



THURBER ENGINEERING LTD.

MEMORANDUM

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cc. Mark Gimpoli, P.Eng.
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SNC Lavalin Inc.

Date: March 9, 2018

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(Reviewed by P.K. Chatterji, P.Eng.)

File: 17265

**FOUNDATION INVESTIGATION MEMORANDUM
CULVERT #23 AND STORMWATER MANAGEMENT POND #1
HIGHWAY 400 WIDENING
TOWNSHIP OF KING, ONTARIO
G.W.P. 2539-04-00**

GEOCRES NO. 30M13-225

PART 1 FACTUAL INFORMATION

1 INTRODUCTION

This memorandum presents the factual data obtained from a foundation investigation carried out at the locations of a proposed culvert and a stormwater management pond to be constructed along the Highway 400 right-of-way between Kirby Road and just south of King-Vaughan Road in the Township of King, Ontario. These works are parts of a larger project involving the widening of the highway to accommodate additional lanes of traffic, but have not been included in the original and revised foundations terms of reference. It is understood that the Ministry of Transportation Ontario (MTO) requires the design to accommodate the ultimate 10-lane configuration including two HOV lanes in each direction within the current MTO right-of-way.

The purpose of this investigation was to determine the subsurface conditions near the locations of the new culvert (Culvert #23) and the new stormwater management pond (SWMP #1), and based on the data, to provide borehole location plans and soil strata drawings, records of boreholes, laboratory test results, and a generalized description of the subsurface conditions.

It is noted that this investigation was carried out after the contract was tendered. The factual information obtained is to provide reference information for the Contractor and has also been used to verify the foundation aspects of the design of these facilities as shown on the contract drawings.



Thurber Engineering Ltd. (Thurber) carried out this investigation as a sub-consultant to SNC-Lavalin Inc. (SLI) under an MTO change order.

Reference has been made to the following reports during the preparation of this memorandum.

- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, Proposed Culvert Extensions and New Culvert, Highway 400 Widening, Major MacKenzie Drive to King Road, York Region, Ontario", G.W.P. 192-00-00 and 2539-04-00, Assignment Nos. 2005-E-0036 and -0037, GEOCRS No. 30M13-190, Report to SNC-Lavalin Inc., File: 19-92-68 dated March 7, 2012 (Reference 1).
- Thurber Engineering Ltd. report titled "Foundation Investigation and Design Report, Stormwater Management Pond #2, Highway 400 Widening, Major MacKenzie Drive to King Road, York Region, Ontario", G.W.P. 192-00-00 and 2539-04-00, Assignment Nos. 2005-E-0036 and -0037, GEOCRS No. 30M13-191, Report to SNC-Lavalin Inc., File: 19-92-68 dated March 2, 2012 (Reference 2).

2 SITE DESCRIPTION

The new Culvert #23 will be located under Highway 400 at Station 24+275, approximately 300 m south of King-Vaughan Road. The proposed SWMP#1 will be located adjacent to the east side of Highway 400 northbound lane (NBL) from approximate Stations 23+570 to 23+670.

The land use adjacent to this section of Highway 400 is largely rural and agricultural, and the terrain is generally flat. Highway 400 slopes gently upwards to the north in this vicinity. A Service Centre ONroute is located on the east side of the proposed pond. The pond will be located between Highway 400 NBL and the service centre near its entrance.

Drainage in the vicinity of the project area is largely controlled by the Humber River and its tributaries (East Humber River). Localized drainage is facilitated by the creeks flowing within the gullies.

The proposed locations of Culvert #23 and SWMP#1 are shown on the plans on the Borehole Locations and Soil Strata drawings in Appendices A and B, respectively.

The project area is located within the physiographic region known as the South Slope which comprised predominantly of the Halton till, which is an interbedded complex of clayey silt to silt till and sand. This till comprises a slightly hummocky till plain into which the surface watercourses have eroded 10 to 15 m deep gullies. Relatively recent fluvial sediments have been deposited in the gullies. The Halton till overlies bedrock at depths in the order of 100 m in the vicinity of the project area.



3 SITE INVESTIGATION, FIELD AND LABORATORY TESTING

The site investigation and field testing for this project were carried out on March 6 and 7, 2017 and consisted of drilling and sampling a total of four boreholes as follows:

- Two boreholes (numbered C17-01 and C17-02) were drilled near the new Culvert #23 location, one borehole near each end of the culvert. The boreholes were extended to 12.8m depth (Elevations 262.0 and 262.1).
- Two boreholes (numbered SWM1-01 and SWM1-02) were drilled within the area of the proposed SWMP#1. These two boreholes were terminated at 9.8 m depth (Elevations 261.0 and 260.4).

Prior to the start of drilling, the borehole locations were marked/staked in the field and utility clearances were obtained. The elevations of the as-drilled boreholes were subsequently provided by SLI. The approximate locations of the four boreholes are shown on Borehole Locations and Soil Strata drawings included in Appendices A and B. The coordinates and elevations of these boreholes are provided on these drawings and on the individual Record of Borehole sheets in Appendices A and B.

A truck-mounted CME55 drill rig, supplied and operated by Geo-Environmental Drilling, was used to drill and sample the boreholes. Solid stem augers were used to advance the boreholes until the target depth was reached. In general, soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with Standard Penetration Testing (SPT). Groundwater conditions in the open boreholes were observed throughout the drilling operations.

Upon completion of the drilling operations, the boreholes were decommissioned in general accordance with Ontario Regulation 903 amended by Ontario Reg. 372.

The drilling and sampling operations were supervised on a full-time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and processed the recovered soil samples for transport to Thurber's laboratory for further examination and testing. Results of field drilling and sampling are presented on the Record of Borehole sheets in Appendices A and B.

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets and, are also presented on the figures included in Appendices A and B.



4 SUBSURFACE CONDITIONS

4.1 New Culvert #23

In general, the subsurface stratigraphy encountered in Boreholes C17-01 and C17-02 consisted of asphalt and sand fill overlying silty clay embankment fill which is underlain by native silty clay with organic inclusions. A deposit of silty clay till underlies the silty clay and extends to the termination depth of the boreholes. The following provides a more detailed account of the stratigraphy depicted in these boreholes.

4.1.1 Asphalt

A 150 mm thick layer of asphalt was encountered at ground surface in Borehole C17-02.

4.1.2 Pavement Granular

Brown sand fill containing trace to some gravel, some silt and trace clay, was contacted below the asphalt in Borehole C17-02, and surficially in Borehole C17-01. The thickness of the sand fill ranged between 600 mm and 650 mm. The depth to the base of the sand fill was 0.6 m and 0.8 m (Elevations 274.2 and 274.1) in Boreholes C17-01 and C17-02, respectively.

SPT 'N' values in the granular fill were 13 and 23 blows per 0.3 m of penetration indicating a compact state. Moisture contents measured in the granular fill were 11 percent and 12 percent.

4.1.3 Embankment Fill

Embankment fill consisting of brown silty clay containing trace sand and trace gravel was contacted below the granular fill in both boreholes. The thickness of the silty clay fill was 1.4 m to 1.6 m. The depth to the base of the silty clay fill was 2.2 m (Elevations 272.6 and 272.7).

SPT 'N' values in the silty clay fill ranged from 7 to 14 blows per 0.3 m of penetration, indicating a firm to stiff consistency. Moisture contents measured for the embankment fill was about 16 percent to 18 percent.

Results of grain size analyses conducted on one sample of fill are presented on the Record of Borehole sheets and illustrated on Figure A1 in Appendix A. The laboratory test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	0
Sand	22
Silt	53
Clay	25



4.1.4 Silty Clay with Organic Inclusions

A layer of dark brown to brown native silty clay with organic inclusions, containing trace sand to sandy, trace gravel and occasional rootlets, was encountered below the embankment fill at 2.2 m depth in both boreholes. The upper 600 mm of the silty clay was black in colour in Borehole C17-02. The thickness of the silty clay layer was 2.1 m. The depth to the base of the silty clay was at 4.3 m (Elevations 270.5 and 270.6).

