

**FOUNDATION INVESTIGATION REPORT  
OVERHEAD SIGN SUPPORTS  
HIGHWAY 401, TOWN OF INGERSOLL  
TOWNSHIP OF SOUTHWEST OXFORD  
G.W.P. 3079-09-00  
GEOCRES No. 40P2-84**

**Submitted  
to  
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**FACTUAL INFORMATION**

**1.0 INTRODUCTION**

This report presents the factual data obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the detailed design of Overhead Sign (OH) supports at the selected locations along Highway 401 near the intersection with Highway 19 in the Town of Ingersoll, Ontario. Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation Ontario (MTO) Agreement Number 3013-E-0027.

The purpose of this investigation is to explore the subsurface conditions at selected locations of the Overhead Sign supports and, based on the data obtained, to provide a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Design parameters for the proposed sign supports have been provided in a tabularized format in Table 1, following the text of this report. In addition, design parameters for a temporary roadway protection system, which could be required at Sta. 17+390 and 18+413, have been provided in Table 2.

**2.0 SITE DESCRIPTION**

The project site extends to the west and east of the intersection of Highway 401 and Highway 19 (Harris Street/Plank Line), in the Town of Ingersoll. The overhead signs are proposed to be installed at the following locations:

Station 15+537, Site No. 23-818,  
Station 16+525, Site No. 23+819,  
Station 17+390, Site No. 23-821, and  
Station 18+413, Site No. 23-820.

At the project site, Highway 401 runs approximately in the southwest-northeast direction, and for the purpose of this report, Highway 401 is assumed to run west-east.

Based on the Quaternary Geology Map, the site is situated in the till plain characterized by the Tavistock Till (Huron-Georgian Bay lobe) consisting of sandy silt to silt matrix with variable amounts of clay and sand and moderate to high carbonate content.

The surrounding land within the project area is gently undulating. The land use generally consists of a mixed agricultural land and commercial properties within the project area. The developed area of the Town of Ingersoll lies a short distance to the north of Highway 401.

### **3.0 INVESTIGATION PROCEDURES**

#### **3.1 Field Investigation and Testing**

The field investigation for this project was carried out on November 27, 2014 and on March 21 and 22, 2016. During the 2014 investigation, four boreholes were drilled at the locations of the overhead signs established in the early stage of the project. Boreholes 16+077 and 16+537 were located to the south of the Eastbound Lanes, some 27 m and 35 m from the Highway 401 centreline, and Boreholes 17+390 and 17+850 were located to the north of the Westbound Lanes, some 36 m and 27 m from the Highway 401 centreline, respectively.

The locations of the advance overhead signs were revised in 2016, and additional three boreholes were drilled within the median or through the shoulder of Highway 401 to provide information for the design of the sign supports, as well as for the design of temporary roadway protection system in proximity to the existing sewer. Borehole 15+537 was located on the shoulder of the Eastbound Lanes, and Boreholes 17+390S and 18+413 were located in the median/Lane 1 of the Westbound Lanes.

The locations of the boreholes were determined based on the drawings provided by MMM and are shown on the Borehole Locations Plan included in Appendix C. Ground surface elevations were obtained from the plans and drawings provided to Thurber by MMM.

The boreholes drilled in 2014 were advanced using solid stem augers to depths ranging from 6.2 to 6.7 m. The boreholes drilled in 2016 were advanced to depths ranging from 8.1 m to 11.3 m using hollow stem augers. In each borehole, soil samples were obtained at selected intervals with a 50 mm outside diameter split spoon sampler driven in conjunction with the Standard Penetration Test (SPT).

Groundwater conditions were observed in the open boreholes throughout the drilling operations. No standpipe piezometer was installed for this investigations. All boreholes drilled in 2014 were backfilled with bentonite and cuttings to the ground surface level. Boreholes drilled in 2016 from

the road surface were backfilled with bentonite and cuttings to a depth of 0.5 m to 0.7 m, then the holes were filled with concrete, and cold asphalt was placed at the surface.

The drilling investigation was supervised on a full-time basis by a member of Thurber's technical staff who located the boreholes in the field, cleared borehole locations of underground utilities, directed the drilling, sampling and in-situ testing operations, and logged the boreholes. The supervisor processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. Results of field sampling and testing are presented in the Record of Borehole sheets included in Appendix A.

Summary of borehole depths and completion details are provided in the Table 3-1 below.

**Table 0-1. Borehole Installation and Backfilling Details**

<b>Borehole Number</b>	<b>Corresponding Overhead Sign Station / Sign Site No.</b>	<b>Borehole Depth/ Base Elevation (m)</b>	<b>Borehole Backfilling Details</b>
15+537	15+537 / 23-818	8.1 / 283.7	Backfilled with bentonite holeplug and cuttings to 0.6 m, concrete to 0.1 m then asphalt patch to surface.
16+077	-	6.7 / 284.0	Backfilled with bentonite holeplug and cuttings to surface.
16+537	16+525 / 23-819	6.7 / 285.1	Backfilled with bentonite holeplug and cuttings to surface.
17+390	17+390 / 23-821	6.7 / 284.5	Backfilled with bentonite holeplug and cuttings to surface.
17+390 S	17+390 / 23-821	8.2 / 283.8	Backfilled with bentonite holeplug and cuttings to 0.9 m, concrete to 0.2 m then asphalt patch to surface.
17+850	-	6.2 / 290.1	Backfilled with bentonite holeplug and cuttings to surface.
18+413	18+413 /23-820	11.3 / 289.3	Backfilled with bentonite holeplug and cuttings to 0.9 m, concrete to 0.2 m then asphalt patch to surface.

### 3.2 Laboratory Testing

Geotechnical laboratory testing consisted of natural moisture content determination and visual identification of all soil samples in accordance with the current MTO standards. Grain size distribution analysis and Atterberg Limits tests were also conducted on selected samples. The results of these laboratory tests are summarized on the Record of Borehole sheets included in Appendix A, and are illustrated on the figures included in Appendix B.

## **4.0 SUBSURFACE CONDITIONS**

### **4.1 General**

This section presents a generalized summary of the subsurface conditions encountered in the boreholes. The detailed subsurface soil and groundwater conditions encountered in these boreholes are presented on the Record of Borehole sheets included in Appendix A. The factual data presented in the records of boreholes govern any interpretation of the site conditions. It should be recognized that the subsurface conditions may vary between and beyond the borehole locations.

The subsurface conditions encountered in the boreholes consist of predominantly cohesionless deposits varying from sandy silt to sand, either glacial till or glaciolacustrine deposit. Boreholes drilled from the road surface encountered a layer of embankment fill. At some locations a layer of silty clay overlies the cohesionless deposit. Water level in open boreholes at four locations was observed between 2.4 m and 9.2 m depth, and three boreholes were dry on completion of drilling operations.

