURE E5

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Sand Fill	20	0	30	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	.22	4
Firm Clay	17	40	0	.22	5
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
19-3745-0
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - South Approach (8 m + 2 m surcharge)
Figure E5A Undrained Analysis - SSM Fill (excess pore water pressure development)

Pore pressure parameter, B = 0.95 (initial fill placement)



29/06/2005 10:38:31 AM C:\SPANG\THURB~12\19-135~4\FIGE5A.GSL Thurber Engineering Ltd. - Toronto F = 1.326

FIGURE E5A

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Granular Fill	20	0	30	0	0
Rock Fill	19	0	42	0	0
Sand Fill	20	0	30	0	0
Stiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	.22	5
Firm Clay	17	40	0	.22	6
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
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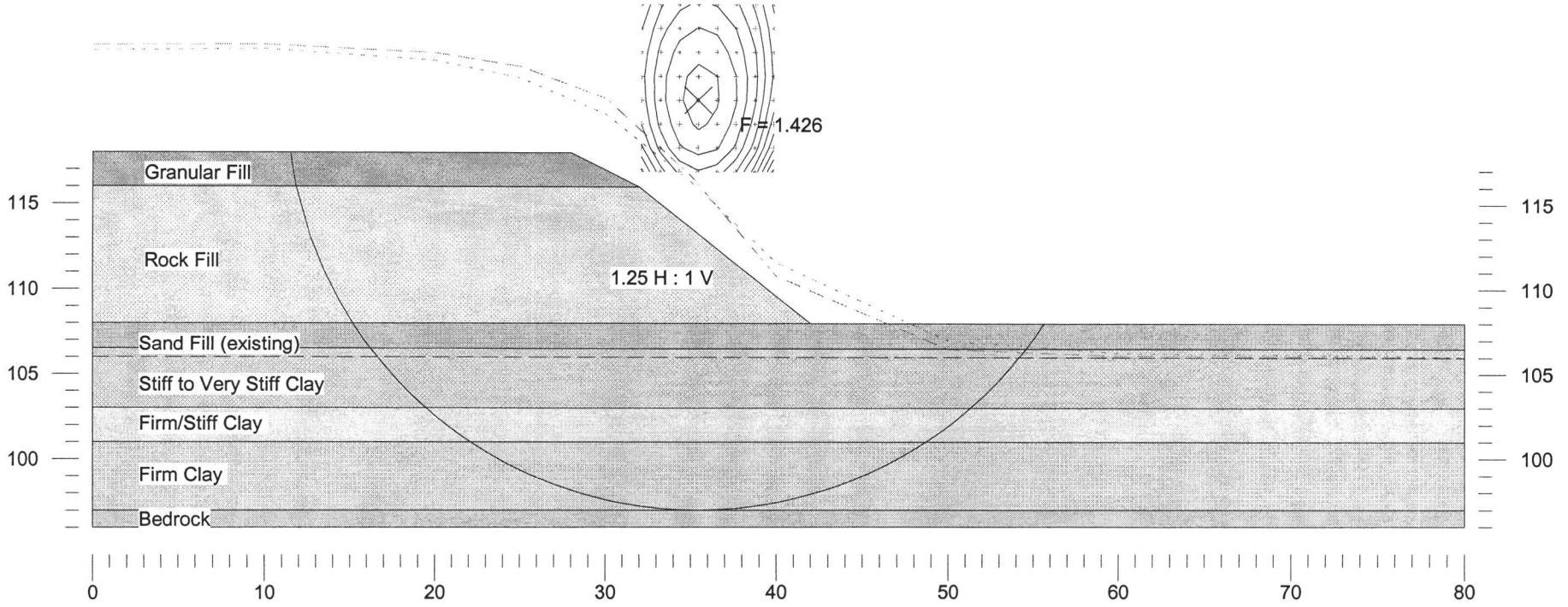
Stability of Side Slopes - South Approach (8 m + 2 m surcharge)
Figure E6 Undrained Analysis - Rock Fill (excess pore water pressure development)

Pore pressure parameter, B = 0.95 (initial fill placement)



29/06/2005 10:39:41 AM C:\SPANG\THURB~12\19-135~4\FIGE6.GSL Thurber Engineering Ltd. - Toronto F = 1.426

FIGURE E6

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	1
Firm Clay	17	40	0	0	1
Bedrock	(Infinitely Strong)				

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Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - NE Ramp
Figure E7 Undrained Analysis - SSM Fill

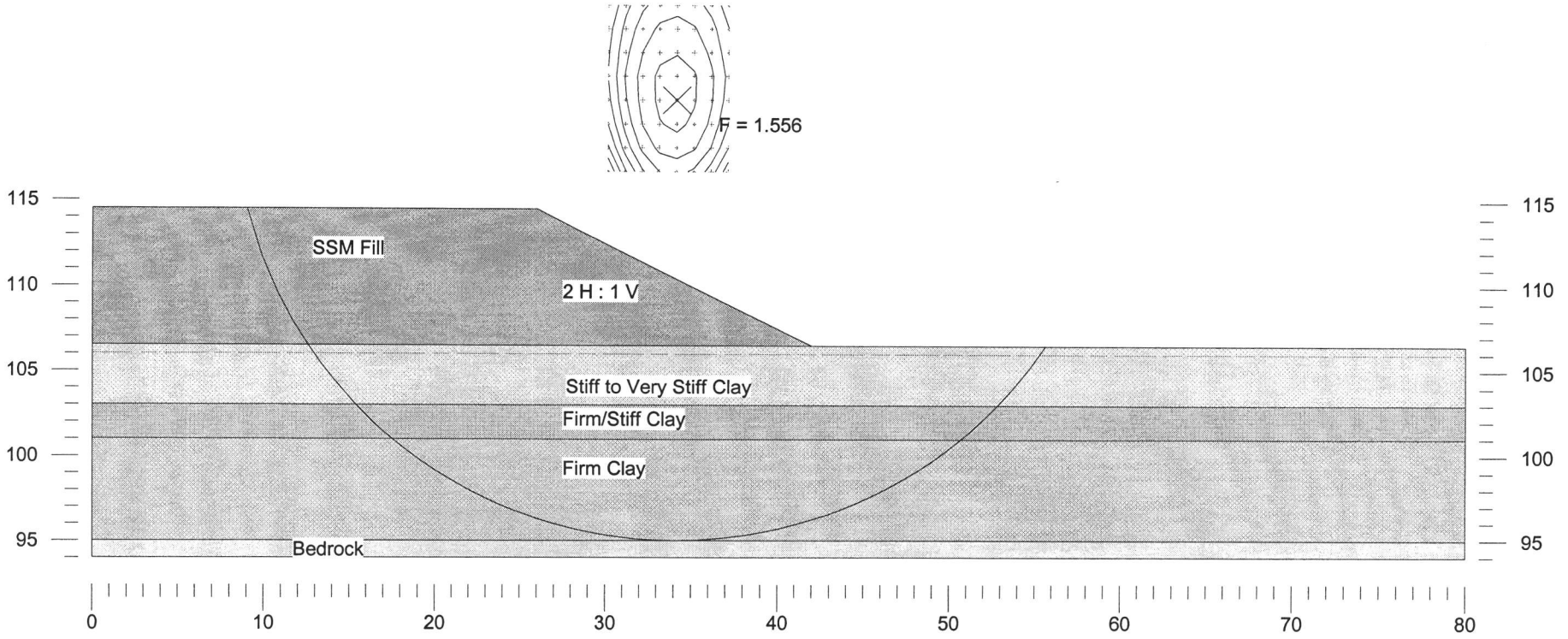

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FIGURE E7

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
StiffvStiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	1
Firm Clay	17	0	27	0	1
Bedrock	(Infinitely Strong)				

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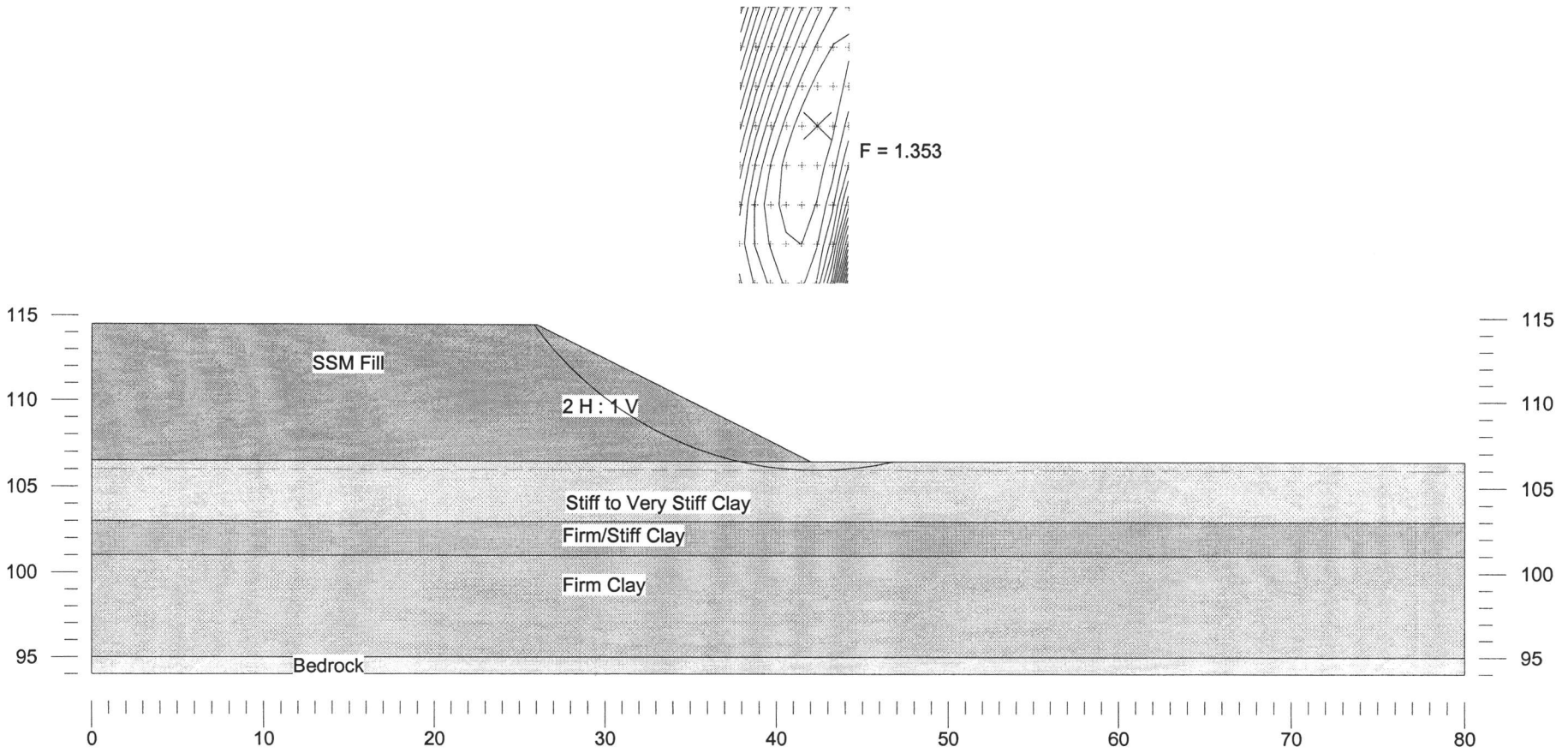
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - NE Ramp
Figure E8 Drained Analysis - SSM Fill



29/06/2005 10:47:33 AM C:\SPANG\THURB~12\19-135~4\FIGE8.GSL Thurber Engineering Ltd. - Toronto F = 1.353

FIGURE E8

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	3
Firm Clay	17	40	0	0	4
Bedrock	(Infinitely Strong)				

