

**FOUNDATION INVESTIGATION REPORT  
HIGHWAY 401 UNDERPASS AT NORWICH AVENUE  
CITY OF WOODSTOCK, ONTARIO  
SITE 23-170, G.W.P. 3054-13-00**

**GEOCRES No.: 40P2-78**

**Report to  
MMM Group Limited**

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

April 26, 2016  
File: 19-5161-224

H:\19\5161\224 Hwy 401 Ingersoll 3013-E-0027  
Foundations\Reports & Memos\Norwich Avenue\1 -  
Underpass\Revised GWP Apr 26 16\Norwich Underpass with  
Patt - FIR\_final Apr 26 16.docx

## TABLE OF CONTENTS

### **PART 1      FACTUAL INFORMATION**

<b>1</b>	<b>INTRODUCTION .....</b>	<b>1</b>
<b>2</b>	<b>SITE DESCRIPTION .....</b>	<b>1</b>
<b>3</b>	<b>SITE INVESTIGATION AND FIELD TESTING.....</b>	<b>2</b>
<b>4</b>	<b>LABORATORY TESTING.....</b>	<b>3</b>
<b>5</b>	<b>DESCRIPTION OF SUBSURFACE CONDITIONS .....</b>	<b>3</b>
5.1	Pavement Structure .....	4
5.2	Topsoil .....	5
5.3	Embankment Fill .....	5
5.4	Sandy Silt/Silt to Sand .....	6
5.5	Silty Clay to Clayey Silt .....	7
5.6	Sandy Silt to Silty Sand Till .....	8
5.7	Silty Clay Till .....	9
5.8	Groundwater Levels.....	10
5.9	Analytical Testing.....	11
<b>6</b>	<b>MISCELLANEOUS.....</b>	<b>12</b>

### **APPENDICES**

Appendix A	Record of Borehole Sheets
Appendix B	Laboratory Test Results
Appendix C	Analytical Test Results
Appendix D	Site Photographs
Appendix E	Borehole Location and Soil Strata Drawings
Appendix F	Previous Investigation, Borehole Locations and Soil Strata Drawing and Record of Borehole Sheets, Geocres No.: 40P2-45

**FOUNDATION INVESTIGATION REPORT  
HIGHWAY 401 UNDERPASS AT NORWICH AVENUE  
CITY OF WOODSTOCK, ONTARIO  
SITE 23-170, G.W.P. 3054-13-00**

**GEOCRES No.: 40P2-78**

**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the results of a foundation investigation completed at the location of a proposed replacement of the Highway 401 Underpass at Norwich Avenue (Highway 59) near Woodstock, Ontario. The replacement of the Norwich Avenue structure constitutes part of the Highway 401 improvement project.

The purpose of this investigation was to explore the subsurface conditions at the project site and, based on the data obtained and available archive data, to provide a borehole location plan, records of boreholes, stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions presented in the report was developed from the compilation of data obtained in the course of the current and previous investigations.

A previous foundation investigation was carried out at this site in 1990 for the-then proposed widening of Highway 401. The results of the investigation were documented in the MTO report titled "Foundation Investigation and Design Report for Highway 59 Underpass and Athlone Avenue (N/S-W Ramp), W.P. 481-89-03, Site 23-170, Highway 401, District 2, London, GEOCRES 40P2-45", dated September, 1990. The information presented in the above noted report was reviewed and incorporated in this report. Relevant Record of Borehole sheets and the Borehole Location and Soil Strata drawing are enclosed in Appendix F, for reference.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation (MTO) Agreement Number 3013-E-0027.

**2 SITE DESCRIPTION**

The site of the underpass is located at the intersection of Highway 401 and Norwich Avenue (Highway 59), south of the City of Woodstock. At the project site, Norwich Avenue runs generally in the north-south direction and Highway 401 runs in the west-east direction. The existing bridge is a single span structure approximately 33 m in length and accommodates two lanes of traffic in each

direction; with the middle lane used for left-turn traffic immediately north and south of the structure. The existing interchange ramps are in a diamond configuration.

The surrounding land use generally consists of a mixture of commercial properties to the west, north and east of the project site with agricultural land and a golf course located to the south.

Photographs of the bridge and surrounding area are presented in Appendix D.

The topography of the site is generally undulating with drumlins to the south and southeast. The site is situated in the Physiographic Region known as the Oxford Till Plain characterized by drumlinized till deposits. The surficial deposits contain mainly silt with variable amounts of clay, sand and gravel particles.

### **3 SITE INVESTIGATION AND FIELD TESTING**

The site investigation and field testing for this project was carried out between November 10 and 17, 2014 and between December 14 and 16, 2015, and consisted of drilling and sampling a total of thirteen (13) boreholes, identified as NW-01 to NW-10 and PA-01 to PA-03. During the 2014 field investigation, two boreholes (NW-02 and NW-03) were drilled at the location of the north bridge abutment, one borehole (NW-04) at the south abutment and the remainder of boreholes, namely Boreholes NW-05 to NW-10, were advanced along the proposed realignment of the Norwich Avenue embankment to the north and south of the bridge. During the 2015 investigation, additional three boreholes denoted as PA-01 to PA-03 were drilled along Pattullo Avenue West located to the south of the Underpass Structure. Boreholes were extended to depths ranging from 6.4 to 15.8 m below the existing ground surface. The approximate borehole locations are shown on the Borehole Locations and Soil Strata Drawings included in Appendix E.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. In 2014, drilling was carried out using a track mounted CME 55 drill rig with solid stem augers; during the 2015 investigation, drilling was conducted using Diedrich D-120 with hollow stem augers. Soil samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT).

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 in Oakville, Ontario for further examination and testing.

Groundwater conditions were observed in the open boreholes during and upon completion of the drilling operations. Three standpipe piezometers were installed in the boreholes. Two piezometers consisted of 25 mm Schedule 40 PVC pipe with a 1.5 m long slotted screen were installed at alternate corners of the structure within boreholes NW-02 and 04, and a piezometer consisting of 19 mm Schedule 40 PVC pipe with a 3 m long slotted screen was installed in Borehole PA-01 on Pattullo Avenue West. The piezometers screens were enclosed in filter sand to permit groundwater level monitoring. Following the final water level reading, the piezometers were decommissioned and

boreholes backfilled in general accordance with MOE Regulation 903. Details of the borehole depths, base elevations and completion details are summarized in Table 3.1 below.

**Table 3-1. Borehole Installation and Backfilling Details**

<b>Borehole</b>	<b>Borehole Depth/ Base Elevation (m)</b>	<b>Borehole Backfilling Details</b>
NW-01	10.2 / 285.5	Backfilled with bentonite holeplug and cuttings to surface.
NW-02	14.0 / 289.9	Piezometer with 1.5 m slotted screen installed with tip at 12.2 m/Elev. 291.8. Filter to 10.4 m, bentonite holeplug to 9.8 m, bentonite holeplug and cuttings to 600 mm then concrete to surface.
NW-03	11.0 / 284.5	Backfilled with bentonite holeplug and cuttings to surface.
NW-04	10.8 / 282.4	Piezometer with 1.5 m slotted screen installed with tip at 9.1 m /Elev. 284.1. Sand filter to 7.3 m, bentonite holeplug to 6.7 m, bentonite holeplug and cuttings to surface.
NW-05	10.1 / 282.3	Backfilled with bentonite holeplug and cuttings to surface.
NW-06	6.4 / 292.3	Backfilled with bentonite holeplug and cuttings to surface.
NW-07	6.7 / 285.4	Backfilled with bentonite holeplug and cuttings to surface.
NW-08	6.7 / 287.6	Backfilled with bentonite holeplug and cuttings to surface.
NW-09	6.7 / 285.3	Backfilled with bentonite holeplug and cuttings to surface.
NW-10	6.7 / 284.9	Backfilled with bentonite holeplug and cuttings to surface.
PA-01	15.8 / 274.4	Piezometer with 3.0 m slotted screen installed with tip at 11.9 m/Elev. 278.3. Filter to 8.5 m, bentonite holeplug to surface.
PA-02	15.8 / 276.3	Backfilled with bentonite holeplug and cuttings to surface.
PA-03	15.8 / 279.5	Backfilled with bentonite holeplug and cuttings to surface.

#### **4 LABORATORY TESTING**

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to gradation analysis (hydrometer and/or sieve) and Atterberg Limits testing, where appropriate. The results of these tests are summarized on the Record of Borehole sheets included in Appendix A, and are presented on the figures included in Appendix B.

#### **5 DESCRIPTION OF SUBSURFACE CONDITIONS**

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets included in Appendix A and on the "Borehole Locations and Soil Strata" drawings included in Appendix E.

A general description of the stratigraphy, based on the conditions encountered in the boreholes, is given in the following paragraphs. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It should be recognised that soil conditions may vary between and beyond borehole locations.

The subsurface information documented in the 1990 MTO report (Geocres 40P2-45) was reviewed and relevant borehole information utilized in preparation of this report to supplement the soil stratigraphy at the pier and abutments. The Record of Boreholes 1 to 7, and the Borehole Location and Soil Strata drawing from the above report are enclosed in Appendix F.

In summary, the soil stratigraphy below the fill materials and topsoil generally consists of a native deposit of sandy silt and silty clay to clayey silt believed to be of the glaciolacustrine origin, underlain by a very dense cohesionless till and very stiff to hard silty clay till. The water levels in the piezometers installed in Borehole NW04 and PA-01 were measured at 3.5 m depth (Elev. 289.7) and 5.5 m depth (Elev. 284.7), respectively. In Borehole NW-02, the piezometer was dry.

Descriptions of the individual strata are presented below.

### **5.1 Pavement Structure**

Borehole NW-02 was drilled through the existing Norwich Avenue north approach and encountered a pavement structure consisting of approximately 125 mm of asphalt overlying 1.4 m of granular road base extending to a 1.5 m depth (Elev. 302.4). In Boreholes PA-01 to PA-03 drilled through the shoulder of Pattullo Avenue, the road base was encountered extending to a depth between 2.1 m and 2.3 m or to Elev. 288.1 and Elev. 283.0, respectively. The granular road base was predominantly sand and gravel with trace to some silt. A silty sand layer with some clay was noted in Borehole PA-01 at 0.8 m depth. SPT tests performed in this material gave N-values ranging from 9 to 34 blows per 0.3 m of penetration, indicating a loose to dense relative density. Moisture contents within this fill varied from 2 to 10%.

Grain size analysis was completed on a sample of the road base material. The results are summarized on the Record of Borehole sheet in Appendix A, and the grain size distribution curve for the sample is included in Figure B1 of Appendix B. The results of the tests are summarized as follows:

<b>Soil Particles</b>	<b>Percentage (%)</b>
Gravel	16 to 44
Sand	42 to 56
Silt	31
Clay	11
Silt and Clay	7 to 13

## **5.2 Topsoil**

A surficial layer of topsoil was encountered in the remaining boreholes (NW-01 and NW-03 through NW-10) drilled adjacent to the west side of Norwich Avenue. The thickness of the topsoil layer varied from 125 to 150 mm.

Boreholes 3 to 5 from the 1990 investigation encountered 200 mm to 700 mm of topsoil/organic soil.

## **5.3 Embankment Fill**

Boreholes NW-02 and 7 (1990 investigation) were advanced from the top of the existing Norwich Avenue approaches to the bridge and encountered an embankment fill. The fill was classified as sandy clayey silt in Borehole NW-02 drilled on the north side of the bridge. In Borehole 7, drilled on the south site, the fill was described as sand with some silt and some gravel. The fill extended to a depth of 6.1 m (Elev. 297.8) in Borehole NW-02, and to 5.9 m depth (Elev. 295.6) in Borehole 7. SPT tests performed in the sandy clayey silt fill gave N-values between 8 and 31 blows per 0.3 m of penetration, indicating a stiff to hard consistency of the material. The sand fill (on the north side) was compact to dense.

Moisture contents within the cohesive fill varied from 10 % to 16%; no moisture content measurements were available for Borehole 7 completed in 1990. The Atterberg Limits testing was performed on a sample of this fill and a Liquid Limit of 25% and Plasticity Index of 9 % was obtained (Figure B6 in Appendix B) indicating low plasticity of this material.

Boreholes NW-06 to NW-10 were drilled along the west toe of the Norwich Avenue embankment and encountered as much as 2.8 m of fill. The fill in Borehole NW-06 located on the north side of the bridge consisted of approximately 1.4 m of sand and silt with some clay and occasional cobbles. The base of this fill was encountered at 1.5 m depth (Elev. 297.2).

The fill in Boreholes NW-07 to NW-010 located on the south side of the bridge consisted of predominantly granular material ranging in composition from silt to sand and silt with trace to some gravel and clay. The granular fill thickness ranged from 1.3 m to 2.8 m, with the base of fill encountered between Elev. 290.5 and Elev. 291.3. SPT tests performed in the granular fill gave N-values between 7 and 18 blows per 0.3 m of penetration, indicating a loose to compact relative density. Moisture contents within the granular fill varied from 15 to 22 %.

In Borehole NW-10, a 0.6 m thick layer of clayey silt fill was encountered below the topsoil with the base at Elev. 290.8. One SPT test performed in this fill gave N-value of 18 blows per 0.3 m of penetration, indicating a very stiff consistency. Moisture content of 20 % was measured in this fill.

The fill in Boreholes PA-01 to PA-03 located along Pattullo Avenue West consisted of predominantly silty sand to sand silt with trace to some gravel, some clay and occasional cobble. Frequent silty clay lenses were noted within this fill material. The fill thickness

ranged from 3.8 m to 5.0 m. The base of the fill was encountered between Elev. 284.1 in Borehole PA-01 and Elev. 289.2 in Borehole PA-03.

SPT tests performed in the fill gave N-values between 1 and 30 blows per 0.3 m of penetration, indicating a very loose to compact relative density. A very loose fill zone in Boreholes PA-01 and PA-02 between 2.1 m and 3.8 m depth may indicate presence of soft silty clay lenses in the fill, as no water was observed during drilling. Borehole PA-02 was dry on completion of drilling operations, and the water level in Borehole PA-01 was encountered at 9.2 m depth, below the soft zones.

In Borehole PA-01, a 900 mm layer of sand and gravel fill was encountered underlying the silty sand fill. The base of the sand and gravel fill was encountered at 7.0 m depth or at Elev. 283.2.

Moisture contents within the granular fill varied from 8 to 22 %.

Grain size analysis were completed on selected samples of the fill material. The results are summarized on the Record of Borehole sheets in Appendix A, and the grain size distribution curves for these samples are included in Figures B2a and B2b of Appendix B. The results of the tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 41
Sand	28 to 47
Silt	28 to 54
Clay	10 to 18
Silt and Clay	13

Atterberg Limits tests were completed on a sample of the sandy clayey silt collected from Borehole NW-02. The results are summarized on the Record of Borehole sheet in Appendix A and the Atterberg Limits plot is presented on Figure B7 of Appendix B. The results of the laboratory tests indicate on a low plasticity of the deposit.

#### **5.4 Sandy Silt/Silt to Sand**

A deposit ranging in composition from sandy silt to silt to sand with trace to same clay and trace of gravel was encountered underlying the fill or topsoil in Boreholes NW-02, NW-03, NW-07, NW-10 and in Borehole 5 (1990). In Borehole NW-09, approximately 1.8 m of this deposit was encountered embedded in the silty clay/clayey silt. Occasional clay seams were noted in this deposit. The thickness of this layer ranged from 0.8 to 3.0 m with an underside depth of 1.4 m to 9.1 m (Elev. 294.8 to Elev. 287.9).



SPT tests performed in this layer gave N-values from 9 to 109 blows per 0.3 m of penetration indicating a loose to very dense relative density, predominantly being compact. The moisture content of this cohesionless layer ranged between 8% and 22%.

Grain size analyses were completed on two samples of this layer. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figure B3 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	21 to 22
Silt	60
Clay	18 to 19

Atterberg Limits analysis was also completed on samples of the sandy silt with some clay consisting of clayey silt seam collected from Boreholes NW-03 and NW-09. The Liquid Limits of 17% and 22% and the Plasticity Indices of 6% and 9% were obtained, indicating a low plasticity seams within the transition of the sandy silt to silty clay/clayey silt. The results of the Atterberg Limits testing are presented on Figure B8 in Appendix B, and on the Record of Borehole sheets.

### **5.5 Silty Clay to Clayey Silt**

A deposit of silty clay to clayey silt with trace to some sand and trace gravel was encountered in all boreholes either below the fill or native cohesionless deposit or below the topsoil. Where fully penetrated in the boreholes drilled in the northern part of the site, namely in Boreholes NW-01 to NW-06 and Boreholes 3 to 5 and 7, the thickness of this layer ranged from 1.3 m to 7.0 m with an underside depth of 1.5 to 12.9 m (Elev. 294.2 to 286.3 m). Boreholes NW-07 to 10 were terminated within this layer at a depth of 6.7 m below the ground surface (Elev. 287.6 to 284.9).

