

**FOUNDATION INVESTIGATION AND DESIGN REPORT
NEW BRIDGE OVER NORTH SCHOMBERG RIVER
FILL EMBANKMENTS AND SUCKER CREEK CULVERT
HIGHWAY 400 AND LINE 5 INTERCHANGE RECONSTRUCTION
BRADFORD WEST GWILLIMBURY, ONTARIO
TBWG WP P13-03
MTO GWP 2122-10-00**

GEOCRES No. 31D-605

Report to

AECOM

Thurber Engineering Ltd.
2010 Winston Park Drive, Suite 103
Oakville, Ontario
L6H 5R7
Phone: (905) 829 8666
Fax: (905) 829 1166

June 12, 2015

File: 19-4406-15

H:\19\4406\15 Foundation Engineering, Hwy.400 and 5th
Line\Reports & Memos\Ancillary Structures & High
Fills\19440615 Hwy 400 Line 5 N Schomberg Bridge and
Fills FIDR FINAL jun 15.doc

TABLE OF CONTENTS

SECTION	PAGE
PART 1 FACTUAL INFORMATION	
1 INTRODUCTION	1
2 PROJECT AND SITE DESCRIPTION	1
3 SITE INVESTIGATION AND FIELD TESTING	2
3.1 Methane Gas	6
4 LABORATORY TESTING	7
5 DESCRIPTION OF SUBSURFACE CONDITIONS	7
5.1 New Bridge at realigned Sideroad 5 over the North Schomberg River.....	8
5.1.1 Topsoil.....	8
5.1.2 Silty clay.....	8
5.1.3 Sandy silt, Sand and Silt to Silty Sand	9
5.1.4 Sand and Gravel	9
5.1.5 Silty Clay Till	10
5.1.6 Sand.....	10
5.1.7 Groundwater Levels	11
5.2 High Fills for Ramps N-EW, E-S and W-N, and Line 5 (near Station 9+740)	11
5.2.1 Topsoil.....	12
5.2.2 Fill	12
5.2.3 Sand, Sandy Silt to Silty Sand.....	13
5.2.4 Sand and gravel.....	13
5.2.5 Silty clay.....	14
5.2.6 Silt	15
5.2.7 Groundwater Levels	15
5.3 Ramps S-EW and W-S, and Coffey Road - Fills lower than 4.5 m.....	16
5.3.1 Topsoil.....	16
5.3.2 Asphalt	16
5.3.3 Fill	17
5.3.4 Sandy silt.....	17
5.3.5 Silty clay.....	17
5.3.6 Groundwater Levels	18
5.4 Sucker Creek Culvert Extension - Highway 400 north of Line 5.....	18
5.4.1 Topsoil.....	18
5.4.2 Asphalt	18
5.4.3 Fill	19
5.4.4 Silty Clay.....	19
5.4.5 Groundwater Levels	20
6 MISCELLANEOUS	21

PART 2 ENGINEERING DISCUSSION AND RECOMMENDATIONS

7	GENERAL	23
8	NEW BRIDGE AT REALIGNED SIDEROAD 5 OVER THE NORTH SCHOMBERG RIVER	24
8.1	Foundation Alternatives	24
8.2	Driven Steel H-Piles	25
8.2.1	Axial Resistance	25
8.2.2	Downdrag on Piles	25
8.2.3	Lateral Resistance.....	26
8.2.4	Frost Protection	28
8.2.5	Pile Installation.....	28
8.3	Augered Caissons (Drilled Shafts)	29
8.3.1	Axial Resistance	29
8.3.2	Lateral Resistance.....	29
8.3.3	Caisson Installation	29
8.4	Approach embankments	30
9	HIGH FILLS AND LOW FILLS	30
9.1	Foundation Settlement and Preloading	32
9.2	Stability Analysis.....	33
9.3	Embankment Design and Construction (High Fills and Low Fills)	34
9.3.1	Subgrade preparation.....	34
9.3.2	Embankment Construction	34
10	SUCKER CREEK CULVERT	35
10.1	Sucker Creek Culvert Under Highway 400 (North of Line 5)	35
10.2	Foundation Alternatives	36
10.3	Foundation design	36
10.4	Concrete Frame (Open Footing) Culvert.....	36
10.5	Cast-in-place and Precast Culvert Options	37
10.6	Culvert Settlement.....	38
10.7	Embankment Stability	39
10.8	Frost Depth	39
11	CULVERT BACKFILL AND LATERAL EARTH PRESSURES	39
12	SCOUR PROTECTION AND EROSION CONTROL	40
13	ROADWAY PROTECTION	41
14	EXCAVATION AND BACKFILL.....	41
15	GROUNDWATER AND SURFACE WATER CONTROL	42
16	SEISMIC CONSIDERATIONS.....	42
16.1	Seismic Design Parameters	42
16.2	Liquefaction Potential	43

16.3 Retaining Wall Dynamic Earth Pressures	43
17 EXISTING UTILITY SERVICES	44
18 CONSTRUCTION CONCERNS	44
19 CLOSURE	45

Appendices

Appendix A	New Bridge at realigned Sideroad 5 over the North Schomberg River Boreholes 14-43 to 14-48
Appendix B	High Fills for Ramps N-EW, E-S and W-N and Line 5 (Station 9+740) Boreholes 14-01, 14-05 to 14-18, 14-23, 13-24, 13-25, 13-26, 14-31, 14-51, 14-52
Appendix C	Ramps S-EW and W-S, and Coffey Road - Embankments lower than 4.5 m Boreholes 14-32, 14-38 and 14-42
Appendix D	Sucker Creek culvert extension - Highway 400 Boreholes 14-01 to 14-04
Appendix E	Comparison of Foundation Alternatives for Sideroad 5 Bridge
Appendix F	List of OPSS Documents and NSSP Wording
Appendix G	Selected Slope Stability Analysis Results
Appendix H	Instrumentation and Monitoring Specifications for High Fills

Each of Appendices A to D includes:

- Record of Borehole Sheets
- Laboratory Test Results
- Drawings titled “Borehole Locations and Soil Strata”

**FOUNDATION INVESTIGATION AND DESIGN REPORT
NEW BRIDGE OVER NORTH SCHOMBERG RIVER
FILL EMBANKMENTS AND SUCKER CREEK CULVERT
HIGHWAY 400 AND LINE 5 INTERCHANGE RECONSTRUCTION
BRADFORD WEST GWILLIMBURY, ONTARIO
TBWG WP P13-03
MTO GWP 2122-10-00

GEOCRES No. 31D-605**

PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the design and reconstruction of the Highway 400 and Line 5 interchange in the Town of Bradford West Gwillimbury, Ontario. This report includes geotechnical recommendations for the following design components: new bridge structure at Sideroad 5, Sucker Creek culvert extensions, high fills at the new Ramps N-EW and ES.

The purpose of this investigation was to explore the subsurface conditions at the specific location of each of the proposed project component and, based on the data obtained, to provide borehole location plans and soil strata drawings with stratigraphic profiles and cross-sections (where required), records of boreholes, laboratory test results and written descriptions of the subsurface conditions. A model of the subsurface conditions was developed for the site based on the data obtained from the present investigation.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a foundation sub-consultant to AECOM, ultimately for the Town of Bradford West Gwillimbury (TBWG).

2 PROJECT AND SITE DESCRIPTION

The site is located at the existing Highway 400 and Line 5 interchange; approximately 2.5 km south of Highway 400 and Simcoe Road 88 (former Highway 88) interchange in the Town of Bradford West Gwillimbury, Ontario.

This report presents subsurface data for the high fills and ancillary structures of the proposed interchange reconstruction. Foundation information of the main Highway 400 Line 5 underpass bridge and its immediate approaches are presented in Thurber report titled "Foundation Investigation Report, Highway 400 Line 5 Underpass and Interchange Reconstruction, Bradford West Gwillimbury, Ontario", TBWG WP P13-03, MTO GWP 2122-10-00, dated January 16, 2015.

Details of the major project components covered by this report are summarized in the following table.

Project Component	Location
New bridge	- Realigned Sideroad 5 over the North Schomberg River (approximately 700 m west of Highway 400)
High fill embankments (higher than 4.5 m)	- Line 5 (near Station 9+740) - Ramps N-EW, E-S and W-N (near Line 5)
Low embankments (lower than 4.5 m)	- Ramps S-EW and W-S, and Coffey Road
Sucker Creek culvert extension	- East and west extensions to Sucker Creek culvert under Highway 400 (approximately 450 m north of Line 5)

The lands surrounding the interchange are relatively flat and primarily used for agricultural purposes. The existing Sideroad 5 and Coffey Road run alongside Highway 400 at the southwest and southeast quadrants, respectively. The North Schomberg River meanders on the west side of Highway 400 and flows under the highway through a culvert to the north of Line 5. Within the project area, vegetation cover largely consists of grass with some shrubs and small trees along the highway and Line 5. On the west side of Highway 400, the land is relatively flat.

Within the area of the new bridge at the proposed realigned Sideroad 5, the land is relatively flat and covered with grass and shrubs, some residential dwellings are located approximately 150 m north of the Line 5 and Sideroad 5 crossing.

From published geological information, the site is located within the physiographic region known as the Schomberg Clay Plains which consists of deep deposits of stratified clay and silt overlying a drumlinized till plain. Depending on their sizes, the drumlins are completely or partially buried by the clays and silt deposits. The clay and silt deposits have average thicknesses of about 5 m although thicker deposits have also been identified.

3 SITE INVESTIGATION AND FIELD TESTING

Details of the site investigation and field testing for each project component are presented in Table 3.1. Some of the boreholes were supplemented by dynamic cone penetration testing (DCPT) conducted from the base of the sampled borehole and extended to practical refusal or adequate depth below the foundations.

Table 3.1 – Borehole Designations and Details

Design component	Date (2014)	Borehole	Sampled borehole termination depth* (m)	Sampled borehole termination elevation* (m)	Appendi x
New Bridge					
New bridge at realigned Sideroad 5 over the North Schomberg River	November 6, 7, 10, 27, 28, December 1	14-43, 14-44 14-45, 14-46 14-47, 14-48	9.4 to 15.7	203.4 to 212.0	A
High Fills					
High fill for Ramp N-EW (max. height 9.0 m)	January 29 and 30, October 27 to 30, December 4, 5 and 8	14-01, 14-05, 14-06, 14-07, 14-08, 14-09, 14-15, 14-52, 13-24, 13-25, 13-26	8.2 to 22.2	199.6 to 215.2	B
High fill for Ramp E-S (max. height 10.0 m)	October 23, 28, 29, November 3 and 4, December 2	14-11, 14-12, 14-14, 14-17, 14-18	10.2 to 22.2	199.9 to 211.1	B
High fill for Ramp W-N (max. height 6.0 m)	November 11	14-31	8.2	217.0	B
High fill for Line 5 (max. height 6.0 m)	November 18	14-23	8.2	215.2	B
High fill and culvert	October 23, 24, 29, 30, November 4 and 5	14-15, 14-16, 14-17, 14-51	12.6 to 20.1	202.1 to 208.9	B
High fill and culvert	October 27, 28, November 4, December 3	14-10, 14-12, 14-13	9.8 to 13.3	208.3 to 211.8	B
Low Fills					
Ramps S-EW and W-S, and Coffey Road (embankments less than 4.5 m high)	November 14, 17 and 19	14-32 14-38 14-42	6.7 to 8.2	217.6 to 219.5	C

Design component	Date (2014)	Borehole	Sampled Borehole termination depth* (m)	Sampled Borehole termination elevation* (m)	Appendix
Culvert Extension					
Sucker Creek Culvert extension under Highway 400	January 16, 31, October 28, November 24	14-01, 14-02, 14-03, 14-04	9.8 to 24.7	202.8 to 216.2	D

* Borehole termination depths include termination depth of DCPT

The approximate locations of the boreholes drilled during the investigation are shown on the attached Borehole Locations and Soil Strata Drawings in Appendices A to D. The coordinates and elevations of the boreholes are given on the drawings and on the individual Record of Borehole Sheets in Appendices A to D.

The borehole locations were marked in the field and utility clearances were obtained prior to drilling.

During this investigation, track mounted D90, D56 and D6 drill rigs were used at this site. A truck-mounted drill rig was used for boreholes drilled on the existing Highway 400, Line 5 and Sideroad 5 platforms. A combination of solid and hollow-stem augers were used to advance the boreholes. Wash-boring methods with casing and tripod were employed at five borehole locations, where drill rig access was not possible, within the northwest quadrant of the Highway 400 and Line 5 interchange. Soils samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). The in situ shear strength of the soft to firm cohesive soils was also assessed using the MTO shear vane.

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.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Standpipe piezometers consisting of a 19 mm diameter Schedule 40 PVC pipe with a 3.0 m long slotted screen, were installed and enclosed in filter sand in selected boreholes to permit longer term groundwater level monitoring. The completion details of the boreholes with piezometer installations are summarized in Table 3.2. Boreholes without piezometer installations were backfilled with bentonite holeplug and drill cuttings, except for Borehole 14-52 where methane gas was encountered during drilling (see Section 3.1 for details).

Table 3.2 – Piezometer and Borehole Completion Details

Design Component	Borehole Number	Piezometer Tip Depth / Elevation (m)	Completion Details
New bridge at realigned Sideroad 5 over the North Schomberg River	14-45	15.4/206.4	Backfilled with filter sand from 15.4 to 12.9m, bentonite holeplug from 12.9 to 6.7 m, then bentonite holeplug and auger cuttings from 6.7 m to ground surface.
	14-47	15.2/203.7	Backfilled with filter sand from 15.5 to 11.6 m, bentonite holeplug from 11.6 to 9.4m, bentonite holeplug and auger cuttings from 9.4 to 0.9 m, then bentonite holeplug to ground surface.
High fill for Ramp N-EW	14-01	9.1/213.4	Backfilled with filter sand from 9.8 to 5.8 m, bentonite holeplug from 5.8 to 4.0 m, bentonite holeplug and auger cuttings from 4.0 to 0.15 m, then cement to ground surface.
	14-06	9.1/213.6	Backfilled with filter sand from 9.1 to 6.7 m, bentonite holeplug from 6.7 m to ground surface.
	14-08	9.1/212.3	Backfilled with filter sand from 9.8 to 5.5 m, bentonite holeplug from 5.5 to 3.0 m, bentonite holeplug and auger cuttings from 3.0 to 0.15 m, then cement to ground surface.
	13-24	7.6/215.8	Backfilled with filter sand from 8.2 to 4.3 m, bentonite holeplug and auger cuttings from 4.3 m to ground surface.
	13/25	10.7/213.5	Backfilled with filter sand from 11.3 to 7.3 m, bentonite holeplug and auger cuttings from 7.3 m to ground surface.
	13-26	10.6/215.2	Backfilled with filter sand from 11.3 to 7.3 m, bentonite holeplug and auger cuttings from 7.3 m to ground surface.
High fill for Ramp W-N	14-31	7.6/217.7	Backfilled with filter sand from 8.2 to 3.9 m, bentonite holeplug and auger cuttings from 3.9 m to ground surface.
High fill and culvert	14-16	12.8/208.4	Backfilled with filter sand from 13.3 to 9.4 m, bentonite holeplug from 9.4 m to ground surface.
	14-17	12.5/209.0	Backfilled with filter sand from 13.3 to 8.9 m, bentonite holeplug from 8.9 to 5.2 m, then bentonite holeplug and auger cuttings to ground surface.
High fill and culvert	14-10	9.1/212.3	Backfilled with filter sand from 9.8 to 6.5 m, bentonite holeplug from 6.5 m to ground surface.

Design Component	Borehole Number	Piezometer Tip Depth / Elevation (m)	Completion Details
	14-13	9.4/212.4	<u>Deep Piezometer</u> Backfilled with filter sand from 9.8 to 5.8 m, bentonite holeplug and auger cuttings from 5.8 to 0.15 m, then cement to ground surface.
		3.0/218.5	<u>Shallow piezometer</u> Backfilled with filter sand from 3.6 to 1.4 m, bentonite holeplug and auger cuttings from 1.4 to 0.15 m, then cement to ground surface.
Sucker Creek Culvert extension (north of Line 5)	14-04	10.7/211.6	Backfilled with filter sand from 11.3 to 7.3 m, then bentonite holeplug and auger cuttings from 7.3 m to ground surface.

Once groundwater monitoring is completed, all piezometer installations will be decommissioned in accordance with Ministry of the Environment Regulation 903 and its Amendments (the water well regulation under the OWRA).

3.1 Methane Gas

The following summarizes factual information associated with the encountering and handling of methane gas in Borehole 14-52.

- On October 30, 2014, methane gas was encountered while conducting drilling operations in Borehole 14-52. This borehole is located approximately 50 m north of Line 5 and 125 m west of Highway 400 in an open field. As the drilling advanced to 18.1 m depth (Elevation 203.8 m) within the native silty clay, the drill rig was slightly shifted. While augers were being removed, water gushed out from the borehole and then settled down at 0.9 m depth. Bubbling sound was heard in the borehole and the augers were vibrating. Drilling operations were ceased with deployment of safety measures (e.g. shut off drill rig, advise fire department, use of gas mask) and gas monitoring commencing immediately.
- On October 31, a gas detector indicated that hydrogen sulphide gas (H₂S) was emitting from the borehole. An area of approximately 9 m in radius surrounding the borehole and the drill rig was cordoned off.
- On November 1, methane gas (CH₄) was detected with a concentration of 30,000ppm inside the borehole.
- On November 2, the methane readings were 40,000 ppm inside and 500 ppm outside of the borehole.

- On November 3, the augers in the ground were lifted up for about 0.9 m using a mechanical jack. Before the augers were lifted, the methane reading inside the borehole was 50,000 ppm and 1,000 ppm outside. As the augers were removed, the methane gas concentration inside the borehole dropped from 50,000 ppm to 30,000 ppm. Readings in the atmosphere above the borehole decreased from 1,000 ppm to 0 ppm.
- On November 4 and 5, the borehole was grouted and backfilled using pumped cement, concrete and peltonite. Methane readings decreased from 40,000 ppm to 1,200 ppm inside the borehole (as the level of grout rose) and from 1,200 ppm to below 600 ppm immediately above the borehole (after the grout reached ground surface). The methane readings above the borehole eventually dropped to 0 ppm.
- On November 6 and 7, methane readings remained at 0 ppm above the borehole.

It is noted that the local residents indicated that methane gas has occasionally been encountered in the existing wells in the vicinity and the sound of bubbling gas is not uncommon.

4 LABORATORY TESTING

All recovered soil samples were subjected to visual identification and to natural moisture content determination. At least 25% of the recovered soil samples were subjected to grain size distribution analysis. Atterberg Limits tests were carried out on selected samples of native silty clay and silty clay till to determine the plasticity characteristics. The results of the laboratory testing are summarized on the Record of Borehole sheets and also presented on the figures included in Appendices A to F.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets included in Appendices A to F. Details of the encountered soil stratigraphy are presented in these appendices and on the “Borehole Locations and Soil Strata” drawings also in Appendices A to F. An overall description of the stratigraphy for each design component is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the subsurface stratigraphy at the location of each of the project components consists of surficial topsoil, asphalt or fill overlying native silty clay. The silty clay is generally firm to very stiff within the upper 4 to 6 m, firm to soft to approximately 11 to 12 m depth, then becomes stiff to hard with depth. Very stiff to hard silty clay till was contacted below the silty clay. The till is underlain by a dense to very dense layer of sands and silts. The groundwater level within the cohesive deposits is at, or less than 2 m depth below, existing ground surface.

5.1 New Bridge at realigned Sideroad 5 over the North Schomberg River

A total of six boreholes, numbered 14-43 to 14-48, were drilled near the location of the proposed bridge at the realigned Sideroad 5, located approximately 640 m west of Highway 400. Boreholes 14-44, 14-45, 14-47 and 14-48 were drilled at the proposed abutments, and Boreholes 14-43 and 14-46 at the proposed approach embankments. Records of boreholes, laboratory testing results and stratigraphic drawings are contained in Appendix A.

5.1.1 Topsoil

Topsoil was encountered at ground surface in Boreholes 14-43, 14-45, 14-46 and 14-48, with a thickness varying from 25 to 125 mm.

The topsoil thickness may vary between and beyond the borehole locations, and the limited data presented in this report should not be used for quantity estimation purposes.

5.1.2 Silty clay

A deposit of native silty clay was encountered below topsoil in Boreholes 14-43, 14-45, 14-46 and 14-48 and surficially in Boreholes 14-44 and 14-47. The silty clay contained trace sand and gravel and occasional roots and rootlets. It was generally brown to grey in colour. The thickness of the silty clay ranged from 5.7 to 8.7 m. The base of this deposit varied between 5.7 and 8.8 m depths (Elevations 212.9 to 214.8 m).

In situ vane testing in the silty clay indicated that the undrained shear strength typically ranges from 44 to 100 kPa. SPT 'N' values typically ranged from 3 to 15 blows per 0.3 m of penetration indicating a firm to stiff consistency. An SPT 'N' value of 19 blows per 0.3 m of penetration was measured in Borehole 14-46 indicating a very stiff zone near Elevation 220.8 m. The moisture contents ranged from 14% to 35%.

Samples of silty clay were subjected to gradation analysis and Atterberg Limits testing. Grain size distribution curves for samples of silty clay tested are presented on the Record of Borehole sheets and on Figures A1 and A2 in Appendix A. Atterberg Limit test results are presented on Figures A6 and A7 of Appendix A. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 13
Silt	45 to 68
Clay	32 to 53

Soil Particles	Percentage (%)
Liquid Limit	28 to 37
Plasticity Index	8 to 17

The results indicate that the silty clay typically has low to medium plasticity (CL to CI).

5.1.3 Sandy silt, Sand and Silt to Silty Sand

A layer of sandy silt, sand and silt to silty sand containing trace gravel, trace to some clay and occasional clay pockets was contacted below the silty clay in all the boreholes, except in Borehole 14-46 at depths ranging from 5.7 to 8.8 m. The thickness of these cohesionless soils ranged from 3.0 to 6.2 m in Boreholes 14-44, 14-45 and 14-48. Boreholes 14-43 and 14-47 were terminated within the sand and silt layers at 9.4 and 15.5 m depths (Elevations 210.7 to 203.4 m), respectively. Where fully penetrated, the base of these soils were at 8.8 to 13.2 m depths (Elevations 211.7 to 208.5 m).

SPT 'N' values recorded in the sands and silts ranged from 18 blows for 0.3 m penetration to greater than 100 blows for less than 0.3 m of penetration indicating a compact to very dense condition.

The moisture contents generally ranged from 4% to 13%. Moisture contents of 20% were measured in Boreholes 14-44 and 14-48.

Samples of sandy silt, sand and silt, and silty sand were subjected to gradation analysis. Grain size distribution results are presented on the Record of Borehole sheets and on Figure A3 of Appendix A. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 13
Sand	17 to 57
Silt	20 to 58
Clay	8 to 25

5.1.4 Sand and Gravel

A layer of sand and gravel was encountered below the silty sand at 8.8 m depth in Borehole 14-44. The thickness of the sand and gravel layer was 1.4 m. The base of the layer was at 10.2 m depth (Elevation 210.3 m).

An SPT 'N' value recorded in the sand and gravel was 100 blows for less than 0.3 m of penetration indicating a very dense state.

The moisture content of the sand and gravel was 9%.

5.1.5 Silty Clay Till

Grey silty clay till containing some sand and trace to some gravel was contacted below the sands and silts at 10.2 m depth in Borehole 14-44, at 11.8 m depth in Borehole 14-45, below the silty clay at 8.5 m depth in Borehole 14-46, and at 13.2 m depth in Borehole 14-48. The thickness of the silty clay till was 2.0 m where fully penetrated in Borehole 14-44. The base of the silty clay till was at 12.2 m depth (Elevations 208.3 m) in Borehole 14-44. Boreholes 14-45, 14-46 and 14-48 were terminated within the silty clay till at 9.8 to 15.7 m depths (Elevation 206.0 to 212.0 m).

Where measured, SPT 'N' values were greater than 100 blows for less than 0.3 m of penetration indicating a hard consistency. An 'N' value of 23 blows per 0.3 m of penetration indicating a very stiff consistency was measured in the silty clay till in Borehole 14-46.

The measured moisture content of samples of the silty clay till ranged from 9% to 13%.

Two samples of the silty clay till were subjected to gradation analysis. Grain size distribution results are presented on the Record of Borehole sheets and on Figure A4 of Appendix A. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	3 to 7
Sand	27 to 30
Silt	41 to 45
Clay	21 to 26

Glacial tills inherently contain cobbles and boulders.

5.1.6 Sand

A layer of sand containing trace silt and trace gravel was contacted below the silty clay till in Borehole 14-44 at 12.2 m depth. Boreholes 14-44 was terminated within the sand layer at 13.9 m depth (Elevation 206.6 m).

SPT 'N' values recorded in the sand were 100 blows for less than 0.3 m of penetration indicating very dense condition.

The measured moisture contents of samples of the sand were between 8% and 9%.

A sample of sand was subjected to gradation analysis. Grain size distribution curve for the sand sample tested is presented on the Record of Borehole sheets and on Figure A5 of Appendix A. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	9
Sand	56
Silt	26
Clay	9

5.1.7 Groundwater Levels

Water levels were observed in the open boreholes upon completion of drilling operations. Standpipe piezometers were installed in two boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers along with the measurements recorded in the open boreholes upon completion of drilling are summarized in Table 5.1.

Table 5.1 – Water Level Measurements

Borehole Number	Date	Water Levels		Comment
		Depth (m)	Elevation (m)	
14-43	November 7, 2014	1.1	219.0	Open borehole
14-44	November 6, 2014	1.3	219.2	Open borehole
14-45	December 8, 2014	0.7	221.1	Piezometer
	January 6, 2015	0.9	220.9	Piezometer
14-46	November 27, 2014	2.6	219.2	Open borehole
14-47	December 8, 2014	0.9	218.0	Piezometer
	January 6, 2015	0.5	218.4	Piezometer
14-48	November 28, 2014	1.9	219.8	Open borehole

The piezometric readings indicate that water level at this site ranges from 0.5 to 0.9 m depths below ground surface (Elevations 218.4 to 220.9 m).

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.2 High Fills for Ramps N-EW, E-S and W-N, and Line 5 (near Station 9+740)

A total of twenty two boreholes (numbered 14-01, 14-05 to 14-18, 14-23, 13-24, 13-25, 13-26, 14-31, 14-51, 14-52) were drilled at the northwest quadrant of the Highway 400 and Line 5 interchange, where two ramps (high fills) and two new culverts are proposed. The high fills are approximately 9 to 10 m high. Selected boreholes were positioned along the alignments of Ramps N-EW and E-S, and Culverts 1E and 1H. Two of these boreholes were drilled along alignments of Ramp W-N and Line 5 (Station 9+740), respectively, where embankments are between 4.5 and 6.0 m high. Dynamic cone penetration testing

(DCPT) was conducted from the base of Boreholes 14-09 and 14-14 which extended to 22.2 m depth.

5.2.1 Topsoil

Topsoil was encountered surficially in all the boreholes drilled for the high fills and Culverts 1E and 1H, except in Boreholes 14-05 and 14-23. The topsoil thickness typically ranged from 150 to 800 mm, except in Boreholes 14-06, 14-14, 14-16 and 13-25 where the topsoil thickness varied from 25 to 100 mm.

The topsoil thickness may vary between and beyond the borehole locations, and the limited data presented in this report should not be used for quantity estimation purposes.

5.2.2 Fill

A layer of brown to grey silty clay fill with sand, trace to some gravel with occasional rootlets and wood fibres was contacted below the topsoil in Boreholes 13-25 and 13-26. The thickness of the silty clay fill was 2.8 to 2.9 m. A 0.6 m thick layer of brown clayey silt fill with sand, trace gravel was encountered below the topsoil in Borehole 13-24. A layer of brown sand fill containing trace gravel was encountered at ground surface in Borehole 14-23. The thickness of the sand fill was 1.1 m. The depth to the base of these fill deposits ranged between 0.8 and 3.0 m (Elevations 221.1 to 222.9 m).

SPT 'N' values recorded in the silty clay/clayey silt fill ranged from 8 to 20 blows per 0.3m penetration indicating a stiff to very stiff consistency. An SPT 'N' value in the sand fill was 9 blows per 0.3 m of penetration, indicating a loose state.

The measured moisture content of samples of the silty clay/clayey silt fill ranged from 14% to 24%. A moisture content in the sand fill was measured at 13%.

Samples of silty clay/clayey silt fill were subjected to gradation analysis and Atterberg Limits testing. Grain size distribution curves for samples of silty clay/clayey silt fill tested are presented on the Record of Borehole sheets and on Figure B1 in Appendix B. Atterberg Limit test results are presented on Figures B13 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 11
Sand	21 to 38
Silt	31 to 53
Clay	19 to 26

Soil Particles	Percentage (%)
Liquid Limit	38
Plasticity Index	16

The results indicate that the silty clay fill has a medium plasticity (CI).

5.2.3 Sand, Sandy Silt to Silty Sand

Layers of sand, sandy silt and silty sand containing trace gravel and clay were contacted below the topsoil or interbedded within the silty clay in Boreholes 14-05 to 14-11, 14-13, 14-15, 14-17, 14-23 and 14-51 at depths ranging from 0.6 to 2.4 m. Some clay to clayey zones were noted in Boreholes 14-13 and 14-15. Gravelly sand was noted in Boreholes 14-05, 14-09, 14-10 and 14-11. The thickness of the sands and silts ranged from 0.4 to 1.8 m. The depth to the base of these cohesionless soils ranges from 1.4 to 4.1 m (Elevations 217.3 to 220.8 m).

SPT 'N' values recorded in these layers ranged from 5 to 20 blows for 0.3 m penetration indicating loose to compact conditions.

The measured moisture contents of samples of the sands and silts ranged from 5 to 20%.

Two samples of sand and silt were subjected to gradation analysis testing. The results of these tests are summarized in the table below as well as on the Record of Borehole sheets included in Appendix B. Figure B2 in Appendix B presents the grain size distribution curves for these samples.

Soil Particles	Sand/Silt
Gravel	0
Sand	41 to 42
Silt	36 to 39
Clay	20 to 22

A pocket of clay encountered within the sand layer in Borehole 14-13 was tested for Atterberg Limits and the results indicated a plasticity index of 10% and a liquid limit of 25%. This clay has a low plasticity (CL). Test results are presented in Figure B14.

5.2.4 Sand and gravel

A 1.1 m thick layer of sand and gravel was contacted below the sand and silt at 1.4 m depth in Borehole 14-13. The depth to the base of this layer was 2.5 m (Elevation 219.0 m).

SPT 'N' value recorded in the sand and gravel was 35 blows for 0.3 m penetration, indicating a dense condition.

The measured moisture content in the sand and gravel was 6%.

5.2.5 Silty clay

An extensive deposit of native brown to grey silty clay containing trace to some sand, and occasionally with sand, trace gravel was encountered typically below topsoil and the surficial cohesionless soils in all boreholes, except for Borehole 14-05 where the silty clay was contacted at ground surface. The boreholes were terminated within the silty clay at depths ranging from 8.2 to 20.1 m (Elevations 202.1 to 215.2 m).

Immediately underlying the topsoil or exposed at ground surface, a silty clay layer up to 600mm in thickness is mixed with topsoil and roots, and has higher water contents and lower SPT 'N' values. This softer layer has likely resulted from previous farming activities and free-thaw effects.

Within the silty clay, a weathered crust in the order of 3 to 4 m thick, transitioning to a lightly over-consolidated zone of between 4 m to 10 m thick, was encountered in most of the boreholes. In Boreholes 14-01, 14-05 to 14-07, 13-23 to 13-26 and 14-31, the crust was apparently thicker and measured up to about 7 m. The silty clay generally becomes stiff to very stiff with depth below the lightly over-consolidated zone.

Within the weathered crust, the SPT 'N' values recorded in the silty clay typically ranged from 4 to 22 blows per 0.3 m of penetration indicating a firm to very stiff consistency. Field vane shear strengths measured in the crust in Borehole 14-01 ranged from 55 to 90 kPa. There were occasional soft zones at shallow depths as indicated by 'N' values of 3 blows.

In the underlying lightly over-consolidated zone, the SPT 'N' values generally varied from 1 to 8 blows per 0.3 m of penetration. In conjunction with field vane shear values generally ranging between 20 and 50 kPa, this zone has a soft to firm consistency. Occasional values up to 60 kPa indicate the presence of stiff layers.

The measured moisture content of samples of the silty clay ranged from 9% to 38%. A moisture content of 50% was measured in Borehole 14-06 at about 8 m depth.

Samples of silty clay were subjected to gradation analysis and Atterberg Limits testing. Grain size distribution curves for samples of silty clay tested are presented on the Record of Borehole sheets and on Figures B3 to B12 in Appendix B. Atterberg Limit test results are presented on Figures B15 to B21 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 5
Sand	0 to 40
Silt	26 to 72
Clay	21 to 59

Soil Particles	Percentage (%)
Liquid Limit	21 to 38
Plasticity Index	9 to 19

The results indicate that the silty clay typically has low plasticity (CL). Two samples of the silty clay from Borehole 13-24 and one sample from Borehole 13-25 showed medium plasticity (CI).

5.2.6 Silt

A layer of grey silt containing trace sand and clay was contacted at 16.9 m depth in Borehole 14-14. The thickness of the silt layer was 1.4 m. The depth to the base of the silt was at 18.3 m (Elevation 203.8 m).

An SPT 'N' value of 14 blows per 0.3 m of penetration indicating a compact state was measured.

The measured moisture content of a sample of the silt was 22%.

5.2.7 Groundwater Levels

Water levels were observed in the open boreholes upon completion of drilling operations. Standpipe piezometers were installed in twelve boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers along with the measurements recorded in the open boreholes upon completion of drilling are summarized in Table 5.2.

Table 5.2 – Water Level Measurements

Borehole Number	Date	Water Levels		Comment
		Depth (m)	Elevation (m)	
14-01	November 7, 2014	1.4	221.1	Piezometer
	December 8, 2014	1.2	221.3	Piezometer
	January 6, 2015	1.4	221.1	Piezometer
14-05	December 8, 2014	1.1	221.1	Open borehole
14-06	December 8, 2014	1.0	221.7	Piezometer
	January 6, 2015	1.0	221.7	Piezometer
14-07	December 4, 2014	1.6	220.0	Open borehole
14-08	November 7, 2014	2.5	219.0	Piezometer
	December 8, 2014	2.4	219.1	Piezometer
	January 6, 2015	2.7	218.8	Piezometer
14-09	October 29, 2014	2.1	219.7	Open borehole
14-10	December 8, 2014	1.4	220.0	Piezometer
	January 6, 2015	2.1	219.3	Piezometer
14-11	December 2, 2014	1.4	219.9	Open borehole
14-12	November 4, 2014	1.9	219.7	Open borehole

14-13	December 8, 2014	1.2*	220.3	Piezometer
	January 6, 2015	1.3*	220.2	Piezometer
14-14	December 8, 2014	1.2	220.3	Piezometer
	January 6, 2015	1.4	220.1	Piezometer
14-14	October 29, 2014	2.5	219.6	Open borehole
14-15	October 30, 2014	1.9	220.3	Open borehole
14-16	November 7, 2014	1.6	219.6	Piezometer
	December 8, 2014	1.4	219.8	Piezometer
	January 6, 2015	2.0	219.2	Piezometer
14-17	November 7, 2014	1.9	219.6	Piezometer
	December 8, 2014	1.7	219.8	Piezometer
	January 6, 2015	1.7	219.8	Piezometer
14-18	November 3, 2014	2.0	219.9	Open borehole
13-24	February 26, 2014	2.5	220.9	Piezometer
13-25	February 26, 2014	2.5	221.7	Piezometer
13-26	February 26, 2014	4.7	221.2	Piezometer
14-31	December 8, 2014	0.3	225.0	Piezometer
	January 6, 2015	0.4	224.9	Piezometer
14-51	October 24, 2014	1.7	219.8	Open borehole
14-52	October 30, 2014	1.0	220.9	Open borehole

* Shallow piezometer

The piezometric readings indicate that the water level to the west of Highway 400 ranges from 1.0 to 2.7 m depth below ground surface (Elevations 218.8 to 221.7 m). On the east side of Highway 400, Borehole 14-31 recorded a water level very close to ground surface at 0.4 m depth, or Elevation 224.9 m.

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.3 Ramps S-EW and W-S, and Coffey Road - Fills lower than 4.5 m

Boreholes 14-32, 14-38 and 14-42 were drilled at selected locations within the alignments of the proposed Ramps S-EW and W-S, and Coffey Road (Station 10+890), respectively, where the embankments are lower than 4.5 m.

5.3.1 Topsoil

Topsoil of 0.8 m in thickness was contacted surficially in Borehole 14-42.

The topsoil thickness may vary between and beyond the borehole locations, and the limited data presented in this report should not be used for quantity estimation purposes.

5.3.2 Asphalt

Pavement structure consisting of asphalt overlying granular fill materials (road base) was encountered in Boreholes 14-32 and 14-38. The thickness of the asphalt was 25 to 100mm.

5.3.3 Fill

A layer of brown to dark brown sand fill containing some gravel to gravelly was contacted below the asphalt in Boreholes 14-32 and 14-38. The thickness of the sand fill was 0.8 and 1.1 m in Boreholes 14-32 and 14-38, respectively. The depth to the base of the sand fill was 0.9 to 1.1 m (Elevations 226.8 to 224.2 m).

An SPT 'N' value for the sand fill of 12 blows per 0.3 m indicated a compact condition.

Moisture contents measured in this fill ranged from 4% to 7%.

5.3.4 Sandy silt

A 0.6 m thick layer of native brown sandy silt was encountered below the sand fill at 0.9 m depth in Borehole 14-32. The depth to the base of the sandy silt was 1.5 m (Elevation 226.2 m).

An SPT 'N' value of 19 blows per 0.3 m of penetration was measured in the sandy silt indicating a compact condition.

A moisture content measured in the sandy silt was 19%.

5.3.5 Silty clay

Native brown to grey silty clay containing trace sand and gravel was encountered below the topsoil, sand fill and sandy silt layers. Cobbles were inferred in Borehole 14-42 near Elevation 220.4 m.

Boreholes 14-32, 14-38 and 14-42 were terminated within the silty clay at depths ranging from 6.7 to 8.2 m (Elevations 217.6 to 219.5 m).

SPT 'N' values recorded in the silty clay typically ranged from 11 to 27 blows per 0.3 m of penetration indicating a stiff to very stiff consistency. An SPT 'N' value of 49 blows per 0.3 m of penetration, indicating a hard consistency, was measured in Borehole 14-42 near Elevation 221 m. The measured moisture content ranged from 15% to 29%.

Samples of silty clay were subjected to gradation analysis and Atterberg Limits testing. Grain size distribution curves for samples of silty clay tested are presented on the Record of Borehole sheets and on Figure C1 of Appendix C. Atterberg Limit test results are presented on Figure C2 of Appendix C. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0 to 4
Silt	55 to 63
Clay	37 to 45

Soil Particles	Percentage (%)
Liquid Limit	28 to 37
Plasticity Index	12 to 17

The results indicate that the silty clay typically has low plasticity (CL) with occasional zones of medium plasticity (CI).

5.3.6 Groundwater Levels

The water levels measured in the open boreholes upon completion of drilling are summarized in Table 5.3. No piezometer was installed in any of these three boreholes.

Table 5.3 – Water Level Measurements

Borehole Number	Date	Water Levels		Comment
		Depth (m)	Elevation (m)	
14-38	November 17, 2014	1.9	223.4	Open borehole
14-42	November 14, 2014	3.4	220.9	Open borehole

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

5.4 Sucker Creek Culvert Extension - Highway 400 north of Line 5

Four boreholes, numbered 14-01 to 14-04, were drilled near the culvert extension footprints at the west and east ends of the existing Sucker Creek Culvert. A dynamic cone penetration test was conducted in Borehole 14-02 which extended to 24.7 m depth (Elevation 202.8 m).

5.4.1 Topsoil

Topsoil was encountered surficially in Boreholes 14-01 and 14-04, drilled at both ends of the culvert. The topsoil thickness was 800 mm and 125 mm on the west and east sides of the existing culvert, respectively.

The topsoil thickness may vary between and beyond the borehole locations, and the limited data presented in this report should not be used for quantity estimation purposes.

5.4.2 Asphalt

Pavement structure consisting of asphalt overlying granular fill materials (road base) was encountered in Boreholes 14-02 and 14-03, drilled on the shoulders of Highway 400. The thickness of the asphalt was 75 to 125 mm.

5.4.3 Fill

A layer of granular fill consisting of brown sand and gravel, some silt, was encountered below the asphalt in Boreholes 14-02 and 14-03. The thickness of the granular fill was 1.1 m and 0.7 m in Boreholes 14-02 and 14-03, respectively.

A layer of brown silty clay fill containing trace to some sand and trace gravel was contacted below the sand and gravel fill at 0.8 m depth in Borehole 14-03. The thickness of the silty clay fill was 3.8 m. The depths to the base of the granular fill varied between 1.2 and 0.8 m (Elevations 226.3 and 226.7 m). The depth to the base of the silty clay fill was 4.6 m (Elevation 222.8 m).

SPT 'N' values recorded in the granular fill were 17 and 29 blows for 0.3 m penetration, indicating a compact condition. The SPT 'N' values of the silty clay fill ranged from 17 to 26 blows per 0.3 m of penetration indicating a very stiff consistency.

Moisture contents of the sand and gravel fill were 3% to 4%, and those measured for the silty clay fill were 7% to 21%.

One sample of the sand and gravel fill, and one sample of the silty clay fill, were subjected to laboratory gradation analysis.

Grain size distribution results for these tests are presented on the Record of Borehole sheets included in Appendix D and on Figures D1 and D2 of Appendix D. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%) Granular Fill	Percentage (%) Silty Clay Fill
Gravel	39	0
Sand	50	0
Silt	-	48
Clay	-	52
Silt and Clay	11	-

A sample of the silty clay fill was tested for Atterberg Limits and the results revealed a plasticity index of 11% and a liquid limit of 26% indicating a low plasticity (CL). The results of the Atterberg Limits are presented in Figure D5 of Appendix D.

5.4.4 Silty Clay

A deposit of native brown to grey silty clay was encountered below the topsoil and fill. The silty clay typically contained trace gravel and trace to some sand, except in Borehole 14-02 where the clay contains a higher proportion of sand.

Borehole sampling was terminated within the silty clay at depths ranging from 9.8 m to 13.1 m (Elevations 211.0 to 216.2 m).

Within the upper crust, SPT 'N' values recorded in the silty clay typically ranged from 6 to 19 blows for 0.3 m of penetration indicating a firm to very stiff consistency. Below the crust, a firm to stiff zone was generally encountered as indicated by SPT 'N' values ranging from 4 to 9 blows per 0.3 m of penetration. In situ vane shear strengths in the silty clay ranged from 88 to 40 kPa. In Borehole 14-03, the silty clay was very stiff to stiff throughout the investigated depth.

The measured moisture contents of samples of the silty clay ranged from 9% to 26%. Moisture contents of 35% and 44% were measured at shallower depths in Borehole 14-04 indicating a layer of wet, softer clay just below the topsoil.

Samples of silty clay were subjected to gradation analysis and Atterberg Limits testing. Grain size distribution results are presented on the Record of Borehole sheets in Appendix D and on Figures D3 and D4. Atterberg Limit test results are presented on Figures D6 and D7 of Appendix D. The results of the laboratory test are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 5
Sand	0 to 24
Silt	40 to 61
Clay	30 to 50

Soil Particles	Percentage (%)
Liquid Limit	22 to 34
Plasticity Index	11 to 15

The results indicate that the silty clay has low plasticity (CL).

5.4.5 Groundwater Levels

Water levels were observed in the open boreholes upon completion of drilling operations. Standpipe piezometers were installed in two boreholes to monitor water levels after completion of drilling. The water levels measured in the piezometers along with measurements recorded in the open boreholes upon completion of drilling are summarized in Table 5.4.

Table 5.4 – Water Level Measurements

Borehole Number	Date	Water Levels		Comment
		Depth (m)	Elevation (m)	
14-01	November 7, 2013	1.4	221.1	Piezometer
	December 8, 2014	1.2	221.3	Piezometer
	January 6, 2015	1.4	221.1	Piezometer
14-02	November 24, 2014	5.9	221.6	Open borehole
14-03	January 16, 2014	9.4	218.1	Open borehole
14-04	January 21, 2014	1.3	221.0	Piezometer

The piezometric readings indicate that water level at this site ranges from 1.2 m to 1.4 m (Elevations 221.1 to 221.3 m) depth below ground surface.

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

6 MISCELLANEOUS

Borehole locations were established in the field based on information provided by URS. The ground surface elevation and coordinates at all as-drilled borehole locations were established by Thurber upon completion of drilling. Underground utility clearances were obtained for the borehole locations prior to drilling.

Walker Drilling Inc. of Utopia, Ontario supplied track-mounted and truck-mounted drill rigs, as well as a portable rig mounted on a tripod, and conducted the drilling, sampling and in-situ testing operations.

The field investigation was supervised by Mr. George Azzopardi, C.E.T. and Ms. Eckie Siu of Thurber. Geotechnical laboratory testing was carried out in Thurber's Toronto Area laboratory.

Planning and co-ordination of the field program was conducted by Mr. Lukasz Gilarski, P.Eng. Overall direction of the program was provided by Mr. Sydney Pang, P.Eng. Interpretation of the data and preparation of this report was carried out by Mr. Sydney Pang, P.Eng. and Ms. R. Palomeque Reyna, P.Eng.

The report was reviewed by Mr. P.K. Chatterji, P.Eng., who is a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.



Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer



Sydney Pang, P.Eng.
Associate, Senior Foundations Engineer



P. K. Chatterji, P.Eng.
Review Principal, Designated MTO Contact

**FOUNDATION INVESTIGATION AND DESIGN REPORT
NEW BRIDGE OVER NORTH SCHOMBERG RIVER
FILL EMBANKMENTS AND SUCKER CREEK CULVERT
HIGHWAY 400 AND LINE 5 INTERCHANGE RECONSTRUCTION
BRADFORD WEST GWILLIMBURY, ONTARIO
TBWG WP P13-03
MTO GWP 2122-10-00

GEOCRES No. 31D-605**

PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

This report provides an interpretation of the geotechnical data in the factual report, and presents foundation design recommendations to assist the design team to select and design suitable foundation systems for the major project components of the proposed reconstruction of the existing Highway 400 and Line 5 interchange, located in the Town of Bradford West Gwillimbury, Ontario. The project components included in this report are as follows:

Project Component	Location
New bridge	- Realigned Sideroad 5, over the North Schomberg River (approximately 700 m west of Highway 400)
High fills (4.5 m or higher)	- Line 5 (near Station 9+740) - Ramps N-EW, E-S and W-N (near Line 5)
Low fills (lower than 4.5 m)	- Ramps S-EW and W-S, and Coffey Road
Extension of Sucker Creek Culvert	- Sucker Creek Culvert under Highway 400 (approximately 450 m north of existing Line 5)

The discussions and recommendations presented in this report are based on the factual data obtained during the course of the investigation. The plans and profiles used for preparation of this report were provided by AECOM.

8 NEW BRIDGE AT REALIGNED SIDEROAD 5 OVER THE NORTH SCHOMBERG RIVER

8.1 Foundation Alternatives

A new bridge is proposed at the crossing of the realigned Sideroad 5 over the realigned North Schomberg River, located approximately 700 m west of Highway 400.

A preliminary General Arrangement (GA) drawing dated January 2015 provided by URS indicates that the new bridge will be a single-span structure supported on two abutments. Integral abutments are proposed and each to be supported by a single row of steel H-piles. Precast pre-stressed box girders will span the abutment pile caps to support the deck finishing. The length of the structure will be 30.0 m between abutments and the width will be 13.3 m. The north and south approach fills are up to 2.8 and 2.2 m in height, respectively.

