

**FOUNDATION INVESTIGATION REPORT
STRUCTURAL CULVERTS
HIGHWAY 69 FOUR-LANING
FROM THE SOUTH JUNCTION OF HIGHWAY 529 NORTHERLY 15 KM
G.W.P. 5076-06-00
SOUTH SECTION – HIGHWAY 529 TO NAISCOOT LAKE**

Geocres Number: 41H-130

Report to

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

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for the proposed structural culverts required along a section of the Highway 69 four-laning project extending from Highway 529 northerly approximately 3.8 km to north of Naiscoot Lake. Two of the culverts associated with this project are required along the proposed Naiscoot Access Road (existing Highway 69), located to the west of the proposed Highway 69.

The report is one of two reports addressing a larger section of the four-laning project extending from the south junction of Highway 529 northerly for 15 km in the Townships of Harrison and Wallbridge, Ontario. The report deals with the culverts in the south part of this section; the remaining culverts in the north part of the section are dealt with in a separate report.

The purpose of the investigation was to explore the subsurface conditions at the proposed culvert locations and, based on the data obtained, to provide record of borehole sheets, borehole location plans, stratigraphic profiles, laboratory test results, and a generalized description of the subsurface conditions at each location. This information provides a model of the anticipated geotechnical conditions influencing design and construction of the structural culverts.

Thurber carried out the investigation as a sub-consultant to MMM Group Limited (MMM) under the Ministry of Transportation Ontario (MTO) Agreement Number 5006-E-0030.

2 SITE DESCRIPTION

Highway 69 in the study section (Highway 529 northerly approximately 3.8 km to north of Naiscoot Lake) is currently a two lane undivided roadway. The proposed four-lane alignment will run roughly parallel to the existing alignment, with a new median centreline approximately 130 m west of the current alignment at the south project limit, before crossing to the east side and running approximately 70 m to the east. Both northbound and southbound lanes will be on new alignment

in this section. The existing Highway 69 will become Naiscoot Access Road as part of the four-laning project.

The roadway corridor typically has a rolling topography with frequent bedrock outcrops of generally low relief, separated by low-lying swamp areas, water bodies, and small streams. In general, the area is heavily wooded except in swamp areas.

The site lies within the physiographic region known as the Georgian Bay Fringe, characterized by very shallow soils and bare rock knobs and ridges. Where present, the overburden materials consist of sand, silt and clay. Recent organic deposits of peat and muck occur in abundance in bedrock hollows and valleys. The area is underlain by strongly foliated and highly to intermediately deformed rocks of Precambrian age, primarily migmatitic rocks and gneisses.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for the six (6) culverts in the south section were carried out in two phases. The first phase consisted of drilling and sampling eleven boreholes located off of the existing Highway 69 between February 11 and March 8, 2011. During the first phase of drilling one Dynamic Cone Penetration Test (DCPT) was performed from surface and a second DCPT was conducted at the base of one of the boreholes. The second phase of drilling was completed during June 2012 and consisted of two boreholes drilled on Highway 69 through the existing highway embankment. During the second phase of drilling a DCPT was conducted from the base of one of the boreholes. In addition to these boreholes and DCPTs specific to the culverts, four boreholes drilled in 2009 for the swamp crossings and high fill embankments investigation (BH10-02, BH11-02, BH13-07, and BH14-08) are included in this report for a total of seventeen boreholes and three DCPTs (one from surface and two from the base of a borehole).

The boreholes drilled at each culvert are listed in Table 3.1 along with additional information regarding the culvert location. In general, one borehole was located at each of the proposed culvert inlets, outlets, and mid points. The approximate borehole locations are shown on the Borehole Locations and Soil Strata drawings included in Appendices A through D.

The boreholes were advanced to depths of 1.1 m to 19.8 m (Elev. 191.4 to 179.0 m). The DCPT performed from surface extended to a depth of 13.1 m (Elev. 178.4 m). The two DCPTs conducted from the bottom of a borehole extended to depths of 12.5 m and 27.6 m (Elev. 179.0 and 172.3 m). All of the boreholes and DCPTs were terminated upon refusal on probable bedrock, except for boreholes C330-1 and C330-2 which were extended with a DCPT to refusal and borehole C332-2 which was advanced 1.2 m into bedrock to confirm the rock fill – bedrock interface.

The borehole locations were established by Thurber relative to culvert centreline staking by MMM Group Limited. Ground elevations at the borehole locations were approximated from survey data and detailed topographic plans provided by MMM Group Limited.

Table 3.1 – Summary of Culvert Locations and Corresponding Boreholes

Culvert	Site Number	Location		Boreholes/DCPTs	Appendix
		Station	Road/Direction		
313 314	44-600/C1 44-600/C2	19+303 19+299	Hwy 69 NBL Hwy 69 SBL	C313-1 to 3, C314-1 & 2, BH10-02, and BH11-02	A
317 318	44-603/C1 44-603/C2	19+830 19+830	Hwy 69 NBL Hwy 69 SBL	C317-1 & 2, C318-1, BH13-07, and BH14-08	B
330	44-601/C	11+890	Naiscoot Access Rd	C330-1 & 2, C330-2D and C314-2	C
332	44-602/C	12+357	Naiscoot Access Rd	C332-1 to 3	D

Prior to commencement of drilling, utility clearances were obtained for all borehole and DCPT locations.

Where accessible, a CME-45 track-mounted drill rig equipped with hollow stem augers was used to advance the boreholes. Wash-boring methods with casing and portable tripod were employed where drilling was conducted on ice. A truck-mounted drill rig was used for boreholes drilled on the existing Highway 69 platform. Hollow stem augers, HQ casing, and NQ coring techniques were used to advance these boreholes.

Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the fill and native soils. Where firm to soft cohesive soils were encountered, in situ vane shear testing was carried out to assess the undrained shear strength of soft to firm cohesive deposits.

Where practical, groundwater conditions were observed in the open boreholes during the drilling operations. Standpipe piezometers were installed in selected boreholes to monitor groundwater levels. The standpipe piezometers consisted of 19 mm diameter PVC pipe with a 1.5 m long slotted screen enclosed in filter sand. A bentonite seal was placed above the filter sand and the remainder of the borehole was backfilled with bentonite and/or cuttings to the ground surface. Boreholes without piezometer installations were backfilled with bentonite and/or auger cuttings upon completion. The piezometers installation details are summarized in Table 3.2 and are shown on the Record of Borehole sheets in Appendices A to D.

Table 3.2 – Piezometer Installation Details

Borehole	Piezometer Tip Depth/ Elevation (m)	Installation Details
C317-2	4.3 / 188.1	Piezometer with 1.5 m slotted screen installed, sand filter from 4.3 to 2.5 m, bentonite seal from 2.5 to 2.0 m, cuttings from 2.0 to 0.6 m, bentonite from 0.6 to 0.3 m, then cuttings to surface.
C330-2	9.1 / 182.4	Piezometer with 1.5 m slotted screen installed, sand filter from 9.5 to 7.3 m and bentonite from 7.3 m to ground surface.

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

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. The results of this testing are presented on the Record of Borehole sheets included in Appendices A to D.

Selected samples were also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of the testing program are summarized on the Record of Borehole sheets and figures included in Appendices A to D.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Details of the encountered soil stratigraphy are presented on the Record of Borehole sheets and the Borehole Locations and Soil Strata Drawings included in Appendices A to D of this report. A general description of the stratigraphy based on the conditions encountered in the boreholes is given in this section. However, the factual data presented in the borehole logs takes precedence over this general description and interpretation of the site conditions. It must be recognized that soil conditions may vary between and beyond borehole locations.

The specific conditions encountered at individual sites vary. Generalized descriptions of the individual strata at each culvert site are presented below.

5.1 Culverts 313 and 314 (Station 19+303 NBL and 19+299 SBL) (Appendix A)

General

This site consists of a pond. The site stratigraphy below the pond bottom generally consists of layers of silty clay and peat overlying sand and gravel at the eastern extent of

the site and a thin layer of peat overlying silty sand to sand and gravel at the western extent of the site. Probable bedrock was encountered below these overburden deposits.

Ice and Water

Ice and water were encountered at surface at all seven borehole locations. In general, the ice was approximately 0.3 m thick at the time of drilling. The depth of the ice and water ranged from 1.2 m to 1.6 m.

Peat

A thin layer of peat (25 to 50 mm) was encountered at the ground surface, below the ice and water in Boreholes C313-2, C314-1 and C314-2. The thickness of surficial peat material may vary between and beyond the borehole locations.

A thicker layer of peat was also encountered below a layer of silty clay in Boreholes C313-1 to 3, and BH10-02. This layer of peat was typically fibrous and had a dark brown colour. The peat contained trace sand at some locations.

The thickness of this buried layer of peat ranged from 0.6 m to 1.5 m and the lower boundary of this layer was encountered at depths of 1.3 m to 2.5 m below the pond bottom (Elev. 190.7 to 189.3 m).

SPT ‘N’ values recorded in the peat layer ranged from 0 to 2 blows for 0.3 m penetration, indicating a very soft to soft consistency.

Moisture contents of the peat ranged from 119 to 663%.

Silty Clay

Silty clay was encountered below the water or thin peat layer in five of the seven boreholes drilled along the proposed alignment of the culverts. In three of these boreholes, a second clay layer was encountered below an interlaying layer of peat. The clay layers ranged in thickness from 0.2 to 1.3 m, and the lower boundary of the lowest layers was encountered at depths of 1.6 to 5.2 m below the ice surface, 0.3 to 3.8 m below the pond bottom (Elev. 191.6 to 188.0 m).

SPT ‘N’ values recorded in the silty clay ranged from 0 to 4 blows for 0.3 m penetration, indicating a very soft to soft consistency. A SPT ‘N’ value of 50 blows for 0.125 m penetration was recorded in the silty clay in Borehole C313-2 at the silty clay-bedrock interface.

Moisture contents of the silty clay ranged from 22% to 76%.

Three samples of the silty clay underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure A1, Appendix A.

Gravel %	0
Sand %	18 to 21
Silt %	50 to 55
Clay %	27 to 29

Silt and Sand

A layer of silt and sand was encountered locally in Borehole C313-3, below the peat. The silt and sand was grey and contained trace clay.

The layer of silt and sand was 1.0 m thick with the lower boundary of this layer encountered at a depth of 2.3 m below the pond bottom (Elev. 189.7 m).

A SPT ‘N’ value of 7 blows for 0.3 m penetration was recorded in the silt and sand layer, indicating a loose relative density.

The moisture content of one sample of the silt and sand was measured to be 15%.

One sample of the silt and sand underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curve for this sample is plotted on Figure A2 of Appendix A.

Gravel %	0
Sand %	42
Silt %	54
Clay %	4

Sand

A layer of sand was encountered below the silty clay in Boreholes C314-1 and BH10-02, below the silt and sand in Borehole C313-3, below the thin peat layer in Borehole C314-2, and at ground surface (below the ice and water) in Borehole BH11-02. The sand was typically grey and contained trace silt to silty, trace gravel to gravelly, and trace clay.

The thickness of the sand layer ranged from 0.5 to 1.3 m, with the lower boundary of the sand layer encountered at depths of 0.8 to 3.7 m below the pond bottom (Elev. 191.1 to 188.0 m).

SPT ‘N’ values recorded in the sand layer ranged from 3 to 17 blows for 0.3 m penetration, indicating a very loose to compact relative density. Higher ‘N’ values were also recorded in the sand layer upon refusal on probable bedrock and are not indicative of the relative density of the sand.

Natural moisture contents of the sand ranged from 14 to 43%. The higher moisture contents (> 23%) were measured in samples collected just below the pond bottom and may reflect an organic component.

One sample of the sand underwent laboratory grain size analysis testing, the results of which are summarized below. These results are also presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curve for this sample is plotted on Figure A3 of Appendix A.

Gravel %	5
Sand %	73
Silt %	20
Clay %	2

Sand and Gravel

A layer of sand and gravel was encountered below the lower layer of silty clay in Borehole C313-1 and below the sand in Borehole C314-2. The sand and gravel was brown to grey and contained trace silt as well as occasional cobbles.

The sand and gravel layer was 4.2 m thick in Borehole C313-1, with the lower boundary of this layer encountered at a depth of 8.0 m below the pond bottom (Elev. 183.8). In Borehole C314-2, the sand and gravel layer was 0.8 m thick with the lower boundary at a depth of 2.2 m below the pond bottom (Elev. 189.4).

SPT ‘N’ values recorded in the sand and gravel generally ranged from 7 to 9 blows for 0.3 m penetration, indicating a loose relative density. ‘N’ values of greater than 50 blows for less than 0.3 m penetration were also recorded in the sand and gravel layer at refusal on probable bedrock.

Natural moisture contents of the sand and gravel ranged from 9 to 15%.

Two samples of the sand and gravel underwent laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the Record of Borehole sheets included in Appendix A. The grain size distribution curves for these samples are plotted on Figure A4 of Appendix A.

Gravel %	39 to 53
Sand %	40 to 55
Silt and Clay %	6 to 7

Bedrock

The boreholes were terminated at depths ranging from 0.8 m to 8.0 m below the pond bottom (Elev. 191.1 to 183.8 m) upon refusal on probable bedrock. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.1.

Table 5.1 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Pond Bottom (m)	Elevation (m)
C313-1	8.0	183.8
C313-2	3.4	188.4
BH10-02	3.7	188.0
C313-3	2.8	189.2
C314-1	0.8	191.1
BH11-02	1.1	190.6
C314-2	2.2	189.4

Groundwater Conditions

Water levels were not observed in the open boreholes as water was introduced into the boreholes during the drilling process.

The ice surface was at Elevation 193.2 m at the time of drilling. The water level in the pond will fluctuate subject to seasonal variations, rainfall patterns, and possible beaver dams.

5.2 Culverts 317 and 318 (Station 19+830 NBL and SBL) (Appendix B)

General

The stratigraphy at this site generally consists of peat and/or organics overlying silty clay and silty sand to sand, underlain by probable bedrock. At one borehole location (C317-1) no silty clay was encountered and at one borehole location (C317-2) no sand was encountered.

Peat and Organics

A layer of fibrous peat and/or organics was encountered at surface in all five boreholes. This layer was dark brown to black and occasionally contained trace sand.