SPT tests performed in this deposit gave N-values ranging from 4 to in excess of 100 blows per 0.3 m of penetration indicating a firm to hard consistency. Typically, the N-values ranged from 9 to 40 blows per 0.3 m of penetration indicating a stiff to hard consistency of the deposit. Moisture contents within this layer varied from 11 to 32%.

Grain size analyses were completed on selected samples of the silty clay/clayey silt. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figures B4a and B4b of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	5 to 21
Silt	37 to 70
Clay	14 to 51

Atterberg Limits tests were also completed on selected samples of the silty clay/clayey silt. The results are summarized on the Record of Borehole sheets in Appendix A and the Atterberg Limits plots for these samples are included in Figure B9 of Appendix B. The results of the laboratory tests indicate on a low to intermediate plasticity of the deposit.

Parameter	Value
Plastic Limit	15 to 19
Liquid Limit	25 to 38
Plasticity Index	9 to 19

## 5.6 Sandy Silt to Silty Sand Till

A till deposit grading from sandy silt to silty sand with trace to some clay and trace gravel was encountered in Boreholes NW-01 to NW-06, PA-01, PA-02 and Boreholes 3 to 5 and 7 underlying the silty clay to clayey silt or extending below the fill. Occasional layers of gravelly sand and occasional cobbles were also encountered within the till during drilling. Boreholes NW-01 to 05 and Boreholes 3 to 5 and 7 were terminated within this layer at a depth varying from 6.4 to 25.9 m below ground surface (Elev. 292.3 to 271.2). In Boreholes PA-01 and PA-02, the silty sand to sandy silt till was 6.6 m and 4.2 m in thickness and extended to depths of 13.6 m (Elev. 276.6) and 11.3 m (Elev.280.8).

In Boreholes 3 and 5 from the 1990 investigation, the content of gravel was noted to increase to as much as 18 % below a depth of 10.6 (Elev. 284.6) and at 21.8 m (Elev. 272.5), respectively. This deposit was classified in the 1990 investigation as “Heterogeneous mixture of clayey silt, sand and gravel (Glacial Till)”, which would be comparable to the silty sand/sandy silt till with some clay and gravel described in this section. Boreholes 3 and 5 were terminated in this till at a depth of 18.7 m and 23.1 m (Elev. 276.5 and 271.2).

SPT tests performed in this layer gave N-values from 21 to in excess of 100 blows per 0.3 m of penetration indicating a compact to very dense relative density. The majority of the recorded N-values were higher than 100 blows per 0.3 m of penetration, indicating a very dense relative density of the till. The moisture content of the till layers ranged between 9% and 25%.

Grain size analyses were completed on selected samples of this deposit. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figures B5a and B5b of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	3 to 32
Sand	18 to 61
Silt	25 to 71
Clay	7 to 14
Silt and Clay	7

Glacial till inherently contain cobbles and boulders.

### 5.7 Silty Clay Till

Underlying the cohesionless till in Boreholes PA-01 and PA-02, and fill in Borehole PA-03 was a cohesive till consisting of silty clay with trace to some sand and trace gravel. Occasional coarser layers were encountered in the cohesive till. In Borehole PA-03, the upper 0.9 m layer of the deposit consisted of significant proportion of sand and was classified as sandy silty clay till, and a layer of gravelly silty sand was encountered at the base of this borehole. Boreholes PA-01 to PA-03 were terminated in the silty clay till at a depth of 15.8 m below the ground surface with the base of the boreholes between Elev. 274.4 and Elev. 279.5.

SPT tests performed in this deposit gave N-values ranging from 10 to in excess of 100 blows per 0.3 m of penetration indicating a stiff to hard consistency. Typically, the consistency of the silty clay till was hard with a stiff zones encountered in Borehole PA-03 to approximately 10 m depth. Moisture contents within the silty clay till varied from 8 to 35%.

Grain size analyses were completed on selected samples of the silty clay till. The results are summarized on the Record of Borehole sheets in Appendix A and the grain size distribution curves for these samples are included in Figure B6 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 4
Sand	5 to 48
Silt	29 to 37
Clay	19 to 63

Atterberg Limits tests were also completed on selected samples of the silty clay till. The results are summarized on the Record of Borehole sheets in Appendix A and the Atterberg Limits plots for these samples are included in Figure B10 of Appendix B. The results of the laboratory tests indicate on an intermediate plasticity of the deposit.

Parameter	Value
Plastic Limit	19 to 22
Liquid Limit	39 to 44
Plasticity Index	20 to 24

Glacial till inherently contain cobbles and boulders.

## 5.8 Groundwater Levels

Water levels were observed during drilling operations and in the open boreholes upon completion of the drilling. As outlined in Table 3-1, standpipe piezometers were installed in Boreholes NW-02, NW-04 and PA-01 to monitor groundwater levels after drilling. The measured groundwater levels are summarized in Table 5-1, below.

The values shown are short-term readings and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation after periods of significant or prolonged precipitation events.

**Table 5-1. Measured Groundwater Levels**

Borehole	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
NW-01	Nov. 12, 2014	9.4	286.4	Open Borehole
NW-02	Nov. 17, 2014	Dry	-	Open Borehole
	Nov. 28, 2014	Dry	-	Piezometer
	Jul. 15, 2015	Dry	-	
NW-03	Nov. 12, 2014	7.3	288.1	Open Borehole
NW-04	Nov. 14, 2014	1.6	291.6	Open Borehole
	Nov. 19, 2014	3.9	289.3	Piezometer
	Nov. 28, 2014	3.7	289.5	
	Jul. 15, 2015	3.5	289.7	
NW-05	Nov. 13, 2014	4.3	288.1	Open Borehole
NW-06	Nov. 11, 2014	Dry	-	Open Borehole

Borehole	Date	Groundwater Level		Comment
		Depth (m)	Elevation (m)	
NW-07	Nov. 13, 2014	4.6	287.5	Open Borehole
NW-08	Nov. 13, 2014	4.3	290.0	Open Borehole
NW-09	Nov. 10, 2014	4.1	287.9	Open Borehole
NW-10	Nov. 10, 2014	Dry	-	Open Borehole
PA-01	Dec. 15, 2015	9.2	281.0	Piezometer
	Jan. 06, 2016	5.5	284.7	
PA-02	Dec. 15, 2016	Dry to 8.8	Dry to 283.3	Open Borehole
PA-03	Dec. 16, 2016	12.2	283.1	Open Borehole
3 <sup>*)</sup>	Apr. 20, 1990	3.2	292.0	Open Borehole
4 <sup>*)</sup>	Apr. 23, 1990	4.8	290.3	Open Borehole
5 <sup>*)</sup>	Apr. 19, 1990	2.3	292.0	Open Borehole
7 <sup>*)</sup>	Apr. 26, 1990	12.0	289.5	Open Borehole

Note: <sup>\*)</sup> Geocres No. 40P2-45

## 5.9 Analytical Testing

Two representative soil samples retrieved from the site were submitted to AGAT Laboratories in Mississauga, Ontario for analysis of pH and soluble sulphates. The analysis results are presented below in Table 5-2.

**Table 5-2. Results of Analytical Testing**

Location	Borehole	Sample	Depth (m)	pH	Sulphate (µg/g)
North Abutment	NW-02	SS 11	12.5	7.9	42
South Abutment	NW-04	SS1	0.3	7.6	18

The results of the analyses are enclosed in Appendix C.

## 6 MISCELLANEOUS

Borehole locations were selected and marked in the field by an experienced Thurber staff member and were established with a Trimble Pathfinder ProXRT differential GPS unit. The co-ordinates and ground surface elevations at the boreholes were surveyed by MMM Group Limited upon completion of drilling.

Determination Drilling and Soil Investigations Holdings Inc. from Hamilton, Ontario supplied and operated the drill rig, sampling and in-situ testing equipment for the field program carried out in 2014. Altech Drilling and Investigative Services Ltd. of Elmira, Ontario, supplied and operated the drilling, sampling and in-situ testing equipment for the field program conducted in 2015. The field investigation was supervised on a full time basis by Mr. George Azzopardi of Thurber in 2014 and Mr. Tim Craplewe in 2015, both of Thurber. Overall supervision of the investigation program was conducted by Mr. Stephane Loranger, C.E.T and Weiss Mehdawi, P.Eng.

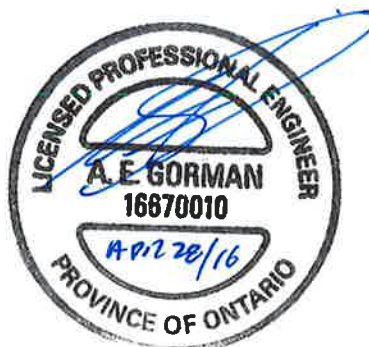
Routine laboratory testing was carried out by Thurber's geotechnical laboratory in Oakville, Ontario. Interpretation of the data and preparation of this report were carried out by Ms. Anna Piascik, P.Eng. The report was reviewed by Mr. Alastair Gorman, P.Eng. and by Dr. P.K. Chatterji, P.Eng., who is a Designated Principal Contact for MTO Foundations Projects.

### Thurber Engineering Ltd.

Anna Piascik, P.Eng.  
Senior Geotechnical Engineer



Alastair Gorman, P.Eng.  
Senior Foundation Engineer/Senior Associate



P. K. Chatterji, Ph.D, P.Eng.  
Review Principal



## **Appendix A**

### **Record of Borehole Sheets**

## 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 <sup>(1)</sup> 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

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


### 4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

### 5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level  
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value      Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT      Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.



## EXPLANATION OF ROCK LOGGING TERMS


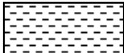



### ROCK WEATHERING CLASSIFICATION

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

### DISCONTINUITY SPACING

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

### SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

### STRENGTH CLASSIFICATION

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

### TERMS

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

# UNIFIED SOILS CLASSIFICATION

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

# RECORD OF BOREHOLE No NW-01

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 259.9 E 204 177.4 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.12 - 2014.11.12 CHECKED BY SBP

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 (%)								
								○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE					w <sub>P</sub> w                      w <sub>L</sub>								
295.8	GROUND SURFACE							20	40	60	80	100					GR	SA	SI	CL	
0.0	TOPSOIL: (150mm)							20	40	60	80	100									
0.2	Silty <b>CLAY</b> to Clayey <b>SILT</b> , some sand, trace gravel, occasional rootlets Firm to Stiff Brown Moist		1	SS	8		295							○				0	15	61	24
			2	SS	13									○							
294.2																					
1.5	<b>SILT</b> , some sand grading to <b>SAND</b> and <b>SILT</b> , trace clay, trace gravel, occasional cobbles Very Dense Brown Moist (TILL)		3	SS	54		294							○							
			4	SS	103									○							
							293							○							
			5	SS	100/ 0.150									○							
							292														
			6	SS	103/ 0.150		291							○							
							290														
			7	SS	122									○							
							289														
			8	SS	111		288							○							
							287							○							
			9	SS	106		286														

Continued Next Page

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

# RECORD OF BOREHOLE No NW-01

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 259.9 E 204 177.4 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.12 - 2014.11.12 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page		10	SS	111												
285.5																	
10.2	END OF BOREHOLE AT 10.2m. BOREHOLE OPEN TO 10.2m AND WATER LEVEL AT 9.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

# RECORD OF BOREHOLE No NW-02

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 252.1 E 204 206.5 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	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 <sub>P</sub> w      w <sub>L</sub>				GR	SA	SI	CL
303.9	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT:(125mm)							20	40	60	80	100							
0.1	SAND and GRAVEL, trace silt Dense Brown Moist (FILL)		1	SS	34		303							○					41   52   7 (SI+CL)
			2	SS	32									○					
302.4																			
1.5	Clayey SILT, sandy Stiff to Hard Brown/Grey Moist (FILL)		3	SS	16		302							○					
			4	SS	17									○					
			5	SS	31		301							○	H				0   28   54   18
			6	SS	8		300												
							299							○					
							298												
297.8																			
6.1	Sandy SILT, trace gravel Very Dense Brown Moist		7	SS	70		297							○					
			8	SS	109		296							○					
							295												
294.8																			
9.1	Silty CLAY, some sand Hard Grey Moist		9	SS	36		294							○					0   12   42   46

Continued Next Page

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

# RECORD OF BOREHOLE No NW-02

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 252.1 E 204 206.5 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.17 - 2014.11.17 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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																
291.8			10	SS	104/ 0.150												
12.2	Sandy <b>SILT</b> , trace gravel Very Dense Brown Moist (TILL)		11	SS	106/ 0.150												
289.9			12	SS	62/ 0.150												
14.0	END OF BOREHOLE AT 12.8m. BOREHOLE OPEN TO 12.8m AND DRY. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m)  2014.11.28 Dry 2015.07.15 Dry																

# RECORD OF BOREHOLE No NW-03

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 238.5 E 204 184.8 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.12 - 2014.11.12 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
295.4	GROUND SURFACE							20	40	60	80	100								
0.0	TOPSOIL: (125mm)							20	40	60	80	100								
0.1	Sandy <b>SILT</b> , some clay, trace gravel Compact Brown Moist		1	SS	16		295													
	Clayey silt seams		2	SS	28															
293.9							294													
1.5	Silty <b>CLAY</b> , trace to some sand, trace gravel Hard Brown Moist		3	SS	36															
			4	SS	57		293													
292.4																				
3.0	Silty <b>SAND</b> to <b>SILT</b> , some sand, some clay, trace gravel Very Dense Brown Moist (TILL)		5	SS	107		292													
			6	SS	103/ 0.150		291													
							290													
			7	SS	112/ 0.150		289													
			8	SS	109		288													
			9	SS	103		287													
							286													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No NW-03

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 238.5 E 204 184.8 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.12 - 2014.11.12 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	Continued From Previous Page																
284.5			10	SS	114		285										
11.0	END OF BOREHOLE AT 11.0m. BOREHOLE OPEN TO 11.0m AND WATER LEVEL AT 7.3m BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																



# RECORD OF BOREHOLE No NW-04

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 160.3 E 204 200.0 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.14 - 2014.11.04 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	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										
293.2	GROUND SURFACE							20	40	60	80	100							
0.0	TOPSOIL: (150mm)							20	40	60	80	100							
0.2	Silty <b>CLAY</b> , trace to some sand Firm to Hard Grey Moist		1	SS	4									○					
			2	SS	4									○					
			3	SS	7									○	—			0	9
			4	SS	38									○					
			5	SS	37									○					
			6	SS	43									○	—			0	21
287.7																			
5.5	<b>SAND</b> and <b>SILT</b> , trace clay, trace to some gravel Very Dense Grey Wet (TILL)		7	SS	105									○					
			8	SS	110									○				0	43
			9	SS	104/ 0.150									○					

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15 5  
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No NW-04

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 160.3 E 204 200.0 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.14 - 2014.11.04 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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																
282.4			10	SS	114/		283										
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE OPEN TO 10.8m AND WATER LEVEL AT 1.6m. Piezometer installation consists of 25mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.  WATER LEVEL READINGS: DATE      DEPTH (m)      ELEV. (m)  2014.11.19    3.9          289.3 2014.11.28    3.7          289.5 2015.07.15    3.5          289.7				0.150												

## METRIC

SOIL PROFILE					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES <div>NUMBERTYPE"N" VALUES</div>	GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT
292.4	GROUND SURFACE				<div>0 20 40 60 80 100</div> <div>○ UNCONFINED + FIELD VANE</div> <div>● QUICK TRIAXIAL × LAB VANE</div> <div>PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT</div> <div>w<sub>P</sub> w w<sub>L</sub></div> <div>WATER CONTENT (%)</div> <div>20 40 60</div> <div>kN/m³ GR SA SI C</div>
0.0	TOPSOIL:(125mm)				
0.1	Silty CLAY, trace sand, occasional rootlets in the upper 1.0m zone Firm to Hard Dark Brown Moist		1 SS 8		292
			2 SS 9		291
			3 SS 6		
			4 SS 28		290
			5 SS 31		289
			6 SS 30		288
					287
286.3	Sandy SILT to Silty SAND, some gravel, trace clay Very Dense Grey Wet (TILL)		7 SS 102		286
6.1					
			8 SS 104		285
					284
			9 SS 112		283

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

# RECORD OF BOREHOLE No NW-05

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 135.8 E 204 205.9 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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 (%)						
						20	40	60	80	100	20	40	60				
282.3	Continued From Previous Page		10	SS	108												
10.1	END OF BOREHOLE AT 10.1m. BOREHOLE OPEN TO 10.1m AND WATER LEVEL AT 4.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.				0.150												

# RECORD OF BOREHOLE No NW-06

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 283.2 E 204 178.9 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.11 - 2014.11.11 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT  γ  kN/m <sup>3</sup>	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									
298.7	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (125mm)							20	40	60	80	100					
0.1	SAND and SILT, some clay Compact Brown Moist (FILL)		1	SS	11		298							○			0 39 43 18
			2	SS	15									○			
297.2																	
1.5	Clayey SILT, trace to some sand, trace gravel Hard Brown Moist		3	SS	43		297							○			
			4	SS	59		296							○			
			5	SS	70		295							○			
294.2																	
4.6	SILT, some sand, some clay, trace gravel Very Dense Brown Moist (TILL)		6	SS	80		294							○			0 18 68 14
							293										
292.3			7	SS	104									○			
6.4	END OF BOREHOLE AT 6.4m. BOREHOLE OPEN TO 6.4m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																


ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

# RECORD OF BOREHOLE No NW-07

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 112.9 E 204 215.1 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	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							PLASTIC LIMIT w <sub>p</sub>  NATURAL MOISTURE CONTENT w  LIQUID LIMIT w <sub>L</sub>  WATER CONTENT (%)		
292.1	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (150mm)							20	40	60	80	100					
0.2	<b>SAND</b> and <b>SILT</b> , some clay, occasional rootlets Compact Brown Moist (FILL)		1	SS	10		292								○		
			2	SS	18		291								○		0   40   43   17
290.6																	
1.5	<b>SAND</b> , some gravel, trace silt Compact Brown/Dark Brown Moist		3	SS	19		290								○		
289.9																	
2.3	Silty <b>CLAY</b> , trace sand, trace gravel Very Stiff Grey Moist		4	SS	29		289								○		
			5	SS	22		288										
						287									○		
			6	SS	17	286											

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

# RECORD OF BOREHOLE No NW-08

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 097.2 E 204 222.0 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.13 - 2014.11.13 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT      NATURAL MOISTURE      LIQUID CONTENT      LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)						
								20   40   60   80   100					w <sub>P</sub> w                      w <sub>L</sub>						
						○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL      × LAB VANE													
294.3	GROUND SURFACE																		
0.0	TOPSOIL: (150mm)																		
0.2	Silty <b>SAND</b> , some gravel, some clay Loose to Very Dense Brown Moist (FILL)  Occasional cobbles		1	SS	12		294												
			2	SS	50/ 0.150														
			3	SS	10		293												
			4	SS	6		292												
291.3																			
3.0	Clayey <b>SILT</b> to Silty <b>CLAY</b> , some sand, trace gravel Stiff to Hard Brown Moist		5	SS	8		291												
			6	SS	30		290												
			7	SS	32		289												
287.6																			
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 4.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																		

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

# RECORD OF BOREHOLE No NW-09

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 041.3 E 204 235.2 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.10 - 2014.11.10 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	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 <sub>p</sub> w      w <sub>L</sub>				GR	SA	SI	CL	
292.0	GROUND SURFACE																				
0.0	TOPSOIL: (125mm)																				
0.1	SAND and SILT, some clay, occasional rootlets Loose Brown Moist (FILL)		1	SS	8																
			2	SS	7																
290.5																					
1.5	Clayey SILT, trace sand, trace gravel Very Stiff Brown Moist		3	SS	16																
289.7																					
2.3	Sandy SILT to Silty SAND, some gravel, trace to some clay Loose to Compact Brown Moist		4	SS	9																
			5	SS	27																
287.9																					
4.1	Clayey SILT to Silty CLAY, trace sand  Hard Grey Moist		6	SS	32																
			7	SS	51																
285.3																					
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 4.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																				

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



# RECORD OF BOREHOLE No NW-10

1 OF 1

METRIC

GWP# 3054-13-00 LOCATION Norwich Ave. Underpass N 4 775 012.3 E 204 248.7 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.10 - 2014.11.10 CHECKED BY SBP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
291.6	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (150mm)							20	40	60	80	100					
0.2	Clayey <b>SILT</b> , trace sand, occasional rootlets Very Stiff Brown Moist (FILL)		1	SS	18		291										
290.8																	
0.8	Sandy <b>SILT</b> , some clay, occasional clay seams Compact to Dense Brown Moist		2	SS	33		290										
			3	SS	20		289										
			4	SS	27		288										
288.6																	
3.0	Silty <b>CLAY</b> , trace sand Stiff to Very Stiff Brown Moist		5	SS	24		287										
			6	SS	15		286										
			7	SS	26		285										
284.9																	
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																


ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

# RECORD OF BOREHOLE No PA-01

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 966.2 E 204 187.9 ORIGINATED BY TIM  
HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2015.12.14 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
290.2	GROUND SURFACE							20	40	60	80	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
0.0	<b>SAND</b> and <b>GRAVEL</b> , some silt Loose to Compact Grey Moist (FILL)  Layer of silty sand with some clay and gravel between 0.8 and 1.2m depth		1	SS	20		290																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No PA-01

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 966.2 E 204 187.9 ORIGINATED BY TIM  
HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
DATUM Geodetic DATE 2015.12.14 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	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																
			10	SS	50/ 0.163		280										
			11	SS	200/ 0.100		278										
276.6							277										
13.6	Silty <b>CLAY</b> , trace to some sand, trace gravel Hard Brown Moist (TILL)		12	SS	42		276									0 6 37 57	
			13	SS	39		275										
274.4																	
15.8	END OF BOREHOLE AT 15.8m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.  WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2015.12.15 9.2 281.0 2016.01.06 5.5 284.7																

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

# RECORD OF BOREHOLE No PA-02

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 971.2 E 204 210.3 ORIGINATED BY TIM  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.12.15 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
292.1	GROUND SURFACE						20	40	60	80	100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	
0.0	<b>SAND</b> and <b>GRAVEL</b> , some silt Compact Brown Moist (FILL)		1	SS	12										34 53 13 (SH+CL)
			2	SS	16										
			3	SS	17										
290.0															
2.1	Silty <b>SAND</b> , some gravel, some clay, occasional cobbles, frequent silty clay lenses Very Loose to Compact Brown Moist (FILL)		4	SS	3										
			5	SS	1										
	Slight organic odour		6	SS	26										16 42 28 14
			7	SS	11										
285.0															
7.1	Silty <b>SAND</b> to Sandy <b>SILT</b> , trace to some gravel, trace clay, occasional cobbles Very Dense Brown Moist (TILL) 0.5m layer of gravelly sand at 7.5m depth		8	SS	28										32 61 7 (SH+CL)
			9	SS	62										

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No PA-02

2 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 971.2 E 204 210.3 ORIGINATED BY TIM  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.12.15 - 2015.12.15 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  γ  kN/m <sup>3</sup>	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					
280.8			10	SS	50/ 0.150		282						
11.3	Silty <b>CLAY</b> , trace to some sand, trace gravel, occasional cobbles Very Stiff to Hard Brown Moist (TILL)						281						
			11	SS	80		280			○			0 16 34 50
							279						
			12	SS	46		278			○			
							277						
276.3			13	SS	18						○		0 5 32 63
15.8	END OF BOREHOLE AT 15.8m. BOREHOLE OPEN TO 8.8m DEPTH AFTER AUGER REMOVAL AND DRY BOREHOLE BACKFILLED WITH CUTTINGS AND BENTONITE HOLEPLUG TO SURFACE.												




ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

# RECORD OF BOREHOLE No PA-03

1 OF 2

METRIC

GWP# 3054-13-00 LOCATION N 4 774 978.5 E 204 249.5 ORIGINATED BY TIM  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2015.12.16 - 2015.12.16 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  <b>γ</b>  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE							PLASTIC LIMIT w <sub>p</sub> NATURAL MOISTURE CONTENT w LIQUID LIMIT w <sub>L</sub> WATER CONTENT (%)					
295.3	GROUND SURFACE							20	40	60	80	100								
0.0	<b>SAND</b> and <b>GRAVEL</b> , some silt Compact to Dense Brown Moist (FILL)		1	SS	13		295													
			2	SS	33		294													
			3	SS	31		293													
293.0							293													
2.3	Sandy <b>SILT</b> , some clay, trace to some gavel, occasional cobbles, frequent silty clay lenses Compact Brown Moist (FILL)		4	SS	30		292													
			5	SS	11		291													
			6	SS	23		290													
289.2							289													
6.1	Silty <b>CLAY</b> , trace to some sand, trace gravel, becoming sandy to 7.0m depth, occasional cobbles, slight organic odour Stiff to Hard Brown Moist (TILL)		7	SS	10		288													
			8	SS	37		287													
			9	SS	10		286													

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to  
Sensitivity

20  
15  
10  
(%) STRAIN AT FAILURE

## METRIC

[illegible][illegible]

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 4/27/16

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity

## **Appendix B**

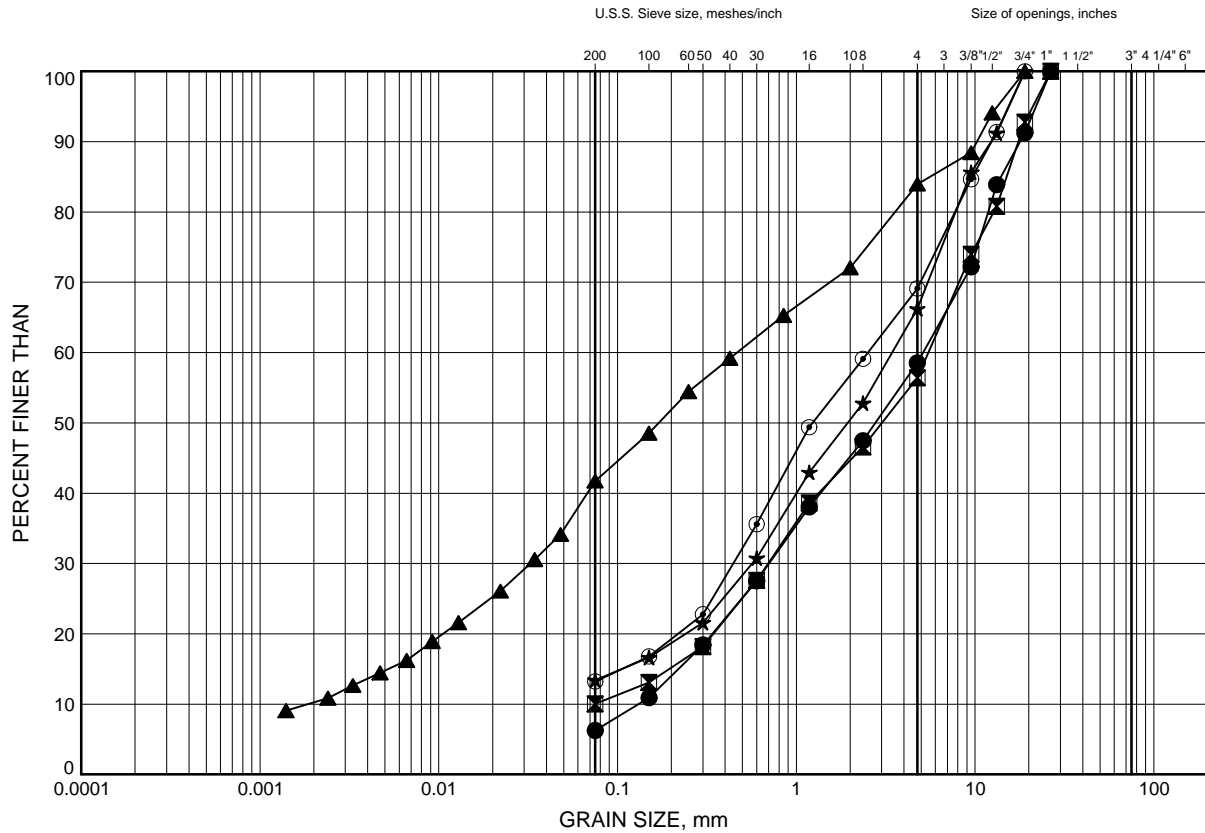
### **Laboratory Test Results**



# GRAIN SIZE DISTRIBUTION

FIGURE B1

## SAND & GRAVEL FILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-02	1.07	302.88
⊠	PA-01	0.30	289.90
▲	PA-01	1.07	289.13
★	PA-02	0.30	291.80
⊙	PA-03	1.07	294.23

Date April 2016

GWP# 3054-13-00



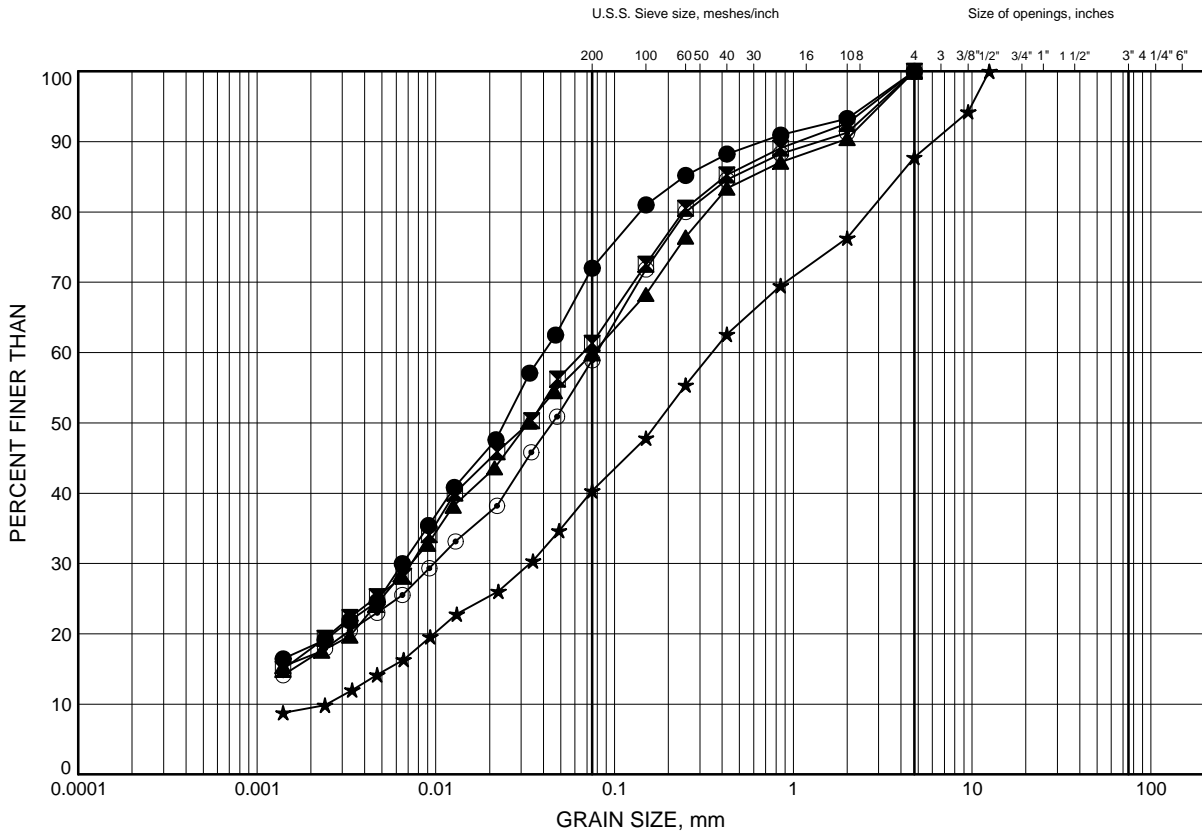
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B2a

## EMBANKMENT FILL MATERIALS



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-02	3.35	300.59
⊠	NW-06	1.07	297.68
▲	NW-07	1.07	291.07
★	NW-08	1.83	292.47
⊙	NW-09	1.07	290.95

Date April 2016

GWP# 3054-13-00



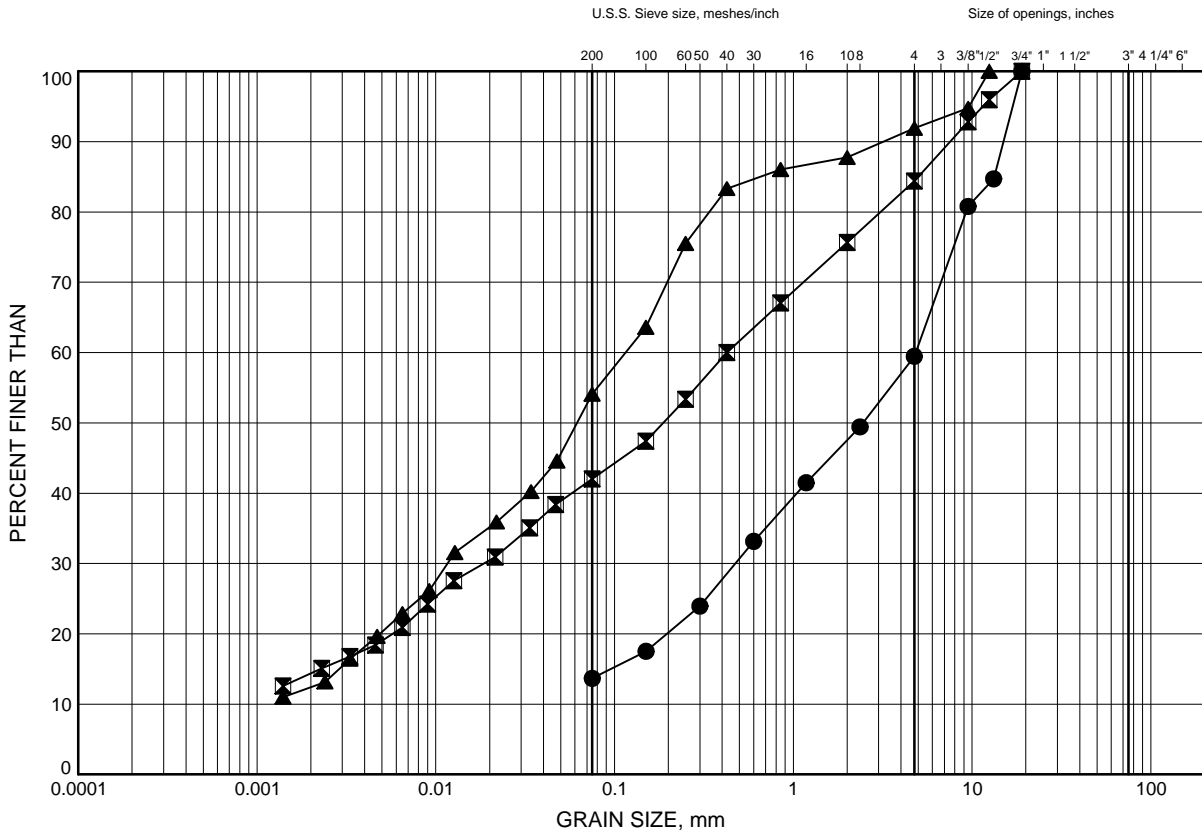
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B2b

