

**Appendix F:**  
**Geotechnical Investigation**



**PRELIMINARY GEOTECHNICAL INVESTIGATION  
CLASS EA PHASE 3 AND 4 FOR  
BAYVIEW DRIVE AND BIG BAY POINT ROAD IMPROVEMENTS  
BARRIE, ONTARIO**

**for**

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Report: 1

Mr. Shannon Roulston, P.Eng.  
C.C. Tatham & Associates Ltd.  
41 King Street, Unit 4  
Barrie, Ontario  
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Dear Mr. Roulston

**Preliminary Geotechnical Investigation  
Class EA Phase 3 and 4 for  
Bayview Drive and Big Bay Point Road Improvements  
Barrie, Ontario**

Peto MacCallum Ltd. (PML) is pleased to present the results of the preliminary geotechnical investigation recently completed at the above noted project site. Authorization for the work described in this report was provided by Mr. S. Roulston, in an email dated September 22, 2015 and executed C.C. Tatham & Associates Ltd. Sub-consultant Agreement.

The City of Barrie is proposing improvements in the year 2031 to the transportation corridors of Bayview Drive and Big Bay Point Road. The following improvements are contemplated:

- Bayview Drive between Big Bay Point Road and Little Avenue (1.3 km) will be reconstructed and widened from two lanes to three lanes, and possibly up to five lanes. Replacement of watermain and local sanitary sewers, replacement of five culverts along the alignment and associated drainage improvements are also proposed. Underground utilities will be bored under the existing railway crossing just north of Big Bay Point Road.
- Big Bay Point Road between Bayview Drive and Welham Road (1.2 km) will be reconstructed and widened from two lanes to seven lanes. The works will include replacement of watermain and local sanitary sewers, drainage improvements, and some services bored beneath the existing railway crossing on Welham Road, just north of Big Bay Point Road.

Final design, including inverts and grades are not yet established.

The purpose of this investigation was to conduct a limited number of exploratory boreholes to determine the generalized soil and ground water conditions at the site, and based on this information, provide a preliminary assessment of the subsurface conditions impacting the proposed improvements. Geoenvironmental assessment of the site was not within the terms of reference, and no work has been carried out in this regard.



The assessment provided in this report is based on the subsurface conditions as revealed in a limited number of boreholes. Final design, including inverts and finished grades are not yet established. Accordingly, the comments and recommendations provided in this report are preliminary in nature, and suitable only for preliminary planning purposes. When design details are available, supplementary investigation and analysis will be required to finalize the geotechnical design.

### **INVESTIGATION PROCEDURES**

The field work for the investigation was carried out on October 26 and 27, 2015 and consisted of nine boreholes:

- Boreholes 1 to 5 drilled to 5.0 to 10.1 m depth along Bayview Drive for culvert replacements and pavement reconstruction;
- Borehole 6 drilled to 6.6 m depth for utilities crossing under the railway tracks on Bayview Drive;
- Borehole 7 and 8, drilled to 2.0 m depth for pavement reconstruction along Big Bay Point Road;
- Borehole 9, drilled to 6.6 m depth for utilities crossing under the railway tracks on Welham Road.

Borehole locations are shown on Drawing 1.

Boreholes were advanced using continuous flight solid stem augers, powered by a truck mounted CME-75 drill rig, equipped with an automatic hammer, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a member of our engineering staff.

The pavement component thicknesses encountered in the boreholes were measured and samples of the granular material collected. Representative samples of the underlying subgrade soils were recovered at frequent depth intervals for identification purposes using a conventional split spoon sampler. Standard penetration tests were carried out simultaneously with the



sampling operations to assess the strength characteristics of the subsoil. Ground water conditions were closely monitored during the course of the field work.

The location of each borehole was established in the field by PML, cognizant of underground utility locates.

Traffic control was provided by PML in accordance with the Ontario Traffic Manual, Book 7. All boreholes were backfilled and capped with cold mix asphalt. All recovered samples were returned to our laboratory for moisture content determination and detailed examination to confirm field classification.

#### **SITE DESCRIPTION AND SUMMARIZED SUBSURFACE CONDITIONS**

Within the project limits, existing Bayview Drive and Big Bay Point Road are two lane roads with discontinuous shallow ditching. Along Big Bay Point Road the immediate surrounding topography is relatively flat and the road platform is generally even with the surrounding lands. Along Bayview Drive, the immediate surrounding lands are slightly higher on the west side of the road with typically lower lying lands to the east. There is a shallow creek tributary running through the existing culvert near the south end of Bayview Drive. All the other culvert crossings (Boreholes 1 to 4) were dry at the time of the investigation.