The thickness of the surficial peat/organic layer ranged from 0.1 m to 0.3 m.

A natural moisture content of 91% was measured in one sample.

The thickness of peat and organics may vary between and beyond the borehole locations.

Silty Clay

A layer of silty clay was encountered below the peat in four of the boreholes; no silty clay was encountered in borehole C317-1. The silty clay was brown to grey and contained trace sand with occasional sandy zones and occasional sand seams.

The thickness of the silty clay layer ranged from 1.4 m to 4.1 with the lower boundary of the silty clay encountered at depths of 1.5 m to 4.3 m (Elev. 191.2 to 188.1 m).

SPT ‘N’ values recorded in the silty clay layer ranged from 0 to 11 blows for 0.3 m penetration, indicating a very soft to stiff consistency. Generally, the ‘N’ value was in the range of 3 to 11 blows for 0.3 m penetration (soft to stiff). The undrained shear strength of the silty clay determined by an in situ vane shear strength test in Borehole C317-2 was 50 kPa (firm to stiff).

The moisture content of samples of the silty clay ranged from 20% to 53%.

Five samples of the silty clay underwent laboratory grain size analysis testing. Four of these samples also underwent Atterberg Limits testing. The results of these tests are summarized on the Record of Borehole sheets included in Appendix B and are presented below. These results are also plotted on Figures B1 and B3, Appendix B.

Gravel %	0
Sand %	3 to 22
Silt %	40 to 57
Clay %	24 to 56
Liquid Limit	33 to 58
Plastic Limit	16 to 22

The results of the Atterberg Limits tests indicate that the silty clay ranges from low plastic to high plastic with group symbol CL to CH.

Silty Sand to Sand

A layer of silty sand to sand was encountered directly below the peat/organics in Borehole C317-1 and below the silty clay layer in Boreholes BH13-07, BH14-08, and C318-1. The silty sand to sand is brown to grey and contains trace gravel, trace to some clay, and occasional cobbles.

The thickness of the sand layer ranged from 0.2 m to 1.4 m with the lower boundary of the silty sand to sand layer encountered at depths of 1.2 m to 4.8 m (Elev. 191.4 to 187.1 m).

SPT ‘N’ values recorded in the silty sand to sand ranged from 53 blows for 0.3 m penetration to 50 blows for 0.075 m penetration. However, all of the ‘N’ values were recorded at borehole refusal upon probable bedrock and are therefore not representative of the denseness of the silty sand to sand layer.

Natural moisture contents of the silty sand to sand ranged from 15 to 25%.

One sample of the silty sand to sand underwent laboratory grain size analysis testing. The results of this test are summarized below and are presented on the Record of Borehole sheets included in Appendix B. The grain size distribution curve for this sample is plotted on Figure B2 of Appendix B.

Gravel %	6
Sand %	61
Silt %	23
Clay %	10

Bedrock

The boreholes were terminated at depths ranging from 1.2 m to 4.8 m (Elev. 191.4 to 187.1 m) upon refusal on probable bedrock. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.2.

Table 5.2 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C317-1	1.2	191.4
BH13-07	1.8	190.9
C317-2	4.3	188.1
BH14-08	4.8	187.1
C318-1	2.4	190.5

Groundwater Conditions

Water levels were observed in the open boreholes upon completion of drilling. A standpipe piezometer was installed in Borehole C317-2 to monitor water levels after completion of drilling. The water levels observed in the boreholes upon completion of drilling and subsequently measured in the piezometer are summarized in Table 5.3.

Table 5.3 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
C317-1	Feb. 11, 2011	0.9	191.8	Open borehole
BH13-07	Feb. 12, 2009	0.5	192.2	Open borehole
C317-2	Feb. 22, 2011	0.0	192.4	Piezometer
	Mar. 1, 2011	0.0	192.4	Piezometer
	Mar. 13, 2011	0.0	192.4	Piezometer
	Apr. 27, 2011	0.1	192.3	Piezometer
BH14-08	Feb. 12, 2009	0.0	191.9	Open borehole
C318-1	Feb. 11, 2011	0.6	192.3	Open borehole

The above values 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 the spring snowmelt or after periods of heavy rainfall.

5.3 Culvert 330 (Station 11+890 Naiscoot Access Rd) (Appendix C)

Pavement Structure

Pavement structure consisting of a thin layer of asphalt overlying granular fill was encountered in Borehole C330-1, which was drilled through the existing highway shoulder. The asphalt was 40 mm thick.

The granular fill underlying the asphalt consisted of dark brown sand containing some gravel. The sand fill was 1.0 m thick with the lower boundary of the sand fill encountered at Elevation 198.9 m. The moisture content of one sample of the sand fill was measured to be 2%.

Rock Fill

Rock fill was encountered below the pavement structure in Borehole C330-1. The rock fill consisted of cobble and boulder sized pieces with some gravel. Coring techniques were required to advance the borehole through the rock fill.

The rock fill was 9.2 m thick, with the lower boundary of the rock fill encountered at a depth of 10.3 m (Elev. 189.6 m).

Ice and Water

Ice and water were encountered at surface at the location of Borehole C314-2. The ice was 0.3 m thick at the time of drilling. The ground surface was encountered 1.6 m below the top of ice (Elev. 191.6 m).

Peat

A layer of peat was encountered surficially in Borehole C330-2 and at surface (below the water) in Borehole C314-2. At Borehole C330-2 the peat was 0.7 m thick and at Borehole C314-2 the peat was 50 mm thick. The thickness of peat may vary between and beyond the borehole locations.

A SPT ‘N’ value of 4 blows for 0.3 m penetration was recorded in the peat, indicating a soft consistency.

Silt and Sand

A layer of silt and sand was encountered locally in Borehole C330-2, below the peat. The silt and sand was brown and contained trace gravel and trace clay.

The silt and sand layer was 1.1 m thick, with the lower boundary of the silt and sand encountered at a depth of 1.8 m (Elev. 189.7).

SPT ‘N’ values recorded in the silt and sand layer ranged from 18 to 25 blows for 0.3 m penetration, indicating a compact relative density.

The moisture content of samples of the silt and sand ranged from 8 to 19%.

One sample of the silt and sand was selected for laboratory grain size analysis testing, the results of which are summarized below. The grain size distribution curve for this sample is plotted on Figure C1, Appendix C.

Gravel %	2
Sand %	41
Silt %	54
Clay %	3

Sand

A layer of brown sand was encountered below the sand and gravel layer in Borehole C330-1 and below the silt and sand layer in Borehole C330-2. The sand was brown and contained trace to some gravel and trace to some silt and clay. A layer of grey sand containing some silt and trace gravel was encountered below the thin layer of peat in Borehole C314-2.

The sand encountered in Borehole C314-2 was 1.3 m thick with the lower boundary of the sand encountered at a depth of 3.0 m below the ice level (Elev. 190.2). The sand encountered in Boreholes C330-1 and C330-2 was not fully penetrated and the sampled boreholes were terminated at depths of 19.8 m and 11.3 m, respectively (Elev. 180.1 and 180.2).

SPT ‘N’ values recorded in the sand layer ranged from 0 to 33 blows for 0.3 m penetration, indicating a variable relative density ranging from very loose to dense. In general, the sand had a loose to compact relative density (‘N’ values of 4 to 28).

Moisture contents of samples of the sand typically ranged from 15 to 23%. A moisture content of 40% was measured in a sample of sand collected from just below the water in Borehole C314-2.

Four samples of the sand underwent laboratory grain size analysis testing. The results of these tests are summarized below and are presented on the Record of Borehole sheets included in Appendix C. The grain size distribution curves for these samples are plotted on Figure C2 of Appendix C.

Gravel %	0 to 5
Sand %	73 to 97
Silt and Clay %	3 to 22

Sand and Gravel

A layer of sand and gravel was encountered below the sand layer in Borehole C314-2 and below the rock fill in Borehole C330-1. The sand and gravel was brown and contained trace to some silt.

The thickness of the sand and gravel layer in Borehole C314-2 was 0.8 m, with the lower boundary of this layer encountered at a depth of 3.8 m below the ice surface (Elev. 189.4 m). In Borehole C330-1, the sand and gravel layer was 1.6 m thick with the lower boundary encountered at a depth of 11.9 m below ground surface (Elev. 188.0 m).

SPT ‘N’ values recorded in the sand and gravel in Borehole C330-1 ranged from 3 to 7 blows for 0.3 m penetration, indicating a very loose to loose relative density. In Borehole C314-2, a SPT ‘N’ value of 61 blows for 0.275 m penetration (very dense) was recorded near refusal on probable bedrock.

The moisture content of samples of the sand and gravel ranged from 9 to 10%.

One sample of the sand and gravel underwent laboratory grain size analysis testing. The results of this test are summarized below and are presented on the Record of Borehole sheets included in Appendix C. The grain size distribution curve for this sample is plotted on Figure C3 of Appendix C.

Gravel %	53
Sand %	40
Silt and Clay %	7

Bedrock

Borehole C314-2 was terminated upon refusal on probable bedrock. Boreholes C330-1 and C330-2 were terminated within the sand layer and a DCPT was performed from the bottom of each of these boreholes to refusal on probable bedrock. A DCPT was also conducted 3 m west of Borehole C330-2 (designated C330-2D). The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.4.

Table 5.4 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C314-2	2.2	189.4
C330-1	27.6	172.3
C330-2	12.5	179.0
C330-2D	13.1	178.4

Groundwater Conditions

Water levels were not observed in the open boreholes upon completion of drilling since water was introduced into the boreholes during the drilling process. One piezometer was installed at this site, in Borehole C330-2, with a 1.5 m long screen encased with filter sand. The water levels observed in the piezometer are summarized in Table 5.5.

Table 5.5 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
C330-2	Mar. 13, 2011	0.0	191.5	Piezometer
	Apr. 27, 2011	0.5	191.0	Piezometer

The above values are short-term observations. The surface water depth and depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

**5.4 Culvert 332 (Station 12+357, Naiscoot Access Rd)
 (Appendix D)**

General

The stratigraphy encountered at this site generally consists of peat or organics overlying deposits of silty clay and sand overlying bedrock. At the existing highway embankment, the stratigraphy consists of pavement structure overlying rock fill overlying bedrock.

Pavement Structure

Pavement structure consisting of a thin layer of asphalt overlying granular fill was encountered in Borehole C332-2, which was drilled through the existing highway shoulder. The asphalt was 50 mm thick.

The granular fill consisted of brown gravelly sand containing some silt. The sand fill was 1.1 m thick with the lower boundary of the sand fill encountered at Elevation 196.1 m. The moisture content of one sample of the sand fill was measured to be 4%.

One sample of the granular fill underwent laboratory grain size analysis testing. The results of this testing are presented on the corresponding Record of Borehole sheets included in Appendix D and are plotted on Figure D1, Appendix D. The laboratory results are summarized as follows:

Gravel %	29
Sand %	59
Silt and Clay %	12

Rock Fill

Rock fill was encountered below the pavement structure in Borehole C332-2. The rock fill consisted of cobble and boulder sized pieces with some gravel and sand. Coring techniques were required to advance the borehole through the rock fill.

The rock fill was 6.4 m thick, with the lower boundary of the rock fill encountered at a depth of 7.5 m (Elev. 189.7 m).

Peat and Organics

A layer of peat 0.8 m thick was encountered at surface in Borehole C332-3 and a layer of organics (200 mm) was encountered at surface in Borehole C332-1. The thickness of peat and organics may vary between and beyond the borehole locations.

Silty Clay

A layer of silty clay was encountered below the organics in Borehole C332-1, below the rock fill in Borehole C332-2, and below a layer of native sand in Borehole C332-3. The silty clay was brown and generally contained trace sand.

The thickness of the silty clay ranged from 0.1 m to 1.9 m, with the lower boundary of the silty clay encountered at depths of 2.1 m to 7.6 m (Elev. 189.8 to 189.1 m). The layer of silty clay was the thinnest in Borehole C332-2, where it was encountered below the rock fill.

SPT ‘N’ values recorded in the silty clay ranged from 5 to 9 blows for 0.3 m penetration, indicating a firm to stiff consistency. A SPT ‘N’ value of 50 blows for 0.1 m penetration was also recorded in the silty clay in Borehole C332-3 at the silty clay – bedrock interface.

The moisture content of samples of the silty clay ranged from 25% to 37%.

Two samples of the silty clay underwent laboratory grain size analysis and Atterberg Limits testing, the results of which are summarized below. The results of these tests are also summarized on the Record of Borehole sheets included in Appendix D and plotted on Figures D2 and D3, Appendix D.

Gravel %	0
Sand %	5
Silt %	42 to 48
Clay %	47 to 53
Liquid Limit	48 to 52
Plastic Limit	21

The results of the Atterberg Limits tests indicate that the silty clay is medium to high plastic with group symbol CI-CH.

Sand

A layer of brown sand containing some silt to silty was encountered below the silty clay in Borehole C332-1 and below the peat in Borehole C332-3.

The thickness of the sand layer ranged from 0.1 m to 0.6 m, with the lower boundary of the sand layer encountered at depths of 1.4 m to 2.2 m (Elev. 190.2 to 189.7 m). Borehole C332-1 was terminated below the sand layer upon refusal on probable bedrock.

A SPT ‘N’ value of 4 blows for 0.3 m penetration was recorded in the sand in Borehole C332-3, indicating a very loose to loose relative density.

The moisture content of one sand sample was measured to be 19%.

Bedrock

Boreholes C332-1 and C332-3 were terminated upon refusal on probable bedrock and Borehole C332-2 was advanced 1.2 m into the bedrock to confirm the transition from rock fill to bedrock. The depths and elevations of the probable bedrock surface at the borehole locations are summarized in Table 5.6.

Table 5.6 – Depth/Elevation of Probable Bedrock

Borehole	Probable Bedrock Surface	
	Depth below Ground Surface (m)	Elevation (m)
C332-1	2.2	189.7
C332-2	7.6	189.6
C332-3	2.5	189.1

Groundwater Conditions

Water levels were observed in the open boreholes upon completion of drilling, where possible. The water levels observed during drilling are summarized in Table 5.7.

