



THURBER ENGINEERING LTD.



**DRAFT
FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH EMBANKMENTS AT
PROPOSED LLOYDTOWN-AURORA ROAD INTERCHANGE
HIGHWAY 400 WIDENING
TOWNSHIP OF KING, ONTARIO
G.W.P. 2085-13-00**

GEOCRES NO.

Report

to

WSP / MMM Group

Date: March 28, 2017
File: 12187

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of the interchange reconstruction of the Highway 400 Underpass at Lloydtown-Aurora Road in the Township of King, Ontario, as part of the overall widening of Highway 400 project.

The purpose of this investigation was to explore the subsurface conditions in the areas of the proposed high fills and to delineate the extent of soft/loose soils at the east abutment. Based on the data obtained, a borehole location plan, stratigraphic profiles, records of boreholes, laboratory test results, and a written description of the subsurface conditions are provided.

Thurber was retained by WSP / MMM Group (MMM) to carry out this foundation investigation under the MTO Assignment Number 2015-E-0016.

2. PROJECT AND SITE DESCRIPTION

The site is located at the interchange of Highway 400 and Lloydtown-Aurora Road in the Township of King, Ontario. The existing Lloydtown-Aurora Road Underpass is a single span structure approximately 34 m in length and 15 m in width with abutments supported on spread footings. The existing underpass and approaches will be replaced, and a system of new ramps will be constructed at the site.

The general topography at the site is relatively flat. Occasional treed areas, residential dwellings and commercial properties are located in the vicinity of the site. The land to the west is used for agricultural purposes.

The project area is located within the transition zone between physiographic regions known as the South Slope and the Oak Ridges Moraine, although the Lloydtown – Aurora Road Underpass site seems to be located within the Oak Ridges Moraine area (*Physiography of Southern Ontario, Chapman and Putman, 1984*). The surficial soils within the Oak Ridges Moraine are comprised of till overlying sands and gravels.

3. INVESTIGATION PROCEDURES

3.1 Previous Investigations

A foundation investigation was carried out in October and November 2010 for the proposed replacement of the Lloydtown-Aurora Road Underpass, and involved drilling a total of six boreholes designated as LA1 to LA6. The results of the investigation were presented in the Foundation Investigation Report, Geocres No: 31D-550, prepared by Golder Associates Ltd., dated November 2012 (Reference 1). Copies of the Record of Borehole sheets and Borehole Locations and Soil Strata Drawings are enclosed in Appendix D of this report. The subsurface conditions at those borehole locations have been referenced in this report where appropriate.

3.2 Current Investigation

The site investigation and field testing for this project were carried out from February 27 to March 3, 2017 and consisted of drilling and sampling twelve (12) boreholes designated as 17HF-01 to 17HF-12. Boreholes 17HF-01 to 17HF-03 were located in the north-west quadrant of the site. Boreholes 17HF-04, 17HF-08 and 17HF-09 were drilled in the south-east quadrant, and Boreholes 17HF-06, 17HF-10 to 17HF-12 were drilled in the north-east quadrant of the site. Those boreholes were terminated at depths ranging from 5.2 m to 6.7 m (Elevations 299.9 to 292.7). In addition, Boreholes 17HF-05 and 17HF-07 were advanced through the existing Lloydtown-Aurora Road embankment on the east side of the existing underpass to depths of 15.5 m and 8.2 m or Elevations 295.4 and Elev. 301.1, respectively.

Prior to the start of drilling, the borehole locations were marked/staked in the field and utility clearances were obtained.

A track-mounted D50 drill rig was used to drill and obtain soil samples in the boreholes. Solid stem augers were used to advance the boreholes until the target depth was reached. Samples of the encountered soils were obtained from the boreholes at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) procedures as per ASTM D1586.

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

The co-ordinates and elevations of the as-drilled boreholes were provided by MMM in the MTM NAD 83 northing and easting coordinates. The approximate locations of the boreholes are shown on Borehole Locations and Soil Strata drawings included in Appendix C. The coordinates and elevations of these boreholes are provided on these drawings and on the individual Record of Borehole sheets in Appendix A.

Groundwater conditions were observed in the open boreholes throughout the drilling operations and upon completion of drilling. Standpipe piezometers were installed in Boreholes 17HF-02, 17HF-05, 17HF-07, 17HF-09 and 17HF-11. Each piezometer consisted of a 19 mm Schedule 40 PVC pipe with a 1.5 m long slotted screen enclosed in a filter sand column to permit groundwater level monitoring. Piezometer installation details, groundwater level observations and water level readings are shown on the Record of Borehole sheets. Upon completion of the drilling operations, the boreholes without piezometers were abandoned in general accordance with Ontario Regulation 903, amended by Ontario Reg. 372, (O.Reg. 903). The piezometers will be decommissioned as per O.Reg. 903 after the final set of water level readings are taken. The details of standpipe piezometer installation and borehole completion details are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Station	Borehole Depth / Base Elevation (m)	Piezometer Tip Elevation (m)	Completion Details
17HF-01	6.7 / 299.6	None installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17HF-02	6.7 / 297.8	6.1 / 298.4	Borehole backfilled with sand filter from 6.7 to 4.1 m, bentonite holeplug from 4.1 m to surface.
17HF-03	6.7 / 297.1	None installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17HF-04	5.2 / 299.9	None installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17HF-05	15.5 / 295.4	15.2 / 295.7	Borehole backfilled with sand filter from 15.2 to 12.8m, bentonite holeplug to 3.0 m, then bentonite holeplug and auger cuttings to 0.15 m and asphalt to surface.

Station	Borehole Depth / Base Elevation (m)	Piezometer Tip Elevation (m)	Completion Details
17HF-06	5.2 / 298.8	None installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17HF-07	8.2 / 301.1	7.5 / 301.6	Borehole backfilled with sand filter from 8.2 to 5.2 m, bentonite holeplug to 3.1 m, bentonite holeplug and auger cuttings to 0.20 m, then concrete to surface.
17HF-08	6.7 / 297.9	None installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17HF-09	6.7 / 297.5	6.1 / 298.1	Borehole backfilled with sand filter from 6.7 to 4.0 m then bentonite holeplug to surface.
17HF-10	6.7 / 297.1	None installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.
17HF-11	6.7 / 296.4	6.1 / 297.0	Borehole backfilled with sand filter from 6.7 to 4.0 m then bentonite holeplug and auger cuttings to surface.
17HF-12	6.7 / 292.7	None installed	Borehole backfilled with bentonite holeplug and auger cuttings to surface.

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance to MTO and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets in Appendix A and are presented on the figures included in Appendix B.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendix A. Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and on the "Borehole Locations and Soil Strata" drawings included in Appendix C. A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description and should be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions encountered in the boreholes drilled outside of the LLoydtown-Aurora Road embankment consisted of surficial topsoil and at some locations variable fill, overlying a deposit of a till comprising silty clay and clayey silt with sand underlain by another till comprising mainly sand and silt, and exhibiting slight plasticity at some locations. A sand deposit was encountered below the till at some locations. In the boreholes advanced from the top of the embankment, surficial very soft/very loose soils were encountered immediately below the embankment fill. These surficial soils were underlain by native soils similar to those present elsewhere at the site. Groundwater levels in the piezometers were observed between approximately 5 m to 12 m depths on March 13, 2017.

More detailed descriptions of the individual strata are presented below.

5.1 Topsoil

A layer of topsoil between 150 and 600 mm in thickness was encountered at ground surface in all boreholes, except in Boreholes 17HF-05 and 17HF-07, which were advanced from the top of the embankment.

The topsoil thickness may vary between and beyond the borehole locations, and the limited data is not suitable for estimating topsoil quantities.

5.2 Asphalt

A 150 mm layer of asphalt underlain by sand and silt fill was encountered in Boreholes 17HF-05 and 17HF-07.

5.3 Embankment Fill

Embankment fill was encountered to depths of 7.3 m (Elev. 303.6) and 5.8 m (Elev. 303.5) in Boreholes 17HF-05 and 17HF-07, respectively.

5.3.1 Sand and Silt Fill

The upper cohesionless fill material was classified as brown sand, sand and silt and sandy silt containing trace clay and trace gravel. The base of this fill was at 4.0 m and 2.4 m depths (Elev. 306.9. at both locations) in Boreholes 17HF-05 and 17HF-07, respectively.

SPT 'N' values recorded in the sand and silt fill ranged from 11 to 26 blows per 0.3 m of penetration, indicating a compact condition. Measured moisture contents ranged between 5

percent and 12 percent.

5.3.2 Clayey Silt Fill

The cohesionless fill was underlain by a layer of clayey silt with sand fill. Trace gravel, occasional lenses of topsoil and sand were noted in the fill. The thickness of the cohesive fill was 3.3 m and 3.4 m in Boreholes 17HF-05 and 17HF-07, respectively.

SPT 'N' values recorded in the clayey silt fill ranged from 9 to 27 blows per 0.3 m of penetration indicating a stiff to very stiff consistency. Measured moisture contents ranged between 8 percent and 18 percent.

The results of grain size analyses conducted on a sample of sand and silt fill and four samples of clayey silt fill are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figures B1 and B2 of Appendix B. The laboratory test results are summarized in the following table.

Soil Particle	Percentage (%) Silty Sand	Percentage (%) Clayey Silt with Sand
Gravel	2	2 to 6
Sand	55	31 to 35
Silt	37	42 to 50
Clay	6	14 to 20

5.4 General Fill

A layer of clayey silt to silty clay fill was encountered underlying the topsoil in Boreholes 17HF-01, 17HF-02 and 17HF-11. Trace to some sand, trace gravel, oxidation staining and occasional lenses of topsoil were noted in the fill. The thickness of this fill ranged from 0.6 m to 1.6 m. The base of fill was at 0.8 m to 2.2 m depth (Elev. 302.3 and Elev. 304.1).

SPT 'N' values recorded in this cohesive fill varied from 3 to 10 blows per 0.3 m of penetration, indicating soft to firm and occasionally stiff consistency. Moisture contents of the cohesive fill varied from 10 percent to 19 percent.

A 1.2 m thick layer of sand fill was encountered in Borehole 17HF-09 underlying the topsoil. The fill comprised some silt becoming silty, with trace clay and trace gravel. A 0.5 m of silty sand fill with trace gravel and some clay was underlying the topsoil in Borehole 17HF-10. Occasional

topsoil lenses were noted in the fill. The base of fill was at 1.4 m depth (Elev. 302.8) and 0.8 m depth (Elev. 303.0) in Boreholes 17HF-09 and 17HF-10, respectively.

The cohesionless fill was loose with SPT 'N' values of 4 to 9 blows per 0.3 m of penetration. Moisture contents of 10 percent and 19 percent were measured in this fill.

5.5 Sandy Silt

A layer of very loose sandy silt was encountered in Borehole 17HF-05 immediately beneath the embankment fill at 7.3 m depth below the existing Lloydtown-Aurora Road grade. The layer was 1.5 m in thickness and extended to a depth of 8.8 m, or Elev. 302.1. No SPT 'N' value was obtained in this layer as the split spoon sampler sank under the weight of hammer.

5.6 Clayey Silt to Silty Clay Till

Underlying the fill materials or topsoil in all boreholes, except in Boreholes 17HF-09 and 17HF12, was a till deposit ranging in composition from clayey silt with sand to silty clay with some sand and trace gravel. Occasional zones with less sand content were observed in the till. The thickness of this cohesive till ranged from 1.4 m to 3.0 m with the base of the cohesive till ranging from 2.2 m to 10.2 m depths (Elev. 300.2 to 302.4).

SPT 'N' values obtained in the cohesive till ranged from 3 blows for 0.3 m penetration to 26 blows for 0.3 m of penetration, indicating a soft to very stiff consistency. Moisture contents of the clayey silt till ranged from 8 percent to 22 percent.

The results of grain size analyses conducted on cohesive till samples are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figures B3 and B4 of Appendix B. The laboratory test results are summarized in the following table.

Soil Particle	Percentage (%)
Gravel	0 to 5
Sand	13 to 46
Silt	34 to 52
Clay	13 to 41

The results of Atterberg Limits tests conducted on samples of the cohesive till are provided on the Record of Borehole sheets in Appendix A and illustrated in Figure B8 of Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	19 to 29
Plasticity Index	8 to 14

The results of the Atterberg Limits testing indicate the deposit to be of slight to low plasticity with a group symbol CL-ML.

Glacial till inherently contains cobbles and boulders, and such obstructions may be present in this deposit at other locations.

5.7 Sand to Sand and Silt Till

Underlying the cohesive till, a deposit of generally cohesionless till ranging in composition from sand to silt, with trace to some clay and trace gravel was encountered in all boreholes drilled. Zones of till exhibiting slight plasticity were noted in this generally cohesionless deposit. All boreholes were terminated in this till at depths between 5.2 m and 15.5 m or between Elev. 292.7 and Elev. 301.1.

SPT 'N' values obtained in the cohesionless till generally ranged from 12 blows per 0.3 m of penetration to more than 100 blows per 0.3 m of penetration, indicating a compact to very dense condition. The very high 'N' values may be indicative of the presence of cobbles or boulders, which are inherently present in the till deposit. However, SPT 'N' values of 4, 6 and 8 blows per 0.3 m of penetration, were obtained in the upper zone of the deposit in Boreholes 17HF-06, 17HF-08 and 17HF-12, indicating loose zones.

The results of grain size analyses conducted on samples of the cohesionless till are presented on the Record of Borehole sheets in Appendix A, and are illustrated in Figures B5 to B7 of Appendix B. The laboratory test results are summarized in the following table.

Soil Particle	Percentage (%) Sand Till	Percentage (%) Sand and Silt Till
Gravel	0	0 to 8
Sand	81 to 98	7 to 64
Silt	7 to 16	30 to 86
Clay	2 to 3	3 to 14
Silt and Clay	2	-

The moisture content of the samples tested varied from 3 percent to 20 percent.

5.8 Groundwater Conditions

Groundwater levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. Standpipe piezometers were installed in Boreholes 17HF-02, 17HF-05, 17HF-07, 17HF-09 and 17HF-11 to permit longer term water level monitoring. Water levels measured in the boreholes on completion of drilling operations and in standpipe piezometers are summarized below.

Table 5-1. Summary of Water Level Observations

Borehole Number	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
17HF-01	February 28, 2017	5.5	300.8	On completion
17HF-02	February 28, 2017	5.5	299.0	On completion
	March 13, 2017	5.9	298.6	
	March 28, 2017	5.6	298.9	
17HF-03	February 28, 2017	Dry to 6.7	-	On completion
17HF-04	February 28, 2017	Dry to 4.9	-	On completion
17HF-05	March 3, 2017	12.2	298.7	On completion Piezometer
	March 13, 2017	12.2	298.7	
	March 28, 2017	11.8	299.1	
17HF-06	February 27, 2017	Dry to 5.2	-	On completion
17HF-07	March 3, 2017	Dry	-	On completion In piezometer
	March 13, 2017	7.9	301.4	
	March 28, 2017	6.3	303.0	
17HF-08	February 28, 2017	Dry to 5.9	-	On completion
17HF-09	February 28, 2017	Dry to 6.7 m	-	On completion In piezometer
	March 13, 2017	5.4	298.8	
	March 28, 2017	5.0	299.2	
17HF-10	February 27, 2017	Dry to 6.7 m	-	On completion
17HF-11	March 13, 2017	4.9	298.2	In piezometer
	March 28, 2017	4.7	298.4	
17HF-12	February 27, 2017	3.4 m	296.0	On completion

The water levels shown in Table 5-1 are short-term readings and seasonal fluctuations of the groundwater level are to be expected. The groundwater level may be at a higher elevation after periods of significant or prolonged precipitation. Further readings will be taken to monitor the water level measurements before finalization of this report.

