



**THURBER** ENGINEERING LTD.

**FOUNDATION INVESTIGATION REPORT  
HIGHWAY 401 – HIGHWAY 15 INTERCHANGE IMPROVEMENTS  
HIGH FILL EMBANKMENTS  
KINGSTON, ON**

**Agreement No. 4015-E-0013  
G.W.P. 4059-11-00**

**GEOCRES Number: 31C-251**

**Report**

**to**

**WSP | MMM Group**

**September 15, 2016**

**File No. 12093**



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**FOUNDATION INVESTIGATION AND DESIGN REPORT  
HIGHWAY 401 – HIGHWAY 15 INTERCHANGE IMPROVEMENTS  
HIGH FILL EMBANKMENTS  
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**PART 1: FACTUAL INFORMATION**

**1 INTRODUCTION**

This report presents the factual data obtained from a foundation investigation conducted at the location of proposed improvements to the Highway 15 Interchange on Highway 401 in the City of Kingston, Ontario. The proposed improvements include widening of the N/S-W and W-N/S ramps and embankments and of Highway 15 at the north ramp terminal.

No previous foundation investigation information was available for the subject embankments.

The purpose of this investigation was to obtain subsurface information at the site and, based on the data obtained, to provide a model of the subsurface conditions including a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions.

Thurber Engineering Ltd. (Thurber) carried out the investigation as a sub-consultant to WSP | MMM Group (WSP | MMM) under MTO Agreement Number 4015-E-0013.

**2 SITE DESCRIPTION**

The Highway 401 and Highway 15 interchange has an existing underpass structure that carries Highway 15 over Highway 401. For the purpose of this report, Highway 401 is assumed to run west-east and Highway 15 is assumed to run north-south. Highway 15 consists of two lanes of traffic in each direction, and Highway 401 is a four-lane (two lanes in each direction) divided freeway. The interchange also includes a single on- or off-ramp in each quadrant (E-N/S, N/S-W, W-N/S and N/S-E ramps).

The site lies within the physiographic region known as the Napanee Plain, which is generally characterized by limestone plains, covered by a discontinuous thin layer of drift. Geological mapping indicates that knobs of Precambrian rock are also present in the area, including the west half of the N/S-W ramp. Locally, the bedrock is exposed at several locations including both sides of Highway 401 near the bridge structure, and portions of Highway 15, the E-N/S ramp, the N/S-W ramp and the N/S-E ramp.

The N/S-W ramp is approximately parallel to the Highway 401 westbound lanes. The easternmost portion of the ramp, from the intersection with Highway 15 to approximately 100 m west of the intersection is on a fill section up to approximately 8 m high. The north side of the embankment is sloped at approximately 2H:1V and is vegetated with wild grasses and brush. This embankment slope wraps around the northwest corner of the intersection with Highway 15 and extends up the west side of Highway 15, with a decreasing height. A residential property is located in the northwest quadrant of the intersection at the toe of slope. The south side of the N/S-W ramp embankment slopes down to Highway 401 at approximately 3H:1V and is vegetated with wild grasses and brush. West of this fill section, the ramp extends through a rock cut section. No evidence of settlement or stability concerns were noted.

The W-N/S ramp starts approximately parallel to the Highway 401 eastbound lanes and then turns away to meet Highway 15 at a signalized intersection. An existing park and ride lot is present at the southwest corner of the intersection of the ramp and Highway 15. A motel and commercial properties are present on the west side of Highway 15 south of the park and ride lot. The ramp is located on a fill embankment up to 8 m high. The existing slopes are graded at approximately 1.5H:1V and covered with rock fill. Wild grasses, brush and small trees are present at the toe of slope. A small area with stagnant surface water is also present at the toe of slope on the south side. No evidence of settlement or stability concerns were noted.

Selected photographs of the ramps and embankments are attached in Appendix D.

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

The borehole investigation and field testing program was carried out between April 12 and 19, 2016. The program consisted of drilling and sampling seven boreholes with boreholes spaced approximately every 50 m along the length of the high fill embankment widening areas. Boreholes 16-1, 16-2 and 16-3 were located along the N/S-W ramp with Borehole 16-1 located at the crest of the existing embankment and Boreholes 16-2 and 16-3 located at the toe of the existing outside embankment slope. Boreholes 16-4, 16-5, 16-6 and 16-7 were located along the W-N/S ramp with Borehole 16-4 located at the crest of the existing embankment and Boreholes 16-5, 16-6 and 16-7 located at the toe of the existing outside embankment slope. The

approximate locations of the boreholes are shown on the Borehole Location Plans and Soil Strata Drawings provided in Appendix A.

Prior to the start of drilling, the borehole locations were established in the field and utility clearances were obtained. The co-ordinates and elevations of the as-drilled boreholes were subsequently determined by Thurber based on chainage and benchmarks included on the base plans provided by WSP | MMM.

A truck-mounted drill rig equipped with hollow stem augers was used to drill and sample the boreholes on the roadway. A portable tripod drill rig was used to drill and sample the toe of slope boreholes. Soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). The boreholes were advanced to depths ranging from 1.5 m to 17.4 m, with some boreholes reaching refusal. In-situ shear vane testing was attempted within cohesive soil deposits.

A member of Thurber's technical staff supervised the drilling and sampling operations on a full time basis. The supervisor logged the boreholes, secured the recovered soil samples in labelled containers, and transported the samples to Thurber's laboratory for further examination and testing.

The boreholes were backfilled with soil cuttings mixed with bentonite. The upper portion of the boreholes through the existing embankments were backfilled with the existing granular material and premium grade asphalt patch.

Results of the field drilling and sampling are presented on the Record of Borehole sheets in Appendix B.

#### **4 LABORATORY TESTING**

All recovered soil samples were subjected to Visual Identification and to Natural Moisture Content determination. Selected soil samples were subjected to Grain Size Distribution analyses (sieve and hydrometer) and Atterberg Limit testing. The results of this laboratory testing program are shown on the Record of Borehole sheets in Appendix B and on the Figures in Appendix C.

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

Reference is made to the Record of Borehole sheets in Appendix B for details of the soil stratigraphy encountered in the boreholes. An overall description of the stratigraphy encountered at the N/S-W and W-N/S ramp embankments is given in the following sections; however, the factual data presented in the record of boreholes governs any interpretation of the site conditions. It should be noted that soil conditions may vary between and beyond the borehole locations.

## **5.1 N/S-W Ramp**

In general, the subsurface conditions encountered in the boreholes in the area of the proposed high fill embankment widening consist of granular fill over clayey embankment fill overlying a native clay deposit. A thin deposit of silty sand over inferred bedrock was encountered in one of the three boreholes (16-3). More detailed descriptions of the individual strata are presented below.

### **5.1.1 Granular Embankment Fill**

A layer of asphalt 80 mm in thickness was encountered at ground surface in Borehole 16-1 which was drilled through the existing shoulder of the N/S-W ramp.

The asphalt was underlain by sand with silt and gravel fill that extended to a depth of 3.0 m below surface (elevation 109.7 m).

The SPT N-value for the granular embankment fill ranged from 11 to 19 blows per 0.3 m penetration, indicating a compact state. The colour of the granular fill is brown. The moisture content of the granular fill ranged from 3% to 7%. The results of grain size analysis conducted on one sample of the granular fill material are presented on Figure C1 in Appendix C. The results are summarized in the following table.

<b>Soil Particles</b>	<b>%</b>
Gravel	18
Sand	71
Silt and Clay	11

### **5.1.2 Sandy Clay with Gravel: Embankment Fill**

Sandy clay with gravel fill was encountered below the granular fill in Borehole 16-1. The thickness of the sandy clay embankment fill was 4.6 m. The base of the embankment fill was encountered at elevation 105.1 m.

The SPT N-value for the embankment fill ranged from 3 to 14 blows per 0.3 m penetration; this fill is generally described as having a firm consistency. The water content of the recovered embankment fill samples ranged between 19% and 38%. The colour of the embankment fill is dark grey.

The results of grain size analysis conducted on one sample of the sandy clay fill are presented on Figure C1 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	16
Sand	29
Silt	30
Clay	25

Atterberg limit testing was carried out on a sample of the sandy clay fill. The liquid limit was 42% and the plasticity index was 21%. The sample can be classified as clay of intermediate plasticity (CI). The results are presented on Figure C5 in Appendix C and summarized in the table below.

Test	%
Plastic Limit	21
Liquid Limit	42
Plasticity Index	21

### 5.1.3 Rootmat

Rootmat, 50 mm to 100 mm in thickness, was encountered at surface in both toe of slope boreholes (16-2 and 16-3).

### 5.1.4 Silty Sand Fill

A silty sand fill was encountered below the rootmat in Borehole 16-2. The base of this fill material was encountered at elevation 104.9 m, 0.8 m below ground surface.

The SPT N-value for this silty sand fill was 4 blows per 0.3 m penetration, indicating a loose state. The water content of the silty sand fill sample was 11%. The colour is brown.

A thin organic layer was encountered at the base of the silty sand fill, possibly compressed vegetation and topsoil.

### 5.1.5 Clayey Silt

A 0.5 m thick clayey silt layer was encountered below the rootmat in Borehole 16-3. The base of this fill material was encountered at elevation 105.6 m.

The SPT N-value for this clayey silt was 7 blows per 0.3 m penetration, indicating a firm state. The water content of the sample was 34%. The colour is brown.

### 5.1.6 Clay

A native clay deposit was encountered in all boreholes beneath the fill or thin surficial deposits. This layer was observed to range from 2.8 m to greater than 9.8 m in thickness. Boreholes 16-1 and 16-2 were terminated within this deposit at termination elevations of 95.4 m and 96.6 m respectively. The base of this layer in Borehole 16-3 was at elevation 102.9 m. This deposit contained trace organic material near its surface.

The SPT N-values in the clay deposit ranged from 6 to 69 blows per 0.3 m penetration. In conjunction with measured field vane shear strengths ranging from 78 to greater than 106 kPa, the clay was found to have a typically stiff to very stiff consistency.

Borehole 16-1 was extended by carrying out a dynamic cone penetration test (DCPT) from elevation 95.4 m to 93.0 m. The DCPT blow counts ranged from 8 to 16 blows per 0.3 m penetration; the material was inferred to be a continuation of the clay deposit.

The colour of the clay is brown to greyish brown. The water content of the clay samples ranged from 22% to 51%.

The results of grain size analyses conducted on eight samples of the clay are presented on Figure C2 and Figure C3 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	0
Sand	0 to 6
Silt	32 to 47
Clay	52 to 65

Atterberg limit testing was carried out on eight samples of the clay. The clay can be classified as clay of intermediate to high plasticity (CI to CH). The results are presented on Figure C5 and Figure C6 in Appendix C and summarized in the table below.

Test	%
Plastic Limit	16 to 25
Liquid Limit	40 to 62
Plasticity Index	21 to 39

### 5.1.7 Silty Sand

A native soil deposit of silty sand was encountered just below the clay in Borehole 16-3. The thickness of this layer in Borehole 16-3 was 0.4 m with the base elevation of 102.4 m. The SPT N-value for this deposit was 24 to greater than 100 blows per 0.3 m penetration, indicating a



compact to very dense state. The water content of the recovered sample was 20%. The colour of this deposit is brown.