Table 5.7 – Water Level Observations

Borehole	Date	Water Level		Comment
		Depth (m)	Elev. (m)	
C332-1	Feb. 2, 2011	0.0	191.9	Open borehole
C332-3	Feb. 2, 2011	0.1	191.5	Open borehole

The above values are short-term observations. The surface water depth and depths to groundwater will vary depending upon seasonal fluctuations, rainfall patterns and swamp outlet conditions such as presented by beaver dams. In particular, water levels may be higher after the spring snowmelt or periods of heavy rainfall.

6 MISCELLANEOUS

MMM Group survey personnel staked the centreline alignment of the culverts prior to drilling of the boreholes. The borehole locations were established by measuring offset distances from the centreline staking. The approximate ground surface elevations at the boreholes were interpreted from the survey data and contour plan provided by MMM Group Limited.

Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario supplied and operated the drilling and sampling equipment for the field program.

Supervision of the field activities, including obtaining utility clearances, was carried out by Ms. Eckie Siu, Mr. Stephane Loranger, Mr. Jason Mei and Mr. Will Ball of Thurber.

Supervision of the field program was carried out by Ms. Lindsey Blaine, E.I.T. and Ms. Rocío Palomeque Reyna, P. Eng. Interpretation of the field data and preparation of the report was performed by Ms. Lindsey Blaine, E.I.T. and Mr. Murray Anderson, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.

Lindsey Blaine, E.I.T.
Project Manager



Murray R. Anderson, P.Eng.
Senior Geotechnical Engineer



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

Appendix A

Culverts 313 and 314

**Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings**

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level
 C_{pen} Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

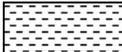
ROCK WEATHERING CLASSIFICATION

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

DISCONTINUITY SPACING

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

SYMBOLS

	CLAYSTONE
	SILTSTONE
	SANDSTONE
	COAL
	BEDROCK

STRENGTH CLASSIFICATION

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

TERMS

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

RECORD OF BOREHOLE No C313-1

2 OF 2

METRIC

GWP# 5076-06-00 LOCATION N 5 055 317.8 E 235 075.4 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.02.26 - 2011.02.26 CHECKED BY RPR

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

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C313-2

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 311.2 E 235 056.3 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.02.26 - 2011.02.26 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
193.2	Pond Surface														
0.0	ICE: (300mm)														
192.9															
0.3	WATER														
191.8															
191.4	PEAT: (25mm)														
1.5	Silty CLAY, trace sand Very Soft Grey		1	SS	0										
190.6			2	SS	2										
2.6	PEAT, trace sand Very Soft Dark Brown Wet														
189.5			3	SS	1										
3.7	Silty CLAY, some sand Very Soft Grey Wet		4	SS	2										
188.4			5	SS	50/										
4.8	END OF BOREHOLE AT 4.8m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS TO SURFACE.				0.125										

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C313-3

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 304.7 E 235 037.1 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.02.25 - 2011.02.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
193.2	Pond Surface														
0.0	ICE: (300mm)														
192.9															
0.3	WATER														
192.0															
1.2	Silty CLAY, some sand Soft Grey		1	SS	2										
191.4															
191.8	SAND														
1.9	PEAT, trace sand Very Soft Dark Brown Wet		2	SS	2										
190.7															
2.5	SILT and SAND, trace clay Loose Grey Wet		3	SS	7									0 42 54 4	
189.7															
3.5	SAND, some gravel to gravelly Compact Grey Wet		4	SS	17										
189.2															
4.0	END OF BOREHOLE AT 4.0m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS TO SURFACE.														

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C314-1

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 298.7 E 235 019.2 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.02.25 - 2011.02.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE									
193.2	Pond Surface																
0.0	ICE: (300mm)																
192.9																	
0.3	WATER																
191.9																	
191.8	PEAT: (50mm)																
191.6	Silty CLAY, trace sand, occasional roots and rootlets		1	SS	4												
1.6	Soft Grey																
191.1	SAND, fine grained		2	SC	50/												
2.1	Loose Grey Wet				0.025												
END OF BOREHOLE AT 2.1m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH AUGER CUTTINGS TO SURFACE.																	

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

RECORD OF BOREHOLE No C314-2

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 291.4 E 234 998.4 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.02.25 - 2011.02.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
193.2	Pond Surface														
0.0	ICE: (300mm)														
192.9															
0.3	WATER														
191.6															
191.8	PEAT: (50mm)														
1.7	SAND, some silt, trace gravel Loose to Compact Grey Wet		1	SS	7										
			2	SS	16									5 73 20 2	
190.2															
3.0	SAND and GRAVEL, trace silt Very Dense Brown Wet		3	SS	61/ 0.275									53 40 7 (SI+CL)	
189.4															
3.8	END OF BOREHOLE AT 3.8m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS TO SURFACE.														

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No BH10-02

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION Harrison Twp., Station 19+301 C/L, NBL ORIGINATED BY WB
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2009.03.01 - 2009.03.01 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa 20 40 60 80 100							
193.2	Pond Surface														
0.0	ICE and WATER: (1500mm)						193								
191.7							192								
1.5	Silty CLAY, some sand, some peat Very Soft Grey		1	SS	0		191								
191.0							191								
2.2	PEAT, fibrous Very Soft Brown Wet		2	SS	0		190						310		
							190						663		
189.5							189							0 18 55 27	
3.7	Silty CLAY, some sand Very Soft Grey		4	SS	0		189								
188.7							189								
4.5	SAND, trace gravel, trace silt Loose Grey Wet		5	SS	5		188								
188.0							188								
5.2	END OF BOREHOLE (SAMPLER BOUNCING) AT 5.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH HOLEPLUG AND AUGER CUTTINGS UPON COMPLETION.		6	SS	50/ .000										

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No BH11-02

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION Harrison Twp., Station 19+301 C/L, SBL ORIGINATED BY WB
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2009.03.04 - 2009.03.04 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80					
193.2	Pond Surface															
0.0	ICE and WATER: (1500mm)															
191.7	Silty SAND, occasional peat and roots Very Loose Brown Wet		1	SS	3											
1.5			2	SS	115/											
190.6	END OF BOREHOLE (SAMPLER BOUNCING) AT 2.6m UPON AUGER REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH HOLEPLUG AND AUGER CUTTINGS UPON COMPLETION.															
2.6																

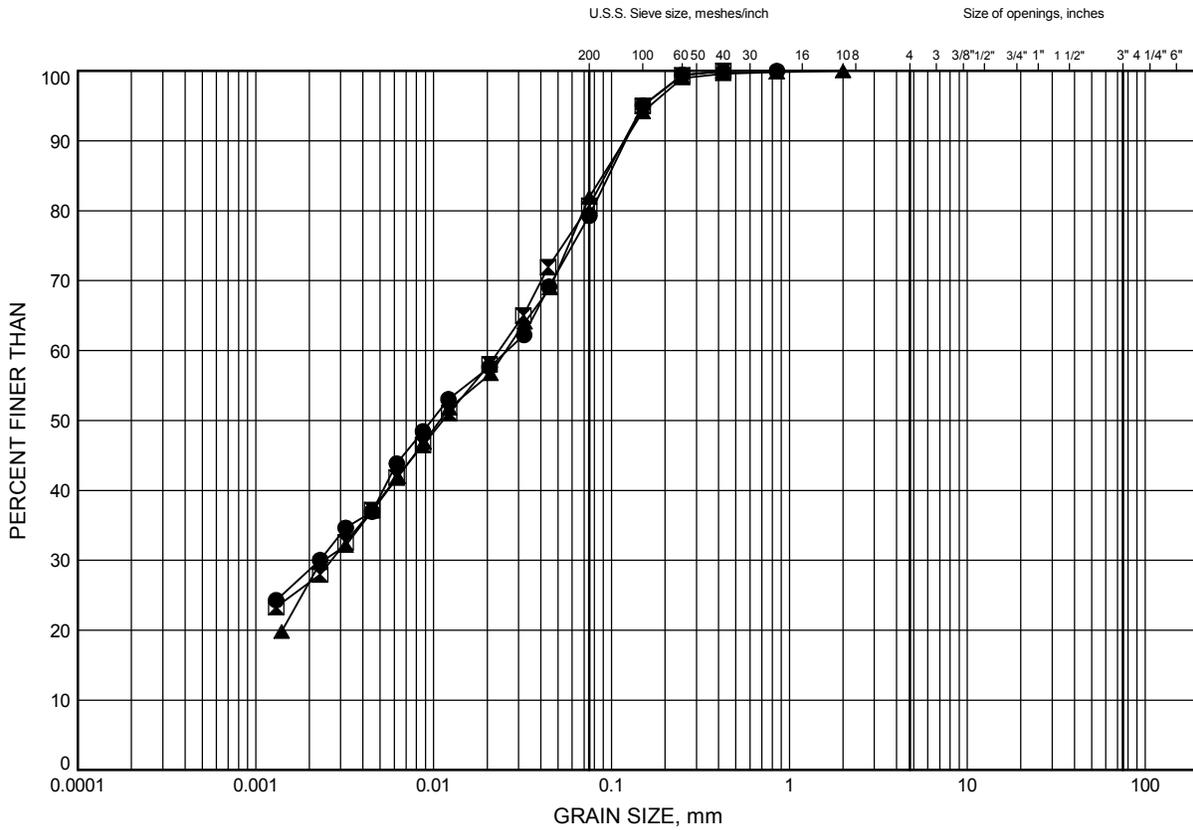
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE A1

Silty Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C313-1	4.78	188.42
⊠	C313-2	4.04	189.16
▲	BH10-02	4.11	189.09