6. MISCELLANEOUS

Geo-Environmental Drilling of Halton Hills, Ontario, supplied and operated a track-mounted D50 drill rig to carry out the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full-time basis by Mr. Sam Bastan of Thurber. Geotechnical laboratory testing was carried out by Thurber in its MTO-approved laboratory. Overall supervision of the field program was carried out by Mr. Stephane Loranger, CET.

Overall project management was provided by Dr. Sydney Pang, P.Eng. Interpretation of the field data and preparation of this report was completed by Ms. Anna Piascik, P.Eng. The report was reviewed by Messrs. Sydney Pang, P.Eng and P.K. Chatterji, P.Eng. who is a Designated Principal Contact for MTO Foundations Projects.



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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This report presents an interpretation of the geotechnical data presented in the factual report and provides geotechnical recommendations for the design of high embankments as part of the proposed reconstruction of the Highway 400/Lloydtown-Aurora Road interchange in the Township of King, Ontario. Comments are also provided on the extent of the surficial soft/loose soils in the east abutment area.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction contractor. The contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the information provided as it may affect equipment selection, proposed construction methods and scheduling.

Information on the proposed reconstruction of the interchange, including a GA drawing, was provided by MMM. It is understood that the new Highway 400/Lloydtown-Aurora Road interchange is envisioned as a Parclo A4 configuration. The existing 33.7 m single span rigid frame underpass (Site No. 37-60) will be replaced with a two-span structure with a total length of 81.2 m on integral abutments and a centre pier on spread footings. The proposed grade of the Lloydtown-Aurora Road in the vicinity of the new bridge abutments was shown at approximately Elevation 313.2. The foundation design for the Lloydtown Underpass replacement structure and approach embankments was provided in Reference 1 (Geocres Report No: 31D-550).

This report provides discussion and recommendations for design of the proposed ramp embankments of which some sections will have heights ranging from 4.7 to 6.8 m. In addition, comments are provided on the impact of the pockets of very soft/loose surficial deposits encountered immediately below the embankment fill in the proposed east abutment and approach areas.

The discussions and recommendations presented in this report are based on information provided by MMM and on the factual data obtained during the course of the field investigation. In addition, the subsurface information contained in Reference 1 (Geocres Report No: 31D-550), prepared for the proposed replacement of the Lloydtown-Aurora Road Underpass, has been utilized in this report. Selected Record of Borehole sheets and the Borehole Locations and Soil Strata drawing from Reference 1 are included in Appendix D of this report.

8. EMBANKMENT DESIGN

8.1 General

The ground surface within the interchange area varies between Elev. 303.0 and Elev. 305.0 resulting in the new ramp embankments up to approximately 7 m in height. The grade of Highway 400 at the underpass structure is at about Elevation 305.0.

Based on the 90% Design Drawings, the high embankment sections were identified at the following locations:

Ramp Designation	Approx. High Embankment Stations along Ramp	Max. Embankment Top Elevation/Height (m)	Relevant Boreholes
E-S	9+750 to 9+840	311.8 / 6.8	17HF-01 to 17HF-03, LA2
W-N	9+775 to 9+985	311.8 / 6.4	17HF-04, 17HF-05, 17HF-08, 17HF-09, LA5
E-N	9+490 to 9+952	309.0 / 5.2	17HF-10 to 17HF-12

The east and west approaches to the underpass structure will be widened. The grade of Lloydtown-Aurora Road will be raised up to the order of 2 to 2.5 m. The footprints of the new ramp embankments will partially overlap the footprints of the existing embankments near the new underpass abutments.

No evidence of any slope instability problems with the existing embankments was observed during the field investigation. The existing embankment inclinations are relatively flat and covered by vegetation (grass and occasional shrubs).

Based on the subsurface information, the ramp embankments will be constructed on a deposit of low plastic till consisting of firm to very stiff clayey silt / silty clay with sand. The cohesive till is underlain by a compact to very dense and typically cohesionless till consisting of various proportions of sand and silt with trace to some clay and trace gravel. Slight plasticity of the lower till deposit was observed at some locations.

The new ramp embankments may be constructed with Select Subgrade Material (SSM) satisfying OPSS.PROV 1010 requirements, or with locally excavated clayey silt to silty clay till that is free of organics and deleterious materials.

At all locations/areas of the new embankment fill placement, the stability and settlement analyses are based on the assumption that prior to construction of the new embankments, all organic matter/topsoil and soft, disturbed soils are removed from below the embankment footprint. It is understood that the existing embankment fill will be left in place in the transition zones between approach and ramp embankments.

Discussions on the embankment slope stability and settlements are presented in the following sections.

8.2 Assessment of Embankment Stability

The global stability of the proposed embankments has been assessed using the commercially available slope stability program GEO-SLOPE produced by Geo-Studio International Ltd., and employing the Morgenstern-Price method of analysis. Cross-sections of the embankments at the E-S Ramp at Sta. 9+757 and at the W-N at Sta. 9+782 were selected for the analyses since they are the critical cross-sections with the greatest height and the least favourable subsurface conditions. Stability analyses were carried out for both short term (undrained) and long term (drained) conditions using 2H : 1V slopes with fill heights of 6.8 m and 6.3 m for the E-S and W-N ramps, respectively.

The stability analyses were carried out to check that the target minimum Factor of Safety was achieved for the design embankment height and geometry. As per MTO practice, Factors of Safety of 1.3 and 1.5 are considered appropriate to achieve short term (during construction) and long term stability for embankments, respectively.

Soil parameters used in the stability analyses were evaluated based on empirical correlations with results of SPT testing and geotechnical classification testing, and both total stress and effective stress analyses were carried out for the selected cross-sections.

Based on this evaluation, the following soil parameters were utilized in the analyses.

Table 8.1- Engineering Parameters for Slope Stability Analysis

Soil Type	Unit Weight (kN/m ³)	Undrained Shear Strength (kPa)	Angle of Internal Friction (degrees)	Effective Cohesion (kPa)
New/Existing Embankment – SSM Fill	20	-	30	-
Firm Clayey Silt/Silty Clay Till	19	40	28	-
Stiff Silty Clay Till	19	60	29	-
Dense to very dense Sand to Sand and Silt Till	21	-	32	-

The groundwater level in the interchange area at Elev. 300.0 was assumed for analysis in consideration of the high water level/spring thaw in the area.

The results of the slope stability analyses are illustrated on Figures F1 to F4 in Appendix F. The estimated factors of safety exceed the required minimum values of 1.3 and 1.5 for short-term and long term embankment stability, respectively.

Considering the subsurface conditions and the fill heights for the ramps, the SSM fill embankments built with side slopes at inclinations of 2H : 1V or flatter are anticipated to meet the MTO requirements for embankment stability.

8.3 Assessment of Embankment Settlement

8.3.1 Design Criteria and Parameter Selection

The criteria for acceptable post construction settlement applicable to embankment design for MTO projects are defined in the MTO Guidelines “Embankment Settlement Criteria for Design”, dated July 2010. The following criteria has been selected for use to assess the embankment settlement.

**Table 8.2 - Post – Construction Settlement Criteria for New Embankments
MTO Guidelines**

Type of Road/ Type of Pavement	Maximum Limits During Pavement Design Life	
	Total Settlement (mm)	Differential Settlement Rate
Freeways on Compressible Soils	100	200:1

Information obtained from the field investigation and laboratory testing has been compiled and geotechnical parameters for estimating consolidation settlements were selected for the clayey silt and silty clay with sand till deposit, based on empirical correlations with water contents, Atterberg Limits and available data from the geotechnical literature.

8.3.2 Results of Settlement Analysis

Consolidation settlements of the underlying silty clay/clayey silt till can be expected as a result of the loading from the new fill, in addition to self compression of the fill. To estimate the magnitude of the expected settlements, analyses were carried out on critical sections of the proposed ramp embankments. For the analyses, the critical section was considered to be the one located on the east side of the proposed structure near the proposed east abutment, where the embankment is the highest and in consideration of consistency/compressibility of the underlying foundation soils.

The magnitude of the long term settlements due to consolidation of the cohesive till under the embankment loadings have been estimated using Terzaghi's one-dimensional consolidation theory.

For a 7 m high ramp embankment, the primary consolidation settlements of the foundation soils have been estimated to range from 50 mm to 100 mm in the area of the east approach/new abutment. Elsewhere, the consolidation settlements of the ramp embankments are expected not to exceed 50 mm with most settlements to take place during construction and within the first month following completion of the embankments. The highway platform should be overbuilt as required to accommodate the anticipated settlements.

Based on the analysis of the time rate of consolidation, approximately 90% of settlement due to primary consolidation of the silty clay/clayey silt till is expected to be completed within a period of two months after the embankment is constructed to its full height. These settlements will occur along the new roadway both longitudinally and laterally. The new fill will be placed against the existing embankment fill. Since consolidation of the silty clay/clayey silt till beneath the existing

embankment has already been completed, the remaining settlements will occur as differential settlements between the crest of the existing embankment and the crest of the new ramp embankment.

In order to accommodate the settlements discussed above, it is recommended that the paving operations be delayed by up to three months after the fill is placed to its maximum height.

The settlement/compression of the embankment fill itself has been estimated to be in order of 30 to 35 mm which corresponds to approximately 0.5% strain under its own weight for a maximum 7m high embankment.

It is anticipated that those settlements would be relatively evenly distributed across the site and therefore, the MTO criteria of 200:1 would be met.

8.4 Recommended Embankment Geometry

Considering the magnitude of the estimated embankment settlements, the new ramp embankments with a height not exceeding 7 m and with side slopes at 2 horizontal to 1 vertical should be considered for this site.

It is estimated that 90% of the foundation settlements will occur within the first two months following the completion of fill placement for embankment construction. In order to allow some more of the fill compression to take place, it is recommended that the contract schedule takes into consideration this timing requirement such that paving will not start until three months after the top of fill is reached.

9. RAMP EMBANKMENT CONSTRUCTION

Construction of the ramp embankments should be carried out in accordance with OPSS.PROV 206 and OPSS.PROV 209. The new embankment fill may consist of SSM or locally excavated clayey silt to silty clay till that is free of organics and deleterious materials.

Where the footprint of the new embankment overlap the footprint of the existing road embankment, the new embankment fill must be keyed into the existing fill in accordance with the requirements of OPSD 208.010.

It is recommended that all existing surface vegetation, any organic deposits, including peat and topsoil, and any disturbed material or otherwise loose/soft soils should be stripped from within the embankment footprints. The new fill should be placed and compacted in accordance with OPSS.PROV 206 and OPSS.PROV 501.

Erosion protection of the new embankment slopes in the form of topsoil placement and seeding should be implemented as soon as possible. Surface run-off should not be allowed to discharge on the embankment slopes in an uncontrolled manner. Asphalt barrier curb or curb with gutter as per OPSD 601.010 should be considered to protect the embankment slopes before erosion protection is established.

Inspection and approval of the foundation surfaces should be conducted by qualified geotechnical personnel.

10. EAST APPROACH EMBANKMENT

During the foundation investigation carried out for the replacement of the Lloydtown-Aurora Road Underpass (Reference 1 - Geocres Report No: 31D-550), a layer of surficial, very soft clayey silt deposit was encountered immediately beneath the embankment fill in Borehole LA5 located in the vicinity of the new east abutment. Part of the scope of the current investigation was to delineate the extent of the very soft deposit, and provide comments on the impact of this deposit on the performance of the approach embankment.

Based on Reference 1, the surficial clayey silt contained trace to some sand, trace gravel and noticeable rootlets and organics. An organic content of 2.1% was reported in Borehole LA5. The clayey silt layer was 2.1 m in thickness with the base at a depth of 8.7 m or Elev. 302.3. During the current investigation, four boreholes were drilled near the proposed east abutment to delineate the extent of the very soft soils. Only Borehole 17HF-05, which was located some 15m to the north of Borehole LA5, encountered 1.5 m of very loose sandy silt at a similar depth. The base of the sandy silt was at a depth of 8.8 m or Elev. 302.1.

No very soft/loose zones were identified in any other borehole. It is probable that these surficial, very soft clayey silt/very loose sandy silt soils exist in pockets in the vicinity of the east abutment. These soils are not expected to have adverse effects on the proposed abutment foundations.

Staged construction has been planned in conjunction with roadway protection to maintain traffic during the excavation and removal of some existing approach fills during new abutment construction and approach widening. Should the very soft/very loose surficial soils or any deleterious materials be exposed at the embankment subgrade level including that within the widening, they should be subexcavated and replaced with well compacted granular fill material.

11. CONSTRUCTION CONCERNS

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

- Cobbles, boulders or other buried obstructions may be encountered during excavation of the existing embankment fill.
- The existing Lloydtown-Aurora Road embankment may experience surficial distress during ramp embankment construction as new fill is placed against existing fill. Periodic maintenance of the pavement surface should be allowed to ensure safe traffic operation of the existing road.

12. CLOSURE

Engineering analysis and preparation of this report was carried out by Ms. Anna Piascik P.Eng. The report was reviewed by Messrs. Sydney Pang, P.Eng. and P.K. Chatterji, P.Eng. who is a Designated Principal Contact for MTO Foundations Projects.



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Review Principal, Designated MTO Contact

Client: MMM Group Ltd.

File No.: 12187

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High Embankments Hwy 400 DRAFT FIDR mar 17.docx

Date: March 28, 2017

Page: 20 of 20

Appendix A

Record of Borehole Sheets

DRAFT

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

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

 Water Level
 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.

EXPLANATION OF ROCK LOGGING TERMS


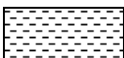



ROCK WEATHERING CLASSIFICATION

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.

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
	(MPa)	(psi)	
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

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 % 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.

