6th Line Municipal Class Environmental Assessment

County Road 27 to St John's Road
Town of Innisfil, ON

September 6, 2016

APPENDIX F: FACTUAL GEOTECHNICAL AND PAVEMENT DESIGN REPORT

November 13, 2015

FACTUAL GEOTECHNICAL AND PAVEMENT DESIGN REPORT

CLASS ENVIRONMENTAL ASSESSMENT FOR 6th LINE FROM 20th SIDEROAD TO ST. JOHN'S ROAD, INNISFIL, ONTARIO

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REPORT

Report Number: 14-13283

Distribution:

4 Copies - HDR Inc.
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1.0 INTRODUCTION

The Town of Innisfil (Town) has retained HDR Inc. (HDR) as the Project Management Consultant to complete the Municipal Class Environmental Assessment (EA) and Preliminary Design Study for the widening and potential rehabilitation or reconstruction of the 6th Line from County Road 27 to St. John's Road, in the Town of Innisfil, County of Simcoe, Ontario. Golder Associates Ltd. (Golder) is part of the HDR team and is providing factual geotechnical engineering information and preliminary pavement engineering services for the project.

The pavement engineering component of the project includes a visual reconnaissance survey, a limited number of boreholes, material sampling laboratory testing, and the preparation of a preliminary Pavement Design Report while the geotechnical component includes a limited number of boreholes, material sampling, laboratory testing and factual geotechnical information for buried municipal services such as sanitary and storm sewers and water mains included in the report.

Currently 6th Line is a 2-lane road with a posted speed of 80 km/h. Based on predicted future uses, the segment of roadway between 20 Sideroad to St. John's Road (approximately 3 km in length, and including the planned Sleeping Lion Development) is anticipated to have future urbanized characteristics, while the segment from County Road 27 to 20 Sideroad (approximately 12 km in length, with mostly agricultural properties) will operate as a rural section.

Based on the recommendation from the 2013 Transportation Master Plan, and additional assessment conducted through this EA study, the Town is proposing to widen 6th Line, between 20 Sideroad and St. John's Road, from a 20 m wide 2-lane local road to a 26-30 m wide 4-lane *urban major collector road*, and proposing to reconstruct 6th Line, between County Road 27 and 20 Sideroad, from a 20 m 2-lane local road to a 2-lane *rural arterial road* with paved shoulders and 30 m right-of-way protection. The project limits are shown on the Key Plan, Figure 1.

In addition to confirming the cross section and preliminary conceptual design of the roadway, the study will review the need for the following corridor features:

- Bike lanes or multi-use trails;
- Potential need for a future interchange at Highway 400;
- New structure or structure widening over the existing GO rail line;
- Intersection improvements.

This report summarizes the results of the preliminary geotechnical investigation and provides preliminary pavement design recommendations. The factual geotechnical data and preliminary pavement designs should be reviewed, and updated during the detailed design stage.

2.0 SCOPE OF WORK

The geotechnical and pavement scope of work includes the following:

- A visual pavement condition survey evaluating the existing condition of the pavement;
- A pavement investigation consisting of a limited number of shallow boreholes on the mainlanes and in the widening areas as well as full depth cores to check the thickness of the surface treatment/asphalt layers;
- A geotechnical investigation consisting of limited number of deeper boreholes to assess the suitability of the subgrade soils and shallow groundwater conditions for the installation of underground services;
- A laboratory testing program on selected granular and subgrade soils samples;
- Pavement engineering analysis and design to provide recommendations for the preferred design strategies; and,
- Factual geotechnical information to support the design of underground services for Section 1.

This report should be read in conjunction with the "Important Information and Limitations of This Report" in Appendix A. The reader's attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

3.0 PROJECT UNDERSTANDING

The 6th Line is currently an east-west local road extending from County Road 27 easterly to Lake Simcoe. Section 1, from the 20th Sideroad to St. John's Road, is a two lane rural facility with an aged surface treatment wearing course over the major part with short sections surfaced with asphalt, mainly at the intersections with the 20th Sideroad and St John's Road.

We understand the Town is planning to upgrade Section 1 to an urban cross section by reconstruction and widening as required, to accommodate up to four lanes as well as provide left turn lanes between the 20th Sideroad and future Street B (~1.9 km). A two lane urban cross section will be provided from Street B to St. John's Road (~1.1 km).

Section 2, from County Road 27 to the 20th Sideroad is currently a two lane rural facility with an aged surface treatment wearing surface over the majority of its length with short sections of asphalt wearing surface near the intersections with 5th, 10th, and 20th Sideroads, Yonge Street, and County Road 27, and the Hwy 400 overpass.

The Town is planning to upgrade this section of 6th Line to accommodate higher traffic loading based on future growth in the area and the potential future construction of an interchange at Highway 400. Eventually Section 2 may also be widened to accommodate up to four lanes of traffic, but in the interim, the current two lane rural cross section will be maintained.

Photographs showing the conditions on the existing pavement are provided on Figures 3A to 3C following the text of this report.

4.0 INVESTIGATION PROCEDURES

The field investigation was carried out on April 15th and April 16th, 2015. Eight (8) deeper boreholes to obtain geotechnical information for site servicing, eight (8) shallow boreholes through the existing pavement, ten (10) shallow hand auger holes in the pavement widening areas and six full depth cores to check the surface treatment and asphalt thicknesses, were advanced within the limits of Section 1. Twelve (12) shallow boreholes through the existing pavement and four (4) coreholes to check the existing wearing surface thicknesses were advanced within the limits of Section 2. A topographic survey to locate the boreholes was not part of this assignment and the boreholes were marked in the field based on measurements from site features. As such, the recorded locations are considered approximate. Borehole elevations were provided by HDR. The boreholes/auger holes were advanced to depths of approximately 1.0 m to 8.0 m below the existing ground surface. Boreholes drilled through the existing pavement were advanced using a truck mounted drill rig supplied by KC Drilling Ltd. Portable gasoline-powered hand augering/spooning equipment was used to drill the boreholes located in the widening areas.

Groundwater conditions and water levels in the open boreholes were observed during and upon completion of drilling operations. Two 19 mm diameter piezometers were installed, one in Borehole BH103, and the other in BH104 to allow for groundwater level monitoring.

The boreholes that did not have piezometers were backfilled with bentonite upon completion, in accordance with Ontario Regulation 903 (as amended) and the road surface was reinstated using dry mix and/or cold asphalt patch. Backfill around the piezometers consisted of filter sand within the slotted screen section, above which bentonite pellets were placed to create a seal. Soil cutting were placed above the bentonite seal to ground surface. Flush mount covers were provided to access the piezometers.

The fieldwork was monitored by members of Golder's technical staff, who located the boreholes and coreholes, arranged for the clearance of the underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined the recovered granular and subgrade samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's geotechnical laboratory where the samples underwent further visual examination and laboratory testing. Classification testing (water content and grain size distribution) was carried out on selected samples. Record of Borehole sheets for the boreholes advanced for site servicing are provided following the text of this report while the results of boreholes advanced within the existing pavement and in the widening areas are provided in Tables 1 to 3. Corehole information is provided in Table 4.

5.0 SUBSURFACE CONDITIONS

Stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. The subsoil conditions are expected to vary between and beyond the borehole locations.

Soil descriptions contained in this report and on the Record of Borehole sheets are based on commonly accepted methods of classification employed in geotechnical practice. Classification and identification of soil involves judgement and Golder does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The method of Soil Classification and Symbols and Terms Used on Records of Boreholes are provided following the text of this report to assist in the interpretation of the borehole logs.

The following is a summary of the subsurface conditions encountered at the site.

5.1 Existing Pavement and Subgrade Conditions

Based on the results of the geotechnical investigation, the existing pavement structure and the subgrade conditions along the mainlanes of the road sections within the limits of Section 1 are summarized in the following table.

BH #	Surface Treatment (mm)	Granular Base (mm)	Granular Subbase (mm)	Total Thickness (mm)	Granular Base /Subbase Condition	Predominant Subgrade Classification	Subgrade Moisture Condition	Subgrade Frost Susceptibility	Water Level (m)
BH101	110*	130	210	450	-	SM to ML	Moist to Wet	Medium to High	2.0
BH102	30	70	510	610	Unacceptable	SM to CL	Moist	Low	4.0
BH103	25	75	900	1000	-	CL	Moist	Low	1.4
BH104	25	125	380	530	-	CL-ML	Moist	Medium	6.2
BH105	30	120	420	570	-	CL	Moist	Low	-
BH106	30	120	340	490	-	ML/SM	Moist	Low	3.7
BH107	30	240	430	700	-	ML/SM	Moist	Low	-
BH108	25	125	260	410	Unacceptable	ML/SM	Moist	Low	-

*Asphalt was encountered in the borehole advanced at this location

The topsoil and organic material thickness measurements and the subgrade soil conditions within the proposed widening areas of Section 1 are summarized in the following table.

BH #	Topsoil/ Organic Material Thickness (mm)	Predominant Subgrade Classification	Subgrade Moisture Condition	Subgrade Frost Susceptibility	Water Level (m)
BH201 22+200 9.0 Lt of C/L **BH202** 22+600 7.5 Lt of C/L **BH203** 22+600 9.5 Rt of C/L **BH204** 23+142 8.0 Lt of C/L **BH205** 23+400 17.0 Lt of C/L **BH206** 23+400 18.0 Rt of C/L **BH207** 23+800 10.0 Rt of C/L **BH208** 24+300 8.80 Lt of C/L **BH209** 24+800 10.0 Lt of C/L **BH210** 25+300 7.8 Rt of C/L	290-600 Avg. 420	ML ML/SM	Moist to Wet	HSFH LSFH	Encountered at surface to below 1.0 m depth

Highly frost susceptible soils were encountered in BH101 and BH201. Frost susceptible material, where encountered, should be excavated to the frost penetration depth (1.5 m) and backfilled with suitable earth borrow or Granular B, Type I material.

Based on the results of the geotechnical investigation, the existing pavement structure and the subgrade conditions on the mainlanes of the road sections within the limits of Section 2 are summarized in the following table.

BH #	Asphalt or Surface Treatment (mm)	Granular Base (mm)	Granular Subbase (mm)	Total Thickness (mm)	Granular Base /Subbase Condition	Predominant Subgrade Classification	Subgrade Moisture Condition	Subgrade Frost Susceptibility	Water Level (m)
BH301	25	385	260	670	-	CL-ML	Moist	Medium	-
BH302	25	295	320	640	Unacceptable	CL-ML	Moist	Medium	-
BH303	25	275	370	670	-	CL-ML	Moist	Medium	-
BH304	25	210	300	560	-	CL-ML	Moist	Medium	-
BH305	25	175	700	900	-	ML/SM	Wet	Low	0.9
BH306	25	225	225	590	-	SM	Moist	Low	-
BH307	25	425	450	900	-	CL-ML	Moist	Medium	-
BH308	25	315	330	670	Unacceptable	SW	Moist to Sat.	Low	1.1
BH309	25	275	350	650	-	SM	Moist to Sat.	Low to Medium	1.2
BH310	80*	160	220	460	-	SM	Moist	Low	-
BH311	25	95	440	560	-	SM	Moist	Low	-
BH312	180*	120	160	460	-	SM	Moist	Low	-

*Asphalt was encountered in the borehole advanced at this location

The results of the gradation tests carried out on selected granular base samples indicated that the granular samples tested did not meet the OPSS 1010 requirements for Granular A Type I due to the grading being too fine on multiple sieves.

The results of the gradation tests carried out on selected granular subbase samples indicated that the granular samples tested did not meet the OPSS 1010 requirements for Granular B, Type I due to excessive fines.

Grain size distribution curves for two granular base and two granular subbase samples are shown on Figures B1 and B2, respectively in Appendix B.

The results of particle size analysis of five subgrade samples are shown on Figures B3 to B6, in Appendix B.

5.1.1 Buried Asphaltic Material

A buried layer of surface treatment, approximately 25 to 30 mm in thickness was encountered within the granular base material in Boreholes BH301, BH302 and BH303. In Boreholes BH307, BH308, and BH309, a layer of Recycled Asphalt Pavement (RAP) approximately 125 to 155 mm in thickness was encountered underlying the surface treatment and above the granular base material. In the summary table in Section 5.1, both the buried surface treatment and RAP thicknesses have been included as part of the granular base layer for pavement design analysis purposes. Refer to the Record of Pavement Boreholes in Table 1 and Table 2 for detailed pavement structure information.

5.1.2 Organic Material

Organic material was encountered directly underlying the pavement structure and overlying the native subgrade soils in Boreholes BH305, BH307, and BH308. The organic material was generally characterized as moist and loose, and saturated below the groundwater table. Where encountered beneath the pavement structure the organic material ranged from approximately 280 to 300 mm in thickness.

5.2 Subsoil Conditions for Service Installations

Boreholes BH101 to BH108 were advanced to depths ranging from 4.6 m to 8.0 m below the existing road surface. The subsurface soil conditions encountered below the pavement structure and shallow fill materials in the above noted boreholes generally consisted of deposits of glacial tills, ranging in gradation from sandy silty clay till to silt and sand till. A non-cohesive layer of silt was encountered in BH101. Fill materials were encountered below the granular materials in BH101 to BH104, BH106 and 107, and extended to depths ranging from approximately 1.4 m to 5.6 m below the existing road surface. The subgrade soils within the drilling depth (up to about 8 m) and the physical characteristics of each stratum are summarized in the following table:

Subsoil Stratum	Boreholes	Depth (m) below Ground Surface	"N" Values (blows/0.3 m Penetration)	Consistency / Relative Density	Water Content (%)	Comments
Fill Materials	BH101 BH102 BH103 BH104 BH106 BH107	Encountered below the pavement granulars and extended to depths ranging from 1.4 m to 5.6 m	14 to greater than 100	Compact to very dense	7 to 25	- Some organic material encountered within fill in BH106 from 0.5 to 1.4 below the pavement surface and BH107 from 0.7 to 1.4 below the pavement surface.
(ML) Silt	BH101	Encountered below Fill Materials and extended to depth of 5.0 m	24 to 48	Compact to dense	15 to 26	
(CL) Silty Clay	BH102 BH103 BH105	Encountered below Fill Materials and extended to depth of 2.1 m	15 to 28	Stiff to very stiff	14 to 24	
(CL) Silty Clay Till	BH102 BH103	Encountered below Fill Materials or Silty Clay and extended to depth of 2.9 m	39 to 44	Hard	11 to 23	
(ML/SM)Silt and Sand	BH102 BH103 BH104 BH105 BH106 BH107 BH108	Encountered below Fill Materials, Silty Clay or Silty Clay Till and extended to depths ranging from 4.7 m to 8.0 m	40 to greater than 100	Dense to very dense	4 to 16	

5.3 Shallow Groundwater

Groundwater was encountered in Boreholes BH101, BH102, BH103, BH106, BH304, BH305, and BH309 during drilling, at depths ranging from 0.9 to 4.0 m below ground surface. Boreholes BH104, BH105, BH107 BH108, BH301 to BH303, BH306, BH307, and BH310 to BH312 were dry upon completion of drilling. The groundwater level within the piezometer installed in BH104 was dry upon completion of installation; but subsequently on April 28, 2015, the water level was measured at a depth of 6.2 m below ground surface. The stabilized groundwater level measured in the piezometer installed in BH103 was 1.4 m below ground surface on April 28, 2015.

It should be noted that these observations reflect the shallow groundwater conditions encountered in the boreholes during the time of the field investigation and the measurements recorded on April 28, 2015. Seasonal fluctuations should be anticipated throughout the project limits.