SPT 'N' values measured in the silty clay ranged from 4 to 7 blows per 0.3 m of penetration, indicating a firm consistency. Moisture content measured in this layer ranged from 21 percent to 23 percent.

Results of grain size analyses conducted on one sample of the silty clay are presented on the Record of Borehole sheets and illustrated on Figure A2 in Appendix A. The laboratory test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	3
Sand	22
Silt	51
Clay	24

4.1.5 Silty Clay Till

A deposit of brown to grey silty clay till containing some sand to sandy, and trace gravel, was contacted below the silty clay in both boreholes at 4.3 m depth. The thickness of the silty clay till was 5.6 m. The underside of this till layer is at Elevations 264.9 to 265.0.

The SPT 'N' values measured in the silty clay till varied from 12 to 26 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. An SPT 'N' value of 43 blows per 0.3 m of penetration, was measured in Borehole C17-02, near Elevation 267.0, indicating a hard consistency. Moisture content in the silty clay till varied from 12% to 22%.

Results of grain size analyses conducted on silty clay till samples are presented on the Record of Borehole sheets and illustrated on Figure A3 in Appendix A. The test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	0
Sand	15 to 26
Silt	32 to 54
Clay	26 to 40

Results of Atterberg Limits tests conducted on two samples of the silty clay till are provided on the Record of Borehole sheets and illustrated on Figure A5 in Appendix A. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	27 to 31
Plasticity Index	13 to 15

The results of the Atterberg Limits tests show that the silty clay till is of low plasticity with a group symbol of CL.

Glacial till inherently contains cobbles and boulders.

4.1.5 Clayey Silt Till

Grey clayey silt till containing some sand to sandy and trace gravel, was contacted below the silty clay till in both boreholes, at 9.9 m depth (Elevations 264.9 and 265.0). Both boreholes were terminated within the clayey silt till at 12.8 m depth (Elevations 262.0 and 262.1).

Typically SPT 'N' values measured in the clayey silt till ranged from 17 to 18 blows per 0.3 m of penetration indicating a very stiff consistency. Some 'N' values of 43 to 55 blows per 0.3m of penetration were measured indicating the presence of hard zones within the till. Moisture content measured in the clayey silt till ranged from 10 percent to 18 percent.

Results of grain size analyses conducted on two clayey silt till samples are presented on the Record of Borehole sheets and illustrated on Figure A4 in Appendix A. The test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	0 to 5
Sand	23 to 29
Silt	48 to 59
Clay	18



Results of Atterberg Limits tests conducted on two samples of the clayey silt till are provided on the Record of Borehole sheets and illustrated on Figure A6 in Appendix A. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	16 to 17
Plasticity Index	5 to 6

The results of the Atterberg Limits tests show that the clayey silt till is slightly plastic with a group symbol of CL-ML.

Glacial till inherently contains cobbles and boulders.

4.1.6 Groundwater Conditions

The water levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. A groundwater level was measured at 10.1 m depth (Elevation 264.7) in Borehole C17-01. Cave-in was noted at 11.6 m depth (Elevation 263.3) in Borehole C17-02. These are short term observations and the groundwater level is subject to seasonal fluctuations and climatic changes.

4.2 STORMWATER MANAGMENT POND (SWMP) # 1

The subsurface stratigraphy encountered within the footprint of SWMP #1 consisted of clayey silt with organics and occasional roots and rootlets, overlying an extensive deposit of silty clay till. An interlayer of sand was encountered within the silty clay till in one borehole. The following provides a more detailed account of the stratigraphy depicted in the boreholes.

4.2.1 Clayey Silt with organics

Clayey silt mixed with organics was encountered surficially in both boreholes. The thickness of this layer ranged between 600 mm and 800 mm. Moisture content measured in this soil ranged from 29 percent to 38 percent.

4.2.2 Silty Clay

Native, brown to grey silty clay containing some sand, trace gravel, was contacted at 0.6 m depth and 0.8 m depth in Boreholes SWM1-01 and SWM1-02, respectively. The thickness of the silty clay layer was 1.4 m to 1.5 m. The depth to the base of the silty clay was at 2.1 m and 2.2 m (Elevations 268.7 and 268.0) in Boreholes SWM1-01 and SWM1-02, respectively.



SPT 'N' values measured in the silty clay ranged from 11 to 14 blows per 0.3 m of penetration indicating a stiff consistency. Moisture contents measured in the silty clay varied between 15 percent and 18 percent.

4.2.3 Silty Clay Till

An extensive deposit of brown to grey silty clay till containing some sand to sandy, and trace gravel, was contacted below the silty clay in both boreholes. Boreholes SWM1-01 and SWM1-02 were terminated within the silty clay till at 9.8 m depth (Elevations 261.0 and 260.4).

The SPT 'N' values measured in the silty clay till varied from 13 to 24 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. Moisture contents measured in the silty clay till ranged from 11 percent to 18 percent.

A 600 mm thick interlayer of sand was contacted within the silty clay till at 4.0 m depth in Borehole SWM1-01.

Results of grain size analyses conducted on silty clay till samples are presented on the Record of Borehole sheets and illustrated on Figure B1 in Appendix B. The test results are summarized in the following table.

Soil Particles	Percentage (%)
Gravel	0
Sand	15 to 23
Silt	41 to 49
Clay	29 to 44

Results of Atterberg Limits tests conducted on samples of the silty clay till are provided on the Record of Borehole sheets and illustrated on Figure B2 in Appendix B. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	24 to 27
Plasticity Index	11 to 13

The results of the Atterberg Limits tests show that the silty clay till is of low plasticity with a group symbol of CL.

Glacial tills inherently contains cobbles and boulders.



4.2.5 Groundwater Conditions

The water levels in the boreholes were observed during the drilling operations and measured upon completion of drilling. Groundwater level was measured at 8.5 m and 5.3 m depth (Elevations 262.3 and 264.9), SWM1-01 and SWM1-02, respectively. These are short term observations and the groundwater level is subject to seasonal fluctuations and climatic changes.



THURBER ENGINEERING LTD.



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Attachments

- Appendix A Culvert #23 – Records of Boreholes, Laboratory Test Results and Borehole Locations and Soil Strata Drawing
- Appendix B SWMP #1 – Records of Boreholes, Laboratory Test Results, Borehole Locations and Soil Strata Drawing

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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


4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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

 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

EXPLANATION OF ROCK LOGGING TERMS


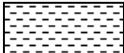



ROCK WEATHERING CLASSIFICATION

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.