UNIFIED SOILS CLASSIFICATION



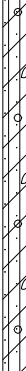
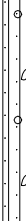
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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			

RECORD OF BOREHOLE No 17HF-01

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 494.2 E 297 824.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.28 - 2017.02.28 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
306.3	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL , fibrous Dark Brown Moist		1	SS	7		306													
305.7																				
0.6	Clayey SILT , some sand, trace gravel, oxidation and black organic staining Soft to Firm Brown Moist (FILL)		2	SS	5		305													
			3	SS	3															
304.1							304													
2.2	Clayey SILT , with sand, trace gravel Firm to Very Stiff Brown Moist (TILL)		4	SS	7															
			5	SS	16		303													
							302													
301.6																				
4.7	SAND and SILT , some clay, trace gravel, slightly plastic Dense Brown to Grey Moist (TILL)		6	SS	42		301													
							300													
			7	SS	50															
299.6																				
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE CAVED AND WATER LEVEL AT 5.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																			

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17HF-02

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 498.2 E 297 786.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.28 - 2017.02.28 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
304.5	GROUND SURFACE							20	40	60	80	100					
0.0 304.2	TOPSOIL, fibrous							20	40	60	80	100					
0.3	Clayey SILT , trace sand, trace gravel, occasional lenses of topsoil Firm Brown Moist (FILL)		1	SS	10		304										
			2	SS	5												
303.1																	
1.4	Clayey SILT , with sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		3	SS	14		303										
			4	SS	10		302										
			5	SS	24		301										
300.2																	
4.3	Silty SAND , trace clay, trace gravel Very Dense Brown Moist (TILL)		6	SS	50/ 0.125		300										
							299										
			7	SS	51		298										
297.8																	
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE CAVED AND WATER LEVEL AT 5.5m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.03.13 5.9 298.6 2017.03.28 5.6 298.9																

ONTMT4S MTO-12187.GPJ 2015TEMPLATE(MTO).GDT 3/29/17

RECORD OF BOREHOLE No 17HF-03

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 540.3 E 297 758.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.28 - 2017.02.28 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
303.8	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL fibrous Dark Brown		1	SS	3												
303.2																	
0.6	Clayey SILT , with sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		2	SS	9		303										
			3	SS	10		302										0 30 50 20
			4	SS	19		301										
300.8																	
3.0	Silty SAND , some clay, trace gravel, slightly plastic Dense to Very Dense Brown Moist (TILL)		5	SS	44		300										
			6	SS	31		299										0 54 35 11
							298										
			7	SS	57												
297.1																	
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE CAVED AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

ONTMT4S MTO-12187.GPJ 2015TEMPLATE(MTO).GDT 3/29/17

RECORD OF BOREHOLE No 17HF-04

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 504.2 E 297 958.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.28 - 2017.02.28 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					W _P W W _L WATER CONTENT (%)							
305.1	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL: (150mm)						305								○					
0.2	Silty CLAY , with sand, trace gravel, topsoil stained in upper 0.5m zone Soft to Stiff Brown to Light Brown Moist (TILL)		1	SS	3										○					
			2	SS	6		304								○					
			3	SS	8		303								⊞			0	29 49 22	
			4	SS	10										○					
302.1							302								○			0	50 38 12	
3.0	SAND and SILT , some clay, trace gravel, slightly plastic Dense Brown Moist (TILL)		5	SS	35		301													
			6	SS	43		300								○					
299.9																				
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE CAVED TO 4.9m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																			

+³, ×³: Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17HF-05

1 OF 2

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 541.2 E 297 943.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
310.9	GROUND SURFACE							20	40	60	80	100								
0.0	ASPHALT: (150mm)							20	40	60	80	100								
0.2	SAND and SILT , trace clay, trace gravel Compact Brown Moist (FILL)		1	SS	23		310							○						
			2	SS	18									○						
			3	SS	11		309							○						2 55 37 6
	Occasional silty sand seams		4	SS	19		308							○						
			5	SS	11									○						
306.9							307													
4.0	Clayey SILT , with sand, trace gravel, occasional topsoil and sand lenses Stiff Dark Brown Moist (FILL)		6	SS	9		306							11						2 35 44 19
							305							○						6 31 44 19
			7	SS	12		304													
303.6																				
7.3	Sandy SILT , trace to some clay, trace gravel Very Loose Brown Wet		8	SS	WH		303							○						0 22 71 7
							302													
302.1																				
8.8	Clayey SILT , with sand, trace gravel Stiff Brown Moist (TILL)		9	SS	11									○						5 40 41 14
							301													

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
 20
 15
 10
 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17HF-05

2 OF 2

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 541.2 E 297 943.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY AMP



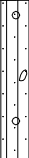
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									WATER CONTENT (%)
	Continued From Previous Page							20	40	60	80	100					
300.7																	
10.2	SAND , trace to some silt, trace gravel Very Dense Light Brown Moist to Wet (TILL)		10	SS	68												

RECORD OF BOREHOLE No 17HF-06

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 566.2 E 297 943.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.27 - 2017.02.27 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							WATER CONTENT (%) W _P W W _L PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		
304.0	GROUND SURFACE							20	40	60	80	100	20	40	60		
0.0	TOPSOIL , fibrous Loose Dark Brown Moist		1	SS	7									○			
303.4																	
0.6	Clayey SILT , with sand, trace gravel Firm to Very Stiff Brown Moist (TILL)		2	SS	7		303							○			
			3	SS	6		302							○			0 46 40 14
			4	SS	18		301							○			
300.4			5	SS	26									○			3 46 34 17
3.6	SAND and SILT , trace clay, trace gravel Very Dense Brown Moist (TILL)						300										
			6	SS	50/ 0.100									○			
298.8							299										
5.2	END OF BOREHOLE AT 5.2m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No 17HF-07

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 546.2 E 297 989.0 ORIGINATED BY SB
HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2017.03.03 - 2017.03.03 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
309.3	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT:(150mm)		1	SS	100/ 0.056		309										
0.2	SAND, trace silt, trace gravel, occasional cobbles Compact Brown Moist (FILL)																
308.4			2	SS	21		308										
0.9	Sandy SILT, trace gravel Compact Brown Moist (FILL)		3	SS	26		307										
306.9																	
2.4	Clayey SILT, with sand, trace gravel, occasional topsoil lenses Very Stiff Brown Moist (FILL)		4	SS	18		306										
			5	SS	27		305										
			6	SS	24		304										
303.5																	
5.8	Clayey SILT, some sand, trace gravel Firm Brown Moist (TILL)		7	SS	7		303										
302.0																	
7.3	SAND and SILT, some clay, trace gravel, slightly plastic Very Dense Brown Moist (TILL)		8	SS	40		302										
301.1																	
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE CAVED AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.03.13 7.9 301.4 2017.03.28 6.3 303.0																

ONTMT4S MTO-12187.GPJ 2015TEMPLATE(MTO).GDT 3/29/17











+³, ×³: Numbers refer to
Sensitivity 20
15 10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17HF-08

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 533.2 E 298 016.9 ORIGINATED BY SB
HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
DATUM Geodetic DATE 2017.02.28 - 2017.02.28 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
304.6	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL , fibrous Black		1	SS	3		304										
0.2	Silty CLAY , some sand, trace gravel, rootlets in upper 0.5m zone Soft to Firm Brown Moist (TILL)		2	SS	6												
			3	SS	8		303										
302.4																	
2.2	SAND , some silt, trace clay, trace gravel Loose to Dense Brown Moist (TILL)		4	SS	4		302										
			5	SS	22		301										
																	
			6	SS	33		300										
							299										
			7	SS	31		298										
297.9	END OF BOREHOLE AT 6.7m. BOREHOLE CAVED TO 5.9m AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																
6.7																	

ONTMT4S MTO-12187.GPJ 2015TEMPLATE(MTO).GDT 3/29/17

RECORD OF BOREHOLE No 17HF-09

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 498.2 E 298 051.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.28 - 2017.02.28 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
304.2	GROUND SURFACE							20	40	60	80	100							
0.0	TOPSOIL, with roots and rootlets, mixed with clay		1	SS	4		304												
0.2	SAND, some silt to silty, trace clay, trace gravel, occasional topsoil lenses Loose Brown Moist (FILL)		2	SS	9		303												
302.8																			
1.4	SAND, trace clay, trace silt, trace gravel Compact to Dense Brown Moist (TILL)		3	SS	21		302												
			4	SS	23		301												
			5	SS	42		300												
300.1																			
4.1	SILT, some sand to sandy, trace clay, trace gravel Very Dense Brown Moist to Wet (TILL)		6	SS	53		299												
							298												
			7	SS	50/ 0.125														
297.5																			
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN AND DRY UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.03.13 5.4 298.8 2017.03.28 5.0 299.2																		

ONTMT4S MTO-12187.GPJ 2015TEMPLATE(MTO).GDT 3/29/17

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 17HF-11

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 641.2 E 297 937.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.27 - 2017.02.27 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
303.1	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL, with roots and rootlets						303											
0.2	Silty CLAY , some sand, trace gravel, occasional oxidized seams, occasional topsoil lenses		1	SS	8													
302.3	Firm Brown Moist (FILL)		2	SS	12		302											
0.8	Silty CLAY , with sand, trace gravel Stiff Brown Moist (TILL)		3	SS	15		301											0 21 52 27
300.8							300											
2.3	SAND and SILT , some clay, trace gravel, slightly plastic Very Dense Brown Moist (TILL)		4	SS	50/ 0.150													
			5	SS	62		299											6 45 35 14
			6	SS	73		298											
							297											
			7	SS	50/ 0.150													
296.4																		
6.7	END OF BOREHOLE AT 6.7m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2017.03.13 4.9 298.2 2017.03.28 4.7 298.4																	

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 17HF-12

1 OF 1

METRIC

W.P. 2085-13-00 LOCATION Lloydtown-Aurora Rd. Interchange, N 4 873 821.2 E 297 874.0 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.02.27 - 2017.02.27 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%) W _P W W _L				GR	SA	SI	CL
299.4	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL , fibrous Brown		1	SS	2		299								○					
298.8																				
0.6	SAND and SILT , trace clay, trace gravel Loose to Compact Light Brown to Grey Moist to Wet (TILL)		2	SS	6		298								○					
							298													
			3	SS	8															
							297													
			4	SS	24										○					0 57 40 3
							296								○					
			5	SS	22															
295.4																				
4.0	SAND , some silt, trace clay, trace gravel Dense Grey Moist to Wet (TILL)		6	SS	40		295								○					0 88 10 2
							294													
			7	SS	23		293								○					
292.7																				
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE CAVED TO 3.4m AND WATER LEVEL AT THE BASE UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																			

ONTMT4S MTO-12187.GPJ 2015TEMPLATE(MTO).GDT 3/29/17

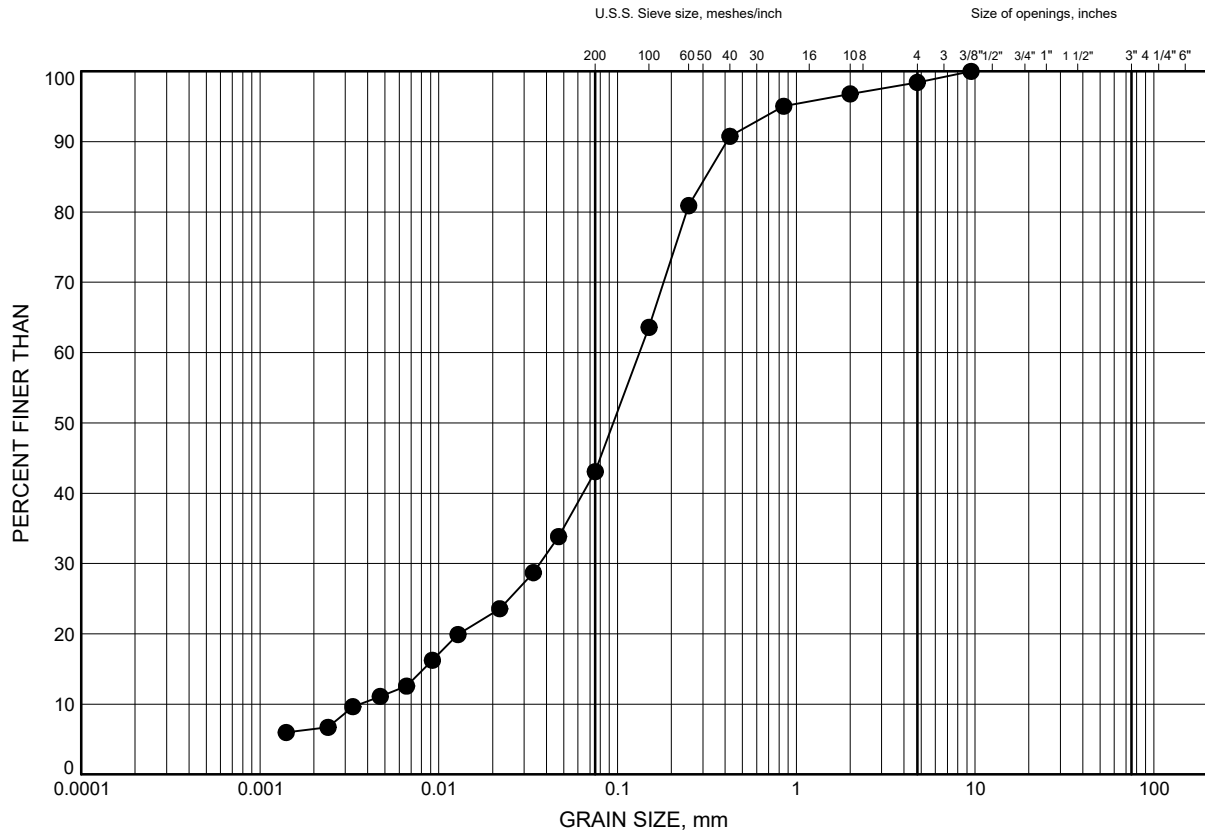
Appendix B
Laboratory Test Results

DRAFT

Lloydtown-Aurora Rd. Interchange,
GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND and SILT FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-05	1.83	309.07

Date March 2017
W.P. 2085-13-00

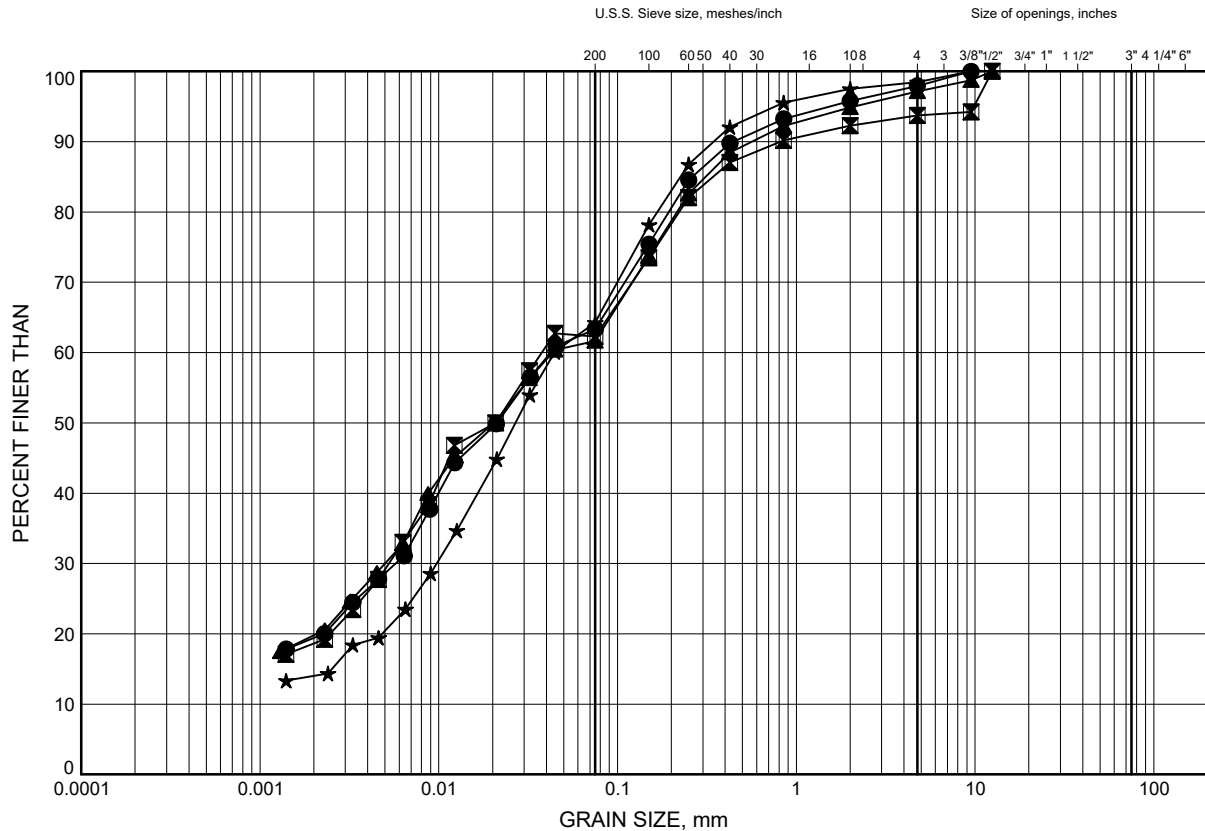


Prep'd AN
Chkd. AMP

Lloydtown-Aurora Rd. Interchange, GRAIN SIZE DISTRIBUTION

FIGURE B2

Clayey SILT, with sand FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-05	4.88	306.02
⊠	17HF-05	6.40	304.50
▲	17HF-07	3.35	305.95
★	17HF-07	4.88	304.42