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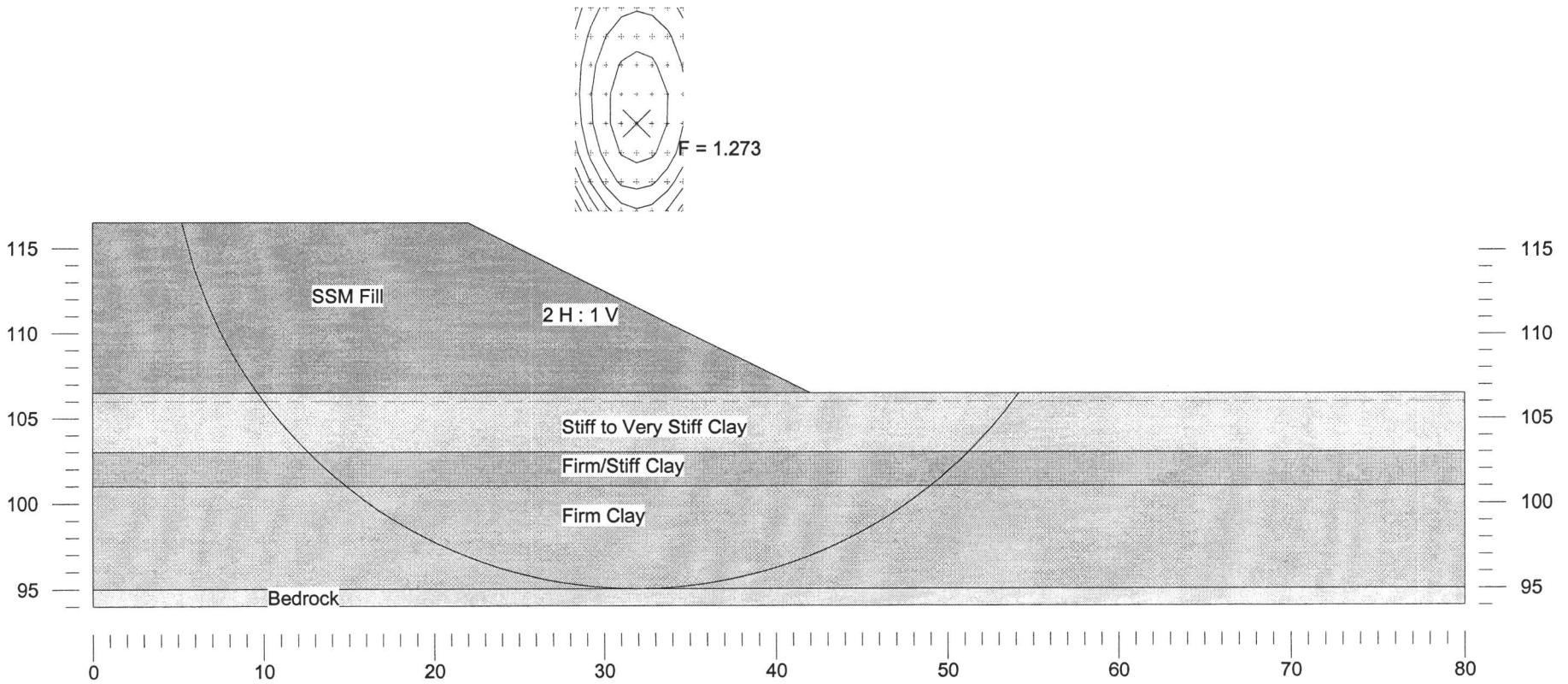
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - NE Ramp (8 m + 2 m surcharge)
Figure E9 Undrained Analysis



29/06/2005 10:49:12 AM C:\SPANG\THURB~12\19-135~4\FIGE9.GSL Thurber Engineering Ltd. - Toronto F = 1.273

FIGURE E9

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	.22	3
Firm Clay	17	40	0	.22	4
Bedrock	(Infinitely Strong)				

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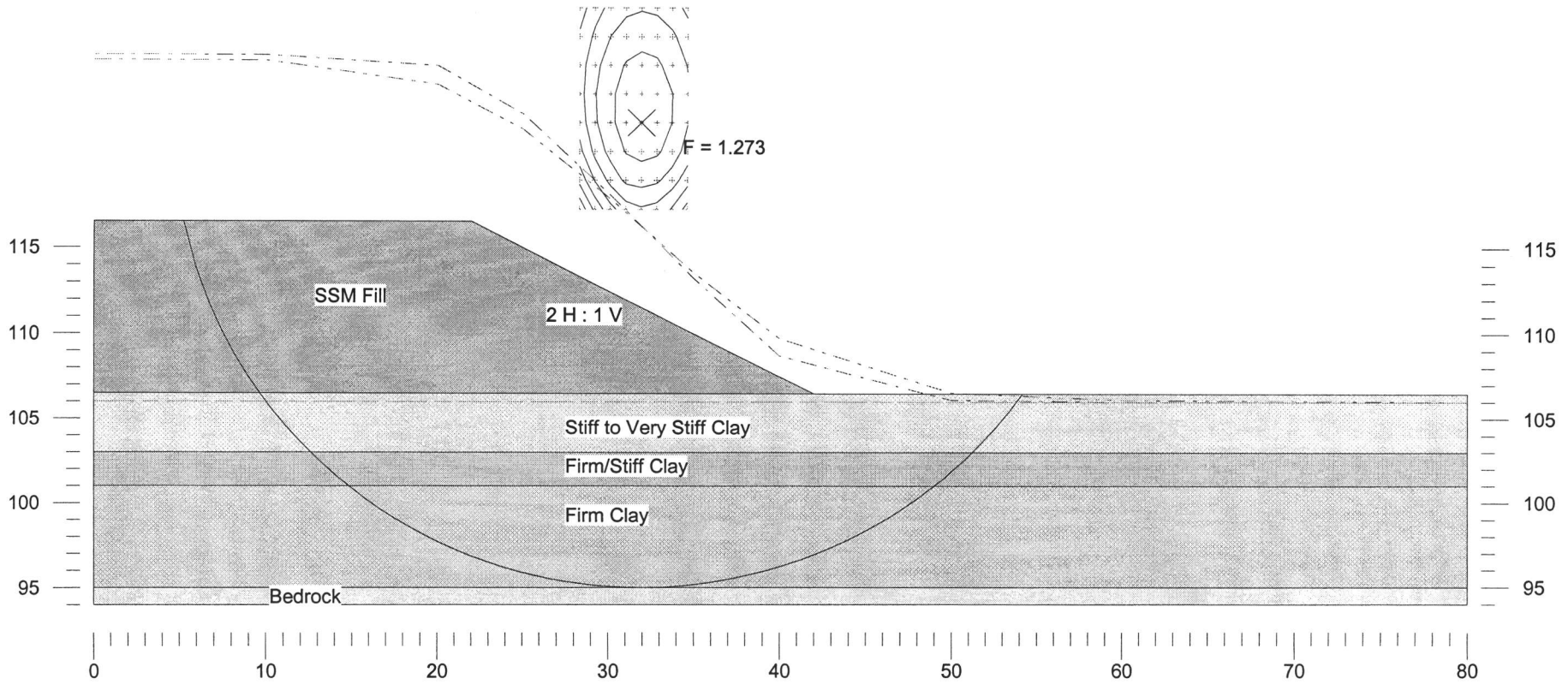
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - NE Ramp (8 m + 2 m surcharge)
Figure E9a Undrained Analysis - SSM Fill (excess pore water pressure development)

Pore pressure parameter, B = 0.95 (initial fill placement)



29/06/2005 10:50:21 AM C:\SPANG\THURB~12\19-135~4\FIGE9A.GSL Thurber Engineering Ltd. - Toronto F = 1.273

FIGURE E9A

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Granular Fill	22	0	32	0	0
Rock Fill	19	0	42	0	0
Stiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	4
Firm Clay	17	40	0	0	5
Bedrock	(Infinitely Strong)				

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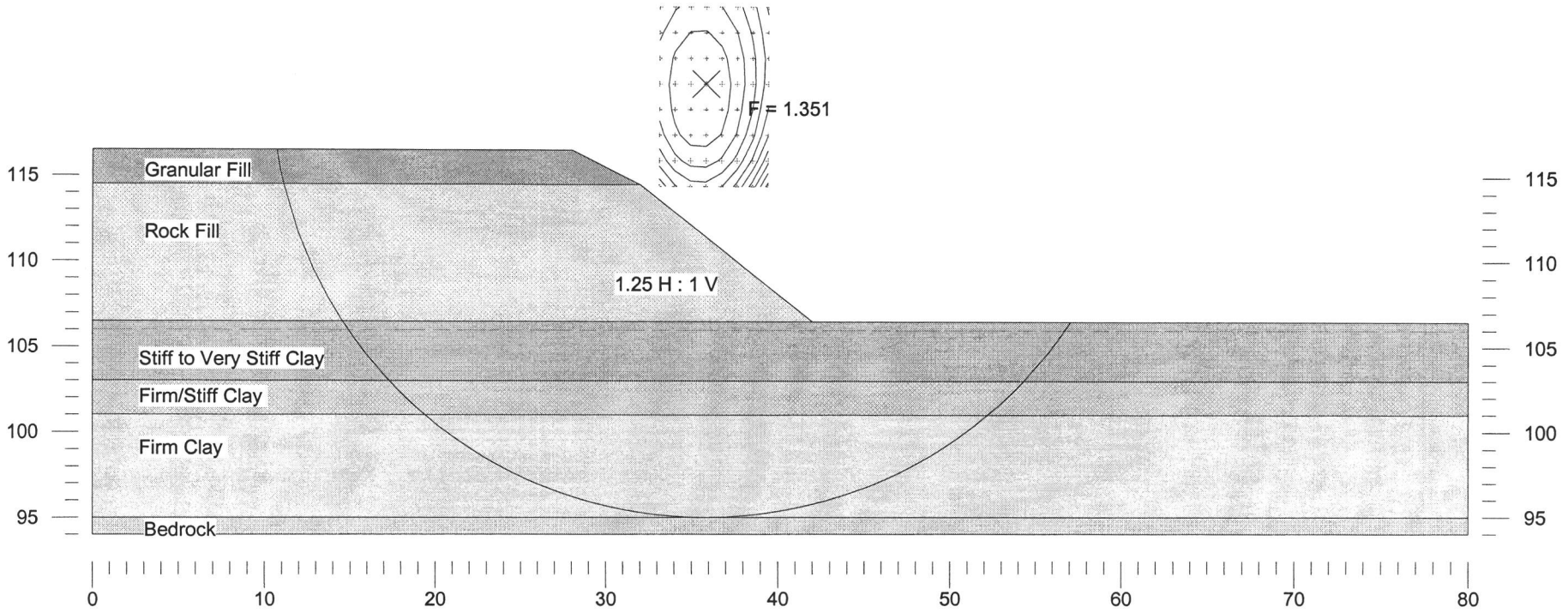
Stability of Side Slopes - NE Ramp (8 m + 2 m surcharge)
Figure E10 Undrained Analysis - Rock Fill



29/06/2005 11:00:31 AM C:\SPANG\THURB~12\19-135~4\FIGE10.GSL Thurber Engineering Ltd. - Toronto F = 1.351

FIGURE E10

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Granular Fill	22	0	32	0	0
Rock Fill	19	0	42	0	0
Stiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	.22	4
Firm Clay	17	40	0	.22	5
Bedrock	(Infinitely Strong)				