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			



Appendix A

Culvert #23

Record of Borehole Sheets (C17-01 and C17-02)

Laboratory Test Results

Drawing titled "Borehole Locations and Soil Strata"

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

METRIC

[illegible]

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No C17-02

2 OF 2

METRIC

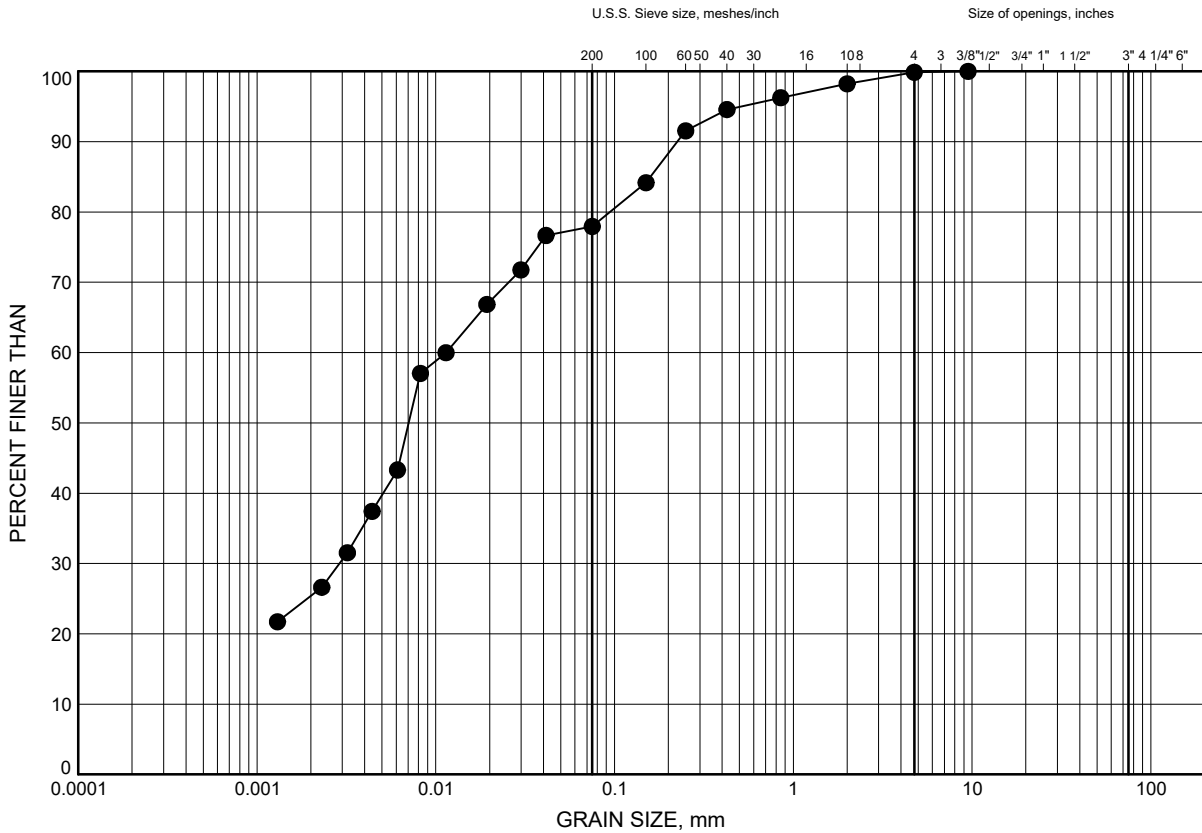
GWP# 2539-04-00 LOCATION Culvert #23, Sta. 24+275 N 4 862 218.1 E 299 906.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.06 - 2017.03.06 CHECKED BY RPR

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					
								○ UNCONFINED	+	FIELD VANE							
						● QUICK TRIAXIAL	×	LAB VANE			WATER CONTENT (%)						
						20	40	60	80	100	20	40	60				
9.9	Continued From Previous Page Clayey SILT , sandy, trace gravel Very Stiff Grey Moist (TILL)		10	SS	17											5 29 48 18	
	Hard		11	SS	44												
262.1																	
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE CAVED IN TO 11.6m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN ASPHALT TO SURFACE.																

Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A1

Silty CLAY FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-02	1.83	273.07

Date April 2017
 GWP# 2539-04-00

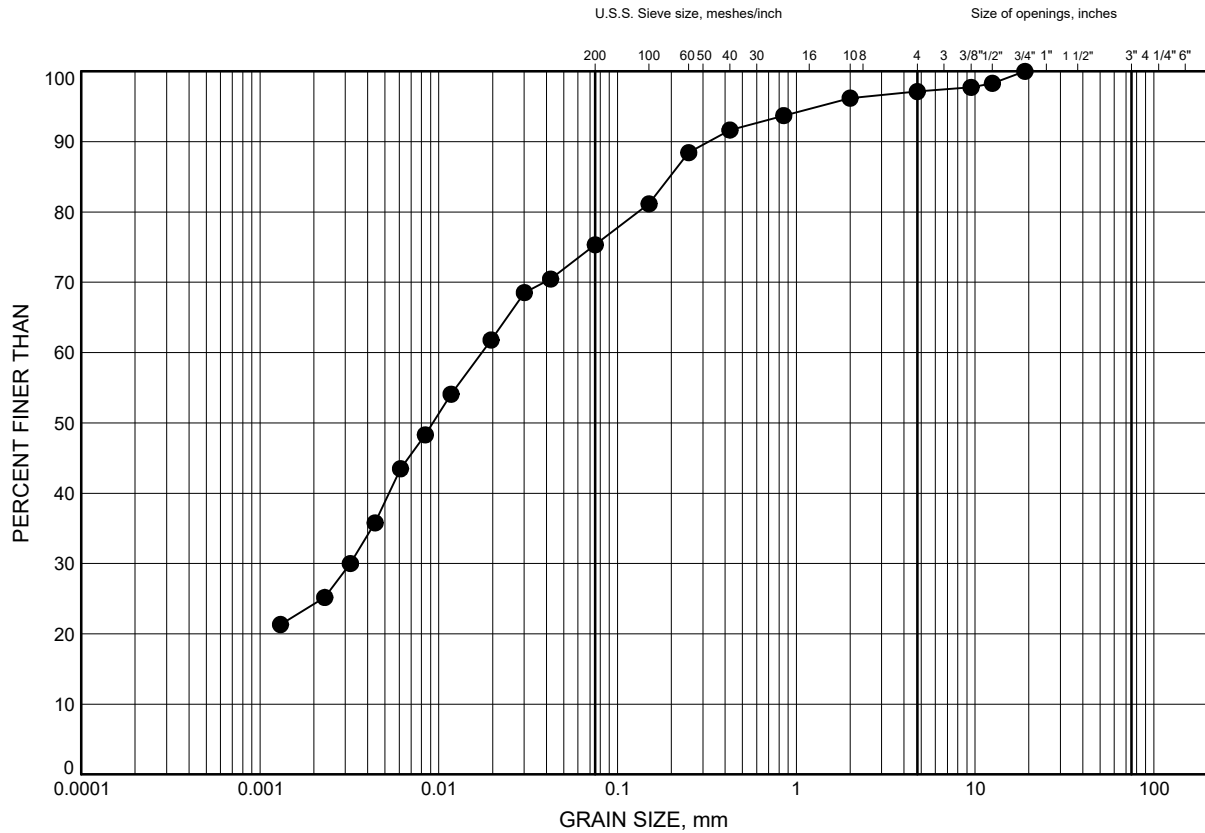


Prep'd AN
 Chkd. RPR

Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A2

Silty CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	2.59	272.21

Date April 2017
 GWP# 2539-04-00

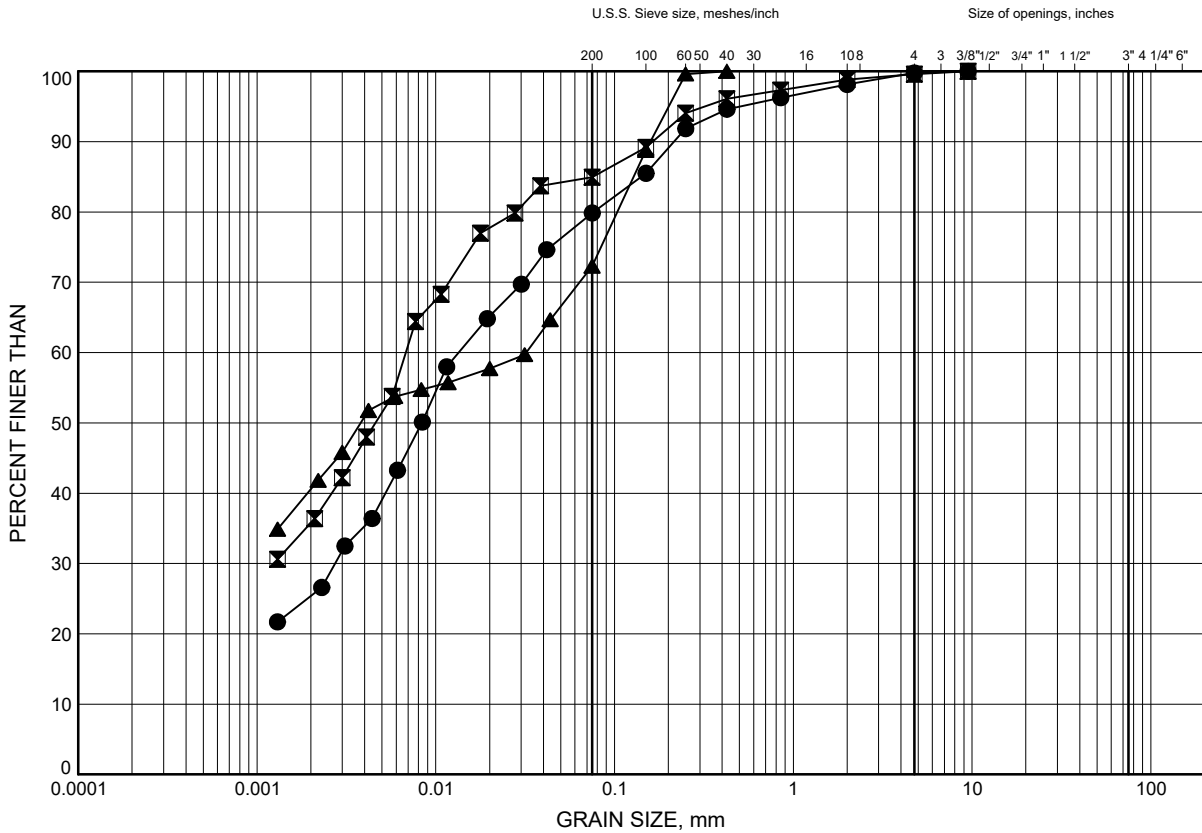


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Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A3