### **4.2 Topsoil**

Topsoil was encountered in all boreholes drilled in 2014. The thickness of the topsoil at the borehole locations ranged from 75 mm to 100 mm. Topsoil thickness may vary in other areas of the site.

### **4.3 Asphalt**

A layer of asphalt ranging in thickness from 75 mm to 200 mm was observed in the boreholes drilled in 2016, namely in Borehole 15+537, 17+390S and 18+413.

### **4.4 Fill**

Underlying the topsoil in Boreholes 16+077 and 17+390 and asphalt in Boreholes 15+537, 17+390S and 18+413 was fill materials. The fill consisted of gravel with trace sand and trace silt in Borehole 16+077, and sand and gravel with trace to some silt in the remaining boreholes. The thickness of the fill varied from 1.3 m to 2.1 m and the base of the fill was encountered between elevations 289.3 and 298.5.

SPT 'N' values recorded in the fill materials varied from 23 to 50 blows per 0.3 m penetration, indicating a compact to dense relative density.

Grain size distribution analyses were completed on samples of the fill. The results are summarized on the Record of Borehole sheets in Appendix A, and the grain size distribution

curves of the fill are presented on Figure B1 of Appendix B. The results of the analysis are summarized as follows:

Soil Particles	Percentage (%)
Gravel	34 to 51
Sand	39 to 45
Silt and Clay	6 to 21

The measured water contents of the fill material ranged from 2% to 10%.

#### 4.5 Silty Clay Till

A layer of till consisting of silty clay with some sand and trace gravel was encountered below the fill in Borehole 17+390. The sand content within the silty clay till was noted to increase with depth and the silty clay became sandy below approximately 2.3 m depth. The silty clay till was brown in colour. The thickness of the layer was 1.6 m with the base at elevations 288.2.

SPT 'N' values measured in this till deposit were 54 and 64 blows for 0.3 m penetration indicating a hard consistency.

Grain size distribution analysis was completed on a sample of this deposit. The results are summarized on the Record of Borehole sheet in Appendix A, and the grain size distribution curve is presented on Figure B2 of Appendix B. The results of the analysis are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	26
Silt	43
Clay	31

The results of Atterberg limits test conducted for a sample of this deposit are as follows:

Index Property	Percentage (%)
Liquid Limit	13
Plastic Limit	24

The Plasticity Index of 11% indicates low plasticity of the soil. Measured moisture contents of the silty clay till samples generally ranged from 9% to 14%.

Glacial till inherently contains cobbles and boulders.

#### 4.6 Sand to Silty Sand

A layer of sand with trace to some silt, grading to silty sand and containing occasional cobble was encountered below the fill material in Borehole 16+077. In Borehole 17+390, the sand with some silt, trace clay and trace gravel was underlying the silty clay till. The sand to silty sand deposit is probably of glaciolacustrine origin. In both boreholes, the sand to silty sand was found to extend to a depth of 6.7 m investigated in the boreholes (Elevation 284.0 and 284.5).

SPT tests performed in this deposit gave N-values between 18 blows per 0.3 m of penetration and more than 50 blows per 0.15 m of penetration, indicating a compact to very dense relative density.

Grain size analyses were completed on selected samples of this deposit. The results are presented on the Record of Borehole sheets in Appendix A and are shown on Figure B3 in Appendix B. The results of the grain size distribution tests are summarized below for the sand to silty sand:

Soil Particles	Percentage (%)
Gravel	0 to 3
Sand	64 to 87
Silt	10 to 29
Clay	3 to 4

Moisture contents in this layer ranged from 4 to 18%.

#### 4.7 Silty Clay

A deposit consisting of silty clay with trace sand was encountered in Borehole 18+413 extending from approximately 4.0 m depth (Elev. 296.8) to the base of the borehole at 11.3 m depth (Elev. 289.5). A 3 m thick silt layer was encountered in the silty clay deposit at 6.1 m depth. The upper approximately 2 m of the silty clay was soft to firm with a recorded SPT-N value of 4 blows per 0.3 m of penetration. Below the silt layer, the silty clay was stiff to very stiff with SPT-N values of 15 and 16 blows per 0.3 m of penetration.

Grain size distribution analysis was completed on a sample of the silty clay. The results are summarized on the Record of Borehole sheet in Appendix A, and the grain size distribution curve is presented on Figure B6 of Appendix B. The results of the analysis are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0
Sand	0
Silt	59
Clay	41

The results of Atterberg limits test conducted for a sample of this deposit are as follows:

Index Property	Percentage (%)
Liquid Limit	33
Plastic Limit	18

The Plasticity Index of 15% indicates a low plasticity of the soil. Measured moisture contents of the silty clay samples generally ranged from 17% to 24%.

#### 4.8 Silt

A layer of silt with trace to some sand and trace clay was observed within the silty clay deposit in Borehole 18+413. The silt was found to extend from 6.1 m to 9.1 m depth (Elev. 294.7 to 291.7).

SPT tests performed in this deposit gave N-Values of 21 and 5 blows per 0.3 m of penetration, indicating a loose to compact relative density.

Measured moisture contents of the silt samples were 18% to 21%.

#### 4.9 Cohesionless Till

A cohesionless till consisting of sandy silt to silty sand was encountered below the topsoil in Boreholes 16+537 and 17+850, and below the embankment fill in Boreholes 15+537, 17+390S and 18+413. The till deposit was brown in colour and contained trace to some clay, trace to some gravel and occasional cobbles. It should be noted that cobbles and boulders inherently occur in glacial deposits and should be expected within the soil matrix.

The noted above boreholes, except for Borehole 18+413, were terminated in the cohesionless till at depths ranging from 6.2 m to 8.2 m (Elevations 290.1 to 283.7). In Borehole 18+413, the till was 1.7 m in thickness and extended to 4.0 m depth (Elev. 296.8).

SPT tests performed in this deposit gave N-Values ranging from 6 blows per 0.3 m of penetration to greater than 50 blows per 0.15 m of penetration, indicating a loose to very dense relative density.

Grain size analyses were completed on selected samples of this deposit. The results are presented on the Record of Borehole sheets in Appendix A and are shown on plots in Figure B4 and B5 of Appendix B. The results of the grain size distribution tests are summarized below:

Soil Particles	Percentage (%)
Gravel	0 to 8
Sand	29 to 48
Silt	30 to 59
Clay	8 to 16

Moisture contents in this layer ranged from 4 to 22%.

#### 4.10 Groundwater Conditions

Groundwater conditions were observed during drilling operations and water levels were measured in the open boreholes upon completion of drilling. The water levels in the open boreholes are summarized below.