## EMBANKMENT FILL MATERIALS



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PA-01	6.40	283.80
⊠	PA-02	4.88	287.22
▲	PA-03	2.59	292.71

Date April 2016

GWP# 3054-13-00



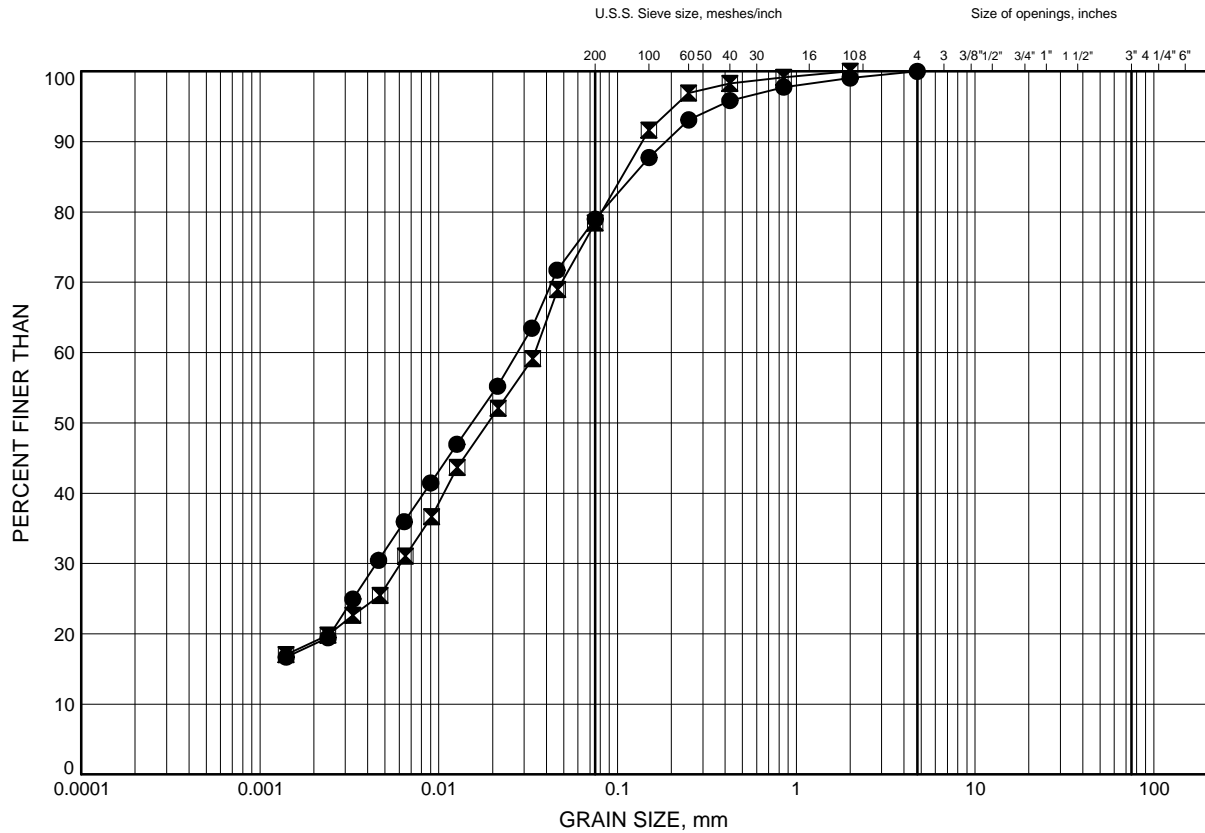
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B3

## SANDY SILT



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-03	1.07	294.38
⊠	NW-10	2.59	289.03

Date April 2016  
GWP# 3054-13-00

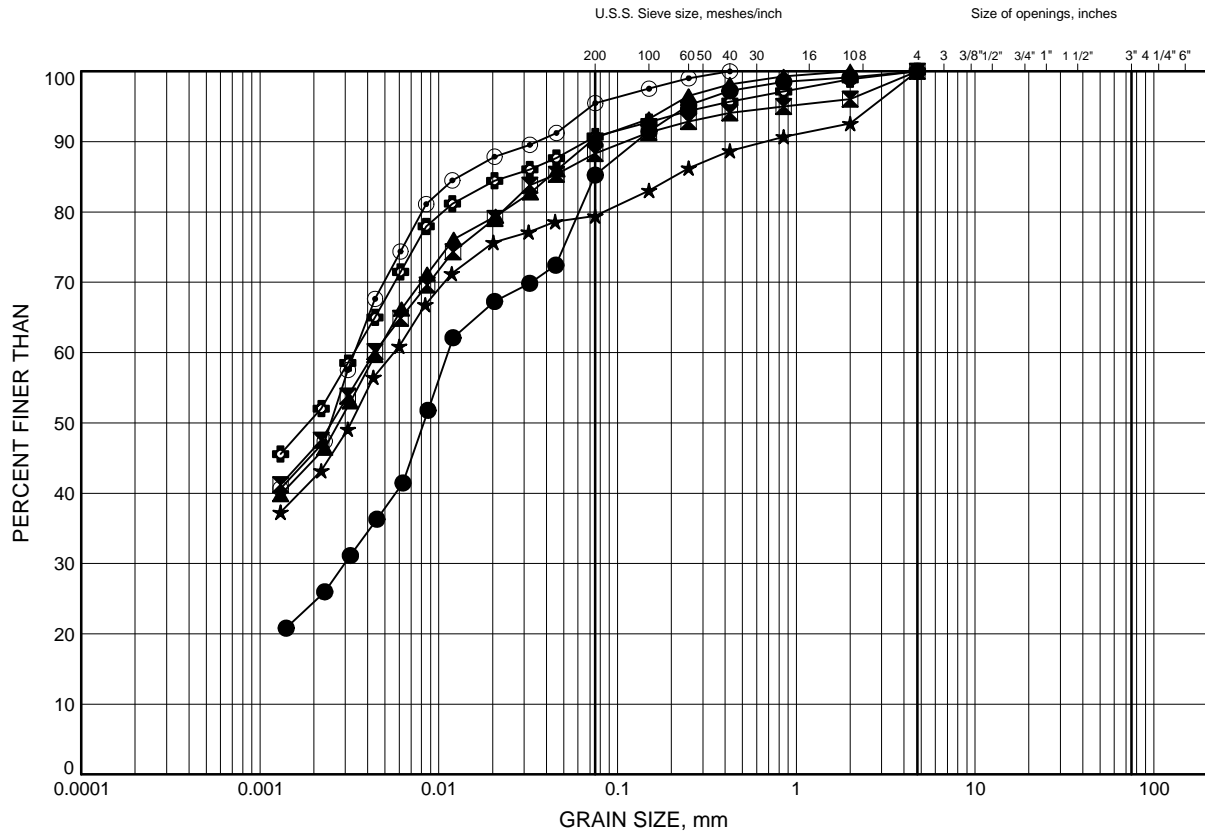


Prep'd AN  
Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B4a

## SILTY CLAY to CLAYEY SILT



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-01	1.07	294.69
⊠	NW-02	9.45	294.49
▲	NW-04	1.83	291.40
★	NW-04	4.88	288.36
⊙	NW-05	2.59	289.78
⊕	NW-07	6.40	285.74

Date April 2016

GWP# 3054-13-00



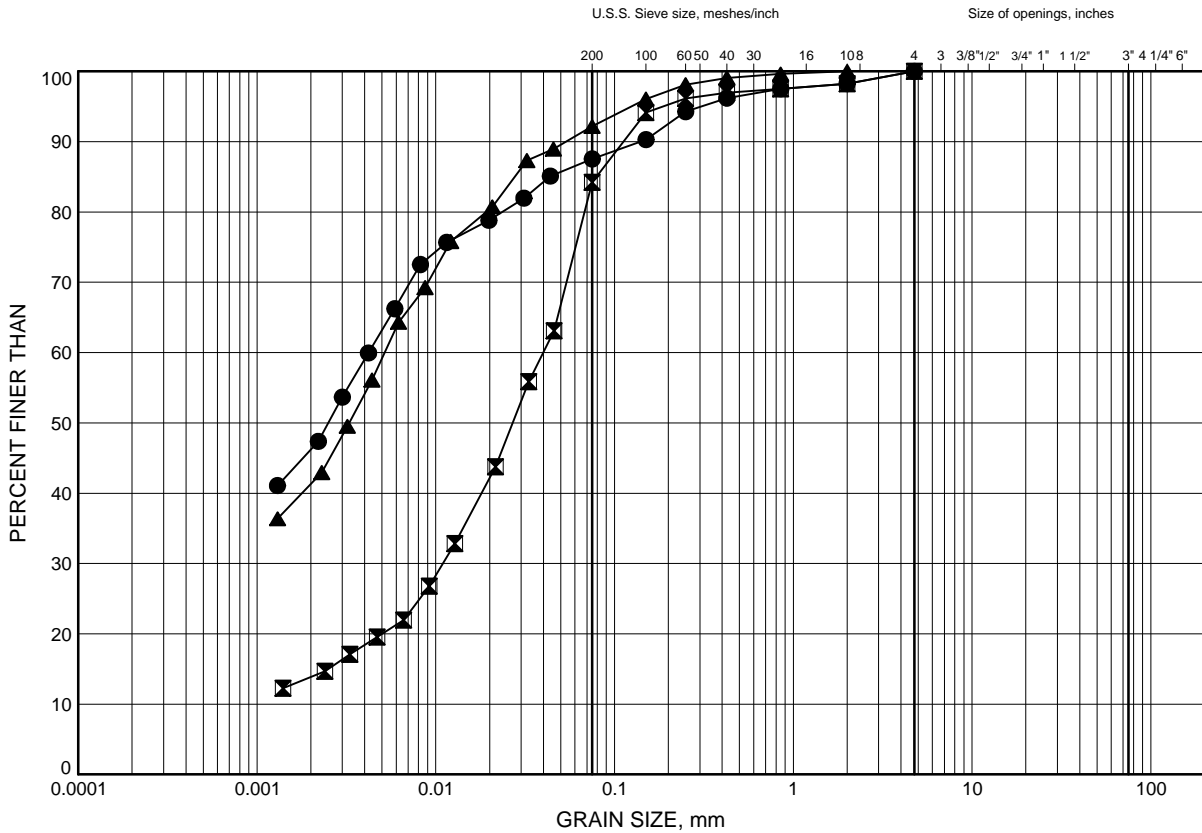
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B4b

## SILTY CLAY to CLAYEY SILT



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-08	4.88	289.42
⊠	NW-09	4.88	287.14
▲	NW-10	6.40	285.22

Date April 2016

GWP# 3054-13-00



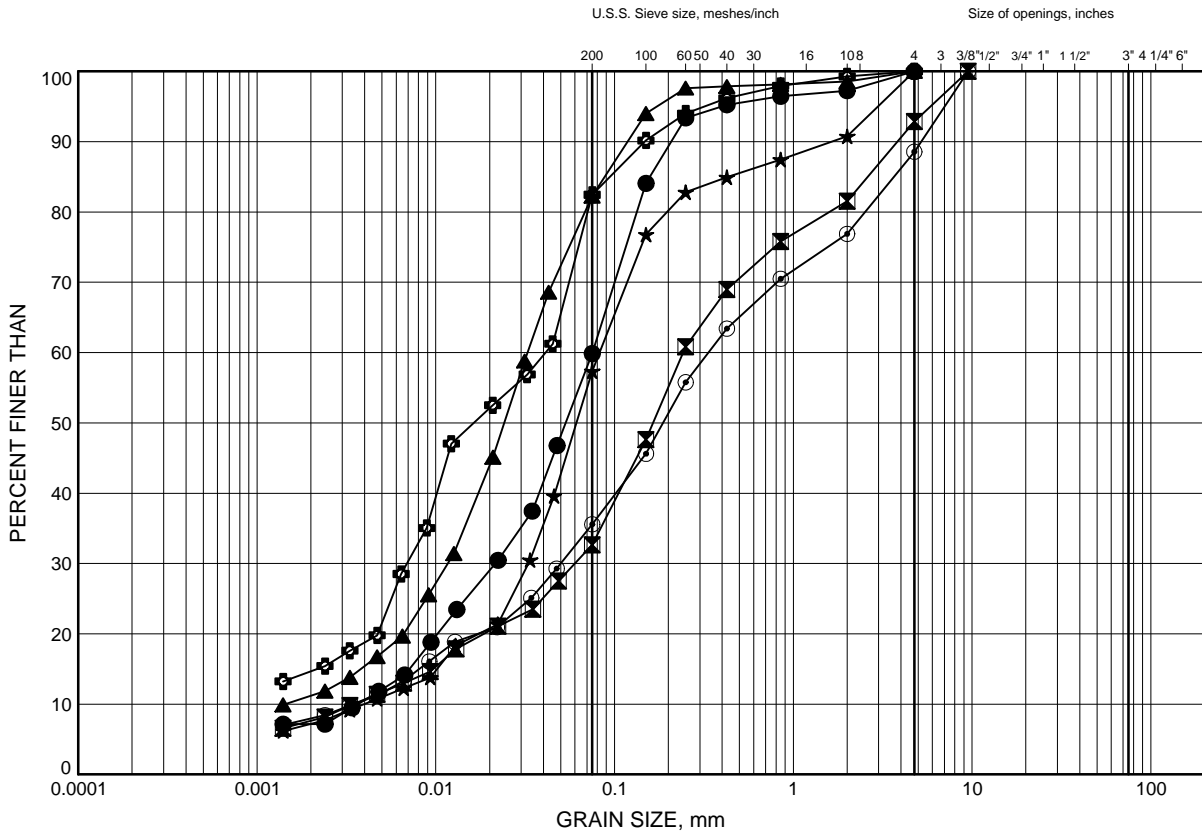
Prep'd AN

Chkd. AMP

# Norwich Ave. Underpass GRAIN SIZE DISTRIBUTION

FIGURE B5a

## SILTY SAND to SANDY SILT TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-01	6.40	289.36
⊠	NW-03	3.35	292.09
▲	NW-03	7.92	287.52
★	NW-04	7.92	285.31
⊙	NW-05	9.45	282.92
⊕	NW-06	4.88	293.87

Date April 2016

GWP# 3054-13-00



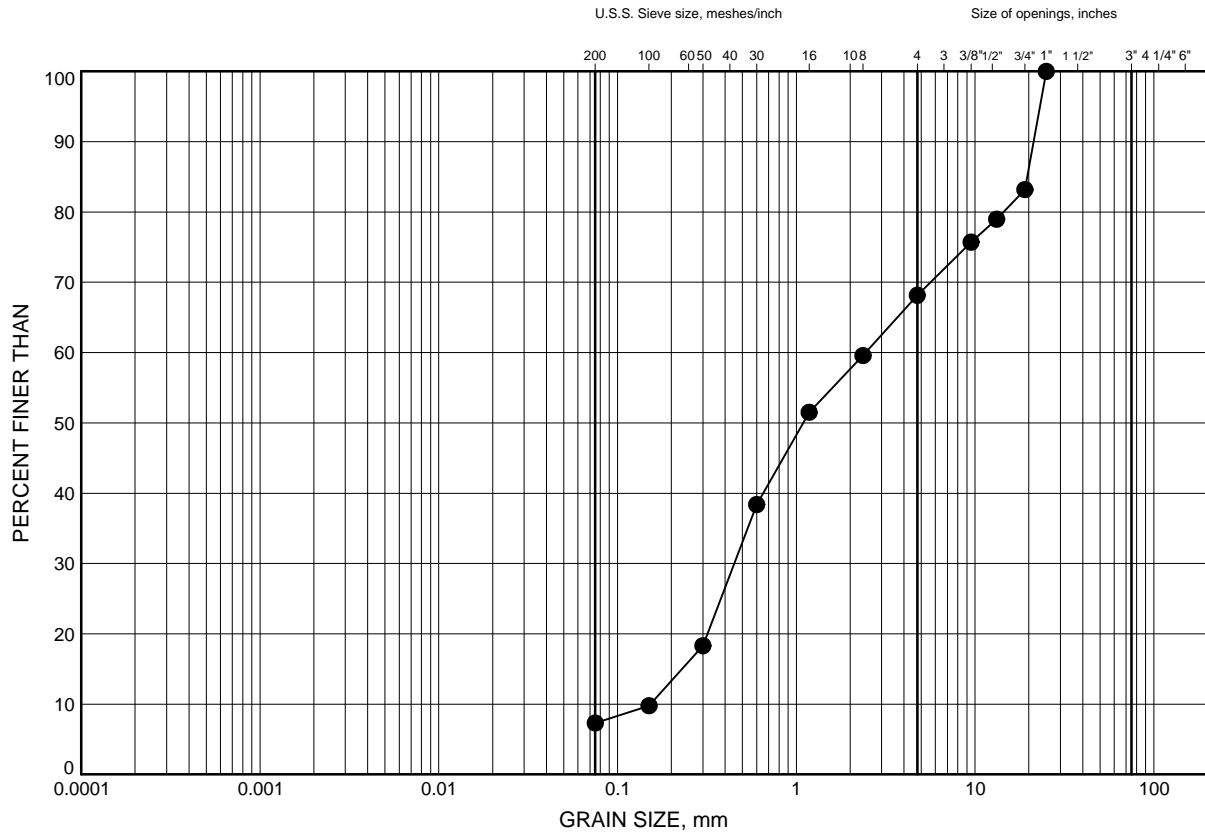
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B5b