Date March 2017
W.P. 2085-13-00

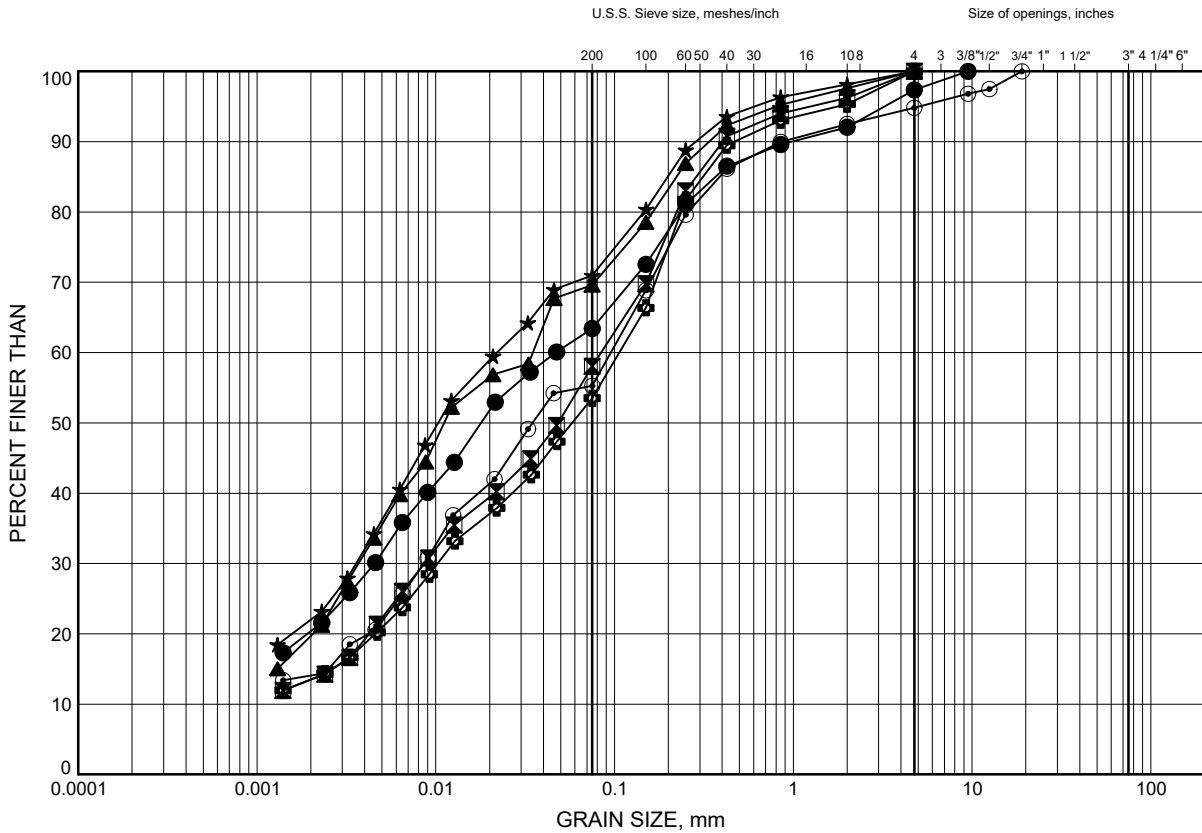


Prep'd AN
Chkd. AMP

Lloydtown-Aurora Rd. Interchange,
GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty CLAY/Clayey SILT, with sand TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-01	3.35	302.95
⊠	17HF-02	3.35	301.15
▲	17HF-03	1.83	301.97
★	17HF-04	1.83	303.27
⊙	17HF-05	9.45	301.45
⊕	17HF-06	1.83	302.17

Date March 2017
W.P. 2085-13-00

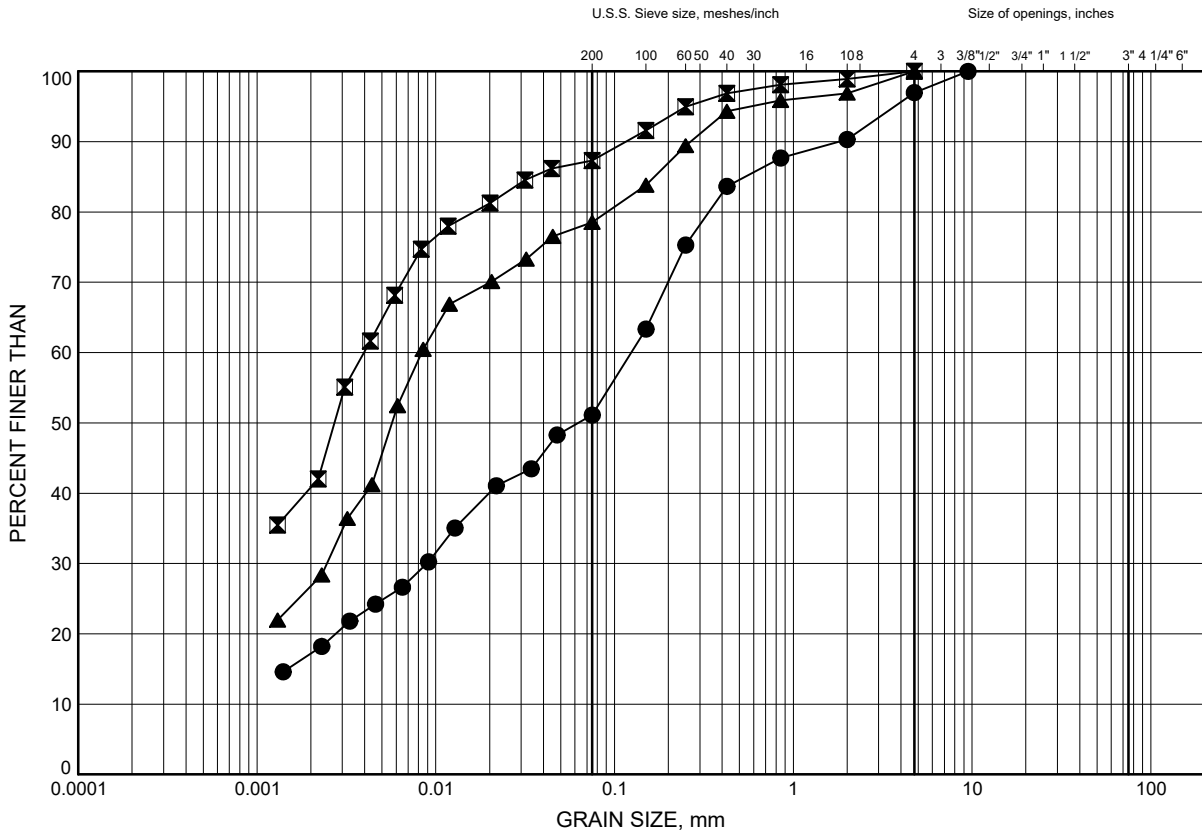


Prep'd AN
Chkd. AMP

Lloydtown-Aurora Rd. Interchange, GRAIN SIZE DISTRIBUTION

FIGURE B4

Silty CLAY/Clayey SILT, with sand TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-06	3.35	300.65
⊠	17HF-08	1.83	302.77
▲	17HF-11	1.83	301.27

Date March 2017
W.P. 2085-13-00

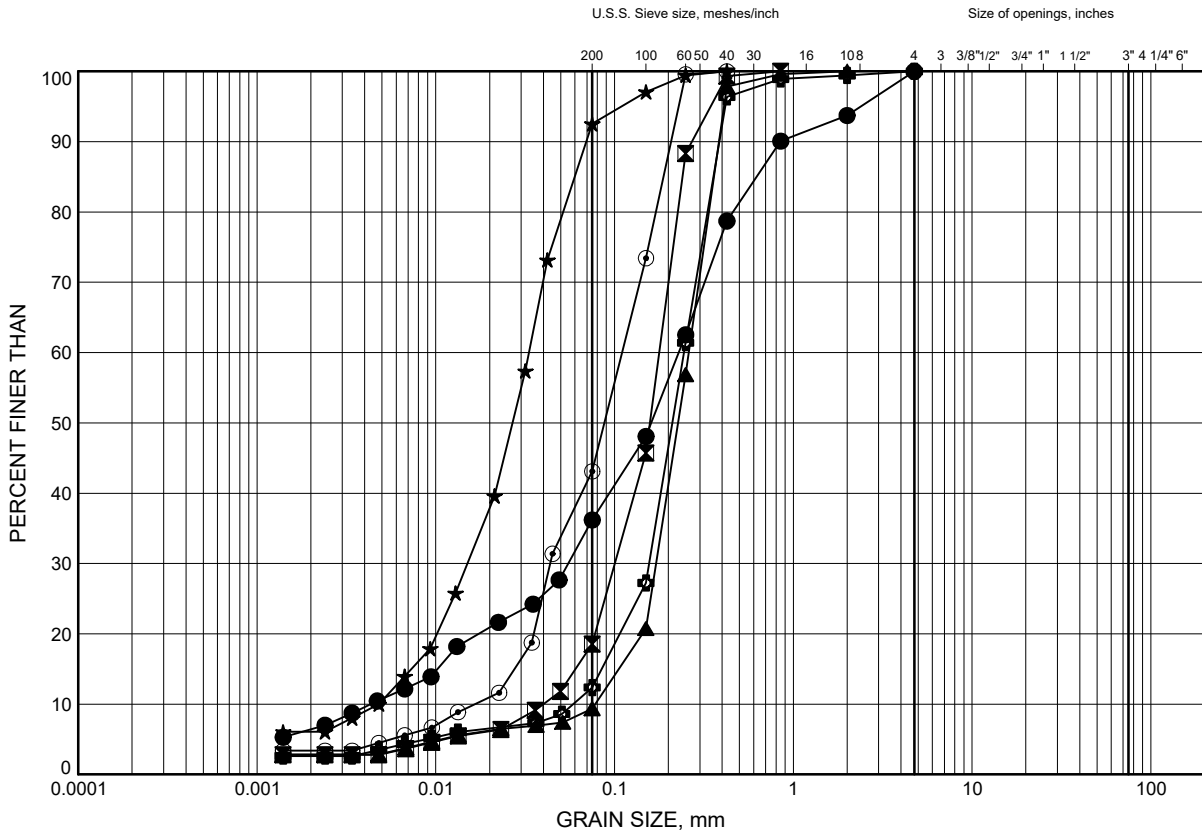


Prep'd AN
Chkd. AMP

Lloydtown-Aurora Rd. Interchange,
GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND to SAND and SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-02	4.88	299.62
⊠	17HF-08	4.88	299.72
▲	17HF-09	2.59	301.61
★	17HF-09	4.88	299.32
⊙	17HF-12	2.59	296.81
⊕	17HF-12	4.88	294.52

Date March 2017
W.P. 2085-13-00

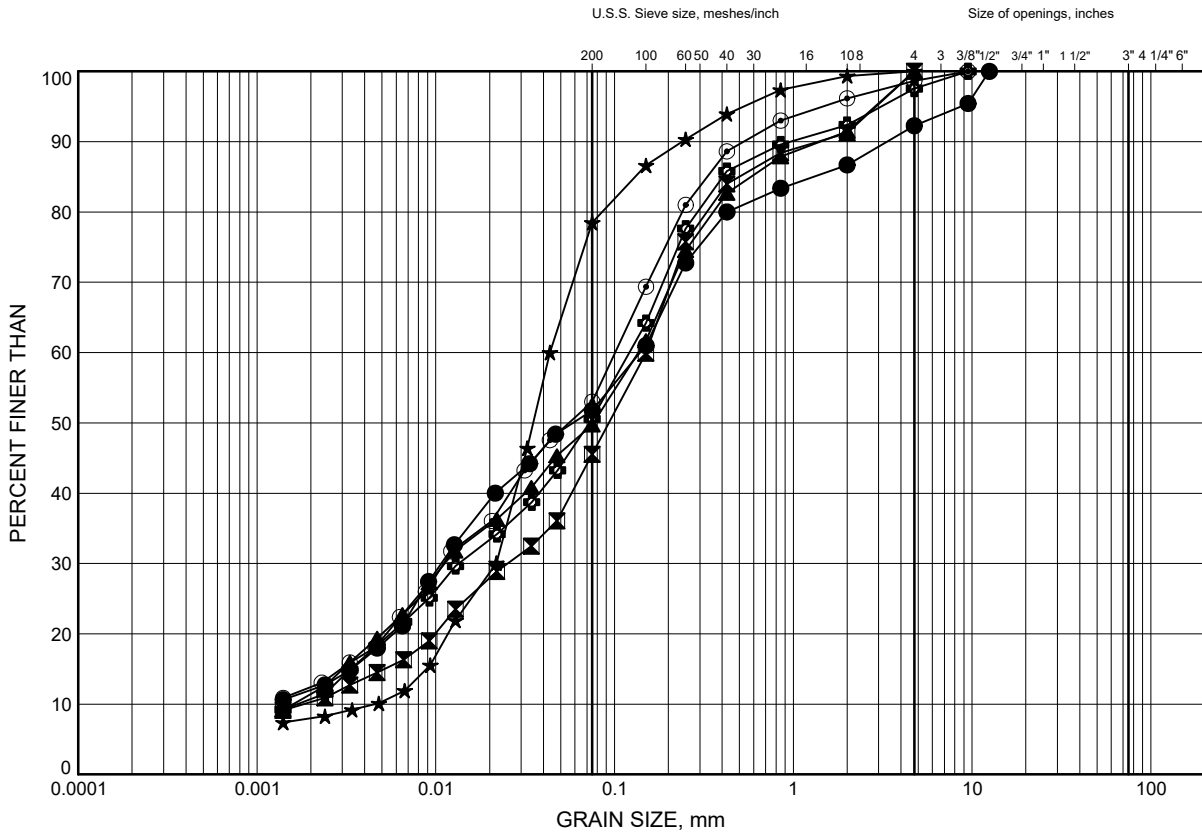


Prep'd AN
Chkd. AMP

Lloydtown-Aurora Rd. Interchange,
GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND to SAND and SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-01	4.88	301.42
⊠	17HF-03	4.88	298.92
▲	17HF-04	3.35	301.75
★	17HF-05	7.92	302.98
⊙	17HF-07	7.92	301.38
⊕	17HF-10	2.59	301.21