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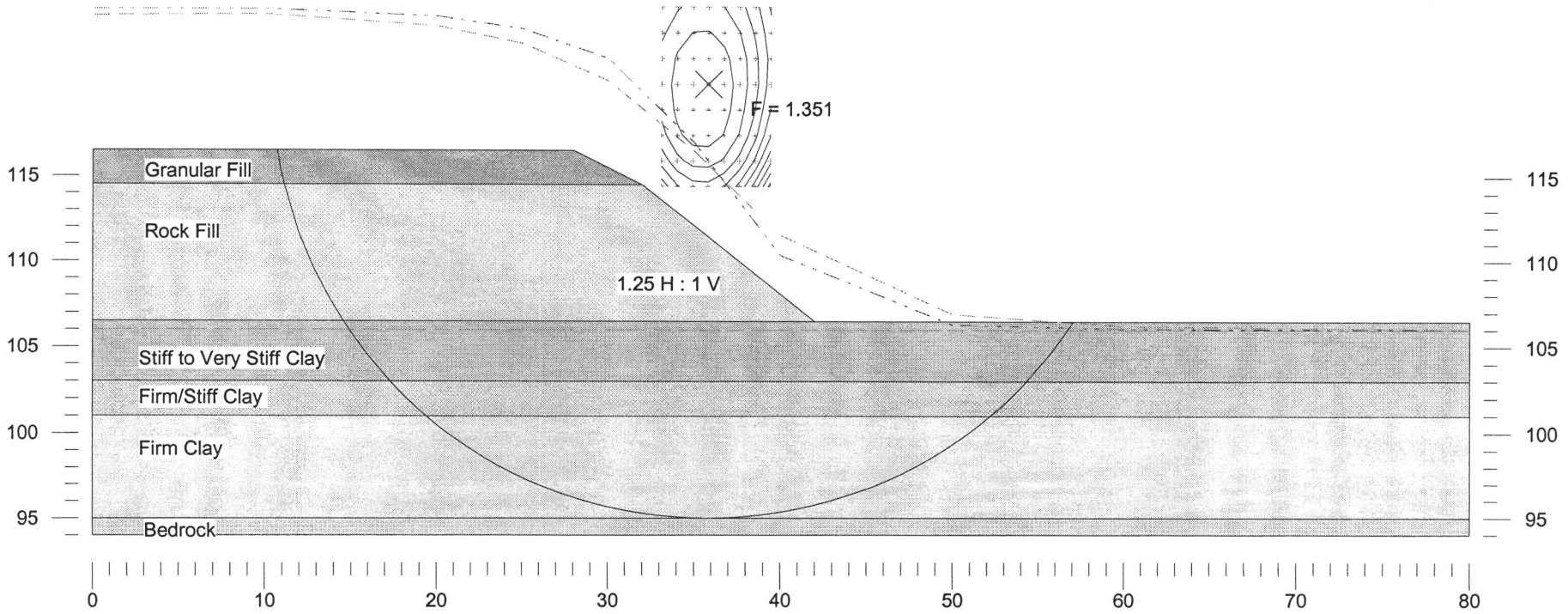
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - NE Ramp (8 m + 2 m surcharge)
Figure E10A Undrained Analysis - Rock Fill (excess pore water pressure development)

Pore pressure parameter, B = 0.95 (initial fill placement)



29/06/2005 10:53:02 AM C:\SPANG\THURB~12\19-135~4\FIGE10A.GSL Thurber Engineering Ltd. - Toronto F = 1.351

FIGURE E10A

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Stiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	3
Firm Clay	17	40	0	0	4
Bedrock	(Infinitely Strong)				

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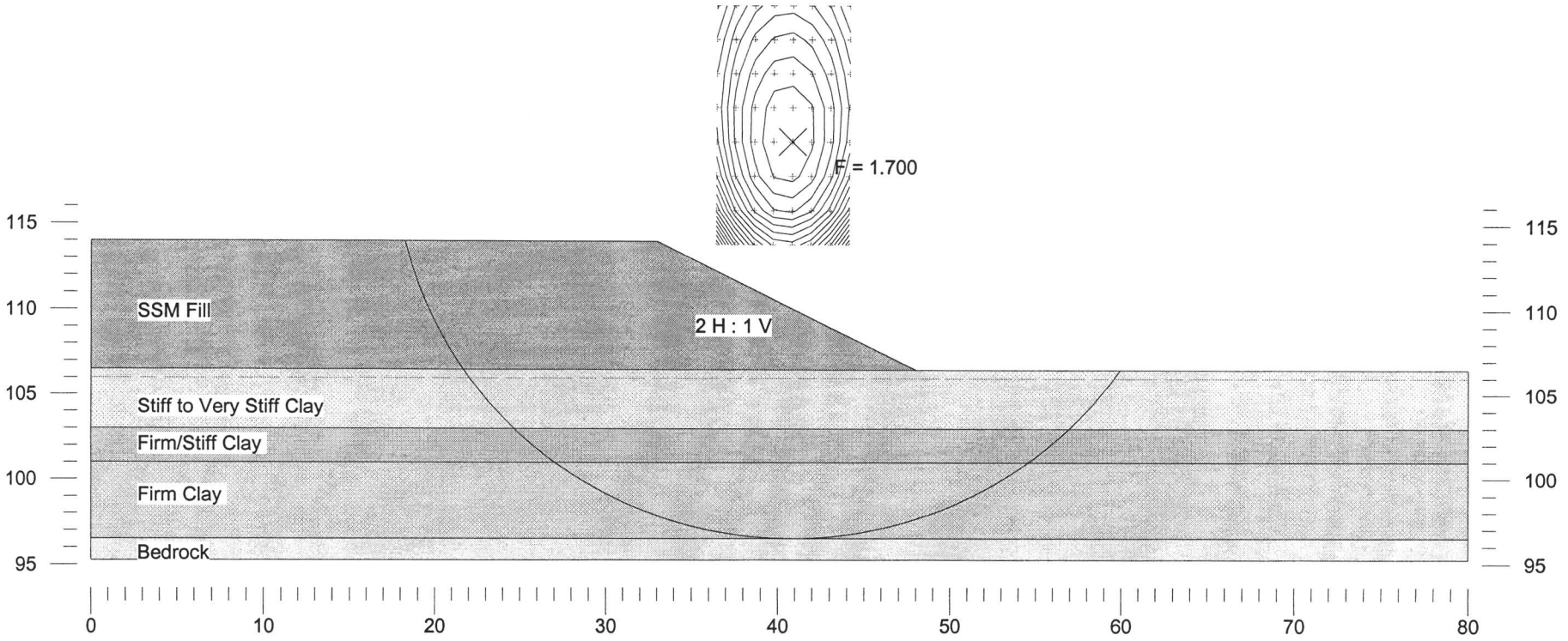
Stability of Side Slopes - SE Ramp (7.5 m high)
Figure E11 Undrained Analysis - SSM Fill



29/06/2005 10:54:31 AM C:\SPANG\THURB~12\19-135~4\FIGE11.GSL Thurber Engineering Ltd. - Toronto F = 1.700

FIGURE E11

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Stiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	3
Firm Clay	17	0	27	0	4
Bedrock	(Infinitely Strong)				

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June 20, 2005
Stability of Side Slopes - SE Ramp (7.5 m high)
Figure E12 Drained Analysis - SSM Fill

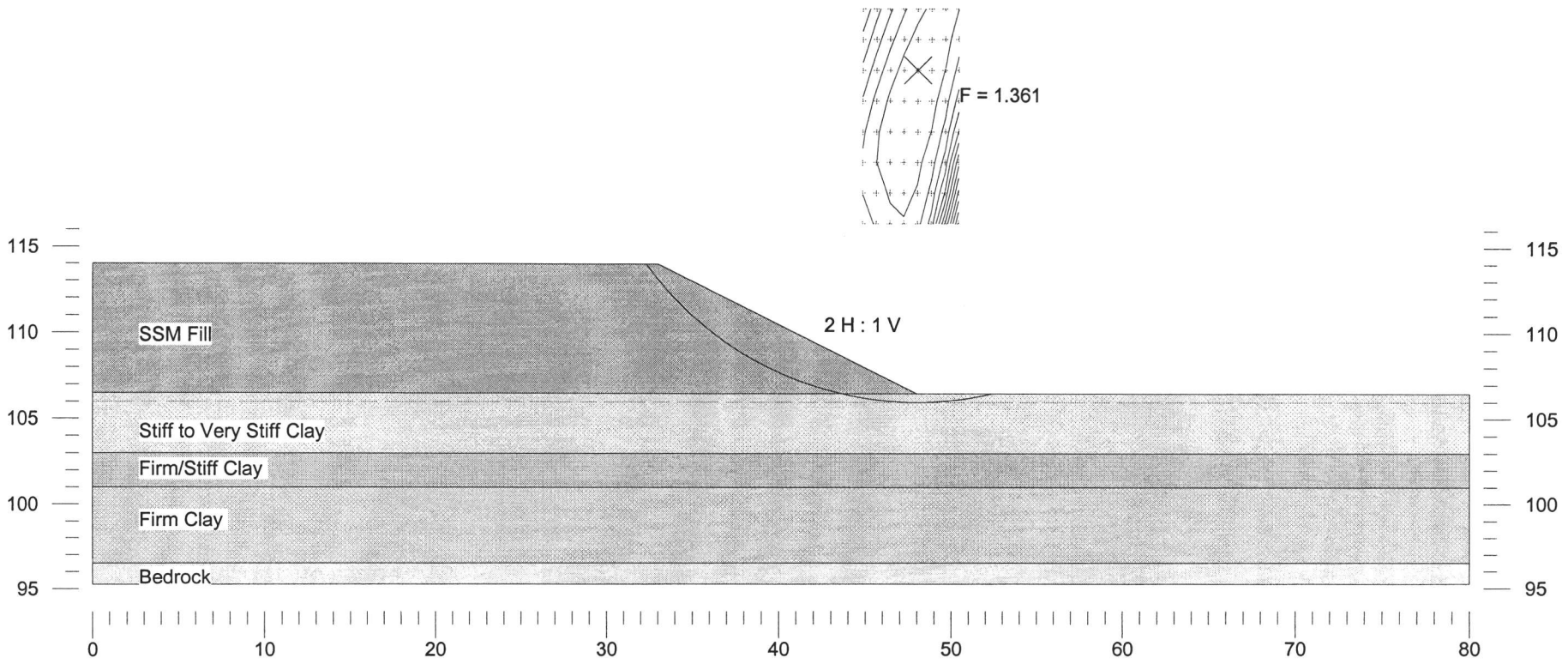

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FIGURE E12

	Gamma	C	Phi	Min	Piezo
	kN/m3	kPa	deg	c/p	Surf.
Surcharge	21	0	30	0	0
SSM Fill	21	0	30	0	0
Stiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	3
Firm Clay	17	40	0	0	4
Bedrock	(Infinitely Strong)				

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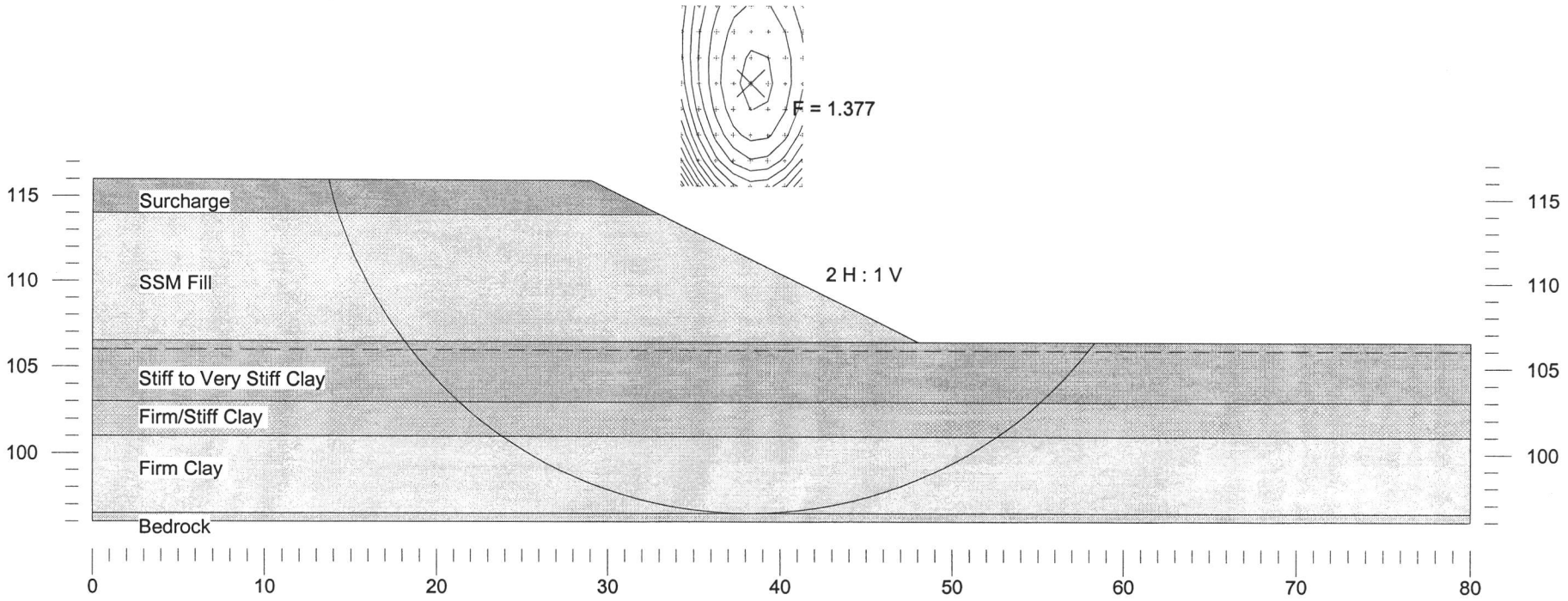
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - SE Ramp (7.5 m high + 2 m surcharge)
Figure E13 Undrained Analysis - SSM Fill