Reference is made to the appended Log of Borehole sheets for details of the subsurface conditions, including soil classifications, pavement thicknesses, inferred stratigraphy, Standard Penetration "N" values, ground water observations and the results of laboratory water content determinations.

Below the pavement, the boreholes revealed fill, over a major sand or till unit. A description of the distribution of the subsurface conditions is presented below.



## Pavement

The table below summarizes the pavement structure encountered in the boreholes:

BOREHOLE	ASPHALT (mm)	GRANULAR BASE (mm)	GRANULAR SUBBASE (mm)	TOTAL THICKNESS (mm)
Bayview Drive				
1	120	160	180	460
2	160	120	180	460
3	170	120	170	460
4	110	150	200	460
5	110	160	200	470
6	160	170	200	530
<b>Average</b>	138	147	188	473
<b>Range</b>	110-170	120-170	170-200	460-530
Big Bay Point Road				
7	140	140	190	470
8	110	150	160	420
<b>Average</b>	125	145	175	445
<b>Range</b>	110-140	140-150	160-190	420-470
Welham Road				
9*	110	120	140	370
Note: * Borehole advanced through shoulder pavement.				

## Fill

Below the pavement structure, fill was encountered in all boreholes to depths of 1.0 to 5.5 m. The fill comprised silty sand to sandy silt with variable clay and gravel content. Trace organics were generally noted within the fill, with a more defined topsoil layer, locally at the base of the unit. Wood pieces were also locally observed. The fill was typically moist, locally very moist to wet at the base of the layer. Moisture contents ranged from 2 to 22%.



## **Sand**

A native sand unit was encountered below the fill in Boreholes 1 to 5 and 9, extending to the 5.0 to 10.1 m depth of exploration. The unit contained trace to some silt and trace gravel, often grading to a till like silty sand at depth. The unit was typically loose to compact, locally dense or very dense. Moisture contents were generally 2 to 12% (moist), locally 14 to 18% (wet) in Borehole 5.

## **Till**

A till deposit was found below the fill in Boreholes 6 to 8 (south end of the site) extending to the 2.0 to 6.6 m depth of exploration. The till comprised silty sand/sandy silt, with trace gravel. Cobbles and boulders were noted. The till was compact to very dense. Moisture contents were 7 to 8%, with the material being moist.

## **Ground Water**

Upon completion of augering, water was observed only in Borehole 5 at 3.2 m depth. At this location, the creek tributary water level was about 2.1 m below the road level with the creek only trickling through the culvert (maximum depth of 0.1 m).

It is noted that with the exception of the creek culvert at Borehole 5, the other culvert locations (Boreholes 1 to 4) were dry.

Ground water levels will fluctuate seasonally and in response to variations in precipitation.



## **GEOTECHNICAL ENGINEERING CONSIDERATIONS**

### **General**

The City of Barrie is proposing improvements to the transportation corridors of Bayview Drive and Big Bay Point Road for the year 2031. The following improvements are contemplated:

- Bayview Drive between Big Bay Point Road and Little Avenue (1.3 km) will be reconstructed and widened from two lanes to three lanes, and possibly up to five lanes. Replacement of watermain and local sanitary sewers, replacement of five culverts along the alignment and associated drainage improvements, are also proposed. Underground utilities will be bored under the existing railway crossing just north of Big Bay Point Road.
- Big Bay Point Road between Bayview Drive and Welham Road (1.2 km) will be reconstructed and widened from two lanes to seven lanes. The works will include replacement of watermain and local sanitary sewers, drainage improvements, and some services bored beneath the existing railway crossing on Welham Road, just north of Big Bay Point Road.

The assessment provided in this report is based on the subsurface conditions as revealed in a limited number of boreholes. Final design, including the details of the road, culvert inverts and finished grades are not yet established. Accordingly, the comments and recommendations provided in this report are preliminary in nature, and suitable only for preliminary planning purposes. When design details are available, supplementary investigation and analysis will be required to finalize the geotechnical design.

### **Culvert Replacements**

It is understood that future culverts will likely comprise closed bottom concrete box culverts or CSP's with inverts similar the existing culverts.

Reference is made to OPSS 400 Series and OPSD 800 Series for general culvert installation requirements including granular bedding, embedment, cover material requirements and frost tapers.





Based on Boreholes 1 to 5, the subgrade for the culverts at existing invert levels is expected to comprise 0.2 to 2.0 m of fill over loose to compact native sand. The existing fill will need to be sub-excavated and replaced with increased thickness of bedding material. The underlying native soils are considered satisfactory to supporting the culverts.

Culvert walls must be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the wall.

Frost tapers will likely be required for the approaches of most if not all culverts.