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00

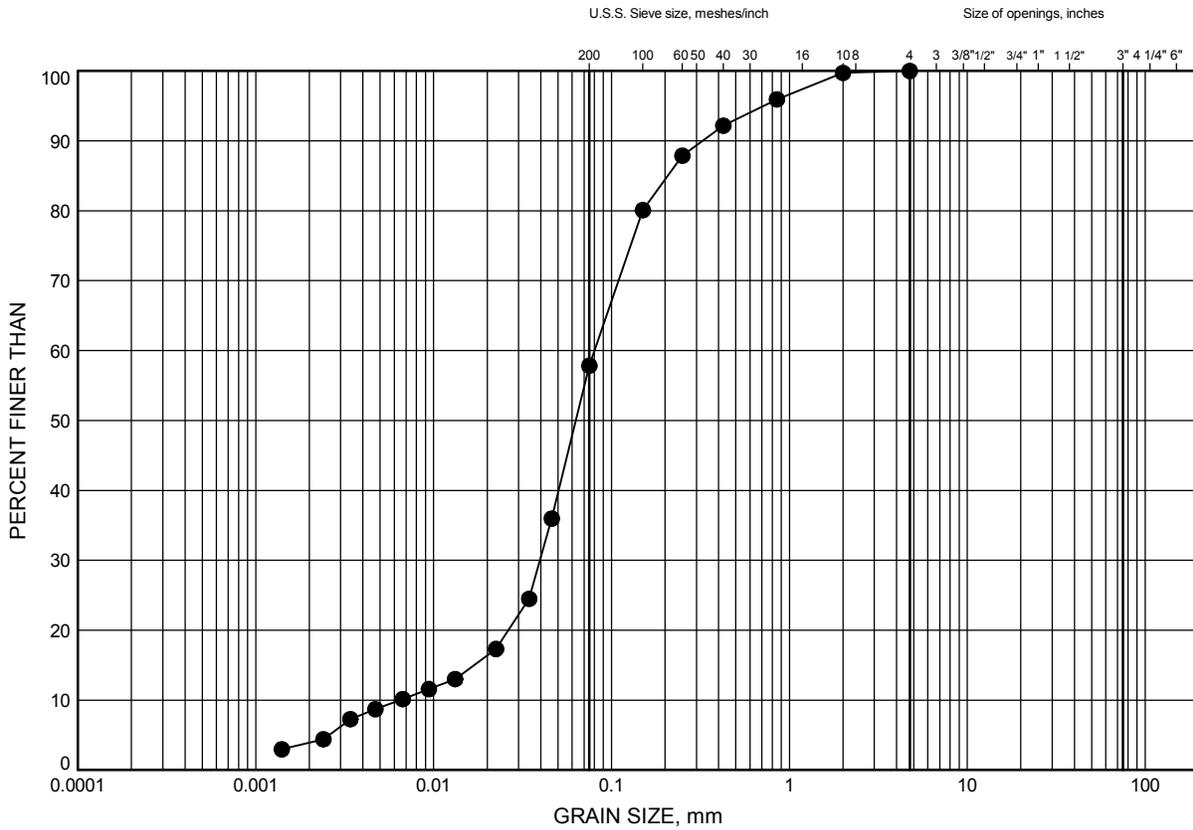


Prep'd MFA
 Chkd. MRA

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE A2

Silt and Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C313-3	3.05	190.15

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00

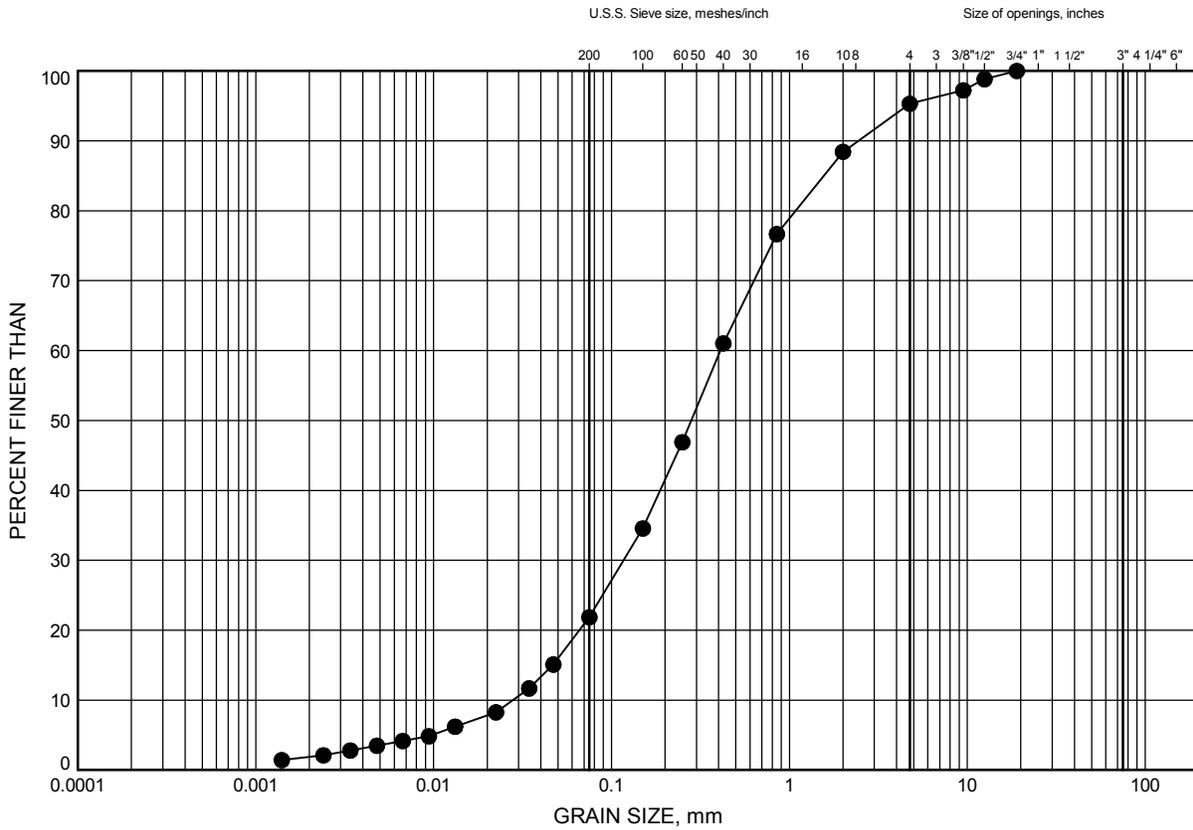


Prep'd MFA
 Chkd. MRA

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE A3

Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C314-2	2.69	190.51

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00

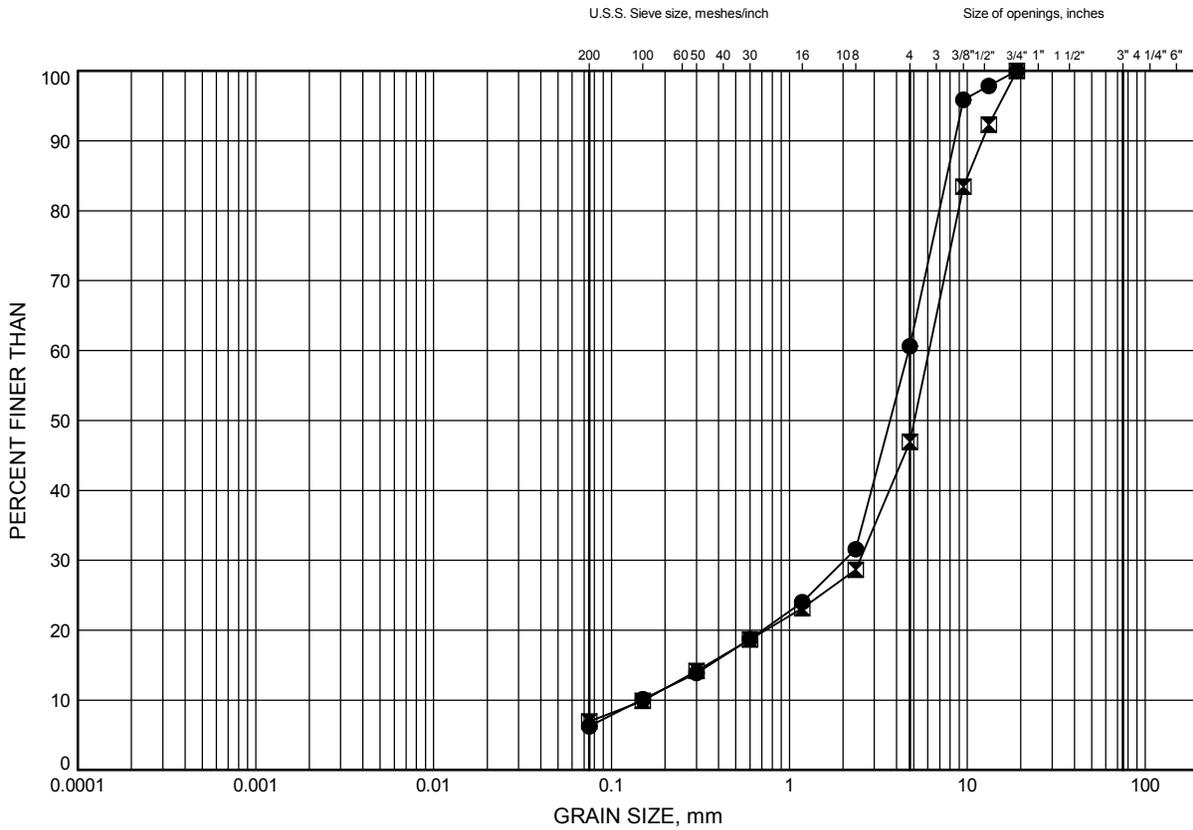


Prep'd MFA
 Chkd. MRA

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE A4

Sand and Gravel



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C313-1	9.22	183.98
⊠	C314-2	3.36	189.84

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00



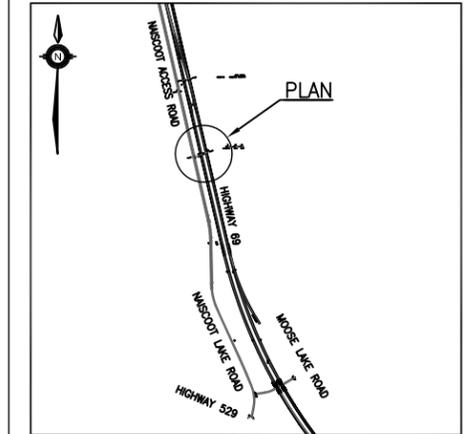
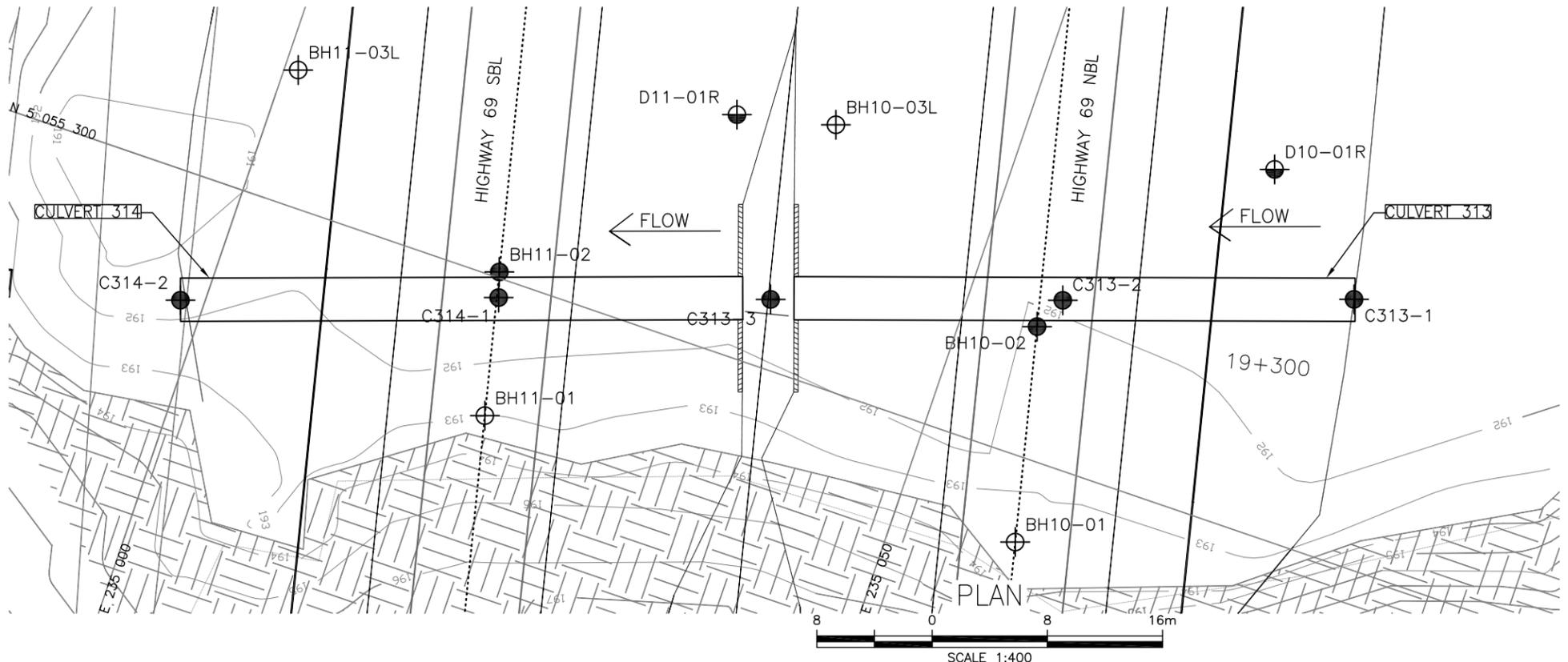
Prep'd MFA
 Chkd. MRA

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

CONT No
WP No 5134-12-01/02
HIGHWAY 69 FOUR-LANING
SOUTH SECTION
CULVERT 313 AND 314
BOREHOLE LOCATIONS AND SOIL STRATA



SHEET



KEYPLAN

LEGEND

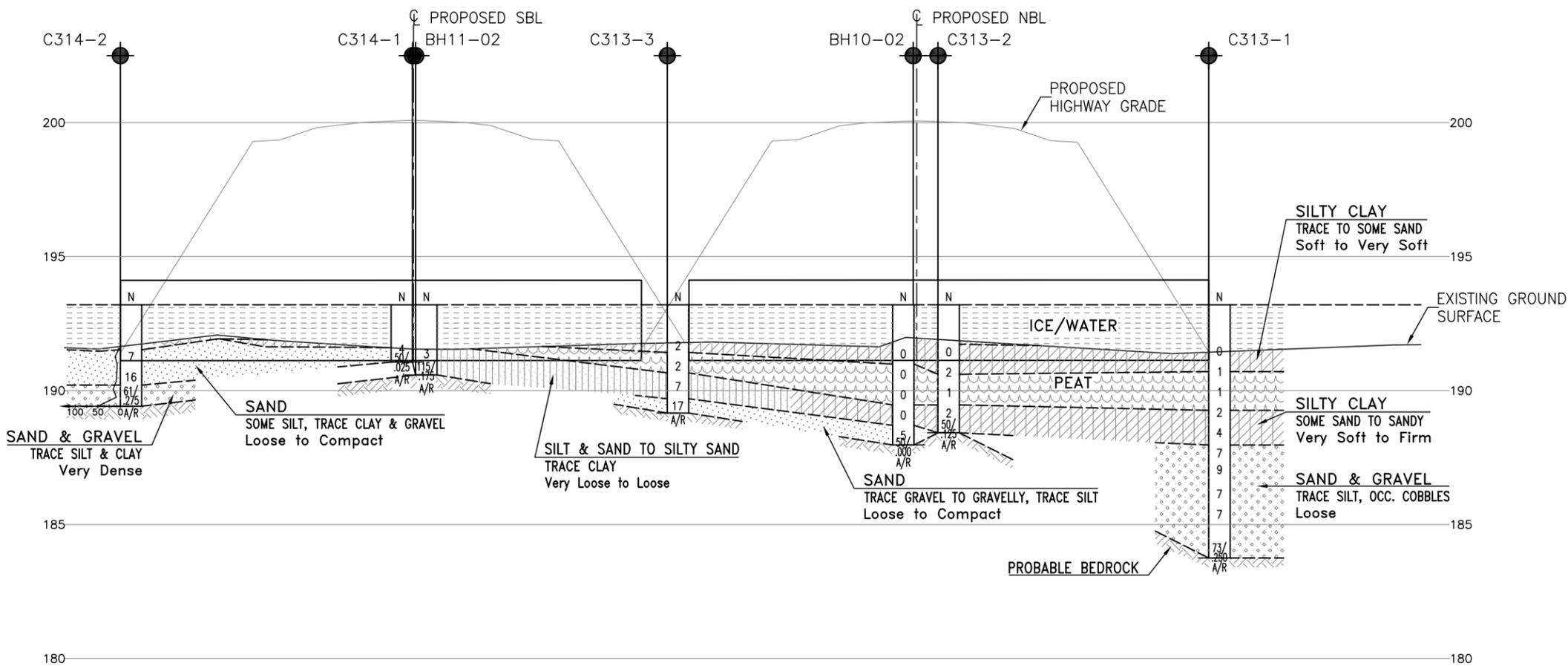
- Culvert Report Borehole / Cone
- Other Borehole / Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- Water Level During Drilling
- Water Level in Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH10-01	193.2	5 055 294.3	235 058.6
BH10-02	193.2	5 055 308.9	235 055.2
BH10-03L	193.2	5 055 317.6	235 037.5
BH11-01	193.2	5 055 290.7	235 020.9
BH11-02	193.2	5 055 300.4	235 018.7
BH11-03L	193.2	5 055 309.1	235 000.9
C313-1	193.2	5 055 317.8	235 075.4
C313-2	193.2	5 055 311.2	235 056.3
C313-3	193.2	5 055 304.7	235 037.1
C314-1	193.2	5 055 298.7	235 019.2
C314-2	193.2	5 055 291.4	234 998.4
D10-01R	193.2	5 055 324.5	235 067.3
D11-01R	193.2	5 055 316.1	235 030.8

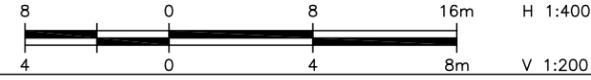
-NOTES-

- 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. 41H-130



CULVERT 313 AND 314



DATE	BY	DESCRIPTION
DESIGN	LRB	CHK MRA CODE LOAD DATE AUG. 2014
DRAWN	MFA	CHK LRB SITE 44-600/C1&2 STRUCT DWG 1

Appendix B

Culverts 317 and 318

**Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings**

RECORD OF BOREHOLE No C317-1

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 827.6 E 234 950.3 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE Hollow Stem Augers (CME 45) COMPILED BY AN
 DATUM Geodetic DATE 2011.02.11 - 2011.02.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
192.7	Ground Surface																
0.0	PEAT																
0.2	SAND, trace to some silt, trace gravel, occasional cobbles Brown Moist to Wet																
191.4			1	SS	59/ 0.200												
1.2	END OF BOREHOLE AT 1.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.9m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.																