29/06/2005 10:57:01 AM C:\SPANG\THURB~12\19-135~4\FIGE13.GSL Thurber Engineering Ltd. - Toronto F = 1.377

FIGURE E13

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Surcharge	21	0	30	0	0
SSM Fill	21	0	30	0	0
Stiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	.22	3
Firm Clay	17	40	0	.22	4
Bedrock	(Infinitely Strong)				

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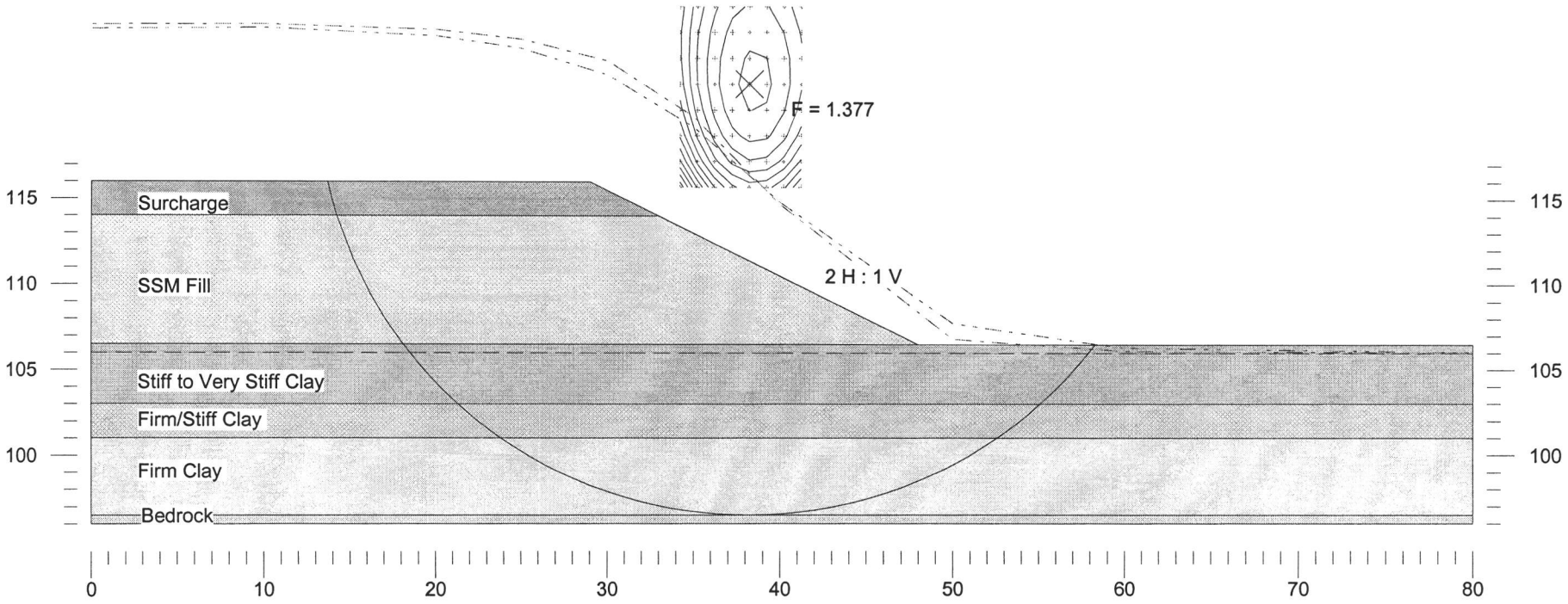
Highway 17 Twinning - White Lake Road
June 20, 2005
Stability of Side Slopes - SE Ramp (7.5 m high + 2 m surcharge)
Figure E13A Undrained Analysis - SSM Fill



29/06/2005 10:57:47 AM C:\SPANG\THURB~12\19-135~4\FIGE13A.GSL Thurber Engineering Ltd. - Toronto F = 1.377

FIGURE E13A

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Sand Fill	20	0	30	0	0
StiffvStiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	1
Firm Clay	17	0	27	0	1
Bedrock	(Infinitely Strong)				

Seismic coefficient = 0.185

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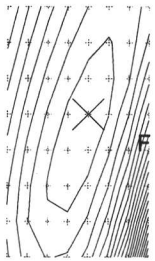
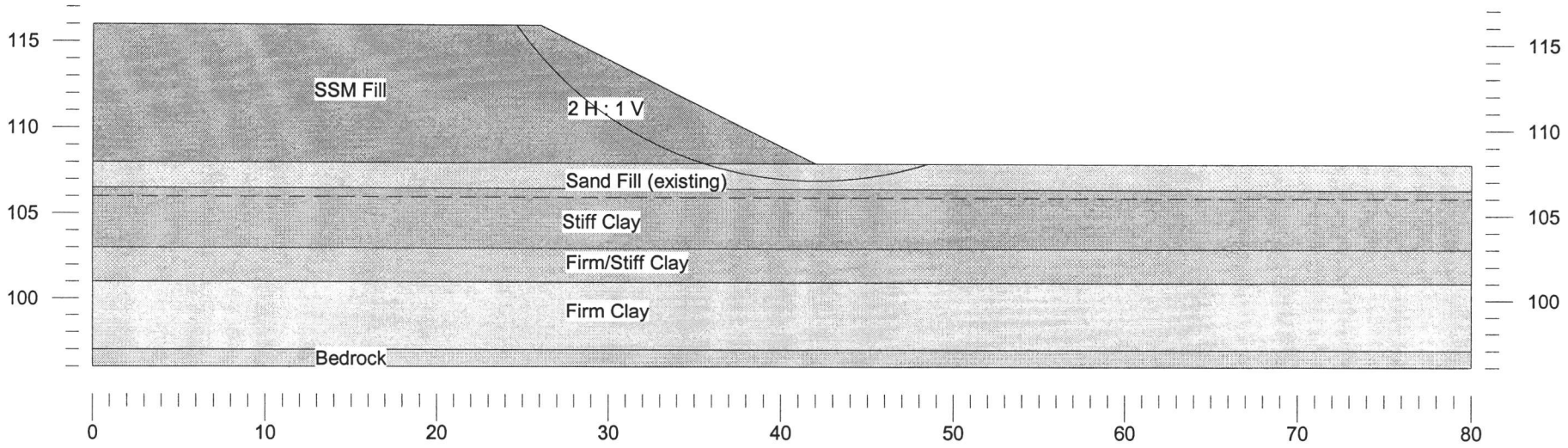
June 20, 2005
Seismic Stability of Side Slopes - South Approach
Figure ES1 Drained Analysis - SSM Fill



F = 1.007



29/06/2005 11:23:57 AM C:\SPANG\THURB~12\19-135~4\FIGDS1.GSL Thurber Engineering Ltd. - Toronto F = 1.007

FIGURE ES1

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
StiffvStiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	1
Firm Clay	17	0	27	0	1
Bedrock	(Infinitely Strong)				

Seismic coefficient = 0.135

Thurber Engineering Ltd. - Toronto
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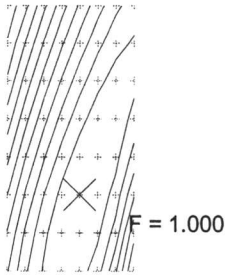
Highway 17 Twinning - White Lake Road
June 20, 2005
Seiemic Stability of Side Slopes - NE Ramp
Figure ES2 Drained Analysis - SSM Fill



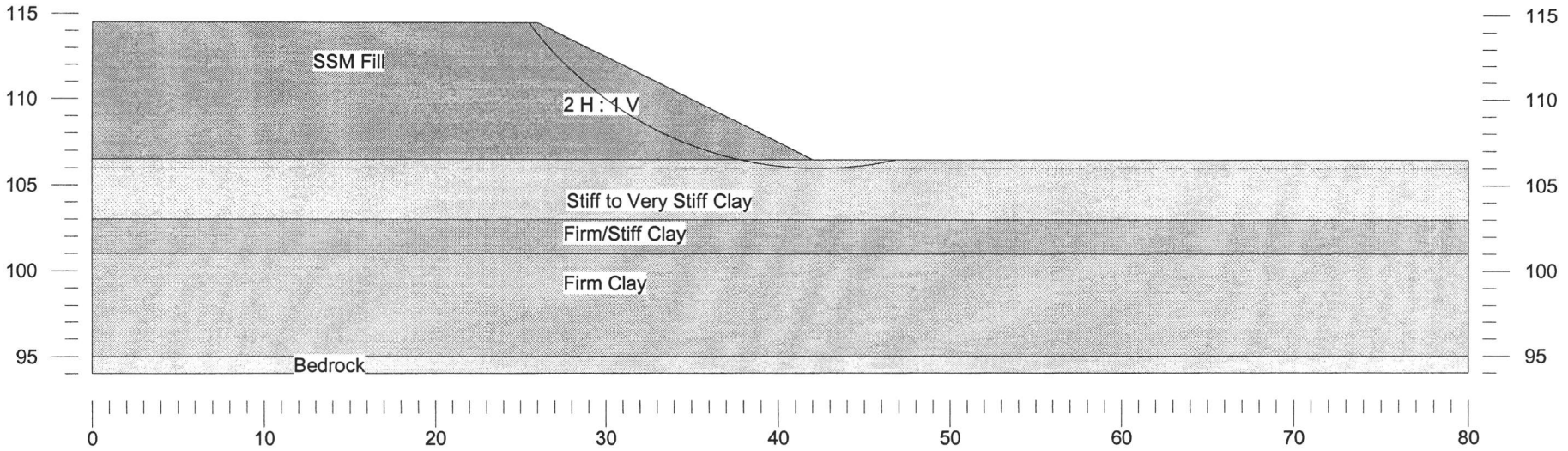


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FIGURE ES2

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Stiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	3
Firm Clay	17	0	27	0	4
Bedrock	(Infinitely Strong)				

Seismic coefficient = 0.135

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Highway 17 Twinning - White Lake Road
June 20, 2005
Seismic Stability of Side Slopes - SE Ramp (7.5 m high)
Figure ES3 Drained Analysis - SSM Fill