**Table 4.1 Water Level Observations in Boreholes**

Borehole Number	Date	Depth /Elevation (m)
15+537	March 22, 2016	Dry to 8.1 m / Elev. 283.7
16+077	November 27, 2014	Dry to 6.7 m / Elev. 284.0
16+537	November 27, 2014	2.4 m / Elev. 289.4
17+390	November 27, 2014	4.9 m / 286.3
17+390S	March 21, 2016	8.1 m / 283.9
17+850	November 27, 2014	Dry to 6.1 m / Elev. 290.2
18+413	March 21, 2016	9.2 m / Elev. 291.6

It should be noted that the above observations are very short term and the actual groundwater levels may be higher. Moreover, the groundwater levels are subject to seasonal fluctuations and severe climatic events.

#### 5.0 MISCELLANEOUS

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

Determination Drilling and Soil Investigations Holdings Inc. from Hamilton and Altech Drilling and Investigative Services of Waterloo, Ontario supplied and operated the drilling, sampling and

in-situ testing equipment for the field programs conducted in 2014 and 2016, respectively. The field investigation was supervised on a full time basis by Mr. George Azzopardi of Thurber during both investigations. Overall supervision of the investigation program was conducted by Mr. Stephane Loranger, C.E.T.

Routine laboratory testing was carried out by Thurber's geotechnical laboratory in Oakville, Ontario. Interpretation of the data and preparation of this report was carried out by Ms. Anna Piascik, P.Eng. The report was reviewed 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



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MTO Designated Review Principal



**TABLE 1**  
**GEOTECHNICAL DESIGN PARAMETERS**  
**OVERHEAD SIGN (OH) SUPPORTS**  
**HIGHWAY 401, TOWN OF INGERSOLL**  
**G.W.P. 3079-09-00**

Approx. Location Of Overhead Sign	Relevant Borehole No	Simplified Stratigraphy	Depth Below Existing Grade (m)	Geotechnical Design Parameters						
				$c_u$ (kPa)	$\phi'$ (deg.)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$n_h$ (MN/m <sup>3</sup> )	$K_p$	Groundwater depth (m)
15+537	BH 15+537	Sand and Gravel Fill Sandy Silt to Sand and Silt Till	0.1 – 1.4	-	30	20	-	2.5	3.0	8.1
			1.4 – 8.1	-	35	21	-	7.5	3.7	
				-			-			
16+525	BH 16+537	Sandy Silt Till Silty Sand Till	0.1 – 2.3	-	30	20	-	2.5	3.0	2.4
			2.3 – 6.7	-	35	-	11	6.0	3.7	
17+390	BH 17+390	Sand and Gravel Fill Silty Clay Till Sand (above wl) Sand (below wl)	0.1 – 1.4	-	30	20	-	2.5	3.0	4.9
			1.4 – 3.0	150	-	18	-	-	-	
			3.0 – 4.9	-	35	21	-	10.0	3.7	
			4.9 – 6.7	-	35	-	11	6.0	3.7	
17+390	BH 17+390S	Sand and Gravel Fill Sandy Silt to Silty Sand Till (above wl) Sandy Silt to Silty Sand Till (below wl)	0.2 – 1.5	-	30	20	-	2.5	3.0	8.1
			1.5 – 8.1	-	35	21	-	10.0	3.7	
			8.1 – 8.2	-	35	-	11	6.0	3.7	
18+413	BH 18+413	Sand and Gravel Fill Sand and Silt Till Silty Clay Silt Silty Clay (below wl)	0.2 – 2.3	-	30	20	-	2.5	3.0	9.2
			2.3 – 4.0	-	33	21	-	6.5	3.4	
			4.0 – 6.1	25	-	17	-	-	-	
			6.1 – 9.1	-	29	20	-	2.0	2.8	
			9.1 – 11.3	100	-	-	8	-	-	

Notes: - For symbol definitions please refer to legend below.  
- This Table should be read in conjunction with the report.  
- The ultimate lateral resistance in front of the caisson within the upper 1.3 m below the final grade should be neglected to account for frost action and surficial disturbance.

Legend:

$c_u$	=	undrained shear strength
$\phi'$	=	angle of internal friction
$\gamma$	=	bulk unit weight
$\gamma'$	=	submerged unit weight
$K_p$	=	coefficient of passive earth pressure.

**TABLE 2**  
**GEOTECHNICAL DESIGN PARAMETERS**  
**TEMPORARY ROADWAY PROTECTION SYSTEM**  
**HIGHWAY 401, TOWN OF INGERSOLL**  
**G.W.P. 3079-09-00**

Location of Overhead Sign/Roadway Protection	Relevant Borehole No	Simplified Soil Stratigraphy	Depth Below Existing Grade (m)	Geotechnical Design Parameters						
				$c_u$ (kPa)	$\phi'$ (deg.)	$\gamma$ (kN/m <sup>3</sup> )	$\gamma'$ (kN/m <sup>3</sup> )	$K_a$	$K_p$	Groundwater depth (m)
17+390	BH 17+390S	Sand and Gravel Fill	0.2 – 1.5	-	30	20	-	0.33	3.0	8.1
		Sandy Silt to Silty Sand Till (above wl)	1.5 – 8.1	-	35	21	-	0.27	3.7	
		Sandy Silt to Silty Sand Till (below wl)	8.1 – 8.2	-	35	-	11	0.27	3.7	
18+413	BH 18+413	Sand and Gravel Fill	0.2 – 2.3	-	30	20	-	0.33	3.0	9.2
		Sand and Silt Till	2.3 – 4.0	-	33	21	-	0.29	3.4	
		Silty Clay	4.0 – 6.1	25	(25)*	17	-	(0.41)*	(2.4)*	
		Silt	6.1 – 9.2	-	29	20	-	0.36	2.8	
		Silty Clay (below wl)	9.2 – 11.3	100	(25)*	-	8	(0.41)*	(2.4)*	

\* Effective stress parameters for silty clay are shown in brackets.

**Legend:**

$c_u$	=	undrained shear strength
$\phi'$	=	angle of internal friction
$\gamma$	=	bulk unit weight
$\gamma'$	=	submerged unit weight
$K_p$	=	coefficient of passive earth pressure
$K_a$	=	coefficient of active earth pressure.

**Notes:**

- Temporary protection system should be implemented in accordance with OPSS.PROV 539.
- Performance Level 2 (maximum 25 mm horizontal deflection) should be assumed in design.

## **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.

# UNIFIED SOILS CLASSIFICATION

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

# RECORD OF BOREHOLE No 15+537

1 OF 1

METRIC

GWP# 3079-09-00 LOCATION N 4 765 231.2 E 193 386.2 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2016.03.22 - 2016.03.22 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ  kN/m <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
291.8	GROUND SURFACE																		
0.0 0.1	ASPHALT: (75mm)																		
	SAND and GRAVEL, some silt Dense Brown Dry to Moist (FILL)		1	SS	41														
			2	SS	30														
290.4																			
1.4	Sandy SILT to SAND and SILT, some clay, trace gravel Dense to Very Dense Brown Dry to Moist (TILL)		3	SS	23														
			4	SS	69														
			5	SS	51														
			6	SS	37														
			7	SS	62														
			8	SS	84														
283.7																			
8.1	END OF BOREHOLE AT 8.1m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.6m, CONCRETE TO 0.1m, THEN ASPHALT PATCH TO SURFACE.																		