Date March 2017
W.P. 2085-13-00

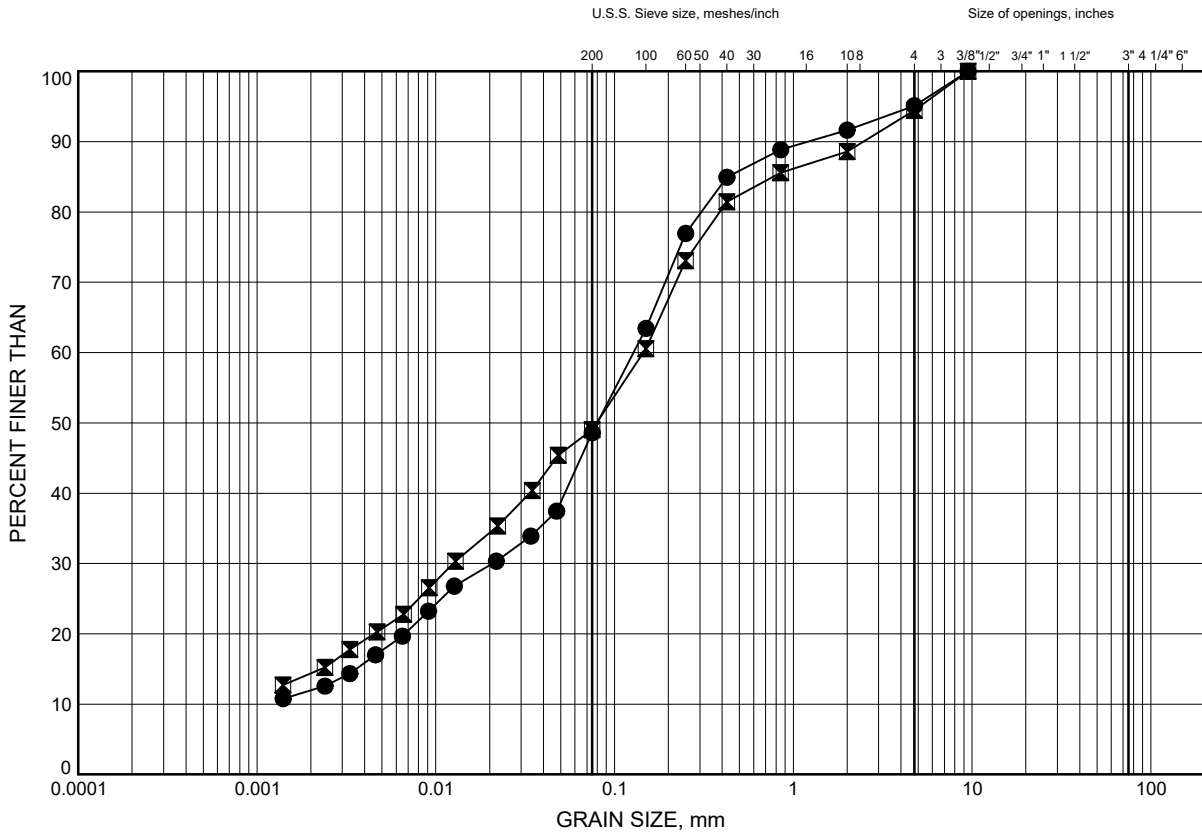


Prep'd AN
Chkd. AMP

Lloydtown-Aurora Rd. Interchange,
GRAIN SIZE DISTRIBUTION

FIGURE B7

SAND to SAND and SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-10	4.88	298.92
⊠	17HF-11	3.35	299.75

Date March 2017
W.P. 2085-13-00

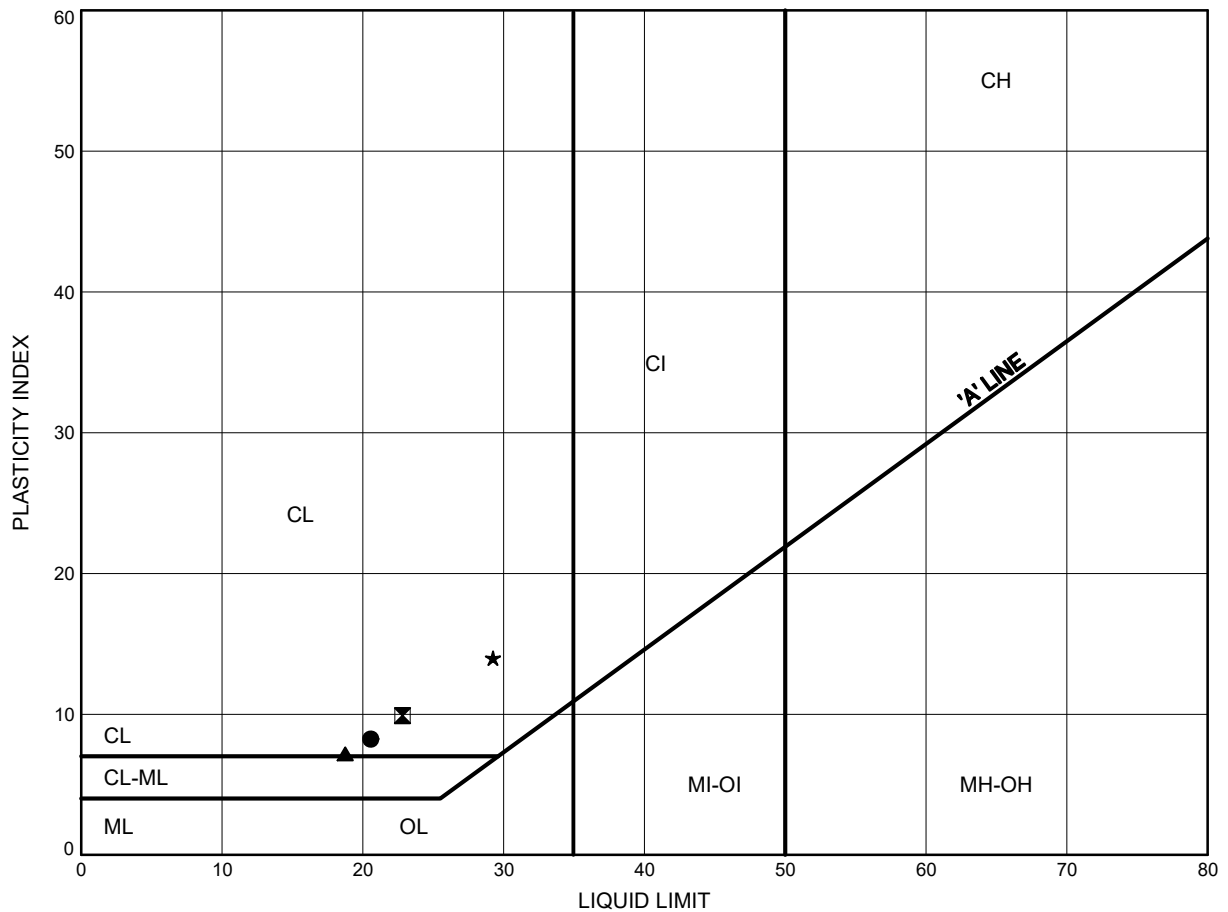


Prep'd AN
Chkd. AMP

Lloydtown-Aurora Rd. Interchange,
ATTERBERG LIMITS TEST RESULTS

FIGURE B8

Silty CLAY/Clayey SILT, with sand



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17HF-03	1.83	301.97
⊠	17HF-04	1.83	303.27
▲	17HF-05	4.88	306.02
★	17HF-11	1.83	301.27

Date March 2017
W.P. 2085-13-00

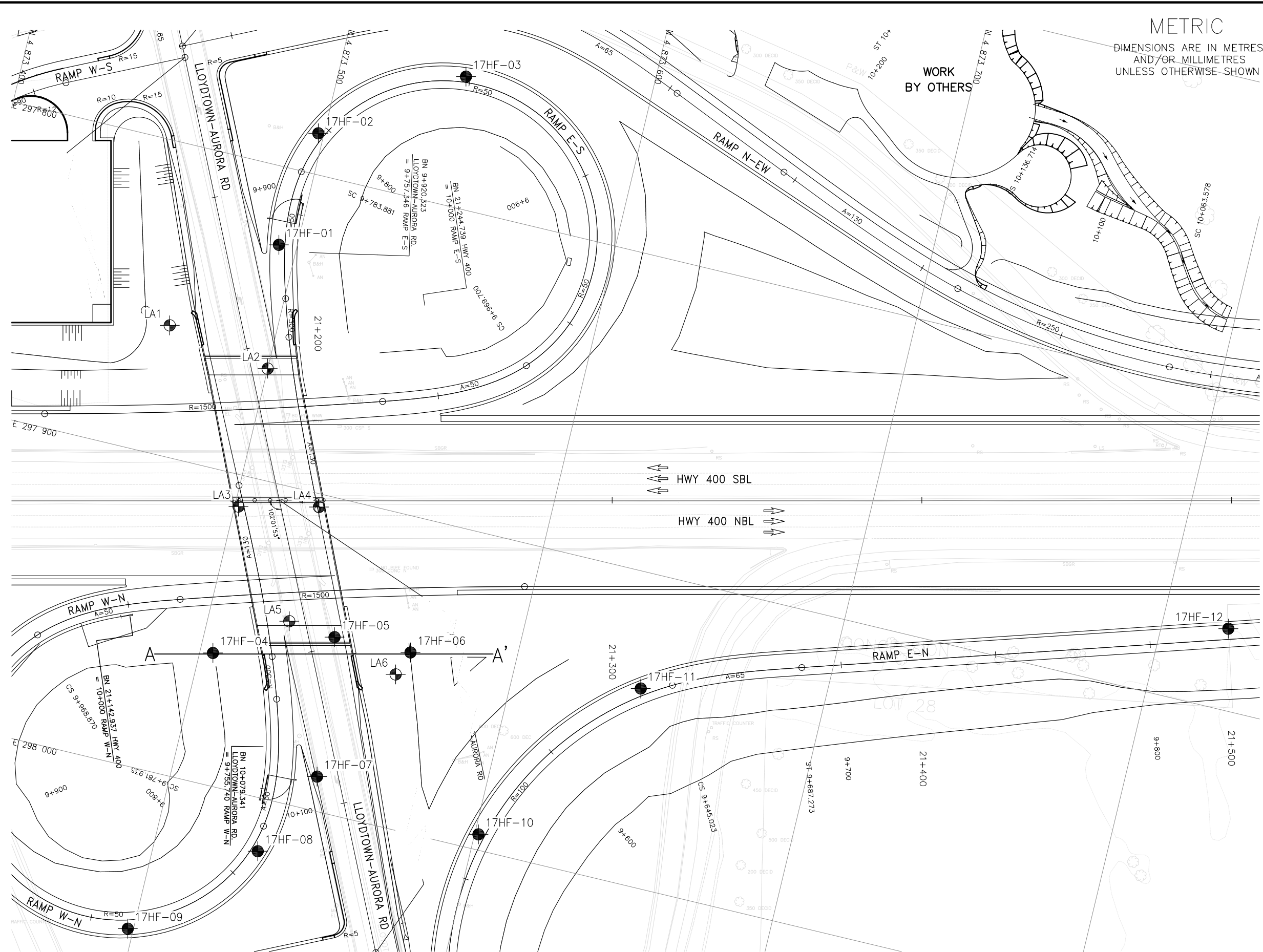


Prep'd AN
Chkd. AMP

Appendix C

Borehole Locations and Soil Strata Drawing

MINISTRY OF TRANSPORTATION OWNED



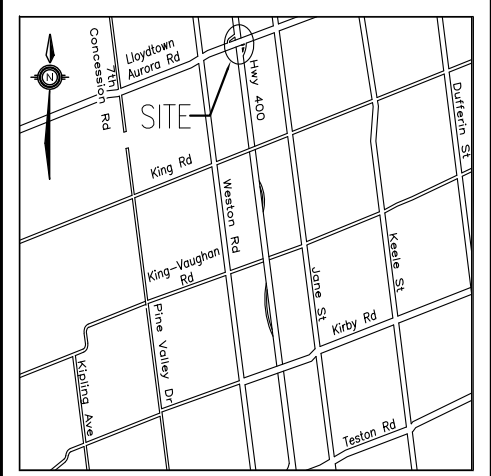
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 2085-13-00

HIGHWAY 400 AND
LLOYDTOWN-AURORA ROAD
INTERCHANGE
BOREHOLE LOCATIONS PLAN

MMM GROUP

SHEET



KEYPLAN

LEGEND

- Borehole (Current Investigation)
- Borehole (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level
- Head Artesian Water
- Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17HF-01	306.3	4 873 494.2	297 824.9
17HF-02	304.5	4 873 498.2	297 786.9
17HF-03	303.8	4 873 540.3	297 758.0
17HF-04	305.1	4 873 504.2	297 958.0
17HF-05	310.9	4 873 541.2	297 943.9
17HF-06	304.0	4 873 566.2	297 943.0
17HF-07	309.3	4 873 546.2	297 989.0
17HF-08	304.6	4 873 533.2	298 016.9
17HF-09	304.2	4 873 498.2	298 051.0
17HF-10	303.8	4 873 601.2	297 995.0
17HF-11	303.1	4 873 641.2	297 937.0
17HF-12	299.4	4 873 821.2	297 874.0

NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No.








REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AMP	CHK SKP	CODE
DRAWN	AN	CHK AMP	SITE
			LOAD
			STRUCT
			DWG 1
			DATE MAR 2017

FILENAME: H:\Drafting\12000\12187\12187-BHPP-01.dwg
PLOTDATE: 3/29/2017 9:22 AM



LEGEND

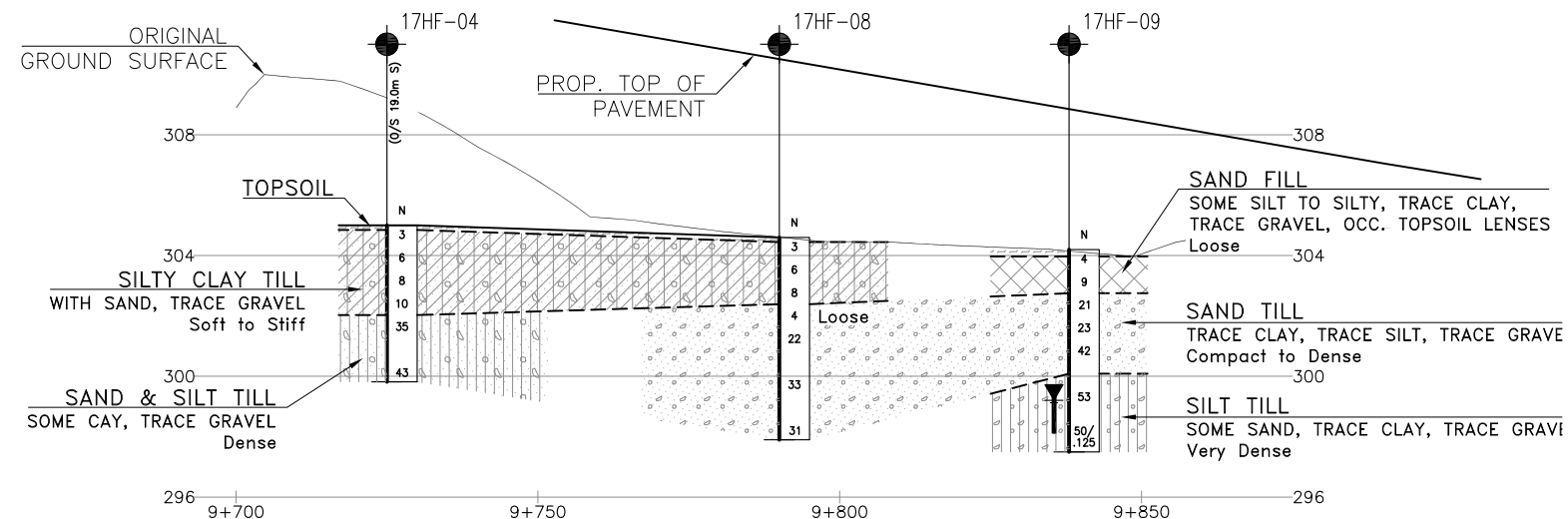
	Borehole (Current Investigation)
	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17HF-01	306.3	4 873 494.2	297 824.9
17HF-02	304.5	4 873 498.2	297 786.9
17HF-03	303.8	4 873 540.3	297 758.0
17HF-04	305.1	4 873 504.2	297 958.0
17HF-05	310.9	4 873 541.2	297 943.9
17HF-06	304.0	4 873 566.2	297 943.0
17HF-07	309.3	4 873 546.2	297 989.0
17HF-08	304.6	4 873 533.2	298 016.9
17HF-09	304.2	4 873 498.2	298 051.0
17HF-10	303.8	4 873 601.2	297 995.0
17HF-11	303.1	4 873 641.2	297 937.0
17HF-12	299.4	4 873 821.2	297 874.0

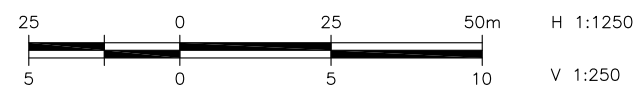
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

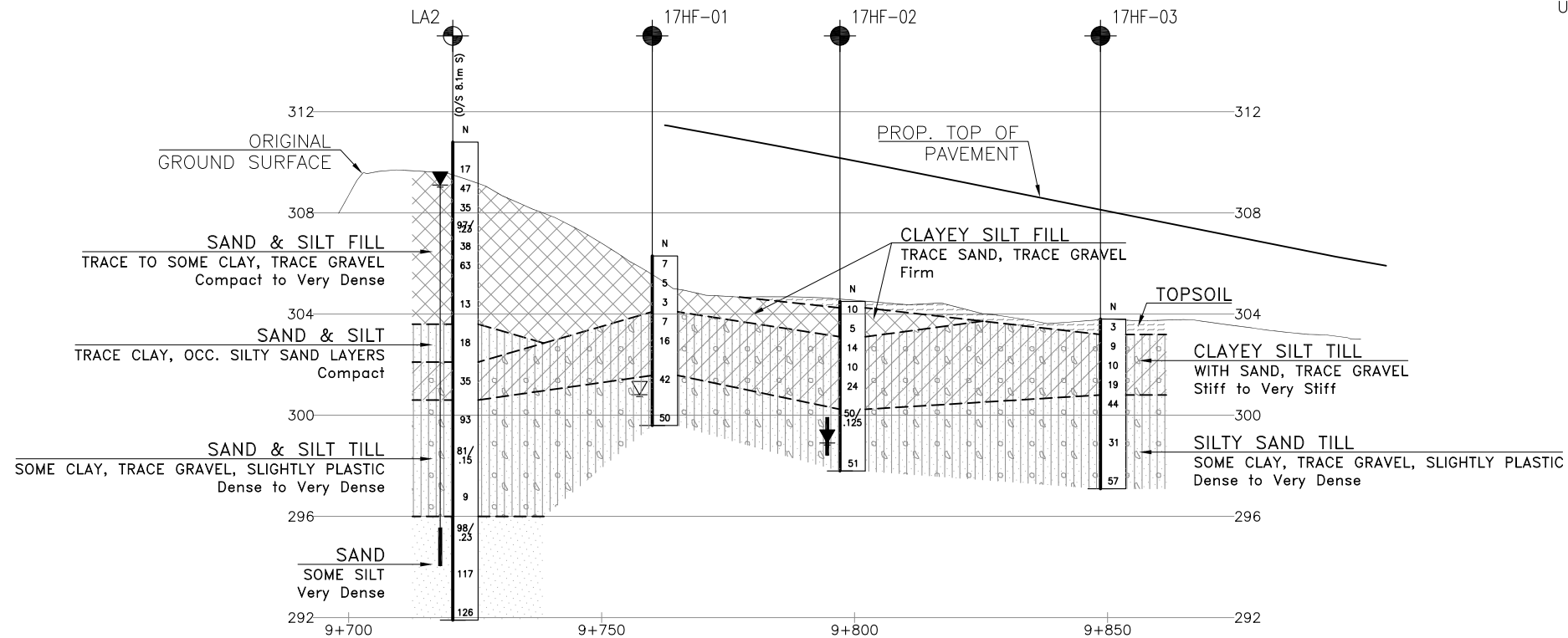
GEOCRES No.



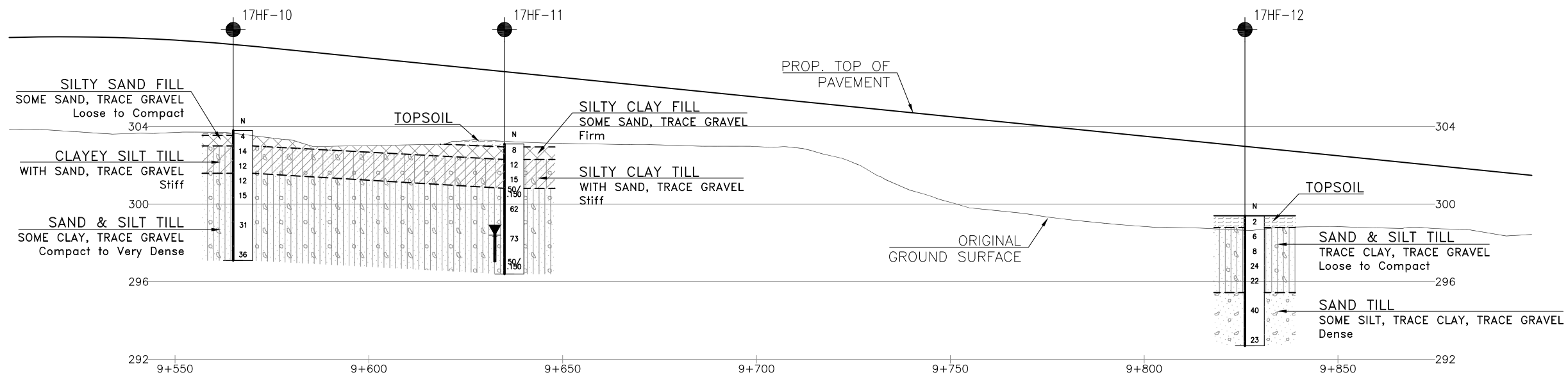
PROFILE ALONG RAMP W-N

[illegible]

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



PROFILE ALONG RAMP E-S



PROFILE ALONG RAMP E-N



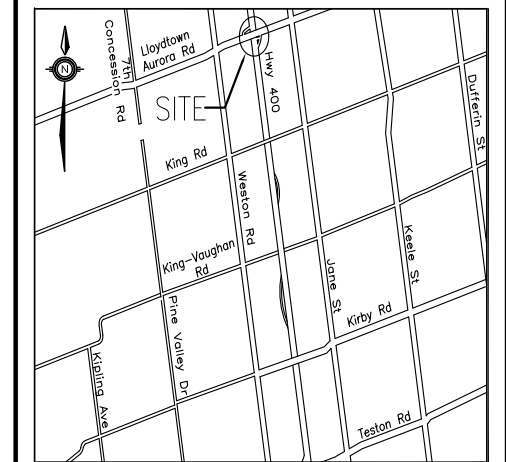
H 1:1250

V 1:250

CONT No
WP No 2085-13-00

HIGHWAY 400 AND
LLOYDTOWN-AURORA ROAD
INTERCHANGE
BOREHOLE SOIL STRATA

SHEET



KEYPLAN

LEGEND

	Borehole (Current Investigation)
	Borehole (Previous Investigation)
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
	Water Level
	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
17HF-01	306.3	4 873 494.2	297 824.9
17HF-02	304.5	4 873 498.2	297 786.9
17HF-03	303.8	4 873 540.3	297 758.0
17HF-04	305.1	4 873 504.2	297 958.0
17HF-05	310.9	4 873 541.2	297 943.9
17HF-06	304.0	4 873 566.2	297 943.0
17HF-07	309.3	4 873 546.2	297 989.0
17HF-08	304.6	4 873 533.2	298 016.9
17HF-09	304.2	4 873 498.2	298 051.0
17HF-10	303.8	4 873 601.2	297 995.0
17HF-11	303.1	4 873 641.2	297 937.0
17HF-12	299.4	4 873 821.2	297 874.0

NOTES-

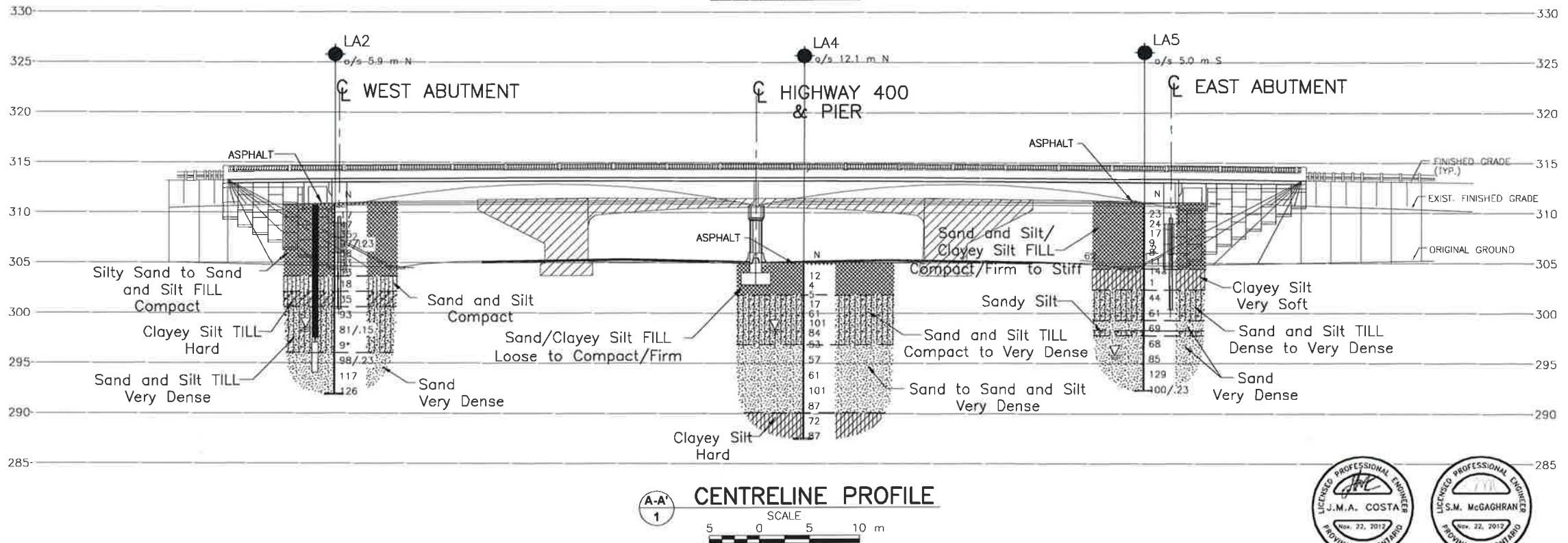
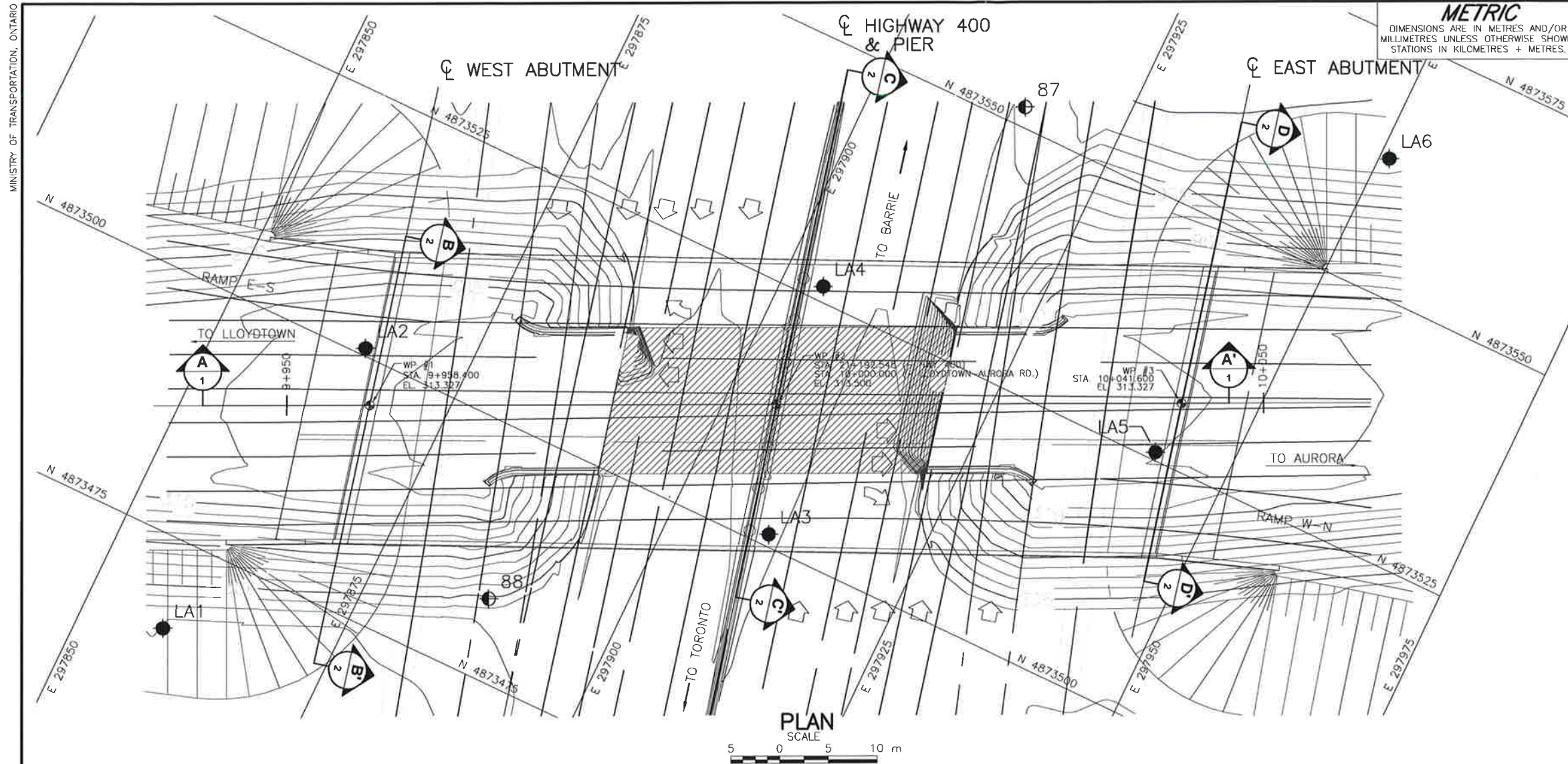
- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No.