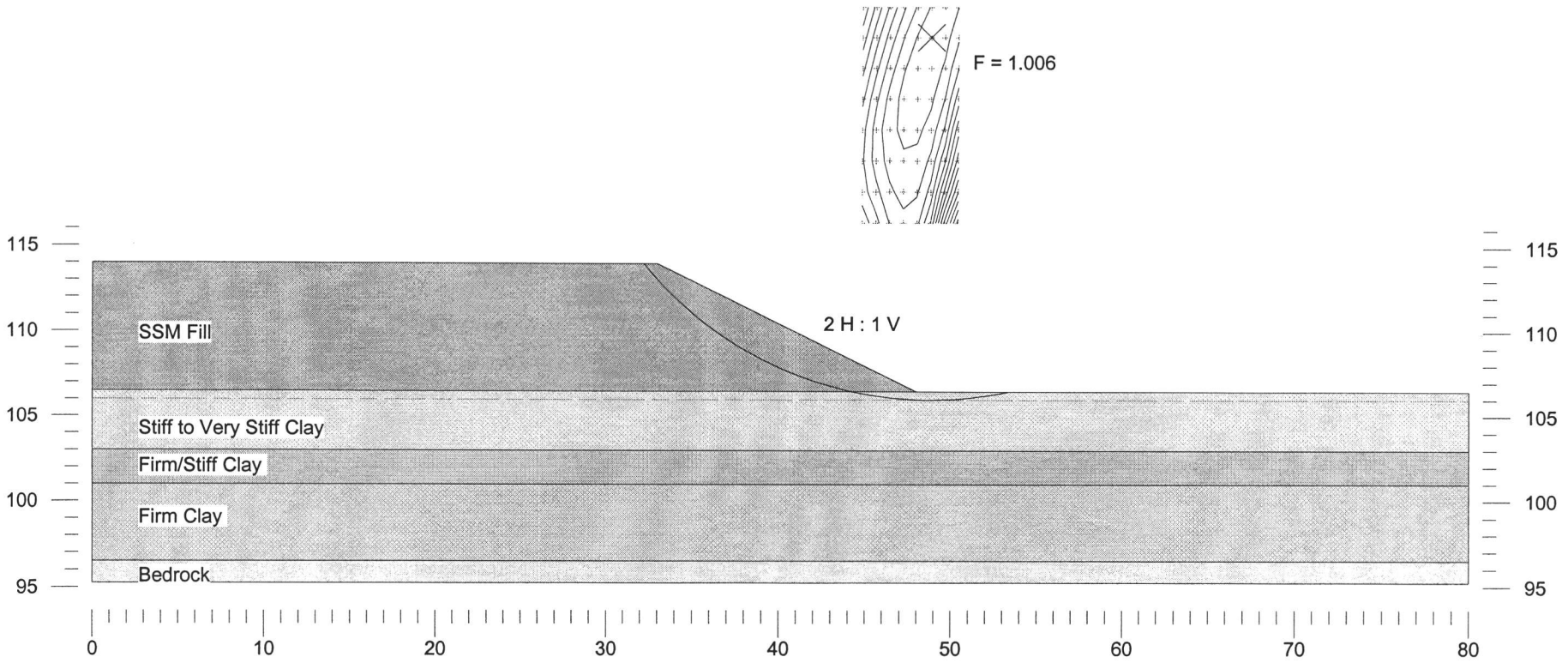

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FIGURE ES3

Appendix F

Selected Stability Analyses Results

Madawaska River Bridge Approaches

	Gamma	C	Phi	Min	Piezo
	kN/m3	kPa	deg	c/p	Surf.
Rock Berm	19	0	42	0	0
Rock Fill	19	0	42	0	0
vStiff Clay	17	0	29	0	1
Bedrock	(Infinitely Strong)				

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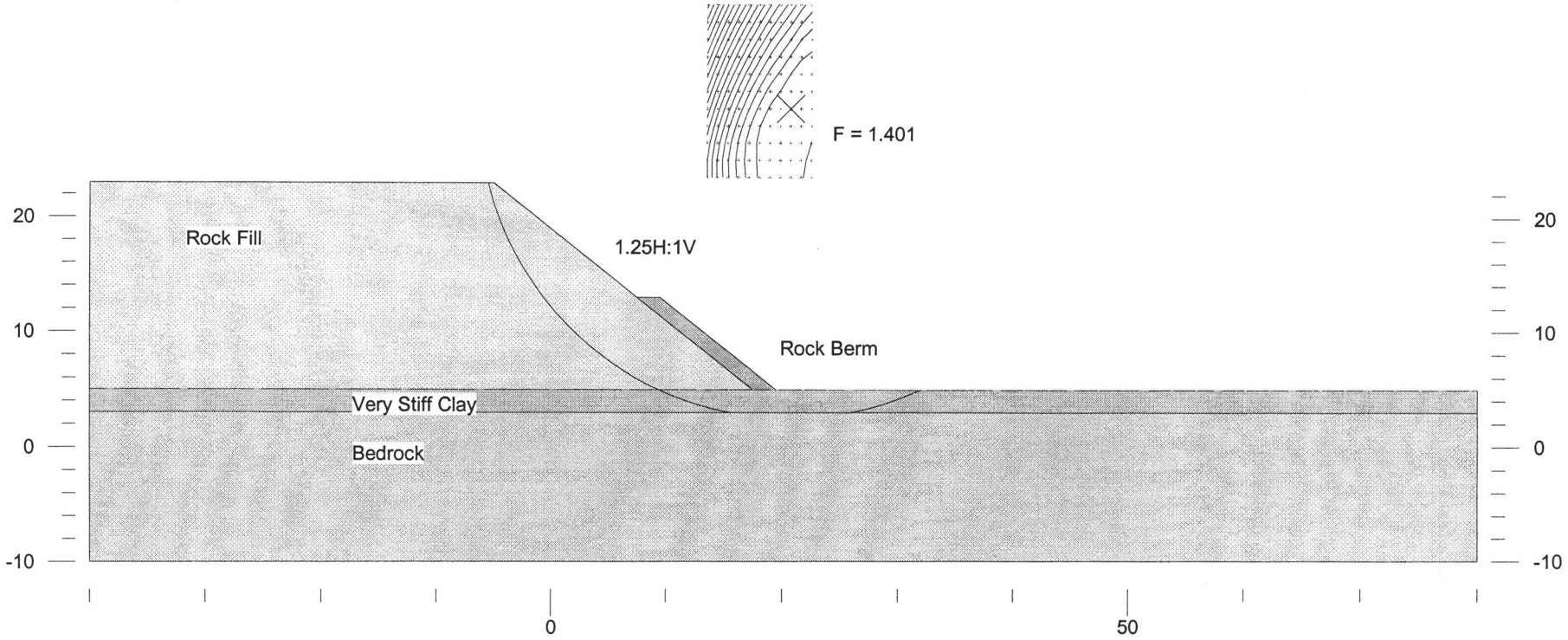
Hwy 17 Twinning
June 21, 2004
Stability of Embankment Side Slopes - Madawaska River Bridge - East Approach
FIG F1 Drained Analysis - 18 m high embankment with 2 m wide mid-height berm



29/06/2005 10:02:56 AM C:\SPANG\THURB~12\19-135~4\FIGF1.GSL Thurber Engineering Ltd. - Toronto F = 1.401

FIGURE F1

	Gamma	C	Phi	Min	Piezo
	kN/m3	kPa	deg	c/p	Surf.
Rock Berm	19	0	42	0	0
Rock Fill	19	0	42	0	0
vStiff Clay	17	80	0	0	1
Bedrock	(Infinitely Strong)				

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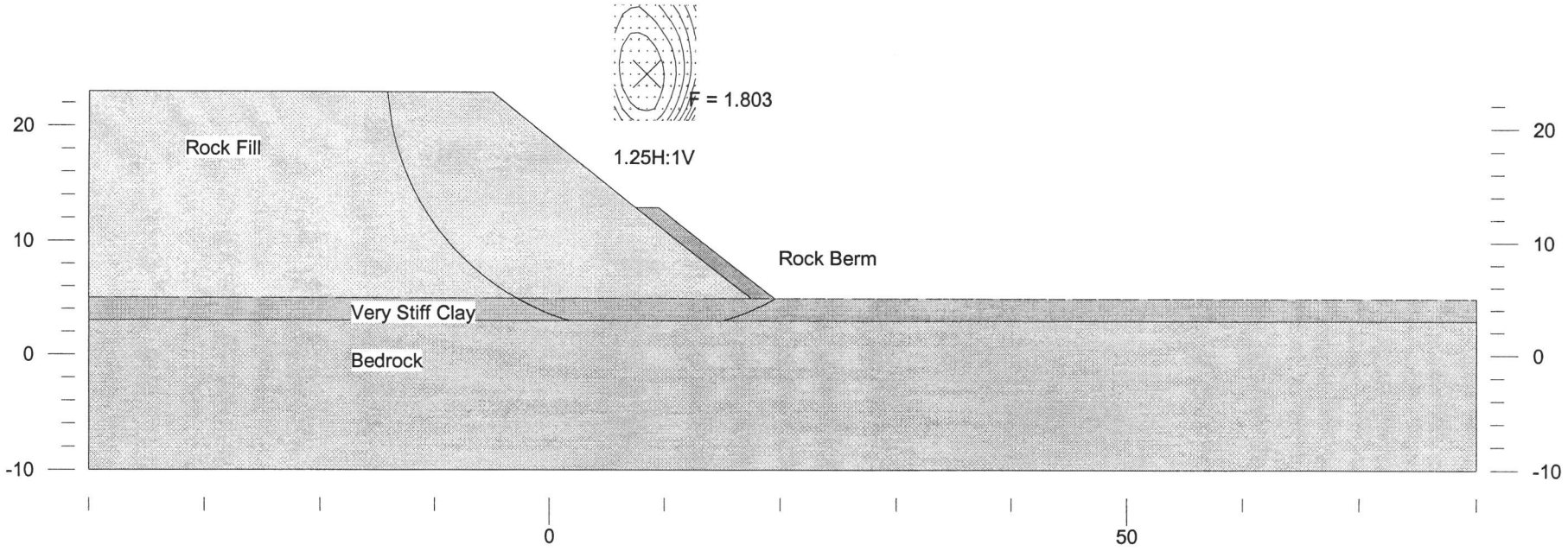
June 21, 2004
Stability of Embankment Side Slopes - Madawaska River Bridge - East Approach
FIG F1A Undrained Analysis - 18 m high embankment with 2 m wide mid-height berm



29/06/2005 10:14:00 AM C:\SPANG\THURB~12\19-135~4\FIGF1A.GSL Thurber Engineering Ltd. - Toronto F = 1.803

FIGURE F1A

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Rock Berm	19	0	42	0	0
Rock Fill	19	0	42	0	0
vStiff Clay	17	80	0	0	1
Bedrock	(Infinitely Strong)				

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June 21, 2005
Stability of Embankment Side Slopes - Madawaska River Bridge West Approach Sta. 30+925 to 30+975
FIG F2 Undrained Analysis - 18 m high embankment with 2 m wide berm

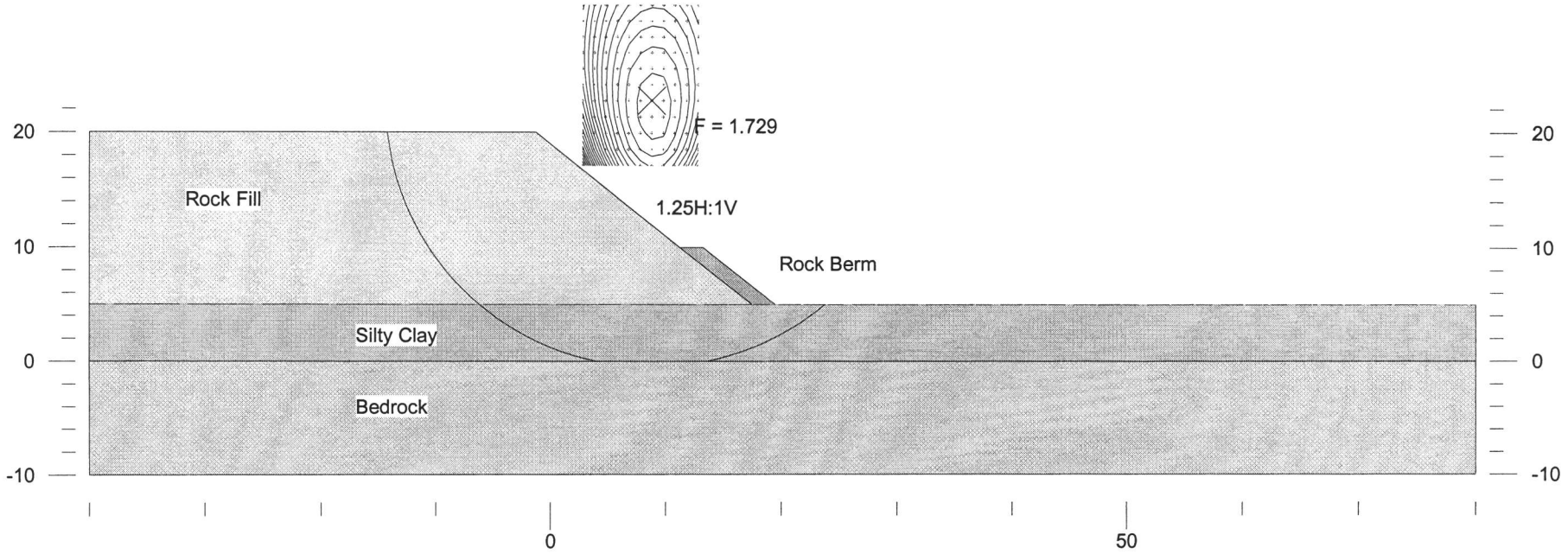

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FIGURE F2

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Rock Berm	19	0	42	0	0
Rock Fill	19	0	42	0	0
vStiff Clay	17	0	29	0	1
Bedrock	(Infinitely Strong)				