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

20  
15 10 5  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 16+077

1 OF 1

METRIC

GWP# 3079-09-00 LOCATION N 4 765 578.7 E 193 795.6 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.27 - 2014.11.27 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									
290.7	GROUND SURFACE						20	40	60	80	100						
0.0 0.1	<b>TOPSOIL:</b> (75mm)		1	SS	31												
	<b>GRAVEL</b> , trace sand, trace silt Dense Grey Dry (FILL)		2	SS	32												
289.3																	
1.4	<b>SAND</b> , some silt, trace clay Compact Brown Dry		3	SS	21												
			4	SS	18												
			5	SS	29												
286.1																	
4.6	Silty <b>SAND</b> , trace clay, trace gravel Dense Brown Dry		6	SS	37												
			7	SS	36												
284.0																	
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 2/11/16

# RECORD OF BOREHOLE No 16+537

1 OF 1

METRIC

GWP# 3079-09-00 LOCATION N 4 765 867.2 E 194 155.5 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.27 - 2014.11.27 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 (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										
291.8	GROUND SURFACE							20	40	60	80	100						
0.0	TOPSOIL: (100mm)							20	40	60	80	100						
0.1	Sandy <b>SILT</b> , trace clay, trace gravel Loose to Compact Brown Moist (TILL)		1	SS	6		291											
			2	SS	11													
			3	SS	15		290											
289.5																		
2.3	Silty <b>SAND</b> , some clay, trace gravel, occasional cobbles Dense to Very Dense Brown Moist (TILL)		4	SS	84		289											
			5	SS	50/ 0.150													
							288											
			6	SS	48		287											
							286											
			7	SS	49													
285.1																		
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 2.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																	

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 2/16/16

# RECORD OF BOREHOLE No 17+390

1 OF 1

METRIC

GWP# 3079-09-00 LOCATION N 4 766 496.0 E 194 743.7 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.27 - 2014.11.27 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									
291.2	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL: (100mm)							20	40	60	80	100					
0.1	SAND and GRAVEL, some silt Compact to Dense Brown Moist (FILL)		1	SS	23		291							○			34 45 21 (SI+CL)
			2	SS	35									○			
289.8							290										
1.4	Silty CLAY, some sand, trace gravel Hard Brown Moist (TILL)		3	SS	64									○			
	Becoming sandy below 2.3m depth		4	SS	54		289										
																	0 26 43 31
288.2																	
3.0	SAND, some silt, trace clay, trace gravel, occasional cobbles Dense to Very Dense Brown Moist		5	SS	68		288							○			
			6	SS	50/ 0.150		287							○			
							286										
							285							○			0 87 10 3
284.5			7	SS	43												
6.7	END OF BOREHOLE AT 6.7m. BOREHOLE OPEN TO 6.7m AND WATER LEVEL AT 4.9m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.																

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

# RECORD OF BOREHOLE No 17+390 S 1 OF 1 METRIC

GWP# 3079-09-00 LOCATION N 4 766 480.7 E 194 756.4 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2016.03.21 - 2016.03.21 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 (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
292.0	GROUND SURFACE							20 40 60 80 100					
0.0	ASPHALT: (100mm)							20 40 60 80 100					
0.2	SAND and GRAVEL, trace silt Dense Brown Dry (FILL)		1	SS	37	291							49 45 6 (SI+CL)
			2	SS	43								
290.5													
1.5	Sandy SILT to Silty SAND, some clay, trace gravel Very Dense Brown Moist (TILL)		3	SS	55		290						
			4	SS	85								
			5	SS	84	289							
			6	SS	91		288						
						287							
			7	SS	70								
							286						
						285							
			8	SS	55								
283.8	Wet below 8.1m depth						284						
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE OPEN TO 8.2m AND WATER LEVEL AT 8.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.												

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 3/30/16

# RECORD OF BOREHOLE No 17+850

1 OF 1

METRIC

GWP# 3079-09-00 LOCATION N 4 766 810.1 E 195 077.7 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2014.11.27 - 2014.11.27 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 (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa													
○ UNCONFINED      + FIELD VANE ● QUICK TRIAXIAL    × LAB VANE																					
296.3	GROUND SURFACE						20	40	60	80	100	PLASTIC LIMIT W <sub>P</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	GR	SA	SI	CL			
0.0	TOPSOIL: (100mm)						20	40	60	80	100	WATER CONTENT (%)									
0.1	SAND and SILT, trace to some clay, trace to some gravel, occasional cobbles Compact to Very Dense Brown Moist (TILL)		1	SS	25												6	43	37	14	
				2	SS	33															
				3	SS	33												6	45	36	13
				4	SS	52															
			5	SS	57																
			6	SS	88												3	42	46	9	
290.1			7	SS	50/																
6.2	END OF BOREHOLE AT 6.2m. BOREHOLE OPEN TO 6.1m AND DRY. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO SURFACE.				0.150																

ONTMT4S 1224.GPJ 2015TEMPLATE(MTO).GDT 2/11/16

# RECORD OF BOREHOLE No 18+413

1 OF 2

METRIC

GWP# 3079-09-00 LOCATION N 4 767 184.2 E 195 497.6 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2016.03.21 - 2016.03.21 CHECKED BY AMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT			UNIT WEIGHT  γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)								
300.8	GROUND SURFACE							20	40	60	80	100	W <sub>P</sub>	W	W <sub>L</sub>	GR	SA	SI	CL	
0.0	ASPHALT:(200mm)							20	40	60	80	100								
0.2	SAND and GRAVEL, trace silt Compact to Dense Brown Dry to Moist (FILL)		1	SS	26		300									3	42	41	14	
			2	SS	31		299													
			3	SS	50															
298.5																				
2.3	SAND and SILT, some clay, trace gravel Compact Brown to Grey Moist (TILL)		4	SS	28		298													
			5	SS	22															
296.8							297													
4.0	Silty CLAY, trace sand Firm Grey Moist		6	SS	4		296													
							295													
294.7																				
6.1	SILT, trace to some sand, trace clay Compact to Loose Grey Wet		7	SS	21	294														
					8	SS	5	293												
						292														
291.7																				
9.1	Silty CLAY, trace sand Very Stiff Grey Wet		9	SS	16	291										0	0	59	41	

Continued Next Page

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 18+413

2 OF 2

METRIC

GWP# 3079-09-00 LOCATION N 4 767 184.2 E 195 497.6 ORIGINATED BY GA  
 HWY 401 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN  
 DATUM Geodetic DATE 2016.03.21 - 2016.03.21 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																
289.5			10	SS	15		290										
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE OPEN TO 11.3m AND WATER LEVEL AT 9.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND CUTTINGS TO 0.9m, CONCRETE TO 0.2m, THEN ASPHALT PATCH TO SURFACE.																