Grain size analysis conducted on a sample of the soil are presented on Figure C4 in Appendix C. These results are summarized in the following table.

Soil Particles	%
Gravel	0
Sand	88
Silt and Clay	12

#### **5.1.8 Refusal**

Refusal on inferred bedrock was encountered below the silty sand in Borehole 16-3 at elevation 102.4 m.

#### **5.1.9 Groundwater Conditions**

Free water was not observed in any of the boreholes at the time of drilling.

### **5.2 W–N/S Ramp**

In general, the subsurface conditions encountered in the boreholes in the area of the W-N/S ramp consist of granular fill overlying a clay deposit, overlying a thin layer of silty sand/sandy silt overlying refusal on inferred bedrock. More detailed descriptions of the individual strata are presented below.

#### **5.2.1 Embankment Fill**

A layer of asphalt 150 mm in thickness was encountered at ground surface in Boreholes 16-4 which was drilled through the outside shoulder of the existing ramp.

The asphalt was underlain by gravel fill with silt and sand extending to a depth of 2.1 m below surface (elevation 105.8m) in Borehole 16-4. The SPT N-values for this upper fill ranged from 29 to 40 indicating a compact to dense state. The water content of all three samples tested was 3%.

The upper granular fill was underlain by a fill layer of cobbles and gravel, some sand (possible rock fill). This layer is 1.3 m thick and extended to elevation 104.6 m. The SPT N-values within this layer were 8 and 100 blows for 75 mm of penetration, suggesting a loose to very dense state. Sample recovery within this layer was limited. The low SPT N-value of 8 may have been due to voids between cobbles. Asphalt was found in the tip of the split spoon sampler in sample SS-5 at an elevation of 104.6 m.

The possible rock fill layer was underlain by a 0.9 m thick fill layer of brown sand with silt some gravel extending to elevation 103.6 m. The sand fill layer was underlain by a 3.9 m thick silty sand to silty gravel fill containing occasional to frequent cobble sized particles. The base of the embankment was noted at 8.2 m below the road surface (elevation 99.8 m). The SPT N-value for the lower embankment fill ranged from 8 to 29 blows per 0.3 m penetration, indicating a loose to compact state. The water content of the recovered lower embankment fill samples ranged between 6% and 15%. The colour of the lower embankment fill is brown to greenish-brown.

The results of grain size analysis conducted on three samples of the embankment fill are presented on Figure C7 in Appendix C. The results are summarized in the following table.

Soil Particles	%
Gravel	1 to 58
Sand	27 to 89
Silt and Clay	10 to 15

### 5.2.2 Rootmat

Rootmat, 50 mm in thickness, was encountered at surface in all three toe of slope boreholes (16-5, 16-6 and 16-7).

### 5.2.3 Silt

A 0.5 m to 0.8 m thick silt layer was encountered below the rootmat in boreholes 16-5, 16-6 and 16-7. The base elevation of this material ranged from 97.0 m to 102.1 m. This silt contained variable amounts of sand and clay, and ranges from sandy silt to clayey silt to silt, some sand.

The SPT N-values within the silt deposit ranged from 4 to 12 blows per 0.3 m penetration, indicating a loose to compact state. The water content of the silty material ranged from 34% to 40%. The colour is brown.

### 5.2.4 Clay

A native clay deposit was encountered in all boreholes. This deposit was found just beneath the base of the embankment fill in Borehole 16-4, and below the silt deposit in the toe of slope boreholes. This layer was observed to range from 0.6 m to 4.2 m in thickness. The base of this material ranged from elevation 93.7 m to 98.7 m.

The SPT N-values within the clay deposit ranged from 3 to 38 blows per 0.3 m penetration. In conjunction with measured field vane shear strengths ranging from 72 to greater than 106 kPa, the clay was found to have a typically stiff to very stiff consistency.

The colour of the clay is brown to grey. The water content of the clay samples ranged from 31% to 53%.

The results of grain size analyses conducted on four samples of the clay are presented on Figure C8 in Appendix C. The results are summarized in the following table.

<b>Soil Particles</b>	<b>%</b>
Gravel	0
Sand	1 to 5
Silt	35 to 46
Clay	50 to 64

Atterberg limit testing was carried out on four samples of the clay. The clay can be classified as clay of intermediate to high plasticity (CI to CH). The results are presented on Figure C10 in Appendix C and summarized in the table below.

<b>Test</b>	<b>%</b>
<b>Plastic Limit</b>	17 to 26
<b>Liquid Limit</b>	44 to 60
<b>Plasticity Index</b>	27 to 38

### 5.2.5 Sandy Silt

A native soil deposit of sandy silt was encountered just below the clay in Borehole 16-6. The thickness of this layer was 0.8 m with the base elevation at 92.8 m. The SPT N-value for this deposit was 31 blows per 0.3 m penetration, indicating a dense state. The water content of recovered samples was 23% and 25%. The colour of this deposit is brown.

Grain size analysis conducted on a sample of the soil are presented on Figure C9 in Appendix C. These results are summarized in the following table.

<b>Soil Particles</b>	<b>%</b>
Gravel	0
Sand	42
Silt	32
Clay	26

### **5.2.6 Refusal**

Refusal on inferred bedrock was encountered below the clay in all boreholes at elevations ranging from 92.8 m to 98.7 m.

### **5.2.7 Groundwater Conditions**

Free water was observed in Boreholes 16-6 and 16-7 at depths of 0.05 m and 0.2 m, respectively (elevations 97.8 and 97.7 m).

## 6 MISCELLANEOUS

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

George Downing Estate Drilling Ltd. of Hawkesbury, Ontario, supplied and operated a track-mounted CME 55 drill rig as well as the portable tripod drill rig to carry out the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Justin Gray E.I.T. of Thurber. Laboratory testing was carried out by Thurber in its MTO-approved laboratory.

Overall project management and direction of the field program was provided by Mr. Paul Carnaffan, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Justin Gray E.I.T. and Mr. Paul Carnaffan P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



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Review Principal, Designated MTO Contact

## **Appendix A**

### **Borehole Location Plans**



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



CONT No  
GWP No 4059-11-00

HIGHWAY 401 &  
HIGHWAY 15 INTERCHANGE  
N/S-W RAMP  
BOREHOLE LOCATIONS AND SOIL STRATA



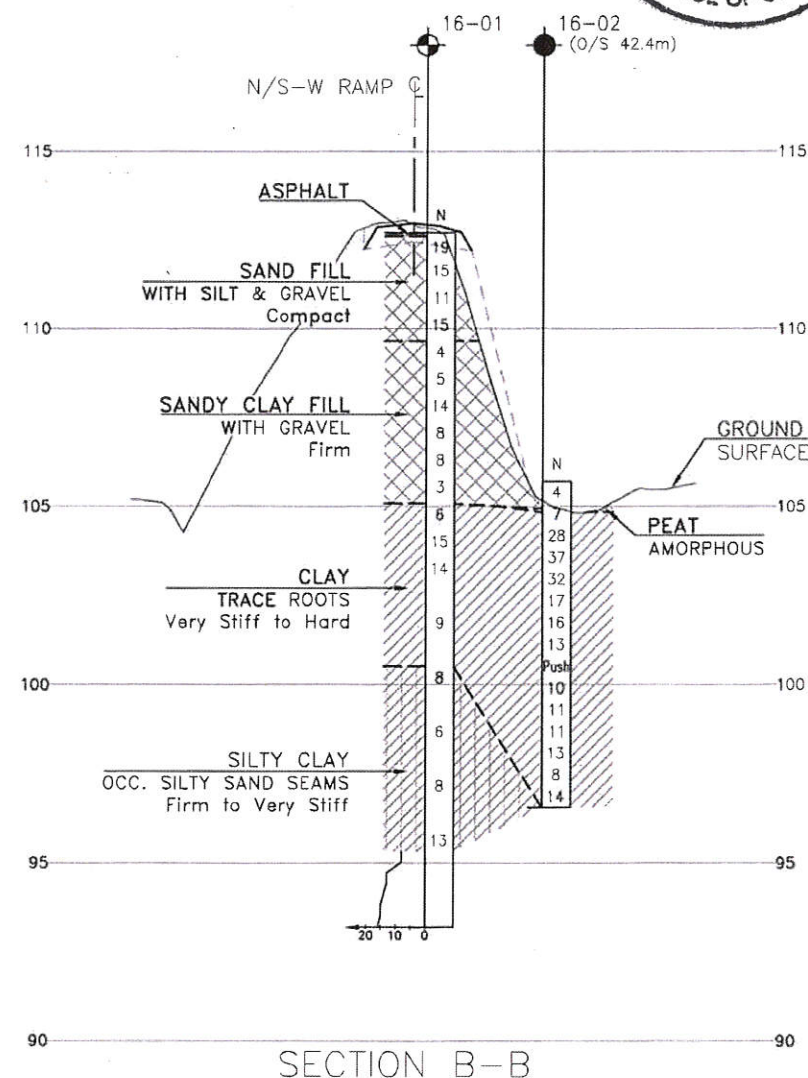
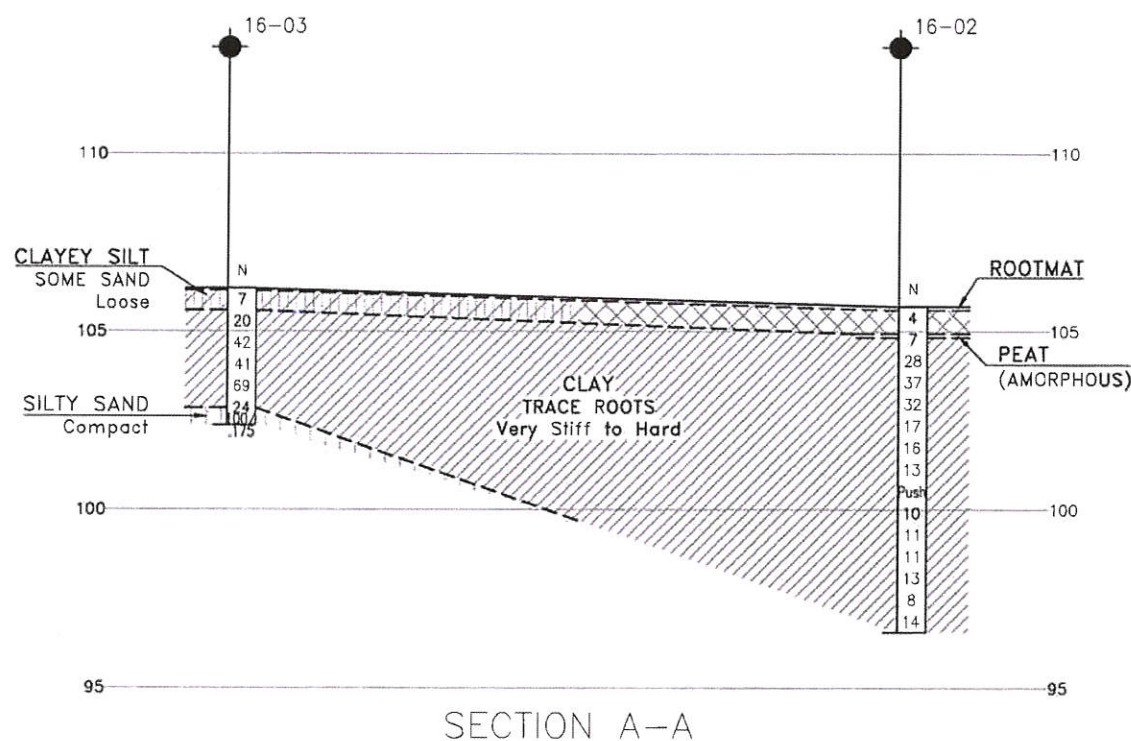
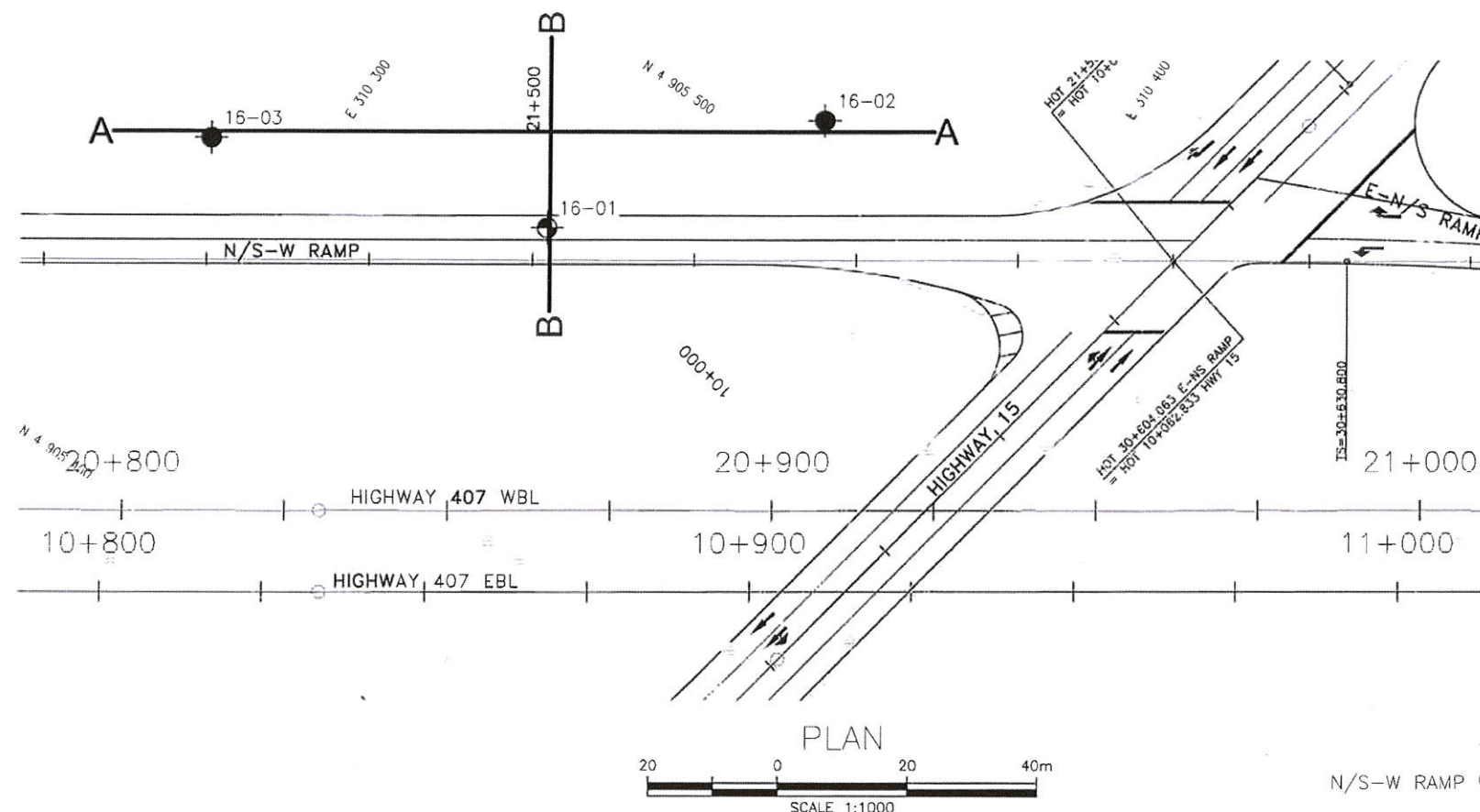
NO	ELEVATION	NORTHING	EASTING
16-01	112.7	4 905 471.5	310 335.
16-02	105.7	4 905 509.1	310 362.
16-03	106.2	4 905 454.2	310 285.