In general, excavated site soils are expected to be acceptable for reuse as backfill above the culverts, subject to exclusion of deleterious content/organics and geotechnical review and approval during construction.

### **Site Servicing**

As part of the works the watermain along the full road alignments and local sections of sanitary sewer, will be replaced.

### **Trench Excavation and Ground Water Control**

Trench excavation and ground water control for services is discussed in Excavation and Ground Water Control later in the report.

### **Pipe Bedding**

Based on the boreholes, the subgrade at assumed watermain and sanitary sewer invert levels is expected to comprise a thin fill layer over native sand or till. Where fill or other deleterious materials are encountered at invert level, such fill should be sub-excavated and replaced with increased bedding thickness, subject to geotechnical field review.



### Trench Backfill

Trench backfill should be compacted to 95% Standard Proctor maximum dry density in 200 mm thick lifts. In general excavated materials from beneath the road are expected to be acceptable for reuse subject to exclusion of deleterious content/organics, moisture and geotechnical review and approval during construction.

### **Utility Crossings Under Railway Tracks by Horizontal Directional Drilling, and Jack and Bore**

It is understood that services will be installed beneath the railway crossings on Bayview Drive and Welham Road just north of Big Bay Point Road. In this regard, Horizontal Directional Drilling (HDD) and Jack and Bore are both are considered feasible subject to the commentary below.

Based on Borehole 6 on Bayview Drive, the operation will encounter dense to very dense silty sand/sandy silt till. Ground water was not observed. Borehole 9 on Welham Road shows the operation will encounter compact to very dense sand with ground water also not observed.

It is advised that Bayveiw Drive boring may encounter cobbles and boulders in the till. No obstructions are anticipated in the sand deposit on Welham Road based on Borehole 9.

HDD installations should be carried out in accordance with OPSS 450, Construction Specifications for Pipeline and Utility Installation in Soil by Horizontal Directional Drilling.

Jack and Bore installations should be carried out in accordance OPSS 416, Construction Specifications for Pipeline and Utility Installation by Jacking and Boring.

A monitoring program to measure the vertical ground movements is recommended. Consideration should be given to a monitoring program that follows the plan outlined in MTO's Guidelines for Foundation Engineering – Tunnelling Specialty for Encroachment Permit Application, including a series of monitoring points, daily measurements, and review level and alert levels of movement where a specific plan of action is in place for these levels of movement.



### **Excavation and Ground Water Control**

For purposes of this report, it is assumed that excavation for the watermain, sanitary sewers and culverts could extend down to as much as about 4.0 m below the present road level, to be confirmed when design details are established. In this regard, excavation will be carried out through the existing pavement, fill, and into the underlying sand or till. Excavation within these materials should be straightforward, and may be carried out using conventional equipment. Harder digging and the presence of boulders should be anticipated where till is encountered.

All construction work must be carried out in accordance with the requirements of the Occupational Health and Safety Act (OHSA). The site soils are considered as Type 3 soil requiring side walls to be constructed at no steeper than one horizontal to one vertical (1H:1V) from the base of the excavation.

Ground water was observed only in Borehole 5 where excavation will be required below the creek tributary water level.

In this regard, conventional sump pumping should suffice to control ground water seepage and surface water run-off in most excavations. It is envisioned that a combination of sump pumping, coffer dams, creek diversion, and granular drainage blankets will be required at and near the creek tributary at Borehole 5.

A PTTW is not anticipated.



## **Pavement Design and Construction**

Bayview Drive will be widened from two lanes to three lanes, possibly up to five lanes, and Big Bay Point Road will be widened from two lanes to seven lanes. It is understood that the proposed pavements will likely be fully reconstructed, however, consideration may be given to constructing the widening with new pavement while rehabilitating the existing road platform. It is noted the existing pavement structure is relatively thin (460 to 530 mm on Bayview Drive, and 420 to 470 mm on Big Bay Point Road) with increased traffic and considering these pavements would exceed their service life in 2031, full reconstruction would be recommended.

The AASHTO design methodology using DARwin software was utilized for this project.

### **Bayview Drive**

Projected 2031 traffic volumes of 10,200 AADT with 5% commercial traffic, provided by the Client, with 3% growth assumed, were utilized in our design.

Based on the traffic volumes provided and the anticipated moderately to highly frost susceptible silty sand to sandy silt subgrade, the following pavement structure is recommended for an 18 year service life:

<b>MATERIAL</b>	<b>THICKNESS (mm)</b>
Asphalt	140
Granular A Base Course	150
Granular B Type I Subbase Course	450
Total Thickness	740

### **Big Bay Point Road**

Projected 2031 traffic volumes of 27,400 AADT with 5% commercial traffic, provided by the Client, with 3% growth assumed, were utilized in our design.