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Hwy 17 Twinning
June 21, 2005
Stability of Embankment Side Slopes - Madawaska River Bridge West Approach Sta. 30+925 to 30+975
FIG F3 Drained Analysis - 18 m high embankment with 2 m wide berm

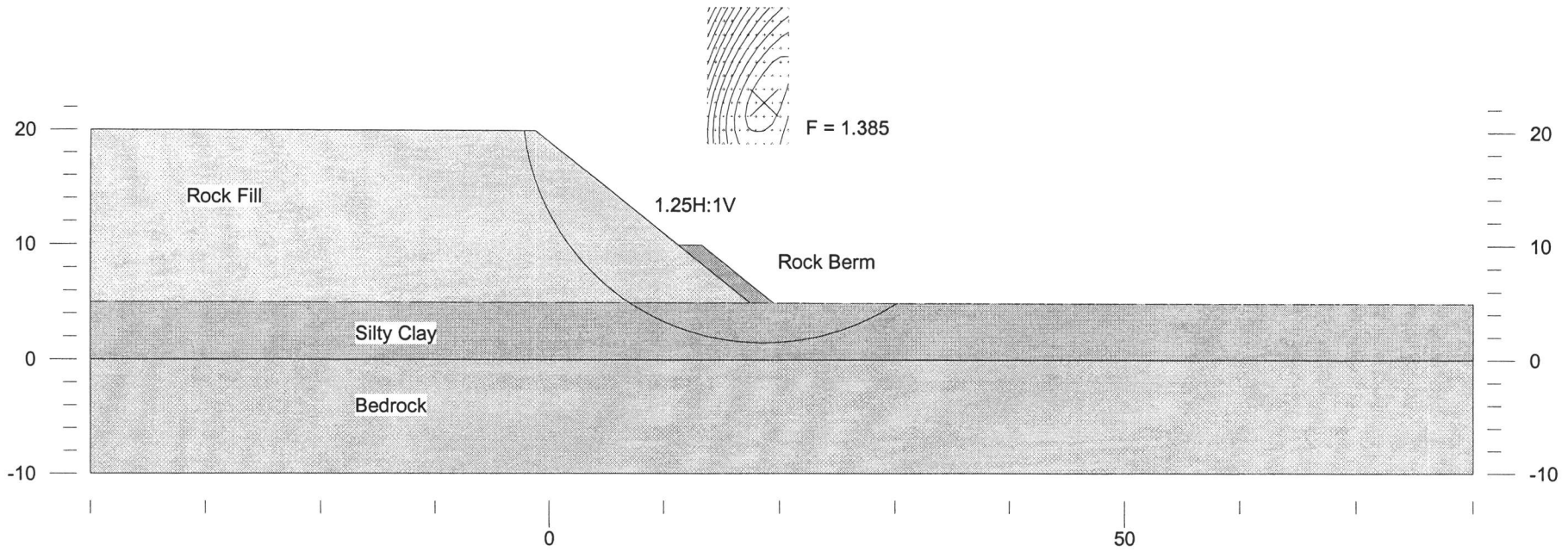

FIGURE F3

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Rock Fill	19	0	42	0	0
StiffvStiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	1
Bedrock	(Infinitely Strong)				

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19-3745-0
Hwy 17 Twinning
June 21, 2005
Stability of Embankment Side Slopes - Madawaska River Bridge West Approach Sta. 30+675 to 30+700
FIG F4 Undrained Analysis - 8 m high embankment

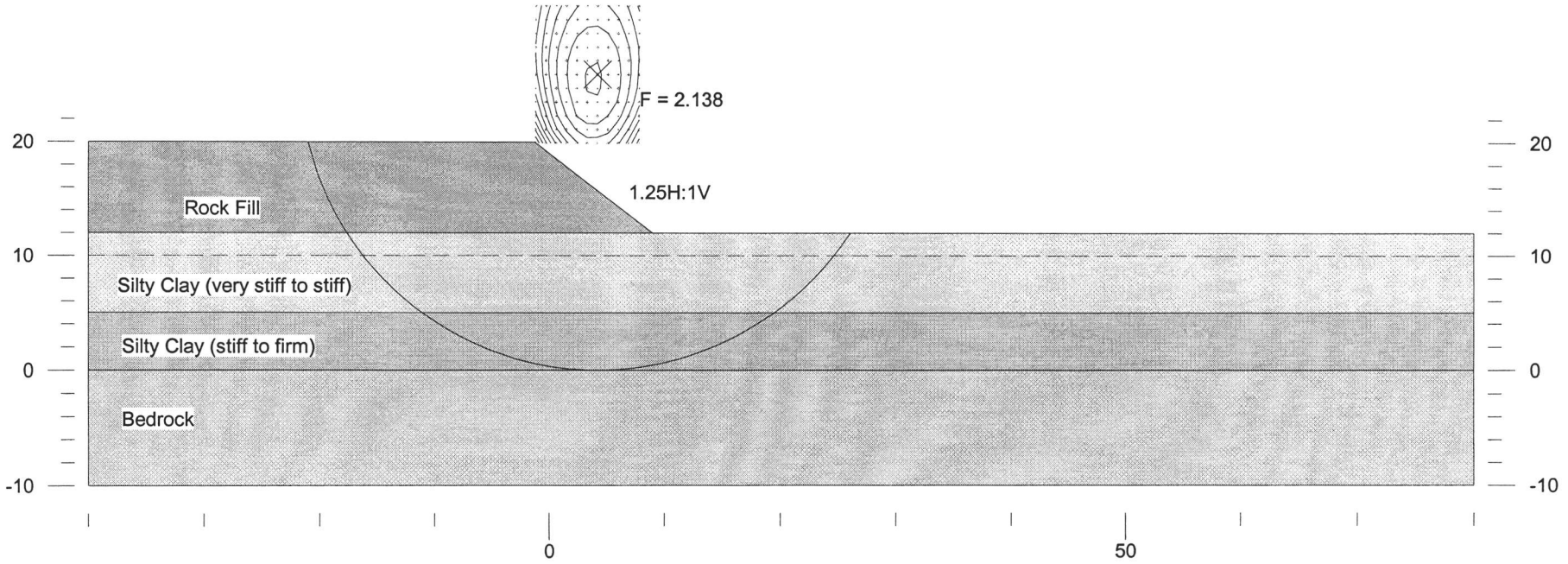

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FIGURE F4

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Rock Fill	19	0	42	0	0
StiffvStiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	1
Bedrock	(Infinitely Strong)				

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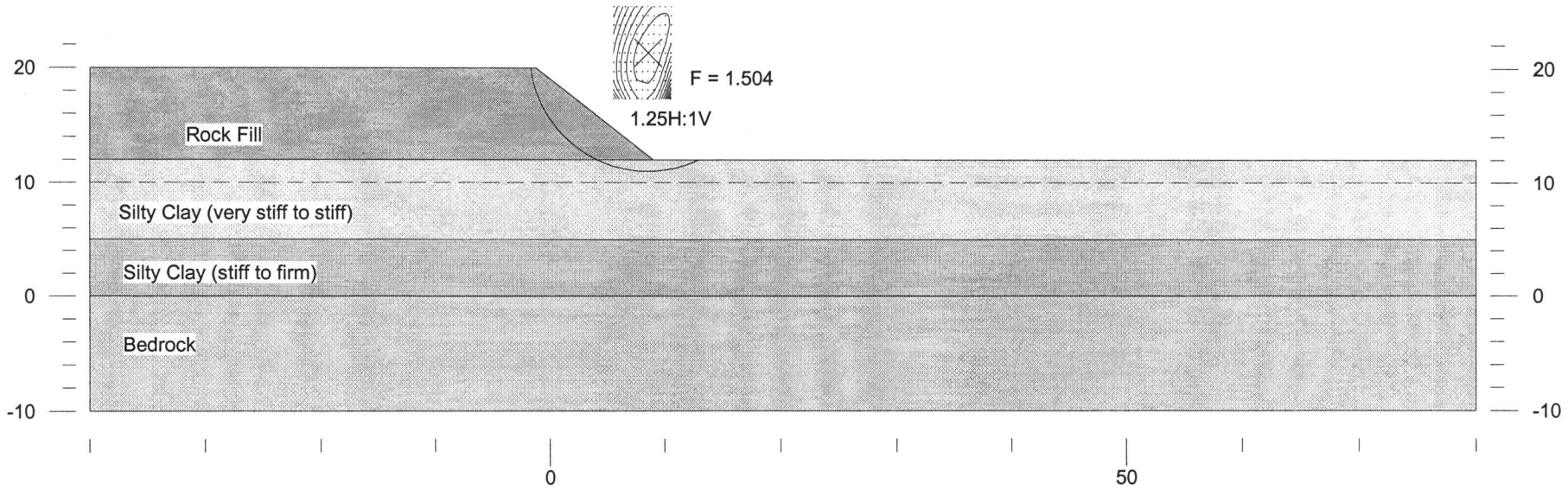
Hwy 17 Twinning
June 21, 2005
Stability of Embankment Side Slopes - Madawaska River Bridge West Approach Sta. 30+675 to 30+700
FIG F5 Drained Analysis - 8 m high embankment



29/06/2005 10:21:53 AM C:\SPANG\THURB~12\19-135~4\FIGF5.GSL Thurber Engineering Ltd. - Toronto F = 1.504

FIGURE F5

	Gamma	C	Phi	Min	Piezo
	kN/m3	kPa	deg	c/p	Surf.
Earth Berm	20	0	30	0	0
SSM Fill	20	0	30	0	0
vStiff Clay	17	80	0	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
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Hwy 17 Twinning
June 21, 2005
Stability of Embankment Side Slopes - Madawaska River Bridge West Approach Sta. 30+925 to 30+975
FIG F6 Undrained Analysis - 18 m high embankment with 2 m wide berm