-NOTES-

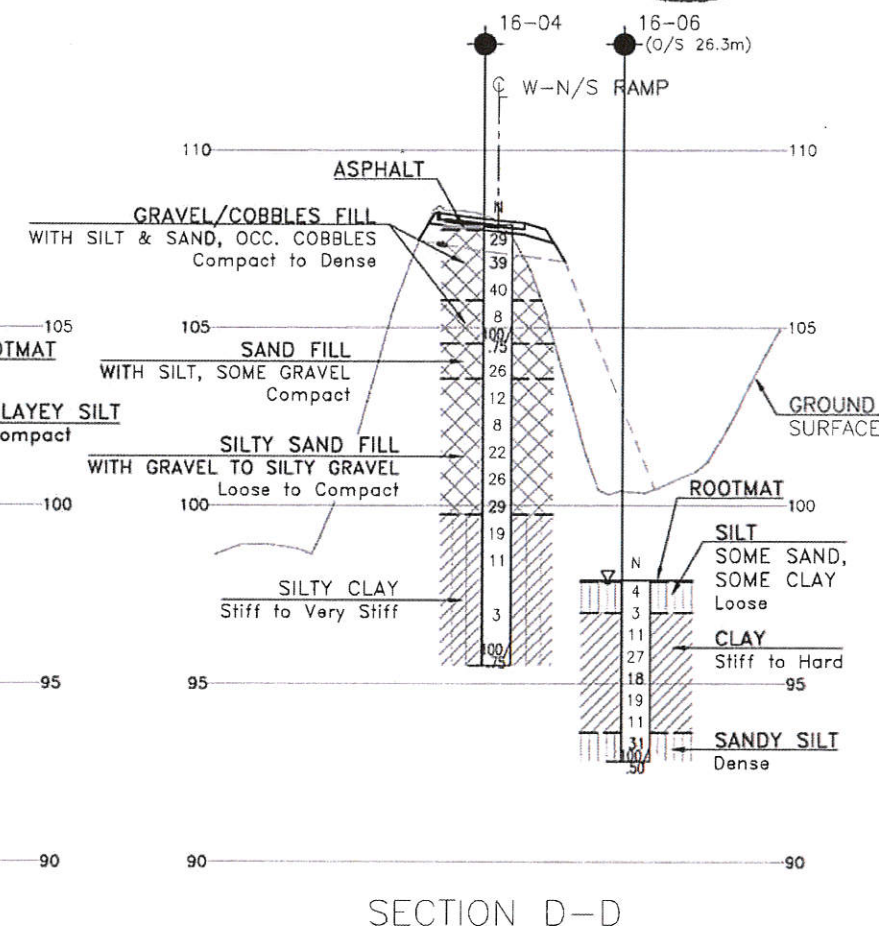
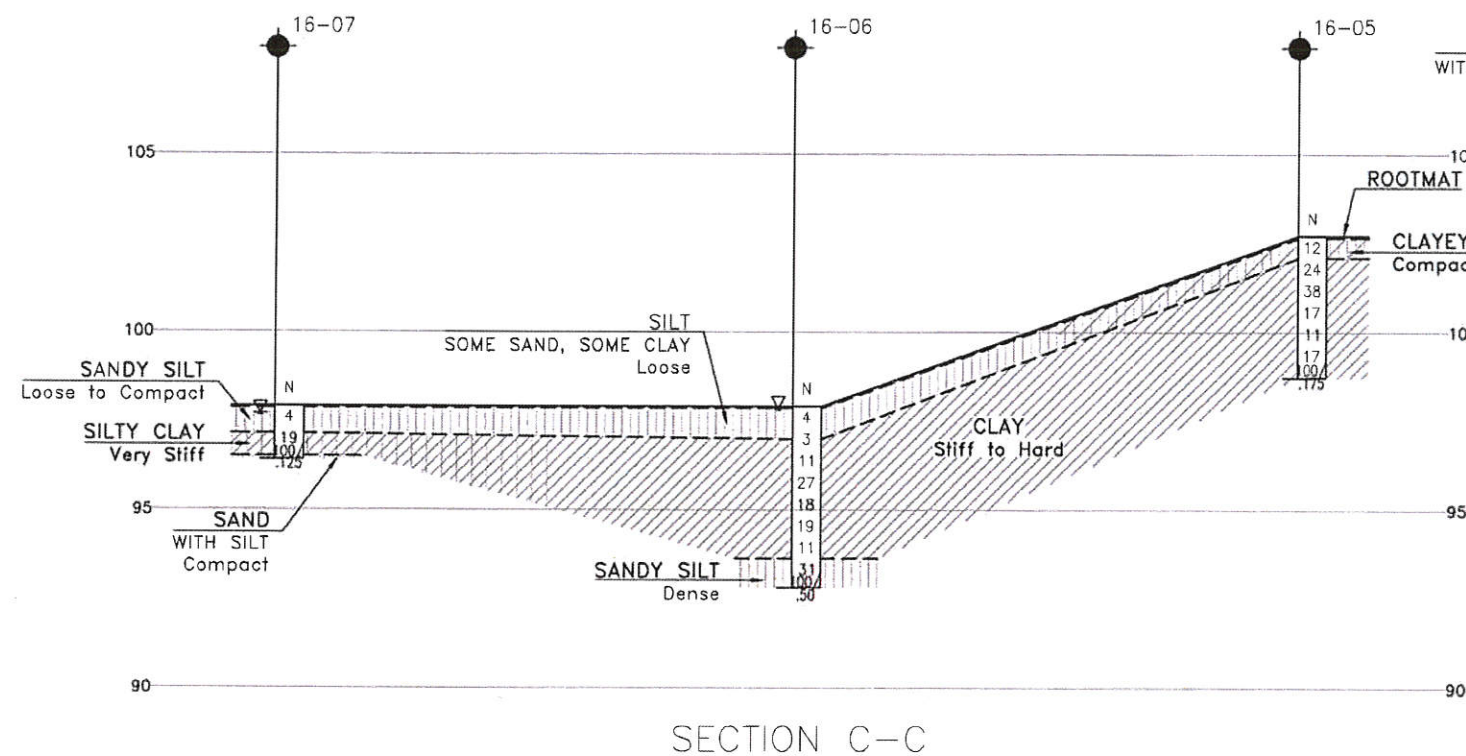
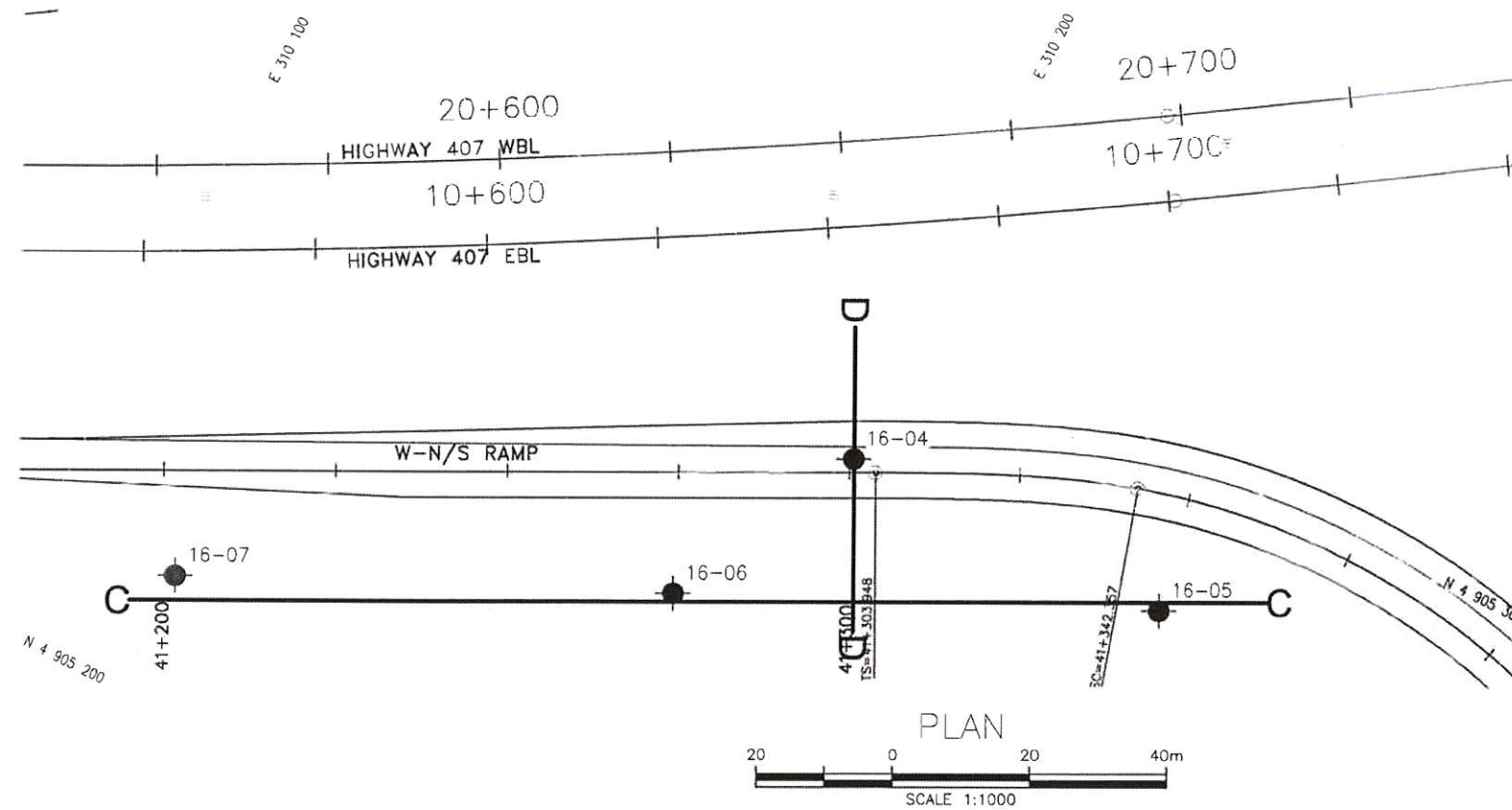
- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