## SILTY SAND TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PA-02	7.92	284.18

Date April 2016

GWP# 3054-13-00



Prep'd AN

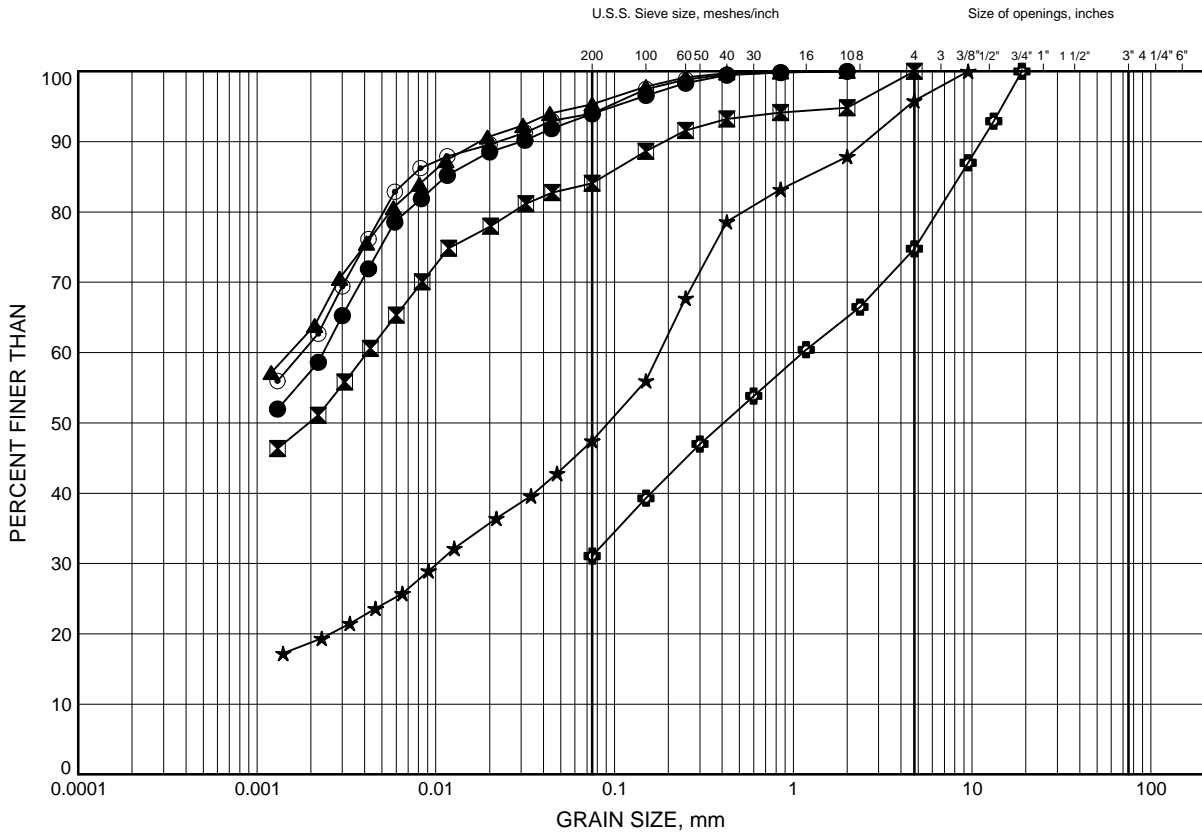
Chkd. AMP



# GRAIN SIZE DISTRIBUTION

FIGURE B6

## SILTY CLAY TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	PA-01	14.02	276.18
⊠	PA-02	12.50	279.60
▲	PA-02	15.54	276.56
★	PA-03	6.40	288.90
⊙	PA-03	9.45	285.85
⊕	PA-03	15.54	279.76

Date April 2016

GWP# 3054-13-00



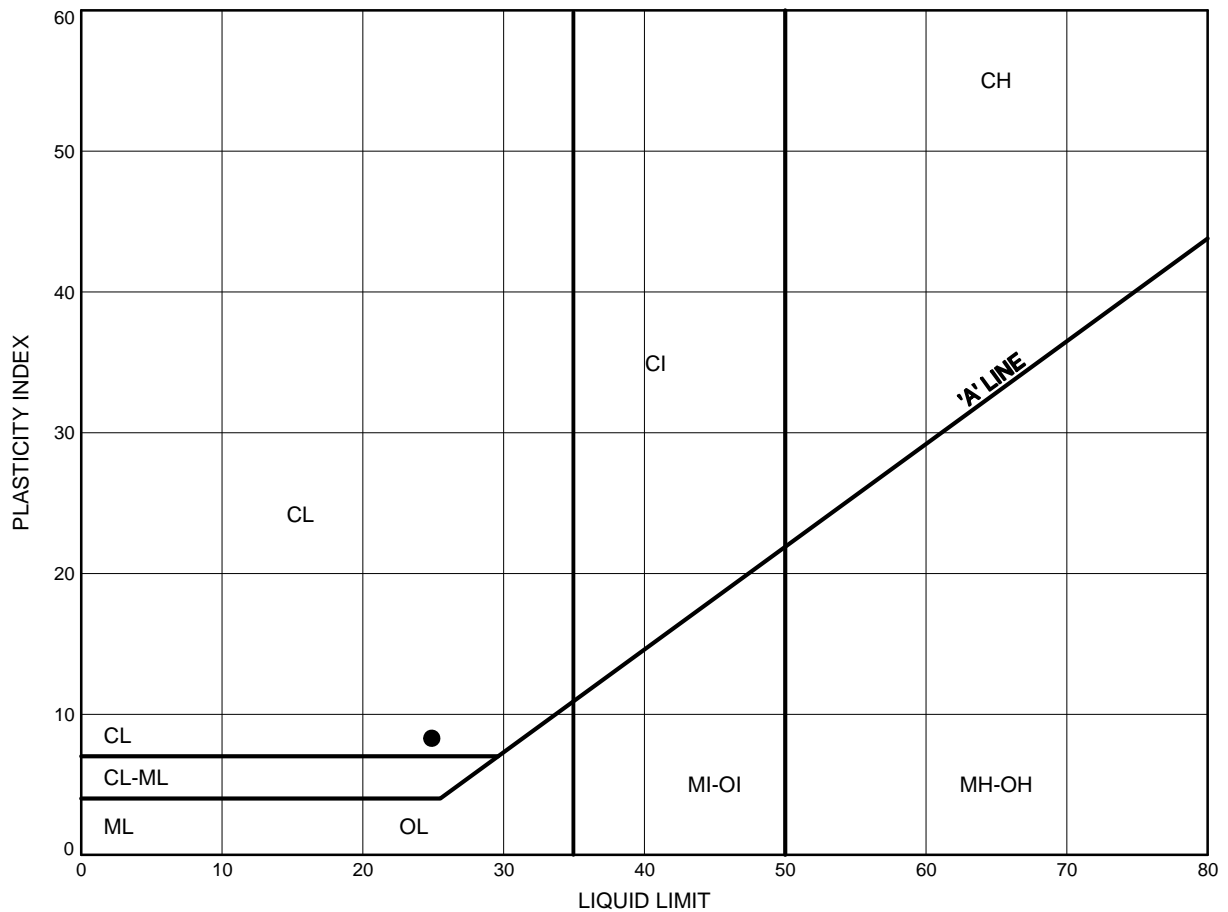
Prep'd AN

Chkd. AMP

# ATTERBERG LIMITS TEST RESULTS

FIGURE B7

## EMBANKMENT FILL MATERIALS



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-02	3.35	300.59

Date April 2016  
GWP# 3054-13-00

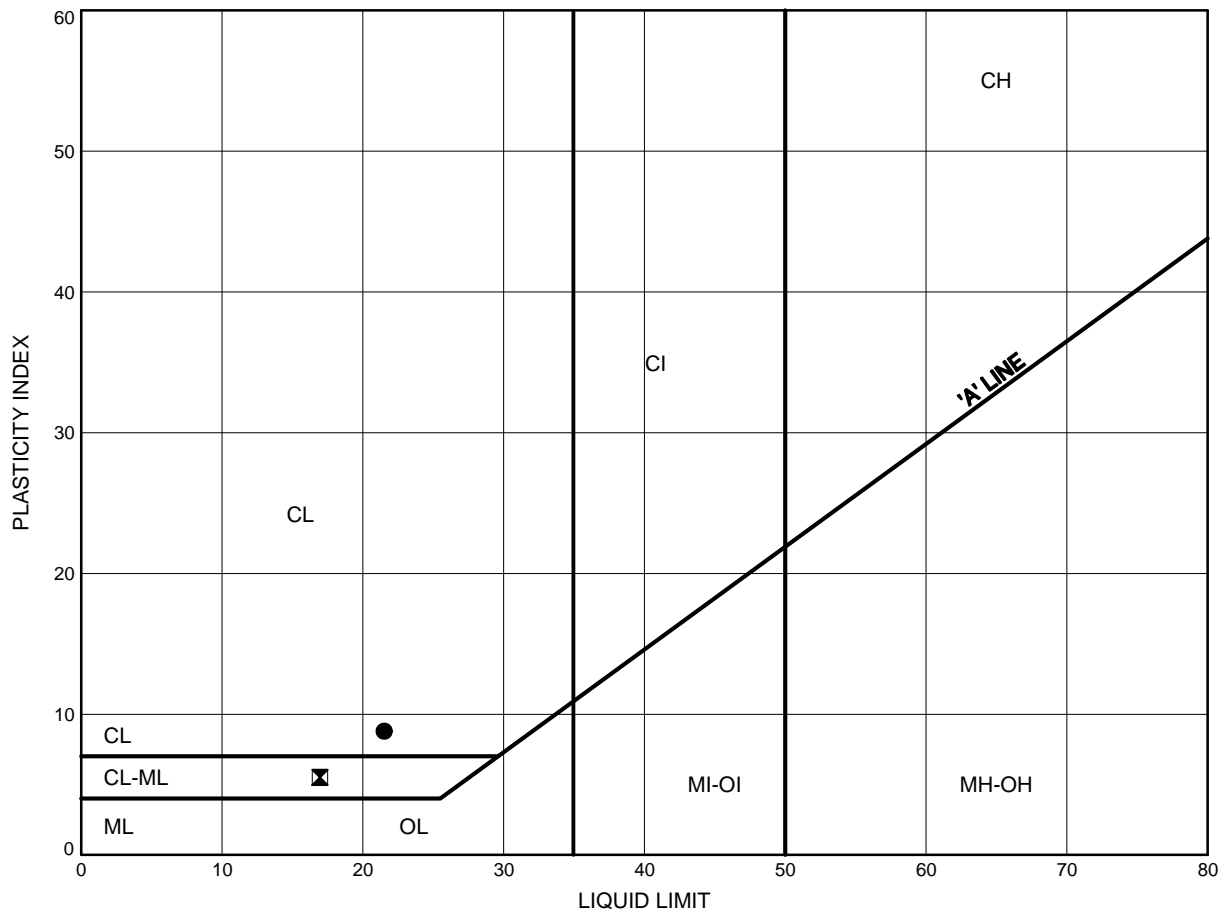


Prep'd AN  
Chkd. AMP

# ATTERBERG LIMITS TEST RESULTS

FIGURE B8

## CLAYEY SILT



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-03	1.07	294.38
⊠	NW-09	2.59	289.42

Date April 2016

GWP# 3054-13-00



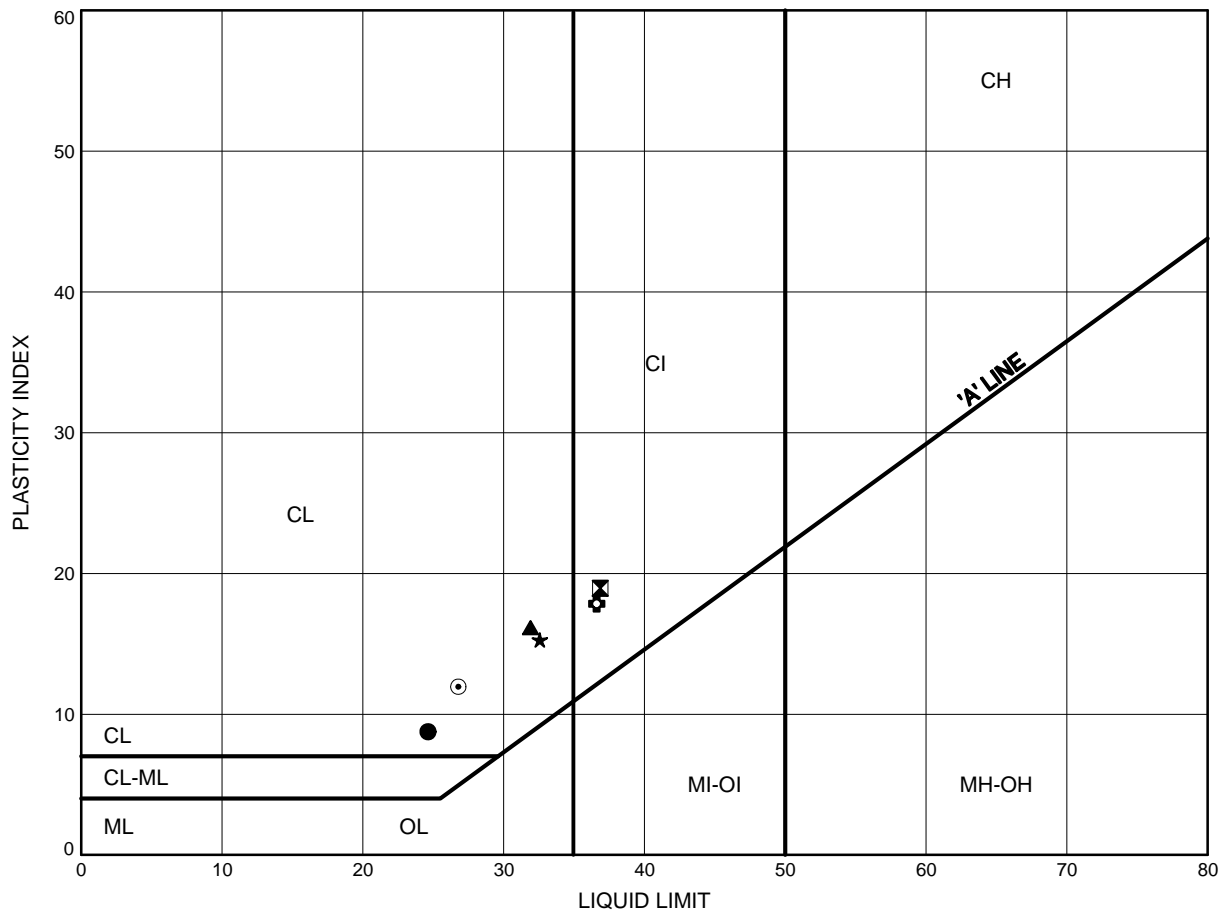
Prep'd AN

Chkd. AMP

# ATTERBERG LIMITS TEST RESULTS

FIGURE B9

## SILTY CLAY to CLAYEY SILT



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-01	1.07	294.69
⊠	NW-04	1.83	291.40
▲	NW-04	4.88	288.36
★	NW-05	2.59	289.78
⊙	NW-07	6.40	285.74
⊕	NW-08	4.88	289.42