In general, the subsurface conditions at this site consist of surficial topsoil overlying native, typically firm to stiff silty clay. The thickness of the silty clay ranged from 5.7 to 8.7 m. A layer of compact to very dense sands and silts was contacted below the silty clay. Hard silty clay till was encountered below the cohesionless soils at the abutments. Piezometric readings indicate that the water level is 0.5 to 0.9 m below ground surface, or Elevations 218.4 to 220.9 m.

Based on the existing site conditions, initial consideration was given to the following foundation types:

- Spread footings
- Augered caissons (drilled shafts)
- Steel H-piles

More detailed comparison of the technical advantages and disadvantages of the alternative foundation schemes is presented in Appendix G.

The subsurface conditions at this site are considered suitable for an integral abutment design. Each integral abutment is required to be supported on a single row of steel H-piles driven to achieve resistance in the underlying hard silty clay till or dense to very dense sands and silts.

Augered caissons (drilled shafts) may be considered if integral abutments are not used. It is noted, however, that the sands and silts are under a significant hydrostatic head which will create basal instability. The risk of basal instability can be minimized by construction techniques such as maintaining a head of water inside a temporary lining.

Due to the presence of firm silty clay at shallow depths, spread footings founded on native soils are not recommended due to the low geotechnical resistance that would be available

and potential post construction settlement. Geometric constraints of the low approach fills prohibit the use of footings founded on compacted granular fill pads.

8.2 Driven Steel H-Piles

Integral abutments are required to be supported on steel H-piles driven to practical refusal within the underlying hard silty clay till or the very dense sands and silts. A standard HP 310 x 110 section or a heavier HP 360 x 132 section may be used. Tills and other glacially derived soils inherently contain cobbles and/or boulders. The pile tips should, therefore, be reinforced to enhance driving (see Section 8.2.4).

For planning and design purposes, the recommended design pile tip elevations are as follows:

Table 8.1 – Design Pile Tip Elevations

Foundation Unit		Reference Borehole	Design Pile Tip Elevation (m)
North Abutment	West Side	14-47	208.0
	East Side	14-44	210.0
South Abutment	West Side	14-48	209.0
	East Side	14-45	208.0

The pile tip elevations shown in Table 8.1 should be used for estimating purposes only. The actual pile tip elevations will be controlled as described in Section 8.2.4 Pile Installation.

8.2.1 Axial Resistance

For steel H-piles driven to practical refusal at the estimated elevations given above, the following axial design geotechnical resistances per pile may be used.

Table 8.2 – Pile Axial Resistances

Pile Section			
HP 310 x 110		HP 360 x 132	
Factored Geotechnical Resistance at ULS (kN)	Geotechnical Resistance at SLS (kN)	Factored Geotechnical Resistance at ULS (kN)	Geotechnical Resistance at SLS (kN)
1,000	800	1,200	1,000

The SLS values correspond to a maximum pile settlement of 25 mm.

8.2.2 Downdrag on Piles

Downdrag forces could be induced on piles embedded within the silty clay deposit due to consolidation of the silty clay under the weight of the approach fill. Reference should be

made to the CHBDC (2010) Clauses 6.8.4 and C6.8.4 (commentary) for downdrag calculations.

For design purposes, unfactored downdrag loads of 180 kN and 210 kN per HP 310 x 110 and HP 360 x 132 pile, respectively, should be used to evaluate the impact of downdrag on the abutment piles. The location of the neutral plane for a pile or pile group should be determined by using unfactored loads and unfactored geotechnical parameters.

For structural design of a pile, the downdrag loads above should be multiplied by a load factor of 1.25 as per the CHBDC. In accordance with the code, the sum of the factored downdrag load and the factored permanent loads acting on the pile should not exceed the structural resistance of the pile. In geotechnical analysis of downdrag, live load effects should not be considered.

8.2.3 Lateral Resistance

For integral abutments, the flexibility of the upper portion of the pile may be provided by a single corrugated steel pipe (CSP) system. Reference should be made to the integral abutment manual for details of this system.

For pile lateral resistance design below the flexible zone, soil-pile interaction analyses may be carried out using the coefficient of horizontal subgrade reaction values provided in Table 8.3 below.

Table 8.3 – Recommended Geotechnical Parameters for Lateral Resistance Design

Location	Reference Boreholes	Approximate Elevation (m)	Undrained Shear Strength C_u (kPa)	Unit Weight γ (kN/m ³)	K_p	n_h (kN/m ³)	Soil Conditions
North Abutment	14-44 14-47	219.0 to 214.0	50	18	-	-	Silty clay, firm to stiff
		214.0 to 210.0	-	11*	3.2	4,000	Silty sand/sandy silt, compact to very dense
		210.0 to 205.0	-	11*	3.7	7,000	Silty sand/sandy silt, very dense
South Abutment	14-45 14-48	222.0 to 214.0	50	18	-	-	Silty clay, firm to stiff
		214.0 to 209.0	-	11*	3.2	5,000	Silty sand/sandy silt, compact to very dense
		209.0 to 206.0	200	21	-	-	Silty clay till, hard

The lateral resistance of a pile may be calculated using the k_s values and the lateral pressures obtained from the analysis should not exceed the ultimate values given in the following relationships.

Silty Clay / Silty Clay Till

$$k_s = 67 C_u / B \quad (\text{kN/m}^3)$$

$$p_{ult} = 9 C_u \quad (\text{kPa})$$

where p_{ult} = ultimate lateral resistance mobilized by a pile, kPa
 C_u = undrained shear strength of cohesive soils, kPa
 γ = total unit weight of soil, kN/m³
 B = width of pile, m

Sands and Silts

$$k_s = n_h \cdot z / B \quad (\text{kN/m}^3)$$

$$p_{ult} = 3 \cdot \gamma' \cdot z \cdot K_p \quad (\text{kPa})$$

where z = depth of embedment of pile, m
 B = pile width, m
 n_h = coefficient related to soil density, kN/m³
 γ' = submerged unit weight of soil, kN/m³
 K_p = passive earth pressure coefficient

For cohesive soils, the lateral resistance provided by the ground located between the final grade and a depth of 1.5B below that level should be neglected.

The above equations and recommended parameters may be used for numerical analysis of the interaction between a pile and the surrounding soil.

The spring constant, K , for analysis may be obtained by the expression, $K = k_s \times d_z \times B$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m³), B is the pile width (m), d_z is the length (m) of the pile segment or element used in the analysis. The ultimate lateral resistance on any one segment of pile, P_{ult} , may be obtained from the expression, $P_{ult} = p_{ult} \times d_z \times B$. This represents the ultimate load at the contact between the soil and the pile above which additional load cannot be supported at greater displacements.

The lateral resistance of an HP 310 x 110 pile driven into these soils should be limited to 120 kN at ULS and 40 kN at SLS.

For lateral soil-pile group interaction analysis, the values for k_s should be reduced based on pile spacing.

Where a pile group is oriented *perpendicular* to the direction of loading, group action may be considered by reducing values of k_s by a reduction factor R as follows:

Pile Spacing Perpendicular to Direction of Loading	Horizontal Subgrade Reaction Reduction Factor, R
4 B	1.00
1 B	0.50

where B is the diameter of the pile, and spacing is measured centre to centre.

Where a pile group is oriented *parallel* to the direction of loading, group action may be considered by reducing values of k_s by a reduction factor R as follows:

Pile Spacing Parallel to Direction of Loading	Horizontal Subgrade Reaction Reduction Factor, R
8 B	1.00
6 B	0.70
4 B	0.40
3 B	0.25

Intermediate values may be obtained by interpolation.

8.2.4 Frost Protection

Frost protection should be provided to all the pile caps and may take the form of 1.4 m of earth cover in any direction, or equivalent thermal insulation, over the underside of the cap.

8.2.5 Pile Installation

All piles shall be installed in accordance with OPSS 903.

Pile driving must be controlled in accordance with Standard Provision SS103-11 (Hiley Formula) and an ultimate pile resistance must be specified by the designer. The Hiley formula does not need to be used until the pile tip is within 2 m of the design tip elevation. The appropriate pile driving note to be shown on the contract drawing is “Piles to be driven in accordance with Standard Provision SS103-11 using an ultimate geotechnical resistance of “R” kN per pile where “R” must have a minimum value of twice the design load at ULS.

To facilitate pile installation, embankment fill through which piles will be driven must not contain any material with particle sizes greater than 75 mm.

Glacially derived soils inherently contain cobbles and boulders. Hard driving conditions through the hard or very dense soils should be expected. In order to minimize pile damage while driving through boulders, cobbles and harder/dense zones to achieve the required tip

elevations and soil resistance, it is recommended that the pile tips be reinforced with driving shoes such as the Titus Standard Points for H Piles, or the conventional driving shoes as per OPSD 3000.100.

8.3 Augered Caissons (Drilled Shafts)

Augered caissons socketted within the hard silty clay till may be considered to support the abutment foundations. Augered caissons are unsuitable for supporting integral abutments. Table 8.4 presents the recommended founding depths and elevations for the caissons.

Table 8.4 – Recommended Founding Depths and Elevations for Augered Caissons

Foundation Unit	Borehole	Founding Depth below existing ground surface (m)	Founding Elevation (m)
North Abutment	14-44	11.0	209.5
	14-47	10.9	208.0
South Abutment	14-45	13.8	208.0
	14-48	13.7	208.0

8.3.1 Axial Resistance

The following Table 8.5 presents geotechnical resistances recommended for typical 1.2 and 1.5 m diameter caissons associated with the founding depths given in Table 8.4.

Table 8.5 – Vertical Geotechnical Resistance for Augered Caissons

Foundation unit	Caisson Diameter (m)	Axial Geotechnical Resistance	
		Factored ULS _r (kN)	SLS (up to 25 mm settlement) (kN)
North/South Abutments	1.2	2,200	1,800
	1.5	3,400	2,700

8.3.2 Lateral Resistance

Lateral bridge loadings can be geotechnically resisted by the caissons through passive pressure developed along the embedded portion of the shaft. The methodology outlined in Section 8.2.2 above may be used to estimate the lateral geotechnical resistance of the caisson by substituting the pile width, B, with the caisson diameter, D.

8.3.3 Caisson Installation

Caisson installation must be carried out in accordance with OPSS 903 where applicable.

The caisson installation equipment should be able to dislodge and remove any obstructions such as cobbles and boulders and to penetrate harder layers within the silty clay till or

denser zones in the sands and silts. An NSSP addressing this issue must be included in the contract documents to alert the bidders (see Appendix H).

The resistance values provided in Table 8.5 above are based on shaft friction and end bearing assuming that the walls and base of each caisson are cleaned of loose or disturbed material prior to placement of concrete. The groundwater levels observed in the boreholes are close to ground surface. Soil sloughing and water seepage will occur in unsupported holes primarily from the sands and silts. Temporary liners must, therefore, be available on site to support the caisson sidewalls and to provide seepage cut-off where required. Any accumulated water may have to be pumped out from the hole prior to placing concrete. Concrete should be placed with a minimum delay after the caisson hole is drilled and cleaned. Should water-bearing sands and silts be encountered, techniques such as maintaining a balancing head of water in the excavation may be used to minimize the risk of base boiling. Tremie techniques may be required to place concrete inside the caisson hole.

8.4 Approach embankments

Based on the GA drawing provided by URS, it is estimated that the existing approach embankments are up to 2.8 and 2.2 m in height at the north and south abutments, respectively. The subgrade of the approach embankments consists generally of native firm to stiff silty clay. It is recommended that OPSS 1010 Granular A or B Type II be used as backfill immediately behind the abutment walls. Backfill selection, placement and compaction immediately behind the abutment walls are discussed in Section 11. Subgrade preparation and compaction must be carried out in accordance with OPSS 206 and 501. Beyond the abutment backfill, Select Subgrade Material (SSM) or granular materials satisfying OPSS 1010 may be used for embankment construction. Embankments constructed using these materials will be stable at a slope inclination not steeper than 2H : 1V.

It is expected that subgrade settlement will occur as the fill is placed and be completed by the end of fill placement. Post construction settlement of the approach fill itself is estimated to be up to the order of 0.5% of the embankment height, or in the order of 10 to 15 mm.

9 HIGH FILLS AND LOW FILLS

Proposed reconstruction of the Highway 400 and Line 5 interchange involves construction of new ramps at each quadrant. Both high fills (4.5 m or higher) and low fills (lower than 4.5 m) will be required. Based on information provided by AECOM, the locations of high fills and low fills as well as their proposed heights are summarized below:

	Location	Approximate Stations	Maximum Height (m)
High Fills	Ramp N-EW	10+320 to 10+570 at Line 5	9.0
	Ramp E-S	10+250 to 10+000 at Line 5	10.0
	Ramp W-N	Near Line 5	6.0
	Line 5	9+740±	6.0
Low Fills	Ramp S-EW Ramp W-S Coffey Road	Elsewhere along the ramp and road alignments	< 4.5

Two new culverts are proposed below Ramps N-EW and E-S. These two culverts are designed to be used as relief to stormwater surge at the highway interchange areas. Foundation comments and recommendations for these two culverts, as they relate to the high fill design and construction, are provided in a separate report on culverts.

Major factors governing high fills design at this site include the following:

- Proposed embankment geometry (height, slope angle, footprint, etc.).
- Embankment material type (SSM, granulars, earthfill).
- Embankment subgrade preparation.
- Thickness and engineering properties of foundation soils.
- Groundwater conditions.
- Embankment stability in the short and long terms
- Post construction settlements.

The assessment for the high fills has been carried out based on the following assumptions:

- High fills will be constructed with side slopes not steeper than 2H : 1V.
- Subgrade preparation will be carried out as per OPSS 206.
- Where an earth slope is greater than 8 m high, a 2 m wide mid height bench will be incorporated.
- The high fills will be constructed using OPSS 1010 (SSM) or granular materials and compacted to OPSS 501 requirements.

In general, the stratigraphy at the high fill and low fill locations identified within the depth of exploration in this investigation consisted primarily of topsoil or fill overlying native silty clay. The upper 4 to 5 m of the silty clay has a firm to very stiff consistency (weathered crust) transitioning to firm to stiff with occasionally soft zones. The silty clay becomes stiff to very stiff at depth. At some locations, layers of sands and silts were encountered at shallow depths.

Based on this information, the new high fills will induce time-dependent ground settlement as a result of consolidation of the underlying silty clay deposit. Consideration was given to alternate options of fill construction:

- Preloading is a feasible means to mitigate post construction ground settlement taking into consideration the subsurface conditions and the project requirements.
- Sub-excavation is not feasible at this site since the silty clay deposit is extensive and the more compressible zones are present at depths below the upper crust.
- Wick drains are generally useful in accelerating consolidation within softer clays but are unnecessary and are likely not cost effective for this site.
- Lightweight fill such as extruded polystyrene (EPS) can be used, however given that a waiting period is available for the preloading, this option is likely not cost effective for this project.

The recommended fill construction method at these locations is to preload to induce ground settlement within a waiting period.

9.1 Foundation Settlement and Preloading

The placement of approximately 6 to 10 m of fill for the new ramps and at Line 5 will induce immediate (elastic) settlement in the sand/silt layers and re-compression in the silty clay. Time dependent (consolidation) settlement in the underlying silty clay will occur after fill placement.

The estimated immediate and consolidation settlements at various locations are summarized in Table 9.1:

Table 9.1– High Fill Foundation Settlements

Location	Maximum Embankment Height (m)	Elastic Settlement (mm)	Primary Consolidation Settlement (mm)
Ramp N-EW	9.0	10	90
Ramp E-S	10.0	15	100
Ramp W-N	6.0	<10	60
Line 5	6.0	<10	60

In order to mitigate post construction settlement, it is recommended that all high fill embankments be constructed well in advance of pavement construction. A waiting period of 6 months should be made available between completion of fill placement and paving. If preloading is carried out as recommended, it is estimated that post construction settlement should not exceed 20 mm in 10 years.

The estimated settlement of earth or granular embankments due to fill compression is 0.5% of the embankment height and is expected to be completed within one to two years after construction. The estimated settlements within the 10 and 9 m embankments are expected to be up to the order of 50 and 45 mm, respectively.

Embankment and platform width should be overbuilt to allow for the anticipated foundation and embankment compression settlements. Based on the above settlement estimates, the extent of overbuilding within high fill sections is summarized as follows:

- Ramp N-E/W: 150 mm (height); 300 (platform width on both sides)
- Ramp E-S: 170 mm (height); 340 (platform width on both sides)
- Ramp W-N: 100 mm (height); 200 (platform width on both sides)
- Line 5 West Approach: 170 mm (height); 340 (platform width on both sides)
- Line 5 East Approach: 120 mm (height); 240 (platform width on both sides)
- 6 m high fills: 100 mm (height); 200 (platform width on both sides)

Instrumentation and monitoring should be carried out at the embankments during and after the preload waiting period to confirm that settlements have stabilized prior to paving. Appendix H presents the instrumentation and monitoring specifications for the high fill sections.

9.2 Stability Analysis

Based on the design high fill configuration/profiles for the ramps and roadways provided by URS, limit equilibrium stability analyses were carried out using the commercially available slope stability program GEO-SLOPE, employing the Morgenstern-Price method.

The computed factors of safety for the high fill areas are as shown in Table 9.2. Slope stability computation outputs are included in Figures I1 to I10 of Appendix.

Table 9.2 – Estimated Factors of Safety

High Fill	Maximum Embankment Height (m)	Case	Estimated Factors of Safety		Figure
			Gran. A or B Type II	SSM	
			$\Phi' = 35^\circ$	$\Phi' = 30^\circ$	
Ramp E-S	10.0	Drained	1.82	1.67	I1, I2
		Undrained	1.80	1.79	I3, I4
Ramp N-EW	9.0	Drained	1.82	1.48	I5, I6
		Undrained	1.75	1.74	I7, I8
Ramp W-N & Line 5	6.0	Drained	1.58	1.41	I9, I10
		Undrained	> 2	> 2	I11, I12

As per typical MTO requirements, a Factor of Safety (F.S.) of 1.3 is acceptable for short term (undrained) conditions. A F.S. of 1.5 is acceptable for long term (drained) conditions after excess pore pressures generated in the foundation soil caused by fill placement have dissipated. The results indicate that these acceptance criteria are generally satisfied for the cases analysed.

9.3 Embankment Design and Construction (High Fills and Low Fills)

9.3.1 Subgrade preparation

The fills and approach embankments for this project will be constructed largely on farm fields and riverbeds (North Schomberg River to be realigned). The boreholes indicate the presence of up to 800 mm of topsoil which is underlain by an extensive deposit of silty clay. The upper 600 mm of silty clay below the topsoil has higher moisture content and is moisture sensitive. After stripping topsoil, this upper portion of the clay may become severely disturbed when subjected to construction traffic, resulting in trafficability problems during subgrade preparation. Remedial measures may include sub-excavation of the wet/soft subgrade clay and replacement with suitable compacted granular fill. Site and subgrade drainage will also be critical to maintaining good trafficability of the subgrade for construction equipment. The contractor must be advised of these issues in the tender documents so that he may adjust his operations to suit the difficult subgrade conditions. Suggesting wording for an NSSP to this effect is included in Appendix H.

9.3.2 Embankment Construction

It is recommended that MTO approved SSM or granular materials satisfying OPSS.PROV 1010 requirements be used for constructing both the high fills and low fills. Based on the above analyses, the high fills constructed using these materials will be stable at a slope inclination not steeper than 2H : 1V with a mid-height berm of at least 2 m in width where the total fill height is 8 m or higher. Embankments less than 4.5 m in height will be stable at a slope inclination not steeper than 2H : 1V.

The topsoil must be stripped from the subgrade prior to placing fill.

All embankment fill must be constructed with adequate quality control in accordance with OPSS 206 and 501 requirements. Earth borrow in compliance with OPSS.PROV 212 may be used although it should be noted that cohesive soils are expected to undergo larger post construction settlement than SSM or granular. Clayey materials are not recommended for embankment construction at this site due to potentially higher post construction settlement, difficulties in achieving the specified compaction and potential embankment stability issues.

It is also recommended that all permanent slope surfaces be vegetated and seeded in accordance with current MTO practice with reference to OPSS 804. Erosion and sedimentation control should also be implemented with reference to OPSS 805 where watercourses are in close proximity to the embankments. The erosion control measures must be implemented well before the onset of the first winter subsequent to fill construction. Otherwise, erosion and gullying may occur on the embankment slopes during the following spring when subjected to surface run-off from the road surface. A minimum 150 mm high asphalt barrier curb as per OPSD 601.010 should be provided along the slope crest on either side of the roadway to minimize un-controlled surface run-off downslope from the road surface. Consideration should also be given to using rock-lined ditches perpendicular to the slope crest at periodic intervals.

10 SUCKER CREEK CULVERT

This section provides foundation recommendations for the extension of the Sucker Creek culvert. All other culverts included in the foundation engineering scope of work are covered by a separate report.

10.1 Sucker Creek Culvert Under Highway 400 (North of Line 5)

Sucker Creek Culvert is located approximately 450 m north of the existing Line 5 bridge and carries a tributary of the North Schomberg River under Highway 400.

The existing Sucker Creek Culvert is a cast-in-place concrete arch culvert of about 50 m in length with a span of 7.32 m and a rise of 3.66 m.

Based on a GA drawing dated November 2014 provided by URS, the proposed extensions will also be cast-in-place concrete arch segments that closely match the geometry of the existing culvert. The extensions will be approximately 27 m long on the west side and approximately 31 m long on the east side. Placement of new fill in the order of 4 to 5 m high will be required adjacent to the culvert extensions to widen the Highway 400 platform for accommodating the new Ramps N-EW and E-N.

The widening portions are those related to the new ramps merging with the existing highway platform. These are typically low fill sections where settlements are anticipated to be completed by the end of fill placement. In the vicinity of the Sucker Creek culvert extensions where fills are in the order of 4.5 m high, it is recommended that the new fill be placed up to 3 months in advance (Section 10.6 below) to allow much of the settlement to occur prior to paving. Even without preloading, differential settlement at the interface between existing and new fills would be negligible as the fill height tapers away from the highway. Minor pavement distress can be remediated by repaving as part of this interchange reconstruction project.

10.2 Foundation Alternatives

For the Sucker Creek Culvert extension, it is understood that consideration is being given to matching the existing cast-in-place concrete arch culvert for aesthetics and hydraulic amongst other reasons. This report focuses on providing foundation recommendations for this option. No other option has been developed.

10.3 Foundation design

The subsurface stratigraphy at the culvert extension footprints consists of topsoil overlying native firm to very stiff silty clay. The groundwater level generally ranges from 1.2 to 1.4m depths below ground surface (Elevations 221.3 to 221.0 m).

The GA drawing dated November 2014 indicated that the proposed invert levels at the east extension will vary from approximate Elevations 221.73 to 221.81 m (new inlet), whereas the proposed invert levels at the west extension will vary from approximate Elevations 221.61 to 221.55 m (new outlet). It is recommended that the strip footings for supporting the concrete arch extensions be founded at 1.5 m depth below the invert.

10.4 Concrete Frame (Open Footing) Culvert

Based on the borehole data and proposed invert elevations, the highest recommended founding levels for the strip footings are presented in Table 10.1.

Table 10.1 – Highest Recommended Founding Levels for Strip Footings

Culvert	Reference Borehole	Approx. depth below ground surface (m)	Elevation (m)	Founding Soil Type
Sucker Creek Culvert west extension	14-01	2.5	220.0	Stiff silty clay
	14-02	1.5	220.3	Stiff to firm silty clay
Sucker Creek Culvert east extension	14-03	1.0	220.8	Stiff to very stiff silty clay
	14-04	1.2	221.1	Firm to very stiff silty clay

The geotechnical resistances presented in Table 10.2 below are recommended for design of strip footings founded on the native strata recommended in Table 10.1. The footing widths shown in Table 10.2 are either provided by AECOM, typical widths for strip footings or assumed. The footing width must be designed based on loading requirements from the culvert structure and the overlying embankment fill. The geotechnical resistances will

need to be reviewed if the design footing width is different from what is shown in Table 10.2.

Table 10.2 – Geotechnical Resistances for Strip Footings

Culvert	Factored Geotechnical Resistance At ULS (kPa)	Geotechnical Resistance at SLS (kPa)	Footing Width (m)
Extension			
Sucker Creek west	160	120	2.5*
Sucker Creek east	225	150	2.5*

* From AECOM

The above values are for vertical, concentric loads only. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHDBC 2010 Clauses 6.7.3 and 6.7.4.

The geotechnical resistances at SLS were computed on the basis of limiting the settlement of an individual culvert footing to 25 mm under the applied load. At some locations, the actual settlements of the culverts will be governed by compression of the foundation soils under the weight of the surrounding new embankment fills. Comments related to settlements are presented in Section 10.6 below.

The sliding resistance of concrete placed on the silty clay and native sand/sand and gravel may be computed on the basis of an ultimate coefficient of friction of 0.35 and 0.4, respectively. These are “ultimate” values and require a degree of sliding movement to occur to fully mobilize the resistance.

Following excavation to the design founding levels, any topsoil, alluvial deposits or soft/loose soils at the bearing surfaces should be sub-excavated and replaced with compacted Granular A or Granular B Type II material in accordance with OPSS 501 and OPSS 902. A 100 mm thick concrete mud slab should be placed over the approved founding surface within 24 hours of excavation, inspection and approval to protect the surface from disturbance during construction.

The Contractor’s QVE must verify that the bearing surfaces for the foundations have been prepared on undisturbed, native soil and are free of topsoil, fill or other deleterious materials.

10.5 Cast-in-place and Precast Culvert Options

The foundation recommendations provided in the preceeding sections for the various culvert types apply to both cast-in-place and precast culvert options.

The designers may select cast-in-place or precast culverts on the basis of a number of considerations, including the required extent of excavation, site disturbance, duration of construction, structural performance and cost effectiveness. As discussed previously and from a foundation engineering perspective, precast units are preferred over cast-in-place units since the former can be installed expeditiously and with minimal disturbance to the founding subgrade, thus reducing the risk of having to sub-excavate and replace disturbed subgrade soils. Concerns regarding joint leakage associated with precast units are acknowledged. It is recommended that the relative cost effectiveness between the two options be evaluated.

10.6 Culvert Settlement

Settlement analysis involved computation of the immediate and re-compression (elastic) settlement of the foundation soils under the imposed embankment loading, and estimation of long-term consolidation settlement using Terzaghi's one-dimensional consolidation theory.

The estimated subgrade settlements due to the embankment loads are presented in Table 10.3.

Table 10.3 – Culvert Foundation Settlements

Culvert	Maximum Embankment Height (m)	Elastic Foundation Settlement (mm)	Consolidation Settlement (mm)
Sucker Creek Extensions	4.5	<10	30

Where practical, consideration should be given to preloading at the above locations as a feasible means to mitigate post construction ground settlement.

Consideration may be given to placing the new ramp fill for widening the Highway 400 platform at the Sucker Creek Culvert to the design height about 3 months prior to constructing the culvert extensions. Excavation of some of the fill will be required. This option requires temporary creek diversion. The extensions constructed under such conditions will be subject to not more than 25 mm of post-construction settlement.

If preloading is not carried out prior to construction of the extensions, an estimated settlement up to the order of 40 mm will need to be incorporated in the structural design.

Should a proprietary product be selected for the arch culvert extensions, the proprietary manufacturer/supplier will need to be consulted to determine if their product can sustain the estimated maximum magnitude of settlement.

10.7 Embankment Stability

At the Sucker Creek Culvert extensions, the adjacent fill slopes at a proposed 3H : 1V inclination will be stable.

10.8 Frost Depth

A frost protection soil cover of 1.4 m, or equivalent thickness of insulation, should be used to provide protection against frost action on the culvert base and foundations.

11 CULVERT BACKFILL AND LATERAL EARTH PRESSURES

It is recommended that backfill to the culvert, wing walls and retaining walls consists of free-draining, non-frost susceptible granular materials such as Granular A or Granular B Type II conforming to the requirements of OPSS 1010. Reference should be made to the backfill arrangements stipulated in OPSD 803.01 as appropriate.

All fills must be placed in regular lifts and be compacted in accordance with OPSS 501. The backfill must be placed and compacted in simultaneous lifts on both sides of a culvert, and the top of backfill elevation should be the same on both sides of the culvert at all times. Heavy compaction equipment must not be used adjacent to the walls and roofs of the culverts.

Earth pressures acting on the culvert walls may be assumed to impose a triangular distribution. For a fully drained backfill, the pressures should be computed in accordance with the CHBDC 2010 but are generally given by the expression:

$$p_h = K (\gamma h + q)$$

where	p_h	=	horizontal pressure on the wall at depth h (kPa)
	K	=	earth pressure coefficient (see table below)
	γ	=	bulk unit weight of retained soil (see table below)
	h	=	depth below top of fill where pressure is computed (m)
	q	=	value of any surcharge (kPa)

If full drainage is not achievable, the culvert walls must be designed to withstand full hydrostatic pressure assuming a water level at least equal to the design creek or stream water level. This is applicable when the water level behind the culvert wall is higher than the creek level.

Earth pressure coefficients for backfill to the retaining walls are dependent on the material used as backfill. Recommended unfactored values are shown in the following Table 11.1. Active pressures should be used for any wing wall or unrestrained wall.

For rigid structures such as concrete box culverts, it is recommended that at-rest horizontal earth pressures be used for design.

Table 11.1
Earth Pressure Coefficients (K)

Wall Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ; \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I (modified) $\phi = 32^\circ; \gamma = 21.2 \text{ kN/m}^3$		Embankment Fill $\phi = 30^\circ; \gamma = 20.0 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (Unrestrained Wall)	0.27	0.40	0.31	0.48	0.33	0.54
At rest (Restrained Wall)	0.43	0.62	0.47	0.70	0.50	0.76
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	3.0	-

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I, or at a depth of 1.7 m for Granular A or Granular B Type II.

12 SCOUR PROTECTION AND EROSION CONTROL

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

Typically, rock protection should be provided over all surfaces with which creek water is likely to be in contact. Treatment at the outlets should be in accordance with OPSD 810.010. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS 804.

It is recommended that a clay seal or a concrete cut-off wall be used to minimize the potential for piping around the culvert. The clay seal must extend to the order of 0.3 m above the high water

level and laterally for the width of the granular material, and have a minimum thickness of 0.5 m. The material requirements should be in accordance with OPSS 1205. A geo-synthetic clay liner may be used as a clay seal.

13 ROADWAY PROTECTION

Roadway protection may be required during construction of the culverts and bridge. An item titled “Protection System” as per OPSS 539 should be included in the contract documents. It is recommended that Performance Level 2 as per Clause 539.04.01.01 and the alignment of the shoring be specified on the contract drawings.

The design of roadway protection should be the responsibility of the Contractor. However, one option that is considered to be suitable for use as temporary shoring at this site is a soldier pile and lagging wall. It is anticipated that the soldier piles will need to be extended into the stiff to very stiff silty clay below the excavations in order to develop the required toe resistance. It is anticipated that the shoring system may be stiffened by cross bracings, where applicable.

A temporary soldier pile and lagging wall may be designed using the parameters given below:

γ	=	20 kN/m ³
γ_w	=	10 kN/m ³
K_a	=	0.33 (approach fills)
	=	0.33 (silty clay)
K_p	=	3.0 (approach fills)
	=	3.0 (silty clay)

The designer of the roadway protection system should check whether the depth of pile is sufficient to provide base fixity.

The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system. All shoring systems should be designed by a Professional Engineer experienced in such designs.

14 EXCAVATION AND BACKFILL

Temporary excavations will be required at this site. All temporary excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purpose of OHSA, the native silty clay, sands/silts and existing fills at the site may be classified as Type 3 soils. Exposed sands and silts below the groundwater level are classified as Type 4 soils.

All excavations must be carried out in a manner that avoids undermining or destabilising the existing structures and road embankments.

Excavation and backfilling for foundation construction should be carried out with reference to the requirements in OPSS 902. Backfill to the abutments should consist of Granular A or Granular B Type II materials meeting the gradation and relevant requirements stipulated in OPSS 1010. Compaction procedures and equipment to be used adjacent to the existing structures must be in accordance with the relevant OPSS 501 requirements.

15 GROUNDWATER AND SURFACE WATER CONTROL

The water table is high (near ground surface) at this site. However, the foundation soils are predominantly silty clay which is relatively impermeable. It is anticipated that the amount of perched water within existing fills would be limited. Groundwater from water-bearing interlayers within the silty clay should also be minimal. However, groundwater flow from surficial sand and silt layers should be expected. For temporary excavations for bridge construction, groundwater control will likely be limited to diverting surface runoff and preventing precipitation from entering the excavations supplemented by sump pumping. Filtered sumps must be designed properly so that construction drainage water containing eroded soil and fines do not flow onto existing roadways and watercourses.

At the culvert extension locations, the groundwater level is expected to be largely governed by the water level in the creek or stream. In order to facilitate the construction works, unwatering methods including, but not necessarily limited to, temporary diversion of surface water, sandbag and/or sheetpile cofferdams will be required. Diversion of surface water by means of piping and/or other means is anticipated at locations of higher flows such as at Sucker Creek. The Contractor must make provisions to control any water seepage, surface runoff and ponding by measures including the use of sump pumps to maintain dry excavations during the course of the extension works.

The design of any dewatering system that may be required is the responsibility of the Contractor and the Contract Documents must alert him to this responsibility and the need to engage a dewatering specialist.

16 SEISMIC CONSIDERATIONS

16.1 Seismic Design Parameters

The following seismic parameters should be used for design:

- Velocity Related Seismic Zone 0
- Zonal Velocity Ratio 0.05
- Acceleration Related Seismic Zone 1
- Zonal Acceleration Ratio 0.05

- Peak Horizontal Acceleration 0.167 g

The peak horizontal acceleration of 0.167 g is for a seismic event with 2% probability of exceedance in 50 years (2475-year return period) per NBCC 2010. The soil profile type for this site has been classified as Type I. Therefore, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient “S” (ground motion amplification factor) of 1.0 should be used in seismic design.

16.2 Liquefaction Potential

Based on the CHBDC, the foundation silty clay at this site is assessed to be not prone to liquefaction.

Embankments composed of compacted SSM or granular materials will be constructed above the groundwater level and are not considered to be prone to liquefaction.

16.3 Retaining Wall Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading.

For the design of retaining walls, the coefficients of horizontal earth pressure in Table 16.1 may be used.

Table 16.1 – Earth Pressure Coefficient (K) for Earthquake Loading

Condition	Earth Pressure Coefficient (K)	
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$	OPSS Granular B Type I or Existing fill $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$
Active (K_{AE})*	0.34	0.38
Passive (K_{PE})	3.4	3.0
At Rest (K_{OE})**	0.65	0.69

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.

** After Woods

17 EXISTING UTILITY SERVICES

It is recommended that the exact locations of any existing utilities be established by the designer, and compared with the extent of the potential work zones related to the construction of the proposed works. These utilities must not be adversely affected during construction of the works.

If necessary, relocation of, and/or special protective measures for affected utilities may be required.

18 CONSTRUCTION CONCERNS

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

Ramp and Line 5 Embankment Footprints

- The silty clay subgrade at this site is susceptible to softening due to ponding water and disturbance by construction and personnel traffic. Particular attention/measures will be required to minimize such traffic and provide a stable trafficable base for movement of heavy equipment.
- The extensive silty clay deposit at this site will undergo post construction consolidation settlements under the loading of new fills. The construction schedule and procedures shall be specifically adapted to comply with the recommendations in this report in order to limit post construction settlement.
- An instrumentation and monitoring program should be implemented for the preloading fills to confirm the rate and magnitude of settlement, and to establish when settlement has practically stabilized prior to other construction activities.

Deep Foundations

- Glacial till deposits inherently contain cobbles and boulders. Although there was little direct evidence of their presence during drilling, such obstructions may affect installation of driven piles for the Sideroad 5 bridge. The Contractor shall be prepared to remove, pre-auger and/or otherwise penetrate these obstructions and extend the piles to the design founding levels.
- The cohesionless sands and silts at depth would be susceptible to disturbance under conditions of unbalanced hydrostatic head. If caissons are employed, temporary liners will be required to support caisson sidewalls and provide seepage cut-off where required. A balancing head of water may be required in the caisson excavation to minimize the risk of base boiling.

Culverts

- Daily visual inspection of the pavement surface must be carried out in the vicinity of the culvert extensions below or adjacent to the travelled roadway. If cracks in the pavement or settlement is observed, the observations must immediately be brought to the attention of the C.A. to determine whether remedial action is required.

- Adequate dewatering of the temporary excavations to install the foundation for the new culverts; creek/stream diversion and/or cofferdam may be required.
- Removal of peat, organics, soft soils and alluvial deposits near creek and stream channels.
- Confirmation that the culvert backfills are adequately placed and compacted to specifications.

19 CLOSURE

Engineering analysis and preparation of the report were carried out by Ms. R. Palomeque Reyna, P.Eng and Dr. Sydney Pang, P.Eng.

The report was reviewed by Dr. P. K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

THURBER ENGINEERING LTD.



Rocio Palomeque Reyna, P.Eng.
Geotechnical Engineer



Sydney Pang, P.Eng.,
Associate, Senior Foundations Engineer



Report Reviewed by:
P. K. Chatterji, P.Eng.,
Review Principal, Designated MTO Contact

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.

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

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	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 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.

Appendix A

New Bridge at Sideroad 5, over the North Schomberg River

Boreholes 14-43 to 14-48

- Record of Borehole Sheets
- Laboratory Test Results
- Drawing titled “Borehole Locations and Soil Strata”

RECORD OF BOREHOLE No 14-43

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 303.9 E 294 163.6 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.07 - 2014.11.07 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT 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 (%)				GR	SA	SI	CL		
								20	40	60	80	100	W _P	W		W _L					
220.1	GROUND SURFACE																				
0.0	TOPSOIL: (25mm)																				
	Silty CLAY , trace sand, trace roots Firm to Soft Brown Moist		1	SS	6							○									
			2	SS	4							○									
	Grey Wet		3	SS	3							○					0	0	52	48	
217.9																					
2.2	Stiff		4	SS	12							○									
			5	SS	12							○									
216.0																					
4.1	Firm		6	SS	5							○									
214.4																					
5.6																					
			7	SS	10							○	—					0	0	61	39
212.9																					
7.2	Silty SAND , some clay, some gravel Compact Grey Moist		8	SS	29							○									
	Very Dense		9	SS	100/							○									
210.7																					
9.4	END OF BOREHOLE AT 9.4m. WATER LEVEL IN OPEN BOREHOLE AT 1.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH				0.250																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-43

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 303.9 E 294 163.6 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.07 - 2014.11.07 CHECKED BY RPR

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			20 40 60 80 100	20 40 60 80 100	W _p W W _L				
	Continued From Previous Page BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.													

RECORD OF BOREHOLE No 14-44

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 297.2 E 294 173.4 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.06 - 2014.11.06 CHECKED BY RPR

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 (%)				GR	SA	SI	CL	
								20	40	60	80	100	W _P	W	W _L						
220.5	GROUND SURFACE																				
0.0	Silty CLAY , trace sand, occasional roots and rootlets Firm Brown Moist		1	SS	6								○								
			2	SS	4								○								
	Brown to Grey																				
			3	SS	7								○								
	Trace sand Grey Wet		4	SS	4								○								
			5	SS	4								○								
216.4																					
4.1	Stiff																				
			6	SS	8								○								
214.8																					
5.7	Silty SAND , some clay, trace gravel Compact Grey Wet		7	SS	22								○								
	Very Dense		8	SS	62/ 0.225								○								
211.7																					
8.8	SAND and GRAVEL Very Dense Grey Wet		9	SS	100/ 0.050								○								

Continued Next Page

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

RECORD OF BOREHOLE No 14-44

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 297.2 E 294 173.4 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.06 - 2014.11.06 CHECKED BY RPR

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					WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					w _P w w _L				
	Continued From Previous Page							20	40	60	80	100					
210.3																	
10.2	Silty CLAY , some sand, trace gravel Hard Grey Moist (TILL)		10	SS	103/ 0.275		210								○		
							209										
208.3																	
12.2	SAND , trace silt, trace gravel Very Dense Grey Wet		11	SS	100/ 0.075		208								○		
							207										
206.6			12	SS	111/ 0.200										○		
13.9	END OF BOREHOLE AT 13.9m. WATER LEVEL IN OPEN BOREHOLE AT 1.3m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

RECORD OF BOREHOLE No 14-45

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 275.3 E 294 186.5 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.12.01 - 2014.12.01 CHECKED BY RPR

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								
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE					
221.8	GROUND SURFACE						20	40	60	80	100	20	40	60	kN/m ³	GR SA SI CL
0.0	TOPSOIL: (75mm)															
0.1	Silty CLAY , trace sand, trace gravel, occasional roots and organics Firm to Stiff Dark Brown to Brown Moist		1	SS	6								○			
			2	SS	13								○			
			3	SS	15								○			
			4	SS	12								○			
	Grey Moist		5	SS	9								○	—		0 0 47 53
			6	SS	6								○			
	Some sand Wet		7	SS	6								○	—		0 13 45 42
	Wet to Moist		8	SS	14								○			
213.0																
8.8	Sandy SILT , trace gravel Compact Grey Moist		9	SS	27								○			

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-45

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 275.3 E 294 186.5 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.12.01 - 2014.12.01 CHECKED BY RPR

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		
	Continued From Previous Page							20	40	60	80	100									
	Sandy SILT , trace gravel Very Dense Grey Moist Occasional cobble		10	SS	83		211						○								
210.0							210														
11.8	Silty CLAY , with sand, trace gravel Hard Grey Moist (TILL)		11	SS	100/ 0.250		209						○					7	27	45	21
							208						○								
			12	SS	103/ 0.250		207														
206.4			13	SS	113/ 0.200								○								
15.4	END OF BOREHOLE AT 15.4m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 0.7 221.1 Jan 06/ 15 0.9 220.9																				

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

RECORD OF BOREHOLE No 14-46

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 260.1 E 294 187.8 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.27 - 2014.11.27 CHECKED BY RPR

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					W P W W L				GR SA SI CL				
								20 40 60 80 100				20 40 60									
221.8	GROUND SURFACE							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)								
0.0								20	40	60	80	100									
0.1	TOPSOIL: (100mm)																				
	Silty CLAY , trace sand, occasional roots		1	SS	10		221								○						
	Very Stiff to Stiff																				
	Dark Brown to Brown																				
	Moist																				
	Trace gravel		2	SS	19										○						
			3	SS	9		220								○						
219.6																					
2.2	Firm		4	SS	7		219								○						
218.8																					
3.0	Grey Moist		5	SS	8		218								○						
			6	SS	12		217								○						
216.1																					
5.6	Firm		7	SS	5		216								○						
214.6																					
7.2			8	SS	8		214								○						
213.3																					
8.5	Silty CLAY , some sand, trace gravel																				
	Very Stiff																				
	Grey																				
	Moist																				
	(TILL)																				
			9	SS	23		213								○						
212.0																					
9.8	END OF BOREHOLE AT 9.8m.																				

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-46

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 260.1 E 294 187.8 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.27 - 2014.11.27 CHECKED BY RPR







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 (%)					
	Continued From Previous Page													
	WATER LEVEL IN OPEN BOREHOLE AT 2.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.													