GEOCRES No. 31C-251

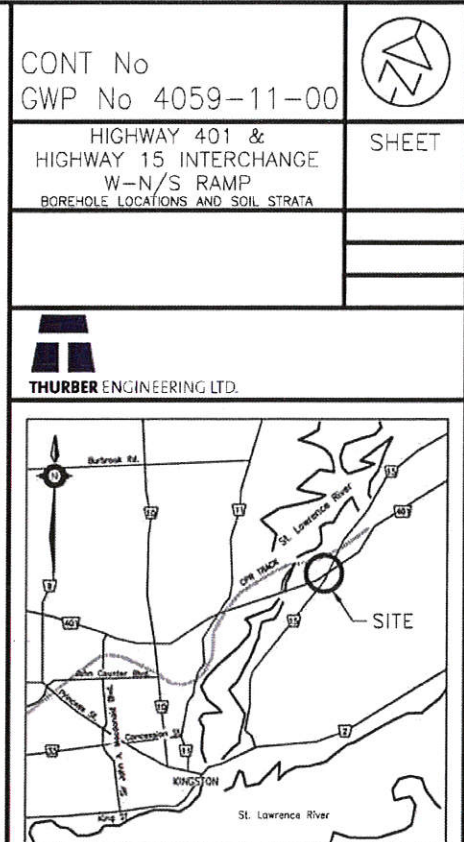
REVISIONS									
DATE		BY		DESCRIPTION					
DESIGN	CM	CHK		CODE	LOAD	DATE	SEP 201		
DRAWN	AN	CHK		SITE	STRUCT	DWG	1		












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



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
16-04	107.9	4 905 278.2	310 201.8
16-05	102.7	4 905 278.1	310 251.7
16-06	97.9	4 905 248.9	310 186.9
16-07	97.9	4 905 218.9	310 120.7

-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. 31C-251

REVISIONS						
	DATE	BY	DESCRIPTION			
DESIGN	CM	CHK	CODE	LOAD	DATE	SEP 2016
DRAWN	AN	CHK	SITE	STRUCT	DWG 2	



## **Appendix B**

### **Record of Borehole Sheets**

## **SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS**

### **TERMINOLOGY DESCRIBING COMMON SOIL GENESIS**

Topsoil	mixture of soil and humus capable of supporting vegetative growth
Peat	mixture of fragments of decayed organic matter
Till	unstratified glacial deposit which may include particles ranging in sizes from clay to boulder
Fill	material below the surface identified as placed by humans (excluding buried services)

### **TERMINOLOGY DESCRIBING SOIL STRUCTURE:**

Desiccated	having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc.
Fissured	having cracks, and hence a blocky structure
Varved	composed of alternating layers of silt and clay
Stratified	composed of alternating successions of different soil types, e.g. silt and sand
Layer	> 75 mm in thickness
Seam	2 mm to 75 mm in thickness
Parting	< 2 mm in thickness

### **RECOVERY:**

For soil samples, the recovery is recorded as the length of the soil sample recovered.

### **N-VALUE:**

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

### **DYNAMIC CONE PENETRATION TEST (DCPT):**

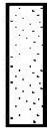
Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.

**STRATA PLOT:**

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders  
Cobbles  
Gravel



Sand



Silt



Clay



Organics



Asphalt



Concrete



Fill



Bedrock

**TEXTURING CLASSIFICATION OF SOILS**

Classification	Particle Size
Boulders	Greater than 200 mm
Cobbles	75 – 200 mm
Gravel	4.75 – 75 mm
Sand	0.075 – 4.75 mm
Silt	0.002 – 0.075 mm
Clay	Less than 0.002 mm

**SAMPLE TYPES**

SS	Split spoon samples
ST	Shelby tube or thin wall tube
DP	Direct push sample
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ etc.	Rock core sample obtained with the use of standard size diamond coring equipment

**TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)**

Descriptive Term	Undrained Shear Strength (kPa)
Very Soft	12 or less
Soft	12 – 25
Firm	25 – 50
Stiff	50 – 100
Very Stiff	100 – 200
Hard	Greater than 200

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

**TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)**

Descriptive Term	SPT “N” Value
Very Loose	Less than 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	Greater than 50

### MODIFIED UNIFIED SOIL CLASSIFICATION

Major Divisions		Group Symbol	Typical Description
COARSE GRAINED SOIL	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	SILT AND CLAY SOILS $W_L < 35\%$	ML	Inorganic silts, 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.
		OL	Organic silts and organic silty-clays of low plasticity.
	SILT AND CLAY SOILS $35\% < W_L < 50\%$	MI	Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts.
		CI	Inorganic clays of medium plasticity, silty clays.
		OI	Organic silty clays of medium plasticity.
	SILT AND CLAY SOILS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other organic soils.

Note -  $W_L$  = Liquid Limit

## EXPLANATION OF ROCK LOGGING TERMS

### ROCK WEATHERING CLASSIFICATION

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

### 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 0.1 m in length or larger, as a percentage of total core length
Unconfined Compressive Strength: (UCS)	Axial stress required to break the specimen.
Fracture Index: (FI)	Frequency of natural fractures per 0.3 m of core run.

### DISCONTINUITY SPACING

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

### STRENGTH CLASSIFICATION



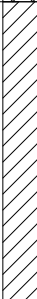
Rock Strength	Approximate Uniaxial Compressive Strength (MPa)
Extremely Strong	Greater than 250
Very Strong	100 – 250
Strong	50 – 100
Medium Strong	25 – 50
Weak	5 – 25
Very Weak	1 – 5
Extremely Weak	0.25 – 1

# RECORD OF BOREHOLE No 16-1

1 OF 2

METRIC

GWP# 4059-11-00 LOCATION NS - W Ramp, Highway 401/15 Interchange N 4 905 471.5 E 310 335.7 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG  
 DATUM Geodetic DATE 2016.12.04 - 2016.12.04 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT  $\gamma$  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				W P W W L								
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%)								
112.7							20 40 60 80 100													
0.0	Asphalt (80mm)																			
0.1			SAND with silt and gravel compact brown FILL	1	SS	19														
				2	SS	15														
				3	SS	11														
	4	SS		15																
109.7																				
3.0	Sandy CLAY with gravel firm dark grey FILL		5	SS	4															
			6	SS	5															
			7	SS	14															
			8	SS	8															
			9	SS	8															
			10	SS	3															
105.1																				
7.6	CLAY (CH), trace roots stiff to very stiff brown to grey		11	SS	6															
			12	SS	15															
			13	SS	14															

Continued Next Page

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

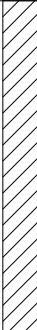
20  
15  
10  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 16-1

2 OF 2

METRIC

GWP# 4059-11-00 LOCATION NS - W Ramp, Highway 401/15 Interchange N 4 905 471.5 E 310 335.7 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG  
 DATUM Geodetic DATE 2016.12.04 - 2016.12.04 CHECKED BY PC

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						20	40	60	80	100	WATER CONTENT (%)					
100.5	CLAY (CH), trace roots stiff to very stiff brown to grey		14	SS	9												
12.2			CLAY (CH to CI), silty, occasional silty sand seams firm to very stiff grey	15	SS	8											
			16	SS	6												
			17	SS	8												
95.4			18	SS	13												
17.4	End of Borehole at 17.4 m Borehole dry on completion DCPT driven from 17.4 m to 19.8 m in Inferred Clay																

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

# RECORD OF BOREHOLE No 16-2

1 OF 1

METRIC

GWP# 4059-11-00 LOCATION NS - W Ramp, Highway 401/15 Interchange N 4 905 509.1 E 310 362.0 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Portable COMPILED BY JAG  
 DATUM Geodetic DATE 2016.04.19 - 2016.04.19 CHECKED BY PC