Based on the traffic volumes provided and the anticipated moderately to highly frost susceptible silty sand to sandy silt subgrade, the following pavement structure is recommended for an 18 year service life:

<b>MATERIAL</b>	<b>THICKNESS (mm)</b>
Asphalt	170
Granular A Base Course	150
Granular B Type I Subbase Course	500
Total Thickness (mm)	820

#### General

The pavement subgrade will comprise existing silty sand to sandy silt fill. It is anticipated that the existing fill will remain in place. In this regard, in order to minimize potential settlement issues, following rough grading, subgrade preparation should include proofrolling the exposed subgrade to minimum 95% Standard Proctor maximum dry density. Any unstable zones identified during this process should be sub-excavated and replaced with compacted material to establish uniform subgrade support conditions, subject to geotechnical field review.

Where platform widening is to take place, topsoil, organics, and deleterious soil should be stripped to the new toe of slope and grades raised with on-site soil placed in maximum 200 mm thick lifts compacted to a minimum 95% Standard Proctor maximum dry density.

#### Geotechnical Review

The comments and recommendations provided in this report are based on the subsurface conditions as revealed in a limited number of boreholes. Currently, the details of the road improvements are not yet established. Accordingly, the comments and recommendations provided in this report are preliminary in nature, and suitable only for preliminary planning purposes. When design details are available, supplementary investigation and analysis will be required to finalize the geotechnical design.



## CLOSURE

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to call our office.

Sincerely

Peto MacCallum Ltd.



Geoffrey R. White, P.Eng.  
Associate  
Manager, Geotechnical and Geo-environmental Services



Turney Lee-Bun, P.Eng.  
Vice President

GRW/TLB:jlb

Enclosures:  
List of Abbreviations  
Log of Borehole Nos. 1 to 9  
Drawing 1 - Borehole Location Plan

# LIST OF ABBREVIATIONS



## PENETRATION RESISTANCE

Standard Penetration Resistance N: - The number of blows required to advance a standard split spoon sampler 0.3 m into the subsoil. Driven by means of a 63.5 kg hammer falling freely a distance of 0.76 m.

Dynamic Penetration Resistance: - The number of blows required to advance a 51 mm, 60 degree cone, fitted to the end of drill rods, 0.3 m into the subsoil. The driving energy being 475 J per blow.

## DESCRIPTION OF SOIL

The consistency of cohesive soils and the relative density or denseness of cohesionless soils are described in the following terms:

<u>CONSISTENCY</u>	<u>N (blows/0.3 m)</u>	<u>c (kPa)</u>	<u>DENSENESS</u>	<u>N (blows/0.3 m)</u>
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		
WTPL	Wetter Than Plastic Limit			
APL	About Plastic Limit			
DTPL	Drier Than Plastic Limit			

## TYPE OF SAMPLE

SS	Split Spoon	TW	Thinwall Open
WS	Washed Sample	TP	Thinwall Piston
SB	Scraper Bucket Sample	OS	Oesterberg Sample
AS	Auger Sample	FS	Foil Sample
CS	Chunk Sample	RC	Rock Core
ST	Slotted Tube Sample		
	PH	Sample Advanced Hydraulically	
	PM	Sample Advanced Manually	

## SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

## LOG OF BOREHOLE NO. 1

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0604922E  
**LOCATION** Barrie, Ontario      4912829N      **PML REF.** 15BF048  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 26, 2015      **ENGINEER** GW  
**TECHNICIAN** AT

SOIL PROFILE			SAMPLES			SHEAR STRENGTH (kPa)		PLASTIC NATURAL LIQUID			UNIT WEIGHT	GROUND WATER OBSERVATIONS AND REMARKS
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	+ FIELD VANE   Δ TORVANE   ○ Qu	▲ POCKET PENETROMETER   ○ Q	LIMIT	MOISTURE CONTENT	LIMIT		
						DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST ×		W <sub>p</sub>	W	W <sub>L</sub>		GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						20	40	60	80			
0.0	SURFACE ELEVATION											
0.46	PAVEMENT: 120 mm asphalt, over 160 mm granular base, over 180 mm granular subbase, moist		1A 1B	GS	-							
1.0	FILL: Dark grey to black, sandy silt/silty sand, trace to some gravel, moist		2	SS	19							
2.1	SAND: Loose to compact, brown, sand, trace to some silt, trace gravel, moist		3	SS	7							Approximate Invert Depth of Existing Culvert 1.2 m Below Road Surface
			4	SS	5							
			5	SS	8							
			6	SS	20							
5.0	Becoming grey, silty sand, trace gravel, till-like											
	BOREHOLE TERMINATED AT 5.0 m											Upon completion of augering No water No cave