6.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides engineering information for the factual geotechnical and pavement design aspects of the project, based on our interpretation of the borehole data, the results of our visual pavement evaluation and on our understanding of the project requirements. The information in this portion of the report is provided for the guidance of the design engineers. Where comments are made on construction, they are provided only in order to highlight aspects of construction which could affect the design of the project.

Our professional services for this assignment address only the geotechnical (physical) aspects of the subsurface conditions at this site. The geo-environmental (chemical) aspects, including the consequences of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources, are outside the terms of reference for this report and have not been investigated or addressed.

6.1 Pavement Design and Recommendations

The pavement design and analysis was carried out in accordance with the "*1993 AASHTO Guide for Design of Pavement Structure*" and the 'Innisfil's Engineering Design Standards and Specifications Manual" (Town's Standards). Details of the pavement design and analysis are provided in Tables C1 to C6, Appendix C.

6.1.1 Traffic Loading and Pavement Structural Analysis

Traffic load calculations were carried out in accordance with the Ministry of Transportation Report "Procedures for Estimating Traffic Loads for Pavement Design, 1995". Traffic data for this section of 6th Line from the 20th Sideroad to St. John's Road provided by HDR in an email dated March 23, 2015 are summarized in the following table.

Location	From	To	2015 AADT	2015 %COMM	2031 AADT	2031 %COMM	Annual Rate of Increase	Town of Innisfil Road Classification
Section 1	20th Sideroad	St. John's Road	800	4%	17,100	5%	17%	Major Collector
Section 2	County Road 27	20th Sideroad	300	3%	11,300	5%	21%	Major Arterial

Based on the road classification and the results of the geotechnical investigation, the design parameters selected for the AASHTO design analysis are presented in following table.

Design Considerations	Parameters Selected for Pavement Design	Parameters Selected for Pavement Design
	Section 1 - 6th Line From 20th Sideroad to St. John's Road	Section 2 - 6th Line from County Road 27 to 20th Sideroad
Road Classification	Urban Minor Arterial (Equivalent MTO classification)	Urban Principal Arterial (Equivalent MTO classification)
Initial Serviceability Index	4.4	4.5
Terminal Serviceability Index	2.2	2.5
Reliability (%)	85	90
Standard Deviation	0.49	0.49
Estimated Resilient Modulus for Subgrade Soils (MPa)	25	25

The Equivalent Single Axle Loads (ESALs) were calculated for a 20 year design life for the proposed reconstruction and widening. Based on the traffic data, the design life, and the parameters selected, the estimated ESALs, the associated required Structural Number (SN) and the existing pavement SN are summarized in the following table.

Road	ESALs	Required SN (mm)	Existing Pavement SN (mm)	Structural Deficiency in SN (mm)
6th Line from 20th Sideroad to St. John's Road	1.9 X 10^6	117	30	87
6th Line from County Rod 27 to St. John's Road	1.7 X 10^6	125	34	91

Based on the results of the investigation and laboratory testing, the existing pavement on the 6th Line is significantly structurally deficient to carry future traffic.

In Section 1, it is understood that grades will be adjusted. As such, we have included an option that incorporates a grade raise as well as a full depth reconstruction option for Section 1. Based on the traffic load and pavement structural analysis, the following reconstruction/widening strategy is recommended for 6th Line between St. John's Road and the 20th Sideroad:

Option 1 - Grade raise greater than 440 mm

Remove the existing surface treatment to provide for:

- 40 mm HL-3 Surface course
- 100 mm HL-8 Binder course (in two 50 mm lifts)
- 300 mm Granular A, Base

Option 2 - Full Depth Reconstruction and Grade Raise Less than 440 mm

- 40 mm HL-3 Surface course
- 100 mm HL-8 Binder course (in two 50 mm lifts)
- 150 mm Granular A, Base
- 450 mm Granular B, Type I, Subbase (minimum)

The reconstructed road will have a Structural Number of 120 mm which exceeds the requirement of 117 mm. The thickness of pavement structure layers also satisfies the minimum requirements of the Town's Standards. The thicknesses of the surface and binder courses have been adjusted slightly to satisfy the minimum lift thickness for each type of asphalt mix.

In Section 2, it is understood that grades could be adjusted, but there will be additional costs to reinstate entrances. As such, we have included an option that incorporates a grade raise as well as a full depth reconstruction option for Section 2. Based on the traffic load and pavement structural analysis, the following reconstruction strategies are recommended:

Option 1 - Grade Raise of ~440 mm

Remove the existing surface treatment to provide for:

- 40 mm HL-3 Surface course
- 100 mm HL-8 Binder course (in two 50 mm lifts)
- 300 mm Granular A, Base

Option 2 - Full Depth Reconstruction

- 40 mm HL-3 Surface course
- 100 mm HL-8 Binder course (in two 50 mm lifts)
- 150 mm Granular A, Base
- 500 mm Granular B, Type I, Subbase (minimum)

We understand that the potential future condition for the 6th Line is the construction of an interchange at the Highway 400 crossing. The increase in traffic volumes would necessitate widening of the 6th Line between County Road 27 and the 20th Sideroad to two lanes in each direction.

6.1.2 Other Design Features and Construction Considerations

The road reconstruction work should be carried out in accordance with OPSD 216.010 and 216.020 and the Town's Standards. Some design features and construction considerations are highlighted below.

Stripping of Topsoil/Organic Materials

Topsoil or organic material should be removed completely regardless of depth. Stripping quantities should be estimated based on the average topsoil or organic material depth of 420 mm.

Subgrade Preparation

The predominant subgrade material within the footprint of the reconstruction/widening is expected to be silty sand, silty clay, silt materials and acceptable fills in proposed widening areas. If highly frost susceptible silt is encountered when excavating for the pavement structure it should be sub-excavated to the 1.5 m frost depth and replaced with suitable earth borrow or Granular B, Type I. The subgrade should be proof-rolled prior to placement of any granular materials. Loose or soft areas encountered in the subgrade should be excavated and replaced with Granular A material in accordance with the Town's Standards, and compacted to provide a stable uniform subgrade. After proofrolling, grade the subgrade to the desired crossfall and compact any required fill material to a minimum of 95 percent of the material's Standard Proctor Maximum Dry Density (SPMDD). Earth grading should be carried out in accordance with OPSD 200 Series.

The majority of the widening will be over shallow fill. Fill material for this project may be obtained from the removal of the existing roadbed, as well as from offsite sources. Earth borrow material, if required, should consist of approved materials which meet the requirements of OPSS 212. The existing granular base, sandy subbase materials excavated from the existing roadbed can also be used as earth borrow provided that the materials are kept free of contamination by topsoil and other organics. To ensure adequate and uniform support throughout the pavement structure, the placement of borrow material should be carefully controlled. Mixing of materials from different sources that could result in differential settlement, frost heave, or drainage problems

should be avoided. The existing non frost susceptible soils excavated during construction could also be used as earth borrow provided they are free of organics and deleterious materials.

Granular Materials

Granular A should be used as granular base material and Granular B, Type I should be used as granular subbase material. As an alternative, 20 mm crusher run limestone can be used as granular base material and 50 mm crusher run limestone can be used as granular subbase in this project. All granular materials and placement should be conformed to OPSS.MUNI 1010.

Granular materials used in the road base and subbase shall be placed in layers not exceeding 150 mm and compacted to 100 percent of the material's SPMDD.

Care should be taken during excavation to ensure that the existing and new granular materials are not contaminated by construction traffic.

Asphalt Mixes

It is recommended that HL-3 mix can be used as surface course and HL 8 mix can be used as binder course. Alternatively, Superpave hot mix asphalt could be used in place of conventional Marshall type mixes as outlined in the following table. The traffic category and Performance Grade Asphalt Cements (PGAC) of the asphalt mixes for both the Marshall and the Superpave alternatives are listed in the table below.

Courses	Marshall HMA Type	Superpave Equivalent	Traffic Category	PGAC Grade
Surface Course	HL- 3	SP 12.5	B	58-28
Binder Course	HL- 8	SP 19.0	B	58-28

Asphalt material and placement requirements should be in accordance with OPSS 310 and OPSS 1150. According to the Town's Standards, use of Superpave mixes must be approved by the Town and the design and placement of Superpave mixes should conform to OPSS.MUNI 1151 and current AASHTO specifications.

The binder course (HL-8 or SP 19.0) should be compacted to at least 91 percent of the material's Maximum Relative Density (MRD), and the surface course (HL-3 or SP 12.5) should be compacted to at least 92 percent of the material's MRD.

Drainage

Subdrains should be installed beneath the new curb and gutter area in accordance with OPSD 216.021. The drainage system should consist of a 100 mm diameter, perforated corrugated plastic pipe wrapped in filtercloth, placed inside a trench and surrounded by Granular A, to satisfy the Town's guideline. The trench should be lined with a suitable geotextile prior to placing the Granular A material. At the top of the trench, the geotextile should overlap a minimum of 100 mm.

Pavement Transitions

Where the new pavement abuts existing pavement at the limits of the project, as well as at the adjacent streets and major driveways, proper transverse joints should be constructed to key the new asphalt into the existing paved surface, in accordance with the Town's Standards.

Sideroads and Entrances

Paving at existing sideroads intersecting the 6th Line should be extended through the intersection to beyond the radii (i.e. St. John's Road, 20th Sideroad, Yonge Street, 10th Sideroad, 5th Sideroad and Country Road 27). Additional investigations should be completed during Detail Design to determine the paving or reconstruction requirements. Paved residential entrances should be reinstated with a 40 mm extension of the surface course. Paved commercial entrances should be reinstated with an extension of both the surface and the upper binder courses (90 mm).

6.2 Geotechnical Considerations for Installation of Underground Services

It is understood that the Town will evaluate the need for servicing during Detail Design of the project. The finalized alignments and profiles of the utilities were not provided to us at this time, however, based on a review of current design drawings dated March 2015, and the email received from HDR on May 8, 2015, the minimum cover for the proposed watermain and sewers will range between 1.5 m to 2.8 m below the road surface.

6.2.1 Trench Excavations

Based on the information provided by HDR and typical pipe sizes of 300 mm to 900 mm diameter, watermain and sewer installations will require trench excavations approximately 2 m to 4 m in depth below the existing road surface. Based on the results of the geotechnical investigation, the founding soils for the services will be primarily glacial tills ranging in gradations from sandy silty clay till to silt and sand till, silt (in the vicinity of Borehole BH101) and fill materials. The native subsoils (underlying the shallow fills) are considered to be suitable for supporting the pipes, provided the integrity of the base can be maintained during construction. The suitability of the existing fill materials to support the pipes, if encountered at the base of the trench, should be further assessed during construction.

As mentioned in Section 5.3, groundwater was encountered during the drilling investigation in Boreholes BH101 to BH103 and BH106 at depths ranging from about 2.0 m to 4.0 m below ground surface. Further, groundwater levels in the monitoring wells installed in Boreholes BH103 and BH104 were measured at a depth of 1.4 m and 6.2 m below ground surface on April 28, 2015, respectively. Considering the trench excavation depths anticipated (i.e., up to about 4 m in depth), the services will generally be at or below the local groundwater table at most locations.

A Permit to Take Water (PTTW) should be obtained from the Ontario Ministry of Environment and Climate Change (MOECC) for any required dewatering in excess of 50 m^3/day. A PTTW may be required for the project and should be further examined during Detail Design.

It would be prudent to carry out a "public digging" (i.e., test pitting) during the tender stage, especially within the vicinity of shallow water conditions in Boreholes BH101 and BH103, to allow prospective bidders to assess the subsurface conditions and determine the type of groundwater control required. The responsibility for the design, equipment selection and operation of construction dewatering method for the installation of the servicing should entirely be that of the contractor. Suspended particulate should be removed from all abstracted water from the excavations prior to release to the environment. Additional groundwater level monitoring in the existing piezometers should also be considered to further assess the seasonal fluctuations at the site.

It is anticipated that the majority of the construction of the service installations will be carried out using vertically excavated, unsupported excavations (using a properly engineered trench liner box for protection, certified by an experienced engineer); or by a supported (sheeted) excavation, if conditions warrant, in close proximity to adjacent underground services or structures.

It must be emphasized that a trench liner box provides protection for construction personnel but does not provide any lateral support for adjacent excavation walls, underground services or existing structures. For this reason, it is imperative that underground services and existing structures adjacent to the trench excavations be accurately located prior to construction and adequate support provided where required, as per the Town's Standards.

Where trench boxes are utilized, it is anticipated that in the fill materials and non-cohesive silty/sandy soils, the unsupported soils on the trench sides will relax, filling the void between the trench walls and trench box. This may lead to loss of ground below the pavement and potentially undermine and reduce the stability of the pavement structure adjacent to open traffic lanes. To minimize this effect, the gap between the trench walls and trench box should be minimized during the excavation and trench box installation.

Where excavations are conducted by conventional temporary open cuts, side slopes should not be steeper than 1 horizontal to 1 vertical. However, depending upon the construction procedures adopted by the contractor, actual groundwater seepage conditions, the contractor's groundwater control methods and weather conditions at the time of construction, some flattening and/or blanketing of the slopes may be required. Care should be taken to direct surface water runoff away from the open excavations and all excavations should be carried out in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects. According to OHSA, the shallow fill materials and native soils below the ground water table would be classified as Type 3 soils. Native soils above the groundwater table would be classified Type 2 soils. The native silt material in the vicinity of Borehole BH103 would be classified under OHSA as Type 3 soil above the water table as well as below.

Some difficulty may be encountered in excavating the dense/hard tills at some locations. Although, not observed directly, cobbles and boulders are inferred to exist within the till and fill material within the vicinity of Borehole BH104, BH107, and BH108, based on observations of auger grinding and auger refusal during the drilling investigation.

6.2.2 Pipe Bedding and Cover

The bedding for the underground services should be compatible with the type and class of pipe, the surrounding subsoil and anticipated loading conditions and should be designed in accordance with the Town's Standards. Where granular bedding is deemed to be acceptable, it should consist of at least 150 mm of OPSS Granular A or sand material. Clear stone bedding material should not be used in any case for pipe bedding or to stabilize the base. From the springline to 300 mm above the obvert of the pipe, sand cover may be used. All bedding and cover materials should be placed in maximum 150 mm loose lifts and should be uniformly compacted to at least 95 percent of the material's SPMDD.

6.2.3 Trench Backfill

The majority of the excavated materials from the site will consist of glacial till materials and some silty/sandy/clayey fill materials. The majority of the fills and native soils anticipated to be reused as trench backfill are generally near their estimated optimum water contents for compaction. The moderate to highly frost susceptible silty soils should not be used a backfill within the frost depth.

The excavated soils at suitable water contents may be reused as trench backfill provided they are free of significant amounts of topsoil, organics or other deleterious material, and are placed and compacted as outlined below. It should be noted that due to the predominantly fine-grained nature of the majority of the native subsoils, some difficulty would be expected in achieving adequate compaction during wet weather. All topsoil and organic materials should be wasted or used for landscaping purposes, as appropriate. All oversized cobbles and boulders (i.e., greater than 150 mm in size) should be removed from the backfill.

All trench backfill, from the top of the cover material to subgrade elevation, should be placed in maximum 300 mm loose lifts and uniformly compacted to at least 95 percent of the material's SPMDD. From 1 m below subgrade to subgrade elevation, the materials should be placed in maximum 150 mm loose lifts and uniformly compacted to at least 98 percent of SPMDD.

Alternatively, if placement water contents at the time of construction are too high and there is insufficient space and/or time available to adequately dry the trench backfill material, or if there is a shortage of suitable in-situ material, then an approved imported granular material which meets the requirements for OPSS Select Subgrade Material (SSM) could be used. It should be placed in loose lift thicknesses as indicated above and uniformly compacted to at least 95 percent of SPMDD. Backfilling operations during cold weather should avoid inclusions of frozen lumps of material, snow and ice.