RECORD OF BOREHOLE No 14-47

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 289.9 E 294 160.9 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.10 - 2014.11.10 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W _P	W	W _L		
218.9	GROUND SURFACE																
0.0	Silty CLAY , trace sand, occasional roots and rootlets Firm to Stiff Dark Brown Moist		1	SS	6		218										
			2	SS	4		217										
	Occasional wood fibres		3	SS	5		216										
	Grey		4	SS	10		215										
			5	SS	8		214										
							213										
							212										
							211										
213.2																	
5.7	Sandy SILT , some clay, occasional clay pockets Very Dense Grey Wet		7	SS	93		210										
							209										
	Moist		8	SS	98		208										
							207										
210.2																	
8.6	SAND and SILT , some clay, trace gravel Very Dense Grey Moist		9	SS	100/ 0.125		206										
							205										
208.9																	

Continued Next Page

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

RECORD OF BOREHOLE No 14-47

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 289.9 E 294 160.9 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.10 - 2014.11.10 CHECKED BY RPR

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 (%)							
							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT							
							W P W W L							
							20 40 60 80 100							
							20 40 60 80 100							
10.0	Continued From Previous Page													
	Sandy SILT , some clay, trace gravel Very Dense Grey Moist													
	Wet sand layer (125mm) at 10.9m		10	SS	127		208							
	Occasional sand layers		11	SS	118/ 0.200		207							
							206							
205.6														
13.3	Silty SAND , trace clay, trace gravel Very Dense Grey Moist		12	SS	100/ 0.125		205							
							204							
203.4			13	SS	103/ 0.225									
15.5	END OF BOREHOLE AT 15.5m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 0.9 218.0 Jan 06/ 15 0.5 218.4													

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

RECORD OF BOREHOLE No 14-48

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sideroad 5 Bridge N 4 881 268.4 E 294 180.1 ORIGINATED BY ES
 HWY Sideroad 5 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.28 - 2014.11.28 CHECKED BY RPR

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				W P W W L				GR	SA	SI	CL			
								○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × LAB VANE													
221.7	GROUND SURFACE							20	40	60	80	100										
0.0	TOPSOIL: (125mm)							20	40	60	80	100										
0.1	Silty CLAY , trace sand, occasional organics, occasional roots and rootlets Stiff Dark Brown to Brown Moist		1	SS	10																	
			2	SS	12																	
			3	SS	15																	
			4	SS	11																	
			5	SS	8																	
	Trace gravel																					

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

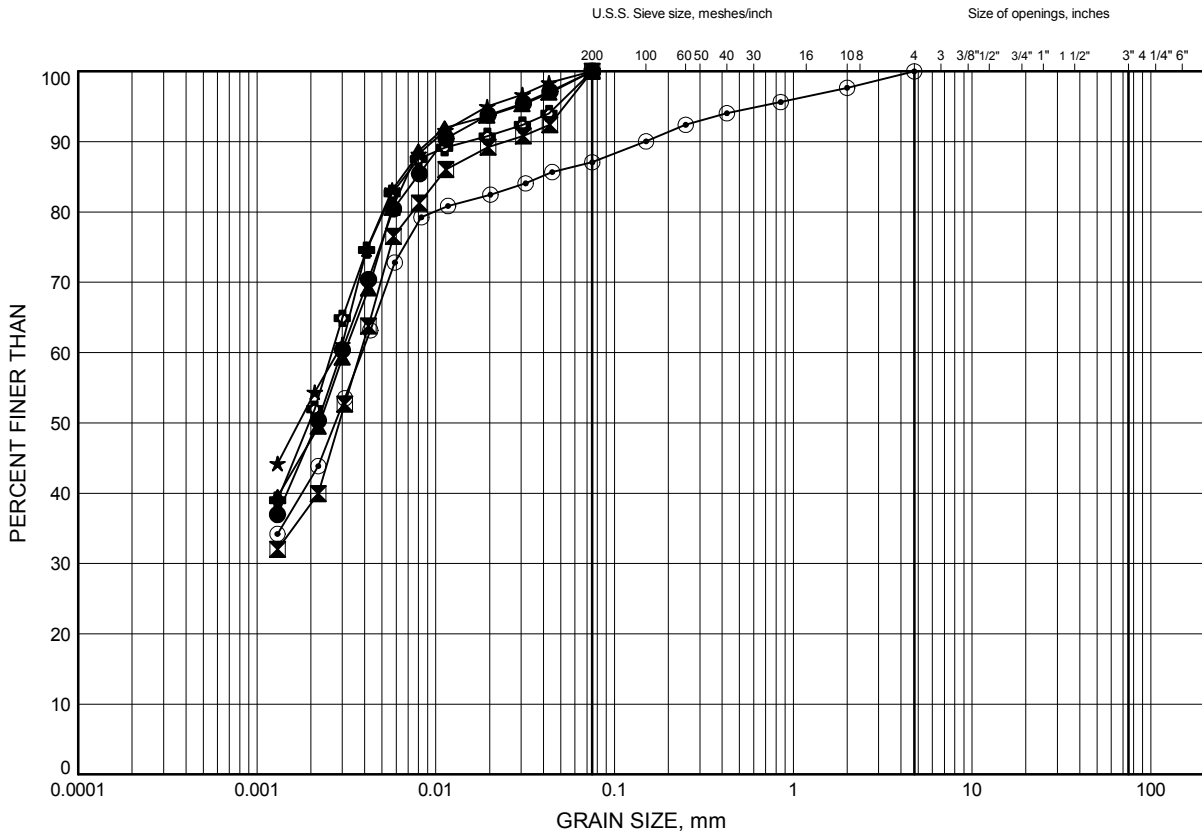
METRIC

+³, ×³: Numbers refer to Sensitivity

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE A1

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-43	1.83	218.25
⊠	14-43	6.40	213.68
▲	14-44	2.59	217.90
★	14-45	3.35	218.48
⊙	14-45	6.40	215.43
⊕	14-46	2.59	219.19

Date February 2015
W.P. P-13-03

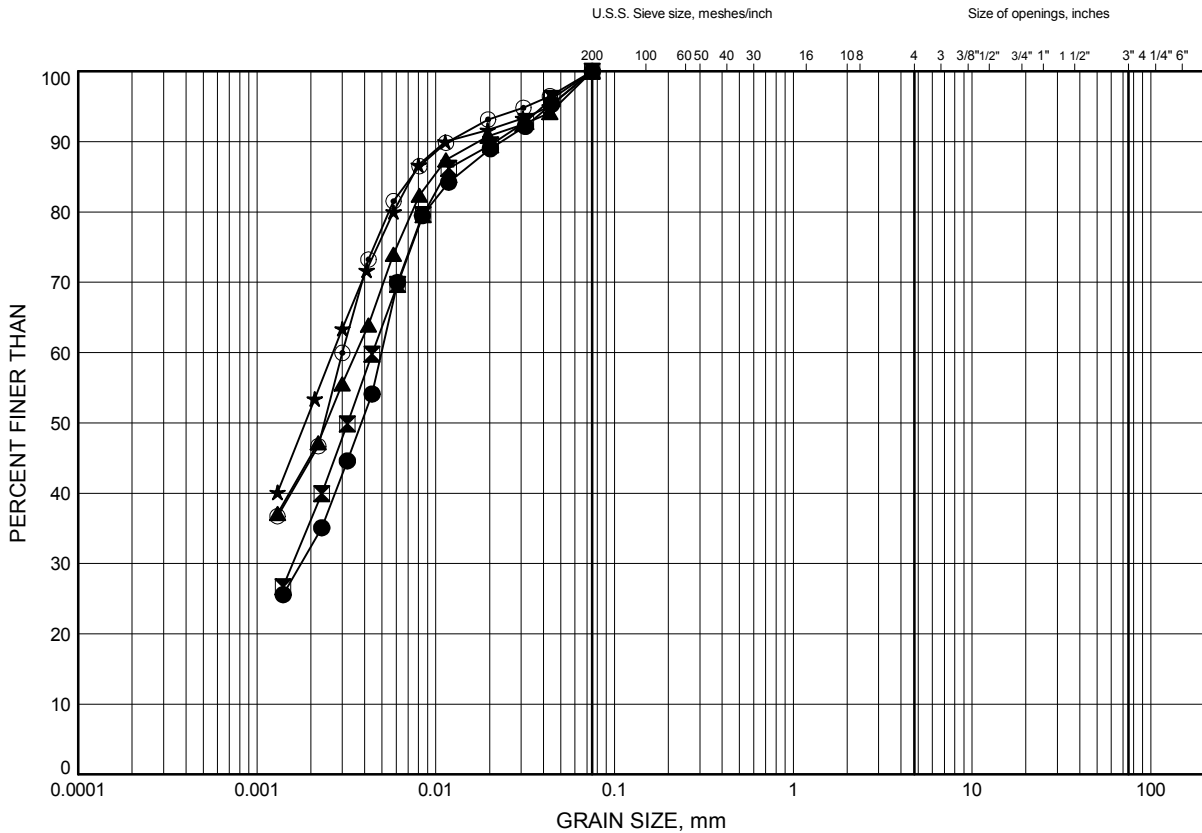


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE A2

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-46	4.88	216.90
⊠	14-46	7.92	213.85
▲	14-47	1.07	217.79
★	14-48	1.83	219.89
⊙	14-48	6.40	215.32

Date February 2015
W.P. P-13-03

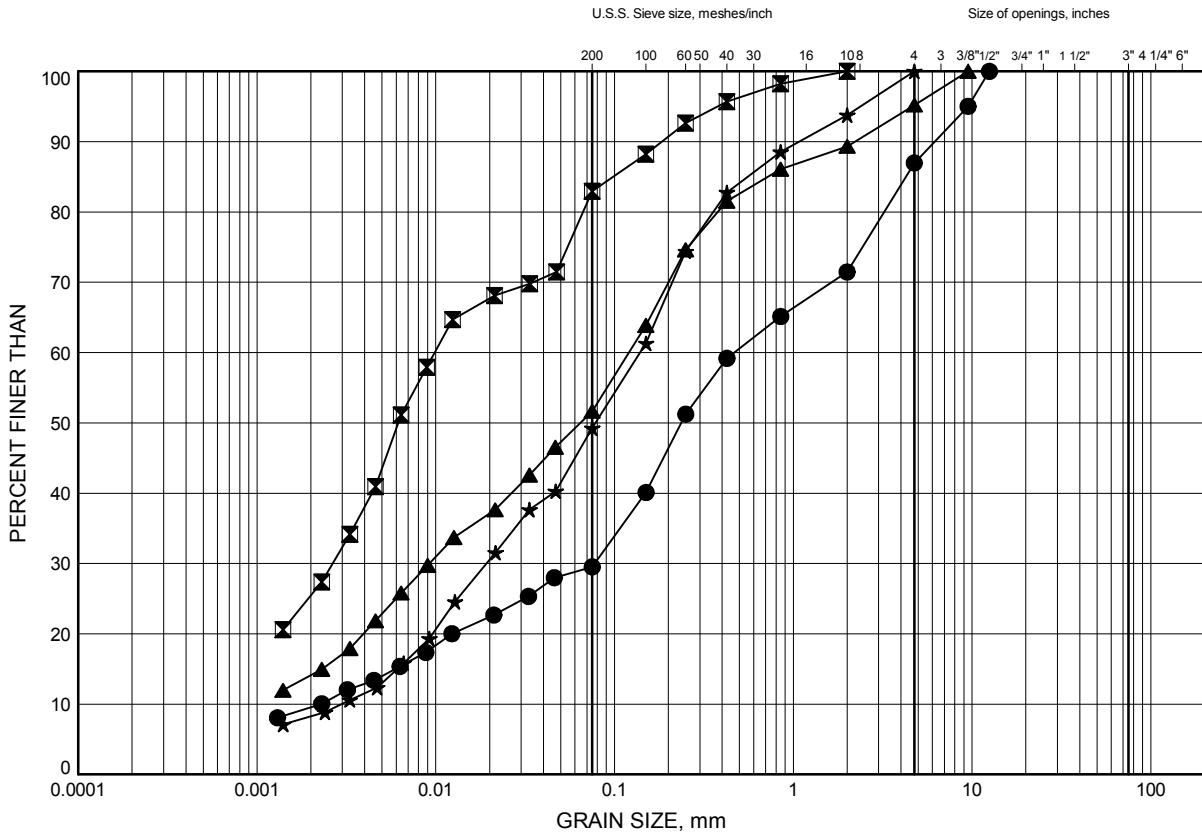


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE A3

SILTY SAND/SAND & SILT/SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-43	9.27	210.81
⊠	14-47	6.40	212.45
▲	14-47	9.45	209.40
★	14-48	10.97	210.75

Date February 2015
W.P. P-13-03

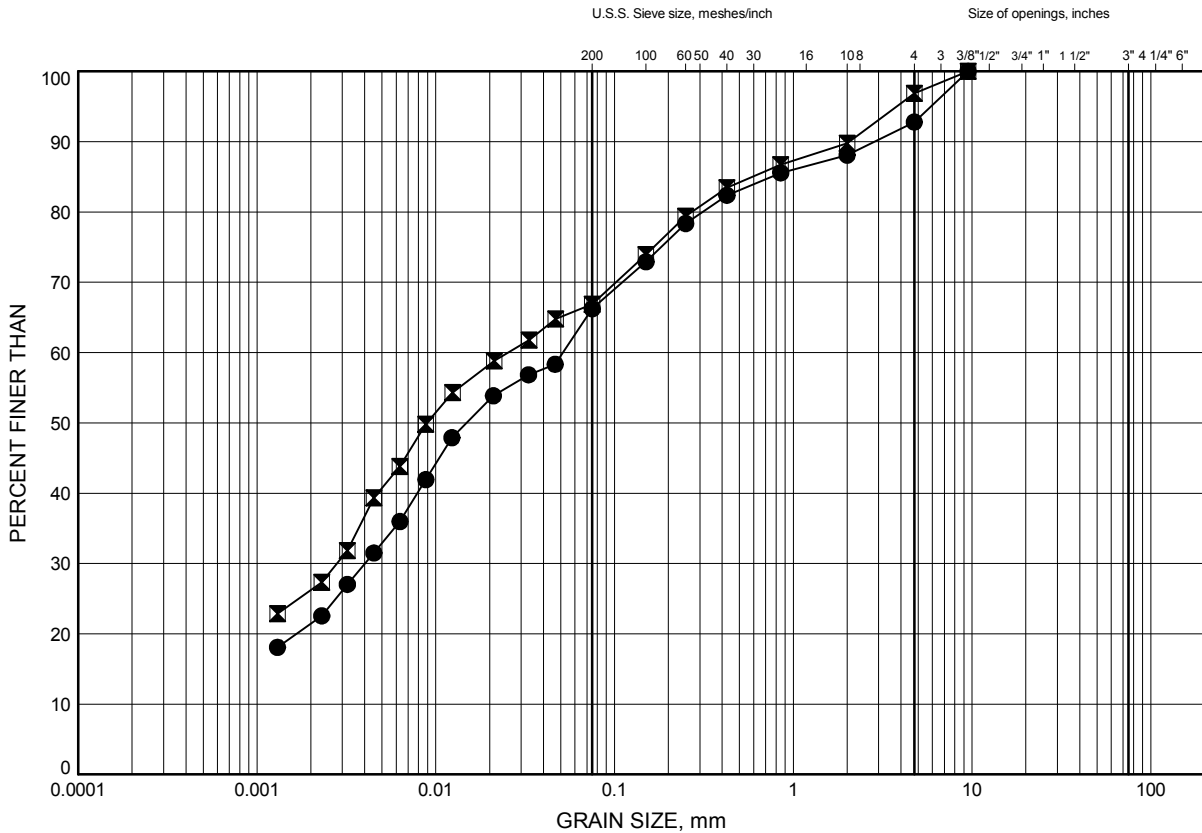


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE A4

SILTY CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-45	12.50	209.34
⊠	14-48	13.83	207.89

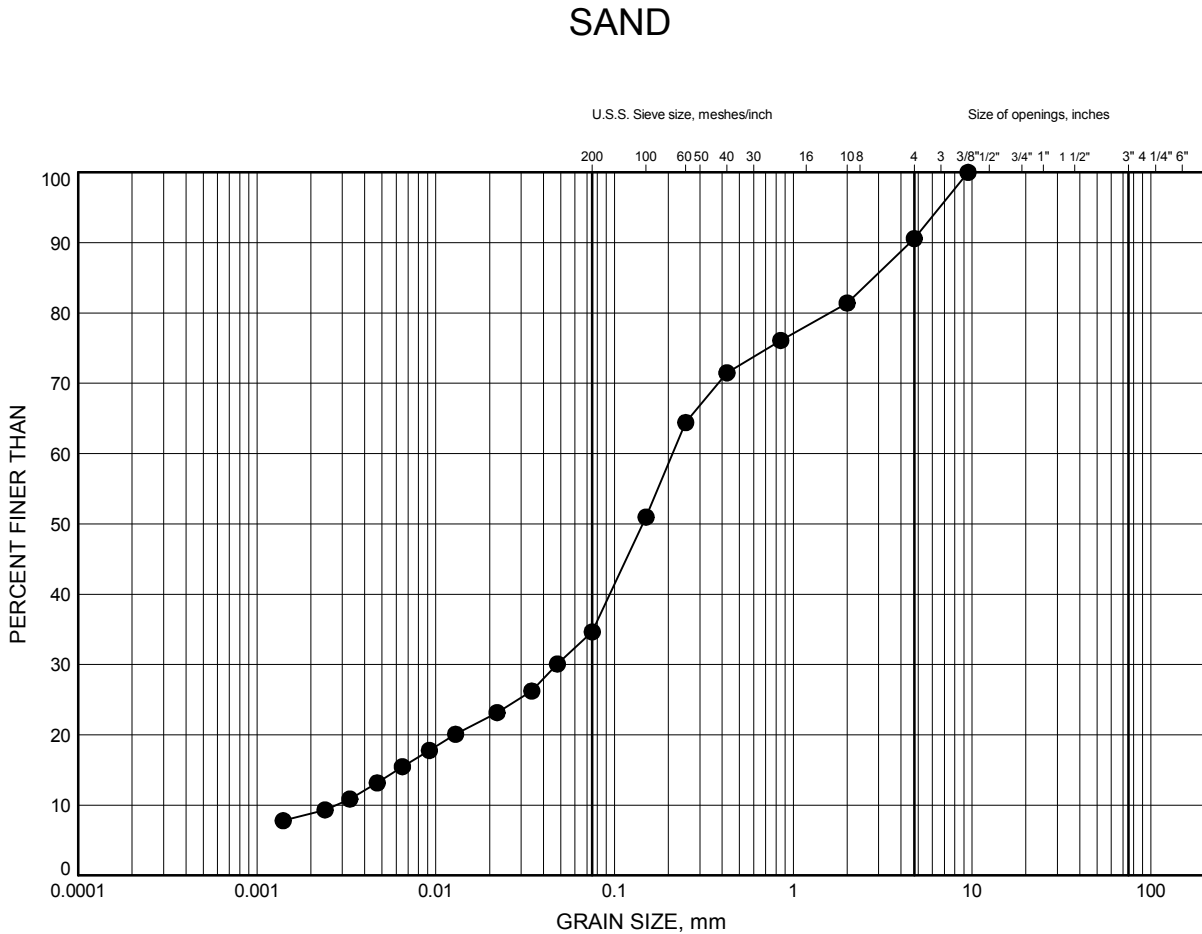
Date February 2015
W.P. P-13-03



Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE A5



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-47	14.02	204.83

Date February 2015
W.P. P-13-03

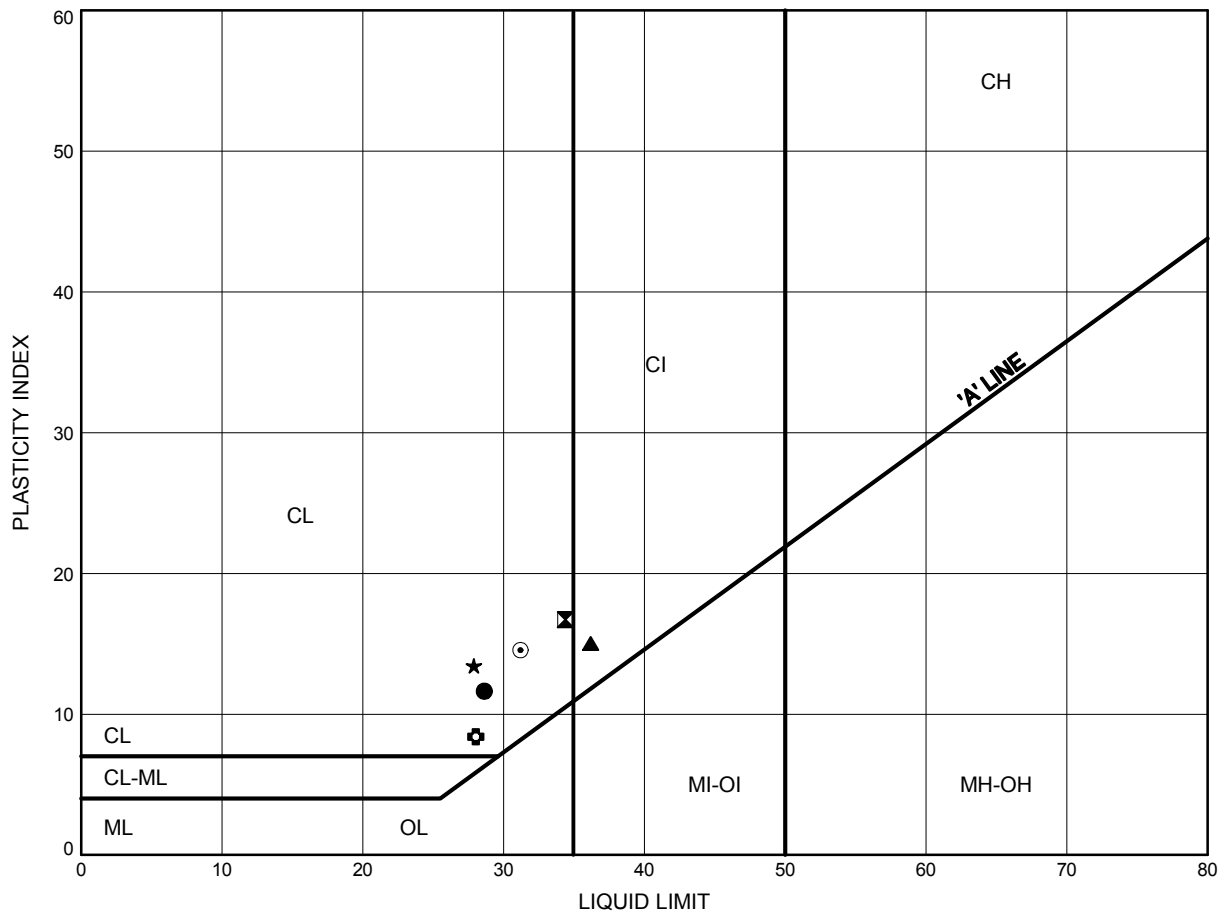


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE A6

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-43	6.40	213.68
⊠	14-44	2.59	217.90
▲	14-45	3.35	218.48
★	14-45	6.40	215.43
⊙	14-46	2.59	219.19
⊕	14-46	4.88	216.90

Date February 2015
 W.P. P-13-03

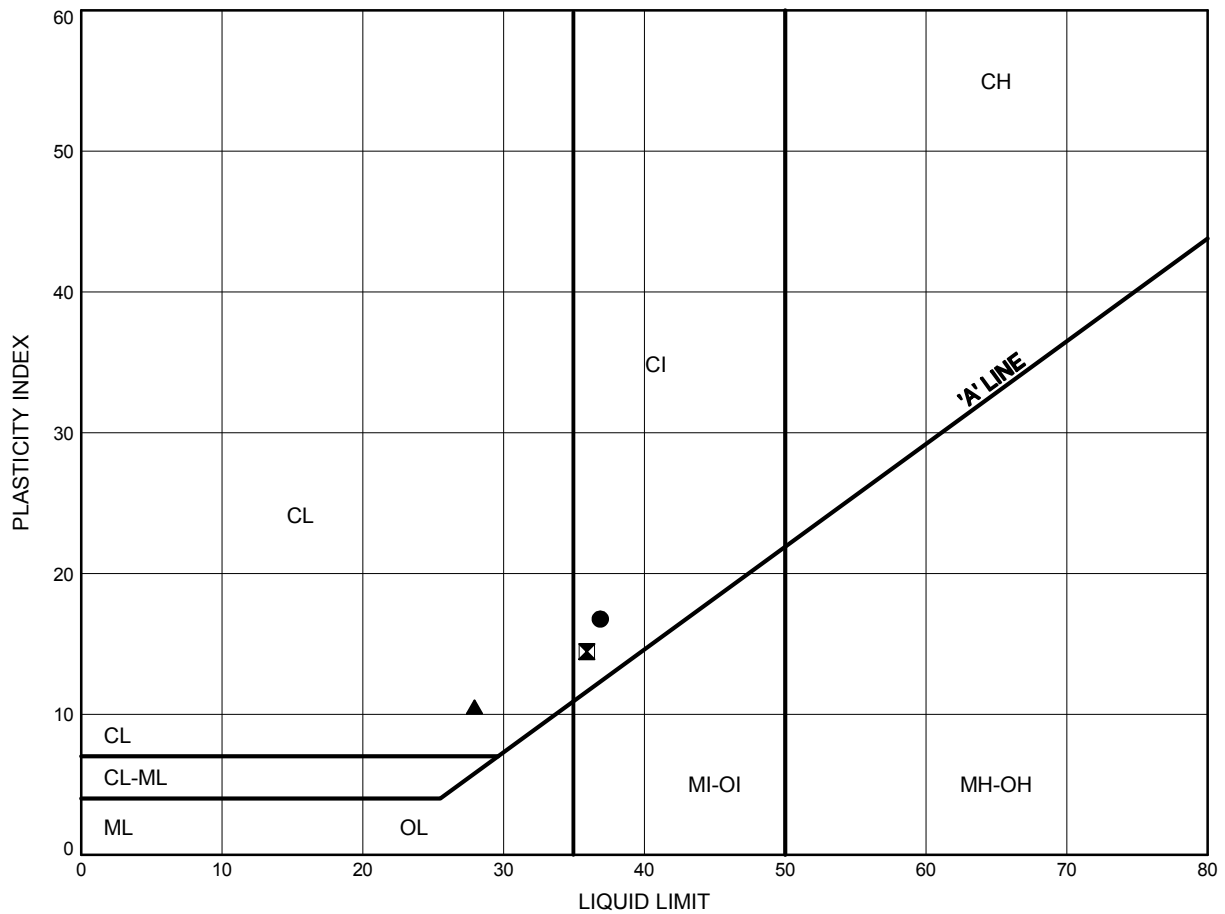


Prep'd AN
 Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE A7

SILTY CLAY



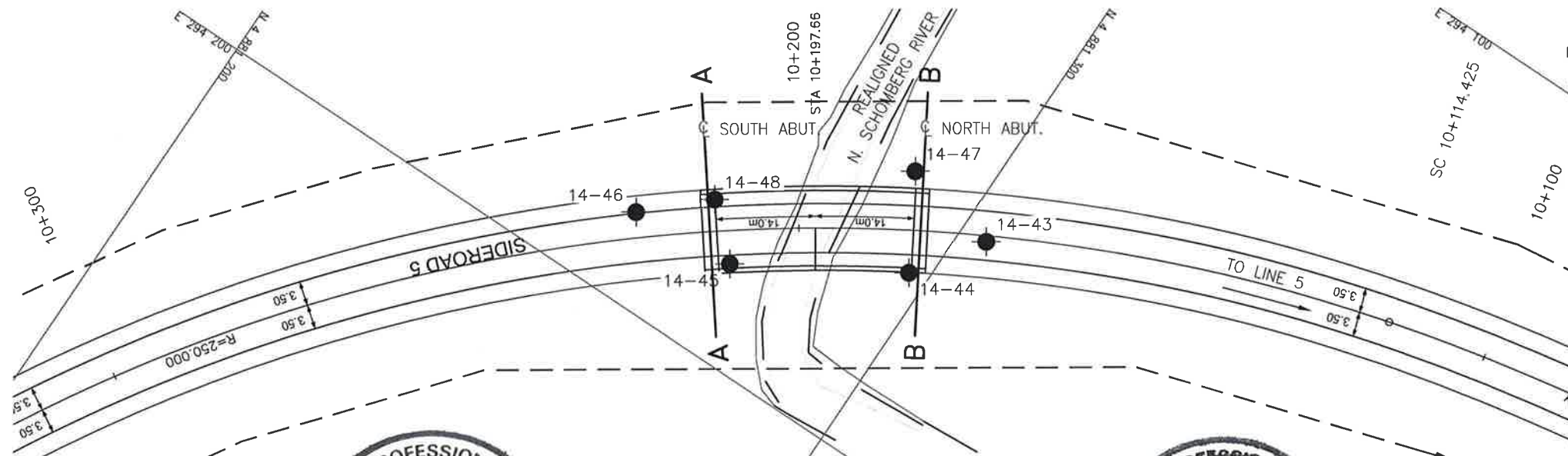
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-47	1.07	217.79
⊠	14-48	1.83	219.89
▲	14-48	6.40	215.32

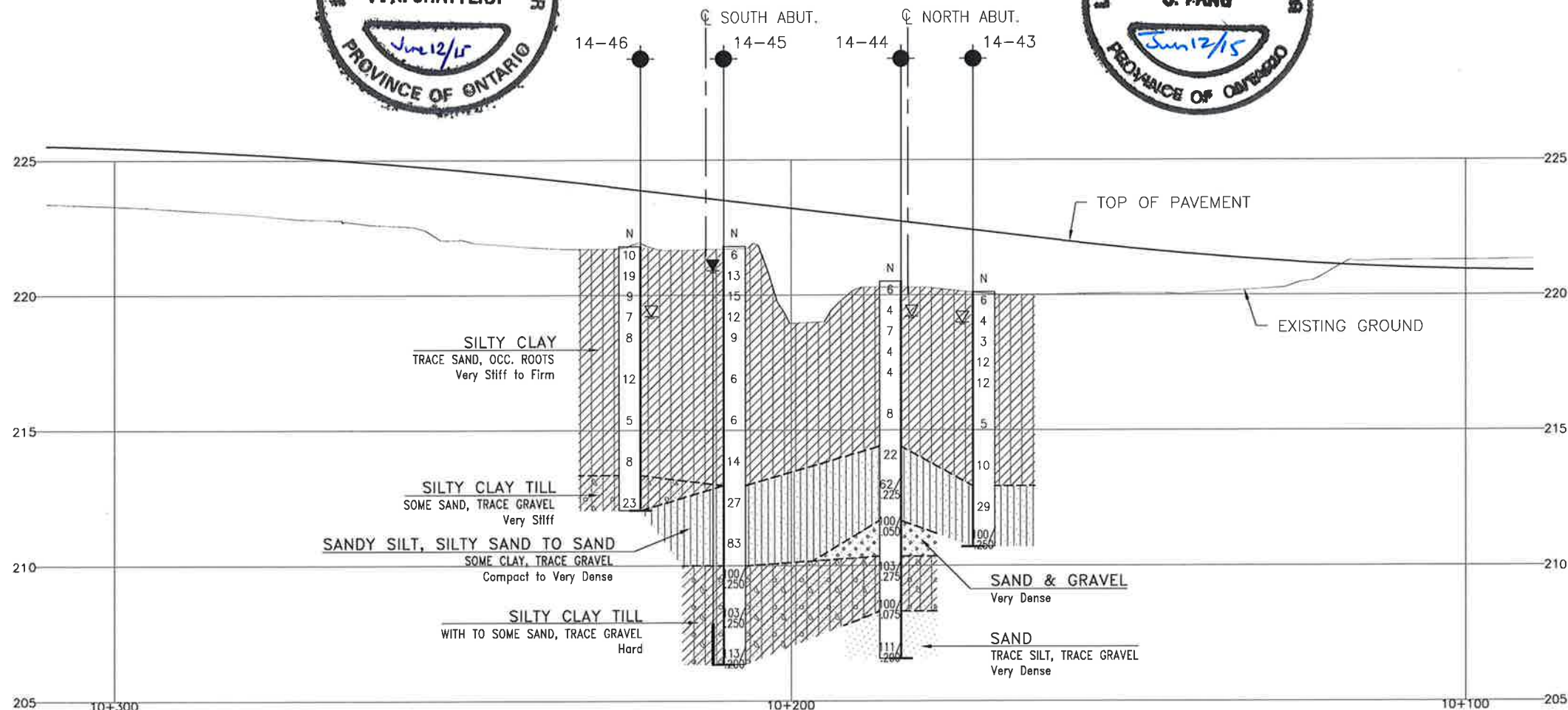
Date February 2015
W.P. P-13-03



Prep'd AN
Chkd. RPR



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



PROFILE ALONG C SIDEROAD 5



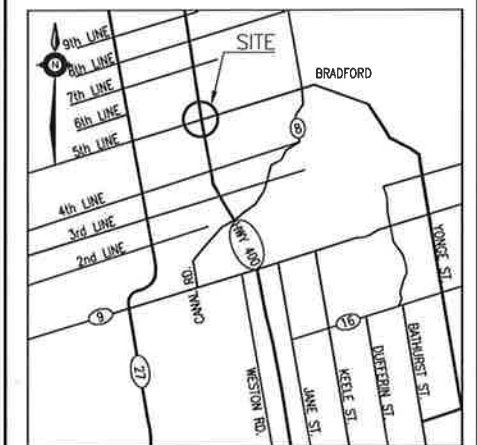
CONT No
WP No P13-03

HIGHWAY 400 & LINE 5
SIDEROAD 5
NEW BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

AECOM



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole
	Borehole and Cone
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
14-43	220.1	4 881 303.9	294 163.6
14-44	220.5	4 881 297.2	294 173.4
14-45	221.8	4 881 275.3	294 186.5
14-46	221.8	4 881 260.1	294 187.8
14-47	218.9	4 881 289.9	294 160.9
14-48	221.7	4 881 268.4	294 180.1

-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. 31D-605

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK PKC	CODE
DRAWN	AN	CHK RPR	SITE
			LOAD
			DATE JUN 2015
			STRUCT
			DWG 1A

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

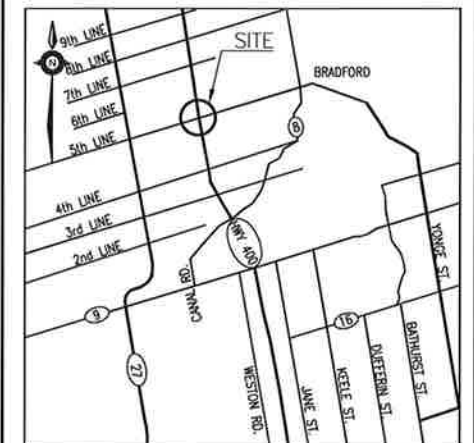
CONT No
WP No P13-03

HIGHWAY 400 & LINE 5
SIDEROAD 5
NEW BRIDGE
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET








THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

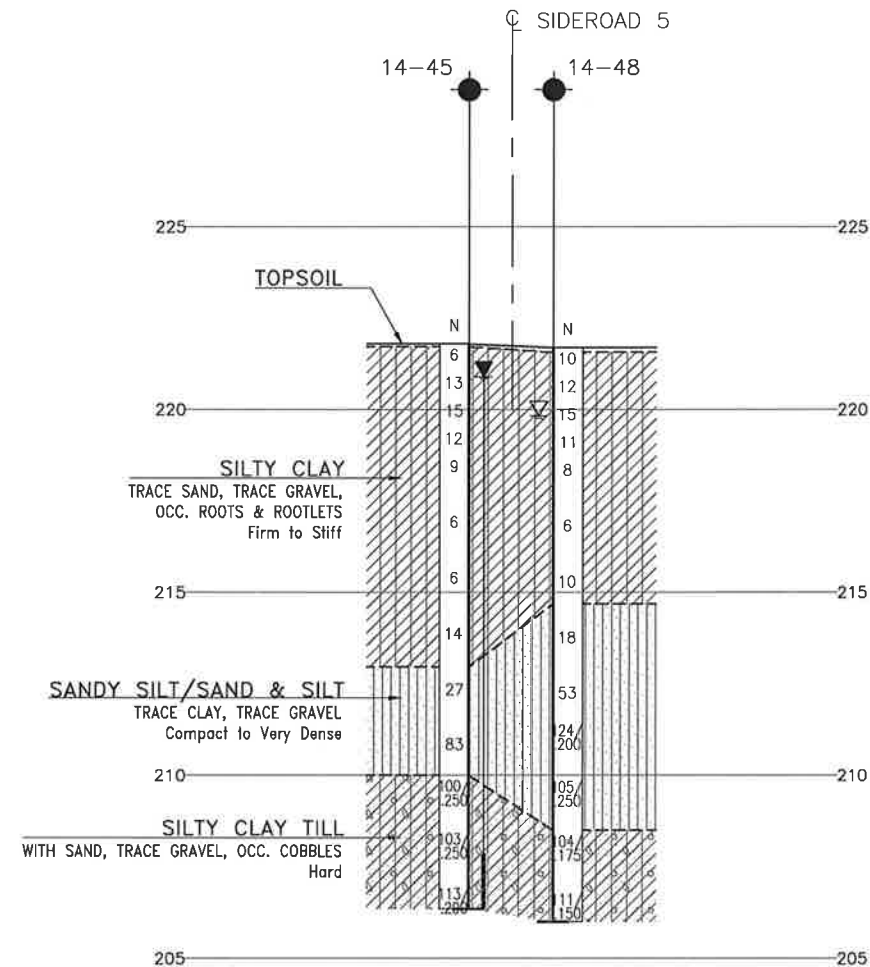
- | | |
|---|---------------------------------------|
|  | Borehole |
|  | Borehole and Cone |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| 90% | Rock Quality Designation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

NO	ELEVATION	NORTHING	EASTING
14-43	220.1	4 881 303.9	294 163.6
14-44	220.5	4 881 297.2	294 173.4
14-45	221.8	4 881 275.3	294 186.5
14-46	221.8	4 881 260.1	294 187.8
14-47	218.9	4 881 289.9	294 160.9
14-48	221.7	4 881 268.4	294 180.1

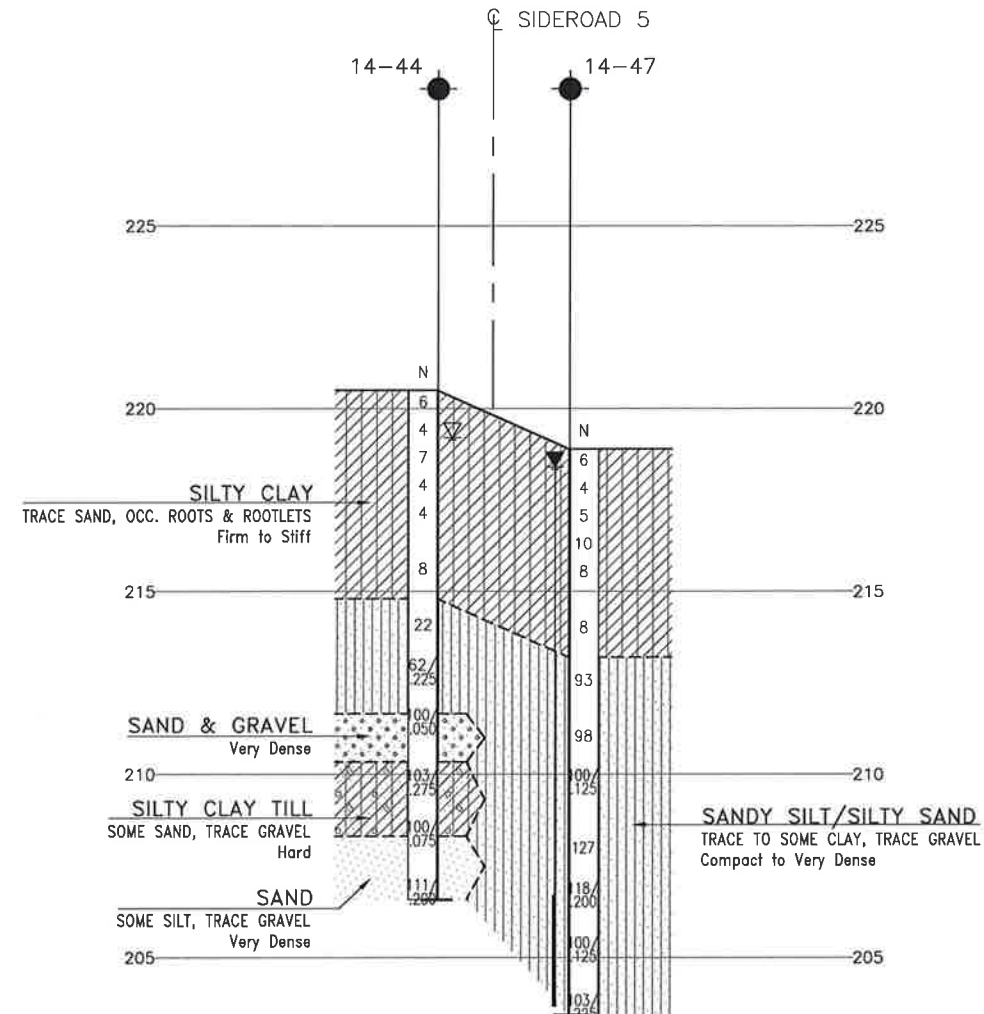
-NOTES-

- 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. 31D-605



SECTION ALONG A-A
(SOUTH ABUT.)



SECTION ALONG B-B
(NORTH ABUT.)

[illegible]

Appendix B

High Fill for Ramps N-EW, E-S and W-N and Line 5 (station 9+740)

Boreholes 14-01, 13-05 to 14-18, 14-23, 13-24, 13-25, 13-26, 14-31, 14-51, 14-52

- Record of Borehole Sheets
- Laboratory Test Results
- Drawing titled “Borehole Locations and Soil Strata”

RECORD OF BOREHOLE No 14-01

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 058.1 E 294 691.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.28 - 2014.10.28 CHECKED BY RPR

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 (%)				GR	SA	SI	CL		
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE													
222.5	GROUND SURFACE						20 40 60 80 100														
0.0	TOPSOIL , occasional roots and rootlets Loose Dark Brown Moist		1	SS	6																
221.7																					
0.8	Silty CLAY , trace sand, trace gravel, occasional rootlets Firm to Stiff Brown to Grey Moist		2	SS	6												0	9	61	30	
	Occasional sand seams		3	SS	7				2.6												
220.3																					
2.2	Stiff Grey		4	SS	13																
			5	SS	10				2.8												
			6	SS	9				2.3									0	7	47	46
			7	SS	9				2.2												
215.3																					
7.2	Firm		8	SS	9				2.4									0	6	55	39
			9	SS	8				2.2												
212.7																					
9.8	END OF BOREHOLE AT 9.8m.																				

Continued Next Page

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

RECORD OF BOREHOLE No 14-01

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 058.1 E 294 691.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.28 - 2014.10.28 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT 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					W _p	W	W _L		
							20	40	60	80	100						
	Continued From Previous Page																
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 07/ 14 1.4 221.1 Dec 08/ 14 1.2 221.3 Jan 06/ 15 1.4 221.1 NOTE: Field vane shear values were measured in a separate hole located adjacent to the original sampled borehole.																

RECORD OF BOREHOLE No 14-05

1 OF 2

METRIC

W.P. P-13-03 LOCATION Ramp N-EW N 4 882 039.1 E 294 709.1 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN
 DATUM Geodetic DATE 2014.12.08 - 2014.12.08 CHECKED BY RPR

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									
222.2	GROUND SURFACE							20	40	60	80	100	PLASTIC LIMIT w _P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L		
0.0	Silty CLAY , trace sand, trace gravel, occasional organics, occasional roots Firm Dark Brown to Brown Moist		1	SS	6	▽	222							○			
			2	SS	7		221								○		0 5 54 41
			3	SS	5										○		
220.1							220							○			
2.1	Gravelly SAND													○			
219.7	Loose Brown		4	SS	5		219							○			
2.5	Wet													○			
	Silty CLAY , trace to some sand, trace gravel, occasional black sand layer Firm to Very Stiff Grey Moist		5	SS	17		218							○			
														○		0 0 56 44	
			6	SS	7		217										
							216							○			
							215										
							214							○			
							213										
			7	SS	12									○			
			8	SS	10									○			
			9	SS	10											0 10 43 47	
212.4																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-05

2 OF 2

METRIC

W.P. P-13-03 LOCATION Ramp N-EW N 4 882 039.1 E 294 709.1 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN
 DATUM Geodetic DATE 2014.12.08 - 2014.12.08 CHECKED BY RPR

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									
	Continued From Previous Page																
	WATER LEVEL AT 1.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

RECORD OF BOREHOLE No 14-06

2 OF 2

METRIC

W.P. P-13-03 LOCATION Ramp N-EW N 4 881 939.3 E 294 702.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN
 DATUM Geodetic DATE 2014.12.05 - 2014.12.05 CHECKED BY RPR

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			20	40	60	80	100					
	Continued From Previous Page Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 1.0 221.7 Jan 06/ 15 1.0 221.7																

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

RECORD OF BOREHOLE No 14-08

1 OF 2

METRIC

W.P. P-13-03 LOCATION Ramp N-EW N 4 881 803.1 E 294 648.2 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.27 - 2014.10.27 CHECKED BY RPR

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						
								20 40 60 80 100						
								20 40 60 80 100						
221.5	GROUND SURFACE													
0.0	TOPSOIL: (175mm)													
0.2	Silty CLAY , trace sand, occasional organics, occasional rootlets Stiff Brown Moist		1	SS	8		221							
			2	SS	9		220							0 8 50 42
			3	SS	9									
219.4														
2.0	SAND , trace silt, trace gravel Loose Grey Wet						219							
2.5	Silty CLAY , trace sand Stiff Grey Moist		4	SS	10									
	Wet		5	SS	12		218							0 6 49 45
							217							
			6	SS	11									
							216							
215.8														
5.6	Firm		7	SS	5		215							
							214							
			8	SS	6									
							213							
			9	SS	7		212						0 0 66 34	
211.7														
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-08

2 OF 2

METRIC

W.P. P-13-03 LOCATION Ramp N-EW N 4 881 803.1 E 294 648.2 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.27 - 2014.10.27 CHECKED BY RPR

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									
	Continued From Previous Page																
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 07/ 14 2.5 219.0 Dec 08/ 14 2.4 219.1 Jan 06/ 15 2.7 218.8																

RECORD OF BOREHOLE No 14-09

1 OF 3

METRIC

W.P. P-13-03 LOCATION Highfill/Ramp N-EW N 4 881 757.0 E 294 628.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2014.10.29 - 2014.10.29 CHECKED BY RPR

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									
221.8	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (175mm)							20	40	60	80	100					
0.2	Silty CLAY , trace to some sand, mixed with organics, occasional roots and rootlets Firm to Stiff Brown to Grey		1	SS	7	▽	221										
			2	SS	13		220										
	Occasional sand seams, occasional oxide staining		3	SS	9		219										
219.6							218										
2.2	Gravelly SAND Compact Brown Wet		4	SS	15		217										
219.1							216										
2.7	Silty CLAY , trace to some sand, trace gravel Stiff Grey Moist		5	SS	15		215										
			6	SS	14		214										
							213										
							212										
216.2																	
5.6	Firm Wet		7	SS	7												
			8	SS	7												
			9	SS	5												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

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			w _P	w	w _L			WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
	Continued From Previous Page							20 40 60 80 100							GR SA SI CL	
	Silty CLAY , trace sand Firm to Stiff Grey Wet							2.5 +								
			10	SS	7		211						I-I		0 0 54 46	
			11	SS	11		210	2.8 +					o			
							209									
208.5 13.3	Very Stiff															
			12	SS	17		208						I-o-I		0 0 51 49	
207.0 14.8							207									
			13	SS	9		206						o			
			14	SS	9		205						o			
204.4 17.4	End of sampling at 17.4m and start of DCPT						204									
							203									
							202									

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 14-09

3 OF 3

METRIC

W.P. P-13-03 LOCATION Highfill/Ramp N-EW N 4 881 757.0 E 294 628.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2014.10.29 - 2014.10.29 CHECKED BY RPR

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 (%)					
	Continued From Previous Page							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60					
199.6							201							
22.2	END OF BOREHOLE AT 22.2m UPON DCPT REFUSAL. WATER LEVEL AT 2.1m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.						200							

RECORD OF BOREHOLE No 14-10

1 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1H N 4 881 817.1 E 294 699.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN
 DATUM Geodetic DATE 2014.12.03 - 2014.12.03 CHECKED BY RPR

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							
221.4	GROUND SURFACE							<div><div>20406080100</div><div>○ UNCONFINED + FIELD VANE</div><div>● QUICK TRIAXIAL × LAB VANE</div></div>							
0.0	TOPSOIL , occasional roots and rootlets Compact Dark Brown Moist		1	SS	10		221								
220.7															
0.7	Silty CLAY , trace sand, trace gravel, occasional organics Firm Brown to Grey Moist		2	SS	7		220								
			3	SS	4										
219.0															
2.4	Gravelly SAND Compact Brown Wet		4	SS	20		219								
			5	SS	13		218								
217.3															
4.1	Silty CLAY , trace sand Firm Grey Wet		6	SS	8		217								
							216								
			7	SS	6		215								
							214								
			8	SS	4		213								
							212								
211.6			9	SS	4										
9.8	END OF BOREHOLE AT 9.8m.														

Continued Next Page

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

RECORD OF BOREHOLE No 14-10

2 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1H N 4 881 817.1 E 294 699.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN
 DATUM Geodetic DATE 2014.12.03 - 2014.12.03 CHECKED BY RPR







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									
	Continued From Previous Page																
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 1.4 220.0 Jan 06/ 15 2.1 219.3																

RECORD OF BOREHOLE No 14-11

1 OF 2

METRIC

W.P. P-13-03 LOCATION Ramp E-S N 4 881 784.6 E 294 730.4 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN
 DATUM Geodetic DATE 2014.12.02 - 2014.12.02 CHECKED BY RPR

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 (%)					
221.3	GROUND SURFACE					▽							GR SA SI CL		
0.0	TOPSOIL , clayey, occasional roots Loose Dark Brown Moist		1	SS	4		221								
220.6															
0.8	Silty CLAY , mixed with organics, some sand, trace gravel Firm Brown Moist Occasional roots and rootlets Dark Brown		2	SS	6		220								
			3	SS	4										
219.1															
2.2	Gravelly SAND Compact Grey Wet		4	SS	16		219								
218.6															
2.7	Silty CLAY , trace sand Firm to Stiff Grey Moist		5	SS	8		218								
217.2															
4.1	Very Stiff		6	SS	22	217									
							216						No sample recovery		
215.7															
5.6	Wet		7	SS	6	215									
							214								
			8	SS	6										
							213								
							212								
			9	SS	6										

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-11

2 OF 2

METRIC

W.P. P-13-03 LOCATION Ramp E-S N 4 881 784.6 E 294 730.4 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Wash Boring/Tripod COMPILED BY AN
 DATUM Geodetic DATE 2014.12.02 - 2014.12.02 CHECKED BY RPR

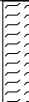

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
211.1																	
10.2	END OF BOREHOLE AT 10.2m. WATER LEVEL AT 1.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.																