Silty CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	4.88	269.92
⊠	C17-02	4.88	270.02
▲	C17-02	7.92	266.98

Date April 2017
 GWP# 2539-04-00

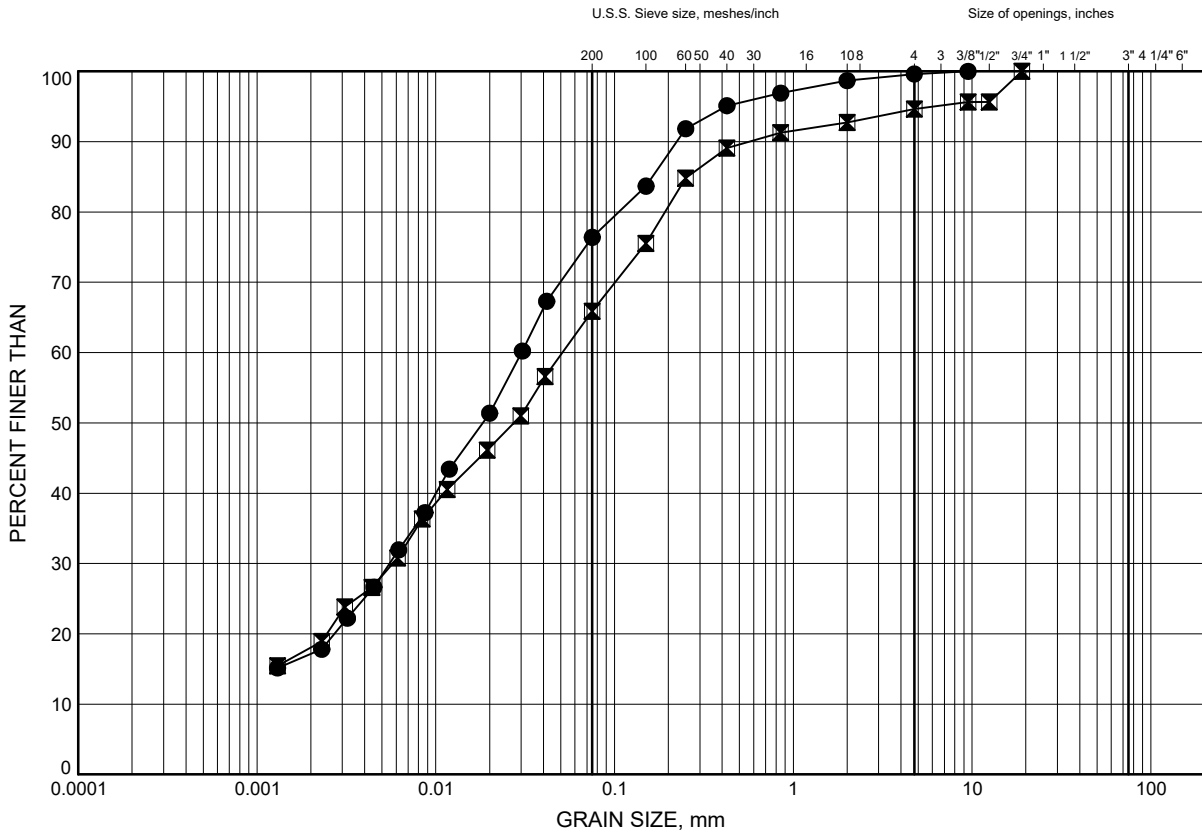


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Culvert #23, Sta. 24+275
GRAIN SIZE DISTRIBUTION

FIGURE A4

Clayey SILT TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	10.97	263.83
⊠	C17-02	10.97	263.93

Date April 2017
 GWP# 2539-04-00



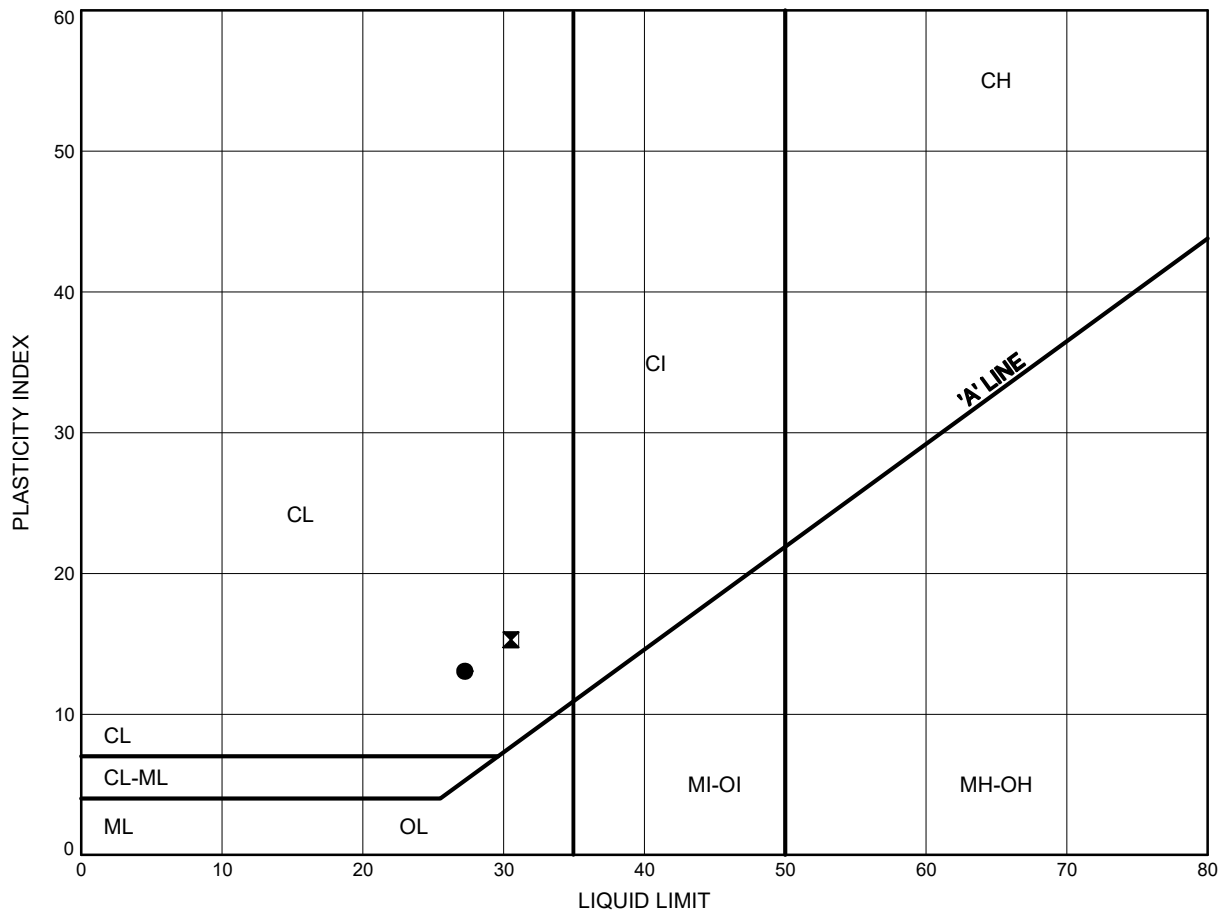
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Culvert #23, Sta. 24+275