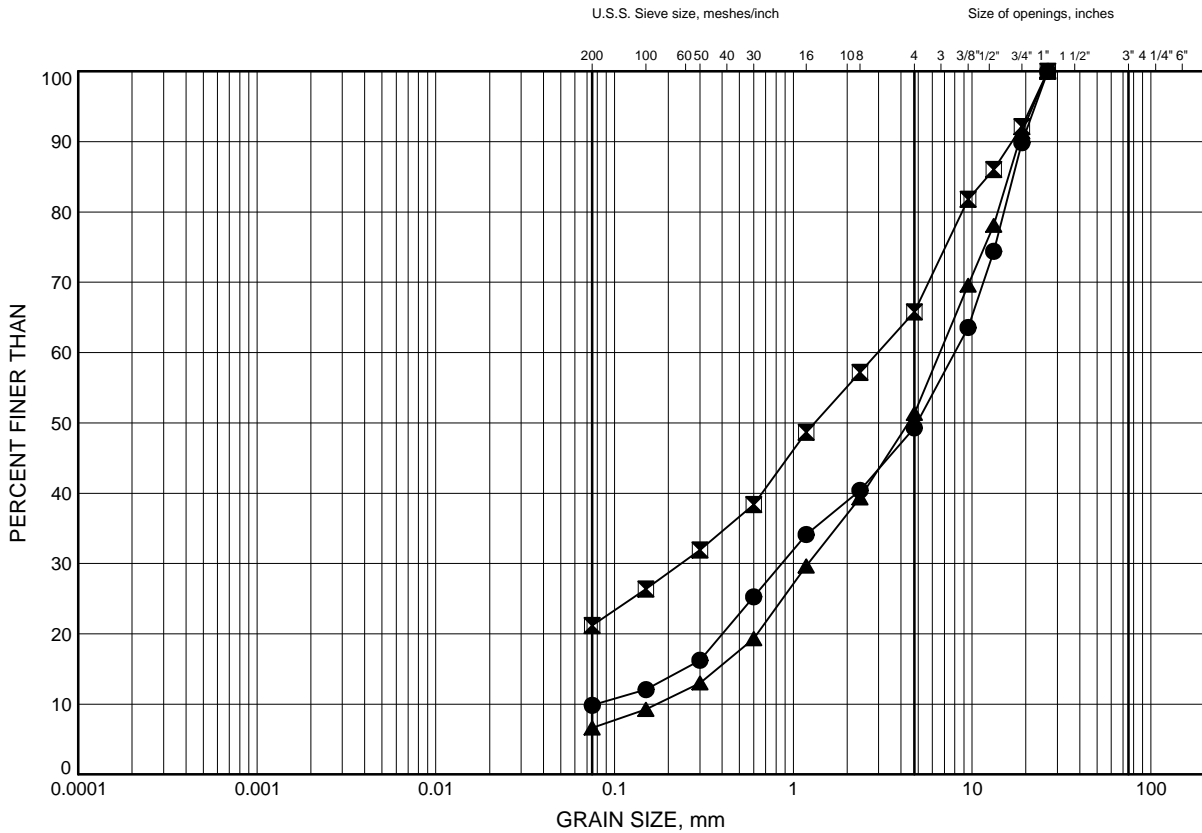
## **Appendix B**

### **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)
●	15+537	1.07	290.73
⊠	17+390	0.30	290.90
▲	17+390 S	0.53	291.47