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AMP	CHK	SKP
DRAWN	AN	CHK	AMP
CODE			
LOAD			
DATE	MAR	2017	
STRUCT			
DWG	3		

Appendix D

**Previous Investigation
Borehole Locations and Soil Strata Drawing
and Record of Borehole Sheets**



12187

METRIC
 DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 2835-02-00

HIGHWAY 400
 LLOYDTOWN - AURORA ROAD UNDERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates Ltd.
 MISSISSAUGA, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation, Golder Associates Ltd. Report No. 001-1122F-7, dated May, 2001
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on May 28, 2011
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
87	305.0	4873552.0	297915.0
88	305.0	4873483.0	297887.0
LA1	304.4	4873466.0	297858.4
LA2	310.8	4873500.8	297864.6
LA3	305.0	4873501.2	297910.1
LA4	304.8	4873526.5	297904.2
LA5	311.0	4873525.8	297942.3
LA6	304.3	4873563.2	297951.0

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by URS, drawing file no. Aurora Rd Underpass GA dwg, received November 17, 2010.

NO.	DATE	BY	REVISION

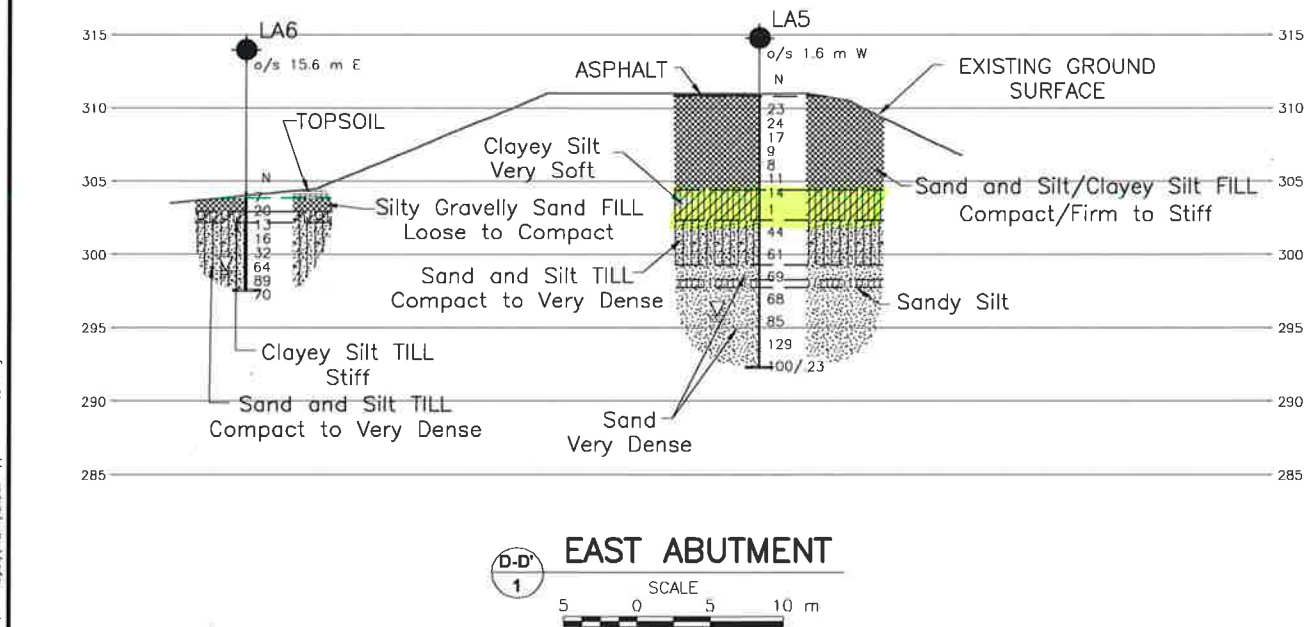
Geacres No. 31D-550

HWY.	PROJECT NO.	DIST.
400	09-1111-0018	

SUBM'D TT	CHKD. SMM	DATE	SITE
		11/22/2012	

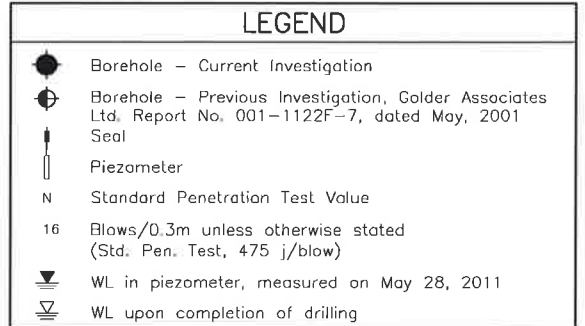
DRAWN:	CHKD. SMM	APPD. JMAC	DWG.
JFC			1





METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN
STATIONS IN KILOMETRES + METRES.

SHEET



BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
87	305.0	4873552.0	297915.0
88	305.0	4873483.0	297887.0
LA1	304.4	4873466.0	297858.4
LA2	310.8	4873500.8	297864.6
LA3	305.0	4873501.2	297910.1
LA4	304.8	4873526.5	297904.2
LA5	311.0	4873525.8	297942.3
LA6	304.3	4873563.2	297951.0

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

Base plans provided in digital format by URS, drawing file no. Aurora Rd Underpass GA.dwg, received November 17, 2010.

NO.		DATE		BY		REVISION			
Geocres No. 31D-550									
HWY. 400				PROJECT NO. 09-1111-001B				DIST.	
SUBM'D. TT		CHKD. SMM		DATE: 11/22/2012				SITE:	
DRAWN: JFC		CHKD. SMM		APPD. JMAG				DWG. 2	



PROJECT 09-1111-0018			RECORD OF BOREHOLE No LA1			SHEET 1 OF 1			METRIC							
G.W.P. 2835-02-00(b)			LOCATION N 4873466.0 ; E 297858.4			ORIGINATED BY CS										
DIST Central HWY 400			BOREHOLE TYPE 108 mm Outside Diameter Continuous Flight Solid Stem Auger			COMPILED BY SKB										
DATUM Geodetic			DATE October 25, 2010			CHECKED BY SMM										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
304.4	GROUND SURFACE															
0.0	TOPSOIL															
0.2	Clayey silt, some sand, trace gravel, containing rootlets (FILL) Firm Brown Moist		1	SS	8											
			2	SS	7											
303.0	CLAYEY SILT with SAND, trace gravel (TILL) Very stiff to hard Brown Moist		3	SS	19											
1.5			4	SS	44											
301.4	SAND and SILT to Silty SAND, trace clay, trace gravel, some sand pockets and sand seams (TILL) Very dense Brown Moist		5	SS	84											
3.0			6	SS	89											
			7	SS	160											
298.2			8A	SS	179/28											
297.9	CLAYEY SILT, some sand, trace gravel (TILL) Hard Brown Moist		8B	SS												
6.6	END OF BOREHOLE															
NOTE: 1. Water level in open borehole at a depth of 5.6 m below ground surface (Elevation 298.8 m) upon completion of drilling.																

GTA-MTO 001 0911110018.GPJ GAL-GTA.GDT 11/22/12 SIB

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No LA2		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4873500.8 ; E 297864.6</u>		ORIGINATED BY <u>CS/TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>210 mm Outside Diameter Continuous Flight Hollow Stem Auger</u>		COMPILED BY <u>SKB</u>			
DATUM <u>Geodetic</u>		DATE <u>October 26-28, 2010</u>		CHECKED BY <u>SMM</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
								○ UNCONFINED	+ FIELD VANE							● QUICK TRIAXIAL	x REMOULDED	
310.8	GROUND SURFACE							20	40	60	80	100		GR SA SI CL				
0.0	ASPHALT							20	40	60	80	100						
0.3	GRANULAR FILL Silty sand, trace clay, trace gravel (FILL) Compact Brown Moist		1	SS	17													
309.4																		
1.5	Sand and silt, trace to some clay, trace gravel (FILL) Compact to very dense Brown Moist		2	SS	47													
	- Occasional sandy silt and clayey silt layers/pockets between the depths of 1.5 m and 5.6 m (Elev. 309.3 m and 305.2 m)		3	SS	35									1 50 41 8				
			4	SS	97/23													
			5	SS	38													
			6	SS	63									3 49 38 10				
	- Containing rootlets and sand seams/pockets between the depths of 5.6 m and 7.2 m (Elev. 305.2 m and 303.6 m)		7	SS	13									1 46 45 8				
303.6																		
7.2	SAND and SILT, trace clay, occasional silty sand layers Compact Grey Moist		8	SS	18													
302.1																		
8.7	CLAYEY SILT, trace to some sand, trace gravel, sand lenses (TILL) Hard Brown Moist		9	SS	35													
300.6																		
10.2	SAND and SILT, trace to some clay, trace gravel (TILL) Very dense Brown Moist		10	SS	93									3 45 46 6				
	- Augers grinding between 11.3 m and 12.2 m depth																	
			11	SS	81/15													
			12	SS	9*									5 43 46 6				
296.0																		
14.8																		

GTA-MTO 001 0911110018.GPJ GAL-GTA.GDT 11/22/12 SIB

Continued Next Page

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 09-1111-0018		RECORD OF BOREHOLE No LA2		SHEET 2 OF 2		METRIC	
G.W.P. 2835-02-00		LOCATION N 4873500.8 ; E 297864.6		ORIGINATED BY CS/TT			
DIST Central HWY 400		BOREHOLE TYPE 210 mm Outside Diameter Continuous Flight Hollow Stem Auger		COMPILED BY SKB			
DATUM Geodetic		DATE October 26-28, 2010		CHECKED BY SMM			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			
								20	40	60						80	100	20	40
--- CONTINUED FROM PREVIOUS PAGE ---																			
291.9 18.9	SAND, some silt Very dense Brown Wet		13	SS	98/23		295									0 84 14 2			
			14	SS	117			294											
			15	SS	126	293													
	END OF BOREHOLE						292												
<div>NOTES:</div> <div>1. * SPT "N" Value considered to be affected by sample disturbance due to groundwater inflow to borehole.</div> <div>2. A hydrostatic head of water and drilling fluid was required inside the augers at a depth of 15.2 m below ground surface (Elev. 295.6 m) in order to advance the borehole due to "blowing " sands.</div> <div>3. Water level in open borehole at a depth of 12.3 m below ground surface (Elev. 298.5 m) during drilling on October 27, 2010.</div> <div>4. Borehole advanced using drilling mud; water level not measured upon completion of drilling as it is not reflective of in-situ water conditions.</div> <div>5. Water level measurement in the piezometer:<div><div>Date</div><div>Depth (m)</div><div>Elev. (m)</div><div>11/25/10</div><div>1.8</div><div>309.0</div><div>12/02/10</div><div>1.7</div><div>309.1</div></div></div> <div>6. Piezometer damaged - unable to obtain water level reading on May 27, 2011.</div>																			

GTA-MTO 001 0911110018.GPJ GAL-GTA.GDT 11/22/12 SIB

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No LA3		SHEET 1 OF 1		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4873501.2 :E 297910.1</u>		ORIGINATED BY <u>TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>108 mm Outside Diameter Continuous Flight Solid Stem Auger, Wash Boring</u>		COMPILED BY <u>SKB</u>			
DATUM <u>Geodetic</u>		DATE <u>November 2, 2010</u>		CHECKED BY <u>SMM</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
305.0	GROUND SURFACE													
0.0 304.7	ASPHALT													
0.4	Sand, some silt, trace gravel, trace clay, containing pockets of clayey silt and organics (FILL) Loose Brown Moist to wet		1	SS	6		304							
			2	SS	5		303							
302.8	SAND and SILT, trace clay, trace to some gravel, containing sand seams and pockets (TILL) Compact to dense Brown Moist becoming wet below 3.1 m depth		3	SS	14		302						10 38 47 5	
2.2			4A	SS	22									
			4B											
			5	SS	46		301							
			6	SS	49		300						3 51 40 6	
							299							
298.6	SAND, some silt Dense to very dense Brown Moist		7	SS	44		298							
6.5														
			8	SS	97		297						0 84 15 1	
							296							
295.3	END OF BOREHOLE		9	SS	61									
9.7	NOTE: 1. A hydrostatic head of water and drilling fluid was required inside the hollow stem augers at a depth of 6.7 m below ground surface (Elev. 298.3 m) in order to advance the borehole due to "blowing" sands; water level could not be determined upon completion of drilling.													

GTA-MTO 001 0911110018.GPJ GAL-GTA.GDT 11/22/12 SIB

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No LA4		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4873526.5 :E 297904.2</u>		ORIGINATED BY <u>TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>210 mm Outside Diameter Continuous Flight Hollow Stem Auger, Wash Boring</u>		COMPILED BY <u>SKB</u>			
DATUM <u>Geodetic</u>		DATE <u>November 1-2, 2010</u>		CHECKED BY <u>SMM</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED	+ FIELD VANE							
								● QUICK TRIAXIAL	× REMOULDED							
304.8	GROUND SURFACE															
0.0	ASPHALT															
304.5																
0.4	Sand, some silt, trace gravel, trace clay, containing clayey silt layers (FILL) Loose to compact Brown Moist		1	SS	12											
303.0			2	SS	4											
1.8	Clayey silt, trace to some sand, trace gravel (FILL) Firm Brown Moist		3	SS	5											
301.6			4	SS	17											
3.2	SAND and SILT, trace gravel, trace clay (TILL) Compact to very dense Brown Moist		5	SS	61											
			6	SS	101											
	- Containing sand pockets between the depths of 6.1 m and 6.7 m (Elev. 298.7 m and 298.1 m)		7	SS	84											
296.8			8	SS	53											
8.0	SAND, some silt, trace clay to SAND and SILT Very dense Brown Wet															
			9	SS	57											
			10	SS	61											
			11	SS	101											
			12	SS	87											
290.0																
14.8																

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ ³% STRAIN AT FAILURE

GTA-MTO 001 0911110018.GPJ GAL-GTA.GDT 11/22/12 SIB

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No LA4		SHEET 2 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4873526.5 ; E 297904.2</u>		ORIGINATED BY <u>TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>210 mm Outside Diameter Continuous Flight Hollow Stem Auger, Wash Boring</u>		COMPILED BY <u>SKB</u>			
DATUM <u>Geodetic</u>		DATE <u>November 1-2, 2010</u>		CHECKED BY <u>SMM</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
								<div><div></div><div></div><div></div><div></div><div></div></div>							<div><div></div><div></div><div></div></div>		
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100	W _p	W	W _L		
	CLAYEY SILT, trace to some sand, trace gravel Hard Grey Moist	<div></div>	13	SS	72											0 8 65 27	
287.4			14	SS	87												
17.4	END OF BOREHOLE																
	NOTE: 1. A hydrostatic head of water and drilling fluid was required inside the augers at a depth of 6.5 m below ground surface (Elev. 298.3 m) in order to advance the borehole due to "blowing " sands; water level could not be determined upon completion of drilling.																