RECORD OF BOREHOLE No 14-12

1 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1H/Ramp E-S N 4 881 789.8 E 294 692.0 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.04 - 2014.11.04 CHECKED BY RPR

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			20 40 60 80 100	W _P W W _L	SHEAR STRENGTH kPa					WATER CONTENT (%)			GR	SA	SI	CL	
										○ UNCONFINED + FIELD VANE												
										● QUICK TRIAXIAL × LAB VANE												
221.6	GROUND SURFACE																					
0.0	TOPSOIL , occasional roots and rootlets Loose Dark Brown Moist		1	SS	7		221															
220.9																						
0.7	Silty CLAY , trace sand, occasional rootlets Soft Brown Moist		2	SS	3		220															
220.2																						
1.4	Stiff to Very Stiff		3	SS	11		219															
	Grey Wet		4	SS	15		218															
			5	SS	12		217															
			6	SS	18		216															
			7	SS	10		215															
214.4																						
7.2	Soft to Firm																					
			8	SS	2	214																
			9	SS	6	213																

Continued Next Page

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

RECORD OF BOREHOLE No 14-12

2 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1H/Ramp E-S N 4 881 789.8 E 294 692.0 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.04 - 2014.11.04 CHECKED BY RPR

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				WATER CONTENT (%)					
								20 40 60 80 100				W P W W L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	Silty CLAY Firm Grey Wet						211		2.6 +						0 0 65 35		
			10	SS	5												
							210		2.3 +								
			11	SS	7		209										
208.3									2.5								
13.3	END OF BOREHOLE AT 13.3m. WATER LEVEL AT 1.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

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

RECORD OF BOREHOLE No 14-13

1 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1H N 4 881 762.5 E 294 697.8 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.27 - 2014.10.28 CHECKED BY RPR

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						
221.5	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL , occasional roots and rootlets Loose Dark Brown Moist		1	SS	5		221							
220.9														
0.7	SAND and SILT , some clay to clayey, pockets of clay Loose Brown Moist		2	SS	6		220							0 42 36 22
220.1														
1.4	SAND and GRAVEL Dense Brown Wet		3	SS	35		219							
219.0														
2.5	Silty CLAY , trace to some sand, trace gravel Stiff to Very Stiff Grey Moist		4	SS	9		218							0 15 50 35
			5	SS	22		217							
			6	SS	16		216							
215.9														
5.6	Firm to Soft Wet		7	SS	5		215							
							214							
			8	SS	3		213							0 0 46 54
							212							
211.8			9	SS	5									
9.8	END OF BOREHOLE AT 9.8m.													

Continued Next Page

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

RECORD OF BOREHOLE No 14-13

2 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1H N 4 881 762.5 E 294 697.8 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.27 - 2014.10.28 CHECKED BY RPR

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																									
	Continued From Previous Page																																
	<p>WATER LEVEL AT 1.7m UPON COMPLETION.</p> <p>Piezometers installation consists of two 19mm diameter Schedule 40 PVC pipes with a 1.52m and 3.05m slotted screen.</p> <p>NOTE: A separate hole was drilled for installing the shallow piezometer.</p> <p>WATER LEVEL READINGS (DEEP PIEZOMETER):</p> <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH (m)</th> <th>ELEV. (m)</th> </tr> </thead> <tbody> <tr> <td>Dec 08/ 14</td> <td>1.2</td> <td>220.3</td> </tr> <tr> <td>Jan 06/ 15</td> <td>1.4</td> <td>220.1</td> </tr> </tbody> </table> <p>WATER LEVEL READINGS (SHALLOW PIEZOMETER):</p> <table border="1"> <thead> <tr> <th>DATE</th> <th>DEPTH (m)</th> <th>ELEV. (m)</th> </tr> </thead> <tbody> <tr> <td>Dec 08/ 14</td> <td>1.2</td> <td>220.3</td> </tr> <tr> <td>Jan 06/ 15</td> <td>1.3</td> <td>220.2</td> </tr> </tbody> </table>	DATE	DEPTH (m)	ELEV. (m)	Dec 08/ 14	1.2	220.3	Jan 06/ 15	1.4	220.1	DATE	DEPTH (m)	ELEV. (m)	Dec 08/ 14	1.2	220.3	Jan 06/ 15	1.3	220.2														
DATE	DEPTH (m)	ELEV. (m)																															
Dec 08/ 14	1.2	220.3																															
Jan 06/ 15	1.4	220.1																															
DATE	DEPTH (m)	ELEV. (m)																															
Dec 08/ 14	1.2	220.3																															
Jan 06/ 15	1.3	220.2																															

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

RECORD OF BOREHOLE No 14-14

1 OF 3

METRIC

W.P. P-13-03 LOCATION Ramp E-S N 4 881 762.4 E 294 658.9 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2014.10.28 - 2014.10.29 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL LIMIT 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 (%)						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
								20 40 60 80 100	20 40 60							
222.1	GROUND SURFACE					▽	222							GR SA SI CL		
0.0	TOPSOIL: (100mm) Silty CLAY , trace to some sand, occasional organics, occasional roots and rootlets Firm to Soft Brown and Grey Moist		1	SS	6										0 8 63 29	
0.1			2	SS	9											
			3	SS	3											
	Trace gravel, occasional sand layer															
219.9							220									
2.2	Stiff to Very Stiff Grey		4	SS	14											
			5	SS	22											
							218									
			6	SS	15											
						217										
216.5							216									
5.6	Firm to Soft Wet		7	SS	4											
							215									
			8	SS	2											
							214									
							213									
			9	SS	3											

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-14

2 OF 3

METRIC

W.P. P-13-03 LOCATION Ramp E-S N 4 881 762.4 E 294 658.9 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2014.10.28 - 2014.10.29 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT 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					
	Continued From Previous Page						20 40 60 80 100	PLASTIC LIMIT W _P NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L					
	Silty CLAY , trace sand, trace gravel Firm Grey Wet						212	2.9					
			10	SS	5		211						
								2.5					
							210						
			11	SS	6								
							209	2.8					
							208						
			12	SS	5								
							207	2.5					
							206						
			13	SS	6								
							205	3.0					
205.2													
16.9	SILT , trace sand, trace clay Compact Grey Wet		14	SS	14		204						
203.8													
18.3	Silty CLAY , some sand Stiff Grey Wet		15	SS	14								
203.2													
18.9	End of sampling at 18.9m and start of DCPT						203						

Continued Next Page

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

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

RECORD OF BOREHOLE No 14-14

3 OF 3

METRIC

W.P. P-13-03 LOCATION Ramp E-S N 4 881 762.4 E 294 658.9 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Auger/Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2014.10.28 - 2014.10.29 CHECKED BY RPR

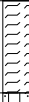

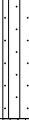


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
	Continued From Previous Page						202	20	40	60	80	100		
							201							
199.9							200							
22.2	END OF BOREHOLE AT 22.2m UPON DCPT REFUSAL. WATER LEVEL AT 2.5m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.													

RECORD OF BOREHOLE No 14-15

1 OF 3

METRIC

W.P. P-13-03 LOCATION Culvert 1E/Ramp E-S N 4 881 704.9 E 294 627.0 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.29 - 2014.10.30 CHECKED BY RPR

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 (%)				GR	SA	SI	CL		
								20 40 60 80 100				w _P w w _L									
								○ UNCONFINED + FIELD VANE													
	● QUICK TRIAXIAL × LAB VANE																				
222.2	GROUND SURFACE																				
0.0	TOPSOIL , trace roots and rootlets, trace sand Loose Dark Brown Moist		1	SS	5		222														
221.6																					
0.6	SAND and SILT , some clay Compact Brown Moist		2	SS	11		221											0 41 39 20			
220.8	Silty CLAY , trace sand, trace gravel Stiff Grey Moist		3	SS	10		220														
1.4																					
					4		SS	15	219												
					5		SS	15	218												
			6	SS	9	217												0 7 52 41			
216.6	Soft Wet					216															
5.6																					
					7	SS	3	215													
					8	SS	4	214													
					9	SS	1	213											0 0 65 35		

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-15

2 OF 3

METRIC

W.P. P-13-03 LOCATION Culvert 1E/Ramp E-S N 4 881 704.9 E 294 627.0 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.29 - 2014.10.30 CHECKED BY RPR

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 (%)				
	Continued From Previous Page							20 40 60 80 100		W _P W W _L				
	Silty CLAY Firm to Stiff Grey Wet							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100		20 40 60			GR SA SI CL	
							212	2.5 +						
			10	SS	5						○			
							211							
								3.5 +						
							210				○			
			11	SS	5									
							209							
			12	SS	7						○			
							208							
								3.0 +						
							207							
			13	SS	6						○			
							206		4.0 +					
			14	SS	7						○			
							205							
								2.5 +						
							204							
	Trace sand		15	SS	9						○		0 5 49 46	
	Some sand, trace gravel Moist						203							
	Sandy		16	SS	50/						○		0 40 26 34	

Continued Next Page

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

RECORD OF BOREHOLE No 14-15

3 OF 3

METRIC

W.P. P-13-03 LOCATION Culvert 1E/Ramp E-S N 4 881 704.9 E 294 627.0 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.29 - 2014.10.30 CHECKED BY RPR

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	W P	W	W L	WATER CONTENT (%)		
202.1 20.1	Continued From Previous Page END OF BOREHOLE AT 20.1m. WATER LEVEL AT 1.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.				0.100									

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 14-16

2 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1E/Ramp N-EW N 4 881 695.2 E 294 599.3 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.04 - 2014.11.05 CHECKED BY RPR

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									
	Continued From Previous Page																
	Silty CLAY Soft to Firm Grey Wet		10	SS	2		211	3.0									
							210										
								2.4									
			11	SS	4		209										
207.9							208	2.6									
13.3	END OF BOREHOLE AT 13.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 07/ 14 1.6 219.6 Dec 08/ 14 1.4 219.8 Jan 06/ 15 2.0 219.2																

RECORD OF BOREHOLE No 14-17

1 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1E/Ramp E-S N 4 881 714.1 E 294 655.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.23 - 2014.10.23 CHECKED BY RPR

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						
221.5	GROUND SURFACE							20 40 60 80 100						
0.0	TOPSOIL , some sand, occasional roots and rootlets Loose Dark Brown Moist		1	SS	4		221							
221.0														
0.6	Sandy SILT , occasional sand seams Loose Brown Moist		2	SS	7									
220.1														
1.4	SAND , trace silt Compact Brown Wet		3	SS	13		220							
219.2														
2.3	Silty CLAY , trace to some sand Stiff to Very Stiff Grey Moist		4	SS	13		219							
	Trace gravel		5	SS	19		218							
	Wet		6	SS	9		217							
215.9							216							
5.6	Firm		7	SS	7		215							
214.3							214							
7.2	Soft		8	SS	3		213							
212.8							212							
8.7			9	SS	6									

Continued Next Page

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

RECORD OF BOREHOLE No 14-17

2 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1E/Ramp E-S N 4 881 714.1 E 294 655.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.23 - 2014.10.23 CHECKED BY RPR

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									
	Continued From Previous Page																
	Silty CLAY , occasional sand seams Firm Grey Wet		10	SS	6												
			11	SS	7												
208.2																	
13.3	END OF BOREHOLE AT 13.3m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 07/ 14 1.9 219.6 Dec 08/ 14 1.7 219.8 Jan 06/ 15 1.7 219.8																

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 14-18

2 OF 2

METRIC

W.P. P-13-03 LOCATION High Fill/Ramp E-S N 4 881 681.1 E 294 688.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.03 - 2014.11.03 CHECKED BY RPR

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				WATER CONTENT (%)					
								20 40 60 80 100				W P W W L					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
	Continued From Previous Page																
	Silty CLAY , trace sand, occasional silt seams Firm Grey Wet		10	SS	7		211	1.8					○				
							210	2.9									
			11	SS	6								┌─○─┐		0 3 40 57		
208.6							209										
13.3	END OF BOREHOLE AT 13.3m. WATER LEVEL AT 2.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.							2.3									

RECORD OF BOREHOLE No 14-23

1 OF 1

METRIC

W.P. P-13-03 LOCATION High Fill/Line 5 N 4 881 603.2 E 294 549.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.18 - 2014.11.18 CHECKED BY RPR

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			
223.4	GROUND SURFACE							20	40	60	80	100						
0.0	SAND , trace gravel Loose Brown Moist (FILL)		1	GS			223							○				
222.3			1	SS	9									○				
1.1	Silty CLAY , some sand, trace gravel Stiff Brown Moist		2	SS	11		222							○				
221.2																		
2.2	SAND , some gravel, trace clay Compact Brown Moist		3	SS	19		221							○				
220.6																		
2.8	Silty CLAY , trace sand, trace gravel Stiff to Very Stiff Brown to Grey Moist		4	SS	14		220							○	—		0 0 47 53	
							219											
			5	SS	15		218							○				
			6	SS	15		217							○	—		0 8 56 36	
							216											
			7	SS	14									○				
215.2																		
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																	

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13-24

1 OF 1

METRIC

W.P. P-13-03 LOCATION High Fill/Ramp N-EW N 4 881 617.8 E 294 596.3 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.30 - 2014.01.30 CHECKED BY KY

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								
223.4	GROUND SURFACE															
0.0	TOPSOIL: (150 mm)															
0.2	Clayey SILT , with sand, trace gravel, occasional rootlets Stiff Brown		1	SS	9		223									9 38 34 19
222.6	Moist (FILL)															
0.8	Silty CLAY , trace sand Stiff to Very Stiff Brown Moist		2	SS	8		222									
			3	SS	12											
			4	SS	16		221									
			5	SS	14		220									0 0 41 59
			6	SS	17		219									
			7	SS	13											0 0 54 46
							218									
	Grey Wet		8	SS	13		217									
							216									
	Firm		9	SS	7											
215.2																
8.2	END OF BOREHOLE AT 8.2 m. BOREHOLE OPEN TO 8.2 m AND WATER LEVEL AT 8.2m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Feb 26/ 14 2.5 220.9															

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13-25

1 OF 2

METRIC

W.P. P-13-03 LOCATION High Fill/Ramp N-EW N 4 881 628.3 E 294 649.5 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.29 - 2014.01.29 CHECKED BY KY

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									
								20	40	60	80	100					
							○ UNCONFINED + FIELD VANE										
							● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)					
							20	40	60	80	100	20	40	60			
224.2	GROUND SURFACE						224									6 35 36 23	
0.0	TOPSOIL: (50 mm)		1	SS	20								○				
	Silty CLAY , with sand, trace gravel																
	Very Stiff to Stiff		2	SS	12		223						○				
	Brown																
	Moist																
	(FILL)		3	SS	9		222						○				
	Occasional rootlets																
	Grey		4	SS	8								○				
221.1																	
3.0	Silty CLAY , trace sand, trace gravel		5	SS	6		221						○				
	Firm to Stiff																
	Grey		6	SS	9		220							○			
	Moist																
219.7																	
4.5	Very Stiff		7	SS	20		219						○				
218.5																	
5.6			8	SS	15		218						○				
							217										
			9	SS	14		216						○				
							215						○				
			10	SS	12												

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 13-25

2 OF 2

METRIC

W.P. P-13-03 LOCATION High Fill/Ramp N-EW N 4 881 628.3 E 294 649.5 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.29 - 2014.01.29 CHECKED BY KY

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					
212.9	Silty CLAY Firm Grey Wet		11	SS	7		214										
							213										0 0 44 56
11.3	END OF BOREHOLE AT 11.3 m. BOREHOLE OPEN TO 10.6 m AND WATER LEVEL AT 7.1 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Feb 26/ 14 2.5 221.7																

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

RECORD OF BOREHOLE No 13-26

2 OF 2

METRIC

W.P. P-13-03 LOCATION High Fill/Ramp N-EW N 4 881 634.1 E 294 689.2 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.29 - 2014.01.29 CHECKED BY KY

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 (%)								
	Continued From Previous Page							20	40	60	80	100					
214.6	Silty CLAY , some sand Firm Grey Wet		11	SS	9		215										
11.3	END OF BOREHOLE AT 11.3 m. BOREHOLE OPEN TO 10.6 m AND WATER LEVEL AT 7.8 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Feb 26/ 14 4.7 221.2																

RECORD OF BOREHOLE No 14-31

1 OF 1

METRIC

W.P. P-13-03 LOCATION High Fill/Ramp W-N N 4 881 690.8 E 294 937.0 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.11 - 2014.11.11 CHECKED BY RPR

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									
							20	40	60	80	100						
225.3	GROUND SURFACE																
0.0	TOPSOIL , occasional roots Firm Dark Brown Moist		1	SS	6												
224.7																	
0.6	Silty CLAY , trace sand, trace gravel Firm Brown Moist		2	SS	7												
223.8																	
1.4	Very Stiff		3	SS	17												
			4	SS	17												
			5	SS	19												
			6	SS	17												
	Grey		7	SS	19												
			8	SS	18												
217.0																	
8.2	END OF BOREHOLE AT 8.2m Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Dec 08/ 14 0.3 225.0 Jan 06/ 15 0.4 224.9																

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

RECORD OF BOREHOLE No 14-51

1 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1E N 4 881 727.4 E 294 691.7 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.24 - 2014.10.24 CHECKED BY RPR

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									
221.5	GROUND SURFACE					▽											
0.0	TOPSOIL , occasional roots and rootlets Loose Dark Brown Moist		1	SS	6												
220.8																	
0.7	Silty SAND , trace gravel Compact Brown Moist		2	SS	12												
220.1																	
1.4	Silty CLAY , trace to some sand Firm Grey Moist		3	SS	5												
219.3																	
2.2	Very Stiff Trace gravel		4	SS	16												
			5	SS	22												
217.5																	
4.0	Wet		6	SS	8												
			7	SS	4												
			8	SS	4												
			9	SS	5												

Continued Next Page

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

RECORD OF BOREHOLE No 14-51

2 OF 2

METRIC

W.P. P-13-03 LOCATION Culvert 1E N 4 881 727.4 E 294 691.7 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.24 - 2014.10.24 CHECKED BY RPR

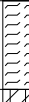




SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						
								WATER CONTENT (%)						
								20 40 60						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
								W P W W L						

RECORD OF BOREHOLE No 14-52

1 OF 2

METRIC

W.P. P-13-03 LOCATION High Fills/Ramp N-EW N 4 881 660.4 E 294 648.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.30 - 2014.10.30 CHECKED BY RPR

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							WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE									
						● QUICK TRIAXIAL × LAB VANE											
221.9	GROUND SURFACE							20 40 60 80 100									
0.0	TOPSOIL, some clay, occasional roots and rootlets Loose Dark Brown Moist		1	SS	6		221										
221.4																	
0.6																	
	Silty CLAY, with sand, occasional roots Soft to Firm Brown Moist		2	SS	3			220									
	Occasional sand layer		3	SS	7				219								
219.7																	
2.2	Stiff Brown to Grey Moist		4	SS	9					218							
			5	SS	12	217											
			6	SS	8		216										
216.3	Firm Grey Wet							215									
5.6																	
			7	SS	4	214											
			8	SS	4		213										
			9	SS	6	212											

Continued Next Page

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

RECORD OF BOREHOLE No 14-52

2 OF 2

METRIC

W.P. P-13-03 LOCATION High Fills/Ramp N-EW N 4 881 660.4 E 294 648.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.30 - 2014.10.30 CHECKED BY RPR

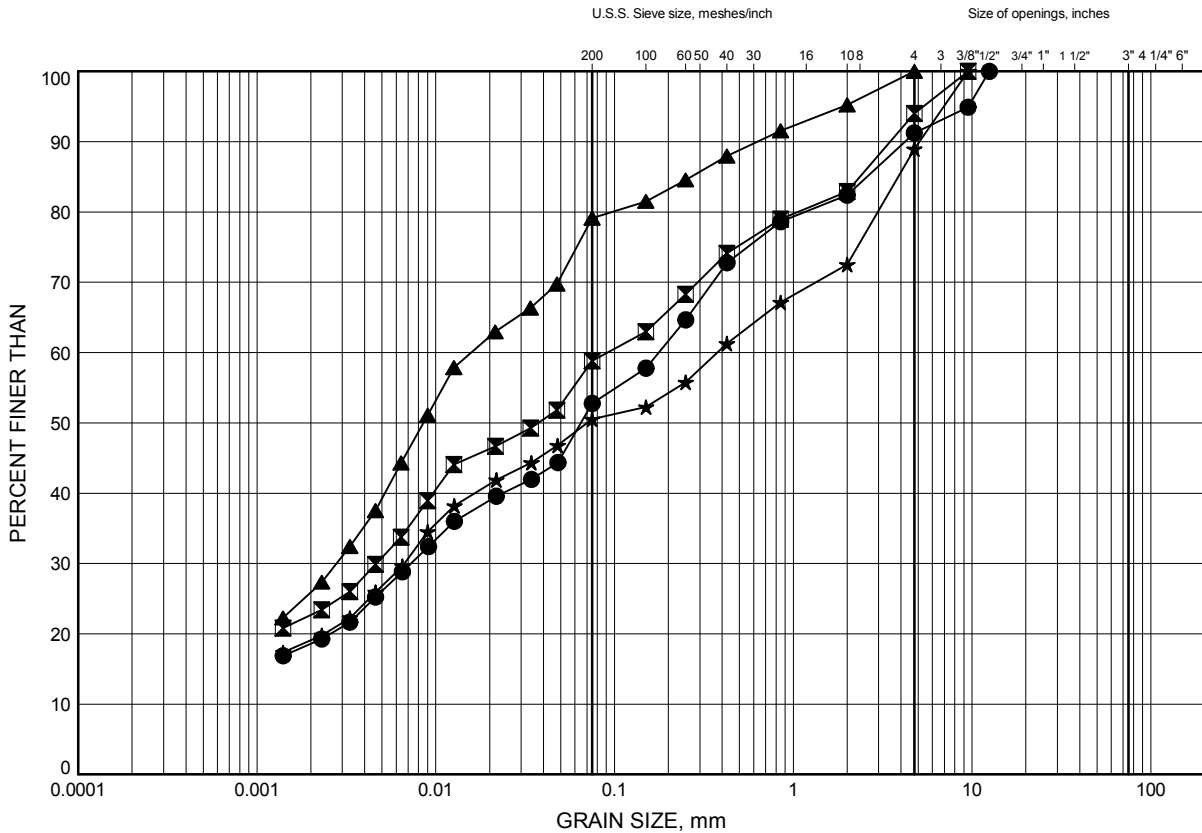
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W _p	W	W _L					
				○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)											
	Continued From Previous Page							20	40	60	80	100	20	40	60	GR	SA	SI	CL
205.6 16.3	Silty CLAY , trace sand Firm Grey Wet								2.7										
			10	SS	5		211												
							210												
			11	SS	7														
							209												
			12	SS	7		208												
							207												
			13	SS	8		206												
203.8 18.1	With sand, trace gravel Very Stiff Grey Moist								3.0										
		14	SS	22		205													
						204													
	BOREHOLE STARTED BUBBLING AT 18.1m. Methane gas detected in the borehole. Monitoring of the methane gas was conducted during and after removal of augers. Borehole was grouted / sealed on November 5, 2014. Gas readings outside of borehole dropped to 0ppm. WATER LEVEL AT 1.0m BELOW SURFACE.																		

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

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B1

CLAYEY SILT/SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-24	0.30	223.08
⊠	13-25	1.07	223.09
▲	13-25	2.59	221.56
★	13-26	1.83	224.08

Date February 2015
W.P. P-13-03

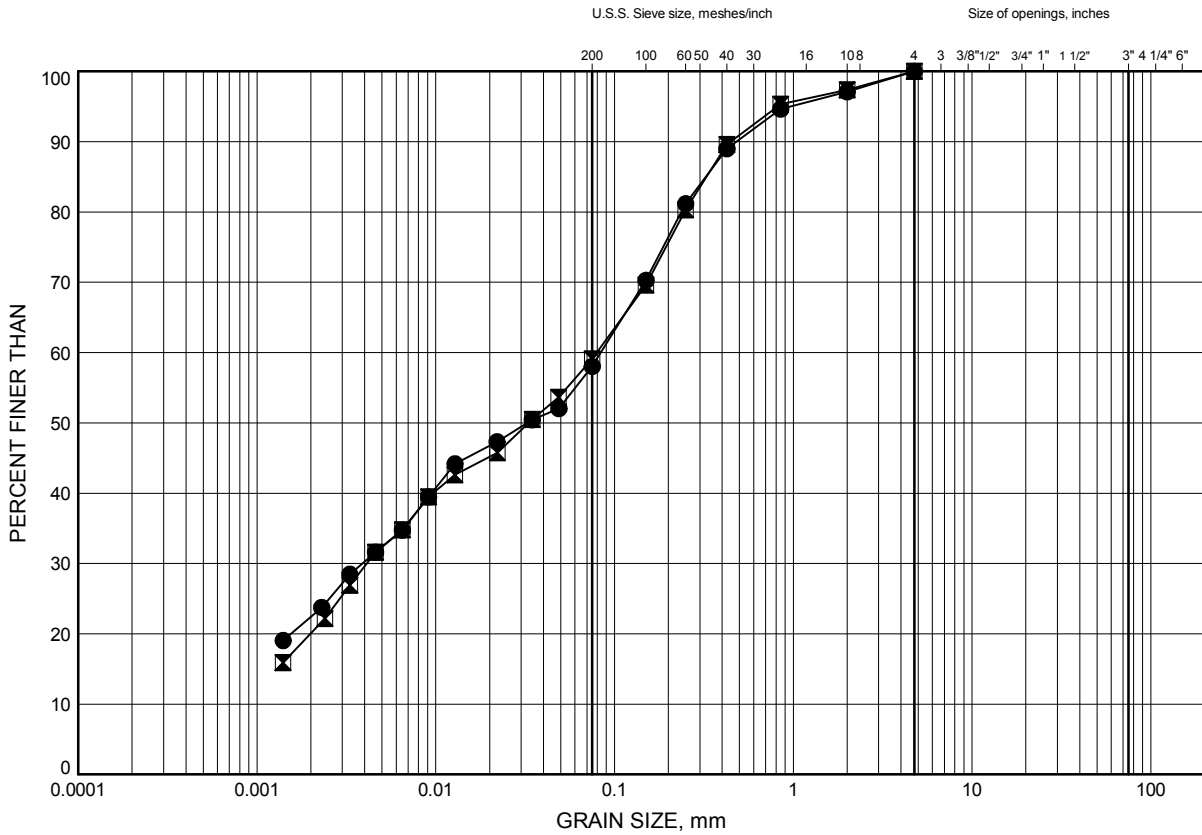


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B2

SAND & SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-13	1.07	220.48
⊗	14-15	1.07	221.13

Date February 2015
W.P. P-13-03

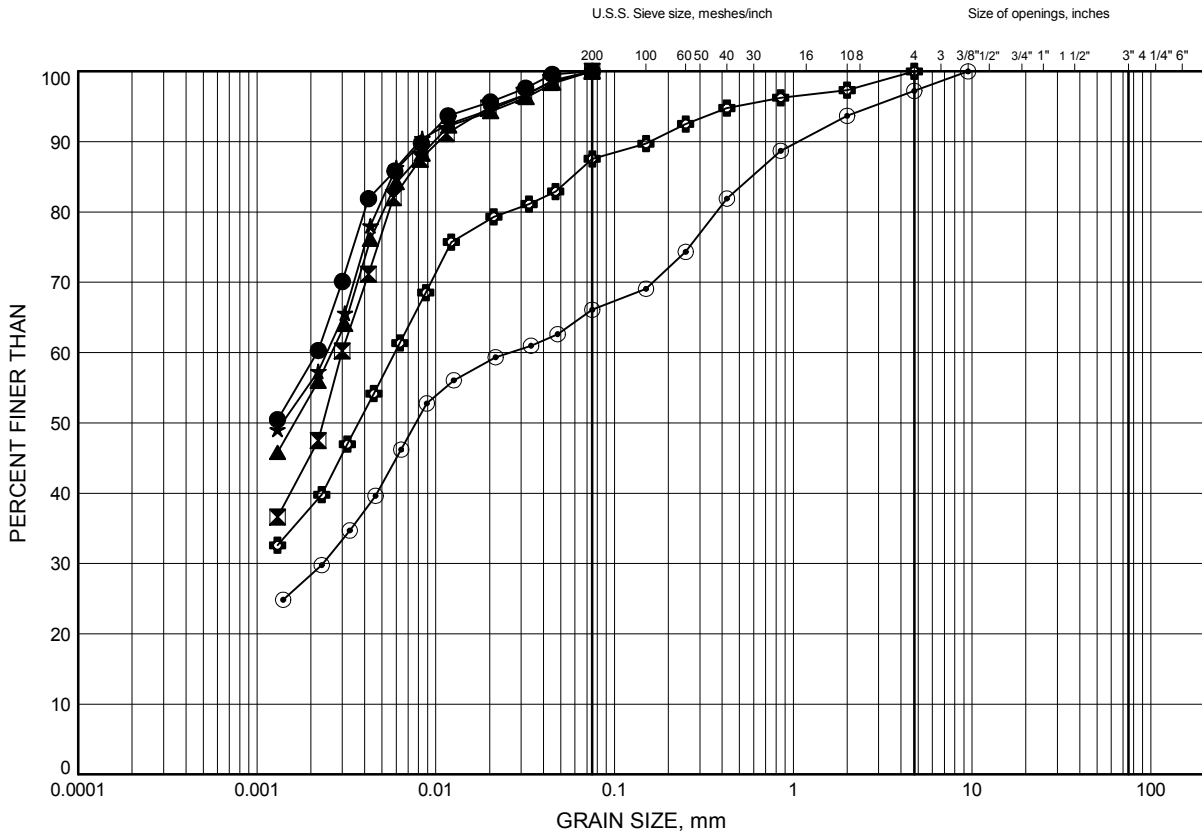


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B3

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-24	3.35	220.03
⊠	13-24	4.88	218.50
▲	13-25	6.40	217.75
★	13-25	10.97	213.18
⊙	13-26	4.11	221.80
⊕	13-26	9.45	216.46

Date February 2015
W.P. P-13-03

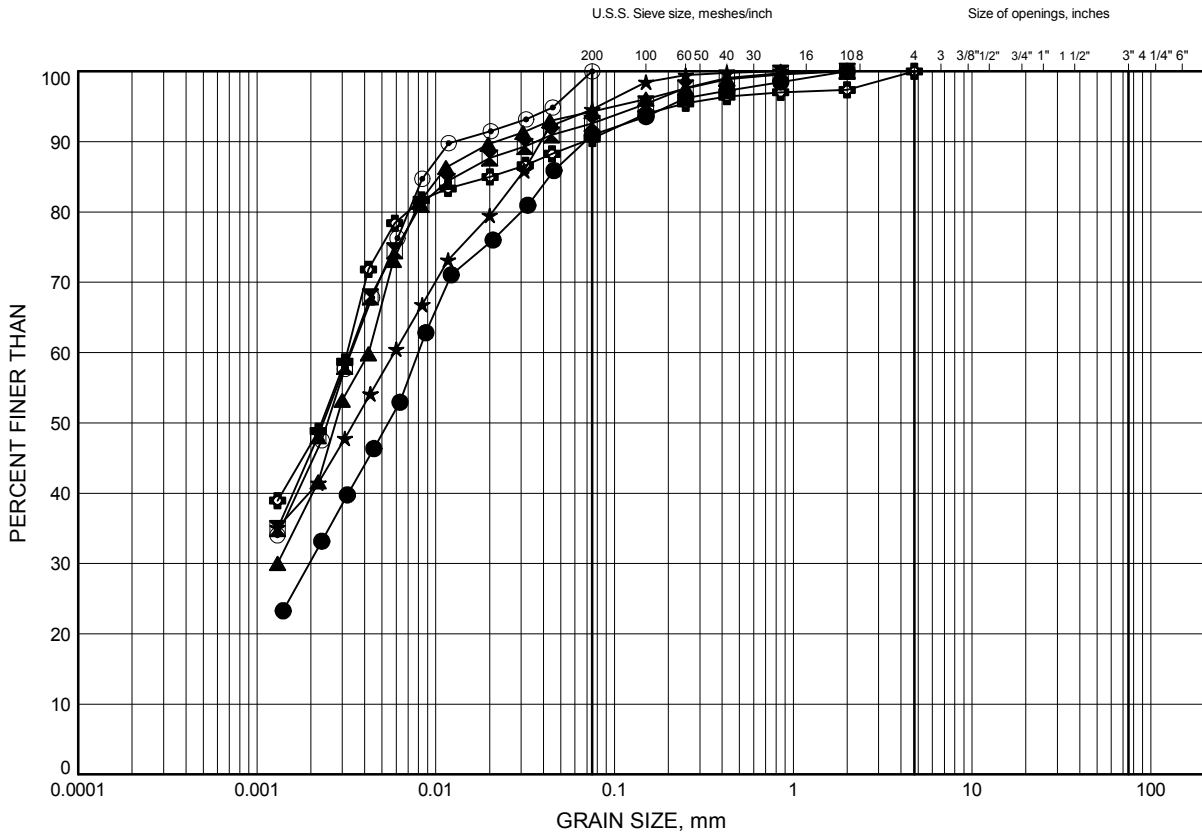


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B4

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-01	1.07	221.43
⊠	14-01	4.88	217.62
▲	14-01	7.92	214.58
★	14-05	1.07	221.12
⊙	14-05	4.88	217.31
⊕	14-05	9.45	212.73

Date February 2015
W.P. P-13-03

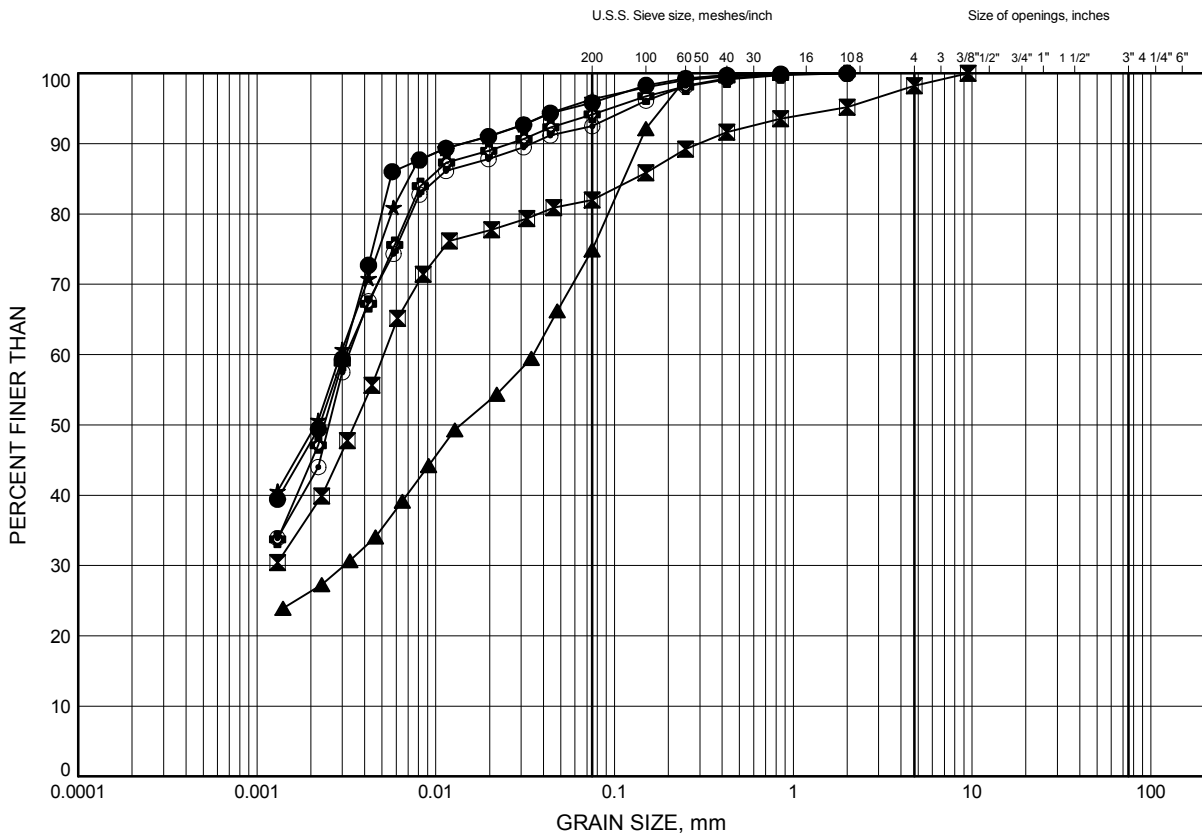


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-06	3.35	219.31
⊠	14-06	7.92	214.73
▲	14-07	1.07	220.56
★	14-07	4.88	216.75
⊙	14-08	1.07	220.39
⊕	14-08	3.35	218.10

Date February 2015
W.P. P-13-03

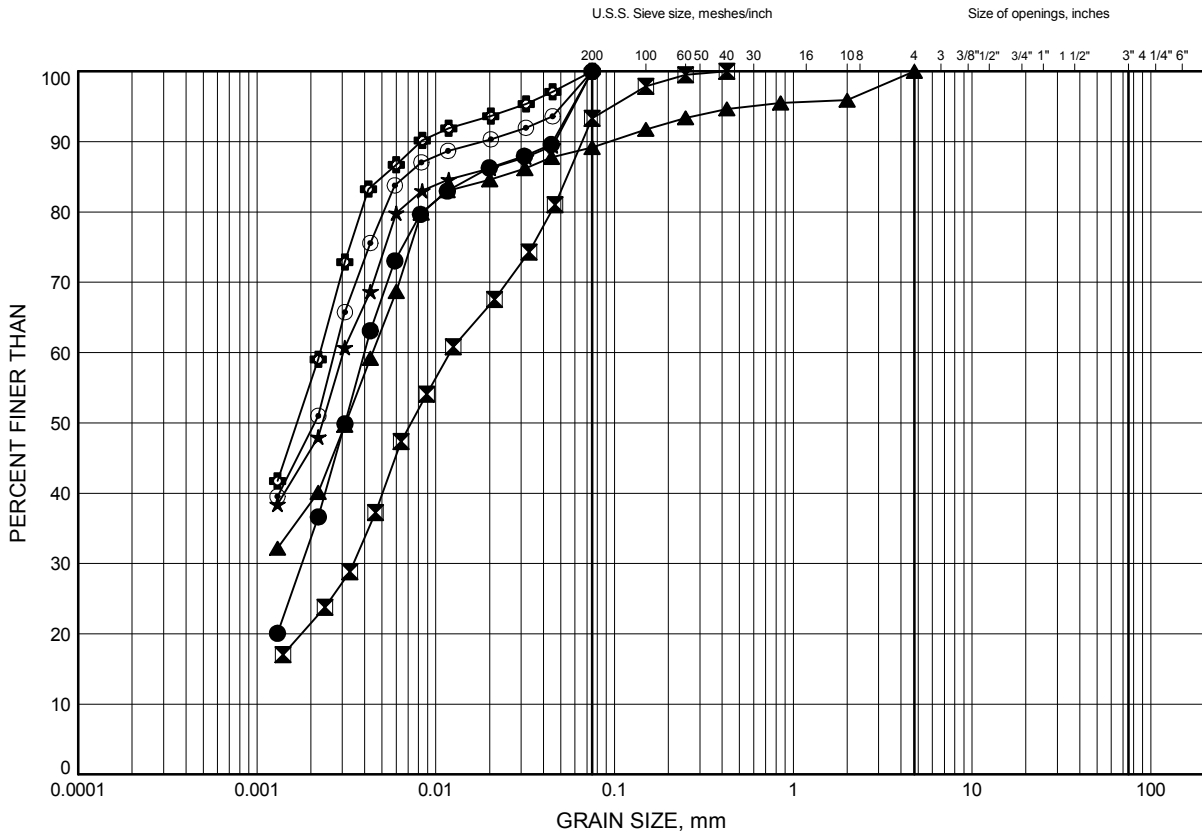


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-08	9.45	212.01
⊠	14-09	1.83	219.97
▲	14-09	6.40	215.40
★	14-09	10.97	210.83
⊙	14-09	14.02	207.78
⊕	14-10	1.83	219.55

Date February 2015
W.P. P-13-03

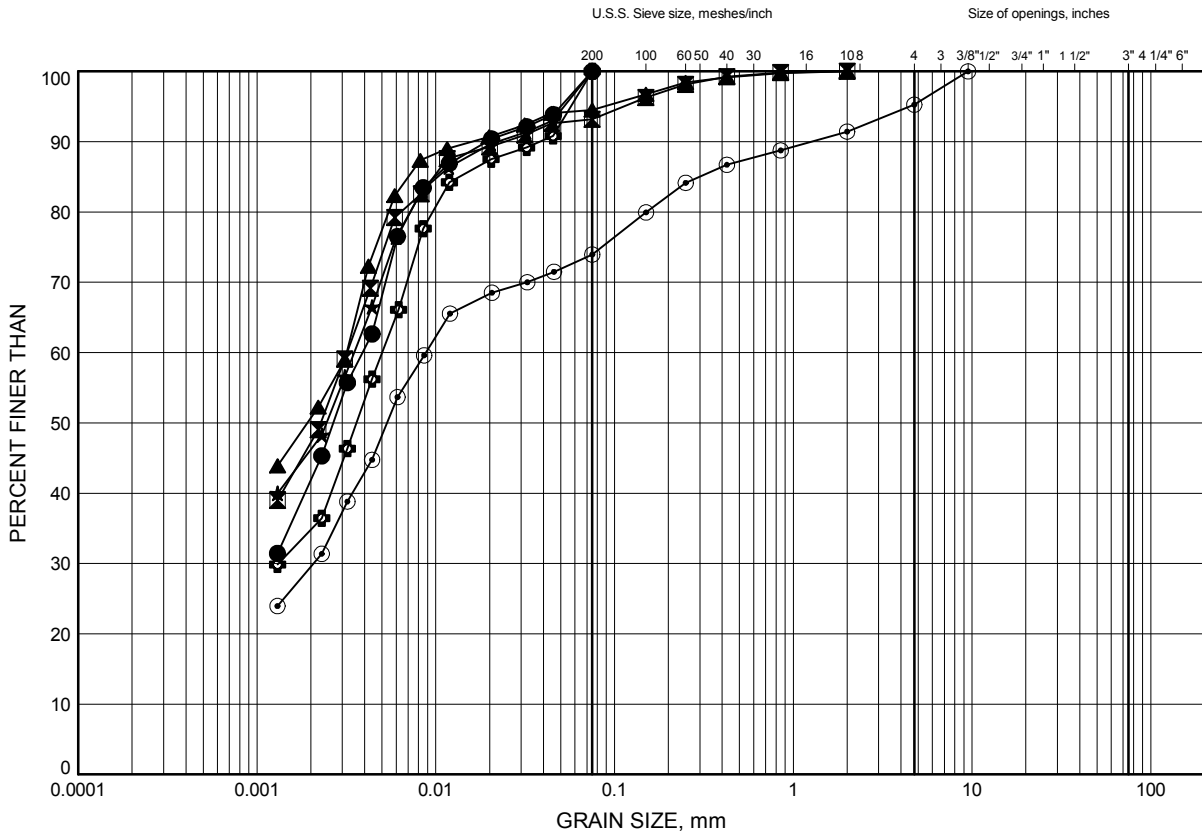


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B7

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-10	9.45	211.93
⊠	14-11	3.35	217.99
▲	14-11	6.40	214.94
★	14-12	2.59	219.01
⊙	14-12	6.40	215.20
⊕	14-12	10.97	210.63

Date February 2015
W.P. P-13-03

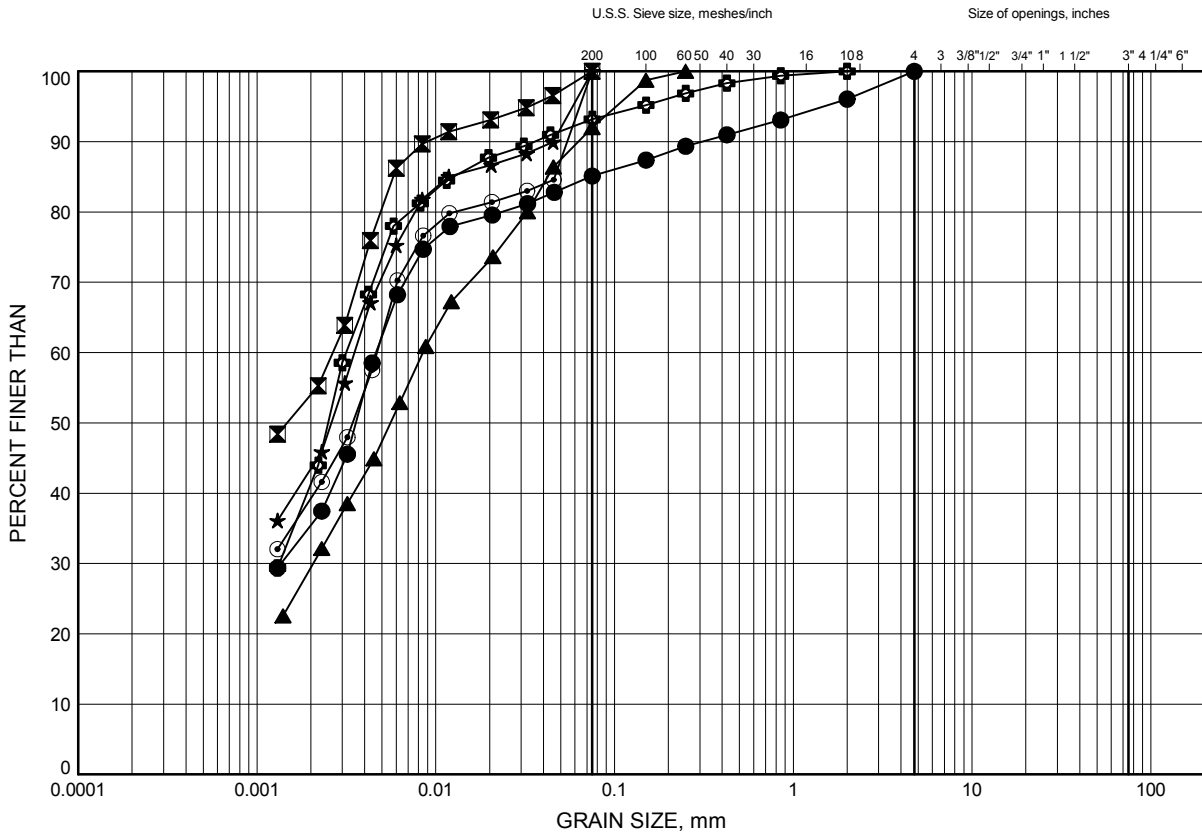


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B8

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-13	3.35	218.19
⊠	14-13	7.92	213.62
▲	14-14	1.07	221.03
★	14-14	4.88	217.22
⊙	14-14	9.45	212.65
⊕	14-15	4.88	217.32