ATTERBERG LIMITS TEST RESULTS

FIGURE A5

Silty CLAY TILL



LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	4.88	269.92
⊠	C17-02	4.88	270.02

Date April 2017
GWP# 2539-04-00



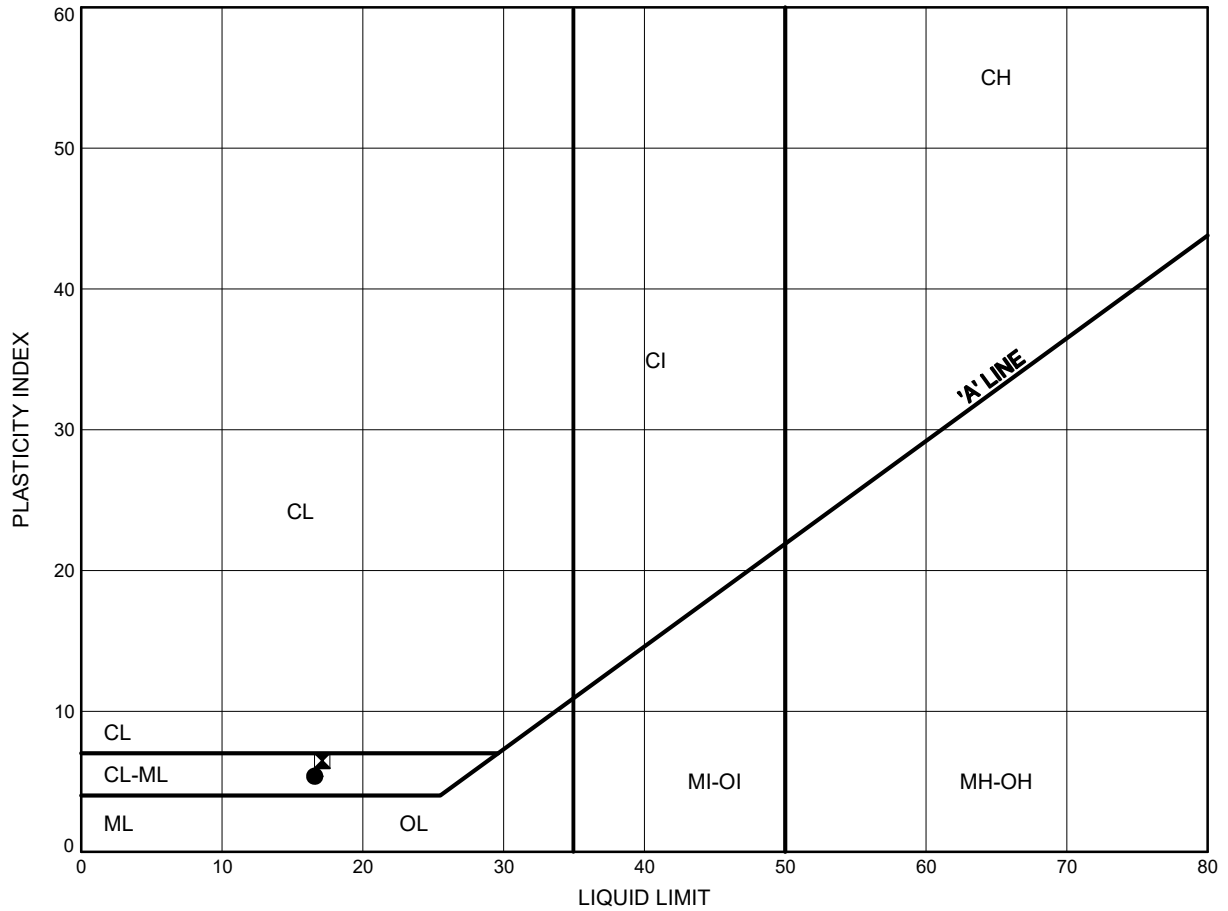
Prep'd AN
Chkd. RPR

Culvert #23, Sta. 24+275

ATTERBERG LIMITS TEST RESULTS

FIGURE A6

Clayey SILT TILL



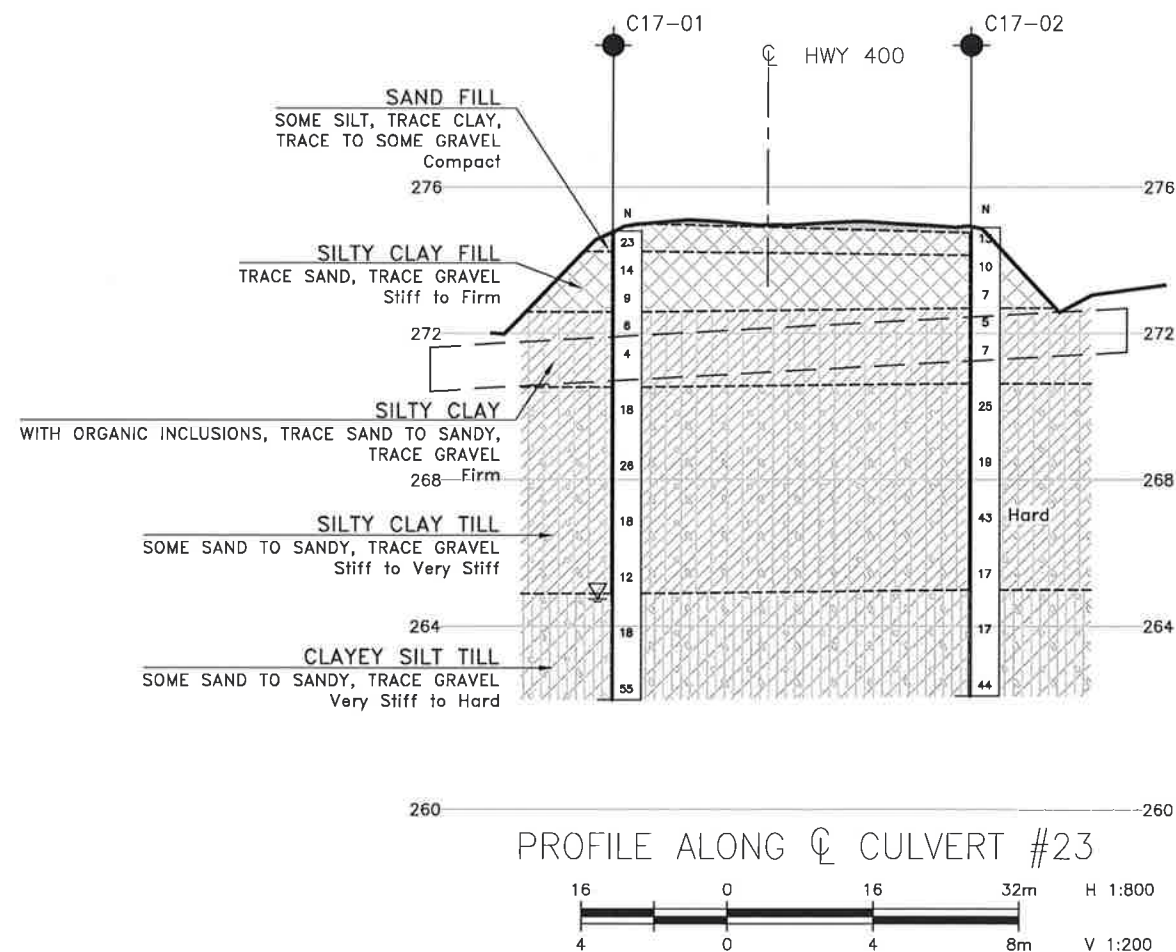
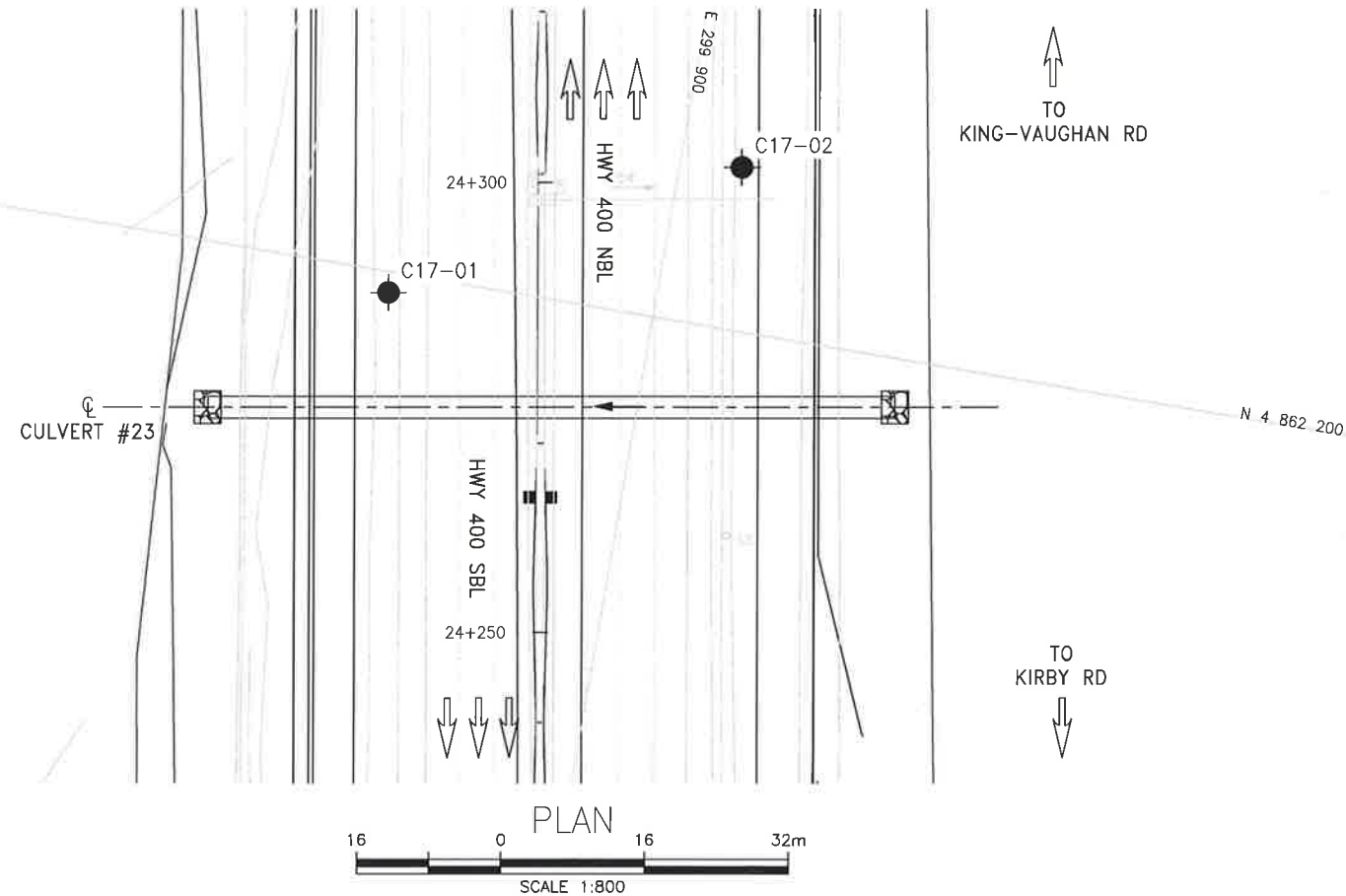
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	C17-01	10.97	263.83
⊠	C17-02	10.97	263.93

Date April 2017
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METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 2539-04-00

HIGHWAY 400
CULVERT #23
STATION 24+275
BOREHOLE LOCATIONS AND SOIL STRATA

SNC-LAVALIN

THURBER ENGINEERING LTD.



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
C17-01	274.8	4 862 197.8	299 870.5
C17-02	274.9	4 862 218.1	299 906.9

-NOTES-

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

GEORES No. 30M13-225



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK SKP	ICODE
DRAWN	AN	CHK RPR	SITE
			STRUCT
			DWG 1



Appendix B

SWMP #1

Record of Borehole Sheets (SWMP1-01 and SWMP1-02)

Laboratory Test Results


Drawing titled “Borehole Locations and Soil Strata”

RECORD OF BOREHOLE No SWM1-01

1 OF 2

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #1 N 4 861 553.4 E 300 044.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.07 - 2017.03.07 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				WATER CONTENT (%)					
270.8	GROUND SURFACE							20	40	60	80	100					
0.0	Clayey SILT , with organics, occasional roots and rootlets Firm Dark Brown Moist		1	SS	4												
270.2																	
0.6																	
	Silty CLAY , some sand, trace gravel, oxide staining Stiff Brown to Grey Moist		2	SS	11		270										
			3	SS	14		269										
268.7																	
2.1	Silty CLAY , some sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		4	SS	13		268									0 19 49 32	
			5	SS	16												
266.8							267										
4.0	SAND , trace silt and gravel (600mm)																
266.2																	
4.6	Grey		6	SS	21		266										
							265										
			7	SS	18		264									0 19 48 33	
							263										
			8	SS	23												
							262										
			9	SS	24												
261.0																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No SWM1-01

2 OF 2

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #1 N 4 861 553.4 E 300 044.9 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.07 - 2017.03.07 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 BOREHOLE CAVED TO 9.0m AND WATER LEVEL AT 8.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO SURFACE.																