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C317-2

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 819.8 E 234 916.4 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE Hollow Stem Augers (CME 45) COMPILED BY AN
 DATUM Geodetic DATE 2011.02.11 - 2011.02.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
192.4	Ground Surface																
0.0	PEAT Black Wet																
0.2	Silty CLAY, sandy to trace sand Soft to Stiff Brown		1	SS	3										0	22 54 24	
	Sand seams		2	SS	9												
			3	SS	3										0	9 49 42	
	Very Soft		4	SS	0												
188.1																	
4.3	END OF BOREHOLE AT 4.3m UPON AUGER REFUSAL ON PROBABLE BEDROCK. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Feb 22/11 0.0 192.4 Mar 01/11 0.0 192.4 Mar 13/11 0.0 192.4 Apr 27/11 0.1 192.3																

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C318-1

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 811.7 E 234 881.7 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE Hollow Stem Augers (CME 45) COMPILED BY AN
 DATUM Geodetic DATE 2011.02.11 - 2011.02.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
192.9	Ground Surface																
0.0	PEAT Black																
0.2	Silty CLAY, trace sand Stiff Brown		1	SS	9												
			2	SS	8											0 3 41 56	
190.7																	
190.8	SAND, trace silt and gravel Brown Wet		3	SS	50/												
2.4	END OF BOREHOLE AT 2.4m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.6m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.				0.075												

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No BH13-07

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION Harrison Twp., Station 19+826 C/L, NBL ORIGINATED BY JM
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LG
 DATUM Geodetic DATE 2009.02.12 - 2009.02.12 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE								
						PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%)								
192.7	Ground Surface													
0.0 0.1	PEAT: (100mm) Dark Brown Moist Silty CLAY, trace sand Soft to Stiff Grey		1	SS	2	∇								
			2	SS	11		192							0 6 40 54
191.2														
1.5 190.9	Silty SAND, some clay, trace gravel Grey to Brown		3	SS	53									
1.8	Moist END OF BOREHOLE AT 1.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.5m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH AUGER CUTTINGS UPON COMPLETION.													

ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No BH14-08

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION Harrison Twp., Station 19+826 C/L, SBL ORIGINATED BY JM
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY LG
 DATUM Geodetic DATE 2009.02.12 - 2009.02.12 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
						20	40	60	80	100						
191.9	Ground Surface															
0.0	PEAT, fibrous, trace sand															
191.6	Very Soft		1	SS	1											
0.3	Dark Brown Wet (300mm)															
	Silty CLAY, trace sand															
	Very Soft to Soft		2	SS	4										0 8 57 35	
	Brown to Grey															
			3	SS	4											
			4	SS	2											
188.5																
3.4	Silty SAND, trace clay		5	SS	6										6 61 23 10	
	Loose Grey Moist															
	Occasional cobbles															
187.1			6	SS	50/											
4.8	END OF BOREHOLE AT 4.8m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG AND AUGER CUTTINGS UPON COMPLETION.				.100											

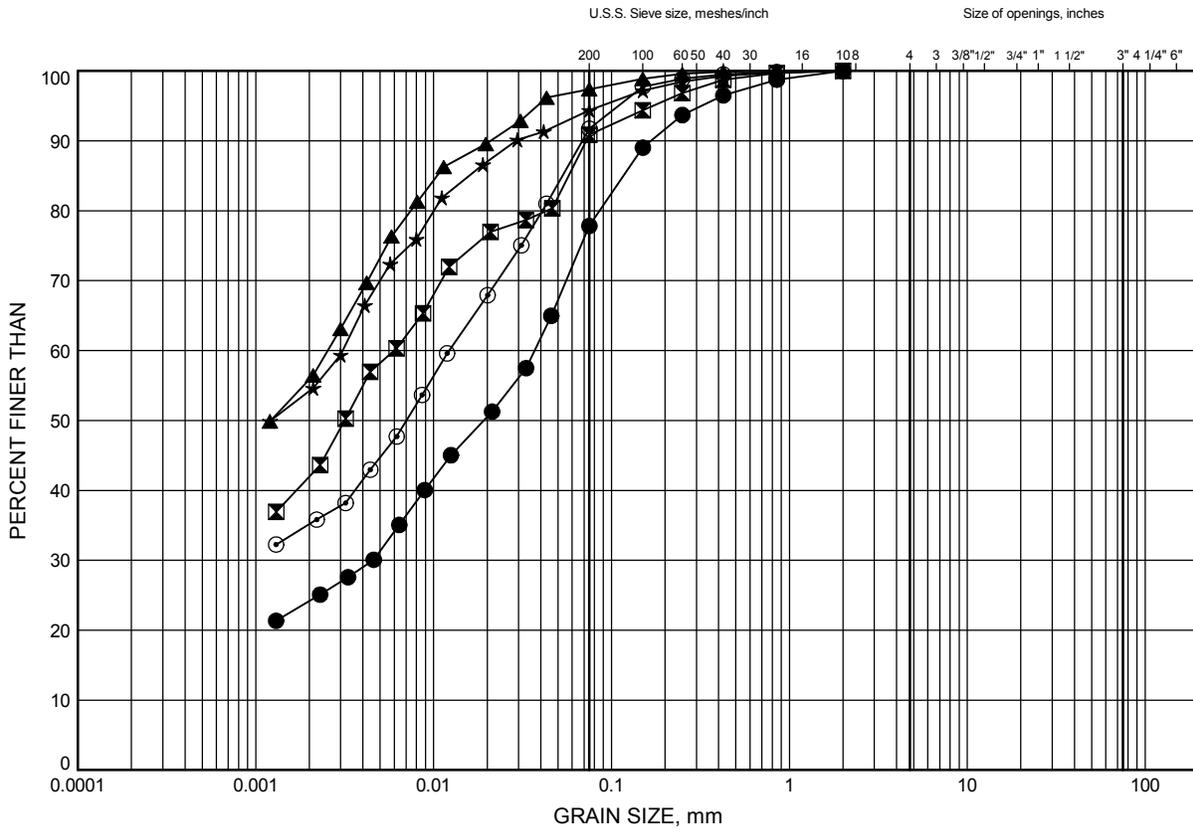
ONTMT4S 6121.GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty Clay



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C317-2	1.07	191.33
⊠	C317-2	2.59	189.81
▲	C318-1	1.83	191.04
★	BH13-07	1.07	191.63
⊙	BH14-08	1.07	190.83

Date August 2014
 GWP# 5076-06-00



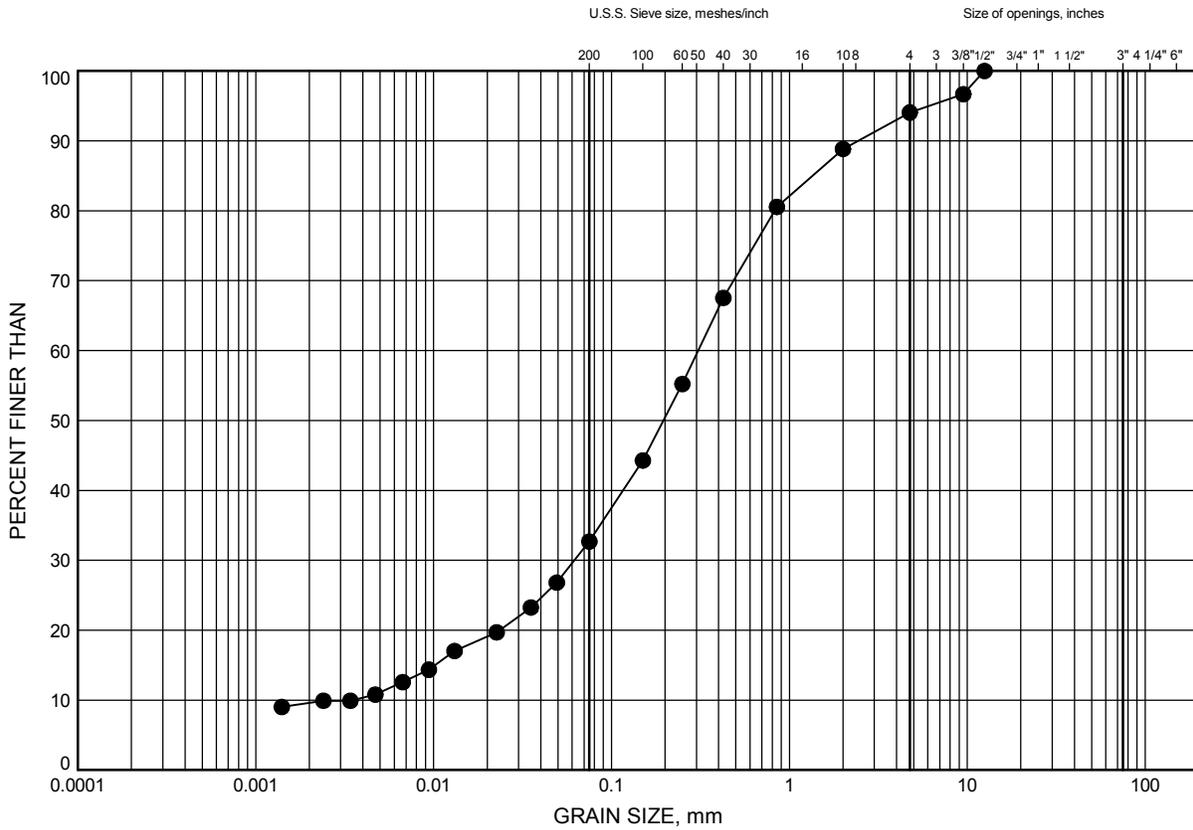
Prep'd MFA
 Chkd. MRA

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE B2

Silty Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BH14-08	3.51	188.39

GRAIN SIZE DISTRIBUTION - THURBER 6121.GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00