Date February 2015
W.P. P-13-03

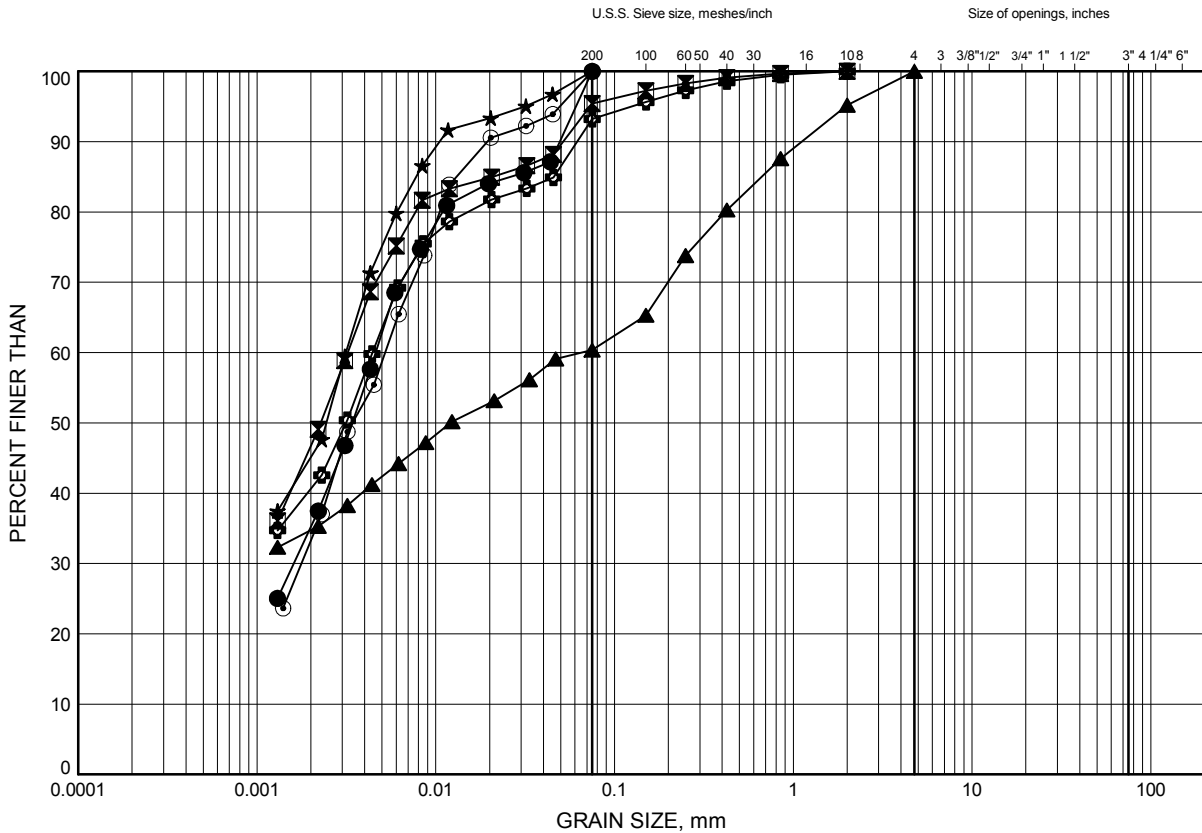


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B9

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-15	9.45	212.75
⊠	14-15	18.59	203.61
▲	14-15	19.89	202.31
★	14-16	3.35	217.86
⊙	14-16	10.97	210.24
⊕	14-17	2.59	218.92

Date February 2015
W.P. P-13-03

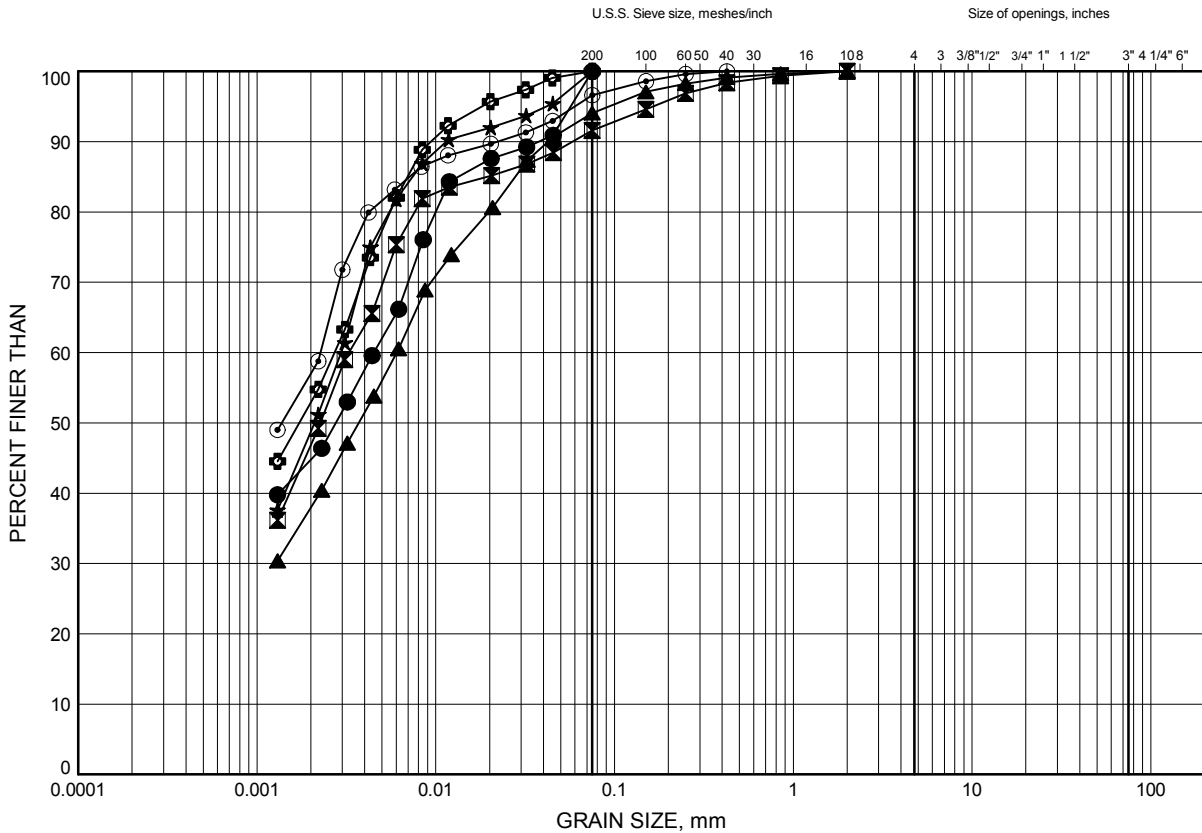


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B10

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-17	6.40	215.11
⊠	14-17	12.50	209.01
▲	14-18	1.07	220.83
★	14-18	4.88	217.02
⊙	14-18	12.50	209.40
⊕	14-23	3.35	220.06

Date February 2015
W.P. P-13-03

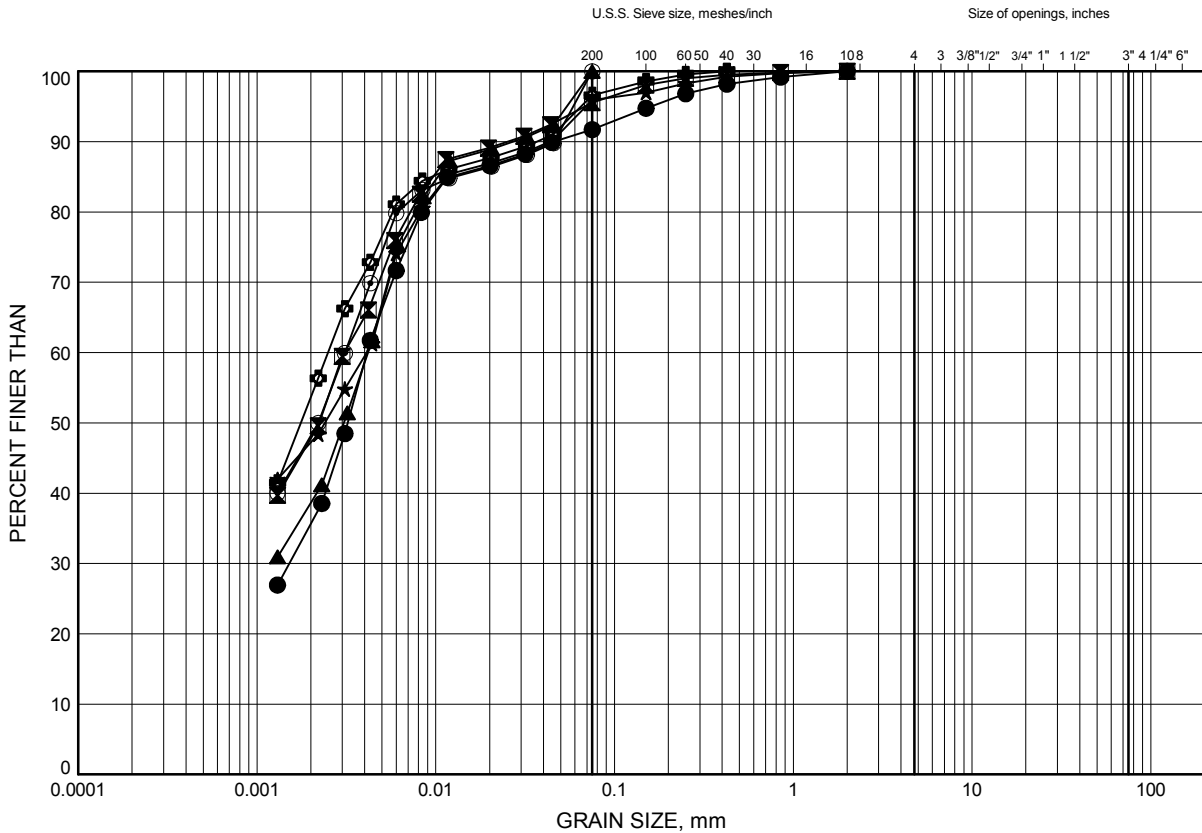


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B11

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-23	6.40	217.01
⊠	14-51	3.35	218.15
▲	14-51	7.92	213.58
★	14-51	10.97	210.53
⊙	14-52	7.92	214.01
⊕	14-52	14.02	207.92

Date February 2015
W.P. P-13-03

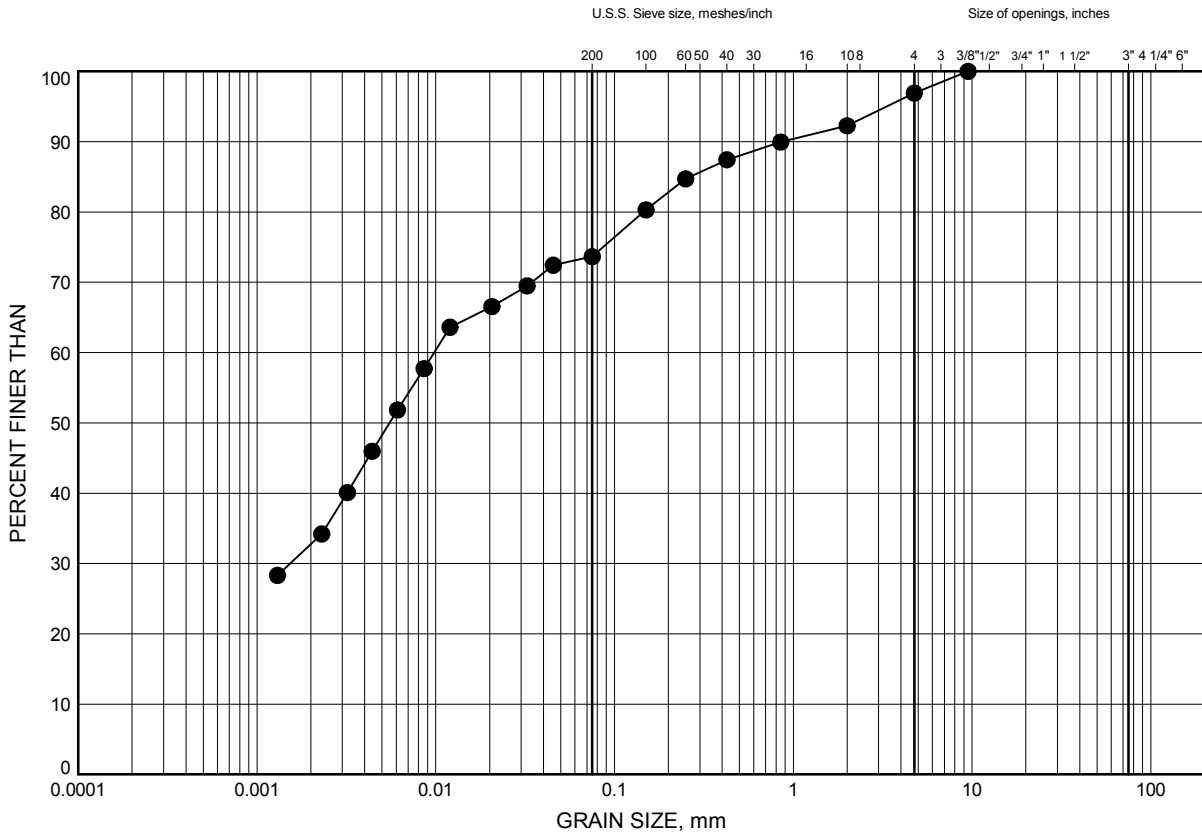


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE B12

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-52	17.07	204.87

Date February 2015
W.P. P-13-03

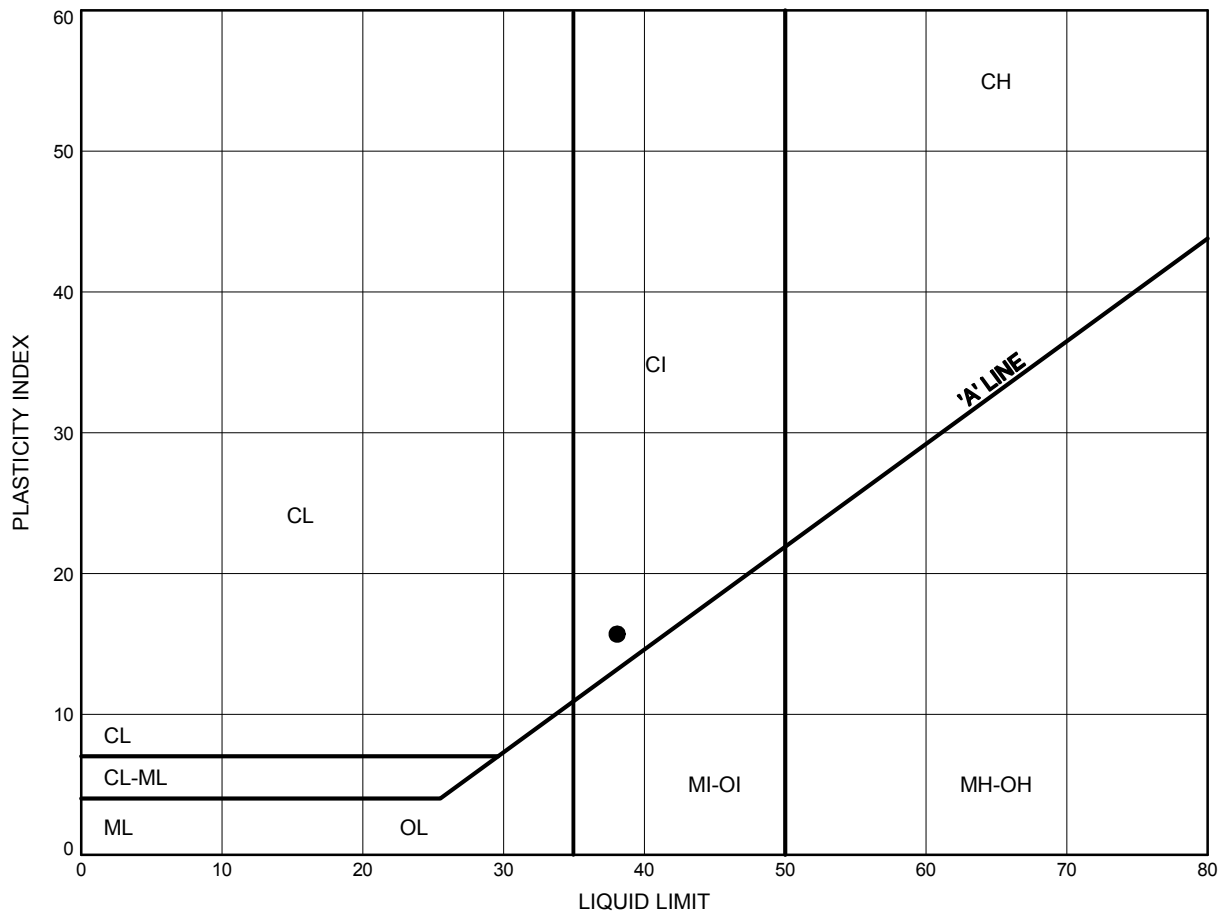


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B13

SILTY CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-25	2.59	221.56

Date February 2015
W.P. P-13-03

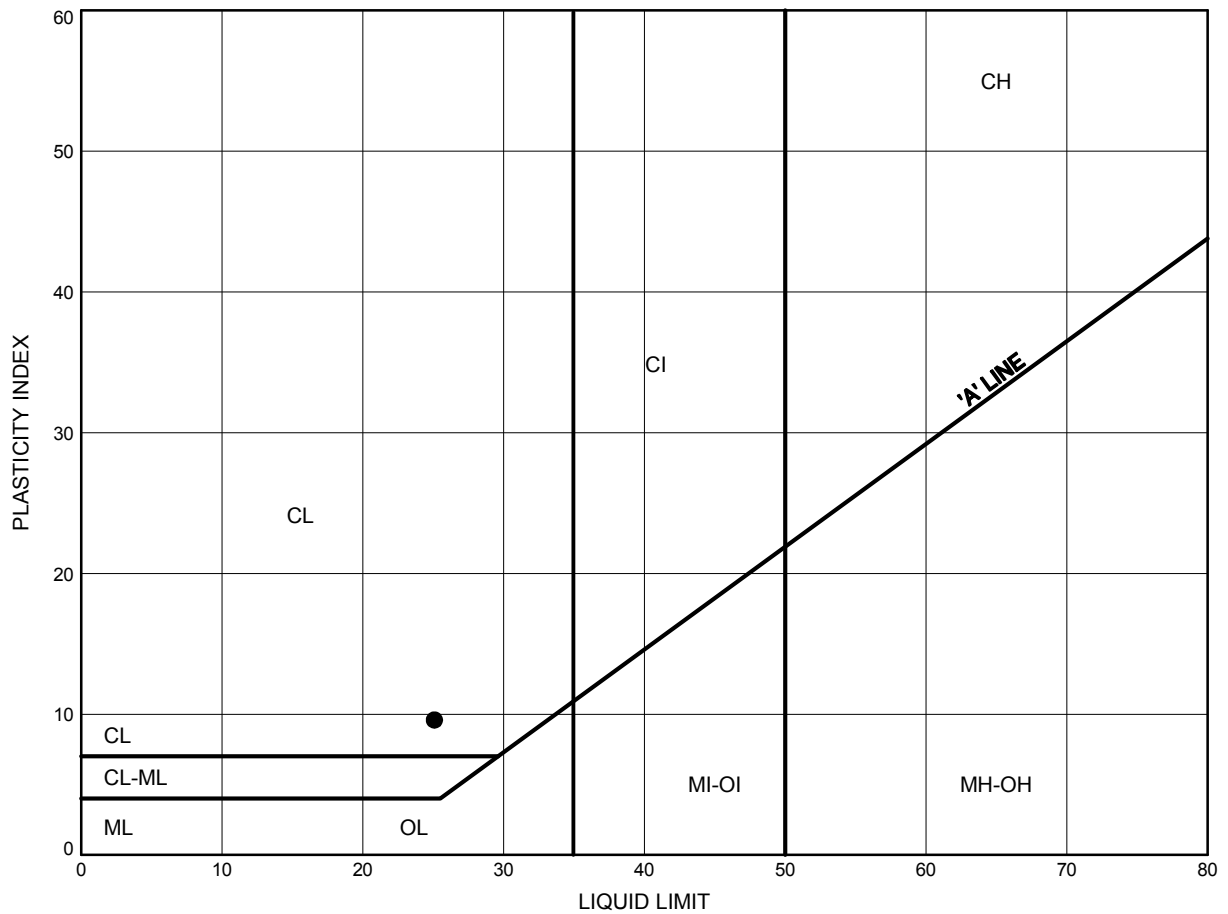


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B14

SILTY/CLAYEY SAND



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-13	1.07	220.48

Date February 2015
 W.P. P-13-03

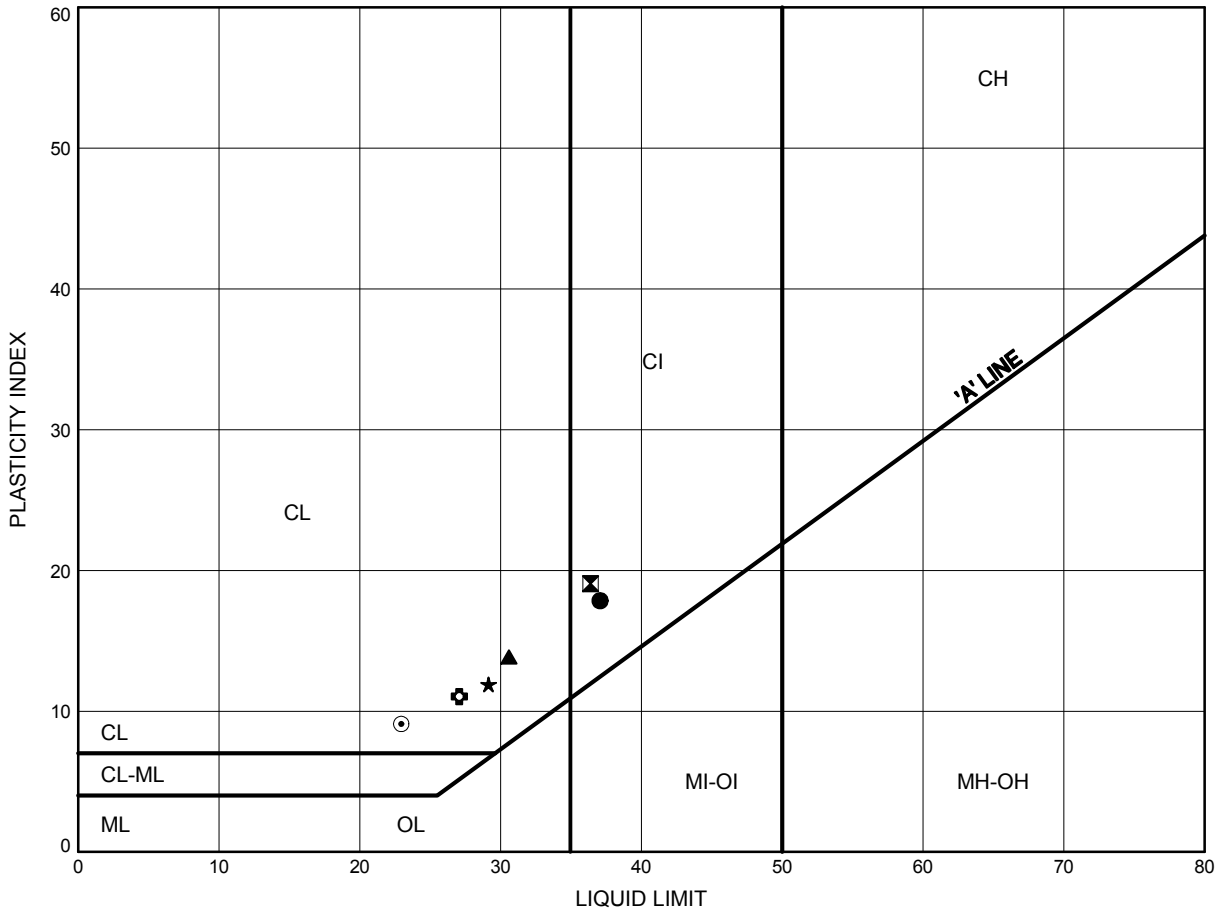


Prep'd AN
 Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B15

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	13-24	3.35	220.03
⊠	13-24	4.88	218.50
▲	13-25	6.40	217.75
★	13-25	10.97	213.18
⊙	13-26	9.45	216.46
⊕	14-01	4.88	217.62

Date February 2015
W.P. P-13-03

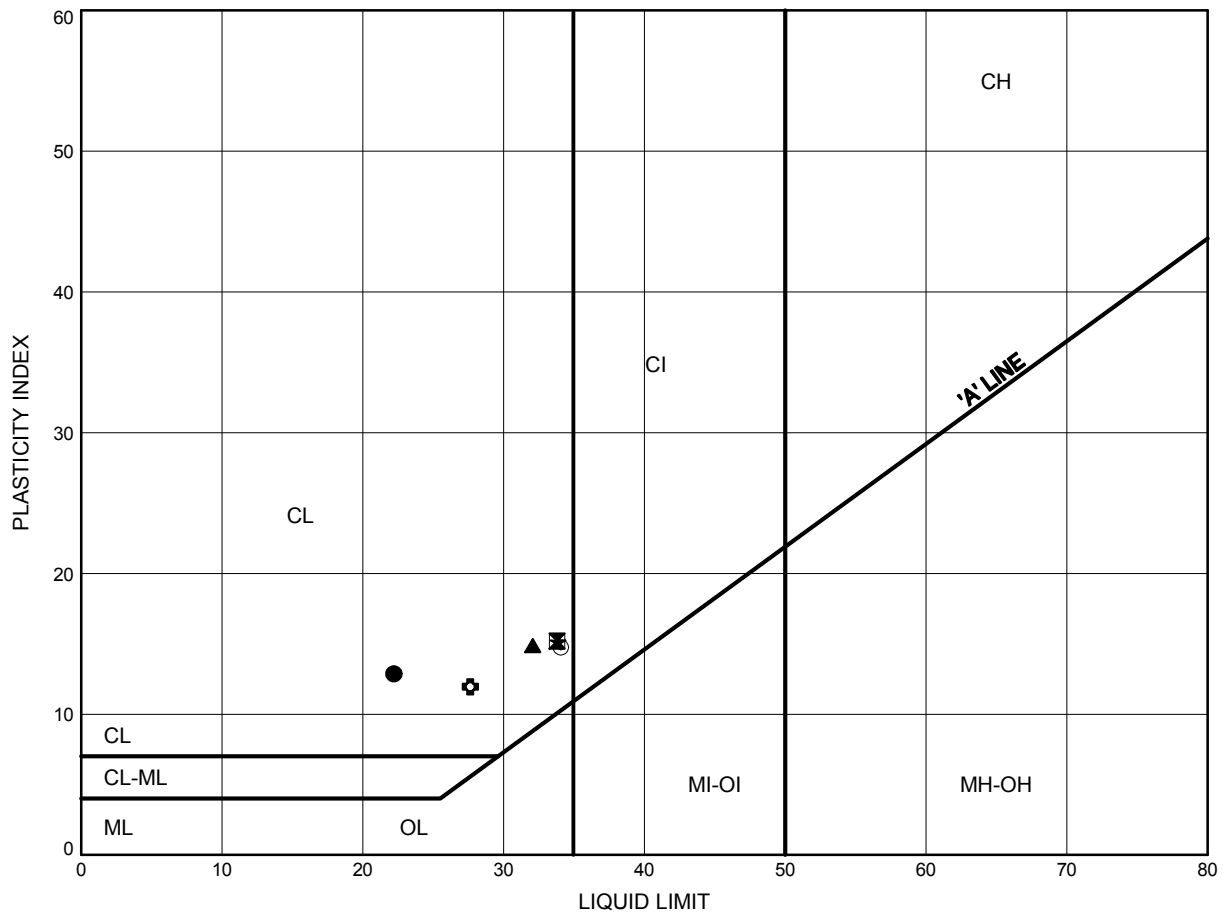


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B16

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-01	7.92	214.58
⊠	14-05	9.45	212.73
▲	14-06	3.35	219.31
★	14-06	7.92	214.73
⊙	14-07	4.88	216.75
⊕	14-08	1.07	220.39

Date February 2015
W.P. P-13-03

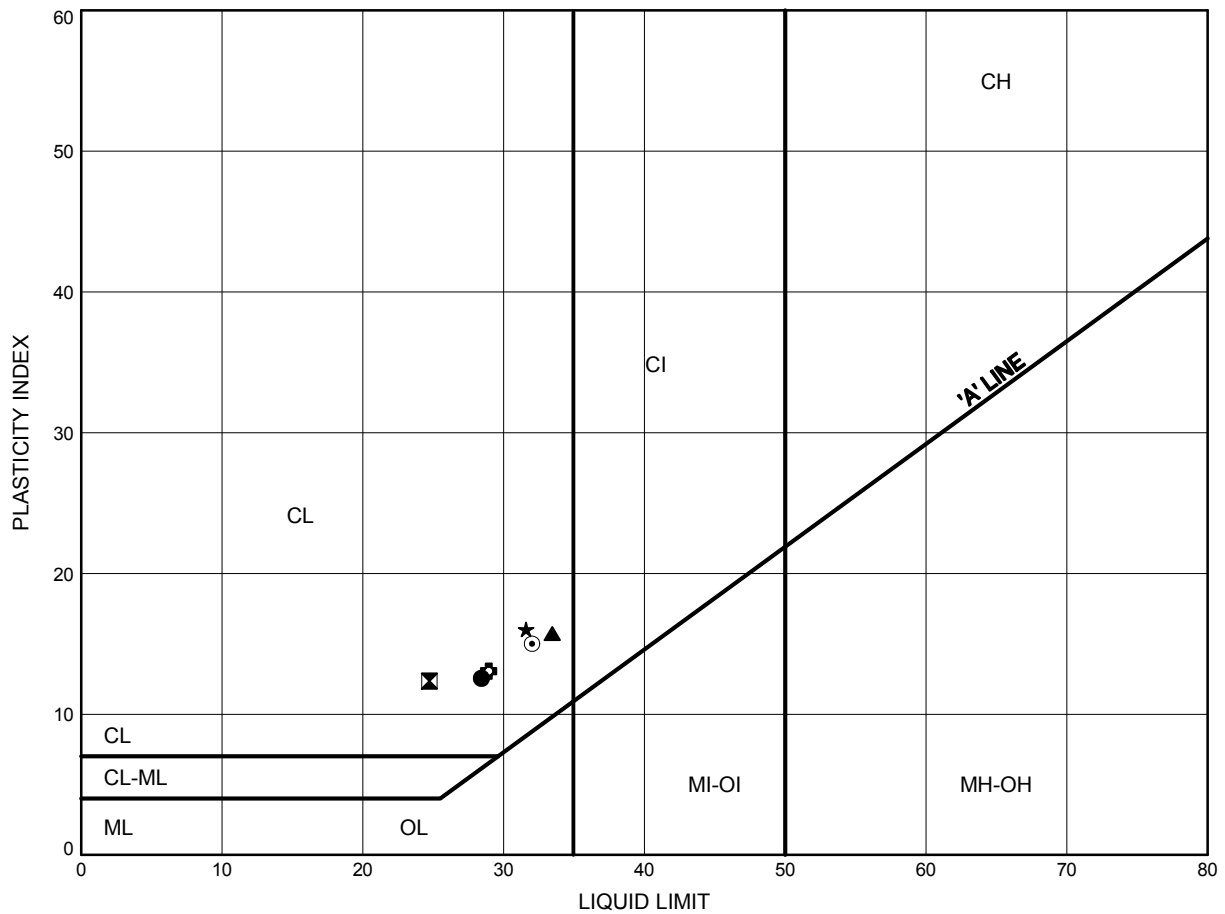


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B17

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-08	3.35	218.10
⊠	14-09	10.97	210.83
▲	14-09	14.02	207.78
★	14-10	1.83	219.55
⊙	14-11	3.35	217.99
⊕	14-11	6.40	214.94

Date February 2015
 W.P. P-13-03

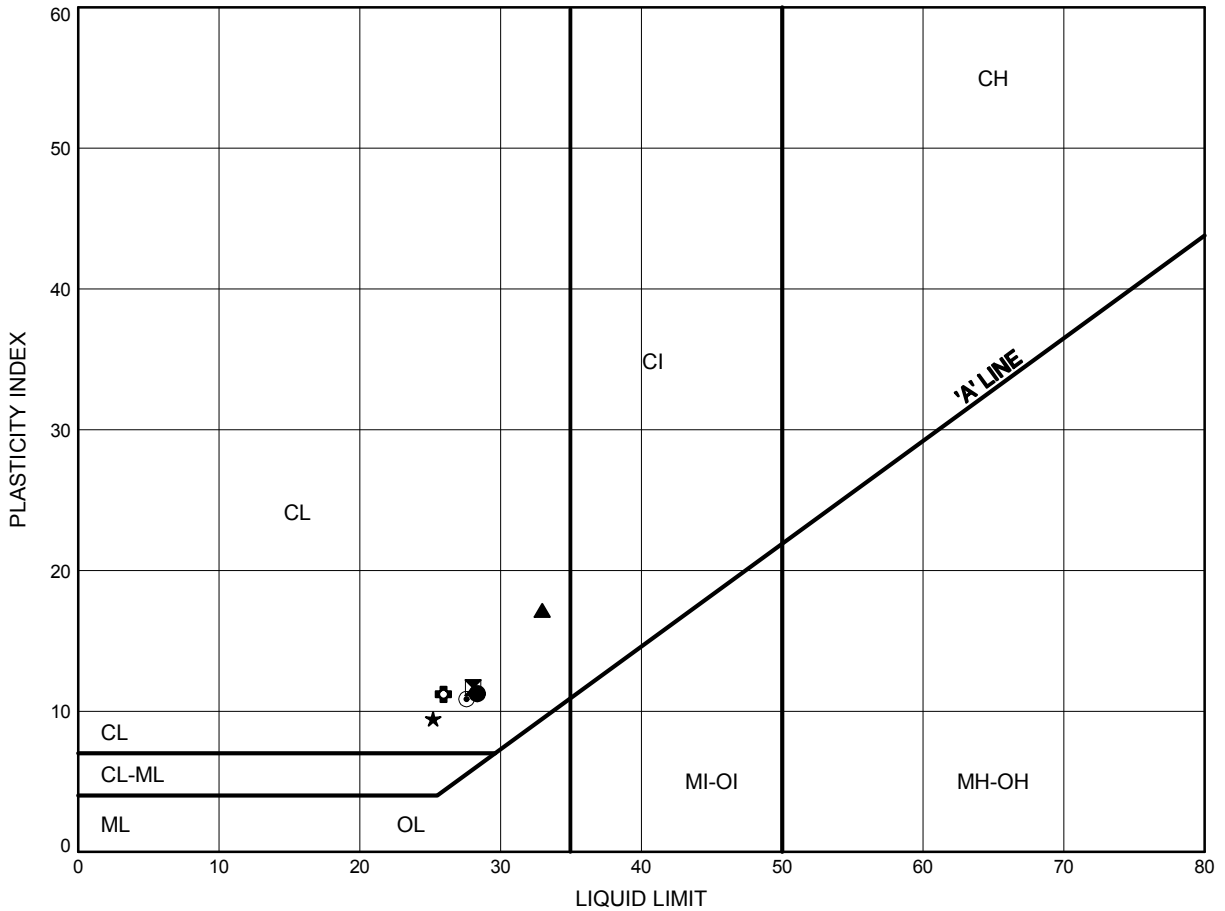


Prep'd AN
 Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B18

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-12	6.40	215.20
⊠	14-12	10.97	210.63
▲	14-13	7.92	213.62
★	14-14	1.07	221.03
⊙	14-14	4.88	217.22
⊕	14-14	9.45	212.65

Date February 2015
W.P. P-13-03

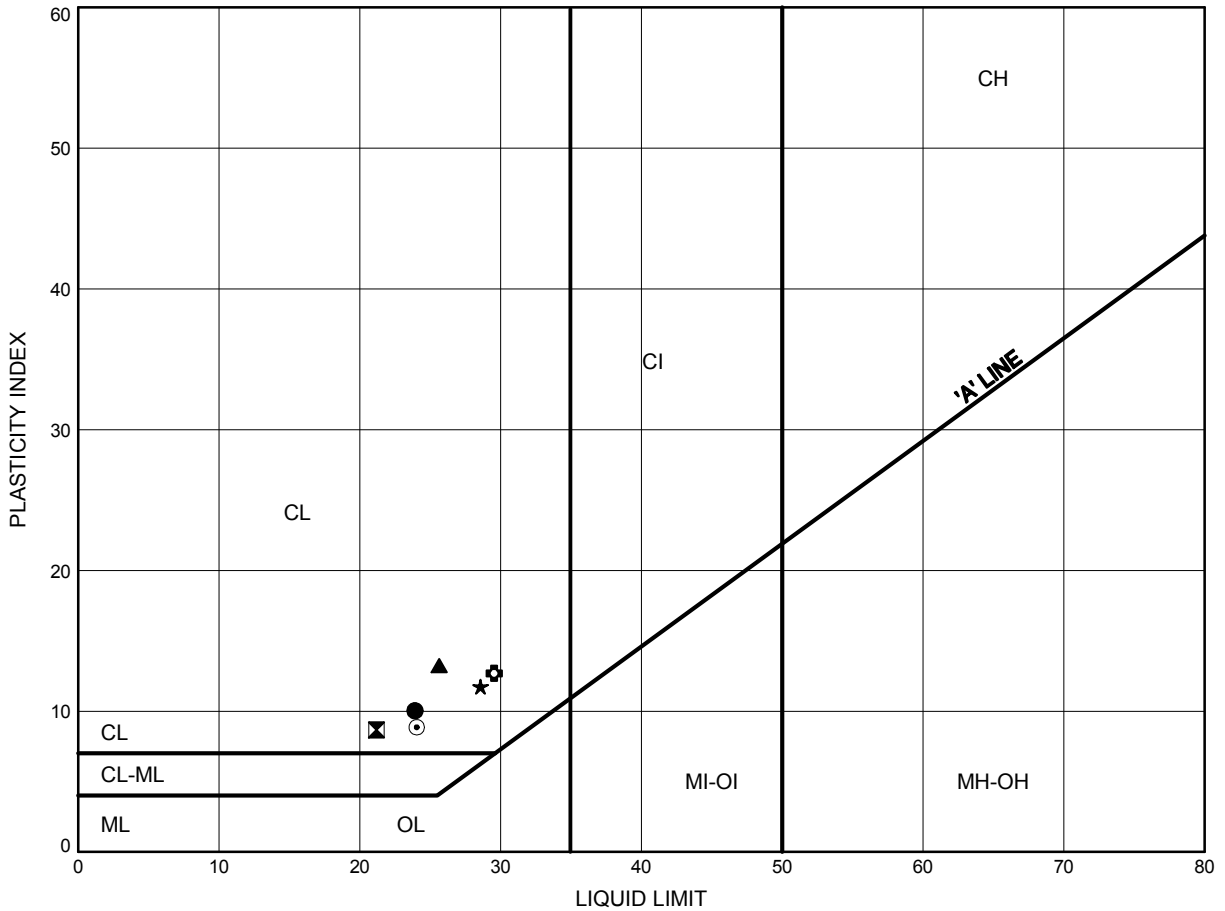


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B19

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-15	4.88	217.32
⊠	14-15	9.45	212.75
▲	14-15	18.59	203.61
★	14-16	3.35	217.86
⊙	14-16	10.97	210.24
⊕	14-17	6.40	215.11

Date February 2015
W.P. P-13-03

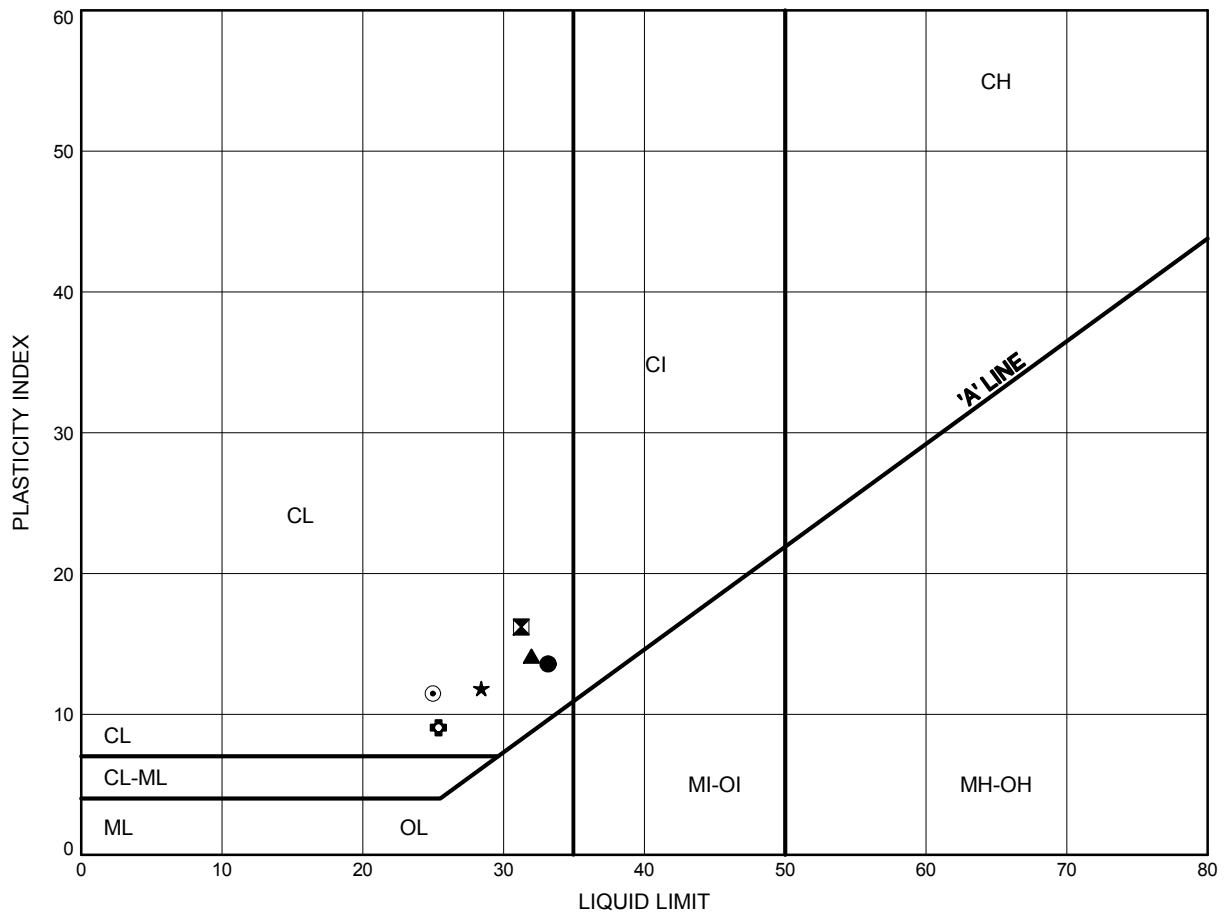


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B20

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-18	4.88	217.02
⊠	14-18	12.50	209.40
▲	14-23	3.35	220.06
★	14-23	6.40	217.01
⊙	14-51	7.92	213.58
⊕	14-51	10.97	210.53

Date February 2015
 W.P. P-13-03

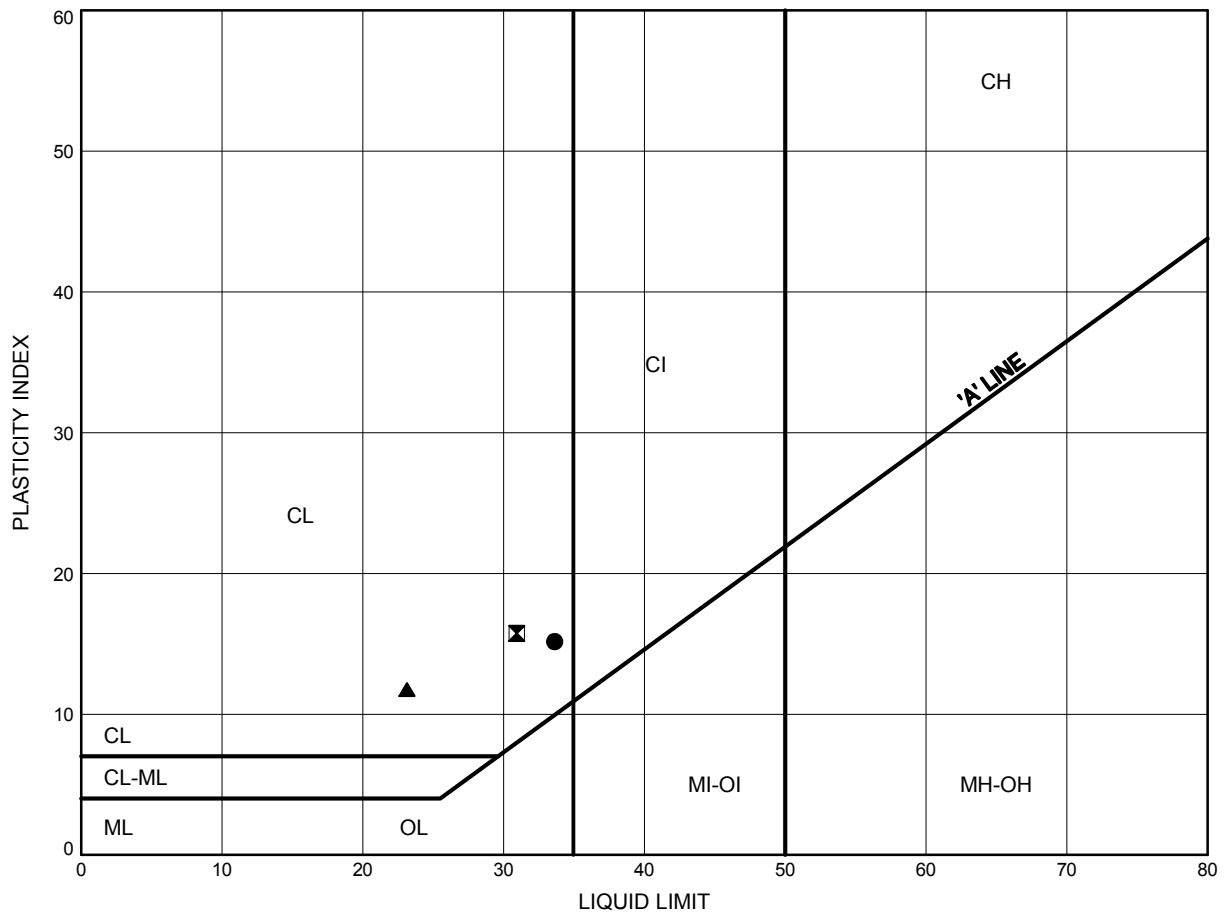


Prep'd AN
 Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE B21

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-52	7.92	214.01
⊠	14-52	14.02	207.92
▲	14-52	17.07	204.87

Date February 2015
W.P. P-13-03



Prep'd AN
Chkd. RPR

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

CONT No
WP No P13-03

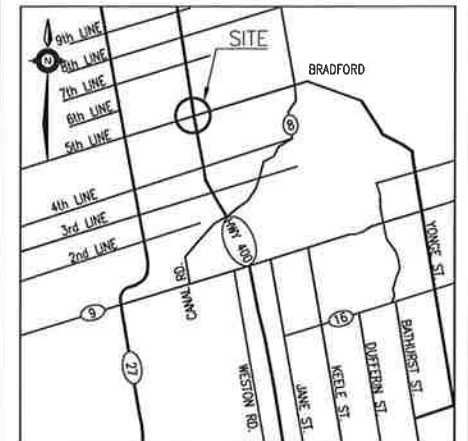
HIGHWAY 400 & LINE 5
N-EW & E-S RAMPS
HIGH FILLS
BOREHOLE LOCATIONS PLAN

AECOM

THURBER ENGINEERING LTD.