7.0 CLOSURE

This report is intended to summarize the subsurface soil and groundwater conditions and provide factual geotechnical data and preliminary pavement engineering recommendations as input to the reconstruction/widening of 6th Line from County Road 27 to St. John's Road. It is recommended that Golder be given the opportunity to review the geotechnical aspects of the final design to confirm that the intent of this report has been met.

We trust this report satisfies your current requirements. Please do not hesitate to contact this office if you have any questions.

Report Signature Page

GOLDER ASSOCIATES LTD.

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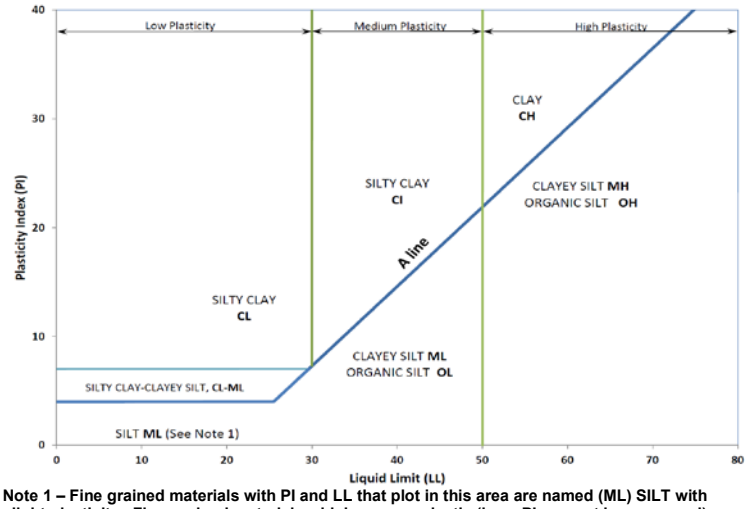
METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil		Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
					Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)		Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
					Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
					Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
				Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
					None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)		Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% (see Note 2)	CL	SILTY CLAY
				Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
				Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures								30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat								75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to ~~or~~ indicate~~s~~ a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
2. Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N_{60} values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1] (blows/0.3m)
Very Soft	<12	0 to 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	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
σ_1, σ_2, σ_3	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

PROJECT: 1413283

RECORD OF BOREHOLE: BH101

SHEET 1 OF 1

LOCATION: 22+200 1.20 m Lt of C/L

BORING DATE: April 15, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. + U - ◐, Pocket Pen - ■) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		263.86						
0	Truck Mounted CEM 45D 150 mm O.D. Solid Stem Auger with SPT Sampling	ASPHALT		0.00						
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact		0.11 / 0.24 / 263.41	1	GS				
		FILL-(SM) gravelley SILTY SAND; brown; (SUBBASE), non-cohesive, moist, compact		0.45						
1		FILL-(SM) SILTY SAND, trace clay; brown, oxidation staining; non-cohesive, moist to wet, dense		262.49	2	SS	32			
		(ML) SILT, trace sand, some clay; light brown, oxidation staining; non-cohesive, wet, compact		1.37	3	SS	24		MH	GR=0% SA=2% SI=91% CL=7%
2		Dense; below 2.29 mbgs			4	SS	32			
3		Grey; below 3.05 mbgs			5	SS	37			
4					6	SS	40			
					7	SS	48			
5				258.83						
		End of Borehole.		5.03						
6		NOTE: 1. Free water measured at 2.05 mbgs in open borehole upon completion of drilling. 2. Borehole caved to 2.05 mbgs upon completion of drilling.								
7										
8										
9										
10										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: JBH

PROJECT: 1413283

RECORD OF BOREHOLE: BH102

SHEET 1 OF 1

LOCATION: 22+600 1.30 m Rt of C/L

BORING DATE: April 15, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. + U - ◐, Pocket Pen - ■) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		253.30						
0	Truck Mounted CEM 45D 150 mm O.D. Solid Stem Auger with SPT Sampling	SURFACE TREAMENT			1	GS				
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact		0.10	2	GS			M	GR=27% SA=57% FINES=16%
		FILL-(SM) gravelley SILTY SAND; brown; (SUBBASE), non-cohesive, moist, compact		252.69 0.61						
1		FILL-(SM) SILTY SAND, trace gravel, some clay; brown; non-coheisve, compact		251.93	3	SS	26			
		(CL) Sandy SILTY CLAY, low plastic, some sub-rounded to sub-angular gravel; brown, oxidation staining; cohesive, w~PL, very stiff		1.37	4	SS	24			
2		(CL) Sandy SILTY CLAY, low plastic, some sub-rounded to sub-angular gravel; brown, oxidation staining; (TILL), cohesive, w~PL, hard		251.17 2.13	5	SS	44			
		(ML/SM) SILT and SAND, trace sub-rounded to sub-angular gravel, some clay; light brown to grey, oxidation staining; (TILL), non-cohesive, moist, very dense		250.40 2.90	6	SS	50/127mm			
3					7	SS	50/102mm			
4					8	SS	50/127mm			
		End of Borehole.		248.60 4.70						
5		NOTE: 1. Free water measured at 3.95 mbgs in open borehole upon completion of drilling. 2. Borehole caved to 4.25 mbgs upon completion of drilling.								
6										
7										
8										
9										
10										

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: JBH

PROJECT: 1413283

RECORD OF BOREHOLE: BH103

SHEET 1 OF 1

LOCATION: 23+142 1.50 m Lt of C/L

BORING DATE: April 14, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. + U - ◐, Pocket Pen - ■)	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT PERCENT (Wp, W, Wl, NP - Non-Plastic)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Ground Surface		245.69							
	Truck Mounted CEM 45D 150 mm O.D. Solid Stem Auger with SPT Sampling	SURFACE TREAMENT		0.10							
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact			1	GS					
1		FILL-(SM) gravelley SILTY SAND; - brown; (SUBBASE), non-cohesive, - moist, compact			2	SS	50		○		Cuttings
				244.32							
		(CL) Sandy SILTY CLAY, low plastic; brown to dark brown, oxidation staining; cohesive, w>PL, stiff		1.37	3	SS	15		○		Apr. 28/15
2				243.56							
		(CL) SILTY CLAY, low plastic, trace sand, trace fine gravel; brown mottled grey; (TILL), cohesive, w>PL, hard		2.13	4	SS	39		○	MH	Bentonite GR=2% SA=5% SI=42% CL=51%
				242.79							
3		(ML/SM) SILT and SAND, trace sub-rounded gravel, some clay; brown, oxidation staining; (TILL), non-cohesive, moist to wet, very dense		2.90	5	SS	50/127mm		○		Silica Sand
					6	SS	50/76mm		○		1.5 m Slot PVC Screen
4				241.07	7	SS	50/51mm		○		
		End of Borehole.		4.62							
5		NOTE: 1. Free water measured at 2.30 mbgs in open borehole upon completion of drilling. 2. Free water measured at 1.38 mbgs in peizometer on April 28, 2015									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

LOGGED: DM

CHECKED: JBH

PROJECT: 1413283

RECORD OF BOREHOLE: BH104

SHEET 1 OF 1

LOCATION: 23+358 1.50 m Rt of C/L

BORING DATE: April 14, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		249.21				SHEAR STRENGTH Cu, kPa: nat V. + Q - ●, rem V. + U - ◐, Pocket Pen - ■ (20 40 60 80)	WATER CONTENT PERCENT: Wp, W, Wl; NP - Non-Plastic (10 20 30 40)		
0	Truck Mounted CEM 45D, 150 mm O.D. Solid Stem Auger with SPT Sampling	SURFACE TREAMENT		0.03	1	GS					
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact		0.15	2	GS					
		FILL-(SM) gravelley SILTY SAND; brown; (SUBBASE), non-cohesive, moist, compact		248.68 0.53							
1		FILL-(CL-ML) Sandy CLAYEY SILT, slight plasticity, some sub-angular to sub-rounded gravel; brown, oxidation staining; cohesive, w<PL, hard			3	SS	32		○		
					4	SS	50/127mm		○		Cuttings
2					5	SS	43		○		
3		Brown to black; below 3.05 mbgs			6	SS	39		○		
		Suspected boulders and cobbles at 3.66 mbgs									
4		FILL-(ML/SM) SILT and SAND, trace sub-angular to sub-rounded gravel, some clay; light brown to black; non-cohesive, moist, compact		245.17 4.04	7	SS	18		○		Bentonite
5											
		(ML/SM) SILT and SAND, trace sub-rounded gravel, some clay; light brown to grey; (TILL), non-cohesive, moist, very dense		243.65 5.56							
6					8	SS	50/127mm		○	MH	Silica Sand GR=3% SA=45% SI=44% CL=8% Apr. 28/15
7											1.5 m Slot PVC Screen
					9	SS	50/102mm		○		
8		End of Borehole.		241.18 8.03							
9		NOTE: 1. Free water not encountered in open borehole upon completion of drilling. 2. Free water measured at 6.23 mbgs in peizometer on April 28, 2015 3. Auger Refusal on suspected boulders and cobbles at 3.66 mbgs. Drilled second hole and continued sampling 2 m east.									
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: JBH

PROJECT: 1413283

RECORD OF BOREHOLE: BH105

SHEET 1 OF 1

LOCATION: 23+800 1.50 m Lt of C/L

BORING DATE: April 14, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		231.05				SHEAR STRENGTH Cu, kPa; nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■ (20 40 60 80)	WATER CONTENT PERCENT: Wp, W, Wl; NP - Non-Plastic (10 20 30 40)		
0	Truck Mounted CEM 45D; 150 mm O.D. Solid Stem Auger with SPT Sampling	SURFACE TREAMENT		0.03							
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact		0.15	1	GS					
		FILL-(SM) gravelley SILTY SAND; brown; (SUBBASE), non-cohesive, moist, compact		230.48 0.57							
1		(CL) SILTY CLAY, low plastic, trace fine gravel, some sand; light brown to grey mottled brown, oxidation staining; cohesive, w<PL, very stiff to hard			2	SS	28		○		
				229.37	3A	SS	50/127mm		○		
		(ML/SM) SILT and SAND, trace sub-rounded to sub-angular gravel, some clay; light brown, oxidation staining; (TILL), non-cohesive, moist, very dense		1.68	3B						
2					4	SS	50/127mm		○		
3					5	SS	50/127mm		○		
		Grey; below 3.81 mbgs			6	SS	50/127mm		○		
4		Some clay; below 4.57 mbgs			7	SS	60		○		
5				226.02							
		End of Borehole.		5.03							
		NOTE: 1. Free water not encountered in open borehole upon completion of drilling. 2. Borehole caved to 4.50 mbgs upon completion of drilling.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: JBH

PROJECT: 1413283

RECORD OF BOREHOLE: BH106

SHEET 1 OF 1

LOCATION: 24+300 1.60 m Rt of C/L

BORING DATE: April 15, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ◐, Pocket Pen - ■) (20 40 60 80)	WATER CONTENT PERCENT (Wp, W, Wl; NP - Non-Plastic) (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		227.16									
0	Truck Mounted CEM 45D; 150 mm O.D. Solid Stem Auger with SPT Sampling	SURFACE TREAMENT		0.03	1	GS							
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact		0.15 226.67	2	GS							
		FILL-(SM) gravelley SILTY SAND; brown; (SUBBASE), non-cohesive, moist, compact		0.49									
1		FILL-(ML/SM) SILT and SAND, trace sub-rounded to sub-angular gravel, some clay, some organics; brown to black; non-cohesive, moist, compact		225.79	3	SS	14						
		(ML/SM) SILT and SAND, trace sub-rounded to sub-angular gravel, some clay; brown, oxidation staining; (TILL), non-cohesive, moist, dense to vey dense		1.37	4	SS	50						
2		Boulders and/or cobbles inferred from auger grinding at 2.29 mbgs			5	SS	50/76mm						
3		Light brown; below 3.05 mbgs			6	SS	50/127mm						
4					7	SS	50/127mm						
		Wet; below 4.57 mbgs		222.46	8	SS	50/127mm						
		End of Borehole.		4.70									
5		NOTE: 1. Free water measured at 3.70 mbgs in open borehole upon completion of drilling. 2. Borehole caved to 3.85 mbgs upon completion of drilling.											
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: JBH

National IM Server:GINT_GAL_NATIONALIM Unique Project ID: Output Form:ONT_BHS 001 SBowerman 12/5/15

PROJECT: 1413283

RECORD OF BOREHOLE: BH107

SHEET 1 OF 1

LOCATION: 24+800 1.50 m Lt of C/L

BORING DATE: April 14, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		225.67				SHEAR STRENGTH Cu, kPa (20 40 60 80); nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■	WATER CONTENT PERCENT (10 20 30 40); Wp, W, Wl; NP - Non-Plastic		
0	Truck Mounted CEM 45D 150 mm O.D. Solid Stem Auger with SPT Sampling	SURFACE TREAMENT		0.03							
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact		225.40 0.27							
		FILL-(SM) gravelley SILTY SAND; brown; (SUBBASE), non-cohesive, moist, compact		224.97 0.70							
1		FILL-(ML/SM) SILT and SAND, trace rounded to sub-rounded gravel, some clay, some organics; grey to black; non-cohesive, moist, compact		224.30 1.37	1	SS	17		○		
		(ML/SM) SILT and SAND, trace to some sub-rounded gravel, some clay; light brown, oxidation staining; (TILL), non-cohesive, moist, very dense			2	SS	53		○		
2					3	SS	50/127mm		○		
3		Grey; below 3.05 mbgs			4	SS	50/127mm		○		
					5	SS	50/102mm		○		
4					6	SS	50/102mm		○		
		End of Borehole.		220.84 4.83							
5		NOTE: 1. Free water not encountered in open borehole upon completion of drilling. 2. No cave of borehole upon completion of drilling.									
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: JBH

PROJECT: 1413283

RECORD OF BOREHOLE: BH108

SHEET 1 OF 1

LOCATION: 25+300 1.60 m Rt of C/L

BORING DATE: April 15, 2015

DATUM: -

SPT Hammer: Mass, 140lbs.; DROP, 30in.

DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		222.49				SHEAR STRENGTH Cu, kPa; nat V. + Q - ●; rem V. ⊕ U - ◐; Pocket Pen - ■ (20 40 60 80)	WATER CONTENT PERCENT: Wp, W, Wl; NP - Non-Plastic (10 20 30 40)		
0	Truck Mounted CEM 45D 150 mm O.D. Solid Stem Auger with SPT Sampling	SURFACE TREAMENT		0.03	1	GS			○	M	GR=38% SA=54% FINES=8%
		FILL-(SW-SM) SAND and GRAVEL, crushed, some silt; brown; (BASE), non-cohesive, moist, compact		0.15	2	GS					
				222.08							
		FILL-(SM) gravelley SILTY SAND; brown; (SUBBASE), non-cohesive, moist, compact		0.41							
1		(ML/SM) SILT and SAND, trace to some sub-rounded to sub-angular gravel, some clay; light brown, oxidation staining; (TILL), non-cohesive, moist, dense to very dense			3	SS	40		○		
					4	SS	50/127mm		○		
2		Boulders and/or cobbles inferred from auger grinding at 2.13 mbgs			5	SS	50/102mm		○		
		Suspected boulder and cobbles at 2.74 mbgs									
3					6	SS	50/102mm		○		
				218.98							
		End of Borehole.		3.51							
4		NOTE: 1. Free water not encountered in open borehole upon completion of drilling. 2. No cave of borehole upon completion of drilling. 3. Auger Refusal on suspected boulders and cobbles at 2.74 mbgs. Drilled second hole and vontinued sampling 2 m east. 3. Auger Refusal on suspected boulders and cobbles at 3.51 mbgs in second hole.									
5											
6											
7											
8											
9											
10											

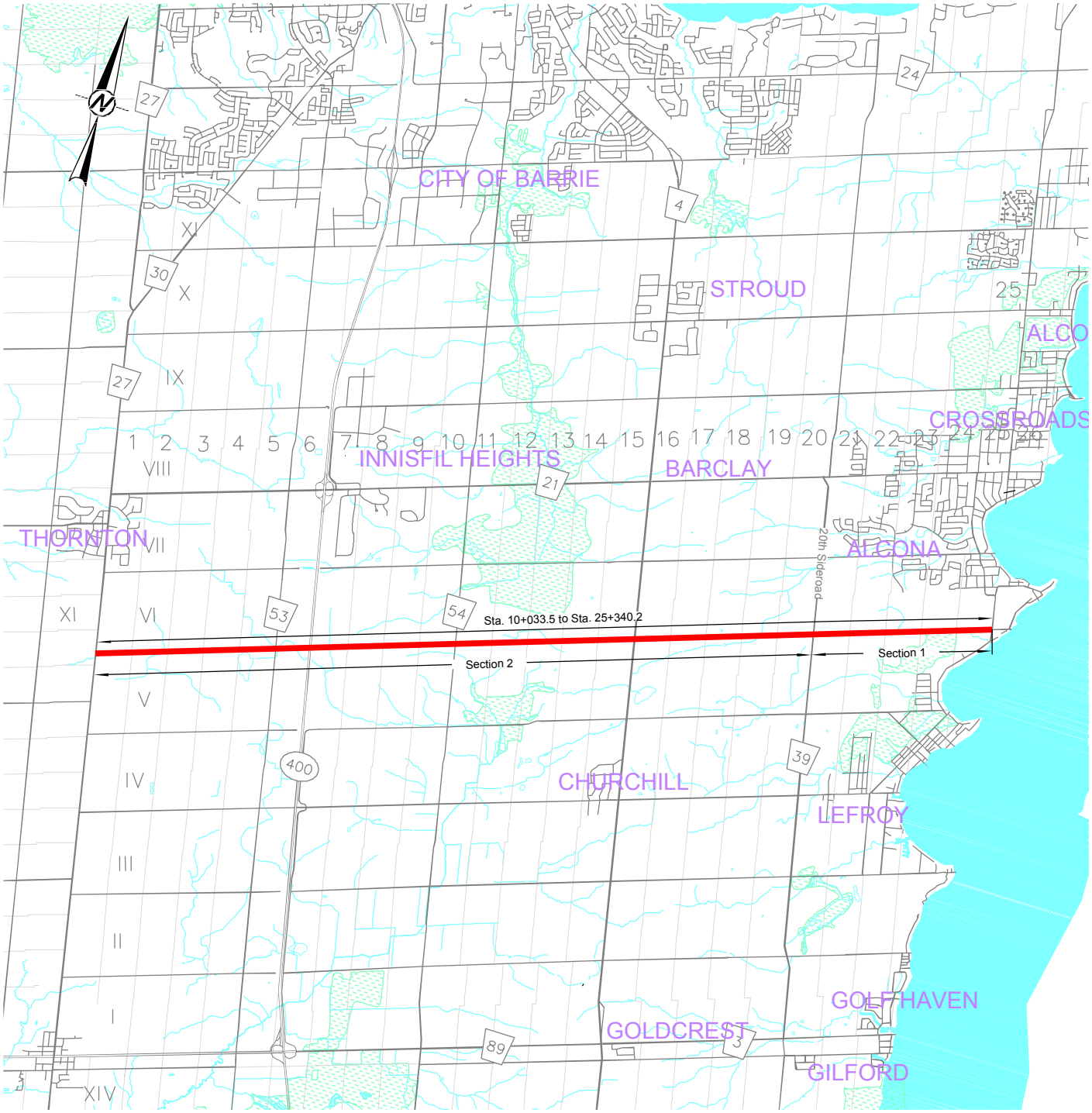
DEPTH SCALE

1 : 50

Golder Associates

LOGGED: DM

CHECKED: JBH



0 2,000 4,000 6,000

1:100000 METRES

LEGEND

- Road
- Site Location
- Watercourse
- Water Area, Permanent
- Wetland, Permanent

REFERENCE

Datum is UTM NAD 83 Zone 17
OBM Features ESRI Geography Network

CLIENT
TOWN OF INNISFIL

PROJECT
6th LINE FROM COUNTY ROAD 27 TO ST. JOHN'S ROAD, INNISFIL, ONTARIO

TITLE
KEY PLAN

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-06-11
PREPARED	STB
DESIGN	
REVIEW	DM
APPROVED	

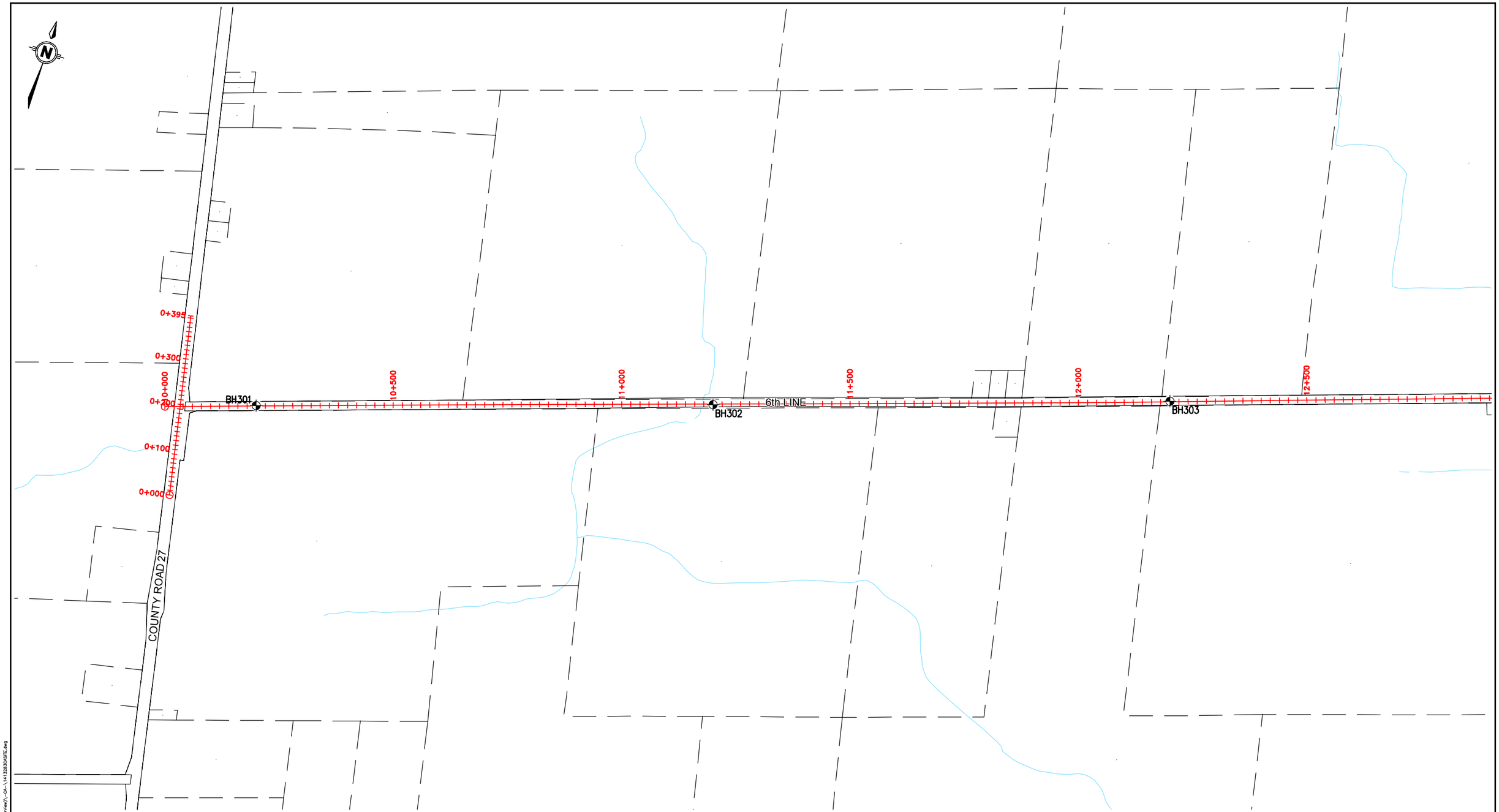
PROJECT No.	Phase	Rev.	Figure
141-3283	-	AA	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

25 mm

0

Path: \golder.gds\gal\Barrie\CAD rojects\2014\141-3283 (Innisfil, 6th Line Contaminant Overview)\-BA\ | File Name: 1413283BAOBM.dwg



LEGEND

- Borehole Location
- Parcel Boundary

NOTES

1. Datum UTM NAD 83 Zone 17
2. Satellite Imagery from DiscoverSimcoe.ca 2012

0 40 80 200 400

SCALE 1:8000 metres

PROJECT

CLASS ENVIRONMENTAL ASSESSMENT FOR 6TH LINE FROM COUNTY ROAD 27 TO ST. JOHN'S ROAD, INNISFIL ONTARIO

TITLE

BOREHOLE LOCATION PLAN

Golder Associates
Barrie, Ontario, Canada

PROJECT No.		141-3283	FILE No.	1413283CASITE.dwg	
DESIGN		10/20/2014	SCALE	AS SHOWN	REV.
CAD	STB	2014-10-20	DRAWING No.		
CHECK		11/13/2015		2-A	
REVIEW		11/13/2015			

PLOT DATE: November 13, 2015
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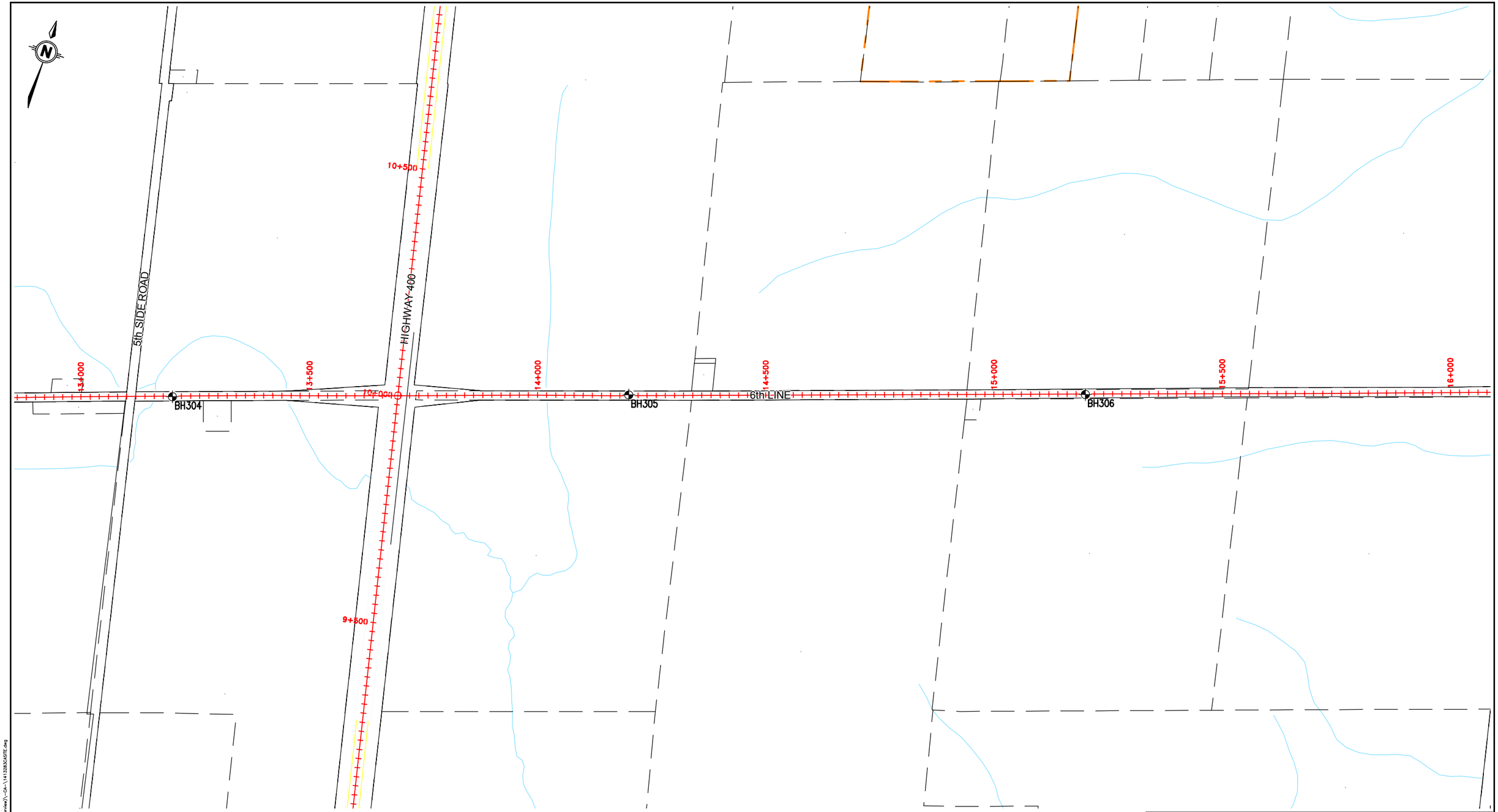

LEGEND

- Borehole Location
- Parcel Boundary

NOTES

1. Datum UTM NAD 83 Zone 17
2. Satellite Imagery from DiscoverSimcoe.ca 2012

0 40 80 200 400

SCALE 1:8000 metres

PROJECT

CLASS ENVIRONMENTAL ASSESSMENT FOR 6TH LINE FROM COUNTY ROAD 27 TO ST. JOHN'S ROAD, INNISFIL ONTARIO

TITLE

BOREHOLE LOCATION PLAN

Golder Associates
Barrie, Ontario, Canada

PROJECT No.		141-3283	FILE No. 1413283CASITE.dwg	
DESIGN		10/20/2014	SCALE AS SHOWN	REV.
CAD	STB	2014-10-20	DRAWING No.	
CHECK		11/13/2015	2-B	
REVIEW		11/13/2015		