ONTMT4S MTO-17265.GPJ 2015TEMPLATE(MTO).GDT 4/26/17

RECORD OF BOREHOLE No SWM1-02

1 OF 2

METRIC

GWP# 2539-04-00 LOCATION Storm Water Management Pond #1 N 4 861 508.3 E 300 048.1 ORIGINATED BY SB
 HWY 400 BOREHOLE TYPE Solid Stem Augers COMPILED BY AN
 DATUM Geodetic DATE 2017.03.07 - 2017.03.07 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
270.2	GROUND SURFACE							20	40	60	80	100					
0.0	Clayey SILT , with organics, occasional roots and rootlets Firm Dark Brown Moist		1	SS	4		270										
269.4																	
0.8	Silty CLAY , some sand, trace gravel, oxide staining Stiff Brown to Grey Moist		2	SS	11		269										
			3	SS	11												
268.0							268										
2.2	Silty CLAY , some sand to sandy, trace gravel Very Stiff Brown Moist (TILL)		4	SS	15												
			5	SS	18		267										
							266										
	Grey		6	SS	20		265										
							264										
			7	SS	15												
							263										
	Wet		8	SS	18		262										
							261										
			9	SS	18												
260.4																	
9.8	END OF BOREHOLE AT 9.8m.																

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

METRIC

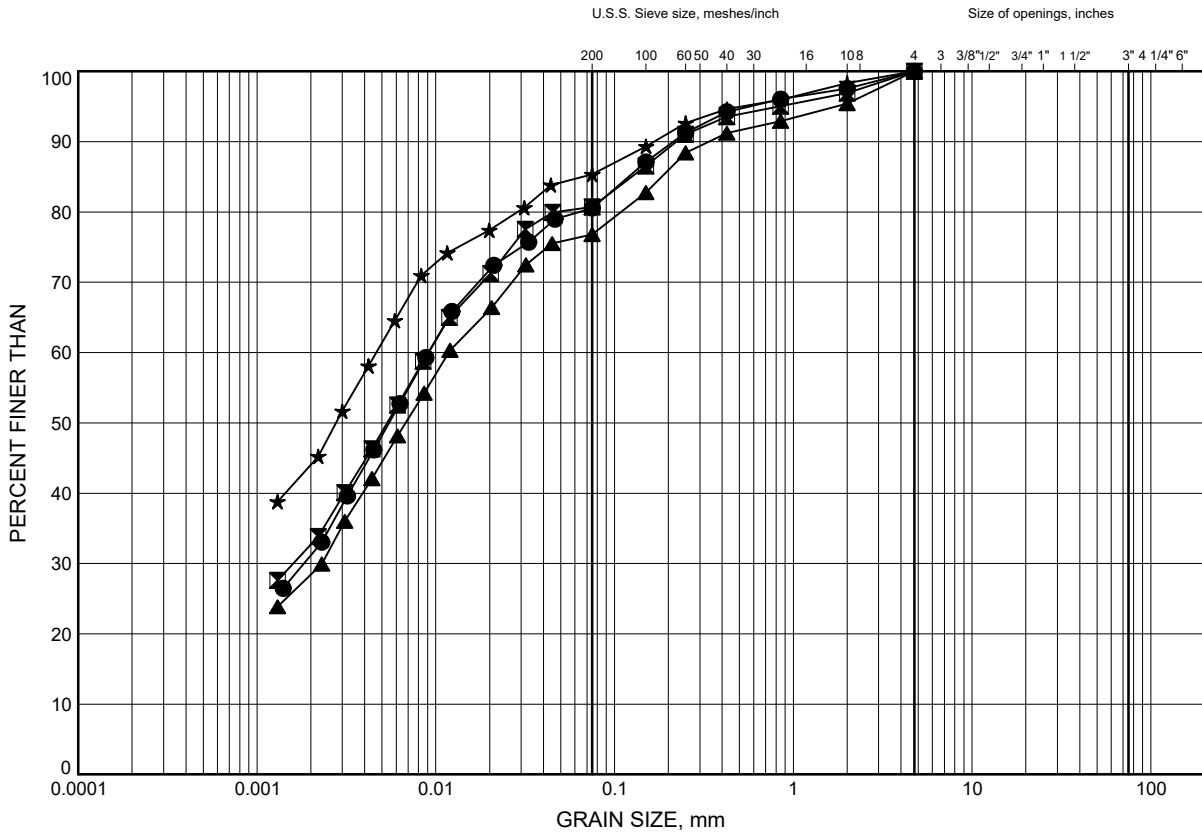
[illegible]

Storm Water Management Pond #1

GRAIN SIZE DISTRIBUTION

FIGURE B1

Silty CLAY TILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SWM1-01	2.59	268.21
■	SWM1-01	6.40	264.40
▲	SWM1-02	3.35	266.85
★	SWM1-02	7.92	262.28

Date April 2017
GWP# 2539-04-00

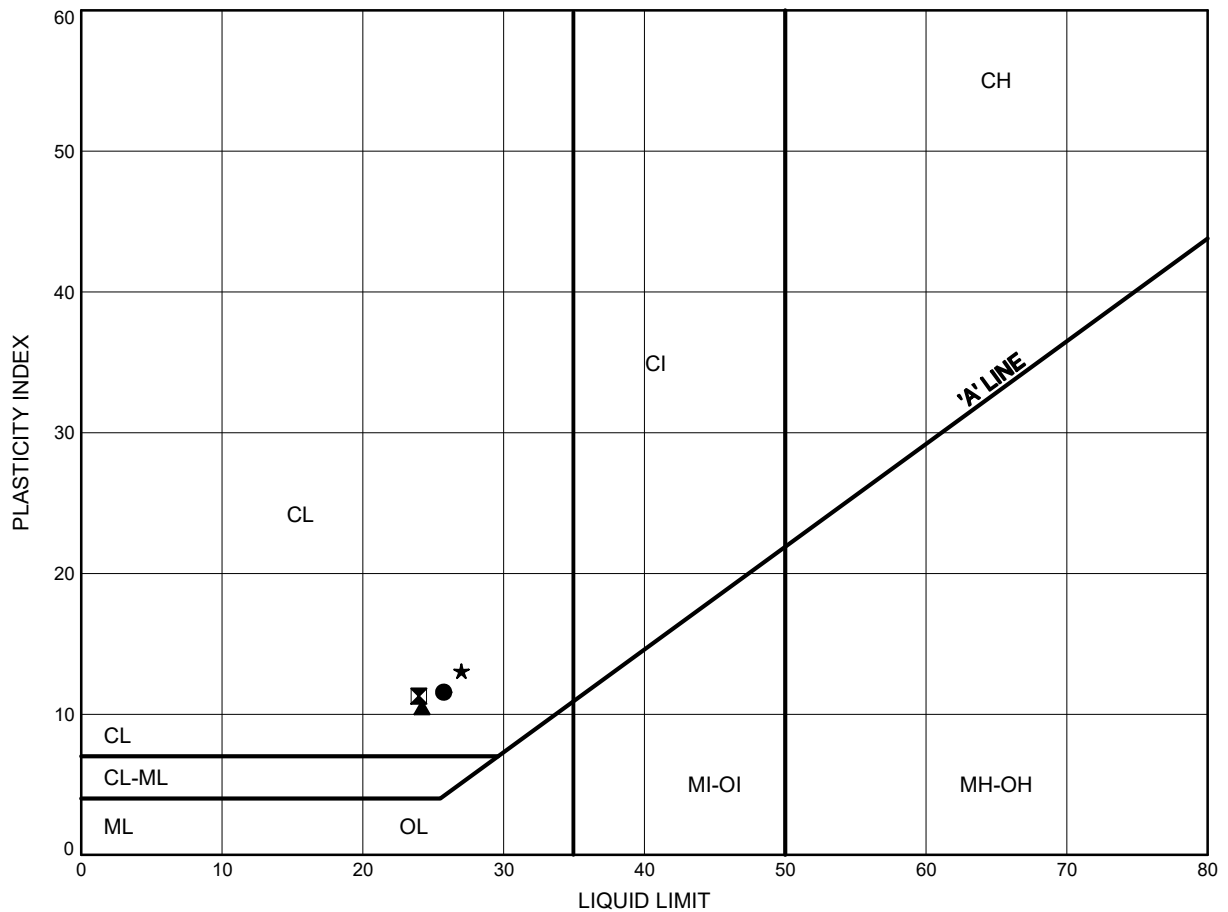


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Storm Water Management Pond #1
ATTERBERG LIMITS TEST RESULTS