SHEET



KEYPLAN
LEGEND

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

NO	ELEVATION	NORTHING	EASTING
13-24	223.4	4 881 617.8	294 596.3
13-25	224.2	4 881 628.3	294 649.5
13-26	225.9	4 881 634.1	294 689.2
14-01	222.5	4 882 058.1	294 691.5
14-02	227.5	4 882 047.5	294 728.5
14-03	227.5	4 882 057.7	294 754.1
14-04	222.3	4 882 070.2	294 799.2
14-05	222.2	4 882 039.1	294 709.1
14-06	222.7	4 881 939.3	294 702.6
14-07	221.6	4 881 857.5	294 677.9
14-08	221.5	4 881 803.1	294 648.2
14-09	221.8	4 881 757.0	294 628.6
14-10	221.4	4 881 817.1	294 699.6

-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. 31D-605

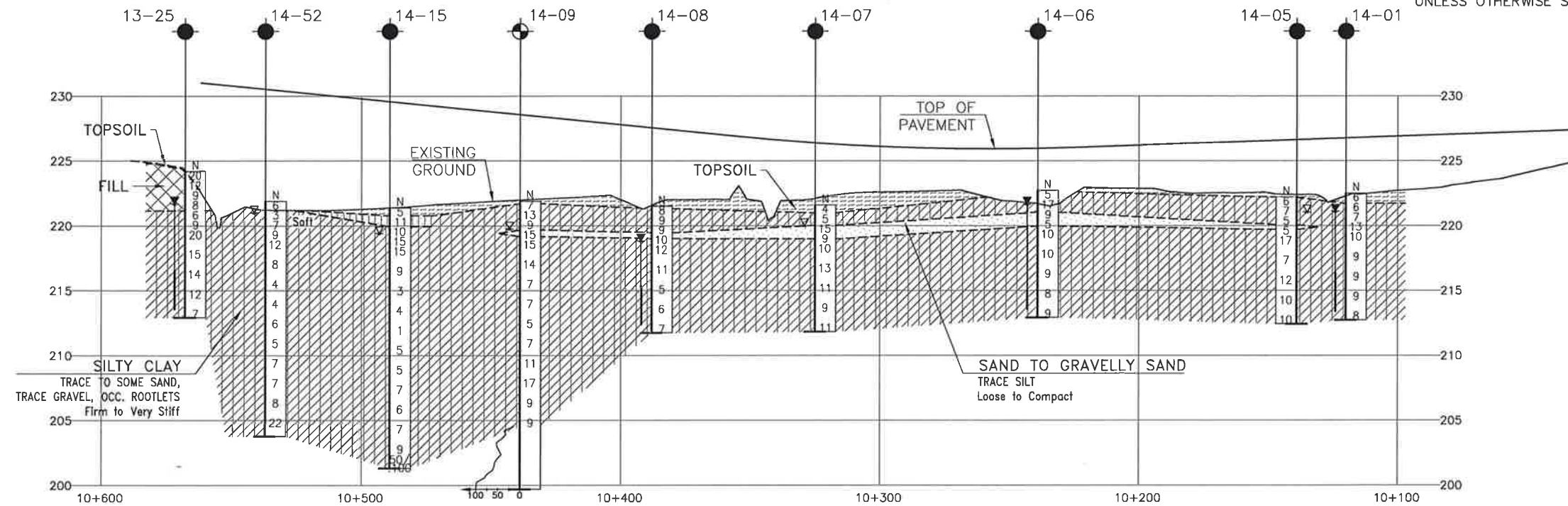
REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK PKC	CODE
DRAWN	AN	CHK RPR	SITE
			STRUCT
			DWG 1B
			DATE JUN 2015

NO	ELEVATION	NORTHING	EASTING
14-11	221.3	4 881 784.6	294 730.4
14-12	221.6	4 881 789.8	294 692.0
14-13	221.5	4 881 762.5	294 697.8
14-14	222.1	4 881 762.4	294 658.9
14-15	222.2	4 881 704.9	294 627.0
14-16	221.2	4 881 695.2	294 599.3
14-17	221.5	4 881 714.1	294 655.5
14-18	221.9	4 881 681.1	294 688.6
14-23	223.4	4 881 603.2	294 549.6
14-31	225.3	4 881 690.8	294 937.0
14-51	221.5	4 881 727.4	294 691.7
14-52	221.9	4 881 660.4	294 648.5

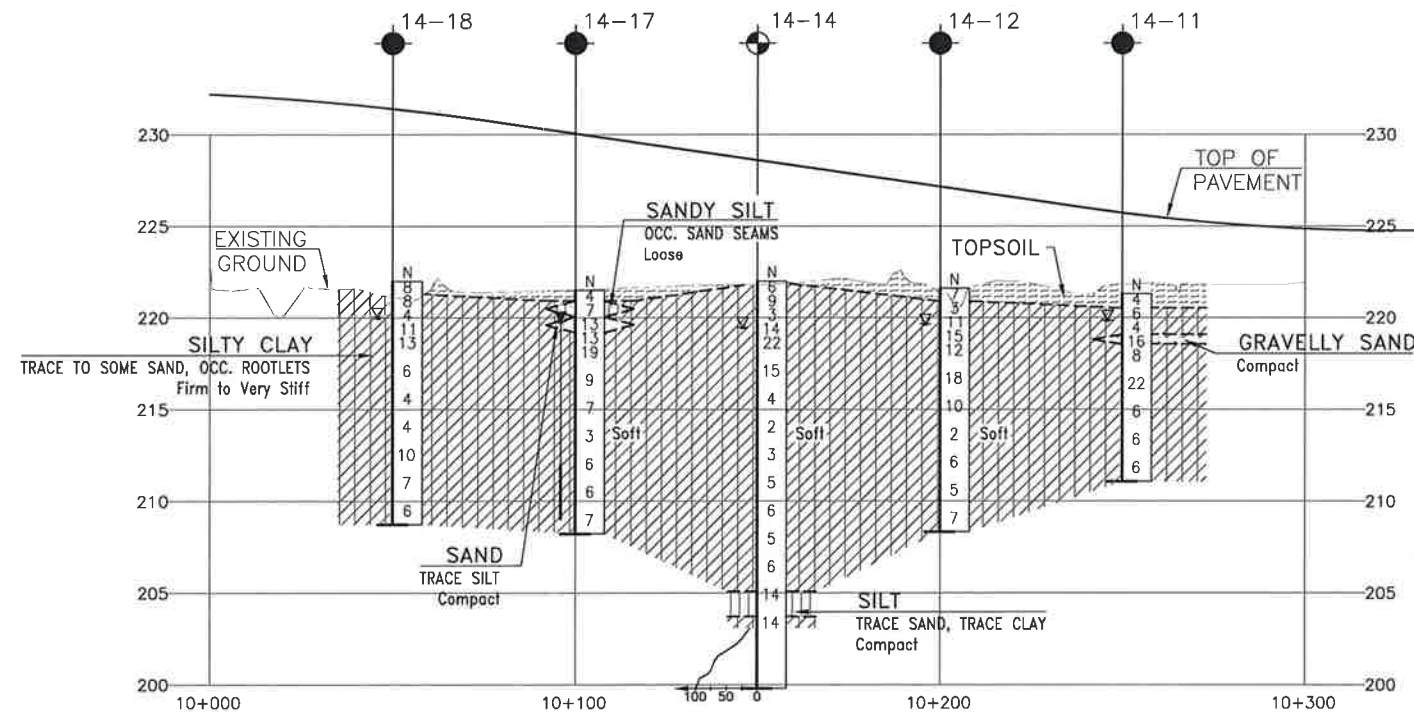
PLAN



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



PROFILE ALONG CL RAMP N-EW



PROFILE ALONG CL RAMP E-S



NO	ELEVATION	NORTHING	EASTING
13-25	224.2	4 881 628.3	294 649.5

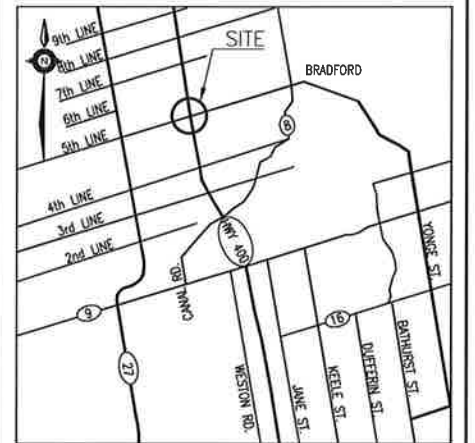
CONT No
WP No P13-03

HIGHWAY 400 & LINE 5
N-EW & E-S RAMP
HIGH FILLS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

AECOM

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
14-01	222.5	4 882 058.1	294 691.5
14-05	222.2	4 882 039.1	294 709.1
14-06	222.7	4 881 939.3	294 702.6
14-07	221.6	4 881 857.5	294 677.9
14-08	221.5	4 881 803.1	294 648.2
14-09	221.8	4 881 757.0	294 628.6
14-11	221.3	4 881 784.6	294 730.4
14-12	221.6	4 881 789.8	294 692.0
14-14	222.1	4 881 762.4	294 658.9
14-15	222.2	4 881 704.9	294 627.0
14-17	221.5	4 881 714.1	294 655.5
14-18	221.9	4 881 681.1	294 688.6
14-52	221.9	4 881 660.4	294 648.5

-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.

GEORES No. 31D-605

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK	PKC
DRAWN	AN	CHK	RPR

Appendix C

Ramps S-EW and W-S and Coffey Rd. - Embankments less than 4.5 m high, Boreholes 14-32, 14-38 and 14-42

- Record of Borehole Sheets
- Laboratory Test Results
- Drawing titled “Borehole Locations and Soil Strata”

RECORD OF BOREHOLE No 14-32

1 OF 1

METRIC

W.P. P-13-03 LOCATION Ramp S-EW N 4 881 698.8 E 294 979.0 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.19 - 2014.11.19 CHECKED BY RPR

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						
227.7	GROUND SURFACE													
0.0	ASPHALT: (100mm)													
0.1														
	SAND, some gravel to gravelly Brown Damp (FILL)		1	GS										
226.8														
0.9	Sandy SILT, trace clay Compact Brown Moist		1	SS	19									
226.2														
1.5	Silty CLAY, trace sand, trace gravel Stiff to Very Stiff Brown Moist		2	SS	11									
			3	SS	12									
			4	SS	14									
		Grey		5	SS	17								
			6	SS	11									
			7	SS	13									
219.5														
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.													

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-38

1 OF 1

METRIC

W.P. P-13-03 LOCATION Ramp W-S N 4 881 471.0 E 294 781.6 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY RPR

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 (%)					
225.3	GROUND SURFACE							20 40 60 80 100		W P W W L				GR SA SI CL	
0.0	ASPHALT: (25mm)		1	GS			225							0 0 63 37	
224.2	SAND, some gravel to gravelly Compact Brown to Dark Brown Moist (FILL)		1	SS	12		224								
			2	SS	14		223								
1.1	Silty CLAY, trace sand, trace gravel Stiff to Very Stiff Dark Brown to Brown Moist		3	SS	13		222								
			4	SS	15		221								
			5	SS	16		220								
			6	SS	13		219								
218.6															
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL IN OPEN BOREHOLE AT 1.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.1m, THEN ASPHALT TO SURFACE.														

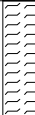

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

RECORD OF BOREHOLE No 14-42

1 OF 1

METRIC

W.P. P-13-03 LOCATION Coffey Road N 4 881 460.9 E 294 936.9 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.11.14 - 2014.11.14 CHECKED BY RPR

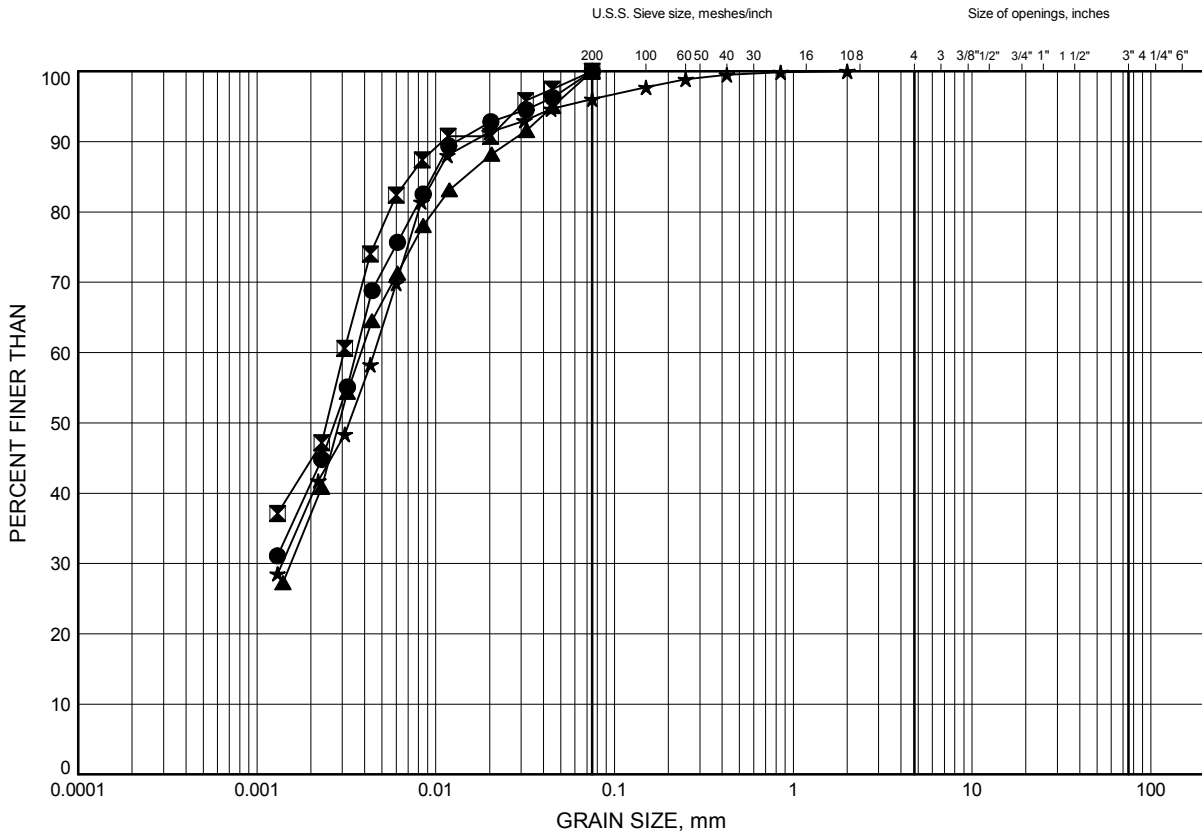
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)				
								20 40 60 80 100				W P W W L				
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
224.3	GROUND SURFACE					▽										
0.0	TOPSOIL , trace clay, occasional roots and rootlets Very Loose Dark Brown Wet		1	SS	1		224								83	
223.5																
0.8	Silty CLAY , trace sand Stiff to Very Stiff Brown Moist		2	SS	11		223						○			
			3	SS	17		222						○			
	Grey		4	SS	27		221						○			
221.4																
3.0	Hard Grey Wet		5	SS	49		220									
	Inferred cobbles															
220.2																
4.1			6	SS	20	219						○				
			7	SS	18	218						○				
217.6																
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL IN OPEN BOREHOLE AT 3.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.															

ONTMT4S 0615.GPJ 2012TEMPLATE(MTO).GDT 2/13/15

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE C1

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-32	2.59	225.11
⊠	14-32	4.88	222.82
▲	14-38	1.83	223.47
★	14-38	4.88	220.42

Date February 2015
W.P. P-13-03

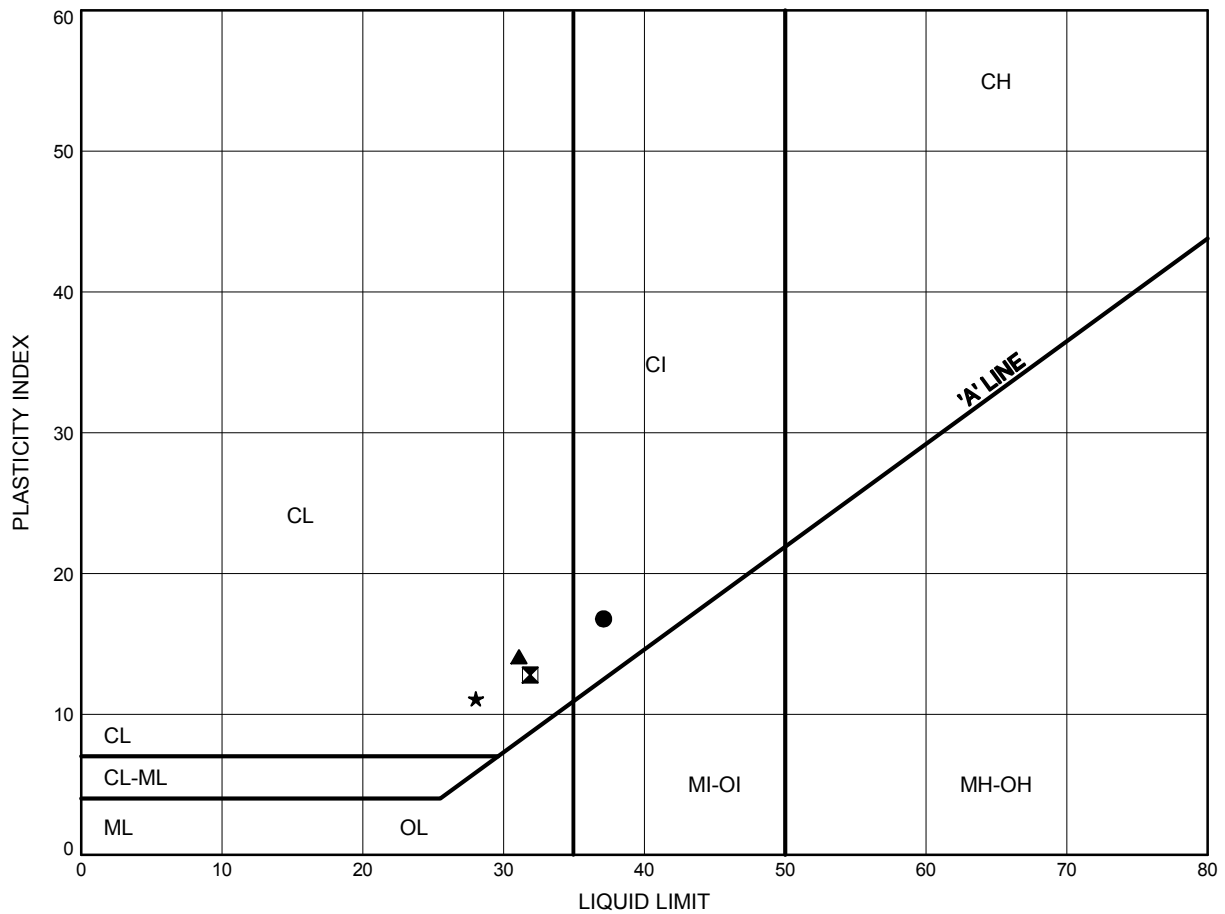


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE C2

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-32	2.59	225.11
⊠	14-32	4.88	222.82
▲	14-38	1.83	223.47
★	14-38	4.88	220.42

Date February 2015
 W.P. P-13-03



Prep'd AN
 Chkd. RPR

SHEET

LEGEND

NO	ELEVATION	NORTHING	EASTING
14-32	227.7	4 881 698.8	294 979.0
14-38	225.3	4 881 471.0	294 781.6
14-42	224.3	4 881 460.9	294 936.9

GEOCRES No. 31D-605

REVISIONS											
DATE	BY	DESCRIPTION									
DESIGN	RPR	CHK	PKC	CODE	LOAD					DATE	JUN 2015
DRAWN	AN	CHK	RPR	SITE	STRUCT			DWG	1C		

Appendix D

Culvert extensions at Sucker Creek Culvert, Highway 400

Boreholes 14-01 to 14-04

- Record of Borehole Sheets
- Laboratory Test Results
- Drawing titled “Borehole Locations and Soil Strata”

RECORD OF BOREHOLE No 14-01

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 058.1 E 294 691.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.28 - 2014.10.28 CHECKED BY RPR

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								
222.5	GROUND SURFACE							20	40	60	80	100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
0.0	TOPSOIL , occasional roots and rootlets Loose Dark Brown Moist		1	SS	6		222									
221.7																
0.8	Silty CLAY , trace sand, trace gravel, occasional rootlets Firm to Stiff Brown to Grey Moist		2	SS	6		221									0 9 61 30
	Occasional sand seams		3	SS	7					2.6						
220.3																
2.2	Stiff Grey		4	SS	13		220									
			5	SS	10		219			2.8						
			6	SS	9		218			2.3						0 7 47 46
							217									
			7	SS	9		216			2.2						
215.3																
7.2	Firm		8	SS	9		215			2.4						0 6 55 39
							214									
			9	SS	8		213			2.2						
212.7																
9.8	END OF BOREHOLE AT 9.8m.															

Continued Next Page

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

RECORD OF BOREHOLE No 14-01

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 058.1 E 294 691.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.10.28 - 2014.10.28 CHECKED BY RPR

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									
	Continued From Previous Page																
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Nov 07/ 14 1.4 221.1 Dec 08/ 14 1.2 221.3 Jan 06/ 15 1.4 221.1 NOTE: Field vane shear values were measured in a separate hole located adjacent to the original sampled borehole.																

RECORD OF BOREHOLE No 14-02

1 OF 3

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 047.5 E 294 728.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration test COMPILED BY AN
 DATUM Geodetic DATE 2014.11.24 - 2014.11.24 CHECKED BY RPR

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						
227.5	GROUND SURFACE													
0.0	ASPHALT:(125mm)													
0.1	SAND and GRAVEL Compact Brown Moist (FILL)		1	GS										
			1	SS	17									
			2	SS	19									
			3	SS	15									
			4	SS	18									
			5	SS	11									
222.0														
5.5	Silty CLAY, with sand, trace gravel Firm Brown Moist		6	SS	4									
220.3														
7.2			7	SS	19									
	Trace sand Firm Grey Wet		8	SS	5									

Continued Next Page

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

ONTMT4S 0615.GPJ 2015TEMPLATE(MTO).GDT 4/21/15

RECORD OF BOREHOLE No 14-02

2 OF 3

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 047.5 E 294 728.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration test COMPILED BY AN
 DATUM Geodetic DATE 2014.11.24 - 2014.11.24 CHECKED BY RPR

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			20 40 60 80 100	20 40 60 80 100					
	Continued From Previous Page													
	Silty CLAY , some sand Firm to Stiff Grey Wet		9	SS	7		217	2.4						
							216	2.9						
			10	SS	9		215							0 15 50 35
214.4 13.1	End of sampling and start of DCPT						214	2.5						
							213							
							212							
							211							
							210							
							209							
							208							

Continued Next Page

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

RECORD OF BOREHOLE No 14-02

3 OF 3

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 047.5 E 294 728.5 ORIGINATED BY ES
 HWY 400 BOREHOLE TYPE Hollow Stem Augers/Dynamic Cone Penetration test COMPILED BY AN
 DATUM Geodetic DATE 2014.11.24 - 2014.11.24 CHECKED BY RPR

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	W _p	W	W _L	WATER CONTENT (%)		
	Continued From Previous Page						<div> <div>20 40 60 80 100</div> <div> <div>○ UNCONFINED</div> <div>● QUICK TRIAXIAL</div> </div> <div> <div>+ FIELD VANE</div> <div>× LAB VANE</div> </div> </div>							
202.8														
24.7	END OF BOREHOLE AT 24.7m. WATER LEVEL IN OPEN BOREHOLE AT 5.9m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.													

RECORD OF BOREHOLE No 14-03

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 057.7 E 294 754.1 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.16 - 2014.01.16 CHECKED BY RPR

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 (%)					GR	SA	SI	CL
								<div><div></div><div></div><div></div><div></div><div></div></div> <div>20 40 60 80 100</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div>				<div><div></div><div></div><div></div><div></div><div></div></div> <div>20 40 60</div> <div>w_P w w_L</div>								
227.5	GROUND SURFACE																			
0.0 0.1	ASPHALT:(75 mm)		1	SS	29		227						○			39	50	11 (SI+CL)		
226.7	SAND and GRAVEL, some silt and clay Compact Brown Moist (FILL)		2	SS	26		226						○							
0.8	Silty CLAY, trace to some sand, trace gravel Very Stiff Brown Moist (FILL)		3	SS	24		225						○							
			4	SS	18		224						○							
			5	SS	17		223						○							
			6	SS	19		222						○							
222.8			7	SS	15		221						○							
4.6	Silty CLAY, trace sand Stiff Brown to Grey Moist		8	SS	14		220						○							
			9	SS	16		219						○							
	Trace gravel Very Stiff Grey Moist to Wet		10	SS	17		218						○							

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 14-03

2 OF 2

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 057.7 E 294 754.1 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.16 - 2014.01.16 CHECKED BY RPR

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									
	Continued From Previous Page																
216.2	Silty CLAY , trace sand Stiff Grey Wet		11	SS	13		217										
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 11.3m AND WATER LEVEL AT 9.4m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.3m, CONCRETE TO 0.1m THEN ASPHALT PATCH TO SURFACE.																

RECORD OF BOREHOLE No 14-04

1 OF 2

METRIC

W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 060.0 E 294 769.6 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.31 - 2014.01.31 CHECKED BY RPR

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						
222.3	GROUND SURFACE													
0.0	TOPSOIL: (125 mm)													
0.1	Silty CLAY, trace sand, occasional rootlets Firm Brown to Grey Moist to Wet		1	SS	7		222							
			2	SS	7		221							
	Wet		3	SS	7									
220.1	Stiff to Very Stiff		4	SS	13		220							0 5 51 44
2.2	Grey Wet		5	SS	18		219							
			6	SS	17		218							
			7	SS	16		217							
	Trace gravel		8	SS	13		216							5 6 43 46
			9	SS	9		215							
			10	SS	6		214							
	Firm						213							

Continued Next Page

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

RECORD OF BOREHOLE No 14-04

2 OF 2

METRIC

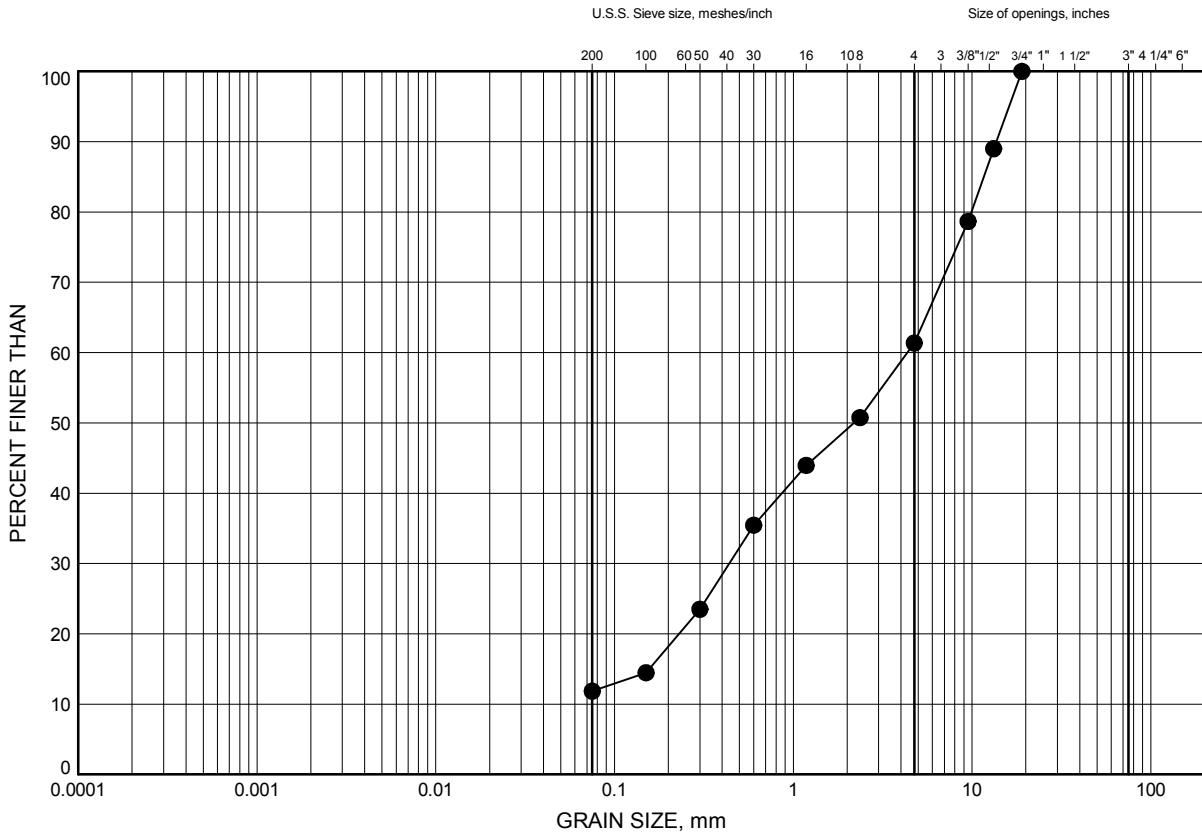
W.P. P-13-03 LOCATION Sucker Creek Culvert N 4 882 060.0 E 294 769.6 ORIGINATED BY GA
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2014.01.31 - 2014.01.31 CHECKED BY RPR

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									
	Continued From Previous Page																
211.0	Silty CLAY Firm to Stiff Grey Wet		11	SS	6		212										
11.3	END OF BOREHOLE AT 11.3 m. BOREHOLE OPEN TO 11.3 m AND WATER LEVEL AT 1.5 m. Piezometer installation consists of 19 mm diameter Schedule 40 PVC pipe with a 3.0 m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Jan 21/ 15 1.3 221.0																

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE D1

SAND & GRAVEL FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-03	0.38	227.07

Date February 2015
W.P. P-13-03

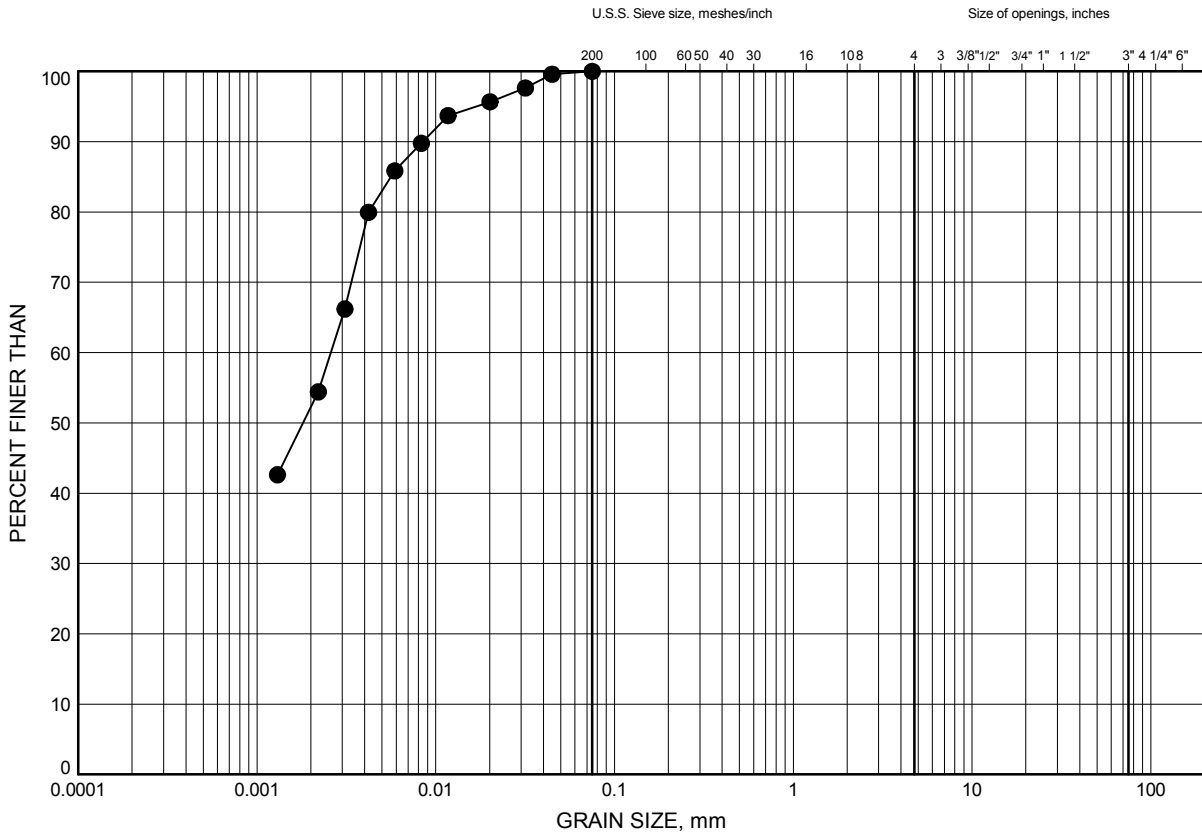


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE D2

SILTY CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-03	4.11	223.34

Date February 2015
W.P. P-13-03

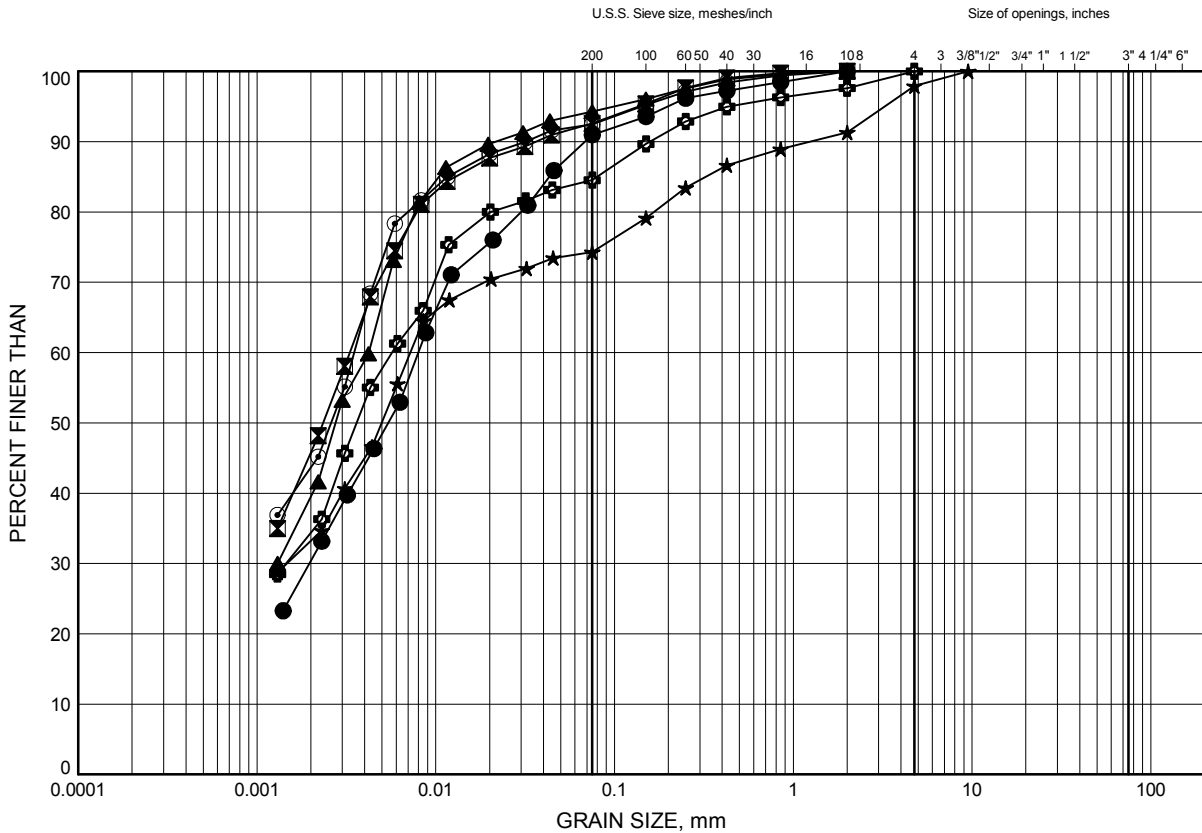


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE D3

SLLTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-01	1.07	221.43
⊠	14-01	4.88	217.62
▲	14-01	7.92	214.58
★	14-02	2.59	224.86
⊙	14-02	9.45	218.00
⊕	14-02	12.50	214.96

Date February 2015
W.P. P-13-03

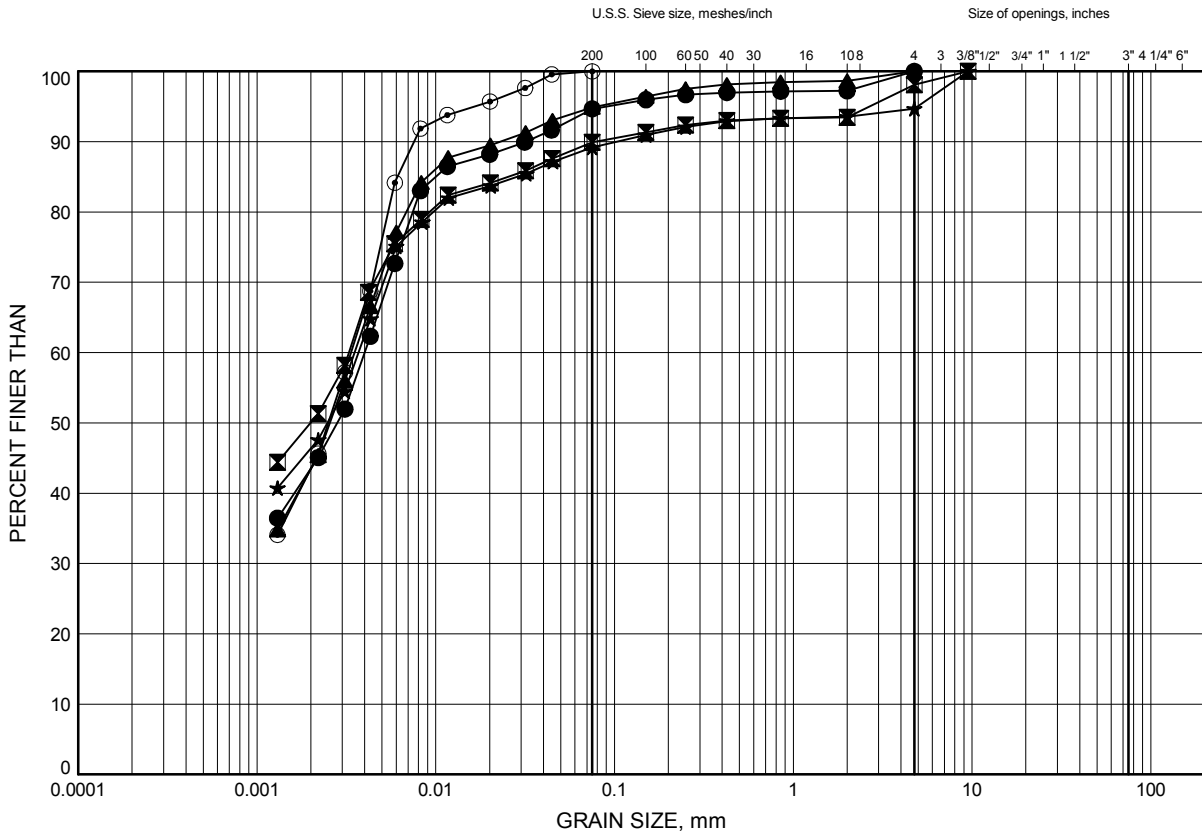


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
GRAIN SIZE DISTRIBUTION

FIGURE D4

SLLTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-03	4.88	222.58
⊠	14-03	7.92	219.53
▲	14-04	2.59	219.71
★	14-04	6.40	215.90
⊙	14-04	10.97	211.33

Date February 2015
W.P. P-13-03

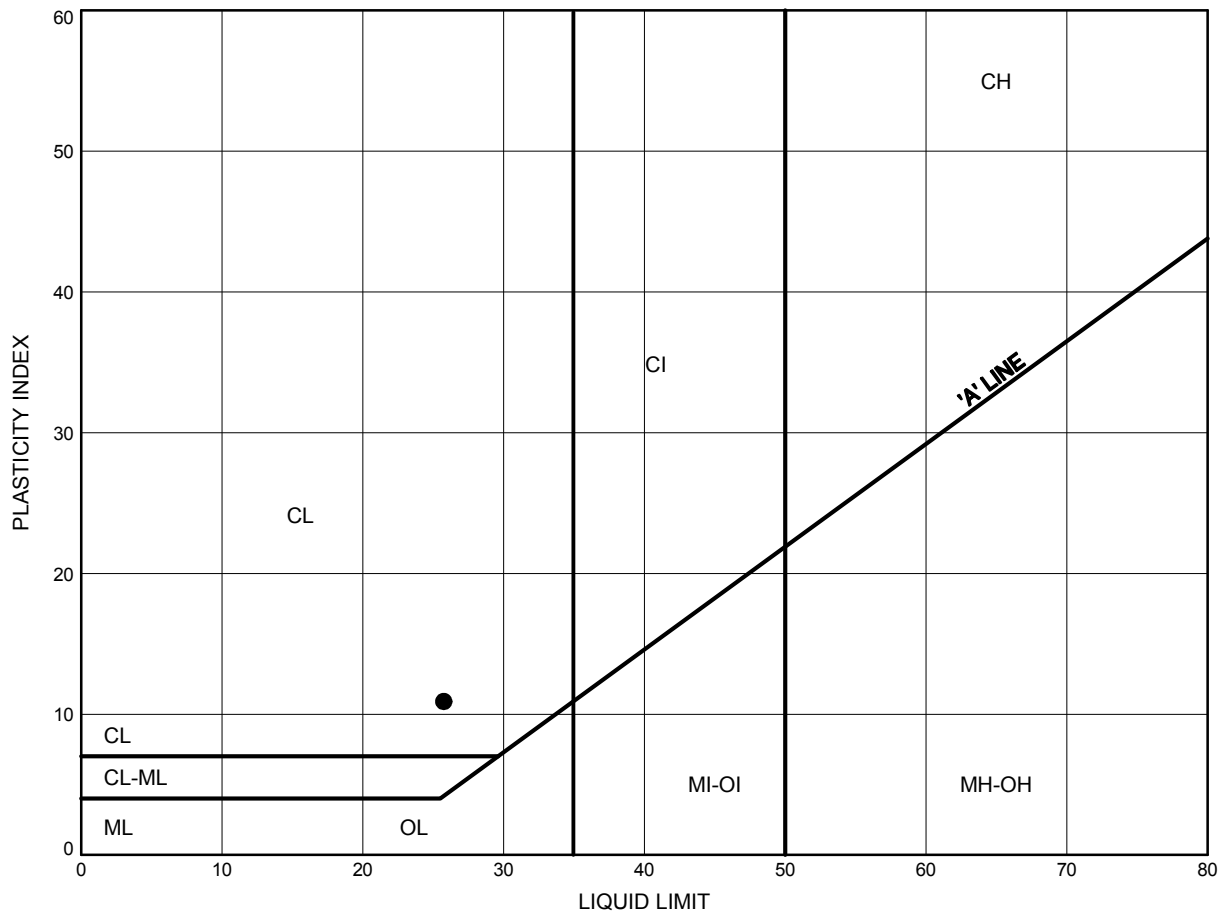


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE D5

SILTY CLAY FILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-03	4.11	223.34

Date February 2015
 W.P. P-13-03

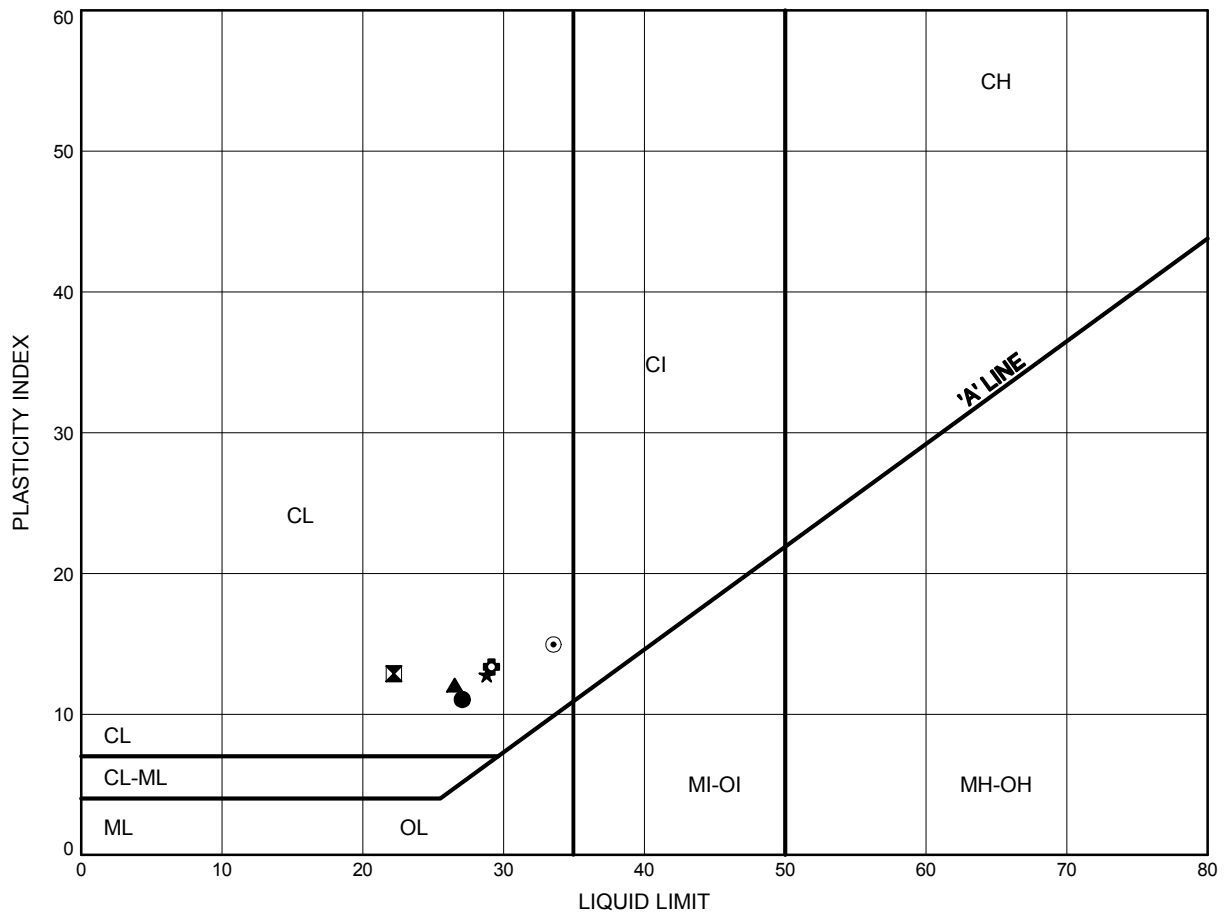


Prep'd AN
 Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE D6

SILTY CLAY



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-01	4.88	217.62
⊠	14-01	7.92	214.58
▲	14-02	2.59	224.86
★	14-02	9.45	218.00
⊙	14-03	4.88	222.58
⊕	14-03	7.92	219.53