Date April 2016

GWP# 3054-13-00



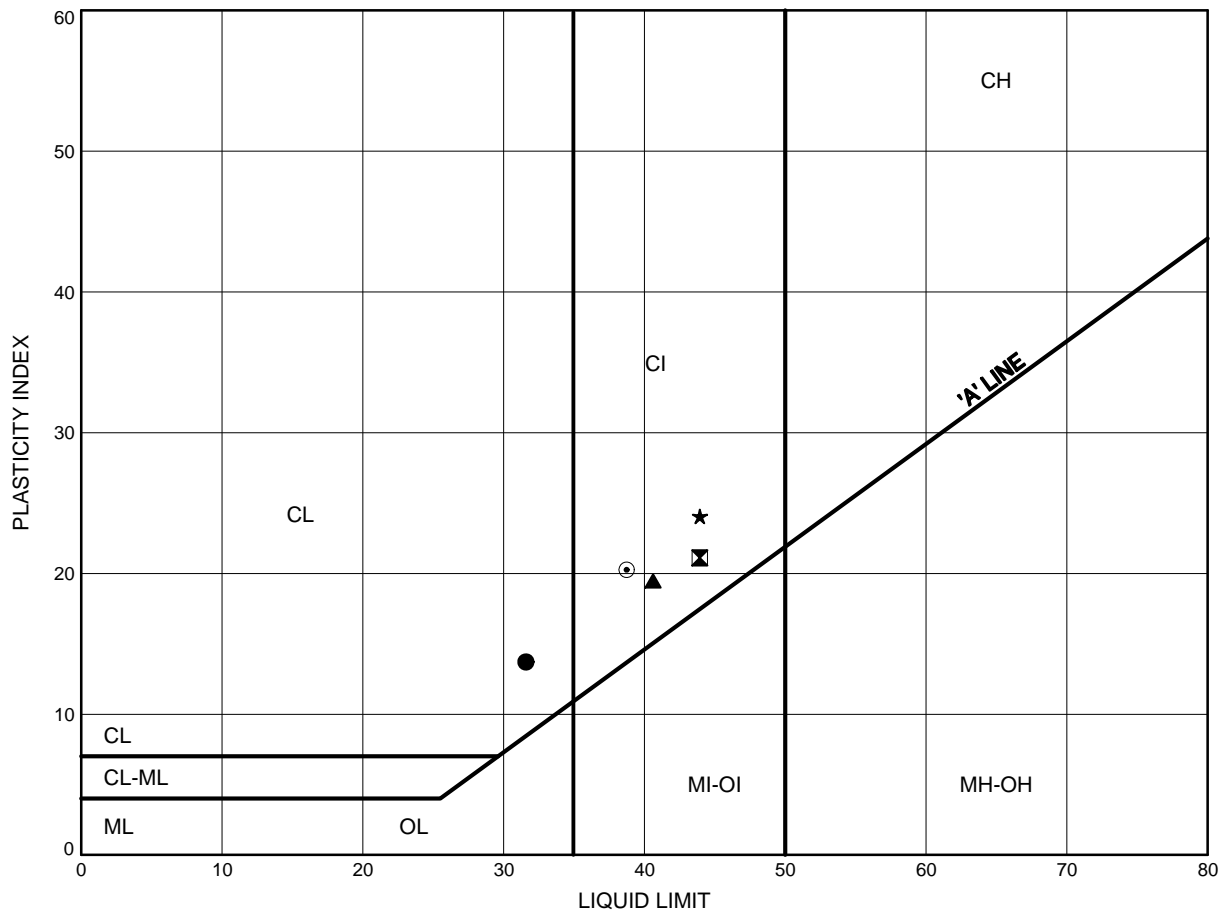
Prep'd AN

Chkd. AMP

# ATTERBERG LIMITS TEST RESULTS

FIGURE B10

## SILTY CLAY TILL



### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	NW-10	6.40	285.22
⊠	PA-01	14.02	276.18
▲	PA-02	12.50	279.60
★	PA-02	15.54	276.56
⊙	PA-03	9.45	285.85

Date April 2016

GWP# 3054-13-00



Prep'd AN

Chkd. AMP

## **Appendix C**

### **Analytical Test Results**



**AGAT** Laboratories

## Certificate of Analysis

AGAT WORK ORDER: 14T925116

PROJECT: 19-5161-224

5835 COOPERS AVENUE  
MISSISSAUGA, ONTARIO  
CANADA L4Z 1Y2  
TEL (905)712-5100  
FAX (905)712-5122  
<http://www.agatlabs.com>

CLIENT NAME: THURBER ENGINEERING LTD

SAMPLING SITE:

ATTENTION TO: Stephen Peters

SAMPLED BY:

pH, Sulphate (Soil)						
DATE RECEIVED: 2014-12-05			DATE REPORTED: 2014-12-15			
		SAMPLE DESCRIPTION:		14-04 SS11 (40'-42')	14-02 SS1 (6'-2')	NW-02 SS11 (40'-42')
		SAMPLE TYPE:		Soil	Soil	Soil
		DATE SAMPLED:		12/4/2014	12/4/2014	12/4/2014
		G / S	RDL	6157014	6157025	6157026
Parameter	Unit			8.13	8.12	7.91
pH, 2:1 CaCl2 Extraction	pH Units					7.57
Sulphate (2:1)	µg/g	2		33	25	42
						18

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard



**Certified By:**

## Method Summary

CLIENT NAME: THURBER ENGINEERING LTD

AGAT WORK ORDER: 14T925116

PROJECT: 19-5161-224

ATTENTION TO: Stephen Peters

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
<b>Soil Analysis</b>			
pH, 2:1 CaCl <sub>2</sub> Extraction	INOR-93-6031	MSA part 3 & SM 4500-H+ B	PH METER
Sulphate (2:1)	INOR-93-6004	McKeague 4.12 & SM 4110 B	ION CHROMATOGRAPH





**AGAT** Laboratories

5835 COOPERS AVENUE  
MISSISSAUGA, ONTARIO  
CANADA L4Z 1Y2  
TEL (905)712-5100  
FAX (905)712-5122  
<http://www.agatlabs.com>

## Quality Assurance

CLIENT NAME: THURBER ENGINEERING LTD

PROJECT: 19-5161-224

SAMPLING SITE:

AGAT WORK ORDER: 14T925116

ATTENTION TO: Stephen Peters

SAMPLED BY:

### Soil Analysis

RPT Date: Dec 15, 2014			DUPLICATE			Method Blank	REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD		Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
pH, Sulphate (Soil)															
pH, 2:1 CaCl2 Extraction	6157135		7.90	7.91	0.1%	NA	100%	80%	120%	NA			NA		
Sulphate (2:1)	6156506		17	17	3.8%	< 2	99%	80%	120%	103%	80%	120%	102%	70%	130%

Comments: NA signifies Not Applicable.

**Certified By:**



**AGAT QUALITY ASSURANCE REPORT (V1)**

Page 3 of 4

AGAT Laboratories is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation Inc. (CALA) and/or Standards Council of Canada (SCC) for specific tests listed on the scope of accreditation. AGAT Laboratories (Mississauga) is also accredited by the Canadian Association for Laboratory Accreditation Inc. (CALA) for specific drinking water tests. Accreditations are location and parameter specific. A complete listing of parameters for each location is available from [www.cala.ca](http://www.cala.ca) and/or [www.scc.ca](http://www.scc.ca). The tests in this report may not necessarily be included in the scope of accreditation.

Results relate only to the items tested and to all the items tested

## **Appendix D**

### **Site Photographs**



**Photograph 1 – Looking north along the Norwich Avenue bridge deck**



**Photograph 2 – Looking south along the Norwich Avenue bridge deck**



**Photograph 3 – Looking east onto Highway 401 from the bridge deck**



**Photograph 4 – Looking west onto Highway 401 from the bridge deck**





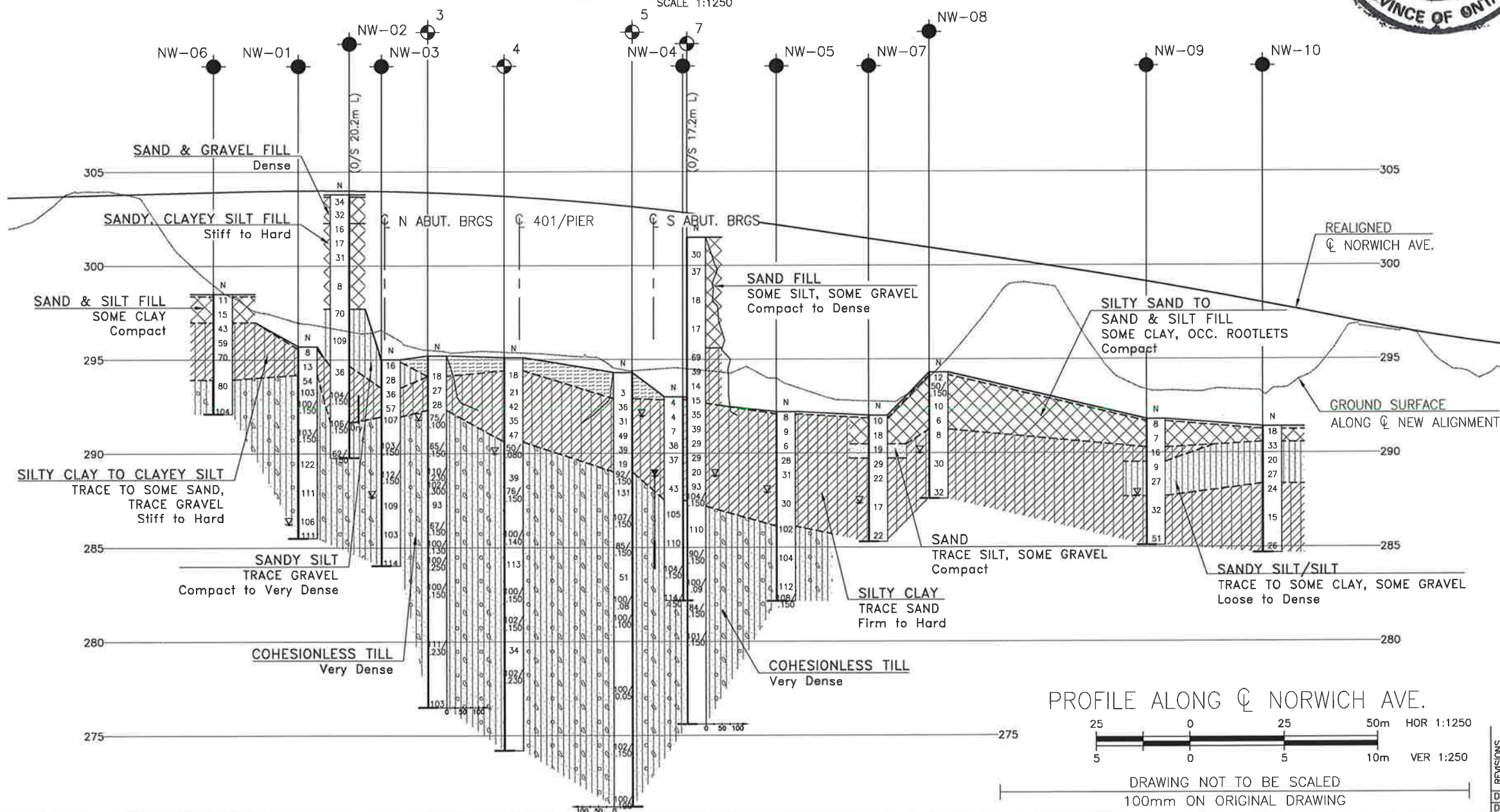
**Photograph 5 – Looking north-west towards the bridge.**



**Photograph 6 – Looking south-east towards the bridge**

**Appendix E**  
**Borehole Locations and Soil Strata Drawings**





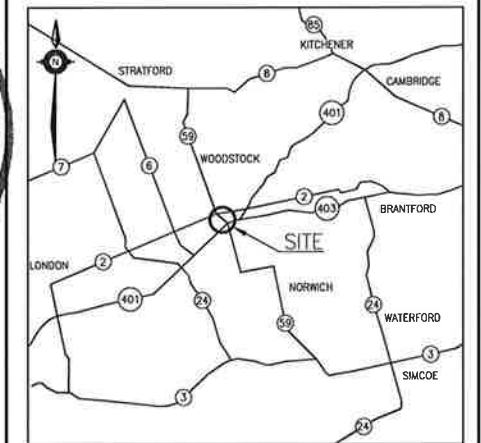
Horizontal scale bar (HOR) 1:1250: A line with tick marks at 25, 0, 25, and 50m.

Vertical scale bar (VER) 1:250: A line with tick marks at 5, 0, 5, and 10m.

DRAWING NOT TO BE SCALED  
100mm ON ORIGINAL DRAWING







SHEET  
ST-2



## KEYPLAN

### LEGEND

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

NO	ELEVATION	NORTHING	EASTING
NW-01	295.7	4 775 259.9	204 177.4
NW-02	303.8	4 775 252.1	204 206.5
NW-03	295.4	4 775 238.5	204 184.8
NW-04	293.0	4 775 160.3	204 200.0
NW-05	292.2	4 775 135.8	204 205.9
NW-06	298.5	4 775 283.2	204 178.9
NW-07	292.0	4 775 112.9	204 215.1
NW-08	294.3	4 775 097.2	204 222.0
NW-09	291.8	4 775 041.3	204 235.2
NW-10	291.4	4 775 012.3	204 248.7
3	295.2	4 775 227.2	204 191.8
4	295.1	4 775 209.7	204 206.8
5	294.3	4 775 175.4	204 201.7
7	301.5	4 775 163.2	204 222.3

**-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. 40P2-78

[illegible]



HWY 401 CONT No 2015-3021 GWP No 3054-13-00	
HIGHWAY 401/ NORWICH AVENUE UNDERPASS BOREHOLE LOCATIONS AND SOIL STRATA	SHEET ST-3
	METRIC

**THURBER ENGINEERING LTD.**

**KEYPLAN**

**LEGEND**

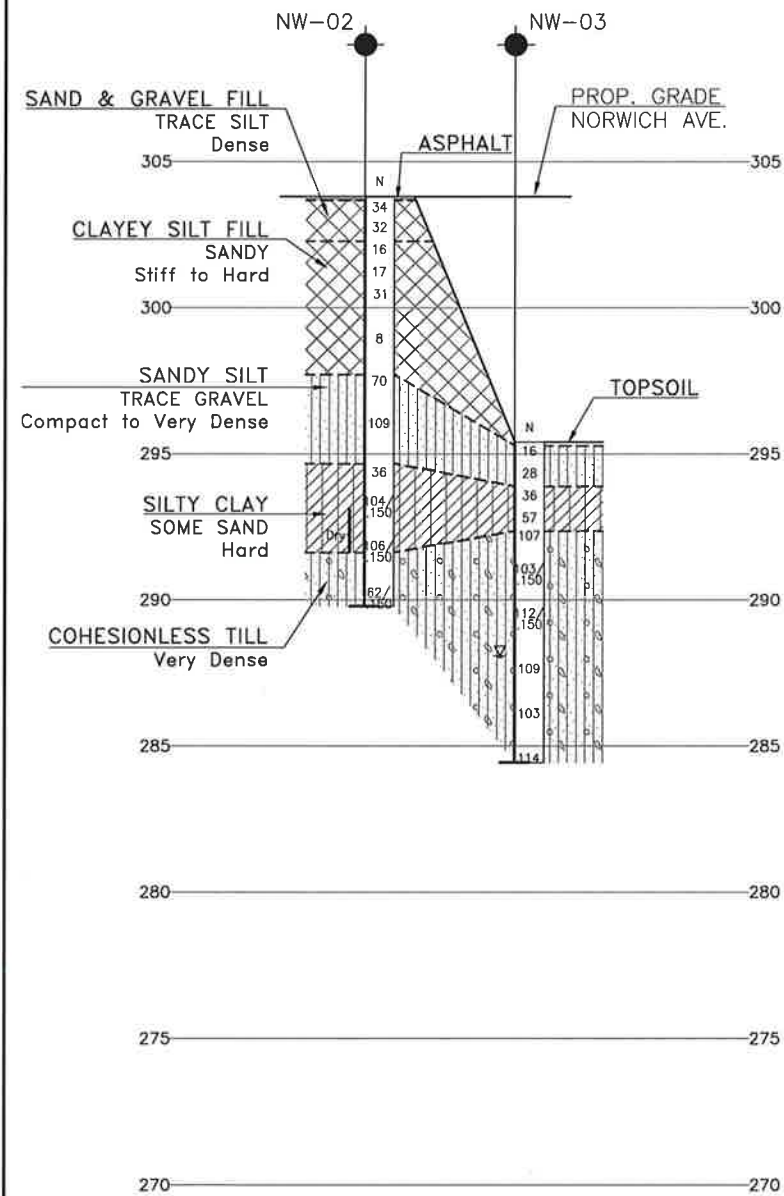
- Borehole (Current Investigation)
- ⊕ Borehole (Previous Investigation)
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60° Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level
- ⊕ Water Level in Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
NW-01	295.7	4 775 259.9	204 177.4
NW-02	303.8	4 775 252.1	204 206.5
NW-03	295.4	4 775 238.5	204 184.8
NW-04	293.0	4 775 160.3	204 200.0
NW-05	292.2	4 775 135.8	204 205.9
NW-06	298.5	4 775 283.2	204 178.9
NW-07	292.0	4 775 112.9	204 215.1
NW-08	294.3	4 775 097.2	204 222.0
NW-09	291.8	4 775 041.3	204 235.2
NW-10	291.4	4 775 012.3	204 248.7
3	295.2	4 775 227.2	204 191.8
4	295.1	4 775 209.7	204 206.8
5	294.3	4 775 175.4	204 201.7
7	301.5	4 775 163.2	204 222.3