Date March 2016  
GWP# 3079-09-00

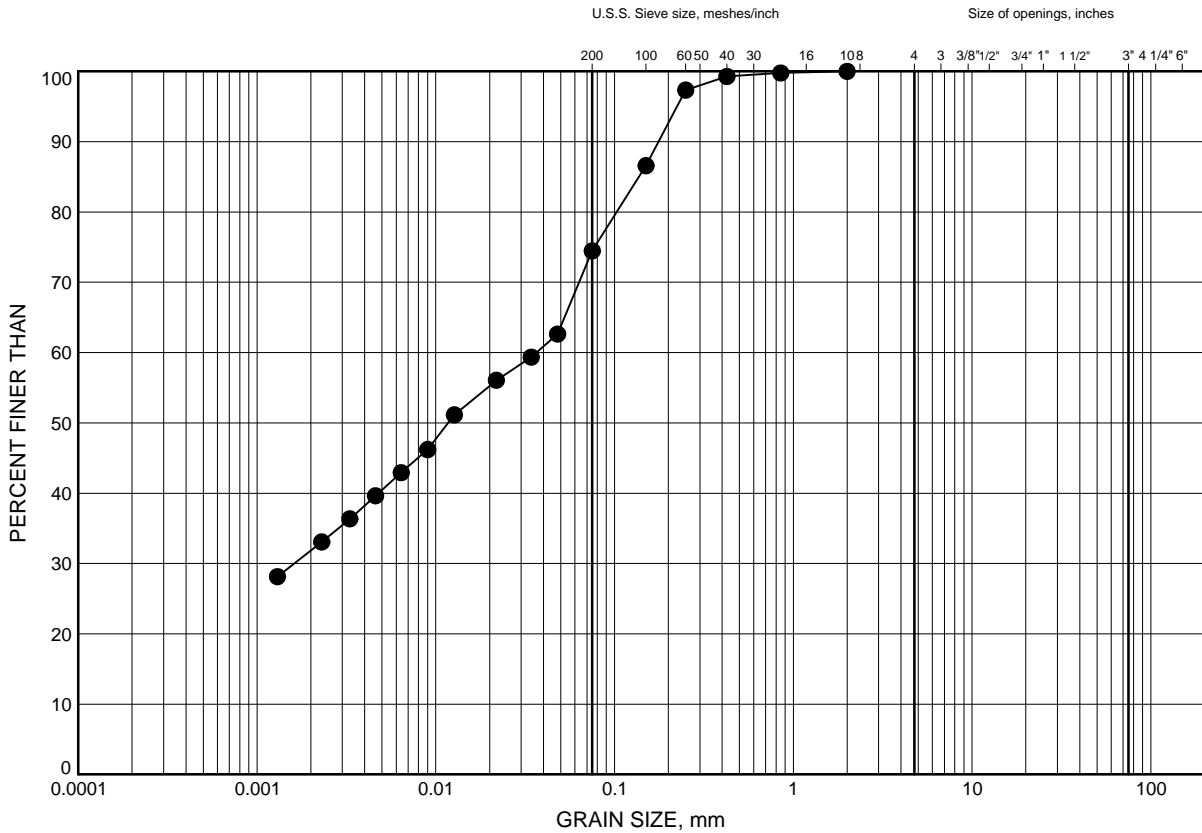


Prep'd AN  
Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B2

## Silty CLAY TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17+390	2.59	288.61

Date February 2016  
GWP# 3079-09-00

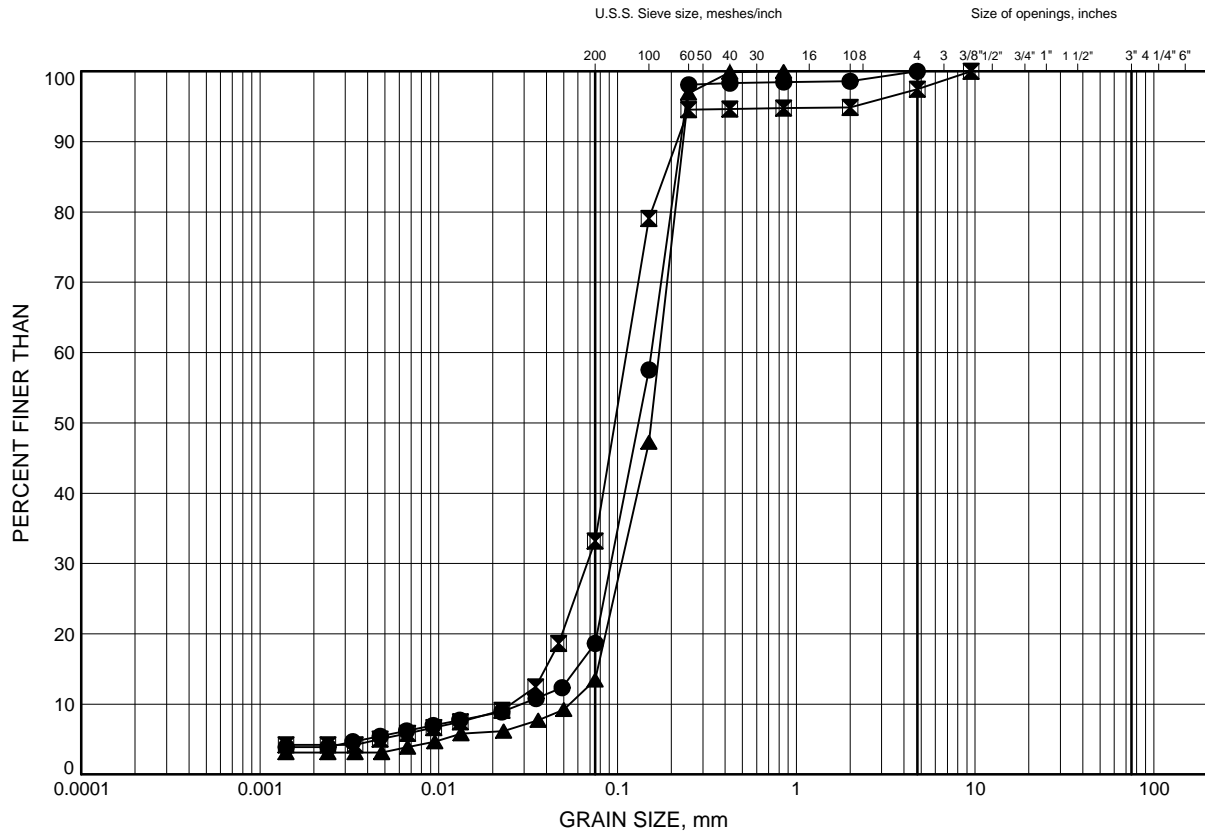


Prep'd AN  
Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B3

## SAND to Silty SAND



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16+077	3.35	287.35
⊠	16+077	6.40	284.30
▲	17+390	6.40	284.80

Date February 2016

GWP# 3079-09-00



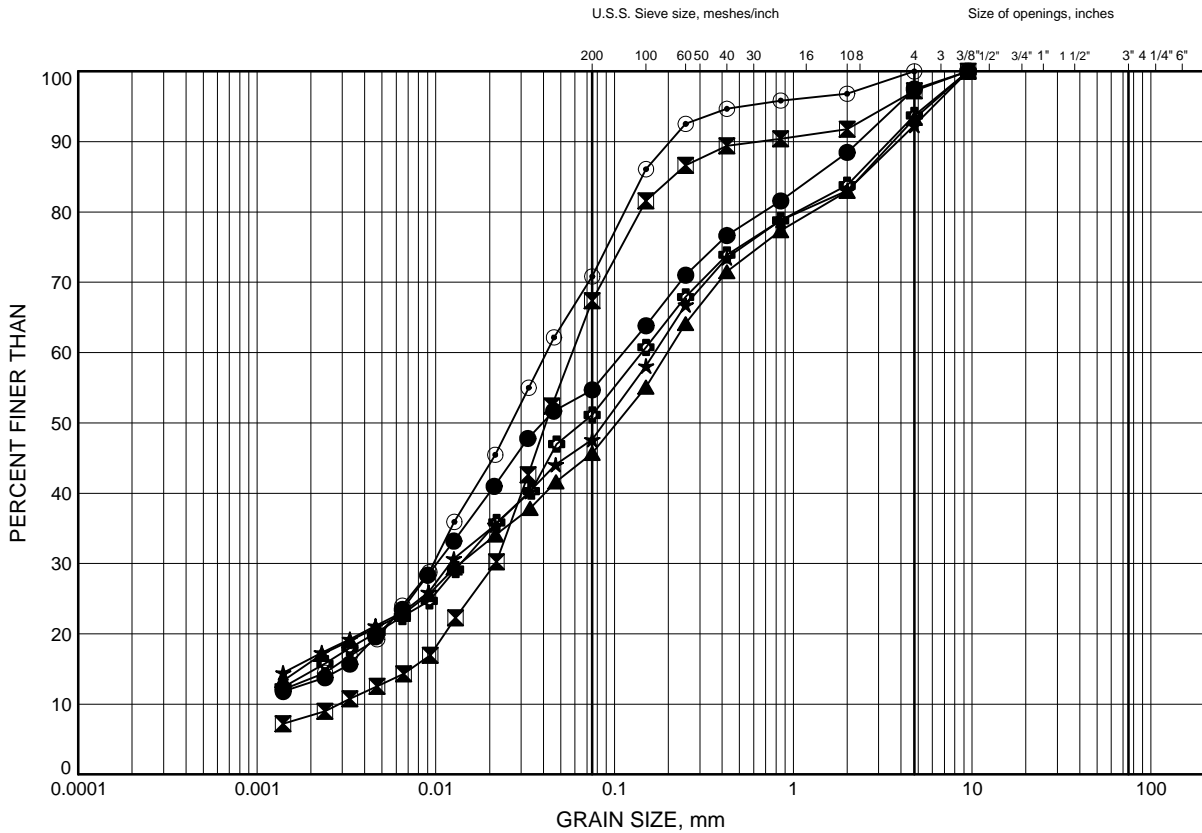
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B4

## Sandy SILT to Silty SAND TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	15+537	4.88	286.92
⊠	16+537	1.07	290.73
▲	16+537	3.12	288.68
★	16+537	6.40	285.40
⊙	17+390 S	6.40	285.60
⊕	17+850	0.30	296.00