NOTES



## LOG OF BOREHOLE NO. 2

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0604955E  
**LOCATION** Barrie, Ontario      4912734N  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 26, 2015      **PML REF.** 15BF048  
**ENGINEER** GW      **TECHNICIAN** AT

SOIL PROFILE			SAMPLES			SHEAR STRENGTH (kPa)		PLASTIC NATURAL LIQUID			UNIT WEIGHT	GROUND WATER OBSERVATIONS AND REMARKS					
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	FIELD VANE TORVANE POCKET PENETROMETER	MOISTURE CONTENT	W <sub>p</sub>	w	W <sub>L</sub>			kN/m <sup>3</sup>				
						DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST		WATER CONTENT (%)			GRAIN SIZE DISTRIBUTION (%)						
						20	40	60	80	10	20	30	40	GR	SA	SI	CL
0.0	<b>SURFACE ELEVATION</b>																
0.46	PAVEMENT: 160 mm asphalt, over 120 mm granular base, over 180 mm granular subbase, moist		1A 1B	GS	-												
1.0	FILL: Dark grey to black, sandy silt/silty sand, trace gravel, trace organics, moist to very moist		2	SS	16												
2.0			3	SS	17												
2.9	Becoming black, silty sand topsoil, trace gravel, wood pieces		4	SS	14												
3.0	SAND: Loose to compact, brown sand, some silt, moist		5	SS	8												
5.0	Becoming grey, silty sand, trace gravel, till-like		6	SS	15												
5.0	BOREHOLE TERMINATED AT 5.0 m																
6.0																	
7.0																	
8.0																	
9.0																	
10.0																	
11.0																	
12.0																	
13.0																	
14.0																	
15.0																	

Existing Culvert Damaged or Covered. Exact Invert Unknown.

Upon completion of augering  
No water  
No cave

**NOTES**

## LOG OF BOREHOLE NO. 3

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0605023E  
**LOCATION** Barrie, Ontario      4912408N      **PML REF.** 15BF048  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 26, 2015      **ENGINEER** GW  
**TECHNICIAN** AT

SOIL PROFILE			SAMPLES			SHEAR STRENGTH (kPa)		PLASTIC NATURAL LIQUID			UNIT WEIGHT kN/m <sup>3</sup>	GROUND WATER OBSERVATIONS AND REMARKS	
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	+ FIELD VANE	△ TORVANE	○ Qu	w <sub>p</sub>	w			w <sub>L</sub>
						▲ POCKET PENETROMETER	○ Q	○ Q					
						DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST ×			WATER CONTENT (%)				
						20	40	60	80	10	20	30	40
0.0	SURFACE ELEVATION												
0.46	PAVEMENT: 170 mm asphalt, over 120 mm granular base, over 170 mm granular subbase, moist		1A	GS	-								
	FILL: Dark grey to black, sandy silt, trace gravel, moist		1B										
1.0			2	SS	18								
	Becoming brown to dark brown, silty sand, trace to some gravel, moist		3	SS	13								
2.0			4	SS	30								
3.0			5	SS	20								
4.0													
5.0			6	SS	16								
5.5	SAND: Compact to dense, brown, silty sand, moist												
6.0			7	SS	12								
7.0													
8.0													
9.0													
10.0	Becoming dark grey, silty sand, trace gravel, till-like		8	SS	34								
10.1	BOREHOLE TERMINATED AT 10.1 m												
11.0													Upon completion of augering No water No cave
12.0													
13.0													
14.0													
15.0													

Approximate Invert Depth of Existing Culvert  
3.4 m Below Road Surface

Upon completion of augering  
No water  
No cave

**NOTES**

## LOG OF BOREHOLE NO. 4

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0605050E  
**LOCATION** Barrie, Ontario      4912292N  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 26, 2015      **PML REF.** 15BF048  
**ENGINEER** GW      **TECHNICIAN** AT