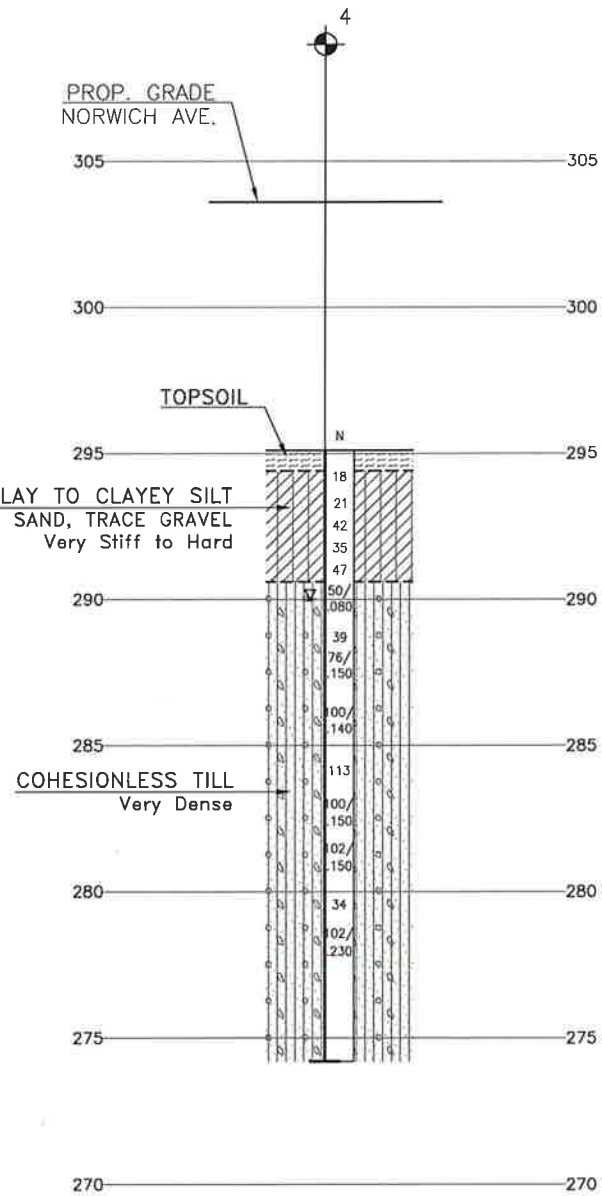
**NOTES-**

- 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.

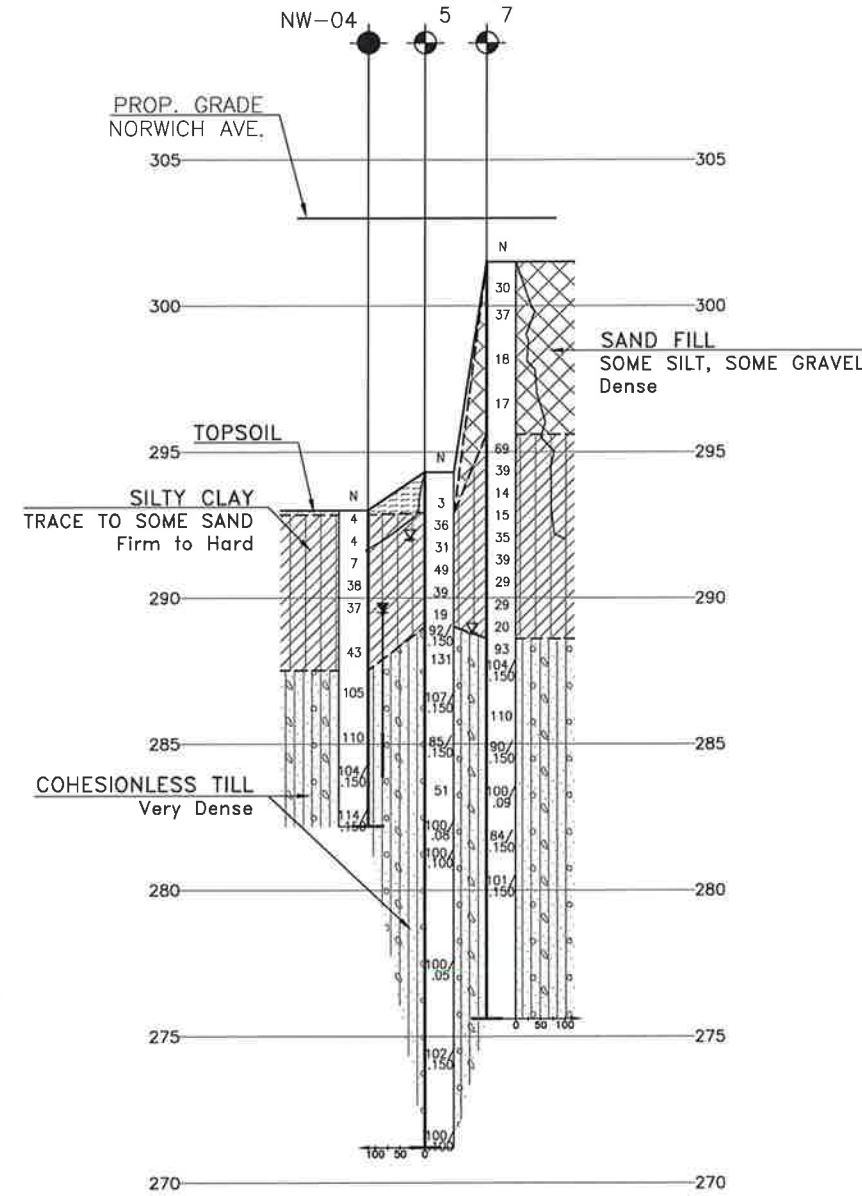
**GEOCRES No. 40P2-78**



SECTION A-A



SECTION B-B



SECTION C-C



DRAWING NOT TO BE SCALED  
 100mm ON ORIGINAL DRAWING

REVISIONS	DATE	BY	DESCRIPTION
DESIGN	SBP	CHK	SBP
DRAWN	AN	CHK	SITE
			23-170
			STRUCT
			SCHEME
			LDWG
			3







## **Appendix F**

### **Previous Investigation Borehole Locations and Soil Strata Drawing and Record of Borehole Sheets Geocres No.: 40P2-45**

## EXPLANATION OF TERMS USED IN REPORT

**N VALUE:** THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS  $\bar{N}$ .

**DYNAMIC CONE PENETRATION TEST:** CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

**CONSISTENCY:** COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ( $c_u$ ) AS FOLLOWS:

$c_u$ (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	> 200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

**DENSENESS:** COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	> 50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

**RECOVERY:** SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

**MODIFIED RECOVERY:** SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

**JOINTING AND BEDDING:**

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	> 3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

### STRESS AND STRAIN

$u_w$	kPa	PORE WATER PRESSURE
$r_u$	1	PORE PRESSURE RATIO
$\sigma$	kPa	TOTAL NORMAL STRESS
$\sigma'$	kPa	EFFECTIVE NORMAL STRESS
$\tau$	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
$\epsilon$	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
$\mu$	1	COEFFICIENT OF FRICTION

### MECHANICAL PROPERTIES OF SOIL

$m_v$	$kPa^{-1}$	COEFFICIENT OF VOLUME CHANGE
$C_c$	1	COMPRESSION INDEX
$C_s$	1	SWELLING INDEX
$C_\alpha$	1	RATE OF SECONDARY CONSOLIDATION
$c_v$	$m^2/s$	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
$T_v$	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
$\sigma'_{vo}$	kPa	EFFECTIVE OVERBURDEN PRESSURE
$\sigma'_p$	kPa	PRECONSOLIDATION PRESSURE
$\tau_f$	kPa	SHEAR STRENGTH
$c'$	kPa	EFFECTIVE COHESION INTERCEPT
$\phi'$	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
$c_u$	kPa	APPARENT COHESION INTERCEPT
$\phi_u$	-°	APPARENT ANGLE OF INTERNAL FRICTION
$\tau_R$	kPa	RESIDUAL SHEAR STRENGTH
$\tau_r$	kPa	REMOULDED SHEAR STRENGTH
$S_t$	1	SENSITIVITY = $\frac{c_u}{\tau_r}$

### PHYSICAL PROPERTIES OF SOIL

$\rho_s$	$kg/m^3$	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	$e_{min}$	1, %	VOID RATIO IN DENSEST STATE
$\gamma_s$	$kN/m^3$	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	$I_D$	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
$\rho_w$	$kg/m^3$	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
$\gamma_w$	$kN/m^3$	UNIT WEIGHT OF WATER	$s_r$	%	DEGREE OF SATURATION	$D_n$	mm	n PERCENT - DIAMETER
$\rho$	$kg/m^3$	DENSITY OF SOIL	$w_L$	%	LIQUID LIMIT	$C_u$	1	UNIFORMITY COEFFICIENT
$\gamma$	$kN/m^3$	UNIT WEIGHT OF SOIL	$w_p$	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
$\rho_d$	$kg/m^3$	DENSITY OF DRY SOIL	$w_s$	%	SHRINKAGE LIMIT	q	$m^3/s$	RATE OF DISCHARGE
$\gamma_d$	$kN/m^3$	UNIT WEIGHT OF DRY SOIL	$I_p$	%	PLASTICITY INDEX = $w_L - w_p$	v	m/s	DISCHARGE VELOCITY
$\rho_{sat}$	$kg/m^3$	DENSITY OF SATURATED SOIL	$I_L$	1	LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$	i	1	HYDRAULIC GRADIENT
$\gamma_{sat}$	$kN/m^3$	UNIT WEIGHT OF SATURATED SOIL	$I_C$	1	CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$	k	m/s	HYDRAULIC CONDUCTIVITY
$\rho'$	$kg/m^3$	DENSITY OF SUBMERGED SOIL	$e_{max}$	1, %	VOID RATIO IN LOOSEST STATE	j	$kN/m^3$	SEEPAGE FORCE
$\gamma'$	$kN/m^3$	UNIT WEIGHT OF SUBMERGED SOIL						

# RECORD OF BOREHOLE No 1

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 051.1; E 204 202.2 ORIGINATED BY M.V.  
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M.V.  
DATUM GEODETIC DATE 90 04 24 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
304.0	Hwy. 59 Shoulder													
0.0			1	SS	96	/15cm								
			2	SS	17									
			3	SS	15									
			4	SS	14									
298.3	Sand, Some Silt, Some Gravel, Compact ( Fill )		5	SS	102									
5.7	Silty Sand, Trace of Gravel, Very Dense		6	SS	107									
296.5			7	SS	83									
7.5	Silty Clay, Trace of Sand, Trace of Gravel, Hard		8	SS	67									
			9	SS	67									
			10	SS	88									
293.0			11	SS	56									
11.0			12	SS	50	/5cm								
			13	SS	75	/8cm								
			14	SS	100	/8cm								
			15	SS	75	/15cm								
	Sandy Silt, Trace of Gravel, Very Dense		16	SS	91	/15cm								
			17	SS	100	/10cm								
282.4			18	SS	81	/15cm								
21.6	End of Borehole													
	* Water Level Not Stabilized													

# RECORD OF BOREHOLE No 2

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 030.4; E 204 171.0 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 20 CHECKED BY \_\_\_\_\_

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE								
296.3	Ground Surface											
0.0												
293.9												
2.4	End of Cone Test											

# RECORD OF BOREHOLE No 3

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 007.0; E 204 176.8 ORIGINATED BY M V  
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
DATUM GEODETIC DATE 90 04 20 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT 7 kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
295.2	Ground Surface													
0.0	Topsoil													
294.1	Sand, Some Silt, Compact		1	SS	18									
1.1	Clayey Silt, Trace of Sand, Trace of Gravel, Very Stiff		2	SS	27									
292.3			3	SS	28									
2.9			4	SS	75	10cm								
			5	SS	65	15cm								
	Sandy Gravel, Some Silt		6	SS	110	23cm								
			7	SS	102	3cm								
			8	SS	93									
	Silty Sand, Trace of Gravel, Very Dense		9	SS	67	15cm								
			10	SS	100	13cm								
284.6			11	SS	100	25cm								
10.6			12	SS	100	15cm								
			13	SS	111	23cm								
	Heterogeneous Mixture of Clayey Silt, Sand & Gravel, Hard ( Glacial Till )													
276.5			14	SS	103									
18.7	End of Borehole													

# RECORD OF BOREHOLE No 4

1 of 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 774 989.5; E 204 191.8 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 23 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100					
295.1	Hwy. 401 Median													
294.8	Sand And Organic Silt		1	SS	18		294							1 8 43 48
0.7	Silty Clay to Clayey Silt, Trace of Sand, Trace of Gravel, Very Stiff to Hard		2	SS	21									
			3	SS	42		292							
			4	SS	35									
290.6			5	SS	47									
4.5			6	SS	50	8cm	290							7 22 38 33
			7	SS	39									
			8	SS	76	/15cm								3 44 (53)
			9	SS	100	/14cm	288							
			10	SS	113		286							
			11	SS	100	/15cm	284							
			12	SS	102	/15cm								
	Sandy Silt, Trace of Gravel, Dense to Very Dense		13	SS	34		282							
			14	SS	102	/23cm	280							5 17 (78)
274.2							278							
20.9	End of Borehole						276							
	• Water Level Not Stabilized													



# RECORD OF BOREHOLE No 5

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 774 955.2; E 204 186.7 ORIGINATED BY M V  
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST, HOLLOW STEM AUGER & BW CASING COMPILED BY M V  
DATUM GEODETIC DATE 90 04 17 TO 90 04 19 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT UNIT		UNIT WEIGHT 7 kN/m <sup>3</sup>	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 <sub>p</sub> W W <sub>L</sub>	10 20 30		
284.3	Ground Surface						294	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE		WATER CONTENT (%)			
0.0	Topsoil		1	SS	3		292	120/28cm		44			
292.9	Sand And Silt, Trace of Gravel, Loose		2	SS	36		290						0 1 46 53
1.4	Silty Clay, Trace of Sand, Trace of Gravel, Very Stiff to Hard		3	SS	31		288						45 47 (8)
			4	SS	49		286						
			5	SS	39		284						0 38 (62)
289.0			6	SS	19		282						
5.3			7	SS	92	/15cm	280						
			8	SS	131		278						
	Sand And Gravel		9	SS	107	/15cm	276						
			10	SS	85	/15cm	274						
			11	SS	51		272						
			12	SS	100	/8cm							
			13	SS	100	/10cm							
			14	SS	100	/5cm							
			15	SS	102	/15cm							
272.5	Heterogeneous Mixture of Clayey Silt, Sand and Gravel, Hard ( Glacial Till )		16	SS	100	/10cm							16 45 (39)
21.8													
271.2	End of Borehole												
23.1													





# RECORD OF BOREHOLE No 7

1 OF 1 METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 774 943.0; E 204 207.3 ORIGINATED BY M V  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
 DATUM GEODETIC DATE 90 04 25 & 90 04 25 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			20 40 60 80 100	20 40 60 80 100	20 40 60 80 100					
301.5	Hwy. 59 Shoulder														
0.0			1	SS	30										
			2	SS	37										
	Sand, Some Silt, Some Gravel, Compact to Dense ( Fill )		3	SS	18										
			4	SS	17										
295.6			5	SS	69										
5.9			6	SS	39										
	Sand, Some Silt, Some Gravel		7	SS	14										
			8	SS	15										
			9	SS	35										
	Clayey Silt, Trace of Sand, Trace of Gravel, Very Stiff to Hard		10	SS	39										
			11	SS	29										
			12	SS	29										
288.5			13	SS	20										
12.9			14	SS	93										0 0 63 37
			15	SS	104	/15cm									22 45 (33)
	Silty Sand, Some Gravel, Occasional Gravel Seams, Very Dense		16	SS	110										
			17	SS	90	/15cm									
			18	SS	100	/8cm									
			19	SS	84	/15cm									
			20	SS	101	/15cm									46 41 (13)
275.6															
25.9	End of Borehole														
	• Water Level Not Stabilized														

# RECORD OF BOREHOLE No R1

1 OF 1

METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 135.0; E 204 146.0 ORIGINATED BY M.V.  
 DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M.V.  
 DATUM GEODETIC DATE 90 04 26 & 90 04 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
288.7	Unpaved Parking Area												
0.0	Gravel Fill		1	SS	23								
			2	SS	19								
			3	SS	51								
			4	SS	44								
			5	SS	51								
			6	SS	106								
			7	SS	102	/23cm							
			8	SS	120								
289.1	Sand, Some Silt, Very Dense		9	SS	76	/13cm							
9.6	End of Borehole												
	Note: Borehole was Terminated Due to Presence of Very Hard Strata												