PLOT DATE: November 13, 2015
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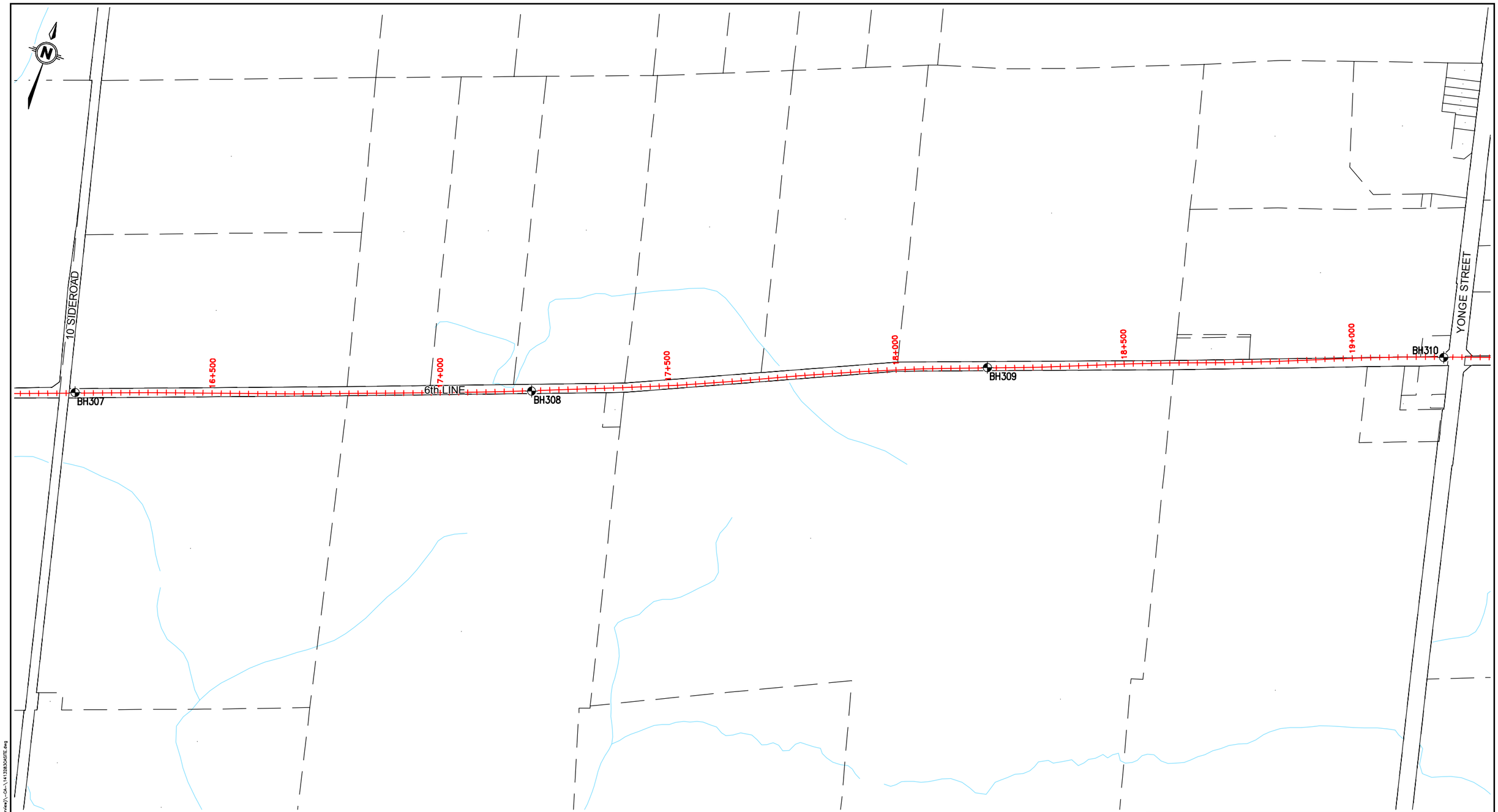

LEGEND

- Borehole Location
- Parcel Boundary

NOTES

1. Datum UTM NAD 83 Zone 17
2. Satellite Imagery from DiscoverSimcoe.ca 2012

0 40 80 200 400

SCALE 1:8000 metres

PROJECT

CLASS ENVIRONMENTAL ASSESSMENT FOR 6TH LINE FROM COUNTY ROAD 27 TO ST. JOHN'S ROAD, INNISFIL ONTARIO

TITLE

BOREHOLE LOCATION PLAN

Golder Associates
Barrie, Ontario, Canada

PROJECT No.		141-3283	FILE No. 1413283CASITE.dwg	
DESIGN		10/20/2014	SCALE AS SHOWN	REV.
CAD	STB	2014-10-20	DRAWING No.	
CHECK		11/13/2015	2-C	
REVIEW		11/13/2015		

PLOT DATE: November 13, 2015
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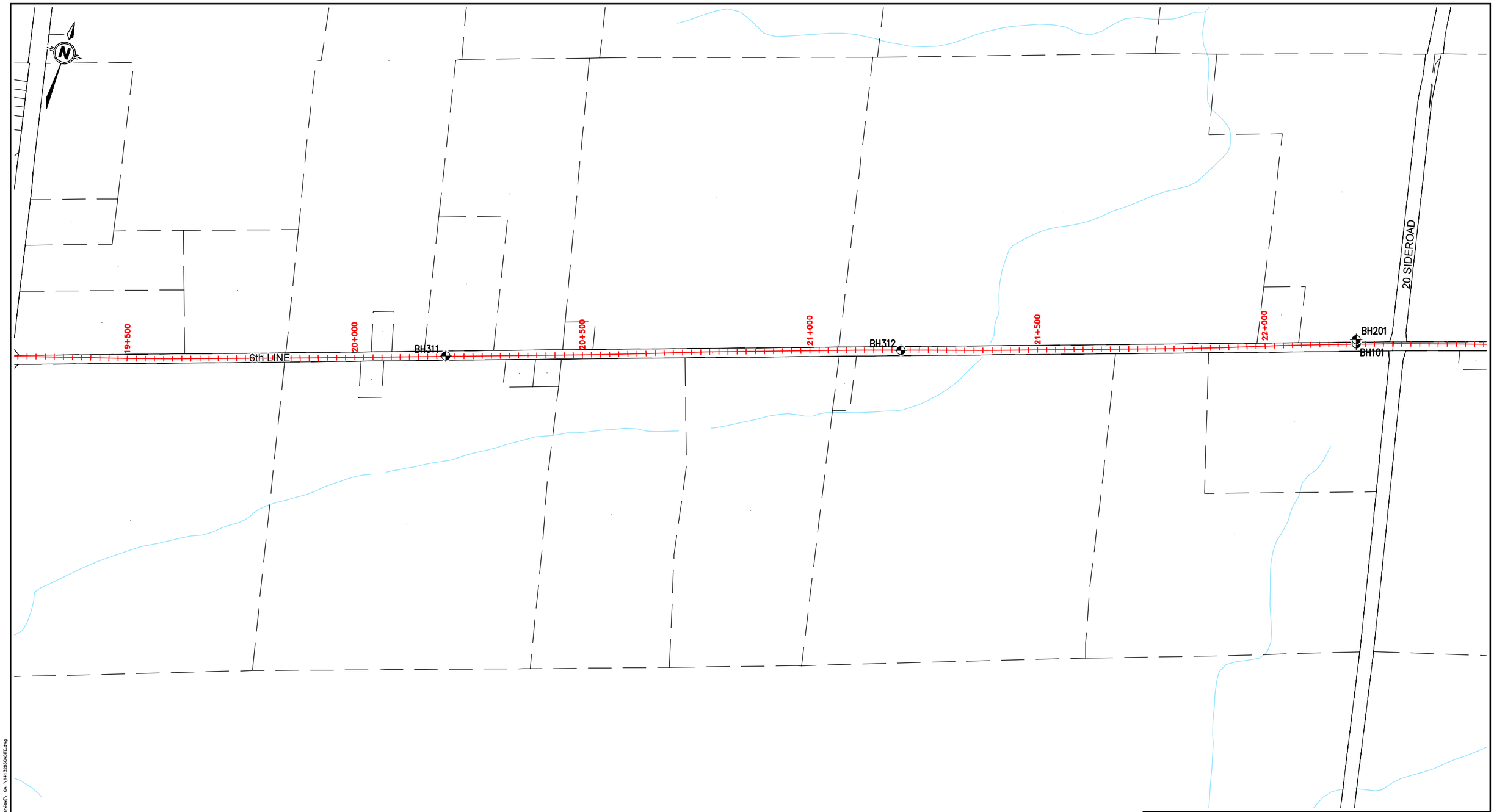

LEGEND

- Borehole Location
- Parcel Boundary

NOTES

1. Datum UTM NAD 83 Zone 17
2. Satellite Imagery from DiscoverSimcoe.ca 2012

0 40 80 200 400

SCALE 1:8000 metres

PROJECT

CLASS ENVIRONMENTAL ASSESSMENT FOR 6TH LINE FROM COUNTY ROAD 27 TO ST. JOHN'S ROAD, INNISFIL ONTARIO

TITLE

BOREHOLE LOCATION PLAN

Golder Associates
Barrie, Ontario, Canada

PROJECT No.		141-3283	FILE No.	1413283CASITE.dwg	
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REVIEW		11/13/2015			

PLOT DATE: November 13, 2015
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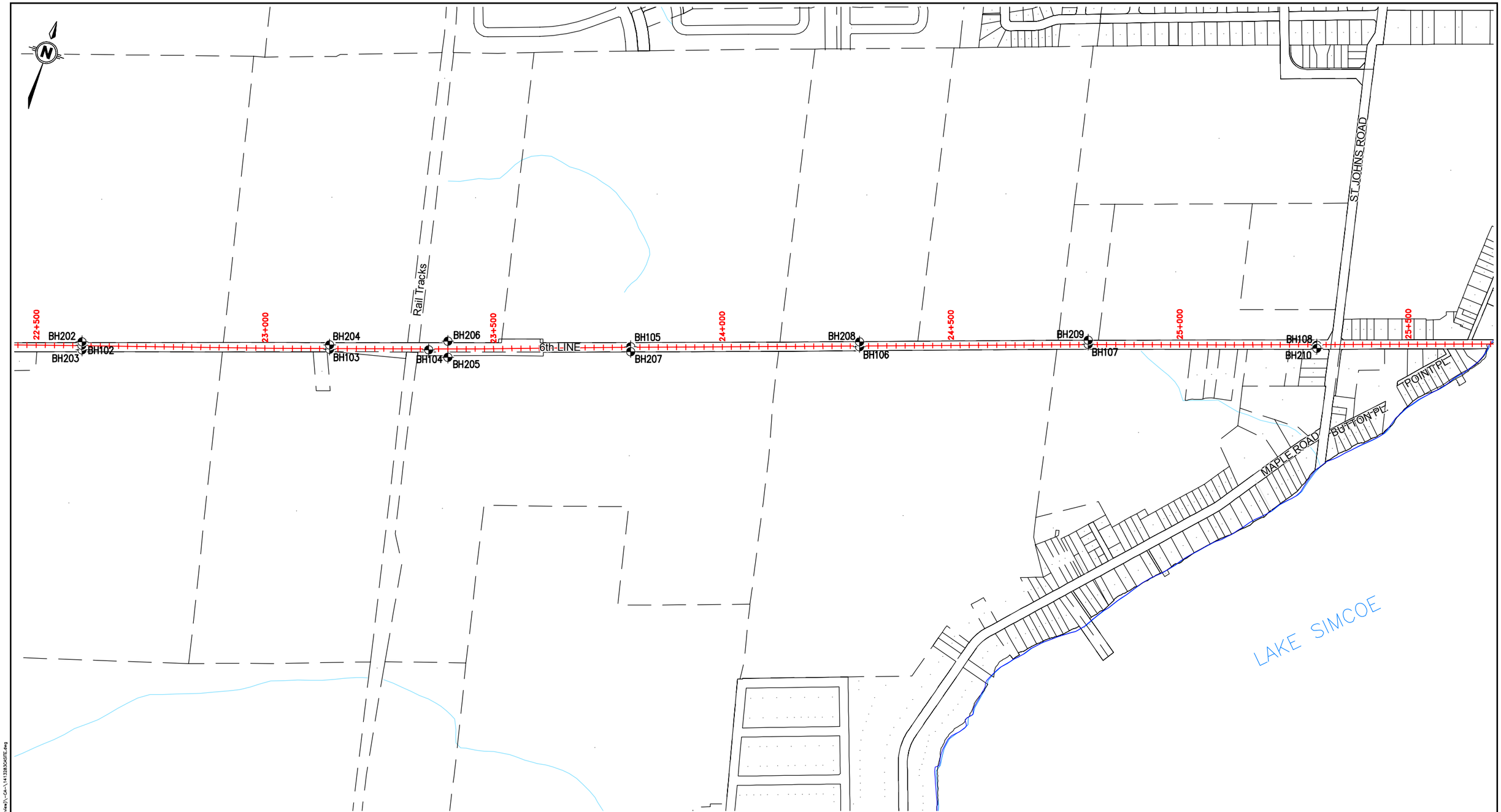

LEGEND

- Borehole Location
- Parcel Boundary

NOTES

1. Datum UTM NAD 83 Zone 17
2. Satellite Imagery from DiscoverSimcoe.ca 2012

0 40 80 200 400

SCALE 1:8000 metres

PROJECT

CLASS ENVIRONMENTAL ASSESSMENT FOR 6TH LINE FROM COUNTY ROAD 27 TO ST. JOHN'S ROAD, INNISFIL ONTARIO

TITLE

BOREHOLE LOCATION PLAN

Golder Associates
Barrie, Ontario, Canada

PROJECT No.		141-3283	FILE No.	1413283CASITE.dwg	
DESIGN		10/20/2014	SCALE	AS SHOWN	REV.
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REVIEW		11/13/2015			

PLOT DATE: November 13, 2015
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CLASS ENVIRONMENTAL ASSESSMENT FOR 6th LINE, INNISFIL, ONTARIO

FIGURE 3A

6th Line ~Sta. 14+500, looking east (up chainage).

6th Line ~Sta. 15+500, looking east (up chainage).

Project No.	14-13283		Taken by:	JBH
Photo Date:	July, 2015	**Golder Associates Ltd.**	Checked By:	*ACB*

CLASS ENVIRONMENTAL ASSESSMENT FOR 6th LINE, INNISFIL, ONTARIO

FIGURE 3B

6th Line ~Sta. 16+500, looking east (up chainage).

6th Line ~Sta. 17+500, looking east (up chainage).

Project No.	14-13283		Taken by:	JBH
Photo Date:	July, 2015	**Golder Associates Ltd.**	Checked By:	*ACB*

CLASS ENVIRONMENTAL ASSESSMENT FOR 6th LINE, INNISFIL, ONTARIO

FIGURE 3C

6th Line ~Sta. 19+500, looking east (up chainage).

6th Line ~Sta. 22+500, looking east (up chainage).

Project No.	14-13283		Taken by:	JBH
Photo Date:	July, 2015	**Golder Associates Ltd.**	Checked By:	*ACB*

Surface Treated Pavement Condition Evaluation Form

Location: INNISFIL LINE ROAD 6 (6th LINE)

From: COUNTY ROAD 27 **To:** ST JOHNS ROAD

LHRS Begins: _____ Offset: _____ km **Section Length:** 15.3 **District:** _____

Survey Date: Year 15 Month 04 **PCR:** 68 **RCR:** 5.5 **Traffic Direction:** B (B: Both Directions, N: North Bound, S: South Bound, E: East Bound, W: West Bound) **Highway:** _____

Ride Condition Rating (at Posted Speed))

10 **Excellent** Smooth and Pleasant
8 **Good** Comfortable
6 **Fair** Uncomfortable
4 **Poor** Very rough and bumpy
2 **Very Poor** Dangerous at 80 km/h
0

Pavement			Severity of Distress			Density of Distress Extent of Occurance, %		
			Slight	Moderate	Severe	Intermittent	Frequent	Throughout
						<20	20-50	>50
			1	2	3	1	2	3
SURFACE DEFECT	Loss of Cover Aggregate	1		X			X	
	Streaking	2		X			X	
	Flushing	3	X				X	
	Potholes	4			X	X		
	Pavement Edge Breakup	5		X			X	
SURFACE DEFORMATION	Rippling	6	X			X		
	Wheel Track Rutting	7		X			X	
	Distortion	8			X	X		
CRACKING	Longitudinal	9	X				X	
	Transverse	10	X			X		
	Pavement Edge	11		X			X	
	Alligator	12	X				X	

Shoulders	Density of Distress Extent of occurrence, %							
	RIGHT				LEFT			
Distress	10-30		>30		10-30		>30	
	1		2		1		2	
Encroaching Growth	X				X			
Poor Cross-fall								

Maintenance Treatment	Extent of Occurance %		
	<20	20-50	>50
	1	2	3
Manual Patching	X		
Machine Patching			
In Situ Recyling			
Manual Spray Patching			
Manual Chip Seal			
Machine Chip Seal			
Fog Seal			
Manual Burn and Seal			

Distress Comments (Items not covered above)

Moderate desitortion near intersection of 20th Sideroad

Other Comments (e.g. subsections, additional contracts)

Asphalt Sections at County Road 27, Hwy 400 Overpass, 5th Sideroad, Yonge Street, 20th Sideroad and St. John's Road

Evaluated by: John Hagan

Golder Associates Ltd.