Date February 2015
W.P. P-13-03

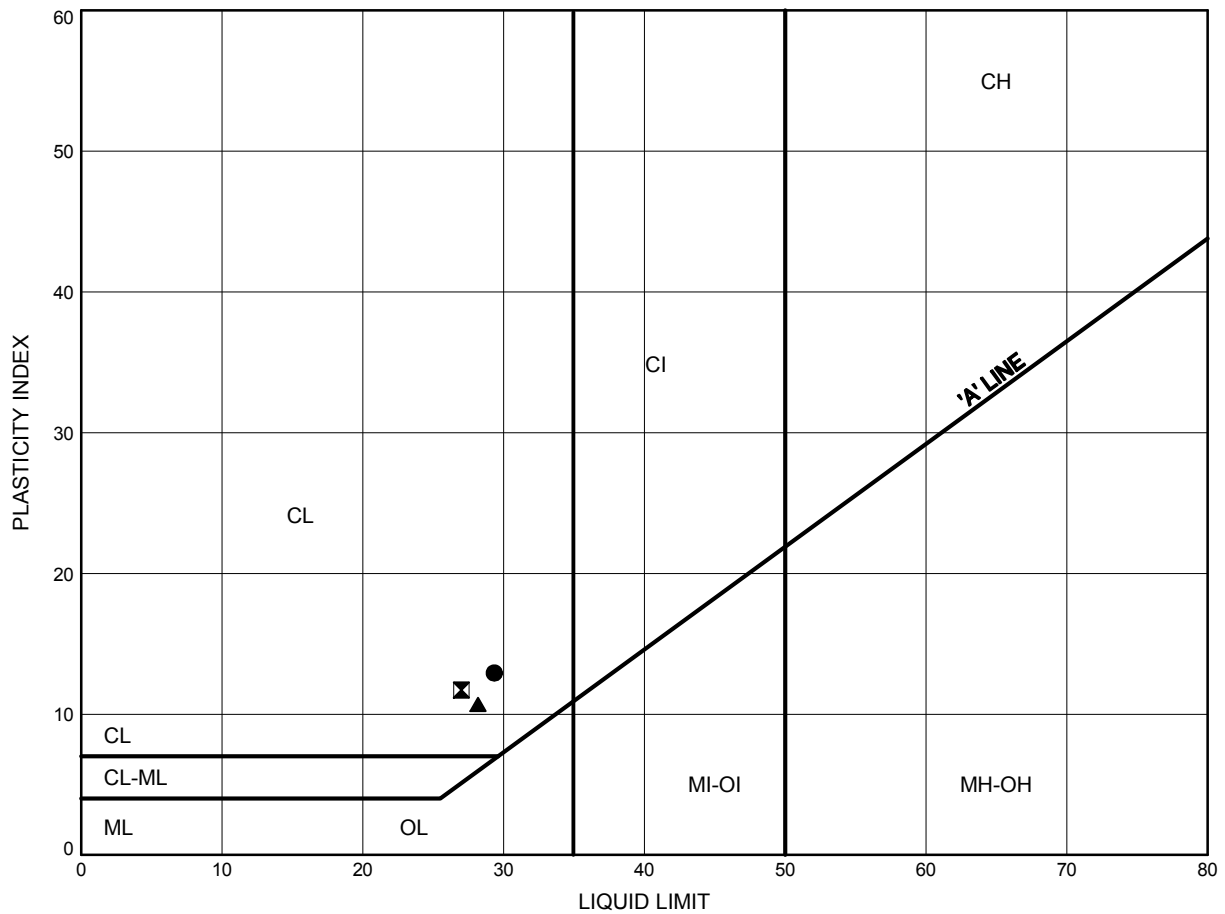


Prep'd AN
Chkd. RPR

Foundation Engineering, Hwy. 400 and 5th Line
ATTERBERG LIMITS TEST RESULTS

FIGURE D7

SILTY CLAY



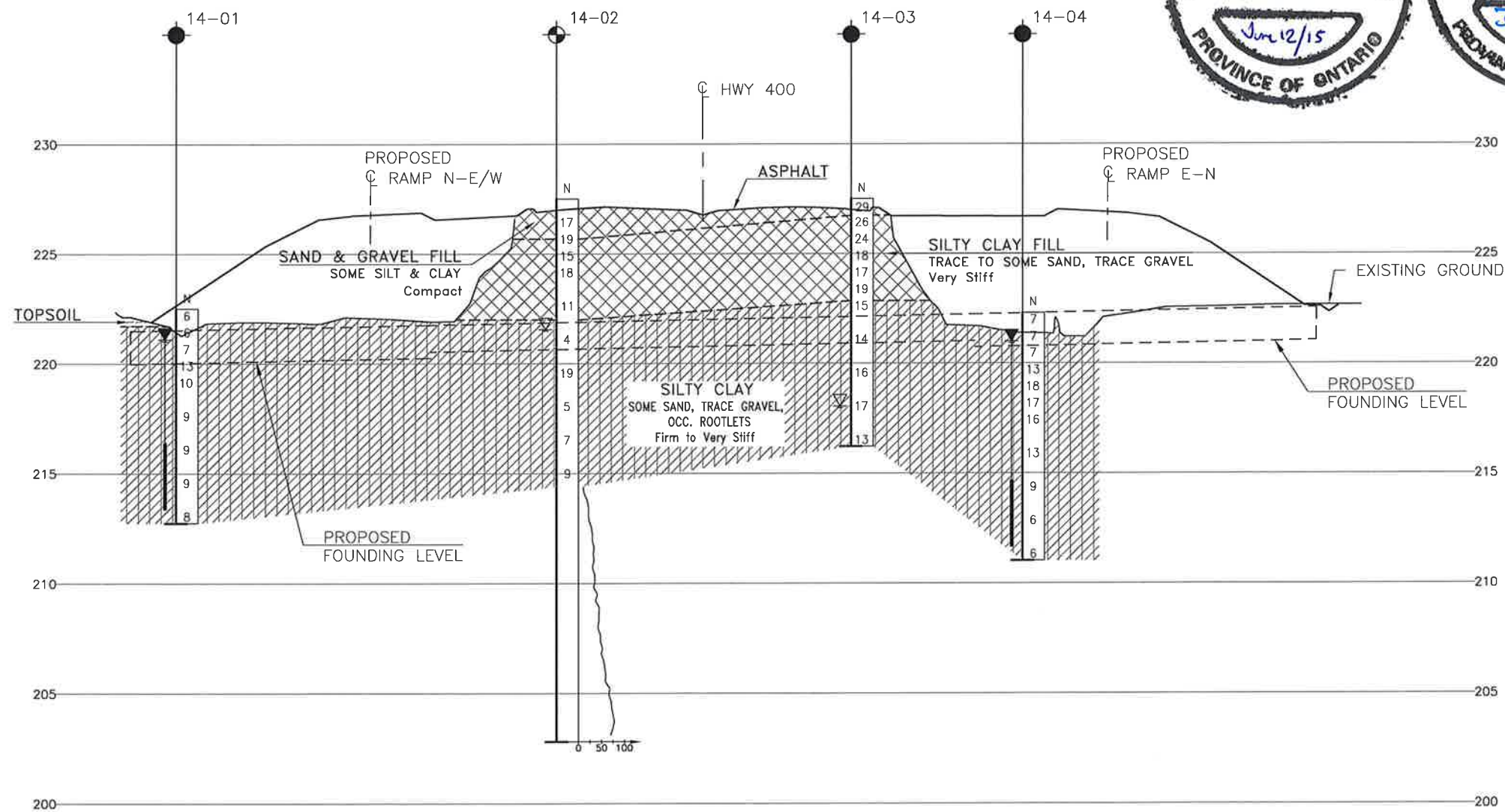
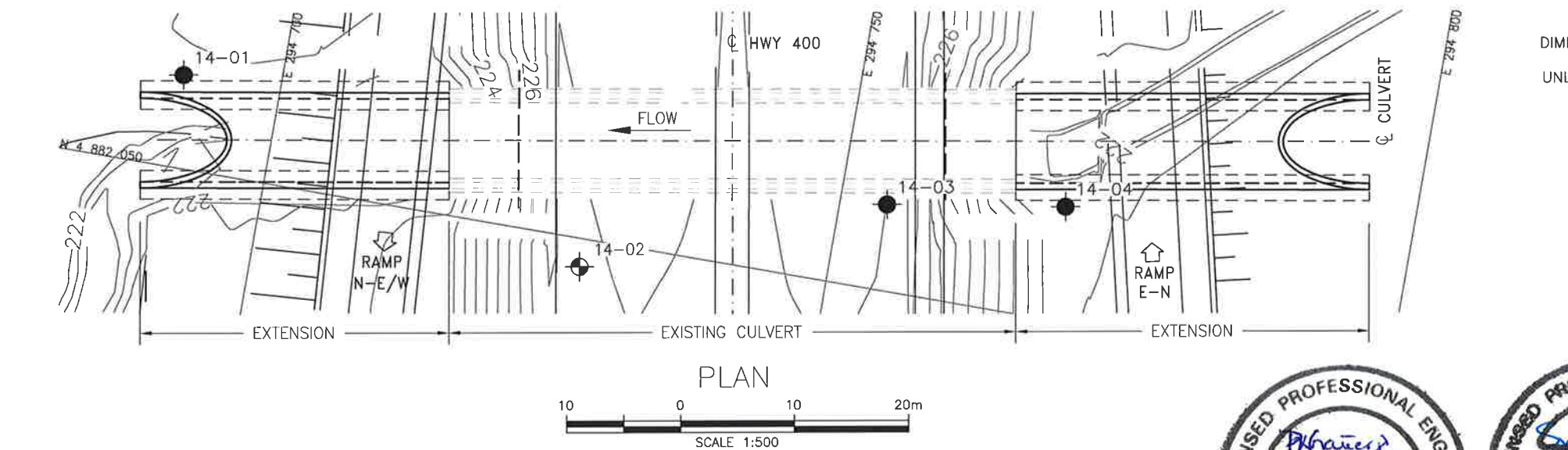
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	14-04	2.59	219.71
⊠	14-04	6.40	215.90
▲	14-04	10.97	211.33

Date February 2015
W.P. P-13-03



Prep'd AN
Chkd. RPR



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



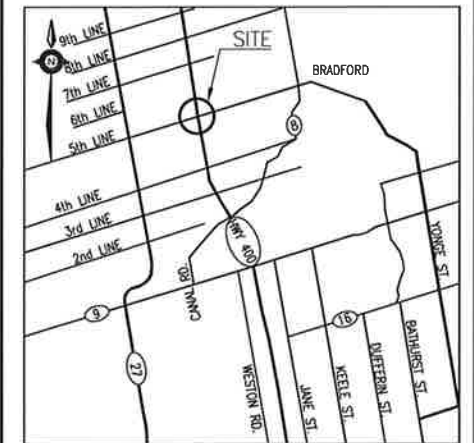
CONT No
WP No P13-03

HIGHWAY 400 & LINE 5
SUCKER CREEK
CULVERT EXTENSION
BOREHOLE LOCATIONS & SOIL STRATA

AECOM



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	Borehole
⊙	Borehole and Cone
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
14-01	222.5	4 882 058.1	294 691.5
14-02	227.5	4 882 047.5	294 728.5
14-03	227.5	4 882 057.5	294 754.1
14-04	222.3	4 882 060.0	294 769.6

-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. 31D-605

REVISIONS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						</
-----------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	----

Appendix E

Comparison of Foundation Alternatives for New Bridge at Sideroad 5

COMPARISON OF FOUNDATION ALTERNATIVES FOR NEW BRIDGE AT SIDEROAD 5

Foundation Unit	Spread Footings on Native Soils	Driven Steel H-Pile into Native Glacial Till/Sand and Silt	Augered Caissons (Drilled Shafts) into Native Glacial Till/ Sand and Silt
	<p>Advantages:</p> <ul style="list-style-type: none"> i. Ease of construction. ii. Lower cost than deep foundations. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Relatively low geotechnical resistance is available. ii. Potential for long-term settlement of foundation soils due to consolidation under approach fill loads. iii. Dewatering may be required, depending on depth of excavation and groundwater level at time of construction. 	<p>Advantages:</p> <ul style="list-style-type: none"> i. Ease of construction. ii. Allows choice of conventional, integral or semi-integral abutment design. iii. Dewatering not required for pile installation. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher unit cost compared to footings. ii. Subject to downdrag force at abutments unless preloading/surcharging is implemented. iii. Relatively lower lateral resistance is available given the pile dimension. iv. Potential obstruction to pile penetration at elevations higher than the design tip elevations. v. Larger number of piles will likely be required to resist foundation loads. 	<p>Advantages:</p> <ul style="list-style-type: none"> i. Higher axial resistance than H-pile. ii. Higher lateral resistance is available due to larger diameter. iii. Less number of caissons is required for each foundation element than if steel piles were used. iv. Construction of caissons could continue in freezing weather. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher unit cost than steel driven piles. ii. Not suitable for integral abutments iii. Steel liners will be required to install caissons to minimize sidewall sloughing and water seepage. iv. Tremie concrete may need to be used should accumulated water in excavation cannot be removed. v. Difficulty in cleaning and inspecting bases.
Abutment	NOT RECOMMENDED	RECOMMENDED	FEASIBLE

Appendix F

List of OPSS Documents and Nssp Wording

1. List of OPSS Documents Referenced in this Report

- OPSS 903
- OPSS 206
- OPSS 804
- OPSS 805
- OPSS 501
- OPSS 539
- OPSS 902
- OPSS 10103
- OPSD 3000.100

2. Suggested Text for NSSP on “Drilling of Caisson Sockets”

The native soil deposits generally increase in strength with depth and contain hard zones throughout. Caisson installation through glacially derived soil deposits may encounter cobbles and/or boulders, and the installation equipment should be capable of dislodging and removing such obstructions. Augering and excavation through the obstructions and hard zones may be difficult.

3. Suggested Text for NSSP on “Embankment Subgrade Preparation”

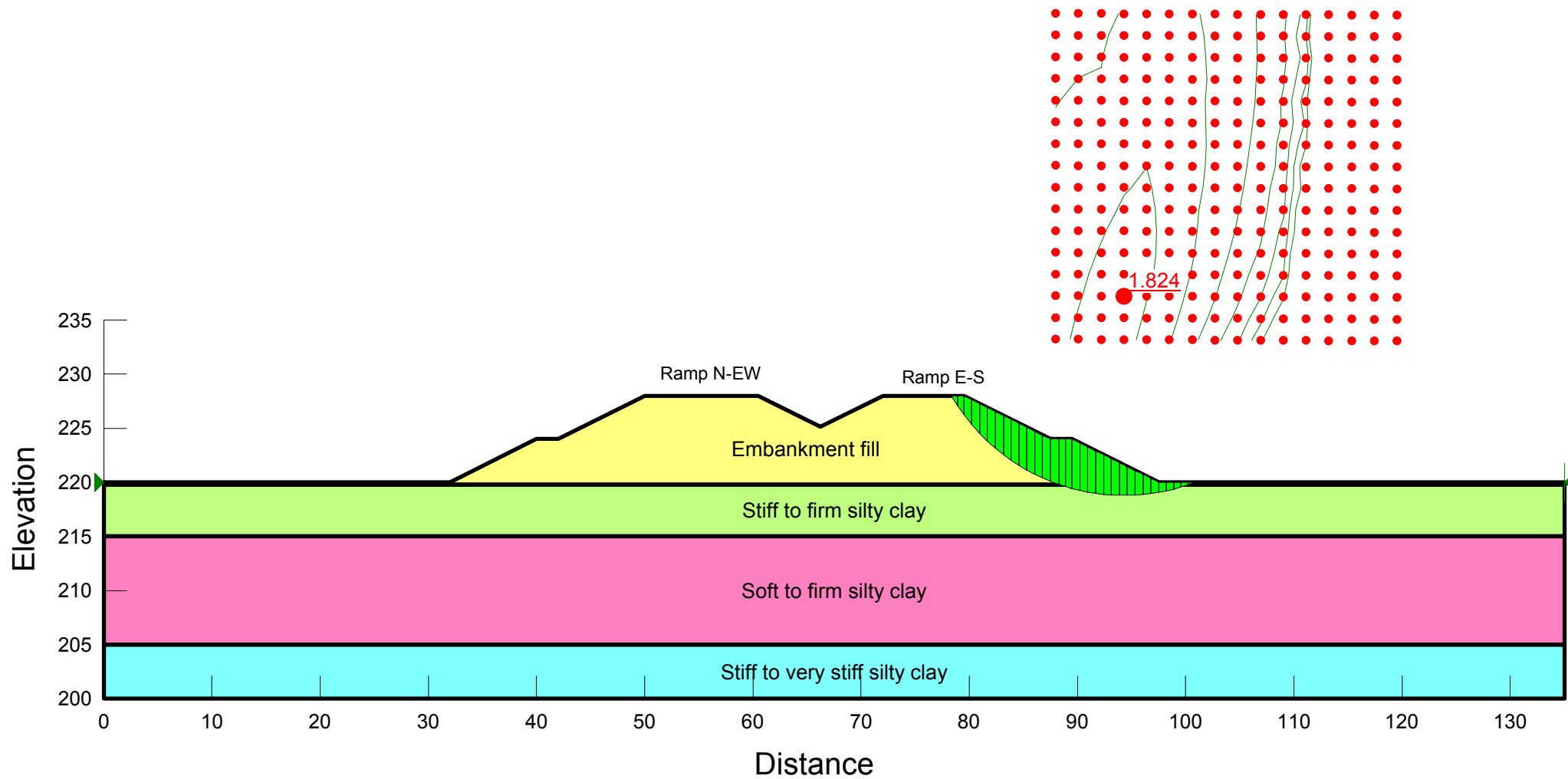
The Contractor is advised that the native silty clay, that will be exposed at the subgrade following clearing, grubbing and/or stripping of topsoil, is soft and moisture sensitive and may become severely disturbed or otherwise negatively impacted when subjected to construction traffic, freeze-thaw actions, ingress of surface water and/or fluctuations of the water table. The Contractor shall be responsible for providing adequate site and subgrade drainage to maintain good trafficability on the subgrade for construction equipment. No additional compensation shall be made to the Contractor for carrying out his operation or construction activities to suit these conditions.

Appendix G

Selected Embankment Stability Analyses Results

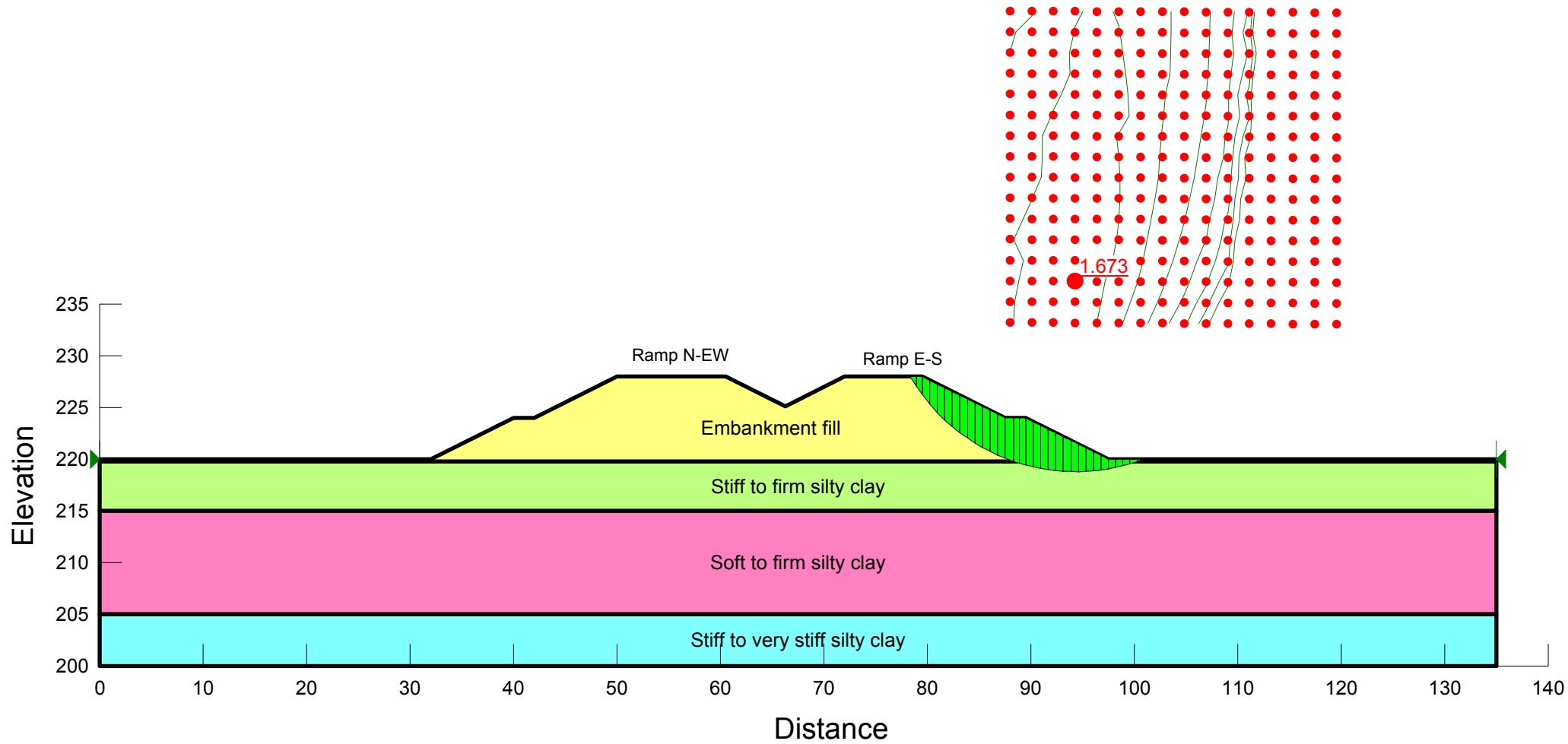
19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp E-S
 Long Term / Drained Analysis

Embankment fill	21 kN/m ³	0 kPa	35 °	1	Yes		
Stiff to firm silty clay	20 kN/m ³	0 kPa	30 °	1	0.3	No	
Soft to firm silty clay	19 kN/m ³	0 kPa	28 °	1	0.6	No	
Stiff to very stiff silty clay	21 kN/m ³	0 kPa	32 °	1	0.3	No	



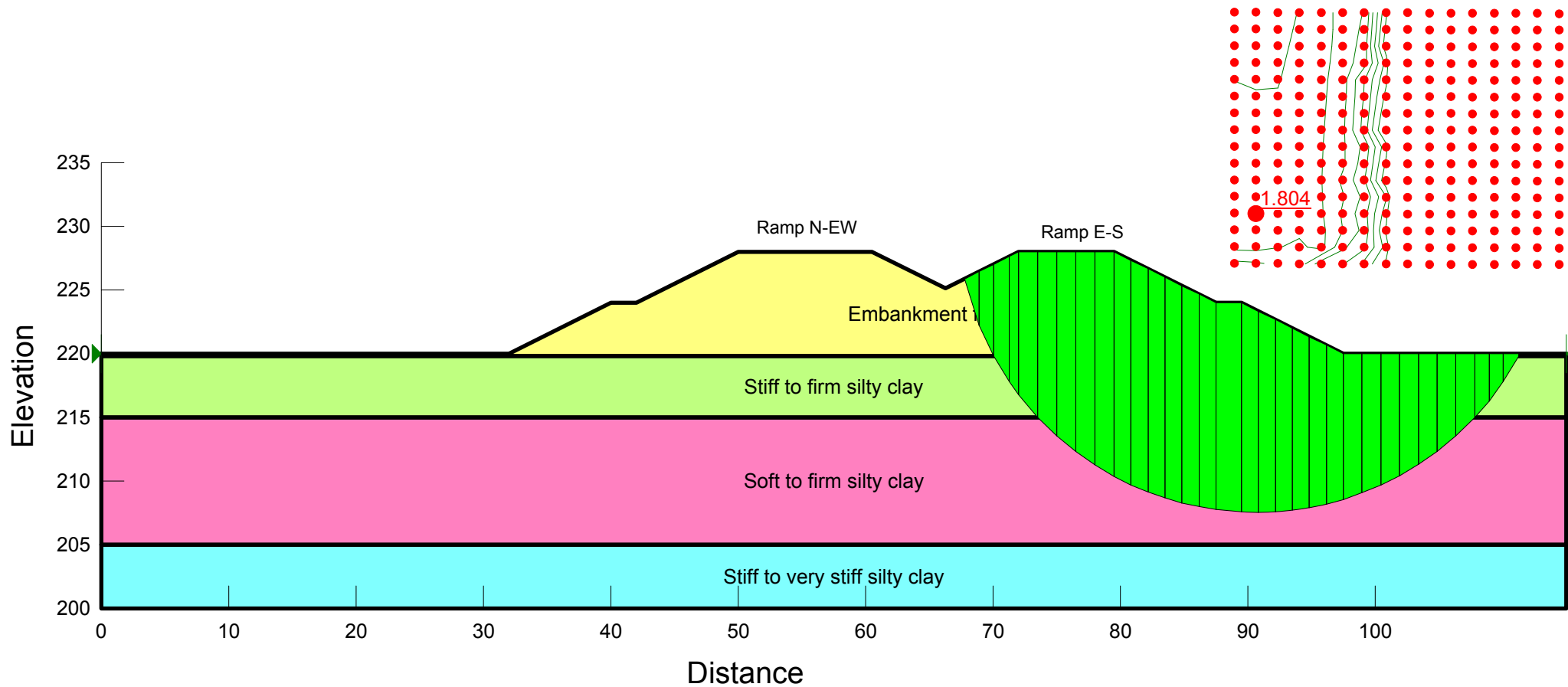
19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp E-S
 Long Term / Drained Analysis

Embankment fill	21 kN/m ³	0 kPa	30 °	1	Yes	
Stiff to firm silty clay	20 kN/m ³	0 kPa	30 °	1	0.3	No
Soft to firm silty clay	19 kN/m ³	0 kPa	28 °	1	0.6	No
Stiff to very stiff silty clay	21 kN/m ³	0 kPa	32 °	1	0.3	No



19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp E-S
 Short Term / Undrained Analysis

Embankment fill	21 kN/m³	0 kPa	35 °	1
Stiff to firm silty clay	20 kN/m³	75 kPa	0 °	1
Soft to firm silty clay	19 kN/m³	45 kPa	0 °	1
Stiff to very stiff silty clay	21 kN/m³	125 kPa	0 °	1



19-4406-15

Highway 400 & 5th Line

Slope stability analysis of Ramp E-S

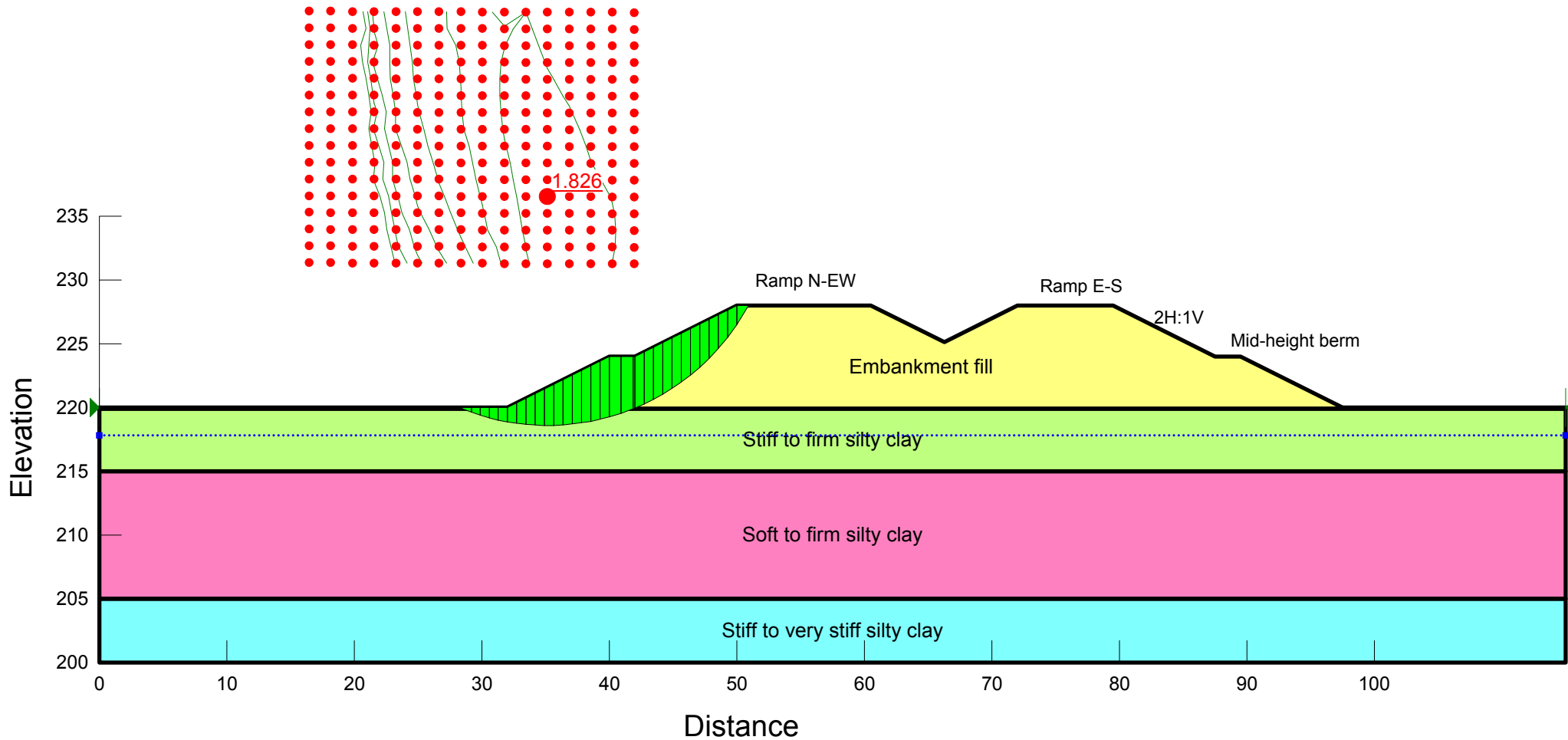
Short Term / Undrained Analysis

Embankment fill	21 kN/m ³	0 kPa	30 °	1
Stiff to firm silty clay	20 kN/m ³	75 kPa	0 °	1
Soft to firm silty clay	19 kN/m ³	45 kPa	0 °	1
Stiff to very stiff silty clay	21 kN/m ³	125 kPa	0 °	1



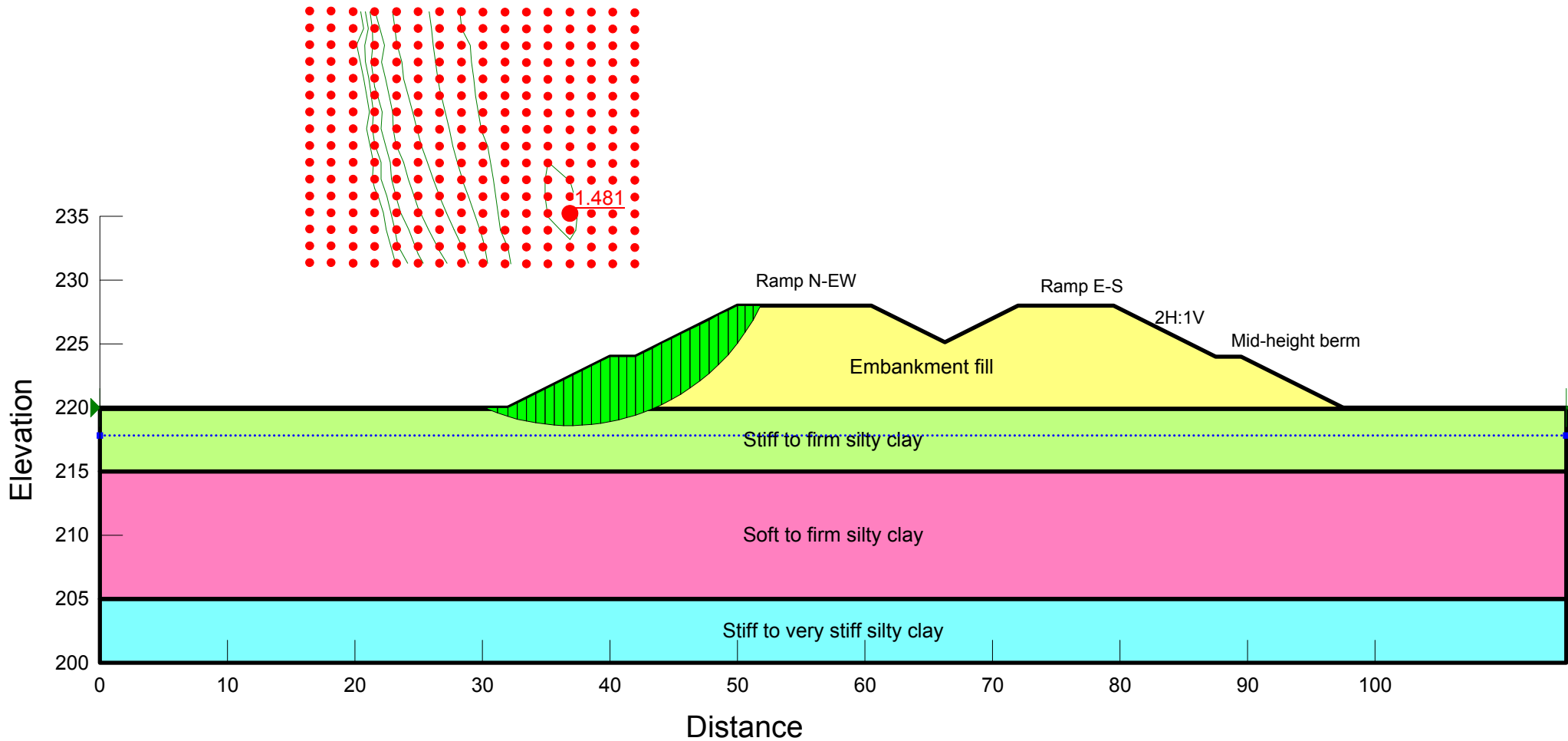
19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp N-EW
 Long term/Drained

Embankment fill	21 kN/m³	0 kPa	35 °	1	Yes	
Stiff to firm silty clay	20 kN/m³	0 kPa	30 °	1	0.3	No
Soft to firm silty clay	19 kN/m³	0 kPa	28 °	1	0.6	No
Stiff to very stiff silty clay	21 kN/m³	0 kPa	32 °	1	0.3	No



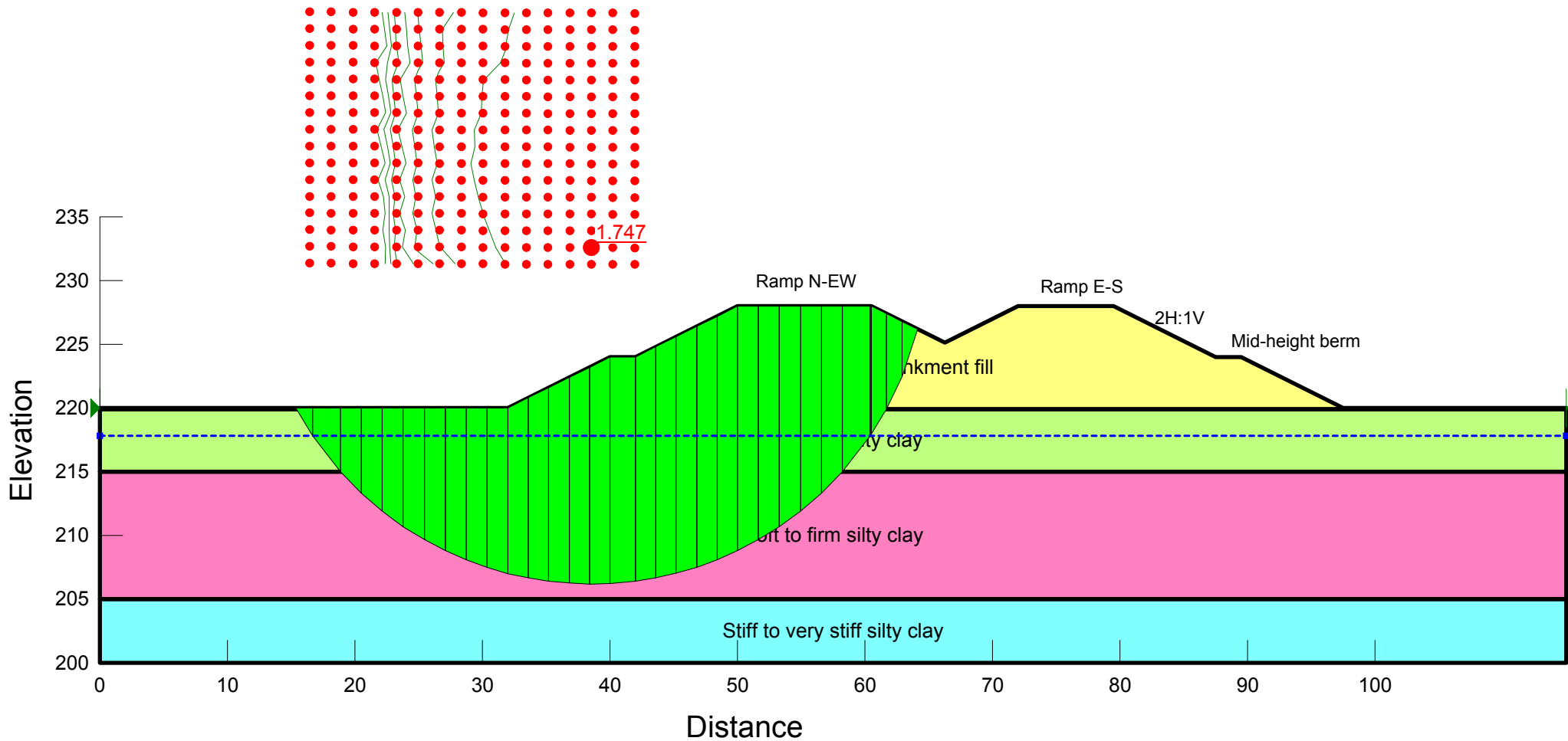
19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp N-EW
 Long term/Drained

Embankment fill	21 kN/m³	0 kPa	30 °	1	Yes	
Stiff to firm silty clay	20 kN/m³	0 kPa	30 °	1	0.6	No
Soft to firm silty clay	19 kN/m³	0 kPa	28 °	1	0.3	No
Stiff to very stiff silty clay	21 kN/m³	0 kPa	32 °	1	0.6	No



19-4406-15
Highway 400 & 5th Line
Slope stability analysis of Ramp N-EW
Short term/Undrained

Embankment fill	21 kN/m ³	0 kPa	35 °	1
Stiff to firm silty clay	20 kN/m ³	75 kPa	0 °	1
Soft to firm silty clay	19 kN/m ³	45 kPa	0 °	1
Stiff to very stiff silty clay	21 kN/m ³	125 kPa	0 °	1



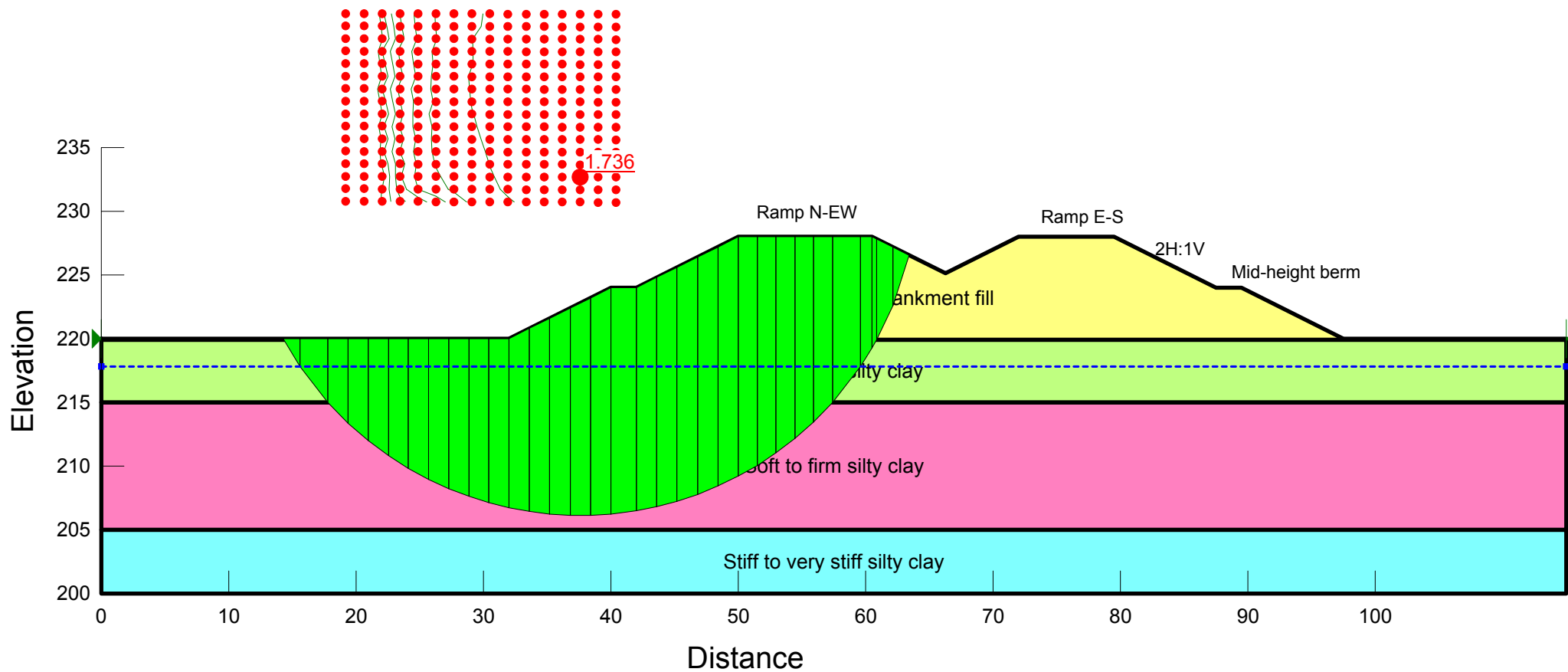
19-4406-15

Highway 400 & 5th Line

Slope stability analysis of Ramp N-EW

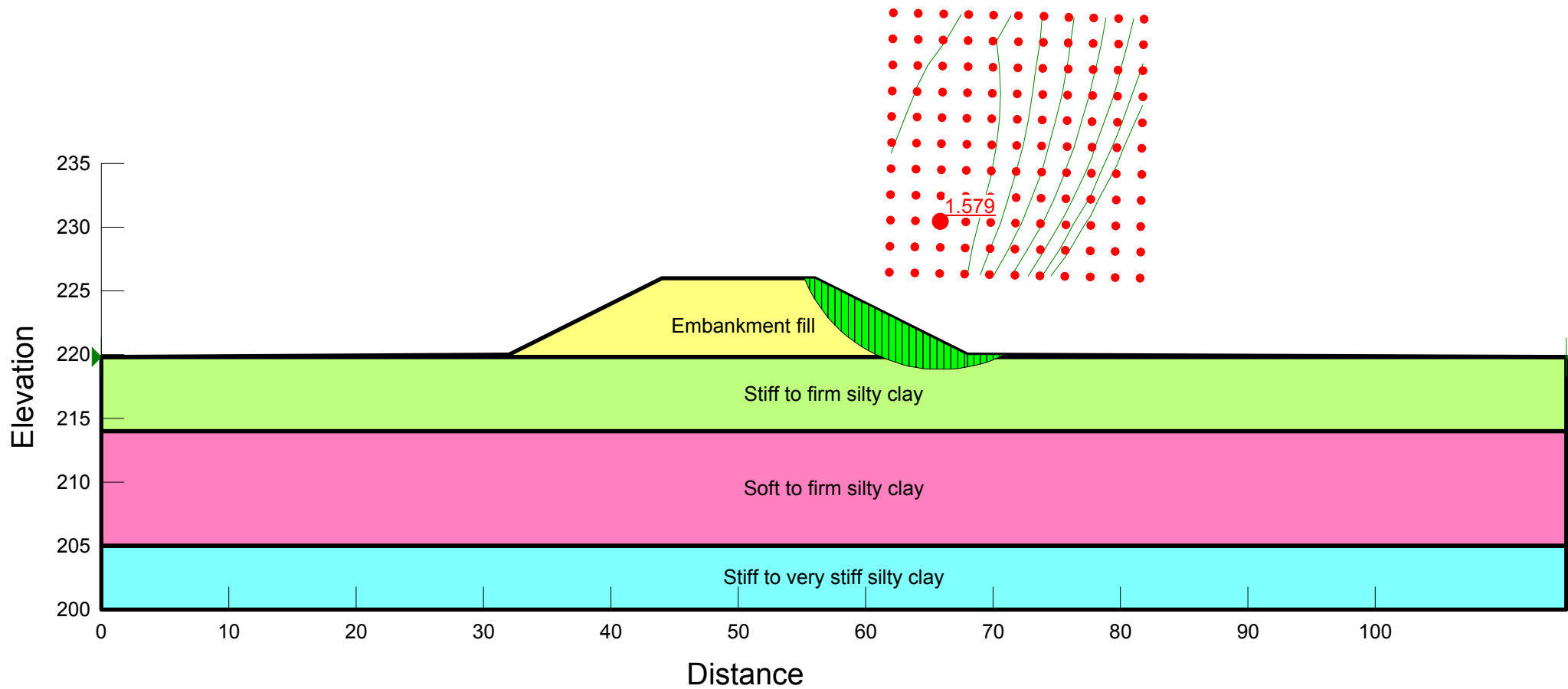
Short term/Undrained

Embankment fill	21 kN/m ³	0 kPa	30 °	1
Stiff to firm silty clay	20 kN/m ³	75 kPa	0 °	1
Soft to firm silty clay	19 kN/m ³	45 kPa	0 °	1
Stiff to very stiff silty clay	21 kN/m ³	125 kPa	0 °	1



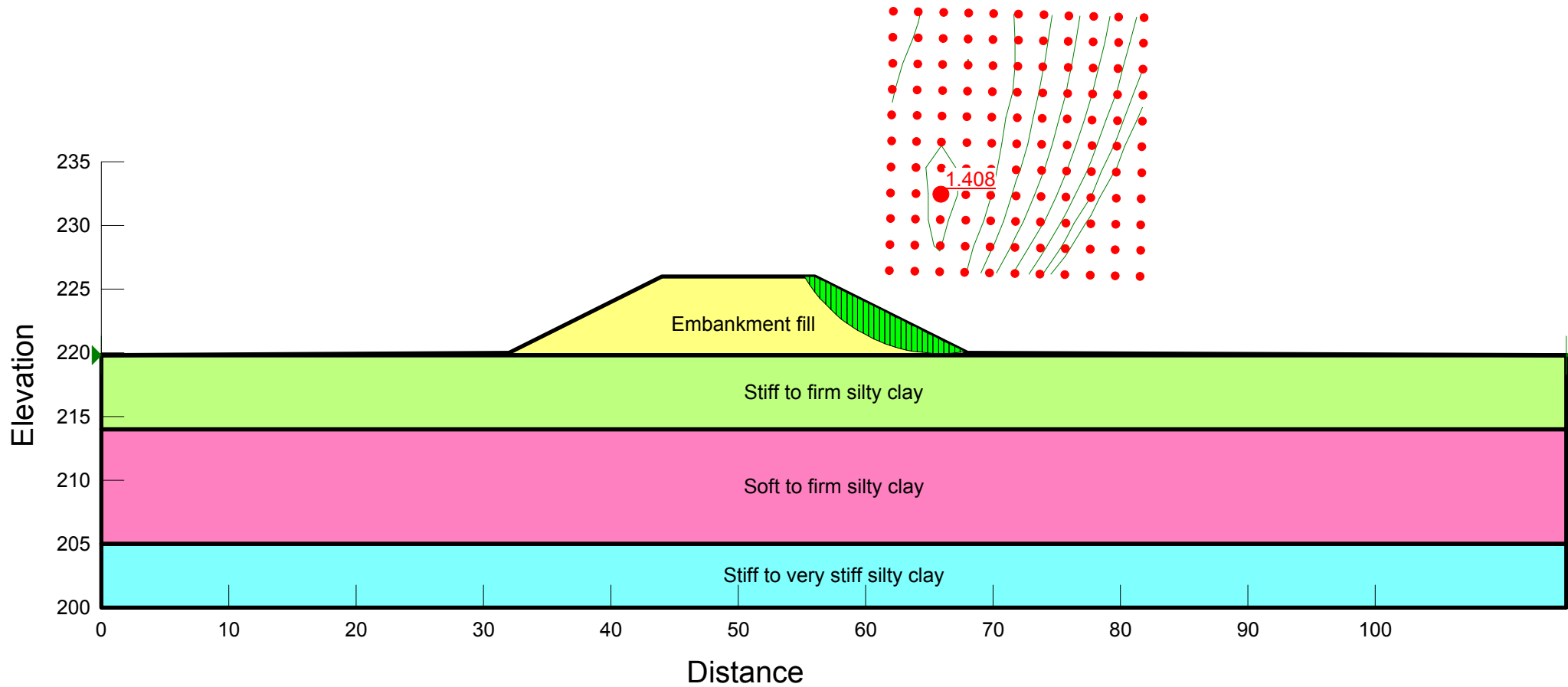
19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp W-N
 Embankment height 6.0 m
 Long Term / Drained Analysis