Date March 2016

GWP# 3079-09-00



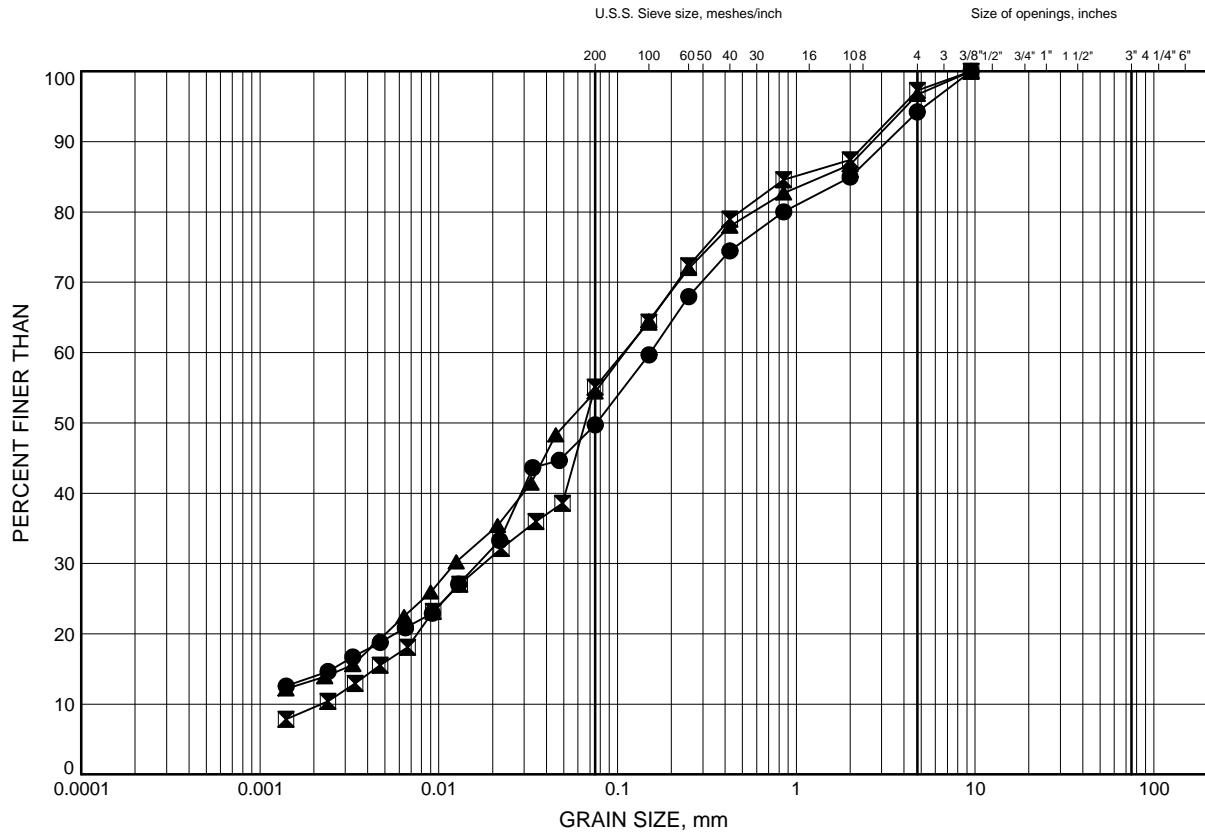
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B5

## Sandy SILT to Silty SAND TILL



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	17+850	1.83	294.47
⊠	17+850	4.72	291.58
▲	18+413	2.59	298.21