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 (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)											
105.7								20	40	60	80	100											
0.0	Rootmat (100mm)		1	SS	4																		
0.1	SILTY SAND loose brown																						
104.9	FILL		2	SS	7		105																
104.8	Amorphous Peat (100mm)																						
0.9	CLAY (CH) very stiff brown to greyish brown		3	SS	28		104																
			4	SS	37																		0 3 37 60
			5	SS	32		103																
			6	SS	17																		
			7	SS	16		102																0 2 42 56
101.4	CLAY (CH to CI) stiff grey		8	SS	13		101																
4.3			9	GS	Push																		
			10	SS	10		100																0 1 38 61
			11	SS	11																		
			12	SS	11		99																
			13	SS	13		98																
			14	SS	8																		0 2 46 52
			15	SS	14		97																
96.6																							
9.1	End of Borehole at 9.1 m Borehole dry upon completion																						

ONTMT4S 12093.GPJ 2012TEMPLATE(MTO).GDT 5/8/16

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



# RECORD OF BOREHOLE No 16-3

1 OF 1

METRIC

GWP# 4059-11-00 LOCATION NS - W Ramp, Highway 401/15 Interchange N 4 905 454.2 E 310 285.1 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Portable COMPILED BY JAG  
 DATUM Geodetic DATE 2016.04.19 - 2016.04.19 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
106.2								20 40 60 80 100						
0.0	Rootmat (50mm)		1	SS	7		106							
105.6	Clayey SILT some sand firm brown		2	SS	20									
0.6	CLAY (CH), trace roots very stiff brown		3	SS	42		105							
			4	SS	41		104							
			5	SS	69									
102.9			6	SS	24		103							
3.4	SILTY SAND compact brown		7	SS	100/									
102.4														
3.8	End of Borehole at 3.8 m on Inferred Bedrock Borehole dry on completion				175mm									

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

20  
15  
10  
5  
0  
5  
10  
15  
20  
(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 16-4

1 OF 2

METRIC

GWP# 4059-11-00 LOCATION W- NS Ramp, Highway 401/15 Interchange N 4 905 278.2 E 310 201.8 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG  
 DATUM Geodetic DATE 2016.12.04 - 2016.04.13 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT      NATURAL MOISTURE CONTENT      LIQUID LIMIT				UNIT WEIGHT  $\gamma$  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									
107.9																	
0.0																	
0.2	Asphalt (150mm)																
	GRAVEL with silt and sand, occasional cobble compact to dense brown FILL		1	SS	29												
			2	SS	39												
			3	SS	40												
105.8																	
2.1	COBBLES and GRAVEL, some sand, occasional void loose grey FILL																
			4	SS	8												
			5	SS	100/												
104.6																	
3.4	- Asphalt at 3.3 m				75mm												
	SAND with silt, some gravel compact brown FILL																
			6	SS	26												
103.6																	
4.3	SILTY SAND with gravel to Silty GRAVEL with sand, occasional to frequent cobbles loose to compact greenish brown FILL																
			7	SS	12												
			8	SS	8												
			9	SS	22												
			10	SS	26												
			11	SS	29												
99.8																	
8.2	CLAY (Cl), silty stiff to very stiff brown to grey																
			12	SS	19												
			13	SS	11												

Continued Next Page

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

# RECORD OF BOREHOLE No 16-4

2 OF 2

METRIC

GWP# 4059-11-00 LOCATION W- NS Ramp, Highway 401/15 Interchange N 4 905 278.2 E 310 201.8 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Hollow Stem Auger COMPILED BY JAG  
 DATUM Geodetic DATE 2016.12.04 - 2016.04.13 CHECKED BY PC

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	WATER CONTENT (%)					
	Continued From Previous Page													
	CLAY (Cl), silty stiff to very stiff brown to grey													
	-Wet		14	SS	3		97							0 4 46 50
							96							
95.5	-Rock fragment in tip of split spoon		15	SS	100/									
12.4	End of Borehole at 12.4 m with Auger Refusal on Inferred Bedrock Borehole dry upon completion				75mm									

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

# RECORD OF BOREHOLE No 16-5

1 OF 1

METRIC

GWP# 4059-11-00 LOCATION W- NS Ramp, Highway 401/15 Interchange N 4 905 278.1 E 310 251.7 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Portable COMPILED BY JAG  
 DATUM Geodetic DATE 2016.04.18 - 2016.04.18 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT						UNIT WEIGHT  $\gamma$ 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							
102.7								20	40	60	80	100			
0.0	Rootmat (50mm)		1	SS	12										
102.1	Clayey SILT compact brown		2	SS	24		102								
0.6	CLAY (CH) stiff to very stiff brown to greyish brown		3	SS	38		101								
			4	SS	17										
			5	SS	11		100								
			6	SS	17										
			7	SS	100/ 175mm		99								
98.7	-Trace gravel														
4.0	End of Borehole at 4.0 m on Inferred Bedrock Borehole dry upon completion														

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

20  
15  
10

(%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 16-6

1 OF 1

METRIC

GWP# 4059-11-00 LOCATION W- NS Ramp, Highway 401/15 Interchange N 4 905 248.9 E 310 186.9 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Portable COMPILED BY JAG  
 DATUM Geodetic DATE 2016.04.18 - 2016.04.18 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT  $\gamma$  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					
								20 40 60 80 100					
97.9													
0.0	Rootmat (50mm)		1	SS	4								
	SILT, some sand, some clay loose brown												
97.0			2	SS	3		97						
0.9	CLAY (CH) stiff to very stiff brown to grey												
			3	SS	11								
			4	SS	27		96						
			5	SS	18								
			6	SS	19								
			7	SS	11		95						
93.7													
4.3	Sandy SILT dense grey		8	SS	31								
92.8			9	SS	100/		94						
5.1	End of Borhole at 5.1 m on Inferred Bedrock Water at 0.05 m on completion				50mm		93						


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

# RECORD OF BOREHOLE No 16-7

1 OF 1

METRIC

GWP# 4059-11-00 LOCATION W- NS Ramp, Highway 401/15 Interchange N 4 905 218.9 E 310 120.7 ORIGINATED BY JAG  
 HWY 401/15 BOREHOLE TYPE Portable COMPILED BY JAG  
 DATUM Geodetic DATE 2016.04.18 - 2016.04.18 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT  $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
97.9								20	40	60	80	100			
0.0	<b>Rootmat (50mm)</b>		1	SS	4		97								
97.1	Sandy <b>SILT</b> loose to compact brown														
0.8	<b>CLAY (CH)</b> , silty very stiff brown		2	SS	19										0 5 42 53
96.5			3	SS	100/										
96.4	<b>SAND</b> with silt compact brown				125mm										
1.5	End of Borehole at 1.5 m on Inferred Bedrock Water at 0.2 m on completion														