TABLE 1
RECORD OF PAVEMENT BOREHOLES - Section 1
6th Line from Side Road 20 to St. Johns Road, Innisfil, Ontario

Borehole No.	BOREHOLE LOG: Depth (mm/m)	BOREHOLE LOG	Sample Depth (mm)	Frost Susceptibility	K Factor (Erodability)	LABORATORY TESTING: Water Content (%)	LABORATORY TESTING: Gradation
6th Line Innisfil							
Location	Station 22+200, offset 1.2 m left of the centerline of 6th Line (WBL). Elevation: 263.86						
BH101	0 - 110	Asphalt					
	110 - 240	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)					
	240 - 450	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)	250 - 450				
	450 - 1.4	Brown SILTY SAND, trace clay, moist to wet, compact (FILL)	760 - 1.2			25.1	
	1.4 - 2.0	Light brown SILT, trace sand, some clay, wet, compact	1.5 - 2.0	HSFH	0.7	18.0	Figure B3
Location	Station 22+600, offset 1.3 m right of the centerline of 6th Line (EBL). Elevation: 253.30						
BH102	0 - 30	PST					
	30 - 100	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)	25 - 100				
	100 - 610	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)	300 - 600			4.6	Figure B2, Unacceptable Granular B Type 1, too silty
	610 - 1.4	Brown SILTY SAND, trace gravel, some clay, moist, compact (FILL)	760 - 1.2			7.4	
	1.4 - 2.0	Brown sandy SILTY CLAY, some gravel, w~PL, very stiff	1.5 - 2.0			13.4	
Location	Station 23+142, offset 1.5 m left of the centerline of 6th Line (WBL). Elevation: 245.69						
BH103	0 - 25	PST					
	25 - 100	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)					
	100 - 1.4	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)	760 - 1.2			6.8	
	1.4 - 2.0	Brown to dark brown sandy SILTY CLAY, w>PL, stiff	1.5 - 2.0			23.9	
Location	Station 23+358, offset 1.5 m right of the centerline of 6th Line (EBL). Elevation: 249.21						
BH104	0 - 25	PST					
	25 - 150	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)	25 - 150				
	150 - 530	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)	200 - 500				
	530 - 2.0	Brown sandy CLAYEY SILT, some gravel, w<PL, hard (FILL)	760 - 1.2			9.7	
Location	Station 23+800, offset 1.5 m left of the centerline of Innisfil 6th Line (WBL). Elevation: 231.05						
BH105	0 - 30	PST					
	30 - 150	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)					
	150 - 570	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)	200 - 500				
	560 - 1.7	Light brown to grey SILTY CLAY, trace gravel, some sand, w< PL, very stiff to hard	760 - 1.2			15.3	
	1.7 - 2.0	Light brown SILT and SAND, trace gravel, some clay, moist, very dense	1.7 - 1.8			16.3	
Location	Station 24+300, offset 1.6 m right of the centerline of 6th Line (EBL). Elevation: 227.16						
BH106	0 - 30	PST					
	30 - 150	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)	30 - 150				
	150 - 490	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)	150 - 480				
	490 - 1.4	Brown to black SILT and SAND, trace gravel, some clay, some organics, moist, compact (FILL)	760 - 1.2			18.6	
	1.4 - 2.0	Brown SILT and SAND, trace gravel, some clay, occasional cobbles and boulders, moist, dense to very desne	1.5 - 2.0			9.1	

TABLE 1
RECORD OF PAVEMENT BOREHOLES - Section 1
6th Line from Side Road 20 to St. Johns Road, Innisfil, Ontario

Borehole No.	BOREHOLE LOG: Depth (mm/m)	BOREHOLE LOG	Sample Depth (mm)	Frost Susceptibility	LABORATORY TESTING: K Factor (Erodability)	Water Content (%)	Gradation
6th Line Innisfil							
Location	Station 24+800, offset 1.5 m left of centerline of 6th Line (WBL). Elevation: 225.67						
BH107	0 - 30	PST					
	30 - 270	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)					
	270 - 700	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)					
	700 - 1.4	Grey to black SILT and SAND, trace gravel, some clay, some organics, moist, compact (FILL)	760 - 1.2			20.2	
	1.4 - 2.0	Light brown SILT and SAND, trace gravel, some clay, moist, very dense	1.5 - 2.0			7.9	
Location	Station 25+300, offset 1.6 m right of centerline of 6th Line (EBL). Elevation: 222.49						
BH108	0 - 25	PST					
	25 - 150	Brown crushed SAND and GRAVEL, some silt, moist, compact (Granular Base)	30 - 150			4.2	Figure B1, Unacceptable Granular A, too fine on multiple sieves
	150 - 410	Brown grvelly SILTY SAND, moist, compact (Granular Subbase)	150 - 400				
	410 - 2.0	Brown SILT and SAND, trace gravel, some clay, occasional cobbles and boulders, moist, dense to very desne	760 - 1.2			8.4	

Inputted by: DM
Checked by: JBH

TABLE 2
RECORD OF PAVEMENT BOREHOLES - Section 2
6th Line from County Road 27 to Side Road 20, Innisfil, Ontario

Borehole No.	BOREHOLE LOG					LABORATORY TESTING	
	Depth (mm/m)		Sample Depth (mm)	Frost Susceptibility	K Factor (Erodability)	Water Content (%)	Gradation
6th Line							
Location	Station 10+200, offset 1.5 m left of centerline of 6th Line (WBL)						
BH301	0 - 25	PST					
	55 - 140	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	140 - 170	PST					
	170 - 440	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	440 - 700	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	700 - 1.5	Grey sandy CLAYEY SILT, trace gravel, moist compact					
Location	Station 11+200, offset 1.0 m right of cenerline of 6th Line (EBL)						
BH302	0 - 25	PST					
	25 - 140	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	140 - 165	PST					
	165 - 320	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)	175 - 300			4.3	Figure B1, Unacceptable Granular A, too fine on multiple sieves
	320 - 640	Brown gravely SAND, some silt, moist compact (Granular Subbase)	350 - 600				
	640 - 1.5	Grey sandy CLAYEY SILT, trace gravel, moist compact	1 - 1.3				
Location	Station 12+200, offset 1.2 m left of centerline of 6th Line (WBL)						
BH303	0 - 25	PST					
	25 - 130	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	130 - 155	PST					
	155 - 300	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	300 - 670	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	670 - 1.5	Brown CLAYEY SILT and SAND, trace gravel, moist, compact					
Location	Station 13+200, offset 1.5 m right of centerline of 6th Line (EBL)						
BH304	0 - 50	Asphalt					
	50 - 260	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	260 - 560	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	560 - 1.5	Brown CLAYEY SILT and SAND, trace gravel, moist, wet @ 900, compact					
Location	Station 14+200, offset 1.5 m left of centerline of 6th Line (WBL)						
BH305	0 - 25	Asphalt					
	25 - 200	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)	25 - 200				
	200 - 900	Brown gravely SAND, some silt, moist compact (Granular Subbase)	200 - 500				
	900 - 1.2	Dark Brown to Black ORGANIC SILT and SAND, trace clay, free water @ 900, saturated, loose	900 - 1.2				
	1.2 - 1.5	Grey SILT and SAND, trace clay, trace gravel, wet, comp	1.2 - 1.5				
Location	Station 15+200, offset 1.4 m right of centerline of 6th Line (EBL)						
BH306	0 - 25	PST					
	25 - 250	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	250 - 590	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	590 - 1.5	Brown SILTY SAND, trace clay, moist, compact					

TABLE 2
RECORD OF PAVEMENT BOREHOLES - Section 2
6th Line from County Road 27 to Side Road 20, Innisfil, Ontario

Borehole No.	BOREHOLE LOG Depth (mm/m)		Sample Depth (mm)	Frost Susceptibility	K Factor (Erodability)	LABORATORY TESTING Water Content (%)	Gradation
6th Line							
Location	Station 16+200, offset 1.6 m left of centerline of 6th Line (WBL)						
BH307	0 - 25	PST					
	25 - 180	RAP					
	180 - 450	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	450 - 900	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	900 - 1.2	Dark Brown to Black ORGANIC SILT and SAND, trace clay, moist, loose					
	1.2 - 1.5	Brown to Grey sandy CLAYEY SILT, moist, compact					
Location	Station 17+200, offset 1.5 m right of centerline of 6th Line (EBL)						
BH308	0 - 25	PST					
	25 - 150	RAP					
	150 - 340	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)	150 - 350				
	340 - 670	Brown gravely SAND, some silt, moist compact (Granular Subbase)	400 - 600			3.8	Figure B2, Unacceptable Granular B Type I, too silty
	670 - 950	Black ORGANIC SAND and SILT, moist, loose	700 - 900				
	950 - 1.5	Brown SAND trace silt, moist, free water @ 1.10, saturated, compact	1.2 - 1.5				
Location	Station 18+200, offset 1.6 m left of centerline of 6th Line (WBL)						
BH309	0 - 25	PST					
	25 - 150	RAP					
	150 - 300	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	300 - 650	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	650 - 1.5	Brown SILTY SAND, trace clay, moist, free water @ 1.20, saturated, compact	1.0 - 1.3	LSFH-MSFH	0.35	15.7	Figure B6
Location	Station 19+200, offset 1.4 m right of centerline of 6th Line (EBL)						
BH310	0 - 80	Asphalt					
	80 - 240	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	240 - 460	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	460 - 1.5	Brown SILTY SAND, moist, compact	1.1 - 1.4				
Location	Station 20+200, offset 1.3 m left of centerline of 6th Line (WBL)						
BH311	0 - 25	PST					
	25 - 120	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)	50 - 100				
	120 - 560	Grey gravely SAND, some silt, moist compact (Granular Subbase)	200 - 400				
	560 - 1.5	Brown to grey SILTY SAND, some clay, trace gravel, moist, compact	1.2 - 1.5	LSFH	0.30	15.1	Figure B6
Location	Station 21+200, offset 1.5m right of centerline of 6th Line (EBL)						
BH312	0 - 180	Asphalt					
	180 - 300	Brown crushed SAND and GRAVEL, trace to some silt, moist, compact (Granular Base)					
	300 - 460	Brown gravely SAND, some silt, moist compact (Granular Subbase)					
	460 - 1.5	Brown SILTY SAND, some clay, trace gravel, moist, compact					

Inputted by: DM
Checked by: JBH

TABLE 3
RECORD OF HAND AUGER BOREHOLES - Section 1
6th Line from Side Road 20 to St. Johns Road, Innisfil, Ontario

Borehole No.	Depth (mm/m)	BOREHOLE LOG
6th Line Innisfil		
Location	Station 22+200, offset 9.0 m left of centerline of 6th Line. Elevation: 900 mm below road surface at ceterline	
BH201	0 - 290	Dark Brown Silty Topsoil, free water @ 100, saturated
	290 - 1.0	Brown SILT, trace sand, trace clay, saturated, compact
Location	Station 22+600, offset 7.5 m left of centerline of 6th Line. Elevation: 450 mm below road surface at centerline	
BH202	0 - 380	Dark Brown Silty Topsoil, free water @ 200, saturated
	380 - 1.0	Brown SILT and SAND, some clay, trace gravel, moist, compact
Location	Station 22+600, offset 9.5 m right of centerline of 6th Line. Elevation: 200 mm below road surface at centerline	
BH203	0 - 320	Dark Brown Silty Topsoil
	320 - 1.0	Brown SILT and SAND, some clay, trace gravel, moist, compact
Location	Station 23+142, offset 8.0 m left of centerline of 6th Line. Elevation: 1.70 m below road surface at centerline	
BH204	0 - 450	Dark Brown Silty Topsoil, free water @ surface, saturated
	450 - 1.0	Brown SILT and SAND, some clay, trace gravel, moist, compact
Location	Station 23+400, offset 18.0 m right of centerline of 6th Line. Elevation: 4.20 m below road surface at centerline	
BH205	0 - 400	Dark Brown Silty Topsoil
	400 - 1.0	Brown SILT and SAND, some clay, trace gravel, moist, compact
Location	Station 23+400, offset 17.0 m left of centerline of 6th Line. Elevation: 3.50 m below road surface at centerline	
BH206	0 - 490	Dark Brown Silty Topsoil
	490 - 1.0	Brown SILT and SAND, some clay, trace gravel, moist, compact
Location	Station 23+800, offset 10.0 m right of centerline of 6th Line. Elevation: 400 mm below road surface at centerline	
BH207	0 - 470	Dark Brown Silty Topsoil
	470 - 1.0	Brown SILT and SAND, some clay, trace gravel, occasional cobbles, moist, compact
Location	Station 24+300, offset 8.8 m left of centerline of 6th Line. Elevation: 300 mm below road surface at centerline	
BH208	0 - 600	Dark Brown Silty Topsoil, free water @ 100, saturated
	600 - 1.1	Brown SILT and SAND, some clay, trace gravel, occasional cobbles, moist, compact
Location	Station 24+800, offset 10.0 m left of centerline of 6th Line. Elevation: 700 mm below road surface at centerline	
BH209	0 - 450	Dark Brown Silty Topsoil, free water @ 100, saturated
	450 - 1.0	Brown SILT and SAND, some clay, trace gravel, occasional cobbles, moist, compact
Location	Station 25+300, offset 7.8 m right of centerline of 6th Line. Elevation: 350 mm below road surface at centerline	
BH210	0 - 300	Dark Brown Silty Topsoil, free water @ 100, saturated
	300 - 1.0	Brown SILT and SAND, some clay, trace gravel, occasional cobbles, moist, compact

Inputted by: DM
Checked by: JBH

Table 4
RECORD OF CORING
6th Line from County Road 27 to St Johns Road, Innisfil, Ontario

Station	Core Number	OFFSET FROM EX. C/L (m)	Twp.	CORE THICKNESS (mm)	CRACK TYPE	CRACK WIDTH	
						TOP (mm)	BOTTOM (mm)
11+200	01	1.0 m Rt	Innisfil	25	N/A	-	-
14+200	02	1.5 m Lt	Innisfil	25	N/A	-	-
17+200	03	1.5 m Lt	Innisfil	25	N/A	-	-
20+200	04	1.3 m Lt	Innisfil	25	N/A	-	-
22+200	05	1.2 m Lt	Innisfil	110	N/A	-	-
22+600	06	1.3 m Rt	Innisfil	30	Alligator	1	5
23+358	07	1.5 m Rt	Innisfil	25	N/A	-	-
24+300	08	1.6 m Rt	Innisfil	30	N/A	-	-
24+800	09	1.5 m Lt	Innisfil	30	N/A	-	-
25+300	10	1.6 m Rt	Innisfil	25	Alligator	5	5

Inputted by: DM
Checked by: JBH

APPENDIX A

Important Information and Limitation of This Report

IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use o f the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