SOIL PROFILE			SAMPLES			SHEAR STRENGTH (kPa)		PLASTIC NATURAL LIQUID			UNIT WEIGHT	GROUND WATER OBSERVATIONS AND REMARKS	
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	+ FIELD VANE    Δ TORVANE    ○ Qu	▲ POCKET PENETROMETER    ○ Q	LIMIT	MOISTURE CONTENT	LIMIT			kN/m <sup>3</sup>
						DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST    ×		WATER CONTENT (%)					
						50	100	150	200				GRAIN SIZE DISTRIBUTION (%)
						20	40	60	80	W <sub>p</sub>	W	W <sub>L</sub>	GR SA SI CL
0.0	SURFACE ELEVATION												
0.46	PAVEMENT: 110 mm asphalt, over 150 mm granular base, over 200 mm granular subbase, moist		1A 1B	GS	-								
1.0	FILL: Brown to dark grey, sand, trace gravel, silt pockets, moist		2	SS	23								
2.0	Becoming black, silt topsoil		3	SS	11								
2.1	SAND: Compact to loose, brown, sand, trace to some silt, moist		4	SS	16								Approximate Invert Depth of Existing Culvert 1.9 m Below Road Surface
3.0			5	SS	7								
4.0													
5.0	Becoming dense, light grey, silty sand, trace gravel, till-like		6	SS	34								
5.0	BOREHOLE TERMINATED AT 5.0 m												Upon completion of augering No water No cave

Approximate Invert Depth of Existing Culvert 1.9 m Below Road Surface

Upon completion of augering  
No water  
No cave

**NOTES**



## LOG OF BOREHOLE NO. 5

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0605154E  
**LOCATION** Barrie, Ontario      4911795N      **PML REF.** 15BF048  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 26, 2015      **ENGINEER** GW  
**TECHNICIAN** AT

SOIL PROFILE			SAMPLES			SHEAR STRENGTH (kPa)		PLASTIC NATURAL LIQUID			UNIT WEIGHT	GROUND WATER OBSERVATIONS AND REMARKS	
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	+ FIELD VANE	△ TORVANE	○ Qu	LIMIT	MOISTURE CONTENT			LIMIT
						▲ POCKET PENETROMETER	○ Q		w <sub>p</sub>	w	w <sub>L</sub>		
						DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST		×	WATER CONTENT (%)				
						20	40	60	80	10	20	30	40
0.0	SURFACE ELEVATION												
0.47	PAVEMENT: 110 mm asphalt, over 160 mm granular base, over 200 mm granular subbase, moist		1A 1B	GS	-								
1.0	FILL: Brown to dark grey, silty sand/sandy silt, trace gravel, moist to wet		2	SS	19								
2.0			3	SS	24								
3.0			4	SS	6								
4.0			5	SS	6								
4.0	SAND: Loose to dense, brown, sand, trace to some silt, wet		6	SS	6								
6.0	Trace gravel		7	SS	45								
10.1	BOREHOLE TERMINATED AT 10.1 m		8	SS	56								
11.0													Upon completion of augering Wet cave at 3.2 m

Approximate Invert Depth of Existing Culvert  
2.1 m Below Road Surface

**NOTES**

## LOG OF BOREHOLE NO. 6

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0605209E  
**LOCATION** Barrie, Ontario      4911615N      **PML REF.** 15BF048  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 27, 2015      **ENGINEER** GW  
**TECHNICIAN** AT

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH (kPa)		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT kN/m <sup>3</sup>	GROUND WATER OBSERVATIONS AND REMARKS
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		+ FIELD VANE	△ TORVANE					
0.0	SURFACE ELEVATION												
0.53	PAVEMENT: 160 mm asphalt, over 170 mm granular base, over 200 mm granular subbase, moist		1A 1B	GS	-								
1.0	FILL: Brown to black, silty sand/sandy silt, trace gravel, very moist		2	SS	11								
2.1	TILL: Dense to very dense, grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist		3	SS	5								
4.0			4	SS	49								
5.0			5	SS	76								
6.0			6	SS	38								
6.6			7	SS	49								
7.0	BOREHOLE TERMINATED AT 6.6 m												Upon completion of augering No water No cave

**NOTES**

## LOG OF BOREHOLE NO. 7

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0605286E  
**LOCATION** Barrie, Ontario      4911601N      **PML REF.** 15BF048  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 27, 2015      **ENGINEER** GW  
**TECHNICIAN** AT

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH (kPa)				PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT	GROUND WATER OBSERVATIONS AND REMARKS			
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		+ FIELD VANE	△ TORVANE	○ Qu	▲ POCKET PENETROMETER						○ Q	×	Wp
						DYNAMIC CONE PENETRATION STANDARD PENETRATION TEST				WATER CONTENT (%)								
						20	40	60	80				10	20	30	40	kN/m <sup>3</sup>	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0	SURFACE ELEVATION																	
0.47	PAVEMENT: 140 mm asphalt, over 140 mm granular base, over 190 mm granular subbase, moist		1A 1B	GS	-													
1.0	FILL: Brown, sandy silt, trace clay, trace gravel, moist		2	SS	22													
2.0	TILL: Very dense, grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist		3	SS	57													
2.0	BOREHOLE TERMINATED AT 2.0 m																	Upon completion of augering No water No cave
3.0																		
4.0																		
5.0																		
6.0																		
7.0																		
8.0																		
9.0																		
10.0																		
11.0																		
12.0																		
13.0																		
14.0																		
15.0																		