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

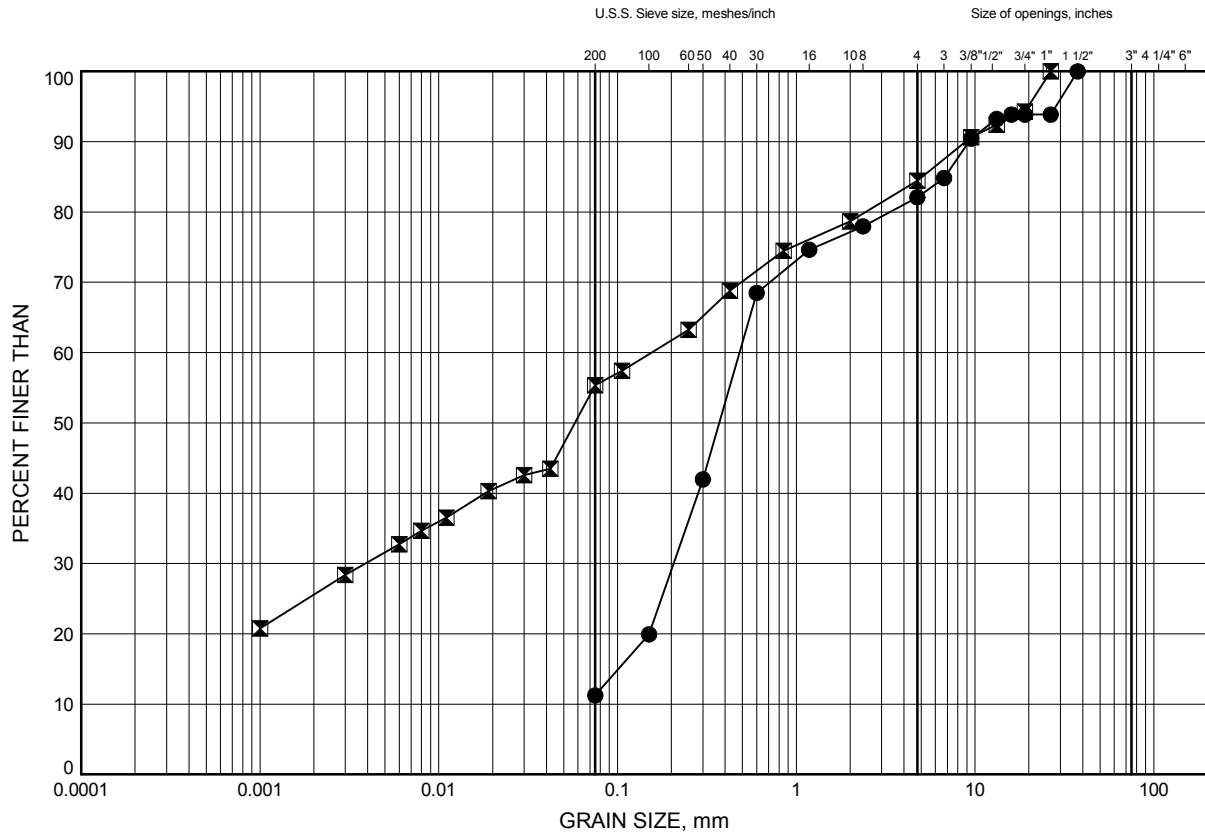
## **Appendix C**

### **Laboratory Test Results**

NS - W Ramp, Highway 15/401 Interchange  
**GRAIN SIZE DISTRIBUTION**

FIGURE C1

**Granular and Embankment Fill**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	1.07	111.66
⊠	16-1	5.64	107.09

Date May 2016  
 GWP# 4059-11-00

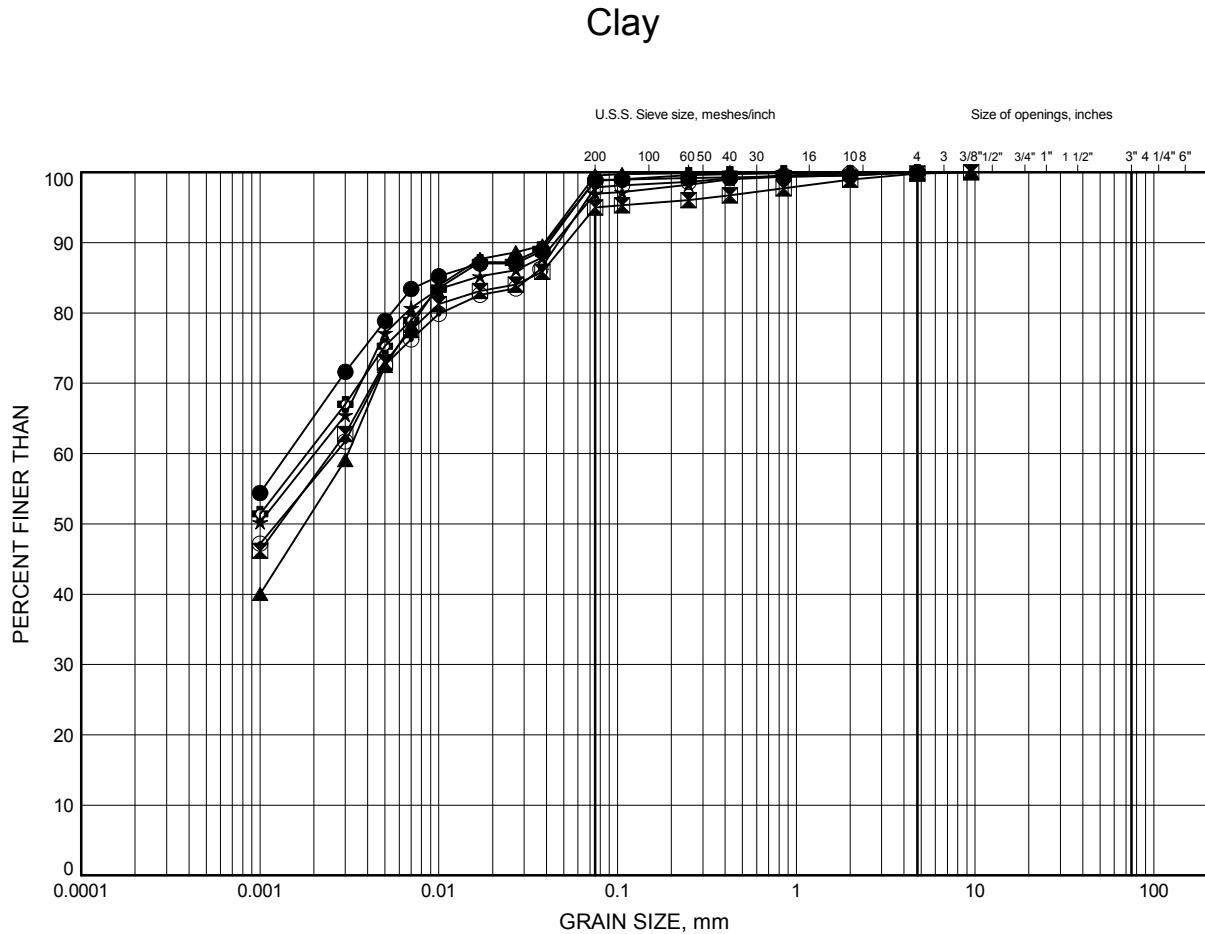


Prep'd JAG  
 Chkd. PC



NS - W Ramp, Highway 15/401 Interchange  
GRAIN SIZE DISTRIBUTION

FIGURE C2



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	9.45	103.28
⊠	16-1	12.50	100.23
▲	16-1	17.07	95.66
★	16-2	2.13	103.57
⊙	16-2	3.96	101.74
⊕	16-2	5.79	99.91