Date March 2016

GWP# 3079-09-00



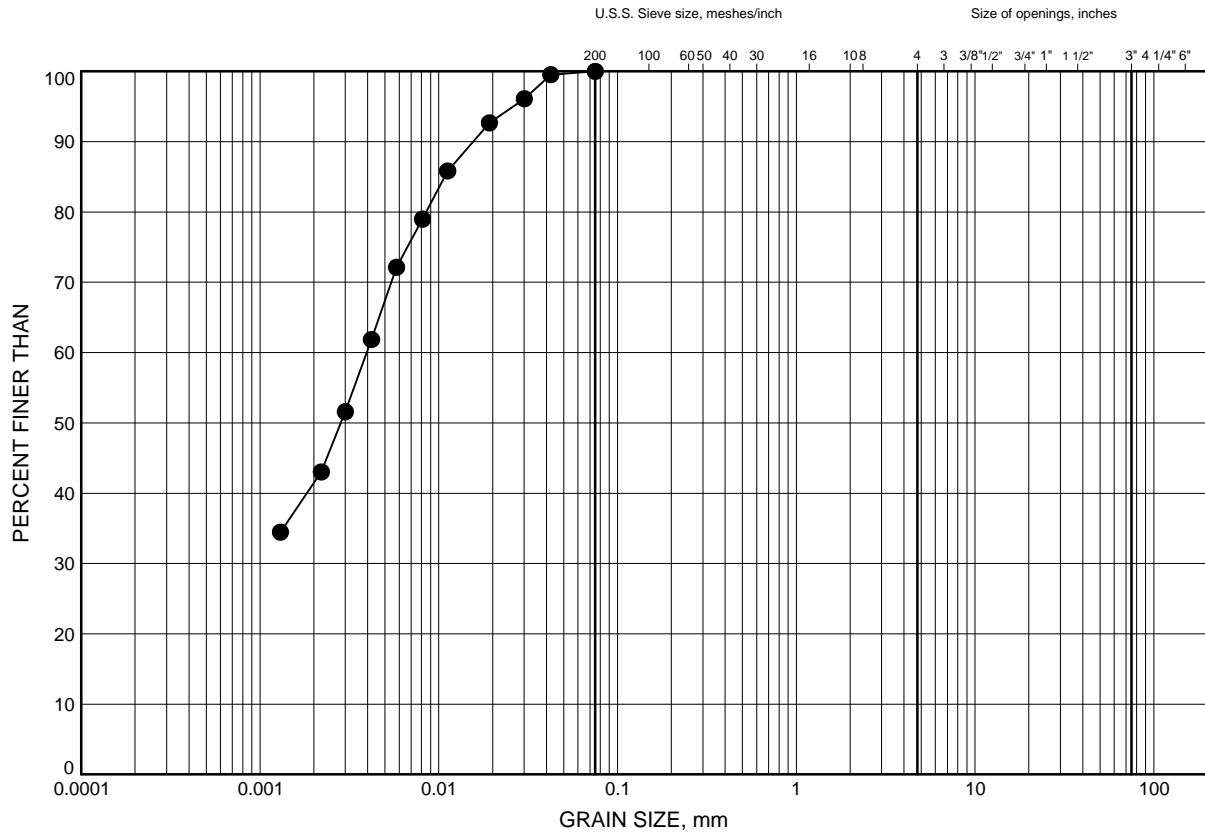
Prep'd AN

Chkd. AMP

# GRAIN SIZE DISTRIBUTION

FIGURE B6

## Silty CLAY



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	18+413	9.45	291.35

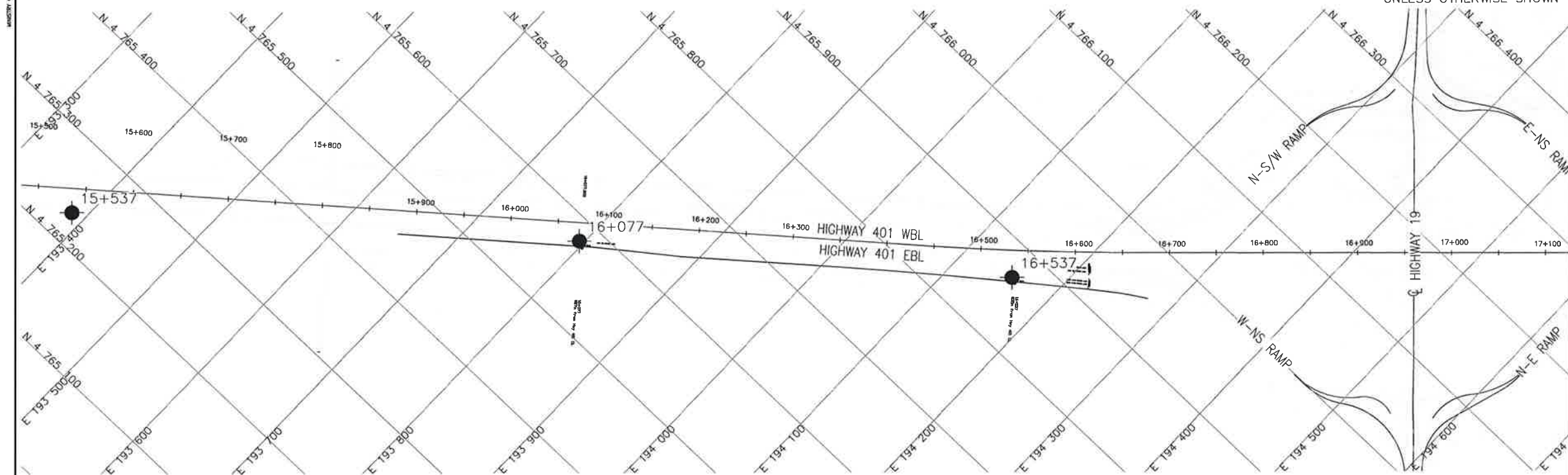
Date March 2016  
GWP# 3079-09-00



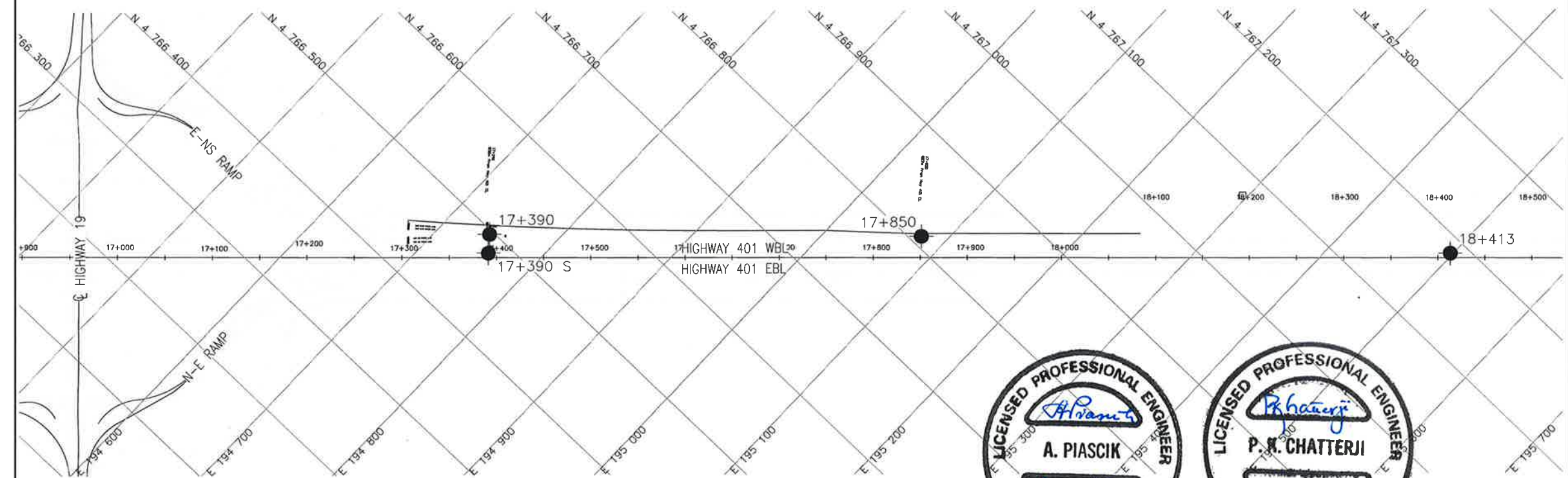
Prep'd AN  
Chkd. AMP

## **Appendix C**

### **Borehole Location Plan**



PLAN

100 0 100 200m  
SCALE 1:5000

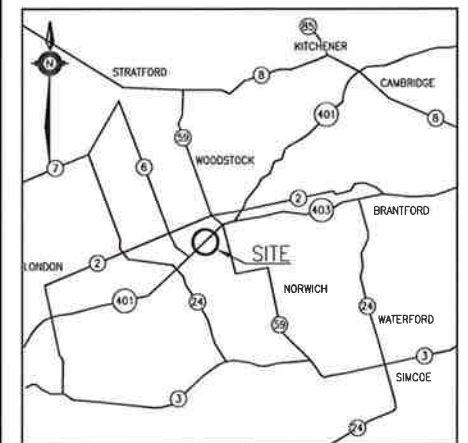
PLAN

100 0 100 200m  
SCALE 1:5000METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWNCONT No  
WP No 3079-09-00HIGHWAY 401  
TOWN OF INGERSOLL  
OVERHEAD SIGNS  
BOREHOLE LOCATIONS PLAN

SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
15+537	291.8	4 765 231.2	193 386.2
16+077	290.7	4 765 578.7	193 795.6
16+537	291.8	4 765 867.2	194 155.4
17+390	291.2	4 766 496.0	194 743.7
17+390 S	292.0	4 766 480.7	194 756.4
17+850	296.3	4 766 810.1	195 077.7
18+413	300.8	4 767 184.2	195 497.6

## -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. 40P2-84



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	AMP	CHK	AMP
DRAWN	AN	CHK	SITE
LOAD	DATE	APR 2016	DWG 1