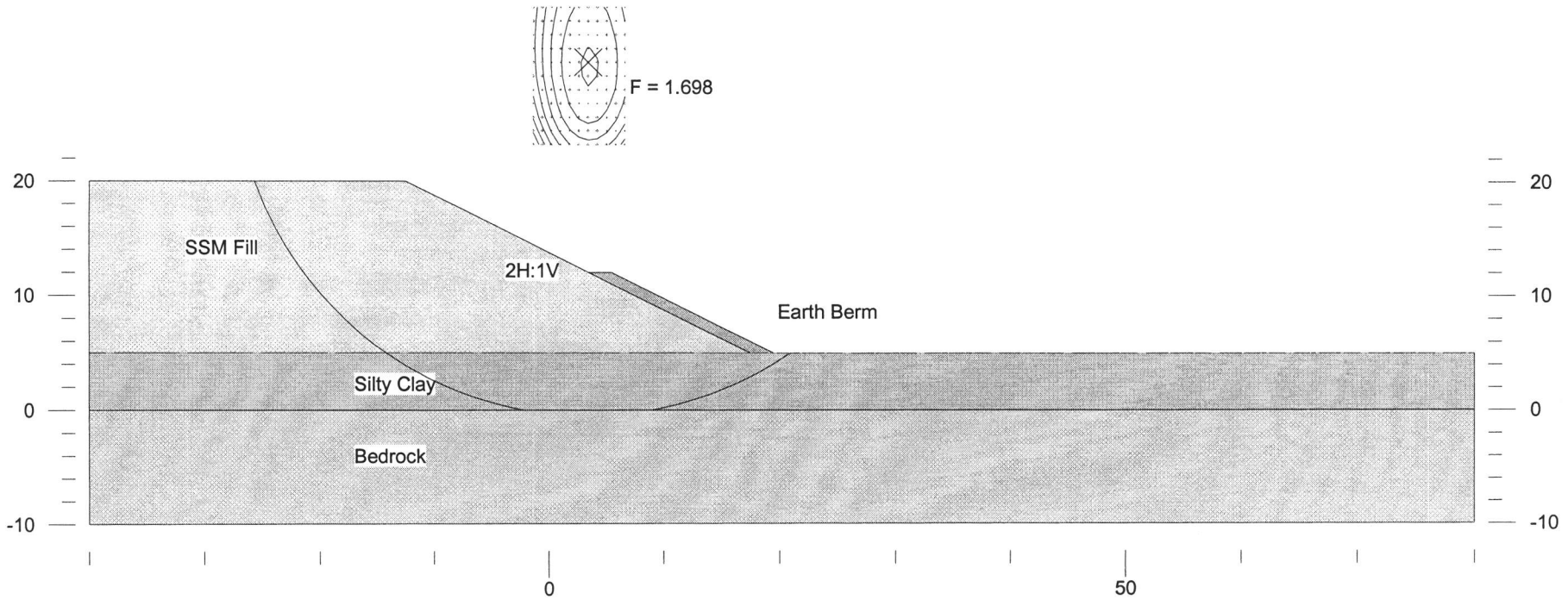

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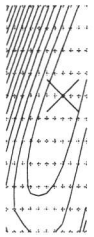
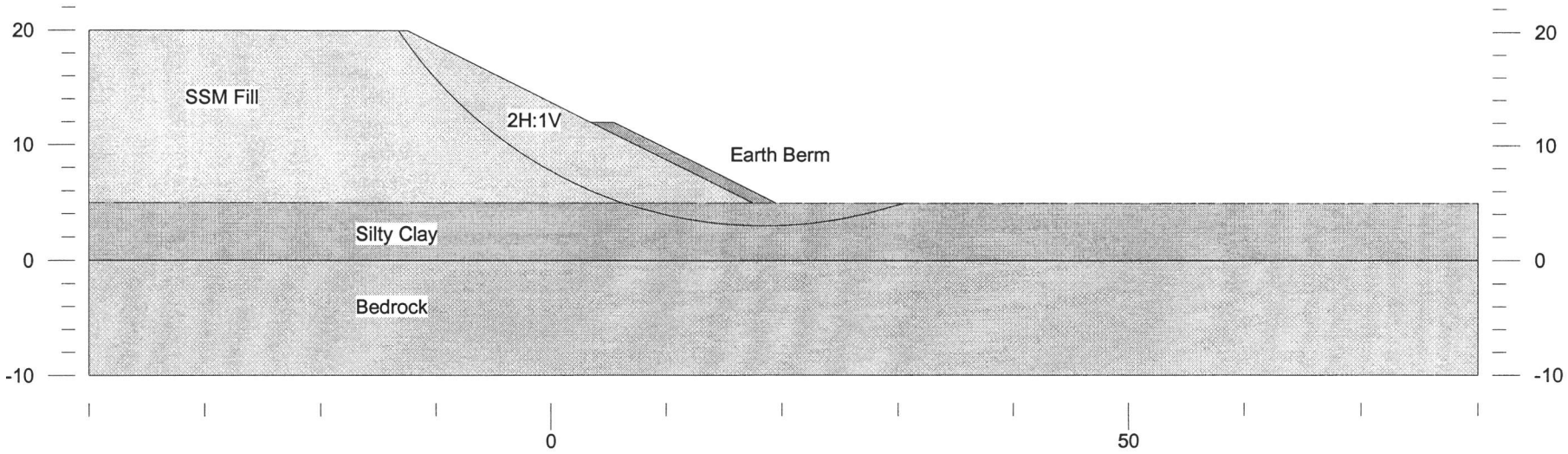
FIGURE F6

	Gamma	C	Phi	Min	Piezo
	kN/m3	kPa	deg	c/p	Surf.
Earth Berm	20	0	30	0	0
SSM Fill	20	0	30	0	0
vStiff Clay	17	0	29	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
19-3745-0
Hwy 17 Twinning
June 21, 2005
Stability of Embankment Side Slopes - Madawaska River Bridge West Approach Sta. 30+925 to 30+975
FIG F7 Drained Analysis - 18 m high embankment with 2 m wide berm



F = 1.380



29/06/2005 10:23:45 AM C:\SPANG\THURB~12\19-135~4\FIGF7.GSL Thurber Engineering Ltd. - Toronto F = 1.380

FIGURE F7

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Earth Berm	20	0	30	0	0
SSM Fill	20	0	30	0	0
vStiff Clay	17	0	29	0	
Bedrock	(Infinitely Strong)				

Seismic coefficient = 0.13

Thurber Engineering Ltd. - Toronto
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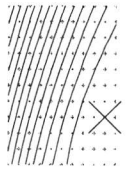
Hwy 17 Twinning
June 21, 2005
Seismic Stability of Embankment Side Slopes - Madawaska River Bridge West Approach Sta. 30+925 to 30+975
FIG FS1 Drained Analysis - 18 m high embankment with 2 m wide berm



F = 1.001

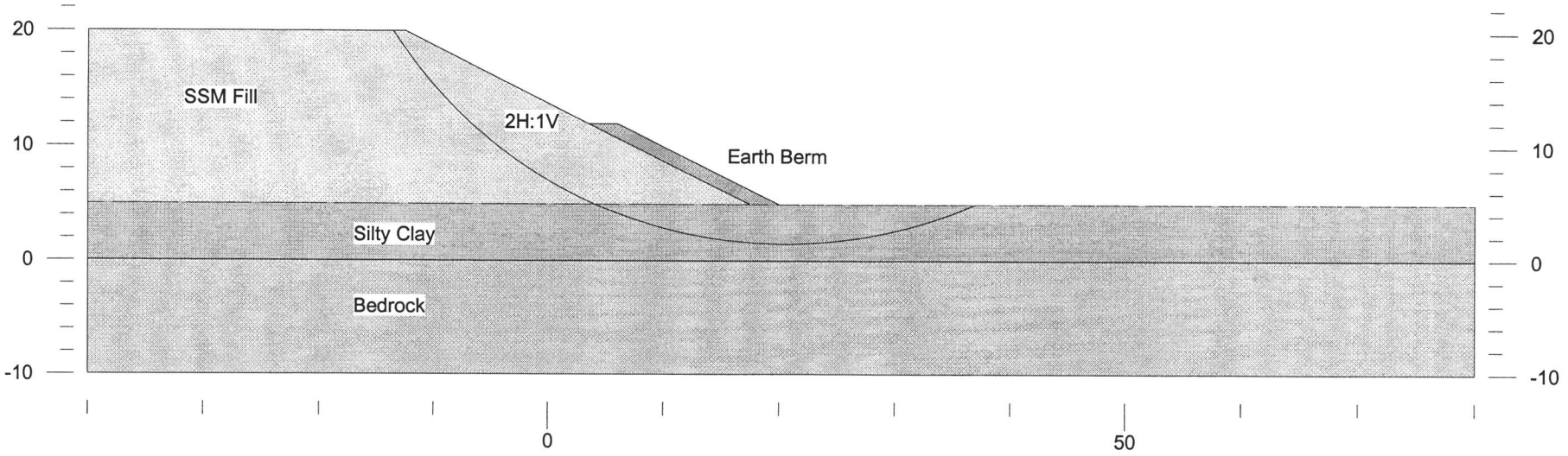


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FIGURE FS1

Appendix G

Selected Stability Analyses Results

CPR Overhead Arnprior Bridge Approaches

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Stiff Clay	17	80	0	0	1
Firm/Stiff Clay	17	50	0	0	1
Bedrock	(Infinitely Strong)				

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Highway 17 Twinning - CPR Overhead (Arnprior) Bridge
June 21, 2005
Stability of Side Slopes - West Approach
Figure G1 Undrained Analysis - SSM Fill

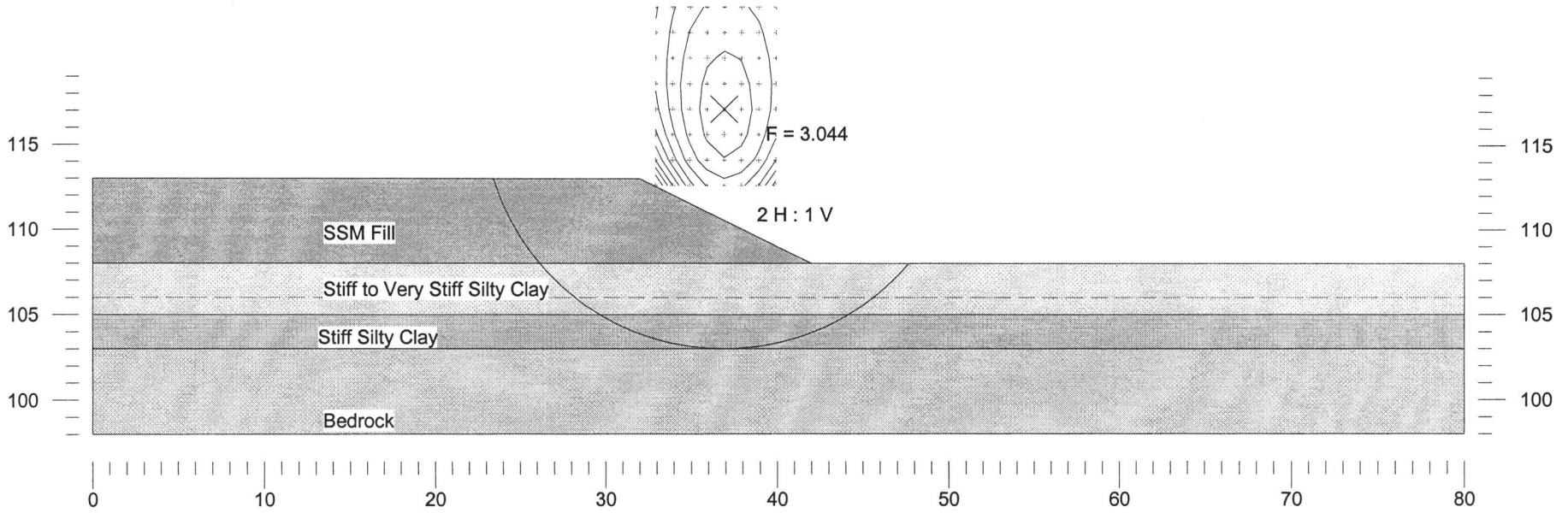

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FIGURE G1

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Stiff Clay	17	0	29	0	1
Firm/Stiff Clay	17	0	28	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
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Highway 17 Twinning - CPR Overhead (Arnprior) Bridge
June 21, 2005
Stability of Side Slopes - West Approach
Figure G2 Drained Analysis - SSM Fill