NOTES



## LOG OF BOREHOLE NO. 8

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0605883E  
**LOCATION** Barrie, Ontario      4911803N  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 27, 2015      **PML REF.** 15BF048  
**ENGINEER** GW      **TECHNICIAN** AT

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH (kPa)				PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT kN/m <sup>3</sup>	GROUND WATER OBSERVATIONS AND REMARKS	
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		+ FIELD VANE	△ TORVANE	○ Qu	▲ POCKET PENETROMETER						○ Q
						50	100	150	200							
0.0	SURFACE ELEVATION					20	40	60	80							
0.42	PAVEMENT: 110 mm asphalt, over 150 mm granular base, over 160 mm granular subbase, moist		1A 1B	GS	-											
1.0	FILL: Brown to light brown, sand, trace to some silt, trace gravel, moist		2	SS	13											
1.4	TILL: Compact, grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist		3	SS	23											
2.0	BOREHOLE TERMINATED AT 2.0 m															
3.0																
4.0																
5.0																
6.0																
7.0																
8.0																
9.0																
10.0																
11.0																
12.0																
13.0																
14.0																
15.0																

Upon completion of augering  
No water  
No cave

**NOTES**

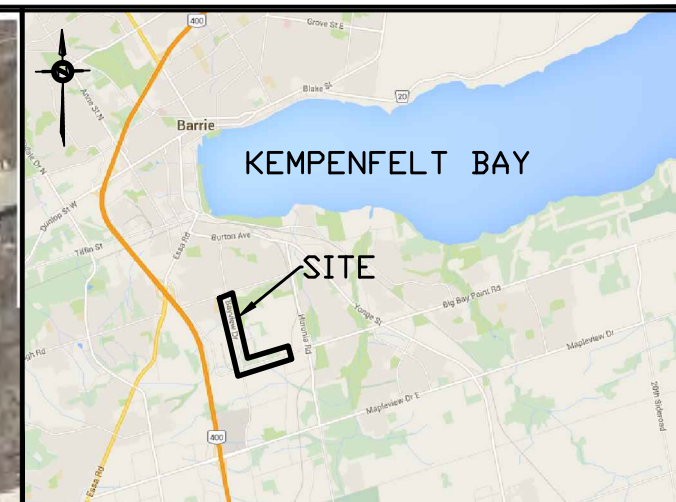
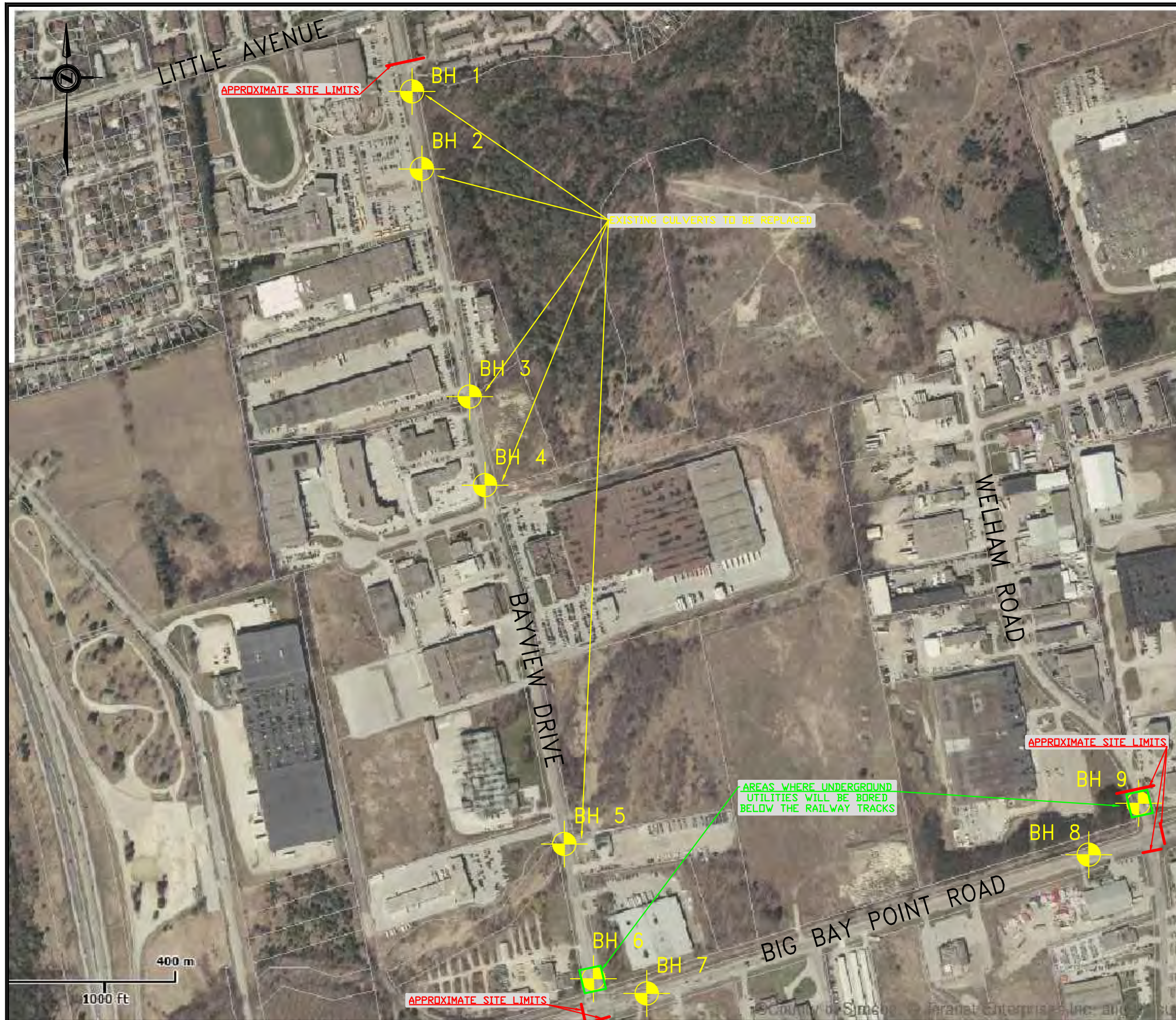
## LOG OF BOREHOLE NO. 9