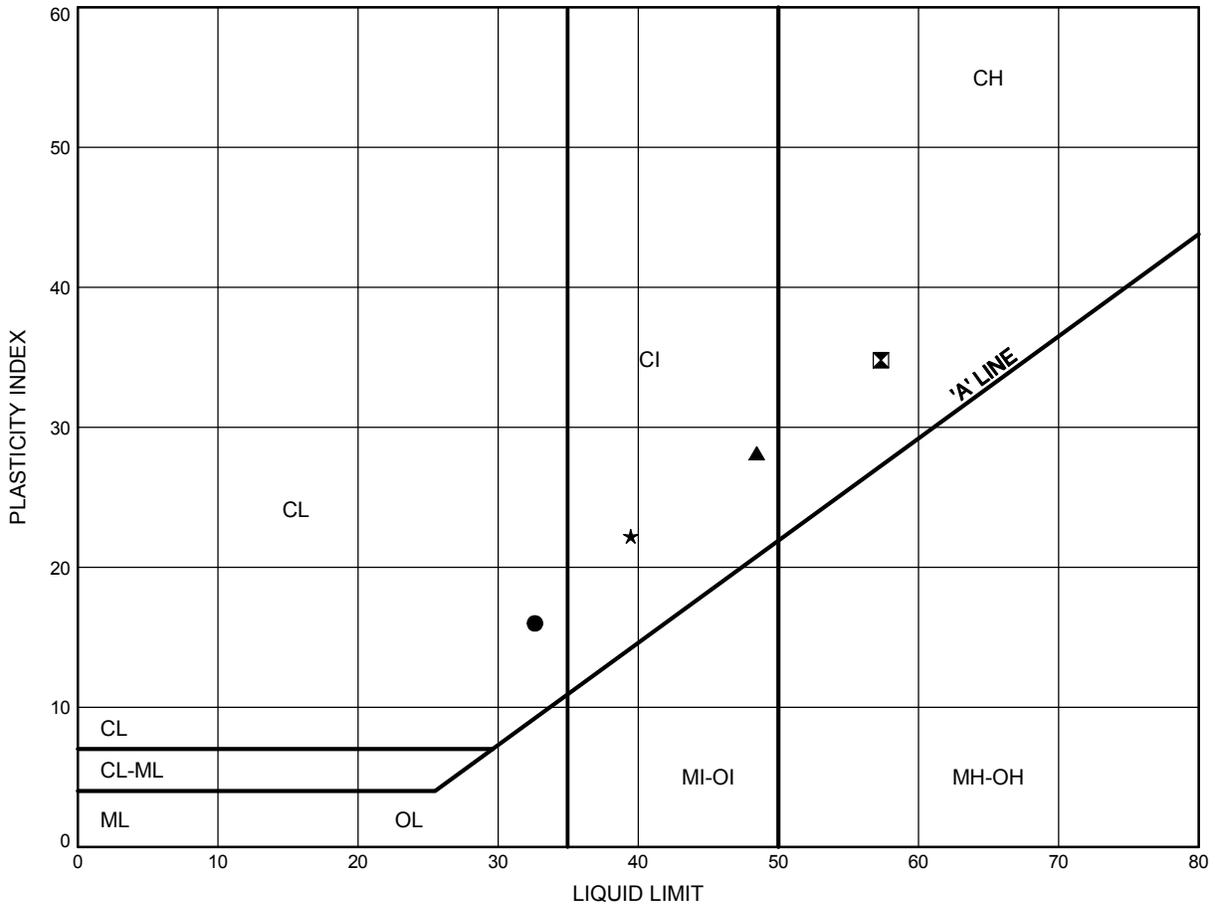


Prep'd MFA
 Chkd. MRA

Hwy 69 Four-Laning North of Hwy 529
ATTERBERG LIMITS TEST RESULTS

FIGURE B3

Silty Clay



LEGEND

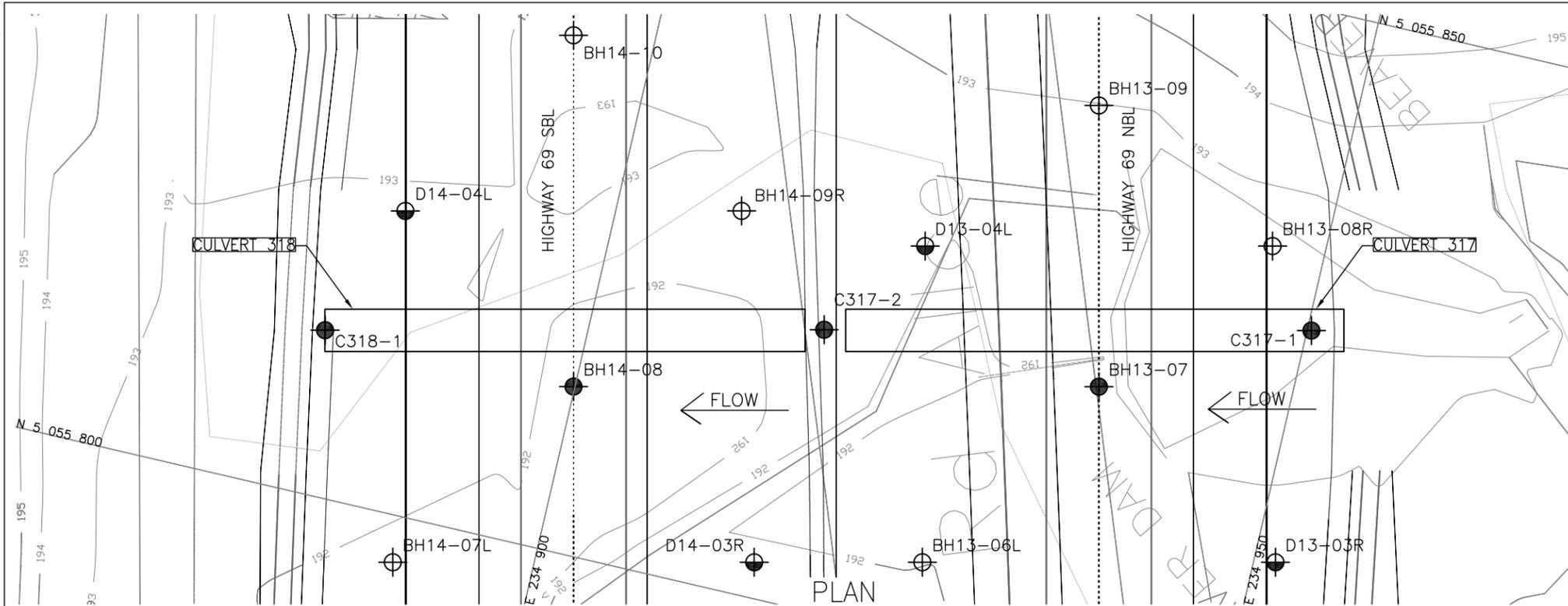
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C317-2	1.07	191.33
⊠	C318-1	1.83	191.04
▲	BH13-07	1.07	191.63
★	BH14-08	1.07	190.83

THURBALT 6121(CULVERTS)GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00



Prep'd MFA
 Chkd. MRA



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

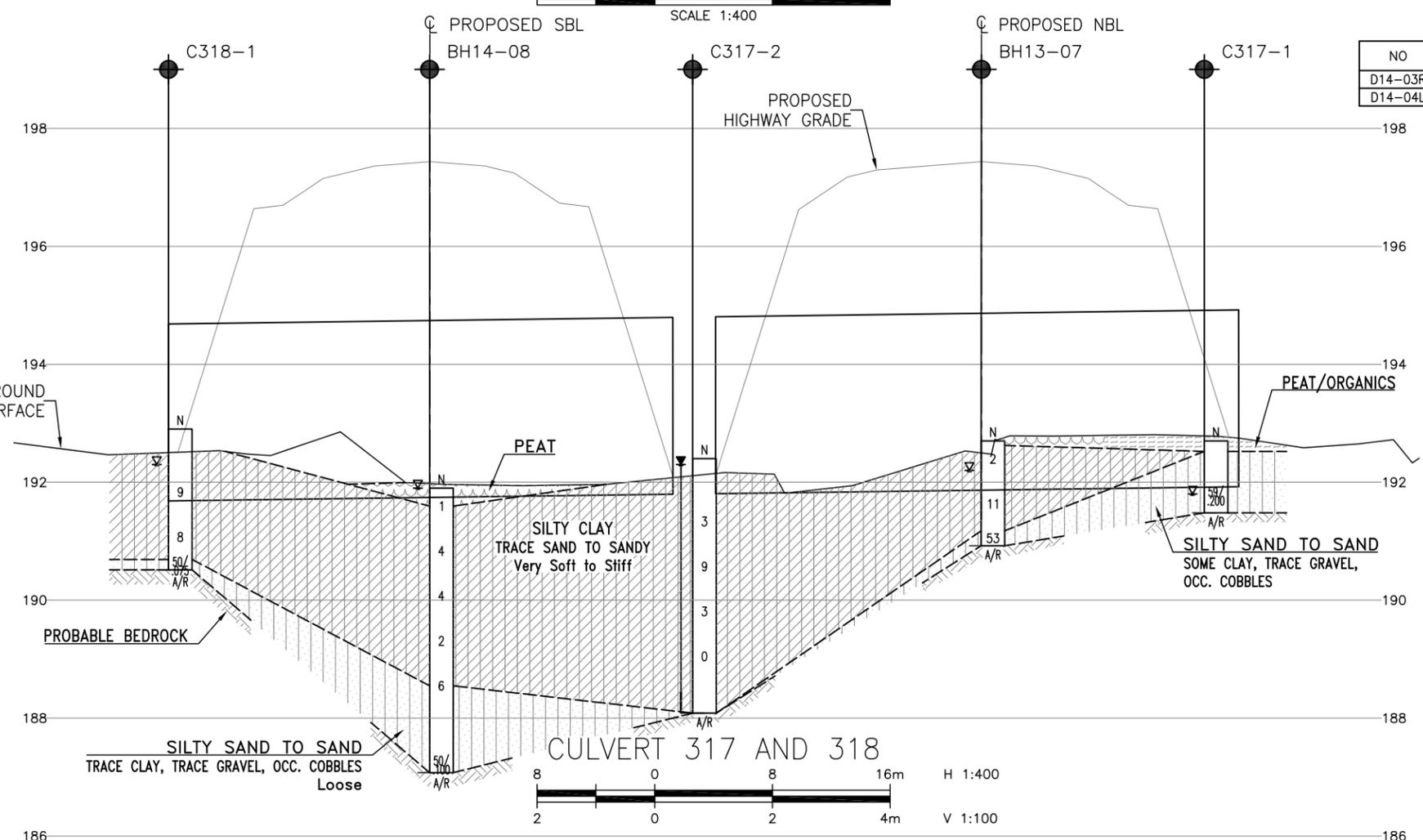
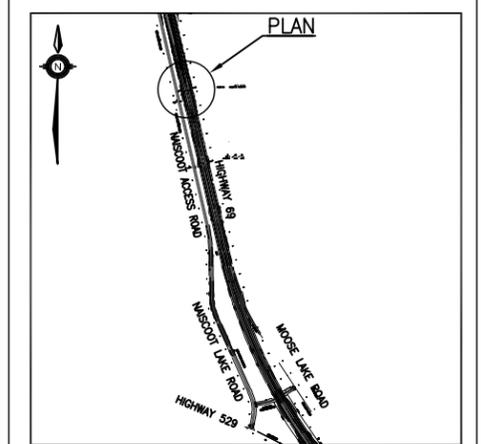
LICENSED PROFESSIONAL ENGINEER
M. R. ANDERSON
Aug 21/14
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 21/14
PROVINCE OF ONTARIO

CONT No
WP No 5134-12-05/06

HIGHWAY 69 FOUR-LANING
SOUTH SECTION
CULVERT 317 AND 318
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET



NO	ELEVATION	NORTHING	EASTING
D14-03R	192.0	5 055 802.5	234 915.3
D14-04L	192.8	5 055 821.3	234 885.4

KEYPLAN

LEGEND

- / ● Culvert Report Borehole / Cone
- ⊕ / ⊕ Other Borehole / Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level During Drilling
- ⊥ Water Level in Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
BH13-06L	192.0	5 055 805.3	234 927.0
BH13-07	192.7	5 055 820.3	234 936.4
BH13-08R	192.8	5 055 832.8	234 946.2
BH13-09	193.0	5 055 839.8	234 931.9
BH14-07L	191.9	5 055 796.7	234 890.2
BH14-08	191.9	5 055 811.8	234 899.9
BH14-09R	192.1	5 055 826.7	234 908.8
BH14-10	192.6	5 055 836.2	234 894.2
C317-1	192.7	5 055 827.6	234 950.3
C317-2	192.4	5 055 819.8	234 916.4
C318-1	192.9	5 055 811.7	234 881.7
D13-03R	193.3	5 055 811.0	234 951.5
D13-04L	192.1	5 055 827.2	234 922.1

-NOTES-

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

GEOGRES No. 41H-130

DATE	BY	DESCRIPTION
DESIGN	LRB	CHK MRA CODE
DRAWN	MFA	CHK LRB SITE 44-603/C1&2 STRUCT

LOAD DATE AUG. 2014
DWG 1

Appendix C

Culvert 330

**Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings**

RECORD OF BOREHOLE No C330-1

1 OF 3

METRIC

GWP# 5076-06-00 LOCATION N 5 055 288.6 E 234 971.2 ORIGINATED BY ES/GM
 HWY 69 BOREHOLE TYPE Hollow Stem Augers/HQ/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.12 - 2012.06.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
199.9	Road Surface														
0.0	ASPHALT: (40mm)														
198.9	SAND, some gravel Dark Brown Damp (FILL)		1	GS											
1.0	ROCK FILL														
			1	RUN											
			2	RUN											
			3	RUN											
			4	RUN											
			5	RUN											

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Continued Next Page

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

RECORD OF BOREHOLE No C330-1

3 OF 3

METRIC

GWP# 5076-06-00 LOCATION N 5 055 288.6 E 234 971.2 ORIGINATED BY ES/GM
 HWY 69 BOREHOLE TYPE Hollow Stem Augers/HQ/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.12 - 2012.06.12 CHECKED BY LRB

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			20	40	60					
	Continued From Previous Page															
172.3																
27.6	END OF BOREHOLE AT 27.6m UPON REFUSAL ON PROBABLE BEDROCK OR BOULDER. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.															

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C330-2

1 OF 2

METRIC

GWP# 5076-06-00 LOCATION N 5 055 278.7 E 234 945.0 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.03.03 - 2011.03.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80			100
191.5	Ground Surface													
0.0	PEAT Soft Dark Brown		1	SS	4									
190.8														
0.7	SILT and SAND, trace gravel, trace clay Compact Brown Wet		2	SS	18									2 41 53 4
			3	SS	25									
189.7														
1.8	SAND, trace to some gravel, trace to some silt and clay Loose to Very Loose Brown Wet		4	SS	5									
			5	SS	4									
			6	SS	2									
			7	SS	4									
			8	SS	3									1 86 13 (SI+CL)
			9	SS	2									
			10	SS	5									
	Compact		11	SS	28									
			12	SS	28									0 97 3 (SI+CL)

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

Continued Next Page

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

RECORD OF BOREHOLE No C330-2

2 OF 2

METRIC

GWP# 5076-06-00 LOCATION N 5 055 278.7 E 234 945.0 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.03.03 - 2011.03.08 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	Continued From Previous Page															
180.2	SAND, trace silt and clay Loose to Very Loose Grey Wet	[Dotted pattern]	13	SS	8	[Dotted pattern]	181	[Plot area]	[Plot area]	[Plot area]	[Plot area]	[Plot area]	[Plot area]	[Plot area]	[Plot area]	
			14	SS	2											
11.3	Start DCPT at 11.2m						180	[DCPT Plot]								
179.0							179	[DCPT Plot]								
12.5	END OF BOREHOLE AT 12.5m UPON REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.8m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Mar 13/11 0.0 191.5 Apr 27/11 0.5 191.0															

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C330-2D

2 OF 2

METRIC

GWP# 5076-06-00 LOCATION N 5 055 278.0 E 234 942.0 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN
 DATUM Geodetic DATE 2011.03.08 - 2011.03.08 CHECKED BY LRB

SOIL PROFILE			SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	20			40	60	80					
	Continued From Previous Page															
178.4																
13.1	END OF BOREHOLE AT 13.1m.															

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C314-2

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 291.4 E 234 998.4 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Wash Boring COMPILED BY AN
 DATUM Geodetic DATE 2011.02.25 - 2011.02.25 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60					
193.2	Pond Surface														
0.0	ICE: (300mm)														
192.9															
0.3	WATER														
191.6															
191.8	PEAT: (50mm)														
1.7	SAND, some silt, trace gravel Loose to Compact Grey Wet		1	SS	7										
			2	SS	16									5 73 20 2	
190.2															
3.0	SAND and GRAVEL, trace silt Very Dense Brown Wet		3	SS	61/ 0.275									53 40 7 (SI+CL)	
189.4															
3.8	END OF BOREHOLE AT 3.8m UPON REFUSAL ON PROBABLE BEDROCK. BOREHOLE BACKFILLED WITH HOLEPLUG AND CUTTINGS TO SURFACE.														