Date May 2016

GWP# 4059-11-00

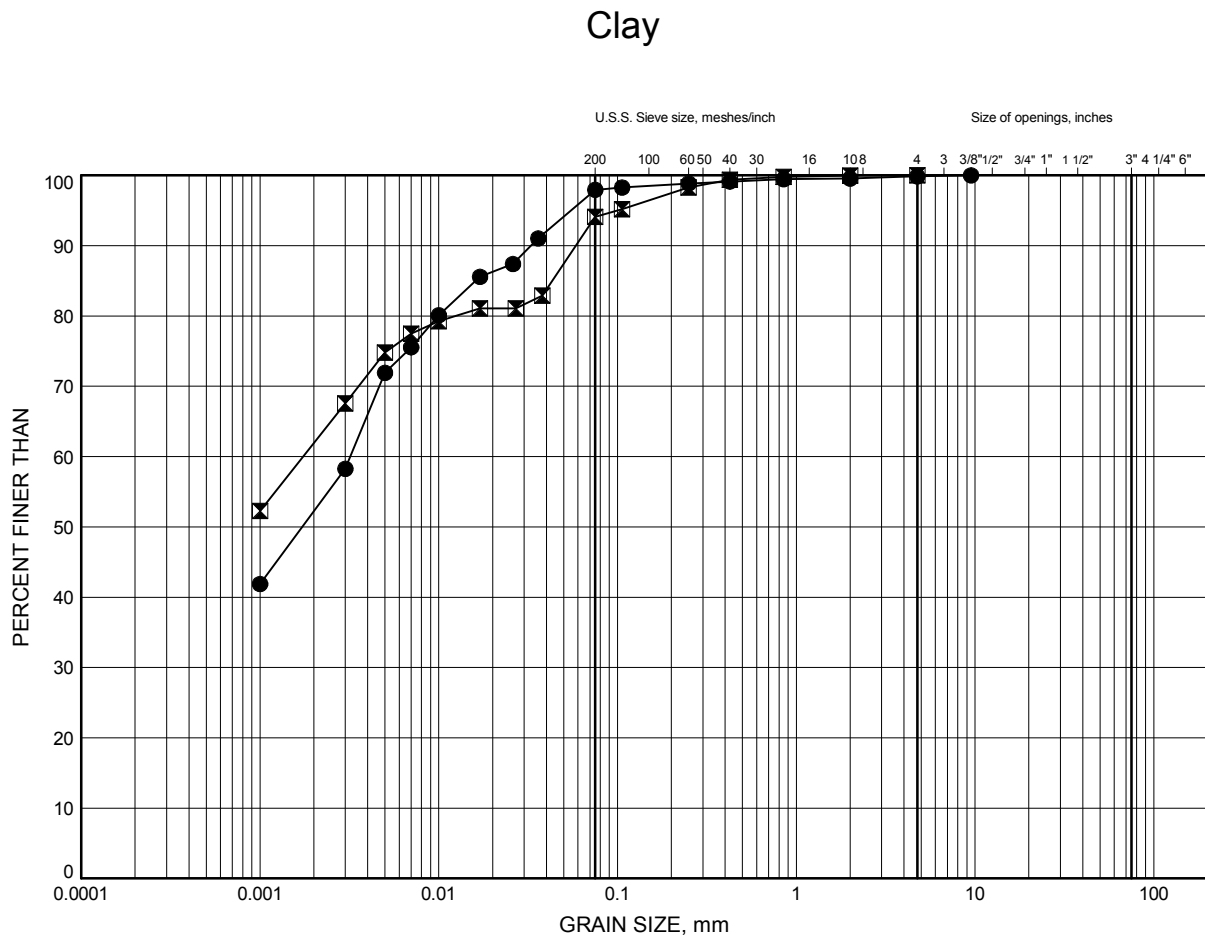


Prep'd JAG

Chkd. PC

NS - W Ramp, Highway 15/401 Interchange  
GRAIN SIZE DISTRIBUTION

FIGURE C3



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

### LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-2	8.23	97.47
⊠	16-3	1.52	104.72

Date May 2016  
GWP# 4059-11-00

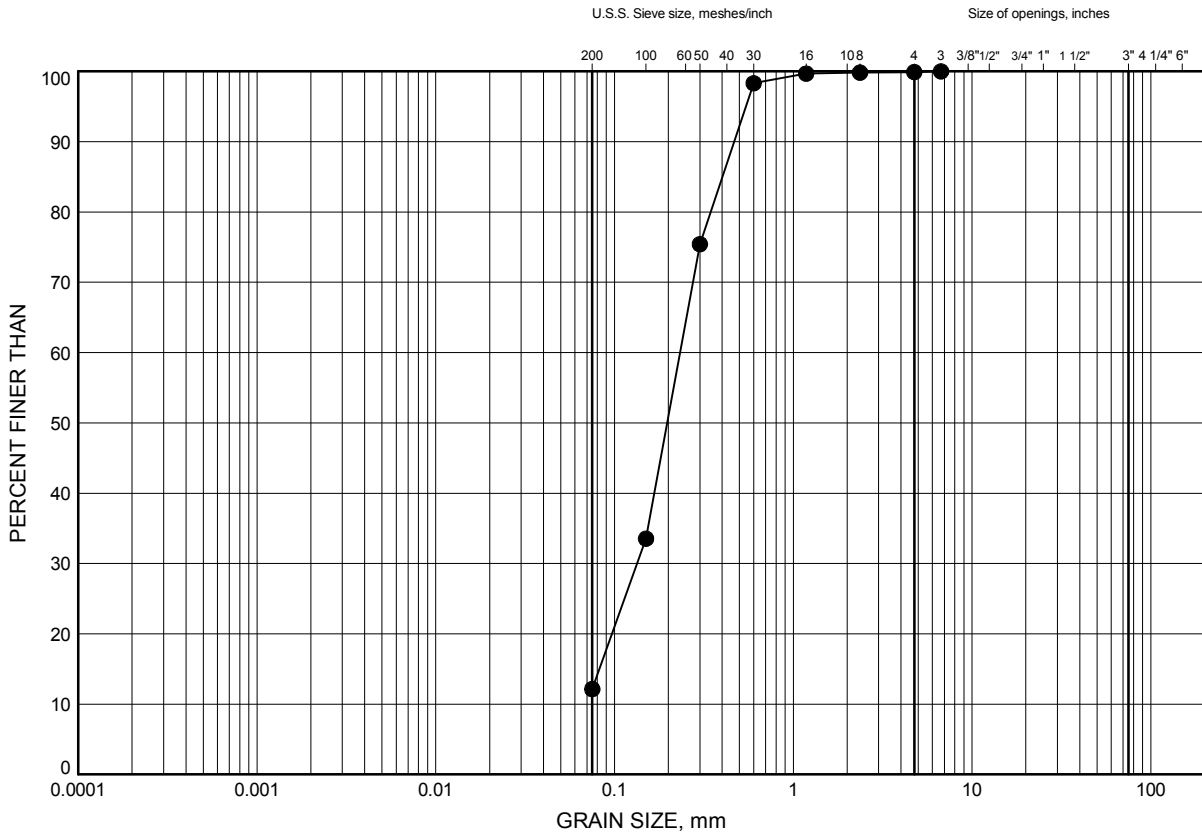


Prep'd JAG  
Chkd. PC

NS - W Ramp, Highway 15/401 Interchange  
GRAIN SIZE DISTRIBUTION

FIGURE C4

Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-3	3.75	102.49

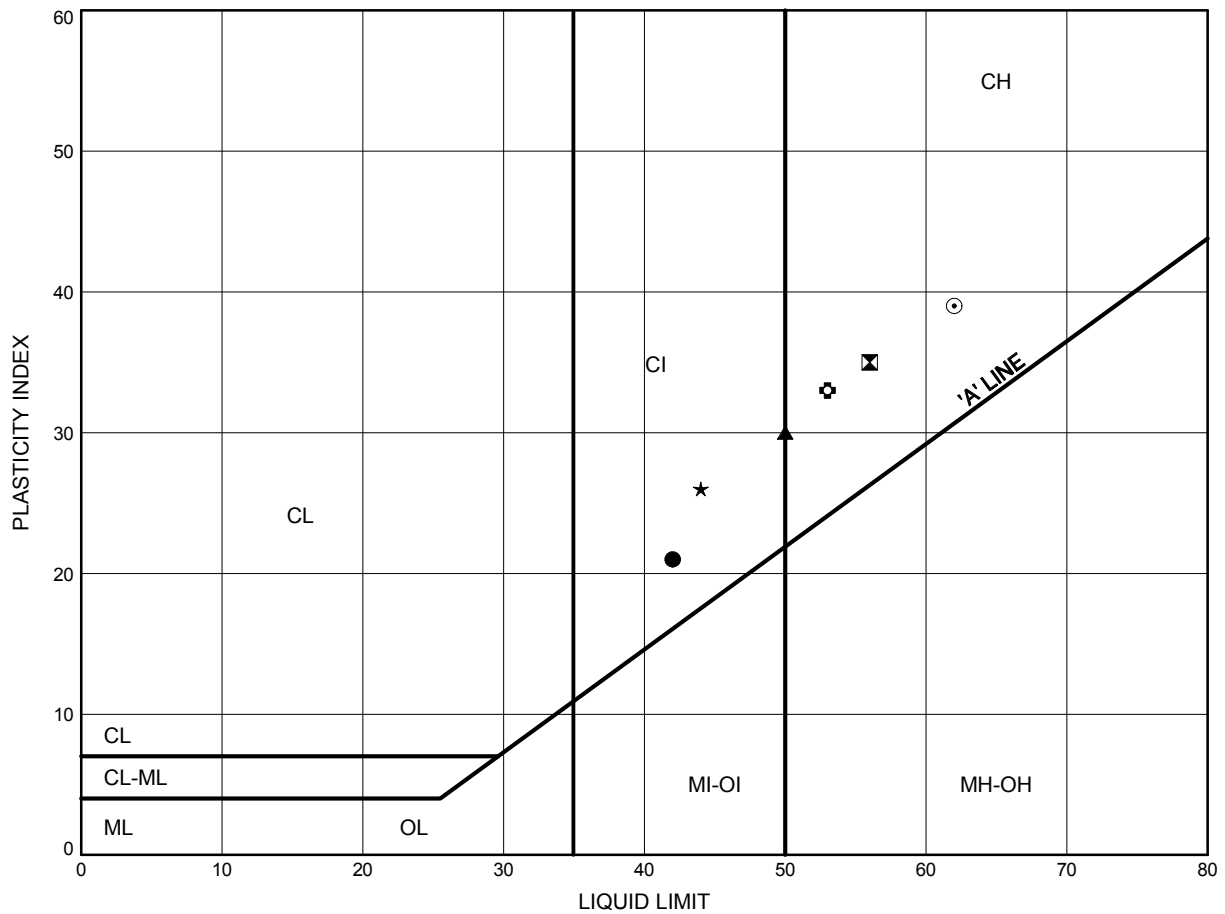
Date May 2016  
GWP# 4059-11-00



Prep'd JAG  
Chkd. PC

NS - W Ramp, Highway 15/401 Interchange  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C5



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-1	5.64	107.09
⊠	16-1	9.45	103.28
▲	16-1	12.50	100.23
★	16-1	17.07	95.66
⊙	16-2	2.13	103.57
⊕	16-2	3.96	101.74

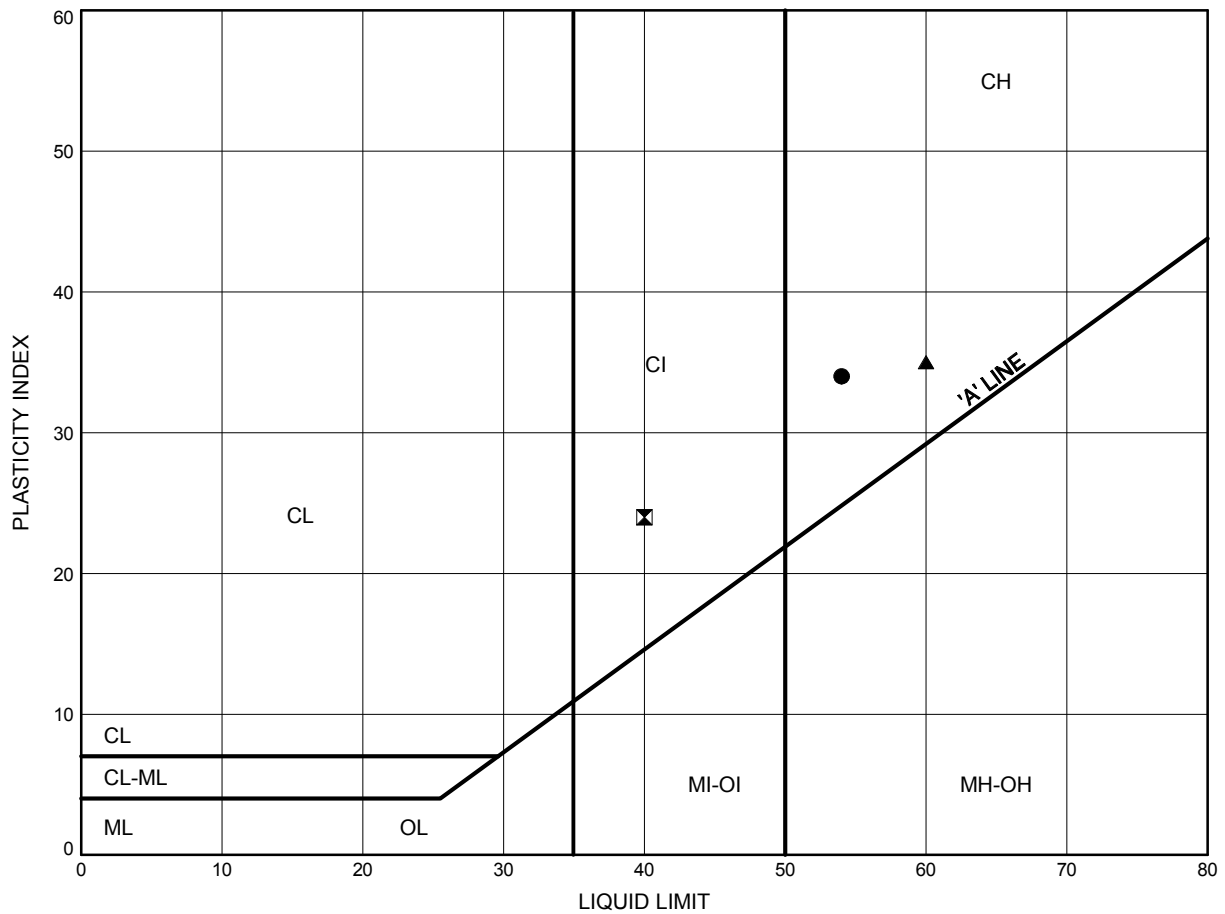
Date May 2016  
 GWP# 4059-11-00



Prep'd JAG  
 Chkd. PC

NS - W Ramp, Highway 15/401 Interchange  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C6



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-2	5.79	99.91
⊠	16-2	8.23	97.47
▲	16-3	1.52	104.72

Date May 2016

GWP# 4059-11-00



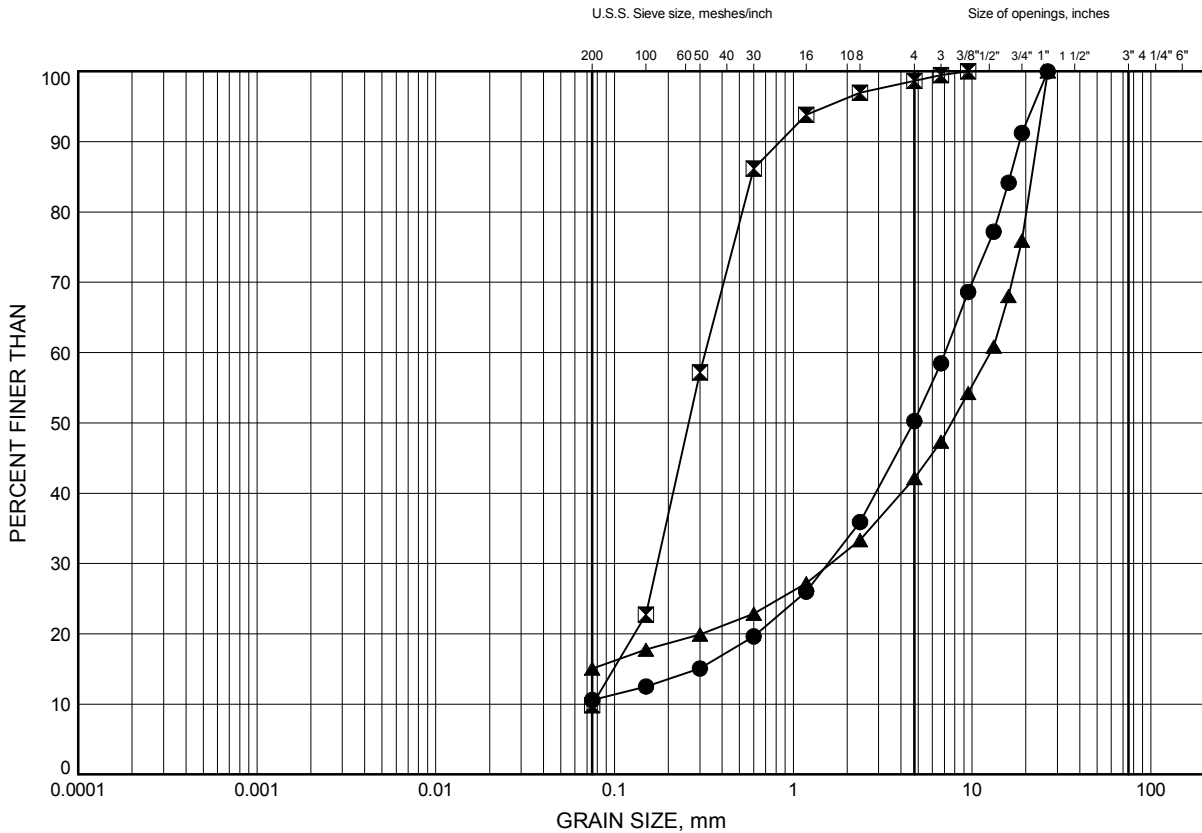
Prep'd JAG

Chkd. PC

W- NS Ramp, Highway 15/401 Interchange  
**GRAIN SIZE DISTRIBUTION**

FIGURE C7

**Granular and Embankment Fill**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-4	1.83	106.11
⊠	16-4	4.11	103.82
▲	16-4	7.16	100.77