**PROJECT** Class EA Phase 3 and 4 - Bayview Drive and Big Bay Point Road Improvements      17T 0605945E  
**LOCATION** Barrie, Ontario      4911860N  
**BORING METHOD** Continuous Flight Solid Stem Augers      **BORING DATE** October 27, 2015      **PML REF.** 15BF048  
**ENGINEER** GW      **TECHNICIAN** AT

SOIL PROFILE			SAMPLES			SHEAR STRENGTH (kPa)		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT kN/m <sup>3</sup>	GROUND WATER OBSERVATIONS AND REMARKS
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	+ FIELD VANE    Δ TORVANE    ○ Qu	▲ POCKET PENETROMETER    ○ Q	w <sub>p</sub>	w	w <sub>L</sub>		
						ELEVATION SCALE		WATER CONTENT (%)				
						DYNAMIC CONE PENETRATION ×						
						STANDARD PENETRATION TEST ●						
						20    40    60    80		10    20    30    40				
0.0	SURFACE ELEVATION											
0.37	SHOULDER PAVEMENT: 110 mm asphalt, over 120 mm granular base, over 140 mm granular subbase, moist FILL: Brown, sand, trace silt, moist		1A 1B	GS	-							
1.0			2	SS	14							
1.4	SAND: Compact to very dense, light brown, sand, trace silt, stratified, moist		3	SS	20							
2.0			4	SS	54							
3.0			5	SS	55							
4.0												
5.0			6	SS	73							
6.0												
6.6	BOREHOLE TERMINATED AT 6.6 m		7	SS	80							
7.0												Upon completion of augering No water No cave
8.0												
9.0												
10.0												
11.0												
12.0												
13.0												
14.0												
15.0												

NOTES





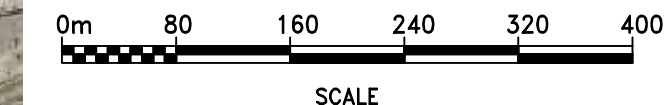
**KEY PLAN**  
BARRIE, ONTARIO

**LEGEND:**

 BOREHOLE 1

**REFERENCE:**

PLAN PRODUCED FROM 2012 SIMCOE COUNTY SATELLITE MAPPING



**BOREHOLE LOCATION PLAN**

CLASS EA PHASE 3 AND 4 FOR BAYVIEW DRIVE AND BIG BAY POINT ROAD IMPROVEMENTS BARRIE, ONTARIO



DRAWN	AT	DATE	SCALE	PML REF.	DRAWING NO.
CHECKED	GRW	JAN. 2016	AS SHOWN	15BF048	1
APPROVED	GRW				