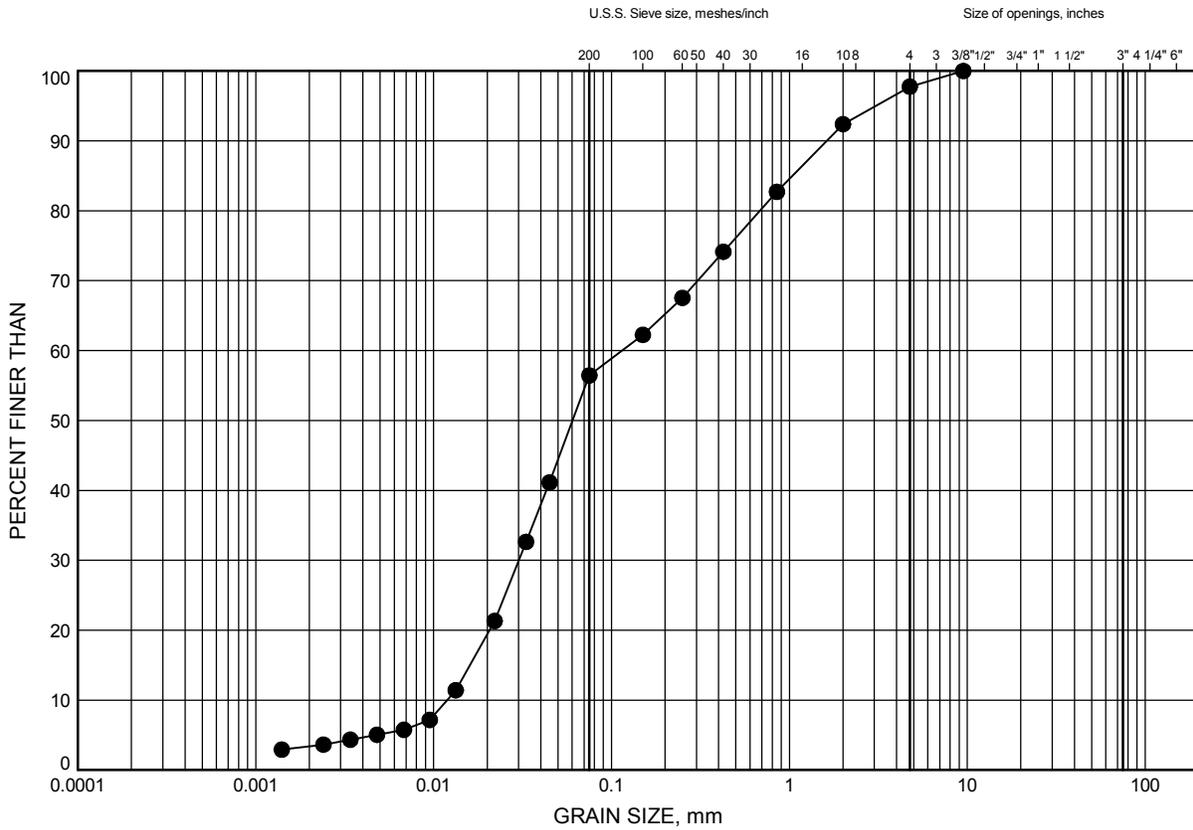
ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE C1

Silt and Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C330-2	0.91	190.59

Date August 2014
 GWP# 5076-06-00

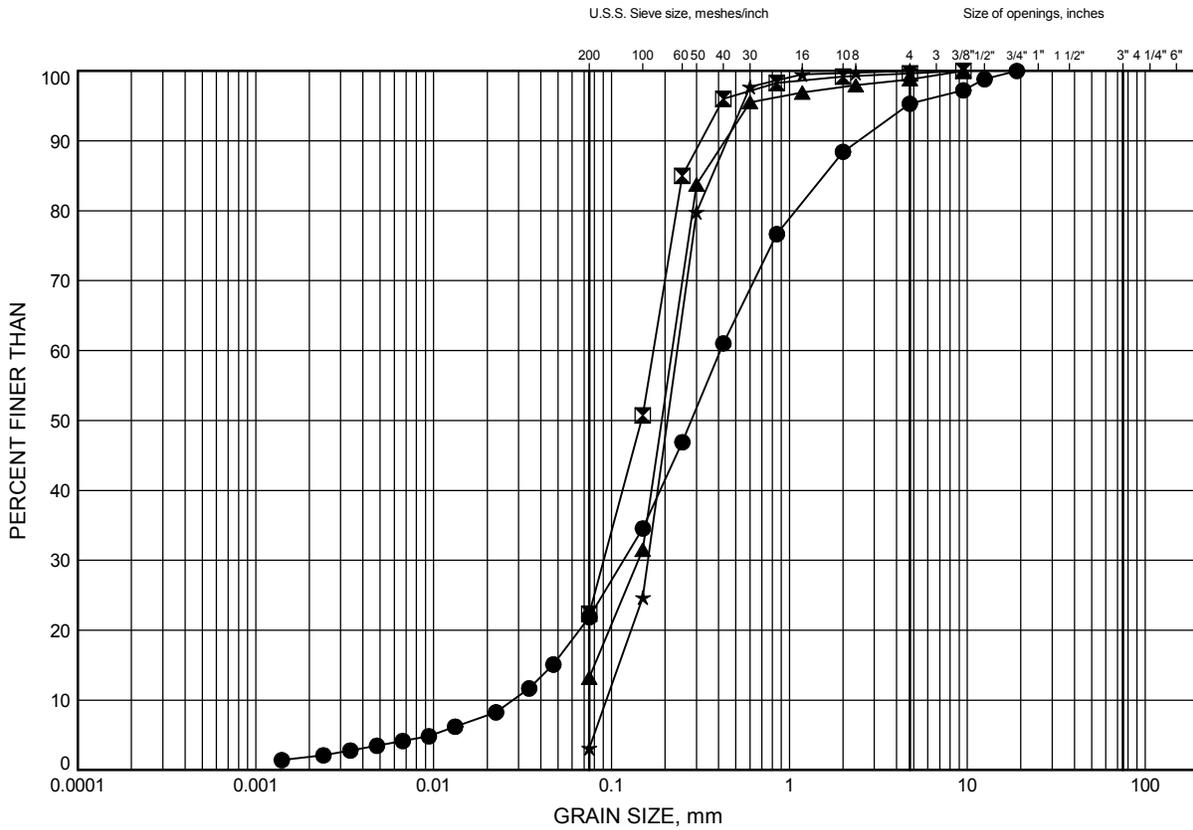


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Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE C2

Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C314-2	2.69	190.51
⊠	C330-1	19.51	180.39
▲	C330-2	4.88	186.62
★	C330-2	9.45	182.05

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00

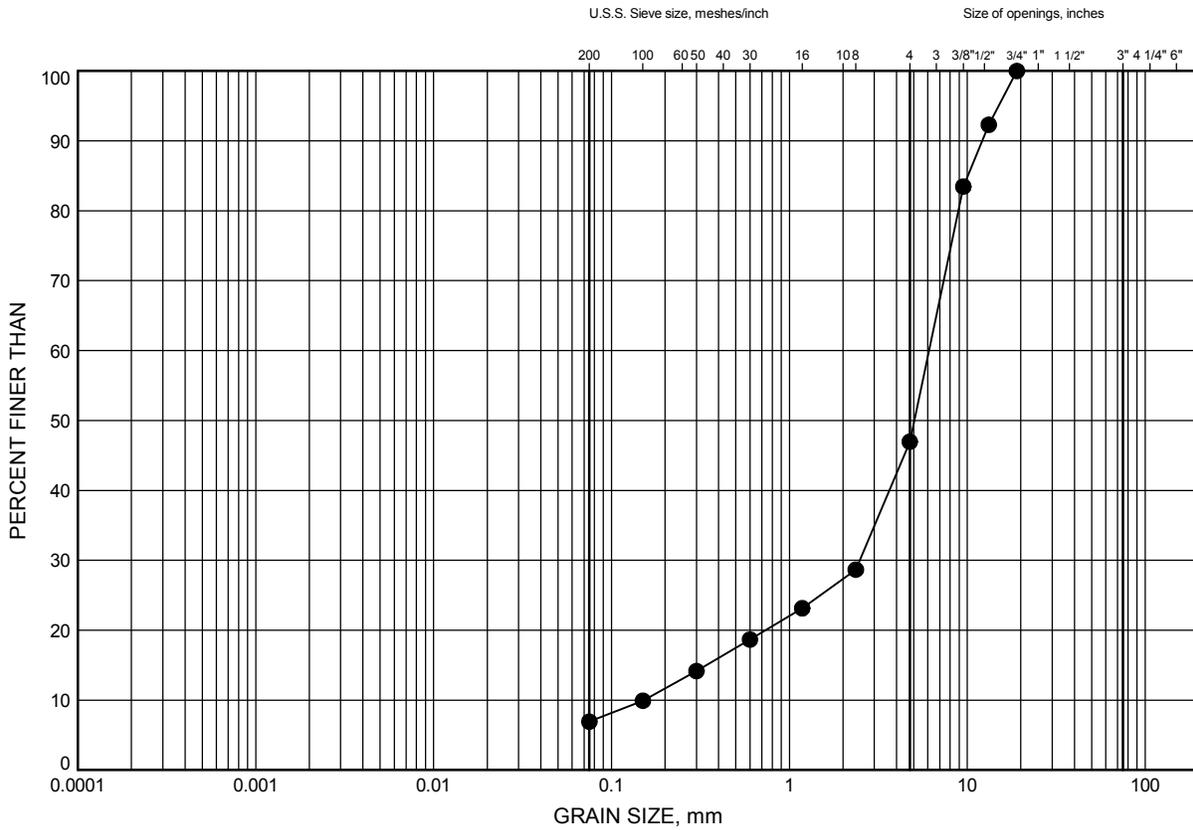


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 Chkd. MRA

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE C3

Sand and Gravel



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

LEGEND

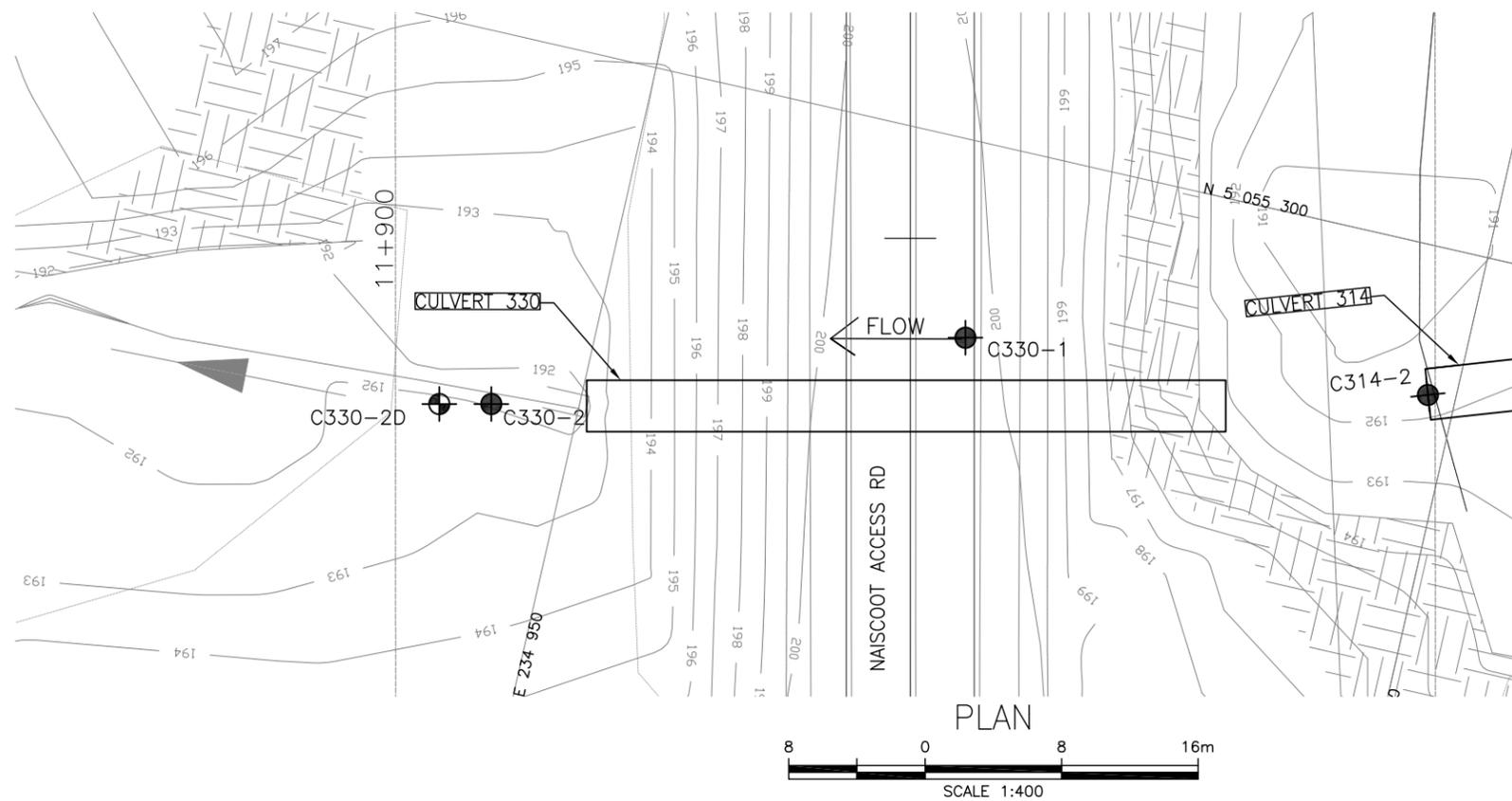
SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C314-2	3.36	189.84