FIGURE B2

Silty CLAY TILL



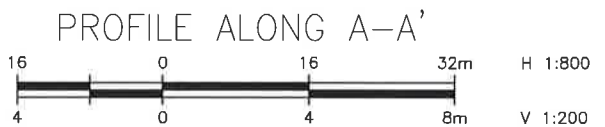
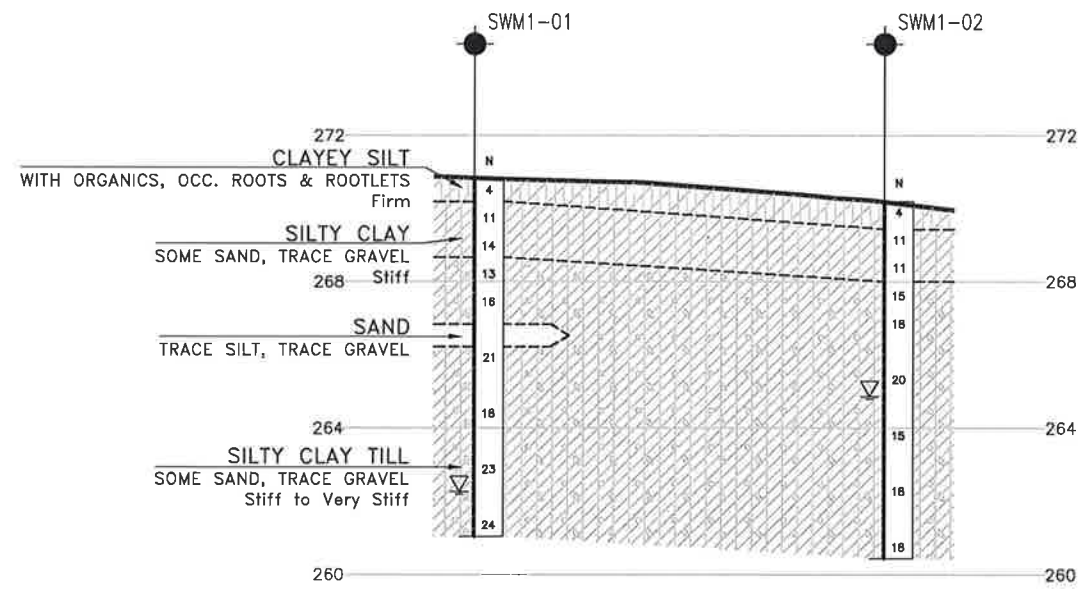
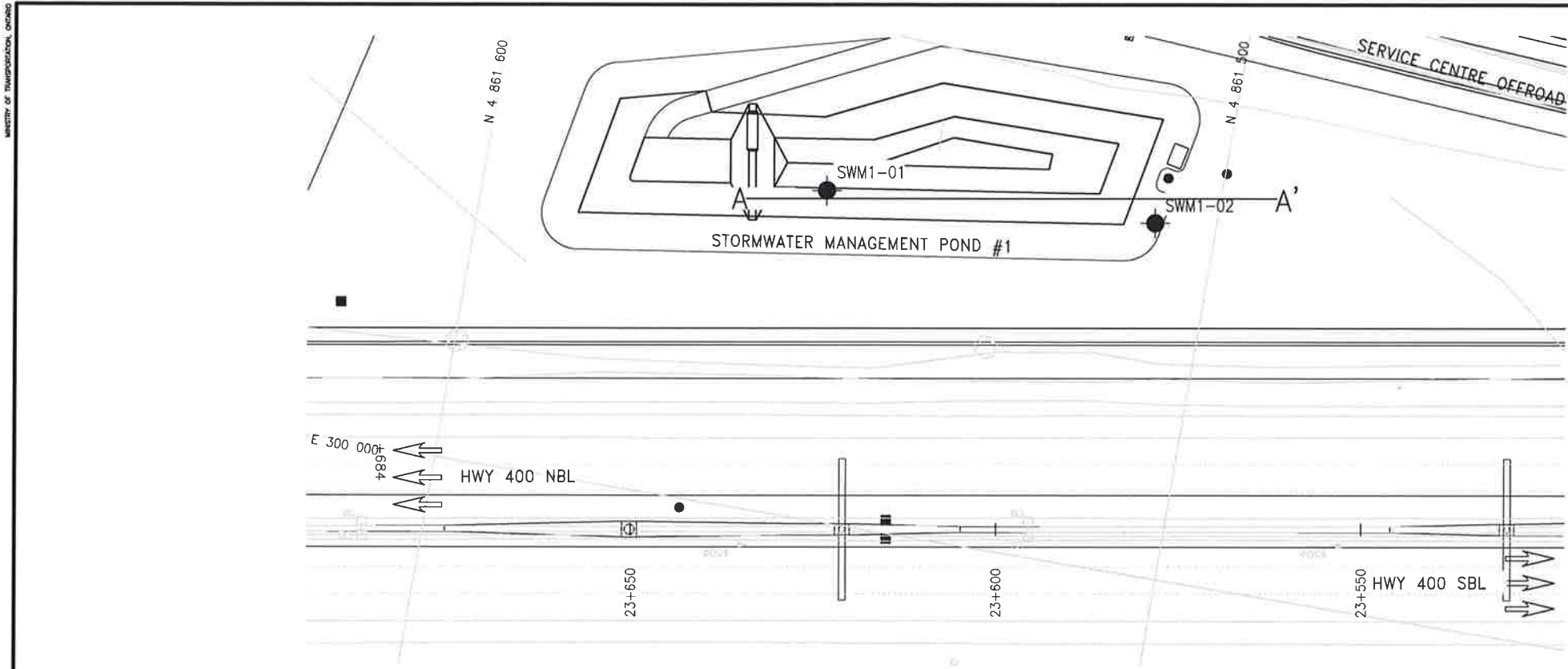
LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	SWM1-01	2.59	268.21
⊠	SWM1-01	6.40	264.40
▲	SWM1-02	3.35	266.85
★	SWM1-02	7.92	262.28

Date April 2017
 GWP# 2539-04-00



Prep'd AN
 Chkd. RPR



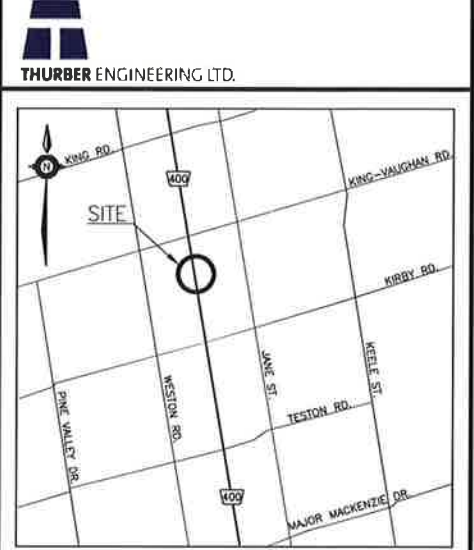
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
WP No 2539-04-00

HIGHWAY 400
STORMWATER MANAGEMENT
POND #1
BOREHOLE LOCATIONS AND SOIL STRATA

SNC-LAVALIN

SHEET



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
SWM1-01	270.8	4 861 553.4	300 044.9
SWM1-02	270.2	4 861 508.3	300 048.1

NOTES-

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GEOCRES No. 30M13-225



REVISIONS	DATE	BY	DESCRIPTION
DESIGN	RPR	CHK SKP	CODE
DRAWN	AN	CHK RPR	SITE
			STRUCT
			DWG 1
			DATE MAR 2018

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