Embankment fill	21 kN/m ³	0 kPa	35 °	1	Yes	
Stiff to firm silty clay	20 kN/m ³	0 kPa	30 °	1	0.3	No
Soft to firm silty clay	20 kN/m ³	0 kPa	28 °	1	0.6	No
Stiff to very stiff silty clay	21 kN/m ³	0 kPa	30 °	1	0.3	No



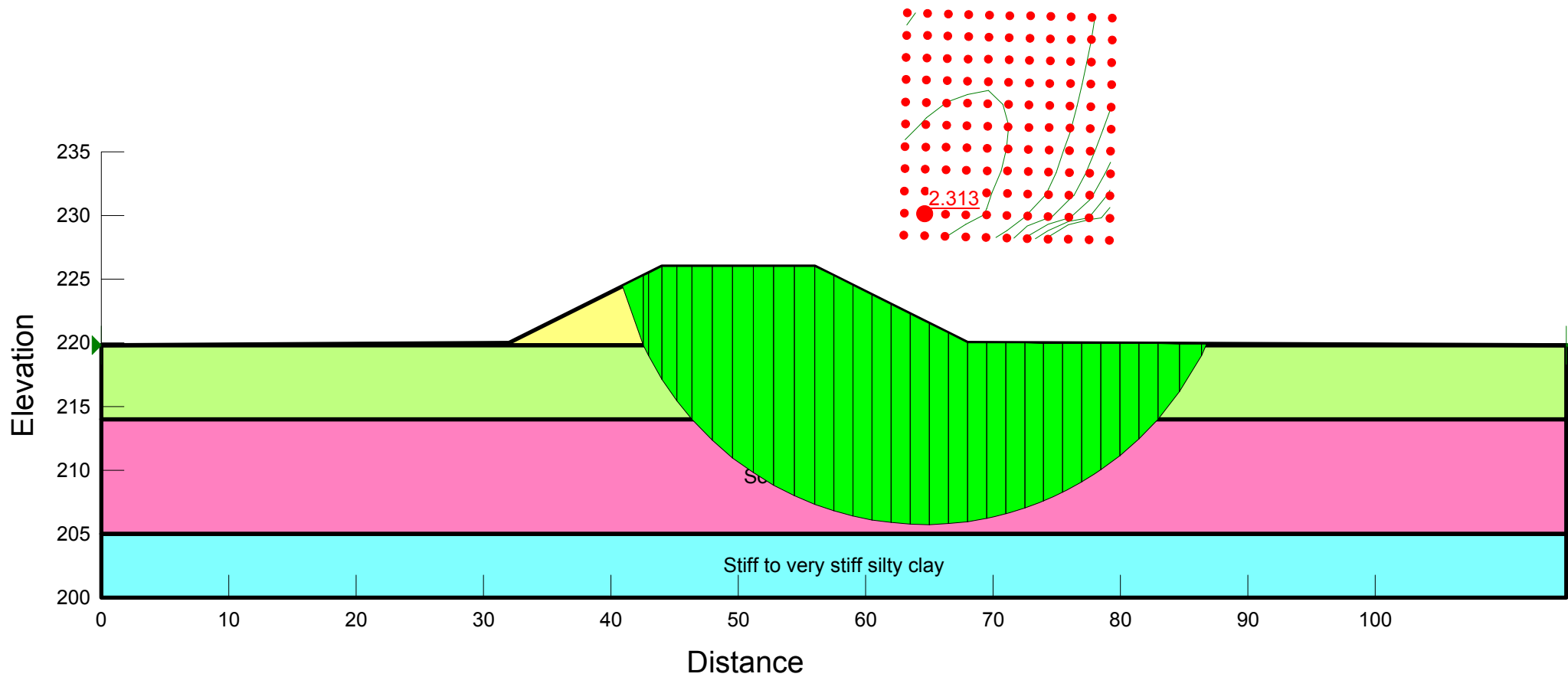
19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp W-N
 Embankment height 6.0 m
 Long Term / Drained Analysis

Embankment fill	21 kN/m ³	0 kPa	30 °	1	Yes	
Stiff to firm silty clay	20 kN/m ³	0 kPa	30 °	1	0.3	No
Soft to firm silty clay	20 kN/m ³	0 kPa	28 °	1	0.6	No
Stiff to very stiff silty clay	21 kN/m ³	0 kPa	30 °	1	0.3	No



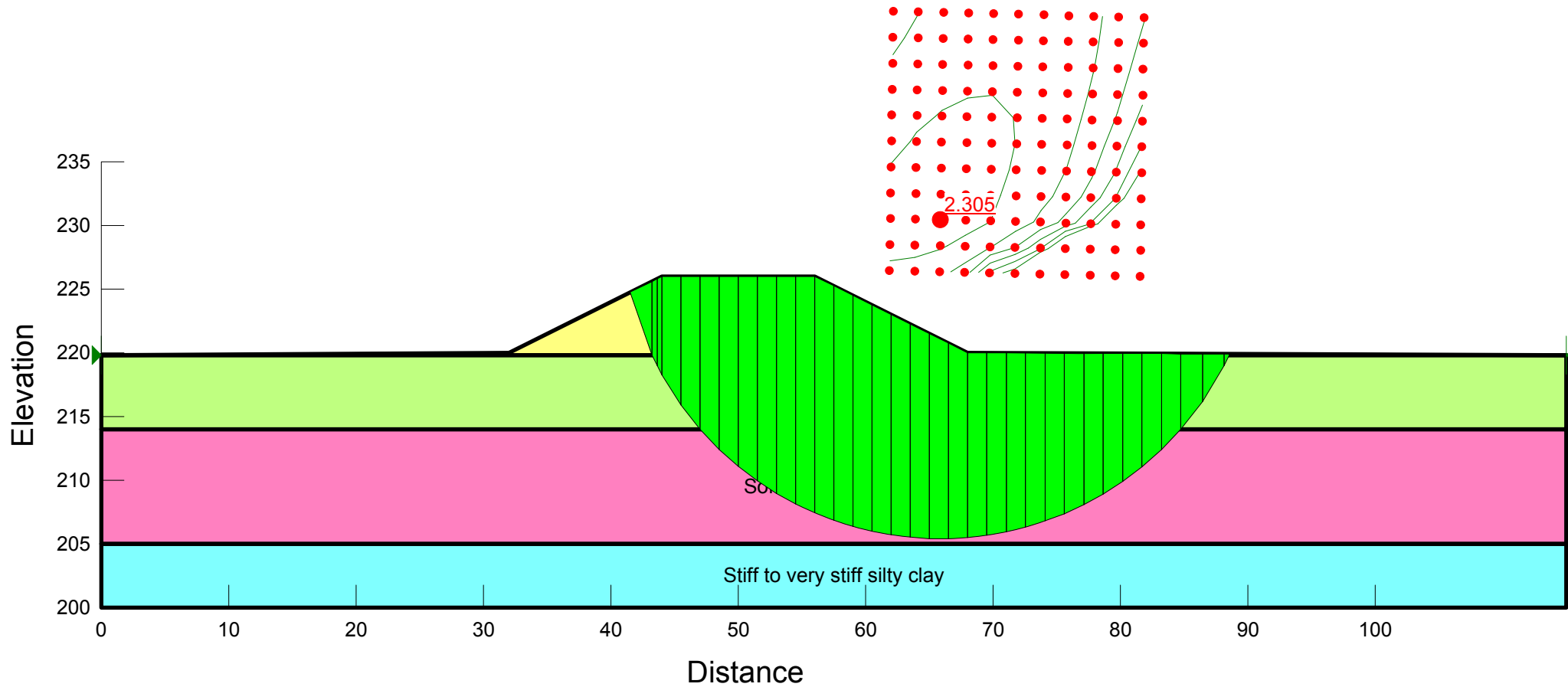
19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp W-N
 Embankment height 6.0 m
 ShortTerm / Undrained Analysis

Embankment fill	21 kN/m ³	0 kPa	35 °	1
Stiff to firm silty clay	20 kN/m ³	75 kPa	0 °	1
Soft to firm silty clay	20 kN/m ³	45 kPa	0 °	1
Stiff to very stiff silty clay	21 kN/m ³	125 kPa	0 °	1



19-4406-15
 Highway 400 & 5th Line
 Slope stability analysis of Ramp W-N
 Embankment height 6.0 m
 ShortTerm / Undrained Analysis

Embankment fill	21 kN/m ³	0 kPa	30 °	1
Stiff to firm silty clay	20 kN/m ³	75 kPa	0 °	1
Soft to firm silty clay	20 kN/m ³	45 kPa	0 °	1
Stiff to very stiff silty clay	21 kN/m ³	125 kPa	0 °	1



Appendix H

Instrumentation and Monitoring Specifications for High Fills

SUPPLY AND INSTALLATION OF MONITORING EQUIPMENT - Item No.

Special Provision

1.0 GENERAL

1.0.1 Scope

This special provision contains the requirements for the supply and installation of the following geotechnical instruments:

- Settlement Pins (SP)
- Survey Benchmarks (BM)

1.0.2 Purpose

The purpose of these instruments is to monitor settlements of the foundation soils and fill compression during preloading at the high fills for the proposed Highway 400 - Line 5 Underpass interchange area.

1.0.3 Personnel

The Contractor shall retain a Geotechnical Consultant with MTO classification of Geotechnical (Structures and Embankments) – **Medium Complexity**, to carry out the supply and installation of geotechnical instruments.

The Contractor shall be understood to refer to the Contractor and their Geotechnical Consultant.

1.0.4 The term, 'or equal', shall be understood to indicate that the equal product is the same or better than the specified product in function, performance, reliability, quality and general configuration.

1.0.5 Notification

The Contract Administrator (CA) shall be notified a minimum of 7 working days in advance of commencing the installation of instruments.

1.0.6 Submission Requirements

The Contractor shall submit details of proposed installation methods, including data acquisition method, survey benchmarks, and installation schedule to the Contract Administrator, a minimum of 15 days before the start of instrument installation.

1.0.7 Drawings

Reference shall be made to the following drawings:

- Monitoring Section Location Plan
- Typical Monitoring Section Type A
- Typical Monitoring Section Type B
- Monitoring Instrument Details.

1.0.8 Subsurface Conditions

The subsurface conditions at the site are described in the following reports

- Foundation Investigation and Design Report, Highway 400 Line 5 Underpass and Interchange Reconstruction, Bradford West Gwillimbury, Ontario, TBWG WP P-13-03, MTO GWP 2122-10-00, dated March 20, 2015, prepared by Thurber Engineering Ltd.
- Foundation Investigation and Design Report, New Bridge Over North Schomberg River, Fill Embankments and Sucker Creek Culvert, Highway 400 and Line 5 Interchange Reconstruction, Bradford West Gwillimbury, Ontario, TBWG WP P-13-03, MTO GWP 2122-10-00, dated June, 2015, prepared by Thurber Engineering Ltd.

1.0.9 Equipment Operation and Weather Conditions

All installation and monitoring equipment and associated materials shall be capable of withstanding the range of temperatures possible for their locations within the ground or on the surface year-round. The instruments shall be capable of operating within the manufacturer's stated accuracy throughout the temperature range.

The Contractor shall repair or replace any mal-functioning monitoring instruments caused by the Contractor's work as required at no cost to the Town of Bradford West Gwillimbury.

1.1 Installation

Table 1 - Instrument Quantities and Locations

Location	Monitoring Section Type	Settlement Pin (SP)	
		Quantity	Offsets
West Approach Line 5	A	3	North (shoulder) South (shoulder) 0 (centreline)
Ramp N-E/W	B	2	East (shoulder) West (shoulder)
	B	2	East (shoulder) West (shoulder)
	B	2	East (shoulder) West (shoulder)
Ramp N-E/W & Ramp E-S	A	3	East (shoulder) West (shoulder) 0 (centreline/median)
Ramp E-S	B	2	East (shoulder) West (shoulder)
	B	2	East (shoulder) West (shoulder)
East Approach Line 5	A	3	North (shoulder) South (shoulder) 0 (centreline)

Ramp S-E/W	B	2	East (shoulder) West (shoulder)
Ramp W-N	B	2	East (shoulder) West (shoulder)
TOTAL		23	

1.1.1 Instrument Locations

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation at each instrument location. Approximate instrument locations are provided on the Monitoring Section Location Plan. The actual locations shall be decided in the field in consultation with the CA and the Foundation Monitoring Consultant.

1.1.2 Survey Benchmarks (BM)

The Contractor shall provide a minimum of two non-yielding deep seated survey benchmarks at the site. At least one BM shall be provided on each side of Highway 400. More than two BMs may be required.

The number and locations of benchmarks shall be such that direct sighting is possible between any SP and at least one BM. BMs shall be located in areas not affected by construction activities.

1.1.3 Accuracy of Surveying for Elevations

Elevations shall be surveyed to an accuracy of ± 2 mm or better.

1.1.4 Materials and Equipment

The Contractor shall supply all materials and equipment required for the installation and monitoring of instruments unless otherwise noted.

1.1.5 Underground Utilities

The Contractor shall be responsible for locating and protecting all underground utilities prior to drilling boreholes for installing benchmarks. Any damage to underground utilities caused by the Contractor's work shall be repaired by the Contractor, at no cost to the Contract Administrator.

1.1.6 Marking and Labelling

The location of any above ground monitoring fixture shall be made clearly visible to nearby traffic including construction equipment. Marking shall be of sufficient size to be visible from a reversing vehicle and after snow accumulation.

1.1.7 Protection of Instruments

All instruments shall be adequately protected by the Contractor such that they are not damaged during construction. Any instrument damaged by the Contractor's work shall be immediately replaced at the Contractor's cost.

1.1.8 Boreholes

The Contractor shall make a basic stratigraphic log of boreholes as they are being drilled for installation of instruments.

Boreholes shall be advanced using conventional drilling methods and shall be as straight and vertical as practicable.

1.1.9 Installation Program

Table 2 provides a summary of the installation schedule requirements.

Table 2 - Installation Program

TYPE	START INSTALLATION	FINISH INSTALLATION
BM	-	prior to embankment construction
SP	immediately after top of fill is reached	upon completion of embankment construction

2.0 BENCHMARKS (BM) - SUPPLY AND INSTALLATION

2.1 General

2.1.1 Scope

This section contains the requirements for the supply and installation of benchmarks (BM).

The purpose of a benchmark is to provide non-settling datum for the surveying of settlement pins (SP).

2.1.2 General Procedure

The benchmarks shall be installed prior to embankment construction. A benchmark (BM) consists of a steel rod anchored to the bottom of a borehole using concrete.

2.1.3 Number and Locations

The minimum number of BM is two. The required number and locations of benchmarks shall be determined in the field such that direct sighting is possible between any SP and at least one BM.

The rod anchor shall be installed a minimum of 2 m into the very stiff silty clay/silty clay till, or dense to very dense sands and silts underlying the firm silty clay.

2.2 Materials

2.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the BMs.

2.2.2 Rod

The Contractor shall supply a steel pipe Schedule 40 with an outside diameter not less than 25.4mm (1"), supplied in lengths as required to complete the installation as described in Section 2.3.

The top end of each length of rod shall be threaded to receive a cap. The top of the rod should be angled such that a single survey point can be clearly identified and repeated.

2.2.3 Sand

The Contractor shall supply clean washed sand. The sand shall be Sakcrete washed general purpose sand, or equal.

2.2.4 Grout

The Contractor shall supply cement-bentonite grout. A suitable grout mix design consists of 23 kg of bentonite (OPSS 1205), 143 litres of water and 40 kg of cement (Type 10 - OPSS 1301).

2.2.5 Rod Anchor Grout

The Contractor shall supply cement-bentonite grout. A suitable grout mix design consists of 14 kg of bentonite (OPSS 1205), 49 litres of water and 40 kg of cement (Type 10 - OPSS 1301).

2.2.6 Friction Reducing Sleeve

The Contractor shall supply a friction reducing sleeve consisting of Schedule 40 - 50.8 mm (2") O.D. PVC pipe cut perpendicular to the axis of the pipe

2.3 Installation

2.3.1 General

The Contractor shall install benchmarks (BM) as per the drawings provided in addition to the information below.

2.3.2 Borehole Installation

The borehole shall be advanced to the elevations indicated in Section 2.1.3 using suitable drilling techniques. The diameter of the borehole shall be sufficient to fit the rod, friction reducing sleeve and rod anchor. The sides of the borehole shall be stable and the borehole shall be free of drilling mud and debris.

2.3.3 Rod

The coupling of the rods shall be such that all sections have the same axis and no separation or contraction shall occur at the couplings.

2.3.4 Rod Anchor

The rod shall be installed vertically in the borehole with its bottom end resting at the bottom of the borehole. The bottom portion of the rod shall be fixed against the surrounding native soil by grouting the bottom 0.5 m of the borehole to form a concrete/soil anchor.

Once grouting is completed and the rod anchor grout has set, the contractor shall place 0.5 m of clean sand in the borehole above the concrete/soil anchor to create a base on which the end of the friction reducing sleeve can be rested.

The elevation of the bottom of the rod anchor shall be determined by measuring the length of the rod from the ground surface elevation.

2.3.5 Friction Reducing Sleeve

The friction reducing sleeve shall cover the entire length of the rod above the rod anchor and sand.

2.3.6 Installation Details

The elevation, easting and northing of the top of the benchmark rod shall be surveyed.

2.4 Documentation

The Contractor shall notify the Contract Administrator no later than 3 days after installing a benchmark. At this time, the Contractor shall also supply the following information to the Contract Administrator.

- Easting and northing
- Elevation of the rod anchor and top of rod;
- Stratigraphic log of subsurface conditions at the benchmark, including drilling method notes
- Dates of installation;
- Installation notes / sketches;
- Description of benchmark, sleeve and rod anchor.

2.5 Co-ordination with Monitoring

2.5.1 Baseline Readings

The Contractor shall obtain three daily sets of baseline readings on three consecutive days. Elevations shall be surveyed to an accuracy of ± 2 mm or better.

The baseline readings shall be obtained at least 7 days prior to start of placement of preload fills.

2.5.2 Monitoring

Monitoring of settlements with reference to the benchmarks shall be carried out by others. The Contractor shall provide installation information as specified above and provide access to the benchmarks for monitoring including, but not limited to, snow clearing in the winter. The Contractor

shall provide electric power and general area lighting as needed.

3.0 SETTLEMENT PINS (SP) - SUPPLY & INSTALLATION

3.1 General

3.1.1 Scope

This section contains the requirements for the supply and installation of settlement pins.

The purpose of the settlement pin is to directly monitor settlement of the embankment. Settlement is measured by surveying the top of the pin with reference to stable non-settling benchmarks.

3.1.2 General Procedure

The settlement pins shall be cast into concrete at the top of the embankments as per attached drawings. The concrete shall be cast in-situ in a hole excavated at the following locations.

3.1.3 Location

The locations of the settlement pins are given in Table 3.

Table 3 - Approximate Settlement Pin Locations

Location	Approximate Station	Monitoring Section Type	Offset*	Number of SP
West Approach Line 5	9+915	A	Left	1
			0	1
			Right	1
Ramp N-E/W	10+525	B	Left	1
			Right	1
Ramp E-S	10+050	B	Left	1
			Right	1
Ramp N-E/W & Ramp E-S	10+100 (Ramp E-S)	A	Left	1
			0	1
			Right	1
Ramp N-E/W	10+425	B	Left	1
			Right	1
	10+290	B	Left	1
			Right	1

Location	Approximate Station	Monitoring Section Type	Offset*	Number of SP
Ramp E-S	10+150	B	Left	1
			Right	1
East Approach Line 5	10+085	A	Left	1
			0	1
			Right	1
Ramp S-E/W	10+350	B	Left	1
			Right	1
Ramp W/N	10+050	B	Left	1
			Right	1

NOTE: (*) Offset distance from centreline depends on width of ramp or roadway; pins (except for the middle ones) are to be located near the crest of fill slope.

3.2 Materials

3.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the settlement pins.

3.2.2 Concrete

The Contractor shall supply concrete (OPSS 1350) with strength and set time sufficient to secure the settlement pin within two days of placing.

3.2.3 Pin

The Contractor shall supply a 25.4 mm minimum diameter reinforcing steel bar (OPSS 905) cut to a length of 0.4 m.

The top of the reinforcing steel bar shall be angled or rounded in such a way that a single survey point can be clearly identified and repeated.

3.3 Installation

3.3.1 General

The Contractor shall install settlement pins as per the drawings provided.

3.4 Co-ordination with Monitoring

3.4.1 Notification

The Contractor shall notify the Contract Administrator no later than three days after installing a settlement pin. At this time, the Contractor shall also supply the following information to the Contract Administrator.

- Settlement pin location, easting, northing;
- Elevation of top of pin;
- Dates of installation and datum readings;
- Installation notes / sketches.

3.4.2 Monitoring of the settlement pins shall be carried out by others. Monitoring shall commence as soon as they are installed immediately after the top of fill is reached. Contractor shall provide installation information as specified above and provide access to the settlement pins for monitoring.

4.0 DECOMMISSIONING OF INSTRUMENTS

4.1 General

The Contractor shall decommission all the settlement pins (SP) and benchmarks (BM) as directed by the Contract Administrator.

5.0 PAYMENT

5.1 Basis of Payment

Payment at the Lump Sum price for this tender item shall be full compensation for all labour, monitoring equipment and materials to do the work.

MONITORING PROGRAM - Item No.

Special Provision

1.0 GENERAL

Foundation Monitoring Consultant; services, deliverables and records apply to all the instrumentation monitoring. Instrumentation monitoring is required for the following items:

- Settlement Pins (SP)

The instrumentation monitoring services include:

- Requirements for data collection, data reduction and reporting
- Adherence to criteria used to assess the foundation performance based on the monitoring data collected from the instrumentation installed by others.

1.1 Foundation Monitoring Consultant

It is understood that the Town of Bradford West Gwillimbury (TBWG) will retain a Foundation Monitoring Consultant to carry out the monitoring and data interpretation services for the project.

1.2 Services, Deliverables and Records

The Foundation Monitoring Consultant shall:

- Review reports with instrumentation installation details submitted by the Contractor;
- Work with an experienced surveyor retained by the Contract Administrator (CA) or the TBWG to monitor the settlement pins (SP)
- Reduce settlement data supplied by the surveyor and prepare reports
- Transmit instrumentation readings and reports to the CA
- Interpret instrumentation readings as needed for the purposes of determining when settlements at the preload fills are essentially complete
- Notify the CA if the estimated instrument readings, as specified herein, for any instrumentation are about to be reached; discuss as soon as possible (within 24 hours) with the CA response action(s), if necessary.

A monthly progress report shall be provided to the CA, TBWG and MTO. The progress report shall discuss the Contractor's operations including installation of instrumentation and a summary of the monitoring that was completed for the month.

2.0 PURPOSE

The purpose of this Monitoring Program is to monitor the total settlement due to preloading of the ground and compression due to self-weight of the fill at the proposed high fills of the Highway 400 Line 5 interchange area.

The waiting time for preloading shall be controlled by the instrumentation readings, prior to paving and other ramp construction activities.

The instrumentation shall not be decommissioned unless instructed by the TBWG or the CA.

3.0 DRAWINGS

Reference shall be made to the following drawings included in the Contract Document.

- Monitoring Section Location Plan
- Typical Monitoring Section Type A
- Typical Monitoring Section Type B
- Monitoring Instrument Details.

4.0 SUBSURFACE CONDITIONS

The subsurface conditions at the site are described in the following reports:

- Foundation Investigation and Design Report, Highway 400 Line 5 Underpass and Interchange Reconstruction, Bradford West Gwillimbury, Ontario, TBWG WP P-13-03, MTO GWP 2122-10-00, dated March 20, 2015, prepared by Thurber Engineering Ltd.
- Foundation Investigation and Design Report, New Bridge Over North Schomberg River, Fill Embankments and Sucker Creek Culvert, Highway 400 and Line 5 Interchange Reconstruction, Bradford West Gwillimbury, Ontario, TBWG WP P-13-03, MTO GWP 2122-10-00, dated June 2015, prepared by Thurber Engineering Ltd.

5.0 EQUIPMENT OPERATION

Monitoring shall commence immediately after instrumentation installation once the top of embankment fill is reached and continue during the waiting period of the preloading. All monitoring equipment shall be maintained and rendered operational throughout the monitoring period.

Any equipment malfunction shall be investigated and attempts shall be made to remedy the malfunction. Notification of any equipment malfunction and equipment that cannot be repaired shall be given to the Contract Administrator (CA). Documentation of the possible causes and suggested remedial measures shall be forwarded to the Contract Administrator (CA).

6.0 READING SCHEDULE AND FREQUENCY

- 6.1 The Foundation Monitoring Consultant shall save and archive survey data in electronic and hard copy format.
- 6.2 Monitoring shall commence immediately after the installation of an instrument. Monitoring is to continue until the end of the preloading period. The actual length of the monitoring period depends on the construction schedule amongst other factors, and is estimated to be about 6 months following the completion of fill placement.
- 6.3 The minimum monitoring frequencies for each instrument along with the anticipated number of readings are given in Table 1. The monitoring frequency is the same for each individual instrument in the table. Instruments shall be read more or less frequently if judged to be required by the Contract Administrator (CA).

Table 1 - Minimum Monitoring Frequency

Stage	Frequencies	Anticipated Number of Readings Per Instrument (**)
Baseline Readings (*)	Three readings on three consecutive days immediately following completion of installation, which must be carried out as soon as the top of fill is reached.	3
Preload waiting period	Weekly for the first month; Biweekly for the second month; Monthly from the third month up to the end of the sixth month.	10

(*) Baseline Readings: Value of instrumentation readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess the settlement.

(**) Number of readings may vary.

7.0 INSTRUMENTATION SPECIFIC REQUIREMENTS

7.1 Surveying

The elevations of all instruments shall be surveyed to an accuracy of ± 2 mm or better and shall be reported to the nearest millimetre.

Surveying for settlement monitoring shall be conducted by an experienced surveyor, to be retained by the CA or the TBWG, with appropriate equipment and experience.

7.2 Reporting

An updated processed copy of monitoring data accompanied by a brief interpretation shall be provided to the Contract Administrator within five (5) working days after each set of readings is obtained, unless the trend of the readings is considered unusual (such as accelerated rate of settlement) by the Foundation Monitoring Consultant in which case the subject readings should be reported immediately. The data shall be presented in tabular and graphical format.

As a minimum, the following shall be reported to the Contract Administrator within five (5) days of obtaining a set of readings from all instruments:

- A plot of settlement/heave versus time for each instrument;
- Preload fill height at location of instrument;
- Plan view, cross section and profile sketches showing the top of fill elevation of the embankment, and the settlement readings at each monitoring section.

7.3 Settlement of Preload Fills

The total settlement has been estimated at each selected location of high fills. Table 2 summarizes the estimated settlements due to a portion of the primary consolidation, secondary compression and fill compression. It is noted that the SPs will not measure immediate settlement as the latter would be

completed by the end of fill placement.

Table 2 – Estimated Settlements at Settlement Pins (SP)

Instrument Type	Location	Maximum Embankment Height (m)	Estimated Settlement (mm)
Settlement Pin (SP)	West Approach Line 5	10	120
	Ramp N-E/W	9	100
	Ramp E-S	10	120
	East Approach Line 5	8	90
	Ramp S-E/W	6	70
	Ramp W/N	6	70

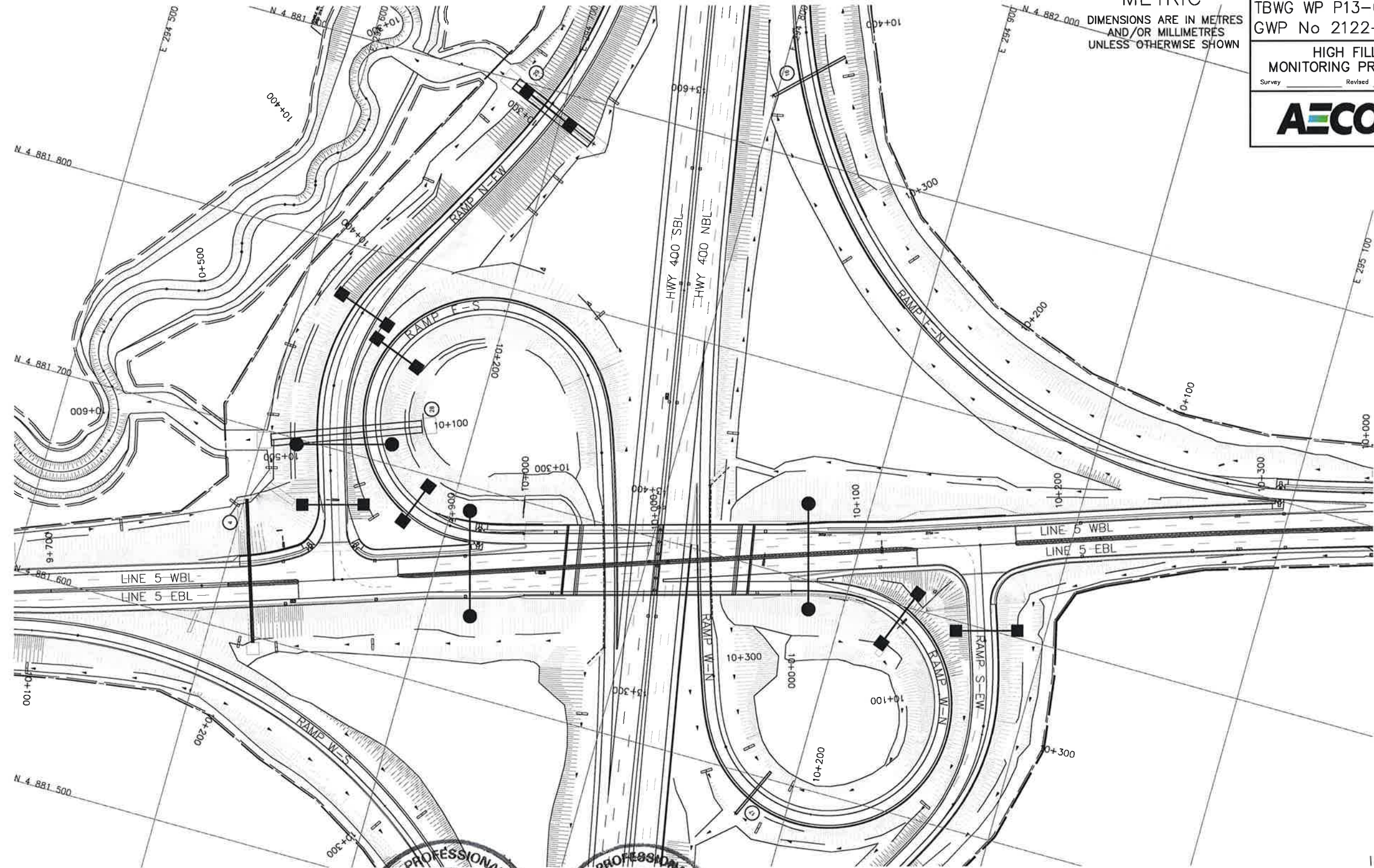
8.0 CONTROL MONITORING LEVELS

8.1 General

The monitoring program will provide input for determining the end of the preload waiting period, prior to paving and other ramp/road construction activities.

9.0 FINAL REPORT

Upon completion of the monitoring program, a final monitoring report shall be issued to the Contract Administrator, TBWG and MTO. The monitoring results shall be presented in tabular and graphical format as described above for each instrument. Interpretation of the monitoring readings shall be included in the report.




LEGEND:

- — ● MONITORING SECTION TYPE A
- — ■ MONITORING SECTION TYPE B

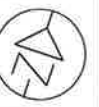


TOWN OF BRADFORD WEST GWILLIMBURY		
HIGHWAY 400 LINE 5 INTERCHANGE BRADFORD WEST GWILLIMBURY ONTARIO		
MONITORING SECTION LOCATION PLAN		
JOB# 19-4406-15		

 THURBER ENGINEERING LTD.		
ENGINEER : SKP	DRAWN : AN	APPROVED : PKC
DATE : JUNE 2015	SCALE : 1:2000	DRAWING No.: 19-4406-15-1

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

TBWG WP P13-03
GWP No 2122-10-00
HIGH FILLS
MONITORING PROGRAM
Survey _____ Revised _____



SHEET

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

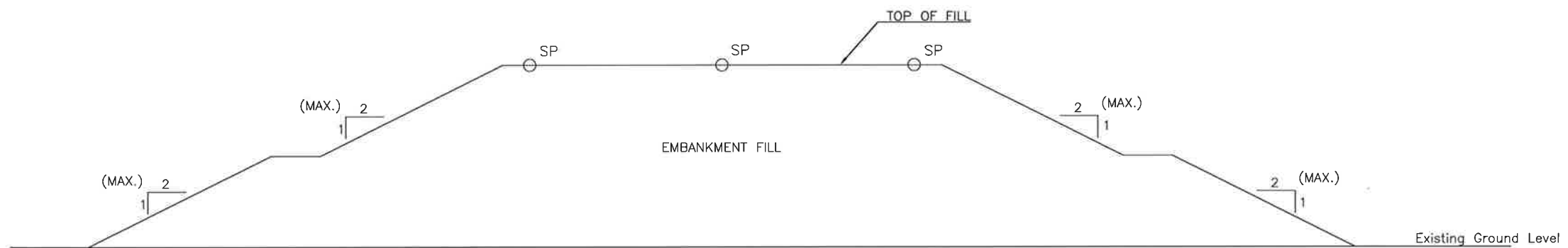
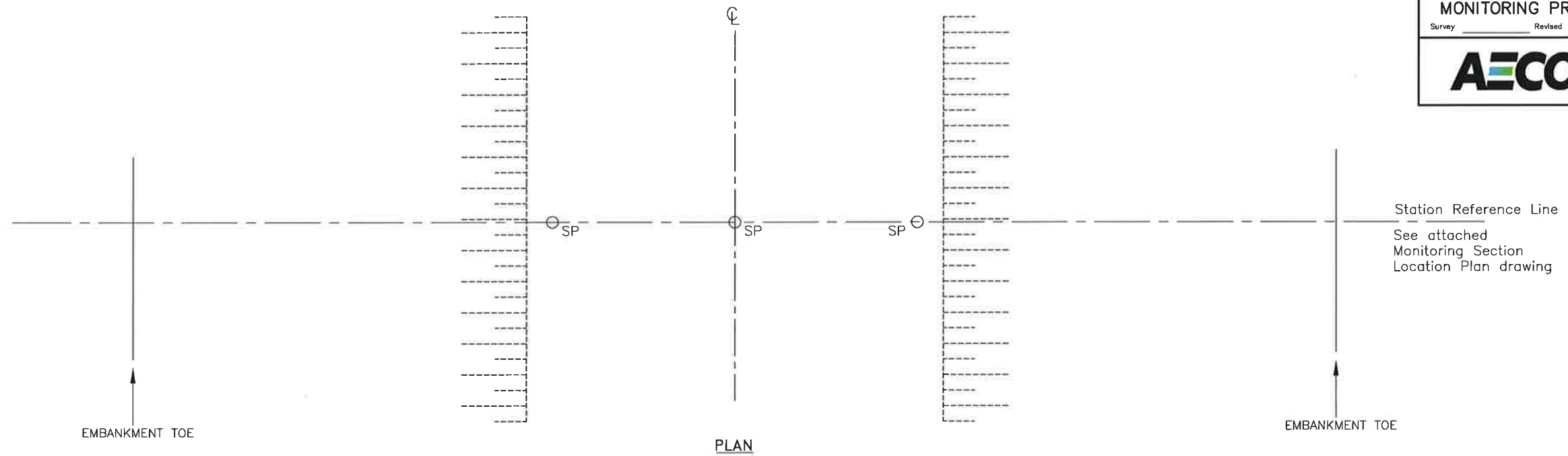
TBWG WP P13-03
GWP No 2122-10-00

HIGH FILLS
MONITORING PROGRAM

Survey _____ Revised _____

AECOM

SHEET



LEGEND:

○ SP - Settlement Pin

NOTES:

Refer to NSSP "Supply and Installation of Embankment Monitoring Equipment" for details of installation.

The two tiered slopes may not exist at all locations.

Where the cross-section intersects two parallel roadways at Ramp N-E/W and Ramp E-S, the middle SP should be located at the median.



TOWN OF BRADFORD WEST GWILLIMBURY

HIGHWAY 400 LINE 5 INTERCHANGE
HIGH FILLS AT RAMPS
BRADFORD WEST GWILLIMBURY
ONTARIO
TYPICAL MONITORING SECTION TYPE A

JOB# 19-4406-15



THURBER ENGINEERING LTD.

ENGINEER:	DRAWN:	APPROVED:
SKP	AN	PKC
DATE:	SCALE:	DRAWING No.
JUNE 2015	NTS	19-4406-15-2

FILENAME: H:\Drafting\19440615\ec0615-MonitoringPlan.dwg
PLOTDATE: Jun 12, 2015 - 11:33 AM

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

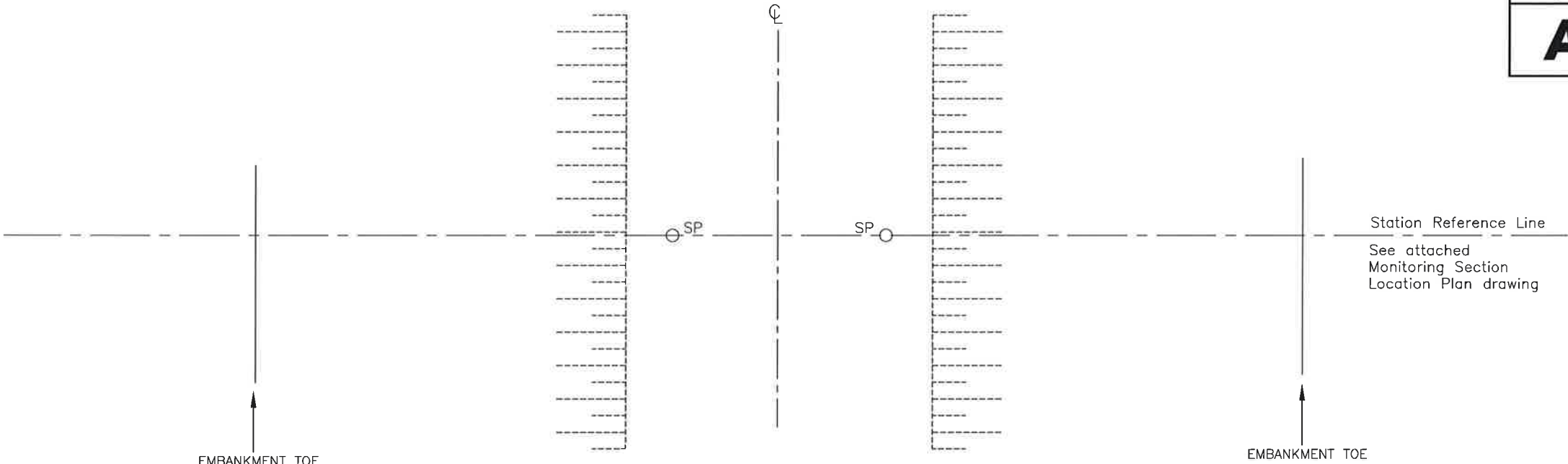
TBWG WP P13-03
GWP No 2122-10-00

HIGH FILLS
MONITORING PROGRAM

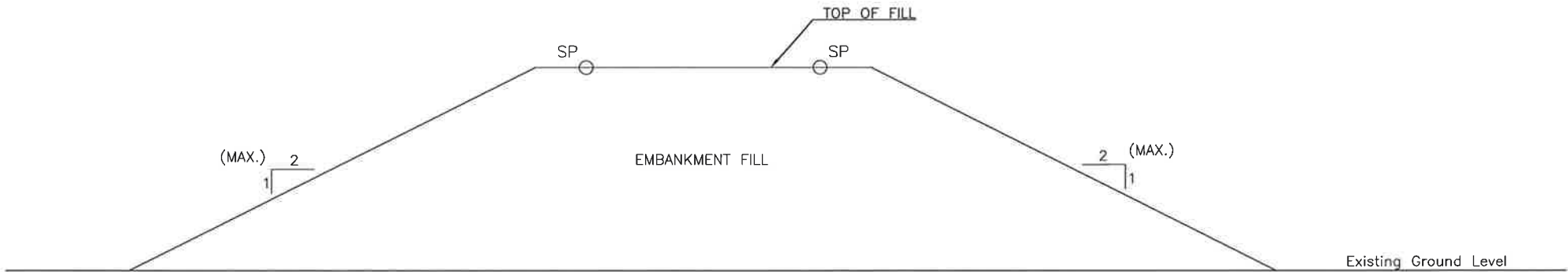
Survey _____ Revised _____



SHEET



PLAN



SCHEMATIC CROSS - SECTION B

LEGEND:

○ SP - Settlement Pin

NOTE:

Refer to NSSP "Supply and Installation of Embankment Monitoring Equipment" for details of installation.



TOWN OF BRADFORD WEST GWILLIMBURY		
HIGHWAY 400 LINE 5 INTERCHANGE		
HIGH FILLS AT RAMPS		
BRADFORD WEST GWILLIMBURY		
ONTARIO		
TYPICAL MONITORING SECTION TYPE B		
JOB# 19-4406-15		
THURBER ENGINEERING LTD.		
ENGINEER:	DRAWN:	APPROVED:
SKP	AN	PKC
DATE:	SCALE:	DRAWING No:
JUNE 2015	NTS	19-4406-15-3

FILENAME: H:\Drafting\19440615\Med0615-MonitoringPlan.dwg
PLOT DATE: Jun 12, 2015 - 11:33 AM

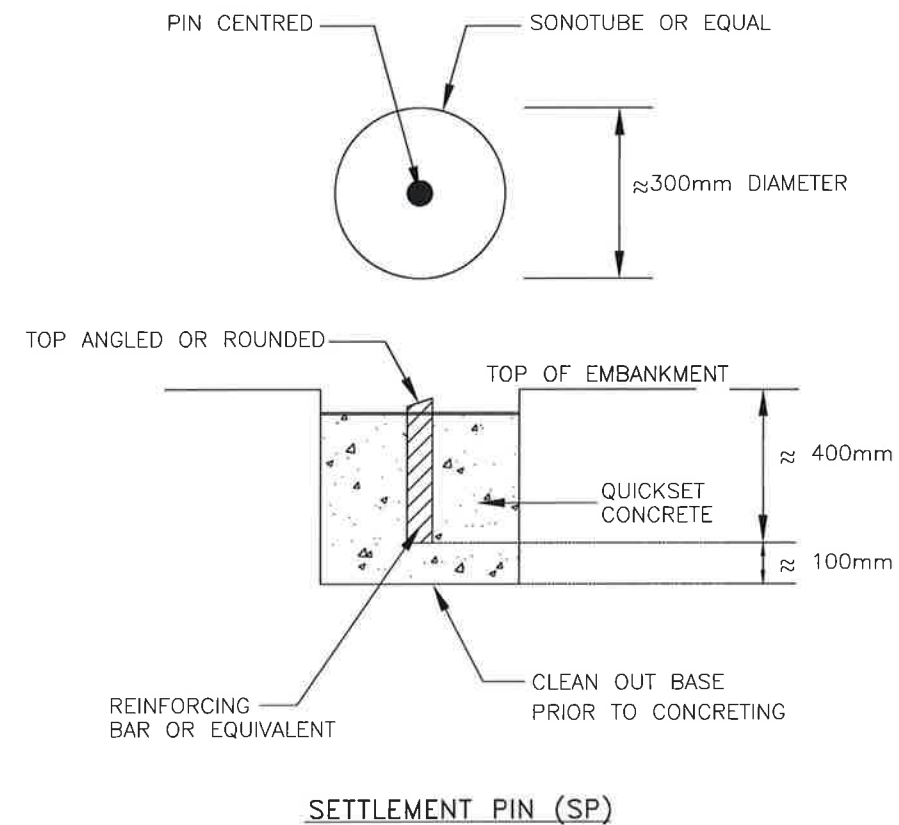
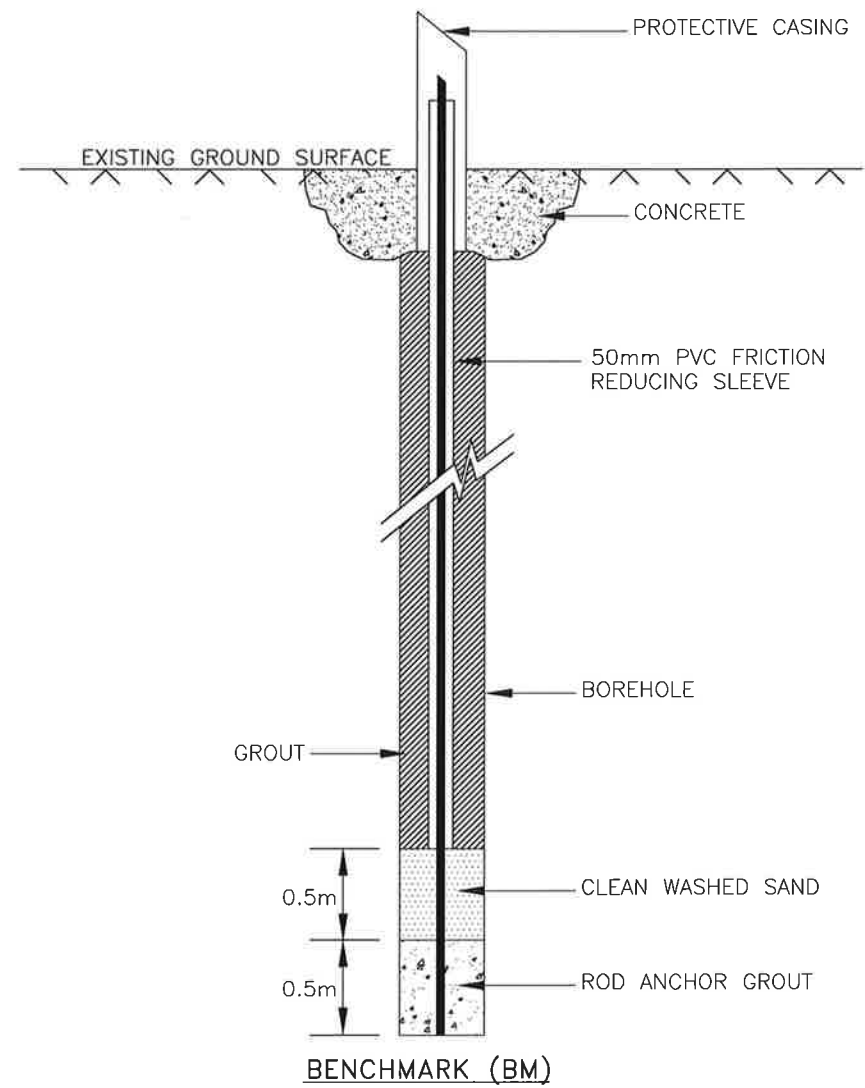
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

TBWG WP P13-03
GWP No 2122-10-00

HIGH FILLS
MONITORING PROGRAM
Survey _____ Revised _____



SHEET



TOWN OF BRADFORD WEST GWILLIMBURY
HIGHWAY 400 LINE 5 INTERCHANGE
HIGH FILLS AT RAMPS
BRADFORD WEST GWILLIMBURY
ONTARIO
MONITORING INSTRUMENT DETAILS
JOB# 19-4406-15



THURBER ENGINEERING LTD.

ENGINEER:	SKP	DRAWN:	AN	APPROVED:	PKC
DATE:	JUNE 2015	SCALE:	NTS	DRAWING No:	19-4406-15-4