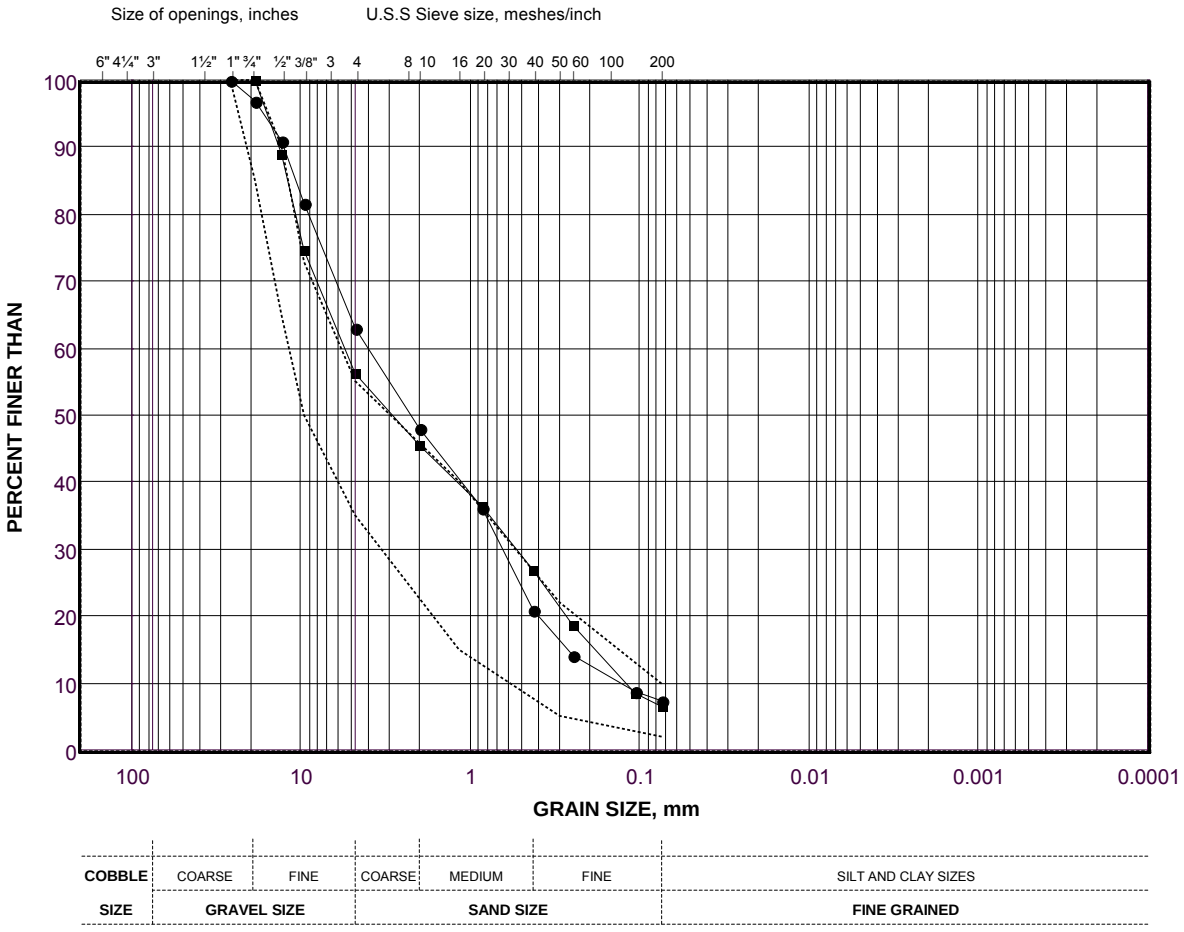
APPENDIX B

Laboratory Test Results - Grain Size Distribution

GRAIN SIZE DISTRIBUTION

OPSS. PROV 1010 Granular A

FIGURE B1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH-108	GS1	0.030 - 0.300
■	BH-302	SA13	0.180 - 0.300

Project Number: 1413283

Checked By: JBH

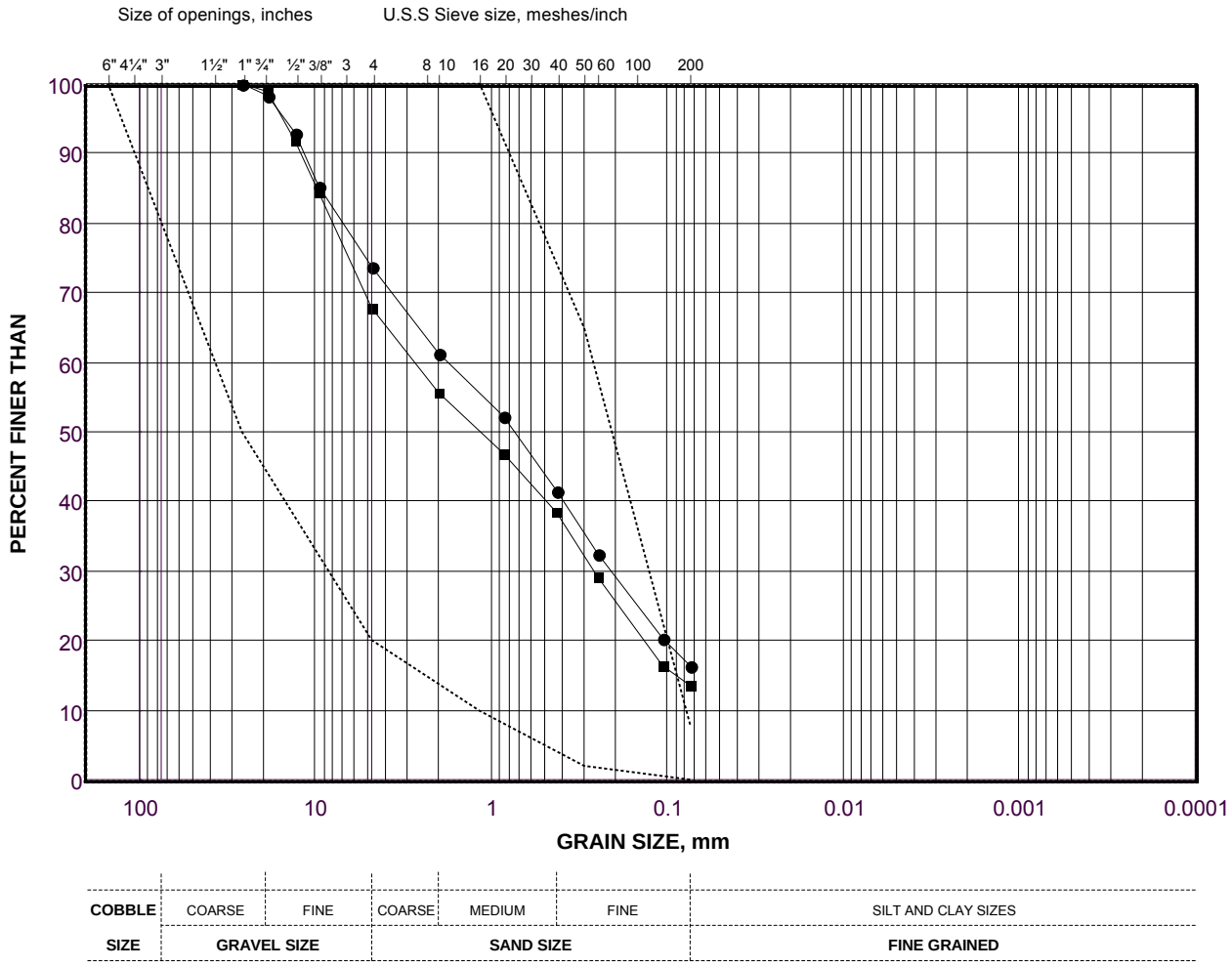
Golder Associates

Date: 26-May-15

GRAIN SIZE DISTRIBUTION

OPSS. PROV 1010 Granular B, Type I

FIGURE B2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH-102	GS2	0.300 - 0.600
■	BH-308	SA6	0.400 - 0.600

Project Number: 1413283

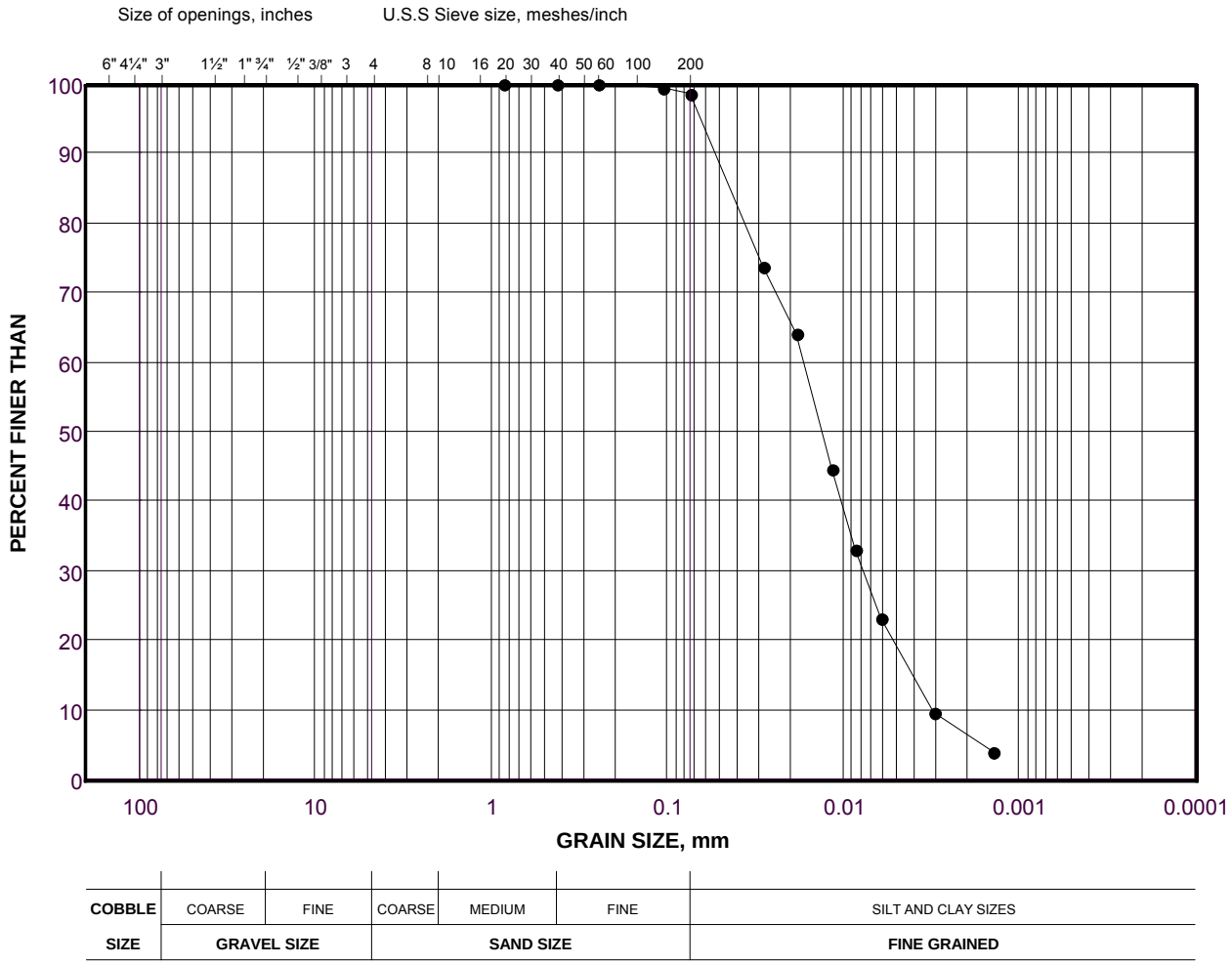
Checked By: JBH

Golder Associates

Date: 26-May-15

GRAIN SIZE DISTRIBUTION
(ML) SILT

FIGURE B3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH-101	SS3	1.52 - 1.98

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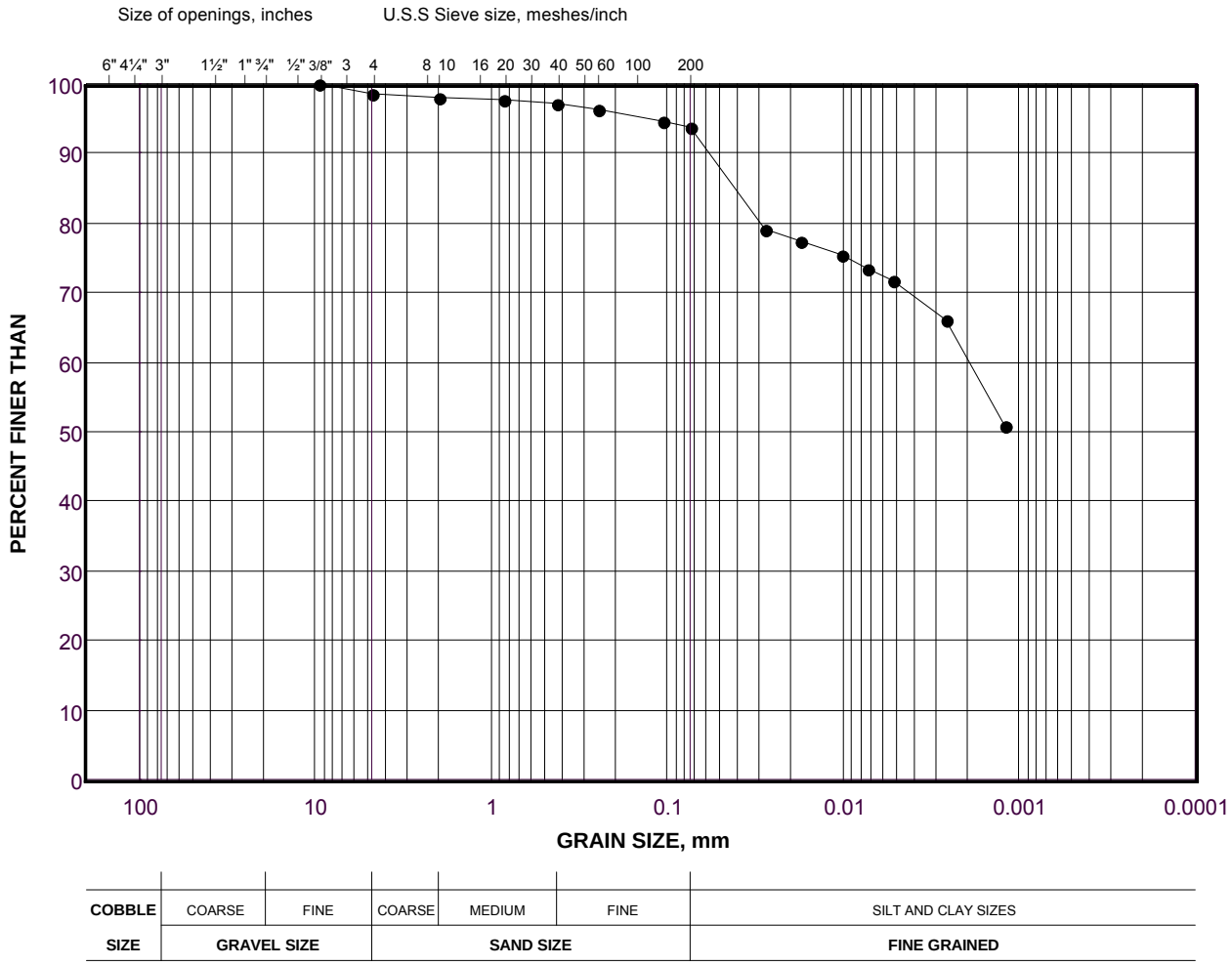
Date: 14-May-15