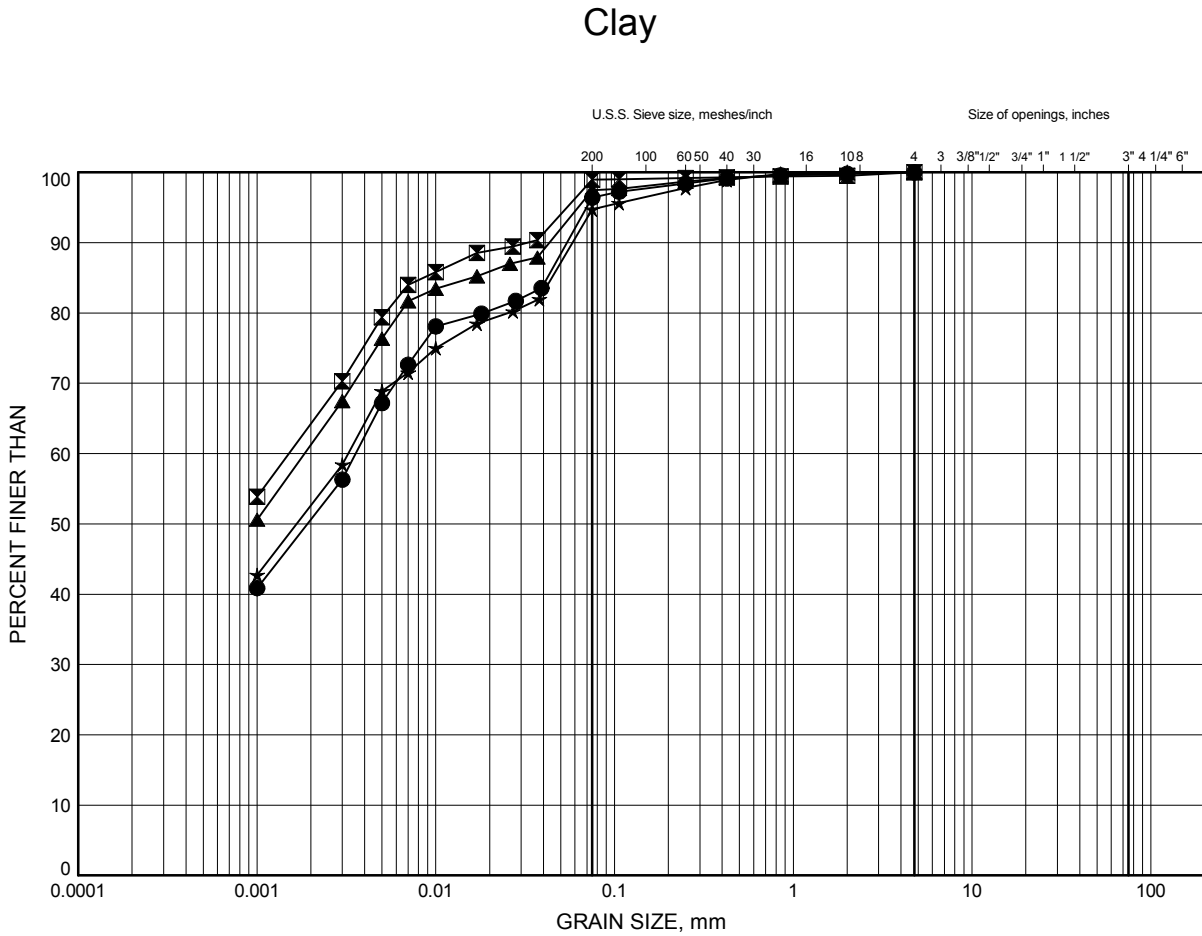
Date May 2016  
 GWP# 4059-11-00



Prep'd JAG  
 Chkd. PC

W- NS Ramp, Highway 15/401 Interchange  
GRAIN SIZE DISTRIBUTION

FIGURE C8



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-4	10.97	96.96
⊠	16-5	3.35	99.38
▲	16-6	2.74	95.18
★	16-7	0.91	96.97

Date May 2016

GWP# 4059-11-00



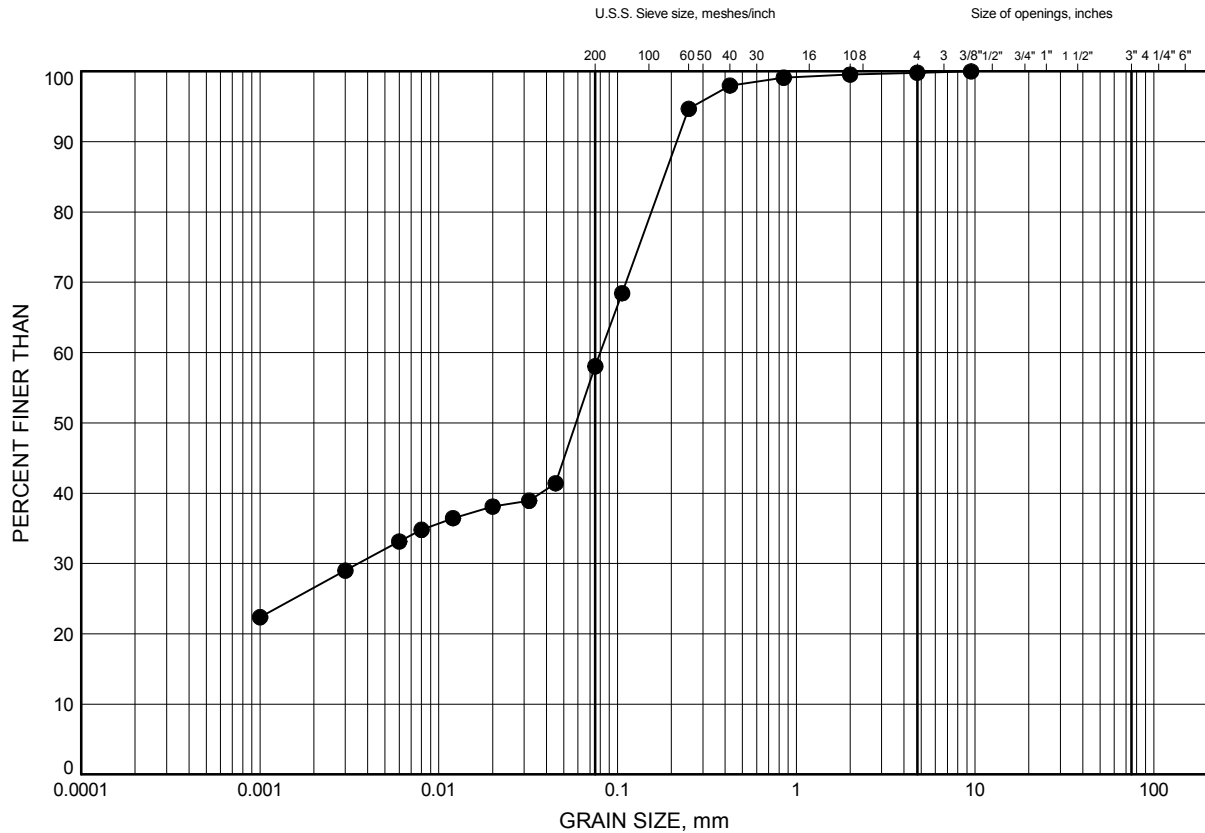
Prep'd JAG

Chkd. PC

W- NS Ramp, Highway 15/401 Interchange  
**GRAIN SIZE DISTRIBUTION**

FIGURE C9

**Sandy Silt**



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

**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-6	4.57	93.36

Date May 2016  
 GWP# 4059-11-00

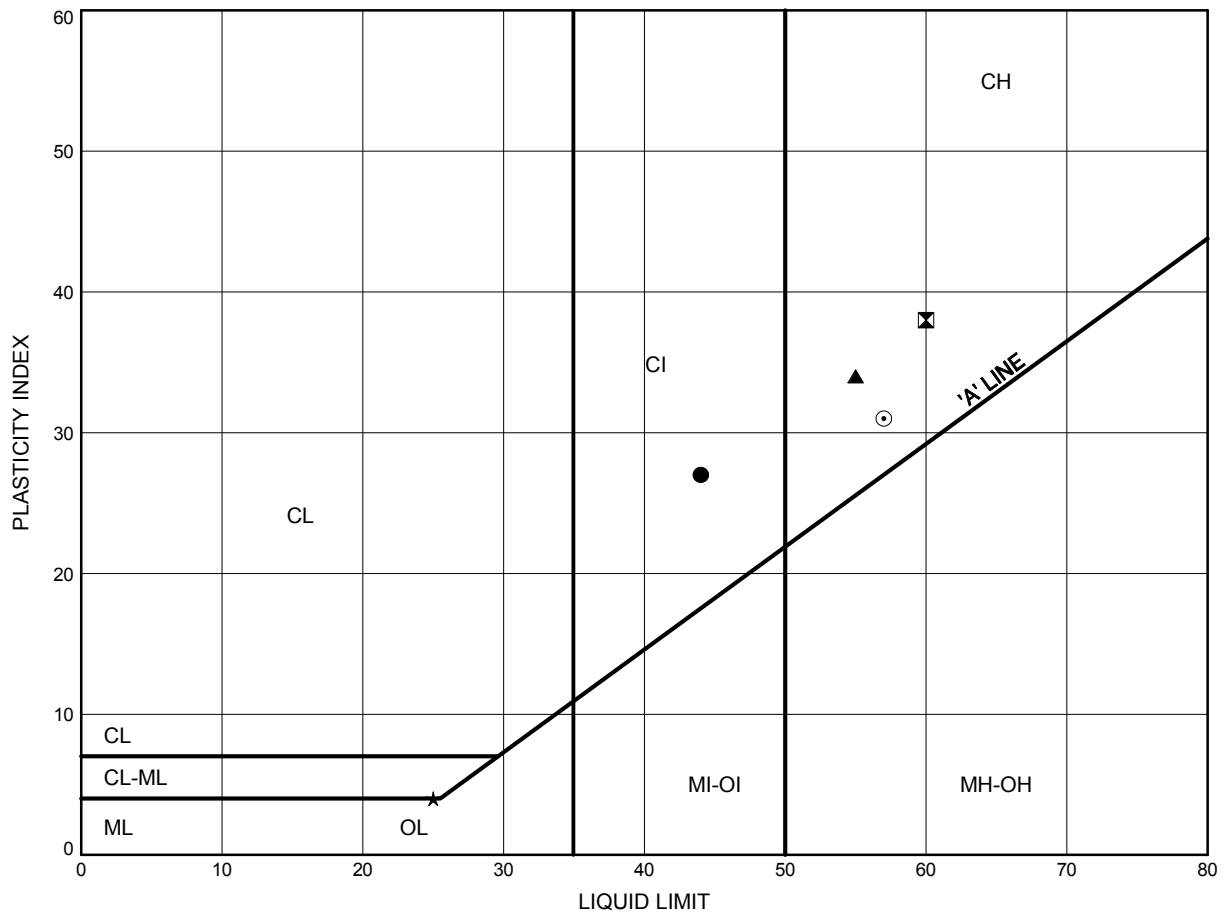


Prep'd JAG  
 Chkd. PC



W- NS Ramp, Highway 15/401 Interchange  
**ATTERBERG LIMITS TEST RESULTS**

FIGURE C10



**LEGEND**

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	16-4	10.97	96.96
⊠	16-5	3.35	99.38
▲	16-6	2.74	95.18
★	16-6	4.57	93.36
⊙	16-7	0.91	96.97

Date May 2016  
 GWP# 4059-11-00



Prep'd JAG  
 Chkd. PC

## **Appendix D**

### **Site Photographs**

**Photo 1: N/S-W Ramp – looking west towards Borehole 16-1**



**Photo 2: N/S-W Ramp north side slope– looking west**





**Photo 3: W-N/S Ramp – looking east towards Borehole 16-4**



**Photo 4: W-N/S Ramp side slope – looking east at Borehole 16-7**





**Photo 5: W-N/S Ramp side slope – looking west at Borehole 16-6**



**Photo 6: W-N/S Ramp side slope – looking west from crest of embankment**