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

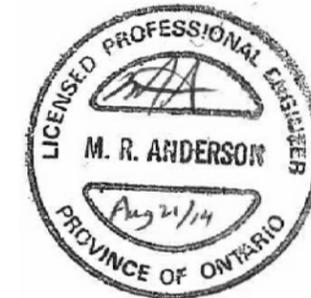
Date August 2014
 GWP# 5076-06-00



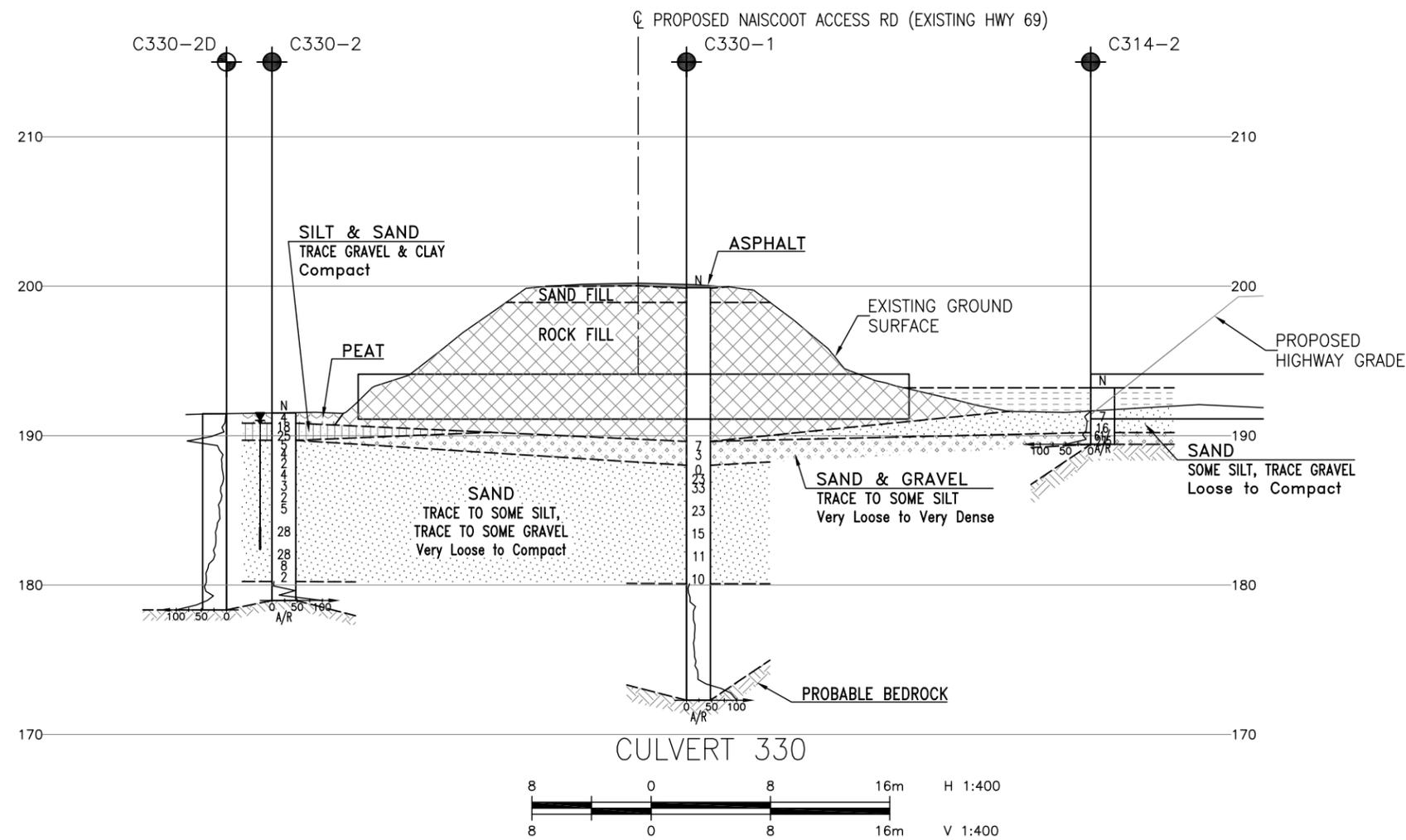
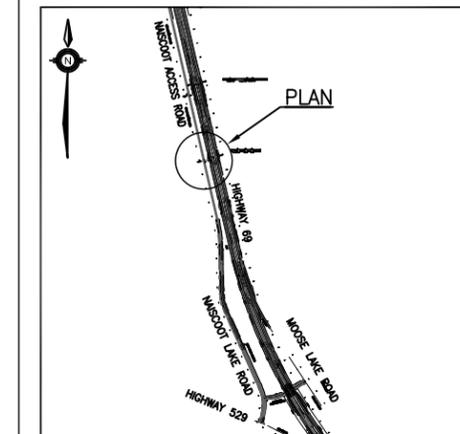
Prep'd MFA
 Chkd. MRA



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



CONT No
WP No 5134-12-03
HIGHWAY 69 FOUR-LANING
SOUTH SECTION
CULVERT 330
BOREHOLE LOCATIONS AND SOIL STRATA



LEGEND

- / ● C Culvert Report Borehole / Cone
- / ○ Other Borehole / Cone
- N Blows /0.3m (Std Pen Test, 475J/blow)
- CONE Blows /0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- ▽ Water Level During Drilling
- ⊥ Water Level in
- ⊥ Piezometer
- 90% Rock Quality Designation (RQD)
- A/R Auger Refusal

NO	ELEVATION	NORTHING	EASTING
C330-1	199.9	5 055 288.6	234 971.2
C330-2	191.5	5 055 278.7	234 945.0
C330-2D	191.5	5 055 278.0	234 942.0
C314-2	193.2	5 055 291.4	234 998.4

-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.

GEOCRIS No. 41H-130

DATE	BY	DESCRIPTION
DESIGN	LRB	CHK MRA CODE
DRAWN	MFA	CHK LRB SITE 44-601/C/STRUCT

LOAD DATE AUG. 2014
DWG 1

Appendix D

Culvert 332

**Record of Borehole Sheets
Laboratory Test Results
Borehole Locations and Soil Strata Drawings**

RECORD OF BOREHOLE No C332-1

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 735.4 E 234 849.5 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE Hollow Stem Augers (CME 45) COMPILED BY AN
 DATUM Geodetic DATE 2011.02.11 - 2011.02.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
191.9	Ground Surface																
0.0	ORGANICS, roots and rootlets																
0.2	Silty CLAY, trace sand Firm Brown		1	SS	7												
189.8			2	SS	9											0 5 48 47	
188.7	SAND, some silt to silty Brown Wet																
2.2	END OF BOREHOLE AT 2.2m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT SURFACE UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.																

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C332-2

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 740.6 E 234 870.1 ORIGINATED BY ES
 HWY 69 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN
 DATUM Geodetic DATE 2012.06.13 - 2012.06.13 CHECKED BY LRB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
197.2	Ground Surface														
0.0	ASPHALT: (50mm)														
196.1	Gravelly SAND, some silt Brown Damp (FILL)		1	GS			197							29 59 12 (SI+CL)	
196.1	ROCK FILL						196								
1.1			1	RUN			195								
			2	RUN			194								
			3	RUN			193								
			4	RUN			192								
			5	RUN			191								
							190								
189.7	Silty CLAY, some gravel Firm Brown Moist						189						FI	RUN #5 TCR=100% SCR=100% RQD=72%	
189.6	BEDROCK, granite, grey/pink Vertical fracture from 8.4m to 8.7m		5	RUN											
188.4	END OF BOREHOLE AT 8.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 6.4m, CUTTINGS TO 1.2m, BENTONITE HOLEPLUG TO 0.1m, THEN ASPHALT TO SURFACE.														

ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

RECORD OF BOREHOLE No C332-3

1 OF 1

METRIC

GWP# 5076-06-00 LOCATION N 5 055 743.5 E 234 881.5 ORIGINATED BY SLL
 HWY 69 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2011.02.11 - 2011.02.11 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
							20	40	60	80	100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					WATER CONTENT (%)			
							20	40	60						
191.6	Ground Surface														
0.0	PEAT, roots and rootlets					∇									
190.8							191								
0.8	SAND, some silt Loose Brown		1	SS	4										
190.2															
1.4	Silty CLAY, trace sand, occasional rootlets Firm Brown		2	SS	5		190								0 5 42 53
189.1															
2.5	END OF BOREHOLE AT 2.5m UPON AUGER REFUSAL ON PROBABLE BEDROCK. WATER LEVEL AT 0.1m UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH CUTTINGS TO SURFACE.		3	SS	50/ 0.100										

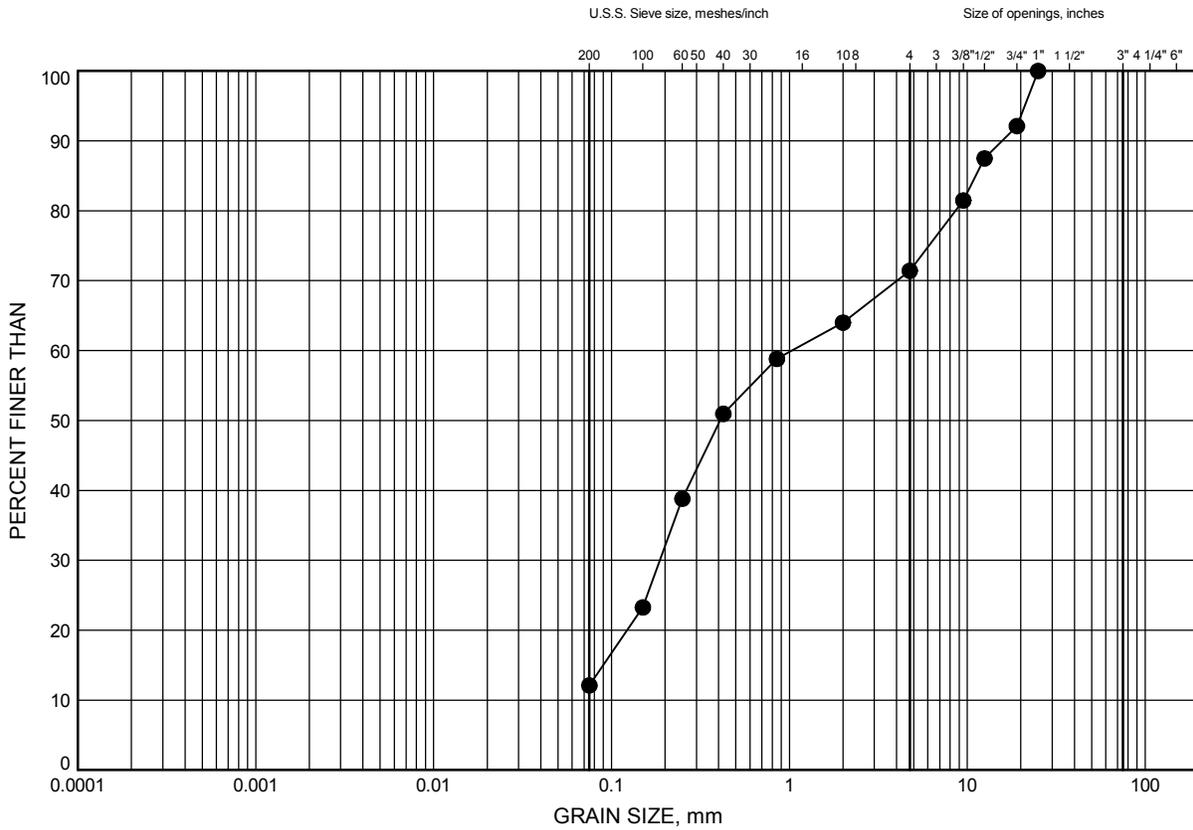
ONTMT4S 6121(CULVERTS).GPJ 2012TEMPLATE(MTO).GDT 8/20/14

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

Hwy 69 Four-Laning North of Hwy 529
GRAIN SIZE DISTRIBUTION

FIGURE D1

Gravelly Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C332-2	0.50	196.70

GRAIN SIZE DISTRIBUTION - THURBER 6121(CULVERTS).GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00

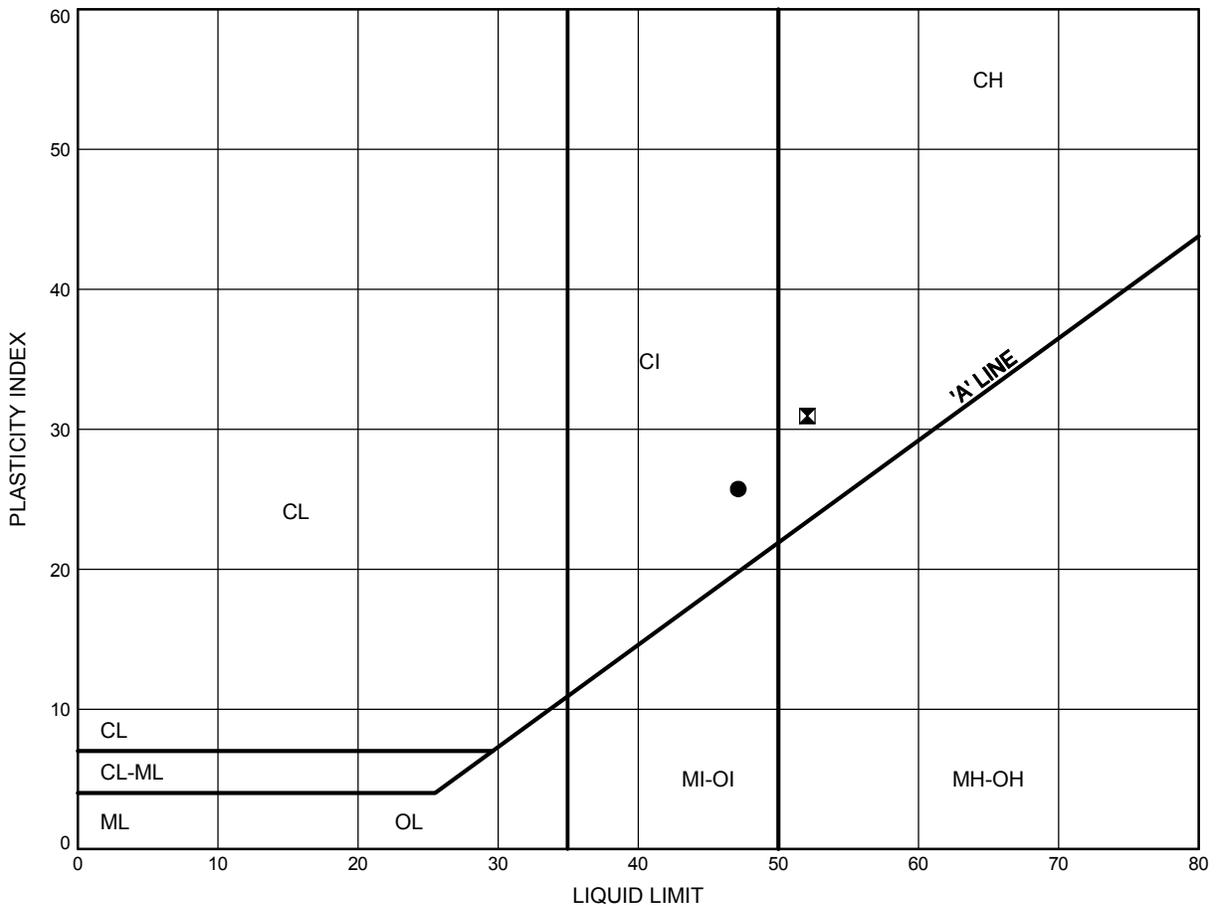


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Hwy 69 Four-Laning North of Hwy 529
ATTERBERG LIMITS TEST RESULTS

FIGURE D3

Silty Clay



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C332-1	1.83	190.07
⊠	C332-3	1.83	189.77

THURBALT 6121(CULVERTS)GPJ 8/20/14

Date August 2014
 GWP# 5076-06-00



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