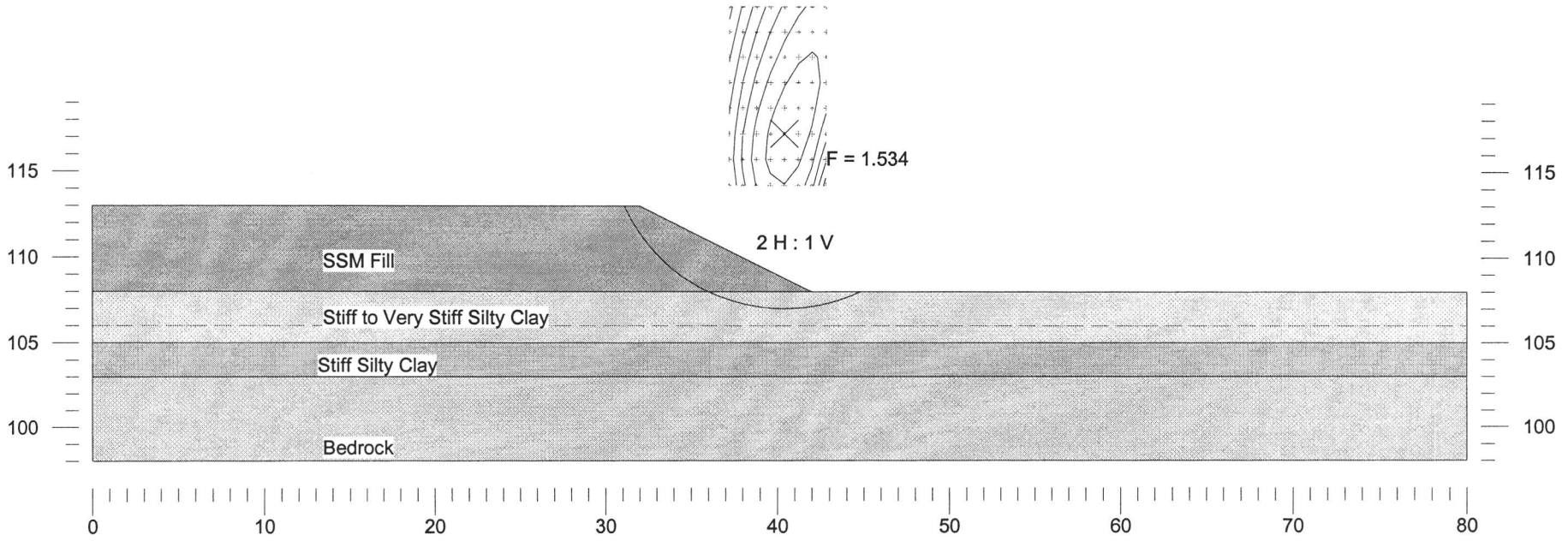

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FIGURE G2

Appendix H

Selected Stability Analyses Results

Division Street Underpass Approaches

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Firm/Stiff Clay	17	50	0	0	1
vStiff Clay Till	17	80	0	0	1
Bedrock	(Infinitely Strong)				

Thurber Engineering Ltd. - Toronto
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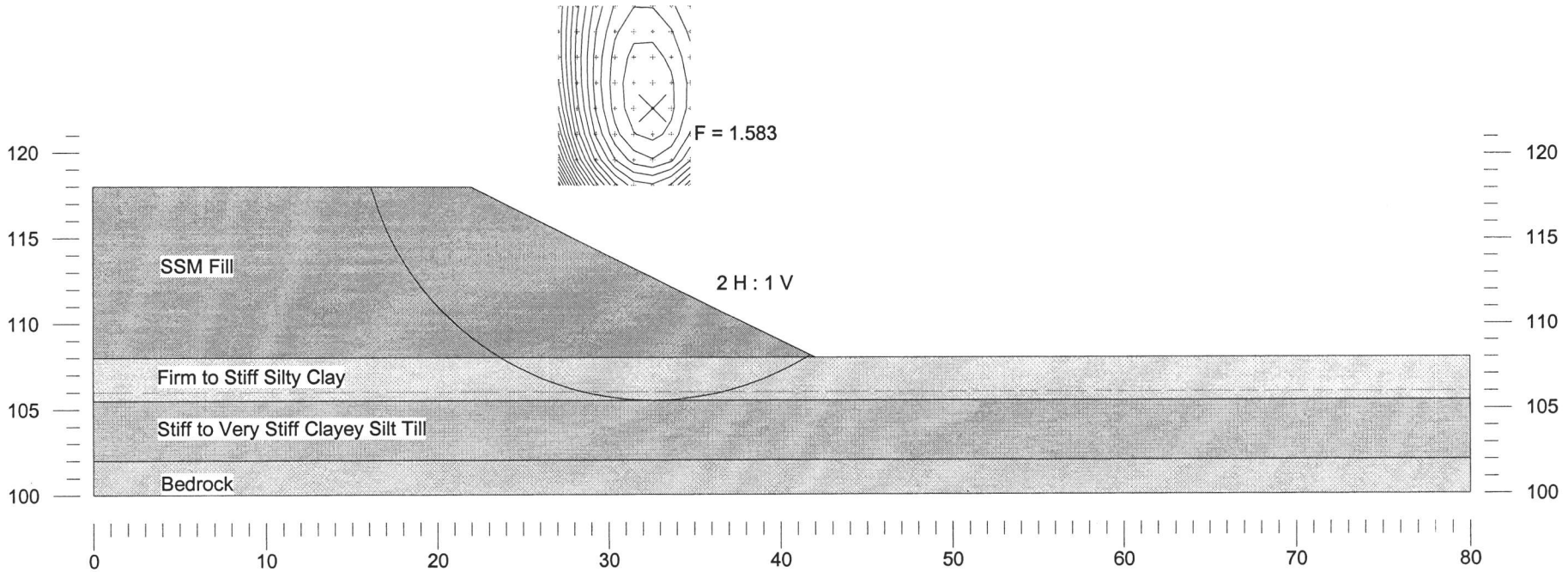
Highway 17 Twinning - Division Street Underpass
June 21, 2005
Stability of Side Slopes - East Approach
Figure H1 Undrained Analysis - SSM Fill



29/06/2005 11:29:42 AM C:\SPANG\THURB~12\19-135~4\FIGH1.GSL Thurber Engineering Ltd. - Toronto F = 1.583

FIGURE H1

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Firm/Stiff Clay	17	0	28	0	1
vStiff Clay Till	17	0	29	0	1
Bedrock	(Infinitely Strong)				

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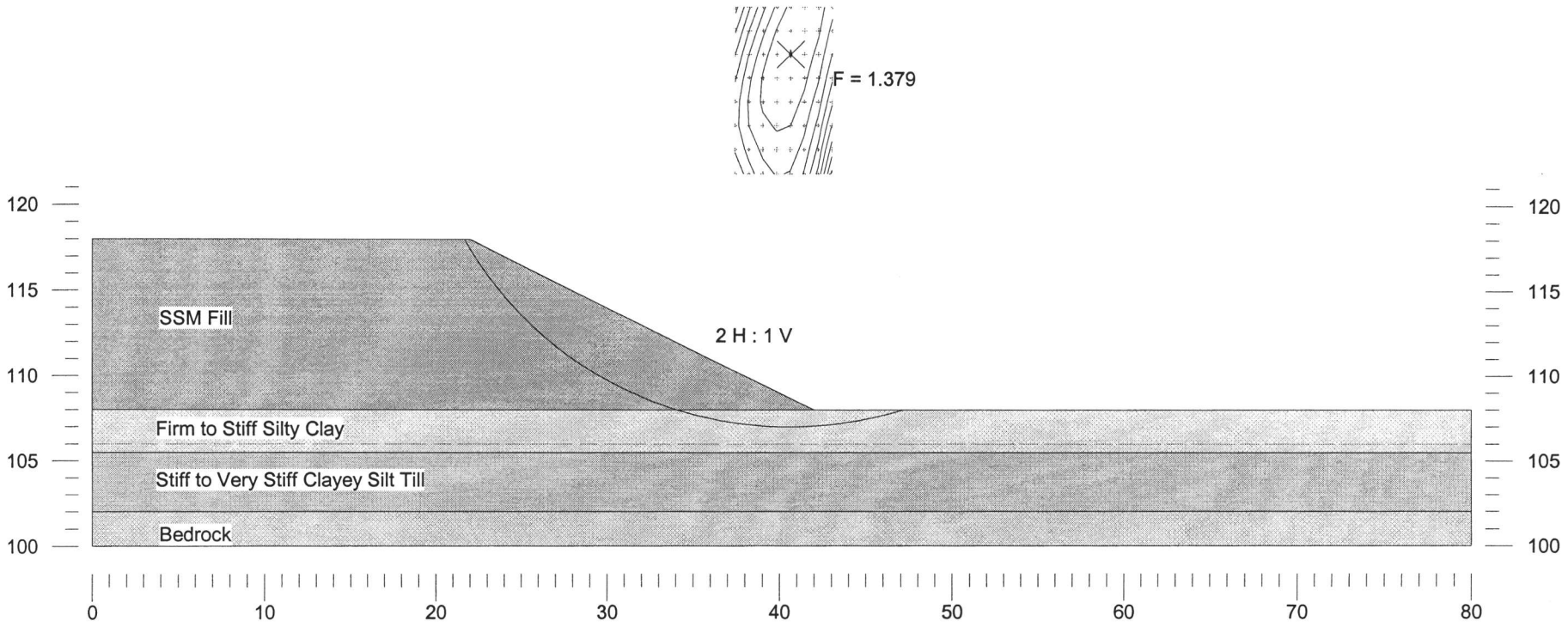
Highway 17 Twinning - Division Street Underpass
June 21, 2005
Stability of Side Slopes - East Approach
Figure H2 Drained Analysis - SSM Fill



29/06/2005 11:30:26 AM C:\SPANG\THURB~12\19-135~4\FIGH2.GSL Thurber Engineering Ltd. - Toronto F = 1.379

FIGURE H2

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
SSM Fill	21	0	30	0	0
Firm/Stiff Clay	17	0	28	0	1
vStiff Clay Till	17	0	29	0	1
Bedrock	(Infinitely Strong)				

Seismic coefficient = 0.145

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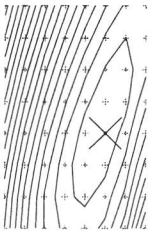
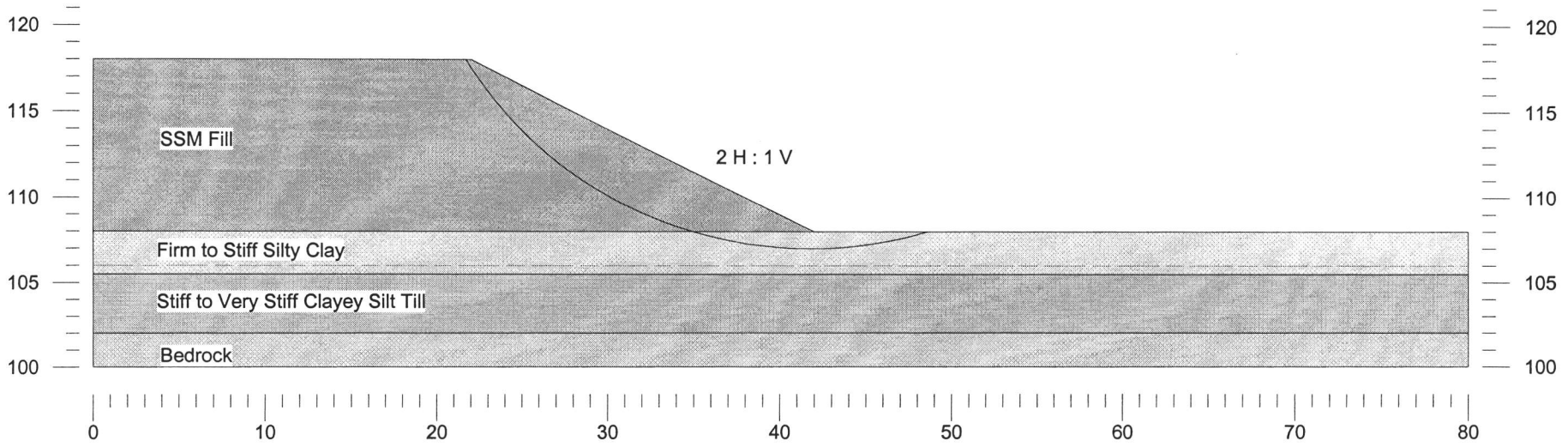
Highway 17 Twinning - Division Street Underpass
June 21, 2005
Seismic Stability of Side Slopes - East Approach
Figure HS1 Drained Analysis - SSM Fill



F = 1.002



29/06/2005 11:31:54 AM C:\SPANG\THURB~12\19-135~4\FIGHS1.GSL Thurber Engineering Ltd. - Toronto F = 1.002

FIGURE HS1