PROJECT 09-1111-0018		RECORD OF BOREHOLE No LA5		SHEET 1 OF 2		METRIC	
G.W.P. 2835-02-00		LOCATION N 4873525.8 ; E 297942.3		ORIGINATED BY TT			
DIST Central HWY 400		BOREHOLE TYPE 210 mm Outside Diameter Continuous Flight Hollow Stem Auger, Wash Boring		COMPILED BY SKB			
DATUM Geodetic		DATE October 29 & November 19, 2010		CHECKED BY SMM			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)			
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						x REMOULDED	W _p	W	W _L
								20	40	60						80	100	10	20
311.0	GROUND SURFACE																		
0.0	ASPHALT																		
0.1	Sand and silt, trace to some clay, trace gravel (FILL) Compact Brown Moist		1	SS	23														
			2	SS	24														
			3	SS	17														
308.0																			
3.0	Clayey silt with sand, trace gravel, containing rootlets and sand and silt pockets (FILL) Stiff Brown Moist		4	SS	9														
			5	SS	8														
			6	SS	11														
305.9																			
5.1	Sandy silt, trace gravel (FILL) Brown to grey Moist																		
305.4																			
5.6	Clayey silt with sand, containing sandy silt seams (FILL) Stiff Brown to grey Moist		7A	SS	14														
304.4			7B	SS															
6.6	CLAYEY SILT, trace to some sand, trace gravel, containing rootlets and organics between the depths of 6.6 m and 8.1 m (Elev. 304.4 m and 302.9 m) Very soft Grey Moist		8A	SS	1														
			8B	SS															
302.3																			
8.7	SAND and SILT, trace to some clay, trace gravel (TILL) Dense to very dense Brown Moist		9	SS	44														
			10	SS	61														
299.3																			
11.7	SAND, some silt Very dense Brown Moist		11	SS	69														
298.3																			
12.8	Sandy SILT, trace clay Brown Moist																		
297.7																			
13.3	SAND, trace to some silt Very dense Brown Wet		12	SS	68														

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 0911110018.GPJ GAL-GTA.GDT 11/22/12 SIB



+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE



+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 0911110018.GPJ GAL-GTA.GDT 11/22/12 SIB



Appendix E
List of OPS Specifications

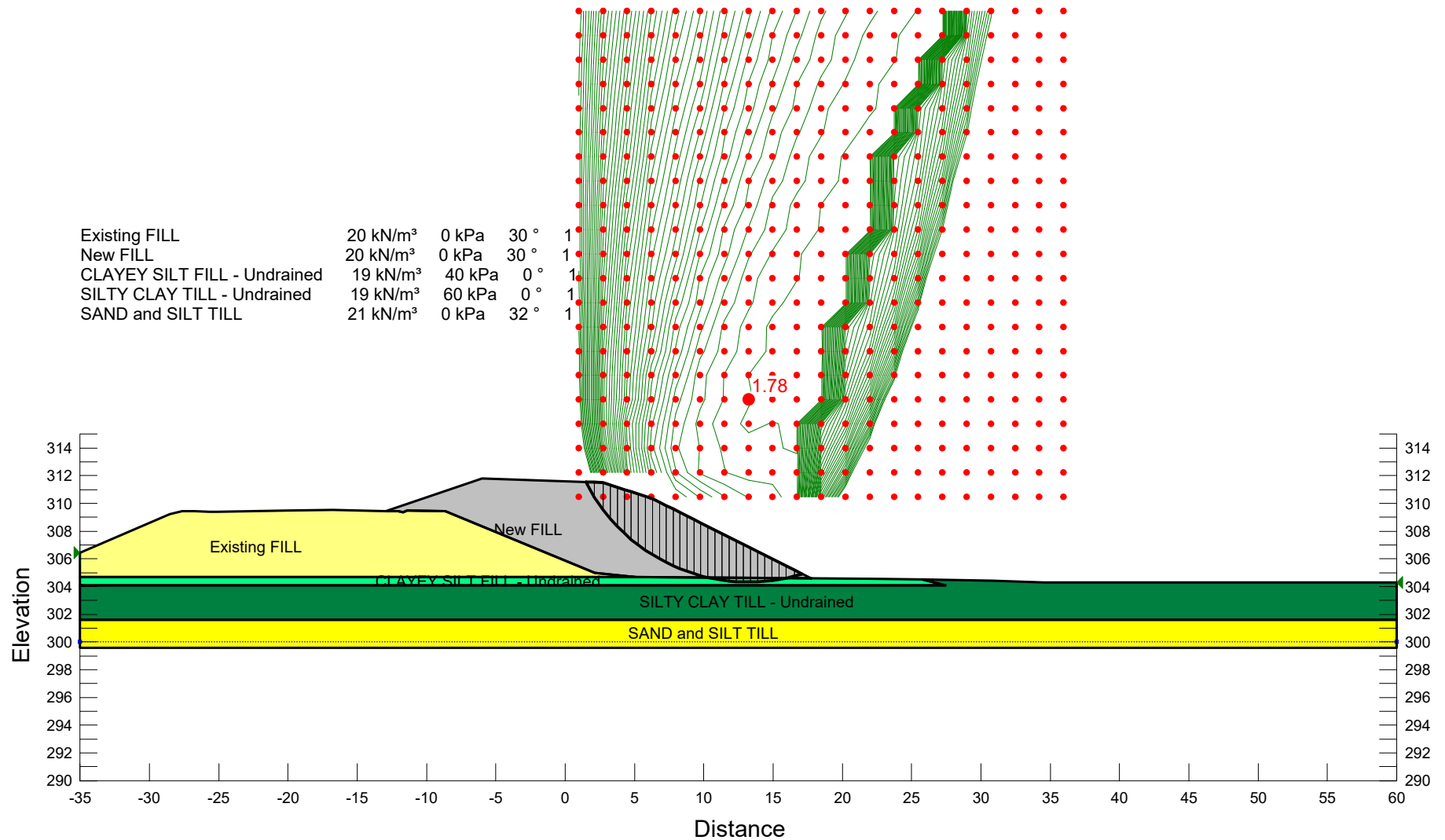
List of OPS Documents Referenced in this Report

- OPSS.PROV 206
- OPSS. PROV 209
- OPSS.PROV 1010
- OPSS.PROV 501
- OPSD 208.010
- OPSD 601.010

Appendix F
Results of Slope Stability Analyses

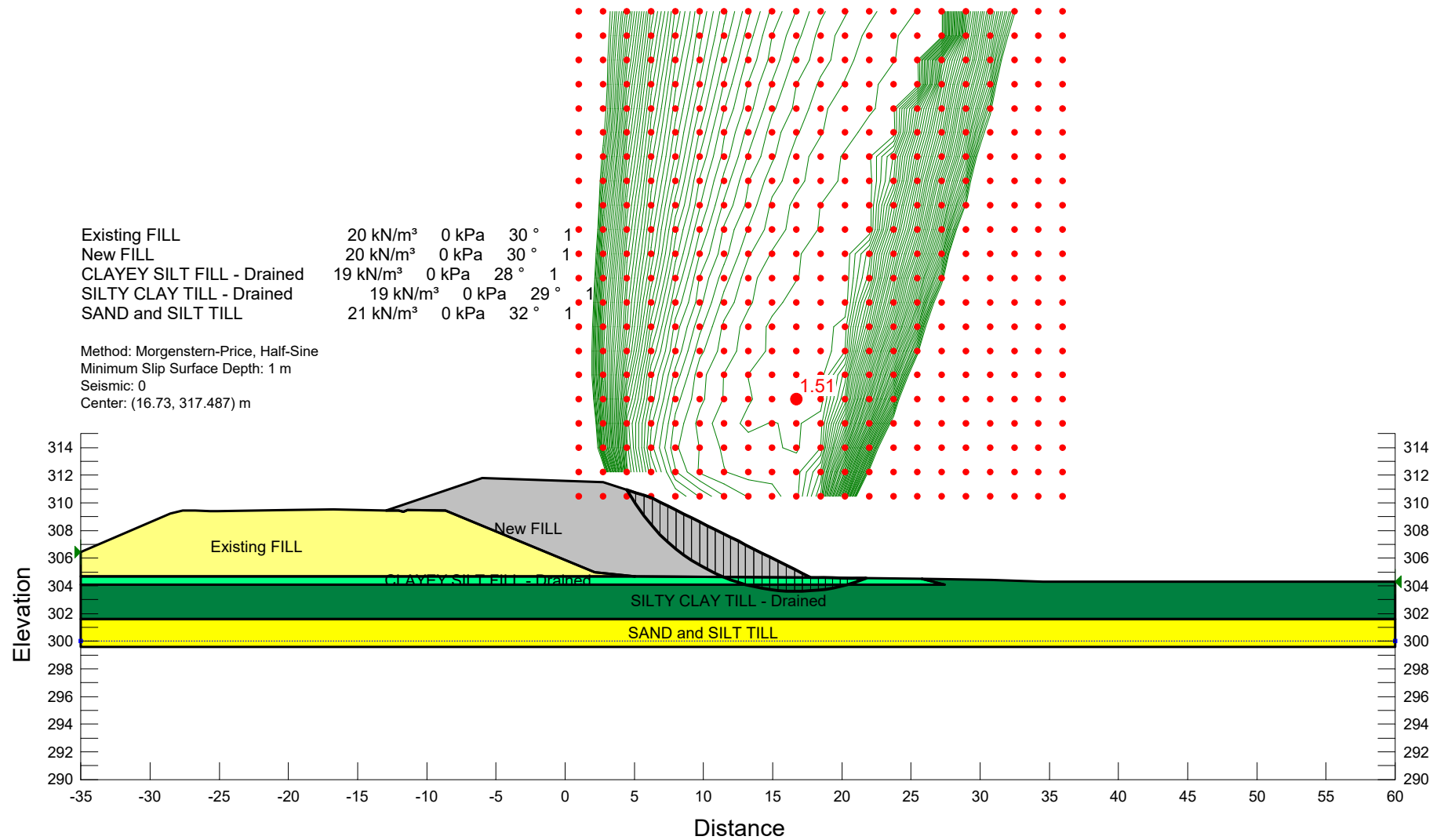
Global Slope Stability **Highway 400 Lloydtown – Aurora Road Interchange** **Ramp E – S (Sta. 9+757.35)**

Figure F1



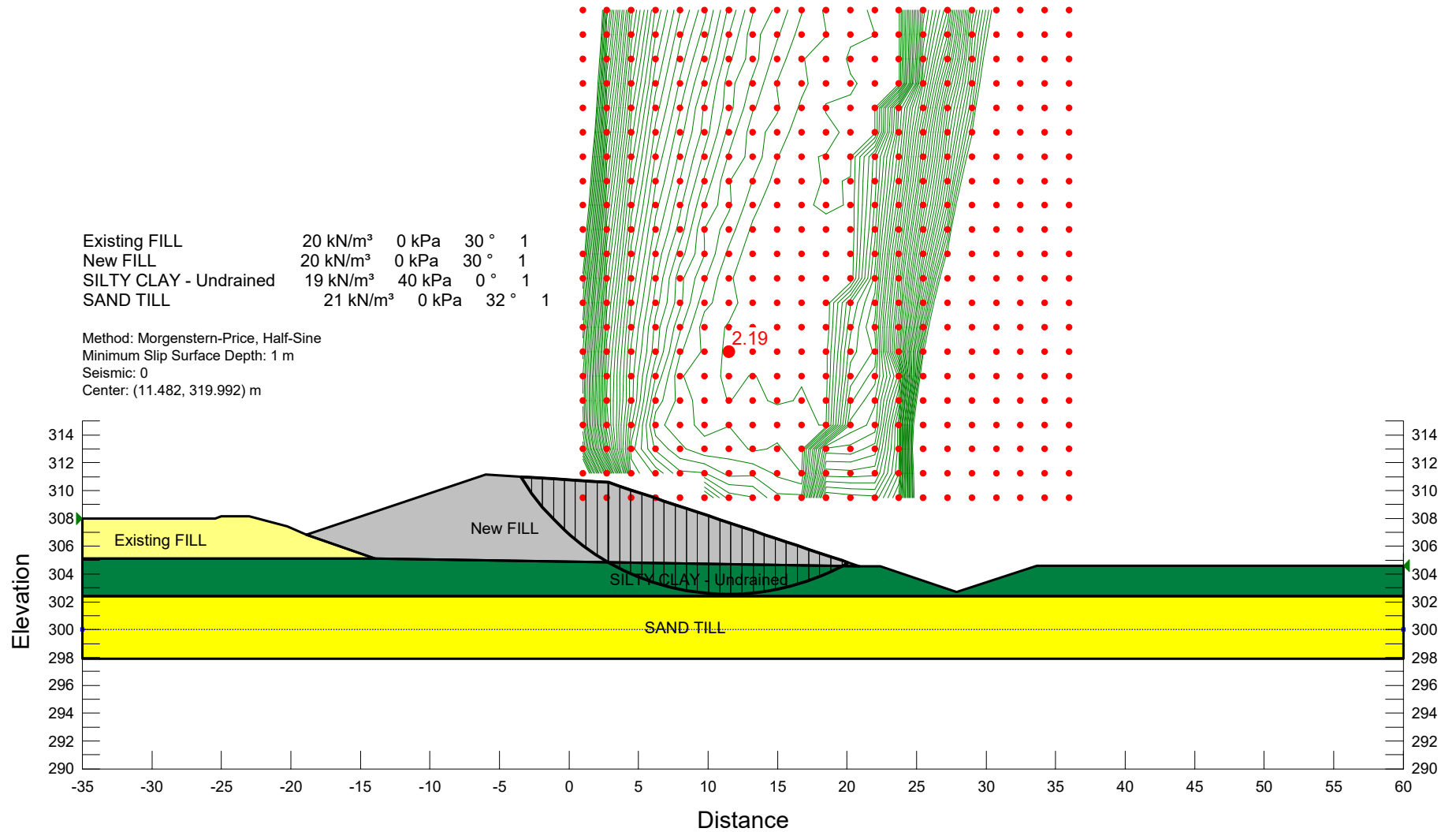
Global Slope Stability **Highway 400 Lloydtown – Aurora Road Interchange** **Ramp E – S (Sta. 9+757.35)**

Figure F2



Global Slope Stability **Highway 400 Lloydtown – Aurora Road Interchange** **Ramp W – N (Sta. 9+781.94)**

Figure F3



Global Slope Stability **Highway 400 Lloydtown – Aurora Road Interchange** **Ramp W – N (Sta. 9+781.94)**

Figure F4