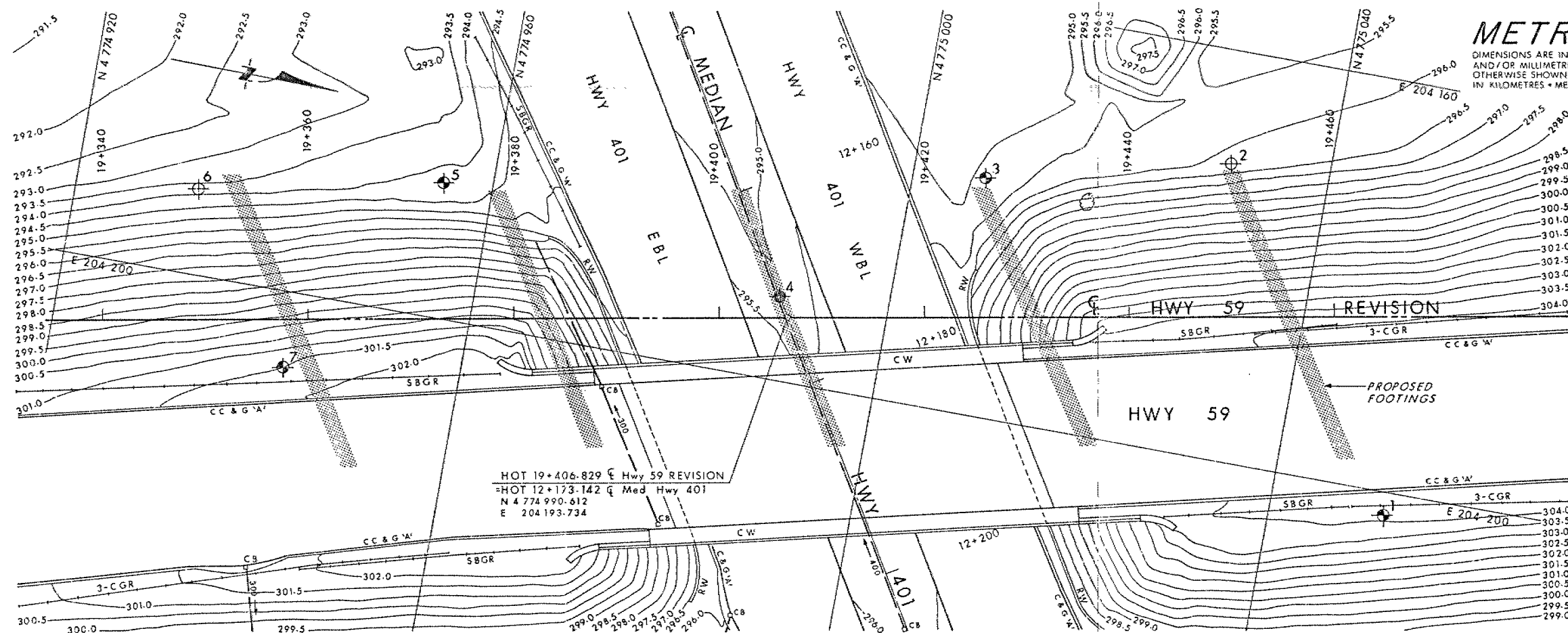
# RECORD OF BOREHOLE No R2

1 OF 1

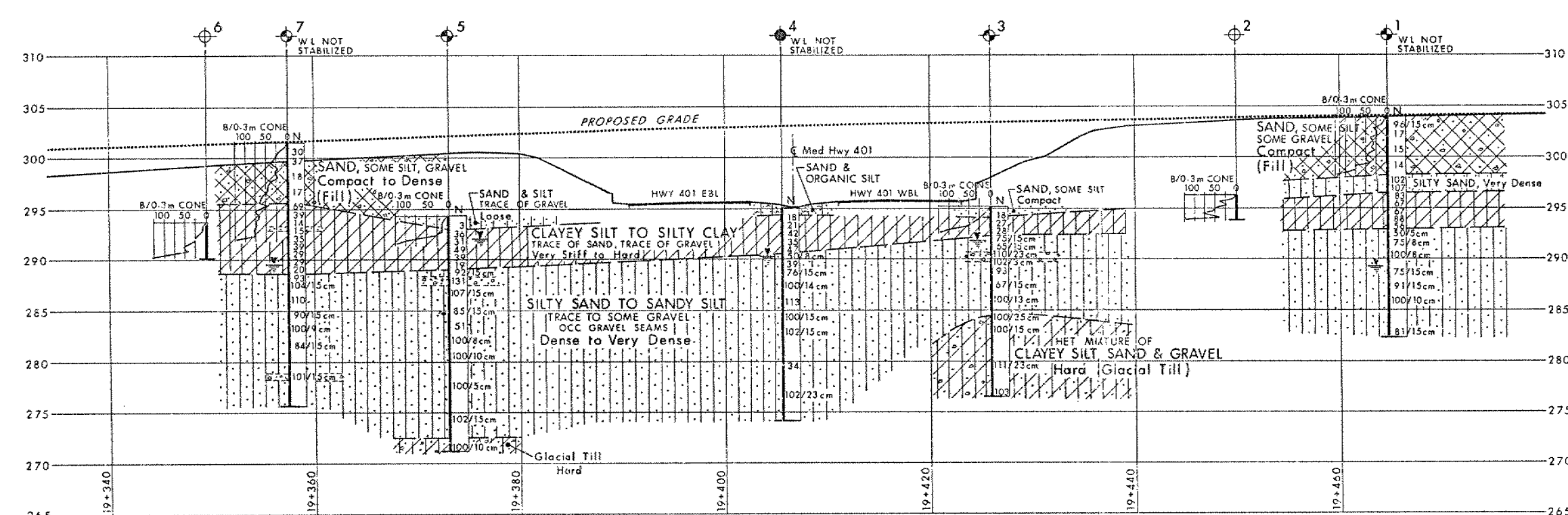
METRIC

W.P. 481 - 89 - 03 LOCATION CO-ORDS. N 4 775 107.0; E 204 094.0 ORIGINATED BY M V  
DIST 2 HWY 401 BOREHOLE TYPE CONE TEST & HOLLOW STEM AUGER COMPILED BY M V  
DATUM GEODETIC DATE 90 04 27 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES								
296.9	Unpaved Parking Area												
0.0	Gravel Fill		1	SS	36								
			2	SS	46								
	Gravelly Sand, Some Silt, Very Dense		3	SS	60								
			4	SS	70								
			5	SS	122								
	Clayey Silt to Silt, Some Sand, Trace of Gravel, Occasional Sand Seams, Hard ( Glacial Till )		6	SS	76	/15cm							
			7	SS	125								
289.1			8	SS	55	/3cm							
7.8	End of Borehole												
	Note: Borehole Was Terminated Due to Presence of Very Hard Strata												
	* Water Level Not Stabilized												



PLAN  
SCALE  
5m 0 5m

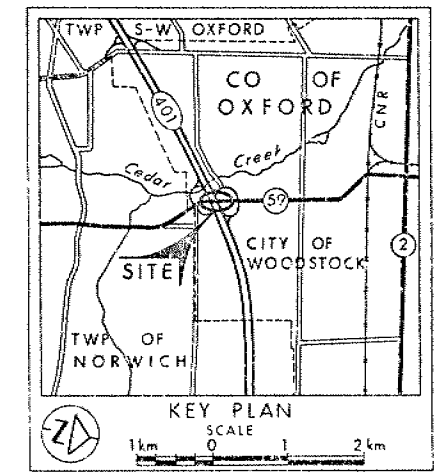


Q PROFILE HWY 59 REVISION

SCALE  
5m 0 5m

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

CONT No  
WP No 481-89-03  
HWY 59 UNDERPASS  
BORE HOLE LOCATIONS & SOIL STRATA



- LEGEND**
- Bore Hole
  - Dynamic Cone Penetration Test (Cone)
  - Bore Hole & Cone
  - N Blows/0.3m (Std Pen Test, 475 J/blow)
  - CONE Blows/0.3m (60° Cone, 475 J/blow)
  - WL at time of investigation 1990 04

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
1	304.0	4775051.1	204 202.2
2	296.3	4775030.4	204 171.0
3	295.2	4775007.0	204 176.8
4	295.1	4774 989.5	204 191.8
5	294.3	4774 955.2	204 186.7
6	293.7	4774 932.0	204 191.6
7	301.5	4774 943.0	204 207.3

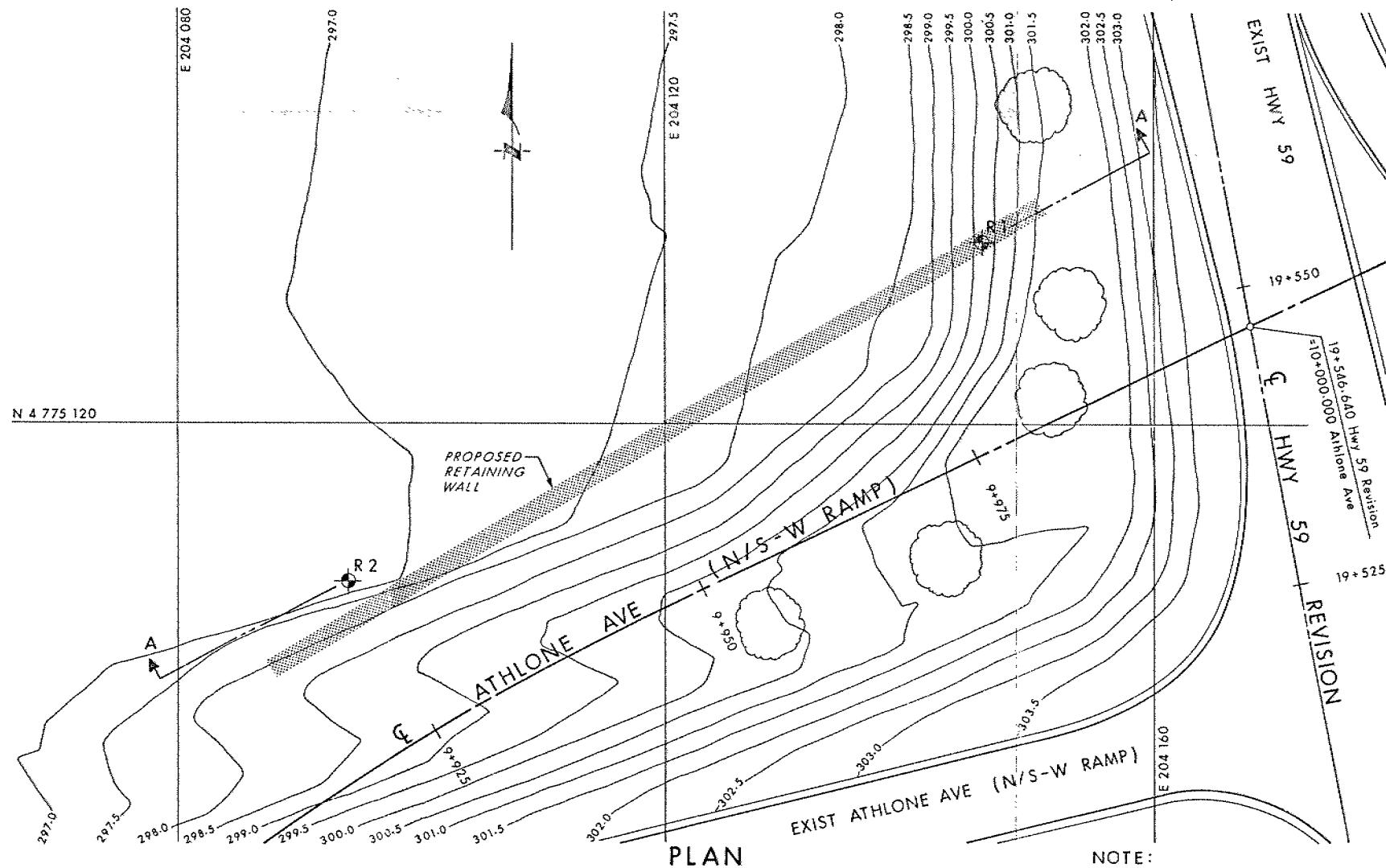
**NOTE**  
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

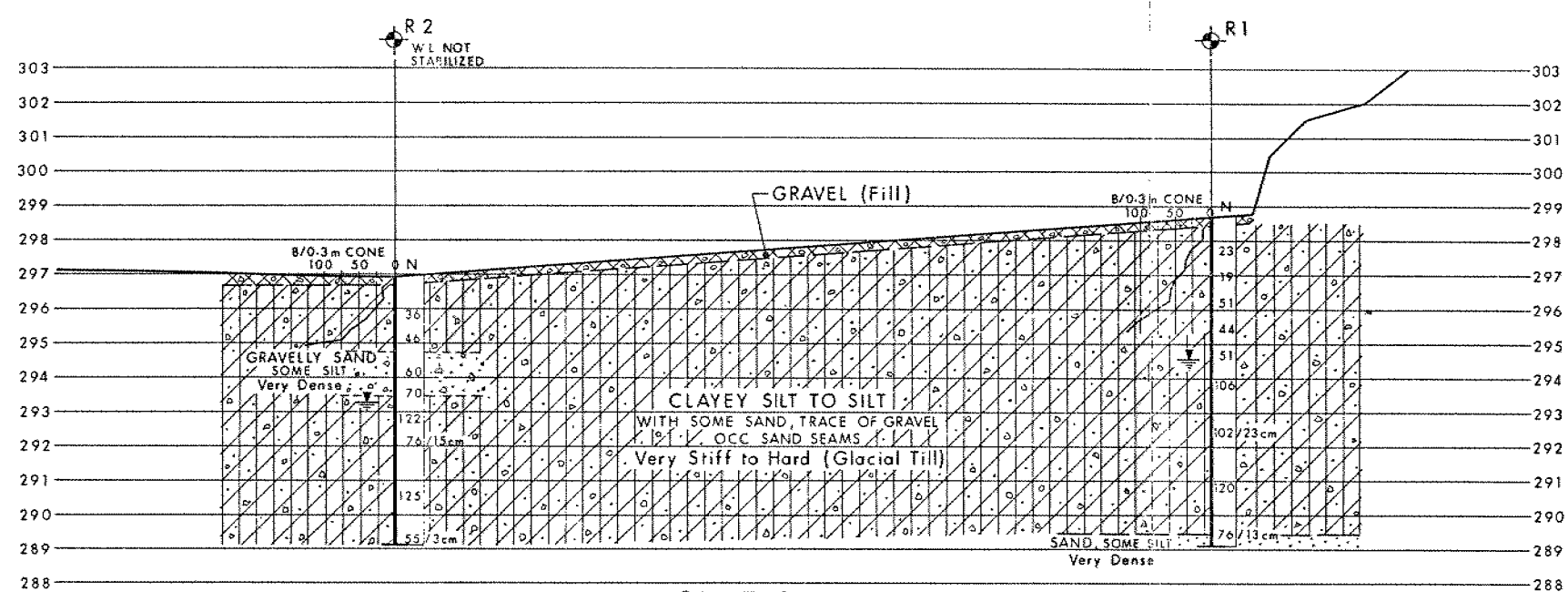
REV	DATE	BY	DESCRIPTION

Geocres No 40P2-45

HWY No 401	DIST 2
SUBMITTED BY: CHECKED: DATE 1990 09 12	SITE 23-170
DRAWN: CHECKED: APPROVED:	DWG 4818903-A



NOTE:  
Contours in the area of retaining wall location do not reflect actual conditions encountered at time of field investigation.

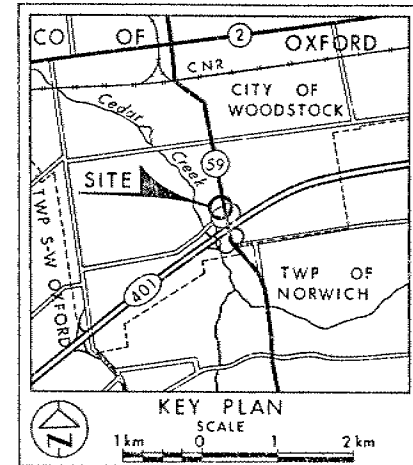


**METRIC**  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES UNLESS  
OTHERWISE SHOWN. STATIONS  
IN KILOMETRES + METRES.

CONT No  
WP No 481-89-03  
ATHLONE AVE (N/S-W RAMP)  
RETAINING WALL  
BORE HOLE LOCATIONS & SOIL STRATA



SHEET



LEGEND

- Bore Hole
- ⊕ Dynamic Cone Penetration Test (Cone)
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W.L. at time of investigation 1990 04

No	ELEVATION	CO-ORDINATES	
		NORTH	EAST
R1	298.7	4 775 135.0	204 146.0
R2	296.9	4 775 107.0	204 094.0

NOTE

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV	DATE	BY	DESCRIPTION

Geocres No 42 P2-45

HWY No 401/59 DIST 2  
SUBMIT: M.V. CHECKED: DATE 1990 09 14 15 TE  
DRAWN: CHECKED: APPROVED: DWS 4818903-B