GRAIN SIZE DISTRIBUTION
(CL) SILTY CLAY

FIGURE B4



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH-103	SS4	2.29 - 2.74

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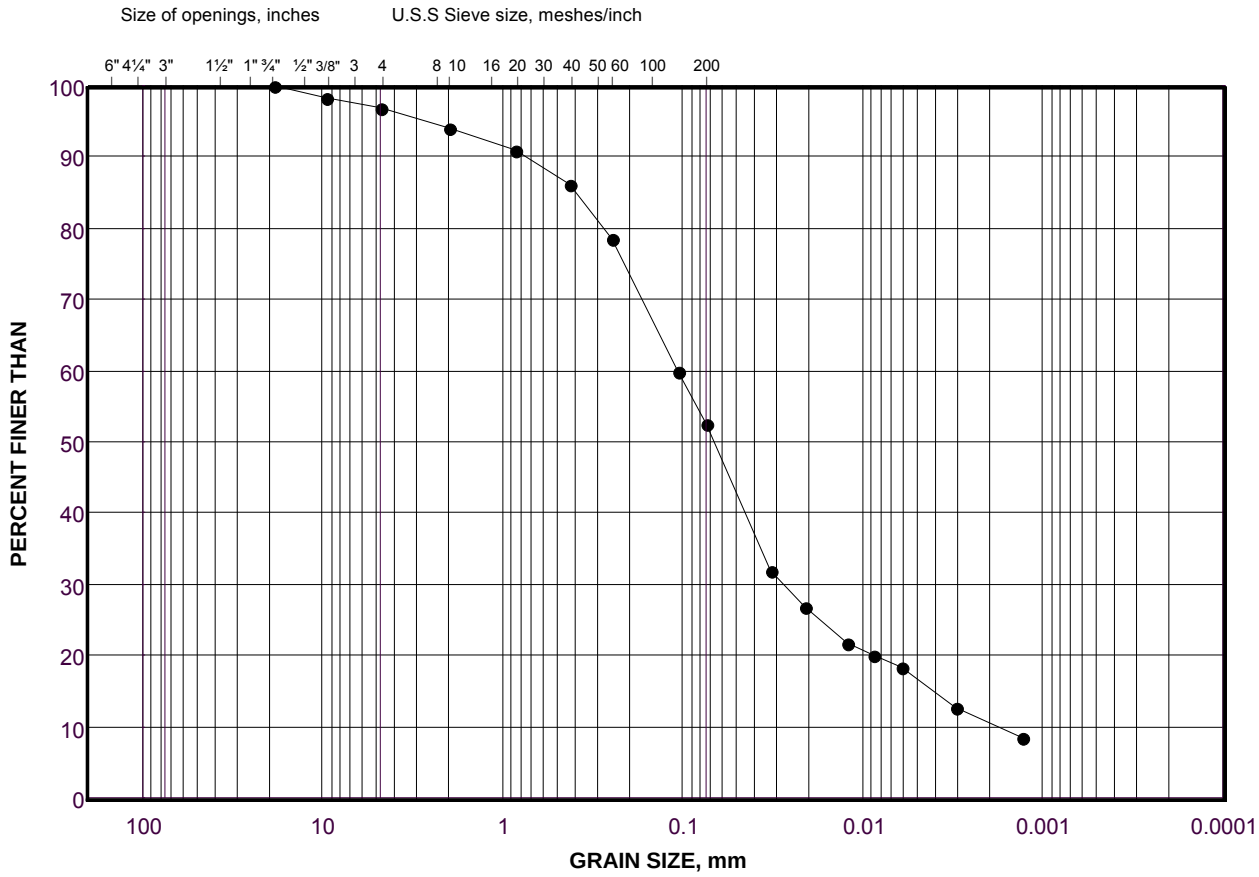
Date: 14-May-15

GRAIN SIZE DISTRIBUTION
(ML/SM) SILT and SAND

FIGURE B5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH-104	SS8	6.10 - 6.55

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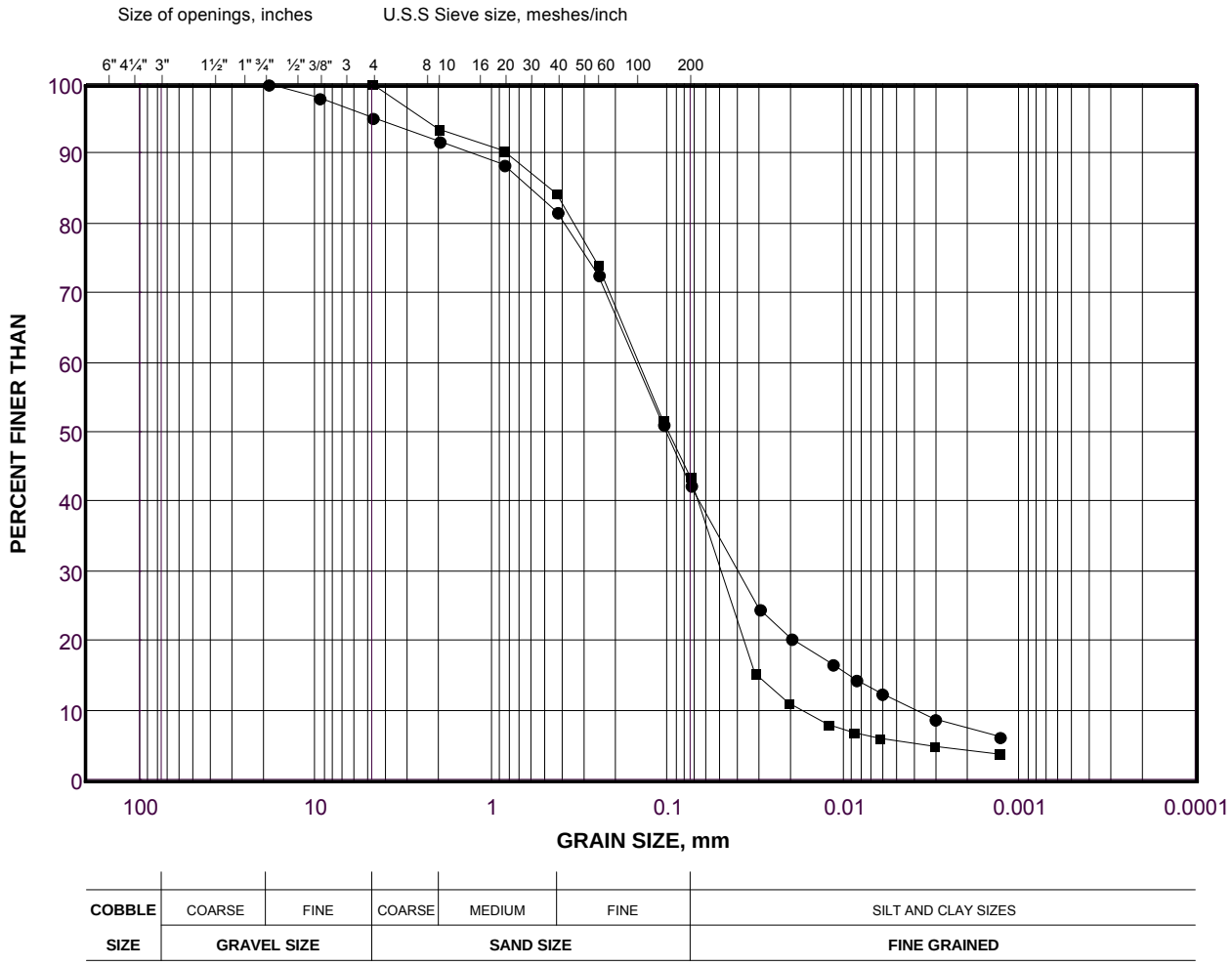
Date: 26-May-15

GRAIN SIZE DISTRIBUTION
(SM) SILTY SAND

FIGURE B6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	BH-311	SA3	1.20 - 1.50
■	BH-309	SA5	1.00 - 1.30

Project Number: 1413283

Checked By: JBH

Golder Associates

Date: 14-May-15

APPENDIX C

AASHTO Pavement Design Sheets

TABLE C-1

EQUIVALENT SINGLE AXLE LOAD CALCULATION

Town of Innisfil - 6th Line Environmental Assessment
PAVEMENT DESIGN FOR RECONSTRUCTION OF 6th LINE (20 Year Design)
(Using Traffic Data from the 20th Sideroad to St. John's Road)

1) Traffic Analysis

Traffic Data Year	*2015*	*2031*	*2036*
Design Year	**2016**		
Traffic Analysis Period		16	5
Average Annual Daily Traffic (AADT)	800	17,100	18,500
Average Rate of Increase in Traffic (%)		21.1	1.6
Truck Fraction of Total Traffic	4.0%	5.0%	5.0%
Average Rate of Increase in Truck Fraction (%)		1.4	0.0
Number of Lanes in One Direction	1	1	1
Directional Factor	0.5	0.5	0.5
Lane Distribution Factor	1	1	1
Daily Truck Volume	**20**	**428**	**463**

2) Daily ESALs Analysis

Road Classification	***Urban Minor Arterial***		
Breakdown of Truck Proportions			
Class 1	0.65		
Class 2	0.05		
Class 3	0.2		
Class 4	0.1		
Daily Truck Volumes for 4 Classes	*2016*	*2031*	*2036*
Class 1	13	278	301
Class 2	1	21	23
Class 3	4	86	93
Class 4	2	43	46
Truck Factors for 4 Classes of Truck			
Class 1	0.5		
Class 2	2.3		
Class 3	1.6		
Class 4	5.5		
Weighted Average Truck Factor	**1.310**		
Daily ESALs per Truck Class			
Class 1	6	139	150
Class 2	2	49	53
Class 3	6	137	148
Class 4	11	235	254
Total Daily ESALs in Design Lane	**26**	**560**	**606**

3) Total ESALs for Base Year

Base Year	*2016*	*2031*	*2036*
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**9,394**	**204,409**	**221,144**

4) Cumulative ESALs for the Design Period

Design Period	20	
Span of Design Periods	*2016 to 2031*	*2031 to 2036*
Average Rate of Increase in Truck Volume (%)	22.8	1.6
Number of Years Within Design Period	15	5
Geometric Growth Factor over Number of Years	91.07	5.16
Number of ESALs over Design Period	855,566	1,054,989
Cumulative ESALs for the Design Period		**1,910,555**

Note: The ESAL calculations are based on the Guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions".

Designed: DM
Checked: JBH

TABLE C-2

Project: 6th Line Environmental Assessment, Section 1
Subgrade: Silty Clay Subgrade

Reconstruction Design

Flexible Structural Design

80 kN ESALs Over Initial Performance Period	1,900,000
Initial Servicability	4.4
Terminal Servicability	2.2
Reliability Level	85
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	25
Stage Construction	1
Required Design Structural Number	**117**

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1	140	59
2	New Granular A	0.14	1	150	21
3	New Granular B, Type I	0.09	1	450	41
Total	**-**	**-**	**-**	**600**	**120**

Layered Thickness Analysis

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1	2,750,000	131	55
2	New Granular A	0.14	1	210,000	145	20
3	New Granular B, Type I	0.09	1	90,000	460	41
Total	**-**	**-**	**-**	**-**	**605**	**117**

Designed: DM
Checked: JBH

TABLE C-3

EQUIVALENT SINGLE AXLE LOAD CALCULATION

Town of Innisfil - 6th Line Environmental Assessment

PAVEMENT DESIGN FOR RECONSTRUCTION OF 6th LINE (20 Year Design)

(Using Traffic Data from County Road 27 to 20th Sideroad)

1) Traffic Analysis

Traffic Data Year	*2015*	*2031*	*2036*
Design Year	**2016**		
Traffic Analysis Period		16	5
Average Annual Daily Traffic (AADT)	300	11,300	13,600
Average Rate of Increase in Traffic (%)		25.5	3.8
Truck Fraction of Total Traffic	3.0%	5.0%	5.0%
Average Rate of Increase in Truck Fraction (%)		3.2	0.0
Number of Lanes in One Direction	1	1	1
Directional Factor	0.5	0.5	0.5
Lane Distribution Factor	1	1	1
Daily Truck Volume	**6**	**283**	**340**

2) Daily ESALs Analysis

Road Classification: ***Urban Principal Arterial***

Breakdown of Truck Proportions

Class 1	0.3
Class 2	0.1
Class 3	0.45
Class 4	0.15

Daily Truck Volumes for 4 Classes	*2016*	*2031*	*2036*
Class 1	2	85	102
Class 2	1	28	34
Class 3	3	127	153
Class 4	1	42	51

Truck Factors for 4 Classes of Truck

Class 1	0.5
Class 2	2.3
Class 3	1.6
Class 4	5.5
Weighted Average Truck Factor	**1.925**

Daily ESALs per Truck Class			
Class 1	1	42	51
Class 2	1	65	78
Class 3	4	203	245
Class 4	5	233	281
Total Daily ESALs in Design Lane	**11**	**544**	**655**

3) Total ESALs for Base Year

Base Year	*2016*	*2031*	*2036*
Number of Days of Truck Traffic	365	365	365
Total ESALs for Base Year	**4,095**	**198,492**	**238,893**

4) Cumulative ESALs for the Design Period

Design Period	20	
Span of Design Periods	*2016 to 2031*	*2031 to 2036*
Average Rate of Increase in Truck Volume (%)	29.5	3.8
Number of Years Within Design Period	15	5
Geometric Growth Factor over Number of Years	160.75	5.39
Number of ESALs over Design Period	658,350	1,070,267
Cumulative ESALs for the Design Period		**1,728,618**

Note: The ESAL calculations are based on the Guidelines "Procedures for Estimating Traffic Loads for Pavement Design" by Jerry Hajek, 1995, and on MTO's "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions".

Designed: DM
Checked: JBH

TABLE C-4

Project: 6th Line Environmental Assessment, Section 2
Subgrade: Silty Clay Subgrade

Reconstruction Design With Grade Raise

Flexible Structural Design

80 kN ESALs Over Initial Performance Period	1,700,000
Initial Servicability	4.5
Terminal Servicability	2.5
Reliability Level	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	25
Stage Construction	1
Required Design Structural Number	**125**

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1	140	59
2	New Granular A	0.14	1	300	42
3	Existing Granular Base	0.11	0.9	160	16
4	Existing Granular Subbase	0.06	0.9	360	19
Total	**-**	**-**	**-**	**820**	**136**

Layered Thickness Analysis

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1	2,750,000	131	55
2	New Granular A	0.14	1	210,000	224	31
	Existing Granular Base	0.11	0.9	180,000	145	14
3	Existing Granular Subbase	0.06	0.9	70,000	452	24
Total	**-**	**-**	**-**	**-**	**821**	**125**

Designed: DM
Checked: JBH

TABLE C-5

Project: 6th Line Environmental Assessment, Section 2
Subgrade: Silty Clay Subgrade

Option 2 - Reconstruction Design

Flexible Structural Design

80 kN ESALs Over Initial Performance Period	1,700,000
Initial Servicability	4.5
Terminal Servicability	2.5
Reliability Level	90
Overall Standard Deviation	0.49
Roadbed Soil Resilient Modulus	25
Stage Construction	1
Required Design Structural Number	**125**

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di) (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1	140	59
2	New Granular A	0.14	1	150	21
3	New Granular B, Type I	0.09	1	500	45
Total	**-**	**-**	**-**	**650**	**125**

Layered Thickness Analysis

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Elastic Modulus (kPa)	Calculated Thickness (mm)	Calculated SN (mm)
1	New Hot Mix Asphalt	0.42	1	2,750,000	131	55
2	New Granular A	0.14	1	210,000	162	23
3	New Granular B, Type I	0.09	1	90,000	590	53
Total	**-**	**-**	**-**	**-**	**752**	**131**

Designed: DM
Checked: JBH

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